

Boliden Summary Report

Resources and Reserves | 2021

Petiknäs Norra



Prepared by
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Front page: Picture showing Petiknäs mine site from 2007

1 SUMMARY

Petiknäs Norra, is located close to the Petiknäs mine that was mined out and closed in 2007. A drift was developed to the mineralization and ca 25 000 ton were test mined in 1997. In 2007 a scoping study and a Mineral Resource estimation was made on Petiknäs Norra. The study could not present a processing method that was economically viable. In august 2019 a new scoping study was initiated with the main focus on the metallurgical process. The Mineral Resource estimation and mine plan was updated together with an updated market analysis for the various concentrates that may be produced. Even though the results from the study showed that it is not possible to reach a positive NPV for the deposit based on current long term prices and terms (Kläre et al., 2019, internal Boliden report) there is a reasonable possibility for Petiknäs Norra to become economic in the future especially if some of the required process investments can be shared with other ongoing project.

The reported figures summarized in the Table 1 below were originally reported in 2019 and remain unchanged from the previous year's disclosure.

Table 1. Petiknäs Norra Mineral Resources no dilution added.

Classification	kton	2019							
		Au (g/t)	Ag (g/t)	Cu (%)	Zn (%)	Pb (%)	As (%)	S (%)	Sb (g/t)
Mineral Resources									
Indicated	356	8.1	72	1.6	2.8	0.3	8.3	21	1422
Inferred	1710	4.4	54	0.9	2.1	0.3	3.5	14	978

The Mineral Resources are defined without waste dilution added.

2 COMPETENCE

The Mineral Resource estimation was made in 2019 by Boliden staff according to the current routines. The estimation results have been reviewed by Jan Kläre, Hans Årebäck and discussed with Gunnar Agmalm.

Table 2. Contributors and responsible competent persons for this report.

Description	Contributors	Responsible CP
Compilation of this report	Jan Kläre	Hans Årebäck
Geology	Roger Nordin	Jan Kläre
Resource Estimations	Lina Åberg	Jan Kläre

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¹ Fennoscandian Association for Metals and Minerals Professionals

3 GENERAL INTRODUCTION

This report is issued annually to inform the public (shareholders and potential investors) of the mineral assets in Petiknäs Norra held by Boliden. The report is a summary of internal reports for Petiknäs Norra. Boliden method of reporting Mineral Resources and Mineral Reserves intends to comply with the Pan-European Standard for reporting of Exploration results, Mineral Resources and Mineral Reserves (The PERC Reporting standard 2017). It is an international reporting standard that has been adopted by the mining associations in Sweden (SveMin), Finland (FinnMin) and Norway (Norsk Bergindustri), to be used for exploration and mining companies within the Nordic countries.

3.1 Pan-European Standard for Reporting of Exploration Results, Mineral Resources and Mineral Reserves – The PERC Reporting Standard

PERC is the organisation responsible for setting standards for public reporting of exploration results, mineral resources, and mineral reserves by companies listed on markets in Europe. It is the European equivalent of JORC in Australasia, SAMREC in South Africa, and similar reserves standards bodies elsewhere. PERC is a member of CRIRSCO, the Committee for Mineral Reserves International Reporting Standards, and the PERC Reporting Standard is fully aligned with the CRIRSCO Reporting Template.

The PERC standard sets out minimum standards, recommendations and guidelines for Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves in Europe.

3.2 Definitions

Public Reports on Exploration Results, Mineral Resources and/or Mineral Reserves must only use terms set out in the PERC standard.

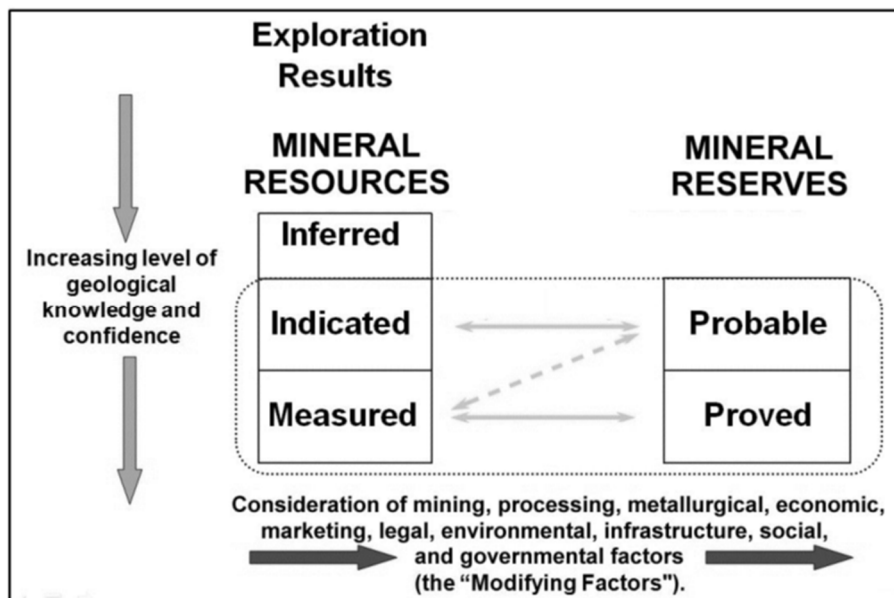


Figure 1. General relationship between Exploration Results, Mineral Resources and Mineral Reserves (PERC 2017).

3.2.1 Mineral Resource

A Mineral Resource is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction.

3.2.2 Mineral Reserve

A Mineral Reserve is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined or extracted and is defined by studies at Pre-Feasibility or Feasibility level as appropriate that include application of Modifying Factors. Such studies demonstrate that, at the time of reporting, extraction could reasonably be justified.

4 PETIKNÄS NORRA

The Petiknäs mine and Petiknäs Norra mineralization are located in Norsjö municipality in Västerbotten, Northern Sweden, approximately 20 km west of the Boliden Area mill, and some 2-3 km west of the operating Renström mine (Figure 2).

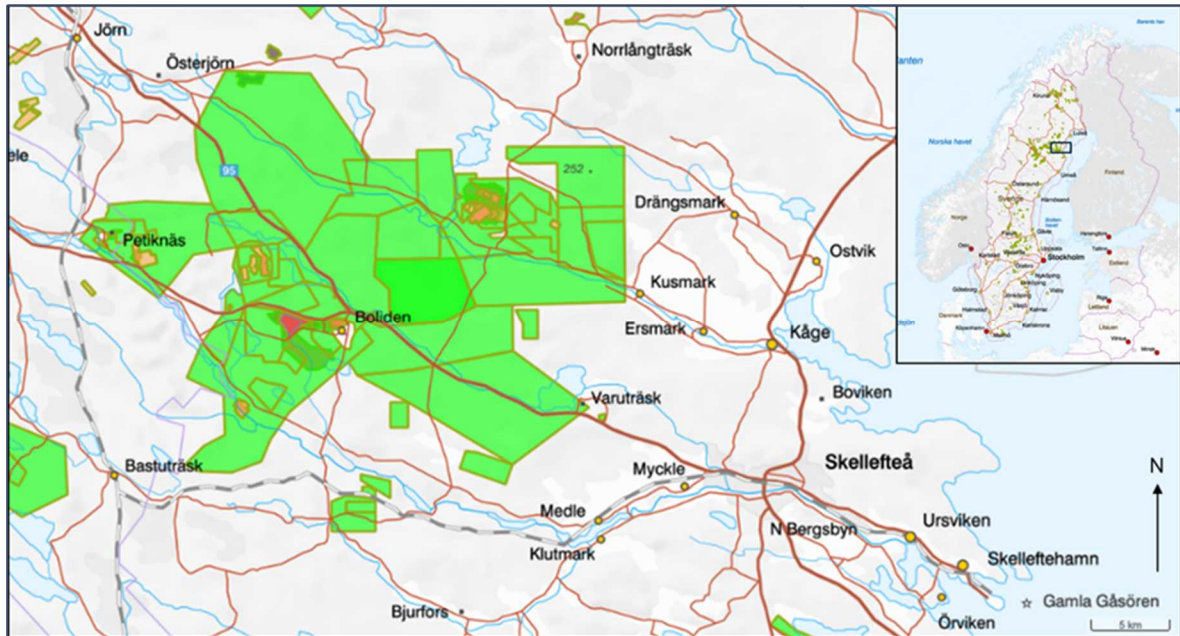


Figure 2. The location of Petiknäs in relation to Boliden and Skellefteå. Boliden owned exploration permits indicated as green polygons.

Petiknäs Norra is a massive sulphide mineralisation with values in gold, zinc, silver, copper and lead (see Table 1).

4.1 Major changes and technical studies

The Petiknäs Norra deposit is a deposit that has been studied several times without proof to be profitable. The challenge of Petiknäs Norra is its mineralogical complexity with high contents of As and Sb that result in low recoveries of payable metals and the production of “unclean” concentrates, i.e. concentrates high in penalty elements. In 2019 a new scoping study was initiated with focus on the metallurgical process together with a market analysis for the concentrates. A new model with an updated Mineral Resource estimation together with a mine plan was created. The 2019 scoping study was completed in early 2020 and the results show that regardless to process method it is not possible to reach a positive NPV for the deposit based on current long-term prices and terms (Kläre et al., 2019, internal Boliden report). The Petiknäs - Renström area is highly prospective for exploration, encouraging further studies. There is a reasonable possibility for Petiknäs Norra to become economic viable especially if some of the required process investments can be shared with other ongoing projects.

4.2 Location

The Petiknäs mine (also known as Petiknäs Södra) and Petiknäs Norra mineralization are located in Norsjö municipality in Västerbotten, approximately 20 km west of the Boliden Area mill, and some 2-3 km west of the operating Renström mine (Figure 3). The distance

between Petiknäs mine and Petiknäs Norra deposits is 800 m and the Petiknäs Norra deposit is accessed through the Petiknäs mine.



Figure 3. Location for Petiknäs mine (Petiknäsgruvan), through which the Petiknäs Norra deposit is being accessed.

4.3 History

Systematic exploration started in the Petiknäs area in 1983. Several drill programs were performed and Petiknäs Norra was intersected with the 19th hole. In 1989 ramp construction started towards Petiknäs Norra, but with the discovery of the Petiknäs Södra deposit all activities were focused there. Mining in Petiknäs commenced in 1992 and ended in 2007. In total, 5.4 Mt ore was mined in Petiknäs.

A ramp was developed from the Petiknäs mine decline to Petiknäs Norra and in 1997 test mining and processing of ca 25 000 t were performed, see Table 3.

Table 3. Tonnes and grades from test mining in Petiknäs Norra.

Tonnes	Au (g/t)	Ag (g/t)	Cu (%)	Zn (%)	Pb (%)	S (%)
24 666	3.86	64	0.70	2.09	0.34	13.60

Exploration at Petiknäs Norra recommenced in 2006, about 1 year before the Petiknäs mine was scheduled to close. An exploration drift was developed at 600 m level. Drilling, targeting the deeper parts of the mineralization, was conducted from the exploration drift and the results were evaluated in 2007. The latest Mineral Resource estimation was carried out in 2019 in conjunction with the scoping study but did not show economic viability.

4.4 Ownership and permits

Boliden has 100 % ownership of Petiknäs Norra. Boliden holds exploration permit Renström nr. 1005, which is valid until 2022-05-09 and Mining Concessions Petiknäs K nr1, valid until 2026-10-22 both are shown in Figure 4.

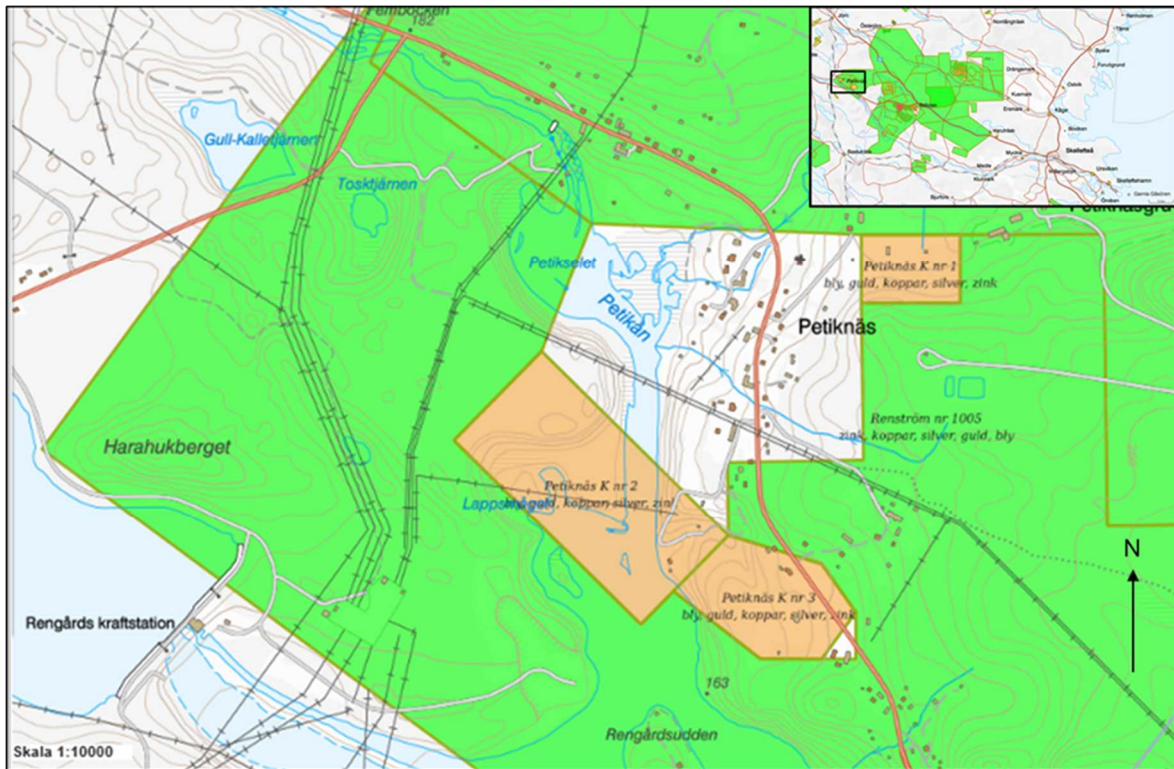


Figure 4. Boliden owned Exploration permit Renström nr 1005 and mining concession, Petiknäs K nr 1, K nr 2 and K nr 3. Petiknäs Norra covered by K nr 1.

4.5 Geology overview

The deposit is situated in the Skellefte district, Northern Sweden, which comprises rocks of the Paleoproterozoic Svecofennian of 1.87– 1.9 Ga age. The district covers an area of 120 km length and 30 km width (Figure 5) and hosts more than 85 pyritic Zn-Cu-Pb-Au-Ag massive sulfide deposits as well as epigenetic gold deposits. The region is one of the most significant and richest mining districts of Sweden and Europe and one of the gold richest massive sulphide districts in the world.

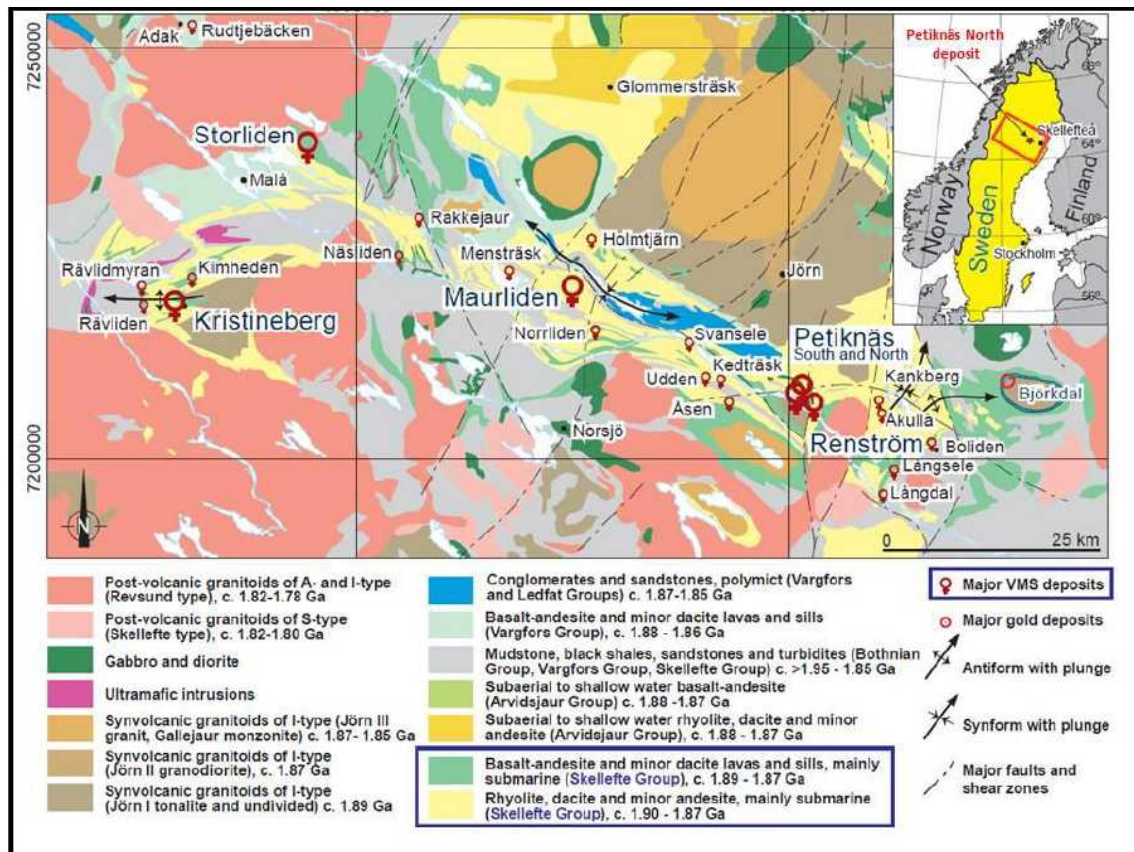


Figure 5. Geological overview of Skellefte district, modified after Allen et al. (1996) and Schlatter (2007).

4.5.1 Regional geology

The Skellefte district is a felsic dominated volcanic-magmatic area, hydrothermally and diagenetically altered. It is regionally metamorphosed, ranging from greenschist to amphibolite facies. The region is strongly deformed, characterized by tight vertical and sub vertical folds, affected by a complex system of shear zones and brittle faults. The stratigraphy is composed of a thick volcanic succession (named the Skellefte Group) overlain by sedimentary formations (named the Vargfors Group) and intruded by late granitoid intrusions.

4.5.2 Local Property Geology

The volcanic massive sulphide deposit, Petiknäs Norra, is located in the eastern part of Skellefte district (Figure 6). In the eastern part, the Petiknäs Norra structural block is separated from the Petiknäs Södra deposit by the Petiknäs Main Fault Zone (PMFZ). The PMFZ represent a large regional scale shear zone with a northeast – southwest strike direction, which dips moderately southward. The Petiknäs Norra deposit is located directly underneath this fault zone. The upper part of the deposit is truncated by this fault.

The deposit is hosted by felsic volcanic rhyolitic rocks. The stratigraphic footwall is composed of a large felsic volcanic complex, over 5 km in length, and more than 800 meters in thickness and in excess of 1 km in depth. This immediate host sequence is overlain by finer grained volcanic rocks. The hanging wall consists of mass flow breccias and black graphitic shales. The Petiknäs Norra area is intruded by barren dacite and andesite sills.

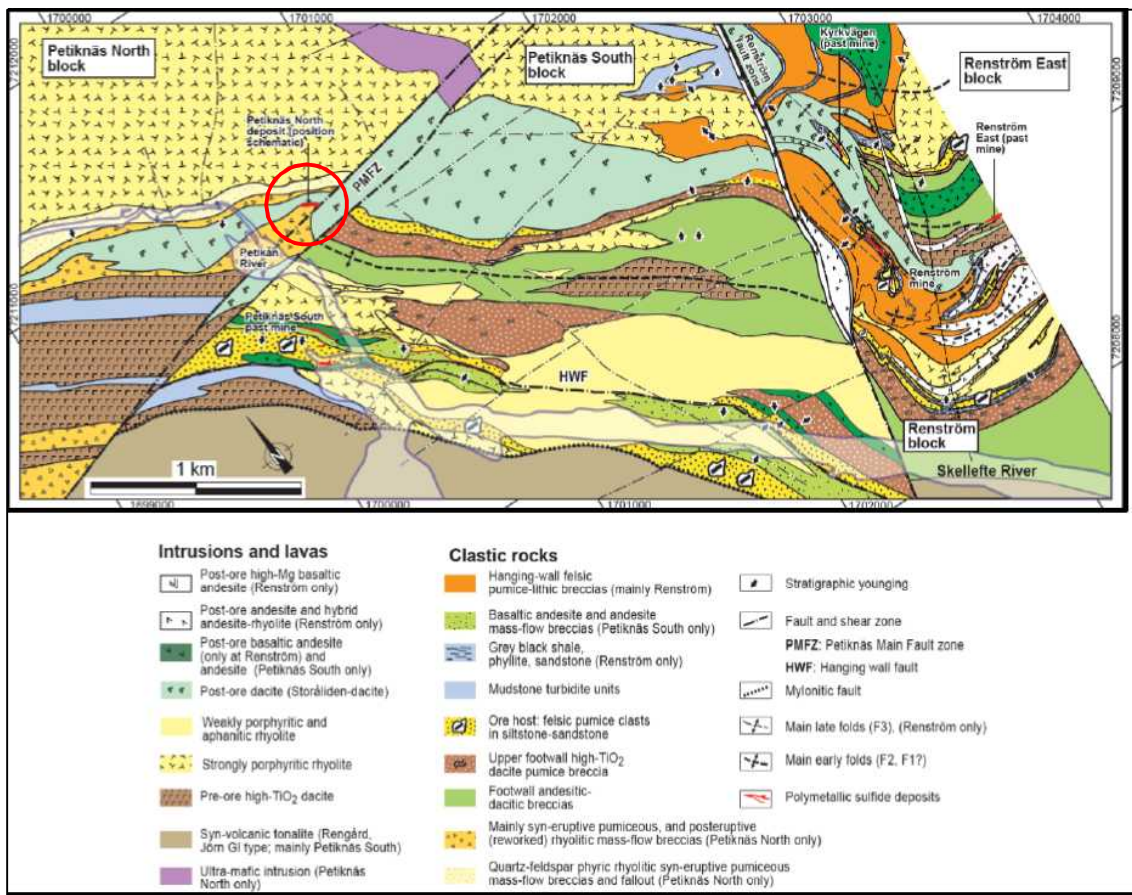


Figure 6. Geological map of Renström – Petiknäs area (modified after Allen et al. 1996, Allen & Svensson, 2004, in Schlatter, 2007). Coordinates are from the Swedish national grid coordinate system RT90. Petiknäs Norra deposit marked in red within the red circle.

4.5.3 Mineralization

The mineralization style is a sub-sea floor replacement style where venting of mineralizing fluids occurred not at the actual sea floor, but a few meters below the active sea floor. This explains the distribution of sulfide dissemination, stringers and pods throughout the host sequence. This type of volcanogenic massive sulphide (VMS) style deposits is associated with a relatively shallow water depth of a few 100 m to 1500 m, as found in active modern hydrothermal systems.

The Petiknäs Norra deposit is a 2 – 8 m thick sheet like deposit, with associated stringer mineralization below and above the ore horizon. The deposit is composed of a main A – lens, stratigraphically overlain by a secondary B – lens, occurring within a few 10's of meters from each other. The deposit has a vertical dip of 80 ° to north and a plunge of 70 ° to the east. The economic mineralization can be followed about 100 m on a north east – south west strike direction. The lenses are characterized by fine and medium-grained mineralization, dominated by pyrite with sphalerite (ZnS), chalcopyrite (CuFeS₂), pyrrhotite (FeS), arsenopyrite (FeAsS) and minor amounts of galena (PbS) and Ag-Sb-As-S minerals rich in silver and antimony (Figure 7). The deposit is very rich in gold, which mostly occur as electrum, i.e. an Au-Ag mineral. The highest gold grades are related to the copper rich parts of the ore body. The area with the highest amount of copper were found around the fault which separates the A- and B-lens.

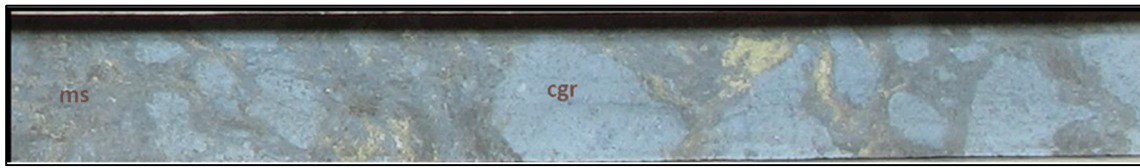


Figure 7. A 35 cm core section illustrating the Petiknäs Norra mineralization as fine-grained pyrite-sphalerite and chalcopyrite (Manuc, 2016). The mineralization is replacing the matrix between the angular to sub rounded quartz-feldspar rhyolitic porphyritic clasts within a mass flow unit. This type of mineralization typically hosts high Cu and Au grades (photo from PE202, section 379.65-380 m).

4.6 Mining methods, mineral processing and infrastructure

4.6.1 Mining methods

There is no planned mining in Petiknäs Norra and no mining assumptions were used in the Mineral Resource estimation 2019.

4.6.2 Mineral processing

There are several processing tests done in Petiknäs Norra between 1987, 2011 and 2019 but high content of arsenic and antimony causes problems in concentrate quality and low metal recovery (refractory Au in arsenopyrite). The costs for these solutions have so far been too high for economic viability.

4.6.3 Infrastructure

All infrastructure facilities are basically in place since the previous mining at the Petiknäs mine. The nearby Renström mine has been in continuous operation since the 1950's. There is a drift between Renström and the Petiknäs mine and ore from Renström can be transported to surface using the existing Petiknäs mine decline. Ore can be transported by truck approximately 25 km to the Boliden mill.

4.7 Exploration activities

Some underground exploration work in the Petiknäs area was carried out during 2021 from the drift connecting the Renström mine and Petiknäs mine. The results of that work do not change the current interpretation and results of the Petiknäs Norra Mineral Resource. No underground exploration specifically on Petiknäs Norra has been done since 2007. Intensive mine site exploration is being carried out in nearby Renström mine.

Data from diamond drill holes ordered by Boliden Mineral AB and performed by several different contractors has been used for this Mineral Resource definition.

4.8 Prices, terms and costs

Prices used for the present Mineral Resource estimation and used for the scoping study 2019 are presented in Table 4.

Table 4. Boliden long term planning prices 2019, used in the 2019 Mineral Resource estimation.

	Planning prices, 2019
Copper	USD 6600/t
Zinc	USD 2400/t
Lead	USD 2100/t
Gold	USD 1200/tr.oz
Silver	USD 17/tr.oz
USD/SEK	8.00

No strict cut-off is used for the resource estimation. It is based on the geological interpretation of the mineralization, although some low-grade parts are excluded.

4.9 Mineral Resources

The latest Mineral Resource estimation was the 2019 Petiknäs Norra Mineral Resource estimate prepared in September/October 2019. CAD-program Microstation V8i was used for the interpretation of the outline of the mineralization. Block modelling and the Mineral Resource estimation was done in Datamine Studio RM.

The project limits and coordinates were based upon the local Boliden “Petiknässystemet” (G1PSystemet).

The data used for the Mineral Resource estimation is based on information from surface and underground diamond-drill holes ordered by Boliden Mineral AB. All data are stored in a central Acquire database on a server located at the Boliden Mineral main exploration office.

Density has not been measured. Density is calculated out of the grades Cu, Zn, Pb, As and S in a polynomial formula of first grade. Density of barren rock is 2.7.

In the estimation, the following density formula was used:

$$\text{Dens} = 2.7 + 0.0043 \cdot \text{Cu} + 0.004 \cdot \text{Zn} + 0.02 \cdot \text{Pb} + 0.027 \cdot \text{As} + 0.034 \cdot \text{S}$$

The resource estimate has used an updated drillhole database as at 16 September 2019 which includes all drill hole sample assay results. The interpretation was not based on NSR values or mining assumptions. The geology and the assay results controls the interpretation of the ore and the area defined as massive to semi massive sulphides, with high amount of valuable metals was domained out (Figure 8 and 9).

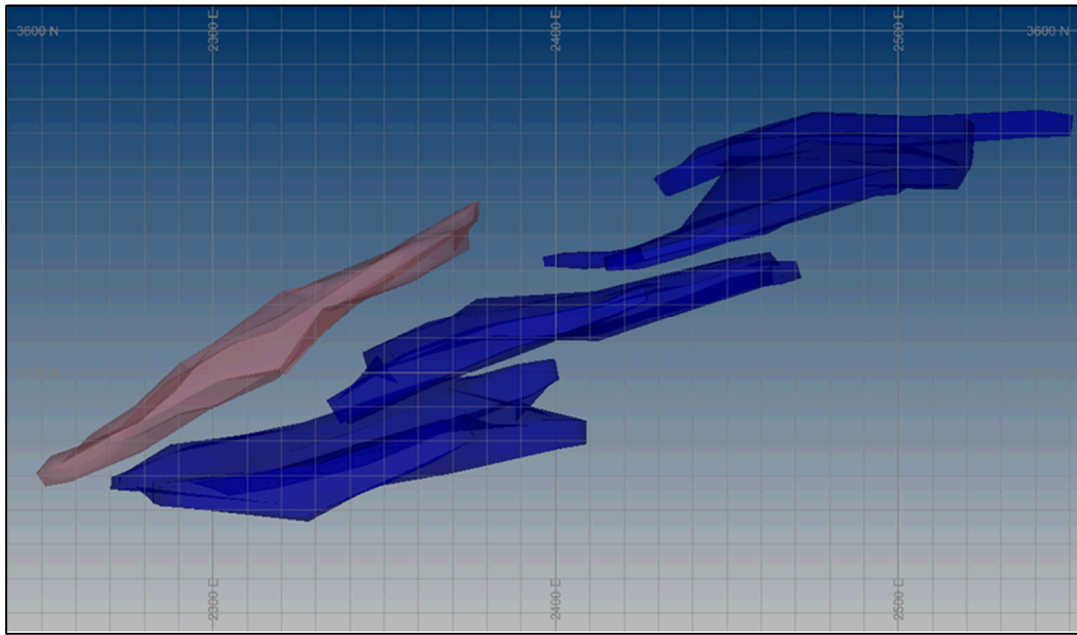


Figure 8. Top view of the 3d model in local G1P coordinate system (blue wireframe = Lens A and pink wireframe = Lens B).

There is often more than one mineralized zone per drill hole. Stringer zones are often found in the footwall, between the closely spaced lenses and in the hangingwall.

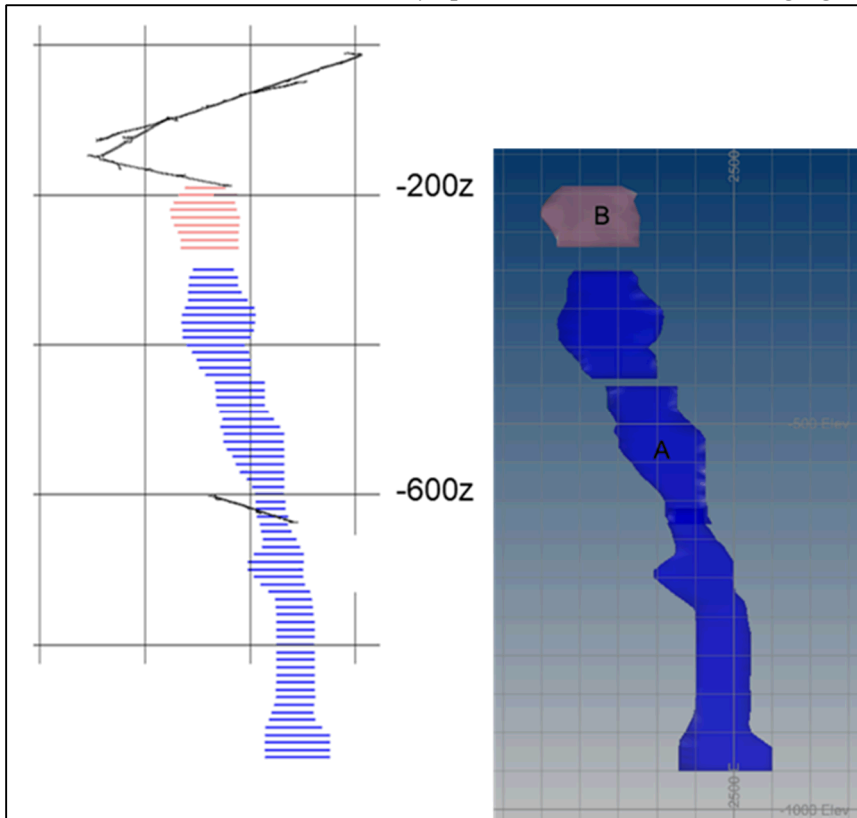


Figure 9. 2D long section view of the ore interpretation on the left (looking north, with 10 m level interpretations displayed as blue lines, and the ramp system as black lines) and 3D model to the right (blue wireframe = Lens A and pink wireframe = Lens B).

The block model utilizes a block size of 20x4x20 m, with sub-blocks down to 5x1x5 m. The block model framework parameters are presented in Table 5.

Table 5. Block model framework parameters.

	Origin	Cell size (m)
X	2200	20
Y	3400	4
Z	-100	20

To classify the resource, the following key indicators were used:

- Geological continuity/complexity
- Quality and quantity of data
- Drill hole spacing

The Petiknäs Norra deposit has been classified as containing Inferred and Indicated Mineral Resource. Required drill pattern are for Inferred Mineral Resource < 100×100 m and for Indicated Mineral Resource < 50×50 m.

Figure 10 shows the Petiknäs Norra deposit as classified block model.

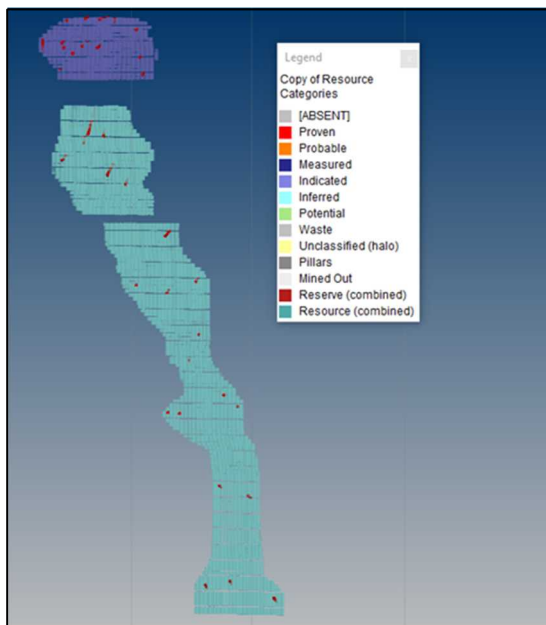


Figure 10. Long Section view of the classified Petiknäs Norra deposit 3D model, looking north (blue: Indicated; cyan: Inferred). Intersecting drill holes are marked in red.

For grade estimation inverse distance squared with a power factor of two was used.

The Petiknäs Norra Mineral Resource as of December 31, 2021 are given in Table 7. No changes since December 31, 2020.

Table 7. Mineral Resources for Petiknäs Norra as of 2021-12-31, figures are presented without dilution.

Mineral resource classification	Kton	Au (g/t)	Ag (g/t)	Cu (%)	Zn (%)	Pb (%)	As (%)	S (%)	Sb (g/t)
Indicated	356	8.1	72	1.6	2.8	0.3	8.3	21	1422
Inferred	1710	4.4	54	0.9	2.1	0.3	3.5	14	978

4.10 Mineral Reserves

There is no Mineral Reserve defined in Petiknäs Norra.

4.11 Comparison with previous estimation

No Mineral Resource estimation update has been conducted during 2021 or 2020. The latest model update was made in 2019. The latest estimation prior to 2019 was made in 2007 after the last drill campaign. The documentation on the resource estimation from 2007 was poor and thus the classification was downgraded in 2018, although the total figures stayed the same. Results from the previous Mineral Resource Estimation from 2007 with adjusted figures after the downgrade in 2018 is presented in Table 8. Table 9 lists the results from the three Mineral Resource estimations that have been conducted on Petiknäs Norra since test mining in 1997.

Table 8. Mineral Resources for Petiknäs Norra as of 2018-12-31. Figures include 15 % waste dilution.

Mineral Resource Classification	kton	Au (g/t)	2018 Ag (g/t)	Cu (%)	Zn (%)	Pb (%)	kton	Au (g/t)	2007 Ag (g/t)	Cu (%)	Zn (%)	Pb (%)	Comments
Measured							310	8.1	73	1.8	3.1	0.3	
Indicated	310	8.1	73	1.8	3.1	0.3	1 200	2.7	52	0.6	1.8	0.3	Measured downgraded to indicated
Sum M and I	310	8.1	73	1.8	3.1	0.3	1 510	3.8	56	0.8	2.1	0.3	
Inferred	1 920	2.9	45	0.5	1.6	0.2	720	3.3	33	0.5	1.2	0.2	Indicated downgraded to inferred

Table 9. Comparison between estimations from 1999, 2007 and 2019 total tonnes and grades for all resource classes.

Mineral Resource Classification	kton	Au (g/t)	Ag (g/t)	Cu (%)	Zn (%)	Pb (%)	As (%)	S (%)	Sb (g/t)	Dilution (%)
1999	2668	4.0	52	1.5	2.8	0.2	4.7	14	1760	15 - 20
2007	2230	3.7	49	0.7	1.8	0.2	2.6	11	1000	15
2019	2066	5.0	57	1.0	2.2	0.3	4.3	15	1054	0

5 REFERENCES

5.1 Public references

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5.2 Boliden Internal references

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