LARGE-SCALE INJECTION OF ^{60}FE IN MOLECULAR CLOUDS.

N. Ouellette[1], M. Gounelle[1] and P. Hennebelle[2]. Laboratoire de Minéralogie et de Cosmochimie du Muséum, CNRS & MNHN, UMR 7202, CP52, 57 rue Cuvier, 75005 Paris, France. E-mail: nouellet@mnhn.fr. [2]École Normale Supérieure et Observatoire de Paris, 24 rue Lhomond, 75231 Paris Cedex 05.

Introduction: The origin of the short-lived radionuclides (SLRs) present in the early solar system is still somewhat of a mystery. Understanding this origin is important, as it will help understand the birthplace and the formation of the Solar System. One SLR that places an important constraint on the birthplace of the Sun is ^{60}Fe. Present in the early solar system at levels of a few $^{60}Fe/^{56}Fe$ = a few x 10^{-7} [1,2], this neutron rich element can only be efficiently be produced in nucleosynthetic reactions [3]. The most probable source of this element is one or several core-collapse supernova [4]. Previous models have attempted to explain the abundance of ^{60}Fe in the solar system by direct injection into a core [ex: 5] or an already collapsed disk [4], but these models have been argued to be unlikely, or require a very specific geometry [5,6]. Here we argue for a more general model that would inject this SLR at the molecular cloud scale, insuring that a majority of systems formed within that cloud would have a share of ^{60}Fe.

The Model: Dubbed “Supernova Propagation And Cloud Enrichment”, or SPACE, our model proposes that supernovae in massive star forming regions contaminate the surrounding ISM with ^{60}Fe. This medium will then cool rapidly and form a molecular cloud, following a mechanism similar to convergent flows [7]. This ^{60}Fe rich cloud will then form stellar systems [8]. Another possible scenario is for ^{60}Fe to be injected directly in a molecular cloud, bypassing the need to form one from scratch. However, supernovae will affect their surroundings in a significant way, and this physical effect cannot be neglected.

Methodology: To test this model, we use a 3-D hydrodynamics code called RAMSES [9]. We use this code to simulate supernovae in various astrophysical contexts and test if ^{60}Fe will be delivered efficiently to molecular clouds. In addition, we will be able to assess the effects of supernovae on the surrounding medium. To achieve this, an appropriate cooling curve was added to accurately simulate supernova explosions, and tracer particles are used to follow the ejecta of each supernova and follow the ^{60}Fe.

Results: Our preliminary results show that a supernova on the edge of a molecular cloud will not prevent the collapse of the gas into denser cores. However, it will create a low-density cavity, which will allow much of the ^{60}Fe to escape from the dense cloud gas. About 15% of the ^{60}Fe will be injected inside the molecular cloud as it collapses into dense cores. For a cloud of ~1000 solar masses, the ^{60}Fe abundance resulting from this injection will be consistent with the solar system abundance. Simulations of other scenarios are underway.

References: [1] Tachibana S. and Huss G. R. 2003. *Astrophysical Journal* 588:416. [2] Dauphas N. et al. 2008. *Astrophysical Journal* 686:560. [3] Lee T. et al. 1998. *Astrophysical Journal* 506:898. [4] Ouellette N. et al. 2007. *Astrophysical Journal* 662:1268. [5] Vanhala H. A. T. and Boss A. P. 2002. *Astrophysical Journal* 575:1144. [6] Gounelle M. and Meibom A. 2008. *Astrophysical Journal* 680:781. [7] Hennebelle P. and Audit E. 2007. *Astronomy and Astrophysics* 465:431. [8] Gounelle M. et al. 2009. *Astrophysical Journal Letters* 694 :1. [9] Fromang S. et al. 2006. *Astronomy and Astrophysics* 457:371.