American Mineralogist, Volume 88, pages 1169–1172, 2003

Nanometer-scale measurements of iron oxidation states of cronstedtite from primitive meteorites

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ABSTRACT

We report the first nanometer-scale measurements of the iron (III) to total iron ($Fe^{3+}/\Sigma Fe$) ratios from primitive meteorites. These ratios from the matrices and fine-grained rims (FGRs) of the Murchison, Murray, and Cold Bokkeveld CM chondrites fall within a tight range, from 0.45 to 0.54 (±0.02). The measurements were made using electron energy-loss spectroscopy (EELS) on cronstedtite, which is a product of aqueous alteration early in the history of the solar system. The results indicate that the alteration of these meteorites, which display a broad range of alteration intensity, occurred under similar redox conditions and, further, that alteration likely occurred in situ on asteroidal bodies rather than in the solar nebula.