# A preliminary investigation of chlorine XANES in silicate melts

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The nature of chlorine speciation in silicate melts affects volatile exsolution history, rheological, and thermodynamic properties of the melt, but is poorly known. XANES (X-ray Absorption Near Edge Structure) spectra, taken from 26 natural and synthetic samples, have been used to constrain Cl-speciation in silicate melts, and to test the hypothesis that Cl in silicate melts is hosted by a combination of salt-like cation-Cl complexes.

The results are consistent with the existence of a $CaCl_2$ species that has reduced short-range order compared to the $CaCl_2$ salt. Identification of a similar $MgCl_2$ species is complicated by the presence of water in the standard. It is concluded that Cl in silicate melts can be represented by a combination of salt-like cation-Cl species, with or withour additional mixed cation-Cl species, polymeric cation-Cl species, lone Cl species, and Cl incorporated into network-forming polymers. Further investigations using XANES, alternative spectroscopic techniques, and forward modelling approaches are required to distinguish between these possibilities. NaCl-like features exhibited by the natural samples are attributed to NaCl present in the sample that is not hosted by the melt.

# Radiation effects in zircon and apatite

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There is increasing interest in the possible effects of radiation damage, particularly from α-decay events, on the results of techniques used in thermochronometry, such as (U-Th)/He dating of apatite. During the past decade, there have been extensive studies of α-decay event damage in minerals that have been considered as potential host-phases for the immobilization of actinides, particularly short-lived actinides, such as $^{238}Pu$ and $^{239}Pu$. This presentation summarizes the results of radiation damage investigations of apatite, britholite and zircon.

An α-decay event consists of a ~5 MeV α-particle with a range of 10 μm, dissapating most of its energy by ionization processes, and a 70-90 keV recoil nucleus with a range of 30 to 40 nm, losing nearly all of its energy by ballistic interactions. Damage accumulation is essentially a process of an increase in the damage fraction as the fluence increases. At the first percolation point the overlap of the displacement cascades creates interconnected pathways of amorphous material, and at the second percolation point, the crystalline domains become isolated from one another. The evolution of the nanoscale structure depends on the temperature of the irradiation and thermal history, as well as radiation-induced phenomena, such a radiation-enhanced diffusion. Damage accumulation has been studied by: *i.*) investigations of suites of natural samples whose total dose is estimated based on U/Th-content and age, *ii.*) samples doped with $^{238}Pu$ and $^{239}Pu$, and *iii.*) systematic electron-beam and heavy ion-beam irradiations as a function of temperature. Models have been developed that quite successfully describe the damage in-growth process as a function of dose, time and temperature for zircon and apatite, and the general results of these models are consistent with observations of natural zircon.

Most recently, experiments have been completed using dual beam irradiations to simulate combined α- and α-recoil effects. Radiation-enhanced annealing leads to a substantial increase in the required dose for amorphization. In addition, we have completed studies that combine diamond anvil cell experiments (up to 18GPa) with very high energy irradiations (10s of GeV) to investigate the effect of pressure and temperature on damage accumulation and track formation.