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What can zircon ages from the Jack Hills detrital zircon suite really tell us about Hadean geodynamics?

Martin Whitehouse and Alexander Nemchin
Swedish Museum of Natural History, Dept. of Geosciences, Stockholm, Sweden (martin.whitehouse@nrm.se)

As the only direct sample of the Hadean Earth, detrital zircon grains from the Jack Hills, Western Australia, have been the subject of intense investigation over the almost three decades since their discovery. A wide variety of geochemical and isotopic analyses of these grains, as well as their mineral inclusions, have been used variously to support two fundamentally different models for Hadean geodynamics: (i) Some form of (not necessarily modern-style) plate recycling generating felsic (continental-type?) crust at the boundaries [1, 2], or conversely (ii) the persistence of a long-lived, stagnant basaltic lid within which magmatism occurred as a result of internal temperature perturbations and/or impacts [3, 4], a model also generally consistent with a wide range of observations from post-Hadean geochemical reservoirs. Despite the considerable time and resources expended, the majority of these studies uncritically accept the individual U-Pb zircon ages, even though their veracity is key to many of the interpretations [5, 6]. We report here the results of an in-depth evaluation of all published (and new) U-Pb ages from the Jack Hills zircon suite in order to define age populations that can be used with a high degree of confidence in geodynamic interpretations.

A notable problem in the interpretation of U-Pb data from ancient zircon grains (including those as young as the Neoarchean) is that disturbance of the systematics even several 100 Ma after crystallization causes data to spread along the concordia curve without becoming discernably discordant within the relatively large error bounds associated with U/Pb ages from in situ dating methods (e.g. SIMS). While 207Pb/206Pb ages are typically more precise, individually they provide no means to detect Pb-loss-induced younging. However, if two or preferably more analyses have been made in the same zircon growth zone, a reasonable evaluation of the possibility of Pb-loss can be made. In the available Jack Hills zircon dataset, only 111 grains have been analysed at least twice and of these, only 48 give a consistent internal age, while only 14 have been analysed more than twice and can strictly be considered to yield true ages. Two resulting age peaks at 4.18 – 4.08 Ga and 4.05 – 3.98 Ga potentially represent major magmatic events in the Hadean. In order to explain ages >4.18 Ga, a magmatic event as old as the oldest reliable Jack Hills zircon age of 4.374 Ga is also required. The significance of this limited number of magmatic events for Hadean global geodynamic models will be discussed.

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