MAPPING FE2+/FE3+ DISTRIBUTIONS IN MINERALS USING ELECTRON SPECTROSCOPIC IMAGING IN A TEM

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Using electron spectroscopic imaging (ESI) in a transmission electron microscope (TEM) we have, for the first time, imaged the distribution of Fe2+ and Fe3+ in an iron-bearing mineral. This opens new possibilities in mapping solid state phase transformations as well as studying oxidative reaction fronts. Mineral intergrowths resulting from such processes determine the magnetic properties of the host rocks and Fe2+/Fe3+ ratios reflect redox conditions in the earth. Determination of Fe2+/Fe3+ ratios has been a major goal of geochemistry and although methods for bulk samples are available, the challenge has been to develop a method for quantitative analysis at the nanometre scale. Recently, this has been achieved by an analysis of the electron energy loss spectrum (EELS) in which both the fine structure and the energy loss associated with the L2,3 absorption edge are sensitive to the oxidation state. Mapping a Fe2+/Fe3+ distribution from point analyses is however not practicable. We demonstrate here that oxidation state distributions can be mapped at high resolution and with high contrast using ESI in which only those electrons within a specific energy loss range form the image. The example used will include TEM studies of intergrowths in titanohematite minerals.