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Minto Large Igneous Province: A 2.00 Ga Mafic Magmatic Event in the Eastern Superior Craton Based on U-Pb Baddeleyite Geochronology and Paleomagnetism

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A precise U-Pb baddeleyite age of 1999 ± 2 Ma has been obtained for the NNW trending Lac Shpogan dyke swarm of the James Bay area of the eastern Superior craton. Previously the age of the swarm was only constrained by its crosscutting relationship with the older but poorly dated (>2216 Ma) Sakami Formation quartz arenites.

The new age confirms a link with the 1998 ± 2 Ma W-WNW trending dykes of the Minto swarm (Buchan et al. 1998) located ~500 km to the north, a link which had been tentatively proposed on basis of similarities in geochemistry and paleomagnetism (Buchan et al. 2007). Both dyke sets likely belong to a single giant dyke swarm which may represent part of the plumbing system for a ca. 2.00 Ga large igneous province (LIP) with a wide distribution in the eastern Superior craton. Combining the paleomagnetic results from the two dyke sets yields an improved estimate of the paleopole for the eastern Superior craton at that time.

The two most prominent Lac Shpogan dykes can each be traced for 150-300 km and appear to converge slightly to the north toward a focus in eastern Hudson Bay. Most of Minto dykes, including the dated Minto dyke, generally fit this convergent pattern, although each dyke is only exposed over a short distance. Maurice et al. (2009) include a wide swath of WNW trending dykes that are subparallel to the dated Minto dyke as part of the Minto swarm, although dating or paleomagnetic study is needed to confirm this interpretation. The most northeastern of the Minto dykes described by Buchan et al. (1998) has a well-defined NW trend which does not appear to fit the overall radiating Minto-Lac Shpogan pattern. It also has distinct geochemistry and opposite magnetic polarity from other Minto dykes and Lac Shpogan dykes (Buchan et al. 1998; Buchan et al. 2007). It is possible that this dyke is of a somewhat different age and not part of the Minto set.

Both the Lac Shpogan and Minto paleomagnetic directions are likely primary because older ca. 2.22 Ga Senneterre and Maguire dykes from the same areas give consistent magnetic directions (Buchan et al. 2007) that are quite different from the Lac Shpogan and Minto directions. This demonstrates that no substantial magnetic overprinting has occurred since the emplacement of Lac Shpogan and Minto dykes. As noted by Buchan et al. (2007), the consistency of the Senneterre-Maguire paleomagnetic directions in the two areas also indicates that there has been no substantial post-2.22 Ga relative rotation. Given that the Lac Shpogan and Minto dykes are of identical age, that the paleomagnetic data for each are likely primary, and that no substantial rotation has occurred between the two areas where the dykes are found, we assume that any difference in paleomagnetic directions is most likely due to secular variation. Therefore, we have calculated an overall mean paleopole at 31.4N, 171.2E, A_{95}=12 based on 9 dykes (6 Minto dykes and 3 Lac Shpogan dykes). We have excluded the NW dyke trending “Minto” dyke as it could be of a somewhat different age based on its distinct trend, geochemistry and reversed polarity compared to other Minto and Lac Shpogan dykes. The combined Minto-Lac Shpogan pole, which falls a few degrees south of the published Minto pole, is considered to be a better estimate of the pole for the eastern Superior craton at 2.00 Ga than was previously available based on only the Minto dykes.

Several geological units in the eastern Superior craton and eastern Hudson Bay may be part of the Minto LIP based on geochronology, paleomagnetism or geochemistry. The Watts Group of the Purtuniq ophiolite in the Cape Smith Belt has been dated at 1998 ± 2 Ma (U-

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Pb zircon; Parrish 1989), an age that is indistinguishable from ages of either the Lac Shpogan or Minto dykes. Hence, these and related rocks of the Cape Smith Belt are likely associated with the LIP. The Eskimo volcanics of the Belcher Islands have a primary paleomagnetic remanence (Schmidt 1980) that is broadly similar to that of the Minto-Lac Shpogan dykes suggesting that they could be of similar age and part of the LIP. The Nastapoka Formation basalts at Richmond Gulf have a paleopole (Schwarz and Fujiwara 1981) that is similar to the Minto-Lac Shpogan pole, although it has not been demonstrated primary. Paleopoles for Persillon Formation volcanics in the northern and southern portions of Richmond Gulf are somewhat more scattered (Schwarz and Fujiwara 1981), although a link has been proposed between the Persillon Formation volcanics and the Eskimo volcanics based on geochemistry (Legault et al. 1994).

The Minto LIP has a locus in eastern Hudson Bay based on the presence of the voluminous mafic volcanic flows and the proposed focus of the giant radiating dyke swarm. It should be noted that this location is consistent with the model of Halls and Davis (2004) in which ca. 2.00 Ga rifting in Hudson Bay is linked to the relative rotation of the eastern and western Superior craton that has been documented in the paleomagnetic literature, although other models for this rotation have been described.

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