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Phase relations in the system Fe-Ni-Si to 200 GPa and 3900 K and implications for Earth's core

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The phase relations of Fe-alloys under high pressure (P) and temperature (T) are fundamental data when one discusses the physical and chemical properties of Earth's core. In this talk, we will present newly determined phase relations in the system Fe-Ni-Si constrained in a diamond anvil cell (DAC) up to about 200 GPa and 3900 K. Silicon is considered a plausible candidate for the light element in Earth's core, which is a consequence of metal-silicate equilibration during core formation process. Phase relations and equations of state of solid phases in the system Fe-(Fe)Si have extensively been studied by experiment and theory. However, the system Fe-Ni-Si was less studied although the core likely includes 5-10 wt% Ni from cosmochemical observations. We here mapped up the P-T space in an Fe-Ni-Si alloy by conducting high-P-T experiments in an internally resistive heated DAC with in-situ synchrotron X-ray diffraction. The internally heated DAC heats the sample by its resistance, with an improved accuracy in temperature with respect to conventional laser heated DAC (Komabayashi et al. 2009; 2012; 2019). Results show that the hexagonal close-packed (hcp) structure was observed up to the highest P-T condition studied. We also placed tight constraints on the P-T locations of an important phase relation in the Fe alloys, which is a transition between the face-centred cubic (fcc) and hcp structures. The P-T locations of the boundaries in the Fe-Ni-Si alloy cannot be explained by a simple interpolation of those in Fe (Komabayashi et al., 2009), Fe-Ni (Mao et al., 2005; Komabayashi et al., 2012), and Fe-Si (Tateno et al., 2015; Komabayashi et al., 2019). We will show the experimental data and discuss the location of the triple point where the hcp, fcc, and liquid are stable in a compositional range of the system Fe-Ni-Si. Also we will discuss the effect of simultaneous inclusion of Ni and Si on the Fe properties under high P-T and propose a new phase diagram for Earth's core.