Nano-scale TEM imaging of caesium incorporation into illite interlayers

ADAM J. FULLER[1]*, SAMUEL SHAW[2], MICHAEL B. WARD[1], SARAH J. HAIGH[2,3], J. FREDERICK MOSSELMANS[4], CAROLINE L. PEACOCK[1], STEPHEN STACKHOUSE[1], ANDREW J. DENT[4], DIVYESH TRIVEDI[5] AND IAN T. BURKE[1]

[1]Univeristy of Leeds, UK
(*correspondence: eeajf@leeds.ac.uk)
[2]University of Manchester, UK
[3]SuperSTEM, Daresbury Laboratories, UK
[4]Diamond Light Source, UK
[5]National Nuclear Laboratory, Warrington, UK

The contamination of land by radiocaesium has long been seen as a serious environmental problem. It is known that Cs preferentially sorbs to clay minerals, specifically illite. However, until now, the exact sorption mechanism has not been fully explained.

Here we use atomic resolution STEM imaging, EDX and EXAFS to determine the exact mechanism whereby Cs initially sorbs to the illite frayed edge sites before migrating into the clay interlayer.

We observe that caesium rapidly and irreversibly sorbs onto illite via exchange with Ca at the frayed edges, causing them to collapse. The Cs does not remain at the edge of the illite but instead migrates into the interlayer sites normally occupied by K (Fig. 1). This allows additional Cs to sorb onto the interlayer edges explaining why the sorption capacity of illite for Cs appears to increase over extended time periods.

This detailed atomic scale understanding of Cs sorption to this important mineral provides a new level of understanding which is essential for accurately predicting Cs behaviour in the environment.

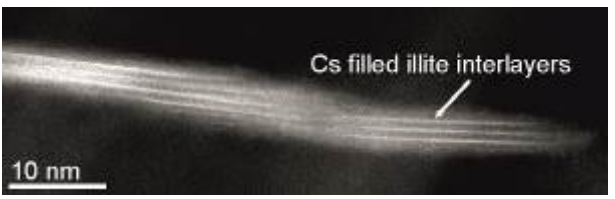

Figure 1 HAADF STEM image of illite after exposure to a Cs solution for one year, showing Cs incorporation into the interlayer (bright lines)