

SUBSOLAR NOBLE GASES IN AN ACID-RESISTANT RESIDUE OF THE EH5 CHONDRITE ST. MARK'S. H. Busemann¹, H. Baur², and R. Wieler², ¹ Physics Institute, University of Bern, Sidlerstr. 5, CH-3012 Bern, Switzerland. busemann@phim.unibe.ch, ²ETH Zürich, Institute for Isotope Geology, Sonneggstr. 5, CH-8092 Zürich, Switzerland.

Introduction: Enstatite chondrites have remarkable properties: they were formed in a reducing environment, they are putatively similar to precursor material of Earth, Venus, or Mercury, have a terrestrial oxygen isotopic composition and an uncommon noble gas signature [1-5]. Trapped noble gases in E-chondrites are intermediate between solar and chondritic composition and consist of two components: "Subsolar", enriched in Ar and Kr relative to Xe and Q-gas, possibly residing in enstatite, micro-vesicles or graphite within enstatite [6,7] and Q-gases [5,8].

He and Ne isotopic and elemental abundances of Q and subsolar gases in E-chondrites are not well defined, but essential to determine the origin of these gases. Here, we present preliminary data of a stepwise online etching experiment [9] on a carbonaceous HF/HCl-resistant residue of EH5 St. Mark's, especially suitable due to a cosmic-ray exposure age of only 1Ma [10].

Results and discussion: The first steps show relatively constant elemental abundances, indicating the release of a single component. Surprisingly, these steps yield a subsolar element pattern with $^{36}\text{Ar}/^{132}\text{Xe} \sim 400$ and $^{84}\text{Kr}/^{132}\text{Xe} \sim 1.7$, similar to the bulk composition [10]. We cannot decide yet whether the oxidisable acid-resistant residue, by definition phase Q, represents the main carrier, because $\sim 4\%$ of the bulk concentrations were released so far. Enstatite [6] is clearly not the only subsolar gas carrier.

The four steps least compromised by cosmogenic Ne yield $^{20}\text{Ne}/^{22}\text{Ne} = 11.65$. In agreement with the subsolar element pattern, we indeed found "subsolar" $^{20}\text{Ne}/^{22}\text{Ne}$ intermediate between SW (13.8) and Q (10.1-10.7) [9,11]. The low $^{21}\text{Ne}/^{22}\text{Ne}$ of 0.0366 indicates negligible amounts of cosmogenic Ne. Thus, the gases do not originate from silicates that might have survived.

The same steps give $^3\text{He}/^4\text{He} = 2.1 \times 10^{-4}$, which is, like Ne, between SW (4.6×10^{-4}) and Q (1.23×10^{-4}) [11,12]. This ratio, if confirmed, could have important consequences, because it is higher than those of He-Q or Jupiter (1.66×10^{-4} [13]) thought to represent the protosolar cloud and thus pre-D-burning He. E-chondrites then would contain post-D-burning He. The discovery of subsolar gas in certain chondrules of the EH3 Y-79190 thought to originate from solar wind incorporated into chondrule precursors [14] might be in line with this. However, SW incorporation does not

explain the Q-like isotopic Ar-Xe data from our acid-resistant residue.

Retrapping of subsolar gas from silicates into an acid-resistant phase of EH4 Abee during impact-induced partial melting has been suggested to explain elevated $^{36}\text{Ar}/^{132}\text{Xe}$ and $^{84}\text{Kr}/^{132}\text{Xe}$ ratios [7]. $^{20}\text{Ne}/^{22}\text{Ne}$ in Abee [7] is at the lower end of the Q ratios [9], though subsolar Ne should increase the originally trapped $^{20}\text{Ne}/^{22}\text{Ne}$. St. Mark's, which yields a high $^{20}\text{Ne}/^{22}\text{Ne}$, is not an impact melt [15]. Re-distribution from silicates into the HF/HCl-resistant carrier therefore seems unlikely.

Incorporation of gases released from carbonaceous material during chondrule formation and parent body metamorphism could explain the observed subsolar gas in chondrules and enstatite. However, noble gases in phase-Q-like material incorporated into E-chondrites must then originally have been subsolar, whereas the other chondrites incorporated phase Q with the common composition.

Conclusion: Our on-going noble gas analysis of St. Mark's has already yielded intriguing results emphasizing the particular character of E-chondrites.

References: [1] Larimer J.W. and Bartholomay M. (1979) *GCA*, 43, 1455-1466. [2] Javoy M. (1995) *GRL*, 22, 2219-2222. [3] Wasson J.T. (1988) in: *Mercury*, University of Arizona Press, Tucson, 622-650. [4] Clayton R.N. (1993) *Annual Rev. Earth Planet. Sci.*, 21, 115-149. [5] Crabb J. and Anders E. (1981) *GCA*, 45, 2443-2464. [6] Crabb J. and Anders E. (1982) *GCA*, 46, 2351-2361. [7] Takaoka N. et al. (2000) *Antarct. Met.*, XXV, 148-150. [8] Huss G.R. et al. *GCA*, 60, 3311-3340. [9] Busemann et al. (2000) *MAPS*, 35, 949-973. [10] Patzer A. and Schultz L. (2001) *MAPS*, 36, in press. [11] Wieler R. (1998) *Space Sci. Rev.* 85, 303-314. [12] Busemann et al. (2001) *in preparation*. [13] Mahaffy P.R. et al. (2000) *JGR*, 105, 15061-15071. [14] Okazaki R. et al. (2000) *Antarct. Met.*, XXV, 124-126. [15] Zhang Y. et al. (1995) *JGR*, 100, 9417-9438.