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From Rifting to Ultra-High-Pressure Metamorphism

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In Alpine-type orogens Ultra-High-Pressure (UHP) rocks are often found associated with serpentinites. This juxtaposition is generally interpreted to originate in subduction channels, where the hydration of the mantle wedge overlying a subduction zone, leading to the buoyant rise of newly formed serpentinites, has the potential to drive the early phases of exhumation. A study of the lithostratigraphy of the Zermatt-Saas Zone, in the Lago di Cignana area (Western Alps) contradicts this hypothesis, suggesting that the UHP rocks were already juxtaposed with serpentinites prior to orogenesis and that pre-orogenic rift-related lithostratigraphic associations may be preserved during burial to UHP conditions and subsequent exhumation.

The Zermatt-Saas Zone, in the Lago di Cignana area, consists of abundant serpentinized mantle, intruded by Jurassic gabbros and locally overlain by syn- and post- rift sediments. The Lago di Cignana syn- and post-rift metasediments crop out along the upper part of the Zermatt-Saas Zone, where slivers of continental crust and pre-rift-sediments are also found. The association of continental basement rocks, pre-rift sediments and ophiolites has generally been ascribed to the formation of a tectonic melange during the Alpine orogeny.

Here, we report a new study on zircons from Permian plutonic rocks of the Etirol-Levaz continental basement slice, which crops out in Valtournenche, only a few hundred meters from Lago di Cignana, at the same structural level. Our study shows that a distinctive phase of zircon growth occurred at ca. 170-160 Ma. High U/Th ratios and zoning patterns suggest that zircons grew as a result of melt infiltration related to the intrusion of mafic magmas, also dated at ca. 170-160 Ma, in the underlying serpentinites. Therefore, the continental basement slices and the oceanic basement rocks were already juxtaposed in the Jurassic and they were probably part of an Ocean-Continent Transition Zone (OCTZ), where the Lago di Cignana sediments were deposited.

Omphacite-bearing zircon rims from the Etirol-Levaz slice crystallized at 47.3$\pm$1.3 Ma, showing that the continental basement underwent the same Alpine history as the underlying serpentinites and gabbros and as the Lago di Cignana metasediments. Alpine tectonics resulted only in minor reworking of the Jurassic contacts, generally preserving the original geometry.

The partial preservation on a regional scale of the original relationships between rock units that underwent subduction to UHP conditions indicates that (1) the association of serpentinites and UHP rock units does not necessarily derive from chaotic counter-flow in a subduction channel, but may also be an inherited feature from the OCTZ and (2) the process of tectonic burial and exhumation is not necessarily chaotic.

Indeed, OCTZ's are placed in a favorable position to reach UHP conditions, following negatively buoyant oceanic lithosphere into subduction, and then be accreted to the orogen, in response to the arrival of more buoyant continental lithosphere, resisting subduction.