THE FORGOTTEN UNCERTAINTIES IN USING RADIOCHRONOMETRY TO DATE MINERALS THAT FORMED IN THE EARLY SOLAR SYSTEM—THE EXAMPLE OF ^{53}MN. M. A. Tyra[1], [1]National Institute of Standards and Technology, Gaithersburg, MD, (mark.tyra@nist.gov).

Introduction: Many cosmochemical studies that employ radiochronometric methodologies report analytical uncertainties but leave out, depending upon the measurement and system, perhaps the primary source of uncertainty—that of the used system's half-life. In fact, often the half-life of the system used in a publication is reported as invariant with not even a citation to the workers who derived the value or to the database where the consensus value is stored. That the half-lives of radiochronometric systems that are used to date minerals are often not considered in the discussion of the merit of a derived value results in analyses with uncertainties that are not fully considered. This may affect the conclusions of a study and have repercussions that affect how results from different radiochronometric systems fit together.

Not only is half-life uncertainty perhaps underappreciated in Early Solar System (ESS) geochronology, but many systems need verification. For example, the half-life of ^{60}Fe was recently radically revised [1]. Furthermore, many radionuclidic systems that are relied upon in geochronology have not been scrutinized for over 40 years; recently a meta-analysis of ^{87}Rb, ^{147}Sm, ^{176}Lu, ^{230}Th, ^{232}Th, ^{235}U, and ^{238}U found all but the value for ^{238}U critically lacking [2,3]. As Pb-Pb dated angrites have been used to correlate many radionuclidic systems used in the Early Solar System (of which the ^{235}U-^{207}Pb system is crucial) [4], a poorly-constrained underpinning for ESS geochronology is a problem that must be addressed.

This presentation discusses systems currently used in ESS geochronology (e.g., ^{135}Cs, ^{107}Pd, ^{129}I, ^{41}Ca, ^{53}Mn, and the isotopes of U) and focuses on the history of the ^{53}Mn-^{53}Cr system, including the reasons for the current consensus value and what pitfalls exist for using this and other systems.

Mn-53: From 1955 to 1974, there were nine evaluations of the half-life of ^{53}Mn (Fig. 1). To my knowledge, there have been no further measurements since. One of the last four analyses [5] was chosen to represent the half-life of ^{53}Mn and the common value of 3.7 ± 0.37 (10%) My has been adopted [2], most likely because this study had the lowest reported analytical uncertainty.

Can a combination of studies do better? There are many ways to combine the results of different studies. For instance, the latest four derived values shown in Fig. 1 look like they could be representations of the actual value of the half-life of ^{53}Mn. Without evaluating the merits of the work behind each value, one can construct a weighted mean using the inverse of the variance and calculate a value of (3.74 ± 0.24) x 10^6 years. If we use the last three references, one can calculate a half-life of (3.77 ± 0.24) x 10^6 years. Both of these values "improve" the uncertainty term from 10% to ~6.5%. Other methodologies, such as using criteria to evaluate the merit of a study and combining results with a random effects model [e.g., 2], can improve upon this result.

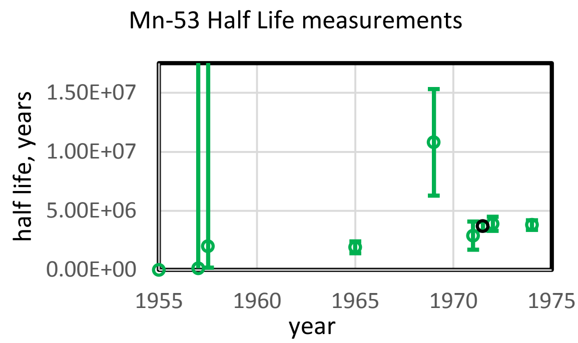

Fig. 1. Nine determinations of the ^{53}Mn half-life. The black symbol denotes the current consensus value [5].

Summary: A systematic evaluation of the chronometers that we use in ESS studies is necessary. As analytical precision has increased, the half-lives of many radiochronometers now used represent the largest sources of uncertainty in analyses. Improving these numbers, either through meta-analysis [e.g., 2] or through redetermination is needed. Improving these values not only will improve our understanding of events that occurred in the ESS, but have broad implications for geochronology and even nuclear forensics.

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