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NECHAKO NATMAP PROJECT - 1996 OVERVIEW

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A Contribution to the Nechako NATMAP Project

KEYWORDS: Nechako Plateau, NATMAP, multidisciplinary, bedrock mapping, surficial mapping, biogeochemistry, till geochemistry, geochronology, conodonts, radiolarian, geophysics, Babine Porphyry Belt, Eocene extension.

INTRODUCTION

The Nechako NATMAP project, which began in 1995, is a joint mapping and geoscientific research project between the British Columbia Geological Survey Branch (BCGSB) and the Geological Survey of Canada (GSC) that also includes participation by universities and industry (Struik and McMillan, 1996; McMillan and Struik, 1996). The co-ordinators of this project are the authors of this report. Work done by BCGSB field crews is funded wholly by the Energy and Minerals Division of the Ministry of Employment and Investment; GSC funding is from the Cordilleran division in Vancouver supplemented with additional funding from the National Mapping Program (NATMAP).

The project area, which encompasses over 30,000 square kilometres in central British Columbia, includes NTS map sheets 93F, 93K, and parts of 93L, 93M, 93N and 93G (Figure 1). The primary objective of the project is to improve the quality and detail of bedrock and surficial maps while focusing on several geological problems. In particular it will address questions of Tertiary crustal extension, Mesozoic compression and the manner of accretion of exotic terranes, the geological and geophysical definition of the terranes, the sequence of changing Pleistocene glacial ice flow directions, and the character and dispersion of glacial deposits. This new data will be used to better understand structural controls on the distribution of known mineral deposits and to identify target areas favourable for the discovery of new mineral resources by integrating geological, geophysical and geochemical data using a GIS.

In this second field season of the Nechako NATMAP project, mapping crews did 1:50 000 scale bedrock mapping in ten areas and surficial mapping in five areas (Figure 2). This work was enhanced by detailed geophysical and remote sensing surveys and stratigraphic studies based on micro and macro paleontology and radio-isotopic age dating. Stratigraphic studies concentrated on sections within the Cache Creek Group near Fort St. James and mainly volcanic sequences of the Ootsa Lake and Endako groups. Field crews also collected samples of till, silt , lake water and vegetation

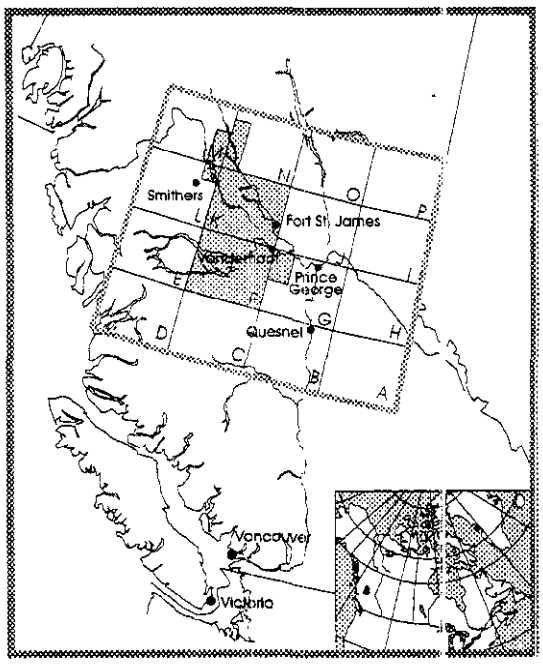

Figure 1. Location of the Nechako Natmap project

in selected areas in order to assess the potential for detecting known and new mineral deposits. Geophysical line surveys included ground-based magnetics, gravity and electromagnetics. Digital GIS projects included final compilations of data on the Quesnel Trough, compilation of mapping data from Placer Dome Incorporated, and cartography of some existing geology maps.

OVERVIEW OF RESULTS TO DATE

Bedrock mapping

Don MacIntyre, Ian Webster and Pat Desjardins of the BCGSB with the assistance of summer students Joseph Schrank and Susan Hand completed 1:50 000-scale geologic mapping of NTS map sheet 93M/1 (Figure 2, D) (MacIntyre *et al.*, 1997, this volume). Bedrock mapping of the Fulton Lake map sheet (93L/16) was completed in 1995 (MacIntyre *et al.*, 1996). The main objective of this work is to acquire a better understanding

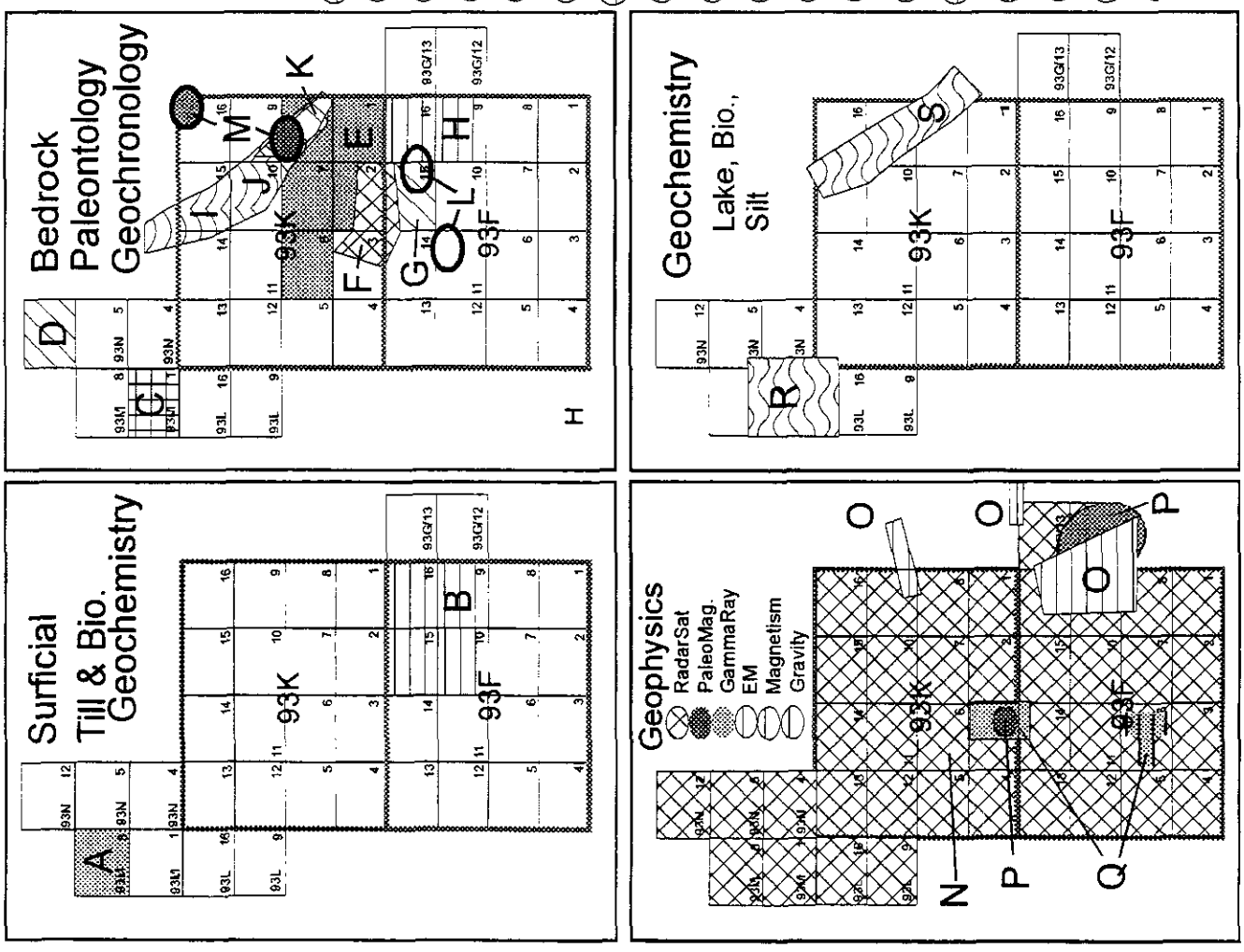

Figure 2. Projects active in the Nechako Natmap project area in 1996. See text for explanation of symbols.

of late Tertiary tectonics in the area and to integrate this with concurrent surficial and geochemical surveys in an attempt to define new exploration targets. Mapping to date, which has focused on new areas of rock exposure created by logging activities, plus new fossil collections and isotopic age dating (Villeneuve and MacIntyre, 1997) has helped to place previous mapping by Carter (1973) and Tipper and Richards (1976) into a modern stratigraphic framework. New mapping has confirmed that rocks ranging from Pennsylvanian to Early Cretaceous (Albian) in age were folded and thrust faulted in a major contractional tectonic event that probably took place in mid Cretaceous time, prior to eruption of Late Cretaceous volcanics of the Kasalka Group. In the Babine Lake area, early Cretaceous and older rocks are unconformably overlain and cut by the Eocene Babine Igneous suite of volcanics and high level intrusions. A preliminary model suggests volcano-plutonic centers were formed as pull-aparts on right lateral transcurrent faults related to an Eocene transtensional tectonic event. Age dating and mapping suggest development of Eocene volcanic basins in the Babine Lake area began with building of stratovolcanoes, followed by emplacement of high level stocks and dikes of biotite-feldspar porphyry and formation of porphyry copper deposits. These basins were further disrupted by late Tertiary block faulting with blocks tilted to the southeast thus truncating the older, north trending volcanic basins. Understanding the late Tertiary extensional tectonics of the area is critical to the delineation of areas favourable for the discovery of new mineral resources and for the successful exploration at existing properties.

Paul Schiarizza and Garry Payie (BCGSB) conducted bedrock mapping on the east side of Takla Lake in the western part of the Manson River map area (93N/12,13). This mapping has resulted in an improved understanding of the stratigraphy and structure of the Sitlika assemblage (Patterson, 1974), and its structural relationships with Cache Creek terrane to the east and Stikine Terrane to the west (Schiarizza and Payie, 1997, this volume). Mapping of the Sitlika belt is supported by U-Pb radiometric dating and geochemical studies carried out by Fiona Childe of MDRU (Childe and Schiarizza, 1997, this volume). The lithology and stratigraphy, Permo-Triassic age, and primitive tholeiitic geochemistry of the Sitlika assemblage support its correlation with the Kutcho Formation of northern British Columbia (Monger *et al.*, 1978), which hosts the Kutcho Creek volcanogenic massive sulphide deposit.

Bert Struik (GSC) and a crew of seven university students conducted bedrock mapping in the southeast quadrant of Fort Fraser map area (93K/1,2,6,7,8; Struik *et al.* 1997; Figure 2, E). The mapping has yielded new stratigraphy for the Tertiary Endako and Ootsa Lake groups, refined the distribution of the metamorphic facies of the Cache Creek Group, better defined the distribution and characterized contact relationships of some of the Mesozoic plutonic bodies and determined the tectonic block fault pattern in some of the Tertiary sequences. Janice Letwin initiated a Bachelors thesis at the University of Alberta (UA) on the geology of the Shass Mountain area underlain primarily by Cache Creek Group ultramafic, mafic and pelagic metasedimentary rocks. As part of the regional mapping of the Cache Creek Group, a contract research project has been conducted by Fabrice Cordey on the radiolarian biostratigraphy (Figure 2, L). This work will assist in defining the age range, paleogeographic setting, biostratigraphy and structures of the Cache Creek Terrane in the central Canadian Cordillera. More detailed results from last summer's sampling are reported in Cordey and Struik (1996). Newly determined age relationships have been used to locate a thrust fault, and have established a Triassic age range for ribbon cherts of the Cache Creek Group in the vicinity of Fort St. James.

Henriette LaPierre of the Universite Joseph Fourier, France (UJF) and Mark Tardy of the Universite de Chambery, France (UCH) sampled upper Paleozoic and Mesozoic volcanic rocks of the Cache Creek and Takla Groups for detailed geochemical analyses and some $^{40}Ar/^{39}Ar$ dating. This study attempts to characterize the source environments, and therefrom, tectonic regimes of the volcanic rocks and their host suites. Some comparisons will be made with existing interpretations of similar aged terranes in the southern Canadian and United States Cordillera.

Joe Whalen (GSC) conducted geochemical sampling of plutonic suites in the Endako/Fraser Lake area (93F/15 north and 93K/2) and characterized their lithological features and contact relationships. At least two plutonic groups were identified, an older penetratively deformed suite and a younger, locally slightly foliated to massive, group of intrusions. Each of these displays mafic to felsic compositional variations. In conjunction with Bob Anderson, petrographic, chemical, and isotopic work in progress will establish the age, petrogenesis and tectonic significance of these plutonic suites. Preliminary Nd isotopic results on samples collected in 1995 from some of the younger intrusions indicate they were derived mainly from juvenile sources (e.g., depleted mantle) rather than by remelting of old continental crust (Struik *et al.*, 1997; Anderson *et al.*, 1997)

Bob Anderson (GSC) with Rob L'Heureux conducted 1:50 000 mapping of the Hallet Lake map area (93F/15, G). Mesozoic and Tertiary volcanic units were distinguished. Mesozoic sedimentary and volcanic sequences are locally overturned to the north-northwest. Jurassic, Early Cretaceous and Late Cretaceous plutonic suites were mapped. Some Early Cretaceous phases, which are correlative with those of the Endako Mine camp, host widespread molybdenite showings. Follow-up mineralogical, chemical and geochronological work will define the composition and age of these suites. Rob L'Heureux's Bachelor's Thesis (UA) concerns the geological, petrological, and geochronological character of the plutonic suites which host the Nithi Mountain Molybdenum showings.

Lithological, textural and structural characteristics of the Eocene Ootsa Lake, Eocene-Oligocene Endako and Miocene Chilcotin groups were documented and

contrasted. Mapping and analysis of plutonic rocks suggest at least 5 magmatic episodes whose character, age, distribution, and composition were previously unknown. Many have characteristics typical of plutonism recognized elsewhere in Stikine and Quesnel terranes but Early Cretaceous plutonism is unique to the Nechako NATMAP area and hosts the Endako porphyry molybdenite deposits.

Stephen Wetherup (UA) and Christopher Anderson of the University of British Columbia (UBC) completed mapping of the Nulki Lake (93F/16) and Tatuk Lake (93F/9) map areas. The western and southern bounds of the Vanderhoof Metamorphic complex were delineated (Wetherup, 1997). A clearer idea has been developed of the distribution of dioritic to monzonitic plutons of probable Jurassic and Cretaceous ages, and the contact relationships between the Tertiary volcanic suites. Wetherup's mapping in the Nulki Hills and south to Finger Lake will be part of a Masters thesis (UA) concentrating on the tectonic history of the Vanderhoof Metamorphic Complex.

SURFICIAL MAPPING AND GEOCHEMISTRY

Vic Levson, Dan Meldrum, Erin O'Brien and Craig Churchill (BCGSB) in collaboration with Andrew Stumpf and Bruce Broster from the University of New Brunswick (UNB), Alain Plouffe of the GSC and Brent Ward of the Ministry of Forests. conducted regional surficial mapping, drift geochemical sampling and glacial studies in the Babine Porphyry Belt (93M/8) (Figure 2, A) (Levson *et al.*, 1997, this volume; Stumpf *et al.*, 1997). Time-stratigraphic, 1:50 000, surficial geology mapping, incorporating local and regional ice flow history data, was conducted on 93M/8. This work will extend 1995 mapping on 93L/16 and 93M/1 and will provide a complete overview of the surficial geology of the Babine porphyry copper belt. Ice flow studies in the region show a dominant regional southeasterly flow. Glacial dispersal patterns of mineralized rock in the area reflect this dominant southeasterly flow. Surficial units, in which there is a high potential of tracing mineral anomalies to their bedrock source, as well as deposits such as glacial lake sediments, where the usefulness of soil geochemistry is limited, were identified during the mapping program. Surficial geology data from the Babine area will also be integrated with new bedrock geology mapping in the region.

The main objective of the till geochemical sampling program is to identify potential mineral anomalies in drift covered areas for industry follow-up by producing 1:50 000 regional till geochemistry maps for 93 L/16, 93M/1 and 93M/8. Quaternary stratigraphy studies were conducted in the Bulkley River valley and Nechako Reservoir areas in order to determine the regional Quaternary history. Till stratigraphy, ice flow history and lithologic studies were also conducted to determine regional dispersal patterns in different types of sample media, needed for appropriate design of exploration programs.

Detailed case study investigations were conducted in collaboration with Steve Cook (BCGSB) and industry geologists at the Hearne Hill, Lennac Lake, Nak and Trail Peak porphyry copper prospects. The work included detailed lithologic, sedimentologic and geochemical studies of surficial sediments around areas of known mineralization. Processes of dispersal of mineralized bedrock from different deposit types will be modeled to determine the size and shape of anomalies in various sediment facies and size fractions.

Steve Cook (BCGSB) conducted lake sediment, silt and till sampling for geochemical studies in the area of 93L/16, 93M/1 and 93M/8 (Figure 2, R; Cook, 1997). The Babine regional lake sediment and water geochemistry survey was conducted over the entire Babine porphyry belt. Lake sediments and waters were obtained from 332 sites over the equivalent of four 1:50 000-scale map sheets in areas of ongoing bedrock mapping. In addition, case study investigations were conducted in collaboration with Vic Levson (BCGSB) at the Hearne Hill, Lennac, Nak, Trail Peak and Dorothy prospects. The objective of these investigations is to document the till geochemical expression of the hydrothermal alteration zones associated with these Babine deposits.

Colin Dunn (GSC) also joined forces with Steve Cook to conduct a detailed till and biogeochemical study at the Lennac prospect. In this study the principal biogeochemical sample medium was again Lodgepole pine outer bark, but supplemented with samples of alder. The latter has a propensity to accumulate molybdenum and is useful, therefore, in defining zones of Mo and Cu enrichment. Bark samples were obtained from more than 120 sites over the general vicinity of the Lennac prospects.

Alain Plouffe (GSC), Francois Therrien and Holly Keyes conducted surficial mapping, and till and Lodgepole pine bark sampling throughout the northeast quadrant of the Nechako River map area (Figure 2, B; Plouffe, 1997). The work has more clearly defined the distribution of Glacial Lake Fraser sedimentation in the area. Colin Dunn (GSC) worked with the group to establish and integrate the till and tree bark sampling program. The Lodgepole pine outer bark samples (236 sites) were obtained throughout the same area and at most of the same sites that till samples were collected. The complementary till and biogeochemical data will be used to assist regional mapping of till dispersal and concealed bedrock. In addition, bark analyses to date indicate zones of metal enrichment not previously reported near Nulki Lake (Mo, Cu, Ag), and north of Goldie Creek (Mo, Ba, Sr), both in 93F16. The latter occurrence is in the vicinity of a quarry into layered felsic tuffs that have a tridymite coating on bedding surfaces.

Pat Rasmussen, Colin Dunn and Gwendy Hall (GSC) conducted a preliminary regional biogeochemical and hydrogeochemical survey in the Pinchi Creek area to determine the natural distribution and mobilization of

mercury and related trace elements from geological sources to the atmosphere, vegetation and surface waters. Their study was designed to complement previous studies of mercury distribution in till (Plouffe, 1996) and in lake sediments (Steve Cook, personal communication, 1995), both of which provided valuable information for environmental applications.

GEOPHYSICAL STUDIES

Rob Shives (GSC) readied gamma ray, aeromagnetic and very low frequency electromagnetic data collected over the Endako Mine (parts of 93K/3 and 93F/15) and Wolf-Capoose prospect (part of 93F/6) areas (Figure 2, Q) for publication (Shives, in press). The magnetic data clearly show the location of the Casey Fault in the Endako area, and the thorium/potassium ratios highlight the alteration patterns of each of the known large mineral occurrences as well as some unidentified sources.

Eric Grunsky (BCGSB), is planning to do image analysis studies in the Nechako NATMAP area using RADARSAT data. Two standard images (100 x 100 km) and one ScanSAR (500 x 500 km) have been ordered through the Application Development and Research Opportunity Project.

The areas covered are:

- Takla Lake area (93M 01, 08; 93N 04, 05; 93K 12, 13; 93L 09, 16)
- Nechako River (93K 01, 02, 03; 93F 01, 02, 03, 06, 07, 08, 09, 10, 11, 14, 15, 16; 93C 06, 07, 09, 10, 11, 14, 15, 16)
- NATMAP Project Area (93C,F,K,N)

Randy Enkin (GSC) sampled Tertiary plutonic rocks in and around the Endako Mine and near the Vanderhoof Complex to use paleomagnetic techniques to establish the history of Tertiary block movements in these regions (Figure 2, Q). This will test the hypothesis that Tertiary dextral strike-slip and listric extensional faults bound the Vanderhoof Complex and have affected much of the upper plate rock package of the region.

Mel Best and Carmel Lowe from the GSC, with students Michael Heyd and Jason Halko, conducted gravity, magnetic and electromagnetic (EM) surveys along several transects that crossed the Pinchi Fault and the boundary of the Vanderhoof Metamorphic Complex (Figure 2, P). These integrated geophysical surveys were used to map in three dimensions faults, bedrock structures and lithology beneath glacial drift. Preliminary results indicate that drift-covered faults and contacts, and in some instances structural features, were detected using these methods. In addition the EM survey conducted by M. Best provided new information on the southern extent of glacial Fraser Lake sediments. C. Lowe has recently compiled the regional aeromagnetic and gravity data over the entire Nechako NATMAP area and has carried out a preliminary interpretation.

GEOCHRONOLOGY

Mike Orchard (GSC) and Hillary Taylor (GSC) sampled the Mount Pope limestone of the Cache Creek Group near and northwest of Fort St. James (Figure 2, F); this sampling also complemented the detailed stratigraphic studies of Hiroyoshi Sano (KU). This work is a follow up to sampling and conodont determinations done prior to the NATMAP project (Orchard and Struik, 1997) and those that resulted from collections made during 1995 (Orchard, *et al.*, 1997). New conodont data from a transect northeast from Stuart Lake to Pinchi Lake shows that the carbonate youngs from Late Carboniferous, (Bashkirian to Mocovian) to Early Permian (probably Gzhelian-Asselian). The limestone interbedded with basalt that crops out adjacent to Stuart River at Fort St. James is mid Permian (Guadalupian). Anomalous Early Triassic conodonts are mixed with Carboniferous fauna in one collection from the region, implying a younger dissolution history for some of the Cache Creek limestones. Younger Triassic conodont fauna is also now known from west of Stuart Lake at Whitefish Bay.

Mike Villeneuve (GSC) worked closely with each of the mapping projects sampling and isotopically dating plutonic and volcanic suites, to determine the age of compressional and extensional fabrics hosted by some of the rocks, to establish the relationship between plutonism and ore generation, and to correlate Tertiary tectonics and volcanism throughout the project area. Studies continue on dating orthogneiss protoliths, the provenance of detrital zircons and post-crystallization thermal events in the Vanderhoof Metamorphic Complex. The Babine Igneous Suite, hosting porphyry Cu (+/- Au) deposits at northern Babine Lake, have yielded isotopic emplacement ages of 49-52 Ma (Villeneuve and MacIntyre, 1997).

STRATIGRAPHY

Hiroyoshi Sano of Kyushu University, Japan (KU) measured sections of the Cache Creek Group's Mount Pope sequence in detail (Figure 2, K; Sano and Struik, 1997). He has determined some of the possible depositional environments of the unit, and has associated this sequence with deposition on and surrounding oceanic island-atolls.

Derek Thorkelson of Simon Fraser University (SFU) did reconnaissance work on Tertiary volcanic sections in the northern Nechako River map area (Figure 2, L). He has examined some unconformities and has found some lithological relationships and sequences that merit further work.

GEOGRAPHIC INFORMATION SYSTEMS

Stephen Williams (GSC) and Eric Grunsky (BCGSB) are working with scientific staff of both the GSC and BCGSB in the compilation of computer geological, geochemical and geophysical data to be published through various digital media (floppy disk, tape, CD-ROM, web site). That data will be integrated with a common GIS platform. A recent CD-ROM product contains information relevant to the Quesnel Trough of central British Columbia including NTS map areas 93K, 93N, 93J, 93O(SW) and 94C (Williams *et al.*, 1996). The computer information on that CD is available in several formats and is accessible with software included with the CD-ROM.

Andrew Harries and Ralph Westera (GSC) completed the digitization of the Placer Dome Inc. geological maps (Kimura *et al.* 1980). These maps were used as guides in the field mapping, and will be included in the compilation of the Nechako project maps.

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