

Re-Os systematics in orogenic peridotite massifs and constraints on the petrogenesis of pyroxenites

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Orogenic lherzolites are considered to represent large portions of the upper mantle that have been tectonically emplaced in the crust. They are composed of lherzolites, harzburgites, dunites and small proportions of pyroxenites of variable thickness and composition. The study of such massifs has provided much information on the spatial distribution of geochemical variations in the upper mantle. Because of the extreme compatibility of osmium and its resistance to secondary effects like metasomatism and retrograde alteration, the Re-Os isotopic system provides an additional perspective to help understanding the origin of orogenic lherzolites massifs.

Here we investigate, Re-Os concentrations and isotopic compositions of peridotites and pyroxenites from three ultramafic massif: Beni-Bouza (North Morocco), Ronda (South Spain) and Lherz (French Pyrenees).

The Os isotopic ratios ($^{187}\text{Os}/^{186}\text{Os}$) for the peridotites range from 0.951 to 1.102 in good agreement with data published previously and with upper mantle value, while the concentration range from 0.531 to 8.740 ppb and is in general higher than those encountered in mantle xenoliths. It is widely admitted that orogenic massif come from the asthenospheric mantle that accreted into the lithosphere sub-continental (SCLM) via limited diapiric upwelling. Subsequently the correlation between Os isotopic ratios and Mg# or Al_2O_3 may result from ancient melt extraction (Fig. 3).

Our study of mafic layers has focused on two family of pyroxenites: spinel websterites and garnet pyroxenites. The garnet pyroxenites are more differentiated than spinel websterites and have high concentration in Al_2O_3 , CaO end V and low concentration in MgO, Ni and Co. The osmium isotopic ratios of garnet pyroxenites range from 1.752 to 12.352 (Fig. 2). These values are higher than those encountered in the websterites (from 1.058 to 1.904) and are the result of a large Re/Os fractionation (160 to 900).

Among the mafic samples, Os isotopic ratios are found to decrease strongly with increasing Os concentration. The negative correlation obtained between Re/Os and Mg# confirms the incompatible nature of Re.

The pyroxenites data of Beni-Bouza show a positive correlation ($R^2 = 0.97$, Fig. 1) between $^{187}\text{Os}/^{186}\text{Os}$ and $^{187}\text{Re}/^{186}\text{Os}$ ratios which yield an apparent 'age' of 700 ± 55 Ma. This age is in agreement with the model age obtained with ^{206}Pb - ^{207}Pb systematics for the same massif (590 ± 150 Ma; Hamelin and Allègre, 1988) and may reflect the time when was incorporated in the non-convecting SCLM. This event is younger than the stabilisation of the Ronda ultramafic massif deduced for Os isotopes (~1.2 Ga, Reisberg and Lorand, 1995).

The high Os isotopic ratios in mafic layers suggesting that this material cannot represent recent partial melting, or cumulates derived from recent melt of the surrounding ultramafic rocks. They provide evidence for a process that occurred at least hundreds of millions of years ago.

Comparison of the Os and Pb data for the peridotites and pyroxenites with the range observed in oceanic basalts shows that the radiogenic ratios in basalts could be produced by a mixture of peridotite-pyroxenite in the source which lends support to the hypothesis that the lithologies found in orogenic massifs are representative of the upper mantle, the 'marble cake' model (Allègre and Turcotte, 1986).

However, the geochemical characteristics of pyroxenites, the zonation observed in some mafic layers and the positive correlation observed between the model age versus thickness (Fig. 4) suggests that this material represent high-pressure crystallization from melts of subducted oceanic crust (Pearson *et al.*, 1993). Although in the basis of FeO-MgO- Al_2O_3 systematics, small proportion of Beni-Bouza pyroxenites may represent subducted, metamorphosed oceanic crust directly recycled into the mantle (Kornprobst *et al.*, 1991).

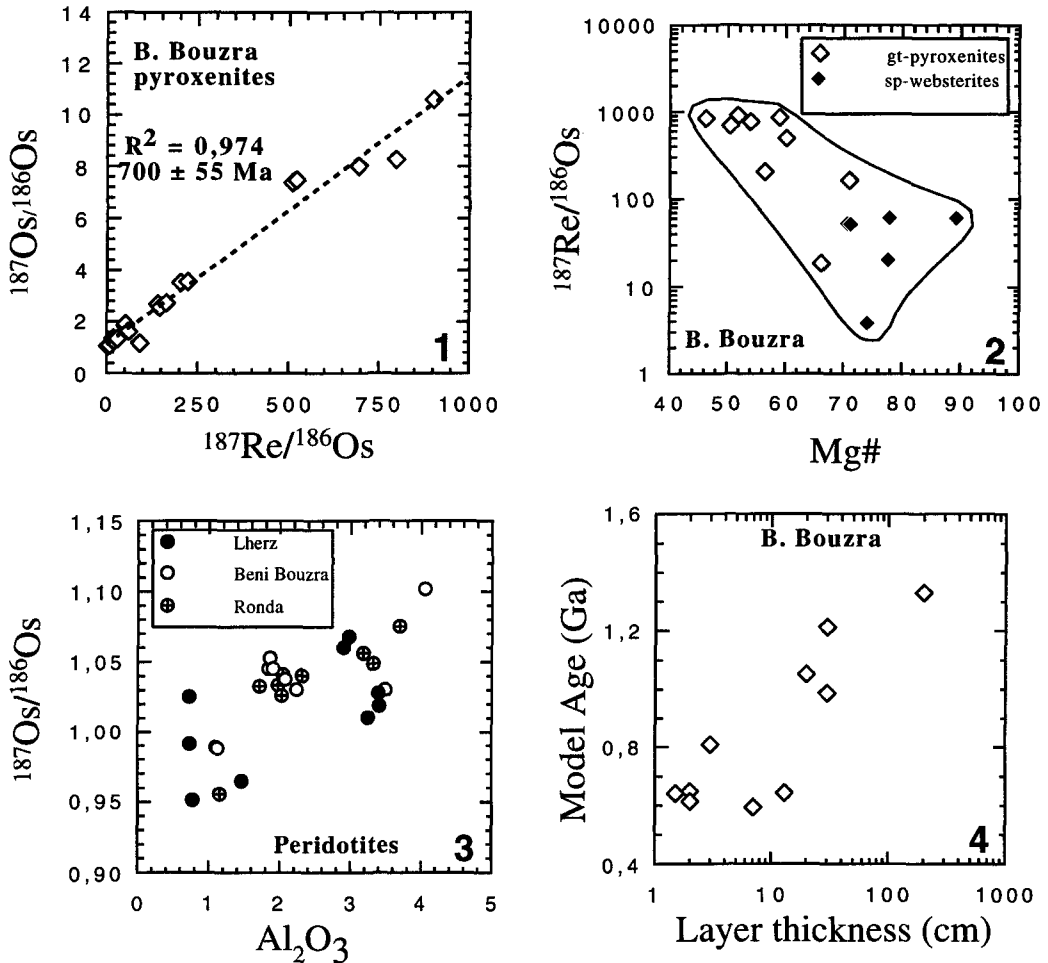


FIG.

Isotopic and elemental data have been obtained for minerals (cpx, gt) separated from garnet-pyroxenites. These results indicate that silicate phases dominate the Re budget and that their Re/Os ratios is always higher than the whole rock, especially for garnet. The low Os concentration in minerals (down to few ppt) show that sulphides dominate the Os budget in mantle rocks. This distribution led to a spatial and temporal decoupling of Re and Os in agreement with the work of Burton *et al.*, (submitted).

References

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