U-series isotope composition of primary minerals to determine regolith production rates on three different lithologies

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The complex interaction between weathering, erosional and biological processes converts bedrock into regolith, namely the ensemble of soil and saprolite. Assessing rates of regolith formation is necessary to evaluating soil sustainability and investigating landscape's past history and future evolution.

Recently, uranium-series isotopes have been used to quantify independent time-integrated regolith and soil production rates [e.g. 1, 2, 3]. This is because their abundance in regolith is function of time and weathering. However, until now this method has been applied to bulk material, without distinguishing among primary minerals, secondary phases and other soil components. The overall research goal is to improve the U-series method accuracy, measuring regolith production rates on primary mineral phases in place of bulk material.

Three weathering profiles developed over basalt, granite and sandstone in NSW, Australia, have been sampled from flat-topped areas chracterized by comparable climatic regime and low erosion. Separation of primary minerals along the weathering profiles and their uranium-thorium isotopic composition will provide rates of regolith production. This will contribute to improving U-series technique and will emphasize the role of parent material in determining soil formation rates.

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Superheating water to model soil "immobile" water

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Superheating

The superheated liquids are less stable than their vapour, while their criteria of internal stability are met. They can be produced when an increasing T or a decreasing internal P (including negative pressure, or liquid tension) beyond the stable values is produced in liquid in such conditions that vapor does not nucleate. This nucleation suppression can be reached in nature either during a short time by a very rapid P or/and T variation (phreatomagmatism, for instance), or by decreasing the air humidity at a liquid-air interface located in infra-micronic container (soil capillarity, for instance). The method of choice to experimentally probe superheating is the micro-thermometry of fluid inclusions [1], that can be designed in terms of composition and density of occluded liquids (in quartz). Their volumes are intermediate between macro-systems, in which superheating is restricted to low tensions with very short lifetime, and nanosystems, wherein the host matches the size of the critical vapor nucleus.

Properties and behaviours of interest

The first property available from the present experiments are the surface of the metastable PT domain available for aqueous solutions, that depends on the liquid composition and densities [2]. A second property of interest is the ability of this in-pores tensioned liquids to change the mechanical tensor in the surrounding solid, by recording the SiO_2 Raman bands in quartz during a microthermometric cycle. The third property is the transmission of the liquid tension to the dissolved solutes, again through recording characteristic Raman shifts of solutes with known liquid tension. Consequently, the solubility of gases and minerals in such superheated mixtures changes, and in general increases, with consequences on weathering and external gas cycles. At last, the superheating lifetime, the energy of the critical boiling, and the direct consequences of this return-to-equilibrium to local paragenes are explored.

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