**THE HUNT FOR SHOCKED ZIRCON IN THE JACK HILLS: 21,000 AND COUNTING…**

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**Introduction:** The Jack Hills, located in Western Australia, includes 3.0 Ga metasedimentary rocks which contain zircon grains ranging in age from 4.4 to 3.0 Ga [1]. Studies have shown that this suite contains the highest percentage of Hadean grains found in any zircon population on Earth (~10%) [1,2]. The ages of these grains indicate that they must have survived early meteorite bombardment [3], but to date no shocked zircon grains have been confirmed in the Jack Hills suite [4,5].

Shocked zircon grains provide diagnostic evidence for an impact event and are characterized by various microstructures that form at pressures >20 GPa [6,7,8]. These microstructures form due to hypervelocity impact, with high pressures creating planar microstructures within zircon as shock waves travel through target rocks [9]. Zircon is a widely used mineral in deciphering and understanding past impact events, as it is resistant to annealing. In past studies, shocked zircon has been proven to survive post-impact thermal conditions, weathering, erosion, uplift and sedimentary transportation [10,11,12,13].

As the Jack Hills zircon grains are detrital, they represent numerous source rocks spanning a ~1.4 billion year timespan. Therefore it is possible that zircon shocked during any Archean impact event older than ca. 3.0 Ga may be present in this suite. Other studies have speculated that Hadean Jack Hills zircon may have originated from impact melt sheets [14] or from impact-generated anatexis [3]. However, the volume of bedrock containing shock-deformed zircon produced in impact events is much greater than the volumes of both impact melt and anatectic melt [15], which leads us to believe that shocked grains should far outnumber melt sheet zircon in sedimentary suites, an observation confirmed previously at the Vredefort Dome [12].

**Method:** Zircon grains were separated from clast-supported metaconglomerate sample 01JH13, which was collected from the famous W74 site [16] in 2001. A total 21,000 zircon grains were hand-picked onto 16 SEM stubs on carbon tape and carbon coated. Over 130 hours of SEM time was dedicated to survey external grain morphologies and search for shock microstructures using backscattered electron imaging (BSE) with a Hitatchi 3030 scanning electron microscope (SEM). Higher resolution images of selected grains were collected with a Tescan Mira3 field-emission SEM, also at Curtin University.

Grains with interesting planar microstructures were subsequently removed from the SEM stubs, placed onto double-sided tape and cast in an epoxy mount. Grains were then ground and polished to investigate internal microstructures, and to further evaluate features within potentially shocked zircon grains.

**Results:** A total of 21,000 grains were surveyed for shock microstructures on exterior surfaces during this study. Nearly 100 grains were identified as targets of interest due to the presence of interesting microstructures and planar features on exterior surfaces (Fig. 1). Grain morphologies ranged from nearly euhedral to anhedral, with suspected metamorphic overgrowths covering parts of some grains. Various mineral inclusions (quartz, xenotime, others) were identified along fractures and within interior regions of some grains with textural evidence indicating many are secondary.

None of the planar features identified on exterior surfaces were confirmed as a diagnostic shock microstructure when viewed on polished surfaces. Many of the planar features are irregular, or restricted to thin concentric zones near grain rims. The planar features are largely surficial, rather than penetrative, and likely result from lattice expansion due to metamictization of high U domains near grain margins (Fig. 1). While our study did not identify any shocked grains, our results further constrain the abundance of shocked zircon in the Jack Hills suite [4], if indeed they are present, to less than 1 in 21,000 grains, or < 0.005%. Assuming 10% of the grains surveyed here (i.e., 2100 grains) are Hadean, the abundance of shocked Hadean grains is calculated to be less than 1 in 2100, or <0.05%.

**Conclusion:** Microstructural analysis of the Jack Hills zircon suite to search for shocked grains is important, as it allows a robust constraint on shocked mineral abundance in the richest population of Hadean zircon known. The paucity of shocked zircon in the Jack Hills suite is difficult to explain in the context of global meteorite bombardment models [3], given that (1) zircon-bearing rocks were clearly present on the Hadean Earth [1], and (2) detrital shocked zircon survives sedimentary processing [10]. The preservation of detrital grains up to 4.4 Ga [2] indicates the veracity of detrital zircon to survive events on the early Earth. The current record of preserved Hadean zircon populations, including the apparent absence of shock grains, needs to be considered in models of early impact bombardment.

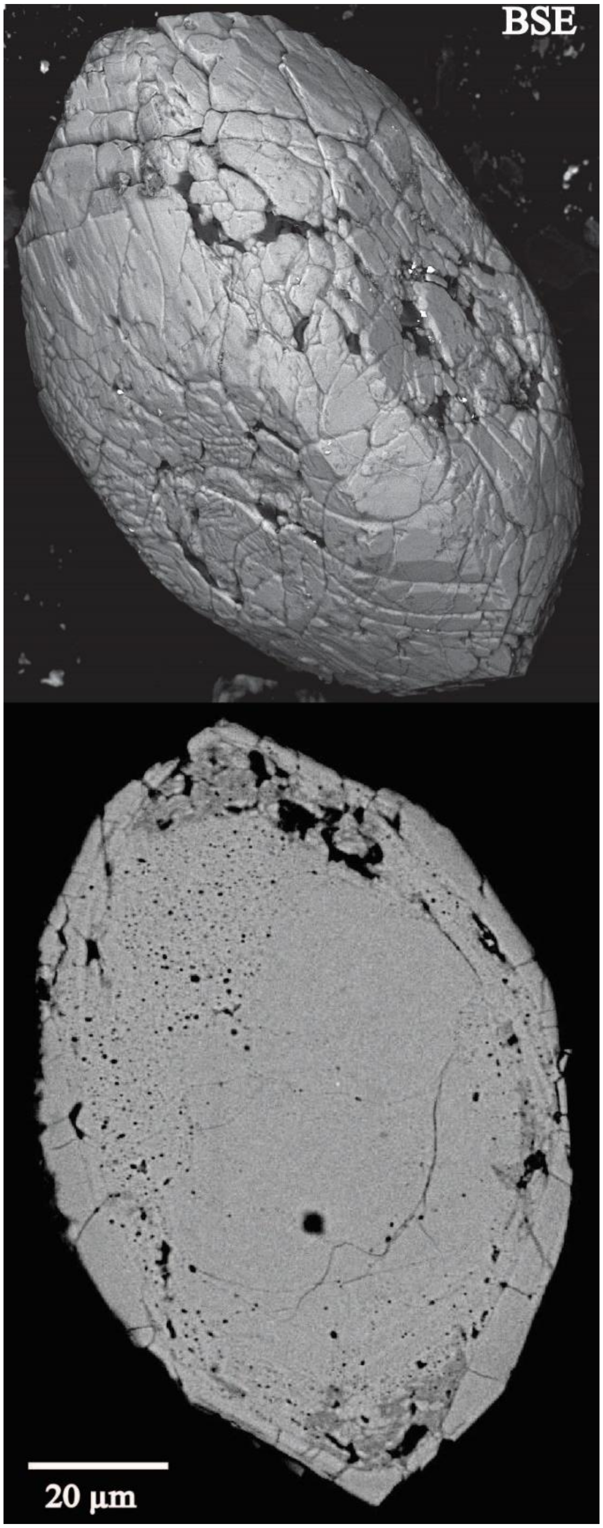


**Figure 1**. BSE images of a Jack Hills detrital zircon with planar microstructures on the exterior surface (top) that are not present in the interior of the grain (bottom). The surface features and vuggy interior domains are attributed to lattice expansion from metamictization.

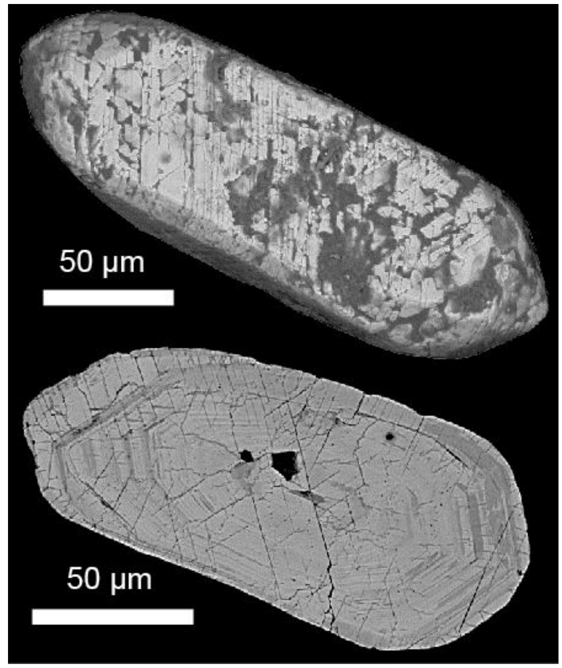


**Figure 2.** BSE images of detrital shocked zircon grains derived from the Vredefort Dome and collected in the Vaal River of South Africa [12]. Planar features on the surfaces of grains (top) are penetrative features that are readily visible in polished section (bottom).

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