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Evolution of fluids from a subduction zone: unraveling P-T and compositional evolution path based on complex inclusion study

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As direct candidates of fluids trapped at subduction-zone conditions, primary multiphase fluid inclusions (MFI) as well as coexisting quartz and zircon inclusions (all in garnet host) were carefully studied in both eclogite and granulite from the Cabo Ortegal Complex (NW-Spain). Thermodynamic modelling using bulk MFI compositions showed, that the originally trapped fluids can be described in the COHN system, where dominant fluid components in the fluid were H_2O and CO_2, whereas N_2 was present in minor amounts (H_2O: 56 mol%, CO_2: 34 mol% and N_2: 10 mol% in the studied eclogite). Entrapment pressure and temperature (P-T) conditions of the MFI were estimated using elastic Raman thermobarometry on quartz and zircon inclusions, which occur in the same growth zone of the host garnet in a studied granulite. Our results indicate that crystal inclusions and MFI are likely to have been entrapped along prograde-to peak metamorphic stage, near peak conditions, at ~1.5-1.8 GPa and 700-800 ºC as shown by intersection of their isomekes in the stability field of garnet+COHN fluid, latter based on thermodynamic modelling using bulk composition of the MFI.

During their post-entrapment evolution, the originally trapped fluid in MFI has interacted with the host garnet during the exhumation path, resulting in 1) the formation of carbonates and phyllosilicates (step-daughter minerals); 2) the passive enrichment of nitrogen in the residual fluid (N_2 content: 13-68 mol% in the observed MFI) together with 3) local enrichment of methane (varying from 21 to 87 mol%). Thermodynamic models revealed that step-daughter assemblage is stable at low P-T (between 2-9 kbar and 300-400 °C) conditions. Our model further suggests that formation of step-daughter minerals is expected at the same time due to metastable behavior at higher P-T. A specific horizon in shallow subduction-zone around 300-400 ºC (when crossing the stability field of pyrophyllite during exhumation path) can be marked as a nitrogen-enriched fluid regime. The release of these fluids may contribute significantly to the understanding of N_2-rich fluid composition during devolatilization in the forearc regions of convergent margins (Spránitz et al., under review).

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