6.1.35

Noble gases in Shergotty: Bulk, pyroxene and maskelynite

S. P. SCHWENZER, S. HERRMANN AND U. OTT

Max-Planck-Institut für Chemie, Kosmochemie, J.-J. Becher Weg 27, D-55128 Mainz, Germany (schwenze@mpch-mainz.mpg.de; ott@mpch-mainz.mpg.de)

All five noble gases have been measured in a pulverized bulk sample and in two handpicked separates (pyroxene and maskelynite) from Shergotty using the procedure described in [1]. Selected data for the bulk sample and the maskelynite separate have been presented in [2].

Radiogenic ^{4}He: Abundances of ^{4}He are 1.21 (±0.09) x10^{-6} (bulk), 1.26 (±0.03) x10^{-6} (pyroxene), and 0.97 (±0.09) x10^{-6} (maskelynite) cc STP/g. Correcting for the cosmogenic contribution reduces the remaining ^{4}He to 84 % (bulk, pyroxene) and 95 % (maskelynite). This remaining ^{4}He corresponds to ^{4}He from U and Th decay. The amount of radiogenic ^{4}He, which should be present, can be calculated from the U and Th contents [3, 4] and the crystallization age of the meteorite [5]. 71 ± 3 % of the produced ^{4}He have been lost from the bulk sample, presumably due to the shock event. Using elemental abundance data [3, 6] and our Ne data, cosmic ray exposure ages for the bulk sample can be calculated with the method developed by Eugster and coworkers [7]. The average exposure age from T_3+T_{21}+T_{38} is 2.56 Ma, including T_{78}+T_{126} it is 2.70 Ma, which is in agreement with previous studies [e.g. 8].

The heavy noble gases show two Martian components: Data from the bulk sample and from pyroxene fall close to the Chassigny, i. e. Martian interior, endmember in respect to the ^{36}Ar/^{132}Xe and ^{84}Kr/^{132}Xe elemental ratios (all corrected for cosmogenic contributions) if plotted vs. ^{129}Xe/^{132}Xe. In some temperature steps, especially in the maskelynite sample, small but distinct contributions of Martian atmosphere can be seen. The maximum ratio of ^{129}Xe/^{132}Xe observed in maskelynite is 1.44 ± 0.07 in our 1535 °C step, where also the maximum Xe release occurs. ^{40}Ar/^{36}Ar in all three samples is high as well, apparently due to the presence of Martian atmosphere plus some radiogenic contribution. Especially for the phases containing low amounts of K (pyroxene: K content 175 ppm; [8]) up to 90 % of the ^{40}Ar are probably of Martian atmospheric origin. For the phases containing higher amounts of K (1810 ppm (bulk) and 3340 ppm (maskelynite) [8]), the relative contribution from the atmosphere is smaller.

References

[1] Mohapatra R.K. et al. (2001) *MAPS* **36**, A139.
[2] Schwenzer S.P. et al. (2003) *MAPS* **38**, A116.
[3] Jochum K.P. et al. (2001) *MAPS* **36**, A90-A91.
[4] K.P. Jochum, priv. communication
[5] Nyquist L.E. et al. (1979) *GCA* **43**, 1057-1074.
[6] Meyer C. (2001) Martian Meteorite Compendium.
[7] Eugster O. et al. (1997) *GCA* **61**, 2749-2757.
[8] Terribilini et al. (1998) *MAPS* **33**, 677-684.

6.1.36

Li isotopic study of Martian meteorites

P. BECK[1], J-A. BARRAT[2], M. CHAUSSIDON[3],
PH. GILLLET[1] AND M. BOHN[4]

[1] Laboratoire des Sciences de la Terre, Ecole Normale supérieure de Lyon, France (pbeck@ens-lyon.fr)
[2] U.B.O.-I.U.E.M, Brest, France
[3] CRPG-CNRS UPR 2300, Nancy, France
[4] Ifremer-Centre de Brest, (CNRS-UMR 6538), France

Li abundance in pyroxenes from the Zagami and Shergotty martian meteorites [1], suggested that Li was lost by their parent magmas. Such a behavior suggested the involvement of an aqueous fluid during the crystallization of the meteorites because of the strong affinity of Li with water-rich fluids [2]. In order to extend this observation, we studied in detail the Li behavior in the Northwest Africa 480 shergottite (NWA 480). Lithium concentrations and isotopic compositions were measured in individual grains of pyroxene, and in a few maskelynites and Ca-phosphates grains [3].

In pyroxenes Li abundances are nearly constant from core to rim with concentrations ranging between 3 and 4 µg/g while δ^{7}Li values significantly increase within single crystals from ~ −17 ‰ in the core to ~ +10 ‰ in the rim. Because of the incompatible behavior of Li, the present constancy of Li concentrations within zoned pyroxenes rules out any simple crystallization model in a closed system for Li. The large Li isotopic variations observed within pyroxenes support this conclusion. There is no evidence in support of secondary alteration of NWA 480 to explain the Li isotopic variations, which thus most likely reflect magmatic processes on Mars. Degassing might explain the Li systematics observed in NWA 480 pyroxenes. Because Li has a strong affinity with water-rich fluids, a significant loss of Li from NWA 480 parental melt can happen upon melt emplacement and cooling. Li isotopic fractionation is anticipated to accompany this process, ^{7}Li being depleted relative to ^{6}Li in the volatile phase.

This detailed work was completed by measurements of Li isotopic composition in pyroxene cores from 12 different meteorites representative of every sub-classes of the martian meteorite family.

Reference

[1] Lentz at al. (2001), *Geochim., Cosmochim. Acta*, **65**, 4551-4565.
[2] Brenan et al. (1998), *Geochim. Cosmochim. Acta* **62**, 3337-3347.
[3] Beck et al. (2004), *Geochim., Cosmochim. Acta*, in press.