Petrographic study of the xenoliths hosted within lamprophyric dykes from the Shaksgam Valley (Xinjiang, China)

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The Tibetan Plateau, consisting of several terranes progressively accreted onto the stable North Asian Siberian–Mongolian craton since the Early Mesozoic, is the highest and largest topographic feature on Earth, and represents the archetypal product of continent-continent collision. Although many hypotheses have been advanced to explain the development of such high-elevation plateaus in collisional belts, the processes that formed the Tibetan Plateau remain almost unclear (e.g. Searle et al., 2011). The limited occurrence of exhumed deep crustal rocks in most of the Tibetan Plateau hampers the direct observation of the deeper crust and upper mantle beneath the orogen, whose structure is mainly interpreted basing on the results of deep crustal seismic experiments (e.g. Zhao et al. 1993; Nelson et al. 1996; Hetényi et al. 2007; Nábelek et al. 2009).

Direct information on the structure and composition of the lower crust and upper mantle can be inferred from xenoliths entrained in ultrapotassic volcanic rocks that have sampled the lower crust on their way up to the surface. Post-collisional volcanic rocks are widespread in the whole Tibetan Plateau (e.g. Chung et al., 1998, 2003, 2005; Miller, 1999; Wang et al., 2010); ultrapotassic dykes hosting lower crustal xenoliths have been reported from the Qiangtang terrane of central Tibet (Hacker et al. 2000, Jolivet et al., 2003; Ding et al., 2007), the Lhasa terrane of southern Tibet (Chan et al., 2009) and the Pamirs (Ducea et al. 2003; Hacker et al., 2005). Post-collisional potassic and ultrapotassic dykes have been also reported from the Karakoram terrane, which represents the western equivalent of the Qiangtang terrane (Pognante, 1990; Searle et al., 2010); however, so far, no crustal xenoliths have been reported from the northern Karakoram terrane.

The hereby presented preliminary petrographic data on crustal xenoliths hosted by lamprophyric dykes (Fig. 1a) from the Shaksgam valley, northern Karakoram terrane (Xinjiang, China), provide new important information on the composition of the deep, intermediate and upper crust beneath the western segment of the Himalayan-Tibetan collisional belt.

The lamprophyric dykes are mostly porphyritic minettes, consisting of abundant phlogopite fenocrysts set in a fine-grained groundmass consisting of K-feldspar ± phlogopite ± augitic clinopyroxene ± amphibole ± aegirinic clinopyroxene ± plagioclase (Fig. 1b,c). The lamprophyric dykes host various types of xenoliths sourced at different depths, from the deep to the intermediate and lower crustal levels, and variably affected by the thermo-metamorphic effects induced by the dyke intrusion.

Most of the analysed xenoliths are of deep crustal origin and include:

(i) apatite-bearing clinopyroxenite: this xenolith is mostly composed of clinopyroxene (> 90 vol%), apatite and minor phlogopite (Fig. 1d); its genesis remains uncertain, although the abundant occurrence of coarse-grained apatite suggests a deep crustal rather than a mantle source;
(ii) basic granulite: this xenoliths consists of clinopyroxene, garnet, plagioclase and magnetite (Fig. 1e) and reflects thermobaric conditions typical of the deep crust;
(iii) acid granulites (Qtz + Kfs + Grt + Pl): these xenoliths are characterized by the presence of abundant K-feldspar (up to 40 vol%) and garnet (up to 30 vol%) (Fig. 1f), the almost complete lack of hydrous minerals (biotite < 2 vol%) and by the local occurrence of relict kyanite. Rutile and graphite are common accessory minerals. Microstructures and mineral assemblages suggest that these acid granulites may represent the restitic product of a former pelitic protolith that experienced high pressure dehydration melting.

Cite as: Botta, S., Groppo, C., Rolfo, F. and Ferrando, S., 2014, Petrographic study of the xenoliths hosted within lamprophyric dykes from the Shaksgam Valley (Xinjiang, China), in Montomoli C., et al., eds., proceedings for the 29th Himalaya-Karakoram-Tibet Workshop, Lucca, Italy.

Xenoliths from intermediate to upper crustal levels include:

(i) biotite ± garnet gneiss: microstructures and mineral assemblages suggest that these xenoliths derive from a igneous protolith (e.g. granodiorite) re-equilibrated under high-temperature amphibolite-facies P-T conditions.

(ii) thermo-metamorphosed quartzitic-sandstone: this is a sedimentary rock with a well-preserved clastic structure, showing pervasive effects of the thermo-metamorphism induced by the dyke.

Overall, the analysed xenoliths allow to reconstruct a quite complete crustal section from the deeper to the upper structural levels; microstructures and mineral assemblages suggest derivation of the xenoliths from subducted ultrafemic, basic, granodioritic and pelitic crust that experienced variable degree of high pressure dehydration melting and metamorphic re-equilibration at different depths and at different P-T conditions.

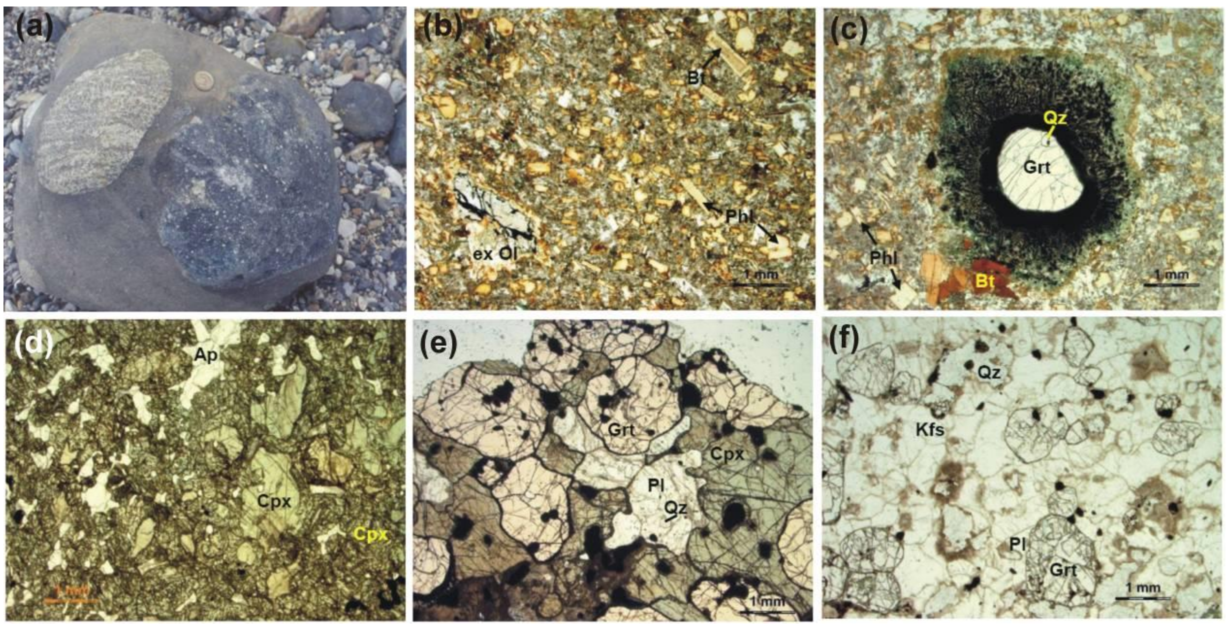

Figure 1. (a) Crustal xenoliths hosted by a lamprophyric dyke. (b-f) Representative microstructures (optical microscope, Plane Polarized Light) of the lamprophyric dykes (b,c) and of the xenoliths (d: Ap-clinopyroxenite; e: basic granulite; f: acid granulite).

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