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Silicates in carbonatites – origin and interpretation

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Carbonatites are igneous rocks containing substantial carbonates [1]. Other rock-forming minerals are usually phosphates (mainly apatite) and Fe-oxides (mainly magnetite), but also silicates like olivine, monticellite, clinopyroxene, amphibole and mica. Phlogopite is the most abundant of these silicate phases and often forms distinct, very micaceous portions in carbonatites. This is somewhat surprising, as the low solubility of silica and aluminium in carbonate melts should allow only limited amounts of mica formation [2]. Furthermore, silicates typically crystallise in an early magmatic stage of carbonatite magmas and therefore, significant Si depletion is expected during the magmatic evolution of carbonatites. This raises the question about the origin and interpretation of these silicates.

Various studies [2,3,4 and references therein] have shown that interactions between silicate wall-rock and carbonatite magma can induce a significant contamination effect that triggers the formation of specific silicates. While in experimental studies (almost H_2O-poor/free), mainly clinopyroxene is formed by silicate wall-rock contamination [e.g., 3], natural occurrences favour the formation of mica (mostly biotite/phlogopite), less clinopyroxene (diopside, aegerine) and more rarely wollastonite, amphibole (e.g., tremolite, katophorite, richterite) and olivine [4]. Natural examples can be directly related to silicate wall-rock contamination by e.g. black wall features at contact zones. Further observations have shown that the type of silicate minerals formed is primarily dependent on the type of contaminating silicate wall-rock.

[1] Yaxley et al. (2022) Annu. Rev. Earth Planet. Sci. 50, 261-293. [2] Giebel et al. (2019) JPet 60(6), 1163–1194. [3] Anenburg et al. (2020) Sci. Adv. 6(41), eabb6570. [4] Chmyz et al. (2022) Lithos 106647.

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