Noble gases in Lohawat howardite

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Introduction: The Lohawat meteorite, a howardite fell in Rajasthan, India in 1994. It is a breccias composed of a variety of minerals and lithic fragments [1, 2]. Howardites are understood to originate from a common parent body, Vesta, with eucrites and diogenites, for they have the same O-isotope ratio [3].In this study, we performed noble gas and nitrogen isotopic analyses of separated grains, matrix and bulk. The results show presence of solar wind and primordial components (Q, HL) in Lohawat.

Samples and analysis: We examined the separated grains of Lohawat with Noblesse noble gas mass spectrometer at Physical Research Laboratory, using standard procedures [4]. The grains include spherules, diogenitic pyroxene, eucritic pyroxene, melt glass, plagioclase and clastic ground mass [5,6]. Gases were extracted from the sample by laser heating. The measured signal was corrected for interferences in applicable cases.

Results : The noble gas analysis reveal that the Lohawat howardite contains a mixture of noble gases of various origin viz.,galactic cosmic ray (GCR), solar wind (SW), primordial (Q/HL) and radiogenic. The data points of neon for grain separates of Lohawat plot in mixing region of GCR, SW and Q/HL. The data of temperature extraction in few grains fall on the mixing line of SW and GCR. The presence of solar wind in grains point out of their residence on the surface of Vesta, this is inferred since the implantation depth of solar gases in solid matter is less than a micron. $^{40}Ar/^{36}Ar_t$ ratio varies from 197 to 4387 in the grains, while it is 145 and 165 for bulk and matrix respectively. The ^{40}K-^{40}Ar gas retention age for Lohawatbulkand matrix is 2.8 Ga and 3.4 Ga, respectively. Interestingly, few of the grains show gas retention age as more than 4.56 Ga, which is unrealistically high, higher than the solar system age. This calculated higher age is possibly due to excess ^{40}Ar present in these grains, which probably is the gas liberated from impactor and the host rock during impact that got adsorbed together with solar wind implantation on the grain surface.The elemental ratios $^{36}Ar/^{132}Xe$ and $^{84}Kr/^{132}Xe$ in totals indicate the presence of solar wind primordial noble gases in the Lohawat howardite (Fig. 1).

It is understood that noble gases, which have very low abundance in the differentiated meteorites, get easily influenced by any type of addition from the foreign source.The impactor clasts with holding noble gases become part of the Vestan regolith and thus get incorporated in the howardite breccias. The noble gases therefore are the best candidate that reveal information about the impactors. It is implicit that the volatiles get released during differentiation processes but low gravity of Vesta would probably not be able to hold it on its surface. The indigenous volatile budget of Vesta is not known and its estimation would be tricky. The data obtained from the grain separates indicate predominantly extraneous noble gas input within the Lohawat howardite. Presence of the primordial components (Q and HL) of noble gases in the Lohawat howardite suggests that the impactors were mostly primitive type chondrites.

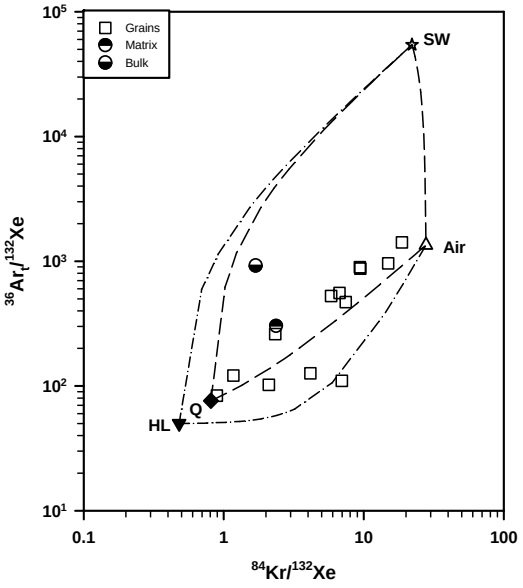

Fig. 1. Plot of elemental ratios $^{36}Ar/^{132}Xe$ versus $^{84}Kr/^{132}Xe$ of separated grains, matrix and bulkof the Lohawat meteorite.

References: [1] Sisodia M. S.et al.(2001)MAPS, 36, 1457-1466. [2] BasuSarbadhikari et al. (2016) 79th Annual Meeting of the meteoritical Society, #6145 [3] Clayton R. N. and Mayeda T. K. (1996) GCA 1999-2017.[4] Mahajan R. R. (2015) PSS, 117, 24-34. [5] Sisodia et al. (2015a) Bridging the Gap III # 1014 [6] Sisodia M. S. et al. (2015b) Astrobiological Science Conference, #7069.