Identification of trace amounts of H_2O in CO_2-rich fluid inclusions in granulite facies rocks

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Granulite facies metamorphism is characterized by mostly anhydrous mineral assemblages that include orthopyroxene, plagioclase, garnet and quartz. It has been proposed that granulites are generated during dry melting of the deep crust at ultra high P-T conditions. The role of the fluids during granulite formation has been the subject of debate for decades. The debate is centered on whether or not low a_{H2O} fluids were present during metamorphism [1]. Numerous workers have reported high density "pure" CO_2 fluid inclusions as evidence that granulite facies fluids are carbonic and do not contain H_2O. However, silicate minerals show low solubilities in CO_2 and the poor wetting ability at grain boundaries inhibits infiltration, making it more difficult to dissolve silicate minerals and transport elements such as U and Rb out of the lower crust [1].

We show that H_2O is a common but minor fluid component in "pure" CO_2 fluid inclusions from various previously well-studied granulites. The inclusions were analyzed at 150°C using a recently developed technique that involves a Raman microprobe coupled with a Linkam THSG 600 heating/cooling stage [2]. Over a wide range of temperatures, CO_2 and H_2O are largely immiscible. Because of this, and because H_2O is the "wetting" phase, at room temperature small amounts of H_2O in CO_2-rich fluid inclusions will be present as a thin film wetting the walls and will be optically unresolvable [3]. In this study, fluid inclusions were heated from room temperature (~25°C) to a temperature above the one-phase / two phase boundary (≈150°C), and the liquid H_2O phase that occurs as a thin film at room temperature evaporated into the CO_2 phase. Raman analysis of this homogeneous phase at elevated temperature revealed the presence of H_2O, as evidenced by a small but sharp peak at ~3641 cm^{-1}. H_2O was detected in all primary-appearing fluid inclusions in quartz that formed at peak metamorphic conditions. In secondary fluid inclusions in garnet from Southern India, H_2O was not detected. Rather, hydrogarnet was found covering the walls of inclusions in this phase, as evidenced by a peak at ~3661 cm^{-1}. The hydrogarnet is interpreted to be a "step-daughter" phase that was formed by reaction of the H_2O in the fluid with the garnet host during retrogression. These observations suggest that granulites may not be as dehydrated as previously thought, and provide evidence for an H_2O-bearing fluid that could transport LILE out of the lower crust.

[1] Newton et al., (1998) *Precambrian Research* **91**, 41-63.
[2] Berkesi et al. (2006) *J of Raman Spectroscopy* **40**, 1461-1463.
[3] Roedder (1972) *USGS Professional Paper* **440**, 164 pp

CHARACTERISTICS OF LATE MESOZOIC GRANITIC ROCKS IN SW CORNER OF SOUTHERN VIETNAM

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Late Mesozoic magmatic belt stretches north- south in the central Vietnam to the northern part of southern Vietnam. In the central Vietnam, at the eastern part of the Dalat zone, the Late Mesozoic plutonic and contemporaneous volcanic rocks are widespread, and are interpreted as subduction-related products (Nguyen Thi Bich Thuy et al., 2004a, b). The Late Mesozoic granitic rocks are divided into three suites: the Dinhquan, the Deoca and the Ankroet suites. The Dinhquan and Deoca suites are widely developed as a northeast-southwest trending belt south of the Kontum Massif and along the coast. The Dinhquan and Deoca granitic rocks are crosscut by Ankroet granitic rocks. The Ankroet suite is more quartz-rich with predominantly leucocratic sub-alkaline granites. Beside the main granitoid suites of Dalat zone, there are few scattered igneous bodies, especially the southwest corner of southern Vietnam, such as That Son and Ba Den batholiths. The Dinhquan, the Deoca and the Ankroet suites are also given for these batholiths although they are separated over 400 to 500 km from the Dalat zone. Our previous studies indicate the late Mesozoic granitic rocks of Dalat zone can be divided into two suites: the Dinhquan-Deoca I-type granite and the Ankroet A-type granite suites. In the field, mafic microgranular enclaves are rather common in late Mesozoic granitic rocks of Dalat zone. However, enclaves are less common in late Mesozoic granitic rocks in SW corner of southern Vietnam. We will present in-situ U-Pb zircon dating and Lu-Hf isotopic analyses, and whole rock geochemical and Nd-Sr isotopic analysis of Dinhquan, Deoca and Ankroet suites in SW corner of southern Vietnam in order to compare the characteristics of these granites suites with those from the Dalat zone.