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Major and trace element chemistry of pyrope garnets from the El Kseibat area (Algeria): implications for lithosphere features in the north-eastern part of the West African Craton

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Thirty-eight (39) pyrope garnets from the El Kseibat area (north-eastern part of the West African Craton or WAC, Algeria) have been studied using major and trace element chemistry to obtain information on the lithospheric mantle composition and thermal properties. All pyrope grains are found in Cretaceous and Quaternary alluvial sediments. They are well rounded and have undergone a long history of transportation, like the diamonds of Djebel Aberraz placer from the El Kseibat area (Kahoui et al., 2008). 37 of the studied garnets are lherzolitic in composition (including five high-Ti peridotitic, or G11, according to Grutter et al., 2004) and two grains are harzburgitic (G10), very close to the borderline with lherzolitic garnets.

The plot of the garnet grains, in the Zr/Y vs. Y/Ga diagram (Griffin et al. 1998), shows that our pyropes fall within the Archon/Proton field consistent with the Eglab Shield geology which is a Proton with some Archaean relics. Some pyrope grains fall outside the fields of Archons and Protons. It seems that there are two layers in the mantle, one shallower and one deeper, like in the Lac de Gras area, Slave Craton, Canada (Griffin et al., 1999).

The thermobarometry of garnet with the use of Ni-thermometry and Cr-barometry (Griffin et al., 1989) and the calibration by Ryan et al. (1996) gives T(Ni) = 790–1392°C and P(Cr) = 26.3 – 49.8 Kb. The geotherm corresponding and calculated using heat flow constraints is high (45-50 mW/m2), with nearly all garnets lying in the graphite field; this geotherm indicates a sampling interval of ca 100–170 km.

Based on trace element distribution, garnets can be divided in three groups: (1) depleted low Sr, (2) high Zr, low Ti, Sr and (3) high Zr, Ti. The diagram Ti vs. Zr indicates that group 1 may be considered as depleted, but group 2 and 3 show a wide range-intensity of metasomatic processes: phlogopite-metasomatism being typical of group 2, and melt-metasomatism, typical of group 3.

There are four types of chondrite normalized rare earth element (REEN) distinguished in garnets (terminology of Creighton et al., 2009): sloped, normal, humped and sinusoidal. The sinusoidal patterns characteristic for subcalcic harzburgitic garnets are interpreted as evidence for a highly depleted lithosphere followed by fluid/melt metasomatism (Lehtonen, 2005; Creighton et al., 2008). Metasomatism is also advocate for garnets with the humped and sloped patterns (Creighton et al., 2008).

The pyrope garnets of El Kseibat area indicate a lherzolitic composition of a most likely Archaean lithosphere which underwent several metasomatic processes. Some of the sources may be diamondiferous.