Hadean shocked zircons?

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"We are either modeling the wrong process, or we're modeling the process wrong"
L. Elkins-Tanton, 2013

One enduring early Earth enigma is the absence of identified evidence in the terrestrial record for meteorite impact events during the Hadean, particularly during the so-called Late Heavy Bombardment from 4.0 to 3.8 Ga. Zircon is an excellent mineral for preserving shock deformation; pervasively shocked detrital zircons have been shown to survive in siliciclastic sediments eroded and transported as far as >750 km from their source craters, including the Vredefort [1,2], Sudbury [3], and Santa Fe [4] impact structures. Thus, attributing the absence of shocked Hadean detrital zircons to their destruction during erosion and transport is not consistent with the presence of shocked zircons in modern sediments. Attributing the absence of Hadean detrital shocked zircons to wholesale destruction of early crust by tectonics, burial, or erosion does not explain why unshocked Hadean detrital zircons with ages up to 4.4 Ga are preserved [5]. Attributing the absence of Hadean detrital shocked zircons to the absence of zircon-satured rocks on the early Earth is also not consistent with the preservation of unshocked Hadean zircons. Modern mafic oceanic crust contains abundant zircon [6,7]; a large impact into a modern ocean basin would produce detrital shocked zircons if the crater is later subjected to subaerial weathering. Unshocked Hadean detrital zircons do not appear to be related to impact processes, as their geochemistry is distinct from unshocked zircons in impact-generated melts [8,9]. Simultaneous destruction of the early terrestrial impact record due to impact-related melting/assimilation of the early crust does not explain the preservation of a global impact record, including shocked zircons, on the Moon [10]. If our understanding of the early impact bombardment is correct, shocked Hadean detrital zircons should be preserved; one explanation for their absence is that they have thus far been overlooked.

[1] Cavosie *et al* (2010) GSAB. [2] Erickson *et al* (2013) GCA. [3] Thomson *et al* (2014) GSAB. [4] Lugo and Cavosie (2014) LPSC. [5] Valley *et al* (2014) *Nature Geosci*. [6] Cavosie *et al* (2009) Am Min. [7] Grimes *et al* (2011) CMP. [8] Darling *et al* (2009) Geol. [9] Wielicki *et al* (2012) EPSL. [10] Timms *et al* (2012) *Met. Plan. Sci*.