Isothermal equation of state of Fe_5Si_3 up to 96 GPa

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The composition of Earth's core has first-order implications for many problems in deep-Earth geophysics, including Earth's thermal and chemical history. Silicon is a candidate for the major light element in the core (Georg et al., 2007). The Fe-Si system has been extensively studied at high pressure and temperature, including Fe-Si alloys and stoichiometric silicides, FeSi, Fe_2Si and Fe_5Si_3 (Fischer et al., 2014; Errandonea et al., 2008; Santamaria-Perez, 2004). We revisited the earlier set of equation of state (EOS) measurements on Fe_5Si_3 (Errandonea et al., 2008) and extended them to pressures up to 96 GPa, using gas-loading techniques to ensure a quasi-hydrostatic medium. We measured the Fe_5Si_3 unit cell volume using synchrotron-based X-ray diffraction at GSECARS at the Advanced Photon Source (APS). The bulk modulus ($K_{T,0}$ = 172 (6) GPa) and its pressure derivative ($K_{T,0}'$= 5.0 (2)), were determined from a fit of the data to a 3rd-order Birch-Murnaghan (BM) EOS. Our new EOS for Fe_5Si_3 has significantly lower bulk modulus than previous experiments (Errandonea et al., 2008; Santamaria-Perez, 2004), and is indistinguishable from pure iron (Dewaele et al., 2006).

In the course of analyzing this data set, we have developed tools for extracting 2-dimensional information from X-ray diffraction images. We present results from a simple Gaussian fitting program in IDL that requires user-input, and an exciting new automatic peak detection wavelet program in Python that may have broad applicability for analyzing synchrotron X-ray diffraction images.