Geological Survey of Canada

CURRENT RESEARCH
2002-C14

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2002

Natural Resources Canada   Ressources naturelles Canada

Canada

Catalogue No. M44-2002/C14E-IN
ISBN 0-662-31515-4

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MacHattie, T., 2002: Physical volcanology of komatiite in the Laughland and Walker Lake areas, Committee Bay belt, Nunavut; Geological Survey of Canada, Current Research 2002-C14, 7 p.

Abstract: Volcanic successions within the Committee Bay supracrustal belt are dominated by spinifex-textured komatiite, less abundant komatiitic basalt, basalt, and rare intermediate to felsic volcanic/volcaniclastic rocks. Well preserved komatiite occurs extensively in the Laughland Lake area, with the largest accumulation located on the northeastern margin of the central tonalite (northeast komatiite zone). In this area, komatiite units vary considerably in flow composition, morphology, and thickness. Spinifex-textured flows range between 30 cm to more than 50 m in thickness. Conformable lensoidal bodies of layered, harrisite-bearing olivine cumulates may represent remnants of large lava channels. The presence of thick (> 100 m) pillowed komatiitic flows indicates large-volume proximal submarine eruptions. The close lateral/stratigraphic association between distal and vent-proximal facies suggest a complex and dynamic volcanic environment. Younging directions from spinifex-textured komatiite in the northeast komatiite zone indicate that these are immediately overlain by interlayered chert, laminated mudstone, quartz arenite, and ultramafic schist.

Résumé : Les successions volcaniques à l'intérieur de la ceinture de roches supracrustales de Committee Bay renferment principalement des komatiites à texture de spinifex, de moindres quantités de basalte komatiitique et de basalte ainsi que de rares roches volcaniques et roches volcanoclastiques de composition intermédiaire à felsique. Les komatiites bien conservées occupent de grandes étendues dans la région cartographique de Laughland Lake, les plus importantes accumulations se situant à la périphérie nord-est de la tonalite centrale (zone à komatiite nord-est). Dans ce secteur, la composition des coulées komatiitiques ainsi que leur morphologie et leur épaisseur varient considérablement. L'épaisseur des coulées à texture de spinifex varie de 30 cm à plus de 50 m. Des corps lenticulaires concordants de cumulats à olivine harrisite stratifiés pourraient être les vestiges de grands chenaux de lave. La présence d'épaisses (> 100 m) coulées komatiitiques en coussins est indicatrice de faciès proximaux d'éruptions sous-marines volumineuses. L'étroite association latérale et stratigraphique de faciès distaux et de faciès proximaux (par rapport à la position des évents) laisse croire à un milieu volcanique complexe et dynamique. L'identification de sommets stratigraphiques dans les komatiites à texture de spinifex dans la zone à komatiite nord-est indique que celles-ci sont surmontées en contact direct par une succession de cherts, de mudstones laminés, d'arénites quartzeuses et de schistes ultramafiques interstratifiés.

INTRODUCTION

Komatiite eruptions are largely restricted to the Archean and constitute important components of many greenstone belts formed between 3.4 and 2.7 Ga. They not only provide some of the most important constraints on the thermal and chemical structure of the early Earth's mantle, but host some of the world's largest Ni-Cu-PGE sulphide deposits.

The supracrustal assemblages within the Committee Bay belt of Nunavut (Fig. 1) contain extensive tracts of ca. 2.7 Ga komatiite. Despite the fact that komatiitic rocks have been recognized in the belt since the early 1960s, their remote location has hampered their study. This contribution describes regional and local detailed mapping of some well preserved komatiite sequences within the Laughland Lake and Walker Lake areas conducted during the summers of 2000 and 2001 under the auspices of the Committee Bay Integrated Geoscience Initiative, a collaborative mapping initiative between the Canada–Nunavut Geoscience Office and Geological Survey of Canada.

The majority of better-preserved komatiite units are located in the Laughland Lake area (Fig. 1), and largely within an area located on the northeastern margin of the large, ovoid, central tonalite (northeast komatiite zone). As such, the most detailed mapping and sampling has been focused in that area. The more continuous, better-exposed, but poorly preserved, supracrustal sequences within the Walker Lake area provide important belt-scale stratigraphic information with respect to relationships between komatiite and other supracrustal rocks.

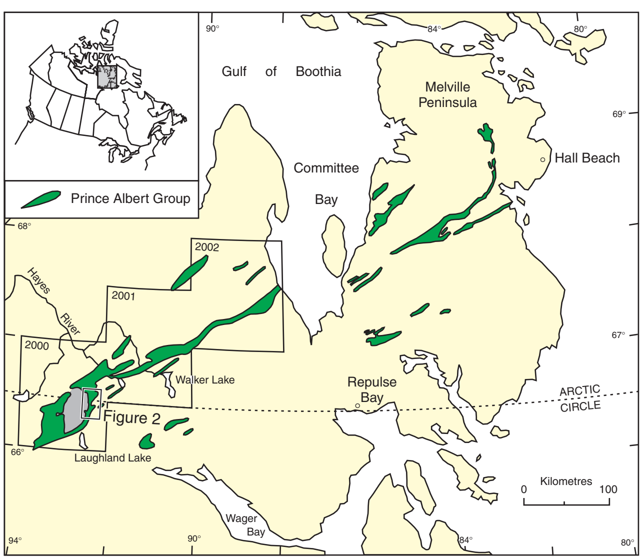

Figure 1. Location of the Archean Prince Albert Group within Nunavut. Indicated are the Laughland and Walker Lake areas mapped in 2000 and 2001 and the location of Figure 2. The central tonalite located within the Laughland Lake area is shaded grey. Modified after Schau (1982).

PREVIOUS WORK

Previous mapping expeditions in the Committee Bay belt southwest of Committee Bay have been conducted at a variety of scales. The original reconnaissance mapping by Heywood (1961) roughly delineated the distribution of supracrustal versus granitoid rocks. More detailed mapping within the Laughland Lake (NTS 56 K) and northern Walker Lake (NTS 56 J north) map sheets by Schau (1982) further subdivided the supracrustal assemblages and surrounding granitoid rocks. The most recent mapping prior to the initiation of this study was conducted in the early 1990s. These studies involved local detailed mapping and archival compilation to assess the mineral resources in the area (Jefferson and Schau, 1992; Chandler et al., 1993).

Accompanying the mineral-resource assessments were some geochemical analyses of komatiite samples from within the Laughland Lake area (Fitzhenry, 1993). The samples were analyzed for major and selected trace elements, including some platinum group elements, in an attempt to assess the potential for komatiite-associated Ni-Cu-PGE sulphide mineralization. Although no significant sulphide mineralization could be documented from the relatively thin spinifex-textured flows sampled during that study, an earlier assessment of the Ni-Cu potential of the Prince Albert Group komatiite units conducted by Eckstrand (1975) suggested that thick olivine cumulates observed within the Laughland Lake area were the most significant targets for sulphide mineralization.

The major-element geochemical data of Fitzhenry (1993) indicated that the komatiitic rocks are Al-undepleted, having near chondritic Al_2O_3/TiO_2, typical of most ca. 2.7 Ga komatiite units (Arndt, 1994). Most are true komatiites, having MgO contents greater than 18 wt % on an anhydrous basis, only a few would be considered komatiitic basalts with MgO between 12 and 18 wt %.

GENERAL GEOLOGY

The Committee Bay belt comprises Archean supracrustal rocks of the Prince Albert Group, flanked and intruded by metaluminous and peraluminous granitoids, respectively. The northeast-trending supracrustal belt extends for over 650 km across central mainland Nunavut, across Committee Bay to Melville Peninsula (Fig. 1). The belt is dominated by metasedimentary rocks, mainly psammite and semipelite, and lesser amounts of quartzite, pelite, and both silicate- and oxide-facies banded iron-formation (Sandeman et al., 2001a). Spinifex-textured komatiite dominates the volcanic successions in the belt, basalt is uncommon, and komatiitic basalt and felsic-intermediate volcanic rocks are rare.

Within the Laughland Lake area, the geometry of the supracrustal belt is strongly influenced by the presence of a large, ovoid, tonalitic body (the central tonalite), about which the belt is wrapped (*see* Fig. 1). Southwest of the tonalite, the belt is bound by cataclastic and protomylonitic rocks of the Amer shear zone (Tella and Heywood, 1978), and to the north of the tonalite by east-west-trending splays of the Walker Lake shear zone (*see* Johnstone et al., 2002). Within the Walker Lake area, the main supracrustal belt contains moderate to strong, northeast-trending fabrics and is composed of several narrow supracrustal screens (*see* Sanborn-Barrie et al., 2002). The supracrustal rocks generally preserve greenschist- to lower amphibolite-facies metamorphic assemblages in the Laughland Lake area (Sandeman et al., 2001b), with higher metamorphic grades recorded in the Walker Lake area, ranging from amphibolite in the southwest to upper amphibolite- to lower granulite-facies in the northeast (*see* Sanborn-Barrie et al., 2002).

The best preserved komatiite successions within the Laughland Lake area are located on the southwest and northeast margins of the central tonalite (Fig.1). The fortuitous location of these successions has permitted their exclusion from the east-west-trending, brittle and ductile deformation associated with the Amer and Walker Lake shear zones and the penetrative northeast-trending fabrics and higher metamorphic grade seen in the Walker Lake area. The following section is largely derived from the detailed mapping in this area, and mainly within the northeast komatiite zone (Fig. 2).

KOMATIITIC ROCKS

All Archean komatiites are hydrothermally altered and metamorphosed to some extent; because of this they rarely retain primary igneous minerals or textures. Herein, reference to the primary mineralogy will be made for simplicity. No primary olivine or pyroxene has been recognized in Prince Albert Group komatiite units despite textural preservation that is locally exceptional by Archean standards. The typical secondary mineral assemblage of Prince Albert Group komatiite is serpentine, chlorite, tremolite-actinolite, and magnetite. Anthophyllite, talc, and carbonate minerals are locally important, and their appearance generally signifies partial to complete textural destruction of the rocks. In some cases intense alteration and deformation have obliterated all primary features, making protolith identification difficult, for example distinguishing between komatiite and peridotite.

However, the overwhelming majority of ultramafic rocks in the belt are differentiated, peridotitic lava flows, that is, having upper portions composed of spinifex textures and lower portions composed of cumulus polyhedral olivine. This type of flow has been described in great detail by Arndt et al. (1977), wherein he includes the flow top and spinifex-textured portions of the flow as the A-zone, and the lower portion of polyhedral olivine cumulates as the B-zone. Generally, the olivine spinifex increases in grain size from top to bottom, and changes from randomly oriented to a bladed variety oriented approximately perpendicular to the flow direction. Often separating the A- and B-zones is a thin layer of bladed olivine cumulates oriented parallel to the flow direction. Some crystals may be hollow and are referred to as hopper olivine. This textural layering is clearly visible in the field, where spinifex-textured layers weather grey-green and cumulate layers a distinctive rusty brown (Fig. 3). Despite the locally intense deformation and metamorphism that may destroy this primary textural information, this distinctive colour, and mineralogical banding is commonly apparent. Therefore even intensely deformed rocks can still be recognized as komatiite.

Spinifex-textured flows vary widely in their character, particularly in their thicknesses. Flows are as thin as 30 cm but can reach thicknesses greater than 50 m. The majority have thicknesses between 2 and 10 m. The spinifex zones are divisible into upper portions comprising randomly oriented skeletal olivine plates (Fig. 4), and lower portions composed of books of olivine plates oriented approximately perpendicular to the inferred flow direction. In some of the thickest flows, composite books composed of several olivine plates are greater than 1 m in length. Flow tops are generally between 5 and 10 cm thick and are recognized by distinctive round to ovoid polyhedra and an anastamosing network of concave to convex fractures occurring mainly parallel to the layering in the flow (Fig. 5). The textural and grain-size variation within the spinifex-textured zones and recognition of flow-top horizons allow unequivocal determination of the stratigraphic younging direction. Superimposed on the broad-scale layering in flows are the distinctive B1-zones (Arndt et al., 1977). These zones typically mark the transition between cumulate and spinifex-textured zones. Two broad types of B1 zone have been recognized: 1) 2 to 20 cm thick layers composed of tabular olivine phenocrysts aligned parallel to layering in the flow and, imparting a distinctive igneous foliation; and 2) 10 to 30 cm thick zones of hollow and embayed hopper olivine (Arndt et al., 1977). The olivine phenocrysts in the latter type do not display any preferred orientation and seem to be most common in the thickest flows.

Although spinifex-textured lava flows predominate, pillowed as well as thick, coarse-grained, olivine-rich cumulate flow units are common. An extremely thick flow unit (> 100 m) located within the northeast komatiite zone contains a 10 to 15 m thick zone of large, lobate, ultramafic pillows, several of which are greater than 1 m in cross-section (Fig. 6). The lower portion of this flow is composed of variably sized, but generally coarse-grained olivine cumulates. Some of the thick, olivine-rich, cumulate bodies have lenticular forms and are conformable with surrounding thick komatiitic flows. A large cumulate body in the northeast komatiite zone (> 100 m thick) is flanked by a continuous sequence of thin 2 to 3 m thick spinifex-textured komatiite units overlain by a thick (> 50 m) spinifex-textured flow. In several of the olivine-rich flow units, distinctive layers and pods of very coarse-grained (> 30 cm) tabular olivine crystals with hollow cores known as harrisite. All these features suggest that these large cumulate bodies are indeed flows, and potentially represent large lava channels.

Interlayered with the komatiite flows throughout the belt are relatively small volumes of komatiitic basalt and basalt. These form thin flows in comparison to the komatiite and are generally less than 15 to 20 m thick. Komatiitic basalt may exhibit differentiation into lower zones comprised of pyroxene (now actinolite) and plagioclase (Fig. 7), and upper spinifex-textured zones of needle-like pyroxene. The latter are oriented almost entirely perpendicular to the flow

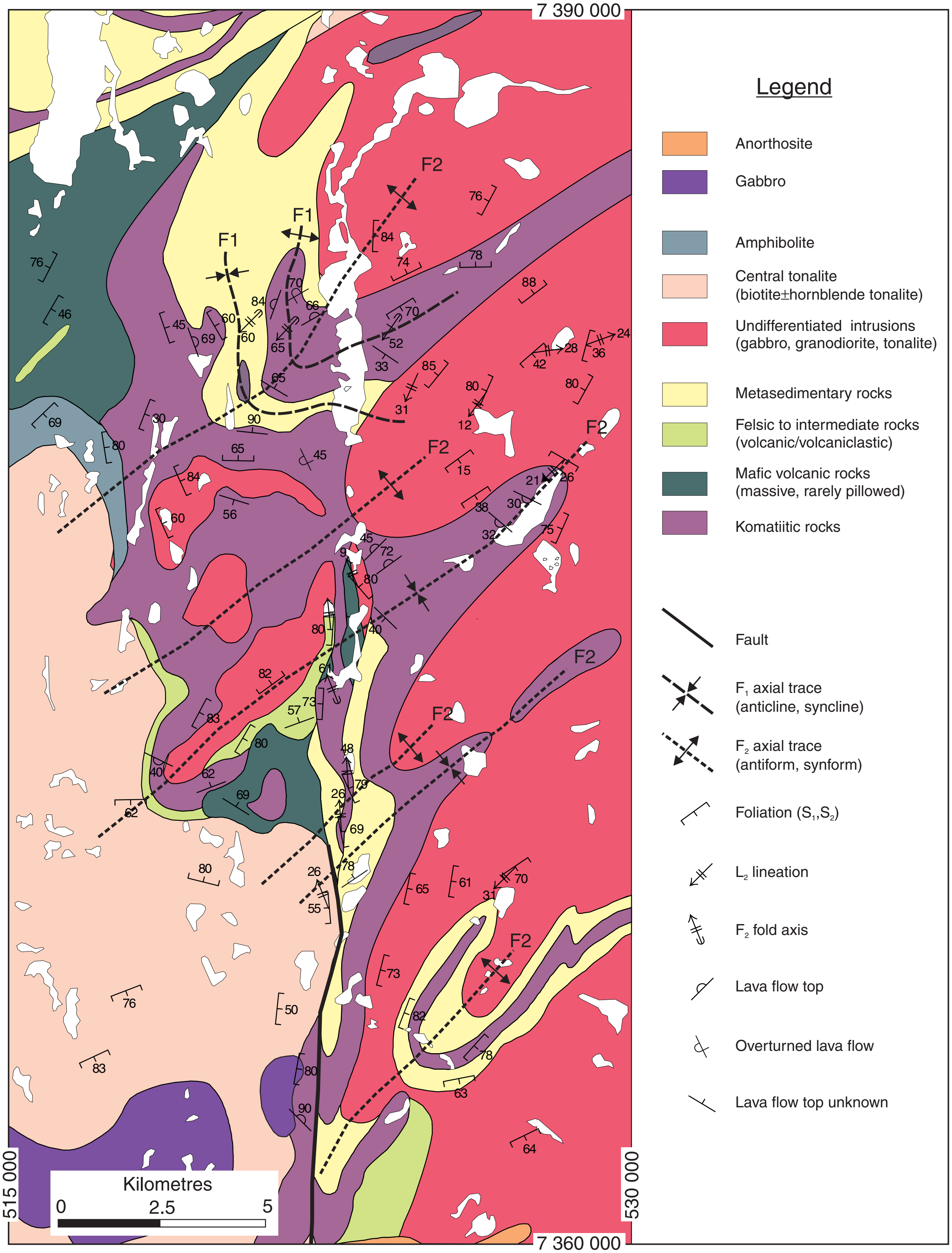

Figure 2. Geological map of the northeast komatiite zone in the Laughland Lake map area.

Figure 3. *Alternating cumulate (brown) and spinifex-textured (green) zones of thin komatiite flows. Photo taken within the northeast komatiite zone. Hammer for scale.*

Figure 4. *Randomly oriented spinifex-texture from the upper portion of a komatiite flow. Photo taken within the northeast komatiite zone. Penny for scale.*

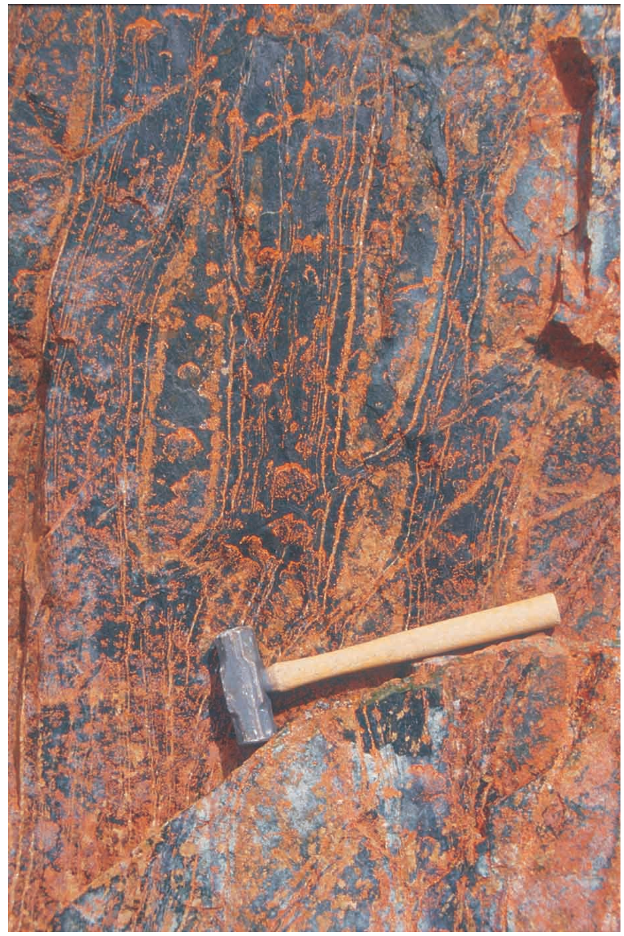

Figure 6. *Large lobate pillows from a thick (> 100m) komatiite flow. Photo taken from the northeast komatiite zone. Hammer is 50 cm long.*

Figure 5. *Chilled and fractured ovoid polyhedra of a komatiite flow top. Photo taken within the northeast komatiite zone. Penny for scale.*

Figure 7. *Plagioclase-phyric, actinolite-rich komatiitic basalt. Photo taken within the northeast komatiite zone. Pen magnet for scale.*

direction (Fig. 8). Some komatiitic basalt flow units have ovoid polyhedra and fractured flow tops similar to those observed in the komatiite. Distinguishing between komatiitic basalt and basalt is difficult without the aid of geochemical data. In the field, komatiitic basalt is distinguished from basalt by the presence of distinctive flow tops, spinifex-textures, and lower modal abundances of plagioclase. Using this as a guide, basalt is therefore more common than komatiitic basalt.

STRUCTURAL AND STRATIGRAPHIC RELATIONSHIPS

Mapping in the northeast komatiite zone (Fig. 2) suggests that the present-day outcrop pattern of this zone is largely controlled by the interference of tight, upright, northwest-southeast-trending F_1 folds and larger wavelength, northeast-southwest-trending, doubly plunging F_2 folds (Fig. 2). The bounding granitoid rocks to the west and east occupy large antiformal structures along the contacts, forming kilometre-scale mushroom structures with the supracrustal rocks (Fig. 2). Intrusive relationships have been observed at two localities; however, the majority of contacts are not exposed and are now interpreted to be largely structural. Several granitoid bodies are exposed in the central portion of the zone. These bodies may be intrusive to the komatiite or they represent structural culminations of the bounding granitoids that plunge under the zone from its margins. The latest episode of deformation involves north-south-oriented faulting and development of high-strain zones. This deformation has rotated structures into a north-south orientation and is developed mainly in the southern part of the area shown in Figure 2, and along the eastern granitoid-supracrustal rock contact (Fig. 2). Within the northern portion of the zone, younging directions from spinifex-textured komatiite delineate an F_1 anticline-syncline pair. Rocks coring the syncline include a distinctive package of chert (Fig. 9), finely laminated mudstone (Fig. 10), sulphide-rich quartz arenite, and metre-wide layers of ultramafic schist.

Regional mapping in the Walker Lake area suggests that komatiitic rocks form two distinctive units: 1) thick komatiite horizons devoid of other interlayered lithologies except for rare interflow metasedimentary rocks; and 2) thin komatiite flows or composite flow units that are interleaved with other supracrustal rocks. The thickest komatiite horizons occupy some of the lowest structural, and potentially stratigraphic, levels observed in a particular supracrustal belt, whereas the thin units occupy higher stratigraphic levels (*see* Skulski et al., 2002).

Figure 9. *Chert from the northeast komatiite zone. Pen magnet for scale.*

Figure 8. *Oriented, pyroxene spinifex-texture (now actinolite) in komatiitic basalt. Photo taken within the northeast komatiite zone. Pen magnet for scale.*

Figure 10. *Finely laminated mudstone from the northeast komatiite zone. Pen magnet for scale.*

MINERAL POTENTIAL

Although no significant sulphide accumulations were documented during this or previous investigations, the potential for Ni-Cu-PGE mineralization associated with komatiite units of the Prince Albert Group should not be discounted. The recognition of thick olivine-rich cumulates, interpreted as large-volume lava flows and channels should be considered significant targets for potential sulphide mineralization. Continued, detailed, volcanic-facies analysis in 2002 will help to better constrain the economic potential of the belt with respect to the komatiites.

SUMMARY

Regional and detailed mapping of komatiite sequences within the Laughland Lake (NTS 56 K) and Walker Lake (northern NTS 56 J) areas indicate that komatiite units dominate the Archean volcanic successions. The overall lower metamorphic grade and structural shielding of komatiite sequences in the Laughland Lake area has permitted the common preservation of primary volcanological features.

In the northeast komatiite zone, field observations suggest a dynamic and complex volcanic environment. The recognition of thick spinifex-textured, cumulate-dominated, and pillowed flows suggest vent-proximal facies, probably all deposited in subaqueous environments. These thick deposits were apparently erupted synchronously with more abundant, thin, spinifex-textured flows that are interpreted as distal deposits. Variations in the volumes and rates of eruption may be responsible for the superposition of these two distinct flow units.

Younging directions from spinifex-textured komatiite in this zone indicate that the dominant structural patterns are the result of fold interferences between northwest-southeast-trending F_1 folds and larger scale, northeast-southwest-trending F_2 folds. In this zone a thick lower komatiitic horizon is overlain by interlayered metasediment. These observations imply that if the thick komatiitic units in the Laughland Lake and Walker Lake areas were deposited synchronously, then they would constitute an extensive horizon erupted over several hundred kilometres and yielding a magmatic association of comparable scale to some continental flood basalt provinces.

ACKNOWLEDGMENTS

This work could not have been completed without the assistance of all persons directly and indirectly involved in the 2000 and 2001 mapping initiatives. Financial and logistical support from the Canada–Nunavut Geoscience Office (Dr. Hamish Sandeman and Dr. David Scott) and the Geological Survey of Canada (Dr. Tom Skulski) is greatly acknowledged. Dennis Plaza's cheerful assistance during mapping and sampling in the Laughland Lake area was invaluable.

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Geological Survey of Canada Project 000014