SAXS study on the morphology of etched ion tracks in apatite

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Tracks consist of narrow cylindrical defect regions that are left behind by high-velocity heavy ions (swift heavy ions) when they pass through a variety of solids. Such tracks are used for determining the age and thermal history of geological material by studying the number and length distribution of chemically etched tracks that result from spontaneous fission of natural inclusions of uranium in the material. The etching enlarges the original damage area such that the track can be studied using optical microscopy. The currently used fission track dating techniques use empirical analysis of chemically etched track distributions, yet it largely ignores variations in un-etched tracks due to varying geological parameters such as pressure, temperature, crystallographic orientation and composition of the mineral. Recent studies in the group focus on the variations in the un-etched track morphology characterized by synchrotron based small angle x-ray scattering (SAXS). This project will study how differences in the un-etched track morphology translate into etched ion track dimensions to bridge the gap between the fundamental research into track formation and their application in fission track dating.

Natural apatite samples from four different locations were irradiated with 185 MeV Au ions at ANU Heavy Ion Accelerator Facility to simulate fission tracks. The sample have been chemically etched and the resulting track morphology was investigated using synchrotron SAXS as well as optical and scanning electron microscopy (SEM). To study the annealing kinetics of the tracks, isochronal annealing was performed prior to chemical etching. We present preliminary results from the SAXS measurement showing the etching process is highly anisotropic yielding faceted etch pits with a 6-fold symmetry. The measurements are a first step in gaining new insights into the correlation between etched and unetched fission tracks and the use of SAXS as a tool for studying etched tracks.