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Drilling targets within the Björkdal Mine,
Skellefteå, Sweden

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REPORT

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Summary:
This report presents an evaluation of potential drilling targets within the Björkdal Mine. The selection of these drilling targets is based on the conceptual structural geological model which re-interprets the geometry of the mineralised body to consist of 5 sheets of mineralised granodiorite juxtaposed across thrusts planes which have considerable displacement. Mineralisation is interpreted to have occurred prior to crustal compression associated with the thrusts and is related to the development of brittle-ductile shear zones associated with crustal extension. The gold is hosted in steep shear zones associated with the shear zones. The dissected geometry of the orebody implies that ore-sheets have been placed on top of one another and that mineralisation potential may exist both below the level of the present pit bottom and in extensions to ore zones in thrust sheets of known mineralisation outside of the mine. Targets are derived from areas where a known geological structures is open at depth or along strike and also areas which are poorly drilled but have the potential of being mineralised as other parts of the same thrust sheet are mineralised. A number of targets have been identified and volumes have been derived for these undrilled areas from DATAMINE software. These are; East Pit Hangingwall, East Pit Bottom, East of Quartz Mountain, South of West Pit, West Pit Extension, West Pit Bottom, Central Pit Bottom, West of Nylund, and North of Nylund. These targets have been prioritised for a potential drilling program.

Keywords: geological model	structure	gold mineralisation
thrust displacement	quartz veins	drilling targets

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1. Introduction

This report presents the findings of one weeks analysis of potential drill targets within the Björkdal Mine. Most of this work has been carried out by analysis of existing drillholes using DATAMINE software. The resulting analysis has produced volumes in the target areas on which to drill. These volumes were also created with DATAMINE software.

2. The geological model

In order to understand the philosophy to support the selection of drilling targets it is necessary to understanding the geological processes involved in the creation and modification of the orebody, for it is these processes which govern the orebody geometry and determine the complexity of this orebody. The following section proves a brief overview of this model.

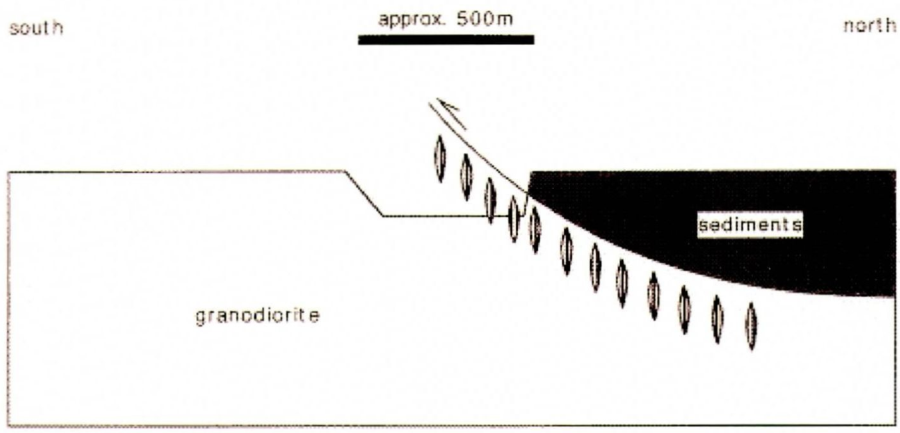

Figure 1: Schematic diagram of model previously used at Björkdal before the structural re-interpretation. The veins are considered as being formed at the same time as the overthrusting and are therefore assumed to die out away from the limestone contact both in a horizontal and a vertical direction. This model limits the potential prospectivity of the claim area.

Figure 1 shows a schematic diagram of the model used in the Björkdal Mine. The mineralisation is contained within steep quartz veins which strike WSW-ENE. These are localised within a granodiorite body along the contact with overlying sediments. The veins were considered as having formed as a response to overthrusting of the sediments. This model limits further prospectivity both in the mine area and outside it as the veins are interpreted to die out away from the contact. However, recent re-interpretation of the geology over the past few years has led to a renewed interest in prospectivity. **Figure 2** shows the relationship between the veins and the overthrust sediments in the West Pit. The veins formed extensional geometries whereas the overlying sediments are emplaced by compressional tectonics. Therefore, it appears that the veins are unrelated to the overthrust contact. There are, however, other tectonic structures which are more closely related to the development of the veins. These are high angle extensional conjugate shear zones.

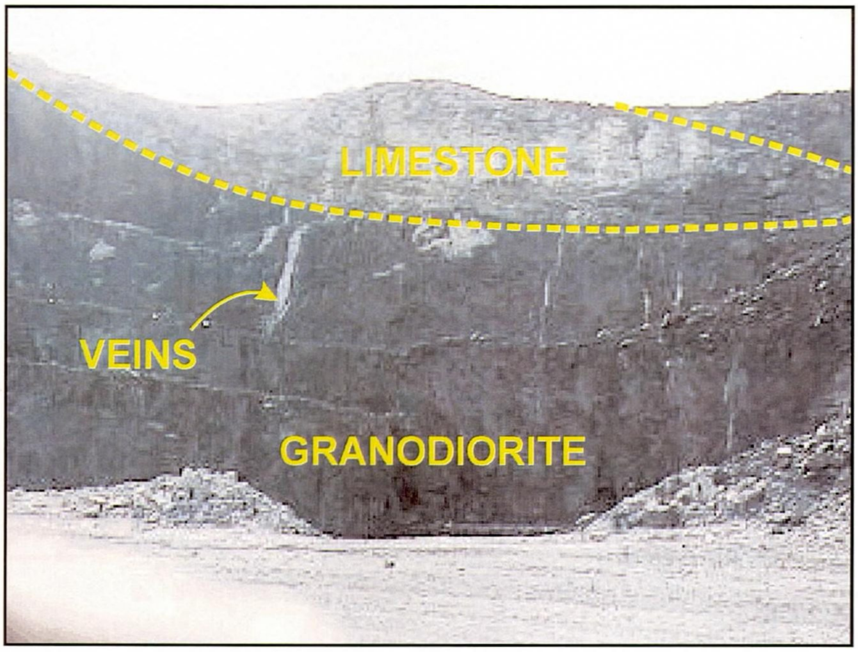

Figure 2: West wall of West Pit showing steep gold-bearing veins. These are cut off and are overlain by sediments.

Figure 3 shows a cross-section of such structures. These are parallel to the veins and display timing relationship similar to the veins. They also control the distribution of the highest gold grades. One of these structures which forms both the mineralisation in the East Pit and on Quartz Mountain has been mined extensively.

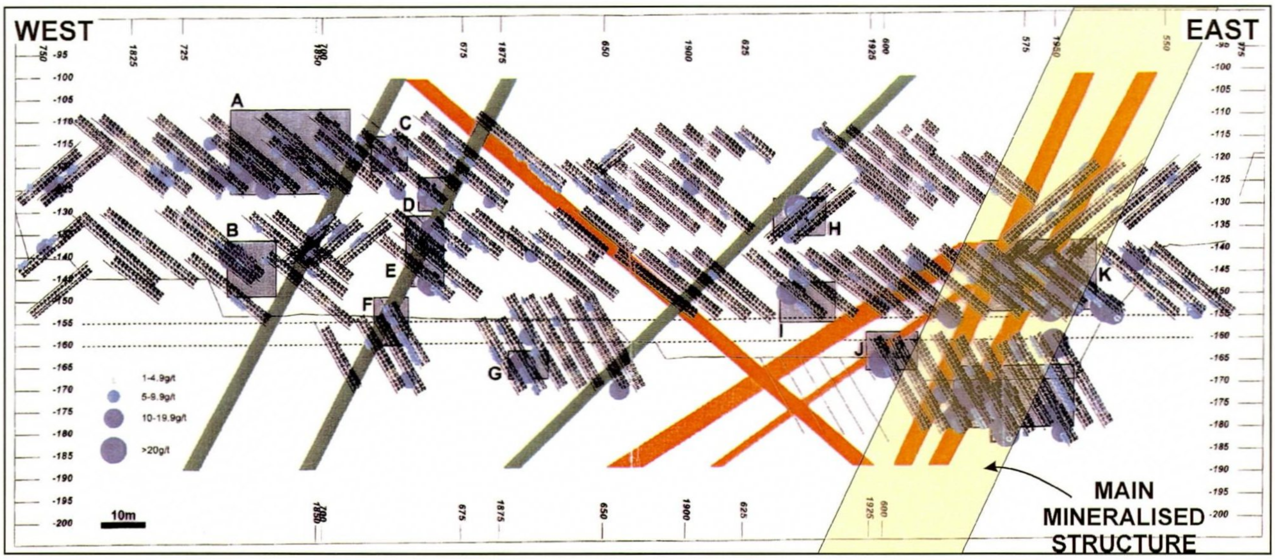

Figure 3: Cross-section of a typical RC drilling profile in the East Pit (looking north). The coloured lines are mineralisation related shear zones. These are extensional structures which pre-date the overthrusting of the sediments and are directly responsible for the development of the veins. The most important structure here is the structure marked at the right of the profile. This contains most of the gold associated with this profile.

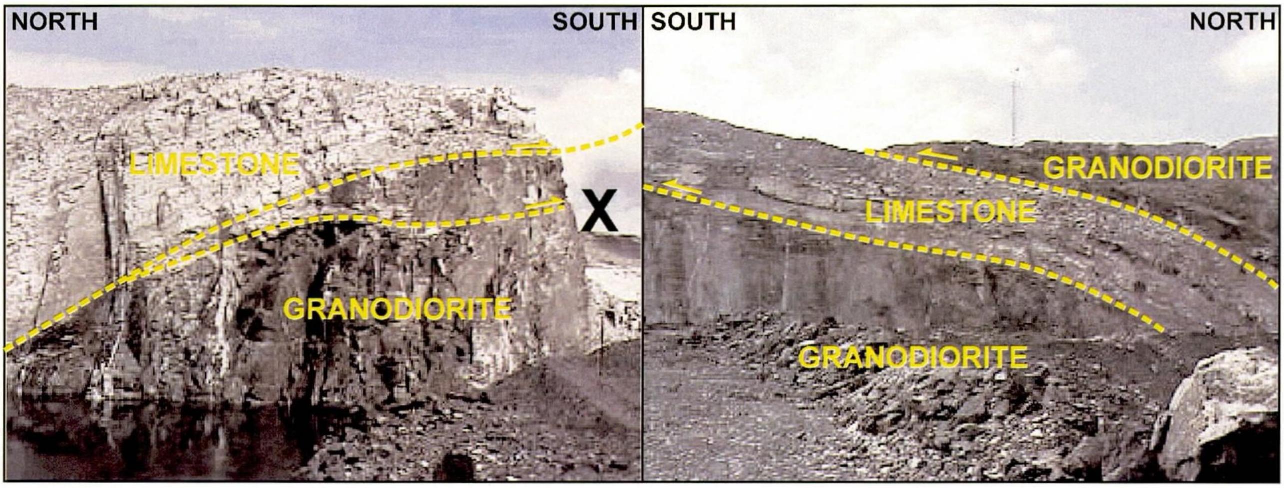

Figure 4: (Left) View looking west in the Central Pit. Limestone is emplaced over granodiorite. This contact marks the hangingwall to the mineralisation in the West Pit. This is, in turn, overlain by granodiorite. This granodiorite sheet comprises much of the mineralised material in the Central Pit. (Right) the limestone contact in the West Pit. A small thrust in the footwall to the main limestone overthrust has approximately 5m displacement (marked X). This suggests a very large amount of displacement on the larger structures of at least several hundred metres and perhaps several kilometres.

The interpretation that the mineralised granodiorite is capped by a single structure overthrusting the sediments has also been altered. **Figure 4** shows the limestone over granodiorite relationship shown in **Figure 2.** This is in fact the same contact seen in the West Pit but in the Central Pit. However, the limestone is in turn overlain by granodiorite, demonstrating that the mineralised granodiorite is split up unto separate sheets. Moreover, the mined out volume of the Björkdal Mine has been mined through a number of these "thrust sheets" and that these separate sheets have a variable mineralisation potential (**Figure 5**).

Figure 5: (Left) View looking north in the Central Pit. The base of the pit lies below a thrust structure. The thrust sheet below this thrust is mineralised (marked Y). The thrust sheet above this thrust is non-mineralised (marked Z). The veins are cut by the thrust. (Right) Thrust structure within granodiorite on Quartz Mountain. Here the structure is over a metre thick and contains limestone slivers, presumably dragged along the thrust plane from depth.

It is clear from **Figure 5** that these structures, which emplace variably mineralised sheets of granodiorite over one another, with perhaps several hundred metres to kilometres of displacement, occur not only in the hangingwall to the mineralisation but within the mineralised body itself. A model is envisaged where the granodiorite was mineralised over several kilometres across strike, dissected by thrust structures, then these thrust sheets were emplaced one over the other (**Figure 6**).

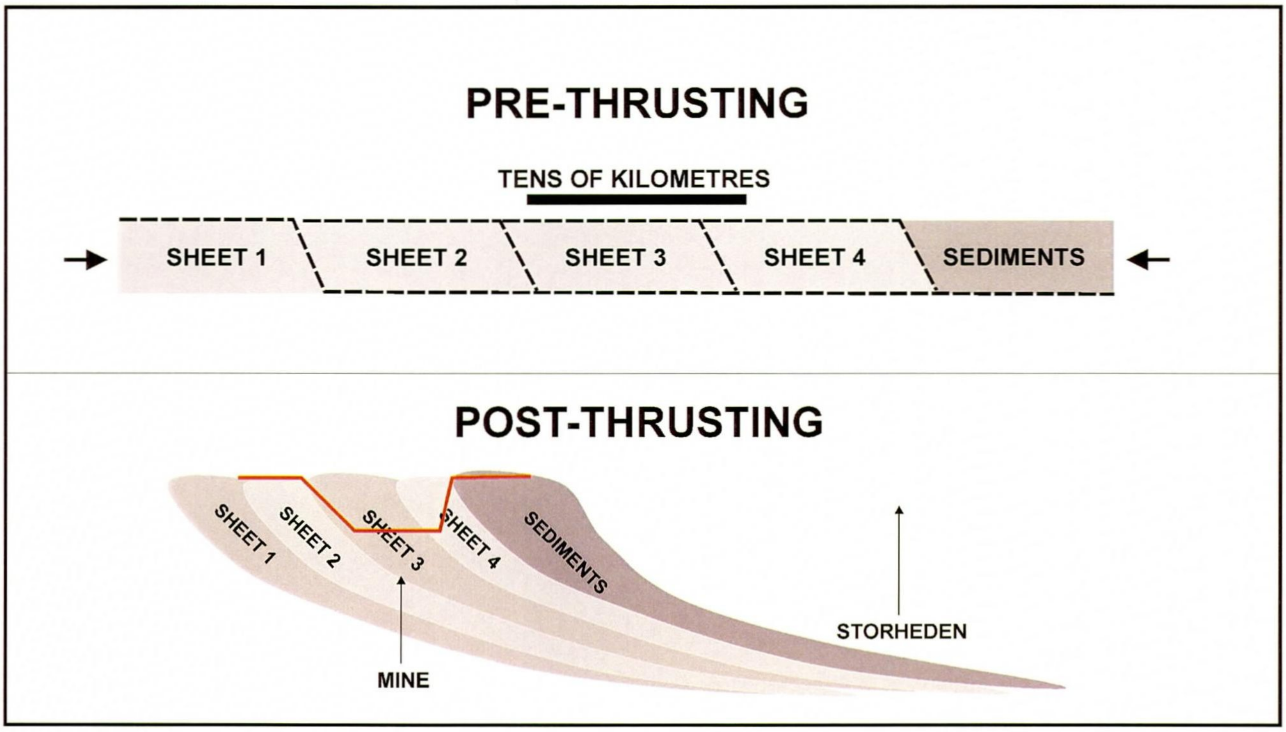

Figure 6: Schematic diagram of pre-thrusting and post-thrusting geometry of the granodiorite hosting the Björkdal mineralisation. Mineralisation is interpreted to occur at some time prior to thrusting. Thrusting has emplaced sheets of variably mineralised granodiorite on top of one another.

This new interpretation is important for the further development of an exploration drilling philosophy within the Björkdal Mine and surrounding area as it opens up the possibility that mineralisation exists at depth, bellow the present level of drilling within the Björkdal Mine and also the possibility that mineralisation exists in granodioritic sheets in the hangingwall to the present Mine, for example Storheden. **Figure 7** schematically shows that the base of the present mined level is defined by a thrust plane. Below this level a completely new granodiorite sheet is present. This may, or may not, be mineralised.

Figure 8 demonstrates that this model has also major implications for prospecting outside of the mine area. Previous work has shown that these thrust sheets extend well outside of the mine area and indeed cover all of the Björkdal claim area. This implies that it may be possible for mineralised sheets of granodiorite to have been thrust up to the surface almost anywhere in the claim area. Therefore, a detailed knowledge and understanding of these structures is critical to furthering exploration philosophy.

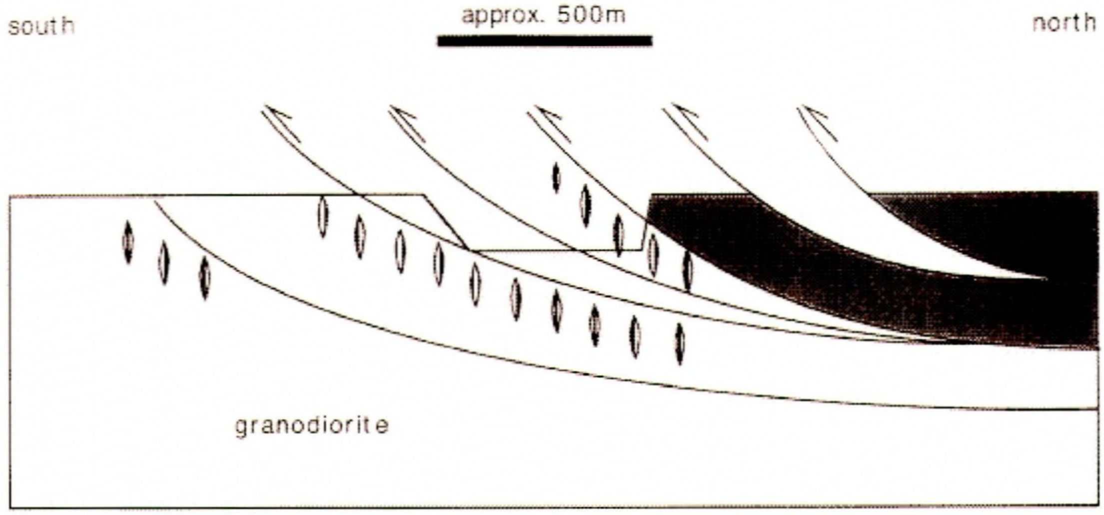

Figure 7: Schematic diagram of the new structural model for the Björkdal Mine. The deposit is considered to be made of several thrust sheets of granodiorite displaced over one another with displacements of at least tens of metres and potential several kilometres. The assumption, therefore that the veins die out away from the limestone contact is not necessarily valid. This model opens up potential target areas in the footwall to the known mineralisation and in the hangingwall where mineralised sheets may have been emplaced.

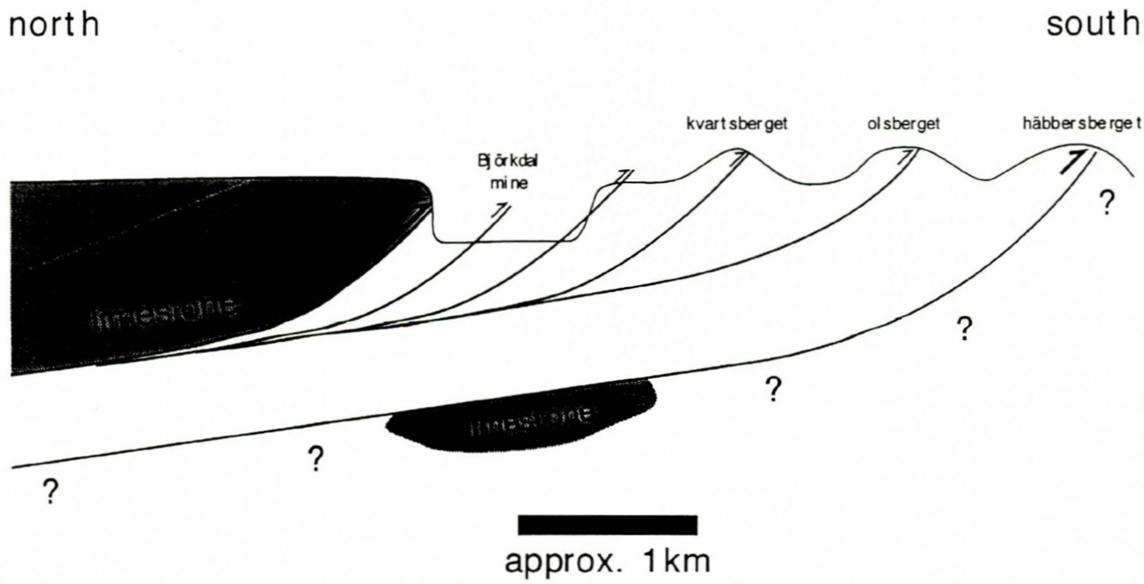

Figure 8: Schematic model of the potential for mineralisation outside of the Björkdal Mine.

Detailed mapping of the thrust structures in the mine followed by relogging of over 10km of diamond drillcore have lead to a complete 3D interpretation of the thrust structures in the mine and therefore an understanding of the geometry of the different mineralised sheets. **Figure 9** shows a plan section through the mine showing the layout of these thrust structures.

5 main structures are present within the mine area (although, in reality, the geometry is probably more complex). These are structurally descending from the top of the thrust pile;

- ***HWETP***: The structure forming the base of the limestone contact in the East Pit.
- ***HWE:*** The structure forming the top of the mineralised granodiorite in East Pit.
- ***HWW:*** The structure at the base of the limestone/top of the mineralised granodiorite in the West Pit.
- ***QM:*** The structure outcropping on the top of Quartz Mountain.
- ***FW:*** The structure forming in the footwall to the QM thrust.

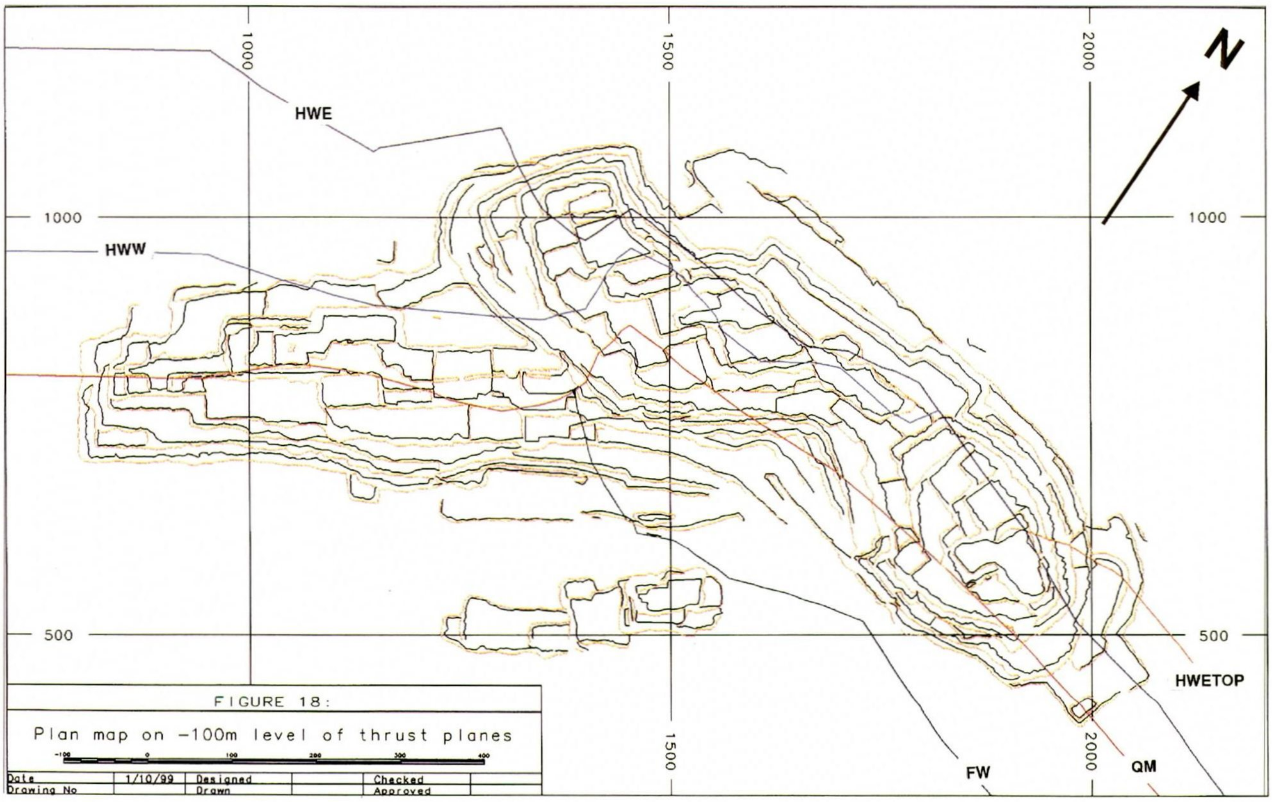

Figure 9: Plan map of the Björkdal Mine with the projected intersections of mapped thrust structures on the –100m bench level.

All of these structures can be traced in outcrop and in borehole throughout the mine area, although continuous outcrop of a single structure is not observed. It should be stated at this point that these structures are problematic to map, especially when they occur within the granodiorite. **Figure 10** shows a cross-section through the East Pit, looking east. The mine topography is shown as well as the interpreted location of the thrust structures. The position of a diamond borehole, to test the thrust sheet model and drilled in the summer of 1998, is shown. No mineralisation was encountered in this hole until the very base of the hole where extensive quartz was observed. The presence of this quartz was coincident with the presence of the FW thrust, suggesting that the borehole had penetrated through an unmineralised sheet into a mineralised one. The structural location of this "mineralisation" is well below the base of the mine. This hole demonstrates that mineralisation can be present at depth below the mine and it is likely that the presence of unknown mineralisation is controlled by the presence of thrust structures.

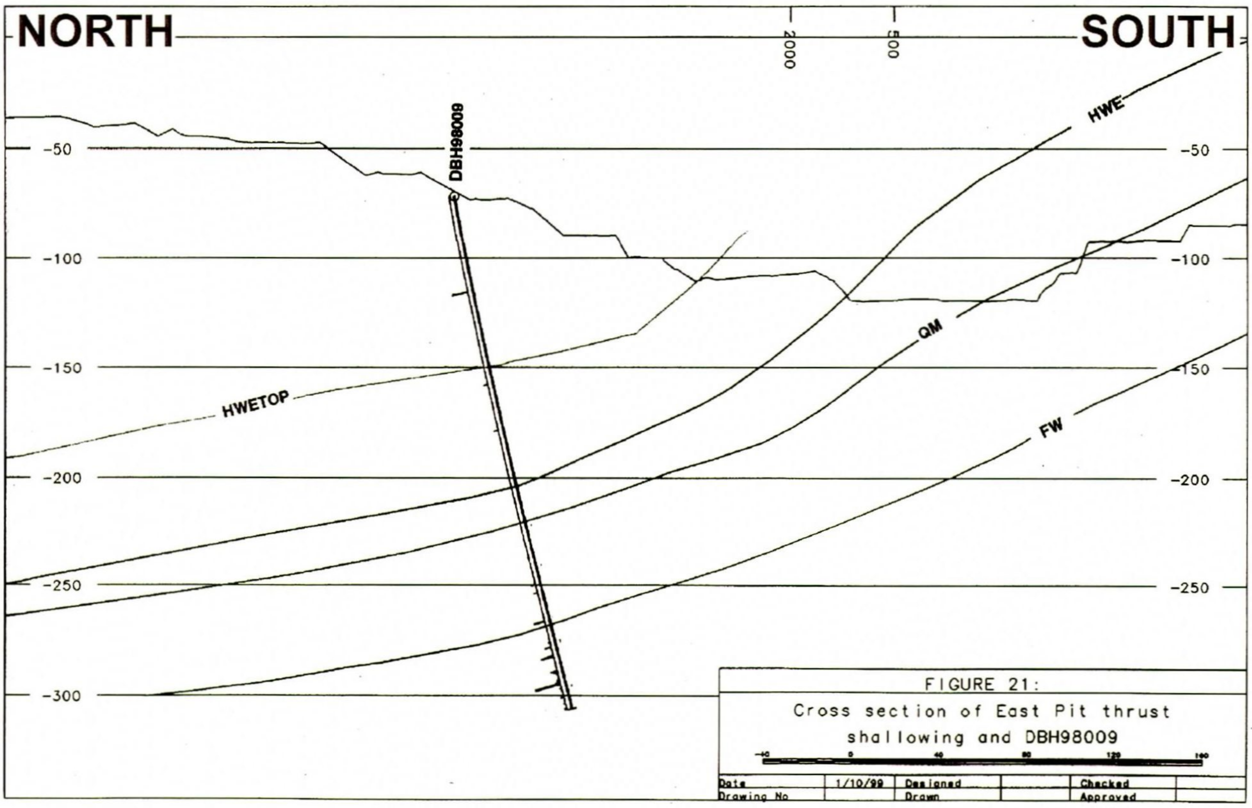

Figure 10: Cross-section through the East-Pit looking east. The interpreted thrust structures are marked. A diamond hole drilled in the summer of 1998 is also shown. This borehole allowed two important and interesting observations. Firstly, the thrust pile is unmineralised until the thrust sheet below the FW thrust is entered. This demonstrates that there is mineralised material below the level of the present pit bottom. The borehole also shows that the upper contact of the mineralised thrust pile is shallower than expected down-dip. This means the contact shallows with depth and may imply that the waste:ore ratio may be less in this area.

3. Target areas

Analysis of the mine area in relation to existing drilling, the geological model discussed above, and the present resource model allows the definition of three different target types. These are:

- Volumes in the block model which are not mined.
- Extensions to volumes, described by the block model as resource, but undrilled.
- Volumes poorly constrained which are adjacent to the block model.

This report is concerned with the second and third target types to try and expand the mine into areas that are presently undrilled. The following section presents these target areas (see **Figure 11**).

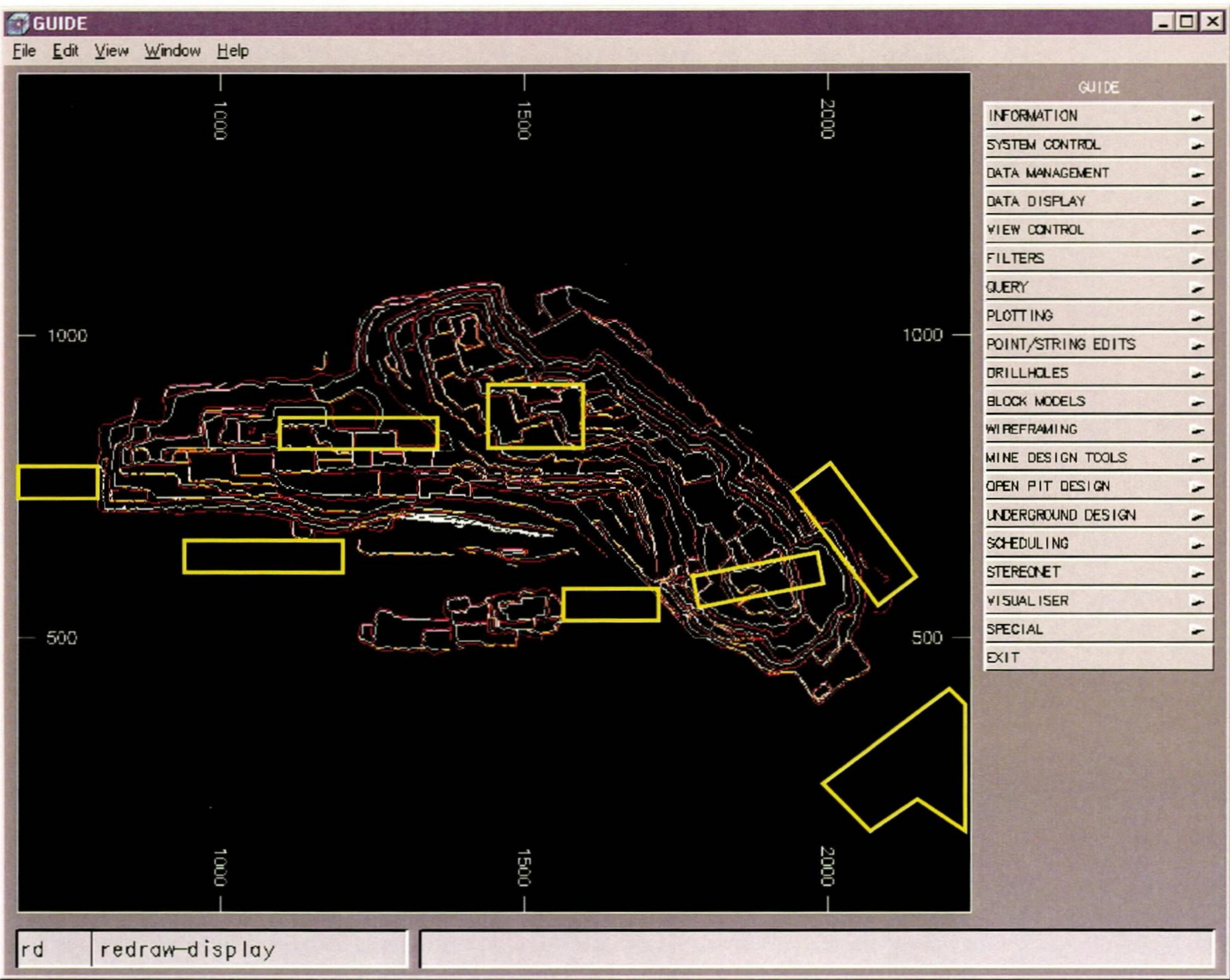

Figure 11: Potential target areas within the Björkdal Mine. The target areas are shown in yellow.

3.1 EAST PIT HANGINGWALL

Figure 10 demonstrates that the hangingwall to the mineralisation is interpreted to shallow with depth. This geometry is consistent with how thrust structures have been interpreted previously. However, the block model in this are is modelled as a constant plane at depth down the hangingwall contact. This could imply two things:

- There is a zone of potentially mineralised material lying above the block model, which is poorly drilled, but lying below the level of the newly interpreted, shallowed top contact to the mineralisation.
- The amount of stripping needed to reach mineralisation that already lies within the block model could be reduced.

However, previous work has shown that an increase in resource volume would only be noticeable above a gold price of $350 per ounce. This demonstrates that at the present gold price, that this target would not be viable.

3.2 EAST PIT BOTTOM

Mineralisation that has been previously mined in the East Pit has been, historically, of the highest grades and is associated with the presence of a mineralised shear zone. The geometry of this structure is quite predictable. This shear zone is parallel to the quartz veins (WSW-ENE) and continues from the East Pit, westwards towards Quartz Mountain. This zone is predicted, from the new geological model, to be truncated at depth below the East Pit by the FW structure. However, of all of the thrust structures modelled in 3D, this structure is least well constrained below the East Pit. In addition, the level of present drilling stops at the same depth as this structure. If this structure was 20m lower than predicted, a volume of 366 000m^3 lies undrilled below the present East Pit and is potentially mineralised (**Figure 12**).

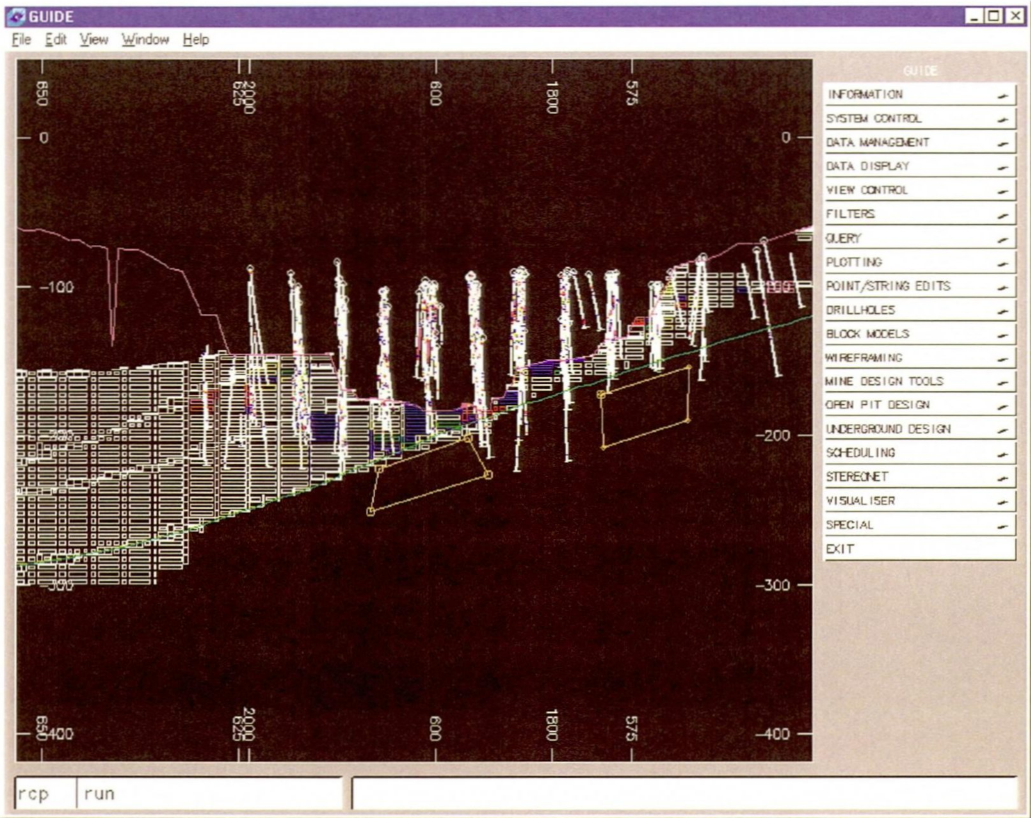

Figure 12: Cross-section through the East Pit looking east showing the shallow base to the present drilling level and potential target areas.

3.3 EAST OF QUARTZ MOUNTAIN

The same mineralised structure which is observed and was mined in the East Pit is interpreted to continue westwards and is in fact the same structure which outcrops on top of Quartz Mountain. However, the volume between the East Pit and Quartz Mountain is relatively undrilled and was thought to be relatively barren. However, 3D modelling has shown that this zone is capped by a relatively unmineralised sheet of granodiorite with a thrust surface lying very close to the surface (**Figure 13**). The nature of the granodiorite sheet below this was unknown. However, drilling in the summer of 1999 (BH99015) showed that the thrust sheet below the QM thrust was mineralised (the mineralised structure is shown orange in cross-section in **Figure 13**). Further drilling should be done here to back up the findings of this one hole.

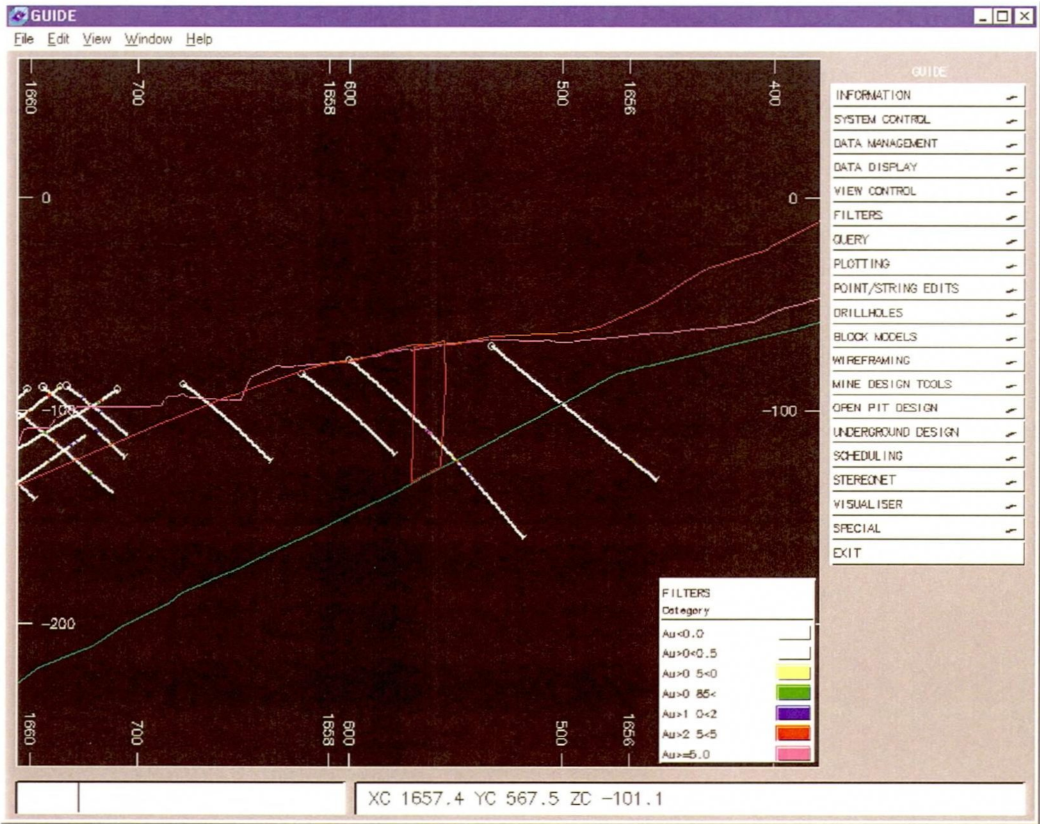

Figure 13: Cross-section through Quartz Mountain looking to the north-east. The purple line is topography and the red line is the interpreted QM Thrust. Mineralisation is thought to lie below this thrust structure. Drilling in 1999 found grades of 500g/t Au in one metre interval.

3.4 SOUTH OF WEST PIT

The area immediately to the south of the West Pit has been poorly drilled, as is shown in **Figure 14**. Although the knowledge from this area is poor, there is no reason why this volume could not be mineralised. This is a continuous zone of undrilled volume several hundred metres long and several tens of metres wide.

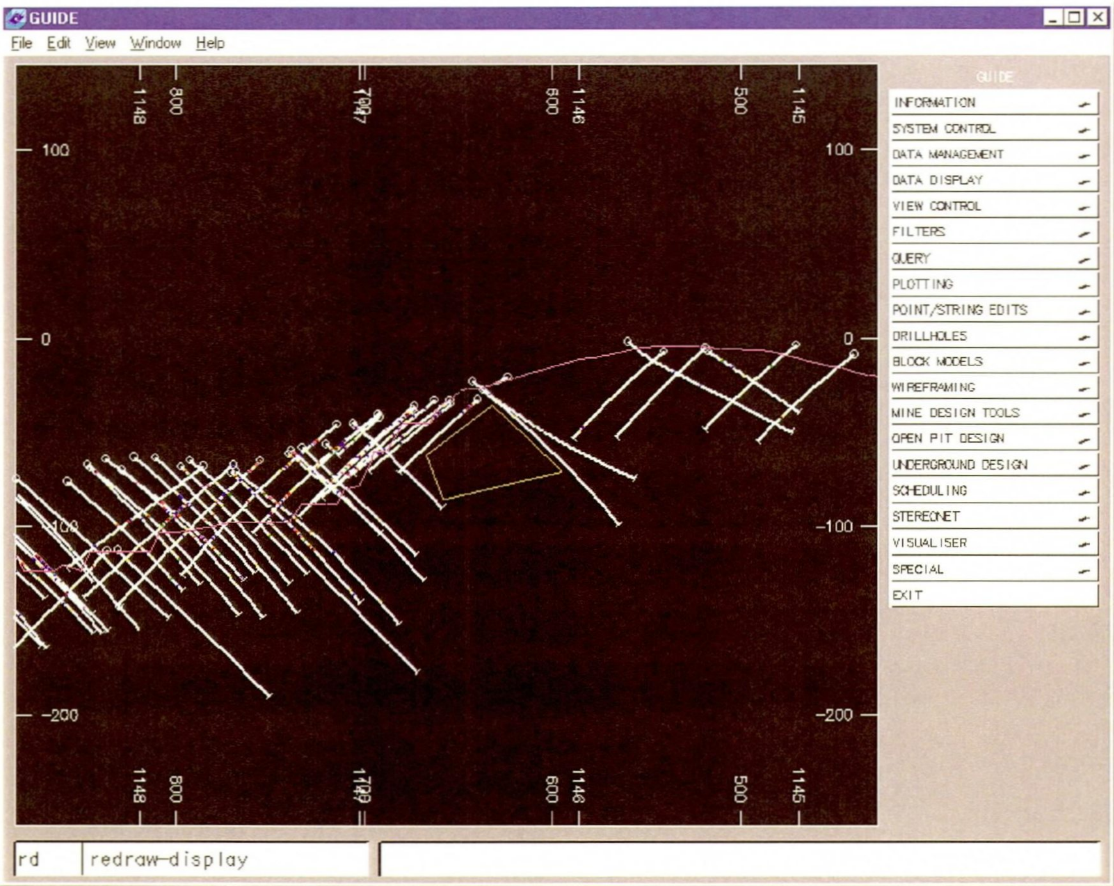

Figure 14: Cross-section looking east through the area to the south of the West Pit. This area is poorly drilled in a zone 300m long parallel with the south margin of the West Pit.

3.5 WEST PIT EXTENSION

The western margin of the West Pit is generally well-drilled and shows no apparent extension of this mineralisation further westward here. However, strong quartz veining is present in the south western wall of the West Pit and this corresponds to high grades in the RC profile which corresponds with the present wall of the pit (**Figure 15**). However, examination of the RC profiles further west from this structure show that it is potentially mineralised (**Figure 16**). Although the projected volume is small (approximately 91 000m3), this area provides reasonable geological knowledge that this structure may continue westwards.

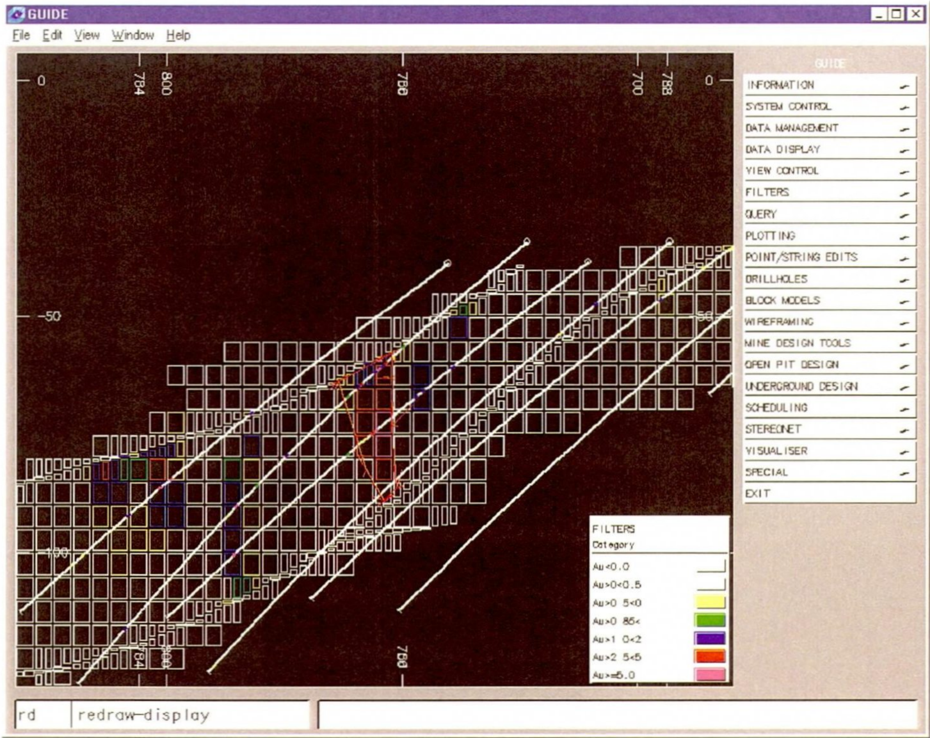

Figure 15: RC profile through the west wall of the West Pit showing gold grades. These grades are up to 105g/t Au in some metres.

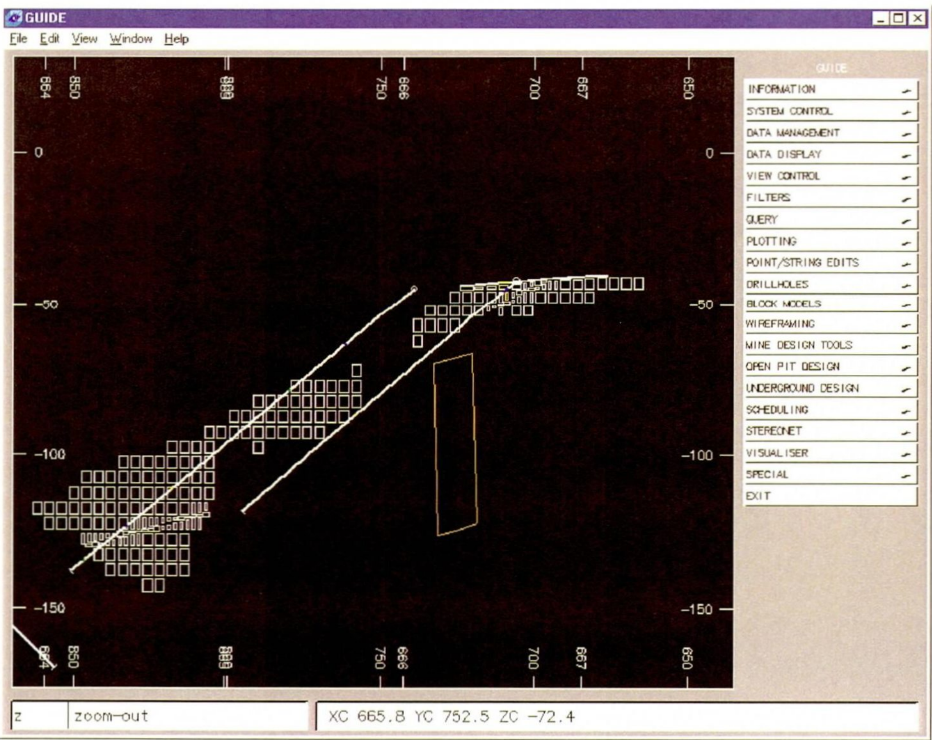

Figure 16: Possible extension of the zone visible in outcrop (veins) and in drillhole profiles in the West Wall of the West Pit. This zone is poorly drilled and may continue as an extension of the West Pit.

3.6 WEST PIT BOTTOM

Prior to drilling in the summer of 1999, the depth to the base of drilling in the West Pit was less than 30m and at this point in time the base of the West Pit was considered to be a promising target area. However, the drilling in 1999 proved to be disappointing and yielded only a few grades in several of the holes. However, most of the holes that were drilled were on profiles located towards the western half of the West Pit. Several profiles from this drilling program remain to be drilled (eastwards of 1250 profile). However, these drillholes are unlikely to add a great volume to potentially mineable material and are therefore considered to be low priority. No volume has been created for this area.

3.7 CENTRAL PIT BOTTOM

The Central Pit bottom is one of the most poorly drilled areas in the Björkdal Mine. In some areas the depth to the present maximum depth of drilling is 15-20m (**Figure 17**). This zone extends over a considerable volume under the Central Pit (green volume in **Figure 18**) with an estimated volume of approximately 1.2Mm^3. The same structural level (i.e. between the QM Thrust and the FW Thrust) in the East Pit is mineralised. The geological model described above suggests that this zone is potentially mineralised.

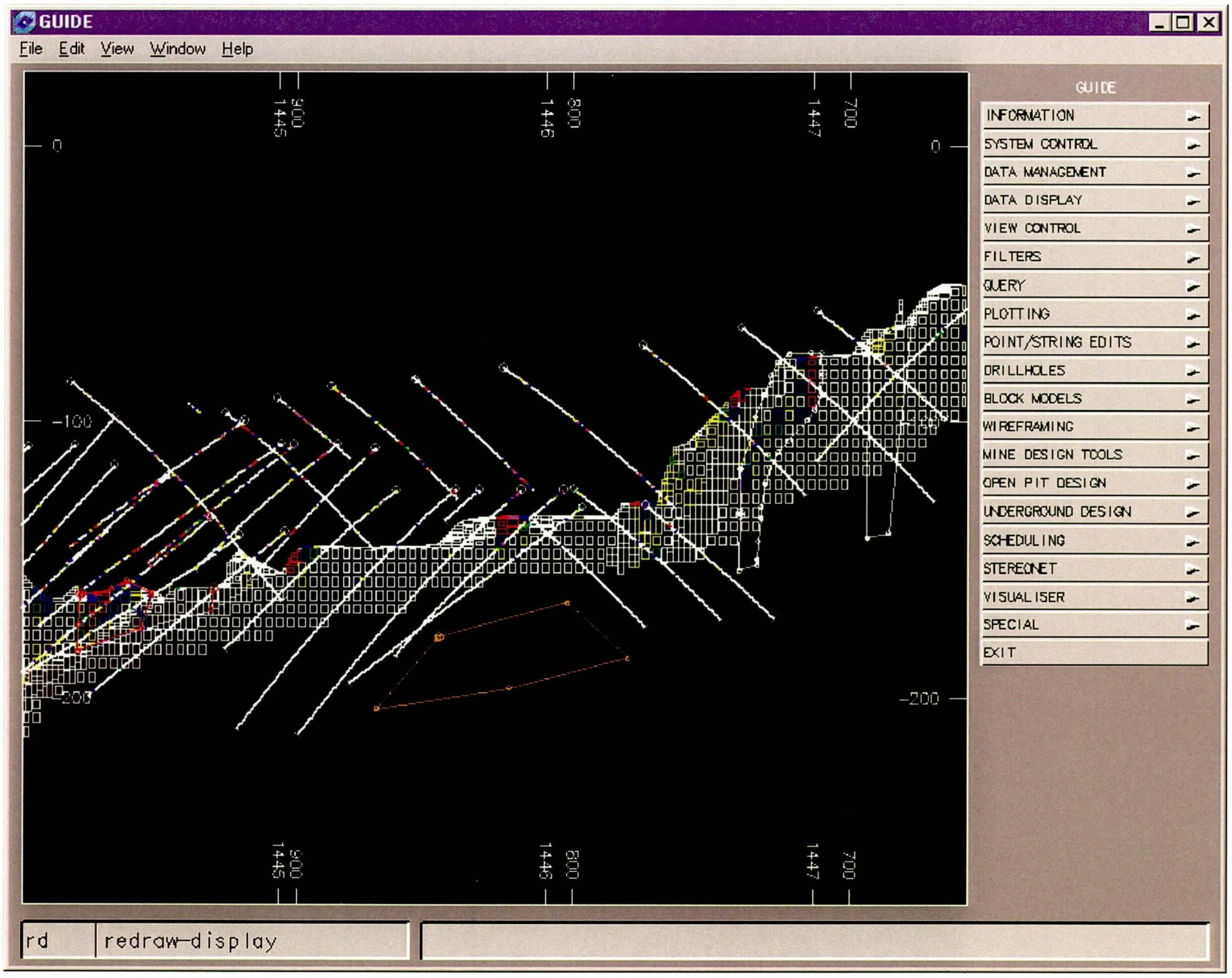

Figure 17: Undrilled zone below the Central Pit. Cross-section looking east. The base to the present zone of drilling information is, in some places, as shallow as 15-20m.

3.8 WEST OF NYLUND

The block model for the Björkdal Mine does not extend far outside of the present mined area. In the Eastern Pit, the model extends only a few tens of metres further east. Between the eastern extent of the block model and the RC and diamond drilling in the Nylund area there is no drilling information. This area, known as "West of Nylund" was partially drilled in the summer drilling campaign in 1999. Drilling results for this were poor, however, only the northern part of this volume was drilled. It is still possible that a potentially WSW-ENE striking structure has not been drilled in this area. This undrilled volume is approximately 2.3Mm^3 and should be drilled (see **Figure 18**).

3.9 NORTH OF NYLUND

The limestone contact in the East Pit was previously modelled as exiting the East Pit and striking eastwards to intersect the northern limit of the existing drilling in the Nylund area.

However, recent re-interpretation of RC drill holes along this contact have shown that it is more likely that this contact strikes more to the north-east and subcrops somewhat to the north of this area of drilling in Nylund. This implies that there is a zone of undrilled and unknown rock type which lies to the north of the present Nylund area which may be granodiorite. Geochemistry suggests that there is a moderate gold anomaly in the base till. This area gives a potential volume of approximately 3.5Mm^3 (**Figure 18**) and should be drilled. If this zone proves not to be mineralised granodiorite, drilling could be aborted after only a few holes.

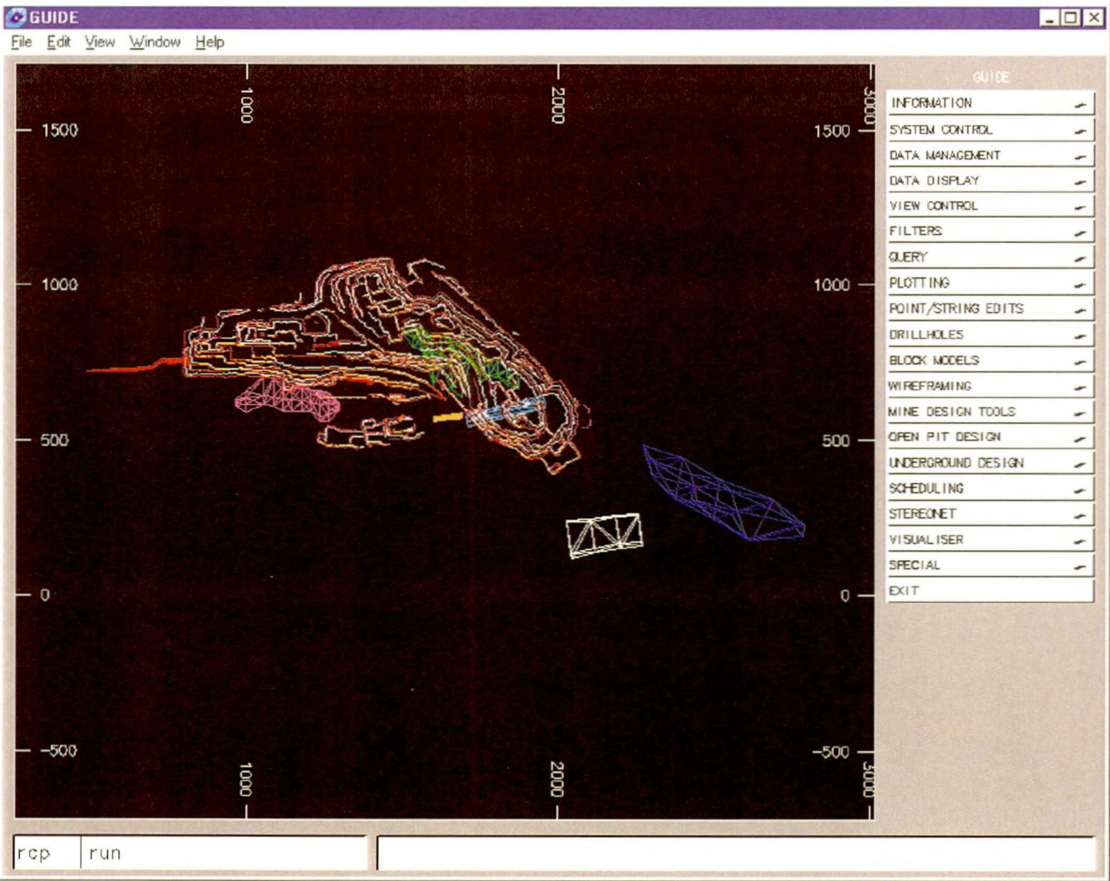

Figure 18: Potential target areas within the Björkdal Mine showing the volumes constructed on DATAMINE. Red is the "West Pit Extension"; purple is the "South of West Pit"; orange is the "East of Quartz Mountain"; green is the "Central Pit Bottom"; light blue is the "East Pit Bottom"; white is the "West of Nylund" and dark blue is the "North of Nylund" target area. The details of these target areas are given in Table 1.

TARGET AREA	COLOUR	DATAMINE FILE	VOLUME
WEST EXTENSION	RED	VEXT2TR	91 000m^3
SOUTH OF WEST PIT	PURPLE	SOUTHWTR	610 000m^3
EAST OF QUARTZ MOUNTAIN	ORANGE	OKVTR	89 000 m^3
CENTRAL PIT BOTTOM	GREEN	CENT2TR	1 117 000m^3
EAST PIT BOTTOM	LIGHT BLUE	OSTTR	366 000m^3
WEST OF NYLUND	WHITE	WOFNYTR	2 300 000m^3
NORTH OF NYLUND	DARK BLUE	NRTHNYTR	3 460 000m^3

Table 1: Details of potential target areas within the Björkdal Mine. Volumes were created and measured on DATAMINE.

4. Proposal for drilling meterage

This section briefly suggests a possible meterage for drilling in order to gauge likely costs of a drilling program to determine the nature of the volumes described above. This is given as:

East of Quartz Mountain.. 1000m

East Pit Bottom.. 1000m

Central Bottom.. 700m

West Extension.. 600m

Nylund (both West of Nylund and North of Nylund).. 800m

West Pit Bottom.. 300m

No drilling is, at present, prioritised for the East Pit hangingwall, as the drillholes would have to penetrate a considerable amount of overburden before they came into mineralised material. No detailed drilling plan is provided at present and these meterages would inevitably change after drilling commenced.

5. Conclusions

- The mineralisation in the Björkdal Mine is dissected by thrust structures with unknown displacement but potentially up to several hundred metres if not kilometres.
- Mineralisation took place at some unconstrained time prior to thrusting. Thrust displacement then emplaced mineralised granodiorite sheets of variable mineralisation potential on top of one another.
- Mineralisation can therefore be present below the level of the present drilling level or in the hangingwall above the present northern margin to the mine.

- This geological model provides a positive philosophy for further exploration within the Björkdal claim area, as these thrust structures are present over a large area and could have potentially brought to the surface mineralised granodioritic sheets.
- 9 targets have been identified and prioritised based on the constraints of the geological model, present drilling knowledge and block model constraints. Potentially mineralised volumes have been created on DATAMINE software for 7 of these targets.
- Further work should concentrate on determining a borehole layout plan in 3D (using DATAMINE software) as the best method to drill these volumes efficiently.