

Fluid and halogen activities in the high-grade blueschists from the Dora-Maira Massif, Western Alps

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Introduction

Knowledge of the composition of fluids attending high pressure (HP) metamorphism is essential for understanding metasomatic activity in subduction zone. During metamorphism, the concentration in solution of common rock-forming cations (Na, K, Ca,...) is likely to be dependent on the availability of complexing ligands such as Cl and F. Because Cl has a strong affinity for aqueous fluids relative to solid phases, study in HP-rocks of fluid inclusions and minerals that concentrate Cl should be of interest in assessing the effectiveness of the flushing of fluids during progressive dehydration. In this study, fluid inclusions and halogen (F, Cl) concentration of micas, talc and chlorite were investigated in the coesite-pyrope quartzites (Py-Qtz), interlayered jadeite quartzites (Jd-Qtz) and their country rock gneisses (Gneiss) from the Dora-Maira Massif, Western Alps.

Textural observations

In Py-Qtz, fluid inclusions and halogen-bearing minerals are present in different textural settings, reflecting trapping (or remobilization) of fluids and (re)-crystallization of hydrous phases at different stages of the prograde and retrograde metamorphic history of the rocks (Fig. 1a). Mineral inclusions in pyrope (chl, par, gl, phe, phl), talc and phengite in the rock matrix and fluid inclusions present both in pyrope and in kyanite grains included in pyrope are sensitive indicators of the chemistry of the fluids prior and during pyrope growth. During the retrograde path, noticeable textural features include 1) inversion of coesite to palisade quartz, the latter containing diffuse clusters of fluid inclusions, 2) pressure-sensitive and water-conserving reaction R1 and 3) pyrope alteration either into $\text{phl} + \text{ky} + \text{qtz} \pm \text{tc} \pm \text{scapolite}$ (R2) or, at a later stage, into $\text{chl} \pm \mu \pm \text{Na-phl}$ (R3). Garnet in Jd-Qtz shows similar R3 alteration. Associated fluid inclusions occur as secondary trails in matrix polygonal quartz and in relic kyanite in chloritized pyrope. In gneiss, fluid inclusions are secondary in origin.

Results

Mineral inclusions in pyrope have low halogen concentrations (Fig. c, f). Matrix talc shows a significant increase in F-content compare to inclusion talc (Fig. c). Fluids present in kyanite inclusions in pyrope are low salinity aqueous brine (≤ 12 wt% NaCl eq.) containing some $\text{CO}_2 \pm$ additional solid phases. In pyrope, decrepitated trails of fluid inclusions - now characterized by a solid assemblage composed of Mg-phosphate, magnesite, halite/sylvite, talc, and opaque mineral with no residual fluid phase preserved - attest to the presence of a briny aqueous $\pm \text{CO}_2$ fluid during pyrope growth. In palisade quartz, highly-saline aqueous brine inclusions coexist with CO_2 -rich inclusions containing some H_2O (Fig. 1b). F-depletion of phengite during R1 seems to be compensated in-situ by crystallization of F-rich phlogopite (Fig. 1d). This contrasts with early (R2) Cl-rich phlogopite and scapolite alteration product of pyrope (Fig. 1e). Late (R3) chlorite, muscovite and Na-phlogopite assemblage show low halogen concentrations (Fig. 1f). Associated fluid inclusions are pure water to low-salinity aqueous brine (Fig. 1b). In Jd-Qtz, additional secondary halite-pyrite-bearing inclusions showing clear evidence of necking down are occasionally present. Fluid inclusions in Gneiss are slightly more saline than in Py-Qtz and Jd-Qtz. Note that there is no correlation of XMg with halogen content in phlogopite in Py-Qtz and Jd-Qtz (Fig. 1f).

Discussion

The data above indicate that the Cl content of fluids and F concentration of talc increased with ongoing devolatilisation. Adding salt to the fluid phase must have favoured talc breakdown and the formation of $\text{py} + \text{coe} + \text{V}$ and $\text{phl} + \text{ky} + \text{qz} + \text{V}$ (R2) by shifting both reaction curves toward lower temperatures as water activity was lowered (Fig. 1a). Such high salinity fluids could represent relic testimony of, now obliterated, evaporitic horizons, relate to water extraction by a melt phase (Jd-Qtz

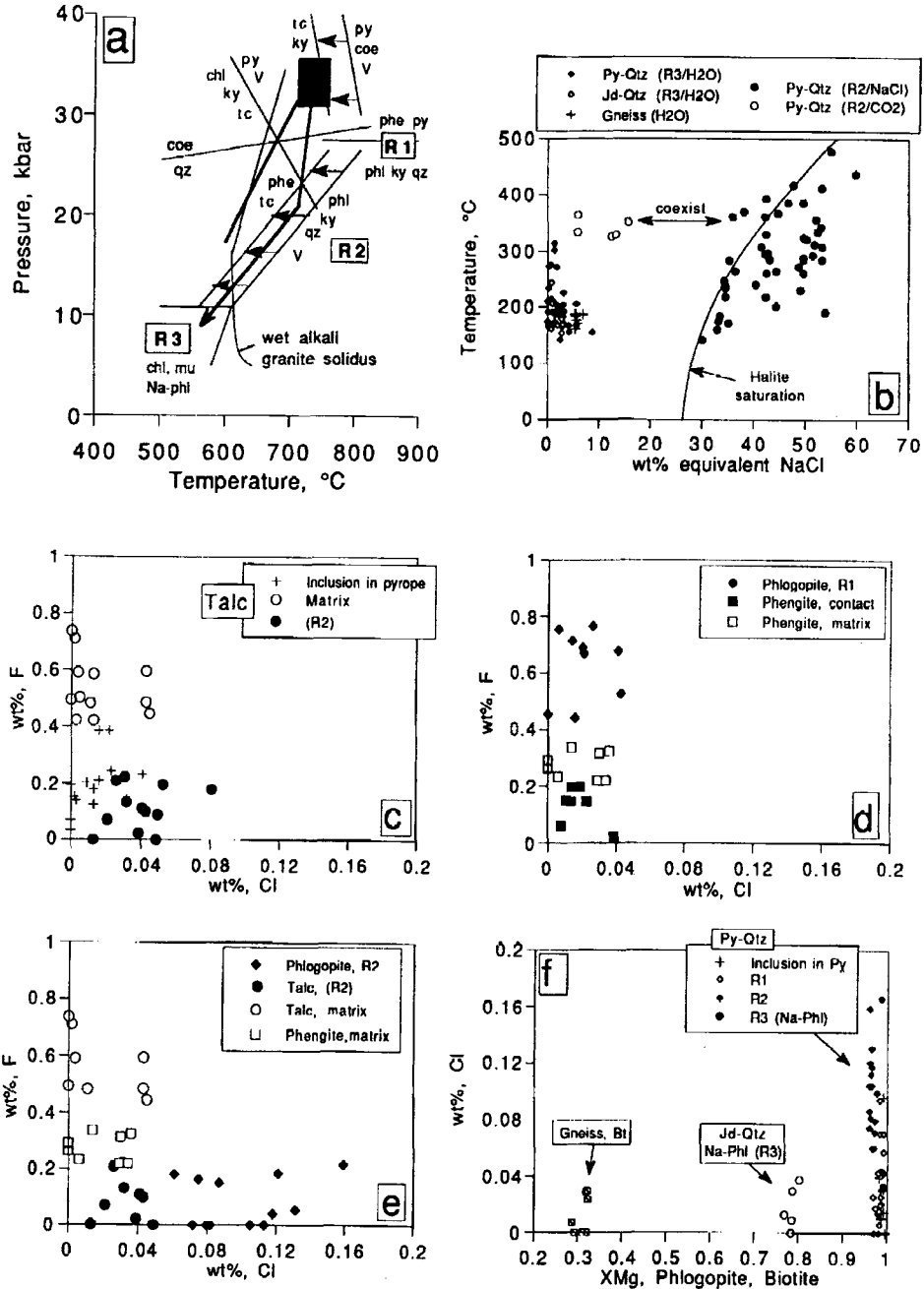


FIG. 1.

layer), or both. Nevertheless, it is clear that during the prograde and early retrograde path, fluid and halogen activities were internally-buffered by the host rocks and the flushing of fluids was not effective. Only during late stage pyrope alteration

(R3) were the rocks scavenged by significant volumes of aqueous fluid. These fluids could have been derived from the surrounding gneisses or from a crystallizing melt phase.