N92-12915

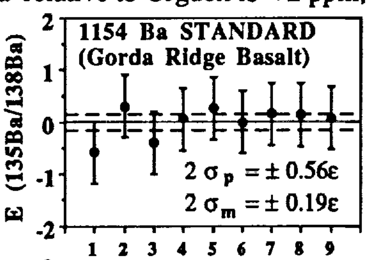
^{135}Cs - ^{135}Ba: A NEW COSMOCHRONOMETRIC CONSTRAINT ON THE ORIGIN OF THE EARTH AND THE ASTROPHYSICAL SITE OF THE ORIGIN OF THE SOLAR SYSTEM; C. L. Harper, H. Wiesmann, and L. E. Nyquist, SN2, NASA/JSC, NASA Road 1, Houston, TX 77058.

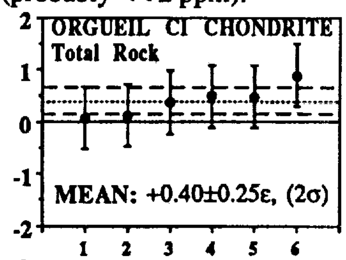
^{135}Cs is produced in the rapid neutron capture process (thought to occur in supernovae) with a production ratio of ~0.6 relative to stable ^{133}Cs, which is estimated to be about 85% *r* -process in the bulk solar system reservoir (BSS) [1]. Inferred *ab initio* BSS abundances of other unshielded extinct radionuclides, ^{107}Pd (τ_m = 9.4 Ma, [2]), ^{182}Hf (13 Ma, [3]), and ^{129}I (23 Ma, [4]) in the early solar system are consistent with a model in which most of these nuclides are contributed to the protosolar reservoir very near in time to the birth of the sun following a long *r* -process separation ("free decay") interval of ~10^8 yr, as expected if the solar system formed in the vicinity of a massive star association generated during the passage of a galactic spiral density wave. Because of its relatively short mean-life (3.3 Ma), ^{135}Cs is a critical test nuclide for this "late input" scenario. For a late input *r* -process fraction, $N_r^*/N_r = 1 \times 10^{-4}$, for Cs (inferred from ^{129}I, assuming constant $^iN_r^*/^iN_r$ in the mass region), the late-input model predicts ^{135}Cs/^{133}Cs ~ >3 x 10^{-5} for a decay interval of less than one half life (2.3 Ma) between synthesis and the origin of the solar system. Live ^{26}Al (1 Ma) in the early solar sytem suggests the possibility of an even shorter time-scale.

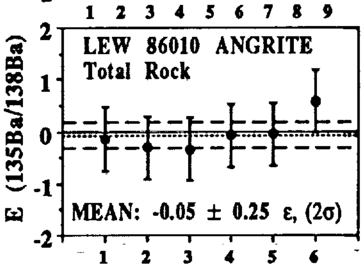
^{135}Ba/^{138}Ba relative precisions of ±25 ppm ($2\sigma_m$), normalized to ^{136}Ba/^{138}Ba = 0.109540, are achievable by averaging the results of 6 multiple 100 ng multicollector runs with ±60 ppm ($2\sigma_p$) external reproducibility (*fig*. 1). The use of ^{138}Ba in the normalization is justified at this level because ^{138*}Ba/^{138}Ba from the decay of ^{138}La is only 2.5 ppm in BSS, and because the meteorites included in this study have identical bulk La/Ba to within uncertainties of ~±25%. La/Ba in our terrestrial standard "1154", a Gorda ridge basalt, is 1.8 x CI: hence Δ^{138*}Ba/^{138}Ba relative to Orgueil is < 2 ppm, (probably << 2 ppm).

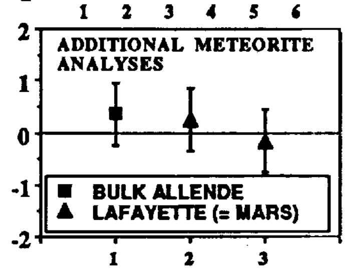
Six runs each of Ba separated from whole rock samples of the Orgueil (*fig*. 2) and LEW 86010 (*fig*. 3) meteorites, having ^{133}Cs/^{135}Ba ratios of 1.3 and 0.0 respectively, reveal a statistically resolved difference of 45±35 ppm (2σ) in ^{135}Ba/^{138}Ba (*fig*. 4). We interpret this difference as evidence for live ^{135}Cs in the early solar system at an *ab initio* level: ^{135}Cs/^{133}Cs ~(3±2) x 10^{-5}. Further higher-precision measurements are planned to evaluate this tentative conclusion.

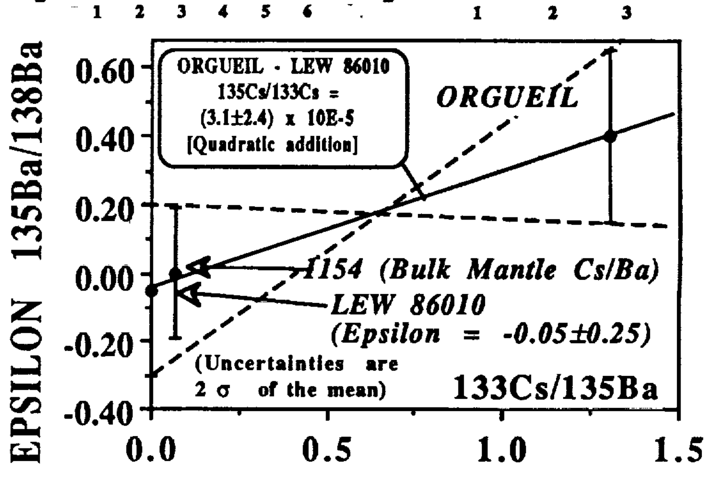
The LEW 86010 data is in close agreement with the terrestrial normal (*fig*. 4). ^{53}Mn - ^{53}Cr chronometry indicates that the LEW 86010 angrite crystallized from a melt at the same time (to within ~2 Ma) as the formation of the refractory Ca, Al-rich inclusions in the Allende meteorite (at ~4566±2 Ma [5]) during a very early (essentially *"ab initio"*) period of solar system history. *If* ^{135}Cs was indeed present in the early solar system at the level inferred, then 2 major conclusions follow: (i) A supernova contributed newly synthesized *r* -process matter into the protosolar reservoir within ~5 Ma of the Cs/Ba fractionation recorded in LEW 86010; (ii) The strong Cs depletion in the bulk earth reservoir (^{133}Cs/^{135}Ba ~0.1) took place very early in solar system history. If this volatile-loss was pre-accretionary (*viz*., in the nebula or planetesimals), then the accretionary chronology of the earth is not constrained. However if it is a consequence of accretion, then a very tight time constraint of <~5 Ma (rel. to LEW 86010) is obtained for accretion of most of the earth's mass.











References: [1] F. Käppeler *et al.*, (1989). *Rep. Prog. Phys.*, 52: 945; R. Gallino, *pers. comm.*; [2] J. H. Chen and G. J. Wasserburg, *GCA*, 54: 1729; [3] C. L. Harper *et al.*, (1991). *LPSC XXII:* 515; [4] R. S. Lewis and E. Anders, (1975). *Proc. Nat. Acad. Sci. USA*, 72/1, p. 268; [5] G. Manhes *et al.*, (1986). *Terra Cognita*, 6/2: 173; C. Göpel, *pers. comm.*.