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Similarities of Tritonian guttae and Martian dark dune spots

H. I. Hargitai
Eötvös Loránd University, Department of Physical Geography, 1117 Budapest Pázmány P st 1/a Hungary.
hhargitai@gmail.com

Abstract

Dark spots with bright halo near the edge of the Triton's photographed south polar cap and Martian Dark Dune Spots (DDS) sometimes with bright halo, found at the Martian circumpolar regions show striking morphological similarities which may imply similar formative processes.

1. Introduction

Triton's guttae (drop, lat.), (Fig 1.) originally named 'mushrooms' [1] and now named maculae in the IAU nomenclature, have been photographed by Voyager 2. They are found in groups between 5S and 45S, on or near the edge of the south polar cap [2], on bright smooth terrain (albedo: 0.85) [3]. They are irregular spots with an albedo lower than the surrounding terrain (albedo: 0.7), with brighter (albedo: 0.9) annular aureoles around them whose materials are visually similar to the opaque bright material on the south polar cap [2].

Martian Dark dune spots (Fig. 2.), also called 'Dalmatian spots' and 'fried eggs' [4] are located in the southern and northern circumpolar region, at latitudes higher than about 65° on seasonal-frost covered dark basaltic sand dunes. They are 10s of m across, commonly showing an internal structure with a darker (umbra-like) core and a lighter, ring shaped (penumbra-like) outer area, around which a bright halo (collar) is sometimes also seen [5]. They form groups within the dune covered terrain.

These two features display morphological similarities, although the ones on Triton are much larger. Any analysis based on morpholgical similarities should take the concept of equifinality (form-convergence) into consideration [6]. In this case there is only a snapshot available from Triton, but putatively corresponding Martian DDS's have been observed through several seasons revealing their seasonal development sequence. The two features may have similar origin.

2. Formative processes

Guttae have been interpreted as residual deposits of a pre-existing, thicker and more extensive polar cap [2]. They are proposed to have been formed as the low albedo interior is sublimating N_2 at high rate, which rises local N_2 pressure that radiates outwards, where under the locally increased partial pressure, condensation temperature is higher and consequently N_2 re-condensates as frost (or sublimates at slower rate), resulting in the bright annulus [3]. They have been compared to outliers of the permanent Martian cap shaped by ablation [2] or CO2 frost halos on the south polar residual cap, where frost accumulation occurs due to higher sublimation rates on sun-facing slopes [3].
In this paper I propose that guttae have similar origin to seasonally formed inliers on the Martian polar seasonal frost cover that form over dark dunes. DDS's have been proposed to form by defrosting, sublimation of CO_2 frost, exposing the underlying dark surface. Defrosting occurs as low albedo polar sand heats beneath an optically thin layer of frost, causing the frost to evaporate. This vapor is re-precipitated in the colder outer zones forming a bright halo. As the core evolves, the bright halo narrows and disappears, but the spot develops a dark interior and a grey exterior zone. [7].
On Triton only a dark interior and a bright outer zone have been observed, both with sharp boundaries, composed of N_2 frost. On Mars, DDS's have a prominent dark core with a temporary grey outer zone with a diffuse bright halo, composed of CO_2 frost. The Tritonian example may be a temporal state in seasonal guttae deveopment.

3. Implications

If guttae have similar origin to that of DDS's, a seasonal change on their distribution and morphology should be supposed for the Tritonian features, similar to that shown by dark dunes spots on Mars.
If guttae and DDS's formed similarly, it has implications on the Dark Dune Spots Mars Surface Organism (DDSMSO) model [8]: it favors a model that can be applied to both Triton's and Mars' near polar cap environments.

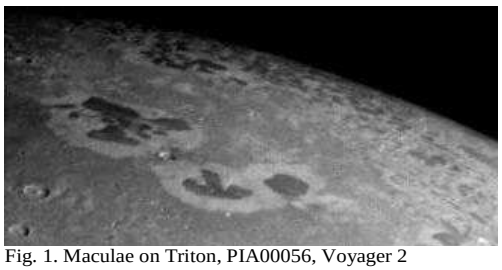

Fig. 1. Maculae on Triton, PIA00056, Voyager 2

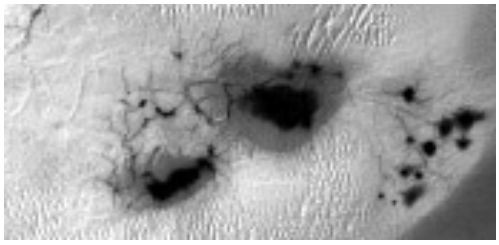

Fig. 2. DDS on Mars, Richardson Crater, HiRISE PSP_003175_1080

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