Introduction

The Burntwood Lake intrusive complex was identified by the Manitoba Geological Survey (MGS) in the early 1970s during regional mapping, and later examined in detail by McRitchie (1987) as a potential host for zirconium mineralization. In 2011, the MGS evaluated its potential for rare earth element (REE) mineralization (Martins et al., 2011a). The Burntwood Lake area has seen relatively little exploration but there are records of a radiometric airborne geophysical survey conducted for uranium exploration in 1954 (Assessment File 91616, Manitoba Growth, Enterprise and Trade, Winnipeg), and a magnetic survey and till sampling for diamond exploration in 1993 (Assessment File 94323, Manitoba Growth, Enterprise and Trade, Winnipeg).

Geological setting

The Burntwood Lake intrusive complex is located in the central Kisseynew domain (KD), a metasedimentary basin in the internal zone of the Trans-Hudson orogen. The tectonic setting of the Kisseynew basin remains a matter of debate: it has been previously interpreted as a back-arc, intra-arc or fore-arc basin (Ansdell et al., 1995; Zwanzig, 1997; Zwanzig and Bailes, 2010). The Burntwood Lake area is largely underlain by turbiditic metagreywacke of the Burntwood group (Zwanzig, 1990), which was deposited between ca. 1860 and 1840 Ma (Machado et al., 1999). Early folding and thrusting (D₁) occurred during the later stages of sedimentation (1842–1835 Ma; Machado et al., 1999; Zwanzig, 1999), prior to metamorphism in the KD, and was accompanied by intrusion of ca. 1840–1820 Ma calcalkalic plutons (Machado et al., 1999). The youngest calcalkalic intrusions in the KD constitute the enderbitic Touchbourne suite, which intruded between ca. 1830 and 1820 Ma (Gordon et al., 1990; Machado et al., 1999), prior to the main tectonometamorphic event. Two generations of isoclinal, nappe-style folds (D₂–D₃; 1820–1800 Ma; Zwanzig, 1999) formed coeval with peraluminous granitoid intrusions (1820–1810 Ma; Kraus and Menard, 1997; White, 2005). The majority of the KD experienced low-pressure granulite-facies metamorphic conditions of 750° ±50°C and 5.5 ±1.0 kbar (Gordon, 1989) following the D₂ deformation phase (White, 2005). Peak metamorphic conditions continued through D₃ folding. Folding and faulting associated with the regional D₄ and D₅ deformations continued until after ca. 1790 Ma (Zwanzig, 1999).

Geology of Burntwood Lake intrusive complex

The Burntwood Lake intrusive complex is a compositionally and texturally heterogeneous syenite body that intruded Burntwood group metasedimentary rocks and peraluminous granitic rocks. This syenite body was examined by MGS in 2011 and the following description is simplified from Martins et al. (2011a). The intrusion includes two main phases: pink-beige syenite and red syenite (Figure 1). Both phases are locally cut by quartz bearing pegmatite bodies (not shown on Figure 1). Minor phases include fluorite-bearing quartz syenite as well as a band of massive apatite (up to 15 cm thick). The syenite intrusion shows wide variations in texture and modal compositions at outcrop scale, suggesting the possibility of several other intrusive phases, but contact relationships were obscured in 2011 by mature vegetation and extensive lichen and moss cover. Heterogeneous single outcrops locally vary from fine- to coarse-grained and contain from 5% to 80% mafic minerals.
The pink-beige and red syenite phases vary from fine- to coarse-grained, massive to weakly foliated, and are metaluminous (Figure 2). Common mineralogy is feldspar, clinopyroxene, apatite and titanite. Minor components are biotite and quartz (up to 3%), and trace amounts of sulphide. The fluorite-bearing quartz syenite is fine grained, massive and appears relatively homogeneous. It contains pinkish-beige feldspar, quartz, clinopyroxene and fluorite and is interpreted to represent a more highly fractionated phase of the intrusive complex. Fluorite-bearing feldspathic veins are locally present within the pink-beige syenite phase. Fine-grained massive apatite was observed in a narrow (<15 cm) discontinuous band. It is unclear if this band represents metasomatic veins or cumulate layers.

The different phases of syenite include zones that contain relatively equant clots, irregular patches, discontinuous layers and veins of mafic minerals (mainly clinopyroxene, biotite, titanite and hornblende). The contacts of these features vary from diffuse to sharp. Apatite is typically enriched in these zones, composing up to 10% of the rock, and trace amounts of carbonate are locally

**Figure 1:** Detailed geological map of the Burntwood Lake intrusive complex (modified from Martins et al., 2011a).

**Figure 2:** Aluminum Saturation Index diagram showing the largely metaluminous nature of the syenite phases of the Burntwood Lake intrusive complex. Abbreviations: Fl, fluorite.
Exploration potential

Martins et al. (2011a) described the Burntwood Lake intrusive complex as having many similarities to the Eden Lake (EL) complex, which contains occurrences of REE-Th-U mineralization and several carbonatite bodies (e.g. Mumin, 2010), and has been explored for REE (e.g. Assessment File 74371, Manitoba Growth, Enterprise and Trade, Winnipeg). These similarities include: textural and modal heterogeneity; dominantly metaluminous geochemistry (Figure 2); trace element concentrations (Figure 3a–d); enrichment in Ba, Sr and REE; and abundant clinopyroxene, titanite, apatite, and locally carbonate and fluorite. As with the EL complex, at least some of the heterogeneity of the Burntwood Lake intrusive complex (e.g. massive apatite band, titanite enriched zones, mafic-rich layers, extreme variations of concentrations of mafic minerals) appears to be the result of metasomatism. This metasomatism could have resulted from carbonatitic magmatism of a carbonatite body that is not presently exposed or alternatively a volatile-rich syenite magma that lead to autometasomatism.

Martins et al. (2011a) described local Th and REE enrichment in veins and massive apatite that are encouraging from the perspective of exploration potential.

Figure 3: Normalized trace element compositions of rocks from the Burntwood Lake intrusive complex (Martins et al., 2011b): a) Chondrite-normalized REE diagram and b) primitive mantle normalized multi-element diagram of non-metasomatized rocks; c) Chondrite-normalized REE diagram and d) primitive mantle-normalized multi-element diagram for heterogeneous rocks, which likely represent a combination of magmatic and metasomatic rocks. The grey field outlines representative analyses of metasomatic rocks from the Eden Lake complex; analyses of carbonatite and a massive apatite vein from Eden Lake are also given for comparison; Data for the Eden Lake rocks are from Couësplan (2005) and Chakhmouradian et al. (2008). Trace element normalization factors are from McDonough and Sun (1995).

1 Alkaline-silicate and carbonatitic magmatism is commonly accompanied by characteristic sodic or potassic metasomatism, coupled with siliciloss, in the country rock; these processes are commonly known as fenitization.
Rare Metals in Manitoba: Burntwood Lake intrusive complex

There is a well known spatial association (and inferred temporal relationship) between alkaline igneous rocks and carbonatitic magmatism (Woolley, 2003). However, a similar association of silica-saturated syenite and quartz syenite is also recognized and suggests potential may exist for carbonatite at Burntwood Lake. Examples of this type of association include the EL complex (Chakhmouradian et al., 2008), the Maoniuping REE deposit in China (Xu et al., 2003), and the Tamil Nadu carbonatites in India (Schleicher et al., 1998).

Martins et al. (2011a) argue on the basis of geochemical and mineralogical similarities that the Burntwood Lake intrusive complex and EL complex could be derived from a geochemically similar (mantle?) source. The location of both complexes within the internal zone of the Trans-Hudson orogen in Manitoba, and specifically within or along the margins of the Kisseynew basin, implies regional potential for other intrusive complexes of this type.

References


