3 ULiBS

Li

Understanding lithium-bearing systems in Sweden

2022/03373

Sustainable and innovative exploration and exploitation of Swedish lithium ores

Project leader
Karin Högdahl, Uppsala University

Partners
Orexplore Systems AB, Bergby Lithium AB

Project duration
2023-04-01 – 2026-03-31

SWEDISH MINING INNOVATION

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Goals of the ULiBS-project

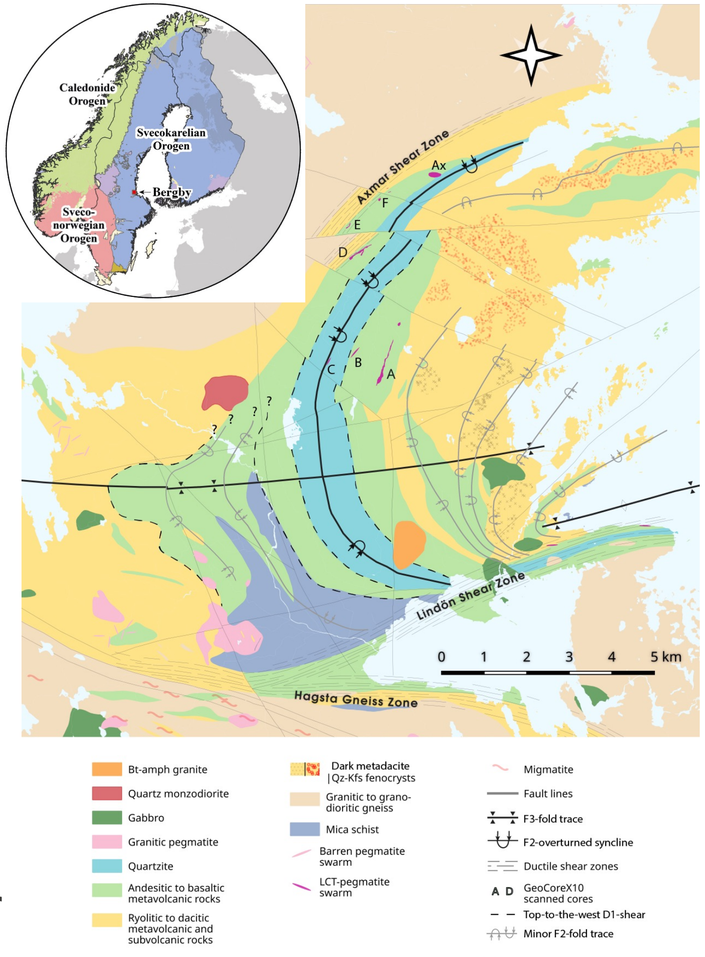
Characterise the Li-ore field at Bergby, central Sweden, constrain the geological evolution and the tectonostratigraphic position of the Li-bearing rocks

Develop Orexplore GeoCore X10 XCT-XRF drill core scanning technique for Li-ores

Calculate the proportion of the main ore phases (petalite and spodumene)

Determine the composition of gangue minerals and evaluate their suitability for industrial applications

Test and assess field based spectroscopic methods for Li-exploration



Bergby LCT-pegmatite field

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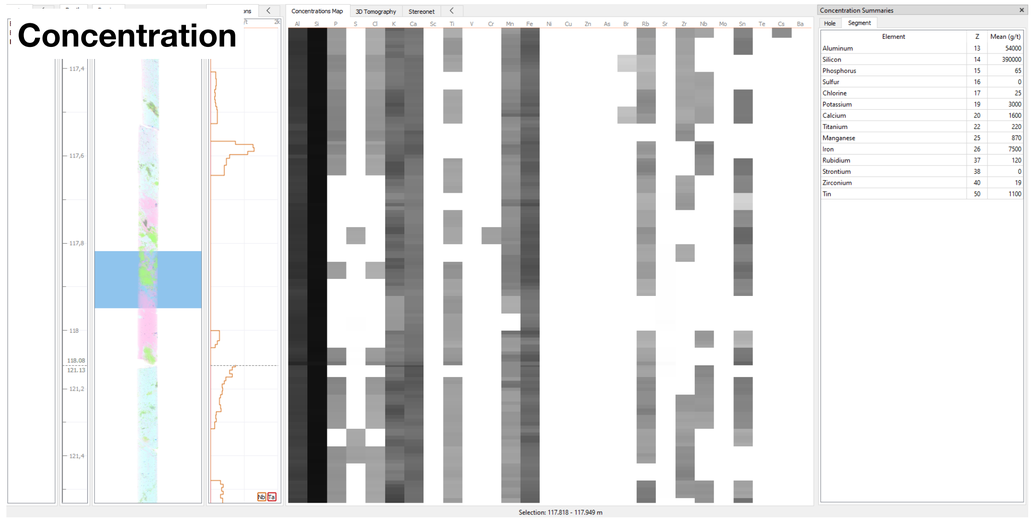
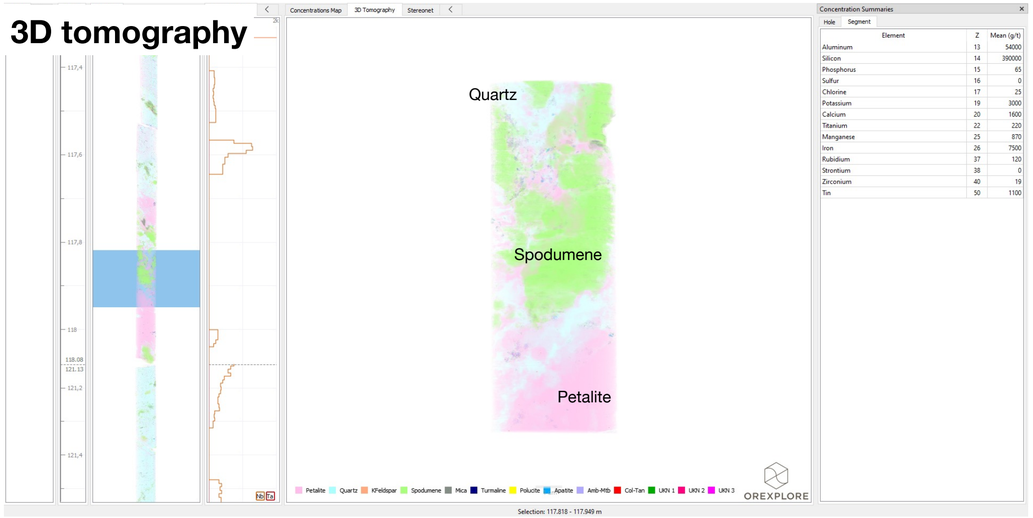
Orexplore GeoCore X10 and Insight®

Orexplore GeoCore X10 XCT-XRF drill core scanner





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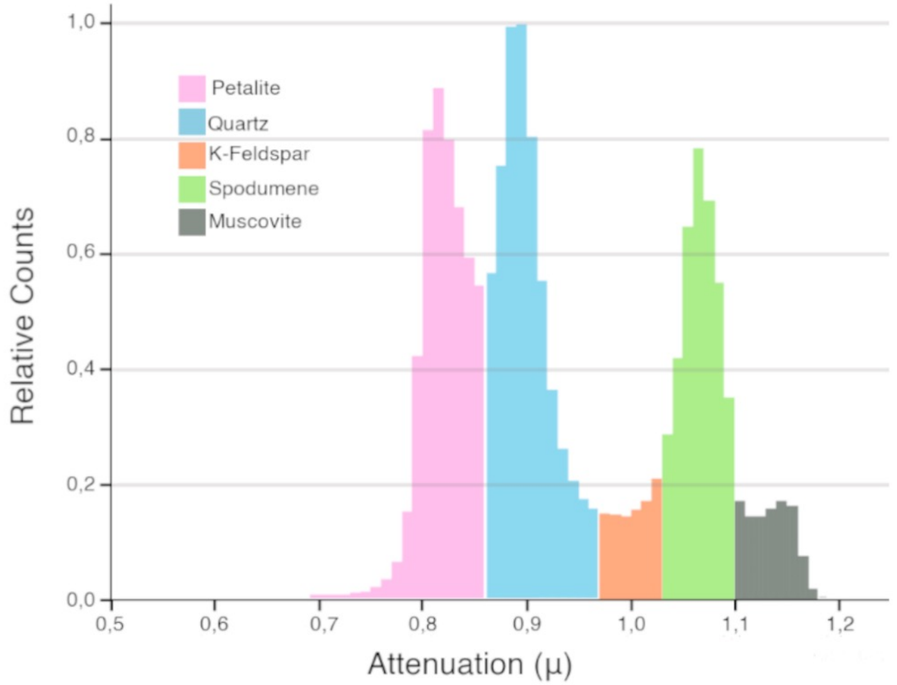
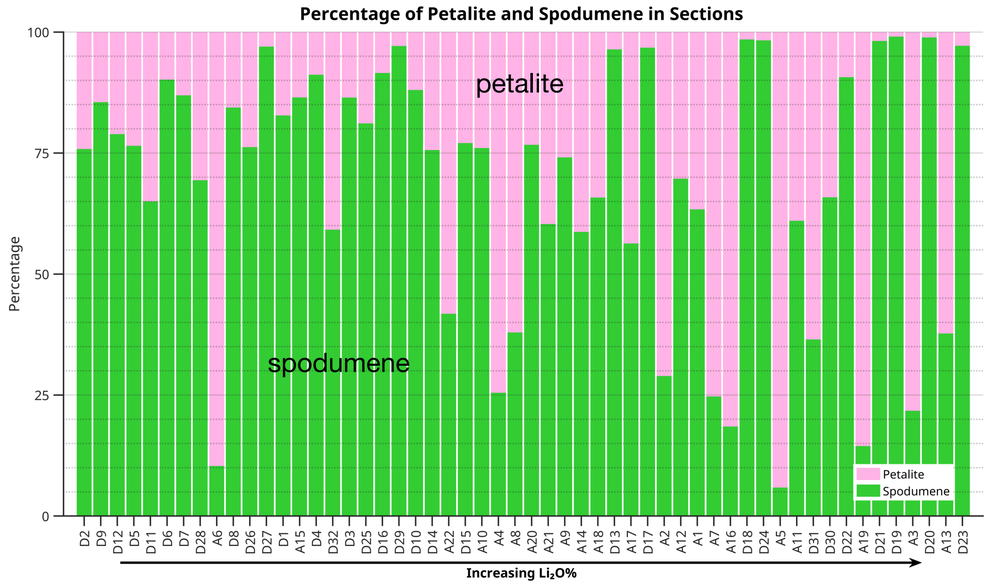
Results: Orexplore GeoCore X10

- The attenuation intervals for all minerals have been defined
- The proportion of the two main ore minerals (spodumene and petalite) and the Li-concentration have been calculated from the volume of these minerals
- The proportion corresponds to chemscan on concentrates
- The Li-concentrations is generally lower than assay-data
- Related to the presence of other Li-bearing species





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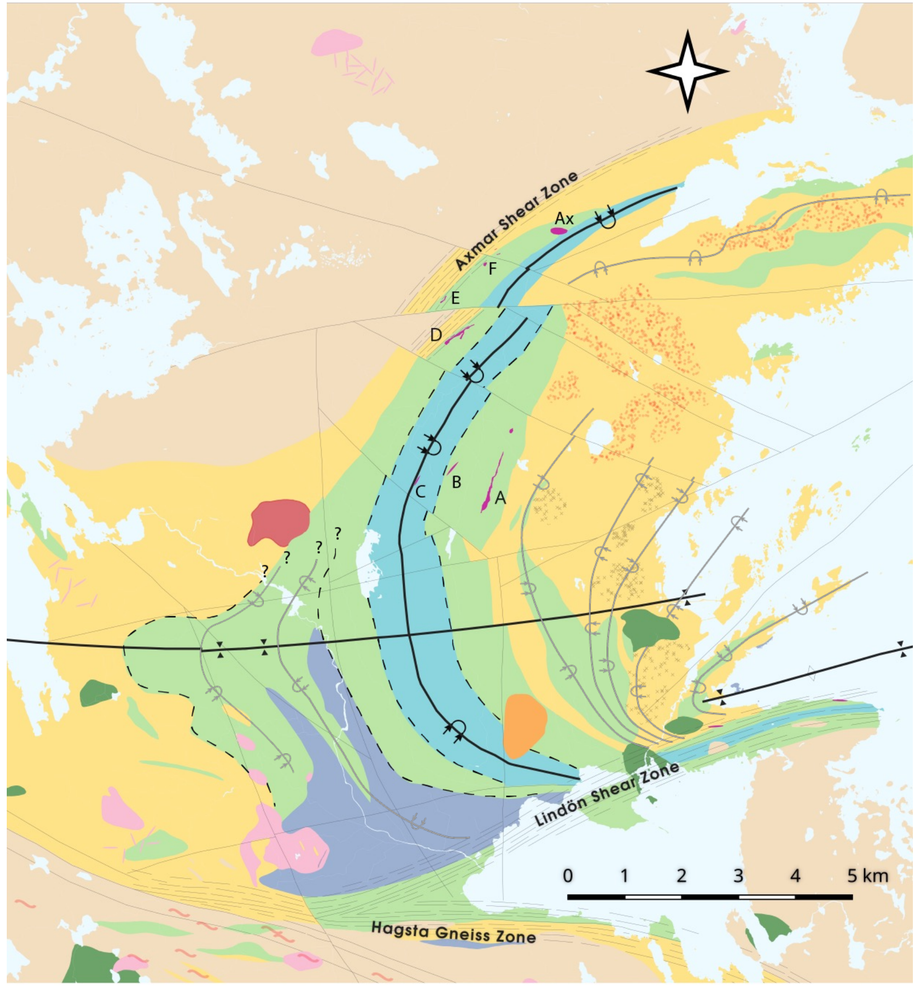
Results: structural evolution of the Li-ore field

- The supracrustal rocks define a refolded synform
- Several lower order F2 and F3 folds and top-to-the-west D2-shear zones have been identified
- Larger off-set of the faults to the north than previously known
- Pegmatites D and E-F belong to the same dyke swarm system



Bt-amph granite
Quartz monzodiorite
Gabbro
Granitic pegmatite
Quartzite
Andesitic to basaltic metavolcanic rocks
Ryolitic to dacitic metavolcanic and subvolcanic rocks
Dark metadacite | Qz-Kfs fenocrysts
Granitic to grano-dioritic gneiss
Mica schist
Barren pegmatite swarm
LCT-pegmatite swarm
Migmatite
Fault lines
F3-fold trace
F2-overturned syncline
Ductile shear zones
A D GeoCoreX10 scanned cores
Top-to-the-west D2-shear
Minor F2-fold trace

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Results: geochronology of the Li-ore field

- U-Pb zircon and monazite SIMS geochronologi on post-metamorphic intrusive rocks
- 1.80 Ga ms-granite, barren and Li-pegmatites
- 1.70 Ga Quartz monzodiorite and bt-amph-granite
- Li-pegmatites and gabbro in shear zones have accommodated parts of the strain

➢ All three major shear zones have recorded late-orogenic plastic deformation at c 1.80 Ga

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Results: Gangue mineral – purity of quartz

- Quartz and albite are the main gangue minerals
- Quartz amounts to c 25 wt% of the rock volume
- The trace element concentrations are between **65-110** ppm (LA-ICP-MS analyses)
- Less then **10 ppm** (ultra high purity quartz) is required for high-tec silicon production
- Good enough for lab glas ….

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Upcoming activities and next step

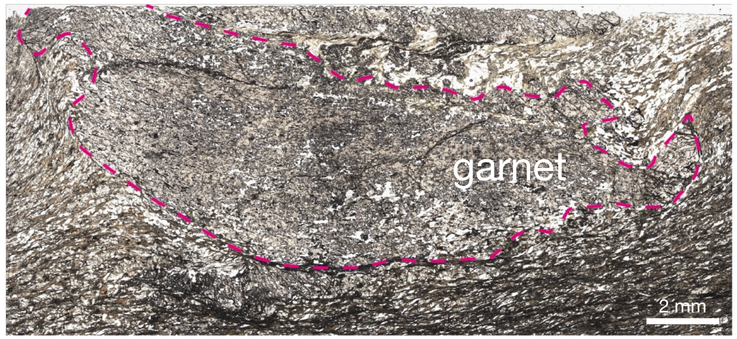
Thermobarometry on early-, syn- and post-kinematic garnet

U-Pb LA-ICP-MS chronology on tapiolite

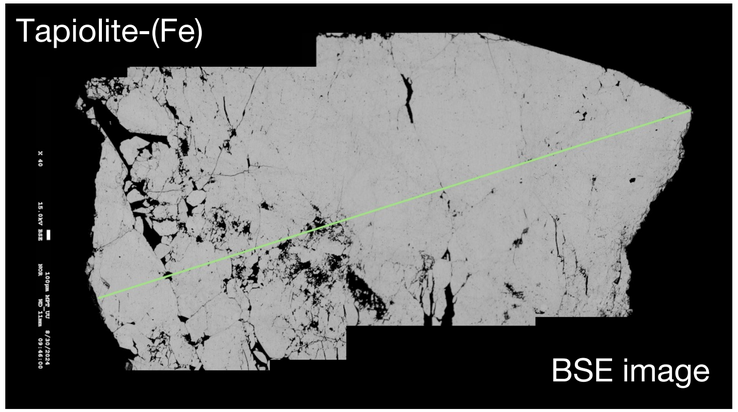
Evaluate wavelength specific spectroscopic Li-exploration methods on drill cores

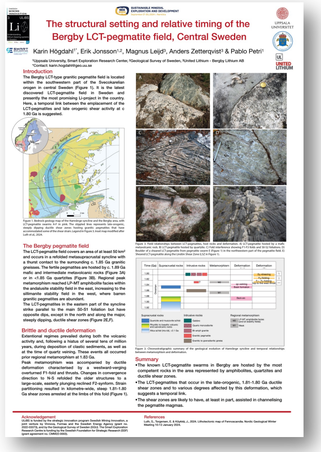
Presentation at the Nordic Geological Winter Meeting, Turku

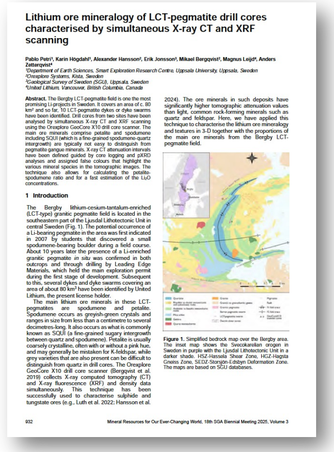
Compilation of data for publications scientific journals



Transmitted plane polarised light







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Publications

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Orexplore Systems and Berby Lithium at FEM last week

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Dissemination

- 5 excursions (GreenPeg, SMS*2, NODD, Geologins Dag)
- 4 BSc theses
- 8 scientific meeting presenations (7 abstracts)
- 1 popular scientific paper
- 8 presentations (FEM*2, Stand-up, IVA, SNKG, Serbian Embassy, SERC and MSc-course on critical metals and minerals)

FIELD TRIP GUIDE
The Bergby LCT-pegmatite field
in the Hamrånge area, 26 April 2023

GREENPEG

GREENPEG International Conference - https://www.greenpeg.eu/

A boulder showing a very coarsely crystallised spodumene and petalite-bearing granitic pegmatite in contact with a c. 1.89 Ga metabasalt, Bergby LCT-field (photo: K. Högdahl).

Magnus Leijd[1], Karin Högdahl[2], Erik Jonsson[2,3] & Anders Zetterqvist[1]

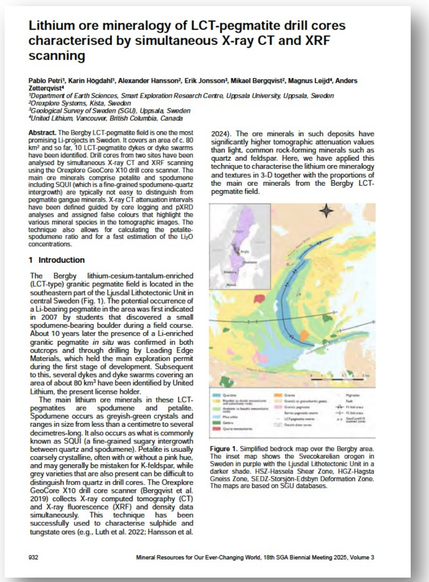
[1]Bergby Lithium AB, [2]Uppsala University, [3]Geological Survey of Sweden

Geologins Dag 13/9 2024
Berggrunden i Hamrånge
Karin Högdahl, Uppsala universitet

Berggrunden i Hamrånge tillhör den berggrundsprovins som delas av östra Sverige och södra halvan av Finland (Figur 1). Den bildades för mellan 2000 och 1800 miljoner år sedan och brukar benämnas Svekokarelska bergskedjan. Den har genom årmiljonerna eroderat ner till det flacka landskap vi har idag. I Gästrikland domineras berggrunden i denna provins av gnejs (brunt i Figur 1) och granit förutom på några platser däribland Hamrånge. I detta område finns bergarter som bildades som en urtida sandstrand och av lava och aska från vulkaner som en gång fanns här. När den Svekokarelska bergskedjan bildades veckades berggrunden och fick det mönster som framträder på geologiska kartor. Efter veckningen blev den förstenade sandstranden och vulkanernas bergarter genomträngda av svarta (gabbro) och röda graniter samt den vita och ibland röda litiumrika bergart som kallas pegmatit. Långt senare under istiden, för mellan ungefär hundratusen till tiotusen år sedan, maldes berggrundsytan ned av den tjocka inlandsisen som också bröt loss och förflyttade både stora och små bergblock. Vissa bergarter har varit mer motståndskraftiga mot att brytas sönder medan andra har varit mer benägna att spricka och bilda just stora stenblock.

På en berggrundsgeologisk karta representeras olika bergarter med olika färger, och de som förekommer i Hamrånge beskrivs nedan.

Figur 1. Karta över Norden som visar olika berggrundsprovinser. Berggrunden i östra delen av Sverige och södra halvan av Finland bildades för mellan 2000 och 1800 miljoner år sedan och är den nederoderade resten av den Svekokarelska bergskedjan (i orange). Kartan kommer från Stephens 2020.
Kartan till höger visar berggrunden Hamrångeområdet. Olika bergarter är representerade av olika färger. Kartan är baserad på data från SGU samt eget arbete och är konstruerad av Pablo Petri.



Lithium ore mineralogy of LCT-pegmatite drill cores characterised by simultaneous X-ray CT and XRF scanning

Pablo Petri[1], Karin Högdahl[2], Alexander Hansson[2], Erik Jonsson[2], Mikael Bergqvist[2], Magnus Leijd[4], Anders Zetterqvist[4]
[1]Department of Earth Sciences, Smart Exploration Research Centre, Uppsala University, Uppsala, Sweden
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[4]United Lithium, Vancouver, British Columbia, Canada

Abstract. The Bergby LCT-pegmatite field is one the most promising Li-projects in Sweden. It covers an area of c. 80 km² and so far, 10 LCT-pegmatite dykes or dyke swarms have been identified. Drill cores from two sites have been analysed by simultaneous X-ray CT and XRF scanning using the Orexplore GeoCore X10 drill core scanner. The main ore minerals comprise petalite and spodumene including SQUI (which is a fine-grained spodumene-quartz intergrowth) are typically not easy to distinguish from pegmatite gangue minerals. X-ray CT attenuation intervals have been defined guided by core logging and pXRD analyses and assigned false colours that highlight the various mineral species in the tomographic images. The technique also allows for calculating the petalite-spodumene ratio and for a fast estimation of the Li_2O concentrations.

1 Introduction

The Bergby lithium-cesium-tantalum-enriched (LCT-type) granitic pegmatite field is located in the southeastern part of the Ljusdal Lithotectonic Unit in central Sweden (Fig. 1). The potential occurrence of a Li-bearing pegmatite in the area was first indicated in 2007 by students that discovered a small spodumene-bearing boulder during a field course. About 10 years later the presence of a Li-enriched granitic pegmatite *in situ* was confirmed in both outcrops and through drilling by Leading Edge Materials, which held the main exploration permit during the first stage of development. Subsequent to this, several dykes and dyke swarms covering an area of about 80 km² have been identified by United Lithium, the present license holder.

The main lithium ore minerals in these LCT-pegmatites are spodumene and petalite. Spodumene occurs as greyish-green crystals and ranges in size from less than a centimetre to several decimetres-long. It also occurs as what is commonly known as SQUI (a fine-grained sugary intergrowth between quartz and spodumene). Petalite is usually coarsely crystalline, often with or without a pink hue, and may generally be mistaken for K-feldspar, while grey varieties that are also present can be difficult to distinguish from quartz in drill cores. The Orexplore GeoCore X10 drill core scanner (Bergqvist et al. 2019) collects X-ray computed tomography (CT) and X-ray fluorescence (XRF) and density data simultaneously. This technique has been successfully used to characterise sulphide and tungstate ores (e.g., Luth et al. 2022; Hansson et al. 2024). The ore minerals in such deposits have significantly higher tomographic attenuation values than light, common rock-forming minerals such as quartz and feldspar. Here, we have applied this technique to characterise the lithium ore mineralogy and textures in 3-D together with the proportions of the main ore minerals from the Bergby LCT-pegmatite field.

Figure 1. Simplified bedrock map over the Bergby area. The inset map shows the Svecokarelian orogen in Sweden in purple with the Ljusdal Lithotectonic Unit in a darker shade. HSZ-Hassela Shear Zone, HCZ-Hagsta Gneiss Zone, SEDZ-Storsjön-Edsbyn Deformation Zone. The maps are based on SGU databases.

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