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Hydrothermal carbonatite alteration by Cl- and F-rich fluids

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The exsolution and/or circulation of hydrothermal fluids in carbonatites has been shown to results in various changes in mineralogy and trace element geochemistry [1,2]. In many cases, it has been associated with the enrichment of critical elements including the REE or Nb to various grades. Yet, natural constraints on the composition and origin of the high-T fluids are scarce and points to an incredible chemical complexity, with fluids not only containing H_2O, CO_2/CH_4 or Cl, but also significant amounts of SO_4^{2-} or CO_3^{2-} [2,3]. The role of different ligands for REE and Nb transport in mildly acidic to alkaline fluids has been the subject of many recent experimental investigations [e.g. 4,5].

To investigate the effect of fluid composition and temperature on carbonatite alteration, we conducted a detailed mineralogical and chemical study of a primary carbonatite that was collected from the Lemitar Mountains (NM, USA)[REF][6] and altered it hydrothermally at 200−400 °C and 600 bar in the laboratory. Two kind of alteration experiments were conducted. The first one used ‘conventional’ cold-seal pressure vessels to alter the carbonatite for periods of 3 weeks with varying initial fluid/rock ratios. The second one enabled direct observation of mineral replacement during hydrothermal alteration using a transparent pressure vessel that allows for *in-situ* XRD characterization. All run products were further characterized by a combination of SEM, SEM-CL, Raman, EPMA and LA-ICPMS. The mineralogy of the altered carbonatite samples is compared to assemblages from other worldwide carbonatite prospects (St Honore, Canada; Mount Weld, USA; Bayan Obo, China) and geochemical simulations with GEMS and the MINES thermodynamic database [7] to provide new insights on the conditions of hydrothermal alteration in natural systems and evaluate current prediction capacities for these complex rocks and fluids.