6000 1904

Mining District File Summary Sheet

DISTRICT	Rosebud
DIST_NO	4010
COUNTY If different from written on document	Pershing
TITLE If not obvious	Petrography and ore microscopy of selected samples from Drill Hole RB-5, July 1989
AUTHOR	Bennett B; Schurer V; Fuchs, W
DATE OF DOC(S)	1989
MULTI_DIST Y / (N?) Additional Dist_Nos:	
QUAD_NAME	Sulphur 7½'
P_M_C_NAME (mine, claim & company names)	Rosebud Mine; Lac Minerals (U.S.A.), Inc. Schurer and Fuchs
COMMODITY If not obvious	gold; silver
NOTES	Petrographic report; geology 34p.

Keep docs at about 250 pages if no oversized maps attached
(for every 1 oversized page (>11x17) with text reduce
the amount of pages by ~25)

SS: DP 9/10/08
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36-3

PETROGRAPHY & ORE MICROSCOPY OF SELECTED SAMPLES FROM DRILL HOLE RE-5

Prepared for: Mr. Robert Bennett
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July 1989

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SAMPLE LIST

RE-5, 190'-195'	(transmitted light only)
RE-5, 265'-270'	" " "
RE-5, 280'-285'	" " "
RE-5, 300'-305'	" " "
RE-5, 335'-340'	" " "
RE-5, 380'-385'	" " "
RE-5, 410'-415'	(combined transmitted & reflected light)
RE-5, 415'-420'	" " " " "
RE-5, 420'-425'	" " " " "
RE-5, 450'	(reflected light only)
RE-5, 485'	" " "
RE-5, 485'-490'	(combined transmitted & reflected light)
RE-5, 505'-510'	" " " " "
RE-5, 530'-535'	(transmitted light only)

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SUMMARY

Fourteen drill samples were submitted for microscopic examination in order to determine the alteration mineralogy, the protolith, and the mode of occurrence of the gold. The samples represent five-foot intervals from depths of 190 to 535 feet in rotary drill hole RE-5. Detailed section descriptions for each sample are provided herein.

Lithology

Altered tuff was observed in the upper levels of the drill hole, in the 190'-195' and the 265'-270' drill intervals. Altered aphanitic volcanic rock was encountered from the 265- to the 535-foot levels. In a few samples, this rock comprises both rock fragments and matrix material of a volcanic breccia. Where less altered, this rock appears to be an intermediate volcanic rock composed of trachytic-textured feldspar (primarily plagioclase), sparse coarser grains and microphenocrysts of clay-altered pyroxene, and occasional plagioclase microphenocrysts.

Alteration Mineralogy

All of the samples have been intensely altered. Quartz/chalcedony and clay are the chief alteration minerals in all samples. Quartz predominates over clay in all but two samples (380'-385' and 885'-490'), where it occurs in amounts either subequal or subordinate to clay. Very subordinate carbonate and chlorite are present only in the deeper samples. Probable secondary K-feldspar (adularia?) occurs at the 530'-535' interval. The trachytic texture of the volcanic protolith is commonly well-preserved in quartz and in clay and is occasionally preserved in carbonate.

Quartz occurs as replacement and as lesser vein material, the latter occasionally forming stockworks or the matrix in breccia-veins. The possibility of hydrothermal brecciation is more apparent in hand specimen than in thin section. Petrographic work on drill core may be required to determine the extent of hydrothermal brecciation. Quartz may also be a devitrification product in some instances.

Clay is generally an alteration product of feldspar, and it also occurs as minor vug-filling in vein quartz. Both smectite and kaolinitic clay may be present. Sparse mafic grains (probable pyroxene) are altered to bright green probable nontronite. X-ray diffraction work will be required to determine the true nature of the clay.

Carbonate (calcite at least in part) forms sparse veinlets (open-space and replacement types) that are sometimes lined with euhedral quartz. In one case, carbonate forms dissem-

inated rhombs enclosed in a clay-chlorite matrix. Chlorite occurs as minor intergrowths in clay, and in one sample it is found along contacts between carbonate and clay. Secondary K-feldspar forms discontinuous microveinlets (± quartz) with poorly defined margins in altered potassium-rich rock.

Alteration Zoning and Paragenesis

Quartz/chalcedony and clay are ubiquitous in the drill hole. Carbonate appears at depths of 380 feet to 535 feet, and its abundance ranges from 1% to 10% (the lowest carbonate abundance occurring at 420'-425'). There is a definite association betweeen carbonate and chlorite, although there is no clear correlation in terms of abundance. Probable secondary K-feldspar is present in the deepest sample (530'-535') and carbonate is still present in significant amounts, but chlorite is very minor. The vertical zonation of alteration in the hole is as follows:

190'-535': Quartz/chalcedony-clay
380'-535': Carbonate-chlorite
530'-535': K-feldspar

The alteration zones clearly overlap. The K-feldspar and carbonate-chlorite may well extend beyond the 535-foot depth in the hole. The secondary K-feldspar may be part of the propylitic assemblage (carbonate-chlorite), but analysis of deeper samples is needed in order to make this determination.

The alteration paragenesis (from oldest to youngest) is interpreted as follows:

1) clay alteration
2) silicification (quartz/chalcedony)
3) possible minor clay formation
4) propylitization (carbonate-chlorite-K-feldspar?)
5) potassic alteration (K-feldspar), unless contemporaneous with stage 4

This sequence, which is based on crosscutting relations and replacement textures, strongly resembles the vertical zonation of alteration in the drill hole.

Ore Mineralogy

Seven samples were examined under reflected light. Sulfides occur as disseminated grains and in veins with calcite and quartz. The opaque mineral content ranges from 1% to slightly more than 6%. Pyrite is always the primary opaque mineral. Marcasite and anatase typically occur in subordinate amounts, and minor to trace amounts of sphalerite and galena are usually present. Very minor arsenopyrite, chalcopyrite, and pyrrhotite are found in some of the samples.

Trace amounts of argentite, proustite-pyrargyrite, unidentified sulfosalts, and electrum are occasionally present. Tetrahedrite-tennantite, stibnite, and native silver may occur as well. Goethite was found in only one section. Table 1 contains the chemical formulas for the ore minerals present.

Pyrite commonly forms disseminated cubes and pyritohedrons and lesser vein material with quartz or calcite. Marcasite is usually intimately intermixed with pyrite. Anatase occurs as disseminated grains but is also found in quartz veins. The other sulfides are often associated with pyrite. Reflected light work on drill core would be required to establish the paragenesis of the ore minerals.

Gold

Gold assays for the samples examined under reflected light range from 0.130 to 0.622 opt Au. Four grains of electrum were found in three samples. Their size and mode of occurrence are as follows:

1) 6-micron electrum grain in pyrite
2) 6-micron electrum grain enclosed in marcasite that is intergrown with pyrite within a quartz-lined calcite vein
3) 5x18-micron electrum grain in quartz-clay
4) 3x10-micron grain of electrum (or silver?) in proustite-pyrargyrite

The electrum observed does not account for the high gold assays. No gold or electrum was found in the samples with the highest gold grades. At this point we can offer no firm explanation for this discrepancy.

Silver

Silver grades for the samples examined range from 5.25 to 13.11 opt Ag. As in the case of gold, the potential silver carriers found in these sections do not appear to account for the high silver assays. Argentite, proustite-pyrargyrite, and electrum/native silver are the obvious silver minerals encountered. Galena may be a very significant silver carrier. Tetrahedrite-tennantite and other unidentified sulfosalts could also account for some of the silver.

Table 1. List of Ore Minerals & Formulas

Anatase	TiO_2
Argentite	Ag_2S
Arsenopyrite	FeAsS
Chalcopyrite	$CuFeS_2$
Electrum	Ag,Au
Galena	PbS
Goethite	FeO(OH)
Marcasite	FeS_2
Native Silver	Ag
Naumannite	Ag_2Se
Proustite-Pyrargyrite	Ag_3AsS_3-Ag_3SbS_3
Pyrite	FeS_2
Pyrrhotite	$Fe_{1-x}S$
Sphalerite	(Zn,Fe)S
Stibnite	Sb_2S_3
Tetrahedrite-Tennantite	$(Cu,Fe)_{12}(Sb,As)_4S_{13}$

SECTION DESCRIPTIONS

RE-5, 190'-195' **Thin Section Description**

Rock Classification: Altered Tuff

Hand Specimen: Drill chips

Assay: 0.004 opt Au

Thin Section (half K-stained):

Chalcedonic/Felsitic Material: 50%; generally micro- to cryptocrystalline; frequently filmy or clouded; occasional crude banding; local quartz phenocrysts and fragments, rounded-embayed and angular, grain size = 0.4-1.4 mm (long dimension); may be a product of both devitrification and silicification

Clay: Roughly 30% (difficult to estimate); probably largely smectite and minor bright blue-green nontronite; generally very fine-grained; occurs as alteration (to varying degrees) of groundmass/matrix and lath-shaped or rectangular (probable feldspar) microphenocrysts, and found intergrown with vein quartz; rare vug- or vesicle-filling in silicified fragments; nontronite occurs as intergrowths with quartz

Secondary Quartz: 15%; occurs as light brown, filmy replacement (colorless elsewhere); also as veinlets and local stockwork veinlets in clay-altered rock; forms local matrix enclosing clay-altered fragments and (probable) phenocrysts; also as sparse silicified lath-shaped (probable feldspar) phenocrysts and fragments in clay-altered rock; rare pressure shadows on opaque grains; common grain size range = 0.06-0.36 mm (long dimension)

Sericite: <0.25%; probable altered biotite microphenocrysts; sparse microveinlets

Rutile: <0.25% overall; acicular-prismatic; local inclusions in quartz

Opaques (mainly Pyrite): 3-4%; cubic habit; disseminated; typical grain dia. = 40-160 microns, maximum size = 3.8 mm (long dimension)

Summary

The sample is a tuff that has been partly altered to clay (probable smectite and minor nontronite) and quartz. Quartz veining postdates clay alteration. The micro- to cryptocrys-

talline chalcedonic material that constitutes most of the sample is probably a product of both devitrification and silica replacement. Pyrite forms sparse disseminated cubes.

Petrographer: Victoria Schurer

RE-5, 265'-270' **Thin Section Description**

Rock Classification: Altered Volcanic Rock & Tuff

Hand Specimen: Drill chips

Assay: 0.006 opt Au

Thin Section (half K-stained):

Chalcedonic Material: 40-45%; cryptocrystalline; intergrown with clay; secondary

Secondary Quartz + Chalcedony: 30-40%, difficult to estimate; replacement quartz frequently clouded by clay inclusions and locally displaying relict trachytic texture; also as colorless, clear vein material (and occasional feeder veinlets in silicified rock); sparse silicified microphenocrysts and fragments; common size range of coarser grained quartz = 60 microns to 0.4 mm (long dimension)

Clay: 15-20% (difficult to estimate); local relict feldspar laths in groundmass and relict microphenocrysts; local relict trachytic texture; forms occasional microveinlets; sometimes potassium-bearing; typical length of relict laths in groundmass = 50-125 microns; smectite forms local intergrowths with cryptocrystalline felsitic material; minor probable nontronite intergrown with quartz in quartz patches

Leucoxene/Anatase: $\leq$1% (difficult to estimate), variable distribution; very fine-grained; occurs as local disseminations

Apatite: <0.5%; elongate-prismatic; locally abundant in altered host rock; typical grain length = 25-100 microns, maximum length = 200 microns

Light Green Clay/Sericite: $\leq$0.25%; altered mafic grains; light green to colorless; potassium-bearing; pseudo-uniaxial(-) interference figure, $2V \geq 0^{o}$

Quartz Crystal Fragments: Trace; subhedral and angular; two fragments found in clay-altered matrix

Jarosite: Trace; local granular aggregates

Cryptocrystalline Material: Trace; local open-space filling in quartz veinlet; very low birefringence (< quartz); higher relief than quartz; refractive index greater than quartz; possible kaolinitic clay

Opaques (mainly Pyrite): 3-3.5%; cubic and lesser pseudo-hexagonal forms; occurs as massive aggregates and liberated chips, and sporadic disseminated cubes; grain dia. (individual cubes) $\leq$100 microns

Summary

The sample consists of volcanic and probable tuff fragments that have been silicified (quartz/chalcedony) and clay-altered. Opaques (mainly pyrite) form patchy aggregates and disseminated cubes.

Petrographer: Victoria Schurer

RE-5, 280'-285' **Thin Section Description**

Rock Classification: Altered Intermediate Volcanic

Hand Specimen: Drill chips

Assay: 0.009 opt Au

Thin Section (half K-stained):

Felsitic Material: 52-57%(?); micro- to cryptocrystalline; may include devitrified glass and hydrothermal silica

Secondary Quartz + Chalcedony: 30-40% (difficult to estimate); crypto- to microcrystalline; vein and replacement material; occasional banded veinlets; occasional veinlets crosscutting clay-altered volcanic rock

Clay: 5-10%(?), difficult to estimate, variable distribution; occurs as alteration of groundmass (including feldspar); occasionally fills quartz-lined vesicles or vugs; locally in vesicles without quartz; altered biotite? microphenocrysts

Leucoxene: <0.5%; anhedral, granular; minute disseminated grains

Plagioclase: 0.25-0.5% overall; localized; abundant in two drill chips; displays simple and multiple twinning; typical grain length = 50-100 microns, maximum length = 150 microns

Opaques (includes Pyrite): 1.5%; mainly cubic habit and minor hexagonal and bladed forms; disseminated grains and aggregates

Summary

The rock is a trachytic-textured intermediate volcanic that has been largely silicified and argillized. Less altered chips consist of partly argillized plagioclase in a devitrified/altered matrix of felsitic material and minor clay. Disseminated opaque grains and aggregates consist of pyrite at least in part.

Petrographer: Victoria Schurer

RE-5, 300'-305' **Thin Section Description**

Rock Classification: Altered Volcanic Rock

Hand Specimen: Drill chips

Assay: 0.004 opt Au

Thin Section (half K-stained):

Felsite + Clay: 92%; felsite > clay

Felsitic Groundmass: Consists predominantly of (polygonal) quartz which formed by replacement of volcanic rock; often deeply clouded by abundant remanent inclusions

Clay: Occurs in highly altered volcanic material and in sparse chips comprised entirely of clay; alteration of groundmass with relict trachytic texture; forms relict (feldspar) laths comprising groundmass and phenocrysts, also some leached laths; includes sparse kaolinitic clay in altered feldspar; typical grain length of relict groundmass laths = 25-60 microns, typical length of relict microphenocrysts = 0.4-0.6 mm

Vein Quartz: 3%; forms microveinlets and relict (feldspar) microphenocrysts

Green Smectite/Nontronite(?): 0.5-1%; forms relict euhedral-prismatic and subequant phenocrysts and grains (pyroxene and possibly olivine); occasional microveinlets; typical length of relict grains = 100-150 microns, typical size of coarser grains and microphenocrysts = 0.24-0.4 mm (long dimension)

Leucoxene: <1%

Apatite: <0.5%, sporadic distribution; prismatic; typical grain length = 25-100 microns, maximum length = 110 microns

Opaques (mainly Pyrite): 3%; disseminated cubes and local disseminated aggregates; also as bladed grains in altered lath-shaped phenocrysts containing quartz; common grain dia. range (individual grains) = 0.08-0.32 mm

(continued)

Summary

The sample consists of silicified and argillized volcanic rock containing clay-altered (feldspar) groundmass laths and microphenocrysts. Sparse euhedral grains and microphenocrysts of pyroxene have been altered to nontronite. Relict trachytic texture is sometimes present in the altered groundmass. Alteration in individual drill chips is usually either clay- or quartz-dominant. Quartz microveinlets and lesser clay microveinlets are sparse. Disseminated pyrite is locally abundant.

Petrographer: Victoria Schurer

RE-5, 335'-340' **Thin Section Description**

Rock Classification: Altered Volcanic Rock

Hand Specimen: Drill chips

Assay: 0.004 opt Au

Thin Section (half K-stained):

Chalcedony: 76-81%; microcrystalline; polygonal-mosaic texture with subordinate to minor intergrown smectite; usually with relict (feldspar) laths and occasionally with clay-altered feldspar laths; one drill chip displays relict spherulitic texture; may include devitrified glass; sometimes crosscut by quartz/chalcedony microveinlets; typical grain size = 10-25 microns (long dimension), typical length of relict laths = 50-100 microns

Clay/Smectite: 7-12%(?), difficult to estimate; irregular distribution; abundant or dominant (and vuggy) in some chalcedonic chips; also in vugs in vein quartz and in quartz-lined vesicles; light to dark brown

Secondary Quartz:

Vein Quartz: 4-5%; sometimes vuggy; later clay or opaques sometimes fill vugs; variable grain size, maximum size = 0.32 mm (long dimension)

Replacement Quartz: 4-5%; replacement of volcanic rock, sometimes with relict trachytic texture; typical clouded, murky appearance; typical grain size = 50-100 microns (long dimension)

Nontronite: <0.25%; sparse altered mafic (prismatic) microphenocrysts and groundmass grains; bright green color; second-order interference colors

Apatite: <0.25%; prismatic

Opaques (includes Pyrite): 2.5%; sparse coarser bladed aggregates with vein quartz, and local finer grained disseminated cubes

Summary

The sample consists of very fine-grained volcanic rock that has been silicified and to a lesser extent clay-altered. Clay alteration probably preceded silicification. It is not clear

whether quartz veining was contemporaneous with or younger than replacement quartz-chalcedony. Vugs in vein quartz are sometimes filled with clay or with opaques. Relict laths and relict trachytic and local spherulitic textures are indicative of a volcanic protolith. Opaque constituents (including pyrite) are present in significant amounts (2.5%).

Petrographer: Victoria Schurer

RE-5, 380'-385' **Thin Section Description**

Rock Classification: Altered Volcanic Breccia

Hand Specimen: Drill chips

Assay: 0.089 opt Au

Thin Section (half K-stained):

Chalcedonic Material + Clay: 84%; the two constituents are present in subequal amounts overall but occur in locally variable proportions

Quartz/Chalcedony: Polygonal-mosaic texture; with intergrown clay (altered feldspar and altered glass); replacement of volcanic rock and possible devitrification product; typical grain dia. = 25-micron range

Clay: Probably largely smectite; very fine-grained alteration of feldspar and minor alteration of volcanic glass?; also as alteration of trachytic-textured volcanic rock and of matrix in volcanic breccia; forms sparse fracture-veinlets and intergrowths with vein quartz

Secondary Quartz:

Replacement Quartz: 4%; clouded by inclusions; irregular sutured grain boundaries; common grain size range = 0.04-0.2 mm (long dimension)

Vein Quartz: 2.5-3%; forms microveinlets ± clay; also forms local stockwork veinlets within matrix of volcanic breccia; local breccia-veinlets contain fragments of host rock; rare silicified lath-shaped microphenocryst

Carbonate: 4.5-5%; local veinlets (replacement and open-space filling) in host rock; coats drusy quartz in one instance; sometimes intergrown with opaques

Nontronite/Smectite: <0.25%, localized; minor in clay-altered rock; also as sparse very small patches in replacement quartz; potassium-bearing; light green color

Apatite: Trace; prismatic

Plagioclase: Possible trace; local in clay-altered volcanic rock; typical grain length = 50-100 microns

(continued)

Opaques (includes Pyrite): 4%; mainly cubic and occasional pseudo-hexagonal habits, and locally bladed forms; disseminated grains and sparse massive patches and aggregates (including bladed marcasite? aggregates); typical dia. of cubic grains = 80-200 microns, typical length of bladed forms = 0.4-0.6 mm

Summary

The sample consists of silicified and argillically altered volcanic breccia. Some drill chips contain altered trachytic-textured fragments in a subordinate matrix of similar material. Some of the quartz-chalcedony may be a product of devitrification, and a minor amount of clay may be an alteration product of volcanic glass. However, most of the clay formed by alteration of feldspar. Quartz and carbonate veinlets occur sporadically. Disseminated opaques (including pyrite) are sometimes associated with carbonate.

Petrographer: Victoria Schurer

RE-5, 410'-415' **Polished Thin Section Description**

Rock Classification: Silicified (and locally brecciated) Volcanic Breccia

Hand Specimen: Drill chips

Assays: 0.130 opt Au, 8.15 opt Ag

Transparent Minerals:

Secondary Quartz: 88% (includes 5% vein quartz); hydrothermal origin (both replacement and vein); silicified rock contains remanent clay-altered feldspar laths and relict fragmental texture of protolith; relict banding in coarser grained quartz of one drill chip; vein quartz forms local breccia matrix; large grain size range: grain size of finer grained replacement quartz $\leq$25 microns (long dimension), typical size range of coarser grained quartz = 25-200 microns

Clay: 5%(?), difficult to estimate; alteration product of feldspar; also found in local vugs in vein quartz; generally very fine-grained

Jarosite: <0.25%; small local patches or granular aggregates

Iron Oxide: <0.25%; minor local staining of quartz

Opaque Minerals:

Pyrite (FeS_2): 5% (3% disseminated grains and 2% massive fragments); euhedral, disseminated, in gangue; pyritohedrons and cubes with pyrite cores and pyrite overgrowths; also massive anhedral grains; some gangue inclusions in larger pyrite grains; minor pyrite in some quartz veins; grain size:
maximum = 300 microns
typical = 25-200 microns

Marcasite (FeS_2): 0.5%; intimately intermixed with pyrite in a veinlet

Anatase (TiO_2): 0.1-0.2%; typical grain size = 2-10 microns; disseminated in gangue, occasionally enclosed in pyrite; also common as larger grains in quartz veins

Sphalerite ((Zn,Fe)S): Minor; inclusions up to 30 microns in size in pyrite-marcasite grain

(continued)

Proustite (Ag_3AsS_3)-Pyrargyrite (Ag_3SbS_3): Minor; attached to another sulfosalt; one 100-micron anhedral grain in gangue (crushed, brecciated material) that encloses small blebs of chalcopyrite $\leq$10 microns in size and a 3x10-micron grain of silver-rich electrum or silver; more grains of proustite-pyrargyrite nearby, one of which also contains another phase with no internal reflections; one 200-micron grain of proustite-pyrargyrite and 20% other sulfosalts; anhedral material associated with pyrite and chalcopyrite; blue-white with strong deep-red internal reflections and strong anisotropy; Vickers hardness (15 gm load) = 62.5, 80.4 (two readings); needs microprobe work

Chalcopyrite ($CuFeS_2$): Minor; anhedral grains associated with stibnite? and tetrahedrite-tennantite?

Electrum (Ag,Au) or Silver (Ag): One 3x10-micron grain enclosed in proustite-pyrargyrite; one 6-micron grain in pyrite with argentite? nearby; both grains are more likely to be electrum than silver

Arsenopyrite? (FeAsS): Rare; possible grains up to 20 microns in size in pyrite in one drill chip

Stibnite? (Sb_2S_3): Rare possible grains associated with chalcopyrite and possible tetrahedrite-tennantite

Tetrahedrite-Tennantite? ($(Cu,Fe)_{12}(Sb,As)_4S_{13}$): Rare possible grains associated with possible stibnite and chalcopyrite; needs microprobe confirmation

Unknown Sulfosalt: Rare; attached to proustite-pyrargyrite and darker sulfosalt; very light gray color with slight brown tint and weak anisotropy; Vickers hardness (15 gm load) = 117, 88.8; needs microprobe work

Unknown 1: Rare; with proustite-pyrargyrite; needs microprobe work

Tan-Gray Sulfosalt: Rare; with unknown sulfosalt?; needs microprobe work

(continued)

Summary

The sample consists of a volcanic breccia that has been largely silicified and to a lesser degree argillized. Relict fragmental and trachytic textures are well-preserved. Quartz occurs as replacment and vein material, and it forms the matrix in locally brecciated host rock. Minor clay fills vugs in vein quartz.

Opaque minerals, which constitute about 6% of the sample, consist largely of pyrite along with subordinate marcasite and anatase. Minor to trace amounts of sphalerite, proustite-pyrargyrite, chalcopyrite, unknown sulfosalts, and possibly arsenopyrite, stibnite, and tetrahedrite-tennantite are also present. A 6-micron grain of electrum was found in pyrite with nearby argentite?, and a 3x10-micron grain of electrum (or native silver?) was found enclosed in proustite-pyrargyrite.

Microscopists: William A. Fuchs
Victoria Schurer

RE-5, 415'-420' **Polished Thin Section Description**

Rock Classification: Silicified Volcanic Rock

Hand Specimen: Drill chips

Assays: 0.404 opt Au, 7.92 opt Ag

Transparent Minerals:

Secondary Quartz/Chalcedony:

Replacement Quartz: 69-74%; relict trachytic texture; clouded by inclusions

Vein Quartz: 7%; includes a local breccia-vein

Chalcedony: 1.5-2%; cryptocrystalline

Clay: 7-12% (difficult to estimate); sometimes intergrown with quartz and occasionally coats drusy vein quartz; occasional massive alteration (of feldspar)

Carbonate: 3%; in vug in vein quartz; minor vug-like intergrowths with quartz elsewhere

Volcanic Fragments: <1%; less altered trachytic-textured remnants; composed of plagioclase and minor quartz and clay; typical length of feldspar grains = 25-50 microns

Opaque Minerals:

Pyrite (FeS_2): 5% overall (3% disseminated grains, 2% larger aggregates); anhedral to euhedral (cubes and pyritohedrons); occasional pyritohedral overgrowths on cubic cores; contains abundant gangue inclusions; grain size: maximum = 600 microns
typical = 20-250 microns

Marcasite (FeS_2): 1%; intimately intermixed with pyrite, typical grain size = 5-20 microns; occasional pure grains up to 50 microns in size (in which case marcasite tends to form tabular crust-like aggregates)

Anatase (TiO_2): 0.1%; anhedral to euhedral; disseminated in wall rock and in quartz veins; grain size:

maximum = 50 microns
typical = 2-20 microns

(continued)

Sphalerite ((Zn,Fe)S): Minor (but considerably more abundant than galena); associated with pyrite/marcasite in veinlets; grain size ≤80 microns; light brown internal reflections; Vickers hardness (15 gm load) = 180

Galena (PbS): Minor; associated with sphalerite in pyrite; grain size ≤36 microns; probable silver carrier

Argentite? (Ag_2S): One possible rounded 24-micron grain attached to pyrite

Note: No gold was observed

Summary

The sample consists of trachytic-textured volcanic rock that has undergone silicification and subordinate clay alteration. Carbonate and clay are sometimes associated with vein quartz. Sparse mildly altered volcanic material consisting largely of very fine-grained aligned plagioclase indicates a protolith of intermediate composition.

Major pyrite, subordinate marcasite, and minor anatase, sphalerite, and galena together comprise about 7% of the sample in the section. Marcasite is usually intergrown with pyrite. One 24-micron grain of possible argentite was found attached to pyrite. No gold was found in spite of the relatively high gold assay.

Microscopists: William A. Fuchs
Victoria Schurer

RE-5, 420'-425' **Polished Thin Section Description**

Rock Classification: Altered/Brecciated Volcanic Rock & Volcanic Breccia(?)

Hand Specimen: Drill chips

Assays: 0.622 opt Au, 13.11 opt Ag

Transparent Minerals:

Secondary Quartz:

Replacement Quartz: 58-61%; relict trachytic texture; sutured grain boundaries

Vein Quartz: 12%; local stockwork veining; forms a breccia matrix in places; chalcedony in one microveinlet; some quartz microveinlets are clearly feeders for replacement quartz

Clay: 15-20%, difficult to estimate; variable distribution; alteration of feldspar; predominant constituent in several drill chips; forms breccia matrix ± chlorite in places; occasional microveinlet

Remanent Volcanic Material: <5%(?), difficult to estimate; trachytic-textured; composed mainly of plagioclase(?) with minor clay alteration

Carbonate: 1%; minor overall; local in quartz veinlet, where it has been largely leached or plucked out; intergrown with sulfide and clay in one drill chip

Chlorite: <1%; sporadic occurrence; locally intermixed with clay; also with clay in local stockwork veining; slight brownish color

Iron Oxide: <0.25%; local

Opaque Minerals:

Pyrite (FeS_2): 4%; anhedral to euhedral (cubes and uncommon pyritohedrons); disseminated grains and occasionally more massive fragments; sometimes in veinlets; grain size: maximum = 325 microns
typical = 20-150 microns

Marcasite (FeS_2): 0.5%; generally intermixed with pyrite; occasional individual grains

(continued)

Anatase (TiO_2): 0.1-0.2%; disseminated in wall rock and occasionally forms clusters; maximum grain size = 60 microns

Sphalerite ((Zn,Fe)S): Minor; three grains found in or attached to pyrite, or in pyrite and gangue; grain sizes = 32, 50, and 70 microns

Galena (PbS): Minor; group of inclusions up to 6 microns in size in one large pyrite fragment; occasional small grains elsewhere in pyrite, associated with nearby argentite? inclusions

Goethite (FeO(OH)): Minor; found in one chip; oxidation product of pyrite

Pyrrhotite ($Fe_{1-x}S$): Rare; grains in pyrite; grain size $\leq$5 microns

Argentite? (Ag_2S): Minor possible elongate inclusions up to 3x16 microns in size near galena inclusions in pyrite; needs microprobe confirmation

Native Silver? (Ag): One possible 6-micron grain in quartz; poor polish; needs microprobe confirmation

Note: No gold was found

Summary

The sample consists of volcanic rock and probable volcanic breccia material that has been variably (mildly to intensely) silicified and argillized. Quartz and clay alternately form the matrix in altered brecciated volcanic material. Minor chlorite is sometimes associated with the clay. The relict texture in altered rock reflects the trachytic texture of the less altered volcanic rock. Minor carbonate vein material is also present. One drill chip with minor to moderate silicification displays original fragmental texture of probable volcanic breccia.

The 5% opaques in the section include major pyrite, subordinate marcasite, and minor to trace amounts of anatase, sphalerite, galena, goethite, pyrrhotite, and possible native silver and argentite. No gold was found despite the relatively high gold assay.

Microscopists: William A. Fuchs
Victoria Schurer

RE-5, 450'-A **Polished Section Description**

Hand Specimen: Large chip from drill cuttings

Assays: 0.260 opt Au, 3.13 opt Ag (445'-450' drill interval);
0.298 opt Au, 4.34 opt Ag (450'-455' drill interval)

Opaque Mineralogy (one of two polished thin sections):

Pyrite (FeS_2): 2%; anhedral to euhedral (cubes); contains moderate gangue inclusions; disseminated grains and as larger masses in veinlets; grain size:

maximum (in aggregate) = 600 microns
typical (disseminated) = 10-150 microns

Marcasite (FeS_2): 0.5%; mixed with pyrite and as pure grains

Anatase (TiO_2): 0.1%; disseminated in gangue, grain size $\leq$52 microns; two subhedral grains (up to 116 microns in size) in quartz vein appear to have been deposited from hydrothermal solutions; Vickers hardness (15 gm load) = 712

Galena (PbS): Minor; occasional small inclusions (up to 18 microns in size) in pyrite/marcasite mixture; has anomalous slight anisotropy

Pyrrhotite ($Fe_{1-x}S$): Minor; small inclusions in pyrite; grain size $\leq$7 microns

Arsenopyrite? (FeAsS): Minor; some possible grains in pyrite

Electrum (Au,Ag): One poorly polished, irregularly shaped 6-micron grain in marcasite within large pyrite/ marcasite mass, not far from a grain of galena; gold and pyrite/marcasite occur in a calcite-dominant vein lined with euhedral quartz

Summary

The sample contains about 3% opaque minerals consisting of major pyrite, subordinate marcasite and anatase, and minor galena, pyrrhotite, and possible arsenopyrite. Most of the marcasite is intermixed with pyrite.

(continued)

One 6-micron electrum grain was found enclosed in marcasite (with nearby pyrite and galena) within a quartz-lined calcite vein. The observed electrum does not account for the gold assays of 0.2-0.3 opt Au.

Microscopist: William A. Fuchs

RE-5, 485' **Polished Section Description**

Hand Specimen: Large chip from drill cuttings

Assays: 0.487 opt Au, 9.34 opt Ag (485'-490' drill interval)

Opaque Mineralogy (polished thin section):

Pyrite (FeS_2): 1.5%; anhedral to euhedral (cubes and less common pyritohedrons); disseminated in wall rock and in larger masses in calcite-dominant veinlets containing pyrite/marcasite and quartz; grain size: maximum = 165
typical = 10-100 microns (disseminated)

Marcasite (FeS_2): 0.5%; mixed with pyrite and occasionally as pure grains

Anatase (TiO_2): 0.3%; disseminated in wall rock

Sphalerite ((Zn,Fe)S): Minor (more common than galena); anhedral; grains ($\leq$132 microns in size) in pyrite; occasionally attached to chalcopyrite; some grains unattached to other sulfides; brown and orange-brown internal reflections

Galena (PbS): Minor; anhedral grains in pyrite/marcasite; grain size $\leq$11 microns

Arsenopyrite (FeAsS): Minor; small rhombic prisms in pyrite/marcasite mixture

Chalcopyrite ($CuFeS_2$): Rare; 24- and 16-micron grains attached to sphalerite and pyrite

Electrum (Ag,Au): One 5x18-micron grain in crushed quartz-clay

Summary

Opaque minerals constitute about 2% of the sample in the section, and they include major pyrite, subordinate marcasite and anatase, and minor sphalerite, arsenopyrite, and galena. A trace of chalcopyrite is also present. Marcasite, arsenopyrite, galena, sphalerite, and chalcopyrite are all usually associated with pyrite. The one 5x18-micron grain of electrum found in gangue does not account for the relatively high gold assay of the drill interval.

Microscopist: William A. Fuchs

RE-5, 485'-490' **Polished Thin Section Description**

Rock Classification: Altered Volcanic Rock & Volcanic Breccia

Hand Specimen: Drill chips

Assays: 0.487 opt Au, 9.34 opt Ag

Transparent Minerals:

Clay + Chlorite: 68%; clay > chlorite (<20% chlorite); alteration of feldspar; relict laths and relict trachytic texture; chlorite is variably distributed and is intermixed with clay (from which it appears to be derived)

Quartz + Chalcedony: 23% (including 3-4% chalcedony); replacement-vein material; forms veinlets, stockwork veining, and local breccia-veinlets; occasional quartz-lined veinlets filled with carbonate

Carbonate: 5%; anhedral; in veinlets, including local stockwork-like replacement veinlets; veinlets often lined with drusy quartz

Kaolinitic Clay?: Trace; in vug in vein quartz; colorless, with very low birefringence

Opaque Minerals:

Pyrite (FeS_2): 2%; anhedral to euhedral (mainly as cubes); disseminated and occasionally in veinlets; grain size: maximum = 150 microns
typical = 15-75 microns

Marcasite (FeS_2): 0.5%; generally mixed with pyrite; occasional pure grains

Anatase (TiO_2): 0.5-0.75%; disseminated; grain size $\leq$60 microns

Galena (PbS): Minor; occasional inclusions in pyrite; grain size $\leq$11 microns

Arsenopyrite (FeAsS): Minor; one 14-micron grain (rhomb) attached to pyrite; lone grains up to 20 microns in size (in gangue) in several chips

Sphalerite ((Zn,Fe)S): Rare; one 56-micron grain; red-brown internal reflections

Note: No gold was found

(continued)

Summary

The sample consists of trachytic-textured volcanic rock and volcanic breccia that have been extensively clay-altered, silicified, and to a lesser extent propylitized (chlorite-carbonate). Clay predominates over hydrothermal quartz/chalcedony. Carbonate fills quartz-lined veinlets and therefore postdates silicification. Chlorite content appears to increase with carbonate content, particularly in the lower levels of the drill hole, suggesting contemporaneous formation of the two phases.

Major pyrite, subordinate anatase and marcasite, minor galena and arsenopyrite, and a trace of sphalerite are the opaque constituents, which comprise about 3% of the sample in the section. No gold was found in spite of the relatively high gold assay for the drill interval.

Microscopists: William A. Fuchs
Victoria Schurer

RE-5, 505'-510' **Polished Thin Section Description**

Rock Classification: Altered Volcanic Rock

Hand Specimen: Drill chips

Assays: 0.335 opt Au, 5.25 opt Ag

Transparent Minerals:

Secondary Quartz: 52-57% (includes about 2.5-3% vein quartz); replacement-vein material with relict trachytic texture; typically clouded by inclusions; local chalcedonic microveinlet and replacement in one drill chip; grain size commonly $\leq$0.4 mm (long dimension)

Clay-Chlorite: 30-35%; alteration of volcanic host and as local microveinlets; rare relict lath-shaped microphenocrysts; clay often dark brown and semi-opaque; clay appears to be altering to light green chlorite, particularly along carbonate-clay margins (including carbonate vein margins)

Carbonate: 9-10%; anhedral vein material often with associated clay-chlorite; carbonate veinlets cross-cut silicified volcanic rock and form local stock-work in brecciated silicified rock; also forms rhombs enclosed in clay-chlorite matrix in one chip; local vein material in (formerly open-space) cores of quartz veinlets

Plagioclase?: 0.5%; possible remanent laths in one clay-altered chip; typical grain length = 25-50 microns

Opaque Minerals:

Pyrite (FeS_2): 1.5%; anhedral to euhedral (cubes and pyritohedrons), most commonly euhedral; contains abundant gangue inclusions; forms disseminated grains; grain size: maximum = 410 microns
typical = 10-100 microns

Anatase (TiO_2): 0.75%; disseminated in gangue; maximum grain size = 56 microns

Arsenopyrite (FeAsS): Minor; forms occasional rhombic prisms in gangue and attached to pyrite/marcasite; grain size: maximum = 102 microns
typical < 40 microns

(continued)

Marcasite (FeS_2): Minor; occasionally found mixed with pyrite

Sphalerite? ((Zn,Fe)S): Minor; found in gangue or attached to chalcopyrite; grain sizes = 40, 72, and 102 microns; Vickers hardness (15 gm load) = 149, 94 (the latter somewhat low for sphalerite)

Unknown Sulfosalt: Minor; numerous inclusions in a moderate-sized euhedral pyrite grain; grain size $\leq$10 microns; gray-white color, anisotropic; Reflectance$_{546}$ = 29.4%; possible silver carrier; needs microprobe work

Chalcopyrite ($CuFeS_2$): Rare; several grains attached to sphalerite; grain size $\leq$6 microns

Note: No gold was found

Summary

The sample is comprised of volcanic rock that has been silicified, argillized, and propylitized. Clay in places is partly altered to chlorite, particularly along carbonate-clay contacts. Carbonate veinlets postdate silicification. Relict trachytic texture is common in silicified and argillized rock. The alteration paragenesis is interpreted as follows:

1) clay alteration
2) silicification (quartz + minor chalcedony)
3) propylitization (carbonate-chlorite)

The opaque mineral content is less than 2.5%. Pyrite, subordinate anatase, minor arsenopyrite, marcasite, sphalerite, and an unknown sulfosalt, and traces of chalcopyrite were observed. No gold was found despite the relatively high gold assay for the drill interval.

Microscopists: William A. Fuchs
Victoria Schurer

RE-5, 530'-535' **Thin Section Description**

Rock Classification: Altered Volcanic Rock

Hand Specimen: Drill chips

Assays: Not available

Transparent Minerals:

Felsitic Material: 70-72%; includes probable secondary K-feldspar, which is dominant in some drill chips; clouded by incipient clay alteration; contains sparse discontinuous microveinlets of K-feldspar (± quartz) with ill-defined boundaries or margins

Secondary Quartz: 14%; small, irregularly disseminated patches in felsitic material; relict trachytic texture in replacement quartz (often filmy or murky appearance); local veinlets

Carbonate: 6.5-7%; occurs mainly as liberated fragments (monomineralic drill chips); relict laths (replacement texture) adjacent to carbonate vein found in one drill chip; occasional alteration of plagioclase; sparse veinlets crosscutting silicified and argillized rock

Clay: 3-5%? (difficult to estimate); mainly smectite, minor bright green nontronite, and local possible sericite; occurs as alteration and local veining; predominant in some chips; rarely as clay fragments in a chalcedonic matrix; sometimes has a brown murky appearance; may be interstratified with chlorite in places; sparse relict prismatic grains (altered pyroxene); sometimes potassium-bearing

Plagioclase: ≤1% overall; euhedral to subhedral (possibly partly resorbed); sparse microphenocrysts and coarser groundmass grains

Chlorite: <1%, minor, sporadic; locally in carbonate veinlet and along margin of carbonate veinlet; rare microveinlet; dull olive-green to light green-brown color

Leucoxene: 0.25-0.5%; very fine-grained; anhedral; disseminated; semi-opaque

Apatite: Trace; prismatic

Clinozoisite/Zoisite: Trace; anhedral to subhedral

(continued)

Kaolinitic Clay?: Trace; cryptocrystalline; local veinlet and rare vug-filling in vein quartz; moderately high relief (> quartz); colorless

Opaques: 1%; usually cubic; disseminated

Summary

The sample contains two types of altered volcanic material: 1) felsitic volcanic rock with probable secondary K-feldspar and sparse plagioclase and clay-altered mafic grains (probable altered pyroxene), and 2) subordinate very fine-grained, argillized, trachytic-textured volcanic rock. The first type of altered rock contains secondary quartz and quartz veinlets, smectite, and minor chlorite and vein carbonate. Potassic alteration is suggested by the presence of sparse discontinuous K-feldspar-rich stringers and locally strong K-staining. Minor carbonate veinlets in silicified and argillized rock formed during a late-stage event. The second type of altered rock has been largely clay-altered, although some degree of replacement by carbonate and quartz has also occurred.

Petrographer: Victoria Schurer