From chondrites to crust

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Rocky bodies of the solar system are generally believed to ultimately originate from accretion of chondritic building blocks. However, the surfaces of larger planetary bodies as seen today are typically fractionated relative to chondrite, either due to processes that took place on smaller bodies before or during accretion, and/or as a consequence of more recent planetary differentiation.

The importance of the first of these possibilities may be assessed by the study of differentiated samples from small (asteroidal) bodies, typically delivered to Earth as meteorites. In this respect, the meteorite record indicates that significant chemical diversity may be generated during the first few million years of the solar system. In general terms, magmatism on small bodies is simplified by the fact that pressure gradients are limited, such that temperature and bulk-composition are the dominant factors affecting melt chemistry. However, despite this apparent simplicity, the chemistry of crustal rocks will be critically dependent on several factors. For example, oxygen fugacity will affect the partitioning of iron between the core and silicate fractions, leading to significant potential variations of Mg#, while depletion in volatile elements (in particular the alkalis) before or during accretion can have a significant effect on the major element chemistry of liquids produced. Furthermore, even if bulk chemistry is known, it is important to distinguish if crust is formed by rapid extraction during partial melting, or by global scale processes following a magma-ocean episode. From this point of view, the physical mechanisms of melt extraction and the role of local and global thermal structure are key issues to consider along with thermodynamic consideration of the chemistry of melts produced. Data from the HED meteorites and from Vesta as seen by the Dawn mission will be used to illustrate these ideas. Furthermore, an attempt will be made to rationalise the chemical diversity of primitive achondrites within this framework.

On larger planetary bodies, pressure variations with depth lead to the possibility of decompression melting during convective upwelling of the mantle. In this case, magmatic crustal rocks provide a potential window into the internal workings of the planet over geological time. This may be illustrated for the case of Mars where the major element chemistry of volcanic provinces shows variations that indicate cooling of the mantle over time [1].

[1] Baratoux D., *et al* (2011) *Nature,* **472** : 338-U235.