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"Kimberlite" from Wekusko Lake, Manitoba: Actually a diamond-indicator-bearing dolomite carbonatite

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ABSTRACT

The petrography, mineralogy and geochemistry of two macroscopically distinct drill core samples of what was previously identified as a potentially diamondiferous kimberlitic rock from the Wekusko Lake area (central Manitoba, Canada) were examined in detail. The rock shows an inequigranular, uniform to segregation texture arising from the presence of abundant macrocrysts (partly or completely chloritized phlogopite, Mg–Al–Cr-rich spinel and Mg–Cr-rich ilmenite) and coarse-grained segregations in a fine-grained dolomitic groundmass (70–85% of the rock volume). The unmodified groundmass dolomite (3–22 mol% ankerite) is enriched in Sr, Ba, light rare-earth elements and shows a distinct "mantle" isotopic signature [$\delta^{13}C_{V\text{-}PDB} = -7.6$ to -5.3‰; $(^{87}Sr/^{86}Sr)_i = 0.70348$–$0.70574$]. Its consistently high $\delta^{18}O_{V\text{-}SMOW}$ values (20–25‰) indicate re-equilibration with low-temperature CO_2-poor fluids. Phlogopite macrocrysts (mg# = 0.64–0.85, 8.8–14.9 wt.% Al_2O_3 and 0.1–1.9 wt.% TiO_2) are cognate with the host rock and exhibit trace-element variation typical of carbonatitic micas (<100 ppm Cr and 200 ppm Ni, but 100–300 ppm Nb and >400 ppm Mn). Both spinel and ilmenite are compositionally indistinguishable from macrocrysts in kimberlites and interpreted to represent mantle-derived xenocrysts. The whole-rock compositions are characterized by elevated levels of compatible trace elements (30–110 ppm Co, 910–990 ppm Cr and 380–610 ppm Ni) and certain incompatible elements (most notably, Sr, light REE, Nb, Zr, Th and U), as well as high Nb/Ta, Zr/Hf and Ga/Al ratios (>21, 48 and 7×10^{-4}, respectively). The most common accessory minerals are Na–Sr–REE-bearing fluorapatite and low-Hf zircon. With the exception of spinel and ilmenite macrocrysts, the mineralogy and geochemistry of the examined samples are inconsistent with their identification as kimberlite. On the basis of their modal, isotopic, major- and trace-element composition, the Wekusko Lake rocks are interpreted as primary magnesiocarbonatite contaminated by mantle-derived material and isotopically re-equilibrated with low-temperature crustal fluids.

1. Introduction

Despite a long and successful history of mineral exploration, the Province of Manitoba has been somewhat of a backwater on the Canadian diamond-exploration scene. Although several prospective targets have been recognized in the central and north-eastern parts of the Province, only one of them has so far been provisionally identified as "kimberlite". This rock was first intersected in drillhole GBO-16 (80.2–85.4 m) by Falconbridge Nickel Mines Ltd. during their 1983 drilling program focused on the Copper Man deposit in the south-western section of Wekusko Lake in central Manitoba. The intersected rock was described as fine- to medium-grained breccia containing "occasional pyrope garnets" (Assessment File 70569, Manitoba Science, Technology, Energy and Mines, Winnipeg). Following up on the reported garnet-bearing breccia, European Ventures Inc. drilled a series of holes in the same area in the early 1990s, three of which (EPV-5-93, EPV-12A-94 and EPV-17-94) intersected what was described as "a kimberlitic rock" visually identical in all of the three holes. A five-kilogram sample of the rock, examined by Gurney and Zweistra (1993), was reported to contain G10, G9 and possible diamond-inclusion eclogitic garnets. Diamond-indicator minerals (chromite, Cr-rich diopside and ilmenite) were also recovered from till samples collected near the shore and further south of the lake. The distribution of indicator minerals and interpretation of aeromagnetic data suggest the existence of a series of intrusions confined to a NW-trending structure dubbed the Wekusko Lake–Hargrave Lake corridor (Hood and Lee, 2007). Although the rock intersected by Falconbridge and European Ventures has not been studied in detail, it has been

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referred to as kimberlite in all printed and electronic resources published to date (e.g., Kjarsgaard, 2007). Clearly, accurate identification of this rock has important implications for diamond exploration in the region. As we shall later show, it also bears on the interpretation of relations between kimberlites and texturally similar rocks and magma-generation processes in the mantle. The lack of reliable petrographic, mineralogical and geochemical data on the Wekusko Lake "kimberlite" prompted us to re-examine the material extracted in the course of the initial exploration activities. The present report is a summary of our findings.

2. Geological setting

Wekusko Lake is located in the eastern part of the Flin Flon–Glennie Complex (FFGC) of the Paleoproterozoic Trans-Hudson Orogen (Bailes and Galley, 1999; Fig. 1). Most of the supracrustal components of the FFGC range in age from 1.91 to 1.88 Ga and represent disparate parts of various ocean-floor and arc magmatic assemblages, tectonically juxtaposed during intra-oceanic accretion at 1.88–1.87 Ga, and subsequent continental collision between the FFGC and Sask craton which began around 1.84 Ga (Syme and Bailes, 1993; Stern et al., 1995; Lucas et al., 1996). The collision resulted in southwesterly thrusting of the FFGC over the 3.10–2.45 Ga rocks of the Sask plate along the Pelican Décollement Zone and intense shear-induced deformation, which continued to at least 1.81 Ga (Ashton et al., 2005; Ansdell, 2005; Bickford et al., 2005). The area was affected by post-collisional shortening ca. 1.80–1.77 Ga, which is attributed to continuing convergence of the Sask and Superior cratons at depth, i.e. below the FFGC (Ashton et al., 2005). The relative extent of the Archean cratonic rocks underplating the FFGC is largely unknown; the recent seismic-reflection and radio-isotope studies indicate that the Sask underplate extends beneath at least 100,000 km^2 of the Trans-Hudson Orogen, including the FFGC (Bickford et al., 2005; Hajnal et al. 2005). Bedrock exposures in the southwestern Wekusko Lake area are dominantly Paleoproterozoic metavolcanic and metasedimentary supracrustal rocks intruded by granitoids and overlain by flat-lying Ordovician dolomite (Gilbert and Bailes, 2005; Fig. 1). The youngest intrusive rocks in the area are the alleged "kimberlitic" dikes, which are the focus of the present work.

3. Petrography and mineral compositions

Only material from the original drillcore (GBO-16, Falconbridge Nickel Mines) and one of the European Ventures holes (EPV-12A-94) was available for research. The two core samples differ in macroscopic color (brownish grey and greyish green, respectively), but both are fresh

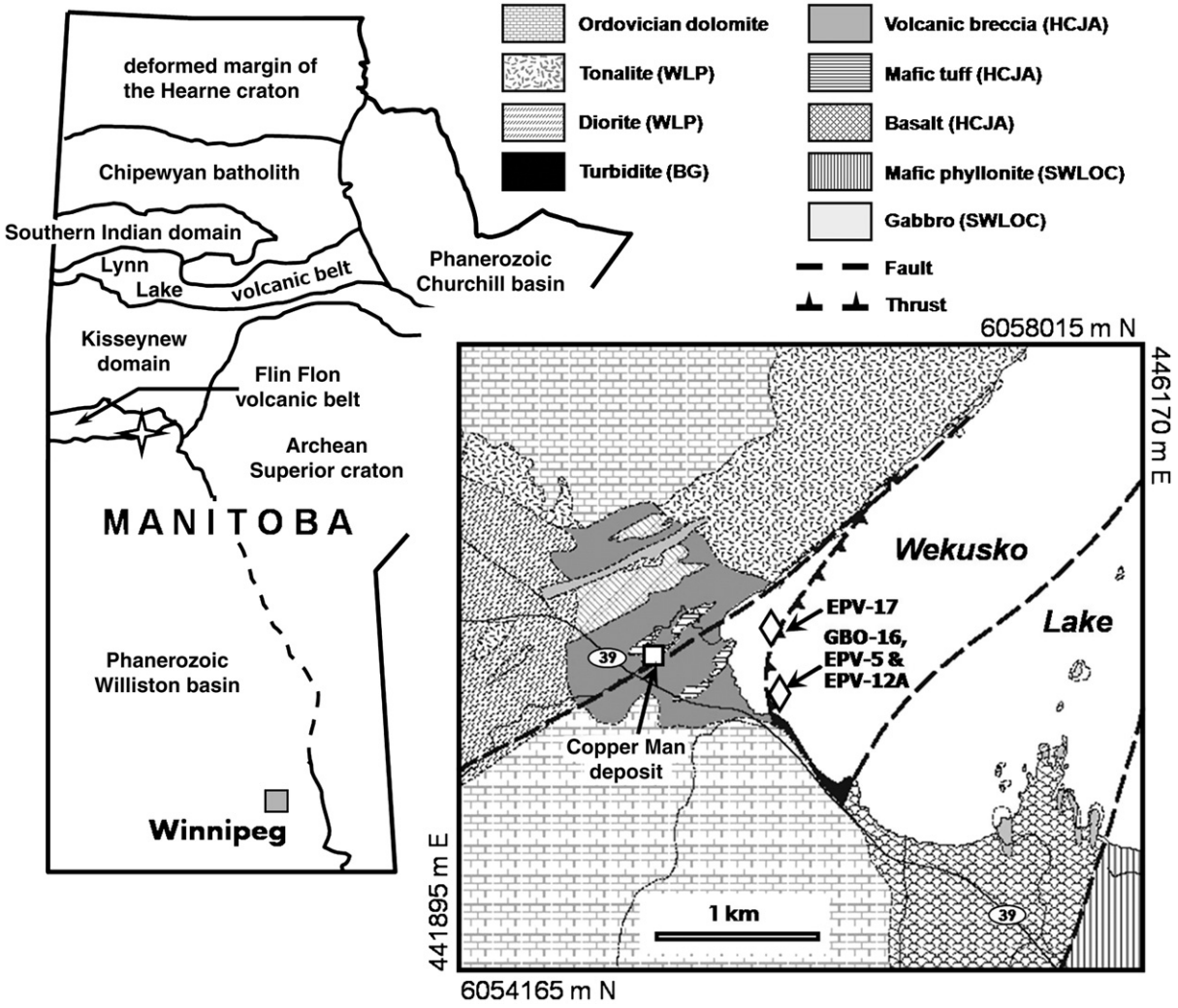

Fig. 1. Schematic map showing the location of Wekusko Lake (star) within the Paleoproterozoic Trans-Hudson Orogen. The inset shows structural relations among the major units in the southern Wekusko Lake area (after Gilbert and Bailes, 2005), including the Wekusko Lake pluton (WLP), Burntwood group (BG), Hayward Creek juvenile arc (HCJA) and South Wekusko Lake oceanic crust assemblage (SWLOC). Corner coordinates are in UTM NAD83 (zone 14).