Cultivable halophiles from cold geysers as indicators of a deep subsurface habitat

Shahrzad Motamedi and William J. Brazelton

Department of Biology, University of Utah

INTRODUCTION

- Halophiles are salt-loving organisms with the capacity of maintaining the osmotic pressure of saline environments by accumulation of KCl or compatible solutes [1].
- Halophiles are classified as halotolerant, moderate halophile, or extreme halophile based on their requirements for salt concentration [1].
- Some of the halophiles that grow optimally at or above 1.7 M NaCl have the ability to grow at 50°C or higher and at pH 8.5 or higher [2]. In order to tolerate UV, they have efficient DNA repair but they also have mechanisms to prevent damage [3].
- Halorhodopsin and sensory rhodopsins are retinal proteins. They act either as light-driven ion pumps that allow cells to grow phototrophically or as photosensory receptors that confer phototactic responses to cells. Phylogenetic studies have shown that these proteins arose for the first time in haloarchaea. Moreover, this kind of phototrophy may be one of the oldest metabolisms on Earth [4].

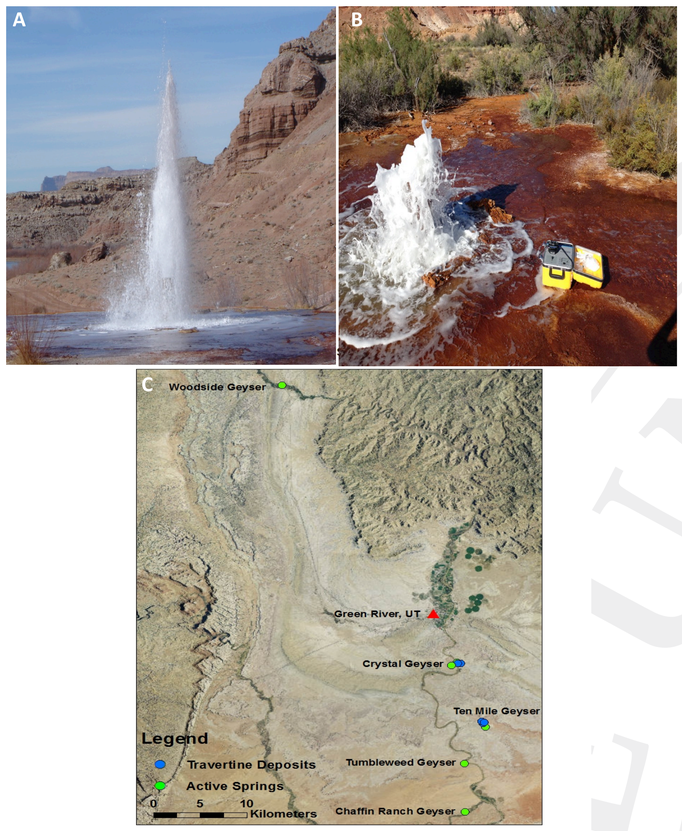
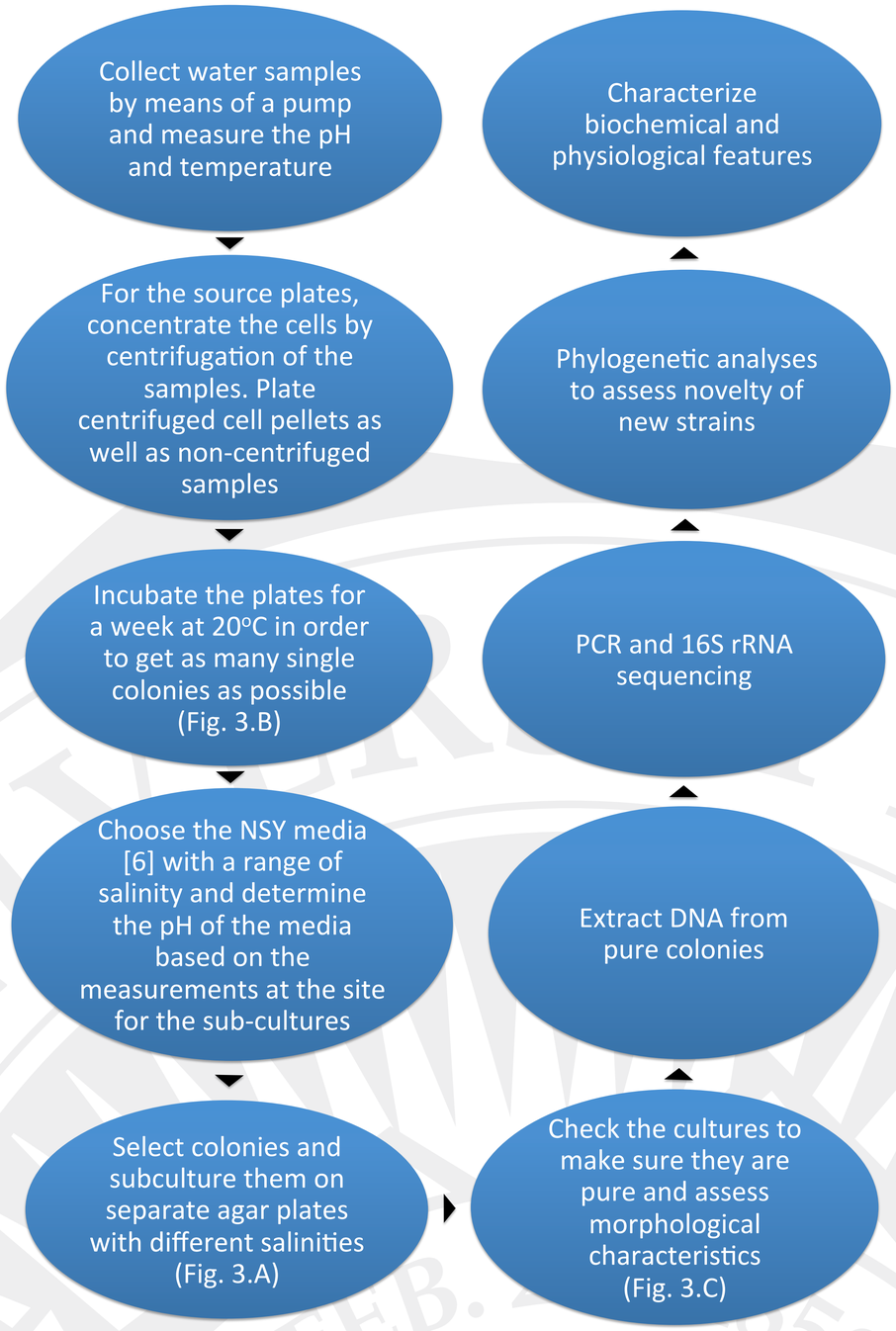


Figure 1. A) Crystal Geyser (CG) and B) Ten Mile Geyser (TMG)
C) The map of Crystal Geyser study area, which also shows the location of CG and TMG .

- A geyser is water ejected turbulently and accompanied by steam. Cold geysers, also known as erupting geothermal wells, are characterized by intermittent discharge of water and CO_2 instead of steam. Many, if not most, cold-water geysers are actually manmade boreholes [3].
- In cold-water geysers, CO_2-laden water lies in a confined aquifer, in which water and CO_2 are trapped by less permeable overlying strata. CO_2 can only escape from faults, joints or drilled wells [3]. (Fig. 2)
- Two of the cold-geysers that are studied in this experiment are Crystal Geyser and Ten Mile Geyser. Both geysers are located on the east bank of Green River, Utah [3]. (Fig. 1.A)
- The two main aquifers that supply water to these geysers are located at different depths and in different rock layers. The first one is called Navajo Aquifer, and it is located in sandstone at a depth of 300-500 m. It supplies 80-90% of the eruption water, and its salinity is quite low. The other aquifer, called Paleozoic Aquifer, is in a saturated salt rock layer at a depth of 1500 m. It supplies 10-20% of eruption water [5]. (Fig. 2)

METHODS



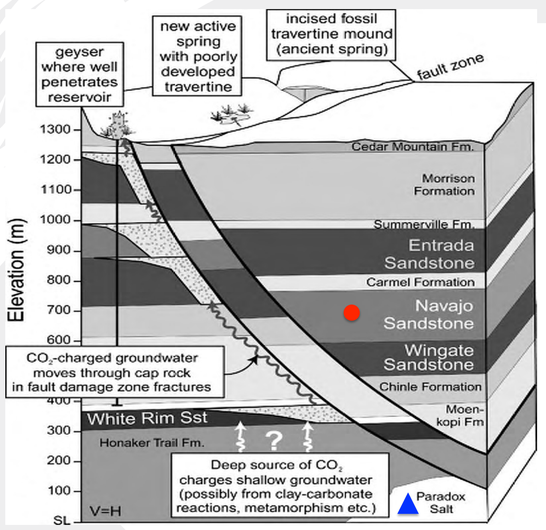


Figure 2. Geological structure of the geysers. The shallower aquifer is in the Navajo Sandstone that is shown by a red circle, and the deeper and more saline aquifer is located next to Paradox salt, which is shown by a blue triangle [7].

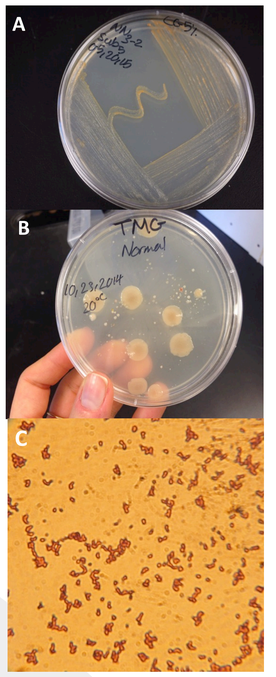


Figure 3. A)The fifth subculture of a potential new halophile from CG. The salinity of the media is 5%, the pH is 6.5 and the incubation temperature is 20°C. B) The source agar plate for TMG non-centrifuged sample, it doesn't have any salt in it, pH is 6.3 and the incubation temperature is 20°C. c) Gram-negative bacteria under the microscope from one of the CG's subcultures.

Hypothesis, Prediction and expected results

- In this project we are trying to assess the microbial diversity of the geysers and to isolate potentially novel halophiles.
- Based on a recent metagenomic study of Crystal Geyser [5], we expect to find some novel microorganisms if they can be cultured.
- We expect to see growth of halophiles at the same salinity as the hypersaline Paleozoic Aquifer, which would indicate the presence of an active, halophilic microbial ecosystem in the deep subsurface.

Summary

- Crystal Geyser and Ten Mile Geyser are CO_2-rich, cold geysers in southern Utah near the Green River.
- The geysers have multiple potential aquifer sources, one of them called Navajo Aquifer and the other one, which is deeper and more saline, called Paleozoic Aquifer.
- Our cultures of halophiles will help us infer the nature of the habitat in these aquifers and the diversity of different kinds of microbes living down there.
- We expect to find some potential new halophiles that grow on the same salinity as the deeper aquifer.

REFERENCES

[1] Kanekar et al. (2012) Microorganisms in Environmental Management, Springer, p. 1-34.
[2] Mesbah et al. (2012) Appl. Environ. Microbiol, 78, 4074-4082.
[3] Glennon et al. (2004) The Gosa Transactions, IX, 184-192.
[4] DasSarma Sh. (2006) Microbe, 1, 120-126.
[5] Emerson et al. (2015) Environ. Microbiol. doi: 10.1111/1462-2920.12817.
[6] Hahn et al. (2004) J. Microbiol. Meth., 57, 379-390.
[7] Shipton et al. (2005) Carbon Dioxide Capture for Storage in Deep Geologic Formations, Elsevier, Volume 2, p. 699-712