A novel method for creating mineral isotopic reference materials to improve solar system radiochronometry, e.g., ^{53}Mn-^{53}Cr

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Many radiochronometric dating methodologies are impeded by the less-than-optimal amounts of target nuclides in a reference material. For example, ^{53}Mn-^{53}Cr isotope systematics in carbonates have been used to explore the timing of formation of early solar system minerals using, for example, SIMS. Unfortunately, the low concentration of Cr in terrestrial carbonates negatively impacts the measurement uncertainty if they are used as isotope reference materials (iRMs).

This sudy presents a method to make carbonate iRMs with naturally in-grown Cr by using short-lived ^{52}Mn ($t_{1/2}$ = 5.591 (3) days) or ^{54}Mn ($t_{1/2}$ = 312.12 (6) days) which are mixed with stable ^{55}Mn in the solution from which the carbonates are precipitated. The ^{52}Mn and ^{54}Mn are synthesized for use in PET imaging and treatment of cancer [1]. Because both Mn radionuclides are commercially available, both decay directly to stable Cr isotopes (^{54}Mn => ^{54}Cr, ^{52}Mn => ^{52}Cr), both have reasonably short half-lives, and both (being Mn isotopes) are chemically similar to stable ^{55}Mn, the combining of these Mn isotopes with ^{55}Mn to produce synthetic calcite allows Mn to be incorporated in the carbonate crystal structure and allows Cr to subsequently be incorporated. Calcite synthesis, including the incorporation of trace Mn, is a relatively simple procedure [2-4] and the first test batches have been grown. Dolomite synthesis will be more challenging [5-7]. After synthesizing and evaluating the carbonates produced with non-radioactive ^{55}Mn, the potential for synthesizing carbonate minerals with in-grown stable Cr from radioactive Mn will be evaluated. The use of short-lived radioactive isotopic materials could open new opportunities for creating specialized iRMs; carbonates are only the beginning.

[1] Wooten, et al., (2015) *ARI* **96**, 154-161; [2] Lemarchand et al., (2004) *GCA* **68**, 4665-4678; [3] Reeder et al., (1996) *ESR* **29**, 29-46; [4] Gruzensky (1967) *Crystal growth*, 365-367; [5] Ichimura and Sugiura (2015), *LPSC* abs# 1795; [6] Arvidson and Mackenzie (1999) *Am J Sci* **299**, 257-288; [7] Lumsden et al., (1989) *GCA* **53**, 2325-2329.