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Lead on the nanoscale in metamorphosed zircon

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Zircon is widely used in geochronology, due to properties that allow a wealth of geological information to be encrypted within its structure. However, reliance on such a mineral, especially in microbeam isotopic geochronology, requires an understanding of processes that might compromise U-Pb isotope systematics on the micro- and nanoscale. Discovery by transmission electron microscopy (TEM) of metallic Pb nanospheres in zircon, from Eoarchean rocks in the ultra-high temperature (UHT) Napier Complex of East Antarctica [1], led to better understanding of spuriously old geochronological results and triggered further nanoscale investigations of zircon in metamorphic terranes. Studies utilizing atom probe tomography (APT) and secondary ion mass spectrometry (SIMS) have revealed clustering of radiogenic Pb in zircon in several terranes; however, Pb nanoinclusions have so far only been conclusively identified by TEM, in the Napier Complex and the UHT Kerala Khondalite Belt (KKB) of southern India [2]. To better understand how widespread this phenomenon is, zircon was examined in an unrelated metamorphic terrane in Labrador, Canada. Gneisses in the Saglek Block have similar geological histories to those of the Napier Complex: Eoarchean protoliths, high-grade Neoarchean metamorphism, and subsequent cratonisation. However, peak metamorphic conditions are lower (amphibolite to granulite facies, as opposed to UHT) and the terrane lacks the widespread charnockitisation observed in the Napier Complex and the KKB. Examination of zircon from multiple samples revealed lead nanoinclusions in, some but not all zircon cores from gneisses, and where observed such inclusions were less abundant and smaller (nanometers as opposed to tens of nanometers). As such, they are less likely to produce the variations in isotopic composition and concentration that affected age measurements during microbeam analysis of samples from the Napier Complex and KKB. Radiogenic Pb nanoinclusions may be a common feature in zircon that has undergone high-T metamorphism, and may assist in the preservation of radiogenic signatures in zircon that has been annealed in such events.
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