Submillimeter observations of SO2 in martian atmosphere using ASTE high-spectral resolution measurement

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With increased knowledge on our 'neighbor' planets Mars and Venus, based on recent aggressive explorations by the US and Europe, our image on them is changing significantly. It is almost certain that Mars once had a duration warm and wet climate and that it still conserves a large amount of water (ice) under the surface. Mars is now called a frozen water planet. Evolution of Mars (Why/When did they diverge?) is important for understanding the process to form the planetary environment for life. Japan launched NOZOMI in 1998 but the insertion to Mars orbit turned out to be unsuccessful. Recently, groups of enthusiastic people got together, forming a working group, to challenge the Mars exploration again.

One of the most puzzling of Mars is that organics have not yet been found on the surface. The simplest of organic molecules, methane, was detected in the Martian atmosphere for the first time in 2003 [Formisano et al., 2004]. Currently, there is no active volcanism on Mars, and traces of the latest active volcanism are 2 to 100 million years old [Neukum et al., 2004]. Thus, the existence and behavior of methane on Mars is of great significance, as methane is a potential biomarker. However, there are still disparity in the previous estimations [e.g., Krasnopolsky et al., 2004; Mumma. 2004;2005]. In addition, weak outgassing from (or interaction with) the surface and subsurface is still possible because the evidence for recent groundwater seepage comes from MOC image. A sensitive search for martian SO2, which is the most abundant species in terrestrial volcanic gases, with a higher spectral-resolution than previous studies should be needed.

Here, we review our current observation relevant to the SO2 of Mars using Atacama Submilimeter Telescope Experiment (ASTE) on December 2007. The purpose of this study is (1) to restrict the recent martian volcanic activity, and the outgassing from the interior, and (2) to verify the relationship with CH4 by observing SO2 in the season which more CH4 was observed by previous study.

A sensitive spectrum puts an upper limit on SO2 on 1ppb. SO2 abundance below this limit may not affect martian photochemistry [Krasnopolsky, 1993]. Seepage of SO2 is less than 15,000 tons per years on Mars which is smaller than the volcanic production of SO2 on Earth by a factor of 700 [Krasnopolsky, 2005. Our upper limit in the martian atmosphere and comparatively long lifetime of SO2 do not support existence of extended regions. Even in the season which more CH4 was detected, the evidence for seepage could not be found. Because the ratio of CH4 to SO2 is typically 10ˆ-4 ˜-3 in volcanic gas on the Earth, our results show seepage is unlikely to be source of the recently discovered methane on Mars and therefore strengthen its biogenic origin (or other possible origin).