SYDVARANGER

Sydvaranger Iron Ore Project

Mining Method Comparative Analysis

November 2017

Table of Contents

1 Introduction & Background

The Sydvaranger group of companies (collectively "Sydvaranger"), including Sydvaranger Eiendom AS as the applicant for the mining concession, were established in April 2016 for the purpose of restoring mining and processing operations of the historic Bjørnevatn iron mine and the production of high quality iron concentrate. Sydvaranger has extraction rights which include the mineral resources of the main ore body in the Bjørnevatn open pit and number of satellite ore bodies located south from the main ore body.

The purpose of this evaluation is to compare both the open pit and underground mining methods for the extraction of iron minerals from the Sydvaranger deposits, and on the balance of factors, select the appropriate method to be employed for the restart of operations. The evaluation takes into consideration the most economically viable approach as well as non-economic factors including technical, environmental impact and operational safety.

Iron ore was discovered at the Kirkenes peninsula during the 1860's and was mined across the period from 1906 to the 1997 and then again from 2009 until 2015. During the mining operations at Bjørnevatn, extensive geological data was collected using diamond drilling exploration. All the geological information was carefully gathered, stored in archives and processed to then provide an interpretation of the iron ore deposit properties in geological block models which are now used in modern mine planning and mine designing software.

Sources for this evaluation include:

i. Sydvaranger internal mine engineering prepared with Deswik software;
ii. Bjørnevatn Optimisation Study, Deswik, 1 June 2017
iii. Sydvaranger internal financial evaluations and forecasts;
iv. Sydvaranger geological block models;
v. Studies undertaken by Sydvaranger Gruve AS and former Sydvaranger operating entities, including the report "Normin-prosjektet storskala underjordsdrift";
vi. Sydvaranger senior mining advisor and senior mining engineer;
vii. External mine engineering consultants;
viii. Various scholarly articles.

2 Alternative Mining Methods

2.1 Overview

The main objective in any commercial mining operation is the exploitation of the mineral deposit at a cost which will ensure an economically robust business. The mining methods available fall into two broad categories – underground mining and open pit mining.

2.1.1 Underground Mining

With an underground mining method, the ore body is accessed from beneath the ground surface by a series of tunnels or shafts which run horizontally, reducing the amount of waste rock to be removed to access the ore. The mining techniques employed remove the ore in sections leaving behind an underground void or cavity. Generally, underground mining occurs when the ore is at distance far beneath the surface or when the open pit mine is depleted.

Underground mines require some crucial design components which include ventilation shafts to clear dust and fumes from drilling and blasting; escape routes; access shafts for workers and equipment; ore-transport tunnels; recovery shafts to carry excavated ore to the surface; and communication systems to send information back and forth between the surface and the depths.

Various underground mining techniques can be employed for extracting ore and the choice is often related to the geology of the deposit and degree of ground support necessary to make the method productive and safe:

1. Historically, Sydvaranger trialled **an open stope system** for underground ore extraction which is a process of extracting the ore from an underground mine, leaving behind an open space known as a stope, with the roof of the mine supported by pillars. Stoping is used when the country rock is sufficiently strong not to collapse or cave into the stope. As the pillars are required for roof support, significant volumes of ore are left behind and sterilized. This, combined with the higher costs of underground mine operations, make this method uneconomic for future operations at Sydvaranger.

   During the 1990's, Sydvaranger mined one trial stope before closure of operations at that time. It is understood that the chosen mining method was a result of the study – "Normin-prosjektet storskala underjordsdrift" which was supported by Forskningsrådet/NTNF and was carried out by the Norwegian mining association. The open stoping method was favoured due primarily to geotechnical concerns regarding the ability of the Sydvaranger country rock to effectively cave and the potential for an uncontrolled collapse of the underground mining infrastructure as well as the investment required which was regarded as excessive for the planned operation.

2. **Block caving** is an alternative method of underground mining which is a bulk mining approach where a large section of rock is removed, creating a cavity that then collapses under its own weight. The technique relies on gravity and internal stresses within the rock to break the rock into pieces. A block is usually a section in the mine layout of a few thousand square meters, with the caving induced by undercutting beneath the block. The broken ore is then funnelled into pre-constructed tunnels and bunkers allowing the ore to be removed. Above the collapsed underground mine, large areas of the surface subside and form sink holes. This bulk mining method is the underground version of open cut mining and due to the large volumes of rock extracted and the production rates that can be achieved, costs can be competitive with open pit surface mining. However, the dilution (waste rock mined with ore) is high and not easily controlled. This method is most suited to massive and steeply dipping ore bodies with soft rock that breaks easily (e.g. sandstones). The main operational risk with this method is if the underground roof stabilizes and does not collapse in a controlled manner, potentially resulting in a catastrophic collapse. In most cases, this type of underground bulk mining has occurred in order to follow mineralization at depth after the exhaustion of open-pit ore. For Sydvaranger, this method would result in significant dilution of the ore and is not considered an economically viable option.

3. **Sublevel caving** is a further underground mining method where mining starts at the top of the ore body and progresses downwards. Tunnels are developed at regular intervals in the ore body to create a void and the roof is then blasted to cave in. As the roofs collapse, the rock from the ground surface will cave into the underground cavity creating sinkholes. This mining method is suitable for large ore bodies with a steep dip and where the ore body and host rock can fracture and collapse under controlled conditions. The method is more selective than block caving and requires more development works, thereby reducing the dilution of the ore mined. Sublevel caving is usually carried out when mining of the ore body through an open pit method is no longer economically feasible. Further in this evaluation of mining methods, the sublevel caving technique is assumed to be the most applicable option for Sydvaranger operations to consider as it enables the maximum volume of ore to be extracted without significant dilution.

While underground mining has higher mining costs than open pit mining, as an open pit mine develops and deepens, accessing ore can result in a higher cost waste stripping requirement. In such circumstances, a transition to underground mining method may enable both ore recovery and the extension of mine life.

2.1.2 Open Pit Mining

Open pit mining is a method of extracting rock or minerals by excavating at the surface of the ground to expose and mine the ore. This method generally requires the removal and relocation of waste rock to an area outside of the mineralized zone. Mining operations occur from the top down in a series of successive layers, or benches, which are above the surface of the ore and/or waste rock being mined. This method is usually adopted when ore appears close to the ground surface.

The open pit design and schedule of mining the ore and waste are prepared with mine engineering based on the geological knowledge of the mine area. While constrained by geology and technical mine engineering, the open pit mine plans also respect the economic limitations of cost of extraction and sales price of the mineral.

The open pit mining method has in general several advantages which often makes it a preferred and attractive option. Such advantages include increased safety, higher production rates, grade control, lower cost and economic risk with the possibility of earlier cash flow as well as less operational risk and increased flexibility. Little development work is required to commence mining and the method is uncomplicated with two broad operations occurring – drilling and blasting followed by loading and hauling. Mine planning and scheduling of open pit operations is therefore relatively simple. If the ore body is suitable, open pit mining is more productive, is quicker to start, more economical and safer for employees.

Despite the advantages of open pit mining, the main challenge occurs if the stripping required to access ore is high, resulting in the method becoming uneconomical. The method may also result in societal concerns including the visual impact from the removal of waste rock and the impact of its placement on surrounding flora and fauna or potential future use of the land area. Environmental impacts must also be carefully considered including noise, dust and vibration, amongst others.

The open pit mining method does not result in ore pillars being sterilized, nor does the ground surface subside creating sink holes, thereby allowing for full extraction of the reserves. Furthermore, the opportunity for underground mining remains open for future investments beyond an open pit mine.

3 Evaluation

For the evaluation of mining method selection, general areas of risk include the

1. Geometry of the ore body
2. Geotechnical conditions
3. Nature and current usage of area surrounding the planned mining activity
4. Maximizing the use of resources
5. Ore availability
6. Economic feasibility
7. Impacts of the mining method

These factors are discussed in the following sections.

3.1 Geometry

With regard to the mineralized zones at Sydvaranger, it can be noted that:

i. The mineralization can be described as an algoma type banded iron formation deposit (here and after "ore") which has a metal (magnetic iron) content at a moderate range.
ii. Ore bodies in the entire mineralized zone lie in the immediate vicinity of the surface at the minimum (0 to 25 m) for extraction depths.
iii. Ore bodies lie in the form of steeply dipping layers of medium to low thickness (50m to 2m).
iv. A number of southern satellite ore bodies contain widespread areas of waste interlayers.
v. Country rocks are presented in quartz, gneisses and amphibolite are inert and environmentally benign (i.e. safe) in regards to chemical content.

The geometry of the ore bodies and their location in relation to the day topography (surface) is a parameter which assists in determining options for the mining method choice from a simple perspective. All deposits, regardless of the mineral type, which are located just underneath the day surface or daylighting at the natural topography are most appropriately mined by the open pit method. It is however noted that specific circumstances surrounding an ore body may require further evaluation of the viability of mining. For example, if the location of the ore deposit is underneath large water reservoirs or for other extraordinary reasons would exclude excavating from surface.

For the Sydvaranger Iron project, there are several ore deposits which daylight at the natural topography including previously active pit areas. The figures provided below provide a few examples of pits where ore is at surface and therefore suitable for open pit mining.

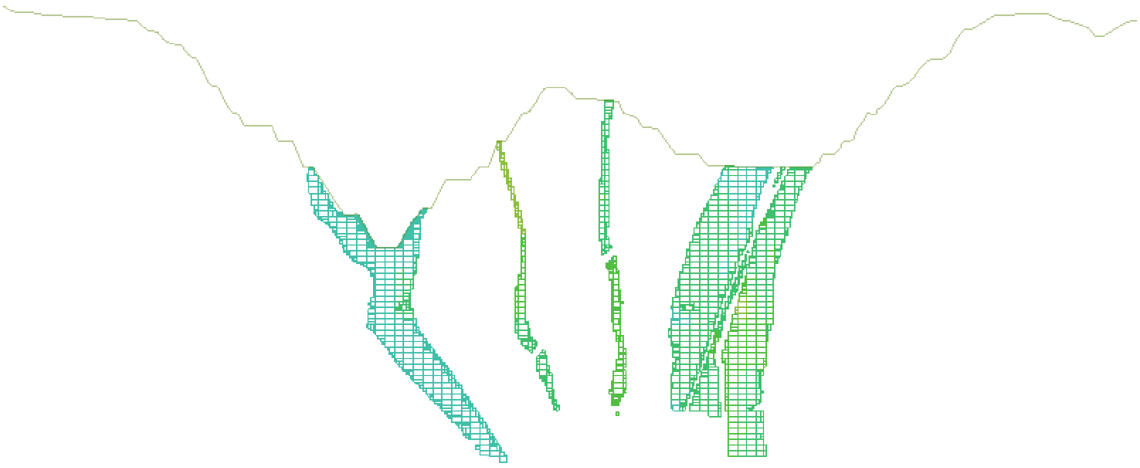

Figure 3.1 Bjørnevatn Iron ore body (vertical cross section looking north)

Figure 3.2 Kjellmannsåsen Iron ore body (vertical cross section looking north)

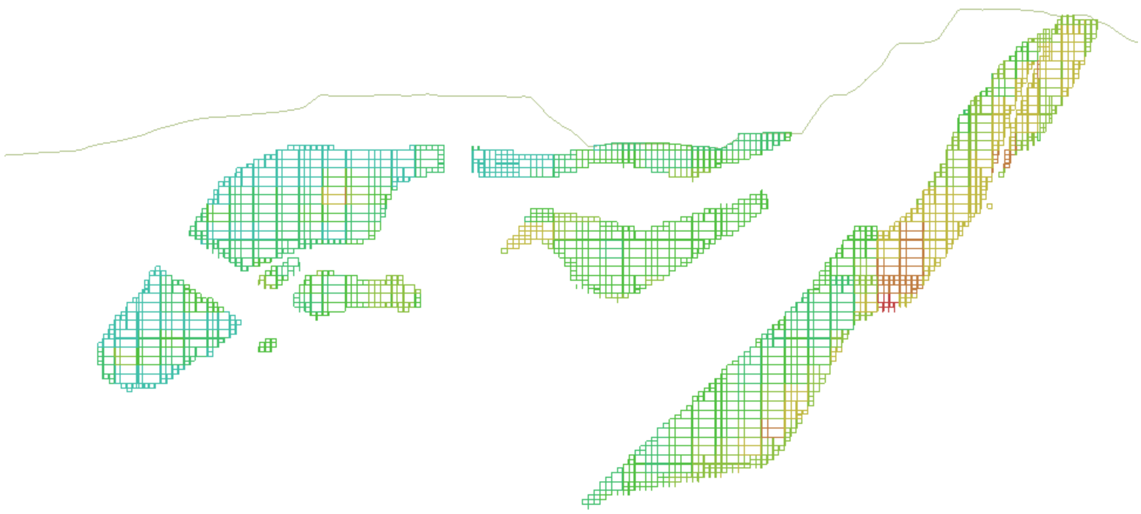

Figure 3.3 Fisketind South west Iron ore body (vertical cross section looking north-west)

3.2 Geotechnical

Geotechnical conditions are amongst the most important factors to be considered in mining evaluation, along with the chemical properties of surrounding country rocks. These parameters in many cases define the approach of mining technique. Taking into account the caving ability of surrounding country rocks or, conversely, resistance to failure as well as chemical aggressiveness helps to make a choice of the potential for underground mining or open pit mining.

Sydvaranger's country rocks are inert in terms of chemical reactions and discharges, a factor which favors an open cut mining approach as the waste rock has no hazardous environmental impact. The country rocks however have a strong rock mass strength and are complex, occurring as both inclined and sub-horizontal layers. The country rock is also interlocked with intrusions of dense igneous rock. As a result of the strength of the rocks, it is expected they have a poor ability to cave. The photos provided below provide some examples of the geotechnical conditions in the proposed mine area. The complexity of the geotechnical conditions indicates that an open pit mining method would be favored compared to an underground mining method.

With underground mining, another geotechnical risk is the risk of collapse, for example if large blocks collapse from the roof of a cave, production areas may also collapse and mining activities halted. If a roof collapses catastrophically, it may produce a destructive and potentially lethal surge of air called a windblast.

Photo 3.4 Bjørnevatn pit looking north

Photo 3.5 Bjørnevatn pit looking east

Photo 3.6 Kjellmannsåsen pit looking west

3.3 Nature and current usage of surrounding (concession) area

When considering mining activities, it is necessary to take into account the surrounding areas. For example, mining activity and selection of mining method may be impacted and restricted where surrounding areas are densely populated or are close to infrastructure such as residential and industrial buildings, power stations, or even historical monuments of architecture.

For the Sydvaranger Iron Project, the proposed mining activities are situated in the historical mixture of 100-years old industrial mining area and forest-tundra of the far north of Norway (refer figure to the right). While the proposed concession area is in proximity to the town of Bjørnevatn and the surrounding area is in proximity to some cabins, the mine has no significant impact or interference with the surroundings outside of the concession area.

Previous mining operations in the area occurred as recently as 2009 through to 2015. Surveys undertaken in 2014 demonstrate that mining activity is largely supported by the local community and other local stakeholders.

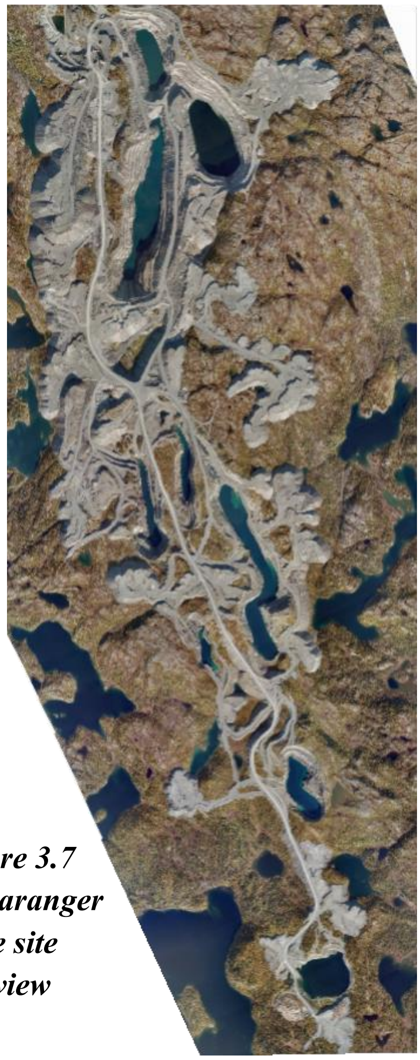

Figure 3.7 Sydvaranger Mine site overview

3.4 Maximising of extraction of mineral reserves

There are a number of areas identified in the Bjørnevatn pit that are sterilized from the possibility of underground mining methods, however are retrievable by an open pit method.

3.4.1 Ore underneath Primary Crusher

There is currently sterilized close to 4Mt of ore beneath the primary crusher at Bjørnevatn with 33,5% magnetic iron content, which equals to 2 Mt of iron concentrate, or around 1 year's production with a revenue value of US$130 million.

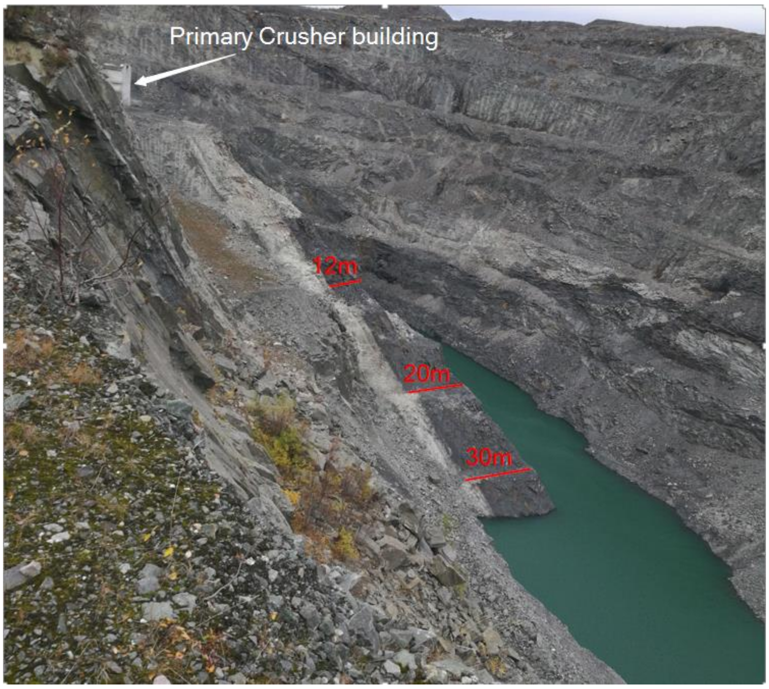

Photo 3.8 Ore located beneath the Primary Crusher

Photo. 3.9 Ore located beneath the Primary Crusher

The ore in this region is exposing to the pit wall, lies in a shape of thin layer and surrounded with layers of unstable country bedrocks disturbed by intrusions. The normal and horizontal thickness of the orebody in the area and the geometry of its location in the wall of the previously mined open pit will ensure that during the blasting process all the ore will be sent to the bottom of the old pit by the force of the blast energy. To try and accomplish recovery of this ore with an underground mining method is not obvious and potentially would result in wall failure upon blasting.

This ore can be liberated from sterilization, maximizing the extraction of the state mineral resources, by mining from surface with open pit method. Furthermore, a pushback in this area will open up further opportunity for ore extraction. The following illustration shows the designed pushback for this area (Stage 1).

An additional benefit of the open pit design is that a pushback results in the disassembly of the old primary crusher and building from previous operations. The crusher will be replaced by modern modular constructions that are easily assembled and then disassembled at the end of mine life.

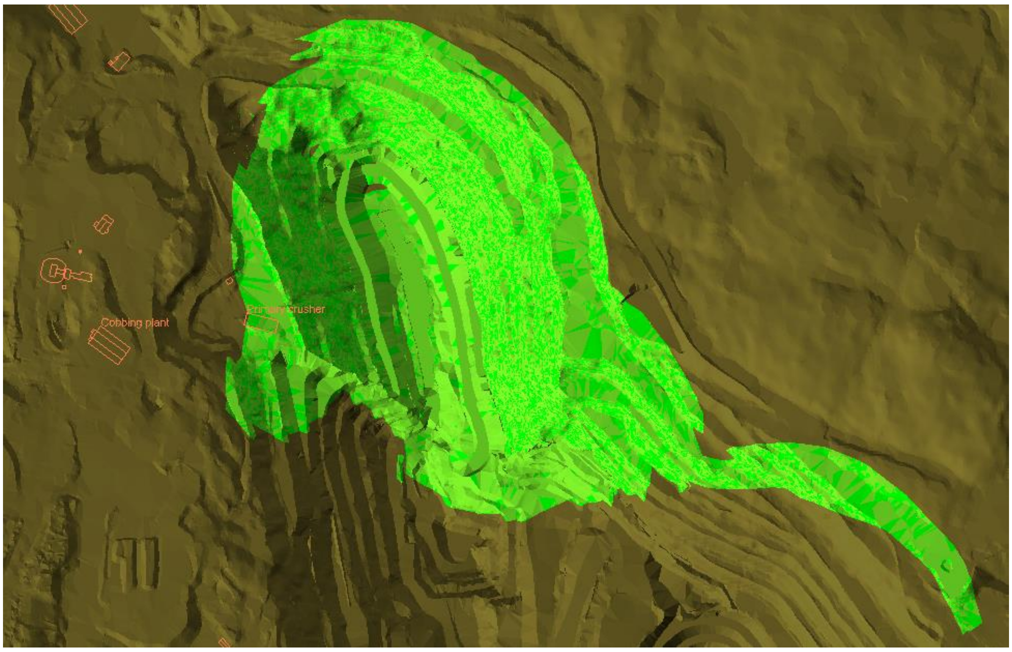

Figure 3.10 Stage 1 Pushback design for Bjørnevatn, top view

3.4.2 Historic Underground Test Mining Infrastructure

Another area where ore is sterilized is around underground test mining infrastructure established in the 1990s (refer Figure 3.11). The underground tunnel for the test mining has been built into and through an ore zone, thus the surrounding rock supporting the infrastructure is sterilized. The quantity of ore surrounding the infrastructure is approximately 25,5Mt of ore at 28% Fe mag which is equivalent to around 10 Mt of iron concentrate with a revenue value of approximately US $650 million.

It is however possible to retrieve approximately 10Mt of ore down to the bench -162RL using an open pit mining method, as shown in Figure 3.12. At the same time, the option for potential future use of the underground decline remains preserved with the entrance at a lower level (See fig. 3.13)

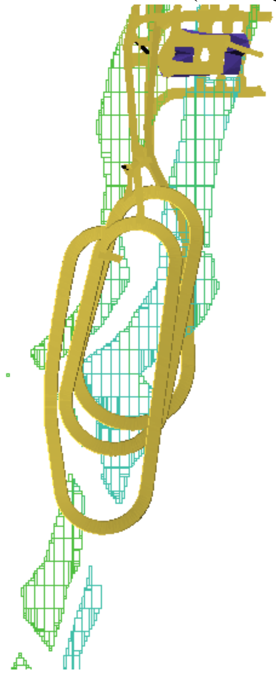

Figure 3.11 Decline and ore body location

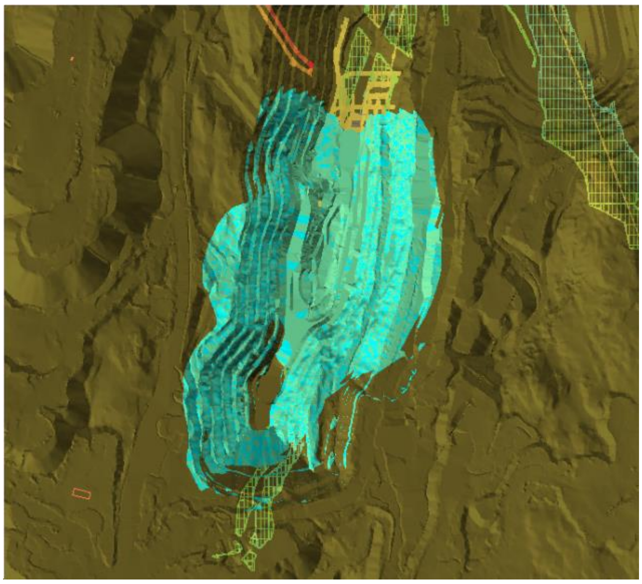

Figure 3.12 Stage 2 Pushback design for at the -200RL Bjørnevatn, top view

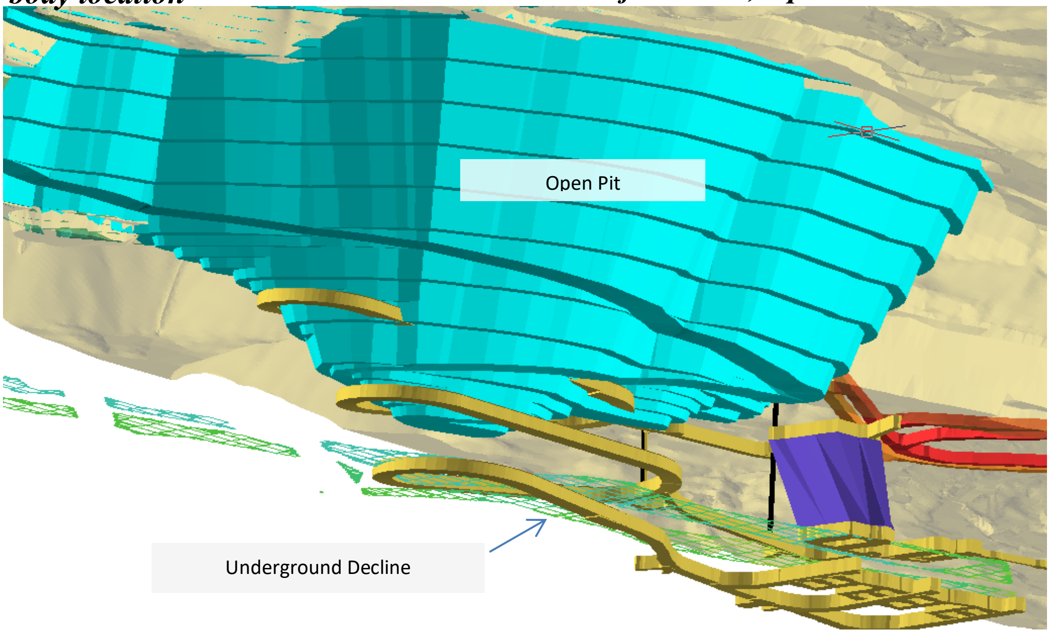

Figure 3.13 Underground decline is accessible from deeper levels

3.4.3 Southern Resources

The majority of the southern deposits are excluded from the potential scope of underground mining method due to the combination of insurmountable circumstances, including:

- For a successful underground operation employing normal and safe mining practices, the ore bodies need to have an appropriate thickness and consistent angle of dipping. For the Sydvaranger southern deposits, the geometry is narrow and angles are inconsistent. Furthermore, ore daylights in the immediate proximity to surface, lending itself to extraction from surface with open pit mining method.

- Internal layers of waste do not allow for selective underground mining methods as extracting the ore will be diluted with large amounts of waste rock at the same time (i.e. the ore becomes diluted, and the average grade of the ore decreases). As a result of the elevated dilution, underground costs are further increased for haulage of waste rock to the crusher.

In addition to the above factors, underpinned by the low grade across the southern deposits, it would be economically impossible to establish multiple smaller underground mines for each of the southern resources where the capital investments are high and the value of the bulk commodity being mined is low. Furthermore, due to the high capital costs, it is unlikely to be economically viable to establish different mining methods across the resources, north and south. To select an underground mining method for the northern resources only potentially puts at risk the ability to economically extract the southern resources.

3.5 Ore Available

3.5.1 Economic Cut-Off Grade

The content of a useful or valuable component in the extracted mineral is a parameter which defines the status of a mineral as ore (i.e., a useful mineral suitable for profitable extraction) or, conversely, off-balance reserves. The borderline indicator of the content of the useful component is the Cut-off Grade (here and after COG) - i.e. such a content of the useful component, below which the mineral extraction ceases to be profitable. It is important to separate waste and ore materials during the mine planning process to ensure the ore processed is not excessively diluted. Any material below the COG is considered to be at a grade too low to process economically.

Here the cost of extraction at all its stages (especially mining cost per tonne mined) is of high importance. The open cut and underground methods of extraction are radically different in mining costs in the direction of a rapid increase in costs for the underground methods of excavation. Due to the cost difference in mining method impacting the economics of extraction, it follows that an open cut mining approach is likely to categorize a higher quantity of a mineral as ore, whereas with an underground mining method, a proportion of the same minerals can become waste (i.e. uneconomic for extraction due to higher cost).

In the case of Sydvaranger, the COG for open pit mining method is approximately 9% magnetic iron content ("Fe mag") and the amount of reserves satisfying this requirement is higher than 270 Mt (Source: Bjørnevatn Optimisation Study, Deswik, 1 June 2017), equivalent to between 30 and 40 years of production at an annual iron concentrate production rate of 2 Mtpa. In comparison, based on previous studies undertaken by Sydvaranger Gruve AS as late as 2015, the COG for an underground method at Sydvaranger requires the minerals to contain approx. 36% Fe mag at a concentrate price of 65 US$/t FOB Kirkenes. The impact is that the quantity of mineral reserves at Sydvaranger is dramatically reduced to an estimated 0.5 Mt, equivalent to approximately 1 month of iron concentrate production at a rate of 2 Mtpa. Evaluation of the differences in COG and the quantity of iron that can be economically extracted by open pit and underground mining methods, the open pit method is considered most likely to offer Sydvaranger a sustainable operation with sufficient ore to make the project viable.

3.5.2 Alternative - All Ore is Available Approach

While it is globally accepted industry practice to evaluate the potential of an ore body and mining method from an economic approach, using the economic cut-off grade, in order to further evaluate the potential of underground mining at Sydvaranger, specifically for the Bjørnevatn deposit, further consideration has been given. In this alternative consideration, it is assumed that all factors favor underground mining, including the geotechnical conditions of the rock to accommodate caving and extract the maximum amount of ore available. In this optimistic case, it is considered that all ore is available for extraction, regardless of the COG.

Figure 3.14 on the next page provides an illustration of the Bjørnevatn underground resource model, showing the potential ore available at various iron grades. It can be observed that the majority of ore available is at the lower end of the grade scale. Table 3.1 provides a useful reference and shows total tonnages available at increasing grade intervals as well as the average grade of ore that would be obtained from underground mining method.

Fe Mag (%) (grade intervals)	Tonnes (Mt)	Fe Mag (%) (Average Grade)
All underground ore	128.10	30.32
> 26.00	117.44	30.71
> 28.00	95.24	31.47
> 30.00	66.43	32.39
> 32.00	38.05	33.28
> 33.00	19.46	33.91
> 34.00	6.47	34.90
> 35.00	1.72	35.96
> 36.00	0.52	36.84
> 38.00	0.08	38.14

Table 3.1 Bjørnevatn Underground Resource – ore tonnes by grade interval

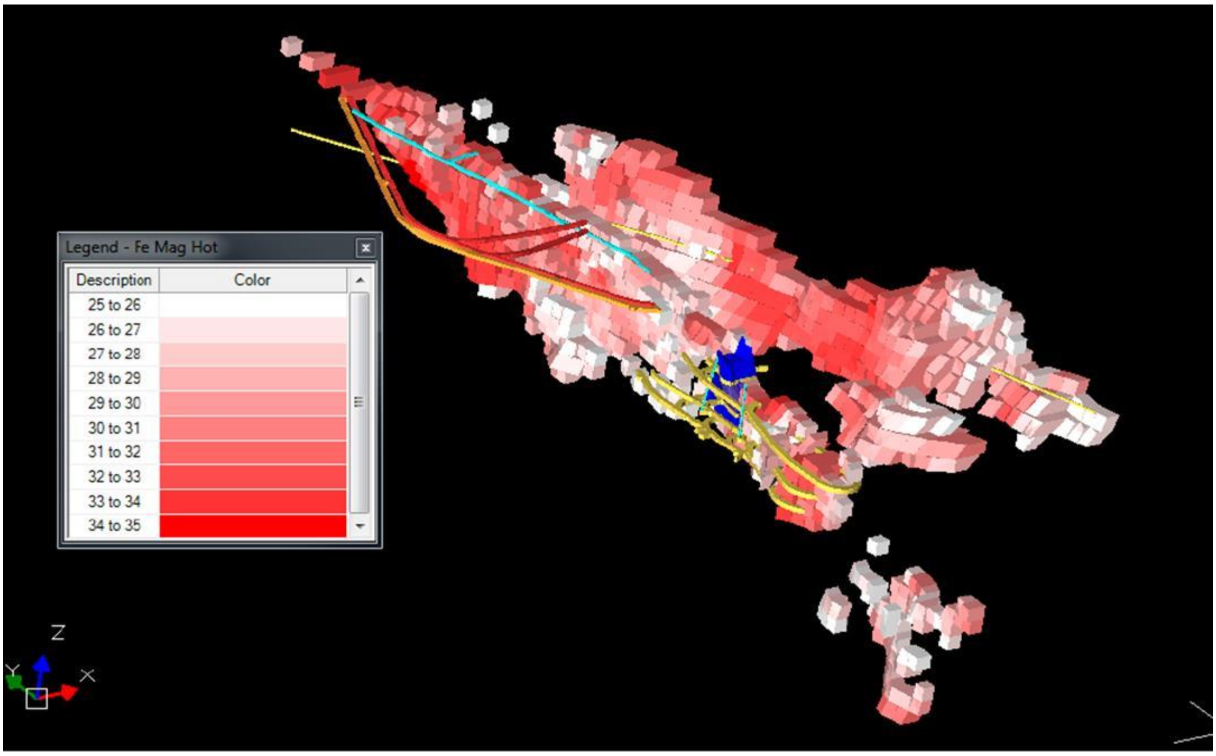

Figure 3.14 Bjørnevatn Underground Resource Model

Both Figure 3.14 and Table 3.1 are derived from the same geological block models from which open pit mining scenarios are developed. Consequently, there is no difference in the basis from which mining method is being evaluated. If it assumed all ore can be retrieved from underground mining, which assumes caving is possible, then the ore that can be extracted would be 128.1 Mt at an average magnetic iron grade of 30.32%.

3.6 Economic Overview of Alternative Underground Evaluation

Assumptions:

1. First stage underground mining in years 1 and 2 would involve underground mining method with ore delivered to the existing underground entrance, followed by load and haul to the existing primary crusher.

    - In 2015, an experienced contract miner a with sublevel caving underground iron ore mining operation in Norway, provided a cost indication for the extraction of ore from underground mining at Sydvaranger. The costs provided were estimated in the range of NOK/t 75 – 125. At a long-term exchange rate, the cost range is approx. US$11/t to US$18/t of ore mined.
    - The cost range indicated excluded load and haul to the primary crusher, excluded "other additional" costs referred to in correspondence with the contractor and excluded any contractor profit mark-up.
    - The cost of load and haul operations from the underground entrance to the primary crusher has been calculated as approximately 6 US$/t of ore. This additional cost is applicable to the first two years of underground mining whilst capital works are undertaken to develop sublevel caving tunnels.
    - The cost range of underground mining for Sydvaranger is therefore indicated to be between US$17/t (lowest) to US$24/t (highest) during the first stage of operations.
    - No additional costs are assumed and contractor profit is excluded, indicating the mine is operated by the owner and as competitive and efficient from the first day of operations as the most experienced Norwegian underground mining operation. Furthermore, efficiency and productivity are maintained at these levels for the life of the mining operation, even with annual production volumes tripling in a short period.

2. Second stage underground mining, year 3 onwards, follows the collapsing of the ground surface and a transition to a sublevel cave mining method.

    - Load and haul operations cease as ground surface is collapsed into the underground mine.
    - Infrastructure established above surface and underground to provide access for workers, ventilation, ore transport and crushing within the underground mine.
    - Production rates and ore production are assumed to be capable of the same rates as an alternative open pit mining method, targeting ore delivery of 9.5 Mt p.a..
    - Capital costs for establishing underground mine infrastructure are estimated to be the same as those presented by another Norwegian underground iron miner and are not inflated from 2008 cost levels when those expenses were incurred. Further, the capital costs do not reflect the increased capacity requirements of Sydvaranger, where production rates would be approximately triple. Thus, the most optimistic capital cost assumptions are applied to the evaluation.

Table 3.2 on the next page provides an overview of the project economics of underground mining costs based on the assumptions listed above.

Period		Years	21.0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pyhsicals & Macro Assumptions	**Source**																									
Ore mined / Ore available for rail	Geological block model	Mt	128.1		0.7	2.6	3.8	5.6	5.1	3.0	2.4	2.6	5.5	6.7	9.2	9.1	8.9	8.1	8.1	7.1	7.6	7.2	8.1	8.1	8.1	0.5
Dilution (waste in ore) / Cobbing	Internal estimate (optimistic)	%	12.5		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Total material mined	Calculated	Mt	144.1		0.8	2.9	4.3	6.3	5.7	3.4	2.7	2.9	6.2	7.5	10.4	10.2	10.0	9.1	9.1	8.0	8.6	8.1	9.1	9.1	9.1	0.6
Grade of ore	Geological block model	Mag Fe %	30.3		30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3
Concentrate Grade	Historical production	%	68		68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
Concentrate produced	Calculated	Mt	56.2		0.3	0.3	1.7	2.5	2.2	1.3	1.1	1.1	2.4	2.9	4.0	4.0	3.9	3.6	3.6	3.1	3.3	3.2	3.6	3.6	3.6	0.2
Economics	**Source**		**Base**																							
Exchange rate	Bloomberg consensus forecast	NOK:USD	6.78		6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78	6.78
WACC / Discount rate	Swedbank	%	15%	1.00	0.87	0.76	0.66	0.57	0.50	0.43	0.38	0.33	0.28	0.25	0.21	0.19	0.16	0.14	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.05
Concentrate Price FOB	Long term forecast	US$/t	65		65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
UG Mining cost	Norwegian contract miner	NOK/t	75		75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
UG Mining cost		US$/t	11		11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
Haulage cost	Internal estimate	US$/t	6		6.0	6.0																				
Total UG mining cost		US$/t	**17**		**17.1**	**17.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**	**11.1**
Other fixed mining costs	Internal estimate (optimistic)	US$/t	0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rail, Processing, Mntce, Admin	Based on historical cost	US$/t	7.4		7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Dewatering of mine	Internal estimate (optimistic)																									
Financial Overviews	**Source**																									
Revenue		US$M	3,600		20.0	20.0	108.4	159.8	145.5	85.6	68.5	74.2	156.9	191.1	262.5	259.6	253.9	231.1	231.1	202.6	216.8	205.4	231.1	231.1	231.1	14.3
Opex		US$M	-2,567		-18.6	-70.2	-76.5	-112.2	-102.3	-60.6	-48.7	-52.6	-110.3	-134.1	-183.8	-181.8	-177.8	-161.9	-161.9	-142.0	-152.0	-144.0	-161.9	-161.9	-161.9	-10.9
Mining		US$M	-1,616		-13.4	-49.9	-47.3	-69.7	-63.5	-37.3	-29.9	-32.4	-68.4	-83.4	-114.5	-113.2	-110.8	-100.8	-100.8	-88.4	-94.6	-89.6	-100.8	-100.8	-100.8	-6.2
Other fixed mining costs		US$M	0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rail, Processing, Mntce, Admin		US$M	-951		-5.2	-19.3	-28.2	-41.6	-37.8	-22.3	-17.8	-19.3	-40.8	-49.7	-68.3	-67.5	-66.0	-60.1	-60.1	-52.7	-56.4	-53.4	-60.1	-60.1	-60.1	-3.7
Dewatering of mine		US$M	-21			-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Net Profit before Tax		US$M	**1,033**		**1.3**	**-50.2**	**31.9**	**47.5**	**43.2**	**25.0**	**19.8**	**21.5**	**46.7**	**57.0**	**78.7**	**77.8**	**76.1**	**69.2**	**69.2**	**60.5**	**64.8**	**61.4**	**69.2**	**69.2**	**69.2**	**3.3**
Capital Expenditure																										
First Equipment	Estimate based on SVG studies	US$M		-13.3	0.0	-5.9	-5.3	-24.9																		
Replacement capex		US$M							-13.3	0.0	-5.9	-5.3	-24.9	0.0	0.0	0.0	0.0	0.0	-11.6	-22.2	0.0	0.0	0.0	0.0	0.0	0.0
Sustaining capex	10% of first equipment (optimistic)	US$M			-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	0.0
Pre-production development	Estimate based on SVG studies	US$M		-21.5	-6.6	-3.1	-0.8	-2.6	-0.8	-0.8	-1.7	-1.6	-1.9	-4.4	-2.6	-2.6	-3.3	-2.3	-2.0	-4.0	-2.1	-2.3	-3.3	-2.3	0.0	0.0
Mine engineering, hydrolgogy, geotechnical and environmental studies	Internal estimate (optimistic)	US$M		-4.0	-1.5																					
Construction management	Internal estimate (optimistic)	US$M		-1.5	-1.5																					
Dewatering	Internal estimate (optimistic)	US$M		-2.0	-2.0																					
Road upgrades	Internal estimate (optimistic)	US$M		-0.1	-1.0																					
Ventilation	Estimate based on SVG studies	US$M		-3.3																						
Power distribution station and underground heatin	Internal estimate (optimistic)	US$M		-3.0																						
Safety - communication system, rescue containers	Internal estimate (optimistic)	US$M		-0.7																						
Capex for caving - cost Rana Gruber in 2008 for 1/3 of Sydvaranger capacity	Internal estimate (optimistic)	US$M			-73.7																					
Cash gain / (loss)		US$M		-49.5	-86.4	-60.6	24.6	18.7	27.8	22.9	10.8	13.3	18.5	51.3	74.8	74.0	71.5	65.5	54.2	33.0	61.4	57.7	64.6	65.5	67.9	3.3
Discounted value of Cash Flows		US$M		-49.5	-75.1	-45.8	16.2	10.7	13.8	9.9	4.1	4.4	5.3	12.7	16.1	13.8	11.6	9.3	6.7	3.5	5.7	4.7	4.5	4.0	3.6	0.2
Net Present Value		US$M		-9.8																						

Table 3.2 Underground Mining Economic Overview

The economic overview indicates the following findings:

- Assuming sublevel caving operations with full and immediate efficiency, even at the lowest indicated operating costs provided by the most experienced iron ore miner in Norway with sublevel caving operations, and with the most favourable capital cost assumptions, the project economics offer a negative outcome.
- To achieve a cash positive operation, Sydvaranger would need to operate at a cost level much lower than is considered achievable by the most experienced Norwegian underground iron ore contract miner.
- When the project is discounted to determine the net present value the results are compelling that the underground mining method will be unsustainable for any period of time unless mining costs can be improved beyond what is currently considered reasonable to achieve.
- Overall, the economics of underground mining illustrate the method is extremely exposed to downside risk due to sensitivity to numerous key factors and estimates.
- All physical, price and cost estimates need to be highly accurate and the lowest indicated cost needs to be improved for underground mining to approach an outcome where a positive economic return is possible.

3.6.1 Market

The value of a mineral in the world market is the key driver in the choice of not only the method of mining, but also the appropriateness of it in a given period of the economic cycle. Sydvaranger plans to extract one of the cheapest metals in the world - iron. The low value of iron is due to its ubiquitous prevalence and oversaturation in the market with supply exceeding demand. Current pricing of iron trades in the range of 50 – 70 US$/t and is in line with market expectations for the long-term future. In evaluating the selection of mining method choice, Sydvaranger must take into consideration the long-term market expectations on iron ore pricing and the value that can be achieved from extraction and processing iron ore concentrate. The mining method and approach to operations for the life of mine must be able to withstand market volatility. In this regard, the open pit mining approach offers the lowest cost of production for the bulk mining of this low value commodity. Conversely, the underground mining method is uneconomic and volatility in market pricing increases the risk and uncertainty of this approach.

3.7 Mining Method Impact

3.7.1 Underground mining method’s impact

The underground mining method can be thought to be invisible for the society and environment given it occurs beneath the surface and therefore, out of sight. However, in many cases, establishing of an underground cave mining operations becomes an issue of the same if not larger scale for the local community and nature for number of reasons as follows:

1. Subsidence - the mine site and surrounding area of the underground mine, including private properties, becomes prohibited for access due to safety reasons such as mine subsidence. Mine subsidence is the movement of the ground surface due to controlled collapse or failure of underground mine workings. Surface subsidence features usually take the form of either sinkholes or troughs resulting in an abrupt depression in the ground surface - refer figure 3.15.

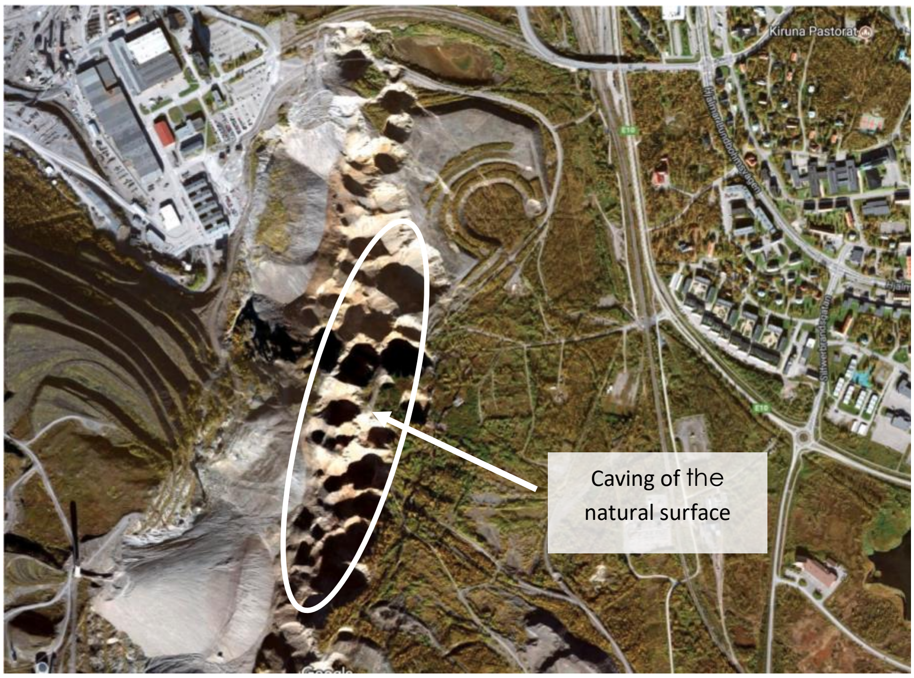

Figure 3.15 Kiruna, Sweden

2. Impact on water resources - underground mine openings can intercept and convey surface water and groundwater. When excavated below the water table, underground mine voids serve as low-pressure sinks inducing groundwater to move to the openings from the surrounding saturated rock. The result is the dewatering and drainage of the surrounding natural water reservoirs and the potential flooding of the underground mine.

3. Infrastructure and vegetation – underground mines require surface facilities to be established, such as buildings for the access shafts. These constructions require significant civil works, including drilling and blasting for the foundations, cutting of the vegetation and removing of soil from surrounding natural surfaces.

   To establish underground operations at Sydvaranger, it is considered reasonable that 5 to 7 shafts would be needed requiring large flat surfaces for each of the industrial buildings and facilities.

Figure 3.16 Example of surface facilities for one UG shaft

4. Roads - access roads to the facilities are built on the bedrock side of the deposit at a significantly safe distance from potential movements of the surface of the underground

mine. Such road construction involves blasting of the natural topography, soil relocation and spreading of waste rock for the base of the road. A large distance between the road and underground mine is necessary to avoid safety risks and potential damage to roads caused my underground mine movements impacting the surface.

In evaluating the potential of using the underground mining method at Sydvaranger, the following activities are considered necessary:

1. Construction of several shafts (5 to 7) and buildings on level surfaces are required to support underground mining activities.

2. New access roads to underground facilities, located at a safe distance from the potential ground deformation with requirement of moving several million cubic metres of rock material for the road base and thereby sterilizing of ore reserves at surface.

3. Natural water reservoirs surrounding the underground mine would possibly need to be dewatered and discharged to avoid potential flooding of the underground mine and to maintain an adequately safe work environment for mine operators.

4. Private properties (cabins) need to be removed or permanently restricted from access as they are located in the immediate proximity to the underground mine and therefore at risk due to ground level subsidence caused by the mining activities.

It is possible that these factors, individually or combined, may be cause for concern for society regarding the impacts of the underground mining method.

3.7.2 Open cut method's impact

Open cut mining methods results in the number of pits of different sizes and waste rock piles formed over the life of the mining period. With the open pit mining, there are several advantages over underground mining methods, however the biggest issue for the surrounding community and nature is the development of piles of waste rock. In some mines, waste rock can have properties that cause chemical pollution, however this is not the case for Sydvaranger rocks. Consequently, the key issues for applying the open pit mining method at Sydvaranger is the visual impact of the waste rock formations and the impact of placement on surrounding flora and fauna as well potential future land uses.

Sydvaranger is a historic site with a long history of operations. As at today, there is an existing footprint and visual impact from earlier mining operations which is shown in figure 3.7 on page 11. In all circumstances, it is unlikely that remediation of historic mining activities can be rehabilitated into any natural condition. However, it is possible that future open pit operations can develop a curtain rock formation which is visually acceptable from outside of the mining area – refer to figure 3.22 on the next page. Conversely, an underground mining operation would not result in an improvement to the external view and would require the mine and surrounding area to be restricted from access due to the ground surface being collapsed and unsafe.

The waste rock piles generated from open pit mining activity have to be formed to offer a natural looking shape so they can be nicely blended into the surrounding landscape. Examples of such rehabilitation measures are found all over the world and Sydvaranger would need to make similar plans if adopting an open pit mining method. In that case, Sydvaranger would propose such rehabilitation measures for waste rock in its mine closure plans which would include:

1. Waste dump and land forming strategy;
2. Landscape design for dozer work to bring the shape of the waste dumps to a natural looking view;
3. Where applicable, a re-vegetation plan to further blend the final rock formation into the landscape.

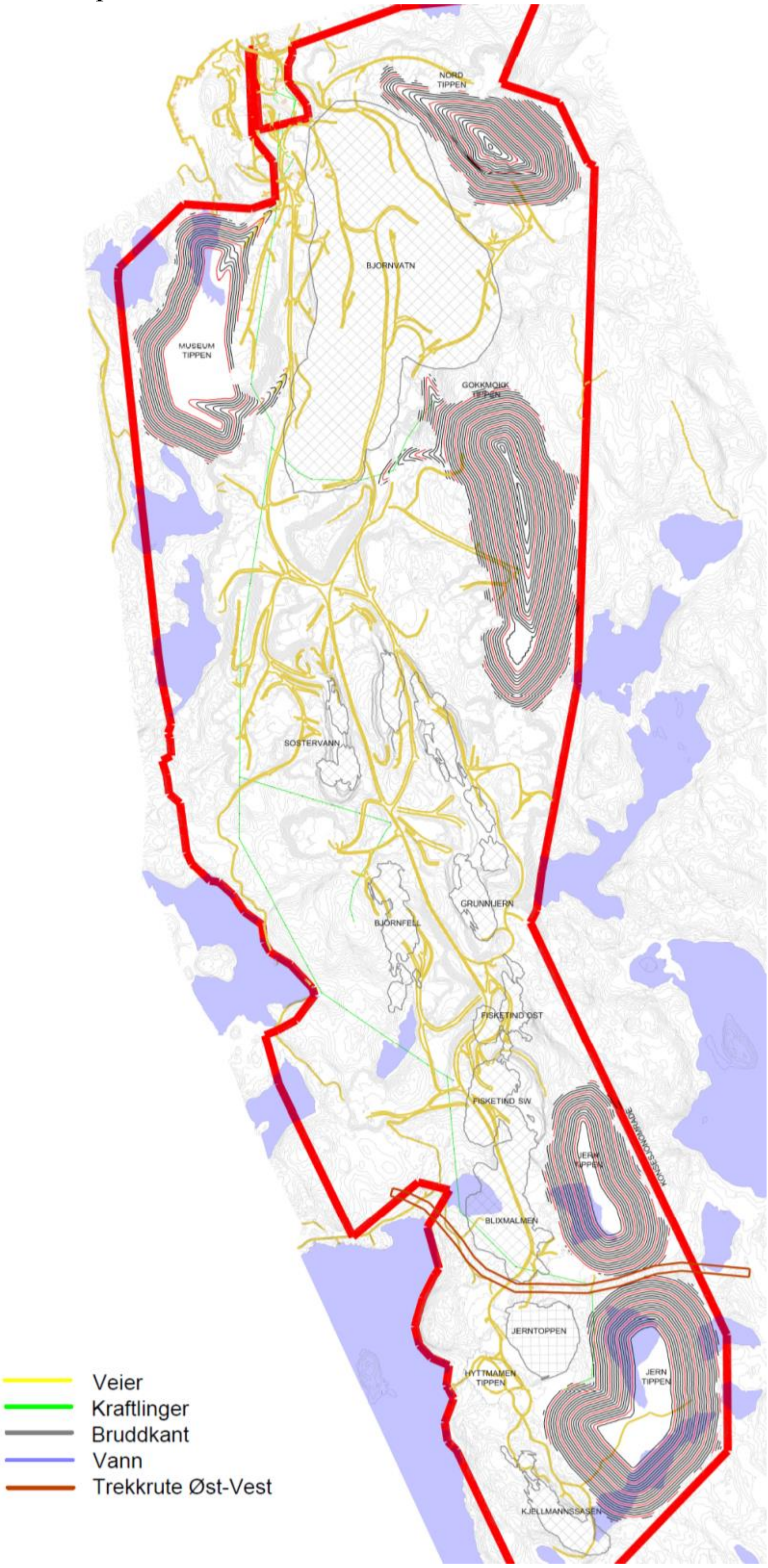

Figure 3.22 End of Sydvaranger AS Life of Mine perspective

4 Conclusions

This evaluation has considered a multitude of factors for the selection of an appropriate mining method at future Sydvaranger operations. On the balance of considerations, an open pit mining method is considered the most favorable and only financially viable approach, supported by:

1. The most optimistic economic evaluation of the underground mining method assuming lowest possible operating costs and minimal capital expenditure offers an unfavorable and negative outcome.

2. Geometry of ore bodies and geology have ore daylighting at or near surface, most suitable for open pit surface mining;

3. Geotechnical factors of the ore bodies are less suited to underground mining methods;

4. The nature and surrounding areas of the proposed mine area have previously been operated and there is an existing footprint. Future open pit operations have the ability to work on the rock formations and improve the current state to be more visually acceptable.

5. Maximising extraction of mineral resources at Sydvaranger is possible with open pit mining whereas significant volumes of ore would be sterilized or not possible to mine with underground methods.

6. Ore availability is maximized with an open pit method as the operating costs are significantly lower and production rates higher. As a result of the more robust economics of open pit mining, the operations can afford to mine larger volumes of lower grade ores and maximize the use of the available resources.

7. Market conditions for iron are volatile and selecting the lowest cost mining method, being open pit mining, offer the most robust method to support long term operations.

8. The impacts of each mining method have been compared and the contrast is significant. The most significant drawback to the open pit method is the generation or rock piles over time, however with modern techniques employed throughout the word, the visual impact can be minimized with reshaping to fit the natural landscape.

9. The impacts of underground mining include disturbance to the natural hydrology with possible dewatering required for nearby water reservoirs to minimize the potential for mine flooding; collapsing and caving of the ground surface at and around the mine area; clearance of multiple land areas on surface for establishing supporting infrastructure for underground access and ore removal; and the establishment of new road infrastructure through virgin land areas with large volumes of waste rock.

Other additional benefits to the open pit mining method over the underground methods include higher production rates, increased ability for grade control of ore, lower cost and economic risk with the possibility of earlier cash flow, less operational risk and increased flexibility. An open pit mining method also allows for a quicker start as little development work is required to commence mining and the approach is uncomplicated – drilling and blasting followed by loading and hauling. Mine planning and scheduling of open pit operations is also straightforward.

In contrast, underground mining is capital intensive, higher cost, less economically robust and more sensitive to movements in market prices for iron, less safe for employees, has a more significant environmental impact, is a more complicated mining method with high operational risk and inflexible to change or deviation in mine planning. The choice of the underground mining method is an irreversible commitment for the extraction of all iron by this method, whereas the continuation of open pit mining while it continues to be economic provides the opportunity for transitioning to underground mining in the future.

The selection of mining method for Sydvaranger to be an efficient and competitive miner in the world industry for a low value commodity is an exclusive choice – i.e. it is financially more demanding to run both underground and open pit operations. On the balance of all factors considered, the clear and obvious choice for future operations is that of an open pit mining method.