RE-EXAMINATION OF ANOMALOUS I-XE AGES: ORGUEIL AND MURCHISON MAGNETITES AND ALLEGAN FELDSPAR. Charles M. Hohenberg, Olga Pravdivtseva, and Alex Meshik, Department of Physics, Washington University, St. Louis MO 63130 (cmh@howdy.wustl.edu)

Introduction: The I-Xe system has been certified as a valid chronometer by direct comparison with Pb-Pb in single mineral systems [1]. This study also provided the intercalibration necessary to transform I-Xe from a relative chronometer into an absolute chronometer. During the comparison of I-Xe and Pb-Pb systems, one of the surprises was that the relative Pb-Pb ages of the phosphate agreed well with the relative I-Xe ages of the feldspar for 5 of the 6 meteorites studied. The only exception was feldspar from Allegan whose apparent I-Xe age was 17 Ma older than the Pb-Pb age of its phosphate [1].

What is disturbing here is not an apparent difference between the I-Xe age of the feldspar and Pb-Pb age of the phosphate because the ages of two different mineral systems need not be concordant (it was, in fact, a surprise to see concordancy for these two different minerals in all the other meteorites). What *was* a surprise is the extremely old apparent I-Xe age of Allegan feldspar (6.9 Ma before the Bjurböle/Shallowater standard). The implied age of 4.573 Ga is as old as those reported by Lewis and Anders [2] for Orgueil and Murchison magnetites, the oldest reported I-Xe ages. This suite of diverse, presumably secondary, minerals have apparent I-Xe ages 10 Ma older than Allende CAIs (4.563 ± 0.002 Ga) [3]. How is this possible? The answers are: (1) Allegan feldspar, like Arapahoe [7], appears to be disturbed by shock and has no valid I-Xe age; (2) A new attempt to confirm the I-Xe age of Orgueil magnetite failed to reproduce the previous results. In fact, Orgueil magnetite is younger than the Shallowater standard leading us to conclude that the reported old I-Xe ages for Orgueil and Murchison magnetites are probably in error.

Results: Magnetite separates from Orgueil, and number of other samples, were irradiated at the University of Missouri Research Reactor, receiving about 2 x 10^{19} n/cm^2 and designated SLC-14. Included in this irradiation were samples of the standard I-Xe irradiation monitor Shallowater. All samples were placed at the same vertical height and at the same radius from the center of the irradiation capsule that was constantly rotated to assure uniform neutron fluence for all samples (monitored by flux wires).

Figure 1 shows isochrons obtained for both the Orgueil magnetite and the Shallowater standard, clearly indicating that these magnetites are younger than the Shallowater standard, postdating it by 2.8 ± 0.3 Ma, not 7.5 Ma older as suggested by the previous studies [2].

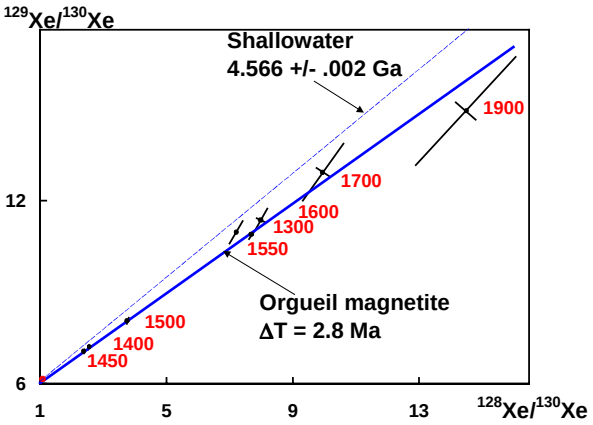

Figure 1. I-Xe isochrones for Orgueil magnetite and the Shallowater standard.

The absolute I-Xe age of the Shallowater standard (4.566 ± .002 Ga) establishes closure of the I-Xe system in Orgueil magnetite at a much more reasonable 4.563 Ga. Age calibration by a chemical monitor, such as KI used by Lewis and Anders [2], is both indirect and very difficult due to the large concentrations of radiogenic ^{128}Xe that are produced. Pure compounds suffer from self-shielding effects. Moreover, the large quantities of radiogenic ^{128}Xe produced must be diluted with so much atmospheric Xe that incomplete mixing can be a problem, historically a source of error [4]. Consequently, we believe that the previously reported I-Xe ages [2] of both the Orgueil magnetite and Murchison magnetite (which used the same monitors) are in error. These samples are not older than the Shallowater enstatite monitor, but are younger by 2.8 Ma.

The L5 chondrite Arapahoe was reported to have an I-Xe age 13 Ma before its Bjurböle standard [5,6], which would correspond to an absolute I-Xe age of 4,579 Ga, even older than that reported for Orgueil and Murchison magnetites. One of the distinguishing features of the apparent isochron of Arapahoe is the need for trapped Xe to have a lower ^{129}Xe/^{128}Xe ratio than any conventional trapped component. It is difficult to imagine how this could occur except in a scenario where ^{127}I becomes intimately mixed (presumably by shock) with trapped Xe. Since it is transformed into ^{128}Xe by the neutron irradiation, the

resulting pseudo-trapped Xe will be enriched in ^{128}Xe, an artifact of shock mixing.

Subsequent studies of artificially shocked Bjurböle confirmed this effect, showing precisely the same behavior observed in Arapahoe [7]. Arapahoe is among the most heavily shocked of the group of black hypersthene chondrites which experienced a major shock event 500 Ma ago [8]. Its I-Xe structure was clearly disturbed leading to an anomalous age [7]. Figure 2 shows the apparent I-Xe isochron (high temperature points) for Allegan feldspar, and that of Arapahoe. Both of these show the need for an anomalous pseudo-trapped Xe component enriched in ^{128}Xe.

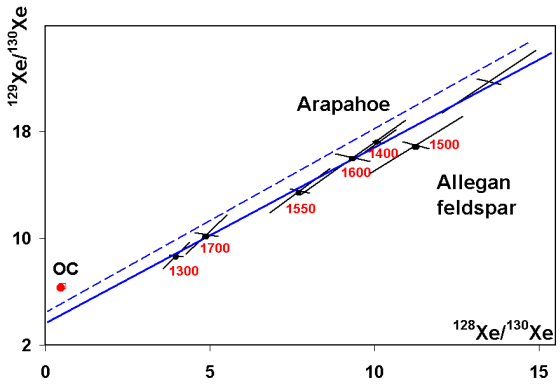

Figure 2. Free fit lines for Arapahoe and Allegan feldspar showing enriched 128Xe in the trapped pseudo-component (OC-Xe is shown as a reference).

Any reasonable trapped Xe component resides near the point representing trapped Xe in ordinary chondrites (OC). I-Xe evolution within a closed system can result in enrichment in ^{129}Xe, but not ^{128}Xe [9]. In fact, no know mechanism, except that resulting from shock effects, and demonstrated in Arapahoe and artificially shocked Bjurböle, can enrich ^{128}Xe in the trapped component. Although overlooked during the comparison of the I-Xe and Pb-Pb systems [1], we now consider the linear array of measured points in Allegan feldspar to be an artifact produced by shock mixing of trapped Xe and iodine. As often noted, shock heating is not a function of the thermal properties of the host site, but the mechanical properties (chiefly compressibility) and, as shown in shocked Bjurböle, Arapahoe and now Allegan feldspar, stepwise heating does not help in resolving shock-induced artifacts.

In summary, all of the anomalously old I-Xe ages (magnetite from Orgueil and Murchison, and feldspar from Allegan) are incorrect. There seem to be no I-Xe ages significantly older than those of the Shallowater/Bjurbole standard, and the Allende CAI inclusions (all close to 4.566 Ga). Reported I-Xe ages whose reference is Murchison magnetite [c.f. 10] are also incorrect. Those using KI monitors for age reference should be carefully reviewed and whole rock I-Xe ages may not be interpretable [1].

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References: [1] Brazzle R. H. et al. (1999) *GCA, 63,* 739-760. [2] Lewis R. S. and Anders E. (1975) *Proc. Nat. Acad Sci. USA, 72,* 268-273. [3] Hohenberg C. M. et al. (1998) *Meteoritics & Planet. Sci., 33,* A69. [4] Hohenberg C. M. and Kennedy B. M. (1981) *GCA, 45,* 251-256. [5] Drozd R. J. and Podosek F. A. (1976) *EPSL, 31,* 15-30. [6] Drozd R. J. and Podosek F. A. (1977) *Geochem. J, 11,* 231-237. [7] Caffee M. W. et al (1982) *J. Geophys. Res, 87,* A318-A330. [8] Heymann D. (1967) *Icarus, 6,* 189-221. [9] Kennedy B. M., et al (1988) *GCA, 52,* 101-111. [10] Swindle T. D. and Podosek F. A. (1988) *Meteorites and the Early Solar System,* 1127-1146.