# REVISED THERMOBAROMETRY OF GRT-PERIDOTITES FROM CIMA LUNGA-ADULA NAPPE COMPLEX, CENTRAL ALPS

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## ABSTRACT

The Cima Lunga-Adula nappe (Central Alps, Penninic system) consists of a crystalline, continental basement with pelitic, mafic and granitoid rocks, partly overlain by a mesozoic cover (Pfiffner and Trommsdorff, 1998). The nappe shows an imbricated structure, with basement slices interbedded with carbonaceous metasediments. Closely associated with the metacarbonate rocks are mafic, in part eclogitic, and ultramafic boudins and lenses, which form a continuous marker horizon from Mt. Duria and Alpe Arami, in the south, to Cima di Gagnone, in the north. Among these ultramafic rocks, several occurrences of Grt ± Amph-bearing peridotites have been found. Based on the many evidences for a serpentinite stage pre-dating the garnet stage, and on the association with metacarbonate rocks and mafic rocks with MORB signature, Pfiffner and Trommsdorff (1998) proposed a derivation from a partially exposed lithospheric mantle in an suboceanic to subcontinental domain near a continental margin. During Alpine orogenesis, the peridotites and the associated mafic rocks underwent subduction and eclogite facies metamorphism.

Although there is general consensus that the Grt-peridotites were involved in a subduction process, their metamorphic history remains controversial. The peak conditions of the metamorphism estimated by Evans and Trommsdorff (1978) (>2.0 GPa/800°C) are consistent with those obtained by Heinrich (1986) for the associated eclogites. However, based on mineralogical (occurrence of possible former Fe-perovskite in b-olivine) and textural arguments, Dobrzhinetskaya et al. (1996) suggested for Alpe Arami an origin from the Transition Zone (>300 km depth). Based on various thermobarometers and apparent chemical disequilibrium among minerals, Brenker and Brey (1997) proposed for Alpe Arami a decompressional-cooling path from very high pressures (5 GPa/1120°C), which would support an origin from great depth.

To solve at least in part this controversy, we have undertaken a revision of P-T estimates for Grt-peridotites from Alpe Arami, Cima di Gagnone and Mt. Duria, using the most up-to-date and widely tested thermobarometers. The preferred methods involve four different equilibria, namely Al-exchange between Opx and Grt (Taylor, 1998) and Cr-exchange between Cpx and Grt (Taylor and Nimis, 1998) as barometers, and Fe-Mg-exchange between Cpx and Grt (Ai, 1994) and Ca-Mg-exchange between Cpx and Opx (Taylor, 1998) as thermometers. $Fe^{3+}$ contents in Cpx and Grt have been measured by Mössbauer spectroscopy to minimize errors arising from uncertain $Fe^{2+}/Fe^{3+}$ partitioning. For most of the samples studied, the loci of the P-T points related to the different thermobarometers intersect one another within a very small P-T range (see Fig. 1). The remarkable consistency among the different thermobarometers demonstrates that an excellent degree of equilibrium was attained at Alpe Arami, while our samples from Cima di Gagnone and Mt. Duria possibly underwent a slight reequilibration under cooling, as far as the Fe-Mg-exchange is concerned. Corresponding P-T estimates for the peak of the metamorphism are 3.2±0.3 GPa/833±34 °C for Arami, 3.2±0.3 GPa/745±35°C for Cima di Gagnone, and 3.3±0.3 GPa/811±33°C for Mt. Duria. For Gagnone the pressure estimates are slightly above extrapolated experimental data on pargasite composition in MORB peridotites (Niida and Green, 1999; folded pargasite enclosed in Gagnone garnet has Na + K = 0.65 atoms per 23 oxygens). The slightly lower temperature obtained for Gagnone is consistent with the southward regional metamorphic gradient recorded by eclogitic rocks from the same tectonic unit (Heinrich, 1986).

Thermobarometric data do not provide any evidence for an exhumation from exceptionally great depth of Alpe Arami. The very high pressures estimated by Brenker and Brey (1997) are believed to derive from incorrect temperature evaluations combined with the strong temperature dependence of the Opx-Grt barometer. The Grt-peridotites of the Cima Lunga-Adula nappe appear to have experienced a similar prograde evolution during Alpine subduction to depths of ca. 90-100 km.

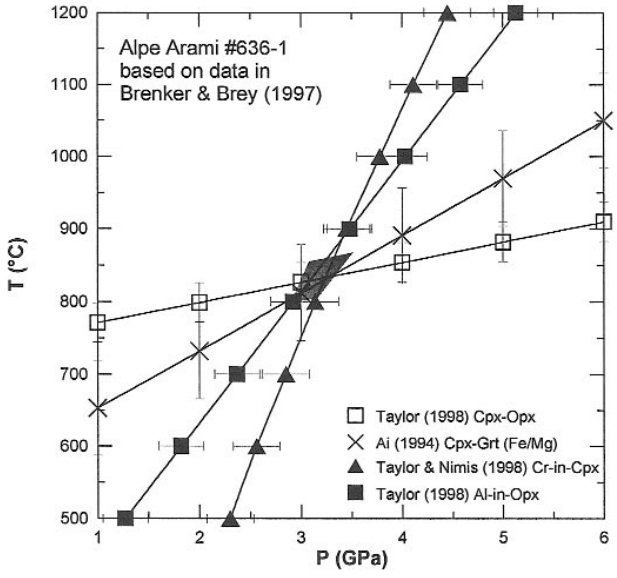


Fig. 1 - Thermobarometry of sample 636-1 based on mineral chemistry data reported in Brenker and Brey (1997). The use of updated and well-tested, independent thermobarometers suggests an excellent degree of equilibration. The shaded area marks the P-T field for which the different thermobarometers yield results that are consistent within their respective uncertainties.

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