Petrology and geochemistry of some unusual corundum-bearing garnet pyroxenites from Ronda lherzolitic Massif (Spain)

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The Betic Cordillera (Southern Spain) is characterized by the outcropping of series of ultramafic massifs. The Ronda massif is the largest surface exposure (~300 km^2) of peridotite on Earth and consists of lherzolite associated with harzburgite and minor dunite, interpreted as residues of partial melting. Less than 5% of pyroxenites occur within the peridotite as layers or lenses with variable thickness (<1 cm to ~3 m). These pyroxenites are characterized by great variability of mineral assemblages and chemical compositions. Their origin and their petrologic evolution are still in debate. The pyroxenites were previously interpreted as melts extracted from the surrounding peridotites with multi-stage model involving melting, crystallization and remelting (e.g. Loubet and Allègre, 1982). Suen and Frey (1987) suggested that the pyroxenites represent a sequence of cumulates derived from crystal/liquid fractionation at high pressure along the walls of magma conduits from melts migrating through the peridotites. Other authors considered some pyroxenites as melts/residues of subducted oceanic lithosphere (e.g. Polvé and Allègre, 1980; Kornprobst *et al.*, 1990; Pearson *et al.*, 1993).

This study has generated interest in garnet pyroxenites from Ronda massif as a result of the discovery of corundum in some garnet clinopyroxenites. The objectives are to define the mineralogy of these rocks and to present geochemical data (major, trace elements, *REE*, and PGE) in order to discuss their origin and their petrologic evolution.

Petrography and geochemistry

Corundum-bearing garnet clinopyroxenites studied here were collected from the northwestern area of the

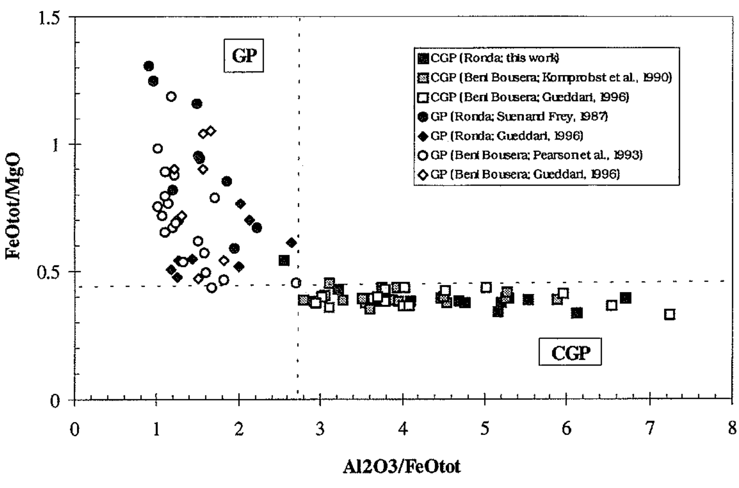

FIG. 1. $FeO_{tot}/MgO-Al_2O_3/FeO_{tot}$ diagram showing the co-existence of two garnet pyroxenites groups in both Ronda and Beni Bousera ultramafic massifs. GP: garnet pyroxenites; CGP: corundum-bearing garnet clinopyroxenites.

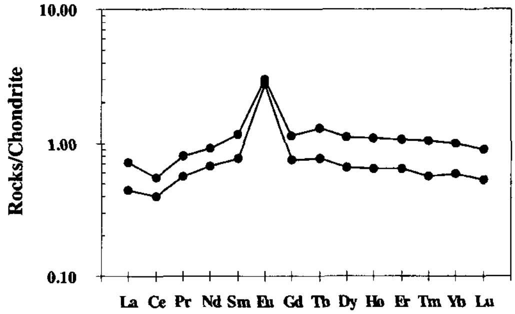

FIG. 2. Rare earth elements (*REE*) patterns field of some corundum-bearing garnet clinopyroxenites from Ronda massif.

Ronda massif associated with garnet lherzolite facies. Similar rocks have been sampled and studied by Kornprobst *et al.* (1990) in Beni Bousera massif (Morocco). These rocks show a fine petrographic zonation and granuloblastic texture. In general, two mineralogical levels have been observed: clinopyroxene-garnet-plagioclase and clinopyroxene-corundum-plagioclase-garnet-(spinel). Clinopyroxene forms a mosaic and is highly aluminous (Al_2O_3: 10.1 to 16.2%). Garnet is always surrounded by rims of kelyphite and can be completely replaced by kelyphites. The composition of relict garnet is variable and is richer in pyrope (~65–68%) in the zones containing corundum. Two types of corundum have been observed (corundum (I) and corundum (II)). The plagioclase is An_{43} to An_{50} in composition. The spinel is rich in Mg and is systematically associated with corundum.

The corundum-bearing garnet clinopyroxenites from Ronda massif have a specific chemical composition and define a separate group of pyroxenites which is similar to Beni Bousera pyroxenites type II studied by Kornprobst *et al.* (1990) and Gueddari (1996). In opposition to most grenatiferous pyroxenites studied previously in Ronda and Beni Bousera massifs, our samples are characterized by high Al contents and low Fe contents ($Al_2O_3/FeO_{tot} > 2.7$ and $FeO_{tot}/MgO < 0.45$) (Fig. 1). This composition resembles those of peraluminous eclogites or grospydites in kimberlites. The corundum-bearing garnet clinopyroxenites are also depleted in Y and heavy rare earth elements (*HREE*) and show positive Eu anomalies (Fig. 2). Their platinum-group elements (PGE) abundance patterns, which are similar to MORB or to some gabbroic rocks, display pronounced PGE and Au depletion (ΣPGE = 2–7.3 ppb). This depletion can be related to segregation of small amounts of sulphides (Pt, Pd, Rh, Au) and to early fractionation of Ir and Ru.

Conclusion

Despite containing garnet and clinopyroxene, the corundum-bearing garnet clinopyroxenites have geochemical characteristics which are not consistent of garnet and pyroxene fractionation at high pressure (e.g. Suen and Frey, 1987). Such characteristics suggest an origin from plagioclase-rich mafic precursors. The present 'primary' assemblage of clinopyroxene-garnet-corundum (I) could be generated by progressive *PT* evolution of these precursors in the garnet lherzolite facies conditions during subduction. By contrast, the plagioclase, spinel and corundum (II) development and the kelyphite formation probably took place when the Ronda peridotite massif ascended from the upper mantle to the crust.

References

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