Back to the Future: The Art of Weathering

SUSAN BRANTLEY[1*] HEATHER BUSS[2] MARJORIE SCHULZ[3]

[1]The Pennsylvania State University, Earth and Environmental Systems Institute, University Park, PA, USA, sxb7@psu.edu (*presenting author)
[2]University of Bristol, School of Earth Sciences, Bristol, UK, h.buss@bristol.ac.uk
[3]U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA, USA, mschulz@usgs.gov

Geologists and soil scientists attempt to go back to the future to read the geochemical record written in regolith. If we could do this, we could use earthcasting models to project the surface earth in the future just as we use forecasting models to project the weather. But going back into geological time to read the record in soil profiles is both a science and an art due to the interdependence of chemistry, physics, and biology at the earth's surface. The art of earthcasting is also hard because such models must have the capacity to span timescales ranging from seconds for hydrogeochemical effects up to tens of millions of years or longer for tectonic processes.

We discuss the contributions of one scientist, Art White (recently retired from the U.S. Geological Survey, Menlo Park, CA, USA), who spent a career investigating geochemical processes and how they affect mineral-water reactions in pursuit of understanding the surface Earth. Art recognized that soil profiles are records of biogeochemistry that can be interpreted using kinetics and thermodynamics. With the use of geochemical, physical, hydrological and biological measurements, regolith formation rates can be constrained and geochemical descriptions can be made quantitative. Art's work in the laboratory – including a 16 year experiment – and at several field sites as part of the USGS WEBB program, including Panola, Georgia; the Luquillo Mountains, Puerto Rico; and the Santa Cruz terraces, CA; resulted in a series of papers that have greatly influenced our understanding of the earth's surface. Today, much of this work is termed Critical Zone science: Art was one of the originators of the Critical Zone Exploration Network and is therefore one of the original CZEN masters. His contributions helped lead to the big programs in Critical Zone science in the U.S.A. and elsewhere. Art and the many scientists before him (back to even the 16th century when soil profiles were first studied) set the stage for today's "artists of weathering". Now, new field opportunities, theoretical models, analytical tools, microbiological observations and sensors are elucidating the beauty and art of the Critical Zone.

Low temperature alkaline pH hydrolysis of oxygen-free Titan tholins

CORALIE BRASSE[1]*, FRANCOIS RAULIN[2], PATRICE COLL[3], OLIVIER POCH[4], AND ARNAUD BUCH[5]

[1] Laboratoire Inter-universitaire des Systèmes Atmosphériques, Créteil, France, coralie.brasse@lisa.u-pec.fr (* presenting author)
[1] Laboratoire Inter-universitaire des Systèmes Atmosphériques, Créteil, France, francois.raulin@lisa.u-pec.fr
[3] Laboratoire Inter-universitaire des Systèmes Atmosphériques, Créteil, France, patrice.coll@lisa.u-pec.fr
[4] Laboratoire Inter-universitaire des Systèmes Atmosphériques, Créteil, France, olivier.poch@lisa.u-pec.fr
[5] Centro de Investigaciones Quimicas, Cuernavaca, Mexico, ramirez_sandra@ciq.uaem.mx
[6]Ecole Centrale Paris, Laboratoire de Génie des Procédés et Matériaux, bucha@ecp.fr

The largest moon of Saturn, Titan, is known for its dense, nitrogen-rich atmosphere. The organic aerosols which are produced in Titan's atmosphere are of great astrobiological interest. particularly because of their potential evolution when they reach the surface and may interact with putative ammonia-water cryomagma[1].

In this context we have followed the evolution of alkaline pH hydrolysis (13wt% ammonia-water) of Titan tholins (produced by an experimental setup using a plasma DC discharge named PLASMA) at low temperature. Our group identified urea as the main product of tholins hydrolysis along with several amino acids (alanine, glycine and aspartic acid). However, those molecules have also been detected in non-hydrolyzed tholins meaning that oxygen gets in the PLASMA reactor during the tholins synthesis[2]. So the synthesis system has been improved by isolating the whole device in a specially designed glove box which protects the PLASMA experiment from the terrestrial atmosphere.

After confirming the non-presence of oxygen in tholins produced with this new experimental setup, it is necessary to perform alkaline pH hydrolysis in oxygen-free tholins in order to verify that organic molecules cited above are still produced or not... Moreover, a recent study shows that the subsurface ocean may contain lower fraction of ammonia (about 5wt% or lower[3]), than previously used. Thus new hydrolysis experiments will take this lower value into account. Additionally, a new report [4] provides upper and lower limits for the bulk content of Titan's interior for various gas species. It also shows that most of them are likely stored and dissolved in the subsurface water ocean. But considering the plausible acido-alkaline properties of the ammonia-water ocean, additional species could be dissolved in the ocean and present in the magma. They could also be included in our hydrolysis experiments.

The preliminary results of those experiments will be presented.

[1] Mitri et al. (2008) *Icarus* **196**, 216-224. [2] Poch et al.(2011) *Planetary and Space Science* **61**, 114-123. [3] Beghin et al. (2012) *Icarus* **submitted**. [4] Tobie et al. (2011) EPSC-DPS2011 **6**.