Eventlike exhumation of high-grade blocks in the young Franciscan subduction zone

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The metamorphic history of exhumed high-grade rocks provides invaluable insight into the thermomechanical processes of subduction zones. While subduction in most orogens has been terminated by continent collision entailing variably strong overprint of related units, the Franciscan Complex of California allows studying a >150 Myr long subduction history that started at ~175 Ma and ended by transformation into a transform plate boundary (San Andreas fault) without significant metamorphic overprint. The highest grade metamorphic rocks of the Franciscan Complex of California are found as blocks in serpentinite and shale matrix mélanges. They include amphibolites, eclogites, blueschists, and blueschist facies metasediments. These Franciscan mélanges inspired the subduction channel return-flow model, but other processes e.g., buoyancy-driven serpentinite diapirism have been argued to be concordant with our current understanding of their metamorphic history, too.

We investigate a suite of metabasite blocks from serpentinite and shale matrix mélanges of the California Coast Ranges. Our new dataset consists of U-Pb dates of metamorphic zircon and \(^{40}\)Ar/\(^{39}\)Ar dates of calcic amphibole and white mica. Combined with published geochronology, particularly prograde Lu-Hf garnet ages from the same blocks, we can reconstruct the timing and time scales of prograde and retrograde metamorphism of individual blocks. We find: (i) Exhumation from the eclogite-amphibolite facies occurred only in a short episode at 165–160 Ma with an apparent southward younging trend. (ii) Exhumation of the blocks was uniform and fast in the eclogite-amphibolite facies with rates of 2–8 km/Myr. In the blueschist facies exhumation of the blocks was less uniform and slowed by an order of magnitude. (iii) The age of amphibole in a metasomatic reaction zone indicates that at least one amphibolite was enclosed in a serpentinite matrix by ~155 Ma. Considering the entire subduction zone system, the high-grade exhumation temporally correlates with a significant pulse of magmatism in the respective magmatic arc (Sierra Nevada) and termination of forearc spreading (Coast Range Ophiolite).

Our findings do not support a steady-state process that is continuously exhuming high-grade rocks. Instead the subduction zone system changed with an eventlike character resulting in...
exhumation of high-grade rocks enclosed in serpentine.