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The $CaSiO_3$ perovskite forming reaction at transition zone and lower mantle conditions.

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We have determined the effects of temperature and chemical composition on the $CaSiO_3$ perovskite formation reaction in the mantle. $CaSiO_3$ perovskite and majorite garnet are the principal host phases for CaO in the transition zone and lower mantle. At approximately 17 GPa majorite garnet becomes saturated in CaO and $CaSiO_3$ perovskite begins to exsolve. With increasing pressure the CaO solubility of garnet decreases and more perovskite exsolves until garnet becomes virtually free of CaO. Previous studies have revealed that in peridotitic and basaltic systems the pressures at which $CaSiO_3$ perovskite starts to form are very similar even though the bulk CaO concentrations are quite different. This implies that some other component influences the saturation point of CaO in garnet.

The solubility of $CaSiO_3$ in majorite garnet has been studied as a function of composition between 17 and 24 GPa and 1200-1800^{o}C using a multianvil apparatus and 10/5 and 10/4 pressure assemblies. Starting compositions were comprised of glasses with CaO-free garnet compositions with varying majorite components mixed with double the proportion of $CaSiO_3$ wollastonite. Multi-chambered Re capsules were used where up to four compositions could be run in the same experiment. A $(Mg,Fe)_2SiO_4$ pressure calibrant was also added to each experiment such that precise pressure determinations could be made from the crystallizing assemblage using the relatively well known phase relations in this system. CaO free majorite garnet and $CaSiO_3$ perovskite crystallized rapidly during the initial stages of each experiment and the garnet became saturated with $CaSiO_3$ over time. Run durations of several days were employed to ensure saturation and reversal experiments were made using presynthesized CaO-bearing garnets. Results show that the solubility of $CaSiO_3$ in majorite garnet increases at a given pressure and temperature with decreasing majorite component.

Garnet, therefore, reaches saturation at lower CaO concentrations in peridotite compositions, where garnet is more majoritic, than in basaltic compositions. These results allow us to calculate the amounts of $CaSiO_3$perovskite coexisting with garnet for any relevant mantle composition at any pressure and temperature. They can also be used to examine if the $CaSiO_3$ perovskite forming reaction produces a detectable seismic signature.