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# Artificial weathering of the ordinary chondrite Allegan: Implications for the presence of $Cl^-$ as a structural component in akaganéite

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## Abstract

A sample of an ordinary chondrite fall, Allegan, was shown by $^{57}$Fe Mössbauer spectroscopy to be unweathered. Using aerated deionized water at 25° and 0 °C, and in one case with dissolved salts added, an attempt was made to simulate meteorite weathering processes in the hot and cold desert environments where these samples accumulate. The progress of artificial oxidation was monitored by $^{57}$Fe Mössbauer spectroscopy, and the final products were analyzed by neutron activation. The results confirm weathering mechanisms proposed for naturally weathered meteorites and suggest that temperature is the major factor controlling the stability of the observed oxide mineral assemblage. Akaganéite was observed as a major oxidation product in the experimentally weathered sample. This finding is interesting because it is widely accepted that β-FeOOH requires $Cl^-$ for stability: The sample weathered in deionized water showed only trace amounts of $Cl^-$ in both the fresh and weathered meteorite. We suggest that both $Cl^-$ and $OH^-$ may be effective in filling tunnel sites and that a complete solid solution is possible between these end-members. In addition, a calculated formation age of 4.59 ± 0.05 Ga and a cosmic-ray exposure age of 5.7–6.2 Ma, was derived from neutron activation analyses of the weathered sample. These ages are consistent with independent measurements made on samples of fresh Allegan, although small sample weights mean that the results should be treated with caution. However, the similar ages obtained in the weathered sample indicates that a wider spectrum of cosmochemical analyses is possible with weathered meteorites than previously thought and that congruent dissolution occurs during meteorite weathering.