Monazite records the Sr-Nd-Pb isotopic composition of UHP fluids in Dora Maira (Western Alps)

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Continental subduction and recycling of its components into the mantle has the potential to change mantle composition in terms of heat-producing elements (*e.g.*, U, Th), radiogenic isotope systematics (*e.g.*, Sm–Nd, Pb–Pb), and trace element abundances (*e.g.*, rare earth elements; REE). While the consequences of mantle enrichment are understood, the release of these elements from the source rock and their original isotopic signature is usually blurred by retrograde processes at the rock scale. The Dora Maira massif (Western Alps) is one of the few ultra-high pressure (UHP) terrain that are direct witnesses of subduction zone processes in the geologic record. The world famous outcrop displays mostly hydrous pyrope quartzite (garnet + coesite + talc + phengite ± kyanite) with subordinate anhydrous jadeite + kyanite + coesite ± garnet quartzite. The latter rock type, referred to as jadeite-kyanite quartzite, is found as discontinuous centimetre-thick layers with progressive contact toward its host pyrope quartzite. The origin of this jadeite-kyanite quartzite remains disputed since it has been suggested either to represent a former UHP melt or to result from the metasomatism of the granitic protolith by an aqueous supercritical fluid. In both hypotheses the minerals from the jadeite-kyanite quartzite have the potential to record mineral-fluid equilibrium at UHP and provide unique insight into the nature and composition of the fluid. Amongst the accessory minerals, monazite is ubiquitous in the matrix as well as in UHP phases. Monazite crystals displays complex zoning and may be grouped in two chemical groups that are consistent population-wide. The first chemical group is U-rich with Th/U < 1, high Y and low Sr; it is interpretated to reflect prograde monazite growth from allanite breakdown. The second group is higher in Th with Th/U > 3, lower Y content and higher Sr (> 3000 ppm); it is interpreted to grow in equilibrium with garnet above 1,5 GPa. In-situ U–Pb geochronology yields an age of 34.7 ± 0.6 Ma for the first group and 34.3 ± 0.4 Ma for the second group in good agreement with previously published UHP zircon and monazite ages. U–Pb isotopic data also show that the monazite crystalized from a fluid which had a more radiogenic $^{206}Pb/^{207}Pb$ signature that terrestrial Pb at that time. Neodymium isotopes in monazite are unzoned and reflect whole rock Nd signature. Monazite Sr isotopes are also unzoned but display a considerably more radiogenic signature ($^{87}Sr/^{86}Sr$ = 0.77815 ± 0.00055; n = 41) than the host rock ($^{87}Sr/^{86}Sr$ = 0.750496 ± 0.000021) which is intriguing because monazite does not contain Rb. It has been suggested in other studies that Sr incorporation in monazite could reflect plagioclase and/or apatite breakdown, which are unradiogenic phases. Rather, our study suggests that a high Rb/Sr phase, probably phengite, contributed to the high-pressure fluid from which monazite crystalized. Monazite has thus the ability to timely record the Sr isotopic signature of fluids released from hydrous-phases breakdown or dissolution during continental subduction.