Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

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Compiled by F.A.M. Devine[1], M. A. Pond[2], D. R. Heberlein[3], P. Kowalczyk[4], W. Kilby[5]

In partnership with Thompson Creek Mining Ltd.

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The recommended reference for this publication is as follows:

Devine, F.A.M., M.A. Pond, D.R. Heberlein, P. Kowalczyk, and W. Kilby (2015): A geo-exploration atlas of the Endako porphyry molybdenum district; Geoscience BC, Report 2015-08.

Author affiliations:

[1] Merlin Geoscience Inc., Geoscience BC
[2] Thompson Creek Mining Ltd., Endako Mine
[3] Heberlein Geoconsulting, Geoscience BC
[4] Consulting Geophysicist, Geoscience BC
[5] CalData Ltd., Victoria, BC

Cover photo: Endako mine, view east

Photo credit: Thompson Creek Metals Company Inc.
URL: http://www.thompsoncreekmetals.com/s/Photo_Gallery asp?ReportID=383262 [July, 2013]

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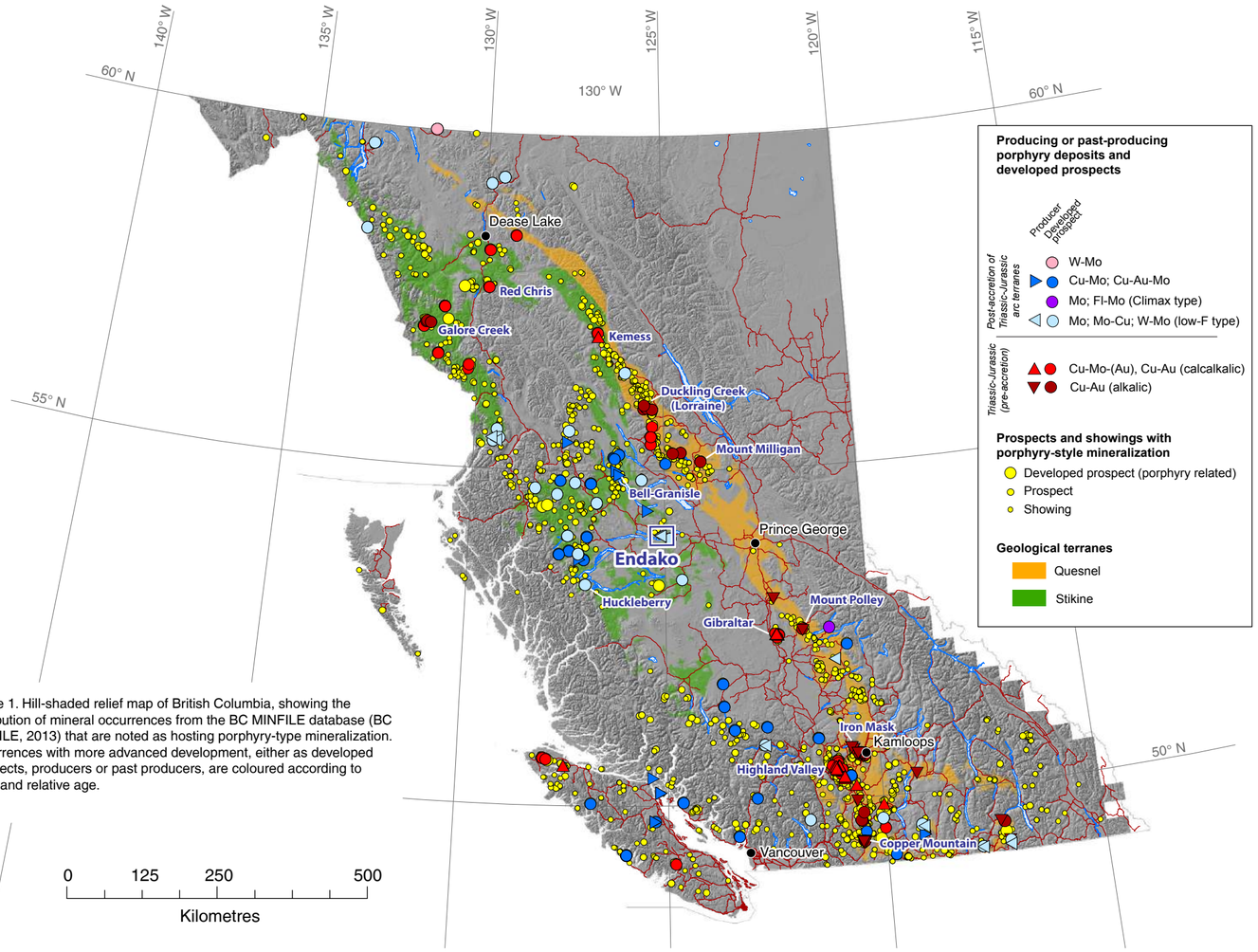

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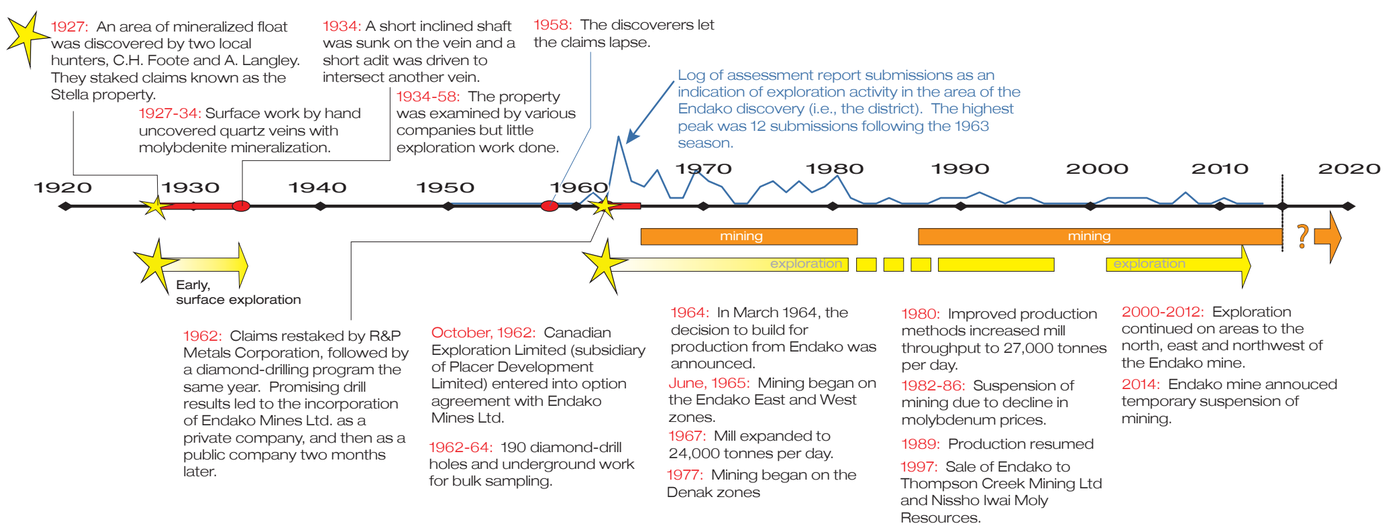


INTRODUCTION

The Endako porphyry molybdenum district, in the Nechako Plateau region of central British Columbia, is centred on the Endako deposit, one of the largest porphyry molybdenum deposits in the North American Cordillera (Figure 1). The Endako mine has operated intermittently since 1965. Originally built and operated by Placer Development Limited (Placer Dome Inc.), it is now operated as a joint venture between Thompson Creek Mining Ltd. and Sojitz Moly Resources Inc..

Endako is a low-fluorine porphyry molybdenum deposit, characterized by a stockwork of molybdenite-quartz veins associated with calcalkaline granitic rocks. Mineralization at Endako is associated with the youngest, most evolved phases of the Triassic–Jurassic Endako batholith in central BC; with mineralization being latest Jurassic in age, it is also one of the oldest porphyry molybdenum deposits in the North American Cordillera.

The physiography of the Nechako Plateau region consists of rolling hills with broad valleys and flat-topped hills. Pine and spruce forests, and grasslands cover much of the region, with lakes and marshes in the valley bottoms. Much of the region is covered by Quaternary glacial deposits, and also by younger volcanic rocks that overlie the older rocks most prospective for porphyry mineralization. In part because of the high degree of cover, exploration and development at Endako was delayed following initial discovery, and drilling has been critical in identifying new mineralization in the district. Because of the locally deep and extensive surficial cover, there is an opportunity at Endako to evaluate the responses of geophysical and geochemical exploration methods in an advanced porphyry molybdenum district that has undergone recent glacial transport of surficial materials.

This atlas is a map compilation of various geological and exploration data that cover the Endako region at different scales. Readers are encouraged to evaluate the data from a regional- as well as district-scale perspective, using the advantage of knowing where the Endako mineralization is located to identify features in the geological, geophysical and geochemical compilations that may be key to discovery of similar deposits elsewhere. Maps that illustrate the terrain and degree of cover are also included. The Endako batholith is known for molybdenite mineralization related to at least two different phases of Late Jurassic intrusions, which are regionally extensive. Given the high degree of young volcanic and glacial cover, there is potential not just for undiscovered Endako-age mineralizaton, but also for Endako-type mineralization in different phases of the Endako batholith. And with broader implications, an assessment of how the exploration data here reflect the structural controls, tectonic development and igneous petrology of the batholith may prove useful in future exploration for low-fluorine porphyry molybdenum deposits in British Columbia and elsewhere.

HISTORY OF EXPLORATION & DEVELOPMENT

The Endako mineralization was discovered in 1927 in the area of what is now the Endako West ore zone (Figure 2). Two local hunters, C.H. Foote and A. Langley, staked claims over an area of mineralized float and carried out work that uncovered quartz-molybdenite veins on what became known as the Stella property (Kimura and Drummond, 1966; Bysouth and Wong, 1995). The veins were explored with a short inclined shaft and limited surface work. The property was assessed several times over a period of two decades, but the claims were not developed due, in part, to the challenges of exploration through overburden. The discoverers let the claims lapse in 1959.

In 1962, R and P Metals Corporation acquired the area of the original Stella property and immediately conducted a drill program that returned promising results. Endako Mines Ltd. was formed the same year and listed publicly before August 1962. In October 1962, Canadian Exploration Limited (Canex), a subsidiary of Placer Development Limited, entered into an option agreement with Endako Mines Ltd. From 1962 to 1964, 190 diamond-drill holes were drilled on the property and Placer decided to put the deposit into production in 1964 (Kimura and Drummond, 1966; Bysouth and Wong, 1995). The mine opened by June 1965.

The 1962 success and subsequent rapid definition and development of the Endako deposit can be credited to insightful exploration, good timing and innovation. The potential of the new discovery at Endako was recognized by geologist E. Schultz of Placer Development, who had experience in porphyry systems in Arizona. Through his experience and relationship with the Longyear Company (Boart Longyear), Endako became the first project in Western Canada to see the new technology of wireline drilling (E. Kimura, pers. comm., 2015). This ability to drill quicker and deeper is a big part of the discovery of the largely covered Endako deposit.

Immediately following the 1962 success in the discovery area and subsequent option to Canex (Placer Development), there was a surge of exploration in the district. Twelve different assessment reports were filed for the 1963 field season, many reporting on soil geochemistry surveys in the area surrounding the discovery property. More than half of these were undertaken by Canex and Endako Mines Ltd. during exploration of the area around the initial discovery. Due to a lack of surface exposure, early exploration was focused on soil geochemistry using colorimetric methods for determination of molybdenum concentration; the method had changed to atomic absorption spectrophotometry by 1969. Endako Mines Ltd. also used ground magnetometer surveys throughout the 1960s to explore for zones of covered alteration. Induced polarization was tested on the Endako mineralization with limited success, due to the lack of sulphides directly associated with the molybdenite mineralization. However, a weak chargeability response was locally noted where peripheral pyrite alteration was present (Bell and Sutherland, 1966). Starting in 1974, drilling became more common in the district, with Endako Mines, Canex and some other operators conducting drill programs through 1981, following up on original geochemical and geophysical surveys. Work during these two decades did turn up several areas of molybdenite mineralization; most significant for Placer was the extension of mineralization from the original discovery to the northwest (e.g., Kimura, 1974). Other occurrences were reported from areas more distant, such as the Tatin Lake prospect (Lodder and Godfrey, 1969), around Sam Ross Creek (Shepherd and Barker, 1966) and at Nithi Mountain (Roberts, 1970).

Mine development during the period 1965 to 1981 progressed from initial development of the Endako pit to development of the Endako East and West zones as a single pit, followed by development of the separate Denak pits beginning in 1977. From 1982 until 1986, mining at Endako was suspended due to a decline in molybdenum prices. Exploration in the district also ceased during this time. In 1988, Placer again started drilling around the pit area, extending the limits of mineralization in the Denak area and continuing to the northwest of the Denak West pit.

In 1997, Placer sold the Endako mine to Thompson Creek Mining Ltd., a subsidiary of Thompson Creek Metals Company, and Nissho Iwai Moly Resources (now called Sojitz Moly Resources Inc., part of Sojitz Corporation; Wild and Thompson, 2002). In addition to pit developments, Thompson Creek continued to explore for additional near-mine mineralization. Exploration drilling from 2001 to 2010 targeted areas of known mineralization in an attempt to expand these zones. They included the northwestern extension of the Denak West zone (Denak Extension), the area east of the Endako East pit and the Casey Lake area. The Denak Extension has proven the most promising and has been the target of most recent exploration campaigns (Pond, 2010).

Outside the Endako deposit area, most recent work in other parts of the district includes work in 2007 by Nation River Resources Ltd.

Figure 2. Timeline highlighting major exploration and development events in the Endako district, from initial discovery of mineralization in 1927 to the present day. Information up to 1995 is from Kimura and Drummond (1966) and Bysouth and Wong (1995). Information from 1997 onward is from Wild and Thompson (2002), Pond (2010), and Thompson Creek Metals Company Inc. (2014a).

on properties to the southwest and northwest of the Endako property. In addition to exploring for Endako-style mineralization, they were following up on the idea, presented in work done during the Geological Survey of Canada–British Columbia Geological Survey (GSC-BCGS) NATMAP project (Struik and MacIntyre, 2001), that there could be younger (Eocene-age), Climax-type molybdenum mineralization in the area (Whalen et al., 2001). They conducted limited soil, water, till and rock sampling, but the results are inconclusive (Campbell, 2007a, b).

At Endako, mining continued on the Denak West pit, although the company focused on processing stockpiled ore from 2012 to 2013. Mining resumed in 2013 and continued until the end of 2014, when a temporary suspension of mining was announced by Thompson Creek Mining Ltd. (Thompson Creek Metals Company Inc., 2014b). If mining eventually resumes at Endako, there could be more than a decade of mine life remaining, which will likely include development of the Denak Extension (16-year mine life reported in Thompson Creek Metals Company Inc., 2013).

REGIONAL GEOLOGY

The Endako area lies within the Nechako Plateau region of central BC. The area is underlain predominantly by intrusive rocks of the Mesozoic Endako batholith (Map 1.2), which is a northwest-elongated, composite intrusive body near the tectonic boundary between the Stikine terrane to the west and the Cache Creek terrane to the east. The northwest elongation of the batholith reflects the Triassic–Jurassic tectonic fabric: the boundary of the Stikine and Cache Creek terranes in this region is a northwest-oriented, east-dipping thrust fault (Struik and MacIntyre, 2001). The oldest (Late Triassic) phases of the batholith were emplaced into the Stikine terrane prior to its amalgamation with the Cache Creek terrane, whereas the younger (Jurassic) phases are generally post-accretion and intrude across the amalgamated boundary between Stikine and Cache Creek terranes.

Overlapping assemblages provide an incomplete record of erosion and structural translations across the region after the Late Jurassic. Cretaceous dextral transcurrent faults, mapped in other parts of central BC, do not occur in the immediate Endako area, although there are local occurrences of Cretaceous coarse clastic sedimentary and volcanic cover rocks. Early to Late Cretaceous intrusive rocks occur throughout the region, some of which have been historically grouped as part of the Endako batholith. Eocene volcanic rocks, and associated intrusive centres, form the majority of overlap cover. Widespread Eocene northwest-directed extension and contemporaneous volcanism resulted in a complex set of extensional fault blocks that expose rocks from different crustal levels. Downdropped blocks preserve Eocene volcanic rocks, whereas pre-Eocene rocks, including the Endako batholith intrusive rocks, are exposed in relatively upthrown areas. The Eocene structural system is represented by northwest-trending faults with dextral strike-slip motions, and northeasterly-trending faults with moderate to shallow dip and extensional downdip motions (Struik and MacIntyre, 2001). There is significant post-Eocene faulting (ca. 45–15 Ma), with steep to moderate dips, that generally follows the Eocene fault systems but does not affect younger Miocene volcanic rocks (Struik and MacIntyre, 2001).

THE ENDAKO BATHOLITH

The Endako batholith is a northwesterly elongate intrusive body extending underlying much of the area east of Francois Lake, over to Burns Lake, and up to Stuart Lake (Map 1.2). Ranging in age from Late Triassic to Late Jurassic, it records a long-lived, episodic intrusive emplacement history of approximately 75 Ma extending from Late Triassic subduction and arc building in Stikine terrane, through Early Jurassic amalgamation of the Triassic-Jurassic arc terranes during their accretion to the North American continental margin. The batholith shows an age and compositional progression from older mafic phases along the margins, to youngest, most chemically evolved, high-level intrusions in its centre. Numerous molybdenite occurrences are associated with the batholith (Map 1.2), including most notably the Endako porphyry molybdenum deposit and associated occurrences.

The Late Triassic–Jurassic calcalkaline intrusive rocks that form the Endako batholith were originally grouped with the Topley intrusions (Armstrong, 1949) as part of a broadly defined, widespread Mesozoic regional plutonic suite extending across central BC. They were later recognized as a separate suite, referred to as the Francois Lake intrusions by Carter (1981). Following interest generated by discovery of the Endako deposit, work compiled by Carr (1966) described the geology of the Endako region in maps that cover a large part of what is now the central Endako batholith. As development of the Endako mine progressed, continued exploration and research generated a better understanding of the intrusive relationships and their distribution. Geologists working for Placer Development and affiliates generated detailed pit maps at the young Endako mine, as well as regional compilations during exploration around the deposit (Kimura and Drummond, 1966; Dawson, 1972; Dawson and Kimura, 1972; Kimura and Waldner, 1972; Kimura et al., 1976; Bysouth and Wong, 1995). This early work is often recognized for its quality and is credited in guiding more recent detailed studies (e.g., Whalen et al., 2001). Radiometric dating using K-Ar methods during this time by White et al. (1970) returned ages of Middle Jurassic to Early Cretaceous for these rocks. Carter (1981) used these data, as well as existing regional data, to identify the Jurassic intrusive rocks in the Endako region as part of the Francois Lake suite, an older intrusive suite relative to other Mesozoic plutonic rocks in the region.

The definition and divisions of the Endako batholith that are now commonly used were defined in the late 1990s through work done under the Nechako NATMAP project (Struik and MacIntyre, 2001). Extensive compilation of historical mapping, new geological mapping, geophysics, geochemistry and a new U-Pb and Ar/Ar geochronological study resulted in a detailed subdivision of more than 20 distinct plutonic phases within the batholith (Whalen and Struik, 1997; Struik and Whalen, 1998; Whalen et al., 1998; Villeneuve et al., 2001; Struik, 2007). Three Late Triassic to Jurassic suites form the main body of the batholith. Following the age progression, and also within each suite, is a compositional progression from older mafic phases with strongly developed foliation through intermediate phases to the youngest Jurassic phases, which are the most chemically evolved and felsic, without penetrative deformation fabrics (Villeneuve et al., 2001). The oldest suite, the Late Triassic Stern Creek suite, includes diorite to granodiorite; the Early to Middle Jurassic Stag Lake suite includes 10 documented phases of diorite, quartz monzonite and granodiorite. The Late Jurassic Francois Lake suite is the youngest, forms the bulk of the batholith and hosts the Endako deposit. It is divided into two subsuites, the Glenannan and the Endako, that are both chemically evolved biotite monzogranite to hornblende-biotite granodiorite.

Porphyry molybdenum mineralization, generally classified as low-fluorine type, within the Endako batholith is most commonly associated with the Late Jurassic (157–144 Ma) Francois Lake suite and occurs in both the Glenannan and Endako subsuites. Numerous molybdenite showings are reported throughout the area (Map 1.2; MINFILE, 2014), but the known occurrences generally cluster in two domains: around the Endako deposit and in the Nithi Mountain area. Mineralization in these two areas, and in other parts of the Francois Lake suite, is of a similar style and has similar intrusive rock associations but slightly different ages. Based on Re-Os geochronology on molybdenite and U-Pb and Ar/Ar geochronology, three distinct molybdenite deposition events are recognized: 154 Ma molybdenite mineralization in the Nithi Mountain area, 148 Ma quartz-molybdenite veins in the Endako deposit and a 145 Ma second-stage event in the Endako deposit (Selby and Creaser, 2001).

There is also an intriguing suggestion of possibly younger molybdenite mineralization within the batholith (Whalen et al., 2001). In the Sam Ross Creek area, high-level felsic intrusions with miarolitic cavities were originally mapped as part of the Francois Lake suite, but subsequent radiometric dating revealed them to be Eocene in age (Villeneuve et al., 2001). The Sam Ross Creek intrusive phase is highly chemically evolved and moderately to highly oxidized (Whalen et al., 2001), and there are historical reports of molybdenite showings in the area (Shepherd and Barker, 1966). In addition, kaolinite alteration in the Endako deposit has been shown to be, at least in part, related to an Eocene hydrothermal event (Selby et al., 2000). These features have led to the suggestion that the Endako batholith region may also be prospective for younger (Eocene-age), Climax-type porphyry molybdenum deposits (Whalen et al., 2001).

GEOLOGY OF THE ENDAKO DEPOSIT

The Endako low-fluorine porphyry molybdenite deposit is hosted entirely within the Late Jurassic Endako phase of the Francois Lake plutonic suite, a northwest-trending body of K-feldspar–porphyritic, biotite-hornblende granodiorite to monzogranite in the south-central part of the Endako batholith (Map 3.1). The Endako phase is bounded to the southwest by the slightly younger Francois Lake subphase, and to the north by the younger, more compositionally evolved biotite monzogranite of the Casey phase, which commonly displays small miarolitic cavities and chloritized biotite (Villeneuve et al., 2001). Two sets of dikes intrude the Endako phase in the area around the Endako deposit. The pre-ore dikes include aplite, porphyritic granite and quartz-feldspar porphyry (Kimura et al., 1976; Selby et al., 2000) and have been dated in the range 149–145 Ma (Villeneuve et al., 2001). These dikes are therefore part of the Francois Lake suite but are cut by molybdenite veins in the deposit area. The second dike set is post-mineral and consists of mafic, aphanitic to plagioclase porphyry. Radiometric dating shows them to be Eocene in age, correlative with volcanic rocks of the Ootsa Lake and Endako groups that occur throughout the area (Villeneuve et al., 2001).

The main orebody at Endako is a northwest-trending, 4.8 km long by 0.75 km wide body (Marek, 2011) that dips southwest but rotates to more shallowly west-dipping as one moves toward the northwest. Ore reserves (proven and probable) reported in 2013 were 305.4 million tonnes grading 0.046% Mo (Pond, 2013). Previous resource estimates included grade domains of up to 0.100% MoS2 (Marek, 2011). The orebody occurs primarily north of a northwest-trending, south-dipping structure called the South Basalt fault. The richest part of the orebody is at the southeastern end (Figure 3), but grades drop off rapidly to the southeast across 'vein system 4', a northeast-trending, west-dipping system (Kimura et al., 1976; Bysouth and Wong, 1995). The orebody is divided into four main structural zones separated by northeast-trending, high-angle, post-mineral (Eocene) structures (Figure 3; Kimura et al., 1976).

The quartz-molybdenite veins that form the orebody are of two types: stockwork and ribbon-textured veins (Figure 4; Selby et al., 2000). The stockwork veins formed early in the development of the system and are concentrated in the Endako East area. They are associated with K-feldspar alteration assemblages (K-feldspar+biotite+quartz) and contain only minor molybdenite as isolated flakes (Selby et al., 2000). Dating of molybdenite by Re-Os methods shows an age of ca. 148–146 Ma for the stockwork veins, which has led to the suggestion that the stockwork veining may be related to the latest stages of emplacement of the Endako phase or the pre-ore granitic dikes (Selby and Creaser, 2001).

Ribbon-textured veins are laminated quartz-molybdenite veins, commonly greater than 5 cm wide; they form the majority of ore at Endako. Veins in the eastern part of the deposit have two general orientations: northeast trending and steeply west dipping, or west trending and south dipping. The west-trending veins form en échelon veins sets that define the orientation of the orebody (Kimura and Waldner, 1972; Kimura et al., 1976). They are associated with sericite alteration (quartz+sericite+disseminated pyrite) and formed paragenetically later than the stockwork veins. Rhenium-osmium dating of molybdenite shows the ribbon-textured veins to have an age of 145 Ma; they are therefore correlated with the emplacement of the Casey phase monzogranite immediately to the north (Selby and Creaser, 2001).

The distribution of alteration assemblages in the Endako pit area (Endako East and West) varies across the orebody (Figure 5). A strongly developed (or preferentially preserved?) barren, footwall, K-feldspar alteration zone occurs to the north of the ribbon-textured veins (main ore zone). The hangingwall side is dominated by sericite-pyrite alteration up to the South Boundary fault (Figure 6; Kimura et al., 1976). Late kaolinite alteration overprints both sides of the deposit and is most strongly developed within the ore zone, replacing sericite alteration associated with ribbon veins (Drummond and Kimura, 1969; Kimura et al., 1976; Selby et al., 2000). Pervasive kaolinization is concentrated in zones of post-mineral (Eocene?) brecciation of quartz veins and Eocene post-mineral structures, leading to the suggestion of a post-ore

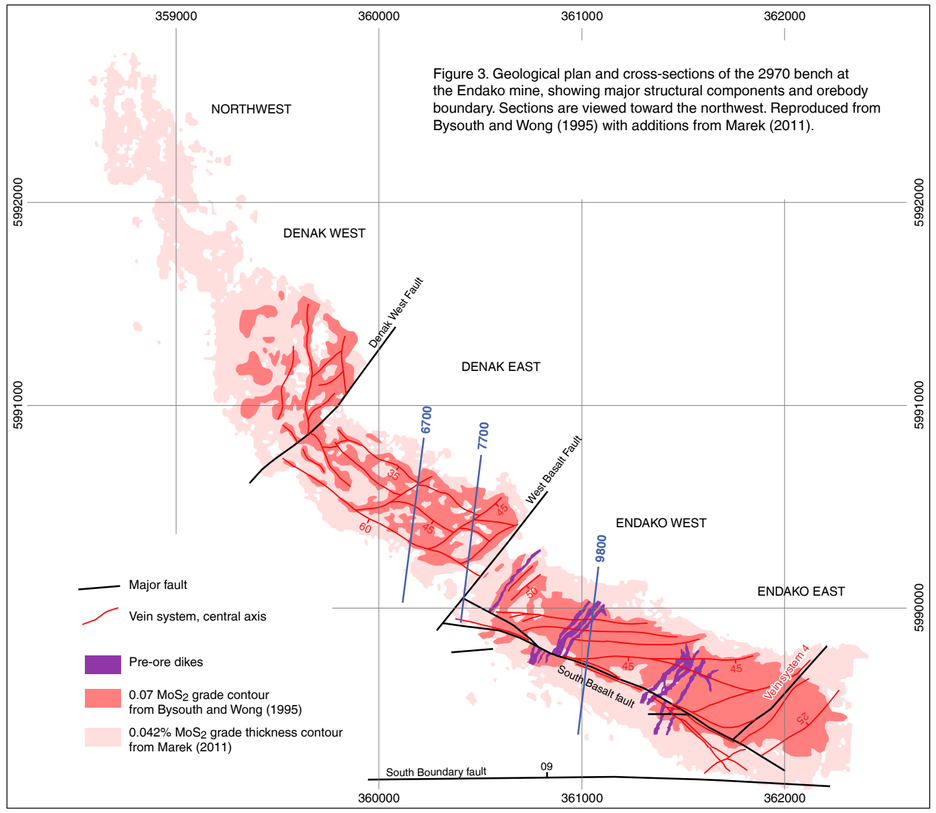
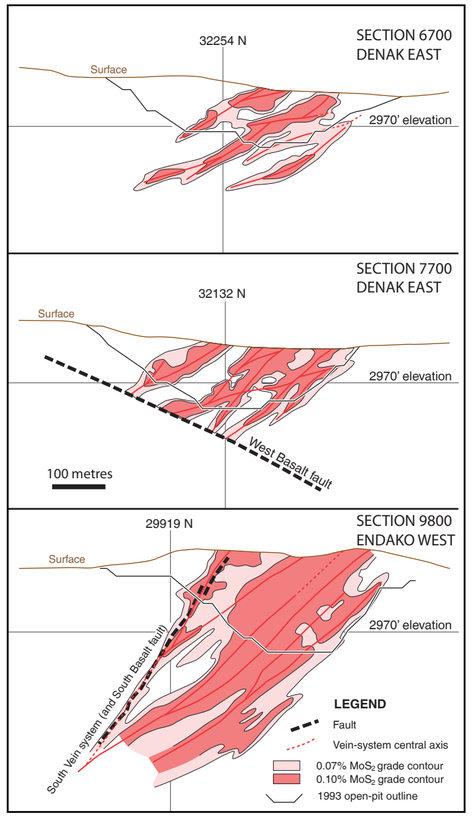


Figure 3. Geological plan and cross-sections of the 2970 bench at the Endako mine, showing major structural components and orebody boundary. Sections are viewed toward the northwest. Reproduced from Bysouth and Wong (1995) with additions from Marek (2011).



(Eocene) age for the kaolinite alteration (Selby et al., 2000).
The structurally dominant orientations within the Endako system progressively changed through the Late Jurassic to Eocene. After the Endako quartz monzonite, the pre-ore dikes are the oldest unit within the deposit area. Kimura and Waldner (1972) mapped conjugate sets of subvertical, northeast and northwest pre-ore dikes that were emplaced immediately prior to quartz-molybdenite veins at Endako. The latest Jurassic (145 Ma) quartz-molybdenite ribbon veins record a different set of structural openings, namely dominant west- to northwest-trending, south-dipping veins and northeast-trending, northwest-dipping veins in the eastern part of the orebody (Dawson, 1972; Kimura et al., 1976; Bysouth and Wong, 1995). Northeasterly structures within the deposit were reactivated in the Eocene, with northeast-trending faults and associated damage zones cutting across the deposit (Selby et al., 2000).

SUCCESSFUL EXPLORATION AT ENDAKO

Soil geochemistry played an important role in early exploration at Endako. Despite the high degree of surficial cover, traditional B-horizon soil sampling with early colorimetric and then atomic absorption methods was very successful in identifying the orebody location (Map 5.1; Kimura et al., 1976). Addition to reserves since discovery has been primarily through diamond-drilling directed by geological interpretations (Bysouth and Wong, 1995).

More modern surface-geochemical methods are also successful in identifying the Endako orebody. Till geochemistry (Map 8.1) returned a down-ice sample with elevated molybdenum, but sample density would have to be carefully considered in this case. Most successfully, biogeochemical sampling of lodgepole pine bark and spruce sap produced a very conclusive molybdenum anomaly in the mine area. An interesting rare-earth-element response in biogeochemical samples also occurred in the area of mineralization (Maps 7.1–7.4).

Geophysical methods, particularly magnetics, have played a large role in understanding regional structures and structural patterns beneath cover. Radiometric surveys, although not effective in differentiating magmatic suites through the district and greater region, do highlight areas of high potassium, possibly related to alteration (Struik and MacIntyre, 2001). The induced-polarization (IP) geophysical method has been used, but with limited success due to the low sulphide concentration of the ore; however, new research using physical rock properties to characterize the geophysical response of different ore and alteration types shows the value of a more detailed integration of geophysics and geology to effectively interpret the geophysical responses in porphyry systems such as Endako (Mitchinson et al., 2013).

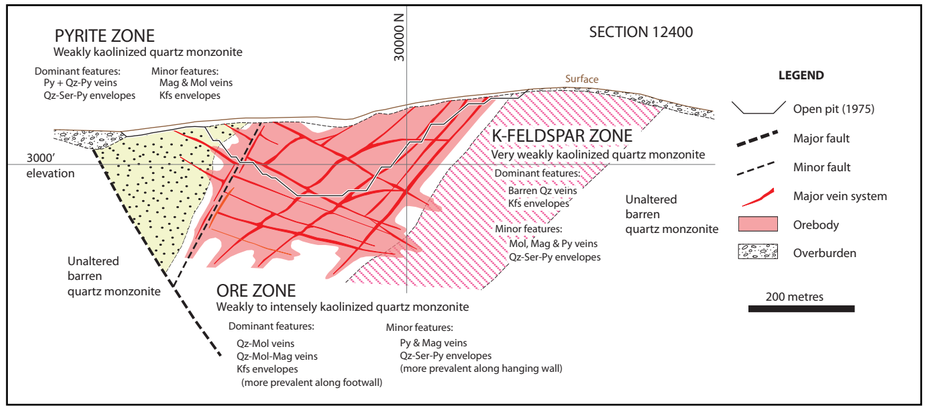


Figure 5. Cross-section showing the general distribution of hydrothermal mineral assemblages, the ore zone and major structures. Redrafted after Kimura et al. (1976).

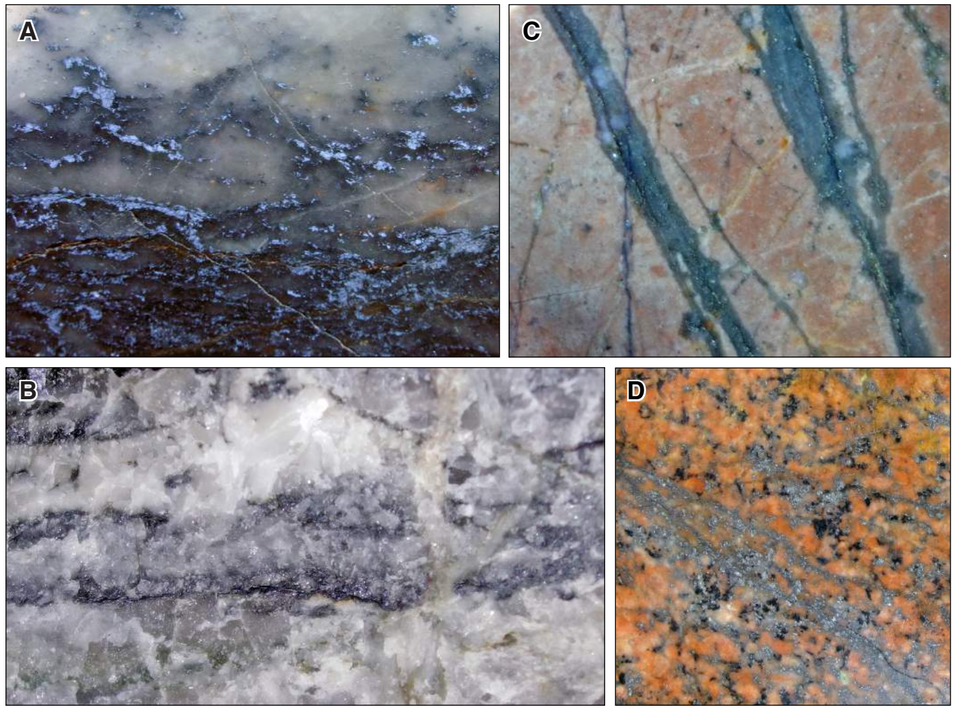


Figure 4. a), b) Quartz molybdenite ribbon veins, which form the bulk of the ore at the Endako mine; c) Potassic alteration of Endako granite with hairline early stockwork molybdenite veins, overprinted by pyrite veins with sericite selvages; d) Pyrite mineralization with late oxidation.

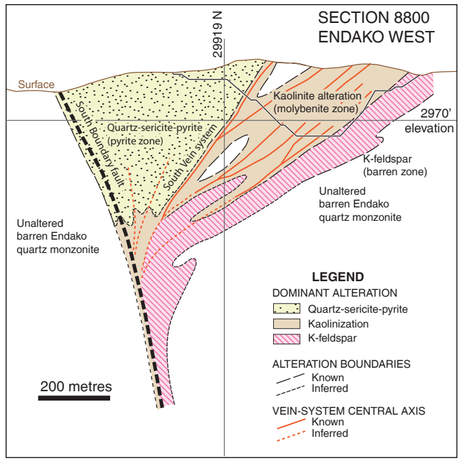


Figure 6. Generalized cross-section showing the inferred relationship between the South Boundary fault, controlling ore structures and hydrothermal alteration. Reproduced from Bysouth and Wong (1995).

ACKNOWLEDGEMENTS

The authors thank Thompson Creek Mining Ltd. for their support of this project and their donation of digital data for the aeromagnetic, soil geochemistry and IP surveys. Thanks also go to Scott Geophysics Ltd. for providing original IP survey data and location maps. The excellent databases produced and managed by the BC Geological Survey and the Geological Survey of Canada have been drawn on extensively in this compilation. The work done under the Nechako NATMAP project in the 1990s was fundamental to understanding the geology of the region. A. Plouffe provided additional background and support on the till geochemistry compilation. Finally, the authors thank E. Kimura for an interesting discussion on the exploration history of Endako and his thoughtful review; and D. Mitchinson for her early participation in the project and review of this atlas.

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Drummond, A.D. and Kimura, E.T. (1969): Hydrothermal alteration at Endako – a comparison to experimental studies; Canadian Institute of Mining and Metallurgy Bulletin, v. 62, p. 709–714.

Kimura, E.T. (1974): Diamond drilling report for Elk 5, Nu 2, Nu 4, and Oval groups of mineral claims; BC Ministry of Energy and Mines, Assessment Report 05021, 125 p.

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Kimura, E.T. and Waldner, M.W. (1972): Structural elements related to mineralization, Endako ore deposit; unpublished paper presented at Geological Association of Canada, Cordilleran Section meeting, February 1972, 17 p.

Kimura, E.T., Bysouth, G.D. and Drummond, A.D. (1976): Endako; in Porphyry Deposits of the Canadian Cordillera, A.S. Brown (ed.), Canadian Institute of Mining and Metallurgy, Special Volume 15, p. 444–454.

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Thompson Creek Metals Company Inc. (2014a): Form 10-K for the fiscal period ending December 31, 2013; United States Securities and Exchange Commission form, submitted February 20, 2014, 140 p.

Thompson Creek Metals Company Inc. (2014b): Thompson Creek Metals Company to place Endako molybdenum mine on temporary suspension; Thompson Creek Metals Company Inc., press release, December 2014, 2 p.

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Whalen, J.B., Anderson, R.G., Struik, L.C. and Villeneuve, M.E. (2001): Geochemistry and Nd isotopes of the Francois Lake plutonic suite, Endako batholith: host and progenitor to the Endako molybdenum camp, central British Columbia; Canadian Journal of Earth Sciences, v. 38, p. 603–618.

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Wild, C.J. and Thompson, I. (2002): Diamond drilling at the Endako mine; BC Ministry of Energy and Mines, Assessment Report 26792, 74 p.

DATA AVAILABILITY

This Publication

The data layers presented in this publication are available in digital form as a GIS package downloadable from the Geoscience BC website. Data from the Endako district have been compiled from various public and company sources. In many cases, original files for imagery, base-map data and geological mapping have not been modified: linework is presented as originally published, although the presentation style of various features may be unique to this atlas. In other cases (e.g., geochemical and geophysical data), new data layers generated from the original data are presented, such as organized geochemical data files and maps, geophysical maps and inverted IP sections, and mapping of interpreted structural features from aeromagnetic data. These new data layers are provided in the compiled GIS package that accompanies this atlas, available for download from the Geoscience BC website (Report 2015-08).

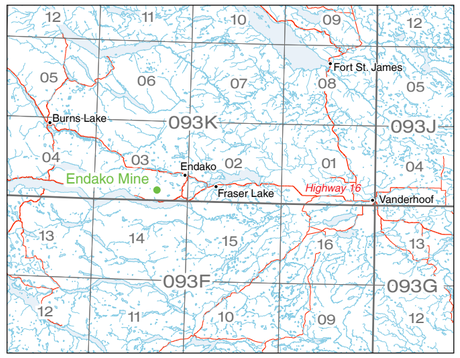


Figure 7. Northern Nechako Plateau region, showing the location of the Endako mine and the National Topographic System (NTS) tiles that cover the area.

Digital Elevation Data

Canadian Digital Elevation Data (CDED) at 1:50 000 scale are used in several maps within this atlas. The data are delivered in tiles that correspond to eastern and western halves of the NTS tiles (Figure 7), and are available through the GeoGratis portal. The data are derived from hypsographic and hydrographic elements within the National Topographic Data Base, as well as other positional data. The grid spacing of the elevation data varies with latitude; in the Endako region, the spacing is approximately 18 m.

Natural Resources Canada (2007): Canadian digital elevation data; Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information, URL <http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/3A537B2D-7058-FCED-8D0B-76452EC9D01F.html> [May 2015].

Mineral Occurrence Data

The BC Geological Survey maintains an inventory of geological, location and economic information on more than 13 900 metallic, industrial mineral and coal mines, deposits and occurrences in British Columbia. It is delivered publicly via the BC MINFILE database. The database is active, with new occurrences being added through review of mineral assessment reports, recent publications, press releases and company websites.

Topographic Data Layers

Topographic vector data from the National Topographic Data Base (NTDB) is available for download at no charge from Natural Resources Canada through the GeoGratis portal. The maps within the National Topographic System (NTS) are available in two standard scales: 1:250 000 and 1:50 000. The 1:50 000 series is available in a variety of raster and vector formats; the vector files are currently delivered as the CanVec product, which conforms to international geomatics standards. The map tiles applicable to the Endako region are shown in Figure 7.

NTDB 1:250 000 scale:

Natural Resources Canada (2007): National Topographic Data Base, tiles 093K, 093F; Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information, URL <http://www.geogratis.gc.ca> [May 2015].

CanVec 1:50 000 scale:

Natural Resources Canada (2013): CanVec, Canada, 093K01-08 and F09-16; Natural Resources Canada, Earth Sciences Sector, Mapping Information Branch, Centre for Topographic Information, URL <http://geogratis.gc.ca> [May 2015].

Imagery: Satellite

Satellite imagery from Google Earth™ is available for viewing through the Google Earth viewer, and for download using a Google Earth Pro licence. Copyright restrictions apply to Google Earth images for many end-user applications.

Imagery: Historic Air Photos

The 1954 airphoto mosaic is compiled from 12 original airphotos acquired from the BC airphoto database. Original images were purchased through GeoBC and were compiled into a single mosaic image by aerial triangulation of the individual scanned images, followed by orthorectification using Shuttle Radar Topography Mission (SRTM) digital terrain modelling data.

GeoBC, 2013: British Columbia airphoto database; Ministry of Agriculture and Lands, Integrated Land Management Bureau, scale 1:31 680, flight lines BC1942 (photos 77-80) and BC1799 (photos 85-88).

Imagery: Remote Sensing

Remote sensing data from the following sources and sensors were collected and analyzed for the Endako district:

Landsat 8
Landsat 8 began operation on May 30, 2013, providing improved sensor capabilities over previous Landsat missions (e.g., increased sensitivity, adjusted band positions and decreased bandwidths). The imagery provides ten 30 m multispectral channels and one 15 m panchromatic band.
URL <http://landsat.gsfc.nasa.gov/?page_id=4071> [May 2015]. Imagery can be downloaded for free from <http://glovis.usgs.gov> [May 2015].

ASTER
The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is an imaging instrument onboard Terra, a satellite launched in December 1999 as a collaborative effort between NASA, Japan's Ministry of Economy, Trade and Industry (METI), and Japan Space Systems. ASTER captures high-spatial-resolution data in 14 bands, from the visible to the thermal infrared wavelengths, and provides stereo-viewing capability for creation of digital-elevation models.
URL <http://asterweb.jpl.nasa.gov/index.asp> [May 2015].
Selected imagery for BC can be downloaded for free from MapPlace <http://www.MapPlace.ca> [May 2015].
Imagery in or touching United States lands can be downloaded for free from <http://glovis.usgs.gov> [May 2015].
Imagery outside the USA may be purchased from Earth Remote Sensing Data Analysis Center (ERSDAC) for ¥3600 at <http://gds.ersdac.jspacesystems.or.jp/?lang=en> [May 2015].

Bedrock Geological Mapping

The digital data used on the bedrock geological maps is taken from the BC Digital Geology Map (Massey et al., 2005), which is a compilation of geological mapping from many sources. The geology for the Endako map sheet (093K3) was published in the compilation by Struik and Whalen (1998).

The Struik and Whalen (1998) compilation included geological information from many contributors as part of the Nechako NATMAP project. In the immediate Endako area, they included geological insights developed through the 1960s and 1970s exploration work by Placer Development Limited. These original geological interpretations can be found in the early publications on Endako, which are the basis for the publication by Kimura et al. (1976) in CIM Special Volume 15.

Kimura, E.T., Bysouth, G.D. and Drummond, A.D. (1976): Endako; in Porphyry Deposits of the Canadian Cordillera, A.S. Brown (ed.), Canadian Institute of Mining and Metallurgy Special Volume 15, p. 444–454.

Massey, N.W.D, MacIntyre, D.G., Desjardins, P.J. and Cooney, R.T. (2005): Digital geology map of British Columbia: whole province; BC Ministry of Energy and Mines, GeoFile 2005-1, URL <http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/GeoFiles/Pages/2005-1.aspx> [May 2015]

Struik, L.C. (2007): Bedrock geology (93K) for the Nechako NATMAP project; in Nechako NATMAP Project: A Digital Suite of Geoscience Information for Central British Columbia, Geological Survey of Canada, Open File 5623 and BC Ministry of Energy and Mines, Open File 2007-10.

Struik, L.C. and Whalen, J.B. (1998): Bedrock geology, Endako, British Columbia; Geological Survey of Canada, Open File 3630, 1 map at 1:50 000 scale.

Surficial Geological Mapping

Surficial geological mapping of the Endako region is from the 1:250 000 scale map of Plouffe (2000) for the Fort Fraser map sheet. The adjacent map sheet to the south (093F) was mapped by Plouffe et al. (2004) and is included in the 1:250 000 scale representation of the regional surficial geology. The digital data for these regions was compiled in consistent format in Plouffe (2007).

Plouffe, A. (2000): Surficial geology, Fort Fraser, British Columbia; Geological Survey of Canada, Map 1986A, 1:250 000 scale.

Plouffe, A. (2007): Surficial geology (93F, K and N) for the Nechako NATMAP project; in Nechako NATMAP Project: A Digital Suite of Geoscience Information for Central British Columbia; Geological Survey of Canada, Open File 5623 and BC Ministry of Energy and Mines, Open File 2007-10.

Plouffe, A., Levson, V.M. and Mate, D.J. (2004): Surficial geology, Nechako River, British Columbia; Geological Survey of Canada, Map 2067A, scale 1:250 000.

Till Geochemistry

Till geochemistry data for the Endako area were collected as part of a Geological Survey of Canada reconnaissance till-sampling program in the Manson River and Fort Fraser map areas (NTS 093K and N). Original geochemical data were released in 1993 (Plouffe and Ballantyne, 1993) but were also included in the 1995 data release for the complete project, which included multi-element geochemical data on several size fractions, as well as pebble, heavy mineral, and gold grain counts (Plouffe, 1995). The results were also included in the 2007 NATMAP program publication focused on the Nechako Plateau region, which included additional regional surveys (Plouffe and Levson, 2007).

Plouffe, A. (1995): Geochemistry, lithology, mineralogy, and visible gold grain content of till in the Manson River and Fort Fraser map areas, central British Columbia (NTS 93K and N); Geological Survey of Canada, Open File 3194, 123 p.

Plouffe, A. and Ballantyne, S.B. (1993): Regional till geochemistry, Manson River and Fort Fraser area, British Columbia (93K, 93N), silt plus clay and clay size fractions; Geological Survey of Canada, Open File 2593.

Plouffe, A. and Levson, V. (2007): A till chemistry database for the Nechako NATMAP project; in Nechako NATMAP Project: A Digital Suite of Geoscience Information for Central British Columbia, Geological Survey of Canada, Open File 5623 and BC Ministry of Energy and Mines, Open File 2007-10.

Biogeochemistry

Biogeochemistry data on lodgepole-pine bark were obtained for a large part of the Nechako Plateau region 1998. The data for the Endako region are found in Dunn and Hastings (1999), and data for adjoining areas were published in Dunn and Hastings (1998, 2000). The digital data for all of these surveys were compiled as part of the Nechako NATMAP Project (Dunn, 2007).

A second regional biogeochemistry survey over the Endako area was completed in 2015, focused on comparing the results of spruce sap, pine sap, Ah soils and pH values around the region (Heberlein et al., 2015).

Dunn, C.E. and Hastings, N.L. (1998): Biogeochemical survey of the Ootsa-François lakes area using outer bark of lodgepole pine (NTS 93F/13, 14, and part of 12); Geological Survey of Canada, Open File 3587, 3 maps at 1:250 000 scale and digital data.

Dunn, C.E. and Hastings, N.L. (1999): Biogeochemical survey of the Fraser Lake area using outer bark of lodgepole pine (NTS 93K02/03); Geological Survey of Canada, Open File 3696, 3 maps at 1:400 000 scale and digital data.

Dunn, C.E. and Hastings, N.L. (2000): Biogeochemical survey of Nechako River area using outer bark of lodgepole pine (NTS 93 F 15/16 and parts of 93 F 9/10), central British Columbia; Geological Survey of Canada, Open File 3594, 4 maps at 1:400 000 scale and digital data.

Heberlein, D.R., Dunn, C.E. and Hoffman, E. (2015): Investigation of tree sap as a sample medium for regional geochemical exploration in glacial sediment covered terrains: a case history from the Endako area, north central BC (NTS map sheets 093F14, 093F15, 093K03 and 093K02); Geoscience BC, Report 2015-02, 49 p.

Struik, L.C., MacIntyre, D.G. and Williams, S.P. (2007): Nechako NATMAP project: A Digital Suite of Geoscience Information for Central British Columbia; Geological Survey of Canada, Open File 5623 and BC Ministry of Energy and Mines, Open File 2007-10.

Soil Geochemistry

Pre-mining soil geochemistry data in the immediate Endako area was made available to this project from the historical files of Thompson Creek Mining Ltd. and is included in the project data release. These data include a compilation of some previously released data (released in historical assessment reports), as well as company-held data from surveys conducted between 1960 and 1971. The earlier section of the data, which dates back to 1960, comes from historical mine files; it is not available in historical assessment reports, as the first assessment report with geochemical data on record for the Endako area dates from 1963. These early samples are assumed to be part of sampling programs organized by Canex. The younger data, collected after mine development had commenced, is partly public, filed in assessment reports from 1969 to 1971. These data are from areas explored for possible extensions of the Endako mineralization.

Where documented, all surveys were testing B-horizon soils overlying till cover. Due to the vintage of most analyses, some of which predate atomic absorption spectrophotometry and all of which predate inductively coupled plasma–mass spectrometry, only molybdenum values are available. The early soil samples in the Endako area were analyzed for molybdenum using colorimetric methods. This commonly involved mixing an ammonium thiocyanate compound to form a coloured liquid, which was then compared visually to calibrated solutions to determine molybdenum content. The 1969–1971 samples were analyzed using atomic absorption spectrophotometry following hot-acid digestion.

Other soil surveys from areas outside of the immediate area of the Endako deposit have been filed in various assessment reports. These data are not compiled digitally here because of their distance from known mineralization and their poorly defined locations.

Lake and Stream Sediment Geochemistry

A combined file that includes all data from the BC Geological Survey Regional Geochemical Survey, as well as the Geoscience BC QUEST and QUEST WEST sample reanalysis projects, was used for the stream- and lake-sediment geochemistry analysis. The samples were subsetted to the limits of the maps presented. The following publications pertain to the Endako area:

Jackaman, W. (2009): Regional drainage sediment and water geochemical data, central British Columbia (parts of NTS 93E, F, G, J, K, L, M, N & O); Geoscience BC, Report 2009-11, URL <http://www.geosciencebc.com/s/2009-11.asp> [May 2015].

Jackaman, W. (2008): Regional lake sediment and water geochemical data, northern Fraser Basin, central BC (parts of NTS 93G, H, J, K, N & O); Geoscience BC, Report 2008-5, URL <http://www.geosciencebc.com/s/2008-05.asp> [May 2015].

Jackaman, W. (2009): QUEST-West project sample reanalysis; Geoscience BC, Report 2009-5, 4 p., URL <http://www.geosciencebc.com/s/2009-05.asp> [May 2015].

Induced Polarization Surveys

Induced-polarization (IP) data from the immediate area of the Endako mine is from two surveys that were designed to test possible extension of the Endako mineralization. The 1996 survey by Scott Geophysics Ltd. for Placer Dome Canada Ltd. included three lines to the northwest of the Endako mine. In 2003, Scott Geophysics Ltd. completed 12,200 feet of IP over three parallel lines to the southeast of the mine for Thompson Creek Mining Ltd. The 2003 survey consisted of a pole-dipole array with 200 foot spacing and 'n' separations of 1 to 4. The digital data from these two surveys are made public by Thompson Creek Metals Ltd. in this publication and the associated digital-data collection.

Other local IP surveys were conducted in more distant parts of the Endako district during exploration programs between 1966 and 1979. Digital data for these surveys are not readily available, although plan maps and some section lines are presented in historical assessment reports filed with the BC Ministry of Energy and Mines, and made available on the ARIS website:

<http://www.empr.gov.bc.ca/Mining/Geoscience/ARIS/Pages/default.aspx> [May 2015].

Gravity Data

Two gravity surveys were combined to make the new images generated for this atlas: the 2008 GSC Nechako survey and the 2008 Geoscience BC QUEST West survey.

Dumont, R. (2008): Bouguer anomaly, Nechako Basin airborne gravity survey, Prince George / Nechako River (NTS 93 G and part of 93 F), British Columbia; Geological Survey of Canada, Open File 5883, 1 sheet, URL <http://gdr.agg.nrcan.gc.ca/> [May 2015].

Dumont, R. (2008): First vertical derivative of the Bouguer anomaly, Nechako Basin airborne gravity survey, Prince George / Nechako River (NTS 93 G and part of 93 F), British Columbia; Geological Survey of Canada, Open File 5881, 1 sheet, URL <http://gdr.agg.nrcan.gc.ca/> [May 2015].

Magnetics and Radiometrics Surveys

The following surveys were combined to generate the airborne magnetic maps:

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako block; internal report for Thompson Creek Mining Ltd., 20 p.

Aeroquest Airborne Ltd. (2014): Fixed wing magnetic geophysical survey, TREK project, Interior Plateau/Nechako region, British Columbia, Canada; Geoscience BC, Report 2014-04, 40 p., URL <http://www.geosciencebc.com/s/Report2014-04.asp> [May 2015].

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534 and BC Ministry of Energy and Mines, Open File 2005-11, 9 maps at 1:50 000 scale, URL <http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/OpenFiles/2005/Pages/2005-11.aspx> [May 2015].

Airborne radiometric maps were produced from the following surveys:

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako block; internal report for Thompson Creek Mining Ltd., 20 p.
Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Nithi block; BC Ministry of Energy and Mines, Assessment Report 29594, 19 p.

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534 and BC Ministry of Energy and Mines, Open File 2005-11, 9 maps at 1:50 000 scale, URL <http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/OpenFiles/2005/Pages/2005-11.aspx>[May 2015].

Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

2007 SATELLITE IMAGERY

1 : 250,000

Data Sources:

Google Earth
Imagery Date: July 6, 2007
© 2013 Digital Globe

SCALE 1:250,000

0 5 10 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

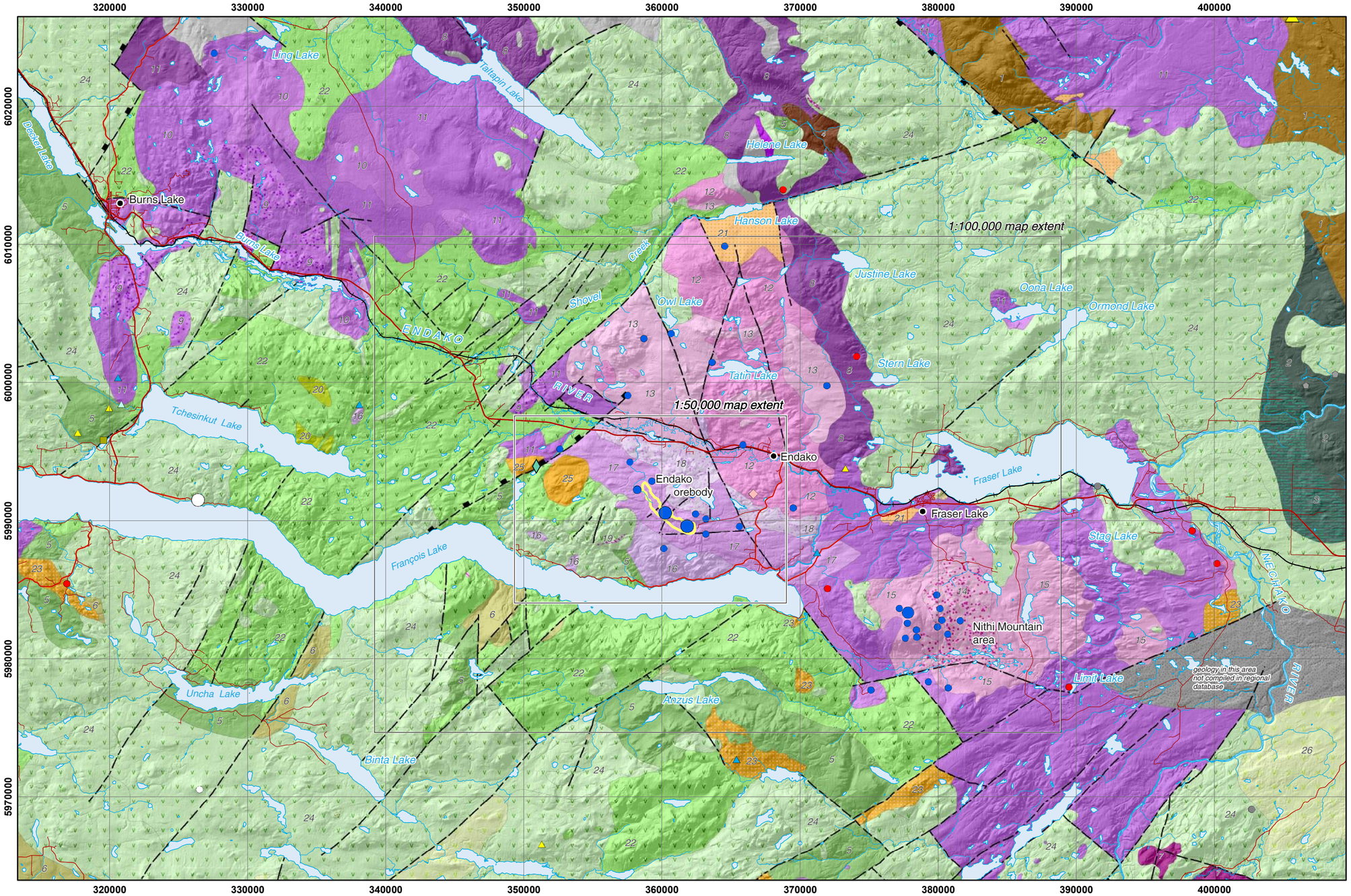
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

BEDROCK GEOLOGY

1 : 250,000



Overlap Assemblages and Post-Accretionary Intrusions

MIOCENE:

- 26 — Chilcotin Group: basalt

EOCENE to OLIGOCENE:

- 25 — granite (Sam Ross Creek pluton)
- 24 — Nechako Plateau, Ootsa Lake, Endako Groups: basalt, andesite

UPPER CRETACEOUS:

- 23 — feldspar porphyritic intrusive rocks
- 22 — Kasalka Group: andesite, coarse clastic rocks

LOWER CRETACEOUS:

- 21 — (Endako batholith) quartz monzonite, granodiorite
- 20 — Skeena Group: volcanic and clastic rocks

Stikine Terrane

ENDAKO BATHOLITH

LATE JURASSIC: Francois Lake Suite

- 19 — high-level quartz-phyric, felsitic intrusive rocks

Endako Subsuite

- 18 — Casey Phase: granite, K-feldspar granite
- 17 — Endako Phase: granodiorite
- 16 — Francois Subphase: granodiorite and other granodioritic rocks

Glenannan Subsuite

- 15 — Nithi Phase: quartz monzonite to monzogranite
- 14 — Nithi Phase
- 13 — Tatin Lake Subphase: granite, K-feldspar granite
- 12 — Glenannan and Leg Lake Phases: granite, K-feldspar granite

EARLY to MIDDLE JURASSIC: Stag Lake Suite

- 11 — diorite, quartz diorite
- 10 — quartz monzonite, monzogranite
- 9 — granite, K-feldspar granite

LATE TRIASSIC: Stern Creek Suite

- 8 — diorites

EARLY TRIASSIC to LATE JURASSIC:

- 7 — Brooks diorite complex

LOWER to UPPER JURASSIC:

- 6 — Bowser Lake group, clastic rocks
- 5 — Hazelton Group volcanic rocks, undivided

UPPER PENNSYLVANIAN to UPPER TRIASSIC:

- 4 — Asitka Group, clastic rocks

Cache Creek Terrane

UPPER TRIASSIC to LOWER JURASSIC:

- 3 — Sitlika Assemblage (clastic)

UPPER PENNSYLVANIAN to UPPER TRIASSIC:

- 2 — Bimodal volanic rocks, undivided
- 1 — Cache Creek Complex (includes some intrusive units)

Symbols

- roads (major, minor)
- railway
- fault
- geological contact

Data Sources:

Anderson, R.G. and Diakow, L. (2007): Bedrock geology (93F) for the Nechako NATMAP Project in Nechako NATMAP Project: A digital suite of geoscience information for central British Columbia; Geological Survey of Canada, Open File 5623 and British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2007-10.

BC Geological Survey (2015): MINFILE BC mineral deposits database; BC Ministry of Energy and Mines, BC Geological Survey, URL <http://minfile.ca/> [February, 2015].

Massey, N.W.D, MacIntyre, D.G., Desjardins, P.J. and Cooney, R.T. (2005): Digital Geology Map of British Columbia: Whole Province; BC Ministry of Energy and Mines, Geofile 2005-1, URL <http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/GeoFiles/Pages/2005-1.aspx> [May 2015]

BC MINFILE

Recorded mineral occurrences: coloured by type, sized by status of development:

1 Showing 2 prospect 3 Developed prospect 4 Producer or past producer

- Molybdenum +/- Copper, Uranium, Zinc, Tungsten (porphyry Mo, low-F type)
- Gold +/- Silver, Antimony, Copper, Molybdenum (Au-quartz veins / polymetallic veins)
- Copper +/- Molybdenum, Gold, Silver, Lead, Zinc (porphyry?)
- Silver-Lead-Zinc +/- Gold, Copper (polymetallic veins)
- Limestone

** Note that MINFILE occurrences are plotted in the location listed in the database, the location of historic workings may vary slightly when located on the ground.

- Clay
- Perlite
- Coal
- Feldspar-Mica-Silica
- Flourite
- Mercury
- Manganese
- Phosphate

SCALE 1:250,000

0 5 10 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

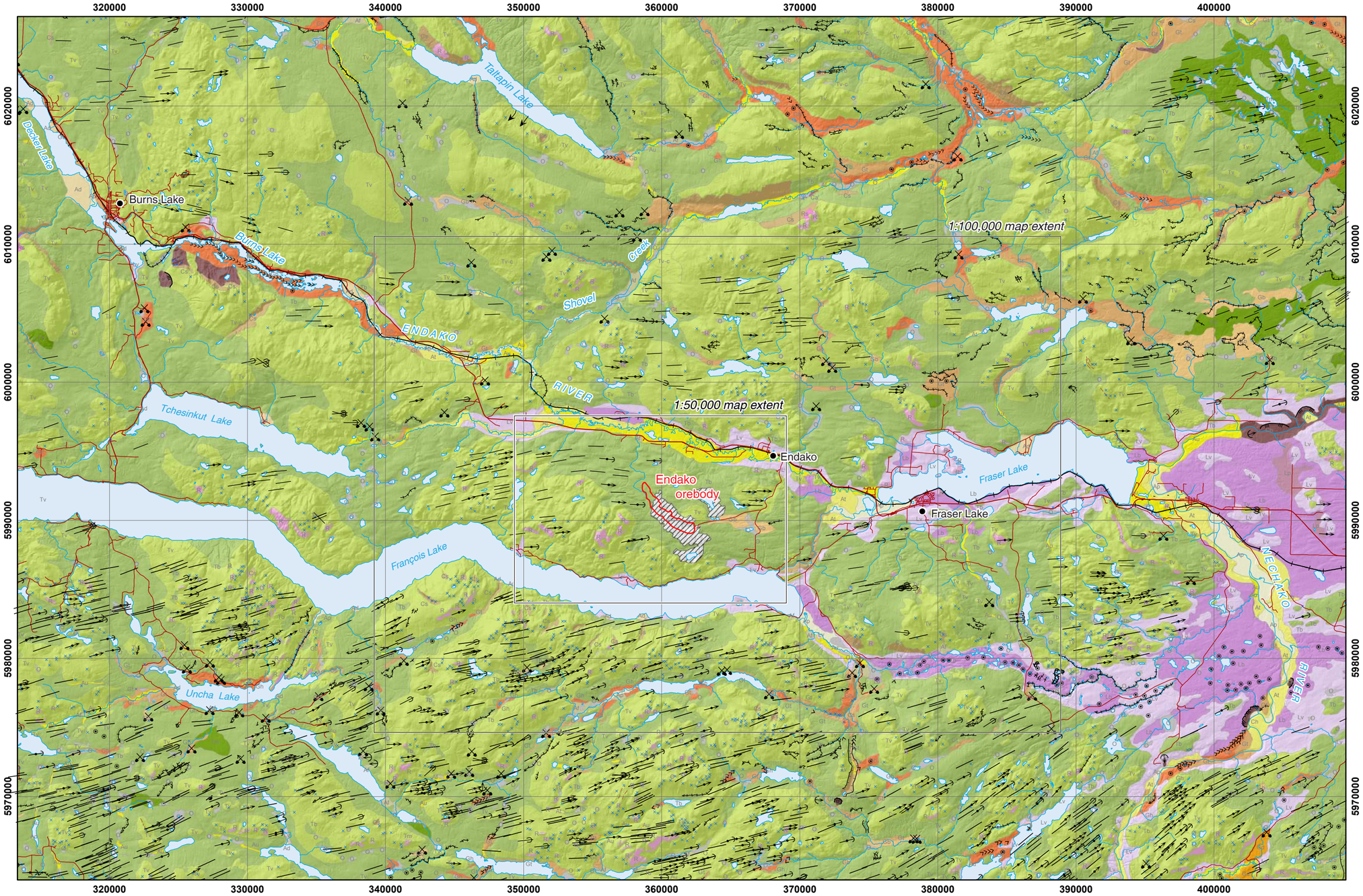
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

SURFICIAL GEOLOGY

1 : 250,000



LEGEND

(modified from Plouffe, 2000 & 2004)

QUATERNARY

Non-glacial environment

- X — Anthropogenic deposits
- O — Organic deposits

Alluvial (Fluvial) deposits

- Ap — Floodplain sediments
- At — Terrace sediments
- Ad — Deltaic sediments
- Af — Fan sediments
- Au — Alluvial sediments (undivided)

Colluvial deposits

- Ch — Landslide debris
- Cs — Slope colluvium
- Ca — Talus

Proglacial and glacial environment

- Lb — Glaciolacustrine blanket
- Lv — Glaciolacustrine veneer
- Lp — Glaciolacustrine plain
- Gt — Glaciofluvial terrace sediments
- Gb — Glaciofluvial blanket
- Gd — Proglacial deltaic sediments
- Gh — Ice contact deposits

Glacial environment

- Tb — Till blanket
- c-Tb — Pinchi lens, clayey till
- Tv — Till veneer
- Tm — Thick till, rolling

PRE-QUATERNARY

- R — Bedrock
- Rs — Bedrock - steep slopes

- bedrock lineation
- debris flow track
- dunes, inactive
- esker (flow direction known, unknown)
- landslide scar
- meltwater channel, large
- meltwater channel, small (flow direction known, unknown)
- moraine (ornamented on glacier side)

Data Sources:

Digital data:

Plouffe, A. (2007): Surficial geology (93F, K and N) for the Nechako NATMAP Project in Nechako NATMAP Project: A digital suite of geoscience information for central British Columbia; Geological Survey of Canada, Open File 5623 and British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2007-10.

Original mapping was released as:

Plouffe, A. (2000): Surficial Geology, Fort Fraser, British Columbia; Geological Survey of Canada, Map 1986A, 1:250 000 scale.

Plouffe, A., Levson, V.M., and Mate, D.J. (2004): Surficial geology, Nechako River, British Columbia; Geological Survey of Canada, Map 2067A, scale 1:250 000.

Ice Flow Indicators

- crag and tail
- drumlin (direction known, unknown)
- striations (direction known, unknown)
- fluting

Symbols

- quarry
- gravel pit
- kettle hole
- landslide scar (small)
- outcrop

Infrastructure

- highway (paved)
- road (various surfaces)
- railway

SCALE 1:250,000

0 5 10 20

kilometres

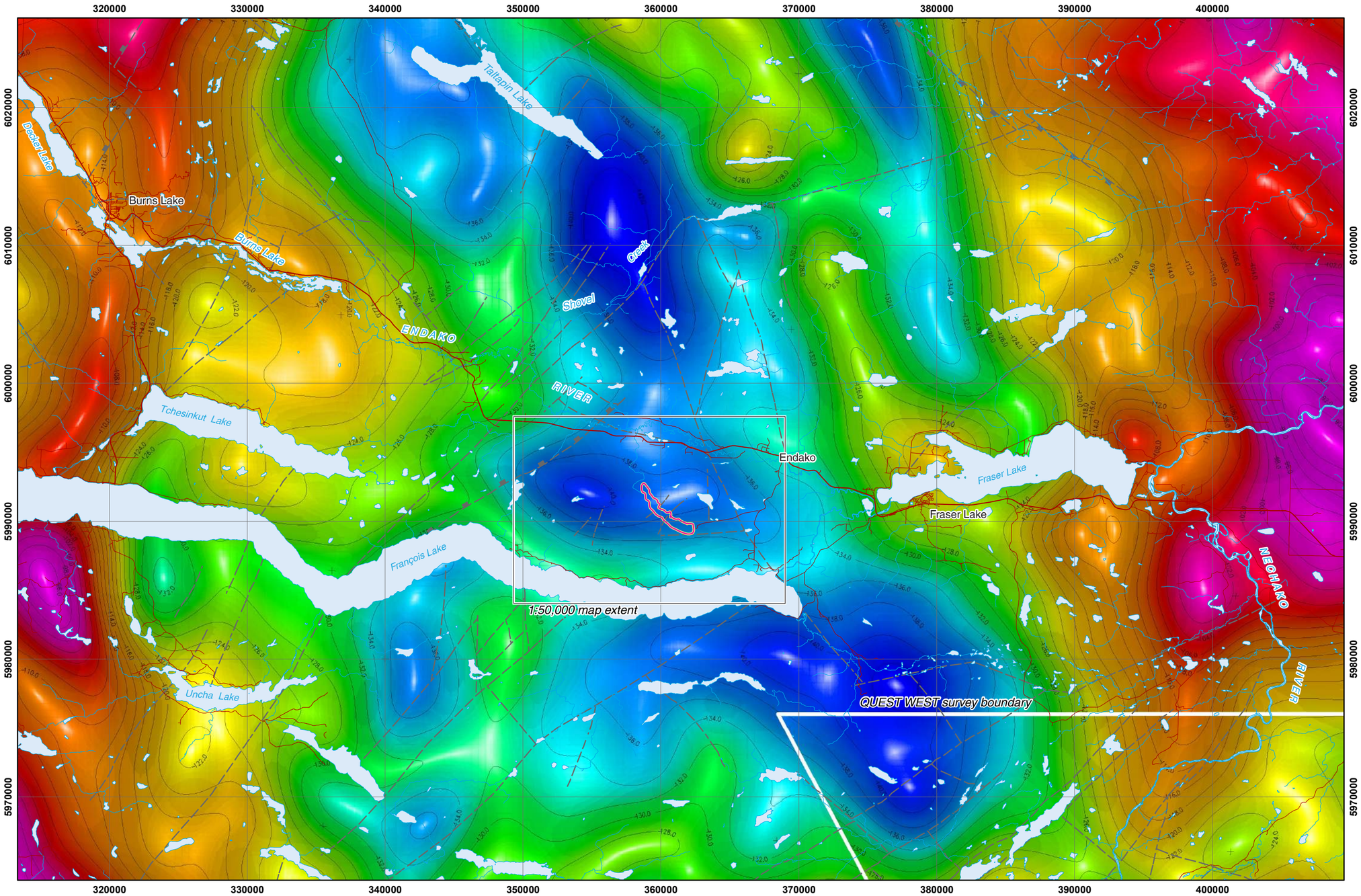
Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

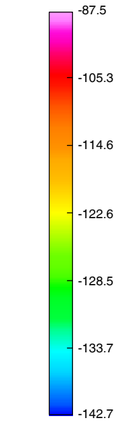
ENDAKO DISTRICT

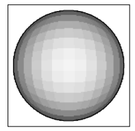
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

GRAVITY
Bouger
1 : 250,000







Azimuth : 90
Inclination : 90

Endako orebody (Marek, 2011)

0.042% MoS_2 simplified grade thickness contour

Symbols

Faults

- fault (undivided)
- extensional fault
- normal fault
- thrust fault

Infrastructure

- Highway 16
- secondary road
- rail line

Data Sources:

Geological Survey of Canada (2008): Nechako Basin airborne gravity survey. URL <http://gdr.agg.nrcan.gc.ca/> [May 2015].

Sander Geophysics Limited (2008): Airborne gravity survey, QUEST West, British Columbia - 2008; Geoscience BC, Report 2008-10, 129 p., URL <http://www.geosciencebc.com/s/2008-10.asp> [May 2015].

SCALE 1:250,000

0 5 10 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

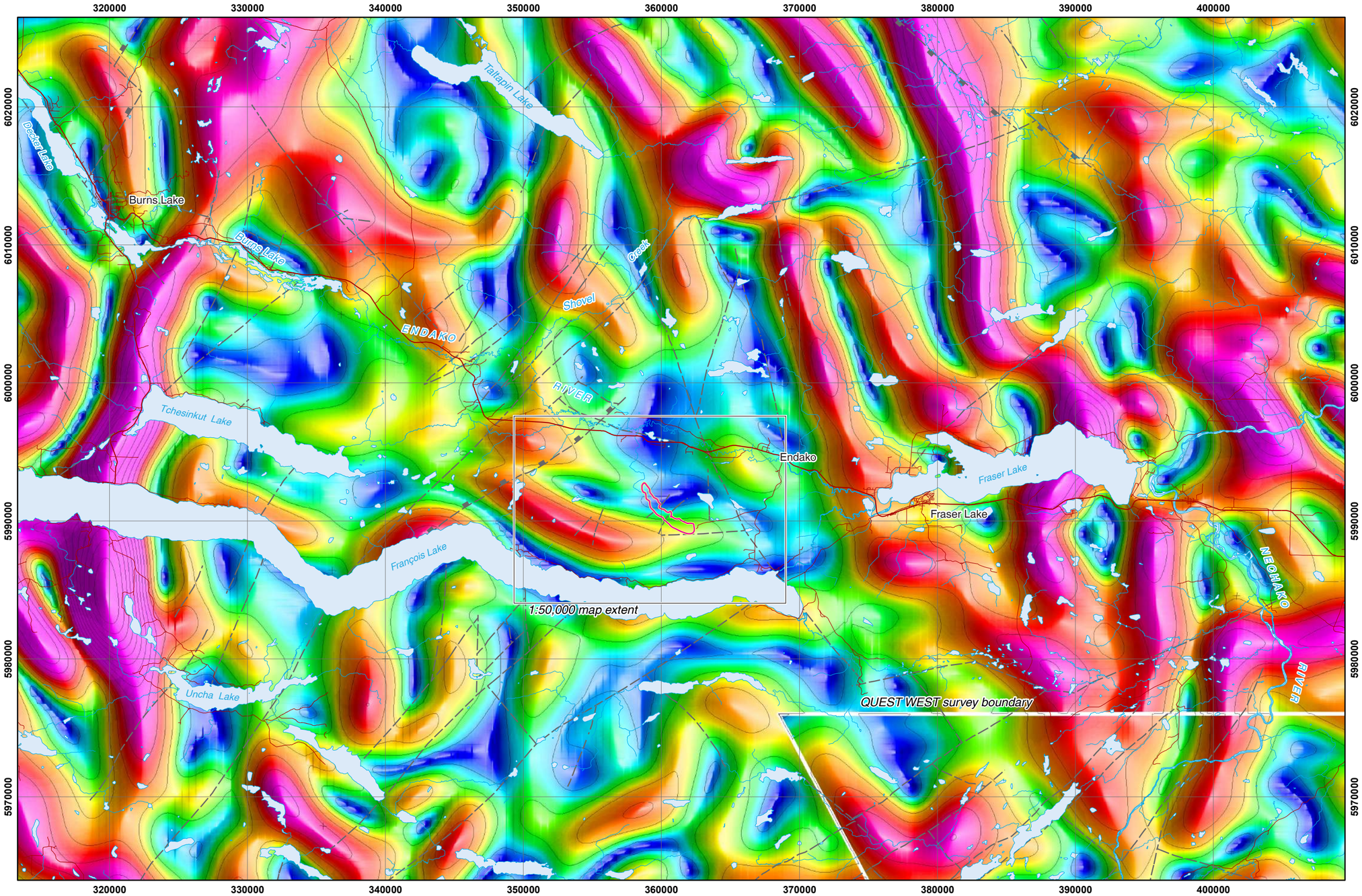
Porphyry Districts of British Columbia Atlas Series

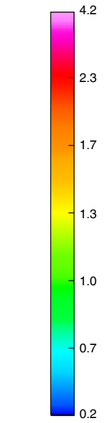
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

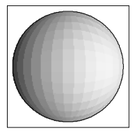
Geoscience BC

GRAVITY
Bouger - Horizontal Gradient
1 : 250,000





Magnitude of Horizontal Gradient (mgals/km)



Azimuth : 90
Inclination : 45

Endako orebody (Marek, 2011)

0.042% MoS_2 simplified grade thickness contour

Symbols

Faults

- fault (undivided)
- extensional fault
- normal fault
- thrust fault

Infrastructure

- Highway 16
- secondary road
- rail line

Data Sources:

Geological Survey of Canada (2008): Nechako Basin airborne gravity survey. URL <http://gdr.agg.nrcan.gc.ca/> [May 2015].

Sander Geophysics Limited (2008): Airborne gravity survey, QUEST West, British Columbia - 2008; Geoscience BC, Report 2008-10, 129 p., URL <http://www.geosciencebc.com/s/2008-10.asp> [May 2015].

SCALE 1:250,000

0 5 10 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

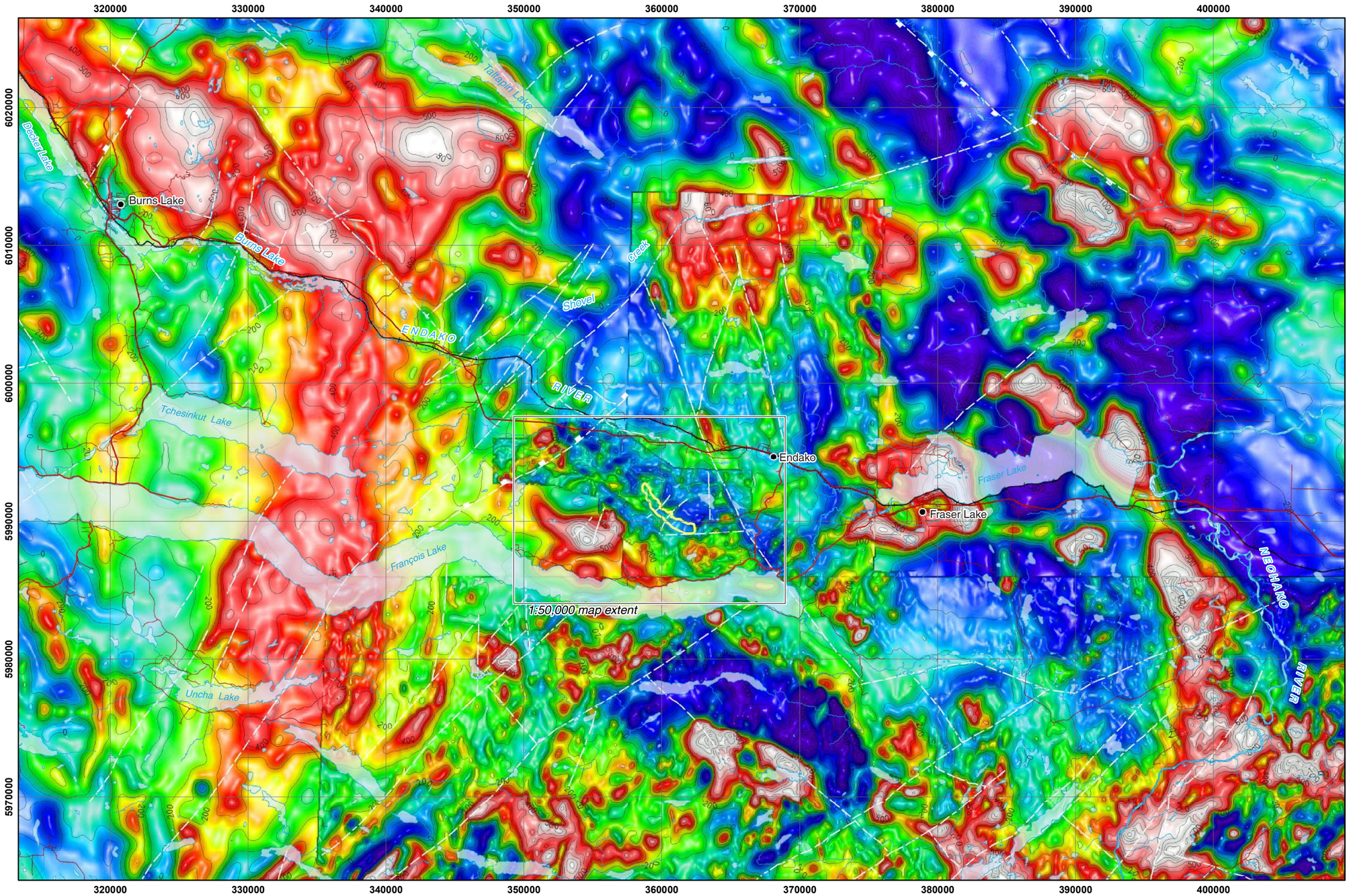
ENDAKO DISTRICT

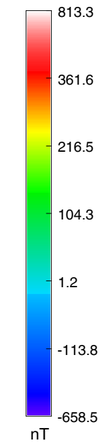
A geo-exploration atlas of the Endako porphyry molybdenum district

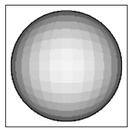
Geoscience BC

MAGNETICS
Residual Magnetic Intensity

1 : 250,000







Endako orebody (Marek, 2011)

0.042% MoS_2 simplified grade thickness contour

Symbols

Faults

- fault (undivided)
- extensional fault
- normal fault
- thrust fault

Infrastructure

- Highway 16
- secondary road
- rail line

Data Sources:

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534, 9 maps, scale 1:50,000
Also published as: British Columbia Ministry of Energy, Mines, and Petroleum Resources, Open File 2005-11.

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako Block; internal report for Thompson Creek Mining Ltd., 20 p.

Aeroquest Airborne Ltd. (2014): Fixed Wing Magnetic Geophysical Survey, TREK Project, Interior Plateau/ Nechako Region, British Columbia, Canada; Geoscience BC, Report 2014-04, 40 p.

There are several vintages of magnetic surveys covering parts of the Endako region. These datasets were flown at different lines spacings and flight heights. Some upward continuation processing has been done to bring the merged data to a similar general appearance.

The background data is a subset of the GSC national 200m x 200m gridded data, downward continued 100m. The Thompson Creek 2007 data has been upward continued 70m to make it comparable with the 2013 Geoscience BC TREK data and the BCGS project 2005-11 data. The GBC TREK data and the BCGS project 2005-11 data have been left unchanged.

Priority has been given to the 2013 GBC TREK data, the Thompson Creek 2007 data, and then the 2005 BCGS data. The surrounds have been infilled with the GSC national 200m x 200m RTF data from the GSC national database. All data has been levelled to the GSC national grid.

SCALE 1:250,000

0 5 10 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

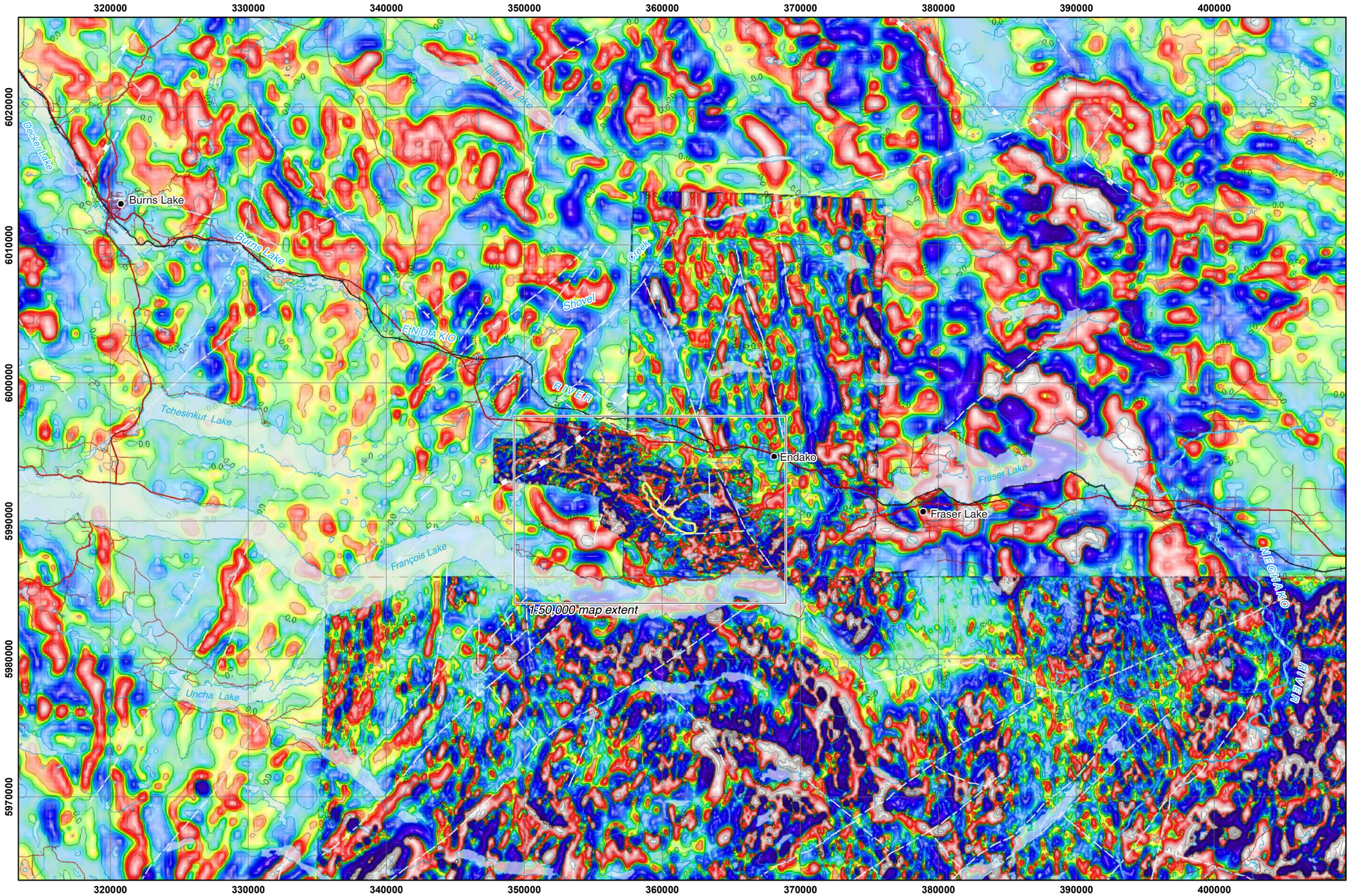
ENDAKO DISTRICT

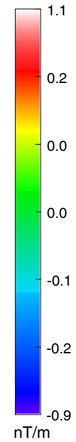
A geo-exploration atlas of the Endako porphyry molybdenum district

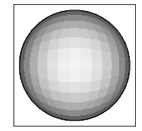
Geoscience BC

MAGNETICS
1st Vertical Derivative

1 : 250,000







Azimuth : 90
Inclination : 90

Endako orebody (Marek, 2011)

0.042% MoS_2 simplified grade thickness contour

Symbols

Faults

- fault (undivided)
- extensional fault
- normal fault
- thrust fault

Infrastructure

- Highway 16
- secondary road
- rail line

Data Sources:

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534, 9 maps, scale 1:50,000
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There are several vintages of magnetic surveys covering parts of the Endako region. These datasets were flown at different lines spacings and flight heights. Some upward continuation processing has been done to bring the merged data to a similar general appearance.

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The 1st Vertical Derivative of the Magnetic Field has been calculated for each survey independently and then the results merged.

Priority has been given to the 2013 GBC TREK data, the Thompson Creek 2007 data, and then the 2005 BCGS data. The surrounds have been infilled with the GSC national 200m x 200m RTF data from the GSC national database. All data has been levelled to the GSC national grid.

SCALE 1:250,000

0 5 10 20

kilometres

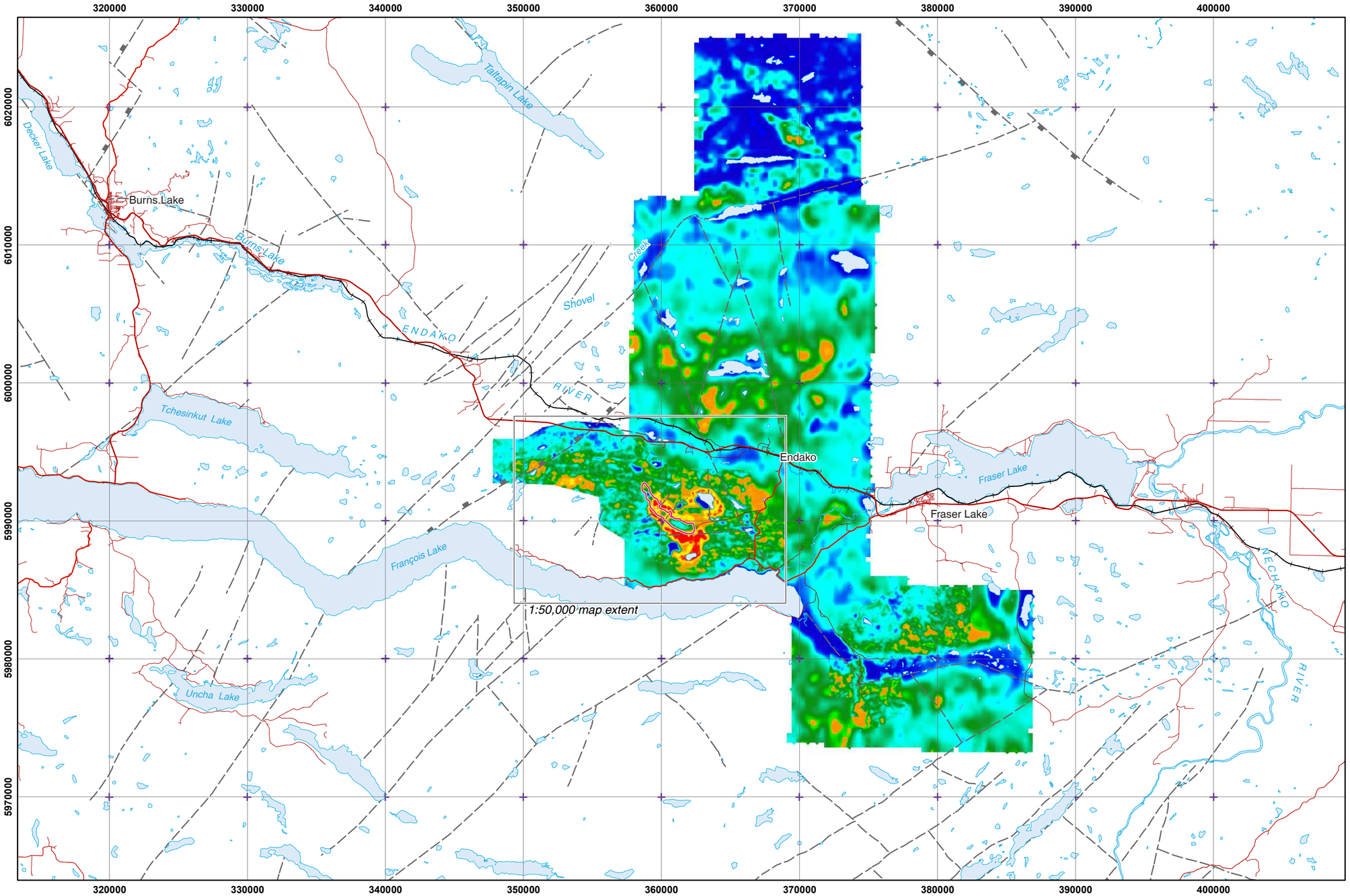
Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

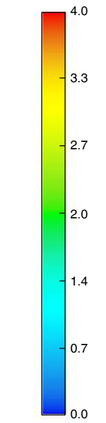
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

RADIOMETRICS
% Potassium
1 : 250,000





Endako orebody (Marek, 2011)

0.042% MoS_2 simplified grade thickness contour

Symbols

Faults

- fault (undivided)
- extensional fault
- normal fault
- thrust fault

Infrastructure

- Highway 16
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Data Sources:

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534, 9 maps, scale 1:50,000
Also published as: British Columbia Ministry of Energy, Mines, and Petroleum Resources, Open File 2005-11.

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako Block; internal report for Thompson Creek Mining Ltd., 20 p.

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Nithi Block; Leeward Capital Corp., British Columbia Ministry of Energy, Mines and Petroleum Resources, Assessment Report 29594, 19 p.

Multiple radiometric surveys are displayed in this image. Priority is given to the 2007 Thompson Creek and Nithi Mountain surveys. All surveys have been qualitatively levelled to minimize differences between them. The absolute calibration of the surveys to allow conversion to radioelement concentrations has been ignored as there are differing and conflicting values for different surveys flown over the same areas. All values should be treated as relative.

Smoothing has been done to improve the counting statistics and to reduce the visual differences between the surveys.

SCALE 1:250,000

0 5 10 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

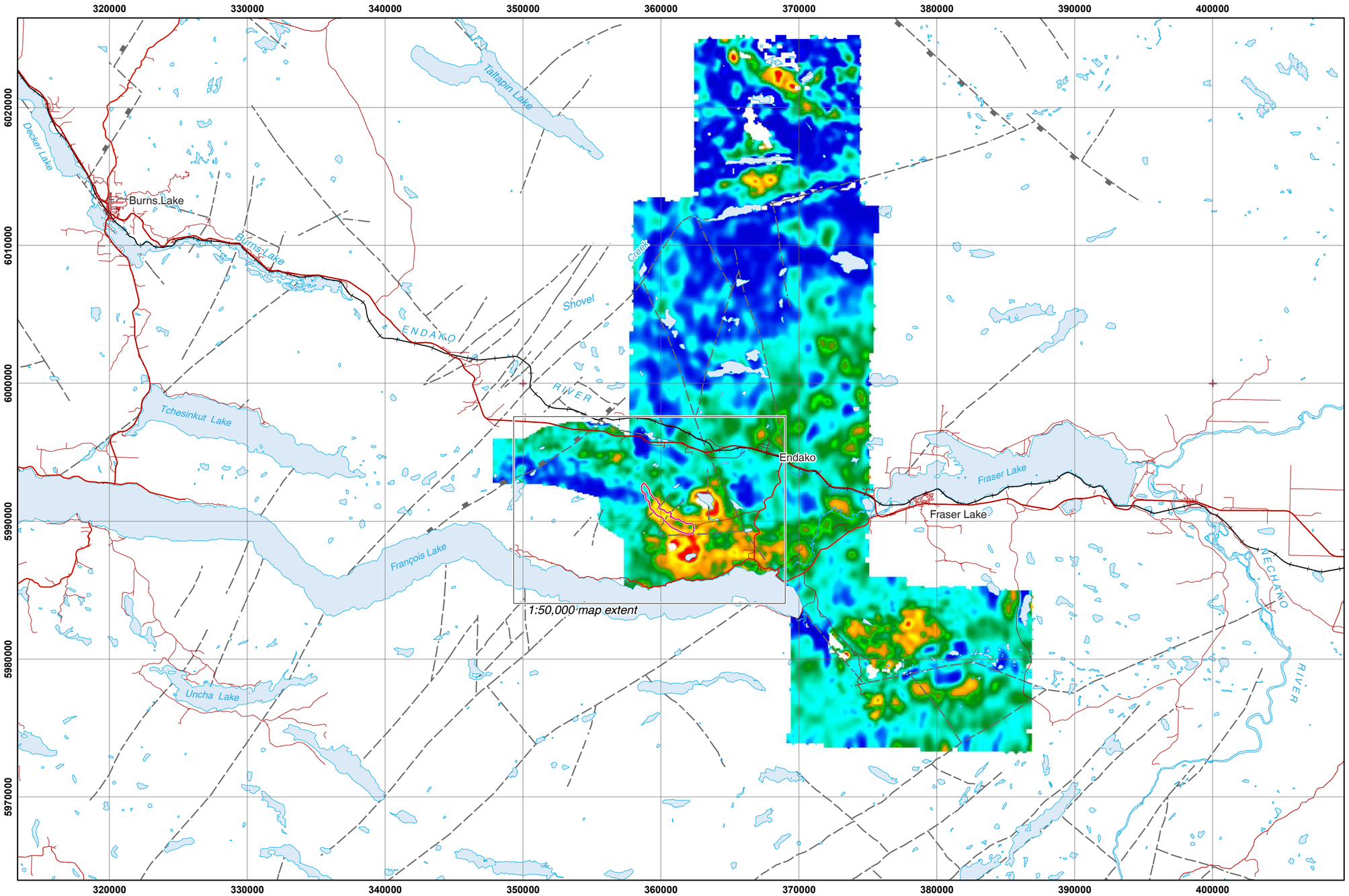
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

RADIOMETRICS K/eTh

1 : 250,000



0.55
0.48
0.42
0.35
0.29
0.22
0.16

% K / eTh(ppm) ratio

Endako orebody (Marek, 2011)

0.042% MoS_2 simplified grade thickness contour

Symbols

Faults

- fault (undivided)
- extensional fault
- normal fault
- thrust fault

Infrastructure

- Highway 16
- secondary road
- rail line

Data Sources:

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534, 9 maps, scale 1:50,000
Also published as: British Columbia Ministry of Energy, Mines, and Petroleum Resources, Open File 2005-11.

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Smoothing has been done to improve the counting statistics and to reduce the visual differences between the surveys.

Areas of low thorium concentration (<1ppm eTh) have been blanked as these produce unstable K/eTh ratio values; these areas are likely over water and of no geologic significance.

SCALE 1:250,000

0 5 10 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

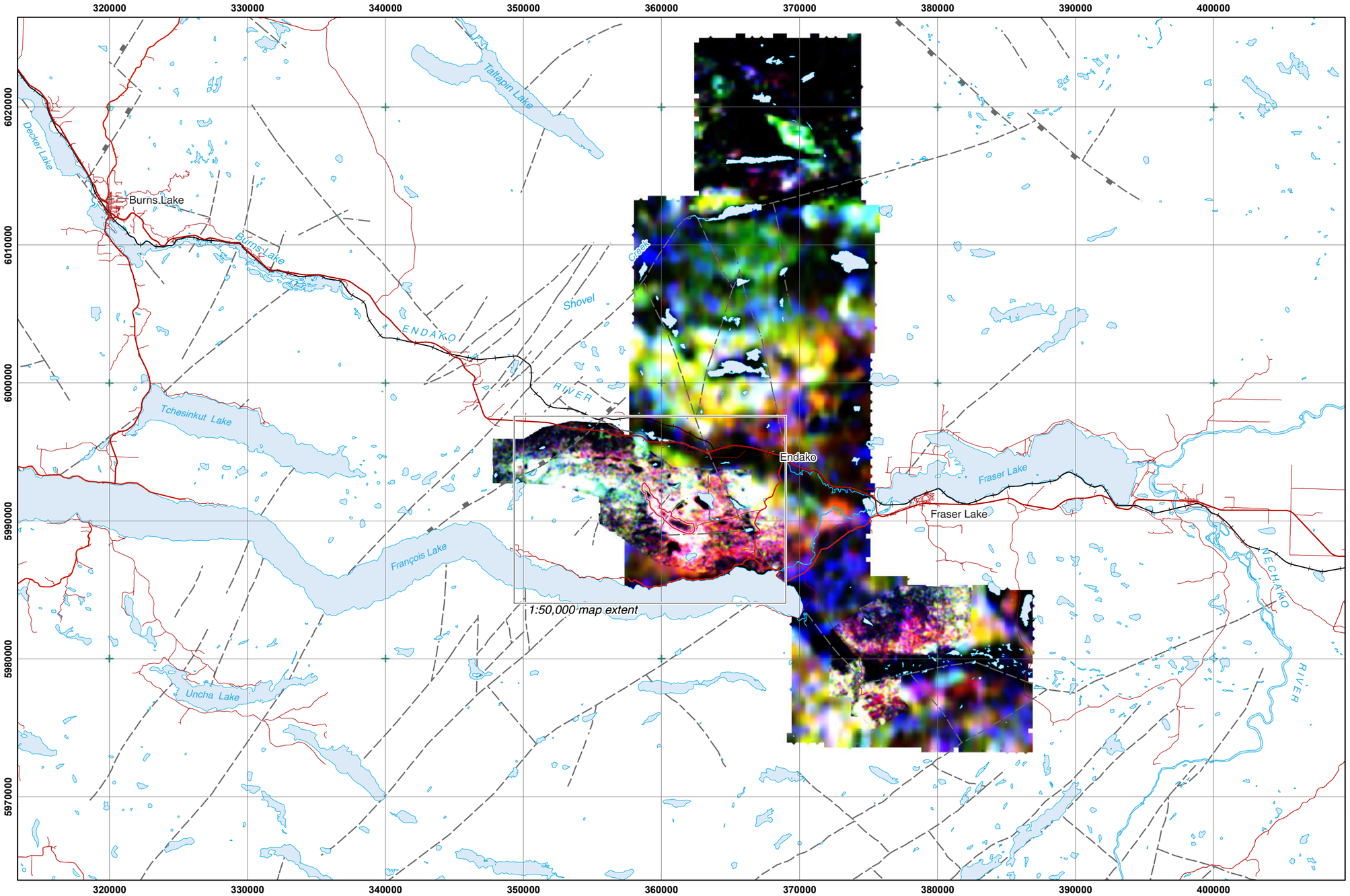
Porphyry Districts of British Columbia Atlas Series

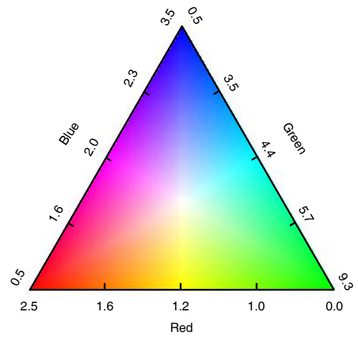
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

RADIOMETRICS
KTU Ternary Image
1 : 250,000





Red : Combined Percent Potassium
Green : Combined Equivalent Thorium
Blue : Combined Equivalent Uranium

All three channels have been histogram equalized

Endako orebody (Marek, 2011)

0.042% MoS_2 simplified grade thickness contour

Symbols

Faults

- fault (undivided)
- extensional fault
- normal fault
- thrust fault

Infrastructure

- Highway 16
- secondary road
- rail line

Data Sources:

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534, 9 maps, scale 1:50,000
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Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Nithi Block; Leeward Capital Corp., British Columbia Ministry of Energy, Mines and Petroleum Resources, Assessment Report 29594, 19 p.

Levelling corrections have been applied to balance the histograms of the various surveys that make this image. Priority has been given to the 2007 Thompson Creek and Nithi Mountain surveys, and the other surveys have been adjusted to provide a smooth visual transition between them. This means that radiometric calibrations for the different surveys have not been honoured exactly as they conflict in overlapping areas. Ratios indicated in the image are relative and approximate.

SCALE 1:250,000

0 5 10 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

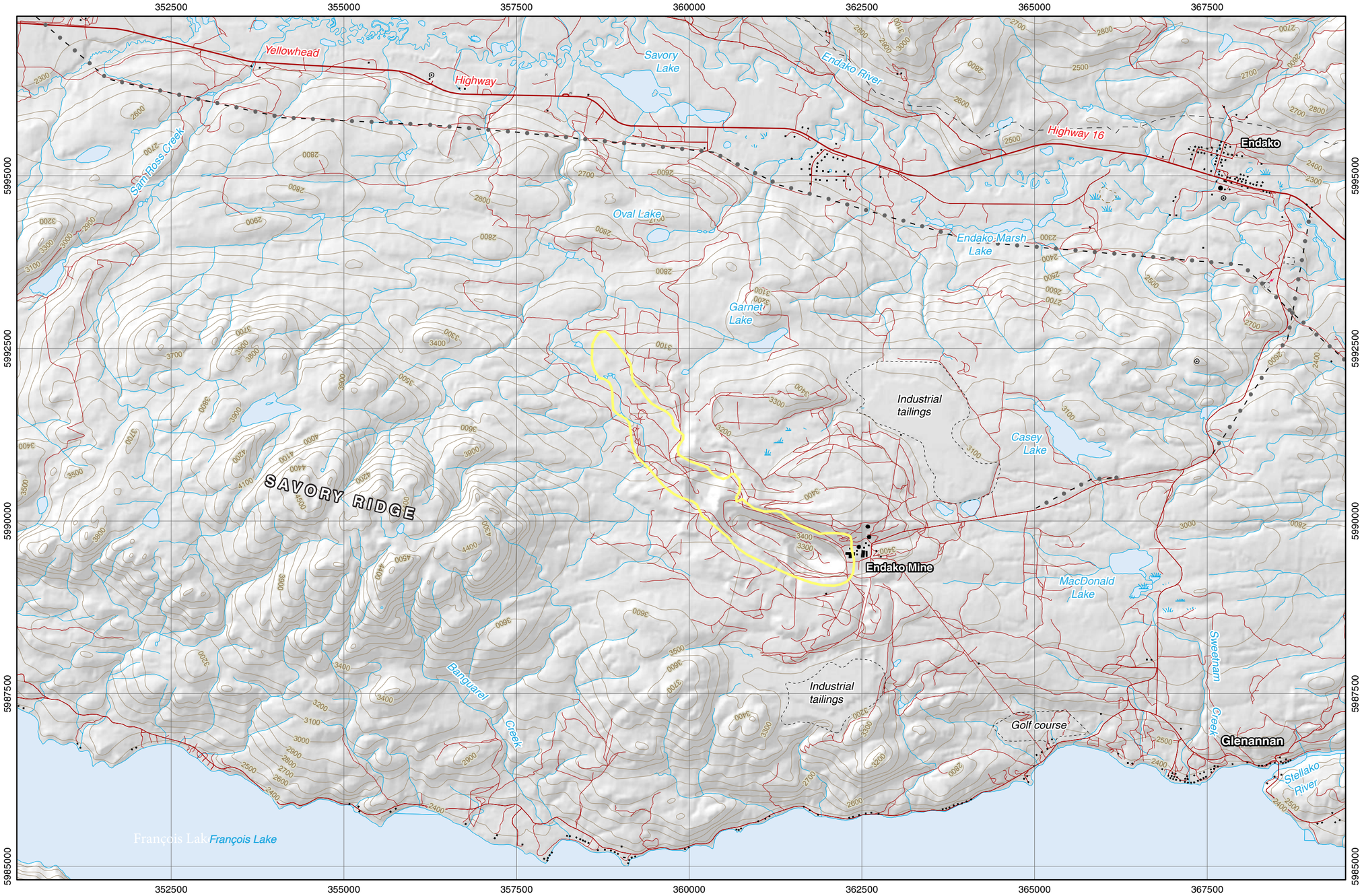
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

TOPOGRAPHY

1 : 50,000



LEGEND

- industrial buildings
- tanks
- chimney (burner)
- buildings
- campground
- picnic site
- transformer station
- tower (communication)
- cemetary
- domestic waste site
- wetland
- highway
- major road
- minor road
- railway
- pipeline (natural gas, underground)
- power transmission line (overhead)

Endako orebody
(after Marek, 2011)

approximate outline of 0.042% MoS_2 grade contour

Data Sources:

Natural Resources Canada (2013): CanVec, Canada, 093K03 and K02; Natural Resources Canada, Earth Sciences Sector, Mapping Information Branch, Centre for Topographic Information, URL <http://geogratis.gc.ca> [May 2015]

GeoBC, 2013: Digital Road Atlas; Crown Registry and Geographic Base, Province of British Columbia, URL <http://geobc.gov.bc.ca/base-mapping/atlas/dra/> [May 2015]

This shaded-relief digital elevation model image behind topography is generated from the GeoBase 1:50,000 scale digital elevation data, with a cell size of 18 metres.

SCALE 1:50,000

0 2.5 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

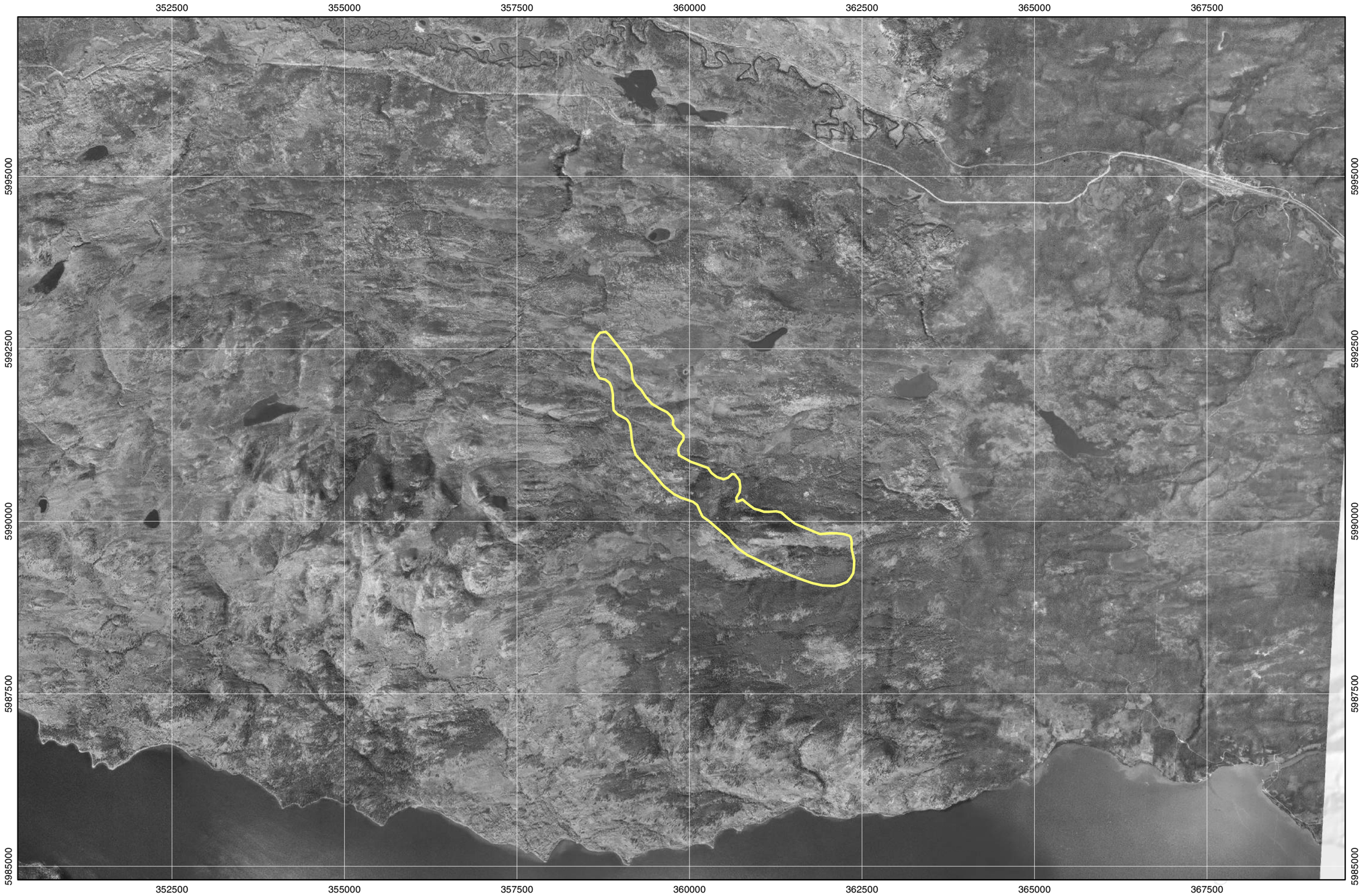
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

1954 AIRPHOTO MOSAIC

1 : 50,000



Endako orebody
(Marek, 2011)

approximate outline of 0.042% MoS_2 grade contours

Data Sources:

original images used to generate the mosaic are from:

GeoBC, 2013: British Columbia Airphoto database; Ministry of Agriculture and Lands, Integrated Land Management Bureau, scale 1:31 680, flight lines BC1942 (photos 77-80) and BC1799 (photos 85-88).

This pre-mining orthophoto image of the Endako region is a mosaic of original 1954 air photos from the BC airphoto database. Original images were purchased through GeoBC and were compiled into a single mosaic image by aerial triangulation of the individual scanned images, followed by orthorectification using Satellite SRTM digital terrain modeling data.

SCALE 1:50,000

0 2.5 5

kilometres

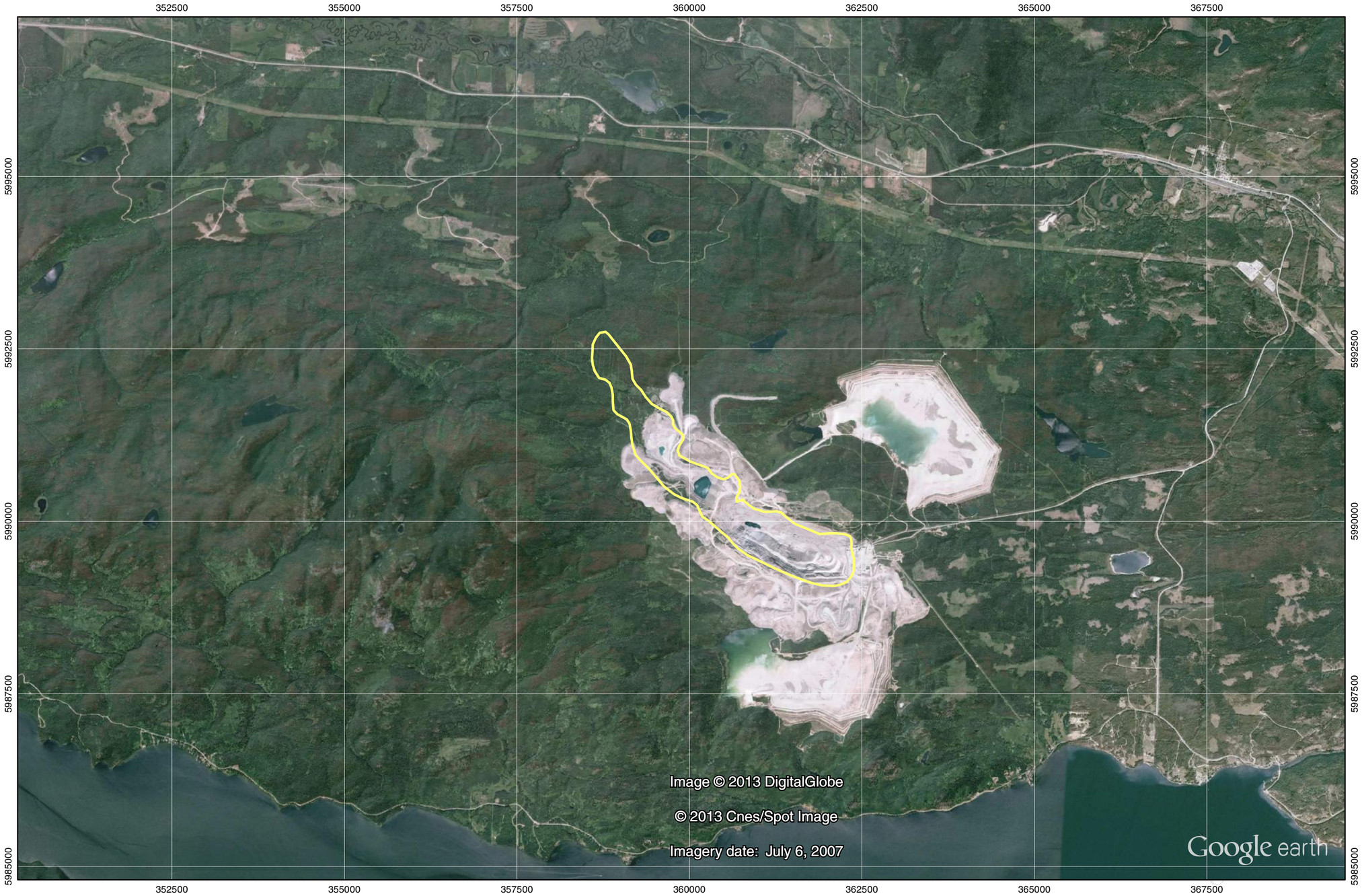
Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

ENDAKO DISTRICT

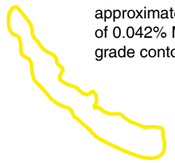
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

SATELLITE IMAGERY
Google Earth - SPOT
1 : 50,000



Endako orebody
(Marek, 2011)



approximate outline of 0.042% MoS_2 grade contours

Data Sources:

Google Earth
Imagery Date: July 6, 2007
© 2013 Digital Globe

SCALE 1:50,000

0 2.5 5
kilometres

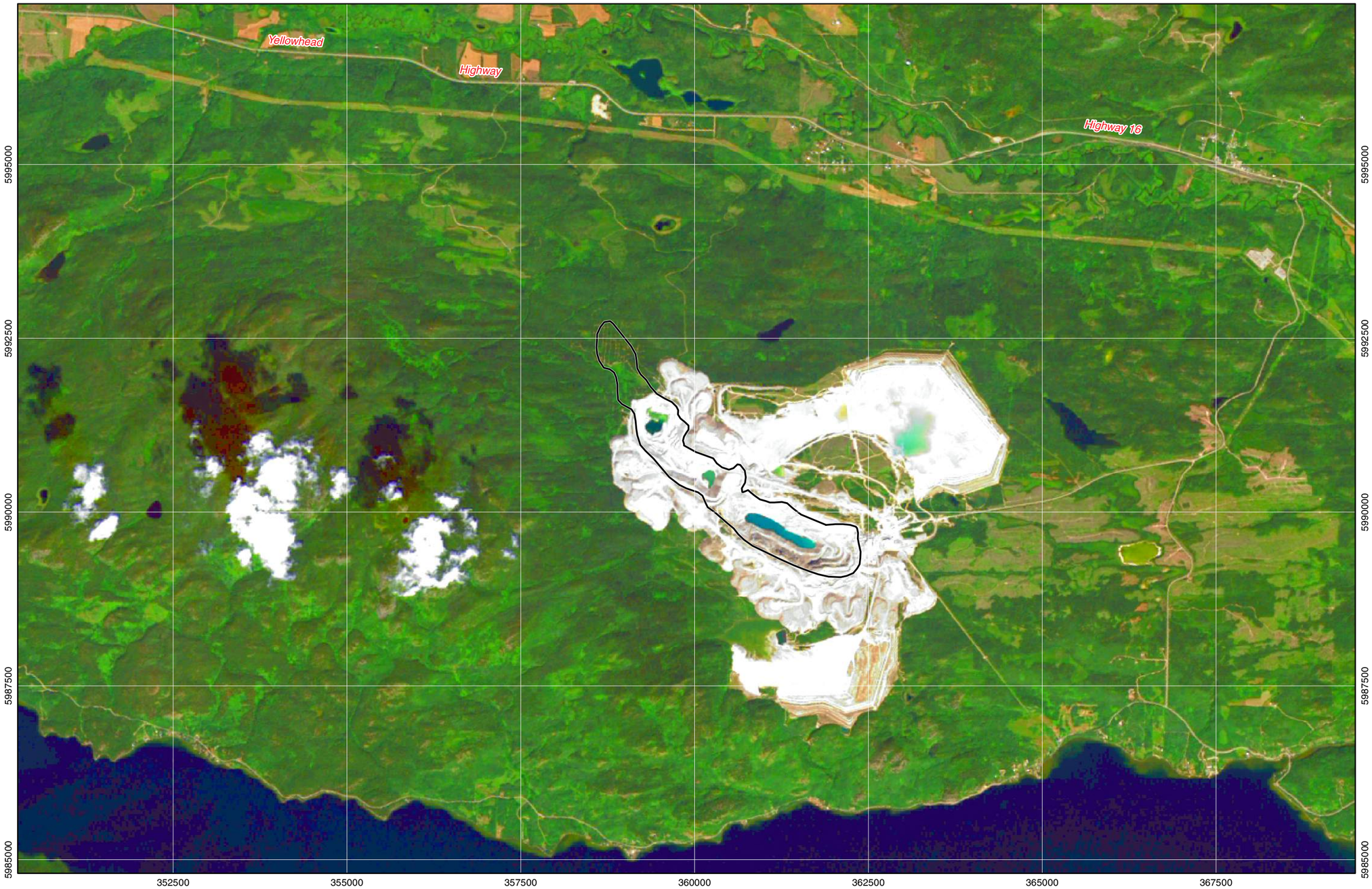
Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

ENDAKO DISTRICT

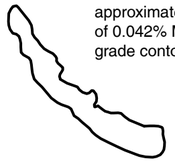
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

SATELLITE IMAGERY
LandSat8 - Natural Colour
1 : 50,000



Endako orebody
(Marek, 2011)



approximate outline of 0.042% MoS_2 grade contours

Data Sources:

Imagery date: July 31, 2013

A natural colour, pan-sharpened LandSat image. Pixel size is 15 metres.

SCALE 1:50,000

0 2.5 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

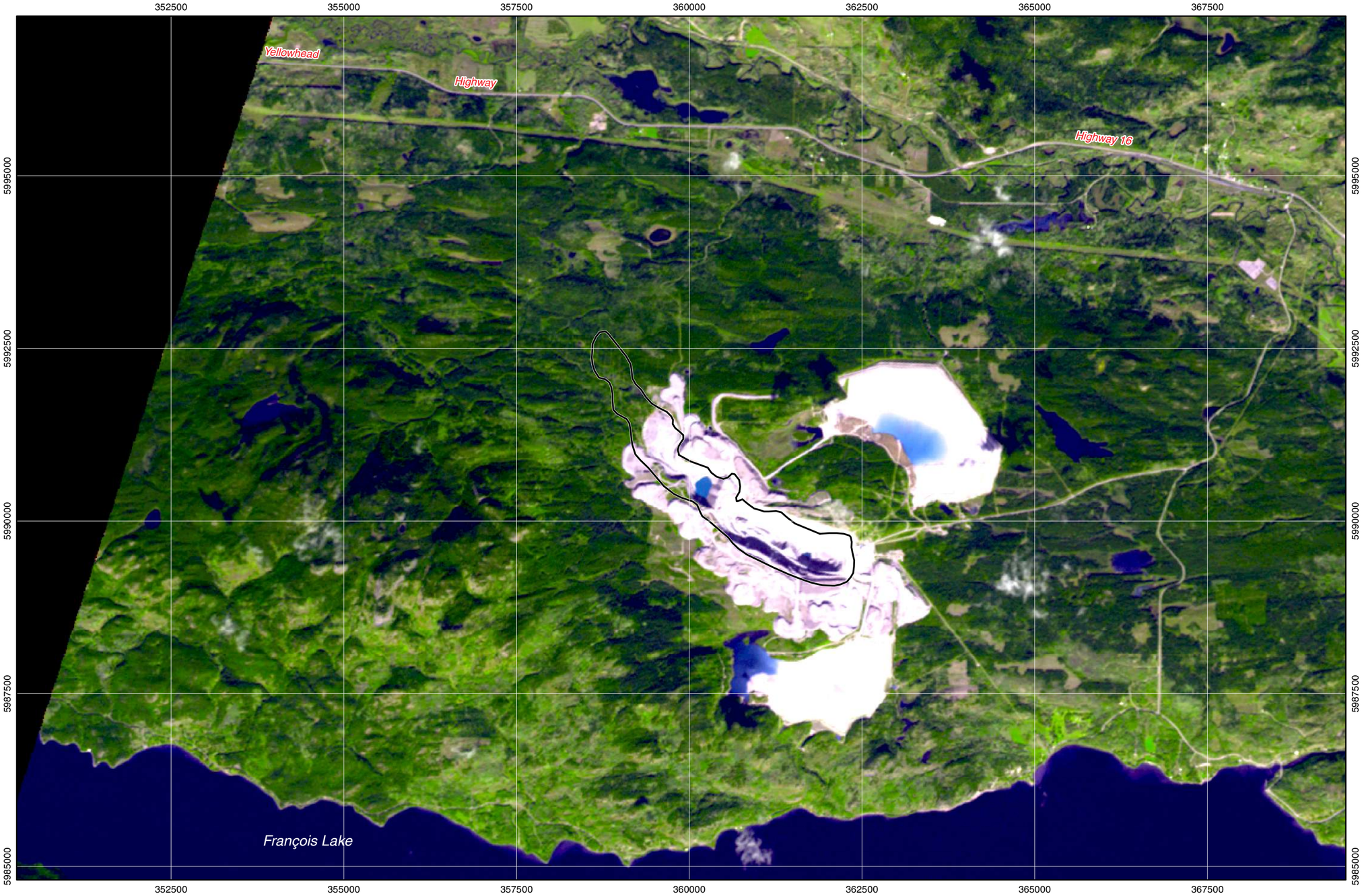
Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

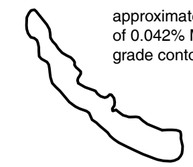
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

SATELLITE IMAGERY
ASTER - Pseudo Natural Colour
1 : 50,000



Endako orebody
(Marek, 2011)



approximate outline of 0.042% MoS_2 grade contours

Data Sources:

A pseudo natural colour image based on the ASTER image; with 15 metres pixels.

Imagery date: September 21, 2000

SCALE 1:50,000

0 2.5 5

kilometres

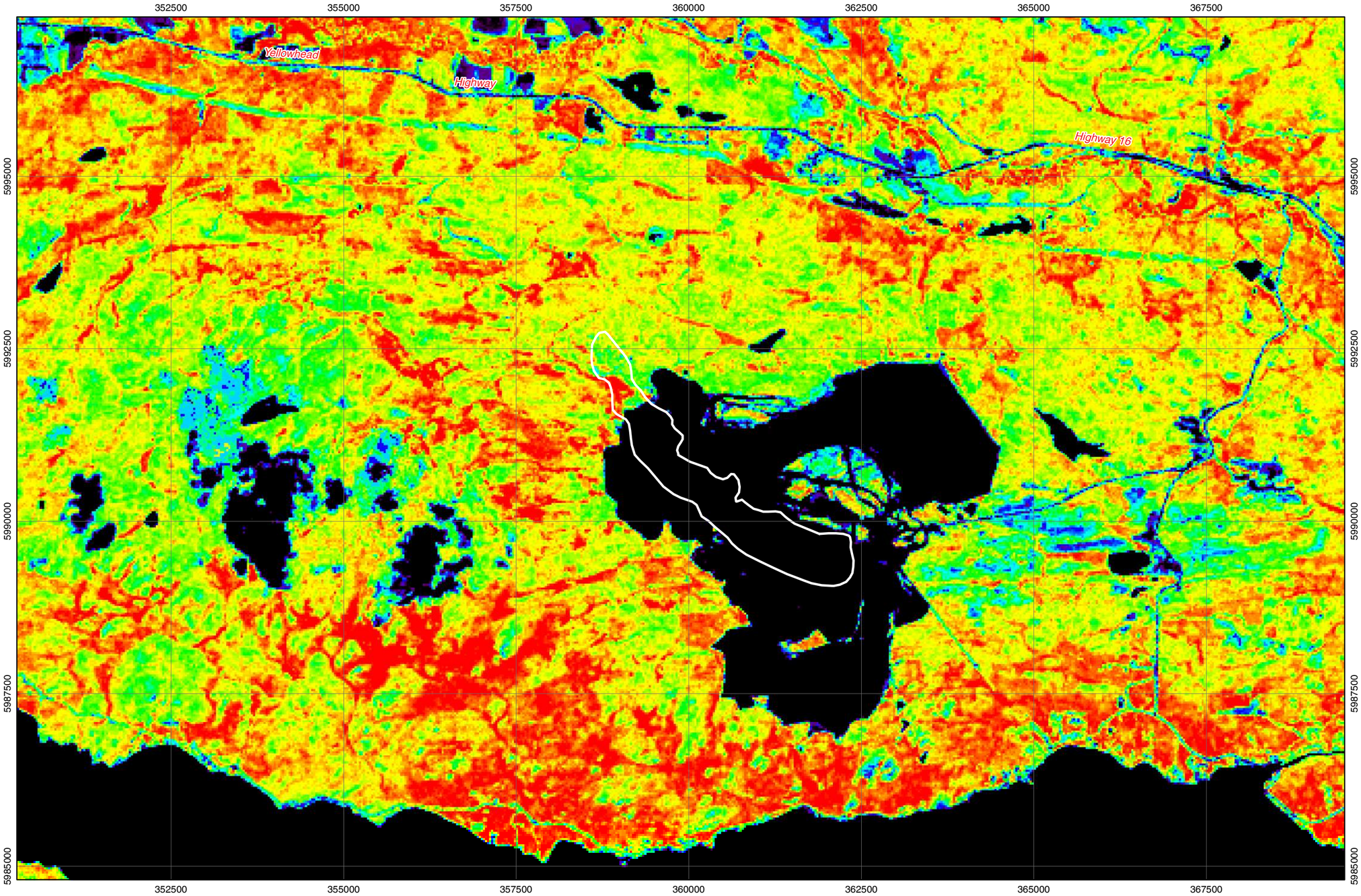
Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

SATELLITE IMAGERY
Landsat8 - Normalized Difference Vegetation Index
1 : 50,000



Landsat 8 bands 4 and 5 are used to calculate the NDVI using:

NDVI = (Band 5 - Band 4) / (Band 5 + Band 4)

NDVI

Chlorophyll Activity

highest

lowest

Data Sources:

Imagery date: July 31, 2013

Normalized Difference Vegetation Index (NDVI) is a traditional index that measures chlorophyll. Green vegetation absorbs electromagnetic radiation in the range of 0.4 - 0.7 µm and reflects EMS radiation in the 0.7 -1.1µm range.

This simple analysis is a powerful tool to quickly identify areas of no vegetation such as rock exposures, snow and water bodies. The relative amount of vegetation covering an area can be delineated and once calibrated with some ground verification can potentially be used to map vegetation differences related to the underlying geology.

SCALE 1:50,000

0 2.5 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

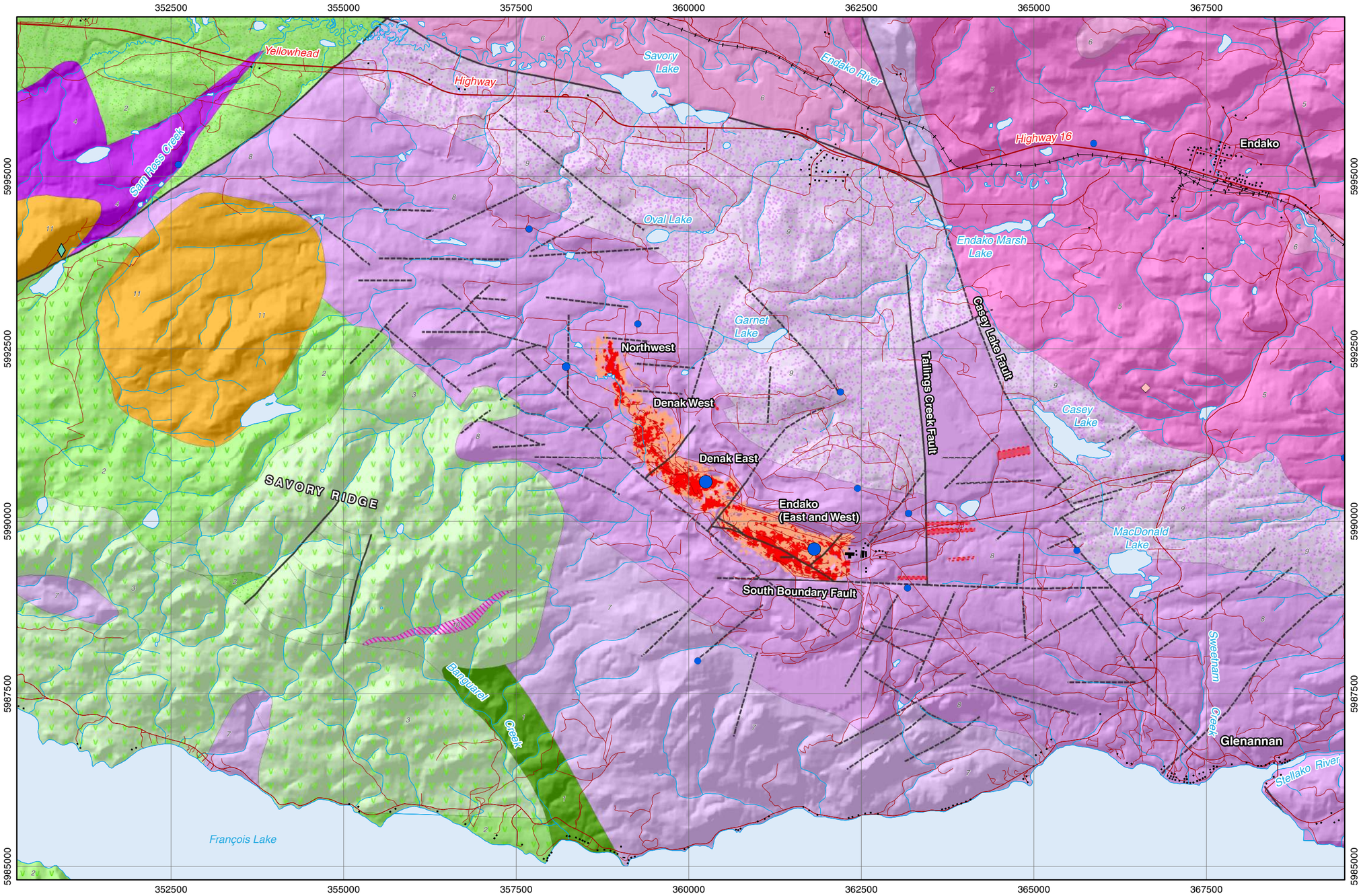
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

BEDROCK GEOLOGY

1 : 50,000



Intrusive Rocks

EOCENE:

- 11 — granite (Sam Ross Creek pluton)

ENDAKO BATHOLITH

LATE JURASSIC: Francois Lake Suite

- 10 — high-level quartz-phyric, felsitic intrusive rocks

Endako Subsuite

- 9 — Casey Phase: granite, K-feldspar granite
- 8 — Endako Phase: granodiorite
- 7 — Francois Subphase: granodiorite and other granodioritic rocks

Glenannan Subsuite

- 6 — Tatin Lake Subphase: granite, K-feldspar granite
- 5 — Glenannan and Leg Lake Phases: granite, K-feldspar granite

EARLY to MIDDLE JURASSIC: Stag Lake Suite

- 4 — diorite, quartz diorite

Volcanic and Sedimentary Rocks

EOCENE to OLIGOCENE:

- 3 — Nechako Plateau, Ootsa Lake, Endako Groups: basalt, andesite

UPPER CRETACEOUS:

- 2 — Kasalka Group: andesite, coarse clastic rocks

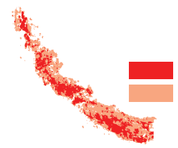
LOWER to UPPER JURASSIC:

- 1 — Hazelton Group

- Mineralized zones, projected to surface; compiled from assessment report data
- Mapped bedrock structures
- Unmapped structures, interpreted from aeromagnetics maps

Endako orebody

grade thickness contours (Marek, 2011)



- 0.1% MoS_2
- 0.042% MoS_2

Data Sources:

Digital data:

Massey, N.W.D, MacIntyre, D.G., Desjardins, P.J. and Cooney, R.T. (2005): Digital Geology Map of British Columbia: Whole Province; B.C. Ministry of Energy and Mines, Geofile 2005-1, URL <http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/GeoFiles/Pages/2005-1.aspx> [May 2015].

BC Geological Survey (2015): MINFILE BC mineral deposits database; BC Ministry of Energy and Mines, BC Geological Survey, URL <http://minfile.ca/> [February, 2015].

Geological data within the Endako map area is from:

Struik, L.C. and Whalen, J.B. (1998): Bedrock geology of the Endako (93K03) map area, British Columbia; Geological Survey of Canada, Open File 3630, 1:50,000 scale.

BC MINFILE Recorded mineral occurrences: coloured by type, sized by status of development:

Molybdenum +/- Copper, Uranium, Zinc, Tungsten (porphyry Mo) — 1 2 3 4

Flourite

Feldspar-Mica-Silica

1 Showing
2 Prospect
3 Developed prospect
4 Producer or past producer

** Note that MINFILE occurrences are plotted in the location listed in the database, the location of historic workings may vary slightly when located on the ground.

SCALE 1:50,000

0 — 2.5 — 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

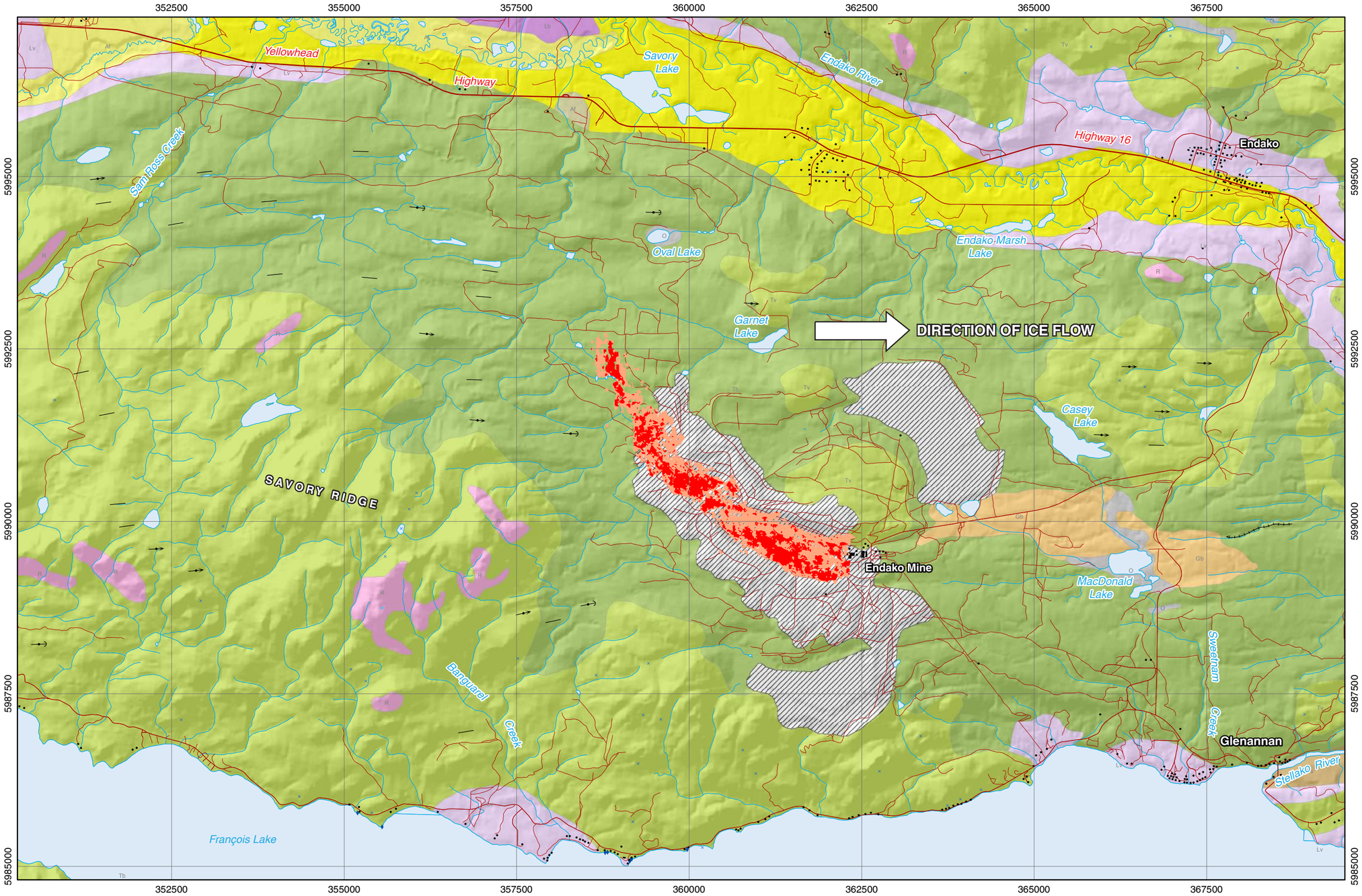
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

SURFICIAL GEOLOGY

1 : 50,000



LEGEND

(modified from Plouffe, 2000)

QUATERNARY

Non-glacial environment

- Anthropogenic deposits
- O — Organic deposits

Alluvial (Fluvial) deposits

- Ap — Floodplain sediments
- At — Terrace sediments
- Af — Fan sediments
- Au — Alluvial sediments (undivided)

Proglacial and glacial environment

- Lb — Glaciolacustrine blanket
- Lv — Glaciolacustrine veneer
- Gb — Glaciofluvial blanket

Glacial environment

- Tb — Till blanket
- Tv — Till veneer

PRE-QUATERNARY

- R — Bedrock

Ice Flow Indicators & Geological Features

- crag and tail
- drumlin (direction known, unknown)
- striations (direction known, unknown)
- fluting
- meltwater channel, small (indicating flow direction)

Infrastructure

- outcrop
- buildings
- highway
- major road
- minor road
- railway

Endako orebody

grade thickness contours (Marek, 2011)

- 0.1% MoS_2
- 0.042% MoS_2

Data Sources:

Digital data:

Plouffe, A. (2007): Surficial geology (93F, K and N) for the Nechako NATMAP Project in Nechako NATMAP Project: A digital suite of geoscience information for central British Columbia; Geological Survey of Canada, Open File 5623 and British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2007-10.

Original mapping was released as:

Plouffe, A. (2000): Surficial Geology, Fort Fraser, British Columbia; Geological Survey of Canada, Map 1986A, 1:250,000 scale.

SCALE 1:50,000

0 — 2.5 — 5

kilometres

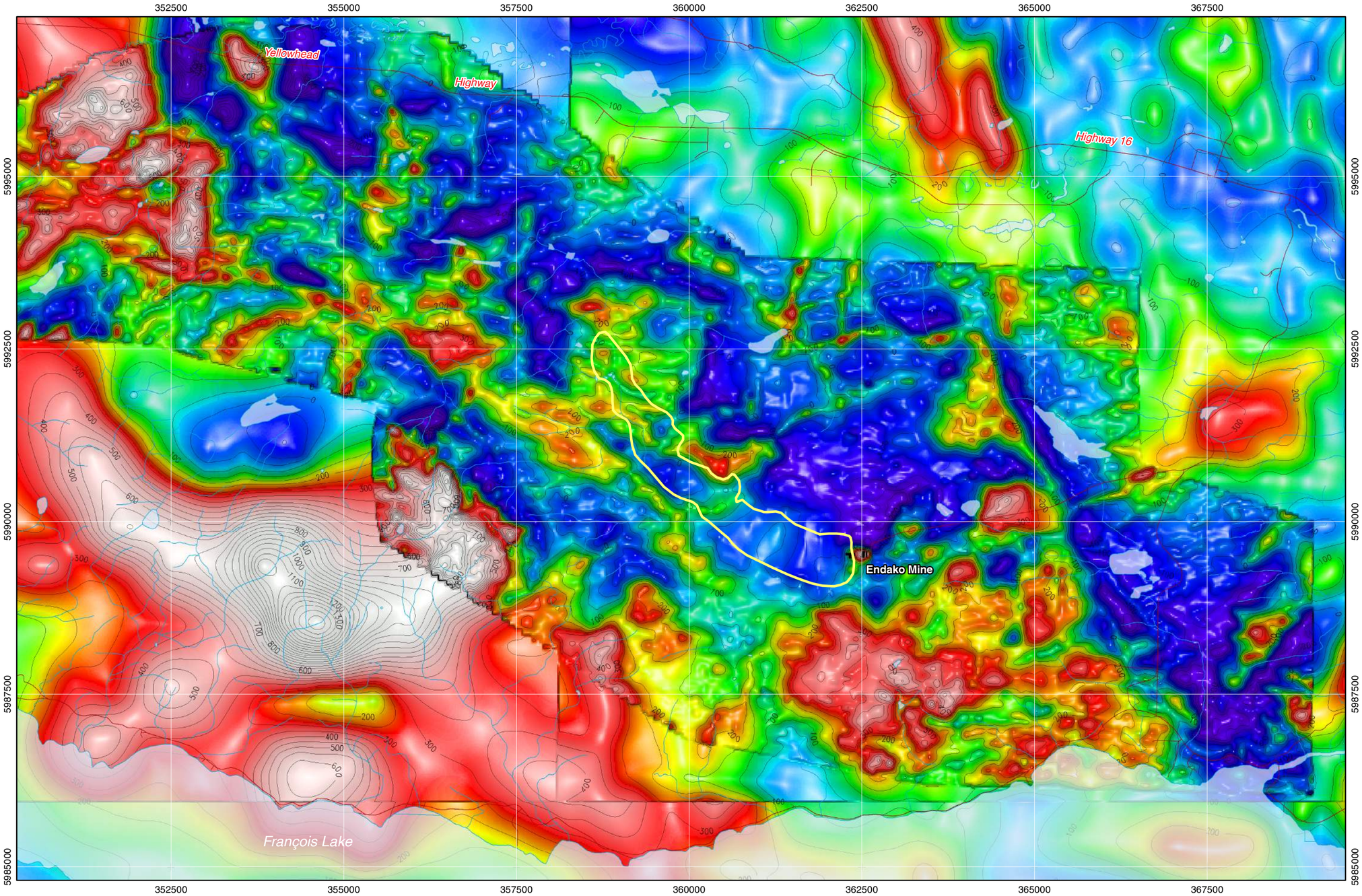
Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

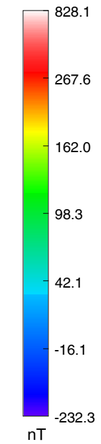
ENDAKO DISTRICT

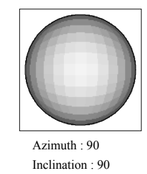
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

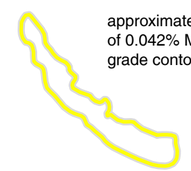
MAGNETICS
Residual Magnetic Intensity
1 : 50,000







Endako orebody
(after Marek, 2011)



approximate outline of 0.042% MoS_2 grade contours

Data Sources:

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako Block; internal report for Thompson Creek Mining Ltd., 20 p.

Aeroquest Airborne Ltd. (2014): Fixed Wing Magnetic Geophysical Survey, TREK Project, Interior Plateau/Nechako Region, British Columbia, Canada; Geoscience BC, Report 2014-04, 40 p.

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534, 9 maps, scale 1:50,000
Repackaging of 1997 GSC Open File 3534: British Columbia Ministry of Energy, Mines, and Petroleum Resources, Open File 2005-11

Geological Survey of Canada, regional 200m x 200m RTF grid

There are several vintages of magnetic surveys covering parts of the Endako region. These datasets were flown at different lines spacings and flight heights. Some frequency domain continuation processing has been done to bring the merged data to a similar general appearance.

The background data is a subset of the GSC national 200m x 200m gridded data, downward continued 100m. The Thompson Creek 2007 data, the GBC TREK data and the BCGS project 2005-11 data have been left unchanged.

Priority has been given to the 2013 GBC TREK data, the Thompson Creek 2007 data, and then the 2005 BCGS data. The surrounds have been infilled with the GSC national 200m x 200m RTF data from the GSC national database. All data have been levelled to the GSC national grid.

SCALE 1:50,000

0 2.5 5

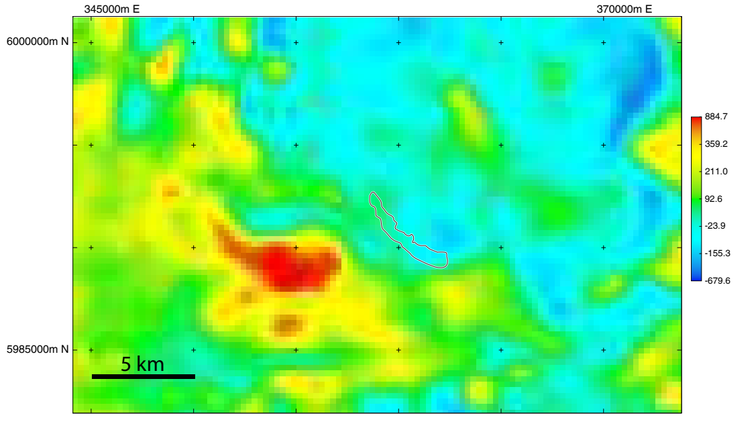
kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

MAGNETIC SURVEYS OVER THE ENDAKO DISTRICT STUDY AREA

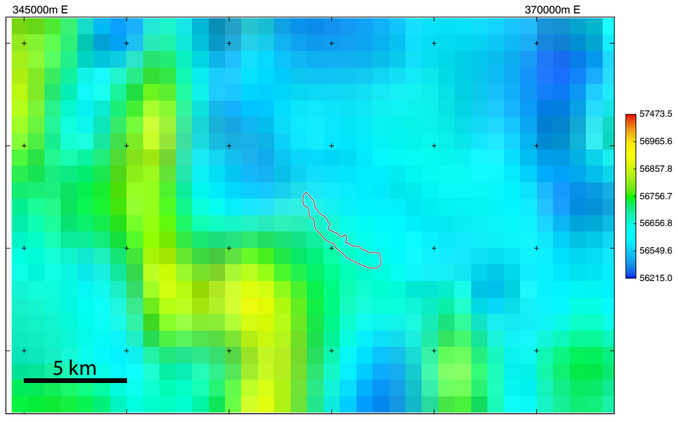
Residual Magnetic Intensity

1968: Geological Survey of Canada, analogue data
805 metre line spacing



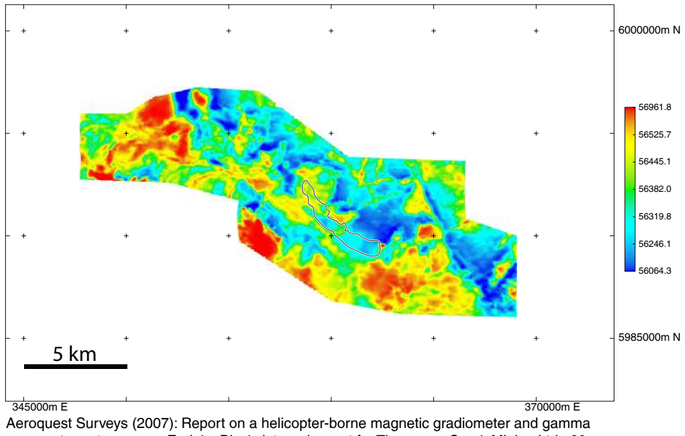
Canadian Aeromagnetic Data Base, Airborne Geophysics Section, GSC - Central Canada Division, Geological Survey of Canada, Earth Sciences Sector, Natural Resources Canada

2009: Geoscience BC, Helicopter-borne AeroTEM
4000 metre line spacing



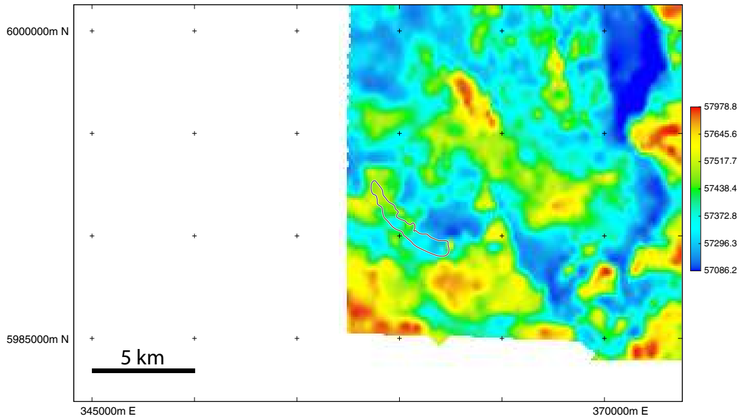
Aeroquest Surveys (2009): Report on a helicopter-borne AeroTEM system electromagnetic & magnetic survey; Geoscience BC, Report 2009-6, 28 p.

2007: Thompson Creek Mining Ltd., airborne survey`
100 metre line spacing



Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako Block; internal report for Thompson Creek Mining Ltd., 20 p.

1997: Geological Survey of Canada, airborne survey
500 metre line spacing

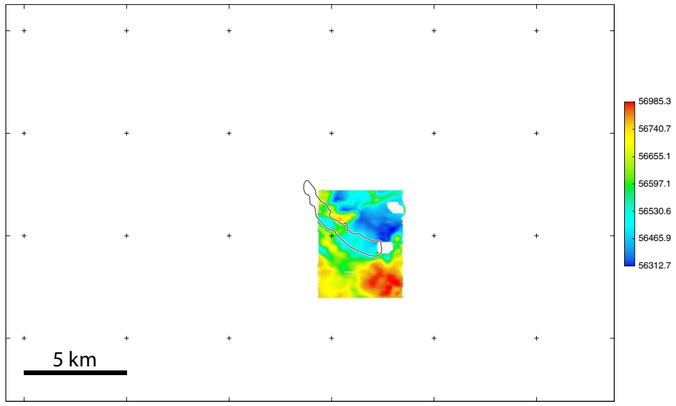


Original survey: Shives, R.B.K. and Holman, P.B., 1997: Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534, 9 maps, scale 1:50,000

Digital data: Canadian Aeromagnetic Data Base, Airborne Geophysics Section, GSC - Central Canada Division, Geological Survey of Canada, Earth Sciences Sector, Natural Resources Canada

Repackaging of 1997 GSC Open File 3534: British Columbia Ministry of Energy, Mines, and Petroleum Resources, Open File 2005-11

2009: Geoscience BC, Helicopter-borne AeroTEM
Endako in-fill block; 200 metre line spacing



Aeroquest Surveys (2009): Report on a helicopter-borne AeroTEM system electromagnetic & magnetic survey; Geoscience BC, Report 2009-6, 28 p. [Endako In-fill Block]

The extent of this survey is not shown here; it borders the southern part of the study area.

Aeroquest Airborne Ltd. (2014): Fixed Wing Magnetic Geophysical Survey, TREK Project, Interior Plateau/Nechako Region, British Columbia, Canada; Geoscience BC, Report 2014-04,

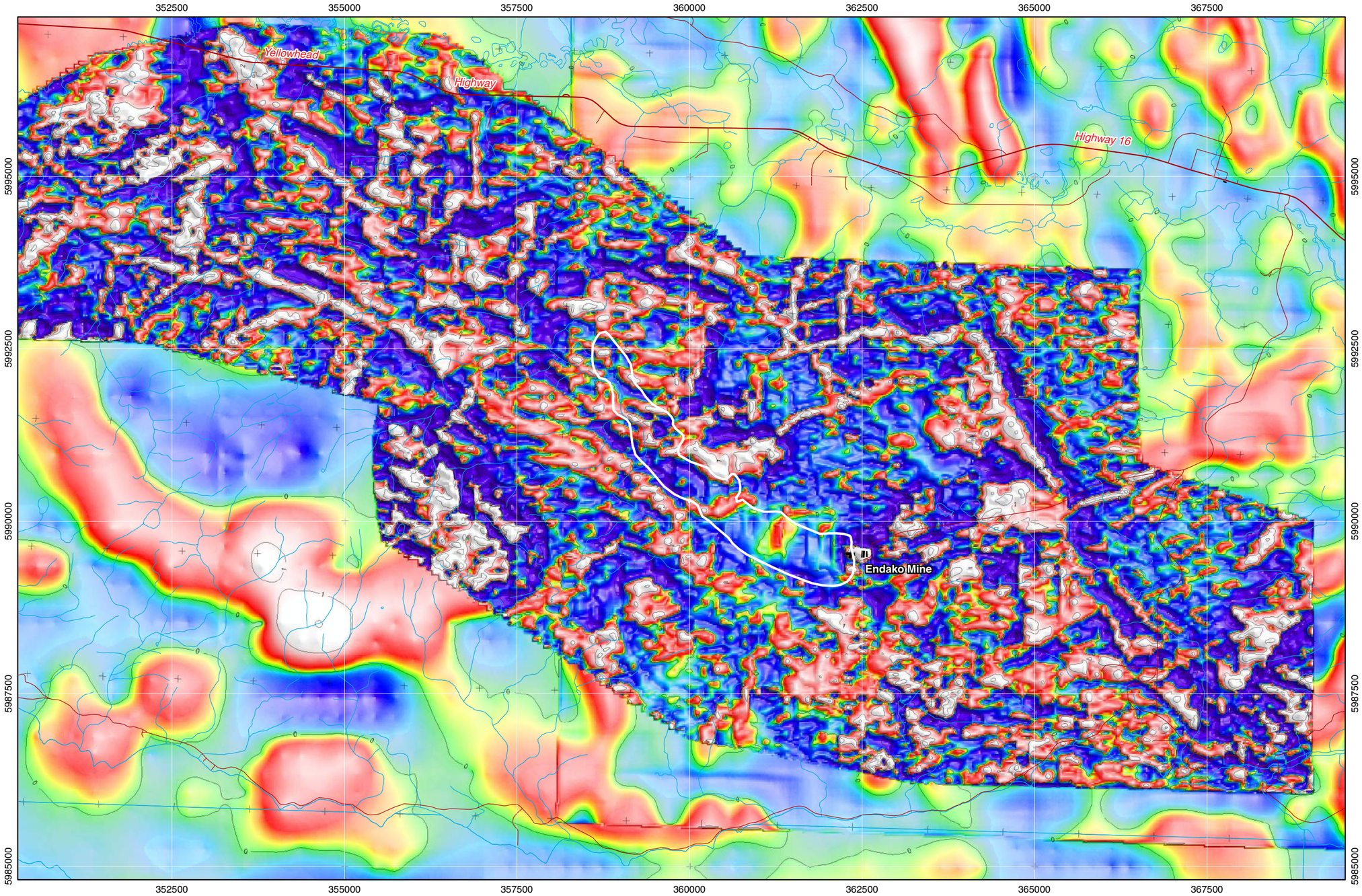
ENDAKO DISTRICT

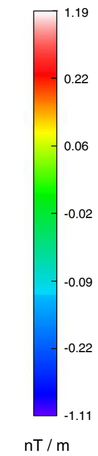
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

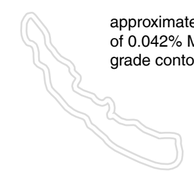
MAGNETICS
1st Vertical Derivative

1 : 50,000





Endako orebody
(after Marek, 2011)



approximate outline of 0.042% MoS_2 grade contours

Data Sources:

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako Block; internal report for Thompson Creek Mining Ltd., 20 p.

Shives, R.B.K. and Holman, P.B. (1997): Airborne geophysical survey, Endako area, British Columbia; Geological Survey of Canada, Open File 3534, 9 maps, scale 1:50,000
Repackaging of 1997 GSC Open File 3534: British Columbia Ministry of Energy, Mines, and Petroleum Resources, Open File 2005-11

SCALE 1:50,000

0 2.5 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

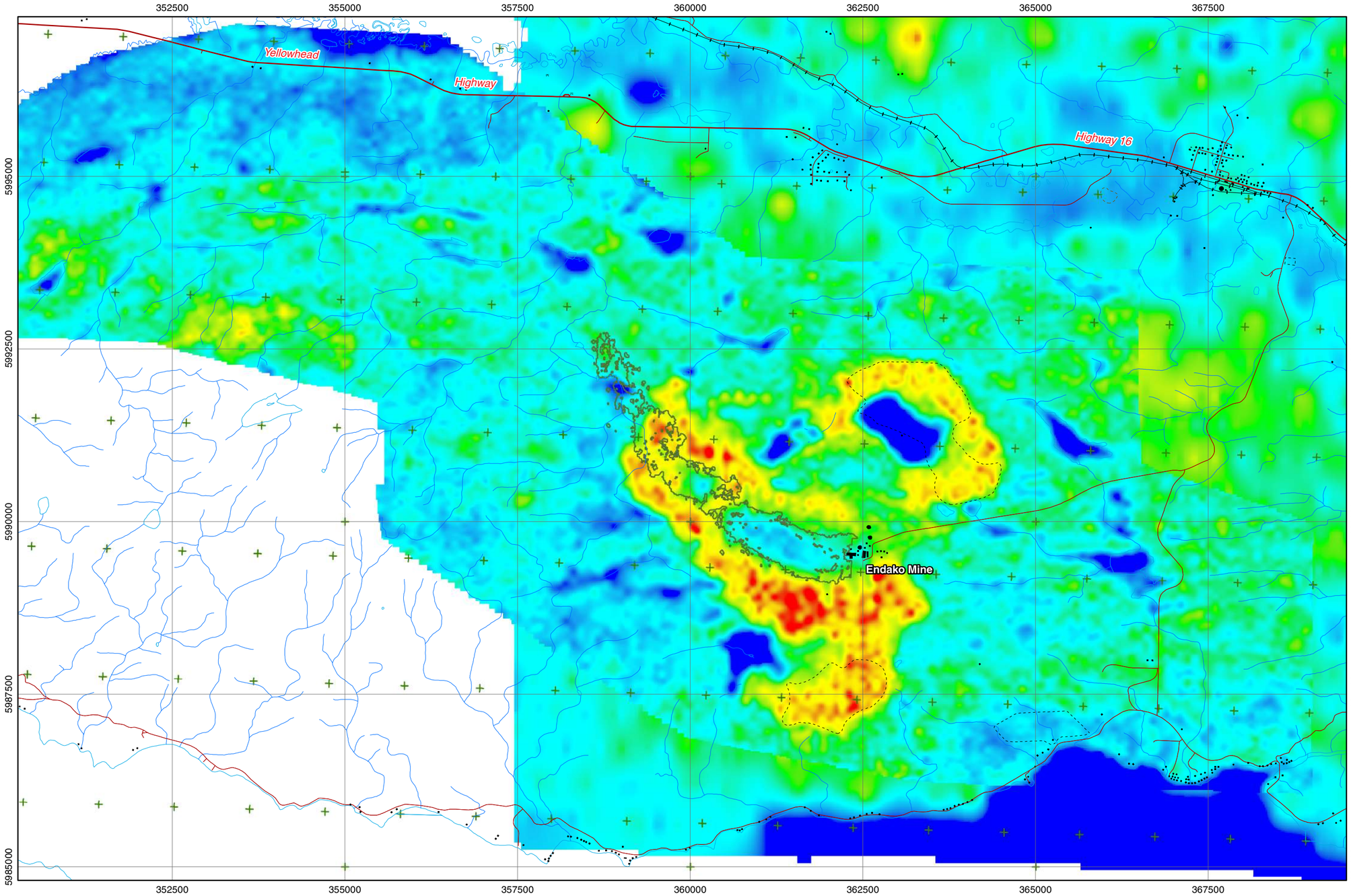
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

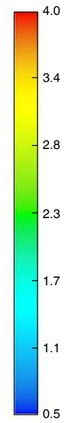
RADIOMETRICS
% Potassium

1 : 50,000



LEGEND

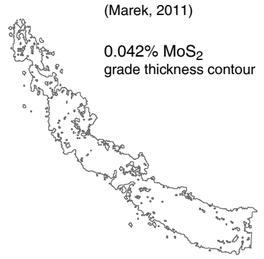
- industrial buildings
- tanks
- chimney (burner)
- buildings
- transformer station
- tower (communication)
- cemetary
- domestic / industrial waste site
- highway
- major road
- railway
- pipeline (natural gas, underground)
- power transmission line (overhead)



% Potassium

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Data Sources:

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako Block; internal report for Thompson Creek Mining Ltd., 20 p.

SCALE 1:50,000

0 2.5 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

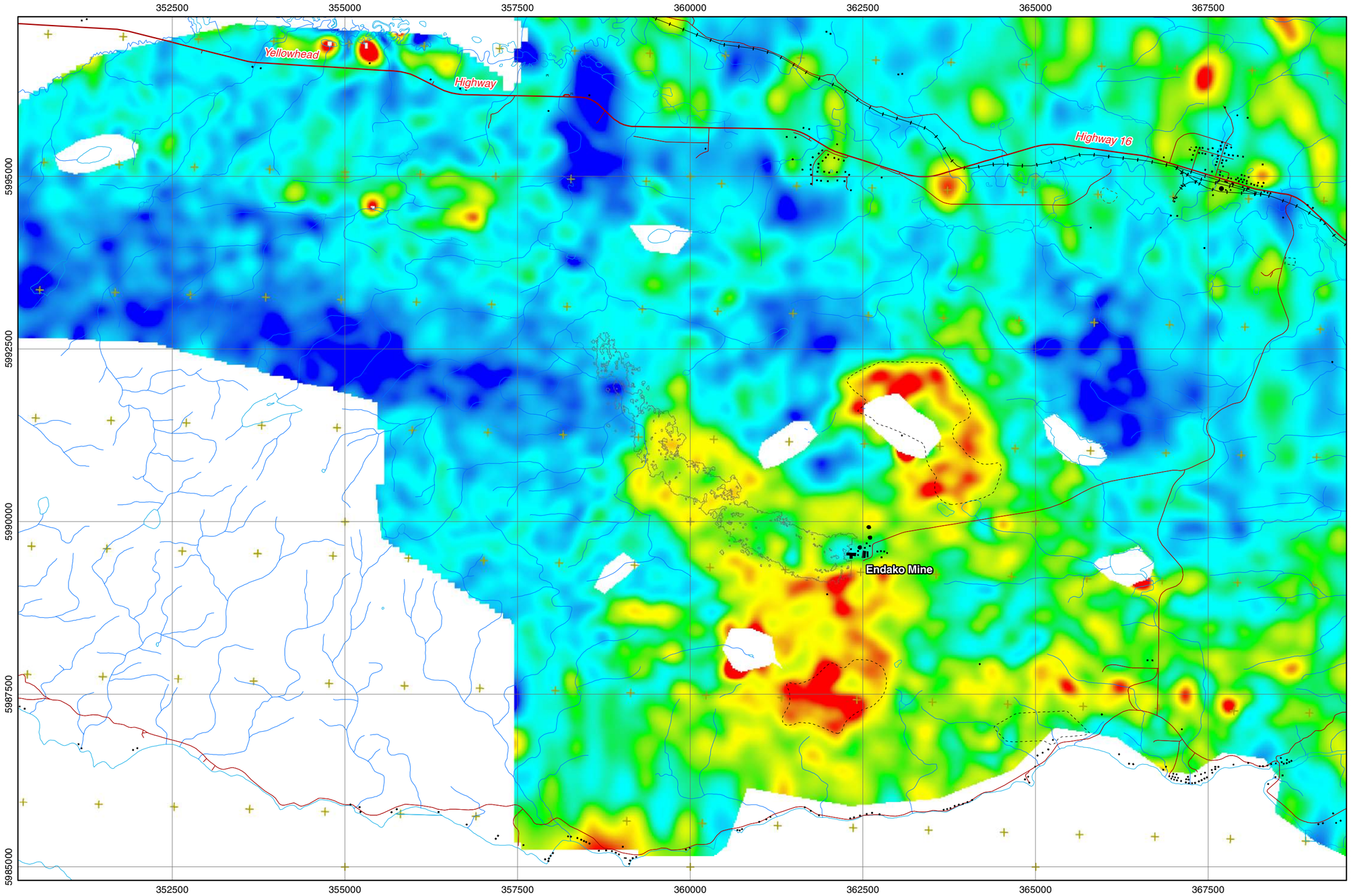
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

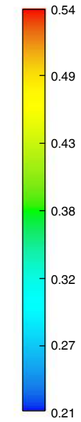
RADIOMETRICS K/eTh

1 : 50,000



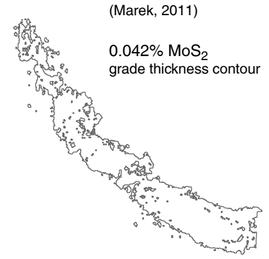
LEGEND

- industrial buildings
- tanks
- chimney (burner)
- buildings
- transformer station
- tower (communication)
- cemetary
- domestic / industrial waste site
- highway
- major road
- railway
- pipeline (natural gas, underground)
- power transmission line (overhead)



Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Data Sources:

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako Block; internal report for Thompson Creek Mining Ltd., 20 p.

SCALE 1:50,000

0 2.5 5

kilometres

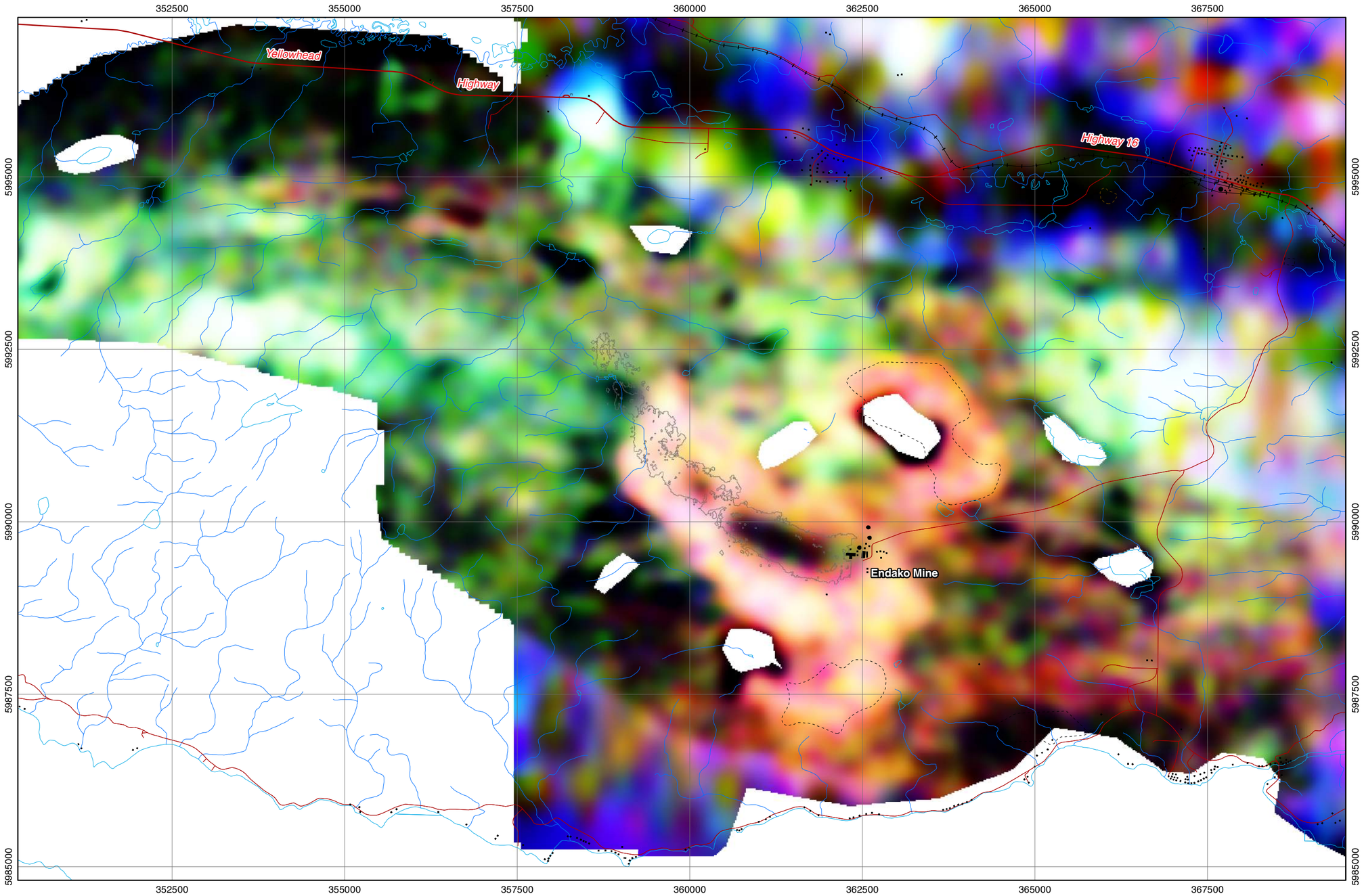
Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

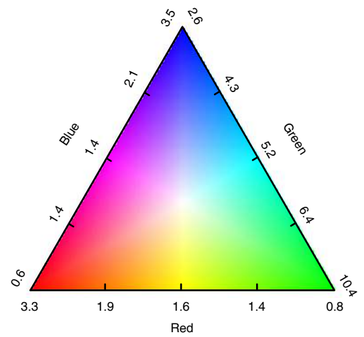
Geoscience BC

RADIOMETRICS
KTU Ternary Image
1 : 50,000



LEGEND

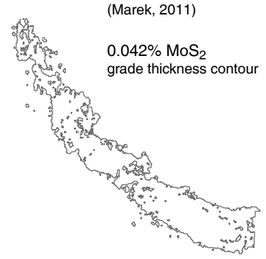
- industrial buildings
- tanks
- chimney (burner)
- buildings
- transformer station
- tower (communication)
- cemetary
- domestic / industrial waste site
- highway
- major road
- railway
- pipeline (natural gas, underground)
- power transmission line (overhead)



Red : Combined Percent Potassium
Green : Combined Equivalent Thorium
Blue : Combined Equivalent Uranium

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Data Sources:

Aeroquest Surveys (2007): Report on a helicopter-borne magnetic gradiometer and gamma ray spectrometer survey, Endako Block; internal report for Thompson Creek Mining Ltd., 20 p.

Radiometric Potassium channel maped to red, Thorium channel mapped to green, Uranium channel mapped to blue. All three channels have been histogram equalized, the GSC equivalent thorium has been levelled to the 2007 Aeroquest data by multiplying by 0.75. The data has been smoothed to improved the image statistics. Radiometric lows over water have been blanked.

SCALE 1:50,000

0 — 2.5 — 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

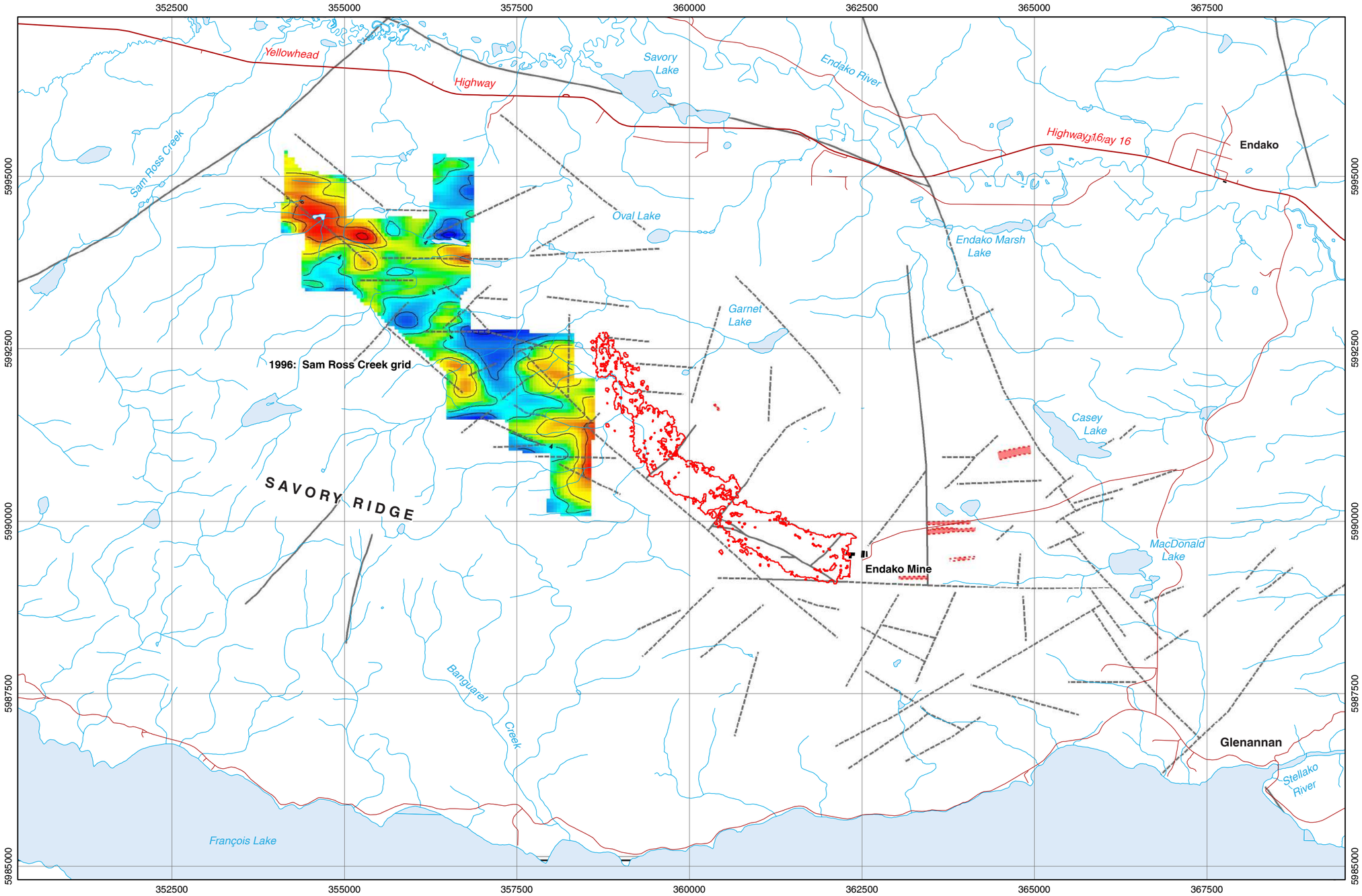
ENDAKO DISTRICT

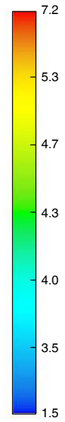
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

IP - CHARGEABILITY
from 3D inversion processing: 250 foot depth slice

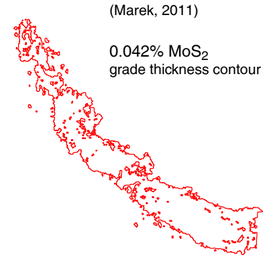
1 : 50,000





Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Mineralized zones, projected to surface; compiled from assessment report data

Mapped bedrock structures

Unmapped structures, interpreted from aeromagnetics maps

Data Sources:

Scott Geophysics Ltd. (1996): Endako Mine IP Survey; Internal report and data for Placer Dome Canada Ltd., Endako Mines Division.

Scott Geophysics Ltd. (2003): Induced Polarization Survey, Endako Mine; Internal report and data for Thompson Creek Mining Ltd. [*report without data was included in the 2004 assessment report listed below*]

Wild, C.J. and Thompson, I. (2004): Induced Polarization Survey and Diamond Drilling at Endako Mine; Assessment Report 27406, for Thompson Creek Mining Ltd., British Columbia Ministry of Energy, Mines and Petroleum Resources, 94 p.

SCALE 1:50,000

0 2.5 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

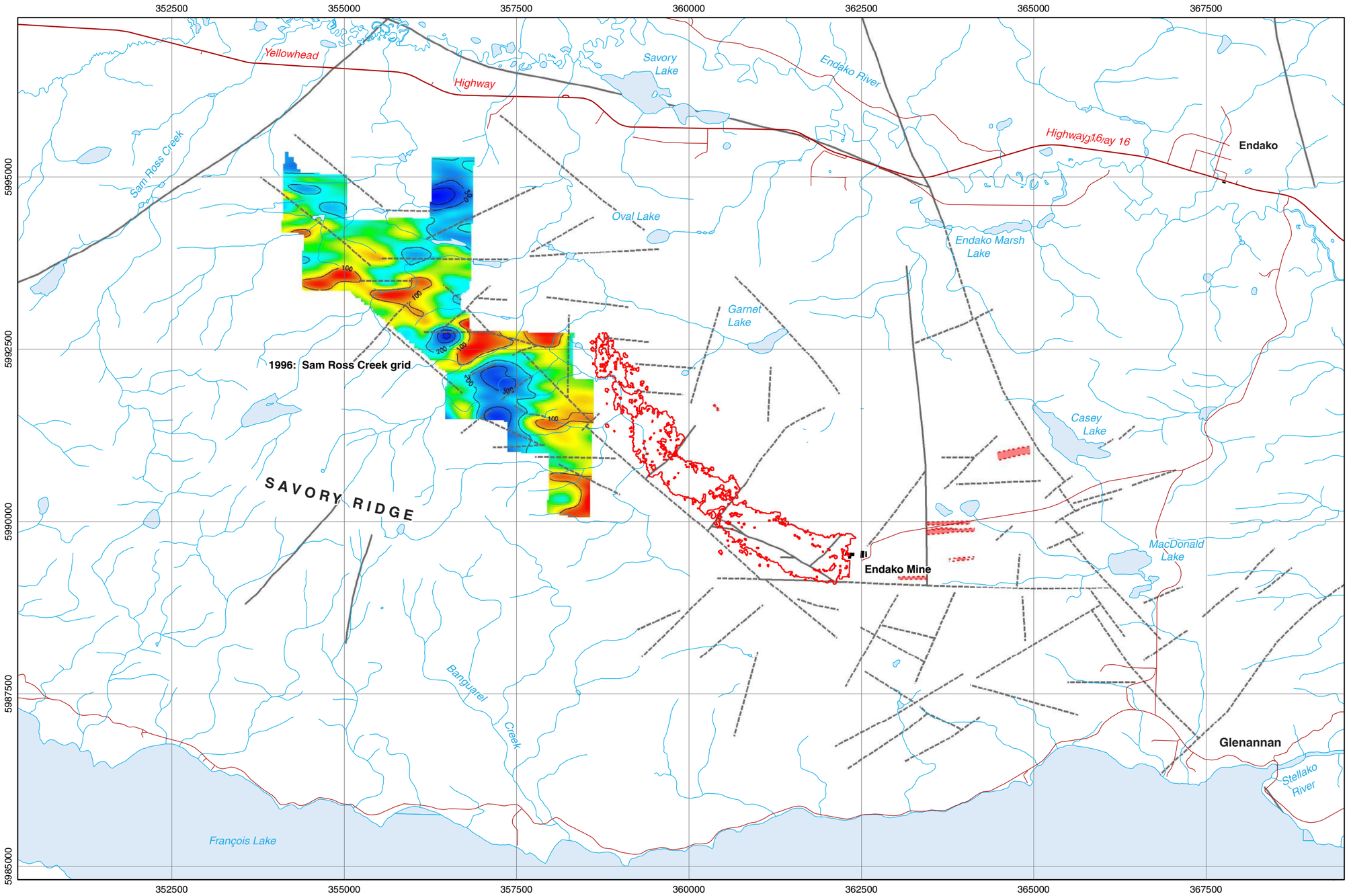
ENDAKO DISTRICT

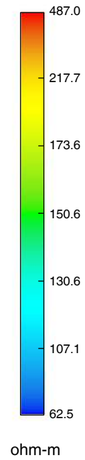
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

IP - RESISTIVITY
from 3D inversion processing: 250 foot depth slice

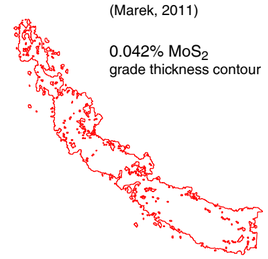
1 : 50,000





Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Mineralized zones, projected to surface; compiled from assessment report data

Mapped bedrock structures

Unmapped structures, interpreted from aeromagnetics maps

Data Sources:

Scott Geophysics Ltd. (1996): Endako Mine IP Survey; Internal report and data for Placer Dome Canada Ltd., Endako Mines Division.

Scott Geophysics Ltd. (2003): Induced Polarization Survey, Endako Mine; Internal report and data for Thompson Creek Mining Ltd. [*report without data was included in the 2004 assessment report listed below*]

Wild, C.J. and Thompson, I. (2004): Induced Polarization Survey and Diamond Drilling at Endako Mine; Assessment Report 27406, for Thompson Creek Mining Ltd., British Columbia Ministry of Energy, Mines and Petroleum Resources, 94 p.

SCALE 1:50,000

0 2.5 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

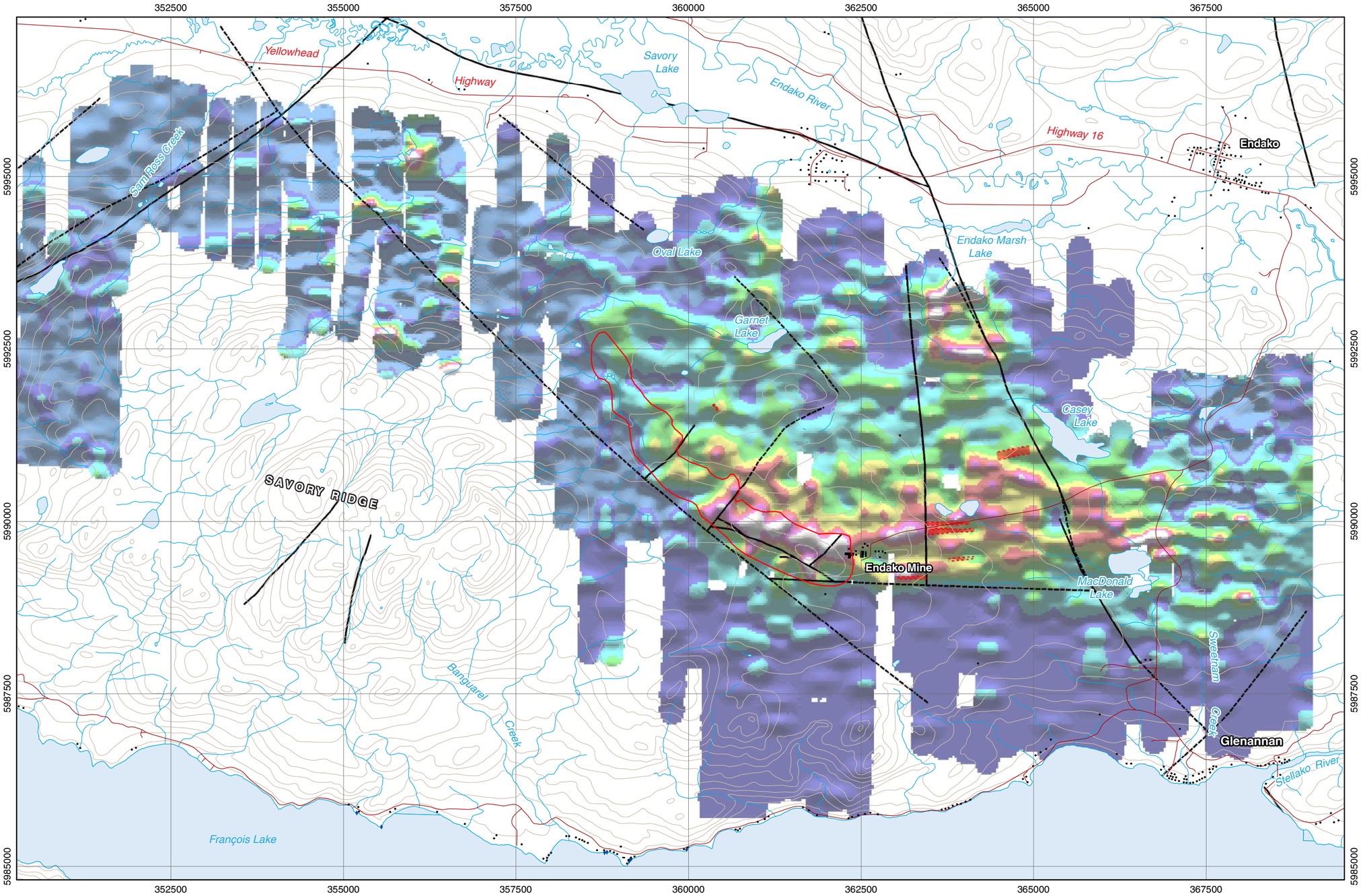
ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

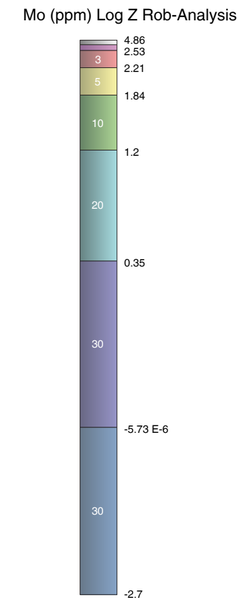
Geoscience BC

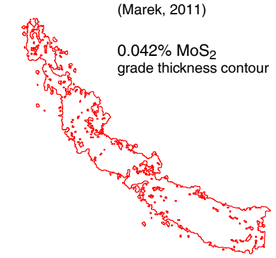
SOIL GEOCHEMISTRY

1 : 50,000



Mo





Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour

Mineralized zones, projected to surface; compiled from assessment report data

Mapped bedrock structures

Unmapped structures, interpreted from aeromagnetics maps

Data Sources:

Digital data provided by Thompson Creek Mining Ltd.

This soil geochemistry grid is a compilation of 1960's pre-mining data and 1969 to 1971 data from near-mine exploration following initial pit development in 1965. All samples are recorded as B-horizon soils over glacial till. The earliest samples were analyzed using colorimetric methods, while atomic absorption methods were used for the later samples.

Soils results were levelled for different analytical methods (colourimetric and atomic absorption) using a Robust Log (10) Z-score. Gridding was done with the IDW algorithm in ioGAS.

SCALE 1:50,000

0 2.5 5

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

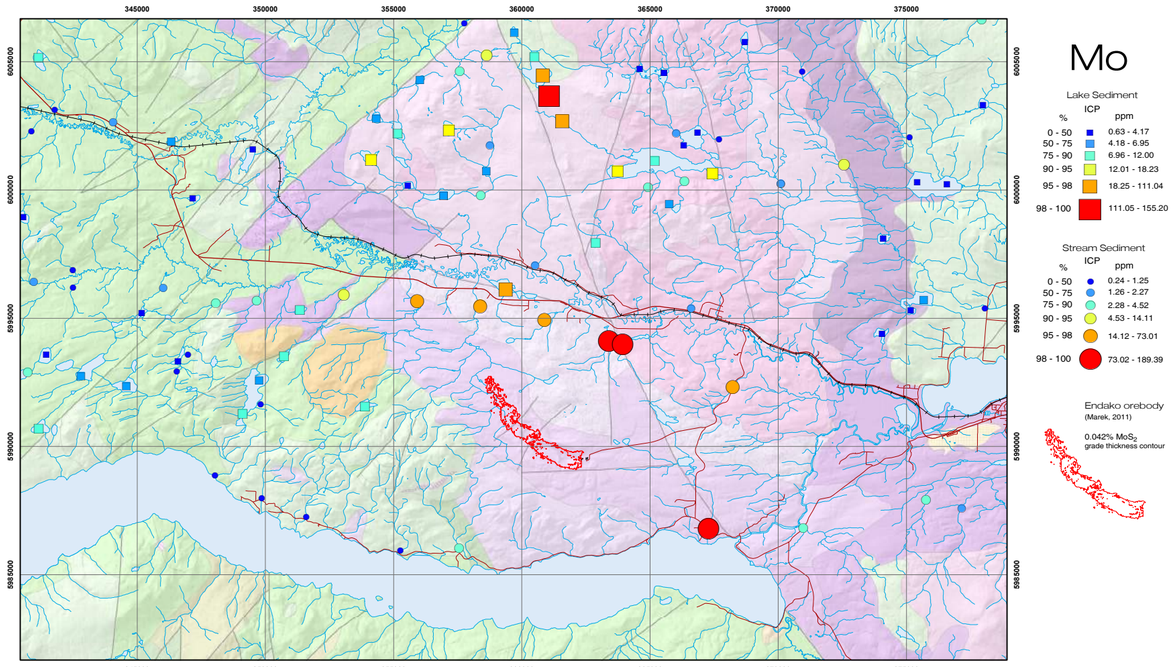
Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

LAKE AND STREAM SEDIMENT GEOCHEMISTRY
Commodity Elements
1 : 200,000



Mo

Lake Sediment

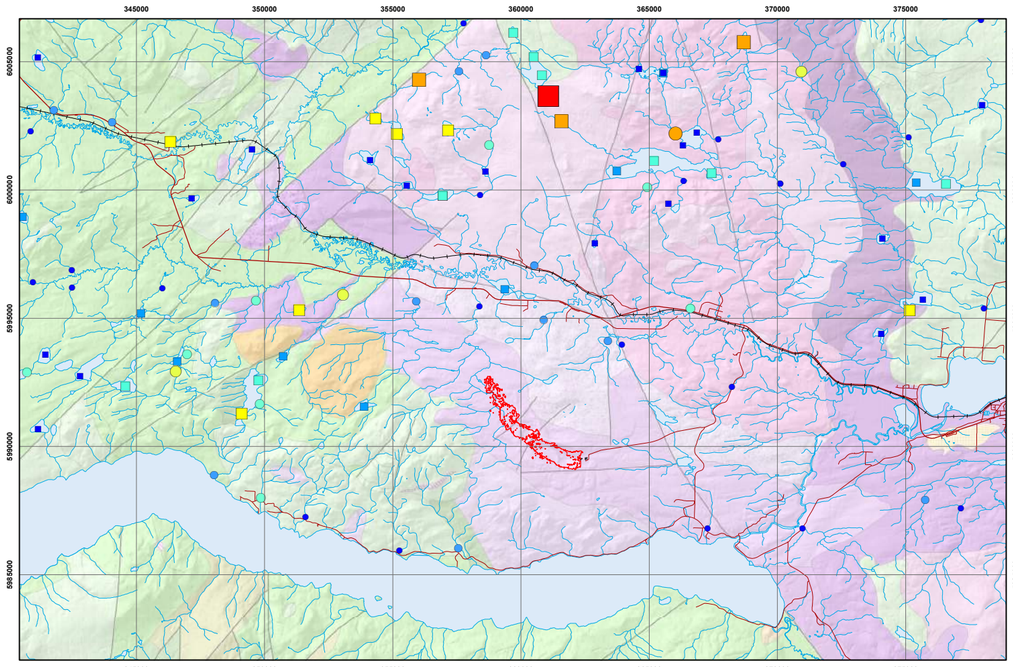
ICP %	ICP ppm
0 - 50	0.63 - 4.17
50 - 75	4.18 - 6.95
75 - 90	6.96 - 12.00
90 - 95	12.01 - 18.23
95 - 98	18.25 - 111.04
98 - 100	111.05 - 155.20

Stream Sediment

ICP %	ICP ppm
0 - 50	0.24 - 1.25
50 - 75	1.26 - 2.27
75 - 90	2.28 - 4.52
90 - 95	4.53 - 14.11
95 - 98	14.12 - 73.01
98 - 100	73.02 - 189.39

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Cu

Lake Sediment

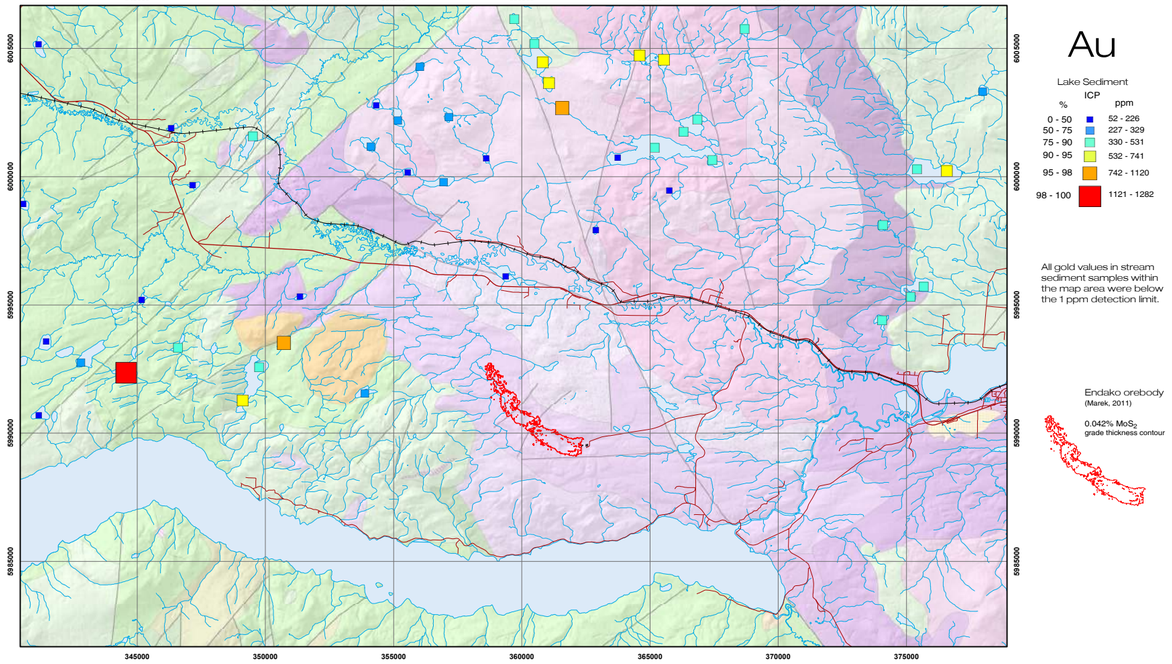
ICP %	ICP ppm
0 - 50	7.80 - 28.90
50 - 75	28.91 - 35.70
75 - 90	35.71 - 44.18
90 - 95	44.19 - 55.50
95 - 98	55.51 - 68.09
98 - 100	68.10 - 71.27

Stream Sediment

ICP %	ICP ppm
0 - 50	4.62 - 14.40
50 - 75	14.41 - 20.63
75 - 90	20.64 - 28.47
90 - 95	28.48 - 36.90
95 - 98	36.91 - 52.72
98 - 100	52.73 - 70.12

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Au

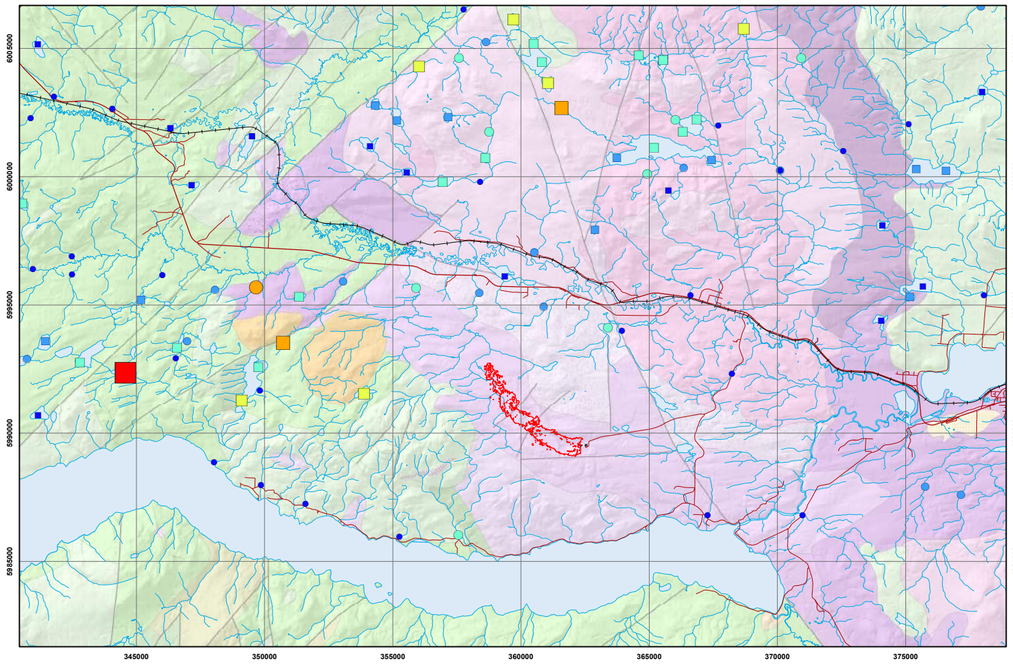
Lake Sediment

ICP %	ICP ppm
0 - 50	52 - 226
50 - 75	227 - 329
75 - 90	330 - 531
90 - 95	532 - 741
95 - 98	742 - 1120
98 - 100	1121 - 1282

All gold values in stream sediment samples within the map area were below the 1 ppm detection limit.

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Ag

Lake Sediment

ICP %	ICP ppm
0 - 50	52 - 226
50 - 75	227 - 329
75 - 90	330 - 531
90 - 95	532 - 741
95 - 98	742 - 1120
98 - 100	1121 - 1282

Stream Sediment

ICP %	ICP ppm
0 - 50	23 - 92
50 - 75	93 - 168
75 - 90	169 - 267
90 - 95	268 - 391
95 - 98	392 - 799
98 - 100	800 - 3561

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour

Data Sources:

Stream sediment data:

A compilation file that includes all data from these sources was used:

Jackaman, W. (2009): QUEST-West Project Sample Reanalysis; Geoscience BC, Report 2009-5, 4 p.

Lett, R.E.W. (2005): Regional Geochemical Survey Database on CD, BC Ministry of Energy, Mines and Petroleum Resources, Geofile 2005-17.

Lake sediment data:

Jackaman, W. (2009): Regional Drainage Sediment and Water Geochemical Data, Central British Columbia (parts of NTS 93E, F, G, J, K, L, M, N & O), Geoscience BC, Report 2009-11. URL< http://www.geosciencebc.com/s/2009-11.asp> [May, 2015].

Jackaman, W. (2008): Regional Lake Sediment and Water Geochemical Data, Northern Fraser Basin, Central BC (parts of NTS 93G, H, J, K, N & O), Geoscience BC, Report 2008-5. URL< http://www.geosciencebc.com/s/2008-05.asp> [May, 2015].

Data Presentation:

Data presented here was subset to the limits of NTS map sheets 093K02, K03, F14, and F15, which comprises 152 stream sediment samples, and 89 lake sediment samples. Percentiles were calculated on the raw values without transformation or levelling.

SCALE 1:200,000

0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

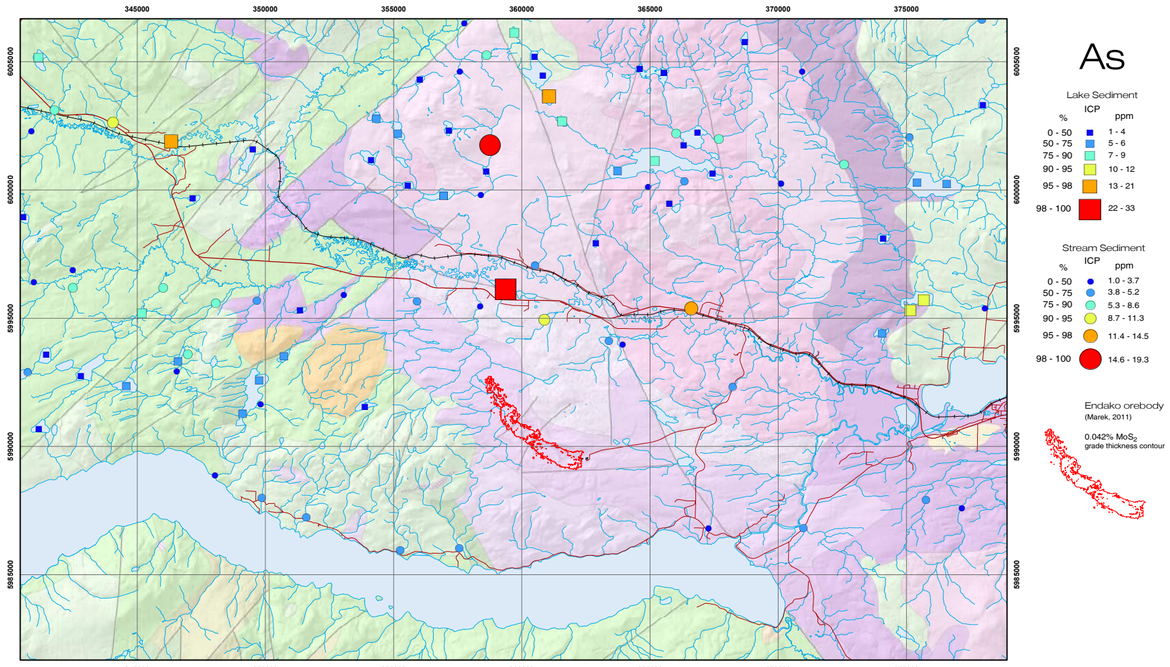
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

LAKE AND STREAM SEDIMENT GEOCHEMISTRY

Pathfinder Elements

1 : 200,000



As

Lake Sediment

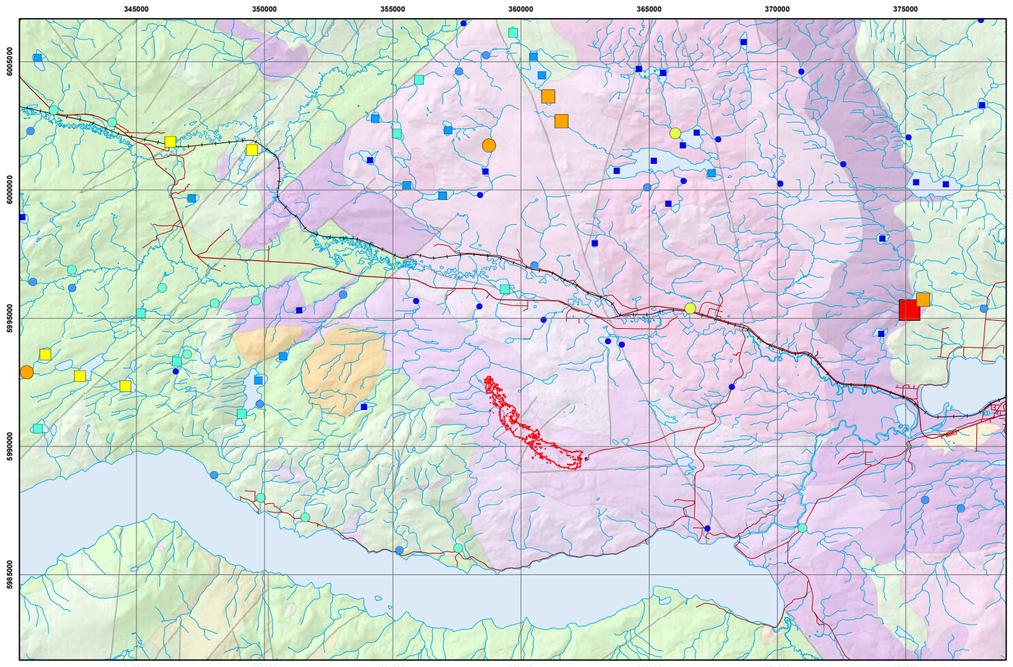
%	ICP ppm
0 - 50	1 - 4
50 - 75	5 - 6
75 - 90	7 - 9
90 - 95	10 - 12
95 - 98	13 - 21
98 - 100	22 - 33

Stream Sediment

%	ICP ppm
0 - 50	1.0 - 3.7
50 - 75	3.8 - 5.2
75 - 90	5.3 - 8.6
90 - 95	8.7 - 11.3
95 - 98	11.4 - 14.5
98 - 100	14.6 - 19.3

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Sb

Lake Sediment

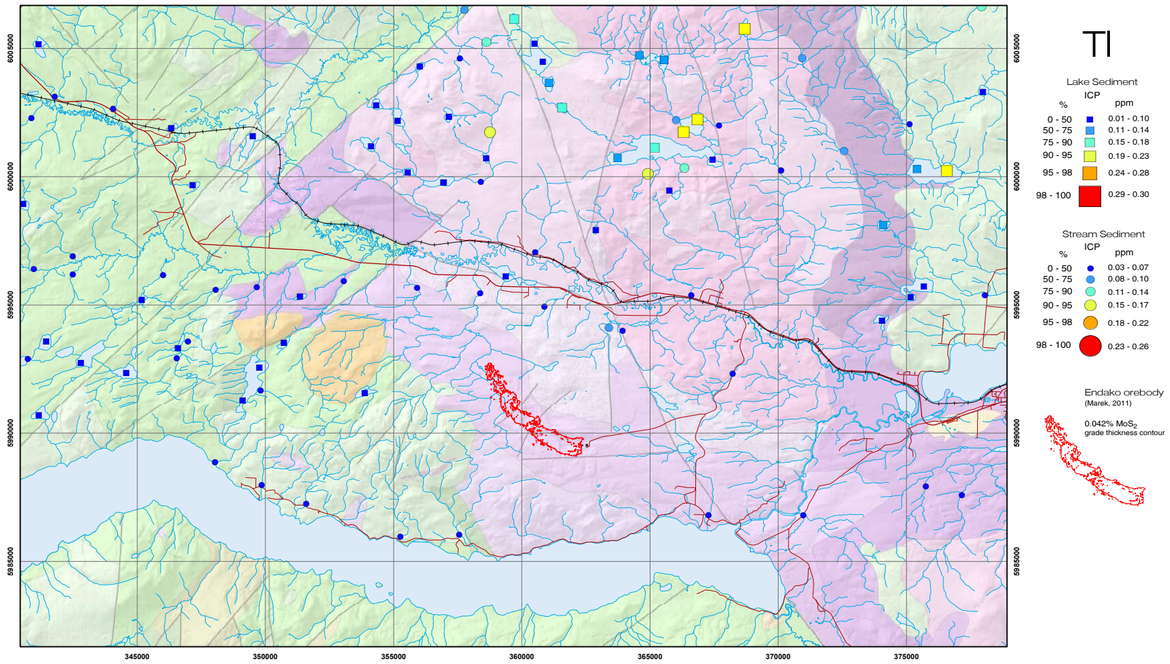
%	ICP ppm
0 - 50	0.10 - 0.36
50 - 75	0.37 - 0.48
75 - 90	0.49 - 0.60
90 - 95	0.61 - 0.91
95 - 98	0.92 - 1.24
98 - 100	1.25 - 1.58

Stream Sediment

%	ICP ppm
0 - 50	0.08 - 0.19
50 - 75	0.20 - 0.28
75 - 90	0.29 - 0.40
90 - 95	0.41 - 0.46
95 - 98	0.47 - 0.60
98 - 100	0.61- 1.58

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Tl

Lake Sediment

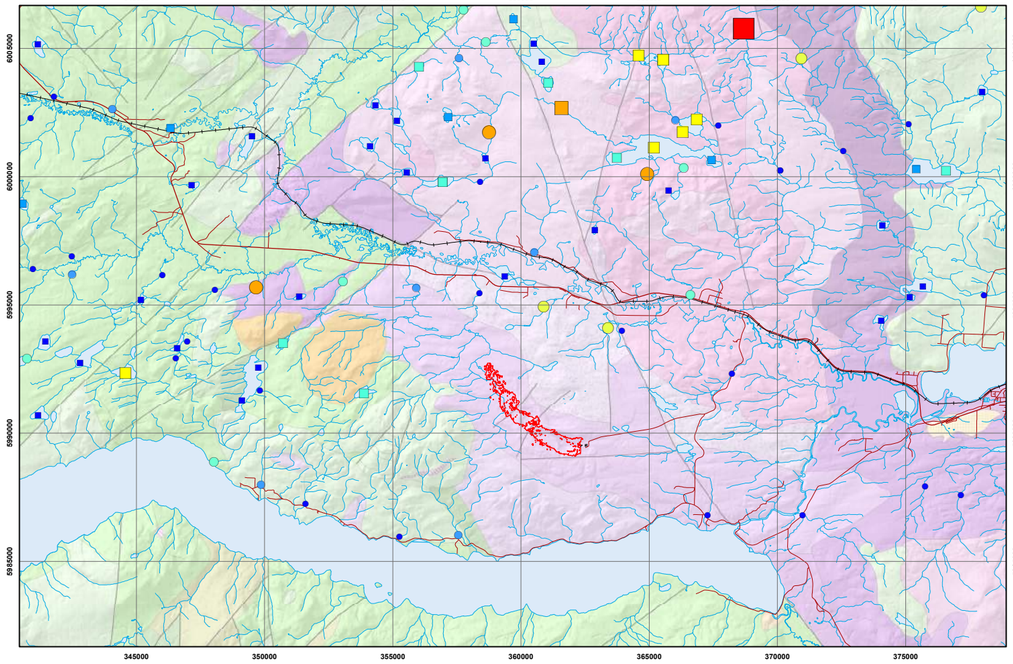
%	ICP ppm
0 - 50	0.01 - 0.10
50 - 75	0.11 - 0.14
75 - 90	0.15 - 0.18
90 - 95	0.19 - 0.23
95 - 98	0.24 - 0.28
98 - 100	0.29 - 0.30

Stream Sediment

%	ICP ppm
0 - 50	0.03 - 0.07
50 - 75	0.08 - 0.10
75 - 90	0.11 - 0.14
90 - 95	0.15 - 0.17
95 - 98	0.18 - 0.22
98 - 100	0.23 - 0.26

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Hg

Lake Sediment

%	ICP ppm
0 - 50	30 - 85
50 - 75	86 - 105
75 - 90	106 - 125
90 - 95	126 - 160
95 - 98	161 - 193
98 - 100	194 - 205

Stream Sediment

%	ICP ppm
0 - 50	5 - 27
50 - 75	28 - 37
75 - 90	38 - 50
90 - 95	51 - 68
95 - 98	69 - 108
98 - 100	109 - 180

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour

Data Sources:

Stream sediment data:

A compilation file that includes all data from these sources was used:

Jackaman, W. (2009): QUEST-West Project Sample Reanalysis; Geoscience BC, Report 2009-5, 4 p.

Lett, R.E.W. (2005): Regional Geochemical Survey Database on CD, BC Ministry of Energy, Mines and Petroleum Resources, Geofile 2005-17.

Lake sediment data:

Jackaman, W. (2009): Regional Drainage Sediment and Water Geochemical Data, Central British Columbia (parts of NTS 93E, F, G, J, K, L, M, N & O), Geoscience BC, Report 2009-11. URL< http://www.geosciencebc.com/s/2009-11.asp> [May, 2015].

Jackaman, W. (2008): Regional Lake Sediment and Water Geochemical Data, Northern Fraser Basin, Central BC (parts of NTS 93G, H, J, K, N & O), Geoscience BC, Report 2008-5. URL< http://www.geosciencebc.com/s/2008-05.asp> [May, 2015].

Data Presentation:

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SCALE 1:200,000

0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

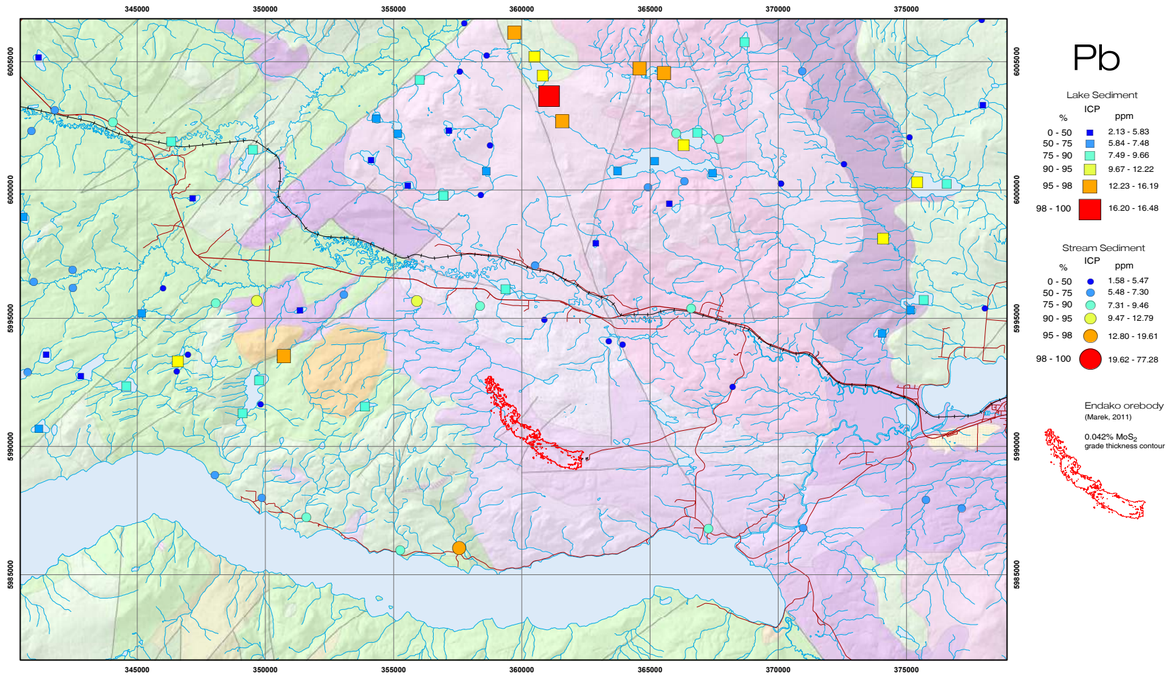
A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

LAKE AND STREAM SEDIMENT GEOCHEMISTRY

Pathfinder Elements (Base Metals)

1 : 200,000



Pb

Lake Sediment

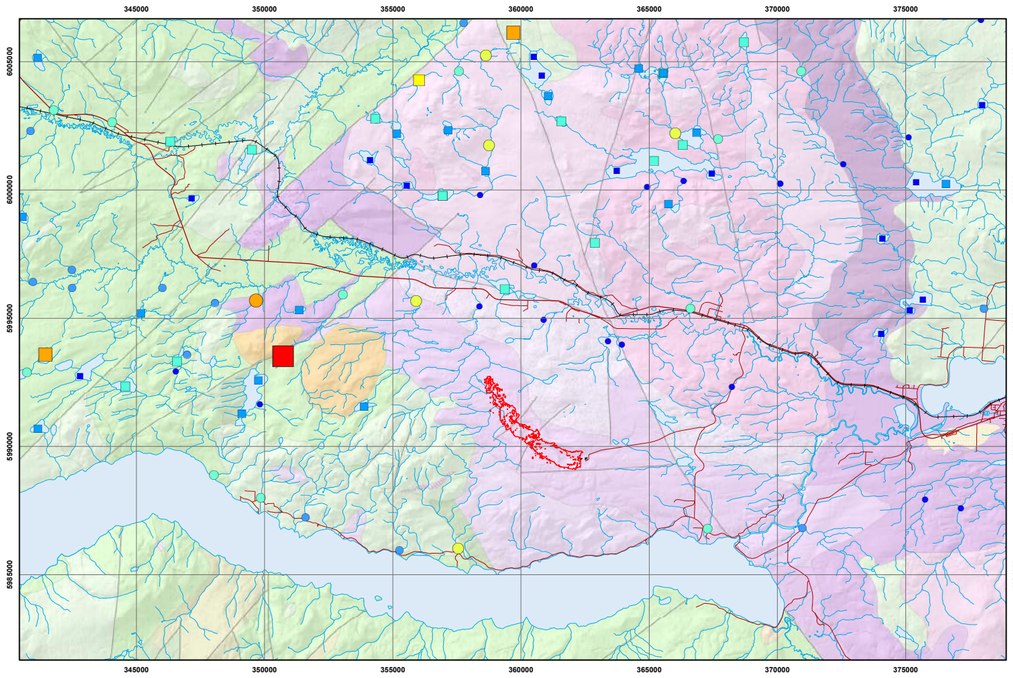
%	ICP ppm
0 - 50	2.13 - 5.83
50 - 75	5.84 - 7.48
75 - 90	7.49 - 9.66
90 - 95	9.67 - 12.22
95 - 98	12.23 - 16.19
98 - 100	16.20 - 16.48

Stream Sediment

%	ICP ppm
0 - 50	1.58 - 5.47
50 - 75	5.48 - 7.30
75 - 90	7.31 - 9.46
90 - 95	9.47 - 12.79
95 - 98	12.80 - 19.61
98 - 100	19.62 - 77.28

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Zn

Lake Sediment

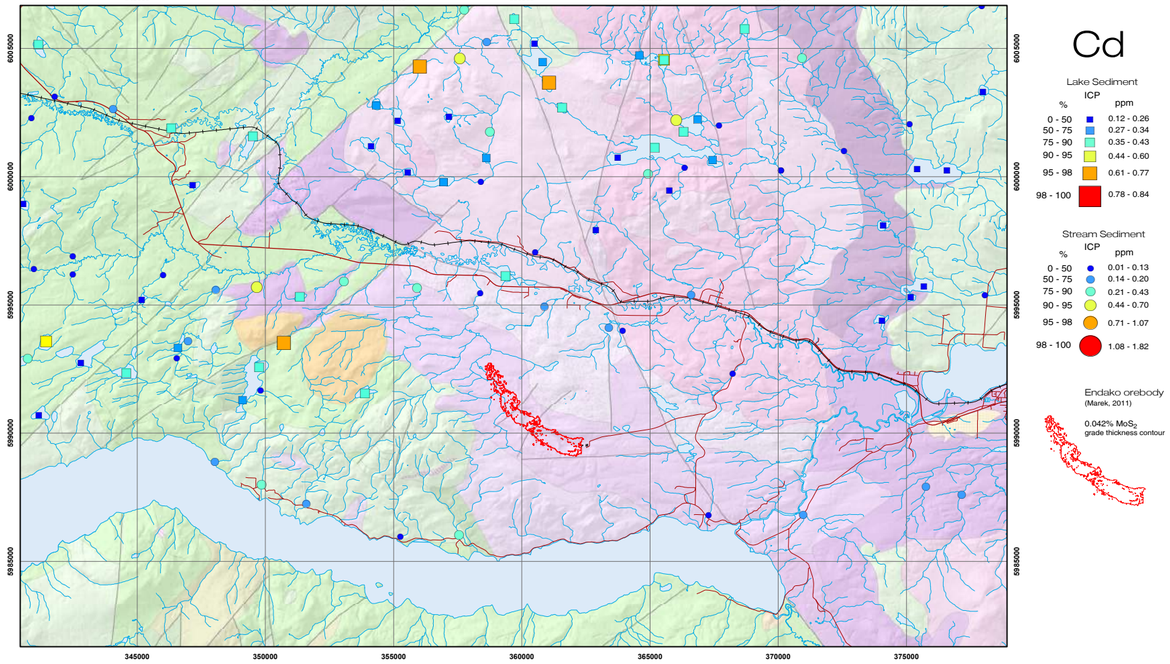
%	ICP ppm
0 - 50	21.50 - 56.40
50 - 75	56.41 - 75.80
75 - 90	75.81 - 95.80
90 - 95	95.81 - 117.90
95 - 98	117.91 - 156.80
98 - 100	156.81 - 273.60

Stream Sediment

%	ICP ppm
0 - 50	22.80 - 45.00
50 - 75	45.01 - 56.20
75 - 90	56.21 - 75.90
90 - 95	75.91 - 92.78
95 - 98	92.79 - 105.48
98 - 100	105.49 - 246.60

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Cd

Lake Sediment

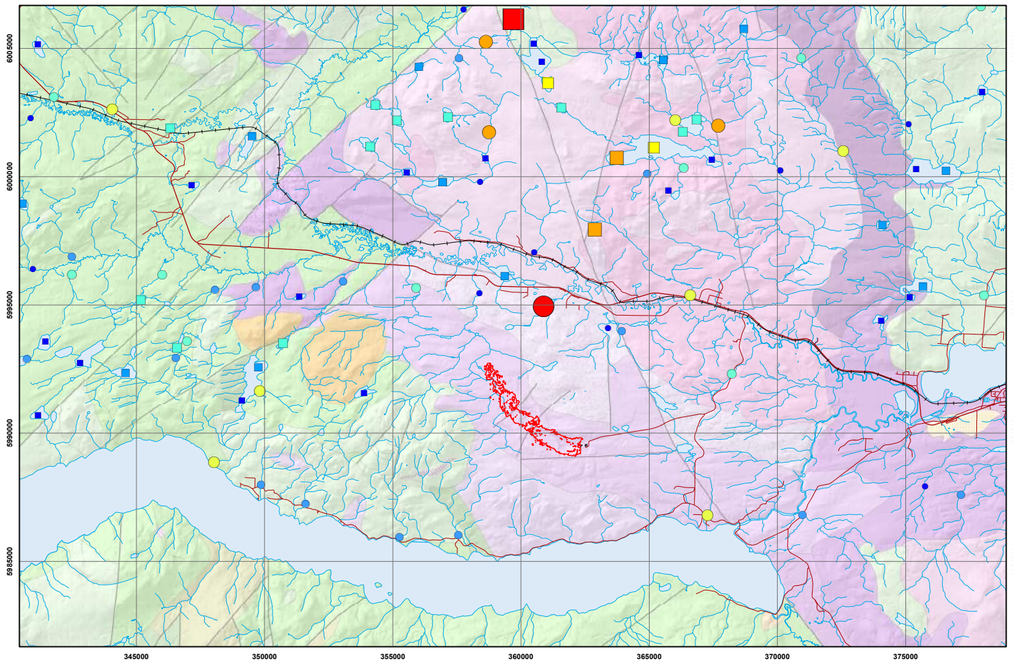
%	ICP ppm
0 - 50	0.12 - 0.26
50 - 75	0.27 - 0.34
75 - 90	0.35 - 0.43
90 - 95	0.44 - 0.60
95 - 98	0.61 - 0.77
98 - 100	0.78 - 0.84

Stream Sediment

%	ICP ppm
0 - 50	0.01 - 0.13
50 - 75	0.14 - 0.20
75 - 90	0.21 - 0.43
90 - 95	0.44 - 0.70
95 - 98	0.71 - 1.07
98 - 100	1.08 - 1.82

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Fe

Lake Sediment

%	ICP percent
0 - 50	0.30 - 1.60
50 - 75	1.61 - 2.34
75 - 90	2.35 - 3.16
90 - 95	3.17 - 5.37
95 - 98	5.38 - 7.55
98 - 100	7.56 - 10.25

Stream Sediment

%	ICP percent
0 - 50	1.17 - 2.04
50 - 75	2.05 - 2.35
75 - 90	2.36 - 2.81
90 - 95	2.82 - 3.38
95 - 98	3.39 - 4.37
98 - 100	4.38 - 4.53

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour

Data Sources:

Stream sediment data:

A compilation file that includes all data from these sources was used:

Jackaman, W. (2009): QUEST-West Project Sample Reanalysis; Geoscience BC, Report 2009-5, 4 p.

Lett, R.E.W. (2005): Regional Geochemical Survey Database on CD, BC Ministry of Energy, Mines and Petroleum Resources, Geofile 2005-17.

Lake sediment data:

Jackaman, W. (2009): Regional Drainage Sediment and Water Geochemical Data, Central British Columbia (parts of NTS 93E, F, G, J, K, L, M, N & O), Geoscience BC, Report 2009-11. URL< http://www.geosciencebc.com/s/2009-11.asp> [May, 2015].

Jackaman, W. (2008): Regional Lake Sediment and Water Geochemical Data, Northern Fraser Basin, Central BC (parts of NTS 93G, H, J, K, N & O), Geoscience BC, Report 2008-5. URL< http://www.geosciencebc.com/s/2008-05.asp> [May, 2015].

Data Presentation:

Data presented here was subset to the limits of NTS map sheets 093K02, K03, F14, and F15, which comprises 152 stream sediment samples, and 89 lake sediment samples. Percentiles were calculated on the raw values without transformation or levelling.

SCALE 1:200,000

0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

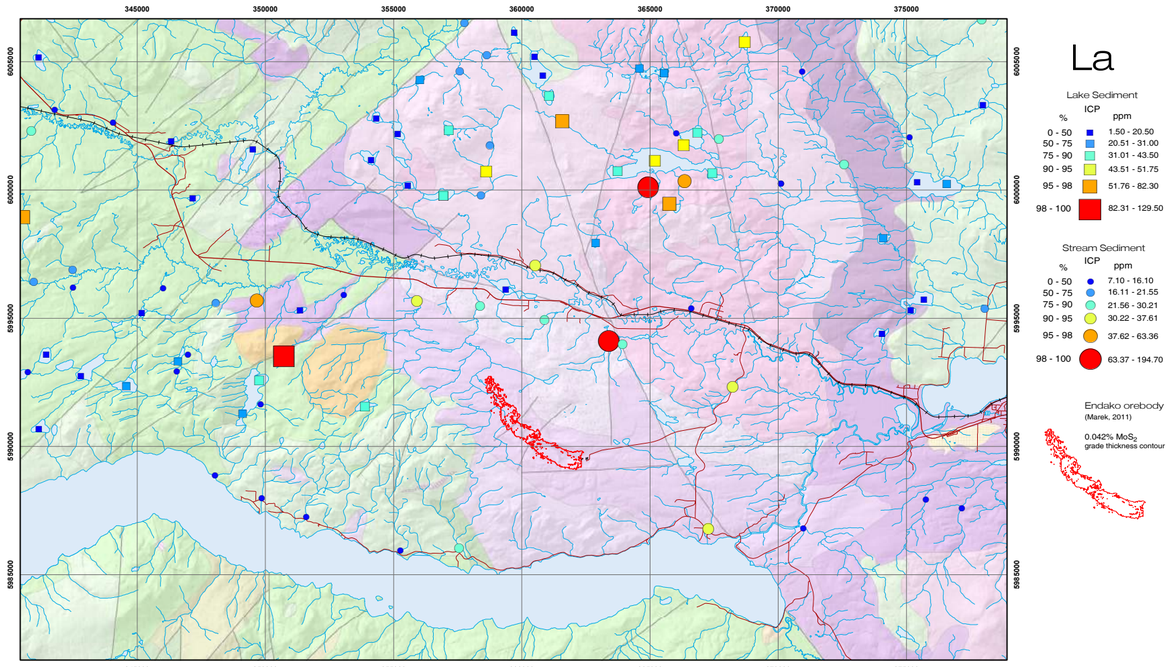
A geo-exploration atlas of the Endako porphyry molybdenum district

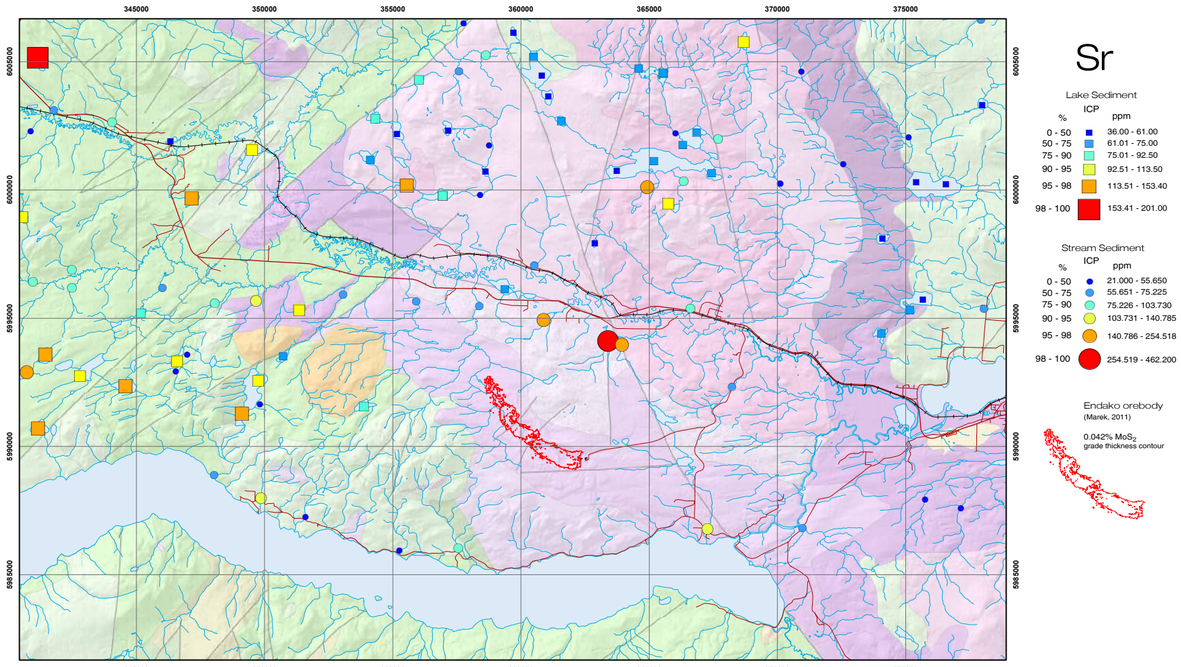
Geoscience BC

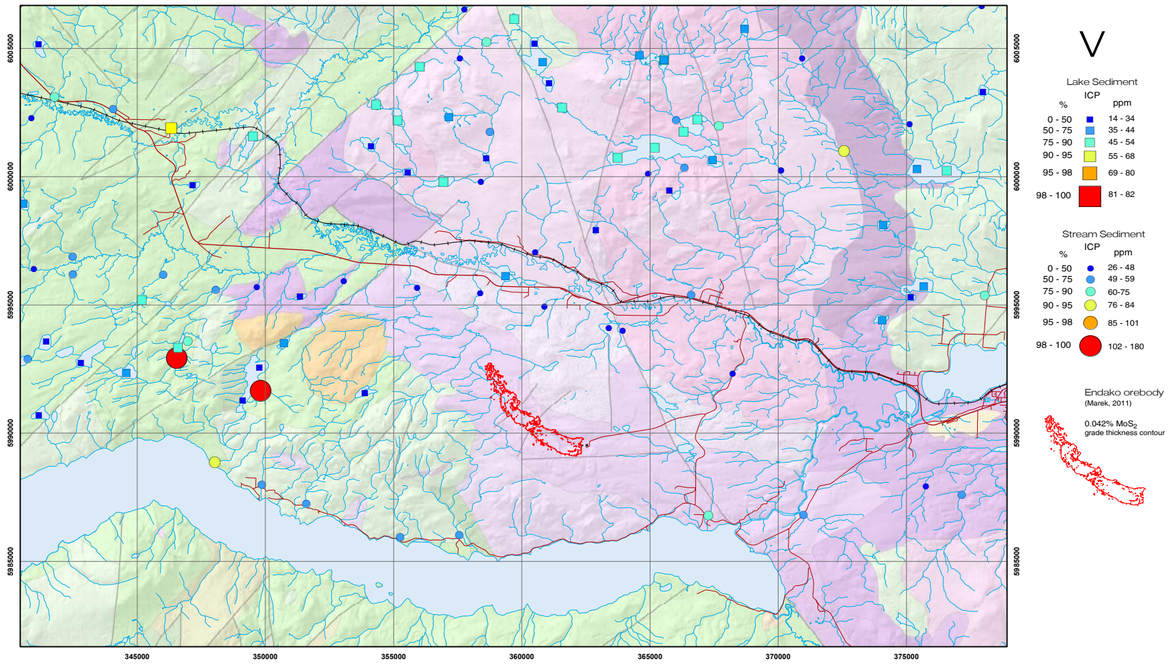
LAKE AND STREAM SEDIMENT GEOCHEMISTRY

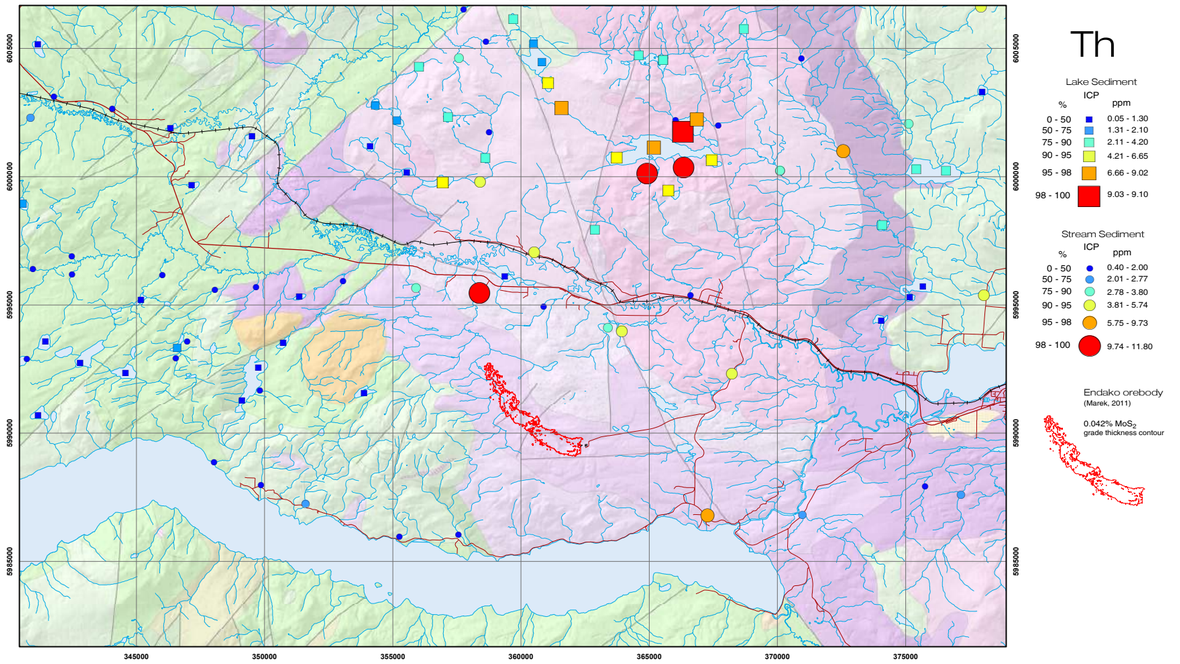
Rare Earth Elements & Sr, V, Th

1 : 200,000









Data Sources:

Stream sediment data:

A compilation file that includes all data from these sources was used:

Jackaman, W. (2009): QUEST-West Project Sample Reanalysis; Geoscience BC, Report 2009-5, 4 p.

Lett, R.E.W. (2005): Regional Geochemical Survey Database on CD, BC Ministry of Energy, Mines and Petroleum Resources, Geofile 2005-17.

Lake sediment data:

Jackaman, W. (2009): Regional Drainage Sediment and Water Geochemical Data, Central British Columbia (parts of NTS 93E, F, G, J, K, L, M, N & O), Geoscience BC, Report 2009-11. URL< http://www.geosciencebc.com/s/2009-11.asp> [May, 2015].

Jackaman, W. (2008): Regional Lake Sediment and Water Geochemical Data, Northern Fraser Basin, Central BC (parts of NTS 93G, H, J, K, N & O), Geoscience BC, Report 2008-5. URL< http://www.geosciencebc.com/s/2008-05.asp> [May, 2015].

Data Presentation:

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SCALE 1:200,000

0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

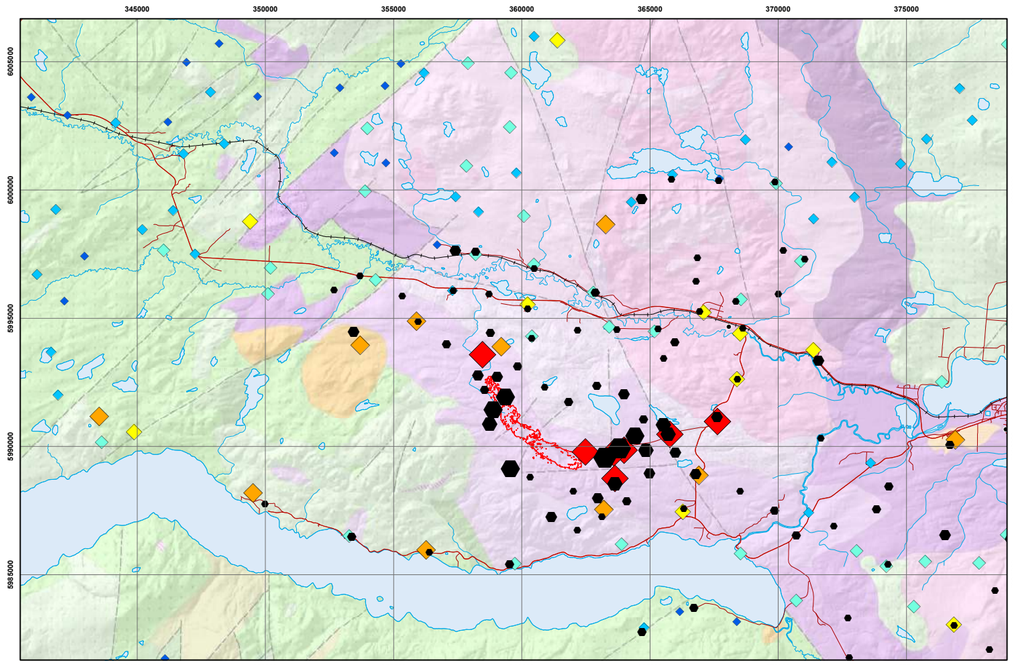
Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

BIOGEOCHEMISTRY
Lodgepole Pine Bark (ash) & Spruce Sap
1 : 200,000



Mo

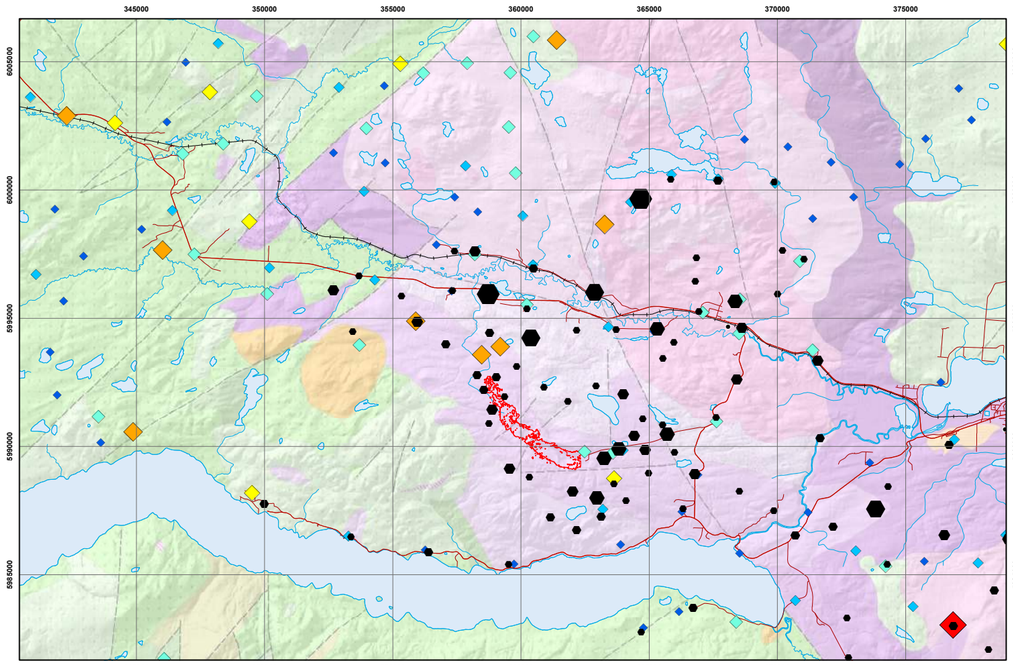
Spruce Sap
ICP-MS

%	ppb
0 - 50	20.00 - 178.00
50 - 75	178.01 - 327.25
75 - 90	327.26 - 558.33
90 - 95	558.34 - 965.62
95 - 98	965.63 - 1653.48
98 - 100	1653.49 - 10509.00

Lodgepole Pine Bark
ICP-ES

%	ppb
0 - 50	20.00 - 178.00
50 - 75	178.01 - 327.25
75 - 90	327.26 - 558.33
90 - 95	558.34 - 965.62
95 - 98	965.63 - 1653.48
98 - 100	1653.49 - 10509.00

Endako orebody
(Marek, 2011)
0.042% MoS_2
grade thickness contour



Cu

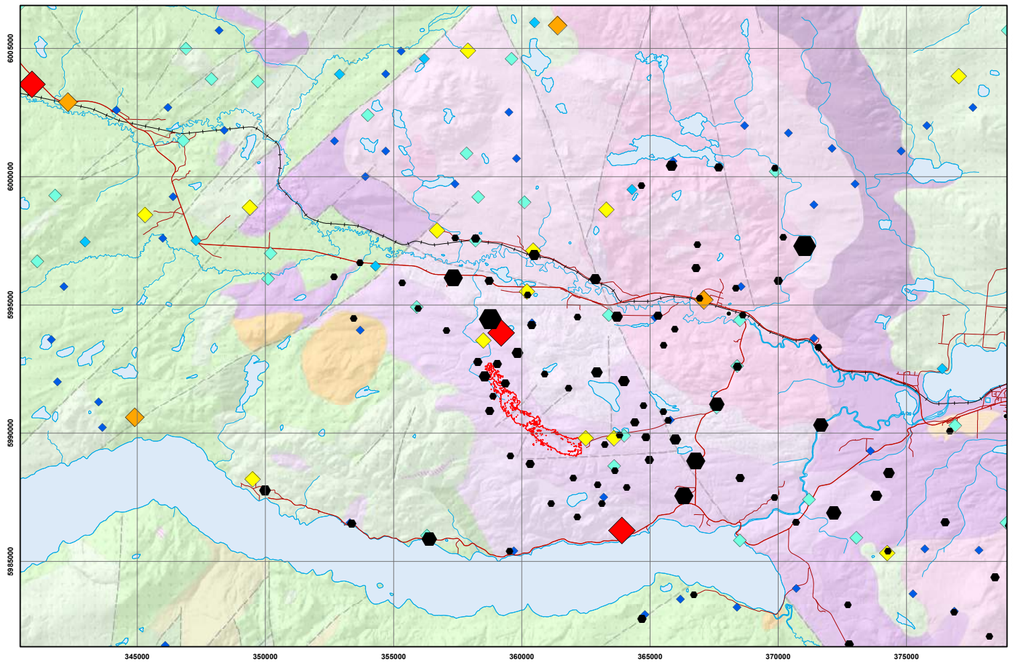
Spruce Sap
ICP-MS

%	ppb
0 - 50	3.12 - 52.21
50 - 75	52.21 - 93.03
75 - 90	93.03 - 171.11
90 - 95	171.11 - 270.22
95 - 98	270.23 - 418.53
98 - 100	418.54 - 624.89

Lodgepole Pine Bark
ICP-ES

%	ppm
0 - 50	25.00 - 98.00
50 - 75	98.01 - 137.75
75 - 90	137.76 - 180.10
90 - 95	180.11 - 232.55
95 - 98	232.56 - 300.44
98 - 100	300.45 - 490.00

Endako orebody
(Marek, 2011)
0.042% MoS_2
grade thickness contour



Au

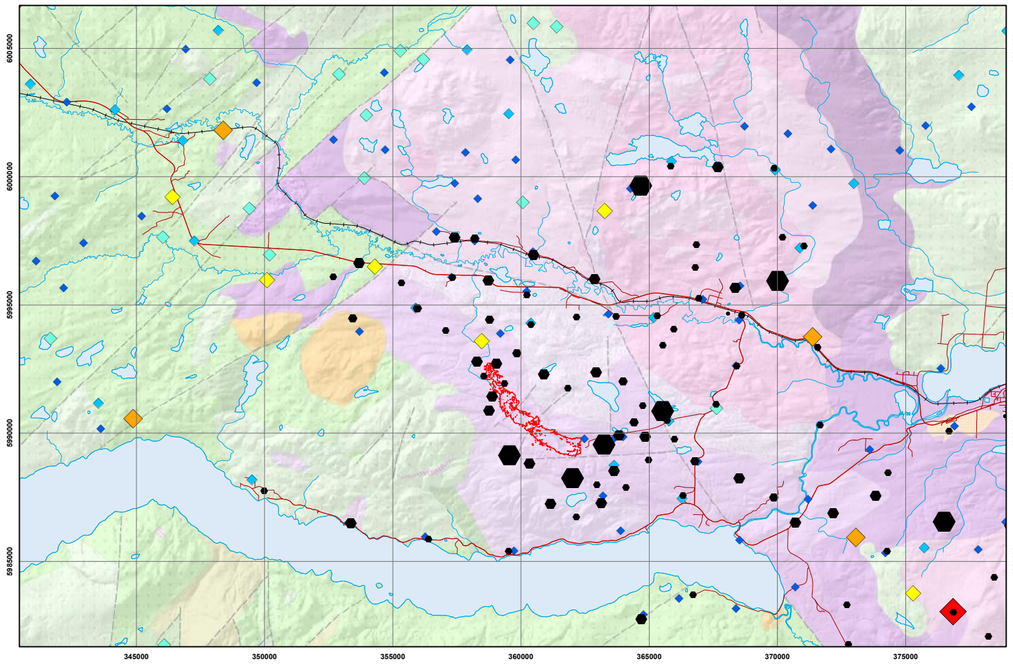
Spruce Sap
ICP-MS

%	ppb
0 - 50	0.0000 - 0.335
50 - 75	0.3351 - 0.593
75 - 90	0.5931 - 0.797
90 - 95	0.7971 - 0.932
95 - 98	0.9321 - 1.086
98 - 100	1.0861 - 1.249

Lodgepole Pine Bark
INAA

%	ppb
0 - 50	2.5
50 - 75	2.51 - 5.00
75 - 90	5.01 - 9.00
90 - 95	9.01 - 12.00
95 - 98	12.01 - 16.00
98 - 100	16.01 - 46.00

Endako orebody
(Marek, 2011)
0.042% MoS_2
grade thickness contour



Ag

Spruce Sap
ICP-MS

%	ppb
0 - 50	0.000 - 0.300
50 - 75	0.301 - 0.360
75 - 90	0.361 - 0.750
90 - 95	0.751 - 0.590
95 - 98	0.591 - 0.370000
98 - 100	0.371 - 1.812431

Lodgepole Pine Bark
ICP-ES

%	ppm
0 - 50	0.15 - 0.60
50 - 75	0.61 - 1.20
75 - 90	1.21 - 2.00
90 - 95	2.01 - 2.65
95 - 98	2.66 - 3.44
98 - 100	3.45 - 6.20

Endako orebody
(Marek, 2011)
0.042% MoS_2
grade thickness contour

Data Sources:

Struik, L.C., MacIntyre, D.G. and Williams, S.P. (2007): Nechako NATMAP project: A digital suite of geoscience information for central British Columbia; Geological Survey of Canada, Open File 5623.

Dunn, C.E. and Hastings, N.L. (1998a-d): Biogeochemical survey of the Ootsa-François lakes area using outer bark of Lodgepole Pine (NTS 93F/13, 14, and part of 12); Geological Survey of Canada , Open File 3587, 3 maps and digital data.

Dunn, C.E. and Hastings, N.L. (1999a-d): Biogeochemical survey of the Fraser Lake area using outer bark of Lodgepole pine (NTS 93K02/03); Geological Survey of Canada, Open File 3696, 3 maps and digital data.

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Heberlein, D.R., Dunn, C.E. and Hoffman, E. (2015): Investigation of tree sap as a sample medium for regional geochemical exploration in glacial sediment covered terrains: A case history from the Endako area, North-Central BC (NTS map sheets 093F14, 093F15, 093K03 and 093K02); Geoscience BC, Report 2015-02, 49 p.

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Data from samples of spruce sap (Heberlein et al., 2015) are presented as percentile values based on the entire population of 120 samples. The limits of sampling are not shown in the map view.

SCALE 1:200,000

0 5 10 15 20

kilometres

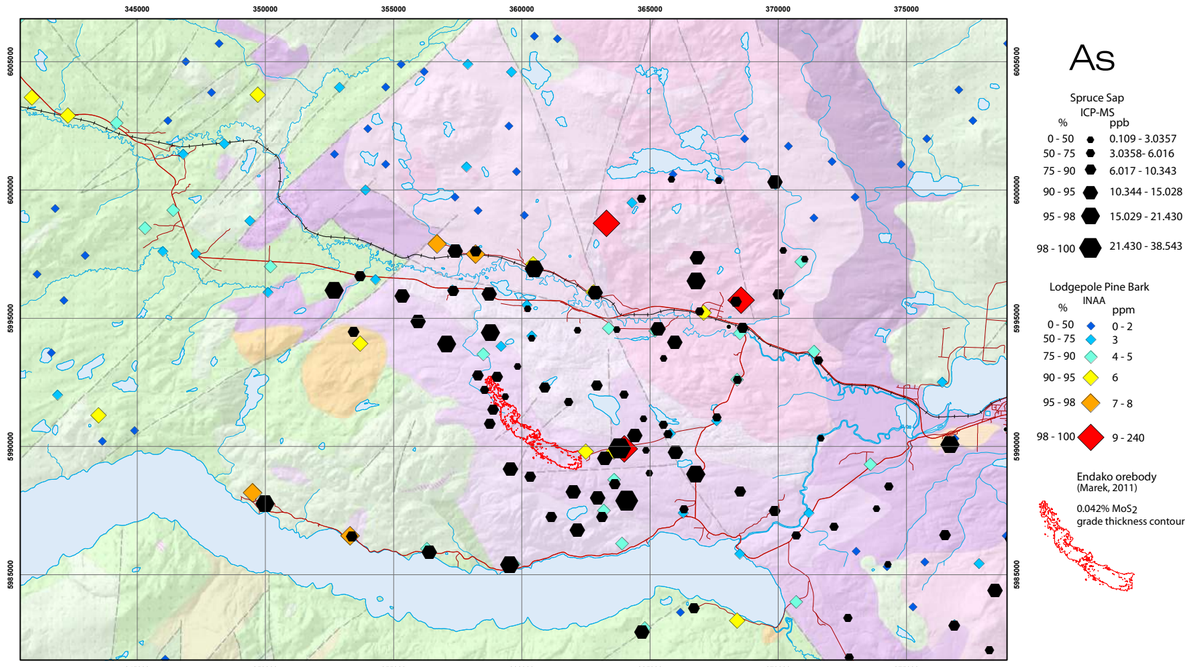
Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

BIOGEOCHEMISTRY
Lodgepole Pine Bark (ash) & Spruce Sap
1 : 200,000



As

Spruce Sap
ICP-MS

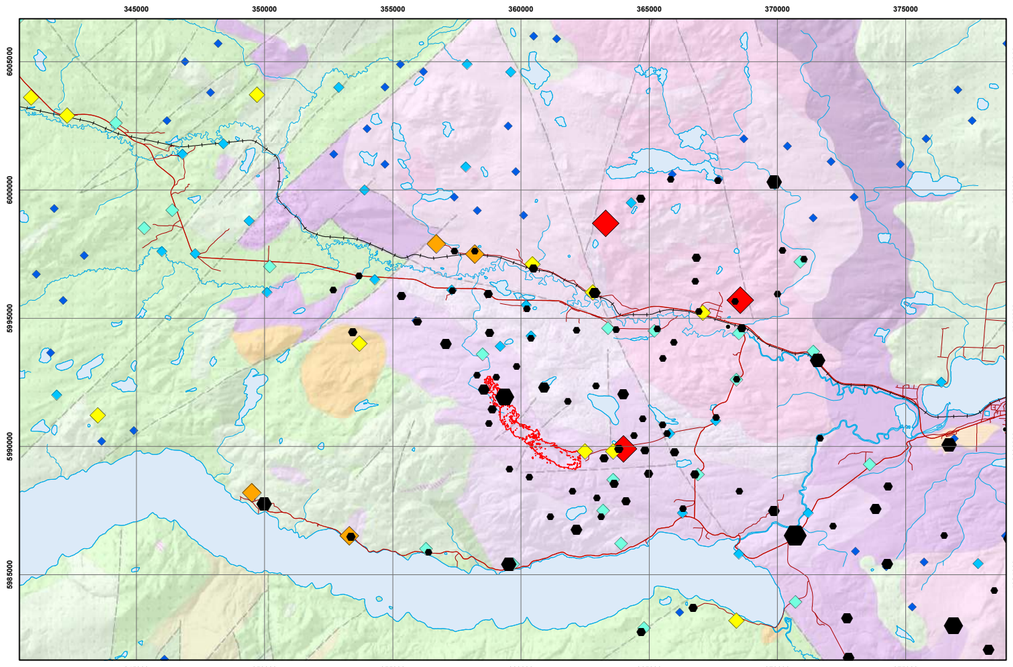
%	ppb
0 - 50	0.109 - 3.0357
50 - 75	3.0358- 6.016
75 - 90	6.017 - 10.343
90 - 95	10.344 - 15.028
95 - 98	15.029 - 21.430
98 - 100	21.430 - 38.543

Lodgepole Pine Bark
INAA

%	ppm
0 - 50	0 - 2
50 - 75	3
75 - 90	4 - 5
90 - 95	6
95 - 98	7 - 8
98 - 100	9 - 240

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Sb

Spruce Sap
ICP-MS

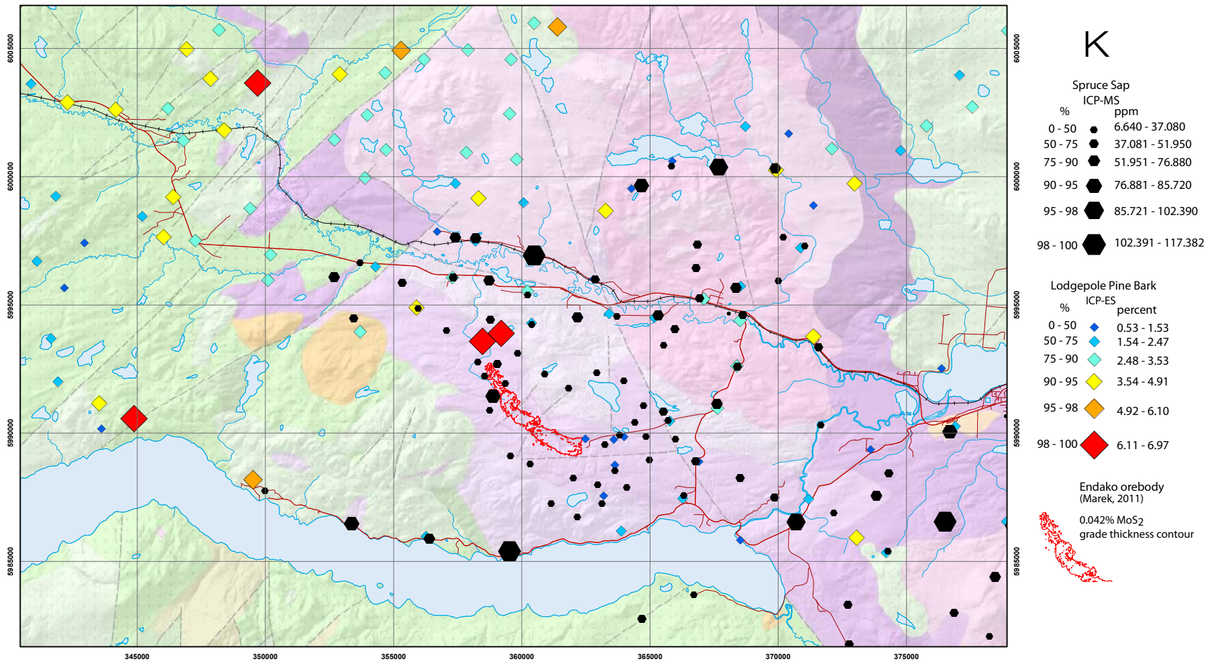
%	ppb
0 - 50	0.000 - 1.010
50 - 75	1.011 - 1.840
75 - 90	1.841 - 2.500
90 - 95	2.501 - 2.910
95 - 98	2.911 - 3.560
98 - 100	3.561 - 9.475

Lodgepole Pine Bark
INAA

%	ppm
0 - 50	0.05 - 0.07
50 - 75	0.71 - 1.03
75 - 90	1.04 - 1.50
90 - 95	1.51 - 1.83
95 - 98	1.84 - 2.90
98 - 100	2.91 - 730.00

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



K

Spruce Sap
ICP-MS

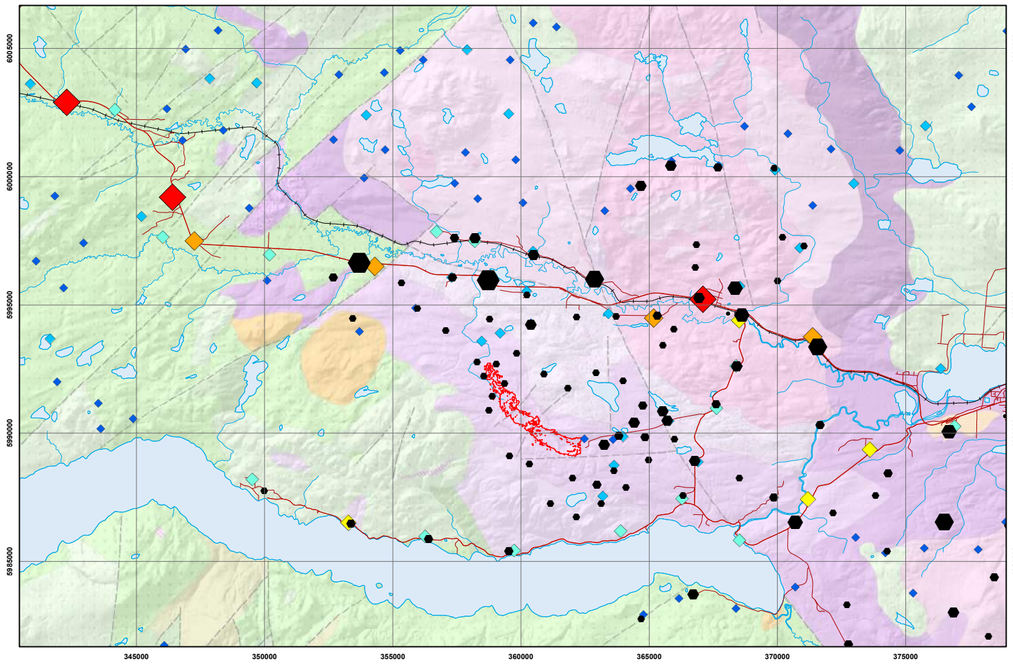
%	ppm
0 - 50	6.640 - 37.080
50 - 75	37.081 - 51.950
75 - 90	51.951 - 76.880
90 - 95	76.881 - 85.720
95 - 98	85.721 - 102.390
98 - 100	102.391 - 117.382

Lodgepole Pine Bark
ICP-ES

%	percent
0 - 50	0.53 - 1.53
50 - 75	1.54 - 2.47
75 - 90	2.48 - 3.53
90 - 95	3.54 - 4.91
95 - 98	4.92 - 6.10
98 - 100	6.11 - 6.97

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Na

Spruce Sap
ICP-MS

%	ppm
0 - 50	0.528 - 2.450
50 - 75	2.451 - 3.760
75 - 90	3.761 - 6.960
90 - 95	6.961 - 9.420
95 - 98	9.421 - 12.470
98 - 100	12.471 - 31.562

Lodgepole Pine Bark
INAA

%	ppm
0 - 50	733.00 - 4480.00
50 - 75	4480.01 - 9970.00
75 - 90	9970.01 - 15000.00
90 - 95	15000.01 - 20125.00
95 - 98	20125.01 - 24270.00
98 - 100	24270.01 - 30000.00

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour

Data Sources:

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SCALE 1:200,000

0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

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Geoscience BC

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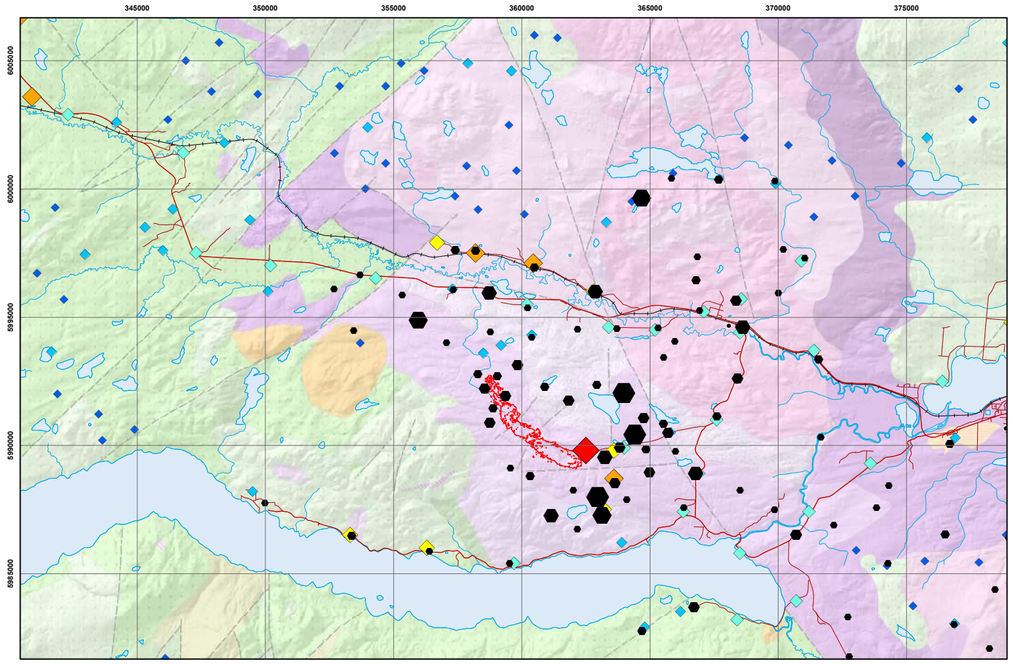
Lodgepole Pine Bark (ash) & Spruce Sap
1 : 200,000



Fe

Spruce Sap
ICP-MS

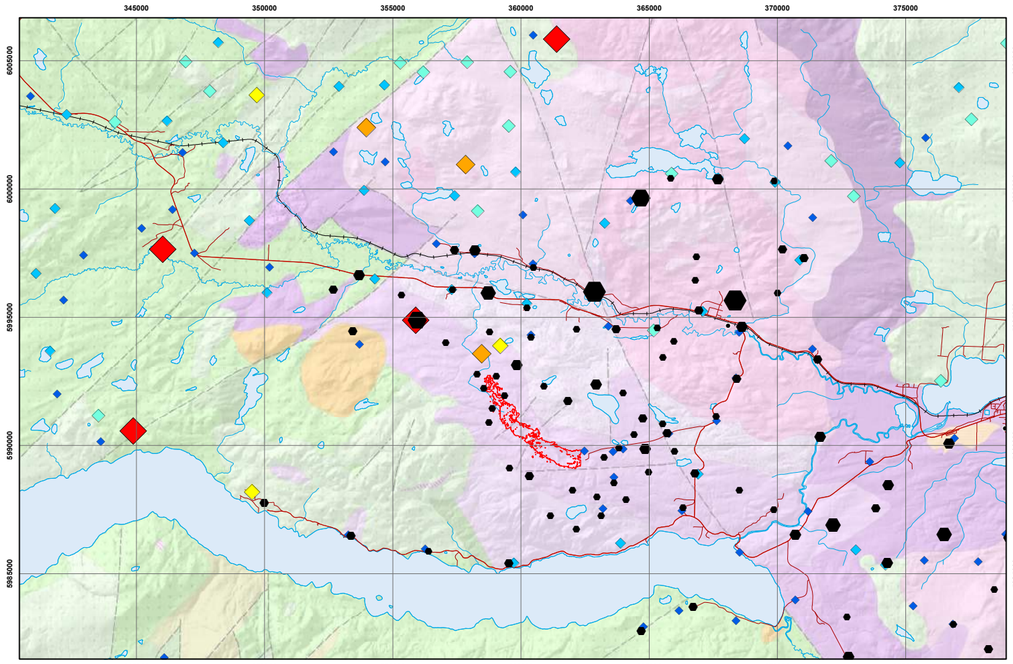
%	ppm
0 - 50	0.047 - 1.050
50 - 75	1.051 - 2.310
75 - 90	2.311 - 5.590
90 - 95	5.591 - 11.510
95 - 98	11.511 - 28.060
98 - 100	28.061 - 46.050

Lodgepole Pine Bark
INAA

%	percent
0 - 50	0.09 - 0.60
50 - 75	0.61 - 1.35
75 - 90	1.36 - 2.23
90 - 95	2.24 - 2.89
95 - 98	2.90 - 3.58
98 - 100	3.59 - 4.84

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Zn

Spruce Sap
ICP-MS

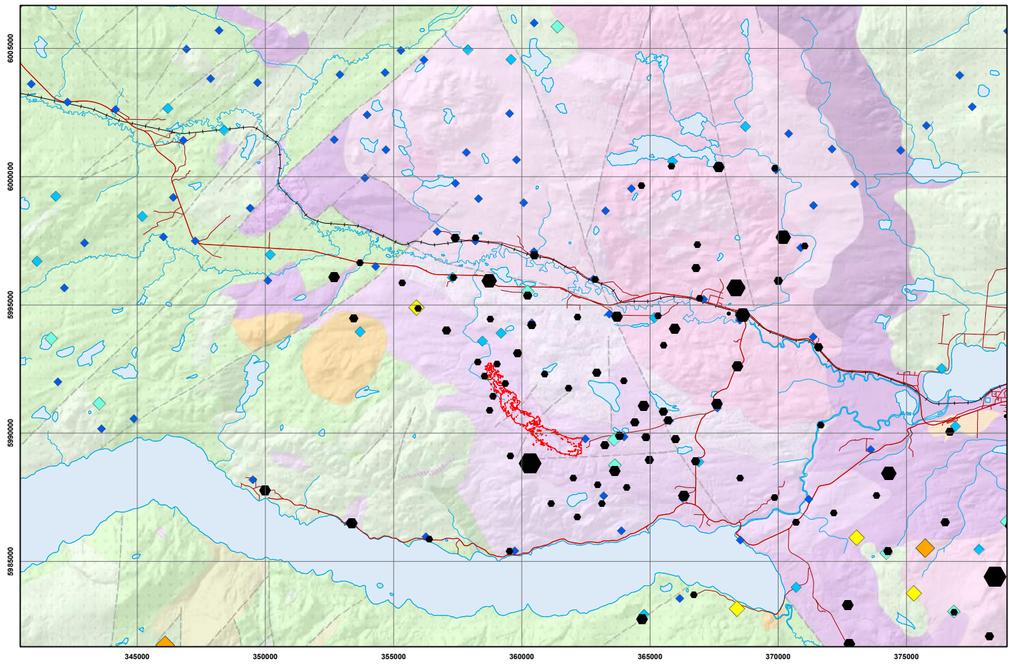
%	ppb
0 - 50	128.370 - 621.300
50 - 75	621.301 - 875.690
75 - 90	875.691 - 1692.960
90 - 95	1692.961 - 2082.890
95 - 98	2082.891 - 2531.140
98 - 100	2531.141 - 2951.516

Lodgepole Pine Bark
ICP-ES

%	ppm
0 - 50	0 - 1052
50 - 75	1053 - 1347
75 - 90	1348 - 1695
90 - 95	1696 - 1900
95 - 98	1901 - 2219
98 - 100	2220 - 2933

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Cd

Spruce Sap
ICP-MS

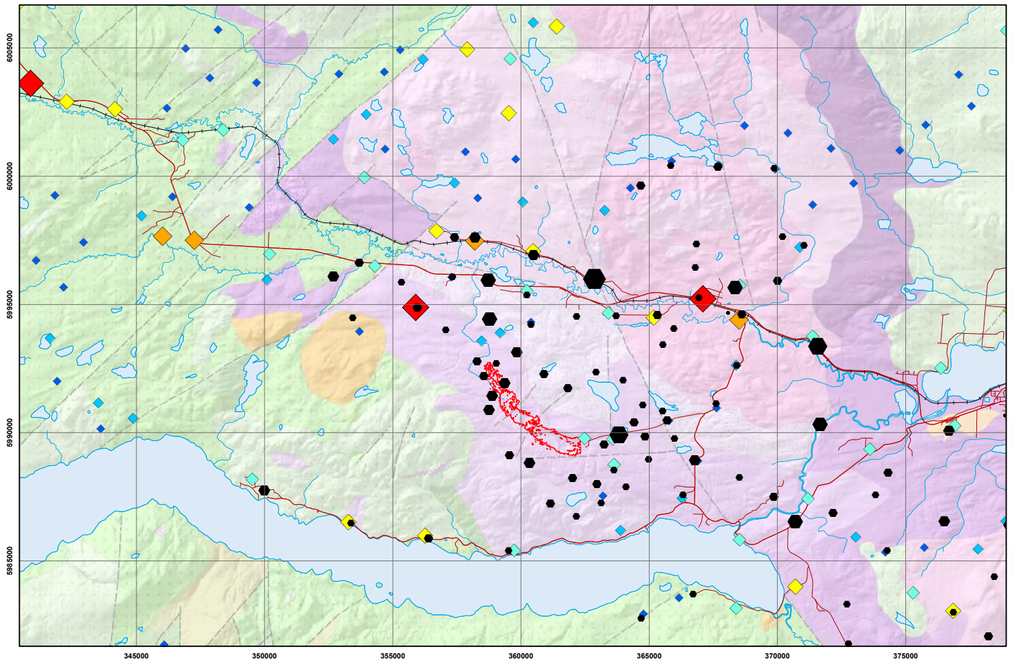
%	ppb
0 - 50	0.076 - 1.390
50 - 75	1.391 - 2.630
75 - 90	2.631 - 5.740
90 - 95	5.741 - 7.540
95 - 98	7.541 - 16.470
98 - 100	16.471 - 25.906

Lodgepole Pine Bark
INAA

%	ppm
0 - 50	2 - 10
50 - 75	11 - 25
75 - 90	26 - 42
90 - 95	43 - 52
95 - 98	53 - 64
98 - 100	65 - 180

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour



Ni

Spruce Sap
ICP-MS

%	ppb
0 - 50	0.432 - 39.000
50 - 75	39.001 - 59.980
75 - 90	59.981 - 102.470
90 - 95	102.471 - 149.360
95 - 98	149.361 - 206.850
98 - 100	206.851 - 259.227

Lodgepole Pine Bark
ICP-ES

%	ppm
0 - 50	1.00 - 10.00
50 - 75	10.01 - 15.00
75 - 90	15.01 - 21.00
90 - 95	21.01 - 26.00
95 - 98	26.01 - 32.22
98 - 100	32.23 - 43.00

Endako orebody
(Marek, 2011)

0.042% MoS_2
grade thickness contour

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0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

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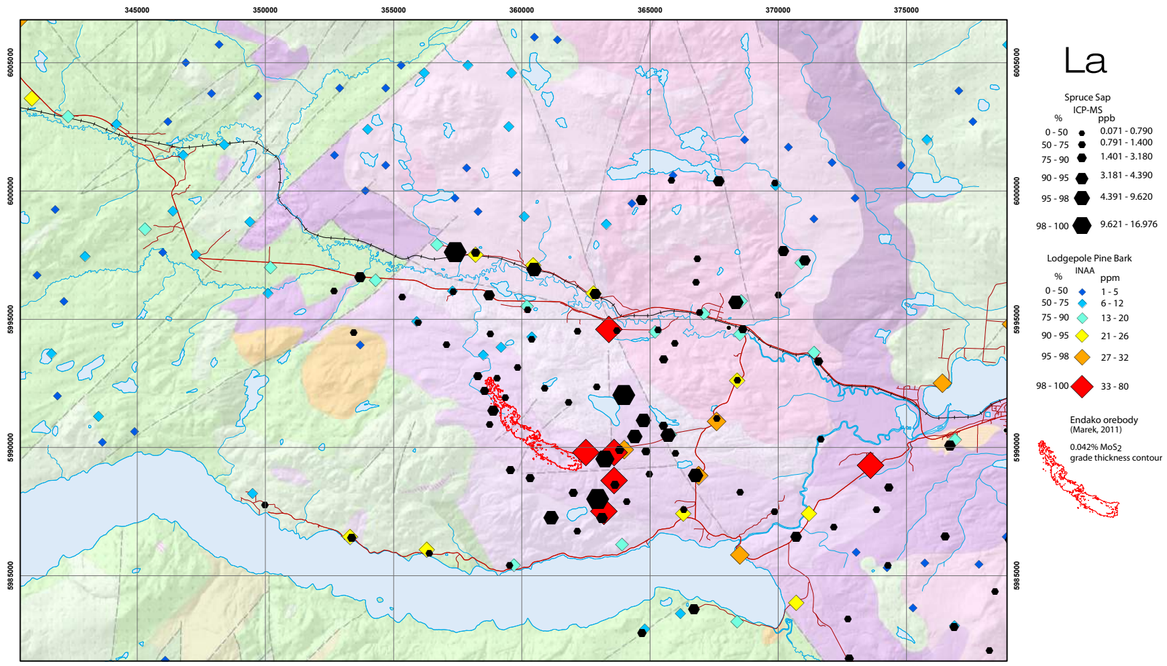
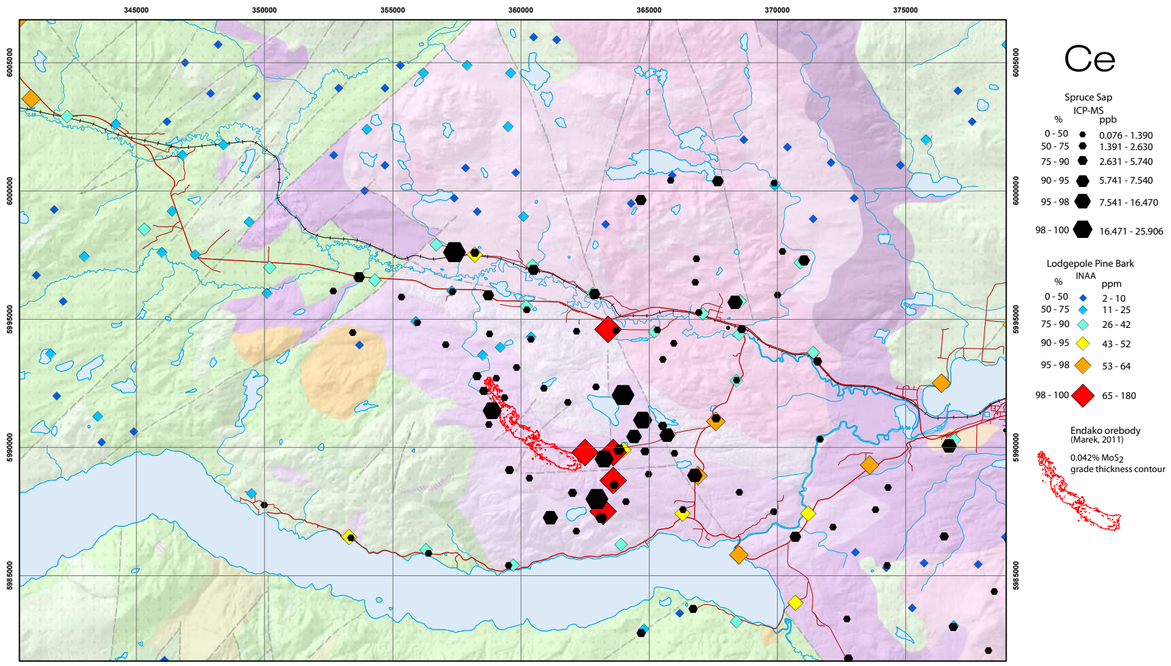
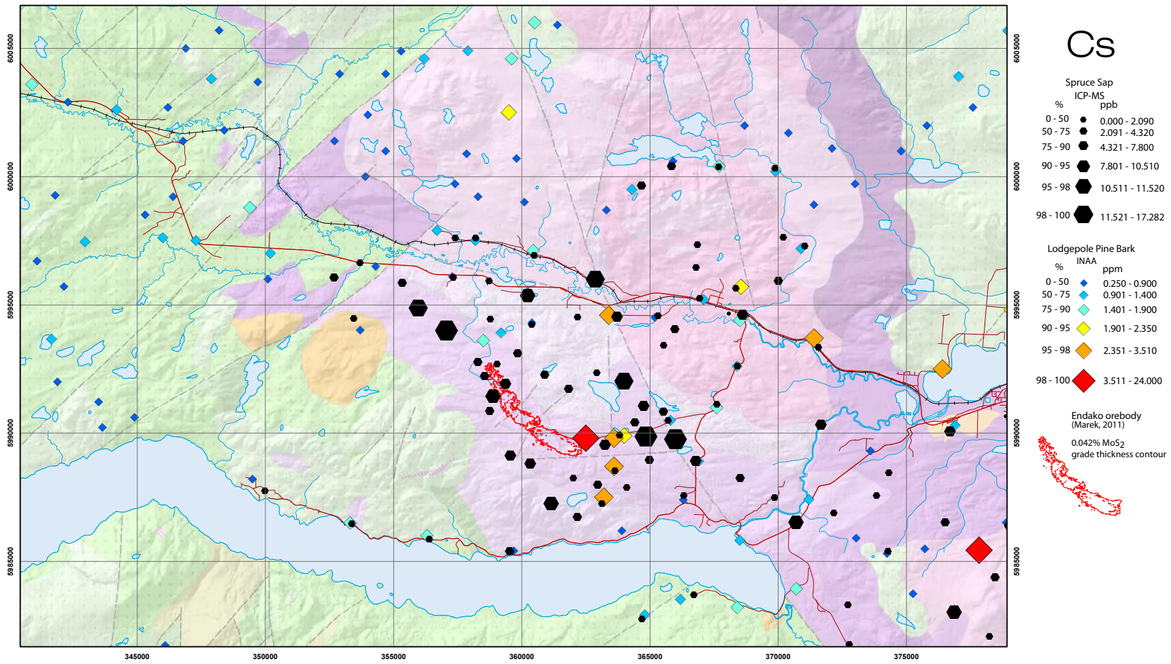
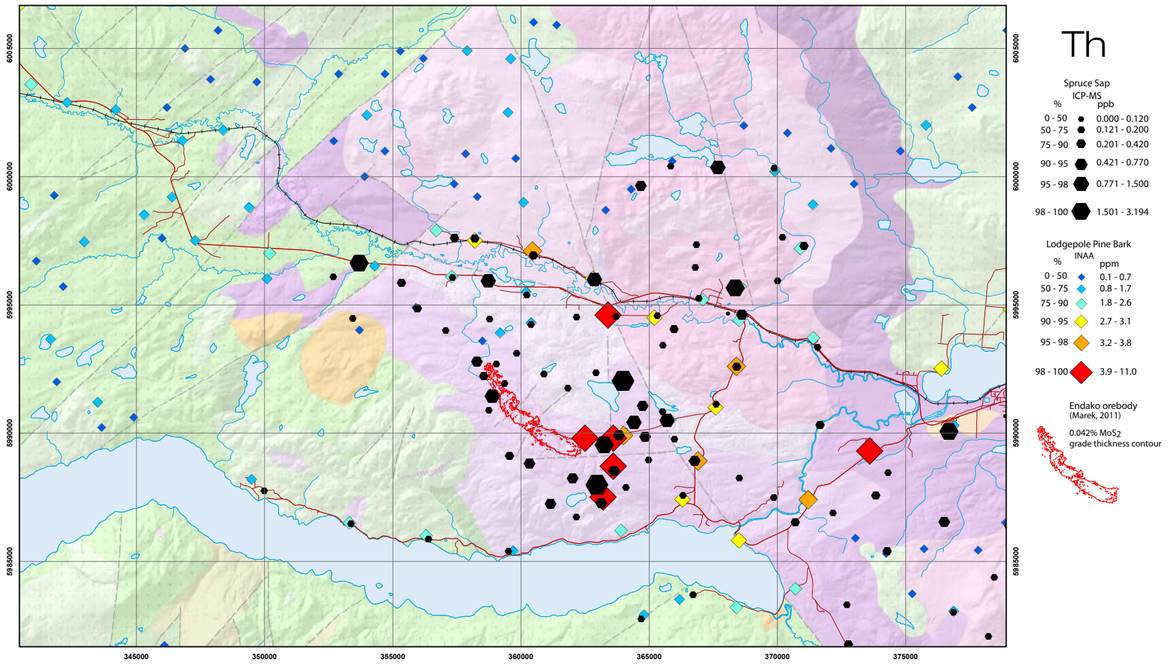








Data Sources:

Struik, L.C., MacIntyre, D.G. and Williams, S.P. (2007): Nechako NATMAP project: A digital suite of geoscience information for central British Columbia; Geological Survey of Canada, Open File 5623.

Dunn, C.E. and Hastings, N.L. (1998a-d): Biogeochemical survey of the Ootsa-François lakes area using outer bark of Lodgepole Pine (NTS 93F/13, 14, and part of 12); Geological Survey of Canada , Open File 3587, 3 maps and digital data.

Dunn, C.E. and Hastings, N.L. (1999a-d): Biogeochemical survey of the Fraser Lake area using outer bark of Lodgepole pine (NTS 93K02/03); Geological Survey of Canada, Open File 3696, 3 maps and digital data.

Dunn, C.E. and Hastings, N.L. (2000a,b,c,d): Biogeochemical survey of Nechako River area using outer bark of lodgepole pine (NTS 93 F 15/16 and parts of 93 F 9/10), central British Columbia; Geological Survey of Canada, Open File 3594, 4 maps at 1:400 000 scale and digital data.

Heberlein, D.R., Dunn, C.E. and Hoffman, E. (2015): Investigation of tree sap as a sample medium for regional geochemical exploration in glacial sediment covered terrains: A case history from the Endako area, North-Central BC (NTS map sheets 093F14, 093F15, 093K03 and 093K02); Geoscience BC, Report 2015-02, 49 p.

Data Presentation:

Data from samples of lodgepole pine bark are presented here as percentile values based on the entire population of 444 samples over map sheets 093K02, K03, F09, F10, F13, F14, F15, F16. Percentiles were calculated on the raw values without transformation or levelling.

Data from samples of spruce sap (Heberlein et al., 2015) are presented as percentile values based on the entire population of 120 samples. The limits of sampling are not shown in the map view.

SCALE 1:200,000

0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

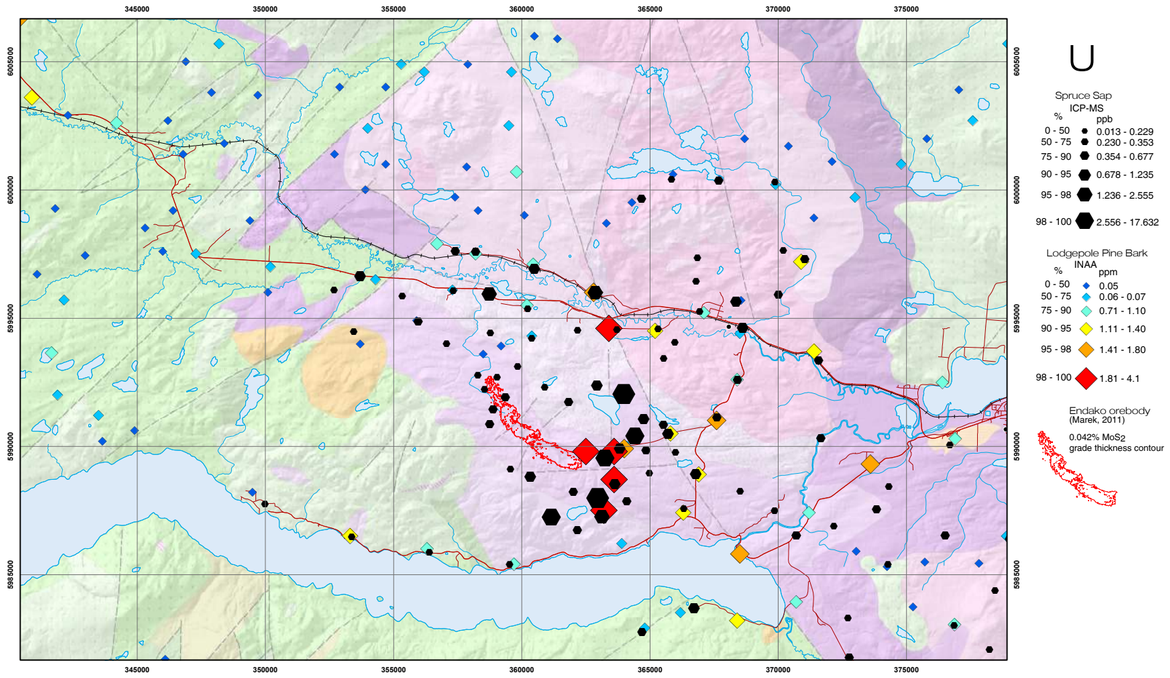
Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

BIOGEOCHEMISTRY
Lodgepole Pine Bark (ash) & Spruce Sap
1 : 200,000



U

Spruce Sap ICP-MS

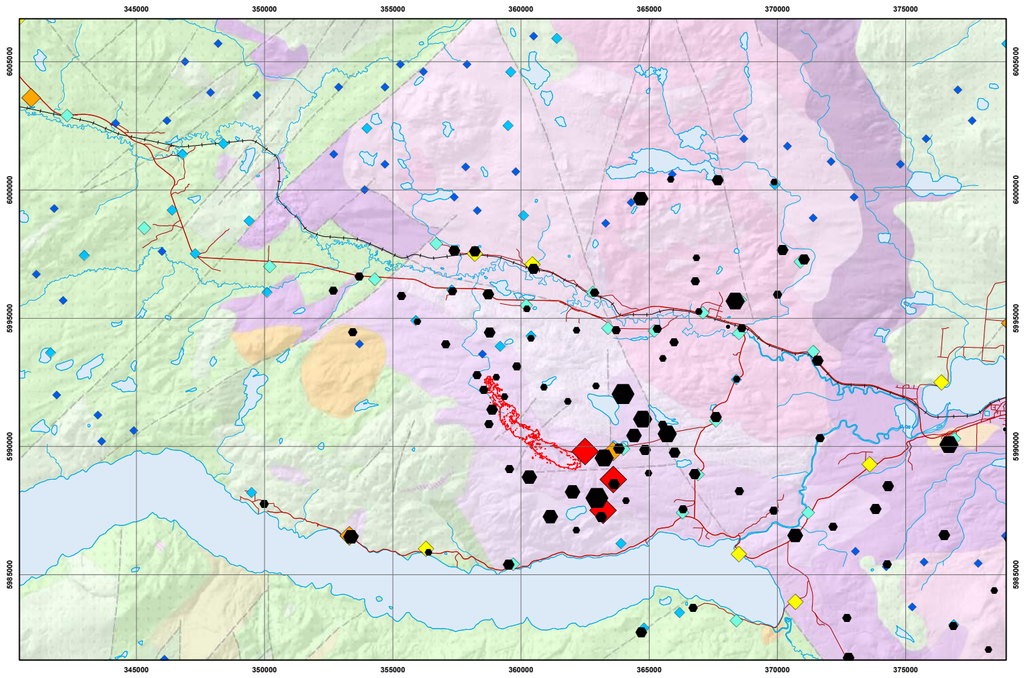
%	ppb
0 - 50	0.013 - 0.229
50 - 75	0.230 - 0.353
75 - 90	0.354 - 0.677
90 - 95	0.678 - 1.235
95 - 98	1.236 - 2.555
98 - 100	2.556 - 17.632

Lodgepole Pine Bark INAA

%	ppm
0 - 50	0.05
50 - 75	0.06 - 0.07
75 - 90	0.71 - 1.10
90 - 95	1.11 - 1.40
95 - 98	1.41 - 1.80
98 - 100	1.81 - 4.1

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Eu

Spruce Sap ICP-MS

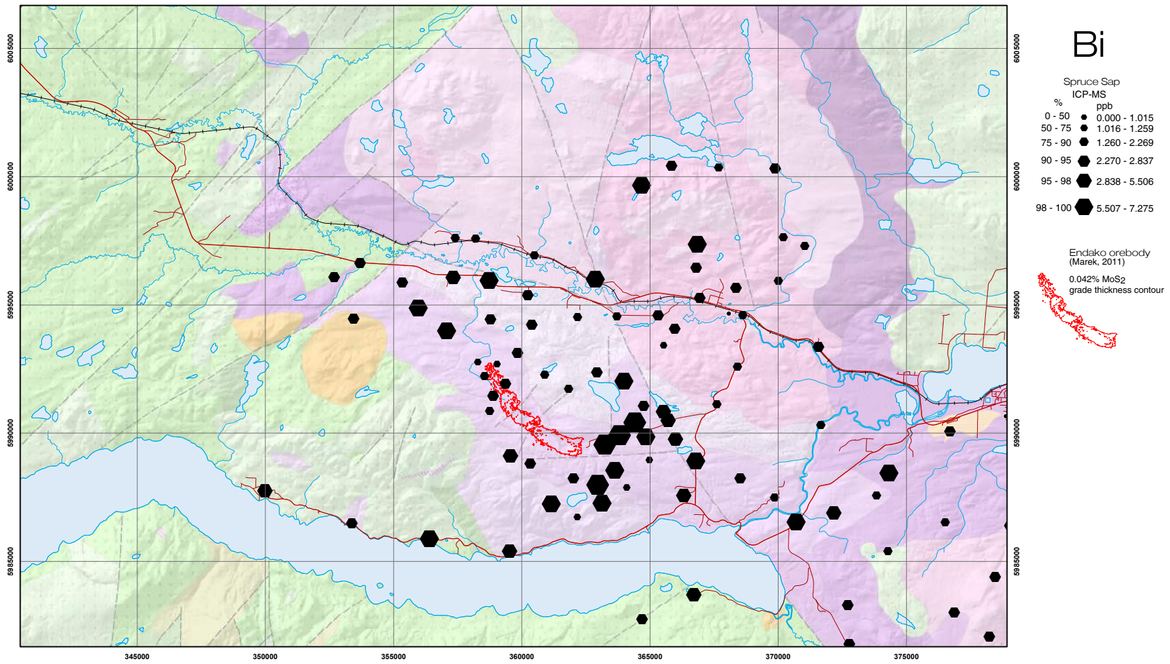
%	ppb
0 - 50	0.000 - 0.052
50 - 75	0.053 - 0.089
75 - 90	0.090 - 0.134
90 - 95	0.135 - 0.184
95 - 98	0.185 - 0.293
98 - 100	0.294 - 0.814

Lodgepole Pine Bark INAA

%	ppm
0 - 50	0.01 - 0.24
50 - 75	0.25 - 0.57
75 - 90	0.58 - 0.94
90 - 95	0.95 - 1.16
95 - 98	1.17 - 1.35
98 - 100	1.36 - 2.35

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



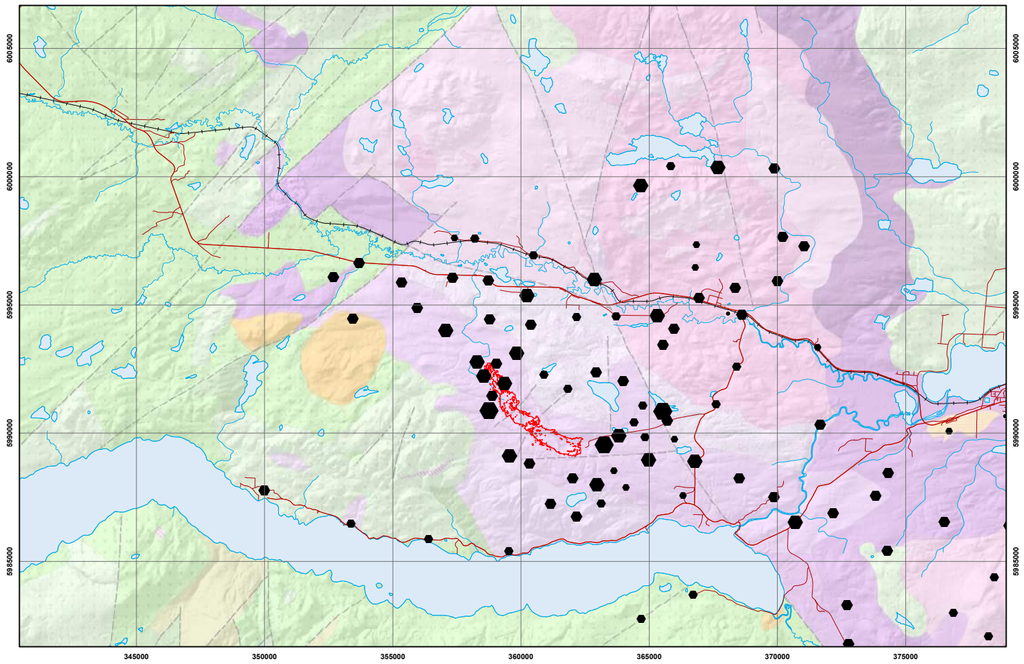
Bi

Spruce Sap ICP-MS

%	ppb
0 - 50	0.000 - 1.015
50 - 75	1.016 - 1.259
75 - 90	1.260 - 2.269
90 - 95	2.270 - 2.837
95 - 98	2.838 - 5.506
98 - 100	5.507 - 7.275

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Re

Spruce Sap ICP-MS

%	ppb
0 - 50	0.000 - 1.044
50 - 75	1.045 - 1.318
75 - 90	1.319 - 1.674
90 - 95	1.675 - 2.062
95 - 98	2.063 - 3.942
98 - 100	3.943 - 11.040

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour

Data Sources:

Struik, L.C., MacIntyre, D.G. and Williams, S.P. (2007): Nechako NATMAP project: A digital suite of geoscience information for central British Columbia; Geological Survey of Canada, Open File 5623.

Dunn, C.E. and Hastings, N.L. (1998a-d): Biogeochemical survey of the Ootsa-François lakes area using outer bark of Lodgepole Pine (NTS 93F/13, 14, and part of 12); Geological Survey of Canada , Open File 3587, 3 maps and digital data.

Dunn, C.E. and Hastings, N.L. (1999a-d): Biogeochemical survey of the Fraser Lake area using outer bark of Lodgepole pine (NTS 93K02/03); Geological Survey of Canada, Open File 3696, 3 maps and digital data.

Dunn, C.E. and Hastings, N.L. (2000a,b,c,d): Biogeochemical survey of Nechako River area using outer bark of lodgepole pine (NTS 93 F 15/16 and parts of 93 F 9/10), central British Columbia; Geological Survey of Canada, Open File 3594, 4 maps at 1:400 000 scale and digital data.

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Data Presentation:

Data from samples of lodgepole pine bark are presented here as percentile values based on the entire population of 444 samples over map sheets 093K02, K03, F09, F10, F13, F14, F15, F16. Percentiles were calculated on the raw values without transformation or levelling.

Data from samples of spruce sap (Heberlein et al., 2015) are presented as percentile values based on the entire population of 120 samples. The limits of sampling are not shown in the map view.

SCALE 1:200,000

0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10

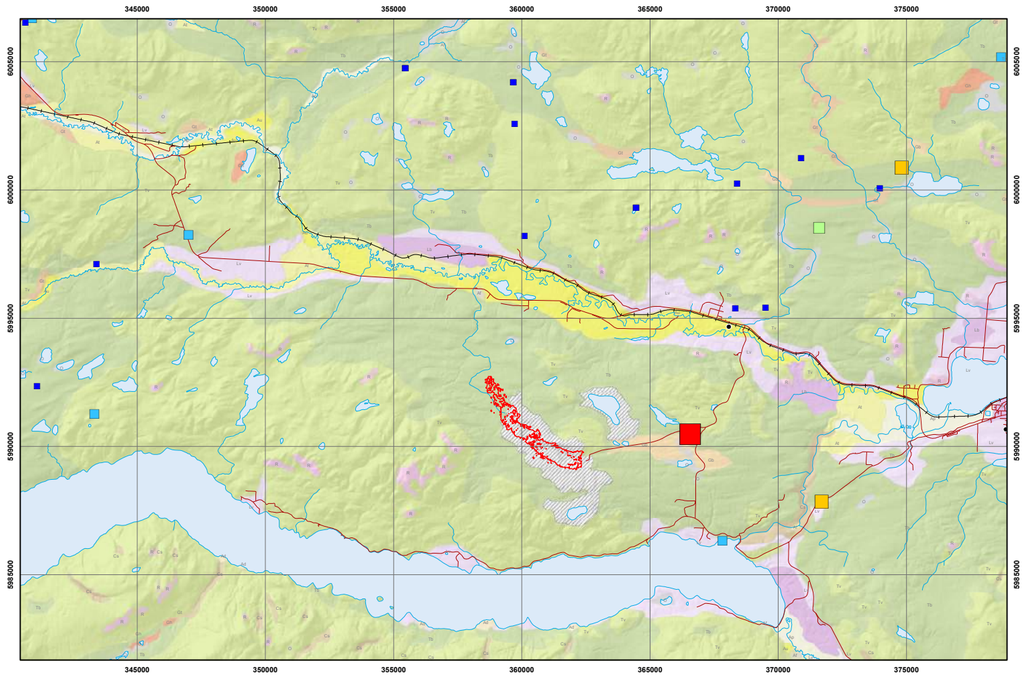
Porphyry Districts of British Columbia Atlas Series

ENDAKO DISTRICT

A geo-exploration atlas of the Endako porphyry molybdenum district

Geoscience BC

TILL GEOCHEMISTRY
Commodity Elements
1 : 200,000



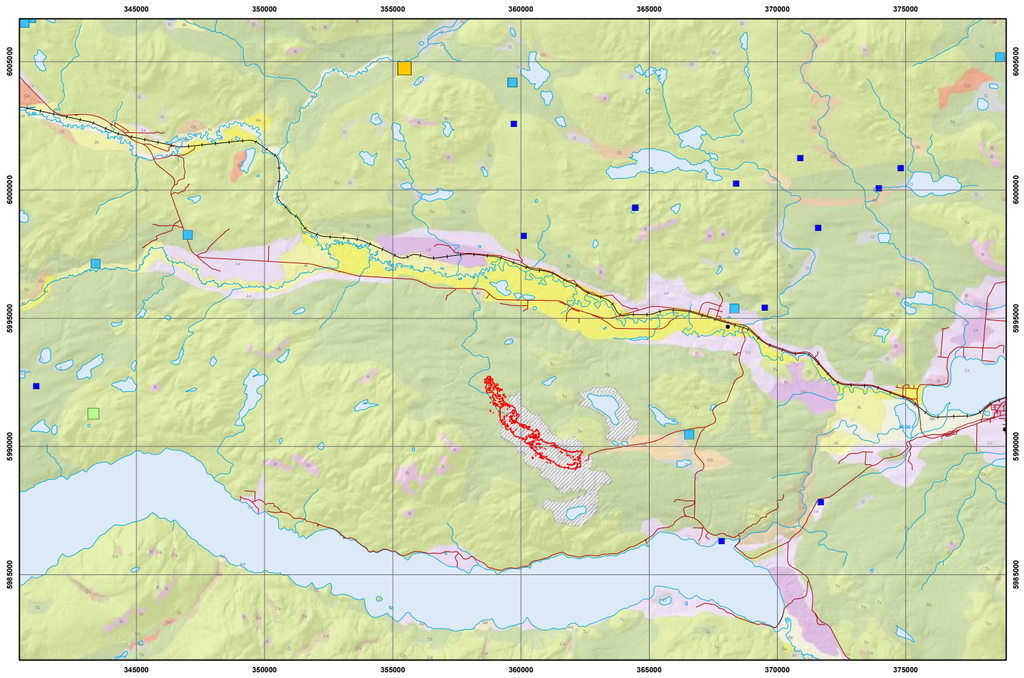
Mo

-2 micron fraction ICP

%	ppm
0 - 50	0.05 - 1.00
50 - 75	1.01 - 2.00
75 - 90	2.01 - 3.00
90 - 95	3.01 - 4.00
95 - 100	4.01 - 26.00

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



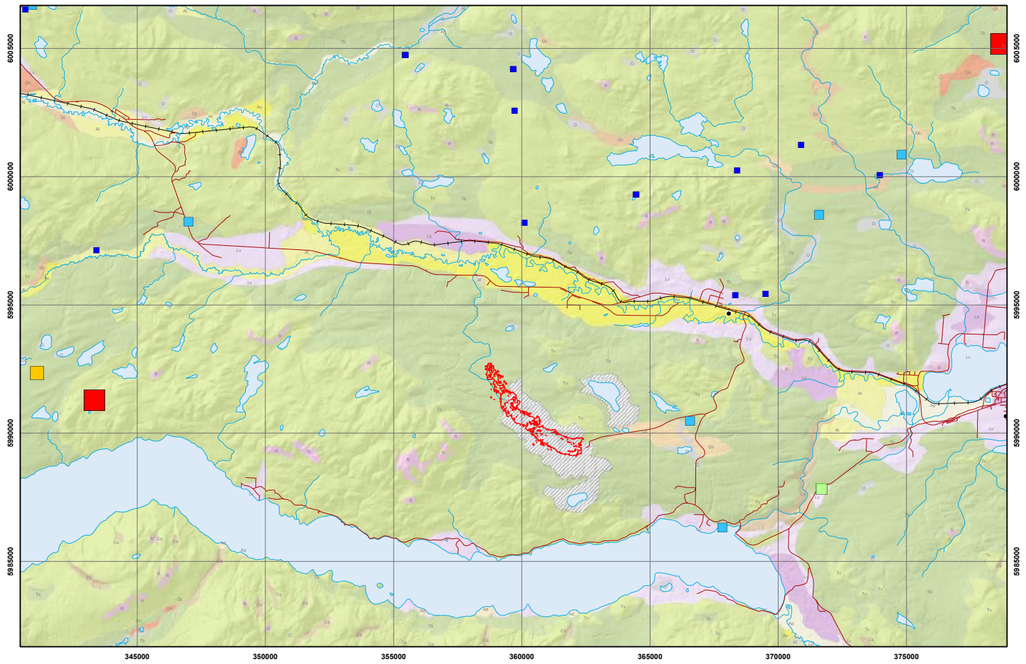
Cu

-63 micron fraction ICP

%	ppm
0 - 50	28.00 - 61.00
50 - 75	61.01 - 76.00
75 - 90	76.01 - 84.80
90 - 95	84.81 - 98.20
95 - 100	98.21 - 346.00

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



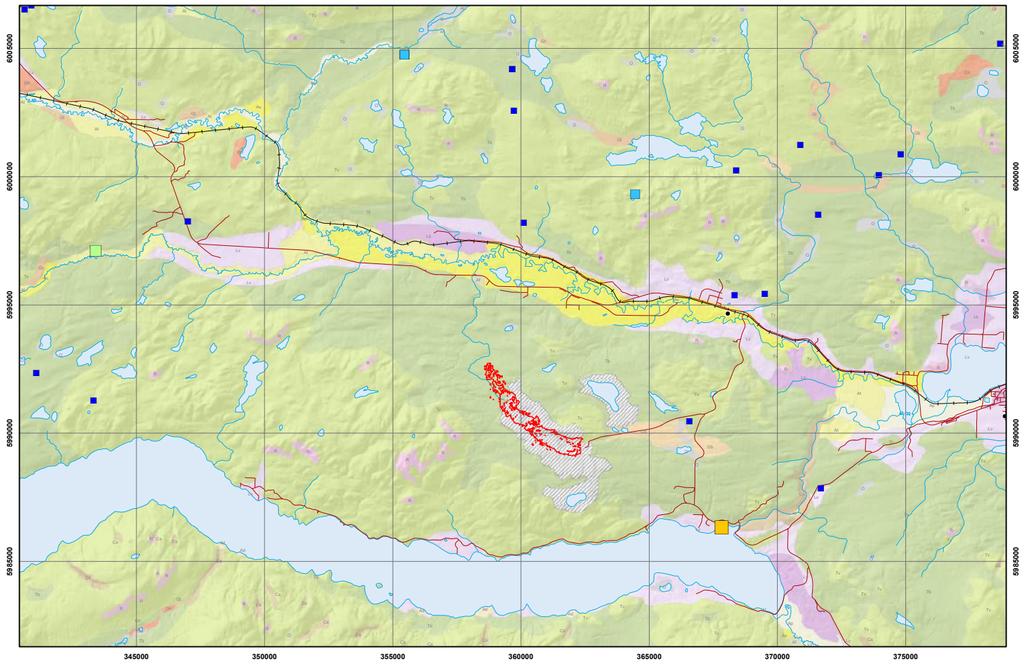
Au

-63 micron fraction ICP

%	ppb
0 - 50	0.00
50 - 75	0.000001 - 1.00000
75 - 90	1.000001 - 2.00000
90 - 95	2.000001 - 4.00000
95 - 100	4.000001 - 16.00000

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour



Ag

-63 micron fraction ICP

%	ppm
0 - 50	0.10
50 - 75	0.11 - 0.20
75 - 90	0.21 - 0.40
90 - 95	0.41 - 0.50
95 - 100	0.51 - 0.60

Endako orebody (Marek, 2011)

0.042% MoS_2 grade thickness contour

Data Sources:

original survey:

Plouffe, A. (1995): Geochemistry, Lithology, Mineralogy, and Visible Gold Grain Content of Till in the Manson River and Fort Fraser Map Areas, Central British Columbia (NTS 93 K and N); Geological Survey of Canada, Open File 3194, 123 p.

digital data source:

Plouffe, A. and Levson, V. (2007): A till chemistry database for the Nechako NATMAP Project in Nechako NATMAP Project: A digital suite of geoscience information for central British Columbia; Geological Survey of Canada, Open File 5623 and British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File 2007-10.

Data Presentation:

Till geochemistry data presented here was subset to the limits of NTS map sheets 093K02 and K03, which comprises 61 samples. Percentiles were calculated on the raw values without transformation or levelling.

SCALE 1:200,000

0 5 10 15 20

kilometres

Universal Transverse Mercator Projection
NAD 83 Datum, Zone 10