Ofioliti, 1999, 24 (1a), 180-181

TRACE ELEMENT AND ND-SR ISOTOPE GEOCHEMISTRY OF THE GABBROIC ROCKS FROM THE NORTHERN APENNINE OPHIOLITES: GEOCHRONOLOGY AND RELATIONS WITH ASSOCIATED PERIDOTITES

Riccardo Tribuzio*,** and **Matthew F. Thirlwall*****

** Dipartimento di Scienze della Terra, Università di Pavia, Via Ferrata 1, 27100 Pavia, Italy.*
*** C.N.R - Centro di Studio per la Cristallochimica e la Cristallografia, Via Ferrata 1, 27100 Pavia, Italy.*
**** Department of Geology, Royal Holloway, University of London, Egham TW20 0EX, UK.*

ABSTRACT

The Northern Apennine ophiolites crop out in different stratigraphic settings. The petrological and geochemical features of the mantle-gabbro association are well known for the ophiolites of the Internal Liguride Units (Rampone et al., 1998). The mantle ultramafics are mainly clinopyroxene-poor plagioclase-bearing lherzolites, residual after the extraction in Permian times of MORB-type liquids, which were intruded in Middle Jurassic times by N-MORB-type gabbros. The mantle ultramafics of the ophiolites from the External Liguride Units dominantly consist of rather fertile plagioclase-bearing lherzolites with pyroxenite bands (Rampone et al., 1995), and they are considered as slices of subcontinental mantle, probably accreted to the lithosphere in the Proterozoic. Little is known about the rare gabbroic rocks from the External Liguride ophiolites, as well as about the mantle ultramafics from the ophiolites which crop out in Southern Tuscany. In this work, we have carried out trace-element and Nd-Sr isotopic investigations of i) the gabbro-peridotite association from Southern Tuscany ophiolites (Lanciaia Unit), and ii) the gabbroic rocks from the External Liguride ophiolites. This has allowed us to depict a complete overview of the gabbro-peridotite association of the Northern Apennine ophiolites.

The gabbroic rocks from the different Units contain clinopyroxenes with similar trace element compositions, that yield N-MORB equilibrium liquids. Moreover, clinopyroxenes show marked trace element zonings, similarly to what was observed for the gabbroic rocks from ODP Leg 153 in the MARK area (Ross and Elthon, 1997), most likely related to the entrapment of interstitial liquid (Tribuzio et al., 1999). The gabbroic rocks considered in this study give Sm/Nd mineral isochron ages ranging from 179 to 170 Ma, interpreted to date the primary magmatic crystallization. These ages are significantly older than those recently found (163 ± 2 to 166 ± 2 Ma) on the basis of U/Pb and Ar/Ar geochronological determinations on zircons and amphiboles for the gabbroic rocks of the Western Alps ophiolites (Bill et al., 1997; Rubatto et al., 1998). $^{87}Sr/^{86}Sr$ of clinopyroxenes and initial ε_{Nd} (8.5 to 8.9) are consistent with a formation from N-MORB. The gabbroic rocks from Internal Liguride ophiolites and the basalts (Rampone et al., 1998) from both Internal and External Liguride ophiolites show closely similar initial εNd. The incompatible trace element compositions of basalts from the different Units resemble those calculated for the parental liquids of the gabbroic rocks.

The studied peridotites from Southern Tuscany ophiolites are porphyroclastic spinel-lherzolites. These rocks have a residual geochemical fingerprint, as shown by the marked depletion in incompatible trace elements of clinopyroxenes, similarly to what was observed for the Internal Liguride lherzolites. The clinopyroxenes from the southern Tuscany lherzolites indeed have slightly lower Sm/Nd values and slightly higher Sr contents than those from the Internal Liguride lherzolites. Major element mineral compositions of Southern Tuscany lherzolites yield relatively low-temperature estimates for the spinel-facies equilibration (ca. 1000 °C), similarly to those found for the External Liguride lherzolites. On the other hand, the latter rocks cleary differ from the Southern Tuscany lherzolites in the occurrence of accessory Ti-rich amphibole and in the fact that clinopyroxenes have markedly higher concentrations of incompatible trace elements.

Nd and Sr isotopic compositions of clinopyroxenes from the Southern Tuscany lherzolites calculated at 170 Ma are respectively higher (ε_{Nd} ca. 11.0) and lower than those of associated gabbros. Therefore, there is not a genetic melt-residue relationship for this gabbro-peridotite association, as inferred by Rampone et al. (1998) for the Internal Liguride ophiolites. The clinopyroxenes from the External Liguride lherzolites are characterized by markedly heterogeneous Nd and Sr isotopic compositions, coupled with a relatively constant Sm/Nd value (Rampone et al., 1995). Similar geochemical relations have been also observed for the Lanzo lherzolitic massif in the Western Alps (Bodinier et al., 1991). In the External Liguride Units, the clinopyroxenes from the Monte Nero lherzolite body, which is locally intruded by gabbroic to basaltic dykes, display Nd and Sr isotopic compositions that are consistent with those of analyzed gabbroic rocks.

As a whole, the ophiolites of the Northern Apennine/Western Alps system are characterized by a homogeneous composition of the gabbroic complex and by a marked heterogeneity of the associated mantle section. The compositional spread of the mantle lherzolites can be related to two major events: 1) partial melting at 300-270 Ma, in relation to the post-Variscan extensional regime; 2) partial re-equilibration with N-MORB liquids derived from deeper astenospheric sources at 180-160 Ma.

REFERENCES

Bill M., Bussy F., Cosca M., Masson H. and Hunziker J., 1997. High-precision U/Pb and $^{40}Ar/^{39}Ar$ dating of an Alpine ophiolite (Gets nappe, French Alps). Ecl. Geol. Helv., 90: 43-54.

Bodinier J.L., Menzies M.A. and Thirlwall M.F. 1991. Continental to Oceanic Mantle Transition - REE and Sr-Nd Isotopic Geochemistry of the Lanzo Lherzolite Massif. J. Petrol., Spec. Lherz. Issue, 191-210.

Rampone E., Hofmann A.W., Piccardo G.B., Vannucci R., Bottazzi P. and Ottolini L., 1995. Petrology, mineral and isotope geochemistry of the External Liguride peridotites (northern Apennine, Italy). J. Petrol., 36: 81-105.

Rampone E., Hofmann A.W. and Raczek I., 1998. Isotopic contrasts within the Internal Liguride ophiolite (N. Italy): the lack of a genetic mantle-crust link. Earth Planet. Sci. Lett., 163: 175-189.

Ross K. and Elthon D., 1997. Cumulus and postcumulus crystallization in the ocean crust: major- and trace-element geochemistry of leg 153 gabbroic rocks. In: Karson J.A., Cannat M., Millet D.J., Elthon D. (Eds.) ODP Sci. Results, 153: 333-350.

Rubatto D., Gebauer D. and Fanning M., 1998. Jurassic formation and Eocene subduction of the Zermatt-Saas-Fee ophiolites. Implications for the geodynamic evolution of the Central and Western Alps. Contrib. Mineral. Petrol., 132: 269-287.

Tribuzio R., Tiepolo M., Vannucci R. and Bottazzi P., 1999. Trace element distribution within olivine-bearing gabbros from the Northern Apennine ophiolites (Italy): Evidence for post-cumulus crystallization in MOR-type gabbroic rocks. Contrib. Mineral. Petrol., 134: 123-133.