

sibility that MG pallasite metal is related to IIIABs is allowed by the Re-Os data [5,7,8].

Metal samples from two mesosiderites (Estherville and Mt. Padbury) and from Bencubbin show small deviations from the IIAB isochron (5‰ for Bencubbin, -5‰ for Estherville, and -7‰ for Mt. Padbury) and indicate the possibility of a more complex evolution. We note that Re and Os concentrations and Os isotopic compositions for the mesosiderite metal are comparable to the data obtained on the IABs [1] and support the inference that mesosiderites are breccias consisting of mixtures of differentiated silicates and IAB metal or relatively unfractionated FeNi [9]. The Re-Os data on mesosiderites yield model ages that range from 23 to -32 m.y. (i.e., from 5‰ to -7‰) from the age of the IIAB isochron and support a two-stage evolution of the FeNi metal in the mesosiderites, presumably prior to its admixture with silicates. Formation of the mesosiderite breccias about 50–80 m.y. later than an initial time of fractionation defined by the IVAs would be consistent with the Sm-Nd chronology of silicates from mesosiderites [10].

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IRON-60/NICKEL-60 ISOTOPE SYSTEM IN THE EUCRITE CALDERA. A. Shukolyukov and G. W. Lugmair, University of California—San Diego, La Jolla CA 92093-0212, USA.

We have recently [1,2] presented evidence for the former existence in the solar system of live ^{60}Fe ($T_{1/2} = 1.5$ m.y.). The evidence is indicated by excesses in the abundance of the stable daughter nuclide ^{60}Ni ($^{60}\text{Ni}^*$) in the eucrites Chervony Kut (CK) and Juvinas. The observed correlations between ^{60}Ni excesses and the corresponding $^{56}\text{Fe}/^{58}\text{Ni}$ show that ^{60}Fe was still extant at the time of solidification of these meteorites. These correlations, if considered as isochrons, yield the $^{60}\text{Fe}/^{56}\text{Fe}$ ratio at the time of ^{60}Fe - ^{60}Ni isotope closure in CK and Juvinas of $\sim 3.9 \times 10^{-9}$ and $\sim 4.3 \times 10^{-10}$ respectively. Based on the absolute Pb-Pb age of angrites [3] and the relative ^{53}Mn - ^{53}Cr ages for angrites and CK we estimated the initial $^{60}\text{Fe}/^{56}\text{Fe}$ in the solar system of $0.4\text{--}6 \times 10^{-8}$ [4], which is roughly consistent with recent calculations of ^{60}Fe production in AGB stars [5] and in molecular clouds [6].

The aim of the present work was to extend the body of evidence for the former existence of live ^{60}Fe and to obtain further constraints for its abundance in the early solar system. The study of the ^{53}Mn - ^{53}Cr isotope system in different mineral phases of the noncumulate eucrite Caldera has shown that it has been reequilibrated, probably during an impact event, which occurred ~ 20 m.y. after CK solidification [7]. This reequilibration most certainly equilibrated the ^{60}Fe - ^{60}Ni isotope system and one can assume, therefore, that $^{60}\text{Ni}^*$ in Caldera would characterize the ^{60}Fe abundance in bulk eucrites.

The first result for an unwashed bulk sample showed a $^{60}\text{Ni}^*$ of $4.1 \pm 0.7\epsilon$ ($1\epsilon = 1$ part in 10^4), which can only be considered as a conservative lower limit of the actual value because Caldera is heavily weathered [7] and contamination with terrestrial Ni is very likely. The terrestrial contamination became evident when the second bulk sample was washed with H_2O and HCl and the isotopic composition of Ni in the washes was found to be indistinguishable from normal. However, because the Ni concentration in these washes was more than $5\times$ larger than that in the residual sample we suspected that the contamination was not removed completely and the measured $^{60}\text{Ni}^*$ of 5.1ε is still a lower limit. A third bulk sample was thoroughly washed, so that the mass loss was already significant. Nickel-60 in the wash showed an excess of $2.2 \pm 1.0\epsilon$ units, indicating that a fraction of meteoritic Ni was already dissolved. The residual sample showed a ^{60}Ni excess of $8.9 \pm 1.2\epsilon$, which we consider a reasonable approximation of $^{60}\text{Ni}^*$ in Caldera.

This excess of 8.9ε is slightly higher than that derived from CK and

Juvinas “bulks” ($\sim 6.3\epsilon$) [2]. Using this new datum and a refined absolute age of CK (~ 4.561 G.y.) based on Mn-Cr data and our eucrite evolution model, this slightly raises the estimate for $^{60}\text{Fe}/^{56}\text{Fe}$ in the early solar system (4.566 G.y.) to $2\text{--}19 \times 10^{-8}$ with a best estimate of 6×10^{-8} . This is true if the Caldera precursor was derived from the parent body mantle at the same time as CK. If, instead, Caldera was derived contemporaneously with Juvinas we calculate an initial $^{60}\text{Fe}/^{56}\text{Fe}$ of 3×10^{-8} . Considering more complicated scenarios, which include prolonged evolution of the ^{60}Fe - ^{60}Ni isotope system in the mantle, leads to essentially similar results.

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ON THE ORIGIN OF PALISADE BODIES FOUND IN REFRACTORY INCLUSIONS IN CV3 CHONDRITES. S. B. Simon¹ and L. Grossman^{1,2}, ¹Department of the Geophysical Sciences, University of Chicago, 5734 South Ellis Avenue, Chicago IL 60637, USA, ²Enrico Fermi Institute, University of Chicago, Chicago IL 60637, USA.

It has been suggested [1] that palisade bodies—shells of spinel within CAIs and the phases the shells enclose—are intact mini-CAIs that were captured by their host inclusions. If this is true, then palisade bodies represent an earlier generation of refractory materials. Here we present new observations and data that conflict with previous interpretations of the features of palisade bodies and suggest instead that they formed *in situ* by filling of vesicles in partially molten inclusions. Studies of two, palisade-body-rich type B2 inclusions from the Axtell CV3 meteorite, AX2 and AX9, and recognition of features similar to palisade bodies in experimental run products crystallized from type B melts, inspired this report.

In experimental run products we observed round voids lined with spinel, indicating that spinel nucleated upon and/or stuck to bubble-melt interfaces, analogous to the commonly observed nucleation of spinel on Pt loops and on the surfaces of experimental charges [2]. We also observe glass-filled, circular structures defined by spinel, which we interpret as vesicles that filled with melt. This process was rejected by [1] as a means of forming palisade bodies in part because they did not observe spinel-lined voids in the run products they studied.

Palisade body AX9 PB2 is ~ 150 μm across and contains melilite (Ak_{16-25}) and a trace of fassaite. It is enclosed in melilite (Ak_{19-30}) and has an ~ 50 -μm-wide opening in its spinel wall, with what appear to be flaps of spinel frozen in either the act of opening or closing. The most straightforward interpretation is that AX9 PB2 formed from a vesicle that broke and filled with melt, and the thin section plane fortuitously sampled the site of rupture.

Additional evidence for *in situ* formation comes from AX9 PB1, which is anorthite dominated and ~ 200 μm across, and has a fassaite grain that is optically continuous across the palisade wall with fassaite in the host. This grain is zoned from 7.0 wt% $\text{TiO}_2^{\text{tot}}$ in its core to 5.9% at the host-palisade contact and from 3.4% just inside the palisade wall to 2.5% toward the interior of PB1. The latter compositions are similar to Ti-poor rims of host grains. The compositional discontinuity is best explained by inward growth of the PB1 fassaite on the host fassaite from a liquid that had evolved after crystallization of the host fassaite and then leaked into a vesicle. For the host fassaite to have nucleated upon that in PB1 requires that $\text{TiO}_2^{\text{tot}}$ of the former increased as it grew, opposite to normal zoning.

We also note that mineral compositions in palisade bodies resemble those of the host CAI, even when the latter are unusual. In AX2, fassaite is V_2O_3 -rich (0.21–1.6 wt%, 0.70 avg.), as in AX2 PB1 (0.18–1.1 wt%, 0.66 avg.), and [1] described a CAI whose melilite is Ak_{84-87} that contains a palisade body whose melilite is Ak_{82-85} . It seems highly unlikely that two CAIs with distinctive mineral compositions would, by random capture, incorporate objects with such similar compositions to their own.

In summary, these observations are most consistent with the following model for the formation of palisade bodies: (1) vesicles form in a molten

CAI; (2) spinel nucleates upon, collects against, and sticks to vapor-melt interfaces; (3) vesicles break during crystallization and fill with melt while spinel shells remain largely intact; and (4) melt inside shells solidifies *in situ*.

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WILCOX PLAYA AND RYAN FIELD: TWO ARIZONA CHONDRITES FROM THE JAMES M. DUPONT COLLECTION. P. P. Sipiera¹, Y. Kawachi², and B. D. Dod³, ¹Schmitt Meteorite Research Group, Harper College, Palatine IL 60067, USA, ²Department of Geology, University of Otago, New Zealand, ³Department of Physics and Earth Sciences, Mercer University, Macon GA 31210, USA.

Listed among the meteorites from the James M. DuPont Collection were two small unclassified stones from Arizona. They were listed as Willcox Playa and Ryan Field respectively. Both were found by Mr. Gordon Nelson, and were later purchased by James DuPont. Willcox Playa is a complete stone with a mass of 61.5 g. Its surface exhibits a typical brownish oxidation crust that is common from long-period exposure in an arid environment. Mr. Nelson found this specimen on the playa during a meteorite search he conducted on December 22, 1979. The location of the find is in Cochise County at an approximate latitude of 32°7'30"N and a longitude of 109°50'W. A petrographic examination of the stone revealed an abundance of well-defined chondrules (porphyritic, radiating pyroxene, and barred olivine). Analyses of the principal silicate phases give a $Fa_{20.3}$ (PMD = 4.74, N = 24), and a pyroxene composition of $Fs_{17.2}$ (PMD = 6.15, N = 11). Relatively unweathered metal is abundant. Based on this data, a classification of H4 is proposed.

The Ryan Field find occurred in Pima County at an approximate latitude of 32°8'N and longitude of 110°53'W. It consists of a small, 8.9-g one-half individual with brown oxidation crust. The find was made in a wash during a meteorite search conducted on February 6, 1982. Petrographic examination of the specimen indicated fewer chondrules and a more brecciated texture than seen in Willcox Playa. Metallic grains were evident, but generally more weathered. Mineralogical analyses give an olivine composition of Fa_{20} (PMD = 8.97, N = 25) and a pyroxene value of Fs_{18} (PMD = 10.21, N = 12). Both values are suggestive of an unequilibrated chondrite. On the basis of principal silicate mineralogy and petrography, an H5 classification is proposed.

RIETVELD CRYSTAL STRUCTURE REFINEMENT OF QUARTZ FROM THE BARRINGER CRATER, ARIZONA. R. Skála, Department of Mineralogy and Petrology, National Museum, Václavské náměstí 68, CZ-11579 Praha 1, Czech Republic.

Material containing quartz, coesite, and stishovite was collected in mid-February at the bottom of the Barringer Crater, Arizona. It was ground in agate mortar. The powder was coated on a flat glass sample holder from alcohol suspension. X-ray powder diffraction data were collected using XRD goniometer HZG-4 in Bragg-Brentano reflecting arrangement and generator TuR M62 operated at 30 kV and 40 mA. Copper radiation from the sealed tube was filtered with a Ni filter; the Soller collimator was placed between the focus and sample. The measuring radius of the goniometer was set to 250 mm. The powder pattern was collected in the range 15°–145° 2 θ with a step-width of 0.02° 2 θ and counting time 7 s. Angular positions and integral intensities of individual peaks were then refined using ZDS software. After indexing on the basis of the theoretical powder pattern generated by the LAZY PULVERIX program [1] from the crystal structure data taken from the ICSD database, unit-cell parameters were refined as (in angstroms) $a = 4.91422(16)$ and $c = 5.40511(41)$. Whole-pattern Rietveld refinement followed the individual peak procedure. The program used was Young's et al. DBWS9411 [2]. The turn-on sequence of the parameters refined was chosen as follows: scale factor, sample displacement, two background polynomial coefficients, unit-cell parameters, third background coefficient, W parameter of half-width, fractional coordinates, overall temperature factor, V and U half-width parameters, coefficients of profile shape function of asym-

TABLE 1. Comparison of crystal structures refined by Rietveld procedure for quartz from the Barringer Crater and for standard.

	Barringer Crater	Standard
Si		
x	0.4709	0.4691
y	0.0000	0.0000
z	0.3333	0.3333
O		
x	0.4115	0.4241
y	0.2656	0.2743
z	0.2128	0.2172
Q	2.5987	2.7312
a	4.9120	4.9124
c	5.4054	5.4053
V	112.9900	112.9900

x, y, z = represent fractional coordinates, Q = overall temperature factor, a and c = unit-cell parameters, V = cell volume.

TABLE 2. Interatomic distances and angles for shocked and unshocked quartz from Rietveld refinement.

Parameter	Barringer Crater	Standard
<i>Intra-tetrahedral distances</i>		
Si-O (a)	1.610	1.599
Si-O (b)	1.608	1.607
<i>Intra-tetrahedral angles</i>		
O-Si-O (a)	111.10	107.96
O-Si-O (b)	108.84	108.27
O-Si-O (c)	108.20	111.94
O-Si-O (d)	108.79	112.50

metric Pearson VII type. Crystal quartz from Marmarosha was used for comparison and the same procedure as for the shocked material was utilized to collect and treat XRD data. Results of the Rietveld refinement are summarized for both shocked and standard quartz in Table 1.

Compared to the unshocked standard, quartz from the Barringer Crater has some special features: (1) the most apparent seems to be a remarkable broadening of peaks in the powder pattern (Fig. 1); and (2) changes of interatomic distances and angles within the structure are rather subtle; however, they indicate unambiguously movement of individual atoms within the crystal structure. This study would indicate a possible interesting approach to

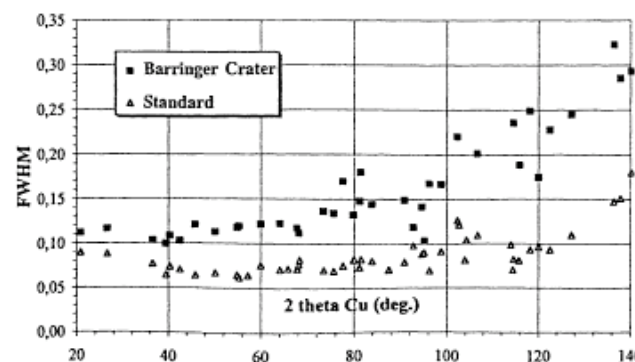


Fig. 1. Plot of full-width-in-half-maximum parameter (FWHM) vs. angular position of the reflection characterized for shocked quartz from the Barringer Crater and unshocked standard. The values represented were obtained from individual peak fitting procedure. Note significantly lower FWHM for unshocked material compared to the shocked one.