PIPLIA KALAN EUCRITE: NOBLE GASES, NITROGEN AND COSMIC RAY EXPOSURE HISTORY

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Introduction: Eucrites and diogenites from HED class of meteorites were likely formed at different depths on the asteroid Vesta, and passed through different evolutionary paths. Eucrites are thought to represent the upper interior part of parent body. Early evolutionary stages are shown in Piplia Kalan [1] indicating the present of metamorphism. Here we present noble gas and nitrogen study in eucrite Piplia Kalan to understand trapped gas composition and cosmic ray exposure history.

Noble gas and nitrogen: Noble gases and nitrogen measurements were performed using standard procedures [2] in bulk sample. Helium, neon and argon are mostly of cosmogenic origin. We calculate the cosmic ray exposure ages using the production rates of [3] and using the chemical composition as discussed in [6]. The exposure ages are T_3 (^{3}He) = 7.3 Ma, T_{21}(^{21}Ne) = 17.6 Ma, T_{38}(^{38}Ar) = 27.9 Ma, T_{83}(^{83}Kr) = 17.9 Ma, and T_{126}(^{126}Xe) = 25.5 Ma. We adopt 22.2 Ma (average of T_{21}, T_{38}, T_{83} and T_{126}) as the cosmic ray exposure age of Piplia Kalan, which coincides with the 22-23 Ma peak of HED meteorites [4]. Lower T_3 indicates loss of gas either by diffusion or during impact event. Piplia Kalan has 1.65 ppm nitrogen and $\delta^{15}N$ = 14.4 (‰). We correct nitrogen for cosmogenic effects by using the methods of [8], which yields trapped nitrogen as $\delta^{15}N_t$ = 0.27 ‰. We assign this value for the indigenous (mantle) reservoir, since eucrites are believed to be derived from interior of Vesta and there is absence of solar wind (SW) in Piplia Kalan. The trapped nitrogen signature is an evolved component, formed locally during differentiation of Vesta. A U,Th-^{4}He age of 1.0 Ga is calculated from radiogenic ^{4}He and U =0.1345 ppb and Th = 0.653 ppb [5]. The calculated ^{40}Ar-^{40}K gas retention age is 3.08 Ga, using K = 345 ppm [6], is less than the ^{39}Ar-^{40}Ar age of 3.54 Ga [7] and the age of solar system 4.5 Ga, indicating impact-resetting in HED meteorites [7]. The elemental ratios ^{36}Ar/^{132}Xe and ^{84}Kr/^{132}Xe are 27.7 and 0.91 respectively, and do not plot in area of Q-SW-Air [9] but they are similar to sub-Q [10], an evolved component observed in enstatite chondrites, owing to metamorphism of parent body.

Conclusions: The noble gases Ar, Kr and Xe show an evolved component in Piplia Kalan. The sample could be derived from subsurface of the parent body as there is absence of solar wind in it. Younger K-^{40}Ar and U,Th-^{4}He ages indicate impact event leading to thermal metamorphism later in the history of this eucrite.

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