Boliden Summary Report

Mineral Resources and Mineral Reserves | 2023

Garpenberg

Prepared by
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1 SUMMARY

In 2023 the total Mineral Reserves in Garpenberg decreased by 8.4 Mt (million metric tonnes) to 100.9 Mt. Measured and Indicated Resources in Garpenberg remained unchanged at 21.6 Mt. Inferred Resources slightly increased by 0.5 Mt to 67.9 Mt.

Table 1-1. Mineral Resources and Mineral Reserves in Garpenberg 2023-12-31.

	2023						2022					
	kton	**Au**	**Ag**	**Cu**	**Zn**	**Pb**	kton	Au	Ag	Cu	Zn	Pb
Classification		**(g/t)**	**(g/t)**	**(%)**	**(%)**	**(%)**		(g/t)	(g/t)	(%)	(%)	(%)
Mineral Reserves												
Proved	**17 200**	**0.25**	**98**	**0.04**	**3.0**	**1.3**	18 658	0.24	97	0.04	3.1	1.32
Probable	**83 700**	**0.31**	**88**	**0.05**	**2.5**	**1.2**	90 640	0.30	85	0.04	2.5	1.14
Total	***100 900***	*0.3*	*90*	*0.04*	*2.6*	*1.2*	*109 298*	*0.29*	*87*	*0.04*	*2.6*	*1.17*
Mineral Resourcess												
Measured	**100**	**0.24**	**108**	**0.03**	**2.8**	**1.0**	68	0.24	108	0.03	2.8	1.04
Indicated	**21 600**	**0.41**	**70**	**0.06**	**2.7**	**1.3**	21 556	0.41	70	0.06	2.7	1.32
Total M&I	***21 600***	*0.41*	***70***	***0.06***	***2.7***	***1.3***	*21 624*	*0.41*	*70*	*0.06*	*2.7*	*1.32*
Inferred	**67 900**	**0.34**	**57**	**0.05**	**2.3**	**1.1**	67 413	0.34	57	0.05	2.3	1.10

Notes on Mineral Resource and Mineral Reserve statement.

- Mineral Resources are reported exclusive of Mineral Reserves.
- Mineral Resources and Mineral Reserves are a summary of Resource estimations and studies made over time adjusted to mining situation of December 31.
- Mineral Resources are reported without dilution.
- All resources produced since 2020 have undergone a Reasonable Prospect of Eventual Economic Extraction (RPEEE) evaluation using Deswik Stope Optimizer.
- The Mineral Reserves are representative of the current Life of Mine Plan (LOMP).
- Cut-offs used to define Mineral Reserves are based on operational costs, as are the cut-offs used to define Mineral Resources even if they are simplified. Costs and cut-offs are presented in chapter 3.11-3.13.
- Tonnes and grades are rounded which may result in apparent summation differences between tonnes, grade and contained metal content.

1.1 Competence

Multiple participants have been involved and contributed to this summary report. Roles and responsibilities are listed in Table 1-2.

Table 1-2. Contributors and responsible competent persons for this report.

Description	**Contributors**	**Responsible CP**
Compilation of this report	Morvan Derrien	Sofia Höglund
Geology	Morvan Derrien	Sofia Höglund
Mineral Resources	Sofia Höglund	Sofia Höglund
Mining and Mineral Reserves	Markus Malmberg	Sofia Höglund
Mineral Processing	Tomas Persson	Anders Sand
Environmental and legal permits	Lotta Tanse	Nils Eriksson

The report has been verified and approved by Sofia Höglund who is employed by Boliden as a Senior Resource Geologist and is a member of FAMMP[1]. Sofia Höglund has 15 years of experience in the Exploration and Mining Industry.

Nils Eriksson works for Boliden as Head of Department for Permitting and Environmental support. Nils Eriksson is a member of FAMMP and has more than 25 years of experience from the Mining Industry.

Anders Sand works as Research Manager of Boliden Mines, with expertise particularly in mineral processing. Anders Sand is a member of FAMMP and has more than 15 years experience in the mining industry. He also holds appointments as docent and associate professor in mineral processing at Luleå University of Technology since 2017.

[1] Fennoscandian Association for Metals and Minerals Professionals

2 GENERAL INTRODUCTION

This report is issued annually to inform the public (shareholders and potential investors) of the mineral assets in Garpenberg held by Boliden. The report is a summary of internal / Competent Persons' Reports for Garpenberg. Boliden method of reporting Mineral Resources and Mineral Reserves intends to comply with the Pan-European Reserves and Resources Reporting Committee (PERC) "PERC Reporting Standard 2021".

The PERC Reporting Standard 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.

Boliden is reporting Mineral Resources exclusive of Mineral Reserves.

2.1 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. 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.

2.2 Definitions

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

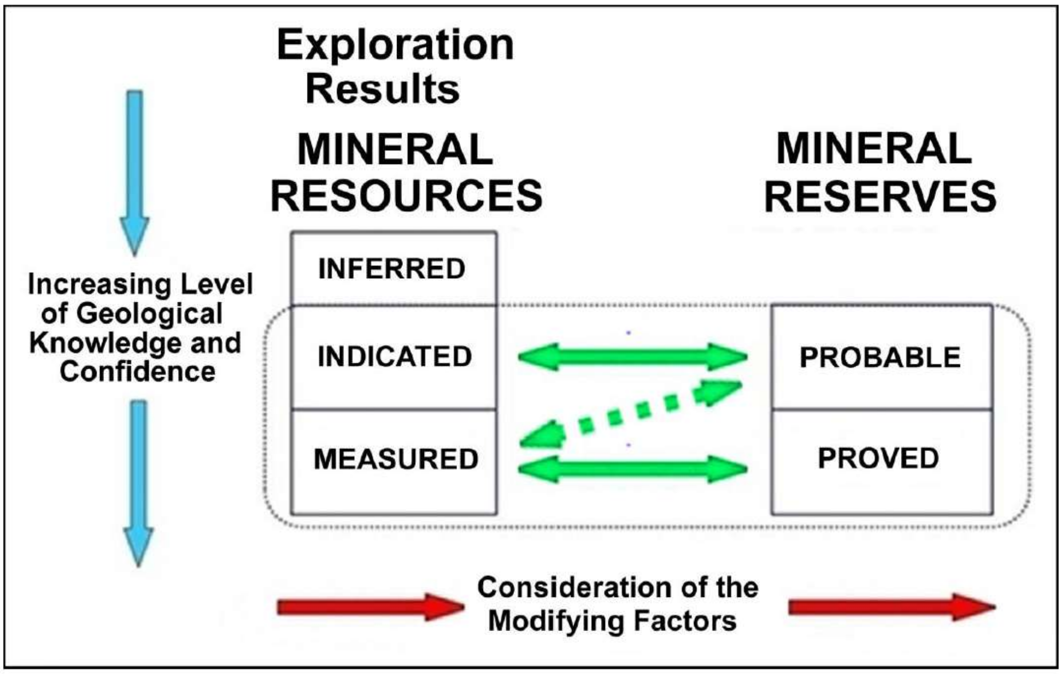

Figure 2-1. General relationship between Exploration Results, Mineral Resources and Mineral Reserves (PERC 2021).

2.2.1 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. The location, quantity, grade or quality, continuity and other geological characteristics of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge, including sampling.

2.2.2 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.

3 GARPENBERG

3.1 Project Outline

Garpenberg is a Zn-Pb-Ag-(Cu-Au) underground mine where the ore is mined from between 450 metres to more than 1 400 metres below surface. The mine encompasses several polymetallic ore bodies. See Figure 3-5 and Figure 3-6.

The mined out ore tonnage in 2023 totaled 3151 Kton. More than 75% of the mined tonnage derived from the largest ore body, Lappberget.

Zinc and silver are the most valuable commodities in Garpenberg. Zinc and silver both accounted for about 36% of the revenue followed by lead at 16% and copper-gold at 12%.

3.2 Major changes 2023

In 2023 the total Mineral Reserves in Garpenberg decreased by 8.4 Mt (million metric tonnes) to 100.9 Mt. Measured and Indicated Resources in Garpenberg remained unchanged at 21.6 Mt. Inferred Resources slightly increased by 0.5 Mt to 67.9 Mt.

3.2.1 Technical studies

In 2023, grindability and beneficiation studies (flotation and gravimetry) related to Lappberget 1530-1650z were finalized and reported.
Some technical studies were also completed regarding the implementation of the Whittle mine optimization for Dammsjön Etage 1100 and 1300 and Lappberget Etage 1250.

3.3 Location

The Garpenberg operation is located in the Hedemora municipality in central Sweden 180 km NW of Stockholm at coordinates (WGS84) latitude 60° 19’ 27”N, longitude 16° 13’ 38”. Figure 3-1 and Figure 3-2 show the geographic location and the surface right concessions of Garpenberg.

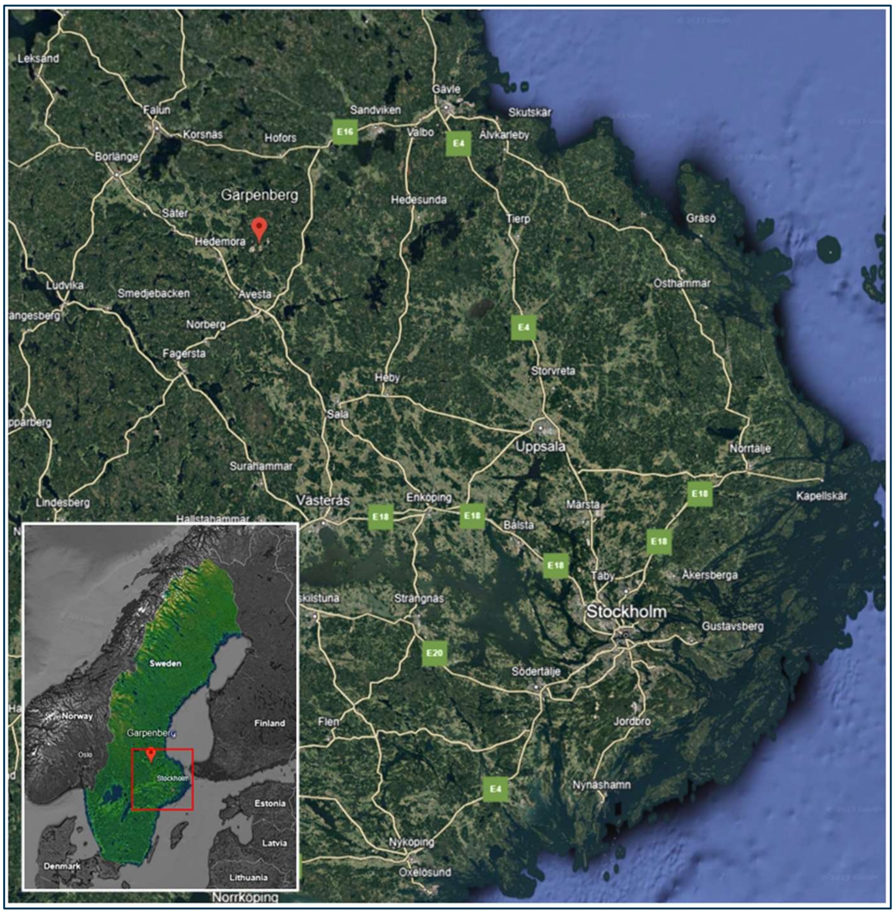

Figure 3-1. Map showing the location of the town of Garpenberg in relation to the city of Stockholm and within the country of Sweden.

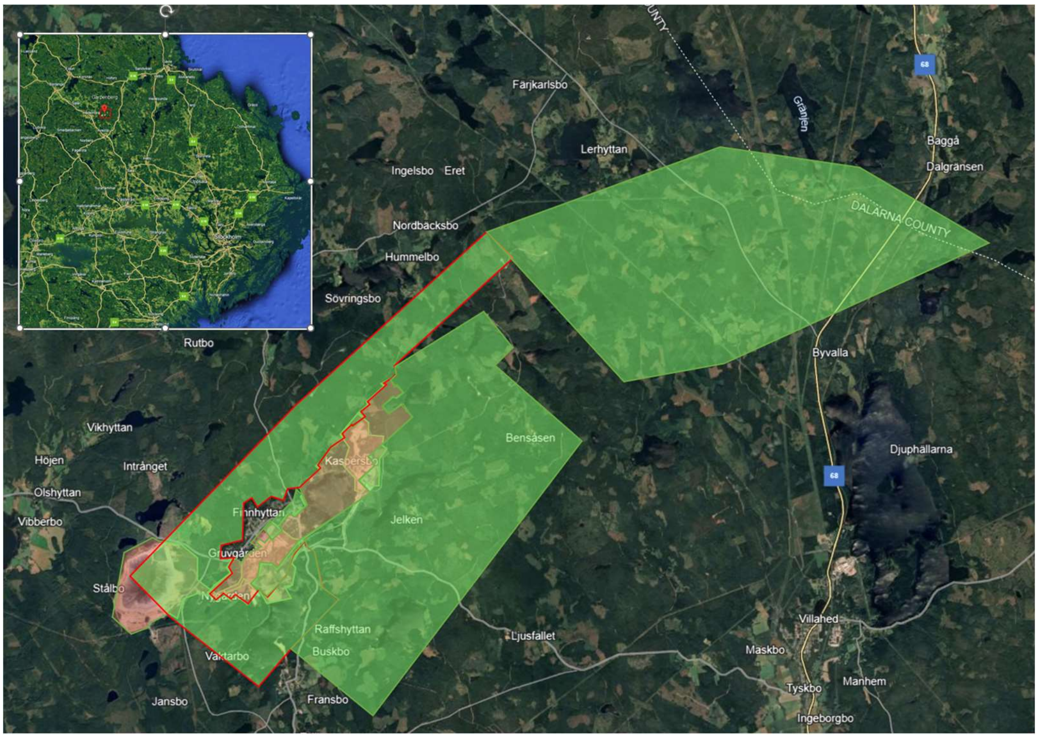

Figure 3-2. Detailed map of Boliden's Garpenberg exploration, exploitation, and surface rights concessions (i.e. green, orange, and red, respectively) in relation to the town of Garpenberg and the city of Stockholm.

3.4 History

Historical documents show that systematic mining has been conducted in Garpenberg since the 13th century. A recent study from lake sediments published in 2017, however, push back the evidence for early ore mining in Garpenberg even further, from the Middle Ages to the pre-Roman Iron Age around 400 BC (Bindler et al. 2017). The Garpenberg mine has been run by multiple companies over the years. In 1957 Boliden acquired the Garpenberg mine from AB Zinkgruvor. A total of 66.5 Mt of ore has been processed since Boliden took over the operations (Table 3-1).

A chronological list of historically significant events is presented in appendix 1.

Table 3-1. Annual production numbers 1957-2023. Between 1957 and 1995 the processed ore tonnes and grades are presented with 5-year intervals, while figures for mined ore are missing. From 2005 to 2014, ore from the Lovisagruvan mine was also processed in Garpenberg. A total of 63.4 Mt of ore has been processed since Boliden acquired the mine from AB Zinkgruvor in 1957.

Year	Mined Ore	Processed Ore	Grades				Lovisa
	Kton	Kton	Au g/t	Ag g/t	Zn %	Pb %	Kton
1957		260	1.2	69	2.84	2.34	
1960		306	0.7	81	4.3	3.0	
1965		297	0.9	116	4.9	3.3	
1970		307	0.9	110	4.2	2.7	
1975		349	0.6	114	3.2	1.9	
1980		427	0.5	112	3.0	1.8	
1985		534	0.4	138	3.0	1.9	
1990		747	0.5	135	3.6	2.0	
1995		750	0.4	133	4.3	2.2	
2000	1003	976	0.5	141	3.9	1.9	
2001	1018	984	0.4	136	3.9	1.8	
2002	997	1058	0.4	153	4.0	1.8	
2003	1067	1062	0.4	151	4.6	1.9	
2004	1087	1074	0.3	124	5.6	2.2	
2005	1115	1102	0.3	117	5.8	2.3	13.3
2006	1167	1182	0.4	123	5.7	2.2	17.1
2007	1218	1255	0.3	126	6.3	2.5	17.1
2008	1341	1365	0.3	130	6.9	2.6	27.7
2009	1425	1394	0.3	139	7.3	2.8	31.7
2010	1369	1443	0.3	133	6.6	2.5	28.9

2011	1441	1456	0.3	134	6.1	2.4	37.5
2012	1602	1484	0.27	130	5.6	2.1	39.0
2013	1600	1495	0.3	153	5.2	2.1	39.8
2014	1891	2224	0.31	136	5.1	2.1	38.7
2015	2304	2367	0.32	156	5.0	2.1	
2016	2610	2622	0.31	150	4.4	1.8	
2017	2630	2634	0.30	134	4.3	1.8	
2018	2625	2622	0.29	135	4.1	1.6	
2019	2865	2861	0.26	118	4.1	1.5	
2020	3000	3000	0.31	109	3.8	1.5	
2021	3052	3056	0.30	119	3.8	1.5	
2022	3041	2989	0.26	117	3.6	1.4	
2023	3144	3151	0.37	97	3.3	1.4	

Mineral Resources for new ore bodies are defined by the exploration department by drilling the mineralized rock body in a 50 x 50 m grid, aiming to produce an Inferred or Indicated Resource. This is typically followed up by denser drilling carried out by the mine department resulting in a Measured Resource and eventually a Mineral Reserve. More on Mineral Resources and Mineral Reserves in chapters 3.12 and 3.13, respectively.

The Mineral Reserve estimates are constantly being revised against the metal grades of the actual mined tonnage through the reconciliation process, see chapter 3.15.

3.5 Ownership

Boliden Mineral AB owns 100 % of the Garpenberg mine.

3.6 Environmental, Social and Governance (ESG)

3.6.1 Existing permits

Boliden is the owner of all land where the mining operations are currently developed. Boliden has renewed mining concessions valid from 2023-03-23, covering all the concessions K nr 1 – 10 for zinc, lead, silver, copper, gold minerals. The concessions will be automatically renewed for as long as the mine is operating. See Figure 3-3 for the location of the concessions K nr 1-10.

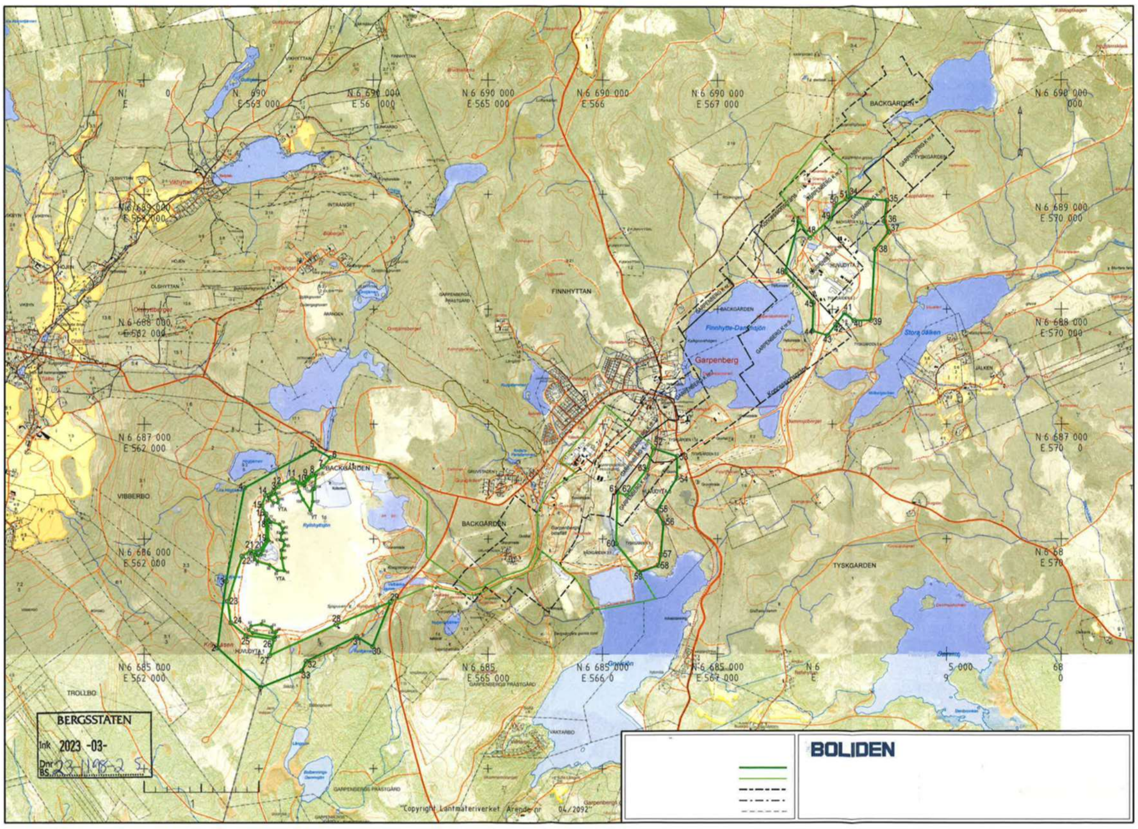

Figure 3-3. Concessions K 1 -10 in Garpenberg.

Boliden has the necessary environmental permits in place to operate the mine. The main permit, in accordance with the Swedish Environmental Act, was issued by the Swedish Environmental Court in 2012 (M461-11 2012-01-31) and the final discharge limits to water were set in 2016 (M461-11 2016-04-15). In 2018, Boliden applied for some changes in the permit which were approved in December 2018 (M467-18, 2018-12-20). These changes in the permit allow Boliden to deposit waste-rock according to life-of-mine plan.

In 2021, Boliden got a new extension permit (M7041-20, 21-06-15) for extracting and processing up to 3.5 Mtpa of ore in Garpenberg, without changing anything else in the conditions of the environmental permit. The only supplement in the permit is a discharge limit for uranium to water.

The permit allows Boliden to operate the mine as described in the application and in particular to (chapter 9 Environmental Act):

- extract and process up to 3.5 Mtpa of ore in Garpenberg,
- deposit tailings in the Ryllshyttan tailings management facility (TMF) and backfill the mine.

In addition, the permit allows Boliden to (chapter 11 Environmental Act):

- raise the dams at Ryllshyttan TMF to the level of +256m with the maximum water level of +254 m and to construct a new outlet,
- extend the waste-rock dumps,
- set the financial guarantee for closure to 490 MSek,
- raise the water level in the clarification pond to the level of +227.9 m,

- extract mine water, and
- extract up to 1.9 Mm3/yr fresh water from the lakes Gruvsjön and Finnhytte-Dammsjön, of which a maximum of 0.95 Mm3 from Finnhytte-Dammsjön.

The permit is associated with a series of conditions and limit values regarding e.g., discharge water quality and noise levels in neighboring houses.

In 2023, Boliden has got a new permit (M4963-22, 2023-06-08) for changing the dam construction method at Ryllshyttemagasinet TMF. The change implies building centerline dams instead of the current up-stream dams. This change will result in even safer dams, allow for future raises above currently permitted heights and increase the capacity of the TMF within already permitted dam heights.

3.6.2 Necessary permits

The existing permit is valid for a period of 10 years (the longest building period allowed for activities under chapter 11 in the Swedish Environmental Act). Therefore, it limits the construction period of the dams surrounding the TMF to 2033 and it also sets a maximum height for the dams. This implies that Boliden needs a new permit in place by 2033 in order to be able to continue raising the TMF or will have to start depositing the tailings elsewhere.

3.6.3 Environmental, Social and Governance considerations

3.6.3.1 ESG Commitments

Our business model set our ESG priorities, and take into consideration the risks and opportunities identified by business intelligence and risk mapping, as well as applicable requirements and expectations such as:

- Stakeholder expectations
- Current and potential legislative trends
- ISO 45001, 14001 and 50001 standards and Forest Stewardship Council (FSC® COC-000122)
- OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-affected and High-risk Areas
- GRI Standards (Global Reporting Initiative)
- UN Sustainable Development Goals (SDGs)
- UN Global Compact
- ICMM Mining principles

We regularly consult prioritized stakeholder groups on our sustainability performance from a broader perspective. These stakeholders are asked to comment on Boliden's performance to drive further improvement.

Boliden is a member of ICMM and the national mining associations in the countries where Boliden Mines operates. These commitments imply implementing relevant international and national Environmental Management System (EMS) standards and guidelines, such as e.g., the Global Industry Standard on Tailings Management (GISTM) on an international level and Mining RIDAS on a national level. In addition to this, Boliden Mines is certified according to a series of standards, such as:

- ISO 14001:2015 - Environmental management systems.
- ISO 45001:2018 - Occupational health and safety management systems.
- ISO 50001:2018 - Energy management systems.

Boliden has implemented an integrated management system (Boliden Management System, BMS) which sets a common base for all activities developed within the company.

Boliden strive to run a responsible business and expect its business partners to do the same. Good business ethics is essential for sustainable and successful business. Boliden has an ethics and compliance department to boost its compliance work. The department is responsible for the strategic development and coordination of Boliden's work regarding anti-money laundering, anti-corruption, competition law, sanctions, human rights, data protection, whistleblowing and Boliden's employees and management work together to create a compliance culture in which everyone knows what is expected of them - Boliden's codes of conduct. Regular risk assessments, trainings, audits and effective controls are important parts of Boliden's compliance efforts. The Group's whistleblower channel enables all employees and external stakeholders to report suspected and actual misconduct confidentially and anonymously. If misconduct is proven, disciplinary actions must be taken. Reprisals against anyone reporting misconduct in good faith will not be tolerated. Group management and the Board of Directors receive regular reports on risks, non-compliance and the status of initiatives in progress.

Boliden's Code of Conduct provides a framework for corporate responsibility based on the company's values and ethical principles. All employees and members of the Board are subject to the Code, which is based on international standards and relevant legislation. As a complement to the Code, there are internal policies that all employees are expected to comply with. Boliden strives for a sustainable value chain and therefore applies an overarching business ethics and risk management strategy when selecting business partners. The Business Partner Code of Conduct reflects the requirements placed on Boliden's own organization and sets the lowest standard of ethical conduct required of all parties in the value chain, whether Boliden is the buyer or seller. As with the internal Code of Conduct, this code is based on international standards such as the UN's Global Compact, the ILO's standard core conventions and guidance from the OECD. Compliance and sustainability risks are assessed when selecting business partners. If there is a risk of non-compliance by a business partner, a more detailed review is made. Depending on the outcome, an action plan may be developed and agreed upon, or the business relation may be terminated or rejected.

Boliden is a member of the United Nations Global Compact and works constantly to implement its ten principles, including preventing and limiting negative impact in the own operations and those of its external business partners. Boliden runs operations in countries where the risk of human rights violations is considered low. No operations are conducted anywhere in UNESCO's World Heritage List. Boliden supports the right of indigenous peoples to consultations under Svemin's interpretation of Free, Prior and Informed Consent (FPIC). Other important aspects are fair working conditions, and the position Boliden has adopted against any form of harassment, discrimination and other behavior that may be considered as victimization by colleagues or related parties. In addition to this, aspects such as child and forced labor as well as the freedom to form and join trade unions are taken into account when evaluating business partners.

Anti-corruption forms a central part of the ethics and compliance work, and Boliden has a zero-tolerance policy regarding all types of bribery and corruption. Boliden has an anti-money laundering policy for identifying and managing risks in various parts of the business and to strengthen its anti-money laundering efforts.

3.6.3.2 Socio-economic impact

Mining and metal processing has been the driving force in the local and regional economy and development in Bergsslagen for centuries if not millenniums. This means that the region lives in symbiosis with mining activities in Garpenberg and develops together with the mine. The large investments and developments that have taken place in Garpenberg over recent years has been a boost in the local economy and competence level which has created a lot of optimism regarding the future in the region. The Garpenberg mine is an important actor on the local and regional scale with about 450 direct employees and creating a large number of indirect jobs. In total, it has been assessed that the Garpenberg mine generates 2300 direct and indirect jobs. More than 85 % of the workforce lives withing the municipalities of Hedemora, Avesta and Säter. The importance and engagement of Garpenberg is also reflected in the support to local organizations, cultural events and social projects.

3.6.3.3 Communities and land-owners

Boliden Garpenberg is located in the small village of Garpenberg. Many of the employees live in the vicinity of the mine, and more than 20 % of the inhabitants in Garpenberg work at the mine. The dominating land use around the mine is forestry performed by private landowners and forestry companies. In addition, there is an active outdoor culture in the area where hunting is much appreciated.

Boliden holds regular information meetings with the local community and landowners. Relations with the local community and landowners are generally good. A new grievance portal has been set up in 2023 on Boliden website through which anyone can file any issues, complaints, or improvement suggestions. During year 2023, local inhabitants raised vibrations from blasting and trucks passing by in high speed on the road in Garpenberg as priority areas to address. Previously, dusting from the TMF has been an important issue but implemented dust control measures have resulted in zero complaints regarding dusting during 2023.

3.6.3.4 Historical Legacy

The long history of mining in Garpenberg has resulted in a complex environmental situation with numerous historical objects on and around Boliden's land holdings in Garpenberg. Due to the age of these objects, Boliden is assessed to have very limited liability for any future remedial works to limit the environmental impact of these objects; however, Boliden has the responsibility as landowner to conduct investigations in order to determine the impact of these historical objects. These investigations are ongoing, as well as a dialogue with the County Administrative Board about the extent of the liability for any future remedial actions on these objects. A process has been initiated by the Water Authority to assess if it necessary to modify the environmental quality standards (EQS) for Gruvsjön and downstream lying water bodies as it has been shown that it is not a realistic admission to meet current EQS, even in a long-term perspective.

3.7 Geology

3.7.1 Regional and Local Geology

The Garpenberg supracrustal inlier (Figure 3-4) is situated in the mineralized Palaeoproterozoic igneous province of Bergslagen, south central Sweden. The region has been actively explored since the 12th century and is host to a variety of ore deposits, predominantly Fe-oxide deposits and to a lesser extent, polymetallic sulphide deposits (Bindler et al. 2017).

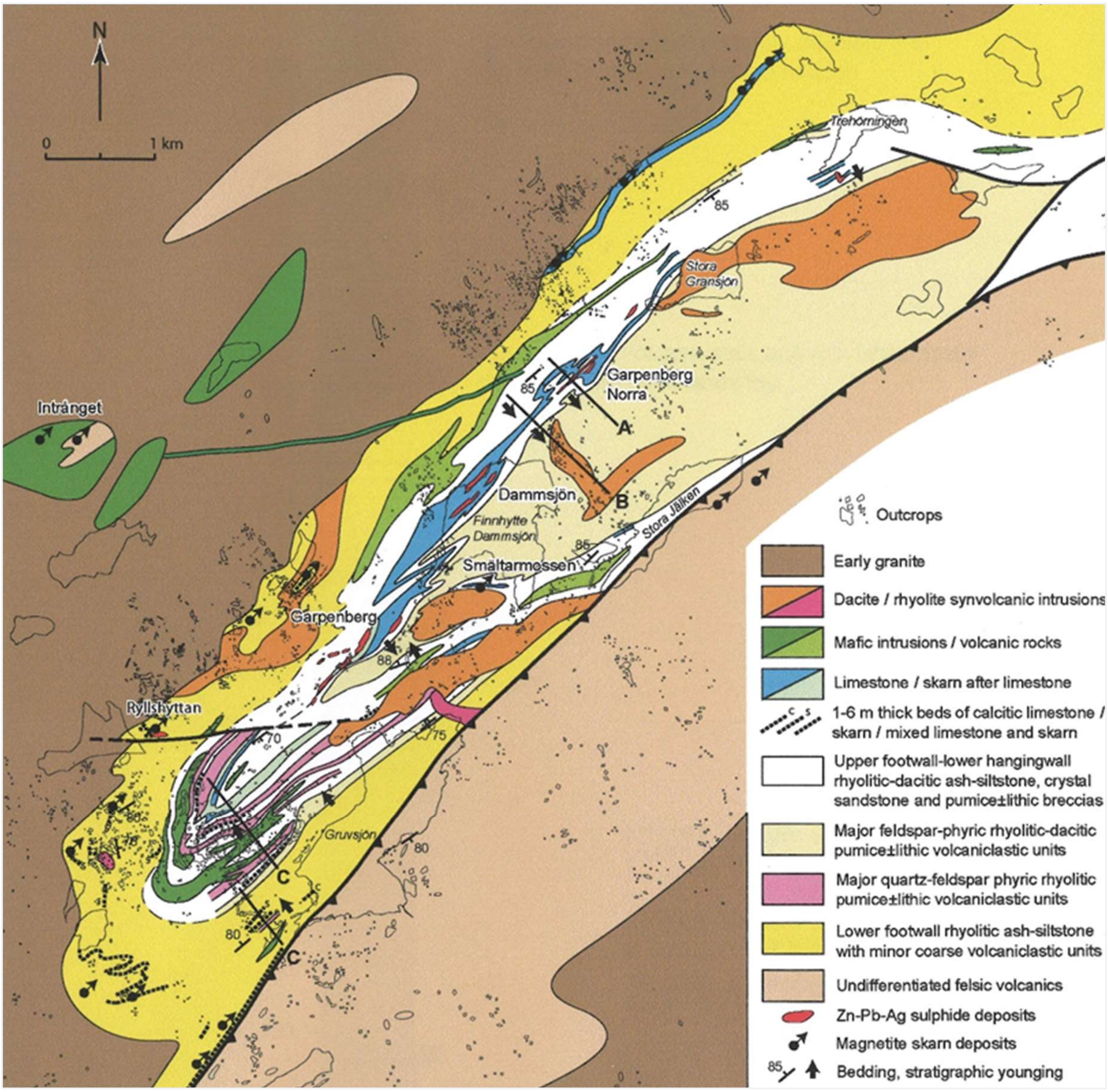

Figure 3-4. Geological map of Garpenberg. From Allen et al., 2003.

Garpenberg is the largest sulphide deposit in the region and consists of multiple polymetallic deposits hosted within a NE-SW trending tight to isoclinal syncline which is ca. 15 km long and 7 km wide (Vivallo 1985). This syncline is compressed at the southern end and opens to the north with a sub-vertical axial plane (Allen et al. 2003). The deposits are, for the most part, hosted along the same stratigraphic level within the predominantly rhyolitic sequence.

3.7.1.1 Stratigraphy

This succession is interpreted to have been originally formed within a large, shallow marine depositional environment where pyroclastic flow material was abundant during multiple periods of volcanic activity (Allen et al. 2003). Bedforms and facies associations indicate that the thick footwall succession accumulated mainly below the wave base prior to a change in conditions that enabled the formation of the limestone unit that is intrinsically linked to the Garpenberg sulphide deposits (Allen et al. 1996). The footwall consists of rhyolitic pumiceous, graded mass-flow breccia and rhyolitic ash-siltstone and sandstone affected by strong phlogopite-biotite-cordierite-sericite-quartz alteration.

The calcitic marble (limestone) unit is thought to represent a volcanic hiatus during which relatively stable and shallow sub-wave base marine conditions prevailed, facilitating the development of an extensive stromatolitic reef. The host stratigraphy is most prospective on the contact between the upper footwall rhyolitic sequence and overlying altered calcitic marble. Along this contact the lower extent of the calcitic marble (limestone) unit is commonly altered to dolomite and Mg +/- Mn-rich skarns. The barren hanging-wall stratigraphic package represents a later depositional environment characterized by uplift, exposure, erosion, and shallow water environments, followed by subsidence to deep water conditions (Allen et al. 2003).

3.7.1.2 Structure

The complex geometry of the ore-host limestone is due to large-scale folding, shearing, and faulting events. Folding, sub-folding, and shearing are the dominant structural controls on the geometry of limestone and adjacent strata. The resultant structures strongly influence the position, geometry, and metal grade of the ore bodies. The F2 folds have undulating fold axis which locally can grade into cone or sheath shapes due to inhomogeneous stretching strain associated with the folding (Allen et al. 1996). This is also evident on the horizontal plane where sheath folding is evident in interpreted plan views, where the hinges of such structures can be highly prospective.

The Garpenberg ore deposits vary somewhat in style depending on their origin and subsequent location within the sequence, from massive in-situ mineralization associated with the altered limestone unit found along the footwall – hanging wall contact, to tectonically remobilized ‘bands’ of ore that run sub-parallel to the dominant footwall foliation. The largest ore bodies are associated with antiform or synform structures, specifically Lappberget and Dammsjön. Even the geometry of the predominantly footwall hosted Huvudmalmen deposit is strongly influenced by parasitic folding of the overlying altered carbonate package.

Many of the Garpenberg deposits show extreme isoclinal folding and sub-folding of footwall mica quartzite and schist which can appear almost ‘interbedded’ with the more ductile overlying altered carbonate units (dolomite and skarns) on the hanging wall side. It is also likely that dip-slip faulting and / or shearing have contributed to this repetition / layering. While deposits are well constrained due to tight drilling intercepts, isoclinal folding is common and deposits often comprise of both remobilized and replacement style mineralization.

3.7.2 Mineralization

Mineralization in Garpenberg mainly consists of pyrite, sphalerite, galena and silver-bearing minerals. The ore bodies occur at the heavily skarn- and dolomite-altered contact zone between the limestone and underlying metavolcanic rocks, forming massive to semi-massive sulphides ore lenses. There is also significant mineralization in the footwall metavolcanic rocks (mica quartzites) that are stratigraphically underlying the marble horizon. The footwall mineralization is tectonically controlled, and forms remobilized semi-compact thin veins that are often associated to mica-rich shear zones. Mineralization is mainly of replacement style and is likely to have taken place where metal-bearing fluids penetrated up along synvolcanic, extensional faults and came in contact with reactive limestone to form large, massive sulphide bodies. The initial main stage of mineralization and alteration at all the known Garpenberg ore bodies is interpreted to be essentially syn-volcanic in timing and to pre-date regional metamorphism and deformation (Jansson & Allen 2011).

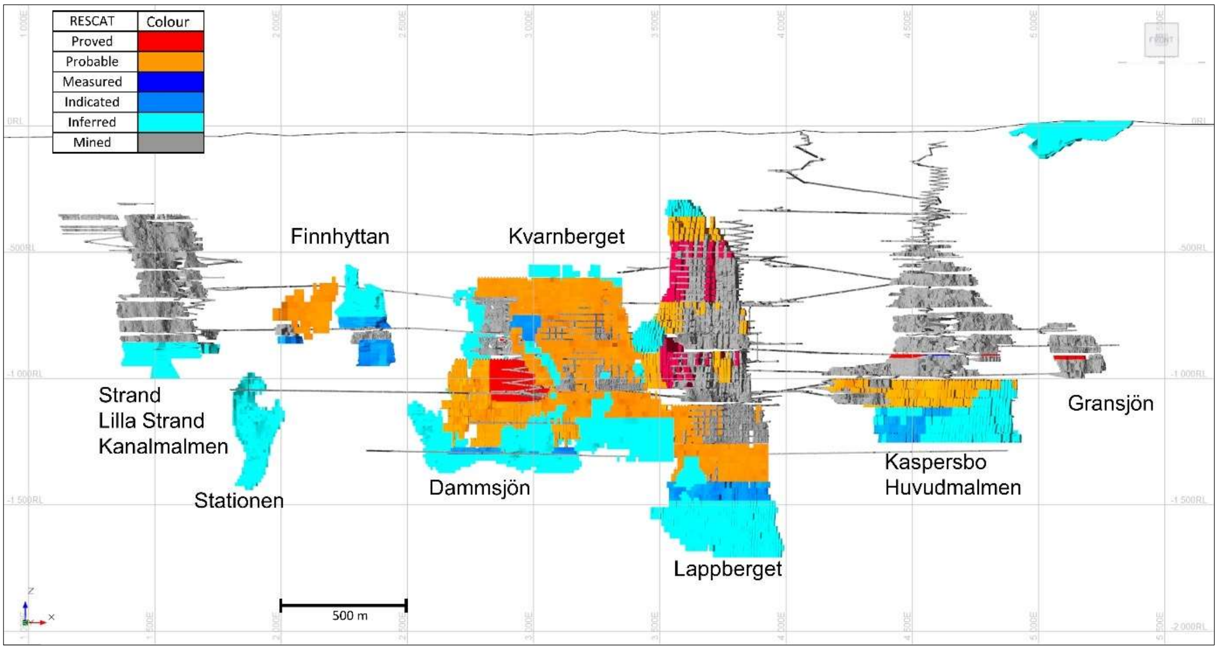

Figure 3-5. Front view of the Garpenberg ore bodies looking north in the local coordinate system. Colours according to resource category.

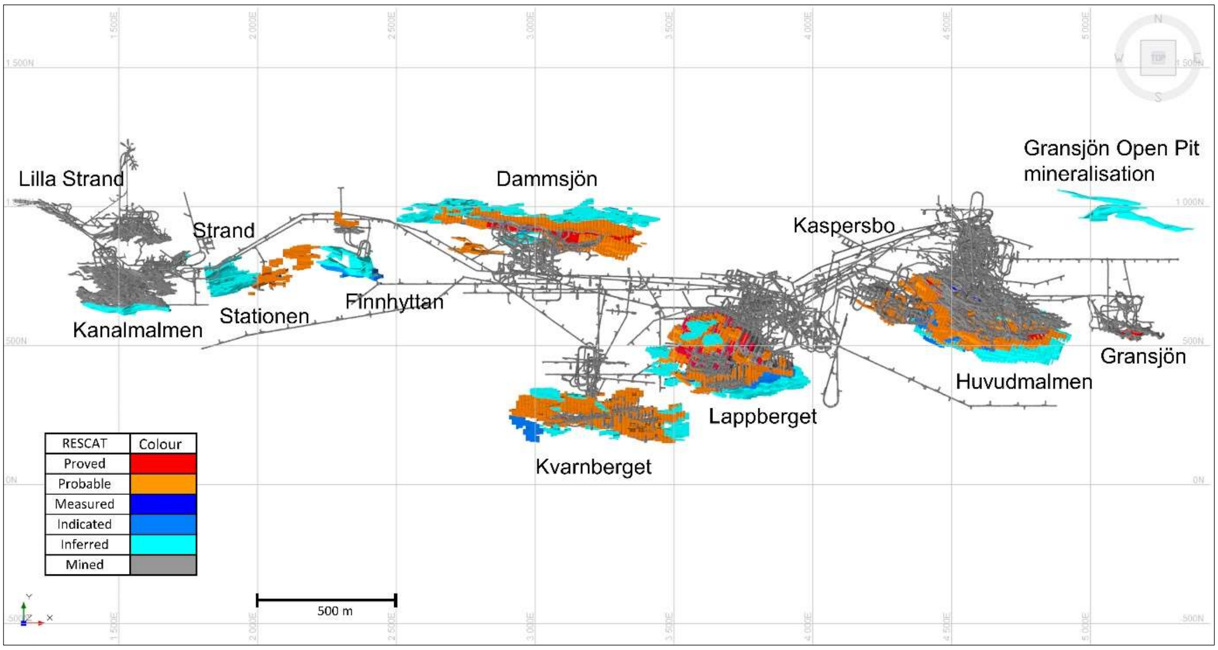

Figure 3-6. Top view of the Garpenberg ore bodies. Colours according to resource category.

3.8 Drilling procedures and data

3.8.1 Drilling techniques and downhole surveying

Diamond drilling in Garpenberg is the principal exploration method, and the data collected from drilling is used for generating 3D geological models and for mineral resource estimation. Most of the drilling is undertaken from underground positions.

Diamond drilling is performed by the drilling contractor, Drillcon and supervised by Boliden personnel. Core drilling at Garpenberg is carried out with the Sandvik Wireline System (WL) where most holes are drilled with WL56 rods which produce a core diameter of 39 mm. In some areas where drilling conditions are complicated due to poor rock quality or extreme deviation, WL66 drill rod diameter is used, producing a core diameter of 50 mm.

3.8.2 Collar and downhole surveying

Collar positions of underground drillholes are measured by Garpenberg's mine survey team, using a LEICA TS16. Two points are measured for each hole: the actual collar point and an additional point on the casing used to measure the azimuth. The survey measurements are sent to the drilling geologist, who enters the collar information into the database.

Deviation surveys are conducted by drilling contractors using their own instruments. Different instruments have been used historically, but the Inertial Sensing Gyro has been used most recently. Measurements are taken every 3 meters in all drillholes longer than 100 m. The drilling operator sends the completed survey to the drilling geologist who is responsible for validating and post-processing the survey. Post-processing consists of entering the collar coordinates and starting azimuth and exporting the survey to a suitable format for the database. Finally, the survey is uploaded into the database by the Geodata department.

3.8.3 Logging

The drill core is logged by Boliden geologists and sampled by Boliden technical personnel. The type of drill hole (i.e. exploration or infill) dictates the amount of detail logged. However, features that are always logged include: lithological units, fractures, level of schistosity, and content of talc. Core losses over 20 cm are registered in the log. Logging information is recorded in WellCAD software before being exported and sent to the database administrators. The logging information is used in the design of the 3D geological models.

3.8.4 Sampling

Sampling intervals are selected considering the degree of mineralization of primarily Zn, Pb, Ag and Cu. Moreover, sampling is done to have full coverage over mineralization and adjacent low-grade halo. The length of the sample sections is 1.0-2.5 m. Samples do not cross lithological boundaries and are selected to represent consistent degrees of mineralization when possible. Core loss intervals are not sampled and therefore do not get assigned any assay values.

For infill drillholes, the whole core is usually sampled, leaving no core left in the core boxes. Exploration drill holes are sawed in half along the drill core axis and one half is sent for analysis while the other half is stored in Boliden's core archive.

3.8.5 Density

Density formulas have been calculated in Garpenberg based on available specific gravity (SG) data and the formulas are reviewed at each resource estimation. The density formulas provided in Table 3-2 are used to assign densities in Garpenberg. Historically, SG measurements were not conducted frequently, but today more data is available to verify formulas. Since 2022, SG measurements on pulps are routinely conducted by ALS Laboratories on all the samples that are sent for analysis.

Historically, a great number of samples are missing S assays, therefore, a calculated value for S has been applied in some areas for those samples. The calculated S value is only used in density calculations.

Table 3-2. Density formulas in Garpenberg.

Ore	Density formula	Density (t/m3)	Comment
Lappberget	LA, LB, LC, LC2, LE, LW: DENSITY=2.7+0.004*CU+0.004*ZN+0.02*PB+0.0365*S LD: DENSITY=2.9+0.004*CU+0.004*ZN+0.02*PB+0.0365*S	2.96	
Dammsjön	Density = 2.7 + 0.004Cu + 0.004Zn + 0.02Pb + 0.0375S	2.95	
Huvudmalmen	HU1-HU3: Density = 2.7 + 0,0043Cu + 0.004Zn + 0.02Pb +0.0375 S HU4-HU6: Density = 2.9 + 0,0043Cu + 0.004Zn + 0.02Pb +0.0375 S	3.05	Values where S is absent have been recalculated by: S = 0.812*Zn + 1.1114 (HUVU lenses) S= 0.404*ZN+0.796 (HUW)
Gransjön	Density = 3.4 + 0,004Cu + 0.004Zn + 0.02Pb	3.48	No S analyses
Kaspersbo	KA1: Density = 2.65 + 0,004Cu + 0.004Zn + 0.02Pb + 0.0375S KA2: Density = 2.95 + 0,004Cu + 0.004Zn + 0.02Pb + 0.0375S	3.12	Values where S is absent have been recalculated by: S = 0.471*Zn + 1.436 (KASP lenses) S=0.404*ZN+0.796 (KAW)
Strand, Lilla Strand	Density = 2.96 + 0.004Cu + 0.004Zn + 0.02Pb	3.03	No S analyses
Kanal ,Tyskgården, Finnhyttan, and Kyrkan	Density = 2.8 + 0.004Cu + 0.004Zn + 0.02Pb	2.86	No S analyses
Kvarnberget	KVA, KVC, KVG: DENSITY=2.65+0.004*CU+0.004*ZN+0.02*PB+0.0375*S KVB, KVD: DENSITY=2.85+0.004*CU+0.004*ZN+0.02*PB+0.0375*S	2.93	

3.8.6 Analysis and QAQC

3.8.6.1 Sample Preparation and Analysis

Drill core analyses are carried out by ALS laboratories. Sample preparation is done in Piteå, Sweden and assays are carried out in ALS's hub-lab in Loughrea, Ireland. ALS laboratories are accredited according to ISO/IEC 17025. Umpire lab check assays are done by MS Analytical. An overview of the different analytical methods is presented in table Table 3-3.

Preparation of the samples, coded PREP-31BY, comprises crushing the rock to 70% less than 2 mm, rotary splitting off 1 kg and pulverizing the split to better than 85% passing 75 microns.

Table 3-3. Overview of ALS's designation of analytical methods. Over-range method applies to samples where assay result reached upper detection limit of primary method.

	Method	Over-range method
Preparation	PREP-31BY	
Assay Au	Au-ICP21	Au-AA25/Au-GRA21
Assay Ag, Cu, Pb, Zn	ME-OG46	Ag - GRA21 Pb - AAORE Zn - ME-ICPORE
Assay S	IR08	
Assay other (48 elements)	ME-MS61	
Specific gravity (core)	OA-GRA08	
Specific gravity (pulp)	OA-GRA08b	

Au-ICP21 is a package of fire assay with an ICP-AES analysis. In ME-OG46, Aqua Regia is used to dissolve base metals and silver while assay is done with ICP-AES. IR08 is used for total sulphur analysis using a Leco Sulphur analyzer. ME-MS61 is a package of a 4-acid digestion process with an ICP-MS analysis. Specific gravity is measured either directly on drill core (OA-GRA08), or on pulps using a pycnometer (OA-GRA08b).

All samples are prepared and analyzed with Au-ICP21, ME-OG46 and IR08 while selected drillholes are analyzed with ME-MS61. Since 2022, all samples are analyzed for Specific Gravity on pulps (OA-GRA08b) as well. Table 3-4 shows which elements are analyzed with lab codes ME-OG46 and ME-MS61.

Table 3-4. Elements analyzed with ME-OG46 and ME-MS61.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	**Cu**	**Zn**	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	**Ag**	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	**Pb**	Bi	Po	At	Rn
Fr	Ra	Ac¨	Ku	Ha													
	*	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
	¨	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

ME-OG46 ME-MS61

3.8.6.2 Verifications of Analytical Quality Control Data

Quality assessment and quality control is continuously monitored using QAQC samples such as in-house standards, blanks and umpire lab checks (pulp duplicates). It is required that each sample batch is submitted with at least one blank sample and one standard sample. Batches with more than 16 samples also require a pulp duplicate sample. As the number of samples in a batch increases, so does the required QAQC samples; for example a batch with 100 samples requires two blank samples, three standard samples and one pulp duplicate sample.

In the existing methodologies, umpire check assays, conducted by an external laboratory, have been incorporated. However, these assays have not been utilized for the evaluation of assay quality because the current procedures do not allow to assess the quality of the umpire lab. The procedures are currently undergoing a review process. The introduction of duplicate samples to monitor the precision of the analytical system is being investigated.

QAQC samples analysis are routinely controlled and validated by the geologists in charge of the drilling. When anomalies are detected, a new analysis is required to the laboratory for parts of the sample batch. The validation carried out by the geologists has shown that the performance of QAQC samples in Garpenberg is acceptable, and that assay analysis can be used for resource estimation.

3.9 Exploration activities and infill drilling

3.9.1 Near mine exploration

In 2023, Near mine exploration continued to extend resource drilling and test potential at two key deposits: Huvudmalmen and Stationen (Figure 3-7). In total, 20 300 metres were drilled by Near mine exploration in 2023.

At Huvudmalmen, the objective of the 2023 resource drilling was to generate data for the forthcoming resource estimate below 1250z (planned for 2024). The vertical extent of this drilling extended from 1250 z down to 1600 z over a strike extent of 500 m. Drilling was carried out by two machines over much of the year and progress was facilitated by the extension of the 1300 level exploration drift, the length of which has allowed drifting and drilling to occur simultaneously. Approximately 340 m of drifting was carried out in 2023 and it is expected that the drift will be completed by the second quarter of 2024. This will allow increased drilling volume in 2024 and extend the northern strike extent of the deposit.

During 2023, Near mine exploration also focused on increasing confidence and volume at Stationen. Two machines were deployed in the 1075 exploration drift during 2023, one of which was allocated to directional core drilling. The objective of the directional drilling was to test the potential depth extent of Stationen below 1400 z. The second machine was tasked with resource drilling to increase confidence in the 2022 resource estimate and to generate volume along strike extent.

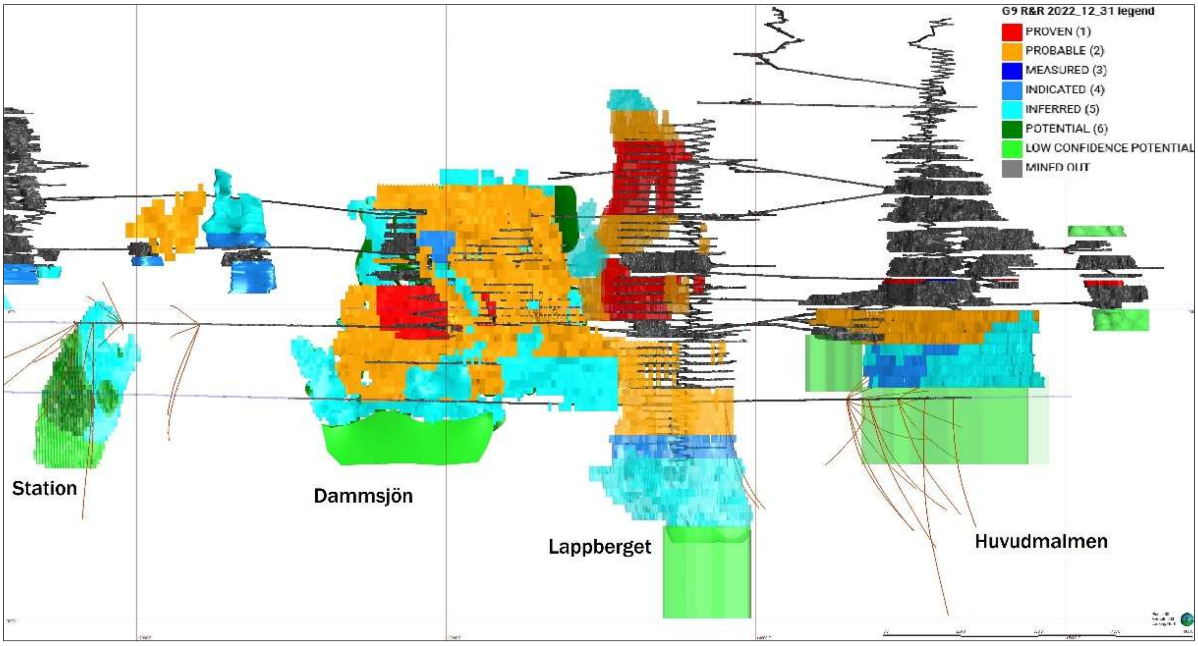

Figure 3-7. Front view with 2022 Reserves & Resources. 2023 Near mine drilling in red.

Significant complications were encountered with directional drilling which ultimately was a failure. However, increased understanding of the stratigraphy during these attempts led to the identification of an optimal collar location from which conventional core drilling successfully intersected the depth extent of Stationen below 1500 z. The single successful attempt at drilling below 1500 z intersected significant massive sulphide mineralization and showed that the prospective dolomite host extends below 1600 z.

In 2023 drifting towards Stationen continued at the 1314 level from Dammsjön. An external contractor was brought in during the fourth quarter of 2023 to increase drifting rate and the 1314 exploration drift was extended by approximately 500 metres in 2023. Significant work by the mine has increased ventilation capacity in this area of the mine which will allow further rapid extension of the 1314 exploration drift towards Stationen in 2024.

3.9.2 Infill drilling

Infill drilling conducted by the mine department in 2023 focused on Lappberget and Huvudmalmen. A total of 16200 metres of infill drilling was completed by the mine department. In addition to that, Garpenberg Mine drilled 4500 metres of geotechnical and infrastructure drilling, mostly focusing on different areas in Lappberget.

In Lappberget, two separate areas were targeted. A large drilling program from the 1432 exploration drift, initiated in 2021, is still under way. The aim of this program is to target the area between 1400-1650z. Due to drifting in the deep ramp and limited access to ventilation in the deepest part of mine, drilling was paused in the second half of 2023, but is planned to resume in 2024. Moreover, another drilling program towards the low-grade area initiated in 2022, on the western limb of the ore body between 650-900z, was completed in 2023.

In Huvudmalmen, a large amount of infill drilling is necessary both in Etage 1100 and Etage 1250 in order to get sufficient coverage. In 2023, drilling was conducted both from the 1100 exploration drift and 1008/1009 drifts, targeting the area between 1000 z and 1150 z.

3.10 Mining methods, mineral processing and infrastructure

3.10.1 Mining methods

The current LOMP of Garpenberg mine consists of five separate, sub-vertical orebodies: Lappberget, Kvarnberget, Dammsjön, Huvudmalmen and Finnhyttan (Figure 3-8). Each orebody has or will have a local ramp, connecting production levels to each other. The local ramps are connected to each other by horizontal access drives. Equipment and materials are transported into the mine via a ramp from the surface, while personnel use mainly the personnel shaft.

The orebodies are divided into mining blocks with 3 to 8 levels of stopes in each block. The top level of each mining block is the sill pillar, which separates the different mining blocks. The level above sill pillar is filled with cemented paste fill, which allows mining the ore left in the sill pillar. Below old, mined out areas backfilled with waste rock, a sill pillar with thickness of 10-15 m will be left. This division to different mining blocks allows the mine to have several production areas being scheduled and mined at the same time. Overview of the orebodies and mining blocks is shown in Figure 3-8.

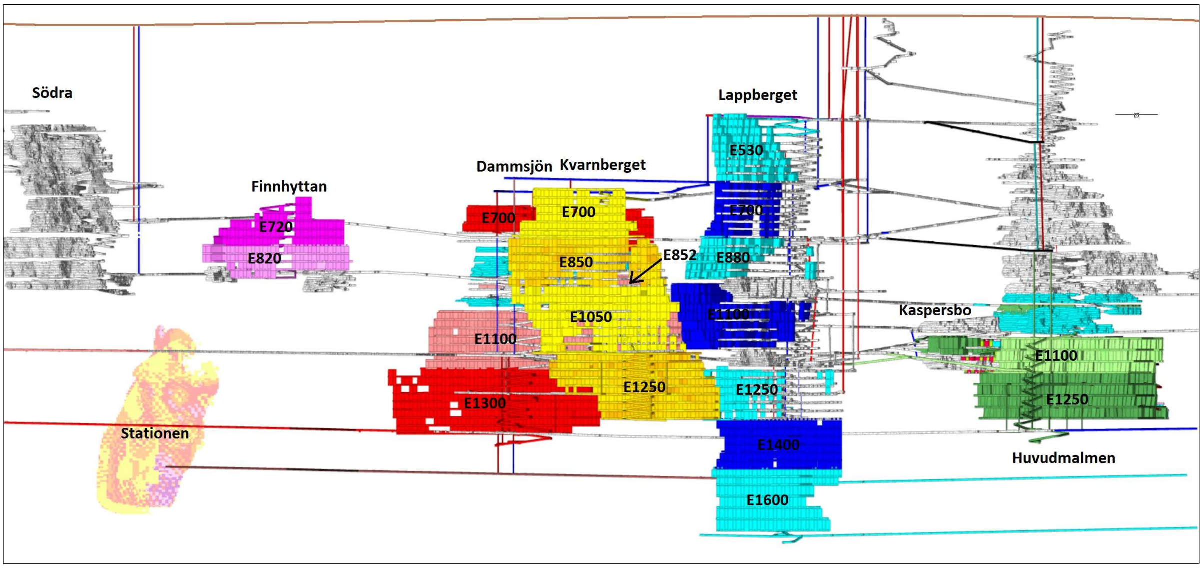

Figure 3-8: Overview of the different orebodies and mining blocks in Garpenberg.

Over 95% of the mined ore in Garpenberg is extracted by sublevel stoping (also called longhole stoping), where the ore is mined in layers between two drifts vertically 25-35 metres apart. Most areas are mined with transversal longhole stoping, where the development and stope axis are perpendicular to the strike of the ore body. In some more narrow areas, longitudinal longhole stoping is used. The orientation of this method is along or parallel to the strike of the ore body. The ore body is split into primary and secondary stopes, which are mined in a predefined order and pyramid shape sequence. The standard stope dimensions are 22-35 m high, 10 m wide for primary stopes and 15 m wide for secondary stopes, with some local variation in dimensions.

Another consideration concerning the mine design of Lappberget is the division into a main and a second pass sequence (2pass). The main sequence contains more of the high-grade areas and is scheduled prior to the second pass sequence, which in general contains lower grade ore (Figure 3-9).

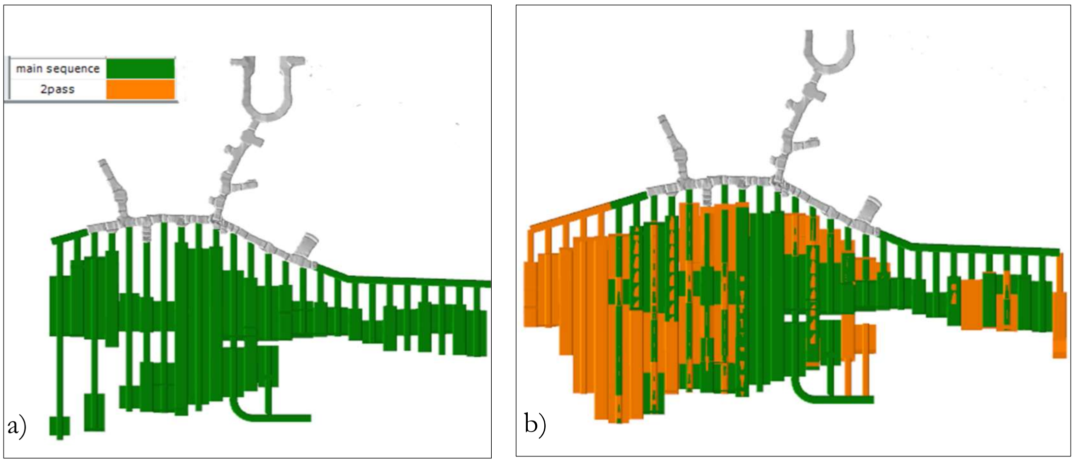

Figure 3-9. Example of mine design in Lappberget
a) High grades layout – main sequence; b) Main sequence (high grades) and 2pass (low grades).

Other rarely used mining methods include cut and fill and avoca (rill) (Table 3-5). With the cut and fill method, mining is carried out in slices along the steeply dipping, narrow ore body. The bottom slice is mined first. The excavated area is then backfilled, so mining can continue with the slice above. The rill method used in Garpenberg is in fact similar to longitudinal stoping, but the stopes are split in 20 m long slices. After being blasted and mucked, the stopes are backfilled before the next slice is blasted. This process repeats until the full size of the stope is done.

Table 3-5. Mining method for Garpenberg ore bodies.

Mining method	Orebody	Width (m)
Primary	Lapp, Kvarn, Kasp, Damm, Huvud	10-15
Secondary	Lapp, Kvarn, Kasp, Damm, Huvud	15-20
Longitudinal	Lapp, Kvarn, Kasp, Damm, Huvud	4-7
Cut and fill	Damm	5-7
Avoca (rill)	Damm	4-7

Mine reconciliation is the comparison of the planned stopes against the actual outcome.

Table 3-6 shows the reconciliation for the large-scale mining methods in 2020 and 2021.

Table 3-6. Reconciliation for longhole stoping 2021 and 2022. Average overbreak includes overbreak ore.

Year	Stopes	Plan compliance	Average Overbreak
2021	Primary	94 %	11 %
	Secondary	95 %	10 %
	Total	94 %	10 %
2022	Primary	94 %	11 %
	Secondary	94 %	9 %
	Total	94 %	10 %

Ore mucked from a stope is tipped into an ore pass or loaded directly on truck. Transport to the crushers is done by trucks from the active mining areas. There are two underground crushing plants at 700z and 1087z. The crushed ore is hoisted to surface in a shaft, unloaded into a bin in the headframe and then transported by conveyor belts to an intermediate ore storage, which can hold approximately a week of production.

3.10.2 Mineral processing

Processing tests are systematically conducted on ore from new mineral resources to confirm the technical and economic feasibility for extraction and processing. Valid processing tests are required for classifying mineralization to Indicated or Measured Resources. For each new area, drill core samples, representative of the different deposits, are selected for metallurgical testing. The work is conducted internally at the Boliden pilot plant and may include grindability investigations, study of mineralogy, as well as flotation and gravimetrical separation. The goal of the metallurgical tests is to evaluate the recoverability of valuables from the different ore types with a similar process to the one currently used at the Garpenberg concentrator. In 2023, grindability and beneficiation studies (flotation and gravimetry) related to Lappberget 1530-1650z were finalized and reported.

In the concentrator, the ore is ground in two stages with autogenous grinding in the primary stage and pebble mill grinding in the second. After grinding, the ore is screened, with the coarse fraction being returned to the primary mill. The fine fraction undergoes gravimetric separation (Knelson) to separate out coarse gold at an early stage. The gravimetric concentrate is collected in big bags. After gravity separation, the pulp stream is classified using hydrocyclones. The overflow constitutes the main flotation feed, while the underflow undergoes flash flotation in the grinding circuit, from which the concentrate is sent directly to CuPb separation in the flotation plant and the tailings back to the mills for further grinding.

Flotation is carried out in a three-stage flotation circuit: CuPb flotation, CuPb separation and Zn flotation. Regrind mills are installed both in the CuPb and Zn circuits. The flotation concentrates are dewatered using thickeners and pressure filters. Three mineral concentrates are produced in flotation: zinc, lead and copper concentrates. The precious metals report primarily to the copper and lead products.

The zinc and lead concentrates are transported by truck to Gävle port and from there by ship to Boliden's smelters in Finland, Sweden and Norway. The copper and gravimetric concentrates are trucked, the copper concentrate later being reloaded to rail, for onward transport to the Boliden Rönnskär smelter in Skelleftehamn. On some occasions, concentrates are also sold externally.

3.11 Prices, terms and costs

Mineral Resources and Mineral Reserves are the basis for the company's long-term planning and will be mined for many years to come. Long-term planning prices, which are an expression of the anticipated future average prices for metals and currencies, are therefore primarily utilized in the estimations. The planning prices are used to calculate the NSR (Net Smelter Return), expressed in SEK/t, in the block models. Boliden currently uses the prices shown in Table 3-7 below.

Table 3-7.Long term planning prices currently used in Boliden.

Commodity / Currency	Planning prices 2023	Assumed Recovery (%)
Copper	USD 7 800/tonne	56.0
Zinc	USD 2 800/tonne	93.1
Lead	USD 2 000/tonne	82.2
Gold	USD 1 400/tr.oz	69.6
Silver	USD 20/tr.oz	75.8
USD/SEK	9.00	
EUR/SEK	9.90	
EUR/USD	1.17	

Based on the long-term prices and recovery from Table 3-7, the following formula is used to calculate the long-term NSR for Garpenberg:

NSR_LTP (SEK/ton)= 247*Au(ppm)+3.80*Ag(ppm)+358*Cu(%)+164*Zn(%)+131*Pb(%)

Zn and Ag are the commodities that contribute the most to the value of Garpenberg, they each account for about 36% of the total value. The other commodities have relatively lower contribution, with 16% for Pb, 11% for Au and 1% for Cu.

The variable costs are around 270 SEK/t. These are the direct costs for mining and processing a ton of ore. Variable costs include for example consumables, transportation and a percentage of spare parts and energy. This value is used as a guideline in the stope creation process to decide, whether to include material in a stope or not, assuming there is spare capacity at the mill.

The operational costs are around 500 SEK/t. This cost includes variable costs as defined above, and additionally fixed costs such as personnel costs and facility maintenance. This value is used as a guideline for the minimum value of a whole stope.

The breakeven costs are around 610 SEK/t. The breakeven cost for the whole site includes fixed and variable costs as defined above, and additionally costs for sustaining investments, such as future strategic mine development and re-purchasing of production machines. Depreciations and capital investments are not included in the site operational costs. This value is used to make sure that a larger set of stopes is profitable over a period of time.

The costs distribution is summarized in Table 3-8.

Table 3-8. Different cost categories in Garpenberg from 2022 cost data.

Costs SEK/t	Total														
	Operational														
	Mine fixed	Mine variable	Mill fixed	Mill variable	G&A fixed	G&A variable	Reclamation	Mine Sustaining investments	Re-investments	EHS	Expansion Investment	De-bottlenecks	Efficiency investments	Depreciations	Costs sum
Variable cost		X		X		X	X								**270**
Operational cost	X	X	X	X	X	X	X								**500**
Breakeven cost	X	X	X	X	X	X	X	X	X	X					**610**

3.12 Mineral resources

All mineral resource estimates for Garpenberg have been prepared by Boliden's own personnel in the Ore reserves and Project evaluation department. These mineral resource estimates are based on diamond drillholes produced by Garpenberg Near Mine Exploration as well as infill drilling from Garpenberg Mine Geology. The resource geologists conducting the mineral resource estimates have all visited Garpenberg underground mine and observed relevant drillcore from the orebodies in question before estimates are conducted.

Figure 3-10 **Error! Reference source not found.**shows the main steps from modelled mineralization to reported resources and reserves, which are described in this chapter. In Garpenberg, mineralization is interpreted in Leapfrog Geo guided by grades, NSR values and geological assumptions. The interpretation process results in 3D mineralization wireframes which are used as domains in resource estimation. Boliden compiles the produced mineral resource estimates annually for Mineral Resources reporting at year-end. The Garpenberg mine planning department uses the generated block models to convert them to Mineral Reserves. The data and methodology that support the mineral resource estimates are documented systematically in internal reports. Table 3-9 lists all the estimations compiled for Garpenberg R&R.

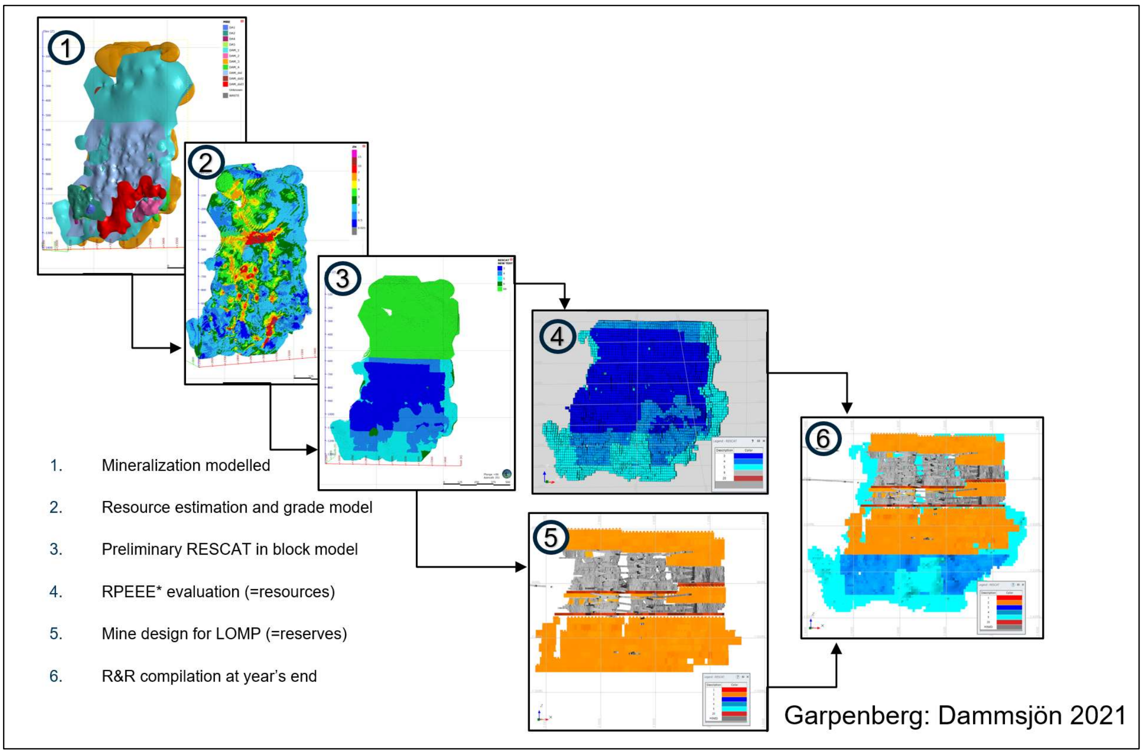

Figure 3-10. Garpenberg modelling workflow.

Two different resource estimation methods are used in block models. Ordinary Kriging (OK) is usually used in areas where there is sufficient drillhole data and Inverse Distance (ID) is usually used in areas with less available data. Resource estimation is conducted in Datamine or Leapfrog Edge. Though, there are still some older mineralization models and block models in use that were created in Propack (add-on to the CAD program MicroStation), however those models contain only a fraction of reported volumes. Table 3-9 shows block models with estimation methods and software used as well as block sizes for each of the ore bodies in Garpenberg. The block sizes are selected from spacing in supporting data, in combination with complexity in ore geometry and scale of mining.

No report is available for older areas included in block model blgar.dm, but their tonnage is relatively small and consists of only 1.3Mton of inferred resources with reconciliation data confirming the volumes and grades of adjacent mined volumes. These areas require extensive resampling and remodeling before they can be included in the LOMP or mineral reserves.

Table 3-9. Garpenberg block models and estimation methods.

Orebody	Block model	Est. Method	Software	Author	Year
Lappberget	bllpb.dm	OK	Datamine/Leapfrog Edge	Höglund, Agmalm	2020, 2021
Kvarnberget	blkvb.dm	OK	Datamine	Höglund	2020
Dammsjön	bldamm.dm	OK	Leapfrog Edge	Höglund	2021
Huvudmalmen	blnor.dm	OK	Leapfrog Edge	Höglund	2022
Kaspersbo	blnor.dm	OK	Leapfrog Edge	Höglund	2022
Gransjön	blnor.dm	OK	Datamine	Fjellström	2014
Gransjön open pit	blgrn.dm	IDW	Propack	Fjellström	2014
Finnhyttan	bltys.dm	IDW	Datamine	Åberg	2018
Kyrkan	bltys.dm	IDW	Datamine	Åberg	2018
Tyskgården	bltys.dm	IDW	Datamine	Åberg	2018
Kanal	blgar.dm	IDW	Propack	Danielsson	<2000
Strand	blgar.dm	IDW	Propack	Danielsson	<2000
Lilla Strand	blgar.dm	IDW	Propack	Danielsson	<2000
Stationen	blstat.dm	IDW	Leapfrog Edge	Höglund	2022

In the end of the resource estimation process, Mineral Resource classification takes place using several criteria. The quality of informing data is first validated where new data generally is deemed of a higher quality than historical data. Considering Garpenberg geology, grade continuity and statistical analyses, a drill pattern of 100 x 100 m is used as a guideline for inferred, 50 x 50 m for indicated and 25 x 25 m for measured resource. However, Tyskgården-Finnhyttan is an exception since complex geological conditions demand a denser drilling grid. The final classification depends on drill pattern in combination of other criteria. The classification process is conducted for every estimation, where the following characteristics are taken into consideration for each of the mineralized lenses:

- Geological complexity
- Quality and quantity of informing data
    - Confidence in analytical results
    - Confidence in borehole surveying
    - Analytical data
    - Results of geostatistical analysis, variography, and QKNA
- Metallurgical factors or assumptions
- Confidence in the block estimates

In resource estimations finished in 2020 or later, an evaluation of Reasonable Prospect of Eventual Economic Extraction (RPEEE) has been conducted in Deswik Stope Optimizer by applying a cut-off and simplified mining parameters on an existing block model. This assessment leads to more realistic mineable tonnage and grades, which results in less adjustments when eventually converting Mineral Resources into Mineral Reserves. Prior to 2020, RPEEE was evaluated according to cut-off and minimum mining width.

Each resource is only remodeled or reevaluated on a yearly basis if there is new data available. The NSR formula and the cut-off used for the reported resources varies between years. A list of the NSR formulas and cut-off values used are listed in Table 3-10. All reserve and resource tonnes and grades are interrogated from the eight active block models in Garpenberg listed in Table 3-9 and reported according to the PERC standard.

Table 3-10. Garpenberg 2023 resources reported with corresponding cut-off and NSR formula.

Orebody	Block model	Year	NSR-formula	Cut-off (SEK)
Lappberget >1400	bllpb.dm	2020	NSR_20LTP22	300
Lappberget <1400	bllpb.dm	2021	NSR_21LTP23	300
Kvarnberget	blkvb.dm	2020	NSR_20LTP22	300
Dammsjön	bldam.dm	2021	NSR_21LTP23	300
Huvudmalmen	blnor.dm	2022	NSR_22LTP24	400
Kaspersbo	blnor.dm	2022	NSR_22LTP25	400
Gransjön	blnor.dm	2014	NSR_14LTP16	270/345
Gransjön open pit	blgrn.dm	2014	NSR_14LTP16	190
Finnhyttan	bltys.dm	2018	NSR_18LTP20	390
Kyrkan	bltys.dm	2018	NSR_18LTP20	390
Tyskgården	bltys.dm	2018	NSR_18LTP20	390
Stationen	blstat.dm	2022	NSR22LTP24	400

3.13 Mineral Reserves

When converting Mineral Resources to Mineral Reserves, a number of parameters have to be considered, the most important ones being economic feasibility and rock mechanics. The rock mechanic conditions determine the amount and size of pillars and sill pillars as well as the length and width of mined stopes. Weak or unstable rock volumes might be discarded completely from the mineral reserves. The volume and geometry of the mineralization will likely determine which mining method to apply. The choice of mining method should also optimize the NPV (Net Present Value) of the ore volume.

With the longhole stoping method, the Mineral Reserves are defined by designed stopes whereas the corresponding Mineral Resources are defined either by designed stopes or by the mineralized envelope above cut-off. Since designed rooms are mostly formed as cubes with 90 degree corners and the mineralized envelopes are irregular, some of the ore at the edge of the mineralization might get left out when converting resources to reserves. Likewise, some waste rock might be included at the edges of the mineralization.

Boliden Garpenberg utilizes the mine planning tool Deswik Stope Optimizer (SO) for designing of stopes. SO automates the design process and allows for a number of stope properties including general shape and orientation, cut-off grade, dilution and pillar size. Table 3-11 summarizes the criteria used by SO in different areas in Garpenberg.

Table 3-11. Design properties used by SO to generate stopes in different ore bodies in Garpenberg.

SO criteria	Allow up	min	max
Waste material	20%		
Dilution	25%		
Stope length Lappberget/ Huvudmalmen/Dammsjön	-	4 m	80 m
Stope length Kvarnberget/ Södra malm	-	4 m	40 m
Stope height	-	20 m	35 m

The cut-off grade used is based on the cost distribution presented in chapter 3.11. Variable costs will define what material can be included in a stope, and a full stope needs to cover operational costs without sustaining investments. Additionally, the average NSR for each time period needs to be higher than the full breakeven costs. Moreover, the cut-off is adjusted for each ore body and mining method.

For Lappberget, the separation into a main ("1-pass") and a second pass ("2-pass") sequence, as mentioned in chapter 3.10, is done based on different cut-offs for different time stages of mining. The cut-off is chosen in such a way that both mining sequences are mineable and a favorable NPV is achieved. The different cut-offs used for design with SO are presented in Table 3-12Table 3-13.

In 2022-2023, a mine optimization project was made in collaboration with Whittle Consultants. As a result of the project, an optimal cut-off was defined for each mining block. These cut-offs are not strictly based on the mining costs, but they are rather values that give the best economical result over the life of mine. These cut-offs are being implemented into the LOMP designs on an ongoing basis and will be updated in Mineral Reserves once completed.

Regarding the classification Proved Mineral Reserves, several criteria must be met. First, the reported position must comply to the conditions for a Measured Resource. Secondly, all required permits must be in place. Today the tailings management facility (TMF) has enough capacity to mine until 2033 according to the current permit. In that regard, it was decided that at least 60% of a position needed to be in the mine plan before 2033 in order to be classified as Proved Reserve.

Table 3-12: Cutoffs used in different mining blocks: the original cutoff used when making the design, and a cutoff converted to day's prices. When cutoff is displayed with a slash (e.g. 700/470), the first number means the cutoff for a whole stope, while the second number shows cutoff for marginal ore for e.g. pillars between stopes.

Mining block	Design date	NSR formula	Original design		Re-calculated to NSR_23LTP25	
			CO (1-pass)	CO (2-pass)	CO (1-pass)	CO (2-pass)
Lapp E530	2023-04	NSR_23LTP25	850	320	850	320
Lapp E700	2023-04	NSR_23LTP25	850	320	850	320
Lapp E880	2020-09	NSR_20LTP22	730	270	850	320
Lapp E1100	2020-09	NSR_20LTP22	300	-	350	-
Lapp E1250	2023-10	NSR_23LTP25	700/470	470/320	700/470	470/320
Lapp E1400	2021-09	NSR_21LTP23	730	270	850	320
Lapp E1600	2022-04	NSR_22LTP24	730	270	850	320
Kvarn E700	2021-04	NSR_20LTP22	300	-	350	-
Kvarn E850	2021-04	NSR_20LTP22	300	-	350	-
Kvarn E1050	2021-04	NSR_20LTP22	300	-	350	-
Kvarn E1250	2021-04	NSR_20LTP22	300	-	350	-
Damm E700	2021-09	NSR_21LTP23	520	-	610	-
Damm E852	2021-09	NSR_21LTP23	520	-	610	-
Damm E1100	2023-09	NSR_23LTP25	610/470	-	610/470	-
Damm E1300	2023-09	NSR_23LTP25	610/470	-	610/470	-
Finn E720/820	2021-04	NSR_20LTP22	270	-	320	-
Kasp E1079	2021-04	NSR_20LTP22	270	-	320	-
Huvu E935	2014	NSR_14LTP16	355	-	420	-
Huvu E1100	2022-09	NSR_22LTP24	400/270	-	470/320	-
Huvu E1250	2022-09	NSR_22LTP24	400/270	-	470/320	-
Gran E990	2014	NSR_14LTP16	355	-	420	-

Table 3-13 shows the Mineral Resources and Mineral Reserves for Garpenberg as per 2023-12-31.

Table 3-13. Mineral Resources and Mineral Reserves in Garpenberg 2023-12-31

	2023						2022					
Classification	kton	Au (g/t)	Ag (g/t)	Cu (%)	Zn (%)	Pb (%)	kton	Au (g/t)	Ag (g/t)	Cu (%)	Zn (%)	Pb (%)
Mineral Reserves												
Proved	**17 200**	**0.25**	**98**	**0.04**	**3.0**	**1.3**	18 658	0.24	97	0.04	3.1	1.32
Probable	**83 700**	**0.31**	**88**	**0.05**	**2.5**	**1.2**	90 640	0.30	85	0.04	2.5	1.14
Total	***100 900***	*0.3*	*90*	*0.04*	*2.6*	*1.2*	*109 298*	*0.29*	*87*	*0.04*	*2.6*	*1.17*
Mineral Resourcess												
Measured	**100**	**0.24**	**108**	**0.03**	**2.8**	**1.0**	68	0.24	108	0.03	2.8	1.04
Indicated	**21 600**	**0.41**	**70**	**0.06**	**2.7**	**1.3**	21 556	0.41	70	0.06	2.7	1.32
Total M&I	***21 600***	*0.41*	***70***	***0.06***	*2.7*	***1.3***	*21 624*	*0.41*	*70*	*0.06*	*2.7*	*1.32*
Inferred	**67 900**	**0.34**	**57**	**0.05**	**2.3**	**1.1**	67 413	0.34	57	0.05	2.3	1.10

3.14 Comparison with previous year/estimation

In 2023 the total Mineral Reserves in Garpenberg decreased by 8.4 Mt (million metric tonnes) to 100.9 Mt. Measured and Indicated Resources in Garpenberg remained unchanged at 21.6 Mt. Inferred Resources slightly increased by 0.5 Mt to 67.9 Mt. Table 3-14 shows the changes in detail, including changes in metal grades.

Figure 3-11 and Figure 3-12 show the changes in Mineral Reserves and Mineral Resources respectively between 2022-12-31 and 2023-12-31, with the explanation of what caused these changes.

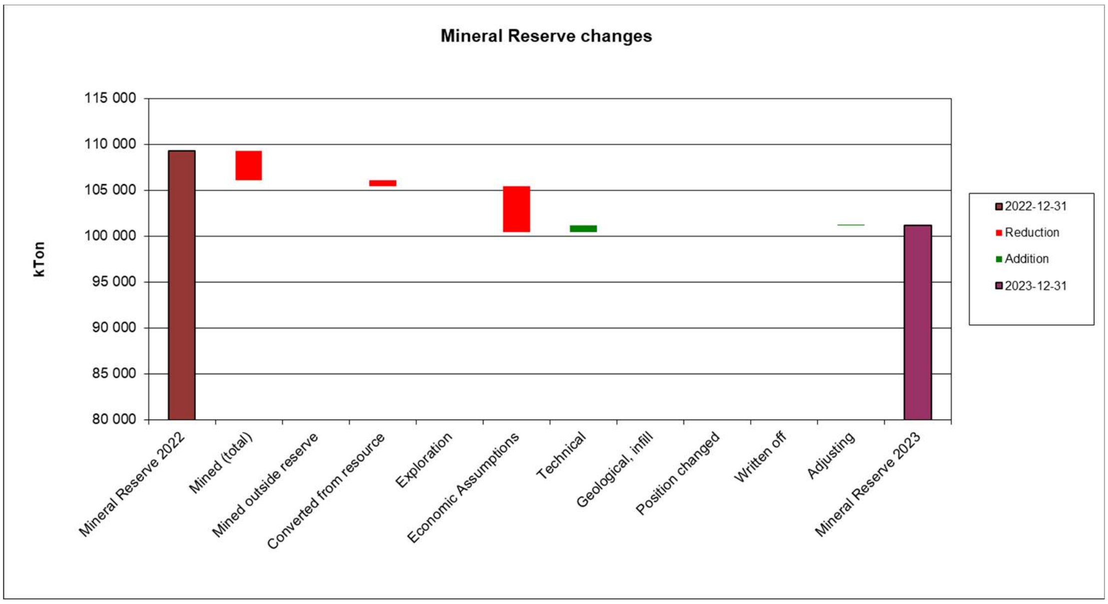

Figure 3-11. Changes to Mineral Reserves between 2022-12-31 (leftmost column) and 2023-12-31 (rightmost column). The other columns show the causes for reduction (in red) and addition (in green) of tonnage. Note that the scale of the y-axis has been adjusted and starts at 80 000 kton.

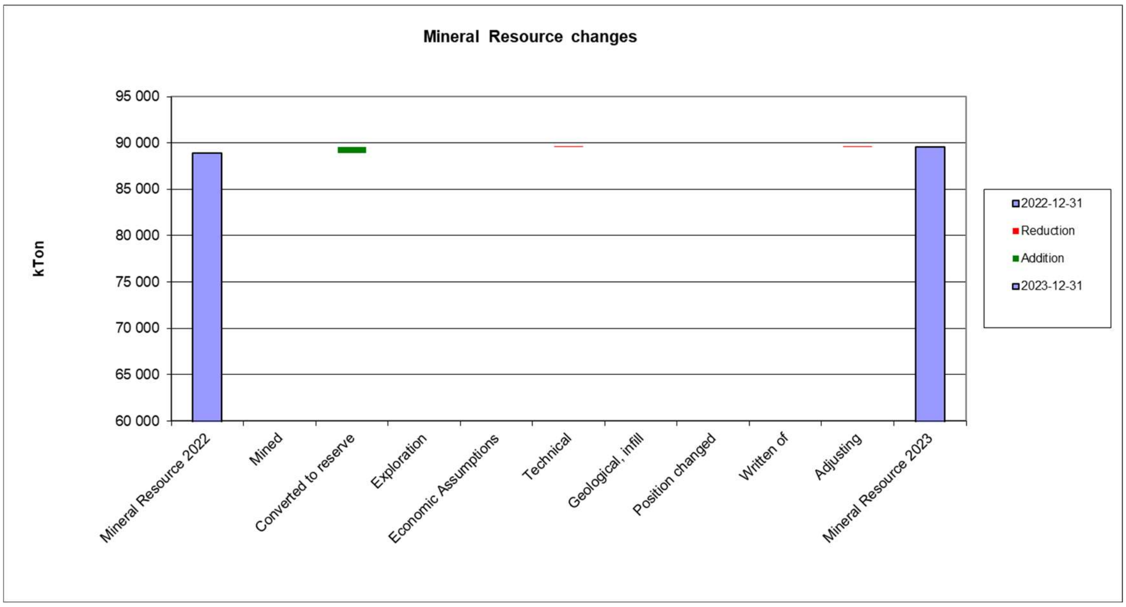

Figure 3-12. Changes to Mineral Resources between 2022-12-31 (leftmost column) and 2023-12-31 (rightmost column). The other columns show the causes for reduction (in red) and addition (in green) of tonnage. Note that the scale of the y-axis has been adjusted and starts at 60 000 kton.

In Dammsjön, a new design was introduced for Etages 1100 and 1300, following the Whittle optimization conducted in 2022/2023, using a higher cut-off than in the previous design (Figure 3-13). The NSR cut-off used for the new design was 610 SEK/t (23LTP25) allowing for pillars as low as 470 SEK/t, instead of previous cut-offs of 470/320. Some other changes in the design were implemented, such as an increase of the height of the stopes to 30 m from 1000z downwards (instead of 25m stopes on all levels previously); and a change in the stoping direction to be more perpendicular to the strike of the ore body. The consequences of these changes are that some of the previously low-grade stopes were shortened or discarded (Figure 3-14). Moreover, in the new design, Etage 1300 lowest level starts at 1270z, and 1270-1300z was reclassified as indicated resource, instead of probable reserve previously. In total, the changes in the design resulted in a decrease of 4.1 Mt in the reported reserve between 900-1300z.

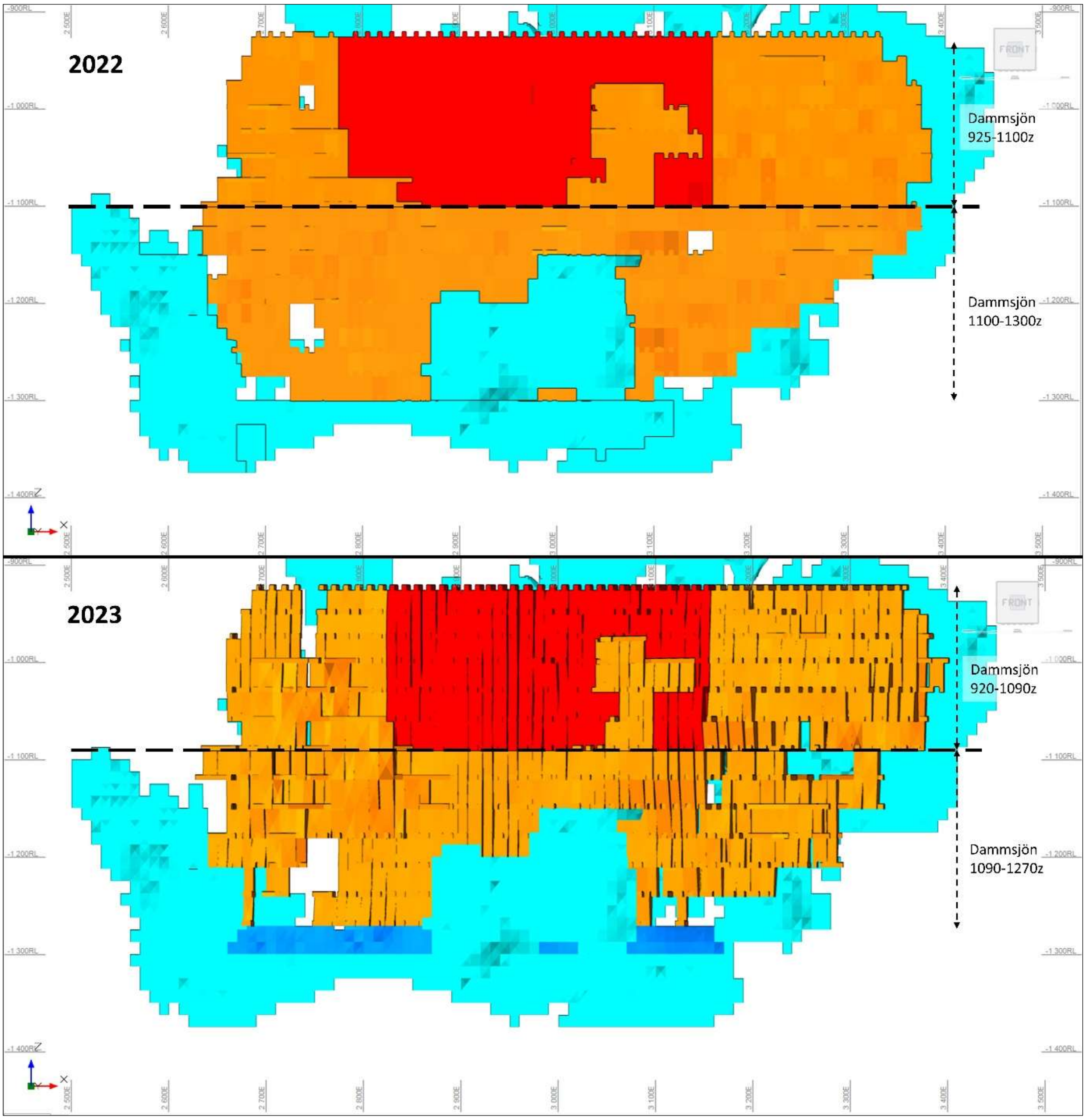

Figure 3-13. Changes in resources and reserves in Dammsjön below 900z. The image is a front view of the Dammsjön ore body, looking North.

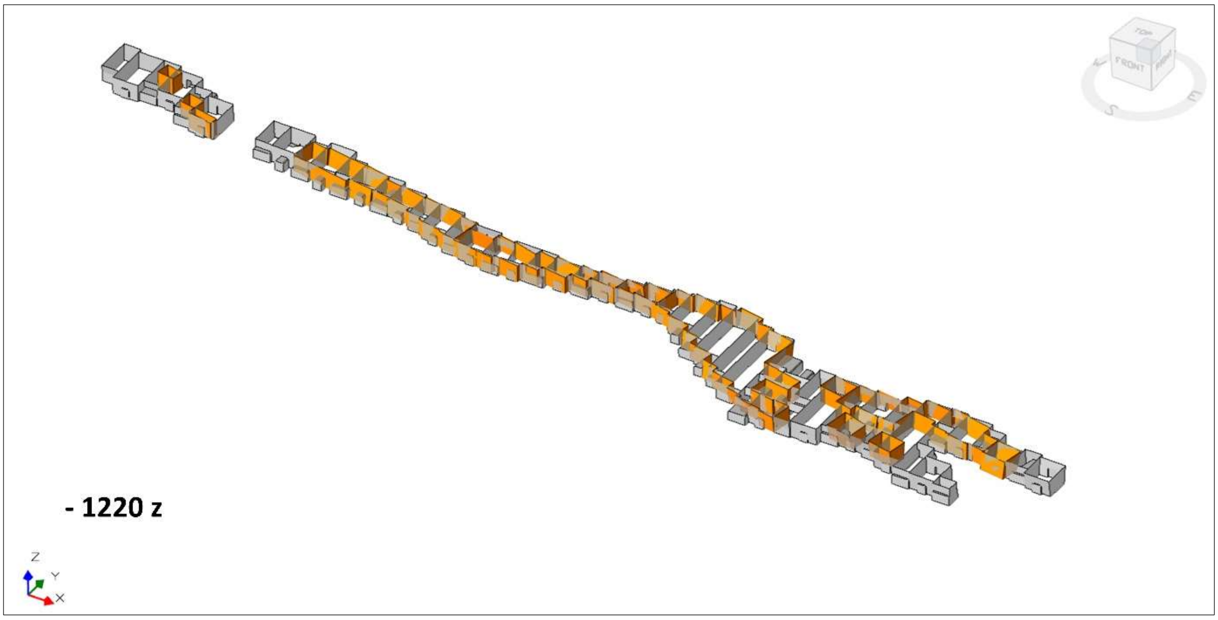

Figure 3-14. Example of change in design in Etage 1300 at level -1220 z. Previously reported reserve in grey, current reported probable reserve in orange. Oblique view, looking North West

In Lappberget, the design of Etage 1250 was also updated following the Whittle optimization. A different set of cutoffs for main sequence and second sequence as per best result from the optimization. For the main sequence, a new NSR cut-off of 700 SEK/ton was used, and 470 SEK/ton for second pass (instead of 850 respectively 320 used previously. The result of this cut-off change was that many of the low-grade stopes in the West were removed from the design.

In the Southern area, positions previously reported as indicated resources have been downgraded to inferred, due to the estimates not being properly documented and have not been reviewed. However, reconciliation data confirming the volumes and grades of adjacent mined volumes led to the decision to keep them in Mineral Resources. This concerns positions LillaStrand855-900 and StoraKanal855-950.

Mined out tonnage in 2023 totals 3 151 Kton, which is an increase by 108 Kton from previous year. Metal grades of the mined out tonnage is as follows: 3.3% Zn, 1.4% Pb and 97 ppm Ag. Over 75% of all mined out ore derived from Lappberget.

Table 3-14. Mineral Resources and Mineral Reserves in Garpenberg as per December 31, 2023. Numbers in brackets show changes from last year.

Classification	kton 2023-12-31		Au (g/t)		Ag (g/t)		Cu (%)		Zn (%)		Pb (%)	
Proved Mineral Reserve	17 249	(-1 410)	0.25	(-)	98	(-)	0.04	(-)	3.0	(- 0.1)	1.3	(-)
Probable Mineral Reserve	83 702	(-6 938)	0.31	(+ 0.01)	88	(+3)	0.05	(-)	2.5	(+0.1)	1.2	(-)
Total Mineral Reserve	*100 933*	*(-8 365)*	*0.30*	*(+ 0.01)*	90	*(+2)*	*0.04*	*(-)*	*2.6*	*(-)*	*1.2*	*(-)*
Measured Mineral Resource	68	(-)	0.24	(-)	108	(-)	0.03	(-)	2.8	(-)	1.0	(-)
Indicated Mineral Resource	21 574	(+18)	0.41	(-)	70	(-)	0.06	(-)	2.7	(- 0.1)	1.3	(-)
Sum Measured and Indicated	*21 642*	*(+18)*	*0.41*	*(-)*	*70*	*(-)*	*0.06*	*(-)*	*2.7*	*(- 0.1)*	*1.3*	*(-)*
Inferred Mineral Resource	67 913	(+500)	0.34	(-)	57	(-)	0.05	(-)	2.3	(-)	1.1	(-)
Total Mineral Resource	*89 555*	(+518)	*0.36*	*(-)*	*60*	*(-)*	*0.05*	*(-)*	*2.4*	*(-)*	*1.1*	*(-)*

3.15 Reconciliation

In order to confirm the precision of the geological interpretation, modelling, grade interpolation etc., actual mining volumes times block model grades are checked against the measured results from the processing plant. This procedure called reconciliation is carried out every month and presented quarterly. Monthly estimates vary dramatically depending on the mine's logistics of stocks in the mine and on surface. The turnover of the stocks also varies a lot.

The grades of the mined-out ore are calculated from the block model using the tonnage reported as loaded from the stopes and ore development. The ore can either be transported directly to the plant or put in stockpiles underground. Above ground, there is an ore storage facility which at the beginning of 2023 contained 82 Kton of ore. During the year the tonnage fluctuated between 40 Kton and 180 Kton. At the end of the year the storage contained 74 Kton of ore.

For the annual report of Reserves and Resources, the reconciliation is compiled from a weighted aggregation of the four quarters (rolling 4 quarters). Table 3-15 shows monthly and quarterly results for 2023 from the mine and the processing plant. The year total is shown on the bottom row. The official grades for Garpenberg are those of the processing plant.

Table 3-15. Comparing measured results from the processing plant with calculated results from the block model. Note that the numbers from the processing plant for December are preliminary.

	Metal Grades of Processed Ore						Metal Grades of Mined Ore from Block Model					
Quarter	kton	Au g/t	Ag g/t	Cu %	Zn %	Pb %	PP kton	Au g/t	Ag g/t	Cu %	Zn %	Pb %
jan	298.3	0.31	102	0.05	4.04	1.62	272.8	0.34	108	0.04	3.65	1.60
feb	236.0	0.40	86	0.07	3.12	1.42	232.7	0.48	95	0.07	3.02	1.60
mar	222.5	0.44	72	0.06	2.88	1.36	234.2	0.33	78	0.05	2.41	1.16
2023 Q 1	**756.7**	**0.38**	**88**	**0.06**	**3.41**	**1.48**	**739.7**	**0.38**	**95**	**0.05**	**3.06**	**1.46**
apr	201.5	0.35	115	0.06	2.76	1.43	234.2	0.45	123	0.06	3.12	1.67
maj	287.1	0.44	114	0.08	3.29	1.62	289.7	0.32	87	0.05	2.92	1.25
jun	283.6	0.37	73	0.15	3.18	1.50	237.2	0.37	104	0.05	3.22	1.28
2023 Q 2	**772.1**	**0.39**	**99**	**0.10**	**3.11**	**1.53**	**761.0**	**0.38**	**104**	**0.06**	**3.07**	**1.39**
2023 Q 1+2	**1528.9**	**0.38**	**94**	**0.08**	**3.26**	**1.50**	**1500.7**	**0.38**	**99**	**0.05**	**3.07**	**1.42**
jul	275.0	0.33	106	0.06	3.69	1.58	265.5	0.38	122	0.07	3.57	1.61
aug	300.4	0.31	89	0.05	2.68	1.17	243.5	0.29	107	0.04	3.06	1.23
sep	285.9	0.37	80	0.07	2.66	1.32	233.5	0.39	75	0.05	2.84	1.23
2023 Q 3	**861.4**	**0.34**	**91**	**0.06**	**3.00**	**1.35**	**742.6**	**0.35**	**101**	**0.05**	**3.15**	**1.35**
2023 Q 1-3	**2390.2**	**0.37**	**93**	**0.07**	**3.16**	**1.45**	**2243.3**	**0.37**	**100**	**0.05**	**3.10**	**1.40**
okt	304.4	0.43	94	0.05	3.27	1.40	283.4	0.36	89	0.05	3.48	1.41
nov	191.4	0.39	119	0.06	3.42	1.35	223.3	0.31	107	0.05	3.67	1.46
dec	265.2	0.30	119	0.04	3.88	1.49	258.5	0.26	112	0.04	3.76	1.46
2023 Q 4	**761.0**	**0.37**	**109**	**0.05**	**3.52**	**1.42**	**765.3**	**0.31**	**102**	**0.05**	**3.63**	**1.44**
2023 Q 1-4	**3151.2**	**0.37**	**97**	**0.07**	**3.25**	**1.44**	**3008.6**	**0.36**	**100**	**0.05**	**3.23**	**1.41**

The rolling 4-quarter graph for zinc, lead and silver is shown below in Figure 3-15. The graph shows the difference in % in weighted metal grades between processed ore and mined ore and is calculated with the following equation: (Metal Grade Processing Plant/Metal Grade Block Model)-1. Thus, a positive number means that the grade is higher in the processing plant than in the block model. The values for Q 1-4 2023 seen at the rightmost side of the graph are: +0.6% Zn, +2.2% Pb and -3.8% Ag.

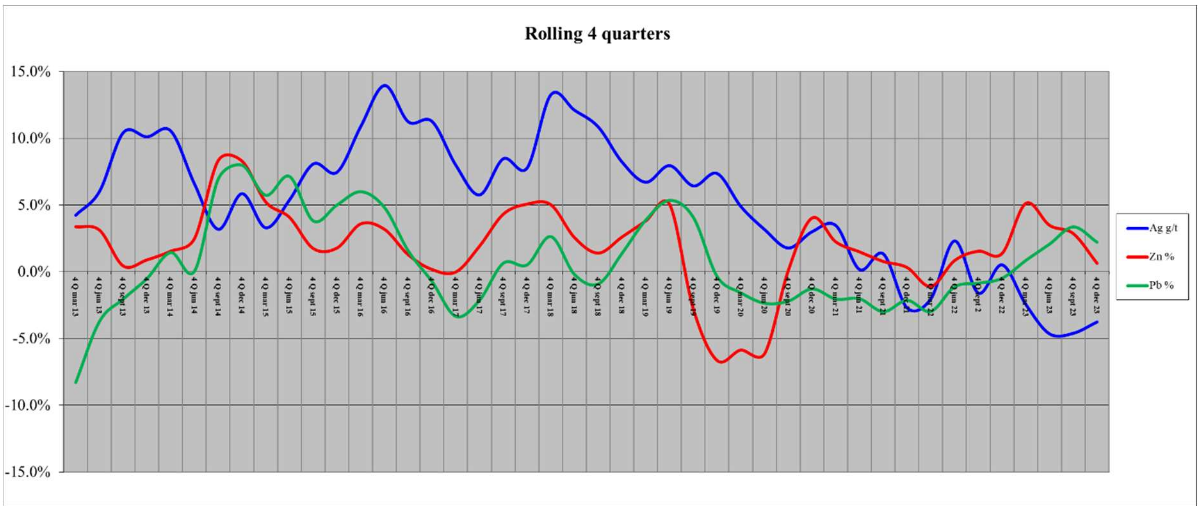

Figure 3-15. Metal grades in processed ore vs metal grades of the mined ore based on the block model, over a ten-year period.

4 REFERENCES

Allen, R. L., Lundström, I., Ripa, M., Simeonov, A. and Christofferson,. 1996. Facies Analysis of a 1.9 Ga, Continental Margin, Back-Arc, Felsic Caldera Province with Diverse Zn-Pb-Ag-(Cu-Au) Sulfide and Fe Oxide Deposits. *Economic Geology,* 91: 979-1008.

Allen, R.L., Bull, S., Ripa, M. and Jonsson, R. 2003. Regional Stratigraphy, Basin Evolution, and the Setting of Stratabound Zn-Pb-Cu-Ag-Au Deposits in Bergslagen, Sweden. Final report SGU-FoU project 03-1203/99, Geological Survey of Sweden.

Bindler, R., Karlsson, J., Rydberg, J., Karlsson, B., Berg Nilsson, L., Biester, H., Segerström, U. 2017. Copper-ore mining in Sweden since the pre-Roman Iron Age: lake-sediment evidence of human activities at the Garpenberg ore field since 375 BCE. *Journal of Archaeological Science Reports* **12**: 99-108

Jansson, N.F., Allen, R.L. 2011. Timing of volcanism, hydrothermal alteration and ore formation at Garpenberg, Bergslagen, Sweden. *Geologiska Föreningens Förhandlingar* **133**: 3-18.

Pan-European Standard for reporting of Exploration results, Mineral Resources and Mineral Reserves (The PERC Reporting standard 2021). www.percstandard.eu

Vivallo, W. 1985. The geology and genesis of an Early Proterozoic massive sulfide deposit at Garpenberg, central Sweden. *Economic Geology,* 80: 17-32.

Appendix 1

A historical overview

~1200	Mining operation commences
1544	Gustav Wasa takes over the mining operation
1840	Discontinuation of mining operation
1906	Mining operation resumed
1908	The first concentrator was built
1923	AB Zinkgruvor, Falun takes over the activity from AB Garpenbergs Odalfält
1928	A new concentrator was built
1950-53	New shaft, head frame and a new concentrator were built
1957	Boliden – new owner
1972	The Garpenberg Norra mine in operation
1989	Increased capacity in the concentrator
1994	Shaft extension to 800 m level in Garpenberg Norra
1996	New hoisting shaft, the Gruvsjö shaft, in the Garpenberg mine
1997	A 1000 m long drill hole was sunk towards the south from the ramp in Garpenberg Norra whereupon Kaspersbo and Lappberget were indicated
2000	Connection drift, development starts
2003	Lappberget diamond core drilling to 800 and 1000 meter level
2003	Lappberget in operation. Kvarnberget was indicated in a drill hole drilled from Lappberget. The connection drift between the two mines was completed – one mine.
2007	Paste plant was built and the mining method longhole stoping commenced
2008	Pre-project study for extension to 2 Mt
2009	Concept study of Water-inflow in Garpenberg
2010	Pre-project study for extension to 2.5 Mt
2011	The expansion to 2.5 Mt commenced during the year Drainage drilling in 500 level in Lappberget started
2013	Drainage pumping has started. The expansion project 2.5 is nearing completion. Kvarnberget has prepared for mining with the first ore blast in December 2013.
2014	Expansion project to 2.5 Mt completed. New crusher, shafts, ore hoists etc. taken into use. First ore from Kvarnberget delivered to the concentrator. Level 1300 Z passed in Lappberget
2016	Production of 2.6 Mt successfully reached. Ventilation shaft to LAPP 554 ready. Record production of paste, 1005 Kton. First transverse stope mined in KVB.
2020	Production of 3.0 Mt successfully reached
2022	Level 1500 Z passed in Lappberget ramp