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The role of apatite as a potential reservoir for the storage of Cl and F in the lower crust and upper mantle

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Apatite is a common accessory mineral in xenoliths from both the lower crust and upper mantle. Silicate minerals in these rocks, such as the feldspars, often indicate that they have undergone some form of metasomatism (e.g., Montanini and Harlov, 2006, Lithos, in press). When analyzed by EMP, the nominal fluorapatite generally shows very high levels of both Cl and OH as well as, when measured, CO_2, (e.g. O' Reilly and Griffin, 2000, Lithos 53, 217; Montanini and Harlov, 2006). In general, the individual apatite grains are inhomogeneous with respect to F and Cl as well as showing variable total F and Cl contents from grain to grain per sample. To date, F and Cl contents in the apatite have been found to range from 0 to 3.24 wt % and 0.26 to 2.48 wt %, respectively, which imply, calculated H_2O contents ranging from 0.22 to 1.63 wt %. Where determined, CO_2 contents can range up to 1.74 wt %. This suggests that the apatite either formed in the presence of Na-K-Ca-brines and/or carbonatitic fluids or else were metasomatised by such fluids. Experimentally, it has been demonstrated that fluorapatite gains copious amounts of Cl in the presence of even low concentration $CaCl_2$-bearing brines under P-T conditions quite similar to those under which the apatite in these xenoliths either formed or were metasomatised (e.g. Harlov and Förster, Am. Mineral. 88, 1209). The origin of such fluids could be highly saline residual brines and CO_2 given off during the crystallization of mafic bodies underplating the base of the lower crust or mineral-bound halogens and CO_2 carried down to the upper mantle via a subducting slab of oceanic crust and released during the breakdown of the mineral hosts. Subsequent percolation upwards through the enriched mantle wedge into the lower crust would then provide the brines and CO_2-rich fluids necessary to metasomatise the apatite. The apparent stability and frequency of apatite in the lower crust and upper mantle suggest that it, along with other halogen-

bearing minerals such as phlogopite, could serve as a major storehouse for halogens in these regions.