Physical Properties and Paleomagnetic Database for South-Central British Columbia

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KEYWORDS: geophysical surveys, physical properties, magnetic susceptibility, density, TGI-3 – Cordillera Project, Geoscience for Mountain Pine Beetle Response Project, south-central British Columbia

South-central British Columbia has become the focus of renewed mineral exploration activity. In response to the devastation facing the region's forests due to the mountain pine beetle infestation, governments are supporting economic diversification with a series of programs. This region is one of the areas identified for the current Targeted Geoscience Initiative III (TGI-3), and both federal and provincial geological surveys have created projects to promote mineral and energy exploration in the Mountain Pine Beetle Infested Zone (BIZ).

Mihalynuk (2007) demonstrated that the BIZ (defined using data from the BC Ministry of Forests and Range, 2005) has significant mineral inventory and mineral exploration deficits. The region has been largely avoided by mineral exploration geologists because of poor outcrop and apparent cover by Cenozoic volcanic rocks. The metallogenic geological provinces surrounding the BIZ almost certainly underlie the BIZ itself, and economic deposits should be available for exploitation. "Perhaps the greatest impediment to attracting significant mineral exploration investment in the BIZ is the geological uncertainty posed by the extent and thickness of cover successions" (Mihalynuk, 2007, p. 141). However traditional exploration strategies are not sufficient and must therefore be complemented with greater use of geochemical and geophysical surveys.

Gravity, magnetic, electromagnetic, radiometric and seismic surveys all provide methods both to image the cover and to recognize exploration targets underneath. To identify the lithological sources of geophysical anomalies, it is necessary to identify the physical property fingerprints of each rock type and each formation. What are the spatial variations of both mean values and their dispersions? Where are geophysically imageable contrasts found, and what techniques should be applied to optimize geophysical surveys and their interpretation? It is necessary to compile a physical properties database to answer these questions.

At present we have collected data from 2932 sites from the TGI-3 – Cordillera and Beetle Infested Zone (Fig 1). The work is still in progress, and we expect the database will increase in size significantly over the coming months.

The goals of the projects that procured these data varied considerably and, accordingly, each employed different methods and strategies. These are grouped into three types of data:

- **In-situ measurement**: Magnetic susceptibility was measured at the outcrop, either with an Exploranium KT9 or with the more sensitive GF Instruments SM-20 susceptibility meter. Typically five to ten measurements were recorded from an outcrop over a distance of several metres and the average was reported.
- **Laboratory measurement of hand samples**: Several mappers have submitted hand samples collected during geological mapping to the physical properties laboratory at the Geological Survey of Canada – Pacific in Sidney. Density was measured using the 'weight-in-air – weight-in-water' method (Muller, 1967). Magnetic susceptibility of the hand samples was measured using the SM-20. Samples that were large enough to subsample and had magnetic susceptibility greater than about 1 x 10^{-3} SI were cored with a 2.5 cm diamond-drill bit. The magnetic remanence was measured with an Agico Inc. JR5-A magnetometer, and accurate magnetic susceptibility was measured using a Sapphire SI2B susceptibility meter. The value of magnetic remanence over susceptibility provides a Koenigsberger ratio, which is the relative strength of remanent to induced magnetism.
- **Sampling for paleomagnetic study**: Lithological formations, which potentially hold strong and stable magnetic remanence, were drilled in the field and oriented using a magnetic or solar compass. This is particularly important for interpreting aeromagnetic maps of the Chilcotin basalts, as the Koenigsberger ratios for these rocks are high (i.e., magnetic remanence dominates over induced magnetism), and they can produce either strong positive anomalies if the magnetic polarity is normal or negative anomalies for reverse polarity flows.

The pooled results for magnetic susceptibility (2932 sites) and density (2387 sites) are shown in Figures 2 and 3. Publication of the database and its analysis are in preparation. For the purpose at hand, it is important to note the distribution of samples. Some regions have excellent coverage due to the availability of suitable outcrops and recent geological activity that led to the sampling. The sampling, however, is never uniform. Mappers do not collect samples on the basis of the area they represent, but rather attempt to sample the range of rock types. Exotic occurrences will be selected while the common hostrocks will only occasionally induce additional sampling. This is particularly the case for altered or mineralized rocks, which are the main

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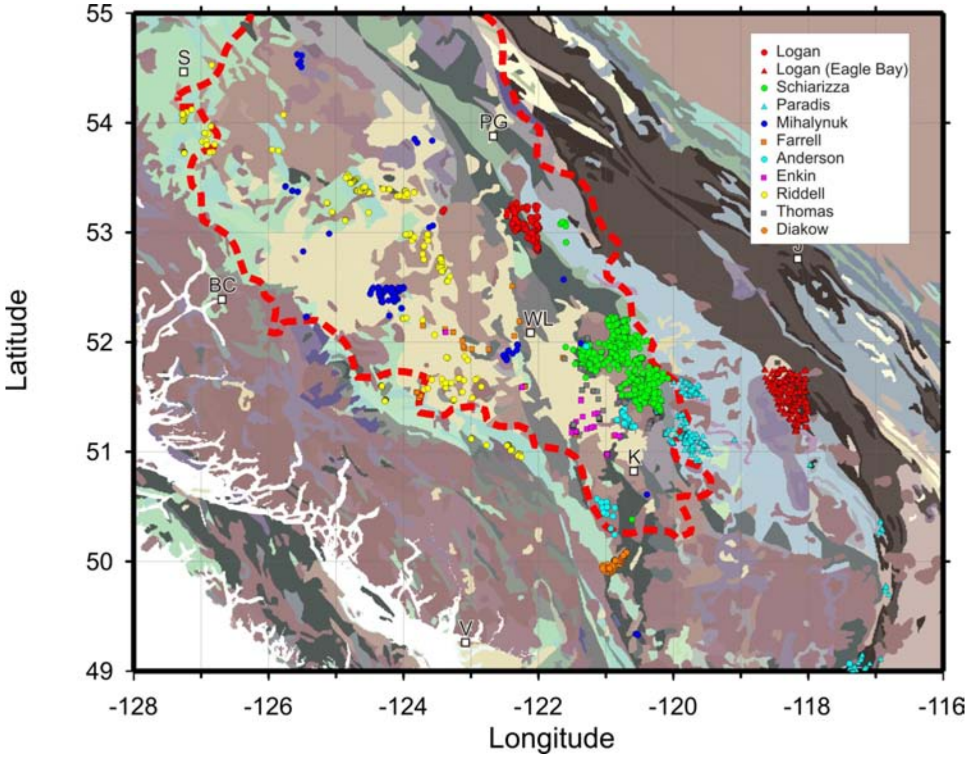

Figure 1. Locations of physical properties data from the Targeted Geoscience Initiative III – Cordillera and Beetle Infested Zone of south-central British Columbia, coded by collection. The base map is adapted from Journeay and Williams' (1995) version of Wheeler and McFeely's (1991) Tectonic Assemblage Map of the Canadian Cordillera. Abbreviations: V, Vancouver; K, Kamloops; WL, Williams Lake; BC, Bella Coola; PG, Prince George; S, Smithers. The Beetle-Infested Zone (BIZ) as defined by Mihalynuk (2007) is outlined with the red dashed line.

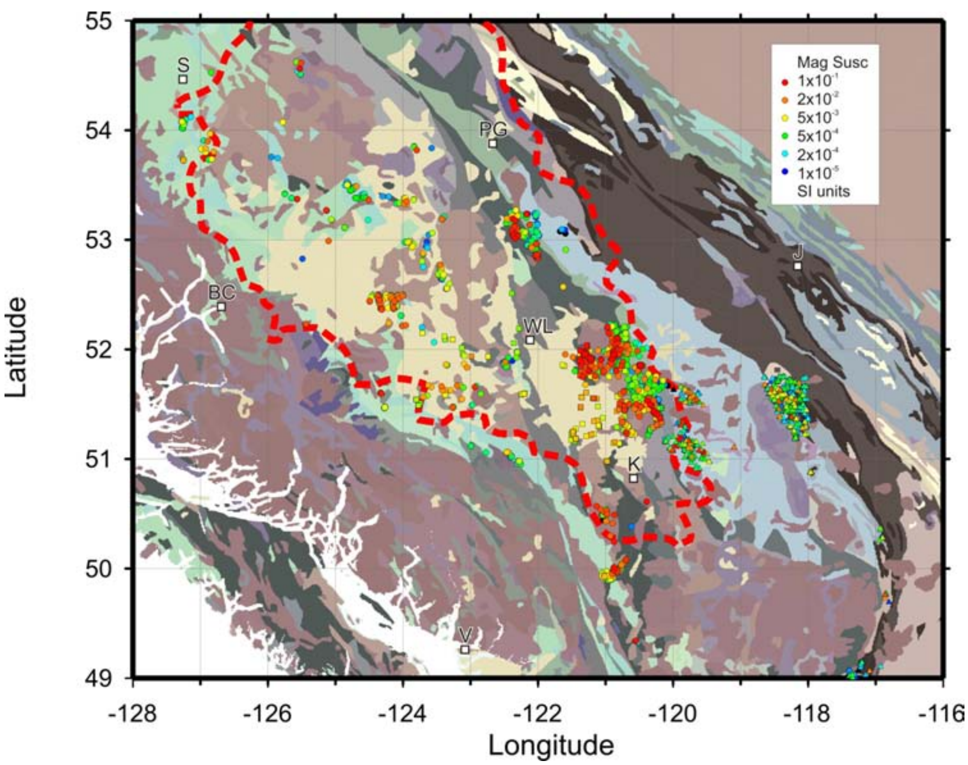

Figure 2. Magnetic susceptibility (SI/volume units) of 2932 sites, coded with a spectrum of colours from blue to red. See Figure 1 for legend of the base map.

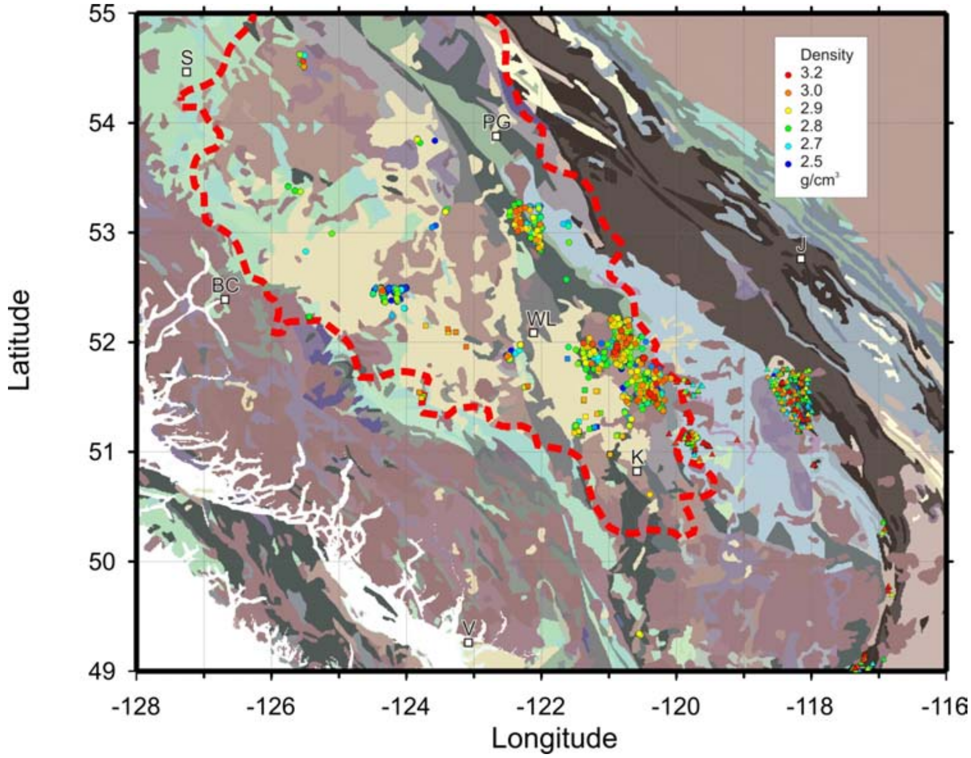

Figure 3. Density (g/cm^3) of 2387 sites, coded with a spectrum of colours from blue to red. See Figure 1 for legend of the base map.

target for geophysical surveys precisely because of their rarity. Furthermore, the three-dimensional nature of stratigraphy means that spatial averaging over two dimensions will necessarily lead to misleading interpretations. It is thus essential, when compiling spatial and lithological means, to give the correct weighting to each sample and, furthermore, to group them correctly together.

That being said, certain patterns are apparent even at the large scale illustrated in Figures 2 and 3. The Thuya and Takomkane plutons north of Kamloops stand out as rocks of high magnetic susceptibility and density that should be easily visible in geophysical surveys, even under glacial or possibly volcanic cover. There are significant variations in the physical properties of the Chilcotin basalts. In the northwest, densities are high while the susceptibility is low. The highest susceptibilities are found in young volcanic rocks north of Kamloops, which are apparently younger than the Chilcotin Group, sensu stricto.

The major paleomagnetic contrast we have noted within the Chilcotin Group is that southern Chilcotin sections, such as at Chasm and Deadman River, show multiple polarity reversals, allowing the possibility to map out regional isochron surfaces. In contrast, sections in the northwest, such as Bull Canyon and Dog Creek, show one polarity with little paleomagnetic directional dispersion, which suggests very rapid effusion.

There are certainly legacy datasets and sample collections that could be measured to add to the physical properties database under compilation. Preferably, all samples should be greater than 250 ml in volume. Sampling location, lithology and formation name must accompany the submission of samples. Readers are invited to notify the authors if they know of sources of samples or spreadsheets of previously measured samples for inclusion in this physical properties database.

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