Reworking of Hadean continental crust in the Acasta Gneiss Complex of NW Canada: Evidence from zircon U-Pb and Lu-Hf isotopes

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Knowledge of early crustal growth is central to understanding the evolution of the early Earth. The oldest known rocks are 3.94–4.03 Ga rocks in the Acasta Gneiss Complex (AGC) of NW Canada [1]; no crustal rocks have been found from the first 500 m.y. of Earth's history. The oldest (>4.06 Ga) identified terrestrial materials are detrital and xenocrystic zircons derived from the Yilgarn Craton, Australia. Geochemical studies of these zircons suggest that sialic crust existed only a few hundred million years after the Earth's formation [e.g. 2,3]. A major issue for early crustal growth studies is whether the extreme rarity of evidence for >4.0 Ga continental crust reflects the paucity of crust present at that time, or whether or it is resulting from following recycling.

To better constrain this problem, we carried out in-situ U-Pb dating and Lu-Hf isotopic analyses on zircons from Acasta gneisses. The U-Pb dating reveals 5 granitoid formation events at 3.9–4.0 Ga, 3.74 Ga, 3.65 Ga, 3.58 Ga and 3.55 Ga. The Hf isotopic compositions of the early Archean granitoids are slightly to markedly unradiogenic relative to chondrite, demonstrating that they formed by remelting of older crust. The calculated chondritic model ages indicate reworking of >4.0 Ga crust in the AGC.

Importantly, we found a very old zircon xenocryst with a U-Pb age of 4.2 Ga within a 3.9 Ga Acasta granitoid. Trace element compositions of the xenocryst suggest that it crystallized from a granitoid magma [4]. This finding is consistent with the Hf isotopic results, providing direct evidence for the existence of 4.2 Ga sialic crust outside the Yilgarn Craton. These results imply that continental crust was more widespread than previously thought in the late Hadean, and that it was efficiently reworked into early Archean continental crust.

References

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