AN ANALYTICAL PROTOCOL FOR CONSTRUCTING AXIAL TOMOGRAMS WITH MULTIPLE SPECTRAL DATA: EVAPORATING BASINS AS A MODEL

Interim Report

JPL Task 1048

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A. OBJECTIVES

We proposed to use Death Valley as the environmental analog for a formerly wet environment on Mars. This area is an evaporated lake which created fields of evaporite minerals that are colonized with layered biological communities. The organisms are most abundant near the last-remaining saline water pools at Badwater. Just under the white salt-crust layer, a photosynthetic community resides throughout the year.

From Badwater, Death Valley, CA, we were to further our understanding of the biological and mineral interactions, utilizing merged datasets from X-ray Computed Tomography (XCT) and Neutron Computed Tomography (NCT) and wrap 2D spectroscopy upon the tomographic data.

B. PROGRESS AND RESULTS

At this point of the data analysis, detailed conclusions cannot be made until the NCT data can be acquired. However, simply analyzing the XCT data does provide some mineralogical information about the samples collected. The data were collected using a Skyscan ™ microXCT scanner with X-ray energies up to100kV. The data processing from spiral tomographs to 2D data was performed with the Skyscan™ bundled software package. The 3D rendering was done using a proprietary software package, “Matrix: 3D rendering.” False color was added using Adobe Photoshop© 7.

The XCT data show three distinct density features in the samples from the upper surface of the evaporate fields. Determining the relative density of each feature is possible when the aluminum co-registration balls and the surrounding air are used as constraints. Aluminum oxide (Al_2O_3) has a density of 3.97g/ml. Gypsum ($CaSO_4$) and Halite (NaCl) densities are 2.5g/ml and 2.3g/ml respectively. Thus a 35% density variation between gypsum and aluminum and an 8% variation between gypsum and halite should be seen when looking at the pixel intensities in the XCT images. The measured variation in pixel values, representative of density, was 35% between the Aluminum balls (densest feature) and the less-dense material, and 10% between the latter and the least-dense feature, which indicates that the two unknown features seen are most likely gypsum ($CaSO_4$), and halite (NaCl). This correlates to data which shows halite/gypsum and no potential borax in this region (ref. 1). The 2% error between the expected density variation and observed variation is most likely due to image processing, and can be minimized if the data is not compressed from 16-bit images to 8 bits, a product of the 3D image manipulation. The addition of other known constraints would also reduce the error.

The addition of the NCT data will provide tomographic data that can be overlain upon the XCT data to indicate where in the halite/gypsum sample the biology resides. At present, what can be shown are the locations where the two mineral species are found (Figure 1).

C. SIGNIFICANCE OF RESULTS

This task has thus far developed a method that utilizes an XCT to evaluate the mineral makeup of a sample via density variation. Additionally, it enables an observer to understand where the minerals are in relationship with other minerals in a sample.

The results indicate that the addition of the NCT data should provide an understanding of the biological relationship with the mineral composition seen with the XCT. This relationship will provide a method by which the structural biosignatures can be maintained and used to determine subsequent testing by more destructive methods.

D. FINANCIAL STATUS

The total funding for this task was $50,000.
The budget allocated for JPL expenditures have been spent.
Presently, $9500 remains in the contract (#1247959) sent to UC-Davis. The contract has been approved for a no-cost extension, where the work will be completed no later than January 31, 2004.

E. PERSONNEL

No other personnel were involved.

F. PUBLICATIONS

None.

G. REFERENCES

[1] Susanne Douglas, “Mineral Biosignatures in Evaporites: Presence of Rosickytite in ednoevporitic Microbial Community from Death Valley, California” *Geology*, v. 30, no 2, Geological Society of America, December 2002, p 1075-1078.

H. APPENDIX: *FIGURE(S)*

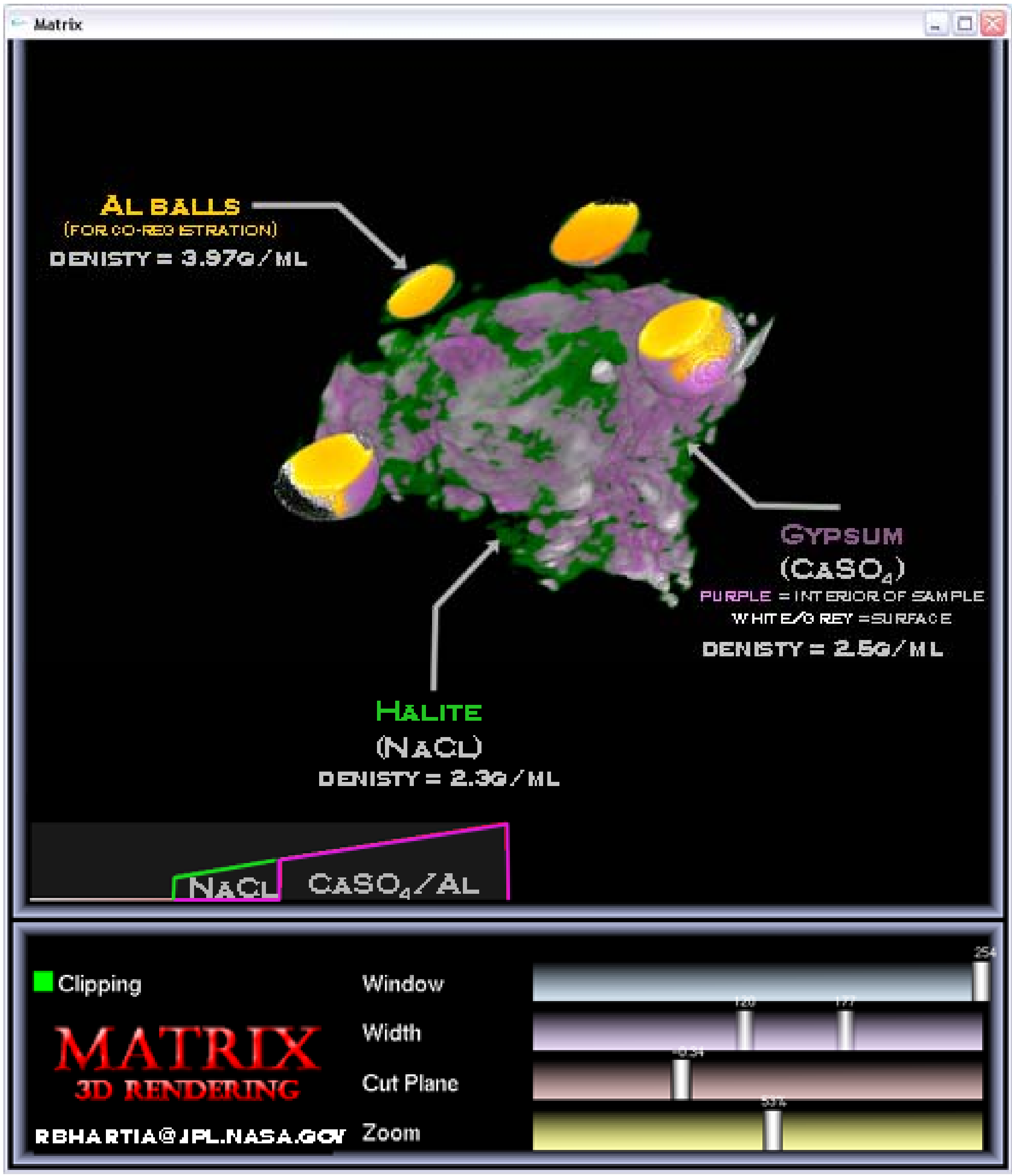

FIGURE 1. Transparent 3D image from "Matrix: 3D rendering" software package of a sample from the upper surface of the evaporate fields at Badwater in Death Valley. The image is an overlay of the densities representative of gypsum + aluminum and the densities representative of halite. The densest material is colored yellow and indicates where Al balls are. The reason for the hint of purple and green on the balls is that a beam-hardening artifact gives the impression of a low-density material on the sides closest to the sample. The white/grey color is indicative of gypsum on the exterior surface; the purple-colored features are also gypsum but show that these features are in the interior. Halite is represented in green and is mostly found on the surface areas. The sample is about 2.5cm^3.