The new results (Fig. 1a) confirm the systematic and significant differences in $^{134}\text{Xe}/^{132}\text{Xe}$ and $^{136}\text{Xe}/^{132}\text{Xe}$ ratios between the samples that we observed previously [1].

We have argued [1] that these variations in Xe-isotopic composition are caused by different mixing ratios of Xe-H and P3. Our new data add more details (Fig. 1b). In particular, there is some evidence of a small but distinguishable difference in the ratio of Xe-H to Xe-L for ED-4 (as revealed by comparing $^{132}\text{Xe}$ and $^{136}\text{Xe}$). ED-4 represents 6% of the total diamond separate, so this variation would not be apparent in bulk analysis. Furthermore, ED-9 (the largest grain-size fraction) exhibits a slight but significant difference in its $^{135}\text{Xe}/^{132}\text{Xe}$ ratio compared to ED-2 and ED-4.

The persistent inseparability of Xe-H from Xe-L has been a puzzling issue since the discovery of Xe-HL. It has been attributed to inefficient mixing of diamonds in the solar nebula [4], while the effect of averaging during analysis may also be important since a few billion grains are necessary for Xe-isotopic measurements; diamonds appear to be destroyed by the same temperature during stepwise analysis independent of grain size and other properties [5]. However, individual supernovae might be expected to produce distinctive grain size distributions and somewhat different isotopic signatures. It seems highly unlikely that mixing processes in individual supernovae would always produce the same Xe-isotopic composition. Rather, we might expect different supernovae to show characteristic Xe-HL patterns. The diamond samples analyzed here have been physically separated into grain-size fractions that exhibit different isotopic signatures (including those for C [1]), so the search for variations in the Xe-H/Xe-L ratio becomes a critical test for astrophysical theories on the origin of Xe-HL [e.g., 6]. Our preliminary results suggest that different supernovae appear to have different Xe-H/Xe-L ratios. We also speculate that the difference in $^{134}\text{Xe}/^{136}\text{Xe}$ between grain-size fractions may suggest some variations in the neutron fluence in the zone where Xe-H was formed in different supernovae [6].

**References:**
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**Oxygen-isotopic composition and high-resolution secondary ion mass spectrometry imaging of Martian carbonate in Lafayette meteorite**

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**Introduction:** Carbonate from SNC meteorites gives insight into a variety of processes on and/or beneath the surface of Mars. In Lafayette, carbonate occurs in unusually intimate association with hydrous phases when compared with other carbonate-bearing SNCs [1]. We have measured the $^{16}\text{O}/^{18}\text{O}$ ratio of carbonate in the alteration veins of Lafayette using the magnetic sector ion microprobe. In addition, we observed isotopic images of major- and minor-element cations in veins with the focused ion beam (FIB) quadrupole SIMS. The spot size of the FIB probe used in this study (~0.03 μm) provides an opportunity for high spatial resolution chemical imaging, which is ideal for examining features in the fine-grained alteration assemblage.

**Oxygen-isotopic Chemistry:** While data presented here are the first reported in situ O-isotopic analyses of Lafayette carbonate, several studies have been performed on released CO$_2$ by a variety of bulk techniques, including combustion, vacuum pyrolysis, and acid etching [2-4].

**Summary of previous bulk CO$_2$ measurements.** The spread in values of $^{16}\text{O}_{\text{SMOW}}$ for released CO$_2$ is reasonably large and ranges from 22–33% (high to low T pyrolysis, respectively [2]), with a single measurement of 10.5%e (144 hr etch [4]) that falls below this range. The latter measurement clearly includes a terrestrial component indicated by its C-isotopic composition [4]. Both pyrolysis studies [2,3] emphasize the possibility of equilibration with O from silicates and released water during extraction. Despite this uncertainty the authors concluded that O from released CO$_2$ is sufficiently heavy relative to the whole rock that it represents a phase out of equilibrium with magmatic silicates. They further conclude that this observation is consistent with carbonate deposition at low temperature.

**Ion microprobe results.** Carbonates within four olivine-hosted veinlets (each from a different host crystal) were measured for their O-isotopic composition in a CAMECA IMS 3f ion microprobe. Ion microprobe results. The spread in values of $^{16}\text{O}_{\text{SMOW}}$ for released CO$_2$ is reasonably large and ranges from 22–33% (high to low T pyrolysis, respectively [2]), with a single measurement of 10.5%e (144 hr etch [4]) that falls below this range. The latter measurement clearly includes a terrestrial component indicated by its C-isotopic composition [4]. Both pyrolysis studies [2,3] emphasize the possibility of equilibration with O from silicates and released water during extraction. Despite this uncertainty the authors concluded that O from released CO$_2$ is sufficiently heavy relative to the whole rock that it represents a phase out of equilibrium with magmatic silicates. They further conclude that this observation is consistent with carbonate deposition at low temperature.

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**Ion microprobe results.** Carbonates within four olivine-hosted veinlets (each from a different host crystal) were measured for their O-isotopic composition in a CAMECA IMS 3f ion microprobe. In addition, we obtained ion microprobe results. The spread in values of $^{16}\text{O}_{\text{SMOW}}$ for released CO$_2$ is reasonably large and ranges from 22–33% (high to low T pyrolysis, respectively [2]), with a single measurement of 10.5%e (144 hr etch [4]) that falls below this range. The latter measurement clearly includes a terrestrial component indicated by its C-isotopic composition [4]. Both pyrolysis studies [2,3] emphasize the possibility of equilibration with O from silicates and released water during extraction. Despite this uncertainty the authors concluded that O from released CO$_2$ is sufficiently heavy relative to the whole rock that it represents a phase out of equilibrium with magmatic silicates. They further conclude that this observation is consistent with carbonate deposition at low temperature.
that employs a liquid Ga ion source accelerated to 30kV. Secondary ions were collected in (+) mode with a quadrupole mass spectrometer. A probe current of ~5 pA was selected to obtain high-resolution ion images for isotopes of Na, Mg, Al, Si, K, Ca, Mn, and Fe of the carbonate-hydrous silicate-transition metal oxide alteration assemblage (Fig. 1c–1e). Arrays of 256 x 256 pixels were collected for two sets of ion images with a field of view of 24 and 8 μm. The resolution and signal/noise ratio of these ion images exceed that for any other "bulk" microanalytical techniques, revealing detail in the iddingsite assemblage previously observable only by transmission electron microscopy. Potassium-39 images reveal intricate banding parallel to the veinlet walls in the central region of the veinlet that is filled with fine-grained phyllosilicate. The presence of multiple K-bearing phases in iddingsite may explain the wide range of formation ages determined by radiogenic isotope methods [9]. Furthermore, 21Na images indicate a surprisingly high ion yield from regions that appear to be pure siderite. The source of the Na is possibly from a nanometer-scale intergrowth of alkali-halogen salts noted in previous studies of nakhlite alteration [7,10]; this provides further evidence for the saline nature of the Lafayette alteration fluid.


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On February 15, 1997, at ~15:23:35 UT (during the hour before midnight local time) a fireball occurred over Shandong Province, China, with an extended terminal burst probably exceeding magnitude ~20 near 35.5°N, 115.6°E. The fireball was observed in the infrared by detectors located in Earth orbit (e.g., 1). Numerous H5 chondrite meteorites fell spectacularly at Juancheng in a strewnfield ~10.5 x 4.3 km oriented roughly east-west [2]. The Juancheng meteoroid was thoroughly fragmented, yielding >1000 individuals massing more than 100 kg in total (but with the largest recovered individual of only 2.6 kg). Counting of radiogenic cosmogenic nuclides in eight individuals of 0.13–0.25 kg yields initial results as follows: 60Co (t1/2 = 53 yr), 9.7–139.3 dpm/kg; 20Na (t1/2 = 2.6 yr), 89.2–121.6 dpm/kg; and 26Al (t1/2 = 704 yr), 52.5–67.7 dpm/kg. The largest 60Co activity requires minimum and maximum radii of ~0.45 and 1.5 m (~1000–50,000 kg) respectively [3,4]. Greater 60Co activities in chondrites have been reported only from the Allende and Jilin meteorites. The 26Al and 20Na activities are less sensitive to minimum size, but, as these activities are nearly constant though much of