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Southeast Slave Craton Lithosphere, Revisited

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We have re-investigated the mantle lithosphere of the southeast Slave Craton by integrating new, and compiled mantle xenocryst (Griffin et al. 2004) and xenolith (Kopylova and Caro 2004) datasets. Kimberlites examined include Gahcho Kué-5034, CL25, CL174, and Snap Lake. Gahcho Kué 5034, Hearne, and Tuzo pipes are currently mined for diamonds, Snap Lake is a past-producing mine, and CL25 and CL174 are not considered to be economic. EPMA data for Cr-diopside and garnet were obtained at the University of Alberta. FITPLOT (Mather et al. 2011) geotherms were generated utilizing Cr-diopside pressure-temperature (P-T) data determined for Gahcho Kué-5034, CL25, and CL174 (Table 1) via single-clinopyroxene thermobarometry (Nimis and Taylor 2000). Mantle xenolith P-T data was also utilized to generate a FITPLOT geotherm for Gahcho Kué-5034. Xenolith and Cr-diopside FITPLOT geotherms for Gahcho Kué-5034 are within uncertainty of each other yielding a lithospheric thickness of ~ 230 km (Table 1). Neither Cr-diopsides, nor mantle peridotites were observed in any heavy mineral concentrates for Snap Lake for samples from this study. Given that the four studied kimberlites are within a limited geographic area (20 x 100 km) in the southeast Slave Craton and are of approximately the same age (542 - 523 Ma; Heaman et al., 2004), we have utilized the FITPLOT geotherm from the CL25 kimberlite as a proxy for Snap Lake when examining garnet temperature - depth profiles.

Garnet Class **Kimberlite**	**GK5034**	**CL25**	**CL174**	**Snap Lake**
Eclogite, Pyroxenite (G3, G4)	0.6	6.2	13.5	15.2
Lherzolite (G9)	83.2	28.5	13.8	73.2
Ti-Lherzolite (G11)	6.4	56.5	62.4	9.6
Harzburgite (G10)	6.4	4.6	6	1.0
Harzburgite-D (G10-D)	3.1	3.8	4	1.0
Wehrlite (G12)	0.3	0.4	0.3	0.0
Diamond In (km)	106 +/- 11	115 +/- 12	116 +/- 11	nd
Diamond In (T °C)	740	835	840	nd
Base of Lithosphere (km)	229 +/- 13	212 +/-13	215 +/-12	nd
Base of Lithosphere (T °C)	1410	1400	1400	nd
Diamond Window (km)	123	97	99	nd

Table 1. Summary percentages of garnet types and key depth - temperature intervals from FITPLOT output.

Garnet grains, including megacrysts (G1), eclogite-pyroxenite (G3, G4 and G3-D, G4-D), lherzolite (G9), high-Ti peridotite (G11), harzburgite (G10 and G10D) and wehrlite (G12) were classified based on their major element chemistry following Grutter et al. (2004). Summary information of these garnet types is provided in Table 1 and Figure 1 (note: megacryst G1 garnets were removed from this calculation). There is significant variability in mantle lithology sampling, both in terms of the composition of the mantle lithosphere, and the depth of the mantle that was sampled by the kimberlite.

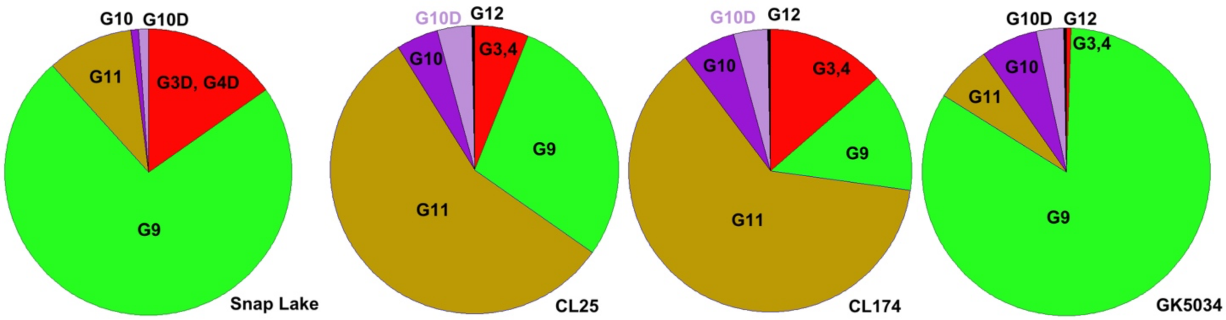


Figure 1. Variation (%) in garnet types at the GK5034, CL25, CL174 and Snap Lake kimberlites.

Peridotite garnet xenocrysts were also classified based on a simplified Ca-intercept model, with G10b, G10a, G9b, G9a, G12 parageneses. Both garnet classification schemes were complemented by trace-element analyses (obtained by LA-ICP-MS at the Geological Survey of Canada and the University of Alberta) to determine enrichment, depletion, and metasomatic events e.g., by utilizing Ti/Eu - Zr/Hf and Y-Zr plots. Peridotite garnet temperatures were determined by Ni-in-garnet thermometry, and calculated temperatures were then projected onto the FITPLOT geotherm to determine their depth. Collectively, the peridotite garnet and Cr-diopside xenocryst data were then utilized to generate mantle lithosphere lithology and sampling profiles for the individual kimberlite bodies, with the depth distribution for all P-type garnets, from each locality illustrated in Figure 2.

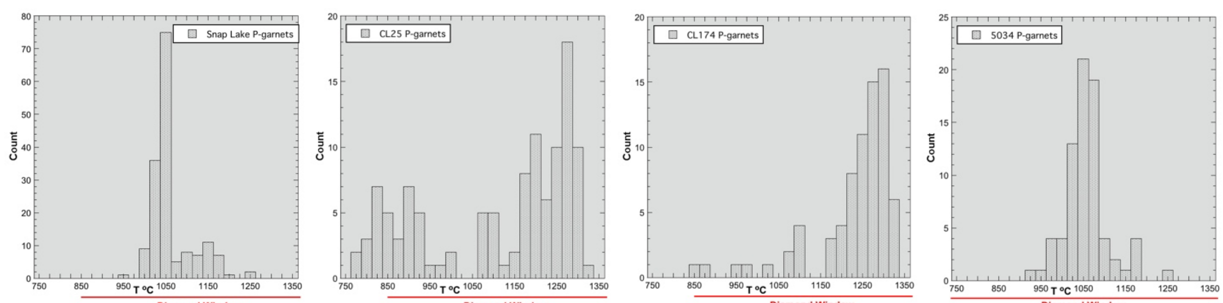
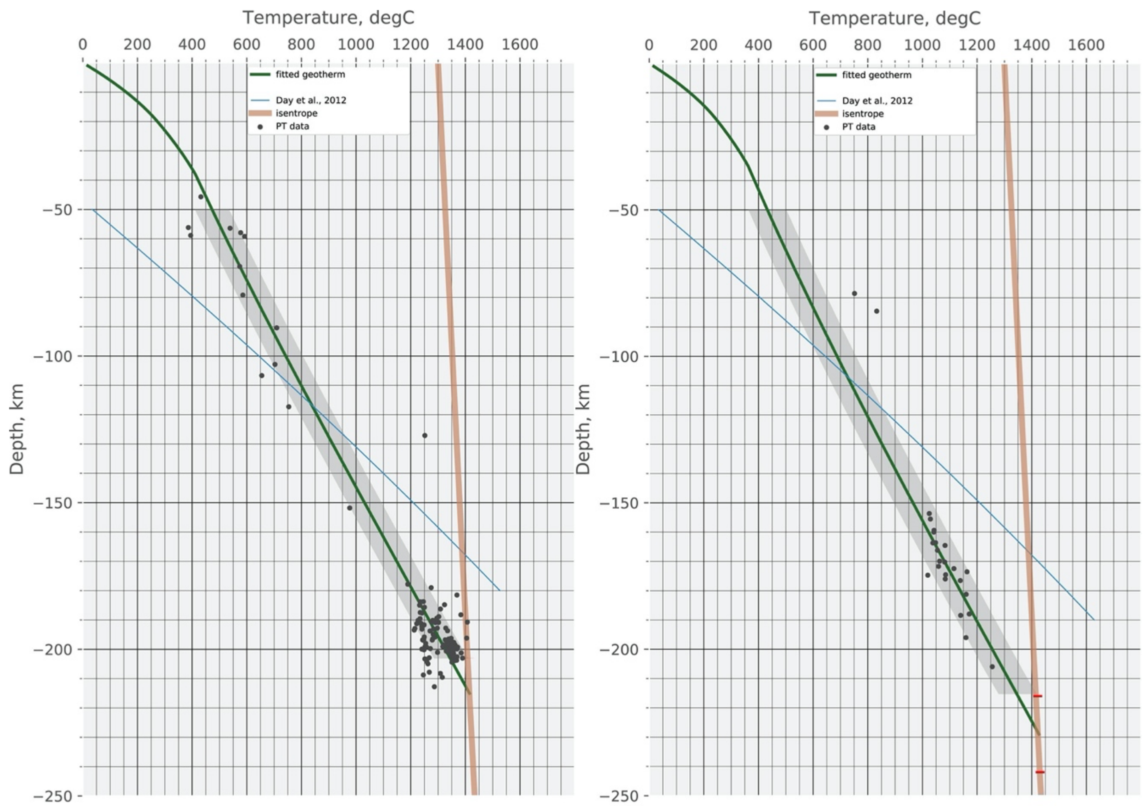


Figure 2. All P-type garnets, sample frequency distribution with temperature. The majority of garnets sampled by the Snap Lake and GK5034 kimberlites are of lherzolite (G9) paragenesis and are derived from the central part of the diamond window (temperatures of ~950 to ~1150 ˚C; depths of ~150 to ~200 km). In contrast, the garnet populations of the CL25 and CL174 kimberlites are dominated by high-Ti peridotite from the basal part of the diamond window (temperatures of ~1150 to ~1350 ˚C; depths of ~180 to ~215 km) i.e., at and just above the lithosphere - asthenosphere boundary.

For the Snap Lake and GK5034 kimberlites, the majority of P-type garnets are sampled from the central temperature/depth interval of the diamond window, whereas CL174 and CL25 kimberlites sampled P-type garnets predominantly from the basal lithosphere section of the diamond window. Furthermore, the P-type garnet temperature/depth distribution (Figure 2) is similar to that of the Cr-diopside temperature/depth distribution for CL174 and GK5034 (Figure 3), consistent with the kimberlite only sampling specific depth intervals throughout (and above) the diamond window. We surmise that the mantle xenocryst (and also xenolith) data (Figures 1, 2, 3) illustrate that lithospheric mantle composition is quite distinct in composition over ~100 km horizontal distance, based on data from 4 kimberlites in the southeast Slave Craton, supporting the previous observations of Preston et al. (2012) from a much larger dataset from the Orapa kimberlite field, Botswana.



CL174 **GK5034**

Figure 3. FITPLOT geotherms for the CL174 and GK5034 kimberlites generated from single grain Cr-diopside P-T data. For CL174, note the lack of mantle sampling of Cr-diopside grains from ~800 to ~1200 ˚C, similar to the temperature distribution of P-type garnets sampled by kimberlite CL174 (see Figure 2). For GK5034, note that absence of mantle sampling of Cr-diopside at lower P-T conditions, similar to that shown by P-type garnet data (see Figure 2). Diamond - graphite transition curve from Day et al. (2012).

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