$^{40}Ar/^{39}Ar$ geochronology of unbrecciated vesicular eucrites PCA 82502 and PCA 91007.

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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 (Mayne et al., 2009) offer the best way to understand the igneous, metamorphic and cooling processes occurring 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 has been shown to record thermal history of the HED parent body, and, in particular, the cooling history of various crustal parts below the 300-250 °C isotherm (Iizuka et al., 2019; Jourdan et al., 2020). Here we focus on eucrites PCA 82502 and 91007; both are fine-grained vesicular eucrites which have been classified as unbrecciated / monomic eucrites. As such, they have the potential to inform us on the early volcanic history of their parent body.

PCA 82502: Recent isotopic analyses with a $\Delta^{17}O$ value of ~ -0.223 ‰ (Greenwood et al., 2017; Zhang et al., 2019) have reinstated this eucrite in the HED clan. We analysed 12 groundmass aliquots using EBSD (electron back-scattered diffraction), Back Scattered electron (BSE) and $^{40}Ar/^{39}Ar$ geochronology. BSE imaging show that the rock is composed of clasts of various sizes within a matrix of ca. 50 µm wide fine-grained (plagioclase and pyroxene crystals are < 10 µm in size) veins of the same rock. EBSD shows that the matrix composing the veins is very fine-grained and shows no sign of shock, whereas the clasts are variously lightly shocked. Sample preparation confirm the crystalline nature of the dark clasts, whereas the veins where made of a crumbly grey material. Six groundmass aliquots from the crystalline clasts returned concordant plateau or mini-plateau ages with a weighted mean of 4531 ± 6 Ma (P = 0.67). Observations support the dual nature of PCA 82502, with the crystalline clasts being igneous in nature whereas the matrix represents impact melt veins infiltrated through cracks during the shock event and rapidly quenched. While the light shock event did not raise the temperature high enough to cause any $^{40}Ar^*$ loss within the crystalline clasts, we assessed the effect of the melt vein injection on the K/Ar system using rock cooling and ^{40}Ar diffusion models. Even when using unrealistically "aggressive" parameters, our models suggest that the series of flat age spectra and weighted mean age of 4531 ± 6 Ma obtained for the crystalline clasts, are the not the result of the resetting of the K/Ar system by diffusion during the infiltration of hot melt veins, but rather that the K/Ar system recorded and preserved its original igneous crystallization age. This suggests that the volcanism continue at/near the surface of Vesta until at least ~ 4531 Ma and we'll explore the implications of a long-lived volcanism in this contribution.

PCA 91007: Although this eucrite contains vesicles, reported petrological observations suggest that this meteorite is slightly different from PCA 82502 and is mostly fine-grained without the dual (clasts / veins) nature of PCA 82502. While we did not conduct any BSE and EBSD at the time of writing this abstract yet, $^{40}Ar/^{39}Ar$ analyses returned 8 concordant plateau ages with a weighted mean age of 4489 ± 9 Ma (P = 0.15), which is surprisingly young for a rock that show little sign of metamorphism and equilibration. Possible causes for such a young age will be discussed during the presentation.

References

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