Biogeochemical Evolution of the Atmosphere:
The BETA Project
Brittanie Dotson, Steven Gomez, Carissa Herkelman, Jose Lopez, Bobbi Minard, Kathryn Patrick, Jessica Wayson, Joshua Sebree, Alexa Sedlacek and Xinhua Shen

Background

• The BETA Project involves undergraduate students in a multidisciplinary study of the biogeochemical evolution of Earth’s atmosphere at three key intervals of Earth’s history:
  1. The anoxic atmosphere that supported Earth’s first life
  2. The Devonian, a period when forest ecosystems radiated onto the land surface and caused major CO₂ drawdown from the atmosphere
  3. The modern agricultural sources of atmospheric NH₃

• Our interdisciplinary team includes the following:
  • Undergraduate Earth Science, Environmental Science, Biology, Chemistry, and All Science Teaching majors from the University of Northern Iowa
  • Faculty from the Earth Science Department and Chemistry and Biochemistry Department at UNI
  • Scientists from NASA Goddard Space Flight Center
  • The team will use a combination of the following to study atmospheric changes at these intervals of Earth’s history:
    • Laboratory simulations
    • Field work and analysis
    • Weather and climate modeling

NASA Collaboration

• Collaboration on this project includes working with scientists at NASA Goddard Space Flight Center
  • Dr. Jennifer Stern
    • Carbon isotope analysis of Devonian age rock
  • Dr. Shawn Domagal-Goldman
    • Ancient Earth atmospheric gas mixtures

Primordial Atmosphere Simulations

To recreate the early Earth’s atmosphere, a continuous flow aerosol chamber has been put into operation.
• Custom mixes of gases can be made and stored.
• Gases are flowed across a UV lamp to start photochemical processes.
• Aerosols that are formed can then be removed from the chamber for study.

Primordial Atmosphere Simulations

Properties of aerosols are determined using
• Elemental Analysis
• GC-MS/MS
• SEM

Sedimentary rocks from the Cedar Valley Region, including from the Rockford Prairie Park and Preserve (left).
• Samples are being collected from Devonian exposures in the Cedar Valley Region, including from the Rockford Prairie Park and Preserve (left).
• Samples are cut, polished and cleaned to identify best preserved materials.
• Powders generated by drill will be analyzed for carbon and strontium isotopic compositions using Elemental Analysis and Thermal Ionization Mass Spectrometry.

Devonian Geology

Terrestrial plants expanded during the Devonian Period, leading to dramatic changes in atmospheric composition. To investigate these changes, we will analyze Devonian age sedimentary rocks.

Fog Measurement

In order to investigate the heterogeneous interactions of reduced nitrogen with fog in northern Iowa, we are interested in addressing the following questions:
• What are the characteristics of ambient NH₃ concentrations in winter months in northern Iowa?
• What are the characteristics of aerosols compositions?
• What are the characteristics of fogwater compositions?
• To what extent do fogs in this region interact with ambient ammonia and fine particles?

CASCC-2 cloud water collector and MiniVol portable air sampler, as well as ammonia analyzer are used to investigate the heterogeneous interactions of reduced nitrogen with fog.

For More Information

• Check out future progress updates at our website:
  www.UNIBETAProject.weebly.com

References