Retrograde fluid inclusions in eclogitic metagabbros from the Ligurian Western Alps

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Abstract: Quartz veins and apatites of the eclogitic Fe-Ti metagabbros from the Ligurian Western Alps contain a variety of aqueous fluid inclusions. The quartz veins are related to fluid flow occurred at different stages of the metamorphic history and formed on a pressure-temperature span ranging from high pressure to greenschist facies conditions. The microstructures and microthermometry allow to relate all the analyzed inclusions to the greenschist retrogression of the eclogitic mineral assemblages. Two main types of inclusions can be distinguished: CO2-free aqueous inclusions and CO2-H2O-rich inclusions with a few moles percent N2 mixed with the CO2. No clear relationships have been observed between the above two groups, but the textural and microthermometric features allow to relate the aqueous fluid inclusions in apatite to the earliest episodes of syn-greenschist fluid infiltration. Fluid/rock interactions during water consuming reactions may have the major effect to concentrate salts and CO2 (when present) in the metamorphic brine. The intersection between the experimental curves defining the stability field of the greenschist assemblages and the calculated isochores of inclusions in apatite, give an approximate trapping estimate of about 3 kbars and 500 °C. Such evaluation consents to derive anomalously high geothermal gradients, related to high uplift rates occurring at the brittle-ductile transition, and preventing the thermal reequilibration of rocks at depth.

Key-words: fluid inclusions, eclogite, greenschist facies, metagabbro, Ligurian Western Alps.

Introduction

Rock nappes constituting the orogenic belts are subject to significant episodes of fluid-rock interaction during their evolution. This fact is documented by widespread prograde and retrograde vein systems (Norris & Henley, 1976; Yardley, 1986; Barnicoat, 1988), by the development of hydrated silicates in the metamorphic assemblages (Holland, 1979; Heinrich, 1986; Griffin, 1987), and by the occurrence of fluid inclusions in the veins and host rocks (Poty et al., 1974; Touret, 1977; Crawford et al., 1979; Mercollli, 1982; Diamond, 1990; Andersen et al., 1989). Such evidence has increased interest in the mechanisms and significance of fluid/rock interaction and fluid evolution (Ferry & Burt, 1982; Walther & Orville, 1982; Trommsdorff & Skippen, 1987; Rubie, 1986; Bowers & Helgeson, 1983a; Thompson, 1987; Austrheim, 1987). Numerous investigations of fluid inclusions in low to medium grade rocks and in granulites demonstrate that fluids coexisting with the various mineral assemblages at elevated temperatures and pressures are commonly mixtures of volatiles such as H2O, CO2, CH4, N2 and electrolytes such as NaCl, KCl, CaCl2 etc. (e.g. Crawford, 1981b; Crawford & Hollister, 1986; Touret, 1981, 1987). Such studies have recently been extended to eclogites and high pressure rocks (Luckscheiter & Morteani, 1980a,b; Ganguin, 1988; Klemd, 1989; Andersen et al., 1990; Philippot & Selverstone, 1991). Eclogites are of considerable interest in the Western Alps and other orogenic belts for two reasons: they preserve the mineral assemblages and textures indicative of the highest pressure conditions achieved during collisional processes (e.g. Chopin, 1984; Mørk, 1985; Koons et al., 1987), and they often partially reequilibrate during subsequent uplift thereby recording informations on the full P-T path (e.g. Fry & Barnicoat, 1988; Klemd, 1989; Messiga & Scambelluri, 1991).

This paper aims to define the interaction processes between metamorphic fluids and the eclogitic Fe-Ti metagabbros in the Voltri Massif.