Early lunar magnetic fields recorded before the late heavy bombardment

I. GARRICK-BETHELL[1]*, B. P. WEISS[1], D.L. SHUSTER[2], V.A. FERNANDES[2] AND T. A. BECKER[2]

[1]Massachusetts Institute of Technology, Department of Earth, Atmospheric and Planetary Sciences, Cambridge, MA 02139, USA (*correspondence: iang@mit.edu) (bpweiss@mit.edu)

[2]Berkeley Geochronology Center, Berkeley, CA 94709, USA

The surprising discovery of magnetization in returned Apollo samples suggested that substantial magnetic fields once existed on the Moon. Previously reported data for about 100 samples have revealed an epoch of apparently intense fields from ~3.9-3.6 Ga that has been thought to signify a core dynamo. However, there are virtually no data before ~4.0 Ga, making it difficult to determine if this high-field epoch was a unique event or the tail end of a magnetic epoch that persisted following accretion. The latter scenario is easier to reconcile with a core dynamo origin for lunar magnetism while the former scenario may indicate that impact-generated plasmas associated with the putative late heavy bombardment could be the field source.

To determine if the high field epoch was a unique event and if the Moon ever had a core dynamo, we have studied lunar samples older than ~4.0 Ga. We have combined new paleomagnetic measurements and $^{40}Ar/^{39}Ar$ dating on 2-4 mm fragments from the Apollo 16 site (sample 63503), shocked norite 78235, anorthositic breccia 60025, and feldspathic breccia 78155. We have found that many of these rocks have Ar ages >4.1 Ga and stable magnetic remanence.

We also analyzed troctolite 76535, perhaps the most pristine known sample of the early lunar crust. The sample has a reported age of ~4.2 Ga and its lack of shock features rules out shock remanent magnetization. The rock apparently cooled from >600°C over ~10 ka after excavation from ~40 km depth [1]. Therefore, if 76535 recorded any ambient magnetic field, it would have been a long-lived field that could not easily have been produced by impact-generated plasmas (which should last at most ~1 hr). This implies that 76535 provides an excellent opportunity to test for a core dynamo on the early Moon. While the sample has been affected by a contaminating isothermal remanent magnetization, a more challenging problem is that most subsamples have anisotropic magnetic mineral fabrics. We will report our most recent efforts to correct for this effect and determine if 76535 acquired any remanence on the Moon.

[1] McCallum, I. S. *et al.* (2006) *GCA* **70**, 6068-6078.

Aerobiogeochemistry perturbations of the Anthropocene Epoch Or - What does this stuff in the air do to the world?

V.H. GARRISON*

US Geological Survey, St. Petersburg, FL 33701, USA (*correspondence: ginger_garrison@usgs.gov)

Long-distance atmospheric transport of mineral dust from the Sahara and Sahel to the Americas, Europe, and Near East has been occurring for hundreds of thousands of years. Over the past several decades, the composition of Saharan dust and air masses have been altered by human activities in the source regions and in the areas over which dust air masses travel: burning of synthetic products, biomass, and waste; widespread use of pesticides, plastics, and other man-made chemicals; and increased industrialization. Toxins, carcinogens, and endocrine disruptors known to be harmful to humans and other organisms (such as corals) have been identified in Saharan dust air masses in source and downwind areas[1]. Transported along with micro- and macronutrients and bioactive metals (Fe, Cu, As, Cs, etc.) that occur naturally in mineral dust are metals of anthropogenic origin (e.g., Pb, As, Hg), viable microorganisms[2], and other biogenic material. Mixtures of multiple persistent organic pollutants [pesticides, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs)] and bioactive metals typically occur. The presence of some contaminants such as PAHs or bacteria can increase the activity or bioavailability of other contaminants/components (e.g., Fe). Our research group is currently investigating whether dust particles, metals, nutrients, and/or chemical contaminants, singly and in mixtures, adversely affect coral reefs or human health, and if so, what pathways and processes are involved. The effects may occur at any level – molecule, cell, organ, organism, and/or ecosystem. Modes of action may be direct (e.g., a contaminant shutting down photosynthesis in phytoplankton; nutrients fueling plant growth), indirect (Fe stimulating a red-tide bloom), or complex (contaminant bioaccumulation in a prey species, causing immune-system suppression in a predator, thereby increasing susceptibility of the predator to disease).

[1] Garrison *et al.* (2006) *Int. J Trop. Bio.* **54** (Suppl. 3) 9-21.
[2] Kellogg & Griffin (2006) *TREE* **21**, 638-644.