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Tracing DUPAL anomaly evolution in the Tethyan-Indian oceanic mantle

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It is well established that Indian- and Pacific-type mantle domains observed in the present-day upper mantle are both long-lived and can be traced back to at least the Early Paleozoic, with their contrasting isotopic compositions inherited from mantle beneath the Tethys and Panthalassic oceans, respectively. But, the long-term evolution of the Tethyan-Indian oceanic mantle remains loosely constrained due to sparse sampling of the Tethyan oceanic lithosphere, which makes it unclear if there has been temporal variation of its diagnostic DUPAL anomaly throughout the Phanerozoic, and what caused any changes. To address these issues, we report new geochemical data, including bulk-rock major and trace elements and Sr-Nd-Hf-Pb isotopes, for samples from Tethyan ophiolites located in the Tibetan Plateau. These results, combined with existing data for ophiolites across the Tethyan domain and Indian oceanic crust, demonstrate that the DUPAL anomaly in the Tethyan-Indian oceanic mantle is long-lasting, but its strength is weakening through time (Fig. 1). The DUPAL anomaly in the Tethyan-Indian upper mantle was most pronounced in the Paleozoic with a homogeneous Indian-type asthenosphere underlying the Proto/Paleo-Tethys oceans, but has become less obvious since the Mesozoic with an isotopically heterogeneous asthenosphere beneath the Neo-Tethys and Indian oceans containing Pacific-type mantle fragments. We propose that the declining DUPAL anomaly in the Tethyan-Indian oceanic mantle since the Mesozoic was most likely associated with inflow of Pacific-type mantle during breakup of Pangea and Gondwana, when interaction between Indian- and Pacific-type mantle was more efficient. On the other hand, Indian-type asthenosphere might have been squeezed out into the Panthalassic-Pacific oceanic mantle during closure of the Tethys Ocean. This transfer may have contributed, at least in part, to the DUPAL isotopic anomaly detected in the Panthalassic-Pacific oceanic mantle. Our findings indicate that tectonically-induced asthenospheric flow permits interactions between Indian- and Pacific-type mantle domains and contributes to evolving mantle compositions.