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The longevity of Neotethyan metamorphic soles from Lu-Hf garnet chronology

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Supra-subduction zone (SSZ) ophiolites typically have a few-hundred-meters thick sequence of metamorphic rocks below their mantle section: a so-called metamorphic sole. Metamorphic soles are derived from oceanic crustal rocks, and they typically show an inverted metamorphic field gradient, ranging from greenschist-facies at the bottom to upper-amphibolite or granulite facies near the contact with the overlying peridotite. The soles are interpreted to represent the top of a nascent subducting slab that accreted to the base of the hot overriding plate. Studying the formation and exhumation of metamorphic soles is key to characterizing the inception of subduction in oceanic settings. Chronology is an important research tool in this regard and is typically done using 40Ar/39Ar thermochronology on amphibolite-hosted hornblende. The 40Ar/39Ar dates of metamorphic soles invariably overlap with the ages of the crust of SSZ ophiolites, suggesting that spreading and sole cooling are causally linked. The time between the inception of subduction and sole cooling is generally assumed to be short, but unquantified. In this study, we shed light on this aspect of ophiolite evolution by petrological analysis and multi-mineral chronology on the Late Cretaceous Pınarbaşı metamorphic sole, central Turkey, and the Jurassic metamorphic soles of the Pindos and Vourinos ophiolites, northern Greece. These Tethyan SSZ ophiolites show, with the exception of Vourinos, well-exposed sole sections, of which the different metamorphic levels were subjected to our integrated analytical approach.

In this presentation we show the results from Lu-Hf dating of garnet from the highest grade garnet-amphibolites of the Pınarbaşı and Vourinos ophiolites and the lower grade garnet-micaschists of the sole at Pindos. The Lu-Hf system in garnet enables reliable age constraints on the growth of this important prograde index mineral, allowing better approximation of the timing of subduction initiation than other mineral chronometers. Our results show that the Pınarbaşı metamorphic sole started to undergo metamorphism around 100 Ma, a few Myr earlier than the 92-99 Ma U/Pb zircon ages from the same sole, and predating the c. 6-10 Myr 40Ar/39Ar cooling ages that are regionally found in Anatolian metamorphic soles. Preliminary results for the highest grade metamorphic rocks of the Vourinos soles provide ages of 163-172 Ma, which are synchronous with ages obtained from 40Ar/39Ar dating on hornblende in these soles.
The results demonstrate a significant age difference between the formation and cooling of the metamorphic sole in Pınarbaşı, and more rapid cooling of the metamorphic sole in Vourinos. This implies that the mechanism of sole formation and thereby the inception of subduction, and the exhumation of the metamorphic sole and the overlying ophiolite is not the same for all tectonic settings where metamorphic soles occur.