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The Greer Lake leucogranite, Manitoba, and the origin of lepidolite-subtype granitic pegmatites

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Abstract

The Archean Greer Lake leucogranite intruded metabasalts of the Bird River Greenstone Belt in the southwestern part of the Superior Province of southeastern Manitoba. The considerably evolved, multiphase, peraluminous, B-, P-, and S-poor leucogranite (K/Rb 132 to 24) was probably generated by fault-friction-assisted anatexis of dominantly metatonalitic rocks and subsequent differentiation. The leucogranite produced interior, transitional, non-crosscutting pods of barren, beryl-columbite- and lepidolite-subtype pegmatites that solidified from local segregations of highly fractionated residual melt. Steep fractionation gradients characterize the granite-to-pegmatite transition, most conspicuously so in the case of the most evolved, Li, Rb, Cs, Be, Mn, Sn, Nb-Ta, F-rich, lepidolite-subtype pod AC #3 (with K/Rb $\geq$ 16 and Cs 330 ppmwt in accessory K-feldspar, $\geq$2.5 and $\leq$11,200 ppmwt, respectively, in lepidolite, Cs $\leq$28,000 ppmwt in beryl, and Ta/(Ta+Nb) at. $\leq$ 0.95 in manganotantalite). The Greer Lake example documents beyond any doubt the igneous derivation of lepidolite-subtype pegmatites from a plutonic parent. Most cases of generally very scarce lepidolite-subtype pegmatites obscure this relationship, as the volatile-rich, highly fluid melts stable to relatively low temperatures commonly migrate to great distances from their plutonic sources.

Keywords: Leucogranite; Granitic pegmatite; Lepidolite; Petrology; Geochemistry; Petrogenesis

1. Introduction

Complex granitic pegmatites of the lepidolite subtype are characterized by lepidolite as the main (up to the only) Li-bearing rock-forming mineral. They are prominently enriched in Li, F, Rb, Cs, commonly also in B and P, and they are prone to carry significant concentrations of minerals of Sn, Nb, Ta, and Be. They belong to the rare-element class of granitic pegmatites, generally located in the environment of lower-amphibolite (to upper-greenschist) facies of metamorphism (e.g., Ginsburg et al., 1979; Černý, 1991a).

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Granitic pegmatites of the rare-element class are generally accepted today as products of magmatic differentiation from pluton-sized granite bodies (as reviewed by Černý, 1991b, 1992a). However, speculations about a direct anatectic origin still persist in some cases, notably concerning lepidolite-subtype pegmatites. Charoy and Noronha (1996) discussed the problem at some length and agreed that the albite+quartz+lepidolite+amblygonite assemblage, late as it is in the evolution of the examined microgranite, is magmatic and produced by igneous fractionation. However, Zasedatelev (1974, 1977) denied origin by magmatic differentiation to lithium-bearing pegmatites in general, favoring instead speculative models of direct anatexis. Stewart (1978) expressed similar views, based on, i.e., bimodal distribution of lithium abundances in granitic pegmatites. Recently, Gordiyenko et al. (1996) developed a complex postmagmatic scheme specifically for lepidolite pegmatites: they are supposed to consolidate from an undefined medium that is otherwise alleged to generate rare-element mineralization superimposed on preexisting barren pegmatite bodies.

We present here the Greer Lake leucogranite, Manitoba, Canada, and its interior pegmatites as a case of derivation of lepidolite-subtype pegmatites from an igneous granitic parent. We also review other cases and arguments supporting this mode of origin, and the reasons why the generally rare lepidolite-subtype pegmatites have been misinterpreted in the past.

2. Regional geology

The Greer Lake leucogranite is located 135 km east–northeast of Winnipeg, Manitoba, at latitude 50°20′39″N, longitude 95°19′W (Fig. 1). The leucogranite and its pegmatite aureole are part of the Cat Lake–Winnipeg River pegmatite field situated in the volcano-plutonic Bird River subprovince of the Superior Province of the Canadian Shield. The Bird River Greenstone Belt, host of the pegmatite field, consists of six formations of metavolcanic and proximally derived metasedimentary rocks intercalated with, or intruded by, syn- and subvolcanic intrusions (Černý et al., 1981). The metasedimentary–metavolcanic edifice forms a broad and complex synclinorium. Two major episodes of folding affected the greenstone belt; the second correlates with the diapiric intrusion of the Maskwa Lake and Marijane Lake batholiths and with the peak of regional metamorphism. Metamorphism attained the greenschist-facies level over most of the area of Fig. 1, but

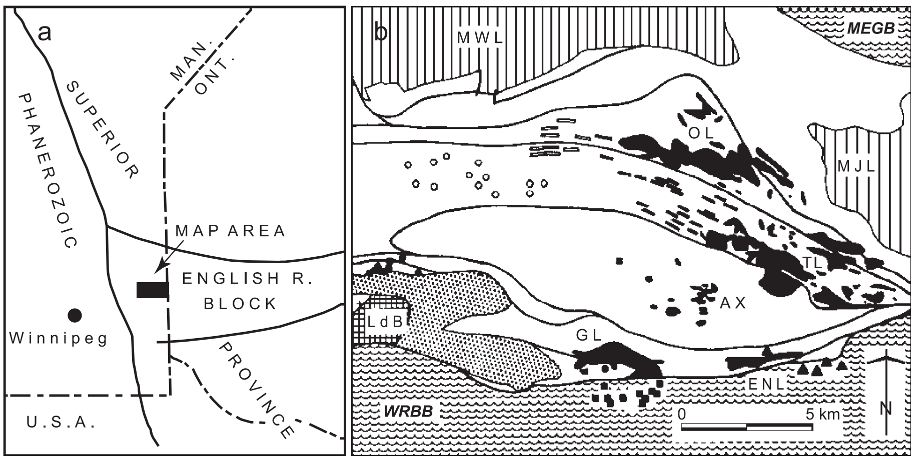

Fig. 1. (a) Location of the Winnipeg River pegmatite district at the Manitoba–Ontario boundary in central Canada. (b) Geology of the district: open, greenstone belt; WRBB, Winnipeg River batholithic belt; MEGB, Manigotagan–Ear Falls Gneiss Belt; MWL, Maskwa Lake; MJL, Marijane Lake tonalitic diapirs; LdB, complex eastern end of Lac du Bonnet batholith; most pegmatite groups (each marked by a different spot symbol) are associated with leucogranites (in black; TL, Tin Lake; ENL, Eagle Nest Lake; AX, Axial; OL, Osis Lake; and GL, Greer Lake, which is also shown in Fig. 2). Modified from Černý et al. (1986).