GS-15 TECTONIC ANALYSIS OF THE ACCRETION OF THE TRANS-HUDSON OROGEN TO THE SUPERIOR CRATON FROM PALEOMAGNETISM WITH GEOBAROMETRIC CORRECTIONS

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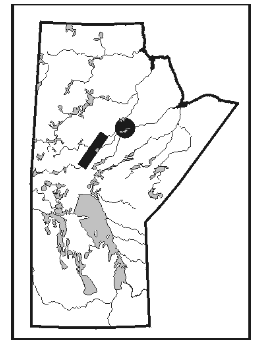

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SUMMARY

Apparent polar wander path (APWP) segments have been established over the past several years for the Lynn Lake - La Ronge belt, Hanson Lake block, Flin Flon Belt and Superior Craton using poles from Paleoproterozoic rock units dated at between ~1890 and ~1830 Ma. These paths extrapolate to a common pole at ~1830 Ma, thus yielding the classical paleomagnetic signature for a continent-continent collisional orogen. The path that requires the greatest extrapolation is the one from the Superior Craton. The current project aims to establish the ~1840 to ~1770 Ma portion of the Superior Craton's APWP. This past summer collections were made from the ~1836 Ma Mystery Lake granodiorite pluton (23 sites), ~1822 Ma Wintering Lake granite pluton (25 sites), ~1811 Ma Fox Lake granite pluton (20 sites) and the contact zones of ~1770 Ma pegmatite dykes from ~30 km south of Thompson (16 sites). The samples will be analysed for their remnant magnetization using standard demagnetization procedures. Where possible, geobarometric corrections, based on the aluminum-in-hornblende geobarometer, will be applied in order to correct for any post-magnetization tilting of the plutons. Two samples were collected for U-Pb zircon geochronological analyses (1 sample from the Mystery Lake granodiorite and 1 sample from the Wintering Lake granitic pluton). Establishment of the Superior Craton's APWP will provide details on the timing, orientation of stress and rate of closure between the Superior Craton and the Trans-Hudson Orogen. Our results will also aid in the interpretation of the tectono-magmatic evolution of the Churchill-Superior Boundary Zone, including the Thompson Nickel Belt (see Peck, GS-7, this volume).

INTRODUCTION

Over the past several years LITHOPROBE has sponsored a series of paleomagnetic studies in the Trans-Hudson orogen (THO), mostly done in the Paleomagnetics Laboratory at the University of Windsor. This work has provided an initial database for several of the terranes within the THO (Symons, 1998; Symons and MacKay, 1998). An important result of these studies has been the establishment of APWP segments for three terranes in the THO and for the Superior Craton between ~1890 and ~1830 Ma (Figs. GS-15-1, 2).

In the THO, the APWP for the: (1) Lynn Lake - La Ronge domain is defined by poles from the ~1890 Ma Lynn Lake gabbro pipes (Dunsmore and Symons, 1990) and the ~1849 Ma Macoun Lake pluton (Symons et al., 1994); (2) Hanson Lake block is defined by poles from the ~1844 Ma Hanson Lake diorite pluton (Gala et al., 1997) and the ~1830 Ma Sahli charnockitic granulite pole (Gala et al., 1998); and, (3) Flin Flon domain is defined by poles from the ~1851 Ma Reynard Lake granodiorite pluton (Symons, 1995) and the ~1838 Ma Boot Lake - Phantom Lake igneous complex (Symons and MacKay 1998). The path for the Superior Craton in this time span is defined by poles from the ~1849 Ma Sudbury igneous complex (Morris, 1984) and the revised C-pole for the ~1883 Ma Molson diabase dykes (Zhai et al., 1994; Halls and Heaman, 1997).

Continent-continent collisional orogens are expressed in paleomagnetic terms by convergence of APWPs to a common pole that records the date of assembly. This pattern is clearly evident in the four APWP segments listed above (Fig. GS-15-2). Note, however, that the three paths from the THO either end or have only short extrapolations

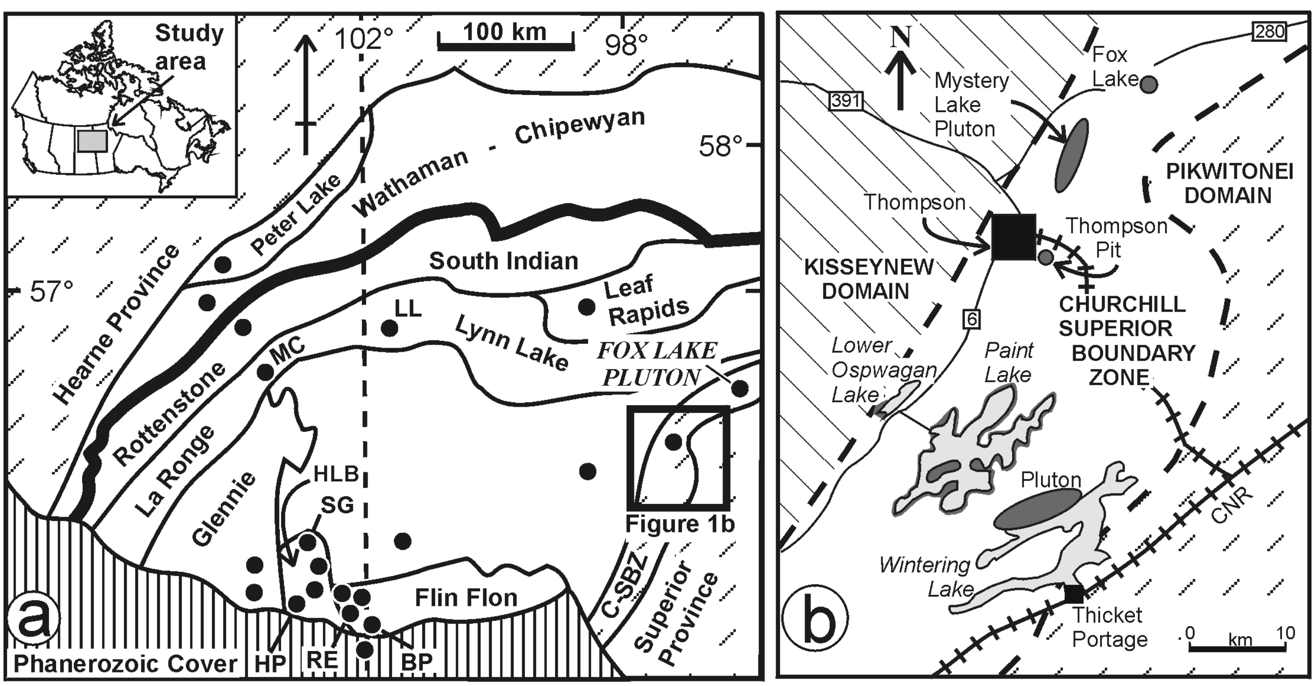

Figure. GS-15-1 a) Tectonic elements of the Trans-Hudson Orogen and location of the Fox Lake pluton. CSBZ - Churchill-Superior Boundary Zone; HLB - Hanson Lake block. Dots show paleomagnetic collection locations with those referred to in the text labelled: BP - Boot-Phantom granites; HP - Hanson Lake pluton; LL - Lynn Lake gabbroic pipes; MC - Macoun Lake pluton; RE - Reynard Lake pluton; and, SG - Sahli granulite. b) Locations of collections near Thompson, Manitoba.

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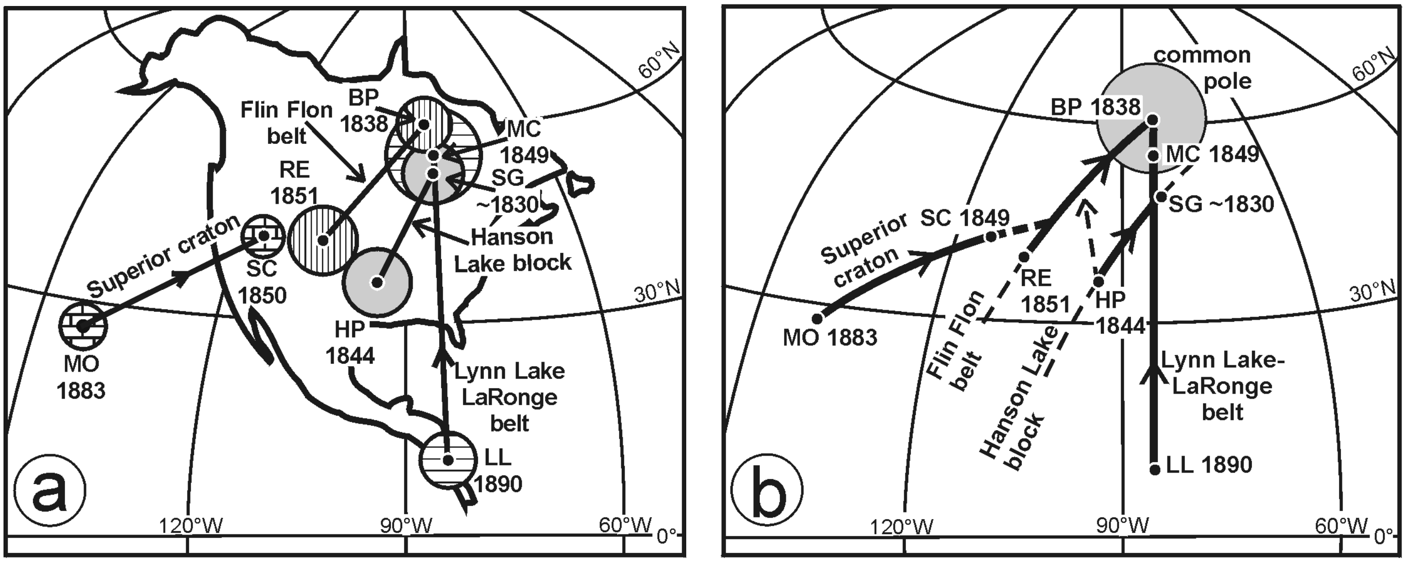

Figure. GS-15-2 a) Apparent polar wander path (APWP) segments for the Superior Craton and Trans-Hudson Orogen domains from ~1890 Ma to ~1775 Ma. Abbreviations for poles noted in Fig. GS-15-1, with the magnetization ages given in Ma. b) Projection of the APWP segments to the ~1840 Ma to ~1775 Ma stillstand.

to a common pole whereas the path for the Superior Craton requires a relatively long extrapolation. The details of the accretion process as indicated by the paleomagnetic data are described in geotectonic terms by Symons and MacKay (1998).

The salient feature that led to this proposal is that the Superior Craton's APWP, because it requires the greatest extrapolation, is the least reliable. Conversely, it is also potentially the most important because the Superior Craton likely behaved as a coherent tectonic domain against which the disparate THO terranes were accreted. Therefore, the principal objective of this project is to better define the APWP for the Superior Craton during and subsequent to the collisional orogeny. A further aspect of our research is to test the hypothesis, in part arising from paleomagnetic data (Symons, 1998), that the collisional orogen was predominantly transpressive because the APWP segments approach each other at an angle of ~45°. By more precisely establishing the Superior Craton's path between ~1840 and ~1770 Ma, it will be possible to assess more accurately the relative importance of compressive and strike-slip strain during accretion.

METHODS OF STUDY

During the summer of 1998, collections were made from the following four units in the Thompson Nickel Belt and the Churchill-Superior Boundary Zone (Fig. GS-15-1b): (1) 23 sites were collected within the Mystery Lake granodiorite pluton (mapped by Weber, 1976), dated at ~1836 Ma by Davis (1989) using the $^{207}Pb/^{206}Pb$ monazite method; (2) 25 sites were collected in the Wintering Lake granite pluton (mapped by Hubregtse, 1978), dated at 1822 ± 3 Ma using U/Pb monazite method by Machado et al. (1987); (3) 20 sites were drilled from the Fox Lake granite pluton (see Corkery et al., 1991), which has given an ~1811 Ma minimum model age from $^{207}Pb/^{206}Pb$ dating (Heaman and Corkery, 1996); and, (4) 16 sites were set in the contact zones of pegmatite dykes at Ospwagan Lake, Paint Lake and along Highway 6, ~30 km south of Thompson. The latter collection is a result of a previous paleomagnetic study of 19 pegmatite dykes from INCO Ltd.'s Thompson and Pipe open pit mines (D. Symons, unpublished data). However, the majority of the pegmatites did not carry a stable characteristic remnant magnetization (ChRM) and the study was abandoned. Lack of a stable ChRM is a fairly common feature of pegmatites. Therefore, during the current study we have focused on sampling the baked and altered country rocks of the pegmatites because several of the few contact samples in the earlier study appeared to carry a useful ChRM. Granitic pegmatites from the Thompson Nickel Belt have given $^{207}Pb/^{206}Pb$ zircon and $^{207}Pb/^{206}Pb$ titanite ages of 1786 ± 3, 1776, 1771 ± 2, and 1768 Ma (Krogh et al., 1985; Machado et al., 1987).

At each site, 5 to 8 cores were collected, providing ~12 ± 4 specimens per site. These will be analysed paleomagnetically using instrumentation and techniques similar to those described by Symons and MacKay (1998) for the Boot - Phantom complex.

To ensure confidence in the interpretation of the paleomagnetic data, the paleohorizontal surface of the rock body should be known to provide a datum from which tectonic-tilt deviations can be calculated. Unlike sedimentary or volcanic rocks where bedding planes may be used, intrusive rocks do not generally have a natural horizontal indicator. However, geobarometric methods can determine an isobaric surface at the time of crystallization and, ideally, the timing of the ChRM. In general this surface will be horizontal, although with very large batholiths, this does become an assumption (Ague and Brandon, 1996). Therefore, we plan to use the temperature-corrected aluminum-in-hornblende geothermobarometric method (Anderson and Smith, 1995) on the three plutons in order to measure the amount of uplift exhumation and to measure the amount of uplift exhumation and tilt (if any) of the plutons, because both parameters have a bearing on the paleomagnetic interpretation. The geothermobarometric determinations will follow the methodology used in the paleomagnetic investigations by Harris et al. (1996, 1997) of several Mesozoic and Cenozoic plutons in the northern Cordillera.

We also intend to use U/Pb zircon or related radiometric methods in an attempt to more precisely date the Wintering Lake and Mystery Lake plutons. It is expected that the experimental work will be completed during the coming year.

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