X-ray microscopy – A tool to study the nanoworld

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With X-ray microscopy it is possible to image particles in the nanometer size range with high spatial resolution even in aqueous environments. By choosing the used X-ray energy appropriately, imaging can be combined with high spectral resolution for spectromicroscopy studies. As a result of the refractive index of matter being close to unity scattered X-ray light will not be reflected from inner surfaces in inhomogeneous media. Clear images are obtained even when studying thick and inhomogeneous samples. Thus, X-ray microscopy images can be used for tomography studies. Electron storage rings, X-ray sources of extreme brightness, are so far the preferred site of installation for X-ray spectromicroscopy stations. In the sub-keV energy range, small scale laboratory X-ray sources have proven their value for imaging and spectroscopy. Two types of microscopes are common in X-ray microscopy; the transmission X-ray microscope takes high resolution images, the scanning transmission X-ray microscope serves as analytical instrument for spectromicro-scopy. As examples for imaging the morphology of artificial and natural nanoparticles, zinc hydroxide particles, clay and soil particles have been imaged with transmission X-ray microscopy. Images are shown from cryo tomography experiments based on X-ray microscopy images to obtain information about the three-dimensional structure of clusters of humic substances. The analysis of a stack of images taken with a scanning transmission X-ray microscope to bring together morphology and chemistry within a soil sample is shown.

New sea-level constraints from IODP sampling on Tahiti, and clues to the process of deglaciation

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Drilling of drowned coral reefs has provided spectacular archives of sea-level rise during the last deglaciation [1, 2]. Absolute chonology of fossil corals, by U-Th dating, has enabled the timings of dramatic sea-level rises to be accurately and precisely determined. Recent drilling, during IODP Expedition 310 'Tahiti sea level', has extended the postglacial sea-level record from 13.8 to 16.0 ka, and in doing so has placed new constraints on the so called Melt Water Pulse 1A (MWP-1A) event, both in terms of timing and local magnitude. Tahiti corals have also thrown light on termination II [3]. Here, coral chronology constrains the timing of sea-level rise, and – in conjunction with analysis of the fossil and sedimentary assemblages – shown there to be millenial scale variability during the deglaciation, confirming earlier observations at 'Aladdin's Cave' [4]. The coral U-Th constraint from Tahiti is that local sea level must have risen to at least 85 m below present by 137 ka, indicating an early rise in sea level that brings into question traditional orbitally driven hypotheses of glacial-interglacial change. The observation of a fall in sea level during the deglacial warming also highlights uncertainty in the behaviour of ice sheets during periods of climatic transition. Current IODP Drilling (Exp 325, 2010) at the Great Barrier Reef will further provide insights into deglacial sea-level rise and reef development.

[1] Peltier & Fairbanks (2006) *Quaternary Science Reviews* **25**(23-24), 3322–37. [2] Bard *et al.* (2009) *Science*, 2010. [3] Thomas *et al. Science* **324**(5931), 1186–9. [4]. Esat *et al.* (1999) *Science* **283**(5399), 197–201.