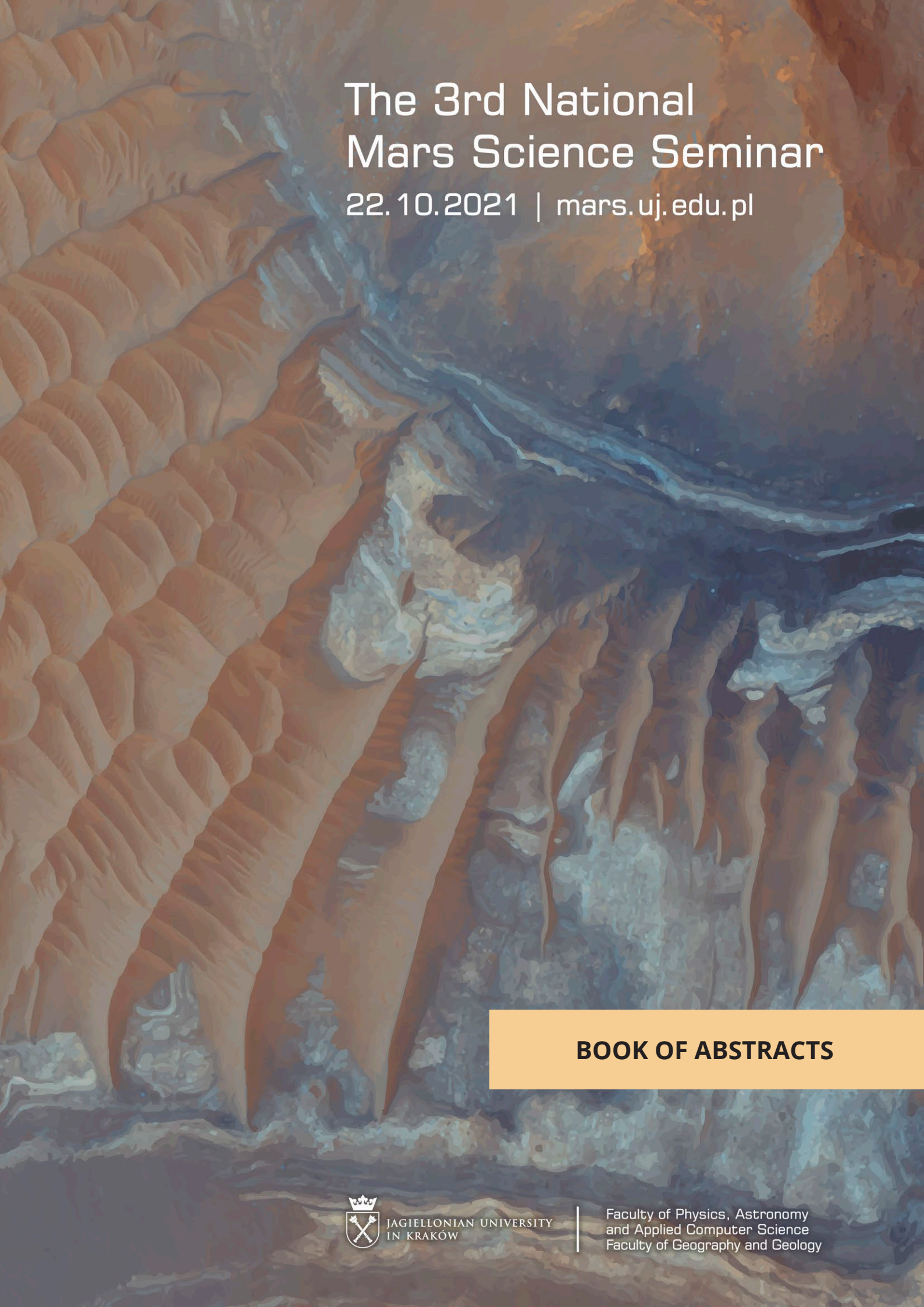

The 3rd National Mars Science Seminar

22.10.2021 | mars.uj.edu.pl

BOOK OF ABSTRACTS

JAGIELLONIAN UNIVERSITY IN KRAKÓW

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

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PROGRAM

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

10:00-12:15 Oral Session (Room A-1-06)

10:00-10:15 Opening of the Third National Mars Science Seminar

10:15-10:30 Joanna Gurgurewicz (Space Research Centre PAS)
Megashears at the crustal dichotomy in Valles Marineris and implications for metalliferous mineralizations

10:30-10:45 Daniel Mège(Space Research Centre PAS)
The proto-Valles Marineris history illuminated by the interacting Martian dynamo and crustal dichotomy

10:45-11:00 Joanna Kozakiewicz (Jagiellonian University in Kraków)
Coarse-grained ripples in Meridiani Planum

11:00-11:15 Pierre-Antoine Tesson (Space Research Centre PAS)
Volcanic airfall deposits in Noctis Labyrinthus

11:15-11:30 Anna Łosiak (Insitute of Geological Sciences PAS)
Teaching planetary geology to engineers during European Rover Challenge competition

11:30-11:45 Paweł Rzońca (AGH University of Science and Technology)
Modeling of propagation of EM ELF waves on the surface of Mars using FDTD method in the context of ground tomography

11:45-12:00 Piotr Koperski (SGPR.TECH and AGH University of Science and Technology)
Some new results from observations of the electromagnetic ELF range phenomena registered on sand dune

12:00-12:15 Magdalena Pilarska-Mazurek (Warsaw University of Technology)
Multi-source classification of Meridiani Planum landforms using deep learning for analysis of HIRISE and Opportunity imagery

12:15-12:30 Break

12:30-13:15 Poster Session (II floor corridor at room A-1-06)

Sam Poppe (Space Research Centre PAS)
DeMo-Planet: a new project to simulate shallow magma emplacement in the fractured crust of terrestrial planetary bodies

Magdalena Baranowska (Adam Mickiewicz University in Poznań)
Mapping features potentially related to glacio-volcanic activity in Utopia Planitia, Mars

Ewa Borowska (University of Warsaw)
Astrobiology Investigation on the New Volcanic Island Surtsey

Natalia Zalewska (Space Research Centre PAS)
Terrestrial analogues of Martian cone chains on Isidis Planitia

13:15-14:00 Lunch (Bar in Main Hall)

14:15-16:15 Workshop (Room F-1-08)

16:15-16:45 Coffee Break (II floor corridor at room A-1-06)

17:00 Opening of the GO Mars project exhibition (Library)

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Megashears at the crustal dichotomy in Valles Marineris and implications for metalliferous mineralizations

Dr Joanna Gurgurewicz
Centrum Badań Kosmicznych Polskiej Akademii Nauk

Two large shear zones that formed in the brittle-ductile domain of the early Martian crust are exposed in a deep erosional window in the Valles Marineris troughs, where it joins the planetary dichotomy boundary. Assemblage of primary minerals revealed in the sheared basement using a new method of nonlinear spectral unmixing gives a magmatic origin. The presence of copiapite, jarosite, and szomolnokite suggests hydrothermal alteration of sulfides crystallized in the shear zone fracture networks. The shears probably initiated as normal faults during the pre-Noachian. Shear zone development, long-lasting tectonic activity, mafic basement composition, hydrothermal circulation, and exhumation, provide one of the most promising environments for primary deposition, concentration, and exposure of base and precious metals, perhaps of cut-off grade. Some metals might have been transported through outflow channels toward the northern lowlands, leaving placer deposits in low-energy environments.

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The proto-Valles Marineris history illuminated by the interacting Martian dynamo and crustal dichotomy

Dr hab. Daniel Mège
Centrum Badań Kosmicznych Polskiej Akademii Nauk

Right-lateral megashears are observed in the most deeply eroded troughs of northern Valles Marineris. They are located at the margin of the Borealis basin, a pre-Noachian impact structure behind the formation of the crustal dichotomy, while the early dynamo was active. The shears are aligned with the putative basin margin, giving credit to its existence; shearing would correspond to ring normal fault reactivation. If correct, other structures circling the basin should exist nearby, though unexposed due to the lack of other erosional windows. Magnetic anomalies measured in eastern Valles Marineris follow such a trend. Dykes and sills injected along ring structures at the time of basin formation gradually cooled, recording the field reversals. Some of these structures were then reactivated in strike-slip regime in a stress field controlled by the growing Tharsis bulge and the crustal step imposed by the dichotomy boundary. All this happened in Valles Marineris before the troughs opened.

Coarse-grained ripples in Meridiani Planum

Dr Joanna Kozakiewicz
Jagiellonian University in Kraków

Coarse-grained ripples are very common features on Mars. These are aeolian sand ridges with surface covered by much coarser particles than they interiors. These forms literally cover Merdiani Planum, an area extensively explored by the Opportunity rover. During its 14 years of investigation Opportunity examined dozen of such bedforms using panoramic and microscopic cameras as well as spectrometers. Using automated methods of data analysis, we were able to characterize materials composing surfaces and interiors of such bedforms. We investigated their morphology and morphometry as well as their orientation. We distinguished several types of such bedforms and proposed a model of their formation and evolution. We also present a comparison of the results based on in situ data to those obtained from orbital data, which will allow for conducting research of such bedforms in locations where in situ data are not available.

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Multi-source classification of Meridiani Planum landforms using deep learning for analysis of HIRISE and Opportunity imagery

MSc Magdalena Pilarska-Mazurek
Warsaw University of Technology

The proposed solution using deep learning of neural networks from multi-source image data was evaluated for the Meridiani Planum area. The data sources used were the High-Resolution Imaging Science Experiment (HIRISE), the image processing system of the Mars Reconnaissance Orbiter (MRO), and image data acquired by the Opportunity rover cameras. The developed analytical system enables conversion of orbital data into cartometric orthophotos and digital terrain model (DTM) and its derivatives - slope, curvature, denivelation, etc., as well as automatic positioning and orientation of Opportunity camera images to create image panoramas. The deep learning neural networks with VGG-16 architecture used in the study enabled automatic classification of aeolian and impacted Mars landforms. Proposed concept of multi-source classification and author's system of deep learning can be without loss of generality of solution extended by analysis of other Mars regions and use of multispectral imaging.

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Teaching planetary geology to engineers during European Rover Challenge competition

Dr Anna Łosiak
Instytut Nauk Geologicznych Polskiej Akademii Nauk

European Rover Challenge (ERC) is an international robotics competition that aims at stimulating and supporting a new generation of engineers by developing competencies, skills, and networks within the space sector. It takes place in Poland since 2014. Most of the competition takes place at a Mars Yard: an artificially build, geologically realistic 40x30 m area re-designed every year to represent a selected region on Mars (Jezero Crater in 2020, Elysium in 2021). The science task was designed to mirror scientific activities performed before and during planetary missions: its aim was to prepare and execute a simple science-driven exploration plan of the Mars Yard. We demonstrated that robotics competition, that includes a properly constructed scientific task, develops new skills related to mapping, understanding the morphology and geology – also within people of purely engineering backgrounds.

Modeling of propagation of EM ELF waves on the surface of Mars using FDTD method in the context of ground tomography

MSc Paweł Rzońca
AGH University of Science and Technology

The presentation will show selected results of modeling the propagation of ELF (extremely low frequencies) electromagnetic waves generated by sandstorms on the surface of Mars. On Mars the properties of the subsurface cannot be neglected. The parameters of the waveguide change significantly with non-conducting ground, which affects the propagation of ELF waves.

Having a sufficiently wide base of solutions, we can use the method of reverse solutions to recreate the parameters of the waveguide, and thus the electrical parameters of the substrate. This opens up new possibilities for ground tomography using ELF waves measurements on the surface of Mars. This method requires the existence of natural radiation sources on Mars such as Dust storms. The results will allow for the interpellation of the results of measurements of real Martian ELF stations, the important details of which were included in the modeling.

The work was created under the research grant: NCN UMO-2015/19/B/ST9/01710.

Some new results from observations of the electromagnetic ELF range phenomena registered on sand dune

Dr Piotr Koperski
SGPR.TECH and AGH University of Science and Technology

It is well known that in dust storms and sandstorms prominent electric fields can develop eventually leading to micro- and macro scale electrical discharges. Large sandstorms and overall dust presence on Mars certainly support the existence of similar phenomena.

To develop technology of measurements and to understand electromagnetic phenomena in the Martian environment, we conducted series of observation of low frequency electromagnetic waves under corresponding conditions on sand dunes on Earth. Besides technological aspects, such observation can provide important addendum to theoretical modelling and to laboratory experiments related to sand- and dust electrification.

In the presentation, we briefly describe the observations we conducted on Czołpińska Dune at Słowiński National Park. We also compare selected features of the magnetic fluctuations in the ELF range registered on top of the dune to those registered in the nearby control localization, out of dune, and to meteorological parameters taken on top of the dune.

The work was carried out under the research project: NCN 2015/19/B/ST9/01710: „Tomography of the Martian ground using inverse solutions for ELF waves generated by dust storms in the ground-ionosphere waveguide", implemented jointly at the Jagiellonian University and AGH Technical University in Kraków.

Volcanic airfall deposits in Noctis Labyrinthus

MSc Pierre-Antoine Tesson
Centrum Badań Kosmicznych Polskiej Akademii Nauk

While there are many evidences of past effusive volcanism on Mars (e.g. lava flows), only a few examples of past explosive eruptions exist. This asymmetry is surprising as explosive eruptions should be more frequent on Mars due to its relatively low atmospheric pressure compared to Earth, for the same volatile content. Here, we sought pyroclastic fall deposits in the vicinity of Tharsis and found up to hundreds of meters thick layered deposits covering Noctis Labyrinthus plateaus and walls. Using available datasets, we mapped their extent to study their depositional characteristics. On walls, the deposits have been reworked by wind forming aeolian bedforms which morphometrics were studied using stereo-derived DTMs from CaSSIS and HiRISE images. Our results suggest that these deposits consist of an accumulation of airborne material which predates the Noctis Labyrinthus fracture system opening. Following chasmata formation, the remaining material on plateaus was transported on walls.

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DeMo-Planet: a new project to simulate shallow magma emplacement in the fractured crust of terrestrial planetary bodies

Dr Sam Poppe
Centrum Badań Kosmicznych Polskiej Akademii Nauk

[POSTER]

Magma emplacement processes on terrestrial planetary bodies other than Earth can only be investigated by observing surface deformation features or through analytical and numerical models. Whereas most common numerical models assume that shallow planetary crust deforms elastically, geological observations on Earth have highlighted the importance of non-elastic deformation. DeMo-Planet is a newly-funded project that aims to model the emplacement of higher-viscosity magma in shallow planetary crust using discontinuum host media in the Distinct Element Method (DEM). By combining field and remote sensing observations from laccolith intrusions in the Intra-Sudetic Syncline (Poland) and laboratory tests of mechanical rock properties with remote sensing observations of magmatic uplift features on the Moon and Mars, this project's outcome will progress our understanding of complex deformation processes during magma emplacement on the Earth, Moon and Mars.

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Mapping features potentially related to glacio-volcanic activity in Utopia Planitia, Mars

BSc Magdalena Baranowska
Adam Mickiewicz University in Poznań

[POSTER]

The Utopia Planitia region is one of the basins on the northern hemisphere of Mars. The landscape consists of structures related to impact cratering and permafrost processes: e.g. scallops, polygons, pits, and texture terrains. We have performed a detailed mapping campaign using Mars Orbiter Laser and CTX images. Couple of features have not been identified before: e.g. “crater-like” features and mounds. “Crater-like” features are irregular holes that are 100 - 500 m in diameter; often aligned in small clusters or in even a line. Their shape, sizes, distribution and alignment suggest they were not made by the impact process. Mounds are 200 - 300 m long and 5 - 50 m high, sometimes they have elongated cracks on the top. Those fissures suggest that formation of those mounds is associated with moving of material below the surface. We suggest that those features are associated with endogenic activity in the past, as it is relatively close to a volcanic region of Elysium Planitia.

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Astrobiology Investigation on the New Volcanic Island Surtsey

MSc Ewa Borowska
University of Warsaw

[POSTER]

Lava tubes are natural caves carved by basaltic pahoehoe magma river flowing down the volcanic slopes. While progressing downhill lava gradually cools off and forms hardened crust on the surface underneath which molten lava continues to flow. The similar fate is correlated with volcanic islands. The same processes were possible on Mars when volcanic eruptions intensive and created new geological forms. We suggest that subsurface lava tubes and other volcanic forms on Mars, similarly as Earth's analogues, may or could in the past sustain diverse microbial community The Surtsey Island create a peculiar place as an analog to investigate evolution on the new volcanic areas and astrobiology approach in research. We would like to present possible probes and examination of volcanic formations and lava tubes investigation above and underwater both. The main goal of the experimental in the laboratory set up part is to confirm evolution of primitive organisms, which form biofilms for its protection.

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Terrestrial analogues of Martian cone chains on Isidis Planitia

Dr Natalia Zalewska
Centrum Badań Kosmicznych Polskiej Akademii Nauk

[POSTER]

On Isidis Planitia there are thousands chains of small cones on Mars. We found 8 characteristic following types of chains of small cones in Isidis Planitia: (1) chains of separate cones, (2) chains of cones connected with each other, (3a) chains of cones connected to the furrow through the center, (3b) chains of cones connected to the furrow through the center with elongated, elliptical cones, (4) chains of cones with the traces of flows, (5) chains of irregular cones without calderas with a depression around the cones, (6a) ridge arches without cones, (6b) chains of cones on the ridges. We found also several new terrestrial structures that could be treated as analogues of Martian chains of cones. We believe that investigations of these analogues can help to indicate processes leading to formation of these Martian structures.

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