**METEORITE MODELS OF ASTROCHEMISTRY AND ASTROBIOLOGY. 3. MICROBIAL AND BRINE SHRIMP BIOASSAYS OF CARBONACEOUS CHONDRITES.** Michael N. Mautner, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284. (mmautner@vcu.edu)

**Introduction:** Carbonaceous chondrite asteroids and meteorites could contribute to the origins and early sustenance of microorganisms. In the future, organics, nutrient electrolytes and water in carbonaceous asteroids can be used as biological resources.

In these respects, we developed biological soil fertility assays of Allende CV3 and Murchison CM2 carbonaceous chondrites. The assays considered the bioavailable nutrient contents, especially $PO_4$-P and $NO_3$-N, and also responses by algae and asparagus tissue cultures. The results showed that the carbonaceous chondrites, and also Martian meteorites, have soil fertilities comparable to productive agricultural soils. [1-3] These studies involved oligotrophs (*Nocardia asteroides*) and autotrophic algae that do not utilize the organic meteorite polymers. To test if these materials can be metabolized, we further subjected meteorite extracts to hydrocarbon degrading microorganism, and also tested toxicity to brine shrimp cultures.

**Experimental Methods:** Samples of 100 mg powdered Allande CV3 and Murchison CM2 meteorites were extracted in 2 mL synthetic seawater, and inoculated with hydrocarbon-degrading microorganisms isolated from under-sea heavy oil samples. After culturing for 30 days the microorganisms were stained with CYBR Green 1 DNA stain and counted microscopically, and also used to inoculate new cultures, repeatedly in four cycles. (With Prof. Pam Morris and Dr. Carol Savoie (Med. Uni. South Carolina)). For shrimp bioassays, Artemia cysts were incubated for 48 hours with mild shaking in meteorite extracts and in seawater controls. Hatching rates were determined by microscopic counting.

**Microbial Nutrient Bioassays.** The microorganisms reached populations of $2–5x10^8$/mL in organic-rich Murchison medium, similar to media enriched with the original oil substrate. In contrast, the populations reached only $2\text{-}5x10^7$/mL in the organic-poor Allende medium, similar to those reached in organic-free control media. The comparison shows that Murchson organics can be utilized efficiently by hydrocarbon degrading microorganisms.

**Shrimp Toxicity Bioassays.** Artemia brine shrimp cysts eggs were incubated in extracts of the Allende and Murchison meteorites. Elemental analysis showed the uptake of nutrient Mg, S and P both from Allende and Murchison by the shrimp eggs and hatched shrimp. However, potentially toxic Ni was also taken up from Murchison. [4] The hatching rates in Allende and Murchison extracts in seawater were 0.75±0.10 similar to that in pure seawater, indicating no significant retarding toxic effects by the meteorite extracts. Hatching rates in pure diluted Murchison extracts were similar, but in concentrated Murchison extracts somewhat lower, possibly due to toxic Ni uptake. From this point of view, Allende type materials seem to be better resources.

**Conclusions and Future Work:** Combined with previous bioassays and soil nutrient analysis, the present results show that diverse microorganisms can grow on nutrients of carbonaceous chondrite materials.

The results indicate that carbonaceous chondrite materials could have supported early life, and that similar materials in carbonaceous asteroids can provide productive soils for future space habitats. These potential roles will be investigated by further astroecology studies on planetary microcosms with mixed populations of autotrophic algae, heterotrophic soil microorganisms, plant cultures and simple multicellular organisms.

**References:** [1] Mautner, M. N. et al. (1995) *Planet. Space Sci., 43,* 139-146 and (1997) *45,* 653-664. [2] Mautner, M. N. et. al. (1997) *Icarus 129,* 245-257 and (1999), *Icarus, 137* 178-195. [3] Mautner M. N. (2002) *Icarus, 158,* 72-86. [4] Kennedy, J. et. al. (2007) *Nucl. Instruments and Methods in Physics Research. B., 260,* 184 - 189.

**Figure 1.** Artemia brine shrimp eggs hatching on Murchison meteorite extracts and powder.