Preliminary Economic Assessment for the revised Zinnwald Lithium Project

Prepared for:	*Deutsche Lithium GmbH* *Am Junger-Loewe-Schacht 10* *09599 Freiberg* *Germany*	*Zinnwald Lithium Plc* *8 St James's Square* *London, SW1Y 4JU* *United Kingdom*
Issue Date:	*06 September 2022*	

CERTIFICATE OF QUALIFIED PERSON

I, Kersten Kühn, EurGeol, do hereby certify that

1. I am Head of the Resources Department and Senior Geologist for G.E.O.S. Ingenieurgesellschaft GmbH, Schwarze Kiefern 2, 09633 Halsbrücke, Germany. E-mail k.kuehn@geosfreiberg.de.
2. This certificate applies to the technical report titled "Preliminary Economic Assessment for the revised Zinnwald Lithium Project, Germany, September 2022" (the "Technical Report"), prepared for Deutsche Lithium GmbH.
3. The Effective Date of the Technical Report is 6th September 2022.
4. I am a graduate of Freiberg Mining Academy, Germany with a diploma degree in Geology.
5. I have worked as a geologist in the fields of mining, mine operation planning and raw material exploration for a total of 33 years since my graduation from University.
6. I am a Member of the Berufsverband Deutscher Geowissenschaftler (BDG) with the status of a "Consulting Geoscientist BDG". Since 2018, I have the title of "European Geologist" conferred by the European Federation of Geologists (EFG) under the EFG number 1557.
7. I have read the definition of "Qualified Person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfil the requirements to be a "Qualified Person" for the purposes of NI 43-101.
8. I am co-ordinating author of the Technical Report, and co-author responsible specifically for sections (1 – 12, 14 - 16, 18.1, 18.2.1, 20.1 – 20.6, 23, 24, 25.1, 25.2, 25.4, 25.5, 26.1, 26.2, 26.4, 26.5, 26.6), unless subsections are specifically identified by another Qualified Person.
9. I have visited the property at least weekly between January 2011 and December 2017 and again on a number of occasions for the purposes of this Technical Report.
10. I am independent of Deutsche Lithium GmbH and Zinnwald Lithium Plc, applying all of the tests in section 1.5 of NI 43-101.
11. I have not had any prior involvement with the property that is the subject of the Report, aside from any involvement in prior NI 43-101s produced for Deutsche Lithium on this property.
12. I have read NI 43-101 and Form 43-101F1; the sections of the Technical Report I am responsible for have been prepared in compliance with that instrument and form.
13. As of the Effective Date, to the best of my knowledge, information and belief, the sections of the Technical Report I am responsible for contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
14. I consent to the filing of the Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public.

Signed on 6th September 2022.

Kersten Kühn

EurGeol, Kersten Kühn
Mining Geologist

CERTIFICATE OF QUALIFIED PERSON

I, Dr Bernd Schultheis, FIMMM, do hereby certify that

1. I am Deputy Head of Department, Chemical / Physical Process Engineering of K-UTEC AG Salt Technologies.
2. This certificate applies to the technical report titled "Preliminary Economic Assessment for the revised Zinnwald Lithium Project, Germany, September 2022" (the "Technical Report"), prepared for Deutsche Lithium GmbH.
3. The Effective Date of the Technical Report is 6 September 2022.
4. I am a graduate of Technical University of Kaiserslautern /Germany with a diploma degree in Chemistry.
5. I have worked as a Process Engineer and a Physical Chemist for 31 years since my graduation from University.
6. I am a Fellow of the Institute of Materials, Minerals & Mining (Membership No. 0476269) and AACE International (Association for the advancement of cost engineering, ID: 204980).
7. I have read the definition of "Qualified Person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfil the requirements to be a "Qualified Person" for the purposes of NI 43-101.
8. I am co-ordinating author of the Technical Report, and co-author and peer reviewer responsible specifically for sections [1, 2, 4.1.5, 4.2, 13, 16.5, 16.6, 17, 18.2, 19, 21, 22, 25, 26], unless another Qualified Person specifically identifies subsections.
9. I visited the company facilities in Freiberg/Saxony, had access to the main experimental results of the pyrometallurgical tests and was involved in the entire hydrometallurgical test programme, including process development and engineering, as a supervisor.
10. I am independent of Deutsche Lithium and Zinnwald Lithium Plc applying all of the tests in section 1.7 and 1.9 of NI 43-101.
11. I have not had any prior involvement with the property that is the subject of the Report, aside from any involvement in prior NI 43-101s produced for Deutsche Lithium on this property.
12. I have read NI 43-101 and Form 43-101F1; the sections of the Technical Report I am responsible for have been prepared in compliance with that instrument and form.
13. As of the Effective Date, to the best of my knowledge, information and belief, the sections of the Technical Report I am responsible for contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
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Signed on 6th September 2022.

Dr Bernd Schultheis, FIMMM

Cautionary Statement Regarding Preliminary Nature of the Preliminary Economic Assessment

Readers are cautioned that this Preliminary Economic Assessment (“PEA”) PEA is preliminary in nature and is intended to provide an initial, high-level review of the project's economic potential and design options. The PEA mine plan and economic model includes numerous assumptions. There is no certainty that the PEA will be realised. Actual results may vary, perhaps materially. The projections, forecasts and estimates presented in the PEA constitute forward-looking statements and readers are urged not to place undue reliance on such forward-looking statements.

The Mineral Resources referred to in the PEA were announced in a Competent Persons Report on the Zinnwald Lithium Project dated 20 September 2020. Zinnwald Lithium confirms that it is not aware of any new information or data that materially affects the information in the above releases and that all material assumptions and technical parameters, underpinning the estimates continue to apply and have not materially changed. Zinnwald Lithium confirms that the form and context in which the Competent Person's findings are presented have not been materially modified from the original market announcements.

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1 Summary

1.1 Introduction

Deutsche Lithium GmbH (the "**Company**" or "**DL**") commissioned this Preliminary Economic Assessment Technical Report (the "**PEA**", "**Technical Report**" or the "**Report**") in relation to its wholly owned Zinnwald Lithium Project (the "**Project**") in Saxony, Germany. In October 2020, Zinnwald Lithium Plc ("**ZLP**"), a public company listed on the AIM Market of the London Stock Exchange, acquired an initial 50% of the Company. Subsequently, in June 2021, it acquired the remaining 50%. Since the Company is controlled, funded and ultimately wholly owned by ZLP, this report is also addressed to ZLP.

The Project is situated near to the town of Altenberg, 35km south of Dresden and adjacent to the border with the Czech Republic and is located in a developed area with good infrastructure, services, facilities, and access roads. Power and water supply is available from well-established existing regional networks. DL has held license areas in Zinnwald since 2011 and conducted various drilling campaigns from 2011 to 2017 to delineate a mineral resource. DL was subsequently granted a mining permit over its core Zinnwald License (the "**License**") area of 2,565,800m^2 valid to December 2047 (subject to receipt of operational permits).

A NI 43-101 Feasibility Study Technical Report for the Project was published in May 2019 and updated in September 2020 (the "**2019 FS**"). However, this was based on a smaller scale, niche end-product (Lithium Fluoride) project designed to be internally financed and integrated to the original owners' operational strategy. Since June 2021, ZLP has refined the development plan in response to the wider lithium market dynamics and has changed strategy to focus on a larger scale operation that produces battery-grade Lithium Hydroxide Monohydrate ("**LiOH**", "**LHM**" or "**LiOH*H$_2$0** ") products; to optimise the Project from a cost perspective, and also to minimise the potential impact on the environment and local communities. All aspects of the Project from mining through to production of the end product will now be located near to the deposit itself.

The Project described in this Technical Report includes an underground mine with a nominal output of approximately 880,000 t/a ore at estimated 3,004 ppm Li and 75,000 t/a barren rock. Ore haulage is via a 7km partly existing network of underground drives and adits from the "Zinnerz Altenberg" tin mine which closed in 1991. Processing including mechanical separation, lithium activation, and lithium fabrication will be carried out at an industrial facility near the village Bärenstein, in close proximity to the existing underground mine access and an existing site for tailings deposition with significant remaining capacity.

The nominal output capacity of the project is targeted at c. 12,000 t/a LiOH with c. 56,900 t/a of potassium sulphate ("**SOP"**), which is used as a fertilizer, as a by-product. Another by-product that is contemplated is Precipitated Calcium Carbonate ("**PCC**") a key filling material in the paper manufacturing process. The estimated mine life covers >35 years of production. The optimisation of mining methods has been a key consideration to realise increased total mined tonnage from the Zinnwald mine. This includes utilising more efficient techniques such as sub-level stoping and Avoca wherever possible and in preference to the less efficient room and pillar method.

The economic analysis included in this Technical Report demonstrates the financial viability of the Project. Based on the assumptions detailed in this report the Project supports a Pre-tax Net Present Value ("**NPV**") of US$1.6 billion (at a discount rate of 8%, "**NPV8**)") and a pre-tax Internal Rate of Return ("**IRR**") of 39%. The after tax NPV8 is US$1.0 billion and post tax IRR is 29.3% The Project has a mine life of over 35 years and the payback period is less than four years post commencement of production.

This Technical Report was prepared according to the rules of the National Instrument 43-101 "Standards of Disclosure for Mineral Projects" developed by the Canadian Securities Administrators effective as per June 30, 2011. The NI 43-101 follows the recommendations of the Canadian Institute of Mining (CIM) Standing Committee on Reserve Definitions.

The report was prepared under the direction of the Qualified Persons – Kersten Kühn (EurGeol) of G.E.O.S. Ingenieurgesellschaft GmbH and Dr. Bernd Schultheis (FIMMM) of K-UTEC AG Salt Technologies.

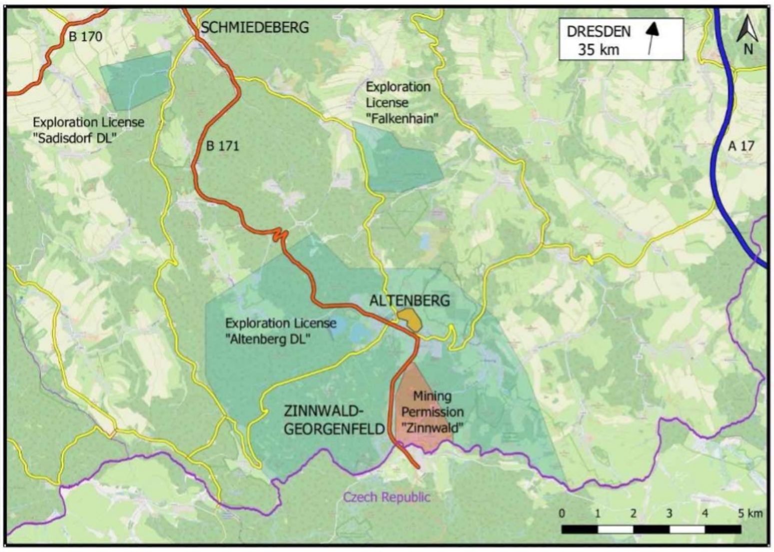
This PEA is preliminary in nature, it includes certain assumptions that are considered too speculative to have economic considerations applied to them. There is no certainty that the Project as described in this PEA will be realised

1.2 Accessibility, Local resources, Infrastructure and Physiography

DL currently holds four licenses in the area. The core Zinnwald License, which forms the basis of this report, has a mining classification and runs to 31 December 2047. It also holds three other exploration licenses at Falkenhain, Altenberg DL and Sadisdorf, as show in **Figure *1*** below:

- **Falkenhain** – the license covers an area of 2,957,000 m^2 and is valid to 31 December 2022. DL has already applied for a 3-year extension and has commenced a 10 drill hole exploration in September 2022. A geological 3-D model of the “Falkenhain” license area is being created and further steps will be taken depending on the results of the drill campaign, such as laboratory-scale processing tests and the construction of a resource model.
- **Altenberg DL** – the license covers an area of 42,252,700 m^2 and is valid to 15 February 2024. DL is currently evaluating historical data, which will be used to define new exploration targets in the area
- **Sadisdorf** – the license covers an area of 2,250,300 m^2 and is valid to 30 June 2026. The previous holder of the license had defined a JORC compliant inferred resource of 25 million at a 0.45% Li_2O grade. DL is reviewing and evaluating this historic data to determine further exploration steps.

Figure 1: Location plan of the exploration licenses and mining permission of DL



Geographically, the area shown above forms part of the upper elevations of the Eastern Erzgebirge Mountains, at elevations of 750 to 880 m a.s.l. The general topography is typical for a low mountain range with steep valleys and smooth summits, the latter gently dipping towards north. It comprises wide grasslands surrounded by forests and is structured by the local river network with pronounced V-shaped valleys belonging to the Elbe River Basin. Most of the land use in the area is agriculture and forestry with most surface rights being privately owned. The surface water bodies are reserved for public water supply, farming or recreation. With an average of 65 inhabitants per km^2 the region is sparsely populated. The town of Altenberg has a population of 7,785 inhabitants.

The main licence area is close to the town of Altenberg. The motorway A 17 (E 55), which connects Dresden with Prague in the Czech Republic (CZ) bypasses the property 17 km to the east. Border crossing between Germany and the Czech Republic at Zinnwald is possible by car and truck. The airports of Dresden, Berlin and Prague are 70, 230 and 100 km away, respectively. The Altenberg railway station is located on the north side of the town. The Heidenau-Altenberg railway (38 km) connects in Heidenau (near Dresden) with the Elbe valley railway. This railway represents line 22 of the Trans-European Transport Network (TEN-T).

The overall area is well developed with respect to regional electricity, sewage, water and gas networks. Electric power, gas and potable water is available in the region. Area-wide broadband internet access is being rolled out, but the area is already well covered by German and Czech mobile telephone networks.

Since the closure of the main regional mining operations 30 years ago following the reunification of Germany, tourism has become an important local industry. In addition, the region is home to numerous small and medium-sized enterprises that are based within in the mechanical, electrotechnical and automotive industry sectors. However, the region faces the challenge of an ageing population and the rural exodus of younger people. This is a supporting factor to local authorities encouraging companies such as DL that are bringing industrial activity and jobs back to a region long steeped in mining history.

1.3 Geology and Mineralization

The area covered in this Technical Report is part of the Erzgebirge-Fichtelgebirge Anticlinorium, which represents one of the major allochthonous domains within the Saxo-Thuringian Zone of the Central European Variscan (Hercynian) Belt. Its geological structure is characterized by a crystalline basement and post-kinematic magmatites (plutonites and volcanites). The Zinnwald deposit belongs to the group of greisen deposits. Greisens are formed by post-magmatic metasomatic alteration of late stage, geochemically specialized granites and are developed at the upper contacts of granite intrusions with the country rock. The Zinnwald greisen is bound to an intrusive complex, which intruded rhyolitic lavas of Upper Carboniferous age along a major fault structure.

The prospective mineralization is of late Variscan age (about 280 million years old) and is geologically restricted to the cupola of the geochemically highly evolved Zinnwald granite. It was in its apical parts underground mined for veins with tin (cassiterite) and tungsten (wolframite, minor scheelite) until the end of the Second World War. Lithium is incorporated by a lithium-bearing mica, which is called “zinnwaldite”, a member of the siderophyllite-polylithionite series, which contains up to 1.9 wt.% lithium. It is enriched in 10 parallel to subparallel stretching horizons below the already mined tin mineralization. Individual lithium-bearing greisen beds show vertical thicknesses of more than 40 m. The mineral assemblage consists of quartz, Li-F-mica (zinnwaldite), topaz, fluorite and associated cassiterite, wolframite and minor scheelite and sulfides.

1.4 Exploration Status

The first underground mining for tin in the Zinnwald deposit on both sides of the current border between Germany and the Czech Republic was recorded in the second half of the 15th century. The “Tiefe-Bünau-Stollen”, which was driven from the year 1686 on, became the most important gallery of the whole Zinnwald ore field. This adit is part of the visitors’ mine “Vereinigt Zwitterfeld zu Zinnwald” and is located in the mining concession. Tin and minor tungsten mining on the German side ceased with the end of the Second World War, and on the Czech side in 1990. From 1890 to 1945 lithium-mica was produced as a by-product and used as raw material for lithium carbonate production. Lithium exploration on the German side started again in the 1950s.

DL initially focused its exploration activities on the central Zinnwald license as well as under-ground on the accessible parts of the abandoned mine. An underground sampling campaign was conducted in 2012, which provided a series of 88 greisen channel samples from the sidewalls of the “Tiefer-Bünau-Stollen” (752 m a.s.l.) and the “Tiefe-Hilfe-Gottes-Stollen” galleries (722 m a.s.l.). DL subsequently expanded the work to peripheral parts of the deposit. Exploration consisted of 10 surface drill holes (9 DDH and 1 RC DH) completed between 2012 and 2014 with a total length of 2,484 m. Infill and verification drilling was resumed and completed in 2017 by DL consisting of 15 surface diamond drill holes with a total length of 4,458.9 m.

1.5 Resource Estimates

The Mineral Resources referred to in this PEA are as previously published in the 2019 FS. In the 2019 FS, the geological and geochemical results of the exploration campaigns were fully integrated in a data base, which comprises the following underlying data:

- 76 surface holes.
- 12 underground holes.
- 6,342 lithium assays of core samples covering 6,465 m of core.
- 88 lithium assays from channels; and

- 1,350 lithium assays from pick samples.

DL's exploration samples were analysed by the accredited commercial ALS laboratory at Roşia Montană, Romania. Duplicates were sent to Activation Laboratories Ltd. In Ancaster, Canada, for external control. QA/QC procedures were carried out for due diligence purposes and the results confirmed the careful sampling and reasonable accuracy and precision of the assays. Twinned drill holes showed a good match. The initial geological model of several parallel to sub-parallel stretching mineral horizons ("Ore type 1 greisen beds") was verified and an authoritative resource assessed.

The general mineral inventory of lithium, shown in **Table *1***, was estimated from the block model based on a zero cut-off and without a constraint of minimum thickness of the ore bodies. It accounts for 53.8 Mt greisen tonnage ("Ore Type 1") with a rounded mean grade of 3,100 ppm.

Table 1: Lithium Mineral Inventory of Zinnwald (German part below 740m)

Mineral inventory "Ore Type 1"	Volume [10^3 m^3]	Tonnage [10^3 tonnes]	Mean Li grade [ppm]
Total	19,900	53,800	3,100

Selection criteria for eventual economic extraction (vertical thickness ≥ 2 m, cut-off = 2,500 ppm Li) applied to the mineral inventory result in a demonstrated (measured and indicated) lithium resource of 35.51 Mt of greisen ore with a mean lithium grade of 3,519 ppm (see **Table *2***).

Table 2: Lithium Mineral Resource – Zinnwald, Base Case

Resource classification "Ore Type 1" greisen beds	Ore volume [10^3 m^3]	Ore tonnage [10^3 tonnes]	Mean Li grade [ppm]	Ore volume [10^3 m^3]	Ore tonnage [10^3 tonnes]	Mean Li grade [ppm]
	Vertical thickness ≥ 2 m, cut-off Li = 2,500 ppm			Vertical thickness ≥ 2 m, cut-off Li = 0 ppm		
Measured	6,855	18,510	3,630	8,954	24,176	3,246
Indicated	6,296	17,000	3,399	8,046	21,725	3,114
Inferred	1,802	4,865	3,549	2,675	7,224	2,995
Total (Measured+Indicated)	13,152	35,510	3,519	17,000	45,901	3,183
	Internal Dilution					
Total (Measured+Indicated+Inferred	4,722	12,749	2,001			

The potential of Sn, W and K_2O have been estimated for the greisen beds as mean grades for "Ore Type 1" for the German part of the Lithium Zinnwald Deposit and below 740 m a.s.l.: At a total volume of rounded 15 million cubic meters and a tonnage of 40 million tonnes, the overall mean tin grade accounts for approximately 500 ppm, mean tungsten grade for approximately 100 ppm and mean potassium oxide grade for approximately 3.1 wt.%.

1.6 Reserve Estimates

Since this Report summarizes the results of a Preliminary Economic Assessment (PEA), no Mineral Reserves have yet been estimated for the revised Zinnwald Lithium Project as per NI 43-101 guidelines. However, for the purpose of project appraisal, the previously calculated Mineral Reserves from the 2019 FS report have been used as mining inventory. This PEA includes assumptions for optimised mining extraction and production methods together with the almost doubling of the Lithium price and accordingly considers this to be a conservative and appropriate approach.

For detailed summary on the calculation of these mineral reserves the reader should refer to the 2019 FS. Some key assumptions are as follows:

- Proven and Probable Mineral Reserves = 31.20 Mt, 3,004 ppm Li
    - Including internal dilution (8%) = 2.28 Mt, 1,929 ppm Li
    - Including external dilution (20%) = 5.5 Mt, 1,700 ppm Li

1.7 Processing and Metallurgical Test Work

1.7.1 Process Stages

The mineral processing consists of 5 stages

- Primary crushing using a jaw crusher
- Secondary crushing using a cone crusher
- Drying of the crushed material
- Dry grinding for liberation
- Dry-magnetic separation

The pyrometallurgical process consists of:

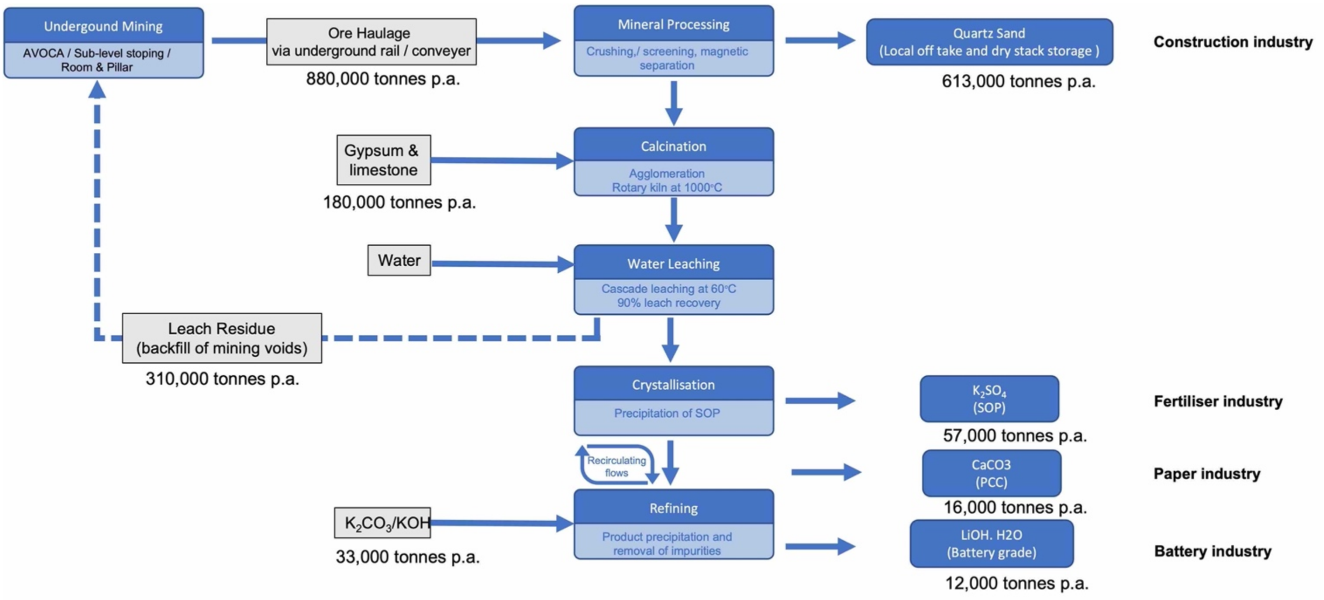
- Fine grinding of mica concentrate to below 315 µm
- Mixing of milled concentrate with suitable additives such as anhydrite/gypsum and limestone
- Roasting in kilns e.g. rotary

The hydrometallurgical processing consists of:

- De-agglomeration of roasted material
- Leaching of roasted material with hot water
- Purification of the mother leach liquor
- Precipitation, washing and drying of lithium hydroxide
- Sulphate of potassium (SOP)-crystallization

The flow sheet is summarised at a high level in **Figure *2*** below.

Figure 2: Simplified Project Flowsheet



1.7.2 Test work undertaken

The most recent testwork programmes undertaken in 2021 and 2022 built on the work done for the Feasibility Study, which itself had confirmed the results of laboratory test work on a technical scale. The earlier FS test work included flowsheet development test work using a split of a 100t lithium-mica greisen ore sample, that in turn generate a 50t sample used in the beneficiation work and a 10t mica concentrate for use in the pyrometallurgical and hydrometallurgical work. This ore was mined by drilling and blasting in the Zinnwald visitor underground mine from ore body B, one of the largest ore bodies in the deposit.

For mineral processing, DL continues to rely on the original metallurgical test work undertaken by UVR-FIA for the 2019 FS, which comprised the following:

- 2011 – approximately 20 t of ore that had a mean Li grade of 3,900 ppm.
- 2017 – approximately 100 t of ore that had a mean Li grade of 4,009 ppm.
- DDH core samples: 25 variability samples selected from drill core from 2012- 2013 and 2017.

For pyrometallurgy, the basic calcination and leaching of Zinnwaldite concentrate have been tested in several stages and are described in the FS report. During 2022, a test campaign was carried out at IBU-TEC to:

- Further optimise the mixing ratios of the reagents
- Test the potential to further increase the leaching recovery of metals, especially potassium
- Confirm that FGD Gypsum can be used as the reagent in the process

For hydrometallurgy, in 2021 further Laboratory scale and Pilot scale hydrometallurgical test work was carried out at K-UTEC using 5.6 t Calcined Zinnwaldite. This Calcined Zinnwaldite that originated from calcination tests carried out in 2018 was used for pilot-scale tests to produce 50 kg of a reference LiOH product sample as well as for the locked cycle test for process verification as part of the process design work. The main areas of testwork were as follows:

- Test the conversion of the leach brine resulting from calcined Zinnwaldite leaching into LiOH.
- Further development of the removal processes for impurities in the leach liquor
- Further development of the processes to ensure no downstream quality issues in the sulphate and carbonate stages of the process
- Improvements to the crystallisation process for the production of Potassium Sulphate (SOP)
- Lock cycle tests to confirm composition and quantity ratios required for the mass balance

1.7.3 Summary of results

The key outcomes of the test work are summarized below and the design criteria that has been used to develop the mass balance are based on these test work results.

- The mineral processing has been shown to be very robust. The lithium recovery was above 90 % for both the 20t test work of the PFS (94 %) and the 50t test work of the FS (92 %). The lithium recovery assumed in the FS and the current PEA is 92 %.
- The pyrometallurgy test work continues to confirm a robust roasting recipe consistently achieving yields of at least 90% for Lithium and 80% for Potassium in the leach.
- The hydrometallurgical work included the following all of which resulted in a battery-grade LiOH with 99.5% purity with a recovery rate of 95%.:
  - The extraction of lithium and potassium through water leach of calcined Zinnwaldite is viable, as well as providing the required amount of leach liquor to verify the downstream processing.
  - The test work around recirculation of the liquors showed the beneficial effects of minimum sulfuric acid consumption for decarbonisation; minimum losses of potassium and sulphate in the leach residues and the purification sludge; and establish a constantly low level of calcium and magnesium concentration below 5 ppm in the brine for further processing
  - To avoid quality issues after downstream processing, the tests show that the pH value should be lowered to just below 4.5 to avoid these.
  - Confirmed the creation of both technical and fertilizer grade SOP with further work to be done to clarify yields of both. The testwork also confirmed the process to remove the remaining impurities.
  - 4 lock cycles were performed that further developed the mass balance and the process.
- The estimated overall recovery rate from ROM to end product (LiOH) is 75.4%.

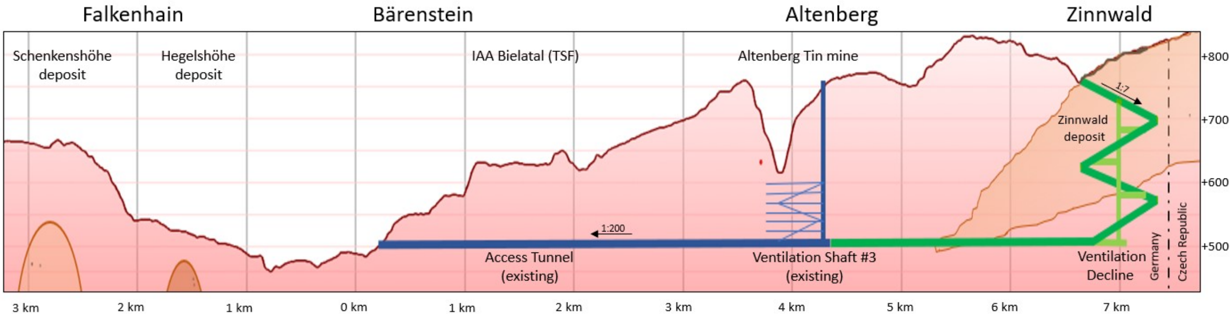
1.8 Mining

The mining operation for the Project is planned as an underground mine development using a main ramp for access to the mine and for ore transportation from the mine to the surface via access tunnels. The operation has been designed for an annual output of c. 12,000 t/a LiOH. Applying the mineral reserve estimation of 3,004 ppm lithium content, and estimated Lithium recovery in downstream processes this corresponds to an average annual ore production of 880,000 tons.

The conceptual plan for mining operations is based on access from Altenberg Mine on 500 m Reduced Level (RL) advancing upwards with room and pillar, Avoca, and sublevel stoping methods followed by hardening backfill. On production levels LHD (Load-Haul-Dump) loaders dump the mined material into ore passes from where the ROM (Run of Mine) is transported 7 kms to ROM pad downhill to Bärenstein via the Zinnerz – Altenberg Mine drainage tunnel.

The mine will be first accessed from two locations: From the Zinnerz – Altenberg Mine with a 4 km tunnel (Access Tunnel) and from Zinnwald with a 1.7 km decline (Ventilation Decline). The two connect at +500 RL in the central pillar / ore pass area. Once connected the decline functions as a second means of exit and as a main ventilation route. The cross-section map of the area shown in **Figure *3*** shows the drainage access tunnel, as well as the two access mining tunnels. It also shows the historic talings facility at IAA Bielatal, as well as the prospective ore body at the Falkenhain license.

Figure 3: **Cross section map of access tunnels to main ore body**



In essence, the deposit structure represents an anticline, at the flanks of which the ore bodies plunge below 400 RL. The Access Tunnel enters the deposit in the north at 500 RL, which will be the first production level. The level will be the loading/transportation level for all the material mined on the level and levels above it. The ore will be transferred on to 500 RL via ore passes.

The development drives are planned with a 5.0 m by 4.0 m profile and will be driven by conventional drilling and blasting technology. The sublevels are planned with a vertical distance of 12.5 m in East and North Flanks and with 25 m spacing in the West Flank. A mining area is first entered on the lowest level, the location of the drive above is designed based on sludge drilling profiles with horizontal spacing 12.5 m – 25 m.

For an optimal development of the mine and a steady output of ore material, the initial development of the mine within the first years will be focused on the bodies between +500 to +600 RL. The deepest envisaged sublevels are in the North Flank at +392 RL and in the East Flank at +360 RL. The uppermost mineable sublevel will be at +688 RL, leaving 20 m vertical distance to the historic mine workings.

The tailings generated comprise two types. A “quartz-sand” tailing generated during the mechanical processing of the greisen ore within the processing plant and a dry Leached Roasted Product (LRP) tailing generated as residue from the metallurgical process. Based on the project outline of c. 12,000 t/a LiOH, c. 610,000 t/a “quartz sand” tailings and about 310,000 t/a (dry) LRP tailings are generated. The “quartz-sand” tailings represent basically a sharp-edged crushed grit to fine sand (< 0.1 mm to 1.25 mm grainsize) and predominantly consist of quartz (> 80 %). This quality of quartz sand is identical to a building aggregate already being mined nearby for use in various construction industries. The Company is exploring options to create a railhead nearby to facilitate the sale and use of this aggregate rather than having to store it.

During the first years of the production the preferred extraction method is AVOCA as it allows immediate backfill. The key working principle of this method is to continuously backfill the excavated stope with waste rock, the dry LRP and quartz sand. This minimises the risk of any potential subsidence and could also increase mining recovery of the resource whilst reducing the need for intermediate storage facilities for materials such as LRP. It is anticipated that c. 90% of the mined-out void will be backfilled.

The ground water draining to the mine will be collected in settling ponds on 500-level. The clarified excess water will be drained further to the Bärenstein processing site into a central water treatment plant. The amount of excess water will change during operation and depends on the weather and backfill operations. The mine drainage water between the surface and +750 RL (TBS level) and +720 RL (THG level) is drained through the existing galleries.

1.9 Recovery Methods

The Zinnwald Lithium Process Plant is designed to process 880,000 dmt/a of ROM feed, at an average grade of 0.30 wt.% Li, to produce a minimum of 12,011 t/a of battery grade $LiOH*H_2O$ (equivalent to 10,530 t/a LCE) and 56,887 t/a of K_2SO_4 and about 16,000 t/a PCC (precipitated calcium carbonate) by-products. The potassium sulfate produced is expected to be sold as a sulfate of potash (SOP) in technical grade and as fertilizer.

The beneficiation plant will operate 24 h/d, using three 8 h shifts per day from Monday to Friday, 260 d/a. The extraction plant is a continuous 24 h/d operation, using three 8 h shifts per day, 7 days per week, 365 d/a. Design plant availabilities are 96 % (6,000 h/a) for the beneficiation plant and 91 % (8,000 h/a) for the extraction plant.

The flowsheet, as shown in **Figure *2***, is based on calcium sulfate/calcium carbonate roasting and consists of the following major unit processes:

- Comminution followed by beneficiation using dry magnetic separation to recover a lithium mica concentrate.
- Calcium sulfate / carbonate roasting, which converts the lithium and potassium to water soluble Li_2SO_4 and K_2SO_4 in the presence of anhydrite or gypsum and limestone
- A hydrometallurgical section where the roasted product is leached in water to form an impure Li_2SO_4 aqueous pregnant leach solution (PLS). Impurities are then removed from the PLS using precipitation and ion exchange prior to the precipitation of battery grade LHM.
- Potassium sulfate is recovered from the mother liquor using crystallization and selective dissolution.
- Precipitated CaCO3 (PCC) is precipitated from the PLS

1.10 Project Infrastructure

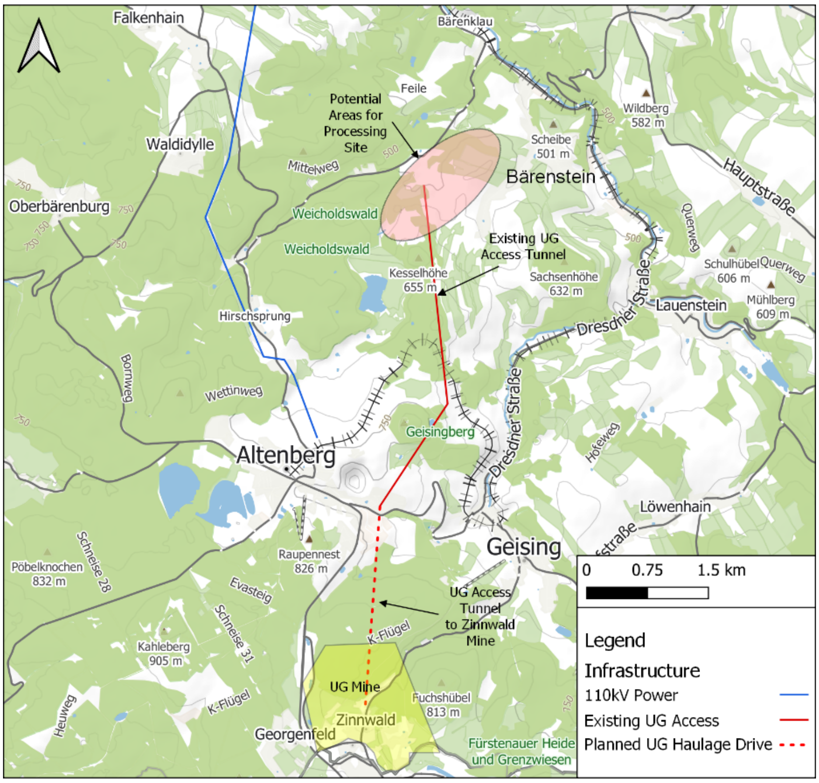
On a high-level basis, the Project is located in a region with developed infrastructure, services, facilities, and access roads. Power and water are provided by existing regional supply networks. It is also located close to the heart of the German automotive and chemical industries. The Project itself comprises several industrial modules each of which have specific requirements to local infrastructure, space and proximity to other parts of the process. Aligned with the conceptual nature of this technical report, the preferred location is focussed on the geographic area of Zinnwald / Altenberg for all facilities. However, as required for on-going development of technical planning and permitting the Project retains some optionality regarding the precise location of certain facilities.

The Company has prioritised the alignment of Project goals with the concerns and needs of other stakeholders and minimise the potential impact of the operation on the local environment, businesses, and residents. By removing the need to transport large volumes of material via roads of the Altenberg and Freiberg region (as was considered in previous technical reports), the expected impact of the operation on the environment and local communities can be reduced significantly.

The preferred Site Option (shown in **Figure *4*** below) is in the area near Bärenstein, due to its key advantages:

- Mine access through existing de-watering adit of the Zinnerz Altenberg mine (ceased operations in 1991, refurbished in 2020, total useable length 4 km, with sufficient cross section).
- Quarry site with intermittent operation.
- Existing tailings storage facility from the former Zinnerz Altenberg mine with remaining capacity.
- Nearby existing rail connection with connection to Dresden.

Figure 4: Local Infrastructure at Altenberg / Barenstein



The Company has identified a second site location option for the location of the pyrometallurgical and hydrometallurgical processes at facilities at an industrial site in Boxberg / Oberlausitz / Kringelsdorf, close to a former lignite open-pit and coal fired power station operated by LEAG. The site is approximately 150 km distance by road and accessible by sealed roads. As an established industrial site, power, gas and other services are already available at site. The site has a rail line within 1km, is itself however not connected to the rail network.

1.11 Environmental Studies

Due to the revised operational plan that involved a significant increase in planned production and the location of the refining plant near to the mine site – the Company has suspended its previous strategy to pursue the Facultative Framework Operational Plan (FFOP). Instead, the Company will convert the permitting progress made so far into a regular permitting process, including EIA/UVP permits within a Mandatory Framework Operation Plan (MFOP) under mining law.

The overall permitting pathway for the project is subdivided between processes to be permitted under

- **Mining Act**, including the mine, its associated infrastructure and the mechanical separation plant. This includes the Mandatory Framework Operation Plan (MFOP) approved by the Saxon Mining Authority.
- **Bundesimmissionsschutzgesetz (BImSchG)** (Federal Emission Protection Act) can be led by either regional authorities or the mining authority and evaluates compliance of facilities with existing technical standards as well as other requirements set by law. It provides for protections from noise and air pollution, vibration, and other impacts on the environment from human activity.
- **Water Permits** All aspects relevant to water use, potential for water pollution etc are reviewed and permitted by the water authority, in this case the lower water authority.

The **MFOP** provides clarity on a first outline of the planned operation, even if final technical items are still outstanding. It provides an overview of the technical process of mining and processing, considerations for environmental aspects, urban planning and expected impact on residents. The MFOP will include a specific EIA on all directly mining related assets.

- Note: Following MFOP approval, the Company will also require a separate Mine Operation Plan Permit to cover the actual construction and operation of the assets.

The **BImSchG** Permit under Germany's environmental legal framework ensures that installations meet all technical minimum standards based on provided technical plans. DL commissioned G.E.O.S. in 2021 to carry out an updated Environmental Impact Assessment Screening study to consider several operational concepts, including trucking ore material over longer distances to external facilities vs. local processing operations. The study concluded that the option to concentrate all processing operations at one location will likely have the least environmental impact of all options under consideration. DL is currently updating this study for the revisions to the site location and technical processes and will submit shortly. The EIAs for the pyrometallurgical and hydrometallurgical plants will fall under the BImSchG.

The Company is committed to being a responsible project developer and maintains the environmentally acceptable and sustainable construction and operation of the Project as a paramount principle in its activities. The Company will comply with all applicable environmental laws and regulations, as well as other industry codes and standards to which we subscribe, such as:

- Social Impact Assessment – noise, light pollution. Vital for local stakeholder support.
- Prevention/ mitigation of impact on Animals, Plants and Biodiversity, based on international best practice.
- Compliance with European Water Framework Directive around groundwater, surface water, mine water.
- Maintenance of Air Quality
- Ensure that the Project does not compromise local recreation and tourism

1.12 Market Review and Lithium Pricing

1.12.1 Background to Lithium and its production

Lithium compounds typically come from one of two sources - metallic brines or hard-rock mining of spodumene ores. In many ways, Lithium extraction and production is a specialty chemicals business rather than a conventional mining one, and it is that chemicals expertise that plays a vital role in a project's success, especially for those designed to produce battery grade lithium compounds. Qualification of battery grade lithium compounds for use in battery cathode materials can take a long time and is often specific to individual battery manufacturers/cathode makers.

Brines

Brine is pumped from subsurface reservoirs to surface ponds and evaporated until the lithium liquor content reaches 6%, when it is removed and processed into lithium chemicals. This processing, initially into lithium carbonate, generally occurs on site. Typically, the timetable to produce a saleable lithium product is in the range of 2 – 3 years, depending on prevailing weather conditions. Several companies are currently experimenting with Direct Lithium Extraction (DLE) technologies in an attempt to speed up the extraction process and utilise lower grade brines. Whilst the application of DLE to low grade brines has been shown to work at a laboratory scale, large scale industrial extraction has yet to be demonstrated. Where DLE has been used in commercially, it has typically been following a pre-concentration step and using higher-grade brines.

Historically, brine producers have enjoyed a significant advantage on the cost curve given the fact that there is no mining and crushing involved and their location in arid regions enables them to utilize evaporative drying. From a sustainability point of view, brines benefit from a low energy intensity for production and the technology involved is conventional and well established. However, it has three main ESG downsides – its water intensity is high and typically in areas where water is scarce; it also takes up a very large physical footprint during production and tailings disposal; finally these sites are typically a long way from the end market for its product with the resultant transport costs and CO_2 emissions.

Hard-rock Mining

Hard rock mining is the more traditional extraction process. Spodumene, a lithium-containing mineral, is mined and crushed to form a low-grade concentrate (4-6%). This mineral concentrate is then sold to lithium processors which use the feedstock to produce lithium chemicals, or to glass and ceramics producers for use as an additive. Mineral producers, compared with Brines, have additional costs associated with both hard rock mining and processing and historically have not benefited from the integration of the chemical conversion. Currently the majority of mineral producers are located in Australia and typically supply concentrate to lithium processors in China. As such they typically often have extensive transport costs due to the low-grade concentrate and distances covered.

From a sustainability point of view, Spodumenes benefit from a relatively low water intensity in their production process and the extraction technology is well established. However, it has three main ESG downsides – the physical footprint of the sites are usually large and often open-pit; the energy required to process a spodumene concentrate is high; and the transport distances are usually extremely large raising the overall CO_2 footprint (especially given that they are effectively transporting 94% waste product). Further, as noted above, the majority of spodumene currently comes from Australia and processed in China which has a high proportion of coal-based power in its energy mix.

1.12.2 Lithium Market – Supply / Demand and Pricing Forecasts

The global lithium market is expanding rapidly due to an increase in the use of lithium-ion batteries for electric vehicle and energy storage applications. In recent years, the compound annual growth rate of lithium for battery applications was over 22% and is projected by Roskill to be more than 20% per year to 2028. This expansion is being driven by global policies to support decarbonisation towards carbon neutrality via electrification, which is underpinned by Carbon Emission Legislation (COP26, EU Green Recovery, Paris Accord); Government regulation and subsidies; and Automakers commitment to EVs.

Benchmark Minerals highlighted that there are 282 Gigafactories at various stages of production/construction, up from only 3 in 2015 (by May 2022, this number had gone over 300). If all these plants did come online in the planned 10 year timeframe, it would equate to 5,777 GWh of battery capacity, equivalent to 109 million EVs. But more relevantly it would require 5m tonnes of Lithium each year, as compared with 480,000 tonnes produced in 2021. They noted that the lack of supply is not due to any geological constraints but to a simple lack of capital investment to build future mines and estimated $42bn needs to be spent by 2030 to meet demand for lithium.

In April 2022, the Belgium-based research university KU Leuven published a report “Metals for Clean Energy” on behalf of Europe’s metal industry group, Eurometaux, and endorsed by the EU. This report explored in detail the supply, demand and sustainability factors at play around critical raw materials, especially in Europe. It noted that Europe’s 2030 energy transition goals would require 100-300kt of lithium rising to around 600-800kt by 2050, equivalent to 3,500% of Europe’s low consumption levels today. In terms of direct European supply, Eurometaux comments that “Several projects are subject to local community opposition (most visibly in Portugal, Spain, and Serbia). Others are dependent on untested technologies to be viable or have less certain economics. However, the EU has made it a strategic priority to improve its self-sufficiency for lithium.”

Lithium Supply is currently concentrated in four main countries, each of which have strengths and weaknesses to their ability to materially ramp-up supply to meet the expected demand.

- Chile – dominated by the incumbent suppliers, SQM and Albermarle. Strengths are that they are the established industry experts in production of lithium from brines. They have announced plans for expanded production, but that is set against a backdrop of local water issues and also a potentially punitive royalty regime at a governmental level on expanded production.
- Argentina – the newcomer in the production from brines with Livent and Orocobre in production and a number of well-funded newcomers, such a Lithium Americas, Neo, POSCO and Millennial. Argentina is expected to be the next major source of battery grade lithium to the market. Its biggest downsides are on a sustainability front around water usage and transport distances to the end-users.
- Australia – the dominant producer of spodumene concentrate globally with the largest producers being Pilbara, Mineral Resources/Ganfeng, Talison JV. Australia has the advantages of a well-established mining industry and significant scope to increase production. Its downsides are that it has almost no processing facilities currently, so its emissions levels from transport and conversion in China are high.
- China – has an existing in-country mining industry, but this is dwarfed by its dominance in the production of end-product lithium based primarily on Australian spodumene. Ganfeng and Tianqi are two of the world’s four biggest lithium companies and are expanding their investments globally. The biggest issue is one of sustainability and that its energy intensive processing of spodumene is largely from coal fired power station, thus worsening the already high emissions levels from transport.

One of the wider issues around constriction of global supply is that of resource nationalism and security of title. Bolivia has had a long-standing nationalised industry that has resulted in its production being suppressed to a fraction of its potential. Mexico has recently nationalised its nascent lithium industry. In the wider mining industry, political and economic instability in many jurisdictions has manifested itself in significant real and perceived risks around security of ownership and continued ability to operate resulting in limited production. These factors have contributed to an increasing interest by western car makers to secure supply in domestic or more “reliable” jurisdictions.

1.12.3 Price Forecasts

Definitive and accurate lithium pricing is inherently problematic, due to the opaque nature of what is, in global mining terms, a relatively new and small market by value. Lithium is not quoted on any major exchange, so there is no readily available information. There is no terminal market, although the LME is working to launch a futures contract. There is a spot market visible in China, but this is a small part of the overall lithium market. As there is no industry wide benchmark for pricing, the bulk of the market is sold based on negotiation between buyer and seller on long term contracts with prices fixed on an annual or quarterly revised basis. This is not wholly surprising given that battery grade lithium is a speciality chemical that requires cycle testing by manufacturers who value the consistency of quality of end product and its impurities and guarantee on supply. Furthermore, the largest current players in the market are companies that are either not listed or ones that are not required by local listing rules to detail their contract pricing achieved. This will likely change as the industry matures and more listed companies become involved.

What is clear is that lithium prices have experienced exponential growth in the last 18 months. SQM announced their Q1 2022 numbers that showed $38,000 per tonne for contract lithium hydroxide. Allkem has also increased its Q2’22 guidance on contract pricing for lithium from $35k to $40k per tonne and that China spot pricing is now around $70k per tonne.

There is also a growing consensus around the worsening Supply / Demand imbalance, which is generally accepted economic pre-cursor to increased prices. In terms of what that means for long term lithium hydroxide prices, back in Q3 2021 Benchmark forecast a price of $12,110 long term, but this is before the step change in balance in the market. In March 2022, Roskill forecast an inflation adjusted long term price of $23,609 per tonne through to 2036 with a nominal rate of $33,200 by 2036.

1.13 Zinnwald Project Business Model

1.13.1 Strengths and Sustainability of the Project

The Zinnwald Lithium Project’s business model is predicated around utilising its inherent advantages to enable it to become one of the more sustainable projects in the global lithium market:

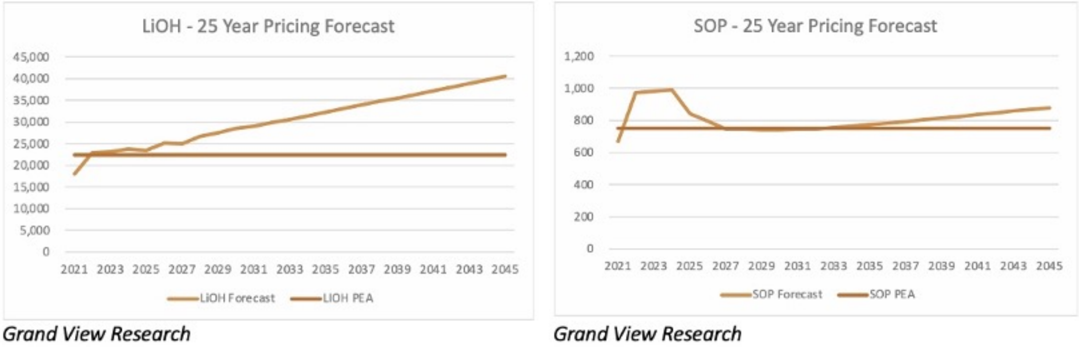
- It is located close to the German chemical industry enabling it to draw on a well trained and experienced workforce and attendant infrastructure. Addresses the issue of “Lithium is a specialty Chemicals industry rather than a conventional mining one.”
- It is situated close to many of the planned Gigafactories, and it is an integrated mining to battery grade product process. The transport distances for emissions will be measured in the tens of kilometres rather than tens of thousands.
- It will be an underground mine and is in an established mining region. There is extensive existing and well-maintained infrastructure that the Project may be able to use.
- It will be permitted under EU environmental rules, which are some of the strictest globally. OEMs will be able rely on the production being done in compliance with EU Battery Chain directives.
- Its basic process has key elements that are more sustainable than some of its main rivals
    - The process has limited water use relative, in particular, to brine producers.
    - The process flowsheet is less energy intensive than traditional spodumene-based production as it involves a single pyrometallurgical step at a lower temperature than is required in a spodumene-based process
    - Overall transport costs and emissions are reduced by being an integrated operation located close to end markets especially when compared to Australian sourced spodumene concentrate processed in China
    - German energy sources currently include a higher overall “low carbon” component than China

- It has the potential to be a low or "zero-waste" project, as the vast majority of both its mined product and co-products have their own large-scale end-markets:
    - Its initial mined waste product, quartz sand, is a "benign dry stack end product" that itself is used as a construction aggregate for roads and other projects.
    - Its primary co-product is high grade Potassium Sulphate, which is in huge demand as a fertiliser.
    - Its secondary co-product is Precipitated Calcium Carbonate ("PCC") typically used as a filler in the paper making process

1.13.2 Project's pricing assumptions

As part of the PEA process, the Company commissioned Grand View Research to provide 25-year pricing forecasts for Lithium Hydroxide and Potassium Sulphate, to underpin the pricing assumptions assumed in the financial model. The results of these forecasts are shown in **Figure *5*** below.

Figure 5: LiOH and SOP – 25 Year Pricing forecasts



Grand View Research *Grand View Research*

Primary Output - Lithium Hydroxide (LiOH)

The Company has used a base average price of **US$22,500 per tonne** of battery-grade Lithium Hydroxide in the financial model used for this PEA. This price is based on a conservative discount to the projections provided Grand View Research. It is also at a discount to pricing forecast data issued by peer companies in recent months (Keliber: $24,936, European Lithium: $26,800, Bearing Lithium: $23,609).

Primary by-product - Potassium Sulphate

The primary by-product produced from the Hydromet stage is a high-grade potassium sulfate (K2SO4 or sulfate of potassium "SOP"). Based on an annual production of c. 12,000 t/a LiOH, the Project will produce approximately **57,000 tonnes of SOP** each year. The process can be adjusted to produce a blend of Fertiliser Grade SOP (98.45% K_2SO_4) and Technical Grade SOP (>99.6% K_2SO_4). The former is a high value fertilizer with particular application for producers of fruits, vegetables and nuts. The latter is supplied to the chemical industry. The bulk of global production is predominantly in China and European production is heavily sourced from Russia. Grand View has produced a forecast that shows combined demand for these types of SOP rising in Europe alone from circa 410,000 tonnes in 2021 to more than a million tonnes by 2045, so the Zinnwald Project's output of SOP should be readily absorbed into this market without distorting pricing. For the purposes of the financial model, a blended SOP price level of **€875 per tonne** has been assumed.

Secondary by-product – Precipitated Calcium Carbonate

PCC is used in 5 five main industrial areas, as a filler in high-performance adhesives and sealants; as dietary calcium in medicines, food and cosmetics; as an extender in paints to increase opacity and porosity; as a coating and surface finishing agent in papers; and as filler/extender in Plastics, such as improving impact strength in rigid PVC fillers. PCC is estimated to represent approximately 20% of the European market for Calcium Carbonate products, which itself is expected to grow at around 5.6% CAGR from 2022 to 2030 to a market size in of US$14.1 billion (circa US$3bn for PCC alone). In terms of pricing, ongoing political turmoil from Russia's invasion of Ukraine, has caused prices to rise to $297 per tonne in Europe in Q1 2022, as compared with €150 per tonne in the same quarter of 2021. For the purposes of the financial model, the Company has used **€150 per tonne** and expects to produce circa **16,300 tonnes of PCC** per annum.

Other by-products - Construction Aggregates
Approximately **75**% of the original ore mined is a coarse grade Quartz Sand, which can either be stored as an inert landfill or potentially sold to construction companies as an industrial aggregate. The current financial model assumes a very limited revenue for this end product of 100,000 tonnes per year at €5 per tonne. However, the goal is to find outlets to take this in-demand industrial product either as a direct revenue stream or simply to reduce the cost of storage.

Other by-products - Tin
The Zinnwald Lithium Project has historically not considered the option of including a tin circuit as part of its production process, primarily because the planned annual mining rate did not support the economics of a such a concept. However, with the planned increase in size of the Zinnwald Project, and the generally stronger tin price, the Company is reviewing both the cost and the practicality of adding beneficiation of tin to the Project. The Company may include further details in any future NI 43-101 Feasibility Study, if the economics support such a plan.

1.14 Capital Cost Estimates

The overall capital cost estimate is summarized in **Table *3***. The capital cost estimates were produced by ZLP, OEMs and external expert consultants.

- G.E.O.S.
- Epiroc for mining capital costs
- Metso:Outotec for beneficiation capital costs
- CEMTEC for pyrometallurgical capital costs
- K-UTEC for hydrometallurgical costs and

It must be noted, that, at the time of writing this study, extraordinary supply chain disruptions are having a general effect on the cost estimates. The estimates presented below are made with the assumption that at the time of construction, the underlying supply disruptions have been resolved and raw material costs normalised. Capital costs below are all presented in US$ and a USD / EUR exchange rate of 1.05 for costs based in €.

The capital cost estimates cover the design and construction of the mine and the process plants, together with on-site and off-site infrastructure to support the operation including water and power distribution and support services. The capital costs associated with the gas supply pipeline and power/steam stations are also included.

Table 3: Overview of the Project's Capital Expense Estimate

Category	Initial Capital (US$m)
Mining	54.0
Mineral Processing	73.1
Pyrometallurgy	49.4
Hydrometallurgy	115.7
Surface Land acquisition	1.6
Subsidies	(15.8)
20% Contingency	58.5
Total Capex	336.5

(* The subsidies are based on present EU and German laws and are granted for investments in the industrial sector of the former German Democratic Republic.)

1.15 Operating Cost Estimates

The project operating cost is mainly determined by the cost of labour, power (electrical and natural gas), consumables and reagents. For this estimate, long term average prices as well as consensus forecasts for reagents and energy were used. Fixed cost components have been drawn from current process unit engineering plans, which include estimates of labour costs. All costs have been attributed to the production of battery-grade lithium hydroxide. The chemical circuits produce a by-product of potassium sulphate ("SOP"), which can be sold as a potash fertiliser, and the financial model treats this as co-product credit revenue with no associated direct costs. **Table *4*** summarizes the average overall operating costs per tonne of LiOH produced over the 36 year life of mine plan of the financial model.

Table 4: **Average Operating Costs per tonne of LiOH**

Category	US$ per tonne LiOH
Mining	2,254
Mechanical Processing	898
Chemical Processing (Pyrometallurgical and Hydrometallurgical)	7,358
G&A	306
Total Operating Costs per tonne LiOH before by-product credits	10,816
Total Operating Costs per tonne LiOH after by-product credits	6,200
Total Cost per tonne mined	147.63

The operating cost estimate has been compiled by ZLP supported by G.E.O.S. / K-UTEC and is based on the basic estimates received from:

- G.E.O.S. for mining operating costs
- Metso:Outotec for mechanical process operating costs
- CEMTEC for pyrometallurgical operating costs
- K-UTEC for hydrometallurgical operating costs

1.16 Economic Analysis

As shown in **Table *5***, the PEA demonstrates the financial viability of the Project at an initial minimum design production rate of approximately 12,011 t/a LiOH (battery grade 99.5 %). The Project is currently estimated to have a payback period of 3.3 years. Cash flows are based on 100 % equity funding. The economic analysis indicates a pre-tax NPV, discounted at 8 %, of approximately US$ 1,605m and an Internal Rate of Return (IRR) of approximately 39%. Post-tax NPV is approximately US$1,012m and IRR 29.3%.

German federal income tax and depreciation were applied to the appropriate capital assets and income categories to calculate taxable income. A basic corporation tax rate of 30.9 % has been assumed together with a 100,000 EUR/a Mining Royalty Tax due to the Government of Saxony. Across its lifetime, the Project is estimated to generate c. €2.0bn in state and federal level taxes.

Table 5: **Overview Financial Analysis**

PEA Key Indicators	Unit	Value
Pre-tax NPV (at 8 % discount)	US$ m	1,605
Pre-tax IRR	%	39.0%
Post-tax NPV (at 8 % discount)	US$ m	1,012
Post-tax IRR	%	29.3%
Simple Payback (years)	Years	3.3
Initial Construction Capital Cost	US$ m	336.5
Average LOM Unit Operating Costs (pre by-product credits)	US$ per tonne LiOH	10,872
Average LOM Unit Operating Costs (post by-product credits)	US$ per tonne LiOH	6,200
Average LOM Revenue	US$ m	320.7
Average Annual EBITDA with by-products	US$ m	192.0
Annual Average LiOH Production	Tonnes per annum	12,011
LiOH Price assumed in model	US$ per tonne	$22,500
Annual Average SOP Production	Tonnes per annum	56,887
Blended SOP Price assumed in model	€ per tonne	875

A sensitivity analysis has shown that the Project is more sensitive to the lithium price than it is to either CAPEX or OPEX. An increase of 22% in the average lithium hydroxide price, from 22,500 US$/t to 27,500 US$/t, increases the post-tax NPV from US$1,012.3m to 1,444.6m (42%) and the post-tax IRR to 36.8%. A decrease of 22 % in the average lithium hydroxide price, from 22,500 US$/t to 17,500 US$/t, decreases the post-tax NPV (8 %) from US$1,012.3m to 579.9m (-42%) and the post-tax IRR to 21.1%.

The financial analysis for this report considers only the project level economics and excludes any cost of financing or any historic cost incurred in the development of the project. The analysis assumes the Project is 100 % equity financed. It includes the project phases comprising 24 months of construction, followed by 12 months of commissioning, ramp-up and stabilisation phases. A total mine life of 36 years is expected when assuming the mining rate of 880,000t / a, and mineral inventory of 31.2Mt which is equivalent to the Proven and Probable category tonnage of the latest Mining Reserve statement, as announced on 31st May 2019. A mean grade of 3,004 ppm Li was assumed, as per the historic Mining Reserve grade, which should account conservatively for potential dilution from mining.

1.17 Project Development Plan

The tentative project schedule in this PEA report is developed on the assumption that the Project will be fully funded throughout both its next stage of producing a Bankable Feasibility Study ("**BFS**") phase and then into construction; all environmental and other regulatory permits will be granted without delays; external agencies and suppliers will be cooperative; and management of the execution will be by competent EPCM / EPC groups. The preliminary development schedule is shown in **Figure *6*** below.

DL is continuously in contact with the administrative bodies in Altenberg and Zinnwald (mayor, municipal council) regarding ongoing project developments. Furthermore, the Company continues to keep the residents of Zinnwald and Altenberg updated about the Project via newspapers and regular information meetings.

1.17.1 Execution Strategy

The execution strategy assumed in the PEA report is based on the hybrid model mixing the conventional EPCM and Engineering Procurement Construction ("**EPC**") approach. This type of hybrid model will allow for extensive participation of the local contractors where possible. The preliminary schedule includes typical durations for major activities based on experience with similar size projects. A more detailed execution plan is to be developed during the BFS phase of the project. Project permitting will cover the mining and processing stages at the same time.

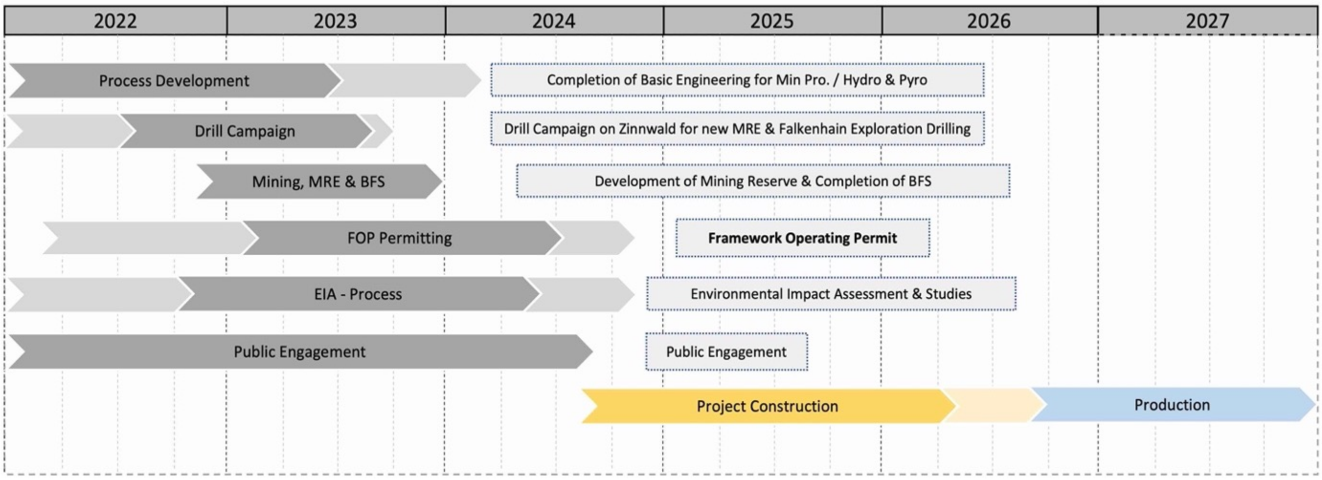
1.17.2 Project Development Plan and Timetable

The project development plan includes the following major phases

- PEA
- Geological and Processing development
- EIA and Permits
- Bankable Feasibility Study
- EPCM and EPC selection
- Construction and commissioning into Production

The schedule of project development shown in **Figure *6***, developed for the PEA phase, is a graphical snapshot of the driving summary activities and logic. The intent is to demonstrate major project execution activities and key milestones following completion of this PEA. The schedule covers the entire project life cycle from the start of the PEA study until commissioning and nameplate production capacity is reached.

Figure 6: Project Development Plan



1.17.3 Sustainability Matters

As a mining development Group operating in Germany and the UK, the Company and the wider ZLP Group (the **Group**”) takes seriously its ethical responsibilities to the communities and environment in which it works. Wherever possible, local communities are engaged in the geological operations and support functions required for field operations, providing much needed employment and wider economic benefits to the local communities. In addition, the Company and Group follows international best practice on environmental aspects of its work. The Company’s goal is to meet or exceed the required standards, in order to ensure the Company obtains and maintains its social licence to operate from the communities with which it interacts.

The Group has already put in place a Sustainability Committee in place at Plc Board level to incorporate and emphasise the Group’s commitment to Sustainability and ESG Matters. The Group’s Sustainability framework. is based on the United Nations’ set of 17 Sustainable Development Goals. The Company recognises the need to proactively consult and engage with the communities that may be affected by our activities. The Company aims to foster long-term relationships with these communities to develop mutual understanding, cooperation, and respect. As part of this process, the Company will put in place a local Sustainability Committee as part of the Group’s wider structures.

1.18 Conclusions and Recommendations

The results of this study confirm the development of an underground mine with an extraction rate of 880,000 t/a and a mine life of more than 30 years, including the ramp-up phase, followed by mechanical processing (crusher and magnetic concentrator) at the mine site for the separation of 179,200 t/a of a Zinnwaldite concentrate and the construction of a plant for the production of c. 12,000 t/a LiOH (corresponding to 10,565 t/a of LCE). The project includes the production of c. 56,900 t/a potassium sulfate as fertilizer and technical product, c. 16,300 t/a PCC (precipitated calcium carbonate) and annual sales of 75,000 t of granite and 100,000 t quartz sand as by-products.

The Project is of substantial size with the potential to produce 496,000 t of LHM over 36 years. It has a robust average grade compared to the cut-off grade, promising an operation at a significant profit margin.

The Company has already commenced an infill drilling programme at the core Zinnwald license with the objective of better defining the Resources and Reserves that lie within the ore body, as well as determine the detailed early years’ mining plan. This will likely lead to revised Resource and Reserves Estimate to be included in the new BFS planned for the re-scoped Project as defined in this PEA Study. The Company has also commenced an exploration drilling campaign at its nearby Falkenhain license to determine the potential for expansion of both the project’s resources and the production level.

The Company will continue to develop the technologies planned for its processes. Individual processing methods and stages are well established in mining and other industries. As the recognition of Zinnwaldite as a source for battery metals is more recent, the application of methods such as high-intensity magnetic separation has not previously been used in beneficiation of this specific type of lithium ore but is utilised and well established in the beneficiation of other ore types. Evaporators and crystallizers are common processing methods in the production of fertiliser salts. The Company has also completed the initial phases of bulk and particle sorting techniques designed to increase the type of resource available to the Project. The Company will also continue to refine its plans for reducing its overall CO_2 footprint and operating costs, such as via the use of electric mining equipment.

The Company has already commenced its EIA and other permit application process, including baseline studies and other reports. This will be the highest priority area over the coming quarters.

This PEA assumes that the Group will adopt an EPCM construction strategy, but in the BFS phase other options should also be evaluated. The EPCM contractor will provide overall management for the Project as Zinnwald will likely look to limit the size of its Owner’s team. The EPCM Contractor will need to work in collaboration with the Company, its consultants and the relevant regulatory bodies.

1.19 Forward Work Program

1.19.1 Geology

The Company is currently executing an In-fill drilling campaign to further improve the mineral resources. In connection with the campaign, it is recommended to

- Further investigate Geo-metallurgical properties of the Ore type 2 to possibly increase the Resources.
- Collect all geotechnical and structural data from the core to better understand small scale features of the deposit and provide information for detailed mine planning.

The Company is also undertaking an exploration drill campaign at its Falkenhain license area in order to test historic drill results. The intention to establish a lithium resource with potential for tin and tungsten. If successful, this could ultimately provide additional high-grade feed for the Project.

1.19.2 Mining

To optimize the full project and to prepare the bankable feasibility study and to minimize further risks, additional recommendations include:

- To ensure access to underground mine galleries in Altenberg. Negotiation with current owner, LMBV, are on-going.
- The ventilation must be optimized and validated by modelling
- Further optimising the logistical system of the mine, both regarding export of ore and return of material for back-filling.
- A more detailed concept for backfilling by means of pumps must be developed in the next project steps.

1.19.3 Processing

The next phase testwork for optimization should focus on the following aspects:

- To further explore the application of ore sorting technology with the goal of
    - Reduction of material for comminution (size reduction) and thus cost / energy reduction.
    - Improve overall process efficiency through the reduction of fines generated in comminution.
    - Facilitate geo-metallurgical control over the ROM-feed material to the mineral processing plant.
- Test work to check whether a tunnel kiln will be better in process stability and cheaper than a rotary kiln
- Evaluation of in-house grinding of limestone chunks to flour with the aim to reduce cost for additives
- Study to further improve SOP and PCC production planning, as economically significant by-products and integrate with the existing extended process design.
- Further test option for in-house production of potassium carbonate (K_2CO_3) from other potassium compounds to reduce costs and supply risks for this reagent.
- Explore the opportunity to additionally reduce the carbon footprint of the process.
- Carry out further testwork for alternative usages of Quartz Sand
- Carry out further testwork for alternative usages of LRP Improve the energy efficiency of processes including heat-recovery, heat recirculation or reduction of overall heat / energy demand within the process stages.
- Progress REACH / CLP registration with the European Chemicals Agency (ECHA) for required reagents as well as products.

1.19.4 Infrastructure

Further work on infrastructure related items is recommended in the following areas:

- To progress negotiations to access the IAA Bielatal tailings facility with the state company LMBV
- To carry out Geotechnical studies on the IAA Bielatal tailings facility with regard to risk assessment
- Alternative options for placement of dry stack tailings material should be investigated.
- Advance the negotiations for land usage / purchase required for surface installations.
- Advance negotiations for service contracts for electric power and natural gas with local power companies as well as supply contracts for required reagents and materials

1.19.5 Environment, Social and Governance

Environmental considerations of the Project are a critical aspect that are a key issue to be advanced. The following aspects should be advanced / improved in the further development of the Project:

- Carry out required environmental baseline surveys for the areas under consideration.
- Complete a comprehensive Environmental and Social Impact Assessment study that will quantify the expected impact of the project, with special regard to:
  - Local environment, flora, and fauna
  - Local residents and stakeholders
  - Possible effect on local economy and businesses
  - Opportunities for additional benefit to local stakeholders by
    - Improved employment opportunities
    - Retention of younger residents and families in an area of overall ageing population
    - Improved local infrastructure for residents and businesses

To continue and intensify efforts of public participation and local stakeholder engagement. These must be carried out with the goal of better local understanding of the project and its potential benefits and risks.

2 Introduction

2.1 Terms of Reference

This Technical Report was commissioned by the Company. The Company holds the mining permit issued according to the Federal Mining Act (BBergG § 8) for the lithium deposit in Zinnwald, Germany. In October 2020, ZLP (a public company listed on the AIM Market of the London Stock Exchange) acquired an initial 50% of the Company. Subsequently, in June 2021, it acquired the remaining 50%. The shares in the Company are now held by Deutsche Lithium Holdings Ltd, a wholly owned subsidiary of ZLP. Since the Company is controlled, funded and ultimately wholly owned by ZLP, this report has also been addressed to ZLP.

The report was prepared under the direction of the Qualified Persons:

- EurGeol Kersten Kühn (Head of Department, G.E.O.S. Ingenieurgesellschaft GmbH, Halsbrücke / Germany), and
- Dr. Bernd Schultheis FIMMM (Deputy Head of Department, Chemical / Physical Process Engineering of K-UTEC AG Salt Technologies).

This Technical Report was prepared according to the rules of the National Instrument 43-101 “Standards of Disclosure for Mineral Projects” developed by the Canadian Securities Administrators effective as per June 30, 2011. The NI 43-101 follows the recommendations of the Canadian Institute of Mining (CIM) Standing Committee on Reserve Definitions.

All investigations and conclusions of this Report are concentrated on and limited within the border of the exploration fields “Zinnwald” and Zinnwald-North” of the SWS Zinnwald license and the mining permission field “Zinnwald” of DL.

This PEA is preliminary in nature, it includes certain assumptions that are considered too speculative to have economic considerations applied to them. There is no certainty that the Project as described in this PEA will be realised.

2.2 Evolution of the Zinnwald Lithium Project

The Project consists of exploration, mining, mineral processing / beneficiation, and battery-grade lithium production. An original NI 43-101 Feasibility Study Technical Report for the project was published in May 2019 and updated in September 2020 (BOCK et al,), but this was based on a smaller scale, niche end-product (Lithium Fluoride) project designed to be internally financed and integrated to the original owners’ operational strategy.

Following the change in the Company’s ownership in June 2021 and coupled with developments in the global and European lithium market, a new development strategy has been established for the Project. One of the most important changes is that the Company has decided to pursue the production of Lithium-Hydroxide Monohydrate (LiOH) products instead of the previously targeted Lithium-Fluoride (LiF) product. In addition, the Company is seeking to increase the scale of the Project with a higher level of annual production of battery-grade lithium compounds than was contemplated in the previous 43-101 study.

The Company has sought to optimise the Project in many ways. For example, the previous concept to truck significant volumes of material to separate processing sites in Saxony has been abandoned and instead the processing of ore, lithium-activation (thermal activation) of concentrate and lithium fabrication installations will be located at one site. This is expected to reduce impact from material transport on both the environment and local residents.

The project management team considers this new strategy to be realistic and the best option for both the company, as well as for local stakeholders. The Company believes that this new approach will deliver robust returns in line with current market trends. As several parts of the operation require further definition, design and study work to be completed, this report intends to update the market on the new strategy and expected financial outcome within a PEA level study report.

2.3 Project Scope and Terms of Reference

This report considers a mining operation at the Zinnwald Lithium deposit near Altenberg, Saxony. The concept includes an underground mine in Zinnwald with a nominal tonnage output of approximately 880,000 t/a ore at estimated 3,004 ppm Li and 75,000 t/a barren rock. Ore haulage is via a 7km partly existing network of underground drives and adits from the "Zinnerz Altenberg" tin mine which closed in 1991. Processing including mechanical separation, lithium activation, and lithium fabrication will be carried out at an industrial facility near the village Bärenstein, in close proximity to the existing underground mine access and an existing site for tailings deposition with significant remaining capacity.

The nominal output capacity of the project is targeted at c. 12,000 LiOH with c. 56,900 t/a of potassium sulphate (SOP). Another by-product that is being developed is Precipitated Calcium Carbonate (PCC) a key filling material in the paper manufacturing process. The estimated mine life covers >35 years of production. The optimisation of mining methods has been a key consideration to realise increased total mined tonnage volumes from the Zinnwald mine. This includes utilising more efficient techniques such as sub-level stoping and Avoca – stoping with concurrent backfill wherever possible and in preference to more costly room and pillar methods.

2.4 Qualified Persons

Q.P. Kersten Kühn of G.E.O.S. Ingenieurgesellschaft mbH (G.E.O.S.), based in Halsbrücke near Freiberg / Germany, has been involved with the Project since its inception and was commissioned by the Company in May 2022 to contribute to the PEA Technical Report on the project. G.E.O.S. and their external experts have been engaged to review the updated technical content on environment, geology, mining and infrastructure. Mr Kühn has been based near the Project area for 40 years and is very familiar with the local geological, environmental, and infrastructural conditions from his former work as mining geologist and Head of Department Geology in the Altenberg tin mine. In addition, as part of his work as Q.P., he participated in the discussion of the Project on all aspects of permissions with the authorities responsible for it, such as Saxon Mining Authority in Freiberg / Germany as well as Lower Water Agency, Lower Nature Protection Agency and Lower Monument Conservation Agency in Dippoldiswalde and in Pirna / Germany

Q.P. Bernd Schultheis, the deputy head of the engineering department of K-UTEC AG Salt Technology (K-UTEC) located in Sondershausen / Germany. Dr Schultheis has been based in the Project area for more than 25 years, gaining extensive experience in the hydro-metallurgical processing of alkaline and alkaline earth minerals and oceanic salts in the dissolved or solid state. He possesses the theoretical knowledge of thermodynamics and chemical principles of the different process steps and the required approaches to determine the relevant design parameters for equipment selection.

2.5 Site Visits

Mr Kühn has visited the Project in the periods of verification and infill drilling, underground chip and bulk sampling between 2012 – 2014 and in 2017 as a rule several times a week. As part of his work, he regularly inspected the technical execution of the on-site exploration work and the sample handling in accordance with the with the QA/QC program drawn up and updated with its participation. For updating the mine planning, he has made several recent visits to the surface and underground situation in the Altenberg mine, the landfill IAA Bielatal and the Zinnwald visitors mine between October 2021 and May 2022.

Dr Schultheis is not required to visit the deposit / planned mine site due to his responsibilities for the engineering of downstream processing technologies. He has visited the prospective processing site in Freiberg, reviewed the relevant results of the pyro-metallurgical test work, and witnessed all hydro-metallurgical test work executed at K-UTEC.

2.6 Frequently used Abbreviations, Acronyms and Units of Measure

Lists of terminology are presented Appendices 1 and 2 of this report. All reported investigations, measurements and calculations are based on the metric system.

3 Reliance on Other Experts

3.1 General Matters

The Qualified Persons have not verified the legal titles to the License nor any underlying agreement(s) that may exist concerning the licences or other agreement(s) between third parties but has relied on the Company to have conducted the proper legal due diligence.

G.E.O.S. has not carried out any independent geological surveys of the License but has completed a multitude of site visits. It has relied on geological descriptions and program results, historic reports, field notes and communications with the Company.

For this PEA, the Company has provided the Economic Analysis for the Project, as outlined in Chapter 22 of this Report, based on input consultation from the Qualified Persons and other Study Participants, as noted in Section 3.2 below.

Any statements and opinions expressed in this document are given in good faith and in the belief that such statements and opinions are not false or misleading at the effective date of this Report.

This Report was prepared using the resource materials, reports and documents noted in the text and listed in Chapter 27 – References. Although the authors have made every effort to convey the content of the reports accurately, they cannot guarantee either the accuracy or the validity of the work described in them.

The Qualified Persons had the responsibility for assuring that this Technical Report meets the guidelines and standards stipulated.

3.2 Expert Team of the Project

Details about qualifications and experience of the owners team of the Project, independent third Parties and current / former employees of the Company, which the Qualified Persons have relied on are reported below:

3.2.1 External Parties

The Qualified Persons to some extent rely on the PERC-Report "Zinnwald Lithium Project" of the year 2014 ***[28]***, which was prepared on behalf of DL (under its former name SolarWorld Solicium GmbH). The preparation of that report was supervised by the Competent Person Dr. Michael Neumann. Dr. Neumann is graduated geologist and European Geologist. The sections of the items 9, 10, 11, and 12 of the actual report, which deal with the historic drilling campaigns and the exploration campaign of the years 2012 - 2014 rely on the respective chapters of the PERC report.

Dr. Wolf-Dietrich Bock, based in Denzlingen / Germany, was the responsible Q.P. for the work done in 2017 and the updated NI 43-101 Technical Report on the Project issued in September 2020 (see ***[0]***). Mr. Bock holds a title as European Geologist (EurGeol) and is a self-employed geologist with a diploma at the University of Hamburg / Germany and a PhD degree of the Free University of Berlin.

Mr. Matthias Helbig performed Data base management and maintenance, modelling, mineral resource estimation and mineral reserve estimation. He is Senior Expert of the G.E.O.S. Ingenieurgesellschaft mbH in Halsbrücke / Germany. Mr. Helbig is graduated Geoecologist (Graduate of Technical University Bergakademie Freiberg / Germany). The work and results of Mr. Helbig are essentially contained in items 1, 14 and 15.

Prof. Dr. Wolfgang Schilka provided important project inputs for the geology and mine planning sections. He is graduated geologist with Diploma and PhD in Geology of Bergakademie Freiberg / Germany.

Mr. André Baumann and Mr. Thomas Graner are responsible for the section "Mine Planning" in the Project. Mr. Baumann is a graduated mining engineer (Dipl.-Ing.) with a Diploma of Bergakademie Freiberg / Germany and the Head of the Division Mining in the G.E.O.S. Ingenieurgesellschaft mbH. Mr. Graner is graduated mining engineer with a Diploma of the TU Bergakademie Freiberg and a project leader in the mining division of G.E.O.S. Ingenieurgesellschaft mbH.

Prof. Dr. Egon Fahning acted as consultant for the mine planning. He holds a doctorate in Mining Engineering and is a graduate of the TU Bergakademie Freiberg / Germany.

Dr.-Ing. Henning Morgenroth is a graduated processing engineer (Dipl.-Ing. of Mineral Processing) and has a PhD in Engineering (Technical University Bergakademie Freiberg / Germany). Dr. Morgenroth is managing director of UVR-FIA GmbH.

3.2.2 Internal Parties

Dr. Thomas Dittrich is a graduated geologist from Technical University Bergakademie Freiberg / Germany with diploma in geology / palaeontology in 2009. Between 2009 and 2017, he was a Scientific Research Assistant at Technical University Freiberg, where he worked in the fields of assessment of rare metal deposits (e.g, gallium) and development of exploration strategies for pollucite bearing rare metal pegmatites (caesium, lithium, tantalum, niobium, tin). He has more than 10 years of experience in science and industry and also spent several months doing fieldwork in Brazil, Australia, and Zimbabwe. In 2017 he joined Deutsche Lithium GmbH where he is in charge of geology, mineral exploration and mining and was Project leader of the 2017 exploration campaign.

Mr Jan Henker is a graduated engineer (Dipl.-Ing.) of Process Engineering (Graduate of Technical University Bergakademie Freiberg / Germany). He has over 15 years industry experience in the sectors mechanical processing, photovoltaics and inorganic chemistry and over five years of experience in managing plant engineering and construction. He was project leader of the working package “Beneficiation” in the “Lithium Zinnwald Project” from 2012 to 2015 and from 2017 to 2022.

Dr. Torsten Bachmann is graduated engineer (Dipl.-Ing.) of Environmental Technology (Graduate of University Mittweida / Germany) and has a PhD in Chemistry (Technical University of Dresden / Germany). Dr. Bachmann has over 20 years of experience in science and industry in the area of photovoltaics and inorganic chemistry and long-term experience in managing of national research projects as well as department manager in technology companies. He was team leader in the “Lithium Zinnwald Project” from 2011 to 2015 and has been project leader of the working package “Chemical Processing” since 2017. He is also now a Managing Director of the Company.

Dr. Matthias Reinecke is a graduated engineer (Dipl.-Ing.) for Materials Science (Graduate of University Mittweida / Germany) and holds a PhD in Chemistry (Technical University Freiberg / Germany). Dr. Reinecke has over 20 years of experience in industry in process development in silicon crystallization and chemistry and of application of Li-ion battery systems for stationary storage. He is project leader of the working package “Hydrometallurgical Processing”.

3.3 Other Study Participants

An overview of the other key participants and their area of responsibility are provided in **Table *6***.

Table 6: Project Key participants and areas of responsibility

Company	Location	Area of responsibility
Actlabs Activation Laboratories Ltd	Canada	Chemical analytics
ALS Global	Romania	Chemical analytics
AMPROMA GmbH	Germany	Basic engineering of hydrometallurgy and Capex and Opex estimation
BBF Baubüro Freiberg GmbH	Germany	Civil engineering and infrastructure
Beratende Ingenieure Akustik-Gutachten-Planung SHN GmbH	Germany	Report acoustic study
Beratende Ingenieure Bau-Anlagen-Umwelttechnik SHN GmbH	Germany	Emission report dust
Bergsicherung Freital GmbH	Germany	Underground mining 100 t
BOG Bohr- und Umwelttechnik GmbH	Germany	Infill drilling
CEMTEC Cement & Mining Technology GmbH	Austria	Process design, flowsheet and basic engineering of pyrometallurgy incl. Capex and Opex estimation
Dr. Ing. Michael Penzel, Geotechnik Projekt	Germany	Expert report on underground stability

ERCOSPLAN Ingenieurbüro Anlagentechnik GmbH	Germany	Process design of SOP crystallization, flowsheet
Eurofins Umwelt Ost GmbH Niederlassung Freiberg	Germany	Chemical analytics
Geomechanik Bohrungen und Umwelttechnik GmbH Sachsen	Germany	Infill drilling
Geomontan GmbH & Co. KG	Germany	Core sawing
G.E.O.S. Ingenieurgesellschaft GmbH	Germany	Exploration, permitting, geological modelling, mineral resource and reserve estimation Mine design engineering Hydrogeological and environmental studies Laboratory test work pyrometallurgy Laboratory test work hydrometallurgy
GEOPS Bolkan Drilling Services Ltd	Bulgaria	Infill drilling
Geotechnisches Sachverständigenbüro Dr. Ing. habil. Bernd Müller	Germany	Expert report blasting
Hans Lingl Anlagenbau und Verfahrenstechnik GmbH & Co. KG	Germany	Laboratory test work on pyrometallurgy (tunnel kiln)
IBU-tec advanced materials AG	Germany	Test work on pyrometallurgy and preliminary process design
IBZ Salzchemie GmbH & Co. KG	Germany	LiF preparation, laboratory test work
iKD Ingenieur-Consult GmbH	Germany	Report water framework directive
K-UTEC AG Salt Technologies	Germany	Test work on hydrometallurgy and process design, flowsheet
MUEG Mitteldeutsche Umwelt- und Entsorgung GmbH	Germany	Backfill leaching test-work
Pruy KG Gesteins-, Bohr- und Umwelttechnik	Germany	Infill drilling
Schulz Umweltplanung	Germany	Environmental investigation
Uhlig & Wehling Beratende Ingenieure GbR	Germany	Expert report traffic connection
UVR-FIA GmbH	Germany	Test work on mineral processing and process design, flowsheet
Wolfener Analytik GmbH	Germany	Chemical analytics
Zinnwald Lithium Plc	UK	Marketing, market study

4 Property Description and Location

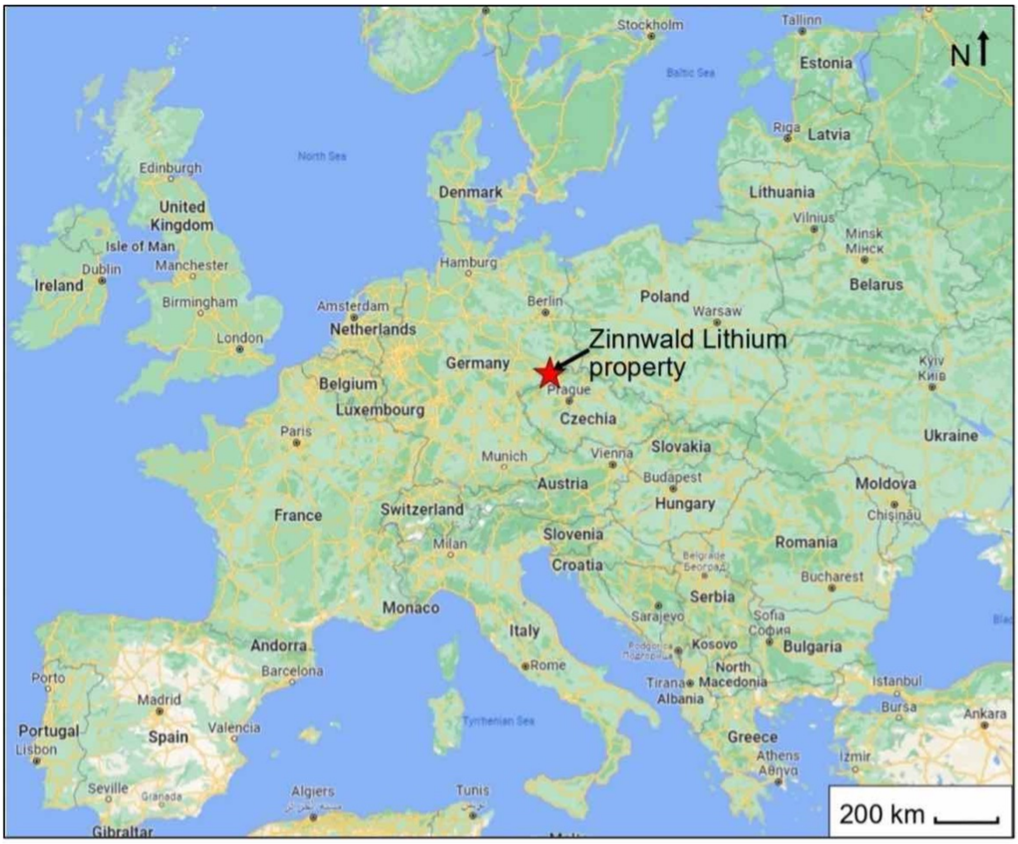
4.1 Mine Site

4.1.1 Location

The Zinnwald property is located in the eastern range of the Erzgebirge Mountains in Germany, approximately 35 km south of the capital of the Free State of Saxony, Dresden, approximately 220 km south of Berlin and 50 km southeast of Freiberg. The centre of the property is situated at about 50°44’11’’N and 13°45’55’’E. The ore deposit stretches along the German-Czech border and continues into the territory of the Czech Republic.

The licenced property parts of the town of Altenberg. Border crossing at Zinnwald is possible by car and truck. The motorway A 17 (E 55), which connects Dresden with Prague in the Czech Republic (CZ) bypasses the property 17 km to the east. The airports of Dresden, Berlin and Prague are 70, 230 and 100 km away, respectively. The Altenberg railway station is located on the north side of the city Altenberg. The Heidenau-Altenberg railway (38 km) connects in Heidenau (near Dresden) with the Elbe valley railway. This railway represents line 22 of the Trans-European Transport Network (TEN-T). The nearest seaport is located in Szczecin (PL) and is 410 km north of Altenberg. **Figure *7*** shows the property in the centre of Europe and the position in Germany.

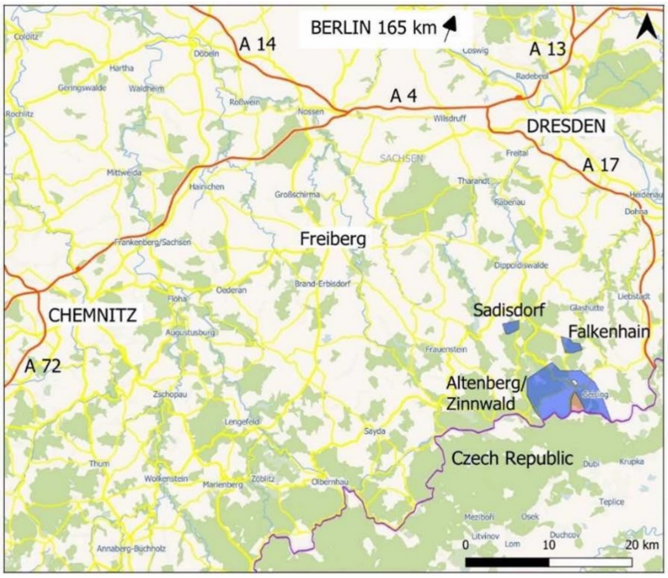
Figure 7: General location of the Zinnwald property in Europe



The Zinnwald deposit Is licensed to the town of Altenberg and has the following administrative categorisation:

Federal state: Free State of Saxony
Directorate: Dresden
Administrative District: Sächsische Schweiz – Osterzgebirge
Town: Altenberg
Municipality: Zinnwald-Georgenfeld
Mining Authority: Sächsisches Oberbergamt, Freiberg (SOBA)

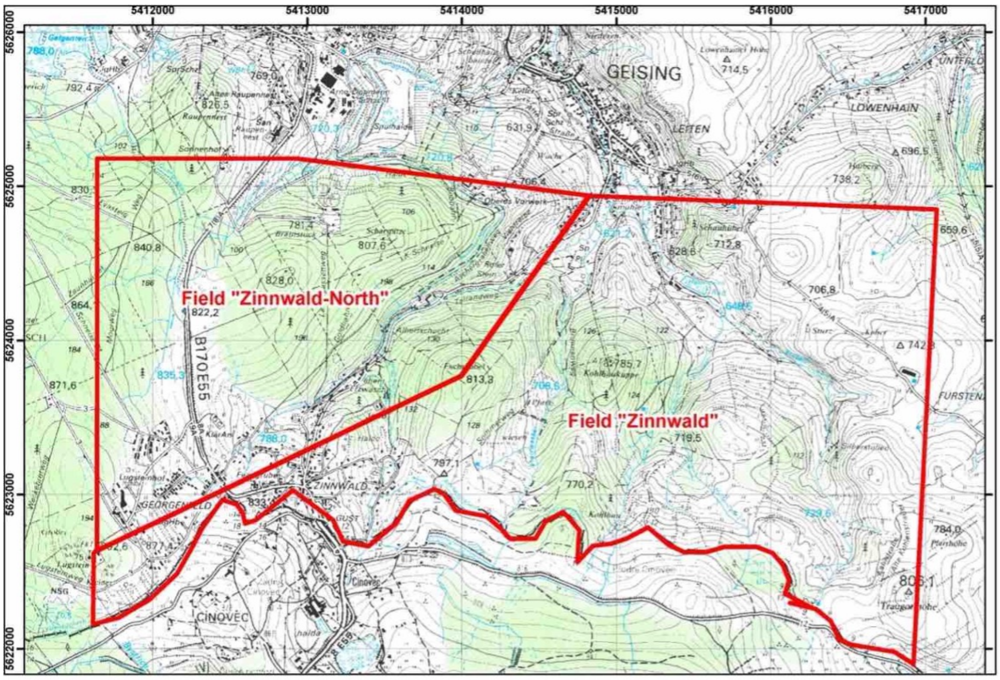
Figure 8: Position of DL license areas on the German / Czech border



4.1.2 Legal Aspects and Tenure

In 2011 and 2012 the two exploration permits for the license areas ”Zinnwald“ and ”Zinnwald-North“ were granted by the Saxon Mining Authority (SOBA) to SolarWorld Solicium GmbH (“SWS“) based in Freiberg / Germany, respectively (**Table *7***). These permits cover the commodities lithium, rubidium, caesium, tin, tungsten, molybdenum, scandium, yttrium, lanthanum and lanthanides, bismuth, indium, germanium, gallium, zinc, silver and gold. The permits were valid up to December 31, 2015 and were extended upon request in November 2015. New expiry date was December 31, 2017. Exploration work consisted of underground sampling in the abandoned mine and of a surface diamond drilling programme. The results were integrated in a geological model of the ore deposit with respect to lithium mineralization and a mineral resource according to the PERC standard was estimated.

Figure 9: Location plan of the exploration licenses “Zinnwald-North” and “Zinnwald”

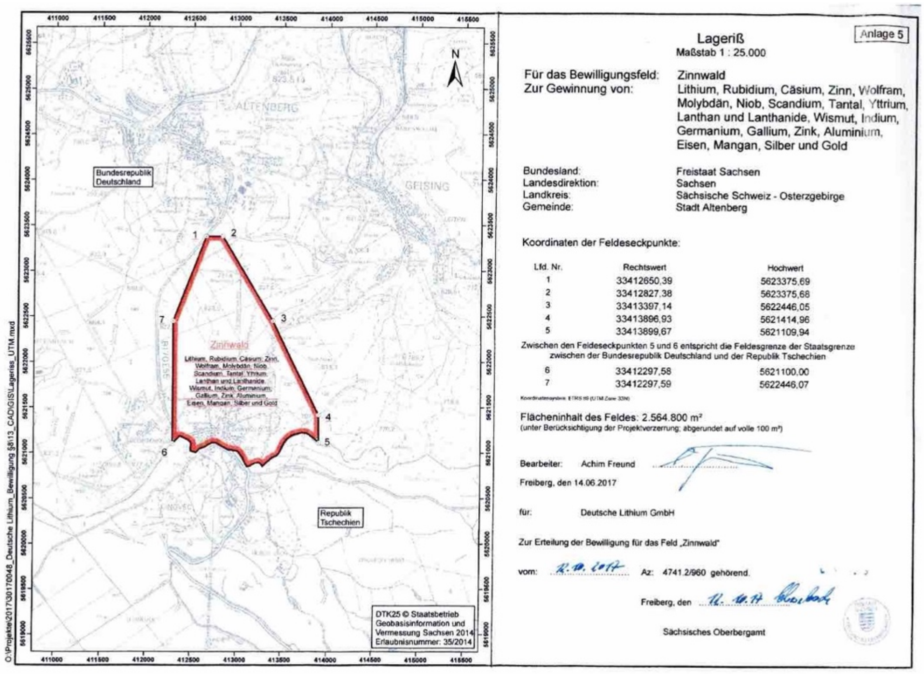


Following the establishment of the joint venture (DL) by SWS and Bacanora Minerals Ltd. (Bacanora) in February 2017, a mining permit was applied, which was approved for the field “Zinnwald“ as of October 12, 2017. The mining permission covers 2,564,800 m² and is valid up to December 31, 2047. (**Figure *10***)[*6*].

Table 7: Coordinates of the edge points of the Zinnwald exploration licenses

Edge points of the exploration licenses			
Field "Zinnwald"	**Field "Zinnwald-North"**	**East (Gauss-Krueger)**	**North (Gauss-Krueger)**
1	5	54 11 639.637	56 22 634.635
2	4	54 14 000.005	56 23 770.004
3	3	54 14 827.197	56 24 938.593
4	---	54 17 080.000	56 24 850.000
5	---	54 16 930.000	56 21 900.000
6	---	54 11 620.000	56 22 160.000
---	1	54 11 639.956	56 25 180.000
---	2	54 12 930.000	56 25 180.000

Figure 10: Location plan of "Zinnwald" mining license (coordinates ETRS 89_UTM33)



Anlage 5

Lageriß
Maßstab 1 : 25.000

Für das Bewilligungsfeld: Zinnwald
Zur Gewinnung von: Lithium, Rubidium, Cäsium, Zinn, Wolfram, Molybdän, Niob, Scandium, Tantal, Yttrium, Lanthan und Lanthanide, Wismut, Indium, Germanium, Gallium, Zink, Aluminium, Eisen, Mangan, Silber und Gold

Bundesland: Freistaat Sachsen
Landesdirektion: Sachsen
Landkreis: Sächsische Schweiz - Osterzgebirge
Gemeinde: Stadt Altenberg

Koordinaten der Feldeseckpunkte:

Lfd. Nr.	Rechtswert	Hochwert
1	33412650,39	5623375,69
2	33412827,38	5623375,68
3	33413397,14	5622446,05
4	33413896,93	5621414,96
5	33413899,67	5621109,94
Zwischen den Feldeseckpunkten 5 und 6 entspricht die Feldesgrenze der Staatsgrenze zwischen der Bundesrepublik Deutschland und der Republik Tschechien		
6	33412297,58	5621100,00
7	33412297,59	5622446,07

Koordinatensystem: ETRS 89 (UTM Zone 33N)

Flächeninhalt des Feldes: 2.564.800 m²
(unter Berücksichtigung der Projektverzerrung; abgerundet auf volle 100 m²)

Bearbeiter: Achim Freund
Freiberg, den 14.06.2017

für: Deutsche Lithium GmbH

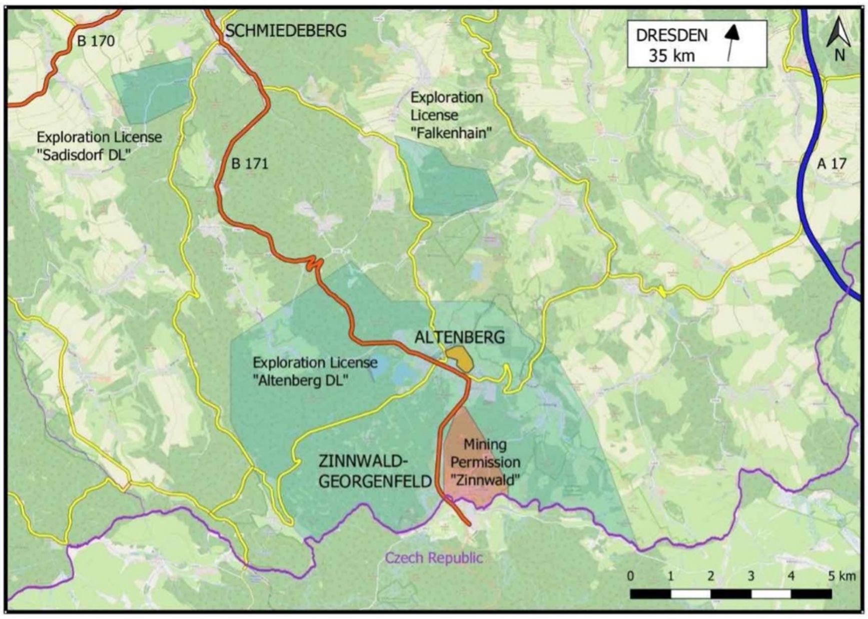
Zur Erteilung der Bewilligung für das Feld „Zinnwald"

vom: 12.10.2017 Az: 4741.2/960 gehörend.

Freiberg, den 12.10.17

Sächsisches Oberbergamt

Figure 11: Location plan of DL's mining and exploration licenses



The coordinates of the surrounding exploration areas granted to DL, are described in the following table:

Table 8: Edge point coordinates of the surrounding DL exploration licenses

	Field “Falkenhain”	
Edge point No.	**East ETRS89_UTM33**	**North ETRS89_UTM33**
1	33411074.66	5630113.43
2	33412187.87	5629789.73
3	33 412473.89	5629380.20
4	33413347.18	5629252,92
5	33413648.06	5628518.44
6	33412461.66	5628128.25
7	33411584.41	5628163.11
8	44411502.60	5628557.24
9	44411161.03	5629613.02
10	33411188.99	5629782.83
	Field “Altenberg DL”	
1	410000.00	5627000.00
2	411000.00	5626000.00
3	413472.45	5626000.00
4	415100.00	5624620.00
5	416000.00	5623000.00
6	417167.51	5619809.01
7	413899.67	5621109.94
8	413896.93	5621414.96
9	413397.14	5622446.05
10	412827.38	5623375.68
11	412650.39	5623375.69
12	412297.59	5622446.07
13	412297.58	5621100.00
14	408826.80	5620086.28
15	408000.00	5621000.00
16	407000.00	5623000.00
17	407000.00	5625000.00
18	412332.60	5624759.13
19	412595.50	5624886.07
20	412773.42	5624889.07
21	413003.33	5624551.20
22	413045.31	5624375.27
23	412912.36	5624221.34
24	412806.40	5624243.33
25	412618.48	5624403.27
26	412640.47	5624539.21
27	412369.59	5624620.18
	Field “Sadisdorf DL”	
1	404014,04	5631608,45
2	406020,23	5632072,25
3	406014,22	5630985,70
4	404866,68	5630427,93
5	404474,84	5630394,95

The edge points no. 1 – 7 of “Altenberg DL” represent the external field border. Its internal border points no. 18 – 27 are identical to the edge points of the mining properiertorship “Zwitterstock and Zinnkluft Altenberg” of the former “Zinnerz Altenberg”, now held by the state-owned company “Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH” (LMBV). Between point 6 and 7 as well as between point 13 and 14 the Zinnwald mining permission field border is in accordance with the state border to the Czech Republic.

The three additional exploration licenses are located in immediate vicinity to the “Zinnwald” mining permission (**Figure *11***). The currently ongoing exploration work aims at identifying additional lithium resources which will extend the lifetime of the Project and its economic viability

Table 9: Summary table of granted licenses

Asset	Holder	Interest	License category	License expiry date	License area m²	Comments
Zinnwald Germany	SolarWorld Solicium GmbH	100 %	Exploration	Dec. 31, 2017	7,794,278	Sampling and drilling completed
Zinnwald North Germany	SolarWorld Solicium GmbH	100 %	Exploration	Dec. 31,2017	5,121,664	Sampling and drilling completed
Zinnwald Germany	Deutsche Lithium GmbH	100 %	Mining	Dec. 31,2047	2,564,800	Development in progress
Falkenhain Germany	Deutsche Lithium GmbH	100 %	Exploration	Dec. 31,2022 (Extension for three years has been applied for)	2,957,000	Exploration in progress
Altenberg DL Germany	Deutsche Lithium GmbH	100 %	Exploration	Feb., 15,2024	42,252,700	Exploration in planning
Sadisdorf DL	Deutsche Lithium GmbH	100 %	Exploration	June 30, 2026	2,250,300	Exploration in planning

4.1.3 Environmental Considerations

Nature conservation areas exist in the surroundings of the deposit. This relates in particular to the “Oberes Osterzgebirge Country Conservation Area” protected landscape area) which extends from the state border to a line across the villages Rechenberg-Bienenmühle-Schmiedeberg-Fürstenwalde. Furthermore, the eastern portions of the mining permission “Zinnwald” are declared as a “nature protection area”.

The two important drinking water protection areas T-5370020 at Altenberg and T-5370019 at Klingenberg-Lehnmühle are not affected by the Project. Some adjacent special areas of conservation (FFH areas according to Natura 2000) must be taken into the account, e.g., “Weicholdswald “(forest), “Bergwiesen um Altenberg” (mountain meadows) and “Bielatal” (stream).

On August 17, 2006 by a decree of the state government office Dresden (Regional Council), the area of Geising-Altenberg was legally confirmed as flood formation area. This means that all new actions in the area are requested by law to include necessary measures for reducing the surficial drainage even in the case of heavy rain. The mining permission area “Zinnwald” is located completely within this area. Current plans for the project foresee minimal surface installations in the Zinnwald area, as mining and haulage are intended to be done in the underground mine.

Official requirements to the exploration permits (see ***[1, 3])*** included the renaturation of all sites used for the exploration works (i.e. for drilling). By end of May 2018 contouring and seeding was completed on all drilling sites used for the infill drillings by DL in 2017.

4.1.4 Minerals Fee (royalty)

Potential royalties over mining products are regulated by national law (§§ 31, 32 BbergG) and by edict transposed into the federal law of the Free State of Saxony. However, the legislation specifically notes that the relevant state administration is charged with the determination of market value of mining products, and also are empowered to entirely remove or apply royalty rates that differ from the prescribed rate in the federal law. Specifically, a project / commodity can be entirely exempt of royalty levies to

A) Avert a disruption of macroeconomic system
B) Avoid a threat to competitiveness of the developing company
C) Avoid a threat to the security of commodity supply of the national market
D) To improve the efficiency of resource utilisation or otherwise protection of national economic interests

Presently, the state of Saxony is not charging any royalty rates on lignite, which is the by volume most mined commodity in the state for reasons of competitiveness of the producing companies.

The assumption of any royalty rate for the assessment of this project would therefore in the eyes of the author be premature, especially considering that lithium and potassium sulphate are considered a strategically significant resource for the domestic economy of Germany. Furthermore, the practical difficulty of defining what would constitute a mining product of the Zinnwald project, and the allocation of appropriate market value to it, makes a royalty inclusion within this project speculative at best.

For the purpose of the economic assessment of the Project, it is currently assumed to pay an annual flat rate royalty of €100,000 to the state of Saxony.

4.1.5 Taxes

An overall taxation of 30 % on the profit is calculated in the project economic analysis and considered in IRR and NPV (has been included separately in section 24).

5 Accessibility, Climate, Local Resources, Infrastructure and Physiography

5.1 Accessibility

The deposit is located within an infrastructurally well-developed region:

- Motorway No. A 17 (E 55) Dresden – Prague, with the nearest motorway access at Bad Gottleuba about 17 km to the east
- Federal road No. B 170 leads from Dresden via Zinnwald / Cínovec to Teplice and crosses the license area at its southwest end
- The state road No. S 174 leads from Pirna and the Gottleuba Valley via Breitenau, Liebenau, Geising and the Heerwasser Valley to Zinnwald-Georgenfeld. This national road is the main connection between the federal road B 172 at Pirna in the north (distance about 25 km) and the B 170 at Altenberg / Zinnwald-Georgenfeld in the west
- Railway stations exist in distances of about 4 km at Geising and of 6 km at Altenberg (both situated on the Altenberg – Heidenau railway line)
- The immediate area of the deposit is accessible through local public, agricultural or forestry roads
- Zinnwald-Georgenfeld / Cínovec is a border crossing point for international transit of vehicles and pedestrians. Next possible border crossing at the motorway A 17 (E 55) Dresden – Prague is 17 km to the east at Bahratal / Petrovice
- The closest international airports are Dresden-International / Germany (50 km to the north) and Prague-Ružyne International Airport / Czech Republic (100 km to the south)

5.2 Climate

The climate at Zinnwald is cool and humid which is typical for the upper levels of a low mountain range like the Erzgebirge. A third of the average precipitation is due to snow, with the first snowfall normally occurring in October that usually does not change to rain until May. Therefore, snow cover exists for approximately 130 days in the year. Furthermore, the climate is characterized by numerous foggy days together with frost periods resulting in pronounced hoarfrost formation.

Meteorological data since 1971 show extreme values as follows:

Highest temperature	31.0 °C (2003-08-13)
Lowest temperature	-25.4 °C (1987-12-01)
Longest sunshine per annum	1,895.8 hours (2003)
Greatest thickness of snow	163 cm (2005-03-14)
Highest precipitation	312 mm/24 h (2002-08-13)
Strongest wind peak	191 km/h (2005-07-29)

Precipitation and Temperatures

The average yearly precipitation in Zinnwald is about 1,000 mm. The annual precipitation does not show long-term tendencies. Over many years precipitation maxima occur in summer and around the turn of the year. However, repeated episodes of heavy precipitation caused flooding with essential damages in the past. Since the so called “flood of the century” in August 2002 the region between Zinnwald / Cínovec, Geising and Altenberg is regarded as a flood formation area. For the 13th and 14th of August 2002, the weather station Zinnwald-Georgenfeld of the German Meteorological Institute (Deutscher Wetterdienst – DWD) recorded 312 mm of rain per square meters, which represents the highest precipitation rate within 48 hours that was ever measured ever until then in Germany.

Figure 12: **Average climate diagram 1961 – 1990 for Geisingberg / Zinnwald-Georgenfeld**

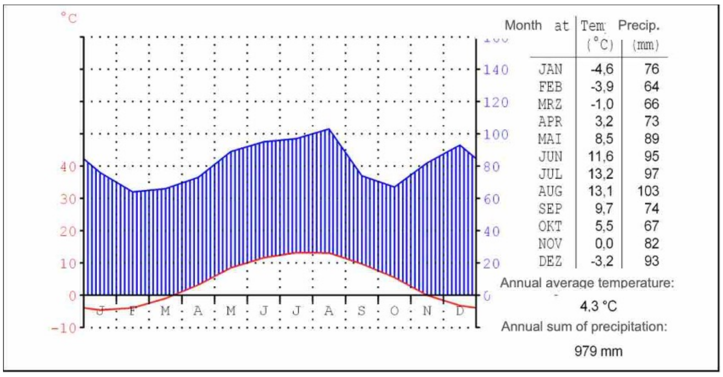


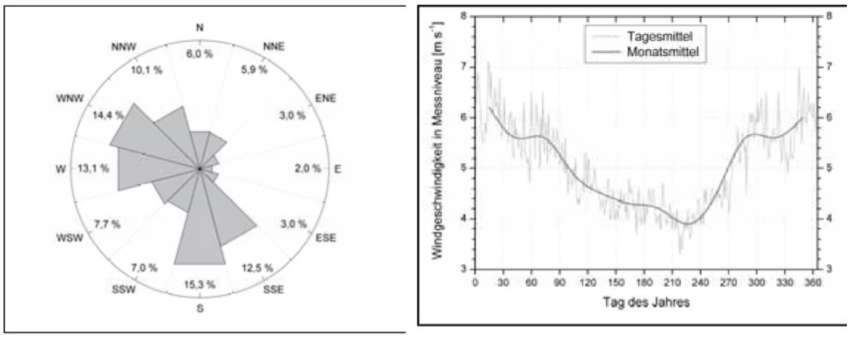
Table 10: **Monthly average precipitation & air temperatures (1971 – 2006)**

Station	Altitude	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Zinnwald-	877 m a.s.l.	Precipitation in mm	75	59	70	64	83	93	107	115	75	68	85	85	980
Georgenfeld		T in °C	-3.9	-3.4	-0.4	3.7	9.1	11.7	13.9	13.9	9.8	5.3	0.0	-2.7	4.8

Wind

Westerly winds predominate in Zinnwald. In addition, southerly breezes, which rise from the Bohemian Basin in the South are characteristic. Wind velocities are much higher during winter than in summer and are caused due to the seasonal temperature differences ***[129].***

Figure 13: **Wind directions (1992 to 2005) & wind velocities (1971 to 2005)**



5.3 Local Resources

With an average of 65 inhabitants per km^2 the region is sparsely populated. Small villages and settlements are typical. Former mining towns like Altenberg or Schmiedeberg have about 2,000 to 3,000 inhabitants. As of December 31, 2021 the city of Altenberg, including all city-districts like Zinnwald-Georgenfeld, has had a population of 7,785 inhabitants. Zinnwald counted 389 inhabitants on the same reference date ***[158].***

Several industrial branches exist in the region. Following the closure of the Altenberg mines in 1991 the region has experienced a radical structural change. As a consequence, a considerable portion of the qualified labour force had left the region. However, essential efforts of the local administration and due to federal, governmental and European funding, the city of Altenberg is now one of the most important recreational centres of Saxony. The local tourism counts up to 10,000 guests per day during the summer season, winter holidays, in Christmas time, or at weekends. Main objects of the tourism are recreation (public bath and sanatorium “Raupennest” in Altenberg) and sports (biathlon “Sparkassenarena Zinnwald”, luge, skeleton and bobsleigh at the “SachsenEnergie-Eiskanal”). Every year significant national and international sport events are held in the region (luge, bobsleigh, skeleton, cross country skiing, biathlon, mountain biking). Additional main tourist attractions are the mining museum in Altenberg and the underground visitor mine in Zinnwald-Georgenfeld and as well as the German watch museum in Glashütte. It is the long mining tradition of the region that causes a wide acceptance of the population for new mining plans.

In addition to tourism, the region is home to numerous small- and medium-sized enterprises that are based within in the mechanical, electrotechnical and automotive industry sectors. The town Glashütte 25 km from Zinnwald is worldwide known for its luxury watch manufacturing with world-famous brands such as “Glashütte Original” and “Lange & Söhne”.

Whilst the tourism and legacy manufacturing economy in the area have managed to prevail since the closure of main industry and mining in the area over 30 years ago, the wider region faces a challenge of ageing population of and rural exodus of younger people. This is another supporting factor to return industrial activity to the region, especially as it fits well with its historical roots.

The education level of the work force in the region based on the German school and work education system is high. Altenberg is one of the two locations of the Grammar School of Dippoldiswalde – Altenberg. Local resources necessary for the exploration, development and operation of the property are available from the industries of the Erzgebirge region and adjacent areas of Saxony.

5.4 Infrastructure

The traffic infrastructure is well established. Main and side streets and forest roads provide a good access to all areas of the mining licence. For further infrastructure details (motorways, railways, airports) see Item 5.1.

The overall area is well developed with respect to regional electricity, water and gas networks. Electric power, gas and potable water is available in the region. The local electricity and gas network is operated by SachsenEnergie AG. The catchment and treatment of the wastewater from Zinnwald-Georgenfeld is performed by the sewage plants of “Oberes Müglitztal Wastewater Association”. In Altenberg and Bärenstein the wastewater system is operated by the city of Altenberg.

Area-wide broadband internet access is in preparation and will go into operation gradually, supported by state subsidies. In addition, the area is comprehensively covered by mobile telephone networks of German and, close to the border, Czech operators.

5.5 Physiography

The deposit is located in the upper levels of the Eastern Erzgebirge at elevations of 780-880 m. The highest peak is represented by the Kahleberg (3 km north of Zinnwald) with 905 m a.s.l.. The topography is typical for a low mountain range with steep valleys and smooth summits, the latter gently dipping towards north. It comprises wide grasslands surrounded by forests and is structured by the local river network with pronounced V-shaped valleys belonging to the Elbe River Basin.

At present, the common land use in the area is agriculture and forestry. Most surface rights are privately owned. The surficial water bodies are reserved for public water supply, farming or recreation.

6 History

6.1 Historical Mining

Mining in the Erzgebirge has a long tradition and tracks back to the Bronze Age (TOLKSDORF et al. 2019 ***[164]).*** The region is host to numerous ore deposits that were important raw material sources for Fe, Sn, W and later also Ag, Zn, Cu, Pb, Co and U in Saxony and the entire Central German region for several centuries (BAUMANN et al. 2000 [***127]***)

The exploitation of tin and later of tungsten in the Zinnwald area started with panning of cassiterite from placers in the valleys south of the present German-Czech border. The first mining activities on the primary deposit are recorded from the second half of the 15th Century. A short time later the mining activities expanded to the German parts of the deposit.

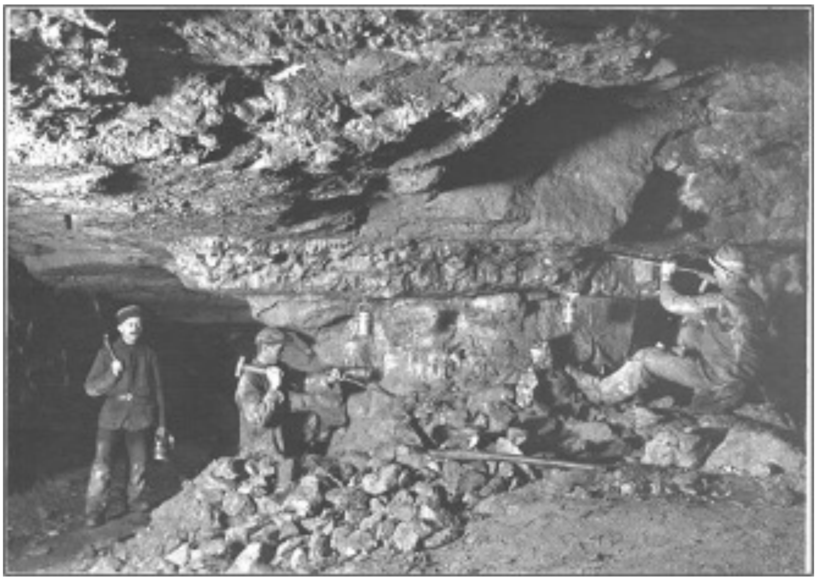
The exact date and circumstances of the discovery of the cross-border deposit Zinnwald / Cínovec are not known. Legends tell of large lumps of tin ore at the surface. The main mining period lasted from 1550 to 1600, during which the mining settlements on the “Zienwald” (in the following history named (Deutsch)-Zinnwald, Böhmisch Zinnwald, Vorder- und Hinterzinnwald and Cínovec respectively) developed. In the early years only tin ores with cassiterite were mined. Mid of the 19th century the mining of tungsten ores became more important.

According to EISENTRAUT, 1944 [***99]*** the production figures are:
1880 – 1890: 4.5 t of tin ore concentrate, 390 t of wolframite concentrate
1891 – 1899: 9 t of tin ore concentrate, 370 t of wolframite concentrate
1900 – 1924: 1,400 t of tin ore concentrate, 1,200 t of wolframite concentrate

Between 1890 until the end of the Second World War with only some short interruptions lithium-mica (zinnwaldite) was produced as a by-product. Production is reported as follows (EISENTRAUT, 1944 [***99]***):
1900 – 1924: 600 t of mica concentrate
1925 – 1933: 4,200 t of mica concentrate

The last mining efforts commenced in 1934, when the State of Saxony and the mining company Metallgesellschaft signed a contract on the takeover of the mining rights and mine facilities of Sachsenerz Aktiengesellschaft. Metallgesellschaft held some optional rights for production of lithium mica from the old tailings and the pre-emption right for half of the mica concentrate production by the new mine operator. The main production of lithium mica was achieved by reprocessing of the tin and tungsten tailing sands.

Figure 14: Mining of the “Flöz 9” Sn-W ore horizon (1921)



From 1936 to 1937 a joint venture of Metallgesellschaft and the mining company Zwitterstock Aktiengesellschaft Altenberg build the Schwarzwasser ore processing plant, situated in the forest between Zinnwald and Altenberg. In addition, the shaft complex of the Albert-Schacht and the cable railway connection to the central Schwarzwasser ore processing plant were developed. Thus, a regular mine production in Zinnwald could restart in 1937. Between January 1943 and April 1945 approximately 7,700 t of mica greisen were mined for lithium ore. Due to decreasing of the Sn and W reserves the production shifted more and more to the Czech part of the deposit. Therefore, the Militärschacht was developed as central shaft and a modern hydrometallurgical processing plant was put into operation at Cínovec in 1940/41.

In the German part of the deposit the mining activities ceased after the Second World War owing to the depletion of the tin and tungsten ore resources. Until 1967 the mine was owned by the Zinnerz Altenberg mining company, but only was kept open for maintenance measures.

The operations on the Czech side were taken over by the state-owned mining company Rude Doly Přibram, which continued the production of tin and tungsten ore by its subsidiary Rudne Doly Cínovec in the block Cínovec 1 (Žily) until 1978 and in the block Cínovec 2 (Jih) until 1990. The last ore was hauled in Cínovec on November 22, 1990. In 1991 the mining activities ceased for economic reasons.

6.2 Recent Safety and Remediation Measures

A substantial part of the mining activities took place in depths near to the surface and therefore affected the rock stability. Collapses of underground mine workings and associated rockfall resulted in the subsidence of the surface and the development of sinkholes at many places, in particular in the settlement areas directly above the deposit. Backfill measures were conducted already since 1920 using tailings disposed on the surface. For this purpose, sealed shafts were reopened and used for hydraulic transportation of the backfilling masses. The tailings were then backfilled by hand in the endangered open stopes.

In 1968 the company Bergsicherung Dresden started a detailed technical investigation to prepare an extensive remediation programme. Based on this study and on a stability risk assessment by VVB Steinkohle Zwickau extensive remediation, stability and backfill measures began in 1969. Within the old mining workings, the adits to the discarded mining blocks were encapsulated using dams and were backfilled with a mixture, which consisted of approximately 175 g of tailing sand on 1 l of water. In addition, numerous old shafts were re-opened and additional new shafts were built in order to gain access to further artisanal mines. This old mining workings were backfilled the same way. All shafts were then sealed near surface by a concrete plug. Hence, the stability conditions in the near surface portions of the old mining area on the German territory was considerably improved and further collapses and rockfalls could thus be prevented.

Between 1990 and 1992 technical rehabilitation and safety measures were carried out on the level of the Tiefer-Bünau-Stollen gallery (German side of the deposit) to secure the installation of an underground visitor mine and museum. This is operated today by the Altenberger Tourismus- und Veranstaltungs-GmbH, owned by the municipality of Altenberg.

Between 2007 and 2011 comprehensive underground operations took place on the German side of the Zinnwald / Cínovec deposit. The specialized company Bergsicherung Freital was contracted by the Saxon Mining Authority for safekeeping of selected mine stopes and drifts and for long-term stable restoration of the water drainage in the old mine. The latter work focussed on the reconstruction of the Albert-Shaft, the system of the Tiefe-Hoffnung-Gottes gallery and the Tiefer-Bünau-Stollen gallery, which .also receives the mine water overflow from the Czech part at the level of the Tiefer-Bünau-Stollen gallery.

From 2011 to 2020, a detailed condition survey and risk analysis of all old mining workings, shafts and adits in the Zinnwald area was carried out on behalf of the Saxon Mining Authority ***[166].*** Between 2018 and 2021 the emergency exit of the Zinnwald visitors mine has been reorganized, using now the reconstructed Rainstein-Shaft [***114***].

6.3 Exploration History

6.3.1 Preface

The Li-Sn-W greisen deposit Zinnwald / Cínovec was target of nine exploration campaigns since 1917. However, main focus of most of these investigations was the tin and tungsten mineralization. Various methods of sampling, geological interpretation and modelling were applied since the first systematic exploration efforts in the year 1917. During the years 1940 and 1941 extensive exploration activities took place in the Czech part.

In the case of lithium, a first systematic exploration in the German part of the deposit began in 1954 and was completed in 1960. This investigation was done by the Freiberg branch of the "Zentraler Geologischer Dienst der DDR" (Central Geological Survey of the G.D.R. – ZGD). During that time the Central Geological Institute of the G.D.R. ("Zentrales Geologisches Institut – ZGI) performed a regional re-assessment of the mineral potential of the Erzgebirge Mountains, including the lithium mineralization at Zinnwald.

In 1977 and 1987 additional exploration campaigns on tin, tungsten and lithium were carried out by the ZGI., with the latter terminated due to the political changes in 1990.

In 2007 the Canadian company TINCO Exploration Inc. in Vancouver (TINCO) received an exploration license "Altenberg TINCO" that covered almost all known tin-tungsten-molybdenum occurrences on the German territory, including substantial portions of the Zinnwald area. TINCO quit the license in September 2011.

In 2010 Solar World AG in Bonn, Germany, applied for exploration permission in all the remaining areas on the German side, which were not blocked by the rights of third companies (Field "Zinnwald"). In November 2011 Solar World further claimed the Field "Zinnwald-North", located `directly bordering north of Field "Zinnwald", which prior to that was covered by the exploration license of TINCO. In 2012 drilling of SolarWorld Solicium GmbH (SWS) commenced in its Zinnwald properties, which continued in the years 2013 and 2014. The successor Deutsche Lithium GmbH (DL) completed a drilling program in 2017.

6.3.2 Geological Mapping

In the 1880's the German Geological Survey started with systematic geological mapping. A first map of the scale 1:25,000 was published 1890. A revised version of the map followed in 1908 (DALMER, revised by GÄBERT ***[130]),*** completed by an explanatory brochure on the geological findings (DALMER, 1890, revised by GÄBERT, 1908 ***[117]).***

6.3.3 Drilling and Sampling

6.3.3.1 Introduction

Drilling and sampling within the German part of the Zinnwald / Cínovec deposit took place during the following campaigns:

The first drill holes were drilled in the beginning of the 20th century. The quality of the geological logging was not sufficient compared to present day standards.

- First systematic exploration drilling (10 drill holes) for lithium took place in Zinnwald from 1954 to 1956 (BOLDUAN, 1956 [***100])*** Most of the drill holes were collared underground on existing mine drifts.
- In the period from 1958 to 1960 further drilling of 17 holes and sampling with respect to lithium followed in Zinnwald (LÄCHELT, 1960 ***[101***])
- From 1977 to 1978 two additional drill holes were drilled for the re-assessment of the tin, tungsten and lithium potential (GRUNEWALD, 1978a ***[107]*** GRUNEWALD, 1978b ***[108]).***
- Between 1987 and 1990 intensive exploration including 8 drill holes and rock chip sampling followed. The work focussed on tin (BESSER & KÜHNE, 1989 ***[110],*** BESSER, 1990 ***[111]).***
- SolarWorld Solicium GmbH (SWS) and its successor Deutsche Lithium GmbH (DL) have performed two exploration drilling campaigns on the Zinnwald lithium property, respectively 10 drill holes in 2012 and 2013 to 2014 and 15 drill holes in 2017.

The individual drilling campaigns are presented in the following chapters.

6.3.3.2 Exploration Campaign No. (1) 1917 – 1918, Germany

The data collective of exploration campaign No. (1) comprises two drill holes – one surface drill hole and one underground drill hole sunk from the adit "Tiefer-Bünau-Stollen" (752 m a.s.l.). Tin and tungsten mineralizations were tested.

A total of 27 geological records were integrated into the "geology" table of the project database. The total length of the drilled holes accounts for 345 m. Neither sample assays and core recovery reports nor survey data are available. The drill hole paths were assumed to be vertical.

No information on data quality and quality control procedures is available.

6.3.3.3 Exploration Campaign No. (2) 1930 – 1945, Germany

This exploration campaign focussed on the investigation of the ore bearing geological structures. Three drill holes that reached the endocontact of the granite were integrated into the database. Two holes were drilled from surface and one from underground. This dataset comprises 39 geological records that cover a total drilled length of 515 m. Neither sample assays and core recovery reports nor survey data were available. With the exception of drill hole "BoFo 7" for which a dip angle of 45° and an azimuth of 244° was reported, all other drillhole paths were assumed to be vertical.

No information on data quality and quality control procedures is available.

6.3.3.4 Exploration Campaign No. (3) 1955, Czech Republic

This exploration campaign was carried out by the Czech Republic and was focussed on investigation of greisen structures containing lithium, tin and tungsten at Cínovec. Data from three surface drill holes of the Czech exploration campaign of 1955 were integrated into the database. The data comprise 74 geological records representing a total drilling length of 601 m. Neither sample assays and core recovery reports nor survey data were available. The drill holes Pc 1/55 and Pc 2/55 were not used for the design of the geological model owing to the lack of a reliable designation and distinction of greisen intervals.

No information on data quality and quality control procedures is available.

6.3.3.5 Exploration Campaign No. (4) 1951 – 1960, Germany

Exploration campaign No. (4) represents the first comprehensive investigation programme that was focused on the search for the principal component lithium. In addition, tin and tungsten grades were reported.

This program comprises a total of 17 surface drill holes and 10 underground drill holes. A total of 5,973 m was drilled resulting in 806 geological records. The geochemical records are as listed in **Table 11**

Table 11: Summary of geochemical data of exploration campaign No. 4

Components	Number of records	Total sample length [m]	Sampling method	Methods of geochemical analysis
Lithium	581	502	core sample	flame photometry
Tin	514	495	core sample	spectral analysis
Tungsten	519	496	core sample	spectral analysis

As the data from the tin assays systematically tended to higher values compared to those of campaigns (7) or (8), BESSER & KÜHNE [*110]*) suggested a correction by a factor of 0.7. Tungsten assays are in general above 250 ppm and therefore appear questionable when compared to results of other exploration campaigns, especially the campaign No. (8) of SWS (2012-2014). Consequently, this data cannot be used for resource estimation.

As no drill hole survey data are available, the drill holes were assumed to be vertical. Core recoveries were reported only fragmentarily. It is assumed that the assayed sample intervals represent recoveries of more than 80 %.

6.3.3.6 Exploration Campaign No. (5) 1961- 1962, Czech Republic

The campaign focussed on tin, tungsten and lithium mineralization and comprises 14 surface drill holes predominantly situated close to the German-Czech border. A total of 929 geological records representing a total sample length of 3,961 m were integrated into the project database. Geochemical records are as listed in **Table *12***:

Table 12: Summary of geochemical data of exploration campaign No. 5

Components	Number of records	Total sample length [m]	Sampling method	Methods of geochemical analysis
Lithium	945	1,289	core sample	not specified
Tin	447	447	core sample	not specified
Tungsten	331	328	core sample	not specified

As no drill hole survey data were available, the drill holes were assumed to be vertical. Major core losses were reported as separate intervals in the drill log. No further data were at hand.

No information on data quality and quality control procedures was available.

6.3.3.7 Exploration Campaign No. (6) 1977 – 1978, Germany

The data set of exploration campaign No. (6) contains information on two surface drill holes with 230 geological recordings representing a total length of 1,216 m. Additionally 1,350 pick samples were collected underground from the “Tiefer-Bünau-Stollen” level (752 m a.s.l.).

This exploration campaign was focused on scientific aspects and was carried out by GRUNEWALD, 1978a [259]) Therefore, rock chip samples were taken from the cores at intervals of 20 cm and compiled to composite samples which represent core intervals of 2 m to 6 m length.

These were assayed by spectral analysis for tin, tungsten and lithium. Intervals that showed elevated tin and tungsten grades during this first screening were reanalysed by X-Ray fluorescence (XRF) using drill core samples of interval lengths of approximately 1 m.

The pick samples were randomly collected at spacings of 2 to 5 m from the sidewalls of the drifts on the “Tiefer-Bünau-Stollen” level.

Table 13: Summary of geochemical data of exploration campaign No. 6

Components	Number of records	Total sample length [m]	Sampling methods	Methods of geochemical analysis
Lithium	373	1,216	rock chip sample	spectral analysis
Tin	373	1,216	rock chip sample	spectral analysis
Tungsten	373	1,216	rock chip sample	spectral analysis
Tin	106	104	core sample	X-Ray fluorescence analysis
Tungsten	106	104	core sample	X-Ray fluorescence analysis
Lithium	1,341	-	pick sample	spectral analysis
Tin	1,341	-	pick sample	spectral analysis
Tungsten	1,326	-	pick sample	spectral analysis

Survey data of the drill holes are available and were integrated in the database. The average core recoveries are reported as follows:

Drill hole 19/77: 97.8 %
Drill hole 20/77: 92.7 %

6.3.3.8 Exploration Campaign No. (7) 1988 – 1989, Germany

During exploration campaign No. (7), eight holes were drilled from surface providing 684 geological records representing a total length of 3,148 m. The sampling and geochemical analysis programme was comparable to that of exploration campaign No. (6). However, this exploration campaign was preliminarily focussed on the tin and tungsten mineralization. Lithium was only tested on rock chip samples.

Table 14: Summary of geochemical data of exploration campaign No. 7

Component	Number of records	Total sample length [m]	Sampling method	Method of geochemical analysis
Lithium	1,188	3,149	rock chip sample	spectral analysis
Tin	1,188	3,149	rock chip sample	spectral analysis
Tungsten	1,188	3,149	rock chip sample	spectral analysis
Tin	397	403	core sample	X-Ray fluorescence analysis
Tungsten	397	403	core sample	X-Ray fluorescence analysis

Survey data of the drill holes are available and were integrated in the database. The average core recoveries are reported as follows:

Drill hole 21/88:	86.8 %,	Drill hole 22/88:	95.9 %
Drill hole 23/88:	95.6 %,	Drill hole 24/88:	95.4 %
Drill hole 25/88:	96.5 %,	Drill hole 26/88:	91.7 %
Drill hole 27/88:	89.3 %,	Drill hole 28/88:	96.7 %

6.3.3.9 Exploration Campaign (8a / 8b) 2012 – 2013, Germany

The exploration campaign of SWS comprises 10 surface drill holes. Nine of them were drilled as diamond drill holes (DDH) with various diameters (at least type NQ with hole diameter 75.7 mm and core diameter 47.6 mm). In addition, one reverse circulation drill hole (RC DH, ZGLi 05/2013) was performed. The drill holes were selectively designed as infill holes and twin holes (ZGLi 05/2013 and 05A/2013, ZGLi 06/2013 and 06A/2013).

In addition, 88 channel samples of 1.5 m length and 2 m spacing were taken from the sidewalls of the “Tiefer-Bünau-Stollen” (752 m a.s.l.) and “Tiefer-Hilfe-Gottes-Stollen” galleries (722 m a.s.l.). A total of 419 geological records representing a total length of 2,563 m are documented. Multi-element assays by ICP-MS were performed on one half of the DDH core and on the channel samples. Supplementary X-Ray fluorescence assays of tin and tungsten grades have been carried out for the drill hole samples from ZGLi 01/2012 and ZGLi 02/2012. The results are fully comparable to ICP-MS assays and were used for the resource estimation.

Table 15: Summary of geochemical data of exploration campaign No. 8

Component	Number of records	Total sample length [m]	Sampling method	Method of geochemical analysis
Lithium	1,247	1,237	core sample	acid fusion + ICP-MS
Tin	1,244	1,235	core sample	Li metaborate fusion + ICP-MS
Tungsten	1,247	1,237	core sample	Li metaborate fusion + ICP-MS
Tin	407	393	core sample	X-Ray fluorescence analysis
Tungsten	406	392	core sample	X-Ray fluorescence analysis
K_2O	1,247	1,237	core sample	Li metaborate fusion + ICP-AES
Na_2O	1,247	1,237	core sample	Li metaborate fusion + ICP-AES

Drill hole surveys were performed on all drill holes and the data was integrated in the database.

6.3.3.10 Exploration Campaign (8c) 2017, Germany

DL drilled 15 holes in 2017 with a total length of 4,458.9 m. Depending on the near-surface conditions in the overburden the about first 10 m were drilled with PQ 85.0 mm core /122.6 mm hole diameter. Owing to technical reasons, HQ 63.5 mm core /96.0 mm hole diameter was used below down to a maximum of 60 m depth. NQ diameter holes with 47.6 mm core / 75.7 mm hole were drilled at greater depth in the granite and the ore zones.

6.3.4 Geochemical Surveys

Stream sediment sampling results were reported by OSSENKOPF [***121]*** in 1982.

A pedogeochemical survey in the regional to detailed local scale followed in the Eastern Erzgebirge including the area of Zinnwald (PÄLCHEN et al., 1989 ***[124]*** and PÄLCHEN et al., 1989 ***[125]***). To eliminate anthropogenic influences two samples were taken at each sampling point, the first from surface to 0.1 m depth and the second from 0.1 to 0.3 m depth.

A wide range of elements were analysed, including the elements relevant to greisen and granite-related mineralizations, such as Li, Sn, W, Mo, Bi, Nb, As and F. The geochemical results indicated significant Sn, W and As anomalies. By implementing further trace elements, the mineral potential of the region was reassessed and recommendations given for further exploration work.

In recent years, the Saxon State Government founded comprehensive reviews of the available historic exploration and research data as well as a new geochemical survey of the Erzgebirge / Vogtland area (BARTH et al., 2019a ***[161]***, HELBIG et. Al., 2018 ***[163]***). This work resulted in the revision and construction of the metallogenetic development of the Erzgebirge and Vogtland area (BARTH et al., 2019a [***161],*** HELBIG et al., 2018 [***163]***), as well as the identification of raw material potential areas, including for Li (BARTH et al., 2019b ***[162]***).

6.3.5 Geophysical Surveys

Systematic geophysical surveys started in the 1950s with gravity measurements (OELSNER, 1961 ***[118]***). A summary report was published in 1964 (LINDNER, 1964 ***[119]***). Geomagnetic data was published in 1966 (SCHEIBE, 1966 ***[120]***). Further detailed geophysical surveys took place in the 1980's in the scope of tin, tungsten and fluorite / barite exploration (STEINER et al., 1987 ***[123]***; PÄLCHEN et al., 1989 ***[125]***) including a special airborne survey (RUHL, 1985 ***[122]***).

The outcomes of the geophysical surveys Indicated relevant gravity anomalies, which were used for the design of detailed geochemical mapping campaigns and for the determination of drilling targets.

7 Geological Setting and Mineralization

7.1 Regional Geology

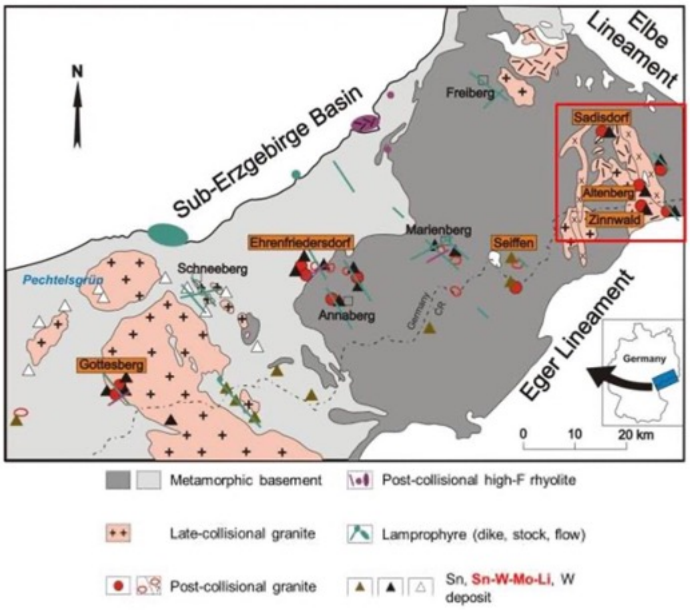
The Erzgebirge-Fichtelgebirge Anticlinorium represents one of the major allochthonous domains within the Saxo-Thuringian Zone of the Central European Variscan Belt, which was formed by the collision of Gondwana and Laurentia in the Late Paleozoic (PÄLCHEN & WALTHER, 2008 ***[128]***). It spreads over an area of about 150 x 40 km within the eastern part of Germany and the north-western part of Czech Republic, where the Erzgebirge Mountains are named Krušné Hory. Metamorphic rocks of Proterozoic and Late Paleozoic age and intercalating magmatic and volcanic units shape the geological structure of the Erzgebirge area. Confined by deep reaching tectonic lineament zones the Erzgebirge forms a fault-block of slightly ascending topography from NW to SE (from 300 to 800.- 1,000 m a.s.l.) and a steep escarpment towards the Eger-Lineament in the SE (**Figure *15***).

The internal geological structure of the Erzgebirge Mountains is represented by a major NE-SW-striking anticline that is dipping towards SW. The pre-Variscan rock series of the Erzgebirge Mountains have received a marked overprint by deformation, metamorphism, magmatism and metasomatism associated with the Variscan orogeny (BAUMANN et al, 2000 ***[127]***). Felsic intrusions intersected the metamorphic basement during the extensional stage of the Variscan orogeny with two peaks of magmatic activity, allowing a subdivision of late collisional magmatism (Older Intrusive Complex [OIC]; 330–- 320 Ma) and post collisional magmatism (Younger Intrusive Complex [YIC]; 310–- 290 Ma) (SEIFERT & KEMPE, 1994 ***[148]***; summarized by ROMER et al., 2010 ***[145]***). In terms of size and volume, the granites of the late-collisional stage significantly exceed the post collisional granites.

The granites of the Erzgebirge Mountains are exposed along two zones in the eastern and western distributional areas with additionally outcropping in- / extrusions of rhyolites and dykes of porphyritic granites in the eastern part (**Figure *16***). The latter are formed in close spatial and temporal association with the younger post collisional granites and can be linked to fault tectonics that occurred dominantly in this particular area. This Carboniferous magmatism and the associated intrusions of granitic magmas is therefore interpreted as the most essential event for the formation of mineral deposits in the Erzgebirge Ore Province (NEßLER et al., 2018 ***[116]***).

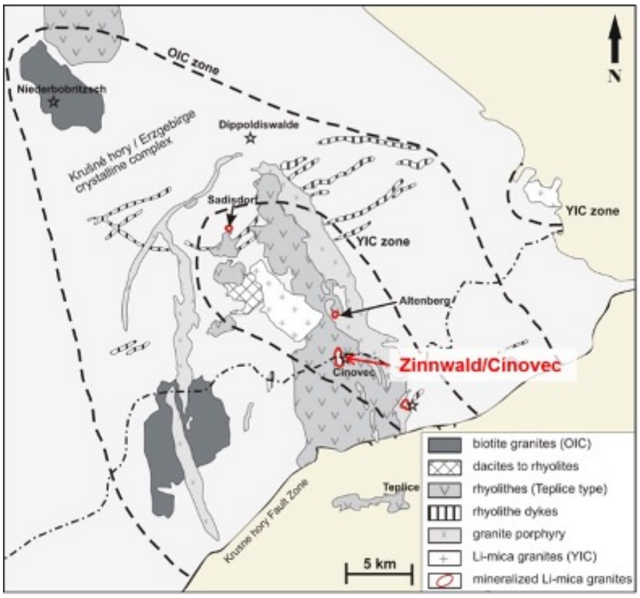
From the Upper Carboniferous throughout the Mesozoic and Caenozoic the Erzgebirge was with short interruptions object of erosional processes that modified this area and defined todays near surface position of the Proterozoic and Palaeozoic units (BAUMANN et al., 2000 ***[127]***; HENNIGSEN & KATZUNG, 2006 ***[137]***).

Figure 15: Simplified geological map of the Erzgebirge Mountains and their mineral deposits



An enlarged view of the area marked with the red box in **Figure *15*** is given in **Figure *16*** (modified from SEIFERT, 2008 ***[149]***).

Figure 16: **Geological map of the eastern Erzgebirge (1:50 000)**

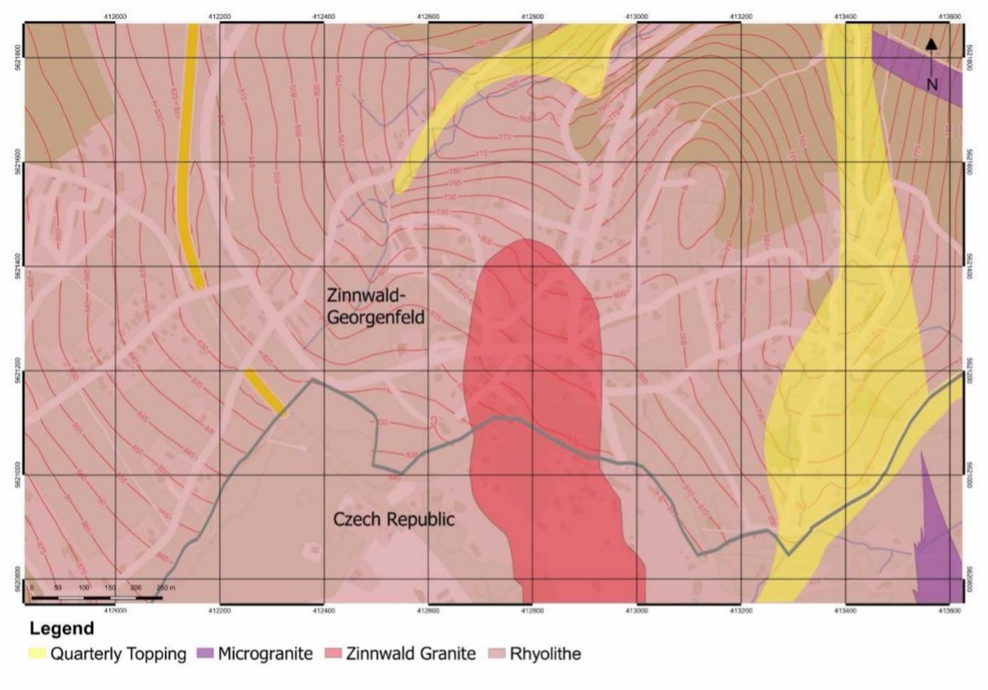


7.2 Project Geology

7.2.1 Lithology

The geological setting of the Zinnwald deposit is characterized by the appearance of two main lithologies, the Teplice Rhyolite (TR) and the Zinnwald Albite Granite (ZG) which are presented in **Figure *17***.

Figure 17: **Geological map of the Zinnwald / Cínovec deposit (1.25 km x 1.25 km**



The ZG is regarded as highly altered albite granite which intruded the volcanic pile of the TR. The ZG intrusive body covers an ellipsoid N-S-striking outcrop area of 1.4 km x 0.4 km and straddles the border between Germany and Czech Republic.

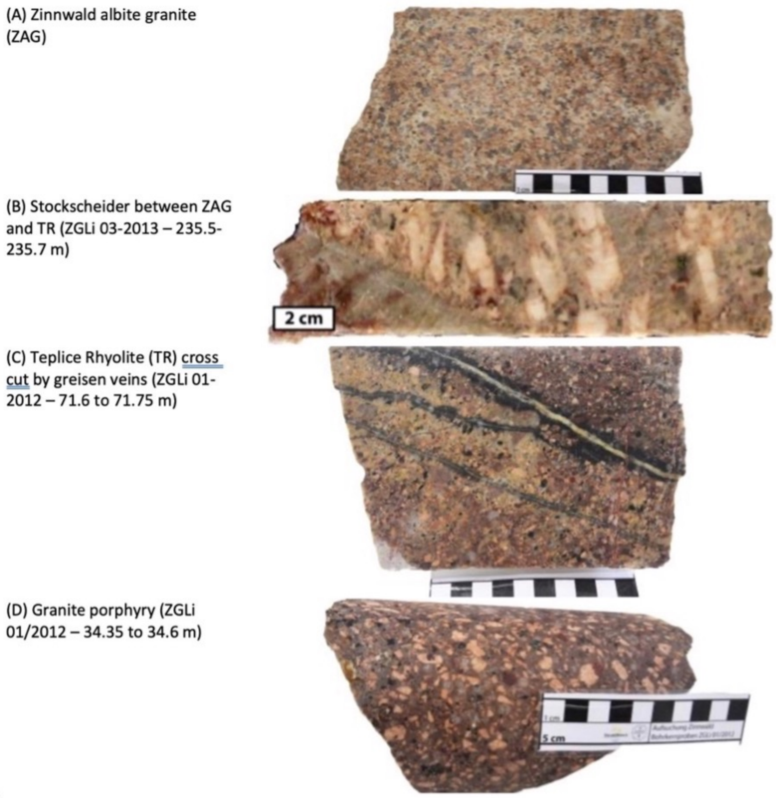
(1) The volcanic rock sequence of the TR, covering a large area at the eastern margin of the Altenberg Block (Altenberger Scholle), extend for about 22 km in NNW-SSE direction (PÄLCHEN, 1968 [106]). Within the property the TR represent the most dominant country rock and exhibit a wide textural variability. They are generally reddish grey to dark red in colour. Based on their textural appearance three subdomains / varieties can be distinguished:
(2) A dominant phenocryst rich rhyolite (Figure 18C).
(3) A subordinate phenocryst poor, ignimbritic rhyolite.
(4) A vein-like, coarse-grained, porphyroidic granite resembling a subordinate type of the TR that is exposed only in borehole ZG 19/77 and ZGLi 01/2012 (Figure 18D).

The general modal composition of rhyolite in the property is about 43.8–- 48.0 % quartz, 24.1–- 32.1 % orthoclase, 5.6–- 14.8 % plagioclase (~10 % anorthite), 10.4. .18.0 % mica with minor haematite, kaolinite, zircon, and apatite. All three varieties can display different types of xenoliths (0.5–- 10 cm) of either rhyolitic material or altered gneiss fragments from the underlying met-amorphic basement.

The ZG is a typical example of a pipe-like felsic intrusive body in a subvolcanic environment. It is ovoid in shape with generally gently inclined (10° - 30°) flanks to the N, E and S of the ZG and a steeply inclined (40° - 70°) W-flank (**Figure *19***). Commonly, the contact of the ZG to the TR presents a marginal pegmatite (“Stockscheider”) with a thickness between 0.3–2 m (GRUNEWALD, 1978b ***[108]***, **Figure *18***).

Detailed petrologic descriptions of the ZG are given amongst others by BOLDUAN & LÄCHELT, 1960 ***[104]***, GRUNEWALD, 1978b ***[108]***, BESSER & KÜHNE, 1989 ***[110]***, NEßLER, 2017 [***115***] and NEßLER et al., 2018 ***[116]*** for the German part and by ŠTEMPROK & ŠULCEK, 1969 ***[152],*** SELTMANN & ŠTEMPROK, 1995 ***[150]*** and RUB et al., 1998 ***[155]*** for the Czech part. The respective data are based on exploration drilling and on surface as well as underground mapping.

Figure 18: **Drill core images of the major lithologies from the Zinnwald endo-contact**

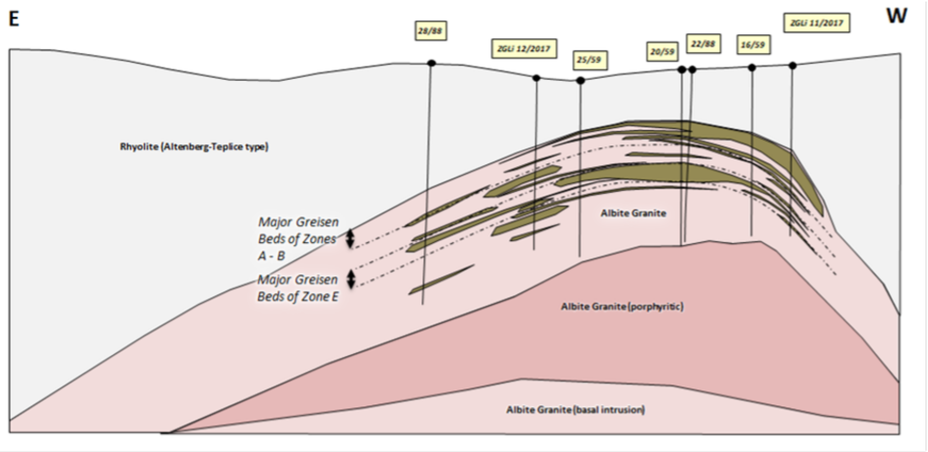

(A) Zinnwald albite granite (ZAG)

(B) Stockscheider between ZAG and TR (ZGLi 03-2013 – 235.5-235.7 m)

(C) Teplice Rhyolite (TR) cross cut by greisen veins (ZGLi 01-2012 – 71.6 to 71.75 m)

(D) Granite porphyry (ZGLi 01/2012 – 34.35 to 34.6 m)

Figure 19: **Geological E-W cross section showing the Zinnwald granite with greisen ore bodies**



Vertical compositional and textural zoning is known from the deep borehole CS-1 (1,596 m) drilled in the intrusive body of Zinnwald / Cínovec (ŠTEMPROK & ŠULCEK, 1969 ***[152]***; RUB et al., 1998 ***[155]***).

To avoid inconsistent terminology, the Zinnwald Granite (ZG) is referred to the complete intrusion independent from any mineralogical, textural or geochemical characteristics. Figure 15 gives a concise summary of different granitic lithologies intersected in the deep drill hole CS-1, starting with a succession of medium-grained equigranular zinnwaldite-albite-granite (ZAG) to a depth of about 730 m, which resembles the dominant rock type within the upper part of the granite cupola and hosts the entire ore mineralization.

The ZAG is generally bright grey to yellowish grey in colour (Figure 13A). On average it is composed of plagioclase (albite 34.8 %), quartz (32.8 %), orthoclase (23.4 %), Li-mica (zinnwaldite 5.9 %), sericite (2.1 %) and accessory topaz, fluorite, zircon, cassiterite and clay minerals. The texture of the rock is granitic, weak porphyritic and poikilitic. Sericite, albite and fine-grained quartz constitute a coherent groundmass with embedded bigger grains of quartz, orthoclase and minor zinnwaldite. Individual sections/portions of the ZAG can be strikingly variable in texture.

Plagioclase of 5 % anorthite (≤ 1.4 mm, Ø = 0.6 mm) is mostly present as small, lath-like, euhedral grains forming the groundmass and showing distinct or faint twinning lamellae. Additionally, it can represent inclusions within bigger grains of quartz or zinnwaldite.

A population of big xenomorphic, phenocryst-like grains of quartz I (≤ 6 mm, Ø = 3 mm) with uneven and crenated grain boundaries towards groundmass-albite can be distinguished from fine grained quartz II (0.3 0.5 mm), which forms a portion of the groundmass.

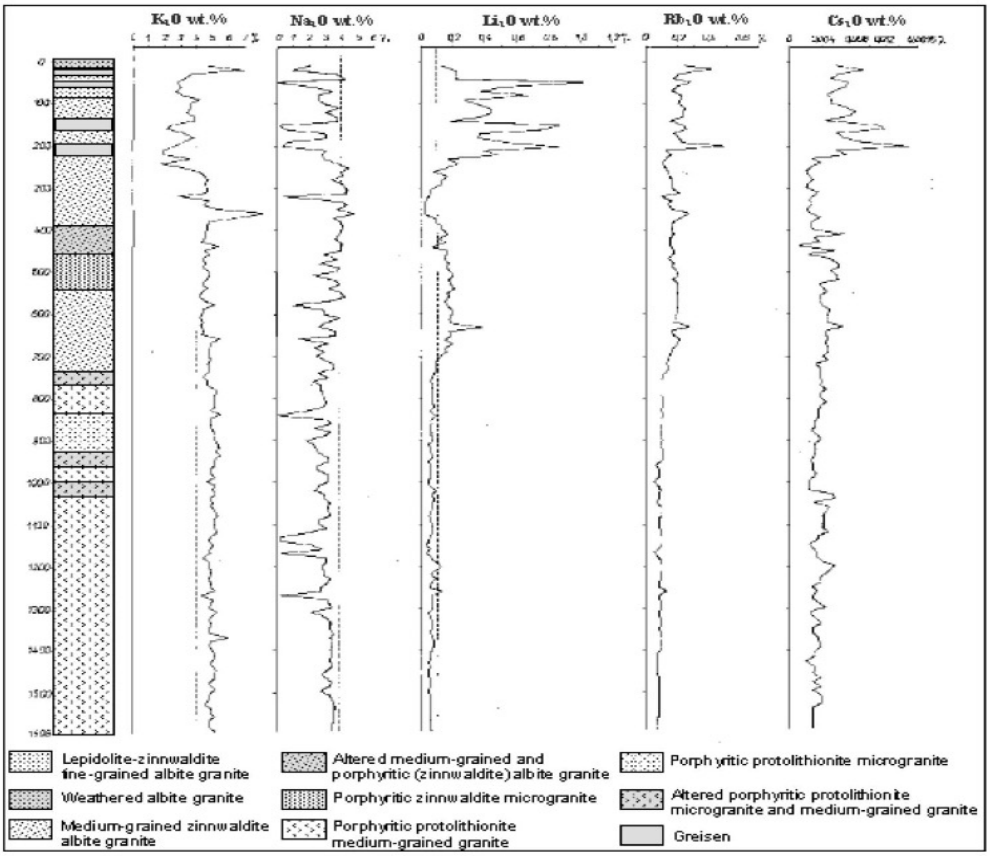
Orthoclase I (≤ 2.5 mm, Ø = 2 mm) is represented by big subhedral grains with evenly shaped grain boundaries and numerous inclusions of plagioclase. The transformation to sericite is very common and can be found in a broad range of intensity. Interstitial orthoclase II (0.15 0.6 mm) of various grain sizes is also common.

Zinnwaldite (≤ 2.5 mm, Ø = 1 mm) was identified as the prevailing mica species in the ZAG. Tabular crystals are corroded by minerals of the groundmass very intensely, in part leaving only relicts of zinnwaldite. Pleochroic haloes are abundant as are inclusions of fluorite and other accessories. Zinnwaldite is transformed to sericite mainly along cleavage planes and can show orientated muscovite overgrowth.

As one of the dominant groundmass minerals sericite is abundant and forms flaky and rosette-like aggregates. The amount of sericite within the rock varies exceptionally (up to 37 %, on average about 2–- 3 %).

Euhedral to xenomorphic cassiterite (≤ 1.2 mm, Ø = 0.15 mm) of various grain shapes and irregular pleochroism and colourless to patchy purple coloured fluorite (≤ 0.3 mm, Ø = 0.2 mm) are among the most common accessory mineral phases.

Figure 20: **Drill log and distribution curve of alkali elements of the deep drill core CS-1**



In drill hole CS-1 the ZAG was found up to a depth of 730 m. From 390 m to 540 m major zones of alternating ZAG and porphyritic zinnwaldite-microgranite (PZM) occurred. Equivalents of this rock type were also found at more shallow depths within different drill holes on the German side. Relatively similar in composition to the ZAG, the PZM shows a prominent porphyritic texture with euhedral grains of quartz (≤ 1.5 cm) and plagioclase (≤ 2 cm) in a groundmass of quartz, plagioclase and sericite. The thickness of equally textured zones is in the range of centimetres to a few meters.

The Zinnwald pluton shows partial depletion in Li, Rb and Cs with depth (ŠTEMPROK & ŠULCEK, 1969 ***[152]***) as presented in Figure 15. In the centre of the cupola a gradual transition into Li-poor, medium-grained, porphyritic protolithionite granite (PPG) is taking place at a depth of 730 m. Differing in texture and mica composition from the upper ZAG this Li-poor PPG is characterized by phenocrysts of orthoclase (2–- 3 cm), rounded quartz, tabular albite crystals and dark green protolithionite. The continuous succession of PPG was intersected by CS-1 to a final depth of 1,596 m.

To the south-west of the Zinnwald property a granite porphyry dike and a small eroded chimney of tertiary basalt are exposed.

7.2.2 Structure

The development of genetically important late to post Variscan tectonic structures in the eastern part of the Erzgebirge are already predefined by deep reaching fault zones of Proterozoic to pre-Ordovician age. Additional to major tectonic lineaments confining the rocks of the Erzgebirge Mountains there are several deep-seated fault zones with a high significance for the tectonic and magmatic development of the region:

- fault system of Niederbobritzsch – Schellerhau – Krupka (NW – SE)
- fault system of Meißen – Teplice (NNW – SSE)
- fault system of Frauenstein – Seiffen (NNE-SSW)
- fault system of the central Erzgebirge (NE-SW)
- fault system of the southern Erzgebirge (NE-SW)

The most important regional tectonic element is represented by the fault “Seegrundstörung” which forms a part of the deep fault system of Niederbobritzsch – Schellerhau – Krupka and runs in the immediate southwest of the Zinnwald granitic intrusion. This fault zone is thought to have a major relevance for the arrangement and postmagmatic development of the deposit.

The tectonic framework of the deposit itself is dominated by the NE-SW directed hydrothermal veins, the so called “Morgengänge” veins, and perpendicular trending cross joints. The latter are characterized by a high-angle dip, large continuity in strike direction, and a mean thickness of 10 cm to 20 cm (max. 50 cm). According to numerous authors, including BERGSICHERUNG DRESDEN, 1991 ***[131]*** and SENNEWALD, 2007 – 2011 ***[112]***, they are formed synchronous with the flat dipping mineralized veins (named “Flöze” by the previous miners) cross cutting them in vertical to sub vertical direction. The direction of displacement is sub-horizontal. Mostly developed along the western flank of the deposit the “Morgengänge” veins are related to younger tectonic movements with displacement in the range of meters. Especially in this area, the contact of the Zinnwald granite to the surrounding Teplice rhyolite is tectonically dominated and a set of progressive step faults shape a steeply dipping western flank.

Additionally, minor tectonic movements appeared along the gently inclined and flat dipping surfaces of quartz veins, displayed by numerous slickensides.

At many locations the “Morgengänge” veins and the adjacent granite are mineralized with quartz, fluorite, cassiterite, and minor wolframite and were frequently exploited during historic mining. “Morgengänge” veins that developed in the host rocks (Teplice rhyolite) can also show greisenization features and minor impregnation with tin oxides.

Several types of variably angled joints documented during the 1950’s reveal a general system that can be applied to the granite and greisen lithologies (**Table *16***).

Table 16: Systematic scheme of joints in the German part of the Zinnwald deposit

System	Index	Azimuth	Dip	Characteristics
Erzgebirgian (morningvein-like)	a	40°	60-80°	well developed, not mineralized, rare joint layer clay
Hercynian (strikingjoint-like)	h	120-160°	48-80°	well developed, not mineralized
L-joints (flöz-like)	L	turning around	following granite contact	poorly developed, mineralized
S-joints	S	100°	80-90°	very poorly developed
Diagonal joints	dk‘	80°	15-65°	very poorly developed, not mineralized
Diagonal joints	dk‘‘	350°	50°	very poorly developed, not mineralized
Q ?–- joints	Q	180°	90°	well developed, not mineralized

7.2.3 Alteration

The ZG has experienced a series of post-intrusive metasomatic and hydrothermal alteration events. Microclinization followed by albitization, greisenization, argillic alteration and haematitization have taken place after solidification (ŠTEMPROK & ŠULCEK, 1969 ***[152]***). Distinct zones of alteration intensity are common for all types of alteration while boundaries of these zones can be either sharp or blurred.

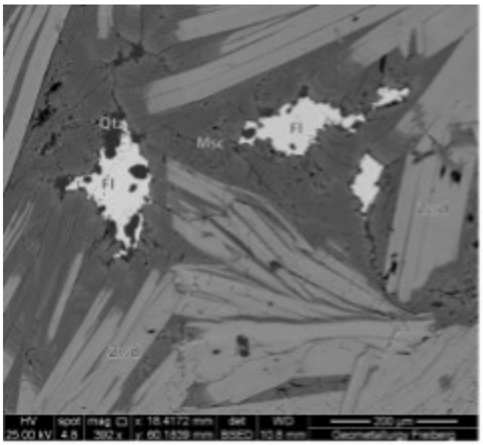
The most prominent alteration feature comprises the transformation of rock forming minerals (e.g., Ca-plagioclase, orthoclase) to albite during Na-metasomatism, the so-called albitization. This type of auto-metasomatic alteration incorporates the entire volume of the upper ZAG and PZM to a depth of 730 m, whereas it is less pronounced or absent in the deeper parts of PPG. The intensity of albitization is highly variable. While most of the ZAG has undergone an intermediated albitization with the transformation of the majority of Ca- / K-feldspar to albite, ongoing Na-metasomatism in combination with removal of SiO_2 produced rocks of up to 70 % albite, so called albitites. Irregular bodies of albitites of up to 1 m thickness are found in drill core and underground.

Similar to albitization, but of much less abundance is the process of K-metasomatism, producing rocks of up to 50 % orthoclase. Together with albitites, these so-called feldspatites are of particular interest for mechanical rock behaviour as they are representing zones of unusual crumbly and unstable rock.

Greisenization is the most important feature of high-temperature alteration in the deposit of Zinnwald / Cínovec. Since it is related to the formation of lithium ore mineralization, it will be discussed in chapter 7.3.1.

Sericitic alteration of the ZAG is common, where a fine-grained variety of muscovite (sericite) is replacing plagioclase, orthoclase and zinnwaldite to a variable degree. It can be accompanied by the formation of illite (a K-deficient muscovite) and clinochlore (member of the chlorite group) and can be recognized as fine-grained, light greyish to greenish aggregates between the other minerals. Likewise, the TR and greisen mineralization can be affected by sericitic and chloritic alteration. The latter shows a pronounced alteration and transformation along the mica's grain boundaries as can be seen in the back-scatter (BSE-) electron image (**Figure *21***).

Figure 21: **Back scatter electron image of a zinnwaldite rich greisen sample**



Argillic alteration of ZAG (and subordinately of all other lithologies within the Zinnwald property) is a common feature as well. Superseding micas and the group of sodic and potassic feldspars, fine grained aggregates of well intergrown kaolinite crystals create a whitish to greyish rock according to the variable intensity of alteration. Argillic alteration can cause a distinct decrease in rock strength as it lowers the cohesive strength of the mineral grains in the rock's fabric.

The impregnation of the matrix of ZAG and TR by fine grained hematite and / or other iron oxides / hydroxides is another common alteration feature and can be found in various intensities. The character of haematitization can be either disseminated and blurry or discrete with local haematite spots and / or stringers.
A type of alteration that is constrained to the lithology of TR is silicification which is most pronounced along the northern and eastern portion of the deposit.

7.3 Styles of Mineralization

Mineralogical and petrological characterization of the different rock types was conducted by macroscopic observation of outcrops (above and below ground), drill core (historic and recent) as well as microscopic investigation of thin sections made from selected drill core samples. Information on modal composition of the rocks was supported by data from literature, basically BOLDUAN & LÄCHELT, 1960 ***[104]*****,** PÄLCHEN, 1968 ***[106]***, ŠTEMPROK & ŠULCEK, 1969 ***[152]*** and GRUNEWALD, 1978a ***[107]***, based on point-counting methods and X-Ray diffraction analysis. Furthermore, recent results on modal composition of greisen ore material from an automated mineral liberation analysing system (MLA) was added here in the report.

Greisen type mineralization at the Zinnwald / Cínovec deposit is related to flat dipping, sheet-like greisen ore bodies and veins in the apical part of a geochemically highly evolved granitic intrusion. Lithium, tin, and tungsten mineralization is potentially economic and occurs mainly as quartz-mica greisen.

Exploration at Zinnwald has defined a Li-Sn-W greisen deposit in several stacked continuous bodies with a dimension of 1.6 x 1.5 km on the German territory (corner points according to Gauss-Krueger coordinate system: 5,412,400; 5,622,650 – 5,414,000; 5,624,150). The deposit reaches from 200 m a.s.l. up to 850 m a.s.l..

Individual greisen beds show a vertical thickness between less than 1 m and more than 40 m.

No other areas of significant mineralization are known at present at the Zinnwald property, but surface exposures and drillings indicate various preliminary investigated or untested anomalies in the vicinity. Li-Sn-W-(Mo) mineralization is also known to exist to the north at the Altenberg "Zwitterstock" deposit. Furthermore, a Sn-W-Nb-Ta mineralization was intersected by drilling in the south-eastern portion of the deposit (NEßLER, 2017 ***[115],*** NEßLER et al., 2018 ***[116]).***

1. The Zinnwald / Cínovec greisen deposit and subordinately the TR can be characterized by a number of different mineralization styles. The most important include: Independent or vein adjoining greisen bodies
II. Flat dipping veins ("Flöze")
III. Subvertical dipping veins ("Morgengänge")
IV. Metaalbite granite Sn-W-(Nb-Ta) mineralization

The vast majority of lithium and portions of the tin and tungsten mineralization within the Zinnwald / Cínovec granite stock can be found in the metasomatic greisen ore bodies (style I). The position of greisen mineralization is a result of late- to post-magmatic fluids, infiltrating the uppermost part of the granite stock. They were distributed in dependence on the granite's joint system along cracks and intergranular pathways. Consequently, faults and joints played an important role in the dispersal of mineralizing fluids throughout the cupola. According to investigations of BOLDUAN & LÄCHELT, 1960 ***[104]*** and BESSER & KÜHNE, 1989 ***[110]*** greisenization as well as the development of the "Flöze" is closely linked to the flat dipping L-joints, representing cracks and joints resulting from the volume loss of the granite during cooling and crystallization. Areas of cross-cutting L-joints and sub-vertical faults / joints are considered to be favourable for the development of particular thick bodies of greisen mineralization.

Mineralization styles II and III are of subordinate importance for lithium but are well mineralized with cassiterite, wolframite and minor scheelite and played therefore an important role during historic mining. The predominant part of this resource was exploited in the past. Subordinate amounts of zinnwaldite can be found in the flat dipping veins (style II) along the endo- and exocontact of the deposit, where it forms selvages of very coarse grained zinnwaldite (up to 50 mm). Detailed information on veining in the deposit will be presented in Item 7.3.3.

Mineralization style IV represents an unusual type of ore mineralization in the Zinnwald deposit and will be discussed in the following chapter based on geological, mineralogical and geochemical findings.

7.3.1 Description of Mineralized Zones

Independent or vein adjoining greisen bodies

The lithium ore mineralization of the Zinnwald property is closely linked to the existence of metasomatic greisen ore bodies that are located at the endo-contact of the uppermost parts of the ZG stock (style I). They form curved, stacked and lensoidal compact greisen bodies that can be highly irregular in shape but commonly exhibit a larger horizontal and limited vertical extend. The presence of stock-like greisen, reported in literature (e.g., BOLDUAN & LÄCHELT, 1960 ***[104]***), remains disputable owing to the lack of prove by drilling intersections. However, maximum intersected greisen thickness was about 44 m (ZGLi 06A/2013). This style of greisen mineralization occurs in the central uppermost part and along the flanks of the ZG and follows with subparallel dip the morphology of the granite's surface. Frequency and thickness generally decrease with depth. True thickness of greisen bodies is consequently consistent with the vertical depth for the central parts where the dip angle is less than 10°. Towards the gently inclined (10° - 30°) flanks of the N, E and S and a steeply inclined (40° - 70°) W-flank the true vertical thickness needs to be recalculated, respectively. On average, thickness of potentially mineable greisen bodies in the property area is between 2 m and 15 m.

In addition to the predominant type of independent greisen ore bodies which are described above, there are greisen masses confined to flat dipping veins and sub-vertical dipping faults / veins, the adjoining greisens. They represent intensely greisenized wall rocks of the veins / faults, are highly irregular in shape and follow the veins / faults in strike direction throughout the upper part of the deposit. They are of limited dimension. Thicknesses vary from a few centimetres to several meters. Although veins and faults obviously represent the controlling structures, general principles regarding the position and thickness of these elements cannot be deduced from under-ground exposures. More precisely, they can be formed either in the hanging and / or in the foot-wall of the vein / fault or they can be completely absent. The thickness of adjoining greisens can be very variable in strike direction. The independent greisen bodies volumetrically exceed the adjoining greisens by far.

The contacts between greisen and albite granite (ZAG) host lithologies can be either sharp or diffuse with a thickness between a few centimetres to some decimetres (**Figure *24***D). However, there are numerous records of transitions from altered ZAG to greisen with relicts of feldspar and typical greisen. Additionally, lenses of irregular shaped pockets of greisenized ZAG can be present.

The Zinnwald greisen contains variable amounts of quartz, Li-Rb-Cs-bearing mica named zinnwaldite, topaz and accessory minerals. Under consideration of the protolith and the modal mineralogical composition several subtypes of greisens can be distinguished. A frequently used and easily applicable classification scheme involves the amount of quartz, mica and topaz plotted in a ternary diagram (see KÜHNE et al., 1967 ***[105]***). Among the greisens of a granitic protolith three ideal end members can be inferred:

I.	Quartz greisen	(quartz 85 to 100 %)
II.	Mica greisen	(zinnwaldite 85 to 100 %)
III.	Topaz greisen	(topaz 85 to 100 %)

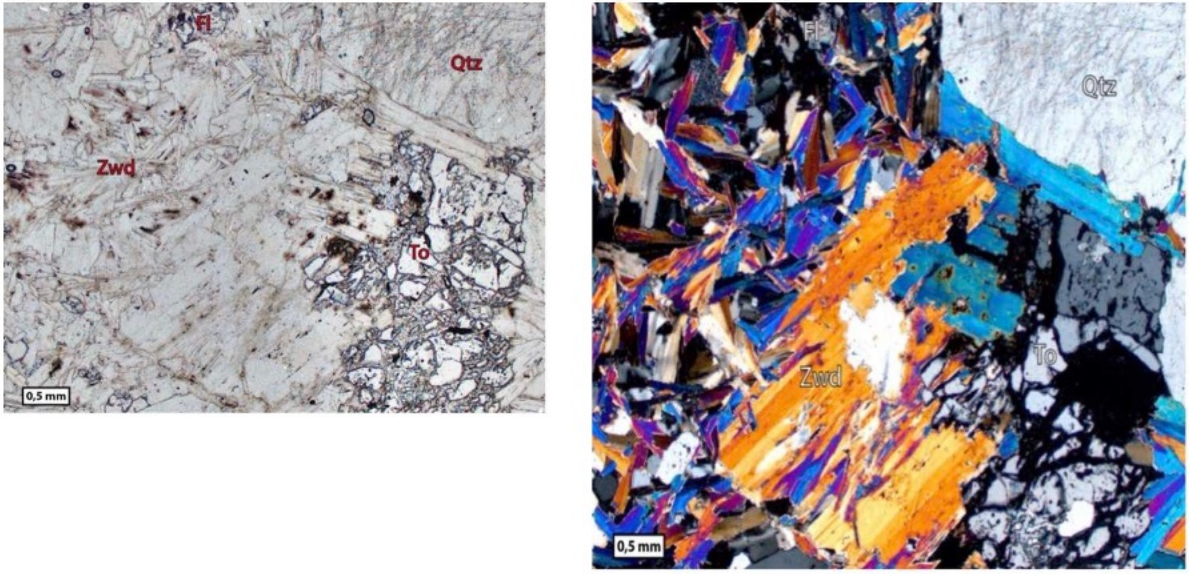
Whereas monomineralic greisen mineralization is of subordinate significance further subtypes with different proportions of quartz-mica-topaz are described for the deposit. The most abundant types and its average composition are the following:

IV.	Quartz-mica greisen	(quartz 65 %, zinnwaldite 25 %, topaz 5 %)
V.	Mica greisen	(quartz 50 %, zinnwaldite 40 %, topaz 5 %)
VI.	Quartz-poor mica greisen	(quartz 15 %, zinnwaldite 75 %, topaz 5 %)
VII.	Quartz-topaz greisen	(quartz 80 %, zinnwaldite 5 %, topaz 10 %)
VIII.	Topaz-mica greisen	(quartz 65 %, zinnwaldite 20 %, topaz 10 %)

(each case including 5 % accessories).

The macroscopic appearance of greisen is homogeneous (Figure 13A). Predominantly light to dark grey in colour the greisen is occasionally stained brick red due to intermediate to intense haematization. The texture can be characterized by coarse-grained, metablastic quartz and zinnwaldite forming a closely interlocked and sutural fabric. Topaz is visible as pale yellow and saccharoidal grains within the interstices of quartz and zinnwaldite. The recognition of the rock’s initial (pre-greisenization) texture is not possible due to the overall replacement and recrystallization of the major components. Intermediate-grained varieties of greisens are less common. Greisen textures can be diversified due to the presence of local mica nests or pockets ranging from about 2 cm to 1 m in diameter representing local zones of quartz-poor mica greisens. According to investigations by GRUNEWALD, 1978a ***[107]*** the grain size of quartz in greisen mineralizations ranges from 1 mm to 10 mm (Ø = 5 mm). Quartz forms irregular shaped, allotriomorphic grains with straight, rounded or serrated boundaries and exhibits euhedral shapes only in small vugs (Figure 17). It can be further characterized by a straight extinction and the existence of numerous fluids and / or gas inclusions (**Figure *22***), mineral inclusions of small euhedral plates of albite, flakes of zinnwaldite and of small grains of cassiterite, fluorite and apatite.

Figure 22: Microphotographs of a representative greisen sample


(A) Transmitted light, linear polarization; (B) Transmitted light, crossed polarization

Zinnwaldite, the host mineral of the vast majority of lithium metal in the deposit is named after its type locality Zinnwald. It forms euhedral to subhedral tablets of mostly thick habitus (0.3 mm to 30 mm, Ø = 1.2 mm) or aggregates of individual grains that have an irregular orientation towards each other (**Figure *22***). In rare cases these aggregates can form fans or rosettes.

Mineral inclusions of fluorite, cassiterite, topaz, haematite, zircon, monazite, and opaque phases are common, and some are surrounded by distinct pleochroic haloes. Exhibiting a zonal structure, abundant alteration of zinnwaldite to muscovite (sericite) took place at the grain boundaries but also along the cleavage plains within the zinnwaldite. Moreover, it can be replaced by quartz in a way that the relicts of zinnwaldite exhibit a skeletal grain shape.

Zinnwaldite is considered as a series of trioctahedral micas on the siderophyllite join (RIEDER et al. 1998, ***[143]***). It represents one of the most common mica species along this join and is reported from various types of granitic rocks all around the world (CUNDY et al., 1960 ***[133]***; UHLIG, 1992 ***[126]***; HAYNES et al., 1993 ***[136]***; NOVÁK et al., 1999 ***[154]***; LOWELL et al. 2000, ***[140]***; RODA ROBLES et al., 2012 ***[144]***). Lithium content of the zinnwaldite mica is in the range of 0.8 to 1.9 wt.%. It contains a high enrichment of iron (8.1 to 11.0 wt.%) and fluorine (3.5 to 7.2 wt.%) (e.g., GOTTESMANN, 1962 ***[103]***; UHLIG, 1992 ***[126]***; GONVINDARAJU et al., 1994, ***[135]***; JOHAN et al., 2012 ***[138]***).

The characteristic physical properties of zinnwaldite are listed in **Table *18***. Zinnwaldite belongs to the group of paramagnetic minerals, which make this mineral favourable for processing by magnetic separation.
Topaz is characterized by grains of columnar to isometric habitus and grain sizes of up to 2.8 mm for single grains and more frequently of up to 5.6 mm for irregular aggregates. Commonly, they are intensely fractured by cleavage cracks and irregular oriented fissures (**Figure *22***), which are usually filled by fluorite, sericite, and minerals of the kaolinite group. Topaz is frequently replaced by clay minerals.

Colourless to irregularly purple-coloured grains or aggregates of fluorite are present at sizes up to 1 mm. Normally fluorite tends to fill small vugs, cleavage cracks or rock fissures and forms therefore anhedral grains (**Figure *22***). Subordinately, it can form small cubic inclusions in quartz and zinnwaldite.

Cassiterite is among the accessory phases of the greisen and is characterized by euhedral to subhedral grains of 0.02 mm size that can agglomerate to aggregates of up to 2 mm. Disregarding traces of tin in the crystal lattice of zinnwaldite, cassiterite represents the sole tin bearing mineral phase in the greisen lithology. Typical brownish to pinkish colours are common as well as a zonal structure. The crystals are generally twinned and show distinct pleochroism. Cassiterite also forms blastic to fine-grained mineral inclusions in zinnwaldite and within the mineral interstices.

Rare wolframite, scheelite and columbite were identified among the accessory minerals. Whereas columbite occurs as euhedral inclusions in zinnwaldite or in aggregates with cassiterite, the tungsten-bearing mineral phases are anhedral, randomly distributed within the rocks fabric and show no preferred paragenesis. Grain sizes are in the range of 0.02 mm to 0.5 mm and 0.01 mm to 0.1 mm for columbite and wolframite / scheelite, respectively. Columbite of Zinnwald can incorporate variable amounts of Ta, Fe, Mn, Ti and U. Growth zoning or irregular “patchy” zones of different composition represent therefore characteristic features. Scheelite was found to originate from alteration of wolframite in flat dipping veins. However, no similar observations were made for greisen lithology so far.

For chemical formulas and grades of commodities see **Table *17***.

Among all other greisen types only quartz-poor mica greisen and quartz greisen are of certain importance. Each type is about less than 5 % of the total greisen volume in the deposit. Quartz-poor mica greisen are characterized by the dominant abundance of zinnwaldite (>70 %). Laths and tablets of metablastic zinnwaldite form an intensely interlocked fabric (**Figure *23***B) with subhedral quartz and abundant fluorite. The texture of this greisen type can differ significantly by zinnwaldite grain sizes ranging from 0.3 mm to 20 mm and by variable amounts of quartz, fluorite and alteration minerals (sericite, green clinochlore). Quartz-poor mica greisen are commonly enclosed in the prevailing quartz-mica greisen forming sheet like intercalations of limited thickness (max 1.0 m) and uncertain lateral extension. Additionally, local nests and pockets of this mica-rich greisen can be formed in quartz-mica greisen as well as in the greisenized ZAG (**Figure *23***C).

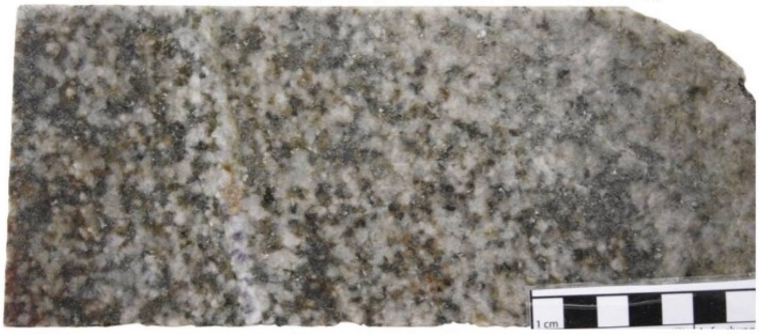
Quartz greisens are almost monomineralic rocks composed of > 85 % quartz, minor zinnwaldite, fluorite, kaolinite, haematite, and cassiterite. They exhibit a greyish colour and feathery / streaky textures due to numerous cracks and inclusions within the quartz (**Figure *23***C). Similar to the quartz-poor mica greisens they form intercalations within the quartz-mica-greisens and can reach a maximum thickness of about 5.5 m.

Table 17: **Zinnwald ore minerals and average commodity grades**

Mineral name	Chemical formula	Element	Average element grade (wt.%)
Zinnwaldite	$kLiFe^{2+}Al(AlSi_3O_{10})(F,OH)_2$	Li	1.6
Zinnwaldite	$kLiFe_2+Al(AlSi_3O_{10})(F,OH)_2$	K	8.9
Cassiterite	SnO_2	Sn	78.8
Wolframite	$(Fe^{2+}, Mn^{2+})WO_4$	W	60.6
Scheelite	$CaWO_4$	W	63.0
Columbite	$Fe^{2+}Nb_2O_6$	Nb	55.0

Figure 23: **Drill core images of the 3 greisen types occurring in the Zinnwald deposit**

(A) Predominant quartz-mica greisen (ZGLi 01/2012 – 108.0 to 108.25 m),



(B) Quartz-poor mica greisen rich in purple fluorite (ZGLi 02-2012 - 97.9 to 98.0 m),

(C) Quartz greisen (ZGLi 02/2012 – 189.85 to 191.0 m)

Other greisenized lithologies

Zinnwaldite is not restricted solely to greisen ore bodies. Subsequent greisenization affected various rock types of the ZG cupola and adjacent wall rocks to a different degree. Therefore, the term “greisenized” is used for rocks that are not completely transformed into a greisen, meaning that they exhibit remnants of feldspar. In terms of volume the ZAG is by far the most influenced lithology. Progressive greisenization produced an enormous amount of greisenized ZAG that exhibits typical features, e.g., beginning replacement of feldspar by the growth of metablastic quartz and zinnwaldite as well as advanced argillic, sericitic and haematitic alteration.

A continuous succession of rocks that underwent a progressive metasomatic overprint can be described as follows:

Unmodified ZAG → slightly greisenized ZAG → intensely greisenized ZAG → greisen

Table 18: **Selected physical and optical properties of zinnwaldite mica**

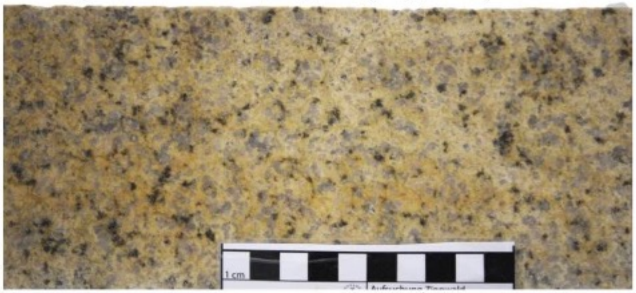
Chemical formula	$kLiFe^{2+}Al(AlSi_3O_{10})(F,OH)_2$
System	Monoclinic
Colour	Greyish-brown, yellowish-brown, silver-grey, green-grey, nearly black
Mohs’ Hardness	2.5 to 4
Lustre	Vitreous, pearly
Transparency	Transparent, translucent
Density (measured)	2.9 to 3.02 g/cm³

For mineralogical processes occurring during the metasomatic transformation see chapter 8.1. Depending on time, the amount and the chemistry of fluids leading to the transformation, the ZAG can show numerous stages of greisenization intensity, commonly accompanied by different types of alteration (**Figure *23***A and B). They display a high degree of variability regarding dimension, greisenization intensity, lithium content, and position towards the greisen bodies.

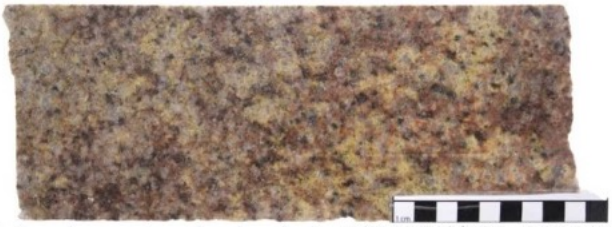
The greisenization of the other granitic lithologies like porphyritic zinnwaldite microgranite is only weakly developed. The aplite and the stockscheider show only minor metasomatic changes.

Figure 24: **Drill core images of the rocks adjacent to ore mineralization**

(A) Intermediate greisenized Zinnwald albite granite (ZAG) (ZGLi 01/2012 – 116.2 to 116.4 m)



(B) Strong greisenized and haematized ZAG (ZGLi 01/2012 – 121.75 to 122.0 m),



C) Nest of quartz-poor mica greisen in greisenized ZAG (ZGLi 01/2012 – 245.65-245.9 m)

(D) Contact of ZAG and greisen separated by a narrow zone of intense haematization (ZGLi 01/2012 - 142.4 to 142.65 m)

Greisenization can also affect the wall rock (TR). Unlike the medium-grained zinnwaldite albite granite, which shows strong greisenization in the upper part, the TR is only affected along flat or steep zones / cracks and along the contact between TR and ZAG, which were potential paths for the hot and pressurised fluids. Greisenized TR can be characterized by a prominent dark colouring due to the presence of fine-grained micas (muscovite and zinnwaldite) dispersed in the matrix of the TR. The original texture of the protolith is still recognisable. Thickness of greisenized TR can reach up to 5 m in direct vicinity of the contact towards the ZAG but tends to be less than 10 cm. Greisenized joints are commonly mineralized in the centre by quartz, zinnwaldite and / or topaz.

Metaalbite granite Sn-W(-Nb-Ta) mineralization

Moderate to intermediate greisenization of albite granite associated with significant mineralization of Sn-, W- and Nb-Ta-oxides (style IV) represents an unusual mineralization style of the Zinnwald deposit. Spatially independent from major greisen ore bodies this style is characterised by greisenized albite granite of common appearance but with a disseminated ore mineralization.

A continuous body of metaalbite granite Sn-W(-Nb-Ta) mineralization with 20 m of apparent thickness was intersected at drill hole ZGLi 06A/2013 (depth from 299 m to 319 m). The mean ore grades are 0.26 wt.% Sn, 520 ppm W, 130 ppm Nb and 40 ppm Ta. Maximum grades amount to 0.39 wt.% Sn, 1200 ppm W, 160 ppm Nb and 50 ppm Ta. Located below a stacked quartz-mica greisen ore body of exceptional thickness and grade (50 m at 0.47 wt.% Li), the presence of this mineralization was indicated by geochemistry rather than by macroscopically significant features on the drill core. The identical style of mineralization was observed in the adjacent drill hole (ZGLi 07/2013) with less thickness and grade. Examination of thin sections from this zone revealed the presence of cassiterite as the sole tin bearing mineral phase. Moreover, scheelite, columbite and rare wolframite were documented. The ore minerals are associated randomly with the main mineral phases quartz, zinnwaldite, albite and sericite. First measurements on the grain size distribution resulted in a cumulative passing of 85 wt.% below 300 µm to 120 µm for cassiterite, 150 µm to 45 µm for scheelite and 100 µm to 30 µm for columbite. No figures can be given for wolframite due to an in-sufficient amount of mineral grains.

Intersections of minor thickness and distinct lower grades have already been reported by GRUNEWALD, 1978a ***[107]***. Exploring the resource data base for the metaalbite granite Sn-W (-Nb-Ta) mineralization at the criteria of > 0.1 wt.% Sn, several more or less continuous intersections were manifested throughout the deposit (see Table 20). The finding of ZGLi 06A/2013 represents the most extensive and constant mineralization with the highest average grade documented for the Zinnwald property. Assuming a flat lensoidal shape of this mineralized zones and a low dip angle, a preliminary correlation between drill holes of the eastern flank is possible due to this new outcrop. Incorporating drill holes 19/77, ZGLi 06A/2013, 26/88, ZGLi 07/2013 and Cn22, a continuous mineralized zone of about 20 m thickness can be followed for about 700 m along strike in N-S direction dipping about 10 to 20° towards north (see **Figure *25*** and **Figure *26***).

Figure 25: **East – West cross section of the Zinnwald Lithium orebodies**

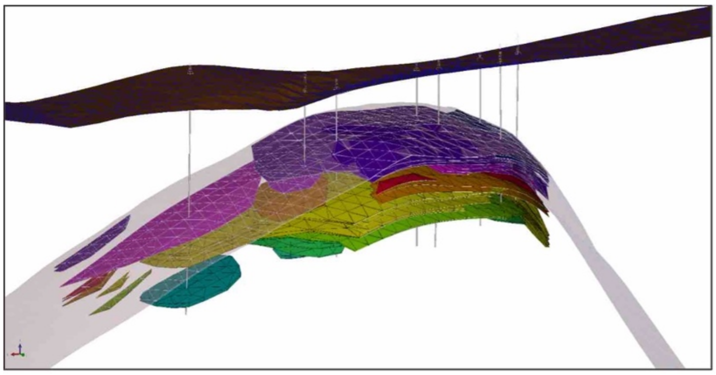


Figure 26: **North – South cross section of the Zinnwald Lithium orebodies**

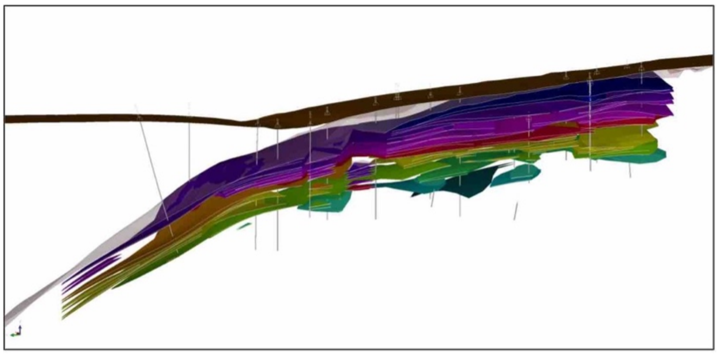


Table 19: Summary of continuous and discontinuous drilling intersections of albite granite

Hole ID	Part of the deposit	Depth from [m]	Depth to [m]	Drilled thickness [m]	Sn [ppm]	W [ppm]
19/77	Eastern flank	346.00	371.00	25.00	1,132	94
24/88	Eastern flank	259.00	265.00	6.00	1,150	130
25/88	Eastern flank	194.00	196.00	2.00	1,115	120
26/88	Eastern flank	269.00	289.00	20.00	1,313	120
Cn 22	Eastern flank	220.00	238.00	18.00	1,076	n.a.
ZGLi 06A/2013	Eastern flank	299.00	318.95	19.95	2,663	522
ZGLi 07/2013	Eastern flank	259.00	269.00	10.00	2,285	346
ZGLi 07/2013	Eastern flank	290.70	303.60	12.90	1,496	95
22/88	Northern flank	231.00	237.00	6.00	1,655	505
23/88	Northern flank	274.00	276.00	2.00	1,130	10
23/88	Northern flank	298.00	301.00	3.00	4,387	163
Cn 65	Central zone	43.90	47.60	3.70	4,287	n.a.
ZGLi 01/2012	Central zone	113.00	124.00	11.00	1,690	153

7.3.2 Ore Grades

For a geological cut-off exclusively petrographic attributes were used for defining the orebodies. The differentiation of potential economically interesting ore types was based on mean lithium grades and aspects of ore processing. According to these criteria two ore types can be distinguished:

“Ore Type 1”: greisen
“Ore Type 2”: greisenized albite granite und greisenized microgranite

The “Ore Type 1” consists of the petrographic sub-types quartz-greisen (TGQ), quartz-mica-greisen (TGQ+GM) and mica-greisen (TGGM). Despite the opportunity to distinguish up to three levels of increasing greisenization intensity, all greisenized intervals of albite granite and microgranite were merged into “Ore Type 2”.

With respect to the generally low lithium grades in greisenized rhyolite the corresponding intervals were not included into “Ore Type 2”. The table below gives an overview of petrographic sub-types bound to the two ore types and the barren host rock (**Table *20***). The weighted mean lithium grades and other statistical parameters for the core samples of exploration campaigns No.s (4), (5) and (8) are shown as well.

The weighted lithium grades for “Ore Type 1” vary from about 1,000 ppm to 8,100 ppm (0.10 % – 0.81 %). The quartz-mica-greisen with a mean of about 3,400 ppm Li (0.34 %) represents the most prevalent petrographic sub-type within this group. It is assumed that this sub-type mainly determines the overall mean Li grade of the ore deposit. The predominant portion of the greisen structures is characterized by extensive beds that can be found in the endocontact of the albite granite cupola of Zinnwald / Cínovec. The inclination of the beds follows predominantly the granite surface.

Table 20: Classification of ore types by evaluation of Li core sample assays–- campaign Nos 4, 5, 8

Ore Type	Petrographic key sign	Petrographic description	Apparent thickness weighted mean Li grade [ppm]	Arithmetic mean Li grade [ppm]	Median Li grade [ppm]	Min Li grade [ppm]	Max Li grade [ppm]	Number of core samples
1	TGGM	mica-greisen	8,133	8,121	7,785	4,160	13,500	8
	TGQ+GM	quartz-mica-greisen	3,438	3,494	3,370	100	14,817	853
	TGQ	quartz-greisen	1,064	1,187	750	10	4,100	56
2	PG_GGM_3 UG_GGM_3 PG_PR_GGM_3	strongly altered to mica-greisen: albite granite, microgranite and porphyritic granite	1,980	2,019	1,858	300	4,830	141
	PG_GGM_2	medium-altered to mica-greisen:	1,837	1,859	1,875	140	11,194	398

	UG_GGM_2 PG_PR_GGM_2	albite granite, microgranite and porphyritic granite						
	PG_GGM_1 UG_GGM_1 PG_PR_GGM_1	weakly-altered to mica-greisen: albite granite, microgranite and porphyritic granite	1,538	1,561	1,620	180	6,642	403
3	PG UG	albite granite and microgranite	1,378	1,413	1,400	50	7,339	543
	YI	rhyolite	656	581	420	50	1,900	47

Quartz-greisen contains less mica and therefore less lithium (1,000 ppm, 0.10 %), whereas quartz-poor mica greisen represents a mica-rich variety (8,100 ppm = 0.81 %) Commonly, thin layers of quartz-greisen can be found as intercalation in massive structures of quartz-mica-greisen.

The lithium grade of greisenized albite granite – and of subordinate greisenized microgranite – (“Ore Type 2”) ranges from 1,500 ppm to 2,000 ppm (0.15 % - 0.20 %). This clearly reflects the lower degree of greisenization intensity.

The “greisenized zones” are thought to envelop the greisen beds and reaching 810 m a.s.l. in the southern part and 350 m a.s.l. in the northern part of the modelled deposit.

The surrounding albite granite and microgranite show considerable high Li grades with 1,400 ppm (0.14 %) on average. This refers to the prominent geochemical specialization of the small granite intrusions of the post-Variscian stage with a remarkable enrichment of incompatible elements like Li, F, Rb, Cs etc. Similar observations can be reported for the overlying rhyolite as far as it is located near the endocontact. Here the core samples showed mean lithium grades of about 600 ppm (0.06 %).

During the exploration campaigns No.s (1) to (7) the greisenized structures were not always identified and completely and correctly distinguished. During these periods it could happen that a rock with lithium grades of 2,000 ppm was determined as an albite granite, which represented rather a greisenized albite granite. The results of campaign No. (8) substantiated extensive greisenized zones throughout the entire upper part of the granitic cupola.

The review of the data sets showed that sampling during the campaign No. (4) by LÄCHELT, 1960 ***[101]***, in many cases ignored lithological boundaries. Therefore, it is possible that granite samples partly include greisen or altered intervals and the other way around. The following mean grades of tin, tungsten, potassium oxide and sodium oxide have been calculated from drill core assays of exploration campaigns No.s (4), (5) and (8).

They are representative for the common mineralization of the greisen beds and greisenized granite.
Locally embedded veins, seams and tin greisen stockworks might show significant higher mean values of tin and tungsten.

Table 21: Approximated mean grades of Sn, W, K2O and Na2O in greisen and greisenized granite

Potential shown as a mineral inventory	**Mean Sn grade [ppm]**	**Mean W grade [ppm]**	**Mean K2O grade [wt.%]**	**Mean Na2O grade [wt.%]**
„Ore Type 1“ greisens	approx. 400	approx. 80	approx. 2.50	approx. 0.2
„Ore Type 1“ Greisenized granite	approx. 240	approx. 40	approx. 3.40	approx. 1.9

7.3.3 Veining

Mineral veins of the ZAG and the surrounding TR can be subdivided into flat dipping so-called “Flöze” (style II) and “Morgengänge” displaying a sub-vertical dip (style III). The “Flöze” are characterized as flat, curved and onion-like shaped ore mineralizations. According to its flat dip and high lateral continuity they were historically designated by the term “Flöz”, corresponding to a coal seam in German mining terminology. The veins of the uppermost part of the Zinnwald intrusion cupola are the main host of the historically exploited tin and tungsten mineralization. They are generally not considered to be hydrothermal veins in the narrower sense, since they are composed solely of greisen minerals, namely quartz, zinnwaldite, topaz, and fluorite. Furthermore, the mineral assemblage of the veins depends on the adjacent host rock, meaning that “Flöze” exhibit quartz, zinnwaldite and topaz in areas of major greisen mineralization whereas they tend to comprise higher, almost monomineralic quartz contents when the adjacent lithology is represented by feldspathic ZAG or TR.

Dip angles are in the range of 15° to 30° and only in the central Czech part of the deposit they exhibit horizontal bedding. They strike almost parallel to each other but none of them continues over the complete extension of the granite. The lateral continuity correlates positively with the mean thickness of the veins. They tend to disintegrate and re-join erratically, which significantly affects the vein thickness. Moreover, lateral continuity is reduced by fault tectonics. “Flöz”-mineralization is considerably frequent along the steep western flank of the granite, probably due to the presence of intense fracture and L-joint systems. Towards the central part the abundance of the “Flöze” diminishes. The vertical spacing of the “Flöze” is variable and varies between 1 m to 40 m. The thickness is in the range of 1 cm to 1 m with an average of around 0.2 m to 0.5 m (**Figure *27***). Displaying a variety of textures, the “Flöze” are commonly symmetrically mineralized showing a selvage of very coarse-grained zinnwaldite followed by pegmatitic and drusy quartz towards the centre. Topaz and euhedral fluorite are present in the interstices.

The predominant ore minerals cassiterite and wolframite occur as nests and nodules either at the interstices of coarse-grained quartz or along the selvages. Further ore minerals include scheelite and sulfide minerals (galena, sphalerite, stannite, arsenopyrite, bismuthinite, and seldom acanthite) in the western part of the deposit. The strong heterogenic character of “Flöz”-mineralization is displayed by very ore-rich portions located close to barren zones consisting of almost pure quartz along strike. Within the property the grade of ore mineralization and thickness of the “Flöze” is considered to diminish below the level of Tiefer-Bünau-Stollen (752 m a.s.l.) and to subsequently wedge out with depth. “Flöz“-mineralizations are also developed in the wall rock (TR) where they are less frequent and display lower thicknesses. Relatively abundant quartz and wolframite compared to minor zinnwaldite and cassiterite and the absence of topaz are the most characteristic features (**Figure *27***A). In close relationship to the “Flöze” subvertically to vertically dipping and NE-SW trending veins, the “Morgengänge” veins, are developed in the Zinnwald deposit. They represent mineralized faults (described in Section 7.3) and are formed synchronous with the “Flöze”. These veins are considered to have served as feeding channels for metal-bearing fluids indicated by accompanying symmetrical greisenization of the adjacent wall rock. They display a broad range of textures. The thickness is about 10 cm to 20 cm and the mineral assemblage equals the “Flöz”-mineralization. The “Morgengänge” veins underwent normal faulting with displacements in the range of a few meters. In some parts of the deposit with post-Variscan reactivation they are accompanied by pink to deep red barite.

Figure 27: Drill core images of intersected vein mineralization

(A) One major and several sub-veins of quartz and wolframite in the wall rock of the Teplice rhyolite (TR) (ZGLi 01/2012 – 71.0 to 71.75 m),

(B) Typical “Flöz” vein hosted in Zinnwald albite granite (ZAG) showing narrow seams of adjoining greisenization (ZGLi 01/2012 – 88.0 to 88.45 m)

8 Deposit Type

8.1 Characterization of Greisen Deposits

Greisen formation is associated with the cooling of a highly fractionated H_2O-rich granitic intrusion and the enrichment of incompatible volatile elements in the upper part of the intrusion such as F, Cl, B and Li during fractional crystallization. The main evolution stages of greisenized granitoids are as follows: (1) solidification and fissuring, followed by (2) formation of pegmatites (stockscheider) and K-feldspathization (microclinization), (3) Na-feldspathization (albitization), (4) greisenization and hydrothermal alteration (sericitic alteration and / or kaolinization) and final (5) formation of veins (SHCHERBA, 1970 [151***] P***OLLARD, 1983 ***[142]***).

The metasomatic greisen formation, called greisenization, is defined as a granite-related, post-magmatic process during which biotite and K- / Na-feldspars became unstable (ŠTEMPROK, 1987 ***[153]***). Subsequently to Na-feldspathization it is commonly controlled by the further decrease of the alkali / H^+ ratios (PIRAJNO, 2009 ***[141]***). Granite minerals and textures are replaced by complex aggregates of micas, quartz, topaz, and fluorite with a considerable addition of some elements such as Sn, W, Li, Mo, Be and others. Highly aggressive, F-bearing solutions induce the formation of fluoride minerals, which are compared to other metasomatic rocks very common in greisen (ROMER et al., 2010 ***[146]***). Greisenization can affect different wall rocks. Its intensity depends basically on the texture of the protolith.

A broad range of formation temperatures between 250°C – 500 °C and pressures of 0.3 kbar – 0.8 kbar is suggested by POLLARD, 1983 ***[142]*** for the formation of greisen minerals. Latest fluid inclusion studies indicate that all elements required for the formation of the mineralization at Zinnwald were contained in a single magmatic hydrothermal fluid that underwent two main processes, fluid rock interaction and depressuration (KORGES et al, 2017 ***[139]***). The authors recorded homogenization temperatures of various generations of fluid inclusions ranging from 490°C to about 300 °C. These numbers are in good agreement with older data that have indicated an average homogenization temperature of 389°C ± 28 °C gained from two-phase fluid inclusions in quartz, Limica, cassiterite and fluorite of albite granite, stockscheider and veins from Zinnwald (UHLIG, 1992 ***[126]***).

8.2 Application to the Zinnwald / Cínovec deposit

The Zinnwald property covers the German portion of the Zinnwald / Cínovec deposit. The Zinnwald / Cínovec deposit is located in a magmatic-volcanic complex in the eastern part of the Erzgebirge Mountains (**Figure *16***), a world-famous metallogenic province with a mining history going back to the 1^{2t}h century. Among a multitude of ore deposit types numerous greisen deposits of economic significance were recognized.

The Zinnwald / Cínovec deposit is a typical example of a granite hosted greisen deposit. Among a number of general characteristic features fulfilled by the ore deposit, most relevant for the classification as a greisen is the existence of subsequent post-magmatic alteration stages including greisenization in the endo-contact. The mineral assemblage of quartz, Li-F-mica (zinnwaldite), topaz, fluorite and the associated ore minerals cassiterite and wolframite prove the affiliation to this deposit type. The flat dipping greisen ore bodies are marked by the absence of feldspar indicating a complete succession of greisenization of the host rocks.

8.3 Regional Deposits

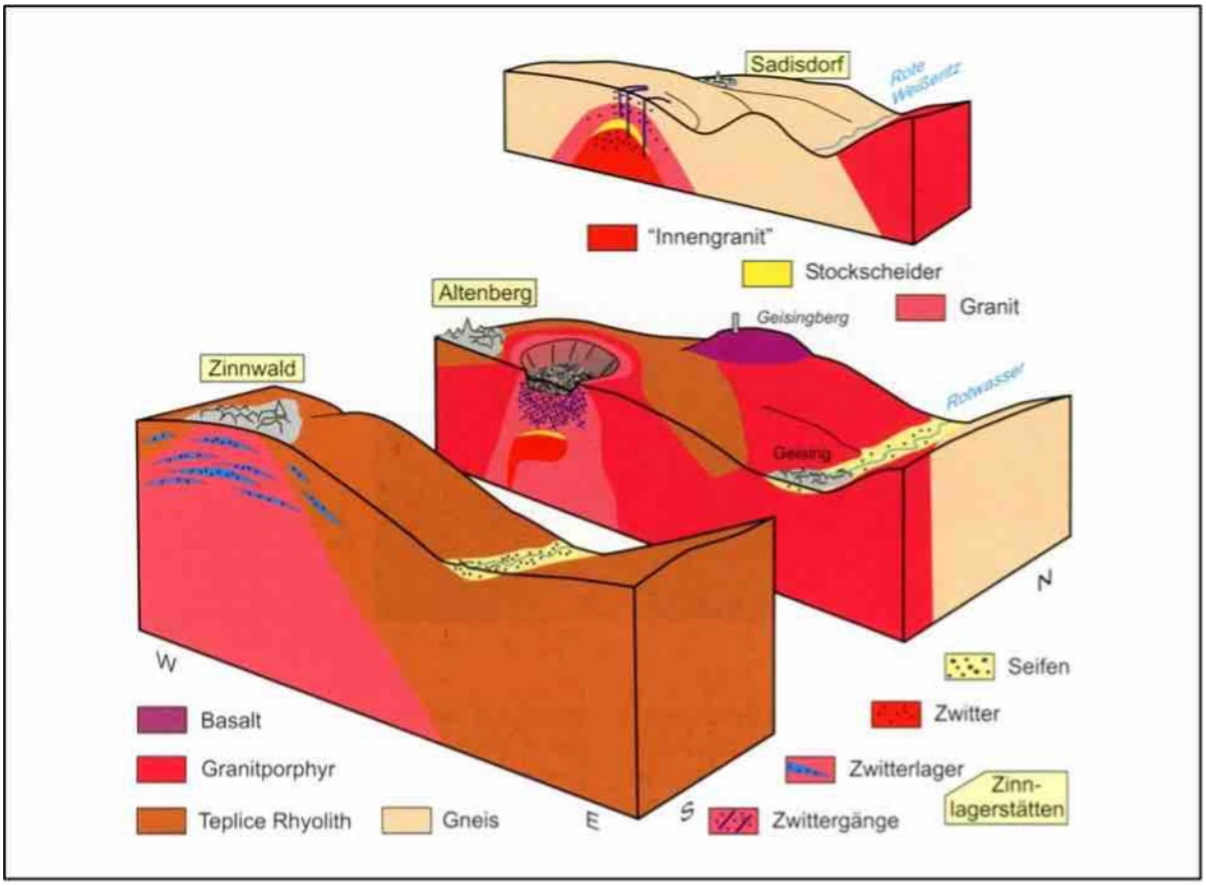
The Zinnwald / Cínovec deposit is located in the Eastern Erzgebirge which is characterized by rhyolitic volcanic and subvolcanic rocks as result of a period with intensive volcano-magmatic activity especially in the Upper Carboniferous. At the end of this period numerous granitic melts were emplaced along major faults resulting in the formation of granitic bodies and multiple mineralized structures (e.g., veins, stockworks, breccias). The reactivation of the tectonic structures was accompanied by an intensive postmagmatic metasomatism, which led to greisenization and the formation of the quartz-mica mineralization. This style of mineralization is typical for the Eastern Erzgebirge and is in association with the enrichment of tin, tungsten, lithium and other typical granitic elements (see also **Figure *15*** and **Figure *16***).

Many deposits within a radius of 20 km to the Zinnwald / Cínovec deposit have been already mined for typical greisen minerals since the middle of the 1^{4th}h century. These include:

- Altenberg directly north of the Zinnwald property with mines like “Zwitterstock“, “Neufang / Rote Zeche”, „Zinnkluft“ and other smallscale mines
- Hegelshöhe and Schenkenshöhe near Falkenhain
- Sachsenhöhe near Bärenstein
- Schmiedeberg / Sadisdorf
- Greisenzone Löwenhain
- Horni Krupka / Graupen (CZ)

Figure *28* presents block pictures of the most important and best-known tin-tungsten deposits in the region of the Eastern Erzgebirge (SEBASTIAN, 2013 ***[147]***).

Figure 28: Tin-tungsten deposits of the Eastern Erzgebirge



Further prospective exploration licenses in the vicinity of the Zinnwald property were already acquired by DL (see Item 23).

9 Exploration

9.1 Introduction

In the abandoned Zinnwald mine a significant part of the historic galleries and workings is still accessible. A visitor mine and mining museum was established in 1992 on the most developed level, named “Tiefer-Bünau-Stollen”. Although the ore resource of “Tiefer Bünau Stollen” is almost completely mined out, it provides an excellent possibility for studying the variability of the greisen ore bodies in terms of structure, mineralogy and geochemistry.

9.2 Underground Channel Sampling

An underground sampling campaign was conducted in the year 2012 [***9***], which provided a series of 88 greisen channel samples from the sidewalls of the “Tiefer-Bünau-Stollen” (752 m a.s.l.) and the “Tiefer-Hilfe-Gottes Stollen” (THG) galleries (722 m a.s.l.).

The lithium grades of these channel were comparable to the results from drill cores with respect to range and variability. The horizontal distribution of lithium grades was found to be relatively homogenous except for high and low outliers due to mica-rich nests or barren quartz greisen, respectively. Lithium distribution is closely linked to the amount of zinnwaldite in the rock. Known from numerous publications, tin and tungsten show a more heterogenic distribution in the greisen mineralization, which was adequately reproduced by the channel sampling method.

The comparison of results from the two different levels of about 30 m vertical distance allowed the discrimination of two geochemically different greisen zones. The upper level showed greisen mineralizations which are more Li-rich and poor in Sn and W, whereas the lower level revealed element concentrations vice versa. Since the mine workings give only an insight into the upper parts of the greisen mineralization, predictions of deeper positioned ore bodies must be made with care.

Channel sampling was conducted discontinuously from March to April 2012 [***18***]. First step was to mark the starting point at each sampling locality and to label 2 m intervals on the side walls of the gallery by using chalk and ribbons.

The channels were cut with a handheld electric Dollmar diamond stone saw (type EC 2412). Therefore, the electric power supply of a junction box next to the Albert shaft was used. Dust formation was reduced by using a water sprayer. For each channel two parallel slits were cut at distance of 4 cm to 5 cm to contour the channel over the complete height of the gallery. The depths of the slits varied slightly between about 2 cm and 3 cm.

After cleaning the dusty faces with brushes and fresh water the rock material between the slits was dug out with hammer and chisel. Particular attention was paid to sample a series of rock bars and not to pulverise the slivering rock as this may result in the separation and therefore loss of minerals of different density and rigidity. The broken material was collected in a big plastic trough held directly beneath the particular sampling section.

After completion of a channel the material was packed into labelled plastic bags and transported to the surface. In analogy to samples from drill cores a sample ticket with a distinct sample number and other information was inserted. The tools and plastic troughs were cleaned with water to avoid contamination of the next sample.

Health and safety measures included use of helmets, safety boots, safety glasses, ear protection and dust respirator. To discharge continuously dusty mine air the ventilation within the mine was controlled by the help of an aerometer. Additionally, different mine doors and curtains have been regulated to ensure a fast and effective aeration.

9.3 Underground Bulk Sampling

About 20 t of bulk ore material was recovered by hand and rock splitter from the underground mine workings of Zinnwald for mechanical processing and metallurgical test work during August 2011 [***2***]. For further beneficiation studies a 100 t greisen ore sample from two selected parts of the Zinnwald public visitors mine was collected by drilling and blasting in August 2017 ***([4], [5], [32]***).

9.4 Mapping

There are only a few detailed geological maps combining the information from the German and the Czech sides of the deposit. A first comprehensive geological map of the area was presented by DALMER (1890), revised version by GÄBERT in 1908 (scale 1:25,000, see ***[130]***). Later detailed geological maps with cross sections of the German part were produced during the three major exploration campaigns and compiled by BOLDUAN & LÄCHELT, 1960 ***[104]***, GRUNEWALD, 1978a ***[107]***, and BESSER & KÜHNE, 1989 ***[110]***. The Czech part of the deposit was mapped and studied in detail by ČABLA & TICHY, 1985 ***[109]***. Information from underground mining is presented in several upright projections compiled by TICHY et al., 1961 ***[102]***.

The underground channel sampling of 2012 was accompanied by detailed mapping of the sampling localities and their immediate surroundings as far as they were accessible. These works were done at a mapping scale of 1:50 by B.Sc. Matthias Bauer from the Technical University Bergakademie Freiberg (NEßLER, 2012a ***[17]***, 2012b ***[18]***). For visualization of the recordings a method was chosen, that allowed the detailed documentation of the roof and both drift faces considering lithology, mineralogy, faults and cleavages as well as the channel location (see report NEßLER, 2012b ***[18]***).

10 Drilling

10.1 Overview

SolarWorld Solicium GmbH (SWS) and its successor Deutsche Lithium GmbH (DL) have performed two surface exploration drilling campaigns on the Zinnwald lithium property, respectively:

- 10 drill holes in 2012 and 2013 to 2014
- 15 drill holes in 2017

For the exploration drilling program of the years 2012 to 2014 SWS contracted various German drilling companies including Geomechanik Bohrungen und Umwelttechnik GmbH Sachsen (Geomechanik) from Penig, BOG Bohr- und Umwelttechnik GmbH (BOG) from Caaschwitz (BOG, as sub-contractor of Geomechanik) and Pruy KG Gesteins-, Bohr- und Umwelttechnik from Schönheide (Pruy). Drill rig positioning was restricted in some cases by the existing landuse dominated by scattered dwellings within pasture areas. The drilling program used both wire line diamond core and percussion drilling (PD) equipment. Reverse circulation (RC) equipment was applied only in a single twin hole for test purposes.

For the second drilling program GEOPS Bolkan Drilling Services Ltd. of Asenovgrad / Bulgaria (GEOPS) was commissioned by DL. Drilling started on September 27, 2017 with two Atlas Copco Christensen wire line diamond core rigs operated parallel by two teams of the company. At the end of the campaign three rigs were used in parallel. Five of the planned holes had to be relocated to alternative places, because several landowners refused access to their land. Drilling was successfully completed at the end of December 2017.

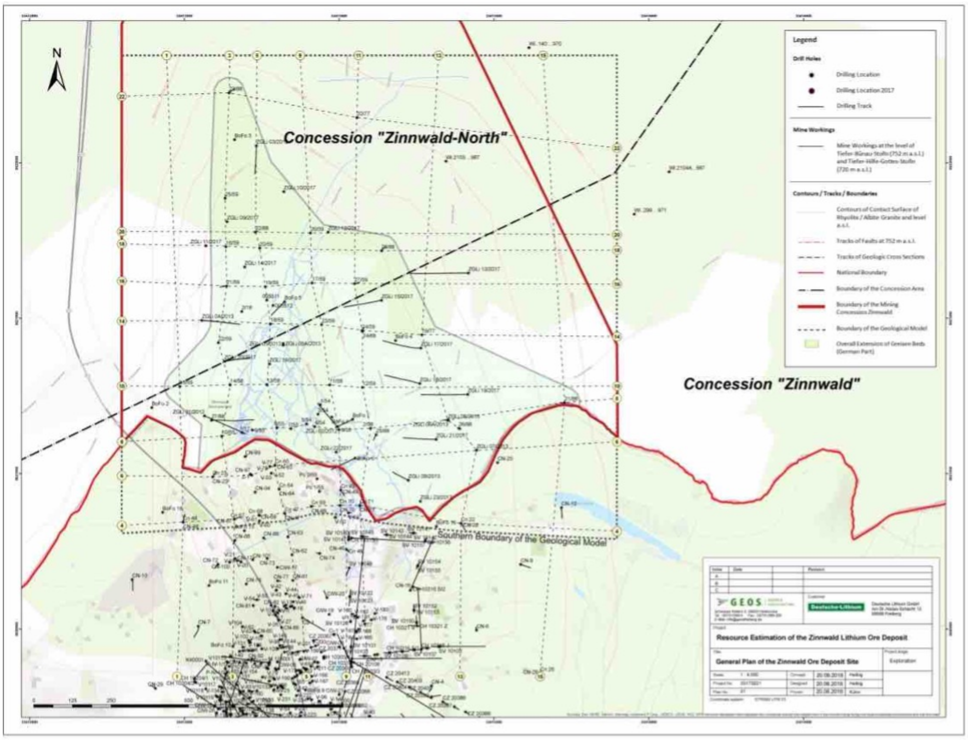
10.2 Drilling Program 2012 – 2014

SWS completed 10 drill holes with a total length of 2,484 m. While drilling in 2012 focused on the verification of historic data by two twin holes, drilling locations of 2013-2014 were chosen on the basis of the first geostatistical results (see also NEßLER & KÜHN, 2012 ***[20]*** and HARTSCH et al., 2013 ***[24]).*** A maximum drill hole spacing of about 120 m was considered to be adequate for the infill holes. Particular attention was paid on greisen ore bodies on the southeastern part of the property where historic drilling was limited. Including the drill holes of all historic campaigns a new drill grid was designed with a drill hole spacing ranging from 150 m to 250 m along north-south and east-west profiles. The holes were drilled down to depths between 79 m and 376 m. 8 of 10 holes achieved or exceeded their planned target depth. For the first two holes diamond core drilling technology was used. During the second campaign the approach was changed. To avoid problems by old mine stopes a pre-collaring by percussion drilling was used to provide fast and cost-effective access to the level below the known historic mine workings (740 m a.s.l.).

The depth of 740 m a.s.l. represents the top of the resource model. Below this level diamond core drilling have taken place. Additionally, one reverse circulation hole was drilled to duplicate a previous diamond drill hole. For all drill holes a downhole survey (inclination, dip) was conducted every 1 m in 2012 and every 0.05 m in 2013/14.

Figure *29* shows the location and distribution of recent and historic drill holes at Zinnwald.

Figure 29: **Overview map of drill holes in the concession area**



10.2.1 Drill Hole Summaries

A summary of the drilling performance and of significant lithium results is presented in the following **Table *22*** to **Table *25*** respectively.

Drilling within the Zinnwald property has confirmed the presence of several lithium bearing greisen ore bodies with dimensions of around 1 km from north to south and of around 1 km in east-west direction at a depth below 820 m a.s.l. Convex and flat to moderately dipping ore bodies follow the endo-contact of the granitic intrusion of Zinnwald / Cínovec. Generally, the orebodies decrease in frequency and thickness with depth.

Greisen mineralization was intersected in every of the holes drilled by SWS. Intersected thicknesses range between a minimum of 0.1 m and a maximum of 43.7 m from drill holes ZGLi 6/2013 and ZGLi 6A/2013, respectively. The deepest exposure of greisen ore was encountered in drill hole ZGLi 07/2013 at a depth of 376 m (416 m a.s.l.).

The contact zone of greisen and the host rock albite granite (ZG) is either sharp or diffuse and is a few centimetres to some decimetres thick. There are numerous intersections of strongly argillic-altered and haematized ZG adjacent to greisen with and without feldspar relicts, which exhibit a total thickness in the order of several meters. Sharp contacts of greisen and poorly greisenized ZG occur independently of depth, position against the greisen bodies (hanging or footwall), and thickness of the greisen bodies.

True vertical thickness of the greisen ore bodies corresponds to the position along the granite contact and is therefore consistent with the vertical depth for the central parts where the dip angle is less than 10°. Towards the gently inclined (10° - 30°) flanks of the N, E and S and the steeply inclined (40° - 70°) western flank, the true vertical thickness needed to be calculated adequately.

Ideas on the spatial orientation of the ore bodies were up to now based on exploration and research of the last 65 years. The model of elongated, N-S trending greisen bodies must be revised to some extent by the results of the SWS drill campaign. A set of shallower greisen bodies occurs in the centre of the deposit (southern part of the property), whereas greisen bodies were found towards the northern and the eastern flank at deeper levels. More detailed information is presented in chapter 7.3.

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The tectonic situation was especially complicated along the western flank of the intrusion. Therefore, drilling results needed to be carefully compared and adjusted with historic mining documents of the German and Czech part to design a coherent lithological-tectonic model.

Log sheets visualizing and summarizing all drilling results were prepared with Golden Software's Strater® 4 which combines information on lithology, alteration, structure, geochemical and geotechnical parameters. Depths are presented as drilled length (m), true vertical depth (m) and depth above sea level (m a.s.l.).

Table 22: Summary of drilling performance by SWS during 2012 and 2014

Drill hole ID	Start of drilling	End of drilling	Drilling performance		Total drilling & inclination survey (m)			Percussion drilling (m)		Diamond drilling (m)	
	Date	Date	Drilling Days	Meters per Day	Plan	Actual	Survey	Plan	Actual	Plan	Actual
ZGLi 01/2012	09/04/12	21.05.12	26	10.8	280	280.0	276.30	-	-	280.0	280.0
ZGLi 02/2012	02/04/12	29.05.12	35	7.5	260	262.5	262.50	-	-	260.0	262.5
ZGLi 3/2013	17/09/13	21.11.13	45	7.3	325	330.2	330.51	65	65	260.0	265.3
ZGLi 4/2013	20/08/13	01.10.13	31	8.4	260	260.0	154.35	68	68	192.0	192.0
ZGLi 5/2013	13/08/13	28.08.13	12	13.0	155	156.3	156.00	55	55	100.0	101.3
ZGLi 6/2013	29/08/13	04.10.13	27	8.5	334	221.3	100.25	40	40	294.0	181.3
ZGLi 6A/2013	07/10/13	14.11.13	24	14.0		336.4	334.73		200		136.4
ZGLi 7/2013	10/10/13	10.01.14	62	6.1	363	376.2	375.55	50	50	313.0	326.2
ZGLi 8/2013	04/11/13	17.01.14	50	5.2	259	260.8	259.95	64	64	195.0	196.8
Sum				Ø 8.0	2,236	2,483.7	2,250.14	342	542	1,894	1,941.8
ZGLi 5A/2013 (RC-Drilling)	24/01/14	29.01.14	4	19.8	150	79	41.49	150	79	---	---

Table 23: Summary of significant Li grades obtained in the SWS drill holes

Drill hole ID	Depth from [m]	Depth to [m]	Drilled thickness [m]	Mean Li [ppm]
ZGLi 02/2012	71.3	82.6	11.3	3,908
ZGLi 02/2012	85.5	114.5	29.0	4,014
ZGLi 04/2013	173.4	179.4	5.9	3,903
ZGLi 04/2013	200.5	207.0	6.5	2,722
ZGLi 05/2013	57.3	66.3	9.0	4,137
ZGLi 05/2013	115.2	127.3	12.2	3,554
ZGLi 06A/2013	214.0	264.0	50.0	4,711
ZGLi 07/2013	238.3	254.7	16.4	2,646
ZGLi 07/2013	349.9	355.6	5.8	2,991
ZGLi 08/2013	121.4	146.6	25.2	3,121

10.2.2 Core Recovery and RQD

Drill core recovery was recorded at the drilling site and ranged on average between 97.4 % for the ore zones and 98.9 % for the total drilled length.

In drill hole ZGLi 06/2013 a zone of intense alteration was intersected from 167 to 171.5 m and from 175 m to 182 m which corresponds to the lithological contact of TR and quartz-poor mica greisen. Due to greisenization accompanied by a strong hydrothermal overprint both lithologies were transformed to loose clay material and rock fragments. Possible tectonic movements within this zone are indicated by brecciation features. Core recovery within this zone dropped below 90 % and partly to 33 %. Further drilling of this zone caused a deadlock of the drill string at a depth of 220 m. For this reason and since the planned final depth was not achieved drilling was halted and the compensatory drill hole ZGLi 06A/2013 was collared about 1.5 m further east. Percussion drilling was then performed to a depth of 161.5 m and again from 180 m to 211.5 m. No complications occurred during further diamond drilling and ZGLi 06A/2013 reached the envisaged final depth (334.7 m) with the required core recovery of at least 95 %.

Analogously, the rock quality designation index (RQD) was recorded at the drill site. One value was documented for every drill run (usually 3 m long; in rare cases 1.5 m). It ranged from 0 % to 100 %. Average RQD value for the total drilled length was about 88.0 %.

10.2.3 Drill Core Logging

Detailed drill core logging was carried out in the project camp by the geologist of the Technical University Bergakademie Freiberg. It is important to note, that all drill core was logged by the same geologist throughout both SWS exploration campaigns.

Log sheets were coded and details recorded downhole for lithology (including types of greisen and intensity of greisenization), modal composition, rock colour, texture, alteration type, alteration intensity, degree of decomposition and other observations. Special emphasis was given to the distribution of different types of greisen mineralization, related alteration mineral associations, and the presence of various types of veins / veinlets and structures.

Geotechnical parameters were recorded including the percentage of core recovery, index of rock quality designation (RQD), cleavage density and features of tectonic stress, as well as fracture fill material. Additionally, all drill cores were photographed either on drill site or in the project camp. All data was then transferred to a digital database.

10.2.4 Drill Core Sampling

In 2012, the core diameter was 101 mm (NSK 146/102). Labelling and photographing have taken place at the drilling site (five consecutive core boxes per photography). After the transport of the core boxes to the permanent core shed next to the main facilities of SWS the cores were cut by a local mason using an automatic diamond stone bridge saw.

The main difference in sample preparation of the 2013 – 2014 campaign compared with 2012 campaign was set up by the reduction of the core diameter to NQ (47 mm). In addition, core cutting was performed directly in the temporary project camp in the immediate vicinity of the drilling field. Cutting was carried out by a transportable diamond bladed core saw. The detailed logging procedure and photography was performed when ten consecutive core boxes were arranged.

A diamond rock saw was used, because it is the most accurate cutting tool, when no sooty or water-soluble minerals are present, which could be lost by wet cutting. Broken or significantly disintegrated core was divided with a trowel in equal parts in order to obtain a representative sample. This work was assisted permanently by at least one person of the responsible and qualified SWS staff.

Core runs were 3 m and 1.5 m long. The cores were placed in core boxes of 1 m length by the drilling crew after cutting with a diamond saw and were systematically logged by the geological staff either at the drilling site or in the project camp immediately after delivery. RQD and core recovery were measured prior to the core cutting. After transportation to the permanent core shed (in 2012) or to the temporary project camp at Zinnwald (in 2013–2014) the sample segments were marked for splitting.

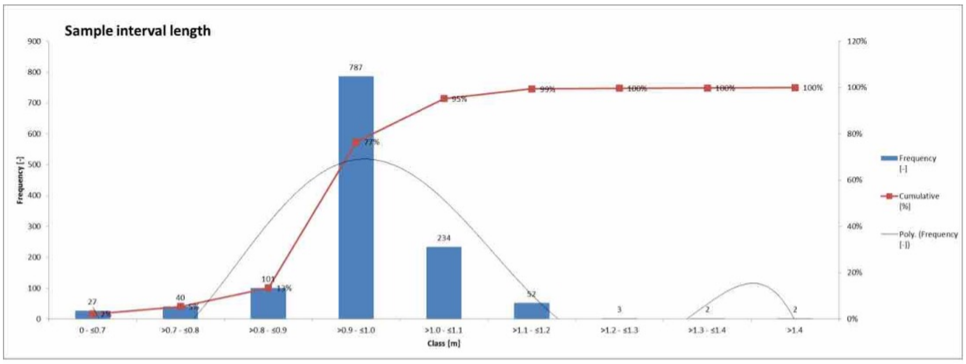
Sample length should not deviate from 1.0 m ± 0.2 m while considering lithological boundaries and different greisenization intensities. Extreme deviations were an exemption represented by a minimum length of 0.30 m and a maximum of 1.55 m. The median sample length was 1.0 m as shown in the histogram of Figure 25. After cutting, one core quarter (in the campaign of 2012) or one core half (in the campaign of 2013 – 2014) was placed in plastic sample bags and tagged accordingly. Core splitting and sampling took place according to the routine that a minimum sample mass of 2 kg was required for preparing the pulp for the chemical analyses.

The sample tickets provided information on project name, drill hole number, sample number, depth interval, lithology code, date of sampling as well as the name of the sampling staff and were put in a robust plastic bag. Additionally, the sample bag was labelled with the number of drill hole and the depth interval. Both the sample bag and tag were marked with a distinct sample number decoding the type and year of the sample, the corresponding drill hole number and a consecutive sample number.

Pre-printed tags were used to avoid double numbers or transposed digits. A strap of seven more sample number tags was put in each sample bag for later usage. Finally, cable ties were used to seal the bags and batches of 20 samples, which were prepared for transportation. In order to allow a quick reference of the assays back to the core, the sample intervals and numbers were marked on the long side of the wooden trays placed in the core boxes.

For exploration projects it is commonly required, that some core must be retained for future examination and verification. Accordingly, all drilled cores from the project were transported to Freiberg and stored in a secured and well-organized manner in a high bay warehouse on the facilities of SWS.

Figure 30: **Histogram of sample length from drill core samples of the period 2012 – 2014**



10.3 Drilling Program 2017

The 2017 exploration program by DL consisted of 15 surface diamond drill holes with a total length of 4,458.9 m. Depending on the near-surface conditions in the overburden the first 10 m or so were drilled with PQ 85.0 core / 122.6 mm hole diameter. Owing to technical reasons, HQ 63.5 core / 96.0 mm hole diameter was used below down to a maximum of 60 m depth. NQ diameter holes with 47.6 mm core / 75.7 mm were drilled at greater depth in the granite and the ore zones. The holes were planned on the one hand as infill holes to improve the density of the drill grid and on the other hand to verify the continuity of ore bodies towards the external borders of the deposit. Drill hole surveys were carried out and the hole were refilled (cementation up to 2 m below ground surface and fill-up to surface with local soil material). Naturally, the geological and sampling team had changed between the two drilling campaigns. Procedures, however, were kept more or less identical. However, in order to assure a transparent documentation and high-quality results of this exploration campaign a new Quality Assurance / Quality Control (QA/QC) instruction [99] was worked out by the DL project leader, which is authoritative for the technical implementation during drilling, sampling, sample preparation and sample processing. A summary flowsheet of the work instructions is shown in the next chapter. The whole process of the QA/QC program was supervised and controlled by the responsible project leader of DL. In addition, the consistent adherence of this QA/QC program with respect to the requirements of the NI 43-101 standard was monitored by the independent qualified persons.

The following principles were adhered for the initial drill core documentation and processing:

- Each cored interval and each core box must be numbered in clear ascending order
- The core must be placed in sections of 1 m within core boxes which have a minimum length of 1.05 m.
- The core boxes are labelled on the upper side and on the front side
- Core losses are logged for each cored interval
- The cores are photographed within the core boxes (3 m intervals per photo)
- One half of the drill core is archived. The other half is used for geochemical and if necessary mineralogical and other investigations
- Sawing of the cores is exclusively done by the responsible specialized company (GEOMONTAN GmbH & Co.KG, Großschirma / Germany)
- The cores are sawed along the long axis of the core and the two halves are positioned correctly back into the core box
- The professional execution of the sawing is monitored by the responsible geologist
- Prior to sampling adherent sawing mud is removed from the core pieces

10.3.1 Drill Hole Summaries

Table 24: Summary of drilling performance by DL in 2017

Drill hole ID	Start of drilling	End of drilling	Drilling performance		Total drilling & inclination survey (m)		
	Date	Date	Drilling Days	Meters per Day	Plan	Actual	Survey
ZGLi 09/2017	02/10/17	10/10/17	9	27.6	249	249	249.1
ZGLi 10/2017	26/09/17	04/10/17	10	26.5	265	265	265.1
ZGLi 11/2017	11/10/17	21/10/17	10	27.1	271	271	271.1
ZGLi 12/2073	14/11/17	22/11/17	11	23.6	260	260.0	260.2
ZGLi 13/2017	02/12/17	15/12/17	15	28.7	430	430	430.2
ZGLi 14/2017	07/12/17	15/12/17	9	23.0	207	207	207.2
ZGLi 15/2017	16/11/17	30/11/17	15	22.1	331	331	331.1
ZGLi 16/2017	06/11/17	14/11/17	9	25.7	231	231	231.3
ZGLi 17/2017	16/10/17	28/10/17	13	26.0	335	338	338.3
ZGLi 18/2017	14/12/17	27/12/17	14	23.0	322	322	322.2
ZGLi 19/2017	27/11/17	12/12/17	15	24.9	374	373.8	373.8
ZGLi 20/2017	07/10/17	03/11/17	30	17.4/ 27.4	259	259	259.0
ZGLi 21/2017	14/11/17	24/11/17	12	27.0	324	324	324.1
ZGLi 22/2017	24/11/17	04/12/17	11	23.1	262	254	254.2
ZGLi 23/2017	26/10/17	10/11/17	17	20.1	342	342	342.0
Sum				**Ø 25.05**	**4,462**	**4,456.8**	**4,458.9**

The drilling results of the 2017 campaign fulfilled the predictions and verified the preliminary geological model of the previous campaign. Drill hole ZGLi 11/2017 with an ore intercept of 26 m even confirmed the continuation of greisen beds beyond the expected limits of the deposit in the west. Drilling progressed without major problems, with the exception of drill hole ZGLi 20/2017, where three caverns were met, and rods lost. ZGLi 22/2017 was deadlocked and aborted 8 m before the planned depth was reached.

Table 25: Summary of significant Li grades obtained in the 2017 DL drill holes

Drill hole ID	Depth from [m]	Depth to [m]	Drilled thickness [m]	Mean Li [ppm]
ZGLi 09/2017	120.45	133.93	13.48	2,957
ZGLi 10/2017	147.30	157.35	10.05	3,986
ZGLi 10/2017	226.23	236.80	10.57	2,396
ZGLi 11/2017	136.15	166.7	30.55	3,627
ZGLi 11/2017	175.20	181.90	6.70	2,526
ZGLi 12/2017	141.8	148.3	6.50	3,835
ZGLi 13/2017	260.50	263.65	3.15	3,029
ZGLi 14/2017	81.30	97.7	16.40	3,724
ZGLi 14/2017	97.7	107.95	10.25	4,388
ZGLi 14/2017	107.95	112.95	5.00	4,046
ZGLi 15/2017	275.50	297.20	21.70	5,894
ZGLi 16/2017	34.60	42.35	7.75	2,162
ZGLi 16/2017	52.40	67.15	14.75	3,017
ZGLi 16/2017	118.75	122.50	3.75	6,240
ZGLi 18/2017	310.60	314.95	4.35	2,787
ZGLi 19/2017	297.20	301.50	3.50	3,195
ZGLi 20/2017	91.75	102.85	11.10	4,693
ZGLi 20/2017	107.30	123.60	16.30	3,392
ZGLi 20/2017	123.60	137.75	14.15	5,926
ZGLi 20/2017	145.75	154.35	8.60	2,805
ZGLi 20/2017	190.30	193.9	3.60	3,256
ZGLi 21/2017	151.10	165.90	14.8	2,196
ZGLi 21/2017	165.90	177.10	11.20	3,012
ZGLi 21/2017	177.10	189.20	12.10	2,994
ZGLi 22/2017	37.20	53.70	16.50	3,664
ZGLi 22/2017	140.80	163.15	22.35	2,555
ZGLi 23/2017	201.80	205.25	3.45	6,299

10.3.2 Core Recovery, RQD and Drill Core Logging

Rock Quality Designation Index (RQD) determinations, ambient gamma radiation dose rate measurements and a general lithological logging were conducted by personnel of Dr. Spang Ingenieurgesellschaft für Bauwesen, Geologie und Umwelttechnik mbH, Freiberg office and BOG Bohr- und Umwelttechnik GmbH in Caaschwitz.

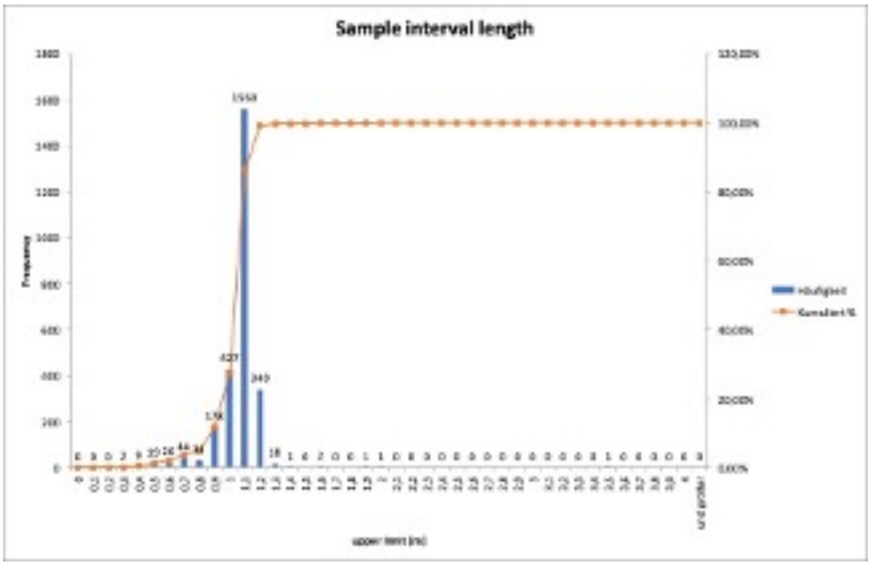
Drill core recovery and detailed drill core logging as well as core sampling was performed by DL staff in a warehouse on the former German / Czech border station near Zinnwald. Core recovery ranged between 97.9 % and 99.5 %

10.3.3 Drill Core Sampling

The core sample intervals were defined following the geological and mineralogical description and interpretation by the responsible geologist. Standard length of the sample interval is 1 m, with a special focus, however, on lithological boundaries. Thus, core splitting was done at sharp lithological boundaries. Fuzzy or gradual boundaries exceeding a total thickness of 0.5 m were sampled individually. If the transitional zones amounted to less than 0.5 m, they were split onto both adjacent lithologies. If alternating lithologies with a thickness of < 1 m were met, these intervals were sampled as coherent sample.

Splitting of the sample intervals was done by a saw or angle grinder. Sample sections were packed in adequately labelled sample bags containing a sample ticket inside. In the case of a poor condition of the core (e.g., fine-grained material, clayey material, fault zones etc.) sampling was done along the long axis of the core using appropriate tools (e.g., palette knives, spoons).

Figure 31: Histogram of sample length from drill core samples of the campaign 2017



Sample length ranged generally between 0.3 m and 1.4 m. Only four samples were more than 1.6 m long due to core loss. Sample length from 2,660 samples averages to 0.98 m.

11 Sample Preparation, Analysis and Security

11.1 2012 – 2014 Drilling Campaign

11.1.1 Method of Sample Preparation

Following the geological documentation and sampling procedure at the project camp site all subsequent sample preparation was executed in the processing laboratory of G.E.O.S. in Halsbrücke near Freiberg. The samples were transported at least once every two weeks to the laboratory by project personnel. The accompanying documents containing a list with the sample numbers were signed by the responsible personnel handing over and receiving the material to assure a chain of custody. Within the laboratory of G.E.O.S the samples were partitioned to batches consisting of not more than 20 samples were handled at the same time. If required, samples first were dried overnight within a drying kiln at 110°C. Following weighing the entire sample was crushed using a jaw crusher (RETSCH BB 200) to 80 % passing 10 mesh (2 mm) sieves. About 500 g of crushed material was split and further grinded to 95 % passing 150 mesh (63 µm) sieves within a ring-and-puck pulverizer (MSL 2 of former VEB Bergbau- und Hüttenkombinat „Albert Funk“, Freiberg / Germany). The particle size of the samples was checked by simple finger test and again by screening random samples in the executing geochemical laboratories.

For each sample a 50 g split of the pulp was placed in an envelope and labelled with preprinted tags. The remainder of the 500 g pulp sample was saved. For samples that were envisaged for QA/QC procedures like duplicates three more subsamples of 50 g each were split off from the pulp reject. All splitting procedures were performed using a riffle splitter made of stainless steel. Remaining material of different grain sizes was packed and labelled accordingly and sent back to the permanent core shed. To avoid contamination, jaw crusher, disk mill and all tools were cleaned neatly after every sample by the help of a stiff brush and high-pressure air. In addition, the ring-and-puck pulverizer was cleaned by grinding with pure quartz sand on a daily basis. Envelopes for the pulps were laid out on the sample preparation pad to allow the insertion of standards to the batches before shipment.

Once QA/QC samples had been inserted the samples were placed in batches of approximately 150 to 350 samples into robust cardboard boxes which were sealed and marked up with the containing sample numbers and shipping details. All procedures were carefully attended and met industry standards for collection, handling and transport of drill core samples.

11.1.2 Methods of Analysis

All drill core samples of the SWS exploration activities during 2012 and 2014 were analyzed by the accredited commercial ALS laboratory at Roşia Montană, Romania. The analytical package comprises the determination of 53 elements. For this purpose, several different digestion and analytical methods were applied.

Lithium which is incorporated in semi-resistant micas was analyzed together with the group of base metals and scandium by ICP-MS after a four-acid digestion (Laboratory code ME-4ACD81). One sample that exceeded the maximum detection level for lithium of 10,000 ppm was additionally analyzed using four acid digestion and AAS finish (Laboratory code: Li-OG63).

Tin and tungsten together with a broad range of other trace elements including rare earth elements were fused with lithium metaborate followed by an acid digestion and ICP-MS measurement (Laboratory code ME-MS81d). This technique solubilizes most mineral species including those, which are highly refractory.

An identical procedure was applied for the group of major elements (Laboratory code: ME-ICP06). During the first campaign (2012) tin and tungsten were additionally analyzed by wavelength dispersive XRF analysis (Laboratory code XRF05) on pressed pellets for cross checking with the results of ICP-MS analysis of fused pellets.

Samples of the second campaign (2013 – 2014) that exceeded the maximum detection level for tin of 10,000 ppm were additionally analyzed by the ion selective electrode method (ISE) following Na_2O_2 fusion and citric acid leach. Ion chromatography after KOH fusion was used to analyze fluorine (Laboratory code F-ELE82 and F-IC881).

Duplicates were sent to Activation Laboratories Ltd. in Ancaster, Canada (Actlabs) for analysis. Analogous to the digestion procedure at ALS the sample material was treated with a four-acid leach and measured for lithium with ICP-OES (Code 8 Lithium ore). The group of elements including tin, tungsten, base metals and rare earth elements was analyzed together with the major elements by ICP-MS and ICP-OES after fusion with lithium metaborate / tetraborate and an acid leach. Sodium peroxide fusion and ICP-MS finish was utilized for samples exceeding the upper limit of detection (LOD) of tin (Sn >10,000 ppm). Fluorine was measured using ISE.

The list of elements analyzed by ALS including the analytical code, the lower and upper detection limits is shown in **Table *26***.

Table 26: List of elements analyzed at ALS, codes of procedure, limits of detection

Element	Code	Unit	lower LOD	upper LOD	Element	Code	Unit	lower LOD	upper LOD
Ba	ME-MS81d	ppm	0.5	10,000	SiO_2	ME-ICP06	%	0.01	100
Ce		ppm	0.5	10,000	Al_2O_3		%	0.01	100
Cr		ppm	10	10,000	Fe_2O_3		%	0.01	100
Cs		ppm	0.01	10,000	CaO		%	0.01	100
Dy		ppm	0.05	1,000	MgO		%	0.01	100
Er		ppm	0.03	1,000	Na_2O		%	0.01	100
Eu		ppm	0.03	1,000	K_2O		%	0.01	100
Ga		ppm	0.1	1,000	Cr_2O_3		%	0.01	100
Gd		ppm	0.05	1,000	TiO_2		%	0.01	100
Hf		ppm	0.2	10,000	MnO		%	0.01	100
Ho		ppm	0.01	1,000	P_2O_5		%	0.01	100
La		ppm	0.5	10,000	SrO		%	0.01	100
Lu		ppm	0.01	1,000	BaO		%	0.01	100
Nb		ppm	0.2	2,500	LOI		%	0.01	100
Nd		ppm	0.1	10,000					
Pr		ppm	0.03	1,000	Ag	ME-4ACD81	ppm	0.5	100
Rb		ppm	0.2	10,000	As		ppm	5	10,000
Sm		ppm	0.03	1,000	Cd		ppm	0.5	1,000
Sn		ppm	1	10,000	Co		ppm	1	10,000
Sr		ppm	0.1	10,000	Cu		ppm	1	10,000
Ta		ppm	0.1	2,500	Mo		ppm	1	10,000
Tb		ppm	0.01	1,000	Ni		ppm	1	10,000
Th		ppm	0.05	1,000	Pb		ppm	2	10,000
Tl		ppm	10	10,000	Sc		ppm	1	10,000
Tm		ppm	0.01	1,000	Zn		ppm	2	10,000
U		ppm	0.05	1,000	Li		ppm	10	10,000
V		ppm	5	10,000	Li	Li-OG63	%	0.005	10
W		ppm	1	10,000	Sn	XRF05	ppm	5	10,000
Y		ppm	0.5	10,000	W		ppm	10	10,000
Yb		ppm	0.03	1,000	F	F-IC881	ppm	20	20,000
Zr		ppm	2	10,000	F	F-ELE82	%	0.01	100

11.1.3 Quality Assurance and Control Measures

Quality assurance and control procedures are required to review the reliability of the assay results. For this reason, control samples had to be included into the analytical program. Control samples may consist of blanks, duplicates and reference standard samples in addition to an appropriate number of duplicate samples analyzed by an external laboratory. Blank samples test for contamination, internal duplicates for contamination, precision as well as intrasample variance grade and reference standards test for assay precision and accuracy. Core quarter duplicates, pulp duplicates, and internal standard material were analyzed in the project.

ALS and Actlabs were certified by the International Organization for Standardization to ISO 9001:2015and / or are accredited after ISO 17025. The laboratories used internal quality control systems. Each assay certificate lists the sample results plus the lab's internal sample control results based on own duplicates, blanks and certified reference standard pulps. They were inserted for each batch.

Reporting of assay results from the laboratory was transferred to SWS in electronic format using both Excel files and PDF format. Complete and final assays were prepared by the labs in PDF format with the lab certification results for each batch.

11.1.3.1 Internal Standard Material

The accuracy of laboratory results during the drilling / sampling program was monitored by two non-referenced internal standards prepared by SWS. Material from preliminary processing test work was used to create the internal lithium standard IS1, a high-grade material made from magnetic separates, and IS2, a low-grade material made from tailings of magnetic separation. About 10 kg of each material was crushed and milled to 95 percent passing 150 mesh (63 µm) sieves, homogenized and bagged in envelopes at the facilities of a local research institute for mechanical processing (UVR FIA in Freiberg). Some 50 g were provided for each standard which was designated for the sample batch.

During the first campaign in 2012 each standard was placed in a frequency of 1 in 40 (2.5 %) while it was reduced to 1 in 80 (1.25 %) in 2013 – 2014.

Figure 32: Li, Sn and W control assays for internal standard IS1 (high grade)

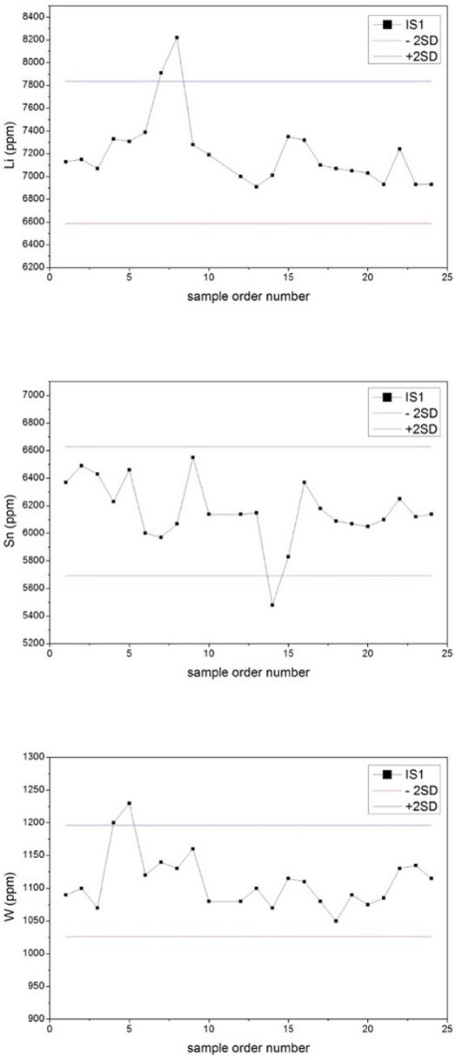


Figure 33: Li, Sn and W control assays for internal standard IS2 (low grade)

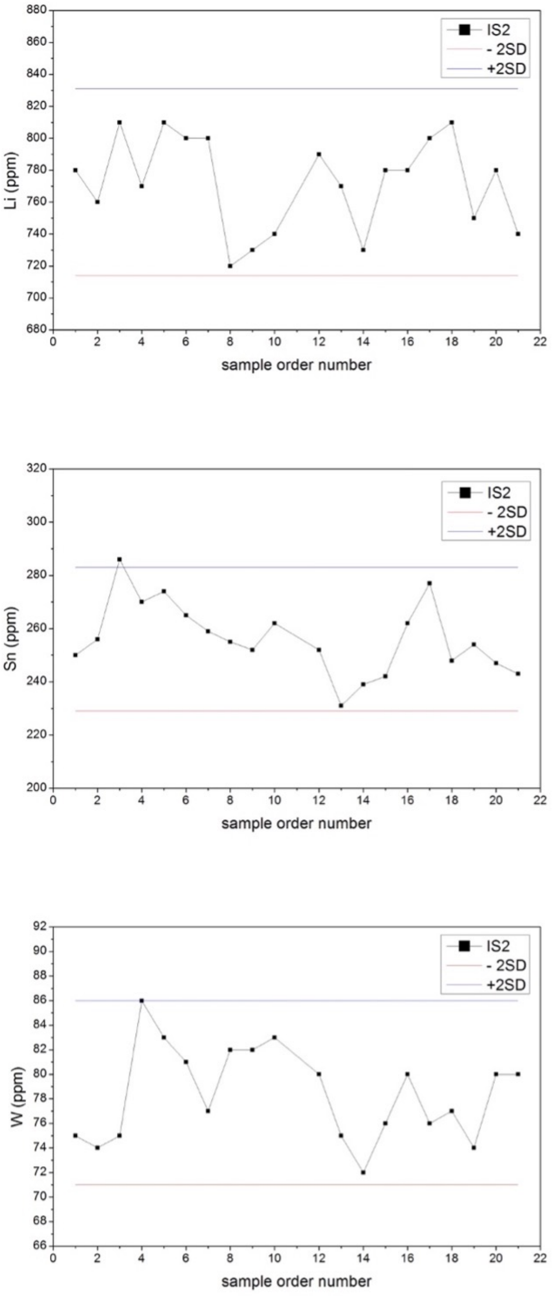


Table 27: Summary of base statistics for selected elements assayed under IS1, IS2

Internal standard	Element	N total	Mean [ppm]	Standard deviation [ppm]	Coefficient of variation	Minimum (ppm)	Median [ppm]	Maximum [ppm]	Range (Max – Min) [ppm]
IS1 (high grade)	Li	23	7,211	311	0.043	6,910	7,130	8,220	1,310
	Sn	23	6,160	233	0.038	5,480	6,140	6,550	1,070
	W	23	1,111	43	0.038	1,050	1,100	1,230	180
IS2 (low grade)	Li	20	773	29	0.038	720	780	810	90
	Sn	20	256	14	0.053	231	255	286	55
	W	20	78	4	0.048	72	79	86	14

11.1.3.2 Certified Reference Standard Material

ALS used certified reference standard material for internal control. Different standard materials were employed with respect to the analytical procedure (**Table *28***). Depending on the assay type these standard samples were implemented at a frequency of about 1 in 100 to 1 in 20 (1 to 5 %).

Table 28: List of certified reference standard material used at the ALS laboratory

Analytical Code	Objectives	Standard identification
4ACD81	Li, Sc, base metals	LS-1; LS-3; OGGeo08
ME-ICP06	Major elements	SY-4; AMIS0085; AMIS0167
ME-MS81d	Trace elements (including Sn, W)	SY-4; TRHB; OREAS 146; AMIS0085
XRF	Sn, W	KC-1a; TLG-1

Figure 34: Li and Sn internal control assays (certified standards LS-1, LS-3, TRHB)

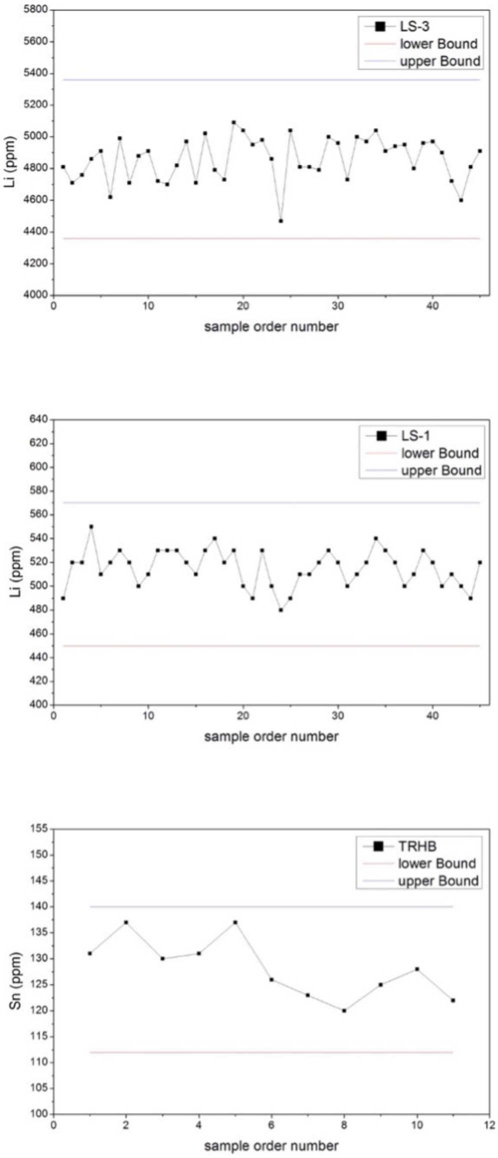
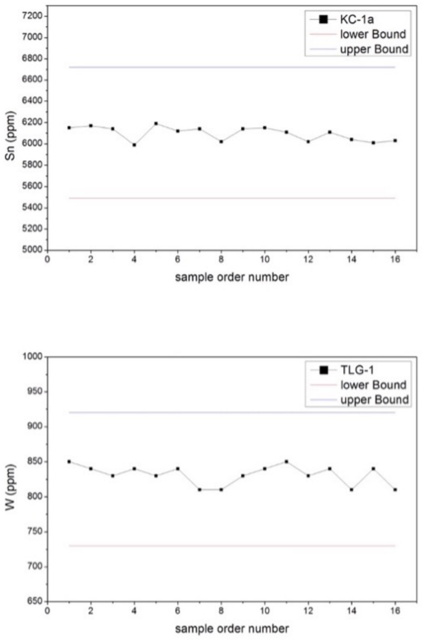


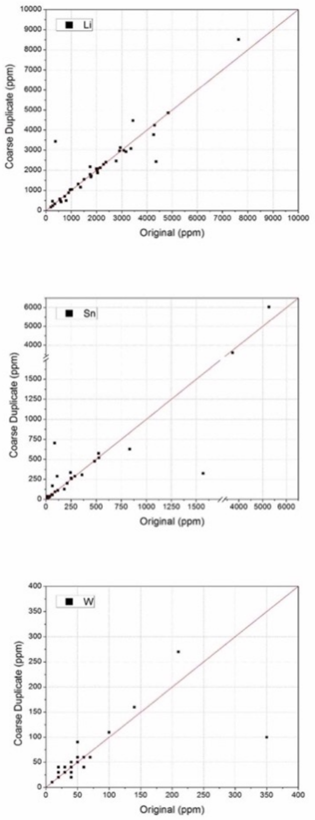
Figure 35: Sn and W internal control assays (certified standards KC-1a, TLG-1)



11.1.3.3 *Core Quarter Duplicates*

During the first exploration campaign of SWS (2012) sample preparation protocol, adequacy of sample mass and uniform distribution of mineralization was tested by inserting duplicate samples of another drill core quarter from the same depth interval. Both samples were analyzed by ALS. This type of control analysis was carried out at a frequency of 1 sample in 10 (10 %).

Figure 36: Scatter plots of Li, Sn and W for core quarter duplicates

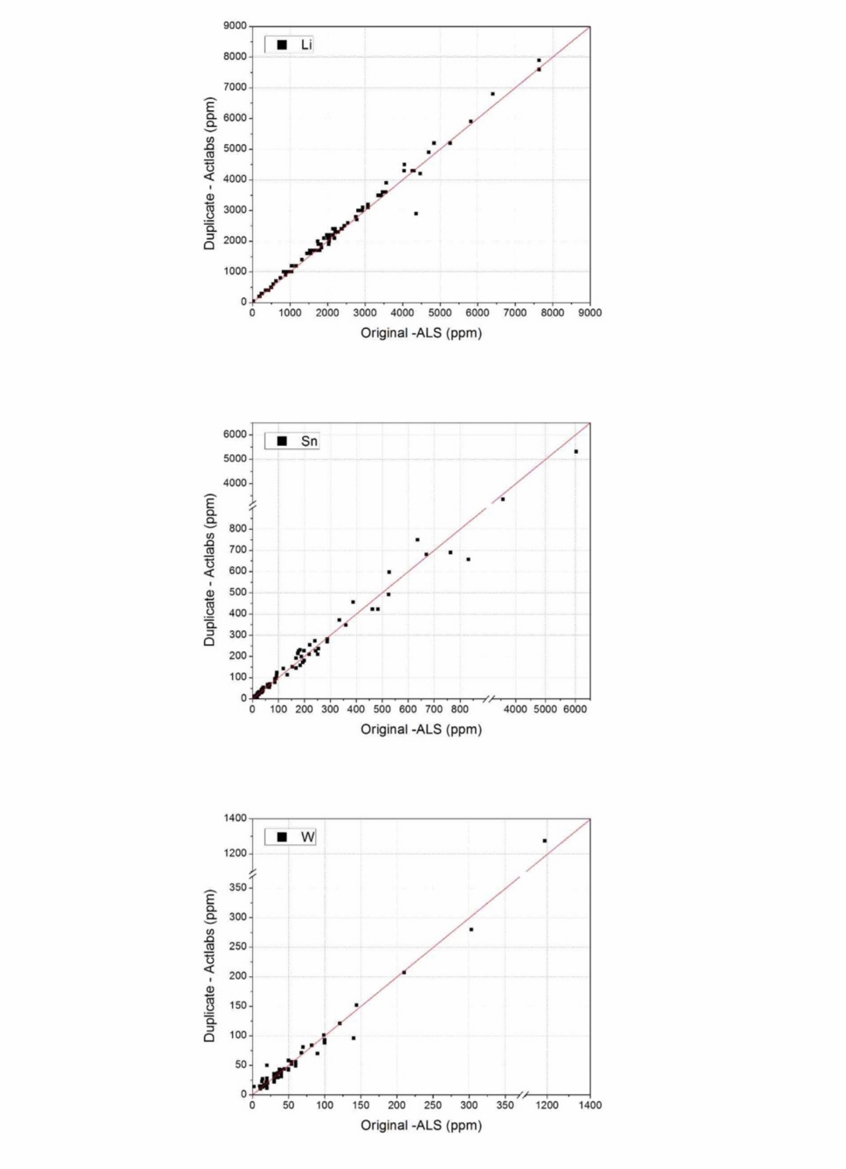


11.1.3.4 Pulp Duplicates

Pulp or lab duplicates were manufactured during ongoing sample preparation at the laboratories of G.E.O.S. and were inserted at a frequency of 1 in 10 (10 %) in 2012. In 2013 – 2014 after an evaluation of the results of the first exploration campaign the frequency could be reduced to a ratio of 1 in 20 (5 %).

The pulps were submitted to an independent laboratory (Actlabs) for an external accuracy check.

Figure 37: Li, Sn and W assays for pulp duplicates of ALS and Actlabs



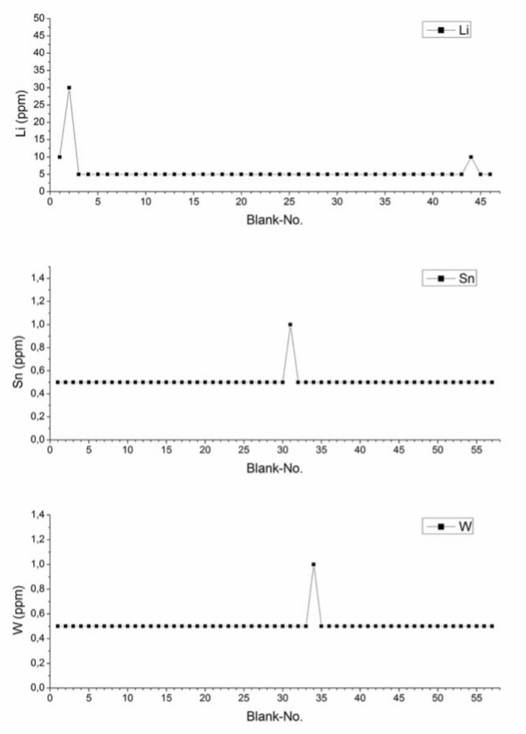
11.1.3.5 Blanks

Explicit blank material was not inserted into the analytical program by SWS. Intersections of very quartz-rich greisen, however, which were sampled throughout the campaigns, provided information on the geochemical spectra at lower limits of detection.

Assays of blank material implemented by the primary laboratory (ALS) were used to detect any contamination.

The following charts present the results of this lab-internal blank analysis compiled for the different analytical procedures.

Figure 38: **Results of lab-internal blank analysis of Li, Sn and W**



11.1.3.6 Internal Standard Performance

The performance of internal (non-certified) standard material was evaluated using the criterion that ninety percent of the results must fall within ± 2 times the standard deviation (±2SD) of the mean value. Assuming GAUSSIAN distribution, this measure implies that each assayed value is in the range of about 95.4 % of all assays of the standard. Results are presented using statistical process control charts. Within the charts the assay values for the standard are presented as black squares and the mean value of the standard is listed on the right side of the chart. Control limits at ±2SD of the mean value are marked with red and blue lines.

Both internal standards (IS1 and IS2) showed no overall bias and no bias with time. For the case of lithium, 21 out of 23 (91 %) assays of IS1 and 20 out of 20 (100 %) assays of IS2 fell within the permitted limits. Similar results are obtained for tin and tungsten where 96 % (IS1) and 95 % (IS2) and 91 % (IS1) and 100 % (IS2) fell within the limits, respectively. The analyses are therefore considered to be within precision and accuracy requirements (**Figure *32***, **Figure *33***, **Table *27***).

11.1.3.7 Laboratory Internal Reference Standard Performance

The evaluation of reference standard material implemented by the lab uses the criterion that ninety percent of the results must fall within the limits (in general ±2SD) of the certified value. The results are presented analogously to the section above, displaying the name of the standard material and the lower / upper limits. Regarding lithium, tin and tungsten all of the samples met the criteria mentioned above and the assays were therefore considered as accurate and precise (**Figure *34*** and **Figure *35***).

11.1.3.8 Core Quarter Duplicate Sample Performance

Duplicate samples of a second quarter of drill core were assayed to check the sample preparation protocol, adequacy of sample mass and uniform distribution of mineralization during the 2012 campaign. If the protocol was adequate, ninety percent of the duplicate pairs of assays should fall within ± 30 %. Lithium assays of core quarter duplicates fell within these control limits. Tin and tungsten duplicates, however, showed only about 75 % assay pairs within the control limits suggesting a more heterogeneous distribution of cassiterite and wolframite (**Figure *36***).

Since the results demonstrated the appropriateness of sampling procedures chosen in 2012 core quarter duplicates were not implemented during the next campaign.

11.1.3.9 Pulp Duplicate Sample Performance

Duplicate samples of pulp material were assayed for another test on assay accuracy and precision. For the 2012 – 2013 program, lithium duplicate pairs from pulp material fell within control limits above the rate of 90 percent ±15 %.

Pearson correlation coefficient was about 0.992 while rank correlation coefficient after SPEARMAN was about 0.993. Tin and tungsten did not meet these criteria, basically because abundant duplicate samples with low grades led to a higher percentage of deviation. However, the coefficient of Pearson correlation of about 0.992 (Sn) and 0.997 (W) demonstrated the strong assay interrelation from duplicate pairs (**Figure *37***).

11.1.3.10 Blank Sample Performance

Blank samples of the lab were measured to detect possible contamination during sample preparation. A large number of the blanks demonstrated low-level lithium grades (< 5 ppm), only 3 samples were characterized by values above this limit (max. 30 ppm). Similar results were obtained for other elements in blanks including tin and tungsten, where all samples except of one showed grades below 0.5 ppm (max. 1 ppm, see Figure 33). Furthermore, analysis of barren quartz greisen consisting of almost pure quartz revealed low concentrations of lithium below 150 ppm.

11.1.3.11 Overall Interpretation of the QA/QC Program

Results from standard material analysis (internal, non-certified standard material and certified reference material implemented by the lab) indicated that the lithium, tin and tungsten assay processes were under sufficient control over a broad range of concentration. A high correspondence of lithium assays from core quarter duplicates and pulp duplicates was obtained and demonstrated. Core quarter duplicate assays of tin and tungsten indicated, however, a more heterogeneous distribution of the respective mineralization. Sample preparation did not induce any relevant contamination. The analysis of blank material by the lab confirmed that contamination was not introduced during the analytical procedures.

The Zinnwald sampling and assaying program meets the industry standards for the accuracy and reliability of lithium, tin and tungsten grades. The assay results were sufficiently accurate and precise for the use in resource estimation.

11.2 2017 Drilling Campaign

In order to assure a transparent documentation and high-quality results of this exploration campaign a Quality Assurance / Quality Control (QA/QC) instruction was worked out by DL [99], which is also authoritative for the technical implementation during sample preparation and sample pro-cessing (**Figure *39***).

The whole process of the QA/QC program was supervised and controlled by the responsible project leader of DL. In addition, the consistent adherence of this QA/QC program with respect to the requirements of the NI 43-101 standard was monitored by the independent qualified persons. Generally, in the 2017 campaign sampling and sample preparation procedures were similar compared to 2012 – 2014 with some minor modifications. DL delivered the core halves (about 2,250 g/sample) to G.E.O.S. in Halsbrücke.

The core material was dried, milled ≤ 2 mm with a jaw breaker, homogenized and successively quartered with a riffle splitter to 250 g. Samples were carefully ticketed und packed for shipment. Duplicates and retention samples were prepared as well. Duplicates and the internal standards IS1 and IS2 were introduced in the sample series according to the QA/QC program of DL.

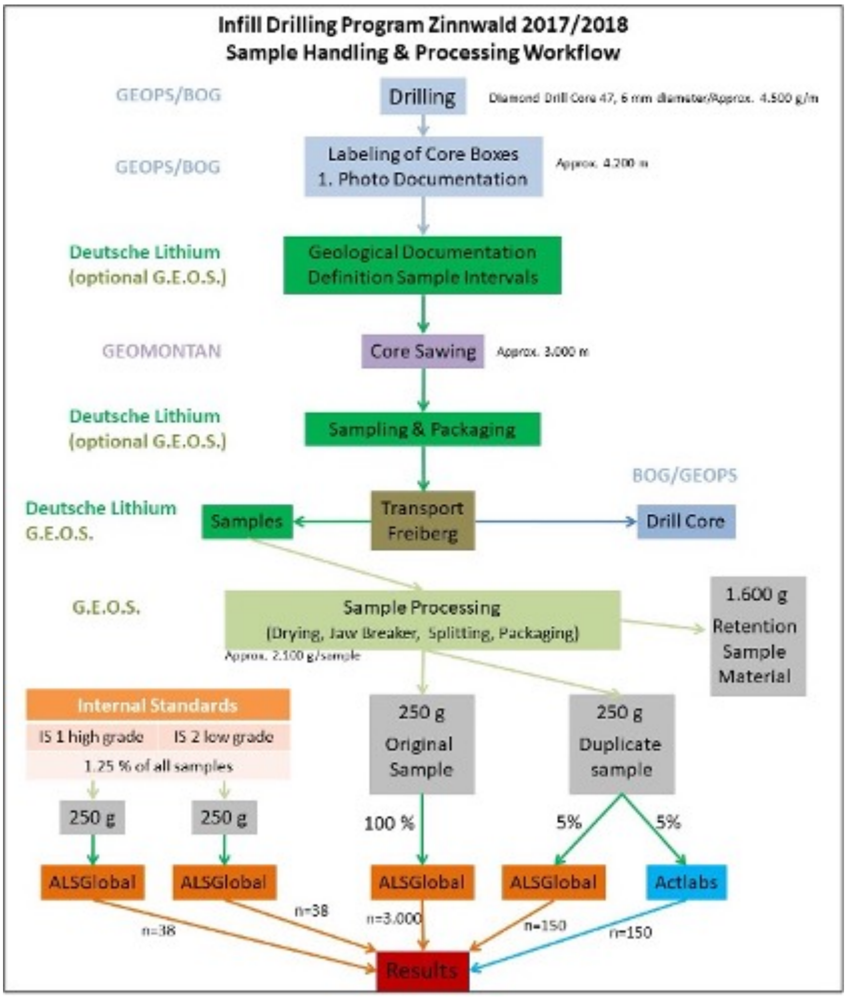
A newly produced lithium high-grade standard IS1 with a grade of about 4,600 ppm Li was used. Within 2,643 samples 280 duplicates and 83 standards were inserted in the sample batches by DL corresponding to about 11 and 3 % on rounded average, respectively.

Shipping of the samples to ALS in Romania and Actlabs in Canada was organized by DL as well as the pick-up and storage of the retention pulps and the remaining core halves in the core store in Freiberg / Brand Erbisdorf. Pulverizing of the sample pulps was conducted by the labs abroad. Assay techniques were the same as in the earlier campaign.

Table 29: Internal and external assay control of the 2017 drill campaign

Drill hole ID.	Drill core samples	Duplicates	Duplicates (%)	Standards	Standards (%)
ZGLi 09/2017	133	14	10.53	4	3.01
ZGLi 10/2017	128	14	10.94	4	3.13
ZGLi 11/2017	128	14	10.94	4	3.13
ZGLi 12/2017	166	18	10.84	4	2.41
ZGLi 13/2017	181	20	11.05	7	3.87
ZGLi 14/2017	132	14	10.61	4	3.03
ZGLi 15/2017	170	20	11.76	8	4.71
ZGLi 16/2017	231	24	10.93	6	2.60
ZGLi 17/2017	179	18	10.06	4	2.23
ZGLi 18/2017	196	22	11.22	6	3.06
ZGLi 19/2017	186	20	10.75	6	3.23
ZGLi 20/2017	198	20	10.10	6	3.03
ZGLi 21/2017	178	18	10.11	6	3.37
ZGLi 22/2017	221	22	9.95	6	2.71
ZGLi 23/2017	216	22	10.19	8	3.70
Total	**2,643**	**280**	**10.59**	**83**	**3.14**

Figure 39: Sample handling and processing of the 2017 drilling campaign



11.2.1 Internal Standard Performance

Assay results of the issuer’s lithium standards IS1 and IS2 show a satisfying consistency.

Figure 40: **Li control assays for internal standard IS1 (high grade)**

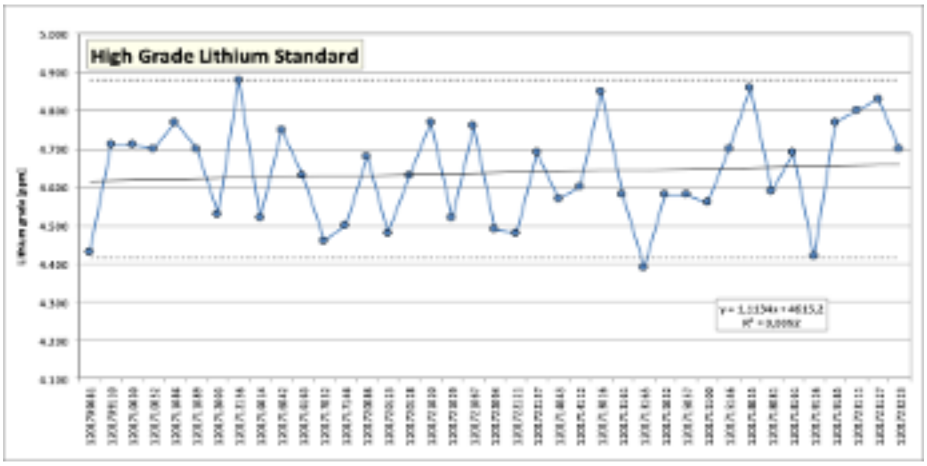
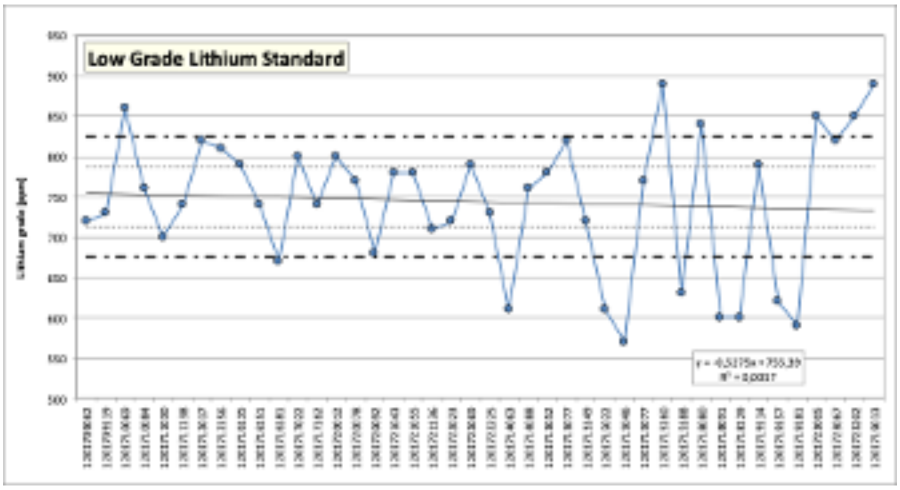


Figure 41: **Li control assays for internal standard IS2 (low grade)**



11.2.2 Internal Duplicate Sample Performance

Excellent results were received from the internal control assays of ALS on lithium, tin, tungsten and potassium oxide with respect to pulp duplicate samples.

Figure 42: **Comparison of lithium assays of original vs. duplicate core samples**

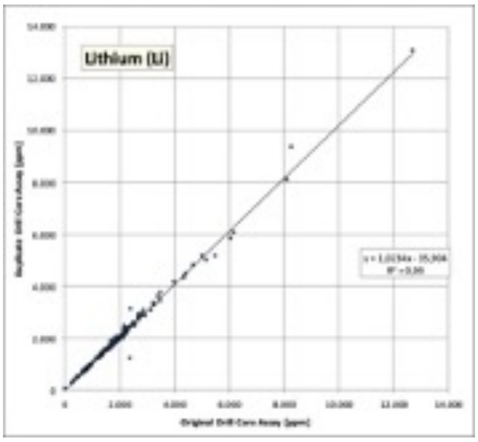


Figure 43: **Comparison of tin assays of original vs. duplicate core samples**

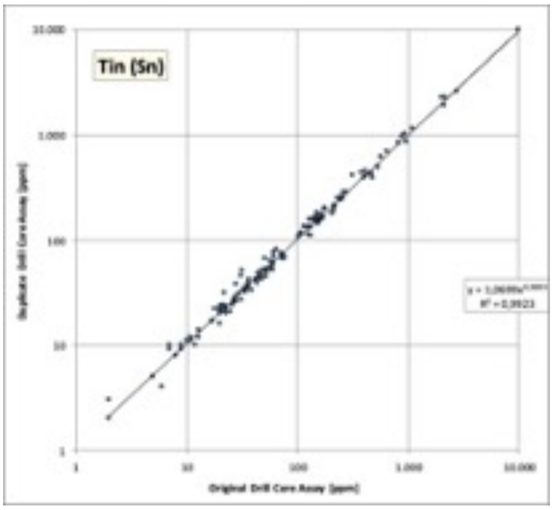


Figure 44: **Comparison of tungsten assays of original vs. duplicate core samples**

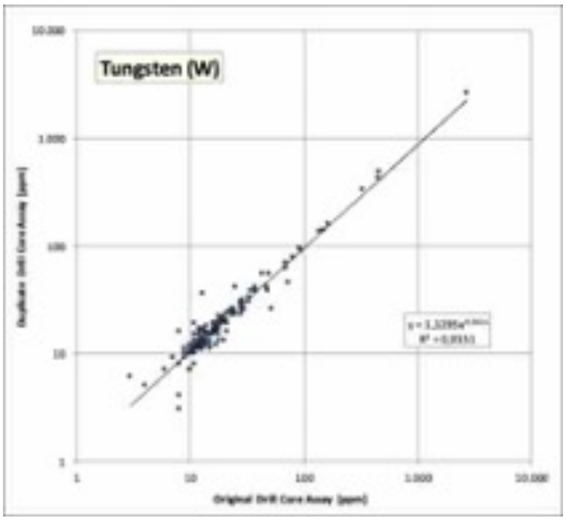
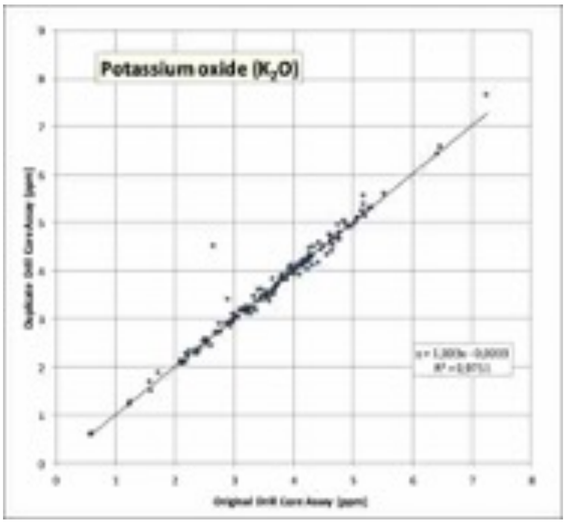


Figure 45: **Comparison of K_2O assays of original vs. duplicate core samples**



11.2.3 External Duplicate Sample Performance

Consistent results were also received from the external control assays of Actlabs on lithium, tin and potassium oxide with respect to pulp duplicate samples. Some outliers, however, were observed for tungsten.

Figure 46 Comparison of lithium assays of original vs. duplicate core samples

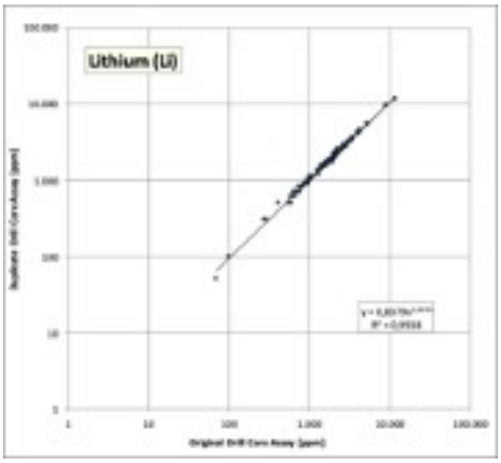


Figure 47: Comparison of tin assays of original vs. duplicate core samples

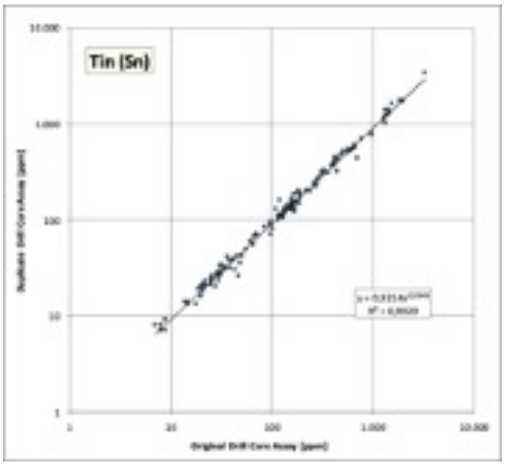


Figure 48: Comparison of tungsten assays of original vs. duplicate core samples

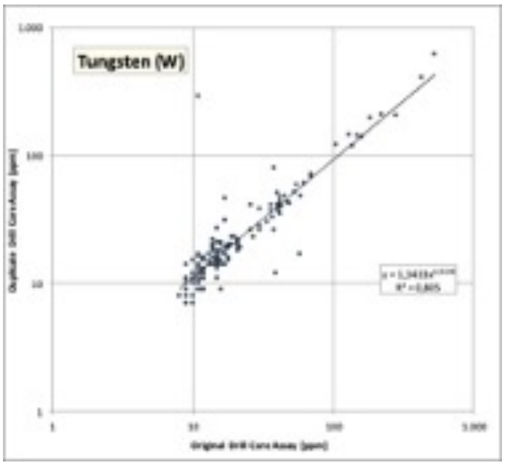
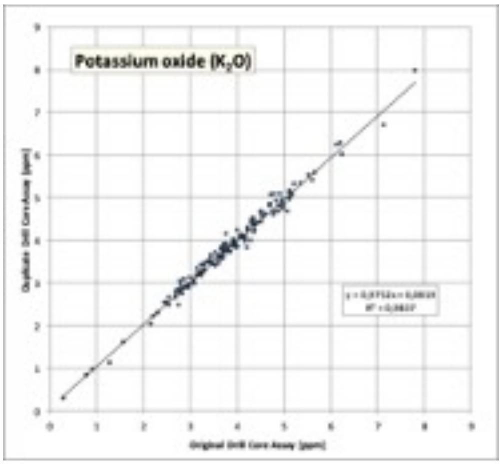


Figure 49: **Comparison of K_2O assays of original vs. duplicate core samples**



11.2.4 Overall Interpretation of the QA/QC Programme

Approximately 10 % of the 2,660 core samples of the 2017 drilling campaign were additionally analysed as duplicates. 140 samples stand for internal control (ALS) and 140 for external control (Actlabs). 40 low-grade standards and 40 high-grade standards were assayed. Blanks were not manufactured by the client. Summing up, accuracy and precision of the core assays concerning lithium, tin, tungsten and potassium oxideecycll again high industrial standards (see **Table *30***).

Furthermore, the geological model and the geochemical characteristics of the lithium deposit were confirmed by the new results. Expectations of ore intercepts and lithium grades were even out-performed. Together with the results of the other exploration campaigns a significant mineral resource estimate is possible.

Table 30: **Summary of assay deviations between original and duplicate samples**

Commodity	**Statistic Parameter**	**Internal Control**	**External Control**
Lithium	Average Deviation	13 ppm	6 ppm
	Standard Deviation of Average Deviation	170 ppm	110 ppm
	Mean Percent Deviation	1 %	0 %
Tin	Average Deviation	1 ppm	-29 ppm
	Standard Deviation of Average Deviation	40 ppm	60 ppm
	Mean Percent Deviation	3 %	-9 %
Tungsten	Average Deviation	-1 ppm	2 ppm
	Standard Deviation of Average Deviation	11 ppm	27 ppm
	Mean Percent Deviation	3 %	25 %
Potassium Oxide	Average Deviation	0.01 wt.%	-0.01 wt.%
	Standard Deviation of Average Deviation	0.2 wt.%	0.14 wt.%
	Mean Percent Deviation	0 %	0 %

12 Data Verification

12.1 Database

For the geological modelling and the calculation of the resource estimate 76 surface holes and 12 underground drill holes have been used. Among these, 25 of the surface holes have been drilled during the past ten years as part of the exploration campaign done by SWS and DL. The samples from the last drilling campaigns (2012–-2017) have been assayed by ALS. In total, 6,342 lithium core sample assays are taken for the evaluation, covering 6,465 m of core. Further 88 assays were available from underground channel sampling, performed by SWS in the year 2012 and another 1,350 assays from underground pick samples, reported by GRUNEWALD, 1978a ***[107]***.

General information on the drill holes is presented in the data table “collar”. The data table “geology” contains the geologic drill logs whereas the data table “sample” contains information on sample assays. Discrete point sample data for underground pick samples and channel samples is given in data table “sample_disc”. In data table “sample” information of the tables “sample” and “geology” was merged. Geological model and resource estimation are based on this table.

12.2 Procedures

12.2.1 Database Verification

For the Zinnwald / Cínovec deposit datasets of various kinds and ages are available. They go back to the 1^{6t}h century and comprise geological, mineralogical, geotechnical and geochemical data. Since the beginning of the 2^{0t}h century the Zinnwald deposit has been investigated by three major exploration campaigns, which built up the fundamental base of the historic datasets used within the recent exploration campaign (LÄCHELT, 1960 ***[101]***; GRUNEWALD, 1978a ***[107]***; BESSER & KÜHNE, 1989 ***[110]***; and BESSER, 1990 ***[111]***). The extent and the results of these programs are described in the report “Lithiumgewinnung in der Lagerstätte Zinnwald–-Ressourceneinschätzung” which was compiled by KÜHN et al., 2012 ***[19]***. From these exploration and research reports the main information used for the evaluation of the Li-Sn-W-deposit Zinnwald consists of information from drill core, mine maps and results of geochemical assays.

All original historic data found in geological and mining archives are available as printed text, tables or figures implemented in final exploration and / or research reports. For the utilization within a multi-source resource model dataset have been converted into digital format by simply typewriting. Naturally, errors arise during this process and a control of digitized data is necessary. Additionally, recent data obtained during the ongoing exploration campaign need to be tested for incorrect values introduced during digitization. **Table *31*** gives an overview of datasets included in the data control.

Prior to the actual controlling process general instructions need to be defined concerning the amount and accuracy of controlled data. As a general rule, the data control is applied to at least 10 % of the entities of each dataset. One entity corresponds to a complete column or row of the dataset (e.g., one depth interval with lithological and tectonic information or one depth interval with numerous analyzed elements). Hence, an amount of 10 % of the data entities is randomly selected from the original documents. All values of this subgroup are transferred to an independent spread sheet similar to the first data transmission / digitization.

This way, the documentation of the digital data and the input template are structured identically. It is important to note, that the input of raw and controlled data is performed by at least two different persons. The analysis of deviating pairs of values is conducted by either ordinary subtracting of one by the other for numeric values or detecting of identical entities for non-numeric values using Excel-routines. Results are then expressed in additional “deviation”-columns. Identical and therefore correct values are designated by a deviation of 0 (zero), independent from the fact whether they are numeric or non-numeric values. As a result, the quantity of incorrect values is calculated as percentage expression of the total number of controlled values within this dataset. A dataset is designated as accurate if this portion of faulty values is below 10 % of the controlled values. If the portion is higher than 10 %, the complete dataset must be digitized again from the original documents. After errors have been detected, which did not exceed the 10 % level, corresponding values are corrected, and the datasets are implemented back into the fundamental database. Within the database, controlled entities are marked separately with an indication of amendment, the name of the conducting person and date of data control.

Table 31: List of datasets used in the re-evaluation of the Li-Sn-W deposit Zinnwald / Cínovec

Li-Exploration: 1954 – 1960 (BOLDUAN & LÄCHELT,1960) (Exploration campaigns No.s (4a) & (4b))	
Drill hole data (number of drill holes = 27)	
	Basic drill hole data
	Lithological drill hole record
	Sample list including the results of chemical analysis from core samples
Research program: 1977 – 1978 (GRUNEWALD) (Exploration campaign No. (6))	
Drill hole data (number of drill holes = 2)	
	Basic drill hole data
	Deviation measurement record
	Lithological bore hole record
	Sample list and results of chemical analysis from soil samples
	Sample list and results of chemical analysis from core samples
Data from underground pick samples (number of samples = 1,350) (Exploration campaign No. (6))	
	Basic location data
	Sample list including the results of chemical analysis
Sn-W-Exploration 1988 – 1989 (KÜHNE & BESSER) (Exploration campaign No. (7))	
Drill hole data (number of drill holes = 8)	
	Basic drill hole data
	Deviation measurement record
	Lithological drill hole record
	Sample list and results of chemical analysis from moil samples
	Sample list and results of chemical analysis from core samples
Li-Exploration 2011–- 2018 (SolarWorld Solicium GmbH and DL GmbH) (Exploration Campaigns No.s (8a) – (8c))	
Drill hole data (number of drill holes = 25)	
	Basic drill hole data
	Lithological drill hole record
	Sample list and results of chemical analysis from core samples
	Rock quality designation index (RQD)

The overall outcome of data control shows that all checked data sets comply with the determined limits in terms of correctness and accuracy. None of the datasets controlled within this project exceeded the limit of 10 % of incorrect values. The most elevated percentage of faulty values is about 1.7 % for the basic drill hole data (collar). A summary of the results from data control of all data sets that have been utilized within the current resource estimation is shown in **Table *32***.

Furthermore, results of data control show that the majority of faulty values are due to transposed digits crept in during digitization. All errors or faulty values are of minor impact, i.e., none would induce major systematic changes or generate deviating interpretations. Nevertheless, even numerical small errors need to be detected and corrected.

Table 32: Results of data control performed on historic and recent exploration data

Data type	Data source	Total number of columns in the original dataset	Total number of controlled columns	Percentage of controlled columns [%]	Total number of controlled entries (rows x columns)	Total number of faulty entries	Percentage of faulty entries [%]
Basic drill hole data	BOLDUAN & LÄCHELT, 1960; GRUNEWALD 1978a; KÜHNE & BESSER 1989; SolarWorld Solicium GmbH 2011-2014	47	47	100.00	235	4	1.70
Lithological drill hole record	BOLDUAN & LÄCHELT, 1960	806	91	11.3	1,547	10	**0.64**

Data type	Data source	Total number of columns in the original dataset	Total number of controlled columns	Percentage of controlled columns [%]	Total number of controlled entries (rows x columns)	Total number of faulty entries	Percentage of faulty entries [%]
Results of chemical analysis of samples from drill core	BOLDUAN & LÄCHELT, 1960	581	60	10.3	300	4	**1.33**
Results of chemical analysis of mine samples	GRUNEWALD 1978a	1,335	142	10.6	994	1	**0.10**
Results of chemical analysis of samples from drill core	KÜHNE & BESSER 1989	1,252	294	23.48	6,468	7	**0.11**
Drill hole deviation record	Objektakte Sn Altenberg, Suche 2–- TG ZW; VEB BLM Gotha	638	84	13.17	336	1	**0.30**
Lithological drill hole record	SolarWorld Solicium GmbH and Deutsche Lithium GmbH 2011-2018	1,370	35	11.1	1,365	6	**0.44**
Results of chemical analysis of samples from drill core	SolarWorld Solicium GmbH and Deutsche Lithium GmbH 2011-2018	4,579	461	10.0	4,610	0	**0.00**
Rock quality designation index (RQD)	SolarWorld Solicium GmbH and Deutsche Lithium GmbH 2011-2018	572	60	10.5	360	0	**0.00**

12.2.2 Reanalysis of Historic Samples

12.2.2.1 Overview

In addition to the recent exploration results of SWS and DL during the period 2011 to 2017, the geological model, assay data and consequently the resource estimation of the Zinnwald property are based on data from historic exploration campaigns reviewed in Item 12.2.1.

In order to validate the results from chemical analysis of these former campaigns a reassessment of the assayed values was conducted during the first year of SWS exploration campaign (2011–- 2012). This work included the geochemical analysis and comparison of about 53 historic samples from drill core at certified analytical labs (ALS and Actlabs).

Since the sample types and the grade of availability are different for the historic exploration campaigns, the results of the reassessment are presented for the campaign of Li-exploration (BOLDUAN & LÄCHELT, 1960 ***[104]*** and Sn-W-exploration (GRUNEWALD 1978a ***[107]*** and 1978b ***[108]***; BESSER & KÜHNE, 1989 ***[110]*** separately.

The original sample material of historic campaigns was stored in the permanent core shed of the Federal State Office for Agriculture, Environment and Geology of Saxony (LfULG) in Rothenfurth, close to Freiberg / Germany. Unfortunately, only a fractional amount of original drill core material is preserved there. Halves of drill core are stored in wooden core boxes in a high-bay racking in the order of the exploration campaign, drill hole number and depth.

Beside the fact that only sporadic parts of the drilled succession are preserved, the cores are stored in a well-organized manner. Furthermore, rejects of pulp drill core samples were found as well. They are stored in small paper bags to about 50 g each and are ordered by drill hole number and depth. A fraction of this material was destroyed by water damage due to roof leakage.

With respect to the different objectives, different sample types and different analytical procedures during Li- and Sn-W-exploration campaigns it is absolutely necessary to evaluate the reanalysis for each campaign separately.

Table *33* and **Table *34*** give a comprehensive overview of type, amount and quality of sample material for the main historic exploration campaigns.

Table 33: Overview of sample material of historic Li-exploration campaign No 4

Li-Exploration (BOLDUAN & LÄCHELT, 1960) (Exploration campaign No. (4))	
Sample type	Drill core (Ø=100 mm)
Sampled lithologies	Greisen
Mean length of sample intervals	1.00 m
Total sample number	562
Analyzed elements	Li, Sn, W
Analytical methods	
Li	Flame photometry
Sn, W	Spectral analysis
Preserved sample material	Half drill core
Estimated portion of preserved sample material	About 1 %

Table 34: Overview of sample material of historic Sn-W-exploration campaigns No 6 and 7

Li-Exploration (BOLDUAN & LÄCHELT, 1960) (Exploration campaign No. (4))	
Sample type I	Soil samples
Sampled lithologies	Complete drill core
Mean length of sample intervals	4.00 m
Total sample number	1,332
Analyzed elements	Ag, As, B, Ba, Be, Bi, Co, Cu, Li, Mn, Mo, Nb, Ni, Pb, Sn, W, Zn, Zr, Y
Analytical method	Spectral analysis
Sample type II	Drill core (Ø=47 mm)
Sampled lithologies	All intersections with moil samples of > 800 ppm Sn
Mean length of sample intervals	1.00 m
Total sample number	498
Analyzed elements	Sn, W (less frequently As)
Analytical method	X-ray fluorescence analysis (XRF)
Preserved sample material	Retained pulp sample, about 50 g each
Estimated portion of preserved sample material	100 % (but partly damaged)

Samples for reanalysis were selected based on the availability of corresponding historic assays and the most extensive spatial distribution throughout the deposit area. In case of Li-exploration about 28 samples (1 m length) of quarter drill core from 4 different drill holes were sampled using a diamond saw.

A representative set comprising 25 retained pulp samples of Sn-W-exploration were selected from 6 different drill holes. All material was crushed and grinded in concordance with project sample preparation instructions at the facilities of Technical University Bergakademie Freiberg and G.E.O.S. prior to shipment to accredited analytical labs.

All chemical analysis was performed by identical methods used during the SWS exploration, which is described in Item 11.1.3.

The following chapter gives a summary of the results obtained by reanalysis of samples from historic exploration campaigns for the elements lithium and tin. The comprehensive final report with detailed results, significant tables and figures and discussion is presented in appendix 5.1 of the PERC Report 2014 [*28*].

12.2.2.2 *Results of Reanalysis of Drill Core Samples from Sn-W-Exploration (Campaigns No. (6) and (7))*

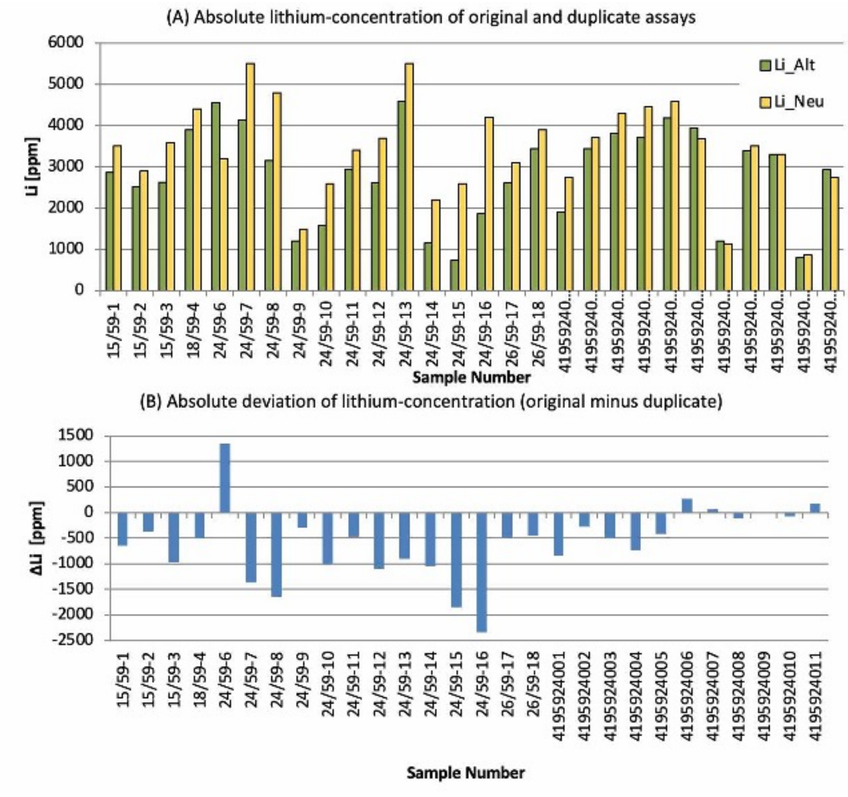
Lithium

About 28 core samples of 4 different historic drill holes were assayed and compared with the original results. As a result, a considerable correspondence of historic and recent Li-concentrations is recognizable (Figure 45). Correlation coefficient of PEARSON (rP) is about 0.8, while rank correlation coefficient of SPEARMAN (rS) is about 0.78.

The present deviations are in a way systematic that recent Li-grades exceed results from historic analysis in about 24 of 28 samples. The absolute value of deviation is most elevated in the sample 24/59-16 with about 2,340 ppm and averages about 590 ppm for all 28 samples. The calculation of a mean percentaged deviation shows that the recent Li-grades are about 132 % of the historic values (median = 118 %). Furthermore, there is no indication of a systematic change of deviation corresponding to the concentration range, which is also shown by Gaussian distribution of the deviations (tested with SHAPIROV-WILK-test and KOLMOGOROV-SMIRNOV-test at 0.05 significance-level).

As a result, the Li-concentrations are almost consistently undervalued. This provides proof that Li-concentrations stand at least on the documented level. Considering a conservative approach, the Li-concentrations are not amended.

Figure 50: Results of sample pairs – historic/recent analysis of Li-exploration data (camp 4)



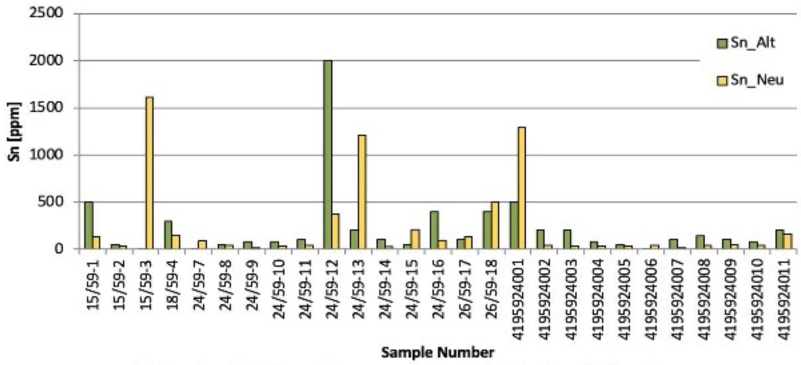
Tin

The assayed Sn-concentrations from Li-exploration data are available over a broad range of concentrations. Generally, they show a slight excess in the historic values compared to recent assays but also indicate several strong deviating sample pairs in both directions (Figure 46). Therefore, the mean absolute deviations are misleadingly small with a mean of about 16 ppm (median = 42 ppm). The low correspondence of the sample pairs is displayed by low values of correlation coefficients (rP = 0.45 and rS = 0.04). Within the rocks of the Zinnwald deposit the element tin is mainly represented by the mineral cassiterite, which is more heterogeneously distributed with local nests and adjacent barren zones.

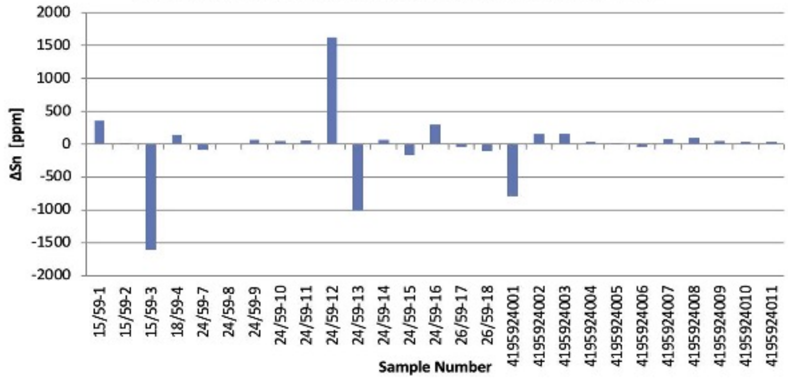
Therefore, interpretation of Sn grades is hampered by the character of distribution in the rocks of the Zinnwald deposit. Results from reanalysis are characterized by a very weak consistency and reproducibility and do not indicate any systematic shift. An overlap of errors induced by analytics and sampling is most likely and impede the usage of historic values for any type of resource classification. However, the confined utilization of tin concentrations for qualitative markers (barren–- weakly mineralized–- strong mineralized) is possible.

Figure 51: Results of sample pairs – historic/recent analysis of Li-exploration data (camp 4)

(A) Absolute tin-concentration of original and duplicate assays



(B) Absolute deviation of tin-concentration (original minus duplicate)



12.2.2.3 Results of Reanalysis of Drill Core Samples from Sn-W-Exploration (Campaigns No. (6) and (7))

Samples from Sn-W-exploration campaigns are available as retained pulp samples grinded to less than 100 µm and packed in small labelled paper bags of about 50 g. The sample material that has been chosen for reanalysis represents drill core material from either chip samples or samples from half drill core (see **Table *34***).

In total, about 25 samples from 6 different drill holes were examined. Since the reanalysis of Sn-W-exploration samples is done on retained pulp material, which represents the identical sample material of the historic analyses, it provides a possibility to determine precision of analytical procedures from that time. No sampling bias is introduced.

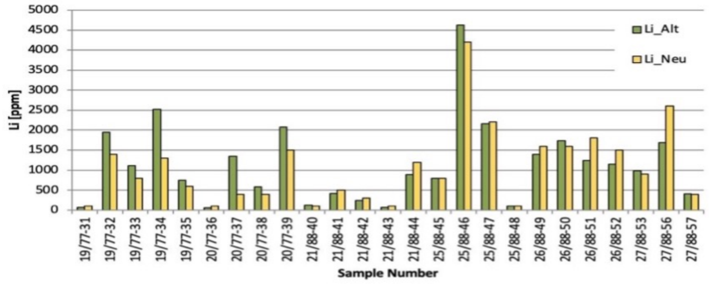
<u>**Lithium**</u>

Results of duplicate analysis indicate a two-sided distribution of deviations for Li-concentrations. Whereas the majority of historic results of campaign No. (6) shows an excess of Li in comparison to the duplicates (mean / median of deviation = 430 / 310 ppm), results from campaign No. (7) indicates higher Li-concentration in the duplicates (mean / median of deviation = 115 / 40 ppm, see **Figure *52***).

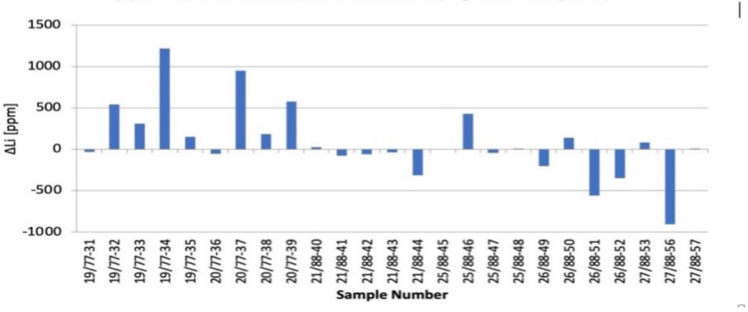
The maximum absolute deviation of campaign No. (6) and (7) is about 1,220 and 920 ppm, respectively. However, since strong correspondence of original and duplicate analysis is displayed by high correlation coefficients of 0.92 (rP) and 0.87 (rS) for campaign No. (6) and 0.96 (rP) and 0.97 (rS) for campaign No. (7) as well as a mean deviation of sample pairs of both campaigns fell into the range of variations of natural greisen samples, Li-assays can be considered as reliable and therefore utilized in the resource calculation procedure.

Figure 52: **Results of sample pairs – historic/recent analysis of Sn-W-exploration data (camp 6,7)**

(A) Absolute lithium-concentration of original and duplicate assays



(B) Absolute deviation of lithium-concentration (original minus duplicate)

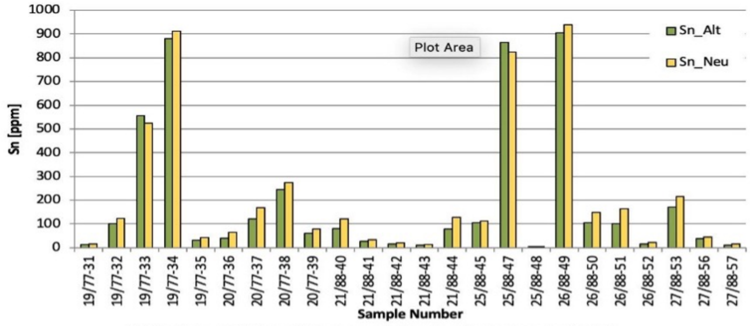


Tin

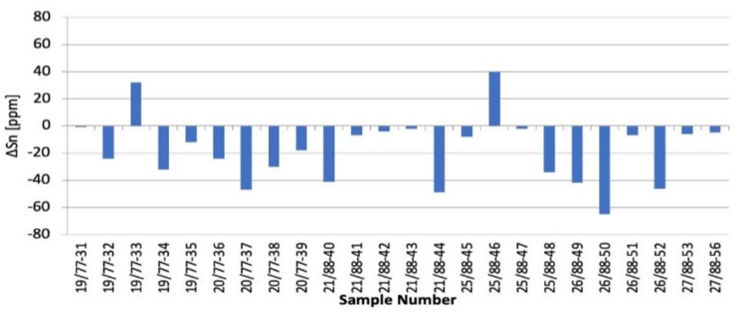
Recent results of duplicate Sn-assays correspond well with the historic values for both campaigns. The trend of deviation indicates a constant but very slight excess of duplicate values in comparison to the historic ones. The maximum absolute deviation of about 65 ppm is close to the overall mean absolute deviation of about 18 ppm (median = 15 ppm) which is supported by correlation coefficients close to 1 (rP=0.996 and rS=0.984). However, one constraint refers to the limited grade range with a maximum of 940 ppm Sn.

Figure 53: **Results of sample pairs – historic/recent analysis of Sn-W-exploration data (camp 6,7)**

(A) Absolute tin-concentration of original and duplicate assays



(B) Absolute deviation of tin-concentration (original minus duplicate)



Sn-concentrations of Sn-W-exploration data result from analytical procedures that can be considered as highly reliably reproducible and can be therefore utilized in the resource calculation with-out correction. However, since pairs of assays are available at limited concentration ranges, attempts should be made to gain material from stronger mineralized sample portions.

12.2.3 Quality Control Procedures

During exploration campaign No. (4) sample duplicates have been analyzed by ZGD (Central Geological Service of the G.D.R.) in Berlin and Dresden. Assays of the laboratory of Dresden seem to be correct as confirmed by an arbitrary analysis of the laboratory of the Department of Non-Ferrous Metals of the Technical University Bergakademie Freiberg. Systematic differences stem from the usage of different sample digestion methods. 10 % of the samples have been internally controlled in Dresden. Further 10 % were analyzed as external control in Berlin and Freiberg using the same digestion procedure.

For exploration campaigns No.s (5), (6) and (7) no information on quality control of geochemical analysis was available so far.

Core quarter and core half duplicates, pulp and coarse (lab) duplicates, and internal standard material as well as certified standard material were applied during the recent exploration campaign No. (8) for the determination of the adequacy of chemical analysis. Furthermore, internal QA/QC measurements were conducted by the involved labs. Assaying was performed by the geochemical laboratory of ALS in Romania. External control based on pulp and coarse duplicates was carried out by the chemical laboratory of SolarWorld Innovations GmbH in Freiberg and by Actlabs, which are all certified through the International Organization for Standardization to ISO 9001:2008 and / or are accredited after ISO 17025.

For the drill holes ZGLi 01/2012 and ZGLi 02/2012 10 % of the samples had been checked by the external laboratory. For further drill holes of campaign No. (8) the ratio was reduced to 5 %.

12.2.4 Drill Hole Database

All data integrated in the database was checked by testing 10 % of the entries of the collar, survey, geology and samples tables. Less than 1 % of the checked data had to be corrected.

A second check for data plausibility has been executed as well. All data manipulation of the testing cycles is documented in the database.

12.2.5 Drilling Location and Survey Control

Drilling locations were controlled by checking the coordinates against the digital elevation model or by localizing the drill holes underground at the “Tiefer-Bünau-Stollen” level.

All collar positions were transformed to or surveyed in UTM 33N coordinates.

For most of the drill holes no downhole survey data was available and so they are assumed to be vertical. For drill holes with survey data, the paths have been controlled visually. The protocols of coordinate deviation of the drilling location towards the endpoint of the survey measurement were checked against the deviation in the SURPAC^{TM} model.

13 Mineral Processing and Metallurgical Testing

13.1 Introduction

A significant amount of test-work on all of the processing stages has been carried since the start of the project in 2011. Due to the modified assumptions and processing changes this study only presents the test-work relevant to current processing selections. The tests left out can be found in the NI43-101 technical report released on the 31st of May 2019.

13.2 Mechanical Processing Tests

13.2.1 Introduction

The mineral processing consists of 5 stages

1. Primary crushing using a jaw crusher
2. Secondary crushing using a cone crusher
3. Drying of the crushed material
4. Dry grinding for liberation
5. Dry-magnetic separation

The key results are

- Beneficiation test work on both the 20 t and 50 t samples using the selected flowsheet gave similar high yields, > 90 % Li recoveries with a difference of only 2 %.
- Variability tests Li-recoveries on 25 drilling core samples ranged from 86.2 wt.% to 96.4 wt.%.

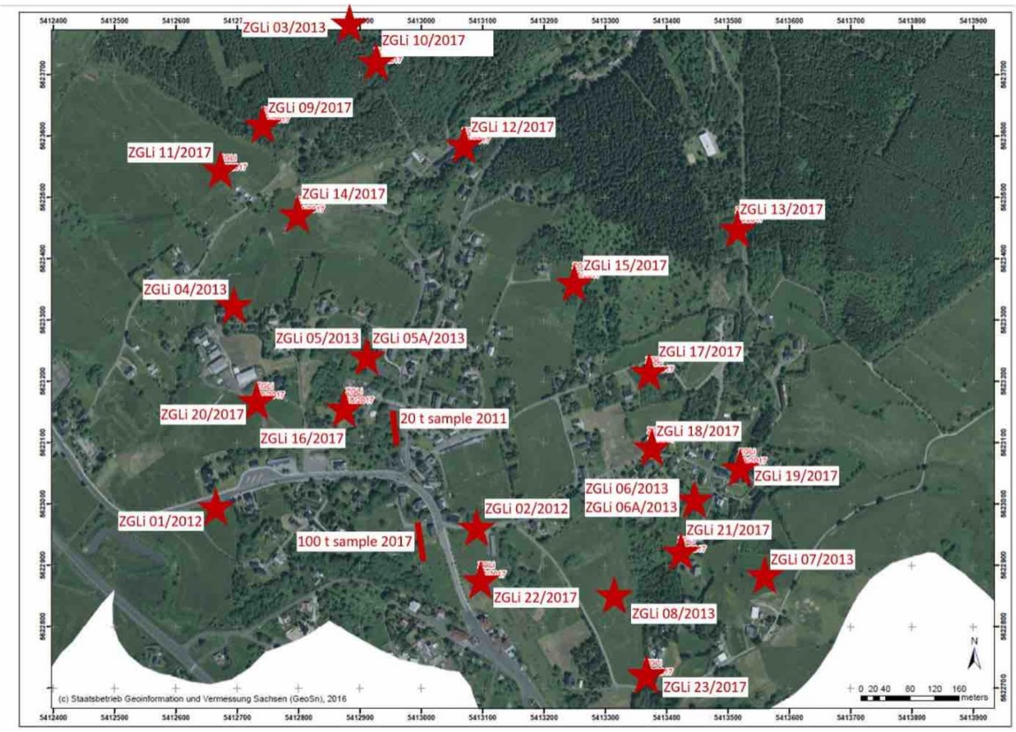
13.2.2 Test Work Sample Selection and Feed Grades

The following test work samples were selected and prepared and used for the PFS and FS metallurgical test work programs:

- 2011, 20 t PFS bulk ore sample [***27***]: Approximately 20 t of lithium mica greisen ore was mined from the visitor mine in Zinnwald. The sample originates from ore body B and had a mean Li grade of 3,900 ppm.
- 2017, 100 t FS bulk ore sample [***59***]: About 100 t of lithium mica greisen ore was mined from the visitor mine in Zinnwald. The sample originates from ore body B and had a mean Li grade of 4,009 ppm. From the 100 t sample, approximately 50 t was used for beneficiation test work. About 10 t of mica concentrate was produced and used for downstream pyrometallurgical and hydrometallurgical test work.
- DDH core samples: In order to test the process using samples from different are-as with the deposit, 25 variability samples were selected from drill core available from the drilling campaigns of 2012-2013 and 2017. The selected samples represent all major ore bodies, as well as their spatial distribution across the deposit (13.6.3 Variability Test Work).

Figure *54* presents the location of the variability samples from the 2012 – 2013 and 2017 exploration drilling campaigns as well as the location of the 20 t and the 100 t bulk ore samples extracted in 2011 and 2017, respectively. The results of the test work completed on these samples are presented in the following sections.

Figure 54: **Locations of drill core samples–- exploration & underground bulk ore samples**



Note: exploration campaigns (2012-2013, 2017) and the underground bulk ore samples (2011 and 2017)

13.2.3 Mineralogical Test Work

13.2.3.1 Sample Selection and Methodology

The mineralogical test work was carried out by the Department Mineralogy, Division of Economic Geology and Petrology of the Technical University of Freiberg ***[11]***. The sample material used for this work originated from the 20 t ROM sample taken 2011. The material was crushed, ground and divided into 6 particle size fractions by UVR-FIA GmbH (**Table *35***)

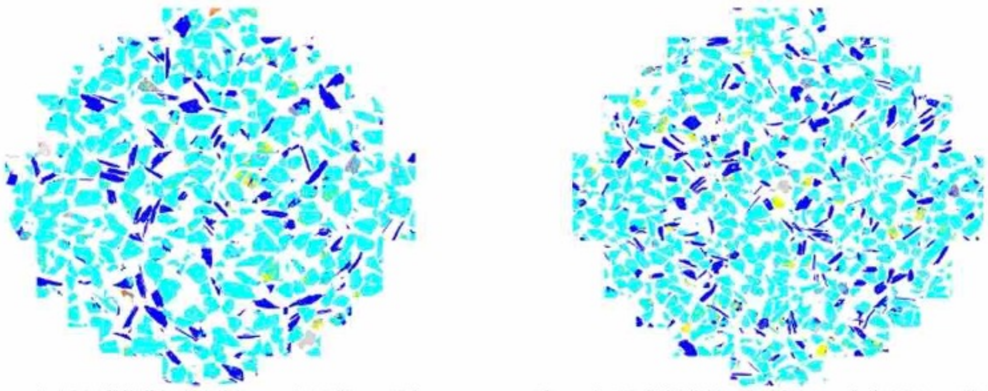
Table 35: **Particle size fractions for MLA measurements**

Fraction 1	Li 1	1.250–- 0.800 mm	Fraction 4	Li 4	0.315–- 0.160 mm
Fraction 2	Li 2	0.800–- 0.630 mm	Fraction 5	Li 5	0.160–- 0.090 mm
Fraction 3	Li 3	0.630–- 0.315 mm	Fraction 6	Li 6	< 0.09 mm

The 6 sub samples were examined using scanning electron microscopy (SEM) with semiquantitative energy dispersive X-ray spectroscopy (EDX). The data obtained were analysed with the mineral liberation analyzer (MLA) software package. The results provided an assessment of the mineralogical composition, mineral intergrowth, degree of liberation as well as grain size and grain shape. It also presented the liberation characteristics for optimum physical separation of the ore minerals (i.e. zinnwaldite) from the gangue (i.e. quartz).

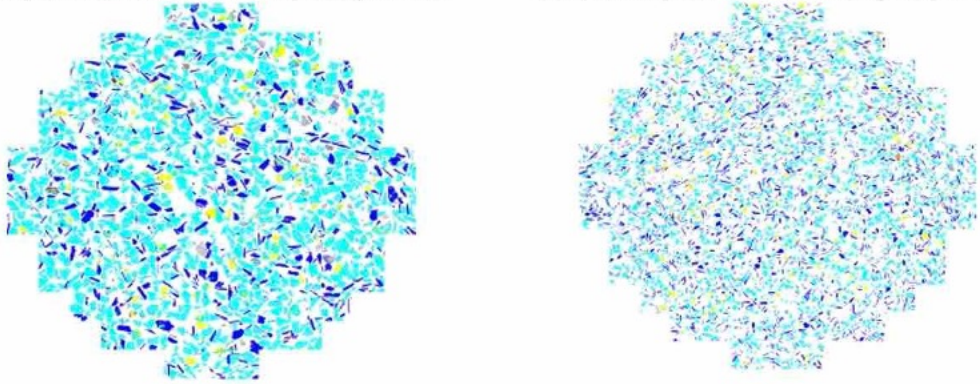
Figure *55* provides an overview of the image data of the measured samples along with an indication of the fraction size and number of measured particles. (Note – Dark blue – Zinnwaldite, light blue – quartz and yellow – topaz

Figure 55: **Overview of the processed image data of samples Li 1 to Li 6**



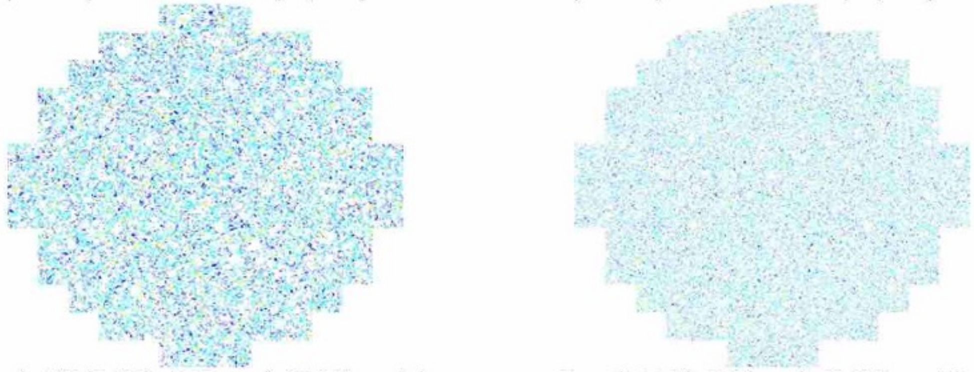
Sample Li 1 (1.250 – 0.800 mm): 558 particles

Sample Li 2 (0.800 - 0.630 mm): 1,013 particles



Sample Li 3 (0.630 – 0.315 mm): 2,157 particles

Sample Li 4 (0.315 – 0.160 mm): 5,274 particles



Sample Li 5 (0.160 – 0.09 mm): 17,116 particles

Sample Li 6 (< 0.09 mm): 63,839 particles

13.2.3.2 Modal Mineralogical Composition

The modal mineralogical composition is derived from the relative percentage area of a mineral on the total area of all investigated mineral grains. The main minerals quartz, zinnwaldite and topaz dominate the composition of the samples and exhibit a combined proportion that range from 96 wt.% in the coarsest fraction (Li 1) up to 88 wt.% in the finest fraction (Li 6).

Figure 56: Distribution of the main minerals quartz, zinnwaldite and topaz

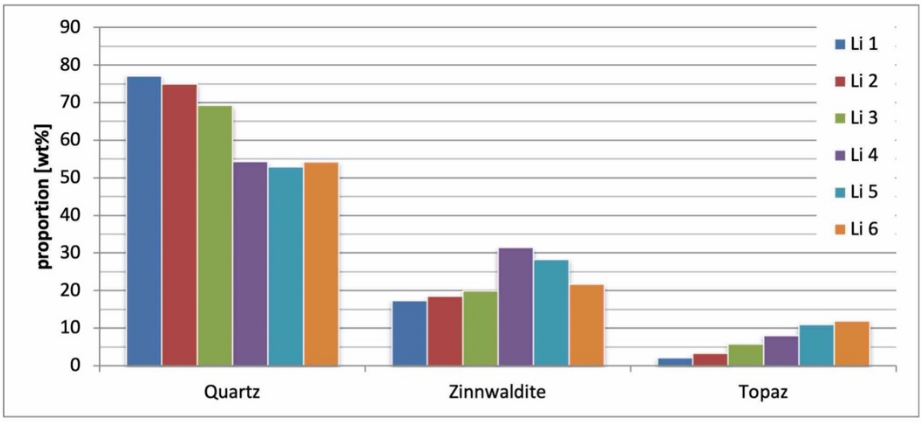


Figure 57: Distribution of subordinate and minor minerals. Topaz shown for comparison

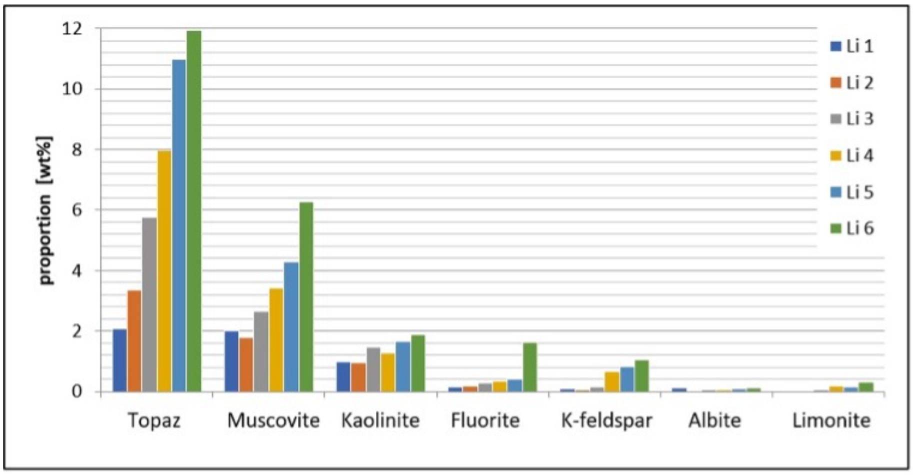
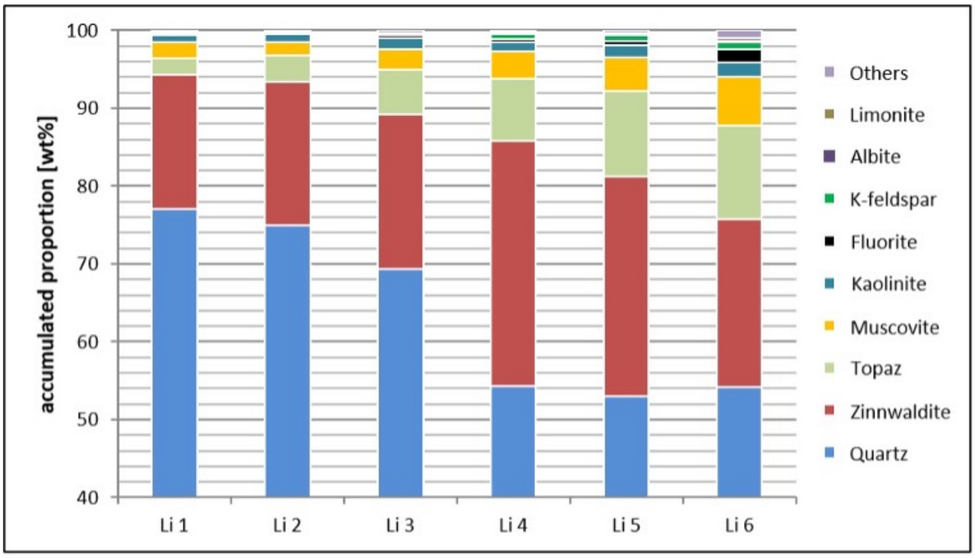


Table 36: Modal mineralogical composition

Mineral [wt.%]	Li 1	Li 2	Li 3	Li 4	Li 5	Li 6
Quartz	77.03	74.95	69.30	54.37	52.97	54.18
Zinnwaldite	17.30	18.44	19.91	31.49	28.26	21.63
Topaz	2.09	3.35	5.75	7.97	10.97	11.95
Muscovite	2,02	1.80	2.64	3.42	4.28	6.26
Kaolinite	1.00	0.94	1.47	1.26	1.67	1.87
Fluorite	0.17	0,20	0.27	0.36	0.42	1.62
K-feldspar	0.08	0.07	0.17	0.68	0.82	1.04
Albite	0.12	0.04	0.06	0.06	0.09	0.12
Limonite	0.04	0.03	0.07	0.19	0.14	0.31
Cassiterite	0.01	0.01	0.10	0.02	0.08	0.11
Wolframite	0.01	0.00	0.00	0.00	0.00	0.00
Scheelite	0.01	0.07	0.05	0.03	0.00	0.12
Total	99.88	99.90	99.79	99.85	99.70	99.21

The relative modal mineralogical composition presented in [***11***], is summarized **Table *36*** and shows that the proportion of quartz in the individual fractions decreases with decreasing grain size from 77 to 53 wt.%. In contrast, the minerals topaz (2 wt.% to 12 wt.%), muscovite (2 to 6 wt.%), kaolinite (1.0 wt.% to 1.9 wt.%), fluorite (0.2 wt.% to 1.6 wt.%) and potassium feldspar (0.1 wt.% to 1.0 wt.%) show an opposite behavior. The main ore mineral zinnwaldite exhibits a bell-shaped distribution with a maximum content of 31 wt.% in the fraction Li 4 (0.315 mm–- 0.160 mm). **Figure *58*** displays the accumulated proportions of the main minerals for the different size fractions. This shows which mineral in the corresponding particle size fraction is enriched or suppressed relative to the others and demonstrates that the proportion of quartz, which decreases towards the finer fractions, is essentially replaced by the growing proportions of zinnwaldite, topaz, muscovite and fluorite. Identified accessory minerals comprise cassiterite, wolframite, scheelite, baryte, chamosite and zircon.

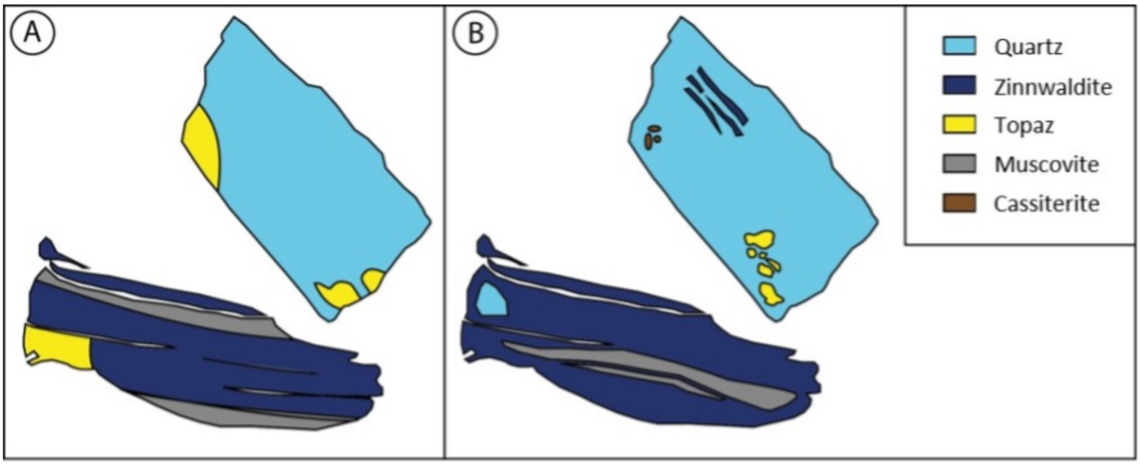
Figure 58: **Accumulated proportion of the main minerals per size fraction**



13.2.3.3 Mineral Intergrowth and Liberation

In addition to the results on particle size and mineralogical composition, the MLA software package provides information about intergrowths, liberation and potential recovery of the main ore mineral zinnwaldite. **Figure *59*** display the two types of zinnwaldite intergrowths observed within the samples. In Figure 54a, the intergrowth consists of two or more minerals and all minerals have a share of the grain boundary. The second type of intergrowth represents mineral inclusions where a mineral is completely enclosed by one or more minerals (**Figure *59***b).

Figure 59: **Schematic illustration of the two types of intergrowth conditions.**



(A) Two- and three-phase intergrowth, where all minerals share a part of the particle boundary.
(B) Three- and multiphase intergrowth in the form of inclusions

The type and extent of mineral inclusions of zinnwaldite within other minerals is illustrated in **Figure *60*** and **Figure *61***. For each grain fraction, the percentage of minerals is shown that completely enclose the zinnwaldite. **Figure *60*** only considers binary intergrowths, i.e. inclusions of zinnwaldite in another phase. This illustrates the dominance of quartz and muscovite in coarser fractions (Li 1 to Li 3) and that these fractions contain the highest proportion of trapped zinnwaldite (up to 53 wt.%). Towards the finer fractions (Li 4 to Li 6) the total proportion of zinnwaldite inclusion de-creases to 21 wt.% while the total amount of zinnwaldite inclusions in potassium feldspar increases, the inclusions in muscovite tend to decrease and inclusions in quartz are at a relatively low level.

Figure 60: **Type and proportion of binary zinnwaldite inclusions**

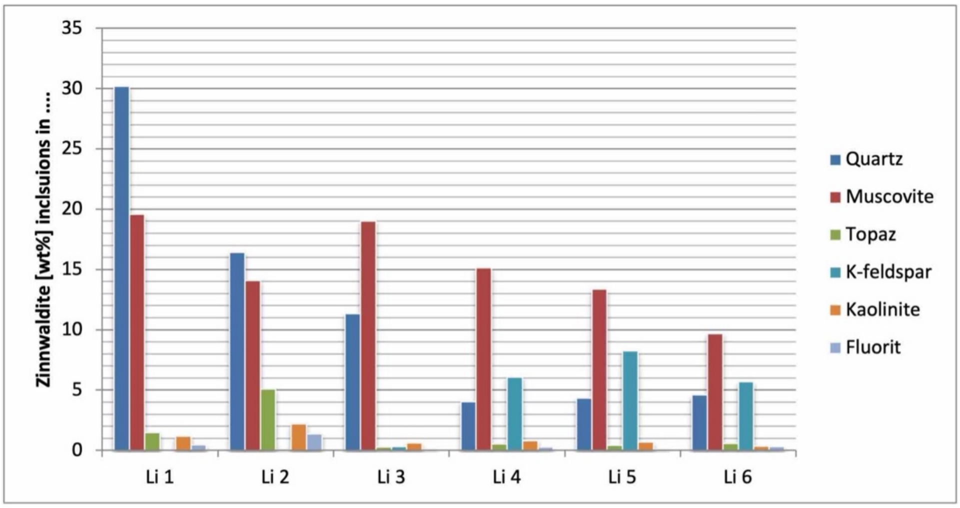


Figure 61: **Type and proportion of zinnwaldite inclusions in multiple phases**

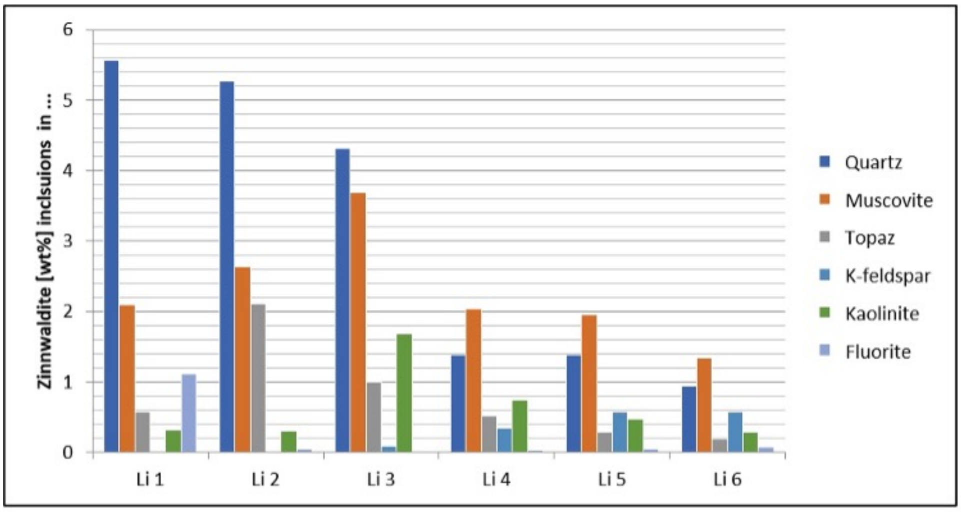
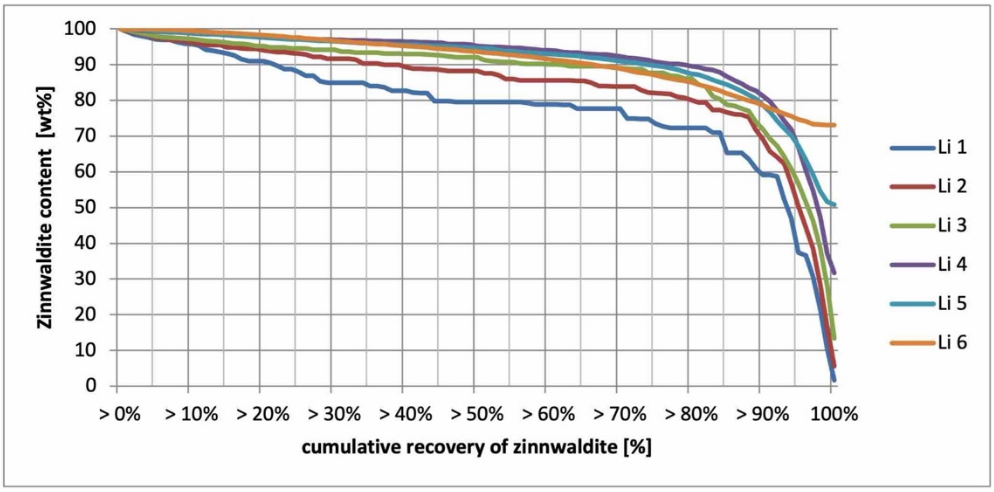


Figure *61* suggests a much lower proportion of included zinnwaldite as tri- and multiphasic inclusions (total 11 to 3 wt.%).

13.2.3.4 Liberation and Recovery

Figure *62* displays the accumulated (cumulative) liberation and potential recovery of liberated zinnwaldite within each size fraction. Thus, the degree of zinnwaldite liberation and recovery is the lowest in the coarsest fraction (Li 1) due to the high degree of intergrowth. This effect decreases towards sample Li 2 and Li 3. Due to the increasing proportion of accompanying minerals such as muscovite, kaolinite, fluorite and others, the zinnwaldite liberation cannot be increased further. Consequently, the optimum ratio of maximum liberation and recovery to maximum zinnwaldite content is considered to be in fraction Li 4 (0.315 mm–- 0.160 mm).

Figure 62: Comparison of cumulative zinnwaldite recovery for the grain size fractions Li 1 to Li 6



13.3 Lithium Extraction Metallurgical Test Work

The lithium extraction metallurgical process consists of two main steps; the pyrometallurgical process and the hydrometallurgical process.

The pyrometallurgical process consists of:

- Fine grinding of mica concentrate to below 315 µm
- Mixing of milled concentrate with suitable additives such as anhydrite/gypsum and lime-stone
- Roasting in kilns e.g. rotary

The hydrometallurgical processing consists of:

- De-agglomeration of roasted material
- Leaching of roasted material with hot water
- Purification of the mother leach liquor
- Precipitation, washing and drying of lithium hydroxide
- Sulphate of potassium (SOP)-crystallization

13.3.1 Pyrometallurgical test-work 2022

The calcination and leaching of Zinnwaldite concentrate have been tested in several stages and are described in NI 43-101 report. During 2022, a test campaign was carried out at IBU-Tec in Weimar / Germany with the goal of:

- Further optimisation of the mixing ratios of the reagents
- Test the potential to further increase the leaching recovery of metals, especially potassium
- Confirm the suitability of FGD Gypsum as reagent in the process

For this purpose, the direct heated batch kiln (0.35 m x 0.6 m) was operated in oxidizing atmosphere at c. 1000 °C and used in combination with an intensive mixer. The sample quantity per batch was 3 kg to 4 kg [Report IBU Tec report 2022.30.4018]. The total of 8 different batch samples were then leached in hot water at K-UTEC lab, and the leaching solutions chemically analyzed. The results confirmed that FGD Gypsum can used in the roasting process without any issues. The yields of lithium are at least 90% and of potassium 80% [Report Matthias Reinecke].

13.3.2 Hydrometallurgical test-work 2021

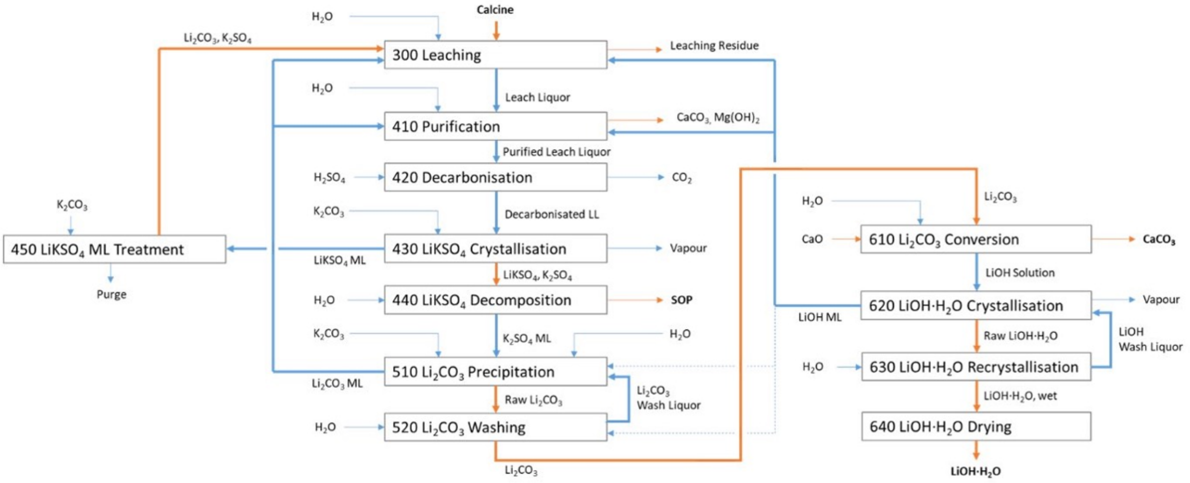
13.3.2.1 Considered processing areas of the test-work

Laboratory scale and Pilot scale hydrometallurgical test work has been carried out at K-UTEC using 5.6 t Calcined Zinnwaldite. Calcined Zinnwaldite from calcination tests carried out in 2018 under the responsibility of Deutsche Lithium was used for pilot-scale tests to produce 50 kg of a reference Lithium Hydroxide Monohydrate (LHM) product sample as well as for the locked cycle test for process verification as part of the process design work.

The detailed results of the hydrometallurgical test work for producing lithium hydroxide monohydrate LHM are presented in references [2021-1, 2021-2].

Figure *63* shows the main process steps included in the pilot-scale test work for LHM and K_2SO_4 production. Lithium hydroxide monohydrate samples were characterized at K-UTEC and Wolfener Analytic.

Figure 63: Principal process steps tested at the hydrometallurgical pilot plant



13.3.2.2 Sub-Area 300–- Leaching of the Calcined Zinnwaldite

The conversion of the leach brine resulting from calcined Zinnwaldite leaching into lithium hydroxide monohydrate is a new approach. Therefore, K-UTEC carried out further test work, which proved that the extraction of lithium and potassium through water leach of calcined Zinnwaldite is viable. Further bench-scale tests were pursued to prove the general leachability of lithium and potassium under the already defined process parameters. The pilot-scale tests provided the required amount of leach liquor to verify the downstream processing.

The leaching parameters with the following value ranges showed only a slight influence on the lithium and potassium yield. The differences in leaching results when varying these process parameters are shown, for example, for the water application in **Table *37***.

- Leaching time (15 min–- 2 h)
- Particle size (0.1 mm – 4.0 mm)
- Working temperature (20–- 100 °C)
- Mixing ratio of water: Calcined Zinnwaldite (0.5: 1:0 up to 2:0: 1:0)

Table 37: Ratio water to roasted product (calcine)

Parameter		Unit	Cycle 1	Cycle 2	Cycle 3	Cycle 4
Ratio Water to Calcine			12:6	6:6	4:6	3:6
	Lithium	g/kg	1.44	1.44	1.45	1.55
	Potassium	g/kg	23.3	22.7	21.9	24.3
	Sodium	g/kg	0.283	0.317	0.281	0.276

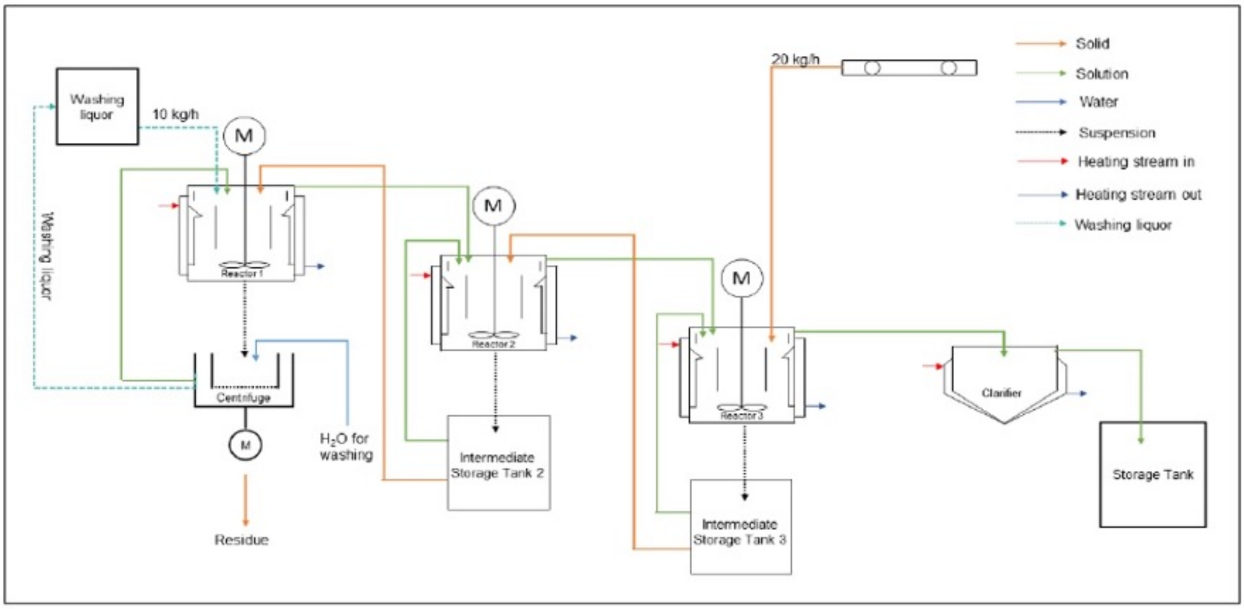
Thus other criteria like energy consumption and formation of secondary and fine-grained precipitates during leaching determined the parameter set for leaching:

- Particle size: approximately 1 mm
- Leaching temperature: 65 °C
- Leaching time: 20 min
- Ratio water: calcined Zinnwaldite: 1 : 1 to 1,5 : 1

Lithium extraction rate was consistent at> 85 wt.%, typically 87 – 90 wt.%. The extraction rate of potassium was 40 – 50 wt.%([***62***]).

Figure 64 illustrates the considered process scheme used for semi-continuous calcined Zinnwaldite leaching of 1 t of feed material on a small pilot scale. The leaching of 5.6 t of calcined Zinnwaldite was carried out with one leaching reactor less but with an otherwise identical basic design. The leaching process generated fine and coarse leach residue and the leach liquor.

Figure 64: Process scheme for the semi-continuous phase of the pilot plant calcine leaching test



13.3.2.3 Area 400 and Area 500 - Downstream processing of leach liquor to produce SOP and Li_2CO_3 (Areas 400 and 500)

The processing of the leach liquor has been tested within a locked cycle test programme, accompanied by additional laboratory tests to clarify detailed aspects. The results have been compared with the mass balances regarding mass flow ratios and process stream composition in order to verify the chosen process design parameter of the hydrometallurgical process. The leach liquor contains lithium, potassium and sulfate as principal components and rubidium, calcium and sodium as secondary components. Fluoride, magnesium, caesium, carbonates, tungsten, silicon, phosphates, aluminium, chromium, iron, copper, zinc and nickel represent the detectible trace elements. Environmentally relevant elements such as arsenic, cadmium or lead are present in concentrations below the detection limit and did not become relevant.

To reduce the concentration of bi- effectively and trivalent cations in the leach liquor recirculating lithium carbonate mother liquor and lithium hydroxide mother liquor to the front end of the hydrometallurgical process has been tested successfully. The test work proved to achieve the following beneficial effects:

- Minimum sulfuric acid consumption for decarbonisation
- Minimum losses of potassium and sulphate in the leach residues and the purification sludge
- Establish a constantly low level of calcium and magnesium concentration below 5 ppm in the brine for further processing

Subsequent ion exchange has been tested and should be considered in the hydrometallurgical process as a quality assurance measure in case of a breakthrough of bi- and trivalent cations after leaching and impurities precipitation. The final purification effect through fractional crystallization of $LiKSO_4$ has been successfully tested by evaporation of the pre-purified process liquor. Evaporation ends once the rubidium and other impurities have been built up in the process liquor to maximum level. Subsequent treatment of the concentrated process liquor after evaporation by adding potassium carbonate has proven an effective reduction of lithium losses through the liquid bleed stream as a mixture of potassium sulphate and lithium carbonate has been recovered. It can be recycled at the beginning of the process. The hydrometallurgical process considers this step because of its efficiency. The recovered $LiKSO_4$ has successfully been tested as suitable starting material for both lithium carbonate and K_2SO_4 (SOP) production. SOP results after carrying out water leaching tests at low temperatures. Adding potassium carbonate to the leach liquor precipitates lithium carbonate, which is suitable to convert it into battery-grade lithium hydroxide. The locked cycle tests' results confirmed the chosen hydrometallurgical process's design parameters up to that process step.

13.3.2.4 Area 600 – Conversion of Lithium Carbonate with Lime and Production of Battery Grade Lithium Hydroxide Monohydrate

Lithium carbonate has been suspended in water and reacted stoichiometrically with lime which also was suspended in water. Before the locked cycle test programme, the optimum water application and temperature for the conversion process had been experimentally determined. Thus, the conversion solution contains lithium hydroxide with a 3.0 to 3.5 per cent concentration. The resulting precipitated calcium carbonate (PCC) contains only negligible amounts of lithium. Its purity is according to the purity of the starting material. Subsequent evaporation without further measures for brine purification followed by cooling crystallisation resulted in a first lithium hydroxide monohydrate product, which was again completely dissolved in a hot solution and recrystallised by cooling. The filtration of the hot solutions before the respective cooling crystallisation was beneficial for the product purity. In this process section, the locked cycle tests also confirmed the process concept with its design parameters.

13.3.2.5 Locked cycle test

Due to the large difference in scale between the industrial process and the experiments in the laboratory or small pilot plant scale, the replication of individual process steps in the laboratory is only possible under approximate process conditions and not as a scaled-down copy of the industrial process. In individual cases, process steps were reproduced in batch mode.

The material losses via sampling and adhesion have a much greater effect on the flow rates in relation to the quantities of material used than in industrial processes and have consequently proved to be one of the main reasons for non-conformity in material quantity ratios. This fact was taken into account by considering each individual process step on its own. This is permissible under the given condition that after leaving one process step, the process streams re-enter the subsequent process step unchanged.

Deviations from the process design also occurred in the grain size distributions of crystallised or precipitated products. These results differ in a laboratory scale to a pilot or industrial scale testing. Consequently, the proportions of adhesive lye and therefore the proportions and compositions of the individual streams differ, which also continues into the subsequent process steps.

XRF examination of the mother liquors from each cycle does not show a hint that radioactive elements in the range from sodium to uranium become built up to a relevant concentration.

14 Mineral Resource Estimates

14.1 Introduction

The Mineral Resource model presented here represents a resource estimate for the Zinnwald Lithium Project license area in the German part of the Zinnwald / Cínovec greisen deposit. The resource estimate was completed by Matthias Helbig, a Senior Consultant (resource geologist at G.E.O.S.). The effective date of this resource estimate is September 30th, 2018. This section describes the work undertaken by G.E.O.S. and summarizes the key assumptions and parameters used to prepare the revised mineral resource models.

The Mineral Resources presented here are reported in accordance with Canadian Securities Administrators' National Instrument 43-101 and have been estimated in conformity with generally accepted CIM "Estimation of Mineral Resource and Mineral Reserves Best Practices" guidelines.
For the scope of this PEA the current Mineral Resource Estimate with effective date of September 30th, 2018 remains unchanged as no new data that will affect the mineral resource estimate are available at present.

14.2 Database Construction and Validation

The database was generated with software MS Access. It contains the following data tables:

- "collar" – general information and locations of drill holes and sampling points
- "survey" – drill path data
- "geology" – lithologic logs of the drill holes
- "sample" – data composition of drill core assays used for resource estimation
- "sample disc" – assays of discrete sample points or channel samples
- data tables with laboratory assay results (originals, duplicates and standards)
- data tables with compiled information (e.g., summary of ore intervals) that is based on data of the 5 main data tables mentioned before

Every data collective has been cross-checked against original source documents by a minimum of 10 % randomly chosen data sets.

14.3 Geological Interpretation and Domaining

For the central part of the Zinnwald lithium deposit the spacing between the drill holes ranges approximately from 100 m in east-west direction to 150 m in north-south direction. The spacing between the marginal drill holes 26/59, 19/77, 20/77, 21/88, 23/88, 26/88, 28/88, Cn 22, Cn 26 and Cn 46 is in the range of 300 - 350 m. Positioning of the last 25 drill holes of exploration campaign No. (8), completed in the period 2012 – 2017 did not change this pattern in general. This is because some of the drill holes had to be placed into the peripheral parts of the deposit.

Like the geological cut-off, exclusively lithologic attributes were used for defining the orebodies. The differentiation of potential economically interesting ore types was based on mean lithium grades and aspects of ore processing. According to these criteria two ore types can be distinguished:
"Ore Type 1": greisen beds and interburden intervals up to 2 m and
"Ore Type 2": greisenized albite granite und greisenized porphyritic microgranite.

The "Ore Type 1" - greisen consists of the lithologic sub-types quartz-greisen (TGQ), quartz-mica-greisen (TGQ+GM) and mica-greisen (TGGM).

Despite the opportunity to distinguish up to three levels of postmagmatic alteration intensities, all greisenized intervals of albite granite and porphyritic microgranite were merged into "Ore Type 2".

According to the base case cut-off grade of lithium of 2,500 ppm, the greisen bed unit ("Ore Type 1") can be seen as the lithologic domain containing most of the ore. This is caused by the statistical character of the lithium grade frequency distribution that reaches roughly from 2,000 to 4,000 ppm for the majority of the greisen assays.

The geological sections and plans of the "Tiefer Bünau Stollen" level of LÄCHELT, 1960 ***[101]*** were used as a first idea for analyzing the core region of the Zinnwald lithium deposit on the German territory. The sections and plans were digitized and geo-referenced.

After this procedure the already interpreted greisen beds were used for digital construction of CAD sections of the conceptual geological model with SURPAC^{TM} (version 6.6).

During the next step, top and bottom of the sections were tied up to the suitable intervals of the diamond drill holes. Based on this stage, the greisen beds were extended to the drill holes of the exploration campaigns performed in the 1970s and 1980s and to the drill holes located on the Czech side, as far as possible.

Based on the conceptual geological model, the 3D greisen bed wire frame models have been constructed by a semi-automated interpolation process. Therefore, point data of the conceptual geological model was complemented by information of strike and dip from a wire frame model of the contact surface of the albite granite and the rhyolite. The contact surface has been identified as the main structural control of the greisen beds.

Outer and inner borders of the horizontal extensions of the greisen layers were defined. For the case that no marginal drill holes existed, the greisen layers were extended further 50 m into the space (half the theoretical drill hole spacing, half the semi-major range). Greisen layers were interrupted half the way between drill holes, if an adjacent drill hole did not show an assignable greisen interval.

According to **Table *38*** the following greisen beds with subordinate layers have been modelled:

Table 38: Greisen beds and modelled subordinate layers

Greisen bed	Subordinated layers
A	A_01, no further subordinate layers modelled
B	B_01a, B0_1b, B_01c, B_02a, B_02b, B_03a, B_03b
C	C_01, C_02
D	D_01, no further subordinate layers modelled
E	E_01, E_02, E_03, E_04, E_05
F	F_01, no further subordinate layers modelled
G	G_01, no further subordinate layers modelled
H	H_01, no further subordinate layers modelled
I	I_01, no further subordinate layers modelled
J	J_01, no further subordinate layers modelled
K	K_01, no further subordinate layers modelled

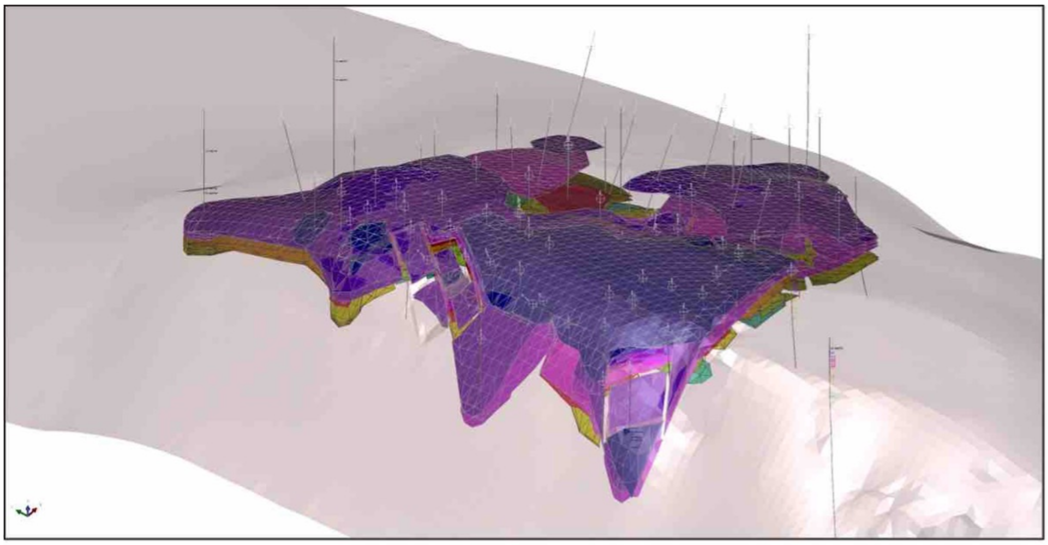
Intersection lines of tectonic structures were digitized from the plans of the "Tiefer Bünau Stollen" level. In the structural model it is assumed that they dip with 85 degrees towards the north-east. They appear as 3D planes in the SURPAC^{TM} model. Tectonic displacements of the greisen beds have been implemented if they could be detected from input data. Displacements of discrete blocks at the western flank of the Zinnwald lithium deposit account for up to 50 m.

The geological model has been continuously updated to reflect the new drill results from exploration campaign No. (8) (2012-2017). It has also been used successfully for drill hole planning. Ore intervals could be predicted sufficiently, and, in most cases, cumulated ore interval thickness exceeded the expectations.

The validation of the geological and structural model was done continuously by Dr. Jörg Neßler (Geologist, Technical University Bergakademie Freiberg / Germany). German and Czech geologic plans of the "Tiefer Bünau Stollen" level were geo-referenced and plotted against the models.

Several inspections of the geology at the "Tiefer-Bünau-Stollen" level were undertaken to verify the models. In this regard even for tectonic structures good congruence could be demonstrated. However, some uncertainties remain for the detailed geological structure of the eastern part of the Zinnwald lithium deposit.

Figure 65: **Albite granite dome of Zinnwald and Cínovec hosting the greisen beds, view to N-E**



It could be shown that the determination of greisenized granite has not been performed very well during former exploration campaigns compared to campaign No. (8). For some of these drill holes even no greisenized granite has been reported.

New investigations confirmed that most of the upper part of the granite cupola consists of greisenized granite. Only small domains, respectively intermediate beds, of albite granite did not underwent metasomatic alteration. One of these beds can be found adjacent to the granite contact at the north-eastern part of the deposit for example.

Consequently, only lithologic data of 23 drill holes of exploration campaign No. (8) has been used for estimation of the total volume of greisenized granite within the overall outer boundary of greisen beds of “Ore Type 1”. The infill drill holes are spread all over the deposit. Cumulated domain thickness of greisenized granite varies between 54 and 158 m. By interpolation of thickness within the deposit’s boundary a simplified volumetric model of “Ore Type 2” domain has been created.

The spatial extension of the greisen layers is presented in the following **Table *39***. The southern borders are limited by the boundary of the license area, ending at y = 5,620,847. For example, the models of the greisen beds “A”, “B” and “E” had to be cut at the Czech border.

Table 39: **Spatial extension of the greisen layers of Ore Type 1**

„Ore Type 1“ Greisen bed	Ymin – Ymax [UTM33]	North – South Extension [m]	Xmin – Xmax [UTM33]	East – West Extension [m]	Zmin – Zmax [m a.s.l.]	Z Extension [m]	Mean vertical thickness [m]	Median vertical thickness [m]	Maximal vertical thickness [m]
A_01	5620903 - 5621938	1,035	33412548 - 33413093	545	587 - 813	225	4.4	3.7	18.1
B_01a	5620858 - 5622273	1,415	33412438 - 33413778	1,340	299 - 797	498	7.1	5.5	34.3
B_01b	5620853 - 5621958	1,105	33412553 - 33413778	1,225	298 - 763	465	5.2	4.6	15.9
B_01c	5621528 - 5621853	325	33412603 - 33412953	350	608 - 722	114	1.0	0.8	4.6
B_02a	5620853 - 5621323	470	33412448 - 33413128	680	498 - 741	244	0.8	0.5	3.4
B_02b	5620858 - 5622273	1,415	33412438 - 33413588	1,150	399 - 777	378	9.8	8.0	40.6

„Ore Type 1“ Greisen bed	Ymin – Ymax [UTM33]	North – South Exten-sion [m]	Xmin – Xmax [UTM33]	East – West Exten-sion [m]	Zmin – Zmax [m a.s.l.]	Z Extension [m]	Mean vertical thick-ness [m]	Median vertical thick-ness [m]	Maximal vertical thick-ness [m]
B_03a	5620853 - 5621878	1,025	33412533 - 33413573	1,040	417 - 755	338	5.1	3.2	20.6
B_03b	5621093 - 5621748	655	33412698 - 33412873	175	655 - 740	86	1.0	0.8	4.9
C_01	5621013 - 5621773	760	33412528 - 33412813	285	526 - 726	200	3.2	1.2	13.9
C_02	5621018 - 5621953	935	33412588 - 33413368	780	430 - 734	304	3.7	3.1	16.3
D_01	5620868 - 5622273	1,405	33412538 - 33413493	955	380 - 723	343	5.6	4.8	17.4
E_01	5620888 - 5622273	1,385	33412523 - 33413503	980	366 - 707	342	2.0	1.9	7.5
E_02	5620878 - 5622273	1,395	33412523 - 33413208	685	349 - 703	355	7.0	5.0	33.4
E_03	5620888 - 5622273	1,385	33412523 - 33413283	760	344 - 700	357	3.1	2.8	11.4
E_04	5620858 - 5621803	945	33412523 - 33413778	1,255	227 - 689	463	10.0	5.3	40.0
E_05	5620883 - 5621773	890	33412523 - 33413278	755	469 - 687	218	2.6	1.9	12.5
F_01	5620858 - 5622118	1,260	33412598 - 33413378	780	401 - 671	270	2.7	2.3	10.1
G_01	5620858 - 5621853	995	33412598 - 33413493	895	444 - 670	227	5.8	4.8	20.2
H_01	5621018 - 5621813	795	33412663 - 33413493	830	437 - 642	205	4.0	1.8	25.7
I_01	5620988 - 5621773	785	33412663 - 33413543	880	360 - 636	276	4.0	3.5	12.8
J_01	5621008 - 5621583	575	33412713 - 33413508	795	352 - 626	274	5.2	4.1	23.1

14.4 Density Analysis

Moisture content determinations of LÄCHELT, 1960 ***[101]*** resulted in an average of 0.5 % H_2O. Because of this low water content, no necessity existed for correcting the dry bulk density value.

Table *40* gives an overview of the bulk densities determined during different exploration campaigns. It can be stated that the greisen shows densities close to 2.7 g/cm³. Consequently, the value of 2.7 g/cm³ was applied for resource calculation of the greisen. Greisenized albite granite shows slightly lower densities around 2.65 g/cm³. Albite granite as the host rock itself was determined to have a dry bulk density of about 2.6 g/cm³. No information was available for rock porosity.

Table 40: Classification of Ore types

Petrographic unit	Location	Method of determination	Bulk density [g/cm³]
Greisen	drill holes 1/54 – 27/59, 40 samples1)	hydrostatic weighing	2.70
Greisen	8 samples2)	not defined	2.72
Greisen	Reichtroster Weitung3)	DIN 18136, DIN 52105, DIN 1048, DGEG Recommendation No. 1.	2.73
Greisen, kaolinized	Reichtroster Weitung3)		2.48 – 2.50
Albite granite	drill hole ZGLi 01/2012 sample no. 904)		2.59
Albite granite	drill hole ZGLi 01/2012 sample no. 2324)		2.52
Rhyolite	drill hole ZGLi 02/2012 sample no. 284)		2.56

Petrographic unit	Location	Method of determination	Bulk density $[g/cm^3]$
Albite granite (weak alteration to mica-greisen)	drill hole ZGLi 02/2012 sample no. 734)	DIN 18136, DIN 52105, DIN 1048, DGEG Recommendation No. 1.	2.64
Albite granite (moderate alteration to mica-greisen)	drill hole ZGLi 02/2012 sample no. 1604)		2.63
Albite granite (intense alteration to mica-greisen)	drill hole ZGLi 02/2012 sample no. 1814)		2.69

1) LÄCHELT, A. (1960) [101]
2) GRUNEWALD, V. (1978b) [108]
3) KÖHLER, A. (2011): [113]
4) SOLARWORLD SOLICIUM GMBH (2013): Measurement of uniaxial pressure strength accordingly to DIN 18136, DIN 52105, DIN 1048, DGEG Recommendation No. 1.

14.5 Assay Data

A Summary of drilling campaigns data is given in **Table *41***.

Table 41: Summary of data of drilling campaigns

Expl. Cam-paign No.	Exploration campaign and data source (D – Germany, CZ – Czech Republic)	Type of data	Number of drill holes	Number of geological records and total length of drill holes	Number of geochemical records and respective total length	Method of geochemical analysis
(1a)	1917 – 1918 (D) Herre	GSF DH	1	17 (195 m)	0 (0 m)	-
(1b)	1917 – 1918 (D) Herre	UG DH	1	10 (150 m)	0 (0 m)	-
(2a)	1930 – 1945 (D) Bergarchiv Freiberg, Schilka (2012)	GSF DH	15	242 (1,608 m)	0 (0 m)	-
(2b)	1930 – 1945 (D) Bergarchiv Freiberg, Schilka (2012)	UG DH	3	60 (295 m)	0 (0 m)	-
(3)	1955 (CZ) Schilka (2012)	GSF DH	3	74 (601 m)	0 (0 m)	-
(4a)	1951 – 1960 (D) Bolduan und Lächelt (1960)	GSF DH	17	423 (4,660 m)	Li: 401 (422 m) Sn: 401 (422 m) W: 400 (421 m)	CS + FP CS + SA CS + SA
(4b)	1951 – 1960 (D) Bolduan und Lächelt (1960)	UG DH	10	383 (1,313 m)	Li: 180 (80 m) Sn: 113 (72 m) W: 119 (75 m)	CS + FP CS + SA CS + SA
(5a)	1959 – 1972 (CZ) GEOFOND	GSF DH	95	4,376 (34,111 m)	Li: 8,704 (12,364 m) Sn: 4,100 (4,704 m) W: 3,842 (4,410 m)	CS + SA CS + XRF & WCA CS + SA
(6)	1977 – 1978 (D) Grunewald (1978)	GSF DH	2	230 (1,216 m)	Li: 373 (1,216 m)1 Sn & W: 373 (1,216 m)1 Sn & W: 106 (104 m)2	RCS + SA RCS + SA CS + XRF
		UG PS from galleries	-	1,350 (-)	Li: 1,341 (-) Sn: 1,342 (-) W: 1,329 (-)	PS + SA PS + SA PS + SA
(7)	1988 – 1989 (D) Kühne and Besser (1988 – 1989)	GSF DH	8	684 (3,148 m)	Li: 1,188 (3,149 m)1 Sn & W: 1,188 (3,149 m)1 Sn & W: 397 (403 m)2	RCS + SA RCS + SA CS + XRF

Expl. Cam-paign No.	Exploration campaign and data source (D – Germany, CZ – Czech Republic)	Type of data	Number of drill holes	Number of geological records and total length of drill holes	Number of geochemical records and respective total length	Method of geochemical analysis
(8a)	2012 (D) SolarWorld Solicium GmbH (2012)	GSF DH	2	116 (543 m)	Li: 415 (401 m) Sn & W: 415 (401 m) Sn & W: 415 (401 m)	CS + ME-4ACD81(ICP-AES) CS + ME-MS81(ICP-MS) CS + ME-XRF05
		UG CHS from galleries	-	83 (at 1.5 m each)	Li: 83 (at 1.5 m each) Sn & W: 83 (at 1.5 m e.) Sn & W: 83 (at 1.5 m e.)	CHS + ME-4ACD81(ICP-AES) CHS + ME-MS81(ICP-MS) CHS + ME-XRF05
(8b)	2013 (D) SolarWorld Solicium GmbH (2013)	GSF DH	8	303 (2,021 m)	Li: 843 (847 m) Sn: 843 (847 m) W: 843 (847 m) Sn: 1 (1 m) Li: 1 (1 m)	CS + ME-4ACD81(ICP-AES) CS + ME-MS81(ICP-MS) CS + ME-MS81(ICP-MS) CS + XRF10 CS + Li-OG63(ICP-AES)
(8c)	2017 (D) Deutsche Lithium GmbH (2017)	GSF DH	15	951 (4,455 m)	Li: 2,660 (2,602 m) Sn: 2,660 (2,602 m) W: 2,660 (2,602 m) Li: 12 (9 m)	CS + ME-4ACD81(ICP-AES) CS + ME-MS81(ICP-MS) CS + ME-MS81(ICP-MS) CS + Li-OG63(ICP-AES)

1) Intervals of semi-quantitative sample assays partly or fully replaced in database by intervals of
2) quantitative sample assays.

Sample data frequency distributions of the data collectives have been compared. As a result, data processing and statistical analysis are summarized as follows:

Table 42: Data joins used for resource and potential estimation

Component	Data collectives	Purpose	Compositing
Lithium	core sample assays of campaigns (4), (5) and (8)	compositing and anisotropic inverse distance interpolation within greisen beds, determination of mean lithium grade for greisenized granite	1-m-interval composites for drill hole greisen bed intersections none
Tin	core sample assays of campaigns (4), (7) with correction factor 0.6 and (8) without correction factor	determination of mean tin grade of low graded sample population for greisen beds, determination of mean tin grade of low graded sample population for greisenized granite	none none
Tungsten	core sample assays of campaigns (7) and (8)	determination of mean tungsten grade of low graded sample population for greisen beds determination of mean tungsten grade of low graded sample population for greisenized granite	none none
K_2O	core sample assays and channel assays of campaign (8)	determination of mean K_2O grade for greisen beds determination of mean K_2O grade for greisenized granite	none none

Component	Data collectives	Purpose	Compositing
Na_2O	core sample assays and channel assays of campaign (8)	determination of mean Na_2O grade for greisen beds determination of mean Na_2O grade for greisenized granite	none none

14.6 Assay Statistical Analyses

14.6.1 Determination of Mean Lithium Grades of Lithologic Units

The characterization of mean lithium grades is based exclusively on drill core assays of exploration campaign No. (8) (**Table *43***) and is explained below

The determination of lithologic core intervals of exploration campaign No. 8 was critically compared with the results of multi-element assay data (i.e., Li, Sn, W, SiO_2, Na_2O, K_2O, MgO, Fe_2O_3, Zn, Sc, La), drill core photographic documentation, as well as the drill cores itself.

It became evident, that lithologic core intervals of the Zinnwald lithium deposit could not always be correctly determined in the first run.

Hydrothermal bleaching activity, as well as fine grained mineral dissemination - as an effect of metasomatic alteration - can produce intervals that pretend to be unaltered granite when examined by common macroscopic methods.

In addition, although contacts between greisen, greisenized granite and unaltered granite can be sharp, they are diffuse in most cases.

Now having the knowledge of 25 in detail investigated drill holes, it is questioned that greisenized granite and unaltered granite intervals have been determined correctly during the exploration campaigns No.s 1, 2, 3 & 4.

Apart from that, it can be assumed that the actual greisen intervals were correctly described in the other campaigns because they can be clearly differentiated macroscopically. Geologists of the named campaigns did not have the opportunity to conduct a verification of their lithologic determination because drill cores have not been assayed at all, or have been assayed only for the determined greisen intervals.

Table 43: Mean Li grades of lithologic units based on drill core assays (Expl campaign 8)

Ore type	Petrographic key sign 2018 (2014)	Petrographic description	Apparent thickness weighted mean Li grade [ppm]	Arithm. mean Li grade [ppm]	Median Li grade [ppm]	Min Li grade [ppm]	Max Li grade [ppm]	Number of core samples
1	TGGM	mica-greisen	8,772	8,330	7,640	4,450	13,950	47
	TGQ+GM	quartz-mica-greisen	3,568	3,481	3,340	120	8,630	822
	TGQ	quartz-greisen	414	463	445	10	1,260	46
2	TF	feldspatite	377	1,154	200	30	1,170	25
	scG_3a_GGM_3 (PG_GGM_3)	intense alteration to quartz-mica-greisen: albite granite	2,161	2,128	2,275	410	3,000	282
	scG_3a_GGM_2 (PG_GGM_2)	moderate alteration to quartz-mica-greisen: albite granite	1,981	1,985	2,040	420	3,000	1,137
	scG_3a_GGM_1 (PG_GGM_1)	minor alteration to quartz-mica-greisen: albite granite	1,373	1,377	1,375	400	3,070	1,198

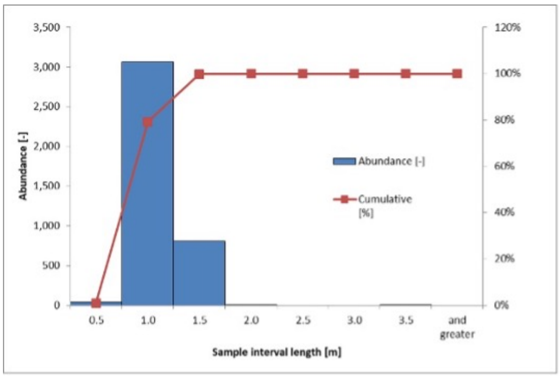
Ore type	Petrographic key sign 2018 (2014)	Petrographic description	Apparent thickness weighted mean Li grade [ppm]	Arithm. mean Li grade [ppm]	Median Li grade [ppm]	Min Li grade [ppm]	Max Li grade [ppm]	Number of core samples
	scG_3a (PG)	albite granite	739	736	775	80	1,140	340
2	scG_3c_GGM_1 (UG_GGM_1)	minor alteration to quartz-mica-greisen: porphyritic microgranite	1,061	1,081	1,000	300	2,470	77
	sG_3c (UG)	porphyritic microgranite	307	303	290	20	900	130
	tpYI_1a (YI)	rhyolite	291	291	230	50	800	35

14.6.2 Summary Statistics of Drill Core Assays of Exploration Campaign No. 8

A detailed statistical characterization of the data from the exploration campaign No. (8) for do-mains of "Ore Type 1" - Greisen and "Ore Type 2" - greisenized granite is presented below.

The following charts show histograms of all drill core assays of exploration campaign No. (8) for sample interval lengths, lithium, tin, tungsten, K_2O and Na_2O grades.

Figure 66: Abundances of all sample interval lengths (Expl. campaign 8)



A total of 3,918 drill core samples have been collected. Most of sample intervals show a length of 1 m. Minimum length accounts for 0.25 m, maximum length for 3.50 m.

Lithium grades show normal frequency distributions where greisen mean values account for 3,000 ppm to 4,000 ppm and greisenized granite mean values account for 1,500 ppm to 2,000 ppm.

Figure 67: Abundances of all lithium drill core assays (Expl. campaign 8)

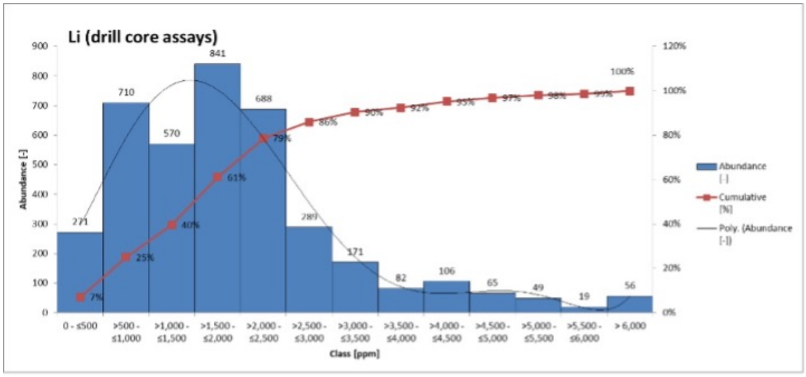


Figure 68: **Abundances of greisen lithium drill core assays (Expl. campaign 8)**

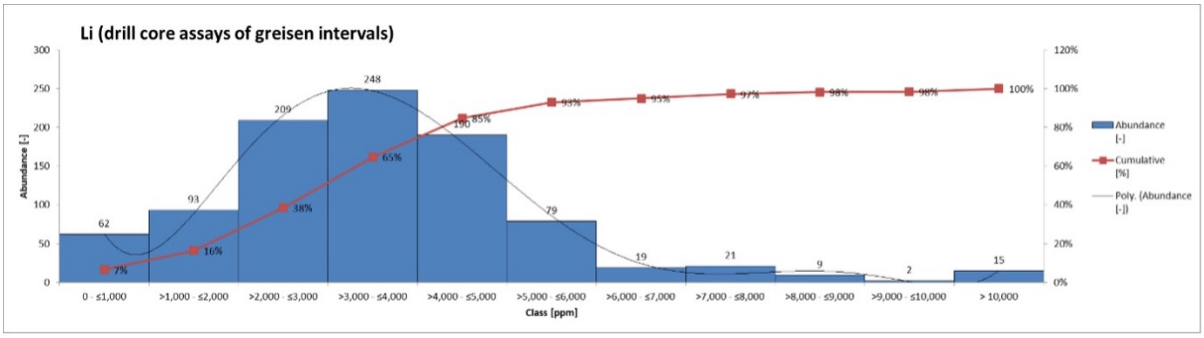
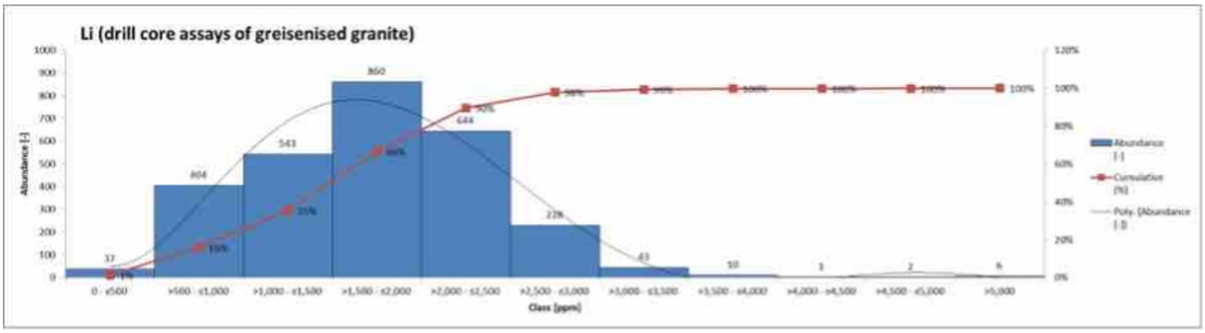


Figure 69: **Abundances of greisenized granite lithium drill core assays (Expl. campaign 8)**



Tin grade frequency distributions indicate three generations of mineralization:
(1) background mineralization of around 35 ppm
(2) low grade mineralization of around 300 ppm (disseminated cassiterite)
(3) high grade mineralization of around 2,000 ppm (cassiterite veins)

Figure 70: **Abundances of all tin drill core assays (Expl. campaign 8)**

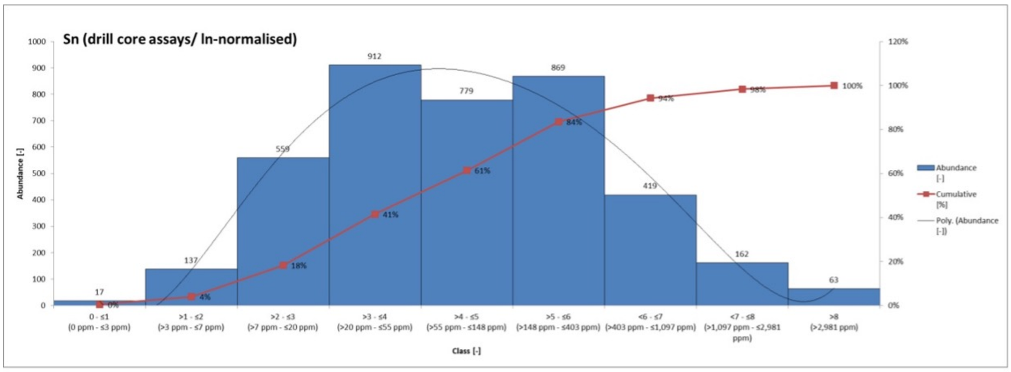


Figure 71: **Abundances of greisen tin drill core assays (Expl. campaign 8)**

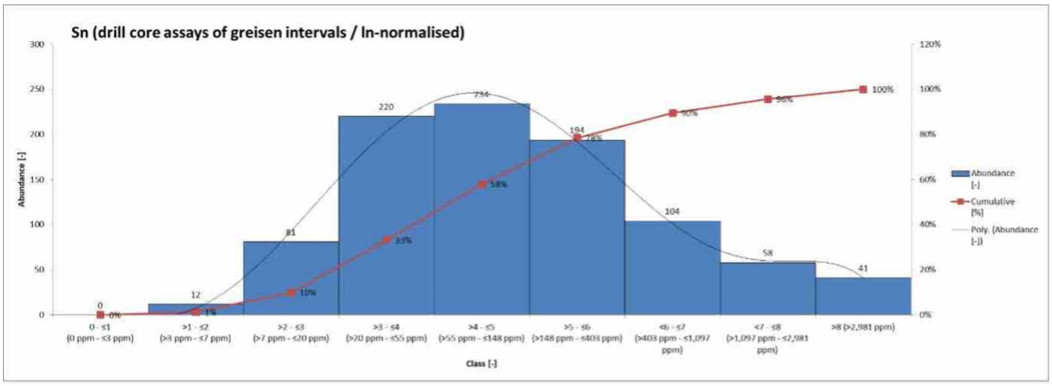
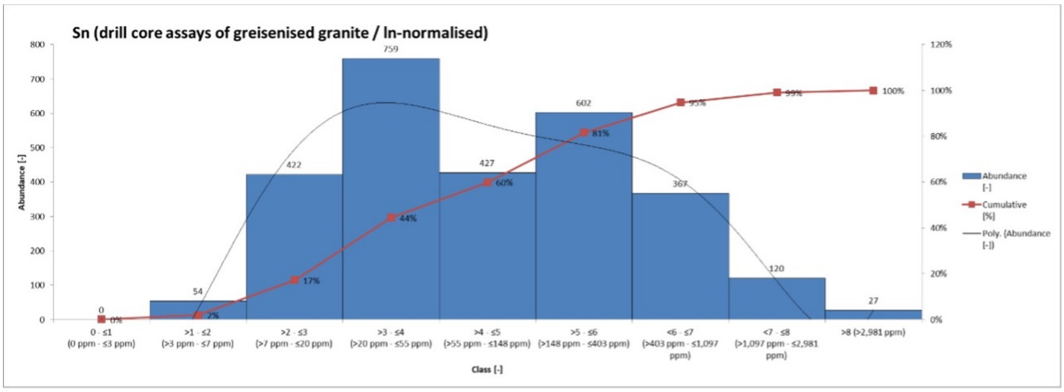


Figure 72: **Abundances of greisenized granite tin drill core assays (Expl. campaign 8)**



Tungsten grades tend to be mostly below 100 ppm. There is evidence of three generations of mineralization:

(1) background mineralization of around 35 ppm
(2) low grade mineralization of around 300 ppm (disseminated)
(3) high grade mineralization of around 2,000 ppm (accumulated veins)

Figure 73: **Abundances of all tungsten drill core assays (Expl. campaign 8)**

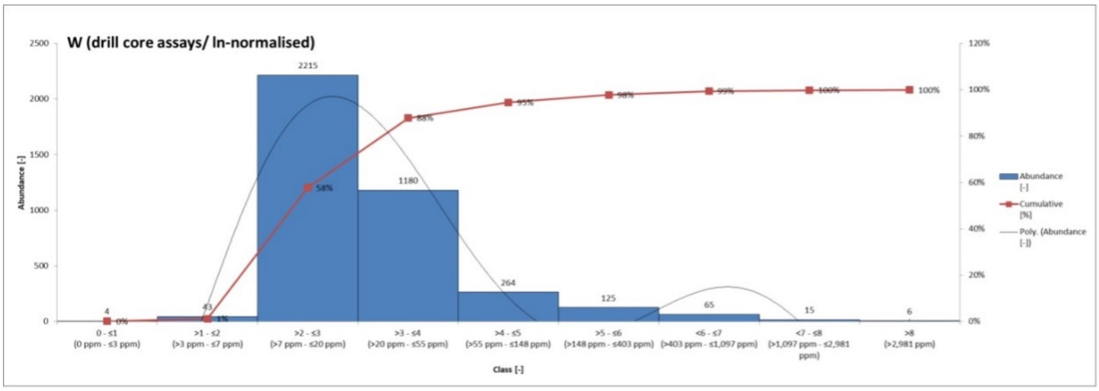


Figure 74: **Abundances of greisen tungsten drill core assays (Expl. campaign 8)**

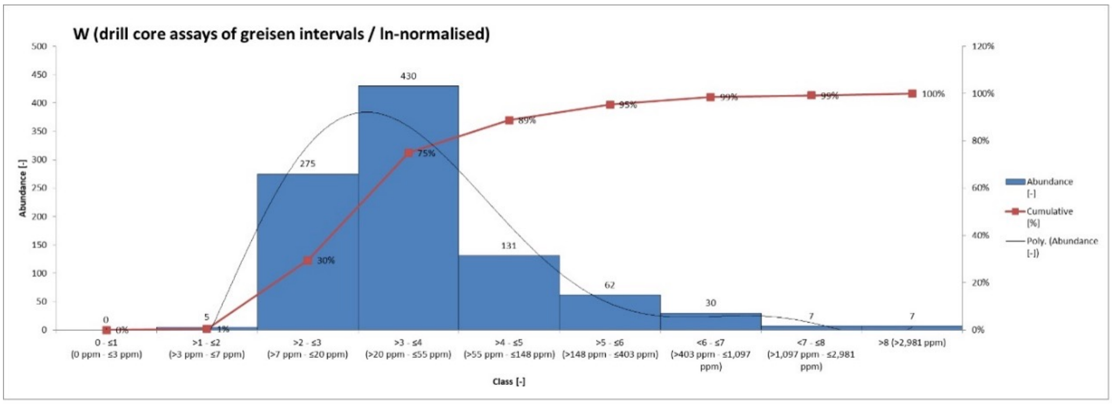
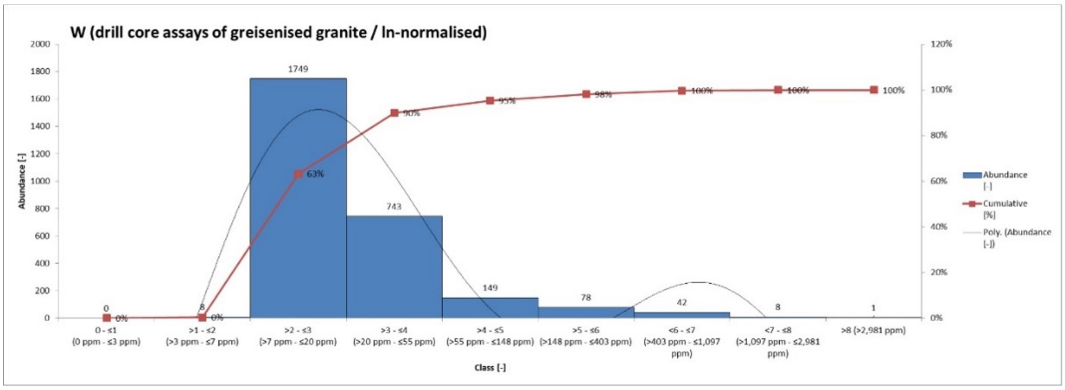


Figure 75: Abundances of greisenized granite tungsten drill core assays (Expl. campaign 8)



The mean K_2O grades of greisen beds (~ 3 wt.%) are lower than those of greisenized granite (3 wt.%- 4 wt.%) or other lithologic units.

Figure 76: Abundances of all K_2O drill core assays (Expl. campaign 8)

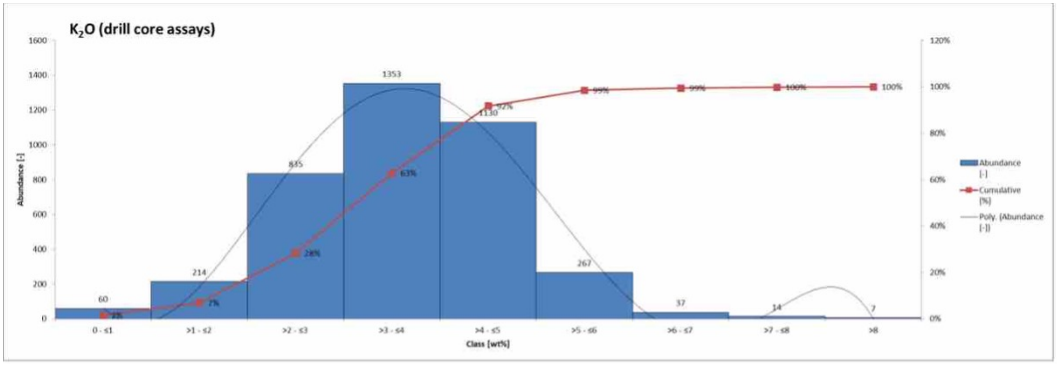


Figure 77: Abundances of greisen K_2O drill core assays (Expl. campaign 8)

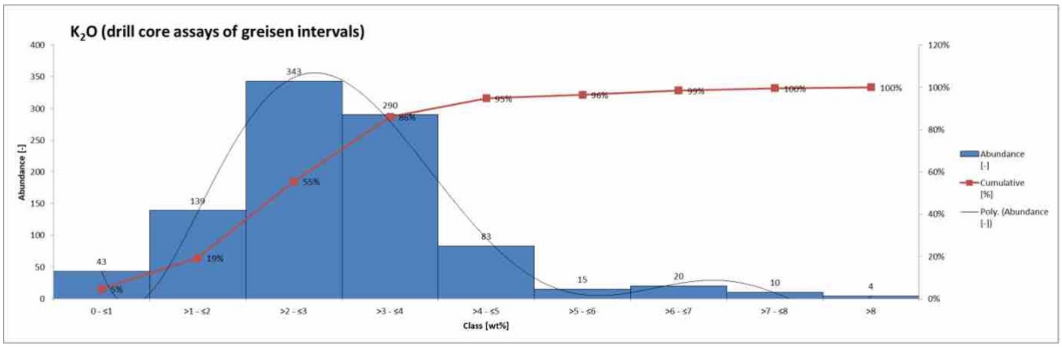
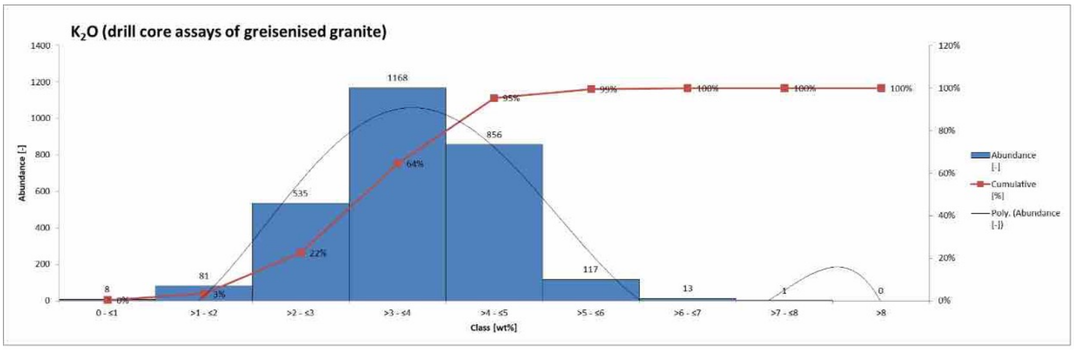


Figure 78: Abundances of greisenized granite K_2O drill core assays (Expl. campaign 8)



Na_2O grades show two populations which can be correlated with the intensity of metasomatic alteration. Greisen beds show mean grades of 0.03 to 0.04 wt.% Na_2O, whereas greisenized granite shows mean grades of

2.0 to 3.0 wt.% Na_2O. Thus, Na_2O can be used in the Zinnwald deposit as geochemical criterion for distinguishing greisens from greisenized granite or unaltered granite.

Figure 79: Abundances of all Na_2O drill core assays (Expl. campaign 8)

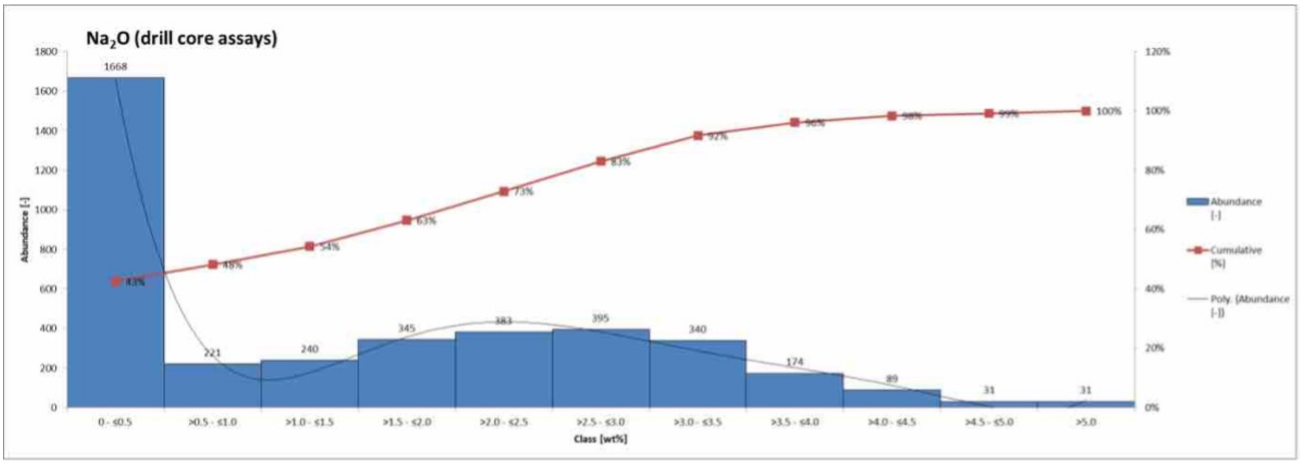


Figure 80: Abundances of greisen bed Na_2O drill core assays (Expl. campaign 8)

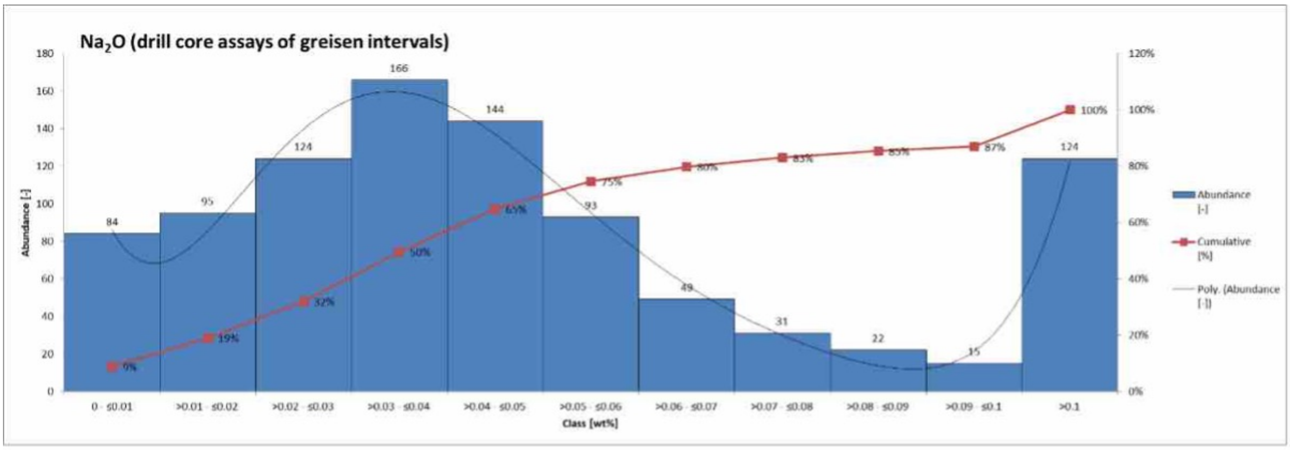


Figure 81: Abundances of greisenized granite Na_2O drill core assays (Expl. campaign 8)

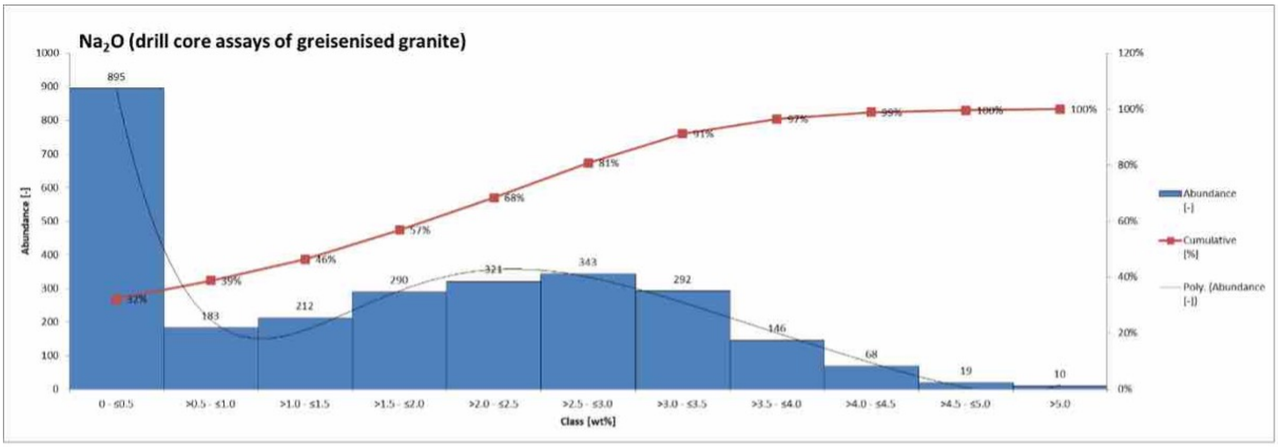


Table 44: Comparison of summary statistical parameters for lithium (Expl. campaign 8)

Greisen Assays				Greisenized granite assays		
Lithium (Li) Core samples + Na_2O_2 digestion ICP-MS				Lithium (Li) Core samples + Na_2O_2 digestion ICP-MS		
Parameter	Value	Unit		Parameter	Value	Unit
Samples	948			Samples	2,779	
Minimum	10	ppm		Minimum	50	ppm
Maximum	13,950	ppm		Maximum	7,010	ppm
Arithmetic mean	3,555	ppm		Arithmetic mean	1,735	ppm
Median	3,320	ppm		Median	1,760	ppm
5 % Quartile	760	ppm		5 % Quartile	740	ppm
25 % Quartile	2,408	ppm		25 % Quartile	1,250	ppm
75 % Quartile	4,435	ppm		75 % Quartile	2,140	ppm
95 % Quartile	6,967	ppm		95 % Quartile	2,750	ppm
Standard deviation	1,939	ppm		Standard deviation	665	ppm
Variance	3,760,318	ppm2		Variance	442,134	ppm2
Coefficient of variation	0.55			Coefficient of variation	0.38	

Table 45: Comparison of summary statistical parameters for tin (Expl campaign 8)

Greisen Assays				Greisenized granite assays		
Tin (Sn) Core samples + Na_2O_2 digestion ICP-MS				Tin (Sn) Core samples + Na_2O_2 digestion ICP-MS		
Parameter	Value	Unit		Parameter	Value	Unit
Samples	945			Samples	2,779	
Minimum	2	ppm		Minimum	2	ppm
Maximum	10,000	ppm		Maximum	10,000	ppm
Arithmetic mean	527	ppm		Arithmetic mean	277	ppm
Median	108	ppm		Median	78	ppm
5 % Quartile	14	ppm		5 % Quartile	11	ppm
25 % Quartile	40	ppm		25 % Quartile	26	ppm
75 % Quartile	340	ppm		75 % Quartile	263	ppm
95 % Quartile	2,570	ppm		95 % Quartile	1,131	ppm
Standard deviation	1,376	ppm		Standard deviation	591	ppm
Variance	1,893,336	ppm2		Variance	348,873	ppm2
Coefficient of variation	2.61			Coefficient of variation	2.13	

Table 46: Comparison of summary statistical parameters for tungsten (Expl campaign 8)

Greisen Assays				Greisenized granite assays		
Tungsten (W) Core samples + Na_2O_2 digestion ICP-MS				Tungsten (W) Core samples + Na_2O_2 digestion ICP-MS		
Parameter	Value	Unit		Parameter	Value	Unit
Samples	948			Samples	2,779	
Minimum	5	ppm		Minimum	3	ppm
Maximum	9,500	ppm		Maximum	3,180	ppm
Arithmetic mean	138	ppm		Arithmetic mean	44	ppm
Median	30	ppm		Median	17	ppm
5 % Quartile	11	ppm		5 % Quartile	10	ppm
25 % Quartile	19	ppm		25 % Quartile	13	ppm
75 % Quartile	54	ppm		75 % Quartile	29	ppm
95 % Quartile	358	ppm		95 % Quartile	136	ppm
Standard deviation	671	ppm		Standard deviation	129	ppm
Variance	450,425	ppm2		Variance	16,747	ppm2
Coefficient of variation	4.86			Coefficient of variation	2.97	

Table 47: **Comparison of summary statistical parameters for K2O (Expl campaign 8)**

Greisen Assays				Greisenized granite assays		
Potassium oxide (K_2O) Core samples + Lithium Metaborate / Lithium Tetraborate Fusion digestionICP-AES				Potassium oxide (K_2O) Core samples + Lithium Metaborate / Lithium Tetraborate Fusion digestion ICP-AES		
Parameter	Value	Unit		Parameter	Value	Unit
Samples	948			Samples	2,780	
Minimum	0.03	ppm		Minimum	0.70	ppm
Maximum	8.88	ppm		Maximum	7.18	ppm
Arithmetic mean	2.96	ppm		Arithmetic mean	3.65	ppm
Median	2.88	ppm		Median	3.67	ppm
5 % Quartile	1.09	ppm		5 % Quartile	2.20	ppm
25 % Quartile	2.26	ppm		25 % Quartile	3.08	ppm
75 % Quartile	3.53	ppm		75 % Quartile	4.24	ppm
95 % Quartile	5.12	ppm		95 % Quartile	4.98	ppm
Standard deviation	1.28	ppm		Standard deviation	0.87	ppm
Variance	1.63	ppm2		Variance	0.76	ppm2
Coefficient of variation	0.43			Coefficient of variation	0.24	

Table 48: **Comparison of summary statistical parameters for Na_2O (Expl campaign 8)**

Greisen Assays				Greisenized granite assays		
Sodium oxide (Na_2O) Core samples + Lithium Metaborate / Lithium Tetraborate Fusion digestionICP-AES				Sodium oxide (Na_2O) Core samples + Lithium Metaborate / Lithium Tetraborate Fusion digestionICP-AES		
Parameter	Value	Unit		Parameter	Value	Unit
Samples	948			Samples	2,780	
Minimum	0.01	ppm		Minimum	0.01	ppm
Maximum	4.40	ppm		Maximum	6.09	ppm
Arithmetic mean	0.16	ppm		Arithmetic mean	1.65	ppm
Median	0.05	ppm		Median	1.68	ppm
5 % Quartile	0.01	ppm		5 % Quartile	0.03	ppm
25 % Quartile	0.03	ppm		25 % Quartile	0.11	ppm
75 % Quartile	0.07	ppm		75 % Quartile	2.77	ppm
95 % Quartile	0.94	ppm		95 % Quartile	3.79	ppm
Standard deviation	0.48	ppm		Standard deviation	1.35	ppm
Variance	0.23	ppm2		Variance	1.82	ppm2
Coefficient of variation	2.94			Coefficient of variation	0.82	

Boxplots of the assays (**Figure *82***, **Figure *83***) clearly display the differences in lithium frequency distributions of greisen and greisenized granite. Tin and tungsten grades are slightly enriched in greisen whereas K_2O and Na_2O grades are depleted.

Figure 82: Boxplots of drill core assays of Li, Sn and W (Expl. campaign 8)

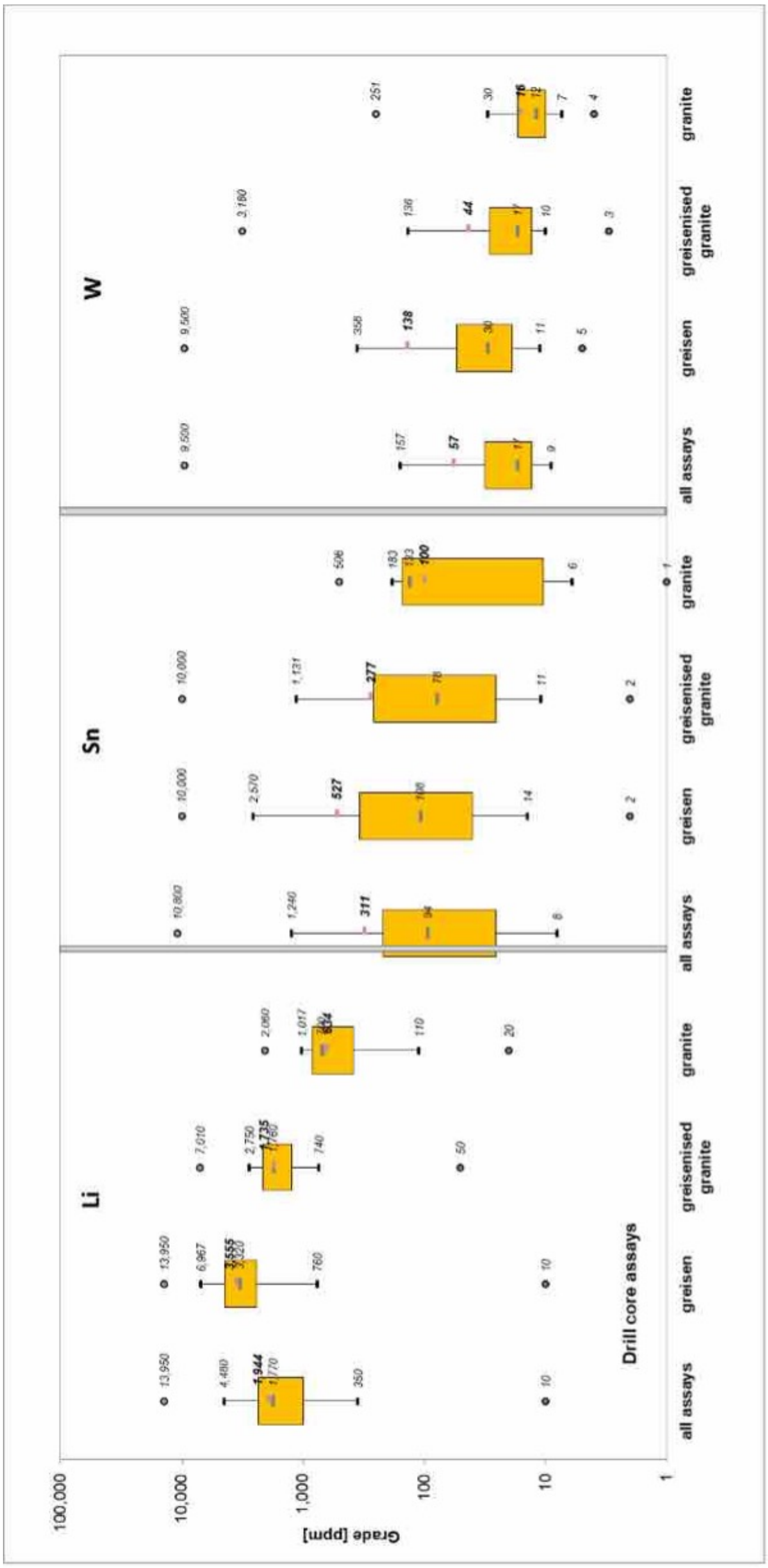
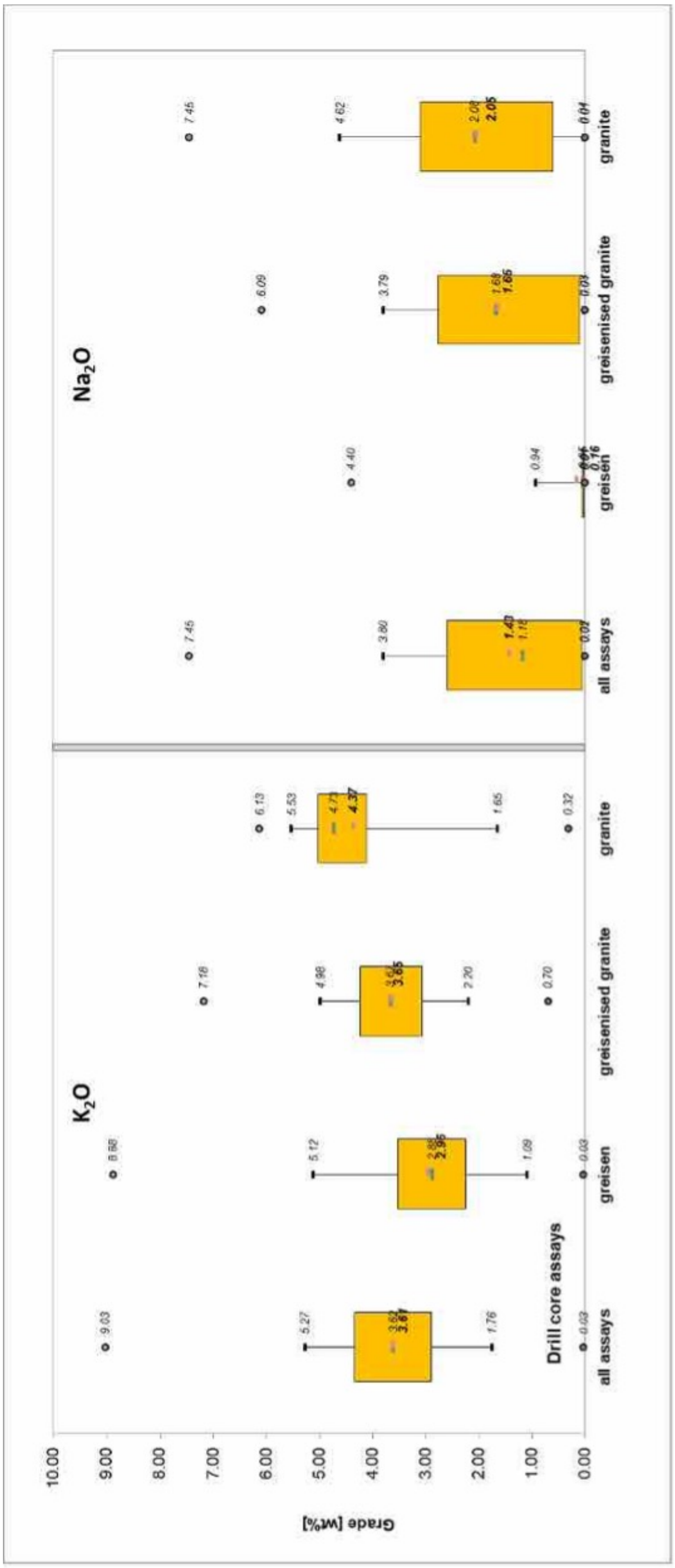


Figure 83: **Boxplots of drill core assays of K_2O and Na_2O (Expl. campaign 8)**



Regarding the correlation matrix of exploration campaign No. (8) no significant relationships between the selected components lithium, tin, tungsten and Na_2O could be found (see **Table *49***). Only for Li and K_2O a linear correlation was found in the greisen beds, probably referred to the joint occurrence of these components in the mineral zinnwaldite ($KLiFeAl(AlSi_3)O_{10}(OH,F)_2$).

Table 49: **Drill core assays exploration campaign No. (8), linear coefficient of correlation R^2**

		Li	Sn	W	K_2O	Na_2O
All assays	Li	1.00				
	Sn	0.19	1.00			
	W	0.15	0.20	1.00		
	K_2O	-0.09	0.06	-0.02	1.00	
	Na_2O	-0.37	-0.10	-0.07	0.08	1.00
Assays of greisen	Li	1.00				
	Sn	0.13	1.00			
	W	0.10	0.09	1.00		
	K_2O	0.67	0.06	0.12	1.00	
	Na_2O	-0.08	-0.03	-0.04	0.04	1.00
Assays of greisenised granite	Li	1.00				
	Sn	0.07	1.00			
	W	0.07	0.41	1.00		
	K_2O	-0.29	0.14	0.04	1.00	
	Na_2O	-0.22	-0.05	-0.05	-0.08	1.00

14.6.3 Summary Statistics of Drill Core Assays of Data Joins

Drill core assay data of exploration campaigns No.s (4), (5), and (8) has been merged for the purpose of resource estimation of "Ore Type 1" – greisen beds as shown in **Table *50***.

Raw data obtained from statistical calculations performed for the several exploration campaigns was extracted from the database, analyzed and summarized. The analysis included:

- summarized statistic parameters of all exploration campaigns
- boxplots
- determination of outlier grades (see **Table *51***)

Prior to the statistical analysis, all data below the laboratory detection limit (sometimes presented as "0" in the older reports) have been substituted by the half the lower detection limit value (see **Table *50***).

Table 50: **Substitution of values below the lower detection limit of the raw data**

Exploration campaign No.	**Li**	**Sn**	**W**
(4)	No assays below detection limit	No assays below detection limit	No assays below detection limit
(5)	8 substitutions for drill core assays (0 replaced by 50 ppm)	No assays below detection limit	120 substitutions for drill core assays (0 replaced by 50 ppm)
(6)	No assays below detection limit	No assays below detection limit	38 substitutions for drill core assays (0 replaced by 5 ppm)
(7)	No assays below detection limit	26 substitutions for drill core assays (0 replaced by 5 ppm)	157 substitutions for drill core assays (0 replaced by 5 ppm)
(8)	No assays below detection limit	2 substitutions for drill core assays (1 replaced by 0.5 ppm)	1 substitution for drill core assays (1 replaced by 0.5 ppm)
	K_2O	Na_2O	
(8)	29 substitutions for drill core assays (0.01 replaced by 0.005 ppm)	No assays below detection limit	

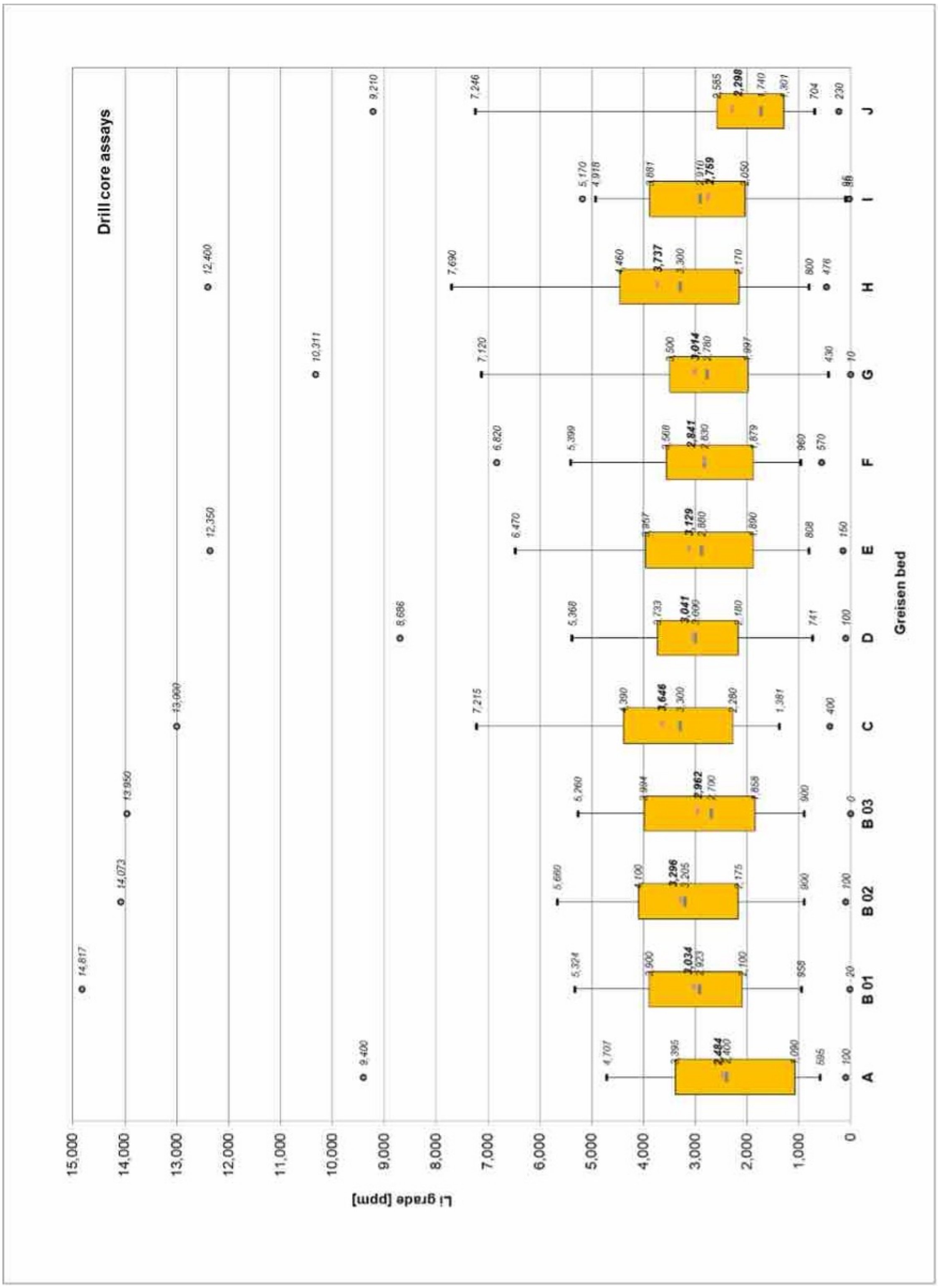
The following tables and figures summarize the statistical analysis of the merged data sets.

Table 51: Summary statistics of the greisen bed lithium drill core assays

Lithium						
Greisen bed	**A**	**B 01**	**B02**	**B 03**	**C**	**D**
Number of composites	139	564	491	169	129	187
5 % Quantile (ppm)	595	958	900	900	1,381	741
25 % Quantile (ppm)	1,090	2,100	2,175	1,858	2,280	2,180
75 % Quantile (ppm)	3,395	3,900	4,100	3,994	4,390	3,733
95 % Quantile (ppm)	4,707	5,324	5,660	5,260	7,215	5,368
Median (ppm)	2,400	2,923	3,205	2,700	3,300	3,000
Arithmetic mean (ppm)	2,484	3,034	3,296	2,962	3,646	3,041
Minimum (ppm)	100	20	100	0	400	100
Maximum (ppm)	9,400	14,817	14,073	13,950	13,000	8,686
Standard deviation (ppm)	1,674	1,519	1,665	1,740	2,172	1,448
Variance (ppm2)	2,780,804	2,303,288	2,765,135	3,010,618	4,682,436	2,086,102
Coefficient of Variation (-)	0.67	0.50	0.51	0.59	0.60	0.48
Greisen bed	E	F	G	H	I	J
Number of composites	514	79	121	85	53	43
5 % Quantile (ppm)	808	960	430	800	96	704
25 % Quantile (ppm)	1,890	1,879	1,997	2,170	2,050	1,301
75 % Quantile (ppm)	3,957	3,568	3,500	4,460	3,881	2,585
95 % Quantile (ppm)	6,470	5,399	7,120	7,690	4,918	7,246
Median (ppm)	2,880	2,830	2,780	3,300	2,910	1,740
Arithmetic mean (ppm)	3,129	2,841	3,014	3,737	2,759	2,298
Minimum (ppm)	150	570	10	476	30	230
Maximum (ppm)	12,350	6,820	10,311	12,400	5,170	9,210
Standard deviation (ppm)	1,882	1,379	1,950	2,332	1,448	1,937
Variance (ppm2)	3,536,694	1,876,547	3,771,818	5,374,978	2,057,795	3,664,597
Coefficient of Variation (-)	0.60	0.49	0.65	0.62	0.52	0.84

Lithium grades of greisen bed intersection intervals, comprising greisen intervals and interburden, are characterized by the following boxplots:

Figure 84: Boxplots of merged Li drill core assay data comparison of individual greisen beds



14.7 Grade Capping

Based on statistical evaluation, 83 lithium grade values exceeding 7,000 ppm had to be substituted by the threshold value before using them for compositing. Furthermore, 11 tin and 3 tungsten grade values exceeded the threshold of 10,000 ppm and had to be truncated. The same applies to 71 K_2O grade values that had to be cut at 60,000 ppm (see **Table *52***). All top-cut thresholds are based on testing of outliers of the components' frequency distributions for greisen lithology.

Table 52: Top-cut Li, Sn, W and K_2O grades

Component	Li	Sn	W	K_2O
Top-cut threshold [ppm]	7,000	10,000	10,000	60,000
Number of top-cut grade values [-]	83	11	3	71

14.8 Compositing

Compositing has been done for Li drill core assays within greisen bed intersections only. This is because of the lack of reliable drill core assays of tin, tungsten, potassium oxide and sodium oxide and because of the lack of correct distinction of greisenized zones throughout the various exploration campaigns.

Tin and tungsten grades generally tend to be very low within greisen beds and greisenized granite except for some singular intervals that might be related to veins, small seams or stockworks having only a local spatial extension. Potassium oxide and sodium oxide core sample assays are available only for exploration campaign No. (8). Consequently tin, tungsten and potassium oxide are estimated as potentials and are reported by ore volume / tonnage and a mean grade.

Li core sample assays of the exploration campaigns No.s (4), (5) and (8) were composited downhole with a 1 m interval length. Small intervals of less than 0.5 m length were appended to the neighbouring 1 m interval. All ore bed interval intersections with ≥ 80 % sampled apparent interval thickness were used for Li resource classification. The midpoints of the concerned interval intersections were applied to interpolate classification zones within the greisen beds based on the anisotropic reach parameter of the inverse distance interpolation process.

Interval intersections with less than 80 % sampled apparent thickness were neither used for interpolation nor for resource classification. Thus, resource classes near these intersection intervals were controlled by the next intersection intervals with ≥ 80 % sampled apparent interval thickness.

Table 53: Summary of the drill hole intersections within the greisen beds

Greisen bed	Number of drill hole intersections	Number of drill hole intersections assayed for Li by ≥ 80 % of the length	Number of drill hole intersections assayed for Sn by ≥ 80 % of the length	Number of drill hole intersections assayed for W by ≥ 80 % of the length	Number of drill hole intersections assayed for K_2O by ≥ 80% of the length
A	27	18	16	15	5
B 01	86	54	51	43	28
B 02	62	41	37	31	15
B 03	45	27	22	20	13
C	45	27	26	21	12
D	36	26	26	20	12
E	104	65	63	52	39
F	27	19	19	17	13
G	25	18	14	11	9
H	18	14	13	11	7
I	15	9	9	8	7
J	12	8	8	8	7
K	1	0	0	0	0
Yet not classified	91	52	57	56	18

14.9 Composite Statistical Analysis

14.9.1 Lithium Composites

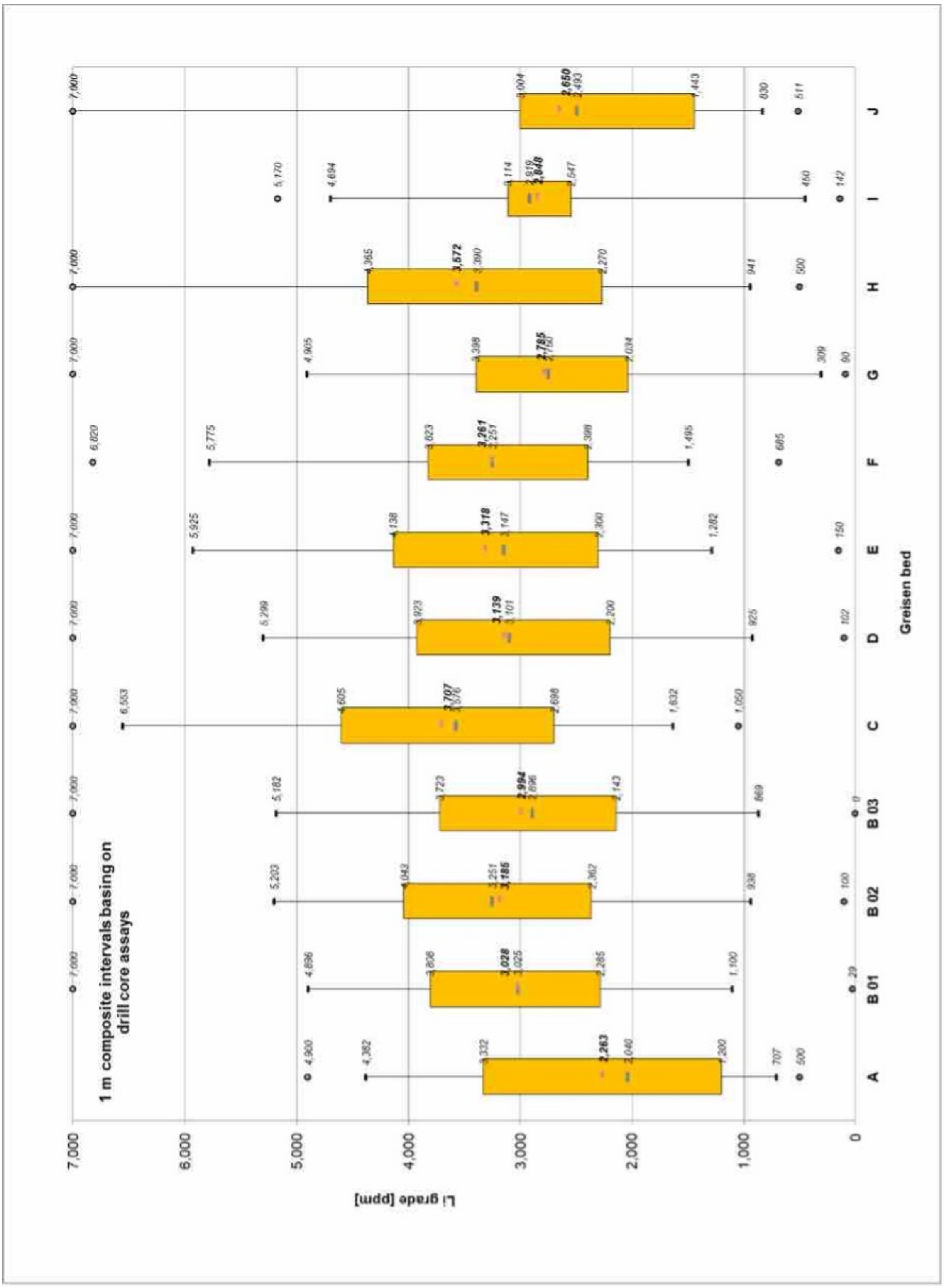
The following **Table *54*** summarizes the general statistics of the composites.

Table 54: Summary statistics of the 1 m composite intervals of the lithium drill core assays

Lithium						
Greisen bed	A	B 01	B02	B 03	C	D
Number of composites	113	438	368	120	79	131
5 % Quantile (ppm)	707	1,100	938	869	1,632	925
25 % Quantile (ppm)	1,200	2,285	2,362	2,143	2,698	2,200
75 % Quantile (ppm)	3,332	3,808	4,043	3,723	4,605	3,923
95 % Quantile (ppm)	4,382	4,896	5,203	5,182	6,553	5,299
Median (ppm)	2,040	3,025	3,251	2,896	3,576	3,101
Arithmetic mean (ppm)	2,263	3,028	3,185	2,994	3,707	3,139
Minimum (ppm)	500	29	100	0	1,050	102
Maximum (ppm)	4,900	7,000	7,000	7,000	7,000	7,000
Standard deviation (ppm)	1,226	1,186	1,293	1,341	1,413	1,357
Variance (ppm2)	1,489,479	1,403,718	1,667,876	1,783,831	1,972,230	1,826,811
Coefficient of Variation (-)	0.54	0.39	0.41	0.45	0.38	0.43
Greisen bed	E	F	G	H	I	J
Number of composites	321	51	91	71	30	27
5 % Quantile (ppm)	1,282	1,495	309	941	450	830
25 % Quantile (ppm)	2,300	2,398	2,034	2,270	2,547	1,443
75 % Quantile (ppm)	4,138	3,823	3,398	4,365	3,114	3,004
95 % Quantile (ppm)	5,925	5,775	4,905	7,000	4,694	7,000
Median (ppm)	3,147	3,251	2,750	3,390	2,919	2,493
Arithmetic mean (ppm)	3,318	3,261	2,785	3,572	2,848	2,650
Minimum (ppm)	150	685	90	500	142	511
Maximum (ppm)	7,000	6,820	7,000	7,000	5,170	7,000
Standard deviation (ppm)	1,452	1,237	1,382	1,805	1,114	1,832
Variance (ppm2)	2,100,532	1,500,641	1,887,614	3,213,728	1,198,614	3,233,496
Coefficient of Variation (-)	0.44	0.38	0.50	0.51	0.39	0.69

Figure *85* presents a boxplot of composited lithium grades for the individual greisen beds.

Figure 85: Boxplots of 1 m interval Li grade composites for individual greisen beds



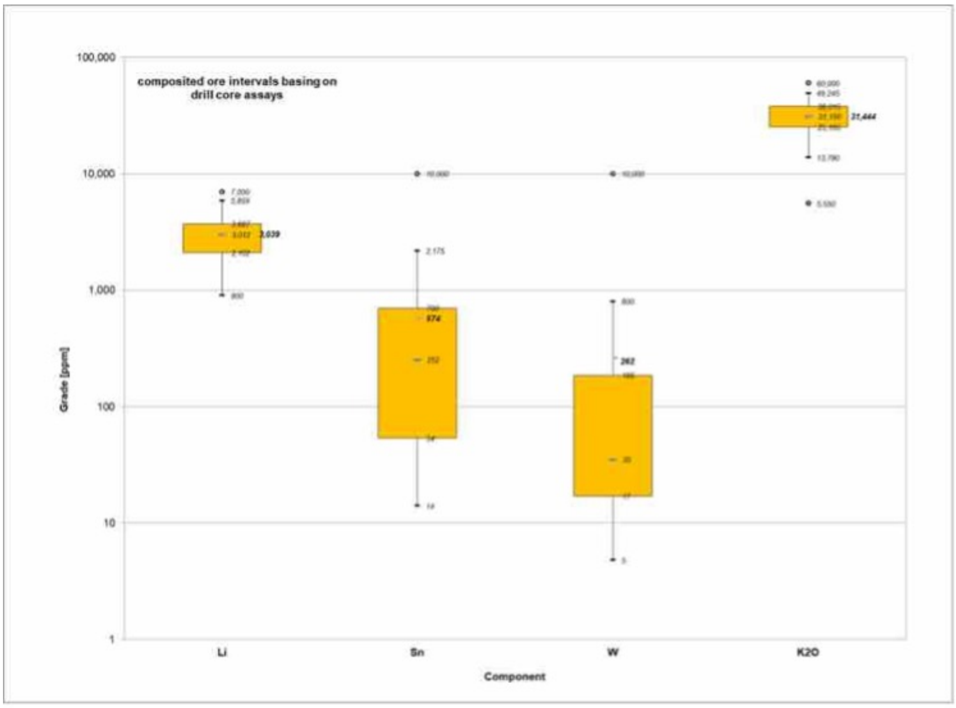
14.9.2 Tin, Tungsten and Potassium Oxide Composites

Summary statics of drill core assays composited by length of ore intervals of “Ore Type 1” are displayed below.

Table 55: Summary statistics of the drill core assays of “Ore Type 1”

Component	Li	Sn	W	K_2O
Number of composites	326	304	257	167
5 % Quantile (ppm)	900	14	5	13,780
25 % Quantile (ppm)	2,102	54	17	25,185
75 % Quantile (ppm)	3,697	700	185	38,015
95 % Quantile (ppm)	5,859	2,175	800	49,245
Median (ppm)	3,012	252	35	31,150
Arithmetic mean (ppm)	3,039	574	262	31,444
Minimum (ppm)	0	0	0	5,550
Maximum (ppm)	7,000	10,000	10,000	60,000
Standard deviation (ppm)	1,385	1,003	891	10,653
Variance (ppm2)	1,912,579	1,002,738	790,439	112,800,013
Coefficient of Variation (-)	0.46	1.75	3.39	0.34

Figure 86: Box plots of the drill core assays composited by length of ore intervals of “Ore Type 1”



14.10 Composite Variographic Analyses

The classification of the lithium resources is based on a geostatistical spatial analysis of the 1 m composites of the lithium grades within the greisen ore bodies, which is characterized by a normal frequency distribution. It is assumed that the intensity of the lithium mineralization has a layered pattern that is parallel to the bottom and top boundary of the greisen beds. Therefore, grade variations in x- and y-direction are generally lower compared to z-direction.

To make use of the knowledge of the mineralization genesis process, composite points were projected to a planar zone surrounding the central plane of the greisen beds. This equates to a coordinate transformation in vertical direction (unfolding). Geostatistical variogram analysis was per-formed based upon the entire transformed composite data keeping a space of 1,000 m in vertical direction between the data collectives of each greisen bed in order to not cross the composite points of adjacent greisen beds in the process of analysis. The resulting semivariograms are presented in **Figure *87*** to **Figure *89***.

Figure 87: Semivariogram of the major axis of lithium composites of the greisen beds

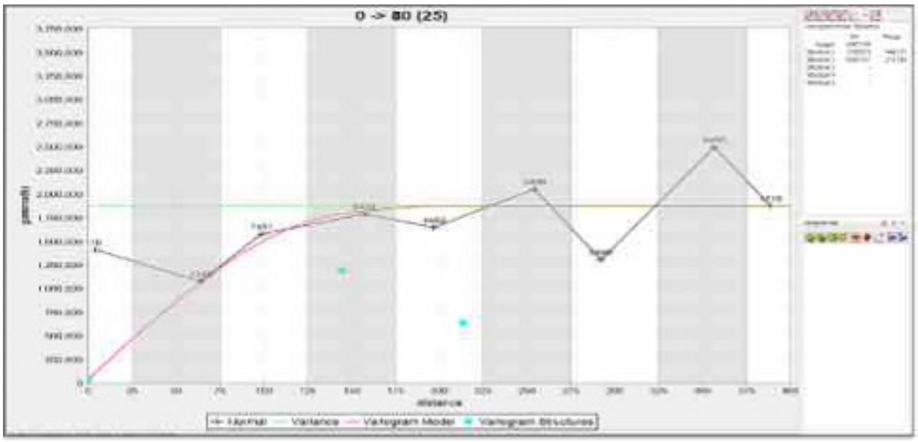


Figure 88: Semivariogram of the semi-major axis of lithium composites of the greisen beds

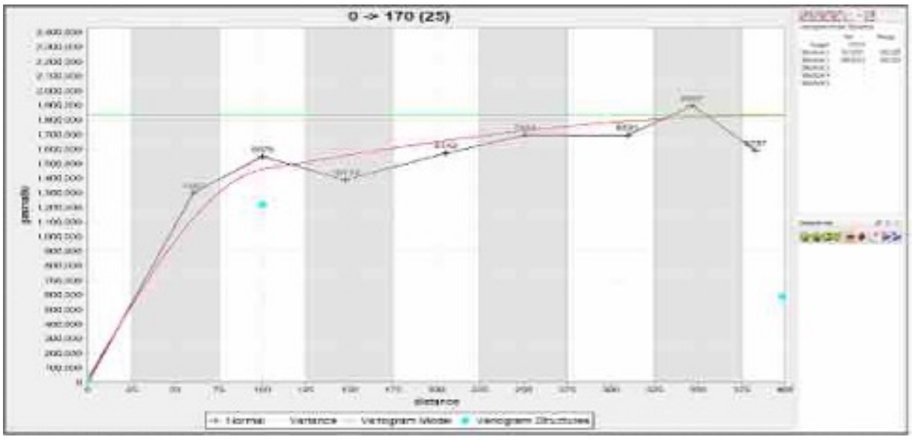
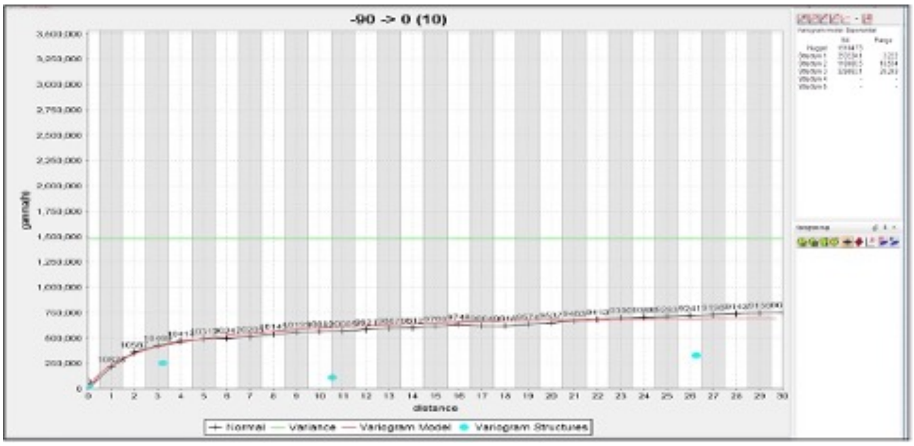


Figure 89: Semivariogram of the minor axis of lithium composites of the greisen beds



Semivariograms reveal evidence for up to 3 structures of the Li mineralization.

Table 56: Variogram parameters

Parameter	1. Structure	2. Structure	3. Structure
Major (bearing of the interpolation ellipsoid) angle: 80°	Sill: 120,000 range: 145 m	Sill: 640,000 range: 213 m	
Semi-major (plunge of the interpolation ellipsoid) angle: 350°	Sill: 222,000 range: 100 m	Sill: 589,000 range: 399 m	
Minor (dip of the interpolation ellipsoid) downhole	Nugget: 16,000, Sill: 253,000 range: 3.2 m	Sill: 111,000 range: 10.6 m	Sill: 329,000 range: 26.3 m

The range of the geostatistical relationship between lithium grades of the first structure accounts for 145 m, having an azimuth of 80° (major axis), and 100 m, having an azimuth of 350° (semi-major axis) within the greisen beds. The minor axis dips with 90° and shows a range of around 3 m (equates to the vertical cross section of the greisen beds). Ranges of the first structure have been used as crucial parameters of resource classification.

Ranges of the semi-major axis have to be regarded with caution. There is evidence that the real range of the first structure accounts for a value between 60 m and 100 m. This confirms with com-parable Li greisen and pegmatite deposits worldwide. However, in the case of the Zinnwald lithium deposit the semi-major still cannot be determined exactly due to the mean drill hole spacing of around 150 m. Only few sample assay pairs show smaller distances than 100 m.

14.11 Prospects for Eventual Economic Extraction

Concerning the minimum vertical thickness of an economically mineable greisen bed ore, a value of 2 m was chosen as a reasonable measure.

The consequent limitation of the lithium orebodies was not done with the 3D geological model only but also in the block model by using the interpolated vertical thickness as a limitation parameter in a database query. Based on the current process development the mining cut-off was calculated at 2,500 ppm lithium as the base case.

Alternative scenarios were calculated with cut-off grades 0 ppm, 1,000 ppm, 2,000 ppm and 3,000 ppm Li. Based on the vertical thickness the linear productivity of the Li mineralization was calculated in order to include potential high-grade intervals with vertical thicknesses below 2 m of the block model into the resource estimate.

Lithium linear productivity is the product of vertical greisen bed thickness and lithium grade. Depending on the minimum vertical thickness and the lithium cut-off grades, linear productivity Li cut-off grades are: 4,000 ppm * m, 4,500 ppm * m, 5,000 ppm * m, 5,500 ppm * m and 6,000 ppm * m.

14.12 Block Model Construction

Empty block models had to be defined for each greisen bed. A horizontal discretization of 5 m x 5 m was chosen. The vertical blocking was set to 1 m due to the minimum thickness of economically minable ore beds of 2 m and in order to consider sufficiently the significantly differing lithium grades in vertical direction as found in the drill hole sample data.

No sub-blocking was applied. **Table *57*** gives an overview of the block model parameterization:

Table 57: Parameterization of the block model

Parameter	x	y	z
Minimum [UTM33]	33,412,400	5,620,800	200 m
Maximum [UTM33]	33,413,800	5,622,300	850 m
Extent	1,400 m	1,500 m	650 m
Parent Block	5 m	5 m	1 m
Sub Block	-	-	-
Max. Number of Blocks [-]	54,600,000		

To reduce the random-access memory requirements, the block models have been constrained by the greisen bed top and bottom boundary planes as defined in the geological model. All blocks intersecting the boundary planes or located inside the beds were assigned to the constrained block model. In general, mineralized portions have not been extrapolated more than 50 m from drill holes collar position. As an additional boundary the German-Czech borderline was included.

14.13 Grade Interpolation

Since lithium assay data collectives are limited, especially for the less extensive greisen beds, inverse distance interpolation procedure was chosen to transfer the statistical characteristics of the sample data into a spatially distribution of grades within the block model.

Kriging interpolation algorithm has not been applied yet to estimate the lithium resource. However, geostatistical analysis reveals that lithium is Gaussian distributed and shows a very low coefficient of variation and a very low nugget value as well. Lithium appears to be homogeneously distributed within the greisen beds. For this reason, the inverse distance method is used to interpolate grades, even for such a large drill hole spacing like in the case of Zinnwald.

The following parameterization of the search ellipsoid of the anisotropic inverse distance interpolation was chosen:

Table 58: Parameters chosen for search ellipsoid of the anisotropic inverse distance interpolation

Parameter	Value
Minimum number of composites to apply	1
Maximum number of composites to apply	10
Maximum number of composites per drill hole	1
Maximum horizontal search radius of the ellipsoid (major)	290 m (twice the major range)
Maximum horizontal search radius of the ellipsoid (semi-major)	200 m (twice the semi-major range)
Maximum vertical search radius of the ellipsoid (minor and vertical constraint)	100 m

The inverse distance interpolation results were assigned to a planar block model as an intermediate step. Therefore, lithium composite points had to be projected to a planar zone surrounding the central plane of the greisen beds. Vertical discretization of composites from different greisen beds was handled by storing them in different files being used for the interpolation and by constraining the interpolation process to each greisen bed. Then interpolated lithium grades were projected in vertical direction to the true spatial location in a second block model.

14.14 Block Model Validation

Validation of the geological model of "Ore Type 1"

A simplified 3D surface model, based on the thickness of drill hole ore intervals of "Ore Type 1" (greisen + interburden) below 740 m a.s.l., has been created to prove the corresponding total greisen volume of the block model. Calculations resulted in a total volume of

21.5 million m³ (58.1 MT, 2.7 t/m³)

which almost equals the total volume of all greisen beds (19.9 million m³, 53.8 MT, 2.7 t/m³) reported from the block model.

Block model validation

Block model validation has been done by comparing percentile graphs of raw sample assay grades, composite grades and interpolated grades of the block centre points.

The percentile graph on the following page, representing a summary of all "Ore Type 1" lithium assay data, composite point and block centre point lithium grade data, reveals that there is a good congruence between the grade frequency distributions. Accordingly, lithium grades have been properly assigned to the block model by inverse distance interpolation.

Slight deviations are caused due to effects of the interpolation procedure leading to average the grades with increasing distance to the next sample point.

Figure 90: Percentile chart of Li drill core assays compared to composite and block model

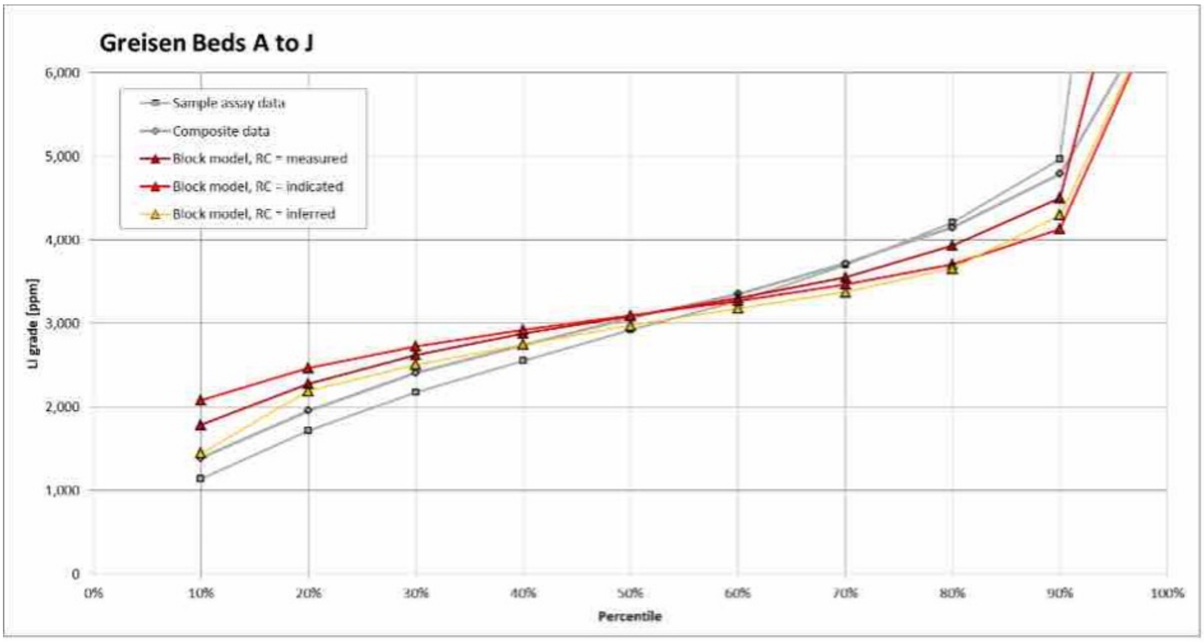


Table 59: Comparison of percentiles of Li grades - core assays, composites & block model

					Percentile		
	Class of data	Number of values	10 %	20 %	30 %	40 %	50 %
All greisen beds	Sample assay data	2,574	1,143	1,714	2,170	2,555	2,926
	Composites	1,840	1,390	1,955	2,409	2,737	3,063
	Block model, RC = measured	557,216	1,788	2,278	2,622	2,877	3,089
	Block model, RC = indicated	469,958	2,081	2,470	2,721	2,919	3,094
	Block model, RC = inferred	133,305	1,445	2,194	2,507	2,750	2,976
	Class of data	Number of values	60 %	70 %	80 %	90 %	100 %
All greisen beds	Sample assay data	2,574	3,270	3,700	4,210	4,964	14,817
	Composites	1,840	3,352	3,717	4,147	4,790	7,000
	Block model, RC = measured	557,216	3,302	3,552	3,929	4,502	9,403
	Block model, RC = indicated	469,958	3,271	3,464	3,704	4,126	6,979
	Block model, RC = inferred	133,305	3,180	3,375	3,656	4,298	7,000

Comparison of the arithmetic mean of lithium grades shows a good accordance between drill core assays, 1 m composites and block model interpolation by inverse distance method.

Table 60: Comparison of arithmetic means of Li grades - core assays, composites, block model

Parameter	Drill core assays		1 m composites		Inverse distance interpolation	
			Measured	Indicated	Inferred	Total
"Ore Type 1" Arithmetic Mean Li [ppm]	3,098	3,105	3,126	3,097	2,958	3,095

14.15 Mineral Resource Classification

14.15.1 Preface

The lithium resource and the potential of Li, Sn, W and K_2O represent the German part of the Zinnwald lithium deposit below a level of 740 m a.s.l. Resource and potential cover greisen bed ("Ore Type 1") and greisenized granite ("Ore Type 2") lithologic domains.

The Mineral Resources of the Zinnwald property were estimated in conformity with generally accepted CIM "Estimation of Mineral Resource and Mineral Reserve Best Practices Guidelines". G.E.O.S. is not aware of any known environmental, permitting, legal, title, taxation, socio-economic, marketing or other relevant issues that could potentially affect this estimate of Mineral Resources. The Mineral Resources may be affected by further infill and exploration drilling which may result in an increase or decrease of a future Mineral Resource estimate. The Mineral Resources may also be affected by assessments of mining, environmental, processing, permitting, taxation, socio-economic and other factors in the future.

The resource estimate was completed by Matthias Helbig, a Senior Consultant (resource geologist at G.E.O.S.). The effective date of this resource estimate is September 30, 2018.

14.15.2 Mineral Resource Classification

Lithium Mineral Resource of Greisen Beds ("Ore Type 1")

Variogram ranges (see Chapter 14.10) have been used as a measure to derive contiguous zones classifying the lithium mineral resource.

Core sample assays were used only from the drill holes. Furthermore, more than 80 % of the intersected greisen interval had to be assayed to generate a classification zoning surrounding the drill hole intersection interval. The criteria used to classify the resource are summarized as follows:

- "Measured" – High level of confidence in data quality, high level of confidence in grade estimation, geological and grade continuity. For the greisen beds ("Ore Type 1") the necessary horizontal distance to drill hole samples accounts for ≤ 73 m in east to west direction and ≤ 50 m in north to south direction as supported by the variogram ranges. A single greisen bed body must be intersected and sampled by at least two drill holes according to the above defined rules. Estimation uncertainty ratio accounts for ± 20 %.
- "Indicated" – Moderate level of confidence in data quality, moderate level of confidence in grade estimation, geological and grade continuity. More widely spaced drill hole sample data. Horizontal distance to drill hole samples accounts for > 73 m to ≤ 145 m in east to west direction and > 50 m to ≤ 100 m in north to south direction. A single greisen bed body must be intersected and sampled by at least two drill holes according to the above defined rules. Estimation uncertainty ratio accounts for ± 40 %.
- "Inferred" – Moderate level of confidence in data quality, low level of confidence in grade estimation, geological and grade continuity. Sparse drilling data compared to variogram ranges: spacing of > 145 m to ≤ 290 m in east to west direction and > 100 m to ≤ 200 m in north to south direction. A single greisen bed body must be intersected and sampled by at least one drill hole according to the above defined rules. Estimation uncertainty ratio accounts for ± 80 %.

Anisotropic inverse distance interpolation was used to estimate the lithium grades within the greisen bed envelopes. The results have been verified by a simplified grid-based 2D model using in-verse distance algorithm. In general, resources have not been extrapolated more than 50 m beyond individual drill hole intersections within the greisen beds (half of the range of the semi-major).

Sn, W and K_2O Potential of Greisen Beds ("Ore Type 1")

Tin and tungsten weighted mean grades measured in the greisen bed intervals (drill core samples) of the exploration campaigns No.s (4), (5) and (8) were interpolated by inverse distance algorithm. Mean grades of the minor elements are reported for each of the greisen beds of "Ore Type 1".

The K_2O weighted mean grade measured in the greisen bed intervals (drill core samples) of exploration campaign No. (8) was interpolated by inverse distance algorithm also. Mean grades of K_2O are reported for each of the greisen beds of "Ore Type 1".

Li, Sn, W and K_2O Potential of Greisenized Granite ("Ore Type 2")

The volume of greisenized granite was derived from a simplified 2D grid-based model. The volume then was multiplied by the bulk density in order to estimate the total tonnage. The weighted means of lithium, tin, tungsten and K_2O grade, obtained from drill core sample assays of exploration campaigns No. (8), were applied to the total tonnage of greisenized granite.

14.16 Mineral Resource Statement

14.16.1 Lithium Mineral Inventory

The Mineral Inventory of lithium was estimated from the block model on the base of a 0 ppm cut-off and without a constraint of minimum thickness of the geological bodies of “Ore Type 1”.

Table 61: Lithium Mineral Inventory of Zinnwald (German part below 740m)

Mineral inventory “Ore Type 1”	Volume [10^6 m^3]	Tonnage [10^6 tonnes]	Mean Li grade [ppm]
Total	19.9	53.8	3,100

14.16.2 Lithium Mineral Resource – Base Case “Ore Type 1”

According to prospects for eventual economic extraction (minimum vertical thickness of greisen beds = 2 m, cut-off value Li = 2,500 ppm) the Lithium Mineral Resource shown below has been calculated for the German part of the Zinnwald lithium deposit and below 740 m a.s.l. as the Base Case “Ore Type 1”. It has been compared with the case zero (minimum vertical thickness of greisen beds = 2 m, cut-off-value Li = 0 ppm) to determine the internal dilution of the orebodies.

Table 62: Lithium Mineral Resource - Zinnwald, Base Case

Resource classification “Ore Type 1” greisen beds	Ore volume [10^3 m^3]	Ore tonnage [10^3 tonnes]	Mean Li grade [ppm]	Ore volume [10^3 m^3]	Ore tonnage [10^3 tonnes]	Mean Li grade [ppm]
	Vertical thickness ≥ 2 m, cut-off Li = 2,500 ppm			Vertical thickness ≥ 2 m, cut-off Li = 0 ppm		
Measured	6,855	18,510	3,630	8,954	24,176	3,246
Indicated	6,296	17,000	3,399	8,046	21,725	3,114
Inferred	1,802	4,865	3,549	2,675	7,224	2,995
(Measured+Indicated)	13,152	35,510	3,519	17,000	45,901	3,183
	Internal Dilution					
Total (Measured+Indicated+Inferred)	4,722	12,749	2,001			

Table 64, greisen beds “B” and “E” are the most important ore bodies of the Zinnwald lithium deposit and comprise around 71 % of the Demonstrated Resource of “Ore Type 1”.

The mean lithium grade for all greisen beds is remarkably higher than 3,000 ppm.

Table 63: Lithium Mineral Resource - Zinnwald, Base Case “Ore Type 1” greisen beds A - E

Resource classification "Ore Type 1" - greisen beds		Cut-off grade Li = 2,500 ppm, below the Tiefer-Bünau-Stollen level (≤ 740 m NN), thickness of greisen beds ≥ 2 m		
Greisen bed	Resource classification	Ore volume [m^3]	Ore tonnage [tonnes]	Mean lithium grade [ppm]
A	Measured	7,525	20,318	3,227
	Indicated	5,150	13,905	3,284
	Inferred	7,050	19,035	2,732
	(Measured+Indicated)	12,675	34,223	3,250
B	Measured	3,358,750	9,068,627	3,569
	Indicated	2,874,075	7,760,004	3,359
	Inferred	425,650	1,149,256	3,392
	(Measured+Indicated)	6,232,825	16,828,631	3,472
C	Measured	311,375	840,713	3,919
	Indicated	226,000	610,201	3,452
	Inferred	226,400	611,280	3,495
	(Measured+Indicated)	537,375	1,450,914	3,723
D	Measured	576,650	1,556,955	3,644

Resource classification "Ore Type 1" - greisen beds		Cut-off grade Li = 2,500 ppm, below the Tiefer-Bünau-Stollen level (≤ 740 m NN), thickness of greisen beds ≥ 2 m		
Greisen bed	**Resource classification**	**Ore volume [m^3]**	**Ore tonnage [tonnes]**	**Mean lithium grade [ppm]**
	Indicated	473,275	1,277,843	3,544
	Inferred	279,375	754,313	3,341
	(Measured+Indicated)	1,049,925	2,834,798	3,599
E	Measured	1,553,700	4,194,991	3,757
	Indicated	1,552,525	4,191,819	3,379
	Inferred	604,850	1,633,097	3,376
	(Measured+Indicated)	3,106,225	8,386,810	3,568

Table 64: Lithium Mineral Resource - Zinnwald, Base Case "Ore Type 1" greisen beds F - J

Resource classification "Ore Type 1" - greisen beds		Cut-off grade Li = 2,500 ppm, below the Tiefer-Bünau-Stollen level (≤ 740 m NN), thickness of greisen beds ≥ 2 m		
Greisen bed	**Resource classification**	**Ore volume [m^3]**	**Ore tonnage [tonnes]**	**Mean lithium grade [ppm]**
F	Measured	247,200	667,440	3,620
	Indicated	314,075	848,003	3,491
	Inferred	33,000	89,100	3,817
	(Measured+Indicated)	561,275	1,515,443	3,548
G	Measured	365,000	985,500	3,456
	Indicated	281,150	759,105	3,134
	Inferred	21,525	58,118	2,610
	(Measured+Indicated)	646,150	1,744,605	3,316
H	Measured	27,675	74,723	3,024
	Indicated	18,725	50,558	2,680
	Inferred	158,975	429,233	5,228
	(Measured+Indicated)	46,400	125,281	2,885
I	Measured	184,775	498,893	3,198
	Indicated	252,575	681,953	3,416
	Inferred	28,125	75,938	3,625
	(Measured+Indicated)	437,350	1,180,846	3,324
J	Measured	223,050	602,235	3,964
	Indicated	298,925	807,098	3,804
	Inferred	17,150	46,305	2,929
	(Measured+Indicated)	521,975	1,409,333	3,872

14.16.3 Lithium Resource – Alternative Cut-Off Grades

The **Table *65*** shows a summary of mean lithium grades and ore tonnages for cases with a minimum vertical thickness of the greisen beds of 2 m and a lithium cut-off grade of 2,500 ppm (Base Case) as well as alternative lithium cut-off grades of 0 / 1,000 / 2,000 / 3,000 ppm.

Table 65: Lithium Mineral Resource - Zinnwald, Cases "Ore Type 1"

Resource classification "Ore Type 1" greisen beds	Ore volume [10^3 m^3]	Ore tonnage [10^3 tonnes]	Mean Li grade [ppm]	Ore volume [10^3 m^3]	Ore tonnage [10^3 tonnes]	Mean Li grade [ppm]
	Vertical thickness ≥ 2 m, cut-off Li = 0 ppm (case zero)			**Vertical thickness ≥ 2 m, cut-off Li = 1,000 ppm**		
Measured	8,954	24,176	3,246	8,649	23,353	3,318
Indicated	8,046	21,725	3,114	7,893	21,312	3,146
Inferred	2,675	7,224	2,995	2,488	6,719	3,143
(Measured+Indicated)	17,000	45,901	3,183	16,543	44,666	3,236

	Vertical thickness ≥ 2 m, cut-off Li = 2,000 ppm			**Vertical thickness ≥ 2 m, cut-off Li = 2,500 ppm (Base case)**		
Measured	7,825	21,128	3,472	6,855	18,510	3,630
Indicated	7,273	19,637	3,256	6,296	17,000	3,399
Inferred	2,179	5,883	3,341	1,802	4,865	3,549
(Measured+Indicated)	15,098	40,766	3,368	13,152	35,510	3,519
	Vertical thickness ≥ 2 m, cut-off Li = 0 ppm (case zero)			**Vertical thickness ≥ 2 m, cut-off Li = 1,000 ppm**		
Measured	5,177	13,979	3,897			
Indicated	4,496	12,139	3,642			
Inferred	1,291	3,485	3,857			
(Measured+Indicated)	9,673	26,119	3,778			

14.16.4 Potential of Li, Sn, W and K2O

Sn, W and K_2O Potential of Greisen Beds (“Ore Type 1”)

The Potential of Sn, W and K_2O have been estimated for the greisen beds as mean grades for “Ore Type 1” for the German part of the Zinnwald lithium deposit and below 740 m a.s.l.

Table 66: Minor Elements’ Potential - Zinnwald, Base Case “Ore Type 1”

"Ore Type 1" - greisen beds		**Cut-off grade Li = 2,500 ppm, below the Tiefer-Bünau-Stollen level (≤ 740 m NN), thickness of greisen beds ≥ 2 m**				
Greisen bed	**Sum**	**Ore volume [10^3 m^3]**	**Ore tonnage [10^3 tonnes]**	**Mean tin grade [ppm]**	**Mean tungsten grade [ppm]**	**Mean potassium oxide grade [wt.%]**
A	Sub Total	19	53	1,115	371	3.2
B	Sub Total	6,658	17,977	692	142	2.9
C	Sub Total	763	2,062	651	704	3.4
D	Sub Total	1,329	3,589	360	51	3.1
E	Sub Total	3,711	10,019	510	51	3.3
F	Sub Total	594	1,604	368	324	3.7
G	Sub Total	667	1,802	95	39	3.0
H	Sub Total	205	554	135	37	3.7
I	Sub Total	465	1,256	58	32	2.7
J	Sub Total	539	1,455	35	29	2.9
All greisen beds together	Total	14,954	40,376	525	134	3.1

Base Case “Ore Type 1” (with a total volume of rounded 15 million cubic meters and a tonnage of 40 million tonnes) overall mean tin grade accounts for approximately 500 ppm, mean tungsten grade for approximately 100 ppm and mean potassium oxide grade for approximately 3.1 wt.%.

Li, Sn, W and K_2O Potential of Greisenized Granite (“Ore Type 2”)

The Potential of Li, Sn, W and K_2O of the greisenized granite domain (“Ore Type 2”) have been estimated as a Mineral Inventory. Multiplication of domain volume, domain dry bulk rock density and domain mean component grades from statistical analysis of data of exploration campaign No. (8) has been applied for the German part of the Zinnwald lithium deposit and below 740 m a.s.l.

“Ore Type 2” is estimated to approx. 81 million cubic meters containing 214 million tonnes (2.65 t/m^3) of ore. With regard to exploration campaign No. (8) “Ore Type 2” has a mean lithium grade of approximately 1,700 ppm. Mean tin grade accounts for approximately 270 ppm, mean tungsten grade for approximately 40 ppm and mean potassium oxide grade for approximately 3.6 wt.%.

The above mentioned, grades of minor elements represent the overall mean contents in the ore types. Veins, seams and locally occurring tin greisen stockworks which are embedded in the ore type bodies might show significant higher grades.

14.17 Grade-Tonnage Curves

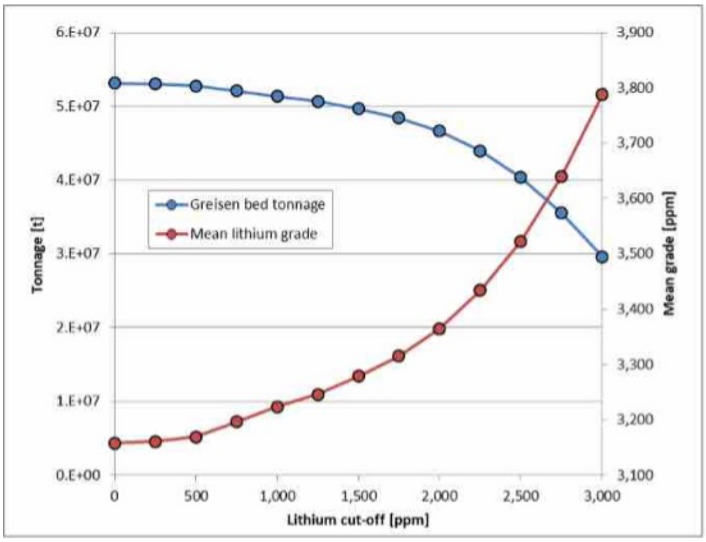
Grade-tonnage curves and tables have been prepared for evaluation of the Lithium Mineral Resource estimate of “Ore Type 1” below 740 m a.s.l. (see **Figure *91***). Curves of ore tonnage and mean lithium grade vs. cut-off grades are regular shapes and do not reveal evidence of errors of the resource estimate.

Lithium

Table 67: Grade-tonnage curve parameters of Lithium Mineral Resource estimate “Ore Type 1”

Lithium cut-off [ppm]	Greisen bed volume "Ore Type 1" [10^3 m^3]	Greisen bed tonnage "Ore Type 1" [10^3 t]	Mean lithium grade [ppm]
0	19,687	53,157	3,158
250	19,676	53,126	3,158
500	19,642	53,034	3,161
750	19,556	52,801	3,169
1,000	19,302	52,117	3,196
1,250	19,031	51,385	3,224
1,500	18,775	50,694	3,246
1,750	18,397	49,674	3,279
2,000	17,939	48,437	3,315
2,250	17,277	46,649	3,365
2,500	16,288	43,979	3,434
2,750	14,954	40,376	3,523
3,000	13,161	35,535	3,640

Figure 91: Grade-tonnage curves of the Lithium Mineral Resource of “Ore Type 1”



14.18 Comparison with Historic Resource Estimates

The Zinnwald lithium deposit was explored for lithium in campaigns No.s (4), (6) and (8). Greisen tonnage and mean grades are only directly comparable for campaigns No.s (4) and (8). Campaign (6) focused on the investigation of tin and tungsten mineralizations (total sums are only in-tended for the comparison with historic values).

Table 68: Comparison of Li ore resource and average Li, Sn and W grades - individual campaigns

Exploration campaign No.	Resource class	Volume $[10^3\ m^3]$	Tonnage $[10^3$ tonnes$]$	Mean Li grade [ppm]	Mean Sn grade [ppm]	Mean W grade [ppm]
(4) BOLDUAN & LÄCHELT (1960) *[101]*	C1+C2 (Greisen intersection interval thickness ≥ 2 m, cut-off = 2,000 ppm)	4,000 1,000 200 Sum C1+C2 5,000	10,700 2,800 500 Sum C1+C2 13,500	3,000	Prognostic mean grade 500	Prognostic mean grade 200
(6) GRUNEWALD (1978b) *[108]*	No classification (Greisen drill hole intersection interval thickness ≥ 5 m, cut-off = 0 ppm)	5,980	16,100	3,000	Not calculated for Li ore	Not calculated for Li ore
(8a – 8b) SWS (2013)	Measured / Indicated / Inferred (Vertical thickness ≥ 2 m; cut-off = 2,000 ppm)	4,234 6,848 4,051 Sum 15,133	11,431 18,490 10,939 Sum 40,860	3,529 3,446 3,578 Mean grade 3,505	Potential Mean grade approx. 400	Potential Mean grade approx. 80
	Potential of greisen	approx. 900	approx. 2,400	approx. 3,200	approx. 400	approx. 80
	Potential of greisenized granite	approx. 44,000	approx. 117,000	approx. 1,800	approx. 240	approx. 40
(8a – 8c) DL (2018)	Measured / Indicated / Inferred (Vertical thickness ≥ 2 m; cut-off = 2,000 ppm)	9,371 6,308 1,597 Total 17,277	25,303 17,033 4,312 Total 46,649	3,446 3,228 3,425 Mean grade 3,365	Potential Mean grade 509	Potential Mean grade 129
	Potential of greisen	-	-	-	-	-
	Potential of greisenized granite	approx. 81,000	approx. 214,000	approx. 1,700	approx. 270	approx. 40

If the geological data of campaigns (5), (6), (7) and (8) as well as the lithium assay data of campaigns (5) and (8) are also taken into account, it can be summarized that the lithium resource of "Ore Type 1" has more than tripled compared to Exploration Campaign No. 4.

Comparison of expected cumulated ore interval thickness ("Ore Type 1") of the 2017 drilling campaign against demonstrated cumulated ore interval thickness yielded values of 383 m vs. 510 m. Expected length weighted mean grade was 3,068 ppm Li. Demonstrated grade was 3,380 ppm Li.

Like the 2014 campaign before, expected ore parameters have been exceeded by the demonstrated ore parameters. Consequently, findings of the last two drilling campaigns 8b and 8c substantiate a continuous growth of the estimated lithium resource.

14.19 Risk Assessment of the Demonstrated Lithium Mineral Resource

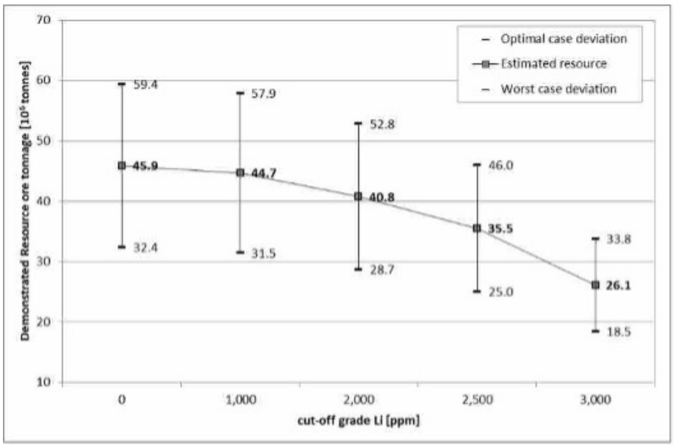
The overall error range of the resource estimation results from the interaction of the uncertainty ratios of different input factors, which are:

1. Errors and lack of drill hole survey data, especially for data before exploration campaign No. 7
2. Errors of geochemical analysis, especially for data of exploration campaign No. 4
3. Errors of data acquisition
4. Uncertainties of the 3D modelled geological shapes of the greisen beds
5. Lack of sufficient spatial data density, especially for greisen beds with small extension, preventing the ability to perform a reliable geostatistical analysis

The before mentioned error factors are summarized as estimation uncertainty ratios, which are ± 20 % for the class measured and ± 40 % for the class indicated. Application of these factors to the estimated and classified ore tonnages results in the corresponding tolerance intervals.

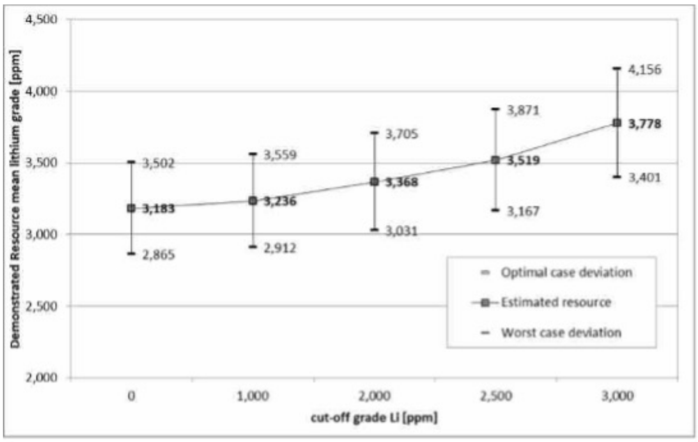
Figure 95 gives an overview of the band of uncertainty that is associated with the Demonstrated Lithium Mineral Resource. The shown ratio must be considered for the economic evaluation and determination of Mineral Reserves. For the example of the base case scenario (cut-off grade lithium = 2,500 ppm, minimum vertical thickness of the greisen beds = 2 m) the tolerance band of demonstrated greisen ore tonnage in place reaches from 25.0 million tonnes to 46.0 million tonnes which equals a range of ± 30 %. The estimated value accounts for 35.5 million tonnes.

Figure 92: Tolerance intervals of the Demonstrated Resource tonnage



For the total Demonstrated Resource the tolerance band encompasses values from 32.4 to 59.4 million tonnes of ore whereas the estimated value accounts for 45.9 million tonnes. Consequently, the range of uncertainty equals ± 29 %. Assuming an uncertainty ratio of ± 10 %, the mean grade of the Demonstrated Lithium Mineral Resource at a cut-off of 2,500 ppm will vary between 3,160 ppm and 3,870 ppm (see **Figure *93***).

Figure 93: Tolerance intervals of the mean lithium grade of the Demonstrated Resource



15 Mineral Reserve Estimates

Since this Report summarizes the results of a Preliminary Economic Assessment (PEA), no Mineral Reserves have yet been estimated for the revised Zinnwald Lithium Project as per NI 43-101 guidelines. However, for the purpose of project appraisal, the previously calculated Mineral Reserves from the 2019 FS report have been used as mining inventory. This PEA includes assumptions for optimised mining extraction and production methods together with the almost doubling of the Lithium price and accordingly considers this to be a conservative and appropriate approach.

For detailed summary on the calculation of these mineral reserves the reader should refer to the previous report. Some key assumptions are as follows:

- Proven and Probable Mineral Reserves = 31.20 Mt, 3,004 ppm Li
    - Including internal dilution (8%) = 2.28 Mt, 1,929 ppm Li
    - Including external dilution (20%) = 5.5 Mt, 1,700 ppm Li

16 Mining Methods

16.1 Introduction

The ore extraction planning in the project has three targets:

- To provide constant volume and quality of ore for the minerals processing
- To economically optimize the process
- To operate efficiently without risking safety or environment

The operation has been designed for an annual output of c. 12,000 t/a LiOH. Applying the mineral reserve estimation of 3,004 ppm lithium content, and estimated Lithium recovery in downstream processes this corresponds to an average annual ore production of 880,000 tons.

The conceptual plan for mining operations is based on access from Altenberg Mine on 500 m Reduced Level (RL) advancing upwards with room and pillar, AVOCA, and sublevel stoping methods followed by hardening backfill. On production levels LHD (Load-Haule-Dump) loaders dump the mined material into ore passes from where the ROM (Run of Mine) is transported 7 kms to ROM pad downhill to Bärenstein via Zinnerz – Altenberg Mine drainage tunnel (“Entwässerungsstollen Altenberg”).

The mine is an integral part of the process tailings management as the Leach Residue from the hydrometallurgical process will be permanently located underground. This requirement has a major impact on selection of mining method and on sequencing of mine production. To prevent impacts on the surface, 90% - of void created in the ore will be backfilled.

16.2 Preparations

The mine will be first accessed from two locations: From the Zinnerz – Altenberg Mine with a 4 km tunnel (Access Tunnel) and from Zinnwald with a 1.7 km decline (Ventilation Decline). The two connect at +500 RL in the central pillar / ore pass area. Once connected the decline functions as second means of exit and as a main ventilation route.

Main preparations at Bärenstein:

- Constructing ROM pad for the material from the development
- Constructing water treatment facility

Main preparations in the Zinnerz Altenberg Mine:

- Zinnerz Altenberg Mine safety inspection
- Upgrading the existing escapeway
- Preparing Zinnerz Altenberg Mine Shaft 3 for ventilation
- Constructing an underground workshop
- Constructing an underground explosive storage
- Enlargement of the drainage tunnel to 20 m^2 profile

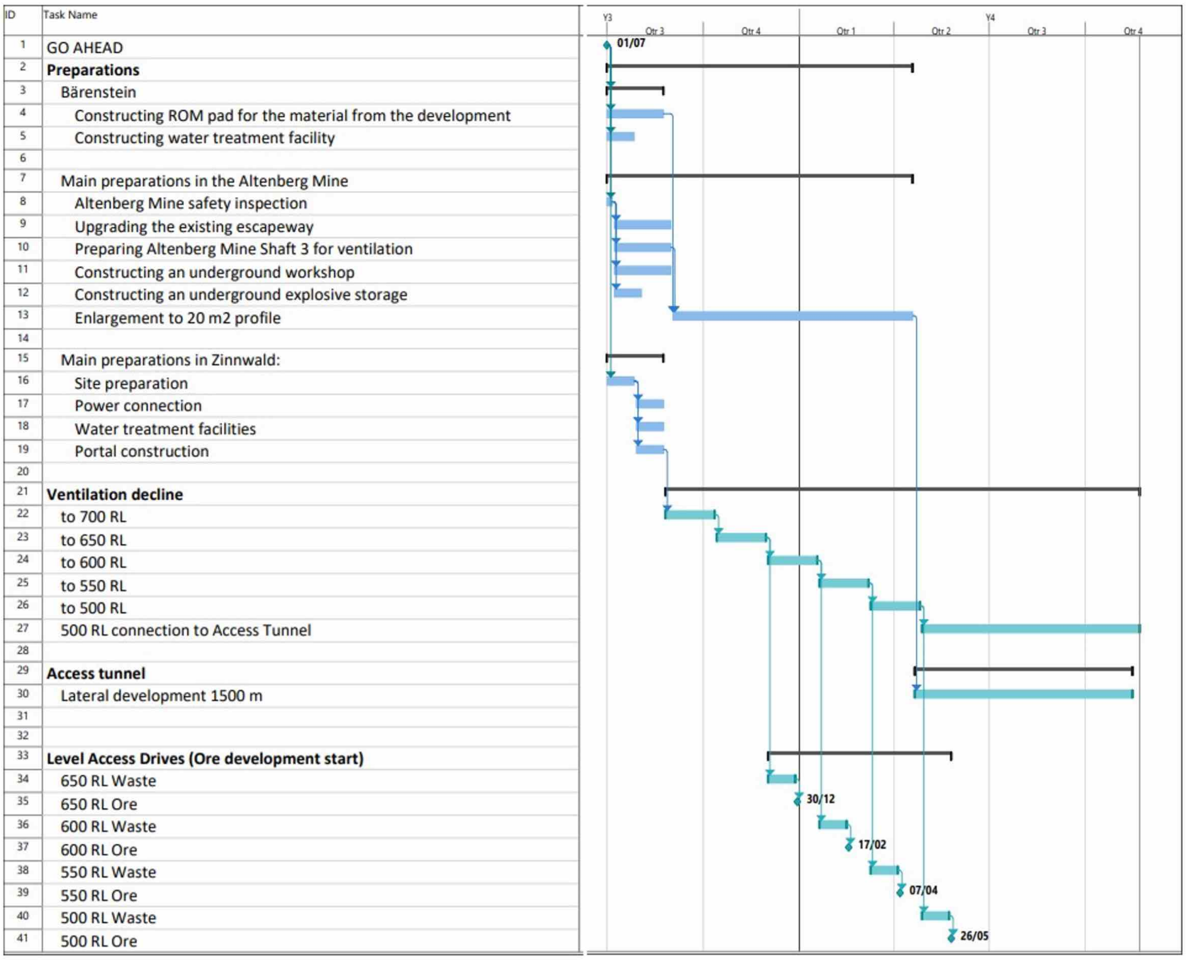
Main preparations in Zinnwald:

- Portal construction
- Power connection
- Water treatment facilities
- Construction of Ventilation Decline

Figure 94: **Access area to Ventilation decline in Zinnwald**

The Ventilation Decline will be connected to the old workings of Tiefe-Hilfe-Gottes gallery (THG) on 700 RL. The connection will be used for ventilation and emergency exit purposes.

Figure 95: **Preparation Timeline** (the dates presented are not binding)



ID	Task Name
1	GO AHEAD
2	**Preparations**
3	Bärenstein
4	Constructing ROM pad for the material from the development
5	Constructing water treatment facility
6	
7	Main preparations in the Altenberg Mine
8	Altenberg Mine safety inspection
9	Upgrading the existing escapeway
10	Preparing Altenberg Mine Shaft 3 for ventilation
11	Constructing an underground workshop
12	Constructing an underground explosive storage
13	Enlargement to 20 m2 profile
14	
15	Main preparations in Zinnwald:
16	Site preparation
17	Power connection
18	Water treatment facilities
19	Portal construction
20	
21	**Ventilation decline**
22	to 700 RL
23	to 650 RL
24	to 600 RL
25	to 550 RL
26	to 500 RL
27	500 RL connection to Access Tunnel
28	
29	**Access tunnel**
30	Lateral development 1500 m
31	
32	
33	**Level Access Drives (Ore development start)**
34	650 RL Waste
35	650 RL Ore
36	600 RL Waste
37	600 RL Ore
38	550 RL Waste
39	550 RL Ore
40	500 RL Waste
41	500 RL Ore

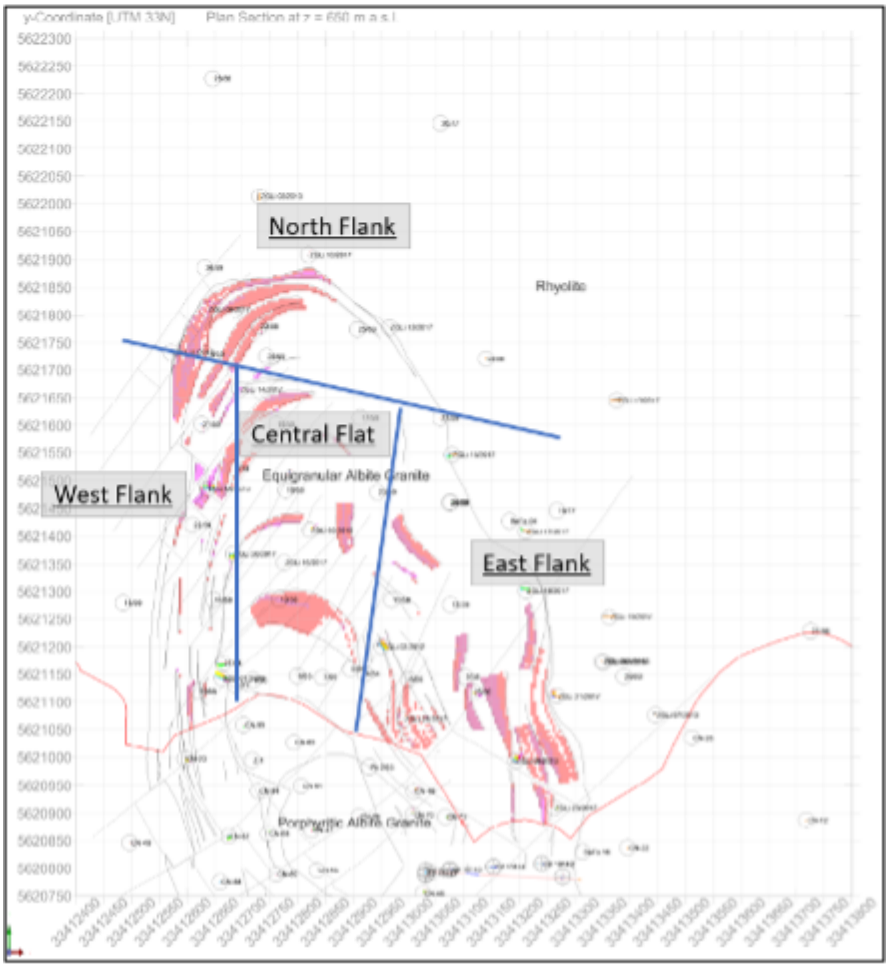
16.3 Production principles

Simplifying, the deposit structure represents an anticline, at the flanks of which the ore bodies plunge below 400 RL. The Access Tunnel enters the deposit in the north at 500 RL, which will be the first production level. The level will be the loading/transportation level for all the material mined on the level and levels above it. The ore will be transferred on to 500 RL via ore passes.

The following mining areas are geologically and technologically defined:

- North Flank
- East Flank
- West Flank
- Central Flat

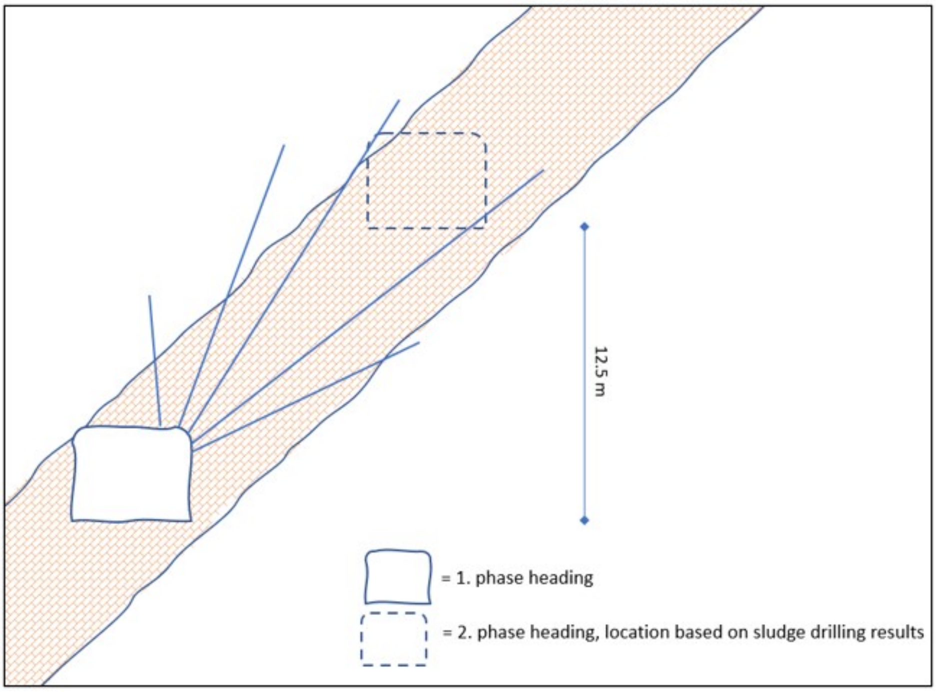
Figure 96: Project level 650 RL with indicative mining area division



The development drives are planned with a 5.0 m by 4.0 m profile and will be driven by conventional drilling and blasting technology. The sublevels are planned with a vertical distance of 12.5 m in East and North Flanks and with 25 m spacing in the West Flank.

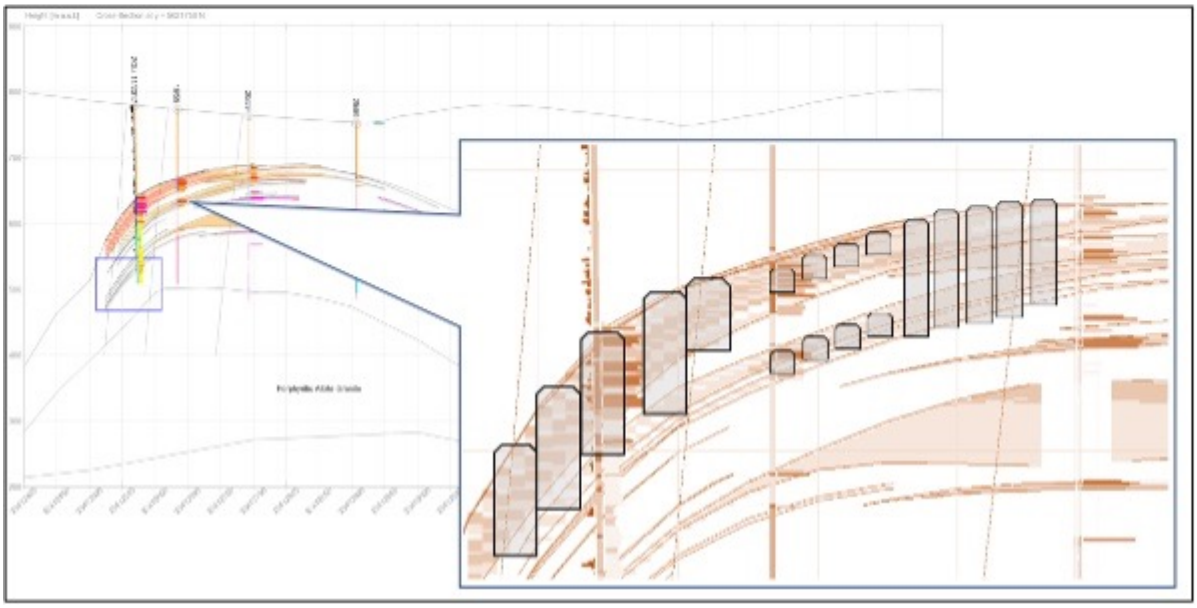
A mining area is first entered on the lowest level, the location of the drive above is designed based on sludge drilling profiles with horizontal spacing 12.5 m – 25 m.

Figure 97: **Sludge drilling**



As the dip (0° – 70° degrees) and the vertical thickness (2 m – 60 m) of the orebody vary, the extraction method has to be adjusted locally. Generally, it is assumed that 33 % of the mined ore is extracted in development phase and 67% in stoping phase.

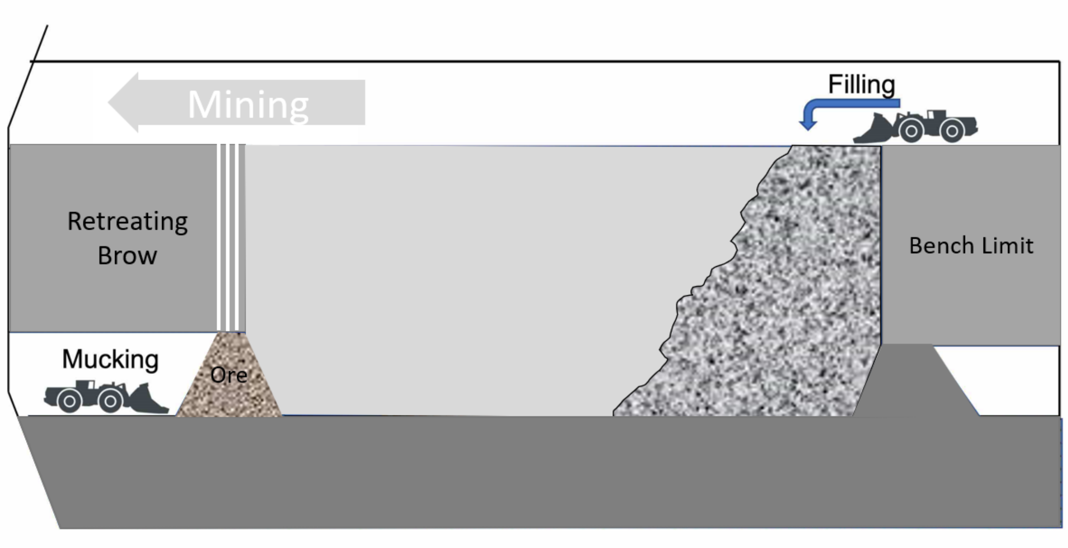
Figure 98: **Idealised section**



During the first years of the production the preferred extraction method is AVOCA as it allows immediate backfill. **Figure *99*** shows the schematic operation of AVOCA, which is suitable for steeply dipping parts of the orebody.

The key working principle of this method is to continuously backfill the excavated stope with barren rock, leached roast product (LRP) and quartz sand. This minimises the risk of any potential subsidence and could also increase mining recovery of the resource whilst it reduces the need for intermediate storage facilities for materials such as LRP.

Figure 99: **Schematic picture of Avoca**



For an optimal development of the mine and a steady output of ore material, the initial development of the mine within the first years will be focused on the bodies between +500 to +600 RL. The deepest envisaged sublevels are in the North Flank at +392 RL and in the East Flank at +360 RL. The uppermost mineable sublevel will be at +688 RL, leaving 20 m vertical distance to the historic mine workings.

The Ore Development and extraction will take place in the following order:

1.	West Flank	+500 to +525 RL
2.	North Flank	+500 to +512.5 RL
3.	East Flank	+500 to +512.5 RL

The mine production schedule was originally based on the 3D ore deposit and block model created for NI 43-101 report. Due to the nature and accuracy of this document, the production is assumed to be steady 880'000 tpa with the NI 43-101 Mineral Reserve grade of 3,004 ppm of Lithium metal.

16.4 Water Management

The ground water draining to mine will be collected in settling ponds on 500-level. The clarified excess water will be drained further to Bärenstein processing site into a central water treatment plant. The amount of excess water will change during operation and depends on the weather and backfill operations.

The mine drainage water between the surface and +750 RL (TBS level) and +720 RL (THG level) is drained through the existing galleries.

16.5 Tailings Management

16.5.1 Overview

The goal of DL is to minimize the amount of tailings material, which has to be permanently stored in the environment. The tailings comprise the waste rock material that had to be mined for the preparation and development of the mine (ramp, ventilation shaft, underground infrastructure etc.) and the residues that were generated from the ROM during mechanical and metallurgical processing.

The tailings management concept of DL is based on three columns:

- Backfill within the mine
- Commercial utilization
- Permanent disposal

To enhance the viability and sustainability of the project and to reduce the environmental impact, the first two mentioned columns are favoured.

The waste rock which has to be mined in order to develop the mine (e.g. main access, ramp, ventilation decline) comprises loose rock masses of microgranite, rhyolite and granite. The tailings generated during the mechanical and metallurgical processes comprise two types. A “quartz-sand” tailing generated during the mechanical processing of the greisen ore within the processing plant and a “leached roasted product” tailing generated as residue from the metallurgical process. The “quartz-sand” tailings represent basically a sharp-edged crushed grit to fine sand (< 0.1 mm to 1.25 mm grainsize) and predominantly consist of quartz (> 80 %) and of subordinate to minor zinnwaldite, topaz, feldspars and clay [***48***]. The “leached roasted product” tailings represent a fine-grained earthy material (0.1 mm to 1 mm grain size) consisting of a mixture of quartz, anhydrite / gypsum, calcium-aluminium silicates, iron oxides, corundum and others [***78***]. “Fines” material from mineral processing is also expected to be generated and could be used either in permanent surface deposition or used in underground backfilling operations. Further test-work is planned to be completed ahead of the next reporting stage.

Based on the project outline of c. 12,011 t/a LHM, about c. 610,000 t/a “quartz sand” tailings and about 310,000 t/a (dry) “leached roasted product” tailings (“**LRP**”) are generated and are available for further utilization.

The following sections summarize the concept for the tailings management.

16.5.2 Waste Rock Material from Mine Development

Some 400,000 t of waste rock including rhyolite, granite porphyry, gneiss and granite is expected to be excavated during first 2 years. The mined-out materials will be further used as building material (e.g. gravel) for forest roads and in the local and regional building industry. If necessary, this material can be temporarily stored in old quarries and used to a later time [170].

The development drifts to the individual mining areas and ore bodies are planned to be mined with-in ore bodies. If additional waste rock has to be mined during active operation, this material will be used for construction purposes (e.g. roadway construction) within the mine or is used as backfill.

16.5.3 Backfill

Backfilling of the mined-out voids serves for a minimisation of material management costs, the prevention of inner and outer subsidence damages, the minimization of mining loss and the minimization of radon entry into the mine and thus enhances the sustainability and profitability of the Zinnwald Lithium Project.

As the technical requirements for backfilling are still under development, the presented estimate is conceptual in nature and based on in-principle assumptions as well as some test-work where available. Precise composition of backfill materials will have to be optimised to suit individual geotechnical conditions in the underground mine generally as well as selected mining methods. This assessment will be part of a renewed bankable feasibility study. In principle, backfilling can be undertaken using coarse development rock materials, leached roast product materials, fine materials as well as non-magnetic quartz sand. Backfilling could be undertaken using hydraulic backfill but also placing barren coarse rock in backfill voids (esp. with AVOCA stope mining).

Production sequence is adjusted to allow backfilling to start effectively immediately after LHM processing commencement. About 310,000 t/a of leached roasted product are available for backfill within the mine. This leached roasted product is then mixed with cement or a mixture of cement and fly ash totalling 20% of total backfill mass. The mixing proportion is selected so that the compressive strength of at least 1 MPa is received after 28 days.

The test work has demonstrated that it is possible to produce suitable backfill material with leached roast product (LRP). Furthermore, necessary strength parameter (1 MPa) can be achieved by both LFA and alternative binders (PREDUR/Cement). Eluate tests have been carried out and the company is expecting feedback on the results from the authorities as this is understood to be a crucial criterion for the approvability. Both strength and eluate behaviour have been assessed and indicate that they meet technical and environmental requirements.

For the permanent backfill it is intended that the chambers are almost completely filled (> 90 %) with self-hardening backfill. The proportion of the used binder should be minimized as much as possible. For the prevention of inner and outer subsidence damages and for the minimization of mining losses, backfill material should have a compressive strength parameter of at least 1 MPa after 28 days.

The LRP is transported underground as return load of the ore haulage. The backfill material will be produced in a mixing plant and pumped by a slurry pump via backfill pipes (DN 150 / DN 125) to the backfill site. Prior to backfilling the chambers will be sealed by a shotcrete reinforced wall. The mixing plant will be constructed in a central location underground. Transport of hardening agents, such as cement and fly ash can be achieved using truck haulage. The individual components (tailings, lignite filter ash, water) will be mixed there to produce a pumpable slurry and transferred to the stope. This backfill station consists of buffer storage, hydraulic power unit slurry pump and a control station.

Table 69: Balance of backfill materials

Subject	Amount/year	Unit
Ø relevant crude ore tonnage mined	880,000	t/a
In-situ Bulk Density crude ore	2.700	t/m³
Volume of rooms	326,000	m³/a
Grade of backfill	90.00	%
Volume of backfill (90%)	293,333	**m³/a**
Density backfill material	2.000	t/m³
Tonnage backfill material	586,667	**t/a**
Available Leached Roast Product (LRP)	310,000	**t/a**
Available Quartz Sand	610,000 (max.)	**t/a**
Available Fines Material	88,000	**t/a**
Available Coarse Rock	75,000	**t/a**

16.5.4 Permanent Disposal

Permanent disposal of materials is an undesired outcome for mined materials, and the priority shall be given to re-utilisation of materials and application of by-products in other industries. However, it is recognised that the ability to realise this ambition is limited, especially in a more rural environment such as the Erzgebirge / Altenberg region.

Key material streams planned to be permanently disposed are:

- Leached Roast Product (LRP) - used as a priority in backfill operations (c. 310,000t / a), as discussed above
- Mineral Processing Slimes, fine quartz / Silica slimes – used in backfill and TSF (c. 88,000t / a)
- Non-Magnetic Quartz Sand Fraction – for sale and placed in TSF (maximum of c. 610,000t / a)

For permanent material storage, the IAA Bielatal is currently considered as a suitable facility. The IAA (Industrielle Absetz Anlage = Industrial Settling Facility) Bielatal was constructed for the storage of tailings material of the Zinnerz Altenberg Mine, which produced tin in the Altenberg area until its closure of operations in 1991, following the re-unification of Germany and dissolution of GDR-state companies. It is estimated that the facility has approximately 18Mm³ of remaining capacity within its current design. The facility was operated as a conventional up-stream slurry dam design and closed and re-habilitated in the early 2000s. Currently, the facility is owned by the state-owned care-taker entity of former East German mining assets, the Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH (LMBV) with whom ZLP is in commercial discussions about the asset.

Whilst the project does not foresee the deposition of slurry tailings, the facility will provide suitable area for the construction of a dry stack tailings storage facility, in line with current industry best practise. Material for deposition will be likely the quartz sand material combined with some of the fine fraction material from the de-sliming process. Previous concept studies by G.E.O.S. have assessed the geotechnical situation of the existing TSF and included operational strategies to construct a dry stack tailings facility on the southern part of the current surface of the IAA, maintaining appropriate safety margins towards the embankment. In any case the stability of IAA Bielatal has yet to be evaluated.

16.6 Mining Equipment

16.6.1 Production Parameters

The mining fleet is designed to handle up to 1 Mt of material, out of which

- 33% comes from development
- 67% from stoping

Considering a maximum production of 1,000.000 t/a and 250 working days per year (five working days per week), the average daily extraction rate amounts to 4,000 t. Based on 4,500 effective operating hours (250 days x 20 hours), an extraction rate of 200 t/h is required.

16.6.2 Mining Fleet

According to corporate target Based on preliminary analysis the fleet would contain following equipment.

Table 70: Mining fleet

Mobile Equipment	Number
Development Jumbo	3
Drilling Rig L/H	3
Loader	4
Dump Truck	5
Shotcrete Unit	2
Auxiliary	2
Rockbolter	2
Personnel carriers etc	10
Total	31

16.6.3 Mine Personnel

The mine personnel plan summarizes 91 employees (see **Table *71***)

Table 71: Mine personnel estimation

Title / Qualification	Personnel / shift	Number of shifts	Personnel factor	Total personnel
Head of mine	1	1	1.00	1
Mining engineer	2	1	1.00	2
Mining geologist	2	1	1.00	2
Mine surveyor	1	1	1.00	1
Clerk	1	1	1.00	1
Foreman	2	3	1.00	6
Driller (L/H, Jumbo)	8	3	1.00	24
LHD operator	4	3	1.00	12
Truck driver	5	3	1.00	15
Rock support crew	2	3	1.00	6
Mechanic, electrician	4	3	1.00	12
Blaster	4	2	1.00	8
Auxiliary	2	3	1.00	6
Total	38			**96**

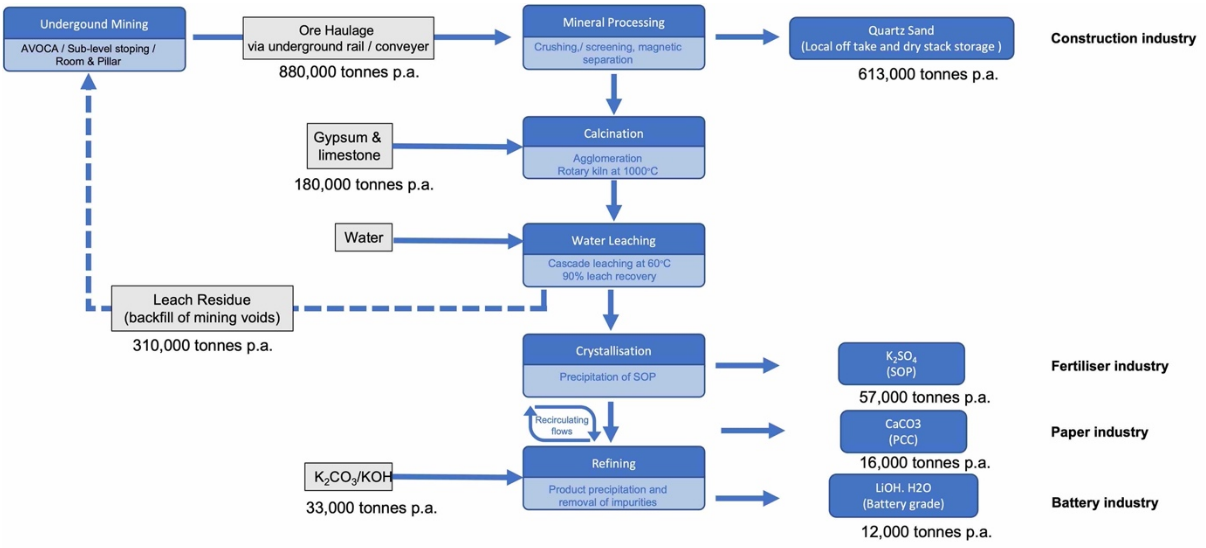
17 Recovery Methods

17.1 Summary Flowsheet

During the FS different flowsheet options were investigated for the recovery of lithium from the zinnwaldite greisen ore. Following test work, which is discussed in Section 13, and economic evaluations, the flowsheet selected for the FS is based on calcium sulfate – calcium carbonate roasting.

The Zinnwald Lithium Process Plant is designed to process 880.000 dmt/a of ROM feed, at an average grade of 0.30 wt.% Li, to produce a minimum of c. 12,000 t/a of battery grade LiOH*H_2O (equivalent to 10,530 t/a LCE) and 56,887 t/a of K_2SO_4 and about 16,000 t/a PCC (precipitated calcium carbonate) by-products. The potassium sulfate produced is expected to be sold as a sulfate of potash (SOP) in technical grade and as fertilizer. A simplified illustration of the flowsheet with tonnages is shown in **Figure *100***.

Figure 100: Flowsheet for the Project

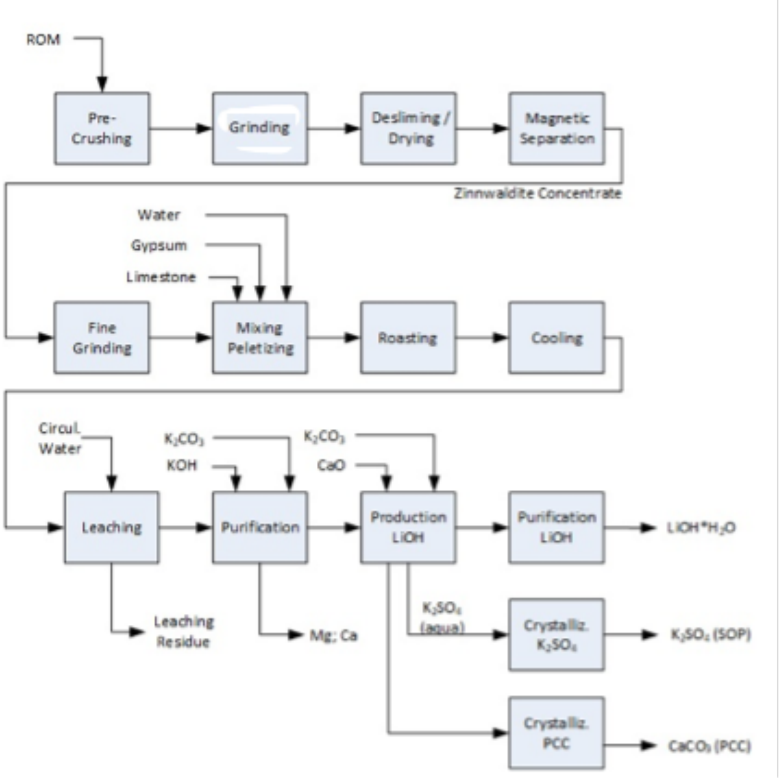


The flowsheet consists of the following major unit processes:

- Comminution followed by beneficiation using dry magnetic separation to recover a lithium mica concentrate
- Calcium sulfate / carbonate roasting, which converts the lithium and potassium to water soluble Li_2SO_4 and K_2SO_4 in the presence of anhydrite or gypsum and limestone
- A hydrometallurgical section where the roasted product is leached in water to form an impure Li_2SO_4 aqueous pregnant leach solution (PLS). Impurities are then removed from the PLS using precipitation and ion exchange prior to the precipitation of battery grade LHM.
- Potassium sulfate is recovered from the mother liquor using crystallization and selective dissolution.
- Precipitated $CaCO_3$ (PCC) is precipitated from the PLS

A summary illustration of the flowsheet is displayed in **Figure *101***

Figure 101: **Summary flowsheet of the processing and extraction process**



17.2 Process Design Criteria

The beneficiation plant will operate 24 h/d, using three 8 h shifts per day from Monday to Friday, 260 d/a. The extraction plant is a continuous 24 h/d operation, using three 8 h shifts per day, 7 days per week, 365 d/a. Design plant availabilities are 96 % (6,000 h/a) for the beneficiation plant and 91 % (8,000 h/a) for the extraction plant.

The key Process Design Criteria (PDC) were used in developing the mass balance that forms the basis for the sizing of process plant equipment. The key elements were derived from the metallurgical test work program (Section 13). Selected aspects of the PDC are summarized in [***91***].

Table 72: **Process Design Criteria Summary**

Description	Units	Nominal Case	Design Case (120 %)
Overall Lithium Recovery	%	75.4	75.4
Beneficiation			
ROM feed rate (dry)	t/h	108.0	130.0
ROM feed grade (dry)	wt.% Li	0.31	0.33
Mass recovery to concentrate	wt. %	23.3	25.0
Lithium recovery to concentrate	wt.%	92.0	92.0
Extraction			
Pyrometallurgy (Feed rate kiln mixture)	t/h	41.0	49.2
Hydrometallurgy (leach liquor clarified)	t/h	42.6	42.6
Leach recovery from Calcine (Lithium)	wt.%	90.0	90.0
LiOH precipitation recovery	wt.%	93.0	95.0
Target product grade LiOH	wt.%	> 99.95	> 99.95
Target product grade SOP	wt.%	> 99.5	> 99.5
Target LiOH production	t/a	12,000	14,400

17.3 Beneficiation Circuit Process Description

This chapter provides the process description corresponding to the FS process flow diagrams (PFDs) produced for the processing plant.

17.3.1 Pre-Crushing

The run of mine (ROM) material is fed into the processing plant by dump trucks. The material has a maximum particle size of 500 mm and a maximum moisture content of 6 wt.%. The ore is fed to the feed hopper which has a storage capacity of approximately 60 t and thus can store up to 2 truckloads to ensure a continuous material flow into the plant. During dumping of the ROM into the hopper, fine water mist is sprayed onto the material to prevent excessive dust generation.

The material is discharged from the hopper by a variable speed vibrating feeder, which continuously feeds the raw material at a controlled rate via a scalping screen to the jaw crusher. The jaw crusher is equipped with a hydraulic jack hammer to break large rocks that block the inlet of the crusher. The area is monitored remotely and controlled from the control room.

The fine material from the scalping screen and the crushed product from the jaw crusher are collected by a belt conveyor and transferred to a bucket elevator, which elevates the material to the crushing circuit vibrating screen.

The screen separates the material into fines below 25 mm particle size and coarse plus 25 mm. The coarse material is fed to the bucket elevator, which feeds the feed hopper of the cone crusher. The feed hopper is equipped with load cells to monitor the material level in the bin and material continuously feeds the cone crusher by a vibrating feeder which is controlled by the plant operator. The crushed material from both crushing stages is circulated back to the screen by belt conveyor and bucket elevator. A belt conveyor collects the crushed materials from the first and the second comminution step, this belt is equipped with a magnetic separator to remove tramp metal.

The fine screen product is transferred via a belt conveyor and bucket elevator to HPGR circuit.

17.3.2 HPGR Grinding and Screening

The material (H_2O c. 5%) is fed onto two parallel screens. The belt conveyor is equipped with two belt scales, one to measure the material flow from the crushing and a second scale that measures screen feed that also includes the high-pressure grinding roll (HPGR) product. A magnet is used to remove tramp metal from the HPGR feed.

Each screen is equipped with a vibrating feeder to ensure proper material distribution over the complete screen width. The double-deck screens separate the material flow into 3 fractions – the coarse fraction (plus 2 mm) is returned to the circuit, the middle fraction (between 0.74 and 2 mm) and the fines fraction (below 0.74 mm).

The >0.74 mm fraction is collected from both screens by a belt conveyor and fed to the dry magnetic separation via a bucket elevator and belt conveyor. The < 0.74 mm fines are collected from each screen with belt conveyors and fed to the desliming circuit via a bucket elevator and belt conveyor. The belt conveyor is equipped with a belt scale.

The HPGR feed hopper is equipped with load cells to monitor the level in the hopper and the speed of the HPGR is controlled to ensure a constant level in the hopper.

17.3.3 Desliming

The < 0.74 mm material is fed into hydrocyclones were the clay minerals are removed. The feed is expected to consist of up to 8% of clay minerals.

The underflow is fed to drying and cooling circuit. The overflow is partly fed to Area 300 in the hydrometallurgical plant and mixed with the leach residue, and further on into the underground workings as hardening backfill. The remainder is mixed with Quartz sand and stored in the TSF.

17.3.4 Drying and Cooling

The drying section is continuously fed via a belt conveyor and bucket elevator, which feeds the rotary dryer. In addition, the belt conveyor is equipped with belt scale to monitor the mass flow into the dryer.
The material is dried with hot air produced by a hot gas generator. The temperature of the hot drying air is controlled by the exhaust air temperature of the dryer. To ensure a continuous mate-rial discharge, a constant moisture content of 0.2 wt.% and an exhaust air temperature of 105°C are required.

After drying, the dried material is fed to a rotary cooler to cool the material below 60°C. This is required to ensure good performance of the downstream magnetic separators. The rotary cooler is operated with ambient air. To save energy, this pre-heated cooling air is recycled to the dryer and used as drying air.
An exhaust air fan pulls the hot air from the dryer and the corresponding bag house filter, where dust is collected. The cleaned exhaust air is emitted via a stack into the environment. The collected dust is recycled into the processing plant by using screw feeder and rotary valve.

All fans are equipped with sound absorbers to reduce the sound emissions in the plant and its surroundings.

17.3.5 Magnetic Separation

The magnetic separation circuit is fed by belt conveyor which feeds the material onto a drag conveyor. This conveyor distributes the complete material flow equally to 9 magnetic separator lines, each line consists of two magnetic separator units. The drag conveyor is equipped with nine slide gates so that each line can be isolated. Below the slide gates, every line has a feed hopper which serves as a buffer for the magnetic separators and enables the material distribution to the several lines.

The magnetic separators consist of three stages. The first stage includes magnetic drum separators which remove tramp metal. The second and third stages consist of high-intensity magnetic drums.
The throughput of the separators is adjusted by vibrating feeders. Depending on the total plant throughput and the settings of the crushing and grinding circuits, the total mass flow to the magnetic separation sections may vary. In this case, the last line fed by the drag conveyor will get an increasing or decreasing amount from the feed hopper.

The magnetic product from the magnetic separator section is collected by drag conveyors and fed to the product storage section. The non-magnetic tailings from the magnetic separator section is collected by drag conveyors and fed to the tailing storage section.

17.3.6 Concentrate and Tailings Storage and Loading

The plant produces three products, clays, lithium mica concentrate and quartz sand. The clays are pumped to hydrometallurgical plant, the quartz sand is conveyed to temporary storage facility in IAA Bielatal, and Zinnwaldite concentrate is stored into silos feeding the concentrate grinding circuit in pyrometallurgical plant

17.3.7 Dedusting System

A bag house filter is provided to collect dust from within the processing plant. The dust is collected from all de-dusting points installed at each equipment and transferred via a piping network to the bag house. An exhaust air fan provides the required air flow through the system and exhausts the cleaned air via a stack into the environment.

To de-dust the magnetic separators, a small baghouse filter is provided. This separate filter is used to adjust the air flow from the magnetic separator. There, the air flow is lower compared to the main dust collection system and hence enables a more accurate and efficient operation of the magnetic separators.
The collected dust from all filters, as well as the dryer de-dusting system, is recycled to the pro-cessing plant by a trough chain conveyor.

All exhaust air fans are equipped with sound absorbers to reduce noise in the plant and its surroundings.

17.4 Extraction and Precipitation

The objective of the extraction circuit is to produce battery grade lithium hydroxide (LiOH) and potassium sulfate (SOP, K_2SO_4) and calcium carbonate (PCC, $CaCO_3$) as by-products. The Li and K are extracted from the lithium mica (zinnwaldite) concentrate by roasting with anhydrite ($CaSO_4$) and limestone ($CaCO_3$) followed by water leaching of sulfates. The dissolved impurities (Ca, Mg, Na, Cs and Rb) are removed in the course of the process and K is recovered as a sulfate salt by-product.

17.4.1 Pyrometallurgy

17.4.1.1 Grinding of Zinnwaldite Concentrate

Prior to the thermal processing of zinnwaldite, the concentrate is ground to a coarse powder (< 315 µm). This is done to facilitate the mixing with additives and enables the mixed powder to be granulated. Test work showed that the best option for grinding the lamellar zinnwaldite concentrate is by a vertical roller mill. The 1.8 m diameter vertical roller mill selected for this application includes a 60,000 m^3/h air classifier.

17.4.1.2 Pelletizing

The ground zinnwaldite concentrate, together with the additives (limestone, flue-gas desulfurization (FGD)-gypsum), is fed to two separate mixing and pelletizing lines.. In this process, barren solution is recycled from the potassium sulfate crystallization circuit and used as binding agent. The potassium sulfate content in this solution enhances the strength of the undried green pellets.

17.4.1.3 Drying, Roasting and Cooling

The pelletized feed is roasted at a temperature of 950 °C to 1,050 °C for 30 minutes using a direct fired rotary kiln. The green pellets are screened and dried in a fluidized bed dryer prior to feeding the roaster. With pre-drying the roasting kiln can be sized smaller and the energy efficiency of the process is improved.
To minimize energy consumption, hot air for the fluidized bed dryer is recycled from the dust-free clean exhaust air of the rotary kiln. Also, the colder dryer outlet exhaust air is used for the cooling of the rotary kiln exhaust air. Moreover, the dust free waste exhaust air, which is not re-cycled to the fluidized bed dryer, feeds a gas / steam heat exchanger to produce steam for downstream processes.

Entrained dust and very fine pellets discharged from the dryer with the exhaust air are recovered via two cyclones and recirculated to the pelletizer feed mixer. The exhaust air is directed to a dry scrubber which utilizes an absorbent as a neutralizing agent. The adsorbent is filtered and partial-ly recirculated to the reactor. The remaining portion is transported to a separate silo for disposal or is recycled to the pelletizing circuit.

The rotary roasting kiln has a natural gas burner which is operated at a design thermal power. Ambient air is used to cool the kiln out-let product in a rotary cooler to a temperature of 55 °C.

The cooled calcined pellets are weighed and transferred for further treatment in the hydrometallurgical plant by conveyor belt.

The block diagram in ***Figure 102*** highlights the main processing steps of the roasting circuit. ***Figure 104*** and ***Figure*** 105 show the top view and the layout of the roasting plant based on the FS basic engineering [208].

Figure 102: Block flow diagram of the roasting process

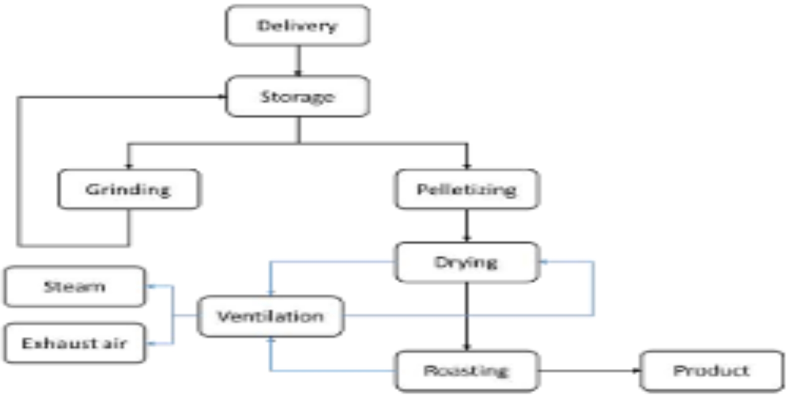


Figure 103: Plan view of the roasting plant

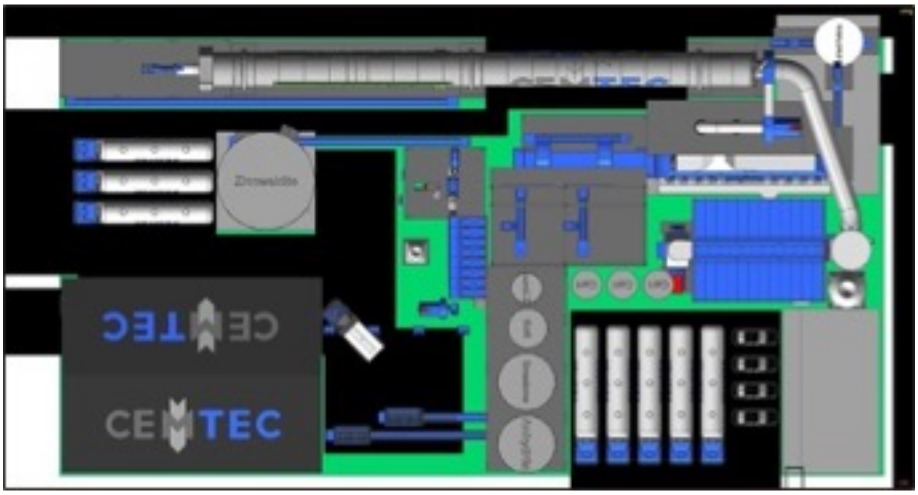


Figure 104: Layout of the roasting plant (View North to South with open buildings)

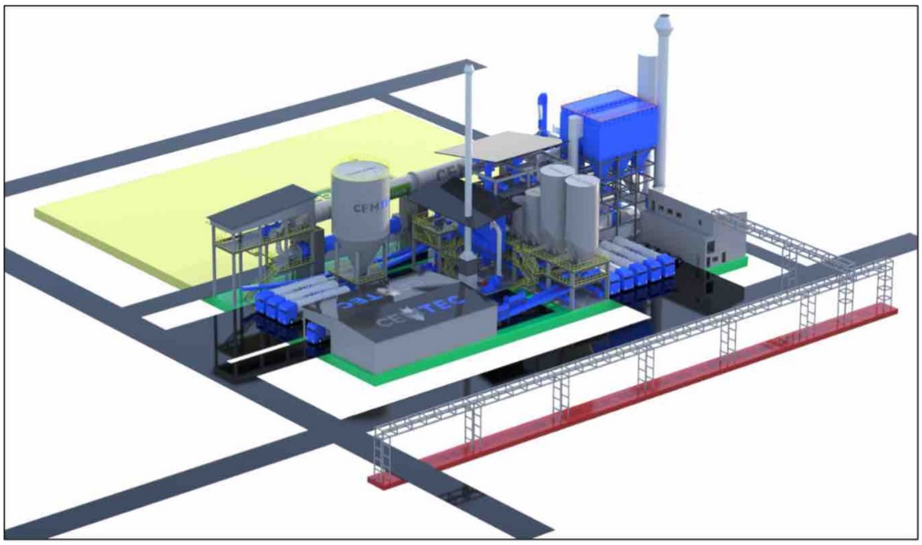
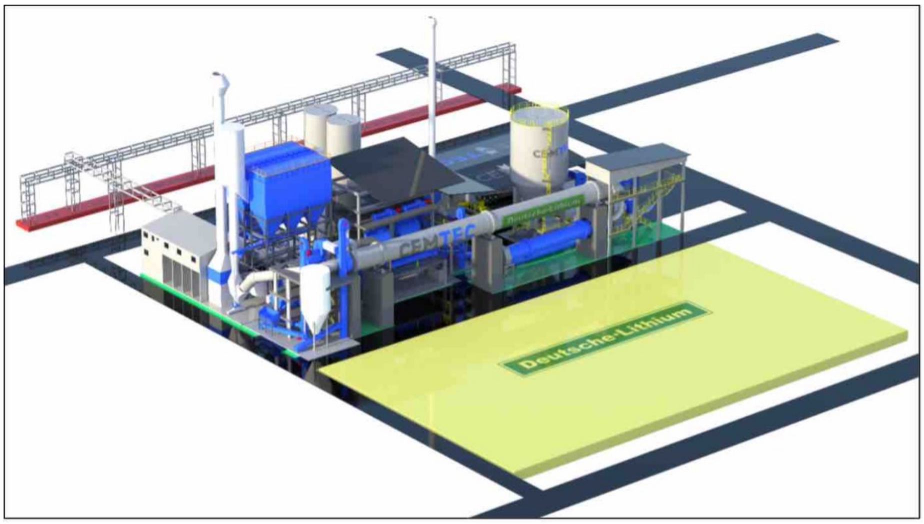


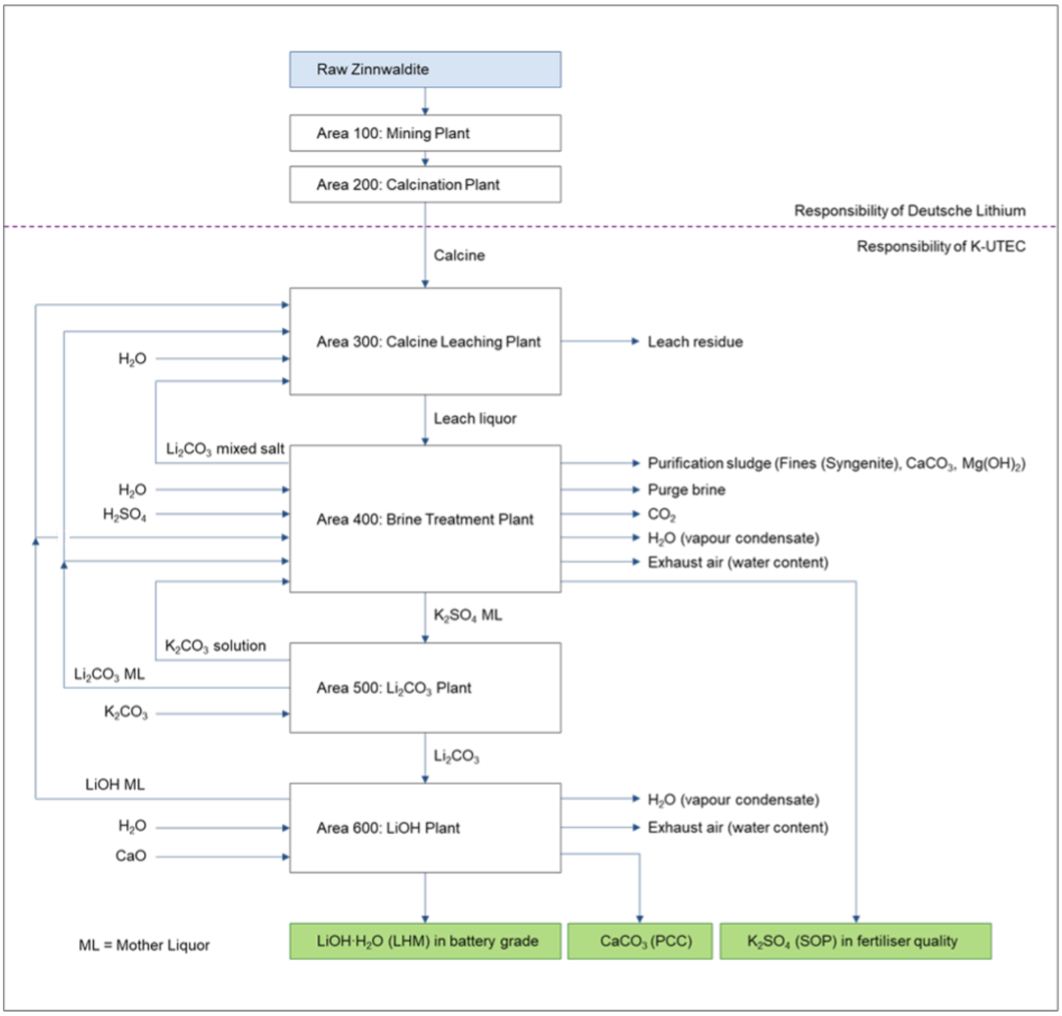
Figure 105: **Layout of the roasting plant (South to North with open buildings)**



17.4.2 Hydrometallurgy

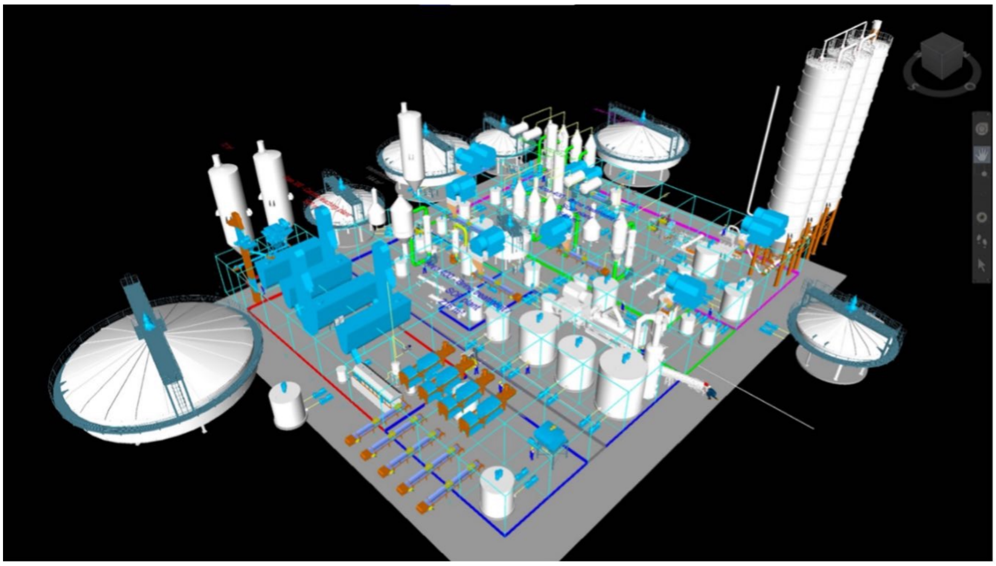
The hydrometallurgical process has been designed by K-UTEC based on the results of the test work and their own experience. Based on this process flowsheet, shown in **Figure *106*** below, K-UTEC has prepared the extended process design to support a study with an accuracy of ±20 % for areas 300, 400, 500 and 600 ***[96]***.

Figure 106: **Simplified flowsheet of the zinnwaldite process of Deutsche Lithium**



The proposed layout of the Hydrometallurgical plant is shown in **Figure *107*** below

Figure 107: Layout of the Hydromet Plant



17.4.2.1 Milling of Roasted Product

The roasted product, which is stored in two 120 t bins, is conveyed to a mill (e.g. a hammer mill) in order to reduce the particle size of this material to less than 1 mm.

17.4.2.2 Leaching and Residual Removal

The milled roasted product is fed to the leaching reactor via a hopper and conveyor system. During leaching, lithium sulfate (Li_2SO_4), along with water soluble metal-sulfate impurities of magnesium, calcium, rubidium, caesium, sodium, and potassium, is transferred from the roasted product slurry into solution. The leached slurry product is pumped to the leach thickener, the overflow from which is transferred to the purification circuit while the thickener underflow slurry is filtered, washed and stored. The recovered filter wash water is re-used in the leach reactor.

17.4.2.3 Purification

During the purification process impurities from mother liquor are removed by the following steps.
Lithium carbonate and lithium hydroxide mother liquor are added to the pre-clarified leach liquor to convert metal-sulfate to poorly soluble metal-carbonates and dissolve magnesium sulphate into precipitated magnesium hydroxide while producing lithium sulfate.

The product from the purification reactors is pumped to the filter feed tank before being filtered in plate and frame filters.

After filtration the purified solution is pumped through an ion exchange column system to remove additional calcium and magnesium. Finally, the pH value is adjusted using sulphuric acid.

17.4.2.4 Fractional Salt Precipitation and Dissolution

The SOP crystallization uses a multiple-stage evaporation unit with mechanical vapour compression to crystallise the technical grade K_2SO_4 and lithium glaserite $LiKSO_4$ separately. This process step is also a purification measure for the later produced lithium salts as the still present impurities remain essentially dissolved. The entire lithium sulfate dissolves by lithium glaserite (LiKSO4) fractional dissolution in water, and potassium sulfate remains partially crystalized and is separated. The lithium sulfate solution is transported to lithium carbonate intermediate production

17.4.2.5 Lithium Salt formation

In the next step, the raw Li_2CO_3 intermediate is precipitated from the mother liquor of $LiKSO_4$ decomposition by the addition of K_2CO_3 solution under the production of dissolved potassium sulphate. The precipitated lithium carbonate undergoes a washing step. In the next area, CaO is used to convert the resulting Li_2CO_3 to LiOH according to the following equations

$$CaO\ (s) + H_2O\ (l) \rightarrow Ca(OH)_2\ (s)$$
$$Li_2CO_3\ (aq) + Ca(OH)_2\ (s) \rightarrow CaCO_3\ (s) + 2\ LiOH\ (aq)$$

The obtained $CaCO_3$ is washed to reduce the Li losses and then refined to the PCC product, while the LiOH solution is further processed to $LiOH \cdot H_2O$.

17.4.3 Water Services

Water services include:

- Process water: Used to prevent excessive dust generation before pre-crushing of the ROM and for pelletizing
- Potable water: Used for sanitary facilities
- Raw water: Used for leaching of roasted material
- Filtered water: Used to dissolve SOP in the process
- Demineralized water (via reverse osmosis and ion exchange / condensate cooling): Used for LiF washing
- Cooling water: Used for cooling crystallization of SOP and for cooling of reactor vessels of KF manufacturing

17.4.4 Other Services

Other services include:

- Natural gas: Supplied to the plant via a main pipeline
- Electrical power supply: From the local power grid. (back-up with emergency power supply system)
- Compressed air: Produced by a compressor
- Steam: Produced by a natural gas fired steam boiler package

17.5 Equipment Selection

Major equipment selected for the PEA was undertaken via budgetary enquiries to multiple vendors. Scope descriptions and process data sheets were prepared for each equipment package to allow budgetary quotation preparation by vendors. These budget quotations were technically and commercially evaluated in order to determine the suitable selection of equipment for the Project.

18 Project Infrastructure

The Zinnwald project comprises several industrial modules each of which have specific requirements to local infrastructure, space and proximity to other parts of the process. Aligned with the conceptual nature of this technical report, the location is focussed on the geographic area of the Zinnwald / Altenberg area for all facilities. However, as required for on-going development of technical planning and permitting the project retains some optionality with regard to the precise location of certain facilities.

The considerations presented here will reflect the current understanding and expectation of the company. It has been the priority of the company to align the project goals with the concerns and needs of other stakeholders and minimise the potential impact of the operation on the local environment, businesses, and residents. By removing the need to transport large volumes of material via roads of the Altenberg and Freiberg region (as was considered in previous technical reports), the expected impact of the operation on the environment and local communities can be reduced significantly.

During further analysis on the project is has become clear that the advantages of locating the downstream processing sites of the operation at an existing remote industrial site in the region are outweighed by the implications of moving significant volumes of material between the industrial site and the mechanical processing facilities that are located as close as possible to the mine.

18.1 Infrastructure requirements of project

The processing facilities require good access by road and, potentially, rail to transport both products and reagents to and from the facilities. Additionally, energy and water utilities will need to be available at site with sufficient capacity. On-going studies are reviewing the potential of energy recouperation, efficiency increases and energy conservation options across all processing stages. Further engineering work will include such opportunities, however they are currently not included in the numbers presented below. A high-level estimate of electricity requirements is presented below in **Table *73***:

Table 73: Estimate of Electricity requirements

Facility	Est. Annual Power Consumption (MWh)	Electrical Line Capacity (MW)
Mining	17,500	4.0
Mineral Processing	13,900	4.0
Lithium Activation	19,000	4.5
Lithium Fabrication	87,500	20.0
Total	**137,900**	**32.5**

Natural gas supply is required for processes around calcination as well as phase change processes in the lithium fabrication units. The current estimate for required supply of natural gas is presented in **Table *74*** below:

Table 74: Estimate of natural gas requirements

Facility	Est. Annual Gas Consumption (MWh)	Natural Gas Line Capacity (MW)
Mining		
Mineral Processing	35,800	9.0
Lithium Activation	152,000	35.0
Lithium Fabrication	60,000	13.0
Total	**247,800**	**57.0**

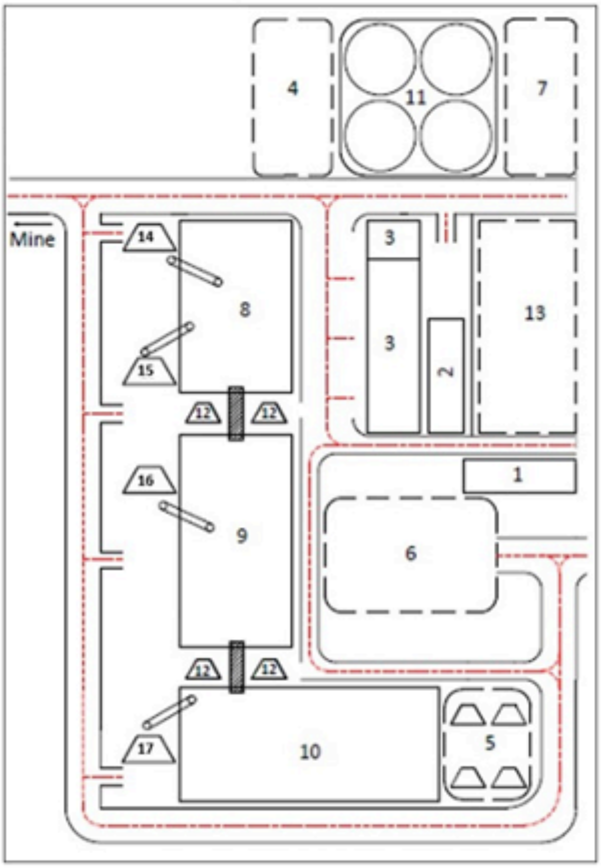
Water is used on the project in several processing stages for example in mineral separation, dissolution / evaporation or precipitation processes. As a precious resource, every effort is made to optimise water recirculation and process water recovery. Further work on this will be included in upcoming technical reports.

The total area requirement for facilities is detailed below in **Figure *108***. These estimates are based on engineering concepts, manufacturer estimates or (if available) basic engineering documents completed by the company. Area requirements could differ based on the final selected site location.

18.2 Conceptual site layout

A conceptual layout of a site containing all process units is presented in illustration below in **Figure *108***:

Figure 108: Idealised layout sketch



No.	Unit	Type	Area (m²)
1	Administration building	Floor	1,300
2	Change house / social facilities	Floor	1,300
3	Workshop and warehouse	Floor	4,000
4	Mining supplies storage yard	Area	4,000
5	End product storage	Area	3,000
6	Processing materials storage	Area	6,500
7	Utilities (natural gas / water / electricity)	Area	3,500
8	Minerals Processing	Area	6,400
9	Pyrometallurgical processing	Area	8,000
10	Hydrometallurgical processing	Area	10,000
11	Water treatment	Area	8,000
12	Intermediate products storages	Area	4,000
13	Parking	Area	7,000
14	ROM / Pre crushed ore storage	Area	2,000
15	Quartz Sand storage	Area	2,000
16	Gypsum storage	Area	1,000
17	LRP storage and loading	Area	2,000
	Site roads and unconstructed	*Area*	*55,000*
Total estimate			**129,000**

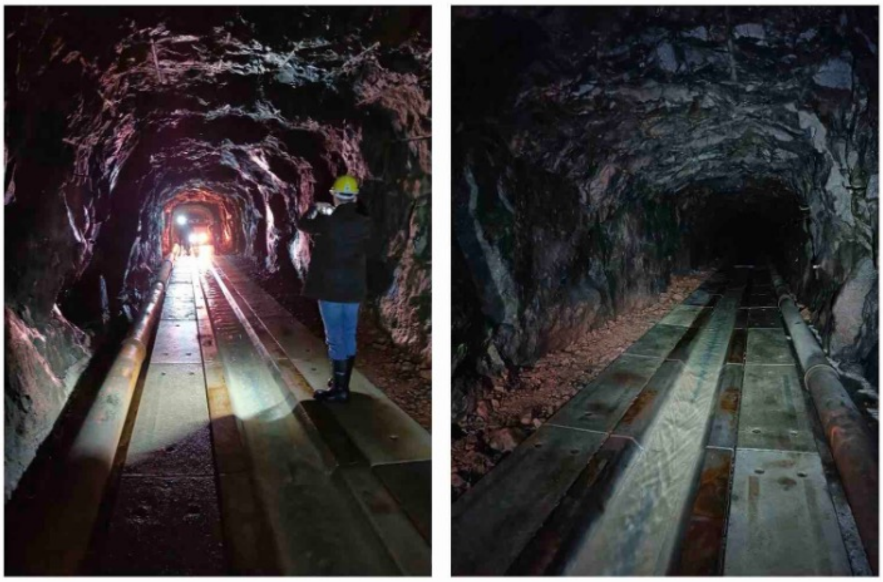
The layout sketch is conceptual only and will be improved with increasing available engineering detail and arrangement to suit a selected site location. These estimates have been used in the identification of a suitable site location and arrangement. The company is already working with local partners for several possible options. Two of these options are presented at a high level below:

18.2.1 Site Option A – Altenberg / Zinnwald / Bärenstein

The site location near Bärenstein has some key advantages, namely:

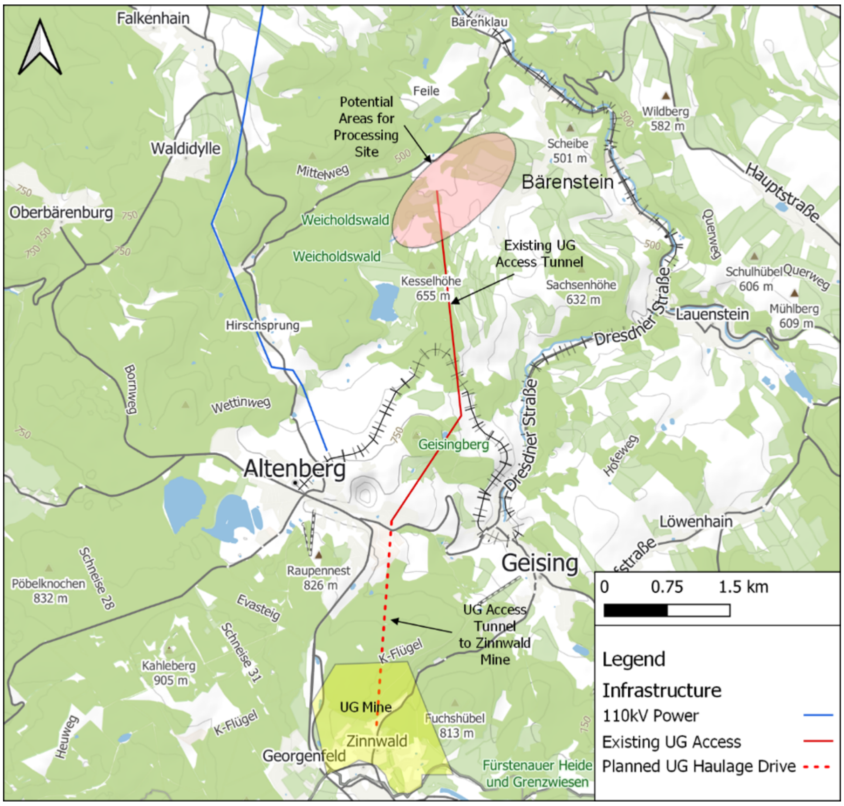
- Mine access through existing de-watering adit of the Zinnerz Altenberg mine (ceased operations in 1991, refurbished in 2020, total useable length 4 km, with sufficient cross section).
- Quarry site with intermittent operation.
- Existing tailings storage facility from the former Zinnerz Altenberg mine with remaining capacity.
- Nearby existing rail connection with connection to Dresden

Figure 109: **Photos from the de-watering adit of the former Zinnerz Altenberg Mine**



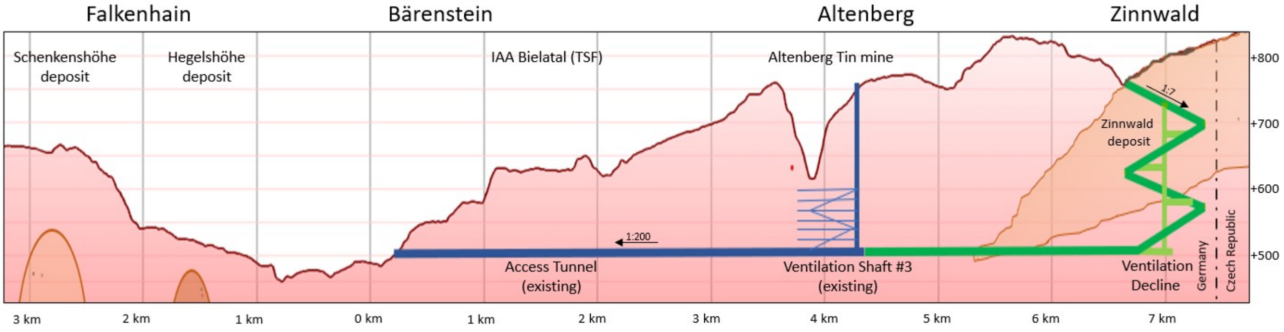
Some of these existing assets are considered to be used for the project. Road access is easily available by regional (federal B170 trunk road to Altenberg), highway A17/E55 from the east and sealed local roads to each site. See an overview of existing area for the Bärenstein option in **Figure *110*** below.

Figure 110: **Local Map of Barenstein area with potential site areas**



Nearest 110kV step down transformer station is located c. 4 km away in Altenberg. Regionally, a well-established natural gas distribution network is present, with major supply routes leading to the Czech Republic.

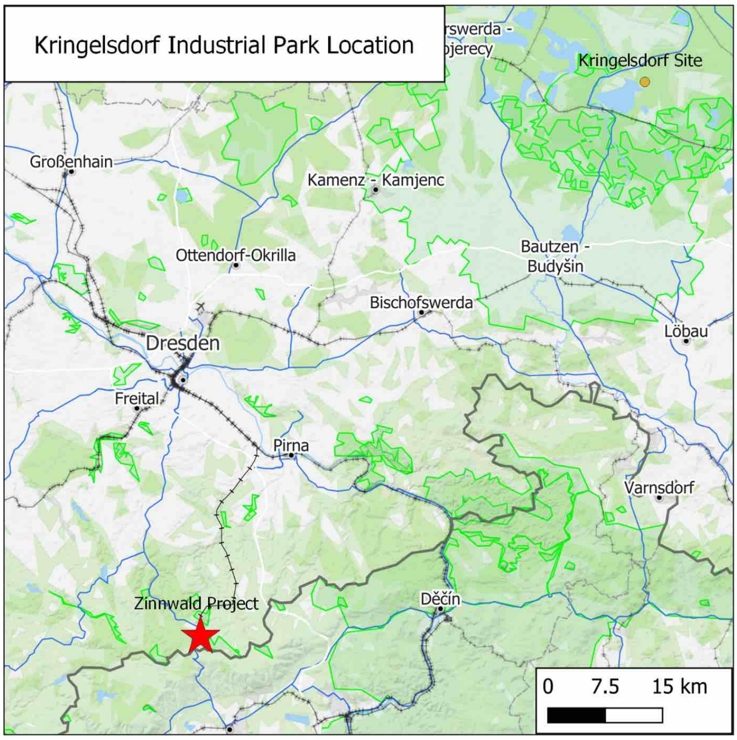
Figure 111: **Long sectional map of area**



18.2.2 Site Option B – Industriegelände Kringelsdorf

A further option under consideration is to locate a part of the processing facilities at an industrial site Kringelsdorf in near by Boxberg / Oberlausitz , close to a lignite open-pit and coal fired power station operated by LEAG. The site is approximately 150 km distance by road and accessible by sealed roads. As an established industrial site, power, gas and other services are already available at site. The site has a rail line within 1km, is itself however not connected to the rail network.

Figure 112: **Map of Kringelsdorf industrial park**



19 Market Studies and Contracts

19.1 Lithium – General background on the Lithium industry

19.1.1 Lithium - Background

Lithium is the lightest metal in the periodic table with the symbol Li and atomic number 3. It is a soft, silver-white metal belonging to the alkali metal group. It has a high electrochemical potential. Under standard conditions, it is the least dense solid element. Like all alkali metals, lithium is highly reactive and flammable and does not exist by itself in nature. This combination of lightness and high reactivity make it uniquely suited for use in batteries, especially those in weight-sensitive applications such as EVs and mobile electronics.

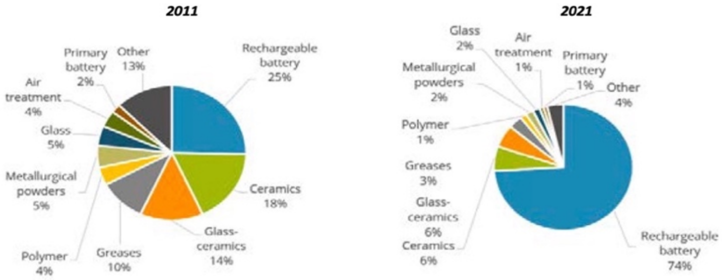
Lithium has been listed as one of the critical Raw Material elements by both the European Union and the United States Department of Energy for the achievement of zero carbon targets, based largely on its importance in rechargeable batteries. Lithium-ion batteries form most of the long-term investment by the major battery and car manufacturers due to its key characteristics:

- lightest metal
- highest energy density by weight
- high conductivity and ability to store electrons

19.1.2 Usage of Lithium

Until fairly recently, the vast majority of lithium globally was used in conventional industrial applications unconnected with the Lithium battery sector. However, in recent years this has changed dramatically as Lithium Batteries, especially in the Electrical Vehicle (EV) sector have driven exponential growth. Roskill estimated 23.5% ***[175*]** annual growth over the last decade solely in the rechargeable battery sector, with **Figure *113*** showing the change in usages over the period ***[175].***

Figure 113: Lithium Usage 2011 to 2021



Source: Roskill *Source: Roskill*

19.1.3 Lithium Source Types and Methods of Extraction

Lithium is not a commodity like other minerals, because there are a number of different lithium compounds traded with different specifications. There are two main forms of lithium compound that are used in lithium-ion batteries for EVs - lithium carbonate and lithium hydroxide. Historically, these Lithium compounds have come from one of two sources, either from metallic brines or from hard-rock mining of spodumene ores. It important to note that in most ways, Lithium extraction and production is a Specialty Chemicals business rather than a conventional mining one, and it is that chemicals expertise plays an increasingly important in project success, especially for projects that are designed to produce battery grade lithium compounds rather than “semi products” such as lithium concentrate or lithium chloride. Qualification of battery grade lithium compounds for use in battery cathode materials can take a long time and is often specific to individual battery manufacturers/cathode makers.

Brines

Brine is pumped from subsurface reservoirs to surface ponds. The power of the sun evaporates excess water and concentrates the lithium content of the brine. Once the lithium content reaches six per cent., the liquor is removed and processed into lithium chemicals. This processing, initially into lithium carbonate, generally occurs on site. Typically, the timetable to produce a saleable lithium product is in the range of 2 – 3 years, depending on prevailing weather conditions.

Extracting lithium from brines via evaporation in large ponds has been the primary source of Lithium Carbonate production in the last decade and has been dominated by the main producers SQM and Albermarle. It has largely come from the so-called “Lithium Triangle” of Chile, Argentina and Bolivia, though no commercial production currently occurs in Bolivia.

New companies are currently experimenting with Direct Lithium Extraction (DLE) technologies in an attempt to speed up the extraction process and utilise lower grade brines. Whilst this has been shown to work at a laboratory scale, large scale industrial extraction has yet to be demonstrated. Where DLE has been used in commercially, it has typically been following a pre-concentration step and using higher-grade brines.

Hard-rock

Hard rock mining has a more traditional extraction process. Spodumene, a lithium mineral, is mined and crushed to form a concentrate. This mineral concentrate is then sold to chemical companies which use the feedstock to produce lithium chemicals, or to glass and ceramics producers for use as an additive. To date, the majority of this mined spodumene ore has come from Australia and shipped to China as a low grade 4-6% spodumene concentrate, where it is converted to downstream lithium products. This supply source from Australia has been a primary driver behind China becoming the largest producer of lithium chemicals.

Zinnwald will be a hard-rock producer of lithium, albeit from a mica-based form of pegmatite. However, Zinnwald will not be producing a low-grade concentrate, it will incorporate the full processing route from ore to battery grade end product.

19.1.4 Cost Curve vs Sustainability

Historically, brine producers have enjoyed a significant advantage given the fact that there is no mining and crushing involved and their location in arid regions enables them to utilize evaporative drying. This allows them to occupy the bottom quartile of the cost curve. Mineral producers, on the other hand, have additional costs associated with both hard rock mining and processing and usually do not benefit from the integration of the chemical conversion stage. They also often have extensive transport costs due to the low-grade concentrate and distances covered.

From a Sustainability point of view, brines benefit from a low energy intensity for production and the technology involved is conventional and well established. But it has three main ESG downsides – its water intensity is high usage and typically in areas where sources of water are scarce; it also takes up a very large physical footprint during production and then disposal of waste tailings; and these sites are typically a long way from the end market for its product with the resultant transport costs and CO2 emissions.

From a Sustainability point of view, spodumenes benefit from a relatively low water intensity in their production process and the extraction technology is well established. However, it also has three main ESG downsides – the physical footprint of the sites is usually large and often open-pit; the energy required to process a spodumene concentrate is high; and the transport distances are usually extremely large raising the overall CO2 footprint (especially given that they are effectively transporting 94% waste product). As noted above, the majority of spodumene is currently mined in Australia, then shipped in a high volume, low-grade concentrate all the way to China, where it is then processed by coal-fired power stations.

19.1.5 Lithium-Ion Batteries

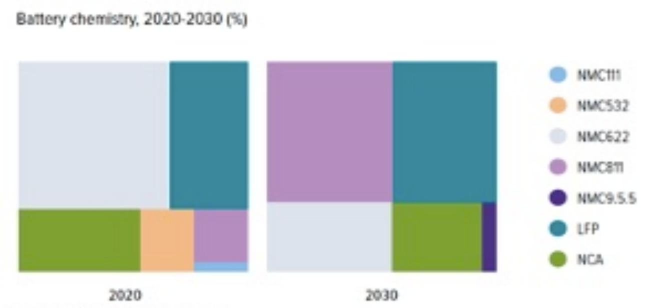
The basic structure of a lithium battery involves a positive cathode, negative anode, and an electrolyte and/or separator of some type. The separator passes ion charges from one side of the battery to the other. When a battery is charging, lithium ions travel from the positive cathode to the negative anode. During the discharge, ions flow from the anode to the cathode. The electrolyte is a medium that helps the ions flow freely from one electrode (cathode) to the other while the separator blocks electrons from traveling freely through the device.

Whilst the material used in the anode is fairly consistent, usually graphite, which is readily available. The cathode can be made using different formulations. The make-up of the cathode has a direct impact on different performance attributes. Different kinds of lithium-ion batteries offer different features, with trade-offs between specific power, specific energy, safety, lifespan, cost, and performance.

However, in all the main types listed below, the Lithium content remains at around 11% of the total metals used in the battery. Thus, whilst the cost of lithium may be volatile and rising, it does not dominate the total cost of a battery. The main acronyms for each battery type are generally referred to by the Cathode materials, as follows. **Figure *114*** shows a forecast on the evolution of market demand for each type of chemistry ***[176]:***

- LCO (Lithium Cobalt Oxide) used mainly for portable electronics. The main drawback is the amount of cobalt required, so rarely used in EV batteries
- NCA (Nickel Cobalt Aluminium) – this was adopted by Tesla a decade ago as a solution to range and performance issues that had hampered EVs initially
- NMC (Nickel Manganese Cobalt) – these are the most common type used in EV batteries due to their energy density and rapid charge time. The numbers refer to the mix of the metal types and Benchmark note that OEMs' current investment schedules imply that 8-1-1 type will be the dominant one by 2025 for Western requirements (long range, fast acceleration, variable weather).
- LFP (Lithium Iron Phosphate) – the main benefit is the lower cost of raw materials and is cheaper than NCM batteries. Technology improvements have been made in LFP performance, and it is expected that this chemistry may remain popular in markets (China, India) and applications where range is viewed as less of an issue by consumers.

Figure 114: Forecast evolution of types of lithium-ion batteries – 2020-2030



Source: IEA / KU Leven

It is expected that cathode manufacturers will increase their preference for lithium hydroxide over lithium carbonate for nickel-rich cathodes for several technical reasons. Lithium hydroxide degrades faster in the cathode manufacturing process than lithium carbonate, thus requiring less energy and making the process more efficient. Lithium hydroxide also allows for improved material crystallinity, greater structural purity and less mixing of lithium and nickel in the Lithium layer, as compared with Lithium Carbonate. Nickel-based battery chemistries typically have higher energy density and also better cold weather performance relative to current iron-based battery chemistries. For this, and other reasons, they have been favoured by European automakers, in particular, suggesting a possible preference for lithium hydroxide over lithium carbonate in the European market in the near term.

19.1.6 Rival Technologies

As with any technology, there can be no guarantee that lithium-ion batteries will remain the dominant technology in either the battery market as a whole or specifically in the EV sector. Advances have been made in alternative technologies such as Solid-state batteries, hydrogen fuel cells, lithium-sulphur, vanadium redox flow batteries, aluminium-graphite, sodium-ion, iron-based batteries. Any one of these new technologies may have the potential to supplant or reduce demand for lithium, if sufficient resources are dedicated to commercialising it. However, the basic attractiveness of lithium as one of the smallest and lightest elements on the periodic table produce chemical bonds that are some of the strongest per unit of weight and volume. It is also one of the most abundant minerals on Earth.

The most advanced of the rival technologies is probably Hydrogen Fuel cells. The main benefits to Hydrogen batteries are their energy to weight ratio, the speed of refuelling and that the waste products are heat and water. However, the downside is that the Hydrogen itself needs an energy intensive process to artificially isolate it as a fuel; it needs to be stored at cryogenic temperatures; and it is highly flammable including reacting with its own metal storage over time. Therefore, it will rely on significant technology advances and the ability to produce "green" hydrogen at scale.

Car and battery manufacturers have invested heavily in lithium-ion technology and, as yet, few seem to be investing material amounts in their hydrogen fuel range, which suggest that they view lithium-ion technology as a cheaper and more practical choice for at least the next decade or so. Indeed, the price per kilowatt hour of a lithium-ion battery has fallen by more than 97% since 1991 and is expected to drop below $100 in the short term. This is point at which an EV reaches broad equivalence to a normal ICE vehicle.

19.2 Lithium Market – Supply / Demand and Pricing Forecasts

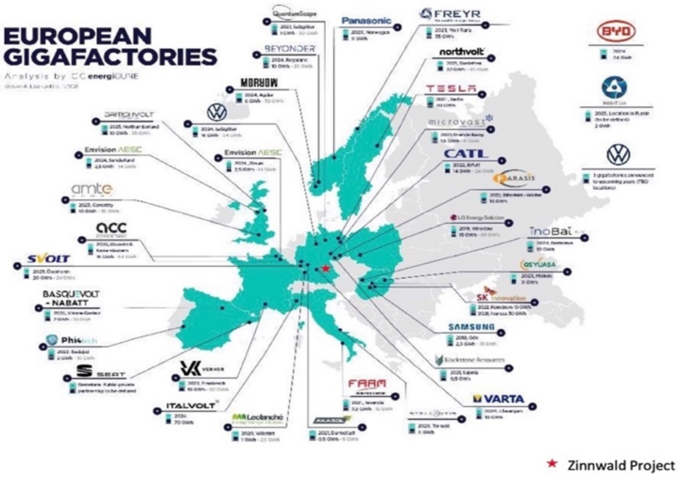
19.2.1 Demand Drivers

The global lithium market is expanding rapidly due to an increase in the use of lithium-ion batteries for electric vehicle and energy storage applications. In recent years, the compound annual growth rate of lithium for battery applications was over 22% and is projected by Roskill to be more than 20% per year to 2028. This expansion is being driven by global policies to support decarbonisation towards carbon neutrality via electrification, which is underpinned by Carbon Emission Legislation; Government regulation and subsidies; and Automakers commitment to EVs.

- ***Emissions Legislation***
  COP26, EU Green Recovery Deal, Paris Accord. In all major vehicle markets, there have been ongoing tightening of limits on vehicle emissions for car makers to meet regarding fuel economy and CO2, together with air quality concerns around nitrogen oxides and particulates. Traditional internal combustion engines generally perform well on either of these metrics (fuel or emissions), but not both.
- ***Government Regulation and subsidies for EVs***
  Historically, China had some of the most generous subsidies, but EU countries in particular are rapidly catching up with either direct subsidies or fiscal incentives to use an EV. Germany, for instance, has increased subsidies for EVs and noted plans to increase taxes on ICE vehicles.
- ***Automakers commitment to EVs***
  In order to meet standards on air-quality and emissions, it is almost impossible for an automaker not to have a material portion of EVs in its range. Whilst some are pursuing an interim phase of Hybrids, most of the majors have stated their commitment to EVs. At the higher-end, Tesla has been the front-runner, but the likes of VW, BMW and Mercedes are investing in cell capacity and EV production lines.

Benchmark highlighted that there are 300 Gigafactories at various stages of production/construction, up from only 3 in 2015 ***[177].*** If all these plants did come online in the planned 10 year timeframe, it would equate to 6,386 GWh of battery capacity, equivalent to 120 million EVs. But more relevantly it would require 5m tonnes of Lithium each year, as compared with 480,000 tonnes produced in 2021. They noted that the lack of supply is not due to any geological constraints but to a simple lack of capital investment to build future mines and estimated $42bn needs to be spent by 2030 to meet demand for lithium. **Figure *115*** shows the announced locations of Gigafactories in Europe ***[178]***.

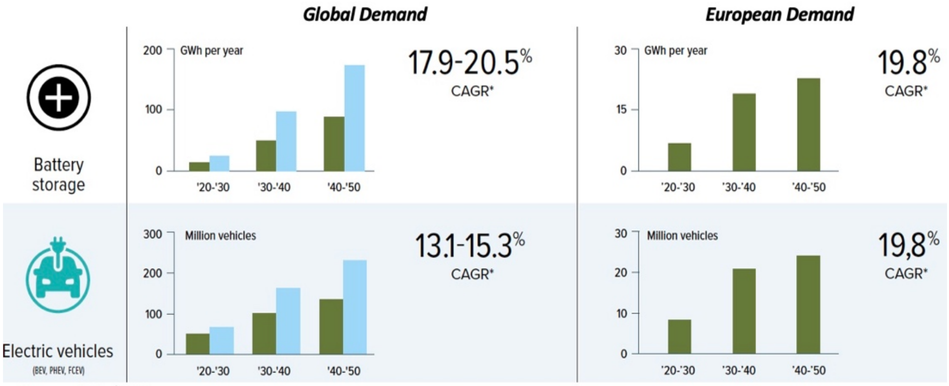
Figure 115: Europe's announced Gigafactories



In April 2022, the Belgium-based research university KU Leuven published a report "Metals for Clean Energy" on behalf of Europe's metal industry group, Eurometaux, and endorsed by the EU. This report explored in detail the supply, demand and sustainability factors at play around critical raw materials, especially in Europe, and what is needed to meet the IEA's two defined technology scenarios. **Figure *116*** shows the expected CAGR rate of demand for battery storage and EVs, both Globally and in Europe [***176].***

- Stated Policies Scenario (STEPS) reflects current policy settings, as well as those that have been announced by governments around the world.
- Sustainable Development Scenario (SDS) shows the requirements to meet in full the world's goals to tackle climate change in line with the Paris Agreement while meeting universal energy access and significantly reducing air pollution.

Figure 116: CAGR of Demand for Battery Storage and EVs

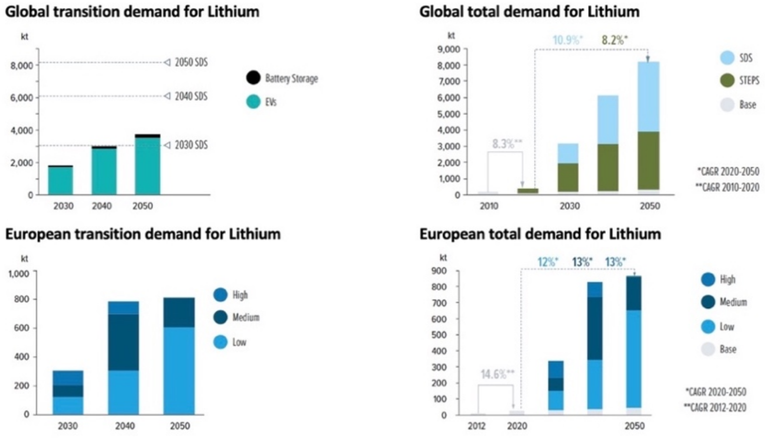


Source: IEA / KU Leven

The report looked at several minerals on a "deep-dive" basis and in terms of transition demand (ie: needed to achieve STEPs and SDS goals) and total demand. They noted in **Figure *117*** below some key items [***176].***:

- Global energy transition requirements for lithium are projected to range from 1,900-3000 kt in 2030, up to 3,700-8000 kt in 2050.
- Lithium has the strongest expected growth of all metals under analysis. Over the next 30 years, average growth of 8-11% is projected, with a peak growth rate of 20% in the 2020-2030 decade. This is a significant acceleration on the lithium's 8% average growth rate in the last decade.
- Overall global demand for lithium is projected to grow to 2,000- 3,000 kt by 2030, and up to 4,000-8,000 kt by 2050
- Europe's 2030 energy transition goals would require 100-300kt of lithium rising to around 600-800kt by 2050, equivalent to 3,500% of Europe's low consumption levels today. They note that Europe had not had a battery -grade lithium market until now with the majority of lithium consumed in the ceramic industry.

Figure 117: Demand forecasts for Lithium 2020 to 2050



Source: IEA / KU Leven

Source: IEA / KU Leven

Aside from its commitment the Paris Agreement, the EU has made several announcements in recent years that directly impact on the Lithium industry:

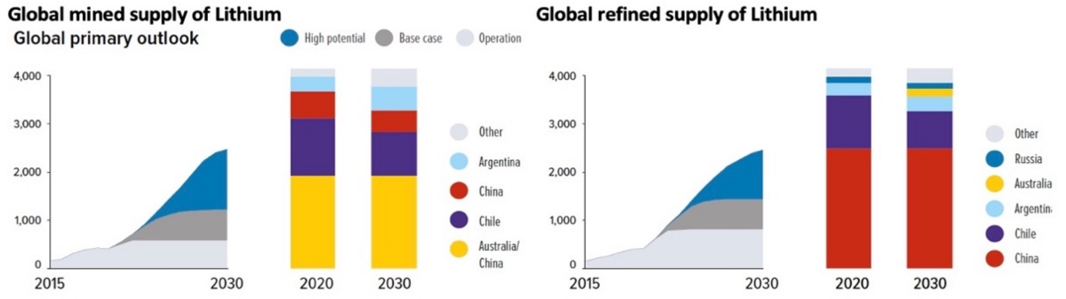
- **European Battery Alliance** – launched in 2017. “The alliance’s main aim is to build up battery technology and production capacity in the EU, which is crucial for low-emission mobility, energy storage, and Europe’s economic strategy. we are working on a competitive, circular, sustainable and safe value chain for all batteries placed on the EU market.”
- **Critical Raw Materials List** – In 2020, Lithium was added to the list that “form a strong industrial base, producing a broad range of goods and applications used in everyday life and modern technologies. CRMs combine raw materials of high importance to the EU economy and of high risk associated with their supply.”
- **EU Green Deal** – Initially announced in December 2019 and further detail provided in 2021. The goal is for the EU to become the first climate neutral continent by 2050, resulting in a cleaner environment, more affordable energy, smarter transport, new jobs and an overall better quality of life. It contains a commitment to spend €1 trillion on climate initiatives by 2030. It also stipulates measures such as CO2 targets and includes a Strategy for Sustainable and Smart Mobility which calls for a 90 percent reduction in emissions from vehicles. In order to meet such an ambitious goal, 30 million zero-emission vehicles will need to be on the roads by 2030.
- **EU Battery Regulation** (Dec’20) – new measures announced around responsible sourcing, CO2 footprint and traceability. This has led in turn to the development of plans around a Battery Passport to cover the full ESG requirements of a sustainable battery.
- **Carbon Border Adjustment mechanism** (Jul’21) – regulation to address risk of carbon leakage caused by asymmetrical climate policies of non-EU countries.

19.2.2 Supply Factors

Lithium Supply is currently concentrated in 4 main countries (see **Figure *118***) [***176].***, each of which have strengths and weaknesses to their ability to materially ramp-up supply to meet the expected demand.

- Chile – dominated by the incumbent suppliers, SQM and Albermarle. Strengths are that they are the established industry experts in production of lithium from brines. They have announced plans for expanded production, but that is set against a backdrop of local water issues and also a potentially punitive royalty regime at a governmental level on expanded production.
- Argentina – the newcomer in the production from brines with Livent and Orocobre in production and a number of well-funded newcomers, such a Lithium Americas, Neo, POSCO and Millennial. Argentina is expected to be the next major source of battery grade lithium into the market. Its biggest downsides are on a sustainability front around water usage and transport distances to the end-users.
- Australia – the dominant producer of spodumene concentrate globally with the largest producers being Pilbara, Mineral Resources/Ganfeng, Talison JV. Australia has the advantages of a well-established mining industry and significant scope to increase production. Its downsides are that it has almost no processing facilities currently, so its emissions levels from transport and conversion in China are high.
- China – it has an existing in-country mining industry, but this is dwarfed by its dominance in the production of end-product lithium based primarily on Australian spodumene. Ganfeng and Tianqi are two of the world’s four biggest lithium companies and are expanding their investments globally. The biggest issue is one of sustainability and that its energy intensive processing of spodumene is largely from coal fired power station, thus worsening the already high emissions levels from transport.

Figure 118: Global Supply of mined and refined lithium



Global mined supply of Lithium

Global refined supply of Lithium

Source: IEA / KU Leven

Source: IEA / KU Leven

In addition to expansion of existing operations or new projects adjacent to existing ones, other options for the possible increase in supply of Lithium products may include in the future some of the following:

- Direct Lithium Extraction (DLE) – the goal to speed up production times from conventional brine assets, reduce need for large evaporation ponds, increased recovery, lower use of fresh water and lower reagents. So far a couple of projects use adsorption DLE in Argentina and China, whilst other types such as use of ion-exchange, membrane-separation or solvent extraction are still at a pre-commercial stage.
- Geothermal DLE – generally focussed on low grade (100-200ppm) with the hope that the geothermal side of production generates sufficient heat to power the extraction. Nothing has yet been proven on a commercial scale, although significant investment is being deployed in an attempt to demonstrate its commercial viability.
- Recycling – battery life is improving rapidly as technology improves and as the wider market expands, the potential volume of lithium available will likely encourage recycling technologies. This may be direct recycling or perhaps more likely, the repurposing of car to extend life through use in home storage sector.

One of the wider issues around constriction of global supply is that of resource nationalism and security of title. Bolivia has had a long-standing nationalised industry that has resulted in its production being suppressed to a fraction of its potential. Mexico has recently nationalised its nascent lithium industry. In the wider mining industry, political and economic instability in many jurisdictions has manifested itself in significant real and perceived risks around security of ownership and continued ability to operate resulting in limited production. These factors have contributed to an increasing interest by western car makers to secure supply in domestic or more “reliable” jurisdictions.

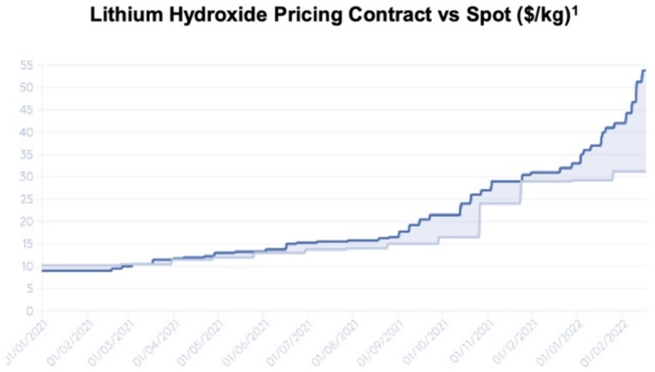
In terms of direct European supply, Eurometaux note that “more than 10 new European lithium mining projects have been announced, in Austria, Czech Republic, Germany, Finland, Portugal, Spain, Serbia, with a total project pipeline of 130 kt by 2030.” However, it also comments that “Several projects are subject to local community opposition (most visibly in Portugal, Spain, and Serbia). Others are dependent on untested technologies to be viable or have less certain economics. However, the EU has made it a strategic priority to improve its self-sufficiency for lithium.”

19.2.3 Price Forecasts

Definitive and accurate lithium pricing is inherently problematic, due to the opaque nature of what is, in global mining terms, a relatively new and small market by value. Lithium is not quoted on any major exchange, so there is no readily available information. There is no terminal market, although the LME is working to launch a futures contract. There is a spot market visible in China, but this is a small part of the overall lithium market. As there is no industry wide benchmark for pricing, the bulk of the market is sold based on negotiation between buyer and seller on long term contracts with prices fixed on an annual or quarterly revised basis. This is not wholly surprising given that battery grade lithium is a speciality chemical that requires cycle testing by manufacturers who value the consistency of quality of end product and its impurities and guarantee on supply. Furthermore, the largest current players in the market are companies that are either not listed or ones that are not required by local listing rules to detail their contract pricing achieved. This will likely change as the industry matures and more listed companies become involved.

What is clear is that lithium prices have experienced exponential growth in the last 12 months. **Figure *119*** from Fastmarkets shows LiOH spot price vs contract price (Asia) in 2021 [***179]***. It is usual in the Lithium industry for contract prices (which account for the bulk of lithium trade) to lag the short-term spot price. However, contract have also enjoyed a substantial recent rise. SQM recently announced their Q1 2022 numbers that showed $38,000 per tonne for contract lithium hydroxide. Allkem has also increased its Q2’22 guidance on contract pricing for lithium from $35k to $40k per tonne and that China spot pricing is now around $70k per tonne.

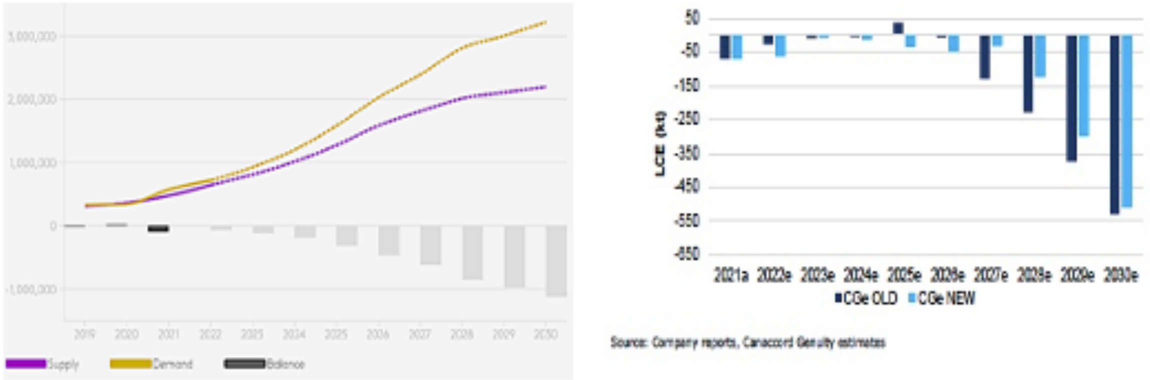
Figure 119: **Lithium Hydroxide pricing 2021 – Spot vs contract**



Fastmarkets

There is also a growing consensus around the worsening Supply / Demand imbalance, which is generally accepted economic pre-cursor to increased prices. **Figure *120*** below shows just some of the most recent forecasts for this imbalance from Canaccord [***181***] and Fastmarkets [***180***]. In terms of what that means for long term lithium hydroxide process, back in Q3 2021 Benchmark forecast a price of $12,110 long term [***182***], but this is before the step change in balance in the market. In March 2022, Roskill forecast an inflation adjusted long term price of $23,609 per tonne through to 2036 with a nominal rate of $33,200 by 2036 [***175***]. **Figure *121*** shows these forecasts.

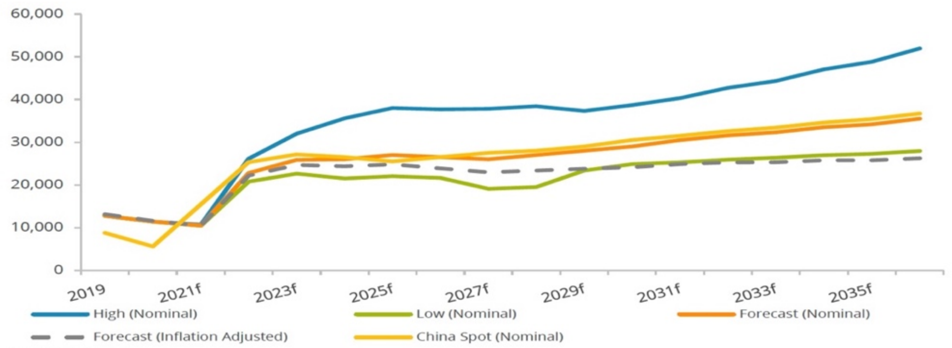
Figure 120: **Forecast Supply / Demand imbalances**



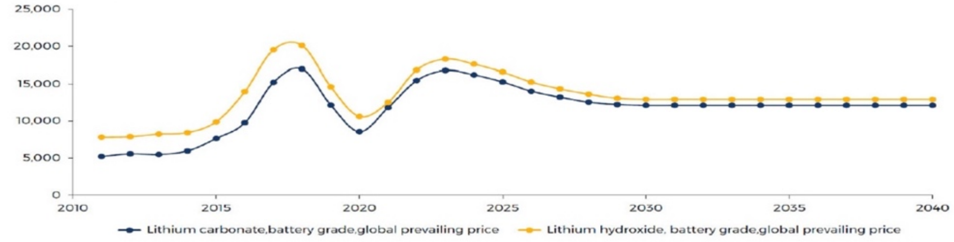
Fastmarkets – Q3'22

Canaccord – Aug22

Figure 121: Long-term lithium price forecasts



Roskill – Mar'22



Benchmark – Sep'21

19.3 Zinnwald Lithium project Business Model

19.3.1 Business Model

The Zinnwald Lithium Project's business model is predicated around utilising its inherent advantages to enable it to become one of the most sustainable projects in the global lithium market:

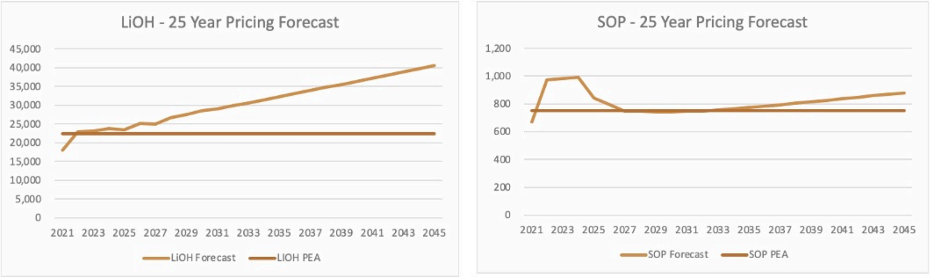
- It is located close to the German chemical industry enabling it to draw on a well trained and experienced workforce and attendant infrastructure. Addresses the issue of "Lithium is a specialty Chemicals industry rather than a conventional mining one."
- It is situated close to many of the planned Gigafactories, and it is an integrated mining to battery grade product process. The transport distances for emissions will be measured in the tens of kilometres rather than tens of thousands.
- It will be an underground mine and is in an established mining region. There is extensive existing and well-maintained infrastructure that the project may be able to use.
- It will be permitted under EU environmental rules, which are some of the strictest globally. OEMs will be able rely on the production being done in compliance with EU Battery Chain directives.
- Its basic process has key elements that are more sustainable than some of its main rivals
    - The process has limited water use relative, in particular, to brine producers.
    - The process flowsheet is less energy intensive than traditional spodumene-based production as it involves a single pyrometallurgical step at a lower temperature than is required in a spodumene-based process
    - Overall transport costs and emissions are reduced by being an integrated operation located close to end markets especially when compared to Australian sourced spodumene concentrate processed in China
    - German energy sources currently include a higher overall "low carbon" component than China
- It has the potential to be a low or "zero-waste" project, as the vast majority of both its mined product and co-products have their own large-scale end-markets:
    - Its initial mined waste product, quartz sand, is a "benign dry stack end product" that itself is used as a construction aggregate for roads and other projects.
    - Its primary co-product is high grade Potassium Sulphate, which is in huge demand as a fertiliser.
    - Its secondary co-product is Precipitated Calcium Carbonate ("PCC") typically used as a filler in the paper making process

19.3.2 Commercial Products and Forecast Pricing

Whilst the production of LiOH from zinnwaldite ore is the Company's primary focus, the Company is extremely fortunate to have mineral resource and production process that produces other valuable minerals. In addition to lithium, the basic ore body is predominantly made up of a mica that can be made into a coarse quartz sand, and the lithium production process produces both a high grade Potassium Sulphate and Precipitated Calcium Carbonate. There is a market for all of these minerals in a number of different areas, which helps the project's overall operational economics, allowing the Company to be a low-cost producer of high quality, battery grade, lithium hydroxide on the doorstep of the EU supply chain.

As part of the PEA process, the Company commissioned Grand View Research to provide 25-year pricing forecasts for Lithium Hydroxide and Potassium Sulphate, to underpin the pricing assumptions assumed in the financial model. The results of these forecasts are shown in **Figure *122*** below ***[183]***.

Figure 122: LiOH and SOP – 25 Year Pricing forecasts



Grand View Research *Grand View Research*

19.3.2.1 *Primary Output - Lithium Hydroxide (LiOH)*

As shown above, the Company has used a base average price of **US$22.500** per tonne of battery-grade Lithium Hydroxide in the financial model used for this PEA. This price is based on a conservative discount to the projections provided Grand View Research. It is also at a discount to pricing forecast data issued by peer companies in recent months (Keliber: $24,936, European Lithium: $26,800, Bearing Lithium: $23,609). Future selling prices of between a low case of $17,500 and a high case of $27,500 per tonne have been modelled as part of a sensitivity analysis exercise included in Section 22 Economic Analysis of this Report.

19.3.2.2 *Primary by-product - Potassium Sulphate*

The primary by-product produced from the Hydromet stage is a high-grade potassium sulfate (K2SO4 or sulfate of potassium "SOP"). Based on an annual production of c. 12,000 t/a LiOH, the Project will produce c. 56,900 tonnes of SOP each year. The process can be adjusted to produce a blend of Fertiliser Grade SOP (98.45% K2SO4) and Technical Grade SOP (>99.6% K2SO4). The former is a a high value fertilizer with particular application for producers of fruits, vegetables and nuts. The latter is supplied to the chemical industry. The bulk of global production is predominantly in China and European production is heavily sourced from Russia. Grand View has produced a forecast that shows combined demand for these types of SOP rising in Europe alone from circa 410,000 tonnes in 2021 to more than a million tonnes by 2045, so the Zinnwald Project's output of SOP should be readily absorbed into this market without distorting pricing. For the purposes of the financial model, a blended SOP price level of **€875** per tonne has been assumed.

19.3.2.3 *Secondary by-product – Precipitated Calcium Carbonate*

Calcium carbonate, as it is used for industrial purposes, is extracted by mining or quarrying. Pure calcium carbonate can be produced from marble, or it can be prepared by passing carbon dioxide into a solution of calcium hydroxide. In the latter case, calcium carbonate is derived from the mixture, forming a grade of product called "precipitated calcium carbonate," or PCC. PCC has a very fine and controlled particle size, on the order of 2 microns in diameter, particularly useful in production of paper. The other primary type of industrial product is "ground calcium carbonate," or GCC. GCC, as the name implies, involves crushing and processing limestone to create a powdery-like form graded by size and other properties for many different industrial and pharmaceutical applications. PCC is used in 5 main industrial areas, as a filler in high-performance adhesives and sealants; as dietary calcium in medicines, food and cosmetics; as an extender in paints to increase opacity and porosity; as a coating and surface finishing agent in papers; and as filler/extender in Plastics, such as improving impact strength in rigid PVC fillers.

PCC is estimated at around 20% of the European market for Calcium Carbonate products that is expected to grow at around 5.6% CAGR from 2022 to 2030 to a market size in of US$14.1 billion (circa US$3bn for PCC alone). In terms of pricing, ongoing political turmoil from Russia's invasion of Ukraine, has caused prices to rise to $297 per tonne in Europe in Q1 2022, as compared with €150 per tonne in the same quarter of 2021. For the purposes of the Financial model, the Company has used €150 per tonne and expects to produce circa **16,300** tonnes per annum.

19.3.2.4 Other by-products - Construction Aggregates

Approximately **75**% of the original ore mined is a coarse grade Quartz Sand, which can either be stored as an inert landfill or hopefully sold to construction companies as an industrial aggregate. The current financial model assumes a very limited revenue for this end product of 100,000 tonnes per year at €5 per tonne. However, the goal is to find outlets to take this in-demand industrial product either as a direct revenue stream or simply to reduce the cost of storage.

19.3.2.5 Other by-products - Tin

The Zinnwald Lithium Project has historically not considered the option of including a tin circuit as part of its production process, primarily because the planned annual mining rate did not support the economics of a such a concept. However, with the planned increase in size of the Zinnwald Project, and the generally stronger tin price, the Company is reviewing both the cost and the practicality of adding beneficiation of tin to the Project. The Company will include further details in the future NI 43-101 Feasibility Study, if the economics support such a plan.

20 Environmental Studies, Permitting and Social or Community Impact

20.1 Introduction

In view of the updated operational concept, specifically relating to change of final product, processing and refining locations as well as operational scale, the previous strategy to pursue the Facultative Framework Operational Plan (FFOP) - permitting pathway has been suspended. Instead, the company seeks to convert the permitting progress made so far into a regular permitting process, including EIA/UVP permits within a Mandatory Framework Operation Plan (MFOP) entirely under mining law.

20.2 Permits

The overall permitting pathway for the Zinnwald project can be subdivided between assets which are permitted under

- **Mining Act**, including the mine, associated mining infrastructure and the mechanical separation plant. This includes the Mandatory Framework Operation Plan after BBergG §52 Subsection 2a which is led by the Saxon Mining Authority.
- **Bundesimmissionsschutzgesetz (BImSchG)** (Federal Emission Protection Act) can be led by either regional authorities or the mining authority and evaluates compliance of facilities with existing technical standards as well as other requirements set by law.
- **Water Permits**
  All aspects relevant to water use, potential for water pollution etc are reviewed and permitted by the water authority, in this case the lower water authority.

20.2.1 Mandatory Framework Operation Plan (MFOP)

The MFOP provides clarity on a first outline of the planned operation, at a time when not all details of technical nature are yet defined. It must give an overview of the technical process of mining and processing, considerations for environmental aspects, urban planning and expected impact on residents. The actual construction and operation of the intended assets must however be separately permitted within a Main Operation Plan Permit (Hauptbetriebsplan), clearly defining the activities of the operation for the next up to 24 months. The process of MFOP is led by the Saxon Mining Authority, however as stipulated in BBergG §54 Section 2, the Saxon Mining Authority must involve and consider positions of other authorities.

Additional permits which lie outside of the scope of the BBergG, such as Environmental Impact Analysis (Umweltverträglichkeitsprüfung – UVP) are carried out to assess all potential impacts on the Environment of the planned mining operation. More detail on this in chapter 20.4.1.

Any other permits required for the operation of the mining and processing assets will have to be gained and included in the application for MFOP, including but not limited to:

- Water Use Permits
- Compatibility with EU Water Framework Directive
- BImSchG of Mineral Processing Plant & Lithium Activation and Lithium Fabrication

20.2.2 BImSchG Permit

The BImSchG law is part of Germany’s environmental law and acts to protect from noise and air pollution, vibration, and other impacts on the environment from human activity. The permitting under this legal framework ensures that installations meet all technical minimum standards based on provided technical plans. A BImSchG process is expected to be carried out for the surface installations of the assets for mining and processing, led by the Saxon Mining Authority.

Aspects that are considered in the BImSchG process are including (but not limited to):

- All technical details of the planned operation.
- State Development Plan and Regional Planning
- Environmental Impact Assessment (EIA / UVP, separate from the MFOP EIA)
- Estimated Noise emissions of operation
- Estimated Air emissions of operation (type and quantity of pollutants, meteorology, impact on climate etc)

- Operational Safety Margins
- Compliance of installation with relevant technical standards such as EN / DIN / ISO
- Fire Safety Standards / Concepts for installation
- Logistical / Transportation Concept
- Waste and Waste Management

20.3 Regional Planning and Constructional Planning

The framework for mineral resources in the Regional Planning is defined in the State Development Plan of Saxony 2013 (“Landesentwicklungsplan Sachsen“ - LEP). Mineral resources are shown in detail in special information maps of the State Development Plan. In map no. 11 – “ore and spar prospective area”, the project area is noted as a recognised Lithium-deposit.

The Regional Plan of Upper Elbe / Eastern Erzgebirge Region (status 2nd proceeding) refers to the ore- and spar-prospective areas in the region. The tin deposits in the Altenberg region are stated in this document with particular significance.

The Building Regulation Plan (Bebauungsplan) does not affect the concerns of the modified project area.

20.4 Specification and Assessment of the Anticipated Environmental Impacts

20.4.1 Preface

Environmental Impact Assessment Studies as defined by the federal law. “Umweltverträglichkeitsprüfungsgesetz” (UVPG) serve as an assessment evidence on estimated impacts on the environment and other legally protected goods, involving both the public and other associated authorities. Mining related EIA / UVP processes are regulated in the special legal text of §57a in the BBergG as well as the “UVP-V Bergbau” (Special legal act regulating EIA processes for mining projects). The UVP-V Bergbau stipulates that an EIA is required for underground mining projects with a surface footprint exceeding 10 ha of area for all associated installations (mining, mineral processing, tailings, maintenance and administration buildings). The surface footprint of the new operational concept is expected to exceed 10 ha, and therefore will require the completion of an EIA for the permitting process.

DL commissioned G.E.O.S. in 2021 to carry out an updated Environmental Impact Assessment Screening study (“UVP-Vorprüfung”), to consider several operational concepts, including trucking ore material over longer distances to external facilities vs. local processing operations. The result of this study highlights that there are key challenges with each strategy however, it is concluded that the option to concentrate all processing operations at one location will have expectedly the least environmental impact of all options under consideration. Some of the operational parameters have changed since the completion of this study, therefore an update of the study must be completed before progressing other EIA permits.

Several assets - specific Environmental Impact Assessments will be carried out for the project:

- Environmental Impact Assessment as part of the MFOP-Applications, for all directly mining related assets (led by the Saxon Mining Authority)
- Environmental Impact Assessment for each down-stream (lithium-activation / fabrication) asset permitted under BImSchG.

20.4.2 Assessment of potential Emissions and Other Substantial Impacts

Due to the conceptual stage of the technical plans presented in this report, a high-level assessment of potential emissions and impacts can be included in **Table *75*** below:

Table 75: High level assessment of type of emission impact

Type of Impact	Comment
Air Pollution	Air pollution will be evaluated in the detailed EIA / UVP submissions to the relevant authorities. Technical and organizational reduction measures will be implemented as much as possible.
Noise Pollution	Noise pollution will be evaluated in line with the technical guideline "TA Lärm". Detailed assessments can only be completed once technical designs are more advanced.
Blasting Vibrations	Mining operations will employ conventional underground mining techniques also including blasting of rock / ore. As it is best international practice, the design of the underground mine will include sufficiently sized pillars to ensure no risk of damage to surface properties. To reduce any further disturbance, no blasting is foreseen to take place at night time between 10pm and 6am.
Site Evaluation	In the planning stage of the project, the reduction of disturbances to residents remains a paramount guiding principle. Impact of construction or operation of assets will be carefully assessed in following EIA and SIA studies.
Impact on Areas with Protected Status	The project is bordering on and in some cases overlapping with areas with designated protection status including: • *Landschaftsschutzgebiet (LSG)* / Protected Nature Reserve • *Naturschutzgebiet (NSG)* / Conservation Area • *Vogelschutzgebiet (SPA)* / Bird Special Protection Area (EU Bird Directive), part of Natura 2000 network • *Flora Fauna Habitat Areas (FFH)* / Protected Nature Area, part of Natura 2000 network • *Flächennaturdenkmale (FND)* / Protected Natural Landmarks • *Trinkwasserschutzgebiete (TSG)* / Zone of Water Well Protection • *Hochwasserentstehungsgebiete* / Area of Flood Formation Risk • UNESCO World Heritage Protection Status – Mining Landscape Altenberg Zinnwald – Archaeological Protection The company will transparently develop the project further with the clear objective on how impacts on these protected areas can be avoided, minimised or appropriately compensated.
Waste Disposal	Mining, processing and refining operations inevitably will produce waste streams. Avoidance of waste wherever possible and where not, responsible handling and deposition is an important aspect for the development of the project. Details and volumes of waste materials will be included further technical studies and described in the permitting process according to the Federal Immission Protection Act (Bundesimmissionsschutzgesetz - BImSchG).

20.5 Environmental and Social Impact

The company is committed to being a responsible project developer and maintains the environmentally acceptable and sustainable construction and operation of the Zinnwald project as a paramount principle in its activities. The company will comply with all applicable environmental laws and regulations, as well as other industry codes and standards to which we subscribe.

20.5.1 Social Impact Assessment

Impacts on human beings during the development and operation of the project cannot be completely excluded. All potential emissions will be reduced by technical and organisational measures to avoid health risks, e.g.:

- Prevention of noise-intensive work in evening- und night-times
- Noise-reduction instalments at the ventilation shaft
- Shielding of noise-intensive installation
- Reduction of impact of light pollution and other visible presence in the local area

Furthermore, the company will complete a comprehensive Social Impact Assessment (SIA) study report as part of further higher confidence feasibility study reports. Active and inclusive consultations and engagement with local stakeholders are a key component of the project's development process with the aim of supporting local socio-economic development.

20.5.2 Animals, Plants, Biodiversity

Impacts on animals, plants and biodiversity result predominantly from the surface activities of the project. Possible impacts could include:

- Habitat loss by cutting and rooting of trees in course of the construction of the project
- Influence on noise-sensitive species
- Influence on habitats by increased traffic
- Influence on light-sensitive species at night
- Influence on surface-based species by blasting (noise and seismic tremors)

These impacts will be reduced by prevention and reduction measures wherever possible. Specific action and management plans will be made in line with international best practice and local laws.

20.5.3 Soil

The soil in the planned project area (i.e. surface plant) is in some areas historically biased and has lost its natural functions. Sealing by the project will have a further impact on the soil and will be avoided wherever possible. Care will be taken to preserve soil wherever possible.

20.5.4 Water

All project relevant aspects of water (groundwater, surface water, mine water) drainage were discussed in an expert study on the compatibility of the project with the European Water Framework Directive (see [***71]***). The responsible lower water authority’s recommendation on water management will further guide the process. This study will be re-evaluated and if required updated in line with the new operational concept of the project.

20.5.5 Air

During operation, air quality can be influenced by dust during loading and / or transportation of materials on surface. Potential air pollution was investigated in an expert study on dust prognosis (see [***47***]). This study found no rule violations.

20.5.6 Landscape and Recreation

The company is committed to preserving the potential for recreation and tourism of the area, and to ensure that none of the project’s activities negatively affect it. The whole area around the mining site is part of the recognised UNESCO World Heritage Erzgebirge/Krušnohoří Mining Region.

20.6 Operation Safety and Neighbourhood Protection

For operation safety and neighbourhood protection, the German acts and regulations have to be considered and implemented which are listed in Item 27.8. Based on these legislations, a health & safety document has to be established with all necessary technical and organizational measures, including risk and hazard analysis. Technical details will be defined in Special Operation Plans, which have to be granted by the mining authority, e.g.:

- Special Operation Plan Processing
- Special Operation Plan Installation and Equipment
- Special Operation Plan Ventilation
- Special Operation Plan Blasting
- Special Operation Plan Mine Drainage
- Special Operation Plan Mine Rescue

Radiation protection

Underground mine workings (“Activities“, according to Radiation Protection Act – Strahlenschutzgesetz - StrlSchG ***[159***]) are legally defined as “Working areas with higher exposition to Radon“. The allowed average annual activity concentration range of Radon-222 and Radon decay products in these working fields is 300 Bq/m³. The limit of effective dosage is 20 mSv/a. For the mine an effective ventilation system is being planned, that at all time guarantees that the Radon and Radon decay products concentrations for the employees are below the legal limits.

Safeguarding of unauthorized persons

The operation area, the ramp portal and the exit of the ventilation shaft will be safeguarded against trespassing by unauthorized persons during mine and site development as well as in the whole operation period of the project.

Trespassing of external guests is only allowed in attendance and with the necessary health and safety equipment.

Mining Rescue

Until the establishment of a fully equipped company-own rescue team, DL will arrange service contracts with rescue teams of other mining companies of Saxony, accompanied by training of company-own local guides for the support of external rescue teams.

Equipment, training and operation of mine rescue are subject to the legal guidelines and standard operation procedures for mining rescue (“Leitlinien des Deutschen Ausschusses für das Grubenrettungswesen für Organisation, Ausstattung und Einsatz von Grubenwehren“) and have to be approved by the Mining Authority in a “Special Operation Plan Mine Rescue“.

21 Capital and Operating Costs

21.1 Capital Costs

The overall capital cost estimate is summarized in **Table *76***. The capital cost estimates were produced by ZL, OEMs and external expert consultants. It must be noted, that at the time of writing this study, extraordinary supply chain disruptions are having a general effect on the cost estimates. The estimates presented below are made with the assumption that at the time of construction, the underlying supply disruptions have been resolved and raw material costs normalised. Capital costs below are all presented in US$ and a USD / EUR exchange rate of 1.05 for costs based in €.

Contributing parties to the capital cost estimation were:

- G.E.O.S.
- Epiroc for mining capital costs
- Metso:Outotec for beneficiation capital costs
- CEMTEC for pyrometallurgical capital costs
- K-UTEC for hydrometallurgical costs

Table 76: Overview of the Project's Capital Expense Estimate

Mining	**Initial Capital (US$m)**
Underground Mining Equipment	22.7
Fixed Installations / Infrastructure	9.7
Pre-Production Development	15.3
Preparation / Surface Infrastructure	6.3
Total	**54.0**
Mineral Processing	
Process Equipment	23.2
Auxiliary Equipment	10.5
Piping and Instrumentation	8.4
Installation / Construction	14.7
Civil Engineering	5.7
EPCM (17%)	10.6
Total	**73.1**
Pyrometallurgy	
Process Equipment / Calcination	20.8
Electrical Systems	4.6
Steel construction	3.7
Trucking of Equipment	2.0
Construction & Commissioning	9.3
Management & Engineering	2.5
Civil Engineering Estimate (15%)	6.4
Total	**49.4**
Hydrometallurgy	
Installed Machinery	51.3
Piping and Instrumentation	15.4
Civils	20.5
Associated Infrastructure	3.9
EPCM	18.3
Steam / Cooling / Chilling Plant	6.3
Total	**115.7**
Other	
Surface Land acquisition	1.6
Sub-Total Capex	**293.8**
Subsidies	- 15.8
20% Contingency	58.5
Total Capex	**336.5**

21.1.1 Mining Capital Expense

The mining capital cost estimate was developed by., Epiroc, G.E.O.S. and ZLP. The initial mining capital cost is estimated at €51.4m / US$54.0m includes all material and up-front underground development work to initiate mining.

At this point all major mobile equipment is assumed to be purchased and maintained in co-operation with the OEM through Service Level Agreements (SLA). An overview of the main unit costs is detailed in **Table *77***.

Table 77: Breakdown of the Mining mobile equipment cost

Description	Quantity	Cost Each (US$)	Cost (US$)
Jumbo	3	1,200,000	3,600,000
Drilling Rig	3	1,200,000	3,600,000
Loader	4	1,100,000	4,400,000
Truck	5	1,200,000	6,000,000
Shotcrete Unit	2	600,000	1,200,000
Auxiliary	2	400,000	800,000
Rockbolter	2	1,400,000	2,800,000
Personnel carriers etc	10	30,000	300,000
Total			**22,700,000**

In addition, other costs associated with mining facilities are broken down in **Table *78*** below:

Table 78: Breakdown of the Mining facilities cost

Description	Quantity	Cost Each (US$)	Cost (US$)
Preparation/Surface			
Ventilation decline portal	1	525,000	525,000
Altenberg mine preparation	1	1,050,000	1,050,000
Surface workshop/facilities	1	4,200,000	4,200,000
ROM pad	1	525,000	525,000
Development			
Drainage tunnel enlargement (m)	4,000	525	2,100,000
Main access (m)	3,000	2,100	6,300,000
Vent decline (m)	1,700	2,100	3,570,000
Level entrances (m)	600	2,100	1,260,000
Orepass System (m)	200	10,000	2,000,000
Fixed Installations			
Ventilation	2	1,050,000	2,100,000
Backfill plant	1	3,150,000	3,150,000
Shotcrete mixing	1	525,000	525,000
Electricity / Transformer Stations	1	1,575,000	1,575,000
Water arrangements	1	525,000	525,000
Loading Stations	1	1,800,000	1,800,000
Total			**31,305,000**

21.1.2 Mineral Processing Capital Expense

A cost estimate for the mineral processing plant was completed by Metso:Outotec, based on scoping level engineering designs. The significant changes of cost in this area compared to the previous technical report relate to the increase in design capacity and inclusion of de-sliming stage in the flow sheet. Estimated costs for ancillary units such as piping and instrumentation as well as material handling and screening stages were scaled up on a linear factor from the previous process design.

The current preliminary design and cost estimate for the mineral processing plant are sufficient for a nominal ROM throughput capacity of 880,000 tpa at an assumed 90% availability. Detailed cost breakdown as per **Table 79** below:

Table 79: Breakdown of the Mineral Processing cost

Description	Cost (US$m)
Processing Equipment Cost	
Crushing circuit	8.9
Grinding circuit	2.9
Drying circuit	4.5
Magnetic Separation	6.8
Processing Equipment Cost Sub Total	**23.2**
Auxiliary Equipment	10.5
Piping and Instrumentation	8.4
Installation	14.7
Civil	5.7
EPCM (17%)	10.6
Total	**73.1**

21.1.3 Pyrometallurgy Capital Expense

A cost estimate for the pyrometallurgical plant was completed by CEMTEC, based on previous engineering designs, scaled up to a slightly higher capacity of 180,000dmt / a of Zinnwaldite concentrate feed, which relates to approximately 360,000mt / a of solid feed mass to calcination (before moisture loss and LOI). Costs for civil engineering and associated site preparation were estimated at 15% of the total other costs. The total cost of breakdown as per **Table *80*** below:

Table 80: Breakdown of the Pyrometallurgical cost

Description	Cost (US$m)
Process Equipment / Calcination	20.8
Electrical Systems	4.6
Steel construction	3.7
of Equipment	2.0
Construction & Commissioning	9.4
Management & Engineering	2.5
Civil Engineering Estimate (15%)	6.5
Total	**49.4**

21.1.4 Hydrometallurgy Capital Expense

A cost estimate for the hydrometallurgical plant was completed by K-UTEC, based on previous engineering designs at AAEC-level 3 technical study, attaching an accuracy range of -20% to +30% of this design. The total cost of breakdown as per **Table *81*** below:

Table 81: Breakdown of the Hyrdometallurgical cost

Hydrometallurgy	Initial Capital (US$m)
Installed Machinery	51.3
Piping and Instrumentation	15.4
Civils	20.5
Associated Infrastructure	3.9
EPCM	18.3
Steam / Cooling / Chilling Plant	6.3
Total	**115.7**

21.1.5 Property and General On-Site Infrastructure

The cost allocation for required land acquisition has been set at US$1.6m for land purchase or access rights in Zinnwald and Altenberg the company does not yet own. This rate reflects regional average prices for agricultural land.

21.1.6 Sustaining Capital Cost Allocation

For sustaining capital cost, 2.5% of overall initial capital cost has been allocated to account for replacement of equipment to maintain production capacity. This is reflective of comparable projects and assumed to be appropriate for the type of equipment / installations used.

21.1.7 EPC and Project Management

Engineering, project management, project controls, procurement and contracting, and site construction management (EPCM) costs have been developed based on the planned construction and commissioning timetable and expected engineering deliverables. These costs include the estimates for the engineers' detailed design work. In general, the following assumptions have been included in the financial model for EPCM costs:

- 2 % of the basic capital cost for all equipment and the construction of buildings and general infrastructure
- 17 % of the basic capital cost for the processing and chemical circuits

21.1.8 Working Capital

Working capital is the required cash on hand for the next period's operating cost. The estimated total is US$35m. Note that this cost is recovered at the end of the project.

21.1.9 Contingencies

Contingency refers to costs that will probably occur based on previous experience, but with some uncertainty with respect to how and where it will be spent. These uncertainties are risks to the project that are often referred to as "known-unknowns". A cost contingency of 20% of the total cost has been applied based on the total project costs.

21.1.10 Subsidies and Grants

Both the European Union as well as Federal Government has available financial support funds for new businesses and industrial investments available, which can be applied from if the applicant meets the qualifying criteria. ZL estimates, that it will be able to qualify for state level grants and subsidies in the amount of 15.0 M EUR over the course of the construction period, on the basis of:

- the amount of capex will be in a range of 50 – 80 M EUR
- investment will take place in the sector of chemical processing
- investment will take place in the industrial sector of the former German Democratic Republic, falling into the remit for structural support funds of the EU and Germany.

There is no funding for the mine and mine equipment itself. Mining and mineral processing facilities are not expected to qualify for subsidies.

21.2 Operating Cost

The project operating cost is mainly determined by the cost of labour, power (electrical and natural gas), consumables and reagents. For this estimate, long term average prices as well as consensus forecasts for reagents and energy were used. Fixed cost components have been drawn from current process unit engineering plans, which include estimates of labour costs. All costs have been attributed to the production of battery-grade lithium hydroxide. The chemical circuits produce a by-product of potassium sulphate ("SOP"), which can be sold as a potash fertiliser, and the financial model treats this as co-product credit revenue with no associated direct costs. **Table *82*** summarizes the average overall operating costs per tonne of LiOH produced over the 36-year life of mine plan of the financial model.

Table 82: Overview of the Project's Operating Expense Estimate

Category	US$/t LiOH
Mining	2,254.13
Mechanical Processing	897.64
Chemical Processing (Hydro & Pyro)	7,358.15
G&A	306.0
Total Operating Costs per tonne LiOH*H20 before by-product credits	10,815.88
Total Operating Costs per tonne LiOH*H20 after by-product credits	6,200.36
Total Cost per tonne mined	147.63

The operating cost estimate has been compiled by ZL supported by G.E.O.S. / K-UTEC and is based on the basic estimates received from:

- G.E.O.S. for mining operating costs
- Metso:Outotec for mechanical process operating costs
- CEMTEC for pyrometallurgical operating costs
- K-UTEC for hydrometallurgical operating costs

21.2.1 Labour Cost / Fixed Costs

Labour related costs make-up most of the fixed cost proportion across all process sectors. Overall, it is estimated that c. 15% of all operating costs are associated with labour. Germany is a high labour cost environment with strict labour laws and benefits. An initial breakdown of labour and labour cost is detailed in **Table *83*** below:

Table 83: Breakdown of the Labour costs

Category	Manpower	Expected annual labour related costs US$m
Mining	96	5.25
Mechanical Processing	40	1.05
Pyrometallurgy	35	3.25
Hydrometallurgy	35	8.0
G&A	25	1.20
Total	231	18.75

21.2.2 Power & Electricity Costs

The power consumption (**Table 84**) has been calculated for the mine, mechanical processing plant and chemical processing plant based on the installed equipment (i.e. excluding standby equipment) multiplied by the load factor. The power consumption is included in the basic engineering documentation as well. At the time of writing this report, there are unusual price volatilities in the energy markets, that have led to an extreme price increase both for natural gas and electrical power. ZL believes that these prices in these energy markets will normalise by the time of project execution. Furthermore, the increased penetration of renewable energy generation into the energy markets is expected to further reduce unit costs. Below prices include the required taxes, charges and duties (see **Table *84*** below).

Table 84: Overview of energy cost input parameters

Source	Cost / kWh (€)
Electrical power	
2019 Technical Report Altenberg	0.1283
2021 H1 Germany Commercial Average (EU Stats)	0.1813
2021 H1 Germany Commercial Average (Destatis)	0.1776
S&P Global Platts Analytics (2026 onwards), Dec 2021 excl. Duties/Taxes	0.06
Used Electric Power Pricing in this study	0.117
Natural Gas	
2019 Technical Report	0.0280
2021 H2 Germany Commercial (Destatis)	0.0683
2023f World Bank CMO - EU Natural Gas Forecast (Apr 2022)	0.0761
Standard & Poor’s beyond 2024 forecast TTF (Mar 2022)	0.0512
Used Natural Gas Pricing Assumption for this study	0.0512

Based on the available engineering details, the following overview can be made for electrical power and natural gas across all process sectors:

Table 85: Project Power Consumption and Cost – Summary

Area	Base Parameter	Units - kWh	Cost per EUR/kWh	Average Annual Consumption - GWh
Mine (Electricity)	Per mined tonne	19.50	0.117	17.1
Mechanical Processing (Electricity)	Per mined tonne	15.5	0.117	13.6
Mechanical Processing (Gas)	Per mined tonne	40.00	0.0512	35.2
Pyrometallurgy (Electricity)	Per tonne ZWD Con	105.00	0.117	18.3
Pyrometallurgy (Gas)	Per tonne ZWD Con	850.00	0.0512	148.4
Hydrometallurgy (Electricity)	Per tonne LiOH	7,283.33	0.117	85.2
Hydrometallurgy (Gas)	Per tonne LiOH	4,783.54	0.0512	56.0

21.2.3 Process Plant Reagent and Consumable Costs

Reagent consumption costs were based on test work consumption rates and process design calculations, where available. Where reagent usage data was not available from test work, consumption rates from the experience of G.E.O.S., CEMTEC and K-UTEC were used (**Table *86***).

Table 86: Annual Reagents and Consumables Operating Cost Estimate

Area	Base Parameter	Units - Tonne	Costs EUR/t	Average Annual Consumption - Tonnes
FGD Gypsum (wet)	Per tonne ZWD Conc.	0.72	14.0	130,000
Limestone powder	Per tonne ZWD Conc.	0.40	29.0	90,000
Calcium Oxide	Per tonne LiOH.	0.76	150.0	9,100
Potassium Carbonate	Per tonne LiOH	2.75	1,000	33,000
Potassium hydroxide	Per tonne LiOH	0.025	1,000	290

21.2.4 General and Administration Operating Costs

An estimated of €3.5m per annum was assumed for German G&A costs to account for DL costs in Germany. No ZL – UK based costs were included for the purpose of project appraisal.

22 Economic Analysis

The following economic analysis, underlying assumptions for pricing, taxation, costs and revenue are considered "forward looking statements". Forward-looking statements reflect the company's current outlook on the project, however, may differ significantly from actual results. All estimations below are presented in both € and US$ using a USD / EUR exchange rate of 1.05 for costs based in €.

An analysis of the projected capital expenditures, revenues, operating expenses, and corporate taxes was prepared on an annual basis to determine the estimated pre- and post-tax cashflows from the Project. **Table *87*** shows the key financial results of this analysis and demonstrates the financial viability of the Project.

Table 87: Key Financial results of economic analysis

PEA Key Indicators	Unit	Value
Pre-tax NPV (at 8 % discount)	US$ m	1,605
Pre-tax IRR	%	39.0%
Post-tax NPV (at 8 % discount)	US$ m	1,012
Post-tax IRR	%	29.3%
Simple Payback (years)	Years	3.3
Initial Construction Capital Cost	US$ m	336.5
Average LOM Unit Operating Costs (pre by-product credits)	US$ per tonne LiOH	10,872
Average LOM Unit Operating Costs (post by-product credits)	US$ per tonne LiOH	6,200
Average LOM Revenue	US$ m	320.7
Average Annual EBITDA with coby-products	US$ m	192.0
Annual Average LiOH Production	Tonnes per annum	12,011
LiOH Price assumed in model	US$ per tonne	$22,500
Annual Average SOP Production	Tonnes per annum	56,887
Blended SOP Price assumed in model	€ per tonne	875

German federal income tax, depreciation were applied to the appropriate capital assets and income categories to calculate the taxable income. A basic corporation tax rate of 30.9 % has been assumed together with a 100,000 EUR/a Mining Royalty Tax due to the Government of Saxony. Across the lifetime of the project, it is estimated to generate c. €2.0bn in state and federal level taxes

The economic analysis for this report considers only the project level economics and excludes any cost of financing or any historic cost incurred in the development of the project. The analysis assumes the project is 100 % equity financed. It includes the project phases comprising 24 months of construction, followed by 12 months of commissioning, ramp-up and stabilisation phases. A total mine life of 36 years is expected when assuming the mining rate of 880,000t / a, and mineral inventory of 31.2Mt which is equivalent to the Proven and Probable category tonnage of the latest Mining Reserve statement, as announced on 31st May 2019. A mean grade of 3,004ppm Li was assumed, as per the historic Mining Reserve grade, which should account conservatively for potential dilution from mining as described in Chapter 16 of this report.

The key inputs to the economic analysis are shown in **Table *88***

Table 88: Key Inputs for Economic Analysis

Category	Units	Value
Lithium Hydroxide Monohydrate Price	US$ / t	22,500
K_2SO_4 (SOP) Fertiliser Grade (50% of total SOP)	EUR/t	750
K_2SO_4 (SOP) Technical Grade (50% of total SOP)	EUR/t	1,000
Potassium Carbonate (K_2CO_3) Price	EUR/t K_2CO_3	1,000
Potassium hydroxide (KOH) Price	EUR/t KOH	1,000
De-Slime Process Li Recovery	%	98
Mechanical Process Li Recovery	%	92
Chemical-Process Li Recovery Leaching	%	90
Chemical Process Li Recovery Liquor to Product rate	%	93
Corporate Tax Rate	%	30.9

The Project annual cash flow is shown in **Table *89***.

Table 89: Project Annual cash flow – Summary

Category	Unit	Total	Year -2	Year -1	Year 1	Year 2	Year 3	Yrs 4 on
Stage of Operations			Construction	Construction	Ramp up	Production	Production	Production
LiOH	Dmt	425,862	-	-	6,005.8	12,011.5	12,011.5	12,011.5
K2SO4	Dmt	2,016,909	-	-	28,443.6	56,887.2	56,887.2	56,887.2
Total Revenue	US$m	11,548	-	-	163.2	325.7	325.7	325.7
OPEX	US$m	4,630	3.7	8.3	75.9	129.9	129.9	129.9
CAPEX	US$m	639	134.6	201.9	8.4	8.4	8.4	8.4
Total Tax Paid (incl. State Royalty)	US$m	2,054	-	-	- 19.6	- 56.8	- 56.7	- 56.6
Pre-tax Cash Flow	US$m	6,275	- 138.3	- 210.2	78.7	187.3	187.3	187.3
Pre-tax NPV (8 %)	US$m	1,605						
Pre-tax IRR	%	39.0%						
Post-tax Cashflow	US$m	4,217			59.0	130.4	130.5	130.6
Post-tax NPV (8 %)	US$m	1,012			-	-	-	-
Post-tax IRR	%	29.3%						

The project is currently estimated to have a payback period of 3.3 years from construction completion. The economic analysis indicates a pre-tax Net Present Value (NPV), discounted at 8 %, of approximately US$m1,605.1 with an Internal Rate of Return (IRR) of approximately 39.0%. The post-tax NPV is US$m1,012.3 and the post-tax IRR is 29.3 %. A sensitivity analysis on the base case NPV at different discount rates and LiOH price assumptions is shown in **Table 90**.

Table 90: Pre and Post Tax NPV Sensitivities (US$m) – Commodity price, Discount Rate

	Pre-Tax NPV (US$m)	***Commodity Price (LHM US$)***				
	1,605.1	*$ 17,500*	*$ 20,000*	*$ 22,500*	*$ 25,000*	*$ 27,500*
DISCOUNT RATE	6%	1,347.3	1,748.0	2,148.7	2,549.3	2,950.0
	7%	1,145.8	1,498.4	1,851.0	2,203.6	2,556.2
	8%	979.4	1,292.3	**1,605.1**	1,918.0	2,230.8
	9%	840.9	1,120.6	1,400.2	1,679.9	1,959.5
	10%	724.5	976.2	1,228.0	1,479.7	1,731.4

	Post-Tax NPV (US$m)	***Commodity Price (LHM US$)***				
	1,012.3	*$ 17,500*	*$ 20,000*	*$ 22,500*	*$ 25,000*	*$ 27,500*
DISCOUNT RATE	6%	831.8	1,108.7	1,385.5	1,662.4	1,939.3
	7%	693.8	937.5	1,181.1	1,424.8	1,668.4
	8%	579.9	796.1	**1,012.3**	1,228.4	1,444.6
	9%	485.1	678.3	871.6	1,064.8	1,258.0
	10%	405.4	579.3	753.3	927.2	1,101.1

A further sensitivity analysis (**Table *91*** and **Table *92***) has been conducted to determine the effect on post-tax and post-tax NPV and IRR from the base operating cost and capital costs. Variations from +50 % to -50 % for each have been used in modelling. The analysis shows the Project is significantly more sensitive to the lithium hydroxide price than it is to CAPEX or OPEX.

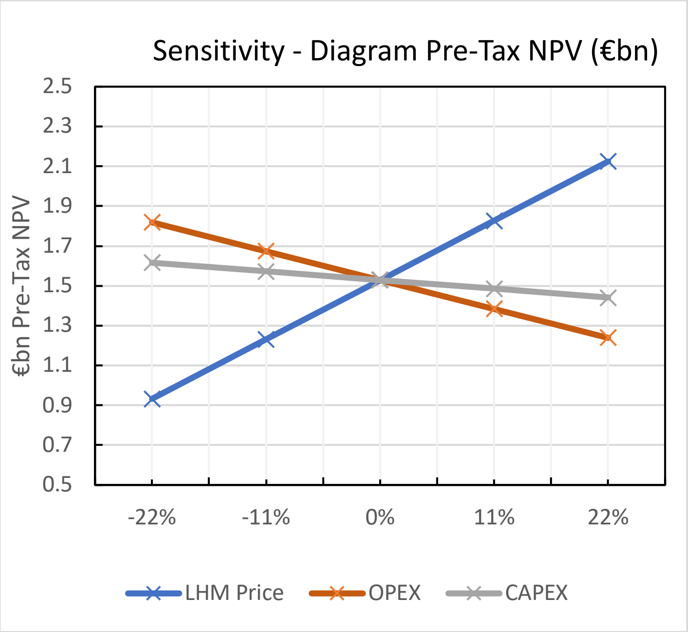
As shown in **Figure *123*** and **Table *91*** an increase of 22% in the average lithium hydroxide price, from 22,500 US$/t to 27,500 US$/t, increases the post-tax NPV from US$m1,012.3 to 1,444.6 (42%).

Table 91: Post-Tax NPV Sensitivities (US$m) – Commodity Price, Capex and Opex

	Post-Tax NPV (US$m)	*Commodity Price (LHM US$)*				
%CHANGE OPEX	**1,012.3**	*$ 17,500*	*$ 20,000*	*$ 22,500*	*$ 25,000*	*$ 27,500*
	-50%	1,053.4	1,269.5	1,485.7	1,701.9	1,918.1
	-20%	769.3	985.5	1,201.6	1,417.8	1,634.0
	0	579.9	796.1	**1,012.3**	1,228.4	1,444.6
	20%	390.6	606.7	822.9	1,039.1	1,255.2
	50%	106.3	322.6	538.8	755.0	971.2

	Post-Tax NPV (US$m)	*Commodity Price (LHM US$)*				
%CHANGE CAPEX	**1,012.3**	*$ 17,500*	*$ 20,000*	*$ 22,500*	*$ 25,000*	*$ 27,500*
	-50%	771.4	987.6	1,203.7	1,419.9	1,636.1
	-20%	656.5	872.7	1,088.9	1,305.0	1,521.2
	0	579.9	796.1	**1,012.3**	1,228.4	1,444.6
	20%	503.3	719.5	935.7	1,151.9	1,368.0
	50%	388.5	604.6	820.8	1,037.0	1,253.2

Figure 123: Sensitivity Analysis on post-tax NPV



A decrease of 22 % in the average lithium hydroxide price, from 22,500 US$/t to 17,500 US$/t, decreases the post-tax NPV (8 %) from US$m1,012.3 to 579.9 (-42%). As shown in ***Table 92***, an increase of the lithium hydroxide price to 27,500US$/t increases the post-tax IRR to 36.8%, while a decrease of the lithium hydroxide price to 17,500 US$/t decreases the post-tax IRR to 21.1%.

Table 92: **Post Tax IRR Sensitivities (%) – Commodity Price, Capex and Opex**

	Post-Tax IRR	*Commodity Price (LHM US$)*				
DR	**29.3%**	*$ 17,500*	*$ 20,000*	*$ 22,500*	*$ 25,000*	*$ 27,500*
		21.1%	25.3%	**29.3%**	33.2%	36.8%

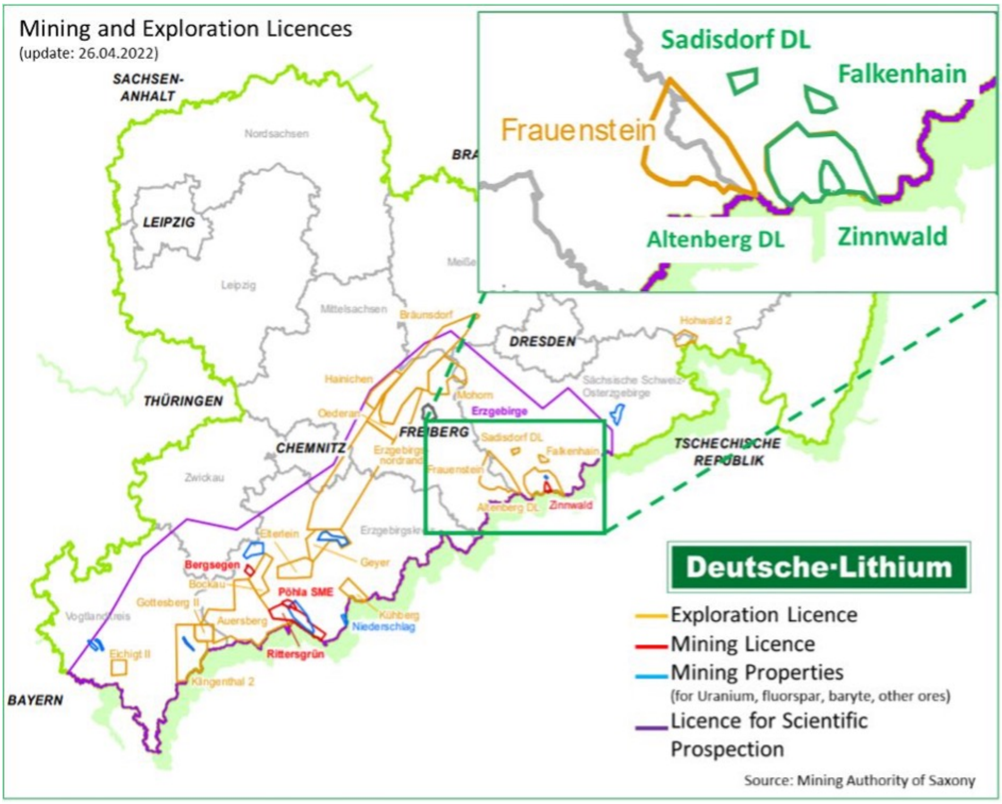
	Post-Tax IRR	*Commodity Price (LHM US$)*				
%CHANGE CAPEX	**29.3%**	*$ 17,500*	*$ 20,000*	*$ 22,500*	*$ 25,000*	*$ 27,500*
	-50%	37.5%	44.2%	50.4%	56.4%	62.0%
	-20%	25.7%	30.6%	35.2%	39.6%	43.9%
	0%	21.1%	25.3%	**29.3%**	33.2%	36.8%
	20%	17.9%	21.6%	25.1%	28.5%	31.8%
	50%	14.4%	17.6%	20.6%	23.5%	26.3%

	Post-Tax IRR	*Commodity Price (LHM US$)*				
%CHANGE OPEX	**29.3%**	*$ 17,500*	*$ 20,000*	*$ 22,500*	*$ 25,000*	*$ 27,500*
	-50%	30.4%	34.2%	37.9%	41.4%	44.9%
	-20%	24.9%	29.0%	32.8%	36.5%	40.1%
	0%	21.1%	25.3%	**29.3%**	33.2%	36.8%
	20%	17.2%	21.6%	25.8%	29.7%	33.5%
	50%	10.7%	15.6%	20.1%	24.3%	28.3%

23 Adjacent Properties

Figure *124* shows the various license areas in the Saxony region that DL currently owns in addition to the core Zinnwald license that underlies this study. As at the end of April 2022, the Saxony Mining Authority has issued 19 exploration licenses, 5 new mining licenses and one new mining property. One of the exploration licenses, the exploration field "Frauenstein" is located near the license areas granted to the DL. These licenses are currently held by Saxony Silver Corp. (SSC), a subsidiary of Excellon Resources Inc. in Toronto/Canada. The main focus for SSC is silver.

Figure 124: DL licenses in the region



Source: Mining Authority of Saxony

It should also be noted that the Zinnwald license covers the German side of the wider ore body that extends into the Czech Republic. The Czech exploration and preliminary mining licences licenses are owned by Geomet s.r.o. (GEOMET), which is 51% owned and controlled by the industrial conglomerate CEZ a.s. (European Metals Holding Limited owns the remaining 49%).

23.1 Falkenhain – Exploration License

Located north of the Zinnwald property, DL holds the exploration license "Falkenhain" with an area of 2,957,000 m². This license was granted on the 18th of December 2017 according to Section 7 of Federal Mining Act (BBergG § 7) for caesium, gallium, germanium, gold, indium, lanthanum and lanthanoids, lithium, molybdenum, niobium, rubidium, scandium, silver, tantalum, bismuth, tungsten, yttrium, zinc, and tin as defined by Section 3 of Federal Mining Act (§ 3 BBergG). It represents, however, primarily a lithium target. The license expires December 31, 2022. An application has just been made to extend the license of "Falkenhain" for a further three years. Already in the last quarter of 2022 after the exploration extension, a campaign with 10 diamond drill holes will be started with the aim to define the exact location of the granite domes, to explore additional ore bodies and to validate the data of the historical drill holes. In addition to the planned drilling, evaluation of historical exploration reports from 1964 to 1990 continues. The evaluation of these reports also includes the re-assay of the existing sample material of the historical core samples for lithium.

A geological 3-D model of the "Falkenhain" license area is being created on the basis of all drillings.
After completion of this exploration phase, further steps will be taken depending on the results, such as laboratory-scale processing tests and the construction of a recourse model.

23.2 Altenberg – Exploration License

Furthermore, DL holds the exploration license “Altenberg DL” according to Section 7 of Federal Mining Act (BBergG § 7) for the same elements with an area of 42,252,700 m^2. The license is directly bordering in the East, North and West of its mining permission “Zinnwald”. This license is closing the gap in the area between the mining permission “Zinnwald” and the exploration license “Falkenhain”. It represents another lithium target. This license was granted on March 7, 2019 and is valid until February 15, 2024.

The "Altenberg DL" exploration licence surrounds the mining property "Zwitterstock und Zinnkluft Altenberg" including the elements arsenic, molybdenum, bismuth, tungsten and tin, administrated by the Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH (LMBV) with the known historic tin mine Altenberg and their significant sinkhole “Pinge”. In the "Altenberg DL" licence area, the evaluation of historical data is currently underway, which will be used to define new exploration targets in the area.

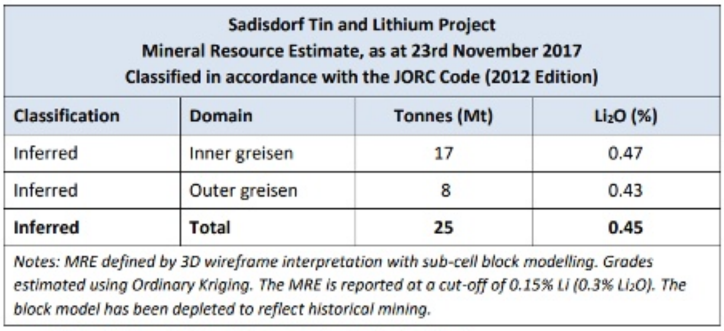
23.3 Sadisdorf – Exploration License

DL was granted the exploration license "Sadisdorf DL" according to Section 7 Federal Mining Act (§ 7 BBergG) on June 8, 2021. This license covers an area of 2,250,300 m^2) for caesium, gallium, germanium, gold, indium, lanthanum and lanthanoids, lithium, molybdenum, niobium, rubidium, scandium, silver, tantalum, bismuth, tungsten, yttrium, zinc, and tin as defined by Section 3 of Federal Mining Act (§ 3 BBergG). The main objective is to find lithium. The license "Sadisdorf DL" is valid until June 30, 2026, which can be extended again.

In the “Sadisdorf” license area there is a long-lasting historical mining of tin, silver and copper, which has been documented since the 14th century. The periodic mining ended in 1953 and the historical data prompted a closer examination of the area.

The lithium deposit in this licence area was assayed for lithium by Lithium Australia NL from February 6, 2013 to December 31, 2020. Previously, Tin International AG, based in Leipzig, held the exploration permit. A technical report was then prepared in accordance with the JORC 2012 Standard and a resource estimate of the “Sadisdorf” deposit was published in the ASX Announcement of December 7, 2017. This maiden resource estimate from 2017 is shown in **Figure *125***.

Figure 125: Sadisdorf – Resource estimate (Dec’17)



Sadisdorf Tin and Lithium Project
Mineral Resource Estimate, as at 23rd November 2017
Classified in accordance with the JORC Code (2012 Edition)

Classification	Domain	Tonnes (Mt)	Li_2O (%)
Inferred	Inner greisen	17	0.47
Inferred	Outer greisen	8	0.43
Inferred	**Total**	**25**	**0.45**

Notes: MRE defined by 3D wireframe interpretation with sub-cell block modelling. Grades estimated using Ordinary Kriging. The MRE is reported at a cut-off of 0.15% Li (0.3% Li_2O). The block model has been depleted to reflect historical mining.

As part of the exploration work undertaken by Lithium Australia NL, the following measures were undertaken: Historical drilling was validated by drilling two holes 151 m and 310 m deep, geochemical analyses were carried out on the new and historical samples and a petrographic description of the lithologies was done. This resulted in a geological 3-D model of the deposit. Based on this, a resource model and a metallurgical testing programme were completed.

Currently, the DL is reviewing and evaluating the obtained data. Afterwards, further exploration steps will be planned and carried out.

24 Other Relevant Data and Information

24.1 Introduction

The tentative project schedule in this PEA report is developed on the assumption that the project will be fully funded throughout both the Bankable Feasibility Study (BFS) phase and then into construction; all environmental and other regulatory permits will be granted without delays; external agencies and suppliers will be cooperative; and management of the execution will be by competent EPCM / EPC groups. The preliminary development schedule is shown in section xx below.

The Company is continuously in contact with the administrative bodies in Altenberg and Zinnwald (mayor, municipal council) regarding ongoing project developments. Furthermore, the Company continues to keep the residents of Zinnwald and Altenberg updated about the Project via newspapers and regular information meetings.

24.2 Execution Strategy

The execution strategy assumed in the PEA report is based on the hybrid model mixing the conventional EPCM and Engineering Procurement Construction (EPC) approach. This type of hybrid model will allow for extensive participation of the local contractors where possible. The preliminary schedule includes typical durations for major activities based on experience with similar size projects. A more detailed execution plan is to be developed during the Bankable Feasibility Study phase of the project. Project permitting will cover the mining and processing stages at the same time.

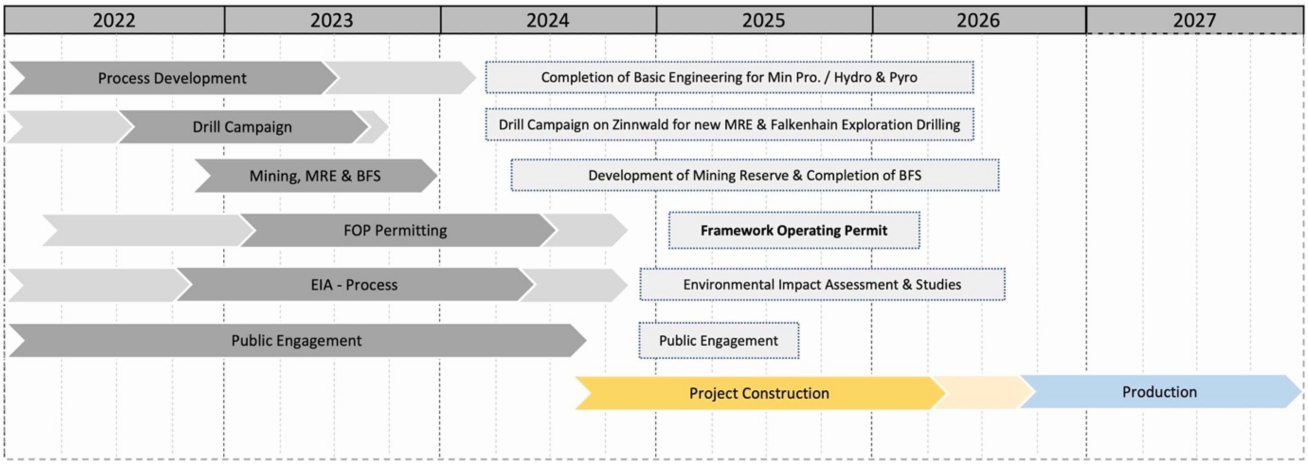
24.3 Project Development Plan

The project development plan includes the following major phases

- PEA
- Geological and Processing development
- EIA and Permits
- Bankable Feasibility Study
- EPCM and EPC selection
- Construction and commissioning into Production

The schedule of project development shown in **Figure *126***, developed for the PEA phase, is a graphical snapshot of the driving summary activities and logic. The intent is to demonstrate major project execution activities and key milestones following completion of this PEA. The schedule covers the entire project life cycle from the start of the PEA study until commissioning and nameplate production capacity is reached.

Figure 126: *Project Development Plan*



The Company has already commenced an infill drilling programme at the core Zinnwald mining permission with the objective of better defining the Resources and Reserves that lie within the ore body, as well as determine the detailed early years' mining plan. This will likely lead to revised Resource and Reserves Estimate to be included in the new BFS planned for the re-scoped Project as defined in this PEA Study. The Company has also commenced an exploration drilling campaign at its nearby Falkenhain license to determine the potential for expansion of both the project's resources and potentially production.

The Company will continue to develop the technologies planned for its processes. Individual processing methods and stages are well established in mining and other industries. As the recognition of Zinnwaldite as a source for battery metals is more recent, the application of methods such as high-intensity magnetic separation has not previously been used in beneficiation of this specific type of lithium ore but is utilised and well established in the beneficiation of other ore types. The roasting technique is applied in other industries, such as the cement industry, but has not previously been used in a lithium hydroxide plant. Evaporators and crystallizers are common processing methods in the production of fertiliser salts. The Company has also completed the initial phases of bulk ore sorting techniques designed to increase the type of resource available to the Project. The Company will also continue to refine its plans for reducing its overall CO_2 footprint and operating costs, such as via the use of electric equipment.

The Company has already commenced its EIA and other permit application process, including baseline studies and other reports. This will be the highest priority area over the coming quarters.

This PEA assumes that the Zinnwald Group will adopt an EPCM construction strategy, but in the Feasibility Study phase other options should also be evaluated. The EPCM contractor will provide overall management for the Project as Zinnwald will likely look to limit the size of its Owner's team. The EPCM Contractor will need to work in collaboration with the Company, its consultants and the relevant regulatory bodies.

24.4 Sustainability Matters

As a mining development Group operating in Germany and the UK, the Company and wider Zinnwald Lithium Plc Group takes seriously its ethical responsibilities to the communities and environment in which it works. It abides by local German and relevant UK laws on anti-corruption and bribery. Wherever possible, local communities are engaged in the geological operations and support functions required for field operations, providing much needed employment and wider economic benefits to the local communities. In addition, the Company and Group follows international best practice on environmental aspects of its work. The Company's goal is to meet or exceed the required standards, in order to ensure the Company obtains and maintains its social licence to operate from the communities with which it interacts.

The Group has already put in place a Sustainability Committee in place at Plc Board level to incorporate and emphasise the Group's commitment to Sustainability and ESG Matters. The Committee is also responsible for overseeing, on behalf of the Board, the development, implementation and monitoring of the Company's sustainable development in all its internal policies and operations around the three pillars of the Group's Sustainability framework. These are based on the United Nations' set of 17 Sustainable Development Goals (SDGs), of which for mining companies, the key takeaways are to extract responsibly, waste less, use safer processes, incorporate new sustainable technologies, promote the improved wellbeing of local communities, curb emissions, and improve environmental stewardship.

The Company recognises the need to proactively consult and engage with the communities that may be affected by our activities. The Company aims to foster long-term relationships with these communities to develop mutual understanding, cooperation, and respect. As part of this process, the Company will put in place a local Sustainability Committee as part of the Group's wider structures.

24.5 Risk Assessment

As part of its plans for the near future, the Company will be completing risk analysis assessments with its key stakeholders to identify potential external factors that may impact the Project in future phases of development. There will be an initial focus on the following areas:

- Political
- Design Engineering
- Environmental
- Finance
- Procurement
- Community

Within each of these external factor categories, the analysis will identify risks (threats) and opportunities and classify them by their consequence and the likelihood that they may occur. The consequence of an event occurring will be evaluated by looking at the potential effects on health and safety, environment, financial, schedule or production, operations, Project delivery and legal and regulatory compliance. In turn, the Company will identify potential treatment plans and strategies for each risk.

25 Interpretation and Conclusions

The following notes describe the main interpretations, conclusions, risks and opportunities resulting from the PEA as aspects to be considered in further project implementation.

The results of this study confirm the development of an underground mine with an extraction rate of 880,000 t/a and a mine life of more than 30 years, including the ramp-up phase, followed by mechanical processing (crusher and magnetic concentrator) at the mine site for the separation of 180,000 t/a of a Zinnwaldite concentrate and the construction of a plant for the production of c. 12,000 LiOH (corresponding to 10,500 t/a of LCE). The project includes the production of 56,900 t/a potassium sulfate as fertilizer and technical product, 16,900 t/a PCC (precipitated calcium carbonate) and 75,000 t/a granite and 100,000 t/a sand as by-products.

The Zinnwald Lithium Project is of substantial size with the potential to produce 425,000 t of lithium hydroxide monohydrate over 36 years. It has a robust average grade compared to the cut-off grade, promising an operation at a significant profit margin.

25.1 Geology

The Project comprises the development of an underground mine for the extraction of lithium-rich greisen ores. As per the previous technical report, these contain a combined Measured and Indicated Mineral Resource of 35.51 Mt with a rounded average grade of 0.35 wt.% Li or 0.75 wt.% Li_2O. The resource is calculated according to the following modifying factors:

- Cut-off grade lithium = 2,500 ppm
- Resource only below the “Tiefer-Bünau-Stollen” level (≤ 740 m a.s.l.)
- Vertical thickness of greisen beds ≥ 2 m
- Dry bulk density 2.7 t/m³

The mineral resources are reported in accordance with the Canadian Securities Administrators National Instrument NI 43-101 and have been estimated in conformity with generally accepted “Estimation of Mineral Resource and Mineral Reserves Best Practices Guidelines” of CIM.

Several previous exploration campaigns had already indicated the lithium mineralization in the German portion below the old Zinnwald / Cínovec underground mine, which ceased operations owing to the depletion of the tin and tungsten mineral resources. In the case of lithium, a first systematic exploration in Germany began in 1954. From 2012 on, SWS and its successor DL implemented a comprehensive data base and contributed to the verification of the data through its own drilling programs consisting of 25 drill holes as well as through underground channel sampling.

The geological model of ten parallel to subparallel stretching mineralized horizons emplaced along the cupola of the Zinnwald granite was demonstrated and improved. The interpreted greisen beds were used for digital construction of CAD sections of the conceptual geological model with SURPAC^{TM} (version 6.6). Anisotropic inverse distance interpolation was applied for the estimation of lithium resources within the greisen beds. An authoritative mineral resource was assessed comprising inferred, indicated and measured categories. The potential of Sn, W and K_2O was estimated at a total volume of rounded 15 million cubic meters and a tonnage of 40 million tons of greisen containing approximate overall average grades of 500 ppm tin, 100 ppm tungsten and 3.1 wt.% potassium oxide.

At the present time significant risks with respect to the mineral resource have not been identified that would inhibit the development of the property. Minor risks are represented by the lack of reliable drill hole survey data, especially for data before campaign No. (7) and by inaccurate geochemical assays for data of exploration campaign No. (4). Uncertainties of the 3D modelled geological shapes of the greisen beds and the lack of a sufficient spatial data density, in particular for greisen beds with small extensions, prevent in places a geostatistical analysis in detail.

25.2 Mining

The key aspects for mining risks of the Project are:

The mining technology requires backfill of the mined-out portions of the deposit. The backfill is planned to consist of a mixture of “leached roasted product” tailings (c. 310,000 t/a), lignite filter ash (c. 110,000 t/a) and cement as binding agent and water. The availability of lignite filter ash is expected to decrease significantly during the mine life, as the German government has embarked on a gradual exit from lignite power production until 2038. Alternative sources for lignite filter ash can be found in the Czech Republic or Poland. In addition, negotiations and contracts might be undertaken with the operators of the power generation plants to generate a sufficient stockpile of lignite filter ash, as they already do for FGD-gypsum. If not, lignite filter ash has to be substituted by cement, which will be more expensive and thus will have an impact on the operating cost structure of the mining operation.

One of the key identified risks in the mining area is the lack of a comprehensive geotechnical assessment. This is required to inform the detailed design and support systems of the underground mine, especially with regards to pervasive tectonic structures and expected weakness zones in the area of the deposit. This work package is outstanding and must be completed ahead of the bankable feasibility study.

Another identified issue is the lack of detailed water management planning in the underground mine. Mining in the underground mine could be faced with challenges from increased ground water influx along historic mine drives or pre-existing natural structures. A hydrogeological model along with new measurements must inform the new mine planning underlying the bankable feasibility study.

Finally, assumptions around operating costs for consumable items in the underground mine, such as explosives, tyres or other structural support for the drives must be thoroughly considered for a renewed bankable feasibility stage document. At the time of writing this report, some of the supply chains for these items are severely disrupted, resulting in increased prices.

25.3 Process Plant

Building on the existing test-work that is the basis for previous technical reports, it is considered that the feasibility of selected processing methods has been proven. Mechanical processing tests were carried out at batch and also pilot scale with overall positive results. However, further work remains to be done to understand the geo-metallurgical variability of the ore across the deposit and expected process responses to it. There is a special concern around the impact of clay-alteration minerals, such as kaolinite in the ore on the efficiency of comminution, sizing, and separation processes.

The ability to produce high purity lithium hydroxide (> 99.95 wt.%) as well as by-products has been confirmed. The target purity of lithium hydroxide is comparable with the technical specifications of the market leaders for lithium hydroxide.

Although the project is considered viable, there have been risks identified that could impact delivery or economics.

The key risks for beneficiation are:

- On-time delivery of critical packages (kiln, crystallizer / evaporator) still requiring design development work
- Adverse outcomes in the design development work for critical equipment packages may result in a detrimental cost impact, potentially linked to materials of construction for key components, especially for the hydrometallurgy plant.
- Availability of anhydrite / gypsum for the roasting process. The roasting technology requires anhydrite / gypsum, which is being supplied as FGD-gypsum (130,000 wmt/a) from nearby lignite power generation plants. The availability of FGD-gypsum is expected to decrease significantly during project live as the German government will decide the gradual exit from lignite power production until 2038. Although, the operators of the lignite power generation plants already have considered the economic meaning of FGD-gypsum and are currently building up stockpiles,

the security of supply remains questionable. Alternative sources for FGD-gypsum might be found in Czech Republic or Poland. Otherwise, gypsum / anhydrite must be substituted by recycled gypsum or natural resources which may have an impact on the operating cost structure of the pyrometallurgical plant.

- Availability of potassium carbonate (K_2CO_3), as it is a key reagent in the process. This issue could be mitigated by self-producing potassium carbonate on-site from other potassium compounds or by self-supply through converting parts of the produced SOP into potassium carbonate and saleable sulphuric acid, this needs to be investigated further.

25.4 Infrastructure

The PEA makes the assumption that the infrastructure required for the project can be delivered. The key risk aspects for the infrastructure are:

- Securing of land rights for the mine site and processing site can have a material impact on the project especially regarding the transportation costs.
- The deposit is partially located in an area which has been declared a UNESCO World Heritage site. Based on letters and guarantees by the government of the State Saxony, the city of Altenberg and the National Heritage Authority there is assumed to be no impact on the Project.

25.5 Environment

Following the re-assessment of the project, a new permitting process in underway with local authorities. The key permitting and environmental risks that may impact the project include:

- A delay of permitting progress or complication of permitting pathway, that would require additional involvement of other authorities or additional time intensive investigations to be carried out.
- The BImSchG – Permit process for the processing plant or other assets could delay the project by delaying the start of the necessary engineering work. A typical BImSchG – Permit process takes approximately 9 - 12 months.

25.6 Lithium Hydroxide Market

Market research has indicated that the European market for battery grade lithium products is dominated by demand for lithium hydroxide given a focus by European battery makers on battery chemistries that require this compound. The market for lithium hydroxide in Europe is growing rapidly and is currently entirely supplied via imports. As such the ability to be a local supplier of this product is likely to be an important strategic advantage. Given this a strategy of focusing on producing this compound is likely to maximise the ability of the Project owners to enter into favourable off-take arrangements with regard to the Project's output. Lithium fluoride by contrast, though a valuable niche product, is a significantly smaller market with fewer natural buyers, As such the shift in Project strategy to focus on producing lithium hydroxide is considered to be appropriate and justified.

26 Recommendations

The following subsections summarize the recommendations and the forward work plan for the Project.

26.1 Geology / Exploration

The Company is currently executing an In-fill drilling campaign to further improve the mineral resources. The Zinnwald lithium deposit is open to the west and at least some additional drill hole west of the hole ZGLi 11/2017 is recommended. Generally, the actual mineral resource categories are expected to be upgraded by the additional drilling and reduction of the distances between drill holes. The potential of the Sn-W (Nb-Ta) mineralization in the meta-albite granite are worth further investigation at a later stage. In connection with the on-going campaign, it is recommended to

- Further investigate geometallurgical properties of the Ore type 2 to possibly increase the Resources.
- Collect all geotechnical and structural data from the core to better understand small scale features of the deposit and provide information for detailed mine planning.
- Setup of an hydrogeological model and a monitoring system for preservation of evidence and monitoring during operation.

26.2 Mining

To optimize the full project and to prepare the bankable feasibility study and to minimize further risks, additional recommendations include:

- The underground mine galleries in Altenberg are owned by the state company LMBV. Negotiations with regards to utilisation of these galleries for access, ventilation and emergency route are on-going. It is recommended to finalize the negotiations and to conclude a contractual agreement as soon as possible.
- The ventilation concept is at a low level of detail and must be optimized and validated by modelling [***85***]. It should also consider expected stricter limits (EU directives) regarding pollutant emissions (especially diesel exhaust gases and particles).
- During the preliminary review of the Facultative Framework Operation Plan (“fakultativer Rahmenbetriebsplan”), it was pointed out that a border security post has to be developed to prevent the impact of the planned mining activity on the territory of the Czech Republic (CZ). Further discussions with the Saxon Mining Authority and the relevant authorities in CZ are necessary.
- Along with the requirement to further optimise the logistical system of the mine, both regarding export of ore and return of material for back-filling, the company should review and conclude detail planning around the mine haulage strategy and requirement for underground ore storage:
- A more detailed concept for backfilling by means of pumps must be developed in the next project steps. In order to achieve a backfill level of 90%, the slope of the voids, the access point with the backfill pipe and the venting during filling must be taken into account."

26.3 Process Plant

The test work carried out to date is sufficient for the basic engineering. To optimize the full project, some test work is recommended to find out further cost reduction potential. The additional test work for optimization should focus on the following aspects:

- To further explore the application of ore sorting technology with the goal of
    - Reduction of material for comminution (size reduction) and thus cost / energy reduction.
    - Improve overall process efficiency through the reduction of fines generated in comminution.
    - Facilitate geo-metallurgical control over the ROM-feed material to the mineral processing plant.
- Test work to check whether a tunnel kiln will be better in process stability and cheaper as a rotary kiln
- Evaluation of in-house grinding of limestone chunks to flour with the aim to reduce cost for additives
- Study to further improve SOP and PCC production planning, as economically significant by-products and integrate with the existing extended process design.
- Further test option for in-house production of potassium carbonate (K_2CO_3) from other potassium compounds to reduce costs and supply risks for this reagent. This generates a beneficial side effect if self-produced SOP is electrochemically converted into KOH and sulphuric acid whereby the produced KOH absorbs CO_2 from the flue gases or atmosphere to form K_2CO_3 [173]. Sulphuric acid can be considered as a saleable product. Explore the opportunity to additionally reduce the carbon footprint of the process.

- Carry out further test work for usage of “quartz sand” tailings for concrete and lime sand brick manufacturing
- Carry out further test work for usage of “leached roasted product” tailings for coloured brick production
- Improve the energy efficiency of processes including heat-recovery, heat recirculation or reduction of overall heat / energy demand within the process stages.

26.4 Infrastructure

For infrastructure, it is recommended to improve the technical planning with respect to:

- The IAA Bielatal in close vicinity to the mine in Altenberg / Zinnwald is presently considered a viable option for mine material storage. Initial studies have been carried out with promising results [26]. It is recommended to continue the negotiations with the state company LMBV as owner of the landfill IAA Bielatal and with the Saxon Mining Authority for the permission procedure to finalize the contracts [46].
- The Company is advised to improve the understanding of present geotechnical properties of the IAA Bielatal facility in view of risk assessment and operational planning for dry-stack tailings placement.
- Alternative options for placement of dry stack tailings material should be investigated.
    - The backfilling procedure with the “leached roasted product” materials is the only long-term storage opportunity for this material until now. The company must continue to improve their planning for mine backfill design, backfill composition and wider operational backfilling strategy. This work must be aligned with the in-situ geotechnical requirements as well as the goal of environmental protection.
    - Integration of other materials into the backfill composition must be investigated, especially with regard to the possible environmental impact.
- Advance the negotiations for land usage / purchase required for surface installations.
- Advance negotiations for service contract for electric power and natural gas with local power companies as well as supply contracts for required reagents and materials
- Progress REACH / CLP registration with the European Chemicals Agency (ECHA) for required reagents as well as products.

26.5 Environment, Social and Governance Considerations

Environmental considerations of the Project are a critical aspect that are a key issue to be progressed. The following aspects should be advanced / improved in the further development of the Project:

- Carry out required environmental baseline surveys for the areas under consideration.
- Complete a comprehensive Environmental and Social Impact Assessment study that will quantify the expected impact of the project, with special regard to:
    - Local environment, flora and fauna
    - Local residents and stakeholders
    - Possible effect on local economy and businesses
    - Opportunities for additional benefit to local stakeholders by
        - Improved employment opportunities
        - Retention of younger residents and families in an area of overall ageing population
        - Improved local infrastructure for residents and businesses

To continue and intensify efforts of public participation and local stakeholder engagement. These must be carried out with the goal of better local understanding of the project and its potential benefits and risks.

26.6 Permitting

Successful engagement with consenting authorities must be continued and intensified in order to keep the targeted timelines for operational permitting of the project. Crucially, a clear permitting structure and designated responsible authorities for different parts of the project must be aligned with the requirements and technical aspect of this complex project. Dependency on separate permitting authorities for integrated processes could incur a delay risk to the permitting process overall. Keeping the progression of permitting processes in step with the overall technical development of the project is a crucial task, without which the project will not be realised.

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Appendix 1 – List of Definitions, Symbols, Units and Technical Terms

List of Definitions	
Title	**Explanation**
A / B	Resource class according to the resource classification of the former G.D.R, comparable approximately with the category “Measured”
Bulk density	In situ density of material
Cut-off grade	The lowest grade or quality of mineralized material that qualifies as economically mineable and available in a given deposit. May be de- fined on the basis of economic evaluation or on physical or chemical attributes that define an acceptable product specification.
C1	Resource class according to the resource classification of the former G.D.R, comparable approximately with the category “Indicated”
C2	Resource class according to the resource classification of the former G.D.R, comparable approximately with the category “Inferred”
Density	The mass or quantity of a given substance per unit of volume of that substance, usually expressed in kilograms or tonnes per cubic metre.
Dip	The maximum angle at which a planar geological feature is inclined from the horizontal.
Grade	Any physical or chemical measurement of the characteristics of the material of interest in samples or product.
Indicated Mineral Resource	That part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed.
Inferred Mineral Resource	That part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that may be limited or of uncertain quality and reliability.
Measured Mineral Resource	That part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity.
Mineralization	Any single mineral or combination of minerals occurring in a mass or deposit of economic interest. The term is intended to cover all forms in which mineralisation might occur, whether by class of deposit, mode of occurrence, genesis or composition.
Mineral Resource	A concentration or occurrence of material of economic interest in or on the Earth’s crust in such form, quality and quantity that there are rea- sonable prospects for eventual economic extraction. The location, quantity, grade, continuity and other geological characteristics of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral Resources are subdivided, in order of increasing geological confidence, into “Inferred”, “Indicated” and “Measured” categories.
Mineral Reserve	The economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified. Mineral Re- serves are sub-divided in order of increasing confidence into “Probable” Mineral Reserves and “Proved” Mineral Reserves.
NI 43-101	National Standard of Disclosure for Mineral Projects, enforced by the Canadian Securities Administrators (CSA)
PERC Code	The Pan European Reserves and Resources Reporting Committee (PERC) Code for reporting of exploration results, mineral resources and mineral reserves sets out minimum standards, recommendations and guidelines for public reporting of exploration results, mineral resources and mineral reserves in the United Kingdom, Ireland and Europe.
Pre-production period	A period of mine commissioning, construction of mechanical and chemical processing plant.
Recovery	The percentage of material of initial interest that is extracted during mining and/or processing. A measure of mining or processing efficiency.

List of element symbols and element oxide conversion factors				
Symbol	**Element**	**Oxide formula**	**Oxide**	**Multiply factor (element to oxide)**
Al	Aluminium	Al_2O_3	Aluminium oxide	1.8895
Ba	Barium	BaO	Barium oxide	1.117
Ca	Calcium	CaO	Calcium oxide	1.399
Cs	Caesium	Cs_2O	Caesium oxide	1.06
Fe	Iron	FeO	Iron (II) oxide	1.2865
Fe	Iron	Fe_2O_3	Iron (III) oxide	1.4297
K	Potassium	K_2O	Potassium oxide	1.2046
Mg	Magnesium	MgO	Magnesium oxide	1.6581
Mn	Manganese	MnO	Manganese oxide	1.2912
Na	Sodium	Na_2O	Sodium oxide	1.348
P	Phosphorus	P_2O_5	Phosphorus oxide	2.2914
Rb	Rubidium	Rb_2O	Rubidium oxide	1.094
Si	Silicon	SiO_2	Silicon oxide	2.1393
Sn	Tin	SnO_2	Tin oxide	1.2696
Sr	Strontium	SrO	Strontium oxide	1.185
Ti	Titanium	TiO_2	Titanium oxide	1.6681
W	Tungsten	WO_3	Tungsten oxide	1.2611

List of Lithium Salts and Lithium salt conversion factors				
Name	**Formula**	**Mass [g/mol]**	**Proportion Li [%]**	**Conversion factor**
Lithium element/metal	Li	6.941	100.00	1.000
Lithium oxide	Li_2O	29.880	46.46	2.152
Lithium carbonate	Li_2CO_3	73.887	18.79	5.323
Lithium fluoride	LiF	25.940	26.76	3.737
Lithium hydroxide	LiOH	23.946	28.99	3.450
Lithium hydroxide monohydrate	$LiOH.H_2O$	41.960	16.54	6.045
Lithium chloride	LiCl	42.392	16.37	6.107
Lithium nitrate	$LiNO_3$	68.944	10.07	9.933
Lithium sulphate	Li_2SO_4	109.940	12.63	7.920
Lithium sulfate monohydrate	$Li_2SO_4.H_2O$	127.995	10.85	9.220
Lithium phosphate	Li_3PO_4	115.790	17.98	5.561

Appendix 2 – List of Abbreviations

Abbreviation	Explanation
AAEC	Australian Atomic Energy Commission
AAS	Atomic absorption spectrometry
Actlabs	Activation Laboratories Ltd., Ancaster, Ontario (Canada)
ALS	ALS Global / ALS Romania SRL, Rosia Montana (Romania)
a.s.l.	Elevation above sea level
ATVC	Altenberg-Teplice volcanic complex (also Altenberg-Teplice caldera)
BBergG	Bundesberggesetz (Federal Mining Act)
BC	Kataclastic breccia (lithology in model)
BBF	Baubüro Freiberg GmbH
BE	Basic engineering
BFS	Bankable Feasibility Study
BOO	Build, own, operate
BSE	Back scattered electron
CAD	Computer-aided design
CAGR	Capex Growing
CHS	Channel sample
CAPEX	Capital expenditure
CEF	Balance measures
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CHS	Channel sample
CIF	Cost, Insurance & Freight
CIM	Canadian Institute of Mining
COO	Chief Operation Officer
C.P.	Competent Person (according to PERC Standard)
CSO	Chief Sales Officer
CTO	Chief Technical Officer
CZ	Czech Republic
DDH	Diamond drillhole
DGEG	Deutsche Gesellschaft für Erd und Grundbau (German Society of Earthworks and Foundation Engineering)
DH	Drill hole
DIN	Deutsches Institut für Normung (German Institute of Standardization)
DIN 18136	German Standard No. 18136 for soil investigation and testing - unconfined compression test
DIN 52105	German Standard No. 52105 for testing compressive strength of natural stone
DL	Deutsche Lithium GmbH
D&M	Distribution and Marketing
E	East
EDX	Energy-dispersive X-ray spectroscopy
EEG	Renewable Energy Sources Act
EFG	European Federation of Geologists
EIA	Environmental impact assessment
EPCM	Engineering, Procurement, Construction and Management
EU	European Union
EUR	Euro
EurGeol	European Geologist (Professional who has had his training and experience peer reviewed and who practises in accordance with the EFC code of ethics. Listened in the register of European Geologists in the section EurGeol title available at www.eurogeologists.eu).
EV	Electric vehicle
EXW	Ex Works (name placed of delivery)
FEED	Front-end engineering design
FEL	Front-end loader
FFOP	Facultative frame operation plan
FGD	Flue gas desulfurization
FIBC	Flexible intermediate bulk container
fl	Fluorite
FM	Finance model

FMC	FMC Corporation
FP	Flame photometry
FS	Feasibility study
GA	Dyke rock (lithology in model)
GDO	Large rotary kiln
G.D.R.	German Democratic Republic
G.E.O.S.	G.E.O.S. Ingenieurgesellschaft mbH
GFE F	VEB Geologische Forschung und Erkundung Freiberg (former G.D.R. company for geological research and exploration)
GL	Gallery
Gy L	VEB Geophysik Leipzig (former G.D.R. company)
HEV	Hybrid electric vehicles
HIMS	High intensity magnetic separation
HPGR	High pressure grinding roll
HQ	Diamond core drilling with core diameter 63.4 mm
HR	Human resources
IAA	Industrial setting plant
ICP-AES	Inductively coupled plasma - atomic emission spectrometry
ICP-MS	Inductively coupled plasma - mass spectrometry
ICP-OES	Inductively coupled plasma - optical emission spectrometry
IRR	Internal rate of return
IS1	Internal standard 1 (high grade standard)
IS2	Internal standard 2 (low grade standard)
ISE	Ion-selective electrode
ISO	International Standards Organization
ISO 9001	International Standard 9001 for quality of management systems
ISO 17025	International Standard17025 for general requirements for the competence of testing and calibration laboratories
IT	Information technology
KDO	Small rotary kiln
KV	Loss of drill core
LCE	Lithium carbonate equivalent
LFA	Lignite filter ash
LfULG	Federal State Office for Agriculture, Environment and Geology of Saxony
LHD	Load - Haul – Dump Technology
LMBV	Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH
Li-OG63	Analysis of lithium by 4-acid digestion and ICP-AES (ALS Romania SRL, range 0.005 – 10 %)
LOI	Loss of ignition
LOMP	Life of mine plan
ME-4ACD81	Analysis of base metals by 4-acid digestion and ICP-AES (ALS Romania SRL)
ME-MS81	Analysis of 38 elements by lithium borate fusion (FUS-LI01) and ICP-MS (ALS Romania)
ME-XRF05	Analysis of single elements by pressed pellet XRF (ALS Romania)
MLA	Mineral Labaration Analyzer
msc	Muscovite
my	Mylonite (lithology in model)
N	North
n.a.	Not analyzed
NCA	Nickel cobalt aluminium battery
NE	Northeast
NI 43-101	National Instrument 43 – 101 Standard of Disclosure for Mineral Projects
NMC	Nickel cobalt aluminium battery
NNE	Northnortheast
NNW	Northnorthwest
NPV	Net present value
NQ	Diamond core drilling with a core diameter of 47.6 mm
NW	Northwest
OIC	Older intrusive complex
OK	Percussion drilling
OPEX	Operational expenditure
PDC	Process design criteria

PDF	Portable document format
PERC (Standard)	Compliance and Guidance Standards Proposed by Pan-European Reserves & Resources Reporting Committee ("The PERC Reporting Standard")
PFS	Prefeasibility study
PG	Albite granite (lithology in model)
PG_GGM_1	Weakly greisenized albite granite (lithology in model)
PG_GGM_2	Medium greisenized albite granite (lithology in model)
PG_GGM_3	Strongly greisenized albite granite (lithology in model)
PG_PR	Porphyritic albite granite (lithology in model)
PG_PR_GGM_1	Weakly greisenized porphyritic albite granite (lithology in model)
PG_PR_GGM_2	Medium greisenized porphyritic albite granite (lithology in model)
PG_PR_GGM_3	Strongly greisenized porphyritic albite granite (lithology in model)
PG_UK	Stockscheider (lithology in model)
PL	Poland
PLS	Pregnant leach solution
PPG	Porphyritic protolithionite granite
PPM	Porphyritic protolithionite microgranite
PQ	Diamond core drilling with a core diameter of 85.0 mm
PZM	Porphyritic zinnwaldite-microgranite
Q	Quaternary (lithology in model)
QA/QC	Quality assurance / Quality control
Q.P.	Q.P. Qualified Person (according to NI 43-101)
Q1, Q2, Q3, Q4	Year quarter1 to 4
qtz	Quartz
RBS	Rock bulk sample
RC	Resource category
RC DH	Reverse circulation drill hole
RCS	Rock chip sample
REACH	Registration, Evaluation, Authorization and restriction of chemicals
ROM	Run-of-mine ore
RQD	Rock quality designation index
R2	Linear coefficient of correlation
R&D	Research and development
S	South
SA	Spectral analyses
SOBA	Sächsisches Oberbergamt (Mining Authority of Saxony)
SD	Standard deviation
SE	Southeast
SEM	Scanning electron microscope
SGK	Staatliche Geologische Kommission (State Geological Commission of the former G.D.R.)
SOP	Sulphate of potash (K_2SO_4)
SQM	Sociedad Química y Minera
SSE	Southsoutheast
SSW	Southsouthwest
StVK	Staatliche Vorratskommission (State Resource Committee of the former G.D.R)
SW	Southwest
SWS	SolarWorld Solicium GmbH
SY	Syenite (lithology in model)
TBS	Tiefer-Bünau-Stollen gallery
TF	Feldspatite or metasomatized feldspathic rock (lithology in model)
TGGM	Mica greisen (lithology in model)
TGQ	Quartz greisen (lithology in model)
TGQ+GM	Quartz mica greisen (lithology in model)
THG	Tiefe-Hilfe-Gottes Stollen gallery
TINCO	TINCO Exploration Ltd.
to	Topaz
TR	Teplice Rhyolite
TU BAF	Technical University Mining Academy Freiberg
UG	Microgranite (lithology in model)
UG_GGM_1	Weakly greisenized microgranite (lithology in model)

UG_GGM_2	Medium greisenized microgranite (lithology in model)
UG_GGM_3	Strongly greisenized microgranite (lithology in model)
UG_GQ_3	Microgranite with strong quartz greisenization (lithology in model)
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
US$	US Dollar
UVR-FIA	UVR-FIA GmbH
VA	Measures for special protection
VBGU	Union for Mining, Geology and Environment
VEB	Public owned enterprise of the former G.D.R.
W	West / also Wolfram = "Tungsten"
WRRL	Water Framework Directive
XE	Xenolith (lithology in model)
XRD	X-ray diffraction analysis
XRF	X-ray fluorescence analysis
YI	Rhyolite (lithology in model)
YI_GGM_1	Weakly greisenized Teplice rhyolite (lithology in model)
YI_GGM_2	Medium greisenized Teplice rhyolite (lithology in model)
YI_GGM_3	strong greisenized Teplice rhyolite (lithology in model)
YI_GQ	Teplice rhyolite with quartz greisenization (lithology in model)
YIC	Younger intrusive complex
ZAG	Zinnwald Albite Granite
ZG	Zinnwald Granite
ZGI	Zentrales Geologisches Institut (Central Geological Institute of the former G.D.R.)
ZW	Zinnwaldite