APPLICATION OF SALINE LAKE STUDIES IN MARTIAN GEOLOGY AND PALEOCLIMATOLOGY: IMPLICATION FOR WIDESPREAD POTASSIUM SALTS ON MARS. M.P. Zheng[1] and W.G. Kong[1], [1]R&D Center of Saline Lakes and Epithermal Deposits, Chinese Academy of Geological Sciences, Beijing, 100037, China (zmp@public.bta.net.cn).

Introduction: Martian salts have long been the key clues for understanding the geology, the geochemistry, and the climate of current and past Mars. The in situ identification of Jarosite by Mössbauer spectrometry on board Opportunity rover at Meridiani outcrop revealed the existence of an aqueous environment in the past [1], while the ubiquitous sulfates bearing materials revealed by orbital remote sensing (e.g. [2-4]) indicate that liquid water was prevalence in an epoch in the geologic history of Mars. The carbonate bearing materials found by CRISM at Nili Fossae region indicate a neutral to alkali aqueous formation environment [5], while the carbonates found at Leiden Crater suggests huge carbonate deposits covered by volcanic materials [6]. Another important type of sediments, chlorites bearing materials, was also suggested to be globally widespread at locally by THEMIS instrument [7], this finding emphasize the importance of aqueous processes in the geological history of Mars. The perchlorate discovered at Phoenix landing site provided an essential environmental marker for Mars [8].

Morphological features such as valley networks and outflow channels are another aspect of evidence for the prevalence of liquid water at Martian surface in history [9], and these morphological features formed through the Noachian and Hesperian period. Like the earth, the huge water bodies had been reacting with rock surfaces through such long geological time and produced the salts mentioned above, and the salt assemblages found on Mars is also similar to that on earth. The chemical compositions of rocks at four landing sites measured by landers (Viking, Pathfinder, Opportunity, and Spirit) are very similar to that on earth [10], so the similarity of salt assemblage between Earth and Mars is understandable. Here, we are trying to get further understanding of the distribution of salts on Mars by applying the principles obtained from the studies of terrestrial saline lakes [e.g. 11，12].

Potential deposits of widespread potassium salts

It is convincing that almost one third of the Martian surface was covered by liquid water [13]. These water surfaces can be either ancient lakes or oceans [14, 15], and most likely, oceans and lakes coexists through most of the period when Mars had a hydrosphere just like the earth today. And these water surface dried up at the late Hesperian and widespread salt deposits has formed, such as the chlorite bearing materials found throughout regions of low albedo in the southern highlands of Mars [7]. These chlorite bearing materials appear at crater floors and local topographic lows relative to the immediate surrounding terrain, implying that these salts may origin from the dry up event of paleolakes on Mars. This type of distribution is also similar to that of the terrestrial saline lakes on the highlands like the Qinghai-Tibet plateau. If the deduction is true, it would not be a surprise that the assemblages and the sequences of salt sediments on Mars are similar to that on earth. So, the application of the principles of terrestrial saline lakes will help us get better understanding of Martian salts.

Here, we choose the results of the chemical analysis of the rocks at Meridiani outcrops by MB+APXS+RAT instruments on Opportunity rover as a case study [16]. In this work, they analyzed the chemical composition of rocks at different layers of the interior wall of Endurance crater, and these chemical data of different layers were used to “label” all 19 measured rocks with a relative layer sequence. After that, they showed several measured salt forming anions (Fig. 1) of these layers. The results showed that bromine generally lies on the top of chlorine, which on earth usually indicates that terrestrial marine potassium salts lies on the top of evaporation saline rocks. Although this is only measured at Meridiani outcrop, it can be indicated that salt deposits at other place on Mars may have similar stratigraphic structure.

Implications for paleoclimate of Mars

Based on the morphological observations [17], the huge water bodies, especially the ancient oceans that covered one third of the surface of Mars have disappeared three billion years ago at late Hesperian period. Since then, Mars has been very dry until today. However, Earth has experienced at least ten globally dry-wet changes ever since the late Proterozoic era, this periodic change happened only under the condition of a relatively stable atmosphere of the Earth. So, the enormous dried up event happened on Mars indicates a substantial change in the atmospheric condition of Mars. The current Mars has a very thin atmosphere compared to the Earth. The pressure at Martian surface is less than one percent of that on earth, and the major constituents of Martian atmosphere is CO_2 (95.52 Vol%), water vapor (0.03 Vol%), nitrogen(2.7 Vol%), oxygen (0.13 Vol%) etc. Unlike the hot surface heated by the greenhouse effect from CO_2 with pressure of 200 bars on Venus, the CO_2 gas with pressure less than 0.01 bars on Mars cannot trap enough energy from the

sun to make the temperature of the Martian surface high enough for liquid water. Furthermore, even with denser CO_2 atmosphere (>1 bar), the greenhouse effect still cannot lead to a temperature sufficient for liquid water due to longer distance from the sun compared to that from Earth [18]. Other processes may also serve enough energy for a surface environment with temperature suitable for precipitation like volcanism or giant impacts. Here we seek to figure out this mystery by detailed study of the origin and distribution of Martian salts.

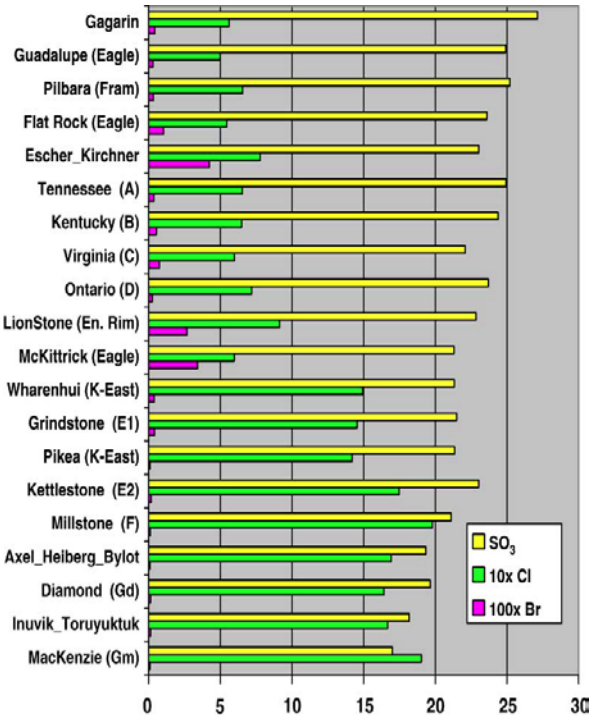

Fig. 1. Salt forming anions (wt%) of rocks at Meridiani outcrop listed in stratigraphic orders from top to bottom (adapted from [16]).

Future works: The large deposits of Martian salts revealed by recent Mars explorations have experienced 3 billion years of supergene processes since the late Hesperian and must be the secondary salt sediments. Thus the distribution of these Martian salts cannot directly reflect their formation environment, so we will primarily choose to study the saline lakes at Qinghai-Tibet plateau and the Solar de Atacama area as the analog sites for the Martian salt studies because their supergene processes are similar to that on Mars. Besides, we will also study the fundamental properties (e.g. the stability field and reacting rates) of selected salts that have essential meanings for Mars.

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