Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06082, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06082
EGU General Assembly 2008

The UHP metamorphism in Dora-Maira whiteschists, western Alps: new data from the peak mineral assemblage and the multiphase solid inclusions in pyrope.

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The whiteschists from the Dora-Maira Massif are the first lithology (and locality) from which coesite was reported from continental crust, and have been the subject of many minerochemical, geochemical, experimental, isotopic and fluid inclusion studies. Nevertheless, their origin and evolution and especially nature and role of the associated fluid phase are still matter of debate. The recent development of microanalytical techniques and the new studies from other UHP terranes supported by experimental petrology results led to their re-examination.

We report the results of a petrological study carried out on minerals and the fluid phase in equilibrium at UHP metamorphic peak in whiteschists from the classic locality of Case Ramello and from a new site. These rocks consist of pyrope-rich garnet, quartz/coesite, phengite, kyanite, talc, chlorite, and minor unusual Mg-rich minerals. Three kinds of pyropes occurr in both sites: 1) reddish megablasts (from 10 to 20 cm across) richer in almandine and mainly include kyanite, chlorite, talc, ellenbergerite, and Mg-durmortierite, but never coesite or quartz; 2) zoned porphyroblasts (from 2 to 10 cm across) with an almandine-richer core - mainly including kyanite, chlorite, talc, ellenbergerite, and Mg-dumortierite (but not quartz/coesite) - and a pyrope-richer rim with inclusions of coesite, kyanite, phengite, talc, but no chlorite; 3) smaller crystals

($<$ 2 cm across) with the same composition as that of the porphyroblast rim, which include coesite/quartz, kyanite, phengite, and talc. The occurrence of coesite inclusions in the rim of the porphyroblastic garnets and in the core of the smaller crystals indicate their crystallisation at UHP conditions: therefore, the whiteschist peak assemblage consisted of pyrope, coesite, phengite, kyanite, talc, and accessory rutile, apatite, zircon and monazite. Barometric estimates, based on the Phe geobarometer at a nominally T of 750˚C, indicate a pressure in excess of 4.0 GPa, which is in agreement with that obtained by experimental studies (4.5 GPa) and with that recently calculated from nearby eclogites (3.8 GPa) and marbles (4.0 GPa).

The evidence of the original peak fluid composition is represented by the multiphase solid inclusions (MSI) which occur in the coesite-bearing garnet portions. MSI have homogeneous size (about 30 microns) and locally show post-entrapment decrepitation features. Each MSI contains Mg-chlorite, Na-phlogopite, Cl-rich apatite, Zn-rich pyrite, and Ca-chlorides, as daughter minerals. Locally, MSI also contain step-daughter minerals (talc and magnesite) and rutile, zircon and monazite as incidentally-trapped minerals. Microthermometric measurements did not reveal the presence of a fluid phase, but maps of total water concentrations collected by infrared synchrotron radiation show gradients that suggest significant H diffusion from the inclusions to the surrounding garnet (Frezzotti et al, 2007, abstract ECROFI XIX). These data indicate that the fluid trapped at UHP peak conditions was an aqueous fluid enriched in Si, Al, Mg, Na, and Ca, and containing significant amounts of Cl, P, and S.

Compared with other UHP rocks, e.g. topaz-kyanite quartzite from Sulu (China), the Dora-Maira whiteschists were characterised by a chemically and isotopically open system that at the UHP peak consists of a hydrous mineral assemblage and a fluid high in chlorine. Our data support a model which envisages a metasomatic process transforming, along shear zones, a precursor granitoids/orthogneiss by influx of external high-Cl-Ca-Mg-Al-Si aqueous fluids generated from prograde serpentinite dehydration.