Origin of isotope heterogeneity in the solar system: Supernova input or thermal processing?

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In the last decade, a variety of nucleosynthetic isotope anomalies in bulk meteorites have been discovered for heavy elements including Cr, Sr, and Mo. These data suggest the existence of planetary scale isotope heterogeneity in the early Solar System, although some elements such as Te, Hf, and Os do not show such anomalies at the current level of analytical precision. To date, two major models that account for the observed normal/anomalous isotope compositions have been proposed. In the first model, the planetary scale isotope anomalies were caused by late injection of a nearby supernova which sprinkled isotopically anomalous grains into the protoplanetary disk, followed by aerodynamic sorting of grains in different sizes. A major difficulty of this model is the lack of anomalies for r-process nuclides of Te, Hf, and Os which are thought to be co-produced via core-collapse supernovae (ccSNe). However, recent observational and theoretical approaches argue for that the neutron star mergers could be a dominant site for r-nuclides, while low-mass r-nuclides (A< 130) were contributed by ccSNe [1]. If true, isotope anomalies in meteorites are found for elements with the atomic number Z< ~56, which would be in consistent with the observation of isotope anomalies in Ba, Sm, and Nd. By contrast, the second model assumes nebular thermal processing which caused selective destruction of thermally labile, isotopically anomalous carriers. We have proposed that the nebular isotope anomaly was caused by the selective volatilization of isotopically anomalous components associated with physical separation of gas and remaining solid [2]. In this case, isotope anomalies can be observed for elements with intermediate 50% condensation temperature (~1000 K $<T_{50\%}<$ ~1600 K), because ultra-refractory and moderately volatile elements are preferentially distributed into the solid and gas phases during the heating event, respectively, which prevents isotopic separation. The only exception which does not meet this condition is Zr. Isotope analysis of some elements with Z >56 and intermediate $T_{50\%}$ (e.g., Pt, Yb) is important for evaluating the two models, which gives a clue for unraveling the origin of isotope anomaly in meteorites.

[1] Tsujimoto and Shigeyama (2014) *ApJL* **795**, L18. [2] Yokoyama et al. (2014) LPSC XLV, 2588.