

THE LASSEN ASTROBIOLOGY INTERN PROGRAM. Sandra L. Dueck¹, David J. Des Marais¹, Hilary B. Davis², Mary N. Parenteau³ and Michael D. Kubo^{1,3}, ¹Exobiology Branch, NASA Ames Research Center, Moffett Field, CA, ²Technology for Learning, North Kingston, RI, ³SETI Institute, Mountain View, CA (Mail Stop 239-4, NASA Ames Research Center, Moffett Field, CA 94035; david.j.desmarais@nasa.gov)

Since 2009 scientists on the Ames Team of the NASA Astrobiology Institute have collaborated with staff at Lassen Volcanic National park and Red Bluff High School, CA to offer this program to junior and senior students. The program provided an authentic place-based hand-on educational opportunity for students to interact directly with research scientists as they learned concepts in astrobiology, conducted field and laboratory research and prepared technical reports.

Concepts: Students learned about the following key concepts in astrobiology: 1) Geological processes interact with solar radiation to shape planetary climates. Such interactions can create and sustain habitable environments where diverse life forms can persist, forming a biosphere. 2) Our biosphere consisted solely of microbial life for more than 80% of its documented 3.7 billion year history. 3) Certain key resources and clement conditions must be available simultaneously to create habitable environments. These requirements can be met in diverse ways that, in turn, can sustain diverse life forms. 4) Volcanic hydrothermal processes create habitable environments. Hydrothermal activity has occurred on Mars. Thus Lassen Volcanic National Park (LVNP) enables research on environments that also occurred on other planets and are key targets to search for life.

Implementation: The curriculum followed the progression of a scientific investigation, starting with literature review and fieldwork and ending with written reports and oral presentations. Each part provided opportunities for students to acquire skills that they would need in a science or technology career.

Online lectures on astrobiology. Recorded online lectures provides the students with basic background about astrobiology (geology, microbiology, water chemistry, etc.). This allowed us to focus on hands-on activities and discussions when we met with the students weekly either in person or via videoconference.

Fieldwork. Three research teams, each consisting of juniors led by a senior, documented volcanic rocks, mineral deposits, hot spring waters and microbial life in Warner Valley, LVNP. They investigated and compared these features at three sites – a near-neutral pH stream and an alkaline and an acidic hot spring.

Laboratory exercises. Students conducted laboratory experiments to analyze minerals in rocks, investigate reactions between rock and simulated spring waters, and culture microorganisms collected in the field.

Examples of student findings. 1) Relative abundances of elements in spring water solutes correlated with the relative elemental abundances in the rocks hosting the springs. 2) Volcanic gases and their oxidation products can greatly enhance rates of rock weathering relative to rates that occur in surface waters. 3) The pH of spring waters reflected the effects of volcanic gases and their reactions with volcanic rocks. 4) Solutes in hot spring waters provided key nutrients for microbes. 5) The abundance and diversity of microbes decreased from neutral pH streams to alkaline hot spring waters to highly acidic hot spring waters. 6) The abundance and nature of microbes were affected by a combination of geological and hydrological processes. 7) Thoughtfully designed laboratory experiments can help to interpret field data but these experiments also have limitations in simulating natural processes.

Written and oral reports. Each student prepared a report to present data and discuss relationships between volcanic rocks and gases, spring waters and microbial communities. The students critiqued each other's draft reports during several states of their preparation during the program. The class presented its findings orally to the school, parents and public at their final evening "graduation" event.

Evaluation: Surveys were administered to students before and after their lectures, labs, fieldwork and discussions with scientists. Students' work was scored using rubrics (labs, progress reports, final report, oral presentation). Parents, teachers, rangers, Ames staff and students completed end-of-year surveys on program impact. Students had a unique and highly valued learning experience with NASA scientists. They understood what scientists do through authentic research and by observing what scientists are like as individuals. Students became familiar with astrobiology and how it can be pursued in the lab and in the field. Student interest increased markedly in astrobiology, interdisciplinary studies and science generally. Testimonials from several graduates revealed that their program participation influenced their decisions regarding college majors in science, technology and education.

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