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013307

Dear Andre,

Enclosed is a summary of results from a thin section study that I made <sup>in 1976</sup> of samples from the Fish Lake deposit. ~~Below~~ Corresponding rock samples for your reference were mailed under separate cover.

Enclosed ~~also~~ are several thin sections that I borrowed last month from Carl Lalonde. Regarding these samples, FL 81-1-172.5, 193.77 and 242.8 I would not refer to ~~them~~ <sup>two of them</sup> as quartz diorite, I suspect they are actually porphyritic volcanic rocks so andesite would be more apt. The thin section descriptions by Giotex were well done. ~~but~~ I noticed carbonate-gypsum-epidote (or zoisite) veinlets in 193.77.

I ~~think~~ <sup>think</sup> the matrix of 172.5 is partly silicified and it is cut by quartz-sericite-magnetite and carbonate veins.

Quartz-chalcopyrite-pyrite veinlets cut hematized magnetite veinlets and are cut and offset by carbonate veinlets. One ~~pyrite~~ <sup>carbonate</sup> veinlet has a <sup>pyrite core</sup> ~~carbonate~~ and a carbonate alteration halo. In 242.8

508810

1A QSA

sericite or pyrite - carbonate - chalcopyrite <sup>veinlets are</sup> (?) cut  
by carbonate veinlets, quartz, with calcite - carbonate  
cores, <sup>and</sup> quartz - gypsum. The matrix has secondary quartz.  
If there was early biotite alteration, no evidence of it  
remains.

Let me know how the Fish Lake project is  
going and I would appreciate it if you  
would contact me ~~on~~ <sup>when</sup> plans for the summer are  
finalized.

Please remind Carl <sup>and Al</sup> about the Victoria  
Invitational Golf Tournament on April 10; you and  
Norma should consider coming ~~if~~ if you can.

Regards to yourself and Norma.

Bill

W. M. Miller

Enclosures - Thin Section Report  
- Golf Tournament Form

Separate Coover - Rock Samples

Fresh Lake

Summary of Thin Section Study

1. Hole Q 73-3: two thin sections both have <sup>alteration to</sup> biotite (partially altered to chlorite) sericite and quartz. One <sup>also</sup> has actinolite the other carbonate alteration.

→ ~~At 200~~ The country rock is <sup>altered mafic</sup> a plagioclase porphyry ... probably by it was porphyritic lava originally. Magnetite-<sup>actinolite-biotite-quartz</sup> rich clumps ~~are common~~. <sup>Pseudomorph mafic. Plagioclase</sup> phenocrysts are <sup>20-40%</sup> altered to hydromica (?). Quartz <sup>occurs as</sup> crystals and clumps of crystals; much of it is probably secondary. The matrix is <sup>50%</sup> <sup>80%</sup> altered to a mix of biotite, chlorite, actinolite, quartz and other components. Pervasive biotite alteration was early; argillic-propylitic alteration was <sup>later</sup>. ~~At 250 a vein matter was sampled. Carbonate veins were fractured then healed with clear quartz.~~

2 Hole Q 73-11: The <sup>country</sup> rock is variable from fine grained to porphyritic matrix alteration varies from 40-100%; phenocrysts are variably altered (less intense deeper in the hole?).

Alteration mineralogy does not change very much with rock type. In all, early <sup>pervasive</sup> biotite alteration was overprinted by an alteration assemblage of sericite, quartz, carbonate, ± chlorite, local hematite after magnetite and varying amounts of gypsum.

Mafic minerals alter to chlorite, iron-rich carbonate and opaque minerals.

Quartz, feldspar porphyries alter to sericite, ± kaolinite, ± carbonate, ± chlorite (after mafics), ± quartz, ± gypsum. <sup>Evidence of</sup> Early biotite alteration is lacking.

Overall, the country rock is variable from massive to porphyritic ~~volcanic~~ lava and is cut by QFP dikes. Biotite Pervasive biotite alteration <sup>occurs</sup> in the country rock but not in the dikes.

<sup>altered, tan colored</sup> Thin sections: 154 <sup>QFP</sup>; 205 Bleached out, tan colored rock - lava?; 290 Dark colored <sup>biotite altered</sup> mafic plagioclase porphyry (lava or intrusive?); 365 Gray plagioclase porphyry

(2)

Q73-11 (Continued) (lava or intrusive ~~ve~~)  
altered to carbonate + sericite + chlorite + quartz; 512 biotitized  
massive, very fine grained rock; partly overprinted by sericite and  
some chlorite alteration (lava?); 585 QFP cutting biotitized lava(?);  
disseminated biotite and  
(clots of biotite - quartz - magnetite in the lava (?), sericite and carbon-  
ate alteration predominate in the QFP but there are clots of <sup>partially chloritized</sup> bio-  
tite - quartz - magnetite (these may be incorporated from the  
country rock); 693 <sup>gray</sup> crowded plagioclase porphyry with minor amounts  
of quartz; <sup>plagioclase</sup> phenocrysts are altered to sericite and carbonate, primary  
mafics are altered to chlorite and iron-rich carbonate or sericite;  
the matrix altered to quartz, carbonate and chlorite. This rock  
is probably a dike, biotite altered lava is nearby; 862 <sup>dark gray</sup> biotitized  
very fine grained rock (lava) that is bleached to a green color adjacent  
to ~~veins~~ <sup>(now 80% altered to chlorite)</sup> fractures; biotite <sup>crowded</sup> is widely disseminated; 1196 QFP; primary bio-  
tite is 90% altered to chlorite and iron carbonate; quartz  
occurs as <sup>phenocrysts</sup> ~~cryst~~ and clumps of crystals, some is secondary;  
the matrix is quartz and feldspar that is 50% altered to seri-  
cite and carbonate; Note that there are quartz veins here with  
~~pyrite~~ pyrite and gypsum in their cores; the rock is QFP from 560

3. Hole Q73-1: Only the upper part of the hole has

biotite alteration. Biotite alteration was early

and is overprinted by a mixed argillic / propylitic alteration; that is, biotite alters to sericite <sup>+ carbonate</sup> ± chlorite ± quartz ± hydromica. ~~scattered~~ The country rock is mafic plagioclase porphyry <sup>with local quartz phenocrysts</sup> that is probably a volcanic rock. A post-mineralization ~~is a~~ dike has carbonate with lesser sericite, chlorite and clay alteration; quartz feldspar porphyry <sup>dikes are pre-mineral.</sup>

Alteration of phenocrysts increases down the hole from 50% to 100% but matrix alteration decreases from 60 to 80% to about 20% below 500 feet.

Thin sections: 237 - plagioclase is complexly zoned, <sup>rimmed albitic,</sup> ~~and~~ 30% altered to carbonate ± chlorite ± biotite; rare, rounded overgrown quartz phenocrysts; <sup>feldspathic</sup> matrix 70% altered to biotite, chlorite and quartz; <sup>cut</sup> by quartz, chlorite, biotite, pyrite veins and quartz magnetite apatite veins; mafic (?) altered to masses of brown or green-brown biotite and opaques; disseminated magnetite. Note, the biotite or chlorite altered zones are irregular and could be pervasive matrix alteration zones rather than pseudomorphs;

388 - crowded chloritized mafic <sup>quartz</sup> plagioclase porphyry (QFP) has ~~feld~~ <sup>(approx An55)</sup> plagioclase like that at ~~(237)~~ 237; mafic mineral was an amphibole originally; quartz phenocrysts are subhedral - this may be Quertan's type 1a - ; 434 yellowish pervasively altered rock, possibly

plagioclase porphyry, altered to carbonate, kaolinite, quartz and hydromica and cut by veins in the following sequence, early quartz (Q) - carbonate (C) - pyrite (P) - hematite cut by Q-C-P then C - ~~kaolinite~~ <sup>kaolinite</sup> and finally C, disseminated hematite after magnetite, ~~the~~ <sup>trace</sup> of veiny quartz-chalcocyanite vein uncertain but it is cut by Q and C veins;

522 - mafic (remnants of secondary biotite, mostly chlorite + carbonate + opaque now) plagioclase porphyry, matrix quartzofeldspathic with 20% carbonate and some sericite alteration; accessory minerals are opaque, apatite and <sup>zircon</sup> zircon;

597 - bleached gray plagioclase porphyry (plagioclase yellow-white), plagioclase altered 90% to carbonate, sericite and quartz, matrix 10% altered to carbonate and sericite, vein sequences are

check TS  
hand lens scope  
mafic → chl + bio

check -  
matrix may be  
silicified

Q-chlorite-C-magnetite - albite cuts Q-C and Q-C-sulphide which is cut by Q-some sericite-sulphide with flakey sericite halos. alteration envelopes, gypsum veins cut all the others; age of ~~the~~ Q-chalcopyrite veins uncertain, magnetite partly hematized;

Further comments: 300 - Post <sup>mi</sup> mineral hornblende (chlorite now) plagioclase porphyry; 169 sericitized plagioclase porphyry with mafics altered to sericite and matrix is olive green, complex plagioclase zoning visible.

Hole Q73-12

4 Hole Q73-12: The country rock varies from <sup>plagioclase</sup> porphyritic biotite altered rock (hornfels in my report) to spotted biotite altered rock. Biotite is invariably partly altered to ~~sericite~~ sericite and generally also to carbonate, chlorite ~~and~~ sometimes quartz; alteration intensity decreased down the hole.

Thin Sections: 240 - green-gray biotitized plagioclase porphyry of volcanic origin with sericite alteration adjacent to fractures, plagioclase 60% altered to sericite biotite and carbonate, biotite is brown or locally green and fine grained, matrix 70% altered to biotite, sericite and carbonate, some secondary quartz, disseminated magnetite, pyrite and chalcopyrite; 302 (hand specimen) - spotted "hornfels" with ~~sericite~~ biotite or chlorite-rich spots, matrix speckled with chlorite; 503 - biotitized plagioclase porphyry, plagioclase glomeroporphyritic complexly zoned, 40% altered to carbonate and sericite, matrix feldspathic, 20% altered, clumps of biotite (brown to green-brown) - carbonate - quartz - opaque, veins of <sup>Quartz</sup> ~~Chlorite~~ - magnetite - chalcopyrite and gypsum (young).

5 Hole Q73-10: The hole <sup>is</sup> ~~is~~ fine grained to plagioclase porphyritic volcanic rock that is cut by QFP, ~~and~~ mafic QFP and Plagioclase porphyry dikes. The country rock had early pervasive biotite alteration that is now variably altered to chlorite and carbonate. Fe feldspars are altered to sericite carbonate quartz and some hydromica, mafics are chloritized. The QFP dikes seem to follow most of the biotite alteration but are affected by propy-argillic alteration.

Thin Sections: 125 - tan altered rock (derived from plagioclase porphyry?) cut by quartz-magnetite (partly hematized) - Chalcopyrite veins that are cut by carbonate with pyritic halos cut by rusty carbonate veins;

125 (cont'd) quartz is <sup>disseminated</sup> in the matrix and <sup>occurs</sup> as clumps of crystals (secondary), the matrix is also altered to sericite and carbonate; 205 - QFP, plagioclase 100% ~~sericitized~~ <sup>altered to sericite</sup> carbonate quartz; matrix to sericite carbonate quartz and hydromica, quartz veins have pyrite, chalcopyrite and berrite in central zones; 276 - partly chloritized biotitized plagioclase porphyry, alteration to biotite quartz, carbonate and some kaolinite(?), chlorite is largely after biotite; veins are quartz-carbonate-apatite and quartz-chlorite with or without biotite and magnetite, several percent disseminated magnetite; 380 - altered spotted "hornfels" - the matrix is altered to chlorite (some green biotite?) sericite and carbonate, the "spots" are pyrite, some chalcopyrite(?), sericite chlorite with coarser halos of chlorite sericite quartz and apatite; veins are sericite-quartz-chloritized biotite carbonate and pyrite, ~~and~~ carbonate with some quartz, and ~~carbonate~~ carbonate-pyrite-chalcopyrite; 399 QFP (~~or ash tuff??~~) - ~~I favor the interpretation~~ cut by yellowish carbonate veins, minor disseminated pyrite; looking at it now <sup>(1981)</sup> it looks layered and could be crystal ash tuff or is flow layered, plagioclase crystals are half altered to carbonate chlorite and kaolinite(?) with minor sericite, the matrix is 60% carbonate sericite chlorite altered, pods of carbonate with local quartz and pyrite are disseminated through the rock; 440 - spotted finely feldspathic rock, matrix half altered to dense, very fine carbonate, the rest ~~to~~ is apparently a fine mosaic of quartz; the spots are pyrite apatite chlorite sericite and carbonate, veins are carbonate <sup>pyrite</sup> ± quartz ± <sup>(Chalco)</sup> pyrite, quartz-chlorite ± sulphides, and gypsum; 574 - dark gray-green mafic(?) plagioclase porphyry dike, relatively crowded (plag. 30%, to 5mm), plagioclase variably sericite and carbonate altered, matrix has fine plagioclase laths, <sup>half</sup> altered to carbonate and chlorite; 608 mottled biotitized "hornfels", darker areas are largely fine biotite, "mottles" are biotite quartz sericitized feldspar and chlorite, <sup>several percent</sup> disseminate magnetite, veins of carbonate-gypsum cut the recrystallized biotite-quartz ~~and~~ "mottles"; 842 - mottled dark gray and ~~gray~~ white ~~is~~ very fine grained rock cut by quartz-chalcopyrite veins, is a mosaic of finer and coarser zones of biotite-quartz-plagioclase (dusted by clay and carbonate alteration), quartz-feldspar (albite or kfeldspar?) veins cut by gypsum-quartz-carbonate with some sericite, also quartz-feldspar-chlorite-carbonate veins; 912 -

912 cont'd) relatively crowded <sup>gray-green</sup> mafic QFP - plagioclase 40% to 5mm, glomeroporphyritic, <sup>the complexly zoned</sup> plagioclase is <sup>20%</sup> altered to carbonate quartz sericite and kaolinite (?), the matrix is <sup>also about</sup> 20% altered but to quartz, biotite (partly chloritized) sericite and carbonate, biotite occurs as ~~clumps~~ clumps of brown crystals, some <sup>have</sup> replaced pyroxene, about 2% disseminated magnetite, veins of magnetite-sulphide-quartz-carbonate; 1228 tan colored QFP, ~~plagioclase~~ plagioclase altered 90% to ~~carbonate~~ sericite and quartz, mafic to carbonate, hydro-mica and sericite, matrix to sericite quartz and carbonate, there are clumps of crystalline quartz-sericite and calcite-filled vugs, minor amounts of pyrite; 1241 - tan colored QFP, plagioclase yellow-white <sup>due to</sup> alteration to carbonate sericite and kaolinite (100%), mafics to hydromica <sup>quartz</sup> and Fe <sup>rich</sup> carbonate and opaques, matrix to carbonate, some hydromica and chlorite (?), veins of quartz-carbonate - <sup>pyrite-chalcopyrite</sup> ~~sulphide~~ are cut by carbonate veins; hand specimen from 180 is altered plagioclase porphyry altered to biotite then partly sericitized, <sup>has</sup> ~~with~~ chalcopyrite in fractures and quartz-flakey sericite fractures <sup>from</sup> ~~at~~ 493 there is a contact between plagioclase porphyry (dike) and <sup>very fine</sup> grained volcanic rock, no chilling is evident, veins ~~of~~ are quartz-magnetite ± chlorite.

6 Hole Q 73-15: The hole is in mafic plagioclase porphyry that ~~is cut by QFP dikes~~ <sup>gives way to an area</sup> dominated by QFP after about 400 feet. In most of the hole ~~feldsp~~ plagioclase is partly altered to sericite carbonate and quartz with ~~local~~ <sup>local</sup> hydromica pyrite and kaolinite, mafics to chlorite ± sericite ± sulphides ± magnetite - Fe carbonate and hydromica, secondary biotite was seen in only one thin section. Alteration averages 50% through the hole.

Thin Sections - 120 - fine grained crowded plagioclase porphyry, with mottled, chloritic matrix, plagioclase, average An 40, has complex oscillatory zoning and is 60% altered to sericite and carbonate, the matrix is biotitized and silicified with later sericite and chlorite alteration, 90% altered, ~~biotite~~ - chlorite - ~~opaque~~ (magnetite) zones <sup>are</sup> probably pseudomorphous after mafics, disseminate magnetite and pyrite; 180 fairly well mineralized - altered <sup>crowded</sup> mafic plagioclase (An 40) porphyry, <sup>1-2mm plagioclase</sup> phenocrysts ~~are~~ altered to a cream-color but remnant complex zoning is visible, alteration products are carbonate



(180 cont'd) and kaolinite with some chlorite and sericite, mafics altered to sericite, chloride apatite (may be inclusions) and sulphide, matrix half altered to chlorite sericite and carbonate, veins of carbonate (siderite?) kaolinite, and quartz with <sup>flaky</sup> sericite-rich envelopes; 310 - Sulphide-rich tan altered rock, original textures destroyed, alteration is to carbonate sericite quartz (in clumps) ~~what were plagioclase crystals~~ are now largely kaolinite with carbonate and sericite, veins of carbonate-quartz cut quartz veins that cut quartz-molybdenite-pyrite veins; 390 - pervasive cream to orange alteration of plagioclase porphyry cut by quartz-pyrite veins with <sup>gray sericitic</sup> ~~altered~~ halos, alteration is 90% to sericite, carbonate and quartz, quartz veins cut by carbonate-quartz veins; 440 - gray green altered plagioclase porphyry, plagioclase complexly zoned, average An<sub>32</sub>, variably altered to sericite and carbonate, matrix 60% altered to carbonate and chlorite, chloritic patches have pyrite and magnetite, <sup>vuggy</sup> veins of quartz-pyrite-apatite-carbonate-chlorite; 49.3 or 493(?)

mafic altered to chlorite sericite and Fe carbonate <sup>100%</sup>

→ altered QFP, plagioclase <sup>is altered</sup> to yellow-white color ~~and~~ <sup>and</sup> is <sup>90%</sup> altered to carbonate and kaolinite (QFP), quartz phenocrysts are partly intergrown with the matrix, the matrix is completely altered to carbonate and quartz, mafic minerals are altered to hydromica and Fe carbonate, veins are quartz, there are clots of quartz-chalcopyrite-hydromica, fractures are covered by quartz-chalcopyrite, primary magnetite is hematized.

7 Hole Q 74-4: The <sup>volcanic</sup> country rock in the hole is mafic plagioclase porphyry or plagioclase porphyry that is cut by QFP dikes of one <sup>section</sup> of QFP is in excess of 100 feet thick and could be a sill (not sure because orientation of QFP zone ~~is~~ <sup>not</sup> known), the QFP matrix is less altered than that of the country rock (except near contacts), the dominant alteration products are carbonate <sup>quartz</sup> and sericite with or without ~~quartz~~, chlorite and kaolinite and local biotite, mafics alter to chlorite with or without sericite, quartz, carbonate, magnetite, pyrite, ~~and~~ apatite and local biotite.

Thin sections - 81 - <sup>gray</sup> mafic <sup>andesine</sup> ~~andesite~~ (An 43) porphyry, plagioclase

(81 cont'd) with ~~to~~ carbonate and some chlorite alteration <sup>and</sup> has complex oscillatory zoning, disseminated magnetite and pyrite, veins are chlorite-quartz-pyrite-carbonate ± sphene (?); 122 - bleached white plagioclase porphyry, pyritic, phenocrysts difficult to see in thin section due to alteration that is mainly carbonate, matrix extensively altered to carbonate and quartz, sheafs of gray birefringent white mica - overall alteration is argillic; 142 - gray plagioclase (An<sub>37</sub>, 12-3mm, 40%) porphyry, alteration like 122 but less intense, mafics altered to chlorite and Fe-carbonate, pockets of carbonate-chlorite <sup>vuggy</sup> veins of pyrite-quartz-sericite (flakey); 155 - dark gray green, slightly porphyritic <sup>altered</sup> ~~metavolcanic~~ rock, plagioclase complexly zoned, An<sub>40</sub> to An<sub>20</sub>, chlorite often forms "knots" or "pockets", alteration of the matrix is to chlorite carbonate and quartz, disseminated pyrite; 200 - gray green somewhat porphyritic volcanic rock, plagioclase 80% altered to carbonate with some sericite, the matrix has chlorite and quartz alteration, some sericite and pyrite-quartz <sup>-sericite</sup> <sup>(-apatite)</sup> "knots"; 268 - altered crowded mafic plagioclase porphyry has similar alteration to that at 200, pyritic, pyrite associated with chlorite-apatite ± sericite ± carbonate ± quartz, veins of pyrite-chlorite-carbonate; 288 - bleached, veined flakey sericite in pockets, rock was plagioclase porphyry; plagioclase <sup>crystal</sup> outlines still visible but <sup>90%</sup> altered to carbonate and sericite; matrix silicified and carbonate altered (80%), <sup>9</sup> pyrite veins have quartz flakey sericite carbonate envelopes, apatite is an alteration product and is associated with quartz, sericite and carbonate, veins carbonate seemingly cut by quartz-sericite ± sulphides, ~~which are~~ <sup>that are</sup> cut by later carbonate; pyrite disseminated and in veins; 323 altered gray <sup>crowded</sup> mafic plagioclase porphyry, plagioclase <sup>average An<sub>43</sub></sup> with oscillatory zoning, 10 to 25% altered to chlorite carbonate, matrix 95% altered to quartz chlorite and carbonate, veins quartz ± sulphide, quartz-chlorite-sericite, abundant disseminated <sup>magnetite</sup> (4%); 370 QFP, matrix looks aphanitic, pinkish color, plagioclase crystals 30% to 5mm, altered to carbonate and sericite and fine grained mineral(s) - possibly clay - alteration 98%, matrix is 15% altered to sericite and carbonate, clumps of quartz-pyrite-sericite-carbonate-apatite, carbonate veinlets; 496 strongly altered QFP, plagioclase 100% altered to carbonate sericite and some quartz, quartz phenocrysts are rounded with minor overgrowths

nick mica

(496 contd) mafics chloritized, matrix 90% altered to carbonate, sericite, quartz and chlorite, pyrite disseminated and in quartz veinlets, 7%; 516 - altered <sup>gray</sup> crowded mafic plagioclase porphyry, plagioclase 1-2 mm, 50%, cores altered to sericite and carbonate, twins still visible, An<sub>37</sub> average, matrix completely altered to carbonate quartz - sericite ~~and~~ chlorite and biotite, pyrite in ragged clumps with quartz sericite chlorite carbonate halos, veins are pyrite - quartz - sericite - chlorite; 577 altered plagioclase porphyry with 10% disseminated and vein pyrite, alteration nearly 100% to carbonate and quartz, veins are pyrite quartz ~~and~~ sericite and carbonate; 625 - altered <sup>gray to</sup> ~~cream~~ <sup>colored</sup> crowded QFP, plagioclase 50%, 1-2 mm, plagioclase altered 100% to carbonate sericite and kaolinite, matrix 30% to carbonate and sericite, veins are quartz - pyrite - chalcopyrite, quartz - carbonate - sericite - pyrite - Fe carbonate - apatite, carbonate veinlets cut sericite fractures; 716 - veined plagioclase porphyry, plagioclase <sup>and matrix</sup> 60% altered to carbonate and sericite, dark gray ~~quartz~~ <sup>pyrite (some quartz)</sup> veins with quartz - sericite envelopes are cut by <sup>carbonate</sup> gypsum veins; 765 - mottled, altered volcanic rock (mafic plagioclase porphyry), plagioclase with <sup>complex</sup> oscillatory zoning, An<sub>35</sub> to An<sub>45</sub>, 20% altered to carbonate and chlorite, matrix 50% altered to greenish brown biotite, chlorite, carbonate and some sericite, clumps of chlorite biotite <sup>magnetite</sup> pyrite apatite and carbonate occur; 800 fairly crowded mafic plagioclase porphyry, plagioclase white, 1-2 mm, 35% in green chloritic matrix, plagioclase 90% altered to carbonate sericite quartz and kaolinite, mafics altered to chlorite pyrite and ~~sericite~~ sericite, matrix 50% to sericite carbonate and chlorite, veins are quartz - chlorite - apatite - ~~pyrite~~ <sup>magnetite</sup> - pyrite