

**MARTIAN ATMOSPHERIC Ar AND THE TRAPPED COMPONENT IN SHERGOTTITES.**

F. Albarède<sup>1</sup>, A. Bouvier<sup>2</sup>, and J. Blichert-Toft<sup>1</sup> <sup>1</sup>Ecole Normale Supérieure, Lyon 69007, France (albarede@ens-lyon.fr). <sup>2</sup>Arizona State University, School of Earth and Space Exploration, Tempe, AZ 85287-1404, USA.

Until 25 years ago, shergottites were thought to give relatively old Ar-Ar ages and the Rb-Sr and Sm-Nd ages were seen as an impact feature [1,2]. The accumulation of young concordant Rb-Sr and Sm-Nd ages given by mineral isochrons, with a prominent peak at 165-185 Ma [3] shifted the consensus to young igneous emplacement events. This prompted Ar chronologists to reinterpret some embarrassingly old Ar ages as indicating excess or 'trapped' ages. Upon re-examination of Pb-Pb ages, Bouvier et al. [4-6] found that the old Pb-Pb isochron ages of shergottites (4.1 and 4.3 Ga) are consistent with the range of isotopic variations observed for whole-rock Rb-Sr (and to a large extent Sm-Nd) data. They observed that (i) the K-Ar ages of melt inclusions [7] are actually old and compatible with Pb-Pb chronology and (ii) that the  $^{40}\text{Ar}/^{36}\text{Ar}$  ratio of the trapped Ar component (~1500) would be smaller than the atmospheric component (~3000):  $^{40}\text{Ar}$  has to be produced in the mantle before it is lost by the atmosphere and a comparison with terrestrial mantle-atmosphere systematics makes this option totally unlikely. Walton et al. [8] provided new Ar-Ar analyses in melt inclusions from shergottites and found "impossibly" old ages in some of them and used their observations to reject the old shergottite age interpretation. They also correctly pointed out that the model used by Bouvier et al. [5] does not allow the atmospheric escape of Ar.

We are here reinvestigating some critical aspects of Ar evidence. First, we show that all gas fractions indicating impossibly old Ar-Ar ages of shock melts contain essentially no  $^{39}\text{Ar}$  and no  $^{37}\text{Ar}$ , and therefore correspond to melts of K- and Ca-free phases, most likely olivine. It is rather clear that whichever  $^{40}\text{Ar}$  is present in these melts is unsupported and has diffused into it under unspecified conditions. Shock melts with measurable amounts of K and Ca give old but not unreasonably old ages (0.5 to 4.0 Ga).

We finally considered a model of Ar isotope evolution in the mantle-atmosphere system that includes atmospheric escape. In order to get a  $^{40}\text{Ar}/^{36}\text{Ar}$  ratio smaller in the atmosphere than in the mantle, we need to assume that  $^{36}\text{Ar}$  is lost much faster than  $^{40}\text{Ar}$ , but then  $^{36}\text{Ar}$  should also be lost preferentially to  $^{38}\text{Ar}$  and the  $^{36}\text{Ar}/^{38}\text{Ar}$  ratio of the Martian atmosphere should be much lower than the value reported by the Viking missions. We therefore conclude that the low  $^{40}\text{Ar}/^{36}\text{Ar}$  ratio of the trapped Ar component used in the literature is not justifiable.

References : [1] Bogard D.D et al., 1979. *GCA* 43: 1047-1055. [2] Bogard D.D et al., 1984 *GCA* 48:1723-1739. [3] Nyquist, L. E. et al., 2001. *Space Sci. Rev.* 96:105-164. [4] Bouvier et al. 2005. *EPSL* 220:221-233. [5] Bouvier et al. 2008. *EPSL* 266:105-124. [6] Bouvier et al. 2009. *EPSL* 280:285-295. [7] Walton E. L. et al., 2007. *GCA* 71:497-520. [8] Walton E. L. et al., 2008, *GCA* 72:5819-5837.