Biogeochemical Evolution of the Atmosphere: The BETA Project

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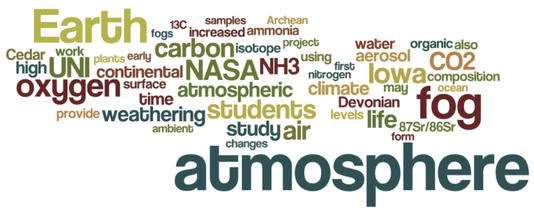
Background

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 Period when forest ecosystems radiated onto the land surface and caused major CO_2 drawdown from the atmosphere
3. The modern agricultural sources of atmospheric NH_3



Our interdisciplinary team includes the following:

- Undergraduate Earth Science, Environmental Science, Biology, Chemistry, and All Science Teaching majors from UNI
- Faculty from the Earth and Environmental 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

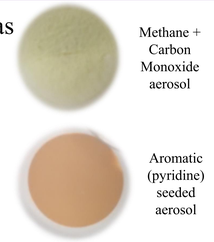
For More Information

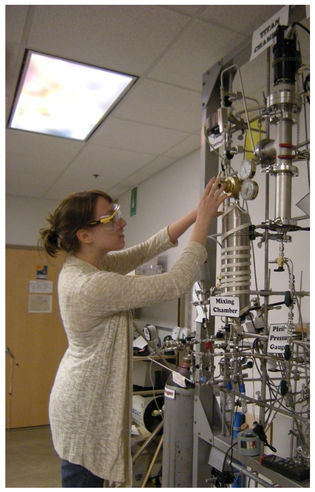
Check out future progress updates at our website: www.UNIBETAProject.weebly.com

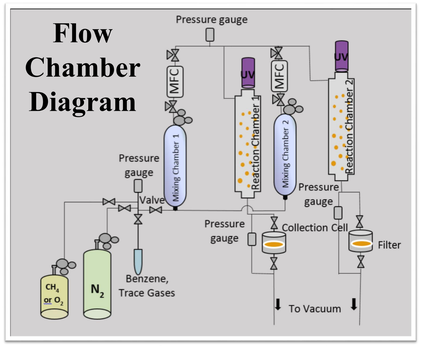
Primordial Atmosphere Simulations

To recreate the early Earth's atmosphere, a continuous flow aerosol chamber has been put into operation.

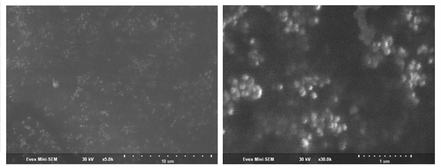
- Custom mixes of gases can be made and stored
- Gases flow across a UV lamp to start photochemical processes
- Resulting aerosols can then be removed from the chamber for study

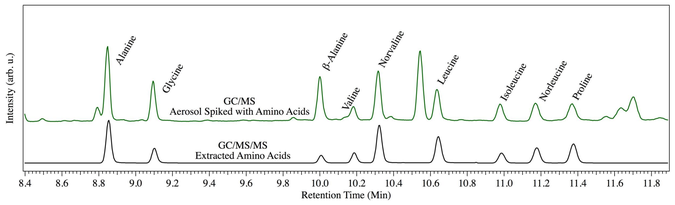




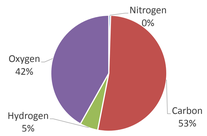


SEM of Benzene Aerosol



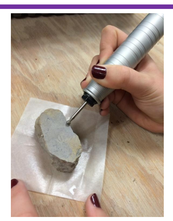


EA of a CHNO Aerosol

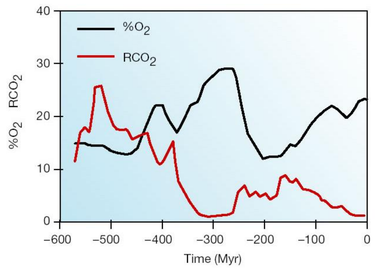


Devonian Geology

Terrestrial plants expanded during the Devonian Period, lowering atmospheric CO_2. We analyze Devonian sedimentary rocks to investigate these changes.



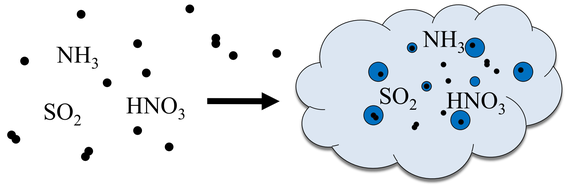
- Sample collection of Devonian exposures in the Cedar Valley Region, including from the Rockford Prairie Park and Preserve
- Samples are cut, polished and cleaned to identify best preserved materials
- Carbon and Strontium isotopic compositions analyzed using Elemental Analysis and Thermal Ionization Mass Spectrometry



Fog Measurement

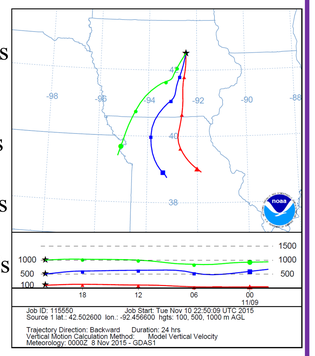
In order to investigate the heterogeneous interactions of reduced nitrogen with fog in northern Iowa, we are interested in addressing the following questions:

- What are the characteristics of ambient NH_3 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
- MiniVol portable air sampler

- Backward trajectory of the air parcel will be analyzed to trace the air parcel's path before it arrives at our sampling site during the fog events
- Information concerning the air parcel's origin, transport distance, and the residence time in each region during its transport is included in the simulation
- The NOAA Air Resources Laboratory's HYSPLIT model is used to calculate backward trajectories



Acknowledgements

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References

Berner, R.A., The long-term carbon cycle, fossil fuels, and atmospheric composition. Nature.2003, 426 (6964), 323-326.