March 27, 2007

Wow! I did not stop today. Originally, I was supposed to be out with the photosynthesis team today. That did not happen. Instead, Deb Bazar grouped everyone together and went out to follow Steve Will and Dr. Henry Sun. When we got to the first site, chaos broke out. Some people ended up going with Dr. Jim Nienow to analyze algae, others left with another pair of scientists, leaving me with Deb. Not that this was necessarily a bad thing, it just seemed so dysfunctional. As Steve Will and his crew took off to collect their samples, we teachers had to be shuttled out to the actual site of interest. As soon as an opening came up, myself and another young lady (I believe she's a grad student) hopped aboard an SUV with Dr. Rafael Navarro-Gonzalez to join the rest of the research team. As it turned out, the rest of the teachers were left behind, waiting for almost two hours. Quite honestly, I was concerned about whether or not I was going to have a ride back, or what I was to do after we had finished our work…rumor had it the group with Deb left. While my concerns were brewing, I did learn how to collect a sterile soil sample from the field. I first watched Heather and Mike do it, and then later worked with Mike on collecting our own. The task mostly involved digging soil using a sterilized spoon and plastic baggies. We had to make sure not to touch any part of the soil or the utensils with our fingers as we'd contaminate our sample with foreign bacteria and other microorganisms…humans are so dirty. I think my idea for a soil auger with a collection chamber is quite viable for such a situation. In one of our assignments, I imagined and described a special auger or scoop with a detachable, sterilized catch chamber for collected soils. A researcher would simply scoop or capture the desired soil, tilt the device upward and allow the sample to slide into the chamber. The spoon I was using was just bending and the plastic sterilized scoops were breaking. Mike and I did obtain a soil sample as the rest of the teacher group finally showed up. The soil we were after was a developed soil, which formed atop a lava flow. As one followed this soil strata, one can see how another lava flow had covered and baked this formation on the opposite side of what is now a small canyon. Essentially, the ash and flow from an initial eruption occurred. Then soil was laid down, developed, and was later partially covered by another volcanic flow. Soil samples were taken from each side of the canyon to compare organic content and the present of organisms. The soil samples Mike and I collected were closer to the surface and thus more developed. Dr. Navarro-Gonzalez took samples (as did Mike and Heather) from the soil buried by the more recent lava flow.

Mike Klum and I collecting soil samples at one of the lava fields.
Photo courtesy of Cherlyn Anderson (date on photo is incorrect)

After collecting our soil samples, we followed the geology team to the top of another lava field. In addition to showing us some petroglyphs, Dr. Will shared with us his hypothesis on how older volcanic rock gets placed on top of younger soils, which is in contrast to the law of superposition. Once the lava fields cool, the very top is broken apart. Once the rock is broken, sediments infiltrate the spaces between the rocks. When the sediment becomes moist, it expands. When the sediment dries it contracts and cracks, leaving space for more sediment to again sneak in beneath the rocks. As the sediment expands again, the rock gets pushed upward. The sediments crack again allowing more sediment to go in, which rises on expansion, and process continues. Dr. Will even chiseled up some of the underlying soil and showed how it cracked in the same patterns of the volcanic rock. He said many people are beginning to accept his theory.

Deb Bazar gathered us teachers and we drove to another site to investigate a lava tube. However, on our way there, we could observe a large wind/sand storm in one direction and a rainstorm in another. As we turned down the road toward the lava tube, everyone began thinking about our safety. In the desert, there could be a downpour of rain in one place and the water will flow and flood the adjacent areas. We were riding in a large passenger van, which could easily get stuck in soft sand let alone a flooded wash. In turn, we decided it would be in our best interest to turn around and head back to the research station.

When we got back, I called my wife and went to the lab to check out what was going on. There was Dr. Sabine Rech and Elaine Pressly Bryant guiding a bunch of folks through a protocol used to isolate bacteria from the soil samples we had collected. So certainly, I sat down and got involved. I joined forces with Eileen Poling to separate microorganisms from two soil samples, #15 and #16. The process first involved the physical separation of the bacteria from the samples. This is done by first placing a solution containing the soil sample into small vials. We then placed the vials onto the vortex, which shakes and detaches the bacteria from the soil granules.

Next, we put the vials into the centrifuge to separate the various substances. We extracted the fluid from the vial and repeated the process two more times. In the end, a solution containing our desired bacteria and an indicator remained. Eileen and I cultured two sets of microculture plates with this solution. The microculture plates contained a series of organic nutrients. As the bacteria metabolized the nutrients, certain waste products are given off, which can be detected by the indicator solution. In other words, if bacteria are present, the sample in the plate will appear purple over time. By using different organic compounds, we can make some determinations about what types of bacteria we isolated.

Eileen and I culturing a plate with our samples.
Photo courtesy of Eileen Poling

This evening, I had a nice chat with Lauren Fletcher and Henry Bortman. Lauren, in his studies of soils found in drainage basins, discovered the amount of organics found in the reservoir of arid regions is equal to the concentration of organic residues in the contributing watershed. This is interesting because many would suspect the concentration of organics to be greatest in the drainage reservoir; all of the sediments in a river or a canyon are washed to a collecting basin or alluvium. In turn, organic matter should also be carried to these areas and increase in concentration. This is true in temperate, forested regions. But in the case of arid environments, according to Lauren, has found the concentrations of soil organics to be equal throughout the watershed. Afterward, Henry and Lauren enlightened me on the whole publishing process in association with NASA. In addition to my interest in writing, I got a better insight on how the research team is established. Dr. Chris McKay is the main scientist in the group. As the study of how to find organisms on Mars evolves, Chris brings in other scientists from around the world to assist with various aspects of the research. When papers relative to this project are written, Dr. McKay edits them prior to their publication. In fact, many of the papers we had for our homework did in fact have his name somewhere in the credits. The entire research team, as one can see, has worked with each other for some time. In fact, this evening we, the teachers, got to observe the scientists review the work done so far this week. I found it absolutely fascinating how everyone pondered each project, discussed their outcomes thus far, and how future research will take place. The whole time, you could just see Chris McKay formulate how each team's research affected the project as a whole. He was very quick to make suggestions on future experiments and how different findings were interrelated. I am very impressed with how Dr. McKay manages all of this data and the different research teams. A couple of the other scientists and grad students shared my thoughts in a later discussion.

This whole project is also a fine example of how new technologies get developed as a result of exploring space and astrobiology. Dr. Linda Powers described, for example, a device she is developing that can make observations of soil organics without having to take samples to the lab. Such a device is being designed for use on Mars, but would have many applications on Earth. All of these scientists are brilliant in the way they are able to apply knowledge from all fields of science and technology. Certainly, the separation of science into distinct "unrelated fields" within our schools is a problem. I know there are a lot of teachers, especially those here at the research station, who are trying to alleviate this problem. But there is plenty of literature suggesting the tendency of our education system to favor the separation of subject matter. At any rate, watching the scientists meet like this provided another example of why students need to be taught in a holistic manner.

March 28, 2007

I just got done isolating DNA from the soil samples. Again, this is something I could take back and use with our school's garden. To expand this to the school garden, I would need to first obtain the equipment. Elaine and Sabine suggested I contact a representative from the manufacturers to obtain used equipment at a lower price. Colleges and universities may also have older equipment available. What doesn't meet their needs would do just fine in a middle school or high school. Certainly, I could utilize this experience to help obtain funds through grants and get my classroom set up. We also had a lot of fun in the lab, speaking with really bad accents and sharing fun stories from our classrooms. Everyone seemed to have a great time.

My bad Groucho Marx impression in the lab and a rare picture without my hat.
Photo courtesy of Meg Deppe.

At 3:00PM, I got to go with Jim Nienow to investigate the desert crust. It has been hypothesized that nature, especially in lower level organisms, growth takes place in defined patterns. Mathematical patterns are a common place in nature, but it hasn't been accurately applied to the growth patterns of cyanobacteria. Interestingly enough, when we got out there, the possibility of a mathematical function became evident. Granted, colonies were not identical, but there were similarities. The soil crusts in the desert seemed to expand outward, but left circular gaps of exposed sand. To obtain empirical data on this phenomenon, our group split off into two groups. One group analyzed one colony with Jim and a special device he had, which measured photosynthetic activity and could more quickly determine algal patterns. Our group used a pair of meter sticks to form a grid. We then made measurements of the occurrence of algae along the grid; I would read off measurements and someone else would record them for use in a computer model later.

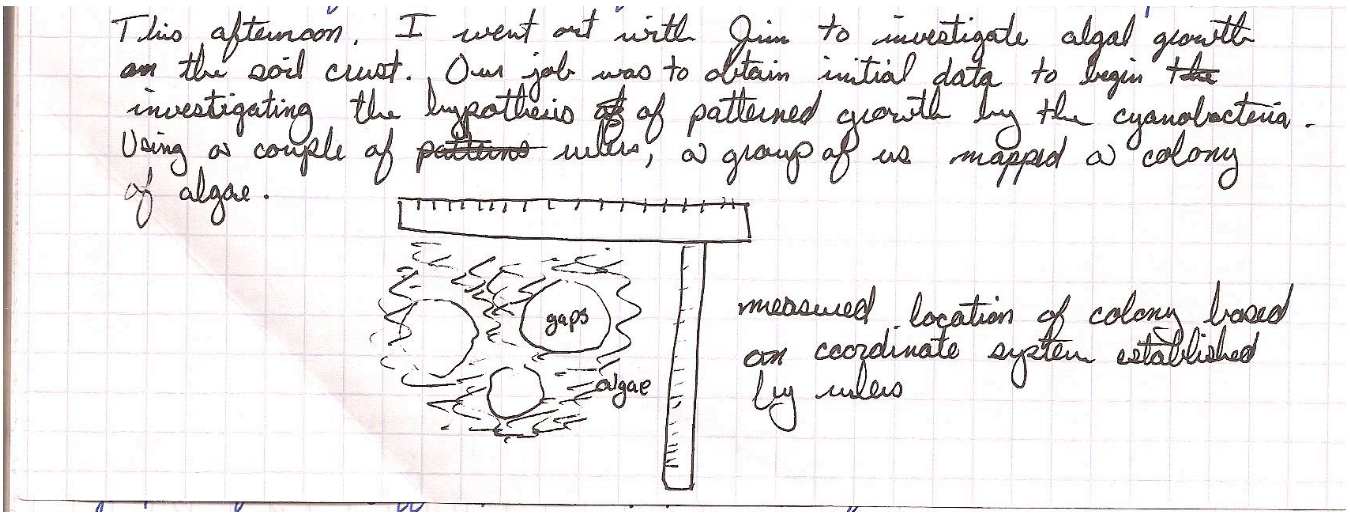


Diagram of how we measured algae colony in the field.

When we got back to the station, I had to ask Jim about the hypolithic algae found in quartzite on the surface of desert soils. On Monday, he took a bunch of people out to collect the algae and study them under the microscope. Though I didn't get a chance to go, Jim did outline for me how to collect and culture the algae. The whole process is quite simple. Upon finding a quartzite rock in the desert, turn it over to see if an algal colony exists underneath. The algae has a bright green to dark green, splotchy color (they haven't been hard to find since I've gotten back). Jim said to take the quartzite and place it on a moist paper towel in a beaker. The paper towel should be moistened with sterile water, Algae Grow will work better. Cover the beaker with a petri dish and the colony will grow.

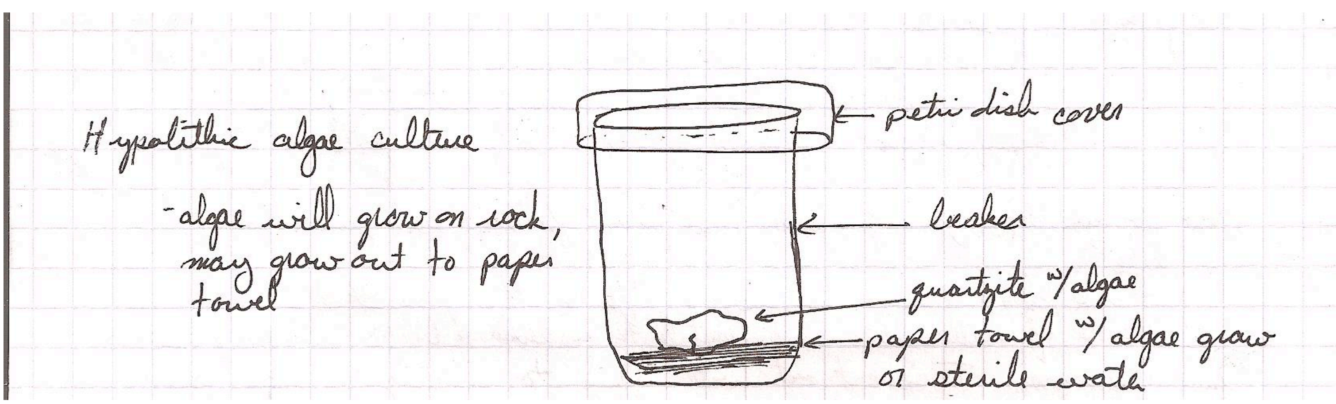


Diagram of how to culture hypolithic algae.

After dinner, a presentation was made about deciphering mathematical functions as a means of determining patterns of algal growth on desert crusts, the very thing I got to go study this afternoon. As mentioned during the presentation, the work is preliminary. In fact, we made the initial measurements today! The testing of the hypothesis will reveal one of three conclusions:

1. null hypothesis – no patterns exist

2. environmental control – environment determines the pattern of growth
3. self control – organism controls itself, including its pattern of growth

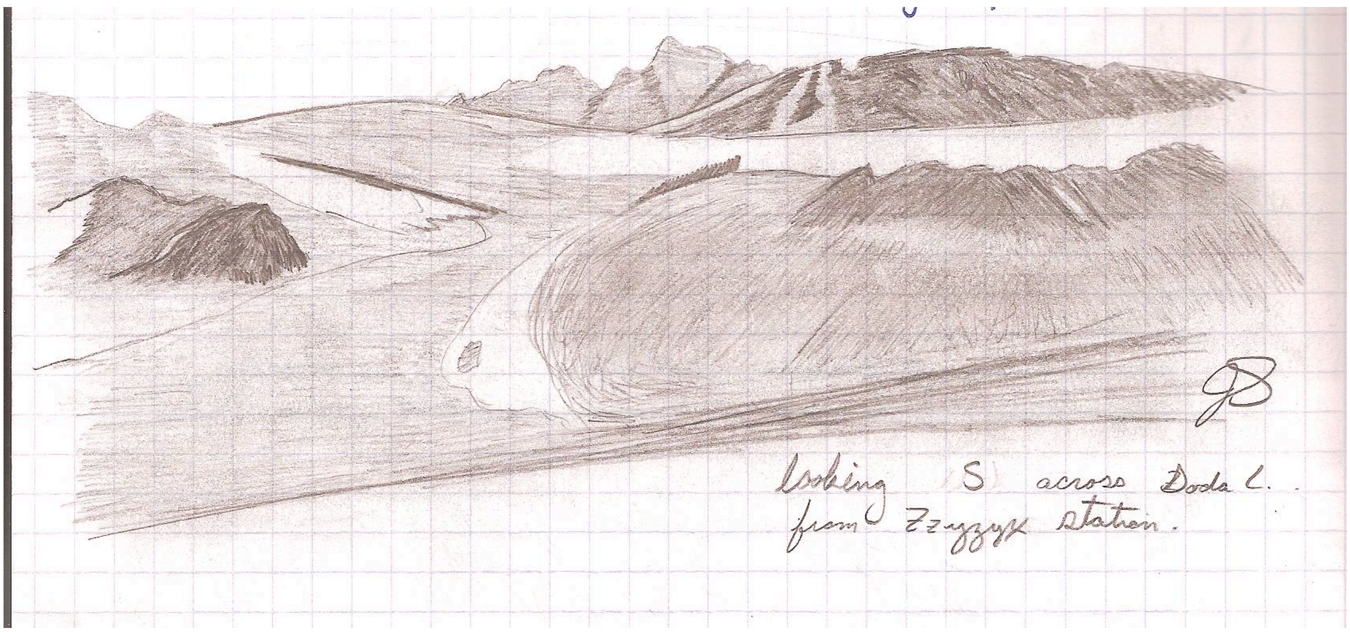
I have to say, environmental control seems to make the most sense to me. As we continue to sort out the apparent chaos associated with nature, some type of orderly, mathematical interpretation of any phenomenon seems to develop. This was supported by a presentation on fractals. But because our environment is a compilation of interrelated ecosystems, it would be foolish to think the pattern of growth wouldn't be influenced by the mathematical functions of other natural constituents. Prior to our discussion of desert algae, members from the Biosphere II team shared with everyone their experiences isolated in a self-contained environment. Though much research was done, the most noted results of Biosphere II are relevant to the psychological effects on human behavior when people are mostly isolated from the rest of the world. This information is quite relevant to Mars research, for should astronauts be sent to the Red Planet, they will need to contend with similar issues. In fact, the conversion of Biosphere II into a planetary simulation facility could become quite useful. However, the building appears to be slated for demolition soon. What an absolute waste! I believe something could be done with the structure. Destroying it is a waste of resources and a case for a lack of vision.

March 29, 2007

Up at 4:00AM. It was a chance shot, but I took it and it paid off. Skip and I were up before dawn to catch a ride with the ballooning crew, along with Linda and Dan. Linda, Skip, and I got into a vehicle with Benjamin, a lawyer friend of Jim, the resident ballooning expert. Jim is an interesting guy. He was a contractor who specialized in disaster repair. To do this, he bought a special camera, which reads infrared radiation, or temperatures of objects. Initially using it to detect water damage in homes, Jim utilized it in conjunction with his two hobbies. He enjoyed ballooning and spelunking. One day he thought, "How could I find new caves to explore?" So Jim figured, if he could take a hot air balloon and photograph an area with the thermographic camera, new caves might be discovered. The idea was premised upon the contrast in temperatures of cave openings with its surroundings. Sure enough, it worked. Thinking it was neat and unique, Jim decided to write a paper about it, which was later published. At the same time, Jut Nelson, a NASA researcher from the University of Northern Arizona, was thinking about how to find caves on Mars. He also came up with the idea to use an infrared camera suspended from a probe suspended by hot air (*a blimp*) only to discover Jim's article. Jut contacted Jim and the two teamed up in the Atacama Desert to check out the effectiveness of such a strategy. Today, they joined forces to conduct breakthrough work. Could caves be discovered in a Mars-like environment using a thermographic camera from a hot air balloon? Once we got out to the lava flows just outside of Barstow, I helped unpack and raise and inflate the balloon. The whole activity was quite exciting and a lot of hard work. Because we didn't want the balloon to rise too high and remain steady for the collection of data, to be controlled more like a blimp, we tied the balloon to available trucks and cars. It was amazing to witness the force of hot air rising; the balloon literally pulled a couple of the parked vehicles backwards a few feet.

While Jut and Jim were taking pictures up in the balloon, Skip and I went out to explore some of the lava tubes. As the ground crew communicated with the balloon crew regarding the location of a cave, Skip and I crawled into it to help describe the structure. Skip had an easier time crawling into the tight, sharply jagged openings; he's much thinner than I am. In a second cave, labeled TEA by the local Bureau of Land Management, Skip went ahead to explore the depths of this geologic feature. I only went in half way. Skip was able to get by a scorpion and discovered a room big enough for him to stand up in. This lava tube went deeper, but Skip said it was getting much too narrow to go any further. He continued to explore the cave with Kobe as I went back to the balloon crew. Once the pictures were taken, Jim said the wind was beginning to create problems and so we began to take it down. The whole process of setting up and taking the balloon down was a lot of work. Raffie, Jim's assistant was a great help. He taught me a few new knots and instructed everyone how to do their jobs very well. After getting the balloon packed away, a bunch of us left for the station as Jut and a few others finished up some measurements. After stopping for breakfast in Ludlow, Benjamin, a friend of Jim's, Raffie, Skip, and I made a couple of stops in the Mojave National Preserve. We stopped to check out the Kelso Depot, and then found some blooming Joshua Trees to investigate.

Having gotten up so early and worked so hard this morning, I needed a moment to rest. I went out to do a little sketching and relaxed a bit before going to the lab to check out what was going on. There, Sabine and Elaine were teaching a group of teachers how to isolate genes from the DNA we isolated the day before. The procedure was quite short. It was really neat for me to have collected soil samples and then to have completed all of the different tests needing to be done to it. Some of the cultures we made earlier in the week were beginning to show results, the DNA from the soil organisms were isolated and some of the genes are going to be taken back to the lab in San Jose State. The whole process was fascinating.



Sketch of landscape east of Soda Lake as viewed from the research station.
On the sketch, I labeled it as south…oops.

March 30, 2007

I'm home. Just before dinner yesterday evening, Meg Deppe and Frank Cleary approached me and said they were going to leave after the final meeting. Nothing was going on this morning save for people packing up and heading to the airport. After some discussion and verification, most of folks from the surrounding area decided we'd go sleep in our own beds last night.

Just before dinner last night, we had a meeting to discuss this week's work and how it could be translated into the classroom. The question was raised, if we were to create a lesson assimilating the procedures we did this week, what would it look like. One of the main ideas of our work at the research station was to isolate, differentiate, and classify the numerous soil organisms found in the Mojave Desert. Many of us teachers came up with ideas to have students analyze numerous objects, observe their properties, then differentiate and classify them. Candy seemed to be a popular choice. Some folks were thinking about using candy bars as subject for analysis, but I was thinking more along the lines of M&Ms vs. Skittles vs. Reeses Pieces vs. other types of similar, candy coated delights. First, each candy type would have to be analyzed remotely, using site. Then it would need to be retrieved using some type of machine. Then the candy could be tested for certain characteristics. Students could try measuring density, hardness, and other characteristics to classify these substances. I also came up with the idea of using corn; a teacher could take different types of corn kernels and develop a set of rules on how to determine a popcorn kernel from other types of kernels without trying to heat them in oil (that would be the final test to see if the students were right). Jim Nienow seemed to have hoped for better ideas. He explained how candy was nice and got the students' attention, but we need to do more realistic, real-life types of lessons. I absolutely do not disagree with him; Jim is very much correct. The question posed to us educators from Chris McKay was how we would incorporate our experiences from this week into the classroom. Speaking for my situation and I know there are others sharing the same experience, many of my students have had very little science by the time they get to me. Often, what time was spent for science is short and lacking in basic science skills, such as measurement, making comparisons, and analyzing any form of data. A real problem in science education today is the lack of process and problem solving taught to students in science classes. Memorization of "facts" and concepts as they appear in a textbook are the focal points of a science classroom. And I am not alone; many of the teachers with whom I worked with shared my feelings regarding this matter. Last Tuesday a bunch of us teachers discussed the upcoming California Science text adoption. All of them told the same story as I. While trying to adopt a science curriculum, we have to put up with teachers choosing materials based on lab videos and pictures. Students can't watch an experiment; they should be doing the experiment! We were all frustrated. There is no such thing as a science curriculum that can appropriately teach the subject by itself. Instead, science textbooks should be used as nothing more than a reference. I completely agree with Jim Nienow. But before we can do the actual sampling of soils, I see a need to show students how to make observations and analyze the data presented before them.

To answer Chris' question, I would simply duplicate the methods experienced during the past week to learn about soils on and around our school campus. I feel the other teachers participating this week would do the same. But as to exactly how this is done is dependent upon each of our situations at our individual sites. Each school is different. Different teachers. Different methodologies. Different facilities and equipment. There is no precise way to teach this information to our students. I'm starting a campus garden and I plan on acquiring the necessary equipment so my students can analyze the soil in the garden and record the changes taking place over time. Each year, students can take their data and publish it in a book, which could be put on display in the school library. I will first set up a weather station like I did with Leo and Dr. Kress. My students can record data on both the weather and soils. As our garden becomes more fertile, I can use the protocols put forth by Sabine and Elaine to document changes in the soil fauna. I will first have to obtain some of the equipment, such as a vortex and centrifuge. Sabine and Elaine gave us some tips on how to do just that. I most definitely plan to show students hypolithic algae and how it grows. It will take some time and money to do all of this, but I know it can be done. This summer, I will begin looking for and submitting grant proposals to help fund my plan. Once put in place, I could have my students figure out what areas in the garden or on campus to check for soil organisms by using the soil data, do an engineering lesson to retrieve the soils, and then perform tests to check for their presence as a lesson on how to find life. I will also need to get a GPS.

Also discussed last night were plans to send a Lunar Recon Orbiter and the Lunar Crater Observation Surveyor in to the Moon in late 2008. Also, NASA is looking for students to look at Martian surface images from high-rise to determine possible research sites. Students would look at images on a computer, and then post suggested areas into a database for consideration. It certainly sounds incredible and I know my students would love to do this. But I am going to first have to check into the availability of computers on campus. We are supposed to get a new computer lab on campus; hopefully it could serve our needs in this matter. We do have carts of laptops, but the internet capabilities in my classroom are very inconsistent.

This past week, being a part of this expedition, was an absolute delight! I learned so much. Not just in terms of science content and field work opportunities, but also how professional scientists operate. I met so many great people. The teachers, the scientists, the grad students, the station caretaker, THE COOK, are all extremely talented people and I am deeply appreciative of the time I got to spend with them. Unfortunately, as the entire group began to really gel into a cohesive unit, just as everyone seemed to be getting really used to each other and enjoying each other's company, we had to depart. I wouldn't have minded a couple more days out in the desert with those folks. I think every teacher needs to do something like this in their specific subject area. It was great to collaborate with other teachers and scientists. I have gained all sorts of new insights to take back to my students!

When we were finished, I drove Linda to Barstow where her husband could pick her up. Then I took the 247 back home to Twentynine Palms. I got home at about 2:00AM. Of course I would prefer to sleep in my own bed, but I really do miss being out at the Zzyzx Station doing all that work with those people. I hope to take part in future NASA expeditions like this one, maybe even a team leader if one is needed.   My time spent during Spaceward Bound: Mojave is an experience I will never forget!