

Thermal history of the parent asteroid of Itokawa

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Based on the evidence derived from mineralogy and isotopic signatures of Itokawa dust particles [1-2], Itokawa was initially formed as an asteroid much larger (> 20 km in radius [3]) than current Itokawa (< 0.5 km). The parent asteroid of Itokawa was heated at around 800 °C and kept at 700 °C or higher at 7.6 Myr after CAI formation [1-2]. Plagioclase in some Itokawa particles exsolves K-feldspar, but plagioclase thermometry [4] fails to obtain equilibrium temperature [5], because of changes in compositions of plagioclase and K-feldspar during slow cooling of the parent asteroid of Itokawa. We performed numerical simulation to understand how slow the Itokawa parent asteroid was cooled down. Diffusion length of Ca, Na, and K in plagioclase crystals during cooling are key parameters to be calculated. The results show that 4.4 Myr is needed for cooling from a peak temperature of 800 to 500 °C of a 50 -km size body and Ca diffusion lengths are ~ 4 μm for dry and low-pressure condition. At 8 Myr after CAIs, Ca diffusion almost completed. Plagioclase in Itokawa particles ranges in size from 20 to 50 μm [1]. Therefore, if the Itokawa parent asteroid was heated under dry condition, then An content of plagioclase cannot be equilibrated within crystals, as is observed in plagioclase in Itokawa dust particles [5]. In contrast, Na-K interdiffusion is at least several orders of magnitude faster than NaSi-CaAl interdiffusion [6]. This suggests that Ab and Or contents are easily re-equilibrated during cooling, while An content cannot be re-equilibrated in plagioclase, which is consistent with observation from plagioclase in Itokawa dust particles.

[1] Nakamura *et al* (2011) *Science* **333**, 1113-1116. [2] Yurimoto *et al* (2011) *Science* **333**, 1116-1119. [3] Wakita *et al* (2013) *Meteoritics and Planetary Science*, published online. [4] Kroll *et al* (1993) *Cont. Min. Pet.* **114**, 510-518. [5] Nakamura *et al* (2014) *Meteoritics and Planetary Science*, published online. [6] Cherniak (2010) *Rev Mineral Geochem.* **72**, 691-733.