The Biogeochemical Evolution of the Atmosphere (BETA) Project, funded through a STEM grant from the Iowa Space Grant Consortium, is not just about the past and the present; it is ultimately about the future.

“We are in a period of rapid climate change today and we spend a lot of time thinking about what might happen in the future,” says Dr. Alexa Sedlacek, an Assistant Professor of Geology at the Department of Earth Science and one of the co-advisors of the BETA Project.

“To really understand and form a predictive model, we need to look at how the atmosphere has responded in the past and quantify some of the changes,” she adds. “This will actually help us make predictions for the future.”

“Dr. Joshua Sebree had the idea of doing an interdisciplinary project,” recalls Dr. Sedlacek. “He approached me because I do a lot of work with Earth’s history and have looked at climate events through earth’s history.”

They brainstormed about what points in Earth’s history would be the most interesting to look at,” Dr. Sedlacek recounts.

With Dr. Xinhua Shen, an atmospheric chemist, joining in, “it was sort of a nice arc to think about three different ways of approaching the study of Earth’s atmosphere.”

The brainstorming subsequently resulted in a grant proposal that the Iowa Space Grant Consortium approved, and the BETA Project was underway.

The three-year project has three components that examine Earth’s atmosphere in three different timeframes.

Dr. Sebree, an Assistant Professor of Astrochemistry and Astrobiology, leads the component that studies the atmosphere in the Archean period, about 4 to 2.5 billion years ago, which marked pre-life and very early life conditions on Earth.

Dr. Shen, an Assistant Professor of Meteorology/Air Quality, is in charge of the component that investigates how reduced nitrogen interacts with fog in northern Iowa, especially in the Cedar Valley region. The investigation is aimed at improving the current understanding of the biogeochemical cycle of nitrogen in the present-day atmosphere.

The component that Dr. Sedlacek leads looks into the atmospheric evolution in the Devonian period.

“In the Devonian, fully developed forest ecosystems showed up for the first time and had a major impact on the atmosphere,” she explains. “Photosynthesis brings carbon dioxide out of the atmosphere and stores it in tissues of plants and animals.”

“It is also in the Devonian when the atmosphere became, for the first time, much more modern and much more familiar in terms of what we experience today,” she adds.

These changes got imprinted in the rocks. Iowa is the perfect place to do such research because Devonian limestones are found in abundance in the eastern part of the state.

“We look at the isotopic composition of these rocks for carbon and strontium,” Dr. Sedlacek says. “Those tell us how carbon dioxide was removed from the atmosphere.”

“You can actually look at these ratios to see how the atmosphere’s carbon dioxide content is changing and how quickly it is changing,” she explains. “The chemistry of these rocks tells you how radiation of plants on lands changes the atmosphere and how quickly it happens.”

“The difference between the Devonian period and today is that the Devonian was a cooling period and today we are in a warming period,” she adds. “Either way, how do the earth systems go into and out of these periods of rapid climate change? You want to think about all the parameters of the system.”

“You can think of it in terms of maybe how people discuss history,” she says. “Those who don’t study history are doomed
to repeat it. We have in the rock records the history of how atmosphere has changed over time."

The focus on the Devonian has also made “it easier to include students in the research projects,” Dr. Sedlacek says. “It’s been interesting to see the students on field trips, see them experience being outside, getting their hands dirty.”

Field trips are exciting alright but can be tricky too.

“It is difficult out in the field; sometimes, you have to walk up and down a really steep slope that’s loose sediment,” she says. “There is a lot of teaching about, say, how to fall if you fall, make sure that you fall towards the slope and not away from it.”

“We have a couple of Earth Science majors who are involved in the project and have had more experience in field trips but, then, we have four Biology majors and one Science Teaching major who have never had to go out to quarries and collect rock samples,” she adds. “It’s fun watching students figure out how to get to a sample in the field when the environment is challenging.”

Being out in the field helps one to understand the scale of the earth and its system, which no amount of classroom activities can do, she says.

That’s one reason why Dr. Sedlacek advises middle and high school students to “get outside, look at the natural world and start asking questions.”

“When you go outside you get a much better feel for the scale on which these processes occur. That’s true for geology or any atmospheric study,” she says.

“You really have to start thinking on a much larger scale than we do in a classroom,” she adds. “For any interested student, just being outside and making observations in the natural world would be the best thing to do.”

Dr. Sedlacek also believes students should be more forthcoming about asking questions to experts.

“Students should be comfortable going to a university with what they have found. Usually, they will find that the faculty are willing to help,” she says. “Just call ahead and tell them that you have found a few things and that you would want to know more about them.”

“There are students in elementary, middle and high schools who have rock or fossil collections. They may not really know what they have collected. If they come to a department like ours we can sit down with them and tell them about what they have found,” she adds.

The Department of Earth Science at UNI does a lot of outreach “because children like fossils and rocks and these spark their curiosity,” says Dr. Sedlacek. “In the past two years, we have had people bring in ‘unknowns’ that they find.”

“Someone brought in a meteorite… somebody brought in a camel tooth, from a camel that lived in North America several million years ago,” she adds.

“Sometimes we get really interesting fossils. I think students should feel confident and know that it is a possibility.”

Dr. Sedlacek and students during a field trip.