Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PPS05-01 Room:106 Time:May 27 14:15-14:30

Examination of Mission Strategy and Spacecraft System to Study Martian Atmospheric Escape

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The atmospheric escape from Mars is considered to be closely associated with the evolution of the Martian atmosphere as well as the existence of the water on Mars. We are now investigating a project to study the global feature and the physical process of the atmospheric escape from Mars. It is expected to consist of two orbiters; the mother satellite is aimed to make in-situ observation of plasma and thin atmosphere at about 150 km altitude, and atmospheric imaging at the apo-apsis of 3RM altitude. The daughter satellite is the solar-wind monitor. We are planning to make simultaneous observation of the atmospheric escape by the interaction with the solar wind by these two satellites. Now we are examining the quantitative measurement targets to fully understand the Martian atmospheric escape. At the same time, the sorts and performance of scientific instruments on these orbiters are examined. And furthermore, the preliminary spacecraft design, orbit design and mission plan to achieve the scientific goal are investigated.

Keywords: Mars, Planetary atmosphere, Solar wind, Planetary Magnetic Field, Plasma

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PPS05-02 Room:106 Time:May 27 14:30-14:50

MARS PLATE-TECTONIC-BASEMENT

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Introduction: The Hadean-age-equivalent (>4.0 Ga) Martian basement complex has heretofore been difficult to characterize. This is due to extensive modification by the Late Heavy Bombardment and subsequent impacts, as well as chemical alteration of the primary rocks (including weathering rinds, clay minerals, Al/Fe oxides/hydroxides, sulfates, and evaporite deposits). Obscuration of a felsic basement includes erosion of the terrain predominantly through wind and water activity, as well pervasive mantling by wind- (e.g., aeolian), water- (e.g., fluvial, alluvial, colluvial, glacial, periglacial), and volcanic- (airfall deposits, lava flows materials, fine-grained volcanic spherules transported by wind) related materials.

Yet, unlike the Hadean rocks that have been obliterated on Earth, the Hadean-age-equivalent ancient Martian basement is still preserved. This is because an Earth-like phase of Mars, including an active dynamo and hypothesized plate tectonism, terminated sufficiently early in its evolutional stage to archive early Mars rocks, early solar system history, and possibly evidence of early life. New evidence for plate tectonism includes a systematic, spatial arrangement of landforms, referred to as the Claritas subduction zone region that is strikingly similar to the plate-tectonic-modified landscapes of the western US that resulted from plate migration and subduction, including the subduction of the denser mafic Farallon Plate beneath the lighter felsic North American Plate. We will present this finding and additional evidence for a Hadean-age-equivalent phase of plate tectonism on Mars and its implications. For greater details see [1].

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Keywords: mars, plate tectonics, basement, felsic

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PPS05-03 Room:A03 Time:May 28 09:00-09:15

Early Evolution of Martian Atmosphere and Hydrosphere: Constraints from Isotopic Compositions

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Current Mars has a cold and dry surface environment with a small amount of water-ice observed at the polar regions (Christensen, 2006). On the contrary, increasing evidence suggests that the early Mars once sustained a warm climate with a large amount of liquid water (e.g., Di Achille & Hynek, 2010). Though impact erosion and thermal/nonthermal escape are accepted to have possibly contributed to the loss of the early atmosphere and hydrosphere (Lammer et al., 2008), the timing of the escape and the relative importance of each process are poorly constrained.

The thermal/nonthermal escape induces isotopic fractionation that leaves behind heavier isotopes in the atmosphere and hydrosphere, whereas the impact erosion removes a fraction of atmosphere without the isotopic fractionation. The early evolution of the atmosphere and hydrosphere is constrained by the isotopic data of the martian meteorite Allan Hills 84001 (ALH 84001), which records a high hydrogen isotope ratio (D/H = $\sim$2-4 times the Martian primordial water) of 4.1 Ga surface water (Boctor et al., 2003; Greenwood et al., 2008). The high D/H ratio suggests that a larger amount of water was lost during the first 0.4 billion years than the later periods by the thermal/nonthermal escape (Kurokawa et al., 2014). On the other hand, the isotope ratios of noble gases at 4.1 Ga show unfractionated values, implying that the atmosphere was lost after 4.1 Ga (Mathew & Marti, 2001; Jakosky & Phillips, 2001). Estimates of atmospheric nitrogen isotope composition of ALH 84001 varies in previous studies (Miura & Sugiura, 2000; Mathew & Marti, 2001).

We calculate the evolution of the total amounts of the atmosphere and hydrosphere and their isotopic compositions individually, considering the impact erosion and thermal/nonthermal escape. First, we calculate the evolution of the total atmospheric pressure due to the impact erosion using a stochastic bombardment model (Kurosawa et al., 2013). We calculate the surface age using the cumulative number of impacts and an empirical curve obtained from the lunar craters (Chyba, 1991). The erosion efficiency at each impact is calculated using a modified sector blow-off model (Vickery & Melosh, 1990). The momentum of an expanding silicate vapor is calculated using the entropy method (e.g., Ahrens & O'Keefe, 1972; Kurosawa et al., 2012) and thermodynamic data for forsterite (Sekine et al., 2012). Second, we calculate the evolution of the isotope ratios of the minor volatile elements (D/H, $^{15}N/^{14}N$, $^{38}Ar/^{36}Ar$) due to the thermal/nonthermal escape following the evolution of the total pressure. We assume the escape rates of the ion pick-up, sputtering, and photochemical escape given by Jakosky et al. (1994) and Pepin (1994) for oxygen, nitrogen, and argon. Hydrogen is lost by the Jeans escape whose escape rate is regulated by the loss of oxygen (Liu & Donahue, 1976). The fractionation factor of hydrogen is assumed to be 0.016 (Krasnopolsky et al., 1998; Krasnopolsky 2000). We adapt the fractionation factors of other species (nitrogen and argon) tabulated in Jakosky et al. (1994).

The total pressure decreases in several orders of magnitude during the first several hundred million years which corresponds to the heavy bombardment period, whereas the degree of pressure reduction is relatively insignificant after this period. The nitrogen and argon isotope ratios start to increase as the total pressure decreases. On the contrary, the D/H ratio increases independently of the total atmospheric pressure because the major reservoir of hydrogen is the hydrosphere.

Comparing our results with the isotopic data at 4.1 Ga recorded in the martian meteorite ALH 84001, we propose a scenario that the loss of atmosphere and hydrosphere had proceeded before 4.1 Ga. An efficient isotopic fractionation of atmospheric nitrogen and noble gases due to the thermal/nonthermal escape started after the impact erosion of the thick early atmosphere during the heavy bombardment period.

Keywords: Mars, atmosphere, hydrosphere, isotope, impact, atmospheric escape

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PPS05-04 Room:A03 Time:May 28 09:15-09:30

Spectral observation of mesospheric CO_2 ice clouds in the Martian mid-low latitude using PFS onboard Mars Express

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Mars is the only known planet where CO_2 ice clouds can be observed. CO_2, main component of Martian atmosphere, can condense and form 'CO_2 ice clouds' in the coldest region; in the troposphere above polar night and in the mesosphere around equator. CO_2 ice has narrow spectral emission peak feature at 4.3 um. Unfortunately, polar cloud in the lower altitude is below thick atmosphere and this spectral feature can not be detected by strong CO_2 gas absorption. However, mesospheric cloud in low-mid latitude is enough high. Dayside nadir observation of OMEGA aboard the Mars Express spacecraft first detected such feature.

In this study, we attempted to detect the spectral feature of mesospheric CO_2 ice clouds in low-mid latitude at 4.3 um band by Planetary Fourier Spectrometer (PFS) onboard Mars Express. In this wavelength, its spectral resolution is ˜1,000, about 10 times higher than that of OMEGA. It enables us to resolve the spectral features of CO_2 ice clouds with enough resolution to estimate their particle size comparing with synthetic spectra. We confirmed that PFS could detect this spectral profil on the orbits where OMEGA detected CO_2 ice clouds. In the PFS spectral resolution, we identified two spectral types, i.e., 'single-peak case' at 4.25 um and 'double-peak case' at 4.25 and 4.28 um, which were not resolved by OMEGA.

Based on this confirmation, we statistically surveyed the CO_2 ice features in all PFS data in 2004-2014 which covers MY 27-32. We identified 272 single-peak cases and 9 double-peak cases. Spatial and seasonal distributions of CO_2 ice clouds agreed with the previous studies. In spatial distribution, CO_2 ice clouds were detected in the latitude range of 20 degS to 20 degN and the longitude range of 100 degW to 30 degE and around 170 degE. In seasonal variation, almost all of CO_2 ice clouds were detected just after spring equinox (L_s: 0-30 deg).

In these samples, the spectral peak in the single-peak case and the first peak of double-peak case was centered at 4.252 um. From this observed feature, we derived the typical particle size of CO_2 ice clouds by the comparison with the synthetic spectra derived by a radiative transfer model with the assumption that cloud particles were made of pure CO_2 ice and had spherical shape. Refractive index of CO_2 ice is from experimental one. Although the observed single-peak feature was reproduced by the model, the peak wavelength appeared at ˜4.27 um, shifted to 0.02 {¥mu}m longer position than the observed one. Such shift of the peak position could not be reproduced by various particle parameters, including radius, size variance, and column density. In addition, the synthetic spectra could not reproduce the double-peak structure observed by PFS. We proposed three possible cases to explain these discrepancies; (1) the uncertainty of the refractive indices, (2) non-spherical particle shape, and (3) different core material in CO_2 ice. For (1), we simply assumed that the model refractive index could be shifted 20 nm toward shorter wavelength. After that, we got satisfied agreement between the observed and model spectrum. Based on the matching of both spectrum, effective radii of observed CO_2 ice cloud were constrained in the range between 0.63 to 1.0 um. This is the first quantitative estimation of the CO_2 ice clouds using 4.3 um feature of CO_2 ice. The effective radii obtained by our model follows the line of CRISM observation (0.5-2.0 um) but slightly small compared with that of previous works. For (2) and (3), they can potentally produce double-peak features observed by PFS. It means that non-spherical haze with a core material might be actual characteristics of the Martian mespheric CO_2 ice cloud.

PPS05-05 Room:A03 Time:May 28 09:30-09:45

Cyclic step on ice: experiments and theoretical study aiming to spiral troughs on Mars' North Polar ice cap

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The spiral troughs observed on the Mars' North Polar Layered Deposits (NPLD) contain a detailed stratigraphic record of surface processes in Mars' recent polar history. SHARAD radar data showed that the troughs have migrated towards the north during the accumulation of the uppermost ˜600 m of NPLD, and Smith et al. (2013) concluded that the spiral troughs should be a kind of cyclic steps formed by katabatic wind blowing on the ice cap. Cyclic steps are spatially periodic bedforms where each wavelength is delineated by an upstream and downstream hydraulic jump. They migrate upstream keeping the same wavelength. Cyclic steps have been reported from various environments on the Earth, such as fluvial and deep-sea settings, and in various bed materials, such as bedrock, non-cohesive sediments, and cohesive sediments. While the formation of cyclic steps on bedrock or beds composed of sediment is a mechanical process, the formation of cyclic steps on ice is not only a mechanical but thermodynamic process. There have not been many studies on the thermodynamics of the formation of cyclic steps on ice to authors' knowledge. In this study, we conducted a series of experiments on the formation of cyclic steps on ice due to flowing water over it. In addition, we performed a linear stability analysis of the water-ice interface and show that the formation of cyclic steps can be explained by the results of the analysis in part.

The experiments were conducted in the cold chamber owned by the Institute of Low Temperature Science, Hokkaido University. We have conducted 8 cases of experiments by the use of the experimental apparatus that consists of a flume, a cooling system of the flume, and a circulating system of water. We kept the ice temperature to be below zero degrees in Celsius, the flowing water temperature to be from 0.2 to 2 degrees in Celsius, and the room temperature to be about 5 degrees in Celsius. As a result, it is found that trains of steps are formed when the Froude number is larger than a value around unity. Those steps are associated with hydraulic jumps, and steps mostly migrate in the upstream direction. Based on these diagnoses and the morphologic feature, these steps can be evaluated as cyclic steps on ice bed.

We performed a linear stability analysis on instability of interface between flowing water and ice, and made physical explanation of the formation of cyclic steps. According to the results of the analysis, the interface becomes unstable when the Reynolds number is relatively large under the condition that the heat flux from ice is sufficiently weak, that is to say, the temperature at the ice bottom is not so low, and the ice thickness is sufficiently large. In addition, the unstable region in the wave number - Reynolds number plane hardly depends on the heat transfer coefficient of air normalized by the heat diffusivity of water and the flow depth.

We compared the results of experiments and the analysis, and found that the experimental data fall on the unstable region both in the wave number - Reynolds number plane and the wave number - Froude number plane where interfacial instability takes place. This indicates that at least the experimental results are consistent with the analytical results. The critical Froude number derived from the analysis is approximately unity in the range of small slope angles, and slightly increases with the slope angle. In the experiments, cyclic steps are not formed in the case of the Froude number smaller than unity while cyclic steps are formed in all the case of the Froude number larger than unity. In terms of the critical Froude number, the experimental results are well explained by the analysis.

Keywords: cyclic step, ice, spiral troughs

PPS05-06 Room:A03 Time:May 28 09:45-10:00

Life search plan on Mars surface and the significance

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The view of active Mars has been emerged based on the recent findings of the exploration and high-resolution imaging of Mars. The finding includes the Recurring Slope Linear (RSL), where the presence of liquid water is most provable. We are planning to test the view of Mars still active and the presence of current life at the most promising place on the Mars surface.

Thought the 1970's Viking mission reported the detection of catalytic reaction that could be attributed to life (Levin and Straat 1977), negative conclusion was made based on the level of organic compound lower than the detection limit. In 2000's, the results of Viking mission was reevaluated(Glavin, et al.2001; Navarro-Gonzalez, 2006), and found that the detection limit of organic compound, 10^6-10^7 cells/g soil, is not sufficient to detect the microbes with lowest microbe density (i.e. deep see water, Atacama desert, Antarctic desert soil) 10^4cells on Earth.

SAM (Sample Analysis at Mars) onboard the NASA's Rover MSL (Mars Scientific Laboratory) Curiosity has detected organic compound in the Gale Crater, though its origin is not clear. SAM detected chlorinated methane 4 micro gram/g Martian soil (Ming et al. 2014). If we assume the amount corresponds to the total organic carbon and the ratio of total organic carbon and microbes similar to those at Atacama Desert (Connon et al. 2007), the 4 x 10^4 cells/g soil is expected for the Gale Crater. We developed the fluorescence microscope system to detect the microbe. We are targeting the most provable place with liquid water. We will use fluorescence microscope and fluorescence pigment that can detect organic compounds and can differentiate it from organic compounds surrounded by membrane, the latter being most provably "cells". We named the system Life Detection Microscope, LDM.

If we were to find life on Mars surface, life will be examined, and totally new knowledge of life extending the knowledge of terrestrial life will be obtained, transforming the Biology to New and so to speak Real Biology.

In the next stage of exploration, genetic material DNA and amino acid will be analyzed. If the Martian life uses genetic material different from DNA or the DNA different from ACGT, it is life emerged independently. If the life on Mars turned out to possess the same DNA (ACGT) as terrestrial life, phylogenetic analysis of Martian life will be conducted. The Martian life may be unrelated to terrestrial life, if there is no homology between genes of the two life forms. If there is homology between genes, phylogenetic tree will tell us whether the life emerged only on Earth and transported to Mars, or the life emerged only on Mars and transported to Earth. In the last case, life may have emerged on the third celestial body and transported to Earth and Mars.

If the life could not be found by LDM, the current scheme on origin of life has to be reconsidered. A. If life emerged both on Mars and Earth, what is the condition supported life only on Earth. B. If life emerged only on Earth, what is the critical factor that prevented the emergence of life on Mars. C. If life emerged only on Mars, why it is extinct on Mars. D. If the life emerged on the third celestial body, what prevented the settling of life on Mars. Prebiotic conditions on Mars and Earth have to be reevaluated.

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Keywords: Fluorescence microscope, Fluorescence pigment, Origin of life, Phylogenetic tree

PPS05-07 Room:A03 Time:May 28 10:00-10:15

Life-Detection Microscope (LDM) onboard 2020 Mars Mission MELOS

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Life-Detection Microscope (LDM) is the primary science payload onboard the MELOS rover which we propose to launch in 2020. LDM is designed to achieve a sensitivity (10^4 cells per gram soil) which is two orders of magnitude better than the Viking Lander experiments. The strategy to achieve this high sensitivity includes: 1) cells, if exist, are dyed with SYTO24, PI, and CDMA pigments; 2) the fluorescence from dyed cells (excited with blue light at 488 nm) is imaged with 1 um/pixel resolution; 3) the field of view in one image is 1 mm^2; and 4) 2 mm^3 volume of Martian soil is scanned.

LDM consists of 3 components: Sample-Handling System (SHS), Fluorescence Microscope (FluM), and Driver and Data Processor (DDP). To receive soil sample from the robotic arm of the rover, one "empty" sample container is selected and is moved to the sample inlet position (X and Y movements in SHS). After receiving the soil sample, the dye is injected and then the container lid is closed so that the rapid evapolation of the solvent under the atmospheric pressure (6 hPa) of Mars is avoided. A set of regolith and dust images in white light are acquired before "fluorescence" mode is started. In "fluorescence" mode, a set of images with different focal depths (0 to 0.1 mm) are acquired at each of 20 (X, Y) positions, achieving scan of desired volume (2 mm^3) of soil sample. The images are examined for suspicious objects and small sections of images which include such objects, if any, are stored in the rover's data recorder for later downlink to the earth.

We will report progress in development of LDM and will discuss the operation strategy of LDM in the mission period on Mars.

Keywords: Mars, Life, Microscope, Fluorescence, Soil, Rover

PPS05-08 Room:A03 Time:May 28 10:15-10:30

Exploration of carbonate and clay mineral on Mars: clues for climate, atmosphere, and deep hydrosphere of early Mars

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High-resolution remote sensing data of Mars Noachian terrains show the widespread existences of clay minerals formed by groundwater circulations [1]. This suggests that hydrothermal activity in deep crusts may have played a major role in hydrological cycles on early Mars [1], which is contrast to those on current Earth and might be similar to those occurred on Europa or Enceladus [2, 3]. To date, however, Mars rovers have performed analyses at outcrops of sedimentary rocks formed mainly by open water activity [4, 5]. Lack of knowledge on the nature of groundwater activity obscures us to understand a whole picture of hydrological cycles, aqueous geochemistry, and habitability on early Mars.

Recent observations and models suggest that there are some locations where groundwater upwelled on the surface of early Mars [6]. These include one of the deepest craters on Mars, McLaughlin Crater, which exhibits layered deposits of carbonates and Mg-Fe-bearing phyllosilicates on the crater floor [6]. The proposed mineral assemblages suggest the occurrence of geochemistry between CO2-bearing, alkaline groundwater and ultramafic rocks [6]. This implies that the outcrops of McLaughlin Crater could serve as a unique window to look into the nature of groundwater activity and its interactions with the atmosphere of early Mars.

Here we propose a Mars rover mission to perform geological and geochemical analyses of outcropped carbonates and clay minerals on McLaughlin Crater. Geological observations of the outcrops would determine the formation processes of these layered deposits. The aqueous geochemical conditions (e.g., the composition, redox state, and pH of groundwater, water-rock ratio, and temperature) would be determined based on results of detailed chemical and mineralogical compositions of the outcrops. These observational data enable us to constrain redox potentials of groundwater, which could support deep biosphere on Mars. In addition, we can estimate the partial pressure of atmospheric CO2 equilibrated with the groundwater. This, in turn, means that our mission will be able to answer the long-standing question whether early Mars had a dense CO2 atmosphere, which will provide critical insights into the habitable zone [7] and formation process of terrestrial planets in the solar system and beyond.

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Keywords: Mars, exploration, geochemistry, carbonate, hydrothermal activity, atmosphere

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PPS05-09 Room:A03 Time:May 28 10:30-10:45

MEMS pirani pressure sensor for the Mars Organic Molecule Analyzer (MOMA) of the ExoMars Mission

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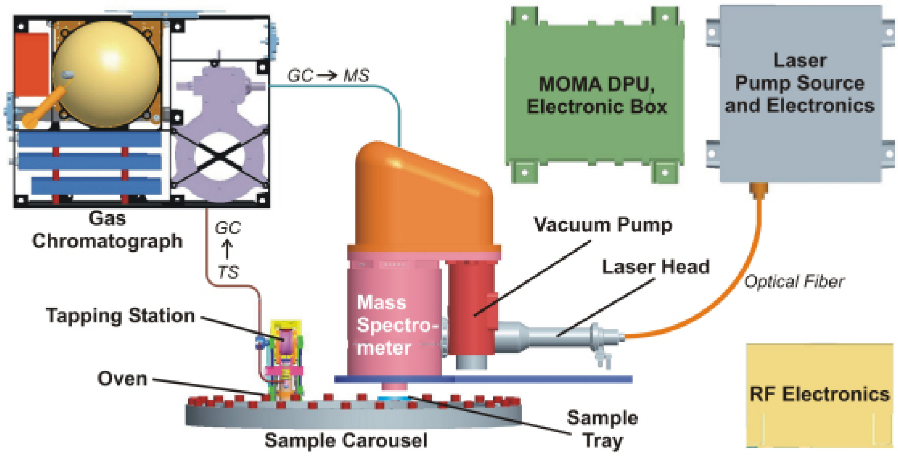
The Mars Organic Molecule Analyzer, MOMA is a collaborative mission by European Space Agency, and NASA Goddard Space Flight Center. MOMA is a key analytical instrument aboard the ExoMars rover, set to launch in 2018. The rover will search for past and present evidence of martian life The twin rovers Spirit and Opportunity have confirmed that water was long standing on the surface of Mars long ago. The Curiosity rover found aromatic, organic compounds in the mudstone at the bottom of a possible ancient lake. Mars Science Laboratory scientists found that chlorobenzene was formed during the reactions inside the Sample Analysis (SAM) instrument from martian chlorine and carbon during the heating of perchlorates known to be present in martian soil. The ExoMars rover will sample martian soil/rock at depths of up to 2 meters, deeper than any instrument before it. The rover collect the sample and analyze them by MOMA. The MOMA has two operation modes: Gas Chromatograph-Mass Spectrometry (GC-MS); and Laser Desorption-Mass Spectrometry (LD-MS). (Please see the image) LD-MS employ laser desorption ionization to avoid the need to heat the sample, thereby preventing perchlorate reactions, which complicate identification of compounds in the sample. GC-MS will identify the chirality of organic molecules, improving understanding of how these molecules were formed.

The MEMS (microelectro-mechanical system) pirani pressure sensor is a critical component that will be used to ensure the ion trap mass spectrometer's time sensitive operation in the LD-MS mode. It employ a high voltage for ionizations, and knowing the pressure of the MS chamber by miliseconds time scale is critical. The pressure data is used for the telemetry of the MS operation. Also the pirani pressure sensor has a critical function that pressure changes as a discontinuous inlet and pump work together to sample the Mars atmosphere in LD-MS mode. It also has to work at ambient temperatures varying from -20 to 80 degrees Celsius and be calibrated for both carbon dioxide for sampling martian atmosphere and helium during use of the gas chromatograph. The MEMS pirani sensor provides better than 0.1 mtorr accuracy over the critical pressure range from 1 mtorr to 0.1 mtorr and has a usable pressure range from 0.1 mtorr to 0.1 torr. This paper will focus on the characterization of the pirani sensor and its electrical interface and modeling ideas of a next generation of MEMS pressure sensor for future planetary and space missions.

Keywords: Robotic Rover Mission on Mars, MEMS pirani pressure sensor, Organic molecule analysis, Ion Trap, Laser Desorption Mass Spectroscopy, Gas Chromatograph Mass Spectroscopy



PPS05-10 Room:A03 Time:May 28 11:00-11:15

Possible landing sites on Mars for an in-situ K-Ar dating by future Japan's Mars rover mission

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Mars shows a variety of surface features affected by geologic processes. Though the crater-based dating has estimated surface ages, ranging from nearly 4.5 Ga age to recent, the absolute ages have not been determined for Martian samples except a mudstone at Gale crater by the Curiosity rover mission (4.21 ± 0.35 b.y.) and meteorites that come from somewhere on Mars. The authors have been developing an in-situ K-Ar dating system for future Japan's landing mission on Mars (e.g., Cho et al., 2014, 2015). In this paper, aims of the chronologic investigation using the system onboard a Mars rover/lander and appropriate landing sites are discussed.

Studies of impact crater densities present three representative eras for geologic history of Mars; Noachian, Hesperian and Amazonian (e.g., Tanaka, 1986). Abundant water should have existed early in Martian history (likely the Noachian and a part of the Hesperian), but most of them disappeared. In order to understand habitable environment, climate changes and atmosphere evolution of Mars it is important to determine the absolute ages of geologically-well-defined Noachian/Hesperian samples. Considering crater chronology, mineralogy, geological setting and engineering requirements (altitude, latitude and thermal inertia), we propose three regions that are covered by Hesperian volcanic rocks as candidates of chronologic investigation; Syrtis Major Planum, north-east side of Tharsis and peripheral area of Amazonis Planitia. Crater counting based on CTX and HRSC images applied to five specific areas in Syrtis Major provides ages ranging in 3.0 - 3.6 Ga (where the model by Hartmann and Neukum, 2001 is adopted). Among which, two areas reveal resurfacing evidences; the crater frequency gives older ages of 3.7 - 3.8 Ga for the sizes >1 km in diameter and the thickness of the younger lava (for the sizes <1 km) is estimated to be ~ 40 m. Syrtis Major, having gentle slope and less abundant dust, is a highly recommended region for the landing site. Further information such as local morphology and shock and alteration phenomena should also be considered.

Keywords: Mars, Mars exploration, K-Ar dating, chronology, Hesperian, Syrtis Major

PPS05-11 Room:A03 Time:May 28 11:15-11:30

Remote sensing of Martian surface events by Electro-magnetic and Sonic Wave observation aboard a Martian rover

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In order to detect many kinds of surface events on Mars, a small instrument with electro-magnetic and sonic wave receivers has been considered as one of the remote sensing equipments onboard a future Japanese Mars rover.

By combining the observation of 3-axes electro-magnetic waves and sonic waves, precise identification of the events source coordinates with respect to the rover position can be realized because of the phase difference of each detecting waves and large difference of the speed of light (c) and sound (Cs). The observation plan has been discussed as a remote sensing instrument for distribution measurement of Martian discharge events (like lightning and thunder on the Earth), however, it can also be applied for the Martian surface studies as a very unique equipment, moreover, the size, weight, and power resources for the instrument is small and suited for installing on the small rover system planned to land the Mars.

On the Mars, as a result of the most recent research activities mainly by the NASA MSL (Opportunity) rover and several orbiters, many possible surface events like fluid motion on the edge of craters, so called RSL (Recurring Slope Lineae) seen as a narrow dark-tones streak activities depending on the Martian season change. Moreover, some scientists reported the possible regions of gas eruption from the surface of the Mars.

Here, we will introduce the recent progress of the instrumentation design and environment test results of the electro-magnetic and sonic wave observation instruments for the future exploration by landing explorer on the Mars.

Keywords: Mars, Electro-magnetic wave, Sonic wave, Surface events, Rover, Remote sensing

PPS05-12 Room:A03 Time:May 28 11:30-11:45

Characterization of Martian Regolith: Toward 2020s Mars Exploration Missions

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Mars once had surficial liquid water (paleo-ocean/lake) and shows a promising sign of current subsurface water/ice. The existence of hydrosphere and cryosphere makes Mars the unique accessible habitable planet next to the Earth. The water-rock interaction between the lithosphere and hydrosphere/cryosphere through the history of Mars has produced a variety of surface rocks (regolith) containing sheet-silicates, phosphates, sulfates, and carbonates, which are closely linked to climate and the potential for life on Mars. This study characterizes the physico-chemical properties (chemical composition, mineral abundance, reflectance feature, and geometric distribution) of Martian regoliths. We further present a way to leverage the database on Martian regoliths as a tool for interpreting remote sensing analyses by onboard instruments (e.g. Life Detection Microscope) for Mars exploration missions in 2020s.

Keywords: Mars, regolith

PPS05-13 Room:A03 Time:May 28 11:45-12:00

Geological implications of landing-site candidates of the MELOS mission

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Ancient Mars is now considered to have had environment somewhat similar to that of Earth in terms of the existence of large bodies of water, a wide range of surface oxidation states, appearances of variety of chemical components potentially building blocks of life, and a magnetic field. Endogenic activities have continued even until very recently, and recent water-related geological features indicate prolonged existence of an aquifer system, where a habitable environment may exist for a significant period of time. Occasional releases of volatiles from such an aquifer system may ultimately account for the inconclusive result (not unambiguous denial) of metabolism-detection instrument onboard Viking landers. Japanese MELOS Mars mission is proposed to carry an in-situ life detection package onboard a 150kg-sized rover, as well as a visible-near IR camera and a Ground Penetrating Radar system to perform geological investigation.

Because the primary purpose of the MELOS mission is to perform the Life Detection Microscope (LDM) instrument experiment, which is designed to detect less than 10ˆ4 cells in 1 gram clay, orders of magnitude higher than previous attempts performed by Viking landers, landing-site candidates of the MELOS mission are selected in terms of the possibility of the existence of near-surface water and recent geological and hydrological activities including the possible release of volatiles (specifically, relatively high water activity ($Aw>0.6$), a relatively higher maximum environmental temperature ($T>250$), and an existence of gradients of free energy). We propose Melas chasma as a prime candidate because of the existence of recurring slope lineae (RSL), where traces of possible liquid water and seasonal flow have been reported, as well as the fact that Valles Marineris provides the best exposures of the ancient geologic history of Mars. The latter includes: (1) Melas chasma being the widest and deepest part of the Valles Marineris; (2) it being connected to the outflow channels; (3) Interior Layered Deposits (ILDs) showing various sulfates deposits, suggesting the existence of abundant past water; and (4) various phyllosillicates having been detected among the canyon units. As for the current volatile release, we find Tharsis/Elysium Corridor region is the best candidate, which shows evidence of long-lived water enrichment and recent geologic activity, including recent venting that could bring materials from the subsurface to the surface environment. In this talk, we examine the morphologic characteristics of these features and discuss geological context of the candidate landing sites.

Keywords: Mars, MELOS, life detection, water, current activity

PPS05-14 Room:A03 Time:May 28 12:00-12:15

Meteorological Instruments of Mars EDL

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Mars Exploration plan is started for Landing at 2020.
Landing to Mars surface, Moving with Rover, and Searching Life itself.
We, Melos Meteorological Sub Working group, also proposal some instruments.
Those are including Thermometer, Anemometer, Barometer, Radiation Meter, Radiation Thermometer and Navigation camera, LIDAR, Particle counter.
We call first 5 instruments basic instruments set, and last 3 instruments Dust sensors.
This presentation is to introduce developing and testing sate of progress of these sensors.

[Thermometer] We use 3 different color thermos-sensors. Difference of radiative absorption makes difference temperature of sensor. Sensible heat is calculated it's difference. And 1 thermo-sensor is heated, for calculating wind velocity.
[Barometer] This instruments is in TRL-5. Using Impedance of Cristal
Oscillator is changing with friction of atmosphere.
If we know the air components, the friction is a function of Pressure, so it works as a barometer.
[Radiation Thermometer] Thermocouple seeing to the surface of Mars. It can measure Surface temperature.
[Anemometer] Same as Thermometer. But we use 4 couple of sensor, for calculating wind direction.
[Navigation Camera] This is a BUS-equipment to monitor around the rover. We use this camera to detect dust-devils.
[LIDAR] Counting the back scatter of LASER, We obtain a sum of cross-section of dusts along LASER path. Resolution along path is around 1m.
[Particle Counter] Small In-situ sensor, mechanism is similar to LIDAR.
Counting the scatter of light within very small (0.5x2x1mm) region.
This can measure number of particle for separated to 5 bin of size.

State of developing is very different each other, some is only discussion,
The others are tested with Mars like environment, Mars Environment Simulation Chamber settled in PERC/Chiba Institute of Technology).

Keywords: Mars, Meteology

PPS05-15 Room:A03 Time:May 28 12:15-12:30

Assessment of Mars surface environment for a exploration program: application of CReSS to Martian atmosphere

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A Mars surface exploration program is now planned by space engineering and planetary science communities in Japan. To support designing the landing module and observation instruments and ensure safety mission operation, evaluation of plausible range of meteorological conditions at proposed landing site is required. For mesoscale assessment of Mars surface environment, we are now trying to apply ”Cloud Resolving Storm Simulator (CReSS)” (Tsuboki and Sakakibara, 2002) to Martian atmosphere.

CReSS is a numerical model based on quasi-compressible system (Klemp and Wilhelmson, 1978). To apply CReSS to Martian atmosphere, radiative transfer scheme (Takahashi et al., 2006) used by planetary atmospheric general circulation model DCPAM (Takahashi et al. 2012) is introduced. The surface topography, albedo, and thermal inertia are adopted from Mars Global Surveyor observation data. The terrestrial calendar included in CReSS, which defines the length of year, month, hour, and minute, is modified to be suitable for Mars' rotation and orbital period.

To examine the model performance, we perform some idealized numerical experiments without the surface topography and effects of large-scale circulation. At first, we perform comparing experiments to the result of one-dimensional radiative-convective calculations (DCPAM-1D) with almost same experimental setting, and find that the simulated diurnal variations of surface temperature and heat budget at the surface are consistent with those of DCPAM-1D. Next, we perform experiments with solar radiative condition at the landing sites of NASA's rover, Spirit and Opportunity. We find that the simulated vertical temperature profiles near the surface in daytime are consistent with the data of NASA's rover if using mixing length of sub-grid scale turbulence parameterization given by Deardorff et al. (1980) which is commonly adopted in previous studies (e.g. Spiga et al., 2010). Following the idealistic experiments mentioned above, we begin to perform more realistic numerical experiments at proposed landing sites. In the experiments, the surface topography and effects of large-scale circulation are considered. In order to consider the effects of large-scale circulation, simulation data of DCPAM is used as initial and boundary conditions.

In this presentation, we show outline of our numerical model and some results of numerical experiments.

Keywords: Martian atmosphere, planetary exploration, numerical modeling, cloud resolution model

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PPS05-16 Room:A03 Time:May 28 12:30-12:45

Scientific significance of sample return from Martian moons

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The asteroid explorer Hayabusa2 began a six-year round trip in December 2014 to return surface samples of a near-Earth carbonaceous-type asteroid 1999 JU_3 following Hayabusa's successful return of the first asteroid samples to Earth. Hayabusa2 will arrive at 1999 JU_3 in mid-2018, and fully investigate and sample the asteroid at three locations during its 18-month stay. The samples from 1999 JU3 will be delivered to the Earth in December 2020. Primitive small bodies are the evolved remnants of planetesimals that were the building blocks of planets, and detailed on-site observation by a spacecraft and analyses of return samples will provide direct evidence of planetesimal formation and dynamical and chemical evolution of the solar system. Moreover, such small bodies could have delivered volatile components to rocky planets in the early solar system.

Sample return missions to primitive small bodies such as main belt asteroids, Jovian Trojan asteroids, icy satellites, and comets require a timescale of decades, and it is important to plan short-term exploration missions to primitive bodies. Here we propose a sample return mission to Martian moons (Phobos and Deimos), of which characteristics resemble those of C-type or D-type asteroids. If they are captured main-belt asteroids, their surfaces have not been heated as much as near-Earth asteroids are. Martian moons are thus likely to preserve more primitive materials such as ice, which is one of possible constituents responsible for their low bulk-densities. If they are remnants of building blocks of Mars, the returned samples will provide us the first and direct information on the formation of Mars, the bulk chemistry of Mars, and the isotopic compositions of volatile elements as a starting point of Martian environmental evolution. Isotopic compositions of returned samples will be a key to address this issue on the origin of Martian moons. Surface regolith of Martian moons may contain ejecta from the Martian surface and/or the escaped Martian atmosphere, and the returned samples may enable us to put constraints on the crustal and environmental evolution of Mars. The remote-sensing observation of Martian atmosphere and surface from the spacecraft can also be done from the spacecraft. In this presentation, we will describe the outline and scientific rationales of the sample return mission from Martian moons.

Keywords: Mars, Satelite, Phobos, Deimos, Sample return