Trapped Ar, Kr, and Xe in ordinary chondrites

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Ordinary chondrites (OCs) make up about 85% of the meteorites fall on Earth. Their importance arises from the fact that some of them are the least altered samples of nebular agglomerates. This kind of material also thought to be one of the ingredients to the rocky planets. The ordinary chondrites show a wide range of oxidation state compared to highly reduced enstatite chondrites and most oxidized carbonaceous chondrites. The OCs are divided into three subgroups referred to as the H, L, and LL chondrites, on the basis of their total Fe-content, high, low and low-low (metallic-Fe content), respectively (Weisberg et al. 2006). An important question is whether meteorite of the same subgroup (H or L or LL) could have been derived from the same parent asteroid. Noble gases are being studied in bulk samples in this context.

Trapped noble gases in chondrites could be of different origin; (1) dissolved gases during accretion or formation of various constituents such as chondrules, CAIs, or matrix, or (2) gases implanted such as solar wind. Phase-Q is considered as one of the main carriers of noble gases in meteorites. Phase-Q lost the noble gases in varying degrees by thermal metamorphism in meteorite parent bodies. The metamorphism also changes elemental composition of Q gases. Therefore, phase-Q component cannot be utilized for the purpose of using as representative for noble gas inventory in the bulk samples (Busemann et al. 2000; Matsuda et al. 2010). Abundances of trapped noble gases in chondrites are important proxies to understand the depletions patter and characterization of volatile reservoirs. Solar type neon is present in many ordinary chondrites and is summarized in Kumar et al. (2021). The purpose of the present work is to determine the range and average of concentrations of trapped Ar, Kr and Xe in subgroups of ordinary chondrites. Trapped noble gases from bulk measurements of these meteorites therefore, not only provides a quantitative approach, but also has genetic relevance.

The ranges among individual subgroup of OCs also provides insights on an asteroid-wide scale for heterogeneity, if they derived from single parent asteroid. The investigations reported here has concentrated on whole-rock samples and melting extraction data set, rather than acid-resistant residues or other specific methods, in an attempt to calculate the overall noble gas inventory of the OCs. Here only those samples are considered where $^{36}Ar_t$, $^{84}Kr_t$ and $^{132}Xe_t$ and isotopic ratios were measured in same aliquot and data of neon isotopic ratios are available in the literature. The concentrations of trapped noble gases are summarized in Table 1. The full list of references for the meteorite data set is beyond the prescribe limit of the abstract, is made available with the author.

Table 1. Trapped gas concentration, cm^3STP/g. Q: meteorites having Q-phase type neon isotopic composition, SW: meteorites having solar wind neon isotopic composition.

OC	Number of meteorites	$^{36}Ar_t$			$^{84}Kr_t$			$^{132}Xe_t$		
		Min (10^{-9})	Max (10^{-8})	Average (10^{-8})	Min (10^{-11})	Max (10^{-10})	Average (10^{-10})	Min (10^{-11})	Max (10^{-10})	Average (10^{-10})
H-Q	38	2.66	19.9	1.71	4.77	8.03	1.73	4.08	7.97	2.05
H-SW	7	7.87	32.7	14.3	13.2	17.2	9.24	15.6	15.8	6.66
L-Q	43	1.19	8.67	1.50	2.60	8.27	1.45	1.88	16.8	1.59
L-SW	3	63.2	33.7	21.3	50.3	22.5	11.7	72.2	22.2	12.5
LL-Q	16	1.39	57.0	1.84	1.84	31.3	5.11	2.73	31.9	4.46

It is observed that the concentrations of trapped $^{36}Ar_t$, $^{84}Kr_t$ and $^{132}Xe_t$ in H, L, and LL chondrites shows wide range. The range is different for those showing phase-Q type and SW type neon isotopic compositions. Higher concentrations are clearly observed in those meteorites showing SW type neon compared to that of phase-Q type isotopic signature.

References

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