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MEMO

TO: Dave Tenney, Chief Geologist
Anvil Range Mining Corporation

FROM: Lee Pigage

DATE: May 24, 1995

SUBJECT: ORE CONTROL to SPREADSHEET for GRUM - NOTES

INTRODUCTION

ORE CONTROL prints two reports in a spreadsheet compatible format, a DIG PACKET report and a MATERIAL MINED report. Neither report coincides with the requirements of Anvil Range Mining Corp. for reporting material blasted, material mined, and reconciliations. During the interval May 20-24, 1995 I have set up a spreadsheet which utilizes the ORE CONTROL reports to prepare summary reports more consistent with ARMC requirements.

The spreadsheet file is currently stored on D:\TEMP as GRUMORE.WK3. The file was created in LOTUS 123 v4 for DOS. It consists of several different spreadsheets contained within the same spreadsheet file. The spreadsheet file is not in finished form. Ranges are not protected, menus and macros have not been written, printing formats (lines, shading, etc.) have not been incorporated. The formulas and output have been initially checked and seem to be internally consistent.

This spreadsheet file can be copied to create similar spreadsheet files for Grum waste, Vangorda ore, and Vangorda waste.

OVERVIEW

The spreadsheet file currently contains 9 worksheets. The worksheets have been

designed so that each sheet is a separate database or calculation-reporting sheet. The worksheets are:

- A MA_CR_CO - worksheet for macros, criteria for data selection, constants and lookup tables for calculations,
- B BLASTED_DATA - worksheet database for dig packet report from ORE CONTROL,
- C MINED_DATA - worksheet database for mined packet report from ORE CONTROL,
- D TRUCK_DATA - worksheet database for truck counts from Engineering,
- E ORE_BLASTED - calculation/reporting spreadsheet for ore blasted in pit,
- F ORE_MINED - calculation/reporting spreadsheet for ore mined in pit,
- G ORE_REMAINING - calculation/reporting spreadsheet for remaining broken ore in pit,
- H STOCKPILES - calculation/reporting spreadsheet for stockpiles,
- I RECONCILIATION - calculation/reporting spreadsheet comparing blasthole ore mined to G91 10 diluted PC-MINE model.

DATABASE WORKSHEETS (B-D)

Databases ORE_BLASTED and ORE_MINED have been designed to receive the ASCII file spreadsheet compatible reports from ORE CONTROL without modification of the ASCII files. The ASCII files are to be imported immediately beneath the last record of the database range. Do NOT overwrite earlier database records.

After importing, the new lines need to be further modified in the spreadsheet. Formulas for CONTAINED PB and CONTAINED ZN need to be copied from the earlier records. DATE, BENCH, and DESTINATION fields need to be entered where appropriate.

The database ranges must be updated to include the new records. A macro \U has been written to complete this updating. This macro is not guaranteed to select the proper range name because the order of range names changes with the addition of new range names.

Database TRUCK_DATA contains fields which can be filled from the daily shift reports

or the Engineering summary. This database is not considered finalized and should be adjusted to reflect the arrangement of the fields in the report from which the data will be taken.

CALCULATION/REPORTING WORKSHEETS (E-G,I)

These worksheets have been designed to calculate summary numbers for currently active blasts. The report consists of 10 rows (lines) and a summary-total row. To report on the basis of blast, the DATE and BLAST fields need to be entered into the selection criteria. Each row corresponds to a separate criteria selection set in spreadsheet MA_CR-CO (A). The criteria selection sets are labelled as BL_CR_1 through BL_CR_10. Selection criteria permitted within each selection set are DATE, BLAST, BENCH, LITH, and DESTINATION.

The DATE selection criterion has presently been set for a cumulative total for all mining up to and including the date selected. The DATE number must be individually entered into each criteria selection set; I was unable to get it to work by reading a single date formatted cell.

All grades and tonnages reported in Sheets E-G are undiluted with no mining recovery factor. The grades and tonnages reported in Sheet I contain dilution and mining recovery factors for the blasthole production summary. Information for all these reports is retrieved and summarized from the spreadsheet databases ORE_BLADED and ORE_MINED.

G9110 bench summaries in Sheet RECONCILIATION (I) are stored in a VLOOKUP table contained in Worksheet MA_CR_CO (A).

STOCKPILE REPORTING WORKSHEET (H)

The design of this worksheet is slightly different (i.e. simpler) than the other reporting/calculation worksheet. It is designed as an incremental report rather than a cumulative report. The report presently contains 3 stockpiles (Grum Low Grade, Grum High Grade, and Crusher). The design and accuracy of this worksheet has not been adequately tested. Numbers generated from this worksheet should be closely verified and formulas edited appropriately. The Crusher stockpile report design is incomplete at present because it doesn't fully allow for transfer of ore from the other stockpiles.

Additional stockpiles may be added to the report by copying the appropriate rows from a single stockpile set or rows and setting up additional stockpile selection criteria areas in Sheet MA_CR_CO (A).

Summary and REMOVED Pb + Zn, Pb, and Zn grades for each stockpile are calculated as average grades from the START and ADDED rows for each stockpile. Engineering and Geology should modify the worksheet after deciding if grades and volumes should be reported.

The selection criteria for the stockpile reports are contained in Sheet MA_CR_CO as SP_CR_1 through SP_CR_6. Each stockpile corresponds to two selection criteria areas. Ore added to the stockpile uses SP_CR_X and ore removed from the stockpile uses SP_CR_X + 1.

The START row for each stockpile is entered manually from the previous incremental report. For start of mining this would be 0 for all values for a new stockpile. The ORE ADDED row for each stockpile is calculated by summing and averaging the records from worksheet database MINED_DATA. The criteria should be set for an incremental DATE and the appropriate DESTINATION (i.e. the intended stockpile). Volumes from the database spreadsheet are adjusted using a swell factor constant from worksheet MA_CR_CO. The ORE REMOVED row for each stockpile is calculated by summing and averaging the records from worksheet database TRUCK_DATA. Tonnes removed are calculated from truck counts using truck factors contained in a HLOOKUP table in worksheet MA-CR-CO (A). Selection criteria for this row should be set for an incremental DATE and the appropriate SOURCE.

MAY 19/95

①

3 DB tables

- ① "BLASTS"
- ② BLAST HOLES
- ③ SAMPLES -

~~TABLES ARE IN~~

DATA PROCESSED

MENU

"0" ↙
↘

F ↙

GR - GREEN BLAST HOLES. ←

EXEC - 010 LEVEL 1

F2 SYSTEM DEFINITIONS

EXEC - 011 L1 -

~~insert~~ L BUTTON = ↙ Y,
 R BUTTON = F10 W ESC. (W N?)

IF "Y", DOES NOT WORK USE "N"

F1. Geometric definitions - ~~defines benches, grids, gridlines~~
 defines: grids (for gridding blasthole data)
 drill benches - organic logs
 mining benches. - important hole info
 (note the equal).

DIGGING - database operations per drillholes.
MINING -

DIGITIZING

D: GEMDIG - digitizing prog.
→ ADETT file

DIGITIZ PROFILE F6

IMPORT PROFILE AT TOP GEMDIG PROFILE!

125PBND4 DIG.

ALPH CHARACTERS IN ADETT FILE - START AT COLUMN # OF
FIRST CHARACTER.

records not conforming to field types are rejected.

after import bundle.

ADETT - 112 L1 → Prepare Blankets Sample Records.

CREATE SINGLE RECORDS ✗ attaches blank to samples
(do not import array data - merge!)

DO NOT / DO NOT USE

"UNCONDITIONALLY CREATE"

always use "blank holes that has no sample"

QDF CENTRE SAMPLE CREATION PROGRAM

sample creation methods: use naming ~~be~~ be
sample reference position: middle.

sample
suffix code Alpha (A...Z).
Supers intervals starts the 1.00 (in)

Y "NO SUFFIX" ~~to track~~ sample name becomes blank name!

D:\WP51\570P

G:\123 FILES

K2

Intrusive Rocks

Unit 10	928	10-A	Granodiorite (kspars>plag, quartz>10%)
	929	B	Adamellite (qtz monzonite)
	939	C	Pegmatite
	956	D	Quartz diorite (kspars<plag, qtz>10%)
	934	E	Diorite (kspars<plag, qtz>10%)
	925	F	Monzonite (kspars>plag, qtz>10%)
	932	G	Pyroxenite
	937	H	Granite (kspars>plag, qtz>10%)
	930	I	Syenite (kspars>plag, qtz>10%)
	938	Q	Bull qtz veins/pods

- 1 Foliated/lineated
- 2 Porphyritic
- 3 Aphanitic
- 4 Smokey qtz-bearing
- 5 Muscovite-bearing
- 6 Kspar-bearing
- 7 Biotite-bearing
- 8 Amphibole-bearing
- 9 Altered (kaolinite, montmorillonite)
- 0 Normal (equigranular)

Yangorda Formation

Unit 5	936	5-A	Variably calcareous, graphitic phyllite (hosts Unit 4; 1E, hosts Unit 2)
	920	B	Calcareous muscovite-chlorite:biotite phyllite (greenschist equivalent of 3D)
	908	C	Metabasite
	910	D	Chloritic phyllite
	904	E	Phyllitic marble and silicated marble
	910	F	Laminarily banded, variably calcareous, chloritic phyllite (associated with 5C)
	949	G	Variably calcareous, graphitic phyllite.

- 1 Siliceous
- 2 Carbonaceous
- 3 Calcareous
- 4 Altered, pyritic (white mica envelope)
- 5 Banded/laminated
- 6 Non-calcareous
- 7 Chlorite laminations
- 8 Chloritic
- 9 Sulfide-bearing
- 0 Normal
- * Carbonate-bearing

Faro, Grum, Yangorda, DY Deposits

Unit 2/A	922	2/A-A	Sulfide-bearing, ribbon-banded, graphitic quartzite
	915	B	Pyrite-free quartzite (may contain base metal sulfides)
	916	C	Base metal-poor, pyritic quartzite
	942	D	Base metal-bearing, pyritic quartzite
	918	E	Massive pyritic sulfides
	923	F	Buckshot facies, massive sulfides
	928	G	Baritic facies, massive sulfides/sulfates (>10% BaSO ₄)
	924	H	Pyrrhotitic facies, massive sulfides
	949	J	Non-pyritic, massive sulfides/oxides
	921	K	Carbonate-bearing, massive pyritic sulfides
	914	L	

- 1 Siliceous
- 2 Coarse, porphyroblastic pyrite-bearing
- 3 Fine pyrite/marcasite-bearing
- 4 Sphalerite and/or galena-bearing
- 5 Carbonaceous
- 6 Barite-bearing
- 7 Pyrrhotite-bearing
- 8 Magnetite-bearing
- 9 Chalcopyrite-bearing
- 0 Normal
- * Carbonate-bearing

2/4L Muscovite-qtz-chl-bio-phyllite (generally sulfide-bearing)

- 1 Siliceous
- 2 Pyrite-bearing
- 3 Calc/kaolinite-bearing
- 4 ZnS and/or PbS-bearing
- 5 Carbonate-bearing
- 6 Chl-bio>qtz-musc phyllite
- 7 Pyrrhotite-bearing
- 8 Magnetite-bearing
- 9 Chalcopyrite-bearing
- 0 Normal

Mt. Mye Formation

Unit 3	916	3-I	Graphitic quartzite in non-calcareous phyllite/schist
	913	H	Tuffaceous calc-silicate phyllite/schist (assoc. with 3D; identical to 5F)
	941	G	Non-calcareous muscovite-chlorite:biotite phyllite/schist (± 1C, 1D)
	906	F	Marble and silicated marble (± 1G)
	963	E	Graphitic phyllite/schist (± 5A)
	913	D	Calc-silicate phyllite/schist (u. greenschist to amphibolite facies equiv. of 5B)
	908	C	Metabasite
	946	B	Chloritic phyllite/schist (c.f. 5D)
	912	3-A	Transition zone with unit 1 (interbanded chloritic phyllite, graphitic phyllite and pelites of Yangorda and Mt. Mye Fms.)

- 1 Siliceous
- 2 Non-calcareous
- 3 Calcareous
- 4 Altered, pyritic (wme)*
- 5 Banded/laminated
- 6 Sulfide-bearing
- 7 Chlorite laminations
- 8 Chloritic
- 9 Carbonaceous
- 0 Normal

Unit 1	902	1-B	Tactite and silicated marble (± 3F)
	943	C	Quartzo-feldspathic, biotite-muscovite gneiss/schist (± 3G)
	947	D	Carbonaceous biotite-muscovite-andalusite schist (± 3G)
	967	E	Graphitic schist (± 5A)
	908	F	Metabasite (± 3C)
	901	G	Marble and silicated marble (± 3F)
	910	1-H	Chloritic schist (c.f. 5D)

- 1 Siliceous
- 2 Carbonaceous
- 3 Calcareous
- 4 Altered, pyritic (wme)*
- 5 Banded
- 6 Clotted
- 7 Staurolitic
- 8 Chloritic
- 9 Sulfide-bearing
- 0 Normal

*greenschist facies
Vaucluse
Grum*

*FARO
Faro
amphibolite
facies*

* (wme) White mica envelope

Notes from Greg Gillson

**DESCRIPTIVE NOTES FOR MAJOR ROCK TYPES AT DY
SULPHIDE WASTE AND ORE TYPES**

NEW | OLD
2 | 4A

RIBBON-BANDED, CARBONACEOUS QUARTZITE

Dark grey finely banded quartzite with alternating interbands of light grey to white quartz sulphides. Banding on a scale of 2 mm - 2 cm. sulphide pyrite + sphalerite (reddish) +/- galena.

Hard - nail or knife leaves metal on surface.

S2 surfaces are dark grey to black and typically mark the fingers.

Typically has a well developed microlithon texture but, not easily visible as banding parallels metamorphic foliation planes in most examples, especially from Faro.

If pyrite content > 30%, then call it pyritic 20.

2A/4A is metallurgically special since the carbon causes itself and other substances to float early with the lead giving a low grade lead concentrate. The softer more fissile and more carbon rich versions are particularly susceptible to this. The harder, higher grade, more sulphide rich versions with less fissility and more silica are not as prone to the early flotation problem.

3 | 4BCD

SLIGHTLY PYRITIC QUARTZITE

Pale grey to creamy white, generally noncalcareous quartzite.

Contains thin ribbons and bands of sulphides - pyrite, sphalerite, galena but, is generally not as well layered as unit 20. Layers tend to be thicker, more irregular, and disrupted.

Commonly contains accessory chalcopryrite along fractures.

Hard - nail or knife leaves metal on surface.

Typically sulphide bands show microlithon texture.

S2 surfaces are pale grey with discontinuous streaks of muscovite. Typically leaves no mark on fingers.

Full gradation exists between 20 and 30. If S2 surfaces are medium grey - i.e. slightly to moderately carbonaceous, the rock should be called carbonaceous 30 (and NOT 20!)

If pyrite content > 30%, then call it pyritic 30 or 40.

4EC SILICEOUS PYRITIC SULPHIDES - SEMI-MASSIVE SULPHIDES

Intermediate rock type which is typically logged either as pyritic 30 or siliceous 50. In the past, we have needed to discourage use as a logging term and restrict its use to sections.

Brassy yellow, fine grained, noncalcareous, moderately hard pyrite.

Typically low grade.

Locally, finely laminated with thin streaks and bands of fine grained magnetite.

Contains diffuse bands and lenses of grey to white quartz. Quartz also disseminated in matrix. Pyrite constitutes 30-60% of unit. Banding is on a scale of 1 cm to 10 cm.

Locally may contain small clasts of dolomite.

4E PYRITIC MASSIVE SULPHIDES

Brownish yellow, fine grained, moderately hard, pyrite with lead zinc sulphides. Pyrite constitutes 60-100%.

Diffuse banding parallel S2 council by variations in sphalerite-galena content.

Contains clasts and lenses of carbonate (calcite, dolomite) and quartz.

Typically high grade.

Typically interbanded with 60 on a scale of centimetres to metres.

For up to 10% barite rock should be called baritic 50.

If containing carbonate as disseminated minerals, then call carbonate mineral beary 50 as opposed to 55 (4K).

4K CARBONATE BEARING PYRITIC MASSIVE SULPHIDES

Similar to rock type 50 except it contains large ameboid blebs of flesh-coloured dolomite/ankerite.

It should not be used for massive sulphides with disseminated matrix carbonate.

4G BARITIE, BEARING MASSIVE PYRITIC SULPHIDES.

Pyritic massive sulphides with > 10% barite visually.

Brownish to purplish, banded to laminated pyritic sulphides with barite.

Soft.

"Burns black" on cut surface as pyrite streak shows on soft barite.

Typically high grade - sphalerite is honey coloured and can be overlooked.

Typically magnetite-bearing.

Typically interbanded with rock type 50 on scale of centimetres to meters.

Typically noncalcareous, although, locally it may contain disseminated carbonate and/or carbonate clasts-lens.

4H PYRRHOTITIC MASSIVE SULPHIDES

Fine-grained, reddish bronze pyrrhotitic massive sulphides.

Magnetic because of pyrrhotite.

Moderately hard.

Generally moderate to high grade.

Strongly laminated deformation texture. Shows ductile flow textures around clasts of carbonate, white quartz, phyllite, metabasite.

Not a common rock on Vangorda Plateau - occurs mainly at margins of sulphide intersections.

May indicate fault zone in sulphides - i.e. high strain zone.

ALTERED PHYLLITES - RELATED TO ORE BODY**4L WHITE MICA ENVELOPE - ALTERED PHYLLITE**

Moderately soft, pale grey to off-white muscovite-quartz +- chlorite phyllite. More grey than green.

Generally sulphide-bearing with discontinuous streaks of

pyrite or pyrrhotite +- sphalerite +- galena.

Locally may be siliceous = hard, that should be noted in modifiers.

Typically pervasively foliated - not microlithoned.

S2 surfaces are silvery white from fine muscovite.

Typically noncalcareous.

Represents highly altered metapelite.

4L6

SLIGHTLY ALTERED MUSCOVITE - CHLORITE phyllite.

Moderately soft, pale creamy green, muscovite-chlorite phyllite. More green than grey.

May be sulphide-bearing with discontinuous pyrite or pyrrhotite streaks.

Typically pervasively foliated - not microlithoned.

Typically noncalcareous.

Represents more slightly altered metapelite.

"Stringered" variant has discontinuous dark green chlorite-pyrrhotite stringers.

"Spotted" variant has discrete scattered grains of brownish carbonate up to 2 mm across.

HOST ROCK TYPES

3G OR 5B6 NONCALCAREOUS MUSCOVITE - CHLORITE PHYLLITE.

Moderately soft, noncalcareous, medium grey phyllite.

Well developed, pervasive S2 foliation. S2 surfaces silvery grey to steely grey. No readily visible individual micas.

Homogeneous to poorly laminated or banded. Laminac defined by shades of grey variations - not by siltstones.

CARBONACEOUS PHYLLITE/SCHIST

Dark grey to black, moderately soft, carbonaceous phyllite/schist.

S2 surfaces are dark steely grey to black and typically

mark the fingers.

Locally, will contain thin pale grey quartz +- calcite +- dolomite siltstone laminae/bands.

Locally will contain interbands of dark grey to black marble with thin white beaded calcite laminae.

Should not be used for only moderately carbonaceous phyllite/schist. S2 surfaces should be dark and mark fingers.

Siltstone bands should be noted.

Carbonates (if present) should be noted.

For S2 surfaces, dark grey to dark study grey, log as carbonaceous 100 and NOT 130.

5C

METABASITE/GREENSTONE

Poorly foliated, dark green, noncalcareous to slightly calcareous, chlorotic metabasite.

Typically relict igneous texture with grey to white altered plagioclase.

Moderately hard to hard.

Altered variants are typically strongly foliated with anastomosing chlorite streaks in a grey to tan-grey carbonate matrix. May contain streaks or bands of bright green "fuchsite". This variant has been called zebra rock.

ALSO INCLUDES PYROXENITE:

Poorly foliated, dark green, noncalcareous to slightly calcareous, chloritic metabasite.

Typically serpentized and therefore slightly magnetic.

Relict igneous textures show pyroxene "bastites".

5D

CHLORITIC PHYLLITE

Foliated, pale olive green, moderately soft, moderately calcareous, chloritic phyllite.

Locally diffusely banded with speckled off-white calcite +- quartz bands.

Typically has thin white quartz-calcite veins parallel S2.

S2 surfaces are silvery pale green and have a slightly gritty texture.

Pervasive S2 foliation.

Marginal contacts with metasediments are sharp.

Altered variants are pale tan with streaks of muscovite on S2 surfaces. Carbonate is typically dolomite/ankerite. Commonly contains specks of bright green "fuchsite".

5B0 CALCAREOUS PHYLLITE

Silvery grey to pale grey, moderately soft, muscovite-chlorite phyllite.

Contains thin pale grey to off-white quartz-carbonate (calcite or dolomite) siltstone laminae to bands. Siltstones give core an overall calcareous aspect. Siltstones are 1-5 centimetres thick.

S2 surfaces are silvery grey. Darker S2 surfaces should be logged as carbonaceous ^{20y}200 and NOT ³⁰130.

Typically S2 foliation defined by crenulation cleavage--microlithons.

Typically contains scattered, isolated pyrite/pyrrhotite porphyroblasts.

10Q BULL QUARTZ VEIN

Coarse grained, milky white, vein quartz. May be sulphide-bearing.

10E HORNBLLENDE-BIOTITE QUARTZ DIORITE.

Medium grained, equigranular, unfoliated, medium grey, hornblende-biotite quartz diorite.

Marginal phase is fine-grained, brown, aphonitic matrix with scattered biotite and hornblende phenocrysts.

REVISED ROCK CODES

The attached core logging guide is the result of extensive consultations between geologists at the mine and at the Whitehorse Office. It is designed around a simpler concept of stratigraphy and lithology than previously, and the dual lithostatigraphic/computer code systems have been replaced by a single rock coding system. Alphabetic mineral descriptors have replaced the old numeric ones, and they are used in a consistent fashion without direct reference to either the lithology or the stratigraphy.

It has been possible to simplify the previous lithostratigraphic coding system because a more perfect understanding of the geological structure of the Faro area has been developed over recent years, and the relationships between rock types better defined. The new rock descriptions are specifically designed by Lee Pigage to adequately distinguish the known stratigraphic subdivisions of the area, and drill core lithology must be described in terms of one of his specified rock types. Some care must be taken in doing this, and Lee's notes on rock types, and the stratigraphic columns which are included later in this manual will help. It is particularly important to note whether or not phyllites and schists are calcareous, as this is one of the prime ways of distinguishing schists and phyllites of the Vangorda Formation (calcareous) and those of the Mt. Mye Formation (non calcareous).

Dave Tenney

July 30/90

CORE LOGGING DATABASES

Gemcom's PC-XPLOR Databases comprise tables which are divided into rows (ranges) and columns (fields). Each table contains specific information about the drill hole. Curragh's diamond drill hole data base contains the following tables:

Table 1 - Header:

Hole # , collar survey, hole length and miscellaneous information (core size, date logged etc).

Table 2 - Surveys. (all dip tests)

Depth, dip azimuth

Table 3 - Lithology:

Depth down hole ("from" and "to"; rock codes, description

Table 4 - Assays:

Depth down hole ("from" and "to"); interval length; core recovery; sample number; rock type; rock code; s.g. assays.

Table 5 - Structures:

Complete definition, in terms of down hole distance(s) core angle(s) of structural elements in drill core. The quantity of data recorded will depend on the purpose for which the hole was drilled.

Table 7 - Geotech:

All geotechnical information including core recovery, R.Q.D., weathering, and comments. Joint number and joint frequency may also be recorded where extra detail is required, as should point load tests if they are done.

Table 8 - Samples:

This table is for samples taken for research purposes, and is not frequently used during routine core logging.

The above tables should be used for all deposits on Curragh's Faro property. A complete example of a drill hole database, actually the one for Vangorda, is attached (Appendix "A"). Note that "fields" in individual tables should be in the same relative position for all deposit databases.

*** WANGORDA - Drill Hole Database ***

 PRINTOUT OF DATABASE STRUCTURE INFORMATION

Database Filename : F:\WANGORDA\WANGORDA.E5A

Table Number : 1
 Table Name : HEADER
 Number of Fields : 12

Field name	Code	Mark	Type	Minimum	Maximum	Default
HOLE-ID	1:1	Optional	String		8	
LOCATION	1:2	Optional	Local			
(X-COORD)	1:2:1		Real	-1.0	20000.0	-1.0
(Y-COORD)	1:2:2		Real	-1.0	20000.0	-1.0
(Z-COORD)	1:2:3		Real	-1.0	1350.0	-1.0
LENGTH	1:3	Optional	Real	-1.0	4000.0	-1.0
UTM ZONAR	1:4	Optional	UTM			
(X-COORD)	1:4:1		Real	-1.0	600000.0	-1.0
(Y-COORD)	1:4:2		Real	-1.0	910000.0	-1.0
(Z-COORD)	1:4:3		Real	-1.0	1350.0	-1.0
TYPE	1:5	Optional	String		6	DDH
SECTION	1:6	Optional	String		15	
CORE SIZE	1:7	Optional	String		10	NS
GEOLOGIST	1:8	Optional	String		10	
LOG DATE	1:9	Optional	Integer	-1	999999	-1
RECORD	1:10	Optional	Integer	-1	999	-1
CORE LSTN	1:11	Optional	String		20	SEUM
COMMENTS	1:12	Optional	String		100	

Table Number : 2
 Table Name : SURVEYS
 Number of Fields : 5

Field name	Code	Mark	Type	Minimum	Maximum	Default
DISTANCE	2:1	Optional	Real	.0	4000.0	.0
DIP	2:2	Optional	Real	-90.0	90.0	-90.0
AZIMUTH	2:3	Optional	Real	.0	360.0	.0
UTMAZIMUTH	2:4	Optional	Real	.0	360.0	.0
METHOD	2:5	Optional	String		20	AT D

*** VANEDR04 - Drill Hole Database ***
 *** ***

Table Number : 3
 Table Name : LITHOLOGY
 Number of Fields : 6

Field name	Code	Mark	Type	Minimum	Maximum	Default
FROM	3:1	Optional	Real	-1.0	4000.0	-1.0
TG	3:2	Optional	Real	-1.0	4000.0	-1.0
UNIT	3:3	Optional	String		8	
DESCRIPTION	3:4	Optional	String		50	
COMMENTS	3:5	Optional	String		50	
ROCK CODE	3:6	Optional	Integer	-1	999	-1

Table Number : 4
 Table Name : ASSAYS
 Number of Fields : 29

Field name	Code	Mark	Type	Minimum	Maximum	Default
FROM	4:1	Optional	Real	-1.0	4000.0	-1.0
TG	4:2	Optional	Real	-1.0	4000.0	-1.0
INTERVAL	4:3	Optional	Real	-1.0	4000.0	-1.0
RECOVERY	4:4	Optional	Real	-1.0	4000.0	-1.0
RECOVERY %	4:5	Optional	Integer	-1	100	-1
SAMPLE #	4:6	Optional	Integer	-1	999999	-1
ROCK TYPE	4:7	Optional	String		8	
ROCK CODE	4:8	Optional	Integer	-1	999	-1
SS-PULF	4:9	Optional	Real	-1.00	10.00	-1.00
SS-WR	4:10	Optional	Real	-1.00	10.00	-1.00
PS-ZN %	4:11	Optional	Real	-1.00	100.00	-1.00
PS %	4:12	Optional	Real	-1.00	100.00	-1.00
ZN %	4:13	Optional	Real	-1.00	100.00	-1.00
ZN RATIO	4:14	Optional	Real	-1.00	1.00	-1.00
AS S/T(AA)	4:15	Optional	Real	-1.0	1000.0	-1.0
AS S/T(FA)	4:16	Optional	Real	-1.0	1000.0	-1.0
AU S/T	4:17	Optional	Real	-1.00	500.00	-1.00
PS+PY %	4:18	Optional	Real	-1.00	100.00	-1.00
PS %	4:19	Optional	Real	-1.00	100.00	-1.00
PY %	4:20	Optional	Real	-1.00	100.00	-1.00
BAO %	4:21	Optional	Real	-1.00	100.00	-1.00
BA %	4:22	Optional	Real	-1.00	100.00	-1.00
CU %	4:23	Optional	Real	-1.00	20.00	-1.00
FE %	4:24	Optional	Real	-1.00	100.00	-1.00
AS %	4:25	Optional	Real	-1.00	10.00	-1.00
MS %	4:26	Optional	Real	-1.00	10.00	-1.00
OXIDATION	4:27	Optional	Integer	-1	100	-1
OXIDE FE %	4:28	Optional	Real	-1.00	100.00	-1.00
OXIDE ZN %	4:29	Optional	Real	-1.00	100.00	-1.00

*** VANBORSA - Drill Hole Database ***

Table Number : 5
 Table Name : STRUCTURES
 Number of Fields : 23

Field name	Code	Mark	Type	Minimum	Maximum	Default
DISTANCE	5:1	Optional	Real	-1.0	4000.0	-1.0
SYMMETRY	5:2	Optional	String		5	
FEATRE-RFE	5:3	Optional	String		5	FS2
DEFN-RFE	5:4	Optional	Integer	-1	10	2
DIP-RFE	5:5	Optional	Integer	-1	90	-1
DIR-RFE	5:6	Optional	Integer	-1	360	220
PLOT-RFE	5:7	Optional	Logical			FALSE
FEATURE-A	5:8	Optional	String		5	
DEFN-A	5:9	Optional	Integer	-1	10	-1
DIP-A	5:10	Optional	Integer	-1	90	-1
DIR-A	5:11	Optional	Integer	-1	360	-1
PLOT-A	5:12	Optional	Logical			TRUE
FEATRE-B	5:13	Optional	String		5	
DEFN-B	5:14	Optional	Integer	-1	10	-1
DIP-B	5:15	Optional	Integer	-1	90	-1
DIR-B	5:16	Optional	Integer	-1	360	-1
PLOT-B	5:17	Optional	Logical			TRUE
FEATRE-C	5:18	Optional	String		5	
DEFN-C	5:19	Optional	Integer	-1	10	-1
DIP-C	5:20	Optional	Integer	-1	90	-1
DIR-C	5:21	Optional	Integer	-1	360	-1
PLOT-C	5:22	Optional	Logical			TRUE
COMMENTS	5:23	Optional	String		100	

Table Number : 6
 Table Name : FAULTS
 Number of Fields : 11

Field name	Code	Mark	Type	Minimum	Maximum	Default
FROM	6:1	Optional	Real	-1.0	4000.0	-1.0
TO	6:2	Optional	Real	-1.0	4000.0	-1.0
FEATURE	6:3	Optional	String		10	
RECOVERY	6:4	Optional	String		10	
DIP-UPPER	6:5	Optional	Integer	-1	99	-1
DIR-UPPER	6:6	Optional	Integer	-1	999	-1
DIP-INTRNL	6:7	Optional	Integer	-1	99	-1
DIR-INTRNL	6:8	Optional	Integer	-1	999	-1
DIP-LOWER	6:9	Optional	Integer	-1	99	-1
DIR-LOWER	6:10	Optional	Integer	-1	999	-1
COMMENTS	6:11	Optional	String		50	

!!! VANGORDA - Drill Hole Database !!!
 !!!

Table Number : 7
 Table Name : GEOTECH
 Number of Fields : 13

Field name	Code	Mark	Type	Minimum	Maximum	Default
FROM	7:1	Optional	Real	-1.0	4000.0	-1.0
TD	7:2	Optional	Real	-1.0	4000.0	-1.0
INTERVAL	7:3	Optional	Real	-1.0	500.0	-1.0
RECOVERY	7:4	Optional	Real	-1.0	100.0	-1.0
RECOVERY %	7:5	Optional	Integer	-1	100	-1
RSD	7:6	Optional	Real	-1.0	100.0	-1.0
RSD %	7:7	Optional	Integer	-1	100	-1
BREAKAGE	7:8	Optional	Integer	-1	15	-1
WEATHERING	7:9	Optional	String		5	
JOINT #	7:10	Optional	Integer	-1	100	-1
JOINT FREQ	7:11	Optional	Real	-1.00	100.00	-1.00
CORE SIZE	7:12	Optional	String		5	NG
COMMENTS	7:13	Optional	String		50	

Table Number : 8
 Table Name : SAMPLES
 Number of Fields : 7

Field name	Code	Mark	Type	Minimum	Maximum	Default
FROM	8:1	Optional	Real	-1.0	4000.0	-1.0
TD	8:2	Optional	Real	-1.0	4000.0	-1.0
UNIT	8:3	Optional	String		8	
ROCK CODE	8:4	Optional	Integer	-1	999	-1
DEPTH	8:5	Optional	String		20	
PURPOSE	8:6	Optional	String		100	
DATE	8:7	Optional	Integer	-1	999999	-1

ROCK CODE SUMMARY

ATTACHMENT # 1

QUARTZITES:

2	4A	Ribbon banded carbonaceous quartzite
3	4C/4D	Pyritic quartzite (<30% pyrite)

SULPHIDES:

4	4EC/4E1/4C3	Semi-massive siliceous pyritic sulphides sulphides (30-60% pyrite)
5	4E/4F	Massive pyritic sulphides (60-100% pyrite)
6	4K	Massive pyritic sulphides with clasts of dolomite/ankerite
7	4G	Baritic pyrite sulphides (> 10% barite)
8	4H	Pyrrhotitic sulphides
9	4J	Nonpyritic sulphides & oxides - pyrite poor

METASEDIMENTS:

20	3G	Noncalcareous, muscovite-chlorite, medium grey phyllite
22	1C/1CD/1D	Noncalcareous, biotite-muscovite-quartz ± staurolite ± andalusite ± garnet ± fibrolite schist
30	5A/5G/3E/1E	Carbonaceous phyllite/schist
32	5E/3F/1G	Marble ± calc-silicate bands
33	1B	Skarn and "silicated" marble
36	3D	Calc-silicate
40	5B	Calcareous, silvery grey, muscovite-chlorite phyllite

META-IGNEOUS ROCKS:

44	5C/3C/1F	Metabasite, poorly foliated greenstone with relict igneous texture
45	5C/3C/1F	Pyroxenite -commonly serpentized - with relict bastites
46	5C/3C/1F	Amphibolite - bluish green hornblende - plagioclase - quartz amphibolite
47	5D/3B/1H	Chloritic phyllite/schist. pale olive green

ALTERED ROCKS: - (DOMINANTLY METASEDIMENTS)

52	4L0	Muscovite > chlorite - quartz phyllite/schist - very pale cream to white
54	4L6	Chlorite > muscovite-quartz phyllite/schist - pale green

CRETACEOUS INTRUSIVES:

60	10Q	Quartz vein- - white bull quartz vein
61	10AB	Anvil Batholith - Mt Mye phase of Anvil plutonic suite. Muscovite - biotite granite
65	10C	Pegmatite
66	-	Aplite
68	10E	Hornblende-biotite quartz diorite - massive and unfoliated
69	10F	Smokey quartz - feldspar porphyry - massive and unfoliated

FAULT ROCK:

To be used only if parent cannot be identified - use rarely!

- | | |
|----|------------------|
| 72 | Gouge |
| 74 | Tectonic breccia |
| 76 | Mylonite |

OVERBURDEN:

- | | |
|----|------------------------|
| 82 | Unclassified - general |
| 84 | Triconed - no recovery |
| 86 | Till - silt -sand |
| 88 | Ferricrete |
| 99 | Air |

MINERAL IDENTIFIERS

CARBONATES:

c	calcite
k	ankerite
v	carbonate - non specific
w	dolomite

MICAS: (LAYER SILICATES)

b	biotite
j	fuchsite
l	chlorite
m	muscovite
s	sericite
t	talc

FELDSPARS - QUARTZ

f	feldspar
q	quartz (fine-grained)
o	kaolinite (clay minerals)
p	potash feldspar
Q	quartz (vein)

CALC-SILICATES

a	actinolite
e	epidote
h	hornblende
i	diopside

ALUMINO-SILICATES/PELITE MINERALS

d	andalusite
n	garnet
r	fibrolite
u	staurolite
z	chloritoid

OXIDES/SULPHIDES/SULPHATES

A	Arsenopyrite
B	Barite
C	Chalcopyrite
G	Galena
L	Limonite (iron oxides)
M	Magnetite
P	Pyrite
R	Pyrrhotite
Z	Sphalerite

OTHER

g	carbon
x	noncalcareous

ROCK TEXTURES

ATTACHMENT # 3

+	equigranular
!	foliated
=	laminated/banded/ribbon-banded
>	coarse-grained
^	medium-grained
<	fine-grained
\	clotted
*	porphyroblastic (buckshot)
%	porphyritic
#	interstitial
@	porous
!	weathered
	fault gouge - ie. mud-more than broken core
X	fault breccia (tectonic)
?	mylonite
"	altered
-	"stringered"
.	"spotted"

ATTACHMENT # 4

GRADE

N	=	no sphalerite or galena	(N = none)
W	=	1 - 3% PbS/ZnS	(W = waste)
L	=	3 - 5%	(L = low grade)
H	=	5 - 10%	(H = high grade)
V	=	10% +	(V = very high grade)

ATTACHMENT # 5

ROCK CODE CONSTRUCTION

ROCK #: MINERAL IDENTIFIERS: TEXTURE: GRADE

NOTES:

- 1) The most abundant rock type comes first if the rock is a hybrid.
- 2) Parentheses are used to separate subordinate rock types.
- 3) Textural codes are appended after the mineral identifier(s).
- 4) Baritic ore ("7") must contain more than 10% barite. If barite content is less than 10% use the appropriate rock code (Not "7") with the mineral identifier for barite ("B").
- 5) Pyritic quartzite is assumed to have no more than 30% pyrite.
- 6) The grade descriptor for zero grade (i.e. N) may be omitted.
- 7) Mineral identifiers when more than one are used are in order of abundance.
- 8) Beware of redundancies when using mineral identifiers (eg. chloritic phyllite is "47" , not "47I"; though possibly the latter could be used for a rock containing extraordinarily large amount of chlorite). In general, characteristics which are normally found in a rock type should not be indicated by a mineral or textural identifier.
- 9) Not all four parts of the rock code construction shown above are necessarily used. Rock number alone is mandatory. It must be accompanied by a grade descriptor if the rock is a sulphide (ie. rock units 4-9)

ATTACHMENT #6

EXAMPLES

<u>Proposed Code</u>	<u>Old Code</u>	
5Z#H	(2E4)	Massive sulphides with over 80% pyrite and heavy sphalerite in a ratio zinc to lead of greater than 1 1/2:1. Texture is network and combined lead/zinc grade is between 5 and 10%.
2ZW	(2A4)	Ribbon banded graphitic quartzite with up to 3% zinc (in sphalerite). < 30% iron sulphides are present by definition.
3/W	(2D)	Quartzite with up to 30% pyrite, and a combined zinc/lead grade of up to 3% in the usual ratio.
5</15/L	(80)	Massive fine grained pyrite with bands of metabasite. Sphalerite and galena are present in usual ratio of 1 1/2:1, and combined lead/zinc grade is between 3 and 5%.
31oY<	(10H9)	Kaolinized granite waste with fine grained pyrite.
3/17/L	(2D1H)	Base metal bearing quartzite with less than 30% pyrite mixed with chloritic phyllite. Combined lead/zinc grade is 3 to 5%. Quartzite constitutes more than 50% of rock.
17/3/L	(1H2D)	As above, but choritic phyllite constitutes more than 50% of rock.

a	actinolite	A	Arsenopyrite
b	biotite	B	Barytes
c	calcite	C	Chalcopyrite
d	andalusite	G	Galena
e	epidote	L	Limonite (iron oxides)
f	feldspar	M	Magnetite
g	graphite	Q	Quartz (vein)
h	hornblende	R	Pyrrhotite
i	diopside	Y	Pyrite
j	fuchsite	Z	Sphalerite
k	ankerite		
l	chlorite		
m	muscovite		
n	garnet		
o	kaolinite (clay minerals)		
p	potash Feldspar		
q	quartz (fine grained)		
r	fibrolite		
s	sericite		
t	talc		
u	staurolite		
v	carbonate (non-specific)		
w	dolomite		
x	non calcareous		
z	chloritoid		

ORE TYPES

- 2 (4A) Ribbon-banded, carbonaceous quartzite
- Dark grey finely banded quartzite with alternating interbands of light grey to white quartz - sulphides. Banding on a scale of 2mm-2cm. Sulphides pyrite & sphalerite (reddish) ± galena.
- Hard - nail or knife leaves metal on surface
S2 surfaces are dark grey to black and typically mark the fingers.
- Typically has a well developed microlithon texture.
- If pyrite content > 30% then call it pyritic 2
- 3 (4C/4D) Slightly pyritic quartzite
- Pale grey to creamy white, generally noncalcareous quartzite.
- Contains thin ribbons and band of sulphides-pyrite, sphalerite, galena
- Hard - nail or knife leaves metal on surface. Typically sulphide bands show microlithon texture
- S2 surfaces are pale grey with discontinuous streaks of muscovite. Typically leaves no mark on fingers.
- Full gradation exists between 2 and 3. If S2 surfaces are medium grey -i.e. slightly to moderately carbonaceous the rock should be called carbonaceous 3 (and NOT 2!)
- If pyrite content > 30% then call it pyritic 3.
- 4 (4EC) Siliceous pyritic sulphides - semi-massive sulphides
- Intermediate rock type which is typically logged either as pyritic 3 or siliceous 5

Brassy yellow, fine grained, noncalcareous, moderately hard pyrite.

Typically low grade.

Locally finely laminated with thin streaks and bands of fine grained magnetite

Contains diffuse bands and lenses of grey to white quartz. Quartz also disseminated in matrix- pyrite constitutes 30-60% of unit. Banding is on scale of 1cm to 10cm.

Locally may contain small clasts of dolomite.

5 (4E) Pyritic massive sulphides

Brownish yellow, fine grained, moderately hard, pyrite with sulphides. Pyrite constitutes 60-100%

Diffuse banding parallel S2 with variations in sphalerite-galena content

Contains clots and lenses of carbonate (calcite, dolomite) and quartz.

Typically high grade.

Typically interbanded with 6 on a scale of cm to metres.

For up to 10% barite rock should be called baritic 5

6 (4K) Pyritic massive sulphides with ankerite/dolomite

Similar to rock type 5 except it contains large ameboid belbs of flesh-coloured dolomite/ankerite

It should not be used for massive sulphides with disseminated matrix carbonate.

- 7 (4G) Baritic, massive pyritic sulphides
- Pyritic massive sulphides with >10% barite visually.
- Brownish to purplish, banded to laminated pyritic sulphides with barite. Soft.
- "Burns Black" on cut surface as pyrite streak shows on soft barite.
- Typically high grade - sphalerite is honey coloured and can be overlooked.
- Typically magnetite-bearing.
- 8 (4H) Pyrrhotitic, massive sulphides
- Fine-grained, reddish bronze pyrrhotitic massive sulphides
- Magnetic because of pyrrhotite
- Moderately hard
- Generally moderate to high grade
- Strongly laminated deformation texture. Shows ductile flow textures around clasts of carbonate, white quartz, phyllite, metabasite
- Not a common rock on Vangorda Plateau - occurs mainly at margins of sulphide intersectons.
- 9 (4J) Nonpyritic massive sulphides
- Unusual, rare rock type
- Coarse to medium grained sphalerite-galena with porphyroblasts of magnetite and pyrite. May also contain ameboid porphyroblasts of carbonate and diffuse quartz bands or lenses
- Typically high grade - colour reddish brown to dark brown.

- 20 (3G) Noncalcareous muscovite-chlorite phyllite
- Moderately soft, noncalcareous, medium grey phyllite
- Well developed, pervasive S2 foliation. S2 surfaces silvery grey to steely grey. No readily visible individual micas.
- Homogeneous to poorly laminated or banded. Laminae defined by shades of grey variations-not by siltstones.
- 22 (1C/1CD/1D) Noncalcareous muscovite-biotite schist
- Moderately soft, noncalcareous, brownish grey schist
- Well developed, pervasive S2 soliation, S2 surfaces silvery with brownish biotite streaking. Individual mica flakes are visible.
- Some varieties are strongly compositionally banded with biotite-rich bands and quartz-rich bands
- May contain clots and bands of biotite-andalusite, staurolite, garnet.
- Coarser-grained than phyllite Typically brownish hue as biotite overshadows carbon.
- 30 (5A/5G/3E/1E) Carbonaceous phyllite/schist
- Dark grey to black, moderately soft, carbonaceous phyllite/schist.
- S2 surfaces are dark steely grey to black and typically mark the fingers.
- Locally will contain thin pale grey quartz + calcite + dolomite siltstone laminae/bands
- Locally will contain interbands of dark grey to black marble with thin white beaded calcite laminae.

Should not be used for only moderately carbonaceous phyllite/schist. S2 surfaces should be dark and mark fingers.

Siltstone bands should be noted. Carbonates (if present) should be noted.

32

(5E/3F/
1G/1B)

Marble and silicated marble

Medium crystalline, medium to pale grey calcite marble.

May locally be very fine grained with mylonite texture.

Typically contains thin bands of pale to dark green calc-silicate and/or dark brown biotitic silicates.

Silicate bands are commonly boudinaged.

May contain coarser skarn textures.

On Vangorda Plateau this is shut down rock

Locally will be carbonaceous dark grey to black with thin laminae of white, beaded calcite defining S2.

36

(3D)

Calc-Silicate

Hard, noncalcareous to slightly calcareous, prominently striped pale green calc-silicate and dark brown biotitic pelite. Banding typically on a scale 1-10cm. Proportions of biotite and calc-silicate vary greatly.

Unit is fine-grained. Non calcareous schist (110) are typically coarser grained.

40

(5B0)

Silvery grey to pale grey, moderately soft, muscovite-chlorite phyllite.

Contains thin pale grey to off-white quartz-carbonate (calcite or dolomite) siltstone laminae to bands. Siltstones give core an overall calcareous aspect. Siltstones are 1-5cm thick.

S2 surfaces are silvery grey. Darker S2 surfaces should be logged as carbonaceous.

Typically S2 foliation defined by crenulation cleavage-microlithons.

Typically contains scattered, isolated pyrite/pyrrhotite porphyroblasts.

44 (5C/3C
1F)

Metabasite

Poorly foliated, dark green, noncalcareous to slightly calcareous, chloritic metabasite.

Typicaly relict igneous texture with grey to white altered plagioclase.

Moderately hard to hard

Altered variants are typically strongly foliated with anastomosing chloritic streaks in a grey carbonate matrix. May contain streaks or bands of bright green "fuchsite" This variant has been called zebra rock.

45 (5C/3C
1F)

Pyroxenite

Poorly foliated, dark green, noncalcareous to slightly calcareous, chloritic metabasite.

Typically serpentized and therefore slightly magnetic. Relict igneous textures show pyroxene "bastites".

46 (5C/3C/
1F)

Amphibolite

Foliated, dark green to bluish green, moderately hard hornblende amphibolite.

Commonly contains pale grey to white streaks parallel S2. Locally calcareous.

47

(5D/3B/
1H)

Chloritic phyllite

Foliated, pale olive green, moderately soft, moderately calcareous, chloritic phyllite.

Locally diffusely banded with speckled off-white calcite \pm quartz bands

Typicaly has thin white quartz-calcite veins parallel S2.

S2 surfaces are silvery pale green and have a slightly gritty texture.

Pervasive S2 foliation.

Marginal contacts with metasediments are sharp.

Altered variants are pale tan with streaks of muscovite on S2 surfaces. Carbonate is typically dolomite/ankerite. Commonly contains specks of bright green "fuchsite".

52

(4L)

White mica envelope-altered phyllite

Moderately soft, pale grey to off-white muscovite-quartz phyllite.

Generally sulphide-bearing with discontinuous streaks of pyrite or pyrrhotite \pm sphalerite \pm galena.

Locally may be siliceous = hard, that should be noted in modifiers.

Typically pervasively foliated - not microlithoned.

S2 surfaces are silvery white from fine muscovite.

Typically noncalcareous.

Represents highly altered metapelite.

- 54 (4L6) Slightly altered muscovite-chlorite phyllite.
Moderately soft, pale creamy green, muscovite-chlorite phyllite.
May be sulphide bearing with discontinuous pyrite or pyrrhotite streaks.
Typically noncalcareous.
Represents more slightly altered metapelite.
- 60 (10Q) Bull quartz vein
Coarse grained, milky white, vein quartz.
- 61 (10AB) Anvil Batholith (biotite-muscovite granite)
Equigranular to slightly foliated, biotite-muscovite, granite.
Medium to coarse grained.
May contain large K-feldspar megacrysts.
Near Tie Fault will have S-C mylonite texture.
- 65 (10C) Pegmatite
Coarse grained granite to pegmatite. Typically occurs as dykes in pelites or Anvil Batholith.
Typically contains tourmaline.
- 66 - Aplite
Fine-grained, "sugary-textured", creamy white K-feldspar-plagioclase-quartz granite/aplite.
Typically unfoliated.
Typically contains garnet and/or tourmaline.
- 68 (10E) Hornblende-biotite quartz diorite.
Medium grained, equigranular, unfoliated, medium grey, hornblende-biotite quartz diorite.
Marginal phase is fine-grained, brown, aphanitic matrix with scattered biotite and hornblende phenocrysts.
May contain hornblende phenocrysts.

- 69 (10F) Smoky quartz-feldspar ± biotite porphyry
- Pale cream, fine-grained granite with numerous phenocrysts of dark brown smoky quartz, biotite, white feldspar. Quartz phenocrysts are commonly euhedral.
- Very soft and punky when altered. Upon weathering typically breaks apart - contains swelling clays.
- Unfoliated - may contain banding and streaking which looks like flow banding texture.
- 82 (*) Overburden - general
- Unspecified overburden
- 84 (*) Overburden - Triconed
- Triconed - no recovery
- 86 (*) Overburden - Till/Silt/Sand
- 88 (*) Overburden - Ferricrete
- Rock fragments cemented by orange to brownish fine grained hematite/limonite/goethite iron oxides.22

META-IGNEOUS ROCKS:

44	5C/3C/1F	Metabasite, poorly foliated greenstone with relict igneous texture
45	5C/3C/1F	Pyroxenite -commonly serpentinized - with relict bastites
46	5C/3C/1F	Amphibolite - bluish green hornblende - plagioclase - quartz amphibolite
47	5D/3B/1H	Chloritic phyllite/schist. pale olive green

ALTERED ROCKS: - (DOMINANTLY METASEDIMENTS)

52	4L0	Muscovite > chlorite - quartz phyllite/schist - very pale cream to white
54	4L6	Chlorite > muscovite-quartz phyllite/schist - pale green

CRETACEOUS INTRUSIVES:

60	10Q	Quartz vein- - white bull quartz vein
61	10AB	Anvil Batholith - Mt Mye phase of Anvil plutonic suite. Muscovite - biotite granite
65	10C	Pegmatite
66	-	Aplite
68	10E	Hornblende-biotite quartz diorite - massive and unfoliated
69	10F	Smokey quartz - feldspar porphyry - massive and unfoliated

META-IGNEOUS ROCKS:

44	5C/3C/1F	Metabasite, poorly foliated greenstone with relict igneous texture
45	5C/3C/1F	Pyroxenite -commonly serpentized - with relict bastites
46	5C/3C/1F	Amphibolite - bluish green hornblende - plagioclase - quartz amphibolite
47	5D/3B/1H	Chloritic phyllite/schist. pale olive green

ALTERED ROCKS: - (DOMINANTLY METASEDIMENTS)

52	4L0	Muscovite > chlorite - quartz phyllite/schist - very pale cream to white
54	4L6	Chlorite > muscovite-quartz phyllite/schist - pale green

CRETACEOUS INTRUSIVES:

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65	10C	Pegmatite
66	-	Aplite
68	10E	Hornblende-biotite quartz diorite - massive and unfoliated
69 massive	10F	Smokey quartz - feldspar porphyry - and unfoliated

FAULT ROCK:

To be used only if parent cannot be identified - use rarely!

72	Gouge
74	Tectonic breccia
76	Mylonite

OVERBURDEN:

82	Unclassified - general
84	Triconed - no recovery
86	Till - silt -sand
88	Ferricrete
99	Air

MINERAL IDENTIFIERS

CARBONATES:

c	calcite
k	ankerite
v	carbonate - non specific
w	dolomite

MICAS: (LAYER SILICATES)

b	biotite
j	fuchsite
l	chlorite
m	muscovite
s	sericite
t	talc

FELDSPARS - QUARTZ

f	feldspar
q	quartz (fine-grained)
o	kaolinite (clay minerals)
p	potash feldspar
Q	quartz (vein)

CALC-SILICATES

a	actinolite
e	epidote
h	hornblende
i	diopside

ALUMINO-SILICATES/PELITE MINERALS

d	andalusite
n	garnet
r	fibrolite
u	staurolite
z	chloritoid

OXIDES/SULPHIDES/SULPHATES

A	Arsenopyrite
B	Barite
C	Chalcopyrite
G	Galena
L	Limonite (iron oxides)
M	Magnetite
P	Pyrite
R	Pyrrhotite
Z	Sphalerite

OTHER

g	carbon
x	noncalcareous

ROCK TEXTURES

ATTACHMENT # 3

+	equigranular
!	foliated
=	laminated/banded/ribbon-banded
>	coarse-grained
^	medium-grained
<	fine-grained
\	clotted
*	porphyroblastic (buckshot)
%	porphyritic
#	interstitial
@	porous
	weathered
	fault gouge - ie. mud-more than broken core
X	fault breccia (tectonic)
?	mylonite
"	altered
-	"stringered"
.	"spotted"

ATTACHMENT # 4

GRADE

N	=	no sphalerite or galena	(N = none)
W	=	1 - 3% PbS/ZnS	(W = waste)
L	=	3 - 5%	(L = low grade)
H	=	5 - 10%	(H = high grade)
V	=	10% +	(V = very high grade)

ORE TYPES

- 2 (4A) Ribbon-banded, carbonaceous quartzite
- Dark grey finely banded quartzite with alternating interbands of light grey to white quartz - sulphides. Banding on a scale of 2mm-2cm. Sulphides pyrite & sphalerite (reddish) ± galena.
- Hard - nail or knife leaves metal on surface
S2 surfaces are dark grey to black and typically mark the fingers.
- Typically has a well developed microlithon texture.
- If pyrite content > 30% then call it pyritic 2
- 3 (4C/4D) Slightly pyritic quartzite
- Pale grey to creamy white, generally noncalcareous quartzite.
- Contains thin ribbons and band of sulphides-pyrite, sphalerite, galena
- Hard - nail or knife leaves metal on surface. Typically sulphide bands show microlithon texture
- S2 surfaces are pale grey with discontinuous streaks of muscovite. Typically leaves no mark on fingers.
- Full gradation exists between 2 and 3. If S2 surfaces are medium grey -i.e. slightly to moderately carbonaceous the rock should be called carbonaceous 3 (and NOT 2!)
- If pyrite content > 30% then call it pyritic 3.
- 4 (4EC) Siliceous pyritic sulphides - semi-massive sulphides
- Intermediate rock type which is typically logged either as pyritic 3 or siliceous 5

Brassy yellow, fine grained, noncalcareous, moderately hard pyrite.

Typically low grade.

Locally finely laminated with thin streaks and bands of fine grained magnetite

Contains diffuse bands and lenses of grey to white quartz. Quartz also disseminated in matrix- pyrite constitutes 30-60% of unit. Banding is on scale of 1cm to 10cm.

Locally may contain small clasts of dolomite.

5

(4E)

Pyritic massive sulphides

Brownish yellow, fine grained, moderately hard, pyrite with sulphides. Pyrite constitutes 60-100%

Diffuse banding parallel S2 with variations in sphalerite-galena content

Contains clots and lenses of carbonate (calcite, dolomite) and quartz.

Typically high grade.

Typically interbanded with 6 on a scale of cm to metres.

For up to 10% barite rock should be called baritic 5

6

(4K)

Pyritic massive sulphides with ankerite/dolomite

Similar to rock type 5 except it contains large amoeboid belbs of flesh-coloured dolomite/ankerite

It should not be used for massive sulphides with disseminated matrix carbonate.

- 7 (4G) Baritic, massive pyritic sulphides
- Pyritic massive sulphides with > .10% barite visually.
- Brownish to purplish, banded to laminated pyritic sulphides with barite. Soft.
- "Burns Black" on cut surface as pyrite streak shows on soft barite.
- Typically high grade - sphalerite is honey coloured and can be overlooked.
- Typically magnetite-bearing.
- 8 (4H) Pyrrhotitic, massive sulphides
- Fine-grained, reddish bronze pyrrhotitic massive sulphides
- Magnetic because of pyrrhotite
- Moderately hard
- Generally moderate to high grade
- Strongly laminated deformation texture. Shows ductile flow textures around clasts of carbonate, white quartz, phyllite, metabasite
- Not a common rock on Vangorda Plateau - occurs mainly at margins of sulphide intersectons.
- 9 (4J) Nonpyritic massive sulphides
- Unusual, rare rock type
- Coarse to medium grained sphalerite-galena with porphyroblasts of magnetite and pyrite. May also contain ameoboid porphyroblasts of carbonate and diffuse quartz bands or lenses
- Typically high grade - colour reddish brown to dark brown.

- 20 (3G) Noncalcareous muscovite-chlorite phyllite
- Moderately soft, noncalcareous, medium grey phyllite
- Well developed, pervasive S2 foliation. S2 surfaces silvery grey to steely grey. No readily visible individual micas.
- Homogeneous to poorly laminated or banded. Laminae defined by shades of grey variations—not by siltstones.
- 22 (1C/1CD/1D) Noncalcareous muscovite-biotite schist
- Moderately soft, noncalcareous, brownish grey schist
- Well developed, pervasive S2 soliation, S2 surfaces silvery with brownish biotite streaking. Individual mica flakes are visible.
- Some varieties are strongly compositionally banded with biotite-rich bands and quartz-rich bands
- May contain clots and bands of biotite-andalusite, staurolite, garnet.
- Coarser-grained than phyllite Typically brownish hue as biotite overshadows carbon.
- 30 (5A/5G/3E/1E) Carbonaceous phyllite/schist
- Dark grey to black, moderately soft, carbonaceous phyllite/schist.
- S2 surfaces are dark steely grey to black and typically mark the fingers.
- Locally will contain thin pale grey quartz + calcite + dolomite siltstone laminae/bands
- Locally will contain interbands of dark grey to black marble with thin white beaded calcite laminae.

Should not be used for only moderately carbonaceous phyllite/schist. S2 surfaces should be dark and mark fingers.

Siltstone bands should be noted. Carbonates (if present) should be noted.

32

(5E/3F/
1G/1B)

Marble and silicated marble

Medium crystalline, medium to pale grey calcite marble.

May locally be very fine grained with mylonite texture.

Typically contains thin bands of pale to dark green calc-silicate and/or dark brown biotitic silicates.

Silicate bands are commonly boudinaged.

May contain coarser skarn textures.

On Vangorda Plateau this is shut down rock

Locally will be carbonaceous dark grey to black with thin laminae of white, beaded calcite defining S2.

36

(3D)

Calc-Silicate

Hard, noncalcareous to slightly calcareous, prominently striped pale green calc-silicate and dark brown biotitic pelite. Banding typically on a scale 1-10cm. Proportions of biotite and calc-silicate vary greatly.

Unit is fine-grained. Non calcareous schist (110) are typically coarser grained.

40

(5B0)

Silvery grey to pale grey, moderately soft, muscovite-chlorite phyllite.

Contains thin pale grey to off-white quartz-carbonate (calcite or dolomite) siltstone laminae to bands. Siltstones give core an overall calcareous aspect. Siltstones are 1-5cm thick.

S2 surfaces are silvery grey. Darker S2 surfaces should be logged as carbonaceous.

Typically S2 foliation defined by crenulation cleavage-microlithons.

Typically contains scattered, isolated pyrite/pyrrhotite porphyroblasts.

44 (5C/3C
1F)

Metabasite

Poorly foliated, dark green, noncalcareous to slightly calcareous, chloritic metabasite.

Typicaly relict igneous texture with grey to white altered plagioclase.

Moderately hard to hard

Altered variants are typically strongly foliated with anastomosing chloritic streaks in a grey carbonate matrix. May contain streaks or bands of bright green "fuchsite" This variant has been called zebra rock.

45 (5C/3C
1F)

Pyroxenite

Poorly foliated, dark green, noncalcareous to slightly calcareous, chloritic metabasite.

Typically serpentized and therefore slightly magnetic. Relict igneous textures show pyroxene "bastites".

46 (5C/3C/
1F)

Amphibolite

Foliated, dark green to bluish green, moderately hard hornblende amphibolite.

Commonly contains pale grey to white streaks parallel S2. Locally calcareous.

47

(5D/3B/
1H)

Chloritic phyllite

Foliated, pale olive green, moderately soft, moderately calcareous, chloritic phyllite.

Locally diffusely banded with speckled off-white calcite \pm quartz bands

Typically has thin white quartz-calcite veins parallel S2.

S2 surfaces are silvery pale green and have a slightly gritty texture.

Pervasive S2 foliation.

Marginal contacts with metasediments are sharp.

Altered variants are pale tan with streaks of muscovite on S2 surfaces. Carbonate is typically dolomite/ankerite. Commonly contains specks of bright green "fuchsite".

52

(4L)

White mica envelope-altered phyllite

Moderately soft, pale grey to off-white muscovite-quartz phyllite.

Generally sulphide-bearing with discontinuous streaks of pyrite or pyrrhotite \pm sphalerite \pm galena.

Locally may be siliceous = hard, that should be noted in modifiers.

Typically pervasively foliated - not microlithoned.

S2 surfaces are silvery white from fine muscovite.

Typically noncalcareous.

Represents highly altered metapelite.

- 54 (4L6) Slightly altered muscovite-chlorite phyllite.
Moderately soft, pale creamy green, muscovite-chlorite phyllite.
May be sulphide bearing with discontinuous pyrite or pyrrhotite streaks.
Typically noncalcareous.
Represents more slightly altered metapelite.
- 60 (10Q) Bull quartz vein
Coarse grained, milky white, vein quartz.
- 61 (10AB) Anvil Batholith (biotite-muscovite granite)
Equigranular to slightly foliated, biotite-muscovite, granite.
Medium to coarse grained.
May contain large K-feldspar megacrysts.
Near Tie Fault will have S-C mylonite texture.
- 65 (10C) Pegmatite
Coarse grained granite to pegmatite. Typically occurs as dykes in pelites or Anvil Batholith.
Typically contains tourmaline.
- 66 - Aplite
Fine-grained, "sugary-textured", creamy white K-feldspar-plagioclase-quartz granite/aplite.
Typically unfoliated.
Typically contains garnet and/or tourmaline.
- 68 (10E) Hornblende-biotite quartz diorite.
Medium grained, equigranular, unfoliated, medium grey, hornblende-biotite quartz diorite.
Marginal phase is fine-grained, brown, aphanitic matrix with scattered biotite and hornblende phenocrysts.
May contain hornblende phenocrysts.

- 69 (10F) Smoky quartz-feldspar + biotite porphyry
- Pale cream, fine-grained granite with numerous phenocrysts of dark brown smoky quartz, biotite, white feldspar. Quartz phenocrysts are commonly euhedral.
- Very soft and punky when altered. Upon weathering typically breaks apart - contains swelling clays.
- Unfoliated - may contain banding and streaking which looks like flow banding texture.
- 82 (*) Overburden - general
- Unspecified overburden
- 84 (*) Overburden - Triconed
- Triconed - no recovery
- 86 (*) Overburden - Till/Silt/Sand
- 88 (*) Overburden - Ferricrete
- Rock fragments cemented by orange to brownish fine grained hematite/limonite/goethite iron oxides.22

CURRAGH INC FARO DIVISION
A GENERAL GUIDE FOR ORE GRADE CONTROL
IN THE GRUM and VANGORDA ORE BODIES
JUNE 1993
Brad Pisony – Grade Control Geologist

INTRODUCTION

With the completion of mineable reserves in the Faro pit in the spring of 1993, and the introduction of ore from the Grum pit at the same time, the practices and procedures of maintaining a consistent (and acceptable) blend of feed to the concentrator had to undergo significant changes. Unlike the ore from the Faro deposit the Vangorda/Grum ore is finer grained due to a lower metamorphic grade (greenschist as opposed to amphibolite facies in Faro pit). As a result the ore requires more grinding than the Faro ore to increase liberation of the contained base metal minerals. The Plateau ores also have inherent differences that create flotation problems. They have a significant copper content which in soluble form can render the ore as refractory (particularly in the upper horizons of the deposits). The ore remaining in the Vangorda pit however does not display refractory characteristics and is currently the best suitable ore for metallurgical treatment. In the Grum pit the initial ore benches contain a majority of carbonaceous quartzites with a largely varying degree of carbon content and poses to be the most problematic in maintaining consistent and qualifying mill feed due to the affect carbon has on the lead flotation circuit.

ROCK DESCRIPTIONS

A detailed description of the ore and waste types for the Grum and Vangorda pits can be found in the Geology department files, also there is detailed structural description by Gilson and Jennings. A numeric lithostratigraphic coding system (see appendix A) was recently developed to integrate the rock types into the Gemcom modelling software and the blasthole database. It is important to know this code. The following is a general description of rock types encountered in the two pits, and some of their visual characteristics.

Rock Type; Baritic Massive Sulphide – This is the main high grade ore type with grades ranging from 6% to 20% Pb+Zn. This ore has a high specific gravity (about 4.0) and is generally easy to identify. It has an iron content ranging from 15% to 25%. This rock type can be found as distinct localized layers between a barren pyritic massive sulphide and can be separated if they are thick enough with the proper equipment, however it is difficult to identify these layers in the blasthole cuttings due to mixing and as a result the whole column is assayed as one minable bench, with the barren sulphide included as dilution. (old code = 60 or 4G, new code = 7)

Carbonaceous Quartzites – This ore type generally overlies the massive sulphides in the hanging wall. It can vary in grade from 0% to 10% combined Pb+Zn. It is easy to identify in the blasthole cuttings because it produces a dark grey smudge on the fingers when handled. In the face it will appear light grey to black and is highly foliated along the S₂ plane (prominent foliation plane). Pyrite and chalcopyrite are visible in the quartzite matrix. The carbonaceous material is found mainly in the foliations. It has been observed that the Carbon content can be correlated with the grade, lower grades indicate more highly foliated quartzite resulting in higher concentrations of carbon. Therefore flotation test results from a +10% Pb+Zn sample will be better than from a 5% Pb+Zn sample. (old code = 20 or 4A, new code = 2)

Semi Massive Pyritic Quartzites – This is an important waste rock located in the footwall. It contains varying degrees of pyrite and chalcopyrite and is extremely hard. Some lead and zinc mineralization does occur near the contact with the baritic ore in the form of thin bands and is gradational towards the ore. The grade can range between 0% and 6% Pb+Zn. Waste grade footwall quartzites are highly acid generating and must be contained in the designated "sulphide waste cells". This rock type requires more drilling time and can be difficult to break. (old code = 40 or 4EC, new code = 4)

Massive Pyritic Sulphide – This rock type contains +60% pyrite and can grade as high as 40% iron. Pb+Zn grades can range from about 1% to 10%. It is easy to identify in blasthole cuttings but can be mistaken for footwall pyritic quartzites, especially in the winter months with long periods of darkness (as a rule all sulphides should be sampled for assay). It was observed that this rock type was especially refractory in the upper benches of Vangorda pit due to the remobilization of zinc and high soluble copper content. It was not uncommon to have a very high lead to zinc ratio in this rock type and the ratio could be used as an indicator for possible refractory ore. (old code = 50/55 or 4EG/4E, new code = 5)

Phyllites/Schists – There is a wide spectrum of these rock types in the Vangorda and Mount Mye formations (see code). The main difference between the two formations is that the Mount Mye formation contain calcareous metasediments and the Vangorda formation contain noncalcareous. The most important of these are the altered phyllites in the Vangorda formation. These rocks are situated as an alteration envelope around the ore zones. They are identified mainly by color where they are light cream to white. Some appear pale green due to chlorite. Pyrite and chalcopyrite are visible and there may be some minor base metal mineralization. It is very important to minimize dilution of this rock type in the mill feed.

GRADE CONTROL

Proper grade control is extremely important for ore recovery in the pit and efficiency in the concentrator. Under normal operating conditions in the latter months of 1992, with two pits being mined, the Geology Department staffed a total of three geologists and four technicians. Twenty four hour coverage was maintained by the technicians in the field and proved to be most effective. They were responsible for blasthole logging and sampling, ore flagging, data entry, and dozer and shovel supervision at the ore face. The technicians reported to the Grade Control Geologist who was responsible for stockpile management, forecasting, ore recovery and mill feed blending. A Mine Geologist was responsible for pit mapping and geological modelling on a continuous basis. The geologists reported to the Chief Geologist who was responsible for the Department and was the liason between Mine and Mill Operations.

The following is a general guide as to how the geology department functioned in the latter part of 1992.

Geological Modelling:

Curragh Inc. uses the Gemcom software (PCXPLO, GEOMODEL, PCMINE, MINESURVEY) to produce geological models of the Anvil deposits. PCXPLO contains all of the diamond drill hole information used in the modelling process. This program is also used for blasthole data in creating short range models. The X,Y and Z coordinates for all the data are digitized from survey information and are combined with lithologic and assay data in individual bench databases. GEOMODEL is used to create files defining the geometrical parameters of the ore body after the structural interpretation is done. Cross and long section interpretations are digitized and then plotted in plan view by bench. The plan views are then interpreted and inconsistencies are "smoothed out". The new plans are digitized into bench files. The three dimensional information along with the lithology and assay data are manipulated in PCMINE to create a model where reserve calculations can be made. Then the pit is designed and its parameters are put into the system and minable reserves can be calculated by bench, rocktype and grade. As mining progresses and new information is obtained from pit mapping and blastholes, the Gemcom system allows the user to make model updates for more accurate reserve estimates and to make separate short range models that can assist in grade control as well as blast pattern design. The power of the Gemcom system as a mining tool is extensive and great effort should be applied to creating short range models. It does however require rapid information gathering and time consuming digitizing. The role of the technician should be expanded into learning the Gemcom modelling system. The entire mine and mill operations evolve from the model. Its' integrity is vital for success. Reconciliations between blasthole calculated and model reserves should be done at least once a month and after a bench is mined. This will tell the user where the model might be in error and establish targets for pit mapping and possibly a small diamond drill project if necessary.

Blast Pattern Design:

The Geology Department played an important role in the blast pattern design and worked closely with the Blasting Engineer. Because of the varying densities of ore and waste types blasthole spacing and powder factors changed with the rock drilled throughout each bench. It was particularly important to know precisely the locations of contacts near the highwall so that wall stability could be maintained. The Blasting Engineer initially designed his patterns based on the most recent short range model created by Geology. Modifications would be made based on the subgrade logs of blastholes from the bench above and the most recent pit mapping. As the bench was drilled off and the blastholes logged, a geologist or technician would discuss with the Blast Engineer any potential problems recognized in the current drill production. It was important for him to know if any sulphide holes bottomed out in phyllites or vice versa because it could create a hard toe or dilution problem. Fault gouge was also important to recognize and if possible locate the trend of any fault before further drilling was done. Copies of the blasthole logs with all available information was given to the engineer prior to loading the holes. He would create a "recipe" for powder factors in each hole based on this knowledge. Several months of experimentation in blasting techniques led to better blasts that minimized dilution and added to highwall stability.

Due to the extremely folded and faulted structure of the Grum Pit, new blasting techniques may have to be developed. In any case the Geology Department will have to continue to work closely with the Blasting Engineer to minimize dilution due to blasting.

Blasthole Logging and Sampling:

The Geological Technicians were responsible for sampling and logging the blastholes as well as many other important tasks. Twenty four hour coverage was maintained by working a rotating four by four, twelve hour shift schedule. This was especially helpful when processing blastholes in the winter months when wet holes would freeze solid within thirty minutes after being drilled. The technicians knew the rock codes and had learned how to recognize the rock types in the cuttings of the blastholes. A mylar copy of the blast pattern was kept in their field binder where they recorded the code of each rock unit encountered and the approximate depth (to the nearest half meter) to the contact from the top of the hole (logging from the bottom of the cuttings pile upwards). It is not an accurate method of estimating horizon depth but it has shown to be satisfactory most of the time.

A statistical study was made in the late eighties on the various methods a person might use when sampling and logging a blasthole. When a technician is pressed for time and faces several blastholes to process, he/she might be persuaded to do a quick and dirty job of it. The study showed that the best way to cut the pile (using a track shovel) is to make two separate slots on opposite sides, choosing the location where the height of the cuttings are about average. The slots should be dug outward from the very edge of the hole scraping all the material down to the base. This allows the best cross section view and by making two such slots variances in horizon thickness can be averaged. The total drill depth of each hole as well as a hole identification was marked on a stake placed in the cuttings. Using a simple visual ratio technique the depths can be estimated. It is important to consider the subgrade depth in the estimates. The study also showed that to obtain a better representative sample it is sufficient to use a minimum of two locations. Independent assay results from different locations in the pile can vary from being sulphide waste to highgrade ore. So it is very important to take portions of the sample from at least two locations. The subgrade portion of the cuttings was removed before sampling (3–5 cm off the top of the pile). The sample was removed by taking a vertical slice (about 3 cm thick) from the side of each slot where the horizon thickness appeared to be average. The two portions were combined in a sample bag and a sample tag was then folded, rolled into the top of the bag and stapled to seal the contents and keep the tag clean and dry. The tags were numerically sequenced but unfortunately the blasthole identifier was alpha–numeric. This resulted in having to write the corresponding blasthole identifier on each duplicate tag and later recording them in a book so that when the assays came back with only the numeric tag value, we were able to match the proper assay with the blasthole. This was a tedious and unnecessary step, and measures were being taken to rectify the problem by having the Blasting Engineer create blast plans with only a numeric identification on each blasthole. New tags would then be made that would match a pre–established sequence for each bench. This way the engineers, assayers, and geologists would have one number for one blasthole, making less room for error and smoother information flow. This system should be implemented in the Grum pit to help simplify and speed up the data gathering process, which would ultimately result in more efficient use of the Gemcom software.

Normally, all blastholes containing sulphides and/or quartzites were sampled even if they were determined by the model as being in a sulphide waste zone. It was discovered that a large portions of the model sulphide waste actually turned out to be a low grade ore, especially near the contacts of high grade zones. Some sulphide waste zones were sampled on an "every other hole" basis. Ore blastholes that contained distinct waste horizons were sampled with a reasonable mining perspective in mind. The technicians would decide from the logs if it was feasible to clean the horizons with a dozer or backhoe after blasting. They would then either sample just the ore portion or include the waste in the sample, depending on their decision. In certain zones where refractory ore was suspected, a second screened sample was taken and analyzed for cyanide soluble copper. Values greater than 0.1% were considered high and appropriate stockpiling measures were taken.

Blasthole Bench Masters:

Large sheets of mylar were used to construct a visual plan of the assay results and logs. The appropriate grids and section lines were plotted on with the Gemcom software (there are five individual map sheet files for the Grum pit, scale = 1:500). As blast patterns were drilled off, the holes were surveyed and plots were produced. These plots were then copied on to the mylar by hand with a fine drafting pen. Each blasthole on the mylar was labeled with the appropriate identifier by overlaying it on the blast design. The logs of each hole were also drafted on. As the assay results came in, the hole locations were coloured according to an established colour code listed below.

colour	grade category Pb+Zn
solid blue	<1% – phyllite waste (not assayed)
blue with blue circle	0–3% – sulphide waste
yellow with slash	3–4% – very low grade ore
solid yellow	4–5% – low grade ore
green	5–6% – medium grade ore
solid red	6–9% – high grade ore
red with red circle	>9% – very high grade ore

When adequate assay information was plotted blocks of ore were outlined on the mylar according to grade and rock type. By having the logs and assays in colour code on the same plan and knowing what types of ore went into the designated stockpiles, it was simply an "eye ball" task in producing the ore blocks. The blocks were labeled according to their stockpile destination. These outlined blocks or "dig packets" represented the actual mining blocks as they would be mucked and stockpiled. Numbered "geopoints" were drawn on the mylar at the intercies of the outlined blocks and then the coordinates were measured and delivered to the surveyors. They were responsible for shooting them in on the blast in advance of mining. The technician would then flag the blast to prepare it for mining.

The entire method described above for producing a blasthole bench master by hand can be done with the Gemcom software, combined with AutoCAD. The survey data is in a useable form without having to make plots for manual transfer (by implementing the previously mentioned numeric blasthole system the identifier of each hole can be recorded as the holes are surveyed). Assay information can be put on disk, formatted to a usable form and imported directly into the Gemcom software. Only the blasthole logs themselves would require manual entry in numeric code but would not be a complicated task. Ore blocks could be produced on the screen with geopoints, and the coordinates transferred back into the survey instrument. Plots could be generated for immediate use. The files created could be added to as new data arrives until a bench was completed and a final bench master could be produced.

An attempt at this idealized streamlined system was made in 1992, however, several problems were encountered that could not be rectified at the time. One problem was in the pit. The drill production could not stay far enough ahead of the shovel operation. Patterns were being drilled, blasted and mucked before all the required data was in. The drills would go down, water problems caused blasthole caving resulting in time consuming redrills. Tight spots slowed down drilling. In addition survey and assay data were sometimes late due to instrument or equipment trouble. Also, not all the Geology staff was adequately trained in the Gemcom and AutoCAD software. A domino affect was created that forced us back to a manual method. But these problems are not insurmountable and can be overcome.

Blasthole Database:

As the blasthole data was obtained it was entered into a Lotus Symphony database called BLASTDAT.WR1 (currently located in the Dell System 325 computer in E:\SYM\CURRENT\). It is very simple to use even with limited Symphony knowledge. The database is set up to record date of entry, phase, bench, blast, blasthole ID, grid dimensions, rocktype, density, tonnes/hole, coordinates, status, tonnes of metal and blasthole logs. Data entry must be made in the form environment (ALT F9). A volumetric calculation is used to calculate tonnage. The density used is a variable dependant on the Pb, Zn and Fe assays calculated by a regression formula (see appendix B). The grid dimensions of each blasthole are entered according to the blast design but should be checked against the survey pickup (highwall holes have different dimensions). A partial grid entry is used when a hole may be part waste. Each blasthole is designated a grade value according to the ore blocks marked out on the bench master. Blasthole logs are entered by code and cumulative depth to contact. Default values can be entered in the definition range. The file contains a "macro" (programmed key strokes) that calculates a weighted average for any selected phase, bench or blast. To invoke this macro type F7, DSUM and follow the prompts. As ore blastholes are being mucked in the pit each day, the status of those holes must be changed from broken to mined, adding the date (ie, BJUL23 changes to MJUL25). The tonnes and grade mined for the period can then be calculated using the DSUM macro. The calculation is then used to update stockpile status and mill feed (separate file).

The blasthole data were used to create a short range model in the Gemcom system. The data first had to be put in the PCXPLO format by extracting the desired range into a Lotus 123 file called DATASORT.WK3 located in E:\FORMS\ (same hardware). There are four macros in this file that must be invoked (ALT F3) in the order AUTO, IMPORT, SORTDATA, PRNT-EXP. The first adjusts the record number and clears the spreadsheet for new data. The second imports the selected records from the blasthole database. The third sorts the data into PCXPLO format and the fourth prints it out and exports it into an ASCII file where it is ready to be brought in to the PCXPLO database.

Any assay data delivered on disk from the lab was in ASCII format produced directly from the atomic absorption equipment. It did not yet have correction factors applied. It had to be put in a usable form with the help of a Lotus 123 file called ASSAYOR.WK3 located in E:\FORMS\ (same hardware) and is self explanatory.

Ore Flagging:

After the surveyors shot in the geopoints (usually as soon as the blast was shot and cleared), the geotech would flag the ore blocks for mucking. The flags used for the Vangorda and Grum pits were a firm vinyl plastic cut in triangular shape and in three colors, red – high grade, yellow – low grade and green – refractory. These flags were stapled on to lathe with 1/2" staples in various combinations and singularly. A supply was maintained in the core logging shed at Vangorda. A copy of the benchmaster showing the block outlines to be flagged was carried in the field for reference. The flags were placed a minimum of three meters apart for good resolution using the geopoints as a guide. They were adjusted for the heave of the blast and the direction that the shovel would be mucking. Any dozer work identified in the blasthole logs was done prior to flagging.

Dig Maps:

Dig maps were made for each blast and updated at the end of each twelve hour shift by the geotech. Copies were distributed to the shovel operators, pit shifters, geologists and shorrange engineer. They were produced on a 11" by 14" mylar by overlaying it on the bench master. As much information as possible was included on the map such as highwalls, section lines and grid, locations of dozer work showing depths to the ore or waste, stockpile destinations, sumps, ramps, geopoints and block outlines colored according to the flagging. An accurate face advance was drawn on at the end of each shift so that the oncoming shovel operator would know exactly what he/she had in front of them when they began their shift. The geotech would discuss the map with the shovel operator and shifter before the shift began and advise them of any potential problem areas and make arrangements for a dozer or backhoe.

Ore Mucking and Scalping:

The most important role of the geotech was the supervision of the ore mucking. This is where "the dollars were either stuffed in the mattress or burned in the fire". Each geotech would spend time with the shovel operator as they were mucking on an ore contact or any other problem area. It was beneficial to get the operators to know how to recognize ore from waste and identify dilution zones on their own because the geotechs weren't always around to watch. A radio call from a concerned shovel operator was all it took to save thousands of dollars in wasted ore. There was an established system of horn signals that the shovel operators would use to communicate with the haulage drivers to identify the stockpile destinations. One horn blast meant waste (sulphide or phyllite waste was established by radio), two horn blasts meant highgrade ore, three horn blasts was refractory ore, and four blasts was lowgrade ore. Because there were several stockpiles in each category the geotech would make a radio announcement to the haulage drivers designating the proper stockpile. The horn system worked alright but was far from perfect. At times the drivers did not hear all of the signal and the load went to the wrong location. Several times each shift the geotech would check all the dump locations for stray loads and take corrective action when necessary. A computerized dispatch system would be ideal to ensure loads were not misplaced.

The best way to prevent dilution was to expose the ore as much as possible with dozers and backhoes (scalping). The Grade Control Geologist would discuss the scalping operations with the shifters and geotechs. Timing was important and the shifters needed to know in advance so that the equipment would be available. Usually only short sections could be prepared at a time until the shovel advanced further ahead because the material generally had to be pushed over the face and long pushes with a dozer is not practical. Low angle contacts are best handled with a dozer whereas high angle contacts were exposed cleanly with a backhoe. The geotechs would discuss the geology with the operators and sometimes get ideas on how best to handle the project. Good communications and relationships with the equipment and shovel operators made a significant impact on ore recovery.

Stockpiles:

As many as seventeen separate ore stockpiles existed on the property in the latter part of 1992 containing in excess of three million tonnes. Ore was being mined in three pits simultaneously and was piling up fast. Areas for practical location were becoming a rare commodity. The requirement for temporary transfer stockpiles at Grum and Vangorda meant rehandling the ore as it was hauled to the concentrator. Not all of the transferred ore could be dumped directly into the crusher and therefore mill stockpiles for each plateau category had to be built to control the crusher feed blending. Maintaining an accurate account of the many various stockpiles was very important and required complicated spreadsheets and databases. As the needs for new and different stockpiles grew the system was rewritten again and again.

The Vangorda and Grum ores were stockpiled separately on transfer pads where a contractor would load a fleet of eighty ton trucks and haul it the fourteen kilometers to the mill. There were five ore stockpile categories for each pit, which are listed below.

category	description
G1	high grade massive sulphides
G2	high grade carbonaceous quartzites
LgG1	low grade massive sulphides
LgG2	low grade carbonaceous quartzites
R	refractory high & low grade sulphides

Three large low grade stockpiles containing Faro pit ore exist near the edge of the pit;

category	description
LgA	4–5% Pb+Zn massive sulphides
LgL	3–4% Pb+Zn massive sulphides
LgC	4–5% Pb+Zn carbonaceous quartzites

Oxidation in these stockpiles causes flotation problems and would possibly have to be screened before feeding to the mill.

Blending restrictions, head grade requirements, and ore availability governed the stockpile situation near the primary crusher. At one time we experimented with "blended stockpiles" where a two pile system was used. Each of the two stockpiles was constructed with layers of different ore in varying thickness (depending on the metallurgical characteristics). While one pile was built a loader would feed the crusher from the other. This system worked very well until some unidentified refractory ore was put in one pile and feed could no longer be taken from it. It caused conjection and as a result each ore type was piled and blended separately until the contaminated pile was slowly fed through.

Stockpile Management:

As previously mentioned, several computer spreadsheets and databases were made to manage the ore flow to and from transfer and mill stockpiles. The latest version used was a Lotus 123 spreadsheet located in the CVR AST 486/33E computer in F:\MILLFEED\DAILY.WK3. A blank form, WKFORM.WK3 is found at the same address. This file combines the daily and weekly forecasts with the stockpile inventories and cannot be described in detail here. A new user with 123 knowledge would need to study the spreadsheet and figure out how it works.

Information from several sources must be gathered each day. The previous days' mined reserves are found using the blasthole database (5% dilution applied at this point). The ore haul from the plateau to the crusher and crusher stockpiles is obtained from the contractor (scaled tonnes). The crusher feed from each stockpile is found on the mine operations shift report (it is very important that the loader operator keeps an individual count from each feed stockpile, using the ratio the tonnes from each are found by reconciling to the rod mill feed). Grade calculations are weighted averages based on a "last in, first out" scenario, due to the way the stockpiles are usually built. Stockpile inventories and grades must be updated daily in order to accurately predict the headgrade to the mill and to make shortrange forecasts. Active stockpiles are surveyed at the end of each month and the tonnes are calculated using a calculated density based on the average Pb, Zn and Fe grades of the pile (regression formula). Large discrepancies are then reconciled.

The stockpile categories and requirements for the Grum pit will undoubtedly continue to change as the pit is mined. The methods for keeping track of ore flow will change with it but will actually become much simpler once Faro and Vangorda stockpiles are gone.

Forecasting:

Predicting headgrades to the mill was done for one, two, four and six week periods to check if budget targets could be attained. If rod mill throughput and/or mining slowed for what ever reason, it directly affected the headgrade required to maintain the budget target. We had to find out how things would be affected down the road.

The Engineering Department would redo the mining sequences and the ore release (tonnes and grade) were calculated from the model for each sequenced block. The updated stockpile inventories were entered into the equation and by knowing what ore would be released, and when, a forecast was made. Weekly forecasts were the most important as they were the first indicators when problems arose. By monitoring actual vs predicted headgrade and ore release on a daily basis according to the weekly forecast, action could be taken as soon a problem was identified.

Ore Blending:

The most challenging aspect of grade control was maintaining a consistent blend of rod mill feed. The flotation circuit demanded a steady flow in order to achieve the maximum concentrate grades and recoveries. Satisfactory concentrate grades were 50% Zn in the zinc con and 60% Pb in the lead con with recoveries of 80% or better.

Each ore type has its own metallurgical characteristics. Massive sulphides will float much better than carbonaceous quartzites (type 2). As a general rule, no more than 20% of the rod mill feed can be type 2, Refractory ore (screened), no more than 5%. An ore blend was established each day based on the weekly forecast. Although the blend may have fluctuated slightly day by day, at the end of the week the quantities of each category fed to the mill usually matched closely with the weekly forecast. Close communications were maintained with the mill metallurgist. When a flotation problem occurred the Grade Control Geologist was notified and a sample from the rod mill belts was taken and observations made to see if it was indeed the ore causing the problem. On many occasions a flotation problem was the result of an internal problem in the mill. But if it did appear to be ore related a change to the blend was made. Only the Grade Control Geologist or the Chief Geologist were authorized to order a blend change (instructions on alternative blends were given to the geotechs on night shifts and weekends).

Experience gained from observing the results of various blend combinations resulted in a "feel" for the ore. One would get to know what combination would perform satisfactorily and by watching and checking the mill stockpiles regularly, potential problems could be averted before any serious consequences happened.

Wet ore put through the primary crusher proved disastrous. Screens and shutes would plug solid in the secondary crushing circuit and the ore would either freeze or plug in the fine ore bins. This was a bad problem in the spring when the ore coming from the pit was usually wet from melting snow and a rising water table. Direct dumping of the 80 tonne trucks had to stop completely and an alternative blend using one or two loaders tramming a bucket at a time in the crusher had to be set up with whatever dry ore was available (usually low grade massive sulphides from the Faro pit ore stockpiles). The wet ore literally had to be "chased" through the crushing circuit with dryer material. This did however affect the head grade and put a kink in the plan, but at least ore was able to be fed.

The long haul from the Plateau to the mill was organized by the Grade Control Geologist. Each morning the contractor was notified as to what ore they would be hauling and how many trucks out of the fleet could dump directly to the crusher (it was desirable to have as many as possible dump direct but the flotation circuit did not always permit it). Blends could sometimes be set up on the plateau side with the ore haul, but to maintain control every single load had to be dumped direct, otherwise the sequence went out of whack. Because of the "highball it" attitude of the long haul contractor, slower trucks would cause the fleet to bunch up and as one was dumping in the crusher another came in right behind him and would dump to the pile, instead of waiting for the crusher pocket to clear. Unless the loader at the crusher could somehow compensate for this, the consistency of the blend was lost.

When the Vangorda pit is completed and the last of its ore fed, the Grum pit will be on its own to supply a satisfactory feed. There will definitely be problems at this stage due to the large quantities of type 2 ore. Stockpiling and blending techniques will have to be modified as well as having a new regrind circuit put in the concentrator. The type 2 ore could possibly be segregated into two or more categories based on texture alone. The transitional behavior of the rock from quartz and pyrite rich to quartz and pyrite poor (grading towards the carbonaceous phyllite contact) may allow a stockpile separation of the highgrade G2 into separate categories. Innovative grade control ideas will none the less come about and satisfactory flotation of the Grum ores will be successful.

Month End Reconciliation:

Ore mined, stockpiled, and milled are reconciled at the end of each month. An inventory balance must be maintained by making necessary positive or negative adjustments at some point in the ore flow process. The mill feed was the benchmark in the process and considered untouchable. Stockpile surveys had a margin of error as well as the volumetric calculations in the blasthole database. By the end of a twelve month period however the positive and negative adjustments, for the most part, cancelled each other out with only minor shuffling of tonnes and grade from one stockpile to another.

CONCLUSION

The procedures and systems for grade control in the Faro and Vangorda pits worked well. The Geology Department operated as a team and positive results were achieved. The department had one of the lowest rates of employee turnover within the Faro Operations. There was always room for improvement (as were pointed out) and there will always be room for improvement.

The future of grade control in the Grum pit depends largely on the streamlining of data processing for faster and less labour intensive office activity. The "hands on" approach in the field will continue to be a key factor in maximizing grades and recoveries both in the pit and concentrator.

With proper initiative, training and innovation the success of the Grum operation is inevitable.

Appendex B

The regression formula used to calculate Specific Gravity was:

$$((2.430 + (0.05 * \text{Pb assay}) + (0.02 * \text{Zn assay}) + (0.054672 * \text{Fe assay})) * 0.98$$

Where 0.98 is the porosity factor

The formula is entered in the default range in the blasthole database,
BLASTDAT.WR1

GRADE CONTROL AND RECONCILIATION

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1.0 THE PROBLEM

Many of the open pit gold mines in Australia suffer from lack of reconciliation between in-pit estimates and actual head grades delivered to the mill. This is often despite adequate grade control sampling and, very often, good geological control. The problem is usually one of dilution. That is head grades are lower than predicted.

The need to quantify dilution, both internal and external, is well known as an important factor in production forecasting. Of course the dilution factor depends on the physical parameters of the orebody. For example, the more complex the geometry of the orebody, the more potential dilution there is likely to be when mining. The dip of the orebody has a bearing on how much dilution will be incorporated within a given bench height. Smaller benches allow more control and hence less dilution. The mining method in general will affect how selective the operation can be.

What exactly is dilution? This term is a convenient explanation for a host of complex relationships giving rise to the observed phenomena.

2.0 THE CAUSES

2.1 Bias

The first and most obvious cause for concern is bias in the sampling program. For instance in certain cases blast hole sampling may consistently under or overestimate the actual grade of an orebody. A thorough investigation early on during feasibility studies involving analysis of different size fractions, replicates and sample masses would determine whether bias is likely. A common problem area is where coarse gold or small scale structures exist. The most accurate representation here is given by sample masses large enough to incorporate such structures. If sample masses are too small the tendency will be towards negative bias, giving the opposite of dilution, that is consistently higher grades when mined. Another problem often encountered is consistent bias in the opposite direction. Blast holes can give a higher grade than actual. This exaggerates the effect of dilution. Sampling bias is probably the most difficult error to measure and certainly warrants careful consideration during an early stage of mining.

Figure 1 illustrates the difficulty in attempting to reconcile

predictions from drillhole sampling. Although the Fe grade vs Fe cutoff curves are similar in shape blocks predicted from blast hole grades are consistently higher than blocks predicted from drillhole predicted grades. There exists an overall bias. The two estimates cannot be reconciled. A decision must be made to correct one set of sampling.

2.2 Regression Effect

Dilution is also partially explained by the so-called regression effect. This is the relationship observed empirically during many years of mining whereby in low grade areas sampling underestimates actual grades mined and in high grade areas it overestimates head grade. This is due to the fact that the mining blocks have a different distribution of average grades compared with the distribution of sample grades. Thus when a cutoff is set on sample grades a different effective cutoff is imposed on actual block grades. Figure 2 illustrates the ellipse containing the scatter of points found when actual block grades are plotted against sample grades. There is a regression relationship between actual and estimated grades which is not a 1:1 relationship. A given cutoff applied to samples corresponds to a different effective production cutoff on block grades. The actual grade and tonnes above cutoff depend on the distribution of block grades and the regression relationship between true block grades and observed sample grades.

2.3 Variance-area Relationship

This leads to concern about the size and shape of the samples compared with the blocks being mined. Obviously there is more variability between sample grades than between mining block grades. Large blocks will tend to be less variable than small blocks. Less selectivity can be practiced on large blocks and hence there is more dilution. If the cutoff grade is below the mean grade blocks have more tonnes at lower average grade than samples (Figure 3). The opposite is true if the cutoff grade is higher than the mean grade. This is the variance-area relationship and it explains the degree of the regression effect. Figure 4 illustrates the distribution of sample grades compared with selective mining unit grades showing the smoothing or decrease in variance of mineable blocks.

2.4 Nugget Effect

Mining decisions are based on blocks estimated from sample grades. How certain can we be about the representativity of individual sample grades, assuming there is no consistent bias? Sampling error or "background noise" can be a problem. Even samples from the same location can be variable. The inherent variability or nugget effect is most serious where there are small scale structures such as coarse gold giving rise, say, to differences between samples from two halves of a split core.

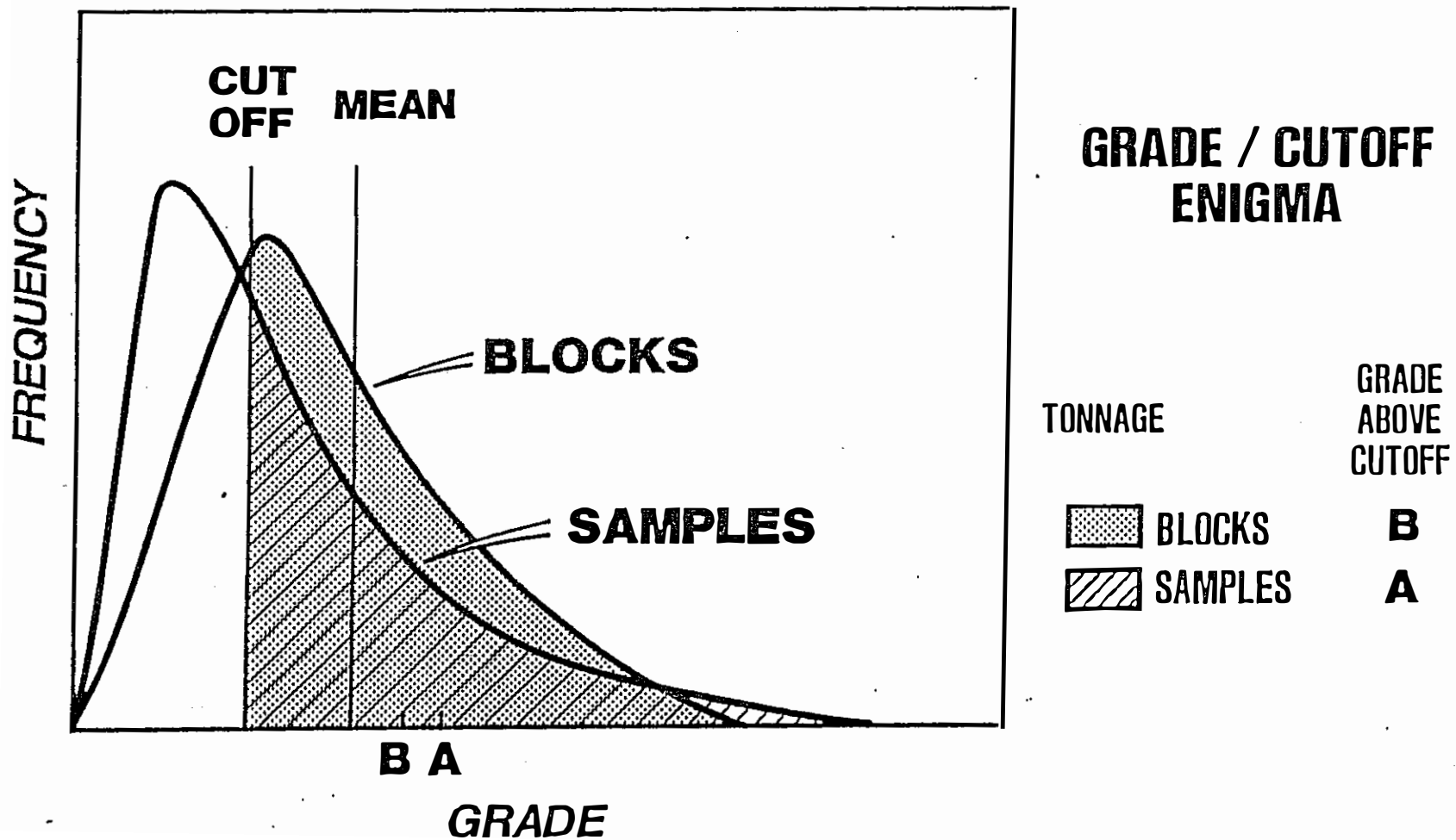


Figure 3 illustrating how for the same cutoff grade blocks have more tonnes at lower grade than samples.

3.0 THE CRITICAL PARAMETERS

The parameters of concern when attempting to reconcile production with forecasts thus include the following:

- Block size and physical parameters
- Cutoff grade
- Head grade
- Tonnage

The block size controls the amount of selectivity possible. Larger blocks have more internal dilution. Hard rock mining is susceptible to more external or mining dilution than soft rock.

Cutoff grades should be applied to blocks rather than samples where blocks represent a selective mining unit.

The head grade incorporates both internal and mining dilution but not mill recovery. Tonnage is measured by weightometer.

4.0 THE SOLUTION

One should thus place a great deal of emphasis on the calculation of block grades to match the degree of selectivity achieved. Successful prediction above cutoff depends on incorporating all these known issues in arriving at a recoverable grade and tonnage estimate. The issues to be considered in calculating the recovery of selective mining units include

- sampling method
- frequency distribution of grades
- continuity of mineralization
- mining method
- interpolation method

4.1 Frequency Distribution

The frequency distribution of grades is important to consider. For example one should check for normality or log normality and for mixed populations. Every effort should be made to separate geological domains in cases of bimodal grade distribution. If data is not normally distributed appropriate steps should be taken to account for deviation from normality. Figure 5 presents log-probability plots for a single lognormal distribution and for two mixed lognormal distributions. Figure 6 gives a bimodal histogram of $\text{SiO}_2\%$ derived from a mixture of banded iron formation and goethite.

4.2 Continuity of Mineralization

Geological continuity can be quantified using semivariogram analysis. This defines not only the overall variability but also the range of influence in given directions and the nugget effect. Figure 7 is a semivariogram plot showing that at small distances samples are correlated. The range of influence is 12 m. Beyond 12 m there is once more an increase in correlation (decrease in semivariogram value) illustrating a hole effect. This semivariogram is typical of the continuity found in a direction

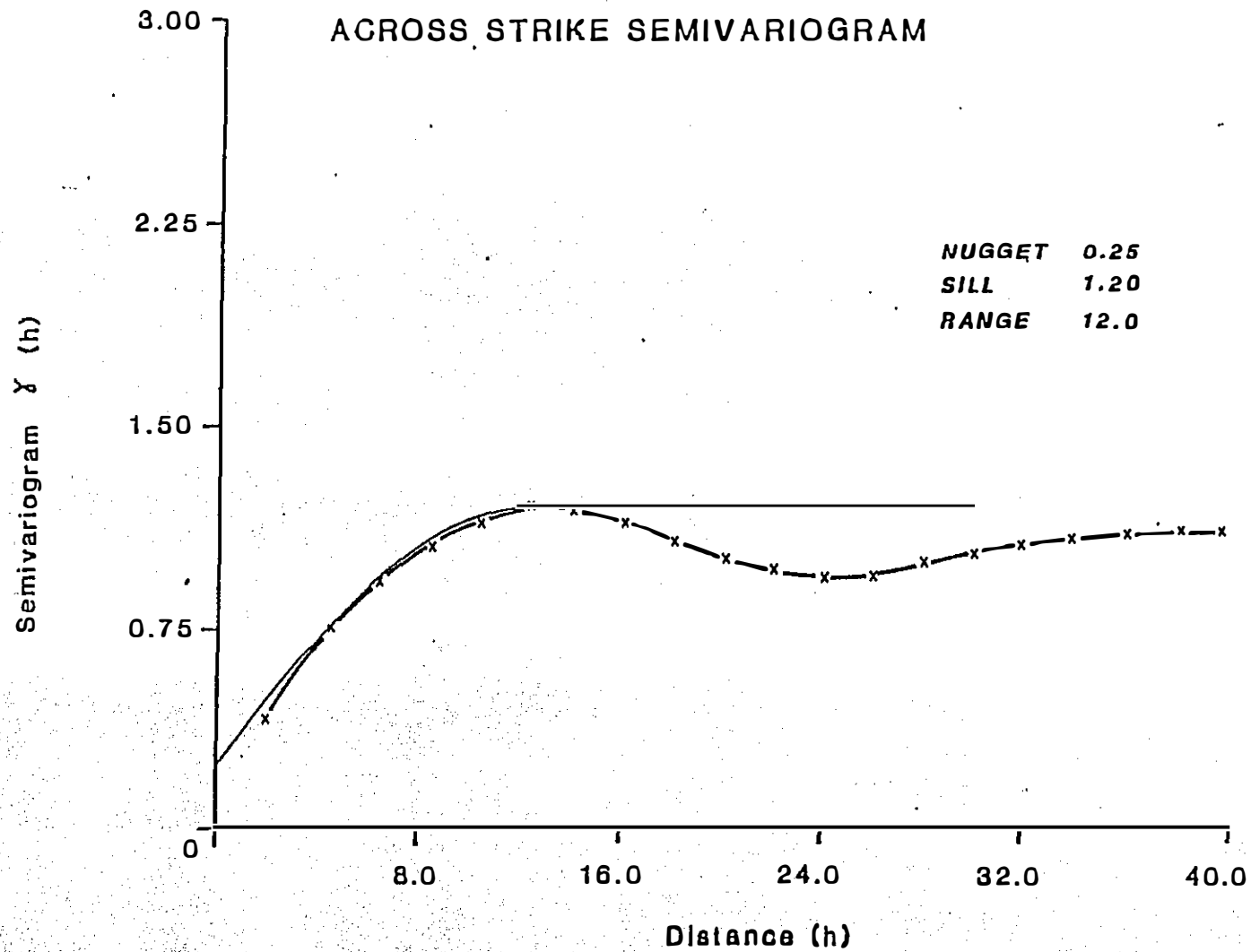


Figure 7 Across strike semivariogram illustrating hole effect

perpendicular to strike. The nugget effect is the degree of inherent sampling error.

Geological continuity has a direct bearing on the magnitude of the variance-area effect for a given block size and mining method. The orebody structure, hardness of the rock and size of operating equipment, together with the overall scale of operation all influence the size of the selective mining unit.

4.3 Interpolation Method

The interpolation method needs to take account of this interwoven complexity of relationships. Estimation can be improved by reducing the variance of estimation hence reducing the regression effect. Economic cutoffs should be placed on selective mining units, not sample grades. Appropriate smoothing techniques such as inverse distance weighting, or preferably kriging, can assist in creating a block model for which grade/tonnage relationships more realistically predict actual production.

5.0 RECONCILIATION

Many reconciliation anomalies are readily explained by the variance-area relationship and the regression effect. Production grades and tonnages defined as polygonal estimates are accurately predicted at a 1 g/t cutoff in Figure 8.1. At a 1.5 g/t cutoff the deviation from production is marked. In both situations the kriged blocks accurately reflect the tonnes and grade produced. However there is a marked difference between the cutoff set on blast holes and the effective production cutoff on blocks. A 1 g/t blast hole cutoff equates here to a 1.67 g/t block cutoff and a 1.5 g/t blast hole cutoff to a 1.8 g/t block cutoff. In both cases the cutoff on blast holes represents a much higher cutoff on selective mining units. It makes economic sense to lower the block cutoff hence expanding the reserve considerably in this example.

Figure 9 reinforces the grade/cutoff relationship by comparing the grade/tonnage relationship for selective mining estimates with that of bulk mining blocks. Selective mining above 0.5 g/t achieves similar tonnes and grade to bulk mining above 0.7 g/t.

The classification of ore and waste is sensitive to whether the cutoff grade is based on sample grades or on true block grades. Figure 10 illustrates how true waste blocks can be classified as ore on the basis of sample grades and how true ore blocks can be discarded as waste. This is because of the regression effect. In order to minimize the areas of error the estimation of blocks needs to be improved, leading to a tightening up of the variance of estimation as illustrated in Figure 11 and hence to less potential misclassification.

In conclusion it should be emphasised that grade control can be carefully monitored and reserves can be optimised by applying careful consideration to the factors described. An understanding of the grade/cutoff enigma and the role of block variability can go far towards assisting in the calculation of recoverable reserves and in reconciling various estimates with production

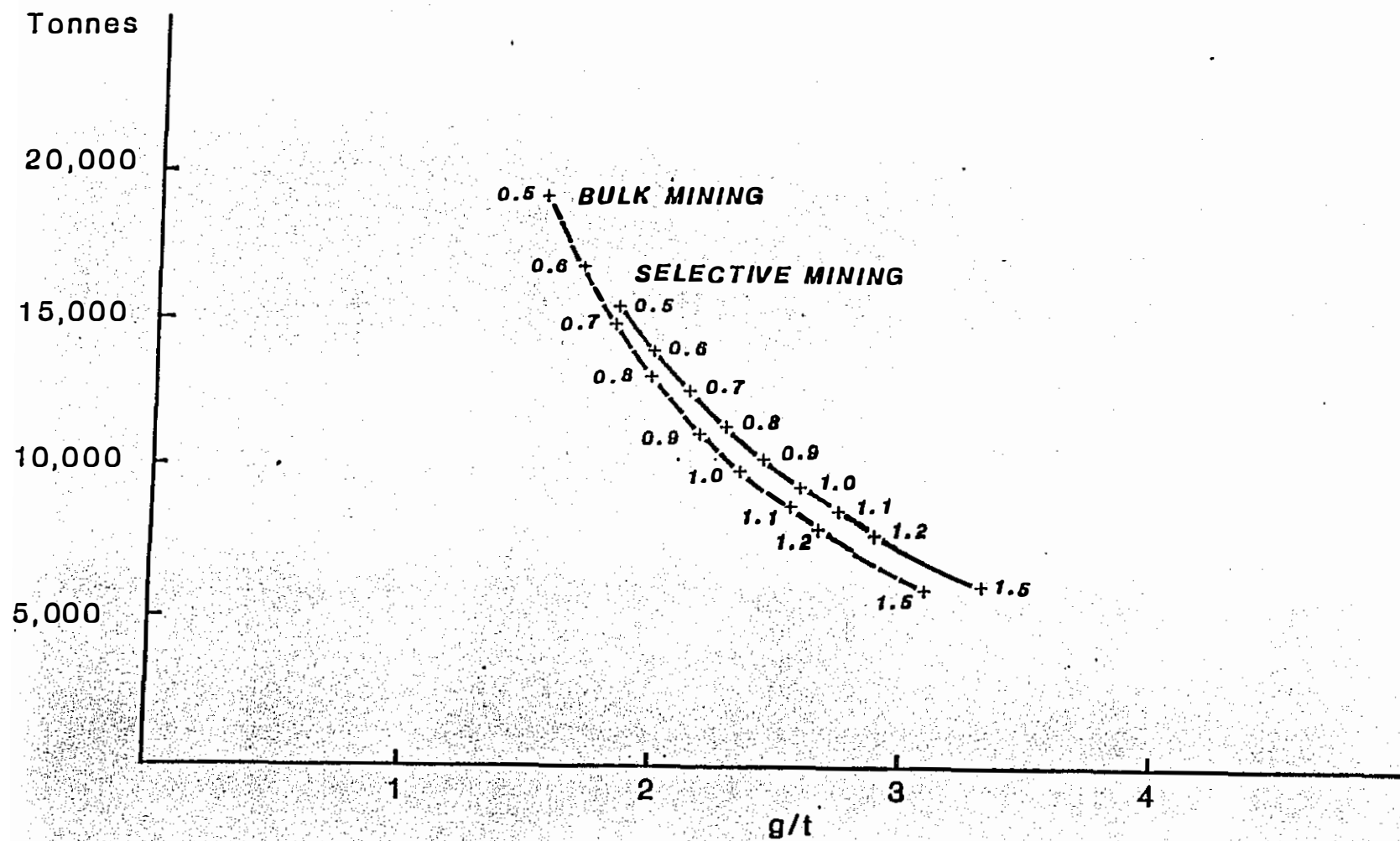
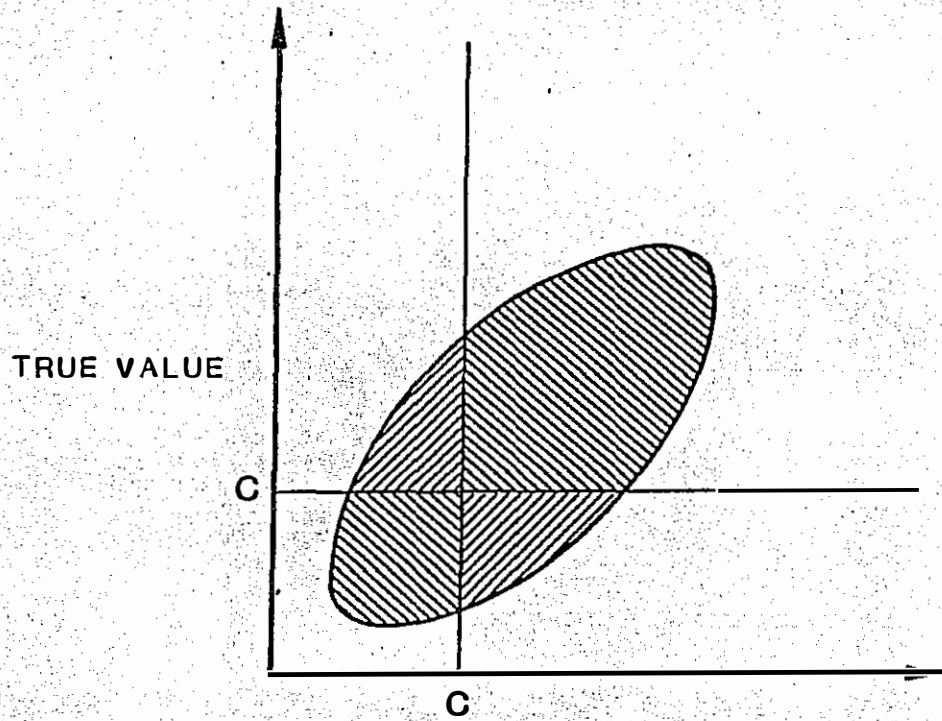
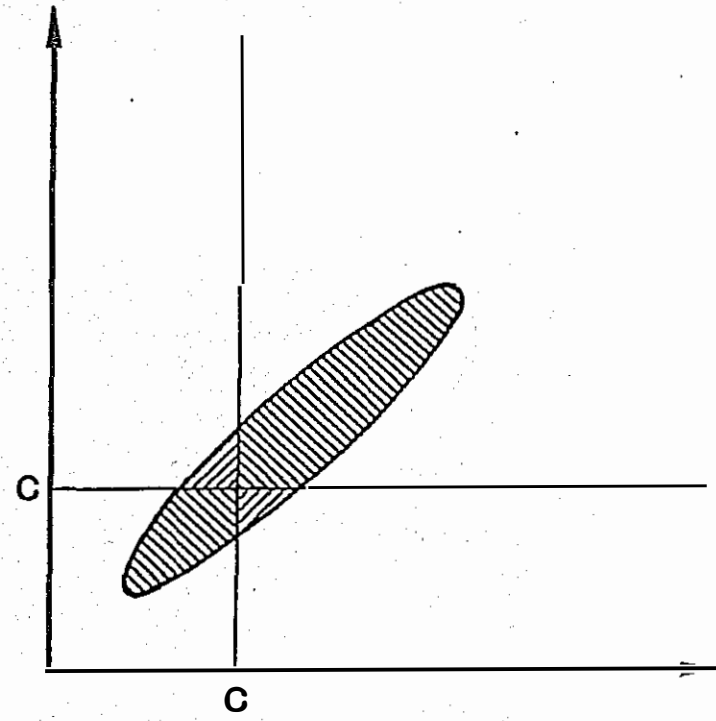


Figure 9 Grade tonnage relationship for Bulk and Selective Mining Units

POOR ESTIMATION



IMPROVED ESTIMATION



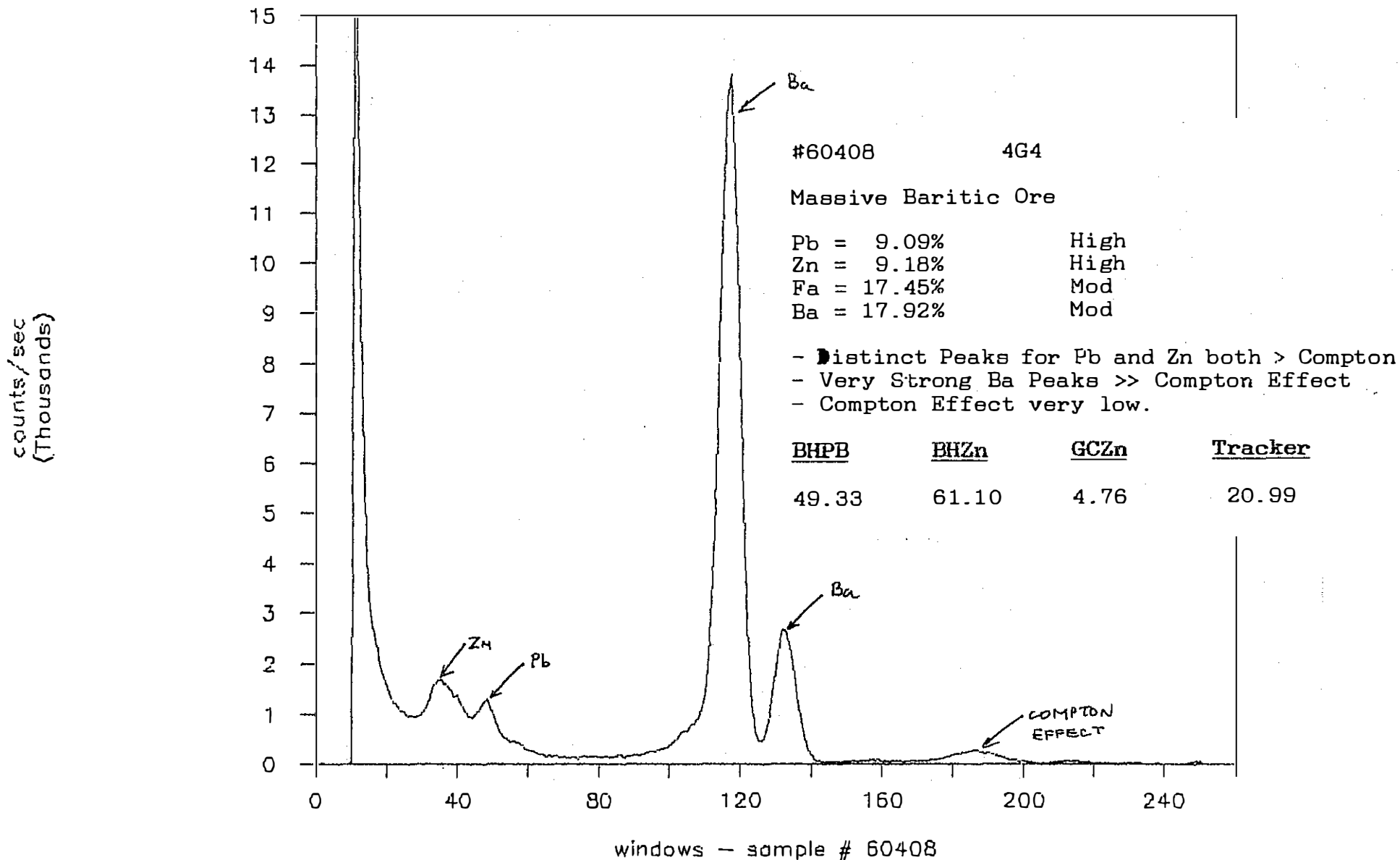
ESTIMATED VALUE

FIGURE 11

EFFECTS OF IMPROVED ESTIMATION

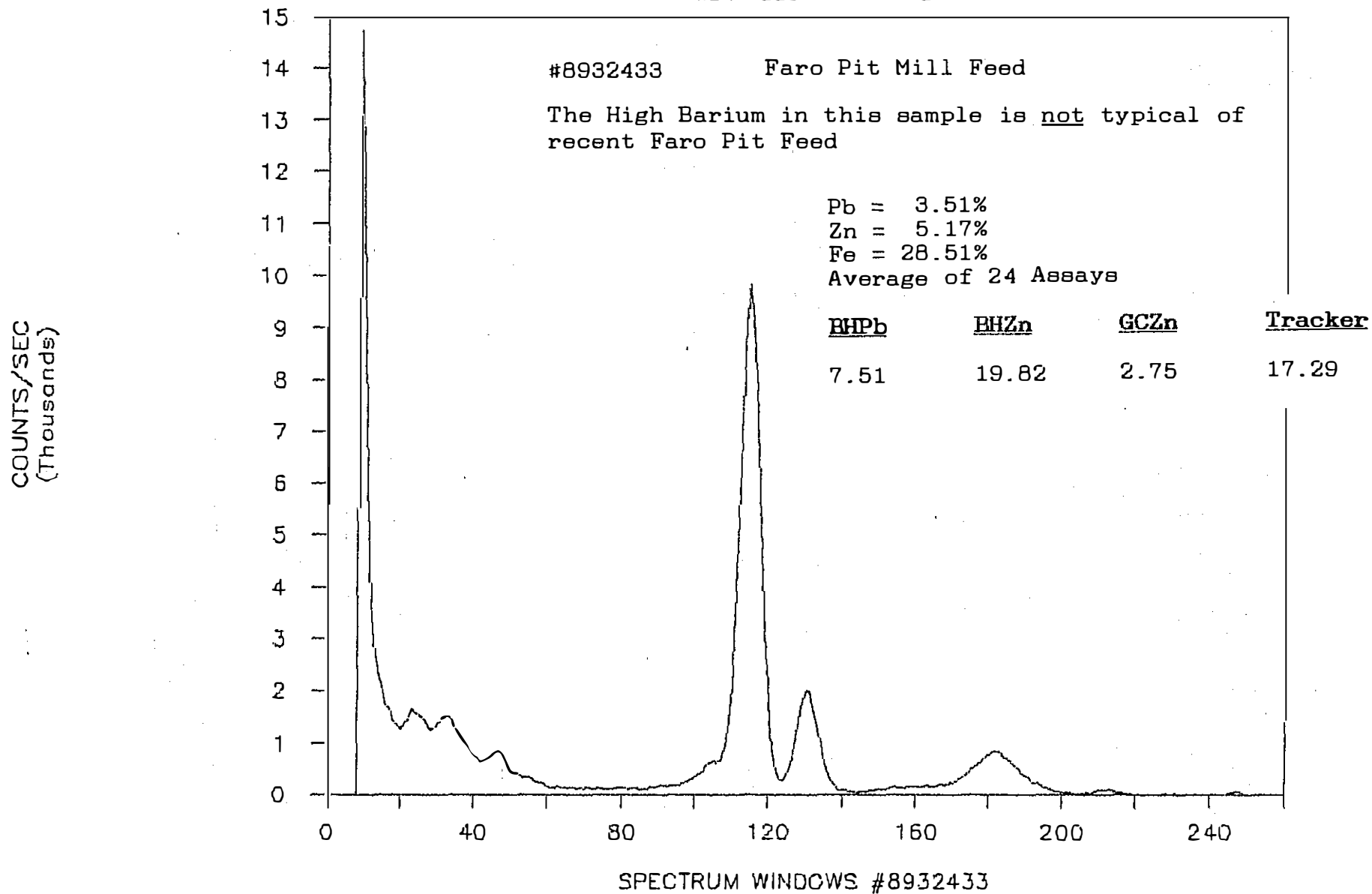
MAP3 XRF ANALYSER

SPECTRUM VANGORDA BARITIC ORE



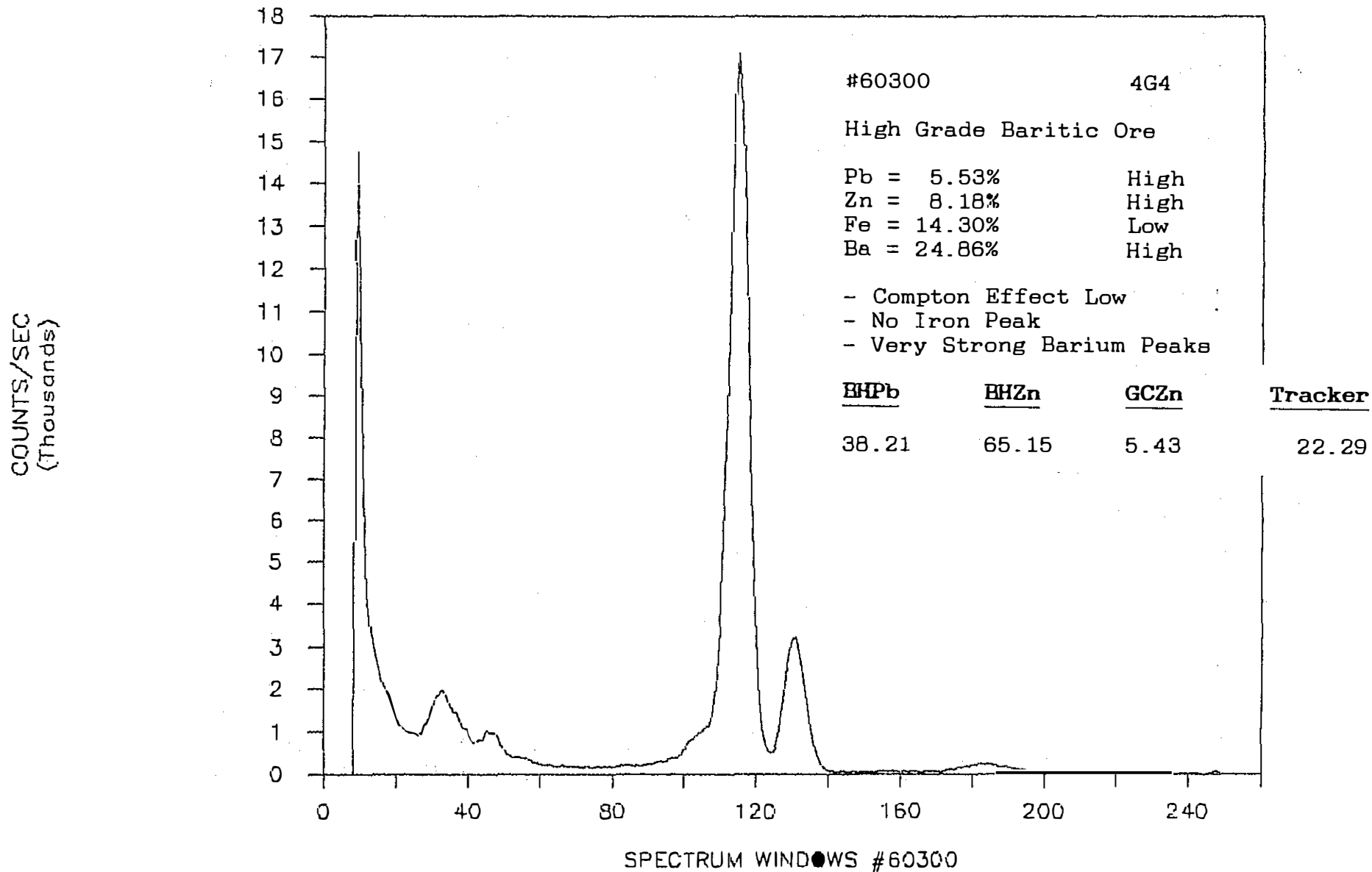
MAP3 XRF SPECTRUM

MILL FEED FARO ORE



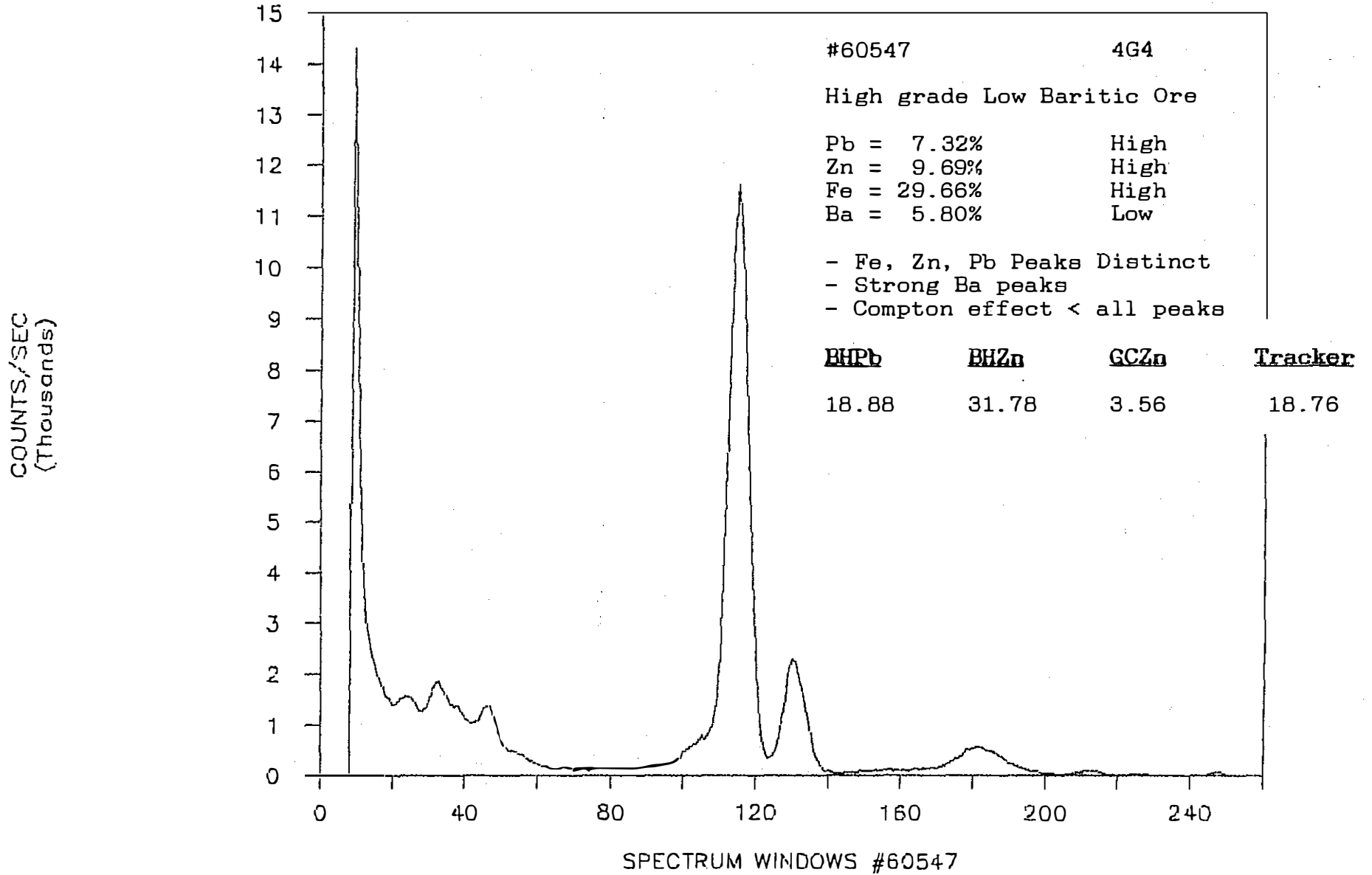
MAP3 XRF SPECTRUM

BARITIC ORE



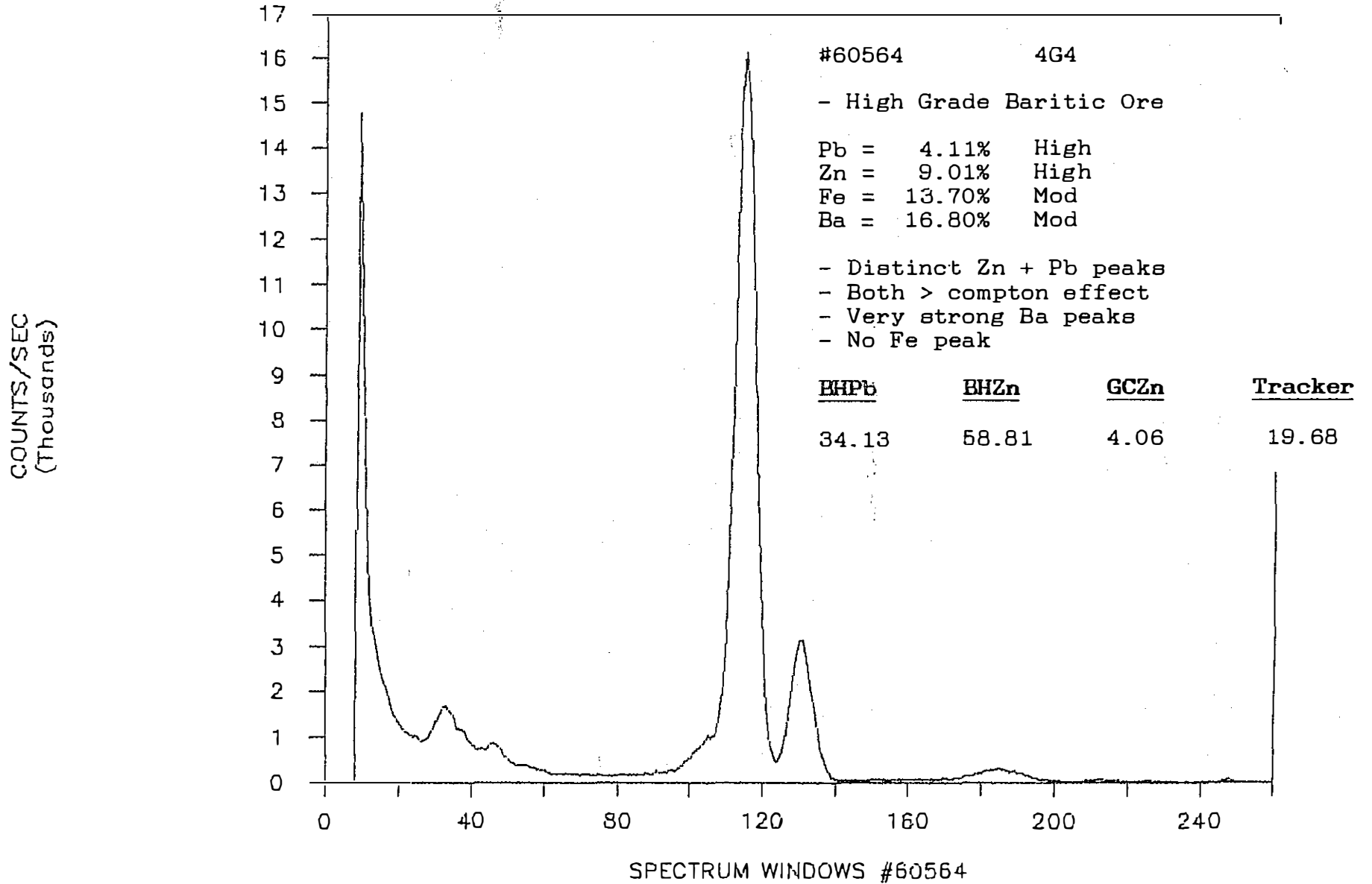
MAP3 XRF SPECTRUM

BARITIC ORE



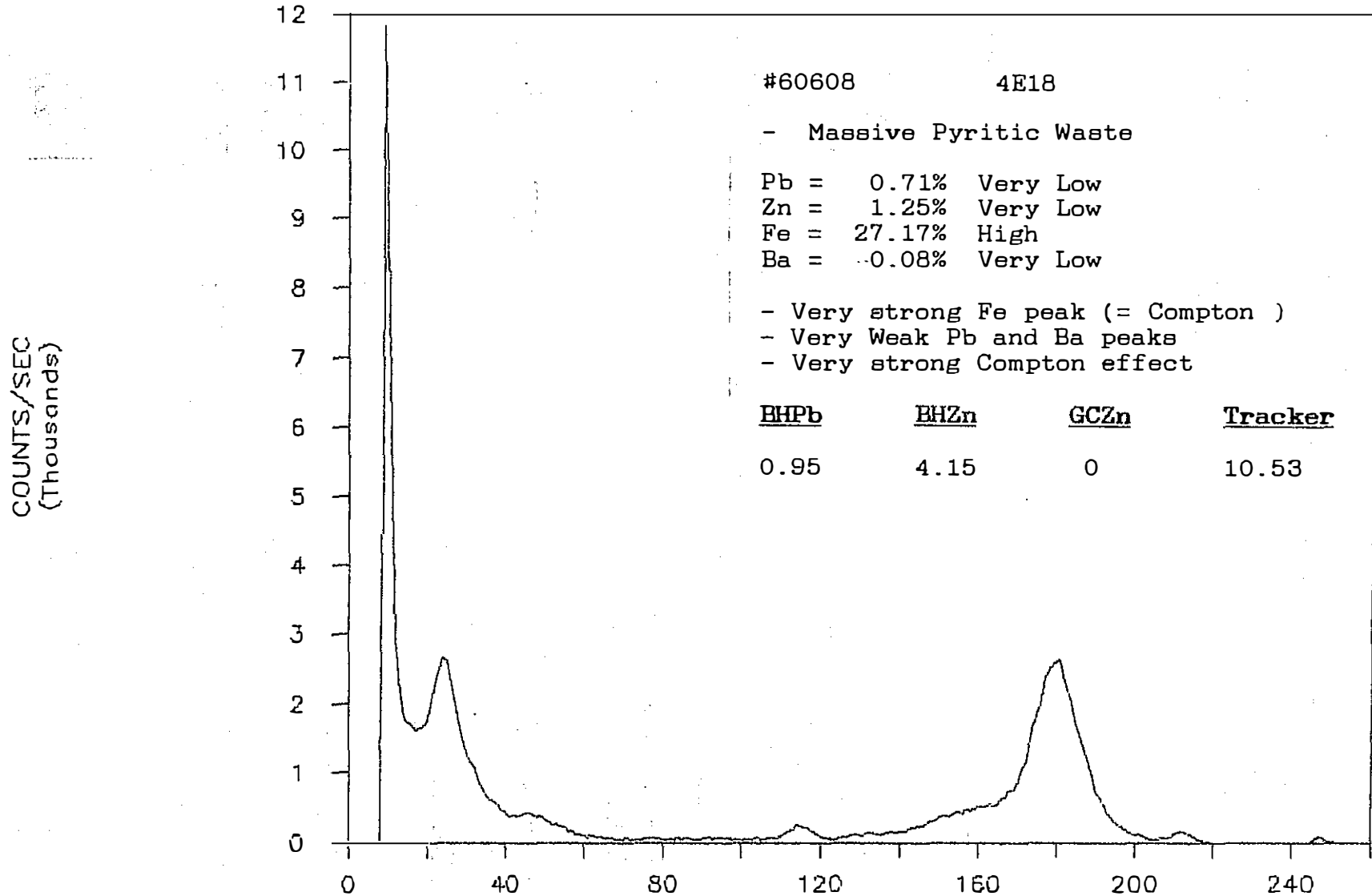
MAP3 XRF SPECTRUM

BARITIC ORE



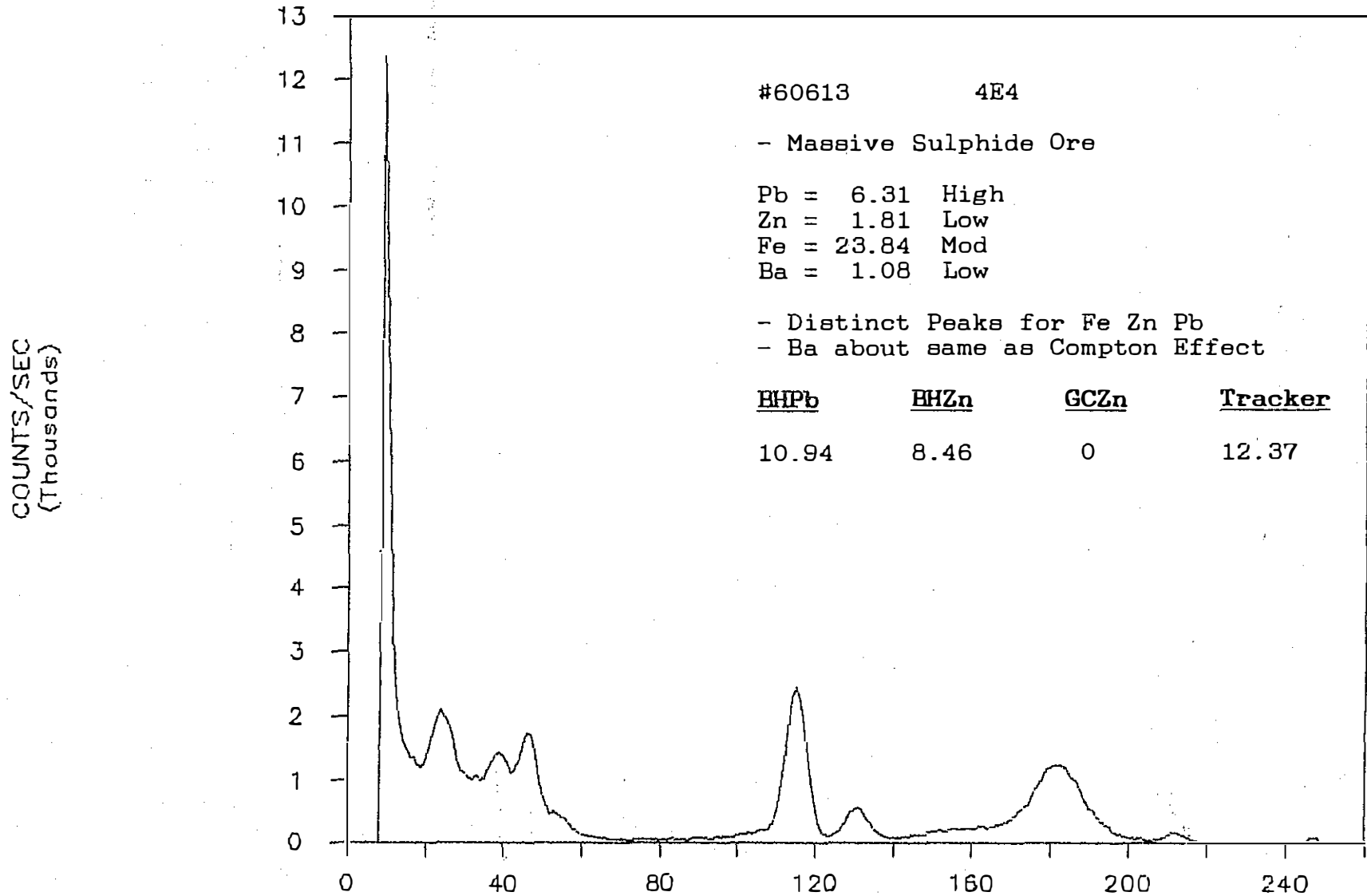
MAP3 XRF SPECTRUM

MASSIVE PYRITIC WASTE



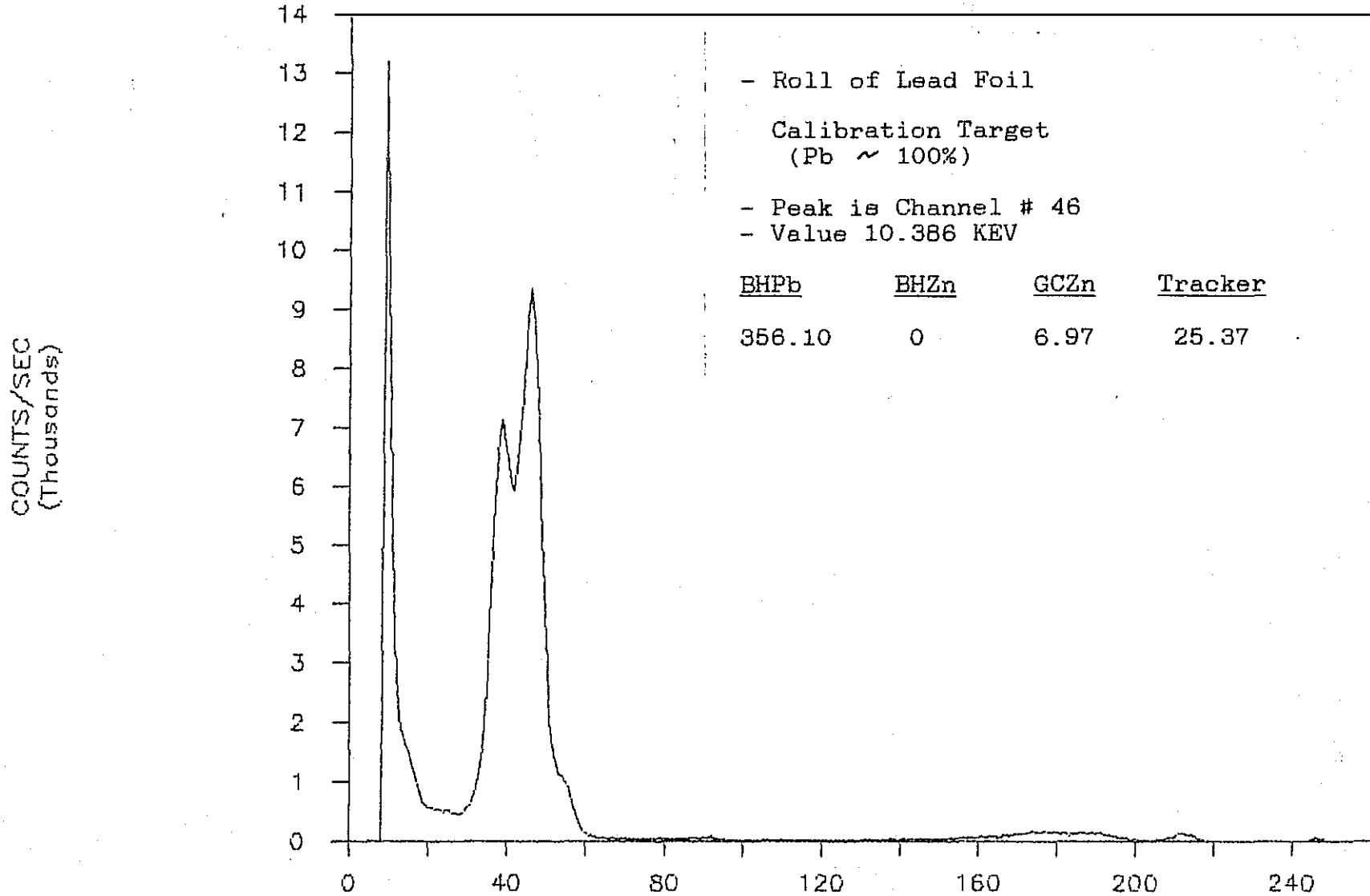
MAP3 XRF SPECTRUM

MASSIVE PYRITIC ORE



MAP3 XRF SPECTRUM

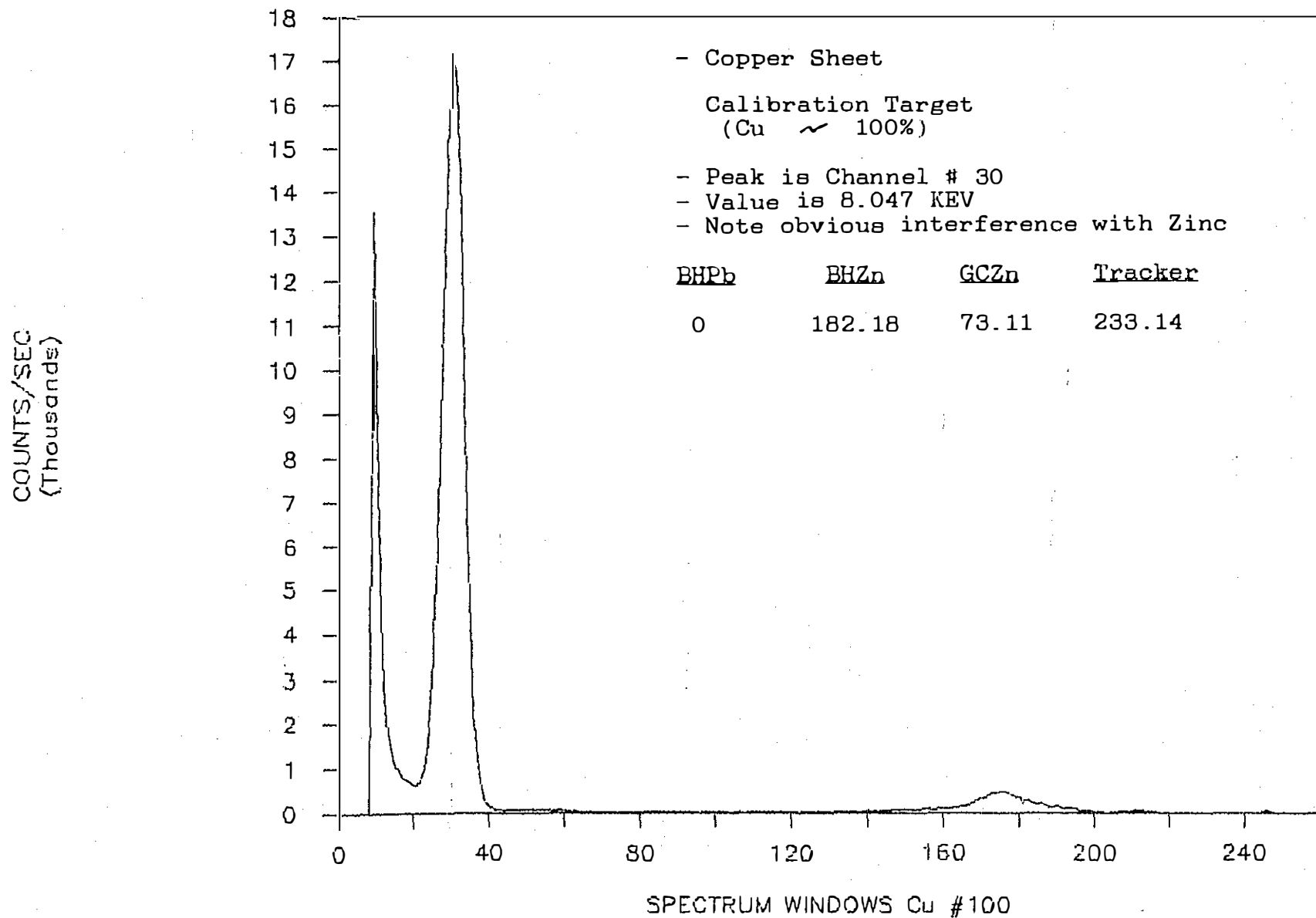
TARGET - LEAD FOIL



SPECTRUM WINDOWS Pb #101

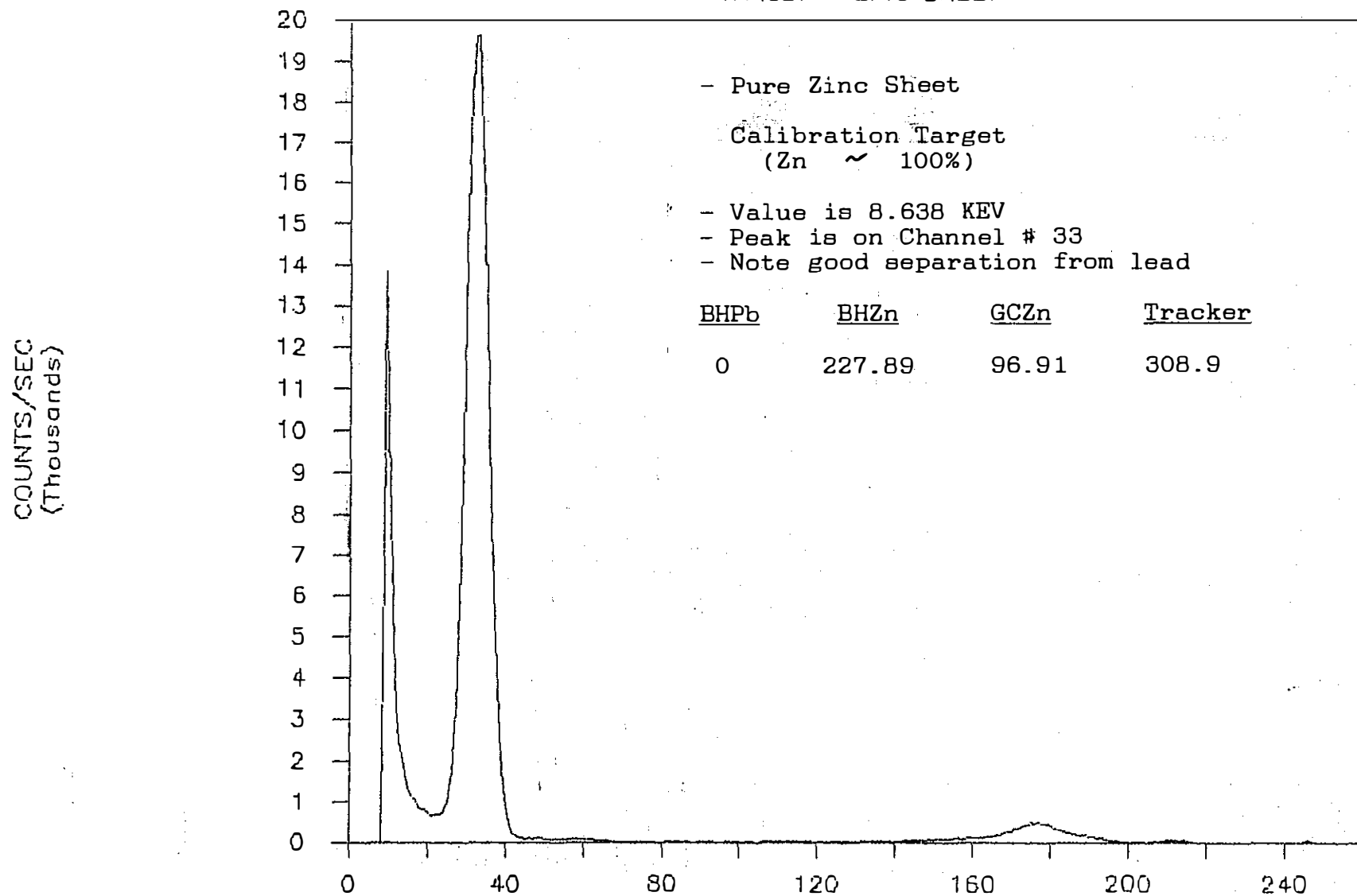
MAP3 XRF SPECTRUM

TARGET - COPPER SHEET



MAP3 XRF SPECTRUM

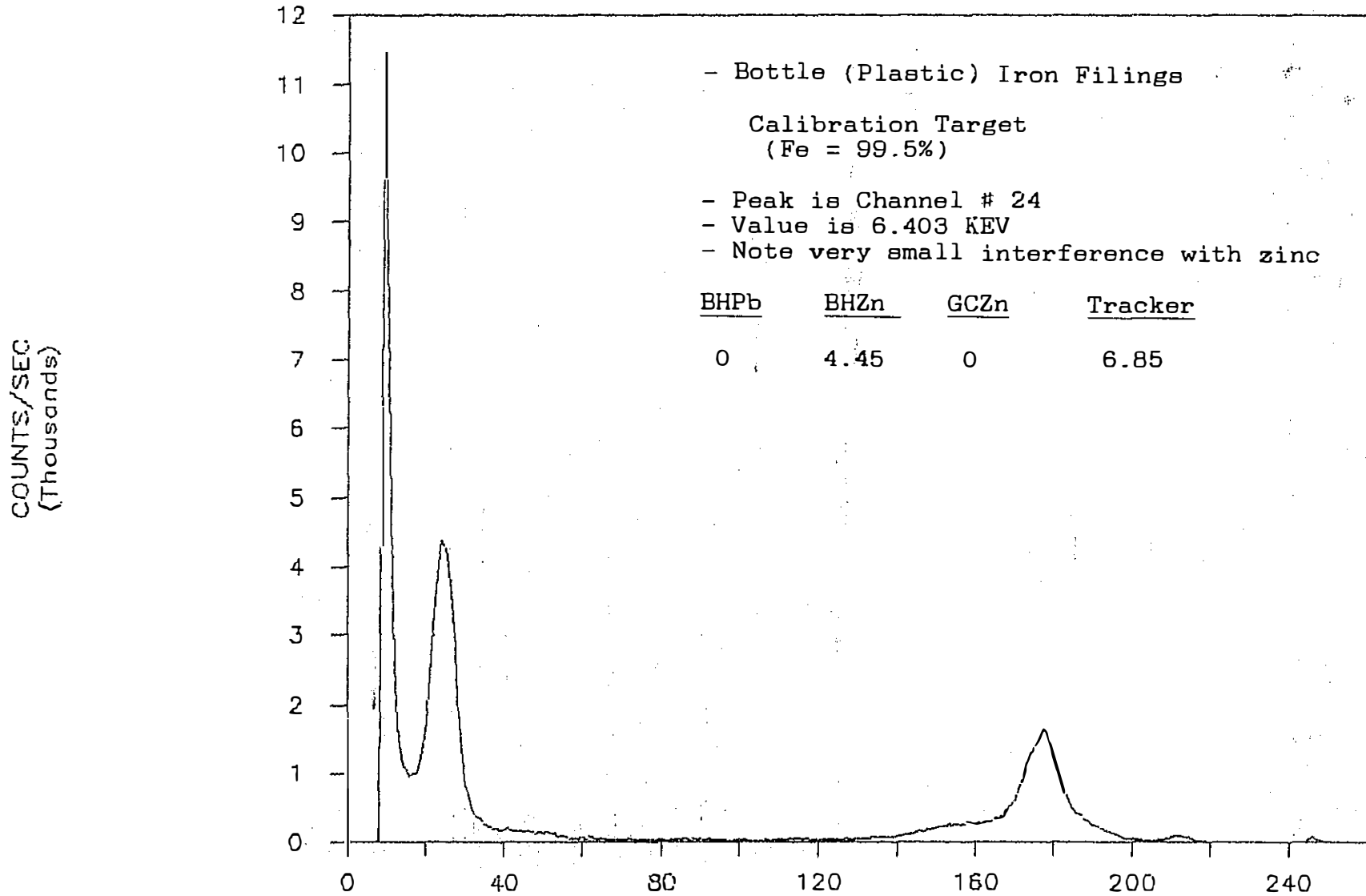
TARGET - ZINC SHEET



SPECTRUM WINDOWS Zn #102

MAP3 XRF SPECTRUM

TARGET - IRON FILINGS



SPECTRUM WINDOWS Fe #103

APR 11, 1995

1. Analysis of the Orientation of Planar Surfaces
by using computer program "DIPS"
 2. Checking & Monitoring the Production figures such as
the amount of ore, waste, sulfide waste, till per
day and of which amount is dumped or removed
by truck → Refer to Joe Vandebroek
- ★ Total blasted tonnes x grade from the start
" trucked tonnes x grade "

139 ~ 186

APR 20, 1995

BENCH	FEATURE	DIP	AZIMUTH	REMARKS
4139 1252	S ₂	22	252	?
5160 ~ 1258	"	16	284	
	J	72	148	
	"	82	134	
	"	80	072	
	"	84	138	
3141	S ₂	12	232	
4142	"	22	236	
5143	"	24	266	
	J	62	050	
	"	74	352	
	"	54	056	
	S ₂	18	246	
5145		22	254	
5146		22	248	
2147		24	228	
3148		14	226	
4149		16	232	
4517		10	245	
5151		16	254	
4152		18	243	
4153		14	248	
4154		16	234	
4155		12	222	
4156		18	254	
4157		20	236	
4158		12	248	
4159		12	240	
4160		22	280	

BENCH	FEATURE	DIP	AZIMUTH	REMARKS
1252	J	65	012	
	"	52	162	
161	S ₂	20	270	
162	"	28	274	
163	"	24	284	
164	"	30	264	
	F	60	012	
165	S ₂	24	262	
166	"	15	268	
167	"	20	248	
168	"	16	252	
	J	32	020	
	"	60	022	
169	S ₂	16	256	
170	"	15	262	
171	"	24	248	
	F	30	028	
	"	30	010	
	"	32	010	
172	1264 S ₂	20	270	
173	"	18	266	
174	"	26	262	
	J	54	030	
175	S ₂	24	260	
	J	40	012	
	"	60	220	
	"	62	220	
176	S ₂	18	276	
177	"	12	302	

BENCH	FEATURE	DIP	AZIMUTH	REMARKS
1264	F	56	016	
	"	50	010	
	"	28	015	
	"	22	010	
178	S ₂	17	282	
179	"	22	284	
180	"	17	298	
	F	38	018	
	J	70	350	
181	S ₂	12	288	
182	"	20	294	
	J	56	204	
	F	20	010	
183	S ₂	18	300	
184	"	22	292	
185	"	20	294	
186	"	14	288	
	J	35	170	

120 ~ 138

①

APR 13, 1995


BENCH	FEATURE	DIP	AZIMUTH	REMARKS
120 / 252	S ₂	24	318	
	F	82	022	
121	S ₂	24	244	
122	"	28	258	
	J	80	150	
123	S ₂	25	270	
	J	76	150	
124	S ₂	21	318	
	F	65	330	
125	S ₂	10	258	
126	"	25	290	
127	"	22	220	
128	"	20	240	
	F	62	010	
	"	72	005	
129	S ₂	27	265	
130	"	12	320	
131	"	16	245	
	F	35	020	
1258	F	61	182	
+122 ~ 1268 ?	S ₂	30	270	
	J	82	101	
	F	58	012	
	J	58	125	
133	S ₂	42	271	
34	"	36	264	
	J	78	100	
135	S ₂	22	314 281	
	F	64	355	

BENCH	FEATURE	DIP	AZIMUTH	REMARKS
1258	F	56	175	
~1270?	J	56	175	
	J	85	130	
136	S ₂	24	270	✓
137	S ₂	34	262	
19 138	"	27	279	

1 ~ 119

LIST OF S₂ FOLIATION & FAULT & JOINT

APR 11, 1995

BENCH	FEATURE	DIP	AZIMUTH	REMARKS	
1	1252	S ₂	42	263	Map ① 
		F	57	228	
		F	76	190	
2	✓	S ₂	56	264	
		F	40	210	
	1258	F	55	310	
3		S ₂	14	270	
4		S ₂	43	289	
5		S ₂	26	270	
	1264	F	85	220	
		F	66	210	
		F	23	337	
6		S ₂	30	310	
		J	70	105	
		J	80	200	
		F	50	350	
7		S ₂	50	300	
8		S ₂	23	293	
9		S ₂	18	290	
10	1252	S ₂	23	310	Map ②
11		S₂	70	274	
12		S ₂	26	272	
		J	68	180	
	1264	F	82	195	
		F	57	228	
13		S ₂	25	230	
		F	39	350	
		F	42	225	
14		S ₂	29	258	
		F	76	190	
15		S ₂	54	264	
16		S ₂	33	272	
		F	40	210	
		F	156	334	
17		S ₂	20	277	
		F	78	350	

BENCH	FEATURE	DIP	AZIMUTH	REMARKS
18	1264	S ₂	37	Map ②
19		S ₂	52	
20		S ₂	25	
		J	58	
21		S ₂	50	
22		S ₂	34	
		F	49	
23		S ₂	30	
24		S ₂	33	
25	1276	S ₂	23	
26		S ₂	24	
27		S ₂	27	
		F	81	
		F	55	
		J	72	
28		S ₂	23	
29		S ₂	22	
30		S ₂	18	
31		S ₂	38	
		F?	90	
32		S ₂	29	
33		S ₂	63	
34		S ₂	33	
35		S ₂	12	
36	1276	S ₂	45	
37		S ₂	35	
		F	50	
38		S ₂	30	
		F	25	
39		S ₂	45	
40		S ₂	45	
41		S ₂	45	
42		S ₂	50	
		F	45	
		F	55	
43		S ₂	20	
44		S ₂	30	
		F	50	

BENCH	FEATURE	DIP	AZIMUTH	REMARKS	
45	1276	S ₂	50	206	Map ③
46		S ₂	50	206	
47		S ₂	50	292	
		F	60	344	
48		S ₂	20	324	
49		S ₂	15	322	
50		S ₂	25	306	
51		S ₂	25	004	
52		S ₂	20	304	
		S ₁ ?	75	252	
53		S ₂	30	292	
54		"	20	290	
55		"	20	343	
56		"	20	330	
57		"	20	360	
58		"	30	330	
		F	60	208	
59		S ₂	15	294	
60		"	25	032	
61		"	20	304	
62		"	20	300	
63		"	20	274	
64		"	30	274	
65		"	30	256	
66		"	35	258	
67		"	20	242	
		F	30	350	
	1294	S ₁ ?	60	172	Map ④
68		S ₂	32	222	
69		"	36	196	
		S ₁ ?	43	210	
70		S ₂	34	214	
71		"	30	185	
72		"	49	188	
73		"	39	208	
74		"	41	220	
		F	32	136	
		S ₁ ?	43	151	

351 or Joint ?

7⁶⁰
7³²

BENCH	FEATURE	DIP	AZIMUTH	REMARKS	
75	1294	S ₂	20	202	Map ④
76	"	"	29	039	
77	"	"	34	199	
	F	57	169		
78	S ₂	62	162		
79	"	35	310		
80	"	40	148		
81	"	37	263		
82	"	39	236		
	S ₁ ?	71	146		
	F	74	112		
	"	80	086		
	"	39	056		
	"	45	085		
	"	39	146		
	"	46	120		
83	S ₂	32	156		
84	"	34	204		
85	"	30	192		
86	"	30	190		
	F	84	084		
	"	64	137		
	"	40	032		
	"	78	112		
	"	40	060		
	S ₁ ?	63	161		
87	S ₂	30	192		
88	"	25	022		
89	"	30	028		
	S ₁ ?	76	176		
	F	58	186		
90	S ₂	28	212		
91	"	30	222		
92	"	30	258		
93	"	10	090		
	F	70	160		
94	S ₂	30	225		
95	"	20	204		

BENCH	FEATURE	DIP	AZIMUTH	REMARKS
96 1294	S ₂	10	228	Map ④
97	"	15	222	
98	"	10	165	
99	"	10	262	
100	"	10	210	
101	"	15	196	
102	"	15	246	
103	"	15	230	
	F	45	105	
104	S ₂	20	180	
105	"	25	208	
106	"	10	210	
	F	30	102	
	"	70	242	
107	S ₂	35	192	
108	"	30	196	
109	"	30	216	
110	"	23	234	
111	"	20	192	
112	"	25	162	
	F	45	115	
	"	55	105	
113 1294	S ₂	44	214	Map ⑤
114	"	40	209	
115	"	44	195	
116	"	38	217	
117	"	15	230	
	F	40	152	
118	S ₂	36	196	
119	"	25	222	
	S ₁ ?	60	172	

3.2.1 EXAMPLE.DIP an example DIPS data file

The example file used in this chapter and throughout this manual is called EXAMPLE.DIP and is supplied as an ASCII text file with this package. EXAMPLE.WK1 is the accompanying LOTUS 123 worksheet file from which EXAMPLE.DIP was created.

The complete example file is as follows:

*The first two lines are project titles;

```
PROJECT IDENTIFICATION
DATA COLLECTOR          DATE
```

*The next line gives the number of traverse identifiers:

```
4 Traverses
```

*The next lines contain traverse information;

```
1;LINEAR;120;30;Level 3,Stope 3.A,sublevel 310
2;PLANAR;100;10;Level 5,Stope 5.D roof before shrinkage
3;BOREHOLE;20;145;120;borehole
4;DIP/DIPDIRECTION;PLANAR;10;190;Level 5 Stope 5.D roof(aux data)
```

*The next line is 'global data orientation type flag';

```
STRIKE/DIPR
```

*The next line is for magnetic declination;

```
-5.5 degrees (east)
```

*This next line is a flag for a quantity column in the data list;

```
QUANTITY
```

*This data line specifies number of additional columns;

```
3 extra data columns
```

*The next line is the header containing data titles:

number ;strike ;dip,(rt);quantity;traverse;spacing,m;type ;surface ;

*Now the data:

1	53	86	1	1	2	joint	smooth
2	57	83	1	1	1	joint	smooth
3	51	84	1	1	1.5	joint	smooth
4	50	82	1	1	2	joint	sl.rough
5	48	83	1	1	3	joint	rough
6	231	86	2	1	0.5	joint	rough
7	47	82	2	1	1	shear	slickens
8	244	87	1	1	0.3	joint	v.rough
9	83	84	1	1	0.75	joint	rough
10	64	86	1	1	1.5	joint	smooth
11	68	84	4	1	1	bedding	sl.rough
12	68	86	1	1	3	shear	slickens
13	69	80	3	1	1.5	bedding	sl.rough
14	61	81	1	1	1	bedding	sl.rough
15	300	64	3	1	0.2	joint	v.rough
16	295	68	1	1	0.5	joint	rough
17	320	75	1	1	0.5	joint	sl.rough
18	316	70	1	1	1	joint	smooth
19	315	65	2	1	1	joint	smooth
20	320	82	1	1	2	shear	slickens
21	312	72	2	2	0.4	joint	smooth
22	346	68	3	2	0.7	joint	rough
23	308	65	1	2	1	qtzvein	sealed
24	310	66	1	2	1.5	joint	smooth
25	310	84	4	2	0.3	joint	sl.rough
26	308	62	1	2	1	shear	slickens
27	308	62	1	2	1	joint	smooth
28	308	62	1	2	1.5	joint	smooth
29	320	68	3	2	0.25	qtzvein	sealed
30	322	68	1	2	1	shear	slickens
31	320	68	2	2	0.3	qtzvein	sealed
32	315	80	1	2	5	fault	gouge
33	320	70	1	2	1	shear	slickens
34	320	70	1	2	2	shear	slickens
35	170	50	1	2	3	joint	smooth
36	168	50	2	2	1.5	joint	sl.rough
37	184	44	1	2	0.8	joint	rough
38	174	46	4	2	0.5	joint	smooth
39	170	44	1	2	0.7	joint	smooth
40	51	274	3	4	0.3	joint	rough
41	51	275	1	4	1	joint	rough
42	75	330	1	4	5	fault	gouge
43	38	274	1	4	1	joint	sl.rough
44	38	294	1	4	2	joint	smooth

*The data must be completed with an END OF FILE MARKER of -1

-1

3.2.2 MINIMUM DATA FILE REQUIREMENTS

The minimum amount of information required to make up a valid data file is illustrated following data file:

```

TITLE 1
TITLE 2
0 [traverses]
DIP/DIPDIRECTION
0 [declination]
NO QUANTITY
0 [extra data columns]
number ;dip ;direction;
    1      20      230
    2      35      225
    3      42      333
    4      66      010
    .
    .
    .
    .
-1

```

3.2.3 TEMPLATE.DIP a working file template

A blank form is supplied in a file called TEMPLATE.DIP and can be used by a word processor or text editor to create a DIP data file by 'filling in the blanks'. A LOTUS 123 template is also supplied in a file called TEMPLATE.WK1.

Do not load TEMPLATE.DIP into DIPS unless you have used it to create a valid data file.

MAR 7 9526402W4 (1264 BENCH N.W. CORNER)

MAR 9 9525201T5 (1252 TILL SOUTH END)

MAR 9 9525201W11 (1252 WASTE EAST SIDE)

MAR 18 9525201T6 (1252 TILL EAST SIDE)

MAR 18 9525201W12 (1252 WASTE N.E. LIMIT)

MAR 21 9525201T7 (1252 TILL EAST LIMIT)

MAR 21 9525201W13 (1252 WASTE MID PIT)

MAR 25 952580101 (1258 ORE NORTH END)

MAR 30 9525201W14 (1252 WASTE NORTH END)

6600 N 37900 E

02

APRIL 1 952580102 (1258 ORE N. END N6515 E 2938)

APRIL 5 952580103 (1258 ORE N. END N6578 E 2945)

APRIL 7 1.4.01 AIRTRACK - 1252 BENCH NW END

APRIL 8 9524001W1 (SINKING CLT) (N 6270 E 2700)

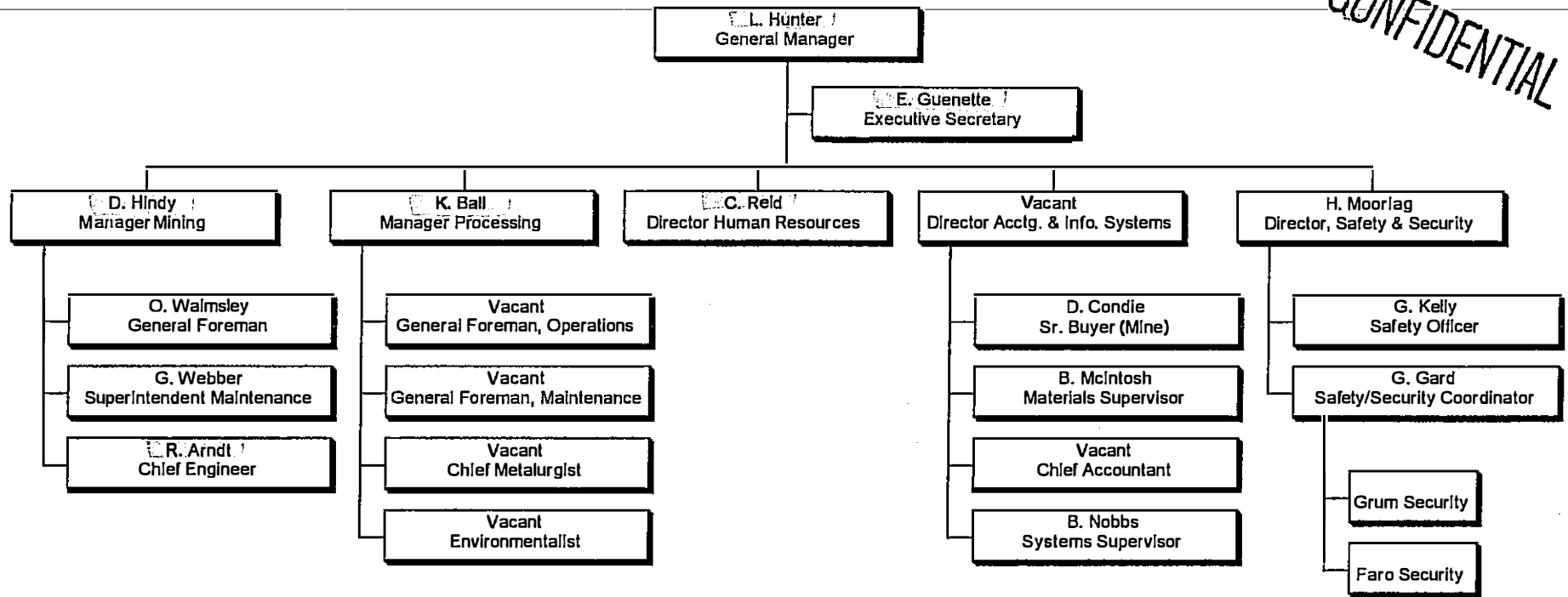
APR. 10 952520101 N 6400 E 2850

9525201W15 N 6550 E 3000

APR. 13. 9524001W2 N 6210 E 2580

APR 16. 952520102 N 6500 E 2900

CONFIDENTIAL

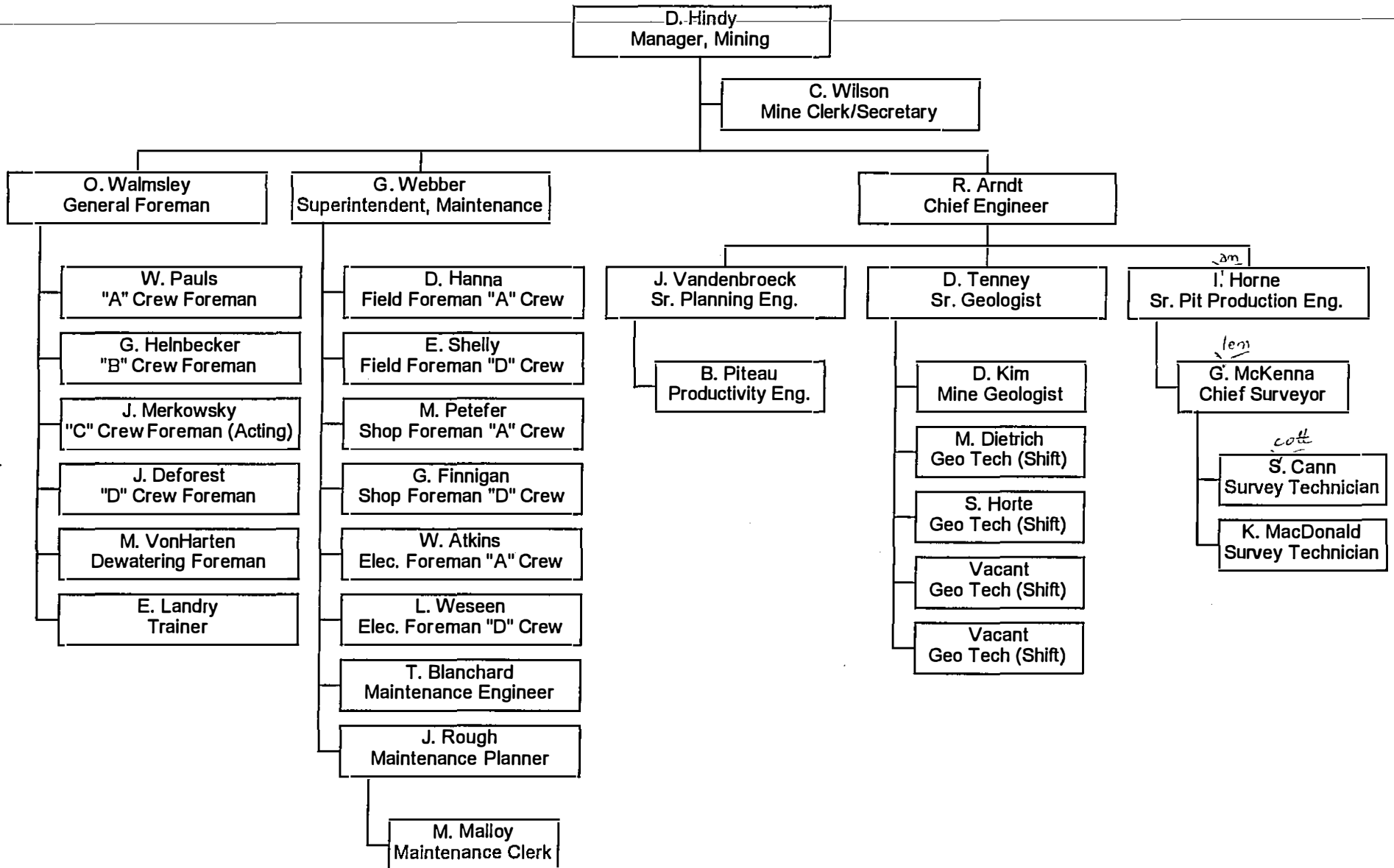


Anvil Range

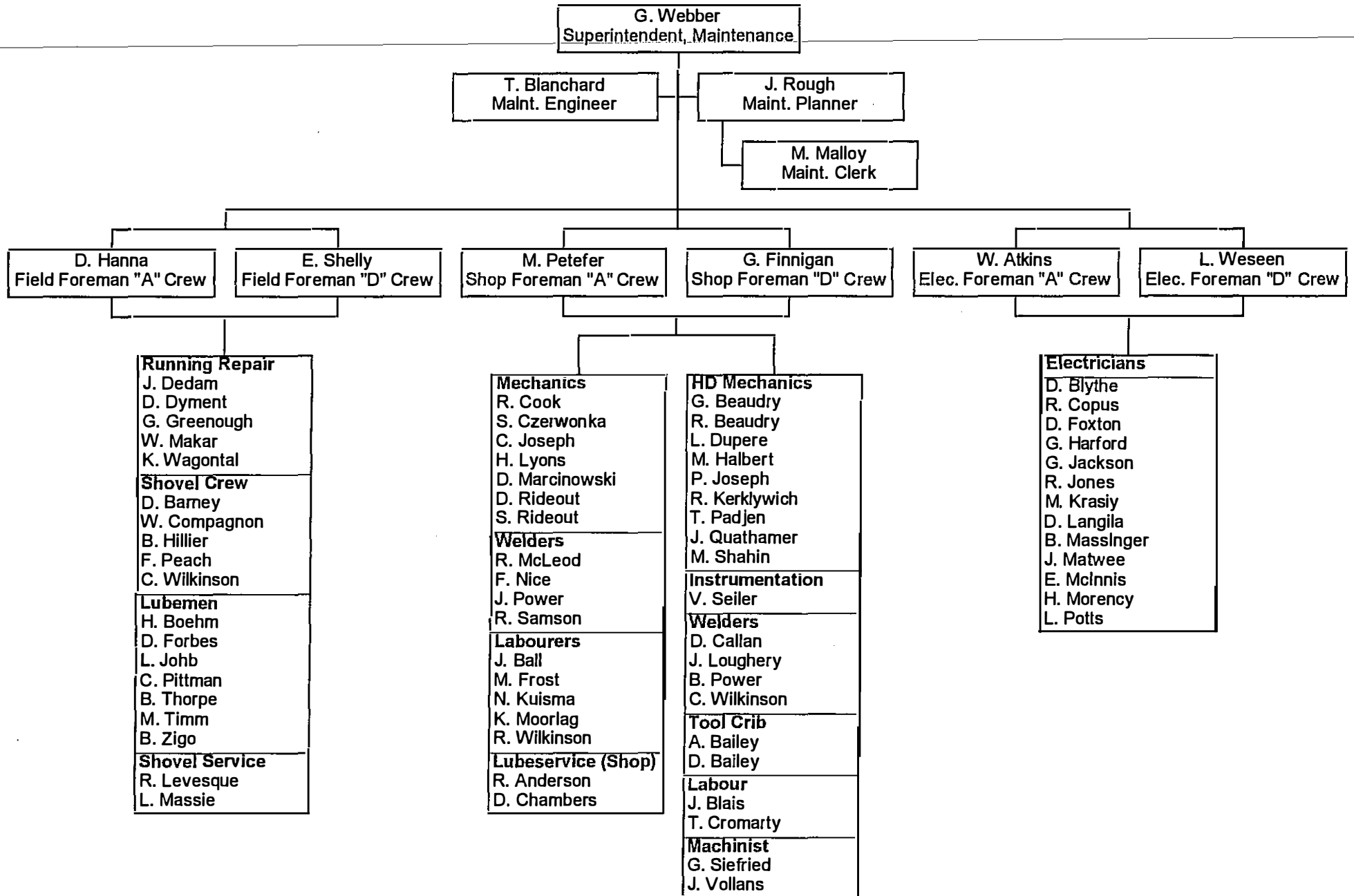
MINING CORPORATION

April 16, 1995

Anvil Range Mining Corporation
Mine Operations

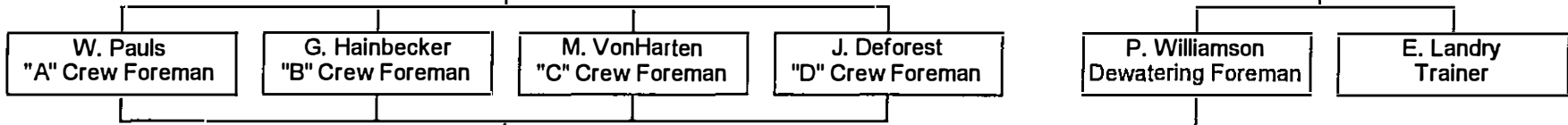


Anvil Range Mining Corporation
 Mine Maintenance



Anvil Range Mining Corporation
Mine Operations

O. Walmsley
General Foreman



Truck Drivers
 L. Amero
 E. Atkins
 D. Babin
 J. Blake
 K. Branner
 L. Byblow
 W. Callahan
 S. Charlie
 W. Charlie
 D. Clark
 K. Clarke
 A. Copus
 D. Croteau
 G. Croteau
 J. Dicks
 P. Donnessey
 B. Doris
 B. Dyer
 M. Fitzpatrick
 J. Ginther
 A. Gray
 D. Heinz
 R. Lawson
 J. Loranger
 G. Miller

Truck Drivers
 S. Nicolle
 C. Pike
 A. Power
 K. Ray
 H. Rice
 W. Risby
 K. Russell
 R. Samel
 H. Schaupp
 R. Sterriah
 R. Stevenson
 D. Trombley
 V. Ghislaine
 Vacant
 Vacant

Shovel Operators
 J. Bowness
 L. Driediger
 J. Gilmar
 J. Lambert
 D. Lawson
 C. Macintosh
 K. Meger
 C. Pardy
 R. Pardy
 R. Raymond
 J. Saio
 T. Smith

Equipment Operators
 L. Atkins
 B. Barry
 A. Barstad
 B. Barstad
 T. Bartlett
 H. Croteau
 J. Drover
 R. Fuller
 D. Fulton
 B. Grau
 S. Janson
 B. Keyes
 H. Misener
 T. Palmer
 B. Pardy
 H. Pardy
 K. Potts
 D. Sawicki
 Vacant

Drillers
 G. Buchan
 L. Cramm
 K. Dussome
 D. Raymond
 K. Samel

Tank Drill
 Vacant

Blasters
 D. Allison
 V. Benes
 L. Boyle
 W. Caesar
 M. Hymiuk
 vacant
 vacant
 vacant

Pump

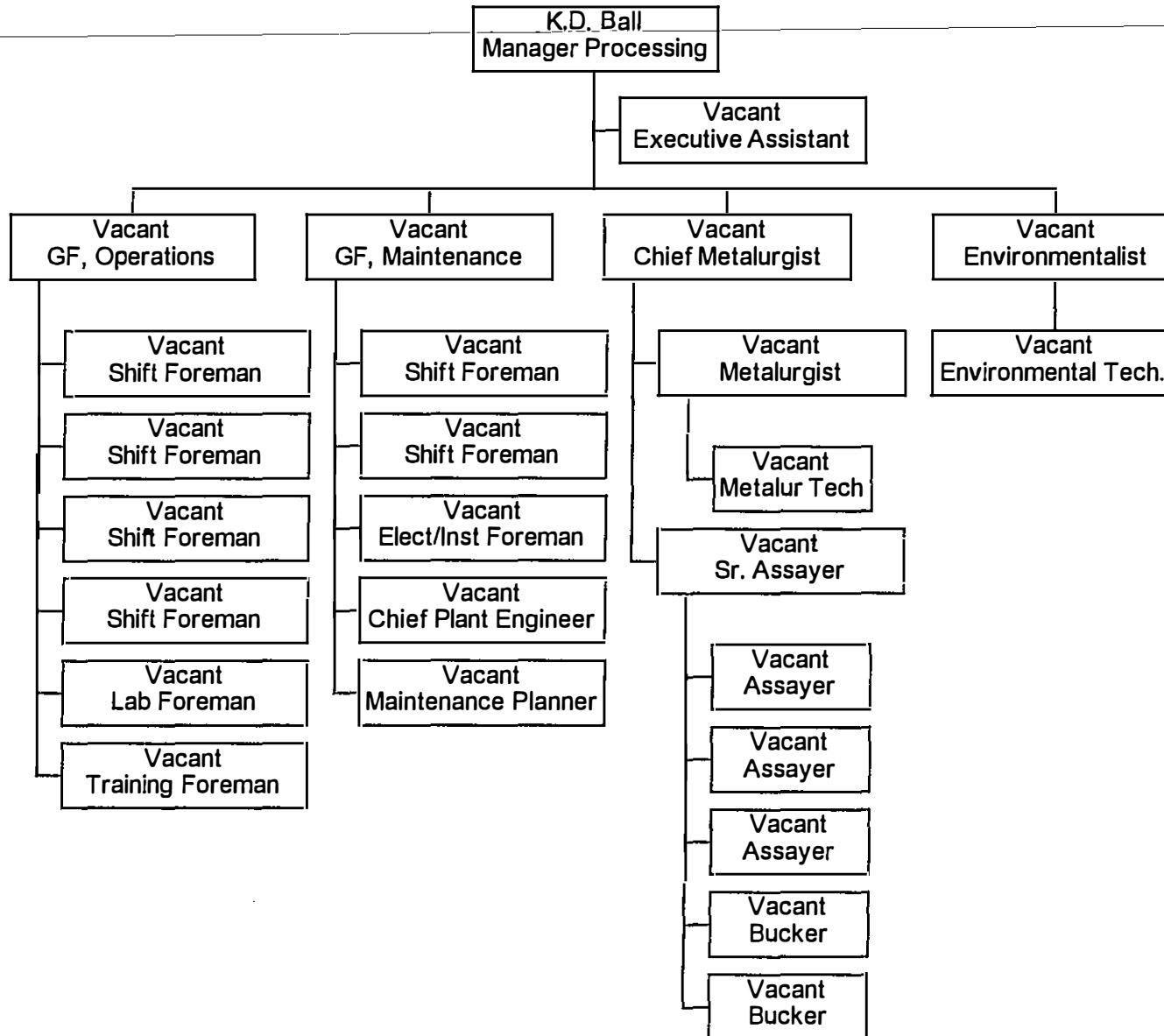
Utility
 C. Billard
 G. Dick
 P. Dick
 J. Etzel
 B. Ledgerwood
 B. Nekon
 B. Neufeld
 S. Sooley
 B. Woodrow

Pump Crew

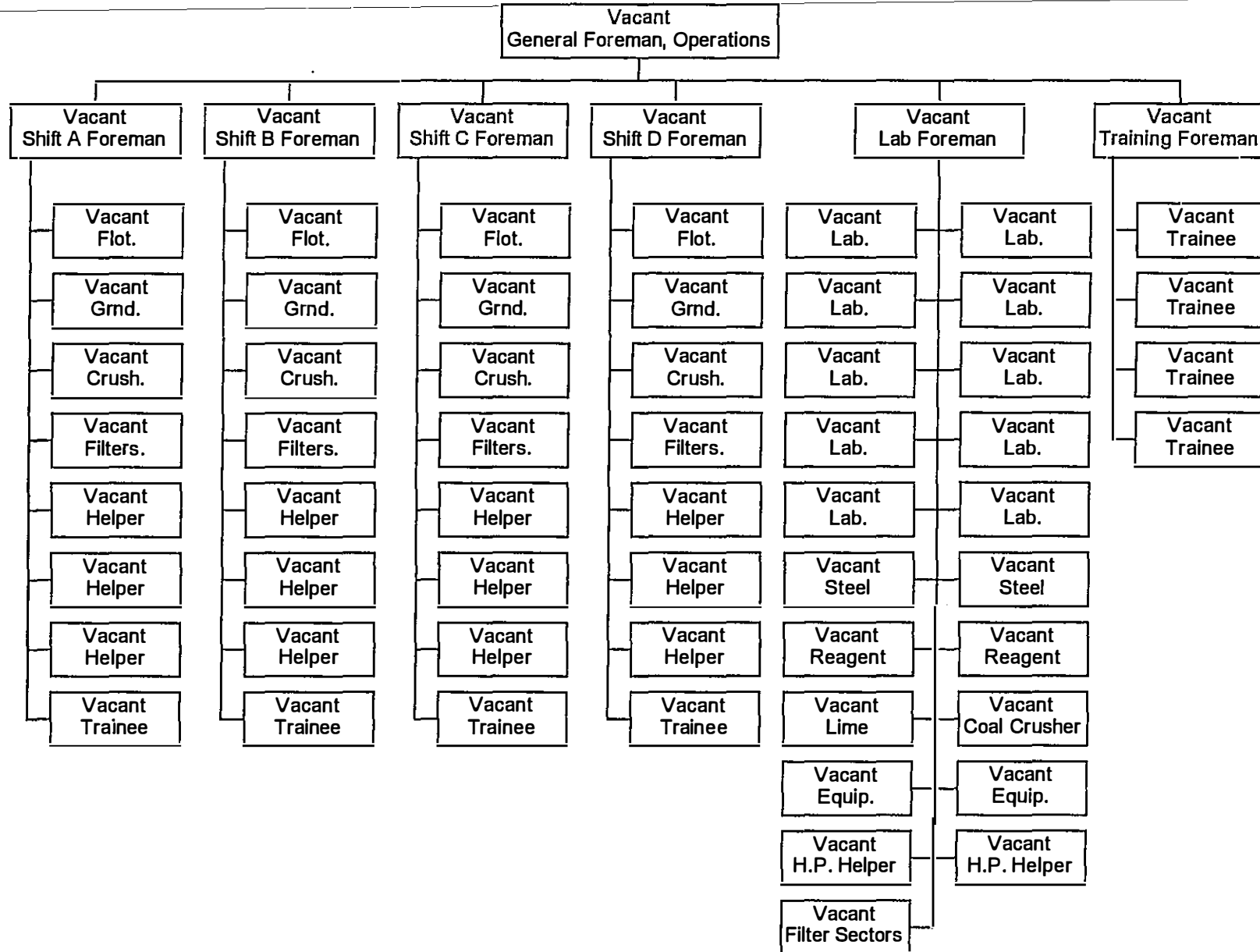
Faro Road

Dewater
 P. Bourassa
 A. Campbell
 R. Cull
 R. Dick
 D. Dulvenvoorden
 R. Griffin
 B. Kitzan
 A. Murray
 P. Risby
 T. Sundin

Anvil Range Mining Corporation
Processing Department



Anvil Range Mining Corporation
Processing Department
Operations



Anvil Range Mining Corporation
Processing Department
Maintenance

Vacant
 General Foreman, Maintenance

Vacant
 Shift Foreman

Vacant
 Shift Foreman

Vacant
 H.P. Chief Engineer

Vacant
 Planner

Vacant
 Elect/Inst Foreman

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 2nd. Class Engineer

Vacant
 Clerk

Vacant
 Elect./Inst.

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 2nd. Class Engineer

Vacant
 Elect./Inst.

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 2nd. Class Engineer

Vacant
 Elect./Inst.

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 2nd. Class Engineer

Vacant
 Shift E/I

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Fire/Propane

Vacant
 Shift E/I

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Millwright

Vacant
 Shift E/I

Vacant
 Welder

Vacant
 Welder

Vacant
 Welder

Vacant
 Welder

Vacant
 Shift E/I

Vacant
 Apprent.

Vacant
 Apprent.

Vacant
 Apprent.

Vacant
 Apprent.

Vacant
 Shift E/I

Vacant
 Shift M.

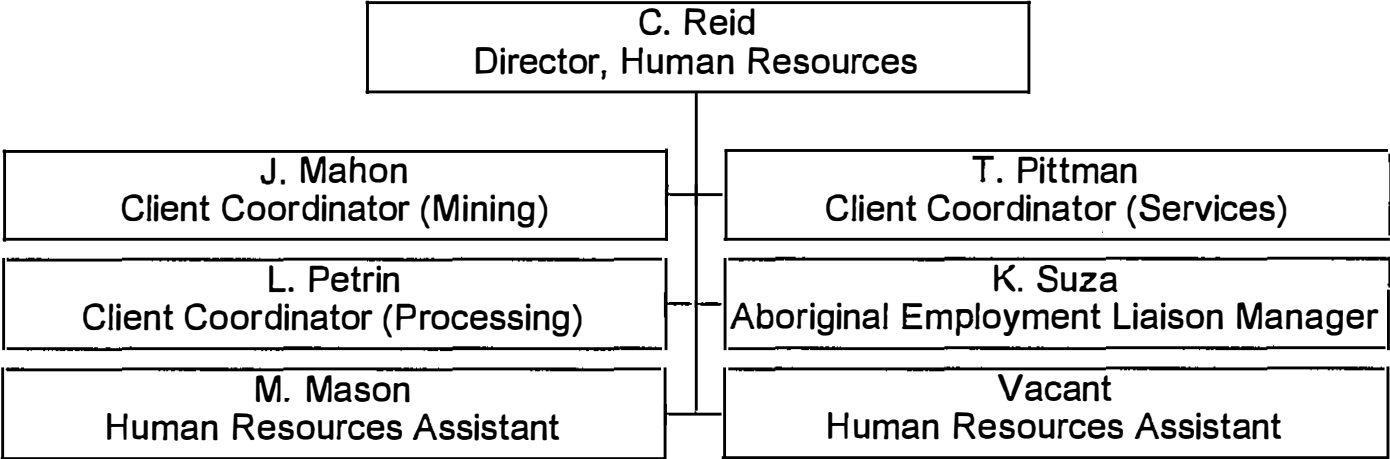
Vacant
 Shift M.

Vacant
 Shift M.

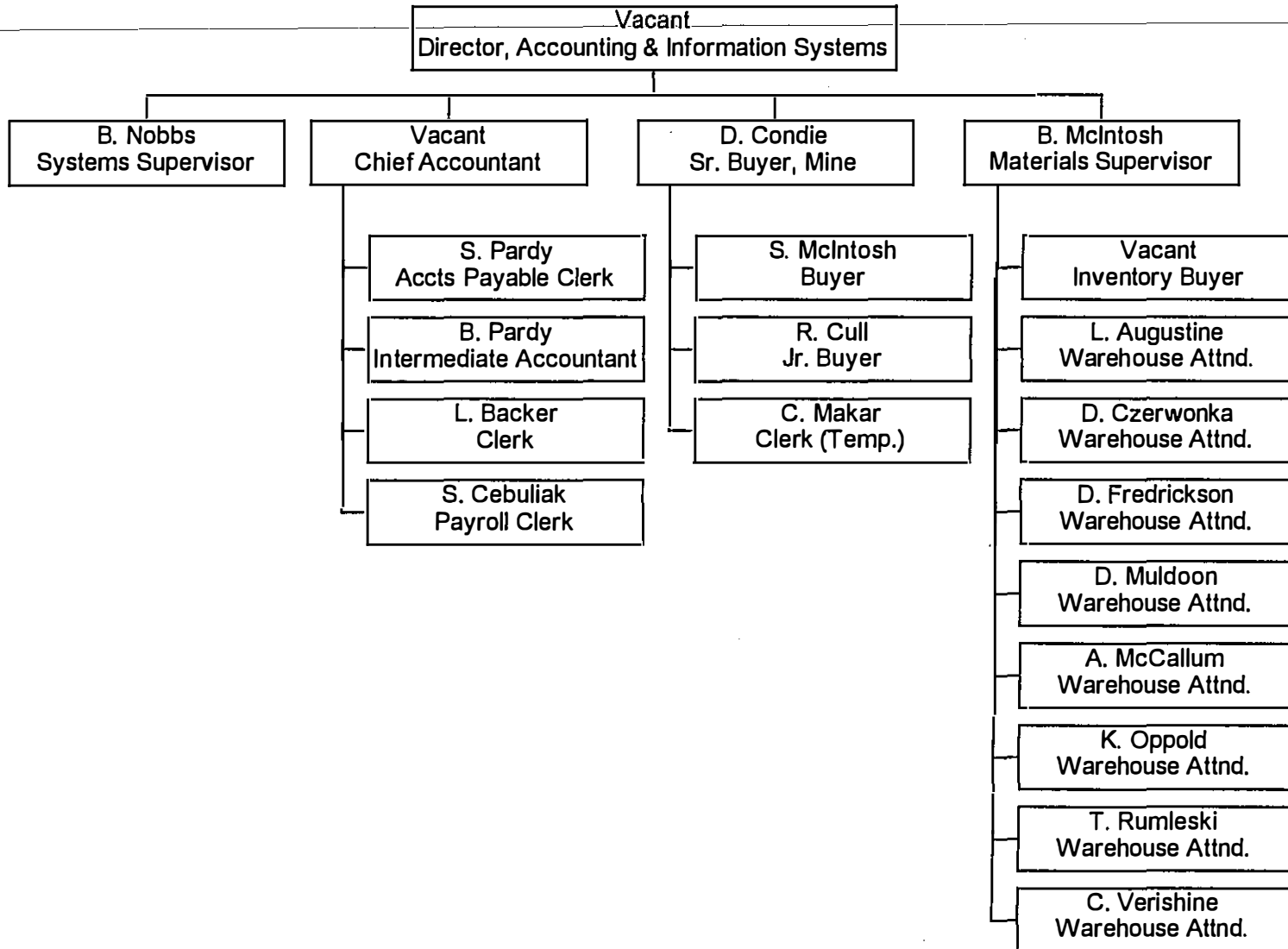
Vacant
 Shift M.

Vacant
 Apr. E/I

**Anvil Range Mining Corporation
Human Resources Department**



Anvil Range Mining Corporation
Accounting & Information Systems Department



**Anvil Range Mining Corporation
Safety & Security Department**

