Dixonville kimberlites, Pennsylvania, USA: Indicator mineralogy and thermobarometry

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The Dixonville (Tanoma) kimberlites in west-central Pennsylvania occur in a narrow east-west-trending zone, at least 3 km long, of sub-parallel dikes that have been encountered in underground coal mines. The kimberlites contain abundant megacrysts of olivine, ilmenite, and phlogopite, and less abundant garnet and clinopyroxene. Although the dikes have no known surface outcrops, panned concentrates from several drainages above the mines contain kimberlitic indicator minerals: ilmenite, garnet, clinopyroxene, orthopyroxene, and olivine (analysed size range for most is 0.25-2mm, and up to 7mm for ilmenites).

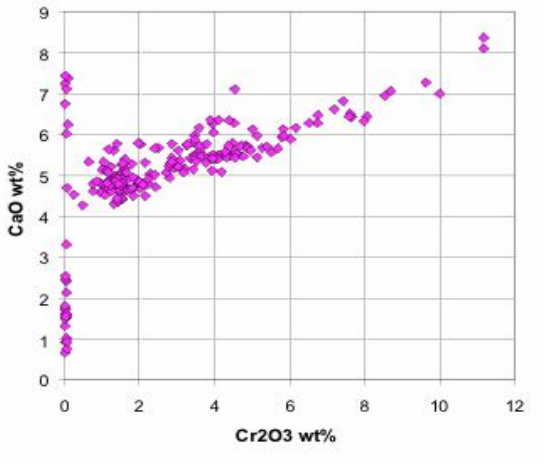

Fig. 1 Garnets from panned concentrates of stream sediments in drainages crossing Dixonville kimberlite dikes.

The only reported deep-source xenoliths are glimmerites. However, the presence of garnet peridotites, either as discrete xenoliths or as disaggregated mineral assemblages, is indicated by lherzolitic G9 purple or pink Cr pyropes that contain up to 11.2 wt% Cr2O3, with two ranges of TiO2 content, 0-0.2 and 0.3-0.7 wt%. Harzburgitic G10 high-Cr, low-Ca garnets are absent. Megacryst garnets are represented by orange to red-orange fragments, containing 0.4-0.9 wt% TiO2 and less than 2 wt% Cr2O3. Garnets with 1-2 wt% Cr2O3 and less than 0.25 wt% TiO2 may be from low-Cr garnet lherzolites or from garnet pyroxenites. Eclogites are absent, based on the lack of jadeitic clinopyroxenes or garnets with Na2O >0.08 wt%. Pink to orange almandine-rich garnets are crustal.

Ilmenites contain 1-4 wt% Cr2O3 and 8-14 wt% MgO (right limb of the MgO-Cr2O3 "parabola"). Rims are enriched in MgO, with almost constant Cr2O3. Nb2O5 contents are 0.14-0.53 wt%.

Clinopyroxenes contain relatively low Cr2O3, up to 1 wt%. Their Al2O3-MgO contents show derivation from both garnet peridotites and garnet-free, spinel peridotites. However, spinels are very sparse in pan concentrates.

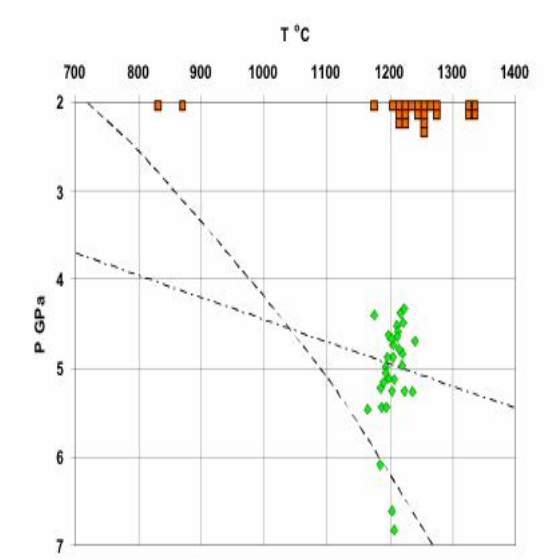

Fig. 2 Clinopyroxene xenocryst temperatures (°C) and pressures (Gpa) (diamond symbols) calculated by the Nimis and Taylor (2000) method. Orthopyroxene xenocryst temperatures (square symbols) calculated from the Lindsley and Dixon (1976) solvus. Dashed line, 38 mW/m^2 shield geotherm; dot-dash line, diamond – graphite stability boundary.

Calculated temperatures and pressures by the Nimis-Taylor method for Cr diopsides of garnet peridotite affinity show an array with T = 1160-1230 degrees C

and P = 4.3-5.4 GPa (with 3 outliers in the 6.0-6.8 GPa range). Calculated temperatures for orthopyroxene xenocrysts, from the Lindsley and Dixon (1976) solvus, show a slightly higher range, 1180-1230 degrees C. The clinopyroxene array is above a continental geotherm, and crosses the diamond-graphite stability boundary. These temperature-pressure values indicate heating of the upper mantle in a depth range of 135 to 175 km beneath Proterozoic, Grenville-age basement. Lack of diamond potential is indicated by the chemistry of the indicator minerals, and by the young cratonic age setting.

References

Lindsley, D.A., Dixon, S.A., 1976. Diopside-enstatite equilibria at 850° to 1400°C, 5 to 35 kb. American Journal of Science 276, 1285-1301.

Nimis, P., Taylor, W.R., 2000. Single clinopyroxene thermobarometry for garnet peridotites: Part I. Calibration and testing of a Cr-in-Cpx barometer and an enstatite-in-Cpx thermometer. Contributions to Mineralogy and Petrology 139, 541-554.