Verification of the onion shell model : U-Pb and Pb-Pb dating of H chondrites

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It is widely believed that the ordinary chondrites with various metamorphic levels reflect the evolution histories of their parent bodies. During the first few tens of million years in the solar system, asteroids with size of around 100km, which are considered as parent bodies of H chondrites, might have thermal "onion shell" structure as a result of internal heating of radioactive nuclides (mainly ^{26}Al) [1]. According to this model, H4 chondrites, which show less thermal metamorphism than H6 meteorites, were at the outer part of the parent body and thus less heated. Trieloff et al. [2] examined the onion shell model by comparing Pu-fission track ages and Ar-Ar thermo-chronologies of various unshocked H chondrites with calculated cooling histories of H chondrites based on the model. In-situ U-Pb chronology of the meteorites will be helpful for better understanding of the evolution history of the primitive asteroids. We report new results of ^{238}U-^{206}Pb and ^{207}Pb-^{206}Pb dating on two kinds of meteoritic phosphates (apatite [$Ca_5(PO_4)_3(F,Cl,OH)$] and merrillite [$Ca_7NaMg(PO_4)_9$]) in two H chondrites, Estacado (H6) and Guenie (H4), using a NanoSIMS.[3]

The results of Guenie (H4) phosphates were obtained as > ~4.5Ga, with the ^{207}Pb-^{206}Pb age of 4.57 ± 0.16 Ga. Those of Estacado (H6) were 4.4-4.5 Ga, with the ^{207}Pb-^{206}Pb of 4.49 ± 0.04 Ga. Although the errors are large due to the low uranium concentrations, it is likely that the Guenie phosphates are older than the Estacado phosphates. Our result may be supportive to the onion shell model and will help to understand thermal structure of their parent bodies with further analyses.

[1] Miyamoto et al. (1981) *Proc. Lunar Planet. Sci.* **12B**, 1145-1152. [2] Trieloff et al. (2003) *Nature* **422**, 502-506. [3] Koike et al. (2014) *Geochem. J.* **48**, 423-431