American Mineralogist, Volume 83, pages 918–924, 1998

Characterization of carbon compounds on a pyroxene surface from a gabbro xenolith in basalt by time-of-flight secondary ion mass spectrometry

E.A. MATHEZ[1,*] AND D.M. MOGK[2]

[1]Department of Earth and Planetary Sciences, American Museum of Natural History, New York, New York 10024, U.S.A.
[2]Department of Earth Sciences, Montana State University, Bozeman, Montana 59717, U.S.A.

ABSTRACT

Time-of-flight secondary ion mass spectrometry (TOF-SIMS) yields mass spectra of the upper several monolayers of an analytical surface. The applicability of TOF-SIMS to the characterization of C compounds on crack surfaces in rocks is demonstrated. A pyroxene grain recovered from the interior of a gabbro xenolith from the 1801 flow of Haulalai volcano, Hawaii, was chosen for this initial study because well-developed carbonaceous films are known to exist on many of the crack surfaces in these rocks. In addition to the anticipated major elements (Si, Al, Fe, Mg, Ca), several minor and trace elements (B, Li, Na, Ti, Mn, Co, Ni, Cu) were identified in the positive ion mass spectra. The unsputtered surface is covered with a hydrocarbon-rich layer, as indicated by the presence of numerous light C_xH_y fragments as well as several masses of several hundred atomic mass units (amu). This layer is much better developed than the ubiquitous atmosphere-derived hydrocarbon layer observed on nominally clean, unsputtered surfaces and therefore must be indigenous. High concentrations of Ni and Cu are associated with the C-rich layer and may exist as organo-metallic compounds. Several C-N fragments, possibly indicative of biogenic compounds, were also identified in negative ion spectra. Imaging reveals the presence of localized islands enriched in oxides of Si, Al, Na, and Ca beneath the carbonaceous layer. This study demonstrates that TOF-SIMS can be used to provide unique and geochemically useful information on crack surfaces in rocks.