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Trace elements and isotopes from Middle Atlas xenoliths (Morroco) : Lithosphere-asthenosphere interaction processes

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The Neogene-Quaternary Middle Atlas province is the largest and youngest volcanic field of Morocco. It extends along a NE-SW strip and covers a surface of ca. 960 km2. Emitted lavas range in composition from nephelinites to subalkaline basalts and brought to the surface a large variety of mantle xenoliths. Different geodynamical models have been previously proposed to explain the geodynamical environment of this area and the nature of the mantle underneath: contribution of the Canary plume via lithospheric channels, subduction or lithospheric thinning. In the present study twenty mantle xenoliths from nine different volcanic localities have been selected in order to sample the variety of petrography, temperatures, and associated eruptive dynamism. The selected xenoliths are mainly lherzolites, but also include one harzburgite, wherlite and one pyroxenite. A multi-method geochemical approach (major and trace elements & Sr-Nd-Pb-Hf isotopes on clinopyroxenes and whole-rocks (WR)) was conducted and combined with deformation and petrographic constraints. Various textures have been recognized such as mylonitic, protogranular, porphyroclastic primary or secondary, with most samples yielding multiple textures. Melts pockets have been observed in different samples. Three main types of samples can be defined on the basis of the whole-rock trace elements distribution: i- samples with variable, slight to strong, enrichment of LREE coupled to a flat tendency of MREE and HREE (1.6<La/Nd<7 and 0.6 <Sm/Yb<0.9), ii- samples with variable degree of enrichment from MREE to LREE, flat HREE and HFSE negative anomalies, iii- samples with a U-shaped profile and negative HFSE anomalies. Comparison between WR and in situ-CPX REE patterns allows us to distinguish two distinct tendencies: equilibrium between WR and CPX patterns, and disequilibrium between WR and CPX and, in particular, a strong LREE-enrichment of the WR pattern. Sr isotopes for both WR and CPX show very low ratios and define a very limited range of variation (0.7023<87Sr/86Sr<0.7035). All samples, except three, yield 143Nd/144Nd ratios ranging from 0.512837 to 0.513301. Reported on the Nd-Sr diagram, they define a field extending between the DMM and HIMU compositions. One sample displays a significantly higher 143Nd/144Nd ratio of 0.513929. Two other samples yield very low ratios (∼0.5126) suggesting a possible contribution of carbonatites. Pb isotopic ratios are high and define a very restricted range with 208Pb/204Pb ranging from 38.87 to 40.54, 207Pb/204Pb from 15.59 to 15.64, and 206Pb/204Pb from 19.08 to 20.29. These radiogenic Pb signatures are similar to the HIMU composition. The LREE budget of metasomatised samples is provided by a neoformed phase finely crystallised in the peridotite matrix. One volcanic site, located on a shear-zone, samples all types of mantle xenoliths found in other Middle Atlas volcanoes. This study suggests a geodynamical model with variable components contribution, i.e. lithospheric mantle and plume. Moreover it clearly underlines the occurrence of multiple metasomatic processes with an earlier percolation of silicate melts and possibly later carbonatitic interaction.