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RADIOGENIC ^{129}Xe IN MINERAL SEPARATES FROM THE ALLENDE METEORITE

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Xenon has been measured in 23 fractions separated from Allende, in order to investigate the siting of $^{129}Xe_r$. A bulk sample was disaggregated by repeated freezing and thawing, and divided by settling into coarse and fine material. A chondrule fraction was removed from the coarse material, after which it was separated by grain size and by magnetic susceptibility. Sulfides were concentrated by handpicking. Most fractions were analyzed for Fe, Cr, Co, Sc, Ir, and Au by INAA. Data have already been reported for several of the sulfide separates (Lewis *et al.*, 1979).

Though 98% of the material and 77% of the trapped Xe were recovered, only some 46% of the $^{129}Xe_r$ remained. This suggests that $^{129}Xe_r$ is either located mainly in a minor, easily lost phase, or that it was leached by water during disaggregation. Separates that are most enriched in a single component — high temperature inclusions, isolated sulfide grains and metal — tend to have particularly low contents of $^{129}Xe_r$ (1 to 4×10^{-10} cc/g; all gas concentrations are given in these units). For the coarse-grained (> 100 μ) material, $^{129}Xe_r$ ranged from 1 to 9 and was inversely correlated with Fe content (44 to 17%). This argues against Fe-bearing phases such as sulfides and iron-rich silicates as the host for $^{129}Xe_r$ in these fractions. More than half of the $^{129}Xe_r$ recovered was in the fine-grained (< 5 μ and < 44 μ) matrix fractions (129_r μ 7) and another 30% was associated with chondrules (129_r μ 7-11).

Preliminary results of a chemical leaching experiment suggest that, at least for chondrules, the $^{129}Xe_r$ is in a minor phase. Treatment of a powdered sample with bromine-water buffered at pH 3 removed only 5% of the mass but more than 80% of the $^{129}Xe_r$. This treatment is fairly specific for removing sulfides (Vilcsek and Wänke, 1965); perhaps there is an I-bearing sulfide in chondrules, distinct from the sulfides separated in our non-destructive procedure.

One component that is often enriched in $^{129}Xe_r$ is sulfide-rimmed chondrules, as previously found by Fireman *et al.* (1970). A measurement on separated rims shown them to be enriched over whole chondrules, although they still account for only a few percent of the mass and $^{129}Xe_r$ of the meteorite. The sulfide mineralogy, peripheral location, and high Ir and Co contents suggest that the rims formed by relatively low temperature (< 700K) alteration of an oxidized metal precursor. An interesting parallel is rims on fine-grained inclusions, which are rich in volatiles and contain a substantial portion of the bulk $^{129}Xe_r$ (Wasserburg and Huneke, 1979; Zaikowski, 1980). These two occurrences suggest that a comparatively late addition of I is responsible for a large part of the $^{129}Xe_r$ in Allende.

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K-U STUDIES OF SILICA-RICH INCLUSIONS IN THE SHAW CHONDRITE

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The K/U can be regarded as a "planetary constant" which is invariant during magmatic processes but which differs for cosmochemical reasons between planets. This assumption is universal in all thermal history calculations for planets. K-SiO_2-rich inclusions are found in Shaw which many authors believe is a chondrite which has been subjected to partial melting (Taylor *et al.*, 1979; Rambaldi and Lamimer, 1976). Although the origin of these inclusions is not well understood, it is possible that they represent the first melts or magmatic fluids produced in the formation of planets. Thus it is of interest to see if U and Th have followed K into these liquids. For the case of Shaw some evidence of K/REE fractionation already exists (Rambaldi and Lamimer, 1976). Six polished sections of Shaw with affixed mica fission track detectors were irradiated with $\sim 2 \times 10^{18}/cm^2$ thermal neutrons. Excellent fission track images were obtained with no evidence for any significant contamination. (Random scans on our most-studied section gave 6 ppb U.) The

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fission track distributions show a high degree of localization. In one section, mapped in great detail, 20-30 large (> 50 micron) fission track localizations, can all be accounted for by whitlockite and chloroapatite. The whitlockite U concentrations (300-700 ppb) are variable, but typical for chondrites. The phosphate grains serve as fiducial points, allowing accurate location of the melt inclusions on the mica track detector (maximum position error = 20 microns). In many cases no localizations of tracks are found (U contents < 10 ppb) corresponding to the K-Si-rich inclusions, but in 7/25 cases localizations are found with U concentrations up to ~ 300 ppb. The inclusions are small (usually < 20μ), and there are many other small track localizations in this size range which have no obvious sources, thus some of these 7 cases may be accidental. However, track mapping at 13 random fields of view showed only 2 localizations (track density 3-4 times surroundings) within 20 microns. The small track localizations of unknown origin can be explained by a combination of buried sources (within 10 microns of surface), local contamination (which can never be ruled out) or localization of U on grain boundaries or cleavage planes in major phases. There is no correlation of U content with inclusion chemistry (K), size, opaque mineralogy, or petrographic location. Many of the inclusions are within large (hundreds of microns) olivine grains, including some that seem U-rich. In two of these cases the track localizations stand out from an almost blank background and match the location and size of the inclusion. It seems inescapable that the tracks do arise from the inclusions in these cases. It may be that these inclusions were a preferential site of contamination during sample preparation or by terrestrial weathering, but it is also possible that U-bearing phases only occasionally participated in the partial melting process. It may be significant that the inclusions contain no P, thus this U reservoir has not participated. Regardless, the important result is that in most cases K was mobilized to a much higher degree than U in the Shaw partial melting event. (The inclusion K/U is at least 10× bulk chondrites.) Although the inclusions are relatively Fe-rich, the concentration of K and Si and the exclusion of U and rare-earths follows the chemical systematics of immiscible silicate melts (Watson, 1976; Ryerson and Hess, 1978). To the extent that Shaw is representative of very small degrees of partial melting in planets, K and U appear to be fractionated.

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COOLING HISTORIES OF CHONDRULES IN THE MANYCH (L-3) CHONDRITE

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The Manych L3 chondrite contains two principal droplet chondrule types, barred olivine (41% SiO_2, 31% MgO) and excentroradial pyroxene (55% SiO_2, 26% MgO), plus abundant lithic clast chondrules (olivine microporphyry) with similar compositions to barred olivine chondrules (Dodd, 1978). Liquidus and glass transition temperatures were determined in controlled cooling experiments on ten-component analogues to the droplet chondrules. These temperatures are 1400 °C and 600 °C for the SiO_2-poor melt, and 1280 °C and 710 °C for the SiO_2-rich melt. Calculations using these data plus viscosity determinations yield critical cooling rates for forming glass of 3000° min^{-1} for the SiO_2-poor melt and 1° min^{-1} for the SiO_2-rich melt (Klein *et al.*, 1980).

The majority of excentroradial pyroxene chondrules contain little glass and therefore cooled more slowly than 1° min^{-1}. Rare silica-poor chondrules composed of glass plus extremely fine sub-parallel spherulitic olivine cooled at rates approaching 3000° min^{-1}. SiO_2-poor glass occurs as a coating on a crystalline lithic chondrule, indicating that objects in Manych cooled at different times as well as at differing rates. The cooling history of olivine microporphyry has not been defined, but the growth of faceted crystals rather than dendritic olivine from such highly olivine-normative melts requires very little undercooling and very low cooling rates (Donaldson, 1975). The range of cooling histories of objects in Manych is more easily explained by impact processes than nebular condensation, because an impact of small objects or impact on a regolith generates liquid that can experience a range of cooling rates.

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