

Critical Raw Materials in ores, waste rock and tailings in Bergslagen

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Cover photo: Waste rock heap at Lilla Dammbergsgruvan in
the Stollberg field.
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SAMMANFATTNING

Inom det av näringsdepartementet angivna regeringsuppdraget "Uppdrag att kartlägga innovationskritiska metaller och mineral" (diarienummer: N2018/01044/FÖF) som tidigare rapporterats av Claeson m.fl. (2020), utfördes undersökningar vid flera platser i Bergslagen. Denna rapport behandlar provtagning och analys av borrkärnor och gruvavfall, huvudsakligen anrikningssand, i Bergslagen.

Provtagning av borrkärnor och gruvavfall, kombinerat med insamlaget av statistiska uppgifter om mängd bruten och bearbetad malm, har pågått vid SGU sedan 2016 (Huisman *et al.* 2017, Hallberg & Reginiussen 2018a). Under 2019 fokuserades arbetet på provtagning av fler sandmagasin i Bergslagen, förtädat provtagning i sandmagasinet där tidigare undersökningar påvisat anomala halter av kritiska råmaterial (eng. *Critical Raw Materials, CRM*) samt tätare provtagning av borrkärnor vid två fyndigheter med påvisade anomala halter CRM. Litogeokemiska multielementanalyser ger ny och viktig information om var och hur mycket CRM som finns samt vilka huvudelement som de associerar till. Genom att relatera dessa analysresultat till annan information om gruvorna och anrikningsverken, till exempel mängd och metallhalt på utbruten malm och gruvavfall, går det att få kunskap om förekomsten av kritiska råmaterial i kvarvarande malm och i sandmagasinet.

Resultaten redovisas i kartor och tabeller med analysdata samt en noggrannare genomgång av potentiella tillgångar i sandmagasinet och kvarvarande malm i fyra områden – Riddarhyttefältet, Grängesbergsfältet, Yxsjöberg och Stollberg – där statistiska data sammanvägs med litteraturuppgifter och provtagningsresultat.

Resultaten från detta och tidigare projekt visar att metodiken med översiktlig provtagning och analys av borrkärnor och gruvavfall är en snabb och kostnadseffektiv metod för att få en överblick av förekomsten av såväl kritiska råmaterial som huvudmetaller. Den metodik som används i projektet är även tillämpbar för att identifiera och översiktligt kvantifiera förekomst av skadliga ämnen.

ABSTRACT

Surveying activities were carried out at several locations in the Bergslagen region, as part of an assignment appointed by the Ministry of Enterprise and Innovation that focuses on critical raw materials in Sweden (Claeson *et al.* 2020). This report deals with sampling and analysis of drill cores and mining waste, mainly tailings, in Bergslagen.

Sampling of drill cores and mining waste, combined with collection of statistical data on the amount of mined and processed ore, has been ongoing at SGU since 2016 (Huisman *et al.* 2017, Hallberg & Reginiussen 2018a). Work continued during 2019 with sampling of additional tailings in Bergslagen as well as detailed sampling where previous investigations had shown anomalous levels of critical raw materials (CRM) and more frequent sampling of drill cores at two deposits with detected anomalous levels of CRM. Lithogeochemical multi-element analyses provide new and important information about where and how much of CRM there is and what main elements they associate with. By relating these analysis results to other information about mines and concentrators, such as the amount and metal content of mined ore and mining waste, it is possible to gain knowledge about the presence of critical raw materials in residual ore and tailings.

The results are reported in maps and tables of analyses as well as a more detailed review of potential assets in tailings and remaining ore in four areas – Riddarhyttefältet, Grängesberg, Yxsjöberg and Stollberg – where statistical data are weighed together with literature data and sampling results.

The results show that the methodology with general sampling and analysis of drill cores and mining waste is a fast and cost-effective method for gaining an overview of the presence of both critical raw materials and main metals. The methods used in the project are also applicable to identify and summarise the presence of harmful substances.

INTRODUCTION

Access to raw materials is fundamental to a modern and sustainable society. Technological developments and innovations generate increasingly complicated products that require a range of metals and raw materials hardly used before. Economic growth and development have increased global demand for many raw materials, and this trend is expected to continue.

With only about 3% of the world's metal-ore production and 25–30% of the world's metal consumption, Europe is heavily dependent on imports of many raw materials (Tiess 2010, Brown *et al.* 2016). The EU Commission launched the Raw Materials Initiative in 2008 as part of the efforts to secure the EU's access to critical raw materials. The term "critical raw materials" usually refers to metals and minerals that are of high economic importance to an industrial sector or geographical area, and for various reasons risk of being in short supply (Graedel *et al.* 2015).

Sweden is one of Europe's leading mining countries, with a mining history stretching back more than 1,000 years. Through the gathered documentation of mining and exploration, available in SGU's archives and databases, we have a good knowledge of how much iron, base metals (copper, zinc, lead, nickel) and precious metals that have been mined in the past and how much is available in the forms of resources and reserves. There is much less knowledge about where other metals, including critical raw materials, occur and in what quantities. This is because demand for these metals has historically been low, and they have been of little interest to the mining and exploration industry.

Production, processing and extraction of main and by-product metals have generated mining waste that contains unknown quantities of several metals including critical raw materials. Mining waste as a potential source for metals has received increased attention lately (e.g. Werner *et al.* 2015, Blengini *et al.* 2019, Kuhn and Meima 2019, Taha & Benzaazoua 2020). More than a thousand years of mining in Sweden has produced more than 2.0 billion tonnes of waste rock and from around year 1900, when mining statistics began to be reported in a modern way, an additional 1.5 billion tonnes of tailings have been produced (SGU's MALMdatabas). The 3.5 billion tonnes of mining waste may potentially contain large quantities of valuable materials including critical metals and minerals.

Although recycling and reprocessing of historic mining waste cannot replace primary production (EASAC 2016), it has advantages from an environmental viewpoint, and may serve as a complement to primary production. Before recycling of tailings can be considered, a careful characterization using petrography, mineral analysis and other aspects of the material must be performed. The economic and technical factors for extraction are important, and very much determine whether extraction will be possible. Recently, researchers from Luleå University of Technology have investigated historic tailings at Yxsjöberg in Bergslagen to characterize various aspects pertaining to the technical possibility of reprocessing as well as reducing negative environmental impact (Hällström *et al.* 2018, Mulenshi *et al.* 2019).

Previous work

SGU commenced reconnaissance sampling of tailings in 2016 during the ProSUM project (Huisman *et al.* 2017). This work continued in 2017 and 2018 as part of an assignment from the Swedish government to map the potential for extraction in Sweden of metals and minerals that are needed to manufacture new environmental and technical innovations being developed in Sweden and Europe, i.e. critical raw materials, CRMs (Fig. 1A). In that project, statistics of mining and mineral extraction was combined with new lithogeochemical multi-element analysis of drill cores and analysis of tailings, with the purpose to identify deposits and mining waste containing CRMs. Available analyses of drill cores, ore-deposits, and mining waste together with new multi-element analyses of drill cores and tailings were collected as part of the project in a database (Fig. 1B). The data and results were reported in 2018 (Hallberg & Reginiussen 2018a, b), in English in 2019 (Hallberg & Reginiussen 2019). A manual on the sampling of waste rock deposits (Sädbom & Bäckström 2018) was also produced in the project.

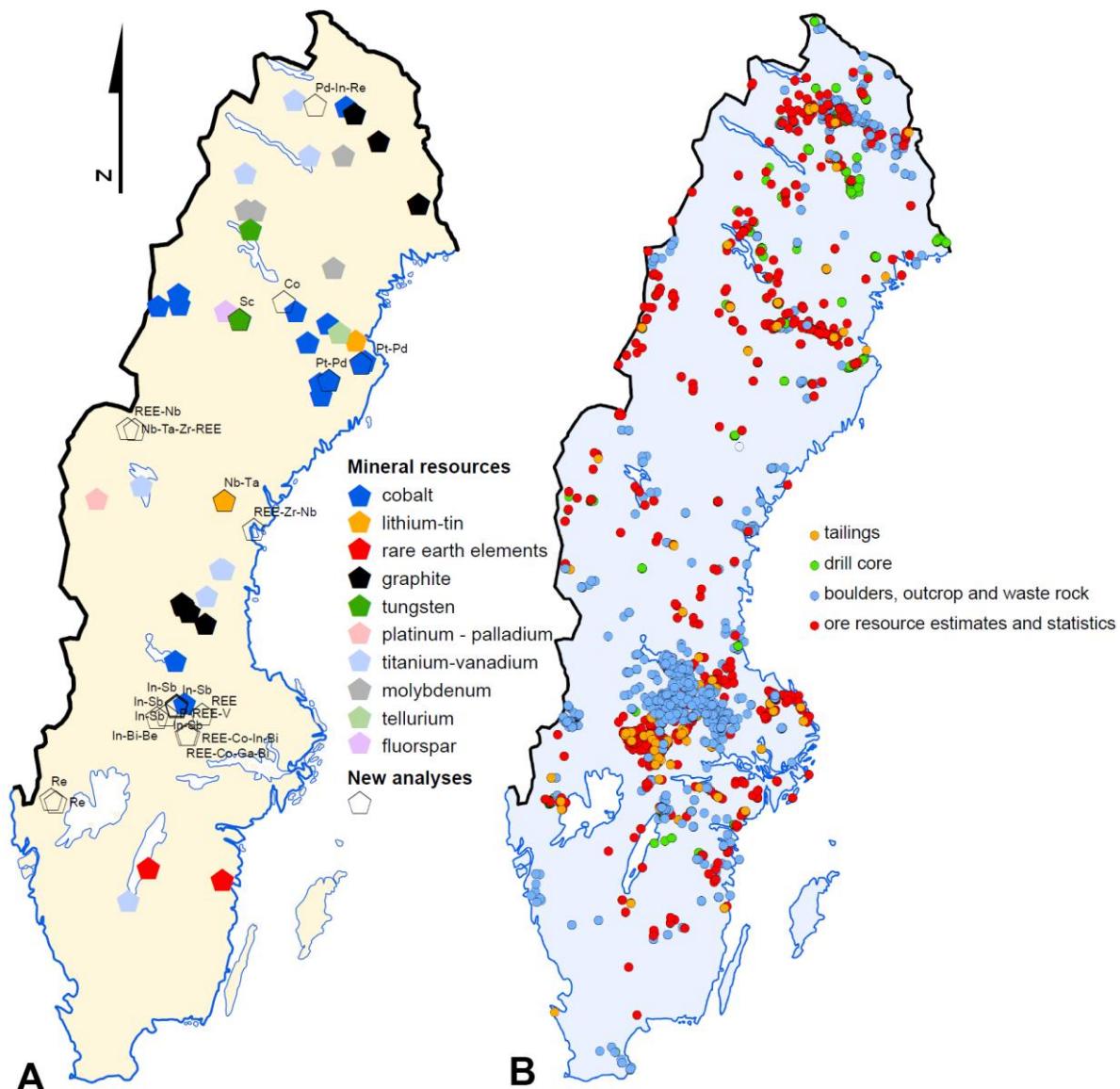


Figure 1. **A.** Map showing deposits with ore resource estimates of critical raw material including some data where digitised older analyses indicate the presence of CRMs in closed mines, in mining waste or in exploration projects. From Hallberg & Reginiussen (2018a). **B.** Location of all digitised analyses of sampled material. Data is reported in Hallberg & Reginiussen (2018b).

METHODS

Drill cores

Diamond drilling is used in the exploration and mining industry to probe the contents of known deposits and potential sites. By withdrawing a small diameter core of rock, geologists can map the underground and analyse the core by chemical assay and conduct other studies of the rock.

Public drill cores from more than 1,500 exploration objects, including 18,000 drill cores and more than 3,000,000 metres of core, are stored at SGU's Mineral resources information office at Malå.

The SGU's drill core scanning project (which lasted from 2014–2015) have produced an open-file dataset of hyperspectral imagery comprising 233,000 metres of selected drill cores from the Malå archive (SGU Website, Söderberg *et al.* 2020). The hyperspectral cameras used in the project measured reflectance spectra in the visible-near infrared and shortwave infrared (VNIR-SWIR) and the longwave infrared (LWIR) regions (Fig. 2B). Together the cameras acquired data in the wavelength ranges 380–2,500 and 7,500–12,000 nanometres. In combination the SWIR and LWIR ranges provide a system well suited for detection of alteration-related mineralogy as well as anhydrous silicate minerals. The system also includes a true-colour line scan camera for high-resolution optical images (Fig. 2A). Measuring across different wavelength ranges significantly increases the mineral detection capabilities of the technology.

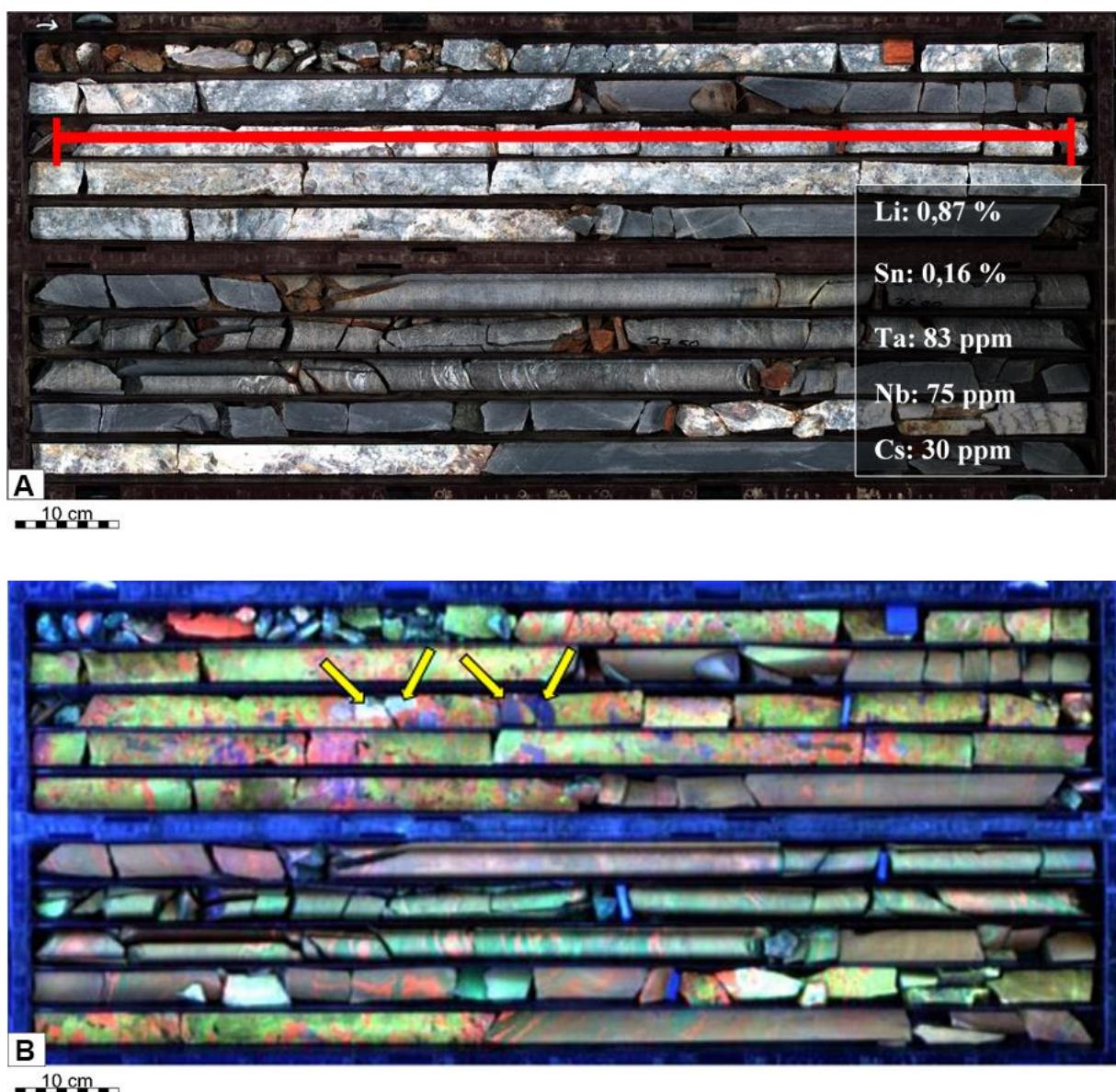


Figure 2. A. Photo of drill core tray with LCT pegmatite. Analytical results for selected elements in 1 m sampled section (red line) are shown. **B.** Same tray with a photo taken with an infrared camera and processed to a False Colour Composite image that uses data from the longwave infrared (LWIR) part of the infrared spectrum. The LWIR camera covers the wavelength interval 7,500–12,000 nanometres (nm) and three infrared bands are rendered in RGB using red = 8,611 nm, green = 10,022 nm, blue = 11,810 nm. The lithium mineral spodumene can be identified in the image and are marked with arrows.

Sampling of drill cores

Using the images produced in the scanning project together with SGU's database of mineral resources, Fennoscandian Ore Deposit Database (Eilu 2012), SGU's mining and mineral processing database MALMdb, digitized exploration reports, core logs and geological maps, a set of core sections was selected for sampling and chemical analyses. When possible, the original drill core sectioning was applied to the sampling, commonly 100–200 centimetres intervals. The sampling was focused on the mineralised parts and ore-zones of the selected objects. In some cases, shorter sections were selected. SGU requires that at least one quarter of the drill core is preserved in the drill core box after sampling. Unfortunately, several interesting sections had previously been sampled several times and could not be further sampled in this project.

Waste rock

Waste rock consist of barren rocks that was removed in order to access the ore by making shafts and drifts or remove wall-rock in open pits. Waste rock from mining activity is in most cases deposited close to the mine from which it originates, and it is therefore appropriate to register this waste type to the mine. In general, waste rock has a low economic value although old waste rock dumps might contain metals and minerals that are of economic interest. Waste rock is often used as aggregates at the mine-site or for other infrastructure purposes. Weakly mineralised rock, marginal ore, which was considered sub-economic at the time of mining, can also be found in waste rock dumps. At some mines this material has been deposited separately from barren waste rock for possible later processing. Other types of waste rock include waste generated from sorting of coarsely grained, crushed ore where rich ore is separated from gangue and from soil and rock that have been removed to uncover the ore.

Sampling of waste rock

The purpose of sampling waste rock in this study is to obtain the best possible data on the average metal content of waste rock heaps. A methodology for sampling has been outlined by Sädbom & Bäckström (2018). In summary they recommend the following approach:

Preparations at office:

- Plan the sampling by reviewing available mine maps, topographic maps in 1:10 000 scale, digital topographic data (LiDAR data), available reports on the deposit, data on other deposits in the area and ore production from the area (all of this data is available digitally).
- With the help of these data, it should be possible to get a preliminary view of where the waste rock comes from, how it was generated, how the material have been handled at the site, the size of the waste rock deposit and how and where it is deposited in the vicinity of the mine.

In the field:

- Make a mental map of the area by locating the mine from which the material comes, figure out how the mine has been operated and locate where the waste rock has been deposited (Fig. 3).
- Examine the waste rock deposit briefly and, if there are easily observed visual differences between different parts of the deposit, divide the deposit into sub-areas.
- Sample each sub-area by picking or hammering loose rock chips in the most objective manner possible.
- Normally the chips will be around 20–75 mm in size and a minimum of 25–50 pieces per sampling area is recommended and a total weight of about 2–5 kg.

Back at office/lab:

- Characterise the rock chips with respect to paragenesis or rock type, the number of rock chips of each rock type is counted (gives an estimate of the distribution of rock types) and weighed (gives an estimate of the impact on the analysis from each rock-type).
- The pooled sample is sent for analysis.

Sädbom and Bäckström (2018) added, based on their experience, that the minimum number of samples, in order to obtain a valid result with respect to the average concentrations ($\pm 25\%$) for the sample set is around 15 samples for waste rock and a step wise approach in analysing samples is recommended in order to obtain a valid result for larger sites. They finally state that “Sampling of mining waste is impossible, but it can still be done!”



Figure 3. Sampling a waste rock heap at Lilla Dammbergsgruvan (6673323/515472) in the Stollberg field. The waste rock material contains a mixture of limestone, skarn, felsic metavolcanic rock and galena-sphalerite mineralisation. Photo: Helge Reginiussen.

Tailings

Tailings is the residual product after the ore have been crushed and milled to a suitable grain size at a mineral processing plant (concentrator) and then treated with mechanical, gravimetric and/or chemical processes to recover economically interesting metals and minerals. The tailings are usually deposited in an impoundment or pond near the mineral processing plant. A mineral processing plant is often optimized for a certain ore-type and for the minerals that contain the main commodity. The recovery of the main commodity seldom exceeds 90% (except for high-value commodities like gold where recoveries close to 100% are observed). Other commodities that were not profitable at the time of processing might have a very poor recovery and be lost to the tailings. A mineral processing plant is not necessarily located at a mine site and ore from several mines within a mining district can be processed at one single processing plant. Therefore, the waste generated from a mineral processing plant must be linked to the concentrator that produced the waste and not to the mine from which the ore originally came.

Location of tailings

The location of tailings has been determined using an in-house SGU database of ore-dressing plants (MALMdb). With this knowledge of processing plant locations, the tailings have been located using GSD-Fastighetskartan, old digital aerial photographs and LiDAR data provided by the Swedish Land Survey and Google Earth. This method works well for modern tailings with distinct ridges or impoundments (see Fig. 4), but less well for older dams (pre 1945) where tailings have been deposited in natural topographic depressions or in lakes without impoundments. In these cases, field work is required to locate the tailings which are generally positioned at short distance down-hill from the ore-dressing plant.

Sampling of tailings

When the tailings were visited in the field, a brief assessment was made to find areas where sampling was possible. A few tailings dams had been covered by a layer of moraine, which was removed before sampling. The exact sampling locations were randomly selected. Sampling of sand was carried out with a shovel or hand-held Edelman auger (Fig. 5). At the sampling site, an approximately 40–70 cm deep hole was excavated or drilled to access non-weathered sand. Approximately 2 litres of sand were sampled at each locality. At some well remedied tailings dams, most notable the Saxberget dam (Envipro Miljöteknik AB, 2000), the cover was too thick and well compacted to permit sampling with this method. In some cases, the cover has been weakened and sometimes partially removed by landslides and natural erosion, making the tailings accessible for sampling. LiDAR data has been successfully applied to locate such areas at Brusmalmen in the Stollberg field (Fig. 4).

The samples were placed in plastic bags and the sample number, coordinates in SWEREF99TM, sample depth, colour and grain size were recorded. Back at office the samples were air-dried, the volume weight was determined for some samples and a sub-sample was taken for chemical analysis.

The remainder of the untreated sample was stored for reference and future work. The samples selected for chemical analysis, together with SGU standard samples were sent to ALS, Piteå for further preparation and analysis.

Ground penetrating radar

A test measurement was made with ground penetrating radar to determine the thickness of the tailings at Brusmalmen in the Stollberg field (see Fig. 8 in chapter *Results*). Ground penetrating radar is a geophysical method in which radar pulses emitted from a transmitter mounted on a moving device can be used to map the subsurface.

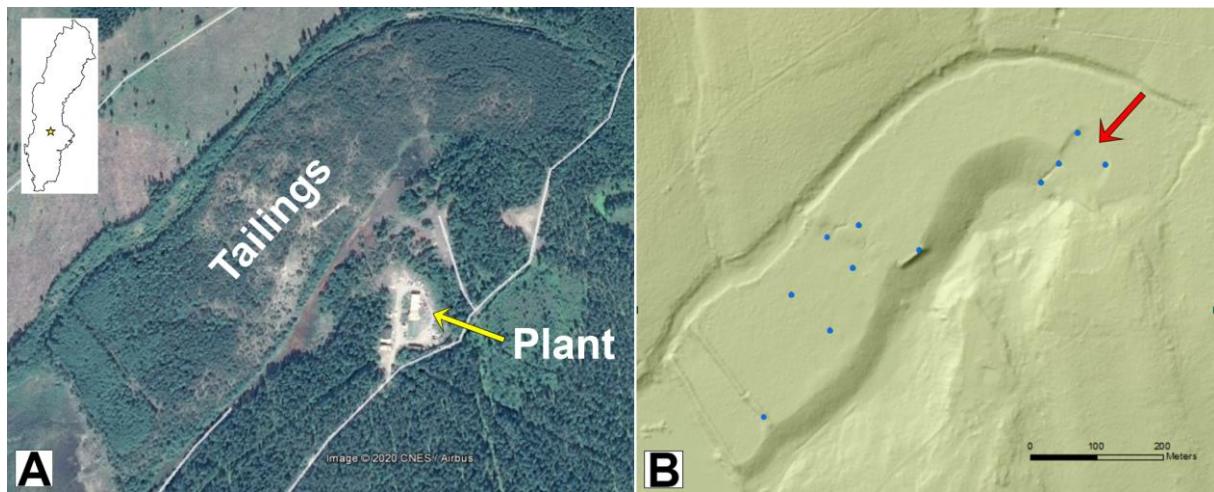


Figure 4. Brusmalmen tailings at the Stollberg field. **A.** Image from Google earth showing the outline of the tailings repository and the location of the historic ore-dressing plant. **B.** LiDAR data enables identification of topographic details not visible in the optical image. Red arrow shows an area where a landslide has exposed the covered tailings. Blue dots are sampling locations.



Figure 5. Sampling of tailings. **A.** Tailings from wolframite processing at Baggetorp (6509289/526788). **B.** Tailings from iron-ore processing at Askö (6556112/556991). Photo: Helge Reginiussen.

Lithogeochemical analysis

At ALS Piteå the samples were registered, weighed and milled to a <75 micrometre powder and a sub-sample was analysed. The ALS laboratory at Galway, Ireland was used for most of the samples. Several different sample digestion methods and analytical methods were used (appendix 1). Each batch included three SGU-standard samples. These standards have been used and analysed by SGU for more than 10 years and is used for continuous monitoring and control of the reproducibility of the analyses (Claeson D., pers. comm. 2020). The locations of the analysed samples are shown in Figure 6.

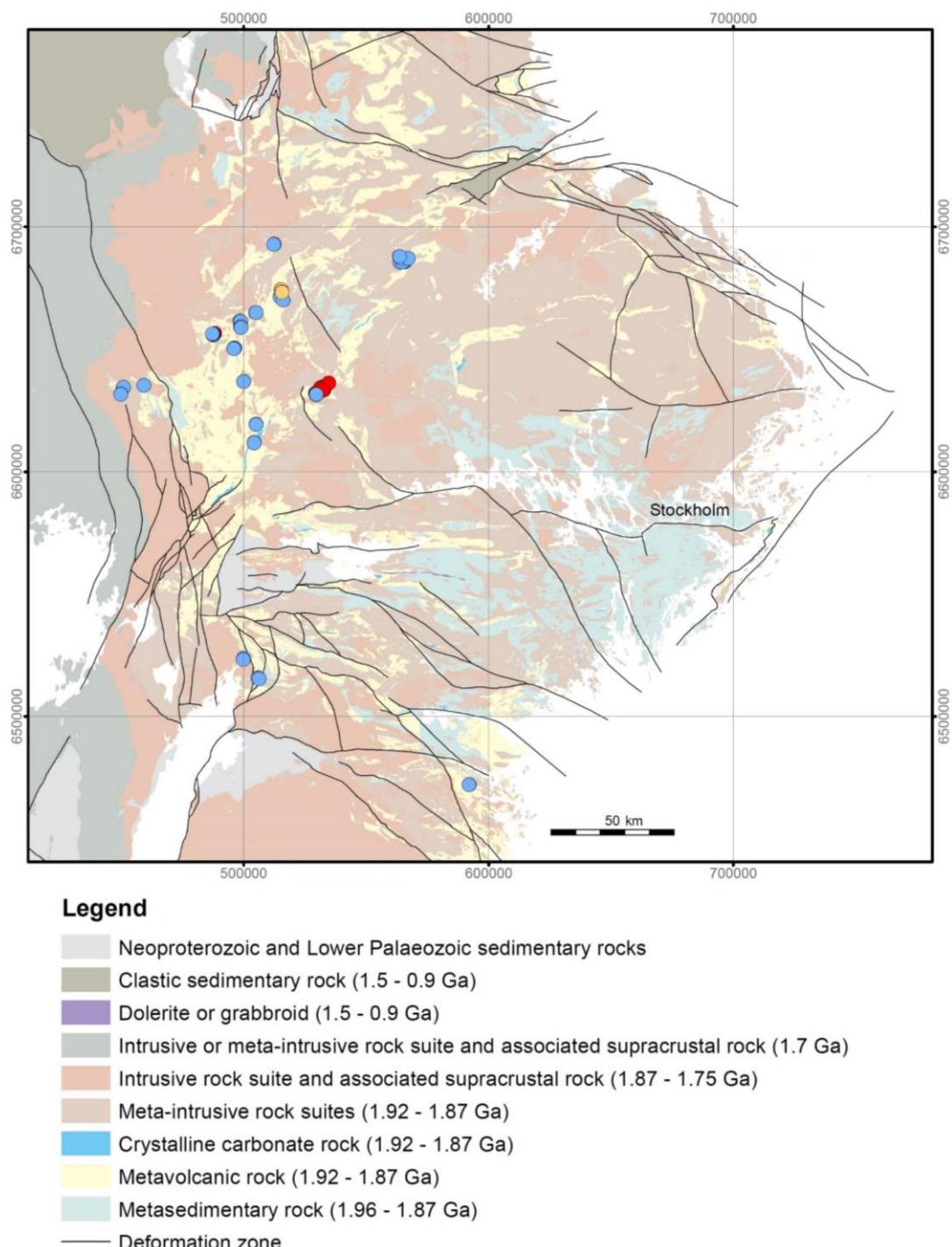


Figure 6. Sampling locations for waste rock (yellow dots), tailings (blue dots) and drill cores (red dots) in 2019. Simplified geological map from SGU's digital bedrock map in 1:1 million scale.

RESULTS

Drill cores

During 2019, 58 drill core sections were analysed. Together with analyses from previous work in the project (Hallberg & Reginiussen 2018a) around 380 multi-element analyses of drill core material from deposits in Sweden have been added to SGUs database. An additional c. 30,500 analyses, often with a limited number of analysed elements, have been digitised during this and previous work (Hallberg & Reginiussen 2018a, b) making up a database of 30,900 drill core analyses (Fig. 1B).

The focus in 2019 was the Yxsjöberg deposit and the Riddarhyttfältet from which 3 and 55 sections, respectively have been analysed, see Appendix 2. At Yxsjöberg the previously recorded anomalous contents of Be, Bi, Cu and W is confirmed. The data is further used in the discussion on the Yxsjöberg deposit and the Riddarhyttfältet in chapter *Focus on mining areas with critical raw materials*.

Waste rock

In 2019, a sampling campaign targeting two waste rock deposits in the Stollberg area was performed. Both deposits are located very close (< 100 meters) to the mines from which the waste rocks probably originated; the Myggruvan skarn iron ore deposit and the Lilla Dammbergsgruvan 3, 4 lead-zinc skarn deposits. The waste rocks at Lilla Dammbergsgruvan have been sampled and analysed for zinc, lead and silver previously (Månsson, 1982). SGU's sampling and analyses broadly agree with the results from Månsson (1982) though our results showed somewhat lower grades. The examination of the rock chips in the lab showed that they could be divided into five groups: limestone, galena-sphalerite mineralised rock, skarn, felsic volcanic rock, and quartz. A surprisingly large amount of the rock chips could be characterized as galena-sphalerite mineralised, both by number of chips and by weight (Table 1 and 2). The pie chart in Fig. 7, where all samples from the Lilla Dammbergsgruvan waste rock is shown, reveal that most of the rock chips consist of mineralised rock. The analyses showed high content of arsenic (more than 6,000 ppm As) and also high cadmium grades. The analysed samples did not show any economically interesting grades of CRMs. The analyses of the waste rocks are found in Appendix 3.

Table 1. Myggruvan, showing the distribution of collected rock fragments, in number of rock chips, weight in grams, and rock type.

Locality	Total sample weight	limestone		galena-sphalerite mineralization		skarn		felsic volcanic rock		quartz	
		# chips	weight	# chips	weight	# chips	weight	# chips	weight	# chips	weight
19083	2000	23	1086	6	247	15	589	2	87	-	-
19084	1300	5	118	10	386	16	587	14	255	-	-

Table 2. Lilla Dammbergsgruvan, showing the distribution of collected rock fragments, in number of rock chips, weight in grams, and rock type.

Locality	Total sample weight	limestone		galena-sphalerite mineralization		skarn		felsic volcanic rock		quartz	
		# chips	weight	# chips	weight	# chips	weight	# chips	weight	# chips	weight
19085	2500	17	696	12	893	18	894	-	-	1	55
19086	3200	17	838	28	1811	9	588	-	-	-	-
19087	1900	6	248	17	910	10	393	11	348	-	-
19088	3500	28	1165	31	1606	16	596	3	115	-	-

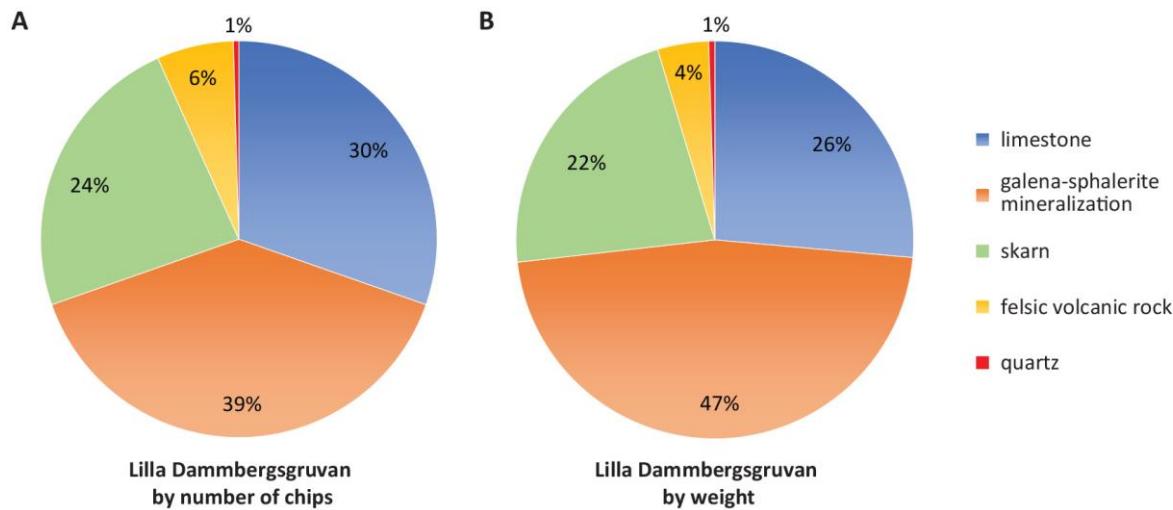


Figure 7. Summary of all samples of waste rock at Lilla Dammbergsgruvan (#19085–19088). **A.** Distribution by number of chips of combined samples. **B.** Distribution by weight of combined samples.

Sädbom & Bäckström (2018) recommend at least 15 samples in order to obtain a valid result with respect to the average concentrations ($\pm 25\%$), but this study shows that also a smaller set of samples, whose results are consistent with previous sampling (Måansson 1982) and sampling from drill cores and tailings (Hallberg & Reginiussen 2018a and this work), may result in a good estimate of the metal content of a waste rock deposit.

Tailings

During 2016–2018, SGU sampled 61 tailings repositories from 46 mining areas which have been reported in Hallberg & Reginiussen (2018a) and Claeson *et al.* (2020). The sampling campaign in 2019 focused on tailings at two active mines (Garpenberg and Zinkgruvan) and at tailings dams that have not been sampled during previous campaigns. Additional samples were also taken at previously sampled tailings that have been found to contain CRMs: Grängesberg, Yxsjöberg and Riddarhyttefältet. Additional sampling at the Stollberg tailing dams was also performed. The results for the latter four areas are discussed separately in chapter *Focus on mining areas with critical raw materials*.

Tailings dams in operation

Today, the Ryllshytte repository at Garpenberg is used by Boliden to deposit tailings from the new mineral processing plant in Garpenberg. At Zinkgruvan the tailings facility is located at Enemossen c. 4 km south of the mine. Two samples from the Ryllshytte tailings and four samples from Enemossen were sampled and analysed and compared to metal grades in tailings that were calculated from mineral processing plant statistics from 2019 (SGU 2020).

In most cases the measured metal grades deviated from the calculated value but remained within the same magnitude. Most of the Zinkgruvan samples deviated considerably in their zinc and lead content being 4–5 times higher than the calculated values. Possibly the sampled Zinkgruvan tailings comes from copper ore processing that occurs periodically at the ore-dressing plant (Lundin Mining 2017) and cannot be compared with the annual production as reported in SGU 2020. This illustrates the risk of having a limited set of samples in a sampling campaign and to be cautious not to overinterpret individual samples.

Other sampled tailings dams in Bergslagen

The tailings at Taberg, Finnmossen, Långban, Ställberg, Idkerberget, Nartorp, and Lejakärret in Bergslagen had not previously been sampled and was sampled and analysed during the 2019 campaign (Fig. 6 and Appendix 4). In tailings from the copper mine Lejagravian, grades of 0.3–0.4% Cu were noted, but no anomalous levels of CRMs. As expected, the sand from Långban's iron-manganese mines contains high levels of manganese, 9–12% MnO, but also anomalous levels of arsenic, lead and barium. Tailings from the skarn iron ore deposits at Finnmossen and Taberg show slightly elevated grades of base metals, while tailings from the Ställberg mine is barren of both environmentally hazardous as well as economically interesting elements. Tailings from the apatite iron ore deposit Idkerberget have a chemical composition that is similar to other apatite iron ores in this study, Grängesberg and Blötberget, and the discussion of anomalous phosphorus and Rare Earth Elements (REEs) at Grängesberg is also valid for Idkerberget.

During 2019 additional samples were collected at previously sampled tailings that had been demonstrated to contain anomalous levels of base metals and CRMs (Hallberg & Reginiussen 2018a, b). These include Intrånget, Kaveltorp, Yxsjöberg, Kälfallet, Blötberget, Grängesberg, and Stripa. The new analyses essentially confirm earlier observations and adds to the geochemical database of the deposits.

Geophysics – Ground penetrating radar

A test measurement (Fig. 8) was made by Johan Söderman and Mats Thörnelöf, SGU, using ground penetrating radar to determine the thickness of the tailings at Brusmalmen in the Stollberg field (Fig. 4). Ground penetrating radar is a geophysical method in which radar pulses emitted from a transmitter mounted on a moving device can be used to map the subsurface. The equipment used was an ImpulseRadar CrossOver 7030 measuring at 70 Mhz. The depth to moraine in the tailings at Brusgruvan has previously been determined by drilling to c. 20 meters (Ohlsson 1980). The ground penetrating radar measurement in this case could only penetrate around 10–15 meters, and no definite conclusion about thickness could be inferred because the radar pulses did not reach the bottom of the tailings. However, the investigation showed internal reflectors dipping gently to the south. These are interpreted as sand layers formed when the dam was filled from the north.

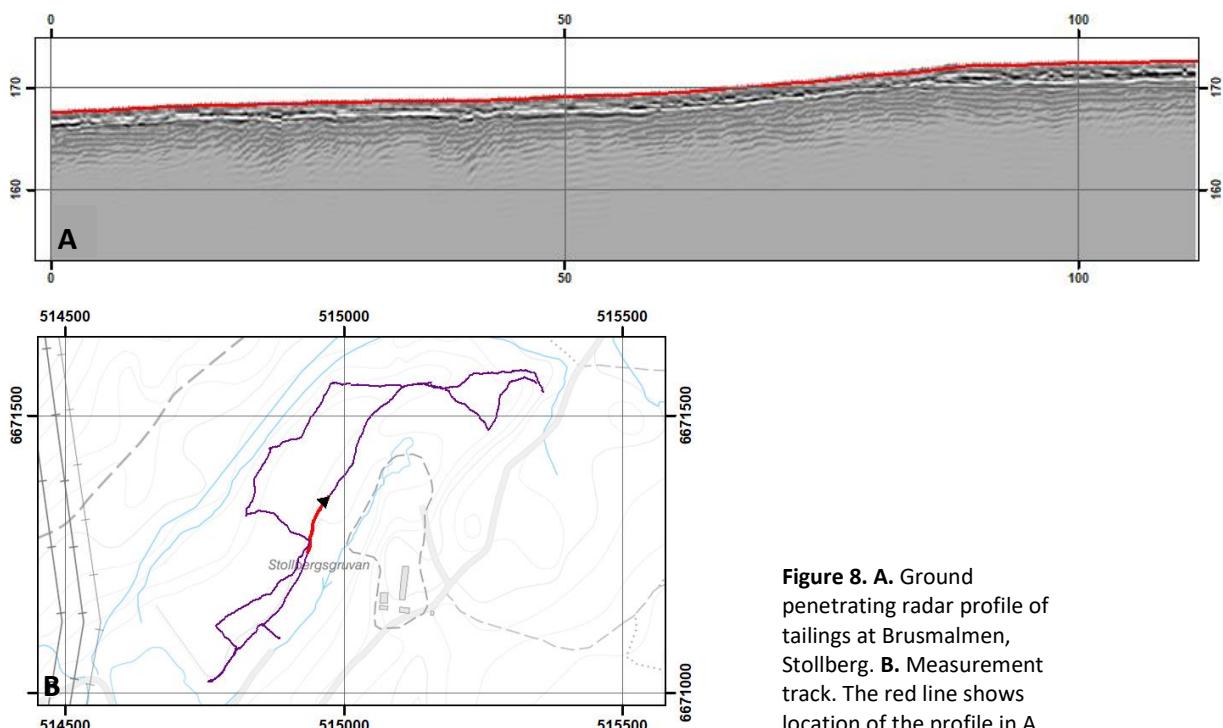


Figure 8. **A.** Ground penetrating radar profile of tailings at Brusmalmen, Stollberg. **B.** Measurement track. The red line shows location of the profile in A.

FOCUS ON MINING AREAS WITH CRITICAL RAW MATERIALS

Riddarhyttefältet

The host rocks to the numerous iron and base-metal massive sulphide deposits in the Riddarhyttefältet are altered Palaeoproterozoic supracrustals dominated by felsic metavolcanics and metasedimentary units (Ambros 1983). Figure 9 is a simplified geological map of the area.

Several elements were first discovered in samples from the Riddarhyttefältet including cobalt, cerium and lanthanum. The Bastnäs deposit which is famous for its contents of REE minerals is located here (Gejer 1923). Mining activities at Riddarhyttefältet is documented from the late 14th century (Carlborg 1923). Iron ore was the first commodity to be mined and has been the dominant commodity throughout the centuries (Tegengren 1924), but periodically copper, cobalt, rare earth elements, and molybdenum have also been produced. Exploration for copper in the area was initiated by king Gustav Vasa in the mid-16th century, which resulted in some minor discoveries and test mining, but copper mining ceased during the last decades of the 16th century. Renewed activity commenced in the 1620s, but the copper mining struggled until the rich copper deposits in Myrbacksfältet was discovered at the end of that century (Tegengren 1924). Ceritgruvan was mined for REE during the last half of the 19th century (Carlborg 1923).

The mining operations in the Riddarhyttefältet ceased when the Bäckegruban mine closed in 1979 and the concentrator a year later. Total ore production is shown in Figure 10. At closure, mining had reached the 360-metre level.

A resource estimate for Bäckegruban and Persgruban, which was updated one year before operations stopped, shows a remaining tonnage of 10 million tonnes at 34.4% Fe and an additional 0.67 million tonnes of low-grade iron-ore with 0.37% Cu (Table 3 and Fagersta Bruk 1978). In addition, it was estimated that the remaining ore in other parts of the Riddarhyttefältet amounted to 14.5 million tonnes. Based on information from drilling, geophysics and geological investigations it can be assumed that the orebody continues below the current mined level and to the north (Fagersta Bruk 1978). Tonnage and grade information about REE and cobalt was not included in the historic ore estimate. SGU has collected and digitised analyses from older publications and exploration reports, analyses from the EURARE project data (Sadeghi 2019) and calculated the production of ore and tailings. In addition, SGU has sampled and analysed 54 drill core sections (Fig. 11, table 5 and Appendix 2) from several mines in the area as well as 17 samples from the tailings at Källfallet and Bäckegruban.

Bäckegruban has two tailings repositories (Figs. 12–13). The oldest tailings are deposited in the Nedre Skärsjön lake. A more recent impounding was constructed to the north of the old tailings (Fig. 12A). The tailings at Källfallet was discharged and deposited south of the processing facility towards the lake Lien (Figs. 14–15).

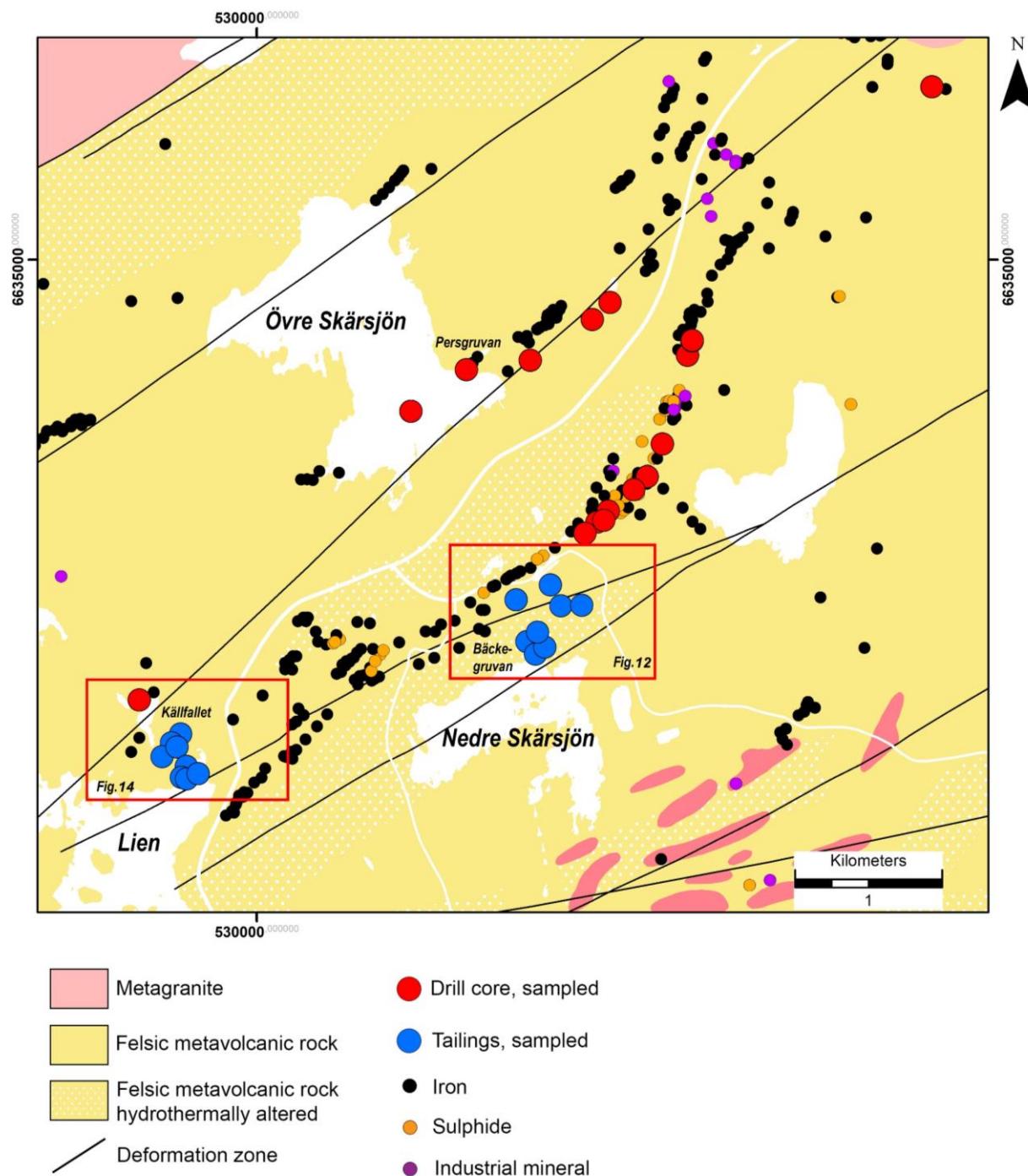


Figure 9. Geology of the Riddarhyttfältet. The geological map is simplified and modified from SGU's digital bedrock map in 50 000 – 250 000 scale. Sampling locations and outlines of fig. 12 and fig. 14 are shown.

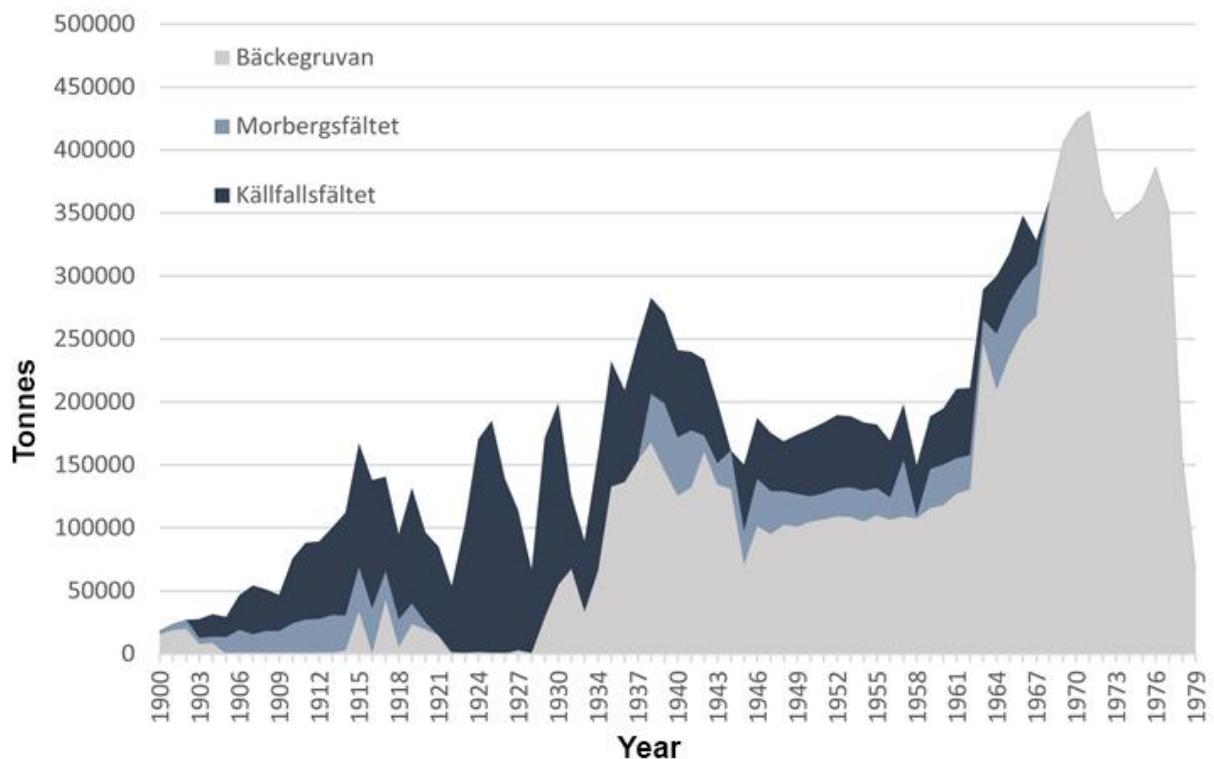


Figure 10. Annual iron ore production (lump ore and dressing ore) at the three largest mines in the Riddarhyttefältet during the period 1900–1979. Small tonnages of additional ore have intermittently been produced in the northern part of the ore field. In addition, copper, cobalt and REE has also been produced.

Table 3. Remaining ore in the Riddarhyttefältet. Data from Fagersta bruk (1978). Mt = million tonnes.

* Non-compliant to CIRSCO.

Data	Object	Tonnage (Mt)	Fe %	S %	Cu %	Mo %
Measured resource*	Bäckegravan	7.5	32.6	-	-	-
	Bäckegravan (iron-ore with Cu)	0.67	29.7	1.0	0.37	-
	Persgruvan	2.8	35.5	-	-	-
Inferred resource*	Riddarhyttefältet	14.5	-	-	-	-

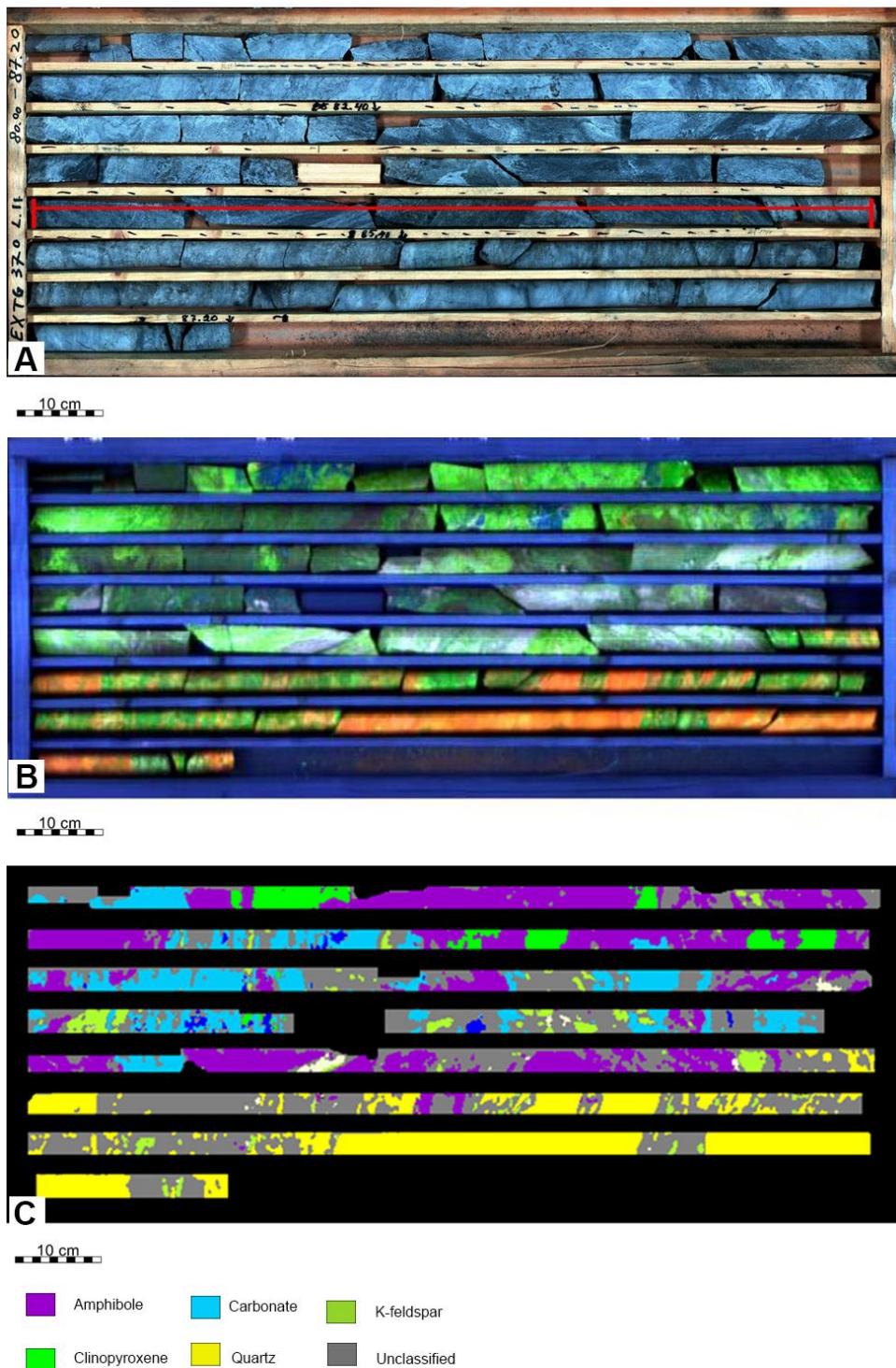


Figure 11 A. Drill core box containing ca 7.20 metres of drill core EXTG370 (6634448 /532958) from Bäckegravan-Bastnäsorsten. Red marker shows one-metres section interval for chemical analysis yielding for selected elements: Fe = 24.47%, REE = 1.68%, Cu = 0.12%, Ga = 41 ppm, Y = 460 ppm. The section contains magnetite and minor chalcopyrite and pyrite. **B.** Same drill core box as in A. showing a False Colour Composite image that uses data from the longwave infrared (LWIR) part of the infrared spectrum. The LWIR camera covers the wavelength interval 7,500–12,000 nanometres (nm) and three infrared bands are rendered in RGB using red = 8,611 nm, green = 10,022 nm, blue = 11,810 nm. **C.** Dominant mineral map based on LWIR hyperspectral data. Magnetite and sulphides render greyish-white in B. and are unclassified in C.

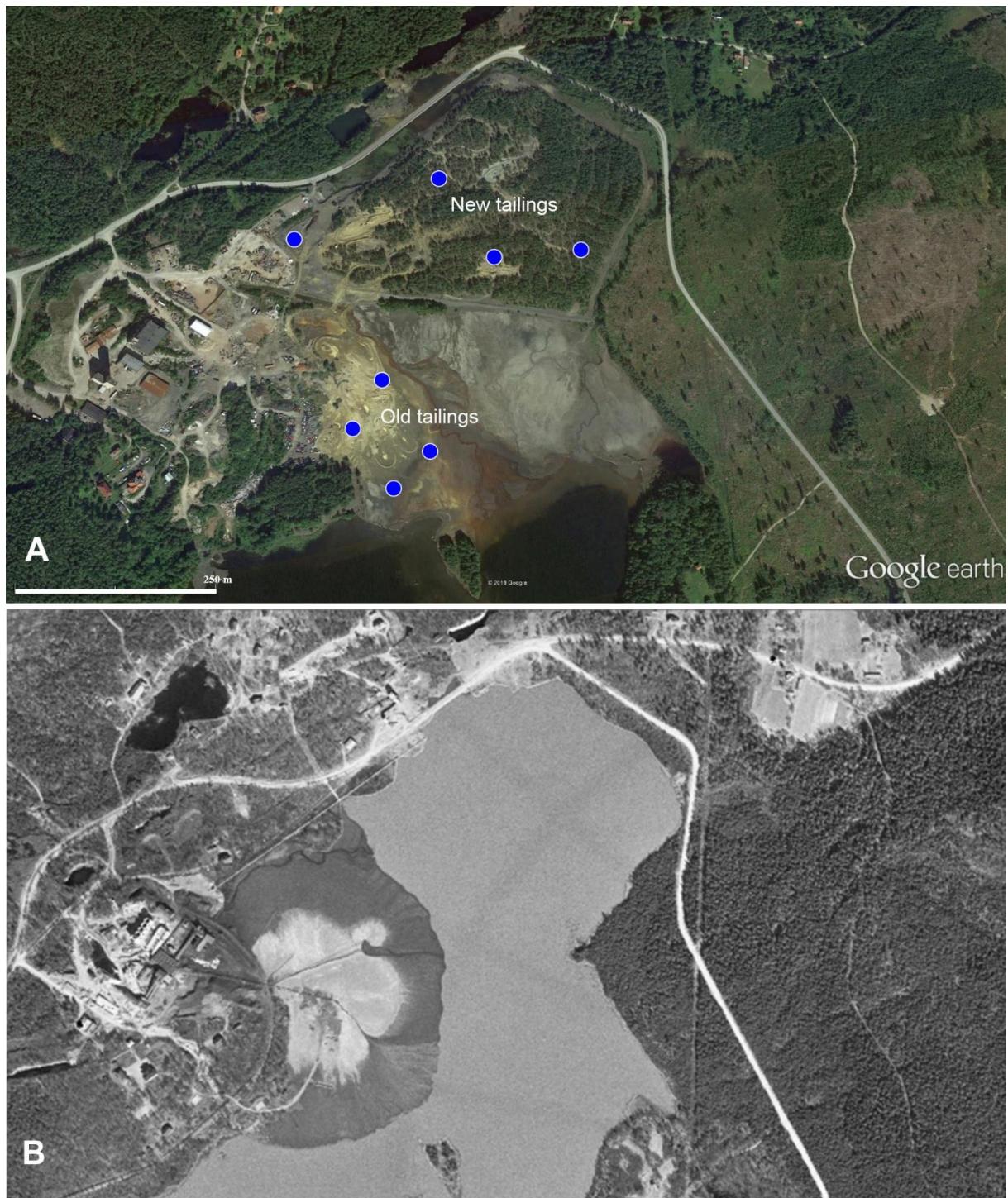


Figure 12. **A.** Overview of Bäckegravan in the Riddarhyttefältet. Two main tailings depositories can be distinguished. The northern, most recent tailings are deposited in a walled impoundment. The older tailings were deposited directly in lake Nedre Skärsjön. Blue dots are sampling locations. **B.** Aerial photograph from c. 1960 showing the area before the new tailings repository had been constructed. Photos: Google Earth, Lantmäteriet.



Figure 13. Old tailings at Bäckegravan (6632468/531908). The wall of the new impounded tailings is visible in the background. Photo: Helge Reginiussen.

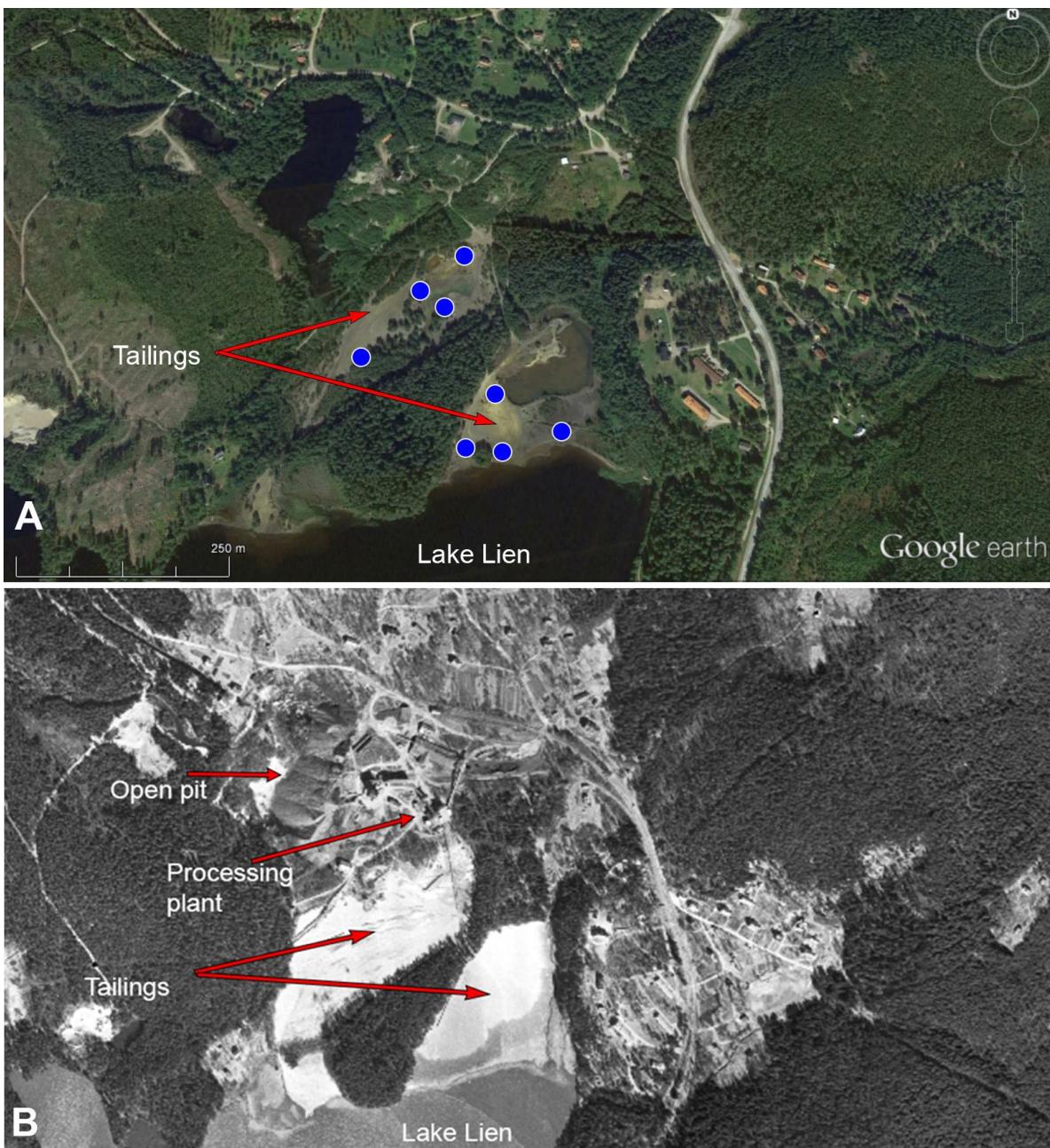


Figure 14. A. Overview of Källfallet. Blue dots are sampling locations. B. Aerial photograph from c. 1960 showing the same area. Photos: Google Earth, Lantmäteriet.



Figure 15. Tailings at Källfallet (6631620/529356). Photo: Helge Reginiussen.

Based on aerial photos and information in Fagersta bruk (1978), it is assumed that the oldest repository was used until 1963, when deposition was shifted to the new location. The composition of the three tailings differs with regards to the metal content. This is reflected both in the calculated grades (Table 4) and in the analysed samples (Table 5) and is probably due to processing of different ores and that the recovery has improved over time. It is estimated that the tailings have a combined tonnage of approximately 7.45 million tonnes of sand with relatively high contents of REE, high contents of copper and cobalt in the old Bäckegravan tailings and high molybdenum grades in Källfallet (Table 4).

Based on the historic ore estimate by Fagersta bruk (1978) and SGU's reconnaissance sampling of tailings it can be concluded that the Riddarhytgefältet as a whole potentially have at least 25 million tonnes of ore and 7.45 million tonnes of tailings with elevated grades of iron, manganese, copper, cobalt, molybdenum, and REE. The number of samples are very limited and can by no means be compared to a modern ore estimate and further work is needed to develop a better estimate that comply with current reporting standards.

Chondrite normalized REE patterns from drill core and tailings in Källfallet are very similar with a distinct LREE enrichment although the REE contents in the tailings are higher than in the drill core samples (Fig. 16). All samples show negative Eu anomalies ($\text{Eu/Eu}^* = (\text{Eu})_{\text{cn}} / [(\text{Sm})_{\text{cn}} \times (\text{Gd})_{\text{cn}}]^{0.5}$). Drill core samples have $\text{Eu/Eu}^* = 0.33 - 0.78$, and tailings have $\text{Eu/Eu}^* = 0.37 - 0.43$. REE patterns for Bäckegravan tailings are also LREE enriched, but do not show a similar pronounced anomaly ($\text{Eu/Eu}^* = 0.71 - 1.02$) (Fig. 17).

Table 4. Ore production and processing at Riddarhyttefältet during the period 1900–1979. Mt = million tonnes.

Data	Object	Tonnage (Mt)	Fe %	S %	Cu %	Mo %
Mined ore	Källfallsfältet	4.11	45.3	0.12	-	-
	Persgruvan (Morbergsfältet)	1.31	43.9	0.29	-	-
	Riddarhytte odalutmål	9.34	35.0	1.01	-	-
Processed in dressing plant	Källfallet	3.57	36.9	0.19	≈0.02	≈0.05
	Bäckegruban	9.27	33.98	1.35	≈0.1	-
Tailings	Källfallet	2.01	8.68	0.16	-	-
	Bäckegruban until 1963	2.22	9.73	2.60	-	-
	Bäckegruban 1964-1979	3.22	11.15	0.40	-	-

Table 5. Analyses of tailings and drill core from Riddarhyttefältet.

Data	Object	Fe %	S %	Cu %	Mo %	Co %	REE %
Tailings¹	Källfallet (n=8)	7.9–25.2	0.0–0.5	0.01–0.04	0.02–0.05	0.00	0.11–0.48
	Bäckegruban, old (n=4)	15.3–23.2	1.5–3.2	0.11–0.32	0.01	0.01–0.11	0.13–0.18
	Bäckegruban, new (n=5)	9.9–18.5	0.8–1.2	0.08–0.12	0.00	0.01–0.02	0.03–0.11
Drill core¹	Bäckegruban (n=23)	2.05–40.92	0.01–0.69	0.00–0.28	0.00–0.29	0.00–0.02	0.01–1.68
	Källfallet (n=11)	6.58–42.11	0.02–0.61	0.00	0.00–0.01	0.00	0.01–0.12
	Persgruvan (n=20)	8.25–59.31	0.01–1.74	0.00–0.28	0.00–0.01	0.00–0.02	0.01–0.82

¹ All analysed samples with complete set of elements in Appendix 2–4.

The resource estimate made a year before closure of the Bäckegruban mine in 1979 indicated a remaining tonnage of 10 million tonnes at 34.4% Fe and an additional 0.67 million tonnes of low-grade iron-ore with 0.37% Cu. It was estimated that the remaining ore in other parts of the Riddarhyttefältet was 14.5 million tonnes (Fagersta bruk, 1978). Analyses of drill cores confirm the presence of copper, cobalt and REE in remaining iron ore, but at the same time show that the mineralisation occur in patches and it is difficult to correlate the mineralisation between boreholes. A patchy pattern can be seen from the mine maps too. This makes it very hard to estimate the content of copper, cobalt, molybdenum, and CRM in the remaining ore. The analyses show high content of copper, cobalt, REE and tungsten in the older tailings at Bäckegruban and high content of molybdenum and REE in the tailings at Källfallet (Table 5). The metal grades in the new tailings at Bäckegruban are significantly lower compared to the other tailing dams.

The old tailings at Bäckegruban also includes toxic and environmentally hazardous elements showing arsenic content in excess of 250 ppm and sulphur content of c. 2%. The content of mercury and cadmium are low, less than 1 g/t.

The number of samples are not enough for a resource estimate of the three tailings and in order to enhance the database additional sampling was done in 2020. The analytical results from these are pending.

Reconnaissance sampling of waste rock has not been carried out in the Riddarhyttefältet.

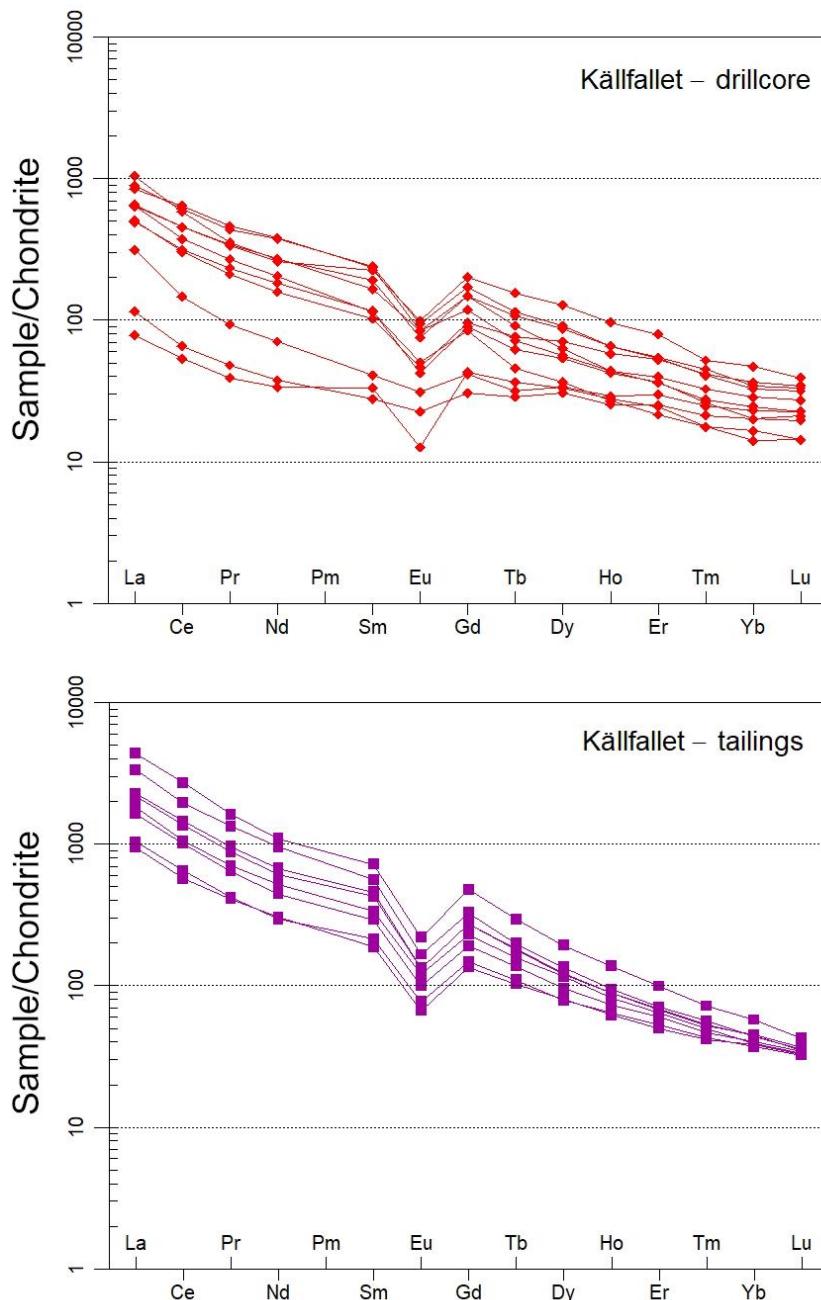


Figure 16. Chondrite normalised REE diagrams for samples from drill core and tailings from Källfallet. Chondrite values are from Boynton (1984).

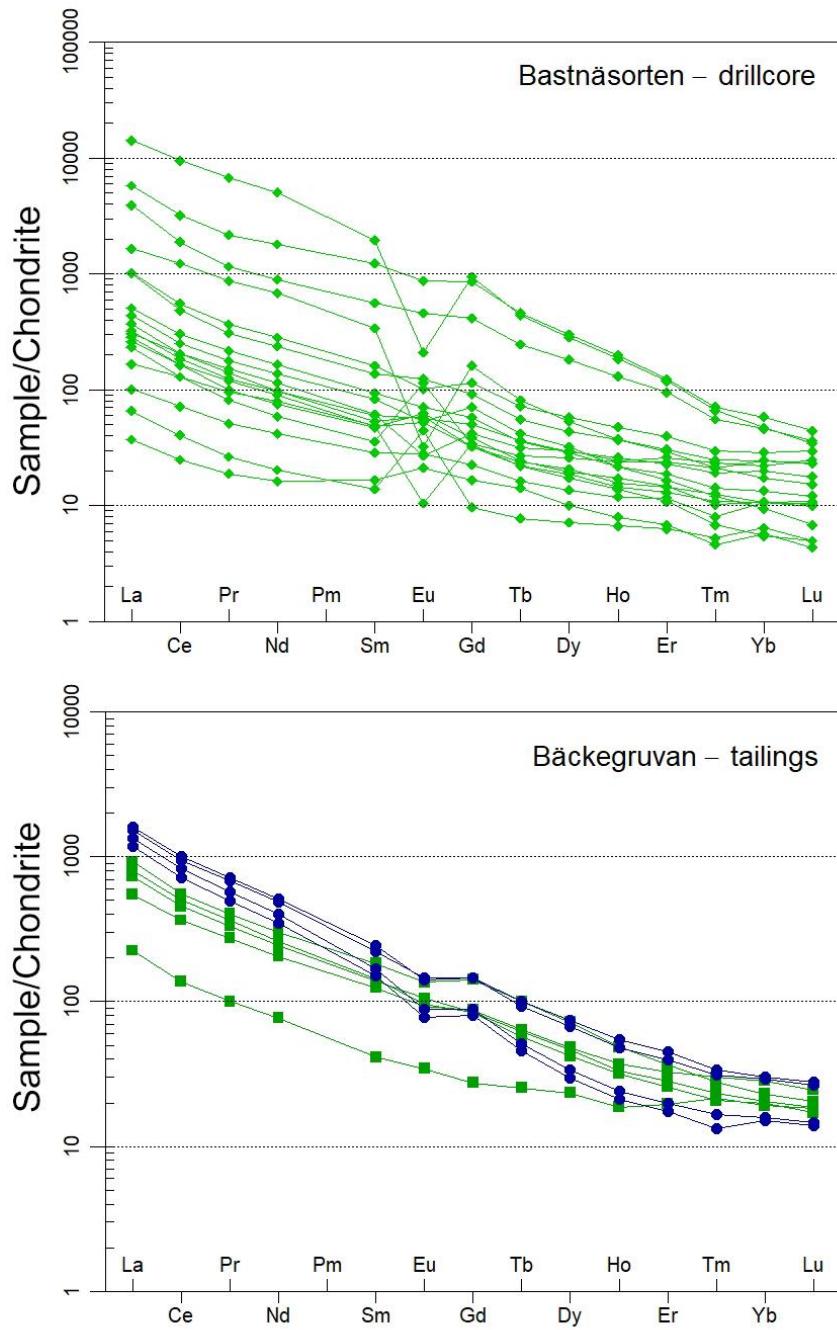


Figure 17. Chondrite normalised REE diagrams for samples from drill core and tailings from Bäckegravan. Blue symbols in the lower diagram represent the old tailings and green symbols are the new tailings. Chondrite values are from Boynton (1984).

Grängesberg

The apatite iron ores in the Grängesberg mining district are the largest ore deposits in Bergslagen. Host-rocks to the ores are c.1.90–1.88 Ga dacitic to basaltic pyroclastic and subvolcanic rocks (Allen *et al.* 2013 and Fig. 18). The iron ores contain varying amounts of apatite, allanite, monazite, and xenotime that comprise significant sources of REE (Majka *et al.* 2013). Over the past 250 years, 156 million tonnes of ore have been extracted from the mines in the area (Table 6). Most of the produced ore was lump ore, but nearly 49 million tonnes has been processed at two concentrators, Bergslagschaktet and Södra verket, and the tailings deposited in three large dams, Gruvallmännen with tailings from Bergslagsschaktet and the Jan-Mats and the Höjtjärn dams where tailings from Södra verket was deposited (Table 6).

Mining operations ended in 1989 when mining had reached the underground 650-metre level. Geophysical investigations indicate that the ore continues down to at least 1,700 metres and a remaining tonnage of 148 million tonnes is demonstrated by a modern resource estimate (Table 7 and Grängesberg Iron AB, 2014).

SGU has sampled and analysed five drill core sections from two drill cores and 15 samples of tailings from the three tailings repositories (Fig. 18). SGU has also collected and digitised analyses from older publications and exploration reports, previous SGU data and compiled statistics on production of ore and mineral processing (Hallberg and Reginiussen 2018b).

The results of the analyses are summarised in Table 8 and in Appendix 2 and 4.

Table 6. Ore production and mineral processing at Grängesberg. Mt = million tonnes.

Data	Object	Tonnage (Mt)	Fe %	P %	S %
Mined ore	Risbergsfältet	20.36	42.5	0.62	0.003
	Grängesberg	132.8	50.0	0.88	0.011
Processed in dressing plant	Risbergsfältet-Bergslagsschaktet	18.52	41.58	0.42	0.004
	Grängesberg-Södra verket	29.92	60.13	0.8	0.02
Tailings	Risbergsfältet-Bergslagsschaktet	8.36	14.55	0.5	-
	Grängesberg-Södra verket	5.71	39.09	0.22	-

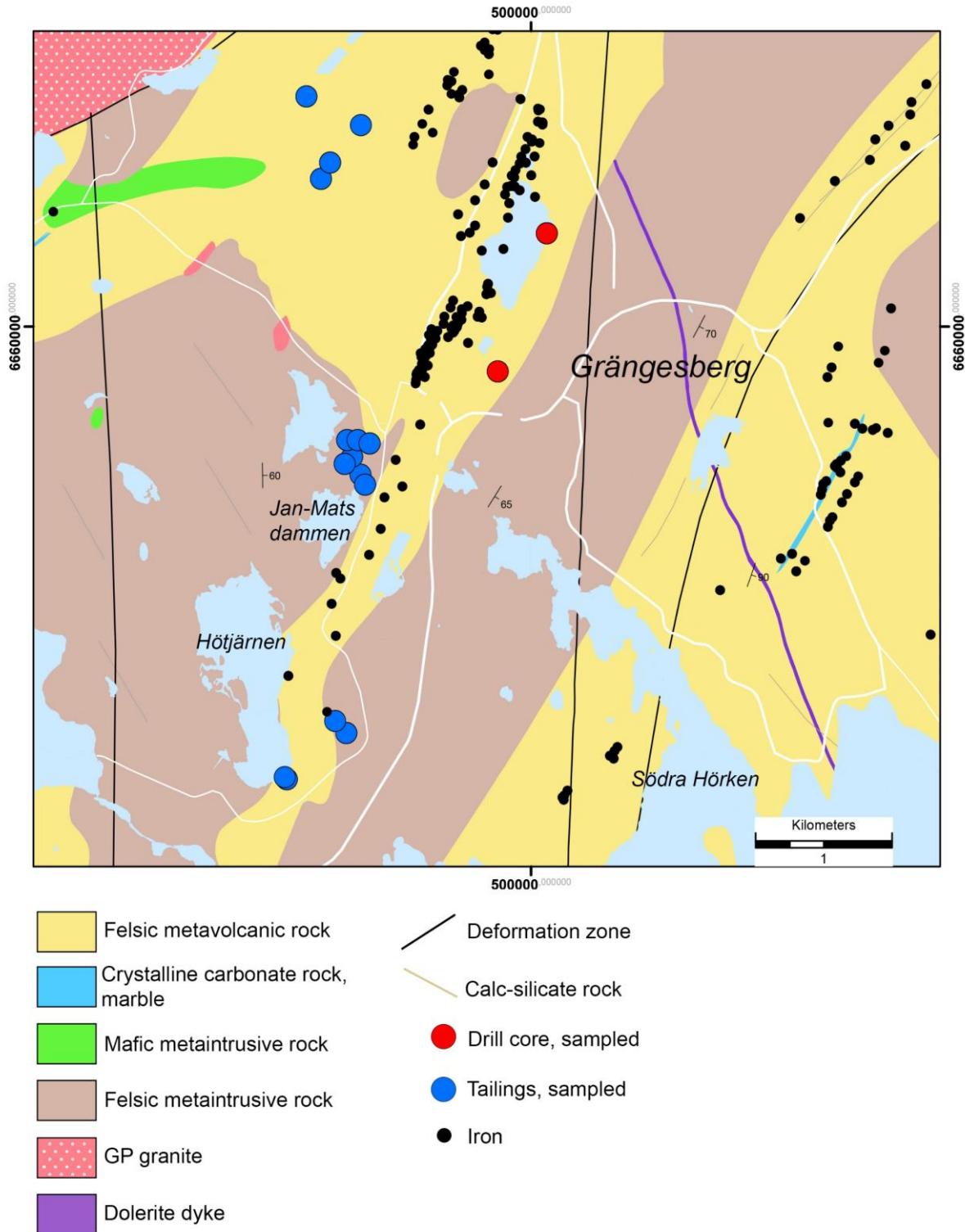


Figure 18. Geology of the Grängesberg area. The geological map is simplified and modified from SGU's digital bedrock map in 50 000 – 250 000 scale. Sampling locations are shown.

Table 7. Resources at Grängesberg (Grängesberg Iron AB, 2014). Mt = million tonnes.

Resource category	Ore Mt	Fe %	P %
Inferred Mineral Resource	33.1	45.2	0.91
Indicated Mineral Resource	115.2	40.2	0.78

Table 8. Analyses of tailings and drill core from Grängesberg.

Data	Object	Fe %	P %	S %	REE %	Sn %
Tailings ¹	Bergslagsschaktet (n=4)	5.2–15.7	0.69–0.97	0.00–0.01	0.06–0.09	0.006–0.010
	Hötjärnsmagasinet (n=4)	18.1–36.4	0.27–1.63	0.00–0.02	0.11–0.25	0.020–0.028
	Jan-Mattsdammen (n=7)	6.3–14.7	0.71–3.18	0.01–0.02	0.07–0.23	0.003–0.012
Drill core ¹	Grängesberg (n=5)	17.4–64.8	0.48–2.06	0.01	0.10–0.47	0.002–0.051

¹ All analysed samples with complete set of elements in Appendix 2–4.

The analyses of drill core sections (Table 8 and Appendix 2) confirm the high phosphorus content of the iron ore and provides information on the content of REE and tin. The data shows that the remaining ore at Grängesberg can be a significant source of phosphorus and REE in addition to iron. The analyses reveal small differences between the different tailings, differences that is probably caused by different approaches in the dressing plants and different quality requirements for the end product, which in all cases was a magnetite concentrate. Figure 19 shows a drill core box and sampling sections from Grängesberg. Chondrite normalised REE patterns from drill cores and different tailings are shown in Figure 20.

The tailing dams at Grängesberg (Fig.18) contain considerable levels of phosphorus and REE. Furthermore, the REE content shows a weak correlation with the phosphorus content, indicating that a large part of the REEs are found in phosphorus minerals. A very rough estimate from the relatively few analyses indicates that the tailing dams together contain more than 100 000 tonnes of phosphorus and 15 000 tonnes REE. Future work is required to determine if the values are correct and, above all, if the tailings can be mined and converted to marketable products in a sustainable manner.

Reconnaissance sampling of waste rock has not been carried out in the Grängesberg field.

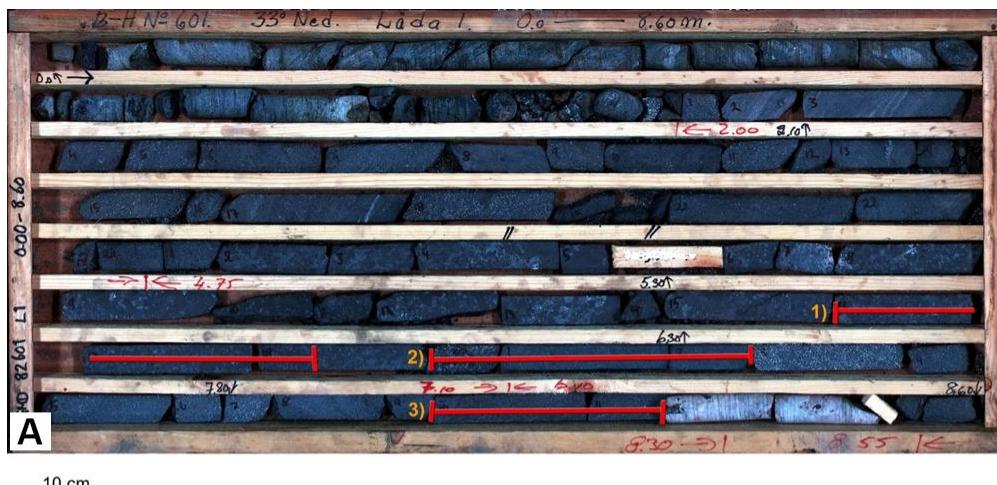


Figure 19. A. Drill core box containing c. 8.6 metres of drill core GMD82601 (6660684/500115) from Grängesberg. Numbered markers show sampling sections; 1) Sample GMD82601 6.45–6.85: “Sjöstjärnsmalm” – mixture of magnetite and hematite (magnetite is dominating) containing 64.77% Fe and 0.22% REE. 2) Sample GMD82601 6.95–7.25: hematite ore containing 64.28% Fe and 0.30% REE. 3) Sample GMD82601 7.95–8.25: magnetite ore containing 57.91% Fe and 0.47% REE. B. The same drill core box as in A. showing a False Colour Composite image that uses data from the longwave infrared (LWIR) part of the infrared spectrum. The LWIR camera covers the wavelength interval 7,500–12,000 nanometers (nm) and three infrared bands are rendered in RGB using red = 8,611 nm, green = 10,022 nm, blue = 11,810 nm. Magnetite-rich portions render white in this image.

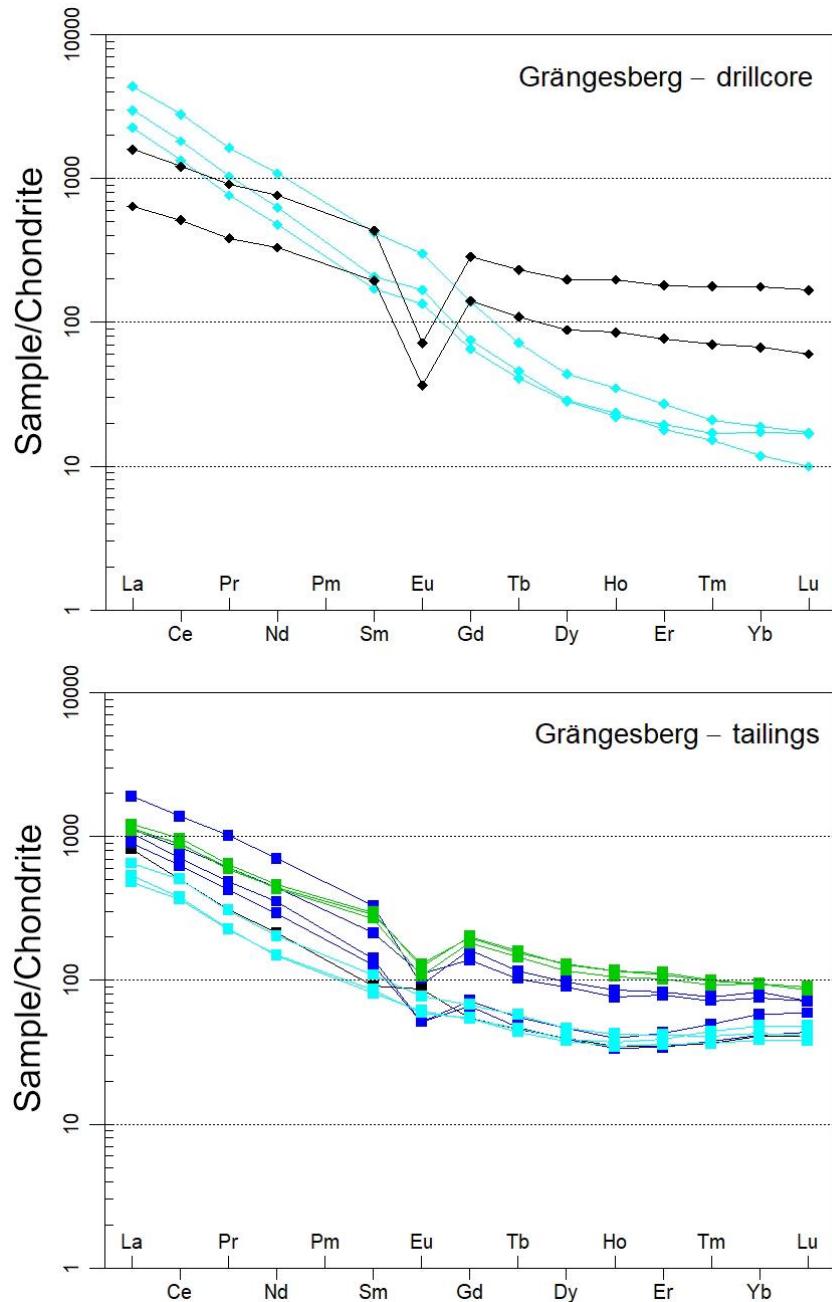


Figure 20. Chondrite normalised REE diagrams for samples from drill core and tailings from Grängesberg. Different colours in lower diagram represent different tailings. Chondrite values are from Boynton (1984).

Yxsjöberg

Most of the tungsten produced in Sweden comes from skarn deposits located near Ludvika in Bergslagen. The largest producer was the mine at Yxsjöberg (Fig. 21), which is by far the largest tungsten deposit in Sweden, accounting for 92% of the mined tonnage (Bergman 2012 and MALMdb). Yxsjöberg was known as a copper deposit in the early 18th century. Tungsten mining started in 1917 (Ohlsson 1979) with intermittent production until 1989. The last period of activity was 1971–1989 (Table 9). U-Pb dating give an age of mineralisation of 1789 ± 2 Ma for the Yxsjöberg deposit (Romer & Öhlander 1994).

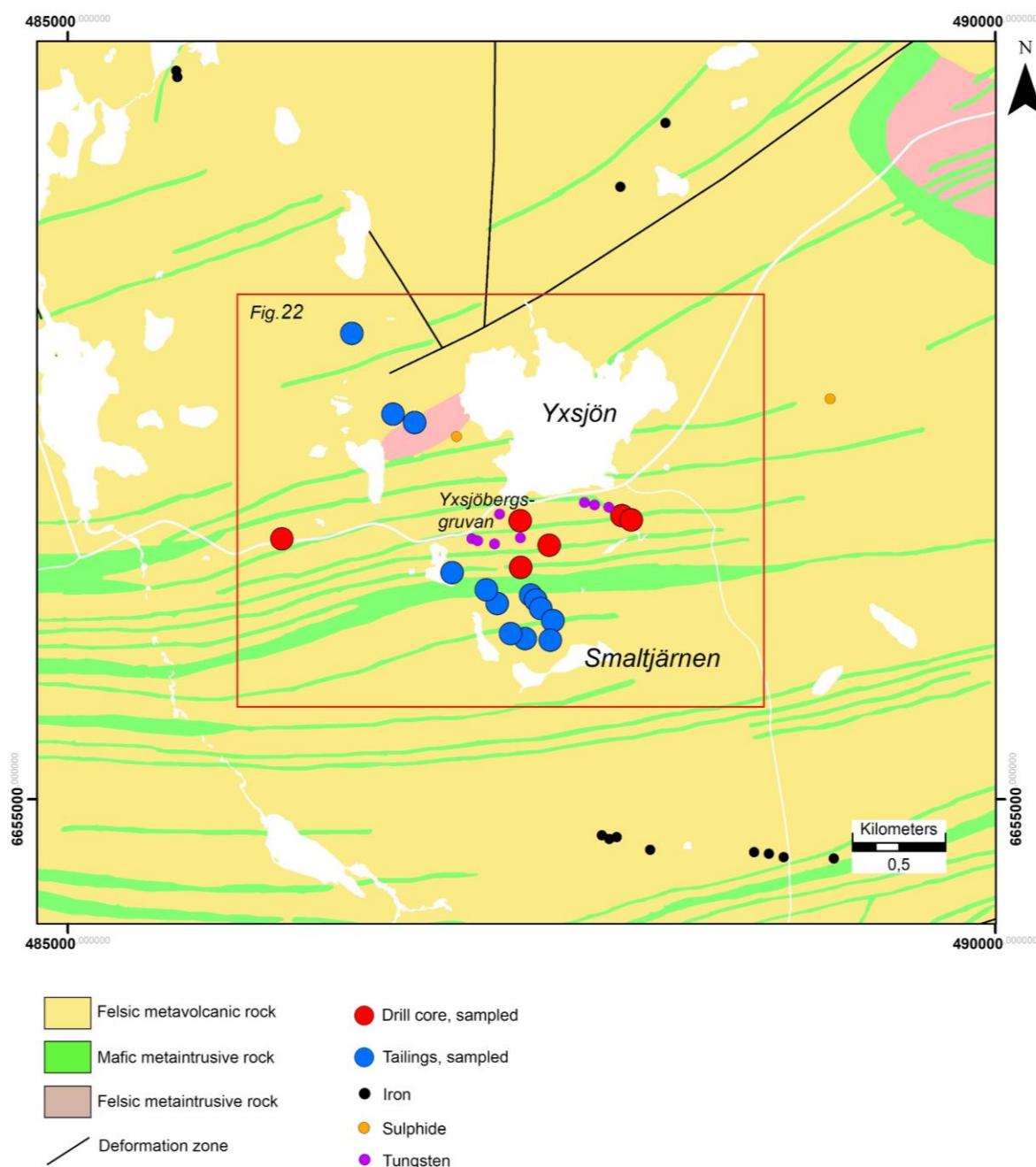


Figure 21. Geology of the Yxsjöberg area. The geological map is simplified and modified from SGU's digital bedrock map in 50 000 – 250 000 scale. Sampling locations are shown. Area of fig. 22 is outlined.

Data from SGU's MALM database indicate that 5.3 million tonnes of ore was processed at the concentrator at Yxsjöberg during the period 1938–1989 (Table 9). Most of the ore was sourced from the Yxsjöberg deposit, but nearby mines such as Sandudden and Wigström also contributed. The economic minerals were scheelite, chalcopyrite and fluorite. Ore processing and production of tungsten, copper and fluorite concentrate have generated more than 5 million tonnes of tailings that have been deposited in two separate repositories. The oldest repository is Smaltjärnen (pre-1964) which contains approximately 2.8 million tonnes. From 1973 onwards 2.4 million tonnes were deposited at Morkulltjärnen.

It should be noted that since statistics on the production prior to 1938 is incomplete it can be inferred that the tonnage at Smaltjärnen probably is higher than the estimate above. The lack of data for some years also introduces uncertainties in the calculation of metal contents in the tailings. An estimate based on the available data suggests that the Smaltjärnen tailings contain 0.05–0.20 percent tungsten. The calculations indicate tailings at Morkulltjärnen have lower grades (Table 9), which is supported by analysis of sampled tailings (Fig. 22 and Table 10).

Possible extraction of tungsten from the Smaltjärnen tailings was considered in 1980, but the efforts did not lead to production (Lindvall 1988). A recent research project (REMinE) with participation from Luleå University of Technology has focused on investigating the environmental impacts and the possibility of reprocessing of the tailings at Yxsjöberg (Hällström *et al.* 2018, Mulenshi *et al.* 2019).

Table 9. Ore production and processing at Yxsjöberg. Mt = million tonnes.

Data	Object	Tonnage (Mt)	W %	Cu %	Fluorite %
Mined	Yxsjöberg	4.95	-	-	-
	Wigström	0.13	-	-	-
Processed in dressing plant	Yxsjöberg	5.32	0.26	0.16	5.88
Tailings	Yxsjöberg–Smaltjärnen (1938–1963)	2.80	0.09	0.09	-
	Yxsjöberg–Morkulltjärnen (1973–1989)	2.43	0.04	0.05	-

Table 10. Analyses of tailings and drill cores at Yxsjöberg.

Data	Object	W %	Cu %	S %	Be ppm	Bi ppm	In ppm	Sn ppm
Tailings¹	Morkulltjärnen (n=4)	0.04–0.22 0.07	0.02– 0.07	0.26– 0.79	117– 162	421– 614	4	200– 246
	Smaltjärnen (n=11)	0.06–1.00 0.36	0.03– 0.36	0.45– 3.42	65–297	440– 864	4–7	276– 371
Drill core¹	Yxsjöberg (n=14)	0.00–0.95 0.84	0.01– 0.84	0.13– 9.97	373– 443	1–1420	0–30	4– 1415

¹ All analysed samples with complete set of elements in Appendix 2–4.

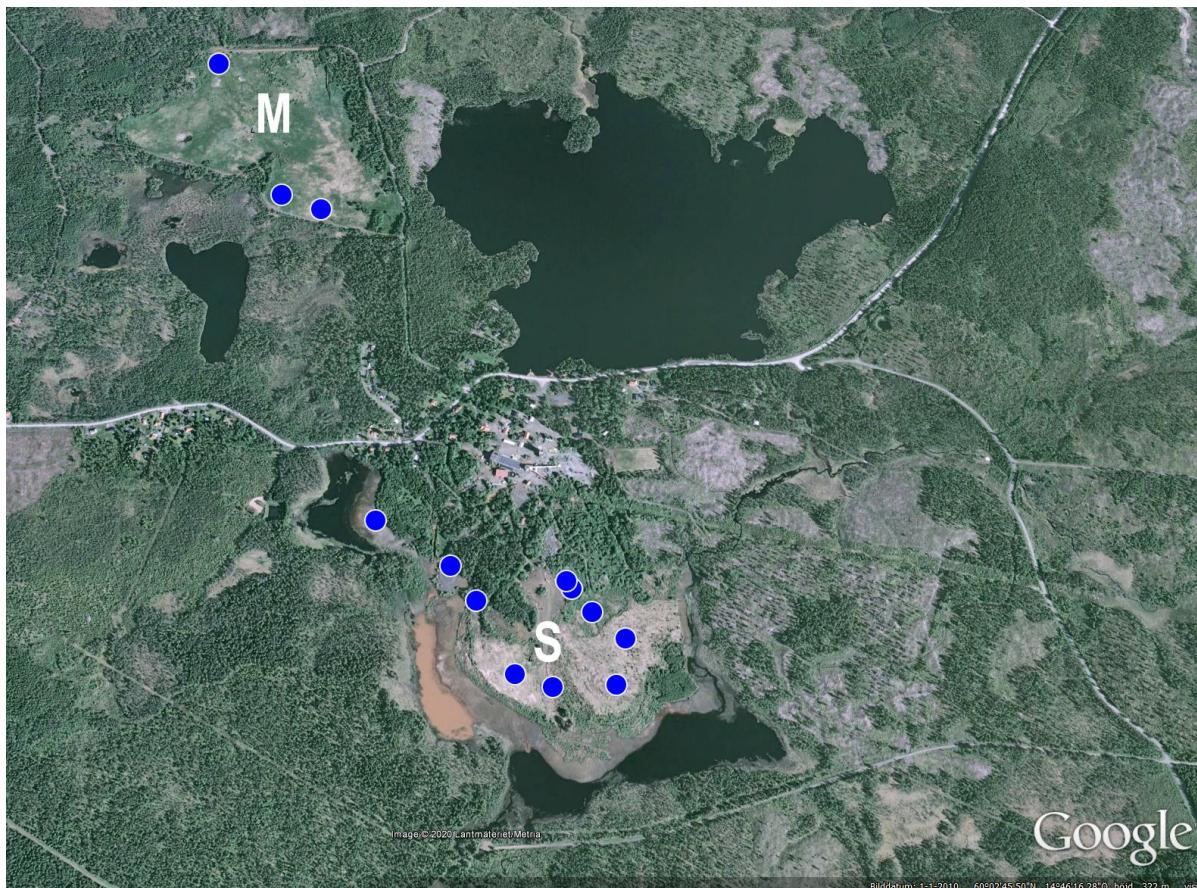


Figure 22. Yxsjöberg. Blue dots are sampling locations for tailings at Morkulltjärnen (M) and Smaltjärnen (S). Photo: Google Earth.

Analyses of drill core sections (Fig. 23 A and B, Table 10) show that the Yxsjöberg Cu-W ore is enriched in several interesting elements in addition to copper and tungsten. Elements with elevated levels include bismuth, beryllium, indium and tin (Table 10 and Appendix 2).

The high copper and tungsten content in the tailings, especially in the older Smaltjärnen dam (Table 10), indicate a rather poor recovery for the main commodities. The elevated levels of bismuth, beryllium, indium, and tin detected in the drill cores are also found in the tailings but the analyses show too large a spread to enable a calculation of the metal content in the tailings dams. Ongoing research (Hällström *et al.* 2018, Mulenshi *et al.* 2019) can provide more accurate information about the metal content. Reconnaissance sampling of waste rock has not been carried out at Yxsjöberg.

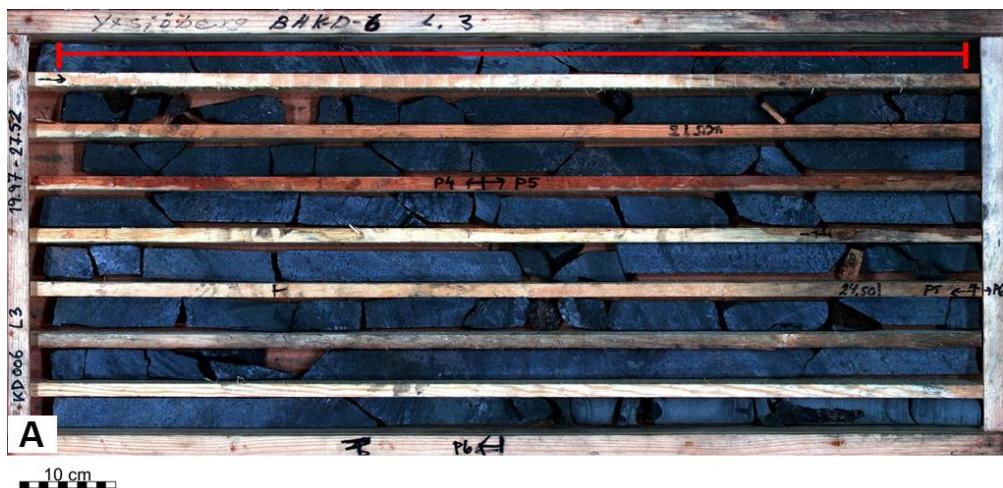


Figure 23. **A.** Drill core box containing c. 7.5 meters of drill core KD006 from Kvarnåsen at Yxsjöberg (6656506/488037). Red marker shows one-meter section for chemical analysis yielding for selected elements: W = 0.50%, Cu = 0.27%, Sn = 0.11%, Bi > 250 ppm, Ge = 37 ppm, In = 30 ppm, Be = 443 ppm. **B.** Same drill core box as in A. showing a False Colour Composite image that uses data from the longwave infrared (LWIR) part of the infrared spectrum. The LWIR camera covers the wavelength interval 7,500–12,000 nanometres (nm) and three infrared bands are rendered in RGB using red = 8,611 nm, green = 10,022 nm, blue = 11,810 nm.

Stollberg

Mining at Väster Silvberg (an older name of the Stollberg district, Fig. 24) is believed to have started in medieval times like many iron-, precious- and base-metal mines in Bergslagen. Early mining in Stollberg was focused on silver that was extracted from galena. Tegengren (1924) mentions several discoveries which yielded rich ore for a few years and was rapidly mined out. Recovery of zinc was suggested in the late 18th century but it was not until the 1860s, according to the statistics, that the first zinc ore was produced from mines in the area (MALMdb). Mining statistics from the mid-19th century shows that ore at Stollberg was produced from three mining fields: the Svartbergsfältet, the Dammbergsfältet and the Stollbergsfältet. Both Fe-Mn and Zn-Pb ore was produced. For production tonnages see Table 11 and Fig. 25. Lump ore was the main product until 1906 when zinc-lead ore for dressing was first mentioned in the statistics, followed by iron ore for dressing in 1911. Prior to that, in 1899, a primitive dressing plant (probably based on gravimetical technique) was built in Silfhyttan around 1.5 km south-east of the Stollberg district. During the period 1906–1912 a new ore-dressing plant was constructed. Mining of zinc and lead ore ended in 1918 and the mining activity was focused on the newly discovered limonite ore located in the southern part of the district. Further details of the medieval to pre-1920 mining history of the Stollberg district can be found in Tegengren (1924).

More recently (the last hundred years), zinc-lead and iron-manganese ore (magnetite ore and the weathered equivalent limonite ore) have been mined. The mining history contains several changes of ownership and intermittent mining activity, with closures due to recession or lack of ore. According to the mining statistics, the Silvhyttan tailing dam was used 1902–1918 and the Gårdmyren/Brusgruvan tailing dam 1945–1981 (SGU's MALM-database).

The Fe-Mn and Pb-Zn deposits in the Stollberg district are on the eastern limb of the north-trending Stollberg syncline. Other Fe-Mn and Pb-Zn deposits can be traced along a partly mineralised, carbonate dominated layer in a succession of volcanic rocks and together this array of deposits define the shape of the Stollberg syncline. Metasedimentary rocks occur in the centre of the syncline, and at the top of the stratigraphy (Jansson *et al.* 2013, Ohlsson 1979). The geology of the northern part of the syncline is well known due to recent research (Jansson *et al.* 2013, Ripa 1988, Ripa *et al.* 2015, Claeson *et al.* 2019) and previous exploration work summarised in Edberg (1988).

Jansson *et al.* (2013) showed that there is a 1 km more or less continuous stratigraphy of supracrustal rocks from the Staren limestone in the east to the Stollberg district consisting of rhyolitic sandstone, siltstone and breccias, overlaid by rhyolitic pumice breccia and sandstones interpreted to be a major pyroclastic deposit. On top of that sequence is a sequence of rhyolitic ash-siltstone with Fe-Mn rich hydrothermally formed sediments and limestones which have been altered by hydrothermal activity and metamorphism to the present Fe-Mn and Zn-Pb mineralised skarn. Large positive Eu/Eu* anomalies was reported from limestone, skarn and iron ore in the Stollberg ore-host. Jansson *et al.* (2013) conclude from their observations that the ores in the Stollberg district represent metamorphosed, hydrothermal-exhalative and carbonate replacement type of mineralisation.

Chondrite normalized REE patterns of drill core, waste-rock and tailings are shown in Figure 26. A notable feature is that the samples of drill core from Lustigkulla (Fig. 27), waste-rock from Myggruvan, Lilla Dammbergsgruvan and tailings from Silfhyttan and Brusgruvan analysed in this report all have distinct positive Eu/Eu* anomalies similar to those reported by Janson *et al.* (2013).

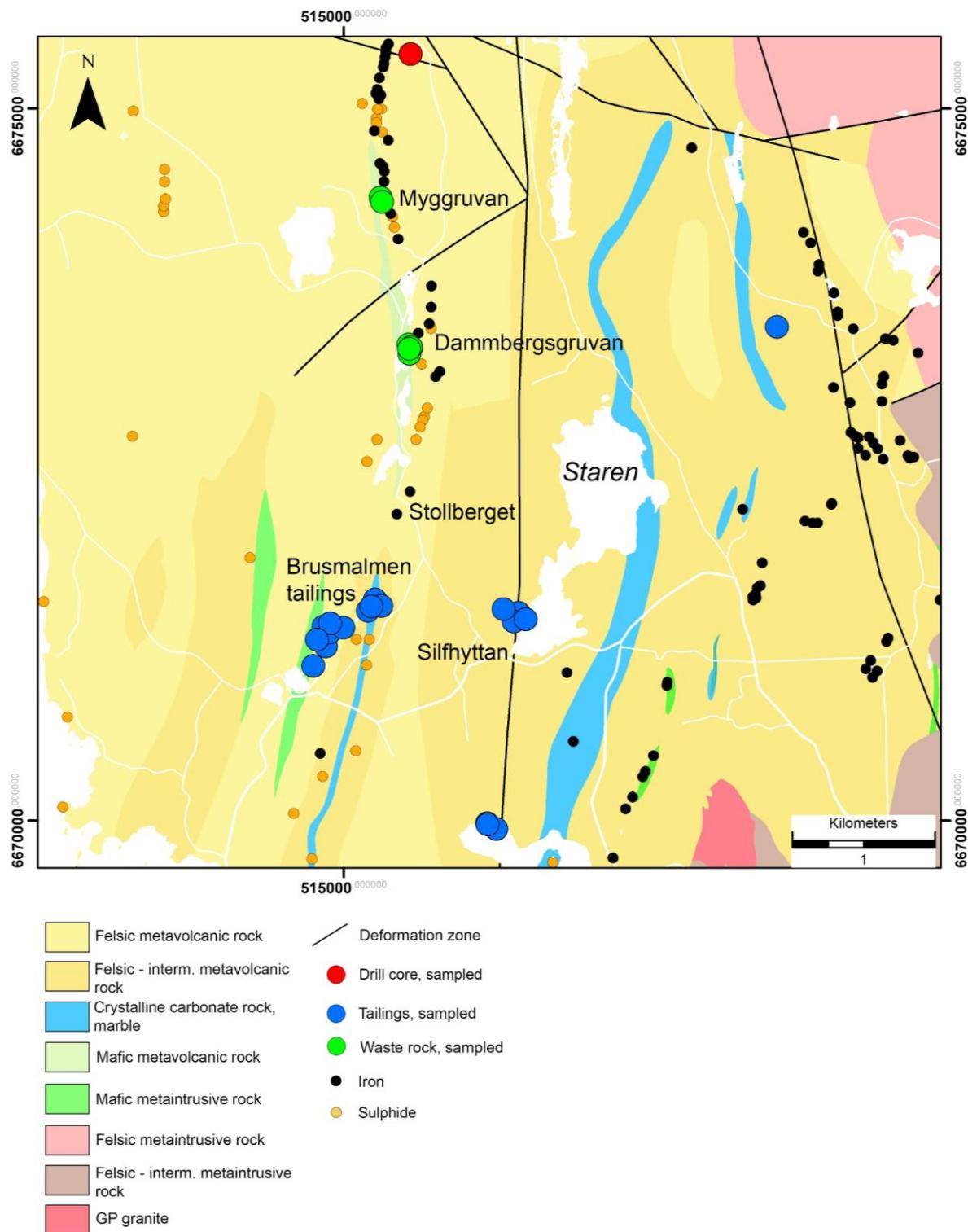


Figure 24. Geology of the Stollberg area. The geological map is simplified and modified from SGU's digital bedrock map in 50 000 – 250 000 scale. Sampling locations are shown.

Table 11. Ore production and processing at Stollbergfältet during 1869–1981. Mt = million ton.

Data	Object	Tonnage (Mt)	Fe %	S %	Mn %	Zn %	Pb %	Ag ppm
Mined ore	Svartbergfältet Fe-Mn	0.13	-	-	-	-	-	-
	Svartbergfältet Pb-Zn	0.01	-	-	-	-	-	-
	Dammbergfältet Zn-Pb	0.03	-	-	-	-	-	-
	Stollbergfältet Zn-Pb	3.48	-	-	-	-	-	-
	Stollbergfältet Fe-Mn	0.3	-	-	-	-	-	-
Processed in dressing plant	Mellanverket	0.38	27.7	3.5	6.7	-	2.7	-
	Stollberg	3.79	16.8	2.5	-	2.6	5.0	93
Tailings	Mellanverket	0.30	12.1	-	6.2	-	-	-
	Stollberg	3.02	7.4	-	-	0.8	0.6	-

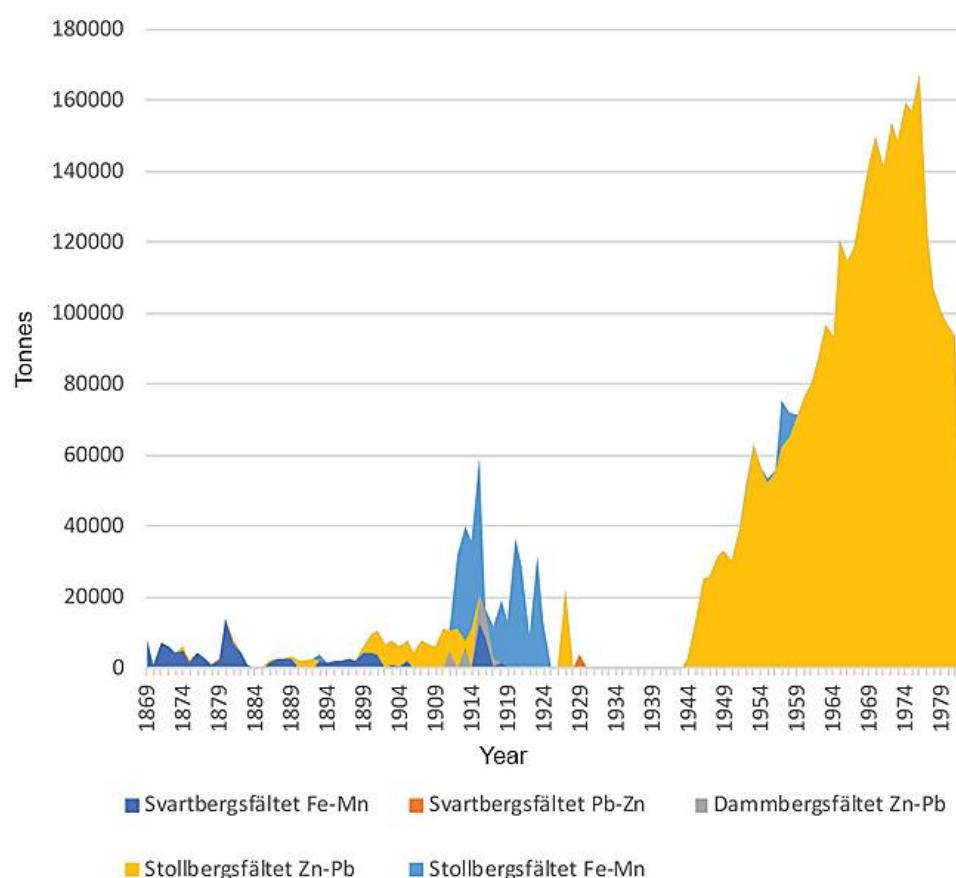


Figure 25. Annual ore-production at Stollberg during the period 1869–1981.

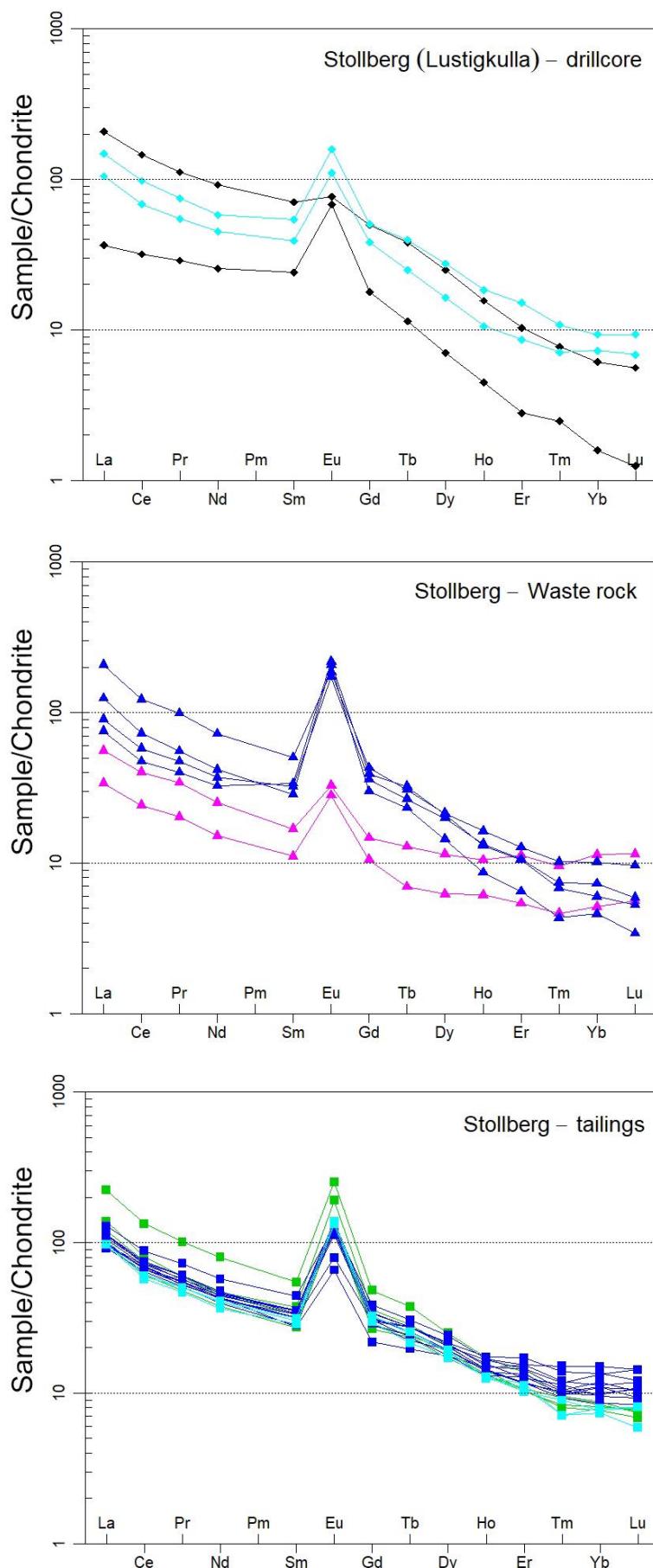


Figure 26. Chondrite normalised REE diagrams for samples from drill core, waste rock and tailings from Stollberg. Chondrite values are from Boynton (1984). Note very distinct positive Eu-anomalies in all samples. Different colours in each diagram represent individual drill cores (uppermost diagram: black = LGK79007, cyan = LGK79009), waste-rock heaps (middle diagram: blue = Lilla Dammerbergsgruvan, cerise = Myggruvan) and tailings repositories (lowermost diagram: blue = Brusmalmen, green and cyan = Silfhyttan).

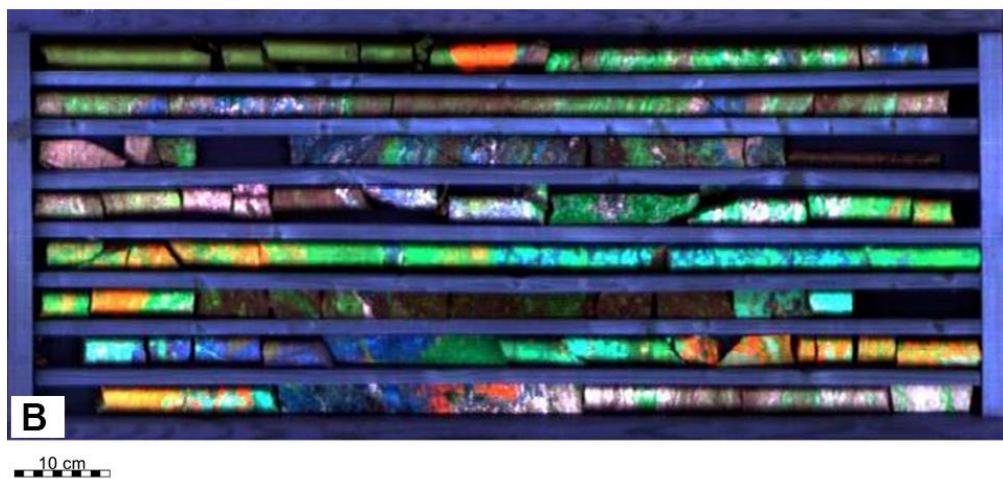
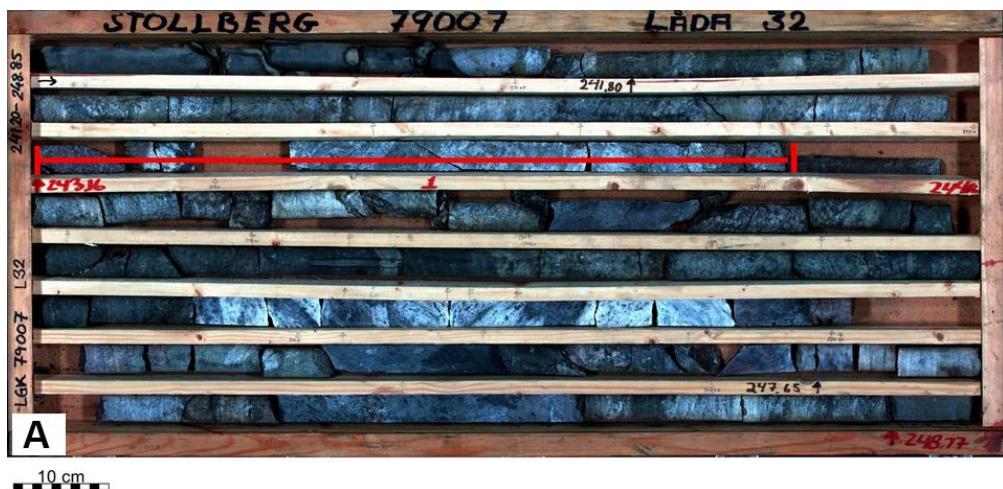


Figure 27. A. Drill core box containing c. 7.5 meters of drill core from Stollbergsfältet/Lustigkulla (6675383/515468). Red marker shows one-meter section interval for chemical analysis yielding for selected elements: Zn = 10.05 %, Mn = 2.19%, Pb = 1.11%, Ag = 58 ppm, Bi = 129 ppm, In = 7.53 ppm. B. The same drill corebox as in A. showing a False Colour Composite image that uses data from the longwave infrared (LWIR) part of the infrared spectrum. The LWIR camera covers the wavelength interval 7,500–12,000 nanometers (nm) and three infrared bands are rendered in RGB using red= 8,611 nm, green = 10,022 nm, blue = 11,810 nm.

The investigations of drill cores, waste rock and tailings (Table 12) in the Stollberg area do not show any significant resources of critical raw materials, possibly with the exception of the elevated levels of indium observed at several places, up to c. 20 ppm In in one drill core sample. On the other hand, both waste rock and tailings contain considerable amounts of the base metals zinc and lead that were originally extracted. The highest levels are found in the old tailings at Silfhyttan that has been deposited at the shore of lake Staren. Concentrations of arsenic in drill core, mine waste and tailings in the analysed samples from Silfhyttan are in most cases in excess of 250 g/t (upper detection limit for the whole-rock analyses) and reach 7,000 g/t where other analytical methods have been used.

Table 12. Analyses of tailings, waste-rock and drill core from the Stollberg field.

Data	Object	Fe %	Pb %	Zn %	Mn %	Ag ppm	As ppm	In ppm	Sb ppm
Tailings¹	Stollberg Brusmalmen (n=11)	6.3– 13.4	0.13– 0.69	0.2– 0.66	1.39– 5.37	5.6– 16.9	250– 5000	0.2– 1.7	8.1– 34.5
	Silfhyttan (n=4)	14.8– 20.8	0.49– 1.09	0.82– 1.25	4.39– 7.58	8.6– 14.6	1710– 7550	1.22– 1.83	18.9– 21.6
Waste-rock¹	Lilla Dammbergsgruvan (n=4)	13.6– 16.5	0.71– 1.30	1.79– 3.36	1.92– 4.40	15.7– 22.3	3960– 7430	1.73– 3.68	16.6– 22.4
	Myggruvan (n=2)	6.9– 9.3	0.58– 1.27	0.49– 0.53	3.62– 3.90	5.6–8 33– 1300	33– 1300	0.45– 2.52	2.6– 4.44
Drill core¹	Stollberg(n=4)	9.1– 34.6	1.10– 20.0	0.10– 10.1	2.10– 5.10	2– 355	10– 250 ²	1.00– 18.40	0.3– 250 ³

¹ All analysed samples with complete set of elements in Appendix 2–4.

CONCLUSIONS

Sampling and analysis of mining waste and drill cores enables identification of ore, mineralisation and mining waste deposits containing elements designated critical.

The results show that reconnaissance sampling are quick and cost-effective methods of obtaining an overview of the presence of both critical raw materials and main metals.

The limited number of samples from each object in this study is in most cases not enough to make a quantitative estimate (ore resource estimate). By demonstrating similarities in elemental distribution in analysed drill cores and mining waste with the documented elemental distribution in mined ore and resource estimates, it is possible to give a very rough quantitative estimate of the critical element content of ore and mine waste. At Grängesberg, however, the amount of data, the uniformity of the analysis results and a good correlation with calculated element contents, make it possible to roughly estimate the amount of phosphorus and REE. Such an estimate can be further refined into an “Exploration Target” or “Exploration Results” in accordance with PERC, JORC code or CIM-standards.

The methods used in the project also apply to identifying and quantifying the presence of hazardous substances, although this has not been the focus of the present project.

REFERENCES

- Allen, R., Jansson, N. & Ripa, M., 2013: Bergslagen: Geology of the volcanic- and limestone-hosted base metal and iron oxide deposits. Excursion Guidebook SWE4, 12th Biennial SGA Meeting 12–15 August 2013, Uppsala, Sweden.
- Ambros, M., 1983: Beskrivning till berggrundskartan Lindesberg NO. *Sveriges geologiska undersökning Af 141*, 1–75.
- Bergman, T., 2012: S010 Western Bergslagen W-Mo. In P. Eilu (ed.): *Mineral deposits and metallogeny of Fennoscandia*, Geological Survey of Finland, Special Paper 53.
- Blengini, G.A., Mathieu, F., Mancini, L., Nyberg, M. & Viegas, H.M. (ed.), 2019: Recovery of critical and other raw materials from mining waste and landfills: State of play on existing practices. Publications Office of the European Union, Luxembourg, JRC116131.

- Brown, T.J., Hobbs, S.F., Idoine, N.E., Mills, A.J., Wrighton, C.E. & Raycraft, E.R., 2016: European Mineral Statistics 2010–2014. Nottingham: British Geological Survey
- Carlborg, H. 1923: Riddarhytte malmfält. Historik. Kungliga kommerskollegium, beskrivningar över mineralfyndigheter nr. 1.
- Claeson, D., Sadeghi, M., Jönberger, J., Persson, L., Bastani, M., 2019: Berggrundsgeologisk undersökning, Ludvika, Bergslagen etapp 1. *SGU-rapport 2019:16*, Sveriges geologiska undersökning, 1–72.
- Claeson, D. (ed.), 2020: Innovationskritiska metaller och mineral i Bergslagen. RR 2020:02, Sveriges geologiska undersökning, 1–77.
- EASAC, 2016: Priorities for critical materials for a circular economy. EASAC Policy report. November 2016.
- Edberg, L., 1988: Sammanställning och sammanfattning av tidigare arbeten i Stollbergsfältet inom ramen för det erhållna statliga prospekteringsstödet, del 1. LKAB-PAB b 8816, 1–16.
- Eilu, P. (ed.) 2012: Mineral deposits and metallogeny of Fennoscandia. Geological Survey of Finland. Special paper 53.
- Envipro Miljöteknik AB. 2000: Saxbergsprojektet. En dokumentation av projektets genomförande.
- Fagersta bruk, 1978: Gruvkarta Bäckegravan.
- Gejer, P., 1923: Riddarhytte malmfält. (Geologisk beskrivning). Kungl. Kommerskollegium. Beskr. över mineralfyndigheter., nr1. Stockholm.
- Graedel, T.E., Harper, E.M., Nassar, N.T., Nuss, P. & Reck, B.K., 2015: Criticality of metals and metalloids. *The Proceedings of the National Academy of Sciences of the United States of America* 112, 4257–4262.
- Grängesberg Iron AB, 2014: Grängesberg_Technical report_2014, Grängesberg Iron AB, www.grangesberg.com.
- Hallberg, A. & Reginiussen, H., 2018a: Kartläggning av innovationskritiska metaller och mineral. Slutrapportering av regeringsuppdrag. RR 2018:05, Sveriges geologiska undersökning, 1–90.
- Hallberg, A. & Reginiussen, H., 2018b: Kartläggning av innovationskritiska metaller och mineral. Arbetsmaterial i form av analyser. RR 2018:05, Sveriges geologiska undersökning, Arbetsmaterial, analyser.
- Hallberg, A. & Reginiussen, H., 2019: Mapping of innovation-critical metals and minerals. *SGU report 2019:20*, Sveriges geologiska undersökning.
- Huisman, J., Leroy, P., Tertre, F., Ljunggren Söderman, M., Chancerel, P., Cassard, D., Løvik, A-N., Wäger, P., Kushnir, D., Rotter, V-S., Mähлиз, P., Herreras, L., Emmerich, J., Hallberg, A., Habib, H., Wagner, M. & Downes. S., 2017: Prospecting Secondary Raw Materials in the Urban Mine and mining wastes (ProSUM) – Final Report, ISBN: 978-92-808-9060-0 (print), 978-92-808-9061-7 (electronic), December 21, 2017, Brussels, Belgium
- Hällström, L.P.B., Alakangas, L. & Martinsson, O., 2018: Geochemical characterization of W, Cu and F skarn tailings at Yxsjöberg, Sweden. *Journal of Geochemical Exploration* 194, 266–279.
- Jansson, N. F., Erismann, F., Lundstam, E., Allen, R. L., 2013: Evolution of the Paleoproterozoic Volcanic-Limestone-Hydrothermal Sediment Succession and Zn-Pb-Ag and Iron Oxide Deposits at Stollberg, Bergslagen Region, Sweden. *Economic Geology* 108, 309–335.
- Kuhn, K. & Meima, J.A., 2019: Characterization and economic potential of historic tailings from gravity separation: implications from a mine waste dump (Pb-Ag) in the Harz mountains mining district, Germany. *Minerals* 9(5), 303.
- Lindvall, M., 1988: Utvinning av volfram ur avfallssand. Slutrapport, Statsgruvor AB, 1–10.

- Lundin Mining, 2017: NI43-101 Technical Report for the Zinkgruvan Mine, Sweden. Lundin Mining, p 133.
- MALMdb, 2020; SGU's database of ore production and mineral processing in Sweden.
- Majka, J., Jonsson, E., Högdahl, K., Troll, V.R., Harlov, D.E. & P.Nilsson, K., 2013: Textural relations and mineral chemistry of REE in the Grängesberg apatite-iron oxide deposit, Sweden: the role of fluids. 12th Biennial SGA meeting, Mineral deposit research for a high-tech world, 1728–1731.
- Mulenshi, J., Khavari P, Chelgani, S.C. & Rosenkranz, J., 2019: Characterization and Beneficiation Options for Tungsten Recovery from Yxsjöberg Historical Ore Tailings. *Processes* 7, 895.
- Måansson, S., 1982: Inventering varphögarna, Stollberg. LKAB-PAB Grb 277, 1–11.
- Ohlsson, L-G., 1979: Tungsten occurrences in central Sweden. *Economic geology* 74, 1012–1034.
- Ohlsson, L.-G., 1980: Zn-, Pb- och Ag-halter i Stollbergs avfallsdamm. Grb 198, prospekteringsrapport, 2 p.
- Ripa, M., 1988: Geochemistry of wall-rock alteration and of mixed volcanic-exhalative facies at the Proterozoic Stollberg Fe-Pb-Zn-Mn (-Ag) deposit, Bergslagen, Sweden. *Geologie en Mijnbouw* 67, 443–456
- Ripa, M. (ed), Sundberg, A., Wik, N.- G., Bergman, T., Claeson, D., Hallberg, A., Hellström, F., Kubler, L. & Nysten, P., 2015: Malmer, industriella mineral och bergarter i Dalarnas län. *Rapporter och meddelanden 139 del 1–3*, Sveriges geologiska undersökning, 1–1276.
- Romer, R.L. & Öhlander, B., 1994: U-Pb age of the Yxsjöberg tungsten-skarn deposit, Sweden. *GFF* 116, 161–166.
- Sadeghi, M. (ed.), 2019: Rare earth elements distribution, mineralisation and exploration potential in Sweden. *Rapporter och meddelanden 146*, Sveriges geologiska undersökning, 1–184.
- Sveriges geologiska undersökning, 2014: Uppdrag att utföra en kartläggning och analys av utvinnings- och återvinningspotential för svenska metall- och mineral tillgångar. Redovisning av regeringsuppdrag. Diarienummer: 3114–1639/2013.
- Sveriges geologiska undersökning, 2020: Bergverksstatistik 2019. *Periodiska publikationer 2020:01*, Sveriges geologiska undersökning.
- Söderberg, L, Stölen, L-K., Levén, J., Zillén Snowball, L. & Reginiussen, H., 2020: How the Geological Survey of Sweden contributes digital data for sustainable development. In: Hill, P. R., Lebel, D., Hitzman, M., Smelror, M. & Thorleifson, H. (eds): The Changing Role of Geological Surveys. Geological Society, London, *Special Publications* 499, 173–182. doi: /10.1144/SP499-2019-43
- Sädbom, S. & Bäckström, M., 2018: Sampling of mining waste – historical background, experiences and suggested methods. BKBAB 18-109 Rep, Bergskraft Bergslagen AB, 1–71.
- Taha, Y. & Benzaazoua, M., 2020: Editorial for special issue “Towards a sustainable management of mine wastes: reprocessing, reuse, revalorization, and repository”. *Minerals* 10, 21.
- Tegengren, F.R. m.fl., 1924: Sveriges ädlare malmer och bergverk. *Sveriges geologiska undersökning Ca* 17, 1–406.
- Tiess, G., 2010: Minerals policy in Europe: Some recent developments. *Resources Policy* 35, 190–198.
- Werner, T.T., Mudd, G.M. & Jowitt, S.M., 2015: Indium: key issues in assessing mineral resources and long-term supply from recycling. *Applied Earth Science* 124, 213–226.

APPENDIX 1. SAMPLE DIGESTION AND ANALYTICAL METHODS

Appendix 1. Sample digestion and analytical methods.

Digestion	Li-borate fusion	Li-borate fusion	aqua regia	Li-borate fusion+4-acid	fire assay	-	4-acid	aqua regia	aqua regia
Method	ICP-AES	ICP-MS	ICP-MS	ICP-MS	ICP-AES	Leco	ICP	ICP-MS	ICP-MS
Code	ME-ICP06	ME-MS81	ME-MS42	ME-4ACD81	PGM-ICP23	C-IR07&S-IR08	Me-OG62	ME-MS41	ME-MS41
Unit	%	ppm	ppm	ppm	ppm	%	%	%	ppm
SiO ₂	Ba	As	Ag	Au	C	Cu	Al	Ag	
Al ₂ O ₃	Ce	Bi	Cd	Pt	S	Pb	Ca	As	
Fe ₂ O ₃	Cr	Hg	Co	Pd		Zn	Fe	Au	
CaO	Cs	Sb	Cu				K	B	
MgO	Dy	Se	Mo				Mg	Ba	
Na ₂ O	Er	Te	Ni				Na	Be	
K ₂ O	Eu	Tl	Pb				S	Bi	
Cr ₂ O ₃	Ga	In	Sc				Ti	Cd	
TiO ₂	Gd	Re	Zn					Ce	
MnO	Hf		Li					Co	
P ₂ O ₅	Ho							Cr	
SrO	La							Cs	
BaO	Lu							Cu	
LOI	Nb							Ga	
Total	Nd							Ge	
	Pr							Hf	
	Rb							Hg	
	Sm							In	
	Sn							La	
	Sr							Li	
	Ta							Mn	
	Tb							Mo	
	Th							Nb	
	Tm							Ni	
	U							P	
	V							Pb	
	W							Rb	
	Y							Re	
	Yb							Sb	
	Zr							Sc	
	Ge							Se	
								Sn	
								Sr	
								Ta	
								Te	
								Th	
								Tl	
								U	
								V	
								W	
								Y	
								Zn	

APPENDIX 2. DRILL CORE ANALYSES

Appendix 2. Drill core analyses.

SGU_ID	Riddarhyttan	Riddarhyttan	Riddarhyttan	Riddarhyttan	Riddarhyttan	Skärsjön	Skärsjön	Skärsjön	Skärsjön
bh	Hästjärn	Bastens	Bastens	Bastens	Bastens	1	1	1	1
from	23	51	56,7	57,7	58,7	108,2	120	158,25	76
to	24	52	57,7	58,7	59,7	109,2	121	159,25	77
N_SWEREF	6634709	6634594	6634594	6634594	6634594	6633970	6633970	6633970	6633970
E_SWEREF	532401	532280	532280	532280	532280	531048	531048	531048	531048
SIO2_%	53,3	52,6	42,5	38	28,4	39,9	11,6	20	10,2
TIO2_%	0,14	0,2	0,13	0,16	0,22	0,04	0,02	0,01	0,02
AL2O3_%	8	11,9	8,09	13,85	12,35	2,78	1,08	1,07	2,51
FE2O3_%	24,9	12,3	27	15,85	33,3	52,8	82,3	69	81,5
MGO_%	7,89	14,7	16,95	22,3	16,6	3,15	5,49	8,5	5,15
CAO_%	0,08	0,04	0,15	0,2	0,33	0,17	0,03	0,27	0,03
MNO_%	0,09	0,05	0,05	0,05	0,05	0,02	0,02	0,02	0,02
NA2O_%	0,12	0,08	0,12	0,17	0,1	0,03	0,04	0,02	0,06
K2O_%	1,97	2,61	2,04	2,3	1,68	0,08	0,03	0,01	0,67
P2O5_%	0,03	0,03	0,03	0,05	0,1	0,01	0,01	0,01	0,01
LOI_%	2,81	3,53	3,18	5,92	4,89	0,68	-1,31	-0,01	-1,31
total_%	99,4	98,06	100,25	98,86	98,03	99,67	99,31	98,9	98,86
C_%	0,07	0,02	0,03	0,03	0,03	0,1	0,05	0,09	0,04
S_%	0,01	1,08	0,04	0,24	1,09	1,74	<0,01	0,79	0,27
AG_ppm	0,01	0,32	0,01	0,02	0,03	0,02	<0,01	0,46	0,18
AS_ppm	0,2	0,6	<0,1	3,7	1,6	0,2	0,1	1,5	0,3
AU_ppm	<0,001	0,033	<0,001	0,002	0,006	0,006	0,001	0,085	0,033
BA_ppm	547	190,5	80,1	85,5	84,4	6	0,5	<0,5	15,5
BE_ppm	8	3,35	2,81	25,6	27,6	<0,05	0,07	35,3	0,33
BI_ppm	0,08	55,6	0,3	0,45	0,92	1,67	0,8	10,9	45,1
CD_ppm	<0,01	0,03	0,01	0,01	0,01	<0,01	0,01	0,01	0,05
CO_ppm	12	67	19	41	108	96	72	57	184
CR_ppm	10	20	10	<10	10	20	<10	<10	<10
CS_ppm	4,97	3,22	5,22	5,33	4,26	0,18	0,07	0,04	1,66
CU_ppm	2	2350	29	100	380	315	<1	2790	1300
GA_ppm	12,2	17	21,5	27,3	42,8	10,4	18,8	48,1	18,2
GE_ppm	7	7	10	10	11	7	9	11	6
HF_ppm	4,7	7,1	5,2	7,5	6,5	1,2	0,9	0,5	1,2
HG_ppm	0,005	<0,005	<0,005	<0,005	<0,005	<0,005	0,008	0,011	0,005
IN_ppm	0,433	0,467	0,307	0,475	0,694	0,389	0,387	0,594	1,125
LI_ppm	50	<10	10	10	<10	<10	<10	<10	<10
MO_ppm	1	15	17	33	7	6	93	13	56
NB_ppm	15,6	21,9	9,5	19,9	15,4	2,3	1,6	0,5	3,8
NI_ppm	1	7	20	30	41	3	1	19	4
PB_ppm	<2	5	3	5	3	<2	<2	<2	<2
PD_ppm	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	77,3	136,5	102	110	85,3	2,7	0,7	<0,2	31,5
Re_ppm	<0,001	<0,001	<0,001	0,008	<0,001	<0,001	<0,001	0,001	0,001
SB_ppm	0,1	0,08	0,07	0,11	0,12	0,06	0,07	0,06	0,11
SC_ppm	4	6	4	5	4	1	1	<1	1
SE_ppm	<0,2	0,9	0,4	0,3	3,6	0,7	<0,2	3,8	0,6
SN_ppm	4	1	2	3	3	6	7	28	21
SR_ppm	2,7	2,2	3,2	4	5,1	3,8	1,1	1,7	0,9
TA_ppm	0,8	1,8	0,9	1,3	1,1	<0,1	<0,1	<0,1	<0,1
TE_ppm	0,01	0,44	<0,01	0,05	0,1	0,26	0,02	0,88	0,27
TH_ppm	9,88	17	13,75	16	22,3	3,22	2	1,58	2,77
TL_ppm	0,15	0,87	0,59	0,72	0,43	0,02	<0,02	<0,02	0,15
U_ppm	3,66	6,07	3,52	12,5	13,9	0,9	1,69	1,5	1,28
V_ppm	12	13	7	5	23	10	10	8	13
W_ppm	1	4	4	46	4	3	2	1	4
Y_ppm	52,1	48,6	338	722	1100	46,3	88,8	344	85,4
ZN_ppm	13	6	21	23	15	8	7	8	13
ZR_ppm	134	210	162	224	213	38	29	12	34
LA_ppm	28,6	140	438	367	1200	28,9	120	1915	145,5
CE_ppm	53	266	1330	1255	2770	44	195	3740	238
PR_ppm	6	31,2	169	202	373	4,36	20,4	426	25,6
ND_ppm	24,5	121,5	674	1010	1600	15,1	80,2	1515	98
SM_ppm	5,77	21,1	96,7	263	329	4,05	17,95	250	19,15
EU_ppm	1,33	2,3	7,93	17,05	27	2,91	2,21	17,1	2,11
GD_ppm	7,9	15,5	85,1	231	301	5,79	19,05	186	18,2
TB_ppm	1,22	1,56	10,05	29,1	40,1	1,06	2,61	17,1	2,44
DY_ppm	8,06	8,61	56,6	159,5	224	6,76	15,25	77,5	14,1
HO_ppm	1,69	1,48	9,13	24,9	36,6	1,25	2,77	11,55	2,61
ER_ppm	5,29	3,93	22,8	57,3	87,8	3,13	6,68	24,1	5,97
TM_ppm	0,68	0,57	2,39	6,3	9,86	0,32	0,72	2,19	0,63
YB_ppm	4,64	3,2	13,35	29,6	45,8	2,04	4,39	11,05	3,91
LU_ppm	0,75	0,54	1,79	3,53	5,82	0,24	0,63	1,33	0,47
REEtot_%	0,01	0,06	0,29	0,37	0,70	0,01	0,05	0,82	0,06

Appendix 2. Continuation.

SGU_ID	Lerklockan	Persgruvan	Persgruvan							
bh	-	-	-	-	-	-	-	-	76	324
from	51	52,7	53,7	54,7	55,7	56,7	57,7	58,7	118,9	84,5
to	52,7	53,7	54,7	55,7	56,7	57,7	58,7	59,7	119,9	85,5
N_SWEREF	6634317	6634317	6634317	6634317	6634317	6634317	6634317	6634317	6634253	6634253
E_SWEREF	531858	531858	531858	531858	531858	531858	531858	531858	531424	531424
SIO2_%	33,5	28,1	40,2	47,6	24	31,2	13,25	18,95	38,5	60,3
TIO2_%	0,01	<0,01	<0,01	0,01	<0,01	0,03	<0,01	0,01	0,08	0,25
AL2O3_%	0,76	0,38	0,42	0,26	0,23	1,27	0,32	0,37	7,63	12,75
FE2O3_%	50,4	58,6	49,1	44	72,4	66,4	84,8	81	29,9	11,8
MGO_%	13,45	11,85	9,25	7,87	5,03	2,14	3,08	2,98	16,5	13
CAO_%	0,26	0,08	0,14	0,05	0,02	0,24	0,01	0,01	0,15	0,11
MNO_%	0,01	0,01	0,02	0,01	0,02	0,02	0,02	0,02	0,03	0,02
NA2O_%	0,03	0,01	0,01	0,01	0,01	0,24	0,02	0,01	0,2	0,16
K2O_%	0,08	0,03	0,01	<0,01	0,02	0,07	0,01	0,01	0,73	1,13
P2O5_%	0,01	<0,01	<0,01	0,01	0,02	0,02	0,01	0,02	0,04	0,04
LOI_%	0,93	0,46	0,16	0,09	-1,2	-1,46	-1,93	-1,84	4,53	2,02
total_%	99,44	99,52	99,31	99,91	100,55	100,17	99,59	101,54	98,29	101,58
C_%	0,03	0,03	0,03	0,03	0,08	0,07	0,08	0,09	0,03	0,06
S_%	0,02	0,01	0,01	0,01	0,03	0,02	0,03	0,04	0,01	0,02
AG_ppm	0,01	0,01	0,03	0,02	0,01	0,01	<0,01	<0,01	0,01	<0,01
AS_ppm	0,4	0,4	0,3	<0,1	0,1	0,2	0,1	0,1	0,2	0,2
AU_ppm	0,002	0,003	0,009	0,007	0,002	0,003	0,001	0,004	<0,001	0,005
BA_ppm	4,5	1,8	1,2	1	<0,5	20,2	1,6	<0,5	16,3	15,5
BE_ppm	2,32	7,49	2,42	0,43	2,5	2,17	0,49	0,21	20,3	4,19
BI_ppm	7,27	6	31	21	6,85	5,06	4,03	6,08	0,84	0,29
CD_ppm	0,01	<0,01	0,01	<0,01	<0,01	0,01	<0,01	<0,01	<0,01	0,01
CO_ppm	24	24	24	27	35	30	38	37	15	19
CR_ppm	<10	<10	<10	10	10	10	<10	<10	<10	20
CS_ppm	0,09	0,05	0,06	0,03	0,01	0,07	0,04	0,05	1,2	1,79
CU_ppm	4	14	13	7	2	3	2	6	<1	9
GA_ppm	6,8	3,9	7,9	4,4	3,2	3,8	2,9	4,3	32,4	38,6
GE_ppm	9	9	10	9	7	5	6	6	9	7
HF_ppm	0,2	0,2	<0,2	<0,2	<0,2	0,4	<0,2	<0,2	4,3	7,9
HG_ppm	0,01	0,007	0,011	0,01	0,011	0,007	0,012	0,011	<0,005	0,005
IN_ppm	0,931	1,175	1	0,782	1,26	1,04	1,335	1,23	0,53	0,218
LI_ppm	<10	<10	<10	<10	<10	<10	<10	<10	20	<10
MO_ppm	60	25	20	12	3	2	6	10	108	2
NB_ppm	2,3	0,8	0,4	0,4	0,6	0,9	1,2	1,4	16,5	17,1
NI_ppm	3	5	16	7	4	2	1	4	18	8
PB_ppm	<2	<2	3	<2	<2	<2	<2	<2	3	7
PD_ppm	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	3	0,9	<0,2	<0,2	<0,2	1,5	<0,2	<0,2	29,4	51,3
Re_ppm	0,002	0,001	0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,003	0,001
SB_ppm	0,1	0,1	0,11	0,09	0,09	0,12	0,08	0,09	<0,05	0,09
SC_ppm	<1	<1	<1	<1	<1	1	<1	<1	3	6
SE_ppm	0,4	0,4	0,7	0,5	0,3	0,3	0,2	<0,2	1,3	0,2
SN_ppm	2	3	2	2	2	2	2	2	5	2
SR_ppm	0,8	0,6	0,7	0,3	0,6	14,8	0,7	0,4	8,4	1,8
TA_ppm	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	0,7	1,2
TE_ppm	0,09	0,17	1,1	0,66	0,26	0,14	0,08	0,09	<0,01	0,04
TH_ppm	0,5	0,33	0,23	0,28	0,17	0,32	0,15	0,54	8,94	13,25
TL_ppm	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	0,12	0,12
U_ppm	0,87	1,03	1,12	1,35	0,64	0,5	0,38	0,41	17,6	5,33
V_ppm	9	8	9	10	10	10	7	8	9	20
W_ppm	2	1	2	2	1	1	2	<1	1	6
Y_ppm	101,5	106,5	145,5	86,4	33,1	17,7	7,7	20,8	400	33,5
ZN_ppm	11	8	7	3	5	11	7	4	13	10
ZR_ppm	7	8	2	3	2	13	<2	5	133	255
LA_ppm	146	208	1115	432	136	40,4	22,6	53,1	140,5	215
CE_ppm	210	294	1565	644	192,5	59,7	32,4	76,5	596	358
PR_ppm	20,4	28,2	140,5	54,8	18,3	6,06	3,17	6,98	104	36,8
ND_ppm	77,7	107	502	192	64,2	22,4	11,7	25,3	580	143,5
SM_ppm	19,15	25,9	94,3	38,8	12,95	4,44	2,15	5,4	184	25,7
EU_ppm	4,17	6,62	19	13,65	4,5	1,48	0,83	1,79	11,9	3,65
GD_ppm	23,3	31,1	77,1	34,3	12,6	4,54	2,61	5,32	169,5	19,25
TB_ppm	2,8	3,78	6,89	3,43	1,27	0,59	0,3	0,63	19,45	1,71
DY_ppm	15,45	19,65	28,6	14,45	6	3,37	1,59	3,39	91,6	7,18
HO_ppm	2,9	3,28	4,09	2,19	0,93	0,56	0,26	0,66	13,7	1,14
ER_ppm	6,5	7,67	8,32	4,76	2,16	1,33	0,64	1,86	28,9	2,9
TM_ppm	0,74	0,81	0,82	0,52	0,21	0,17	0,08	0,19	2,8	0,34
YB_ppm	4,37	4,44	4,81	2,99	1,39	1,18	0,42	1,4	15,25	2,77
LU_ppm	0,58	0,55	0,59	0,37	0,18	0,17	0,08	0,2	1,72	0,42
REEtot_%	0,05	0,								

Appendix 2. Continuation.

SGU_ID	Bastnäsorten										
bh	1	1	2	2	8	8	10	10	10	15	
from	63	9,5	136,7	143,60	85,6	86,6	12,2	2,1	3,1	0	
to	64	10,5	137,7	144,6	86,6	87,6	13,2	3,1	4,1	1	
N_SWEREF	6633216	6633216	6633291	6633291	6633437	6633437	6633524	6633524	6633524	6633747	
E_SWEREF	532312	532312	532388	532388	532561	532561	532654	532654	532654	532757	
SIO2_%	43	61,1	28,2	45,4	48,2	52,6	45,2	28,4	21,1	21,6	
TIO2_%	0,05	0,08	0,11	0,32	0,07	0,03	0,07	0,09	0,07	0,04	
AL2O3_%	3,89	9,74	5,84	11,35	4,84	2,28	5,14	6,88	7,65	3,45	
FE2O3_%	51,6	18,35	52,8	25,9	37,9	34,5	38,1	50,1	49	54,4	
MGO_%	1,12	2,69	5,7	7,11	1,95	3,8	5	6,22	6,52	9,27	
CAO_%	0,15	1,13	7,07	7,75	1,5	3,72	4,21	5,28	9,18	6,56	
MNO_%	0,3	0,15	0,07	0,07	0,03	0,1	0,06	0,1	0,07	0,08	
NA2O_%	0,01	0,04	0,32	0,44	0,07	0,07	0,2	0,58	0,15	0,1	
K2O_%	1,75	3,41	0,66	2,11	1,6	0,55	1,4	1,27	2,42	2,04	
P2O5_%	0,03	<0,01	0,02	0,05	0,03	0,02	0,04	0,04	0,02	0,02	
LOI_%	-0,75	1,31	-0,18	1,01	0,75	1,19	-0,02	0,05	1,01	1,09	
total_%	101,3	98,04	100,62	101,52	99,51	100,23	99,41	99,03	97,21	98,97	
C_%	0,02	0,01	0,02	0,02	0,04	0,22	0,02	0,03	0,01	0,11	
S_%	0,42	0,03	0,11	0,07	0,58	0,67	0,28	0,16	0,32	0,56	
AG_ppm	0,64	0,06	0,21	0,05	0,01	<0,01	0,04	0,69	0,36	0,18	
AS_ppm	1,1	0,2	0,4	0,5	0,8	0,3	0,5	1,1	1,8	2,8	
AU_ppm	0,014	0,05	0,055	0,237	0,001	<0,001	0,003	0,015	0,031	0,027	
BA_ppm	1320	354	41,3	52,2	>10000	>10000	62,2	152,5	192,5	2730	
BE_ppm	1,6	0,87	0,58	0,82	2,22	1,7	1,41	0,79	1,26	0,72	
BI_ppm	2,38	4,87	30,7	44,3	0,24	0,43	24,2	38,6	224	1,48	
CD_ppm	0,08	0,05	0,03	0,01	0,01	0,01	0,04	0,14	0,15	0,02	
CO_ppm	54	9	13	22	6	7	39	30	86	74	
CR_ppm	10	20	10	10	10	10	10	10	<10	<10	
CS_ppm	1,14	1,63	0,18	0,99	1,01	0,54	1,21	1,18	1,61	1,64	
CU_ppm	2840	139	717	102	5	<1	56	785	271	1950	
GA_ppm	8,5	19,3	12,4	29,6	8,1	4,3	18,6	25	44,1	13,3	
GE_ppm	9	<5	7	7	15	18	6	8	9	5	
HF_ppm	2,2	4,9	3,1	9,2	3,6	0,9	3,7	2,9	3,9	1,7	
HG_ppm	0,009	<0,005	<0,005	<0,005	<0,005	<0,005	0,008	<0,005	0,013	<0,005	
IN_ppm	5,56	0,724	1,495	1,15	0,74	0,789	0,306	0,714	1,09	2,02	
LI_ppm	10	20	<10	10	20	10	10	10	20	50	
MO_ppm	1	39	5	26	6	3	284	216	2910	18	
NB_ppm	5,6	14,9	7,2	23,3	7,8	2,4	8,8	9,5	10,1	3,6	
NI_ppm	1	1	3	4	3	1	4	14	27	2	
PB_ppm	<2	<2	<2	<2	<2	<2	<2	5	9	2	
PD_ppm	0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	
RB_ppm	55,8	112,5	19,9	84,6	62,1	23,4	56,8	47,2	95,3	71,4	
Re_ppm	<0,001	0,001	0,001	0,001	<0,001	<0,001	0,005	0,003	0,103	0,002	
SB_ppm	0,23	0,06	0,11	0,11	0,98	1,16	0,16	0,17	0,25	2,46	
SC_ppm	2	5	2	8	2	1	3	4	3	1	
SE_ppm	0,9	0,2	<0,2	0,5	0,2	<0,2	0,9	0,9	5,5	0,3	
SN_ppm	3	3	4	3	2	1	2	5	5	14	
SR_ppm	8,9	10,2	11,5	14,6	77,5	63,1	9,1	38	20,7	18,9	
TA_ppm	0,6	1,4	0,3	1	0,3	<0,1	0,3	0,5	0,5	0,2	
TE_ppm	0,05	0,02	0,09	0,16	0,02	0,01	0,13	0,32	1,08	0,03	
TH_ppm	5,3	15,1	5,71	13,1	6,69	1,9	6,5	5,37	9,44	3,05	
TL_ppm	0,11	0,2	0,02	0,07	0,04	0,02	0,15	0,13	0,24	0,11	
U_ppm	1,43	6,47	3,55	5,37	1,77	0,97	2,51	2,21	5,12	0,88	
V_ppm	16	<5	10	18	13	10	12	15	10	14	
W_ppm	9	37	48	1	1	1	12	322	43	254	
Y_ppm	30,5	48	59,5	125	26,3	14,9	82,5	275	448	43	
ZN_ppm	20	13	6	8	7	6	33	48	34	9	
ZR_ppm	62	144	103	340	103	27	104	91	123	49	
LA_ppm	80,3	94,6	99,6	318	31,3	11,5	313	1215	1790	72,1	
CE_ppm	132,5	165,5	149	446	57,9	20,1	391	1530	2600	104,5	
PR_ppm	14,6	18,45	15,25	44,6	6,2	2,3	37,8	141	264	9,94	
ND_ppm	54,1	69,2	58,4	169,5	25	9,7	142,5	536	1080	35,2	
SM_ppm	9,48	11,9	11,8	31,3	5,62	3,24	26,9	109,5	241	6,96	
EU_ppm	3,86	1,98	4,15	7,44	2,05	1,56	9,16	33,7	63,8	8,5	
GD_ppm	8,41	10,75	12,95	29,9	5,83	4,28	23,6	106,5	223	8,7	
TB_ppm	1,14	1,49	1,71	3,39	0,77	0,67	2,62	11,65	21,9	1,04	
DY_ppm	6,64	9,63	9,48	18,65	4,39	3,22	13,95	59	96,5	5,56	
HO_ppm	1,12	1,75	1,87	3,42	0,85	0,57	2,65	9,33	14,2	0,99	
ER_ppm	3,05	5,47	4,78	8,33	2,45	1,43	6,42	20	26	2,28	
TM_ppm	0,41	0,75	0,62	0,96	0,26	0,15	0,8	1,8	2,31	0,22	

Appendix 2. Continuation.

SGU_ID	Bastnäsorten	Sandvretsgruvan	Sandvretsgruvan							
bh	15	42	42	42	49	49	49	50	1	1
from	15,3	51,15	56	60	64,0	70,7	84	65,3	187,15	221,8
to	16,3	52,15	57	61	65	71,9	85	66,3	188,15	222,8
N_SWEREF	6633747	6634350	6634350	6634350	6634448	6634448	6634448	6634452	6636177	6636177
E_SWEREF	532757	532927	532927	532927	532958	532958	532958	532960	534588	534588
SIO2_%	40,9	33,7	47	40,3	43,4	23,5	12,65	69,9	55	41,1
TIO2_%	0,04	0,04	0,06	0,05	0,06	0,04	0,04	0,09	0,1	0,09
AL2O3_%	4,66	2,01	5,03	3,5	4,65	1,92	2,51	10,05	7,26	4,28
FE2O3_%	43,4	58,5	46	51	46,8	54,8	35	9,88	20,2	29
MGO_%	3,07	3,13	2,07	3,7	3,33	13,8	14,95	2,87	4,2	6,73
CAO_%	1,12	2,39	0,14	0,81	0,74	3,36	16	1,11	0,3	11,2
MNO_%	0,02	0,13	0,03	0,05	0,06	0,09	0,2	0,12	0,15	7,82
NA2O_%	0,07	0,02	0,23	0,04	0,46	0,02	0,01	0,83	0,03	0,07
K2O_%	0,23	0,3	0,99	0,57	0,81	0,04	0,02	3,92	0,55	0,35
P2O5_%	0,01	0,03	0,02	0,02	0,02	0,02	0,02	0,01	0,08	0,05
LOI_%	1,86	0,88	0,37	-0,04	0,31	1,3	15,85	1,14	5,69	0,71
total_%	98,42	101,14	101,99	100,06	100,68	98,89	97,25	100,12	93,57	101,45
C_%	0,06	0,03	0,02	0,06	0,02	0,03	4,1	0,01	0,04	0,24
S_%	0,69	<0,01	<0,01	0,01	0,01	0,19	0,16	0,01	7,61	0,01
AG_ppm	0,01	<0,01	<0,01	0,01	0,04	0,16	0,06	<0,01	9,81	0,04
AS_ppm	9,2	2,2	0,8	1	0,6	1	2,3	3,6	14,2	18,2
AU_ppm	0,001	<0,001	<0,001	0,008	<0,001	0,041	0,019	0,001	0,028	<0,001
BA_ppm	>10000	63,3	303	503	370	14,5	1,6	1645	48,6	415
BE_ppm	2,87	4,83	5,99	1,91	1,92	12,1	65,3	1,03	1,81	1,4
BI_ppm	0,24	4,35	2,01	0,96	1,16	23,7	3,33	0,89	32,4	0,5
CD_ppm	<0,01	0,01	<0,01	0,01	0,02	0,06	0,04	<0,01	111	0,28
CO_ppm	5	6	3	19	13	190	11	4	27	1
CR_ppm	10	10	20	10	10	10	10	10	20	10
CS_ppm	3,83	0,32	0,92	1,46	1,03	0,13	0,08	1,08	2,16	0,66
CU_ppm	8	<1	7	4	<1	1390	1180	<1	307	<1
GA_ppm	7	5,6	9,9	7,1	8,8	18,6	41,3	16	24,6	14,5
GE_ppm	13	11	8	8	7	9	10	5	5	<5
HF_ppm	3,3	1,1	3,4	1,9	2,6	1,2	1,3	5,2	3,2	2,5
HG_ppm	0,01	<0,005	<0,005	<0,005	0,01	0,006	0,01	<0,005	3,2	<0,005
IN_ppm	1,055	1,95	1,39	0,859	1,13	1,675	2,82	0,623	7,74	1,865
LI_ppm	60	<10	10	10	10	<10	<10	10	10	<10
MO_ppm	5	5	1	1	1	6	20	1	15	<1
NB_ppm	8,4	2,3	6,9	5,4	6,7	2,7	2,9	14,8	9,6	4,7
NI_ppm	1	3	3	3	4	12	72	3	12	9
PB_ppm	<2	<2	<2	<2	<2	4	7	2	1840	20
PD_ppm	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	21,3	15,8	39,1	26,5	31,2	1,2	<0,2	121	38,7	26,4
Re_ppm	<0,001	<0,001	<0,001	<0,001	<0,001	0,001	0,005	0,001	<0,001	<0,001
SB_ppm	4,21	10,05	3,46	0,35	0,43	0,24	0,12	1,28	6,09	1,72
SC_ppm	1	1	2	2	2	1	1	4	5	3
SE_ppm	<0,2	0,6	<0,2	0,7	<0,2	1,5	2,8	<0,2	11,6	0,3
SN_ppm	2	1	2	1	2	4	3	4	13	20
SR_ppm	113,5	4,8	5,2	22,3	13,1	1,4	6,2	12,4	3,2	7,5
TA_ppm	0,3	0,3	0,6	0,6	0,1	0,1	0,1	1	1	0,5
TE_ppm	0,02	<0,01	<0,01	0,03	0,02	0,46	0,88	0,01	0,98	0,07
TH_ppm	6,67	2,24	6,57	4,81	6,94	2,28	2,99	13,75	11,85	8,49
TL_ppm	0,07	0,02	0,04	0,04	0,04	<0,02	<0,02	0,13	2,9	0,07
U_ppm	1,13	1,23	2,14	1,66	2,31	1,08	6,32	4,95	6,49	1,04
V_ppm	9	11	11	5	22	13	8	12	11	13
W_ppm	2	15	5	6	1	3	14	3	15	4
Y_ppm	14,9	54,3	46,6	33,6	42,6	95,3	460	47,1	56	24,1
ZN_ppm	3	<2	<2	7	14	42	30	19	47500	623
ZR_ppm	83	34	104	68	69	32	37	146	102	95
LA_ppm	20,3	135,5	157	114,5	88,1	514	4400	51,6	88,3	44
CE_ppm	32,8	203	244	164,5	132,5	992	7710	104,5	157,5	72,6
PR_ppm	3,22	21,6	26,5	17,1	12,2	105,5	823	11,6	18,05	7,99
ND_ppm	12,2	83	98,9	59	44,7	410	3030	47,4	69,9	28,1
SM_ppm	2,7	16,2	18,15	10,35	9,17	66,2	382	9,56	14,1	5,15
EU_ppm	3,28	3,91	5,23	4,33	4,64	2,37	15,5	0,77	7,21	2,87
GD_ppm	2,52	18,4	14,95	8,37	9,97	41,9	243	8,93	14,7	5,72
TB_ppm	0,37	1,98	1,68	1,05	1,16	3,86	20,7	1,28	2	0,73
DY_ppm	2,3	10,35	9,19	5,98	6,3	17	91,1	8,38	12,05	4,7
HO_ppm	0,48	1,55	1,55	1,04	1,23	2,68	13,25	1,72	2,14	0,82
ER_ppm	1,32	3,47	3,93	2,73	3,08	6,12	24,8	4,99	5,63	2,54
TM_ppm	0,17	0,39	0,46	0,35	0,33	0,68	2,15	0,69	0,72	0,3
YB_ppm	1,34	1,96	2,79	2,25	2,21	3,61	9,88	5,09	4,35	2,07
LU_ppm	0,16	0,22	0,39	0,32	0,35	0,49	1,11	0,75	0,69	0,34
REEtot_%	0,01	0,05	0,06	0,04	0,03	0,22	1,68	0,03</td		

Appendix 2. Continuation.

SGU_ID	Sandvretsgruvan	Östergruvan	Östergruvan	Källfallsgruvan						
bh	1	661ö	671ö	3	3	3	3	127	127	127
from	222,8	3,9	42,3	24,5	25,5	26,5	29,5	34,5	35,5	36,5
to	223,8	4,9	43,3	25,5	26,5	27,5	30,5	35,5	36,5	37,5
N_SWEREF	6636177	6633139	6633228	6632007	6632007	6632007	6632007	6632007	6632007	6632007
E_SWEREF	534588	532230	532357	529202	529202	529202	529202	529202	529202	529202
SIO2_%	41,8	74,8	54,7	43,5	22,3	42,9	38,2	44,8	31,8	53,1
TiO2_%	0,16	0,12	0,12	0,09	0,05	0,14	0,07	0,07	0,06	0,08
Al2O3_%	6,35	12,3	7,62	10,6	3,65	10,45	5,98	6,43	6,51	9,18
Fe2O3_%	26,7	2,93	20,4	16,2	60,2	10,05	28,5	34	51,9	20,9
MgO_%	5,26	1,36	1,67	20,5	11,45	22,3	19,85	12,65	9,43	12
CaO_%	8,62	0,38	8,38	0,23	0,1	0,09	0,39	0,21	0,31	0,08
MnO_%	9,32	0,13	2,69	0,03	0,02	0,02	0,02	0,03	0,02	0,02
Na2O_%	0,46	2,09	0,31	0,34	0,09	0,36	0,18	0,09	0,08	0,13
K2O_%	0,54	6,44	3,84	3,58	0,73	4,47	1,19	0,54	0,7	1,49
P2O5_%	0,06	0,02	0,05	0,01	0,01	0,02	0,04	0,01	0,01	0,01
LOI_%	0,38	0,77	0,82	3,7	0,58	3,97	4,01	0,93	0,17	1,4
total_%	99,66	101,44	100,69	98,79	99,18	94,78	98,43	99,76	100,99	98,39
C_%	0,09	0,01	0,08	0,05	0,03	0,02	0,1	0,04	0,03	0,03
S_%	0,01	<0,01	0,01	0,06	0,11	0,61	0,13	0,07	0,14	0,03
AG_ppm	0,03	<0,01	0,01	<0,01	0,01	0,02	<0,01	<0,01	0,01	0,01
AS_ppm	14,7	4	20	<0,1	0,3	0,3	0,2	0,4	0,4	0,3
AU_ppm	<0,001	0,001	0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
BA_ppm	97,5	813	740	91,6	13,2	95,9	24,1	14,4	14	34,5
BE_ppm	3,63	0,73	1,41	2,42	0,18	3,84	0,99	2,08	3,03	1,85
BI_ppm	0,44	0,29	1,1	0,08	0,14	0,16	0,05	0,18	0,09	0,04
CD_ppm	0,15	<0,01	0,04	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
CO_ppm	4	4	9	5	1	2	3	3	3	3
CR_ppm	10	10	10	10	<10	10	<10	10	10	10
CS_ppm	0,5	4,23	2,28	8,56	1,78	8,92	3,01	0,79	0,84	1,66
CU_ppm	<1	4	1	6	12	19	<1	2	2	<1
GA_ppm	25,8	17,2	14,5	44,8	55,3	39,2	37,6	81,9	89,8	46,7
GE_ppm	6	<5	<5	6	5	7	7	8	7	6
HF_ppm	2,6	6,2	4	5,3	1,7	7,9	3	4,5	4,9	6
HG_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	0,008	<0,005	<0,005
IN_ppm	1,685	0,252	0,67	0,314	0,603	0,389	0,385	0,165	0,236	0,137
LI_ppm	<10	20	10	20	<10	10	<10	10	<10	10
MO_ppm	<1	1	<1	9	6	7	2	53	115	88
NB_ppm	9,3	18,3	10,8	11,8	4,7	14,4	8,1	7,5	9,7	12,4
NI_ppm	7	4	7	7	6	9	6	7	2	1
PB_ppm	19	16	40	<2	<2	5	<2	3	<2	<2
PD_ppm	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	42,9	187	130	146,5	28,4	168,5	47,2	25,1	31	64,4
Re_ppm	0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,001	<0,001	0,001
SB_ppm	1,47	0,74	1,43	0,06	0,05	0,09	0,06	0,06	0,05	0,05
SC_ppm	6	4	4	4	1	4	3	2	3	3
SE_ppm	0,2	0,3	0,3	0,5	0,5	1,1	0,3	0,5	0,5	0,2
SN_ppm	43	5	3	15	21	12	15	21	33	19
SR_ppm	4,9	17,2	34,7	10,4	2,2	7,3	5,3	5,6	4,7	5,4
TA_ppm	2,1	1,2	0,6	1,1	0,6	1,4	0,7	0,5	0,9	1,3
TE_ppm	0,02	0,01	0,01	0,02	0,05	0,25	0,02	0,02	<0,01	0,01
TH_ppm	6,48	17,95	8,96	12,9	3,62	16,2	7,56	9,45	9,43	12,35
TL_ppm	0,04	0,12	0,06	0,31	0,07	0,45	0,15	0,04	0,06	0,1
U_ppm	2,95	3,24	3,18	9,06	2,23	2,48	4,32	6,79	10,6	7,61
V_ppm	12	16	14	6	7	<5	8	<5	6	<5
W_ppm	7	2	2	4	2	2	5	38	136	7
Y_ppm	43,2	27,7	45,6	102	60,5	95,4	144,5	159	79,8	65,8
ZN_ppm	577	71	79	12	3	6	10	12	3	4
ZR_ppm	86	170	126	165	58	236	135	134	161	176
LA_ppm	28,7	42,6	93,8	203	198	263	277	324	97,4	35,7
CE_ppm	55,2	98,9	167	367	304	520	497	474	118,5	52,9
PR_ppm	7,58	11,9	17,9	41,9	33	56,8	53,6	43,3	11,4	5,86
ND_ppm	30,2	48,8	68,8	163,5	123,5	229	225	162,5	42,5	22,5
SM_ppm	7,33	9,25	13,5	32,3	22,5	46,2	47,2	37,2	7,96	5,4
EU_ppm	1,5	0,91	2,36	6,16	3,7	6,24	6,94	5,56	2,28	1,67
GD_ppm	7,13	6,5	11,25	30,8	21,9	38,7	44,6	38,3	10,7	7,88
TB_ppm	1,06	0,84	1,34	3,4	2,16	4,34	5,44	5,1	1,51	1,36
DY_ppm	7,11	5,79	7,77	18,3	11,8	20,5	29,4	28	10,85	9,86
HO_ppm	1,37	1,3	1,56	3,11	1,93	3,15	4,72	4,68	2,09	1,82
ER_ppm	3,95	3,5	4,43	8,34	4,52	7,56	11,25	11,45	6,28	5,28
TM_ppm	0,66	0,59	0,59	1,06	0,57	0,89	1,32	1,46	0,8	0,69
YB_ppm	4,83	4,59	3,89	5,97	2,94	5,14	6,88	7,19	4,81	4,2
LU_ppm	0,8	0,71	0,67	0,88	0,46	0,73	1,02	1,07	0,73	0,63
REEtot_%	0,02	0,02	0,04	0,0						

Appendix 2. Continuation.

SGU_ID	Källfallsgruvan	Källfallsgruvan	Källfallsgruvan	Källfallsgruvan	Yxsjöberg	Yxsjöberg	Yxsjöberg
bh	128	128	128	128	KD006	KD006	KD006
from	15	16	90,65	91,65	18	20	40
to	16	17	91,65	92,65	19	21	41
N_SWEREF	6632007	6632007	6632007	6632007	6656507	6656507	6656507
E_SWEREF	529202	529202	529202	529202	488037	488037	488037
SIO2_%	43,9	39,8	59,2	32,3	31,7	38,5	59,1
TIO2_%	0,09	0,05	0,01	0,13	0,02	0,02	0,14
AL2O3_%	7,73	3,83	0,42	5,17	6,04	4,75	15,65
FE2O3_%	30	37,1	9,41	41,3	36,3	34,3	6,69
MGO_%	12,65	15,25	26,9	17	0,7	0,52	0,58
CAO_%	0,55	0,39	0,61	1,51	11,85	15,5	7,02
MNO_%	0,04	0,04	0,05	0,04	0,58	1,73	0,05
NA2O_%	0,08	0,08	0,08	0,11	0,24	0,62	4,96
K2O_%	0,35	0,05	0,02	0,25	3,33	0,75	2,25
P2O5_%	0,02	0,01	<0,01	0,01	0,01	0,01	0,02
LOI_%	3,78	2,6	3,34	2,3	0,61	0,22	3,51
total_%	99,19	99,2	100,04	100,12	91,39	96,92	100,02
C_%	0,12	0,09	0,08	0,03	0,02	0,04	0,02
S_%	0,13	0,1	0,02	<0,01	9,17	2,29	1,41
AG_ppm	0,01	0,01	<0,01	<0,01	0,78	0,66	0,24
AS_ppm	0,5	0,4	0,3	0,4	1,7	1	0,7
AU_ppm	<0,001	<0,001	0,001	<0,001	0,814	0,085	0,019
BA_ppm	7,2	4,3	3,5	8,9	73,1	10,2	223
BE_ppm	18,25	6,36	0,29	1,13	373	443	28,7
BI_ppm	0,17	0,1	0,15	0,1	>250	>250	26,1
CD_ppm	0,05	0,01	<0,01	<0,01	<0,01	<0,01	<0,01
CO_ppm	5	3	5	7	93	31	22
CR_ppm	10	10	<10	<10	20	10	20
CS_ppm	3,28	0,72	0,05	1,68	22,8	1,36	3,75
CU_ppm	<1	<1	<1	<1	3270	2740	1410
GA_ppm	73,7	63,6	2,7	44,7	46	32,4	27
GE_ppm	7	10	9	6	9	37	<5
HF_ppm	4,3	2,2	0,2	2,4	0,2	0,4	7,4
HG_ppm	<0,005	<0,005	<0,005	<0,005	0,087	0,022	0,096
IN_ppm	0,094	0,087	0,039	0,284	1,715	30	0,119
LI_ppm	20	10	<10	<10	<10	<10	10
MO_ppm	59	7	71	23	3	3	5
NB_ppm	10,7	3,1	0,8	9,1	4,1	2,1	13,4
NI_ppm	6	6	5	6	5	3	5
PB_ppm	<2	<2	<2	<2	<2	5	8
PD_ppm	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	23,3	4,2	0,3	14,1	511	22,3	198,5
Re_ppm	0,001	<0,001	<0,001	0,001	0,021	0,005	0,015
SB_ppm	0,07	0,07	0,05	0,06	0,54	0,77	0,18
SC_ppm	3	2	<1	3	3	1	6
SE_ppm	0,6	0,4	0,4	0,6	11	1,8	1,6
SN_ppm	15	11	1	13	143	1095	135
SR_ppm	13,4	8	1,3	3,9	8,2	4,7	86,2
TA_ppm	1	0,6	<0,1	0,5	0,3	0,2	1,2
TE_ppm	0,02	0,01	0,02	0,01	27,2	0,56	2,21
TH_ppm	9,44	4,56	0,56	4,92	0,83	0,78	15,65
TL_ppm	0,08	<0,02	<0,02	0,15	2,91	0,41	0,71
U_ppm	6,51	2,36	5,74	3,38	4,25	3,26	9,75
V_ppm	5	7	6	11	16	7	17
W_ppm	12	13	2	122	6310	4960	2850
Y_ppm	150	116	66,2	219	52,3	10,3	80,6
ZN_ppm	16	8	29	32	406	382	38
ZR_ppm	141	73	8	92	6	12	293
LA_ppm	156,5	153	24,2	198,5	14,2	9,7	56,7
CE_ppm	246	254	43,3	370	30,5	18,3	114
PR_ppm	25,8	28,5	4,77	40,8	3,95	2,13	13,9
ND_ppm	95,1	110	20,2	156	15,1	7,7	56,5
SM_ppm	20,1	22,8	6,51	44	5,45	1,88	12,5
EU_ppm	3,43	3,12	0,93	7,27	1,35	3,3	1,92
GD_ppm	25	23,3	11,15	52,5	5,74	1,93	14,25
TB_ppm	3,61	2,94	1,72	7,42	1,3	0,35	2,38
DY_ppm	22,7	17,4	10,75	41	8,93	2,32	15
HO_ppm	4,16	3,04	2,01	6,94	1,8	0,46	3,09
ER_ppm	11,05	7,68	5,14	16,75	5,91	1,34	9,1
TM_ppm	1,34	0,85	0,57	1,69	1,2	0,28	1,45
YB_ppm	7,61	4,21	3,46	9,86	10,75	2,63	10,55
LU_ppm	1,11	0,68	0,46	1,26	1,75	0,41	1,71
REEtot_%	0,06	0,06	0,01	0,10	0,01	0,01	0,03

APPENDIX 3. ANALYSES OF WASTE ROCK

Appendix 3. Analyses of waste rock.

SGU_ID	Myggruvan (Subområde #1 – gammal del)	Myggruvan (Subområde #2 – yngre del)	Dammbergsgruvan (Subområde# 4 – södra delen)	Dammbergsgruvan (Subområde# 1 – norra delen)	Dammbergsgruvan (Subområde# 2 – mellersta delen)	Dammbergsgruvan (Subområde# 3 – mellersta delen)
N_SWEREF	6674374	6674344	6673279	6673342	6673323	6673313
E_SWEREF	515258	515268	515461	515454	515472	515459
SIO2_%	23	45	15,4	17,55	31,3	21,5
TIO2_%	0,05	0,11	0,04	0,04	0,07	0,04
AL2O3_%	3,21	6,18	2,25	2,13	5,22	2,79
FE2O3_%	9,86	13,25	19,4	21,3	23,5	20,9
MGO_%	9,82	6,11	6,33	5,58	4,95	6,09
CAO_%	22,6	14,2	22,9	23	14,3	21
MNO_%	4,67	5,03	5,69	4,11	2,48	3,55
NA2O_%	0,1	0,12	0,03	0,05	0,09	0,07
K2O_%	0,99	1,37	0,46	0,29	0,98	0,54
P2O5_%	0,03	0,04	0,02	0,03	0,03	0,03
LOI_%	21,3	5,85	13,55	6,82	3,83	6,09
total_%	95,64	97,28	86,07	80,9	86,76	82,61
C_%	6,18	2,04	5,73	4,3	2,37	3,89
S_%	0,47	0,79	3,46	5,31	6,2	5,65
AG_ppm	3,31	5,73	11,95	17,2	19,55	22,1
AS_ppm	1300	33,9	7430	3960	6550	6690
AU_ppm	0,004	0,002	0,029	0,052	0,049	0,082
BA_ppm	91,1	158	36,1	20,4	111	53
BE_ppm	0,44	0,79	0,65	2,96	2,17	1,57
BI_ppm	4,19	0,64	2,36	5,77	7,64	15,6
CD_ppm	14,95	13,65	37,8	73,4	46,4	55,5
CO_ppm	<1	<1	<1	<1	8	4
CR_ppm	10	20	10	10	10	<10
CS_ppm	2,26	2,39	2,18	1,07	2,3	1,08
CU_ppm	39	62	129	274	1210	658
GA_ppm	6,6	9,8	5,5	5,9	11,6	8,3
GE_ppm	<5	<5	<5	<5	<5	<5
HF_ppm	1,6	2,3	0,7	0,9	2	1,2
HG_ppm	0,009	0,01	0,212	0,524	0,242	0,498
IN_ppm	2,52	0,469	1,73	3,32	2,71	3,68
LI_ppm	<10	10	<10	<10	<10	<10
MO_ppm	1	1	1	3	3	3
NB_ppm	2,9	4,9	1,7	1,9	5,1	2,6
NI_ppm	1	<1	2	4	2	6
PB_ppm	5490	12700	9340	12950	6770	11350
PD_ppm	<0,001	<0,001	<0,001	<0,001	0,001	0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	49,7	53,6	25,7	10,8	33,9	14,9
Re_ppm	<0,001	<0,001	<0,001	0,002	<0,001	0,002
SB_ppm	2,6	4,44	16,6	22,4	20,5	18,7
SC_ppm	2	3	1	1	3	2
SE_ppm	1,9	1,4	6,3	11	6,9	7,9
SN_ppm	2	3	5	7	8	6
SR_ppm	23,7	18,6	21,4	19,3	13,5	17,1
TA_ppm	0,2	0,1	0,1	0,1	0,4	0,1
TE_ppm	0,06	0,01	0,02	0,03	0,03	0,05
TH_ppm	3,87	7,33	1,65	2,45	6,17	3,15
TL_ppm	0,42	0,44	0,35	0,19	0,54	0,29
U_ppm	2,92	5,32	1,22	1,41	2,36	1,25
V_ppm	6	8	8	10	8	5
W_ppm	1	4	14	33	34	10
Y_ppm	12,7	21,9	21,9	34,2	36	33,4
ZN_ppm	4810	5150	17900	33600	20100	24500
ZR_ppm	59	88	26	28	67	37
LA_ppm	10,5	17,3	38,5	23,3	64,3	28
CE_ppm	19,5	32,4	58,8	38,2	98,8	46,6
PR_ppm	2,47	4,17	6,74	4,87	12,05	5,78
ND_ppm	9,1	15,1	25,1	19,5	43,4	22,2
SM_ppm	2,16	3,29	5,58	6,59	9,82	6,29
EU_ppm	2,07	2,4	15,15	16	13,65	12,7
GD_ppm	2,73	3,8	7,73	10,15	11,15	9,27
TB_ppm	0,33	0,61	1,1	1,53	1,46	1,26
DY_ppm	2	3,68	4,64	6,79	6,89	6,43
HO_ppm	0,44	0,75	0,62	0,94	1,17	0,96
ER_ppm	1,13	2,36	1,36	2,2	2,67	2,23
TM_ppm	0,15	0,31	0,14	0,22	0,33	0,24
YB_ppm	1,07	2,37	0,96	1,25	2,12	1,52
LU_ppm	0,18	0,37	0,11	0,17	0,31	0,19
REEtot_%	0,01	0,01	0,02	0,01	0,03	0,01

APPENDIX 4. ANALYSES OF TAILINGS

Appendix 4. Analyses of tailings.

SGU_ID	Garpenberg – Ryllshytte- magasinet	Garpenberg – Ryllshytte- magasinet	Garpenberg	Garpenberg	Garpenberg	Garpenberg – Myrdammen	Garpenberg – Myrdammen	Garpenberg – Tappdammen	Garpenberg – Tappdammen	Garpenberg – Bredsjö- magasinet
N_SWEREF	6685452	6685451	6685678	6685537	6685601	6685631	6685553	6685565	6685590	6686871
E_SWEREF	563778	563761	565625	565636	565724	565218	565080	564673	564681	564599
SIO2_%	56,1	64,1	58	62,4	65	28,8	32,8	46	35,6	49,3
TIO2_%	0,07	0,07	0,17	0,19	0,18	0,11	0,12	0,09	0,17	0,08
AL2O3_%	3,45	3,64	8,72	9,29	7,92	3,67	4,32	4,58	5,41	5,26
FE2O3_%	12,95	12,05	11,25	7,95	10,65	12,05	10,65	10,7	28,9	10,6
MGO_%	5,64	4,73	9,4	8,16	6,88	10,75	9,11	19,35	9,25	15,1
CAO_%	6,44	4,68	1,18	2,53	1,86	13,95	14,6	13,35	13,9	3,93
MNO_%	1,01	0,66	0,32	0,35	0,29	0,59	0,55	0,78	0,7	0,36
NA2O_%	0,17	0,21	0,16	0,55	0,24	0,3	0,45	0,39	0,48	0,11
K2O_%	1,14	1,16	1,77	2,05	2,01	0,38	0,64	0,74	0,48	0,68
P2O5_%	0,02	0,03	0,03	0,05	0,05	0,04	0,07	0,02	0,04	0,03
LOI_%	7,88	7,69	7,34	4,62	3,89	1,91	11,05	4,32	2,05	7,45
total_%	94,89	99,04	98,37	98,18	99,01	72,56	84,38	100,34	97	93,02
C_%	1,53	1,07	0,02	0,19	0,12	1,72	3,6	0,52	0,67	0,9
S_%	8,85	8,53	2,6	1,42	2,81	7,19	3,25	0,76	2,15	3,34
AG_ppm	42,5	30,1	6,36	6,75	6,39	17,45	11,55	0,4	4,57	30
AS_ppm	212	140,5	61,6	154	37,8	131,5	173	10,6	154	45,4
AU_ppm	0,169	0,142	0,207	0,224	0,253	0,054	0,069	0,006	0,031	0,135
BA_ppm	203	188	194	346	282	97,9	152	161,5	121	1005
BE_ppm	0,26	0,24	0,38	0,4	0,29	0,72	0,83	0,38	0,48	0,42
BI_ppm	0,11	0,09	5,43	5,34	5	23,4	15,55	4,19	14,7	2,77
CD_ppm	10,9	6,91	120	90,2	16,7	409	259	42,6	63,7	28,2
CO_ppm	12	15	28	15	23	44	23	23	59	18
CR_ppm	10	10	20	20	20	20	20	20	30	20
CS_ppm	0,7	0,64	1,42	1,03	0,86	1,34	1,5	4,43	1,35	0,86
CU_ppm	111	133	1220	616	623	1250	1370	233	591	871
GA_ppm	6	5,6	14,4	14	13,1	11,3	12	9	10,9	8,7
GE_ppm	<5	<5	<5	<5	<5	<5	<5	7	6	<5
HF_ppm	1,1	1,1	2,5	2,6	2,5	0,7	1	1,4	0,9	1,5
HG_ppm	0,213	0,105	0,181	0,158	0,149	1,655	1,1	0,052	0,19	0,298
IN_ppm	0,005	0,006	0,098	0,083	0,074	4,45	3,09	1,565	1,48	0,078
LI_ppm	10	10	10	10	10	<10	10	10	<10	10
MO_ppm	3	3	4	2	4	19	14	10	22	3
NB_ppm	2	2,1	5,5	5,6	5,7	1,4	2,1	3,2	2,1	2,8
NI_ppm	4	1	8	5	10	6	8	5	14	1
PB_ppm	1960	1940	3990	3700	3720	23900	16150	345	5350	7840
PD_ppm	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,001	<0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	34,1	33,1	54,6	52,1	49,8	15,9	24,7	52,7	20,6	24,7
Re_ppm	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,002	0,001	0,001
SB_ppm	43,2	37	6,41	9,59	8,48	13,7	12,85	0,42	3,26	39,5
SC_ppm	2	2	6	6	5	6	6	6	9	3
SE_ppm	1,1	0,7	4,6	3	3,1	17,1	9,3	2,8	3,1	2,4
SN_ppm	1	1	4	3	4	14	13	14	14	3
SR_ppm	24,7	20,2	8,9	32,4	16,8	38,9	43,6	41,5	58,9	11,4
TA_ppm	0,2	0,2	0,5	0,5	0,4	0,1	0,1	0,1	<0,1	<0,1
TE_ppm	0,02	<0,01	0,18	0,1	0,14	1,23	0,58	0,1	0,73	0,01
TH_ppm	2,87	2,84	12	6,82	5,84	1,2	1,84	2,67	1,64	4,33
TL_ppm	2,04	2,31	3,49	1,87	2,01	0,44	0,5	0,29	0,27	2,16
U_ppm	2,08	1,6	2,95	3,89	3,11	3,23	3,31	3,49	3,16	3,51
V_ppm	13	13	22	24	23	40	38	28	65	12
W_ppm	17	8	23	13	19	21	20	13	46	12
Y_ppm	10	8,8	16,6	24,1	22,4	72,7	76,3	34,3	58,3	11,9
ZN_ppm	4160	2530	4460	10900	6180	125500	65500	13850	19300	12850
ZR_ppm	42	37	85	81	86	19	49	42	25	51
LA_ppm	11,8	13,6	10	23,2	21,3	64,7	61,3	26,7	69,9	18,3
CE_ppm	22,5	24,8	17,1	46,8	42,3	117	111,5	49,3	113,5	31,8
PR_ppm	2,47	2,89	1,83	5,57	5,09	13,65	13,1	5,98	12,2	3,85
ND_ppm	9,8	10,6	7	21,1	20	52	51,1	23,1	45,9	14,1
SM_ppm	1,87	2,24	1,75	4,5	4,21	12,15	11,95	5,82	10,15	3
EU_ppm	0,9	1,01	0,54	1,43	1,29	4,25	4,08	1,64	4,11	0,93
GD_ppm	1,98	1,92	2,27	4,57	4,32	13,7	13,65	6,91	12,2	2,85
TB_ppm	0,28	0,26	0,34	0,73	0,62	1,91	1,9	1,04	1,73	0,46
DY_ppm	1,59	1,32	2,38	3,86	3,76	9,81	10,05	5,33	9,05	1,97
HO_ppm	0,31	0,24	0,5	0,78	0,71	1,67	1,77	1,08	1,53	0,41
ER_ppm	0,93	0,7	1,45	2,11	1,98	3,67	4,13	3,04	3,76	1,09
TM_ppm	0,13	0,11	0,23	0,3	0,28	0,44	0,45	0,41	0,44	0,15
YB_ppm	0,9	0,67	1,59	1,89	1,97	2,2	2,64	2,49	2,36	1
LU_ppm	0,11	0,12	0,22	0,26	0,27	0,26	0,3	0,41	0,36	0,16
REEtot_%	0,01	0,01	0,00	0,01	0,01	0,03	0,03	0,01	0,03	0,01

Appendix 4. Continuation.

SGU_ID	Garpenber – Bredsjö- magasinet	Smälta- mossen	Smälta- mossen	Intränget	Intränget	Intränget	Taberg	Taberg	Taberg	
N_SWEREF	6686961	6687089	6687044	6687089	6688016	6687902	6687995	6634356	6634340	6634386
E_SWEREF	564603	567179	567223	567217	563449	563502	563563	450608	450795	450766
SIO2_%	43,4	43,2	43,9	36,2	55,4	56,3	57,6	46	51,5	52,5
TIO2_%	0,07	0,2	0,17	0,14	0,28	0,19	0,19	0,24	0,22	0,23
AL2O3_%	4,12	8,5	7,4	5,81	8,01	7	7,19	9,86	8,5	8,62
FE2O3_%	8,6	18,65	16,5	24,6	19,35	18,25	16,1	11,05	11,9	10,65
MGO_%	20	5,4	6,64	3,89	7,73	11,05	10,45	13,15	10,9	11,1
CAO_%	7,01	19,4	19,4	19,1	5,3	5,6	5,87	12,65	12,55	12,4
MNO_%	0,42	0,31	0,29	0,37	0,22	0,23	0,22	0,39	0,4	0,38
NA2O_%	0,11	0,88	0,88	0,35	0,71	0,63	0,71	0,88	1,08	1,11
K2O_%	0,45	0,17	0,21	0,1	0,5	0,56	0,59	1,56	1,16	1,32
P2O5_%	0,03	0,06	0,05	0,04	0,07	0,09	0,08	0,06	0,08	0,09
LOI_%	8,67	1,94	2,53	6,39	3,15	1,82	1,87	3,5	2,2	2,57
total_%	92,9	98,74	98	97	100,74	101,74	100,89	99,39	100,54	101,02
C_%	1,83	0,76	0,87	0,04	0,02	0,05	0,06	0,53	0,32	0,42
S_%	2,73	0,87	0,99	2,24	0,91	0,31	0,39	0,12	0,15	0,1
AG_ppm	37,7	0,54	0,66	2,02	2,16	1,15	1,13	0,13	0,14	0,15
AS_ppm	55	9	7,4	20,2	2,7	2,1	1,9	1	2	1,5
AU_ppm	0,114	0,003	0,004	0,015	0,275	0,074	0,058	0,02	0,037	0,027
BA_ppm	127	69,4	85,2	42,8	122,5	123	138,5	358	308	343
BE_ppm	0,71	0,13	0,13	<0,05	0,87	2,29	2,32	1,41	1,26	1,32
BI_ppm	6,81	0,46	0,52	1,33	43,2	36,7	31,5	17,3	22,5	20,6
CD_ppm	33,1	0,32	0,29	0,11	2,07	2,37	2,23	0,26	0,27	0,45
CO_ppm	22	44	27	9	40	28	31	19	16	16
CR_ppm	40	<10	<10	<10	70	60	80	60	80	80
CS_ppm	0,72	0,38	0,38	0,37	1,51	2,06	1,89	4,53	2,66	3,08
CU_ppm	1420	108	131	218	1050	976	993	118	193	180
GA_ppm	7,9	13	11,5	10,4	12,5	10,1	9,7	11,6	11,9	12,4
GE_ppm	<5	<5	<5	<5	<5	6	6	<5	<5	<5
HF_ppm	1,5	2,4	2,3	1,7	2,2	1,8	1,9	4,2	4,2	4,4
HG_ppm	0,369	<0,005	0,009	0,011	0,129	0,03	0,052	0,03	0,009	0,008
IN_ppm	0,319	0,292	0,277	0,19	1,55	1,37	1,395	0,752	0,454	0,419
Li_ppm	10	<10	<10	<10	10	10	10	10	10	10
MO_ppm	9	2	2	5	23	16	25	3	2	2
NB_ppm	2,6	5,5	4,4	4,7	4,6	4,2	4,2	11,9	10,4	11,3
NI_ppm	7	7	7	1	18	20	21	24	29	30
PB_ppm	10600	66	55	57	250	91	97	27	17	29
PD_ppm	<0,001	<0,001	<0,001	0,001	0,002	0,001	0,001	0,001	0,001	0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	16	3,7	4,6	2,2	18,8	21,1	22,1	65,1	33,9	40,2
Re_ppm	0,002	0,003	0,003	0,001	0,002	0,001	0,001	0,001	0,002	0,001
SB_ppm	43,9	0,94	0,89	1,38	0,29	0,13	0,14	0,24	0,32	0,22
SC_ppm	2	6	6	4	12	9	10	9	9	9
SE_ppm	6	0,4	<0,2	1	1,7	1,1	0,9	<0,2	0,9	0,7
SN_ppm	5	12	12	9	8	10	10	84	53	59
SR_ppm	13,7	193	169	111	89	64,6	77,7	50,3	60	58,3
TA_ppm	<0,1	0,3	0,2	0,1	0,1	<0,1	<0,1	0,4	0,5	0,5
TE_ppm	0,06	0,35	0,39	0,86	0,82	0,73	0,59	0,57	0,57	0,61
TH_ppm	3,95	7,52	5,67	1,59	3,18	3,35	3,63	6,28	7,22	8
TL_ppm	1,5	0,07	0,06	0,21	0,15	0,14	0,12	0,48	0,35	0,28
U_ppm	4,19	18,2	18,8	7,88	1,02	2,09	1,59	4,59	3,6	3,94
V_ppm	15	25	21	19	68	34	42	45	50	46
W_ppm	11	1	2	4	109	21	24	4	7	6
Y_ppm	10,9	62,7	40,3	27,6	24,5	28	28,8	56,3	63,4	64,2
ZN_ppm	13500	254	337	171	777	855	863	964	525	562
ZR_ppm	46	78	75	60	67	66	61	131	144	152
LA_ppm	18,8	368	261	90,7	20,3	35,4	37,3	35,7	81,8	72,4
CE_ppm	32,3	608	419	151	34,7	61,4	62,2	74,7	167	154
PR_ppm	3,77	47,7	34,2	15,1	4,13	6,88	6,99	9,62	19,15	18,15
ND_ppm	14,2	145,5	101	51,8	16,4	27,1	27,3	40,7	70,5	69,7
SM_ppm	2,93	21,8	13,9	8,19	4,34	6,62	6,6	10,5	15,6	15,9
EU_ppm	0,97	3,4	2,59	1,68	1,62	2,35	2,32	1,45	1,98	2,15
GD_ppm	2,82	16,6	10,25	6,14	4,55	7,15	6,97	12,4	15,2	15,2
TB_ppm	0,42	2,37	1,49	0,94	0,76	1,04	1,03	2,12	2,3	2,44
DY_ppm	2,02	12,15	7,48	4,75	4,31	4,93	4,64	11,85	13,4	13,75
HO_ppm	0,38	2,64	1,63	1,12	0,87	0,93	0,97	2,53	2,7	2,92
ER_ppm	1,05	7,81	4,68	3,28	2,47	2,29	2,57	6,8	7,56	7,65
TM_ppm	0,17	1,04	0,65	0,47	0,34	0,33	0,32	0,91	0,96	1,03
YB_ppm	0,9	6,13	3,83	2,99	2,25	1,95	2,19	4,97	5,66	5,75
LU_ppm	0,15	0,74	0,47	0,43	0,35	0,29	0,35	0,71	0,8	0,78
REEtot_%	0,01	0,12	0,09	0,03	0,01	0,02	0,02	0,02	0,04	0,04

Appendix 4. Continuation.

SGU_ID	Finnmossen	Finnmossen	Långban	Långban	Kaveltorp	Kaveltorp	Kaveltorp	Kaveltorp	Ställberg	Ställberg
N_SWEREF	6631698	6631636	6635308	6635280	6636892	6636862	6636782	6636857	6650442	6650522
E_SWEREF	449640	449633	459142	459096	499975	499986	499995	499940	496174	496210
SIO2_%	43,4	43,5	20,6	10,75	40,5	46,4	42,1	45,8	23,8	23,7
TIO2_%	0,1	0,13	0,07	0,04	0,05	0,03	0,03	0,03	0,14	0,1
AL2O3_%	6,72	7,58	2,14	1,51	3,42	3,3	2,53	2,93	4,87	4,51
FE2O3_%	15,95	19,15	16,1	2,75	7,93	6,76	6,29	10,6	11,85	10,4
MGO_%	11,8	11,6	10,85	15,2	19,25	21,5	22	20,7	5,14	4,87
CAO_%	15,15	12,25	17,4	25,9	11,9	11,45	13,6	11,1	25,1	26,1
MNO_%	0,47	0,54	12,6	8,89	0,75	0,79	0,86	0,76	3,37	3,18
NA2O_%	0,65	0,78	0,26	0,19	0,35	0,34	0,25	0,31	0,18	0,21
K2O_%	0,62	0,66	0,76	0,65	0,82	1,12	0,8	0,87	1,92	1,75
P2O5_%	0,04	0,04	0,04	0,04	0,02	0,02	0,02	0,02	0,04	0,03
LOI_%	4,98	2,83	16,8	31,9	7,14	5,84	9,77	3,56	23,8	23,9
total_%	99,9	99,08	98,05	98,16	92,14	97,56	98,26	96,69	100,23	98,77
C_%	1,1	0,58	4,5	8,52	0,97	1,13	2,12	0,66	6,46	6,52
S_%	0,14	0,38	0,06	0,01	2,84	0,51	0,52	1,34	0,02	0,02
AG_ppm	0,5	0,26	0,03	0,02	8,18	2,97	3,96	4,69	0,1	0,06
AS_ppm	8,1	6,7	3200	1900	12,3	4,9	1,8	9,3	12,9	9,4
AU_ppm	0,049	0,027	0,001	0,001	0,832	0,099	0,057	0,134	0,006	0,004
BA_ppm	190	181	4090	2890	81,5	82,9	50,8	60,9	192,5	163,5
BE_ppm	1,38	1,62	11,9	8,75	3,62	2,21	2,25	2,43	1,04	0,93
BI_ppm	31,6	10,85	0,96	0,69	27,2	8,25	7,64	11,55	3,74	3,37
CD_ppm	0,74	0,72	1,05	1,22	89	6,79	11,6	13,5	0,61	0,67
CO_ppm	16	15	1	<1	9	1	2	4	4	3
CR_ppm	10	20	10	20	10	<10	10	10	<10	<10
CS_ppm	1,2	1,18	3,8	3,35	8,88	15,7	10,7	11,8	5,02	4,19
CU_ppm	136	132	22	23	1740	580	729	1080	167	83
GA_ppm	11	13,8	12,2	7,6	11,8	11,2	9,8	12,6	11	9,5
GE_ppm	<5	<5	9	6	<5	5	5	5	<5	<5
HF_ppm	3,3	4,1	0,9	0,5	1,2	1,4	1	1,4	2,2	1,9
HG_ppm	0,06	0,014	0,022	0,01	0,099	0,055	0,054	0,09	<0,005	0,014
IN_ppm	0,613	0,707	0,09	0,019	0,246	0,064	0,076	0,147	0,633	0,417
LI_ppm	10	10	30	20	10	10	10	10	10	10
MO_ppm	4	2	<1	<1	8	5	9	11	1	<1
NB_ppm	10,5	12,4	2,2	1	5,8	4,9	4,2	6,4	4,9	4,2
NI_ppm	4	18	5	9	1	1	1	<1	7	6
PB_ppm	56	55	3160	3370	8270	3930	4060	5530	41	30
PD_ppm	0,001	0,001	<0,001	0,001	<0,001	0,001	<0,001	0,001	<0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	23,6	24,9	38,1	33,6	82	131,5	105	91,7	71,8	66,4
Re_ppm	0,001	0,002	<0,001	<0,001	<0,001	<0,001	0,001	0,003	0,001	0,001
SB_ppm	0,84	0,86	202	131	3,48	2,71	4,25	3,45	0,27	0,22
SC_ppm	4	5	2	2	2	2	1	2	3	3
SE_ppm	0,9	0,7	0,2	0,3	5,2	1,1	1,4	1,4	0,2	0,3
SN_ppm	59	62	13	3	17	12	11	18	3	3
SR_ppm	45,8	60,2	68,4	78,7	10,6	12,7	15,4	9	33,9	30,1
TA_ppm	0,4	0,5	<0,1	<0,1	0,5	0,8	0,2	0,8	0,1	0,1
TE_ppm	0,36	0,35	<0,01	0,01	0,26	0,11	0,1	0,14	0,04	0,04
TH_ppm	7,37	11,05	1,88	0,97	3	2,58	2,22	3,74	4,83	4,24
TL_ppm	0,14	0,17	0,23	0,22	0,63	0,78	0,58	0,66	0,26	0,25
U_ppm	5,59	9,75	1,26	0,55	1,98	1,89	2,27	2,44	1,79	2,58
V_ppm	15	21	14	12	5	<5	7	6	19	14
W_ppm	5	16	58	12	69	51	43	154	4	3
Y_ppm	59,7	87,8	20,4	5,9	25	19,5	15,1	23,9	21,9	17
ZN_ppm	815	833	851	661	29600	3440	5630	7280	132	156
ZR_ppm	124	132	30	14	34	45	37	38	72	64
LA_ppm	91,5	291	11,4	4,6	17,7	14,9	11,4	21,5	28,7	22,4
CE_ppm	211	694	19,8	8	33,2	29,6	21,5	40,9	50,5	40,9
PR_ppm	25,3	77,1	2,22	0,91	3,93	3,46	2,65	4,57	5,64	4,59
ND_ppm	95,4	274	9	3,7	14,3	12,8	9,7	17	21,6	17,3
SM_ppm	19,4	47	2,64	0,97	3,31	3,06	2,38	3,9	4,58	3,67
EU_ppm	3,57	8,24	3,16	0,5	1,03	1,1	0,79	1,25	1,83	1,34
GD_ppm	16,95	34	3,79	1,14	3,6	3,18	2,38	4,07	4,55	3,77
TB_ppm	2,34	4,61	0,57	0,17	0,59	0,54	0,4	0,61	0,68	0,55
DY_ppm	12,7	22,1	2,86	0,84	3,29	2,82	1,98	3,36	3,66	2,83
HO_ppm	2,58	4,08	0,54	0,17	0,73	0,56	0,42	0,69	0,73	0,6
ER_ppm	6,95	10,7	1,24	0,56	2,22	1,71	1,24	1,82	1,87	1,49
TM_ppm	0,95	1,31	0,17	0,08	0,3	0,23	0,19	0,27	0,25	0,22
YB_ppm	5,71	7,4	1	0,47	2,07	1,48	1,1	1,63	1,41	1,31
LU_ppm	0,83	0,9	0,17	0,08	0,31	0,24	0,16	0,28	0,26	0,23
REEtot_%	0,05	0,15	0,01	0,00	0,01	0,01	0,01	0,01	0,01	0,01

Appendix 4. Continuation.

SGU_ID	Ställberg	Ställberg	Ställberg	Ställberg	Yxsjöberg	Yxsjöberg	Yxsjöberg	Yxsjöberg	Yxsjöberg	Yxsjöberg
N_SWEREF	6650605	6650305	6650251	6650291	6656074	6656028	6655963	6655963	6655858	6655867
E_SWEREF	496229	495957	495897	495913	487522	487550	487615	487615	487601	487465
SIO2_%	19,3	20,2	23,8	22	44,8	44,1	44,1	47	43,2	40,8
TIO2_%	0,18	0,06	0,08	0,08	0,12	0,14	0,1	0,13	0,1	0,1
AL2O3_%	3,84	3,65	4,23	4	6,83	7,09	5,75	7,47	6,94	5,85
FE2O3_%	14,35	15,8	16,05	13,75	20,2	16,55	29,3	23	24,7	28,2
MGO_%	5,6	5,37	5,17	5,61	1,28	1,41	1,32	1,56	1,38	1,28
CAO_%	25,3	24,3	21,7	23,2	19,15	20,1	14,3	15,4	14,5	13,7
MNO_%	4,66	5,95	5,79	5,61	1,56	1,24	1,75	1,67	1,44	1,43
NA2O_%	0,16	0,08	0,16	0,13	1,22	1,39	0,97	1,23	1,25	0,95
K2O_%	1,09	1,04	1,32	1,34	0,86	0,95	0,98	1,26	1,28	1,08
P2O5_%	0,07	0,02	0,02	0,03	0,03	0,03	0,04	0,02	0,02	0,02
LOI_%	24,5	22,9	20,5	23,7	3,31	6,25	1,91	0,67	3,99	4,97
total_%	99,06	99,38	98,84	99,46	99,37	99,26	100,53	99,43	98,82	98,39
C_%	6,94	6,09	5,64	6,58	0,52	1,41	0,17	0,06	0,01	0,03
S_%	0,02	0,02	0,03	0,03	0,74	0,51	0,45	0,97	2,2	2
AG_ppm	0,15	0,03	0,03	0,05	0,49	0,49	0,44	0,5	0,47	0,37
AS_ppm	22,9	4,5	7,1	5,2	1	0,7	1	0,9	0,8	0,7
AU_ppm	0,005	0,002	0,007	0,005	0,129	0,107	0,135	0,113	0,143	0,167
BA_ppm	107,5	95,3	130,5	131,5	51,4	71,2	46,7	68,9	59,2	48,7
BE_ppm	0,78	1,12	1,08	1,5	142	121,5	65,3	134	79,9	76,4
BI_ppm	2,57	2,25	2,39	3,51	>250	>250	>250	>250	>250	>250
CD_ppm	0,55	0,62	0,69	0,98	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
CO_ppm	8	4	5	7	19	16	16	24	16	13
CR_ppm	<10	10	10	10	20	20	20	20	20	20
CS_ppm	3,7	5,09	4,86	6,13	3,59	3,79	4,56	7,37	6,31	5,77
CU_ppm	169	19	26	29	919	896	302	1970	1120	463
GA_ppm	9,9	10,1	10,5	11,2	22,7	21,5	27	24,4	23,8	26,1
GE_ppm	<5	<5	<5	<5	16	13	22	18	17	20
HF_ppm	1,8	1,5	1,6	1,7	1,8	2	1,4	1,8	1,7	1,2
HG_ppm	0,013	0,008	0,007	0,061	0,173	0,234	0,254	0,278	0,196	0,212
IN_ppm	0,776	0,371	0,406	0,458	4,98	3,9	4,06	4,03	4,24	4,68
LI_ppm	10	10	10	10	<10	10	<10	10	10	<10
MO_ppm	<1	<1	2	1	<1	3	2	2	1	1
NB_ppm	3,8	3,4	3,7	4,2	4,1	4,7	4,7	5	4,2	4,3
NI_ppm	4	2	6	7	4	5	5	8	6	3
PB_ppm	25	25	26	41	9	6	7	8	6	4
PD_ppm	<0,001	<0,001	<0,001	0,001	0,001	0,001	0,001	0,001	0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	45,5	43,5	50,1	57,3	62,4	68,3	79,6	116,5	107	85,3
Re_ppm	0,002	0,001	<0,001	0,002	0,005	0,009	0,007	0,01	0,008	0,006
SB_ppm	0,32	0,46	0,46	0,45	0,44	0,39	0,38	0,4	0,41	0,44
SC_ppm	2	3	3	3	4	5	4	5	4	4
SE_ppm	0,5	0,2	<0,2	0,4	1,3	0,8	1,3	1,4	2,2	2,3
SN_ppm	2	3	2	2	640	514	651	539	527	618
SR_ppm	43,6	30	25,3	33,8	30,2	34,9	17,9	27	21	16,5
TA_ppm	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	0,1	<0,1	<0,1
TE_ppm	0,06	0,05	0,06	0,08	3,71	2,35	3,09	2,74	3,14	4,63
TH_ppm	4,13	3,97	3,94	4,49	3,56	4,1	2,56	3,25	2,7	2,04
TL_ppm	0,17	0,16	0,19	0,23	0,43	0,43	0,51	0,89	0,7	0,59
U_ppm	1,29	1,35	1,37	2,31	2,55	3,25	0,75	5,03	1,46	0,87
V_ppm	14	9	11	7	22	26	19	29	20	23
W_ppm	6	2	2	1	647	810	3770	1030	875	994
Y_ppm	16,3	13,2	16,4	15	28,3	25,9	21,1	34,7	22,2	23,2
ZN_ppm	115	134	148	223	307	264	276	365	251	236
ZR_ppm	58	53	56	54	56	63	46	59	48	37
LA_ppm	25,2	17,1	17	18,8	20,2	20,4	9	29,5	18	9,9
CE_ppm	44,9	30,5	31,1	33,7	39,5	40,2	18,7	53,9	39,2	21,1
PR_ppm	5	3,34	3,55	3,74	4,67	4,68	2,46	5,99	4,86	2,67
ND_ppm	18,7	13	13,7	14,4	17,4	17,4	10,2	20,9	18,4	10,2
SM_ppm	3,77	2,87	2,87	3,25	4,57	4,3	2,95	5,37	5,19	2,97
EU_ppm	2,1	1,05	1,28	1,12	1,82	1,79	1,66	2,49	2,12	1,91
GD_ppm	4,11	2,67	3,08	3,33	4,76	4,4	3,31	6,29	4,38	3,35
TB_ppm	0,58	0,41	0,47	0,53	0,87	0,87	0,66	1,14	0,81	0,7
DY_ppm	2,79	2,23	2,79	2,43	5,35	4,96	4,29	6,74	4,51	4,41
HO_ppm	0,53	0,45	0,57	0,52	1,13	1,02	0,92	1,45	0,96	0,9
ER_ppm	1,41	1,38	1,57	1,44	3,39	3,09	2,97	4,53	3,07	2,83
TM_ppm	0,19	0,19	0,24	0,17	0,56	0,53	0,52	0,73	0,54	0,51
YB_ppm	0,96	1,11	1,28	1,1	4,27	3,69	4,1	5,21	4,48	3,74
LU_ppm	0,16	0,17	0,24	0,18	0,68	0,64	0,66	0,82	0,74	0,64
REEtot_%	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01

Appendix 4. Continuation.

SGU_ID	Yxsjöberg	Yxsjöberg	Yxsjöberg	Yxsjöberg	Källfallet	Källfallet	Källfallet	Källfallet	Källfallet	Idkerberget
N_SWEREF	6655893	6656055	6656129	6656222	6631687	6631555	6631480	6631469	6631505	6693042
E_SWEREF	487387	487314	487257	487071	529457	529521	529487	529523	529601	512261
SIO2_%	45,2	37,8	40,6	36,4	58,5	47	57,1	61,9	59	45,2
TIO2_%	0,1	0,12	0,12	0,15	0,1	0,08	0,08	0,08	0,11	0,93
AL2O3_%	6,36	5,84	6,15	5,67	9,08	6,12	8,08	8,71	8,97	10,4
FE2O3_%	24,4	27,2	22	21	14,05	36	20,4	14,75	18,8	18,1
MGO_%	1,36	1,15	1,23	1,79	11,1	7,25	8,79	9,67	9,21	6,95
CAO_%	15,45	15,1	20,1	23	0,28	0,22	0,26	0,26	0,42	10,1
MNO_%	1,66	1,36	1,47	1,24	0,03	0,02	0,03	0,03	0,03	0,15
NA2O_%	1,12	1,08	0,93	0,85	0,41	0,11	0,27	0,22	0,49	2,33
K2O_%	1,21	1,02	1,23	1,11	1,94	0,69	1,01	1,14	1,25	1,29
P2O5_%	0,02	0,03	0,03	0,04	0,02	0,03	0,03	0,02	0,02	3,47
LOI_%	2,04	5,75	3,95	2,18	2,89	2,85	2,35	2,35	2,04	2,14
total_%	98,93	96,46	97,82	93,45	98,41	100,37	98,41	99,14	100,35	101,12
C_%	0,01	0,04	0,37	0,62	0,02	0,02	0,02	<0,01	0,02	0,15
S_%	0,62	3,42	1,74	2,56	0,12	0,46	0,42	0,14	0,42	0,03
AG_ppm	0,52	1,2	0,81	1,53	0,04	0,09	0,04	0,03	0,03	0,05
AS_ppm	1	1,5	1,8	3	1,7	1,7	0,8	0,4	0,6	16,5
AU_ppm	0,138	0,167	0,149	0,112	0,014	0,186	0,016	0,027	0,009	<0,001
BA_ppm	60,2	54,7	58,7	51,7	91,1	26,4	57,2	55,9	86,8	279
BE_ppm	134,5	79,9	297	135,5	6,54	3,96	6,92	5,22	6,32	0,54
BI_ppm	>250	>250	>250	>250	12,4	165,5	18,65	18	15,75	1,03
CD_ppm	<0,01	<0,01	<0,01	0,68	<0,01	<0,01	<0,01	<0,01	<0,01	0,03
CO_ppm	16	28	24	38	12	11	18	12	20	34
CR_ppm	10	30	10	30	10	<10	10	10	10	50
CS_ppm	5,32	5,54	7,42	8,2	2,87	1,27	2,02	2,11	2,1	1,24
CU_ppm	843	1720	1650	3550	214	332	300	124	348	36
GA_ppm	24,2	23,4	26,1	22,1	21,3	45,3	35,9	27,9	31,5	23,6
GE_ppm	19	17	15	13	7	6	6	5	6	<5
HF_ppm	1,7	1,6	1,7	1,8	6	3,9	4,7	5,2	4,9	3,2
HG_ppm	0,232	0,307	0,188	0,278	0,031	0,061	0,013	0,009	0,019	0,012
IN_ppm	6,03	5,69	6,76	6,95	0,475	0,488	0,356	0,246	0,306	0,048
LI_ppm	10	<10	10	10	10	<10	10	10	10	20
MO_ppm	20	5	2	5	238	498	239	209	256	2
NB_ppm	4,5	5,2	5,3	4,7	11,4	11,8	11,2	11	13,2	9,6
NI_ppm	5	7	6	13	6	23	16	11	12	37
PB_ppm	6	9	8	14	5	4	4	<2	8	6
PD_ppm	0,001	0,001	<0,001	<0,001	<0,001	0,001	<0,001	<0,001	<0,001	0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	94,8	92,3	123,5	123,5	90,3	29,9	48,4	52,1	57,2	56,8
Re_ppm	0,007	0,007	0,012	0,01	0,001	0,004	0,004	0,002	0,003	0,004
SB_ppm	0,54	0,61	0,86	0,76	0,08	0,35	0,09	0,06	0,07	0,09
SC_ppm	4	4	4	5	3	2	3	3	3	19
SE_ppm	1,3	3,5	8,1	9,6	1,2	4,1	2,7	1,2	1,5	0,2
SN_ppm	574	585	560	538	6	12	8	7	6	7
SR_ppm	18,9	21,5	19,9	19,3	11,5	4,3	10	7,2	18,4	165
TA_ppm	<0,1	0,7	0,6	0,6	1,2	1,2	1	1,1	1,2	0,9
TE_ppm	3,69	5,02	3,59	2,74	0,37	1,42	0,81	0,41	0,5	0,04
TH_ppm	3,15	3,52	3,13	2,78	13,05	10,95	13,75	13,75	14,1	12,3
TL_ppm	0,66	0,72	1,14	1,13	0,22	0,15	0,14	0,14	0,15	0,09
U_ppm	1,25	1,36	2,44	2,81	5,3	3,92	5,05	4,1	5,61	4,34
V_ppm	22	23	22	34	5	<5	<5	<5	7	347
W_ppm	863	9970	2860	4870	56	243	67	50	52	4
Y_ppm	25,8	27,6	33,5	33,6	155,5	321	211	179	206	154
ZN_ppm	295	208	405	355	10	4	7	5	27	64
ZR_ppm	52	51	60	56	177	106	151	148	150	108
LA_ppm	13,3	9,3	16,5	14,3	322	1360	706	506	671	215
CE_ppm	27,6	22,2	34,8	31,4	525	2190	1175	817	1100	468
PR_ppm	3,38	2,77	4,03	3,78	51,2	198,5	117,5	78,3	107,5	48,4
ND_ppm	13	11	14,4	13,8	176,5	658	407	266	368	175,5
SM_ppm	3,52	3,82	4,33	4,14	41,6	140,5	89,5	57,1	83,1	35,5
EU_ppm	1,86	1,8	1,53	1,79	5,66	16,15	9,75	7,33	9,8	3,72
GD_ppm	3,84	4,15	4,57	4,6	38,4	123,5	71,1	49,4	70,8	33,2
TB_ppm	0,82	0,87	1,02	0,94	5,21	13,95	8,62	6,48	8,57	4,73
DY_ppm	4,71	5,45	6,06	5,77	25,4	62,2	39,2	30,8	39	26,1
HO_ppm	1,01	1,05	1,24	1,17	4,59	9,87	6,4	5,26	6,37	5,36
ER_ppm	3	3,6	3,84	3,57	11,15	20,8	14,45	12,75	14,25	15,7
TM_ppm	0,55	0,63	0,63	0,63	1,4	2,33	1,72	1,51	1,69	2,15
YB_ppm	4,24	4,78	5,51	4,7	7,74	12	9,26	8,46	9,4	12,7
LU_ppm	0,71	0,68	0,76	0,66	1,04	1,37	1,13	1,1	1,18	1,82
REEtot_%	0,01	0,01	0,01	0,01	0,12	0,48	0,27	0,18	0,25	0,10

Appendix 4. Continuation.

SGU_ID	Idkerberget	Idkerberget	Blötberget	Blötberget	Blötberget	Grängesberg – Golfbanan	Grängesberg – Golfbanan	Grängesberg – Golfbanan	Grängesberg – Jan Mats dammen	Grängesberg – Jan Mats dammen
N_SWEREF	6692947	6692905	6664971	6664995	6664948	6661688	6661083	6661203	6659048	6658994
E_SWEREF	512253	512217	504860	504986	505006	498352	498460	498526	498688	498634
SIO2_%	46,5	44,4	61,9	58,6	63,3	55,2	60,5	59,7	42,8	42,9
TIO2_%	0,69	0,74	0,45	0,34	0,31	0,58	0,46	0,54	0,49	0,41
AL2O3_%	9,88	9,52	11,55	10,3	11,15	13,25	13,45	13,15	8,26	8,45
FE2O3_%	14,45	16,9	12,9	18,45	11,35	8,85	7,48	11,45	18,2	16,75
MGO_%	9,07	8,53	1,99	2,07	1,84	5,48	2,99	2,74	7,63	7,4
CAO_%	8,28	8,89	3,73	3,73	3,13	4,96	4,78	4,08	9,91	10,25
MNO_%	0,12	0,12	0,05	0,05	0,05	0,08	0,05	0,05	0,08	0,08
NA2O_%	2,07	1,99	2,74	2,53	2,86	3,7	4,64	4,29	1,9	1,99
K2O_%	1,86	1,45	2,43	2,15	2,37	2,93	2,15	2,44	2,65	2,78
P2O5_%	3,02	3,09	1,18	1,36	1,16	2,23	2,01	1,59	5,11	5,69
LOI_%	2,57	2,56	1,71	1,34	1,4	1,65	0,79	0,78	1,3	1,29
total_%	98,58	98,26	100,69	100,99	98,97	98,94	99,33	100,87	98,36	98,02
C_%	0,12	0,11	0,15	0,11	0,1	0,17	0,01	0,01	0,06	0,06
S_%	0,02	0,02	<0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,01
AG_ppm	0,01	0,02	<0,01	0,01	0,01	<0,01	0,03	0,01	0,01	0,01
AS_ppm	12,5	13,7	4,3	5,7	5	25,8	20,3	20,4	55,4	62,6
AU_ppm	0,001	0,001	0,001	0,002	0,002	<0,001	0,001	0,001	0,001	<0,001
BA_ppm	384	322	390	491	420	276	221	387	167,5	158
BE_ppm	0,69	0,62	1,24	1,16	1,43	1,45	1,02	0,84	4,43	3,92
BI_ppm	0,37	0,44	0,29	0,4	0,28	0,48	0,32	0,35	0,54	0,59
CD_ppm	<0,01	0,01	0,01	0,01	0,01	<0,01	<0,01	<0,01	<0,01	<0,01
CO_ppm	27	30	8	8	6	13	9	8	14	14
CR_ppm	40	40	30	30	20	20	20	30	30	30
CS_ppm	3,01	2,19	2,92	3,05	2,28	11,2	5,68	4,51	8,19	9,07
CU_ppm	15	19	37	5	4	3	4	4	6	5
GA_ppm	22	21,4	13,9	14,3	16,4	16,7	14,2	14,4	18,6	18,3
GE_ppm	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
HF_ppm	4,5	4,1	4	3,1	3,3	4,7	3,6	4,2	3	3
HG_ppm	0,008	<0,005	0,005	<0,005	0,005	0,01	<0,005	0,01	<0,005	0,012
IN_ppm	0,036	0,038	0,029	0,032	0,03	0,064	0,039	0,049	0,083	0,091
LI_ppm	30	30	10	10	10	80	40	40	70	80
MO_ppm	1	2	1	1	1	2	1	2	2	3
NB_ppm	13,5	12,5	11,1	10,4	9,3	20,2	13,8	15,1	12,7	11,4
NI_ppm	35	39	18	21	18	22	12	13	25	27
PB_ppm	9	11	11	10	7	10	11	8	8	9
PD_ppm	<0,001	0,001	0,003	0,002	<0,001	<0,001	<0,001	<0,001	0,001	0,001
PT_ppm	<0,005	<0,005	<0,005	0,008	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	99,4	76,7	115	99,7	99,3	315	202	189,5	283	329
Re_ppm	0,004	0,004	0,002	0,002	0,002	0,002	0,003	0,002	0,008	0,008
SB_ppm	0,43	0,15	0,39	0,66	0,3	0,49	0,33	0,66	0,53	0,58
SC_ppm	14	15	8	7	7	16	12	13	12	10
SE_ppm	<0,2	0,8	0,6	0,7	<0,2	<0,2	<0,2	<0,2	<0,2	0,4
SN_ppm	16	18	18	20	12	67	59	96	83	89
SR_ppm	134	166	78,6	68,2	66,9	59	65,4	65,4	50,9	46,3
TA_ppm	1,2	1,2	1,1	1	0,9	3,5	4	4,3	3,4	2,7
TE_ppm	0,03	0,04	0,01	0,02	0,02	0,01	<0,01	0,01	0,01	0,01
TH_ppm	14,55	13,7	11,35	11	11,9	9,86	7,9	10,3	17,3	14,6
TL_ppm	0,25	0,17	0,13	0,15	0,11	1,06	0,53	0,41	0,79	0,87
U_ppm	9,32	7,29	5,94	5,36	6,58	3,61	3,6	3,93	4,79	4,16
V_ppm	227	279	172	199	168	116	92	105	292	258
W_ppm	5	6	12	11	5	7	5	9	14	19
Y_ppm	168,5	168,5	94	101,5	108	88,8	81,8	81,2	256	262
ZN_ppm	60	63	20	21	21	47	23	26	56	62
ZR_ppm	134	126	134	108	113	124	101	121	90	85
LA_ppm	185	170,5	169,5	254	245	202	149	166	377	342
CE_ppm	423	390	369	495	480	410	295	307	784	724
PR_ppm	43,2	40,6	35,9	49	50,3	37,4	27,5	27,8	78,6	72,4
ND_ppm	158,5	153,5	130	174	183	122	90	89,1	279	265
SM_ppm	35,2	34,2	22,9	29,8	32,3	21,3	16,8	15,9	58	55,5
EU_ppm	3,98	3,3	3,97	5,7	5,84	5,71	4,39	4,52	9,16	9,56
GD_ppm	34,6	33,8	21,9	27,2	29,7	17,6	14,25	13,95	52,4	51
TB_ppm	5,11	4,87	3,21	3,72	3,9	2,74	2,08	2,19	7,63	7,38
DY_ppm	28,9	27,3	16,55	19	19,55	14,9	12,25	12,6	41,3	41,8
HO_ppm	5,92	5,61	3,42	3,68	4,01	3,05	2,49	2,66	8,4	8,38
ER_ppm	16,75	15,8	8,95	9,66	10,85	8,76	7,51	8,17	22,9	23,8
TM_ppm	2,22	2,15	1,38	1,37	1,46	1,32	1,18	1,43	3,2	3,27
YB_ppm	14,05	13	9,23	8,61	9,15	8,98	8,06	10,1	19,7	19,9
LU_ppm	2	1,84	1,44	1,26	1,37	1,32	1,23	1,56	2,75	2,75
REEtot_%	0,10	0,09	0,08	0,11	0,11	0,09	0,06	0,07	0,17	0,16

Appendix 4. Continuation.

SGU_ID	Grängesberg – Erikstorp	Grängesberg – Erikstorp	Grängesberg – Erikstorp	Grängesberg – Jan Mats dammen	Stripa	Stripa	Stripa	Stripa	Zinkgruvan – Enemossen	Zinkgruvan – Enemossen
N_SWEREF	6659168	6659168	6659144	6658843	6619339	6619193	6619201	6619252	6515707	6515669
E_SWEREF	498653	498727	498816	498784	504969	504979	505010	505055	505717	505717
SIO2_%	59,3	42,4	42,4	42,7	68,7	59,4	64,3	66,3	58,2	60,1
TIO2_%	0,44	0,51	0,49	0,52	0,39	0,12	0,16	0,14	0,23	0,27
AL2O3_%	11,45	8,44	8,22	8,99	14,45	5,95	8,25	6,48	10,55	11,05
FE2O3_%	8,97	21	18,85	18,6	3,18	24	15,75	16,85	6,78	6,49
MGO_%	5,87	7,99	7,14	9,53	2,61	2,59	2,84	3,07	3,67	3,16
CAO_%	4,58	8,9	10,1	8,19	4,46	3,33	2,29	3,27	8,56	7,22
MNO_%	0,06	0,08	0,08	0,1	0,04	0,12	0,09	0,11	0,86	0,82
NA2O_%	3,08	1,84	1,94	1,75	3,74	0,45	0,99	0,58	0,59	0,6
K2O_%	3,32	2,99	2,55	3,44	1,29	1,34	2,37	1,74	4,66	4,92
P2O5_%	1,63	4,63	5,26	4,28	0,07	0,05	0,05	0,04	0,1	0,11
LOI_%	1,07	1,43	1,29	1,7	2,44	1,82	2,03	1,73	2,86	2,18
total_%	99,8	100,24	98,35	99,83	101,44	99,23	99,39	100,36	97,34	97,21
C_%	0,05	0,07	0,07	0,07	0,29	0,19	0,35	0,13	0,85	0,57
S_%	0,01	0,01	0,02	0,01	0,01	0,02	0,01	0,01	1	0,68
AG_ppm	0,01	0,01	<0,01	0,01	0,01	0,01	0,03	0,02	18,1	11,7
AS_ppm	17,4	49,2	51,2	46,7	1,1	3	1,8	3,5	111,5	96,9
AU_ppm	<0,001	0,001	<0,001	<0,001	<0,001	<0,001	0,002	0,001	0,006	0,003
BA_ppm	199,5	175,5	160	175	233	474	497	456	2440	2540
BE_ppm	2,9	4,12	4,08	5,08	0,78	5,28	3,73	4,93	1,1	1,27
BI_ppm	0,27	0,55	0,72	0,5	0,06	0,92	0,99	1,45	3,17	1,28
CD_ppm	0,01	<0,01	0,01	<0,01	0,01	<0,01	0,02	0,01	22,2	12,15
CO_ppm	10	13	13	15	9	5	5	5	45	42
CR_ppm	30	30	30	30	170	10	1600	20	10	20
CS_ppm	8,84	9,74	8,05	12,8	3,68	1,36	1,97	1,33	4,29	4,97
CU_ppm	4	8	7	6	8	10	44	58	275	134
GA_ppm	18,2	20,9	18,5	23,2	18,2	11,2	13,4	10,8	16,2	16,3
GE_ppm	<5	<5	<5	<5	<5	7	5	7	<5	<5
HF_ppm	6,3	3,3	3,5	3,8	4,5	2,8	4,1	3,3	6,2	6,4
HG_ppm	0,007	0,009	0,019	0,02	0,01	0,015	0,011	0,009	0,813	0,383
IN_ppm	0,059	0,074	0,079	0,127	0,01	0,525	0,319	0,526	0,097	0,071
LI_ppm	60	80	60	100	20	10	10	10	30	40
MO_ppm	2	2	2	5	<1	1	2	7	2	2
NB_ppm	11,5	13,4	14,5	16,6	10,2	6,8	12,2	7,1	10,9	12,3
NI_ppm	19	25	25	28	54	2	17	5	21	14
PB_ppm	12	9	10	11	9	13	14	18	3780	3220
PD_ppm	0,001	0,001	0,001	<0,001	0,001	0,001	0,001	0,001	0,001	0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	332	337	268	392	59,8	57,4	95,5	67,2	144	152
Re_ppm	0,003	0,006	0,007	0,006	0,001	0,002	<0,001	<0,001	0,002	0,001
SB_ppm	0,32	0,68	0,78	0,84	0,12	5,83	3,82	6,2	23,1	12,15
SC_ppm	12	11	11	11	11	3	5	5	6	7
SE_ppm	0,4	0,3	0,5	0,4	0,3	0,2	0,3	0,6	2,2	2
SN_ppm	29	107	89	100	3	6	6	4	3	3
SR_ppm	48,5	45	52,5	42,5	235	31,5	30,2	27,9	74,6	71,4
TA_ppm	4,9	4,3	6,4	5	1,3	1	1,5	0,9	0,9	0,9
TE_ppm	0,01	0,01	<0,01	0,02	<0,01	0,01	0,01	0,01	0,08	0,05
TH_ppm	11,45	16,9	18,55	17,55	13,45	7,8	12,75	7,76	12,5	13,95
TL_ppm	0,79	0,85	0,7	1,15	0,07	0,03	0,05	0,04	1,84	2,3
U_ppm	5,11	4,65	4,82	6,62	3,15	4,32	5,07	4	3,85	4,21
V_ppm	137	389	303	282	49	19	41	20	20	22
W_ppm	6	13	26	24	2	9	6	4	19	2
Y_ppm	122	243	264	234	26,9	34,3	43,2	41,8	43	42
ZN_ppm	43	61	56	77	19	36	33	39	13450	7520
ZR_ppm	112	89	93	105	153	81	129	99	192	204
LA_ppm	145	321	337	355	39	36,1	48,7	47,9	37,9	42,1
CE_ppm	318	675	693	717	75,7	66,7	97,5	91,3	76,1	84,6
PR_ppm	32,4	70,8	72,6	74	8,48	7,71	11,3	10,35	8,57	9,87
ND_ppm	115,5	257	263	261	29,3	28	41,1	38,6	31,3	36,9
SM_ppm	24,1	52,3	56,4	52,8	6,15	7,06	10,3	9,37	7,49	8,32
EU_ppm	3,81	7,9	7,21	7,88	1,27	1,74	1,6	2,1	1,45	1,69
GD_ppm	23	47,8	51,1	47	5,18	7,68	9,73	9,64	7,46	8,48
TB_ppm	3,45	6,84	7,44	6,9	0,8	1,13	1,41	1,42	1,21	1,33
DY_ppm	19,4	37,6	41	37,7	4,39	6,24	7,7	7,51	7,3	7,06
HO_ppm	4,11	7,66	8,59	7,59	1,02	1,21	1,49	1,4	1,49	1,51
ER_ppm	11,6	21,7	23,1	21,4	2,76	2,95	3,91	3,79	4,34	4,69
TM_ppm	1,8	3,14	3,32	3	0,41	0,43	0,62	0,56	0,66	0,67
YB_ppm	12,9	20,7	20,8	19,65	2,85	2,48	4,11	3,43	4,09	4,18
LU_ppm	1,94	2,93	2,87	2,91	0,37	0,39	0,56	0,51	0,57	0,61
REEtot_%	0,07	0,15	0,16	0,16	0,02	0,02	0,02	0,02	0,02	0,02

Appendix 4. Continuation.

SGU_ID	Zinkgruvan	Zinkgruvan	Nartorp	Nartorp	Nartorp	Åmmeberg – Golfbana	Åmmeberg – Golfbana	Åmmeberg – Golfbana	Lejakärrret	Lejakärrret
N_SWEREF	6515498	6515495	6472070	6472040	6472133	6523957	6523370	6523287	6611782	6611811
E_SWEREF	506273	506246	591972	591919	591904	499865	499854	499825	504216	504210
SIO2_%	60,3	64,6	43,1	44,4	46,8	62,3	55,8	57,1	46,1	48,9
TIO2_%	0,28	0,26	0,13	0,15	0,19	0,24	0,2	0,22	0,03	0,03
AL2O3_%	11,15	11,55	3,75	3,77	5,08	10	9,18	9,46	1,11	1,4
FE2O3_%	5,99	5,25	24,5	21,8	20,8	7,29	9	6,93	13	10,65
MGO_%	2,93	2,67	4,66	5,59	5,08	2,15	2,58	2,35	12,3	12,5
CAO_%	6,19	5,98	23,4	22,2	20,2	8,43	8,52	9,01	19,05	19,5
MNO_%	0,61	0,61	0,34	0,35	0,32	1,29	1,38	1,28	0,44	0,44
NA2O_%	0,71	0,77	0,35	0,42	0,61	0,54	0,4	0,37	0,13	0,13
K2O_%	5,22	5,42	0,16	0,17	0,47	3,63	4,29	4,45	0,42	0,55
P2O5_%	0,1	0,1	0,08	0,09	0,12	0,07	0,07	0,08	0,01	0,01
LOI_%	2,2	2,31	0,09	0,16	0,94	1,77	2,28	2,14	2,9	2,18
total_%	96,12	99,98	100,56	99,1	100,62	97,81	93,85	93,51	95,81	96,66
C_%	0,49	0,47	0,06	0,02	0,21	0,46	0,67	0,61	0,7	0,77
S_%	1,6	0,5	0,01	0,01	0,01	0,66	1,71	1,29	2,63	1,28
AG_ppm	30,6	14,45	0,05	0,03	0,02	12,65	>100	36,6	5,58	3,55
AS_ppm	36,8	26,7	0,6	0,4	0,4	38,8	1025	29,7	4,2	2,7
AU_ppm	0,004	0,002	0,001	0,001	0,002	0,003	0,021	0,007	0,265	0,105
BA_ppm	3730	3960	33	42,9	87,6	860	1155	1005	2860	3450
BE_ppm	1,17	1,16	0,25	0,24	0,35	1,04	0,95	1	0,18	0,2
BI_ppm	1,05	0,61	0,75	0,8	1	0,68	1,28	0,81	6,3	3,87
CD_ppm	52,3	12,1	0,16	0,05	0,12	17,95	32,5	30,2	0,47	0,36
CO_ppm	31	15	27	29	28	8	69	7	93	49
CR_ppm	20	10	10	10	20	30	50	20	<10	10
CS_ppm	5,08	5,09	0,14	0,07	0,36	5,58	4,83	5,4	1,02	1,03
CU_ppm	101	54	17	22	21	51	151	126	3810	3290
GA_ppm	16,3	16,2	8,4	8,6	10,6	15,8	14,1	14,9	3,9	4,8
GE_ppm	<5	<5	7	6	6	9	11	13	<5	<5
HF_ppm	6,3	5,7	1,9	2,1	1,6	5,6	4,7	4,9	0,6	0,7
HG_ppm	1,485	0,472	0,041	0,047	0,083	0,192	1,295	0,464	0,061	0,053
IN_ppm	0,077	0,038	0,684	0,517	0,556	0,028	0,055	0,043	0,488	0,383
LI_ppm	30	30	10	10	10	20	20	20	20	20
MO_ppm	3	4	4	1	1	1	1	2	72	71
NB_ppm	13,4	12,5	3,1	3,3	4,1	11,9	10,7	11,6	1,7	2,2
NI_ppm	8	5	9	6	11	10	38	6	5	2
PB_ppm	10700	3340	25	13	7	3590	14500	9260	69	46
PD_ppm	0,001	0,002	0,002	0,001	0,001	<0,001	0,011	0,001	0,001	0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	170,5	170,5	5,9	5,3	17,8	128	139,5	144,5	11,9	17
Re_ppm	0,001	0,001	0,001	0,001	0,001	0,001	0,006	0,001	0,003	0,002
SB_ppm	14,15	7,04	0,1	0,1	0,1	6,36	43,4	16	0,69	0,59
SC_ppm	7	6	5	6	7	8	7	7	1	1
SE_ppm	4,1	1,1	0,8	<0,2	<0,2	1,9	2,8	3,2	13,8	7
SN_ppm	3	3	23	23	19	4	4	4	13	14
SR_ppm	76,7	74,2	55,4	70,7	83,2	87,1	68,5	74,5	9,7	11,1
TA_ppm	0,9	0,9	0,1	0,3	0,3	1	0,8	1	0,1	0,1
TE_ppm	0,06	0,03	0,03	0,04	0,02	0,06	0,12	0,11	0,65	0,32
TH_ppm	14	13,4	4,34	5,03	6,18	10,35	9,5	10,25	0,98	1,16
TL_ppm	2,29	2,28	0,02	<0,02	0,04	1,84	1,88	1,87	0,42	0,21
U_ppm	3,82	3,61	8,93	8,02	7,89	4,64	14,55	4,14	1,07	1,35
V_ppm	23	20	26	25	32	29	21	25	<5	6
W_ppm	5	3	1	5	1	4	11	2	18	6
Y_ppm	36,3	34,9	28,6	32,4	28,9	49,4	39,8	40,1	10,6	12,3
ZN_ppm	21100	5770	84	75	68	7380	23000	23200	137	128
ZR_ppm	193	181	63	69	55	199	161	165	21	25
LA_ppm	40	35,7	55,2	90,9	71,7	34,8	36,5	34,5	6,6	7,4
CE_ppm	81	71,1	100,5	132	129	69,6	66,6	67,5	10,2	12,2
PR_ppm	9,31	8,29	10,85	12,15	13,2	8,35	7,77	7,97	1,2	1,52
ND_ppm	34,1	30,1	39	41,9	43,7	31,4	29,1	30,4	5,1	6,1
SM_ppm	7,58	6,89	8,28	8,88	8,1	7,24	6,56	6,78	1,69	1,96
EU_ppm	1,3	1,15	3,05	2,91	2,41	1,09	1,16	1,03	0,35	0,38
GD_ppm	7,19	6,44	6,23	7,3	6,01	7,01	6,12	6,37	1,98	2,3
TB_ppm	1,1	1,02	0,93	0,99	0,9	1,18	1,07	1,03	0,33	0,34
DY_ppm	6,68	5,66	5,51	6,16	4,99	7,45	6,21	6,5	1,76	2,13
HO_ppm	1,33	1,21	1,07	1,19	1,03	1,8	1,45	1,48	0,4	0,41
ER_ppm	3,87	3,55	3,09	3,22	2,89	5,46	4,09	3,95	1,04	1,12
TM_ppm	0,55	0,54	0,45	0,5	0,41	0,82	0,62	0,67	0,14	0,18
YB_ppm	3,76	3,53	2,74	3,11	2,63	5,3	3,96	4,01	0,88	0,97
LU_ppm	0,54	0,49	0,35	0,37	0,35	0,89	0,68	0,7	0,13	0,16
REEtot_%	0,02	0,02	0,02	0,03	0,03	0,02	0,02	0,02	0,00	0,00

Appendix 4. Continuation.

SGU_ID	Zinkgruvan	Zinkgruvan	Nartorp	Nartorp	Nartorp	Ämmeberg – golfbana	Ämmeberg – golfbana	Ämmeberg – golfbana	Lejakärret	Lejakärret	Lejakärret
N_SWEREF	6515498	6515495	6472070	6472040	6472133	6523957	6523370	6523287	6611782	6611811	6611908
E_SWEREF	506273	506246	591972	591919	591904	499865	499854	499825	504216	504210	504249
SIO2_%	60,3	64,6	43,1	44,4	46,8	62,3	55,8	57,1	46,1	48,9	45,5
TIO2_%	0,28	0,26	0,13	0,15	0,19	0,24	0,2	0,22	0,03	0,03	0,03
AL2O3_%	11,15	11,55	3,75	3,77	5,08	10	9,18	9,46	1,11	1,4	1,1
FE2O3_%	5,99	5,25	24,5	21,8	20,8	7,29	9	6,93	13	10,65	9,53
MGO_%	2,93	2,67	4,66	5,59	5,08	2,15	2,58	2,35	12,3	12,5	13
CAO_%	6,19	5,98	23,4	22,2	20,2	8,43	8,52	9,01	19,05	19,5	20,8
MNO_%	0,61	0,61	0,34	0,35	0,32	1,29	1,38	1,28	0,44	0,44	0,46
NA2O_%	0,71	0,77	0,35	0,42	0,61	0,54	0,4	0,37	0,13	0,13	0,11
K2O_%	5,22	5,42	0,16	0,17	0,47	3,63	4,29	4,45	0,42	0,55	0,39
P2O5_%	0,1	0,1	0,08	0,09	0,12	0,07	0,07	0,08	0,01	0,01	<0,01
LOI_%	2,2	2,31	0,09	0,16	0,94	1,77	2,28	2,14	2,9	2,18	6,17
total_%	96,12	99,98	100,56	99,1	100,62	97,81	93,85	93,51	95,81	96,66	97,4
C_%	0,49	0,47	0,06	0,02	0,21	0,46	0,67	0,61	0,7	0,77	1,8
S_%	1,6	0,5	0,01	0,01	0,01	0,66	1,71	1,29	2,63	1,28	0,71
AG_ppm	30,6	14,45	0,05	0,03	0,02	12,65	>100	36,6	5,58	3,55	3,47
AS_ppm	36,8	26,7	0,6	0,4	0,4	38,8	1025	29,7	4,2	2,7	1,5
AU_ppm	0,004	0,002	0,001	0,001	0,002	0,003	0,021	0,007	0,265	0,105	0,069
BA_ppm	3730	3960	33	42,9	87,6	860	1155	1005	2860	3450	2880
BE_ppm	1,17	1,16	0,25	0,24	0,35	1,04	0,95	1	0,18	0,2	0,17
BI_ppm	1,05	0,61	0,75	0,8	1	0,68	1,28	0,81	6,3	3,87	4,21
CD_ppm	52,3	12,1	0,16	0,05	0,12	17,95	32,5	30,2	0,47	0,36	0,46
CO_ppm	31	15	27	29	28	8	69	7	93	49	35
CR_ppm	20	10	10	10	20	30	50	20	<10	10	10
CS_ppm	5,08	5,09	0,14	0,07	0,36	5,58	4,83	5,4	1,02	1,03	1,28
CU_ppm	101	54	17	22	21	51	151	126	3810	3290	3080
GA_ppm	16,3	16,2	8,4	8,6	10,6	15,8	14,1	14,9	3,9	4,8	4,1
GE_ppm	<5	<5	7	6	6	9	11	13	<5	<5	<5
HF_ppm	6,3	5,7	1,9	2,1	1,6	5,6	4,7	4,9	0,6	0,7	0,5
HG_ppm	1,485	0,472	0,041	0,047	0,083	0,192	1,295	0,464	0,061	0,053	0,134
IN_ppm	0,077	0,038	0,684	0,517	0,556	0,028	0,055	0,043	0,488	0,383	0,401
LI_ppm	30	30	10	10	10	20	20	20	20	20	20
MO_ppm	3	4	4	1	1	1	1	2	72	71	45
NB_ppm	13,4	12,5	3,1	3,3	4,1	11,9	10,7	11,6	1,7	2,2	1,4
NI_ppm	8	5	9	6	11	10	38	6	5	2	2
PB_ppm	10700	3340	25	13	7	3590	14500	9260	69	46	35
PD_ppm	0,001	0,002	0,002	0,001	0,001	<0,001	0,011	0,001	0,001	0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	170,5	170,5	5,9	5,3	17,8	128	139,5	144,5	11,9	17	13,4
Re_ppm	0,001	0,001	0,001	0,001	0,001	0,001	0,006	0,001	0,003	0,002	0,001
SB_ppm	14,15	7,04	0,1	0,1	0,1	6,36	43,4	16	0,69	0,59	0,74
SC_ppm	7	6	5	6	7	8	7	7	1	1	1
SE_ppm	4,1	1,1	0,8	<0,2	<0,2	1,9	2,8	3,2	13,8	7	5,3
SN_ppm	3	3	23	23	19	4	4	4	13	14	13
SR_ppm	76,7	74,2	55,4	70,7	83,2	87,1	68,5	74,5	9,7	11,1	16,4
TA_ppm	0,9	0,9	0,1	0,3	0,3	1	0,8	1	0,1	0,1	0,1
TE_ppm	0,06	0,03	0,03	0,04	0,02	0,06	0,12	0,11	0,65	0,32	0,4
TH_ppm	14	13,4	4,34	5,03	6,18	10,35	9,5	10,25	0,98	1,16	0,89
TL_ppm	2,29	2,28	0,02	<0,02	0,04	1,84	1,88	1,87	0,42	0,21	0,2
U_ppm	3,82	3,61	8,93	8,02	7,89	4,64	14,55	4,14	1,07	1,35	0,69
V_ppm	23	20	26	25	32	29	21	25	<5	6	5
W_ppm	5	3	1	5	1	4	11	2	18	6	9
Y_ppm	36,3	34,9	28,6	32,4	28,9	49,4	39,8	40,1	10,6	12,3	11,1
ZN_ppm	21100	5770	84	75	68	7380	23000	23200	137	128	108
ZR_ppm	193	181	63	69	55	199	161	165	21	25	16
LA_ppm	40	35,7	55,2	90,9	71,7	34,8	36,5	34,5	6,6	7,4	7,8
CE_ppm	81	71,1	100,5	132	129	69,6	66,6	67,5	10,2	12,2	13,3
PR_ppm	9,31	8,29	10,85	12,15	13,2	8,35	7,77	7,97	1,2	1,52	1,52
ND_ppm	34,1	30,1	39	41,9	43,7	31,4	29,1	30,4	5,1	6,1	6,2
SM_ppm	7,58	6,89	8,28	8,88	8,1	7,24	6,56	6,78	1,69	1,96	1,83
EU_ppm	1,3	1,15	3,05	2,91	2,41	1,09	1,16	1,03	0,35	0,38	0,4
GD_ppm	7,19	6,44	6,23	7,3	6,01	7,01	6,12	6,37	1,98	2,3	2,21
TB_ppm	1,1	1,02	0,93	0,99	0,9	1,18	1,07	1,03	0,33	0,34	0,35
DY_ppm	6,68	5,66	5,51	6,16	4,99	7,45	6,21	6,5	1,76	2,13	1,87
HO_ppm	1,33	1,21	1,07	1,19	1,03	1,8	1,45	1,48	0,4	0,41	0,36
ER_ppm	3,87	3,55	3,09	3,22	2,89	5,46	4,09	3,95	1,04	1,12	0,96
TM_ppm	0,55	0,54	0,45	0,5	0,41	0,82	0,62	0,67	0,14	0,18	0

Appendix 4. Continuation.

SGU_ID	Lejakärret	Stollberg	Stollberg	Silfhyttan – badplats	Stollberg	Stollberg	Stollberg	Stollberg	Stollberg	Silfhyttan – badplats	Silfhyttan – badplats
N_SWEREF	6611815	6671508	6671504	6669981	6671223	6671320	6671356	6671385	6671271	6669941	6669973
E_SWEREF	504237	515263	515194	516006	514874	514899	514996	514903	514811	516069	516009
SIO2_%	47,1	42,8	35,1	25,9	55,7	40,4	41,7	43,5	41,3	24,2	24,3
TIO2_%	0,02	0,11	0,07	0,09	0,13	0,11	0,1	0,15	0,1	0,06	0,07
AL2O3_%	0,79	6,18	4,61	3,71	7,73	6,47	5,86	7,38	6,12	2,92	3,64
FE2O3_%	12,2	12,95	19,15	19,7	10,1	12,95	17,85	11,95	11,55	21,1	24,5
MGO_%	12,65	3,8	4,23	4,05	3,16	4,1	2,32	3,74	4,04	3,15	4,07
CAO_%	20,1	14,1	15,8	13,6	9,37	13,85	11,85	13,85	14,8	11,9	13,05
MNO_%	0,44	3,65	6,93	9,93	1,8	4,12	5,15	3,44	4,03	6,14	10,85
NA2O_%	0,13	0,3	0,1	0,14	0,19	0,23	0,14	0,23	0,22	0,15	0,07
K2O_%	0,23	1,87	0,59	0,35	3,13	1,92	1,45	2,38	1,9	0,48	0,19
P2O5_%	<0,01	0,13	0,03	0,03	0,05	0,15	0,03	0,19	0,16	0,03	0,03
LOI_%	2,41	11,8	11,55	11,05	8,11	12,2	8,3	12,15	13,85	8,55	8,69
total_%	96,23	98,02	98,17	88,56	99,56	96,87	94,77	99,35	98,41	78,69	89,46
C_%	0,75	3,06	3,42	3,6	1,87	3,16	2,21	2,73	3,46	3,08	3,08
S_%	2,35	0,85	0,87	1,46	0,67	0,74	1,25	0,64	0,54	2,5	1,77
AG_ppm	4,61	11,85	2,72	16,85	5,3	7,86	6,51	15,7	11,85	25,7	20,6
AS_ppm	2,4	711	4970	1060	869	572	3600	540	635	1550	1670
AU_ppm	0,381	0,011	0,034	0,023	0,011	0,011	0,032	0,012	0,01	0,034	0,029
BA_ppm	1385	2760	91,1	50,3	771	3070	177	3200	2840	68,8	27,1
BE_ppm	0,18	1,54	1,01	1,11	1,33	1,74	1,39	2,07	1,5	1,76	1,26
BI_ppm	4,63	1,32	7,54	4,42	1,53	1,11	6,25	1,85	1,45	5,86	5,09
CD_ppm	0,44	11,25	8,89	57,6	4,49	16,4	15,2	17,1	11,8	85,8	88,2
CO_ppm	73	1	7	<1	1	<1	5	<1	<1	<1	<1
CR_ppm	10	10	10	10	20	10	10	30	20	10	10
CS_ppm	1,11	2,39	1,12	0,9	1,98	3,1	1,33	3,37	2,78	0,85	0,61
CU_ppm	3680	137	189	209	90	120	280	241	159	224	228
GA_ppm	4,5	11,6	8,1	7,8	14	11,3	11	13,5	11,5	7,6	10,8
GE_ppm	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
HF_ppm	0,4	3,1	1,4	1,1	2,9	2,3	1,9	2,6	2,6	1	1
HG_ppm	0,071	0,235	0,06	0,576	0,06	0,357	0,118	0,385	0,26	0,737	0,636
IN_ppm	0,493	0,413	1,71	5,41	0,4	0,518	1,225	0,603	0,436	5,56	6,1
LI_ppm	20	10	<10	<10	10	10	10	10	10	<10	<10
MO_ppm	63	2	3	3	2	1	4	1	2	6	4
NB_ppm	1,1	5,9	3,2	2,3	6,2	5,6	4,1	6	5,2	2,8	2,1
NI_ppm	3	3	4	3	1	2	3	5	2	2	3
PB_ppm	44	4270	1330	11200	2220	2820	2020	6880	5110	17650	14050
PD_ppm	0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
PT_ppm	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
RB_ppm	8,2	51,3	17,6	15	68,3	56,4	40,3	68,5	53,8	21,2	8,1
Re_ppm	0,003	<0,001	<0,001	<0,001	0,001	0,001	0,002	0,002	0,001	<0,001	0,001
SB_ppm	0,78	19,85	9,23	15,85	11,35	13,65	15,6	34,6	18,7	24,5	19,7
SC_ppm	1	4	3	2	4	4	4	5	4	2	2
SE_ppm	8,7	1,7	0,8	11,5	0,7	1,9	1,3	2,1	1,1	11,5	12,2
SN_ppm	16	6	13	7	7	10	11	7	6	12	11
SR_ppm	8,9	29,5	19,1	22,8	16,3	26,6	22,2	30,5	28,9	18,5	18
TA_ppm	0,1	0,4	0,1	0,1	0,3	0,4	0,3	0,3	0,3	0,6	0,1
TE_ppm	0,51	0,05	0,02	0,02	0,01	0,05	0,07	0,04	0,05	0,03	0,02
TH_ppm	0,59	6,31	4,21	2,97	8,13	7,4	5,31	9,44	6,59	2,61	2,43
TL_ppm	0,66	0,52	0,28	0,16	0,42	0,65	0,42	0,72	0,54	0,18	0,12
U_ppm	0,79	2,52	2,08	1,58	3,15	3,2	2,43	3,79	2,78	1,74	1,5
V_ppm	5	12	11	12	16	14	18	22	11	10	8
W_ppm	16	6	29	14	10	9	39	9	10	25	18
Y_ppm	10,7	33,1	33	28,8	34,6	32,2	37,6	41,1	33	31,3	31,5
ZN_ppm	106	4120	2870	37000	2030	6540	5010	6610	3610	36000	39400
ZR_ppm	10	101	56	42	104	88	64	109	92	35	34
LA_ppm	6,2	28,4	34,4	32	29,5	33,4	34,9	39,8	30,3	30,3	29,9
CE_ppm	10,1	51,6	57,9	50	54,7	59	60,3	71,2	53,5	48,3	46,3
PR_ppm	1,24	6,2	6,98	6,12	6,75	7,34	7,37	8,84	6,72	6,13	5,69
ND_ppm	5,1	23,8	26,4	24	25,7	27,5	28,5	34,4	25,2	24,5	21,9
SM_ppm	1,59	5,5	6,9	5,93	6,17	6,86	6,61	8,64	6,54	6,1	5,61
EU_ppm	0,38	9,67	10,15	9,85	5,83	9,33	8,27	9,45	9,16	10,15	9,76
GD_ppm	2,09	7,51	8,91	8,3	7,78	8,23	8,04	9,94	7,95	8,41	7,66
TB_ppm	0,35	1,06	1,31	1,19	1,3	1,21	1,31	1,45	1,12	1,21	1,02
DY_ppm	1,87	6,23	6,52	6,02	6,53	6,25	6,88	7,8	5,77	6,2	5,52
HO_ppm	0,41	1,02	1,03	0,92	1,19	0,99	1,08	1,2	0,93	0,9	0,92
ER_ppm	1,04	2,41	2,44	2,41	3,04	2,8	3	3,24	2,69	2,28	2,14
TM_ppm	0,14	0,33	0								