PARENTLESS FISSION XENON IN THE METEORITE BHOLGHATI? T. D. Swindle, Lunar and Planetary Lab., U. of Arizona, Tucson, AZ; and C. M. Hohenberg, R. Nichols and C. T. Olinger, Washington U., St. Louis, MO.

In many lunar breccias, directly-implanted solar wind noble gases are accompanied by xenon which was apparently produced by decay of ^{238}U, ^{244}Pu, and/or ^{129}I within the Moon and then implanted into grains as a result of processes operating either in the transient lunar atmosphere or within the regolith (1). Such parentless fission xenon has not been observed in any gas-rich meteorites, but there is evidence for other surface-implanted volatiles in meteorites from the eucrite association (2). As part of the Bholghati Consortium (led by J.C. Laul), we have analyzed Ne, Ar, and Xe in a 50.4 mg sample of matrix from the gas-rich howardite Bholghati.

Gases were extracted by step-wise heating (10 steps) and analyzed in an ion-counting static mass spectrometer. Elemental abundances agree reasonably well with the results of (3). Using the Ne and Ar results from both the present study and (3), we calculate a cosmic-ray exposure age of 9 Ma to 14 Ma. However, we are primarily interested in the isotopic composition of the xenon, so we will concentrate on that aspect of the data.

The total Xe isotopic composition (excluding three blank-level extractions and one extraction with air-like isotopic ratios) is $^{124}Xe/^{126}Xe/^{128}Xe/^{129}Xe/^{131}Xe/^{130}Xe/^{132}Xe/^{134}Xe/^{136}Xe$ = 3.44(5)/3.56(4)/51.5(2)/638.6(1.6)/502.0(1.3)/613.27(1.4)/239.6(7)/203.5(6).

Evidence for parentless fission xenon: When the xenon data are plotted on a three-isotope plot such as Fig. 1, most of the data are consistent with a single straight line, suggesting a simple mixture of two components. In lunar breccias, the two components are often designated "volume correlated" and "surface correlated". The former is dominated by spallation, although it might contain some in situ fission, and falls to the upper left. The latter is dominated by solar wind, but must have some contribution from another source, since the least-squares fit line does not pass through the composition of modern surface-correlated lunar Xe (presumably solar wind). We have calculated the isotopic composition of the additional source of surface correlated gas by two slightly different techniques.

The first technique makes use of the linear correlations. If we assume that the surface correlated component has a $^{126}Xe/^{130}Xe$ ratio equal to that of modern lunar Xe (4), we can calculate the entire isotopic composition from three-isotope plots like Fig. 1. If we then assume that this component is a mixture of solar wind and an unknown component which contains no ^{130}Xe, we can calculate the isotopic composition of the unknown component. The result, given in Table 2 as "Method 1", contains only heavy isotopes, consistent with a fission-produced component.

The second technique assumes that all the gas comes from either spallation, modern lunar Xe or an unknown component containing no ^{126}Xe or ^{130}Xe. We can then partition the $^{126}Xe/^{130}Xe$ ratio between spallation and solar wind and then subtract off both components. The remainder is the unknown component. Again, the result ("Method 2" in Table 2) is consistent with a fission-produced component.

Discussion: One possible source of the unknown component is terrestrial contamination ("Air"). However, this is ruled out by two arguments. First, the line in Fig. 1 passes to the ^{136}Xe-rich side of Air, meaning that there must be another unknown component, even if there is contamination. More importantly, an addition of contamination should be detectable by the isotopic spectrum it would produce, and the pseudo-fission component produced by contamination ("Air fission" in Table 2) is strikingly different in composition from the component we find by either method of calculation.

Another possible source is in situ fission, but this also seems unlikely. In our second technique, any in situ fission would show up in our unknown component, but in the first technique, we would expect in situ fission to be associated with the volume-correlated component, not the surface-correlated component. We can also calculate the amount of "fission" ^{136}Xe we find -- 1.5x10^{-11} cm^{3}STP/gm for Method 1, 1.22x10^{-11} for Method 2. Assuming 4.5Ga of fission, and an initial ^{244}Pu/^{238}U ratio of 0.006 (5), this would require 210 ppb and 170 ppb of uranium respectively, two or three times as great as the measured content of 67-85 ppb (6).

If our unknown source is actually decay, we should be able to determine the progenitor by the isotopic spectrum. Method 1 is not precise enough to be definitive, but the ^{132}Xe/^{136}Xe and ^{134}Xe/^{136}Xe ratios calculated by method 2 are much closer to the ^{238}U spectrum than to the ^{244}Pu spectrum. On the other hand, both calculations suggest the presence of some ^{129}Xe, which, given the 16 Ma half-life of ^{129}I, would suggest an early time of isotopic closure, so we might expect ^{244}Pu fission.

The present study is obviously not the last word on the possibility of parentless fission xenon in Bholghati. More work is clearly needed, including grain-size separates and perhaps stepwise heating analysis of another sample. However, the present results are suggestive. If Bholghati does contain parentless fission xenon, it would not only extend the known occurrences of this previously lunar phenomenon, but it might also make it possible to compare the time of solar wind exposure of the lunar and eucrite parent body regoliths (1).

References: 1) Swindle et al. (1986) Origin of the Moon, 331; 2) Paul et al. (1988) LPS XIX 909; 3) Zahringer (1968) GCA 32 209; 4) Podosek et al. (1971) EPSL 10, 199; 5) Hudson et al. (1982) LPS XIII, 346; 6) Fisher (1973) EPSL 20 151; 7) Wetherill (1953) Phys. Rev. 92 907; 8) Eugster et al. (1967) EPSL 3 249.

Table 1: "Fission" Xe isotopic composition (^{136}Xe=100)

	^{129}Xe	^{131}Xe	^{132}Xe	^{134}Xe	Ref.
Bholghati (Method 1)	80(26)	66(21)	81(24)	73(13)	This study
Bholghati (Method 2)	26(8)	18(8)	51(7)	73(4)	This study
^{244}Pu	<5	24.6(2.0)	88.5(3.0)	93.9(8)	5
^{238}U		7.6(3)	59.5(1.0)	83.2(1.2)	7
"Air fission"	33	68	151	88	

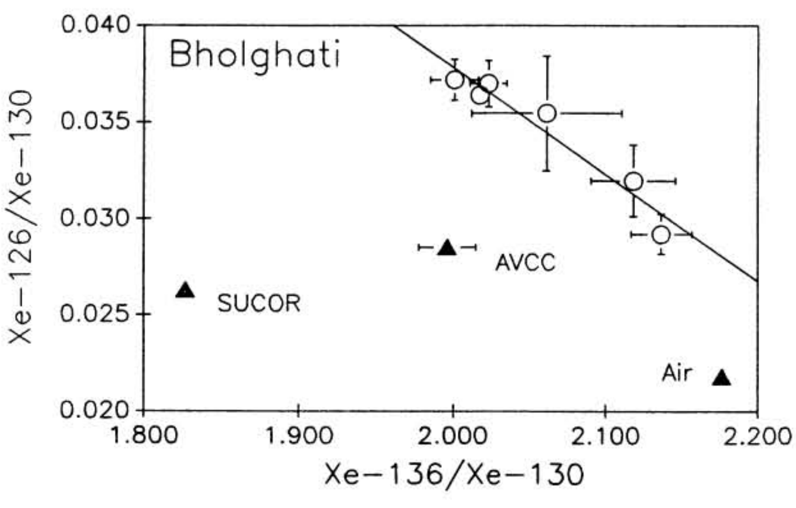

Fig. 1: Xenon from six temperature steps from Bholghati. Note that Bholghati appears to contain ^{136}Xe in excess of SUCOR (4), AVCC (8) or Air.