Geophysical Research Abstracts
Vol. 21, EGU2019-19122, 2019
EGU General Assembly 2019

Two eclogite occurrences with contrasted retrograde paths in the Variscan French Massif Central: implications for subduction and exhumation processes

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The French Massif Central, belonging to the European Variscan Belt, contains two structural units presenting evidences for high pressure metamorphism. The Upper Gneiss Unit (UGU) consists of migmatitic paragneisses intercalated with lenses of retrogressed eclogites. The Intermediate Gneiss Unit (IGU) is dominated by high pressure garnet micaschists associated with orthogneisses and fresh eclogite relics. Two eclogite outcrops from the western Massif Central separated by less than 30 km but belonging to two different tectono-metamorphic units have been investigated in this study.

The UGU eclogites are largely retrogressed into garnet amphibolites. The omphacite is rarely preserved and the garnet is partially replaced by amphibole-plagioclase symplectites. Composition of garnet cores in one sample yielded imprecise eclogitic pressure-temperature conditions around 620-700°C, 17-23 kbar (∼9°C/km). Garnet mantles and amphibole-plagioclase intergrowths were equilibrated at 730-800°C for a pressure of 6-10 kbar (∼20-35°C/km), indicating that these retrogressed eclogites were significantly heated during exhumation. The IGU samples are fresh kyanite-amphibole eclogites with preserved omphacite and eclogitic, pyrope-rich, garnet. Phase diagram calculations indicate eclogitic conditions at 650°C, 25 kbar (7°C/km) compatible with garnet-clinopyroxene-kyanite-quartz thermobarometric estimates (600-650°C, 20-25 kbar). The retrograde path shows no significant warming during exhumation, as temperatures do not exceeded 650°C at pressures <20 kbar.

The different retrograde paths for grossly similar peak pressure conditions suggest different exhumation processes for UGU and IGU eclogites. The high temperature evolution of UGU eclogites during exhumation is similar to the one recorded in host rocks, where thermal metamorphism has been dated around 365-360 Ma. This period is also characterized by active margin magmatism in the same unit proving that the eclogites were accreted to the upper plate before 365 Ma. According to literature review, such exhumation and accretion processes can be driven by slab rollback and/or underplating by basal accretion. The low temperature decompression path of IGU eclogites is in turn typical of exhumation within a subduction channel which lead a rapid rise of high pressure rocks without significant warming.

Beyond the exhumation processes, it would be primordial to know if this duality results from a single subduction event with successive exhumations or two different subductions. These questions will be explored through forthcoming multimethod geochronology (Sm-Nd and Lu-Hf on garnet; U-Pb on zircon) and geochemical-isotopic characterization of the two occurrences of eclogites.