Existence of elevated $\delta^{18}O$ values in the lithospheric mantle: evidence from olivines in Sailipu mantle xenoliths, Tibet

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In southern Tibet Plateau, post-collisional Sailipu ultrapotassic lavas erupted at ca. 17 Ma entrain peridotite xenoliths of small sizes (<1 cm). It has been suggested that the Sailipu mantle xenoliths were derived from a relic of the thickened Asian lithospheric mantle, the lower portion of which has been delaminated by conective removal [1]. Clinopyroxene trace-element compositions, together with the ubiquitous presence of phlogopite, support that the Sailipu mantle xenoliths have been metasomatized by fluids/melts liberated from the subducted Neo-Tethys Ocean [1].

Olivines separated from Sailipu peridotite xenoliths have been analyzed for oxygen isotope using secondary ion mass spectrometry (SIMS). The studied olivines have Fo contents of 88-91, containing 0.04-0.08 wt.% CaO and 0.38-0.55 wt.% NiO. Such compositional characteristics are in stark contrast with olivine phenocrysts crystallized from the host lavas (Fo_{69-81}, 0.14-0.47 wt.% CaO and 0.13-0.28 wt.% NiO). Olivines in each sample display homogeneous oxygen isotope compositions, as both inter- and intra-grain variations are always less than the precision of the method (i.e., ~ 0.5‰). Olivines from eight samples with Fo of 87.7-89.1 have similar $\delta^{18}O$ values ranging from 5.22‰ to 5.41‰, which are well within the range of the upper mantle (5.18 ± 0.28‰) defined by olivines in mantle xenoliths from various settings [2]. In comparison, olivines from one sample with a Fo content of ~ 91.3 has the highest $\delta^{18}O$ values rangin from 7.42‰ to 8.92‰ (with an average of 8.03 ± 0.28‰), which are remarkably higher than the upper mantle values. Such heavy oxygen isotopes could result from metasomatism by slab-released fluids or melts, which commonly have elevated $\delta^{18}O$ values. Therefore, our results support the existence of high oxygen isotopes, at least locally, in the lithospheric mantle.

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Multiple metamorphic events hidden in zircons from the Sanjiang complex belt, southeastern Tibetan Plateau

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Analyses of mineral inclusions within complexly zoned zircons, combined with SIMS U–Pb ages for various domains within the zircons, provide evidence of the origin and multistage metamorphic evolution of the Sanjiang complex, southeastern Tibetan Plateau. Metamorphic zircons with high-pressure (HP) mineral inclusions in paragneisses, amphibolites and garnet pyroxenites, suggest they are formed at 650–720°C and ~14 kb. These HP zircons yield U-Pb ages of 249–230 Ma, indicating an Early–Middle Triassic HP metamorphic event within the Sanjiang complex belt. Two groups of Eocene–Oligocene metamorphic zircons are also present. One of the groups comprises homogenous zircons contain medium-pressure (MP) amphibolite-granulite facies mineral inclusions in paragneisses, amphibolites, and marbles. These assemblages are stable at peak P–T conditions of 720°C–760°C and 8.0–9.6 kb, and yield consistent Eocene ages (44–36 Ma). The second group is homogeneous and all zircons contain distinct low-pressure (LP) mineral inclusions in paragneisses, amphibolites and garnet pyroxenites, and marbles, recording post-peak P–T conditions of 700°C –750°C and 5.0–6.5 kb, and yielding younger Oligocene metamorphic ages (32–25 Ma). $^{40}Ar/^{39}Ar$ analyses of biotite, muscovite, and amphibole yield the youngest ages (25–14 Ma, Miocene) related to late cooling during retrogressive metamorphism under conditions of 520°C–620°C and 4.0–4.5 kb. These new data suggest a clockwise P–T–t path for the Sanjiang metamorphic complex, typical of continent–continent collision, indicating collision–subduction tectonism prior to the strong, left-lateral, ductile deformation along the Ailao Shan–Red River (ASRR) shear zone that started at ~32 Ma and lasted until 25 Ma, causing mid-crustal (18–25 km depth) high-temperature metamorphic conditions. Continued uplift, and a slowing of left-lateral ductile shearing occurred at ~25–14 Ma at a depth of 10–15 km and under relatively low-temperature conditions. This temporal and kinematic link between left-lateral shearing along the ASRR and the opening of the South China Sea supports the occurrence of the block extrusion of Indochina from Eurasia along lithospheric-scale strike-up faults.

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