

Jacob Margolis
PhD Dissertation
University of Oregon
Supported by Corona Corporation

May 21, 1991

Geology and Genesis of Base- and Precious-metal Mineralization,
Sulphurets, British Columbia
Research Outline

Problem: The northern part of the Sulphurets district, the area surrounding Mitchell Glacier, contains several areas of hydrothermal alteration and potentially-economic mineralization apparently consisting of porphyry-style Cu-Mo+Au, pervasive quartz-sericite-pyrite-pyrophyllite alteration enriched in gold, and base- and precious-metal bearing quartz veins. The lithology, structure, geochemistry, intrusive history, timing of mineralization with respect to metamorphism and deformation, the genesis of the hydrothermalism, and the controls that have localized gold mineralization have yet to be studied in detail.

Objectives: To characterize and determine the absolute and relative ages of depositional and intrusive rocks, metamorphism, structural deformation, and hydrothermalism/mineralization in the study area; to map the study area; to characterize the nature of hydrothermal fluids associated with precious- and base-metal mineralization; to determine the source of hydrothermal fluids and their temporal and spatial evolution; to determine the location, timing, and mechanism of gold precipitation; and to specifically address how these conclusions should be used in mineral exploration.

Approximately 10 weeks will be spent in the field during the 1991 field season from about June 25th to September 10th. Work will consist of geologic mapping and sample collecting within the study area. Work outside of this area will be limited to reconnaissance. The scope of isotopic and fluid-inclusion work as listed below is dependent on suitable material and relevance which will be assessed during the course of the study.

I. Geologic Mapping and Sample Collecting

- A. map and define lithologies and stratigraphy; recon in adjacent areas to compare lithologies away from mineralization;
- B. characterize structural features and history, including discrete faults, folds, fractures; determine deformational history; timing of alteration and mineralization w.r.t. structure; orientation of syn- and/or post-mineralization stress
- C. identify and group intrusive bodies (including dikes); determine relative timing of intrusive activity w.r.t. alteration/mineralization
- D. map and characterize surface alteration and mineralization; including major veins, sulfides, alteration type
- E. determine timing of metamorphism w.r.t. alteration/min.
- F. **scale:** mapping will be done on sheets at about 1"=400' (1:4800) and transferred to a more generalized compilation sheet at 1"=1000' which will cover the entire area; detailed outcrop-scale mapping on graph paper will supplement the 1"=400' series

II. Petrography

- A. identify and characterize lithologies
- B. characterize alteration phases and define alteration assemblages and their temporal relationships
- C. determine timing of deformation with respect to alteration/mineralization; evaluate deformation at the thin-section scale
- D. determine metamorphic grade and timing by identifying metamorphic mineral assemblages and their timing with respect to mineralization

III. Microprobe

- A. gold residence
- B. identification of fine-grained metallic phases
- C. paragenesis of metallic phases (paragenesis)
- D. composition of metallic phases where necessary to define large-scale zoning (e.g., tetrahedrite) and properties of hydrothermal fluids (e.g., electrum-argentite for sulfur activity)
- E. identification and composition of alteration phases where these are difficult to identify in thin section (e.g., K-micas, kaolinite-pyrophyllite, barite, alunite)

IV. X-ray Diffraction

identification of alteration assemblages, particularly phyllosilicates

V. Radiometric Dating*

- A. intrusive rocks (via zircon U-Pb or Ar-Ar on hornblende; hb closure at about 500C)
- B. volcanic rocks (via Ar-Ar on hornblende; U-Pb on zircon in any felsic units);
- C. age of metamorphism: fission-track on zircon from volcanic rocks (closure at about 275C) and possibly epidote from metamorphic veins (closure at about 275C) away from alteration
- D. mineralization and alteration: possible techniques under investigation are Re-Os[#] dating of molybdenite and fingerprinting of Pb in galena

VI. Stable Isotopes*

- A. Oxygen-deuterium: source and temperature of dominant hydrothermal fluids by the O-18 composition of quartz and the O-18 and D-H composition of hydrothermal hydrous phases such as sericite, pyrophyllite, and alunite coexisting with quartz; associated fluid-inclusion temperatures (if available) will be used to constrain source of fluids; conclusions will be made concerning the relative roles of magmatic, marine, and meteoric waters
- B. Sulfur: may be used to estimate temperatures of precipitation of coexisting sulfide-sulfide and sulfide-sulfate pairs

VII. Fluid-inclusions

- temperature and salinity data for vein minerals (quartz, pyrargyrite, sphalerite); study will be dependent on quality of inclusions and will aid in defining the nature of the ore-forming fluids

VIII. Geochemistry*

- A. trace-element characterization of alteration assemblages and mineralization types in order to define zoning and trace-element suites which may be used in exploration
- B. major-oxide analyses of intrusive rocks to determine magmatic affinity and alkalinity of intrusive rocks

* No facilities at the University of Oregon

Possible analysis by the U.S. Geological Survey



UNIVERSITY OF OREGON

R.V. Kirkham
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8

May 30, 1991

Dear Rod,

My research plans at Sulphurets are summarized on the enclosed preliminary outline; this field season will dictate the viability of the various techniques. I expect to be in the field from June 25th to about September 10th (no later than that). My first academic year here at Oregon was consumed by course work, most of which is now complete. I have spent much time reviewing exploration reports, theses, and publications by GSC and BCDM workers, as well as looking at a few thin sections; and I'm anxious to get out in the field and stop speculating. This should be an exciting year at Sulphurets, both in terms of our geologic understanding and continued exploration.

The outline addresses a number of important questions concerning the structural, metamorphic, stratigraphic, and intrusive history, as well as the timing of mineralization, for which careful radiometric dating will contribute significantly. Alteration and mineralization studies will then shed light on the nature of ore-forming fluids and their sources.

I ask that you and others at GSC do not discuss the details of my research plans with anyone in industry, out of respect for Corona's support and obvious exploration interests. My work schedule for the coming academic year will focus on petrography, microprobe and SEM work, which together with the field mapping, will provide a strong geologic foundation on which the more detailed radiometric, stable isotope, and fluid-inclusion work can be undertaken primarily during the following year. I am hoping that my dissertation work will be largely complete by mid-1993.

I appreciate your interest in my work, and I look forward to discussing results with you, either in writing or at any upcoming conferences.

Best Regards,

Jacob Margolis



Energy, Mines and
Resources Canada

Geological Survey
of Canada Sector

Énergie, Mines et
Ressources Canada

Secteur de la Commission
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6 June 1991

J. Margolis
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Dear Jake:

Thank you for your letter and your research outline for your thesis. From your outline it looks like our and your work should be nicely complimentary.

Most of what you outline sounds fine. Mapping and petrography will be great contributions. I remind you that Don Harris has a tremendous amount of unpublished mineralogical data for the Sulphurets region. I am sure that he would be most willing to share his information and give you some opinions of what to look for and what to emphasize.

All government workers and the UBC-MDRU group have been concentrating on radiometric dating (enclosed is a sketch showing the approximate location of samples already collected for U/Pb zircon dates). Most of these dates should be published before you finish your thesis. I intend to collect a few more samples for U/Pb dates. Most of the dating has been directed towards igneous events (intrusive and extrusive) but the dating of metamorphism is much more problematic. As you are aware George Albino has some K/Ar dates for the Brucejack area. We obtained a 110 ± 3 Ma date for massive sericite from the West Zone. I also collected a sample from the Moly Zone K/Ar dating but people in the geochronology lab tell me that the muscovite ("sericite") is too fine grained to separate. Your planned fission track studies of zircons (\pm apatites?) sound interesting and well worth pursuing but I am not so sure about Re/Os - molybdenite tends to be a very "leaky" mineral.

.../2

Canada

On stable isotopes if you are interested and if Corona was willing to pay your travel expenses, I would be willing to try to convince Bruce Taylor to let you use his lab and to instruct you in the skills of stable isotope analyses. I can highly recommend Bruce. He is an excellent scientist and is very knowledgeable about ore deposits.

Any fluid inclusion information that you can obtain will be useful. We have done no fluid inclusion work, although I have been trying to talk James Macdonald into doing some around the Brucejack area.

I would have to check, but we might be able to provide you with some chemical analyses. The GSC mainly does silicate, ICP, AA, H₂O, CO₂, C, and S analyses. Neutron activation analyses (e.g. Au + 33 elements) and some other analyses are done outside on contract and you would have to have those done separately.

We are currently working on a GSC paper on Sulphurets and an Open File report which will include 1:20 000-scale preliminary geology and Au, Ag, Cu, Mo, As, and Sb lithochemical distribution maps and 1:5 000-scale preliminary geology map for the Brucejack area. Hopefully this information will be available to you within a reasonable length of time.

Please keep in contact and we will try to make our work as complimentary as possible to your work. I look forward to spending time with you in the field.

Best regards,

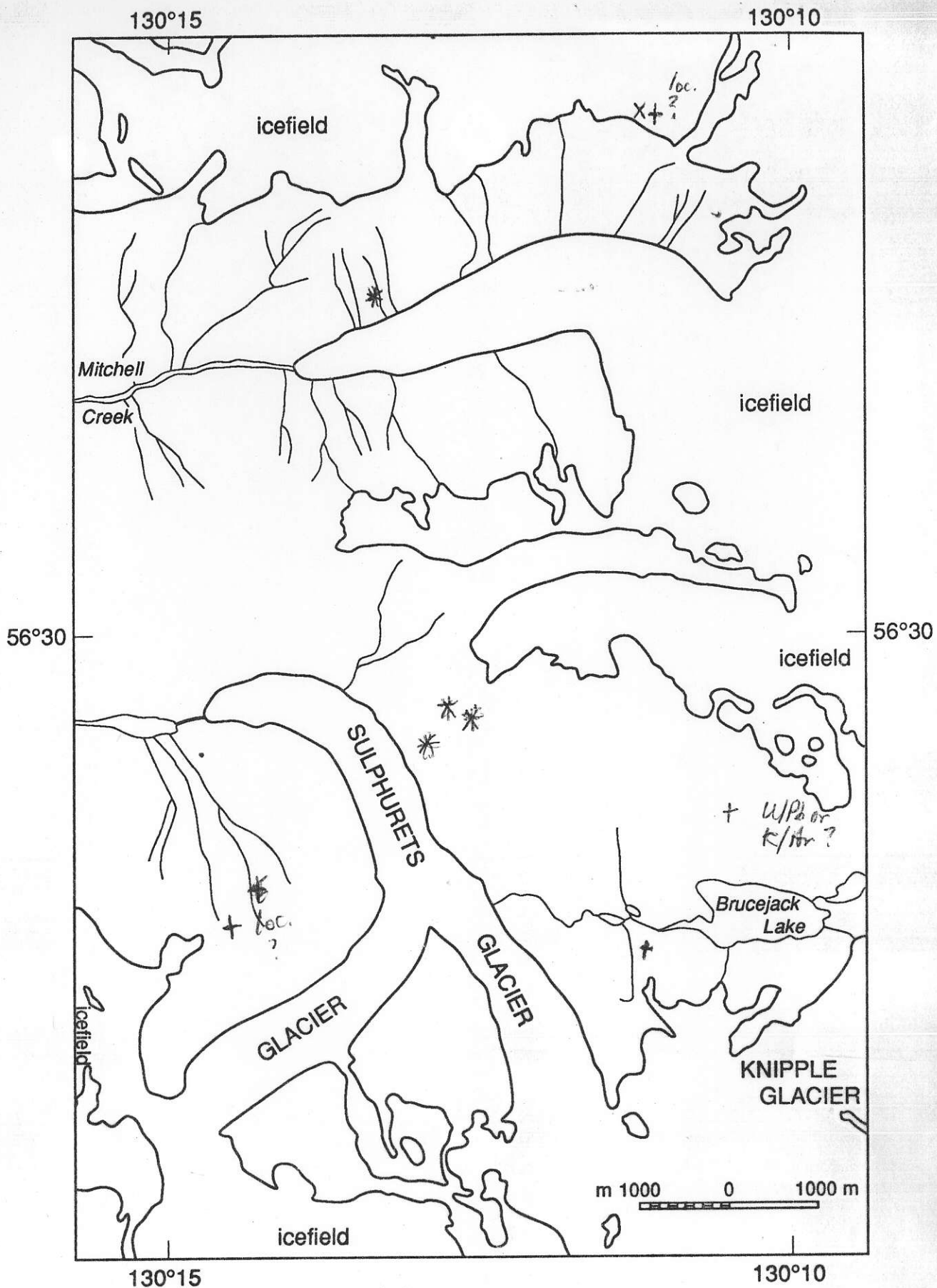


R.V. Kirkham

RVK/lo

Encl.

cc: A. Ransom
F. Hewett
S.B. Ballantyne
D.C. Harris



- + - Dani Alldrick (N.D. Bridge)
- X - Bob Anderson
- * - RVK

Approx. location of U/Pb zircon
samples.
RVK June 5/91