DISTRIBUTION OF ^{26}Al IN THE EARLY SOLAR SYSTEM: A 2014 REAPPRAISAL.

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Introduction: In 1995 we [1] reviewed all available data for extinct ^{26}Al in early solar system materials, comprising approximately 1500 data points. Since that time the volume and (especially) precision of data have increased dramatically. We are undertaking to revise that review in light of the progress made over the past ~ 20 years. As of this writing we have compiled 5235 data points for Ca-Al-rich inclusions (CAIs) and refractory single grains, chondrules, achondrites, and a range of other materials. One of the goals of the current effort is to report initial ^{26}Al/^{27}Al (^{26}Al/^{27}Al$_o$) ratios based on internal isochron slopes as much as possible, instead of simply tabulating individual measurements.

Caveats: The summary histograms presented in Figures 1-4 are *highly preliminary* and will continue to be refined. We have not completed reducing all of the data we do have, and there likely remain more data to be mined from the literature. We have not, for example, measured spots from graphs in abstracts where the data are not tabulated. Data are reported herein at face value, that is, they do not reflect the precisions of the determinations; also, there remains the enormous task of culling to remove dubious data. Although we generally report isochron slopes as published by the many authors, in many cases we have recalculated isochron slopes to take into account the effects of isotopic resetting (see below), and for this we have used a simple Williamson least-squares fitting program instead of the more sophisticated ISOPLOT. Finally, the number of references from which the data have been collected is far too long to give in this abstract and for that we ask indulgence. The final publication arising from this work will tabulate all references, and it is our intention to make the final database available electronically as an on-line supplement.

Treatment of disturbed isochrons in CAIs and chondrules: It is now well-established that plagioclase and spinel are very susceptible to isotopic exchange, especially with each other [2]. Pyroxene, hibonite, and even melilite are much more reliable. New high-precision and high spatial-resolution *in-situ* data from ims-1270 and 1280-class SIMS machines allow isochrons to be determined from such low Al/Mg phases alone, and in many cases they give undisturbed isochrons even when plagioclase is completely disturbed (e.g. [2], their Fig. 7c). For the older lower precision data this is not possible, and in such cases we calculated minimum isochron slopes (minimum ^{26}Al/^{27}Al$_o$) by combining low Al/Mg data with those high Al/Mg data that appear to be the least disturbed, i.e. that yield the highest ^{26}Al/^{27}Al$_o$.

Results: Data for isotopically "normal" CAIs and refractory grains are summarized in Fig. 1. The peak in this histogram, at exactly the so-called canonical value of ^{26}Al/^{27}Al$_o$=5×10^{-5}, is very close to the value (~5.2×10^{-5}) determined from whole-CAI isochrons [3,4]. A secondary peak exists at 0 which consists of data with no resolvable excesses (radiogenic) of ^{26}Mg. Some of these are unquestionably due to complete isotopic resetting [e.g. 5], whereas others arguably represent heterogeneity in ^{26}Al/^{27}Al$_o$ [6]. Data also plot at so-called supra-canonical values, ^{26}Al/^{27}Al$_o$ >> 5.2×10^{-5}. Those at ^{26}Al/^{27}Al$_o$ > 6 are low precision and deemed to be spurious. However, some CAI slopes and some high-precision measurements of individual grains do give values approximating ^{26}Al/^{27}Al$_o$= 6×10^{-5} and these cannot be dismissed [e.g. 7]. There is nothing sacred about the value of 5×10^{-5} observed in most CAIs, and it is possible that at least some hibonite grains do exceed this value. The elusive goal remains of finding a high-precision undisturbed internal isochron that gives ^{26}Al/^{27}Al$_o$ significantly in excess of 5.2×10^{-5}. Until this is done, "supra-canonical" ^{26}Al remains possible but unproven in our opinion.

Data for FUN, F, and UN CAIs and grains are shown in Fig. 2. CAI (internal) and grain (model) isochrons give essentially the same result, with a peak at ^{26}Al/^{27}Al$_o$= 0.9×10^{-5}. Indeed, more than 50% of the available data are resolved from zero. This runs contrary to the common supposition that FUN CAIs and their ilk contained basically no live ^{26}Al at the time of their solidification. Even more surprising is that there is an actual peak instead of just a scattering of values resolved from zero. This is a tantalizing hint that many FUN CAIs etc. largely formed in a single separate isotopic reservoir. This is a topic that needs much more investigation.

Data for chondrules are summarized in Fig. 3. This is largely the same dataset discussed at length by [8] and not much more needs to be added here. There is a broad peak at ^{26}Al/^{27}Al$_o$= 0.5-0.7×10^{-5} with a smattering of values as high as ~2×10^{-5}.

Finally, data for achondrites are summarized in Fig. 4. Approximately 40% of the data are resolved from zero, forming a crude peak at ~ ^{26}Al/^{27}Al$_o$= 0.2-0.3×10^{-5} with a couple values as high as 0.8×10^{-5} (note that axis scale is different from Figs. 1-3). The resolved values represent a variety of achondrites, including angrites, HEDs, mesosiderites, and even one polymict ureilite. There can be no doubt that asteroidal melting took place while ^{26}Al was still live in the early solar system, albeit (apparently) at a much lower value that that recorded in most CAIs. Interpreted in terms of chronology and assuming homogeneous initial distribution of ^{26}Al at the time of asteroidal accretion, then asteroidal melting occurred around 4 m.y. after CAI formation but, locally, perhaps much earlier.

References: [1] MacPherson G.J. et al. (1995) *Meteoritics* 30, 365-386. [2] 76. [2] MacPherson G. J. et al. (2012) *EPSL* 331, 43-54; [3] Jacobsen B. et al. (2008) *EPSL* 272, 353–364; [4] Larsen K. et al. (2011) *Ap. J. Lett.* 735, L37–L45; [5] Caillet C. et al. (1993) GCA 57, 4725-4743; [6] Makide K. et al. (2013) *GCA* 110, 190–215; [7] Liu M. C. et al. (2012) *EPSL* 327–328, 75–83; [8] Kita N. T. and Ushikubo T. (2012) *MAPS* 47, 1108–1119.