IMPLICATIONS OF HETEROGENEOUS ACCRETION OF THE SOLAR NEBULA

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Introduction: Isotopic studies of primitive chondrites are a useful tool for understanding the cosmochemical evolution of the early solar system and for providing information about accretion scenarios of the solar nebula. The Sun and the solar nebula formed, together with other stars, from a molecular cloud. Estimated mixing times for molecular clouds are in the range of ~3 Ma for small molecular clouds (1 pc, 300 $M_{\odot}$) [1] to ≥10 Ma for moderate-sized molecular clouds (30 pc, 10^4 $M_{\odot}$) [2]. Compared to a typical lifetime of ~10 Ma for moderate-sized clouds, it thus can be expected that the properties of chondritic materials reflect incomplete mixing.

Isotopic compositions of chondrites: Chondrites preserve the compositions of kilometer-sized planetesimals and probably the composition of solar nebula material. Previous isotopic studies raise the question of whether these isotopes were heterogeneously distributed in the solar nebula. A study by Trinquier et al. [3] showed that ε^{54}Cr values of inner solar system planets and planetesimals (e.g., carbonaceous chondrites, ordinary chondrites, enstatite chondrites, Mars, etc.) are different, supporting the view of heterogeneous accretion of the solar nebula. Isotopic data of ε^{54}Cr [3] and ε^{62}Ni [4, 5] also show a positive correlation; this is expected because both isotopes were synthesized in the same stellar regions by neutron-capture. Furthermore, excesses of ^{137}Ba and ^{138}Ba (formed by both s and r processes) in carbonaceous and ordinary chondrites compared to Earth favor the assumption of incomplete mixing of diverse nucleosynthetic components [6]. Other studies of Mo isotopes [7] and ^{96}Zr [8] further show that chondritic parent bodies accreted a small excess of neutron burst material as compared to Earth [6]. In addition, FUN inclusions in some carbonaceous chondrites contain excesses in heavy-element isotopes that are produced by r-processes [9]. If the solar nebula was completely mixed, these isotopic differences would not occur.

Summary: Although previous models [10] suggest that the solar system formed from a hot, well-mixed, gaseous disk, variations in isotopic compositions between bulk planetary bodies and planetesimals imply that distinct isotopic reservoirs did exist and that the material was neither completely homogenized nor sufficiently processed to erase these distinct signatures.

References: [1] Xie T. et al. 1995. *Astrophys. J.* 440, 674. [2] Wasson J. T. 2008. Abstract #2470. 39th Lunar and Planetary Science Conference. [3] Trinquier A. et al. 2007. *Astrophys. J.* 655, 1179-1185. [4] Bizzarro M. et al. 2007. *Science* 316, 1178-1181. [5] Regelous M. et al. 2008. EPSL, submitted. [6] Ranen M. C. and Jacobsen S. 2006. *Science* 314, 809-811. [7] Yin Q. et al. 2002. *Nature* 415, 881-883. [8] Yin Q. et al. 2001. Abstract #2128. 32nd Lunar and Planetary Science Conference. [9] McCulloch M. T. and Wasserburg G. J. 1978. *Astrophys. J.* 220, L15-L19. [10] Cameron A. G. W. 1963. *Icarus* 1, 339-342.