Xenon isotopes in nanodiamonds and other presolar grains

Conference or Workshop Item

XENON ISOTOPES IN NANODIAMONDS AND OTHER PRESOLAR GRAINS. J. D. Gilmour[1], A. B. Verchovsky[2] and G. Turner[1], [1]Dept of Earth Sciences, University of Manchester, Manchester M13 9PL, UK, [2]PSSRI, Open University, Milton Keynes MK7 6BT.

Introduction: Nanodiamonds isolated from primitive meteorites contain isotopically 'normal' Xe-P3 and components enriched in heavy and light isotopes - Xe-HL, exotic Xe-P6. Excesses of ^{129}Xe from ^{129}I decay are also observed [1]. We discuss these in the light of data obtained from size-separated Efremovka nanodiamond samples produced at the Vernadsky Institute, Moscow [2].

Results: Excess ^{129}Xe is present in low temperature releases from the largest grain size separate (ED9: 1.5 - 9nm) but not in the remainder (ED2,3,4: <3 nm). In addition, the signature of Xe-P6 is also observed only in separate ED9.

^{129}Xe Excess: ^{129}Xe excesses are widespread in nanodiamond separates [1]. Step-heating release patterns suggest that the site of this component is identical to that of Xe-P3, but ratios of excess ^{129}Xe to Xe-P3 show a distinctive dependence on the extent of parent body processing of the host meteorite. Nanodiamonds from meteorites less processed than reduced CV3 meteorites have similar ^{129}Xe concentrations but decreasing concentrations of Xe-P3, greater degrees of processing have led to ^{129}Xe loss. These observations are most readily explained if the nanodiamond ^{129}Xe excess was present as ^{129}I during processing, xenon loss from this site being associated with a parent body process, as for other components [3]. The data constrain the trapping of the P3 component to within 10 Ma before parent body processing unless even the most P3-rich nanodiamonds have lost >85% of their original Xe-P3. This is consistent with the reported initial iodine ratio for a nanodiamond-rich separate from Inman, which was similar to that of other early solar system reservoirs (^{129}I/^{127}I = 10^{-4} [4]).

Xe-HL and Xe-P6 These components, hosted by nanodiamonds with distinct grain size distributions, are distinguished from each other by a variation in the extent of enrichment of the heavy isotopes and by the ratio of excess ^{134}Xe (over solar) to excesses of ^{131,132,136}Xe. The relative abundance of ^{134}Xe is sensitive to minor parameter changes in both current models of Xe-H production: neutron fluence in the neutron burst model [5] and precursor half life in the model of involving separation of radioactive precursors [6]. Tellurium data are more consistent with the latter [7].

However, the characteristic signature of Xe-H is not observed only in nanodiamonds. Accumulated data from nanodiamonds [1] and SiC xenon analyses [8] require contributions from 3 nucleosynthetic sources - one s-process and two sources of the r-process isotopes. Both r-process endmembers are also observed in SiC grains, suggesting that any model dependent on the size of nanodiamonds for recoil loss of xenon isotopes trapped as radioactive precursors is incorrect.

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