Understanding of natrocarbonatite formation: results from Kerimasi nephelinites

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The Earth's only active natrocarbonatite volcanism at Oldoinyo Lengai suggests that natrocarbonatite melts are formed through a unique geological process. In the East African Rift, the Kerimasi is a neighbor of Oldoinyo Lengai and also contains nephelinites hosting melt and fluid inclusions, which preserve the magmatic processes associated with formation of natrocarbonatite melts. In this study, we present evidence for the presence of coexisting nephelinite melt, fluorine-rich carbonate melt and alkali carbonate fluid. Compositions of these phases differ from the composition of Oldoinyo Lengai natrocarbonatites, therefore, it is not likely that natrocarbonatites formed directly from one of these phases. However, mixing of the outgassing alkali carbonate fluid and the fluorine-rich carbonate melt can yield natrocarbonatite compositions at temperatures close to subsolidus temperatures of the nephelinite (~630 °C). Moreover, the high halogen (F+Cl) content (6-16 wt%) in the carbonate melt precludes saturation of calcite (i.e., formation of calciocarbonatite) and maintains the carbonate melt in the liquid state with 28-41 wt% CaO at temperatures ≥600 °C. Our study suggests that alkali carbonate fluids and melts could have commonly formed in the geological past, but it is unlikely they precipitated calcite that facilitates fossilization. Instead, alkali carbonates precipitated which were not preserved in the fossil nephelinite rocks. Thus, alkali carbonate fluids and melts have been so far unaccounted in the geological record because of the lack of former detailed inclusion studies. In addition, the observed low H_2O (<4 wt%) content of the alkali carbonate fluid phase shows that a H_2O-rich environment is not required for the generation of natrocarbonatites as suggested by previous models. Our model [1] is consistent with the observation that natrocarbonatites are associated with nephelinite rocks [2], as occurs at Oldoinyo Lengai, rather than with calciocarbonatites.

This study was supported by the project NKFIH K-119535.

[1] Guzmics *et al.* (2019) Geology **in press**. [2] Dawson *et al.* (1990) Geology **18**, 260-263.