Hydrous carbonatitic liquids generated by subducted pelagic carbonates

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Pelagic limestones, hundred meters in thickness, are subducted today in a variety of subduction zones worldwide (Colombia, New Zealand, Vanuatu). Impure marbles constitute large tectonometamorphic units in mountain belts (e.g. Alps) testifying to their lithological and geochemical identity throughout the orogenic cycle. Despite the geochemical relevance of systems enriched in $CaCO_3$, experimental investigation mostly focused on carbonated pelites, characterized by low Ca/(Ca+Mg+Fe) ratio.

Here we model the composition and the condition of formation of liquids, formed from subducted impure limestones, in the system CaO-Al_2O_3-SiO_2-H_2O-CO_2, profiting of phase relationships in the subsystem CaO-H_2O-CO_2 (CHC) where a continuous transition between a high-density "vapor" and a carbonated hydrous "melt" was suggested to occur above a second critical endpoint located approximately at 4 GPa [1].

Multianvil experiments were performed at 4.2 and 6.0 GPa on three bulk compositions, where zoisite and/or Al_2SiO_5 saturation prevents the formation of portlandite and dellaite, experimentally recorded on eutectic melting in CHC, but barely found in nature. H_2O contents was varied from 6 to 21 wt%.

Aragonite + kyanite + fluid, and minor lawsonite form at 700 °C, replaced by zoisite at 800 °C. Between 850 °C and 950 °C, a complex sequence of textural features is observed upon quenching of single volatile-rich liquid phase formed at run conditions. Precipitates include dendritic $CaCO_3$, silicate glass and Al-rich whiskers. The bulk composition of such hydrous carbonatitic liquids is retrieved by image analysis on X-ray maps, showing Ca:Al:Si ratios up to 6:1:3.

Hydrous Ca-carbonatitic liquids are efficient media for scavenging volatiles from subducted crustal material and for metasomatizing the mantle wedge. Thermodynamic modelling suggests that reactive percolation in a harzburgitic matrix generates carbonated wehrlite bodies, containing 15 – 20 wt.% clinopyroxene and 5 – 10 wt.% garnet.

[1] Wyllie & Boettcher (1969) *Am. J. Sci.* **267-A**, 489-508.