doi:10.1130/G33285C.1

Forum Comment

Metamorphic replacement of mineral inclusions in detrital zircon from Jack Hills, Australia: Implications for the Hadean Earth

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We appreciate that Rasmussen et al. (2011) have characterized a large number of inclusions in Jack Hills (Australia) detrital zircons, but we find two significant flaws in their paper: one of scholarship and one of omission.

With regard to the first, their paper implies discovery of reset isotopic systems in phosphate inclusions in Jack Hills zircons. This was previously discussed by Caro et al. (2003) and remarked on by us (Hopkins et al., 2010, p. 372), where we noted that open-system behavior of light rare earth element (LREE)–bearing phases such as monazite "...likely reflects the very high radioactivity associated with this mineral ...leading to volume changes that can overcome the confining pressure of the host phase. As such, this behavior has little relevance to the present case. Unless all muscovites in this study were fortuitously emplaced into Hadean magmatic zircons during subsolidus reactions that imparted crystal forms characteristics of igneous muscovite, together with heterogeneous Si/Al ratios, we can conclude that at least some of these assemblages reflect their formation in a geotherm of ~60 °C/km." Youthful phosphate ages have little or no bearing on, for example, the integrity of muscovite inclusions.

The matter of omission is the failure of Rasmussen et al. to address our observation (Hopkins et al., 2008, 2010) of a bimodal distribution of Si_{pfu} values in white mica inclusions, including one population at 3.10–3.26 plaque-forming units (pfu) and another at ~3.45 (i.e., >12 kbar), and both interpreted to be igneous. Moreover, the Si_{pfu} distribution of white micas studied by Rasmussen et al. and interpreted to be metamorphic is 3.06–3.20. Their Si_{pfu} distribution statistically differs from our low-Si_{pfu} population. The identification of a compositionally and texturally distinct metamorphic population, if correct, does not invalidate the interpretations of Hopkins et al. (2008, 2010). Furthermore, left unexplained is how low-temperature/pressure alteration could create such a heterogeneous distribution. If the purpose of Rasmussen et al. was to note the possibility that minerals included in detrital zircons from Jack Hills could have experienced open-system behavior, then they have seconded our earlier position. If instead, it was to attempt to rule out the possibility that specific inclusion assemblages of characteristic habit and composition retain memory of their original constitution, then their success requires one to accept that aqueous fluids with compositions appropriate to precipitating only trioctahedral mica have infiltrated voids of the exact crystal habit of primary muscovite, while depositing phases spanning the known range of celadonite substitution in white mica. It is the unlikelihood of this sequence of events that led us to our original conclusions.

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