$^{40}Ar/^{39}Ar$ thermochronology of unbrecciated eucrites: clues to the crustal formation of Vesta.

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Eucrites are extraterrestrial basalts and cumulate gabbros formed, and subsequently more or less metamorphosed, at the crustal level of the HED (Howardite-Eucrite-Diogenite) parent body, thought to be the asteroid 4-Vesta. Unbrecciated eucrites [1] offer the best way to understand the igneous, metamorphic and cooling processes occuring in the crust of Vesta since they were not substantially affected/altered by secondary impact processes.

The $^{40}Ar/^{39}Ar$ system of unbrecciated eucrites should be in a relatively pristine state, and thus can inform us on the early volcanic and thermal history of the HED parent body, and, in particular, the cooling history of various crustal parts below the 300-200 °C isotherm, which represent the closure temperature of the Ar diffusion in plagioclase [2].

We analyzed plagioclase and pyroxene (± groundmass) separates of 2 cumulate (Moore County and Moama), and 6 basaltic eucrites with the $^{40}Ar/^{39}Ar$ technique using a Thermo© ARGUS VI multi-collection mass spectrometer. The textures of the basaltic samples range from gabbroic (Caldera) and granoblastic (BTN00300, EET90020, GRA98098, QUE97053) to unequilibrated fine-grained (PCA82502). The fine-grained sample yielded an age of 4531 ± 6 Ma which we interpret as the age of eruption, thus suggesting that Vesta was still volcanically active ca. 35 Ma year after formation. The two comulate and the gabbroic rocks also gave ages ranging from 4523 ± 8 Ma to 4533 ± 12 Ma and record when upper crustal magma chambers cooled below 250°C. The granulite ages when coupled with a fifth sample (Lake Carnegie) with $^{40}Ar/^{39}Ar$ ages published by [3], show a well-defined cluster of ages between 4507 ± 20 Ma [3] to 4520 ± 5 Ma for four samples, whereas an age of 4531 ± 5 Ma was obtained for EET90020. Those ages indicate when the mid-lower crust, where those granulites probably resided, cooled below 250°C and suggest a cooling rate of ~16°C/Ma for the lower crust of Vesta since the time of the peak metamorphism at ca. 4555 Ma [4]. This is in agreement with the cooling numerical model proposed by [5].

[1] Mayne et al., MAPS2009; [2] Cassata & Renne GCA2013; [3] Kennedy et al., GCA2013. [4] Iizuka et al., EPSL2015; [5] Zhou et al., GCA2013.