What can we learn from old detrital zircon? A comparison between zircon from Acasta and Jack Hills

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The earliest evidence for crust on earth comes from the Jack Hills zircon, some of which crystalized around 4.3 Ga. The chemistry (isotopic and elemental) of these valuable zircon grains has been heavily investigated in attempts to determine the composition and geological setting of their parental source rocks. However, there is currently no general consensus on their parental rock compositions and the range of rock types proposed is large, ranging from S-type granites to basalts. Here we compare the chemistry of the Jack Hills zircons to a new zircon dataset from the 4.0—2.95 Ga Acasta Gneiss complex in the western margin of the Slave craton in Northern Canada.

The Acasta Gneiss complex (AGC) has been previously studied in detail and contains a range of rock types, including TTG compositions with REE profiles that are variably fractionated indicating a range in melting depth. We find no correlation between steepness of the middle to heavy rare earth element profile of zircon crystals and the whole rock measurements, indicating that zircon REE patterns should not be used as a proxy for depth of melting. We show that the ACG zircon crystals have very similar Ti concentrations to the Jack Hills zircons, potentially indicating similar crystalization temperatures. These low Ti concentrations are different from zircons that form in mafic settings. We also show that chemical discrimination plots, for example P vs REE, which have been used to compare Jack Hills zircon with I-type and S-type granites, can not distinguish Jack Hills zircon from ACG zircon. We therefore conclude that the geological setting for the Jack Hills zircons may be analogous to that of the AGC. Previous work on the AGC has proposed that it formed by internal differentiation of a mafic plateau from 4.02—3.6 Ga and we propose that this is a viable mechanism for formation of the rocks parental to the Jack Hills detrital zircon suite.