MINERALOGICAL ENVIRONMENTS WITHIN SALT-RICH SUBSURFACE AT ATACAMA AND TIBET PLATEAU
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Introduction: The environmental conditions on Mars that are easier to simulate in terrestrial analogs are those within salt-rich subsurface. Because the environment there would be controlled mainly by the surrounding hydrous salts (sulfates, chlorides, perchlorates), their hydration degrees, their amounts, and their burying depths, and would be less influenced by surface atmospheric conditions which are quite different between Mars and Earth.

Until now, we know very little about Mars subsurface mineralogy, the hydration degrees of subsurface salts, and the environments that they maintained. Spectrometers on Mars orbit sense surface mineralogy down to mm only. Rovers and landers dug into tens' cm. On the other hand, thermal models predict the change of temperature profile (which relates directly to relative humidity) in deeper depth when salt-rich layer exist in subsurface. Combining model calculations with the results from laboratory experiments on hydrous salts, the survival probability of the hydrous salts with mid-high degrees of hydration does exist, thus the environments for potential habitability.

For next mission to Mars, the questions include how deep we can dig into and how fast we can check the form of hydrous minerals before dehydation happens (thus to evaluate the habitability) link directly to the technical capabilities of next generation of rover and its payload, and to the cost of a mission. This is the reason for study the mineralogical environments within salt-rich subsurface in hyper arid terrestrial analog sites on high plateaus, such as Atacama and Tibet, by rover deployed drill, or by human made trenches. These investigations can help us understand the salt-rich subsurface environment on Mars.

Field expeditions: We have joined two field expeditions to Atacama Desert in 2012-2013 and a field expedition to Da Langtan (DLT) playa on Tibet plateau. The investigations include orbital remote sensing, in situ sensing of surface and subsurface materials, and laboratory measurements of collected samples.

Laser Raman spectroscopy (LRS) is our major tool to characterize the inorganic and organic species. The Mars Microbeam Raman Spectrometer (MMRS) was tested at 13 sites in Atacama as a stand-alone system in 2012. It was installed on Zoe rover (Carnegie-Mellon University) in 2013, and making in situ measurements of subsurface materials brought up by a drill (Honey-Bee Robotics) right now along the traverse route of Zoe in southeast portion of Atacama. A near IR reflectance spectrometer (WIR) and a UV-fluorescence imager (BUF) were also used for in situ measurements during these expeditions. They provided complimentary data to MMRS. WIR was used for in situ measurement during our first field expedition to Da Langtan Playa on Tibet plateau.

Laboratory measurements for ground truth: All samples that we measured during expeditions were collected, sealed in plastic bags for laboratory mineralogy characterization. LRS, XRD, NIR, MIR, and in some cases LIBS, measurements were (and will be) made on them.

The analyses on the collected samples from Tibet were finished. As predicted by a combined analysis based on lab-experiments and model calculation, large amount of highly hydrated Mg-sulfate (MgSO4.7H2O, MgSO4.6H2O, MgSO4.4H2O) and chloride hydrate (K(MgCl4.6H2O) were identified in the subsurface salt-rich layers of DLT (Figure 1).

Conclusion: It is critical through the terrestrial analog site investigation to understand the nature of geological processes, especially those related to the formation and preservation of high hydrated salts at Mars subsurface, and the maintained environmental conditions by them. In addition, the field campaign helps the understanding of the power of a multi-instrument payload and the synergistic applications of a particular instrument in it.

Acknowledgement: NASA supports from PIDDP, MIDP, ASTID, MFRP, and ASTEP program for the development of MMRS, WIR, BUF and for field tests at Atacama. A special support from McDonnell Center for Space Science at Washington University in St. Louis for the field expedition to DLT on Tibet Plateau.

Figure 1. Laser Raman Spectra of highly hydrated salts preserved in the subsurface of a hyperarid region, DLT in Qidam basin on Tibet Plateau.