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Dept:

MEMORANDUM

02-Feb-1996 11:27am PST David Lefebure of EMPR DLEFEBURE Energy, Mines & Petroleum Res. Tel No: 952-0404

TO: Distribution List suppressed (Current User: David Lefebure of EMPR )

Subject: Island Copper Core Archive File

I will circulate to you a short report and digital file compiled by Kika Ross while working with the Geological Survey of Canada on the Island Copper property and incorporates information collected by Kika, Craig Leitch and possibly other colleagues.

The information includes:

- cross-sections
- sample descriptions
- thin section descriptions
- assays
- two recent published reports

After circulation, the oroginal report and digital file will be placed in the property files.

Cheers, Dave

Thoto Copy



This suite of rocks was collected in Nov. 1995 as part of the archiving of the Island Copper Mine that is due to be shut down Dec. 1995. Drill holes lying on or near five cross sections through the pit were selected, as well as several others of interest. Samples were taken to represent each significant change in alteration or lithology. Sample descriptions are based on visual inspection at the time of collection, but understanding of the alteration is based on a petrographic study of over 200 thin and polished sections completed early in 1995 by K. Ross and C. Leitch.

The diskette contains a file(Corelibr.xls, saved in Excel 5.0) listing the samples, organized by cross section, with the footage the sample was collected at and a brief description of the rock. Four matching suites were collected, multiple footage entries apply to samples in different suites.

The PLOT directory contains the five cross sections with drill hole traces and assays. They are saved in HPGL format and can be printed from DOS.

The THINSECT directory contains the unpublished thinsection descriptions of the alteration study completed earlier in the year, (saved in Excel 5.0). Footages will not match this rock suite, but may serve as a guide to comparing hand samples to the detailed petrography. These files have not been edited and contain typos, abbreviations and comments.

The ASSAY directory contains all assay information for the drill holes in the suite. The plot files contain some additional assay information for holes that were not sampled.

Photocopies of working sections with geological interpretations are also included.

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SECTION 139 W         FOOTACE**         FootAcE**           0.71         50         55         60         70         early GPF, magnetite alteration           126         132         133         sheeted quart magnetite wing grading to bracela           126         132         126         303         blacked quart magnetite wing grading to bracela           128         312         226         303         blacked quarts magnetite wing grading to bracela           1284         313         339         426         Bring grading to magnetite attribution blacked magnetite attribution blacked magnetite attribution of the quart magnetite attribut	IS ND C	OPPER C	ORE LIBR	ARY			***	
SECTION 139 W         FOOTAGE**								
D-71         50         65         60         70         many QFP, magnetic setting starting           128         132         133         absted quart-magnetic varie grading to breach           280         231         226         303         absted quart-magnetic varie grading to breach           280         317         absted quart-magnetic varie grading to breach         absted quart-magnetic varie grading to breach           280         313         329         426         Bonazz varie magnetic varie grading to breach           281         352         353         353         Bonazz varie magnetic varies         Absted varies           284         311         359         426         Bonazz varies         Bonazz varies         Bonazz varies           284         559         Inter contractine varies         Absted varies         Bonazz varies         Bonazz varies         Bonazz varies           284         543         559         Inter contractine varies         Bonazz varie	SECTION	139 W	FOOTA	GE**				
82         86         97         88         quartz-andride comprint of the same QFP           125         132         133         sheeted quartz-magnetic wins grading to breacia           280         231         286         305         308         sheeted quartz-magnetic wins grading to breacia           284         351         352         353         383         Bonanza veloanies intense magnetic suchnolite/biothice/biothe alteration, quartz vales           284         281         389         426         Imagnetic veloanies, magnetic           284         281         389         426         Imagnetic veloanies, magnetic           486         687         689         Har zolice alteration         involuanies overprinting veloanies           760         reside anteration         reside anteration         involuanies anteration         involuanies           781         732         733         745         reside anteration         involuanies           786         reside anteration         involuanies anteration         involuanies         involuanies           786         reside anteration         involuanies         involuanies         involuanies           781         732         733         745         reative involuanies         involuanies		D-71	50	55	60	70		early QFP, magnetite alteration
126       132       133       inheated quartz magnetite vaine grading to breacia         296       297       298       305       306       inheated quartz magnetite vaine grading to breacia         296       317       inhite service vaine grading to breacia       inhite service vaine grading to breacia         384       331       339       426       531       inhite service valencia inhite valencia         488       551       648       inte zeolite-eaklot valencia inhite valencia       inte zeolite-eaklot valencia       inte zeolite-eaklot valencia         488       651       648       inte zeolite-eaklot valencia inhite valencia       inte zeolite-eaklot valencia, magnetia       inte zeolite-eaklot valencia, magnetia         740       732       733       745       relatively trash totage valencia, match patheomysta still visible but probably has patheomystand startion         741       732       733       745       relatively trash totage valencia, disseminated and fracture controlled pytte- calcite egidote chlorite         755       20       24       25       OPP with oblorte magnetia alteration with sericite-pytte- dalay overprint         755       20       24       25       OPP with oblorte magnetia in volcanics       intense valenci         756       20       24       25       OPP with oblorte magnetia alt			82	86	87	88		quartz-sericite overprint of the same QFP
290       291       296       305       308       shere actical overprint on the quart requestie attraction GP         384       351       352       353       353       Bonanca volcanics intense magnetics actinality/biotiet/shlorite attention, quartz value with chalopyrine intense actinates overprinting volcanics.         384       381       383       426       file grained volcanics, magnetic         485       551       643       556       file grained volcanics, magnetic         731       732       733       745       realized volcanics, match attention in volcanics         731       732       733       745       realized volcanics, disseminated and fracture controlled pyrite-colabity frash looking volcanics, match contains sulphides pyrite-chalopyrite 7, quartz and utafaccous cleats         731       732       733       745       realized volcanics, disseminated and fracture controlled pyrite-calite egidate -choira         841       846       propultically attend volcanics, disseminated and fracture controlled pyrite-calite egidate -choira         0.75       20       24       25       OFP with chointe magnetite atteration with a selicite - pyrite volcanics, in such contains         148       propultically attend volcanics, disseminated and fracture controlled pyrite-calite egidate - pyrite voreprint         148       propultically attend volcanics, disseminated and guart wein </td <td></td> <td></td> <td>125</td> <td></td> <td>132</td> <td>133</td> <td></td> <td>sheeted quartz-magnetite veins grading to breccia</td>			125		132	133		sheeted quartz-magnetite veins grading to breccia
286       317       chorite-sericito overprint on the guartz-magnetite alteration QPP         381       352       353       Bonanz volanda interes emagnetite submit/sbutte/short eateration, quartz vains with chalcogyrits         488       381       393       426       181       182         488       667       589       fate zonite-aditor volantics imagnetic       182         488       667       589       fate zonite-aditor volantics, magnetic       182         488       667       589       fate zonite-aditor volantics, magnetic       182         488       667       589       fate zonite-aditor volantics, magnetic       182         740       731       732       733       745       relatively firsh tooking volcantics, matic phenocrysta still visible but probabily has probaby has exclude a probab dyke ly result, matic zonitals adphides pyrite - chalcopyrite / quartz and unity physic volcanics, disseminated and fracture controlled pyrite- calitie explicite chorite         0.75       20       24       25       QPP with chiloitte-magnetic adirection with sericite-adjure disteration with sericite-adjure adjure disteration with sericite-pyrite day overprint.         148       941       947       volcanics, distermination of volcanics, with a cross cutting quartz vein quartz vein write overprint wein enditie-adjure vein explicite adjure disteration of volcanics with acrose cutting quartz vein qquartz wein quartz vein qquartz			290	291	296	305	308	sheeted quartz-magnetite veins grading to breccia
31       352       353       363       Bonaras volcanics intense magnetite extenditation (quartz vens with chalcopyrite 448       391       396       426       Inegraned volcanics, magnetite with chalcopyrite 448       551       543       559       Integraned volcanics, magnetite attraction in volcanics         740       740       747       742       743       745       relatively trash looking volcanics, mafnet only volnating volcanics, magnetite attraction       relatively trash looking volcanics, mafnet phenorrysts still visible but probably has pervasive astinolite magnetite attraction         741       722       723       745       relatively trash looking volcanics, mafnet phenorrysts still visible but probably has pervasive astinolite-magnetite attraction with senicite- epidate -shorite         841       846       97       QFP with chlorits-magnetite attraction with a senicits-pyrite - chalcopyrite ?, quartz and tuffaceous cleats         90.75       20       24       25       QFP with chlorits-magnetite attraction with a senicite- pyrite organiz         186       916       946       97       pyrite volcanics, clottyactivolite/chlorits-magnetite albits attraction with senicite- pyrite volganiz, value volcanics, activactivolite/chlorits-magnetite albits attraction with senicite- pyrite volganiz volcanics, activactivaction/chlorits-magnetite albits attraction with senicite- pyrite volcanics, dissemination of volcanics         186       97       97       97       97       97			296	317				chlorite-sericite overprint on the quartz-magnetite alteration QFP
1       384       391       399       426       fing grande volanies, magnetic         4488       587       558       late zolite-calcite valiates overprinting volanies         680       1       tato GPP dydet with zolite alteration in volcanies         740       722       733       745         741       732       733       745       relatively fresh looking volcanies, mafic phenocrysts still valble but probably has per valve actinalite magnetite alteration         741       732       733       745       relatively fresh looking volcanies, mafic phenocrysts still valble but probably has per valve actinalite magnetite alteration with a scilloides pyrite - chalcopyrite ?, quart2 and tuff accous dasts         741       742       24       25       GPP with chlorite-magnetite alteration with a scilloides pyrite - calcute-epidet - choiries         745       60       119       watery grey quartz veinis in volcanies       watery grey quartz veinis         746       51       Intensel y altered volcanies, clostravetinalite/chlorite-magnetite-albite alteration with sciel/de-pyrite overprint         746       51       Intensel y altered volcanies, clostravetinalite (chlorite-magnetite-albite)         747       742       24       25         746       51       Intensel y altered volcanies, clostravetinalite/chlorite-magnetite valiate         746			351	352	353	363		Bonanza volcanics intense magnetite-actinolite/biotite/chlorite alteration, quartz veins
384       391       389       426       Ine grained volcanics, magnetic         488       565       583       Inagnetic extry veining volcanics         740       -       readite atteration         731       732       733       745         741       732       733       745         741       732       733       745         741       732       733       745         741       732       733       745         741       732       733       745         742       -       readitive fragmetite distration         744       -       -       readitive fragmetite extra control of present pack of a start and tracture control of present pack of a start and tracture control of present pack of a start and tracture control of present pack of a start and tracture control of present pack of a start and tracture control of present pack of a start and tracture control of present pack of a start and tracture control of present pack of a start and tracture control of a start and tracture control of present present and o consist.         746       -       -       -         747       -       -       -         748       -       -       -         749       -       -       -         746       -       -       -								with chalcopyrite
488       587       589       Inter zealite-calcite variate overprinting volcances         680       551       553       559       Inter QPP dydet with zealite attration in volcances         740       731       732       733       745       relatively tresh looking volcances, matic phenocrysts still visible but probably has pervasive actingite-magnitie attration         816       green pabble dyde) forecia, matic contains sulphides pyrite - chalcopyrite ?, quart2 and tuff accous cleats         817       50       24       25         9740       24       25       QFP with chorite magnetite attration with a sericite pyrite - calcite-epidite - chorite         9747       60       119       watery grey quartz view in volcances         9748       46       51       intensely attrad volcancie, actinolific/chlorite-magnetite-albite atteration with sericite-pyrite overprint, watery quartz viem         9749       46       51       intensely attrad volcancie, actinolific/chlorite-magnetite-albite atteration with sericite-pyrite overprint, watery quartz viem         9749       148       51       intensely attrad volcancies, disserninated and quartz vein         9740       148       pyrite overprint, watery quartz vein         9741       149       pyrite overprint, watery quartz vein         9742       227       230       qreen pubble dyde			384	391	399	426		fine grained volcanics, magnetic
680       Inter OPF dyder with cells alteration in volcanics         740       zeolite         741       732         731       732 <td></td> <td></td> <td>488</td> <td>587</td> <td>589</td> <td></td> <td></td> <td>late zeolite-calcite veinlets overprinting volcanics</td>			488	587	589			late zeolite-calcite veinlets overprinting volcanics
680       Inter QPP dydet with zeolite atteration in volcanics         730       732       733       745         816       aparasive autinotic magnetite atteration       parasive autinotic magnetite atteration         816       green pebble dyke/breccia, matrix contains sulphides pyrite - chalcopyrite 7, quartz and tuffaceous class         9740       parasive autinotic magnetite atteration         9747       20       24       25         9775       20       24       25       QFP with chlorite magnetite atteration with a sericite pyrite - clay overprint         9746       60       119       watery grey quartz wins in volcanics         9747       166       51       intensely atterd volcanic, actinotic/chorite magnetite-atbite atteration with sericite-pyrite overprint         9748       166       51       intensely atterd volcanics       intense magnetite actinotie/chorite magnetite-atbite atteration with sericite-pyrite overprint         9748       166       51       intense magnetite actinotie distration of volcanics. with a cross cutting quartz wins         9749       166       green pabble dyke       intense magnetite actinotie with sericite pyrite autoritie/chorite magnetite-atbite atteration with sericite pyrite overprint         9749       168       green pabble dyke       intense magnetite-attinotie with across cutting quartz wins         9741 </td <td></td> <td></td> <td>551</td> <td>543</td> <td>559</td> <td></td> <td></td> <td>magnetite only veinlet in volcanics</td>			551	543	559			magnetite only veinlet in volcanics
731       732       733       745       relatively frash looking volcanics, mafic phenocrysts still visible but probably has pervasive actinuits-magnetize alteration         816       816       great public dyke broekin, matrix contains subhides pyrite - chalcopyrite ?, quartz and tuffaceous clasts         0       841       846       prophibil dyke broekin, matrix contains subhides pyrite - chalcopyrite ?, quartz and tuffaceous clasts         0       2       25       OFP with choints-magnetize alteration with a sericite- pyrite- clay everprint         0       24       25       OFP with choints-magnetize alteration with a sericite- pyrite- clay everprint         166       119       watery grey quartz veins in volcanics       watery grey quartz vein green pebble dyke         192       green pebble dyke       volcanics, diseminated magnetite and quartz veins with a cross cutting magnetite-quart and quartz veins         193       volcanics, diseminated magnetite with guartz veins with pervasive chlorite after action with abundant cross cutting magnetite-quart and quartz veins pervasive magnetite-biotite action probably at least partially chloritize, some chalcopyrite mineralization         193       pervasive magnetite-biotite action probably at least partially chloritize/actinoli			680					late QFP dyklet with zeolite alteration in volcanics
1       732       745       relatively fresh looking volcanics, mafic phenorysts still visible but probably hes pervasive actinuitie-magnetite alteration         1       816       green pebble dyke/ brecois, matrix contains subplides pyrite- chalcopyrite ?, quartz and tuffaceous clasts         1       841       846       propytite olders, disseminated and fracture controlled pyrite- calcite- epidote -bhorite         1       75       20       24       25         1       0       0FP with chlorite-magnetite alteration with a sericite- pyrite- clay overprint         1       60       119       watery gray quartz veins in volcanics.         1       166       51       intensely altered volcanic, scitowitc/blorite-magnetite-abite alteration with sericita- pyrite overprint, watery quartz vein         1       148       quartz magnetite-actinolite alteration of volcanics with a cross cutting quartz vein         1       148       quartz magnetite-actinolite alteration with abundant cross cutting quartz vein         1       148       quartz vein         1       148       prevasive ancinolite alteration with abundant cross cutting quartz vein         1       148       volcanics , disseminated magnetite-actinolite alteration with abundant cross cutting quartz vein         1       148       volcanics , disseminated magnetite-actinolite alteration with abundant crosse cutting quartz vein <t< td=""><td></td><td></td><td>740</td><td></td><td></td><td></td><td></td><td>zeolite alteration</td></t<>			740					zeolite alteration
Bit         pervasive actinolite-magnetic alteration           841         846         green pebbel dyke/brecois, matrix contains sulphides printe-chalcoprinte 7, quartz and tuffaceous class           975         20         24         25         OFF with chlorite-magnetite alteration with a sericite-printe-calcite-epidet-chlorite           975         60         119         Watery grey quartz veins in volcanics           46         51         intensely altered volcanics, clority-chlorite-magnetite-albite alteration with sericite-print watery grey quartz veins in volcanics           148         quartz magnetite volcanics, clority-actinolite/chlorite-magnetite-albite alteration with sericite-print watery quartz vein           148         quartz-magnetite volcanics, clority-actinolite/chlorite-magnetite-veinet           148         quartz-magnetite volcanics, clority-actinolite/chlorite-magnetite-veinet           148         quartz-magnetite volcanics, clority-actinolite/chlorite-magnetite-veinet           148         quartz-magnetite-volcanics, clority-actinolite/chlorite-magnetite-veinet           148         quartz-magnetite-volcanics, clority-actinolite/chlorite-magnetite-veinet           148         quartz-magnetite-veinet           157         520         227           230         intense veinet           1571         520         527           158         pervasive magnetite-veinet<			731	732	733	745		relatively fresh looking volcanics, mafic phenocrysts still visible but probably has
Bit         green pebble dyke/ brecks, matrix contains subplides pyrite - chalcopyrite 7, quartz and tuffaceous clasts           2         841         846         propytitically attered volcanics, dissominated and fracture controlled pyrite- calcite- epidota -chlorite.           2         2         2         2         2         2           60         113         watery grey quartz veins in volcanics.         attention with a sericite- pyrite- clay overprint.           1         166         51         watery grey quartz veins in volcanics.         clastice- pyrite volcanic.           1         166         51         intensely altered volcanics, actinolitis/chlorite-magnetite-albite alteration with sericite- pyrite overprint.           1         148         quartz-magnetite veinlet         autrz-magnetite veinlet           1         187         intense magnetite-actinolite alteration of volcanics with a cross cutting quartz vein quartz vein           1         225         227         230         intense magnetite-actinolite alteration with abundant cross cutting quartz vein quartz veins           1         458         volcanics , disseminated magnetite alteration, probably at least partially chloritized, some chalcopyrite mineralization           1         517         520         527         pervesive magnetite-botite alteration, probably at least partially chloritized, some chalcopyrite mineralization           <								pervasive actinolite-magnetite alteration
841       846       utifaceous cleats         0       841       846         0       2       24       25         0       20       24       25         0       60       119       watery grey quartz venis in volcanics         1       60       119       watery grey quartz venis in volcanics         1       166       119       watery grey quartz venis in volcanics         1       166       118       quartz-magnetis-dibite alteration with sericite-pyrite veny my quartz venis         1       148       quartz-magnetis venist       output to venprint         1       148       quartz-magnetis venist       output to venprint         1       148       quartz-magnetis venist       venist         1       122       green pebble dyke       output to venprint         1       122       227       230       prevasive magnetite-ationite alteration, probably at least partially chloritized, some challed operits venist         1       122       227       230       intense sericite-cyprint with quartz venis with pervasive chlorite alteration, probably at least partially chloritized, some challed operits-ationite alteration, probably at least partially chloritized, some challed operits-ationite alteration, probably at least partially chloritized zoma challed opervasive magnetite-ationite averprint			816					green pebble dyke/ breccia, matrix contains sulphides pyrite- chalcopyrite ?, quartz and
81       846       propylitically attered volcanics, disseminated and fracture controlled pyrite-calcite- gridote-chlorite         D-75       20       24       25         0       60       119       watery grey quartz veins in volcanics         1       46       51       intensely altered volcanic, actinolite/chlorite-magnetite-albite alteration with sericite- pyrite overprint         1       166       51       intensely altered volcanics, actinolite/chlorite-magnetite-albite alteration with sericite- pyrite overprint         1       148       quartz-rengenetite veiniet       intensely altered volcanics, actinolite/chlorite-magnetite-albite alteration with sericite- pyrite overprint, and/or rospening of a quartz-magnetite veiniet         1       148       quartz-rengenetite veiniet       quartz vein         1       149       pyrite overprint, and/or rospening of a quartz-magnetite veiniet       quartz vein         1       122       green pebble dyke       intense magnetite-actinolite alteration with abundant cross cutting magnetite-quartz and guartz veins         1       252       227       230       intense sericite-pyrite verprint         1       511       intense sericite-pyrite verprint       guartz veins         1       526       pervasive magnetite-biotite with quartz-magnetite veiniet       intense sericite-pyrite verprint         1       161<								tuffaceous clasts
0       epidate -chlorite         0       20       24       25       QFP with chlorite-magnetite alteration with a sericite-pyrite-clay overprint.         0       760       119       watery grey quartz veins in volcanics.       actinolite/chlorite-magnetite-albite alteration with sericite-pyrite overprint, watery query zuein         1       166       intensely altered volcanics, actinolite/chlorite-magnetite-albite alteration with sericite-pyrite overprint, watery query zuein         1       148       quartz-magnetite veinlet         1       149       pyrite overprint and/or reopening of a quartz-magnetite veinlet         1       149       pyrite overprint and/or reopening of a quartz-magnetite veinlet         1       122       green pubble dyke       with a cross cutting quartz vein         1       225       227       230       intense magnetite-actinolite alteration with abundant cross cutting quartz vein         1       458       volcanics , disseminated magnetite and quartz veins with pervasive chlorite after         5       520       527       pervasive magnetite-biotite alteration, probably at least partially chloritized, some chalcopyrite micrealize actinolite with quartz veins         5       551       intense sericite-pyrite overprint       intense veinserite-actinolite with quartz veins with pervasive chlorite/actinolite?         705       pervasive biotite magnetite veinse			841	846				propylitically altered volcanics, disseminated and fracture controlled pyrite- calcite-
D-75       20       24       25       QFP with chlorite-magnetite alteration with a sericite-pyrite olay overprint.         0       10       119       watery grey quarz veins in volcanics.         1       166       51       intensely altered volcanic, actinolite/chlorite-magnetite-albite alteration with sericite-pyrite overprint.         1       148       148       quarz-magnetite veinlet         1       148       quarz-magnetite veinlet         1       187       intense magnetite-actinolite alteration of volcanics with a cross cutting quarz vein         1       192       green pabble dyke         1       192       green pabble dyke         1       187       intense magnetite-actinolite alteration with abundant cross cutting magnetite-quarz and quarz veins         1       192       green pabble dyke         1       193       pervasive magnetite-actinolite alteration, probably at least partially chloritized, some chalcopyrite mineralization         1       517       520       527         2       527       pervasive biotite-magnetite veinlet with ghosty early quarz veins         1       517       520       527         2       527       pervasive magnetite-actinolite with ghosty early quarz veins         2       527       pervasive magnetite-actinote with g								epidote -chlorite
D-75     20     24     25     QFP with chointe-magnetite alteration with a sericite-pyrite-clay overprint       60     119     watery grey quartz veins in volcanics       46     51     intensely altered volcanics, actinolite/chlorite-magnetite-albite alteration with sericite-pyrite overprint       186     148     quartz-magnetite veinlet       148     quartz-magnetite veinlet       187     Intensely altered volcanics , clottyactinolite/chlorite-magnetite-albite alteration with sericite-pyrite overprint, watery quartz vein       187     Intense magnetite-actinolite alteration of volcanics with a cross cutting quartz vein       187     Intense magnetite-actinolite alteration of volcanics with a cross cutting quartz vein       192     green pebble dyke       193     volcanics, disseminated magnetite and quartz veins with pervasive chlorite after       225     227     230       225     527     pervasive magnetite-biotite alteration, probably at least partially chloritized, some chalcopyrite mineralization       591     Intense sericite-pyrite overprint       593     Pervasive magnetite-volcanice with quartz-magnetite veinlets       705     pervasive magnetite-actinolite with ghosty early quartz veins       705     pervasive magnetite-veinlets       800     330     coarse magnetite veinlet       1020     intense apprite-veinlet veinlets       1020     intense apyr								
60     119     watery grey quarz veins in volcanics       46     51     intensely altered volcanic, actinolite/chlorite-magnetite-albite alteration with sericite-pyrite overprint       186     intensely altered volcanic, actinolite/chlorite-magnetite-albite alteration with sericite-pyrite overprint, watery quarz vein       148     quarz-magnetite veinlet       149     pyrite overprint, and/or reopening of a quarz-magnetite veinlet       187     intense magnetite-actinolite alteration of volcanics with a cross cutting quarz vein       192     green pebble dyle       225     227       230     intense magnetite-actinolite alteration with abundant cross cutting magnetite-quarz and quarz veins       192     green pebble dyle       2517     520       521     527       pervasive magnetite-botte alteration, probably at least partially chloritized, some chalcopyrite mineralization       531     intense sericite-pyrite overprint       532     pervasive magnetite-actinolite with ghosty early quarz veins       705     pervasive magnetite veinlet with quarz-magnetite veinlets in volcanics with late calcite-zoolite veinsite veinlet veinlet       1020     fine grained volcanics , phenocryste preserved, pervasive magnetite-biotte/actinolite?       with ghosty quarz-magnetite veinlet     vito ghosty quarz-magnetite veinlet       1020     fine grained volcanics with numerous planer magnetite veinlets       1020     i		D-75	20	24	25			QFP with chlorite-magnetite alteration with a sericite- pyrite- clay overprint
46       51       intensely altered volcanic, actionite/chlorite-magnetite-albite alteration with sericite-pyrite overprint         148       quartz-magnetite value         148       quartz-magnetite value         149       pyrite overprint, watery quartz vain         187       intensely altered volcanics , clottyactinolite/chlorite-magnetite-albite alteration with sericite-pyrite overprint and/or reopening of a quartz-magnetite veinlet         187       intense magnetite-actinolite alteration with abundant cross cutting quartz vein         187       green pebble dyke         188       volcanics , disseminated magnetite and quartz veins with pervasive chlorite after         458       volcanics , disseminated magnetite and quartz veins with pervasive chlorite after         511       520       527         521       pervasive magnetite-actinolite with duartz veins with pervasive chloritized, some chaloopyrite mineralization         531       intense explice biotite         531       intense explice biotite-magnetite veinite in volcanics with late calcite-zeolite veins/stockwork         705       pervasive magnetite-veinite veinet         860       fine grained volcanics with numerous planar magnetite veinlets         1020       intense print-calcite overprint on volcanics         226       230       235         227       235       QFP dykelet, intra to lat			60	119				watery grey quartz veins in volcanics
Image: Construction of the second			46			51		intensely altered volcanic, actinolite/chlorite-magnetite-albite alteration with sericite-
166       intensely altered volcanics , clostractinolite/chiorite-magnetite-albite alteration with service pyrite overprint, watery quartz vein.         148       quartz-magnetite veinlet         149       pyrite overprint and/or reopening of a quartz-magnetite veinlet         187       intense magnetite-actinolite alteration of volcanics with a cross cutting quartz vein         192       green pabble dyke         225       227       230         intense magnetite-actinolite alteration of volcanics with a cross cutting quartz vein       quartz veins         225       227       230         225       227       230         intense magnetite-actinolite alteration of volcanics with across cutting quartz vein         quartz veins       quartz veins         225       227       230         intense magnetite-actinolite alteration of volcanics with provisive chlorite after actinolite or biotite         230       520       527         241       intense servicite - pyrite overprint         252       527       pervasive magnetite-actinolite with guartz magnetite veinlets in volcanics with late calcite-zeolite veins/stockwork         705       pervasive indet volcanics is phenocryst preserved, pervasive magnetite-biotite/actinolite?         705       pervasive collect sockwork, rock is highly fractured         1020       intense zoli								pyrite overprint
Image: Serielte - pyrite overprint, wetry quartz vein.         148       quartz-magnetite veinlet.         149       quartz-magnetite veinlet.         187       intense magnetite-actinoite alteration of volcenics with a cross cutting quartz vein.         187       intense magnetite-actinoite alteration of volcenics.         182       green pebble dyke         225       227       230         187       volcanics , disseminated magnetite and quartz veins with pervasive chlorite after actinoite or biotite         458       volcanics , disseminated magnetite and quartz veins with pervasive chloritized, some chalcopyrite mineralization         517       520       527         pervasive biotite-actinoitie verprint       with opsty early quartz veins         705       pervasive magnetite-extinoitie with quartz-magnetite veinlets in volcanics with late calcite-zooite veins/stock work         860       fine grained volcanics , phenocrysts preserved, pervasive magnetite-biotite/actinoite?         with ghosty quartz-magnetite veinlet       ocorse magnetite-veinlet         1020       intense zeolite stockwork, rock is highly fractured         1020       fine grained volcanics with numerous planar magnetite veinlets         1020       intense pyrite-calcite overprint on volcanics         1021       QPP or pebble dyke         1022       QPP or pebble dyke			166					intensely altered volcanics, clottyactinolite/chlorite-magnetite-albite alteration with
148       quartz-magnetite veinlet         149       pyrite overprint and/or reopening of a quartz-magnetite veinlet         187       intense magnetite-actinolite alteration of volcanics with a cross outling quartz vein         192       green pabble dyke         225       227       230         458       Volcanics , disseminated magnetite and quartz veins with pervasive chlorite after actinolite or biotite         517       520       527         591       intense sericite - pyrite overprint         593       pervasive magnetite-actinolite with ghosty early quartz veins         705       pervasive biotite-actinolite with ghosty early quartz veins         860       fine grained volcanics , phonorysts preserved, pervasive magnetite-biotite/actinolite?         880       930       coarse magnetite veinlet         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics w								sericite- pyrite overprint, watery quartz vein
143       pyrite overprint and/or reopening of a quertz-magnetite veinlet         187       intense magnetite-actinolite alteration of volcanics with a cross cutting quertz vein         192       green pobble dyke         225       227       230         458       volcanics , disseminated magnetite-actinolite alteration with abundant cross cutting magnetite-quartz and quertz veins         458       volcanics , disseminated magnetite and quartz veins with pervasive chlorite after actinolite or biotite actinolite alteration, probably at least partially chloritized, some chalcopyrite mineralization         591       intense magnetite-biotite alteration, probably at least partially chloritized, some chalcopyrite mineralization         705       pervasive magnetite-actinolite with ghosty early quartz veins         705       pervasive biotite-magnetite with quartz-magnetite veinlets in volcanics with late calcite-zoilte veins/stockwork         860       fine grained volcanics , phenocrysts preserved, pervasive magnetite-biotite/áctinolite? with ghosty quartz-magnetite veinlet         1020       intense zeolite stockwork, rook is highly fractured         1020       intense pyrite-calcite overprint on volcanics         0-777       16       24         1020       intense pyrite-calcite overprint         1021       intense pyrite-calcite overprint on volcanics         2250       QFP dykelet, intra to late mineral, has watery quartz veins with molybde			148					quartz-magnetite veinlet
187       intense magnetite-actinolite alteration of volcanics with a cross cutting quartz vein         192       green pable dyke         225       227       230         458       volcanics, disseminated magnetite and quartz veins with pervasive chlorite after actinolite or biotite         517       520       527         511       intense magnetite-biotite alteration, probably at least partially chloritized, some chalcopyrite mineralization         591       intense sericite- pyrite overprint         596       pervasive magnetite-actinolite with quartz reins         705       pervasive biotite-magnetite with quartz-magnetite veinlets in volcanics with late calcite-zeolite wins/stockwork         880       930       coarse magnetite veinlet         1020       intense zolite stockwork, rock is highly fractured         1050       fine grained volcanics with numerous planar magnetite veinlets         1020       intense zolite stockwork, rock is highly fractured         1050       fine serifice with calcite overprint on volcanics         126       230       235         257       226       230         128       930       coarse magnetite veinlet         1290       intense zolite stockwork, rock is highly fractured         1050       fine grained volcanics with numerous planar magnetite veinlets <td></td> <td></td> <td>149</td> <td></td> <td></td> <td></td> <td></td> <td>pyrite overprint and/or reopening of a quartz-magnetite veinlet</td>			149					pyrite overprint and/or reopening of a quartz-magnetite veinlet
192       green pebble dyke         225       227       230         458       volcanics, disseminated magnetite and quartz veins with pervasive chlorite after actinolite or biotite         517       520       527         591       intense magnetite-biotite alteration, probably at least partially chloritized, some chalcopyrite mineralization         593       intense sericite - pyrite overprint         596       pervasive magnetite-biotite with quartz-magnetite veinlets in volcanics with late calcite-zeolite veins/stockwork         705       pervasive magnetite-actinolite with quartz-magnetite veinlets in volcanics with late calcite-zeolite veins/stockwork         800       930         1020       intense zolite stockwork, rock is highly fractured         1020       intense zolite stockwork, rock is highly fractured         1020       intense zolite overprint on volcanics         226       230       235         QFP or pebble dyke       QFP or pebble dyke         226       230       QFP with zolite overprint         280       232       QFP with zolite overprint         226       230       QFP or pebble dyke         231       QFP or pebble dyke       QFP with zolite overprint         236       QFP with zolite overprint       green pebble dyke         236			187					intense magnetite-actinolite alteration of volcanics with a cross cutting quartz vein
225       227       230       intense magnetite-actinolite alteration with abundant cross cutting magnetite-quartz and quartz veins         458       volcanics, disseminated magnetite and quartz veins with pervasive chlorite after actinolite or biotite         517       520       527         pervasive magnetite-biotite alteration, probably at least partially chloritized, some chalcopyrite mineralization         531       intense sericite-pyrite overprint         536       pervasive magnetite-actinolite with ghosty early quartz veins         705       pervasive magnetite vein/stook with ghosty early quartz veins         860       fine grained volcanics, shenorysts preserved, pervasive magnetite-biotite/actinolite?         with ghosty quartz-magnetite vein/stook with numerous planar magnetite veinlets         1020       intense pyrite-calcite overprint on volcanics         0-77       16       QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-calcite overprint on volcanics         226       230       QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-calcite overprint the quartz veins with molybdenite, disseminated pyrite-calcite overprint the quartz veins with molybdenite, disseminated pyrite-calcite overprint the quartz veins with molybdenite, disseminated pyrite-calcite overprint         0-77       16       QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-calcite overprint			192					green pebble dyke
Image: Constraint of the second se			225	227	230			intense magnetite-actinolite alteration with abundant cross cutting magnetite-quartz and
458       volcanics, disseminated magnetite and quartz veins with pervasive chlorite after actinolite or biotite         517       520       527         517       520       527         591       intense sericite-pyrite overprint         596       pervasive magnetite-biotite atteration, probably at least partially chloritized, some chalcopyrite mineralization         705       pervasive magnetite-actinolite with ghosty early quartz veins         705       pervasive magnetite-biotixe attendite with quartz-magnetite veinlets in volcanics with late caldite-zeolite veins/stockwork         860       fine grained volcanics, phenocrysts preserved, pervasive magnetite-biotite/äctinolite?         with ghosty quartz-magnetite veinlets       with ghosty quartz-magnetite veinlets         1020       intense zeolite stockwork, rock is highly fractured         1020       fine grained volcanics with numerous planar magnetite veinlets         1050       fine operheld volcanics         226       230       235         QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass         226       230       QFP dykelet, intra to late mineral, has watery quartz veins         226       230       QFP service pyrite-calcite overprint         226       226       GP pyrite-calcite pyrite-calogy overprint the quartz-magnetite atteration, concen								quartz veins
actinolite or biotite       actinolite or biotite         517       520       527         pervasive magnetite-biotite alteration, probably at least partially chloritized, some chalcopyrite mineralization       chalcopyrite mineralization         591       intense sericite- pyrite overprint         566       pervasive magnetite-actinolite with ghosty early quartz veins         705       pervasive biotite-megnetite with quartz-magnetite veinlets in volcanics with late calcite-zeolite veins/stockwork         860       fine grained volcanics, phenocrysts preserved, pervasive magnetite-biotite/actinolite?         880       930       coarse magnetite veinlet         1020       intense zeolite stockwork, rock is highly fractured         1020       intense pyrite-calcite overprint on volcanics         D-77       16       24         226       230       235         QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass         250       QFP with zeolite overprint         260       285       QFP with zeolite overprint the quartz-magnetite alteration, concentrated along fractures         292       relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP         333       sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         333       sericite-			458			ĺ		volcanics, disseminated magnetite and quartz veins with pervasive chlorite after
517       520       527       pervasive magnetite-biotite alteration, probably at least partially chloritized, some chalcopyrite mineralization         591       596       intense sericite - pyrite overprint         705       pervasive magnetite-actinolite with ghosty early quartz veins         705       pervasive biotite-magnetite with quartz-magnetite veinlets in volcanics with late calcite-zeolite veins/stockwork         860       fine grained volcanics , phenocrysts preserved, pervasive magnetite-biotite/àctinolite? with ghosty quartz-magnetite veinlets         890       930       coarse magnetite veinlet         1020       intense zeolite stockwork, rock is highly fractured         1050       fine grained volcanics with numerous planar magnetite veinlets         0       020       intense zeolite overprint on volcanics         0       021       intense zeolite overprint on volcanics         0       022       024       intense zeolite overprint         0       026       027       027         10       028       028       028         0       029       028       024         0       027       16       027         0       028       029       029         0       026       025       0279         0       0279								actinolite or biotite
Image: Second			517	520	527			pervasive magnetite-biotite alteration, probably at least partially chloritized, some
591       intense sericite- pyrite overprint         596       pervasive magnetite-actinolite with ghosty early quartz veins         705       pervasive magnetite-actinolite with quartz-magnetite veinlets in volcanics with late calcite-zeolite veins/stockwork         860       fine grained volcanics , phenocrysts preserved, pervasive magnetite-biotite/actinolite?         880       930       coarse magnetite veinlet         1020       intense zeolite stockwork, rock is highly fractured         1020       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         0-77       16       24         1050       intense pyrite-calcite overprint on volcanics         0-77       16       24         1050       GPP or pebble dyke         226       230       235         QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass         250       QFP with zeolite overprint         285       320       QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along fractures         285       320       QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along fractures         292       relatively fresh QFP, primary K-feldspar in groundmass, intra min								chalcopyrite mineralization
596       pervasive magnetite-actinolite with ghosty early quartz veins         705       pervasive magnetite-actinolite with ghosty early quartz veins         800       pervasive biotite-magnetite with quartz-magnetite veinlets in volcanics with late calcite-zeolite veins/stockwork         800       930       coarse magnetite veinlet         1020       intense zeolite veins, sulphides present         1020       intense zeolite volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       fine grained volcanics with numerous planar magnetite veinlets         1050       grained volcanics with numerous pl			591					intense sericite- pyrite overprint
705       705       pervasive biotite-magnetite with quartz-magnetite veinlets in volcanics with late calcite-zeolite veins/stockwork         860       860       fine grained volcanics , phenocrysts preserved, pervasive magnetite-biotite/actinolite? with ghosty quartz-magnetite veins, sulphides present         890       930       coarse magnetite veinlet         1020       intense zeolite stockwork, rock is highly fractured         1050       6       fine grained volcanics with numerous planar magnetite veinlets         0-77       16       24       intense pyrite-calcite overprint on volcanics         0-77       16       24       intense pyrite-calcite overprint on volcanics         1020       0       0       0         0-77       16       24       0         1050       0       0       0         1050       0       0       0         1050       0       0       0         1050       0       0       0         1050       0       0       0         1050       16       0       0         1050       16       0       0         1050       16       0       0         1050       16       0       0         105			596					pervasive magnetite-actinolite with ghosty early quartz veins
Image: Second			705					pervasive biotite-magnetite with quartz-magnetite veinlets in volcanics with late calcite-
860       second       fine grained volcanics , phenocrysts preserved, pervasive magnetite-biotite/actinolite? with ghosty quartz-magnetite veins, sulphides present         830       930       coarse magnetite veinlet         1020       intense zeolite stockwork, rock is highly fractured         1050       fine grained volcanics with numerous planar magnetite veinlets         0       1050       fine grained volcanics with numerous planar magnetite veinlets         0       1050       fine grained volcanics with numerous planar magnetite veinlets         0       1050       fine grained volcanics with numerous planar magnetite veinlets         0       1050       fine grained volcanics with numerous planar magnetite veinlets         0       1050       fine grained volcanics with numerous planar magnetite veinlets         0       1050       fine grained volcanics with numerous planar magnetite veinlets         0       16       QFP or pebble dyke         16       QFP or pebble dyke       Ger Programmatic pyrite-chalcopyrite in groundmass         226       230       235       QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass         250       QFP with zeolite overprint         260       265       disseminated magnetite in QFP with watery grey quartz veins         285       32								zeolite veins/stockwork
Image: second			860					fine grained volcanics , phenocrysts preserved, pervasive magnetite-biotite/actinolite?
890       930       coarse magnetite veinlet         1020       intense zeolite stockwork, rock is highly fractured         1050       fine grained volcanics with numerous planar magnetite veinlets         0       7         0       0 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>with ghosty quartz-magnetite veins, sulphides present</td></td<>								with ghosty quartz-magnetite veins, sulphides present
1020       intense zeolite stockwork, rock is highly fractured         1050       fine grained volcanics with numerous planar magnetite veinlets         D-77       16       24         D-77       16       24         116       QFP or pebble dyke         200       235       QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass         210       250       QFP with zeolite overprint         260       265       disseminated magnetite in QFP with watery grey quartz veins         285       320       QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along fractures         292       relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP         333       Sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting			890	930				coarse magnetite veinlet
1050fine grained volcanics with numerous planar magnetite veinletsD-771624D-77162416QFP or pebble dyke26230235QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass250QFP with zeolite overprint260265285320285320292relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP333Sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration575QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting			1020					intense zeolite stockwork, rock is highly fractured
D-771624intense pyrite-calcite overprint on volcanics16QFP or pebble dyke16QFP or pebble dyke226230235250QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass250QFP with zeolite overprint260265285320292relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP333Sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration575QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting			1050					fine grained volcanics with numerous planar magnetite veinlets
D-771624intense pyrite-calcite overprint on volcanics16QFP or pebble dyke26230235QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass250QFP with zeolite overprint260265disseminated magnetite in QFP with watery grey quartz veins285320QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along fractures292relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP333Sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration575QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting								
16       QFP or pebble dyke         226       230       235         QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass         250       QFP with zeolite overprint         260       265         285       320         292       relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP         333       sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting		D-77	16	24				intense pyrite-calcite overprint on volcanics
Image: Second			16					QFP or pebble dyke
226       230       235       QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite, disseminated pyrite-chalcopyrite in groundmass         250       QFP with zeolite overprint         260       265       QFP with zeolite overprint         285       320       QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along fractures         292       relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP         333       Sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting								
Image: Second			226	230	235			QFP dykelet, intra to late mineral, has watery quartz veins with molybdenite,
250       QFP with zeolite overprint         260       265         265       disseminated magnetite in QFP with watery grey quartz veins         285       320         292       QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along fractures         333       sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting								disseminated pyrite-chalcopyrite in groundmass
260       265       disseminated magnetite in QFP with watery grey quartz veins         285       320       QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along fractures         292       relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP         333       sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting			250					QFP with zeolite overprint
285       320       QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along fractures         292       relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP         333       sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting			260	265				disseminated magnetite in QFP with watery grey quartz veins
1       fractures         292       relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP         333       sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting			285	320				QFP, sericite- pyrite-clay overprint the quartz-magnetite alteration, concentrated along
292       relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP         333       sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting								fractures
333       sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration         575       QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting			292					relatively fresh QFP, primary K-feldspar in groundmass, intra mineral QFP
575 QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass, some salmon pink zeolite overprinting			333					sericite- pyrite-quartz overprint of QFP, overprinted again by zeolite alteration
some salmon pink zeolite overprinting			575					QFP with minor disseminated magnetite and pink primary K-feldspar in the groundmass,
				· .				some salmon pink zeolite overprinting

		<del>,</del> ,.				
	1	652				same as above, note small fine grained clasts
	1	734				textural change in the QFP, the guartz and plagioclase phenocrysts are smaller, higher
	1					proportion of nink K-feldsnar matrix
		000	001			proportion of prink is foldopar finderia
		889	891			same urr, some suicincation
	D-152	20	25			QFP, intensely silicified matrix, chlorite alteration, disseminated sulphides, with surface
						weathering
		46				intense quartz-chlorite, obliterates protolith-probably volcanic
		81	97	92		volcanics grading into a pebble dyke texture with guartz vein clasts
	1	115				OFP with sericite overprint
•	+	150				valessis and guests using poerly a marginal breeding texture
		152				
		232				quartz-se overprint on breccia
		240				quartz-magnetite veins cross cutting another
	.[	245				pebble dyke/ marginal breccia
		252		Í		volcanic with quartz-magnetite-actinolite alteration
	D-153	25				fine grained magnetite-actinolite altered volcanics
	10.00	21	22	22		ological rean public duka, oblorita putita matrix and quartz clasts
				- 33		Classic green people dyke, chiorito pyrite matrix and don't classis
		/1	83			propylitically altered voicanics, variable disseminated mt
·		172				volcanic, albite/quartz matrix, chlorite clots
		385				volcanic, albite/quartz matrix, chlorite clots
	D-154	201	202			contact between quartz-magnetite altered volcanics and a green QFP with marginal
	1					breccia developed on sides, dyke is 5 metres wide
	D 157	14	16	17		activalita magnetita valegnia, watery guesta vain
	D-157	14	10		21	actinoite-magnetite voicanic, watery quartz ven
		36				watery quartz vein, some chalcopyrite on fractures
	1	42				actinolite-magnetite volcanic, watery quartz vein
		69	70	72	81	old QFP, with quartz-magnetite-albite? vein and watery laminated quartz veins
		88	93			intense sericite overprint of QFP
	1	131				QFP sericite-chlorite alteration, with an sericite-clay overprint, planar grey quartz with
_	[					molybenite down the center
		264				notice that was two phases of OEP, the older phase has soarse even and an intense
		204				contact between two phases of orr, the older phase has coalse eyes and an intense
						silicification of the groundmass, the younger slightly tiner grained phase has more intense
						sericite alteration of plagioclase phenocrysts
		340	391	400		intense quartz-magnetite alteration of older QFP, sheeted quartz-magnetite veins cross
					[	cut by a watery quartz vein
		467	472			magnetite-actinolite altered volcanic
	1	472 5				contact between volcanic and old OEP??
		172				OEP_oldest_blace2
		4/3				
	·	522				contact between voicanic and intra-mineral QFP
	ļ	529				intense sericite alteration on QFP, cannot tell which phase
		555				intra-mineral QFP, quartz-magnetite veins are still present but it lacks the intense quartz-
	1					magnetite alteration characteristic of the older phase
		640				relatively fresh intra-mineral QFP, groundmass is still primary pinkish K-feldspar
	-					
	D-159	37	42	43		fragmental volcanics with clotty chlorite alteration, possibly disseminated magnetite in
						groundmass
		102				volcanics with abundant disseminated magnetite, chlorite clots and groundmass
						albite/guartz? alteration, pyrite on fractures
		220				similar, with magnetite veinlets, cut by later calcite veins
	1	315				similar volcanics with an overnrint of zeolite-calcite, possibly overnrinting pervesive
		315		1		chlorite excisite elteration
	· · · · · · · · · · · · · · · · · · ·					
		350	352	355		TIRST appearance of watery grey quartz veins in volcanics, followed by a sharp contact
		11				with an intra-late mineral QFP
		383	388	403	1	sericite-pyrite alteration on QFP, possibly addition of quartz as well
		412				pink primary K-feldspar and a zeolite overprint, weak quartz magnetite alteration
	+	442	445			sericite alteration, watery quartz veins
	+	· · · ·				
	D 102					internaly mality alternal values in 2
⊢ <u>∕</u>	D-163	92				Intensely zeolite altered voicanics?
L	1	125				volcanics, silicified matrix, chlorite clots, pyrite-chalcopyrite? present, zeolite overprint

L		168	202				pink watery quartz veins, sericite alteration is common around them
		210					intense quartz-zeolite alteration, quartz vein
		240					may be oldest QFP, dark green, very large quartz eyes
		310					sulphides in quartz veins, disseminated magnetite in eyes, sericitic alteration
	C-157	210	215				fragmental volcanics, ablite/quartz groundmass, chlorite clots
		315					similar, with disseminated sulphides, variable fragmental component
	L	565	612				watery grey quartz veins in the same type of chlorite-albite altered voicanic
		620					green QFP, old phase?
		824	845	840			oldest QFP, intense sericite-chlorite alteration
		852	870				sheeted quartz-magnetite veins in old phase of QFP
ļ		1008	990	985	1045	1050	sheeted quartz-magnetite veins in old phase of QFP
		1060					sericite overprint on quartz-magnetite altered QFP
	ļ	1270					magnetite-quartz alteration in QFP??
		1397				<u></u>	magnetite-quartz alteration in QFP??
SECTION	155 W						
	0-72	37	39	/4			clotty volcanics, matrix is either albitized or silicitied, with chloritic clots
		88	84				similar with disseminated and veinlet magnetite
		97					sericite- pyrite overprint on previous alteration
		140					volcanics , possibly chlorite after pervasive blotite
	ł	1/4					magnetite-quartz veiniets in magnetite-actinolite/chiorite altered voicanics
		238					ciotty albite/quartz-chlorite with a weak pyrite overprint
1		281	-				porphyritic volcanics with disseminated magnetite and probably with pervasive
							actinolite/chlorite alteration
		3/2					intense sericite- pyrite- clay overprint of porphyritic voicanics
	-	392	397				magnetite-chlorite/actinolite-albite alteration of volcanics
		452	457				green pebble dyke with definite QFP fragments, do not know which phase of QFP
	D 70	25	20	25			internet remarked and for study controlled enidets purits hometits alteration of valuening
	D-79	25	30	30			intense pervasive and fracture controlled epidote pyrite-hematite alteration of volcanics
		71					with an overprinting calcue-zeolite stock work
							ress interise propyrite alteration, commed to nactures, disseminated magnetite in
		116	127	137			heterogenous fragmental volcanic, possibly a precusor to the clotty chlorite-albite /quartz
		1.10					altered volcanics
		140				<u></u>	sericite- clay-pyrite alteration around a tracture, overprinting sericite- chlorite-epidote
		1/8					propylitic alteration of voicanic
	· · · ·	182					noie ends in a maroon voicanic unit with calcite veins
	D 107	25					fine grained fragmental tuffaceous valegation with oblarite pyrite alteration pervesive and
	D-187	25					inte graned tragmental-tuttaceous voicanics with chlotite-pyrite alteration pervasive and
		20					interes albitis alteration, quarta vains appear to pre-date the albite, which is in turn
		30					intense ablice alteration, quality vents appear to pre-uate the ablice, which is in turn
		45					quartz-magnetite veine, nervesive hiotite alteration in volcanics
		66					abite-oblorite overnrinting the biotite
		162					reliat nervesive highte elteration in volcanice
<u> </u>		230	231				chilled OFP in sharp contact with the volcanics, siliceous groundmass
-v	+	235	240	245			usual coarse OEP with large quartz eves albitized groundmass with a zeolite overprint
		200	240	240			minor quartz veing present, lower contact with volcanics is also chilled
		263					volcanic with chlorite-sericite alteration and a quartz stockwork
		200				· · · · ·	volcanice were prohably pervasively biotite altered at one time, now with a sericite-
1		373					chlorite overnrint, watery quartz veins contain scattered hlebs of chalconvrite-nurite
		357					OFP dykelet with intense sericite alteration and watery quartz veins with nyrite.
ļ							molybdenite 2-chalconvrite
<u> </u>	+	415					zone of pure nink-grey quartz ("guartzalite" in mine terminology) often occurs adjacent
							to contacts with intermediate OFP
<u> </u>		421	424				intra-mineral QEP, pink primary K-feldsnar in groundmass, lower contact to volcanics is
							ambiguous, gradational over 30 cm
	+	475					volcanic with a chlorite overprint, possibly on pervasive biotite quartz veins
	D-188	47					fine grained fragmental volcanics with intense pervasive endote -sericite alteration
	100	86				······································	intense nervasive enidote alteration with calcite-enhalerite? veinlets and euhedral purite
L	l	1 00					interior portuerte opidete ditertation with edicite opidienter venilets and suboral pylits

		114					fine grained volcanics, pervasive epidote , calcite-hematite veinlets, hematite is common
							in epidotized volcanics peripheral to the porphyry system
		122					a maroon, slightly porphyritic volcanic (flow?), 32 feet thick in core
		159					fine grained volcanics, pervasive epidote , euhedral pyrite
		258					End Creek Fault
		278	281				reddish coloured fine grained plagioclase-porphyritic rock, not a QFP, lacks the quartz
		297	296	291			same nornhyritic rock feldspars (nlagioclase) are clay-sericite altered groundmass is
		2.57	200	231			either cilicified or sericite altered, highly variable over a short distance
		330	337				same nornhyritic rock, either a dyke or a flow, not a OFP
		350					fragmental volcanic with hematite and enidote alteration and abundant disseminated
		401					magnental volganic 27 feet thick in core
		429					green fragmental volcanic, enidote alteration
	+	532					more homogenous volcanic, abundant disseminated pyrite
		661					sericite-chlorite alteration of same volcanics
	C-137	++					old core, much missing
		230					intense sericite-clay-pyrite alteration of QFP, quartz stockwork still visible, phase
							uncertain
		352	370	395	400	405	chlorite-sericite-pyrite alteration on volcanics with quartz veins
		542	563	566			chlorite-sericite-pyrite alteration on volcanics with quartz veins
	C-139						old core, much missing
		325	330				intensely sericite-clay altered QFP? with quartz veins, protolith unidentifiable
		370	374				fine grained volcanics with siliceous or albitized groundmass, clots of chlorite and
							disseminated magnetite??
		432	440				sericite-clay alteration of volcanics, overprinting albite-chlorite
		855	860	865			old QFP, large quartz eyes, sheeted quartz-magnetite veins
		1189	1200	1205			intra-late? mineral QFP, weak alteration
	1	1430					chloritized volcanics with calcite-zeolite stockwork
L							
	C-152	400	470				oid core, much missing
	<u> </u>	409	470				ine grained voicanics with pervasive magnetice-ac/chionice alteration, rate pyrite nactures
		645	650	002			possibly quartz-magnetite alteration of voicanics, quartz venis
		084	690				quartz-actinoite-magnetite alteration of the grained voicanics
		824	826				grey massive quartz, quartzaite
		1130	1140				old UPP sericite-chiorite alteration
SECTION	171 14/						
SECTION	1/1 W	26					valegning narinheral propulitie alteration, objects enidete caleite with grass outting
	D-59	20					volcanics, penpheral propyintic alteration, chionte-epidote -calcite with cross cutting
	· .	50					zeolite-calcite veins
		52					intense pervesive enidete estisite purite alteration of velegation
		245					"Valley Deg" to perhapste delemite homestite elevation of voicances
		243					delemite in groundmass, caloite and Facearbonate in veinlate-stockworks
		200					fine grained volcanics with chlorite endote alteration
		280	205				tine graned volcanics with chlorite endote calcite alteration
	+	290	293				The graned volcands with chonte-epidote calcite alteration
	D-83	25	30				fine grained dark grey volcanic, overprinted with sericite- pyrite and abundant calcite
	10.00	60	70				volcanic dark grey colorite-sericte-quartz altered matrix chlorite-nyrite clots and calcite
			,,,,				veine
		9.0					sericite- pyrite overnrint on same clotty volcanic
<u> </u>		150					volcanic, fine grained, epidote chlorite-se-calcite alteration
	1	182					matrix guartz-sericite- albite?? with chlorite-pyrite clots
		235					"Yellow Dog" dolomite-calcite-Fe-carbonate overprint on fine grained volcanic.
		278					intense sericite-pyrite overprint on volcanics
	†	281					"Yellow Dog" dolomite-calcite-Fe-carbonate overprinting intense sericite altered fine
							grained volcanics
		357					"Yellow Dog" dolomite-calcite-Fe-carbonate alteration of volcanics, crackle veinlets of
							calcite and Fe-carbonate

r		1		I	
		407			"Yellow Dog" dolomite-calcite-Fe-carbonate alteration of possibly previously magnetite-
L				ł	quartz altered voicanics, quartz ven may be relicits of this stage
		484		ļ	sericite- chlorite-pyrite altered volcanics with calcite veins
		592			sericite- chlorite alteration with dolomite overprint
		759			fine grained volcanic, pervasive biotite alteration with a chlorite overprint, magnetite-albite
				ļ	quartz-chalcopyrite-pyrite veinlets and disseminated pyrite-chalcopyrite
		783			biotite alteration spreading from a vein overprinting actinolite alteration, pervasive sericite
					overprint and late calcite veinlets
		812			strong dolomite-carbonate-sericite overprint of volcanics
		846			pervasive actinolite-magnetite overprinted by chlorite-pyrite, relict magnetite-albite veins
		865			biotite-sulphide overprint in actinolite-magnetite alteration, weak sericite- pyrite overprint
				1	as well
		++-			
	D-147	40			intra-mineral OFP, pink K-feldspar matrix, some magnetite veinlets and inclusions of older
					OFP with sheated quartz-magnetite veins, variable zeolite overprint
		94	92		older OEP with quarty-magnetite veils, rate inclusion in younger OEP
		101	JZ		lists arr with quartz magnetic quartz veins present magnetic disceminated in
	1	101			mua-inmera Qrr, minor magnetice quality consistence in agriculte disseminated in
				<u> </u>	groundmass locally, molyodenite on silp surfaces
		232			Tresh intra-mineral QPP, molybdenite on slip surfaces
		258	276		older quartz-magnetite altered QFP, contact between the two in faulted, crushed
		383			QFP, possibly a slightly younger phase, it appears to be cutting a quartz-magnetite clast
		402			pure quartz-magnetite with pyrite on fractures
		431	436		younger QFP in sharp contact with older phase, intense clay sericite alteration
		571			intra-late? mineral QFP with a "Yellow Dog breccia" overprint, Fe-carbonate-dolomite
					alteration, veinlets form a crackle breccia texture, dolomite is also present in the
		623			contact between volcanics and QEP is guartz veined and brecciated, and overprinted by
					the Yellow Dog alteration as well, textures are destroyed, this sample is volcanics only
	D-209	25	30		marginal breccia, oblorite (after actinolite?) altered volcanics and pervasive quartz-
1	0.200	23			magnetic alteration in charts activate with a child OEP, guistiz magnetic alteration in
	1				the OE is the first few sm theo OE is totally non-magnetic
		Fal			ine urr in the first lew cm, then urr is totally non-magnetic
		52			magnetite altered urr, the magnetite may be due to partial assimilation of the volcanics
		62			non-magnetic UPP with a quartz stockwork, this is an intermediate phase, not the one
					responsible for the earlier intense magnetite alteration, siliceous, chloritized matics,
ļ					disseminated sulphide, possibly some relict K-feldspar
		85			QFP with some magnetite + /- quartz sheeted veins, some sulphide replacement of the
		ļ			magnetite
		176			this is large body continuous body of porphyry, magnetite hairline veinlets are increasing
					in abundance, sericite alteration of the plagioclase phenocrysts , K-feldspar in
					groundmass is still fresh looking, groundmass is intensely silicified locally
		236			intense quartz-sericite- clay overprint nearly obliterating the QFP texture, quartz-magnetite
					veinlets were not abundant here
		252			alteration front or contact? intense sericite alteration in sharp contact with very fresh
					QFP, the texture of this QFP is slightly different then that previously occuring in this hole.
					it may be a vounger phase
		270			examples of the OFP, there is more K-feldspar groundmass, fewer placinclase
		2.70			happenvets than before some biotic may still be unchloritized, there is a zenlite
		200			pronocrysts than before, some blotte may still be unchanged, there is a 200 me
		200			methode for the sentered quartz altered QFF in thesh younger phase, x-cutting quartz-
		305			quartz-molybgenite vein
		345			intense zeolite overprint, destroys the plagloclase, changes the texture of the QFP,
					quartz + -pyrite-chalcopyrite-molybdenite_stockwork
		438			intense silicification of QFP, quartz-molybdenite-pyrite +- chalcopyrite veins
ļ		549			localized intense sericite of matrix, quartz-molybdenite veins
		605			sericite alteration possibly albite alteration of groundmass, some zeolite overprint ,
					sulphides in quartz veins and disseminated
		642			relatively fresh QFP
		662	670		faulted, brecciated contact between volcanics and QFP, interfingering
		689			volcanic, intense actinolite-magnetite alteration, overprint by chlorite, sheeted quartz-
					magnetite veins, abundant later calcite veins, clast of QFP in one sample

			:			
	C-142	250				volcanics, clotty chlorite in a sericite- chlorite-quartz groundmass, disseminated pyrite
		470	500		-	Yellow Dog overprint in sericite- chlorite altered volcanics
		640				sericite- chlorite alteration, quartz veins, sulphide on fractures, late calcite veinlets
······································						
	C158	200	201	206		intense guartz-sericite-clay overprint of chlorite-sericite, quartz veins in volcanics
		266				chlorite-pyrite clots in a sericite- chlorite-quartz groundmass, volcanics
		270				intense silicification of the same volcanics
		400	403			textural variation of the volcanic, plagioclase-phyric, actinolite-magnetite? altered
						groundmass appears to be transitional back to the clotty chlorite altered volcanics
· · · · · · · · · · · · · · · · · · ·		470				heterogenous, possisbly a fragmental volcanic, guartz-chlorite-sulphide clots with albite-K-
						feldspar? rims in a guartz-albite? altered matix
		780				nervasive biotite alteration with quartz veins and disseminated sulphides
		782	907			an example of the uncommon guartz veins with a K-feldspar envelope, sericitic alteration
		,				and coarser sulphides
		1421				Yellow Dog overnrint on volcanics
		1480				volcanic, actinolite-magnetite alteration, calcite-zeolite veins
		1530				volcanic, actinolite-magnetite alteration, calcite-zeolite veins
		1000				
SECTION	197 W					
JUL TION	C-1364	142				silicified volcanic with chlorite clots
	U TOUR	1-72	515	562		quartz-magnetite 2 altered volcanic
		596	515	505		old green OEP
		625				volcenie
		035				volcanic
		029				Voicanic
	D 160	2.25				valuanian able ritized and intercely reality calaity altered some quarty vain fragments
	D-160	325				voicanics, chionized and intensely zeointe-calcite altered, some quartz vehi hagments
		305	275			contact with QFP, some quartz-magnetite alteration of QFP at the contact
		370	3/5			hon-magnetic UPP dyke, sharp lower contact at 419 with mense sencice- clay alteration
		420		· · · · · · · · · · · · · · · · · · ·		chiorite-magnetite-quartz altered voicanics, cut by quartz-molybdenite veins
		467				obliterating sericite- clay-pyrite overprint on quartz-magnetite altered voicanic
		469				protolith to above alteration, intense quartz-magnetite, very little volcanic component,
						this is the beginning of a large body of marginal breccia
		566				marginal breccia, dominantifysheeted and massive quartz-magnetite
· · · · ·		/15				marginal breccia with a higher proportion of volcanic rock than previous section
		768				small UFP dykelet in sharp contact with pervasively blotiter altered volcanics
		827				pervasive biotite-magnetite 7 altered volcanics with disseminated chalcopyrite -pyrite
····	· · · ·	892				pervasive biotite-magnetite ? altered volcanics with disseminated chalcopyrite -pyrite
		980				pervasive biotite-magnetite altered volcanics with disseminated chalcopyrite -pyrite and
						calcite-chalcopyrite veinlets, some quartz veins with irregular pervasive K-feldspar
		982				pervasive biotite-magnetite altered volcanics with disseminated chalcopyrite -pyrite and
						calcite-chalcopyrite veinlets
	D-164	30				intra or late mineral QFP, silicified or albitized?? groundmass, epidote pyrite alteration and
						intense pervasive zeolite alteration
		129	132	137		intra or late mineral QFP, albitized groundmass with an intense pervasive zeolite overprint
		185	188			magnetite is disseminated in the groundmass locally, but is generally lacking in this QFP
		200				molybdenite and chalcopyrite on a fracture surface
		224	227			intense clay alteration of a coarse QFP - possibly the older phase
		250	252			quartz-magnetite stockwork/breccia
		334	337			quartz-magnetite_stock.work/breccia
		397				QFP with quartz-magnetite stockwork
		476	481	479		QFP with sheeted quartz-magnetite veins and partially digested inclusions of volcanic,
						pink colour due to primary K-feldspar
		530	536	542		QFP with intense quartz-magnetite stockwork
		691	694	695		pure quartz-magnetite , pyrite along fractures
		707				End Creek Fault/ cuts off the orebody
		730				volcanic with intense calcite-zeolite stockwork
		807				volcanic with intense calcite-zeolite stockwork
	1	895	897			fragmental volcanic with chloritic alteration and pyrite veinlets
F		915				intense calcite-zeolite stockwork forming a crackle breccia in the volcanic

		966				regional? propylitic alteration of volcanics, chloritic clots in an albitized matrix,
		1161				volgenia with en entering aroundmass and rounded lenilli? of enidote chlorite-nyrite-
		1101				volcanie with an aphankie groundmass and rounded laping of epidote chlorice pyrite
SECTION	195 W/					
SECTION	D 95	01	85	Q 1		nyronhyllite-dumortierite altered volcanics
	0-05	110	120			pyrophymic damor to the averabilite-dumortierite rock - a clotty chlorite-albite /guartz
			120			oltered velocitie
		142	165			ancede volcame
		265	105			pyrophylitie dumortierite attered volganics
<u> </u>		205				pyrophymite-dumonitente artered breccia
		310				possible precision a clotty chloride abite Addate and Volcanic
		390				sencice overprint of pyrophyline of childre stage
	D 06	25	40			nuranhullita dumartiarita altarad valagniga, como rempant oblavite
	0-86	35	40			pyrophylite-dumortiente altereti volcanics, some remain chiome
		90				
L		104	100			visible
		104	109			precusor precus, prevales the pyrophyme-dumontance
		199		215		
		290	284	315		quartz-sericite alteration on voicanics
		335				sericite overprint on chlorite
		453			_	intense sericite- pyrite-quartz alteration and gilsonite? - black mineral
L		476	481			clotty volcanic, ab/quartz groundmass with chloritic clots
		535	545	548		clotty volcanic, albitic rims on chlorite clots and along fractures
	D-104	88				fine grained volcanics with clotty chlorite in a quartz-sericite- chlorite altered groundmass,
						minor epidote
		112				similar, coarser chlorite clots with pale albitic? or sericitic rims
		117	135			sericite- pyrite overprint on the chlorite alteration
		185				weaker sericite overprint, chlorite clots are still visible, groundmass is more siliceous,
						pyrite in fractures and clots
		355				alternating quartz-sericite alteration and chlorite-sericite alteration in volcanics
		418				sericite- chlorite alteration, chlorite veinlets, later zeolite-calcite-pyrite-chalcopyrite
						veinlets
		527				fine grained volcanics, silicified, pervasive actinolite-magnetite?
		666				pervasive biotite with a sericite overprint, quartz vein with a chlorite envelope and a
						quartz + magnetite? vein with no envelope
		727				chlorite overprint on pervasive biotite, some vague groundmass replacement by quartz
						and possibly K-feldspar, disseminated and blebby sulphides
		767				chlorite overprint on pervasive biotite, relict quartz-magnetite veins with albite envelope,
						disseminated sulphides
	C-160					old core, much missing
		127				fine grained featureless volcanics with intense pyrophyllite-sericite alteration
		137				intense pyrophyllite with some dumortierite
		430				intense sericite- clay altered QFP, texture bearly recognizable, 10 m dyke
		450				intensely silicified, chlorite altered volcanic, sulphide veinlets
		775	860			fine grained volcanic, chlorite-sericite alteration, possibly overprinting pervasive biotite.
						disseminated sulphides?
						F 11
Miscellane	ous					
	D-165	141				late mineral? QFP, intense albite alteration of groundmass, coarse euhedral pyrite
		143	148	150		igneous? breccia with propylitic alteration, volcanic clasts in a possilby igneous matrix.
						both with pyrite-epidote alteration
		167				magnetite-rich, volcanic clast dominated marginal breccia
· .		287				guartz-magnetite-actinolite stockwork in volcanic, possibly pervasive hightite alteration in
		207				the larger clasts
		321	335	360	349	intense zeolite-enidote overprint of the breccia, volcanic clasts dominant, rare OEP
		501	535	0		maning brace with more OFP clasts than further up the hole
		627				charn contact intra-mineral OEP and bracolo
┝		640				the OED is shilled the first 2m from the context, minor quarter magnetite unit-
	1	040				The Grr is chilled the first 2m from the contact, minor quartz-magnetite veiniets are

		645					the QFP grades into a coarse grained variety with large (1cm) quartz eyes, salmon pink
							colour is due to pervasive zeolite alteration
		660					fresher QFP, pink colour is due to primary K-feldspar
		668	681	704			sharp contact between intra-mineral QFP and older quartz-magnetite altered volcanics
		803	815				typical sheeted quartz-magnetite veins, comprise 90% or more of the rock
		830					End Creek Fault cuts off the quartz-magnetite alteration
		857	862			-	volcanics with a stockwork of calcite-zeolite, generally highly fractured
		1020					fine grained volcanics, less zeolite alteration, disseminated mag in matrix?
		1052					propylitically altered volcanics, pyrite-epidote calcite-hematite, typical of propylitic alteration peripheral to the deposit
_							
	D-210						very briefly logged to observe QFP/volcanic contacts and nature of QFP
		168					fine grained volcanic, non-magnetic?? in sharp contact with fresh QFP, minor
		171	164	175			examples of contact between rocks
		175					QFP, fresh K-feldspar groundmass, chloritized biotite, large body of intra or late-mineral porphyry
		356	366				QFP, locally silicified, locally overprinted by zeolite, quartz-molybdenite -pyrite veins, same to end of drill hole
Bay Lake	Zone	-					
<u> </u>	E-92		-				hole goes through over 600 feet of intensely calcite-zeolite altered volcanics
		660					quartz stockwork increasing in intensely altered volcanics, clhorite/actinolite-magnetite
							with calcite-zeolite overprint
		701					sheeted quartz-magnetite veins, K-feldspar? or zeolite in volcanics
		755					sheeted quartz-magnetite veins, in chlorite/actinolite altered volcanics
		781	782	783			sharp, but intensely zeolite altered and crumbly contact with QFP
		798					very fresh QFP, primary K-feldspar matrix, weak zeolite overprint
		840					same QFP with zeolites replacing plagioclase phenocrysts
		909					QFP without the zeolites
		939	964				partially assimilated inclusion? this fine grained rock shows up sporadically in this QFP
ļ							for less than 1 m intervals, in some cases quartz and plagioclase phenocrysts occur in it
		999					QFP/volcanic contact
		1029					actinolite-quartz-magnetite altered QFP, quartz-magnetite veins with intense zeolite
		1067		:			actinolite-quartz-magnetite altered QFP, quartz-magnetite veins with intense zeolite
				-			
**	Four mate	hing sui	tes of ro	ocks we	re collec	ted, two	for BHP, one for MDRU at UBC and one for the BC Geological Survey,
	therefore	multiple	footage	s are lis	ted for s	amples	that were collected further than one foot apart. Each suite will only have
	one samp	le.					



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# PORPHYRY COPPER-GOLD-MOLYBDENUM MINERALIZATION IN THE ISLAND COPPER CLUSTER, VANCOUVER ISLAND

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# Introduction

The Island Copper Cluster (ICC; Figure 11), situated at the northern end of Vancouver Island, consists of five porphyty copper-gold-molybdenum systems genetically associated with stock and dike-like rhyodacitic porphyties of Jurassic age (approximately 180 ma) that intruded the island arc, calc-alkaline basalts, andesites and pyroclastic rocks of the comagmatic Bonanza Group. The systems (Island Copper, Bay Lake; G Zone; Red Island; and Rupert Inlet) are coincident with a series of northwest-trending magnetic highs and regional faults aligned for more than 10 km. They all share many similarities in the alteration-mineralization geometries but vary largely in size and grades. Copper-bearing skarn and vein-type mineralization also constitutes an integral part of the porphyty systems.

# **Reserves and deposit geology**

The only economic deposit of the cluster is the Island Copper mine controlled and operated by BHP Minerals Canada Ltd. The mine had initial estimated reserves of 257 million tonnes at 0.52% copper and 0.017% molybdenum at a 0.3% copper cutoff grade.

Mineralization at Island Copper is associated with multiphase rhyodacitic intrusions and hydrothermal breccia bodies (Figures 11 to 13). Available data suggest that the porphyry system evolved dynamically from an early, probably juvenile-dominated stage, to one strongly influenced by meteoric waters, as the main heat source cooled and further intrusion and brecciation took place. Three main stages of alteration and mineralization have been differentiated:

- 1. An Early Stage, related to the intrusion of a main rhyodacite porphyry, involved the development of four outwardly progressing zones: (a) a copper-barren stockworked core of quartz-amphibole-albite-magnetite-(apatite, scapolite); (b) a biotite-magnetite zone containing chalcopyrite, pyrite and molybdenite; (c) a chlorite zone containing pyrite and minor chalcopyrite and magnetite; and (d) an outermost epidote zone. All are found in Bonanza volcanic rocks except the quartz-amphibole-magnetite stockwork core which, in addition, formed along the margins of the rhyodacite porphyry. The biotite alteration, together with the main copper mineralization, partly overprinted the stockworked core. Preliminary fluid inclusion data indicate that the fluids associated with the iron-rich core of the system were hot (> 500°C) and saline (>50 equiv. weight per cent NaCl) consistent with a magnetic derivation. Mass balance calculations for these assemblages indicate gains of up to 450 per cent Fe and 42 per cent Na.
- 2. A structurally-controlled <u>Intermediate Stage</u>, superimposed upon the earlier assemblages, was related to the emplacement of quartz stockworks and hydrothermal breccias associated with the intrusion of intermineral rhyodacitic porphyry during the

-20000-E Quatse Lake 30000-E N -50000- E 40000-E Figure 3. THE ISLAND COPPER CLUSTER Bay Lake NW Zone G Zone 10000 N ISLAND COPPER PIT A Zone Rupert Inlet Ground magnetic high Cu Geochemistry 1 S 40 Red Island RUPERT INLET 500' 6 152 m

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Figure 11. The Island Copper cluster (ICC), nothern Vancouver Island.

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collapse of the hydrothermal system. Alteration was dominated by quartz-sericite and sericite-clay-chlorite (SCC) assemblages together with pyrite, chalcopyrite and molybdenite.

3. A <u>Late Stage</u>, related to the emplacement of the Pyrophyllite Breccia assisted by further late-mineral rhyodacitic intrusions, is characterized by a pyrite-bearing, copper-barren advanced argillic alteration assemblage of pyrophyllite, kaolinite, sericite and dumortierite. Further low temperature alteration episodes included ankerite-calcite veining, widespread zeolite development, and the precipitation of remobilized carbonbearing organic compounds.

# Mineralization

The bulk of the copper mineralization at Island Copper was introduced during the Early Stage in feldspar-stable, K-silicate conditions (see bench and section copper values in Figures 15 and 16). Copper mineralization was followed by a main episode of molybdenum in a feldspar-destructive, sericitic environment. All of the recovered copper occurs as chalcopyrite, predominantly hosted by biotite-altered Bonanza volcanic rocks. Similar alteration-mineralization geometries characterize the other members of the ICC although hydrothermal pyroxene is conspicuous in the quartz-amphibole-magnetite stockworked core at Bay Lake.

Gold production from Island Copper since production started in 1971 through to the end of 1993 is over 32 000 kilograms, and annually amounts to 1200 to 1500 kilograms. This renders Island Copper one of the largest current gold producers, and historically the seventh largest lode gold producer, in British Columbia. Historical average head-grade of the deposit is about 0.19 ppm gold but includes large volumes having assayed more than 0.40 ppm gold. Only about 50% of the gold is recovered in the copper concentrate, which has averaged about 24% copper, 7 ppm gold and 60 ppm silver.

The bulk of the gold was associated with Early Stage copper mineralization. Some gold seen to be associated with Intermediate Stage assemblages could have originally been introduced by this event or remobilized from earlier mineralization. Gold has been observed in the native form, as micron-sized inclusions in chalcopyrite, pyrite, molybdenite and silicates.

Certain features such as the positive correlation between gold and copper, the association of gold with the potassic, biotite-rich alteration, and the high content of magnetite in the system (> 8 vol. per cent) are characteristic of gold-rich porphyry copper deposits from elsewhere. The spatial arrangement of the ore zones (biotite-chalcopyrite around a copper-barren, quartz-magnetite core) is, however, considered to be unique among porphyry deposits, because copper-gold ore normally accompanies the quartz-magnetite stockwork veinlets (eg. Philippine porphyry deposits).

The copper-gold-molybdenum assemblage at Island Copper confirms that porphyry deposits cannot be exclusively divided into copper-gold and copper-molybdenum categories, but are rather part of a larger spectrum containing intermediate copper-gold-molybdenum examples that has copper, gold and molybdenum-only deposits as end members. Comparisons are also valid between the iron-rich, quartz-amphibole-magnetite-albite-(apatite, scapolite) stockworked core of the systems of the ICC, which at Bay Lake contains additional pyroxene, and the iron ore mineralization of the Kiruna-type.







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# Preliminary studies of hydrothermal alteration events at the Island Copper deposit, northern Vancouver Island, British Columbia

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Leitch, C.H.B., Ross, K.V., Fleming, J.A., and Dawson, K.M., 1995: Preliminary studies of hydrothermal alteration events at the Island Copper deposit, northern Vancouver Island, British Columbia; in Current Research 1995-A; Geological Survey of Canada, p. 51-59.

**Abstract:** Core logging/pit mapping suggest three main stages of intrusion (early, intermediate, late), defined by differences in alteration intensity. Hydrothermal events comprise early biotite-magnetite "hornfels", followed by magnetite-actinolite-plagioclase veining, and then quartz-chalcopyrite veins and fractures with or without "hydrothermal" biotite envelopes. Chlorite-sericite  $\pm$  clay are likely retrograde overprints as the system cooled and collapsed inwards; epidote may be prograde peripheral, retrograde, or both. Chalcopyrite was introduced in several stages: minor with magnetite-biotite, followed by main-stage disseminations/fracture fills accompanying quartz veins, some with biotite envelopes, and finally with epidote-chlorite and pyrite-chalcopyrite filled fractures. Fluid inclusions in quartz-magnetite veins are highly saline (multiple daughter products); in quartz-chalcopyrite veins saline (halite only); in late veins or reopenings associated with epidote less saline (liquid/vapour only).

**Résumé :** De nombreux indices géologiques ont été découverts d'un ou de plusieurs séismes d'importance qui ont secoué la zone de subduction de Cascadie il y a environ 300 ans. Les séismes ont provoqué de fortes secousses, une subsidence crustale et de gigantesques tsunamis le long de la côte du Pacifique, depuis l'île de Vancouver jusqu'au nord de la Californie. Ils ont dû affecter grandement les habitants de ces régions. Les traditions orales des Amérindiens de la côte du Nord-Ouest font état, quoiqu'avec des exagérations, de tsunamis provoqués par ces événements rares, se produisant à la frontière de plaques. Le plus ancien séisme connu de la période historique en Colombie-Britannique a eu lieu en février 1793 et a été consigné par des explorateurs espagnols passant l'hiver dans le détroit de Nootka, dans l'île de Vancouver. Il est possible que ce séisme se soit produit à une faible profondeur dans la croûte ou encore plus profondément, au sein de la plaque Juan de Fuca en subduction.

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# INTRODUCTION

Island Copper is an island-arc type porphyry Cu-Mo-Au deposit (Perelló et al., 1989; Arancibia and Clark, 1990) operated by BHP Minerals Ltd. on northern Vancouver Island near Port Hardy, British Columbia. It resulted from the intrusion of a series of dyke-like bodies of rhyodacitic quartzfeldspar porphyry of about 180 Ma age into possibly comagmatic high-alumina basalts, basaltic andesites, minor rhyolites and pyroclastic rocks of the Middle Jurassic Bonanza Group (Northcote and Robinson, 1973; Muller, 1977; Nixon et al., 1994). The size of the deposit was initially estimated at 257 million tons of ore at 0.52% Cu and 0.017% Mo (Cargill et al., 1976); the final mined plan envisages a total of 377 million tons at 0.41% Cu and 0.017% Mo at a 0.2% Cu cutoff (Perelló et al., in press). Gold has been produced at an annual rate of 1200-1500 kg (40-50 000 oz) from a head grade of 0.19 g/t. Only about 50% of the gold is recovered in the copper concentrate, which averages 24% Cu, 7 g/t Au and also contains 60 g/t Ag. The molybdenum concentrate contains up to 1400 ppm rhenium, making Island Copper Canada's only producer of this element (Perelló et al., in press).

A joint project with the Mineral Resources Division of the Geological Survey of Canada (GSC-MRD), the British Columbia Geological Survey Branch (BCGSB), BHP Minerals Ltd., and Auckland University (New Zealand) has been initiated to study the deeper levels of the deposit before mine closure and pit flooding, anticipated in 1995 or 1996. Project members involved include: Craig Leitch, Katherina Ross, Ken Dawson, Rod Kirkham, Colin Dunn, and Mel Best of the GSC; Graham Nixon, Jan Hammack, Andre Pantelevev, Victor Koyanagi, Steve Sibbick and Peter Bobrowsky of the BCGSB; John Fleming of BHP Minerals; and Stuart Simmons and Geraint Mathias of Auckland University. The objectives of the GSC-MRD team are to study the geology and alteration of the deep exposures and drill core, to better understand the sequence of intrusive, alteration, and mineralizing events at all levels in the deposit. Methods include U-Pb zircon geochronology, fluid inclusion and stable isotope studies, and lithogeochemistry. Other related studies include biogeochemistry over and around the deposit by Colin Dunn of GSC-MRD and depth of overburden using geophysical methods by Mel Best of GSC-Geophysics and Marine Geoscience. Branch. The BCGSB team is updating knowledge of the regional geology, mineral deposits, geochronology, and geochemistry of the surrounding part of northern Vancouver Island. A detailed study of the high-level advanced argillic alteration is the focus of the Auckland University members.

#### PREVIOUS WORK

Since the beginning of production in 1971, the Island Copper deposit has been the subject of numerous geological studies. Brief summaries of the geology were published by Young and Rugg (1971) and Northcote and Robinson (1973). A more detailed description was published by Cargill et al. (1976), and an updated review of the geology was presented by Fleming (1983). Several theses, including those of Cargill (1975), Fahey (1979), and Perelló (1987), have been completed on the deposit; a PhD study by Arancibia, begun in 1977, remains unfinished. The most recent publications include a comprehensive review by Perelló et al. (in press) and partial results of the Arancibia thesis work (Arancibia and Clark, 1990 and in press).

# TIMING OF EVENTS

## Porphyry intrusions

All phases of the porphyry are texturally and mineralogically similar, and probably of rhyodacite composition (dacite to rhyolite: O.N. Arancibia, in Perelló, 1987). Unaltered porphyry (O.N. Arancibia, unpublished data; Leitch, unpublished data) consists of approximately 20-30% coarse (0.5-1 cm) bipyramidal quartz phenocrysts, 15-30% 2-5 mm plagioclase laths and <5% chloritized biotite books to 2 mm set in a fine (10 to 30  $\mu$ m) matrix of quartz and K-feldspar or albite. The plagioclase phenocrysts are oscillatory zoned oligoclase-andesine (An<sub>30-40</sub>) from rim to core (Leitch, unpublished data).

Distribution of the porphyry phases is shown for section 155 through the mine in Figure 1. Three main intrusive events of quartz-feldspar porphyry are recognized in the present study (cf. Perelló, 1987; Perelló et al., in press; Arancibia and Clark, in press), based on differences in alteration/veining intensity, crosscutting relations and included fragments:

Early phase, characterized by intense magnetite-quartz to quartzmagnetite stockwork and/or flooding by disseminated magnetite, frequently leading to total destruction of texture. Quartz-magnetite veins appear to form a continuum with quartzpyrite±chalcopyrite-molybdenite-magnetite veins. Increasingly quartz-rich veins crosscut magnetite-quartz veins.

Intermediate phase, cut only by rare quartz-magnetite veins and magnetite fractures, and characterized by a general abundance of planar grey quartz-pyrite±chalcopyrite±molybdenite veins. This phase rarely contains clasts of intensely magnetitequartz stockworked porphyry. It is generally less intensely altered by clay-sericite-chlorite than the early phase, but the contacts are not always clear, as the porphyries are texturally almost identical. Distinction between the phases is based on the abrupt disappearance of intense quartz-magnetite alteration (including the truncation of veins).

Late phase, completely lacking quartz-magnetite stockwork. This phase contains only minor amounts of disseminated magnetite, and clearly truncates quartz-magnetite veining in the early phase (Fig. 2a, b). It is also observed to cut marginal breccia (see below) developed around the early porphyry. Chalcopyrite is restricted to altered mafic mineral sites. Rare quartz±pyrite veins and crosscutting molybdenite on slips occur. Contacts are fresh, sharp and slightly chilled. Inclusions of earlier intrusive phases are common, but crosscutting relations with intermediate porphyry have not been observed.

#### Breccias

A "marginal breccia" unit mapped around the margins of the early intrusive at Island Copper by previous authors (e.g. Perelló, 1987) appears to be an inclusive term for several breccia types. These range from crackled and hydrothermally veined or stockworked porphyry (unrotated blocks) to heterolithic breccias including volcanic and porphyry clasts (transported blocks) to hydrothermal breccias composed of rounded, intensely altered clasts (highly milled blocks). Matrix to the breccia is difficult to resolve pending petrographic study, but may include some igneous material in addition to the dominant rock flour (cf. Sillitoe, 1989; Perelló et al., 1989). The milled breccia contains clasts of white quartz, dark magnetite-quartz±hematite, and clay-sericitepyrite altered rock in a matrix of siderite-quartz-hematitepyrite±chalcopyrite and rare bornite-chalcocite-covellite. In exposures of marginal breccia, quartz-magnetite veins are cut off in some clasts but cut through other clasts (cf. Padilla-Garza, 1993), indicating several stages of brecciation that possibly overlap the transition from intrusive breccia to hydrothermal breccia associated with the early porphyry. The marginal breccia was not observed to be associated with the intermediate and late porphyries, although Perelló (1987) stated that some breccias post-date the main mineralizing stage.

An extensive area at the west end of the pit is underlain by what has been termed "pyrophyllite-dumortierite breccia"; it has been reported to include fragments of intermediate porphyry and to be cut by late porphyry (Perelló, 1987). Examination of available drill core and pit exposures of this unit, however, suggest an origin by pyrophyllite-dumortierite alteration of a fragmental volcanic rock or intrusion breccia (or both). The location of this breccia adjacent to and transitional



Figure 1. Cross-section 155W at about 27000 E through the east-central part of the Island Copper deposit to illustrate interpreted geology and alteration zoning. All co-ordinates are in feet (vertical scale same as horizontal scale); mine elevations, used for pit bench designation, are relative to a zero at 1000' below sea level. Abbreviations: ac = actinolite, bi = biotite, ch = chlorite, ep = epidote, kf = K-feldspar, pl =plagioclase, mt = magnetite. Drill hole collars are shown by open circles and identified by number.

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to marginal breccia indicates the possibility that it is an early breccia that has later undergone intense advanced argillic alteration.

#### Pebble dykes

Late pebble dykes, rarely observed in the pit, generally trend about 325° across the middle of the deposit. These dykes are up to 0.5 m thick and subvertical, and roughly parallel a minor porphyry dyke trend seen in the pit. They have sharp, commonly faulted or sheared contacts. Other examples are observed in drill core, with apparent widths (probably exaggerated in these steep holes) up to several metres. Pebble



dykes are divisible into two types: a possibly slightly earlier type that is green, sericitic and strongly pyritic (up to 10%) pyrite in the matrix), and a later pink, crumbly and unpyritic type that grades into calcite-zeolite rich fractured or crushed zones. The dykes contain clasts of highly altered and mineralized early porphyry, quartz-magnetite±chalcopyrite veins, and rare clasts of later porphyry in an aplitic-looking matrix (Fig. 2c). The age distinction between the two types is based on the greater degree of alteration, pyritization and lithification of the green type, plus the relation of the pink type to fractured zones. The green type is similar in appearance to some exposures of marginal breccia, implying it may not be much later. Variably pyritic, clay-rich gouge zones are abundant and may in places superficially resemble the pebble dykes, but generally are distinguished by the presence of a less "igneous-looking" matrix (petrography is required to resolve the pebble dyke matrix).

## Alteration

A concentric pattern of alteration assemblages developed within the Bonanza volcanic rocks and centred on the porphyritic intrusions, has been recognized by previous authors (Cargill et al., 1976; Fleming, 1983; Perelló et al, in press; Arancibia and Clark, in press). However, the temporal relationships between porphyry intrusion, alteration and mineralization are not yet completely understood. The main alteration assemblages within the Bonanza volcanic rocks recognized in this study are, from innermost to outermost (Fig. 1): magnetite-actinolite/chlorite-plagioclase±biotite ±K-feldspar (Fig. 3a); plagioclase-chlorite (Fig. 3b); and chlorite-epidote. The distinction between actinolite and chlorite is almost impossible to make in hand specimen; in many places both may be present. Biotite appears to be partly relict in the inner two assemblages and partly late (see below). The alteration feldspar is generally albite but ranges from -

- a) Contact (sheared) of intensely magnetite stockworked and flooded early porphyry (dark grey, texture destroyed) with late, pink porphyry (grey, unveined except by calcite-zeolite). Hole E92 at 781 feet, from Bay Lake zone west of the pit.
- b) Contact of late porphyry (grey, rare white calcite-zeolite veins) with early porphyry (darker grey, intensely magnetite stockworked) at 469.8' and then of early porphyry with intensely magnetite-actinolite-chlorite altered Bonanza volcanics (black, cut by white calcite-zeolite fractures and grey quartz-sericite-pyrite-clay envelopes). Hole D187, section 155W, centre of pit at 0 level (Fig. 1)
- c) Pebble dyke (pink type) containing fragments of quartz vein, magnetite flooded early porphyry, and less altered intermediate or late porphyry in an aplitic matrix (southeast wall of pit, 120 level).

Figure 2. Contact relations of intrusive phases at Island Copper.

oligoclase to locally andesine; K-feldspar, likely orthoclase, is also found with increasing alteration intensity closer to the centre of the system or inward in a single fracture envelope (Arancibia and Clark, 1990; Leitch, unpub. data; cf. Leitch, 1981). Pyrite is found throughout all zones. All these alteration types are cut by later, generally structurally controlled, quartz-sericite-clay- pyrite and pyrophyllite-dumortierite alteration assemblages. Plagioclase±chlorite and quartz-sericitepyrite±clay alteration assemblages are intensely developed locally in both porphyritic intrusions and volcanic rocks. Silicification and magnetite alteration are also moderately to locally intensely developed in the porphyritic intrusive rocks and breccias (Fig. 3c). The distribution of altered intrusive rocks is too variable to show in Figure 1.

The timing of biotite alteration is both significant and contentious. Biotite altered volcanic rock is the most abundant host to copper-gold mineralization. Our observations from pit mapping and drill core logging indicate that a



- a) Biotite alteration as remnant "cores" (dark) in Bonanza volcanics cut by dark magnetite-actinolite ±pyrite veinlets with narrow white plagioclase envelopes, encroached on by albitic alteration (pale grey, on left) and chloritic alteration (grey, on right). Late white calcite-zeolite fractures cut all alteration types (east end of pit, 280 level).
- b) "Mottled" albite (light grey)-chlorite (dark grey) alteration replacing biotite±magnetite altered Bonanza volcanics, cut by late white calcite-zeolite fractures (east end of pit, 320 level).
- c) Magnetite-quartz stockwork (dark) in porphyry (east end of pit, 160 level). Bleached area is due to later quartz-sericite-pyrite±clay alteration.
- d) Late pyrite-chalcopyrite fractures with sericitic envelopes cutting variably biotite-albite altered Bonanza volcanics (north wall of pit, 280 level).

Figure 3. Photographs illustrating mesoscopic features bearing on the timing of alteration and mineralization in the Island Copper deposit.

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pervasive biotite alteration is everywhere cut by magnetiteactinolite/chlorite-plagioclase-pyrite-chalcopyrite veinlets. However, in places (rare in the pit; not uncommon in drill core) the magnetite-bearing veinlets are themselves cut by brown biotite-filled fractures and biotite envelopes to quartzchalcopyrite veins. The biotitic envelopes appear in many places to be retrograded to later sericite. The principal occurrence of the earlier biotite is as widespread remnant "cores" in relatively less fractured areas of the veinlet controlled magnetite-actinolite-plagioclase alteration assemblage (Fig. 3a). Therefore we interpret two biotite episodes: an earlier hornfelsic biotite that predated the magnetite-actinolite/chlorite-plagioclase±chalcopyrite± pyrite alteration, and a later hydrothermal biotite localized along fractures that cut magnetite-bearing alteration assemblages. Biotite-magnetite along with the copper mineralization partly overprints the quartz-amphibole-magnetite "core" assemblage according to Perelló et al. (1989); and biotite-chalcopyrite assemblages that crosscut magnetite have been described by Arancibia and Clark (in press).

Epidote-chlorite hydrothermal alteration assemblages form a peripheral shell that grades outwards to a regional metamorphic assemblage of the same minerals. Quartzsericite-pyrite±clay alteration assemblages are best developed in the quartz-feldspar porphyry intrusions. It overprints quartz-magnetite stockwork, resulting in a quartz-pyrite stockwork. Locally porphyritic intrusions are reduced to a



mass of clay with rounded quartz crystals and pyrite. The pyrophyllite-dumortierite alteration assemblages that occur in the upper levels of the western end of the pit, apparently overprinting fragmental volcanic rocks and/or breccias (see below), will be the focus of a MSc. thesis by Geraint Mathias at Auckland University.

#### Mineralization and veining

At the Island Copper deposit, multiple episodes of copper introduction are interpreted from crosscutting relations observed in drill core and pit exposures, but require refining by detailed petrography.

- 1. The first introduction was near the end of the period of quartz-magnetite veining (e.g. minor chalcopyrite is found with pyrite in magnetite veins in the Bonanza volcanic rocks, particularly in the east end of the pit, north side.
- 2. The "main-stage" copper introduction involved abundant fine hairline fracture fills and disseminations either accompanying or cutting pervasively biotitized rock – it is not clear which. In places this style of mineralization
- a) Type 2 (2-phase) in quartz vein, showing highly variable vapour/liquid ratios from 10 to 70 per cent in a single cluster (hole E96-711').
- b) Type 3 (3-phase) in quartz-pyrite-chalcopyrite vein, showing vapour bubble, halite crystal, and saline brine (hole E95-387').
- c) Type 4 (multi-phase) in quartz-magnetite vein, showing vapour bubble, transparent and opaque daughter products, and saline brine (sample 88PPit 010, intensely potassic (biotite-K-feldspar-magnetite-chalcopyrite ±pyrite-molybdenite) altered Bonanza volcanic, from unknown location in pit; note several adjacent vapourrich inclusions).
- d) Type 2 (2-phase) in quartz phenocryst from strongly albitequartz-chlorite-magnetite±pyrite-chalcopyrite altered early porphyry (hole E111-367.5'). Note abundant Type 1 (dark, vapour-rich) examples in the field of view.
- e) Type 3 (3-phase with halite cube, to right of altered feldspar crystal) and larger Type 2, in quartz phenocryst from clay-sericite-pyrite altered intermediate porphyry cut by calcite-zeolite veins (hole E138-507').
- f. Abundant Type 4 (multi-phase) inclusions in quartz phenocryst from intensely magnetite-chlorite altered early porphyry cut by calcite-zeolite veins (hole E140-168').

**Figure 4.** Photomicrographs of typical fluid inclusions in quartz from the Island Copper deposit (all in plane polarized light; width of field of view 130  $\mu$ m except 50  $\mu$ m in c).

is accompanied by quartz-pyrite-chalcopyrite veins (±biotite envelopes where they cut volcanics, but not porphyritic intrusive rocks; many of these veins now have sericitic envelopes). This is comparable to the main Cu introduction of Arancibia and Clark (in press).

- 3. Minor epidote-chlorite±pyrite±chalcopyrite veining may represent either minor introduction or possibly remobilization of copper.
- 4. Pyrite-chalcopyrite fractures that cut all other veins (Fig. 3d) also possibly represent minor introduction or remobilization of copper.
- 5. Finally, the minor chalcopyrite present in late calcite-zeolitegilsonite veins in the north wall of the pit, probably is remobilized copper.

There may have also been several episodes of molybdenum mineralization:

- 1. The earliest introduction occurs as disseminations, ribbons and parallel fractures in planar, frequently laminated grey-pink quartz veins. These veins are up to 0.3 m in width and occur in sets trending northwest with steep to vertical dips; they can be traced over 30 m.
- 2. The coarsest molybdenite occurs locally in high grade copper-molybdenum breccias developed in the intermediate porphyry.
- 3. The most economically significant molybdenite occurs on widespread slips that cut the late pyrite-chalcopyrite fractures.

Sphalerite was observed in rare quartz-?calcite veins peripheral to the main mineralization. It has also been noted in thin sphalerite-rich veins cutting intermediate and late porphyries, giving rise to local zones of over 1% Zn (Perelló, 1987).

# Fluid inclusion petrography

A preliminary investigation of fluid inclusions was conducted on 40 thin and polished sections from previous petrographic work done on the Island Copper property. There are at least four types of inclusions present:

- Type 1: One phase or vapour-dominant (no liquid phase visible).
- Type 2: Two-phase aqueous inclusions containing liquid and vapour.
- Type 3: Moderately saline three-phase inclusions containing liquid, vapour and a salt crystal, likely halite.
- Type 4: Highly saline inclusions with multiple daughter products.

Type 1-4 inclusions occur dominantly in vein quartz and in quartz phenocrysts in the porphyries, either isolated or along fracture planes indicating pseudosecondary and secondary origin. No inclusions were observed in recognizable growth zones. Two phase inclusions occur in vein quartz, calcite, K-feldspar and ?zeolite. No temperature or salinity data are available yet for any inclusions. The vapour-rich inclusions (Fig. 4) are difficult to interpret because of their superficial similarity to decrepitated inclusions that are filled with air. They are variable in size, but tend to be large (over 15  $\mu$ m) and have rounded, smooth outlines with vapour to liquid ratios 90% or over. There are no visible daughter minerals. These inclusions could contain variable amounts of carbonic (CO<sub>2</sub>+CH<sub>4</sub>) vapour. Crushing and freezing tests will be necessary to further identify the materials present in these inclusions.

The two phase liquid-vapor inclusions are mainly associated with late quartz, quartz-epidote or chlorite reopenings of main stage quartz veins (Fig. 4a). They are also found in late quartz±calcite±zeolite±K-feldspar veins, or in fractures in quartz phenocrysts in porphyritic intrusive rocks (Fig. 4d). Vapour to liquid ratios are highly variable, from 10 to 90 per cent. These inclusions tend to be small, less than 10  $\mu$ m in maximum dimension, and are rounded to irregular in shape. No consistent variation in degree of filling with location in the deposit has so far been observed.

The three phase inclusions are associated with the intermediate stage quartz±pyrite±chalcopyrite±magnetite veins, locally with potassic (biotite and/or K-feldspar) alteration envelopes. They contain a liquid phase, a vapour bubble, and a halite cube. These inclusions are the most important from the point of view of the mineralization, but are the least abundant in the veins (Fig. 4b). They also occur in quartz phenocrysts in altered quartz-feldspar porphyry (Fig. 4e). They range in size from 3-12  $\mu$ m, and are rounded to irregular in shape; liquid to vapour ratios range from 10-40 per cent.

The highly saline, multiphase inclusions are associated with the early stage quartz-magnetite±actinolite/chlorite ±pyrite±chalcopyrite veins. The inclusions are generally in the 5-15  $\mu$ m size range, with a few up to 30  $\mu$ m. They have smooth to rounded or irregular shapes (Fig. 4c). The inclusions consist of a liquid phase, a vapor phase, a halite cube, and a variable number of other daughter products. Two colourless, platelet-shaped (one hexagonal), highly birefringent minerals are most common. A red, translucent, hexagonal phase (hematite?) and an opaque phase (magnetite or chalcopyrite?) are less frequently seen. Liquid to vapour ratios range from 10 to 30 per cent. Inclusions of this type were also commonly observed in quartz phenocrysts in intensely quartz-magnetite±actinolite altered quartz-feldspar porphyry (Fig. 4f).

The inclusion populations thus far outlined fit well with the commonly observed progression in porphyry deposits from early high-salinity fluids trapped in veins and phenocrysts to late low-salinity fluids trapped in veins with phyllic alteration envelopes (e.g. Reynolds and Beane, 1985). So-called "blue" quartz veins at Island Copper that contain scattered low-salinity fluid inclusions have been attributed to early quartz that has been recrystallized by later fluids but without affecting the vein envelope mineralogy (J.T. Reynolds, pers. comm., 1994).

#### Outline of work plan

<u>Geochronology</u>: Three samples of the quartz-feldspar porphyry, representing the early, intermediate and late phases, have been collected for zircon U-Pb dating. These data will complement the zircon U-Pb dating of rhyolitic and andesitic phases of the Bonanza volcanic rocks currently underway on rocks collected by the BCGSB.

<u>Geochemistry</u>: Approximately 50 samples of the main alteration types in volcanic and porphyry and representative, leastaltered samples of the three porphyry phases have been submitted for whole-rock and trace element analysis.

<u>Isotope geochemistry</u>: Samples of vein and phenocryst quartz and feldspar, plus vein calcite, magnetite, and hydrous minerals (chlorite, actinolite, biotite) will be analyzed for oxygen, deuterium, and carbon isotopas. Analyses of feldspar lead and sulphide sulphur are also planned.

<u>Petrography</u>: A comprehensive suite of samples from the lower levels of the pit and from drill core was collected this year to examine alteration changes in detail. Data will be presented as five cross sections and two long sections.

Fluid inclusion studies: At the time of the preliminary investigation, the hand sample equivalents of the thin sections were not available, therefore the overall relationships of veins and alteration were somewhat ambiguous. However, a well constrained set of samples was collected during this year's fieldwork to continue the fluid inclusion study. Following detailed petrography of these samples, microthermometry will be completed.

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# REFERENCES

Arancibia, O.N. and Clark, A.H.

- 1990: Early magnetite-rich alteration/mineralization in the Island Copper porphyry copper-molybdenum-gold deposit, British Columbia; Geological Association of Canada - Mineralogical Association of Canada, Program with Abstracts, v. 15, p. A4.
- in press: Magnetite-amphibole-plagioclase alteration-mineralization at Island Copper, British Columbia: early hydrothermal processes in a porphyry copper-molybdenum-gold deposit; Economic Geology.
- Cargill, D.G.
- 1975: Geology of the "Island Copper" Mine, Port Hardy, British Columbia; PhD. thesis, University of British Columbia, Vancouver, British Columbia, 133 p.
- Cargill, D.G., Lamb, J., Young, M.J., and Rugg, E.S.

1976: Island Copper; Canadian Institute of Mining and Metallurgy, Special Volume 15, p. 206-218.

Fahey, P.L.

1979: The geology of Island Copper Mine, Vancouver Island, British Columbia; MSc. thesis, University of Washington, Seattle, Washington, 52 p. Fleming, J.A.

1983: Island Copper; Geological Association of Canada. Field Trip Guidebook, p. 21-35.

Leitch, C.H.B.

- 1981: Secondary alkali feldspars in porphyry systems; Canadian Institute of Mining and Metallurgy Bulletin, v. 74. No. 831, p. 83-88.
  Muller, J.E.
- 1977: Evolution of the Pacific margin, Vancouver Island and adjacent regions; Canadian Journal of Earth Sciences, v. 14, p. 2062-2085.
- Nixon, G.T., Hammack, J.L., Koyanagi, V.M, Payie, G.J.,

Panteleyev, A., Massey, N.W.D., Hamilton, J.V., and Haggart, J.W.

1994: Preliminary geology of the Quatsino – Port McNeill map areas, northern Vancouver Island (92L/12,11); in Geological Fieldwork 1993; British Columbia Ministry of Energy, Mines, and Petroleum Resources, Paper 1994-1, p. 63-85.

Northcote, K.E. and Robinson, W.C.

- 1973: Island Copper Mine: in Geology, Exploration and Mining in British Columbia – 1972; British Columbia Department of Mines and Petroleum Resources, p. 293-303.
- Padilla-Garza, R.A.
- 1993: Breccias in Island Copper deposit, Vancouver Island, Canada; unpublished report, BHP Minerals Ltd, 6 p.

Perelló, J.A.

. :

1987: The occurrence of gold at Island copper Mine, Vancouver Island, British Columbia; MSc. thesis (Mineral Exploration), Queen's University, Kingston, Ontario, 85 p.

- Perelló, J.A., Arancibia. O.N., Burt, P.D., Clark, A.H., Clarke, G.A.,
- Fleming, J.A., Himes. M.D., Leitch, C.H.B., and Reeves, A.T.
- 1989: Porphyry Cu-Mo-Au mineralization at Island Copper, Vancouver Island, B.C.: Paper presented at Geological Association of Canada -Mineral Deposits Division Workshop on Porphyry Cu-Au Deposits. Vancouver, B.C. April 1989, 22 p.
- Perelló, J.A., Fleming, J.A., O'Kane, K.P., Burt, P.D., Clarke, G.A.,

Himes, M.D., and Reeves, A.T.

- in press: Porphyry copper-gold-molybdenum mineralization in the Island Copper cluster. Vancouver Island; Canadian Institute of Mining and Metallurgy, Special Volume 44.
- Reynolds, J.T. and Beane, R.E.
- 1985: Evolution of hydrothermal fluid characteristics at the Santa Rita. New Mexico. porphyry copper deposit; Economic Geology, v. 80, p. 1328-1347.

Sillitoe, R.H.

1989: Comments on the Island Copper and associated porphyry copper-gold systems, Vancouver Island, British Columbia, Canada; unpublished report, BHP-Utah International Ltd., 7 p.

1971: Geology and mineralization of the Island Copper deposit; Western Miner, v. 44, No. 2, p. 31-40.

Geological Survey of Canada Project 740098

Young, M.J. and Rugg, E.S.