Early Bombardment of Earth and the Absence of $\Delta^{17}O$ Anomalies from 3.8 Ga Apatite from Isua, Greenland

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Thanks to the heroic efforts of Apollo Astronauts to return lunar samples to Earth and to the research of geochemists, it is known that intense, repeated, catastrophic impacts on the Moon ended at 3.8 Ga. Search for evidence of extraterrestrial impacts in Early Archean Earth rocks correlated with the time of lunar "late heavy bombardment" has met with mixed results. Direct evidence is lacking because ancient craters have been erased by Earth's active plate tectonics. The discovery of tungsten isotope anomalies in ca. 3.8 Ga metamorphosed sediments from the Isua Greenstone Belt, Greenland, and of chromium isotope anomalies in 3.2 Ga micro-spherule beds from Barberton Mountain Land, South Africa, demonstrates the existence of geochemical signatures of impacts in Archean rocks. Oxygen isotope anomalies carried by meteorites may be preserved in terrestrial deposits associated with early bombardment. The present study was motivated by the availability of apatite samples from ca. 3.8 Ga banded iron formation from the Isua Supracrustal Belt, Greenland. Analyses of REE suggest that apatites are of primary, sedimentary origin, a potential host for ^{17}O anomalies [1]. It cannot be excluded, however, that the amphibolite-facies metamorphism of Isua may have erased isotope anomalies through dilution.

The slope and intercept of a linearized $\delta^{17}O$ vs. $\delta^{18}O$ plot for 44 samples of orthophosphate is 0.527 (+/- 0.008) and -0.046 per mil (+/- 0.045), respectively, extending over a range in $\delta^{18}O$ from -18 to +20 per mil with an R^2 of 0.9975. The same values for a linear regression of 24 samples (excluding Isua) are 0.527 and -0.035. These comparisons, together with measured values of $\Delta^{17}O$ demonstrate that no contribution from meteorite impactors can be seen in the oxygen isotope composition of Isua apatite.

References

[1] Lepland, A., Arrhenius, G., and Cornell, D. (2002) *Precambrian Research* **118**, 221-241.