Experimental Simulation of Martian Slope Streak Formation

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Introduction:

Definition of Slope Streaks (Fig. 1):
Narrow, fan-shaped features that extend down slope, and are usually found on dust covered and equatorial regions of Mars. Hundreds of meters long and present no topography. All slope streaks start as a point source, progressively widening, then narrowing to a lobate or digitate end [1]. Easily recognizable due to the presence of albedo contrasts with their surrounding environment [1,2]. First discovered in 1977, and currently forming.

Methods:
Mix water and Natrosol (natural cellulose ether), which is a commercial thickener that changes the viscosity of a fluid without altering its other properties. Add food coloring to increase contrast between substrate and solution. Run 50 mL of the solution:
- Using a funnel and 15 m long piece of polyethylene tubing with a 19 mm diameter
- Down two wooden flumes (Fig. 2). One of them at room temperature with dimensions of 0.5x3 m² filled with MMS (Mars Mojave Simulant) and the other one at -20 degrees Celsius with dimensions 0.9x1.5 m² filled with sand.

Let the streaks dry. Measure width, thickness and other relevant aspects of the resulting streak every 5 cm.

Results:

- At lower viscosities with a 20° slope angle:
  - Gully-like features (Fig. 3).
  - More noticeable at room temperature than at -20 °C.

- For higher viscosities with a 20° slope angle, as well as with all viscosities at a 10 degree slope angle:
  - Fluid widens quickly as it progresses down the slope (Fig. 4).

- Using sand as a simulant:
  - Lower viscosity solutions presented levee like features (Fig. 5).
  - More pronounced at room temperature [6] then at -20°C.

- Using MMS as a simulant:
  - No levee like features.
  - Cracks present for all the runs (Fig. 6).
  - High viscosity fluid seeps of to the side (Fig. 7), thus somewhat disrupting the appearance of the streak like feature.


<table>
<thead>
<tr>
<th>Mars slope streaks</th>
<th>Width/Length Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSP_009790_1920</td>
<td>0.073</td>
</tr>
<tr>
<td>Mars slope streaks PSp 001656 2175</td>
<td>0.066</td>
</tr>
<tr>
<td>0.075 Pa s solutions at -20 °C at 10 °</td>
<td>0.070994</td>
</tr>
<tr>
<td>0.075 Pa s solutions at room temperature at 10 °</td>
<td>0.071258</td>
</tr>
<tr>
<td>0.075 Pa s solutions at -20 °C at 20 °</td>
<td>0.034841</td>
</tr>
<tr>
<td>0.075 Pa s solutions at room temperature at 20 °</td>
<td>0.014868</td>
</tr>
</tbody>
</table>


Discussion:

- High viscosity fluid freezes before it has chance to sink in when run at -20 °C (Fig. 8).
  - Sails lower the freezing point of water.
  - Aqueous solution on Mars would contain salts.
  - To get more accurate results: mix in salts to our solutions to run at -20 °C.

- How different viscosities compare to Martian slope streaks:
  - The lowest viscosities presented alcove-like structures.
  - The highest viscosities spread laterally lot.
  - The best simulations occurred for streaks created using fluid of a viscosity of about 0.07 to 0.75 Pa s (Fig. 9). The resulting streaks appeared longer and thinner, thus more closely resembling the Martian streaks (Table 1).

Conclusions:

- Same general shape as Martian slope streaks:
  - Starting at a point source
  - Widening
  - Then narrowing
  - Ending in lobes or digits.
  - Follow the topography of the terrain
  - Present for the most part no other discernable topography, which are problems associated with some dry flow models.

- However, our simulations widen a lot sooner than the Martian streaks do.

- Scaling Problem: Our simulations are only a couple of meters long at the most, while the Martian streaks are hundreds of meters long.

References:

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