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REGIONAL LAKE SEDIMENT AND WATER GEOCHEMISTRY OF THE BABINE PORPHYRY BELT, CENTRAL BRITISH COLUMBIA (NTS 93L/9, 16; 93M/1, 2, 7, 8)

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ABSTRACT

Results of a regional lake sediment and water geochemistry survey conducted in the Babine Porphyry Belt in 1996 highlight several new exploration targets in the northern Interior Plateau of British Columbia. The Babine survey (NTS 93L/9, 16; 93M/1, 2, 7, 8) covers an area of known high mineral potential where exploration has previously been limited by extensive drift cover and poor exposure.

Lake sediments and waters were collected from 332 sites in the survey area at an average density of approximately one site per 10.3 square kilometres. On the basis of results from prior orientation studies in other parts of central B.C., sediment samples were collected from every lake and every sub-basin. These were analyzed for 16 elements by atomic absorption spectroscopy (AAS), and for 27 elements by instrumental neutron activation analysis (INAA). Standard Regional Geochemical Survey (RGS) sampling, analytical and quality control procedures were used. Preliminary discussion of results for several elements including copper, molybdenum and zinc indicate that the survey confirms the locations of several currently known prospects and outlines new areas for prospective porphyry-style mineralization.

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INTRODUCTION

Open File 1997-17 presents new analytical data for 35 different elements from a regional lake sediment and water geochemistry survey (Figure 1) conducted by the British Columbia Geological Survey Branch in the Babine Porphyry Belt during 1996. The Babine Survey, centred on northern Babine Lake, covers the entirety of the Babine porphyry belt. It covers all or part of six 1:50000 NTS map areas in the Smithers (NTS 93L) and Hazelton (NTS 93M) areas of central B.C.: 93L/9 (Topley), 93L/16 (Fulton Lake), 93M/1 (Old Fort Mountain), 93M/2 (Harold Price Creek), 93M/7 (Netalzul Mountain) and 93M/8 (Nakinilerak Lake). Past and current exploration in this region has centred primarily on porphyry copper targets, and the survey area includes the former Bell (MINFILE 93M 001) and Granisle (MINFILE 93L 146) copper mines. Porphyry copper prospects such as the Hearne Hill (MINFILE 93M 006), Nak (MINFILE 93M 010) and Trail Peak (MINFILE 93M 011) deposits remain the primary exploration targets in the region.

A total of 332 sites were sampled over an area of approximately 3406 square kilometres at an average density of 1 site per 10.3 square kilometres (Table 1). Data for base metals, gold, precious metal pathfinders and rare earth elements are provided here. Several new exploration targets are highlighted, and recommendations given for the interpretation and follow-up of geochemical anomalies. The subdued topography, poor drainage and abundance of lakes in this part of the Nechako Plateau make lake sediments an ideal geochemical exploration sample medium. They are an effective tool to delineate regional geochemical patterns and anomalous metal concentrations related to mineral occurrences. Most examples of the successful application of lake sediment geochemistry to Cordilleran mineral exploration come from the Nechako Plateau. For example, epithermal precious metal prospects such as the Tsacha (Cook *et al.*, 1995) and Wolf prospects in the Nechako Plateau (Dawson, 1988) and, further to the north, porphyry molybdenum mineralization at the Mac deposit (Cope and Spence, 1995) were discovered following lake sediment geochemical surveys.

Open File 1997-17 is a contribution to the Nechako NATMAP Project, a joint project of the Geological Survey Branch, the Geological Survey of Canada, and university researchers. It is a multidisciplinary investigation of bedrock geology, glacial history, and lake sediment geochemistry of this part of the Nechako Plateau. Mineral exploration of this area has been limited by extensive drift cover, poor exposure and, until the bedrock mapping of Carter (1973) and, more recently, MacIntyre (1998) and MacIntyre *et al.* (1996a,b; 1997), a relatively low-resolution geological database. The survey area covers the entirety of the Babine porphyry belt from the Lennac Lake area in the south to Frypan Peak in the north, and corresponds to areas of ongoing bedrock mapping (MacIntyre, 1998; MacIntyre *et al.*, 1996a,b; 1997) and surficial mapping and till geochemistry (Levson *et al.*, 1997; Huntley *et al.*, 1996). Porphyry-style copper deposits are the primary exploration target in the area, and new baseline geochemical data should prove useful in stimulating new exploration for these and other mineral deposit types.

The Babine survey was conducted by GSB staff. Sample collection, preparation and analytical procedures used conform to established standards of the National Geochemical Reconnaissance (NGR) and Regional Geochemical Survey (RGS) programs. Details are given here, and in previous lake sediment geochemical reports such as Cook and Jackaman (1994) and Cook *et al.* (1997b). Results will be incorporated at a later date into ongoing regional lake sediment surveys as part of the RGS program. Analytical results and field observations compiled by the RGS program in British Columbia are used in the development of a high-quality geochemical database suitable for mineral exploration, resource assessment, geological mapping and environmental studies.

OPEN FILE FORMAT

Open File 1997-17 is divided into the following sections:

- Introduction, survey methodology and quality control
- Preliminary data interpretation and discussion
- Listings of field variables and analytical data (Appendix A)
- Listings of analytical duplicate data (Appendix B)
- Summary statistics (Appendix C)
- Element distribution, geology and sample location maps (Appendix D)

Analytical and field data are included as an ASCII file on a 3.5-inch high density diskette. Data for each sample are listed in comma-delimited fields over one data record. Document files detailing format specifications and survey details are also included. The diskette is located in the back pocket, together with a 1:100000-scale sample location map.

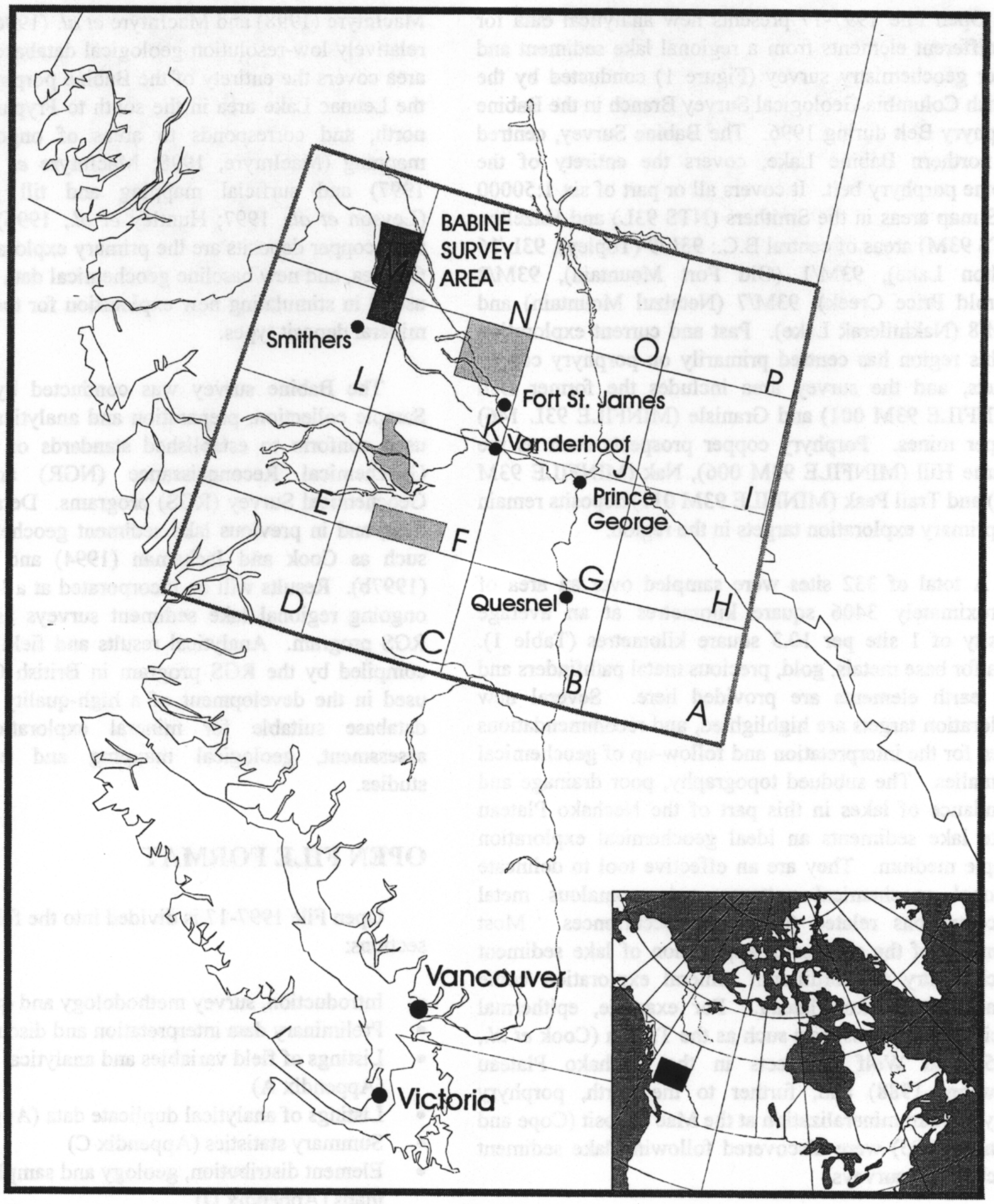

Figure 1. Location of the Babine lake sediment survey area in the Smithers (NTS 93L) and Hazelton (NTS 93M) map areas of the Nechako Plateau, central British Columbia. Areas of prior lake sediment surveys in the region during the period 1993-1996 are also shown (shaded areas). More detailed location maps of the survey area showing bedrock geology, physiographic features and MINFILE occurrences are given in Appendix D.

DESCRIPTION OF THE SURVEY AREA

LOCATION AND ACCESS

The Babine survey area is located about 40-50 km east-northeast of Smithers in west-central B.C. Centred on northern Babine Lake, the survey area comprises a north-south trending strip, approximately 100 km long and 30-40 km wide, with an area of about 3406 square kilometres. The survey area covers all or part of NTS map areas 93L/9 and 16, and 93M/1, 2, 7 and 8. It is bounded in the northwest by the Babine River, and in the northeast by a portion of Takla Lake. The village of Granisle, from which the survey was based, is the main population centre within the Babine survey area. It is accessible from Highway 16 via both Topley and Smithers. Logging roads provide good road access within much of the survey area, particularly that area east of Babine Lake where access is provided by a private logging ferry. Access is limited, however, in the northern portion of the survey area.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The Babine survey area is located at the northern terminus of the Interior Plateau (Holland, 1976), where the rolling hills of the Nechako Plateau grade into the rugged peaks of the Skeena Mountains, to the north, and the Hazelton Mountains, to the west. The Nechako Plateau is a relatively low-lying area which generally lies between about 2500 to 3500 feet (approximately 762 to 1067 m) elevation within the survey area. Lowest topography is near the shorelines of major lakes, and in the marshy southern part of the survey area near Lennac Lake. In more rugged plateau areas, elevations of up to 5148 feet (1569 m) are attained at Old Fort Mountain, and in excess of 4500 feet (1372 m) at Hearne Hill.

Elevations in excess of 3500 feet are common in the mountainous northern part of the survey area, where the southern part of the Bait Range (Skeena Mountains) overlooks the Nechako Plateau, reaching a maximum elevation of 6377 feet (1944 m) at Frypan Peak. Trail Peak, at 5313 feet (1619 m) is another prominent point in this area. In the far southeastern end of the survey area, topography is dominated by Matzehtzel Mountain (5758 feet/1755 m).

The surficial geology and glacial history of the Babine porphyry belt area have been described by Tipper (1971) and, more recently, by Levson *et al.* (1997b) and Huntley *et al.* (1996) at 1:50 000 scale. The area is extensively drift-covered, with till and glaciolacustrine sediments the most widespread Quaternary deposits. Glacial movement was dominantly to the southeast, and resulting morainal sediments vary from less than a metre to several metres in thickness, often occurring as fluted or drumlinized topography. Overlying glaciolacustrine sediments are exposed in the lower-lying parts of the survey area, generally near the shorelines of large modern lakes such as Babine Lake (elev: 2335 feet/711 m), which is a remnant of a postglacial lake. These sediments are generally restricted to elevations less than 950 m.

BEDROCK GEOLOGY

Bedrock geology of the Smithers and Hazelton map areas was first mapped by Armstrong (1944a,b). These areas were later mapped at 1:250 000 scale by Tipper and Richards (1976) and Richards (1990), respectively. The Babine porphyry belt was first mapped by Carter (1973), and has recently been remapped at 1:50 000 scale by MacIntyre (1998) and MacIntyre *et al.* (1997, 1996a,b) as part of the Nechako NATMAP Project. These maps had not all been published at the time of writing. The geological compilation of the Skeena-Nass area (MacIntyre *et al.*, 1994) provides the most recent published geological account of the entire Babine porphyry belt, and is used as the geological base for this report (Appendix D-3).

The Babine lake sediment survey is a directed survey of a belt of rocks of perceived high mineral potential. Here, the survey area traces the distribution of Eocene intrusives within a largely Jurassic-Eocene volcano-sedimentary package. The Eocene intrusives are the most significant unit in this belt for hosting porphyry-style copper deposits, the primary exploration target in the area. The following account of the regional geology of the Babine porphyry belt is summarized from MacIntyre *et al.* (1997):

The Babine porphyry belt is situated within the Stikine terrane. Layered rocks of the survey area range in age from Pennsylvanian-Permian limestones to Tertiary basalts of the Endako Group. Most of the area, however, is underlain by Lower to Middle Jurassic volcanic and sedimentary rocks of the Hazelton Group, a calc-alkaline island arc assemblage which has long been a focus of mineral exploration in British Columbia. These units are intruded by plutonic rocks of varying ages, most notably the Eocene Babine intrusions and Late Cretaceous

Bulkley intrusions which host economic copper mineralization at many localities within the survey area and elsewhere in central B.C. The structural framework of the area is defined by uplifted and tilted fault blocks, and north to north-west trending grabens preserving younger Eocene rocks. MacIntyre *et al.* (1997) provide detailed descriptions of lithological units within the Babine porphyry belt, together with their tectonic history and depositional environments; highlights regarding the five main stratigraphic packages within the survey area are summarized below:

•*Pennsylvanian-Permian:*

Pennsylvanian-Permian limestone, tentatively correlated with the Asitka Group by MacIntyre *et al.* (1997), is exposed to the west of Babine Lake.

•*Triassic:*

Triassic rocks within the survey area include the Topley intrusions (199-210 Ma), and Takla Group volcanic and sedimentary rocks. The Topley Intrusions, predominantly granite and monzonite of late Triassic to Early Jurassic age, are widely exposed in the southeastern part of the survey area. Exposures of Triassic units, dominantly augite porphyry flows and marine sediments, are restricted to the west shore of Babine Lake north of Granisle.

•*Jurassic:*

Lower to Middle Jurassic rocks of the Hazelton Group are the most common sedimentary and volcanic units within the Babine porphyry belt. Lower Jurassic units include subaerial calc-alkaline arc volcanics of the Telkwa Formation and shallow marine clastic sediments of the Nilkitkwa Formation. Telkwa Formation rocks are common within the survey area, particularly south of Fulton Lake in the southern part of the survey area. Nilkitkwa Formation rocks are best exposed east of Morrison Lake. These are overlain by basaltic flows, pyroclastic and volcaniclastic rocks of the Middle Jurassic Saddle Hill Formation, and shallow-water sandstone, siltstone and conglomerate of the Smithers Formation. Saddle Hill volcanics are exposed to the west of Granisle, and in a northward-trending belt extending from the Newman Peninsula to Hearne Hill.

Middle to Upper Jurassic Ashman Formation argillaceous siltstone and greywacke, and Trout Creek Formation conglomerate, also occur within the survey area near the north end of Babine Lake. Rocks of the Ashman Formation had been previously assigned to Bowser Lake Group, but recent fossil evidence suggests an older age (MacIntyre *et al.*, 1997).

•*Cretaceous:*

Rock units of the Lower Cretaceous Skeena Group and Lower to Upper Cretaceous Kasalka Group are present within the survey area. Skeena Group sedimentary rocks, comprising shallow marine greywackes to mudstones, are present in the northern part of the survey area, particularly in the northwestern corner, and in the vicinity of Old Fort Mountain at the north end of Babine Lake. Alkaline trachytic flows and sills are also a part of this group. MacIntyre *et al.* (1997) noted that Skeena Group rocks are generally poorly exposed due to their preservation in low-lying areas within downdropped fault blocks or grabens. The Kasalka Group, comprising feldspar porphyry flows and breccia, is found in the southern part of the survey area.

Late Cretaceous Bulkley intrusions (70-84 Ma) exposed within the survey area are part of a north to northwestward-trending belt of intrusive bodies which extends from the Eutsuk Lake area of the Ootsa Reservoir to north of the Babine River. Here, they comprise hornblende-biotite-quartz-feldspar porphyry and granodiorite, and are restricted to the Lennac Lake area in the southern part of the survey area. Although secondary in economic significance to the Eocene Babine intrusions in this area, they are an important host for porphyry-style copper-molybdenum mineralization at other localities in central B.C. (Carter, 1981).

•*Eocene:*

Early-Eocene-age units in the Babine porphyry belt include the Babine Intrusions, their extrusive equivalents the Newman Volcanics, and the Ootsa Lake Group. The Babine Intrusions (50.2-55.8 Ma) are the most economically-significant intrusive unit in the Babine porphyry belt. The Babine intrusions are exposed in a north-trending belt which extends from Fulton Lake in the south to Trail Peak in the north (MacIntyre *et al.*, 1997). They comprise plugs and dikes of biotite-feldspar porphyry, rhyolite dikes and domes and, less abundantly, granodiorite to quartz diorite. Rhyolite dikes and domes are best exposed near Old Fort Mountain, where they form an arcuate belt of resistant siliceous rocks which MacIntyre *et al.* (1997) likened to the remnants of a ring dike structure. MacIntyre *et al.* (1997) noted that the compositional similarity between the Babine Intrusions, and the older Bulkley Intrusions and Kasalka volcanics to the west, suggested that very similar volcanic environments prevailed during Late Cretaceous and Eocene time.

The Newman volcanics, best exposed along the shores of the Newman Peninsula in Babine Lake, comprise calc-alkaline biotite-feldspar porphyry flows, breccias and lahars which are extrusive equivalents to the Babine intrusions. They are correlable to the Ootsa Lake

Group, widespread in other parts of central B.C., which here form Eocene-age flows, breccias and lahars. Overlying the Ootsa Lake Group are vesicular basalt of the Buck Creek formation, Endako Group. These are the youngest rock units in the Babine survey area.

MINERAL DEPOSITS

Porphyry-style copper deposits are the most important mineral deposit type within the bounds of the Babine survey area, and have been the focus of mineral exploration in this area for several decades. They include those deposits associated with: (i) Eocene-age Babine intrusives, and (ii) Late Cretaceous-age Bulkley intrusives. Only a short commentary on these mines and mineral localities is given here; more detailed descriptions are provided by sources such as MacIntyre *et al.* (1997), Carter *et al.* (1995), Dirom *et al.* (1995) and relevant assessment reports.

The survey area includes the former Bell (MINFILE 93M 001) and Granisle (MINFILE 93L 146) copper-gold mines, which are located on or near the Newman Peninsula in the northern part of Babine Lake. The Bell and Granisle mines operated during the periods 1972-1992 and 1966-1982, respectively. These, and other porphyry copper ± gold prospects such as the Hearne Hill (MINFILE 93M 006), Nak (MINFILE 93M 010) and Trail Peak (MINFILE 93M 011) deposits, are hosted by Eocene biotite-feldspar porphyry Babine Intrusives. These deposits typically exhibit potassic and propylitic alteration zones around a smaller central ore zone of copper-sulphide minerals, as well as extensive pyrite halos with marginal polymetallic veins.

Porphyry copper-molybdenum mineralization is associated with Late Cretaceous Bulkley intrusions at the Lennac Lake Prospect (MINFILE 93L 190) in the southern part of the survey area. Here, copper and molybdenum mineralization is associated with a quartz diorite porphyry stock and dikes within Hazelton Group volcanics. There are no other porphyry copper prospects associated with the older Bulkley Intrusions within the Babine porphyry belt, but numerous similar deposits including the Bear, Huckleberry and Ox Lake deposits occur to the south and west of the survey area.

OTHER GEOCHEMICAL SURVEYS AND RESEARCH IN THE REGION

In addition to the Babine survey, several other publicly-available Regional Geochemical Surveys (RGS) of have been conducted in this part of the Interior Plateau. These include lake sediment, stream sediment and till geochemical surveys.

A regional stream and lake sediment survey of the Smithers map area (NTS 93L) was conducted during 1986 (Johnson *et al.*, 1987b), incorporating the southernmost part of the present Babine survey area. However, this and an adjacent survey of the neighbouring Whitesail Lake map area (NTS 93E; Johnson *et al.*, 1987a) were primarily stream sediment surveys, and lake sediment sampling was confined to the eastern parts of the map sheets. Lake sampling density was very low by NGR geochemical mapping standards, in the order of one site per 30-35 square kilometres, limiting the resolution of regional geochemical trends. Furthermore, the range of element data is limited; no INAA sediment data was provided to complement the standard AAS element suite, although fire assay gold data was reported.

The northern part of the Babine porphyry belt also falls within the bounds of the 1983 RGS stream sediment survey of the Hazelton map area (NTS 93M; McMillan *et al.*, 1984). No stream sediment gold or INAA data is presently available for this area. However, integration of the earlier RGS stream sediment data with lake sediment data contained in this report should aid in geochemical interpretations in the Babine belt.

The Geological Survey Branch also conducted surficial mapping and regional till geochemical surveys over the whole of the Babine porphyry belt during the period 1995-1996. Preliminary information on the till surveys is reported by Stumpf *et al.* (1996), Huntley *et al.* (1996) and Levson *et al.* (1997b). Till geochemical data for the Old Fort Mountain area (NTS 93M/1), in the central part of the Babine belt, was released in May 1997 (Levson *et al.*, 1997c); release of remaining data is pending.

Other geochemical research in the Babine belt has focused on the usefulness of soil and till geochemistry in detecting buried porphyry copper deposits. Levinson and Carter (1979) and Okon (1974) discussed perils in the use of soil geochemistry in the Babine area due to the widespread occurrence of exotic glaciolacustrine silts. A Geological Survey Branch till dispersal study, initiated in 1996, is presently underway in the vicinity of several Babine porphyry prospects (Levson *et al.*, 1997a).

Mineral exploration industry surveys preceded government-funded regional lake sediment surveys in the Nechako Plateau during the 1960's and 1970's, but this data is not generally available in the public domain. Accounts of some industry surveys are described in the literature (*e.g.* Mehrtens *et al.*, 1973; Mehrtens, 1975; Hoffman and Fletcher, 1976; Gintautas, 1984).

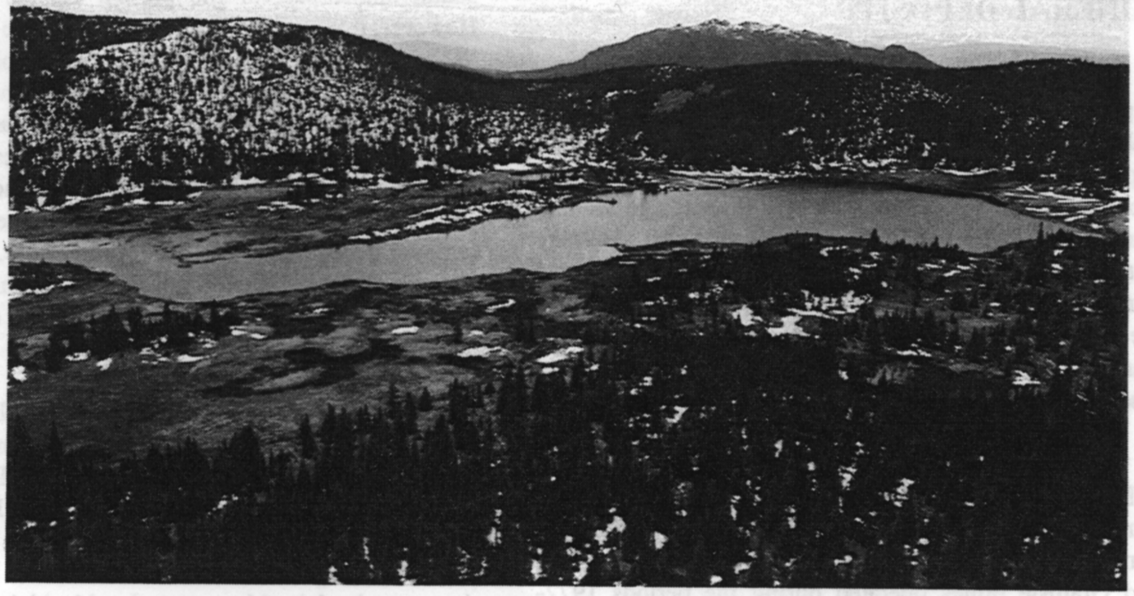

Photo 1. View of a lake on the flank of Matzehtzel Mountain, looking southwest toward Tachek Mountain, at the southern margin of the Babine survey area (June, 1996).

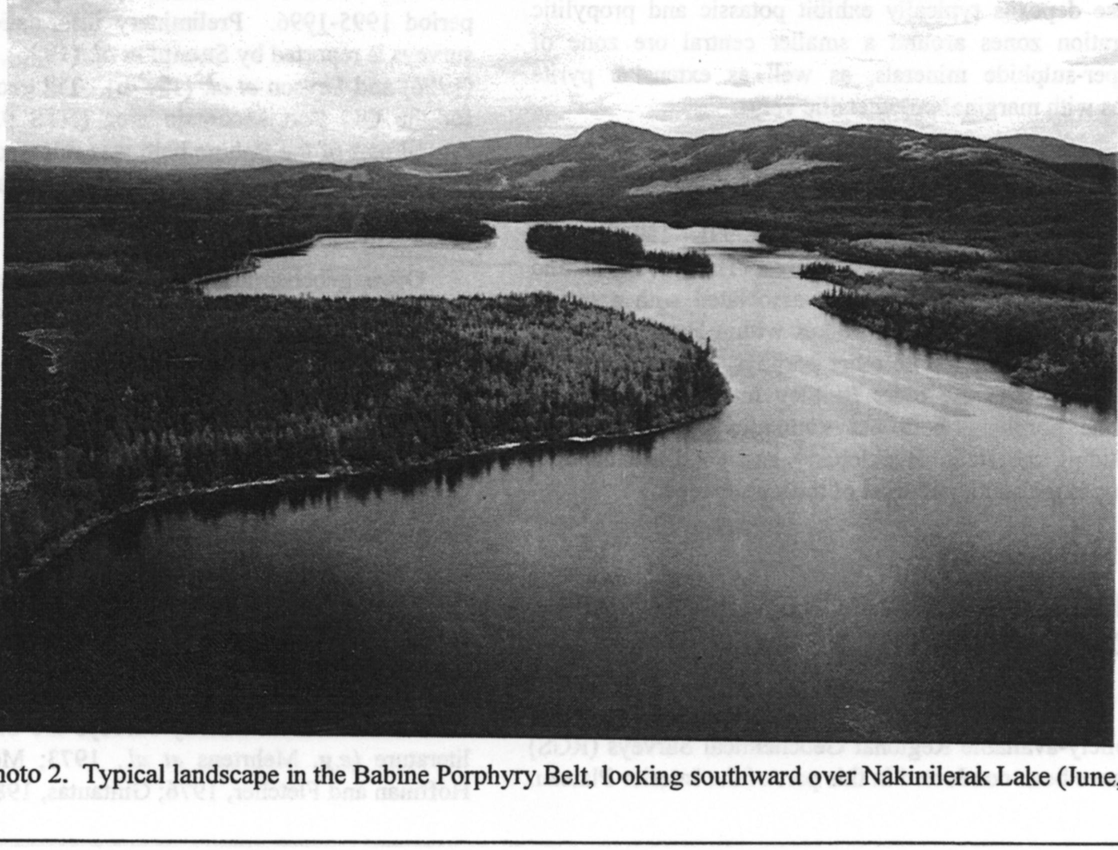

Photo 2. Typical landscape in the Babine Porphyry Belt, looking southward over Nakinilerak Lake (June, 1996).

SURVEY METHODOLOGY

SAMPLE COLLECTION

Helicopter-supported sample collection in the Babine survey area was conducted by the authors during June 1996. A sediment sample and a water sample were systematically collected at each site using a float-equipped Bell 206 helicopter. A total of 352 sediment and water samples were collected from 332 sites (Table 1), at an average site density of approximately 1 per 10.3 square kilometres.

Survey	NTS	Area (square km)	Sampling Density	Sites	Samples
Fawnie	93F/2,3	1862.6	7.9	237	251
Ootsa	93F/6,11,12,13,14 (parts thereof)	1650	7.4	224	238
Pinchi Lake	93K/9,10,15,16	3584.2	8.7	413	438
Babine	93L/9,16; M/1,2,7,8	3406	10.3	332	352
North Gataga	parts of 94M, 104P	5000	11.2	445	471
Totals:		15502.8	9.4	1651	1750

Table 1. Summary of lake sediment geochemistry surveys conducted in central and northern British Columbia during the period 1993-1996. Sampling density is in sites per square kilometre.

SEDIMENTS

Sediments were sampled using a Hornbrook-type torpedo sampler and samples placed in large (5" x 6") Kraft paper bags. On the basis of results of prior orientation studies (Cook, 1993a,b), regional surveys in British Columbia incorporate some departures from standard lake sediment sampling strategies used elsewhere in Canada for the National Geochemical Reconnaissance (NGR) program (Friske, 1991; Friske and Hornbrook, 1991), particularly pertaining to overall site density and the number of sites sampled in each lake.

First, every lake in the survey area was sampled, rather than sampling only a selection of lakes at a fixed density (*i.e.* one site per 13 km^2). Sediment in even small ponds may contain anomalous metal concentrations related to nearby mineralization such as that at the Wolf and Tsacha prospects in the Nechako Plateau (Cook, 1995; Cook *et al.*, 1997). In practice, some small ponds were not sampled due to unfavourable landing conditions. Samples are not generally collected from the centres of very large and deep lakes (> 10 km^2; > 40 m deep), such as Babine, Fulton or Morrison lakes. Organic soils from shallow swamps and bogs were also avoided.

Secondly, centre-lake sediment samples were collected following standard NGR procedure, but sediment from the centres of all major known or inferred sub-basins was also collected to investigate the considerable trace element variations which may exist among sub-basins of the same lake. Consequently, several sites were sampled in some of the larger lakes such as Morrison, Nakinilerak and Friday lakes. Lake bathymetry maps in unpublished reports of the Fisheries Branch, Ministry of Environment, Lands and Parks (Balkwill, 1991) are routinely consulted prior to sampling larger lakes in order to aid in site location.

WATERS

Lake water samples were collected at each site in 250-millilitre high-density polyethylene (HDPE) Nalgene bottles using a custom-designed sampling apparatus. Waters were sampled from approximately 15 centimetres below the lake surface to avoid collection of surface scum, and precautions were taken to minimize suspended solids. These waters were collected for determination of the standard RGS analytical suite (pH, uranium, fluoride, sulphate). An additional 250-millilitre lake water sample was also collected at every second site for more extensive multi-element ICP-MS analysis of trace and major elements. A total of 176 sites were sampled; data for these will be released at a later date.

FIELD OBSERVATIONS

A variety of field variables and observations pertaining to sample media, site and local terrain were recorded at each site using Geological Survey of Canada lake sediment cards (Garrett, 1974). These included sample depth, colour and composition, as well as the general relief and potential sources of contamination. The absence or presence of suspended solids in water samples was also noted. Sample depth was measured by means of graduated markings on the sampling rope.

Site locations were marked on 1:50000 scale NTS topographic maps in the field, transferred to master basemaps, and later digitized at the British Columbia Geological Survey Branch to obtain Universal Transverse Mercator (UTM) site coordinates (NAD27). Variables such as site geology, which reflects the dominant geological unit of the lake catchment, and lake area were coded after sample collection. Site geology was taken from MacIntyre *et al.* (1994), and manually verified to ensure that lake watersheds corresponded to the coded geological unit. Common lake names used on NTS topographic maps and B.C. Forest Service maps were included where applicable. Element maps in Appendix D incorporate a NAD83 topographic base, and both NAD27 and NAD83 UTM site coordinates are included in the data listings in Appendix A.

SAMPLE PREPARATION

SEDIMENTS

Sediment samples were field dried and, when sufficiently dry to transport, shipped to Bondar-Clegg and Company, Ottawa, for final drying (max: 25-30°C) and sample preparation. Preparation was conducted under Geological Survey of Canada supervision. The entire sample, to a maximum of about 250 grams, was pulverized in a ceramic ring mill and screened to minus 80 mesh (< 177 microns). Two analytical splits (20-30 grams each) were taken from the pulverized material for subsequent analysis.

WATERS

All lake water samples were kept cool following collection, and shipped to the Analytical Sciences Laboratory, Victoria, for insertion of control reference standards and distilled water blanks into the sample suite. No further preparation procedures were performed on routine raw lake water samples prior to analysis.

Samples collected for the expanded ICP-MS lake water geochemistry survey were filtered to 0.45 microns by the authors using Sartorius filters (47 mm) and a Nalgene filtration apparatus with hand pump. Filtered waters were transferred to 250-millilitre I-Chem Certified high-density polyethylene (HDPE) acid-washed bottles, and acidified to approximately pH=2 with concentrated nitric acid as per standard methods for analysis of metals (APHA/AWWA/WEF, 1992). Water colour was also recorded at this time.

SAMPLE ANALYSIS

Analysis of routine lake sediment and water samples was conducted by contract laboratories in accordance with established National Geochemical Reconnaissance (NGR) analytical methods. Analytical methods are strictly specified and carefully monitored to ensure consistent and reliable results regardless of the region, year or analytical laboratory. Element suites, detection limits and details of analytical procedures may differ slightly, however, from those reported by Cook and Jackaman (1994) or Cook *et al.* (1997a) for lake sediment surveys of the Nechako River and Fort Fraser map areas, respectively. For example, iron, arsenic, antimony and zinc data for both analytical methods are reported here. INAA nickel, selenium, strontium and molybdenum were reported in some prior surveys, but INAA determinations of these elements for the Babine survey are hampered by inadequate detection limits (nickel), very low abundances relative to detection limits (selenium, strontium) or poor precision (molybdenum), and are not included here. Selenium AAS data are also not given here, although reported by Cook *et al.* (1997a) for the Fort Fraser area. Conversely, INAA zinc data is reported here for the Interior Plateau for the first time.

SEDIMENTS - AAS

A split of each prepared sediment sample was analyzed by CanTech Laboratories Inc., Calgary, Alberta for 16 elements: zinc, copper, lead, silver, molybdenum, cobalt, mercury, iron, manganese, nickel, fluorine, cadmium, vanadium, bismuth, antimony and arsenic. Loss on ignition (LOI) was also determined. Stated analytical detection limits for each element are listed in Table 2. Those concentrations below the stated detection limits are presented in data listings as a value equivalent to one-half the detection limit.

- For the determination of cadmium, cobalt, copper, iron, lead, manganese, nickel, silver and zinc, a 1 gram sample was reacted with 3 millilitres of concentrated HNO_3 for 30 minutes at 90°C. Concentrated HCl (1 millilitre) was added and the digestion was continued at 90°C for an additional 90 minutes. The sample solution was then diluted to 20 millilitres with metal-free water and mixed. Element concentrations were determined by atomic absorption spectroscopy (AAS) using an air-acetylene flame. Background corrections were made for lead, nickel, cobalt and silver.

- Mercury was determined by the Hatch and Ott procedure with some modifications. A 0.5 gram sample was reacted with 20 millilitres concentrated HNO_3 and 1 millilitre concentrated HCl in a test tube for 10 minutes at room temperature and then for 2 hours in a 90°C hot water bath. After digestion, the sample was cooled and diluted to 100 millilitres with metal-free water. The mercury present was reduced to the elemental state by the addition of 10 millilitres of 10% weight-to-volume $SnSO_4$ in H_2SO_4. The mercury vapour was then flushed by a stream of air into an absorption cell mounted in the light path of an atomic absorption spectrometer (CV-AAS). Measurements were made at 253.7 nanometres. This method is described by Jonasson *et al.* (1973).

- Molybdenum and vanadium were determined by aqua regia digestion - atomic absorption spectroscopy (AAS) using a nitrous oxide acetylene flame. A 0.5 gram sample was reacted with 1.5 millilitres concentrated HNO_3 at 90°C for 30 minutes. At this point 0.5 millilitres of concentrated HCl was added and the digestion continued for an additional 90 minutes. After cooling, 8 millilitres of 1250 ppm Al solution was added and the sample solution diluted to 10 millilitres before determination by AAS.

- Arsenic and bismuth were determined by aqua regia digestion - hydride generation atomic absorption spectroscopy. A 1 gram sample was reacted with 3 millilitres of concentrated HNO_3 for 30 minutes at 90°C. Concentrated HCl (1 ml) was added and the digestion was continued at 90°C for an additional 90 minutes. A 1 millilitre aliquot was diluted to 10 ml with 1.5M HCl in a clean test tube. The diluted sample solution was added to a sodium borohydride solution and the hydride vapour aspirated through a heated quartz tube in the light path of an atomic absorption spectrometer (AAS-H).

- Antimony was determined as described by Aslin (1976). A 0.5 gram sample was placed in a test tube with 3 millilitres concentrated HNO_3 and 9 ml HCl. The mixture was allowed to stand overnight at room temperature prior to being heated to 90°C and maintained at this temperature for 90 minutes. The mixture was cooled and a 1 millilitre aliquot was diluted to 10 ml with 1.8M HCl. This dilute solution was determined by hydride evolution-atomic absorption spectroscopy (AAS).

- Fluorine was determined by specific ion electrode as described by Ficklin (1970). A 250 milligram sample was sintered with a 1-gram flux consisting of two parts by weight sodium carbonate and 1 part by weight potassium nitrate. The residue was leached with water. The sodium carbonate was neutralized with 10 millilitres 10% weight-by-volume citric acid, and the resulting solution diluted with water to 100 millilitres. Fluoride was then measured with a fluoride ion electrode (ION) and a reference electrode.

- Loss on ignition was determined using a 0.5 gram sample. The sample was weighed into a 30 millilitre beaker, placed in a cold muffle furnace and heated to 500°C over a period of 2 to 3 hours. The sample was maintained at this temperature for 4 hours, then allowed to cool to room temperature before weighing (GRAV).

SEDIMENTS - INAA

An approximately 30 gram split of each sample was analyzed for 27 elements (gold, antimony, arsenic, barium, bromine, calcium, cerium, cesium, chromium, cobalt, europium, hafnium, iron, lanthanum, lutetium, neodymium, rubidium, samarium, scandium, sodium, tantalum, terbium, thorium, tungsten, uranium, ytterbium and zinc) by Activation Laboratories, Ancaster, Ontario, using thermal instrumental neutron activation analysis (INAA). This technique involves irradiating the sample for 30 minutes in a neutron flux of $7x10^{11}$ neutrons/cm^2/second. After a decay period of approximately 1 week, gamma-ray emissions for the elements were measured using a gamma-ray spectrometer with a high-resolution, coaxial germanium detector. Counting time was approximately 15 minutes per sample and the results were compiled on a computer and converted to concentrations. A complete list of elements and their stated instrumental detection limits are given in Table 2. Additional data for eight elements (molybdenum, silver, mercury, irridium, nickel, tin, selenium and strontium) were not published because of inadequate detection limits, low element abundances and/or poor precision. Gold concentrations below the stated detection limits are presented in data listings as a value equivalent to one-half the detection limit. Analytical sample weights are also reported. Note that INAA data for only 331 sites are reported.

WATERS

Routine unfiltered lake waters were analyzed for the standard RGS water analytical suite of pH, uranium, fluoride and sulphate at CanTech Laboratories, Inc., Calgary. Stated detection limits are given in Table 2.

- Hydrogen ion activity (pH) was measured, on a separate sample aliquot, with a Fisher Accumet pH meter with glass-calomel combination electrode (GCE).

- Uranium was determined by laser-induced fluorescence (LIF) using a Scintrex UA-3 uranium analyzer. A complexing agent, known commercially as Fluran and composed of sodium pyrophosphate and sodium monophosphate (Hall, 1979), is added to produce a uranyl pyrophosphate species which fluoresces when exposed to the laser. As organic matter in the sample can cause unpredictable behaviour, a standard addition method is used. A total of 500 microlitres of Fluran solution was added to a 5 millilitre sample and allowed to stand for 24 hours, as the reaction of uranium with the complexing agent may be delayed or sluggish. At the end of this period fluorescence readings were made with the addition of 0.0, 0.2 and 0.4 ppb uranium. For high-concentration samples, the additions were 0.0, 2.0 and 4.0 ppb uranium. All readings are taken against a sample blank.

- Fluoride was determined by ion selective electrode (ION). A 20 millilitre aliquot of the sample was mixed with 20 millilitres of TISAB II (total ionic strength adjustment buffer) buffer solution. Fluoride was determined with an Orion fluoride electrode in conjunction with a Corning ion meter.

- Sulphate was determined by a turbidimetric method (TURB). A 50 millilitre aliquot was mixed with barium chloride and an isopropyl alcohol-HCl-NaCl reagent, and turbidity of the resulting barium sulphate solution measured with a spectrophotometer at 420 nanometres.

TABLE 2. ANALYTICAL METHODS AND STATED DETECTION LIMITS: LAKE SEDIMENTS AND WATERS

Element		**Detection Limit**	**Method**	**Element**		**Detection Limit**	**Method**
Antimony	Sb	0.2 ppm	AAS	Gold	Au	2 ppb	INAA
Arsenic	As	0.2 ppm	AAS-H	Antimony	Sb	0.1 ppm	INAA
Bismuth	Bi	0.1 ppm	AAS-H	Arsenic	As	0.5 ppm	INAA
Cadmium	Cd	0.2 ppm	AAS	Barium	Ba	50 ppm	INAA
Cobalt	Co	2 ppm	AAS	Bromine	Br	0.5 ppm	INAA
Copper	Cu	2 ppm	AAS	Calcium	Ca	1%	INAA
Fluorine	F	40 ppm	ION	Cerium	Ce	3 ppm	INAA
Iron	Fe	0.05%	AAS	Cesium	Cs	1 ppm	INAA
Lead	Pb	2 ppm	AAS	Chromium	Cr	5 ppm	INAA
Manganese	Mn	5 ppm	AAS	Cobalt	Co	1 ppm	INAA
Mercury	Hg	10 ppb	CV-AAS	Europium	Eu	0.2 ppm	INAA
Molybdenum	Mo	2 ppm	AAS	Hafnium	Hf	1 ppm	INAA
Nickel	Ni	2 ppm	AAS	Iron	Fe	0.01%	INAA
Silver	Ag	0.2 ppm	AAS	Lanthanum	La	0.5 ppm	INAA
Vanadium	V	5 ppm	AAS	Lutetium	Lu	0.05 ppm	INAA
Zinc	Zn	2 ppm	AAS	Neodymium	Nd	5 ppm	INAA
Loss On Ignition	LOI	0.1%	GRAV	Rubidium	Rb	15 ppm	INAA
				Samarium	Sm	0.1 ppm	INAA
				Scandium	Sc	0.1 ppm	INAA
pH-water	pH	0.1	GCE	Sodium	Na	0.01%	INAA
Sulphate-water	SO4	1 ppm	TURB	Tantalum	Ta	0.5 ppm	INAA
Fluoride-water	FW	20 ppb	ION	Terbium	Tb	0.5 ppm	INAA
Uranium-water	UW	0.05 ppb	LIF	Thorium	Th	0.2 ppm	INAA
				Tungsten	W	1 ppm	INAA
				Uranium	U	0.5 ppm	INAA
				Ytterbium	Yb	0.2 ppm	INAA
				Zinc	Zn	50 ppm	INAA

AAS: atomic absorption spectrometry
CV-AAS: cold vapour-atomic absorption spectrometry
GCE: glass-calomel combination electrode
GRAV: gravimetry
INAA: instrumental neutron activation analysis
ION: ion selective electrode
LIF: laser-induced fluorescence
IC: ion chromatography
TURB: turbidimetry

QUALITY CONTROL PROCEDURES AND RESULTS

METHODOLOGY

The ability to discriminate real geochemical trends from those resulting from sampling and analytical variation is of considerable importance in the interpretation of geochemical data. Control reference standards and analytical duplicates are routinely inserted into sample suites to monitor and assess accuracy and precision of analytical results. Control reference standards are used to assess analytical accuracy. Sampling and analytical variation can be quantified using estimates of precision within and between sample sites determined by utilizing field and analytical duplicate data. In accordance with standard National Geochemical Reconnaissance (NGR) and Regional Geochemical Survey (RGS) quality control procedures, each block of 20 lake sediment samples contains (Figure 2):

- Seventeen routine samples,
- One field duplicate sample collected adjacent to one of the routine samples,
- One blind duplicate sample split from one of the 17 routine samples prior to analysis,
- One control reference standard containing sediment of known element concentrations.

The locations of blind duplicate and control reference samples are selected prior to sampling, whereas field duplicate sites are chosen randomly during fieldwork. At these sites, two samples are taken by successive drops of the torpedo sampler. These samples are used to monitor combined sampling and analytical precision, and are a measure of within-site variation. Blind, or analytical, duplicate samples are usually taken from the first sample of each field duplicate pair following sample preparation, and reinserted into the suite to monitor analytical precision. In practice, dry lake sediment samples are sometimes too small (as little as 50 grams) for a blind duplicate split. Here, 50 per cent of the blind duplicates are taken from the corresponding field duplicate sample; the remainder are taken from another routine sample within the block. Blind duplicates are not used in the water suite; a distilled water blank is instead inserted to monitor analytical contamination.

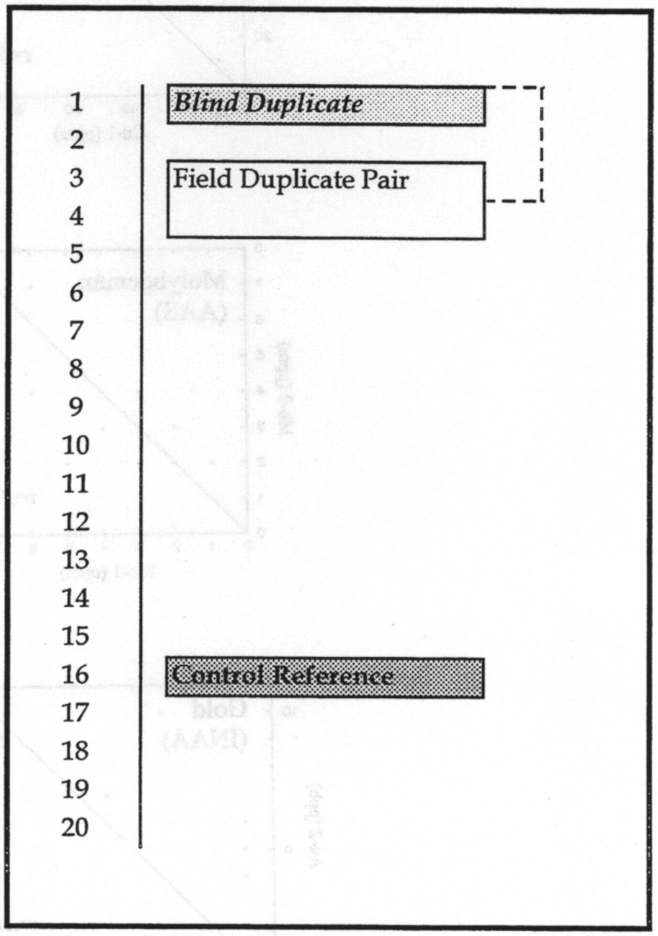

Figure 2. Typical Regional Geochemical Survey sample collection scheme used during the lake sediment survey. The 20-sample collection block incorporates 17 routine samples, a field duplicate sample, a blind duplicate sample and a control reference standard. Blind duplicates are routinely taken from the first sample of each field duplicate pair.

ANALYTICAL PRECISION AND ACCURACY

Variations in element concentrations in lake sediments may be due to regional geological and geochemical variations (different bedrock lithologies and surficial materials, absence or presence of mineralization, limnological variations), within-site variations (combined sampling, preparation and analytical variations), or analytical variation alone. As noted by Fletcher (1981), a high degree of analytical precision is of limited

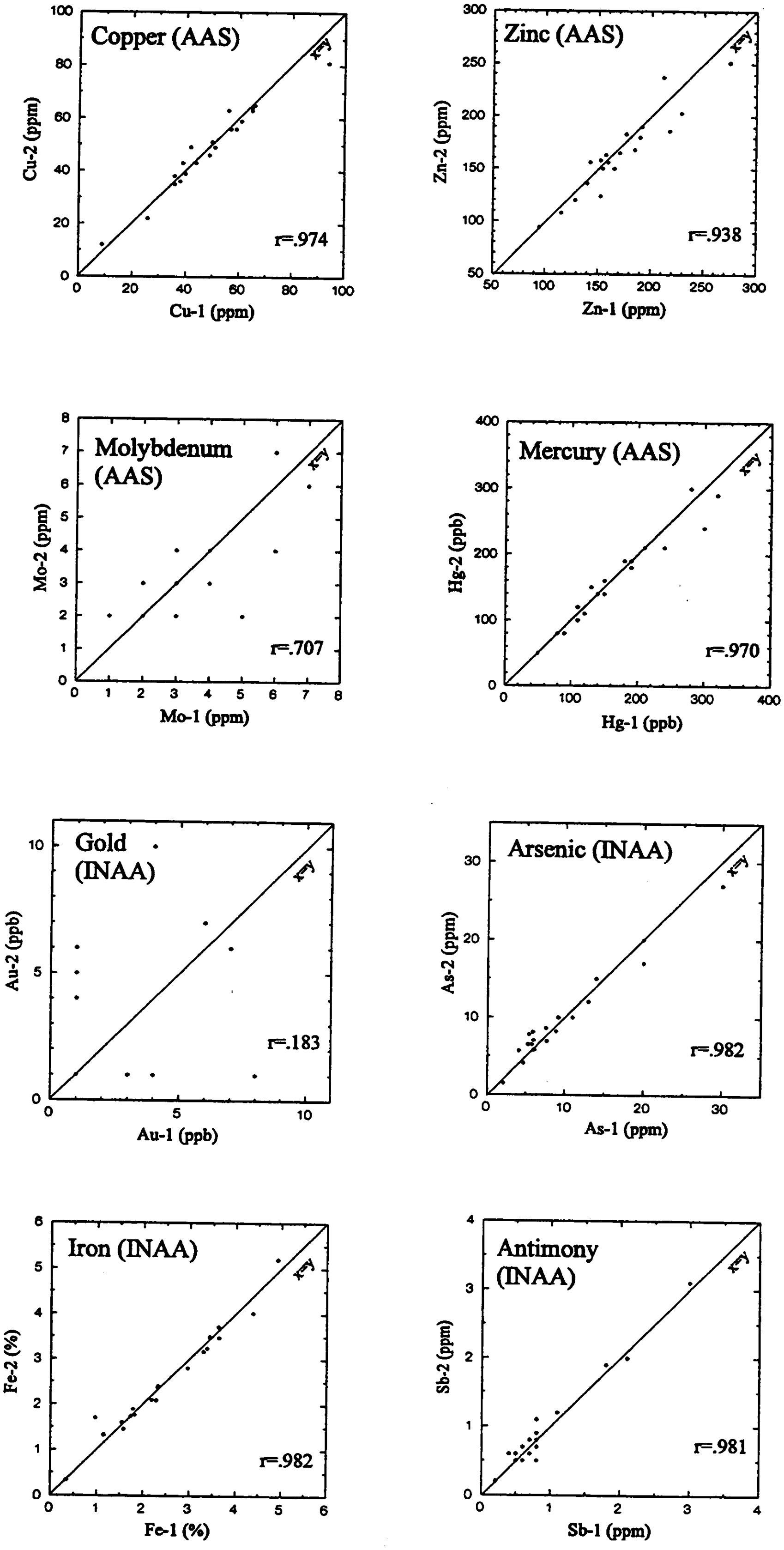

Figure 3. Scatterplots of field duplicate pairs (N=20) for gold, arsenic, iron and antimony (INAA) and for copper, zinc, molybdenum and mercury (AAS).

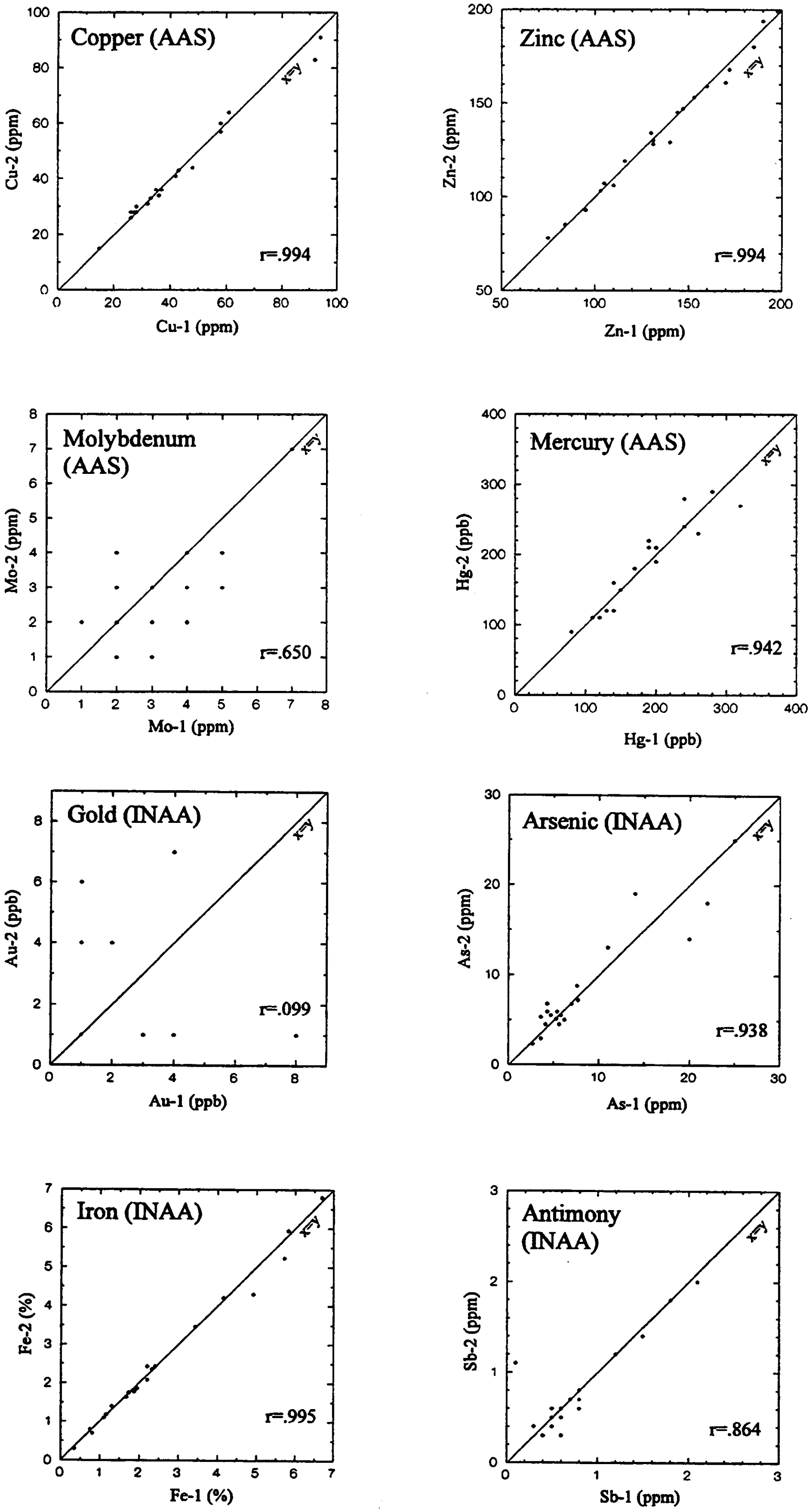

Figure 4. Scatterplots of blind duplicate pairs (N=20) for gold, arsenic, iron and antimony (INAA) and for copper, zinc, molybdenum and mercury (AAS).

importance if the sample collection and preparation error is so great as to be indistinguishable from the regional geochemical variation.

Scatterplots of analytical results for 20 field duplicate pairs (Figure 3) and 20 blind duplicate pairs (Figure 4) are shown for gold, arsenic, antimony and iron (INAA) and for copper, zinc, molybdenum and mercury (AAS). Very good reproducibility, particularly for those elements with concentrations well above detection limits, imparts a high degree of confidence in the quality of both the sampling and analytical procedures. Estimates of analytical precision at different concentration levels are not given for the 20 blind duplicate pairs, as this is fewer than the minimum of 50 pairs recommended by Thompson and Howarth (1978). However, mean relative standard deviation (RSD) values were calculated for both field and blind duplicate pairs of gold determinations by averaging the per cent RSD between each pair. Mean RSD for blind duplicate gold values (n=20 pairs) is 34.3%; mean RSD for field duplicate gold values (n=20 pairs) is higher at 53.3%. The greater precision attained with analysis of blind duplicate pairs is expected, as it is a measure of subsampling and analytical variability only. Analysis of field duplicate sample pairs, on the other hand, measures a combination of field sampling, preparation, subsampling and analytical variability. Field duplicate data for all elements are included within the data listings (as Rep 10 and Rep 20) in Appendix A, and analytical duplicate data are listed in Appendix B.

Two internal standards and a CANMET certified standard (LKSD-1) were used as routine control standards (n=20) for the Babine survey. Analytical data for the control standards compare favourably with accepted values, indicating a high degree of analytical accuracy. For example, AAS analyses of the three standards returned mean copper concentrations of 154.7 ± 3.2 ppm, 48.3 ± 2.3 ppm and 46.4 ± 1.1 ppm (LKSD-1) copper relative to accepted values of 158-171 ppm, 41-44 ppm, and 47 ± 1 ppm copper, respectively. Similarly, mean zinc concentrations for the three standards are 48.0 ± 1.8 ppm, 118.8 ± 2.6 ppm, and 347.1 ± 7.6 ppm (LKSD-1) zinc relative to accepted values of 48-49 ppm, 84-102 ppm, and 337 ± 11 ppm zinc, respectively. Accepted values for internal standards are based on numerous RGS sample analyses conducted over a period of several years. Accepted values for LKSD-1 are from Lynch (1990).

As a measure of the analytical precision of control standards results, relative standard deviation (% RSD) values determined from six to seven replicate analyses of each of the three standards are shown (Table 3) for several elements. In the case of copper, for example, per cent RSD values do not exceed 4.8% for any of the three standards. Higher RSD values, and correspondingly poorer precision, here are associated with those elements such as lead and molybdenum, which commonly occur near the limits of analytical detection. For example, Standard 1 lead concentrations are all in the range 4-6 ppm; Standard 2 molybdenum concentrations are all in the range 2-4 ppm. For both elements, analytical reproducibility of the other two standards increases with increasing mean lead (17.3-87.6 ppm) and mean molybdenum (13.4-14.7 ppm) concentrations.

TABLE 3. SEDIMENT CONTROL STANDARDS RESULTS: PER CENT RSD VALUES FOR SELECTED ELEMENTS

AAS	Zn (%RSD)	Pb (%RSD)	Cu (%RSD)	Mo (%RSD)	As (%RSD)	Hg (%RSD)
Standard 1 (*n=7*)	3.8	20.2	2.0	3.3	9.4	13.2
Standard 2 (*n=6*)	2.2	4.7	4.8	26.6	8.1	25.7
LKSD-1 (*n=7*)	2.2	3.2	2.4	7.3	2.9	9.4

INAA	As (%RSD)	Ba (%RSD)	Fe (%RSD)	Cr (%RSD)	La (%RSD)	Ce (%RSD)
Standard 1 (*n=7*)	12.8	9.9	5.7	7.8	4.8	8.5
Standard 2 (*n=6*)	1.7	8.9	4.8	7.1	5.3	8.2
LKSD-1 (*n=7*)	11.0	15.6	8.3	8.5	7.5	12.6

The standard RGS water analytical suite included distilled water blanks and a series of internal standards. Median results of 0.04 ppb uranium, 10 ppb fluoride and 1 ppm sulphate were obtained for distilled water blanks (N=20 insertions); results are all at or below stated analytical detection limits (Table 2). Four internal water standards (N=20 insertions) were inserted in the Babine analytical suite. Most were natural waters obtained from Interior Plateau lakes. Regarding analytical precision of the water standards results, five replicate analyses of each of the four standards returned relative standard deviation (% RSD) values of 5.7 - 30.5% for uranium, 0.0 - 36.5% for fluoride and 6.6 - 21.3% for sulphate. As with sediment standards, precision is generally poorer for those elements reporting results near the analytical detection limit.

Repeat INAA analyses are routinely conducted on sediment samples reporting gold concentrations greater than the 90th percentile (Au2 in the Appendix A data listings). Here, repeat analyses were conducted on samples from 40 sites with gold concentrations of at least 6 ppb (12.1% of total sites). All reanalyses were conducted on separate splits, of varying sizes, of the original pulverized sample material. This provides a measure of both subsampling and analytical variability, rather than simply analytical variability between two batches of samples. Scatterplot results for Babine gold repeats (Figure 5) are erratic, showing gold reproducibility to be relatively poor compared to that reported from prior Interior Plateau lake sediment surveys (*e.g.* Cook *et al.*, 1997; Cook and Jackaman, 1994). Only 14 of 40 reanalyses yielded gold concentrations greater than the stated analytical detection limit of 2 ppb. Of these fourteen samples, however, ten samples returned gold concentrations of at least 6 ppb, and two returned gold concentrations in the range 10 - 16 ppb.

A mean relative standard deviation (RSD) of 82.5% was calculated for repeat gold analyses by averaging the per cent RSD between each of the 40 analytical pairs. This mean RSD is considerably greater than that reported for the Pinchi Lake survey (19.6%; Cook *et al.*, 1997) to the east of the Babine belt, although there are eight sample pairs here with RSD values < 25%. Poor reproducibility here may be at least partially attributed to the re-analysis of new sample material rather than the original INAA sample capsules. Lake sediment samples, because of their high water content, typically dry to only a fraction of their original field size and weight. Consequently, there is often only a small amount of pulp material remaining should a repeat analysis be required, and the repeat may be less representative of the sediment gold concentration than the original sample. The weights of original and repeat samples can be compared in Appendix A; twelve of the repeats have a mass of less than 10 grams, while five of these are less than 5 grams. Gold reproducibility is discussed further in the section on gold results.

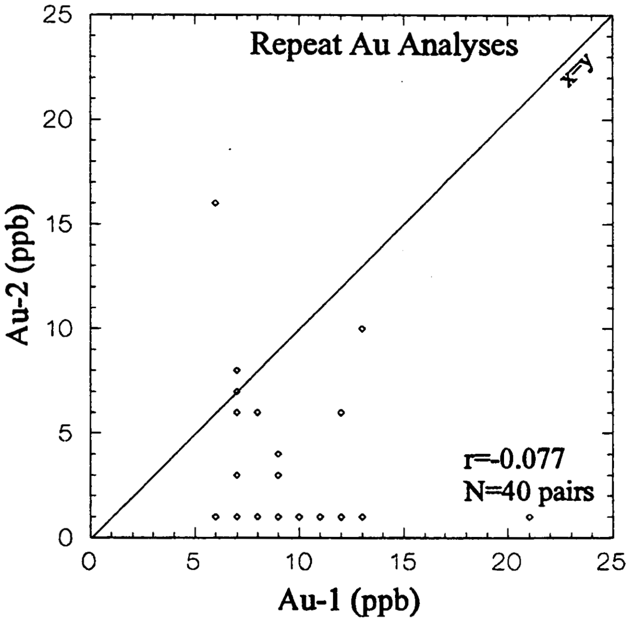

Figure 5. Scatterplot of results for 40 pairs of repeat gold analyses (ppb). Au-1 represents the original gold result; Au-2 represents the value obtained on reanalysis. Both values are reported in the data listings (Appendix A).

Photo 3. Regional lake sediment sampling in the Interior Plateau using a float-equipped helicopter.

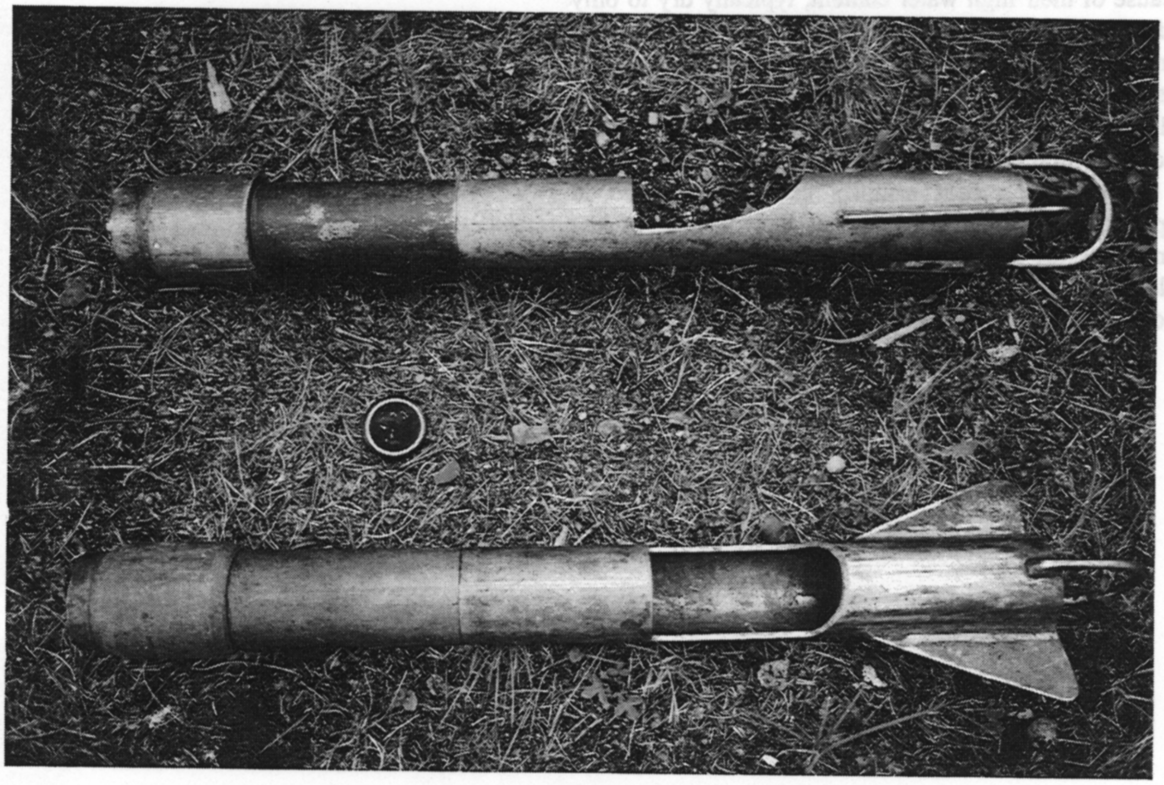

Photo 4. Hornbrook-type lake sediment sampler used in regional geochemical surveys.

PRELIMINARY DATA INTERPRETATION

FIELD VARIABLES

Distribution of lake sediment sites by geological unit in the Babine survey area is shown in Appendix D-3 and, schematically, in Figure 6. Unit designations are those of MacIntyre *et al.* (1994). The watersheds of most lake sediment sites are underlain by Cretaceous to Triassic sedimentary and volcanic units. Of these, the Telkwa Formation of the Lower to Middle Jurassic Hazelton Group contains the greatest number of sample sites (96 sites; 28.9%). Comparatively few sites are within the watersheds of intrusive units due to their relatively small size. Of these, only the Early Jurassic Topley Intrusions (19 sites; 5.7%) host a substantial number of sites.

The majority of sites in the Babine survey area (66%) are in lakes of pond size or smaller (*e.g.* < 0.25 km^2). This is similar to the proportion of pond-sized sites recorded in prior surveys of the Nechako Plateau area (Cook and Jackaman, 1994; Cook *et al.*, 1997a). Approximately 21% of the sites are in lakes in the range 0.25 to 1 km^2, but only 14 sites (4.2%) are in large lakes (*e.g.* > 5 km^2). Samples obtained from such large lakes are often from restricted bays and other relatively shallow areas. Median sample depth in the Babine survey area is 6 metres. Shallow lakes are very common, and more than one-quarter (29%) of all sites have depths of 3 metres or less (Figure 7). A majority of the sites (82%) have depths of 10 metres or less. The deepest site recorded was 37 metres, but overall deep lakes are relatively rare; only 8 sites in the entire survey area (2.4%) have sample depths of more than 20 metres.

It should be noted that sample depth, determined using a marked sampling rope, measures the distance from the water surface to the sample location within the sediment column. It is *not* entirely synonymous with lake depth, which is the distance from the water surface to the sediment-water interface, because the sampler typically penetrates up to a few metres into the sediment before coming to a stop. The depth of sediment penetration may be negligible in small ponds, but may reach up to 3 or 4 metres in large, deep lakes. Some previous surveys (*e.g.* Cook *et al.*, 1997a,b) have reported a true lake depth, measured with a float-mounted depth sounder.

The proportion of sites classed as being in areas of low relief (approximately 41%), is very similar to that encountered elsewhere in the Nechako Plateau (Cook and Jackaman, 1994; Cook *et al.,* 1997a). A further 52% of sites were classed as being in areas of medium relief. Just over 7% of sediment sites were categorized as being in areas of high relief. The Babine belt has a history of mining and mineral exploration and is presently the site of active logging activity. Potential sources of anthropogenic contamination (work or camp sites) were limited, however, to the shores of 27 (8.1%) sites.

SEDIMENTS

The following data interpretation is of a preliminary nature. Discussions on the distribution and abundance of gold, arsenic, antimony, copper, molybdenum, zinc, silver, mercury and lead are intended to highlight geochemical patterns that may be of interest to mineral explorationists, and are not exhaustive. Please refer to the appropriate 1:50000 scale NTS topographic maps for lake and place names.

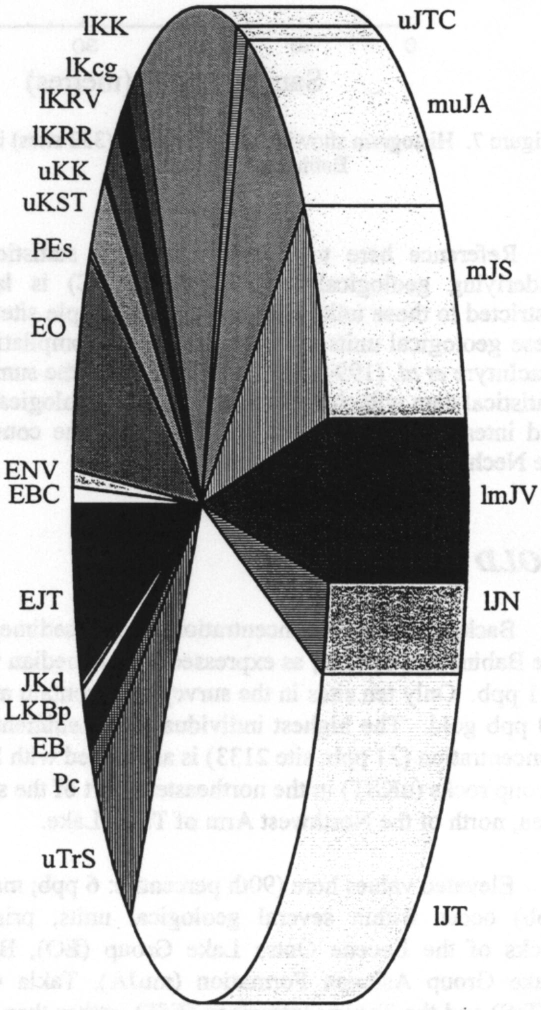

Figure 6. Distribution of 332 lake sediment sample sites by geological unit within the Babine survey area.

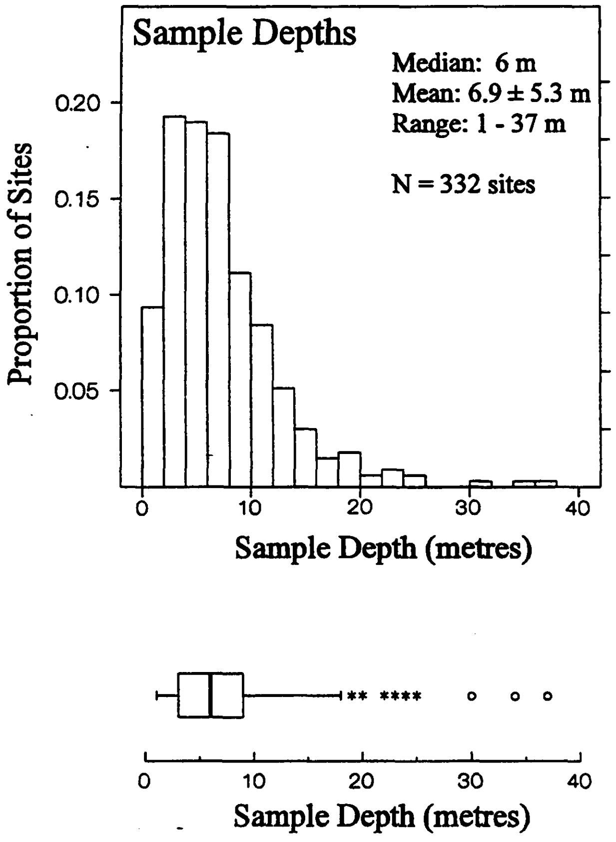

Figure 7. Histogram showing sample depths (332 sites) in the Babine survey area.

Reference here to summary element statistics for underlying geological units (Appendix C) is largely restricted to those units with at least ten sample sites. As these geological units are drawn from the compilation of MacIntyre *et al.* (1994), it is anticipated that the summary statistical data will change slightly as new geological data and interpretations become available over the course of the Nechako NATMAP Project.

GOLD

Background gold concentration in lake sediments of the Babine survey area, as expressed by the median value, is 1 ppb. Only ten sites in the survey area contain at least 10 ppb gold. The highest individual lake sediment gold concentration (21 ppb; site 2133) is associated with Sustut Group rocks (uKST) in the northeastern part of the survey area, north of the Northwest Arm of Takla Lake.

Elevated values here (90th percentile: 6 ppb; max: 21 ppb) occur within several geological units, primarily rocks of the Eocene Ootsa Lake Group (EO), Bowser Lake Group Ashman Formation (muJA), Takla Group (uTrS) and the Topley Intrusions (EJT), rather than being associated with any single unit. Nevertheless, groupings of elevated gold concentrations occur in at least four areas:

- A large northwest-southeast trending zone, approximately 15 kilometres x 7 kilometres, located in the Hautete Creek-Macdougall Creek area (NTS 93M/1). This area, extending from the southeast end of Nakinilerak Lake to the region south of Wedge Mountain, contains two sediment sites with gold values > 95th percentile, and several relatively closely-spaced sites with gold values greater or equal to the 90th percentile (6 ppb). The Dorothy copper-molybdenum prospect (MINFILE 93M 009) is within this zone. Interestingly, some of the most reproducible of elevated gold concentrations in the Babine survey area occur here. Four of only eight sites (at least 6 ppb gold) in the survey area with gold rerun RSD values < 25% are located in this zone.

- A broad area in the northeast part of the survey area (NTS 93M/8) where three widely-spaced sites with elevated gold concentrations >95th percentile occur in lake basins draining Eocene Ootsa Lake Group (EO) and, to a lesser extent, Sustut Group (ukST) rocks. The site with the highest gold concentration in the Babine survey area is among this group, which includes several sites with moderately-elevated gold values of at least 4 ppb. Two known copper showings, Bear Hill (MINFILE 93M 137) and Friday Red (MINFILE 93M 164), occur within a few kilometres of two of the sites.

- The extreme northwestern part of the survey area in the Netalzul Mountain (NTS 93M/7) map area, where two sites containing 9-12 ppb gold are associated with Lower Cretaceous Skeena Group rocks of the Red Rose Formation (lKRR).

- A small area south of Natowite Lake (NTS 93M/1), where two sites containing 11-12 ppb gold in lake sediments are associated with Hazelton Group rocks of the Telkwa Formation (lJT).

In addition to the above, several sites with elevated gold concentrations >95th percentile occur as isolated highs throughout the Babine survey area. For example, four widely-spaced sites with up to 13 ppb gold occur in the Fulton Lake-Matzehtzel Mountain area in the southern part of the survey area. Two of these sites are associated with Lower Jurassic Telkwa Formation (lJT) rocks.

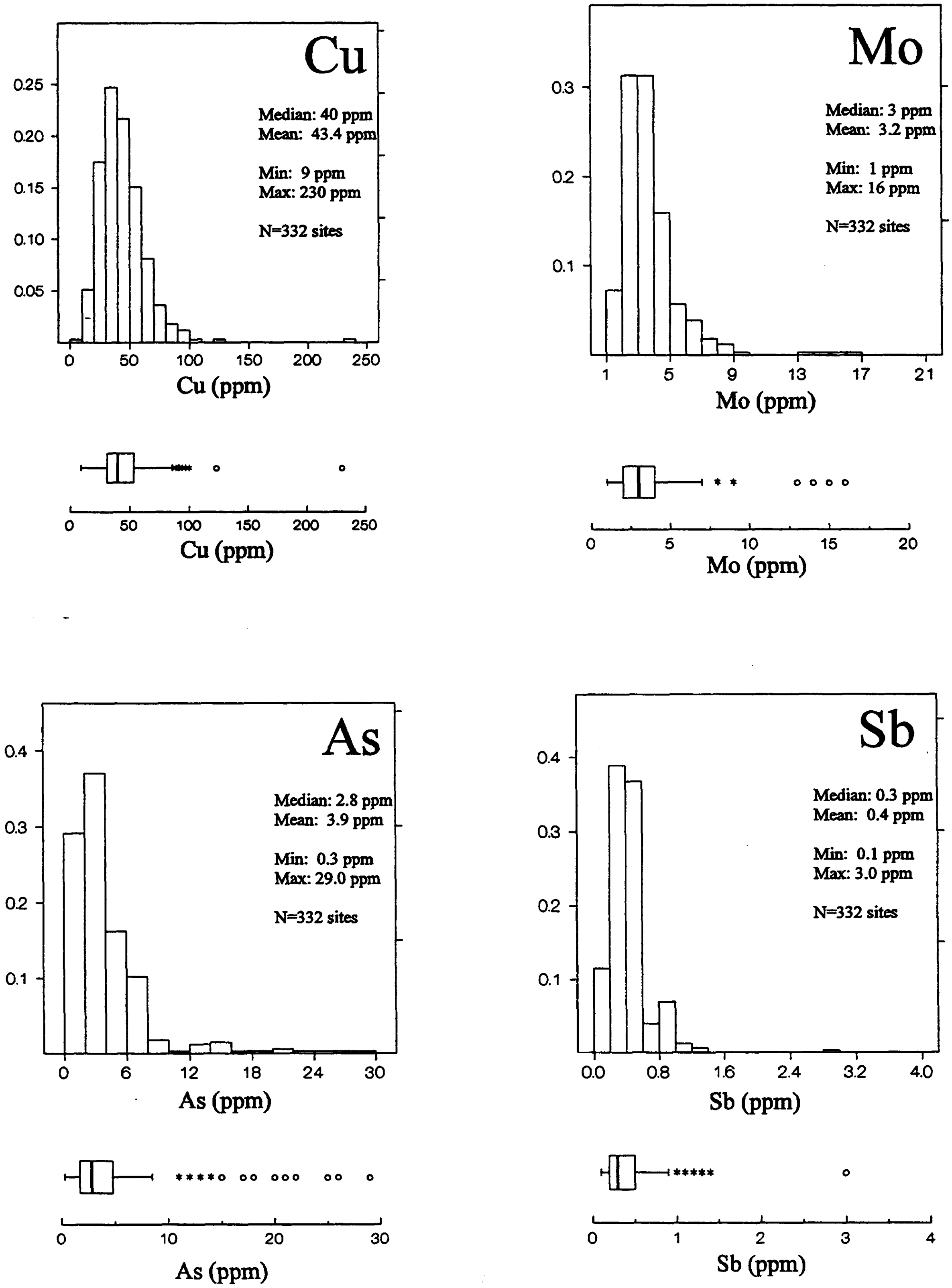

Figure 8. Histograms and boxplots showing distribution of copper, molybdenum, arsenic and antimony (AAS) in lake sediments of the Babine survey area. In the case of boxplots, fifty per cent of the data lies within the box; the lower and upper bounds of each box define the first quartile and third quartile of data, respectively.

ARSENIC AND ANTIMONY

Median arsenic and antimony concentrations (AAS) in the Babine survey area are 2.8 ppm and 0.3 ppm, respectively. Maximum concentrations are 29 ppm for arsenic and 3.0 ppm for antimony. Median INAA arsenic and antimony concentrations are 7.3 ppm (max: 39 ppm) and 0.7 ppm (max: 3.0 ppm), respectively. The following discussion is based on AAS results unless otherwise noted.

Subdivided by geological unit, median arsenic concentrations are in the range 1.1-4.9 ppm for those units with at least ten sample sites (Appendix C). Highest median arsenic concentrations (4.9 ppm) occur in lake sediments draining Hazelton Group Saddle Hill volcanics (lmJv). Median antimony concentrations by geological unit are in the range 0.2-0.6 ppm. Highest median antimony concentrations in lake sediments (0.6 ppm), together with the single highest value (3.0 ppm), are associated with Upper Triassic Takla Group rocks (uTrS).

Most elevated arsenic concentrations >95th percentile occur in two areas:

- A roughly wedge-shaped zone of regionally-elevated sediment arsenic concentrations covering much of the north-central part of the Babine survey area. This zone extends southward from the northwest corner of the survey area to the Saddle Hill area, just north of the base of Old Fort Mountain, and southeastward to Hautete Lake. Sediment sites here are associated with several Jurassic and Cretaceous sedimentary and volcanic units. Within this large area, most of the highest arsenic concentrations occur near the southern end of Morrison Lake, where four sites contain 13-29 ppm arsenic in the general vicinity of the Wolf, Morrison and Hearne Hill porphyry copper prospects.

- The Port Arthur-Deasy Creek area (93L/16) near the western side of Babine Lake, where two sediment sites near the Totem copper showing (MINFILE 93L 199) contain up to 22 ppm arsenic. INAA results for this area show a larger geochemical pattern of four closely-spaced sites containing 20-27 ppm arsenic. All sediment sites in this zone, located along the border of the Topley (NTS 93L/9) and Fulton Lake (NTS 93L/16) map areas, are underlain by the Early Jurassic Topley Intrusions (EJT). An area of more moderately-elevated arsenic concentrations extends for several kilometres to the west of this zone, toward the Lennac Lake copper prospect.

Elevated antimony concentrations >95th percentile are roughly, although not completely coincident with elevated arsenic values, and occur in two zones at opposite ends of the Babine survey area:

- The area between Morrison Lake and the Fort Babine area, where a northeast-southwest trending zone of antimony concentrations > 95th percentile occur within a regional geochemical trend of elevated antimony values similar to that described for arsenic. Six sites in this approximately 10 kilometre x 7 kilometre zone, which lies to the west of a zone of elevated arsenic in lake sediments, contain up to 1.3 ppm antimony. These sites are primarily associated with Bowser Lake Group Ashman Formation (muJA) and Hazelton Group Smithers Formation (mJS) sedimentary rocks.

- The Port Arthur-Lennac area, where a large approximately 20 kilometre x 6 kilometre zone of elevated Sb values > 90th percentile (at least 0.8 ppm) extends from the west side of Babine Lake to the Lennac Lake copper prospect. This zone is coincident with, but much larger than, a zone of elevated arsenic here. Sediment sites are associated with several rock units, most notably the Topley Intrusions (EJT), Takla Group rocks (uTrS), and the Hazelton Group Telkwa Formation (lJT). Most of the higher sediment antimony concentrations > 95th percentile (at least 0.9 ppm) are confined to the area between Port Arthur and the eastern end of Fulton Lake, where the highest antimony concentration (site 2072; 3.0 ppm) occurs near the northern margin of the zone in a small pond near the Michell Bay forest service road. AAS and INAA antimony patterns here are substantially similar, although the INAA geochemical results extend the zone farther to the west.

COPPER

The median copper concentration (AAS) in the Babine survey area is 40 ppm (maximum: 230 ppm), somewhat higher than that reported in some prior surveys of the Nechako River area (NTS 93F) to the south (Cook and Jackaman, 1994) and of the Whitesail and Smithers areas (NTS 93E, L) to the west (Johnson *et al.*, 1987a,b). However, this median copper value is lower than that reported for the Pinchi Lake survey area to the east (50 ppm; Cook *et al.*, 1997). Subdivided by geology, median copper values are in the range 32-61 ppm for those units containing at least ten sample sites (Appendix C), with the highest median values associated with Takla Group rocks (uTrS; 61 ppm) and Topley intrusive rocks (EJT; 56 ppm).

Elevated copper values > 95th percentile (75 ppm) are most commonly associated with lakes draining Hazelton Group Telkwa Formation (lJT), Topley

Intrusive (EJT) and Takla Group (uTrS) rocks. There are four distinct zones of elevated copper concentrations in the Babine survey area:

- The area around the Lennac Lake porphyry copper prospect (NTS 93L/9), where two sediment sites contain 82-230 ppm copper. One of these (site 2029) has the highest copper concentration in the Babine survey area, and is situated adjacent to known bedrock copper mineralization (Leary and Allan, 1972). These sites are associated with Bulkley intrusive (LKBp) and Hazelton Group Telkwa Formation rocks (lJT).

- The Port Arthur-Deasy Creek area (NTS 93L/9, 16) on the west side of Babine Lake, where three sites situated within Topley intrusive rocks (EJT) contain 89-100 ppm copper in sediment. Coincident elevated arsenic and antimony concentrations are also present in this area, and a group of three MINFILE showings occur west and northwest of these sites.

- The Skinhead Lake-Bonehead Lake area (NTS 93L/16) west and upslope of Granisle, where five sites in a group of closely-spaced sediment sites draining predominantly Takla Group (uTrS) rocks contain 72-83 ppm copper in sediments. Recent mapping by MacIntyre *et al.* (1996b) has resulted in the reassignment of parts of this zone to the Lower to Middle Jurassic Hazelton Group and to the Eocene Ootsa Lake Group.

- The Sparrowhawk area (NTS 93M/1) on the northwest side of Babine Lake, where four sites contain 81-123 ppm copper in lake sediments. One of these (site 2185; 123 ppm) represents the second-highest copper concentration in the Babine survey area. The sites are associated with Hazelton Group Telkwa Formation rocks (lJT), and encircle a small intrusive unit. Two MINFILE showings occur nearby: the Sparrowhawk (MINFILE 93M 160) and the Snoopy (MINFILE 93M 003) copper showings.

Among other sites in the survey area with elevated sediment copper concentrations is a small pond (site 2350) with 97 ppm copper, located just east of the Hearne Hill prospect.

MOLYBDENUM

The median molybdenum concentration in Babine survey area sediments is 3 ppm (AAS; maximum: 16 ppm), and does not vary appreciably by geological unit. No INAA molybdenum data is reported here.

Elevated molybdenum concentrations >95th percentile (6 ppm) are most closely associated with lakes draining rocks of the Hazelton Group Telkwa Formation (lJT), the Bowser Lake Group Ashman Formation (muJA), and the Eocene Ootsa Lake Group (EO). Sediment molybdenum concentrations in the Babine survey area are not particularly high compared to some parts of the Pinchi Lake survey area to the east (Cook *et al.*, 1997), where molybdenum concentrations of up to 65 ppm were recorded. Most sites here with elevated molybdenum values > 95th percentile occur as isolated highs throughout the northern part of the survey area. The most notable zone of elevated molybdenum concentrations here is a group of seven sites containing 7-15 ppm molybdenum located in the Deasy Creek-Lennac area on the western side of Babine Lake. One site here (2039) has the second-highest molybdenum concentration (15 ppm) in the Babine survey area. This zone, in the southern part of the survey area, is roughly coincident with similar zones containing elevated concentrations of copper and antimony. Most sites are associated with the Early Jurassic Topley Intrusions (EJT) or Hazelton Group Telkwa Formation rocks (lJT). Several MINFILE copper-molybdenum prospects occur within the zone; one showing, the Port Arthur molybdenum showing near Deasy Creek, was first reported by MacIntyre *et al.* (1996a) following its discovery during regional mapping of the Fulton Lake area (NTS 93L/16).

In addition to the above, several sites in the Hautete Lake-MacDougall Creek area in the east-central part of the survey area contain moderately-elevated sediment molybdenum concentrations > 90th percentile (at least 6 ppm). These sites, mostly associated with Bowser Lake Group rocks of the Ashman Formation (muJA) and Hazelton Group rocks of the Telkwa Formation (lJT), are also roughly coincident with a zone of moderately-elevated gold values.

ZINC

The median zinc concentration (AAS) in the Babine survey area is 154 ppm (maximum: 500 ppm), higher than that reported in prior surveys of the Nechako River area (Cook and Jackaman, 1994; Cook *et al.*, 1997) and of the Whitesail and Smithers areas (Johnson *et al.*, 1987a,b). The median INAA zinc concentration is higher, at 189 ppm (max: 684 ppm), but AAS and INAA zinc distribution patterns are substantially similar. Unless otherwise noted, the following discussion centres on the AAS results.

Subdivided by geological unit, median zinc concentrations are in the range 117-173 ppm for those units with at least ten sample sites (Appendix C). The highest median zinc concentrations are associated with lake sediments draining Skeena Group Kitsuns Creek

Formation (lKK; 173 ppm) and Takla Group (uTrS; 164 ppm) rocks. However, elevated zinc values >95th percentile (220 ppm) are most closely associated with Hazelton Group Telkwa Formation (lJT) and Smithers Formation (mJS) rocks.

The distribution pattern of elevated zinc concentrations in the Babine survey area exhibits the same northwest-southeast regional geochemical trend displayed by arsenic, antimony, iron, lead, mercury and several other elements. This regional trend extends from the northwest corner of the survey area to the Morrison and Nakinilerak lakes area. However, clusters of sites with high zinc values are not common. The highest individual sediment zinc concentration (site 2044; 500 ppm) is found in a subalpine lake on the southern flank of Matzehtzel Mountain. Elevated silver concentrations are also present at this site, which is associated with Telkwa Formation (lJT) rocks. The second-highest zinc concentration (site 2257; 370 ppm) is in the Saddle Hill region to the west of Morrison Lake. This site is underlain by sedimentary rocks of the Smithers Formation (mJS). In addition, elevated zinc values in lake sediments are also present on the east and west side of Hearne Hill, near the Morrison and Hearne Hill porphyry copper prospects.

SILVER

Elevated lake sediment silver concentrations in parts of the Nechako River map area (NTS 93F) to the south led to the staking of the Wolf epithermal gold prospect (Dawson, 1988) in the early 1980's. The background silver concentration in the Babine survey area, as expressed by the median value, is 0.1 ppm. Median silver concentrations here do not vary appreciably from one geological unit to another. Eleven sites have sediment silver concentrations in excess of the 95th percentile (at least 0.6 ppm); only four sites have silver concentrations of 0.8 ppm or greater.

The maximum silver concentration (site 2292; 1.0 ppm) is located in the extreme northwestern corner of the survey area in a region of Red Rose Formation (lKRR) sedimentary rocks of the Lower Cretaceous Skeena Group. Elsewhere, small groupings of elevated silver values occur, in part, in (i) the Skinhead-Bonehead lakes region west of Granisle, (ii) the Saddle Hill area west of Morrison Lake, and (iii) the northeastern corner of the survey area, between the two arms of Takla Lake. In addition, a single site (2044) containing 0.7 ppm silver, 500 ppm zinc, 30 ppm lead and 4.6 ppm cadmium occurs on Matzehtzel Mountain along the southern margin of the survey area.

MERCURY

The median mercury concentration of Babine survey area lake sediments is 140 ppb (max: 500 ppb), similar to the 130 ppb median reported for the Pinchi Lake area (Cook *et al.*, 1997), but greater than median mercury values of 80-110 ppb documented in the Nechako River map area (Cook and Jackaman, 1994).

The following discussion is based on raw data only. Median mercury concentrations, by geological unit, are in the range 110-210 ppb for those units with at least ten sample sites. The highest median mercury values occur in lakes draining Hazelton Group Saddle Hill volcanics (lmJv; 210 ppb), Skeena Group Kitsuns Creek Formation (lKK; 180 ppb) and Hazelton Group rocks of the Smithers Formation (mJS; 170 ppb). Elevated mercury concentrations > 95th percentile (310 ppb) are most closely associated with Kitsuns Creek Formation and Saddle Hill rocks. The distribution pattern of elevated mercury concentrations in the Babine survey area exhibits the same northwest-southeast regional geochemical trend displayed by arsenic, antimony, iron, lead, zinc and a number of other elements. This regional trend extends, in the case of mercury, from the northwest corner of the survey area through to Natowite Lake at its east-central margin. Groupings of sites with elevated mercury concentrations > 95th percentile occur in three main areas:

- The Clota Lake-Haul Lake area at the northwestern margin of the survey area (NTS 93M/7), just east of Nilkitkwa Lake. Several sites with anomalous mercury concentrations occur above Lower Cretaceous Kitsuns Creek Formation (lKK) sedimentary rocks in this area, including one site (2304: 500 ppb) with the highest mercury concentration in the Babine survey area.
- The Saddle Hill area (NTS 93M/1), where two sites associated with Saddle Hill (lmJv) volcanic rocks contain 370-440 ppb mercury in sediment. These sites are located just to the northwest of Old Fort Mountain.
- The southern Nakinilerak Lake area (NTS 93M/8) where four sites, in the south end of the lake and in small lakes and ponds to the west and southwest, contain 320-330 ppb mercury in sediment. These sites drain several geological units.

LEAD

Median lead concentration (AAS) in lake sediments of the Babine survey area is 3 ppm (max: 85 ppm). Subdivided by geological unit, median lead values do not vary beyond the range 3-4 ppm. Elevated lead concentrations > 95th percentile (8 ppm) generally occur as isolated high values and are associated with lake sediments above several geological units, but particularly so with Hazelton Group Telkwa Formation rocks (lJT), with which some of the highest values are associated. For example, the highest sediment lead concentration in the survey area (site 2364; 85 ppm) is situated above Telkwa Formation rocks in the Broughton Creek area, just south of the Granisle-Smithers connector road. However, the field duplicate sample collected at this site did not in this case reproduce the lead anomaly (sample 2365; 4 ppm).

The second-highest lead concentration in Babine-area lake sediments occurs on the south flank of Matzehtzel Mountain (site 2044; 30 ppm). This site, which also drains Telkwa Formation (lJT) rocks, is notable for coincident elevated sediment concentrations of zinc and silver which are also present here. Among other sites with elevated sediment lead concentrations in the Babine survey area are two Morrison Lake sites (10 ppm) near the Morrison and Wolf prospects, and two sites (11-12 ppm) in Tahlo Lake, near Haul Lake, which are underlain by Skeena Group Kitsuns Creek Formation (lKK) sedimentary rocks.

WATERS

WATER pH

The pH of raw surface lake waters in the Babine survey area are in the range 6.1 - 8.1. Most lake waters are neutral, and the median pH is 7.2. Subdivided by geology, median lake water pH values of those units with at least ten sample sites are in the range 7.0 - 7.3. Lakes above the Early Jurassic Topley Intrusions (EJT) have the lowest median pH (7.0). In general, more acidic pH values of 6.8 or lower occur in three areas:

- The relatively flat-lying southwestern part of the survey area, in the region of Findlay, Baboon and Lennac lakes (NTS 93L/9). Lake water pH values as low as 6.4 (site 2022) occur in this area, which is underlain by Telkwa Formation (lJT) rocks of the Hazelton Group.

- The east side of Babine Lake (NTS 93L/16), opposite the village of Granisle, in a region underlain by the Topley Intrusions (EJT). Lake water pH values as low as 6.1 (site 2065) are present here.

- The Clota Lake-Nilkitkwa River area in the northeastern corner of the survey area (NTS 93M/7). This region is underlain by Lower Cretaceous Skeena Group rocks of the Red Rose (lKRR) and Kitsuns Creek (lKK) Formations. Of the only seven of 332 sites in the Babine survey area (2.1% of the total) which exhibit lake water pH values < 6.5, three of them are in this area. One site (2291) has a pH of 6.1.

Conversely, six lake water sites in the survey area (1.8% of the total) have a more alkaline pH of 8.0 or greater. Most of these are associated with Ashman Formation (muJA) and Telkwa Formation (lJT) rocks; many are coincident with elevated lake water sulphate concentrations discussed in the next section.

SULPHATE

Median sulphate concentration in Babine-area lake waters is 3 ppm, similar to median values of 0.6 - 4 ppm sulphate previously reported for the Nechako and Pinchi Lake areas (Cook and Jackaman, 1994; Cook *et al.*, 1997). Subdivided by geological unit, median sulphate values do not vary beyond 2-4 ppm for those units with at least ten sample sites. Maximum sulphate concentration is 47 ppm. Fourteen sites have sulphate concentrations > 7 ppm (95th percentile); concentrations at seven of these sites (2.1%) exceed 9 ppm (98th percentile).

Lakes with elevated sulphate concentrations are most common in areas underlain by Hazelton Group Telkwa Formation (lJT) and Bowser Lake Group Ashman Formation (muJA) rocks. The site with the highest sulphate concentration (site 2338; 47 ppm), for example, is situated above Telkwa Formation rocks just northeast of Tahlo Lake in the Nakinilerak Lake map area (NTS 93M/8). Groupings of lakes with elevated sulphate values > 95th percentile occur in two main areas:

- The northwest corner of the Old Fort Mountain map area (NTS 93M/1), where waters at three sites in small ponds and lakes located about 7 kilometres west of Morrison Lake contain 13-44 ppm sulphate. These sites, which drain Bowser Lake Group Ashman Formation (muJA) sedimentary rocks, are also adjacent to two other sites with elevated sediment antimony concentrations.

- The northeast margin of the survey area, between the two arms of Takla Lake (NTS 93M/8). Waters at three sites above Eocene Ootsa Lake Group (EO) felsic volcanics contain 8-9 ppm sulphate.

In addition to the foregoing, elevated sulphate concentrations in lake waters also reflect the presence of porphyry copper mineralization at both the Morrison and Lennac Lake prospects. Waters from two sites located at the base of Hearne Hill, near the Morrison prospect, contain 10-19 ppm sulphate. In the case of Lennac, a single water sample from a small lake adjacent to bedrock copper mineralization in Bulkley intrusive rocks (LKBp) contains 9 ppm sulphate.

EXPLORATION RECOMMENDATIONS FOR GOLD IN LAKE SEDIMENTS

Lake sediments typically consist of organic gels, organic sediments and inorganic sediments (Jonasson, 1976). Organic gels, or gyttja, are mixtures of particulate organic matter, inorganic precipitates and mineral matter (Wetzel, 1983), and are mature green-grey to black homogenous sediments characteristic of deep-water basins. Organic sediments are immature mixtures of organic gels, organic debris and mineral matter occurring in shallow water and near drainage inflows (Jonasson, 1976). Inorganic sediments, by contrast, are clastic-rich mixtures of mineral particles with little organic matter. Of the three varieties of lake sediments, organic gels are the most suitable geochemical exploration medium because of their higher capacity for adsorbing metals and their greater homogeneity; deep-water basins where they accumulate have been favoured as ideal sites for regional geochemical sampling (Friske, 1991).

Studies in other parts of Canada (Fox *et al.*, 1987; Davenport and McConnell, 1988; Rogers, 1988) have determined lake sediment geochemistry to be an effective gold exploration method. However, results of some studies in the Canadian Shield (Fox *et al.*, 1987; Coker *et al.*, 1982) concluded reconnaissance-scale (one site per 6 to 13 km^2) lake sediment exploration for gold to be inadequate for locating anomalous areas, and suggested that one to three samples per lake be collected. In Newfoundland, Davenport and Nolan (1991) considered a density of at least 1 site per 4 square kilometres to be necessary to ensure the detection of all significant near-surface gold mineralization. Results of geochemical studies in British Columbia (Cook, 1995, 1997) support the detailed sampling (*i.e.* every lake) approach. The following recommendations are given for geochemical exploration for epithermal and other gold deposits in the northern Interior Plateau:

SAMPLE MEDIA AND SAMPLING STRATEGIES

- Lake sediment geochemistry is most effective for gold exploration if every lake and sub-basin in the survey area is sampled, a strategy employed in the Babine and prior surveys. The high and homogenous gold content of, for example, Wolf Pond sediment (Cook, 1995) in the Nechako River map area (NTS 93F) illustrates the importance of sampling even very small lacustrine drainages.

- A single centre-lake sample should be collected from the profundal basin in small lakes, and additional samples should be taken from the centres of all other major basins in multi-basin lakes. For example, a wide range of copper and molybdenum concentrations occur between different sub-basins of lakes adjacent to porphyry molybdenum-copper occurrences (Cook, 1993).

- Collection of centre-lake gyttja samples is the most effective sampling method for trace elements such as copper and zinc, but evidence from studies in the Interior Plateau and elsewhere (Coker *et al.*, 1982; Fox *et al.*, 1987) suggests that gold may also be concentrated in near-shore organic-rich sediments, particularly near drainage inflows. Collection of samples from these areas, in addition to collection of centre-lake sediment, is recommended for detailed surveys.

SAMPLE PREPARATION AND ANALYSIS

- The very low concentrations of gold in lake sediments demand the use of an analytical technique with a low analytical detection limit of 1 or 2 ppb. No comparisons of INAA with either fire assay/GF-AAS or ICP-MS techniques were conducted. If using fire assay techniques, however, low gold detection limits require greater vigilance with respect to sample contamination during analysis. Irregardless of the analytical method, routine analysis of silica blanks inserted within sample suites is a useful means of calculating a working detection limit for each batch of samples.

- A rigourous quality control program is a necessity when using lake sediments for gold exploration due to the particle sparcity effect and the very low concentrations of gold typically found in lake sediments. Inclusion of field duplicates, analytical duplicates, and control standards with appropriate organic-rich matrices and low concentration levels is recommended.

- Analysis for additional elements other than gold is recommended. Arsenic and antimony are useful pathfinder elements in the northern Interior, and elevated concentrations of base metals such as molybdenum, zinc and copper may be present in lakes adjacent to the erosional remnants of lower level hydrothermal systems. Nevertheless, studies in Newfoundland (McConnell and Davenport, 1989; Davenport and Nolan, 1991) determined gold itself to be the best pathfinder, with antimony a more useful pathfinder element than arsenic.

FOLLOW-UP OF ANOMALOUS SITES

- Results of Cook (1995) indicate that gold concentrations of 4 ppb or greater in centre-lake sediments may reflect the presence of adjacent epithermal gold occurrences. Lower gold concentrations are generally indistinguishable from the geochemical background, due to sampling and analytical variability. Similar conclusions were reported from Newfoundland by Davenport and McConnell (1988), who considered gold concentrations greater than 4 ppb to represent anomalies, and those greater than 8 ppb to be strong anomalies. The very subtle level of gold anomalies in lake sediment cannot be overemphasized. For example, sediment in a lake adjacent to the large Hemlo gold deposits in northern Ontario was reported by Friske (1991) to contain only 6 ppb gold in an area with a background of less than 1 ppb.

- Follow-up of anomalous lakes, involving both verification of the original anomaly and determination of a potential source direction, should include resampling of the centre-lake site, as well as the sampling of near-shore sediment from all sides of the lake. It is particularly important, during anomaly follow-up, to sample organic sediments near inflowing drainages. The collection of duplicate field samples is recommended. Delineating the watershed boundaries of anomalous lakes, particularly those small ponds with no apparent stream inflows, will assist in interpreting results of both the regional and follow-up surveys.

SUMMARY

A regional lake sediment and water geochemistry survey, the Babine survey (332 sites), was conducted over the Babine porphyry belt in parts of the Smithers (NTS 93L) and Hazelton (NTS 93M) map areas in the Interior Plateau of central British Columbia. The survey, a contribution to the Nechako NATMAP Project, supplements the ongoing RGS lake sediment geochemical mapping of the Nechako Plateau area which began in 1993.

This survey confirms the locations of known mineral deposits and prospects, and outlines new areas for prospective porphyry-style mineralization. Several areas of particular interest to explorationists include:

- Elevated copper concentrations in lake sediments near the Lennac and Sparrowhawk copper prospects, the Skinhead-Bonehead lakes area west of Granisle, and the Port Arthur-Deasy Creek area on the west side of Babine Lake.

- Elevated concentrations of molybdenum, antimony and, to a lesser extent, arsenic in numerous lake sediment sites in the Port Arthur-Lennac region, in the southern part of the survey area.

- A zone of moderately-elevated and reproducible gold concentrations in lake sediments in the Hautete Creek-Macdougall Creek area, southeast of Nakinilerak Lake.

- A northwest-southeast trending regional geochemical pattern of elevated arsenic, antimony, iron, lead, zinc, barium, mercury and numerous other elements in lake sediments in the north-central part of the Babine survey area.

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SEDIMENT ANALYSIS:

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Activation Laboratories Ltd., Ancaster, Ont. (INA)

WATER ANALYSIS:

CanTech Laboratories Inc., Calgary, Alberta

Survey duties were divided as follows:

Survey Design: *SC*
Sample Collection: *SC, RL, VL,AC*
Quality Control: *SC*
Data Interpretation: *SC*
Statistics: *WJ*
Geochemical Map Production: *SC, GW*
Open File Production and Coordination: *SC*

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BRITISH COLUMBIA
Ministry of Employment and Investment
Energy and Minerals Division
Geological Survey Branch

SAMPLE SITE LOCATION MAP

TO ACCOMPANY

Geological Survey Branch
OPEN FILE 1997-17

REGIONAL LAKE SEDIMENT AND WATER GEOCHEMISTRY OF THE BABINE PORPHYRY BELT, CENTRAL BRITISH COLUMBIA

NTS 93L/9, 16; 93M/1, 2, 7, 8

by Stephen Cook, Ray Lett, Victor Levson, Wayne Jackaman, Anna Coneys and Glenda Wyatt

SCALE 1:100 000

kilometres

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