General Comments on Preliminary report of Tetsuro Urabe March 1981

Baritic Units.

- report intended only to be a progress report, more data is now available, consequently this report should be viewed in this light.

- Fe/Mg ratios in siderite & dolomite interesting, but subject to limitations 1) samples 155 to 159 all come from Horz 5 with 174 from Horz 4 and 178 from Horz 3. when viewed in this light the trends are not as diagnostic as only 3 horizons are examined as opposed to 6 he implies in this report. 2) 3 of his four samples of Horz 5 (156, 158, & 159) fall within the analytical error bars.

- Fe/Mg ratios could prove to be useful only in small regions to be used in correlation problems as Tetsuro as documented lateral variations also.

- Fe/Mg ratios of dolomite and siderite plus the norsethite and barytocalcite stability relationships should be used to model the ppt process in the 4G units, as they suppositdly represent a end member (ie highest in Anvil cycle) If this could be understood then we may have a useful exploration tool on the deposit scale. (look at examples from carbonate iron formations).

- fault of unknown displacement between 79X-16 (257) and 80X-09 (260).

BV Hall

PROGRESS REPORT ON
DY DEPOSIT, FARO, YUKON TERRITORY

No. 1. Mineralogy of the baritic units

March, 1981

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On balance, Fe/Mg carbonate trends in baritic (and other??) horizons seems worth pursuing i.e. correlation / fold pattern recognition

It could prove useful only in small regions as Tetsuro has documented lateral variation also. BYJ

Ten barite-bearing ore samples from drill cores were divided into two groups, namely, (A) DY 155 - DY 178 and (B) DY 257 - DY 260 (Table BA-1). Group A samples are from six different baritic horizons which were intersected in drill hole 79X14. It is probable that part of the strata is repeated by folding but, despite this complication, we can nevertheless investigate vertical variation in mineralogy and geochemistry of the baritic units. Group B samples were taken from four drill holes in a single baritic horizon in order to examine lateral variations.

Group A

Samples are compositionally banded and rich in pyrite and barite. Barite aggregates display embayed mutual boundaries and have no preferred orientation. Carbonate minerals, i.e. dolomite and siderite, tend to occur as discrete grains interlocked with barite and show no replacement textures. Sphalerite, galena, and magnetite are common but minor in amount. Magnetite, which occurs in every sample except DY 174, usually has embayed, corroded outlines. The iron content of sphalerite falls in a range between 1.4 and 3.9 wt. % Fe and shows no apparent systematic variations with stratigraphic position. Arsenopyrite and bismuthinite were identified (by electron microprobe) in sample DY 174. It is noteworthy that reworked textures are observed in only one sample, DY 159.

A most remarkable change in mineral assemblage is observed in siderite and dolomite. Siderite is found exclusively in samples DY 155, DY 156 and DY 158 which are in the "upper" half of barite-bearing horizons. On the other hand, dolomite is found in deeper horizons as well as in DY 158. Furthermore, the mole fraction of magnesium in dolomite and siderite decreases and that of iron increases upwards, respectively, with the exception of the interval between DY 174 and DY 178 (Fig. BA-2). The ratio Fe/Fe+Mg also moderately increases towards the margin within a single grain of dolomite and siderite. Therefore, it is quite probable that the activity of Fe(II) ion in the ore-forming solution increased relative to that of Mg ion with time during ore deposition.

Group B

Group B samples were taken from a satisfactorily correlated section which includes 4 drill holes listed in Table BA-1. The lateral distribution of many adjacent units suggests that sample DY 259 represents the "central" facies and the other three samples are in order of increasing distances from the center of this particular baritic unit.

Barite, pyrite, sphalerite, and galena are the major constituent minerals. Minor amounts of chalcopyrite and

Garbage

good point BVY

Why didn't you look at within BaSO4 horizon vertical variation. You've looked at inter horizon dist'n of $CO_3^=$ but not intrahorizon variation. Intrahorizon variation trends might aid top determination & ident of folds (if present) as well as aid corr. of horizons

IT WOULD BE ... IF THESE 2 DID FOLLOW SUIT. DATA MUST BE CONSIDERED WITH REFERENCE TO THE SITUATION EACH SAMPLE WAS TAKEN FROM. SEE NOTES APPENDED TO TABLE BA-I.

possibly due to temp relationships? ie. one solution changing conditions.

DOES THIS INCLUDE SAMPLE 260?

or does this suggest variation of $a_{Fe^{++}}$ during metamorphism reason being that the coarse grained xtals clearly did not form from the ore solution but are rextallized later

Mg is stable at higher temp than Fe consequently Mg unlikely to be removed.

(SOUTHERN EDGE)

central facies in that the 1) Pb/Zn ratio is highest, 2) the magnetite content is highest, and 3) the 4G is thickest.

In addition $a_{Fe^{++}}$ in natural solutions is often measured in ppb.

carbonate minerals are also common. Sample DY 259 contains both secondary aggregates of quartz and one grain of argentian tetrahedrite (checked by electron microprobe). The carbonate mineralogy of sample DY 258 is very unusual. Two barium-bearing double carbonate minerals, barytocalcite $CaBa(CO_3)_2$ and norsethite $MgBa(CO_3)_2$, were identified in this well-banded sample. Dolomite is closely associated with these carbonates but witherite, $BaCO_3$, has not been found despite careful searching.

Nice, but no big deal

Norsethite was first reported in a dolomitic black oil shale at the Westvaco trona mine, Wyoming by Mrose et al. (1961). Other occurrences of this rare mineral include: (i) as irregularly shaped veins in dolomite gangue at the Rosh Pinah Zn-Pb-Cu hydrothermal deposit, South Africa (Steyn and Watson, 1967) where it is associated with calcite, celsian, barite, barytocalcite, benstonite ($Ca_7Ba_6(CO_3)_{13}$), pyrite, sphalerite, galena, chalcopyrite, and tennantite, and (ii) as a mass in braunite ore of the high-temperature skarn deposit at Långban, Sweden (Sundius, 1965; Sundius and Blix, 1965; Moore, 1971) where it is found with dolomite, barytocalcite and benstonite and is considered to be formed during skarnization from reactants like psilomelane ($BaMn_7O_{14}(H_2O)$) and dolomite.

Crap what does this mean [redacted] in the deposit BYH

Norsethite can be formed by the reaction of barium carbonate with dilute solutions of magnesium chloride and sodium bicarbonate at room temperature (Lippmann, 1973). According to Lippmann, norsethitization is possible only in the presence of excess dissolved CO_3^{2-}. It is widely accepted that witherite is commonly formed from barite at low temperatures and at a high fugacity of CO_2 (Holland, 1967; Baldasari and Speer, 1979) and, as an analogy, "norsethitization" is a possible mechanism for its genesis.

Although norsethite also can be easily precipitated from aqueous solution containing barium, magnesium, and carbonate ions at room temperature (Hood et al., 1974), we prefer a metasomatic origin of norsethite and barytocalcite in DY 258 as is suggested by sub-microscopic mixing of these two carbonates and close association between dolomite and barite. However, it is difficult to explain why barium-bearing carbonates have been formed only in this particular place, because grain by grain association of barite and dolomite is very common (7 samples out of 10) without any evidence of reaction between them.

"Calcareous witherite" was reported by Carne (1976) from the TEA barite deposite, Middery Lake map area, Yukon Territory at the base of baritic ore horizon in the area. However, Lydon et al. (1979) could not confirm the presence of witherite and pointed out that Carne's original identification did not include an x-ray identification. Therefore, our report is probably the first on the occurrence of barium-bearing carbonates in shale-hosted barite-sulfide ore in the Yukon.

Iron and magnesium contents in dolomite grains are laterally zoned from magnesium-rich at the center to iron-rich at the margin (Fig. BA-3). Iron-rich dolomite coexists with siderite in samples DY 257 and DY 260, which represent marginal facies of the baritic unit.

Neither the manganese nor the strontium contents in dolomite shows systematic variation; however, there is a proportional relation between them. This is more obvious in group A samples than in group B and suggests that the concentration ratio between manganese (II) and strontium ions did not change markedly in the ore-forming solutions.

The consistent increase in the ratio Fe(II)/Fe(II)+Mg towards the upper horizon and the margin, ~~as represented by the chemical composition of dolomite and siderite~~, can be explained in several ways. First even though the ratio of total iron vs. magnesium ions may have remained constant, reduction from ferric to ferrous ion would cause a relative increase in ferrous ion concentration over magnesium ion. However, the sulfide orebodies in the DY deposit have repeated "Anvil Cycles"[1] and the trend is

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1 A vertical zoning in mineral assemblages in ore which was first described by D.S. Jennings for the Faro deposit. The sequence from bottom to top is graphite-bearing, quartz-bearing, massive, and barite-bearing sulfide ores.

well-explained by increasing oxidation state throughout the sequence. Therefore, continual upward reduction is not consistent with the general trend of ore deposition. Secondly, a relative increase in pH with time and space can produce the observed trend. A third explanation is to assume that the composition of ore forming solution had evolved during ore deposition. For example, precipitation of a magnesium-rich phase could cause relative enrichment of total iron in the ore-forming solution. Our oxygen, carbon, and sulfur isotopic study in progress should resolve this problem.

both fO_2 & pH are related to 2

lovely!

A possible metamorphic scenario might be oxidation of S^{-2} in pyrite to $SO_4^{=}$ by coupled reduction of Fe^{+3} in magnetite (accounting for corroded magnetite grains) forming abundant Fe^{+2} which combines with $CO_3^{=}$. Zoning would be explained by the fact that conventional wisdom has mt concentrated towards top and ~~edges~~ center of the amul cycle.

$$FeS + 2Fe_3O_4 \rightarrow 7Fe^{++} + 2SO_4^{=}$$

DIFFICULT TO JUSTIFY THERMODYNAMICALLY

[illegible] DO NOT LOOK AT IT AS A REDUCING TREND TOWARD THE MARGINS, BUT AS AN OX[illegible] TOWARD THE "CORE" → A POSSIBLE "SCENARIO" → [illegible] OF ORIGINAL I.F.

A[illegible] THE "A[illegible]" MATERIAL IS THE MAGNE[illegible] NOT [illegible] SO [illegible] A WAY OF CREATING [illegible] ANOMALOUS [illegible] RATHER [illegible] THE UBIQUITOUS Fe^{2+} AND [illegible] APPROACH THE [illegible] VIA

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Table BA-1. Sample locations and mineral assemblages (in order of decreasing amounts) of the barite-bearing ores from DY deposit.
(See Fig. BA-1 for the drill sites.)

Sample No.	Drill Hole	Depth m	Mineral Assemblage (in order of decreasing abundance)
GROUP A			
Horz 5 DY 155	79X14	706.9	Ba, Py, Sd, Sp, Gn, Mt
DY 156	"	712.0	Py, Ba, Sd, Sp, Gn, Mt, Cp
DY 158	"	717.7	Py, Do, Sd, Ba, Gn, Mt, Sp, Cp
DY 159	"	720.7	Ba, Py, Sp, Gn, Do, Mt, Cp
Horz 4 DY 174	"	811.7	Ba, Py, Sp, Do, Gn, As (asp.), Bi (bismuthinite)
Horz 3 DY 178	"	856.9	Py, Ba, Cp, Do, Mt, Sp, Gn
GROUP B			
DY 259	80X08	847.8	Ba, Py, Sp, Gn, Qz, Do, Cp, Ag-Te, Mt
DY 258	80X05	860.5	Ba, Py, Sp, Ba-carbonates (see text), Do, Gn, Cp
DY 257	79X16	818.5	Ba, Py, Sp, Gn, Cp, Do, Sd
DY 260	80X09	769.9	Ba, Py, Sp, Gn, Cp, Sd, Do, Mt

presumably either a detailed or "eyeballed" mode. Would be useful to have a modal chart to allow readers to see actual abundances. Are $CO_3^=$ s a signif. part of phase assem...

→ Fault present between 79-X-16 and 80-X-09

* NOTE – THIS DOES NOT CORROBORATE WITH BVH'S Cu (CP) TRE... J.

Abbreviations: Ba, barite; Py, pyrite; As, arsenopyrite; Sp, sphalerite; Gn, galena; Cp, chalcopyrite; Ag-Te, argentian tetrahedrite; Bi, bismuthinite; Qz, quartz; Mt, magnetite; Do, dolomite; Sd, siderite. Pφ - PYRRHOTITE

155 706.9m → 4A0 705.7, 4L72 706.2
156 712.0m → 4G8 706.4
4L72 714.3
158 717.7m → 4G8 715.5
159 720.7m → 4EC6 720.5
4A0 720.8, 723.9
THESE SAMPLES ESSENTIALLY ONE HORIZON

174 811.7m → 4K41 805.1, 4G4 808.7, 5D3 809.1
178 856.7m → 4E0 856.3, 4E7846 856.8, 4L6 857.7

259 847.8m 80-8 → 4C0 847.0, 4G4 847.6, 848.5, 4E8 850.0
258 860.5m 80-5 → 4G0 857.4, 4G4 859.4, 861.2, 5B46 864.4
257 818.5m 79-16 → 4D4 816.4, 4G4 817.8, 819.9, 4H0 820.2
260 769.7m → 4L3 768.1, 4G74 769.4 – Pφ + Mt IN H/W THROUGHOUT

Table BA-2. Selected analyses of carbonates from barite-bearing samples (see Table BA-1).

	DY 155	DY 156	DY 158	
Weight %	siderite	siderite	siderite	dolomite
CaO	0.77(.20)[1]	0.40(.13)	0.47(.12)	26.21(.36)
MgO	2.07(.33)	3.37(.83)	3.75(.83)	5.17(.41)
FeO	51.35(.52)	52.20(1.29)	51.78(.94)	21.81(.33)
MnO	5.46(1.21)	3.79(.66)	3.56(.17)	2.36(.03)
SrO	0.00	0.00	0.13(.18)	0.29(.04)
CO_2[2]	37.70	38.32	38.44	41.16
Total	97.34	98.08	98.12	97.00
Mole fractions				
$CaCO_3$	0.016	0.008	0.010	0.500
$MgCO_3$	0.060	0.096	0.106	0.137
$FeCO_3$	0.834	0.834	0.825	0.325
$MnCO_3$	0.090	0.061	0.057	0.036
$SrCO_3$	-	-	0.001	0.003
n[3]	(6)	(11)	(5)	(3)

	DY 159	DY 174	DY 178
Weight %	dolomite	dolomite	dolomite
CaO	25.28(.41)[1]	27.61(.61)	24.91(.55)
MgO	4.45(1.13)	13.62(2.15)	9.54(2.08)
FeO	20.23(.98)	8.69(3.13)	8.55(.26)
MnO	4.76(.09)	3.68(.05)	9.60(2.69)
SrO	1.27(.06)	0.09(.15)	1.27(.57)
CO_2[2]	40.58	44.18	41.67
Total	96.57	97.87	95.48
Mole fractions			
$CaCO_3$	0.489	0.490	0.469
$MgCO_3$	0.120	0.337	0.250
$FeCO_3$	0.305	0.120	0.126
$MnCO_3$	0.073	0.052	0.143
$SrCO_3$	0.013	0.001	0.012
n[3]	(3)	(7)	(3)

	DY 259	DY 258		
Weight %	dolomite	norsethite	barytocalcite	dolomite
BaO	0.00	50.86(1.19)	47.60(2.25)	0.00
CaO	28.14(.47)[1]	0.33(.19)	17.94(1.34)	25.40(.70)
MgO	12.85(.76)	8.66(1.44)	1.00(.83)	6.12(1.80)
FeO	9.25(.55)	4.19(1.61)	0.55(.50)	11.41(1.08)
MnO	3.59(1.16)	5.00(.23)	0.66(.53)	8.14(1.99)
SrO	0.00	0.41(.21)	2.03(2.06)	0.54(.29)
CO_2[2]	44.01	30.15	32.03	38.88
Total	97.84	99.59	101.82	90.49
Mole fractions				
$BaCO_3$	0.0	0.484	0.476	0.0
$CaCO_3$	0.502	0.009	0.439	0.513
$MgCO_3$	0.319	0.313	0.034	0.172
$FeCO_3$	0.129	0.085	0.011	0.180
$MnCO_3$	0.051	0.103	0.013	0.130
$SrCO_3$	0.0	0.006	0.027	0.006
n[3]	(4)	(7)	(6)	(8)

	DY 257		DY 260	
Weight %	siderite	dolomite	siderite	dolomite
CaO	0.86(.71)	26.45(.68)	1.50(.61)	25.82(.20)
MgO	3.12(.06)	6.08(1.24)	0.96(.42)	6.22(.99)
FeO	38.36(.11)	16.77(1.21)	55.79(2.18)	18.16(.84)
MnO	12.73(.37)	6.92(1.43)	0.84(.87)	4.79(.46)
SrO	n.d.	0.27(.18)	0.09(.16)	0.39(.12)
CO_2[2]	35.47	42.08	36.96	41.31
Total	90.53	98.57	96.14	96.69
Mole fractions				
$CaCO_3$	0.019	0.493	0.032	0.490
$MgCO_3$	0.096	0.158	0.028	0.164
$FeCO_3$	0.663	0.244	0.925	0.269
$MnCO_3$	0.223	0.102	0.014	0.072
$SrCO_3$	--	0.003	0.001	0.004
n[3]	(2)	(5)	(3)	(4)

1 1σ

2 Calculated assuming stoichiometry

3 Number of analyses

Because they are in fine-grained aggregates, carbonate minerals tend to give low total wt.%. No other elements are above the detection limit by electron microprobe analyzer.

FIGURE CAPTIONS

Fig. BA-1. Drill grid over the DY orebody. Closed circles locate holes from which samples were taken for study (see Table BA-1). Other holes not sampled are indicated by open circles. Dashes outline the zone of mineralization.

Fig. BA-2. Composition of carbonate minerals from six different barite horizons (group A) in drill hole 79X14. Data are from Table BA-2.

Fig. BA-3. Composition of carbonate minerals from group B samples. Distances are measured northward from drill hole 80X08 (sample DY 259). Data are from Table BA-2.

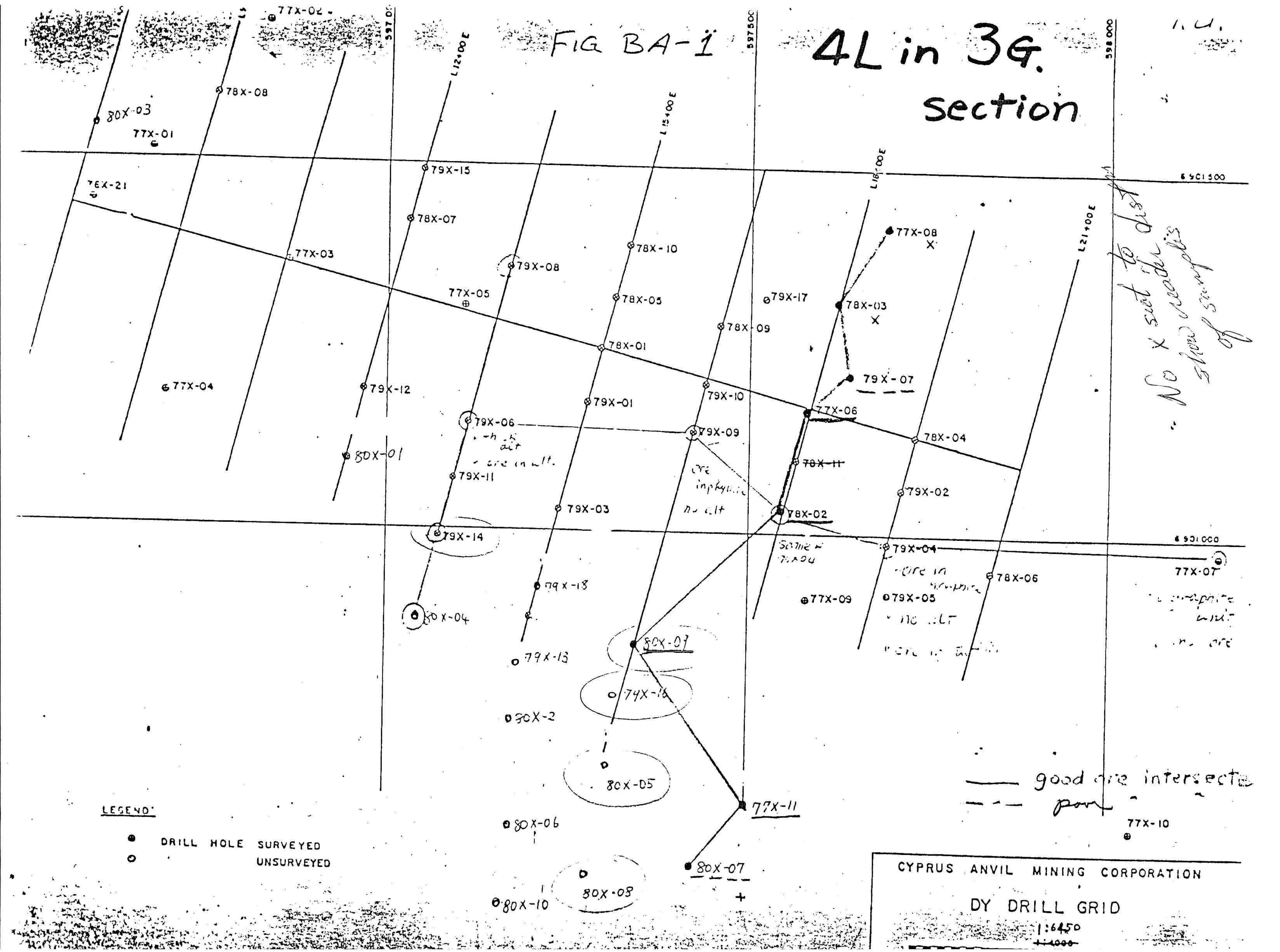


FIG BA-1
4L in 3G.
section
No x set to dist. show results of samples
597 000
597 500
598 000
6 901 500
6 901 000
L12400E
L15400E
L18400E
L21400E
77X-02
78X-08
80X-03
77X-01
79X-15
76X-21
78X-07
77X-03
79X-08
78X-10
77X-08
77X-05
78X-05
79X-17
78X-03
78X-09
78X-01
79X-07
77X-04
79X-12
79X-01
79X-10
77X-06
79X-06
79X-09
78X-04
80X-01
78X-11
79X-11
79X-02
79X-03
78X-02
79X-14
79X-04
77X-07
79X-18
78X-06
77X-09
79X-05
80X-04
80X-09
79X-13
74X-16
80X-2
80X-05
77X-11
80X-06
80X-07
80X-08
80X-10
77X-10
good ore intersected
poor
LEGEND:
DRILL HOLE SURVEYED
UNSURVEYED
CYPRUS ANVIL MINING CORPORATION
DY DRILL GRID
1:6450

FIG. BA-2.

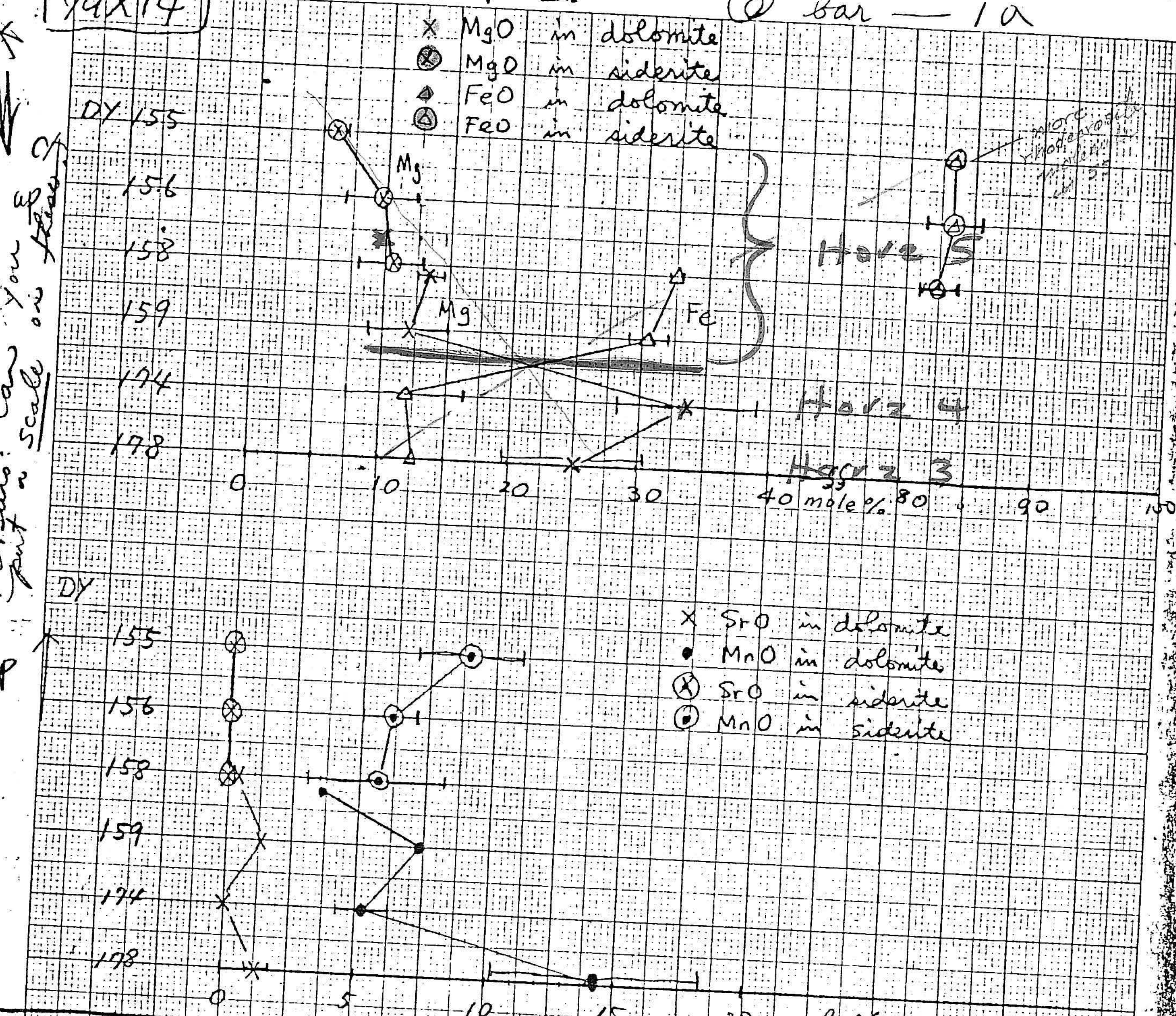
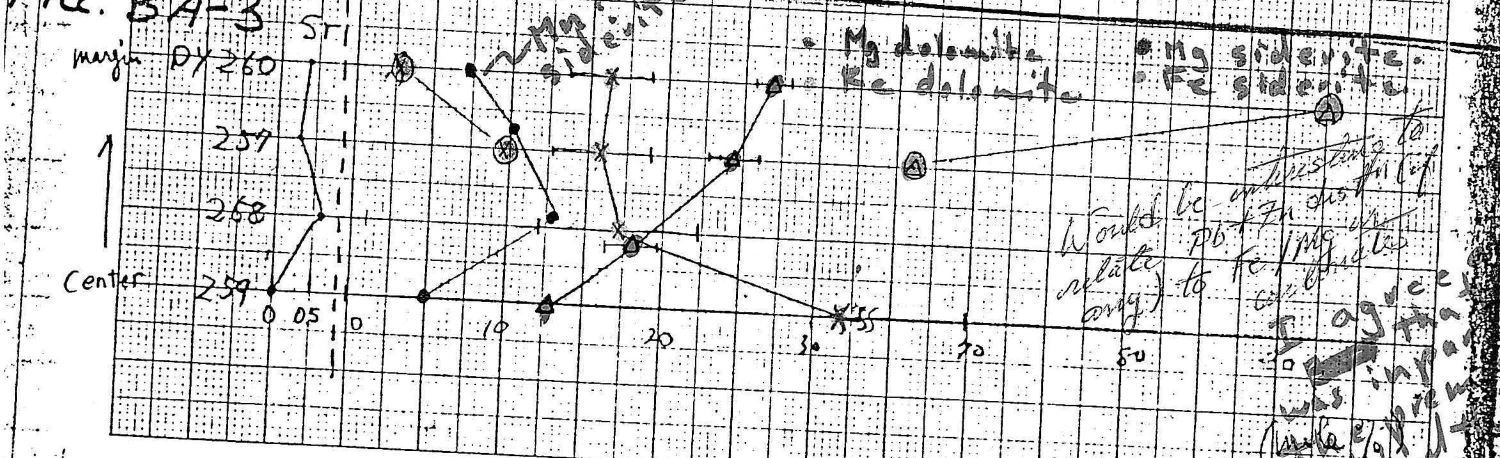


FIG. BA-3



SDS — replot using data in Tables.

BaSO4 / Carbonates

DSY

A 155 – 178 inc. depth

All 1 hole, all different horizons (per current dogma)

155	707 M	All BaSO4 bearing	Sd	Fe Top
156	712		Sd	
158	718		Do > Sd	
159	721		Do	
174	812		Do	Mg Bottom
178	857	↓	Do	

Urabe gives a bunch of mineral analyses which seem fairly irrelevant. Substantial point here is vertical Mg/Fe zoning between horizons — says nothing about " zoning w/in a horizon (would have thought this would have been an object of the study?)

B 257 - 260 single 4G unit

259 "central" ?? Do / no Sd

258 — Do / no Sd; $CaBa(CO_3)_2$ + $MgBa(CO_3)_2$ present BaCO3

257 Do > Sd

260 outer margin ?? Sd > Do

Dol. rls. Mg center / Fe rim (argues w/ early Mg fluids, late Fe fluids per ⊥ section)

No variation in Mn & Sr i.e. not evolving w/ fluid comp? but proportional rel". between Mn & Sr.

Fe / Fe+Mg inc upward (A series