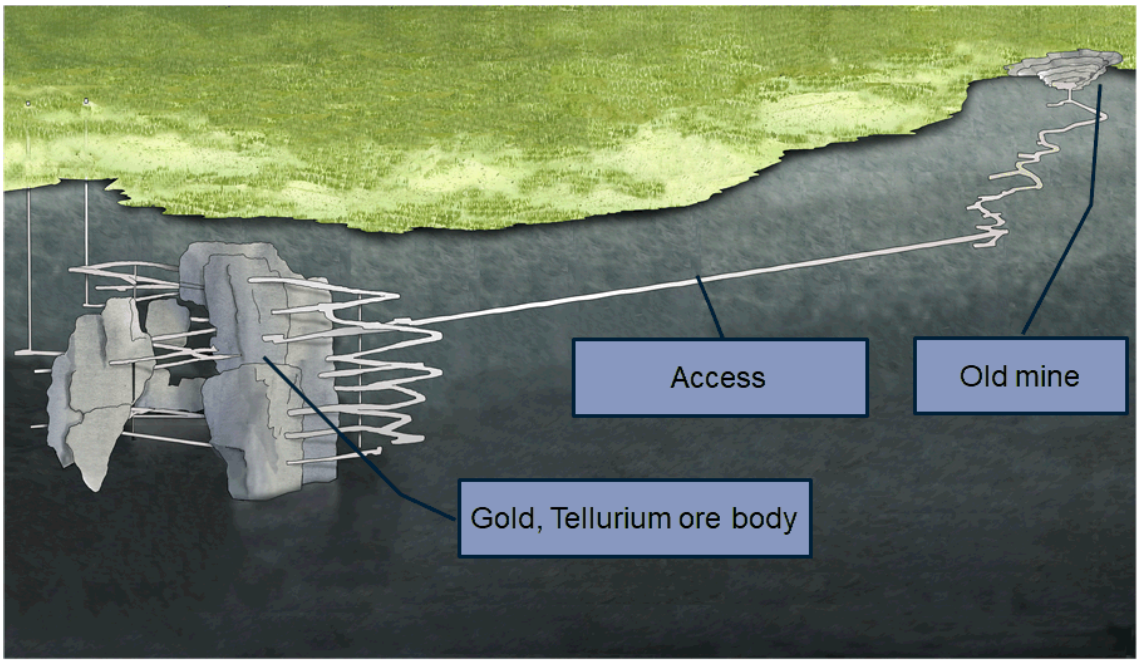
Boliden Summary Report

Resources and Reserves | 2019

Kankberg – Åkulla Östra



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1 SUMMARY

Boliden AB ("Boliden") is a Swedish mining and smelting company focusing on production of copper, zinc, lead, gold and silver. Boliden operates six mining areas and five smelters in Sweden, Norway, Finland, and Ireland. The company primarily processes zinc, copper, nickel, gold, lead, and silver and is engaged in exploration, mining, smelting, and metals recycling.

This Competent Person's Report (CPR) concerns Boliden's wholly owned Kankberg mine (Sweden) and has been prepared in accordance with the guidelines set out in the Pan-European Reserves and Resources Reporting Committee (PERC) "PERC Reporting Standard 2017". The report is updated and issued annually to provide the public (stakeholders, shareholders, potential investors and their advisers) with:

- A comprehensive overview of the Kankberg mine as an on-going mining operation;
- Mineral Resource and Mineral Reserve statements for the mine and a description of methods used to estimate these; and
- An overview of the Boliden Area Operations, of which the Kankberg mine is a part.

The Kankberg mine is located 41 km northwest of Skellefteå in Västerbotten county, northern Sweden. Production commenced in 2012 and has continued uninterrupted to the present day, for a total of 2.9 million tonnes (Mt), with an average grade of 3.5 g/t Au, 11 g/t Ag and 163 g/t Te. Current production is from underground cut and fill methods, between depths of -530m and -330m level, via a ramp-drive system from the historic Kankberg open pit mine to the north. In 2019, the mine produced 478 660 tonnes (t) at an average grade of 3.61 g/t Au, 12 g/t Ag and 194 g/t Te.

Approximately 96% of total forecast revenue from Kankberg is derived from gold (Au), with remainder from tellurium (Te) and silver (Ag).

Run of mine ore from Kankberg is stockpiled and trucked to the Boliden Area Operations central concentrator (10 km), before further processing to final product at the Rönnskär smelter (50 km). Kankberg has a forecast mine life to 2030. The mine employs roughly 117 staff with and additional contractors.

The effective date of this report is 31 December, 2019.

A summary of Mineral Reserves and additional Mineral Resources is presented in Table 1.

Table 1. Mineral Reserves and additional Mineral Resources from the Kankberg Mine 31-12-2019 and comparison against previously reported on 31-12-2018.

Classification	kt	Au (g/t)	Ag (g/t)	Te (g/t)	2019 Bi (g/t)	kt	Au (g/t)	Ag (g/t)	Te (g/t)	2018 Bi (g/t)
Mineral Reserves										
Proved	**3 110**	**3.3**	**11**	**179**	**87**	2 720	3.8	12	182	94
Probable	**1 930**	**3.5**	**6**	**135**	**80**	1 510	3.4	8	153	81
Total	**5 050**	**3.4**	**9**	**162**	**84**	4 220	3.7	10	171	89
Mineral Resources										
Measured	**200**	**3.5**	**8**	**121**	**84**	260	4.0	11	155	88
Indicated	**670**	**4.0**	**8**	**162**	**100**	600	5.2	7	151	97
Total M&I	**870**	**3.9**	**8**	**152**	**97**	860	4.8	8	152	94
Inferred	**1 460**	**3.9**	**7**	**161**	**106**	1 390	5.2	9	209	137

2 COMPETENCE

Information supporting this report includes historic data and recent studies, compiled by a team of Boliden's in-house technical staff and external consultant(s). These individuals are specialists in their field and, in general, have extensive personal experience of the operation. Their role in the preparation of this document is presented in Table 2, along with an indication as to responsibility and Competent Person (CP) status.

Table 2. Contributors and responsible Competent Persons

Report Section	Contributors	Support to Competent Persons	Competent Persons
Overall report compilation	Birger Voigt	Mark Howson	Johan Bradley
Mineral Resources			Gunnar Agmalm
Mineral Reserves			Gunnar Agmalm
Geology	Birger Voigt, Susanne Holmen	Lina Åberg	
Resource Estimation	Lina Åberg		
Reserve Estimation	Tina Zizek	Markus Isaksson	
Mineral Processing	Lisa Malm	Andreas Berggren	
Mining	Tina Zizek	Markus Isaksson	
Environmental permitting	Anna Virolainen	Joanna Lindahl	

See Section 4 for Competent Person professional affiliations and Consent Statements.

3 ASSESSMENT CRITERIA

This section of the report is to support the reporting of Mineral Reserves and additional Mineral Resources by providing information prompted by Table 1 in the PERC Standard.

PERC Table 1 has four columns. The first is 'Assessment Criteria' and its entries are used as the sub-section headings in this section, where they are relevant. This includes 'Table 1 Part 1 – General', 'Part 2 - Sampling Techniques and Data' and 'Part 4 - Estimation and

Reporting of Mineral Resources and Mineral Reserves'. Omissions are in 'Part 3 – Reporting of Exploration Results' and Part 5 on diamonds.

The other three Table 1 columns are respectively 'Exploration Results', 'Mineral Resources' and 'Mineral Reserves'. Given the development status and operating history of the Kankberg mine, the focus of this report is on column four, 'Mineral Reserves'.

3.1 Purpose of Report

This Competent Person's Report (CPR) concerns Boliden's wholly owned Kankberg mine (Sweden) and has been prepared in accordance with the guidelines set out in the Pan-European Reserves and Resources Reporting Committee (PERC) "PERC Reporting Standard 2017" (see www.percstandard.eu). This is one of the world-wide CRIRSCO (see www.crirsco.com) group of standards, along with JORC, CIM, SAMREC etc.

The report is updated and issued annually to provide the public (stakeholders, shareholders, potential investors and their advisers) with:

- A comprehensive overview of the Kankberg mine as an on-going mining operation;
- Mineral Resource and Mineral Reserve statements for the mine and a description of methods used to estimate these; and
- An overview of the Boliden Area Operations, of which the Kankberg mine is a part.

It is a full evaluation of supporting information for the Mineral Reserves and additional Mineral Resources, at the effective date of 31/12/2019.

This CPR is based largely on earlier annual summary reports that were compiled in accordance with the reporting standards of the Fenno-Scandian Review Board (FRB). Boliden adopted the current reporting guidelines (PERC) in 2019. The author acknowledges that work is on-going to address any gaps in supporting information, in order to produce a CPR that is intended, as far as possible, to comply with the PERC Standard and to uphold the main principles governing its operation and application of transparency, materiality, competence, and impartiality.

In support of this transition to PERC, the preparation of this report was assisted by an independent geologist, as outlined in Section 3.12 below.

3.2 Project Outline

The Kankberg mine is located 41 km northwest of Skellefteå in Västerbotten county, northern Sweden. Ore is hosted by an alteration zone in a suite of felsic volcanic and volcaniclastic rocks. Production commenced in 2012 and has continued uninterrupted to the present day, for a total of 2.9 million tonnes (Mt), with an average grade of 3.5 g/t Au, 11 g/t Ag and 163 g/t Te (31 Dec, 2019).

Current production is from underground, cut and fill methods, between depths of -530 and -330 level, via a ramp-drive system from the historic Kankberg open pit mine to the north. Room-and-Pillar layout is used, where the ore is taken in rooms of generally 6m in height, and 10m wide leaving pillars of 6m x 6m. When the level is mined out, it is backfilled so that the level above can be mined. Fill is waste rock, either from elsewhere in the mine, or trucked in from the waste dumps at an historic mine.

In 2019, the mine produced 478 660 tonnes (t) at an average grade of 3.61 g/t Au, 12 g/t Ag and 194 g/t Te.

Run Of Mine (ROM, i.e. just mined) ore from Kankberg is stockpiled on surface before being trucked to the Boliden Area Operations Processing Plant (BAOPP), a distance of 10 km from the mine. The ore from Kankberg is processed in campaigns or batches, each of which may take a few weeks. The recovery of gold achieved from Kankberg ore is 86%. Tailings from all three mines are deposited at a tailings management facility close to the BAOPP. At present production levels, both process plant and tailings management facility are considered to have sufficient capacity to see out the life of Kankberg.

Concentrates and doré bars containing gold and silver from the BAOPP are transported about 50 km to Boliden's Rönnskär smelter at the port of Skelleftehamn, from where the refined metals are marketed. Tellurium is sold as a concentrate mainly to China.

BAOPP receives material from two other mines in the area, namely Renström and Kristineberg. A forth mine, Maurliden, which also used the BAOPP, ceased operations in 2019 due to depletion.

Figure 1: Schematic representation of the location of the Boliden Area Operations in Sweden, showing mines, process plant and smelter location.

A potential risk to the Kankberg Mineral Reserves and Mineral Resources is that future new and more valuable mineral discoveries in the district could replace capacity in the tailings management facility currently earmarked for Kankberg. While negative for the Kankberg operation, this would be a positive risk for the investor.

3.3 History

Figure 2 is a sketch map to show the approximate location of the deposit in relation to three historic open pit workings and other features. The map coordinate grid is SWEREF99 TM.

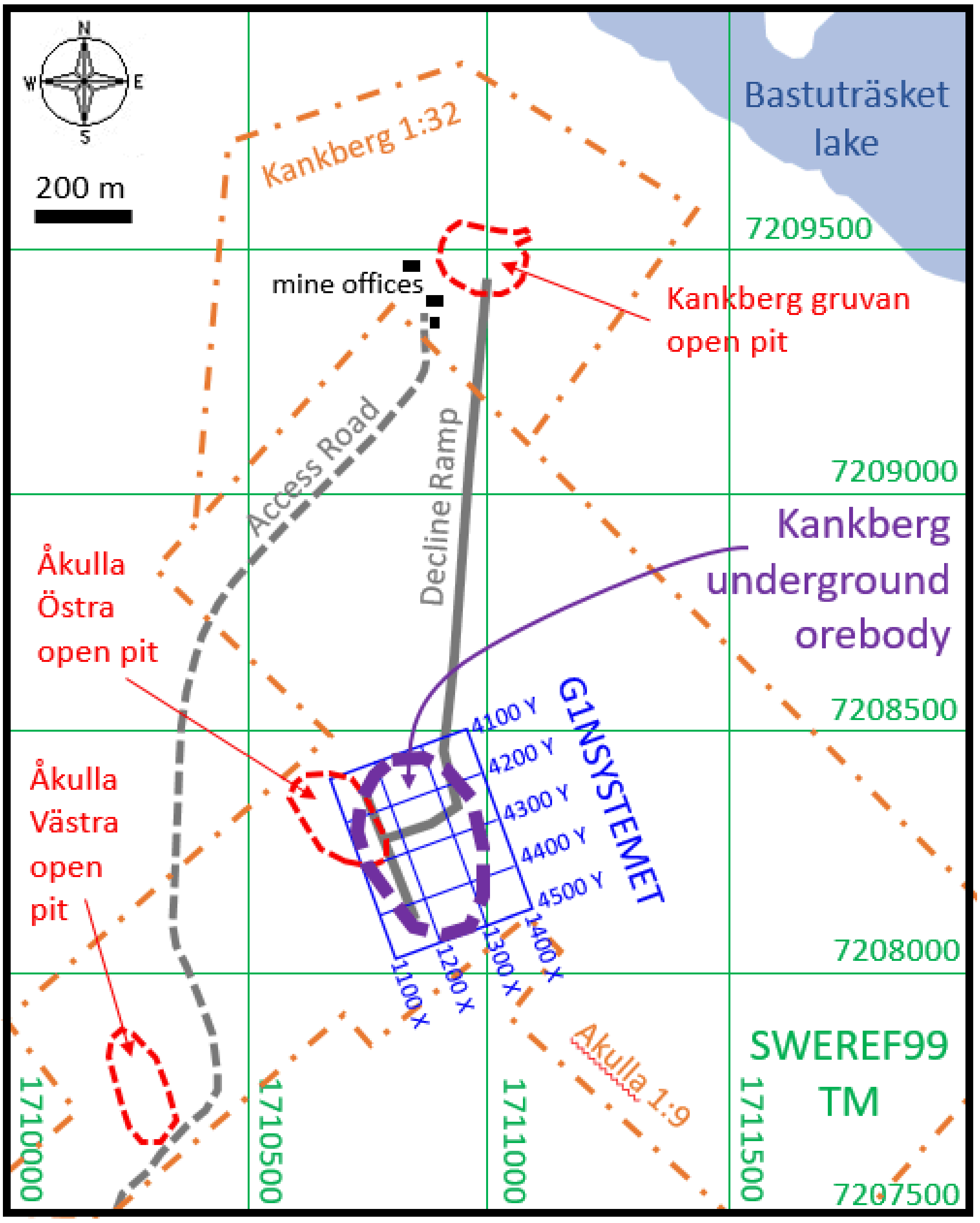


Figure 2: Sketch map of a 2 km x 2.5 km area showing the Kankberg orebody outline and access, historic open pits, land rights and coordinate systems.

The three historic open pits are Åkulla Östra, Åkulla Västra and Kankberg gruvan, which is now also called 'The Old Kankberg Mine'. Sulfide-hosted copper, gold, silver and a little zinc were mined from these deposits. Respectively, their ore tonnages were 197 kt, 967 kt and 1.17 Mt. The former two were mined during 1997 to 1998 and 1947 to 1956 respectively. These open pits have been filled and reclaimed. Kankberg gruvan was mined in two periods, from 1966 to 1969 and 1988 to 1998 and now provides access to the (New) Kankberg Mine, via a decline ramp from the base of the pit to the underground orebody. The mine offices and stockpiles are near Kankberg gruvan at the end of the tarred access road.

A brief pre-production history of the Kankberg project is given in Appendix 1, up to the Feasibility Study (FS) of January 2011 and production commencing in January 2012. The FS included 117 drill holes comprising 15 415 metres, all assayed in mainly 2 m samples.

A feature of the Mineral Resources reported for Kankberg is that they include factors for mining dilution and recovery, which vary with category (i.e. Inferred to Measured). These are described and discussed below under 'Mining factors or assumptions'. These factors mean that Mineral Resources and Mineral Reserves can be aggregated together for analysis; if not for reporting then at least for reconciliation of what was mined with what was estimated through the history of the mine operation.

For comparative purposes, Table 3 lists the Mineral Resources and Reserves (for Au only) reported respectively in:

- The feasibility study from 31-12-2010;
- Total production to 31-12-2018;
- The statement from 31-12-2018; and
- The statement from 31-12-2019.

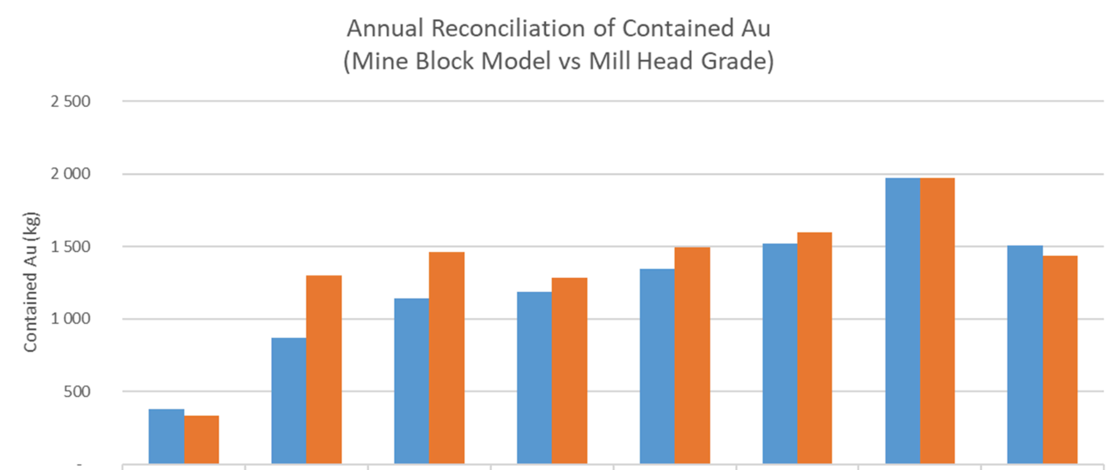
This shows that exploration and infill drilling have increased the contained gold in Mineral Reserves, both mined and to be mined by 130%, or by a factor of 2.3 during the time period 31-12-2010 to 31-12-2019.

Table 3: Mineral Resources and Ore Reserves at FS, total production and comparison between statements reported 31-12-2018 and 31-12-2019 (Au only).

Classification								
FS, reported 2010-12-31			**Total Production**		**Reported 2018-12-31**		**Reported 2019-12-31**	
	kt	**Au (g/t)**	**kt**	**Au (g/t)**	**kt**	**Au (g/t)**	**kt**	**Au (g/t)**
Proved Reserve	**120**	**3.5**	**2 400**	**3,7**	**2 720**	**3.8**	**3 110**	**3.3**
Probable Reserve	**2 661**	**4.1**			**1 510**	**3.4**	**1 930**	**3.5**
Total Reserve	*2 781*	*4.07*			*4 220*	*3.7*	*5 050*	*3.4*
Measured Resource	**59**	**2.2**			**260**	**4.0**	**200**	**3.5**
Indicated Resource	**605**	**2.4**			**600**	**5.2**	**670**	**4.0**
Inferred Resource	**120**	**6.0**			**1 390**	**5.2**	**1 460**	**3.9**

Monthly production figures have been recorded since production started, for both the mine and the mill. The mine figures are calculated using surveyed volumes of what was mined to evaluate tonnes and grades from the most recently estimated block model. These will be of Proved Mineral Reserves, since before ore is mined it has passed through the stages of infill drilling, estimation and planning to reach Proved category.

The mill figures are calculated by weight and sampled grades of comminuted feed after milling. Since there is no grade control sampling to provide independent adjudication, a comparison between the mine and mill figures would be the best indication of the quality of the block model estimation, and hence of the quality of the Proved Mineral Reserves. Figure 3 and Figure 4 show comparisons of contained gold in mine and mill figures, respectively on an annual and quarterly basis. At the time of writing (November 2019) the latest production data available were for October 2019, hence the last year and quarter production figures are represented by 10 months and 1 month respectively.



	2012	2013	2014	2015	2016	2017	2018	2019
Mine	379	866	1 140	1 188	1 350	1 518	1 976	1 510
Mill	336	1 301	1 462	1 284	1 497	1 595	1 973	1 438

Figure 3: Comparison of annual mine and mill contained gold

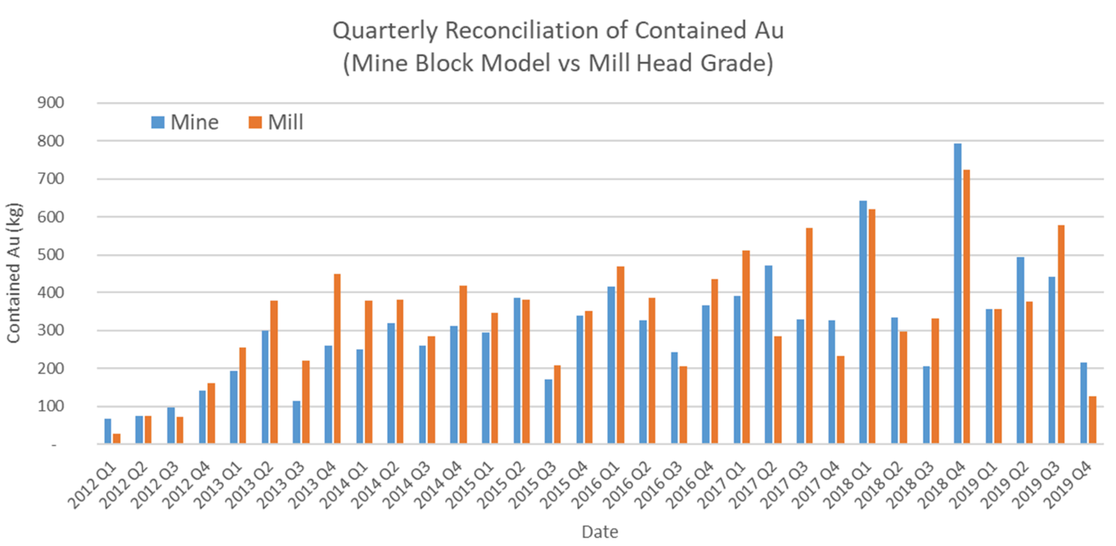


Figure 4: Comparison of quarterly mine and mill contained gold

An important aspect to consider when reviewing these graphs is that ore is mixed through a process of transport and stockpiling, once at the mine, and then again on arrival at the mill. ROM stockpile residence time at the mine typically varies from between 1 to 6 months, but may be as much as 18 to 24 months in smaller sections of the pile. Material residence time at the mill typically varies from between 1 to 3 months prior to batch processing at the BOAPP. As such, there is little value in attempting a monthly reconciliation.

In the quarterly graph, most of the disparity between mine and mill is strongly influenced by this delay. In the annual graph, the effect of stockpiling is less obvious. There appears to be a consistent bias between the years 2013 and 2016, with the mill reporting higher contained gold, followed by an improvement in performance between years 2017 to 2019.

The reconciliation data is summarized in Table 4 and Table 5 below, for the time periods 2012 to 2019 and 2015 to 2019 respectively. The Relative Accuracy figures are at 90% confidence, which means that a result would be expected to fall outside the accuracy range in 10% of cases.

Table 4: Summary of reconciliation data between 2012 and 2019 (all data)

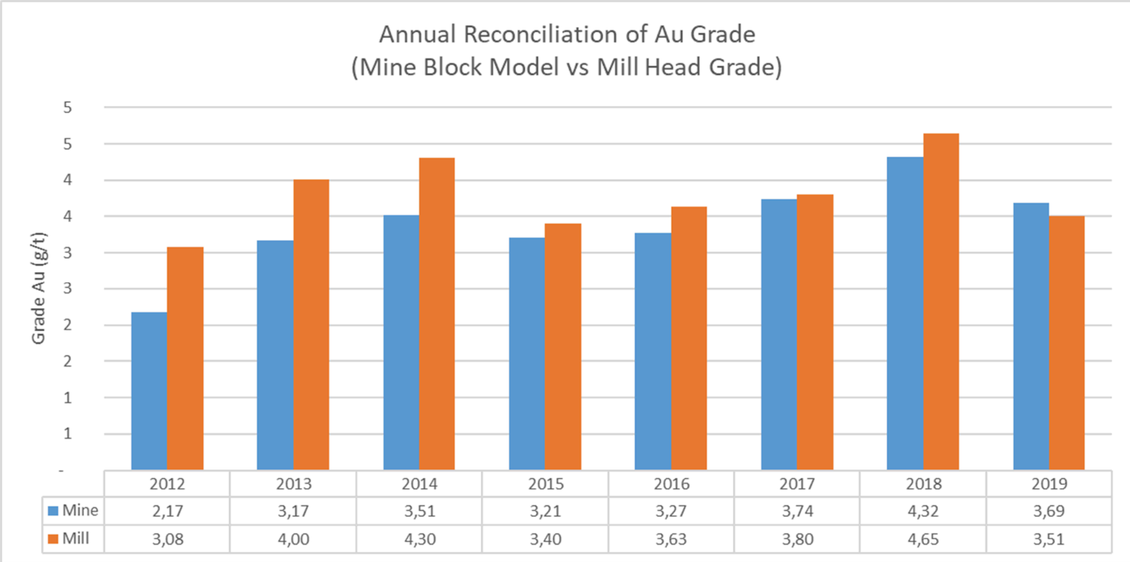
Unit of comparison	Mine	Mill	% Diff	Relative Accuracy Quarterly Basis	Relative Accuracy Annual Basis
Contained Au (kg)	9 927	10 886	9%	27%	15%
Grade (g/t)	3.51	3.99	9%	20%	14%
Tonnes (Mt)	2 827	2 817	0%	30%	15%

Table 5: Summary of reconciliation data between 2015 and 2019 (all data)

Unit of comparison	Mine	Mill	% Diff	Relative Accuracy Quarterly Basis	Relative Accuracy Annual Basis
Contained Au (kg)	7 542	7 788	3%	23%	5%
Grade (g/t)	3.67	3.81	4%	12%	5%
Tonnes (Mt)	2 055	2 043	-1%	23%	3%

For all data shown above, the total contained gold for the mine was 9,927 kt and the total for the mill was 10,886 kt, giving a difference of 9%. Estimation techniques in earlier years were not at the standard that is now applied and there has been gradual improvement. The FS model was calculated using the Inverse Power of Distance estimation calculation rather than the more accurate Kriging. Kriging was introduced early 2012 when the drill density was considered sufficient to support geostatistical variogram study. Since January 2015, the total contained gold for the mine was 7,542 kt and the total for the mill was 7,788 kt, giving a difference of 3%, which is a marked improvement.

To further investigate, Figure 5 and Figure 6 show comparisons of gold grade in mine and mill figures, respectively annual and quarterly. Figure 7 and Figure 8 show comparisons of ore tonnes in mine and mill figures, respectively annual and quarterly.



	2012	2013	2014	2015	2016	2017	2018	2019
Mine	2,17	3,17	3,51	3,21	3,27	3,74	4,32	3,69
Mill	3,08	4,00	4,30	3,40	3,63	3,80	4,65	3,51

Figure 5: Comparison of annual mine and mill gold grade

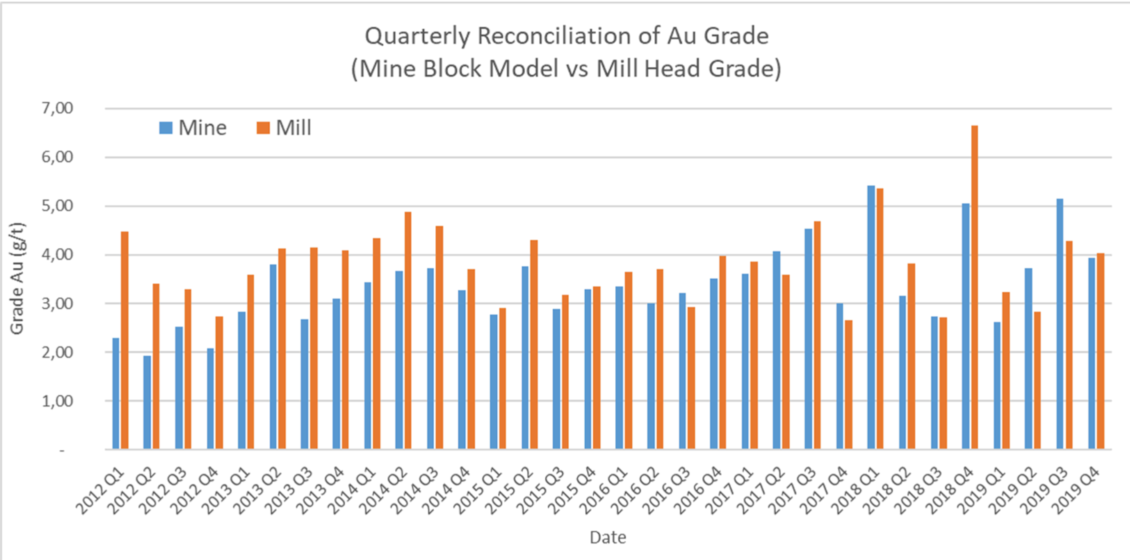
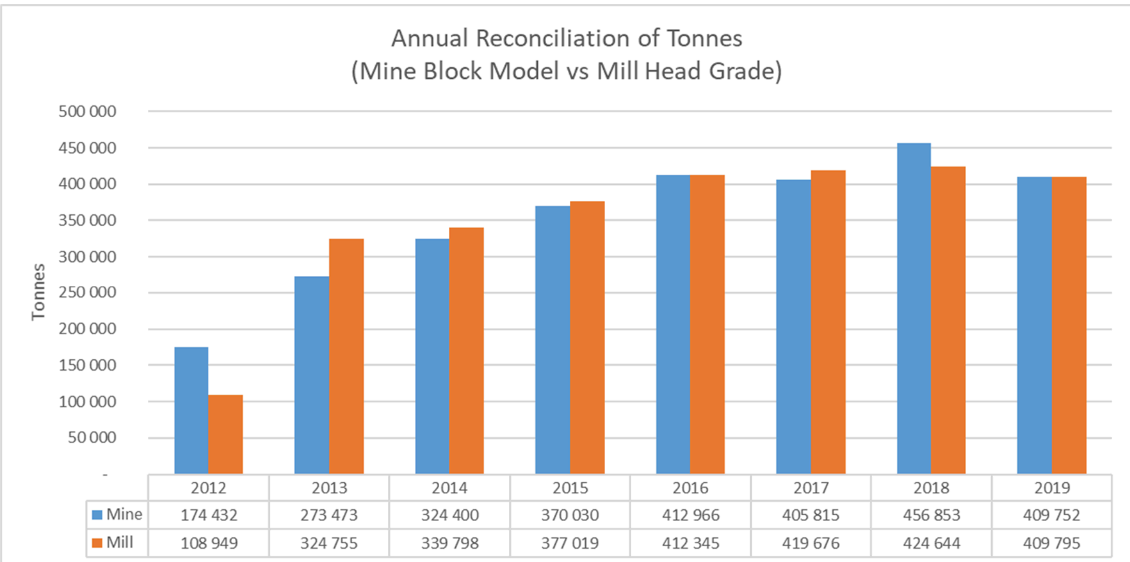


Figure 6: Comparison of quarterly mine and mill gold grade



	2012	2013	2014	2015	2016	2017	2018	2019
Mine	174 432	273 473	324 400	370 030	412 966	405 815	456 853	409 752
Mill	108 949	324 755	339 798	377 019	412 345	419 676	424 644	409 795

Figure 7: Comparison of annual mine and mill ore tonnes

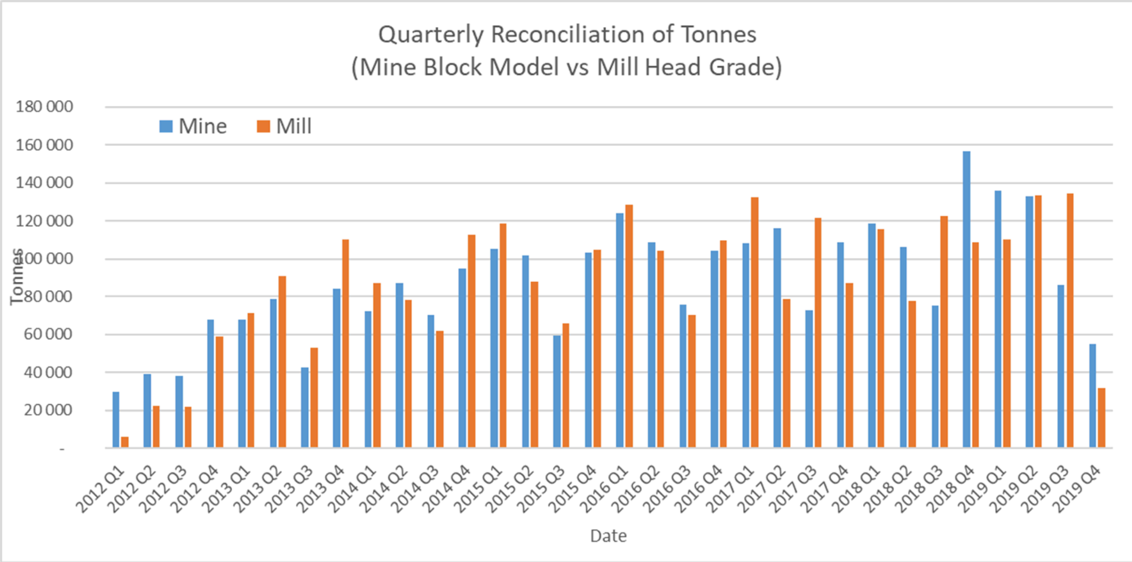


Figure 8: Comparison of quarterly mine and mill ore tonnes

In each case, these four graphs show reasonable correspondence, if allowance is made for the delay in processing described above. There is much greater correspondence in the annual figures due to smoothing of the disparities seen in the quarterly figures.

For all time periods, there was a total of 2.83 Mt of ore for the mine and the total for the mill was 2.82 Mt, giving a difference of under 1%. Since January 2015, there were 2.06 Mt for the mine and the total for the mill was 2.04 Mt giving an even smaller difference. It appears that that the estimation of tonnage is unbiased. One might ask if the same comparison can be completed for grade. But since grade should be weighted by tonnes, this calculation is essentially the same as that carried out for contained gold as described above (see Table 4 and Table 5 above).

There is a specific reason for selecting annual and quarterly time periods for reconciliation. In an important presentation, the Chairman of CRIRSCO and an authority on mineral asset estimation and reporting, Dr Harry Parker (2010) proposed that “Indicated Mineral Resources should be known with a relative accuracy of ± 15 % at 90 % confidence for annual production increments” and that “Measured Mineral Resources should be known with a relative accuracy of ± 15 % at 90 % confidence for quarterly production increments”. The reference to “known” is generally in terms of contained product. These proposals are for a ‘typical’ deposit. After discussion, it has been considered that for a near-marginal iron ore deposit, a relative accuracy of better than ± 10 % rather than ± 15 % may be appropriate, whereas for a nuggetty mineral such as gold, a relative accuracy of ± 20 % may be more appropriate and may still be difficult to achieve.

To investigate the Proved category, which has been transferred from Measured Mineral Resources by planning, the relative accuracy for quarterly production increments must be determined. Assuming that the error is equally distributed between the mine and the mill, and for all the contained gold figures from 2012 Q1, a Coefficient of Variation (CoV) was determined between mine and mill data of 0.1661. Using the inverse of the Normal Distribution, this gives a relative accuracy of ± 27 % at 90 % confidence (Table 4). However, from the graphs, statistics and discussion above, estimation for the early years was probably unreliable relative to the present.

From 2015 Q1 the CoV is 0.1393, which gives a relative accuracy of ± 23 % at 90 % confidence (Table 5). This still may be considered poor, but not in the context of the delay in processing through the effects of stockpiling, which on the quarterly basis must cause most of the disparity between mine and mill. If the effect of this delay could be removed from the mill figures, then it seems likely that the relative accuracy at 90 % confidence would be well within ± 20 % and possibly better than ± 15 %.

Therefore, it is concluded that the drilling density and estimation at the Measured and Proved categories yield results that are both unbiased and of adequate accuracy.

3.4 Key Plan, Maps and Diagrams

Figure 9 shows a road and topography map of the Kankberg - Boliden area. The coordinate system used here is the Svenska Rikssystemet RT 90 2.5 gon väst, and is the older national standard, but is similar to the present national cadastral standard SWEREF99 TM. The location of the 'New' i.e. present Kankberg Mine is shown as a blue mine symbol, while the 'Old' Kankberg Mine, which provides access, is shown as an exhausted (upside-down) mine symbol. Ore from the mine is transported 10 km southeast to the Boliden Area Operations Processing Plant (BAOPP), shown as a blue square near the small town of Boliden.

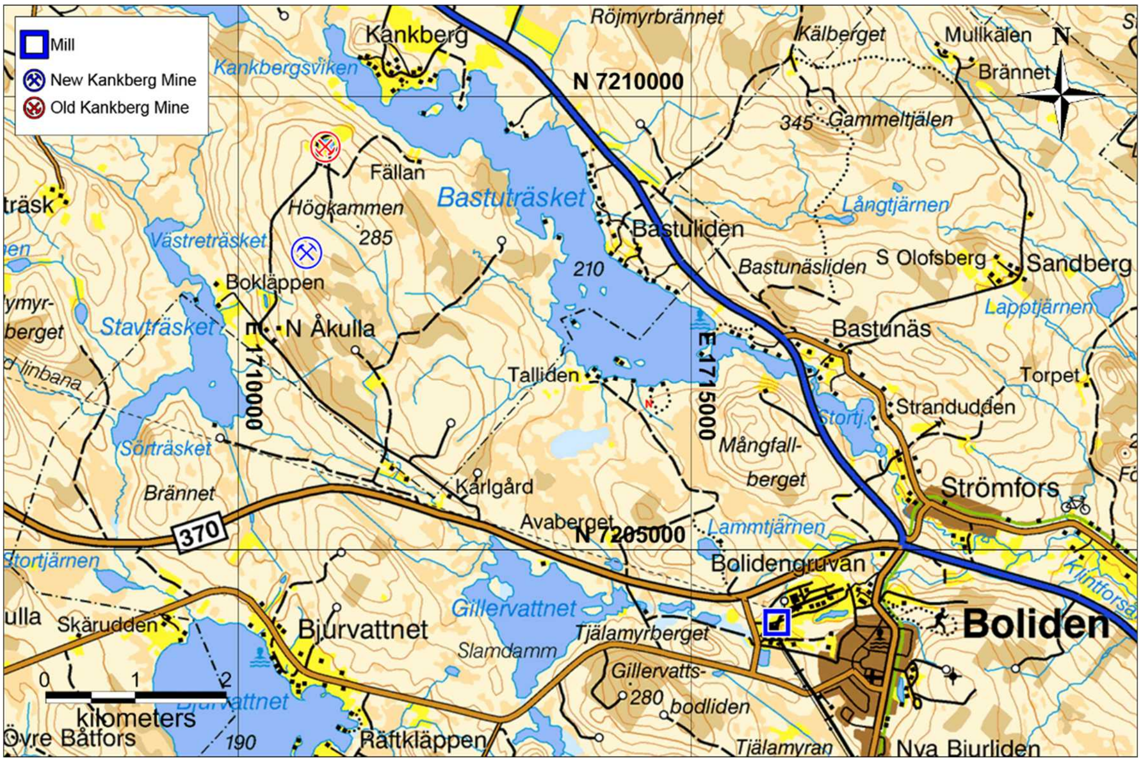


Figure 9: Index Map of the "Kankberg - Boliden" area

3.5 Project Location and Description

The Kankberg mine is located at latitude 64º55'20" N longitude 20º16'00" E in the north of Sweden, the province and county of Västerbotten and in the Skellefteå Municipality, close to its border with the neighbouring Norsjö Municipality. It lies about 41 km northwest of the city of Skellefteå with hotels, airport connections to Stockholm, and its port, Skelleftehamn, on the Gulf of Bothnia.

Figure 10 below is a map that gives locations of mining and exploration concessions in the Kankberg district, with further details under 'Mineral rights and land ownership' and 'Legal Aspects and Tenure', below. The coordinate grid used for the map is the present national cadastral standard SWEREF99 TM. Within the mining concessions there are a few houses, now owned by Boliden and maintained but unoccupied.

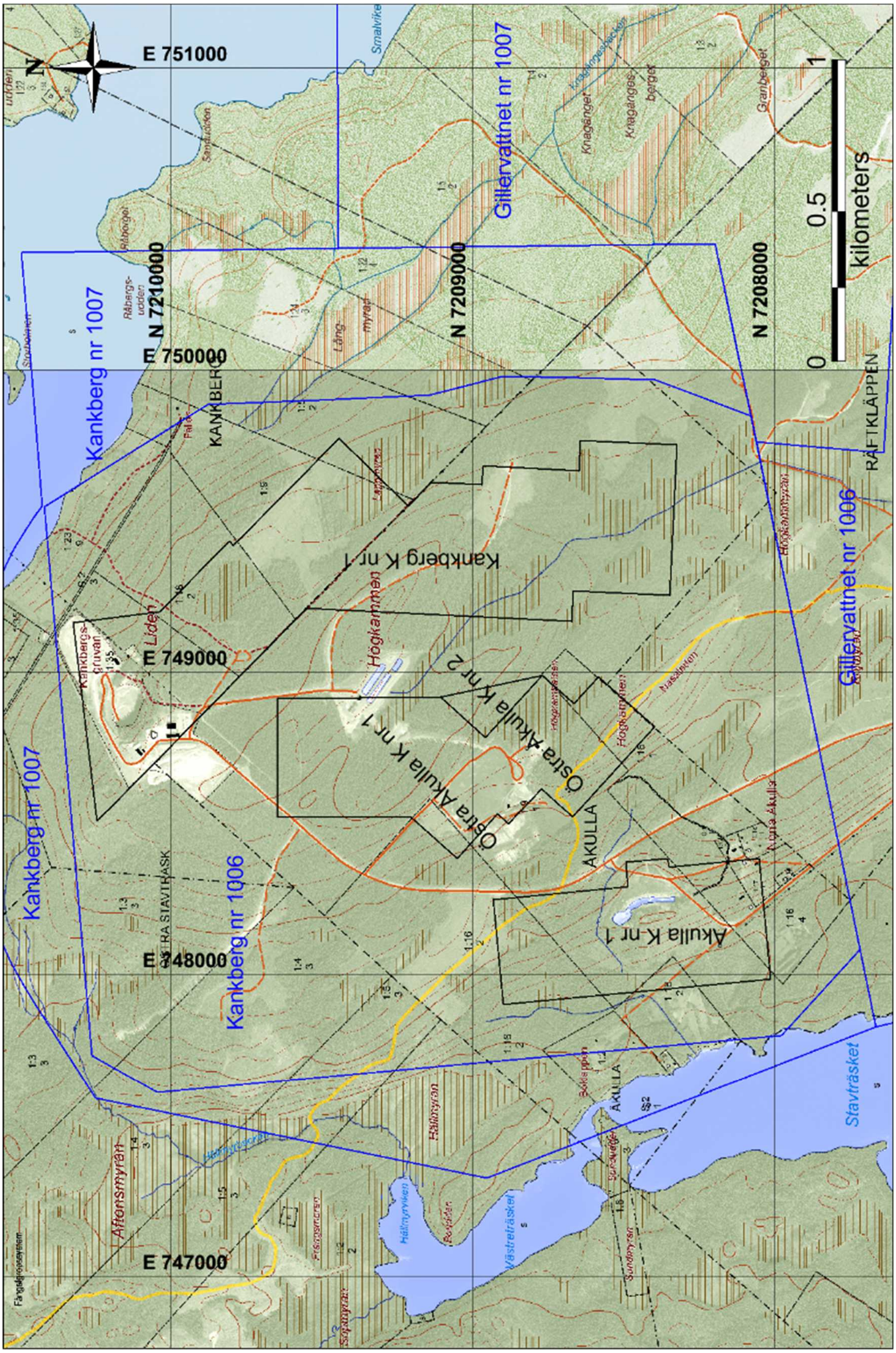


Figure 10: Map of the Kankberg Mining District showing Topography with Mining Concession and Exploration Permits

Boliden have an on-going program of exploration in the district. There is an occurrence of sulfides being investigated by underground drilling from a location by the decline ramp, but there are no exploration sites in the locality that can be shown on a map.

Most mine surveying, all data location and internal plans at Kankberg use the Kankberg Mine coordinate system G1NSYSTEMET. Part of this grid is illustrated in blue in the map above. Plans using the G1NSYSTEMET have 'north' at the top of the page which is rotated 74.215° from the grid north of the national cadastral standard SWEREF99 TM. Please refer to Appendix 2 for a document explaining the relationship between G1NSYSTEMET and national grid systems.

3.6 Topography and Climate

Figure 10 above is a topo-cadastral map of the 4.5 km x 3 km district around the mine to show the topography with mining and exploration concessions held by Boliden.

The topography is flat to undulating with low hills and lakes, consistent with a terrain glaciated during the ice ages. A hill called Högkammen, 285 m, is in the mine area and is one of the highest in the district. The water level of nearby lakes is around 200 m. Most of the mine area is forested, and apart from mining, forestry is the main land use in the district.

The area is sparsely populated and nearest significant settlement is the village of Kankberg, situated about 1 km to the northeast, across the Kankbergsviken embayment of the Bastuträsket lake.

The climate is cold temperate. For Skellefteå the temperature averages 1.9 °C, with month average lows in January and February of -12 °C and a high of 21 °C in July. The high rainfall has an annual average of about 560 mm with significant rainfall in all months. Each day there are 4 hours of daylight in December and 21 hours in June. The underground operation has little influence from the climate, except for de-watering, which is higher during the annual Spring melt. Ventilation air may be heated and the temperature underground in the mine is 8 to 10 °C.

3.7 Geology

The Kankberg Mine lies within the eastern part of the Skellefte mining field, one of the most important mining regions in Sweden, where Boliden has been active since the 1920s. It's significance in relation to 52 other known deposits in the field is shown in Figure 11 from a paper by Allen et al (1996) that describes the marine volcanic arc setting of these Zn-Cu-Au-Ag polymetallic massive sulfide deposits, vein Au deposits and porphyry Cu-Au-Mo deposits.

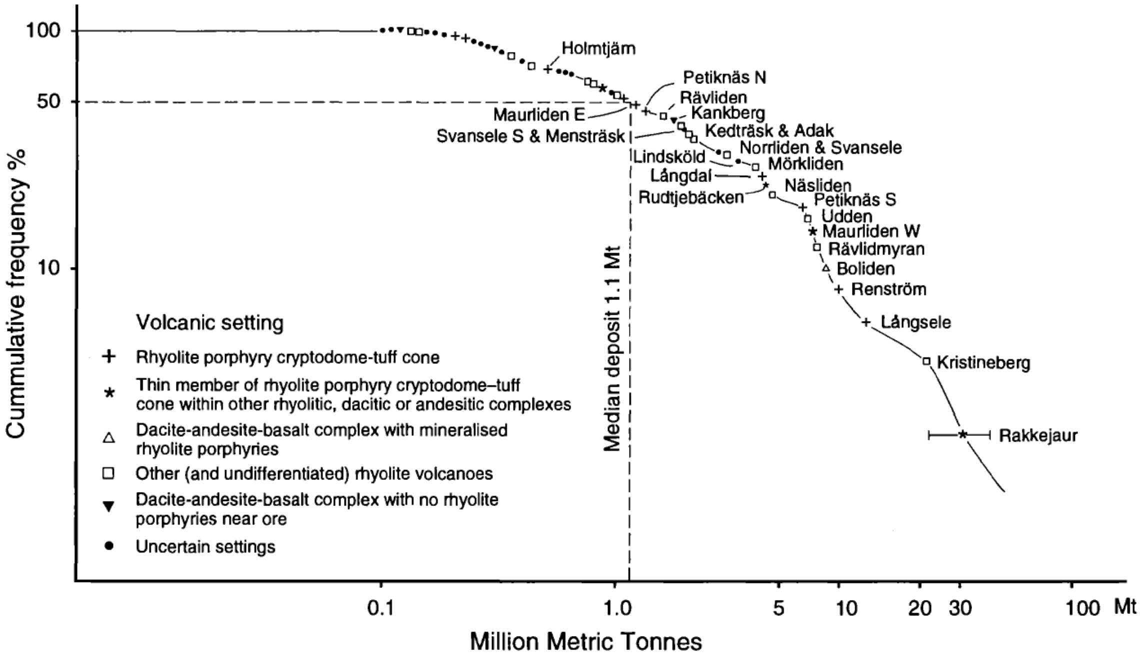


Figure 11: Tonnage-frequency distribution and volcanic setting of the 52 known massive sulphide deposits of 0.1 Mt or more in the Skellefte district (modified from Allen et al (1996)).

The majority of known ore deposits in the Skellefte field occur within the upper parts of the Skellefte group, which is a regionally dominant sequence of volcanic rocks that were formed during a period of intense, extensional, continental margin arc volcanism about 1.89 Ga ago. This group is shown on the geological map in Figure 12, with Kankberg shown at the lower-right. The inset on the left shows the location in relation to Scandinavia.

The host rock in the Kankberg area is dominated by volcanic rocks of primarily dacitic and rhyolitic compositions forming quartz-feldspar porphyritic, rhyolitic and dacitic rock types. The felsic magmas forming these volcanics intruded as shallow (subvolcanic) dykes and sills and extruded as lavas at the surface where they mixed with sediments and mass flows derived from volcanic slopes. The volcanism initiated a convection of solutions through the rocks. These solutions dissolved and transported minerals and metals to sites of deposition.

After the major volcanic period had ended the area was subsequently deformed and folded. This resulted in a dominantly vertical trend of the rocks and structures. At a later stage, brittle deformation took place. Fractures and fissures were intruded by mafic magma forming basaltic and andesitic dykes, which are common in the Kankberg area.

The Kankberg gold deposit is hosted by primarily quartz-feldspar porphyry, volcaniclastic and quartz-andalusite rock types. These form a very competent body, which is surrounded by dacites. In general, a sericite+pyrite±quartz-rich alteration zone is superimposed on the contact between the host rocks and the surrounding dacites. The host rocks are strongly altered by silicification, andalusite ± topaz alteration and to a varying degree, sericitization.

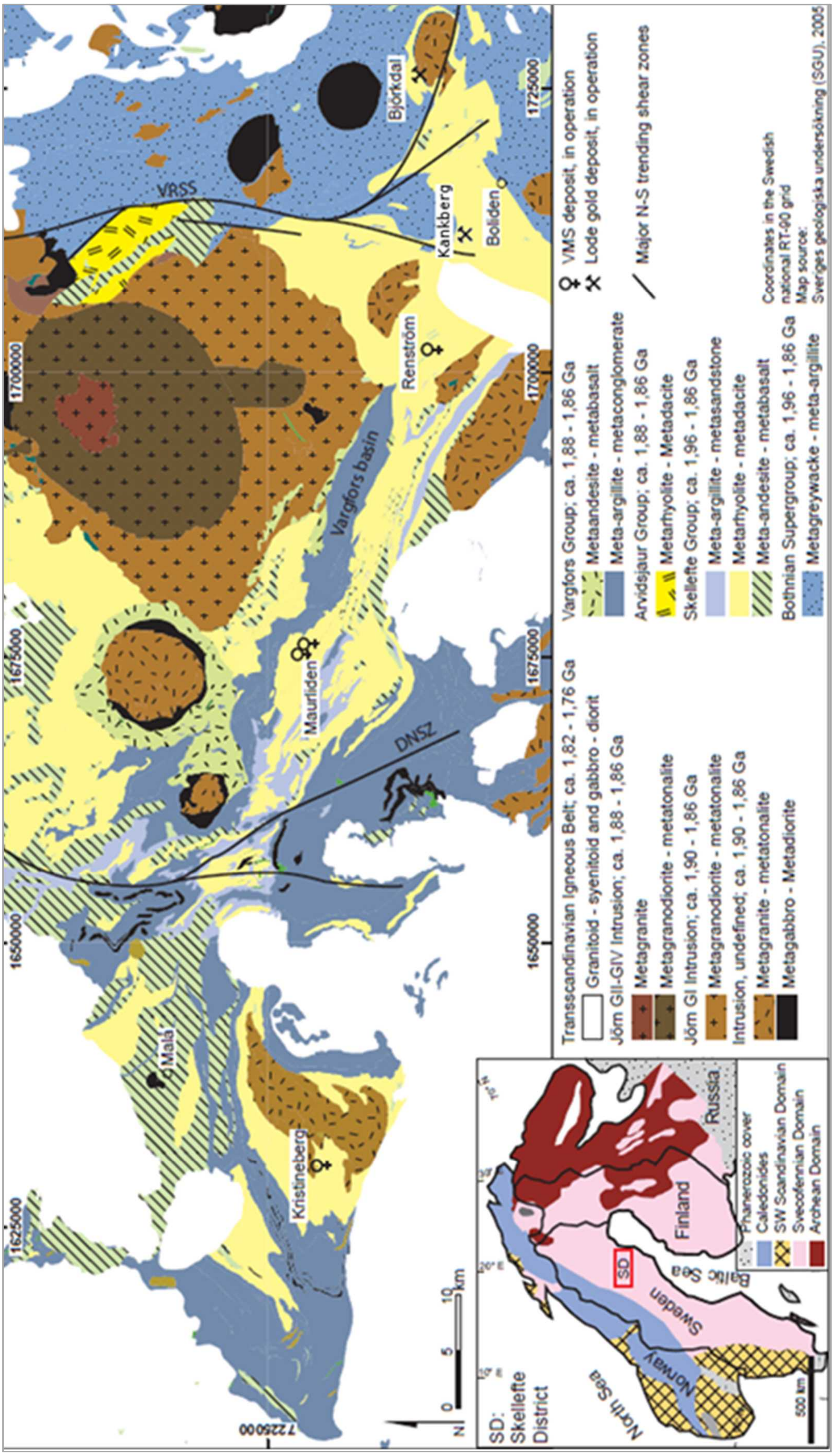


Figure 12. Geological map of the Skellefte district. (modified after Kathol & Weihed, 2005)

For mine planning, the gold mineralization is divided into 5 zones known as FW1, FW2, M1, M2 and M4 as shown below. These aggregate higher-grade lenses are spatially separated by lower-grade rock and may not have genetic significance.

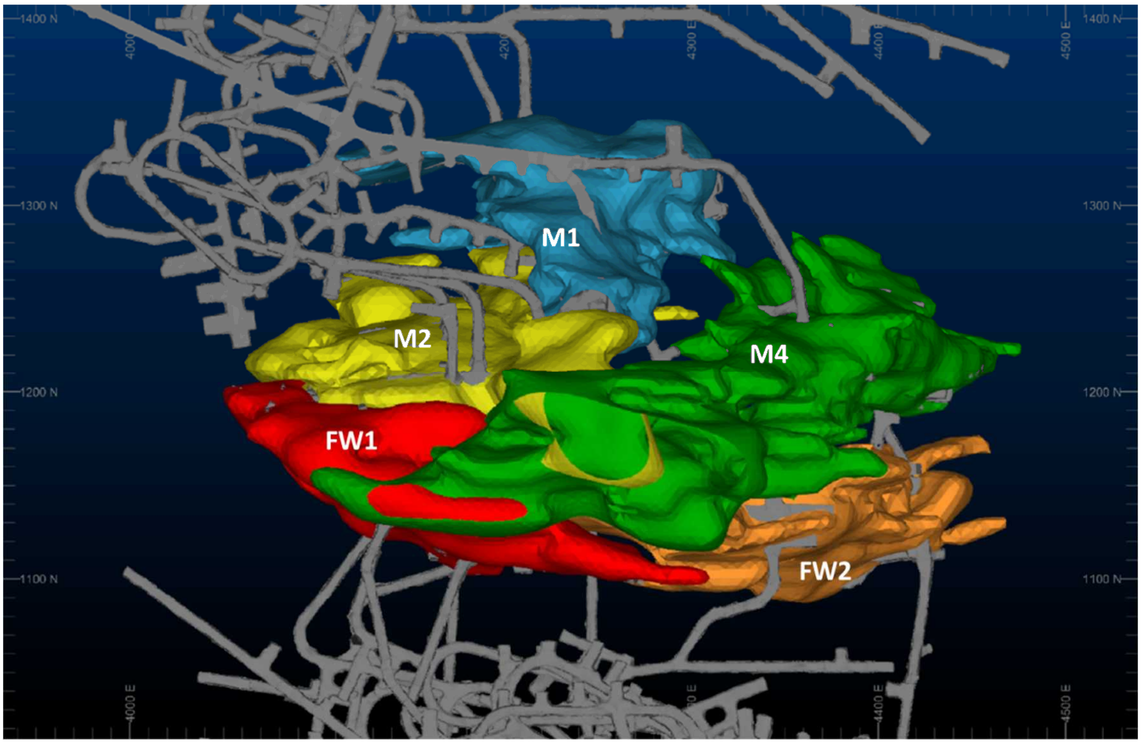


Figure 13: Schematic illustration plan of zones FW1, FW2, M1, M2, M4 and infrastructure with north to left.

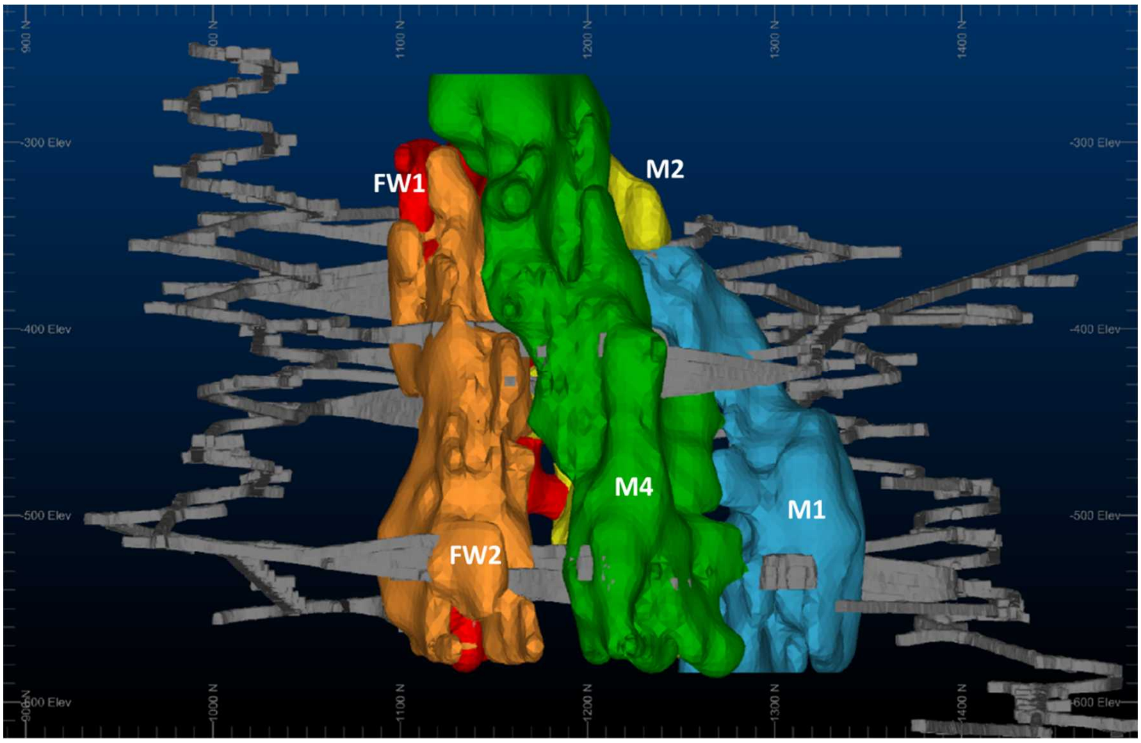


Figure 14: Schematic illustration of zones FW1, FW2, M1, M2, M4 and infrastructure looking towards north.

3.8 Mineralogy

The economic mineralization is contained in 'metallic' minerals primarily located within the quartz-andalusite ± topaz alteration. It includes fine-grained native gold alloyed with silver at proportions of between 0 to 20%. More commonly, gold occurs as gold-tellurides including petzite (Ag_3AuTe_2), calaverite ($AuTe_2$) and sylvanite ($AuAgTe_4$). Another common telluride is tellurobismuthite (Bi_2Te_3). Several more telluride minerals have been identified through microscopy. A mineral list is given in https://www.mindat.org/loc-18583.html .

Sulfides, pyrite with less pyrrhotite, sphalerite and chalcopyrite, are of minor significance but generally increase upwards through the deposit. Through the process route described later, the metallic minerals are reasonably easily separated from the silicate minerals, which generally cause no issues. A minor exception is talc, which can impair flotation by floating with the metallics, but can be of more concern as an occasional cause of poor geotechnical conditions. It is noted with muscovite in core logging. Otherwise, for processing, it has not been considered necessary to further investigate the variability of the mineral species within the alteration envelope, other than what is indicated by grade distributions.

It is worth saying that the topaz and andalusite are far from being of gem quality. They are frequently seen underground as milky bluish-grey patches and fine-grained cream-coloured vein infillings, respectively. But the topaz has itself undergone alteration and the whole rock mass has strong pervasive silicification. The introduction of andalusite seems to be at least partly a later phase, occurring in veins that cut topaz patches. Both these minerals fluoresce under Short-Wave Ultra-Violet (SWUV) light, as shown in Figure 15.

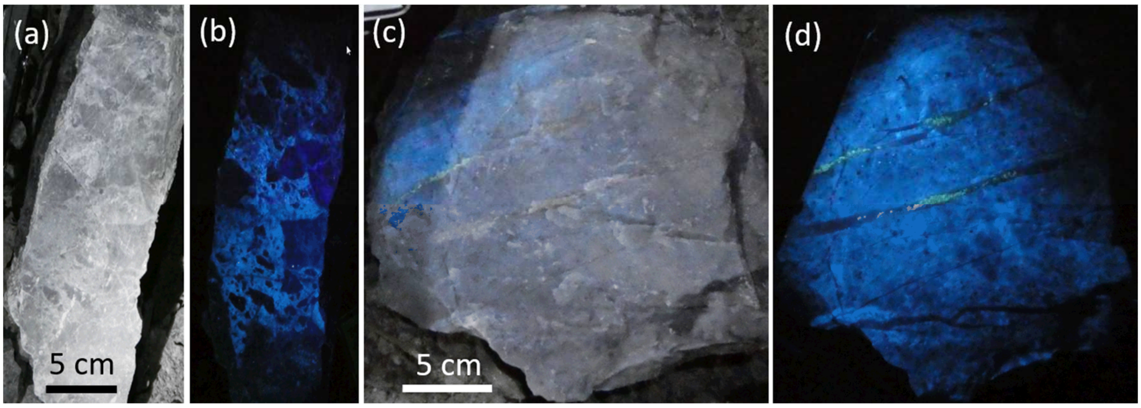


Figure 15: Photographs taken underground of ore fragments; (a) & (b) topaz-altered breccia, (c) & (d) topaz-altered volcanics with andalusite veins, illuminated by (a) & (c) torchlight and (b) & (d) SWUV.

Lens examination of hand-specimens may show, in addition to features above, tourmaline needles and throughout the rock a sparse scattering of tiny (<0.2 mm) dark particles which appear to be metallic minerals. Some are rusted and probably include pyrite/pyrrhotite.

3.9 Mineral rights and land ownership

The four mining concessions whose locations are shown in Figure 10 are all 100% owned by Boliden Mineral AB and entitle the extraction of gold, silver, zinc, copper and lead. In Sweden, tellurium is classified as an industrial mineral (as for example, is limestone) and not a concession mineral and is not therefore required to be specified in the mining concession. Such minerals may be exploited, providing the operator owns the land and has a valid environmental permit. Further details of these concessions are given in Table 6.

Table 6: Mining concessions at Kankberg held by Boliden Mineral AB

Name	Diary No.	Area (ha)	Valid from	Valid to
Östra Åkulla nr 1	2000000066:R	45.1598	2001-02-05	2026-02-05
Östra Åkulla nr 2	2009000945	2.8158	2009-11-10	2034-11-10
Kankberg K nr 1	1998000694:R	95.384	2000-01-01	2025-01-01
Åkulla K nr 1	2000000064:R	33.7698	2001-02-05	2026-02-05

In addition, four exploration permits whose locations are shown in Figure 10 are all 100% owned by Boliden Mineral AB and allow exploration for metals as listed in Table 7: Exploration permits held by Boliden Mineral AB in the nearby area of the Kankberg Mine.

Table 7: Exploration permits held by Boliden Mineral AB in the nearby area of the Kankberg Mine

Name	Diary No.	Area (ha)	Mineral	Valid from	Valid to
Kankberg nr 1006	2017000666	358.20	Au, Cu	2017-11-07	2020-11-07
Kankberg nr 1007	2018000745	222.62	Au, Cu, Zn	2018-11-14	2021-11-14
Gillervattnet nr 1007	2016000088	293.83	Au	2016-04-14	2022-04-14
Gillervattnet nr 1006	2016000067	266.73	Au	2016-03-10	2022-03-10

Boliden owns the land and has full surface rights surrounding and immediately adjacent to the mine. The main relevant plots are Kankberg 1:35 and Akulla 1:9, whose outlines are shown on Figure 10. Reference to these can be found at the following URL:

- https://www.hitta.se/kartan!~64.92183,20.26536,14.890010460154181z/tr!i=1QQ6Z6Xq/tileLayer!l=1/realestate!a=1!l=64.92271:20.26837?&search=kankberg&sst=plc&st=weblist
- https://www.hitta.se/kartan!~64.90115,20.24821,12.623905594365325z/tr!i=1QQ6Z6Xq/tileLayer!l=1/realestate!a=1!l=64.91993:20.26318?&search=kankberg&sst=plc&st=weblist .

Boliden also owns surrounding plots.

3.10 Legal Aspects and Tenure

Boliden Mineral AB is in possession of all required permits to mine Au, Ag, Te, Cu, Zn, Pb at the Kankberg Mine, as listed above, and the necessary land use designation from the Mining Inspectorate. Mining concessions and exploration permits are issued by the Mining Inspectorate of Sweden (Bergsstaten) which is part of the Geological Survey of Sweden (SGU). Details may be found on the website at https://www.sgu.se/en/mining-inspectorate/ . The Inspectorate is headed by the Chief Mining Inspector who decides on matters falling under the Mineral Act (1991:45), issued on the 24th January 1991, which came into force on the 1st July 1992.

There are no known legal proceedings or impediments that may affect Boliden's ability or right to mine at Kankberg. Mining and mining related activities undertaken by Boliden in the district have in general, broad support from the local population, supported by on-going stakeholder engagement as an integral part of Boliden's business processes.

Since Boliden owns all relevant surface and mineral and mining rights, it pays no landowner royalties related to production from Kankberg mine. Notwithstanding this, an annual royalty of 0.05% is payable to the State, based on contained metal in ROM ore and average commodity price over the year.

The capacity and licensing of the existing tailings management facility at BOAPP is sufficient to include material from the existing base case life of mine plan for all the mines operated by Boliden in the Boliden area. This includes tailings from the Kankberg mine.

The mine lies near but outside the northeast boundary of a water protection area for the Skellefteå river valley. This area is classified as a tertiary level protection zone, which has the lowest level of protection, with no specific protection criteria. It should be noted that the entire existing tailings management facility at BOAPP lies within this tertiary zone, with no specified constraints. Therefore, it is considered that this water protection area does not present a risk. There are no other joint ventures, partnerships, historical or cultural sites, wilderness, national park or environmental settings in the vicinity that could present risk to the Kankberg operation.

It is considered that the tenure held by Boliden over the Kankberg Mine, related processing and tailings storage facilities have a high level of security and low-level risk with respect to legal aspects.

3.11 Licenses and permits

Details and location plans for mining and exploration concessions and also land ownership are given in earlier sub-sections.

In accordance with the Environmental Law, a main permit as a partial decision: 2011-04-06, mål (case) nr. M739-09 was issued in April 2011 and updated in 2015 with final conditions for discharges as: 2015-01-23, mål (case) nr. M 739-09. These permits cover matters including:

- Maximum production rate 500 ktpa;
- Maximum total concentrations of elements in discharged water (there is no limitation on quantity);
- Maximum noise levels;
- Dust;
- Requirement to run operations as stated in the technical description;
- Acquisition and importation of additional waste rock and/or tailings sand, also temporary storage, for use as fill underground;
- Environmental monitoring;
- Explosives – spillage etc.;
- Remediation plans, to be submitted at least 1 year before closure; and
- As of 2019-11-27 a new financial bank guarantee of 19,2 MSEK was approved by the Environmental Court in case nr M2723-17. The guarantee shall cover all environmental liabilities in case of bankruptcy.

3.12 Personal introduction into projects and verification of the data

Information supporting this report includes historic data and recent studies, compiled by a team of Boliden's in-house technical staff. These individuals are specialists in their field and have extensive personal experience of the operation and related permitting issues. Their role in the preparation of this document is presented in Table 2, along with an indication as to responsibility and Competent Person (CP) status.

An independent review was carried out by Mr. Mark Howson (BSc ARSM MIMMM CEng FGS, Director and Consultant Mining Geologist with Mineral Resources Professional

Limited), who visited the Kankberg Mine and the offices of Boliden Mineral AB at Boliden during 25th to 29th November 2019. Mark has over 40 years of experience in the mining industry of which 31 were with Rio Tinto plc, especially with Mineral Reserves and Mineral Resources of a variety of projects and mines of gold and other precious and base metals. He is a committee member of PERC. The objective of the visit was to compile the present PERC-compliant Competent Person's Report for issuing at the end of 2019. This is based on the previous (2018) Summary Technical Report that had been produced to satisfy the requirements of the FRB standard. Numerous further details were requested and received during and after the visit. At the same time, the operation was reviewed with regard to the mineral asset reporting and what longer-term improvements could be made. A further purpose was to provide a template report that could be used as an example for other Boliden operations.

The visit was hosted by Mr. Johan Bradley, Strategic Planner, Boliden Operations Area (Strategisk Planerare, Bolidenområdet). Mr. Bradley assisted in compiling this report, reviewed the underlying data and will be acting as Competent Person. In addition, several meetings were held with senior technical staff to obtain details on environmental and legal aspects, drilling and geological data acquisition, mine geology, Mineral Reserves and Mineral Resources estimation and processing. This included a meeting with Mr. Gunnar Agmalm, Manager Ore Reserves & Project Evaluation, Boliden Mines.

The visit included an underground tour of the mine, which was observed to be safe and efficiently operated, using standard mining techniques in good geotechnical conditions. The production rooms visited corresponded with the survey plans reproduced in Appendix 3 at the end of this report. Underground rock faces and drill-core photographs were examined that were consistent, as far as can be seen, with the logging and assays. In a previous visit to Boliden, Mr. Howson toured the BAOPP.

Data review by Mr. Howson includes the drilling database, assays, core photographs and mine and mill production records. Whilst this review does not constitute a full audit, independent verification by Mr Howson does confirm that evidence and information provided by Boliden and summarized in this report is internally consistent. Further, both the Competent Person and the independent reviewer consider that the information reproduced in this report complies with the PERC principals of transparency, materiality, competence, and impartiality.

3.13 Type(s) of sampling

The present orebody has no surface expression and has been explored entirely by drilling, at first from the surface but predominantly by underground drilling as described below. There is no other sampling of in-situ rock.

3.14 Drilling techniques

Exploration and infill drilling are carried out by wireline double-tube diamond core drilling. At present, this is entirely from underground using four rigs equipped with the Wireline 56 system that produces 39 mm diameter core. The Near Mine Exploration Department (UGN) contract the drilling company Protek AB to carry out exploration drilling using two Diamec U6 drill rigs. Additionally, the Kankberg Mine (G1N) carries out infill drilling using two drill rigs, a Diamec U6 and a Diamec S6.

Holes older than 1995 are not used for present estimation and are described in the database as ‘legacy’ holes. Exploration holes have continued to be drilled after the FS until the present. They comprise about a quarter to a third of all the holes, the majority being infill holes. Older holes for the Åkulla Östra were drilled from the surface, as were early FS holes, but most FS holes and all holes since 2011 were drilled from underground and mainly from locations in the mine. To ensure the representative nature of the samples these allow the sub-vertical orebody to be intersected from the side, with holes with dip angles from +45^{o} to -45^{o}. While a wireline is used to retrieve the core barrel, due to the near horizontal holes, a ‘fish’ is pumped along the rods by drilling fluid pressure to grab the core barrel to retrieve the core at the end of a run. No special measures other than good drilling practice and equipment have been needed to maximize core recovery.

To avoid a need for unnecessary or excessive de-watering, all holes drilled for the FS were plugged with concrete. Plastic plugs with an expanding sealant are now used for all holes.

3.15 Drill sample recovery

With such consistently good ground conditions, core recovery is of the order of 99.5% for all holes. It is very unusual to have recovery of less than 100%, as seen in core boxes in Figure 16. Therefore, it is not considered necessary to record sample recoveries or to consider whether a relationship exists between sample recovery and grade or quality and sample bias.

Figure 16: High-grade gold intersections, which are typical boxes of Kankberg mineralised core. Hole ID, box number and from-to depths are shown.

3.16 Logging

Drill core is logged at Boliden Mineral AB's core logging facilities in Boliden. Logging data is captured in WellCAD™ software and data is uploaded to an acQuire™ database.

The following fields are logged:

- Rock type acronym. There are 57 standardized rock types, of which the following 14 are most frequent: quartz-feldspar-porphyry, volcanoclastic, sericite-quartzite, sericite-schist, chlorite-quartzite, chlorite-sericite schist, dacite, andesite, andalusite-quartzite, topaz fragment rock, breccia, basalt (outside mineralization), mass-flow (a generic term for brecciated fragmented that is difficult to classify) and clastic sedimentary.
- Alteration types – andalusite, topaz, sericite, chlorite, silicic
- Mineral proportions of talc and muscovite on a scale of 1 to 5 these affect rock stability and, but of less concern, flotation.
- Other minerals – garnet, tourmaline, sphalerite, galena, chalcopyrite, arsenopyrite, pyrrhotite, pyrite, gold.
- Sulfosalts – tellurides
- Rock Mechanics structures – gouge, disking, crushed drill core – on a 1 to 5 scale: rare, moderate, common, abundant, pervasive.
- Comments. May include small amounts of e.g. gouge, where too small for above logging.
- The start and ends of samples are assigned and length may be adjusted to fit with lithological contacts. Generally, a sample length of about 2 m is aimed for (>90% of all samples).

All core is photographed and the photos are available on-line to Boliden staff. Figure 16 represents core box photographs from two drill holes, selected on the basis that these had the highest gold assay grades in the database. Apart from the fact that they both exhibit strong silicification, the photos show no visual evidence of high grade.

It is considered that the samples have been logged to a level of detail to support appropriate Mineral Resource estimation.

3.17 Other sampling techniques

Apart from by drilling, there are no other samples routinely taken of in-situ rock.

3.18 Sub-sampling techniques and sample preparation

Selection of samples from drilling for assaying is as follows. Exploration holes are generally sampled (and assayed) along their entire length. Infill drill-holes are generally drilled from drill 'cubes' on either side of, and outside the alteration that characterises the ore envelope. The start of the hole is generally not sampled. When the logging geologist identifies alteration that indicates proximity to the ore envelope, sampling starts two core boxes up-hole from the contact. It will continue until the end of the hole, even if it seems that the drill hole has emerged from the other side of the ore envelope into unmineralized rock.

Exploration holes are sampled as half-cores, where core is split length-ways by diamond saw and one half is sent for assaying. The other half is stored for reference. From infill drilling, of those intersections that are sampled, the whole core is submitted as samples. Un-sampled core is stored for a year, after which it is discarded.

Primary samples and QAQC samples (inserted as described below), are bagged and sent by contracted courier service to the ALS geochemistry laboratory in the town of Piteå, about 100 km to the north, where sample preparation – drying, crushing and pulverising - is carried out using procedure PREP – 22. All coarse rejects and sample pulps are stored at the laboratory for a period of three months.

Because the gold and other economic mineralization is so fine grained, the excellent core recovery and drill spacing of 10m x 10m, it is considered that the sampling is representative of the in-situ material collected.

Regarding sample integrity, while the mine and all activity areas including logging have active security, no special measures are considered necessary to protect the integrity of the samples. Visible gold is very rarely seen and the samples have no material value. To liberate gold requires complex metallurgical processing at the concentrator and smelter, which are long-established operations and it would benefit no-one to interfere with drill-core samples to create a false understanding of part of the deposit. To have any material effect on the Mineral Resource estimate, a very large number of samples would need to be tampered with. This would be detected from existing QAQC processes and reconciliation between mine and mill production data.

3.19 Assay data and laboratory investigation

Sample preparation, chemical assaying and measurements of specific gravity is carried out by ALS Piteå – Geochemistry, Hammarvagen 22, SE-943 36 Ojebyn, Piteå Norrbotten, Sweden. All ALS geochemical hub laboratories are accredited to ISO/IEC 17025:2017. As part of the QAQC processes, pulp duplicates are sent from ALS to Hazen Research (Colorado, USA) for Te analysis. Table 8 shows an overview of the methods used. The “Over-range method” applies to samples where assay result reached upper detection limit of the primary method.

Table 8. Overview of ALS’s designation of analytical methods.

	Method	Over-range method
Preparation	PREP – 22	
Assay Au	Au-ICP21	Au-GRA21, Au-AA25
Assay other	ME-M561	Ag-OG62/Ag-GRA21, S-IR08, Te-AA62, (As, Cu, Pb, Zn)-OG62
Specific gravity (core)	OA-GRA08	
Specific gravity (pulp)	OA-GRA08c	

Au-ICP21 is a package of fire assay with an ICP-AES analysis. ME-MS61 is a package of a 4-acid digestion process with an ICP-MS analysis. The Periodic table of elements in Table 6) show which elements (marked in yellow) are assayed for at the Kankberg mine. Results are available in the drilling database, held in acQuire™ software.

Table 9. Periodic Table, highlighted to show assayed elements.

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	

The aims of the exploration and infill drilling differ slightly and standards/certified reference materials (CRM's) and QAQC procedures that are applied differ to address these aims.

Infill drilling insert QAQC samples according to the following guidelines:

- Blanks: 1st blank as the 5th - 10th sample, rate 1:50, and after visible gold and/or particularly strongly mineralized zones;
- Standards/CRM's: rate 1:50, grade of standard reflecting suspected grade of mineralized zone. Added in proportion; 10% low grade, 80% medium grade and 10% high grade. About 10 different international and in-house standards are or have been used; and
- Check assays: rate 1:50, limited to sample series of more than 50 samples, anywhere in sample series.

This result in an average QAQC usage of approximately 5.4% (standards = 2.7%, blanks = 1.7% and check assays = 1.0%).

Exploration drilling follows the QAQC recommendation given by the Exploration department and documented in the internal report (Munck, N; C20556). This results in a QAQC sample frequency as follows:

- In-house standards ca. 3%;
- CRM 1.5%;
- Blanks 2%; and
- Check assays 0.5%.

QAQC results are reported in the "Data Hand-Over for Block Model" report produced annually, prior to the new block model update. During the nearly 3-year period January 2017 to November 2019, 709 batches were assayed of which 22 were re-assayed due to failures, 18 of standards and 4 of blanks. Full details of standards are withheld to keep them secret from the laboratory, which can tell when standards are used but not which standard. As an example, Figure 17 shows the results from a relatively high-grade standard that was used from 2012 to 2016 and that is no longer available.

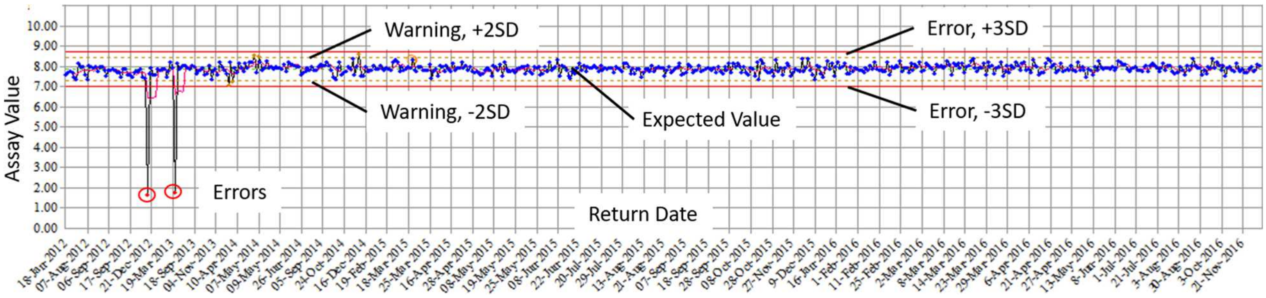


Figure 17: Graph of results for a gold assay standard, from submitting in batches from 2012 to 2016.

Results from the submission of duplicates since 2011 are not available at the time of writing. However, this was a matter for careful attention in the FS. The main assay laboratory used was ALS Chemex in Canada, and 1 in 20 samples were sent for a check assay for gold to RCA Rönnskär smelter and 1 in 40 samples were checked for tellurium at Hazen Research Lab, USA. The differences in both cases (Au & Te) were very small.

3.20 Verification of results

Data acquired before 1995 are not used for estimation. The majority of drilling in the 10m x 10m drilling density used to bring Mineral Resources up to Measured category takes place a few years or months before mining. Consequently, there is no need for twinned holes or deflections to confirm 'old' data. Rather than using duplicates to confirm assays from a relatively low drilling data density, it is accepted that individual sample gold grades will be erratic. This is illustrated in the Probability Graph in Figure 18, where the gold grades span over 5 orders of magnitude. The gold trace on this plot shows a very smooth, single population log normal distribution, that would be very hard to produce if the data was of poor quality or had been tampered with. Refer to the book "Applied Mineral Inventory Estimation" by Sinclair and Blackwell (2002) for an explanation of these graphs.

A high drilling data density (with top-cutting, described later) is applied to minimize any local mis-estimation that the erratic values may cause. Essentially, the closely-spaced drilling and large number of samples takes the operational place of the use of twinned holes, deflections or duplicate samples.

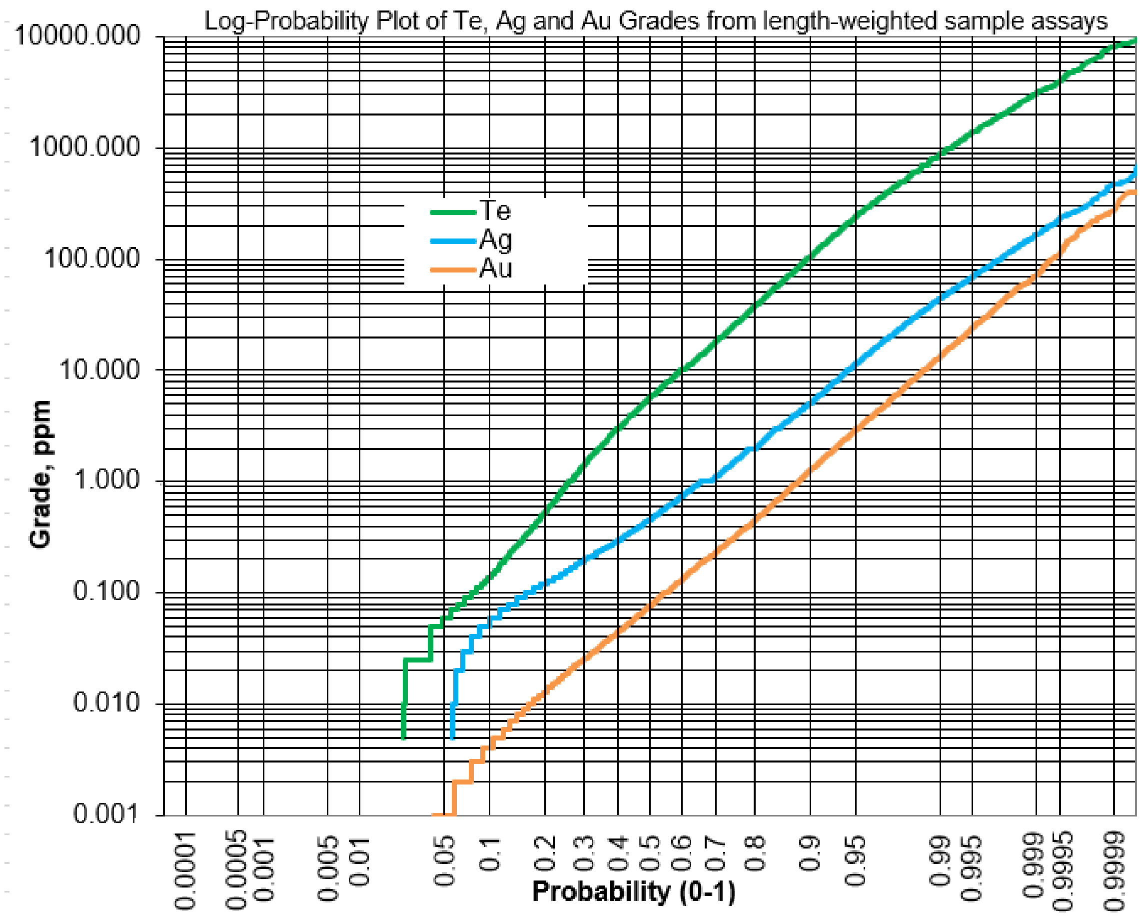


Figure 18: Probability Graph of Te, Ag and Au Length-Weighted Grades from the entire database of drill sample assays.

Verification of selected intersections by either independent or alternative personnel has not been done. It is not considered necessary, since at this well-established operation with its production history, the reconciliation results, discussed under 'History' above, demonstrate that the existing approach of a high data density is adequate.

3.21 Data location

Mine surveying is carried out using a Leica Viva TS15 total station. Survey data management is carried out in Powel Gemini Terrain software. Examples of mine survey plans using the coordinate system G1NSYSTEMET are given in Appendix 2. It is considered that these plans are of excellent quality.

Hole collars are surveyed before drilling and again afterwards. For exploration drilling, downhole deviation surveying is carried out by Protek AB personnel using an Inertial Sensing isGyro instrument. About 10 drill holes have been deviation surveyed using a Reflex Gyro instrument. For infill drilling, deviation surveying is carried out by Kankberg personnel using a Devico DeviFlex or a Reflex Maxibor II instrument. Deviation surveys are checked on drillhole plots and rarely, if there are features such as unnatural kinks, certain data may be identified to be in error and are not included. These are detailed in the "Data Hand-Over for Block Model" report, as mentioned earlier.

3.22 Data density and distribution

The sections above discuss high data density produced by the 10mx10m drill spacing that is required for classification as Measured Mineral Resources and hence Proved Mineral Reserves. Indicated and Inferred classifications require less-close spacings, and these are described below in Section 3.37, 'Classification'.

The orientation of the drilling is mainly at a range of angles around a dip of 0^{o} (i.e. around horizontal) and around the west-east direction. This is near to perpendicular to the vertically orientated mineralized lenses which have a strike around north-south. It is considered that, as far as is reasonably achievable, the orientation of sampling achieves unbiased sampling of significant structures, i.e. the gold mineralized lenses. Given the deposit type, these are reasonably clearly identifiable at an appropriate stage of the progressive infill drilling.

The spacings and orientations are illustrated in a series of representative plans and profiles, each with a depth of view of 20m. At the mid-point of that depth are shown colour-coded block model NSR grades. NSR is 'Net Smelter Return', as described below under 'Metal equivalents or other combined representation of multiple components'. In effect, it is the value of the gold grades since the by-products add little value. These plans are given in Appendix 4 using the G1NSYSTEMET coordinate system.

Particularly due to the reconciliation results described above under Section 3.3, 'History', but also given understanding of the style of mineralization and of other similar deposits, it is considered that data density and distribution are sufficient to establish the degree of geological and grade or quality continuity appropriate for the Mineral Resource and Mineral Reserve estimation procedure and classifications applied.

3.23 Reporting Archives

WellCAD™ software is used for logging data capture. This software includes validation criteria to detect and minimise human error. All data transfer is electronic, including the initial logging and the transfer of assay data from files from the laboratory. Assays and other data are loaded into the acQuire™ database system. Digital data is stored on a central server that is managed by Boliden's IT group, with appropriate security and back-up protocols.

3.24 Audits or reviews

Sampling techniques and data have not been independently audited. However, the independent review carried out by Mr Howson (see Section 3.12), confirms that:

- procedures are aligned with industry best practice;
- are internally consistent; and
- the data are consistent with both what has been observed in core and underground, and similar deposits of this type.

NB. PERC 'Table 1 Part 3 - Reporting of Exploration Results' is omitted from discussion in this section of the report, given the advanced stage and production history of the Kankberg operation.

3.25 Database integrity

As discussed briefly in Section 3.16 above, Boliden has standard operating procedures for the use of WellCAD™ for core logging data, combined with transfer into acQuire™ limit common errors in data capture, risks associated with data transfer, integration with assay results and subsequent search and extraction into modelling and estimation applications.

Before the block model is updated, the new data added is reviewed and a ‘Data Hand Over for Block Model Update’ report is produced. This QAQC report has details of any issues with deviation survey data and action taken, and of any batches submitted for assaying that were re-submitted etc. The logging, sampling and assay data are assessed for overlaps, gaps or duplication. Any deviations are detected during this process and dealt with appropriately to limit influence on the subsequent modelling and estimation process. This process ensures database integrity and as a basis for estimation.

The report for the most recent Mineral Resources estimate update, of 11th November 2019 indicates the numbers of assay results, as listed in Table 10. Large portions of this report are reproduced in edited form herein, to describe the data investigations, geological interpretation and estimation and modelling techniques.

Table 10: Number of drill holes and number of assays per element in the Kankberg database supporting the current estimate

Number of Drillholes	Number of Assay Results					
	Au	Ag	Te	Cu	S	Bi
2 122	138 156	138 166	124 976	132 886	134 399	125 327

3.26 Geological interpretation

Using commercially available software packages (Leapfrog, Datamine Studio, Snowden Supervisor) a 3-dimensionel block model is created into which grade estimations are interpolated. The project limits and coordinates are in G1NSYSTEMET. The model extents and parameters are outlined in Table 11. The parent block size of 6x6x6 m is based on drill hole spacing of approximately 10-20 m. For short term planning purposes, a sub-blocked model with block sizes down to 1.5 m is created.

Table 11: Block Model Parameters

Axis	Origin coordinates	Cell size, m.	Number of cells	Extent, m.	Far corner coordinates
X	3897	6	110	660	4557
Y	997	6	90	540	1537
Z	-753	6	110	660	-93

The mineralisation wireframes used for domaining were created in Leapfrog Geo 4.5. Au grades of 2 ppm, 1 ppm, and 0.5 ppm were used as thresholds for the High, Low, and Waste grade interpolants respectively, as shown in Figure 19. These threshold grades roughly reflect historic cut-off grades and are used to reduce smoothing and produce a more local grade estimate. No changes to the parameters defining the generation of the high, low and waste grade wireframes in Leapfrog have been applied so this is in line with previous updates. Overall the leapfrog wireframes show little change from those in 2018_2 and 2019_1. However, there are minor changes, mostly related to new drilling information.

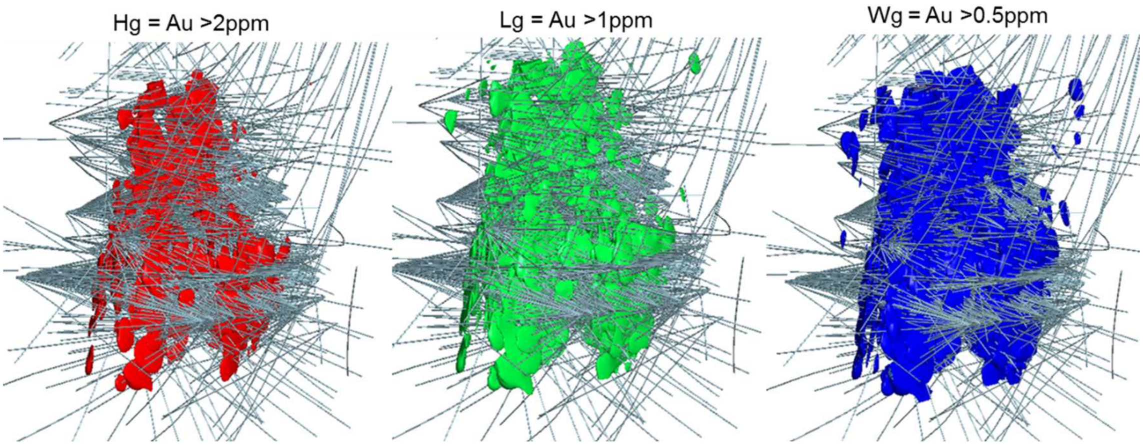


Figure 19: Grade shells created in Leapfrog based on Au ppm values.

3.27 Estimation and modelling techniques

In the horizontal plane, the 5 mineralized zones of which the deposit is informally comprised occur together in a roughly oval shape that extends about 355 m in the X direction in G1NSYSTEMET which may be called the strike direction, but almost N-S in the national grid, and about 225 m in the Y-direction, or E-W in the national grid. Vertically it extends about 530 m.

Initial univariate statistical analysis is shown for the High, Low, and Waste grade interpolants respectively in Table 12. Notably high coefficients of variation ("COV") are reported for all mineralisation variables.

Table 12: Initial length weighted and domain statistics. COV greater than 1.5 has been marked red.

ZONE	FIELD	NRECORDS	NSAMPLES	MINIMUM	MAXIMUM	MEAN	STANDDEV	WGTFIELD	COV
	LENGTH	16738	16738	0.0	14	1.8	0.4	LENGTH	0.2
	AU_PPM	16738	16690	0.0	859	5.7	20.7	LENGTH	3.6
	AG_PPM	16738	16690	0.0	4340	13.5	53.3	LENGTH	4.0
	TE_PPM	16738	16087	0.0	30600	241.0	614.6	LENGTH	2.6
HG	BI_PPM	16738	16087	0.0	10000	131.6	415.8	LENGTH	3.2
	CU_PCT	16738	16212	0.0	8	0.0	0.1	LENGTH	5.4
	S_PCT	16738	16361	0.0	47	0.9	2.9	LENGTH	3.2
	LENGTH	14686	14686	0.0	14	1.8	0.5	LENGTH	0.2
	AU_PPM	14686	14622	0.0	28	1.1	1.5	LENGTH	1.3
	AG_PPM	14686	14622	0.0	273	5.0	10.7	LENGTH	2.1
	TE_PPM	14686	14029	0.0	8900	110.8	245.9	LENGTH	2.2
LG	BI_PPM	14686	14029	0.0	8990	64.1	180.0	LENGTH	2.8
	CU_PCT	14686	14179	0.0	4	0.0	0.1	LENGTH	5.0
	S_PCT	14686	14280	0.0	49	1.0	2.7	LENGTH	2.8
	LENGTH	14773	14773	0.0	11	1.9	0.4	LENGTH	0.2
	AU_PPM	14773	14668	0.0	10	0.5	0.6	LENGTH	1.2
	AG_PPM	14773	14669	0.0	478	2.7	8.6	LENGTH	3.2
	TE_PPM	14773	13950	0.0	9040	67.0	197.0	LENGTH	2.9
WG	BI_PPM	14773	13950	0.0	10000	43.6	171.4	LENGTH	3.9
	CU_PCT	14773	14187	0.0	5	0.0	0.1	LENGTH	4.4
	S_PCT	14773	14312	0.0	49	1.5	3.2	LENGTH	2.2

Histograms and Log probability plots were used to identify the presence of outlier grades for samples of element Au, Ag, Te and Bi. The top-cuts in the 2019_2 update are in line with top-cuts in previous Mineral Resource estimate and these are presented in Table 13.

Table 13: Summary of top cut values applied

Assay	Top-cut	Total number of assays	Number of assays cut	% of number of assays cut	Raw Assay Mean	Grade Capped Mean	Difference [%]
AU_PPM	75	45980	147	0.3	2.66	2.359	-11.2
AG_PPM	200	45981	99	0.2	7.53	7.08	-6.0
TE_PPM	1500	44066	565	1.3	151.00	132.00	-12.6
BI_PPM	1500	44046	267	0.6	86.00	77.00	-10.5

Un-assayed sections of the drillcore have been treated as core-loss, i.e. samples with missing assay results have been set to absent.

Drill core samples are usually taken at 2 m length within geological domains. More than 50% of the samples have a length of exactly 2 m. Length-weighted composites with a target length of 2 m were calculated for the grade estimation process, as for previous estimations. Figure 20 below presents a plot of composite length against average gold grade, with bubble size representing the number of samples in each of the three domains (high grade = HG, low grade = LG and waste = WG).
In the HG Domain it can be seen that composites that are both longer or shorter than the target length, tend to be of lower grade than the mean of about 5 g/t. This is because they are likely to be mainly derived from relatively short peripheral intersections, that may be of lengths that do not neatly sub-divide into 2 m segments, and which are generally of lower grade than more central and longer intersections. This effect seems reasonably symmetrical about the target length. All composites are given the same 'weight' or influence in estimation by Kriging, so the risk is that short composites may have an unduly large influence, and long composites have an unduly low influence. But in this case, because of the symmetry, it seems that bias from short and long composites cancel each other out. Therefore it is considered that, overall, there is no evidence that bias has been introduced during the compositing process.

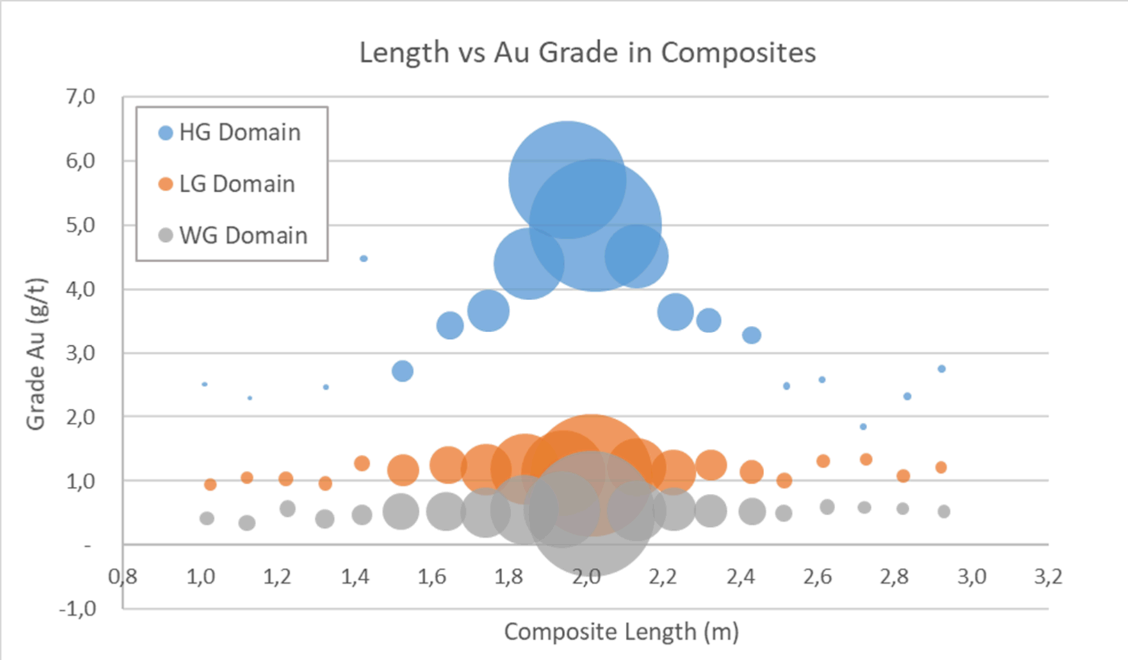


Figure 20: Length (m) vs gold grade (g/t) in composites

In the most recent model update, variogram parameters have been reviewed and are in line with previous used parameters (2018_2, 2019_1). Datamine´s dynamic anisotropy has been used so that the estimation search ellipsoid and variograms are aligned with the structural trends as interpreted within Leapfrog. Table 14 lists all variogram parameters.

Table 14: Semi-variogram parameters for all estimated elements

ASSAY	VREFNUM	VANGLE1	VANGLE2	VANGLE3	VAXIS1	VAXIS2	VAXIS3	NUGGET	ST1	ST1PAR1	ST1PAR2	ST1PAR3	ST1PAR4	ST2	ST2PAR1	ST2PAR2	ST2PAR3	ST2PAR4
AU_PPM	1	25	50	120	3	1	3	0.4	1	12	12	5	0.6					
AG_PPM	2	25	50	120	3	1	3	0.4	1	12	12	5	0.6					
CU_PCT	3	25	60	105	3	1	3	0.25	1	25	25	25	0.6	1	65	65	65	0.15
S_PCT	4	25	60	105	3	1	3	0.08	1	25	25	25	0.66	1	90	90	90	0.26
TE_PPM	5	25	50	120	3	1	3	0.3	1	12	12	5	0.7					
BI_PPM	6	25	70	120	3	1	3	0.4	1	11	12	5	0.6					

Ordinary Kriging was used for the grade estimation of Au, Ag, Te, Cu, Bi and S. It used an orientation of the search ellipsoid that is in line with previous estimations. The search ellipsoid is defined by the orientation of the variogram model. A table of used search ellipsoid parameters is presented in Table 15.

Table 15: Search ellipsoid parameters

SDESC	SREFNUM	SMETHOD	SDIST1	SDIST2	SDIST3	SANGLE1	SANGLE2	SANGLE3	SAXIS1	SAXIS2	SAXIS3	MINNUM1	MAXNUM1	SVOLFAC2	MINNUM2	MAXNUM2	SVOLFAC3	MINNUM3	MAXNUM3	OCTMETH	MINOCT	MINPEROC	MAXPEROC	MAXKEY
AU_PPM	1	2	15	15	8	25	50	120	3	1	3	5	10	2	5	10	5	1	10	0				5
AG_PPM	2	2	15	15	8	25	50	120	3	1	3	5	10	2	5	10	5	1	10	0				5
CU_PCT	3	2	20	20	20	25	60	105	3	1	3	10	20	2	10	20	5	1	20	0				5
S_PCT	4	2	20	20	20	25	60	105	3	1	3	10	20	2	10	20	5	1	20	0				5
TE_PPM	5	2	15	15	8	25	50	120	3	1	3	5	10	2	5	10	10	1	10	0				5
BI_PPM	6	2	15	15	8	25	70	120	3	1	3	5	10	2	5	10	10	1	10	0				5

The minimum number of composites required for a block estimate is five (Cu and S: 10) and the maximum is ten (Cu and S: 20). If the search did not meet the requirements it was doubled in size. The minimum and maximum parameters remained unchanged. In case the expansion of the search volume did not succeed to meet the search requirements the search distances were multiplied by five (Te and Bi: 10) and the minimum number of composites was reduced to one. A maximum of five composites was allowed to contribute from any drill hole.

In order to check that the estimation strategy applied is appropriate, the model was validated using different techniques. These include:

- a statistical comparison of composite against block model estimates;
- validation plots to compare the block model estimates against informing composites along different slices through the deposits; and
- Visual validation of block estimates against informing composites.

In order to compare the model results to the input data a comparison table of block model global mean grades and composite (top-capped) mean grades has been prepared (Table 16). Deviations greater than 10% are marked by red. Au is overestimated compared to the capped composite grades in the HG-zone. The deviations are significant but at this point accepted and an investigation to explain the deviations are recommended. This model update was in line with previous models, models that corresponds well to the production reconciliation.

Table 16: Comparison of block estimates and composites (top-capped). Deviations greater than 10% in red.

ZONE	FIELD	NSAMPLES	MINIMUM	MAXIMUM	MEAN	STANDDEV	Composite Mean	Composite standard dev	Mean diff	Mean diff %
HG	AU_PPM	13063	0.016	63.291	5.624	4.619	4.91945	9.098166	0.7	14
HG	AG_PPM	13063	0.1	108.31	11.69	12.45	12.35907	22.96558	-0.7	-5
HG	TE_PPM	13063	1.858	1426.198	210.235	187.764	204.7338	301.3949	5.5	3
HG	BI_PPM	13063	0.507	1156.738	123.891	146.342	114.1744	220.8502	9.7	9
LG	AU_PPM	12734	0.01	5.723	1.105	0.549	1.14	1.35	0.0	-3
LG	AG_PPM	12734	0	65.07	4.4	5.08	4.99	9.82	-0.6	-12
LG	TE_PPM	12734	0.985	1070.005	95.697	103.707	106.47	189.79	-10.8	-10
LG	BI_PPM	12734	0.293	960.513	57.447	78.216	62.24	141.50	-4.8	-8
WG	AU_PPM	18229	0	2.537	0.529	0.243	0.51879	0.599362	0.0	2
WG	AG_PPM	18229	0	40.33	2.62	3.28	2.6724	6.473042	-0.1	-2
WG	TE_PPM	19229	0	845.344	58.647	71.39	64.29316	143.4327	-5.6	-9
WG	BI_PPM	18229	0	926.049	38.194	63.419	41.17099	119.4043	-3.0	-7

As part of the validation process, the block model and input composites that fall within defined sectional criteria were compared and the results displayed graphically to check for visual discrepancies between grades on 6 m north-south sections.

This validation quickly highlights areas of concern within the model. Each graph also shows the number of samples available for the estimation, which provides information relating to the support of the blocks in the model. The validation plots give a qualitative indication to the amount of smoothing that has been introduced into the model. Figure 21 an example of an Au validation trend plot, also known as a 'Swath Plot'.

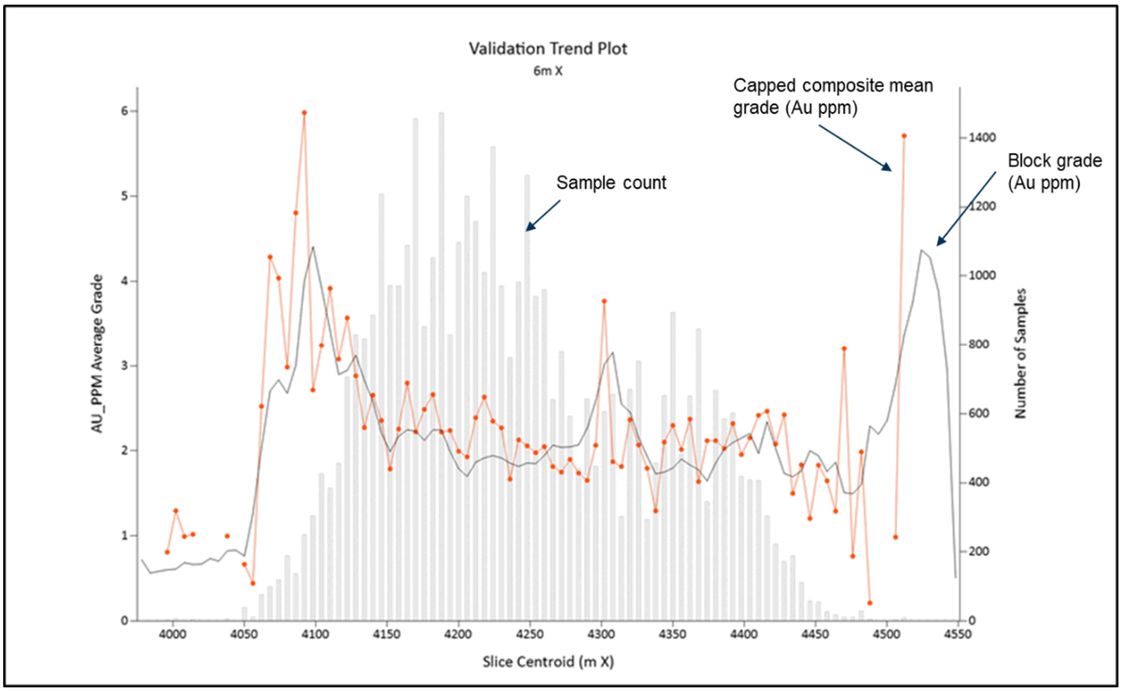


Figure 21: Au Validation Trend Plot showing 6m north-south sections. Red line represents capped composite mean grades and black line represents block grades.

In this plot, where there are the most composites, such as between 4150 and 4250, the blocks appear to be under-estimated relative to the means of the composite grades. But this effect is probably due the large numbers of composites in volumes with 10x10 metre drilling (see later) that is used to upgrade to Measured Mineral Resource category, relative to much smaller numbers that are lower-grade and in peripheral volumes, that may not have been upgraded to this category. Overall, it is considered that the block estimates reasonably reflect the input sample data.

3.28 Metal equivalents or other combined representation of multiple components

For revenue evaluation, a 'Net Smelter Return' (NSR) value is calculated for each model block from the metal prices, costs of processing and smelting, and metallurgical recoveries. The NSR is effectively the value in Swedish Kronor (SEK) for each gram of each contained product or by-product metal attributed to ore arriving at the BOAPP from Kankberg, within Boliden's accounting system. Being a combined product value, it is used as a grade to describe tonnages in terms of SEK/t.

In Table 17 below, the long-term NSR Factors are given for each element in the first column, along with the projected average grades and NSR value per tonne over the Life of Mine (LOM). The 5th column provides percentage revenue contribution from each element to the overall operation.

Table 17: Current Long-Term Plan Net Smelter Return Factors and associated information

Element	NSR Factor, SEK/g	Average LOM Grade, g/t	Average LOM NSR Value, SEK/t	Average LOM Revenue Contribution, %
Au	247	3.29	813	96%
Ag	1.4	10	14	1.7%
Te	0.13	172	22	2.6%

Refer also to Section 3.34, Costs and Revenue Factors for further explanation.

3.29 Cut-off grades or parameters

The basis for defining Mineral Resources is that:

(a) the material is above the marginal cut-off grade of 300 SEK/t; and
(b) is included within the LG (low grade) and/or HG (high grade) domain and not waste (WG) domain.

Using NSR as calculated above, a break-even mining cut-off grade of 525 SEK/t is used to guide mining design and in Mineral Reserve and additional Resource Estimation (see Section 3.34, ' Cost and revenue factors'). When rock below this cut-off must be mined, mainly to access higher-grade material, a marginal cut-off of 300 SEK/t is applied and this material trucked as ore. Rock below 300 SEK/t would be mined as waste and used within the mine as fill.

For production planning and Reserve classification, the entire room must average at least 525 SEK/t to be mined (this could include material which has a grade below 525 SEK/t).

See Table 18 below for a summary of operational (break-even) and marginal cut-off grade assumptions, based on current operating costs and long-term price assumptions.

Table 18: Cut-off grade & NSR assumptions

Cut-off grades	NSR, SEK/t	Metal grades corresponding to NSR cut-off*	Au grade corresponding to NSR cut-off
Operational (Break-even)	>= 525	>= 2.03 g/t Au >= 6.47 g/t Ag >= 105 g/t Te	>= 2.12 g/t Au
Marginal	< 525 and >= 300	>= 1.16 g/t Au >= 3.07 g/t Ag >= 60 g/t Te	>= 1.21 g/t Au
Waste	< 300	< 'Marginal' grades as given above.	< 'Marginal' grades as given above.

**Given the forecast average relative revenue contribution from each metal over the life of mine.*

3.30 Tonnage Factor/In-situ Bulk Density

Two density figures are assumed for estimation of the deposit:

- 2.9 t/m³ is used for material classified as ore.
- 2.8 t/m³ is used for material classified as waste rock

These figure for ore was determined during the FS for the mine when 71 density measurements were made in 1998 and between 2004 and 2005 in Piteå (SGS Piteå, Piteå ALS Chemex) from samples taken from all the major rock types within the mineralisation. The figure for waste is an assumption based on the lower level of alteration in waste rocks.

Recognizing that there is an opportunity to improve accuracy, since February 2018 Boliden Mineral AB has been requesting measurements of specific gravity of drill core samples along with chemical assays. Every fifth sample is measured using the Archimedes principle and all samples are measured using a pycnometer. An evaluation of the measurements is ongoing.

As shown in the mine-mill reconciliation above under 'History', the total mine tonnage for 2012 to 2019 differs from the mill tonnage for the same period by less than 1%. Therefore, it is considered that the densities presently used are 'on average about right'. However, more work on density is considered to be worthwhile, since it may lead to an improvement in weighted averaging of Mineral Resources grades.

3.31 Mining factors or assumptions

The mining method in the Kankberg Mine is a cut-and-fill process that can also be described as room-and-pillar with fill. The ore is mined in 6 m high horizontal rooms or stopes (7 m if it is a bottom room). The rooms are stacked vertically in fours, into levels, which are accessed from the ramp, as shown in Figure 22 (left). The mining starts from a bottom undercut and advances upwards. As shown in Figure 22 (right), the mining cycle is comprised of drilling of the ore, loading of blast holes, blasting, loading of the ore, cleaning of the exposed rock and reinforcing with cemented iron rods and shotcrete.

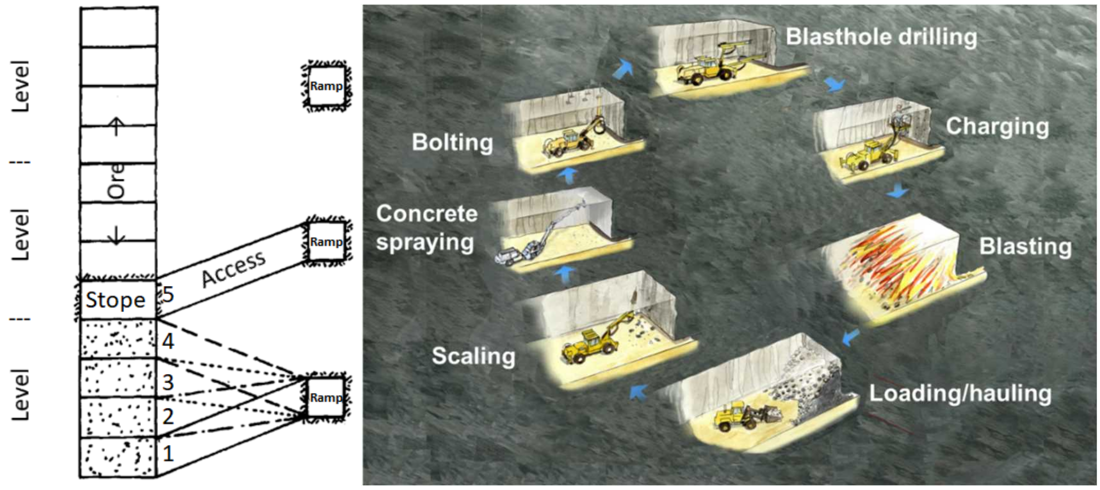


Figure 22: (Left) Sketch profile showing stope access. (Right) Illustration of the mining cycle.

Once the stope is mined, media like water, power supply and ventilation are retreated, as the stope is backfilled with waste material. The fill material serves both as support for the stope walls and as working platform for the next stope. The width of stopes varies between 4.5m to 10m. Where the width of the stope exceeds 10 m, pillars of 6 x 6 m are left at 10 m intervals within the stope. On average 4 to 5 different stopes are in production at any given time with one primary backfill area.

For a better understanding of the arrangement of the pillars, it is recommended to peruse the survey plans given in Appendix 3. Pillars on successive levels are vertically aligned.

In the FS, there were 292 observations giving Rock Mass Rating (RMR) of which 90% were RMR > 60 and 100% were RMR > 25. It was determined that the unstable zone is 8 to 19 m. This determined the span between pillars of 10 m, with the use of rock bolting and shotcreting using fiber-reinforced concrete.

Even though all of the orebody lies below the water level of nearby lakes, because of the impermeability of the rocks (and the plugging of drill holes) the dewatering costs are low.

Mining costs are summarised above in Section 3.29, "Cut-off grades or parameters", where they are used to determine a break-even cut-off grade.

Backfill uses waste rock either from elsewhere in the mine, which comprises around 46% of the requirement, or trucked in from the waste dumps at an historic mine named Långdal about 17 km away. It is thought that there is roughly 0.5 Mt of suitable waste rock (excluding boulders) remaining at Långdal and the cost of transport of this rock is shared with the environmental department who have a responsibility to reclaim the Långdal site. The requirement for the current Life of Mine Plan is 2.3 Mt of waste rock. There are several other historic waste dumps within an acceptable distance of the mine with quantities exceeding the remaining requirement, which Boliden consider would be suitable for backfill.

Essentially, in the present operation of the mine, conversion of the Mineral Resource to a Mineral Reserve mainly consists of the three-dimensional planning of the rooms or stopes and what material will be left behind as pillars.

As indicated by the reconciliation under 'History' above, the performance parameters are considered to be reasonably reliable.

3.32 Metallurgical factors or assumptions

The process used is well established. The ore is delivered by truck to the BOAPP, weighed by truck weigh-bridge and either delivered directly into the plant or stockpiled separately from ore from other mines. Ores from the different mines are processed in batches or campaigns. The feed tonnage to the processing plant is measured using a weighing system with a stationary belt scale. The feed tonnage and the truck weights are used to determine current tonnage in the stockpiles.

As shown in Figure 23 below, there are two stages of grinding. The primary mill is a fully autogenous mill and the secondary mill is a pebble mill fed with pebbles extracted from the primary mill. The ground ore is classified using screens and hydro-cyclones. A gravimetric concentrate containing coarse grained gold bearing minerals is produced in the grinding circuit. The gravimetric concentrate is packed in bags of about 800 kg and delivered to the Rönnskär smelter by truck.

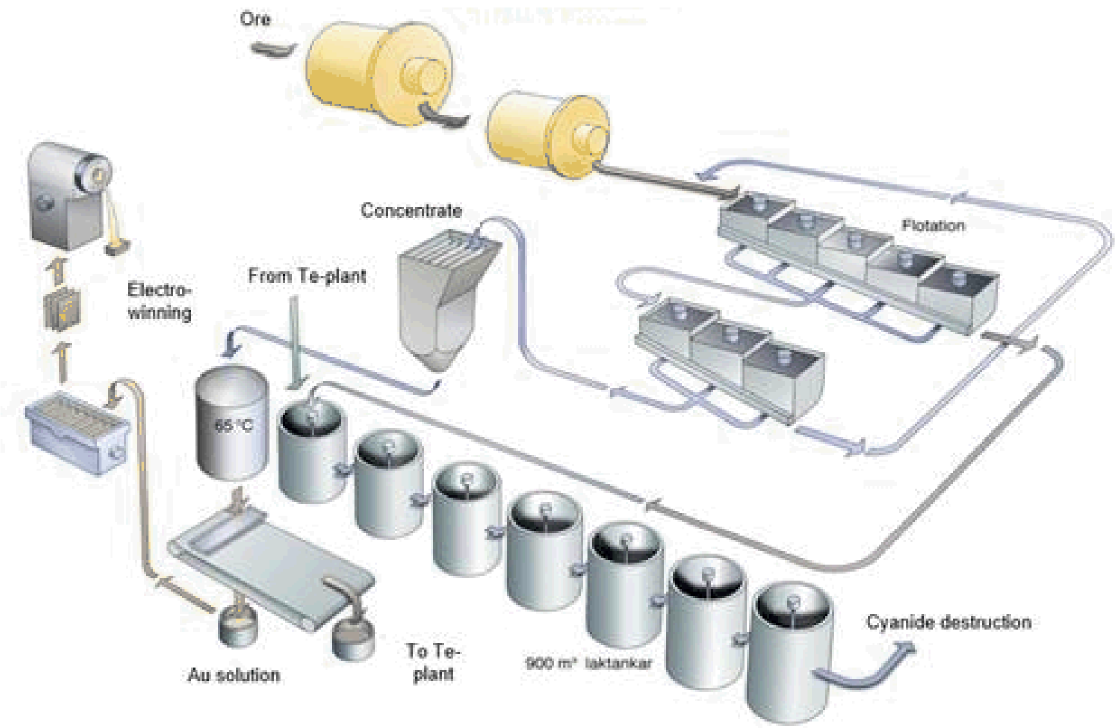


Figure 23: Simplified overview of the different stages of Kankberg ore processing at BAOPP.

Flotation is used to produce a precious metals and tellurium concentrate. The concentrate is accumulated in a leaching tank over a four to five-week campaign. After the completion of a campaign, the concentrate is hot cyanide leached to extract precious metals as a solution. This is done as a batch process. This solution is then separated from the tellurium-rich leach residue using a belt filter. The solution is pumped through a column containing active carbon to recover precious metals. These are then stripped from the carbon as a solution. Electrowinning is used to precipitate the precious metals in the solution to a sludge that is melted and cast into doré bars that are delivered to the smelter.

The tellurium-rich leach residue is stored in a tank so that onward processing can proceed continuously. The residue is leached again in a proprietary process to recover the tellurium to a tellurium concentrate 'cement'. This is a grey-black powder containing principally tellurium and bismuth oxides with 10% moisture. It is packed in steel drums for sale.

Also, in a continuous process, the residue from the tellurium process is added to the flotation tailings which are cyanide-leached at ambient temperature in a CIL process using active carbon. The active carbon is stripped to produce a solution containing precious metals. In the same process, but not at the same time as the batch described above, electrowinning is used to precipitate the precious metals in the solution to a sludge that is melted and cast into doré bars that are delivered to the smelter.

Metallurgical accounting where a sum of products calculated using assays from daily composite samples of main process streams and assays and tonnage for delivered products together with feed tonnage is used to determine the head grade of the ore.

Metallurgical recoveries are presented in Table 19 below.

Table 19: Metallurgical Recoveries

Product	Metallurgical Recovery
Au	86%
Ag	34%
Te	56%

At the time of writing, metallurgical testwork was being undertaken on a zone of Indicated category, sulphide-rich material in the upper parts of the Kankberg mine. This material displayed different metallurgical properties compared to that of standard Kankberg ROM ore and maybe incorporated into the Life of Mine Plan (LoMP), subject to results of process testwork and other factors as discussed elsewhere in this report.

3.33 Mineral Resource estimate for conversion to Mineral Reserves

Mineral Resources are converted into Mineral Reserves when the rooms that will mine them are planned, and that material left in pillars can be excluded from the Mineral Reserves. All other modifying factors, namely processing, metallurgical, infrastructure, economic, marketing, legal, environmental, social and governmental factors, that are required to transfer Mineral Resources to Mineral Reserves are already in place and considered to be favourable. If, for example, potentially economic mineralization was found by drilling at Kankberg that required different processing to that presently used for Kankberg ore, then this material would require a separate Feasibility Study to develop a separate mine with separate mineral asset reporting (see Section 3.32, for a brief discussion of on-going metallurgical test-work on Inferred material in the upper parts of the Kankberg mine).

Mineral Resources are classified into Measured, Indicated and Inferred categories. Only small portions of the block model remain unclassified. The Mineral Resource classification is based upon evaluation of drill hole density and continuity of mineralization. Generally, a sample spacing of at least 60x60 meters is required for Inferred, 20x20 meters is required for Indicated and 10x10 is required for Measured. The assignment of these categories is carried out by manual review, with reference to drilling layouts, whether all planned holes have been drilled, and with regard to geological complexity.

A variable in the block model is assigned depending on whether the volume it lies within is mined, mining design (LoMP) or outside mining design (outside LoMP). Where mining design volumes include Measured and Indicated Mineral Resources, then these are transferred into Proved and Probable Mineral Reserves, respectively, but excluding material in pillars. It may include small quantities of material that are Inferred Mineral Resources that are not transferred. The volumes of the categories are illustrated in three 3D views in Appendix 5. Vertical pillars are included in the mine design but are not transferred into Mineral Reserves, but because they are now in the mining design volumes, they are not reported. The Mineral Resource is the portion of the block model that is within the high-grade shell (i.e. mainly > 2 g/t gold) and within the low-grade shell (i.e. mainly > 1.1 g/t gold) with a NSR value ≥ 300 SEK/t. It includes sill pillars and Inferred Mineral Resources that lie within the LoMP. Only small isolated parts of the block model are not covered by these volumes.

Mineral Reserves and Mineral Resources are estimated from the block model using the above variable to allocate the categories. Because of the way in which blocks are assigned, Mineral Resources are always reported as additional to Mineral Reserves.

The Mineral Resources and Reserves are estimated with waste rock dilution and recovery percentage per category according to Table 20.

Table 20: Waste rock and dilution per category

Waste rock dilution (%)	Recovery (%)	Category	
3.5	100	RESCAT=1 (Proved)	Reserve
15	85	RESCAT=2 (Probable)	Reserve
3.5	90	RESCAT=3 (Measured)	Resource
15	75	RESCAT=4 (Indicated)	Resource
20	70 to 80	RESCAT=5 (Inferred)	Resource

In effect, Measured Mineral Resources are similar to Proved Mineral Reserves, except that the pillars are explicitly omitted from the Proved Mineral Reserves, whereas in the Measured Mineral Resources, the pillars have not been planned, but they are implicitly omitted by the Recovery Factor. The same relationship exists between Indicated Mineral Resources and Probable Mineral Reserves.

For further discussion, see Section 3.38, ‘Audits or reviews’ below.

3.34 Cost and revenue factors.

Mining, transportation and processing costs are outlined in Table 21.

Table 21: Mining, transport and process operatoing costs

	Costs (SEK/t)
Mining (except transport of ore in mine)	335
Ore transport	65
Process (without fixed expenditures)	125
Total	**525**

The total of these costs gives the break-even cut-off used for mine planning, as described above under Section 3.29, 'Cut-off grades or parameters'.

Boliden's planning prices, which are an expression of the anticipated future average prices for approximately 10 years, are presented in Table 22 below.

Table 22. Long-term metal prices and currency exchange rates

Metal prices		**LTP 2021->**
Gold	USD/tr.oz	1 200
	SEK/kg	308 647
Silver	USD/tr.oz	17.0
	SEK/kg	4 373
Tellurium	USD/kg	30
	SEK/kg	240

Currency rates	**LTP 2021->**
USD/SEK	8.00
EUR/SEK	9.35
EUR/USD	1.17

The metal prices given here and the metallurgical recoveries given above in Table 19 under Section 3.32, 'Metallurgical factors or assumptions', provide two of the three parameters that are combined to give the Net Smelter Return factors, in Table 17, under Section 3.28, 'Metal equivalents or other combined representation of multiple components'. Therefore, it would be possible to calculate a combined processing and smelter cost for each of the three products. However, this would be a cost per gram of product, which would only be realistic when the grades and proportions are as they are expected to be over the life of mine. In reality, operating costs are composed of both fixed and variable components relating to operation production rate or through-put. Due to the complexity and confidentiality of the costs associated with processing and smelting, no further details are presented here.

3.35 Market assessment.

International supply and demand for gold and silver do not need explanation here, and Boliden does not stockpile these metals. Including metal from Kankberg, gold and silver in concentrates and doré bars from the BAOPP are smelted at the Rönnskär smelter, described in website https://www.boliden.com/operations/smelters/boliden-ronnskar , the source of information given here on gold and silver. This is 100% owned by Boliden Mineral AB and situated at Skelleftehamn, the port near Skellefteå. It produces almost 18,000 kg of gold as bars or granules every year. Of that amount, approximately 5,000 kg is recovered from electronic scrap, and the rest is from Boliden and external mines. The major part of the gold is sold to the jewellery industry, but the manufacturing industry and the financial sector are also important customers.

The smelter also produces 450,000 kg of silver every year, exceeding 99.99% purity of which about 110,000 kg is from electronic scrap. It is sold to the electrical, electronics and jewellery industries in the form of granules.

The main market for tellurium is in China. Its price has fallen in recent years and there is a risk that the Mineral Resources and Reserves could be reduced slightly if no value can be ascribed to tellurium. However, it is considered that this would not have a material impact on the economic viability of the Kankberg operation. It should be noted that variation in the gold price and foreign exchange rates have a much greater influence on the economics of the operation than whether or not the Kankberg tellurium product is saleable.

3.36 Others

There are no known potential impediments to mining other than what has been described already. All the details prompted in this section have been dealt with earlier in the report.

3.37 Classification

As discussed in Section 3.33, a sample spacing of at least 60x60 meters is required for Inferred, 20x20 meters is required for Indicated and 10x10 is required for Measured.

Indicated Mineral Resources are transferred to Probable Mineral Reserves and Measured Mineral Resources are transferred to Proved Mineral Reserves, in each case by the application of a mining plan, which includes a cut-off of 525 SEK/t. However material below 525 SEK/t can be included, provided this has previously been classified as Mineral Resources and also that the mining rooms created are above an average grade of 525 SEK/t (see Section 3.29, for an explanation of Mineral Resources criteria).

When a level is planned to be included in the LoMP, any Mineral Resources that are excluded from the LoMP are dropped from the reported Mineral Resources. This is because once a level is mined and backfilled, these volumes would no longer be accessible for economic extraction. However, if there is later re-planning of this level before mining, it is possible that these excluded Mineral Resources could be re-incorporated into the LoMP and therefore the Mineral Reserves, if these satisfy the requirements outlined above. For example, if the drilling required to upgrade from Indicated to Measured or Probable to Proved increases the grade in a location that can only be mined by including peripheral material that had formerly been dropped from Mineral Resources, and the resulting room averages above 525 SEK/t, then this excluded material would be brought back into the Mineral Reserves. Another reason for this change may be a lowering of the NSR cut-off due to changes in technical or economic assumptions.

In this transfer from Mineral Resources to Mineral Reserves, pillars are omitted or designed out of the Mineral Reserves, which entails a reduction in volume and therefore tonnage by around 10%. However, as indicated in Section 3.33, 'Mineral Resource estimate for conversion to Mineral Reserves', the assumed mining recovery is increased by 10 percentage points.

All other modifying factors to transfer Mineral Resources to Mineral Reserves have already been considered elsewhere in this report. There are no Probable Mineral Reserves which have been derived from Measured Mineral Resources.

3.38 Audits or reviews

In the opinion of the independent reviewer, Mr. M Howson, the system of allowance for dilution and recovery in the Mineral Resources figures may be unconventional with respect to other operations reporting under CRIRSCO standards. However, this system for Kankberg was set up historically and works well for this mine. It is not considered to be appropriate to change this system at this stage in the mine's life, but rather to explain it clearly in the CP Report.

The current system of conversion from Mineral Resources to Mineral Reserves matches the present mining method. Justification to change the mining method could be to increase mining recovery by reducing material left in pillars, to increase production rates and / or lower unit mining costs. Such a change would require a new Feasibility Study with an associated revision of the Mineral Resources and Mineral Reserves. There is no justification to change the current system at present.

3.39 Discussion of relative accuracy/ confidence

There has been no application of conditional simulation to production increments to try to test the relative accuracy and confidence of the estimates. The geological staff understand this approach, but since the mine has been in production for several years with reporting under the previous FRB system, the results from reconciliation are considered to provide a more appropriate test of accuracy. This is for production increments of quarter-years, each of which include ore from several locations around the mine.

Virtually all of the ore that is mined at Kankberg is from Proved Mineral Reserves that were transferred by mine planning from Measured Mineral Resources. In Section 3.3, 'History', reconciliation shows these estimates to predict the production that is recorded at the mill in an unbiased manner and within a reasonable confidence range. It appears that Measured Mineral Resources are known with a relative accuracy of around ± 20 % at 90 % confidence for quarterly production increments (years 2015 to 2019). Therefore, the 10x10 metres drill spacing that is generally required for Measured Mineral Resources, the mine planning that transfers to Proved Mineral Reserves and the control of mining that delivers the ore are considered to be adequate.

Estimation stages of Inferred and Indicated Mineral Resources and Probable Mineral Reserves cannot be directly tested by reconciliation. To do so would not only require a different model estimation with omission of some drillholes, but also mine planning on the basis of that less perfect model. But in any case, this would not yield useful information.

Indicated Mineral Resources are a 'staging post' between Inferred and Measured, marking the point at which exploration, sampling and testing are considered sufficient to assume geological and grade continuity between points of observation, such that confidence in estimation is sufficient to support preliminary mine planning, which will be changed when more drilling has allowed estimates to be upgraded. The drilling grid for Indicated Mineral

Resources of 20x20 metres involves a quarter of the number of drillholes that is required for Measured, and this ratio is typical in the industry. An exercise to try to test the accuracy or to 'optimize' the spacing for Indicated is not considered worthwhile.

The drilling grid for Inferred Mineral Resources of 60x60 metres also seems rational as providing geological evidence that is sufficient to imply but not verify geological and grade continuity. At this spacing most parts of the mineralized zones (see the end of Section 3.7, 'Geology') would be identifiable with grades that would be sufficiently representative to allow prioritization of infill drilling for upgrading to the Indicated category. Therefore, this spacing is considered to be adequate.

3.40 Schematic description of the principles for reporting of Mineral Resource and Mineral Reserve

Figure 24 below provides a schematic illustration of the principles for reporting of Mineral Resource and Mineral Reserve at Kankberg mine.

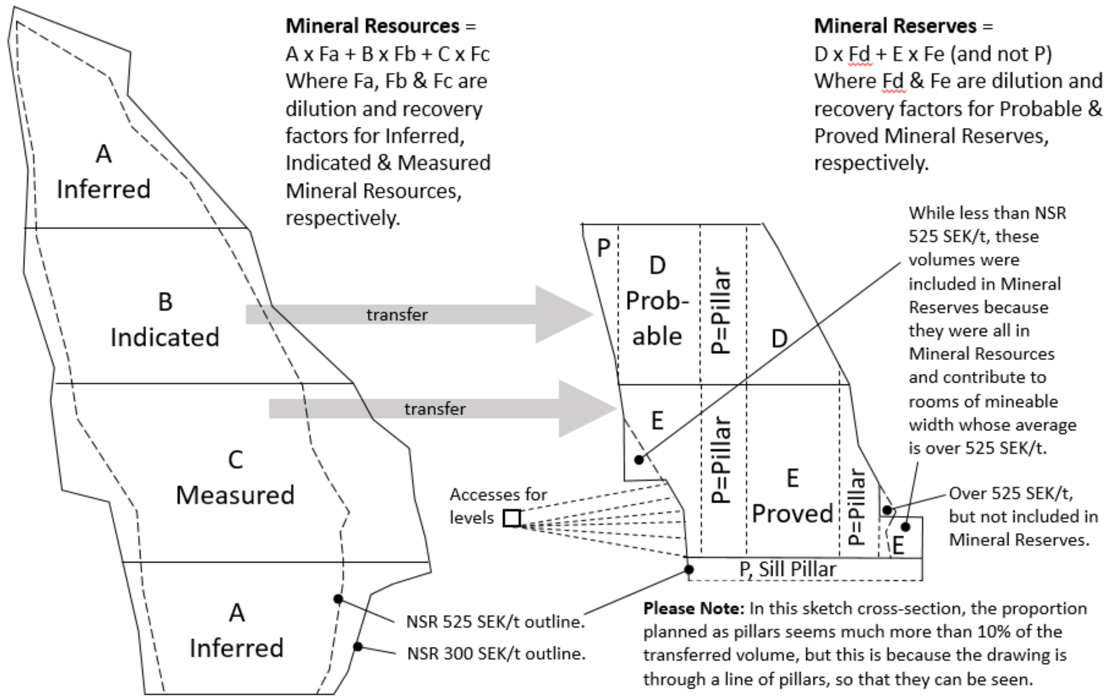


Figure 24: Schematic description of the principles for reporting of Mineral Resource and Mineral Reserve at Kankberg

The above sketch on the left side shows Mineral Resource volumes defined by an NSR 300 SEK/t cut-off. Mine planning transfers much of the Indicated and Measured categories to Mineral Reserve volumes (and pillars) shown on the right. These are defined mainly by an NSR 525 SEK/t cut-off, which is shown on the left side as a dashed line. However, on the right the Mineral Reserves also include rooms that were not entirely above NSR 525 SEK/t, but which were previously classified as Mineral Resources, are of mineable width and which average over NSR 525 SEK/t.

After LoMP planning, there may be small quantities of Mineral Resources with grade above 525 SEK/t on the same level that cannot be included in rooms to be mined. This is generally because to access these would require inclusion of low-grade material such that the average NSR value of the room would be less than 525 SEK/t. Such material is illustrated in the sketch above as 'Over 525 SEK/t, but not included in Mineral Reserves.' This would not be transferred into Mineral Reserves and it would cease to be included in Mineral Resources.

However, if there were to be a revision of the LoMP, for example due to drilling required to upgrade from Indicated to Measured Mineral Resources, and by transference from Probable to Proved Mineral Reserves, then it is possible that this material could be re-included if the requirements for Mineral Reserves become satisfied.

Section 3.33, 'Mineral Resource estimate for conversion to Mineral Reserves', Table 20 gives dilution and recovery factors as percentages, which differ for the Mineral Resources and Mineral Reserve categories shown as A to E in the sketch above. Using values from the block 'Model' aggregated into mine planning volumes, these factors are applied as follows:

Mineral Resources that cannot be transferred to Mineral Reserves:

- A, Inferred, RESCAT 5
    - Tonnes = Model Tonnes x 0.70 x (1+0.2)
    - Au Grade = Model Au Grade / (1+0.2)

Mineral Resources that could be, but have not yet been transferred to Mineral Reserves:

- B, Indicated, RESCAT 4
    - Tonnes = Model Tonnes x 0.75 x (1+0.15)
    - Au Grade = Model Au Grade / (1+0.15)
- C, Measured, RESCAT 3
    - Tonnes = Model Tonnes x 0.90 x (1+0.035)
    - Au Grade = Model Au Grade / (1+0.035)

Mineral Reserves that mine planning has transferred from Mineral Resources:

- D, Probable, RESCAT 2
    - Tonnes = Model Tonnes (excluding pillars) x 0.85 x (1+0.15)
    - Au Grade = Model Au Grade (excluding pillars) / (1+0.15)
- E, Proved, RESCAT 1
    - Tonnes = Model Tonnes (excluding pillars)
    - Au Grade = Model Au Grade (excluding pillars) / (1+0.035)

4 COMPETENT PERSON'S CONSENT STATEMENTS

Pursuant to the requirements of paragraph 3.2 of the PERC Standard.

Gunnar Agmalm

The information in the report to which this statement is attached, relates to Exploration Results, Mineral Resources and Mineral Reserves of the Kankberg Mine. This is based on information compiled by Gunnar Agmalm, who is a professional member of the Australian Institute of Mining and Metallurgy (AusIMM, membership number 227254) and Fennoscandian Association for Metals and Minerals Professionals (FAMMP, membership number 16). Mr. Agmalm is a full-time employee of Boliden Mineral AB.

Mr. Agmalm has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the 2017 Edition of the 'PERC Standard for Reporting of Exploration Results, Mineral Resources and Reserves'. Mr. Agmalm consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

Signed:

Gunnar Agmalm, 31-12-2019

Johan Bradley

The information in the report to which this statement is attached, relates to Exploration Results, Mineral Resources and Mineral Reserves of the Kankberg Mine. This is based on information compiled by Johan Bradley, who is a professional Fellow (membership number 1014008) with 'Chartered' Status of the Geological Society of London and European Geologist Status with the European Federation of Geologists. Mr. Bradley is a full-time employee of Boliden Mineral AB.

Mr Bradley has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the 2017 Edition of the 'PERC Standard for Reporting of Exploration Results, Mineral Resources and Reserves'. Mr Bradley consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

Signed:

Johan Bradley, 31-12-2019

5 REFERENCES

5.1 External references

Allen, R.L., Weihed, P., Svensson, S-Å. (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, p.1022-1053.

Kathol, B., Weihed, P (eds.). (2005): Description of regional geological and geophysical maps of the Skellefte District and surrounding areas, ISBN 91-7158-678-4, SGU: Ba 57

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

Parker, H. (2010) "Quantitative Criteria for Mineral Resource Classification" (presentation) GRZ – CRIRSCO Seminar on Russian and International Mineral Resources / Reserves Reporting Standards – Moscow, 27 September 2010.

Sinclair, A. J. & Blackwell, G. H., (2002), Applied Mineral Inventory Estimation, Cambridge University Press, ISBN 0-521-79103-0

5.2 Internal references

For access to internal references contact author or the Head of Department of relevance.

Agmalm, G. (2011): Kankberg, Åkulla Östra mineralization Feasibility Study. Boliden DMS#: 474882.

Bohlin, N.-J. (2010): Mineralogical study of ore samples from Åkulla Östra. Boliden, TM_REP2009/037.

Baldwin, S. (2018): Kankberg campaign Reconciliation DV_MEMO 2018/01, Boliden DMS #11900535.

Fahlgren, J. (2015a): A lithogeochemical review of the Kankberg Au-Te deposit, Boliden Area. Boliden, GP2015-25.

Fahlgren, J. (2015b): GeoGuide_Kankberg_AuTe_Geology_JF_20150415.

Lundberg M. (2018): Mineral processing, Pers. Comm. 2018.

Lundh, J., Holmen-Fröberg, S., Nordfeldt, P., Munck, M., & Wasström, A. (2016): Kankberg/Åkulla Östra Au-Mineralisation: Exploration Report, 2015 to 1Q2016. Boliden, GP 2016-20.

Munck, N. (2017): U QA_QC Guideline and work flow (C20556).

Voigt, B. (2017): Kankberg/Östra Åkulla Au-mine, Mineral Reserves and Resources as of 2017-12-31, Boliden Mineral Reserves and Resources Report 2017, DMS# 1160696.

Voigt, B. (2018): Reserves and Resources G1N 2018-12-31, Boliden Mineral Reserves and Resources Report 2018 (Excel), DMS# 1307888.

Wasström, A. (1997): Au-mineraliseringen i Åkulla Östra. Boliden, GP97003.

Wasström, A., Agmalm, G., & Nilsson, P. (1999): Exploration Report- Status Report 1999 Åkulla Östra Mine Investigation- Geology. Boliden, GP 99 021.

Wasström, A., Agmalm, G., & Sandström, B. (2009): Åkulla Östra Au-mineralisation and resource estimation 2007-2009. Boliden, GP 2009-47.

Žižek, T. (2018): Mining methods, Pers. Comm. 2018.

Åberg, L. (2019): Mineral Resource estimate for Kankberg, Boliden Ore Reserves Report 2019.

Appendix 1

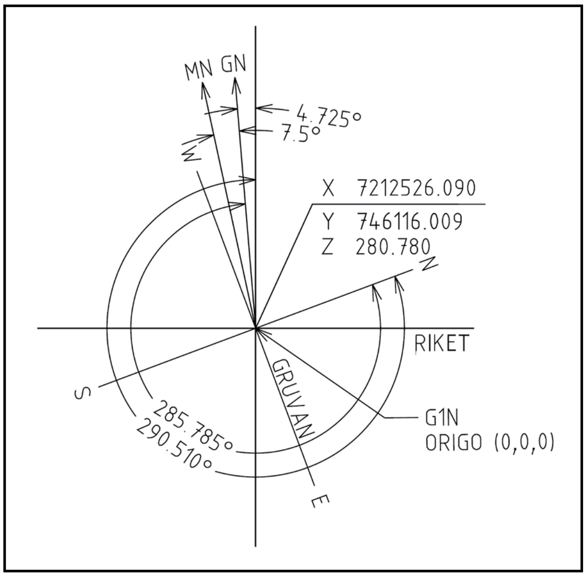
A Brief Pre-Production History of the Kankberg Underground Mine

1927	Exploration started in the Åkulla area.
1928 - 1933	Electrical ground measurements. At Åkulla Östra Cu-Au-Zn mineralization was found in 4 drill cores.
1938	A drift is made from Åkulla Västra under this mineralization. A Cu-Au mineralization associated with quartz-filled cracks was discovered at a depth of 130 m.
1939	Åkulla Östra consists of several small sulphide lenses. The drift was filled with water.
1943 - 1952	Geological exploration and geophysical ground measurements.
1967 - 1969	Drilling and planning for open pit.
1984	Some drill holes drilled in the "Deep-seated sulphide ore" project. No new mineralized bodies were found.
1991	A new exploration campaign with geophysical ground measurements and geological surveying.
1994	Detailed geological outcrop logging and a new drilling campaign. The first drill hole intersected a new 10 m wide massive pyrite lens at a depth of 260 m in December. The grades were 'too low' but the drilling campaign continued due to geological and geophysical interpretations indicating mineralization at a deeper level.
1995	On 1 March a new type of Au mineralization was found in a strong Si-Al alteration zone at a depth of 350 m. This alteration zone had mineable thicknesses with high Au contents, and is characteristic of the present Kankberg orebody.
1996	First metallurgical tests on sample material from drill cores.
1997 - 1998	Åkulla Östra B lens is mined in open pit.
1997	Ramp commenced towards Åkulla Östra Au mineralization.
1998 - 1999	Exploration within the Åkulla Östra Mine commenced. 20 drill holes.
1998	Processing tests on 1 350 t from the ramp.
2004 - 2006	Åkulla Östra Mine exploration continued. Exploration department drilled 86 drill holes of which 3 were extensions of existing drill holes.
2006	Test mining and a pilot processing test on 11 100 t. Some material from the 1999 ramp was used to clean the line.
2007	A drilling programme of 27 drill holes was initiated, of which one was an extension of an existing drill hole.
2008	The drilling programme was concluded. Conceptual study on extraction of tellurides shows good potential for profitability. Analyses campaign on tellurides.
2009 - 2010	A new ramp is started and a new drilling campaign is completed.
2011 -	The Feasibility Study (FS) is completed in January. Infill drilling programme commences.
2012	Production at Kankberg begins in January.

Appendix 2

Explanation of the Mine Local Grid, G1NSYSTEMET

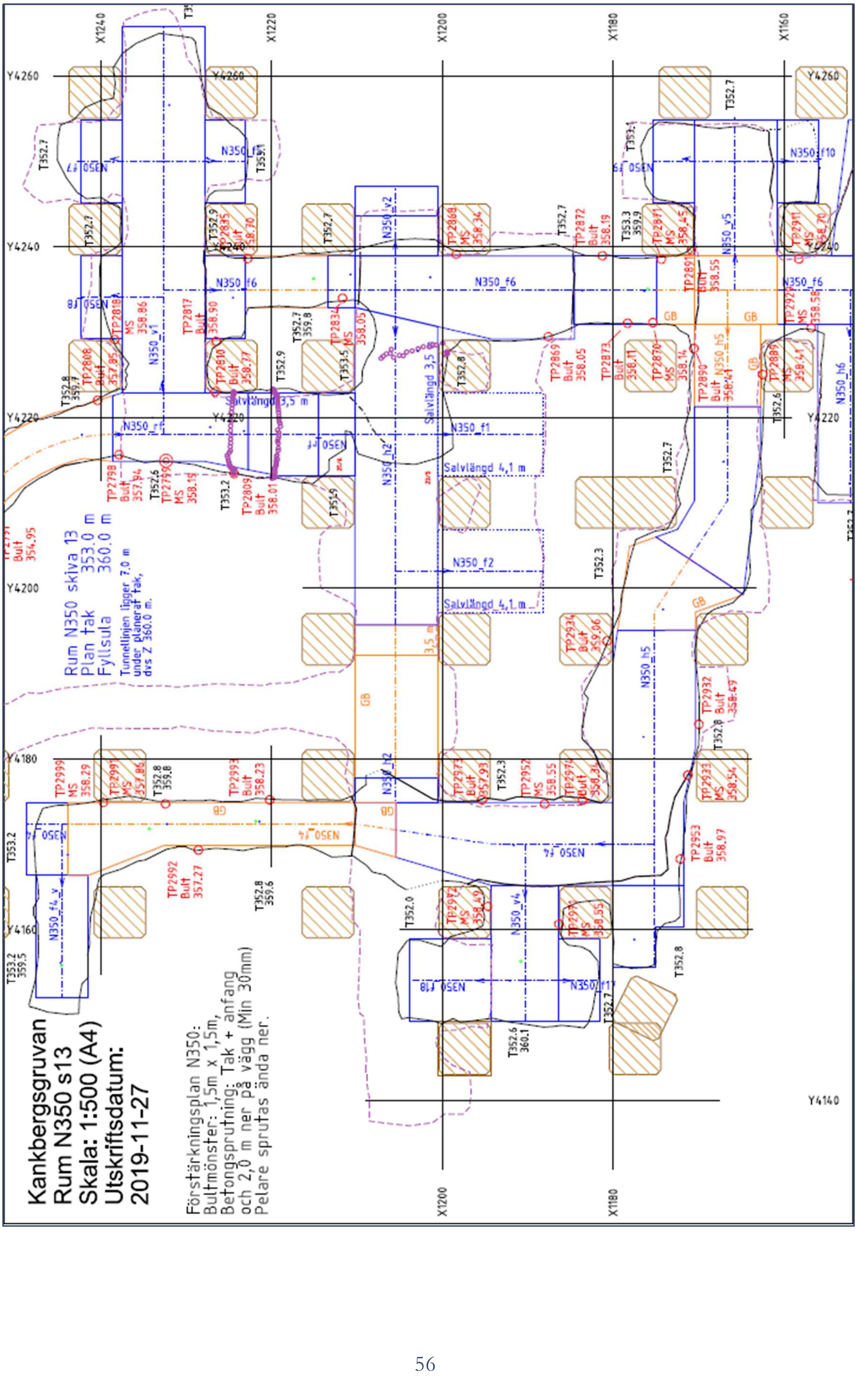
Origin of the mine's local grid has the following coordinates:		
	National grid	
Origin	**SWEREF99 TM** **RH 70**	**(RT90 2.5 g V 0: -15)** **(RH00)**
X **Y** **Z**	7 212 526.158 746 115.962 280.78	(RT90: 7 211 886.192) (RT90: 1 708 251.873) (RH00: 280.000)
Angle from the mine grid's north to the national grid's north is:	290.510 degrees	(289.779 degrees)
E: E-value	285.785 degrees	(285.783 degrees)
MKV: Convergence of meridian	4.725 degrees	(3.996 degrees)
D: Declination	ca 7.5 degrees	
GN: Geographical north		
MN: Magnetic north		
RIKET: SWEREF99 TM		
GRUVAN: Kankberg mine		
All angles are positive clockwise		

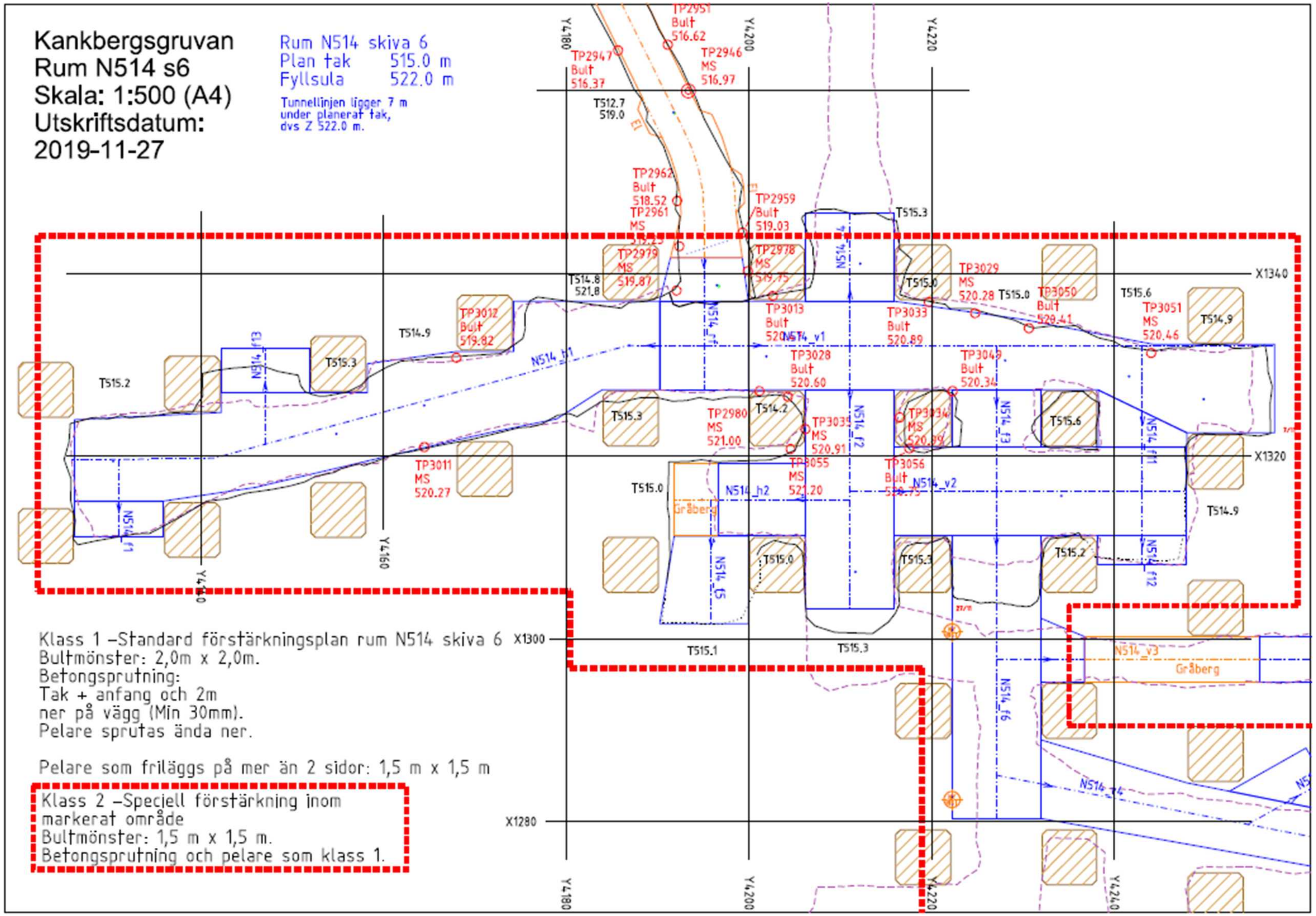


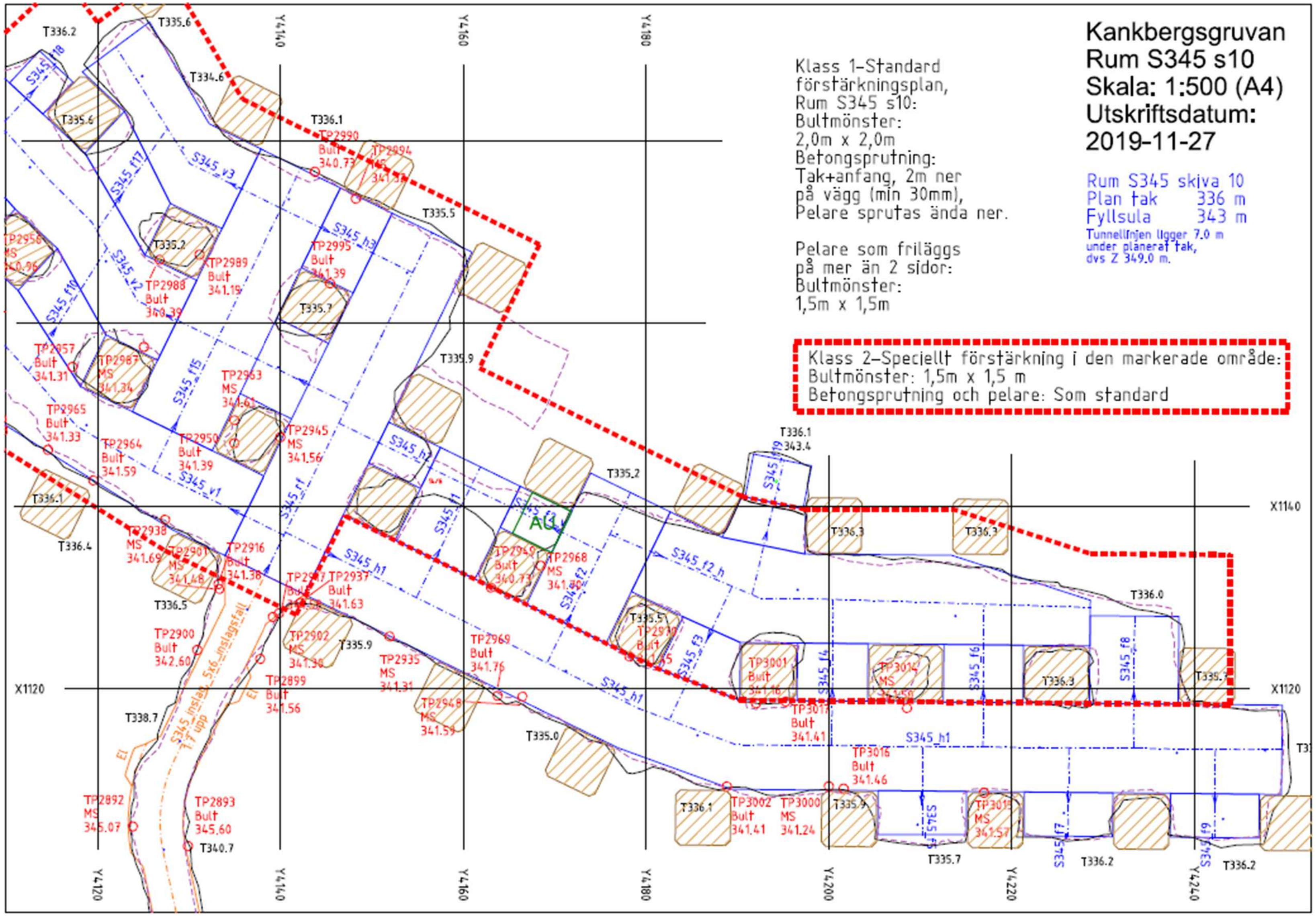
The relationship between the coordinate systems has been established by surveying of fixed local points (Swedish: stompunkter) above ground using GNSS (Global Navigation Satellite System) and a network of permanent reference stations (Nätverks-RTK) in 2010 in the RT90 2.5 gon V 0:-15 system. This relationship was then transformed into the SWEREF99 TM system.
E-value is the angle between geographical north the positive X-axis of the mine grid (G1N systemet).
Convergence of the meridian is the angle between geographical north and the positive X-axis of the national grid
Declination is the angle between geographical north and magnetic north

Appendix 3

Examples of Mine Survey Plans, 3 of 8 that were current in late November 2019.

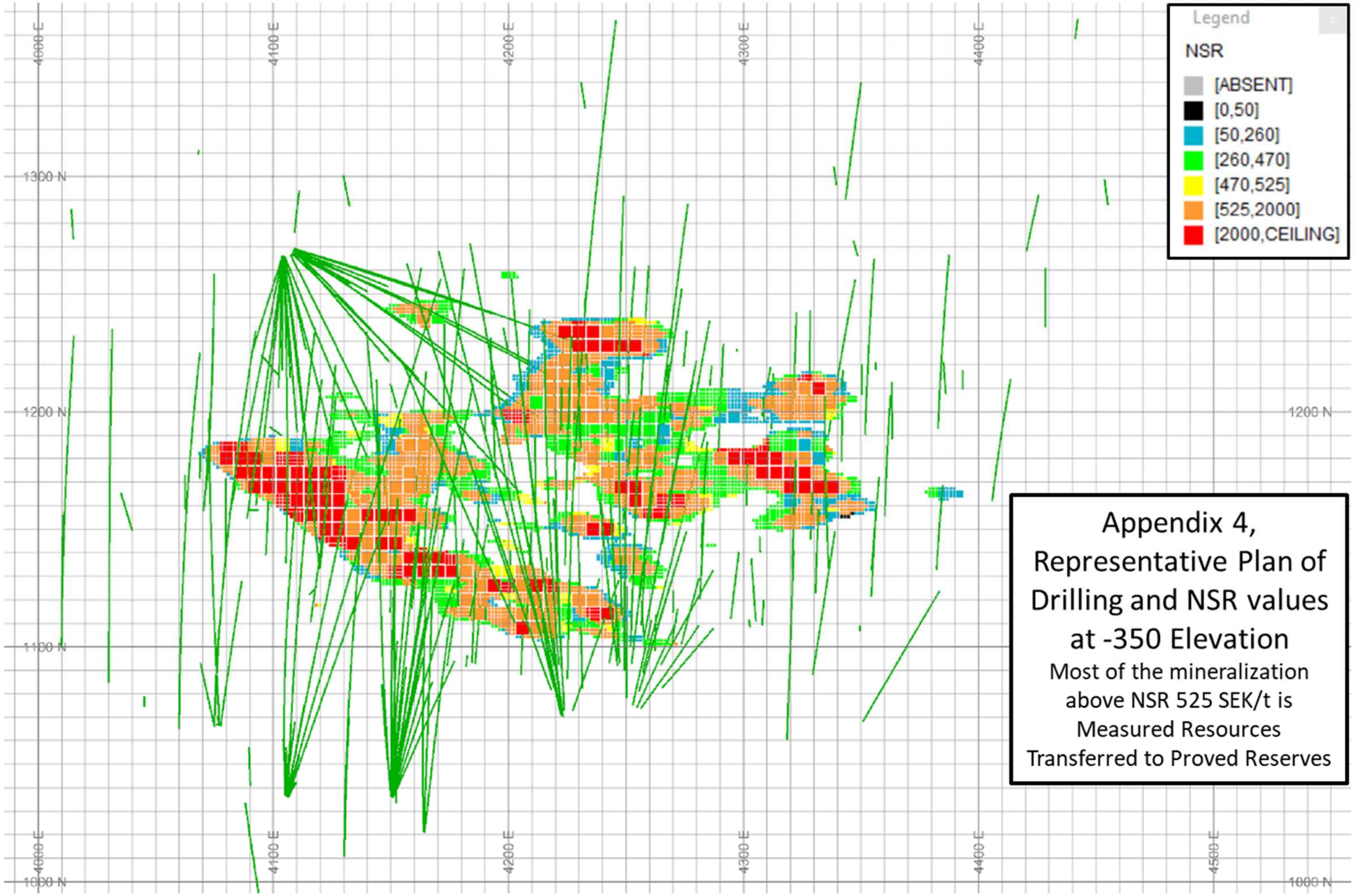


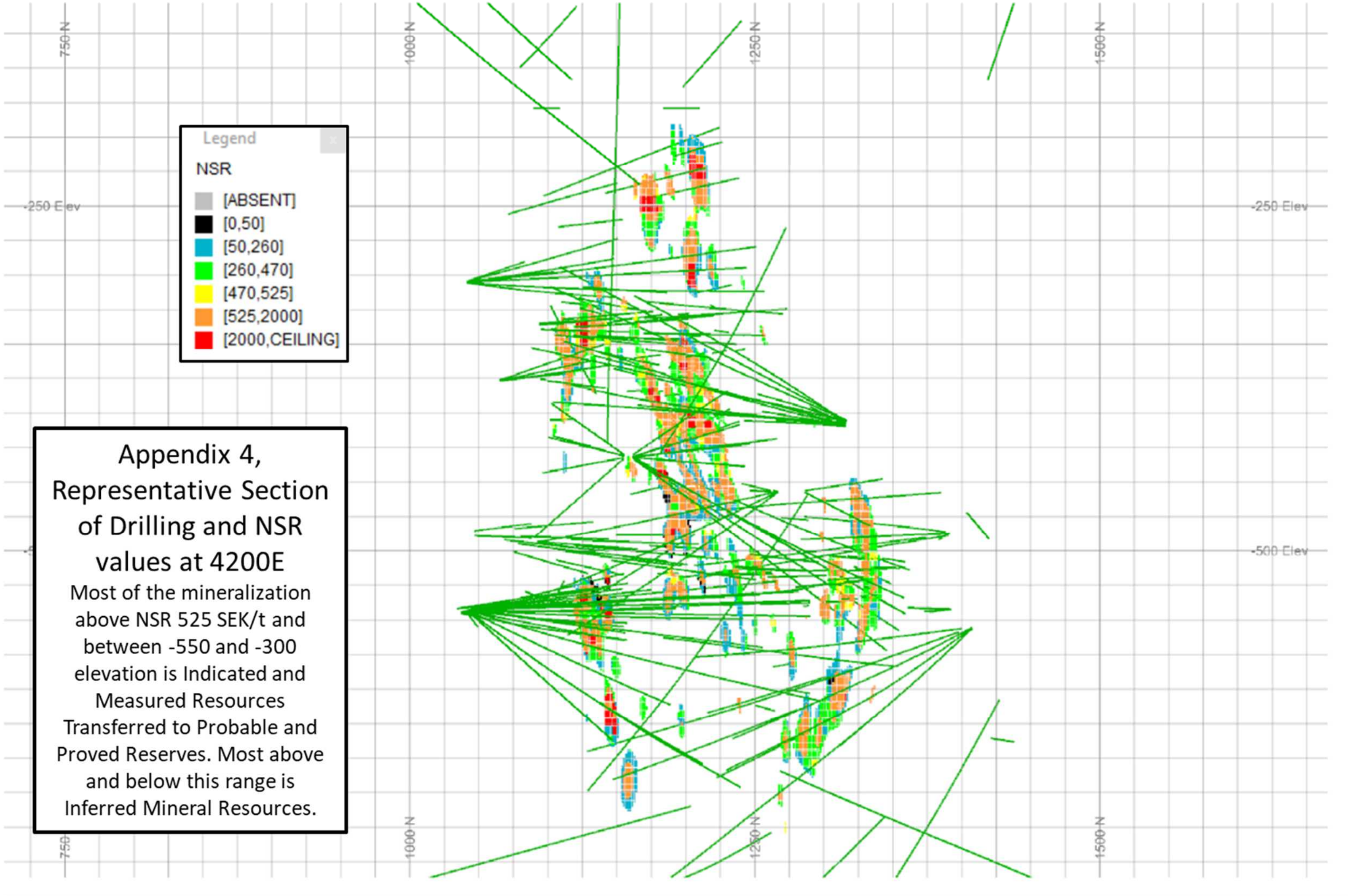

Kankbergsgruvan
Rum N514 s6
Skala: 1:500 (A4)
Utskriftsdatum:
2019-11-27
Rum N514 skiva 6
Plan tak 515.0 m
Fyllsula 522.0 m
Tunnellinjen ligger 7 m
under planerat tak,
dvs Z 522.0 m.
Klass 1 –Standard förstärkningsplan rum N514 skiva 6
Bultmönster: 2,0m x 2,0m.
Betongsprutning:
Tak + anfang och 2m
ner på vägg (Min 30mm).
Pelare sprutas ända ner.
Pelare som friläggs på mer än 2 sidor: 1,5 m x 1,5 m
Klass 2 –Speciell förstärkning inom
markerat område
Bultmönster: 1,5 m x 1,5 m.
Betongsprutning och pelare som klass 1.
X1340
X1320
X1300
X1280
Y4160
Y4180
Y4200
Y4220
Y4240
N514_h1
N514_h2
N514_v1
N514_v2
N514_v3
N514_f1
N514_f2
N514_f3
N514_f5
N514_f6
N514_f11
N514_f12
N514_f13
Gråberg
TP3011
MS
520.27
TP3012
Bult
519.82
TP2980
MS
521.00
TP3028
Bult
520.60
TP3029
MS
520.28
TP3033
Bult
520.89
TP3050
Bult
520.41
TP3051
MS
520.46
TP2962
Bult
518.52
TP2961
TP2959
/Bult
519.03
TP2946
MS
516.97
TP2947
Bult
516.37
TP2951
Bult
516.62
T512.7
519.0
T514.8
521.8
T515.2
T514.9
T515.3
T515.0
T515.6
T515.1


Kankbergsgruvan
Rum S345 s10
Skala: 1:500 (A4)
Utskriftsdatum:
2019-11-27
Rum S345 skiva 10
Plan tak 336 m
Fyllsula 343 m
Tunnellinjen ligger 7.0 m under planerat tak, dvs Z 349.0 m.
Klass 1-Standard förstärkningsplan, Rum S345 s10:
Bultmönster:
2,0m x 2,0m
Betongsprutning:
Tak+anfang, 2m ner på vägg (min 30mm), Pelare sprutas ända ner.
Pelare som friläggs på mer än 2 sidor:
Bultmönster:
1,5m x 1,5m
Klass 2-Speciellt förstärkning i den markerade område:
Bultmönster: 1,5m x 1,5 m
Betongsprutning och pelare: Som standard

Appendix 4

Examples of Plans and Profiles showing drillholes and block model NSR grades.



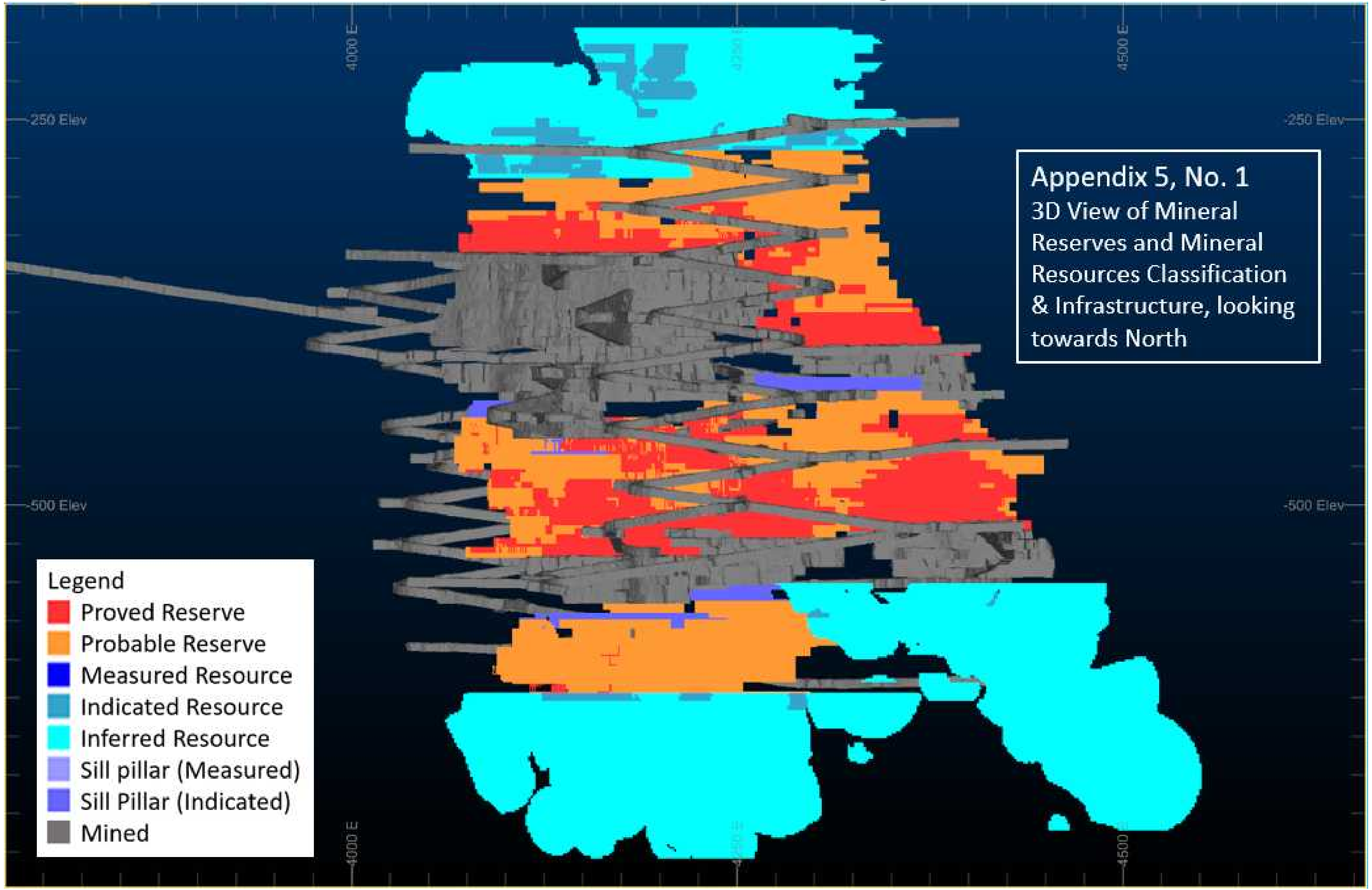


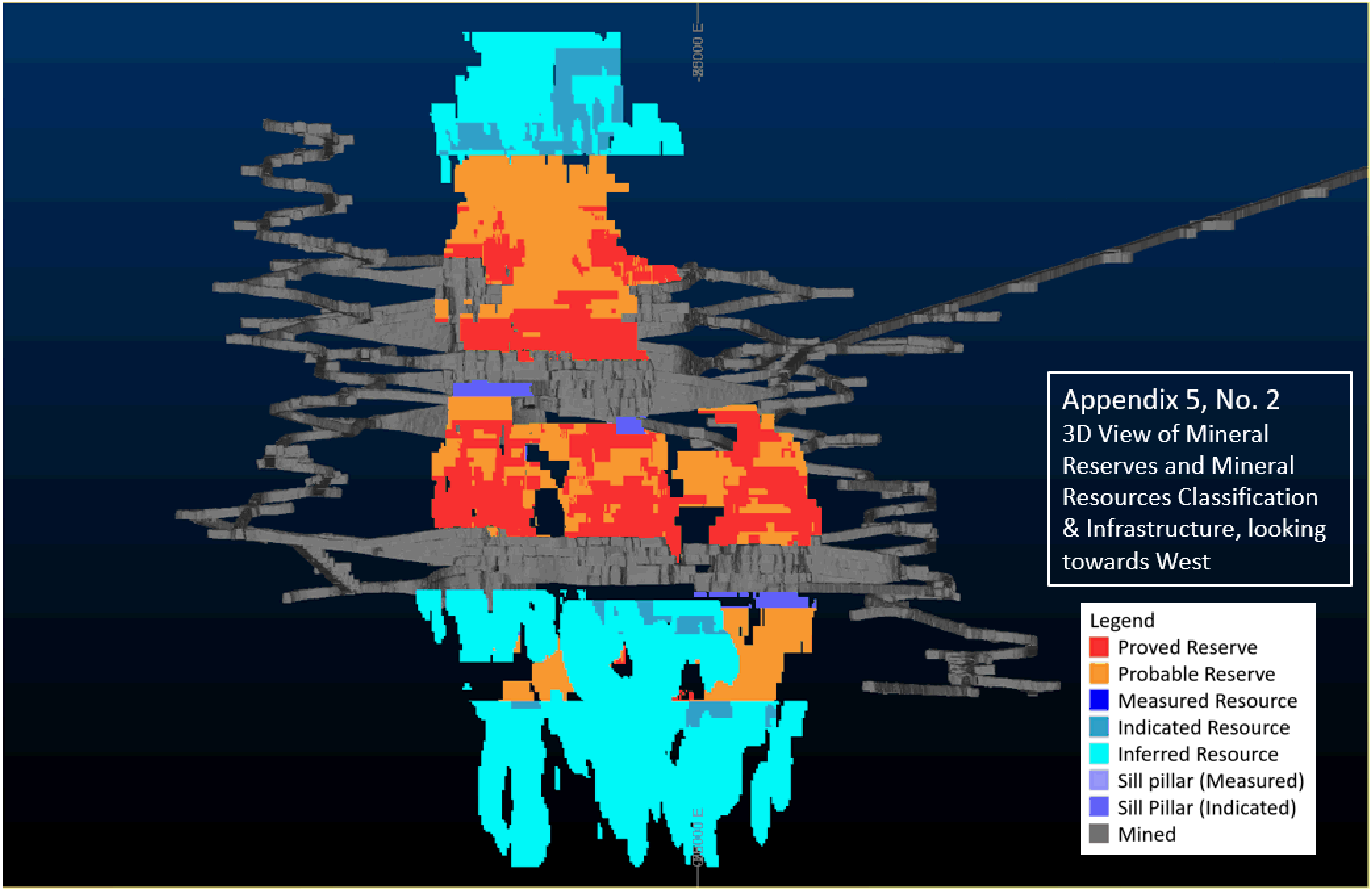
Appendix 4, Representative Section of Drilling and NSR values at 4200E

Most of the mineralization above NSR 525 SEK/t and between -550 and -300 elevation is Indicated and Measured Resources Transferred to Probable and Proved Reserves. Most above and below this range is Inferred Mineral Resources.

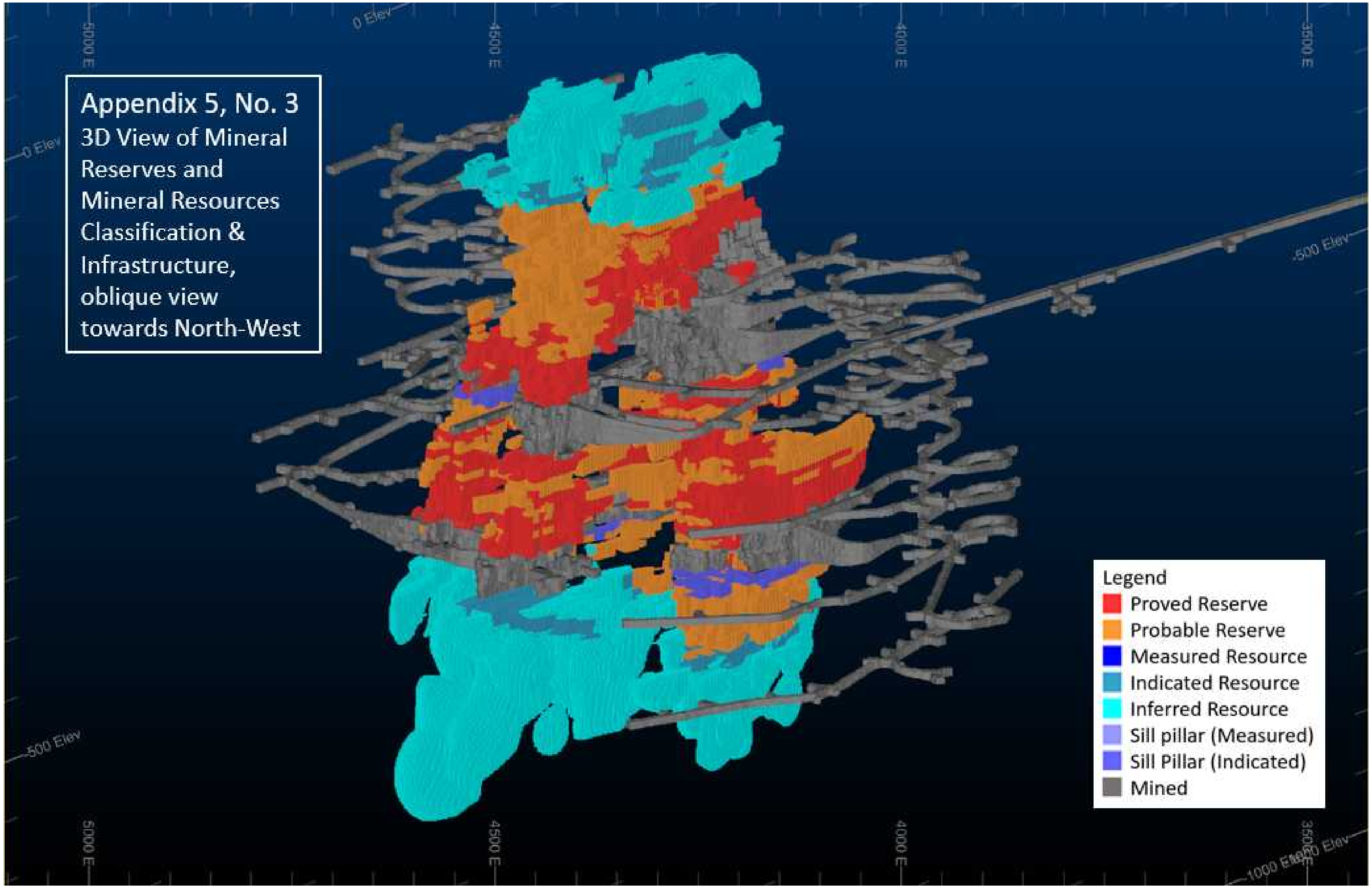
Appendix 5

3D view of Mineral Reserves and Mineral Resources classification and existing infrastructure.





Appendix 5, No. 2
3D View of Mineral Reserves and Mineral Resources Classification & Infrastructure, looking towards West


Appendix 5, No. 3
3D View of Mineral Reserves and Mineral Resources Classification & Infrastructure, oblique view towards North-West
Legend
Proved Reserve
Probable Reserve
Measured Resource
Indicated Resource
Inferred Resource
Sill pillar (Measured)
Sill Pillar (Indicated)
Mined
5000 E
4500 E
4000 E
3500 E
0 Elev
-500 Elev