Zoned ultramafic intrusions of the Chilas Complex in Kohistan (NE Pakistan): Mantle diapers and km-scale melt conduits in extending island arcs

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The Kohistan terrane in NE Pakistan is a fossil oceanic island arc that was trapped during the Himalayan orogeny between the colliding Indian and Asian plates. The Chilas Complex is reported to be the largest (300x30 km^2) mafic-ultramafic intrusion into this paleo-arc. From field and geochemical evidences, the Chilas Complex is regarded to have emplaced during intra-arc rifting. It is subdivided into homogeneous gabbro/gabbronorite enclosing zoned mafic-ultramafic units (UMA). We present field, Sr and Nd isotope measurements and mineral major (EMP) and trace element (La-ICPMS) analyses to evaluate the complicated relationships between the gabbronorite and the UMA.

Field observation gives evidence for upward flow of the UMA with respect to the layered gabbroic sequence. In map view the UMA units have a dike-like shape and are in line, along strike, with hornblendite pegmatites. Across strike the UMA dike-like bodies have a 5-10 km periodicity.

The gabbro, which displays a predominantly magmatic fabric, is composed of plagioclase, clinopyroxene, spinel and amphibole (grain size ~0.5 cm). Appearance of orthopyroxene defines gradual changes into gabbronorite towards the steep contacts with UMA. The UMA are dominantly dunites composed of olivine and spinel. Field observations reveal two settings for associated amphibole-bearing lherzolites. Some are relictual into dunite. The others result from infiltration of a basaltic melt reacting with dunite. Pyroxenites at the contact with the gabbronorite are ultimate products of these reactions. The basaltic melts infiltrating the UMA are parental to the gabbro/gabbronorite.

Preliminary Sr and Nd isotopic data indicate a common, slightly depleted reservoir for both the gabbro/gabbronorite and the UMA. A Sm-Nd whole rock clinopyroxene-plagioclase isochrone yields an "age" of 102 ± 15 Ma, older than the reported ca. 85 Ma crystallization age of the Chilas Complex. In effect, the orthopyroxene isotopic chemistry indicates that the Sm-Nd system has been disturbed by a recent event. Laser-ablation ICPMS trace element mineral analyses have a discrete subduction signature in both UMA and gabbro/ gabbronorite rocks. However, the melt calculated for equilibrium with clinopyroxene has a strong affinity with MORB.

Field, petrological and geochemical data are in accordance with melts derived from a shallow mantle and subsequent fractional crystallization at 6-7 kbars. Melts percolated amphibole-bearing lherzolites to produce dunites and feed the Chilas gabbro/gabbronorite; later cooling triggered new reactions between melts and olivine to produce reactional lherzolites. Accordingly, the Chilas UMA are interpreted as rising mantle diapirs channeling magmas parental to the surrounding gabbro/gabbronorites.