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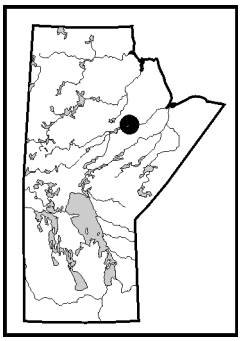
GS-15 Split Lake Block revisited: new geological constraints from the Birthday to Gull rapids corridor of the lower Nelson River (NTS 54D5 and 6)



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Summary

The northwestern margin of the Superior Province consists of several crustal domains of unclear tectonic affinity. One of the largest of these, the Split Lake Block, is the focus of a new multiyear mapping initiative. Initial results from the Birthday to Gull rapids section of the lower Nelson River indicate that this crustal block comprises primarily felsic plutonic rocks and mafic granulite. The oldest units in the area are mafic granulite, pelite and iron formation. These units may represent a single supracrustal assemblage, although several suites of variably deformed felsic plutonic rocks inject and obscure their geological relationships. The oldest of the plutonic suites predates widespread granulite-facies metamorphism. Younger hornblende granitoid rocks may represent syntectonic magmatism related to upper-amphibolite–facies overprinting. Gabbro dikes of Paleoproterozoic age are unmetamorphosed and transect all units in the area. The widespread and voluminous nature of these dikes indicates that significant Proterozoic crustal growth occurred in this part of the northern Superior Province.

Introduction

This report presents the preliminary results from a two-week field study of the Birthday to Gull rapids section of the lower Nelson River and marks the beginning of a new multiyear project to examine the age and tectonic setting of crustal domains along the northwest margin of the Superior Province. The motives for study in this area are both numerous and diverse:

1) The region contains evidence for ancient crust (Böhm et al., 2000). Identification and careful description of ancient crust is paramount for global studies on Earth's primary development.
2) The study area is along strike from the economically important Thompson Nickel Belt (TNB). Determining the position of the northern Superior Province paleomargin and the TNB will allow for more effective exploration activities.
3) A better understanding of the local geology is critical for planning of new hydroelectric projects in the region.

A geological transect of the lower Nelson River by Corkery (1985) included detailed lithological descriptions of units and reports on the metamorphic and structural geology of the area. Reconnaissance-style geochronological results have been reported for a number of samples from the Split Lake Block (Heaman and Corkery, 1996; Böhm et al., 1999). The present study will build on these initial findings, with the objective of developing a robust understanding of the tectonic history of the region.

Regional geology

The Archean Split Lake Block (SLB; Fig. GS-15-1) was recognized as a distinct crustal domain along the northern Superior Province margin, based partly on the presence of amphibolite- and greenschist-facies overprinting of granulite-facies rocks and bounding shear zones (Corkery, 1985). Neodymium isotopes indicate that the majority of the SLB is distinctly younger than ancient crust exposed to the northeast at Assean Lake, but is similar in composition to rocks of the Pikwitonei Granulite Domain (Böhm et al., 1999, 2000).

The SLB is separated from the Assean Lake area by a shear zone, initially identified by Haugh (1969) and described in detail by Kuiper et al. (GS-14, this volume). To the south of the Split Lake Block, rocks of the Archean Pikwitonei Granulite Domain have not undergone amphibolite retrogression (Corkery, 1985). The first suggestion of a paired history for the SLB and Pikwitonei Granulite Domain is coeval ca. 2.7 Ga high-grade metamorphism (Böhm et al., 1999). The eastern boundary of the Split Lake Block is exposed in the Gull Rapids area and is described in detail by Böhm et al. (GS-13, this volume). The northern boundary of the SLB, where it is in contact with the Paleoproterozoic Trans-Hudson Orogen ± ancient crust, is buried by a thick blanket of glacial clay and till. Bedrock

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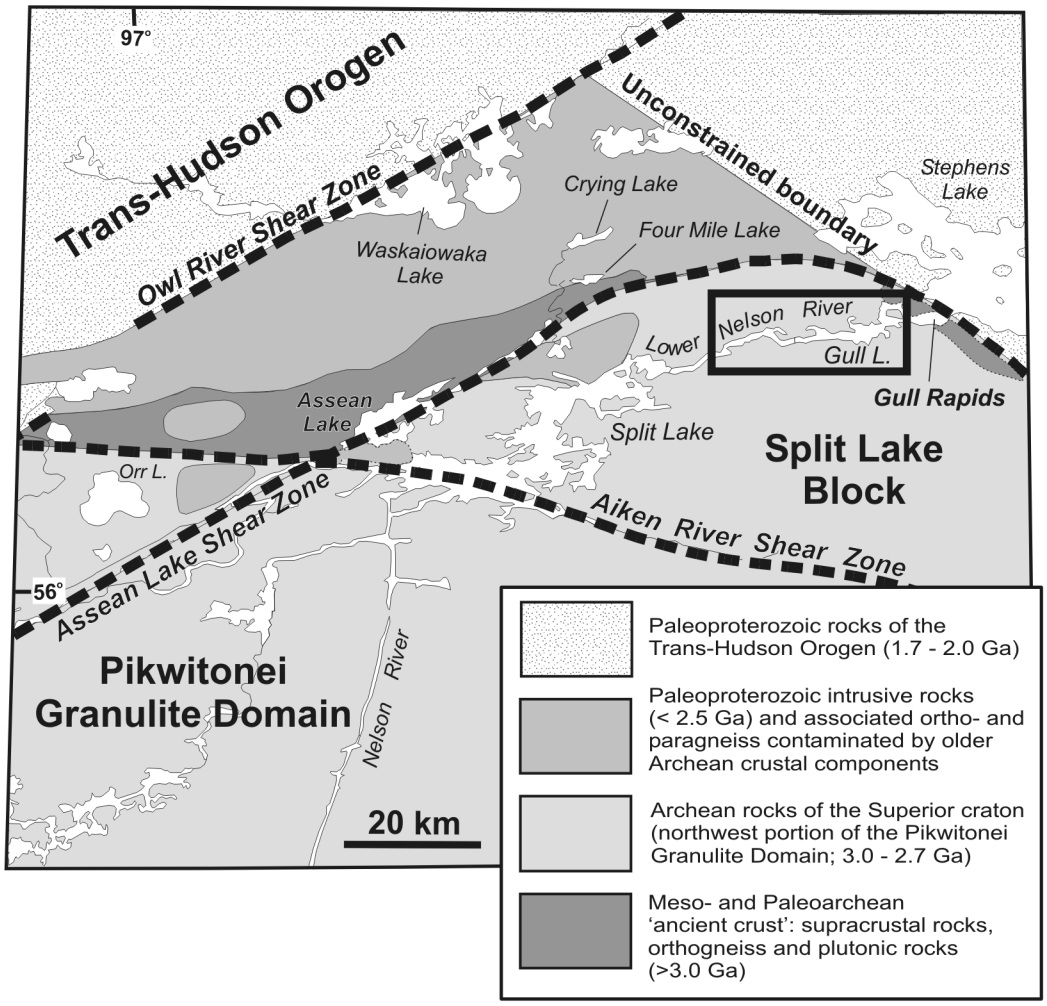

Figure GS-15-1: General geology of the northern Superior Province. Box encompasses the study area.

exposure in the latter area is primarily limited to sporadic occurrences along the shoreline of the lower Nelson River, with the largest exposures found along the northwest shore of Gull Lake and in the west end of the study area.

General geology

The lower Nelson River corridor between Birthday and Gull rapids is dominated by variably deformed felsic plutonic rocks and mafic granulite. Mafic granulite, pelite, and iron formation are the oldest units in the area. Although the relationship of these units to each other is unclear, they may represent an early supracrustal package. These units are cut by several suites of variably deformed Archean felsic plutonic rocks. The granulite-facies metamorphism that is prevalent throughout the Split Lake Block is reflected in the orthopyroxene-bearing nature of the oldest felsic plutonic suite. Hornblende granitoid rocks may represent a younger suite of syntectonic magmatism related to upper-amphibolite–facies overprinting. Unmetamorphosed gabbro dikes transect all units and constitute up to 10% of the area. A late, east-trending shear zone that is exposed at Birthday Rapids cuts the gabbro dikes and represents the youngest phase of deformation in the area.

Mafic granulite

Mafic granulite is black, fine to medium grained, and locally displays compositional layering. The rock is composed primarily of plagioclase, pyroxene and amphibole. Garnet-orthopyroxene melt segregations locally constitute several percent of this unit. Mafic granulite is cut by dikes and veins of granite, and occurs as xenoliths in larger bodies of both granite and enderbite-charnockite.

Pelite

Rusty brown–weathering pelite was found at several exposures on the lower Nelson River. This unit comprises quartz, feldspar, biotite, garnet and sillimanite, with trace sulphides±graphite. Pelite is intruded by Archean granite and is therefore interpreted to be Archean.

Iron formation

Grey-weathering magnetite-garnet±sulphide-facies iron formation was identified at one location along the northwest side of Gull Lake. This unit has excellent compositional layering (Fig. GS-15-2a) and is several metres thick. The iron formation is injected by granite that contains numerous amphibolite xenoliths.

Enderbite-charnockite

Most rocks (>70%) in the study corridor are highly metamorphosed and deformed felsic plutonic rocks. These granitoid rocks can be subdivided into a suite of orthopyroxene-bearing granulite-grade plutons and a suite of younger, hornblende granitoid rocks. The older suite is coarse grained, contains up to 20% orthopyroxene and has abundant xenoliths of mafic granulite. The suite is locally migmatitic, with segregated sills and dikes of granite that cut the earliest fabric commonly present (Fig. GS-15-2b, c). Pre–2.8 Ga protolith ages for enderbite-tonalite in the Split Lake Block were reported by Böhm et al. (1999).

Granite

A second suite of hornblende-bearing granitoid rocks occurs throughout the study area and is locally interlayered with the orthopyroxene-bearing granitoid rocks. Although the hornblende granitoid is compositionally identical to melt segregation in the orthopyroxene granitoid, it appears to grade locally from hornblende to orthopyroxene bearing. The

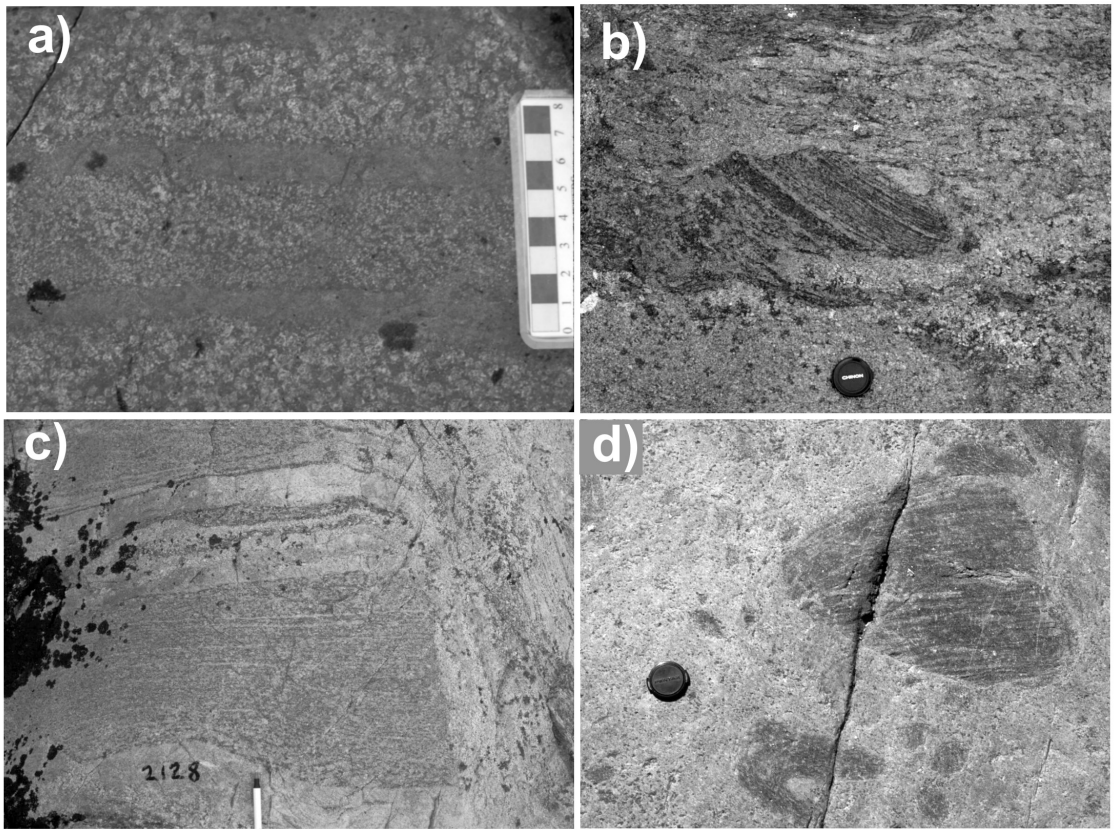

Figure GS-15-2: Rocks of the Split Lake Block: a) compositionally layered iron formation (silicate facies?), forming an approximately 2 by 10 m exposure on the northwest shore of Gull Lake; b) gneissic enderbite with in situ granitic melt, west end of Gull Lake; c) gneissic enderbite-charnockite with injected leucogranite sheets, west end of Gull Lake; d) foliated xenoliths of mafic granulite in massive granite, Birthday Rapids area.

presence of orthopyroxene in the groundmass of this unit, associated with zones where xenoliths of mafic granulite are abundant (Fig. GS-15-2a), suggests that the younger hornblende granitoid rocks have locally scavenged orthopyroxene from partial digestion of xenoliths of mafic granulite. In other areas, most xenoliths of mafic granulite appear to have been retrogressed to amphibolite facies. Within the study area, Böhm et al. (1999) reported finding ca. 2.7 Ga ages for both granite and leucosome in mafic granulite.

Gabbro dikes

A voluminous suite of east-trending mafic dikes of Paleoproterozoic age (Heaman and Corkery, 1996) is found throughout the study area. These dikes are aphanitic to coarse grained and locally have pegmatitic segregations of intermediate composition. The dikes range from less than 1 m to more than 10 m in width, and many are composite bodies of two or more intrusive episodes. The sheer volume of this mafic magmatism indicates that Proterozoic crustal growth in the northern Superior Province was significant. Although the dikes are unmetamorphosed and generally appear to be undeformed, sheared dikes were found within an east-trending shear zone at Birthday Rapids. The common east-trending orientation of all the dikes in the area suggests that either they belong to a single suite or the crustal stress regime remained constant over time.

Economic considerations

This study is one component of a major multi-organizational program whose goals include a better demarcation and understanding of the Superior paleomargin (*see* GS-12, this volume). The Thompson Nickel Belt, Fox River belt and Assean Lake crustal complex — all adjacent to the Split Lake Block — host a multitude of mineral-deposit prospects, including nickel, platinum group elements and shear-hosted gold. Possible concentration of platinum group elements related to the voluminous Paleoproterozoic mafic dikes requires consideration.

Discussion and future work

The initial findings reported here represent just the beginning of considerable information that is available from the Split Lake Block. Petrographic analysis of representative thin sections from all units will improve lithological and metamorphic descriptions of the area. In addition, a solid temporal framework for the geology in the region is needed to further understand the tectonic setting of the Split Lake Block, and its bounding crustal domains. With this in mind, initial work in the first year of this multiyear project will focus on 1) studying provenance sources and determining the timing of sedimentation for supracrustal packages within, and bounding, the Split Lake Block; 2) constraining the composition and crystallization ages of felsic plutonism within the Split Lake Block; and 3) examining the extent, differences and timing of metamorphism along the geological transect.

Acknowledgments

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