GROUND PENETRATING RADAR MEASUREMENT OF LACUSTRINE SEDIMENTS IN THE QAIDAM BASIN, NW CHINA. X. Meng[1], Y. Xu[1], L. Xiao[1, 2], B. Liu[3], S. Gou[3] and Z. Y. Yue[3]. [1]Space and Science Institute, Lunar and Planetary Science Laboratory, Macau University of Science and Technology, Macau, 999078, China (yixu@must.edu.mo), [2]Planetary Science Institute, China University of Geosciences, Wuhan, 430074, China, [3]State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, Beijing, 100101, China.

Introduction: Qaidam Basin, as a suitable analogue site like present Martain environments, lies in the north of Tibetan Plateau. The formation of the Qaidam Basin indicates an enormous body of water which can be traced back to the Jurassic [1]. Previous drilling reveals more than ten kilometers sediments in the basin [2]. Geographical conditions and high elevation of playas in Qaidam Basin induce Mars-like environmental conditions, such as low temperature, low atmospheric pressure and extremely dry envirnonemnt [3]. For Mars exploration, in-situ subsurface structure has never been carried, although Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) and Shallow Radar (SHARAD) have achieved great success and obtained vast amounts of data on Mars [4,5].

Ground Penetrating Radar (GPR) can reveal the stratigraphy of the shallow underground and will be employed in the future martian missions. Because Mars also has lacustrine sediments of high importance for martian paleo-environment and astrobiology, where GPR detection would play a very important role. In this study, we used GPR to detect the subsurface structures of Dalangtan playa in western Qaidam Basin. The aim of this study is to offer terrestrial analogues in the Chinese future Mars exploration missions.

Measurements: In July 2017, we used GPR (pluseEKKO with 50 MHz unshield antennas and 250 MHz shield antennas) to measure the subsurface structure of playas (dry salty lakes) at several sites. When the frequency of antennas is 250 MHz, the sampling time is 0.4 ns and the antenna separation is 0.38 m. The sampling time and antanna separation in the measurement of 50 MHz are 1.6 ns and 2 m, respectively. In our measurements, common offset survey is performed. The results from different frequency are complementary, so a combined interpretation is possible. In addition, we also collected samples at different depths. The samples will be tested in laboratory to get the value of dielectric properties.

Results: Fig. 1 shows a photo of the yardang (38.06 ° N, 93.10 ° E) where we used GPR to detect subsurface structures. The length of the yardang is more than 30 m and the height is about 10 m. The survey line from A to B is on the secondary top of the yardang. We only used the 250 MHz shield antennas because of the narrow space. There is a obvious anomaly with an arched shape in the yardang (Fig. 1). The arched anomaly may be caused by the irregular sedimentation.

Fig. 1 Field photo of the GPR measurement. The length of survey line from A to B is 5 meter. The 250 MHz antennas were used for high resolution images.

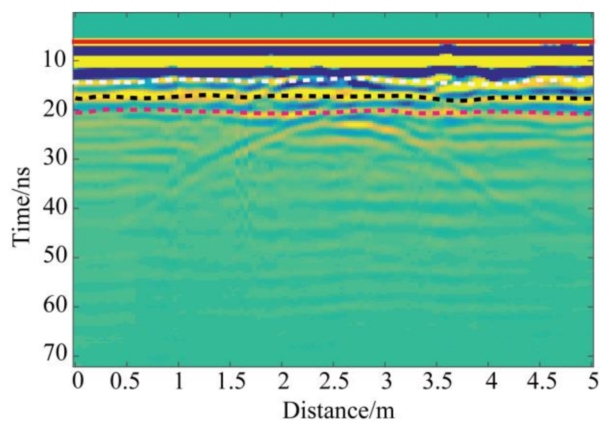

Fig.2 Radargram of the measurement on the surface of Yardang. The red line denotes the surface reflections. The white, black and pink dashed lines indicate the subsurface interfaces.

Results of GPR detection are shown in Fig. 2. The total time window is about 140 ns and the trace number is 125 along the survey line. The vertical resolution of 250 MHz shield antenna is 1.2 m in the free space. In the results, reflectors from the arched anomaly are clear (Fig. 2). These arched reflectors provide references to confirm the locations of the anomaly in the exposed profile of the yardang.

The number of layers in the radargram is less than that in the photo. The reasons may be: 1) the thickness of thin layers in the yardang is less than the vertical resolution of radar; 2) the dielectric contrast between some layers is not enough to cause strong reflectors; 3) the real reflectors are suppressed by multiple waves. We observed more than 5 layers above the arched anomaly in Fig. 1. But only three layers indicated by the colored dash lines in Fig. 2 can be recognized in the radargram. The white dased line (Fig. 2) indicate weak reflectors which may be attributed to the similar values of permittivity near the surface.

According to the measurement, the distance and double travel time between the top of arched anomaly and the surface of yardang is about 1 m and 16.8 ns, respectively. Hence, the relative permittivity of the materials in the first 1 m depth of yardang is estimated to be ~6.4. The value is consistent with rocks such as mudstone and sandstone. However, the value of 6.4 indicates the mean value of the layers within 1 meter from the surface. Future work is to obtain a detailed results of the dielectric properties. GPR modeling based on Finite-Difference Time-Domain (FDTD) is necessary to distinguish the real subsurface reflectors from the rings or multiple waves. Then the results will be compared with the experimental results of the samples.

Discussions: Geomorpological evidences, such as polygons, gullies and mass debris flows, have shown that the early martian environmengt might be warmer and wetter [6]. Lakes or seas may exist in the Valles Marineris and many impact craters on the Mars [7,8]. Layered and massive outcrops which may be relative to subaerial and subaqueous processes display the geomorphic attributes and stratigraphic relations of sedimentary rock [9].

The Qaidam basin is a lake basin and the thickness of fluvio-lacustrine sedimentary deposits in Qaidam basin can extend up to 12,000 m [2]. Layered sedimentary structures are usually exposed by the landforms such as yardangs because of the aeolian erosion. These layers in the yardangs preserve a record of the sedimentation in the formation of the Qaidam basin. GPR measurements on yardangs show if the radargram can reveal the similar stratigraphy of the vertical profile as the exposed layered structure and if the dielectric properties of lake sediments obtained by radar results matches with the compostion analysis of the samples collected on site.

In our measurement, the pluseEKKO radar with 250 MHz shield antennas can reveal the layered structure of lake sediments and its penetration depth is more than 5 m with a high resolution of better than 0.5 m. In the Chinese future Mars exploration missions, the lander may carry GPR with high frequency. This work provides reference of terrestrial analogues for GPR detection on Mars.

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