

Appendix A  
Geology and Exploration in the Anvil Pb-Zn-Ag District

**District Stratigraphy**

The stratigraphic sequence of Anvil District ranges in age from latest Precambrian to Permian. The lower part of the sequence is divisible into three major mappable units (figure A1. From the base these are noncalcareous metapelite of the Mt. Mye formation, calcareous meta-pelite of the Vangorda formation, and meta-basalt of the Menzie Creek formation (Jennings and Jilson, 1986). All formational names in this sequence are informal. The aggregate thickness for this pre-Silurian sequence is approximately 5km.

The strata overlying the above sequence are characterized by shale, chert, coarse clastics rich in chert fragments, minor limestone, and an uppermost basalt unit. Strata of the Devonian-Mississippian Earn Group (Gordey et al., 1982) and Pennsylvanian-Permian Anvil Range Group (Tempelman-Kluit, 1972) are present. All or part of this upper sequence may be allochthonous with respect to the underlying units. The boundary between allochthonous and parautochthonous strata is drawn at the base of the Anvil Range group where red cherts first become prominent in the section. The Earn group locally contains stratiform barite deposits.

The Devonian and younger rocks are not related to the ore deposits in the district and consequently are not discussed further. The three older units either host the ore deposits or are the exploration environment for the orebodies thus are considered in more detail below.

**Mt. Mye formation**

Mt. Mye formation consists dominantly of noncalcareous, biotite-muscovite-andalusite-staurolite +/- garnet schist in areas of amphibolite facies metamorphism and noncalcareous, weakly carbonaceous, light to medium grey muscovite-chlorite phyllite in areas of greenschist facies metamorphism. It contains lesser, interlayered black carbonaceous phyllite or schist, calcitic marble, calc-silicate phyllite or schist, greenstone or amphibolite, and psammitic schist. The formation has a structural thickness of at least 2 km, the base is not exposed. The reddish brown weathering colour of the formation is characteristic and helps distinguish it from noncalcareous portions of the overlying Vangorda formation.

Dark grey to black carbonaceous phyllite or schist members comprise about 10 per cent of the formation. They are more abundant in the upper 400m of the formation.

Calcitic marble and calc-silicate schist or phyllite also constitute about 10% of the Mt. Mye formation. The marble is light grey, medium crystalline calcite marble with boudins of pelite, amphibolite, and calc-silicate. Marble bodies may be up to 75m thick but are generally only a few tens of meters thick; they can be traced laterally for several kilometres. The calc-silicate lithology is a thinly interbanded sequence of purplish brown

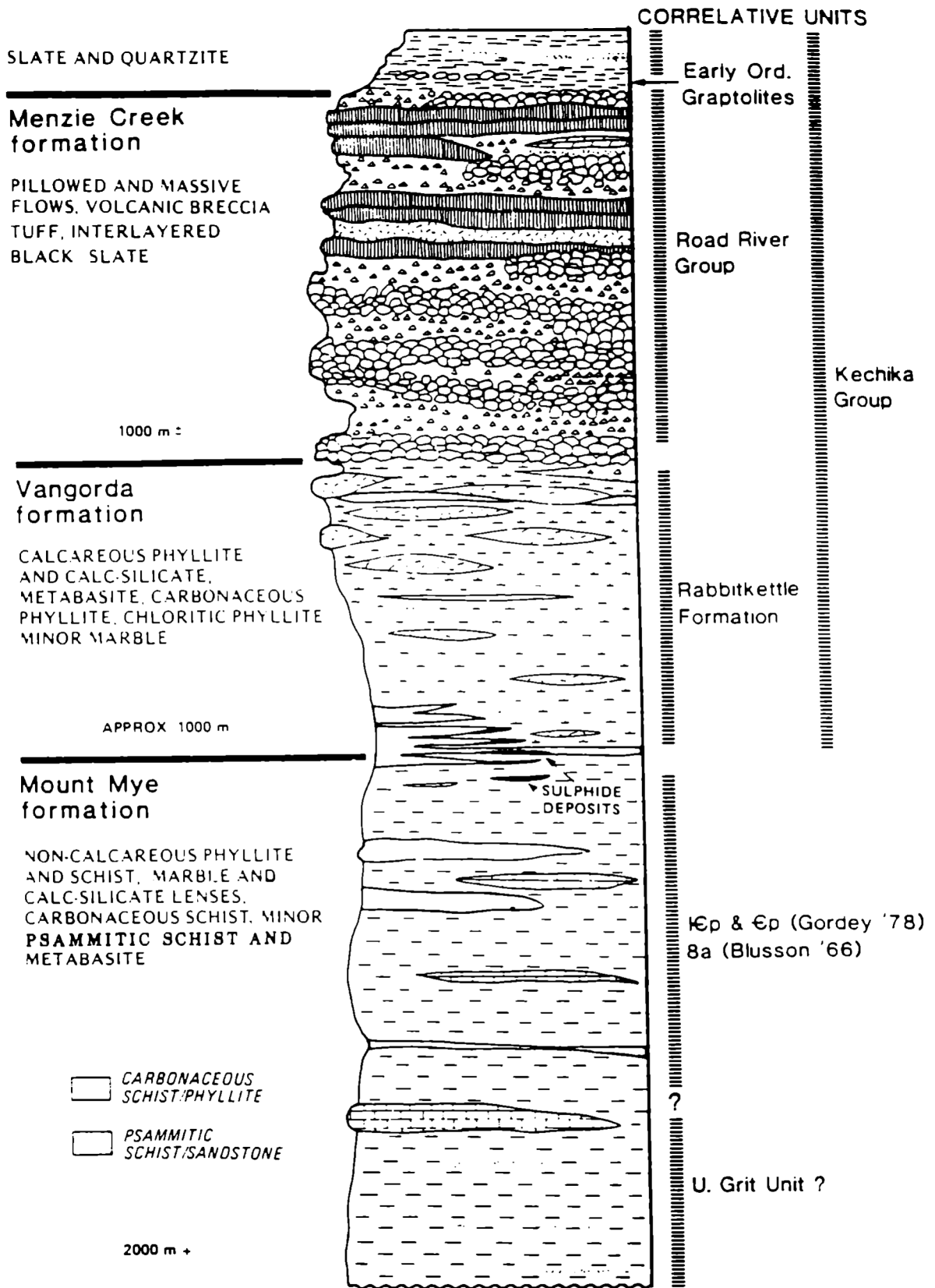


Figure A1: Stratigraphic column of the older portion of the rock units in the Anvil District.

biotite pelite and pale green actinolite-epidote calc-silicates. Typically the calc-silicates are spatially associated with the marbles. A persistent marble and calc-silicate horizon occurs about 500 to 700m below the top of the Mt. Mye formation.

Metabasite bodies in the Mt. Mye formation are generally only a few meters thick and have small lateral dimensions. Volumetrically they constitute less than 1% of the Mt. Mye formation. They are generally strongly foliated, dark green amphibolites lacking relict igneous texture. Compositions are similar to basalts of the Menzie Creek formation (Jennings and Jilson, 1986). They are interpreted as subvolcanic feeder dykes and sills of the Menzie Creek basalts.

The upper portion of the Mt. Mye formation is very similar to the buff weathering mudstone and blue-grey mudstone units described by Gordey (1978) to the east near Howards Pass and unit 8A of Blusson (1966). Correlation with these units would imply the top of the formation is lower Cambrian or possibly middle Cambrian. Jennings and Jilson (1986) suggested that the persistent marble and calc-silicate package may correlate with the widespread early Cambrian limestone conglomerate of Selwyn Basin. Parts of the Mt. Mye formation also resemble rocks underlying those presumed correlative units, implying that the Mt. Mye may include rocks as old as Hadrynian.

### **Vangorda formation**

The Vangorda formation is characterized by light to medium-grey, calcareous, phyllitic rocks made up of very thin (0.1-2cm) interlayers of medium grey, non-calcareous, weakly carbonaceous, muscovite-chlorite pelite and light grey, generally calcareous quartz-calcite +/- dolomite siltstone. At the higher metamorphic grade of amphibolite facies, the Vangorda formation phyllites are transformed to a thinly banded, pervasively foliated, green, cream, and purplish brown, calc-silicate. Major interbanded units include greenstone, carbonaceous pelite, and phyllitic limestone. The Vangorda formation varies between 0.5 and 2km in apparent thickness. The formation becomes more calcareous up section. The light grey to tan coloured, drusy weathering of the formation is characteristic both within the district and elsewhere.

The greenstone bodies range from 1 to 100m in thickness and are up to several kilometres in length. They comprise approximately 15% of the Vangorda formation and are more prevalent near the top of the formation. Whole rock analyses show that the greenstones are compositionally similar to the overlying Menzie Creek basalts (Jennings and Jilson, 1986). Locally the greenstones contain coarsely crystalline serpentinized pyroxenite subunits, which may be pyroxene cumulates. Most greenstone bodies have medium-grained, equigranular centres with strongly foliated margins. Although marginal contacts of the bodies are superficially conformable, detailed inspection indicates the units are locally slightly crosscutting. The metabasites are thus interpreted as subvolcanic dyke and sill feeders to the Menzie Creek formation.

Typically the Vangorda formation adjacent to the metabasites is a thinly banded, hard, pale green, calcareous, chloritic phyllite. This lithology has been interpreted as a marginal tuff adjacent to basaltic flows (as noted in Jennings and Jilson, 1986). More extensive drill core inspection and additional outcrop exposures indicate that instead it represents a slight contact metamorphic aureole caused by intrusion of the greenstone bodies; further evidence that the greenstone bodies are intrusive.

Black, slightly calcareous to dolomitic, carbonaceous pelite members occur throughout the Vangorda formation. Dimensions and lateral continuity of these members are poorly known. The thickest and most extensive of these occurs at the base of the formation; it ranges from only a few tens of meters to 100m in thickness. This basal member becomes thicker in the immediate vicinity of the ore deposits and appears to be laterally equivalent to black, sulphide-bearing, ribbon-banded, carbonaceous, quartzite ores within the mineral deposits. Southwest of the Grum and Vangorda deposits the basal member is very siliceous and slightly pyritic enhancing the impression of equivalence to the carbonaceous quartzite ores.

The Vangorda formation is lithologically similar to, though more argillaceous than the Rabbitkettle Formation seen to the east (Gordey, 1978; Gabrielse et al., 1973). Based on this correlation the Vangorda formation may range in age from middle or late Cambrian through early Ordovician.

### **Menzie Creek formation**

The Menzie Creek formation is a unit of basaltic metavolcanic rocks consisting of pillowed and massive flows with comparable amounts of massive, coarse, monolithic breccias and lesser, thin-bedded, tuff and/or volcanic sandstone and siltstone. The formation reaches a maximum structural thickness of 1.5km in the district. Whole rock major element and trace element data (Jennings and Jilson, 1986) imply that the flows of the Menzie Creek volcanic unit are dominantly alkali basalt erupted in a within-plate setting. Similar major and minor element compositions for the metabasites in the Mt. Mye and Vangorda formations suggest the metabasites are subvolcanic feeders for the Menzie Creek formation.

Carbonaceous phyllite and brown siltstone immediately overlying and interbedded with the uppermost Menzie Creek formation northeast of the Anvil Batholith contain graptolites of middle Ordovician or early Silurian age (Tempelman-Kluit, 1972; Gordey, 1983) suggesting correlation of the Menzie Creek volcanics with the widespread Road River Formation black shale and chert to the northeast. The Menzie Creek formation has been traced for 100km along strike and 30km across strike, showing that it is one of the largest of several basaltic units of its age in Yukon.

## Relation of Stratigraphy to Ore Deposits

The ore deposits of Anvil District are stratiform and confined to an approximately 150m to 200m thick stratigraphic interval which includes the contact of the Mt. Mye and Vangorda formations. This stratigraphic position suggests the mineralization is Cambrian in age. The deposits consist of one to five layers of sulphide mineralization interbanded with barren metasedimentary rocks. For those deposits with more than one sulphide horizon, the mineralized horizons are generally stacked one above the other. At least three of these mineralized horizons appear to be laterally equivalent to part of the basal carbonaceous member of the Vangorda formation. The known deposits occur in a 25km long curving trend following the prominent fold axial trends of the district. Southwest of this trend there is a tendency for the basal carbonaceous member of the Vangorda formation to thicken. The ore horizons tend to occur at the base of thick carbonaceous units suggesting the exhalative ore forming event was an initial stage in the formation of an anoxic sub-basin. Unlike other sedimentary exhalative deposits of Selwyn Basin, the Anvil deposits are not characterized by a host stratigraphic section dominated by black carbonaceous rocks. Instead the carbonaceous rocks in the district are thin and subordinate or locally not even present near the sulphide deposits.

## Ore Deposits

### General Description

The lead, zinc, silver deposits of the Anvil District are of the sediment hosted, stratiform, massive pyritic sulphide type (Gustafson and Williams, 1981; Large, 1980) or sedimentary exhalative (sedex) type (Carne and Cathro, 1982). They occur either as a thick sulphide lens with little or no interbanded metasedimentary rocks (e.g. Faro) or as several thinner lenses stacked approximately one above the other with substantial metasedimentary interlayers (e.g. Grum and Dy).

Detailed mapping and drilling suggest the linearly distributed deposits lie close to a northeasterly "pinch out" or "zero edge" of the basal carbonaceous member of Vangorda formation. To date, no sulphide deposit lithofacies have been encountered in a small number of drill holes through the ore-bearing horizon southwest or northeast of the deposit line. These observations and the relationships to carbonaceous rocks noted previously, suggest some genetic link between sulphide deposits and facies changes at an anoxic sub-basin margin. The linear trend suggests the possibility of fault controlled hinge lines of sub-basins. The faults may have channelled ore fluids leading to sea floor exhalation followed by sulphide deposition in the sub-basin where reduced sulphur was available.

All deposits are composed of a small number of different ore types. The ore types are broadly divisible into massive sulphides and disseminated sulphides in quartzite. There are pyritic, baritic, pyrrhotitic and carbonate bearing variants of the massive

sulphide ore types and carbonaceous and non-carbonaceous variants of the disseminated ore types. Ore type zoning is pronounced in the deposits with lower and distal ore types being disseminated carbonaceous quartzites and while upper proximal types are baritic massive sulphides (figure A2).

Lead-zinc grade and metallurgical performance varies by ore type. The baritic massive sulphides are high grade, easily grindable and yield good grade concentrates with good recoveries. On the other hand carbonaceous quartzites are typically low grade, hard, and produce lower grade concentrates with lower recoveries. Other ore types exhibit intermediate grade and performance.

The mineralization occurs in the thin, laterally extensive, sulphide sheets or horizons are deformed into complex fold structures. The deposits are elongate parallel to the D<sub>2</sub> fold axes and associated lineations in the host metasediments. The Faro deposit, which superficially does not appear to be complexly folded, actually shows great internal complexity in the geometry of high grade and waste layers.

Present deposit lengths are generally two to three times widths; unfolded, the deposits are interpreted to have had an amoeboid shape with diameters up to 4,000m. Individual sulphide horizons commonly are 10 to 40m in thickness. The upper contact and generally the lower contacts of sulphide horizons are sharp while lateral extensions grade into the enclosing host rocks. Parts of some deposits, particularly Vangorda (figure A3), show a footwall rich in quartz and iron sulphides/oxides and enriched in copper and gold relative to zinc. This may be a footwall silicified and sulphide impregnated feeder zone.

All deposits show a variably developed, white mica-dominant, alteration overprint in the wall rocks. This results in the phyllites having a bleached appearance. Chlorite ± pyrrhotite ± carbonate variants of the alteration are also found widely. At lower metamorphic grade this alteration tends to be found in the footwall of the ore horizons. At the Faro deposit, this bleaching/alteration halo is particularly intense and encloses the entire mineralized sulphide lens. The halo at Faro may be a fundamentally different sort of alteration related to the metamorphism of the deposit.

### **Fold Deformation**

The structural and metamorphic history of the Anvil District is complex and of considerable significance to present form and nature of the ore deposits since all of the deposits have experienced the full deformation history. Five fold deformation phases have been recognized within the metasedimentary and metavolcanic rocks of the district. The first two are periods of intense mid-Mesozoic fold deformation and concurrent metamorphism which determined the gross structure of the mineral deposits. The remaining deformations are only locally developed and do not generally form large or significant structures.

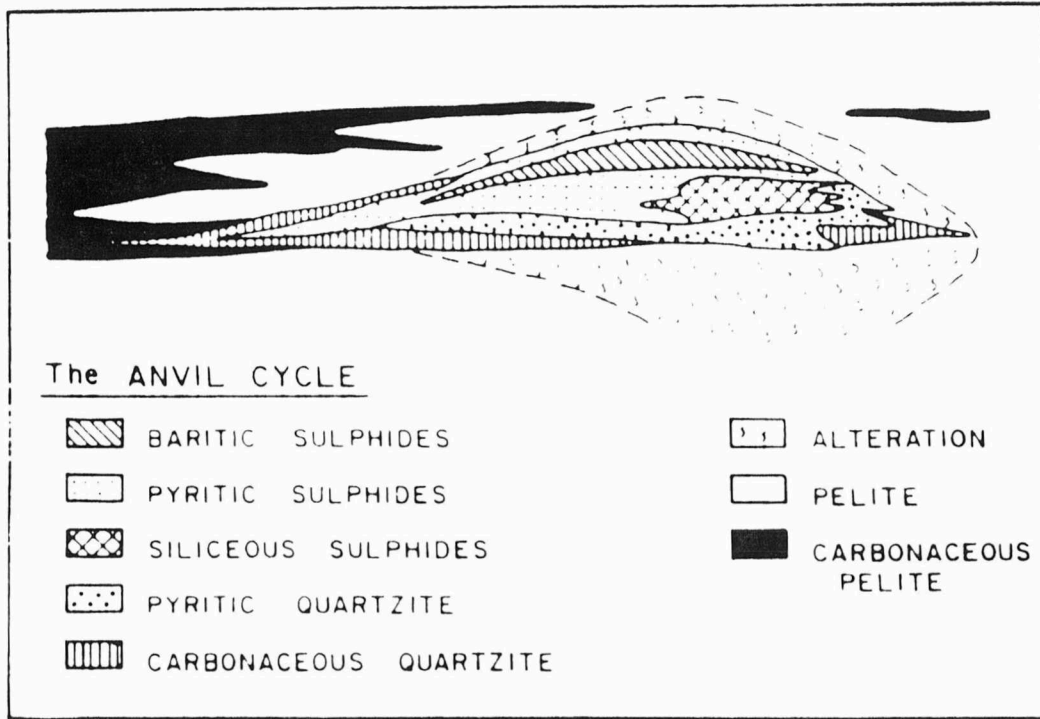


Figure A2: Idealized Anvil cycle of ore type facies variations based largely on the Faro and Vangorda deposit. The section is greatly vertically exaggerated.

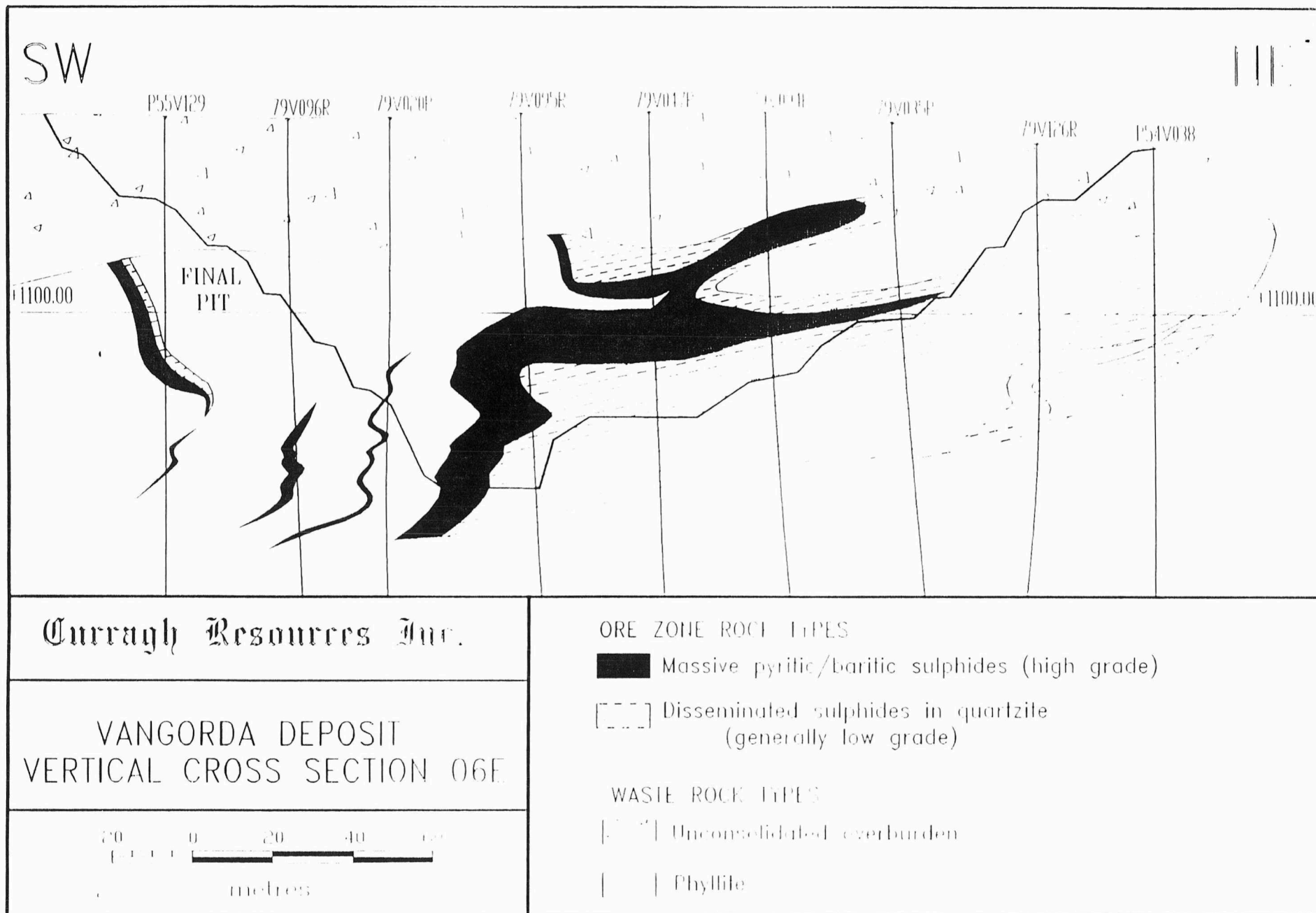


Figure A3: Cross section 6E through the central part of the Vangorda pit showing the ultimate limit. The ore horizons are thrown into Phase II folds with shallowly dipping axial planes. The section looks northwest down the direction of fold plunge. The disseminated mineralization in the footwall of the high grade ore is gold and copper rich relative to zinc and may be a footwall alteration zone.

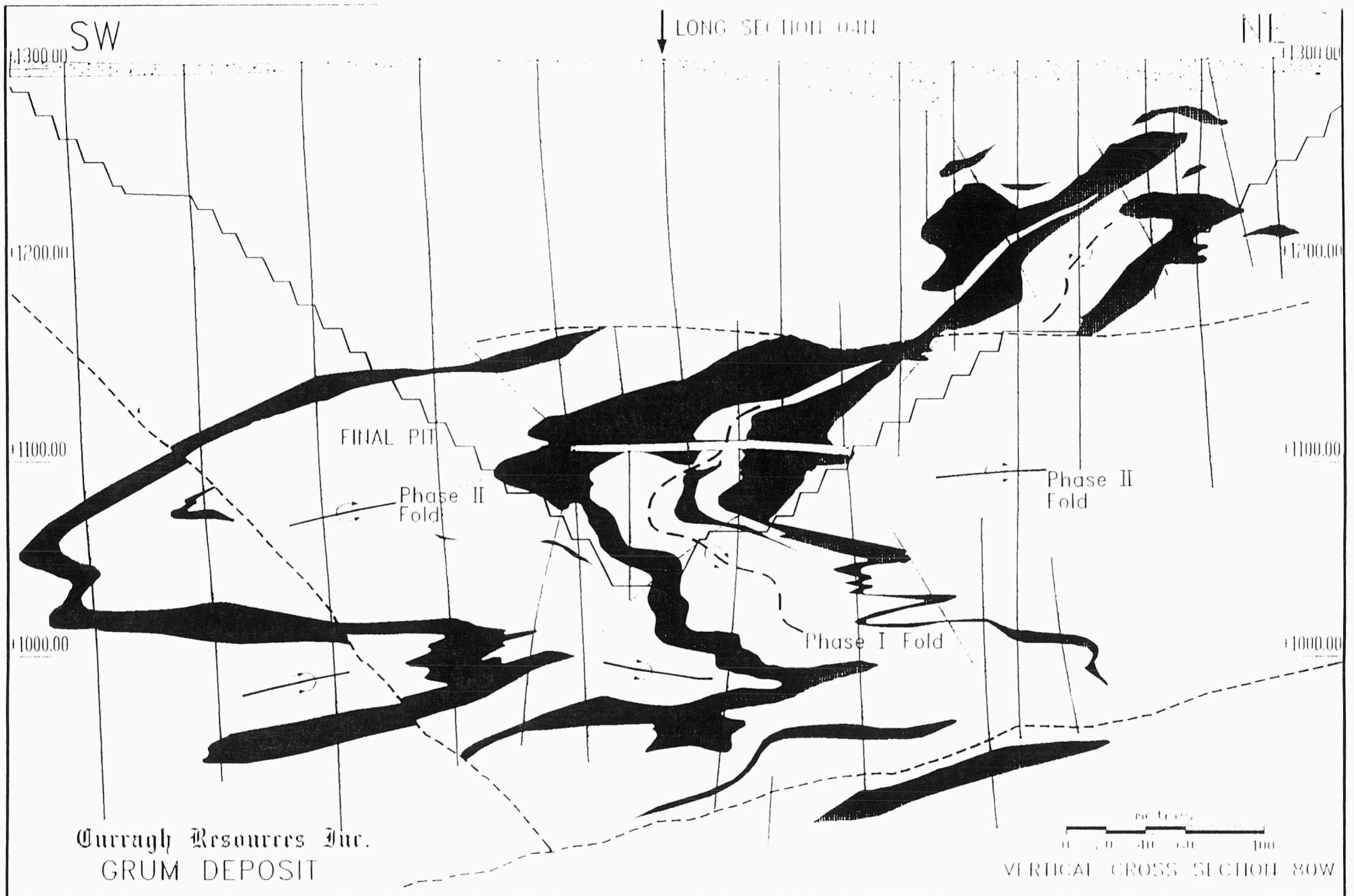


Figure A4: Cross section 80W through the northwest end of the Grum Pit showing the ultimate pit limit. Black includes all massive and disseminated sulphides regardless of grade. The deposit is a good example of a Phase I fold refolded by Phase II folds. Note the 80W crosscut at elevation 1,100m, this is the deepest part of the underground workings at Grum.

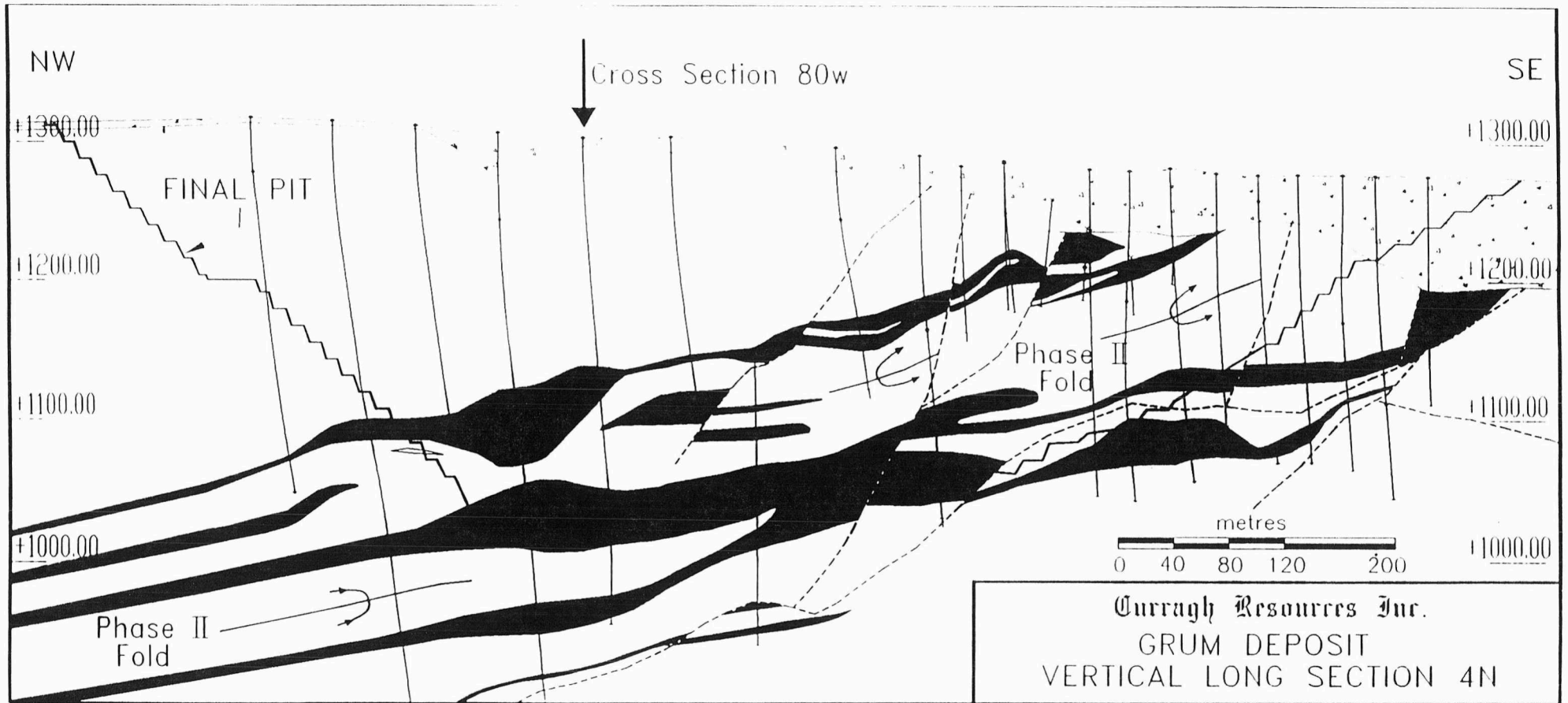


Figure A5: Longitudinal section through the centre of the Grum Pit. Black includes all sulphides. The section is drawn parallel to the fold axis and shows the northwest plunge of the folds and the deposit. The subcrop of Grum is covered by thick glacial till, this combined with the northwest plunge made Grum an essentially blind discovery.

The first deformation ( $D_1$ ) produced a regional metamorphic foliation ( $S_1$ ) axial planar to tight to isoclinal mesoscopic folds ( $F_1$ ) in bedding ( $S_0$ ). Mesoscopic  $D_1$  early folds are rarely preserved in the district; they are ubiquitously north-easterly inclined to upright, northeasterly verging (shaped like a 'Z' looking northwest) structures with shallow northwesterly or southeasterly plunging axes.

During the second deformation event ( $D_2$ ),  $S_1$  was strongly crenulated and ubiquitous close to tight mesoscopic folds ( $F_2$ ) in  $S_1$  were produced.  $S_0$  primary bedding was transposed into near parallelism with the  $S_2$  foliation. Parallel to the axial planes of the  $D_2$  folds is a crenulation cleavage ( $S_2$ ) which imparts a well developed lithon structure to most rocks of the district, especially the strongly banded phyllites of the Vangorda formation.  $F_2$  axial planes and  $S_2$  axial plane foliations dip shallowly to the southwest or northeast, with fold axes subparallel to  $F_1$  fold axes. Southwest of the Anvil Batholith the  $S_2$  surfaces dip dominantly southwest, and  $F_2$  minor folds have southwest vergence (shaped like a 'S' looking northwest). Northeast of the batholith  $S_2$  surfaces dip dominantly northeast, and  $F_2$  minor folds appear, on the basis of limited evidence, to have northeast vergence. The shallow dip of  $F_2$  axial planes, the isoclinal nature of  $F_2$  folds, and the transposition of bedding into foliation creates some of the more important exploration characteristics of the district. Rock units are flat lying to shallowly dipping on the average although there are local exceptions (e.g. Grum). Electromagnetic methods must be able to couple well with flat lying conductors. The shallow dip of the area also means exploration targets tend to present their largest dimension to a vertical drill hole.

The largest megascopic folds known to have been formed during  $D_2$  are those at the Grum Deposit (figure A4) and comparable folds in the Swim Deposit. Three later, less intense periods of folding and associated faulting followed. The later events ( $D_3$  through  $D_5$ ) generally produced open folds and weak crenulations in  $S_2$  related to broad, regional structures. An important exception to this general rule is found in the vicinity of the Faro deposit where the fourth event ( $D_4$ ) is intense with tight mesoscopic folds developed in nearly pervasive  $S_2$ .  $D_4$  minor folds have appreciable mica growth along  $S_4$  axial plane crenulation cleavages.

### **Plutonism**

During the later stages of this deformation history a large granitic body (Anvil Batholith) was intruded into the metamorphic sequence. Anvil Batholith ranges in composition from a biotite-muscovite peraluminous granite to a metaluminous to peraluminous hornblende-biotite granodiorite (Pigage and Anderson, 1985). Textures include equigranular massive, megacrystic massive, and various strongly to weakly foliated variants. Foliation within the intrusive rocks is concordant with  $S_2$  surfaces in the surrounding metasediments. Several K-Ar ages on the granitic rocks yielded ages of 85-100 Ma (Tempelman-Kluit, 1972). Rb-Sr isochron ages of 99-100 Ma (Pigage and

Anderson, 1985) and unpublished zircon model ages (Mortenson, pers comm.) are concordant with the K-Ar ages and indicate rapid cooling after high-level emplacement.

Intrusion of the Anvil Batholith further deformed the metamorphic sequence so that the overall structure of the district is an elongate dome cored by the Batholith. In the later stages of emplacement large extensional fault displacement occurred along the margins of the Batholith (Pigage and Jilson, 1985). S-C mylonitic banding within these fault zones, and in the granitic footwall of some, is consistent with development of the faults during late D<sub>2</sub> deformation. These faults determine the present day limits of several of the deposits.

Anvil Batholith and surrounding metasedimentary rocks are crosscut by two general types of post-tectonic dykes. The majority of the dykes are northeast-trending, medium to dark green, porphyritic, unfoliated, hornblende-biotite quartz diorite. These quartz diorite dykes appear to be associated with late extensional faults. Unfoliated, pale tan, smoky quartz-feldspar porphyry also occurs as late crosscutting dykes. The dyke suites have not been extensively isotopically dated; their absolute ages are thus uncertain. One important date has been obtained on a unsheared quartz-feldspar porphyry intruding the Tie fault zone, one of the major extensional faults. This zircon age indicates that the dyke cooled at 100ma, essentially the same age as the Batholith. This leaves little doubt that the extensional faults are related to late stage high level emplacement and rapid cooling of the Batholith.

### **Metamorphism**

Metamorphism was concurrent with deformation and was most intense during the major D<sub>1</sub> and D<sub>2</sub> folding deformations. D<sub>1</sub> metamorphism has been largely overprinted by the later D<sub>2</sub> metamorphism. Metamorphic grades during these two events appear to be comparable since mica mineral assemblages between microlithons (i.e. S<sub>1</sub> foliations) are similar to those defining the S<sub>2</sub> foliation surfaces. The rest of the discussion will focus on the D<sub>2</sub> metamorphism.

Metamorphic grade ranges from upper amphibolite facies (sillimanite-muscovite zone) to lower greenschist facies (muscovite-chlorite zone) in a low pressure Buchan type facies series. In pelites adjacent to the intrusions the typical assemblage is andalusite-staurolite-garnet-biotite-muscovite-quartz-plagioclase with local fibrolite and cordierite. Lower greenschist facies pelites contain the assemblage muscovite-chlorite-quartz-plagioclase.

Metamorphic isograds are roughly concentric about the Anvil Batholith. Locally isograds are truncated and juxtaposed by the late D<sub>2</sub> extensional faults. The Faro deposit (closer to the Batholith) is metamorphosed to amphibolite facies. All other deposits are only weakly metamorphosed to lower greenschist facies. This difference in metamorphism is reflected in decreased grain size and increased degree of mineral

intergrowth in the less metamorphosed deposits (Tempelman-Kluit, 1970). This has a significant impact on metallurgical response of Anvil district ores.

### **Geophysical Characteristics of the Formations**

The phyllites and schists of the Anvil District have a density of approximately 2.6 to 2.7 gm/cc. They are soft and easily eroded but have few other distinctive characteristics other than a high background chargeability due to their micaceous nature. The carbonaceous layers are black and highly conductive along carbon smeared  $S_2$  folia. These rocks are the most conductive lithologies of the district. They form distinct layers which can be traced to help map the distribution of units in areas of poor exposure since the enclosing phyllites are non-conductive.

Greenstones and amphibolites are relatively dense (3.0 gm/cc), resistant, and commonly magnetic thus tend to form bedrock knobs which when buried by till create a positive residual gravity anomaly. Metabasites in the upper Vangorda formation are locally bounded by carbonaceous lithologies. This lithologic association can create coincident gravity, magnetic and electromagnetic anomalies which are of no economic interest. In general, greenstones create difficult interference for gravity surveys.

Calc-silicates are also a dense rock type, approximating the density of greenstones, however the calc-silicates are more widespread and flaggy, thus less likely to form bedrock ridges. Where calc-silicates do form such ridges the high contrast between the rock and till densities can create a misleading positive residual gravity anomaly.

The Menzie Creek formation on the southwest side of Anvil Batholith is interlayered with carbonaceous phyllites. The Menzie Creek formation and overlying units thus have a very "active" EM signature on airborne and Turam EM surveys and make it easy to delineate the top of the Vangorda formation.

Granitic rocks are homogenous and restive, they create very flat EM response and have very low magnetic relief.

### **Geophysical Characteristics of the Ores**

The sulphides have a number of physical characteristics which are important for geophysical exploration. The massive sulphides have densities in the range of 4.0 to 4.5 grams/cc thus form excellent density contrasts and against all rock types and strong positive gravity anomalies. Because of this density contrast gravity surveys have been an important and definitive exploration tool in the district. As the search depth increases however gravity surveys rapidly become ineffective because of the numerous corrections and spurious influences they are prone to. Disseminated sulphide bearing quartzites can be high grade but have densities only slightly greater than greenstones or calc-silicates (3.0 gm/cc), a further complicating factor.

The massive sulphides are conductive but are actually less conductive than associated carbonaceous phyllites or graphitic quartzites and will not necessarily stand out compared to the carbonaceous rocks.

Several sulphide lithologies are pyrrhotitic and/or magnetite bearing and are strongly to weakly magnetic. Of particular interest is the low grade copper-gold footwall sequence at Vangorda which is rich in pyrrhotite with lesser magnetite. There is a less well developed footwall sequence at Swim. Similar magnetite ± pyrrhotite lithologies occur throughout the upper (Champ) horizon at Grum as well as in the footwall of one of the lower structural panels. At Faro, barren massive pyrite is commonly magnetite bearing and slightly magnetic. In all the greenschist facies deposits the baritic ores are slightly magnetic due to fine, disseminated magnetite. Adjacent to dykes the pyritic sulphides may be altered to pyrrhotitic assemblages or, in extreme cases, to massive pyrrhotite or even massive magnetite. This alteration is particularly pronounced adjacent to the large dyke at the northwest end of the Faro Pit and to a lesser extent along the dyke separating Zone I and Zone II (near section 118).

### **Surficial Geology**

All but the highest peaks in the area were ice covered in the latest glaciation. Ice flow and transport direction was from east-northeast to west-southwest as evidenced by glacial striae and elongate land forms as well as transport of distinctive rock types such as the serpentinized pyroxenites in the upper Dixon Creek area.

Discontinuous deposits of glacial till and glacio-fluvial deposits are common in the area, however with local exceptions the deposits are not thick. Important exceptions are a valley filled with up to 100m of overburden over the subcrop of the Grum deposit (figure 7) and a ridge of highly compacted till up to 40m thick overlying the Vangorda deposit. Thick fluvial deposits also occur in the Rose Creek, the west fork of Vangorda Creek and in the Blind Creek valleys. In Swim Basin there is a widespread, thick, blanket of glacial deposits which significantly inhibits exploration.

Glaciers stripped of most of the weathered mantle, thus most geochemical anomalies are transported either hydromorphically or physically by downhill movements or ice transport.

### **Exploration History and Exploration Techniques**

Exploration in the Anvil District has passed through several phases since the early 1950's when the first discovery was made at Vangorda Creek (Simpson and Jennings, 1984). Each phase of exploration has detected deposits at greater depths of burial.

Conventional prospecting and local but highly effective use of geophysics and geochemistry (Chisholm, 1957) led to the discovery of the Vangorda as well as the shallow or outcropping Firth and Champ occurrences at either end of the Grum structure. In the mid-sixties

these methods were replaced with more widespread saturation airborne geophysical (magnetic and later EM) and less widely used geochemical methods (Aho, 1966; Brock, 1973). These rapid regional surveys were followed up by ground geophysics and rotary or diamond drilling. The second phase located two covered but near surface deposits with relatively strong but not always unambiguous geophysical and geochemical signatures: Swim in 1963 and Faro in 1964.

Followup of the second phase continued until the early seventies producing a patchwork of disconnected surveys, many of them conducted in haste and with poor control during the hectic years following the Anvil staking rush.

In the early seventies, a third phase started when a commitment was made by Cyprus Anvil (then Anvil Mining Corporation) and its parent corporations (Cyprus Mines Corporation and Dynasty Explorations) to initiate district-wide geologic mapping and more systematic ground surveys. A major rotary drilling program, designed to sample overburden, was also carried out in 1971.

Over the years a district wide Turam EM survey coverage was built up. By this time EM took on a more exclusively passive role than in the past, being intended not just to search directly for ore but also to help trace units indicative of ore potential and to aid geologic mapping in areas of poor exposure. Many conductors were screened by gravity surveys and anomalous situations drill tested with generally unencouraging results. By the mid-seventies geological, electromagnetic and drilling information were combined to produce a geological map of the district with common scaled compilations of other exploration information.

This compilation and ongoing regional geologic mapping allowed the establishment of a tentative district stratigraphy which, in turn, led to a structural model for the main part of the belt.

The continuing negative results of anomaly testing and dwindling inventory of attractive targets began to indicate that the near surface, open pitable, potential of the district was becoming limited on C.A.M.C.'s ground. As target depths increased, gravity rapidly became an ineffective screen due to interference by bedrock relief, poor terrain corrections and instruments subject to high drift. Attention turned toward subtle anomalies supported by geology and to blind drilling beyond the limits of geophysical penetration following predictions based on geology.

A similar re-examination of Kerr Addison's land by A.E.X. Minerals led to the re-evaluation of gravity work following geological projections of favourable structure. The Grum discovery resulted in 1973.

The Dy discovery was the result of drill testing the structural and stratigraphic model noted above. The Dy drilling was the beginning of a program of deep drilling laid out with spacing sufficient to make detection of various size targets and various depths likely (basically a Swim sized target to 330m (1,000 ft) and a Faro sized target at greater depths). The discovery

hole was specifically drilled to test the favourable trend where the geologic model predicted favourable stratigraphy at 600m depth. This can be regarded as the fourth phase of exploration.

The deep drilling program was essentially suspended by the massive drilling requirements at Dy but resumed between 1979 and 1981 when several deep holes were put down particularly to test the down dip extensions of the Faro, Vangorda and Swim deposits with scattered holes elsewhere. Unfortunately since the stratigraphic model was incompletely developed at that time, some of these holes were not deep enough. The stratigraphic sequence, as now understood, provides a good "shut down unit", the marble and mixed schist - calc-silicate sequence about 500 to 700m below the top of the Mt. Mye formation. Future drill holes should attempt to reach this unit if at all possible.

### **Exploration Model**

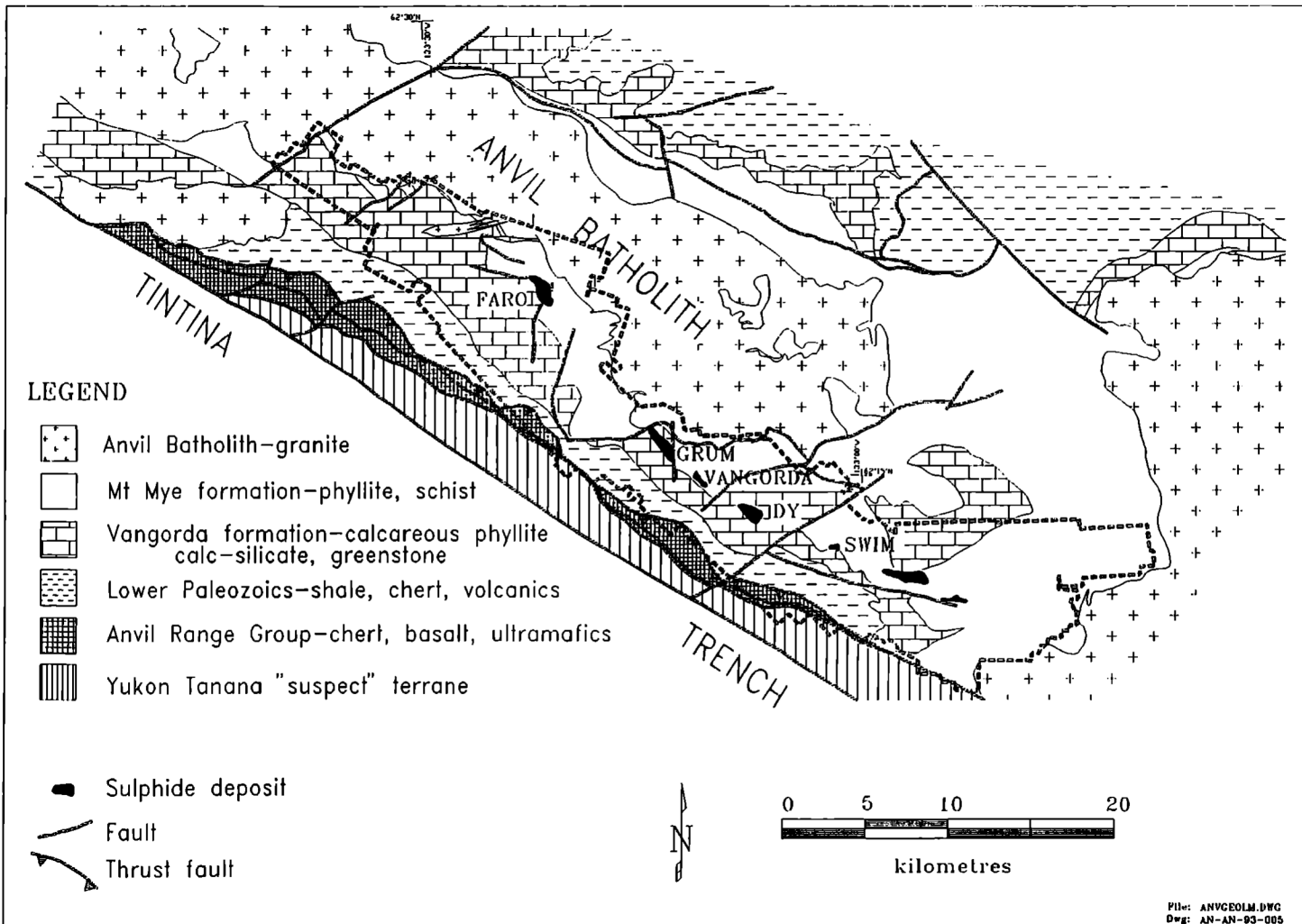
The essence of the exploration model developed over the years is that the Anvil District deposits are stratiform, massive and quartzose disseminated sulphide lenses occurring at several horizons through approximately 150m to 200m thick stratigraphic interval including the upper Mt. Mye and lower Vangorda formations. The individual ore horizons are highly zoned amoeboid bodies which are locally the lateral equivalent to widespread though discontinuous carbonaceous phyllite units. Deposits may consist of one horizon or a stack of three or more superimposed horizons. Deposit shapes are heavily influenced by the complex folding and faulting that affects all rocks of the district. The known deposits fall along a well defined curvilinear trend which appears to be related to facies and/or thickness changes involving carbonaceous lithologies. This trend heavily biases exploration thinking because of the simple empirical observation that success has occurred "on trend" but not yet "off trend" despite considerable effort. Areas on trend are thus considered to have significantly higher potential for ore discovery. It must be constantly realized that the off trend favourable stratigraphic horizon is only exposed at two places in the district and is fully tested by only a few drill holes thus there is considerable scope for new discoveries which could lead to revision of this restrictive exploration model.

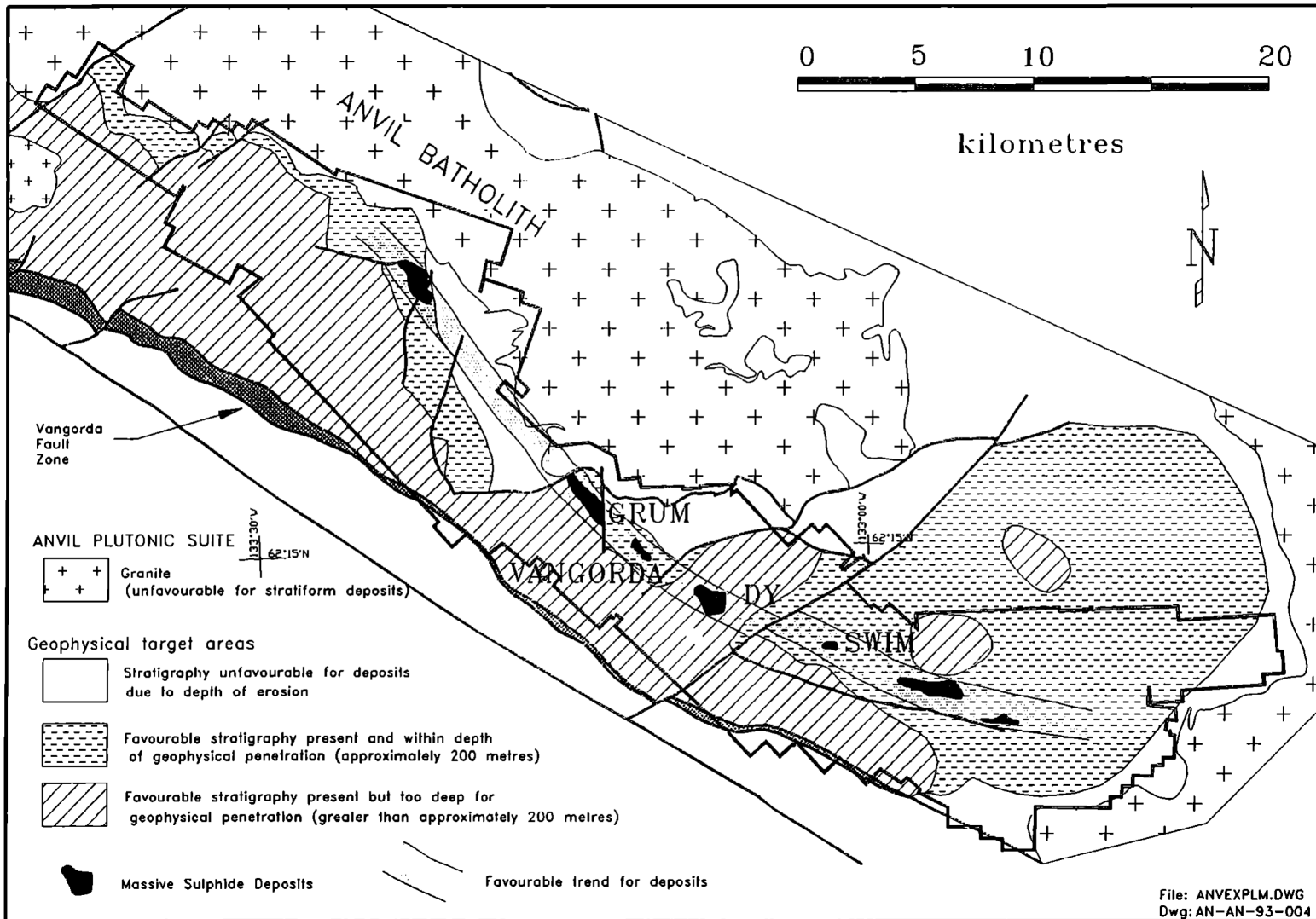
## REFERENCES

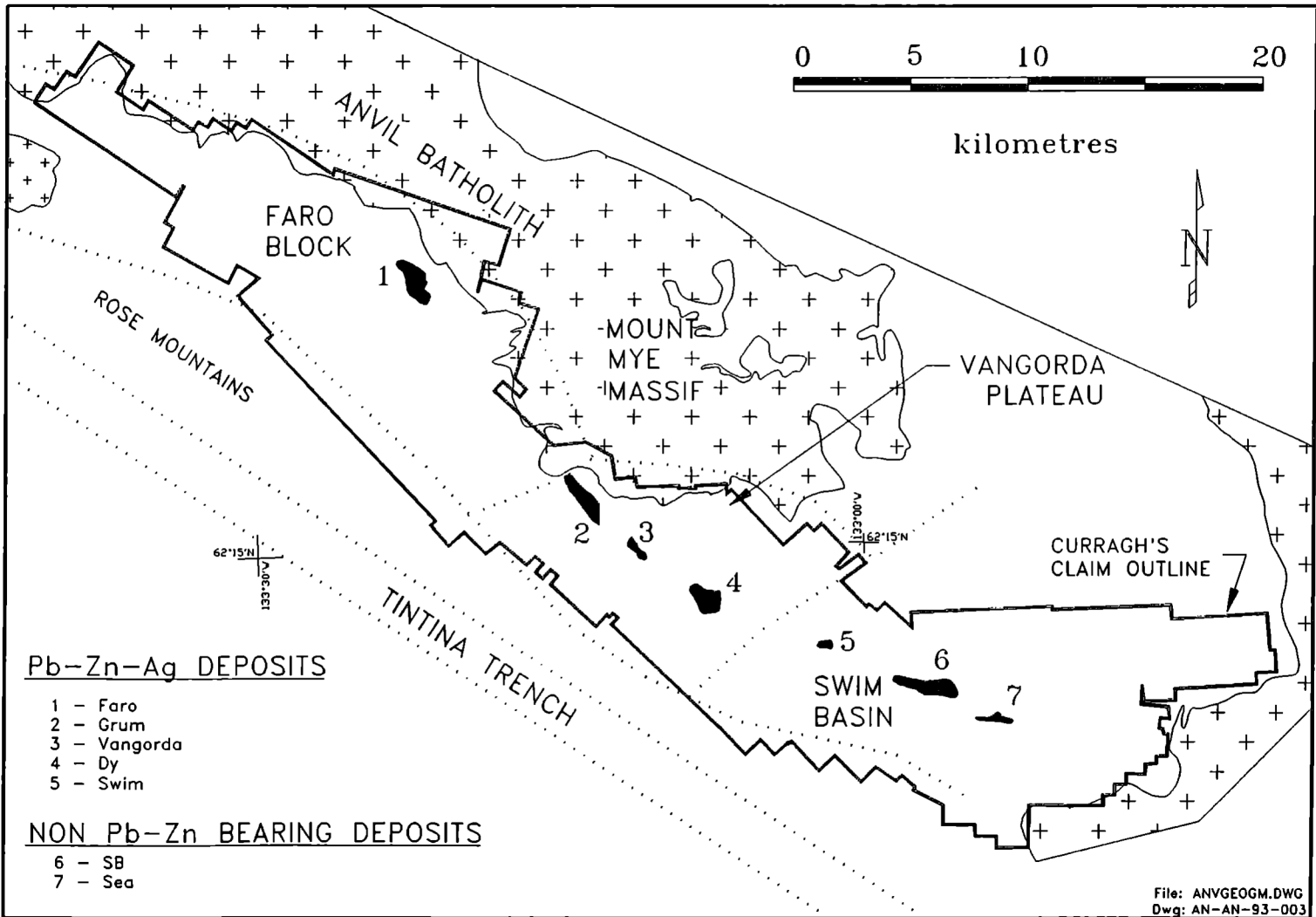
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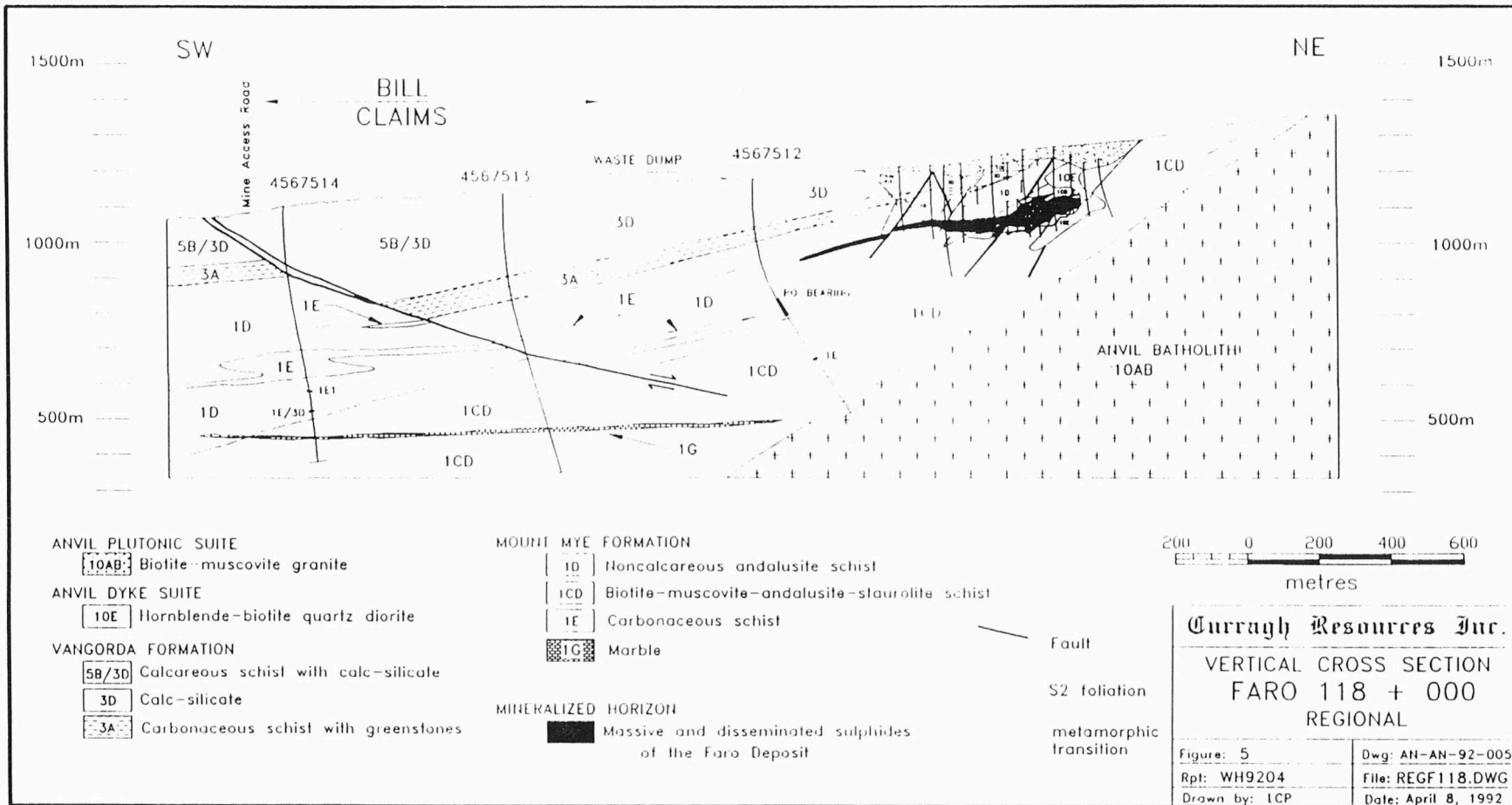


Figure 5: Cross section along Faro Grid section 118 through the centre of the Faro ore deposit. Rock units and ore deposit are transposed into the shallowly southwest dipping  $S_2$  foliation. The carbonaceous unit (1E) in hole 4567514 is the same unit exposed in the BILL claims borrow pit.

**Diluted Ore Reserves**  
**Faro Division - Company Estimates**

	Short Tons (3,4)			Average Grade				
	Dec. 31 1990	Mined Adjust- ments (in thousands)	Dec. 31 1991	Zinc (Percentage)	Lead	Silver (ounces per ton)	Gold	
<b>Proven Reserves:(1) (2)</b>								
Faro open pit and underground . . .	4,838	(1,796)	(1,839)	1,203	4.53	2.47	0.55	0.003
Stockpiles . . . . .	3,393	(318)	(107)	2,968	2.91	1.92	0.44	0.003
Vangorda open pit . . .	6,935	(1,767)	(534)	4,634	4.20	3.34	1.23	0.020
Grum open pit . . . . .	27,735	-	-	27,735	5.01	2.96	1.46	0.024
<b>Probable Reserves: (1) (2)</b>								
Faro underground . . .	697	(668)	248	277	6.95	4.67	1.81	0.004
Dy underground . . . . .	<u>12,456</u>	<u>-</u>	<u>-</u>	<u>12,456</u>	6.84	5.82	2.42	0.027
	<u>56,054</u>	<u>(4,549)</u>	<u>(2,232)</u>	<u>49,273</u>				

- (1) The combined cut-off grade of zinc plus lead is 4% for open pit and stockpile reserves and 9% for underground reserves. Combined grade means the combined amount of zinc and lead metals in the ore. Thus, ore with the same combined grade may contain various combinations of zinc and lead grades.
- (2) In 1991, the average mill recovery was 76.74% for zinc, 76.35% for lead and 48.05% for silver. The percentages and amounts set forth in the table do not reflect these mill recovery rates.
- (3) Adjustments to reserves reflect updated interpretations based on additional drilling information, revised estimation techniques and modified mine designs required to improve operational conditions.
- (4) 1 Short Ton equals 0.90718 tonne.