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The effect of early irradiation and volatility on ^{54}Cr and ^{53}Cr abundances in components of EH3 chondrites

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Heterogeneities of neutron-rich isotopes such as ^{54}Cr and ^{50}Ti in inner solar system objects have been attributed to heterogeneous distribution of presolar grains [1,2]. In contrast, the correlation of ^{53}Cr with Mn/Cr in inner solar system objects is attributed to radiogenic ingrowth from decay of ^{53}Mn [3,4]. The homogenous distribution of ^{53}Mn and correlation of ε^{53}Cr and ε^{54}Cr in solar system objects is difficult to reconcile with the heterogeneity of ^{54}Cr. ε^{54}Cr and ε^{53}Cr were measured in physically separated components (chondrules, magnetic, slightly magnetic, non-magnetic fraction, metal-troilite spherules) and chemical leachates of the EH3 chondrites, Sahara 97072 and Kota Kota. ε^{53}Cr and ε^{54}Cr in leachates and in physically separated components of Sahara 97072 and Kota Kota range from -0.06 ± 0.07 to 1.33 ± 0.08 and -0.20 ± 0.15 to 0.62 ± 0.26, respectively. The correlation of ε^{54}Cr with Fe/Cr in magnetic fractions of EH3 chondrites and a similar correlation in inner solar system bodies (enstatite and ordinary chondrites, Mars, Vesta, Ureilite parent body etc.) can be explained by early irradiation of nebular dust grains and pebbles by solar energetic particles (SEP) and heterogenous mixing of the irradiated dust grains in different domains of the inner solar nebula. The observed isotope variations can be generated by 300 yr long local irradiation of mm to cm sized dust and pebbles with average SEP fluxes of ~ 10^5 times the modern value (consistent with observations from solar mass stars in the Orion nebula, [5]).

The ε^{53}Cr-Mn/Cr correlation in solar system objects can also be a consequence of early irradiation of dust and evaporation and homogenization of irradiation produced ^{53}Mn in the gas because of high temperatures in the inner solar system. Subsequent Mn/Cr fractionation in the solar nebula within the first few million years of the solar system led to the observed ^{53}Cr variations in the inner solar system objects.

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