Evidence for two high pressure metamorphic events in the Sesia Lanzo Zone, Western Alps

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The Eclogitic Micaschist unit of the Sesia Lanzo Zone records a complex metamorphic history relating to its subduction to eclogite facies conditions and subsequent exhumation. A micaschist from Quincinetto contains high pressure pyroxenes, garnet and phengite which have undergone retrogression under blueschist and greenschist facies conditions. Both omphacite and jadeite are present in the sample; omphacite occurs at the rim of large jadeite crystals or as small crystals in the matrix. In sites where jadeite and omphacite are present omphacite is stable whereas jadeite show signs of retrogression. An inclusion of jadeite that has been partially consumed by albite is present in garnet. These textures suggest that jadeite is the earlier high pressure mineral, the growth of which was followed by retrogression, before garnet growth and a second stage of pyroxene crystallisation. These complex textures record the relative timing of each mineral's growth, and indicate two separate stages of high pressure metamorphism.

Zircon overgrowths also preserve evidence of this complex metamorphic history and permits timing of these metamorphic events. Three metamorphic zircon overgrowths record distinct ages, the geological significance of which is preserved in mineral inclusions and the trace element chemistry of each domain. The oldest overgrowth yields an age of ca. 79 Ma. Trace elements in zircon were used to constrain temperature and estimate pressure. Ti-in-zircon thermometry indicates temperatures of approximately 650°C; the absence of a significant Eu anomaly in the REE pattern indicates high pressures (above the stability of feldspar). A high pressure environment for the formation of the ~79 Ma zircon is supported by inclusions of jadeite and high Si phengite.

A zircon domain with distinct zoning and composition is dated at ca. 75 Ma. The Ti in zircon thermometer gives a temperature of approximately 660°C. The trace element pattern of this zircon overgrowth has a strong negative Eu anomaly, indicating the presence of coexisting feldspar at this stage. The crystallisation of feldspar requires a decrease in pressure from the conditions present at ca. 79 Ma.

The texturally youngest zircon domains scatter in age between 76 and 62 Ma. Ti-in-zircon thermometry returns temperature estimates of approximately 600°C. Trace element patterns from these overgrowths have a negligible Eu anomaly and a flat HREE pattern. This suggests high pressure conditions and the presence of coexisting garnet. High pressure conditions are further supported by omphacite inclusions in these zircon overgrowths.

Complex allanite is present in the same sample. Ages from allanite cores and rims are indistinguishable, and provide an age of ca. 70 Ma, similar to the youngest zircon domain.

The geochronological and petrological data suggest a double loop in the rock's P-T-t path. This is a much more complex metamorphic history than has previously been ascribed to this part of the Western Alps, or indeed to any eclogite facies rocks worldwide. The complex metamorphic history has important consequences for our understanding of the dynamics of subduction and exhumation and, in turn, the processes involved in orogenesis.