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KERR ADDISON MINES

GRUM JOINT VENTURE

Preliminary notes on the petrology of the rocks at the Grum Deposit and some observations on the general geology in the Anvil Range Area

Mel deQuadros,
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Faro, Yukon

INTRODUCTION

Twenty-six rock specimens, considered representative of the rock types at the Grum deposit, were selected from diamond drill holes YS-A118 and YS-A121 for petrological study; of these sixteen were thin sectioned and examined under a petrological microscope. In addition, one further thin section was prepared earlier from core of diamond drill hole YS-A91 and examined by a consultant. The object of this exercise was to establish the minerals present in Grum rocks, and their relative abundance in view of establishing the correct petrological nomenclature for these rocks.

The following report is derived from a rapid preliminary examination of the thin-sections and rocks in Vancouver; the petrological notes are appended at the end of this report. A number of field observations have been added to this report and hence this is also a summary of observations made over the last six months at Grum, and of conversations with Kerr-Addison and Cyprus Anvil geologists.

CONCLUSIONS AND OBSERVATIONS

a) The rocks at the Geum deposit are the metamorphosed equivalents of pellitic, semipellitic, calcareous and carbonaceous sediments and also probably some fine-grained volcanic rocks. All observed rocks are very fine grained; there are no obvious clastic or allogenic materials in these rocks. They were probably deposited in a shallow or moderately shallow marine environment away from tidal action or estuarine facies, with periods of quiet lagoonal environment with reducing conditions and volcanic activity.

b) Mineralogically, these rocks have been totally recrystallised, and may be divided into the following assemblages:-

1) Quartz - muscovite ± natrolite?
2) Quartz - chlorite ± natrolite?
3) Quartz - muscovite - chlorite
4) Quartz - calcite - sericite - chlorite ± phlogopite
5) Calcite - sericite - chlorite ± phlogopite
6) Calcite - chlorite - sericite ± phlogopite
7) Quartz - mariposite (fuchsite) ± calcite
8) Quartz - muscovite - chlorite - biotite - almandine ± sphene? ~~These~~ ± cordierite.

These assemblages represent a range of metamorphic facies from the upper zeolite facies through greenschist facies to the biotite-almandine subfacies of the epidote-amphibolite facies, most rocks lying in the greenschist facies, indicating metamorphism under low to moderate load pressures and temperatures and a geothermal gradient of the Pyrenean type.

c) Contact metamorphism appears limited in range. While no thin sections of thermally metamorphosed rocks were studied, it is possible to generalise from field observation and drillcore near granite contacts:-

1) The thermal aureole is small, to be measured in tens of metres rather than in hundreds of meters.
2) The contacts are very irregular, often sheared, mylonitised and kaolinised.
3) there is usually a small zone of hornfelsic rocks, with biotite, garnets, staurolite and possibly andalusite near the contacts.

It should be mentioned here that in the north-west part of the ferum deposit, the calcareous phyllite is probably close to, or in contact with, the granite, indicating the possibility of scheelite-bearing skarn - certainly there is scheelite in the pan concentrates in the Anvil area. Core from near the contacts should be examined under black light.

d) Petrologically, these rocks are to be classified as phyllites. Total recrystallisation and the absence of any clay minerals ~~precludes~~ precludes the term 'shale'; and the fine-grained nature of the rocks precludes the terms 'schist' or 'gneiss'. Calcareous rocks tend to ~~by~~ be banded; ~~and~~ sericitic rocks tend to be slaty and biotite-bearing rocks tend to be schistose; but overall, the term 'phyllite' is most appropriate.

e) Generally most minerals occur in two habits ;
  1) fine grained anhedral equidimensional crystals intergrown with other minerals in a fine mosaic
  2) fine to medium-grained crystal aggregates, occasionally subhedral.
The second type appears to result from recrystallisation of the first - seldom, if ever, is there any suggestion of introduction of minerals from another source (except calcite)

f) Most minerals tend to be elongated along one of two directions, especially calcite and the micaceous minerals. The earlier direction, generally called F_1 by Templeman-Kluit and Kerr-Addison geologists, and S_1 by Cyprus Anvil geologists, is highly contorted and transdocated along a second foliation F_2, (or S_2 at Anvil mine) which is parallel to strong cleavage or parting. (Though the use of the letter 'F' for foliation has precedence in literature in the Anvil area, S (for surface) is a better usage geologically as F can represent 'foliation' or 'fold' in geological literature)

g) The F_1 foliation has been equated with the original bedding plane of these sedimentary rocks (the F_0 or S_0); this is a moot point which probably will be debated by geologist for years. There is a faint suggestion in the thin sections and more concrete evidence from rocks in the Anvil open pit and some exposures at the Blind Creek that there may be a foliation which may predate F_1, and therefore be the F_0.
However, the important point at Grum presently is whether the F_1 foliation seen in the mine is parallel to ore and rock contacts - in general this appears to be the case. It is possible to equate the F_1 foliation seen in the phyllites (very highly contorted and transdocated) with the F_1 in the ore (relatively straight

and continuous) by taking the sinuous F_1 banding in the quartz-sulphides and quartz-graphite sulphides to be intermediate between the extremes, though with some caution. The relationship between the F_1 banding in the two rock types and the relationship between F_1 and F_0 will have to be determined by a combination of stratigraphical and petrofabric analyses.
In thin section F_1 is seen to be due to parallel alignment of micaceous minerals, and segregation of quartz, sulphides and calcite to form distinct contorted bands. Micaceous minerals are often bent to follow the F_1 foliation.

b) The F_2 (or S_2) foliation is easier to see; it is generally caused by parallel alignment of micaceous minerals resulting in a prominent cleavage or parting; this cleavage may be almost slaty in very micaceous rocks. On a small (hand specimen) scale, the F_2 is seen to be often parallel to the ~~fold~~ axial plane of the F_1 folds and in part may be equated to an axial plane cleavage. There is an obvious angular relationship between the F_2 and the ore co and rock contacts; this angle varies in different parts of the decline indicating that the F_2 is either folded itself or that it fans around the fold planes of F_1.
In thin section, this axial foliation tends to be mainly caused by orientation of micaceous minerals, more rarely actual banding of sulphides and other minerals.

i) No definite and distinctive third foliation (F_0? or S_0?) was seen in the thin sections, though it was observed (though vaguely) in the polished sections. In the two field localities where this was observed, at Blind Creek and Faro orebody, this foliation appears as bands of mica which while not penetrative, occurs on surfaces of F_2 foliation (see attached diagram by Mr. Peter Lewis of Cyprus Anvil). ~~In~~ At present no ~~po~~ identification of F_0 has been made at Grum but if it did occur, ~~would~~ it would be interesting to see if it is parallel to the ore and rock contacts.

j.) Two other foliations have been observed in the core in the core from DDH Y5-A121, A86, A99, and A102 ~~and~~. These apparently have the same relationship to each other and to F_2 that the F_2 has to the F_1, i.e. they are development of micaceous minerals along planes along which there is translocation. ~~of the foliation~~. They appear not widespread and probably have no real effect on the ore zones on the scale of mining operations.

k) Bleaching and alteration of rocks is a common feature of the rocks above and below the ore zones, within the fault zones and sometimes apparently not connected with either. In hand specimen these ~~bleached~~ altered zones are of one of two types; ~~a~~

1) very incompetent very fine grained, with powdery mineral (Kaolin?, talc?, carbonate?) and muscovite, ~~with~~ often with pyrite and pyrrhotite, sometimes mineralised with galena and sphalerite, and generally poorly foliated.

2) very competent ~~ed~~ silicified greenish quartz-sericite ± chlorite phyllites, often barren, ~~but quite brittle~~ possibly gradational to the quartz ~~sericite~~ sulphides.

The one thin section of bleached sericite phyllite showed no obvious differences from the ordinary sericitic phyllites in thin section.

l) Calcite is perhaps more common than logged in core; it was identified in minor quantities in some rocks unexpectedly. By the same token, some units identified as calcite phyllite did have more quartz than anticipated. It will require more careful logging to obtain the true distribution of calcite in these rocks and to determine to what extent the calcite is sedimentary or metasomatic. The importance of calcareous units lies in the use of the calcareous units for correlation between diamond drill holes, ~~for~~ and for deciphering the ~~fold patterns~~ structural geology of the ore deposits.

m) The presence of chlorite is somewhat problematical. In hand specimen, the quartz-chlorite phyllites appear to be massive barren rocks with textures rather like of volcanic rocks – this was not observed in thin sections. It is also a common constituent of calcareous rocks; the primary mineral here is uncertain. In the higher ~~grade~~ metamorphic rocks, there appears to be a second generation of chlorite in large flakes, often in optical continuity with biotite which is replacing it – this is probably an intermediate stage between the fibrous chlorite and biotite found in these rocks.

n) Higher rank ~~as~~ minerals such as garnet, biotite, ~~and~~ staurolite? and andalusite tend to be small porphyroblasts giving rocks a rather spotty appearance.

In conclusion, the nomenclature used at Geum is essentially accurate, and well founded. More care however should be taken in determining the relative abundance of minerals in ~~each unit~~ logging.

GRUM JOINT VENTURE

LIST OF THIN SECTIONS

No. 12402 :	QUARTZ-SERICITE-PHYLLITE	D.D.H YS-A121 at	73.4m
12403 :	SILICIFIED QUARTZ-SERICITE-PHYLLITE	at	87.2 m
12404 :	QUARTZ-BIOTITE-SERICITE-PHYLLITE	at	106.5 m
*12406 :	SERICITE-QUARTZ-PHYLLITE	at	130.0 m
12407 :	QUARTZ-SERICITE-PHYLLITE	at	149.3 m
12414 :	QUARTZ-SERICITE-PHYLLITE	at	241.9 m
12415 :	QUARTZ-SERICITE-BIOTITE-PHYLLITE	at	252.5 m
12416 :	RECEMENTED QUARTZ-SERICITE-SULPHIDE BRECCIA	at	213.4 m
12417 :	CALCITE-QUARTZ-SERICITE-GRAPHITE-PHYLLITE	DDH YS A118 at	28.9 m
12419 :	QUARTZ-CALCITE-SERICITE-CHLORITE-PHYLLITE	at	66.9 m
12422 :	QUARTZ-SERICITE-CALCITE-CHLORITE-PHYLLITE	at	93.2 m
12425 :	QUARTZ-SERICITE-CHLORITE-PHYLLITE	at	57.8 m
12426 :	FUCHSITE-CALCITE-QUARTZ-ZEOLITE?-ROCK	at	161.9 m
12428 :	GRAPHITE-SERICITE-CHLORITE-QUARTZ-PHYLLITE	at	201.2 m
12434 :	QUARTZ-SERICITE-SULPHIDE PHYLLITE	at	299.0 m
12437 :	QUARTZ-BIOTITE-CHLORITE-GARNET-PHYLLITE	at	464.3 m

AND ALSO

SAMPLE A-91-448 : CALCITE-CHLORITE PHYLLITE DDH YS A-91 at 448 m.

12402 QUARTZ - SERICITE PHYLLITE

Minerals 1) quartz : very fine, cemented, and very anhedral with a mosaic like texture, edges very uneven 60%

2) sericite a) thin laminae of rather large xals with little quartz. these tend to occur in large flakes 5-10%

b) thinly intergrown bands, with about equal amounts of quartz + sericite, very fine 20%

Both slightly pleochroic

3) chlorite : small flakes, greenish 2-4%

4) barite? : granular, broken, with med to low RI and low interference colours; st. extinction 2-4%

5) Graphite : trace ; Phlogopite trace - brown flakes

Texture finely laminated, and banded, slightly schistose. Appear to be two generations of sericite, possibly ~~that~~ of quartz as well. Very fine grained.

12403 SILICIFIED QUARTZ-SERICITE PHYLLITE

Minerals: quartz : a) fine anhedral intergrown mosaic, unstrained

b) coarse xals, anhedral, ~~unstrained~~ strained; tending to be prismatic parallel to foliation 65%

sericite a fine grained, parallel to ~~schis~~ foliation. minor sericite in crosscutting fractures 15%

chlorite as above, but extremely fine 10

opaques magnetite graphite, pyrite 5%

Texture well foliated and banded, slightly schistose. Numerous small fractures.

12404 QUARTZ – BIOTITE – SERICITE PHYLLITE

Minerals Quartz : finely interlocking mosaic ; well cemented 40%

bent xals. | Sericite : fine grains, generally folded around quartz grains 20%

| Biotite ; brownish, as above, intergrown with sericite 25%

Accessories

Opaque pyrite, usually in the biotite rich bands 5-8%

Tourmaline radiating, length slow

Chlorite anomalous blue, rounded

Calcite 5%

~~12406~~ Texture : fine interlocking and banded, well folliated.

12406 Sericite – Quartz Phyllite

Minerals Sericite : small crystals in parallel growth, bent xals, intergrown thinly with quartz 50%

Quartz : very fine grained, both intergrown in ~~quartz~~ sericite and also in bands ; rounded, anhedral mosaic 40

Chlorite , trace

Opaque pyrite

Texture : fine grained, banded. Shows two foliations,

f_1 thin inconsistent, folded in isoclinal fashion and visible in the flexing of sericite xals.

f_2 gross banding

12407 QUARTZ - SERICITE PHYLLITE

Minerals: Quartz, fine interlocking grains. Grain size variable, paralleling both F_1 and F_2 foliations 65%

Sericite: very fine, generally in the finer quartz bands, 25%

Opaques: pyrite, large xals, generally parallel to either foliation; trace Graphite, 10%

Texture: fine grained interlocking, well banded and foliated in two direction, F_1 and F_2, F_2 dominates.

12414 QUARTZ - SERICITE PHYLLITE

Minerals Quartz: fine interlocking crystals, alternating very fine and fine bands parallel to both foliations 65

Sericite; very fine generally intergrown in the finer quartz bands 25

Chlorite; trace grains

Texture, as above, no obvious signs of bleaching.

1245 QUARTZ - SERICITE - BIOTITE - PHYLLITE

Minerals. Quartz: fine interlocking grains; alternating bands of fine and extremely fine xals. ~~[illegible]~~ 5[illegible]

Sericite; extremely fine, shows tendency to ~~[illegible]~~ F_1 ~~[illegible]~~ 2[illegible]

Chlorite: trace, very fine

Biotite; larger flakes, following F_2 20

Opaque 5

FRACTURE: infilled with fine calcite; slight offsets.

Texture, well banded and foliated fine grained rock.

12416 Recemented Quartz-Sericite-Sulphide Breccia

Minerals Quartz: a) coarse rounded fractured xals, dusty appearance due to inclusion of sericite; strained 30

b. fine interlocking mosaic 25

Sericite fine grained in fractures in (a) and intergrown with (b) above. ~~that~~ Also as dusty particles in (a) above 10

Opaques (pyrite, chalcopyrite 15

Texture: very uneven: suggesting a breccia. Silicified and recemented. No obvious foliation.

12417 Calcite - Quartz - Sericite - Graphite Phyllite

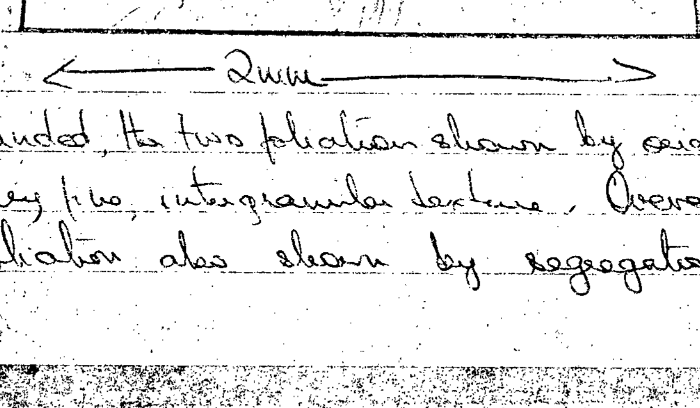
MINERALS: Quartz: very fine grained, interstitial, with tendency of elongation parallel to F_1 foliation ~~35~~ 30

Calcite: long laths, up to 3mm; elongation parallel to F_1 and rarely along F_2 foliation ~~30~~ 35

Sericite: very fine, parallel to F_1 foliation; also F_2 foliation bent crystals 25

Graphite: generally paralleling F_2; but rarely F_1 10 ~~25~~

Chlorite: trace



TEXTURE: Banded, the two foliation shown by orientation of minerals. very fine, intergranular texture. Overall a swirling texture. Foliation also shown by segregation of minerals.

12419 QUARTZ - CALCITE - SERICITE - chlorite - PHYLLITE

<u>Quartz</u> fine, intergranular, rounded to irregular anhedral 30
<u>Calcite</u> larger, irregular anhedral xals; also in fractures 40
<u>Sericite</u> fine grained, elongated parallel to F_2; slightly dusty 15
Chlorite ~~trace~~ platy, interstitial fine 15
Opaques 2%

<u>Texture</u>: banded, well foliated with generally good mineral segregation.

12422 QUARTZ - SERICITE - CALCITE - CHLORITE PHYLLITE

<u>MINERALS</u>

Quartz fine, interstitial, irregular anhedral grains, groundmass 3
Calcite larger twinned, irregular anhedral 2
Sericite bent laths, following F_1 and F_2 3
Chlorite platy, very fine 2
Opaques trace

<u>Texture</u> very swirling F_1 cut by F_2 foliation well indicated by bent chlorite and sericite laths. Rock well banded and foliated; denoted by segregation of minerals in both F_1 and F_2

12425

MINERALS QUARTZ-SERICITE CHLORITE PHYLLITE

Quartz very fine, interstitial, irregular anhedral ~~35~~ 40

Sericite: thick bands of fine bent wavy laths, in F_2 ~~40~~ 40

also across quartz bands in F_1

Calcite larger xals, irregular, possibly idioblastic 5-10

Chlorite: large flakes, full of inclusions, brownish 10

in part

Phlogopite? large brown flakes, pleochroic

Opaques: trace

Texture: Banded well foliated. Banding caused by segregation of minerals. F_1 folds very contorted and refolded. F_2 irregular ~~p~~ but persistent. Minor lenses of slightly coarser quartz

12426 Fuchsite - calcite - zeolite? - phyllite

MINERALS

Fuchsite green, irregular, swirling texture 40

Quartz extremely fine, interstitial, barely visible ~~20~~ 5-10

Calcite larger grains, anhedral, banded 20

Opaques 10

Zeolites? dull, & very fine; possibly ~~[illegible]~~ laumontite? 20

Texture

Banding present due to calcite and fuchsite; ~~texture~~ grain microscopic, barely visible, ~~Sheared~~.

12428

MINERALS GRAPHITE-SERICITE-CHLORITE-QUARTZ PHYLLITE

Graphite ;	parallel to $F_1 + F_2$	very fine	35
Sericite ;	" " "		~~20~~ 30
Chlorite ;	" " "		20
Quartz :	very fine, interstitial		15
Opaques	trace		

TEXTURE: swirling; shows both F_1 and F_2; both of which are folded. Foliation shown by orientation of flaky minerals and by segregation of minerals.

12434

MINERALS Quartz - sericite - Sulphide

Quartz :	very fine, anhedral, interstitial, tending to be elongated parallel to F_2	40
Sericite	very fine, showing both F_1 (rare) and F_2	~~1~~40
Sulphide :	opaques.	20

Texture: as above.

Thickness: uneven —

12437: QUARTZ - BIOTITE - CHLORITE - GARNET PHYLLITE

MINERALS

Quartz: very fine, anhedral, interstitial 30

Biotite: brown, in optical continuity with chlorite; large flakes; full of inclusions 25

Chlorite: large greenish flakes, in optical continuity with biotite, large amt of inclusions 25

Garnet: porphyroblasts; very broken; with inclusions of chlorite and quartz, rarely biotite pinkish 10

Sericite: trace 5

Opaques: 5

Calcite: trace

Cordierite? Sphene? trace

TEXTURE: swirling texture, controlled by flakes of Bio + Chlorite. disseminated porphyroblasts of garnet. Slightly schistose

Oran Deposit
Petrography File

Report for John Lund
Kerr Addison Mines Ltd.

Sample A-91-448

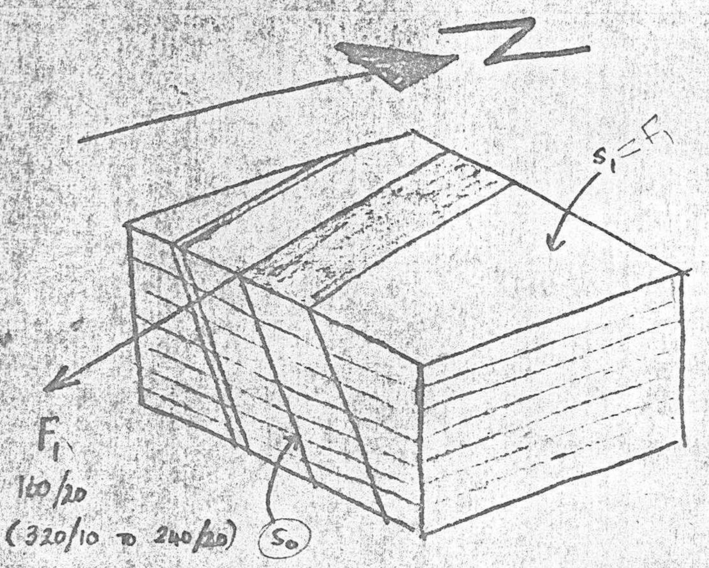
This sample shows gneissic banding and should properly be termed a calcareous-chlorite gneiss. The rock breaks along chlorite bands exposing planes showing phyllitic texture. The original rock was most probably an argillaceous limestone which has been completely recrystallized during metamorphism. It consists of about 75% calcite, 15% chlorite, 10% sericite and minor opaques.

Calcite occurs with two habits. These are calcite (1), 50%, which occurs as fine to medium-grained anhedral grains intergrown with chlorite and sericite, and calicte (2), 25%, which occurs as medium- to coarse-grained, crystalline segregations. Calcite (2) is probably recrystallized from calcite (1) and not introduced from a secondary source. Chlorite occurs as fine- to medium-grained grains which form the bands that impart the gneissic character to the rock. Sericite occurs as fine-grained crystals associated with calcite (1). Opaques are concentrated in chlorite bands. The rock has undergone deformation prior to calcite (1) recrystallization.

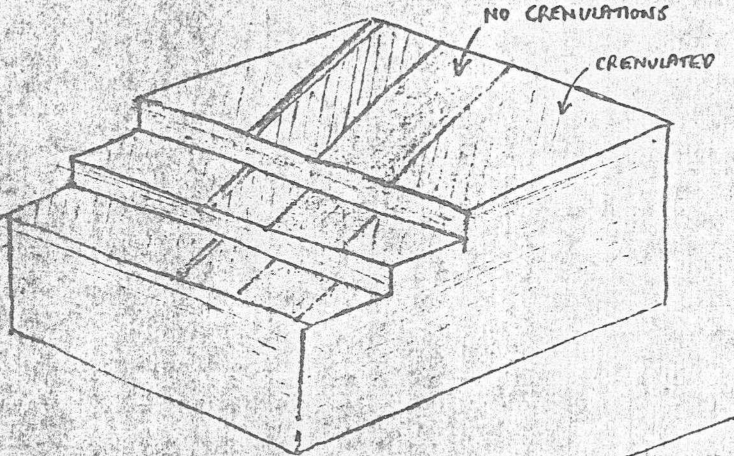
Mel

I don't like the term gneissic for this rock. I think it should be called a calcite chlorite rock with phyllitic banding.

B.



① QUARTZITE (2a) : S_0, POOR S_1
BANDS OF COARSE PURE QUARTZITE
IN SLIGHTLY MICACEOUS QUARTZITE



② MICACEOUS QUARTZITE (2a) : NO S_0, GOOD S_1
BANDING ON S_1 REFLECTS SLIGHT
DIFFERENCES IN MICA CONTENT. S_0 CANNOT
BE SEEN IN THIN SECTION OR HAND
SPECIMEN, IN SURFACE NORMAL TO F_1