Metal-rich anthropogenic glass particles in an urbanised river basin: Novel observations on contaminated sediments

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Sediments in urban systems are commonly highly contaminated but routine assessment has tended to be undertaken using bulk chemical techniques. The research presented here documents, using grain-specific micro-beam techniques, the importance of anthropogenic glass grains as metal hosts within urban sediments with important implications for risk assessment.

Sediments were sampled from road surfaces (road-dust sediment; RDS), channel-bed sediments from a major river in the conurbation (the River Irwell) and a major man-made water body (the Salford Quays of the Manchester Ship Canal). Resin impregnated polished blocks of sediment samples were studied petrographically, chemically and mineralogically using backscattered electron imaging (BSEI), energy dispersive spectroscopy (EDS), electron microprobe analysis (EMPA) and Raman spectroscopy.

Three major types of glass material have been identified: Fe-poor glass (in RDS and river sediments), Fe-rich glass (in RDS and river sediments) and Fe- and metal-rich (Salford Quays sediments). These grains are derived from anthropogenic processes and act as the major hosts for potentially toxic metals (Pb, Cr, Zn, Cu, Sn) in these sediments. We interpret these glass grains to be slag material derived from industrial iron ore and metal smelting processes, or the vitrification of municipal solid waste incineration ashes. The resulting slag is input into urban sediment either through erosion of historical wastes or through the use of slags in road material and cement.

These grain types should be considered in sediment assessment on a wider scale and their presence should be assessed for in other urban basins. We recommend that experimental leaching tests should be undertaken upon these glass grain types to reflect the conditions experienced by sediments on street surfaces, in gully pots and in sewers, in rivers and during early diagenesis in aquatic water bodies. In addition, sequential extraction schemes should be modified to take account of alumino-silicate and high-temperature glass materials.

Origin of OH/water on and in the moon

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In spite of the name Maria for the lunar seas, Apollo soils and rocks ‘proved’ the Moon to be ‘bone-dry.’ When FeOOH – rust – was found in the Apollo 16 samples, Taylor *et al.* (1973a, b, 1974) went to great pains to demonstrate that this was simply oxyhydration of lawrencite ($FeCl_2$), and the A-16 rock boxes had leaked, permitting Houston humid air to react. Similarly, water released during step-wise heating of lunar soils was written off as terrestrial contamination. Even suspected water in agglutinitic glass was shown to be nil (Taylor & Rossman, 1995). However, one idea remained elusive since Apollo: Why did the OH-position of the F-Cl apatites not charge balance?

Fast forward to the SIMS analyses of Saal *et al.* (2008), who measured 40-45 ppm water in lunar volcanic glass beads, reasoning that this was but the residue of the initial volcanic melt. McCubbin *et al.* (2008, 2009) re-raised the question of water in the OH-position of lunar apatite. This was followed by further concentration on water in apatite (Boyce *et al.* 2010; Greenwood *et al.* 2010; Liu *et al.* 2010; McCubbin *et al.* 2010), all reporting the proof-positive evidence for water, up to a maximum of 6200 ppm, and with unexpected D/H, possibly indicative of major cometary input.

In Sept., 2009 (Pieters *et al.* 2009), the Moon Mineralogy Mapper on the Chandrayaan-1 Indian orbiter reported the first presence of remotely sensed OH-HOH over large portions of the Moon, further verified by VIMS from Cassini (Clark, 2009) and EPOXI from Deep Impact (Sunshine *et al.* 2009). Then LCROSS, in October, 2009, reported water and several additional volatiles sensed during its impact into Cabeus Crater, a permanently shadowed crater in the South Pole of the Moon.

All these different measurements of water in and on the Moon have major significance within the framework of the formation and evolution of the Moon. Maybe I was wrong in my earlier assessments of lunar water. Or as the NY Times has quoted this author, ‘I’ve had to eat my shorts!’