Surface Composition Evolution of Toluca Because of the Action of the Bacteria: X-ray Photoelectron Spectroscopy Study

Celia Rogero
Elena González Toril
Jesús Martínez Frías
José Angel Martín Gago
Fernando Rully Ricardo Amils

Centro de Astrobiología, CSIC/INTA, asociado al NASA Astrobiology Institute, Ctra de Ajalvir
SPAIN
rogerobc@inta.es

By means of a surface science technique, X-ray photoelectron spectroscopy, XPS, we have been able to follow the changes in the surface composition of the Toluca meteorite due to the action of the acidithiobacillus ferrooxidans and leptospirillum ferrooxidans bacteria. A fragment of the meteorite was cut into three pieces. One was analyzed as received and the other two were submerged in two Mackintosh acid baths one with and the other without bacteria. Once introduced into the ultra high vacuum chamber and before measuring XPS, the three samples underwent an ion beam etching to clean off surface contamination.

XPS spectra give information about the elemental composition of the surface (the relative abundance of the different elements) and the chemical and electronic states of the atoms. In this case we have determined that, before any Mackintosh acid bath, the meteorite was a Fe-Ni alloy with S, O and C. This result which is in agreement with standard mineralogist studies. After the bacteria action, the shift in the Fe2p core level towards higher binding energies indicates that Fe ions are oxidized (mainly to Fe$^{3+}$). This confirms the capability of the bacteria to use this oxidation process as an energy source. Fe atoms form new compounds into the meteorite, based on the evolution of the S, O and Fe core level peaks. The oxidation of the Ni ions in the meteorite is also detected.