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Melt and fluid inclusions in migmatites: unravelling anatexis and fluid regime of the deep crust

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In recent years, melt inclusions (MI) or nanogranitoid inclusions (NI) found in peritectic minerals have become fundamental tools in crustal petrology and geochemistry. Despite their small size, which poses analytical challenges, a thorough microstructural and geochemical investigation of such inclusions may provide unprecedent in situ information to unravel anatexis, fluid regime of high-grade terranes and initial volatile contents of granitic magmas.

The study of inclusions hosted in peritectic garnet from metapelitic migmatites of the Kinzigite Formation (Ivrea Zone, NW Italy) throughout the upper amphibolite-facies, transition and granulite-facies zones has revealed the coexistence of primary melt and fluid inclusions [Carvalho et al., 2018]. Inclusions have negative crystal shapes, size from 2 to 10 μm and are regularly distributed in the core of the garnet, and therefore were trapped in the same anatectic event. Melt inclusions in this case are NI characterized by the presence of cryptocrystalline aggregates of K-feldspar, plagioclase, quartz, biotite, muscovite, chlorite, graphite and, rarely, calcite. Polymorphs such as kumdykolite, cristobalite, tridymite are also present, and indicate that the original composition of the melt is preserved. FI have similar composition in the three zones and comprise variable proportions of CO_2, CH4 and N2, commonly with siderite, magnesite, calcite, pyrophyllite and kaolinite, suggesting an initial COHN composition of the trapped fluid, later modified during cooling.

These results represent the first and clear evidence of carbonic fluid-present melting in the Ivrea Zone. Anatexis of metapelites occurred through muscovite and biotite breakdown melting in the presence of a COH fluid, in a situation of fluid-melt immiscibility that is to be expected as a rule in graphitic protoliths. Our findings suggest that carbonic fluid-present melting of the deep continental crust represents, together with breakdown melting reactions, an important key process in the origin of crustal anatectic granitoids.

[Carvalho, B.B., Bartoli, O., Ferri, F., Cesare, B., Ferrero, S., Remusat, L., Capizzi, L.S. and Poli, S., 2018. Anatexis and fluid regime of the deep continental crust: new clues from melt and fluid inclusions in metapelitic migmatites from Ivrea Zone (NW Italy). Journal of Metamorphic Geology. DOI: 10.1111/jmg.12463]