Neon Isotopic Study in Ordinary Chondrites

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Introduction: Meteorites are pieces of rocks, which are the segments came from asteroids due to various impacts and collisions on them. Ordinary chondrites are the largest class of available meteorites, almost ~86% are chondrites, and rest are achondrites [1]. Ordinary chondrites can be subdivided into three groups based on their chemical composition [3,4]. Although huge number of meteorites are in the world collection (*Meteoritical Bulletin database*), the neon data in bulk sample is published for limited number of meteorites.

In this work, we have compiled the Neon isotopic data in 790 ordinary chondrites from the published literature. Group wise neon data available in the ordinary chondrites is as below,

- H group: 443 meteorites.
- L group: 264 meteorites.
- LL group: 83 meteorites.

This work has initiated to distinguish the multiple parent bodies of ordinary chondrites and the major trapped component of Ne in it. The knowledge of trapped neon is important in the calculations of cosmogenic gas.
We calculate the concentration of trapped ^{20}Ne in the bulk samples using the protocols given in [11,12]. Concentration of trapped ^{20}Ne (in 10^{-8} cm^3 STP/g) for different class of meteorites are listed in Table 1. We also present minimum and maximum limits of the trapped ^{20}Ne in the ordinary chondrites.

Table 1: Trapped ^{20}Ne components (in 10^{-8} cm^3 STP/g) for ordinary (this study) and carbonaceous [5] chondrites.

Meteorite Type	Minima	Maxima	Average
Carbonaceous chondrite	1.30	459.00	67.77
H- Chondrites	0.022	565.55	16.36
L- Chondrites	0.054	248.90	6.78
LL- Chondrites	0.064	141.56	6.27

Neon three isotopic plots: Neon three isotopic plots for H, L and LL chondrites with different end-member components are shown in Figure A. The data sources for the end-member components are: Solar Wind (SW) [6], Ne-Q [7], Air [8] and HL [9].

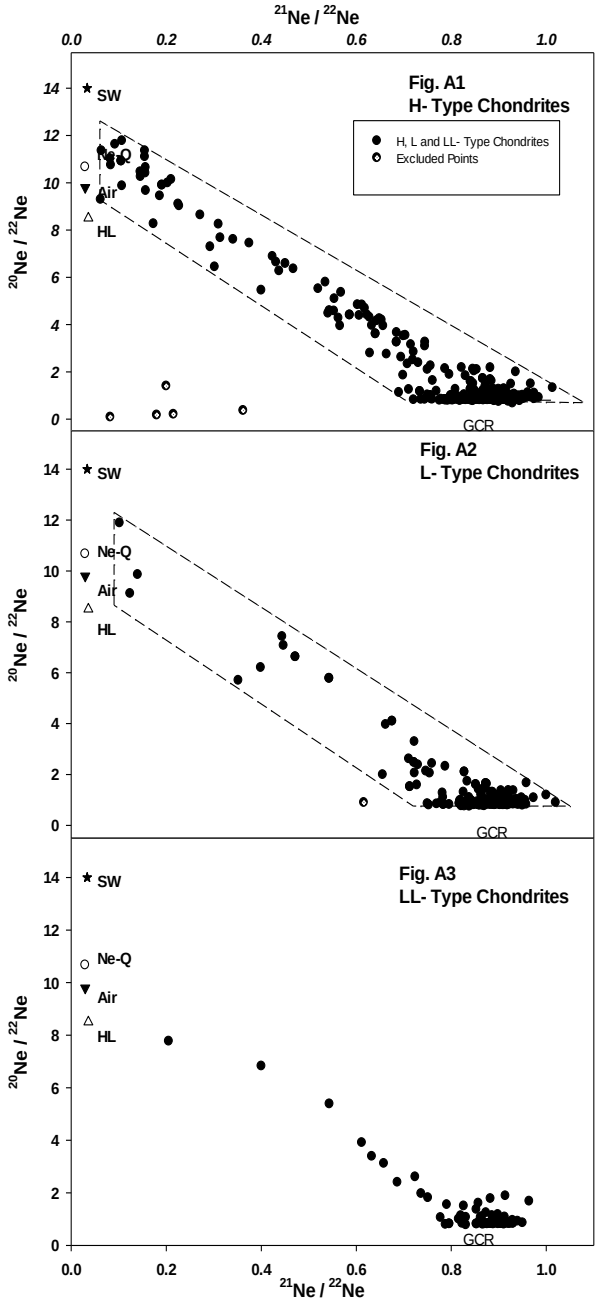

Figure A: For H, L and LL chondrites, three isotopic plot which is showing trapped component.

Discussion:

We derive the range of the concentration of trapped ^{20}Ne in the bulk samples of H chondrite as (0.022 to 565.55) x 10^{-8} cm^3 STP/g, and the average value is 16.36 x 10^{-8} cm^3 STP/g. For L type of chondrites, we estimate the range of trapped ^{20}Ne as (0.054 to 248.90) x 10^{-8} cm^3 STP/g, with the average value 6.78 x 10^{-8} cm^3 STP/g. For LL chondrites, the concentration of trapped ^{20}Ne range is (0.064 to 141.56) x 10^{-8} cm^3 STP/g, with the average value 6.27 x 10^{-8} cm^3 STP/g.

In carbonaceous chondrites, the concentration of trapped ^{20}Ne ranges as (1.30 to 459.00) x 10^{-8} cm^3 STP/g, with the average value 67.77 x 10^{-8} cm^3 STP/g [5]. In general, the average of concentration of trapped ^{20}Ne in H, L, LL chondrites is significantly lower than that of carbonaceous chondrites.

In many meteorites, Q is the main trapped component, and some of them have SW as a major trapped component (Fig. A). Here, trapped component of the different class of ordinary chondrites can be seen as a subtle dotted area (Fig. A). Galactic Cosmic Rays (GCR, high energy interaction of GeV particles) effect, is observed in large number of meteorites. The cluster seen near GCR region is due to the reason of considerable penetration depth (1-2-meter range) of GCR interaction and samples are derived from this region of the meteoroid.

Some meteorites of H and L type is showing the signature of SW. It is due to the following two possibilities.

Asteroidal Surface Regolith Implantation of SW & SCR: Surfaces of the objects in the asteroid belts are exposed to continuous implantation of SW (~KeV range) and SCR (~MeV range). The regolith on the asteroid surface usually undergoes material redistribution During this process, there are chances that surface materials gets exposed to SW and SCR. This leads to the implantation of solar gases (by SW) in the exposed material. This material then agglomerates into the bigger pebble. The meteorites possessing the surface material exposed to SW shows the signature of the solar wind noble gases in the stepwise heating [10].

Early Solar Processes: Our Solar system formed about 4.6 Ga ago with the collapse of the interstellar gas cloud and dust to the solar nebula. It might be a chance that meteoritic mass that we are measuring have SW exposure in the nebula or it has trapped the noble gas from the nebula.

Conclusion: The average concentration of trapped ^{20}Ne in bulk samples of ordinary chondrites is much lower than that of carbonaceous chondrites. Bulk samples exhibit multiple trapped components in ordinary chondrites. Q-component is prominent in many meteorites. Some of the meteorites have gases from SW.

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