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State Key Laboratory of Isotope Geochemistry

Melting mud in the mantle

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Dr. Christopher Spencer received his PhD in Earth Sciences from the University of St Andrews in 2014 under the tutelage of Chemical Laboratories (part of the British Geological Survey) and has been a Curtin Early Career Research Fellow since 2015. His current research interests include secular change in orogenic processes and its implications for long-term preservation of the continental crust. He has published more than 32 papers in the international journals, including Nature Geoscience, Geolgoly and so on.

ABSTRACT: As direct observation of sediment melt generation at mantle depths is not possible, melting of subducted sediment remains controversial. Geochemical fingerprints provide indirect evidence for subduction delivery of sediment to the mantle; however, sediment abundance in mantle-derived melt is generally low (0%–2%), and difficult to detect. In a recent paper published in GEOLOGY, Spencer et al. (2017) provide evidence for melting of subducted sediment in granite sampled from an exhumed mantle section found in the Oman-UAE ophiolite. Peraluminous granite dikes that intrude peridotite in the Oman–United Arab Emirates ophiolite have U-Pb ages that predate obduction. The dikes have unusually high oxygen isotope ($\delta^{18}O$) whole rock and quartz values and yield the highest $\delta^{18}O$ zircon values known (14–28‰ VSMOW). The extremely high oxygen isotope ratios uniquely identify the melt source as high-$\delta^{18}O$ pelitic and/or siliciceous mud, as no other source could produce granite with such anomalously high $\delta^{18}O$. Formation of high-$\delta^{18}O$ sediment-derived granite within peridotite requires subduction of sediment to the mantle, where it melted and intruded the overlying mantle wedge. The granite suite described here contains the highest oxygen isotope ratios reported for igneous rocks, yet intruded mantle peridotite below the petrologic Moho, the most primitive oxygen isotope reservoir in the silicate Earth. Identifying the presence and quantifying the extent of sediment melting within the mantle has important implications for understanding subduction recycling of supracrustal material and effects on mantle heterogeneity over time.