STUDY OF THE OLDEST ANIMAL FOSSILS WITH COMPUTER TOMOGRAPHY

Interim or Final Report

JPL Task 1044

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A. OBJECTIVES

The chances of finding extant life on Mars or any other place in the solar system are probably very slim. However, the consensus among the astrobiological community is that extinct life probably can be found. Many scientists feel very enthusiastic about the existence of life on ancient Mars. However, in this case we will have to deal with very ancient fossils. Given our terrestrial field experience we can expect that fossils will be located inside rocks, and will not be visible from the outside of rock samples. Methods that are capable of detecting fossil forms of life inside opaque material will be very crucial for the success of such endeavors.

In our proposal, we suggested developing a protocol for obtaining 3-dimensional images of small animal fossils embedded in rock matrix. As a result, we will develop a capability to build a digital library of 3-dimensional images using the non-invasive XCT (X-ray Computed Tomography) method, bringing the study of such important fossils to the next level.

B. PROGRESS AND RESULTS

1. Science Data

We developed a protocol for dissolution of part of a mineralogical matrix without damaging fossils we were interested in, and after that we scanned on a desk-top XCT several hundreds of samples to collect enough information to build a library of 3-D images of these ancient fossils. We were able to find several dozens of undamaged samples, and achieved the first-ever 3-D images of the most ancient animals. Using software that had been developed by Rohit Bhartia in our group, we were able to create an interactive 3-D animation of fossils. This technique allows one to look at objects from different angles, and also provides data on relative density profiles inside samples.

Analysis of images showed that, in many cases, we imaged a cell's division at different stages. This also proves that we have dealt with small prokaryotes going through different stages of ontogenesis.

2. Other Results

After collecting a library with 3-D images of the most ancient animals discovered so far, we tried to analyze isolated fossils for the presence of preserved biomarkers. In these preliminary experiments, we discovered that fossils contained amino and fatty acids that have been preserved for 590 million years. That observation will be used for submitting another proposal to investigate the possibility of amino- and fatty-acid preservation in rocks through geological times.

C. SIGNIFICANCE OF RESULTS

This task developed a new method for the visualization of ancient fossils inside of a geological matrix, isolated from phosphorites in Doushantuo formation. This method can be applied to imaging fossils in opaque environments (like rocks, soil, etc.) in terrestrial and extraterrestrial samples.

The results indicate that fossils could be preserved and imaged even after being deposited several hundred million years ago. We provided evidence that phosphorite deposits could protect biomarkers, such as amino and fatty acids, from destruction for geological times. That will help astrobiologists and paleontologists to choose the most promising geological formations for fossil hunting.

D. FINANCIAL STATUS

The total funding for this task was $50,000 all of which has been expended.

E. PERSONNEL

No other personnel were involved.

F. PUBLICATIONS

[1] Tsapin, D. Bottjer, Study of the Oldest Animal Fossils with Computer Tomography, will be presented on GSA meeting, Seattle, November 2003

We plan to submit papers to *Nature* and *Journal of Paleontology* describing our data.

H. APPENDIX:

IMAGES OF FIRST ANIMALS FROM DOUSHANTUO FORMATION

Fig. 1. Cross-section of ancient embryo during division.

Fig. 2. 3-D image of an ancient embryo – division was not completed