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# Surface Charge Density Determination of Micaceous Minerals by $^{235}\text{U}$ Fission Particle Track Method

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**Abstract:** The surface charge density of mica (001) cleavages was determined by counting the number of fission particle tracks in a given area of a 6-mm muscovite disc replica with optical and scanning electron microscopy after saturation of the layer charge by washing with 0.5 M  $\text{UO}_2(\text{NO}_3)_2$  solution, dilution of the excess salt by washing with 0.01 M  $\text{UO}_2(\text{NO}_3)_2$  in 0.005 M  $\text{HNO}_3$  (pH 2.4), blotting off the excess liquid, thermal neutron activation in contact with the muscovite disc, etching the muscovite, and counting the  $^{235}\text{U}$  fission tracks/cm<sup>2</sup>. In initial studies, the uranyl cations were found to hydrolyze from the cleavage surface continuously during the washings with water, ethanol or acetone to remove excess salts, but the uranyl cations in the interlayers near broken edges and crystallographical steps were strongly retained even against washings with 0.5 M  $\text{CaCl}_2$  solution. The hydrolysis of  $\text{UO}_2^{2+}$  from the smooth portions of the flake surfaces was avoided by the use of three 1-hr final washings with the 0.01 M  $\text{UO}_2(\text{NO}_3)_2$  in 0.005 M  $\text{HNO}_3$  solution. Each flake was pressed between filter papers three times to remove the excess solution. A negligible amount of excess salt remained on the cover glass controls. The  $\text{UO}_2^{2+}$  cations retained (mean,  $3.6 \pm 0.2 \times 10^{-7}$  mequiv./cm<sup>2</sup>) on the cleavage surfaces of various micas were nearly equivalent to the theoretical surface charge (cation exchange capacity,  $3.5 \times 10^{-7}$  mequiv./cm<sup>2</sup>), showing that hydrolysis was prevented. The uranium on the unblemished mica planar surfaces increased with increasing uranyl concentrations in the final washing solution, indicating that the excess salt remaining on the surfaces had become significant. With a given  $\text{UO}_2^{2+}$  salt concentration, the uranium on the surface increased on increasing the solution pH from 2.5 to 3.5, attributable to the formation of polymeric ions such as  $\text{U}_2\text{O}_5^{2+}$  and  $\text{U}_3\text{O}_8^{2+}$  with higher uranium retention per unit positive charge equivalent to the fixed negative charge of the mineral surface. Uranyl cations replaced much of the interlayer cations from vermiculites even after K, Rb and Cs presaturation and drying from 110° C were employed. Strong adsorption of uranyl cations (in a form not replaced by washings with a neutral salt solution), which occurred in the defects of micaceous minerals, is important in the interpretation of actinide element retention in soils and sediments wherein these minerals are abundant.

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