

**Final report of biological studies at the MDRS for Crew 31**  
**December 18, 2004 – January 3, 2005**

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**Question:** How can desert microclimates be identified and their physical / chemical properties be measured?

**Hypothesis:** Desert microclimates can be visually identified as locations which feature the following physical characteristics: any natural cave – like structure which possesses an interior volume that is isolated from the climatic conditions that originate from above (precipitation, sunlight etc.), any natural hole – like structure which possesses an interior volume that may be exposed to the open air above, but is isolated from any entity that may originate from the horizontal plane (wind, land dwelling organisms etc.) These locations can be subject to the following measurements in order to assess their microclimatic status: internal temperature, internal humidity, internal air pressure, soil temperature, soil ph, soil moisture content, flora / fauna collection, depth, width, interior levels of solar radiation.

**Introduction:** There are many sites in a harsh environment that may exhibit climatic conditions and physical / chemical gradients significantly different than those that exist on the exposed surface of the surrounding area. Caves, holes, crevasses, cracks, rock fissures all may be candidates for hosting such conditions. Crew 19 crew member Fathi Karouia explains the relationship between a geologist and biologist when conducting Mars life searches: “My overall conclusion about this first week and biology goals is that the association between a biologist and a geologist could be relevant uniquely for scouting”. The point being that life on Mars will probably not be strewn across the planet’s dusty surface, but hidden within and among geologic features, therefore requiring an expert geologist to be a vital part of the searching process. Crew 19 member Nancy Wood reports: “A noteworthy feature of the MDRS area is the presence of ground-water sapping leading to the formation of characteristic theater-headed valleys. These are of particular interest since Mars shows similar morphological features, and may represent sites providing suitable niches for any extant life. Such a valley was previously identified during a Phase I scouting mission (EVA 15). We returned during EVA 48 to take biological samples from selected microhabitats, and to evaluate the physical operations of work at this site. Samples included material from a blue-black deposit, from exfoliating crust under a significant overhang (Morrison formation), from an ochre-colored thin layer, and. Other samples under the overhang were obtained for PIMA analysis of mineral content. We also collected samples further down the slope, including conspicuous salmon-orange gypsum and cross-bedded gypsum stained green from directly overlying layers.” It is within these varied and sheltered locations that numerous organisms may be afforded sufficient survival advantages that would otherwise not exist out on the exposed surface. My plan while at the MDRS was twofold: to locate / identify candidate sites featuring desert microclimates and take a series of measurements that would evaluate the physical and chemical characteristics of each such site. In the short span of two weeks, I was afforded ample opportunity to accomplish the former of

my goals, while success with the latter proved to be elusive. The area around the hab is full of candidate microclimates that run the gamut from barely isolated alcoves to 6 foot deep sinkholes and cave-like structures. However, a combination of equipment shortage, equipment inaccuracy, underdeveloped protocol and a shortage of time made a meaningful physical / chemical profile of the sites difficult to obtain. Clearly, however, the importance of such research should remain evident. In addition, when we finally go to Mars, protocol that MDRS helped to develop on Earth will guide the explorers in their search for life.

## **The Field work**

### **A) Materials**

Oven/meat thermometer  
Standard glass/mercury thermometer  
Radio Shack digital thermometer/humidity sensor  
Carpenter's measuring tape  
Field soil scoop (stainless steel spoon, a plastic cup, or metal probe)  
Plastic sample collection bags and containers  
Soil salt content chemical detection kit  
Dissecting microscope  
GPS device  
pH sensor  
Stanley razor blade

### **B) Procedure**

1. Microclimate sites are unknown prior to EVA; therefore, EVA route was mapped out either according to another crew member's specific goals or under the assumption that a microclimate search would have to be undertaken once arrived at the destination.
2. Upon arrival at a destination, I look for caves (exercising universal precautions due to the fact that these places may be home to wildlife...a problem that should not be a factor on Mars.) I look for protected niches such as holes, cracks in rock faces, overhangs or shelters created by the settling of boulders amongst one another.
3. At the candidate site, a waypoint GPS reading is taken and recorded.
4. I will take a baseline temperature/humidity reading 1 meter above the ground in a location that is completely open to the air and elements. This establishes control measurements with which to compare any subsequent measurements taken inside the microclimate site. Allow 3 minutes for the Radio Shack digital temperature/humidity sensor to process its result.
5. An open air "baseline" or control soil sample is taken while the temperature reading is being processed. Soil sample is scooped up with a scoop type field instrument and placed into a sample collection bag. Upon the outside of the bag, the waypoint name or GPS coordinates are written.
6. Digital photographs taken at this point for further in-hab review of the site's features.

7. The temperature/humidity sensor is placed within the deepest possible point of the microclimate site and allowed to remain so for about 3 minutes to obtain its measurements.
8. At this point, additional interior measurements should be taken such as the amount of solar radiation, width and depth and internal air pressure.
9. Extant flora or fauna collection.

**Results:** Part 1 Locating and Assessing Candidate Microclimates

<b><u>Location</u></b>	<b><u>GPS Coordinates</u></b>	<b><u>Baseline T/ H</u></b>	<b><u>Interior T/H</u></b>
Reservoir of Thro; cave-like alcove to the left of the Southern pond shore	51 8576 42 5269	39 deg F 23 % hum	34 deg F 30 % hum
Inside a shelter Created by two Surface rocks; Each about 1m x 1m x .5 m	same	same	32 deg F 28 % hum
Bob's Rock Garden	51 9090 42 5032	51 deg F 27% hum	N/A
Inside shelter Created by Numerous Boulders each More than 2m x 2m x 1m. Located at the foot of The western hillside.	same	same	34 deg F 33% hum
Under a protective Overhanging rock. Area of overhang more than 4 m x 3 m. Located about 50 m Up the western hillside.	same	same	34 deg F 32 % hum

<u>Location</u>	<u>GPS Coordinates</u>	<u>Baseline T/ H</u>	<u>Interior T/H</u>
Small cave-like Structure “built” into The side of a Conglomerate rock. Dimensions approx. 40 cm x 10 cm x 15 cm. Possibly a shelter for An animal. Located about 50 m up the western hillside	same	same	37 deg F 32 % hum
Small “sinkholes” On Carl Sagan Street. Dimensions:	51 7080 42 5146	not assessed	needs further study

### Results: Part II Flora Studies

While out on my first EVA I came across a plant that caught my attention for the fact that it was the first plant I saw that exhibited a fresh, supple, hydrated and healthy appearance. All the other plants I came across had been almost completely dried out or dead. I proceeded to harvest a small sample (approx. 30 g) of this small silver-leaved organism. The plant was identified as “Saltbush” (*Atriplex* sp.) and subjected to various invasive and non-invasive analyses.

**Physical Appearance** – woody stems bearing 1cm x .5 cm soft, supple, silvery leaves. Leaves attached to main stem in groups of 3 or 4 by short petioles. Leaves are not all the same size indicating differential age.

**Taste** – salty

**Dissection** – under the dissecting microscope, a leaf of the saltbush plant was scraped longitudinally and cut transversely. Upon scraping of the skin it was revealed that under an unspecified depth there lay bright green colored tissue. The silvery skin was deposited evenly on top of this green tissue in a granular fashion and when exposed to the scraping, the skin clumped up in a “moist sand” fashion.

**Light Microscope** – Less than .5 mm cross sections of the leaf were made and wet mounted on a glass slide for viewing under the light microscope, low power. My purpose was to visualize the layering of the skin and underlying green tissue on the cellular level.

## **Conclusions: Part I**

To conclude my investigation into the question “How can desert microclimates be identified and their physical / chemical properties be measured?” I provide the following lessons learned:

- According to the results of my brief study, there seemed to be a uniform increase in humidity inside all of the microclimate sites compared to the baseline readings. Presumably, closed spaces can act as “water vapor traps” where water vapor lingers and accumulates more than it would on an open, breezy surface site. Further study with a larger sample size, more sensitive measuring devices and repeated measurements are needed.
- According to the results of my brief study there appears to be a uniform drop in temperature measured inside the microclimate sites compared to the baseline readings. The easiest explanation for this result is that within the microclimate interiors there is almost continuously a lack of solar radiation. Further study with a larger sample size, more sensitive measuring devices and repeated measurements are needed to address the dependant variable of temperature and the microclimate features which are responsible for observed changes in heat content.
- Although more sensitive measuring devices would be desirable, it is worth noting that even if the temperatures and humidity values may need refinement and verification, the relative values obtained in comparing the surface conditions with the microclimate conditions yields an absolute value that can be thought of as a true and credible result. After all, it’s not necessarily the temperature value that is of importance in characterizing a microclimate, but the difference between microclimate and surface values that is.
- Temperature and humidity readings and microclimate dimensions were the only analyses successfully undertaken on this mission due to time and equipment restraints. In order to assemble a complete picture of a microclimate many more measurements such as soil sample analysis need to be conducted.
- A search for life on Mars must be undertaken by an individual or group who possesses training in Biology and Geology. This study relied on surface maps and visual identification in order to locate microclimate sites. Further studies may include expert geological advice and even radar / satellite support.
- A successful analysis of the characteristics of a microclimate site hinges on the precision and variety of measuring devices as well as the exact and repeated measurement of baseline conditions (conditions outside of the microclimate; surface conditions)

## **Conclusions: Part II**

To conclude my investigations of the desert plant Saltbush I provide the following lessons learned:

- The salty skin of the saltbush plant (*Atriplex* sp.) apparently is an adaptation for living in dry, salty environments. There are specialized structures which deposit the salt on the outside of the leaf so harmful levels of sodium do not accumulate inside the cells.
- This plant can possibly be used as a model for the identification of genes which may confer upon an organism the ability to live in harsh environments. Because the saltbush plant has evolved such effective means for dealing with the inhospitable conditions of the desert habitat, scientists may want to identify the genes responsible and manipulate them in order to create or evolve organisms fit for survival on or near the surface of Mars.
- Further study needs to be done in order to further characterize the exact chemical components of the salty, silvery skin.
- Further study needs to be done in order to fully describe the mechanism by which the underlying green and presumably primary photosynthetic tissue obtains sufficient amount of solar radiation. Being that the reflective silvery “skin” is on top of the photosynthetic tissue, one may assume the number of photons reaching the chloroplasts is severely diminished.
- The saltbush leaf is edible and makes a great seasoning for cooked meats, and can be dried and pulverized in order to be used in sauces.