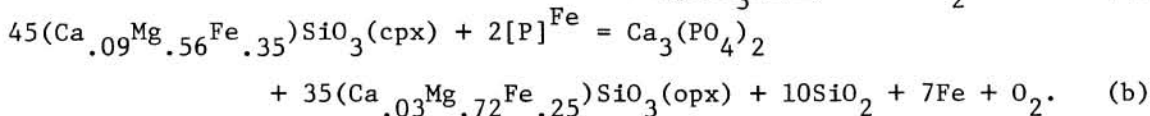
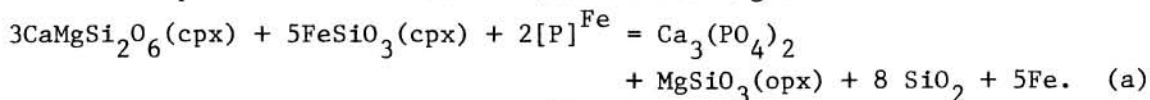


LIQUIDUS PHOSPHORUS REDOX REACTIONS IN MESOSIDERITE SILICATES;
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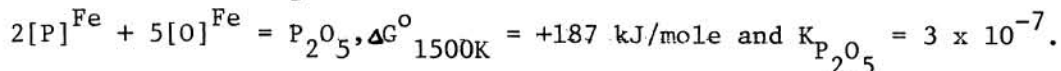
There is good evidence for liquidus reduction of iron from pyroxenes by phosphorus in the silicates of stony-iron mesosiderite meteorites. P/Fe redox reactions account for only a small portion of the metallic iron in these rocks but such reactions are consistent with the major element silicate chemistry of mesosiderites.

Mesosiderite bulk silicate compositions are depleted in FeO and enriched in phosphate and silica compared with related igneous meteorites like the howardites (1). In addition, Fe/Mn ratios in mesosiderite orthopyroxenes tend to decrease with increasing FeO content of the pyroxenes. These characteristics have been interpreted by Agosto et al. (2,3) as evidence for spontaneous reduction of iron from mesosiderite clinopyroxenes by phosphorus diffused from hot metal in the mesosiderite parent body at igneous and subsolidus temperatures in excess of 900°C according to reactions like:

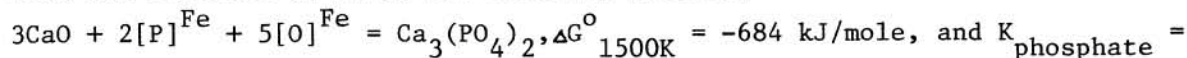


In the above reactions, $[\text{P}]^{\text{Fe}}$ refers to elemental P derived from metal; cpx and opx refer to mesosiderite clinopyroxenes and orthopyroxenes, respectively and their components. In reaction (b) where oxygen is evolved as a product, pyroxene compositions are taken from probe data on ALHA77219, an Antarctic mesosiderite (2).

Comparable P/Fe redox reactions are employed in the iron and steel industry. In the purification of pig iron, phosphorus and other impurities are oxidized out of the iron by iron oxides that line the process furnace. P enters the slag as P_2O_5 . The process is greatly facilitated by the addition of lime to the slag. For the reaction:



With the addition of lime, the reaction becomes:



7×10^{23} (4). Thus, the presence of CaO increases the equilibrium constant for the oxidation of phosphorus by 30 orders of magnitude! In reactions (a) and (b), the CaO content of the clinopyroxenes serves this function and the reaction products include phosphate, silica, iron, oxygen and orthopyroxene with reduced Fe/Mn ratios.

If reaction (b), proceeding to the left, is applied to the bulk mesosiderite silicate analyses of Simpson and Ahrens (5), Floran et al. (6) and Jarosewich, the average compositions of each researcher move from the mesosiderite to the howardite field in the Ol-An-Si pseudoternary diagram adapted from Stolper by Mittlefehldt et al. (1). Thus, in addition to explaining mesosiderite major element chemical trends, reaction (b) genetically links howardites and mesosiderites in an igneous process that is consistent with crustal foundering through liquid mantle to a planetesimal metal core proposed by Chapman and Greenberg (7) as a mechanism for meso-

Agosto, W. N.

siderite formation. In support of a melt environment, Hewins (8) has recently reported significant petrographic evidence for melt textures in at least half the mesosiderites. In particular, the characteristic mesosiderite petrographic feature of inverted pigeonite mantling orthopyroxene would occur if fluid phosphorus lowered the liquidus below the cpx/opx inversion roof of the pyroxene phase volume. Under those conditions, orthopyroxene crystallization would precede pigeonite as is observed.

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