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An accessory mineral and experimental perspective on the evolution of the early crust

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Abstract

As the only known mineral with confirmed ages >4 Ga, zircon is unmatched in the field of early Earth research. In the past two decades, researchers have continued to establish connections between zircon chemistry and the physical/chemical processes that shaped the early crust. This connection has benefited greatly from the application of high-temperature and high-pressure laboratory experiments. This study presents: (1) new zircon U-Pb geochronology and strategies for characterizing and identifying ancient terrestrial material from the Inukjuak Domain in northern Québec, and the Jack Hills, Western Australia; and (2) a blend of new laboratory experiments and measurements of isotope ratios and trace impurities of natural zircon. Research directions in need of future exploration, with emphasis on early Earth studies, are also explored. Topics include Hadean hydrous magmatism and the structural accommodation of "water" into the zircon lattice, Hadean subaerial crust and the identification of peraluminous or metaluminous source melts, methods to characterize the oxidation state of magmas and fluids, and the complementarity of the Si- and O-isotopic systems as proxies for crustal weathering. Finally, the implications of this work are discussed in the context of a possible transition from prebiotic to biotic chemistry on the early Earth.

Keywords: Zircon, oxygen fugacity, hydrous magmatism, Inukjuak, Jack Hills, Si isotopes, origin of life, FTIR