NATMAP: NECHAKO PROJECT, CENTRAL BRITISH COLUMBIA

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INTRODUCTION

The British Columbia Geological Survey Branch, and the Geological Survey of Canada, together with researchers in universities and industry, have initiated a new geoscientific program in central British Columbia (93F, 93K, and parts of 93G, 93L, 93M, 93N). The project is coordinated by both agencies, both fund component projects, and the program is financially augmented by the Geological Survey of Canada's National Mapping Program (NATMAP). Results of bedrock and surficial mapping will be enhanced by integration of isotopic analytical data, paleontology studies, and geophysical and geochemical site studies and interpretations. Ultimately, all data produced will be brought together in computer-accessible format and made available on CD-ROM disks.

The geological database for the central Canadian Cordillera (Figure 1) is poor. The first NATMAP program in British Columbia will address questions that will improve our understanding and guide mineral exploration: Tertiary crustal extension, Mesozoic compression and the manner of accretion of the tectonic terranes that underlie the area, geological and geophysical definitions of the terranes, the history of plutonism, the nature of known mineral deposits and their controls, and the character and dispersion history of glacial deposits.

More than fifty scientists from the Geological Survey of Canada, British Columbia Geological Survey Branch, Canadian Forest Service, universities in North America, Asia and Europe, and mining and exploration companies have major or "in kind" involvement in the program. Over five years, new regional and detailed geological and geophysical maps will be published for the Nechako River (93F), Fort Fraser (93K) and parts of Prince George (93G/12,13), Smithers (93L/16), Hazelton (93M/1), and Manson River (93N/4,5,12) map areas (Figure 1).

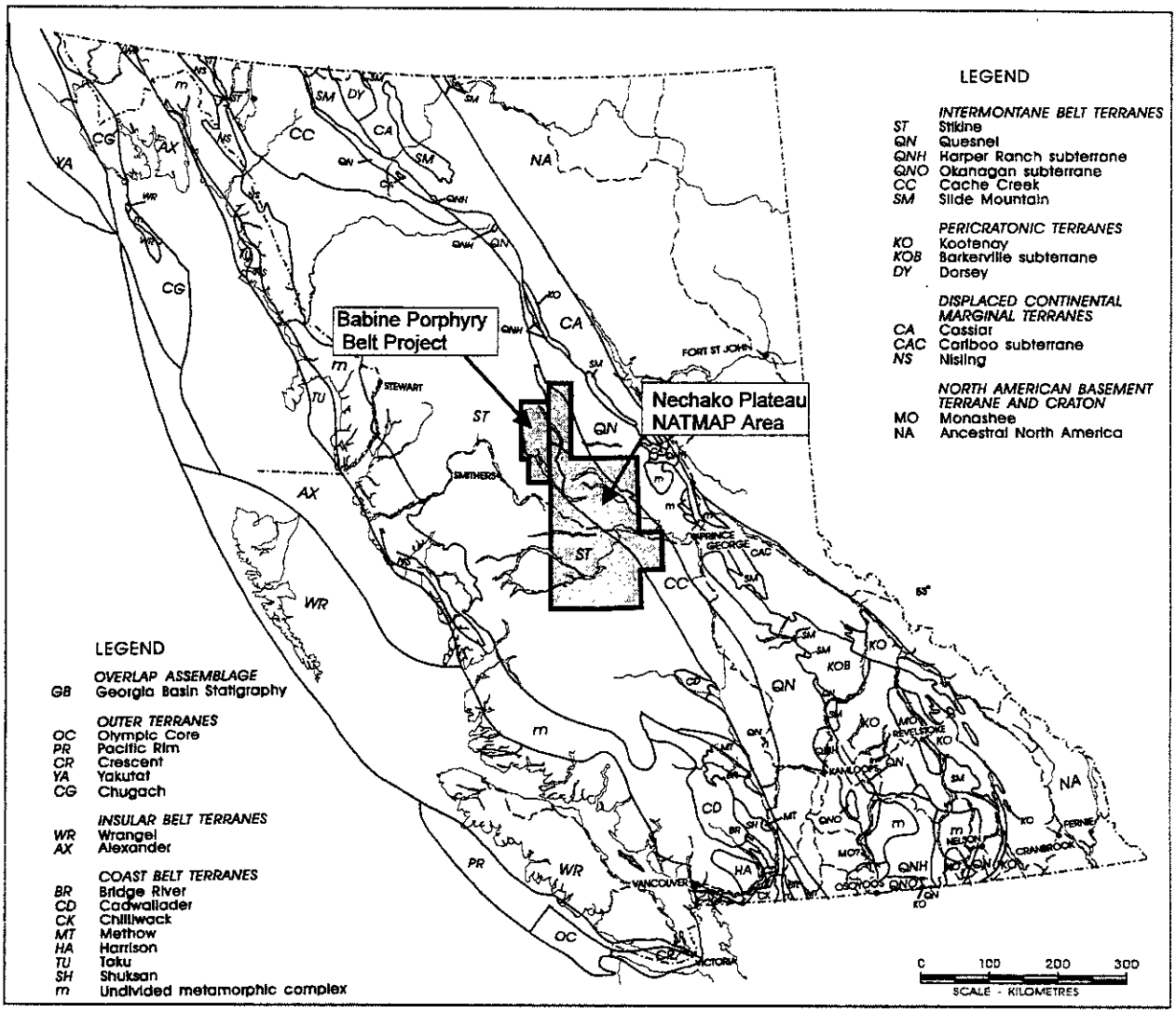
The Nechako area was assigned a high priority for new mapping by the GSC/BCGSB cooperation committee (Tempelman-Kluit and Matysek, 1994). Selection of the area was sanctioned by the industry liaison committees of both organizations, and by the local mineral industry.

NECHAKO NATMAP OBJECTIVES

The study will test the hypothesis that the Eocene volcanic complex in central British Columbia represents the tectonic/magmatic expression of an Eocene regional extensional event (Figure 2; Struik, 1994). Understanding the regional Eocene tectonics, and the structural relationships of the upper and lower plates of the extension complex, will help us understand the potential for epithermal precious metal deposits that could be associated with the contact zone between the upper and lower plates, and to determine the complex history of plutonic events with their potential for new intrusion-related copper-gold and molybdenum deposits. The area will also be evaluated for its potential to host volcanogenic massive sulphide deposits of the Kutcho type.

Some steps to attain these objectives include:

- Bringing obsolete 1:250 000-scale geological maps to modern standards (existing maps are based on fieldwork from the 1940s and 1950s). Revised maps will include bedrock maps for the Babine porphyry belt, 93F and 93K, and surficial maps for the porphyry belt and 93F.
- Unraveling the Triassic-Jurassic volcanic arc sequence of the Skeena Arch by studying stratigraphy, plutonic character, tectonic history and rock distribution, and the copper-gold associations seen so clearly in surrounding areas. More metal production has come from Jurassic mineral deposits in British Columbia than from deposits of any other age.
- Determining the tectonic histories of the three major terranes of the area and testing the hypothesis that the boundary between Stikine and Cache Creek terranes is a regional thrust fault like the Nahlin fault in northern British Columbia.
- Determining changes in the regional Pleistocene ice flow directions through time in central British Columbia, where we know ice sheets from three different directions coalesced (Plouffe, 1995). Retreat of these ice sheets left much of the area covered by unconsolidated glacial deposits. Ice flow information



1: Location of the Nechako NATMAP project area. Tectonic boundaries after Wheeler and McFeeley, (1991).

is very important in drift prospecting, in understanding chemical dispersion patterns, and in tracing lithologic units through covered areas during regional bedrock mapping.

The metallogeny of the region can only be interpreted through a knowledge of the nature of the overprinting and coincident Tertiary tectonic history. Answering the fundamental geological questions will require a broad range of expertise and techniques because bedrock exposure in central British Columbia is poor. Further, the prospective Mesozoic and Eocene bedrock often is covered by either local younger Tertiary plateau basalts or extensive Quaternary deposits.

Geoscientific studies planned include:

- Mapping the bedrock and surficial geology at scales appropriate to the problems being tackled. This will be done through coordinated research by a team of experts applying a broad range of techniques to resolve each problem.

- Mapping the surficial geology to determine the glacial history. Till geochemistry and heavy mineral content, combined with measurements of ice flow directions will be used to trace hidden bedrock lithologies and indicate potential mineralized areas.

- Interpreting the aeromagnetic and gravity data to trace units beneath the cover rocks, to map subsurface structures, and to improve interpretations of geology based on mapping of exposed rock.

- Conducting image analysis of satellite spectral and radar data to provide information on the regional distribution of lithologies, structures and lineaments.

- Conducting radiometric surveys to assist in the differentiation of plutonic units directly through their exposed chemical signature and indirectly through their distributed chemical signature in the surficial sediments, and also to locate areas of hydrothermal alteration.

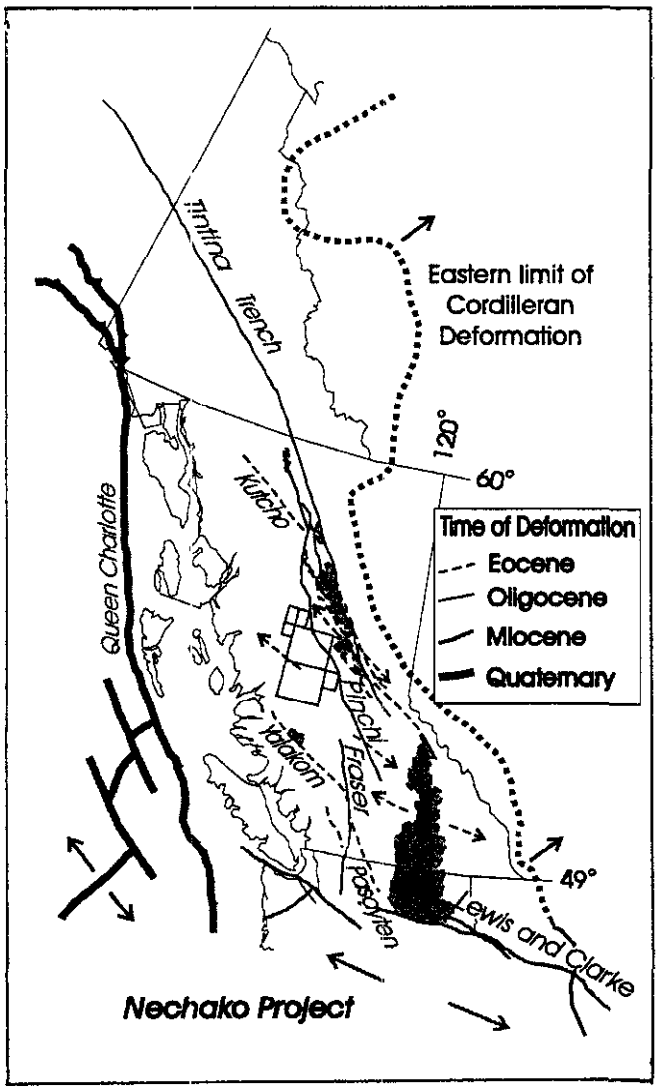


Figure 2: Relationship of the study area to the Eocene tectonic fabric of the North American Cordillera. Shaded areas are metamorphic core complexes.

- Carrying out local gravity and electromagnetic surveys to assist in the delineation of geological structures to depth and to test regional geophysical models.

- Determining paleomagnetic orientations for suites of rocks to assist in determining offsets on terrane contacts and to test for structural rotations that may have accompanied Eocene extension.

- Conducting seismic P-wave crustal studies as a relatively inexpensive way to map the third dimension. This information is needed to solve the contact relationships of the Cache Creek Terrane, and to determine the structural characteristics and geometry of the Eocene extension complex and its upper plate.

- Isotopic dating of all plutonic suites and characterizing them chemically to relate them to tectonic events. These data will aid field identification and classification of the plutonic suites.

- Increasing paleontological control in the area by supporting GSC and university research and determinations, and by providing contracts for identification of radiolarian and fusulinid fauna. Biostratigraphic age controls are needed to clarify internal structural relationships in the Cache Creek and Stikine terranes.
- Collating all the data, using computer technology, into GIS databases that will permit integration and fusion of geoscience information into thematic maps. Providing these datasets to involved researchers and clients, in a simple, easily used format, to encourage analysis of interrelationships of the geoscience data layers.

This research will be published as a series of maps and reports, and as digital databases (Figure 3). We plan to interpret the various data from the perspectives of environmental impact and landuse values to make this pertinent information more widely accessible.

OVERVIEW OF RESULTS TO DATE

BEDROCK MAPPING: BCGSB-GSC - UNIVERSITY- INDUSTRY COLLABORATION

Don MacIntyre, Ian Webster and Kim Bellefontaine of BCGSB, with the assistance of summer student John Bryant, completed 1:50 000-scale geologic mapping of NTS map-sheet 93L/16 (MacIntyre *et al.*, 1996; Figure 3, D). Significant revisions were made to Carter's 1973 Preliminary Map 12 which was the only published geology map of the porphyry belt other than the

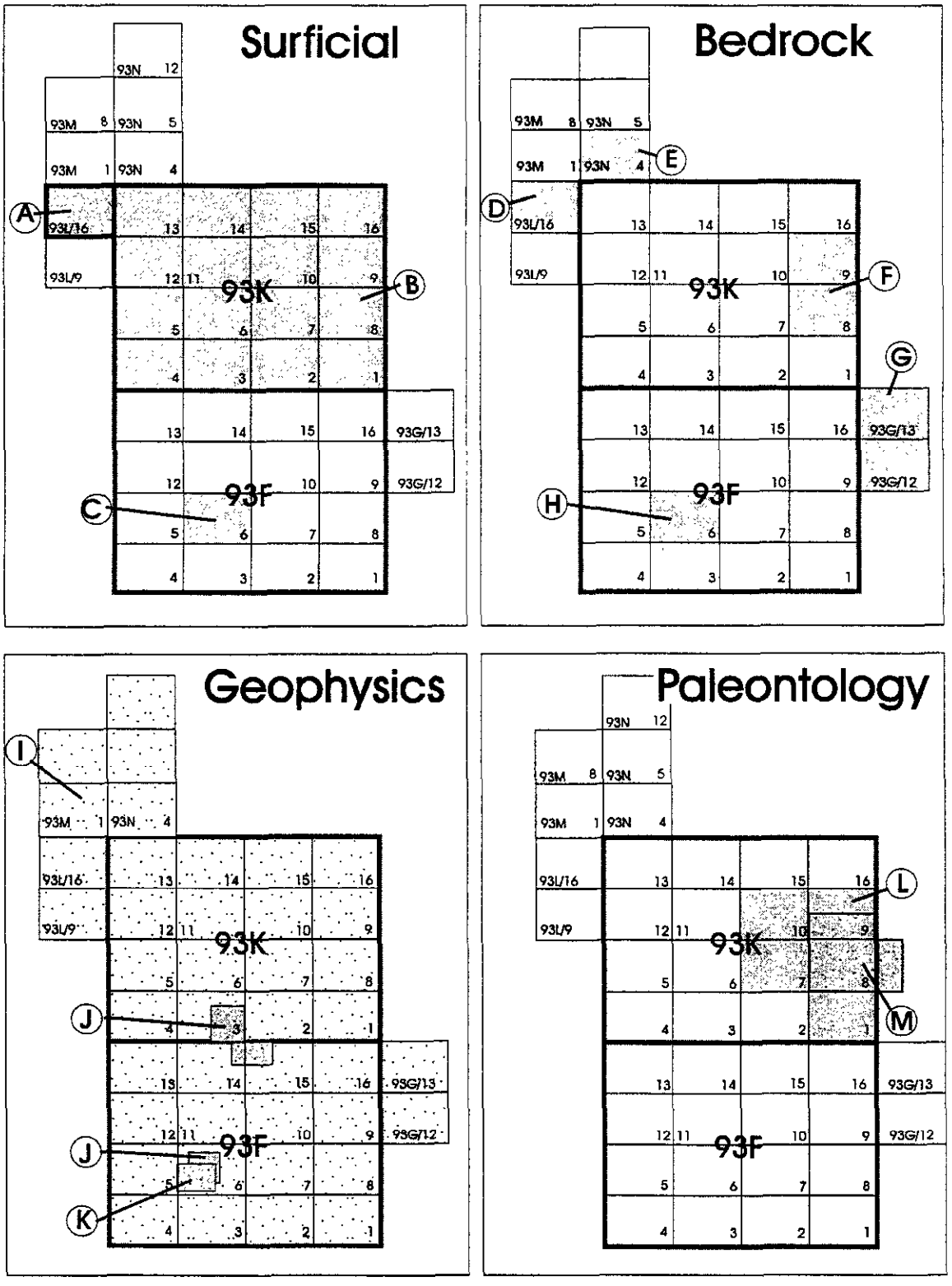


Figure 3: Location of various Nechako NATMAP subprojects active during 1995. Letters are referenced in the text: A. Huntley *et al.* (BCGSB, UNB); B. Plouffe (GSC); C. Levson (BCGSB); D. MacIntyre *et al.* (BCGSB); E. Schiarizza (BCGSB); F. Struik *et al.* (GSC); G. Wetherup and Struik (UA, GSC); H. Diakow *et al.* (BCGSB, GSC); I. Lowe and Seeman (GSC); J. Shives (GSC); K. Enkin (GSC); L. Cordey (contract to GSC); M. Orchard (GSC). Note that not all the projects have publishable results at this early stage in the program.

1:250 000-scale GSC Open File maps (Tipper and Richards, 1976). Carter's geology was placed into a modern stratigraphic framework. Samples were collected for radiometric dating by Mike Villeneuve of the GSC and this information will help to further refine the geology of the area. Several new epithermal systems were located and these appear to be related to either Early Jurassic or post-Eocene hydrothermal events. A stratigraphy was developed for the Eocene Newman volcanics, the extrusive equivalents of the Babine intrusions. Emplacement of porphyries and related extrusive activity appears to predate the main episode of Eocene extensional faulting in the area. Mapping in 1996 will move northward into NTS map-sheet 93M/1.

Paul Schiarizza (BCGSB) spent eight days examining the geology east of Takla Lake (93N/5, 12, 13) in preparation for a geological mapping program that is planned for the area in subsequent years. This project will concentrate on metavolcanic and metasedimentary rocks of the Sitlika assemblage, with the goal of developing an internal stratigraphy and assessing its potential to host volcanogenic massive sulphide (VMS) deposits. The project will establish the relationships between the Sitlika assemblage and adjacent rocks of the Cache Creek Terrane. It will also test the hypothesis that the Sitlika assemblage is a fault-offset correlative of the Kutcho Formation, which hosts the Kutcho VMS deposit in northern British Columbia.

Bert Struik (GSC) and a crew of three university students conducted bedrock mapping of the Vanderhoof Gneiss Complex (93G/12,13 and parts of 93K/5,6 and 11) (Wetherup and Struik, 1996) and began work in the Fort Fraser map area (93K) near Fort St. James (Struik *et al.*, 1996). The Vanderhoof orthogneisses and paragneisses are clearly in fault contact with overlying ultramafic rocks of the Cache Creek Group. Ductile shear in the lower plate gneisses increases toward the contact, and upper plate shear at the contact consists of a narrow zone of brittle gouge. On the eastern side of the complex the upper plate motion was down to the east southeast. Wetherup will be continuing studies of these rocks in the Masters program at the University of Alberta under the supervision of Phillipe Erdmer. Brian Traub mapped the area of metamorphic rocks of southern Babine Lake for a Bachelor's thesis project, also under the guidance of Phillipe Erdmer. This work expands the reconnaissance conducted by Struik and Erdmer (1990).

BIOSTRATIGRAPHIC STUDIES: BCGSB-GSC COLLABORATION

As part of the regional mapping of the Cache Creek Group, contractor Fabrice Cordey has conducted a research project on the radiolarian biostratigraphy (Figure 3, L; Cordey and Struik, 1996). This work will assist in defining the age range, paleogeographic setting, biostratigraphy and structural framework of the Cache Creek Terrane in the central Canadian Cordillera. Preliminary results from this summer are reported by Struik *et al.* (1996). Cordey and Struik (1996) used newly determined age relationships to locate a thrust fault, and have established that Cache Creek ribbon cherts in the Fort St. James area were deposited throughout Triassic time.

Larry Diakow (BCGSB), in concert with Terry Poulton and Howard Tipper (GSC), spent five days revisiting fossil sites in the southern Nechako Plateau area in an effort to better constrain the ages of Lower and Middle Jurassic sedimentary sequences (Figure 3, H). Biostratigraphy is critically important because isotopic dating of interlayered bimodal volcanics has been inconclusive. This work completes a 1:50 000-scale bedrock mapping program funded by the Canada British Columbia Mineral Development Agreement in the Nechako River area. We plan to expand the improved geological coverage provided by this project northward during the NATMAP program, into NTS map sheets 93F/4, 5, 12 and 13.

Mike Orchard (GSC) has brought together a database of existing paleontological information from the project area, particularly conodont fauna from the Cache Creek limestone (Orchard and Struik 1996).

Ed Kimura and Sharon Gardner (Placer Dome Inc.), Glenn Johnston (Endako Mines Limited) and Placer Dome Inc. contributed data from their regional geological mapping of the area around the Endako molybdenum deposit, which is underlain by Mesozoic rocks (93F, 93K). The Placer Dome data are being digitized, and pertinent data elements will appear in the geological compilations for the Nechako NATMAP project.

Joe Whalen (GSC) conducted a reconnaissance of plutonic suites in the Endako/Fraser Lake area (93F/14 and 93K/3) in preparation for mapping and lithogeochemical studies in subsequent years. The plutonic suites show a wide range of genetic types and compositions.

SURFICIAL MAPPING AND GEOCHEMICAL SURVEYS: BCGSB-GSC-UNIVERSITY COLLABORATION

Vic Levson and David Huntley (BCGSB) coordinated regional surficial mapping, drift geochemical sampling and glacial studies in the Babine porphyry belt. They worked closely with Doctoral candidate Andy Stumpf and Masters candidates Erin O'Brien and Gordon Weary under the supervision of Bruce Broster of the University of New Brunswick (93M/01 and 93L/16; Figure 3, A; Huntley *et al.*, 1996; Stumpf *et al.*, 1996).

Surficial geology maps for these two areas will present the kinds of surficial cover, landforms ice flow

patterns and the distribution of glacial erratics. The maps will be released at Cordilleran Roundup 1996. Geochemical results from ICP and INA analyses of some 900 samples of basal till (800), mineralized erratics (40) and other sample media were collected in areas of good mineral potential. These will be published when data becomes available. Interpretation of regional paleo-ice flow patterns, physiographic controls of deposition and the history of glacial "Lake Babine" are in progress. These data will be used to interpret the geochemical results to aid future exploration in the area.

Steve Cook (BCGSB) conducted follow-up studies as an outgrowth of MDA-supported lake geochemical surveys (Figure 3, C). In 1995, he and Wayne Jackaman (BCGSB) and Peter Friske, Martin McCurdy and Steven Day (GSC) carried out a regional lake sediment and water geochemistry survey over the northeastern part of the Fort Fraser map area (NTS 93K/9, 10, 15, 16). This survey is a contribution to the continuing objective of completing Regional Geochemical Survey (RGS) coverage of the northern interior. It was funded by the Canada British Columbia Mineral Development Agreement. The survey area also encompassed mercury deposits along the Pinchi fault zone, and will provide valuable regional baseline data for anticipated studies of naturally occurring mercury in the environment.

Alain Plouffe (GSC) has compiled and published the surficial geology of the Fort Fraser map-sheet (93K) at 1:100 000-scale (Figure 3, B). This work derives from mapping that was conducted under the 1991-1995 MDA program. In addition to the geological maps, Plouffe, and Bruce Ballantyne (GSC), have published results of regional till geochemical surveys for the same region. Those geochemical distributions are being interpreted in the context of the glacial flow direction history (Plouffe, 1995).

GEOPHYSICAL SURVEYS: GSC-BCGSB COLLABORATION

Carmel Lowe (GSC) has begun interpreting existing gravity and aeromagnetic data (93G, 93F, 93K, 93L, 93M, 93N). This information will be used to aid bedrock and surficial mapping, and to assist in interpreting the geology to depth.

Rob Shives (GSC) arranged a contract airborne radiometric, aeromagnetic and VLF (very low frequency electromagnetic) survey that covers a pluton-dominated area near Fraser Lake (93K/3, 93F/14) and an area south of the Kemano Reservoir (93F/6). Results from these study areas will be used to aid and accelerate mapping of the various plutonic suites in the two survey areas. The survey was flown in late September and results are pending.

Randy Enkin (GSC) and Larry Diakow (BCGSB) sampled rocks of the Entiako spur and Nagliko uplift for paleomagnetic studies of the Jurassic sequences (93F/6). This work will test the hypothesis that there were plate translations related to terrane accretion, and block rotations possibly related to Tertiary faulting.

GEOCHRONOLOGY: GSC-BCGSB-UNIVERSITY (MDRU) COLLABORATION

Mike Villeneuve (GSC) and Jim Mortensen (UBC, MDRU) conducted a reconnaissance sampling program for isotopic dating of igneous and metamorphic suites throughout the project area. This work will initially concentrate on defining ages for the numerous plutonic and extrusive suites and establishing the relationships between plutonism and ore generation. Villeneuve is coordinating the isotopic dating and has begun compiling existing isotopic dates for the area (93G, 93F, 93K, 93L, 93M, 93N). This database will become part of the Canadian database of isotopic ages that is compiled by the geochronology section of the GSC.

DIGITAL DATA/GEOGRAPHIC INFORMATION SYSTEMS: GSC- BCGSB-INDUSTRY COLLABORATION

Stephen Williams (GSC) is working with Eric Grunsky (BCGSB) and scientific staff of both organizations to compile existing geological, geochemical and geophysical data to be published on CD ROM. These data will be integrated with a common GIS platform. Initially, it will contain information relevant to the Quesnel Trough of north-central British Columbia, including map sheets 93K, 93N, 93J, 93O(SW) and 94C. Placer Dome Inc. is supporting digitization of their exploration mapping database for central British Columbia. This data will be included in future digital data releases. The computer information will be available in several formats and made accessible by software included on the CD ROM. In the future, data from the Interior Plateau (MDA) and NATMAP project areas will also be available in this form.

ACKNOWLEDGMENTS

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NOTES