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Melting of heavily metasomatized hydrous mantle

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Mantle-derived magmas are traditionally thought to originate from the melting of a uniform spinel- or garnet peridotite dominated by olivine. However, studies of mantle-derived basalts indicate a mineralogically heterogeneous mantle, where even common magmas involve contributions from pyroxenites and hydrous minerals, collectively termed metasomes. Yet, most experimental studies assume homogeneous mantle compositions, limiting our understanding of these heterogeneities.

This contribution reviews recent reaction experiments that move beyond traditional approaches by simulating interactions between peridotite and hydrous assemblages, such as phlogopite, amphiboles, and apatite. These experiments demonstrate that melting of hydrous metasomes and subsequent melt-peridotite interactions are crucial for producing the high alkali contents observed in natural lavas. Hydrous metasomes melt at lower temperatures than peridotite, yielding diverse melt compositions. Their interaction with peridotite further modifies melt chemistry, with pressure-dependent melting behaviors of minerals like orthopyroxene and olivine playing a key role. This process generates K- and Na-alkaline melts with varying silica and alkali contents, reflecting the complex interplay of melting and reaction mechanisms in the mantle.

The formation of hydrous metasomes has also been investigated through experiments simulating melt-peridotite interactions, particularly in sub-arc regions where potassium-rich metasomes form due to sedimentary rock contributions. Given the geochemical signatures of potassic igneous rocks, these experiments predominantly focus on potassium-rich systems.

Future research should emphasize the compositional variability of metasome-derived melts, their reactions with peridotites, and comparisons with surface lavas. Understanding the kinetics of these reactions and melting mechanisms is crucial. However, the mineralogical diversity of hydrous metasomes presents a key challenge, highlighting the need for experiments on additional melt source rocks and their interactions with peridotites. The exploration of how melts from hydrous metasomes react with mantle peridotites has only just begun.