A combined U-Pb-zircon, Pb-Pb-Nd Isotope investigation on the Masirah ophiolite, Oman: indications for generation of acidic rocks by pure differentiation of a depleted mantle source

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Introduction

Field- and sedimentary evidence within the Masirah ophiolite complex, Oman, established generation of oceanic crust $\geq$140 Ma (faunal evidence; Immenhauser, pers. comm., 1994) and the presence of two superposed nappes of oceanic crust (Marquer *et al.*, submitted). Most data discussed here are from the upper nappe. This upper nappe contains rocks of at least three different magmatic events: 1) generation of oceanic crust >140 Ma; 2) alkali magmatism and 3) emplacement of real K-spar granites.

Results

ε_{Nd}[150 Ma] values of a variety of different rock types (i.e. troctolite, different gabbros, anorthosite, dolerite, pillow basalt, pegmatitic gabbro and granite) range from +7 to +9.7. The respective Nd-model age calculations indicate derivation from upper mantle between 160 Ma and 300 Ma. The poor resolution is inherent in the system, as young model ages are always strongly dependent on the used depleted mantle model and error magnification is large. The different rock types show Nd contents from 0.16 (troctolite) to 64.5 ppm (pegmatitic gabbro with large amphiboles). They can be broadly subdivided into three different groups: I) rocks still showing Nd isotopic characteristics of depleted mantle (troctolite, gabbros, pillow basalt; $^{147}Sm/^{144}Nd \approx 0.2$) II) rocks with ε_{Nd}[0] values around +8 (pegmatitic gabbro, fine-grained gabbro, dolerit; $^{147}Sm/^{144}Nd \approx 0.17$) and III) acid rocks with ε_{Nd}[0] values in the range of +5 to +6 (anorthosite, granite; $^{147}Sm/^{144}Nd \approx 0.08$). One gabbro (F-22) shows a relatively low ε_{Nd}[0] value of 6.55. Taking into account that published data from samples from Atlantic Mid Ocean Ridge basalts and basaltic glasses give a range of 6 ε_{Nd} units the offset of F-22 can most easily be explained as natural variation within oceanic crust. A continental crust contribution to this gabbro is not likely due to its tectonic position. Even if such a mixing is considered, the crustal component would be only a fraction of 1% due to the very low Nd content of the gabbro (< 0.4 ppm) (see discussion of the granite below).

U-Pb zircon data of a trachyte from the alkali volcanic suite give a magmatic age of 123 $\pm$ 2 Ma. One granite is significantly younger than 140 Ma (112 $\pm$ 10 Ma) and its Pb isotopic composition, corrected accordingly, also indicate a MORB-type source.

Discussion

The tectonic setting of the acidic rocks and their initial Pb and Nd isotopic composition as well as the lack of correlation between Nd contents and isotopic composition exclude a significant admixture of continental material, although the sensitivity of the isotopic data towards such a contamination is large due to the extremely low Pb, U and REE concentrations (Pb: 0.008 ppm to 2.55; U: 0.002 ppm to 1.74; Nd: 0.16 ppm to 65 ppm.).

The initial isotopic ratios of all samples of this study are found to fall in the fields containing the probable average composition of the upper mantle in terms of Pb and Nd according to Zartman and Haines (1988) (Fig. 1). Thus the whole suite - including the granite can be interpreted as purely mantle derived. However, if the mantle is modeled more narrowly (Fig. 1) the question of a continental crust contribution to the source of the granite arises. Taking the mean of massif gabbros and troctolite of the Masirah ophiolite as representative for the mantle and upper crust values form Zartman and Haines (1988) as representative of the contaminating continental crust, a maximum contamination can be modeled. Up to 12% (12%) of the Nd (Pb) present in the granite could thus be of continental origin. As the concentration of Nd (Pb) in the upper continental crust is more than 120 times (460 times) that of the

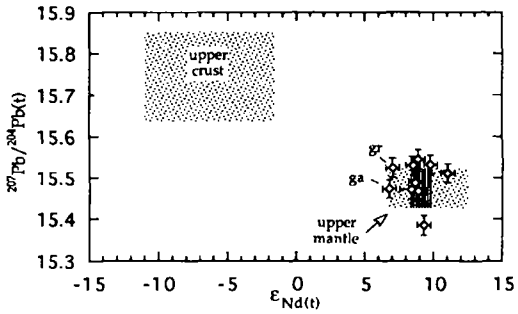

FIG. 1. Initial $^{207}Pb/^{204}Pb$ versus $\varepsilon_{Nd}[t]$ values from rocks the Masirah ophiolite/Oman. Upper crust and upper mantle fields after Zartman and Haines (1988). The narrow, hatched Nd range of the mantle field is defined by the depleted mantle model of Goldstein *et al.* (1984) and DePaolo *et al.* (1991). gr: granite; ga: gabbro F-22.

Masirah ophiolite, the continental crust contribution to the generation of the granite must have been significantly below 0.2%. The initial isotopic signatures of the granite can however easily by explained without any crustal component, assuming granite derivation from a F-22 like mantle source.

Conclusions

At the present state of the investigation, the evolution of the ophiolite is assumed to have taken place as follows: Partial melting of upper mantle material and generation oceanic crust occurred $\geqslant 140$ Ma. About 123 Ma ago alkali magmatism occurred probably due to a hot spot activity with possible addition of new oceanic crust, and at *c.* 112 Ma granites were formed. Moreover, the present study reveals the likelihood of granite generation within the oceanic environment without addition of material from the continental crust.

References

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