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Halogens in amphibole and mica from mantle xenoliths: Implications for the halogen distribution and halogen budget of the metasomatized continental lithosphere

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Abstract

This study reports halogen contents (F and Cl) of amphibole and phlogopite derived from mantle xenoliths and one peridotite massif, for amphibole and phlogopite megacrysts and ultramafic magmatic cumulates (hornblendites) found in alkaline volcanic rocks from 12 localities in Europe and Africa. Amphibole and phlogopite contain more F than Cl with F/Cl ratios reaching about 160 in phlogopites and 50 in amphiboles. Phlogopites are higher in F (median of 3400 µg/g) than amphibole (median of 1000 µg/g), while median Cl contents are higher in amphibole (290 µg/g) compared to phlogopite (180 µg/g).

The Cl contents and the F/Cl ratios in amphibole and phlogopite from mantle xenoliths exhibit large differences between samples of the same region, recording very large variations of halogen contents in the continental lithosphere. We suggest that the halogen content in such samples largely depends on the initial composition of percolating melts and fluids in the continental lithosphere. During reaction of these agents with peridotitic wall-rocks, Cl is preferentially retained in the fluid as it is much more incompatible compared to water and F. This desiccation effect continuously increases salinity (Cl content) and decreases the F/Cl ratio in the agent with time, causing variable Cl contents and F/Cl ratios in amphibole and phlogopite at a specific locality. Subsequent partial melting processes may then sequester and re-distribute, especially Cl among amphibole, phlogopite and melts/fluids as a result of its strong incompatibility, whereas F is much less affected as it behaves slightly compatible. The impact of even small amounts of amphibole and mica on the total halogen budget in the continental lithosphere is significant and both minerals can effectively contribute to the high halogen contents typical of alkaline melts.

Keywords: Continental lithosphere, halogens, amphibole, phlogopite, metasmomatism; Halogens in Planetary Systems