'Impact' of the NAI-MIRS Program on Astrobiology Research at a Minority Institution: Connecting Univ. of Puerto Rico to South Africa to Univ. of Wisconsin to NASA

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Introduction: One of the leading challenges for research faculty at minority institutions (MI) is finding methods of initiating self-sustaining, student-involved, cutting-edge research programs. Specific challenges include: (1) securing financial support for research activities, (2) gaining access to research facilities, and (3) getting students involved. Traditional funding sources (NSF, NASA, NIH) are competitive, and junior faculty members face up-hill battles to get research programs started; faculty at MIs usually have high teaching loads, and limited or no internal funds. So-called 'start-up' packages are not always available. The NASA-MIRS faculty sabbatical program provides an excellent platform for overcoming the above challenges and is a means by which faculty at MIs can initiate a self-sustaining research program. This abstract describes the outcome of the research and student-related activities at the University of Puerto Rico that resulted from the NAI-MIRS award I received in 2009.

The NAI-MIRS proposal: The overall idea was to propose a project that would (1) Advance Astrobiology research goals as outlined in the Roadmap, (2) Provide a means of initiating (or stimulating) faculty research, (3) involve students from UPR, and (4) bring these students to a NASA Astrobiology Institute (NAI) to conduct the work directly. The common thread to the proposal was the Astrobiology research described below.

The Astrobiology Research: Several goals described in the Roadmap (Goals 1.1, 4.1, 4.3) are concerned with how early impact events may have profoundly affected the biosphere and early habitats for life. The hypothesized 'Late Heavy Bombardment' (LHB) model features an increased flux in large bolide impacts on Earth at ca. 3.9 Ga. This is roughly the same age as the oldest chemical evidence for life found at Isua, Greenland, which is preserved in chemically precipitated, water-lain sediments. Thus an environmental paradox exists during the rise of life on Earth- did surface conditions consist of boiling oceans and lava pools from impacts, or calm, cool conditions with water oceans? While the Isua rocks provide 'ground-truth' evidence for surface water at ca. 3.85 Ga, no direct geologic evidence for the LHB has been identified. No Archean age or older impact structures or related deposits are known. To address this disparity, this project focused on how geologic evidence from ancient impact craters is preserved in the geologic record over time as impact craters erode and are dispersed as sediments. To accomplish this goal, impact-shocked minerals in sediments eroding from the Vredefort Dome in South Africa, the largest (~300 km diameter) and oldest (2.0 Ga) impact structure known were investigated. Studies of the shocked minerals were made on previously collected available samples.

The sabbatical roadmap:

The NAI center chosen for the research activities was the Wisconsin Astrobiology Research Consortium at the Univ. of Wisconsin, Madison (UW). Three UPR students were involved, and traveled with me to UW during the summer 2009, where we spent 6 weeks conducting detailed analyses of the South African sand grains for the presence of the tell-tale signature of meteorite impact: unique microdeformations not known to be caused by other natural processes. The students received training in scanning electron microscopy (SEM) and secondary ion mass spectrometry (SIMS). Training involved intensive (submersion-style) hands-on analysis on advanced analytical instrumentation that is not available at UPR.

Science Results:

The students participated in all levels of analysis, and made many discoveries new to science. Excellent examples of shocked detrital minerals were identified and documented in the minerals quartz, zircon, and monazite. The significance of these minerals is that they are ubiquitous in sedimentary systems, and according to our results, are excellent recorders of impact events. The results of this study will guide the search for similar shocked minerals in much older sediments that contain sand dating back the the LHB, as has been found in Western Australia, Montana, China, and elsewhere.

Sustainability

The exciting science results from the 2009 NAI-MIRS sabbatical have already been submitted for publication and accepted (Cavosie et al., Geological Society of America Bulletin, in press). After publication of initial results, additional research proposals are in the works, with a solid foundation. Of the three students that participated, 2 are now in graduate school (UW, UPR), and one is in her 3rd year. The NAI-MIRS award resulted in an immediate published research product, an amplification of my research program, and directly supported 3 students in Astrobiology research, all of whom are on research-related academic paths.