Planetary Science Conference

The 5th National Mars Science Seminar

11.10.2024 | https://mars.uj.edu.pl

BOOK OF ABSTRACTS

JAGIELLONIAN UNIVERSITY IN KRAKÓW

Faculty of Physics, Astronomy and Applied Computer Science
Faculty of Geography and Geology

Planetary Science Conference

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PROGRAM

9:30-10:00 Registration (Main Hall)

10:00-12:30 Talks (Room A-1-03)

10:00-10:05 Opening of the Fifth National Mars Science Seminar, Planetary Science Conference

10:05-10:20 Paweł Czernic (Warsaw University of Technology)
Swarm of drone-assisted Leo-rovers as an alternative to scientific exploration of Mars

10:20-10:35 Joanna Gurgurewicz (Space Research Centre PAS)
Advancing lunar exploration through agile reconnaissance with hopter Galago

10:35-10:50 Sam Poppe (Space Research Centre PAS)
Modelling magma-induced crustal deformation on the Moon, Mars, and Earth

10:50-11:05 Pierre-Antione Tesson (Space Research Centre PAS)
AROMAS: A semi-automatic workflow to study hundreds of lava flows on planetary surfaces

11:05-11:20 Break

11:20-11:35 Claudio Orlanducci (Space Research Centre PAS)
Is the Origin of Martian Magnetic Anomalies Linked to a Giant Impact?

11:35-11:50 Joanna Kozakiewicz (Jagiellonian University in Krakow)
Seasonal Activity of Aeolian Landforms on Mars

11:50-12:05 Paulina Wolkenberg (Istituto di Astrofisica e Planetologia Spaziali – Istituto Nazionale di Astrofisica)
Topographic influence on atmospheric aerosols, temperatures and circulation over Tharsis on Mars

12:05-12:20 Daniel Mège (Space Research Centre PAS)
A comprehensive emplacement scheme for the interior layered deposits of Valles Marineris

12:30-13:00 Posters (corridor in segment A, 2nd floor)

Franciszek Wrona (Jagiellonian University in Krakow)
The various definitions of 'planet'

Szymon Mol (Jagiellonian University in Krakow)
Elevation and impact craters in the vicinity of Opportunity rover traverse

Natalia Zalewska (Space Research Centre PAS)
Mineralogy of the Meridiani Planum site based on the MiniTES spectra of the Opportunity rover

Leszek Czechowski (Space Research Centre PAS)
Origin of faculae on the dwarf planet Ceres

13:00-13:45 Lunch (Main Hall)

13:45-15:45 Synchrotron SOLARIS (trip starting point tbd)

15:45-17:00 Workshop (Room F-1-04)

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Swarm of drone-assisted Leo-rovers as an alternative to scientific exploration of Mars

Paweł Czernic
Warsaw University of Technology

The aim of the project carried out at WUT's CENAGIS center in Jozefoslaw is to develop a methodology for autonomous measurements of landforms using a swarm of Leo-rover rovers and a drone. On a test field imitating aeolian and impact forms found on Mars, research is being conducted using rovers equipped with heterogeneous measurement sensors such as lidar, GPR, and imaging cameras in the visible and near-infrared bands. The method currently being tested will allow for a significant acceleration of field measurements on Mars while increasing the system reliability and significantly reducing costs.

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Advancing lunar exploration through agile reconnaissance with hopter Galago

Dr hab. Joanna Gurgurewicz
Centrum Badań Kosmicznych Polskiej Akademii Nauk

Hopter Galago is a reconnaissance scout robot with a total mass under 9 kg and 50 cm in diameter including actuators, electronics, and payload. In an ESA PLIIS project, a highly energetic actuator (> 50 J) was developed and tested up to TRL 4. It consumes limited power in an overall mass of only 1.5 kg, owing to slow energy accumulation and fast release at the desired energy level. The principle of operation is similar to that of low-velocity penetrators (e.g., HP3 of the InSight mission). Galago is capable of performing traverses up to 1.25 km in 6 hours. It is adaptable for mother-lander proximity missions. Moreover, it can self-egress from the lander and remains scalable to various missions and gravities due to energetic and low-power actuator. The platform can increase scientific return of the mission by obtaining visual and thermal measurements in areas inaccessible to rovers, studying lunar geological processes, regolith properties, and dust dynamics.

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Modelling magma-induced crustal deformation on the Moon, Mars, and Earth

Dr Sam Poppe
Centrum Badań Kosmicznych Polskiej Akademii Nauk

Uplifted and fractured terrain and impact craters on the Moon and Mars are inferred to form by the intrusion of magmatic sills and laccoliths at shallow depths in their crust. Analytical and numerical models that are used to deduce magma intrusion characteristics coarsely simplify the host rocks´ response to linearly elastic, however, whereas complex magma-induced host rock deformation is found on Earth. We have simulated highly discontinuous deformation and dynamic fracturing around an inflating laccolith intrusion in the two-dimensional (2D) Discrete Element Method (DEM). For equal rock strength and amounts of intruded magma, our model results show more vertical surface displacement at the gravitational acceleration of the Moon compared to that of Mars, and more at Mars than on the Moon. Rock strength controls the amount of fracturing more than gravity does. Combining observations from intrusions on Earth with our model, helps better understanding volcanism on Mars and the Moon.

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AROMAS: A semi-automatic workflow to study hundreds of lava flows on planetary surfaces

Dr Pierre-Antoine Tesson
Centrum Badań Kosmicznych Polskiej Akademii Nauk

The Tharsis region on Mars is characterized by extensive basaltic lava flows. These flows are predominantly associated with the three major volcanic centers, the Tharsis Montes shield volcanoes. Understanding the effusive rates at these edifices is essential for understanding their evolutionary history. However, the overwhelming number of individual flows makes inferring their relative chronology non-trivial. Additionally, the frequent overlap of newer flows over older ones makes it challenging to estimate the total volume of erupted material. In this study, we introduce a semi-automatic workflow, AROMAS, designed to reconstruct the stratigraphic sequence and quantify the volume of numerous individual lava flows. We applied this method to a set of recent-looking lava flows in the southwestern region of Arsia Mons. By integrating impact crater retention ages, we estimated effusive rates that are consistent with previous findings within the caldera of the edifice for the same period.

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Is The Origin of Martian Magnetic Anomalies Linked to a Giant Impact?

Claudio Orlanducci

Centrum Badań Kosmicznych Polskiej Akademii Nauk

This study aims to identify if and which of the largest impact basins on Mars (Borealis, Argyre, Hellas, Isidis, Utopia) could be involved in the genesis of magnetic anomalies through intrusive or hydrothermal processes or impact ejecta magnetization. We used a filtered radial component of the magnetic field (>200 nT) to classify the anomalies as circumferential, radial, or randomly oriented with respect to the impact basin centers. We then assessed whether the proportion of the circumferential and radial anomalies exceeded the proportion for a random distribution. We found that crustal processes following the Borealis impact are a plausible source for some of the magnetic anomalies. Other impacts may have contributed as well.

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A comprehensive emplacement scheme for the interior layered deposits of Valles Marineris

Dr hab. Daniel Mège

Centrum Badań Kosmicznych Polskiej Akademii Nauk

Sulfates are abundant on Mars, primarily from volcanic eruptions and degassing. The thickest deposits are in the interior layered deposits (ILD) of Valles Marineris, interpreted as either sedimentary or weathered volcanic products. We used nonlinear spectral unmixing of eight laboratory mineral mixtures and compared them with the CRISM spectrum of the lower ILD in Ophir Chasma. The best fit included primary igneous minerals (orthopyroxene, plagioclase), coquimbite, kieserite, and szomolnokite. Geomorphological evidence suggests that the igneous minerals are from a source within the ILD. Findings indicate that deposition was influenced by Tharsis-related activity and the redox state of an overlying Valles Marineris sea, similar to volcanogenic massive sulfide deposits on Earth. Cooling climate, possibly due to waning Tharsis activity, led to sea freezing, altering volcanic ash and forming the upper ILD, ending with erosion by glacial flows, shaping the current chasmata.

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Seasonal Activity of Aeolian Landforms on Mars

Dr Joanna Kozakiewicz
Jagiellonian University in Kraków

The orientation of aeolian landforms can change when a formative wind direction changes. Such seasonal changes in the wind direction are observed on Mars, but so far no changes in the orientation of aeolian forms have been found in areas studied in situ. In our work, we present results that indicate that such a change in the orientation of aeolian landforms occurs on Mars and has very well described seasonality. In our work, we studied wind streaks and small fine-grained ripples on Meridiani Planum between Mars years 26 and 38 based on orbital and in situ data. Even if the orientation of the studied aeolian landforms indicated the NW winds as the most formative, the aeolian landforms were shaped by the SE winds during summer, while during winter several wind directions played a role in their formation. We also found that aeolian deflation led to complete erosion of smaller dunes and was responsible for the scarcity of fine-grained ripples in this region.

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Topographic influence on atmospheric aerosols, temperatures and circulation over Tharsis on Mars

Dr Paulina Wolkenberg
Istituto di Astrofisica e Planetologia Spaziali (IAPS)
- Istituto Nazionale di Astrofisica (INAF)

We analyzed thermal fields over Tharsis retrieved from observations of the Planetary Fourier Spectrometer (PFS) on board the Mars Express (MEx) spacecraft, collected from MY26 until MY35 during northern fall and winter. Along with atmospheric temperatures, we studied variations of dust, water ice total opacities, and surface temperatures. The behavior of atmospheric temperatures along with a tentative circulation around volcanoes is presented. From atmospheric temperatures, we calculated potential temperatures, static stabilities, and gradients of potential temperatures to derive information on atmospheric stratification and depth of the planetary boundary layer (PBL). We considered observations in the LT variation perspective. In conclusion, the circulation changes from the downward during the night to the upward motions during the day over tops and slopes of volcanoes. Lee waves are observed during the night and early morning associated mostly with the presence of water ice clouds.

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The various definitions of ‚planet'

Franciszek Wrona
Jagiellonian University in Kraków

[POSTER]

The term 'planet' currently does not have a unanimously agreed upon definition. The most widely accepted criteria proposed by the IAU in 2006 are not undisputable. Perhaps the most controversial topic is the idea of determining an object's planetary status not only by its own physical properties, such as mass or roundness, but also its environment, such as the nature or existence of its orbital parent and the object's gravitational dominance. Then there is the difficulty of where exactly to draw the boundaries. Another issue is developing a definition that is universal and useful in classifying objects such as TNOs or extrasolar bodies, for which there is only a limited amount of data available. In the wake of an era of discovery where new objects in the Solar System and exoplanets are being detected, it may be beneficial or even necessary to reconsider and possibly redefine what exactly a planet is.

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Elevation and impact craters in the vicinity of Opportunity rover traverse

Szymon Mol
Jagiellonian University in Kraków

[POSTER]

Opportunity rover (Mars Exploration Rover-B) operated on the surface of Mars between 2004 and 2018, exploring a region called Meridiani Planum. The rover cameras recorded images of various landforms, including many impact craters. Orbital and in situ methods of Martian planetary mapping were utilized in order to determine the buffers of craters' visibility by the rover depending on their diameter. Within these buffers, craters with their degree of degradation were mapped along the entire rover traverse using the HiRISE orthophotomap. Except for the Endeavour crater rim, the frequency of the occurrence of degraded as well as non-degraded craters depends on the elevation. In the lower laying areas, there are usually more craters. Moreover, the distribution of craters seems to depend on the type of surface, which might have various influence on the degradation of the landforms. Sand-gravel sheets probably cover older, eroded craters and at the same time facilitate better preservation of fresh, younger craters.

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Mineralogy of the Meridiani Planum site based on the MiniTES spectra of the Opportunity rover

Dr Natalia Zalewska
Centrum Badań Kosmicznych Polskiej Akademii Nauk

[POSTER]

The Opportunity rover explored the Meridiani Planum area in the years 2004 – 2018. The rover traverse encompassed several craters, where there was liquid water in the past. In some places, the Mossbauer spectrometer indicated large amounts of iron oxides (hematite, goethite) and sulfates (probably jarosite). We wanted to check the consistency of the MiniTES and the Mossbauer results. Our mineralogical interpretation of the spectra should allow for a better understanding of the geological history of this area. Thanks to the Mossbauer spectrometer, the sulfur minerals olivine and hematite were detected primarily. Additionally, we identified pyrite, carbonates and clay minerals. We also observed changes in mineralogy when the rover crossed the crater boundaries. The occurrence of hematite is evidence of the existence of water in this area in the past. Our research combines also the study of analogues of terrestrial concretions. The rich mineralization of these Martian equivalents confirms the possible occurrence of such minerals on Mars. We want to indicate a potential source of minerals found on Meridiani Planum and collected in concretion-type formations.

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Origin of faculae on the dwarf planet Ceres

Prof. dr hab. Leszek Czechowski
Centrum Badań Kosmicznych Polskiej Akademii Nauk

[POSTER]

Faculae are bright spots (made of light matter) observed on the surface of Ceres. They can be divided into four types: (a) floor faculae, (b) faculae on Ahuna Mons, (c) marginal/wall faculae found on the rims or walls of craters, (d) faculae in the form of bright ejecta blankets. Faculae(a) are usually attributed to the evaporation of brines. However, the recent existence of bodies of water on the surface of Ceres is unlikely. It is suggested that faculae (b) and (c) were formed by meteoroid impacts. Impacts are treated as a mechanism for covering and later uncovering deposits of bright matter. We have pointed out several problems with this hypothesis and, based on our numerical experiments, we have proposed other processes, which may be responsible for the formation of faculae.

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