ENVIRONMENTAL GEOCHEMISTRY: THE MICRO PERSPECTIVE

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Environmental geochemistry is multi-disciplinary. Chemical processes between liquids, gases and/or vapours at solid surfaces, near surfaces and interfaces dominate it. This veneer is where sorption, dissolution, diffusion, precipitation, algomeration, condensation and photochemical reactions occur, some catalyzed by microbes. Here, the "micro" world controls the "macro". I will discuss this concept and using coal derived fly ash as an example, provide a brief review of the more promising existing and emerging microscopic and spectrosopic instrumentation available to the geoscience community to directly measure biogeochemical interactions at the atomic and molecular scale.

Ultra-microprobe equiped centres, most based on energetic photon, electron and/or ion sources are a powerful catalyst, uniting the physical, life and engineering sciences into truly natural science networks. For example, the imaging of single atoms by scanning transmission electron microscopy (STEM) and by scanning tunneling microscopy (STM) and the chemical identification of atom clusters of <20 atoms is now possible using analytical electron microscopy (STEM with X-ray fluorescence (EDX), electron energy loss spectroscopy (EELS) and electron diffraction). The classical electron microprobe can even provide near surface information (upper tens of nanometers). Surface sensitive, direct non-destructive micro-analytical techniques, based on measuring electrons' kinetic energies, include small spot/imaging X-ray photoelectron spectroscopy (SXPS) and Auger microscopy (SAM). In addition, surface sensitive but locally destructive microprobes, based on rastered laser or ion beam ablation, can mass selectively characterize (2-D/3-D) a sample's surface region using ejected ion and neutral particles. This list includes secondary ion mass spectrometry/microscopy (SIMS), surface analysis by laser ionization (SALI), and sputtered neutrals (SNMS) and glow discharge mass spectrometry. Techniques that rely on photon energies (UV, soft and hard X-ray regions) are being greatly enhanced by synchrotron radiation which is intense, focused and readily monochromatized for use as UV/X-ray photoelectron and X-ray absorption probes and for surface X-ray fluorescence and X-ray scattering spectroscopy.