

Crystallization history of protohypersthene basalts
from the Ocean of Storms

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The compositions of 9 rocks either lie close to those of cotectic liquids in equilibrium simultaneously with olivine, protohypersthene, pigeonite, subcalcic augite, calcic plagioclase and chrome spinel, or are displaced from these compositions towards that of olivine, perhaps as a result of crystal accumulation.

Among the pyroxenes an orthorhombic phase, protohypersthene (c. $Wo_7 En_{67} Fs_{26}$) crystallizes early (c. $1180 \pm 10^\circ C$) to disappear by reaction with the liquid after the appearance of pigeonite (c. $Wo_{10} En_{62} Fs_{28}$: c. $1180^\circ C$). Pigeonite is joined by subcalcic augite (c. Wo_{22}) at $1145 \pm 10^\circ C$. Olivine (c. Fa_{34}) and chrome spinel begin to crystallize in most of the samples at c. $1180 \pm 10^\circ C$ and anorthite begins to precipitate at c. $1150 \pm 10^\circ C$ shortly after pigeonite. Solidification occurs at c. $1115^\circ C$ in three olivine enriched samples, and $< 1085^\circ C$ in the others.

Evidence of reaction relationships between liquid and (i) low TiO_2 spinel to form high TiO_2 spinel, (ii) olivine to form low calcium pyroxenes, (iii) protohypersthene to form pigeonite and (iv) pigeonite to form subcalcic augite has been found in the study of the natural rocks or their synthetic analogues.

Like samples from the Sea of Tranquility, low pressure fractional crystallization appears to be an important factor in the genesis of these rocks.