Relationships between the composition of planetary crusts and their sedimentary records

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Planetary crusts possess variable sedimentary records in terms of origin, size, lithology, age and composition. At one extreme, Earth has a complex sedimentary record formed in response to weathering, erosion, transport, deposition and recycling. The highly dynamic terrestrial rock cycle precludes preservation of any significant planetary regolith (eolian deposits being the closest analog). At the other extreme, airless bodies like the Moon, and probably Mercury, possess classic impact-derived planetary regoliths as their only sedimentary deposit. Mars provides the intermediate case where a long-lived sedimentary rock record exists but the surface is also covered widely by regolith. Controls on planetary sedimentary records are related to (1) impact and volcanic history, (2) presence and nature of atmospheres (i.e. climate), (3) occurrence, composition and physical state of near-surface volatiles, and (4) presence and nature of crustal tectonics, crustal evolution, and so forth. In turn, the composition of planetary sediments reflects their crustal sources in complex, but generally understandable ways. The terrestrial sedimentary record is lithologically differentiated (shales, sands, carbonates, evaporites) due mainly to large bodies of water. Nevertheless, terrestrial sediments reflect widespread sources and accordingly have long been used to estimate upper crustal composition and to trace crustal evolution. For impact-derived lunar regolith, absence of water and air restricts reworking or transport on any significant scale after initial deposition. Disruption and mixing take place but by impact gardening that operates on local scales and largely in a vertical sense. The result is that lunar regoliths do not sample widespread regions and so are compositionally variable, matching the crust in the vicinity of where they form. Martian sedimentary rocks and regolith formed by a wider array of processes than did lunar regolith, including impact, volcanic, glacial, eolian and subaqueous processes, and are far more complex mineralogically. On the other hand, much less lithological differentiation takes place than is seen on Earth. Sedimentary mixing processes at the surface (e.g. eolian, glacial, impact gardening) were of sufficient scale to minimize variations in regolith composition. Although local geological influences are observed, Martian regolith is of broadly uniform composition, reflecting the average upper crust even for the major elements.

A 4-dimemsional landscape geochemical framework for the remote arid landscapes of Australia's Musgrave Province

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This study integrates geochemical and biogeochemical datasets generated from the remote arid landscape of the Musgrave Province in Central Australia. It demonstrates the inter-relationships between the chemistry of the region and its landscape evolution. Many previous geochemical studies of the arid landscapes of Australia have tended to focus on a single system or sampling medium. Where datasets for several media are combined and compared they have tended to be considered within the context of a featureless 'space' rather than their landscape setting. In this study bedrock geochemical, regolith geochemical, groundwater hydrogeochemical and plant biogeochemical systems are sampled, chemically characterised and compared based on their landscape setting. This study utilises the importance of the evolution of regolith materials that have evolved within the landscape's history as the context.

An initial focus has centred on the Mt Caroline ultra-mafic intrusion, which is considered prospective for Ni-Cu sulphide deposits. Variably think sedimentary cover (10s to 100s m), Aboriginal land access restrictions, and a lack of tracks and roads through the region have limited the development of previous landscape geochemical models. Access to some exploration tenements, however, has allowed the development of a geochemical sampling program incorporating regolith materials, biota (especially Triodia basedowii), and groundwater. Given the extent and variation in thickness of sedimentary cover in the area, however, plotting and comparing these datasets in two dimensions is an over-simplification of the dispersion processes at play in this system. This project optimises the presentation of these datasets to show differences between the results and similarities between anomalies to assist in further developing future exploration programs. The study proposes an effective means of presenting data that incorporates the geochemistry across the landscape in two dimensions but also the role of landforms and varying lithologies in surface expression of concealed mineral deposits.