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In search of proto-Earth Molybdenum isotopic signatures: A case study of Acasta Complex

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The later accretionary processes following the Moon-forming Giant Impact carry profound implications for understanding the general dynamics of the Earth formation and the origin of its habitability. However, persistent convective mixing within the mantle since its formation makes it challenging to find the vestiges of the later accretion as well as proto-Earth in terrestrial rocks. Siderophile elements and their isotopes act as the best tools for deciphering such information. In particular, Mo is a promising proxy due to its moderately siderophile (MSE) character as these elements are not completely lost from the silicate mantle during the core formation events, and retain information about the building blocks of the Earth. Therefore, present day Mo isotopic composition of bulk silicate Earth is an integration of the original and the late accreted materials[1]. As mass-independent (nucleosynthetic) Mo isotopic composition is a valuable tool in constraining a genetic relationship among meteorites and planetary materials[1], it can help in finding vestiges of proto-Earth in terrestrial materials.

In this context, we investigated Archean rocks from Acasta complex, which is known to host the oldest rocks preserved on Earth with a crystallization age of 4.03 Ga[2]. We carried out a Mo isotopic investigation of several mafic and intermediate rocks from the Acasta Complex, which have been least affected by later events involving widespread migration of fluid-mobile elements[3]. During initial analyses, three samples exhibited anomalous mass-independent compositions for Mo against the NIST 3134 standard. Although inconclusive, these results needed further investigation, as spurious Mo mass-independent anomalies could result from a mass-dependent fractionation (MDF) of Mo isotopes in terrestrial samples[4]. We will discuss the results of the additional measurements of these samples and the subsequent implications for the search of proto-Earth Mo isotopic signatures.

References:

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