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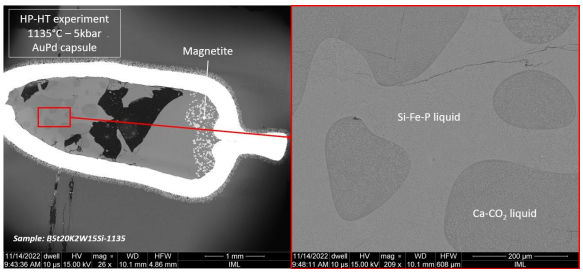

Immiscibility and Rare Metals partitioning between phoscorite and carbonatite magmas: An experimental investigation

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Carbonatites are magmatic rocks distributed worldwide and the world first source for Niobium and Light Rare Earth elements. They may also contain economic grades of phosphate [1]. Those carbonated rocks are often associated with Si-undersaturated alkaline magmatic rocks and locally with an iron-rich phosphate rock called phoscorite [2]. A series of works support that immiscibility in magmas is the main differentiation process responsible for the alkaline-carbonatite-phoscorite magmas association and the partitioning of rare metals among them [2-4].

Our objective is to determine the extent of immiscibility in natural Fe-P-CO2-rich alkaline Si-undersaturated systems, and to understand and parametrize the partitioning of rare metals between the immiscible liquids. We based our approach on new laboratory high-pressure and high-temperature experiments carried out in a piston-cylinder apparatus. We worked at 5 kbar and from 975 to 1180°C in hydrated conditions (2-5 wt% H_2O).

Immiscibility developed between a Ca-CO_2-rich liquid and a Si-Fe-P-rich liquid in equilibrium with magnetite, pyroxene, and apatite. Those liquids could be suitable parental magmas for carbonatites and phoscorites, respectively. The first one has the composition of a silico-carbonatitic magma (20-44 wt% CO_2, 13-25 wt% CaO, 10-20 wt% SiO_2, 8-16 wt% Na_2O, 4-6 wt% K_2O, 4-12wt% FeO, 4-9 wt% P_2O_5). The second one is very close to phoscorites composition (18-30 wt% SiO_2, 13-23 wt% CO_2, 7-15 wt% FeO, 14-20 wt% CaO, 10-14 wt% Na_2O, 4-8 wt% K_2O, 3-6 wt% P_2O_5). The onset of immiscibility mainly depends on the silicon content of the starting mixes. However, the size of the field is essentially influenced by the contents in alkalis and iron. The partitioning of rare metals slightly favors the Si-Fe-P-rich liquid and strongly depends on iron, silicon, and calcium. The genesis of the parental magma for both liquids can be discussed regarding different processes such as silicate rocks assimilation or partial melting of the mantle.

[1] Chakhmouradian & Zaitsev (2012), *Elements* 8, 347-353. [2] Krasnova et al. (2004), Mineralogical Society Series, 10. *Mineralogical Society, London*, 43-72. [3] Weidendorfer & Asimow (2022), *Earth and Planetary Science Letters* 584, 117500. [4] Zaitsev et al. (2014), *Ore Geology Reviews,* 61, 204-225.