High-Silica Hadean Crust

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Understanding Hadean (>4 Ga) Earth requires knowledge of its crust. The composition of the crust and volatiles migrating through it directly influence the makeup of the atmosphere, the composition of seawater, and nutrient availability. Despite its importance, there is little known and less agreed upon regarding the nature of the Hadean crust. For example, compilations of whole rock elemental abundances suggest to some a dominantly mafic crust [1], while the geochemistry and inclusions in Hadean zircons suggest the existence of felsic crust [2] and possibly even life [3].

We address this question by analyzing the $^{87}Sr/^{86}Sr$ ratio of apatite inclusions in Archean zircons from Nuvvuagittuq, Canada, using the Chicago Instrument for Laser Ionization (CHILI) [4]. We show that the protolith of the Nuvvuagittuq zircons had formed a high (>1) Rb/Sr ratio reservoir by ~4.4 Ga. Since high Rb/Sr ratios only occur in high SiO_2 rocks [1], our result suggests that the ~4.4 Ga Nuvvuagittuq source was felsic rather than mafic [5]. Since life itself relies on a range of highly incompatible elements (e.g., K), felsic crust may be intrinsically more habitable than mafic crust. Therefore, our findings suggest the Earth was habitable within ~150 Myr of the start of the Solar System. Finally, this result implies that the early crust had a broad range of igneous rocks, extending from mafic to highly silicic compositions.

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