

The Grum Deposit

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for

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SUMMARY

The Grum deposit is located in the Anvil Range Lead Zinc district, 200 kilometers northeast of Whitehorse, Yukon Territory. It is one of the five deposits owned by the Cyprus Anvil Mining Corporation. The deposit is believed to be a distal massive sulphide type deposit. The entire area has been metamorphosed at least five times, once to amphibollite, and once to greenschist grade. The Grum deposit is labelled as "fine grained" with respect to its sulphides. Through microscopic examination of eleven samples it has been determined that the fine grained nature of this deposit is the result of its extensive metamorphic and deformation history.

A special thanks to Dr. J. K. Mortenson for supplying the problem, samples and data.

INTRODUCTION

The Grum deposit is located within the Anvil Range Lead Zinc district, 200 kilometers northeast of Whitehorse, Yukon Territory. It is one of the five deposits belonging to the Cyprus Anvil Mining Corporation. The Grum deposit is believed to be a distal massive sulphide deposit in which precipitates of metal laden brines from submarine fumaroles ponded in ocean floor depressions (Carson 1977). It is classified as a sediment hosted, stratiform, massive pyritic sulphide type (Gastafson and Williams, 1981, Large, 1980) or sedex type deposit (Carne and Cathro, 1982)(Jilson 1984). With respect to grain size, the Grum deposit is said to be a "fine grained" (Carson, 1977).

The Main sulphide bearing zone consists of at least three now discontinuous sulphide layers. Enclosing the sulphides are phyllite units with interbedded chloritic members. These phyllites and chloritic members were originally marine sediments and volcanics.

On the whole, the Anvil district is polydeformational and polymetamorphosed. There are at least five periods of deformation, with the first two being the most intense. Both of those phases were regional, with one being amphibolite and the other green-schist grade. Within the Anvil camp, the Grum deposit exhibits the largest megascopic folds. These folds can be seen in section 78, (Fig. 1) along with post metamorphic faulting.

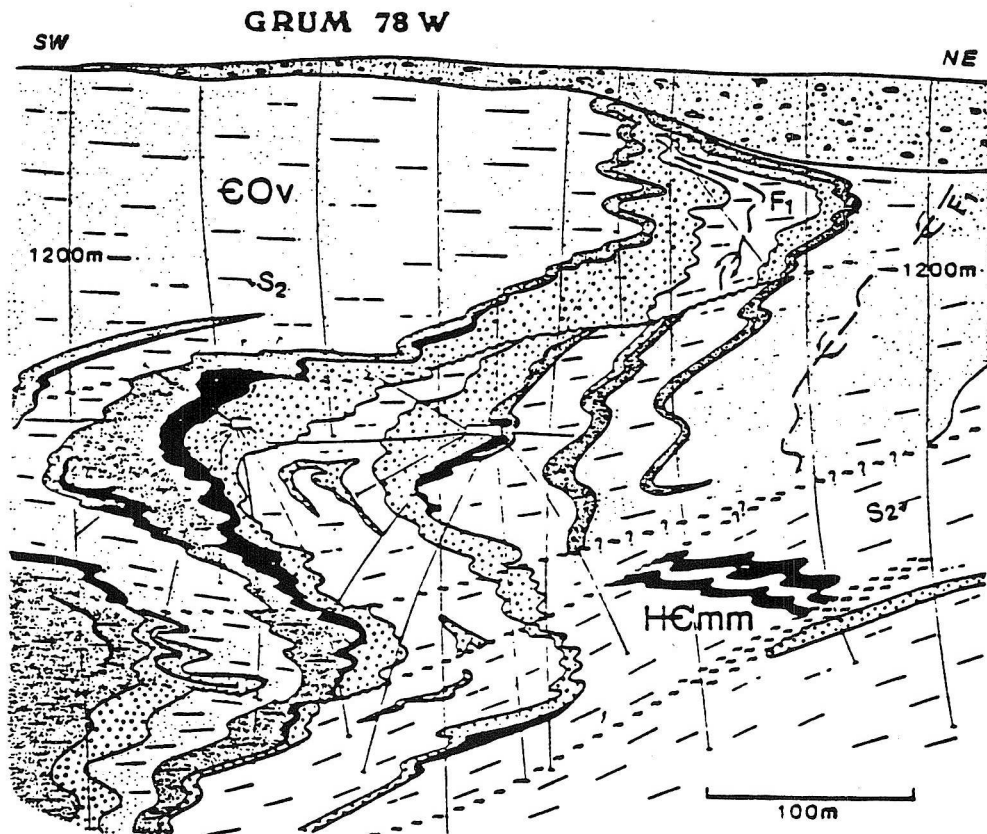





Figure 1. Section 78 W through the Grum deposit. Note the complex folds and faults within the ore zone.

Source: Jilson, Summary of the Geology and Sulphide Deposits of the Anvil Range, Yukon Territory, 1984.

-  massive ore
-  quartzose ore
-  graphitic pyllite

The purpose of this report will be to determine whether the "fine grained" nature of the deposit is an original depositional texture or the result of extensive metamorphism and intense folding. A total of eleven samples were studied and their location can be seen on section 64 (Fig. 2). Mineral percentages and assay results are summarized on Table 1.

TABEL 1 Summary of Assay Results and Laboratory Data

Sample Number	Mode %										Size lge	PY mode	mm	Assay %			g/mt	
	PY	SP	GL	AS	CP	MC	MG	QZ	CA	Cu				Pb	Zn	Ag	Au	
14049	65	2	t	1	t	1	t	28	2	.3	.1	.37	1.53	1.35	23	1.23		
14050	30	9	5	1	t	-	-		m	1.0	.6	.13	4.78	5.55	69	1.30		
14051	20	t	2	1	t	-	-	59	18	.6	.2	.03	5.20	7.80	76	.48		
14052	65	17	4	1	1	-	-	4	8	.7	.3	.12	7.90	7.00	96	1.03		
14053	36	2	3	5	1	1	t	43	11	.4		.04	8.30	15.70	133	1.23		
14054	40	2	1	3	1	t	-	42	11	1.0	.1	.40	.05	.05	9			
14055	12	4	3	1	1	-	-	79	m	.5	.2	.04	1.20	2.60	29	.62		
14056	25	23	5	-	2	t	t	45	m	.5	.1	.05	1.48	4.00	33	.82		
14057	85	2	3	1	t	t	-	2	8	.5	.1	.90	6.10	5.80	77	.96		
14058	20	1	1	1	4	2	3	65	4	1.8	.3	.34	.28	.46	13			
14059	35	3	2	1	1	1	t	43	4	.6	.2	.18	.37	1.03	11			
average	39	7	3	2	1	.5	t	35	7	.7	.2							

Source: Dr. J. Mortenson

Important references for this project are Jilson, Summary of The Geology and Sulphide Deposits of the Anvil Range, Yukon Territory, 1984, Carson, Geological and Mineralogical Investigation of the Metallurgy of the Grum Orebody, Yukon Territory, 1977, and Sirola, The Grum Deposit: Western Miner, Dec. 1975.

Figure 2 Section 64 W with Sample Locations.

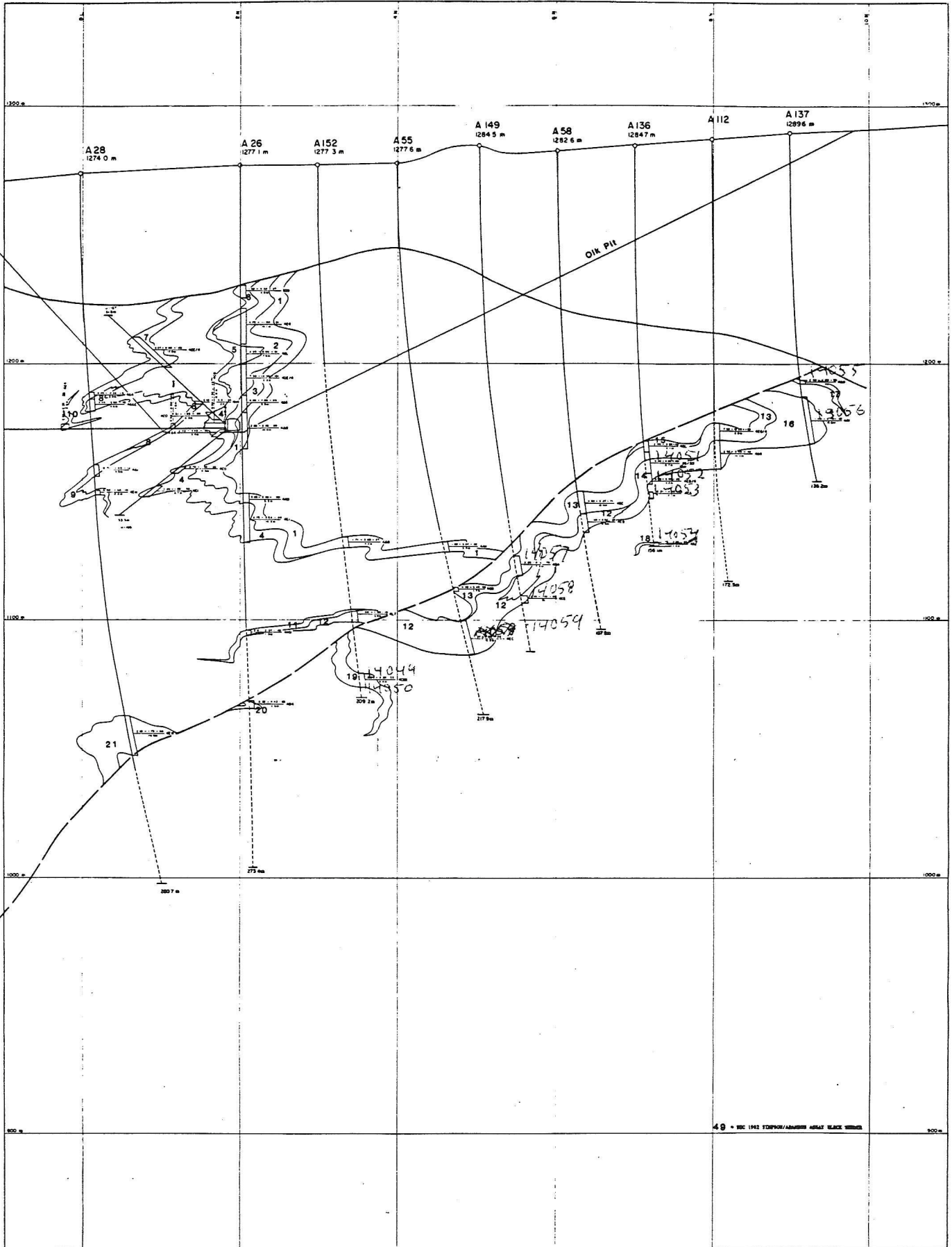


Figure 2 Section 64 W

MAP KEY		CYPRUS ARMY BARRACKS CORPORATION GRUM DEPOSIT VERTICAL CROSS SECTION 64 W L.S.M. MICHAELIS
SHEET 2	SHEET 1	
N 42° 13' 33"		312° VIEW AZIM. = 42° PROFILE

MINEROLOGY

The minerals examined under microscope can be divided into framework minerals and interstitial and replacement minerals. Framework minerals include pyrite and quartz with lesser amounts of sphalerite and arsenopyrite. Interstitial minerals include sphalerite, galena, chalcopyrite, marcasite, magnetite, arsenopyrite, pyrite, and calcite. This group also includes exsolution blebs.

Framework Minerals

The framework minerals are essentially pyrite and quartz. Within the samples these minerals range from fractured massive sulphides (14057) to schistose quartz with subordinate sulphides (14055). The shape of the crystals also varies widely, such as from very euhedral to very corroded in just one sample (14052). Generally the samples show a schistose texture with an even amount of pyrite and quartz.

Pyrite

Within these samples pyrite formed at least twice. There are two fractions with the larger probably forming by recrystallization during early regional metamorphism. The smaller euhedral crystals formed during or after later brittle deformation with the introduction of calcite.

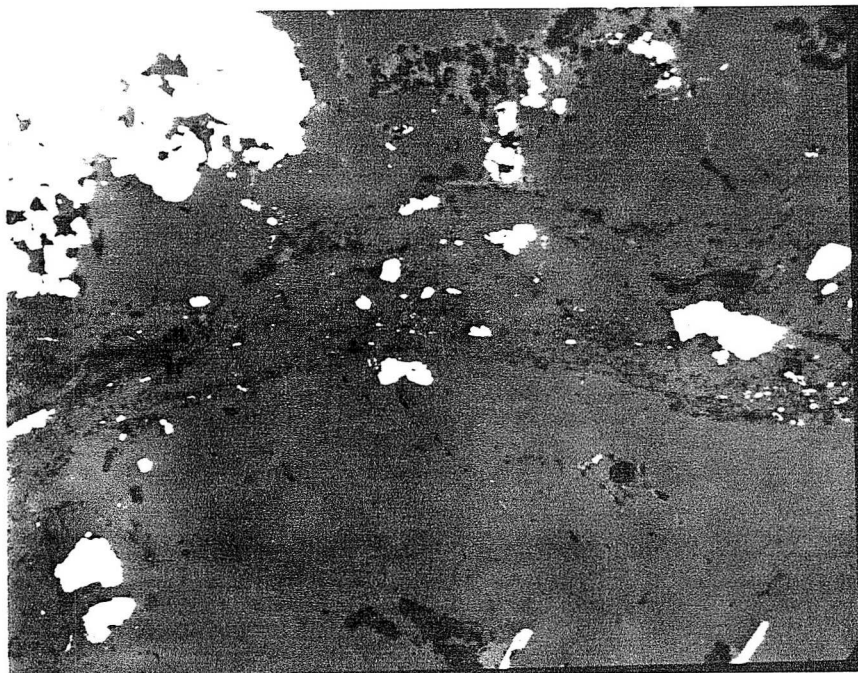
The pyrite is generally subhedral with the smaller crystals being more euhedral. The deterioration of the crystal shape is from both replacement and brittle deformation.

The larger pyrite crystals commonly contain inclusions of sphalerite, chalcopyrite, galena, magnetite and calcite, with the sphalerite being the largest and the chalcopyrite the most common.

The chalcopyrite and polyminerallic inclusions appear to be exsolution blebs which are randomly distributed throughout the crystals(14059). The larger sphalerite inclusions often show more crystallographic control, but appear to form by replacement (14056).

Quartz

The quartz crystals are usually anhedral and commonly occur in aggregates. The quartz appears to be more responsive to the deformation than the pyrite and shows a wispy texture (Fig. 3) instead of just breaking appart (eg. pyrite 14057).



88X

FIGURE 3. Wispy Texture of Quartz as Seen in Sample 14054.

The wispy or schistose texture of the quartz is characteristic of fairly high grades of metamorphism. The wisps often include

calcite and ground fragments of or secondary sulphides. The quartz is often replaced by calcite, both in its pure form and with other sulphides included within it.

Lesser Framework Minerals:

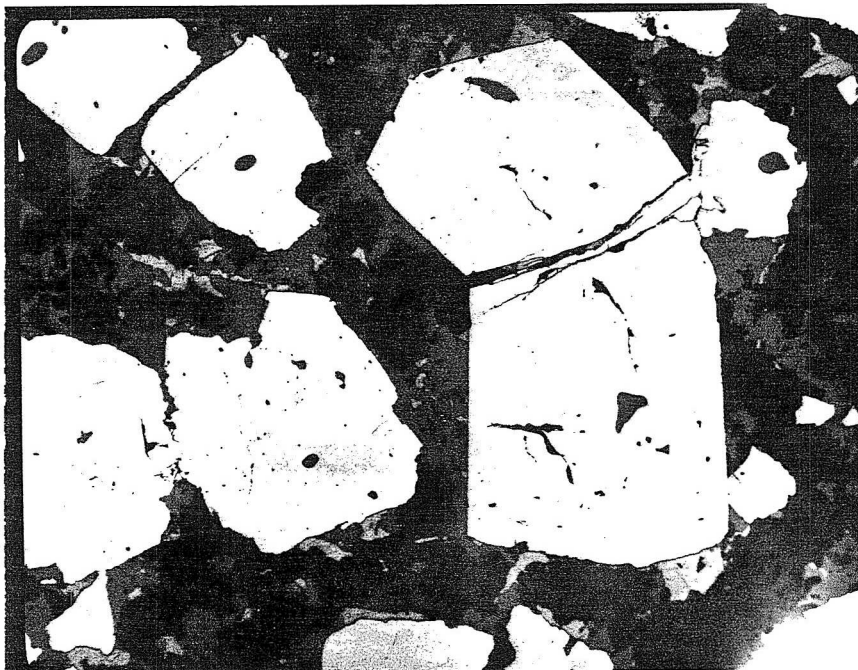
Sphalerite

Where the sphalerite occurs most readily, (14052, 14056) it occurs as irregular interstitial masses within the quartz and pyrite. In a few cases it takes the form of granoblasts (14049) in a pyrite framework. Where the sphalerite is seen in high percentages, it usually has a high proportion of inclusions, mainly chalcopyrite and galena exsolutions and recrystallized or entrained pyrite crystals (14049 Fig. I). The sphalerite commonly replaces pyrite and is often found as large replacement blebs within large pyrite crystals. Whether the sphalerite replaces the galena or visa-versa was not determinable. The sphalerite was mobile in the early and later stages of deformation as it is found both as drawn out granoblasts and as vein filling along with calcite, galena, and chalcopyrite (14049 and 14057).

Arsenopyrite

The arsenopyrite content is not very high, but it is rather consistent. It occurs and acts very similarly to pyrite and lone crystals of arsenopyrite crystals are often found in the pyrite aggregates. Where it clusters it forms drawn out granoblasts (14058), very similar to the sphalerite, and these are usually highly fragmented. The arsenopyrite is also found in with the calcite in the waffle texture, along with the pyrite and marcasite (14058). The most interesting aspect of the arsenopyrite is that

it usually occurs as euhedral or idiomorphic crystals. The arsenopyrite crystals are rarely corroded (except by calcite in 14058) but commonly show signs of brittle deformation (Fig. 4). This indicates that the arsenopyrite formed by replacement of pyrite crystals after the early ductile deformation but previous to the later brittle deformation. The arsenopyrite is most often inclusion free, but does include the odd bleb of pyrite and chalcopyrite.



88X

FIGURE 4. Twinned Arsenopyrite Crystal. Note how euhedral the arsenopyrite is compared to the surrounding pyrite crystals. Also notice the chalcopyrite inclusions in this large than average arsenopyrite crystal. The background to the larger crystals is calcite, sphalerite, and galena.

Interstitial Minerals

The interstitial minerals include mainly calcite, with lesser amounts of sphalerite, galena, chalcopyrite, marcasite, pyrite,

arsenopyrite, and magnetite. The calcite is usually the ground-mass and the other minerals occur within it. These minerals are found in veins, in the waffle texture, and in the interstices of the framework minerals.

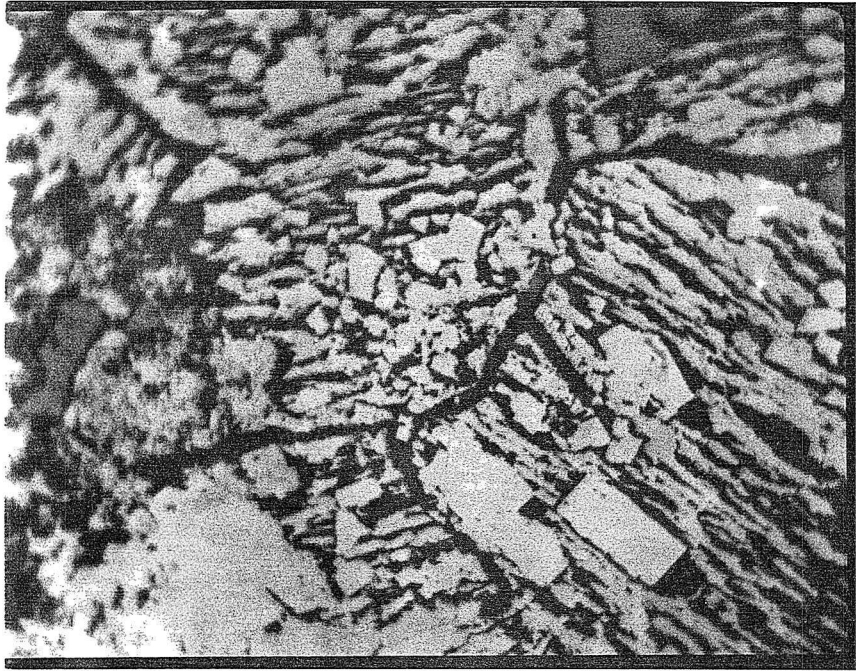
Vein Minerals

During the later brittle deformation stage the framework minerals were broken and fractured. Those fractures were filled with sphalerite, galena, arsenopyrite, magnetite, chalcopyrite, and calcite, in roughly that order (14057 Fig. II). With respect to abundance, the calcite is the greatest, followed by sphalerite, and then the other minerals. Veining is well seen in sample 14050, and most commonly in the pyrite.

Waffle Texture

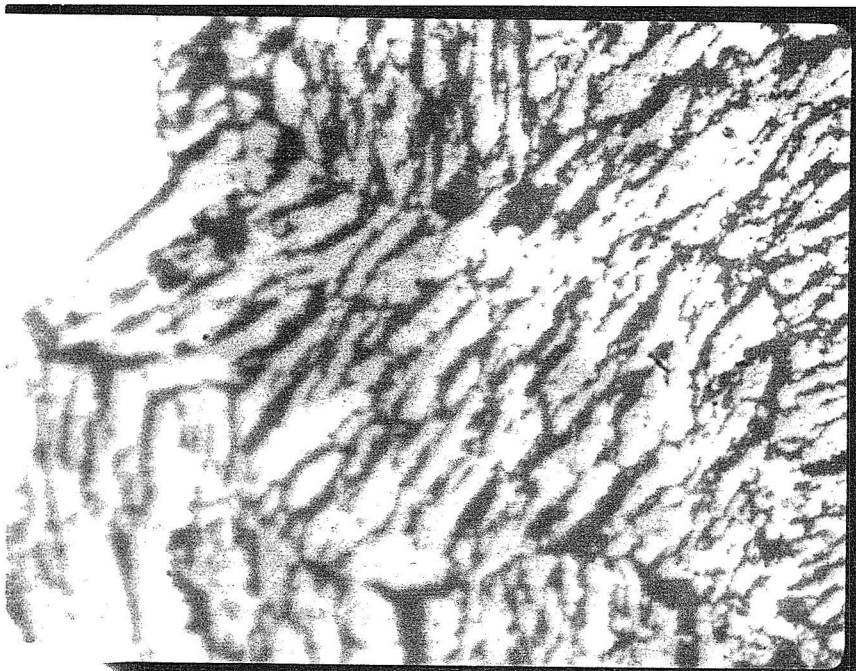
This texture is comprised of rhythmic layering of calcite and very fine euhedral sulphide crystals (Fig. 5). The texture is seen in most samples, but is best exemplified in sample 14058. The most common sulphide is marcasite, which can be seen under very high power to grow into the calcite as elongate crystals (14058). Pyrite is also common but as larger crystals two to five layers thick (Fig. 5). The less commonly occurring minerals are arsenopyrite, chalcopyrite, and magnetite.

This texture formed during the late stages of deformation, possibly in ever widening veins, and are themselves later deformed (Fig. 6).



600X

FIGURE 5. Waffle Texture. The larger crystals are pyrite and the smaller ones are marcasite. The grey background is calcite.



1000X

FIGURE 6. Deformed Waffle Texture. Notice how the waffle texture is formed around the edge of the upper right pyrite cube. This could either be deformation around the pyrite or the result of nucleation off of the pyrite.

Interstitial to Framework Minerals

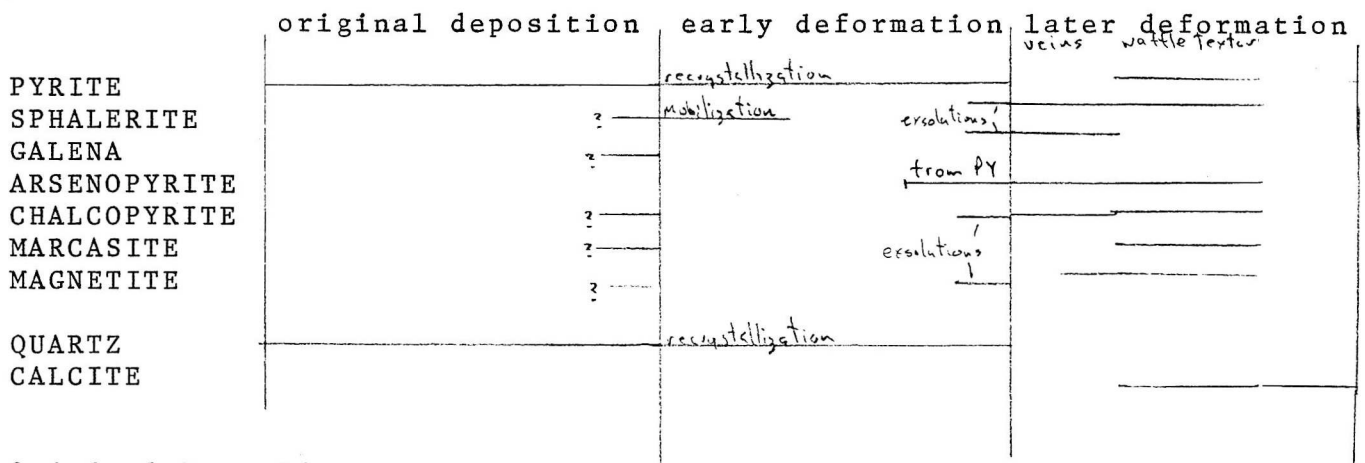
Other than in veins and in waffle textures, secondary sulphides occur in the interstices of the pyrite and quartz. The most common minerals are calcite and sphalerite, with lesser amounts of galena, chalcopyrite, and arsenopyrite.

Exsolutions

Exsolutions most frequently occur in the pyrite crystals and are discussed there.

PARAGENESIS

The paragenesis is divided into three time periods. The first is original deposition which occurred when the sediments and sulphides were first being laid down. The second period is the early metamorphism or deformation. This includes the higher metamorphisms and the ductile deformation regime. The last period covers the later brittle regime.



Original Deposition

The sulphides of the Grum deposit were precipitated from hot metal laden brines that issued from submarine fumaroles and ponded in ocean floor depressions (Carson 1977). There is no way to determine the mode of the original sulphides, but it was probably almost entirely pyrite. The quartz was originally deposited as marine sediments.

Early Deformation

During this stage of the deposits evolution, it was subjected to amphibollite and greenschist metamorphic pressures and temperatures. The solutions involved would be complex submarine brines and sulphide mixes in which complex chemical reaction could take place. Here the marine sediments were changed into pyllites

with schistose texture and they were undoubtedly recrystallized. During this stage megascopic folding occurred which would probably cause sulphide mobilization. This is seen in these samples where the sphalerite has become the dominant background mineral (14054).

The transformation of some pyrite crystals to arsenopyrite probably occurred late in this stage after most of the ductile movement had stopped. The arsenopyrite crystals generally only show brittle deformation, such as the deformation twin in figure 5, and only corrosion by calcite.

Late Brittle Deformation

This stage is marked by the brittle deformation of the framework minerals. This included the breaking and the fracturing of the pyrite and the granulation of the quartz. During this stage numerous deformation fabrics were produced. First there was the sulphide filling of veins. This would require some latent heat from the previous stage to reduce the viscosity of the sulphides. Then there is the waffle texture where calcite was introduced along with minor sulphides such as marcasite, arsenopyrite, pyrite, magnetite, and chalcopyrite. Finally there was just calcite filling of very late veins with no sulphide mobility (14050 Fig. II).

CONCLUSION

From viewing the crosssections (Fig. 1 and 2), it is apparent that the ore zones are stratigraphically controlled (Sirola 1975). In light of the textures seen in polished sections: recrystallized pyrite, schistose texture, deformation twin, waffle texture,^{and} drawn out granoblasts, and the fact that the deposit has been regionally metamorphosed twice, it can be said that the sulphide textures are definitely metamorphic. Using this conclusion it is apparent that the "fine grained" nature of this deposit is the result of extensive metamorphism and intense folding coupled with brittle deformation. Jilson came to the same conclusion about the Anvil camp as a whole when he stated, "the sulphides, sulphates, and host silicates in all deposits are extensively recrystallized and the textures seen today are largely metamorphic " (Jilson 1984).

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