

Boliden Summary Report

Resources and Reserves | 2019

Petiknäs Norra



Prepared by
Lina Åberg

Table of contents

1	Summary	3
2	Competence	3
3	General introduction	3
3.1	Pan-European Standard for Reporting of Exploration Results, Mineral Resources and Mineral Reserves – The PERC Reporting Standard	4
3.2	Definitions	4
3.2.1	Mineral Resource	4
3.2.2	Mineral Reserve	5
4	Petiknäs Norra	6
4.1	Major changes and technical studies	6
4.2	Location	6
4.3	History	7
4.4	Ownership and permits	7
4.5	Geology overview	8
4.5.1	Regional geology	9
4.5.2	Local Property Geology	9
4.5.3	Mineralization	10
4.6	Mining methods, mineral processing and infrastructure	11
4.6.1	Mining methods	11
4.6.2	Mineral processing	11
4.6.3	Infrastructure	11
4.7	Prices, terms and costs	11
4.8	Mineral resources	12
4.9	Mineral reservers	15
4.10	Comparison with previous estimation	15
5	References	16

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 made to the mineralisation and ca 25 000 ton were test mined in 1997. In 2007 a Scooping Study and a Mineral Resource estimation was made on Petiknäs Norra. The study could not present a processing method that was economically viable. No studies has been conducted on Petiknäs Norra since 2007. In august 2019 a new scoping study was initiated with the main focus on the metallurgical process. However, the mineral resource estimation and mine plan needed to be updated together with an updated market analysis for the various concentrates that may be produced. The 2019 Mineral Resources figures are presented in Table 1.

Table 1. Petiknäs Norra Mineral Resources estimate 2019.

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 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	Lina Åberg	Hans Årebäck
Geology	Roger Nordin	Hans Årebäck
Resource Estimations	Lina Åberg	Hans Årebäck

Hans Årebäck works for Boliden as a Senior Project Manager at Business Development and is a member FAMMP¹. Hans Årebäck has over 20 years of experience in the Exploration and Mining industry.

Gunnar Agmalm is Boliden's Ore reserves and Project Evaluation manager and a member of AusIMM² and FAMMP¹

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

¹ Fennoscandian Association for Metals and Minerals Professionals

² Australian Institute of Mining and Metallurgy

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.

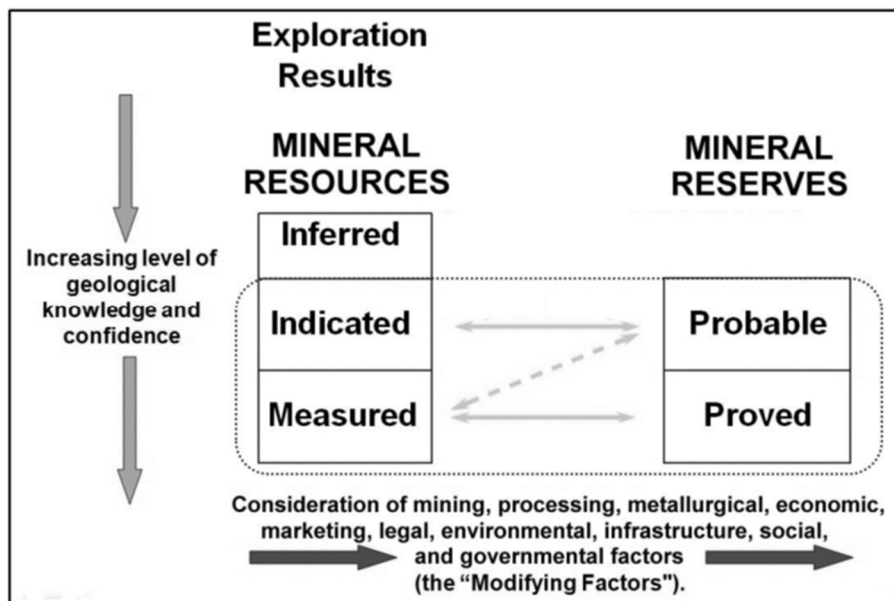


Figure 1. General relationship between Exploration Results, Mineral Resources and Mineral Reserves (PERC 2017).

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 mineralisation 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).

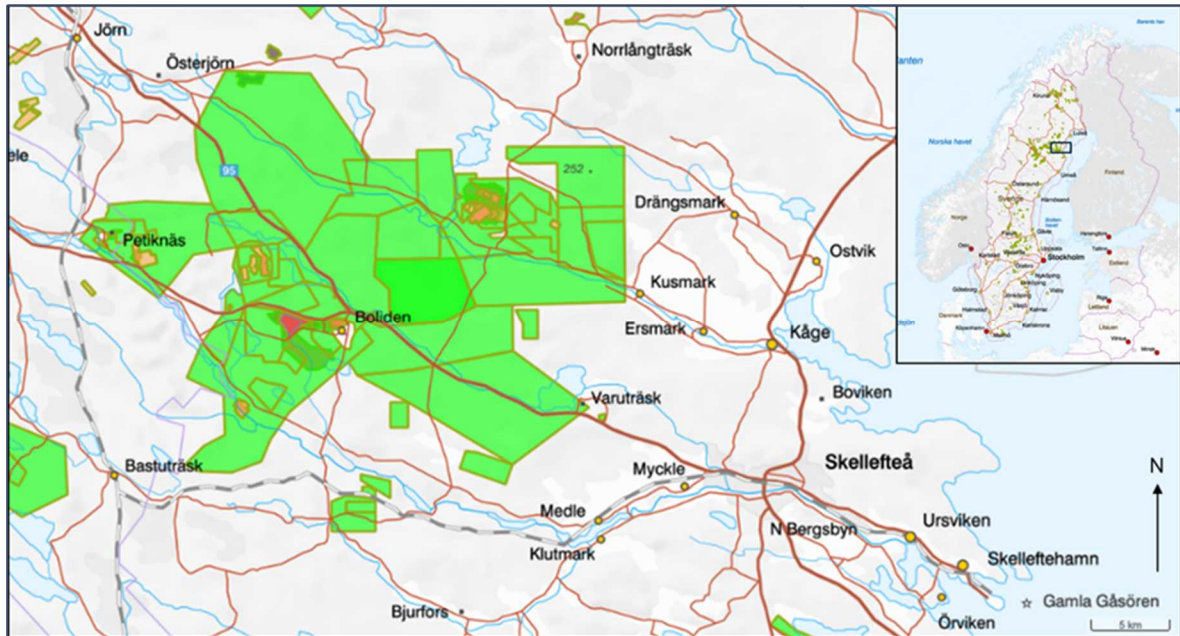


Figure 2. The location of Petiknäs in relation to Boliden. Boliden owned exploration permits indicated as green polygons.

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 before, but has not previously proved to be profitable. In 2019 a new scoping study was initiated with the main focus on the metallurgical process. However, the mineral resource estimation and mine plan needed to be updated together with an updated market analysis for the various concentrates that may be produced. The 2019 Scoping study is ongoing.

4.2 Location

The Petiknäs mine and Petiknäs Norra mineralisation 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 (Figure3). The distance between Petiknäs (Södra) and Petiknäs Norra deposits is 800 m.



4.3 History

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

A ramp was made from Petiknäs to Petiknäs Norra and in 1997 test mining, at 200 m level and processing of ca 25 000 t was made, 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 (%)
24666	3.86	64	0.70	2.09	0.34	13.60

Exploration at Petiknäs Norra re-commenced in 2006, about 1 year before the Petiknäs Södra mine was scheduled to close. An exploration drift was made at 600 m level. Drilling targeting the deeper parts was made from this level and the results were evaluated in 2007. A new Mineral Resource estimation was made but the Scoping Study 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.

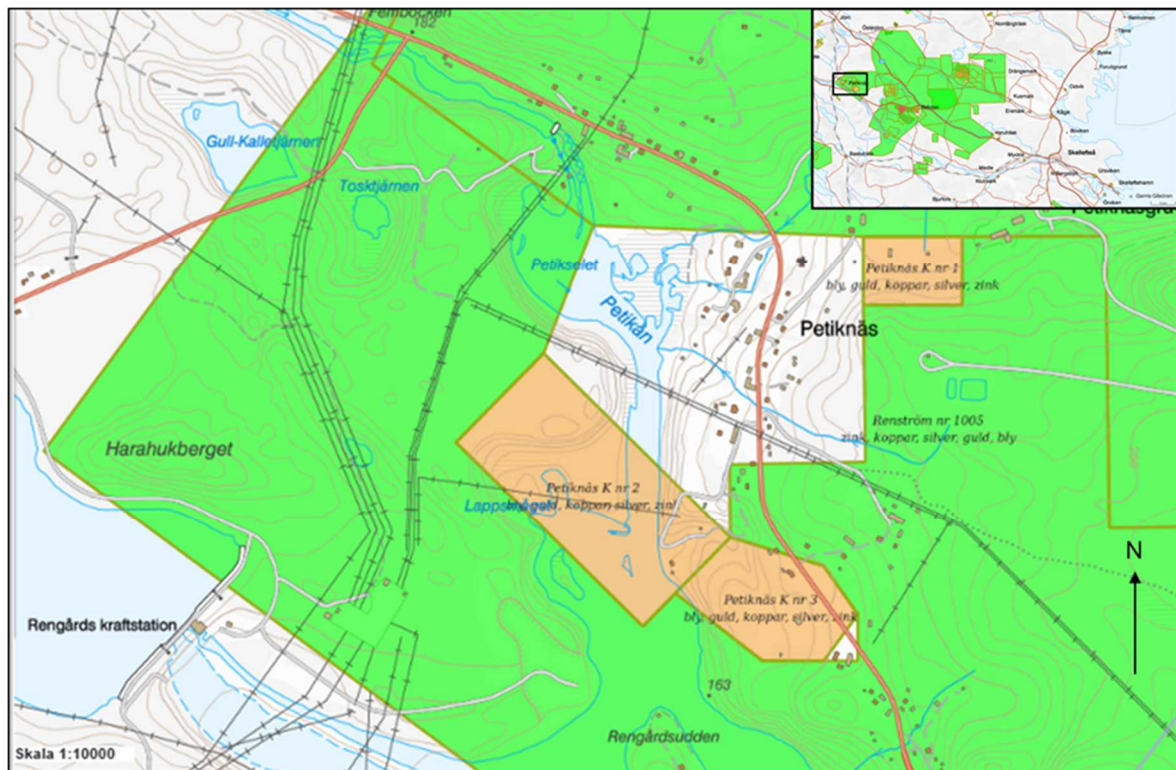


Figure 4. Boliden owned Exploration permit Renström nr 1005 and mining concession, Petiknäs K nr 1, K nr 2 and K nr 3. Petiknäs Norra covered by K nr 1.

4.5 Geology overview

The Paleoproterozoic Svecofennian, 1.87– 1.9 Ga, Skellefte field is situated in, Northern Sweden, covering an area of 120 km length and 30 km wide (Figure 5). The region hosts more than 85 pyritic Zn-Cu-Pb-Au-Ag massive sulfide deposits and also epigenetic gold deposits, being one of the most significant and richest mining districts within Sweden and Europe. The Skellefte field is one of the gold richest massive sulphide districts in the world.

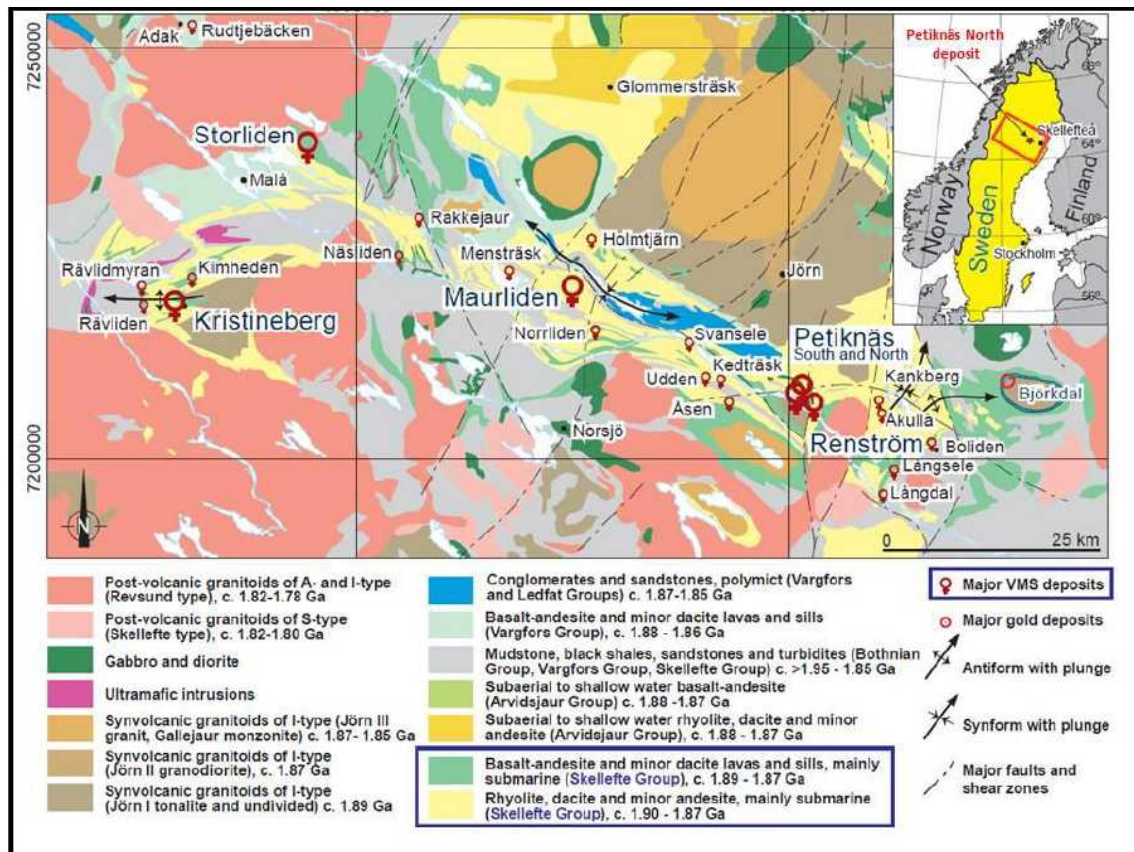


Figure 5. Geological overview of Skellefte district, modified after Allen et al. (1996) and Schlatter (2007).

4.5.1 Regional geology

The Skellefte field is a felsic dominated volcanic-magmatic area, hydrothermally and diagenetically altered. It is regionally metamorphosed, ranging from greenschist to amphibolite facies. From a structural point of view, 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 North, is located in the eastern part of Skellefte district (Figure 6). In the eastern part, the Petiknäs North structural block is separated from the Petiknäs South deposit by 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 North 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 North area is intruded by barren dacite and andesite sills.

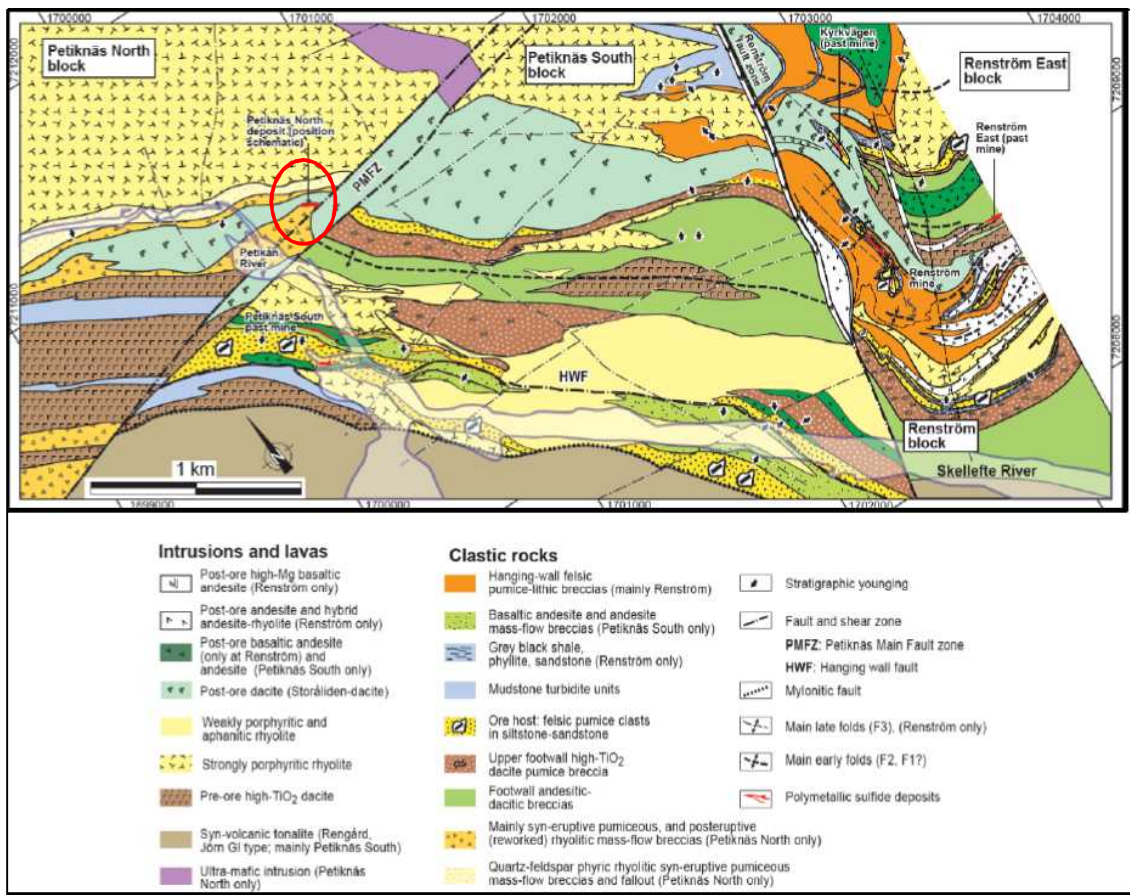


Figure 6. Geological map of Renström – Petiknäs area (modified after Allen et al. 1996, Allen & Svensson, 2004, in Schlatter, 2007). Coordinates are from the Swedish national grid coordinate system RT90.

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 how the distribution of sulfide dissemination, stringers and pods throughout the host sequence. This type of volcanogenic massive sulphide (VMS) style deposits are associated with a relatively shallow water depth, a few hundred to 1500 meter water depth in active modern hydrothermal systems.

The Petiknäs North 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 two A and B lenses.

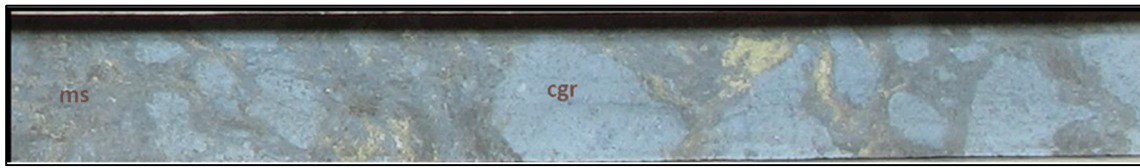


Figure 7. A 35 cm core section illustrating the Petiknäs Norra mineralization as fine-grained pyrite-sphalerite and chalcopyrite (Manuc, 2016). The mineralization is replacing the matrix between the angular to sub rounded quartz-feldspar rhyolitic porphyritic clasts within a mass flow unit. This type 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 was used in the Mineral Resource estimation 2019. Different mining methods are investigated in the ongoing Scoping study.

4.6.2 Mineral processing

There are several processing tests done in Petiknäs Norra between 1987 and 2011 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. The main focus for the ongoing Scoping Study is, once again, the metallurgical challenges.

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 Petiknäs and ore from Renström can be transported to surface using the existing Petiknäs ramp. Ore can be transported by truck approximately 25 km to the Boliden mill.

4.7 Exploration activities

No exploration work is currently being carried out underground in the Petiknäs area and no underground exploration has been done on Petiknäs Norra 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 ongoing Scoping Study 2019 are presented in Table 4.

Table 4. Boliden long term planning prices 2019.

	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 2019 Petiknäs Norra Mineral Resource estimate was 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).

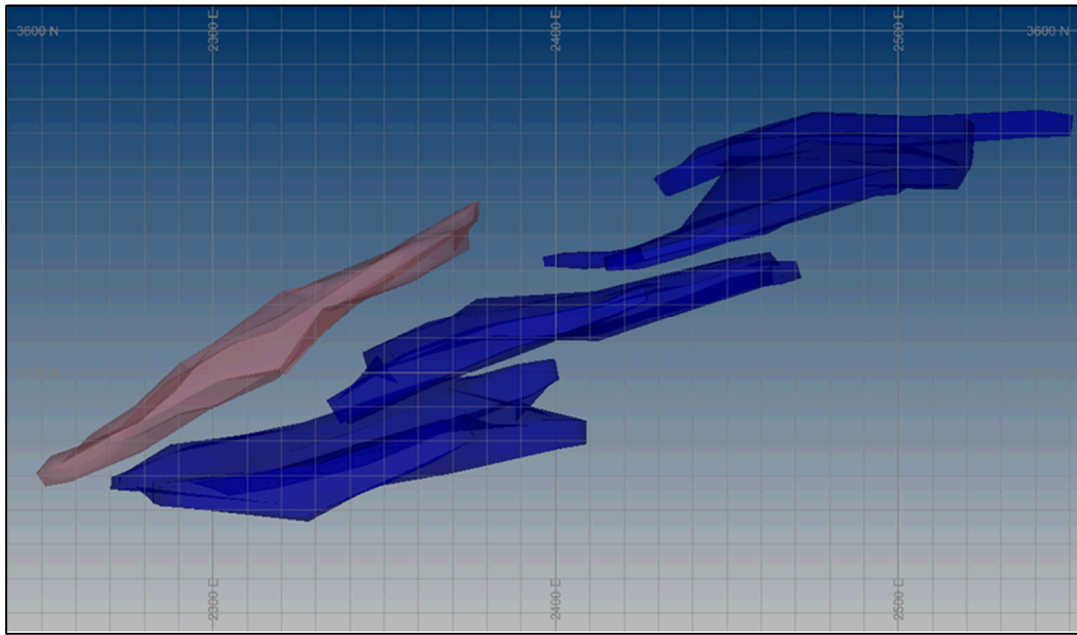


Figure 8. Top view of the 3d model in local G1P coordinate system (blue wireframe = Lens A and pink wireframe = Lens B).

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

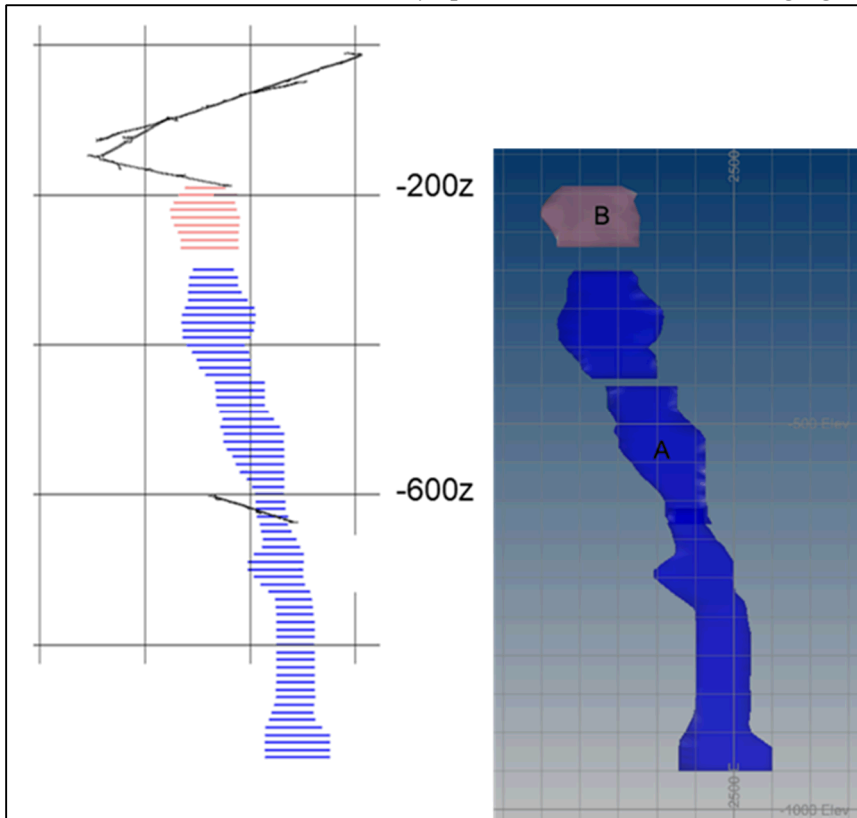


Figure 9. 2D long section view of the ore interpretation on the left (looking north, with 10 m level interpretations displayed as blue lines, and the ramp system as black lines) and 3D model to the right (blue wireframe = Lens A and pink wireframe = Lens B).

The blockmodel utilizes a block size of 20x4x20 m, with sub-blocks down to 5x1x5m. The block model framework parameters are presented in Table 5.

Table 5. Block model framework parameters.

	Origin	Cell size
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 deposit as classified block model.

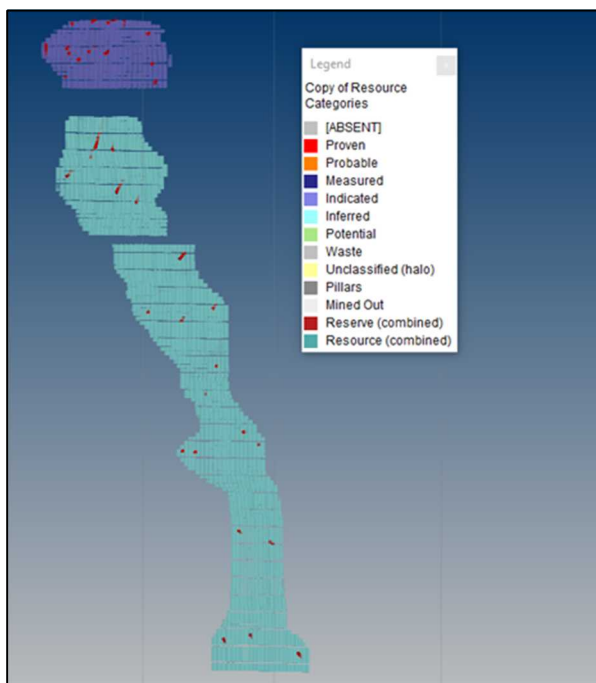


Figure 10. Long Section view of the classified Petiknäs North deposit 3D model, looking north (blue: Indicated; cyan: Inferred). Intersecting drill holes are marked in red.

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

The Petiknäs Norra Mineral Resource as of December 31, 2019 are given in Table 7.

Table 7. Mineral Resources for Petiknäs Norra as of 2019-12-31, figures are presented without dilution.

Mineral resource classification	Kton	Au_ppm	Ag_ppm	Cu_pct	Zn_pct	Pb_pct	As_pct	S_pct	Sb_ppm
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

The previous Mineral Resource estimation 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 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 6. 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

Allen R. et al. (1996) "Setting of Zn-Cu-Au-Ag massive sulphide deposits in the evolution and facies architecture of a 1.9 Ga marine volcanic arc, Skellefte District, Sweden." *Economic Geology* 91: 1022-1053.

Allen R. & Svensson S-Å (2004) "1.9 Ga volcanic stratigraphy, structure and Zn-Pb-Cu-Au-Ag massive sulphide deposits of the Renström area, Skellefte District, Sweden, In: Allen R. Martinsson O., Weihed P. (eds) *Svecofennian ore-forming environments. Volcanic-associated Zn-Cu-Au-Ag, intrusion-associated Cu-Au, sediment-hosted Pb-Zn, and magnetite-apatite deposits of Northern Sweden*, Guidebook Series, v. 33 pp 65-88.

Manuc G. (2016) "Alteration in the Petiknäs North footwall rocks, ore horizon and hanging wall rocks, Västerbotten, Sweden". University of Bucharest, Faculty of Geology and Geophysics, Master program, *Evaluation of Sedimentary Basins and Mineral resources*.

Schlatter D.M. (2007) "Volcanic Stratigraphy and Hydrothermal Alteration of the Petiknäs South Zn-Pb-Cu-Au-Ag volcanic hosted massive sulfide deposit, Sweden." Ph.D. Thesis, Luleå Uni. Of Technology. LTU-DT: 0736. 208 pp.

Pan-European Standard for reporting of Exploration results, Mineral Resources and Mineral Reserves (The PERC Reporting standard 2017). www.percstandard.eu