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Identification of Martian soil components in Martian meteorites using noble gas and thermal ionization mass spectrometric techniques

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The elemental and isotopic composition of noble gases (released by stepwise heating techniques) in Martian meteorites (shergottites) such as EET79001 and shergotty determined using noble gas mass spectrometry techniques closely match with the composition of the Martian atmosphere determined by mass-spectrometers on board curiosity and viking. Some impact melts (IM) in shergottites yield isotopic excesses of 81Kr compared to solar wind Kr which is attributed to thermal neutron (n, γ) capture on 80Br in the top few meters of Martian regolith (soil). Thermal neutrons are produced by galactic cosmic ray (GCR) interactions in the top layers (shallow depth) of the Martian regolith (few percent of frozen water). They don't occur below ~3 meters. Moreover, the same shergottite IM glasses also display isotopic deficits in samarium (149Sm) based on TIMS studies (includes isotope dilution techniques). These mass spectrometry results reveal that some of the precursor grains in the IM glasses were irradiated by an integrated thermal neutron fluence of ~1x1015 n/cm_2 for a period of ~5-8 million years near the Martian surface. Furthermore, TIMS – based Rb–Sr isotopic studies in several IM glasses in EET 79001 yield data points that plot on a linear array in the Rb–Sr isotope diagram (87Sr/86Sr vs., 87Rb/86Sr plot) suggesting that the precursor grain assemblages presumably originated by sequential deposition of gypsum ($CaSO_4$) during progressive evaporation of brines in a closed fluid environment near the shergottite source region on Mars.

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