



# Biogeochemical Evolution of the Atmosphere: The BETA Project

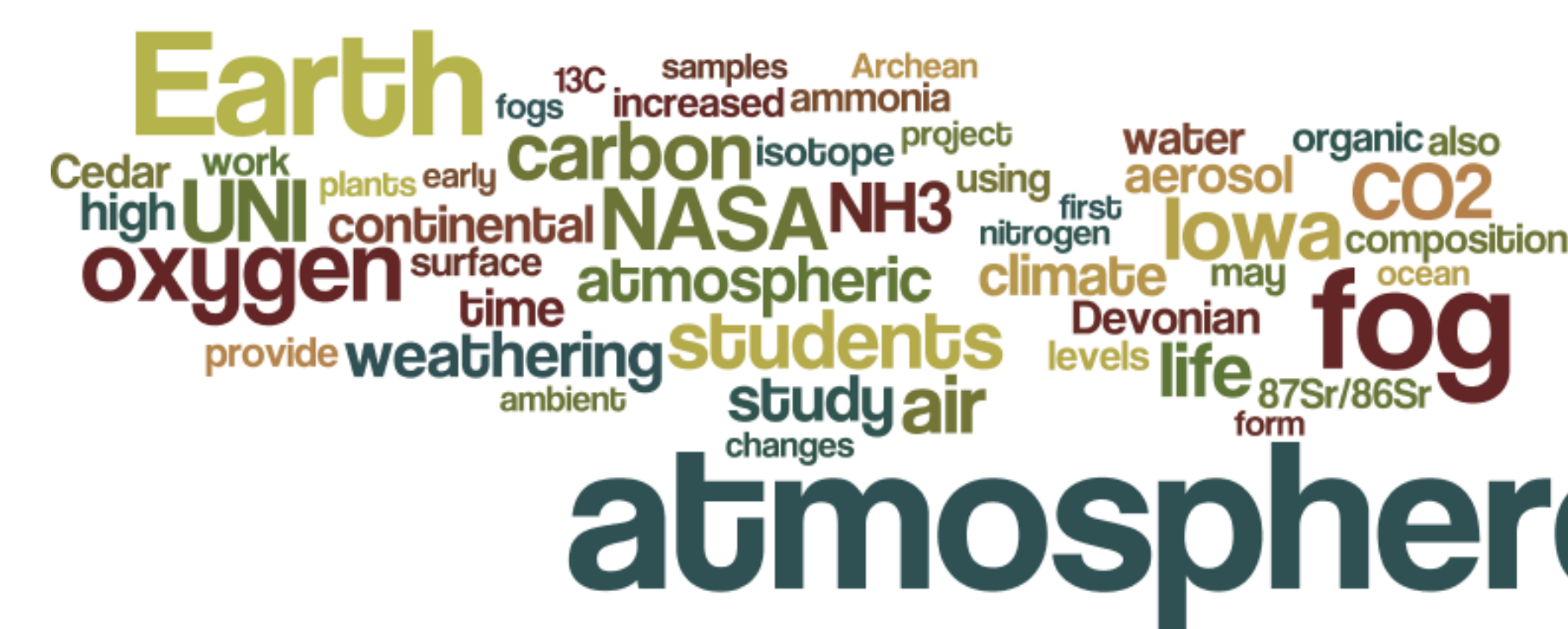


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## Background

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<sub>2</sub> drawdown from the atmosphere
3. The modern agricultural sources of atmospheric NH<sub>3</sub>



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

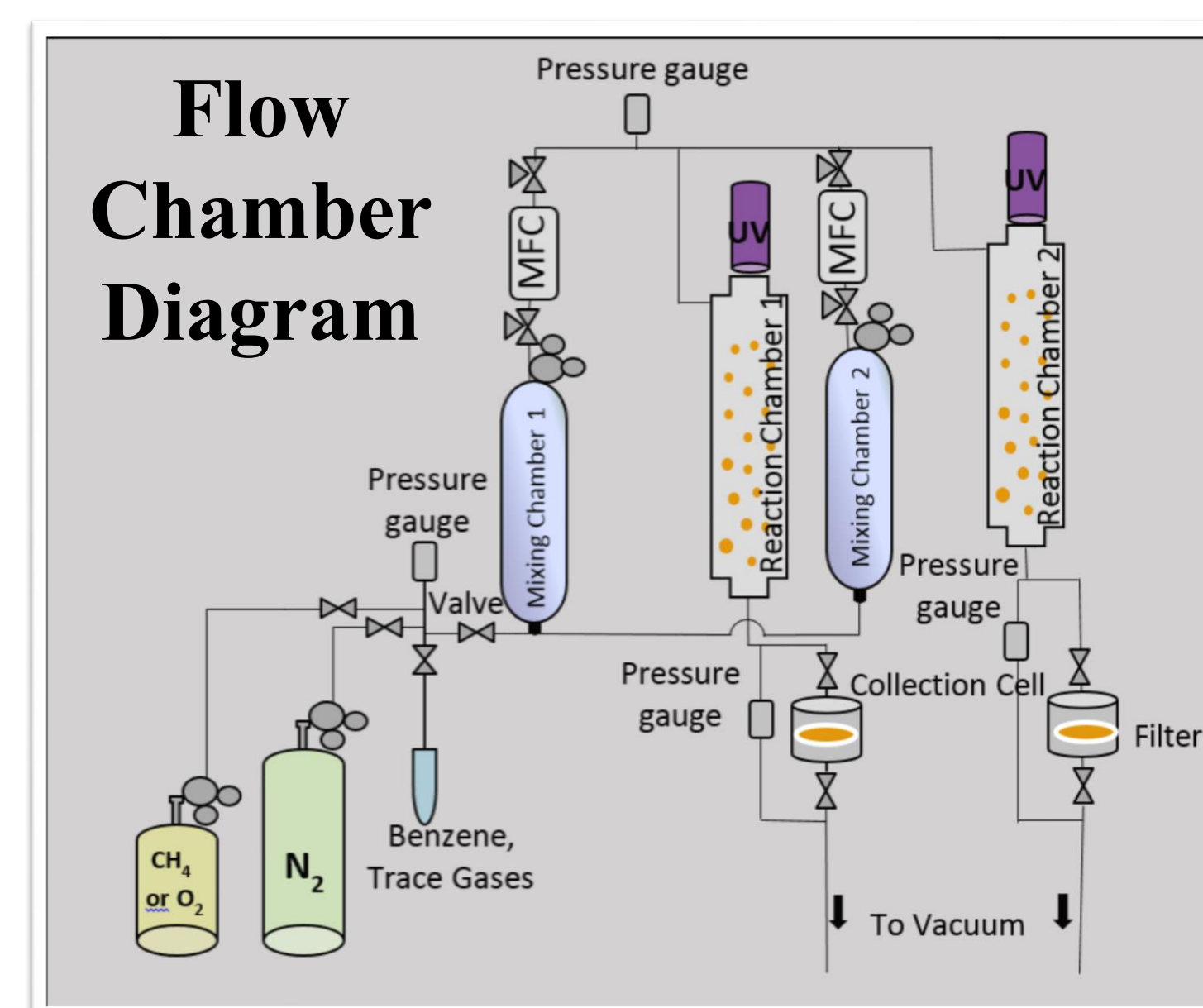
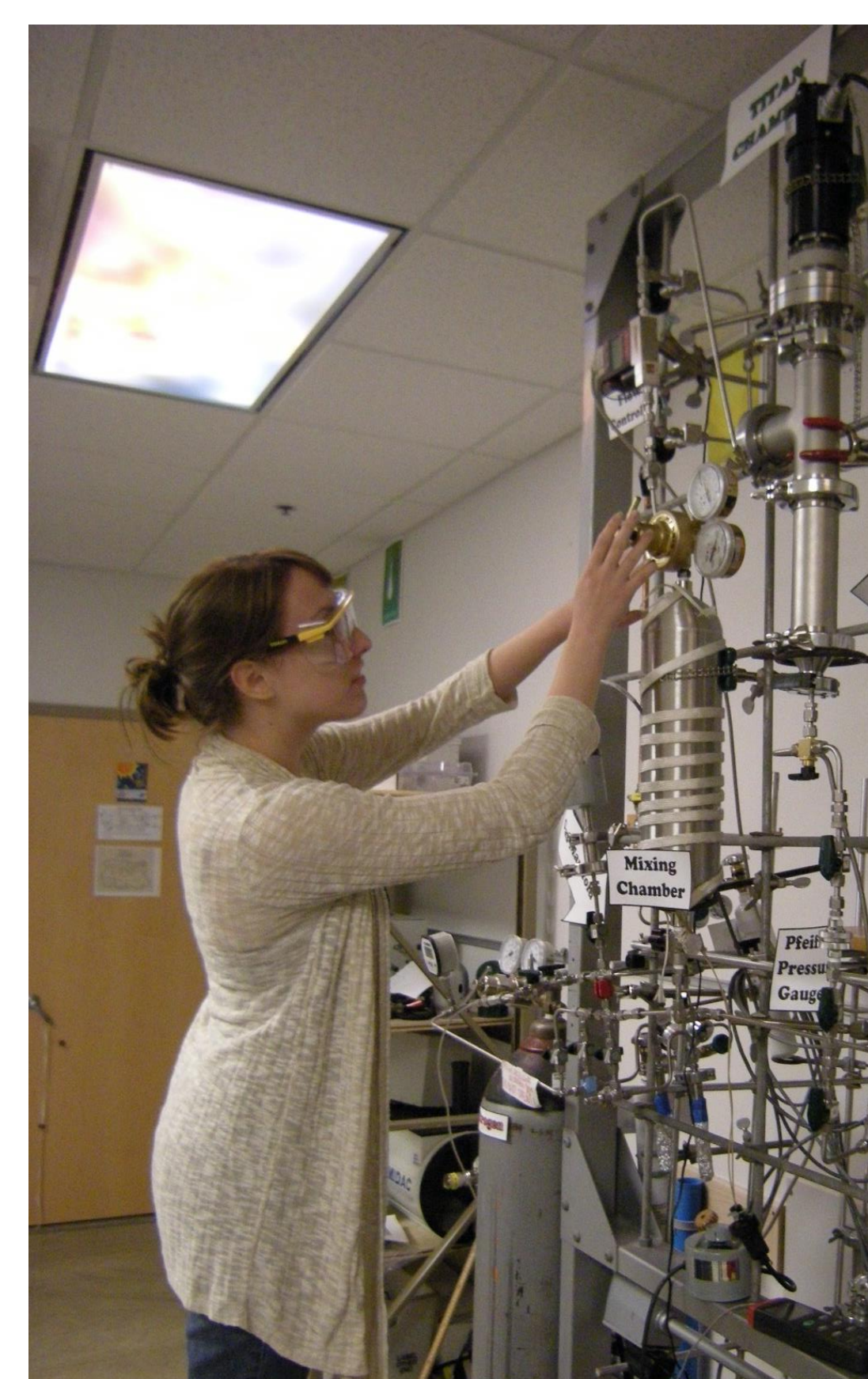


Check out future progress updates at our website:  
[www.UNIBETAProject.weebly.com](http://www.UNIBETAProject.weebly.com)

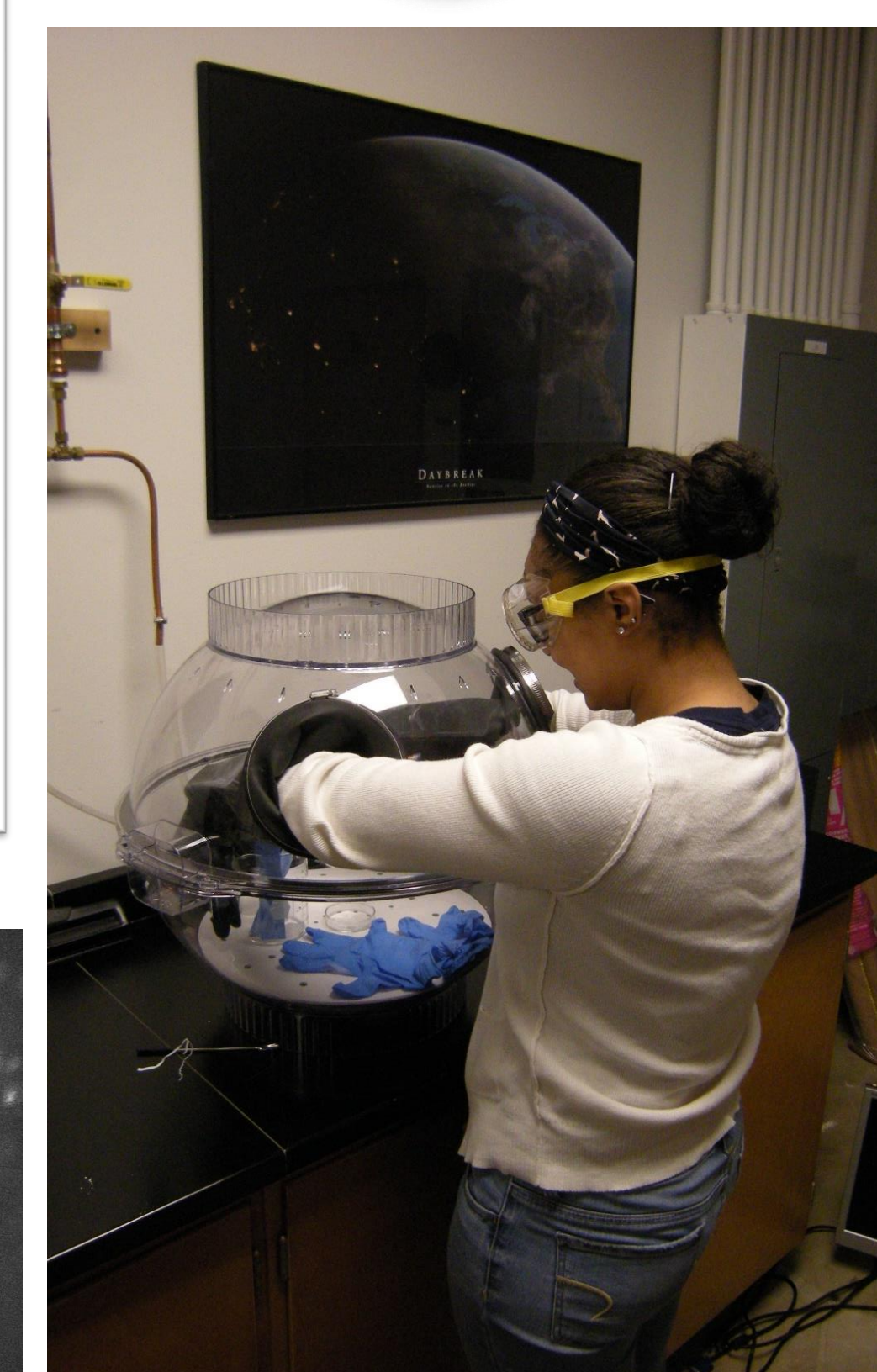
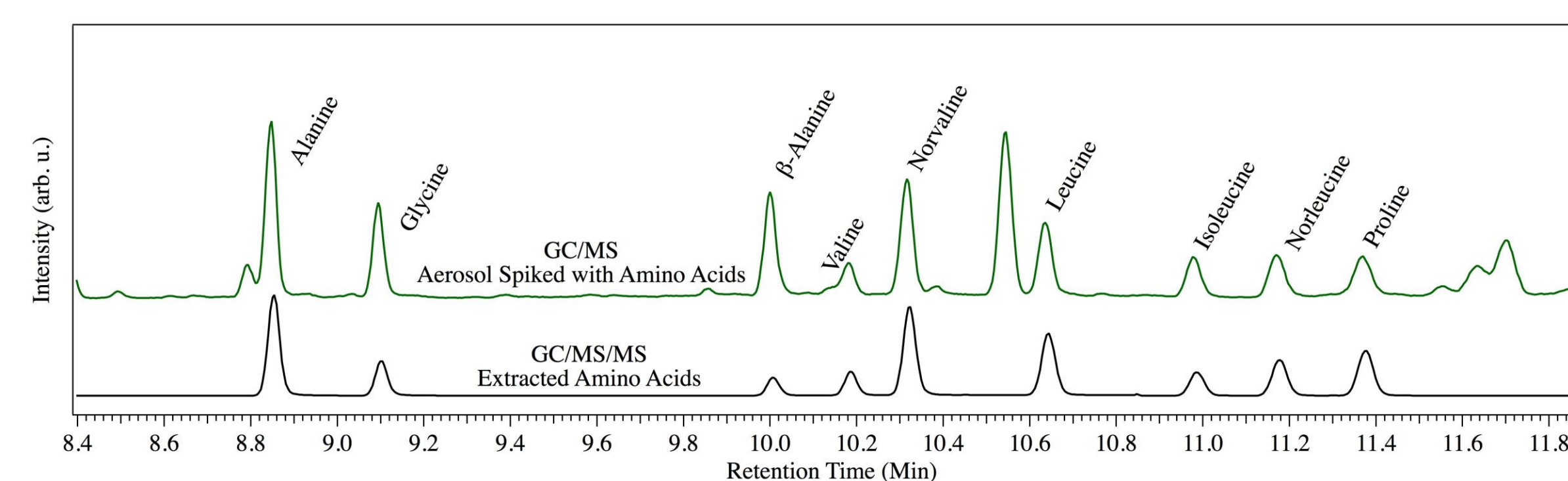
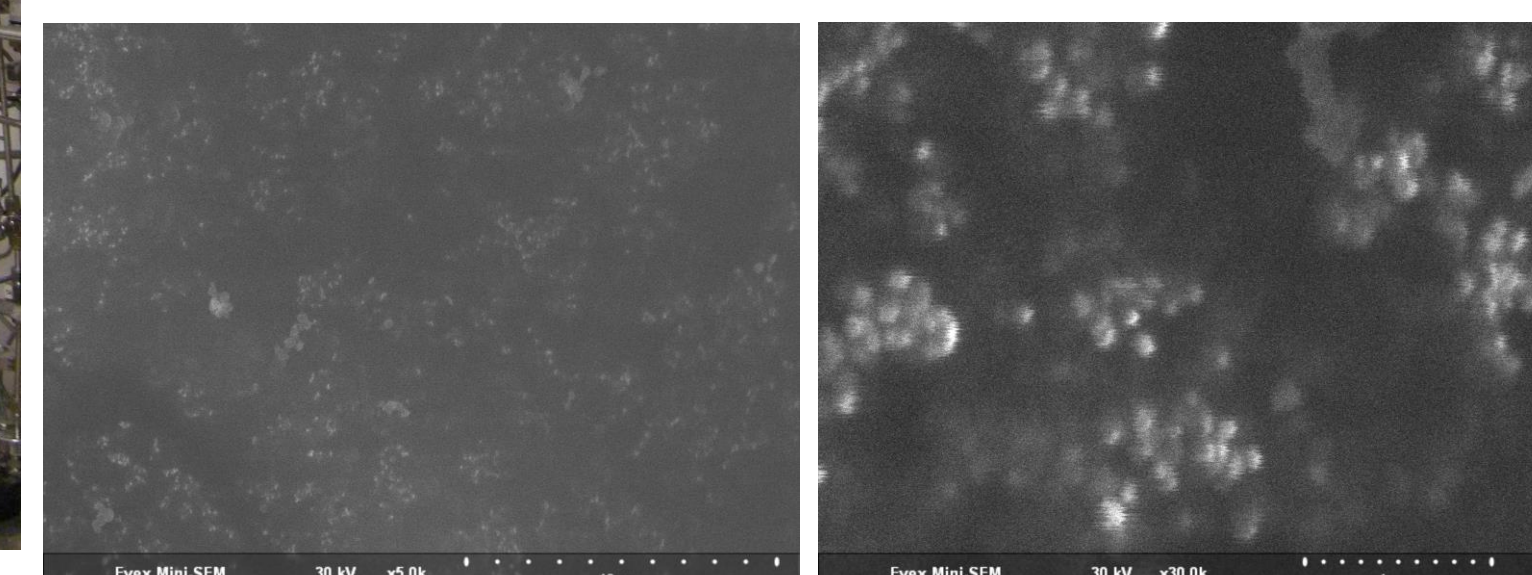
## Primordial Atmosphere Simulations

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

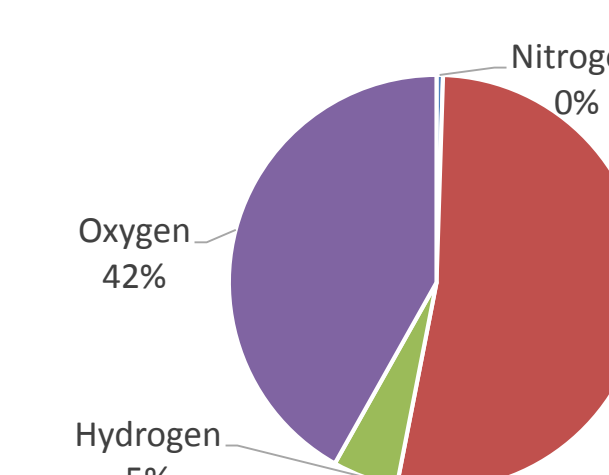
- Custom mixes of gases can be made and stored
- Gases flow across a UV lamp to start photochemical processes
- Resulting aerosols can then be removed from the chamber for study



SEM of Benzene Aerosol



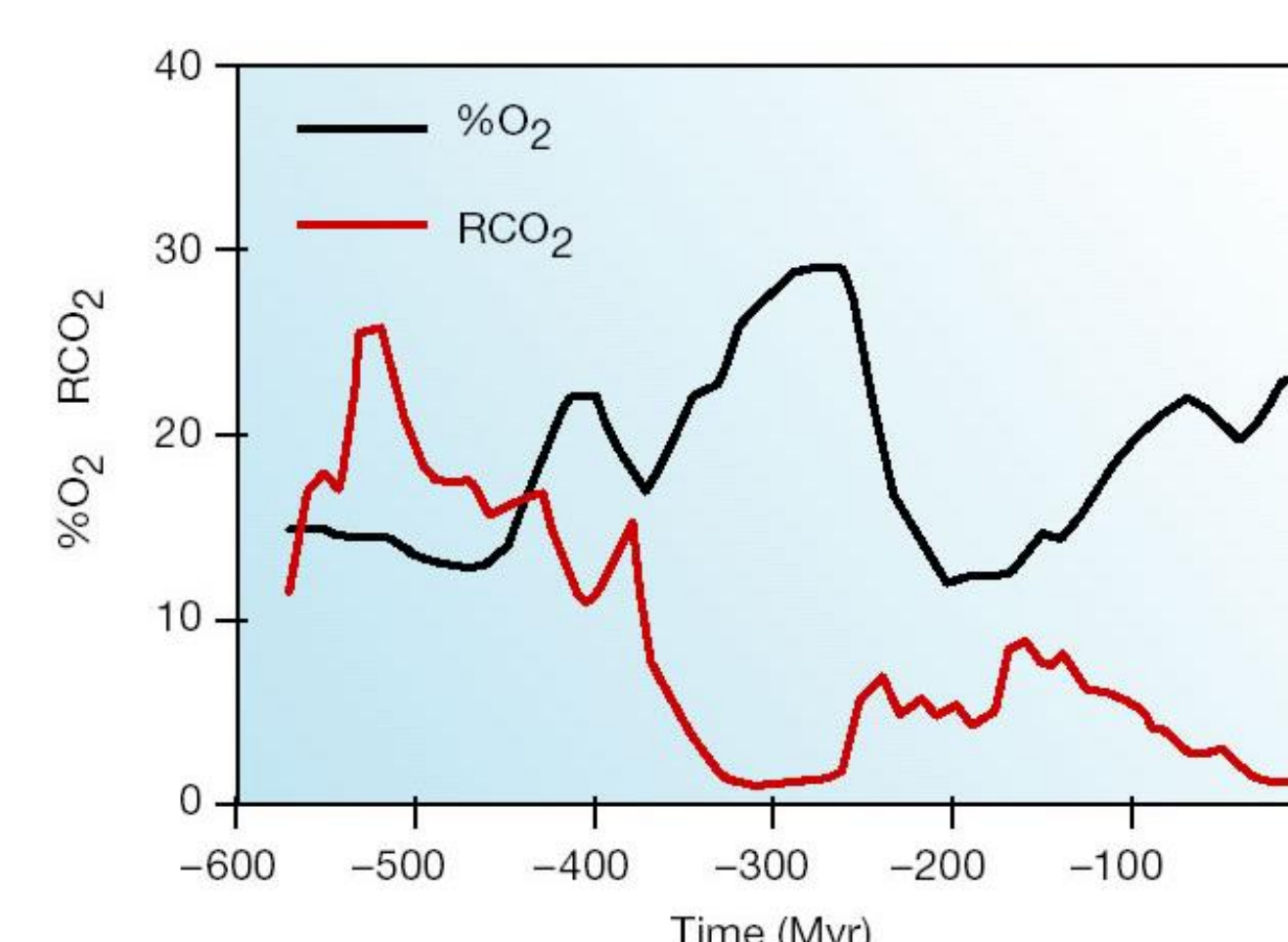
EA of a CHNO Aerosol



## Devonian Geology

Terrestrial plants expanded during the Devonian Period, lowering atmospheric CO<sub>2</sub>. We analyze Devonian sedimentary rocks to investigate these changes.

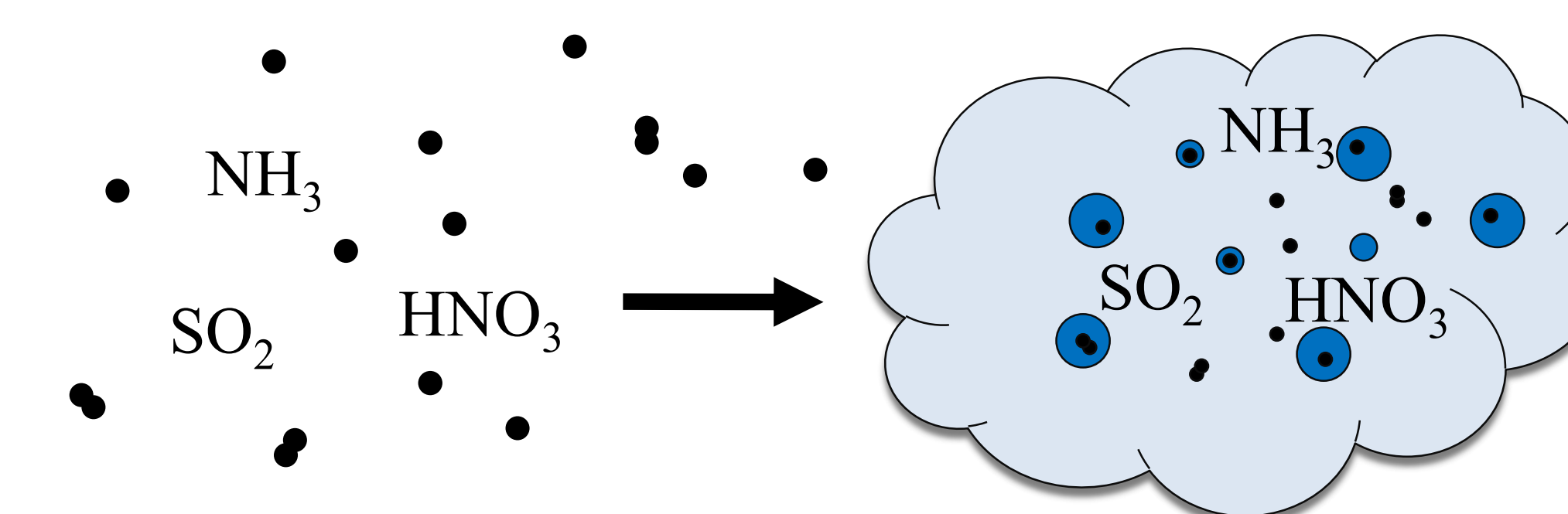
- Sample collection of Devonian exposures in the Cedar Valley Region, including from the Rockford Prairie Park and Preserve
- Samples are cut, polished and cleaned to identify best preserved materials
- Carbon and Strontium isotopic compositions analyzed using Elemental Analysis and Thermal Ionization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



## Fog Measurement

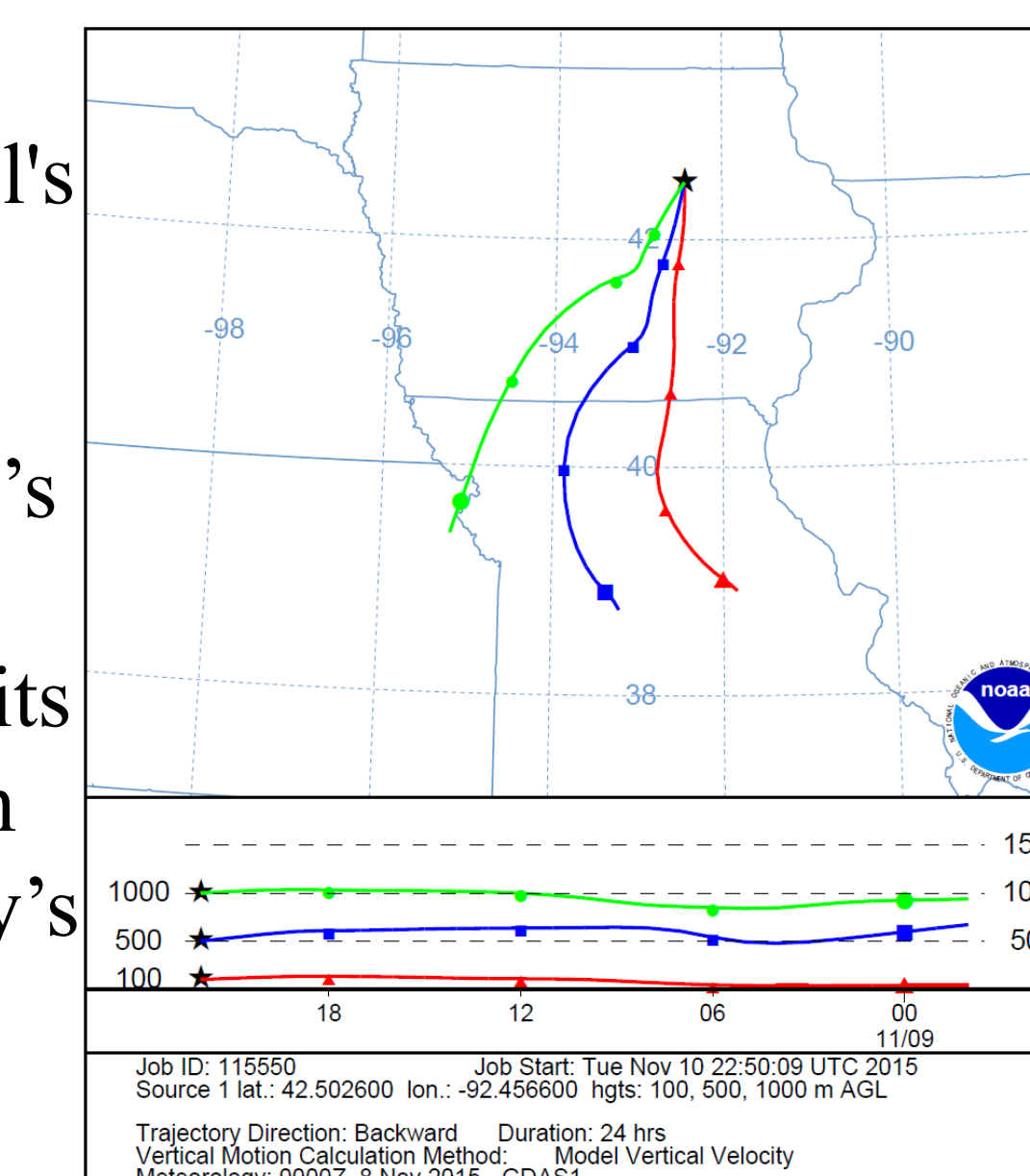
In order to investigate the heterogeneous interactions of reduced nitrogen with fog in northern Iowa, we are interested in addressing the following questions:

- What are the characteristics of ambient NH<sub>3</sub> 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

Iowa Space Grant Consortium  
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## References

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