# Characterization of amphibole surfaces through acSTEM Dual-EELS

RUGGERO VIGLIATURO[1], RETO GIERÉ[1]

[1] Department of Earth and Environmental Science, University of Pennsylvania, 240 S. 33rd Street, Hayden Hall, Philadelphia, PA 19104-6316, U.S.A.

The characterization of amphibole surfaces can be accomplished with several techniques, obtaining detailed chemical data including speciation, valence state, and bonding of the major elements. Techniques such as XPS, Mössbauer spectroscopy, and XANES yield important results in terms of statistics and on the overall state of these mineral surfaces and, eventually, of their evolution. On the other hand, these methods do not allow for a detailed description of or to follow the evolution of the surfaces at a nano- and atomic-scale because of spatial resolution limitations.

The combination of aberration-corrected Scanning Transmission Electron Microscopy (acSTEM) and Dual Electron Energy-Loss Spectroscopy (EELS) permits obtaining information that reaches the atomic scale and is limited only by the use of a suitable sample preparation and by the stability of the material.

In this work, we will show the possibility given by Dual-EELS to characterize a specific region of interest (ROI) of the amphibole surface and near-surface, to distinguish among crystalline and amorphous states by studying the low-loss region of the energy spectrum, in the exact same ROI in which we can determine the Fe oxidation state by studying the core-loss region.

This approach overcomes some of the limitations of past detectors by avoiding the need to sequentially collect a low-loss and a core-loss region of the spectrum, thus minimizing problems related to the re-alignment of the zero-loss peak and the resulting additional beam damages in the selected area. Furthermore, the combination of the spectroscopy data with atomic- and nano-scale visual information allows us to describe and comprehend surface transformation more completely.

In this study, we have analysed the surface and near-surface features of 4 different naturally occuring amphiboles obtaining information on their crystal state and nanotopography, physical state of Si, and Fe valence state.