# Melting the shallow, water-undersaturated mantle wedge at subduction zones

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## Introduction

Mantle melting processes at subduction zones are controlled by the presence of water and affected by inputs from the subducting slab. While much progress has been made in understanding the beginning of mantle melting at the slab–mantle wedge interface, relatively little work has been undertaken to investigate the melts that form in the middle and upper sections of the mantle wedge. In this study, we perform forward experiments on two mantle compositions to investigate the roles of pressure, temperature, water, and bulk composition on the composition of mantle melts.

## Methods

Piston cylinder experiments investigate 1) a primitive upper mantle composition at 1.0, 1.2, 1.6, and 2.0 GPa under water-undersaturated conditions (0-6 wt% $H_2O$) at 1135-1470 °C and 2) a depleted upper mantle composition at 1.2 GPa with small amounts of water (1-3 wt% $H_2O$) at 1225-1275 °C. Both mantle compositions have been modified to include a $\leq$0.5% slab component in the form of additional $Na_2O$ and $K_2O$.

## Results

Melt compositions from both primitive and depleted experiments confirm trends reported by Gaetani and Grove [1], which indicate that increasing $H_2O$ at constant melt fraction F and pressure results in increases of $SiO_2$ and $Al_2O_3$ and decreases of MgO and FeO. CaO and $Na_2O$ remain constant. The results from this study also reveal the role of pressure with constant, small amounts of water at constant F. For primitive experiments conducted at constant F and $H_2O$, decreasing pressure causes a slight increase in $SiO_2$ and a decrease in FeO, with MgO, $Al_2O_3$, CaO, and $Na_2O$ remaining constant.

In the primitive experiments, all major elements except for CaO reproduce the composition of natural primitive, high-Mg andesites (PHMA), rocks that are thought to be direct mantle melts. Curiously, the CaO contents of PHMA from various subduction zones are resolvably different and range from 6 wt% to 10 wt% CaO. That this range in CaO is not achieved in our experiments while the range of $Al_2O_3$ is reproduced suggests that the range of CaO in the natural samples is caused by heterogeneities in the Ca/Al ratio of the upper mantle.

[1] Gaetani and Grove (1998), *CMP* **131**, 323-346