ON THE LOCAL IRRADIATION PRODUCTION OF SHORT-LIVED ISOTOPES IN THE EARLY SOLAR SYSTEM.

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Excesses in the daughter nuclides of radioactive isotopes in various early-solar-system samples have provided evidence for the initial presence of short-lived, now extinct isotopes [e.g., 1, 2]. Two basic production scenarios have been proposed. One is stellar nucleosynthesis. While the abundances of some of the isotopes can result from steady-state nucleosynthesis in the Galaxy, the isotopes with shorter half lives require a single stellar source, either a supernova [3] or an Asymptotic Giant Branch star [4], immediately preceding solar-system formation. The other production mechanism for isotopes with shorter half lives is irradiation by energetic solar particles. All scenarios have some problems. We will concentrate on local irradiation.

Solar-system irradiation has received a boost by the discovery of the early-solar-system presence of ^{10}Be [5], a nuclide that is not produced by stellar nucleosynthesis. It has found a theoretical underpinning in the X-wind model [6]. In this model not only ^{10}Be but other short-lived isotopes such as ^{26}Al, ^{41}Ca and ^{53}Mn in CAIs are produced by solar particles [7, 8]. A cosmic-ray production of ^{10}Be and trapping in the pre-solar-system molecular cloud has been proposed [9], but local irradiation is needed if claims for the initial presence of ^{7}Be [10], whose half life is only 53 days, can be substantiated.

However, while ^{10}Be (and possibly ^{7}Be) most likely has a local irradiation origin, various arguments can be raised against irradiation being the sole/primary source of the other short-lived isotopes:

1) The uniformity of an "canonical" ^{26}Al/^{27}Al ratios in CAIs is difficult to reconcile with local irradiation, which is expected to result in a much wider distribution of the ^{26}Al/^{27}Al ratio.

2) While the X-wind model assumes that only CAIs had the canonical ^{26}Al/^{27}Al ratio, the consistency between the Al-Mg and U-Pb clocks for CAIs and chondrules [11] and feldspars from H4 chondrites [12] indicate that ^{26}Al was wide-spread.

3) The irradiation production of the short-lived isotopes in the observed ratios requires very special target composition and structure and rather extreme energy and composition of the solar energetic particles [7].

4) There is a lack of correlation between ^{10}Be and ^{26}Al and ^{41}Ca in individual CAIs [13, 14].

5) ^{60}Fe, present in the early Solar System, cannot be made by spallation and requires a recent stellar source. Any such source would also provide most of the other short-lived nuclei.

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