

Nanoscale processes and X-rays in geoscience research

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Being able to derive molecular level details about complex mineral-fluid-microbe interactions at high spatial and temporal resolution using conventional and synchrotron-based X-ray approaches has fundamentally changed our understanding of a whole slew of geological, geochemical or biological processes that control many of Earth's global element cycles. Combining such X-ray analyses with complementary high-spatial resolution electron micro-spectroscopic measurements shines light onto a whole slew of terrestrial and planetary geochemical processes that could only be tackled with the onset of such high-resolution tools. Interestingly, and encouraging however, is the fact that many classic geochemical problems are today tackled not solely by geochemists but that this happens through intensive collaborations between geochemist, physicists, material scientist, microbiologist, chemists etc . Our ability to perform such high-resolution measurements has lead to impressive progress in our understanding of reactions in many aquatic environments, soils, sediments, aerosols, interplanetary dusts or even radionuclides. Examples include the role of biology in rock weathering and soil formation, the effect of interfaces in controlling the complexity of intricate carbonate biomineral formation reactions, or even the interactions between nutrients, organics or toxic metal with minerals in modern or ancient geological settings.

All is not rosy in the nano- X-ray world however. I will also address issues related to how and what artefacts such high spatial and temporally resolved measurements can introduce. I will show also how novel, complementary and thus often more and more complex sample handling environments allow users to take one (or many) step (s) closer towards better mimicking natural environments in analogue laboratory experiments. Finally, I will talk about sample preparation and handling. Users often tend to forget that despite all our hopes such high-resolution capabilities can not do magic and non-adequately prepared sample will prevent the user from obtaining the answer staring them most often in the face.