Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09104, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09104
EGU General Assembly 2008

The global average crustal composition of Mercury – a useful measurement or not?

D. A. Rothery

Department of Earth and Environmental Sciences, The Open University, Milton Keynes, MK7 6AA, UK (d.a.rothery@open.ac.uk)

Both MESSENGER and BepiColombo carry X-ray spectrometers and gamma-ray and neutron spectrometers intended to measure the surface abundances of the detectable elements. Determination of the global average composition of Mercury's crust has often been spoken of as an important goal, but is unlikely to be a geoscientifically meaningful set of numbers unless Mercury has only one type of crust.

Almost irrespective of the mechanism by which Mercury grew, accretional/collisional heating makes it highly likely that the body we now know as Mercury was covered by a magma ocean before any of the present surface was formed. Taylor (1982, 1989) defined two distinct mechanisms by which planetary crust may form during and after freezing of a magma ocean. The contrasting modes of origin of primary and secondary crust mean that the composition of each, and the relationship between their compositions and the bulk silicate composition of the planet, will be different.

Primary crust (such as the lunar highlands) is built by floatation of agglomerations of low-density crystals that grew by fractional crystallization within the cooling magma ocean. Secondary crust (such as the lunar maria) arrives later in the form of magma produced by subsequent partial melting of the mantle, and is emplaced volcanically upon, or intrusively within, older crust. For any planetary body, if we wish to measure crustal composition and use this to deduce the composition of the underlying mantle (or of the bulk silicate fraction of the planet), it is vital to understand what type of crust we are dealing with, and to distinguish between measurements of primary crust and secondary crust rather than lumping them together.

The two modes of origin result in distinctly different mineralogical and elemental compositions for the two crustal types. In the case of the Moon, primary crust and secondary crust have similar Si, but primary crust is several times richer than secondary crust in Al and Ca, whereas secondary crust is several times richer than primary crust in Fe, Mg and Ti. An average of the two crust types would not be useful for understanding the Moon's origin and evolution, because i) it depends on the arbitrary proportions of surface occupied by each, ii) it conflates two entirely different crust-forming processes. A similar objection is likely to apply to aggregating Mercury's crust, and so it will be of great importance, wherever possible, to measure primary crust and secondary crust separately.

Acknowledgements: the issues reported above have been discussed within the Bepi-Colombo MIXS science team and ESA's Mercury Surface and Composition Working Group, for whose stimulation I am very grateful. The views expressed here are my own.

References:

Taylor, S.R., 1982, Lunar and terrestrial crusts: a contrast in origin and evolution, Physics of the Earth and Planetary Interiors, 29, 233-241.

Taylor, S.R., 1989, Growth of planetary crusts, Tectonophysics, 161, 147-156.