Noble gas elemental and isotopic compositions in the Martian atmosphere and interior

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Noble gas isotopic and elemental compositions provide a key to understand degassing history from a solid planet and evolution of planetary atmosphere. The first measurement of noble gases on Mars by the Viking landers, followed by the analyses of Martian meteorites provide important information regarding noble gas signatures in atmosphere and interior of Mars. More than 30 meteorites have been identified as the Martian meteorites, and the increasing number of noble gas data set is revealing characteristic distribution profiles of noble gas isotopes on and in the Mars. Shergottites contain the Martian atmosphere, ALH 84001 and Nakhlites would reserve fractionated or ancient atmosphere, and Chassigny represents noble gases in the Martian interior. Radiogenic nuclides 40Ar, 129Xe and fissiogenic heavy Xe isotopes are significant in the Martian atmosphere (e.g., 40Ar/36Ar is larger than 2000, 129Xe/132Xe is larger than 2), but not in the Martian interior. This figure is opposite to that of the Earth. Xe isotopic composition in the Mars interior is similar to that of solar Xe except for a slight increase at 129Xe. In contrast to this, light Xe isotopes in the Mars atmosphere show relative abundance similar to that of atmosphere of the Earth, which shows fractionated abundance pattern relative to solar Xe favoring heavier isotopes.

We are measuring noble gas compositions of basaltic shergottites, mostly from hot deserts, Oman (Dhofar and Sayh al Uhaymir) and Sahara (Dar al Gani and Northwest Africa). DHO 019 gives cosmic-ray exposure age of 20 Ma, which is the longest among the exposure ages so far reported for Martian meteorites. This requires additional impact event on the Mars, which launched the DHO 019 meteorite. Long residence time on the deserts have also been calculated for the meteorites, 0.14 Ma for DaG 476 and 0.28 Ma for DHO 019, based on the concentration of cosmogenic radionuclide 81Kr. Martian atmospheric noble gas signatures in Ar, Kr and Xe were observed in higher temperatures by stepwise heating analyses. Fractionated terrestrial atmospheric noble gases can not be negligible, which may be trapped in terrestrial weathering products after falling on the Earth. All the measured shergottites have short K-Ar ages (less than 1.5 Ga), which is consistent with the young crystallization ages for Martian meteorites except for ALH 84001 orthopyroxenite.

We will show the Martian noble gas signatures obtained from various types of Martian meteorites and discuss on the significance of volatiles of the Mars compared with other planets.