Chemical Signature Of Migmatite-Related Melts Migration In Lower Mafic Crust: Mineral Geochemistry And Zircon Dating Constraints (Variscan Lower Crust, SW Calabria, ITALY)

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Geological sketch map of Calabria, slightly modified after *Festa et al., Geol. J.,* (2015)

Geological sketch map of the Palmi area, slightly modified after *Caggianelli et al., Geol. Field Trips,* (2013)
migmatitic paragneiss

Pietre Nere main gabbro body
Pietre Nere (PN) main gabbro body

- Weakly foliated, coarse- to medium-grained portions
- Foliated, fine-grained portions are also locally present
- An-rich plagioclase (An_{80-88}) frequently developing triple junctions
- Anhedral amphibole and subhedral biotite
- Accessory zircon + ilmenite ± allanite
Migmatitic paragneiss

- Paragneiss: peak metamorphic assemblage: Bt + Kfs + Grt + Sill
- Decimeter-thick layers of fine-grained gabbro
- An-rich plagioclase (An_{86-89}) frequently developing triple junctions
- anhedral amphibole and subhedral biotite
- minor quartz
- accessory zircon + ilmenite + allanite
This study reports **major and trace element mineral data** with **U-Pb zircon dating** of the gabbros.

Data were mainly examined to investigate:

- the chemical effects triggered by the migration of migmatite-related melts into lower mafic crust
- their relationship with grain size and foliation variation
Concordia Age = **301.6 ± 2.5 Ma**

*2σ, decay-const. errs included*

MSWD (of concordance) = 0.88

Probability (of concordance) = 0.35

**Fine-grained gabbro from the Pietre Nere main body**
U-Pb Zircon dating

Fine-grained gabbro from the Pietre Nere main body

Weighted average

= $281.2 \pm 4.7$ 2σ

N = 8; MSWD = 1.5, probability = 0.18
Amphibole consists of cummingtonite grading into hornblende on the rims.
In the main gabbro body the amphibole shows decreasing Mg# from the coarse-grained to the medium- and fine-grained portions.

Amphibole from the gabbro interlayered with the paragneiss shows the lowest Mg#.
- Cummingtonite from the gabbro interlayered with the paragneiss has a highly evolved REE geochemical signature.
- Deep negative Eu anomaly $\Rightarrow$ extensive plagioclase fractionation.
- LREE-depletion $\Rightarrow$ LREE-rich phase (i.e., allanite) fractionation.
It has been experimentally demonstrated that cummingtonite coexists with a liquid of rhyolite composition at temperatures below 780°C (Nandedkar et al., Contrib. Mineral. Petr., 2016).

\[ \text{Opx} + \text{Qtz} + \text{H}_2\text{O} \rightarrow \text{Cumm} \]  

(Metagasite, Sila Massif, Graessner & Schenk, J. Petrol., 2001)

Low Mg#, highly evolved REE geochemical signature of amphibole from the gabbro interlayered with the paragneiss

Involvement of a melt with an evolved geochemical signature,

Mafic mineral (Opx) + volatile-rich melt \(\rightarrow\) Cumm
Intrusion of the gabbro at 302 ± 3 Ma

Thermal event at 281 ± 5 Ma that caused the partial resetting of the U–Pb isotope system of zircons and was most likely related to the partial melting of the paragneiss.

Anatectic melts from the migmatitic paragneiss migrated and interacted with the gabbro promoting the replacement of precursor mafic minerals (e.g., orthopyroxene) with amphibole (associated with segregation of biotite ± allanite).

The migration of the migmatite-related melt governed a geochemical gradient within the gabbros, with the foliated and fine-grained domains recording the strongest modification of the initial compositions.