THE HIGHLAND TERRAIN HOPPER: SCIENTIFIC EXPLORATION OF RUGGED TERRAIN ON LOW-GRAVITY PLANETARY BODIES. D. Mège[1], J. Gurgurewicz[1,2], J. Grygorczuk[2,3], Ł. Wiśniewski[2,3], H. Rickman[2], M. Banaszkiewicz[2], T. Kuciński[2] and K. Skocki[4] , [1]Institute of Geological Sciences, Polish Academy of Sciences, Wrocław, Poland (daniel.mege@twarda.pan.pl), [2]Space Research Centre, Polish Academy of Sciences, Warsaw, Poland, [3]ASTRONIKA Ltd., Warsaw, Poland, [4]Astri Polska, Warsaw, Poland.

Summary: Field geoscientists need to collect three-dimensional data in order characterise the lithologic succession and structure of terrains, reconstruct their evolution, and eventually reveal the history of a portion of the planet. This is achieved by walking up and down mountains and valleys, conducting and interpreting geological and geophysical traverses, and reading measures made at station located at key sites on mountain peaks or rocky promontories. These activities have been denied to conventional planetary exploration rovers because engineering constraints for landing are strong, especially in terms of allowed terrain roughness and slopes. Galago, the Highland Terrain Hopper, a new, light and robust locomotion system currently in development, addresses the challenge of accessing most areas on low-gravity planetary body for performing scientific observations and measurements, alone or as part of a galago commando. It is also an efficient and low-cost way of investigating the surface of very low gravity bodies, such as Phobos, asteroids, cometary nuclei and NEOs, in which wheel-driven locomotion systems are inefficient. Examples of geological applications on Mars and other bodies are given.

Figure 1. Galago is a light and symmetric jumping robot, here jumping in a Valles Marineris-type landscape.

Galago, the Highland Terrain Hopper: There are few limitations in the type of scientific payload conventional exploration rovers can carry, from geology and geophysics to geochemistry and exobiology. They lack two skills, however: the ability of working on rugged or unstable terrain, like in canyons and mountains, and on solid bodies having gravity too low for the friction between the wheels and the ground to generate robot displacement. ASTRONIKA Ltd. and the Polish Space Research Centre are designing Galago, the Highland Terrain Hopper (Figure 1), a small (Ø ~ 50-100 cm), light (5-10 kg), and low-cost jumping robot that may survey any type of landscape.

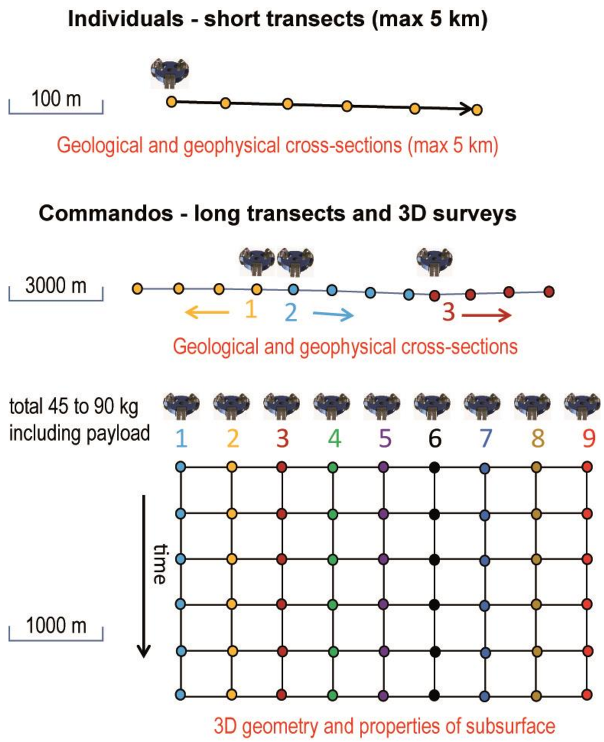

Figure 2. Galago displacement strategies

In order to save space and weight, the main system and payload will be highly miniaturized and designed simultaneously in order to share as much components as possible [1]; no moving parts will be allowed.

Displacement capabilities and scientific strategy: Galago is symmetric and can jump accurately to a height of 4.5 m on Mars, 9 m on the Moon, and much more on Phobos and other small bodies. For one Galago, a nominal horizontal travel distance of 5 km (1000 jumps) is currently planned with the considered energy source, a battery reloaded by solar panels. A Galago may assist other types of robots, or humans, in accessing difficult terrain, or even replace them for specific measurements or campaigning. Its three independent legs make possible several types of motions: accurate jumping (to any place identified in advance), turning over, and tilting. Many risky displacements are made possible by robot symmetry and leg configuration. In case of failed jump, one leg at least is in contact with the ground and can be used for a new jump and a new attempt. Due to low weight and cost, several galagos may be sent to study the geology and geophysics along profiles 10s of km long or grids covering up to hundreds of km^2, with either duplicate or complementary payloads (Figure 2).

Application to *in situ* Valles Marineris exploration on Mars: The full stratigraphy of Mars, from the pre-Noachian [2] to some of the most recent deposits, may be obtained using a small swarm of galagos dropped along a traverse going through one of the main Valles Marineris chasmata (Figure 3) equipped with a payload including a visible-NIR multispectral camera and an inclinometer. At the same time, data regarding rock fracturing, hydrogeologic and paleohydrologic conditions, paleogeography, paleoenvironments, soils and paleosoils, would be collected.

Such measurements would provide helpful information as to early volatile delivery [3] and the very early climate, as well as assessment of past habitability. Galagos carrying a ground resistivity meter could probe the subsurface and look for buried ice; with geophones the present geologic activity and surface dynamics (slope processes such as recurrent slope linae [4], ice movement in rock- or dust-covered glaciers [5] etc.) could be monitored and identified [6]; a magnetometer would provide the first *in situ* measurements of Martian rock magnetization induced by the early dynamo [7].

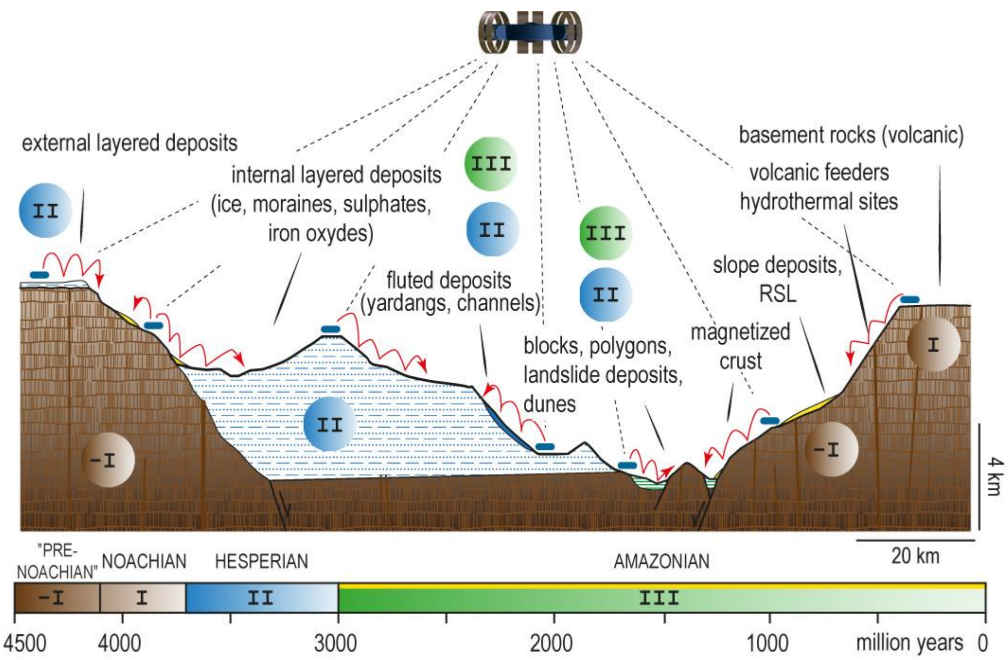

Figure 3. Objects and processes that a series of galagos dropped along a Valles Marineris transect on Mars could investigate.

On the Moon and other small bodies: Galagos could measure the pristine orientation of lunar magnetic field on highlands outcrops and test for the first time if and when a dipolar lunar core dynamo was operating on the Moon [8], retrieve information on the crust revealed by climbing lunar crater central peaks. On Phobos, the whole surface can be visited with a very low energy consumption. The grooves and pit crater chains could be investigated in detail, contributing to the debate as to their formation [9]. The red and blue surface spectral units could also be examined and perhaps interpreted. Asteroid resources [10] could be investigated *in situ*.

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