The Fe-Fe_2P and Ni-Ni_2P phase diagrams at 6 GPa

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Fe-P and Ni-P are among the basic phase diagrams for understanding the core formation in asteroids and planets. Recent finding of high-pressure minerals in iron meteorites (Holtstam et al., 2003; Litasov and Podgornykh, 2017) and abundance of complex Fe-Ni-P-S quench textures with unusual bulk compositions indicate great importance of the study of related systems at elevated pressures. Although high-pressure modifications of meteorite appear under shock impact conditions for the short time, static high-pressure experiments are more relevant for interpretation of these processes relative to shock wave experiments, where duration of shock is too short to model meteorite impact. We have determined the Fe-Fe_2P and Ni-Ni_2P phase diagrams at 6 GPa and 900-1600 ^{o}C. Experiments have been conducted in ceramic (3 MgO + 4 SiO_2) capsules using multianvil technique.
The Fe-Fe_2P system has two stable phosphide compounds: Fe_3P and Fe_2P. The Fe-Fe_3P eutectic is established at 1075 ^{o}C and 16 mol% P. The Fe_3P compound melts incongruently at 1250 ^{o}C to produce Fe_2P and liquid containing 23 mol% P. The Fe_2P compound melts congruently at 1575 ^{o}C. In whole studied temperature range, metallic iron dissolved measurable amounts of P suggesting an existence of limited solid solutions of P in Fe. The maximum P content in Fe, 4.2-5.2 mol%, is established at 1100-1200 ^{o}C. X-ray diffraction study indicates that Fe_2P corresponds to barringerite structure, whereas Fe_3P corresponds to schreibersite. Thus, quenched phases at 6 GPa do not corresponds to high-pressure polymorphs, such as $(Fe,Ni)_2P$ allabogdanite (Britvin et al., 2002), which was synthesized previously at 8 GPa (Dera et al., 2008).
The Ni-Ni_2P system has three stable phosphide compounds: Ni_3P, $Ni_{3-x}P$, where x = 0.4-0.7 and Ni_2P. The Ni-Ni_3P eutectic locates at 975 ^{o}C and 20 mol% P. The $Ni_{3-x}P$ solid solution field narrows to the $Ni_{2.3}P$ composition as temperature increases to 1175 ^{o}C, where $Ni_{2.3}P$ melts incongruently to Ni_2P and liquid containing 29 mol% P. The Ni_2P compound melts congruently at 1250 ^{o}C. Ni also forms limited solid solutions with P. Similarly to Fe-P system, Ni_2P and Ni_3P compounds corresponds to barringerite and nickelphosphide crystal structures at 6 GPa. The intermediate compound $Ni_{3-x}P$ has variable composition, which may correspond to Ni_5P_2 or $Ni_{12}P_5$ observed at 1 atm.
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