

Geochemistry of the lower crustal mafic-ultramafic complex at Finero, Ivrea Zone, N. Italy

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Introduction

In the Ivrea-Verbano Zone, mantle-derived mafic rocks have been emplaced in the lower continental crust in contact with mantle peridotite bodies and granulite-facies metasedimentary rocks. One of these bodies, the mafic intrusion in the Sesia valley near Varallo and Balmuccia, previously investigated by Voshage *et al.* (1990) and Quick *et al.* (1992), probably intruded 270 to 290 Ma ago and assimilated large amounts of crustal material by triggering extensive crustal anatexis. We have studied the mafic-ultramafic complex near Finero in order to compare it with the intrusion near Varallo and Balmuccia. Previous work by Voshage *et al.* (1987) indicated that in contrast with Balmuccia, the phlogopite-bearing mantle peridotite at Finero contains crustal-type isotopic signatures. This mantle peridotite forms the core of an antiformal and is overlain by the three subunits of the mafic complex, the strongly layered inner gabbro, the cumulus amphibole peridotite and the massive external gabbro.

Analytical methods and results

Major element abundances were analyzed by XRF; REE and other trace elements were

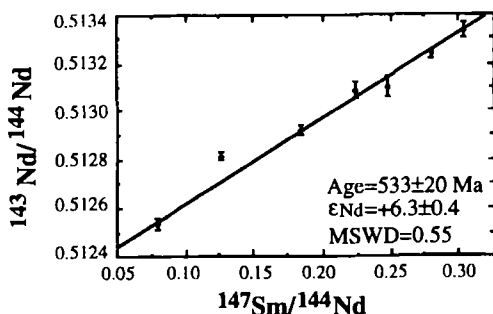


FIG. 1. Sm-Nd bulk-rock apparent isochron for the amphibole peridotite of the mafic-ultramafic complex at Finero.

analyzed by isotope dilution-spark source mass spectrometry (ID-SSMS, Jochum *et al.*, 1988). Sr and Nd isotope analyses were performed on Finnigan-MAT 262 mass spectrometers equipped with multiple ion collectors.

Six samples of the amphibole peridotite yield an apparent Sm-Nd whole-rock isochron of 533 ± 20 Ma (Fig. 1), which we tentatively interpret as the age of intrusion and differentiation of the mafic complex. The isotopic data of the external gabbro also cluster around this isochron with an initial $\epsilon_{\text{Nd}} = +6 \pm 2$. Thus it appears that the Finero mafic complex may be much older than the complex in the Sesia Valley and it shows no sign of significant assimilation of or contamination by the overlying continental crust.

Several internal Sm-Nd isochrons involving garnet, feldspar, amphibole and clinopyroxene yield ages of about 220 Ma, consistent with a late heating event also indicated by a zircon U-Pb age from a syenite intrusion in the phlogopite peridotite (Stähle, 1990).

The mantle-normalized trace element abundances of the external gabbros are surprisingly uniform (Fig. 2). With the exception of relatively high Cs and Rb concentrations (which may be related to secondary alteration or, alternatively, to some cryptic alkali metasomatism) these trace element data show no negative Nb anomalies, positive Pb anomalies, or other signs of crustal contamination. The concentration patterns bear a general resemblance to N-MORB patterns, but Th and U are more highly depleted and Pb, Sr and Eu have deeper negative anomalies than in MORB. These latter anomalies are probably the result of the precipitation of cumulus feldspar, which is prominent in the inner gabbros. The general smoothness of the trace element patterns indicates that the external gabbros approximately represent the composition of the liquid from which they crystallized.

Discussion

The unexpectedly high emplacement age derived

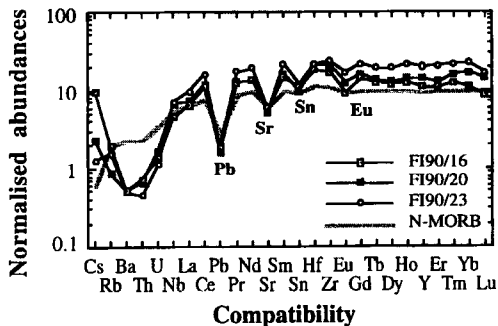


FIG. 2. Trace element concentrations of the external gabbros normalized to primitive mantle (Hofmann, 1988).

from the whole-rock isochron, if it is indeed an isochron, as well as the chemical contrasts between the mafic units at Balmuccia and Finero, may mean that there is no direct genetic relationship between the different mafic-ultramafic associations in the Ivrea-Verbano Zone. This is reinforced by the isotopic and chemical contrasts between the phlogopite peridotite, which was strongly metasomatized by crustal-type fluids, and the intrusive complex, which lacks any evidence for any phlogopite metasomatism. This means that the two bodies were brought into tectonic contact after the cessation of the metasomatic event, which occurred probably about 290 Ma ago as indicated by the Rb-Sr isochron of the phlogopite peridotite

(Voshage *et al.*, 1987).

The anomalously low abundances of Th and U in the gabbros are reminiscent of the gabbros from Oman (Chen and Pallister, 1981). Very low Th and U concentrations also characterize the mafic body near Balmuccia (Obermiller, unpublished data), and this might be a general feature of lower-crustal gabbros. On the other hand, the negative Sr and Eu anomalies of the Finero gabbros have no obvious analogues at Balmuccia. Apparently, the magma chamber at Finero solidified as a closed system with little or no assimilation of crustal material.

References

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