British Columbia Geological Survey
Geological Fieldwork 1991

ADVANCED ARGILLIC ALTERATION AT TREATY GLACIER, NORTHWESTERN BRITISH COLUMBIA (104B/9)

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KEYWORDS: Economic Geology, Iskut, Treaty Glacier, Hazelton, advanced argillic, alunite, sulphur.

INTRODUCTION

Treaty Glacier is located in northwestern British Columbia within the Suphurets map area (Alldrick and Britton, 1988), approximately 75 kilometres north of Stewart. The Sulphurets map covers the eastern part of the area being studied by the Mineral Deposit Research Unit of the University of British Columbia under the project: "Metallogenesis of the Iskut River Region, Northwestern British Columbia". Access is by helicopter from Stewart, Tide Lake airstrip, Bob Quinn Lake or exploration camps in the Eskay Creek - Sulphurets region.

The Treaty Glacier and the South Treaty Glacier surround a large nunatak. A prominent red-brown-weathering gossan occurs on the west side of the nunatak (mineral occurrence 44, Alldrick and Britton, 1988). This gossan (the "main gossan" in this paper) has been of interest to mining companies for a number of years and currently lies at the centre of the Treaty Creek property of Tantalus Resources Ltd. and Teuton Resources Corporation. Alldrick and Britton (1988) reported the presence of alunite and native sulphur within the gossan. A second area of grey and locally limonite-stained bluffs occurs on the north side of the Treaty Glacier, and is referred to here as the "north gossan". Natroalunite and sartorite [$PbAs_2(Sb)S_4$] have been reported from the north gossan (Kirkham *et al.*, in preparation).

Alunite and natroalunite form over a considerable temperature range during low-pH alteration in oxidizing, sulphur-rich environments. Together with pyrite and native sulphur, they comprise an assemblage that is characteristic of acid-sulphate advanced argillic alteration associated with two distinct settings:

- Acid-leach zones developed as blankets in the near surface from the condensation of volatiles released during boiling in geothermal systems.
- Vertically extensive alteration zones developed in and above magmatic-hydrothermal systems due to the release, disproportionation and condensation of magmatic gases.

Both environments may be related to mineralization, but gold mineralization is only associated with the latter (White and Hedenquist, 1990). The origin and timing of alteration is, therefore, important for understanding the metallogenesis of the region (Macdonald *et al.*, 1991).

Fieldwork in 1991 focused on establishing the general geological setting, the morphology and structural style of both the main and north gossans. The preliminary mineralogy, based on limited petrological and x-ray diffraction analyses, and scanning electron microscope and microprobe analyses are also reported. Follow-up geochemical studies are planned. Fieldwork in 1992 will attempt to resolve questions of timing and structural relationships highlighted by the initial work.

GEOLOGICAL SETTING

The Treaty Glacier area is underlain by sedimentary rocks of the Bowser Lake Group and volcanic and epiclastic rocks of the Hazelton Group (Alldrick and Britton, 1988). These rocks are complexly folded and faulted, and their structural history is the topic of ongoing studies at the Mineral Deposit Research Unit and Geological Survey of Canada. Most of the Treaty nunatak, and both the main and north gossans, lie on the upper plate of a regional, southeast-directed thrust fault which places Hazelton Group strata on top of rocks of the Bowser Lake Group (Figure 6-8-1). This thrust fault is exposed discontinuously along the southeastern edge of the nunatak, where fault duplex geometry, minor drag folds and slickensides are all consistent with southeastward movement. Upper plate rocks consist of volcanic and sedimentary rocks of the Salmon River Formation, felsic volcanic rocks of the Mount Dilworth Formation and epiclastic rocks of the Betty Creek Formation. Broad northwest-trending folds and several sets of steeply-dipping faults deform these units. Contacts of the main gossan cut across lithologic boundaries, suggesting that all three map units are affected by alteration. However, the extensive alteration within the gossan makes identification and mapping of geologic contacts between units difficult.

The north gossan is approximately 2 kilometres north of the main gossan and is separated from it by the Treaty Glacier and a section of unaltered rocks at the north end of the nunatak. The northern contact of the north gossan is obscured by a gully which separates it from an unaltered and unfoliated feldspar porphyry. A prominent series of east-trending outcrops higher on the south-facing slope exposes pyritic but texturally well-preserved volcanic fragmental rocks of probable felsic composition. These are overlain to the north by minor grits and shales, suggesting that the two units represent the Mount Dilworth and Salmon River formations, respectively, as mapped by Alldrick and Britton (1988). The east end of the gossan is faulted against unaltered and unfoliated clastic rocks, probably of the Bowser Lake Group.

THE ALTERATION SYSTEM

MAIN GOSSAN

The main gossan covers an area of approximately 1 square kilometre on west-facing slopes below an icefield which occupies the central part of the nunatak (Figure 6-8-1). Exposure is good in the upper part of the gossan and poor on the lower slopes.

The hostrocks are predominantly epiclastic with extensive weak to moderate propylitic alteration. The epiclastic rocks are locally cut by quartz-sericite-pyrite veins and individual beds are selectively replaced by similar sericite-pyrite alteration. The central part of the main gossan is dominated by outcrops of quartz-sericite schist with variable amounts of pyrite and no obvious primary texture. The rock is cut by steeply dipping mafic dikes which strike 80° to 110°. The dikes are subparallel to foliation, moderately boudinaged and propylitically altered. To the north of the central icefield, there are prominent outcrops of quartz-sericite-pyrite schist with irregular pods of silica and brecciated quartz. Rare outcrops show textures suggesting porphyritic and fragmental protoliths. This part of the main gossan is covered by abundant float of strongly laminated and crenulated quartz±pyrite±native sulphur rock, including a massive pile of disaggregated material at the toe of the central ice field. This distinctive lithology has only been found in one small, isolated outcrop in the southern part of the gossan. Adjacent outcrops, 5 to 10 metres away, are quartz-sericite schists. Both the laminated quartz and quartz-sericite schist contain a strong foliation and secondary crenulation. Contacts of the gossan are gradational from sericitic to propylitic alteration with a corresponding increase in textural preservation.

NORTH GOSSAN

The north gossan forms major grey to brown-weathering bluffs adjacent to the north side of the glacier. The bluffs consist of laminated quartz-pyrite with individual siliceous laminae ranging from 1 to 50 millimetres in thickness. Pyrite is disseminated throughout the rock and locally occurs as individual bands of fine pyrite up to 30 millimetres across. The laminated quartz is folded into spectacular chevron crenulations (Plate 6-8-1). The proportion of siliceous material increases upwards in the gossan, and is accompanied by a textural transition from fine laminations, to thicker pods and bands, to massive grey to white microcrystalline silica at the highest levels. There is no evidence for primary texture in the laminated or massive siliceous rocks.

ALTERATION MINERALOGY

Preliminary petrography of outcrop and float samples from the main gossan, supported by limited x-ray diffrac-

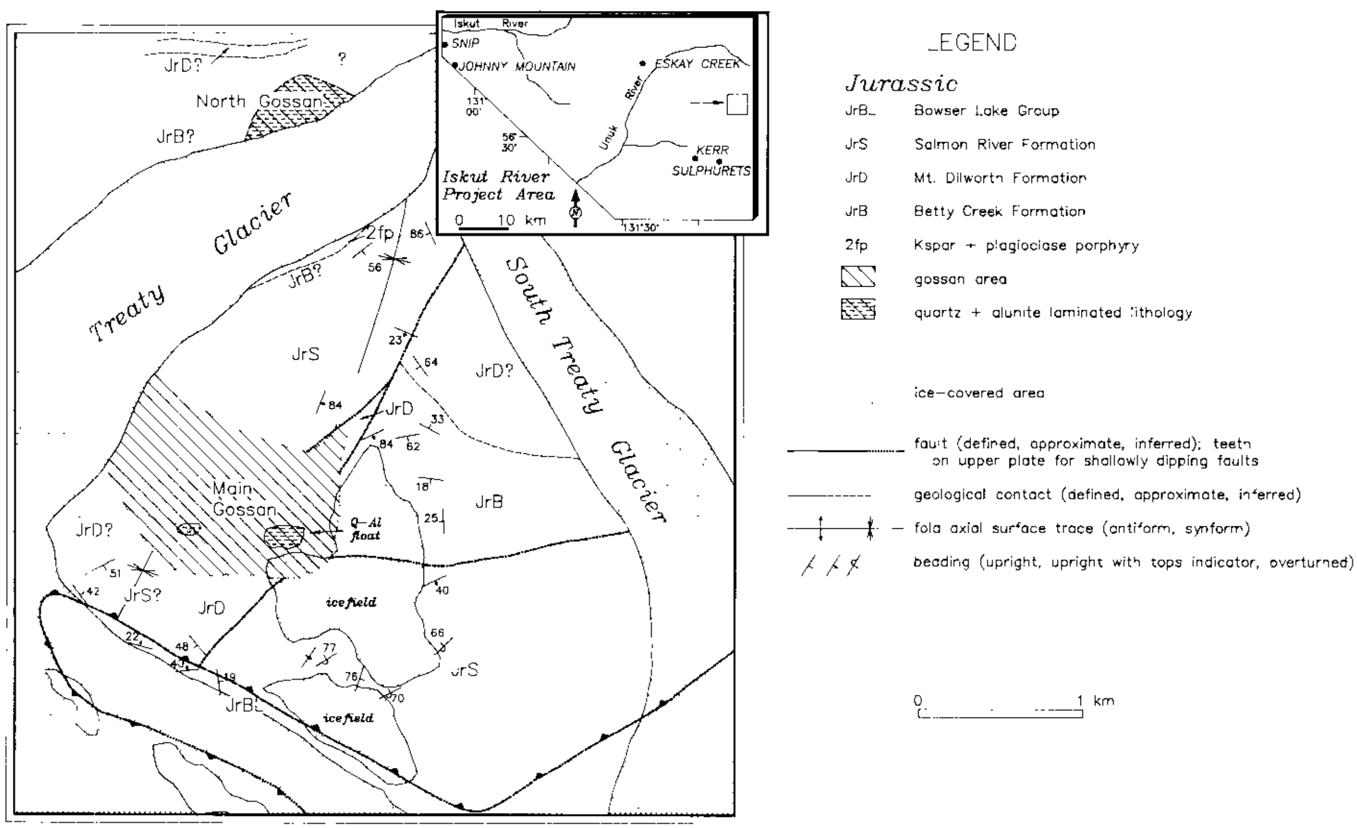

Figure 6-8-1. Generalized geology of the Treaty Glacier area based on this study, Alldrick and Britton (1988), Kirkham (personal communication), and mapping by Tantalus Resources Ltd. and Teuton Resources Corporation.

tion, scanning electron microscope and microprobe analyses, indicates that the laminated quartz rock consists of quartz±alunite interbanded with pyrite±sericite. One sample of float also contains pyrophyllite with laths of diaspore. The alunite consistently produces natroalunite x-ray diffraction peaks although initial microprobe analyses have returned a considerable range of X_{Na} (mole ratio Na/Na+K), 0.38 to 0.74. The sericite is illite or hydromuscovite. Native sulphur occurs locally in the laminated rock as discontinuous veins which cut the laminae, Kirkham *et al.* (in preparation) also report natroalunite and sartorite from the north gossan.

Primary textures are visible in some samples and include individual quartz grains or phenocrysts, quartz-rich clasts and rhombohedral ghosts of possible pseudomorphs of amphibole. Preliminary petrography supports field evidence for multiple protoliths.

Structural Fabrics

The sericitic foliation and the quartz-pyrite both present structural fabrics imprinted on altered rocks of the Treaty gossan. Sericitic foliation is almost ubiquitous in the main gossan but absent from the north gossan. This subvertical foliation is broadly folded and has variable strikes from 045° to 135°. The quartz-pyrite-alunite layering is well developed in the north gossan but is limited to one small outcrop and patches of float on the main gossan. In all locations the laminated layering is refolded by crenulations (Plate 6-8-2). In the main gossan outcrop, laminations are parallel to sericitic foliation in the adjacent rocks and the overprinting crenulations are parallel to axial surfaces of mesoscopic folds in the sericitic rocks. In the north gossan area, subvertical crenulation fabrics strike southeast and deform a subvertical primary lamination which strikes north to northeast.

Microscopic fabrics within the quartz-alunite-pyrite laminated lithology suggest the primary fabric is a post-alteration feature. Samples from float boulders in the main gossan show a strong grain-elongation fabric parallel to compositional layering within the quartz-rich bands. Aspect ratios of quartz-ribbon grains approach 10: (Plate 6-8-2). In some samples, less elongate quartz grains are consistently inclined at 10° to 20° to the primary layering. Pyrite grains commonly have symmetric quartz pressure shadows which show elongation parallel to the primary layering. Alunite shows no evidence of intracrystalline strain, but grains in alunite-rich layers often have weak preferred orientations, with longest dimensions inclined at small angles to the external compositional layering.

Plate 6-8-1. Outcrop of laminated quartz-alunite-pyrite rock on the north gossan, showing strong crenulation.

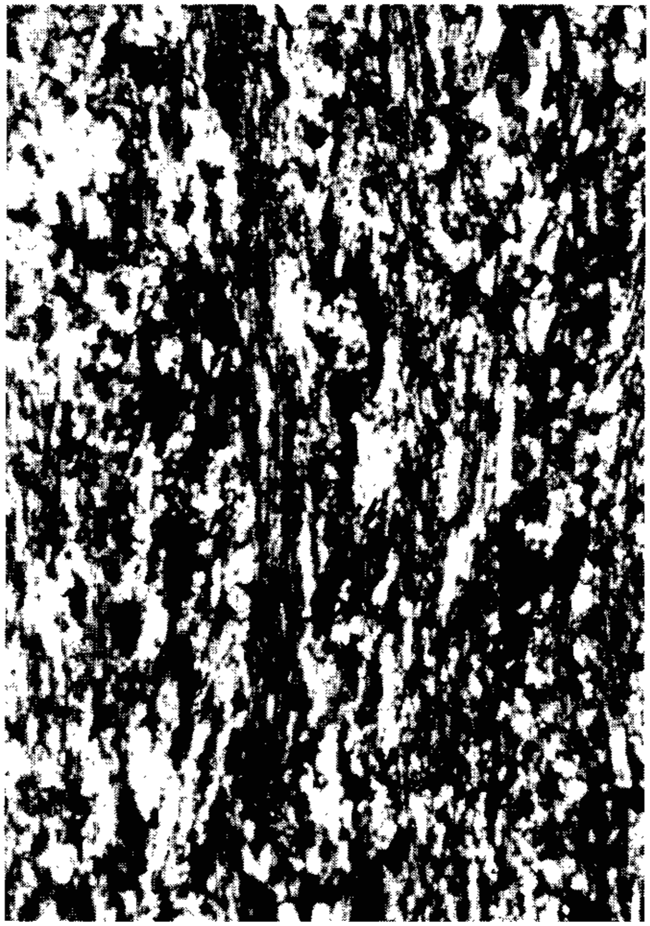

Plate 6-8-2. Photomicrograph of laminated quartz-alunite-pyrite rock showing elongated ribbon quartz and parallel alunite laths of tectonic origin. The field of view is 2.5 millimetres across.

DISCUSSION

The main gossan on the Treaty Glacier nunatuk is dominated by quartz-sericite-pyrite alteration with minor zones of quartz-alunite/natroalunite-pyrite$\pm$sulphur$\pm$pyrophyllite $\pm$diaspore. The alteration system is developed in a variety of hostrocks with selective alteration of fragmental units on the periphery of the system. The quartz-sericite alteration passes outwards into propylitic alteration, also developed in a variety of hostrocks. Preliminary stratigraphic interpretation indicates that the system affects Betty Creek Formation or equivalent intermediate fragmental rocks, Mount Dilworth Formation felsic fragmental rocks, which may be quartz phyric in this area, and pillowed basalts and andesites possible belonging to the Salmon River Formation. If the latter interpretation is correct, it suggests that the alteration system formed or was active until late in the Early Jurassic. Mafic dikes cut sericitic alteration but are partially altered. The dikes are deformed and there is no evidence, to date, for post-deformation alteration.

The north gossan contains laminated quartz-alunite/natroalunite-pyrite and zones of massive silicification. Contacts between the north gossan and surrounding unaltered rocks are faulted or obscured. Lack of foliation or crenulation in these surrounding units either reflects this structural juxtaposition, or the relatively incompetent nature of the quartz-alunite rock. Future fieldwork will attempt to resolve these questions. The protolith for the north gossan is uncertain. The possibility that the lamination reflects a primary banding in a tuffaceous or flow-banded rhyolite protolith cannot be ruled out at this time.

Mesoscopic and microscopic structural characteristics of the laminated quartz-alunite lithology strongly suggest that the laminations represent a tectonic fabric, imposed after alteration and overprinted by a younger crenulation fabric. Concentration of strain along discrete quartz-rich layers, and asymmetric grain-elongation fabrics indicate that a moderate to large component of noncoaxial strain contributed to fabric development.

Fieldwork and initial follow-up has established the following constraints for the formation of the Treaty Glacier alteration system:

- The alteration is dominantly sericitic or phyllic with local zones of acid-sulphate advanced argillic alteration and peripheral propylitic alteration.
- The presence of pyrophyllite-diaspore implies temperatures in excess of 280°C at the time of formation or during post-alteration metamorphism (Hemley *et al.*, 1980). There is no evidence for the latter.
- The system was deformed post-alteration.
- The alteration effects a variety of rock types and there is no evidence for any paleosurface features.

Preliminary conclusions are that alteration relates to the upper part of a magmatic-hydrothermal system which was subsequently deformed. The predominance of natroalunite, and its range of X_{Na} based on initial work, are also consistent with magmatic-hydrothermal environments (Stoffregen and Cygan, 1990; Thompson and Peterson, 1991). These types of systems occur elsewhere in the Sulphurets region and typically show similar timing relationships (Kirkham *et al.*, in preparation; J. Margolis, personal communication, 1991). To date, exploration on the gossan has not been successful but the owners of the Treaty property have discovered numerous precious and base metal rich veins throughout their property. At this stage, no conclusions can be drawn on the relationship of these veins to the Treaty Glacier alteration system or on the potential for mineralization within or below the alteration.

ACKNOWLEDGMENTS

We acknowledge Tantalus Resources Ltd. and Teuton Resources Corporation for granting permission to work on the Treaty property and to publish this paper. The work and ideas benefit from discussions with Rod Kirkham (Geological Survey of Canada) and Dani Alldrick (British Columbia

Geological Survey Branch). The work is funded from the Mineral Deposit Research Unit.

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