**CRACKS IN SEASONAL SEMI-TRANSLUCENT ICE LAYER IN MARTIAN POLAR AREAS.**

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**Introduction**

Martian polar areas exhibit great variety of seasonal phenomena, mainly associated with $CO_2$ ice sublimation/condensation cycle and its interaction with water ice and loose surface material. HiRISE provided a possibility to describe spring polar activity in great details.

Among others, elongated dark features resembling crack pattern (also sometimes polygonal terrain) were observed in the same areas where HiRISE is monitoring early activity of jets.

An example is shown in Fig. 1.

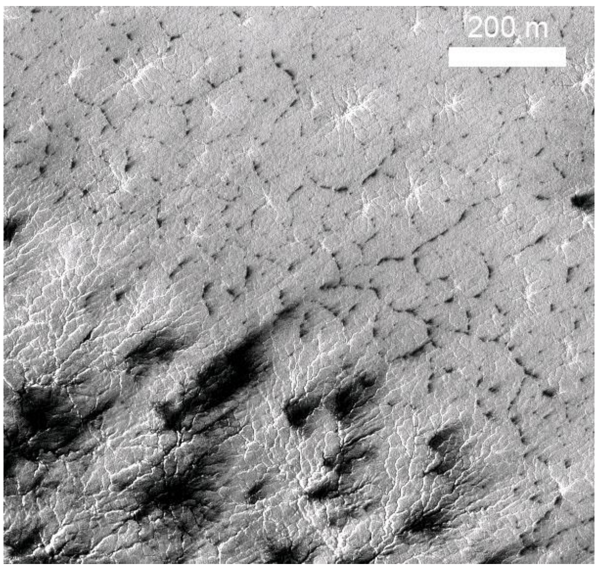


**Figure 1** Sub-frame of HiRISE image ESP_012821_0965 shows araneiforms with overlaying dark jets together with cracks.

**Cracks in translucent slab layer?**

The jets (here in the low left corner) are commonly believed to be outbursts of hot $CO_2$ gas coming from below $CO_2$ ice layer [1]. Based on this hypothesis, cracks could be explained as actual fracture cracks in translucent $CO_2$ slab layer. Models show that ice fracturing can happen very early in spring [2]. When ruptured, ice is expected to form long straight fractures. In this context jets that are coming out from point-like sources are more enigmatic than those coming from cracks. One explanation for this could be that cracks in these cases are very clean and not detectable with present instruments. Alternatively, jets can come from vents that are formed on the places of weakness points in ice.

Alternatively to this hypothesis, cracks might also be thermal fractures.

More detailed search for similar crack features showed that they often appear in the same area with araneiforms and jets, i.e. some of the most active areas in southern seasonal polar cap [3].

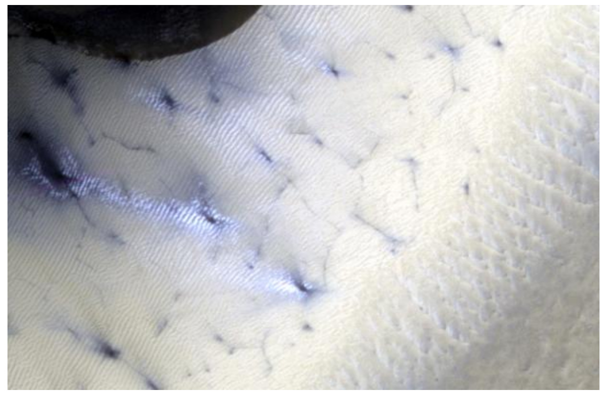

**Figure 2** Sub frame of image PSP_006777_2570. Crest of a dune with cracks and jets of dark and bright bluish material.

Other places where cracks are observed are dune fields that get covered by seasonal $CO_2$ ice. Examples were found in Richardson dunes and even in some north polar dune fields (Fig. 2). In the north these cracks are also associated with jets. However, no araneiforms (or similar channel structures) were yet reported in the northern Martian areas.

Substrate properties seem to play important role in crack formation, because we only observe them in the presence of movable material.

In summer, after all $CO_2$ ice is gone, substrate does not show any traces of cracks in the places where cracks were observed in winter. On subsequent winter the cracks form again. They do form in the same areas. However the appearance, namely their orientation and size, is not repeated from year to year. One example of this is shown in Fig. 3

This supports the hypothesis that the cracks are formed in seasonal ice layer which disappear in summer and forms again in subsequent winter.

In Fig. 2 and Fig. 3 one can also see that cracks themselves become sources of jets.

In other polar areas some jets appear to origin from not simple point sources but rather extended linear source, which was called fissure source [4]. We believe that this kind of sources have same origin as cracks.

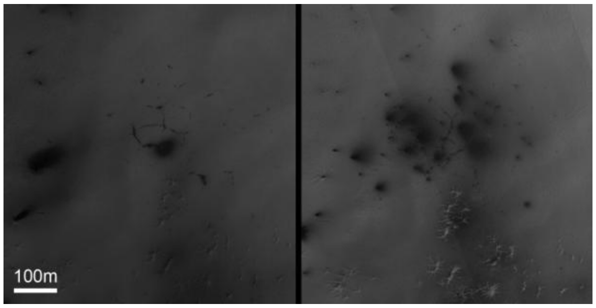


**Figure 3** Sub-frames of HiRISE images PSP_002868 and ESP_011900 taken in so called Inca City area (lat=75S, lon=E) in spring of subsequent Martian years 28 and 29. Cracks and jets form in the same place year over year, however the appearance of cracks and position of jets have changed.

## Relation to araneiforms

However close the cracks are to araneiforms, they avoid overlying araneiforms' channels (see for ex. Fig. 1).

If the cracks form under any kind of stress in ice layer (thermal or mechanical, i.e. by pressure from underneath that is produced by sub-ice sublimation), this stress would be easier released over araneiforms. Their channels provide variability in surface inclination. Hence, ice deposited over such terrain has more weak points than similar ice formed on flat ground. Additionally, outgasing associated with araneiforms releases pressure from underneath the ice. In the beginning of spring this might be enough to get rid of most pressure from underneath the ice layer and delay cracking of neighbor flat ice layer.

Jet activity indirectly support this: jets over araneiforms usually appear earlier than those coming from cracks. Later in season activity over araneiforms gets exhausted, while cracks still exhibit extensive mobility of dust.

By observing cracks in transparent slab ice we will be able to get additional hints about enigmatic and still poorly understood processes in Martian polar areas.

## References

[1] H. H. Kieffer (2007) *JGR*, 112. [2] Portyankina G. et al (2010) *Icarus*, in press. [3] Hansen, C. J. et al (2010) *Icarus*, in press. [4] Thomas N. et al (2010) *Icarus*, in press.