WHY IS THE CANONICAL $^{26}Al/^{27}Al$ RATIO 5 X 10^{-5}?. Jamie Gilmour and Ceri Middleton, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Oxford Road, Manchester M13 9PL, United Kingdom. Jamie.gilmour@manchester.ac.uk

Introduction: The heat source that drove differentiation of planetesimals in the early solar system has been the subject of some controversy. The role of ^{26}Al was unclear because it required sizable planetesimals to have formed soon after the formation of calcium- aluminium-rich inclusions. The canonical $^{26}Al/^{27}Al$ ratio associated with CAIs, 5 x 10^{-5} [1], corresponds to a concentration of ^{26}Al sufficient to heat a planetesimal through ~4000K, provided the planetesimal is large enough to prevent cooling on timescales similar to the half life of ^{26}Al (~10 km) [e.g. 2]. However, the ratio associated with most chondrules ($<10^{-5}$) corresponds to a ^{26}Al concentration only marginally capable of driving differentiation [3]. Thus for ^{26}Al to be the heat source requires early formation of planetesimals. This is at odds with the "classical" progression from dust through chondrules to sizable bodies.

Recent work using radioisotopes to constrain timescales has confirmed previous indications [4] that the earliest planetesimals predate chondrule formation. In particular, Hf-W analyses of magmatic iron meteorites show that differentiation of their parent bodies was, at the latest, contemporaneous with CAI formation [5]. It seems that ^{26}Al was the heat source that powered differentiation. Early forming planetesimals also provide an environment to store CAIs and chondrules preventing their accretion to the sun under the influence of gas drag.

This prompts us to ask why there is a reasonable match between the observed $^{26}Al/^{27}Al$ ratio of the earliest solids and the ^{26}Al abundance necessary to allow differentiation of planetesimals?

Possible Solutions: We identify three broad classes of answers to the question we have posed:

1. Coincidence. It is possible that there is no significance to the observation. At present we have only one solar system to study, however the average $^{26}Al/^{27}Al$ ratio of molecular clouds in the current epoch is ~10^{-5} [6], suggesting that our solar system is not typical in this respect. In fact, the need to explain the abundance of ^{26}Al in the presolar nebula has led to various models involving supernovae shortly before the formation of our solar system.

2. The observed ^{26}Al concentration is self limiting. This class of explanation involves framing an argument that samples of our solar system from epochs before ^{26}Al reached the critical concentration would not be preserved.

One example of such an argument would run as follows; even if solids formed and accreted to planetesimals significantly before ^{26}Al concentrations decayed to the critical level, evidence of their presence would not have survived to the present day without resetting. The presence of identifiable presolar material in our collection argues against this possibility.

It is also noteworthy that while evidence from the Al-Mg system requires preservation of crystalline solids from the relevant epoch, the Hf-W system records the last equilibration of metal and silicate in a differentiating planetesimal. Thus systematic resetting of the Al-Mg system requires heating of solids, whereas evidence from the Hf-W system requires either prevention of the separation of melts (perhaps by vigorous convection) or remixing.

3. Anthropic Selection. Our third class of solution involves anthropic selection. Anthropic arguments have some notoriety in a cosmological context, but are uncontroversial where a large population of planetary systems demonstrably exist.

In this form of solution, we speculate that differentiation of planetesimals (heating to melting point of planetesimal interiors) favours production of planetary systems that allow development of complex life forms or technological civilizations. For instance, melting may be a mechanism to reduce porosity and change the collisional properties of planetesimals. Alternatively, planetesimals forming with high initial ^{26}Al concentrations may become significantly depleted in volatiles, affecting their subsequent evolution. Such arguments may merit further investigation which, in the light of the low ^{26}Al concentrations typical of the ISM, we suggest should focus on selection of unusually high ^{26}Al concentrations. If the proportion of planetary systems forming with a given ^{26}Al concentration decreases as the concentration increases, anthropic selection of those systems with ^{26}Al concentrations above a threshold would provide a natural explanation for the observed match in our solar system.

Final thoughts: Our goal in this abstract has been to raise a question that might provoke interest in the community and outline broad classes of arguments that may be made to address it. We have not found a compelling mechanism to place an upper limit on the ^{26}Al concentration from which samples can survive. In addition, it seems that ^{26}Al concentrations in our solar system are unusually high. For this reason, being unwilling as yet to adopt coincidence as an explanation, we marginally favour an anthropic explanation. Such a selection pressure on the solar system we observe first hand would significantly affect the inferences we can make from formation of our solar system to formation of solar systems in general.

References: [1] MacPherson G. J., et al. (1996) *Meteoritics* **30**, 365-386. [2] Woolim D. S. and Cassen P. (1999) *MAPS* **34**, 897-907. [3] Hevey P. J. and Sanders I. S. (2006) *MAPS* **41,** 95-106. [4] Gilmour J. D. et al. (2000) *MAPS* **35**, 445-455. [5] Markowski A. et al. (2007) *EPSL* **262**, 214-229. [6] Diehl R. et al. (2006) *Nature* **439**, 45-47.