XENON ISOTOPIC MEASUREMENTS IN SHALLOWATER: IN SITU PULSED LASER VOLATILIZATION AND THE SEARCH FOR THE CARRIER OF RADIOGENIC ^{129}XE: K. Kehm, C.M. Hohenberg and R.H. Nichols, Jr., McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130 USA.

Introduction. The present measurements of Xe in Shallowater, a unique enstatite achondrite [1], represent our maiden attempt at *in situ* noble gas laser volatilization. Conventional bulk analyses of Shallowater have shown the presence of large amounts of radiogenic ^{129}Xe (^{129}Xe* from the decay of extinct ^{129}I), which is enriched by a factor of ~3 times the normal trapped ^{129}Xe and is thought to be carried in the enstatite [2]. This enrichment is present in fixed proportion to the amount of I in the bulk meteorite, providing a relatively precise I-Xe age ($\pm 10^5$yrs.) for Shallowater, but offering very little insight into what closure event(s) the I-Xe clock is dating. Much of this ambiguity can, in principle, be eliminated if the carrier phase(s) of the ^{129}Xe* can be determined, thereby associating a bulk I-Xe age with Xe closure in specific mineral phases. Apparent I-Xe ages of enstatite meteorites, unlike other meteorite types, seem to correlate with petrologic type in these objects [cf. 2]. While the Xe-retentive iodine hosts may be largely secondary minerals in most meteorites (and thus the I-Xe age reflects *secondary* processes), the host in enstatite meteorites may be enstatite itself (typically 80% of the bulk) or small inclusions within the enstatite. By selectively excavating Xe from various mineral phases in a Shallowater thick-section, we have tried to identify the carrier phase of ^{129}Xe* in order to provide more insight into the relationship between the bulk I-Xe age determination for Shallowater and its ^{129}Xe* carrier phase. While the carrier phase of radiogenic Xe in Acapulco, for example, has been determined via the analysis of individual mineral grains [3], selective *in situ* laser excavation of noble gases possesses an advantage over bulk and single grain techniques in that it can potentially link noble gas signatures with specific mineral phases in meteorites without the need for mineral disaggregation.

Technique. A polished thick section of Shallowater, approximately 2 mm thick and 1 cm^2 area, was mounted on an Al SEM stub for SEM analysis and subsequent laser volatilization. A back scattered SEM mosaic clearly delineated the primary mineral assemblages discussed by Keil et al. [1] including large ortho-enstatite crystals (~80% by volume), metallic Fe/Ni, and troilite. The section was subsequently loaded into the laser extraction cell of a low-blank noble gas mass spectrometer [4]. The extraction cell is fitted with a Pyrex viewport through which an acoustically pulsed 200 W Nd:YAG laser can be focused on the sample in vacuum. In addition, the cell was mounted on a high-precision (sub-micron resolution), computer controlled XY stage. During laser volatilization, the stage is programmed for side to side movements allowing the sample area to be "rastered" at a strictly controlled rate providing relatively uniform excavation depths (typically, 3×10^{-6} cm^3). Optimum pulse frequency and laser output power were determined to be 600 Hz and ~70 W on the basis of preliminary studies on a Springwater thick section.

Results. Data shown in Fig. 1 indicate that pure enstatite crystals (closed circles) or small inclusions within the enstatite carry most of the ^{129}Xe*. (In both Figs. 1 and 2 values for the bulk meteorite are given by the dashed lines.) No ^{129}Xe* was detected in the two metal phases for

which upper limits are given. The concentrations of $^{129}Xe^*$ in one troilite and one Fe/Ni metal phase (indicated by the open and closed squares, respectively) were at least an order of magnitude below the highest concentrations measured in enstatite. The presence of $^{129}Xe^*$ in these shots may be due solely to the heating or vaporization of nearby enstatite during the excavation of the metal phases. In addition, the analysis of an area of enstatite heavily veined with Fe/Ni metal (open circle) yielded a relatively low concentration of $^{129}Xe^*$, suggesting that I may not be sited along enstatite/metal grain boundaries. The result that enstatite or inclusions within the enstatite carry the $^{129}Xe^*$ is consistent with previous measurements on enstatite meteorites [5,6].

Neon isotopic measurements were also performed so that an independent determination of the excavation volumes could be computed from the cosmogenic ^{21}Ne abundances. The ($^{129}Xe^*/^{21}Ne_{cos}$) ratios in the enstatite (Fig. 2) may thus provide an insight into whether the $^{129}Xe^*$ is carried within the volume of the enstatite or within small inclusions contained within the enstatite. If $^{129}Xe^*$ is derived from the enstatite lattice, then the ratio should plausibly be constant. If, on the other hand, the $^{129}Xe^*$ is carried by small inclusions, then the ratio may vary. However, in this preliminary study, the two highest $^{129}Xe^*$ concentrations for enstatite shots have the two lowest ($^{129}Xe^*/^{21}Ne_{cos}$) ratios to first order, contrary to what we would expect. At the present time we do not fully understand the whole story. Work currently in progress will hopefully provide data that will elucidate some of these problems.

References. [1] Keil *et al.* (1989) *GCA* **53**, 3291-3307. [2] Kehm *et al.* (1993) *LPSC* **24**, 777-778. [3] Nichols *et al.* (1994) *GCA* **58**, in press. [4] Hohenberg (1980) *Rev. Sci. Instr.* **51**, 1075-1082. [5] Crabb and Anders (1982) *GCA* **46**, 2511-2526. [6] Wacker and Marti (1983) *EPSL* **62**, 147-158.

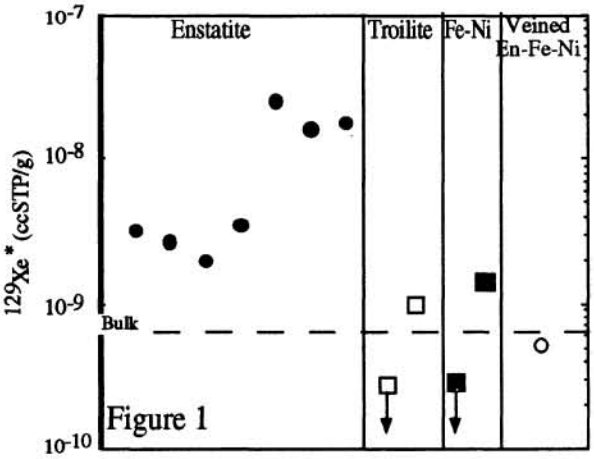

Figure 1

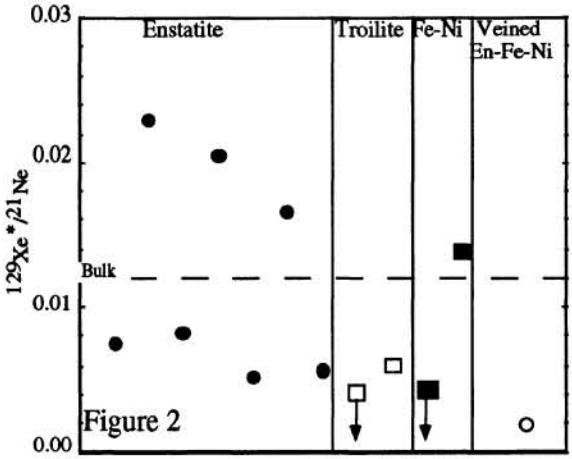

Figure 2