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Energy-filtered transmission electron microscopy (EFTEM) of intergrown pyroxenes

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ABSTRACT

It is demonstrated that energy-filtered transmission electron microscope (EFTEM) imaging in a conventional TEM (CTEM), equipped with a field-emission gun (FEG) electron source, can be used to characterize the local chemical distribution in exsolved pyroxenes. EFTEM imaging, which can be performed in one to tens of minutes, yields two-dimensional compositional maps that can have nanometer-scale resolution. The combination of electron energy-loss spectroscopy (EELS) and EFTEM imaging with techniques such as bright-field and dark-field imaging, high-resolution TEM (HRTEM) imaging, energy-dispersive X-ray spectroscopy (EDS), and electron diffraction allows for the chemical and structural characterization of any sample able to withstand the electron beam.

EFTEM imaging, HRTEM, and EDS data suggest that the augite → orthopyroxene reaction in the samples examined occurs in two-steps; augite → pigeonite → orthopyroxene. In this two-step process, the chemical and structural components are accomplished separately, suggesting that it is energetically or kinetically favorable to dissociate the two components rather than have them occur simultaneously. This two-step transformation is supported by the pigeonite → orthopyroxene transformation, which appears to be an isothermal martensitic transformation since the pigeonite and orthopyroxene compositions are identical within analytical error.