Biomedical Engineering
生醫工程

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Spring 2024

Biomedical Engineering

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(1) Review heat flow in 2D

(2) Landscape evolution

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Example for Heat Flow

$$\alpha^2\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)=\frac{\partial u}{\partial t}$$

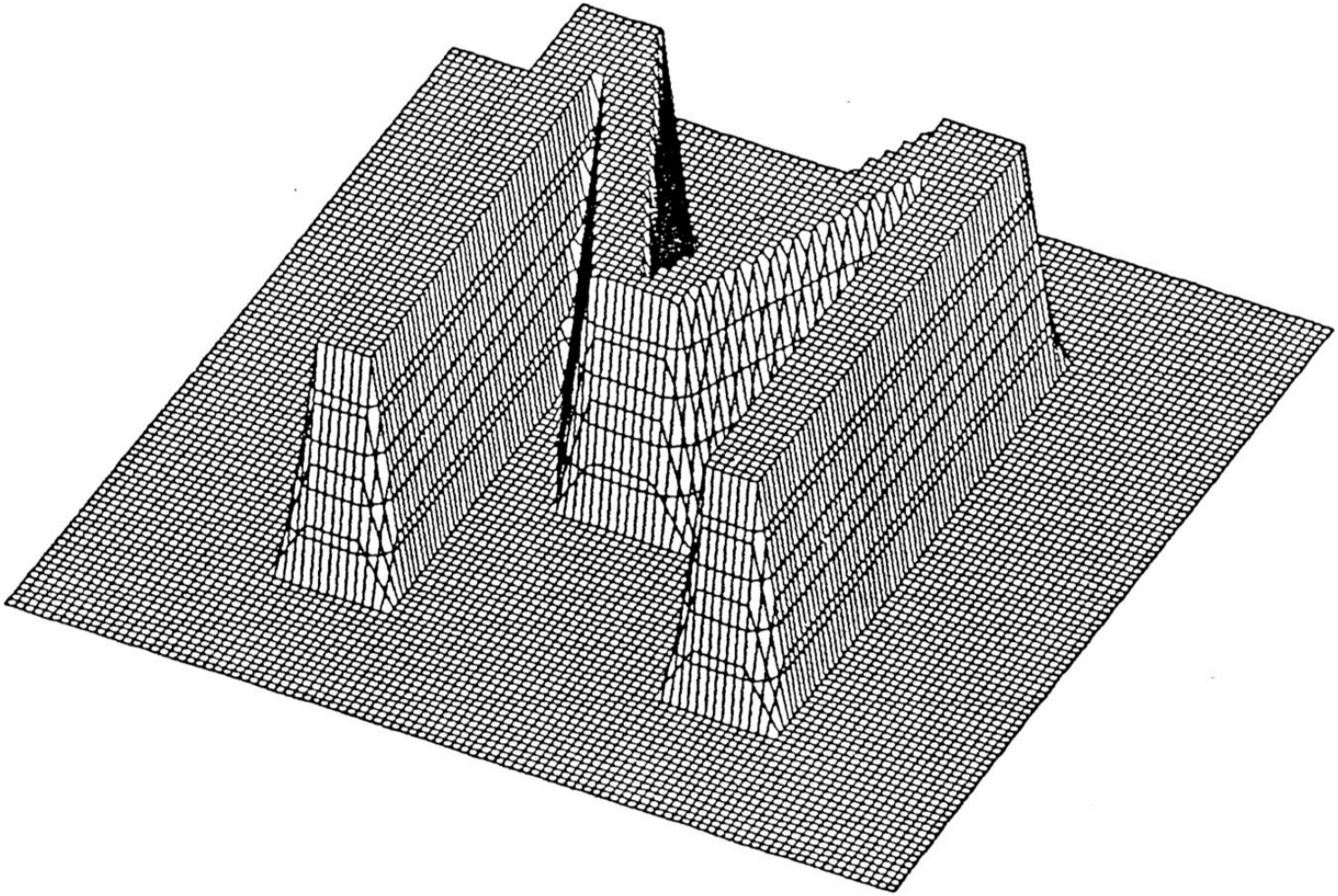

Figure 3.2: $t = 0$

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Example in 2D

$$\alpha^2\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)=\frac{\partial u}{\partial t}$$

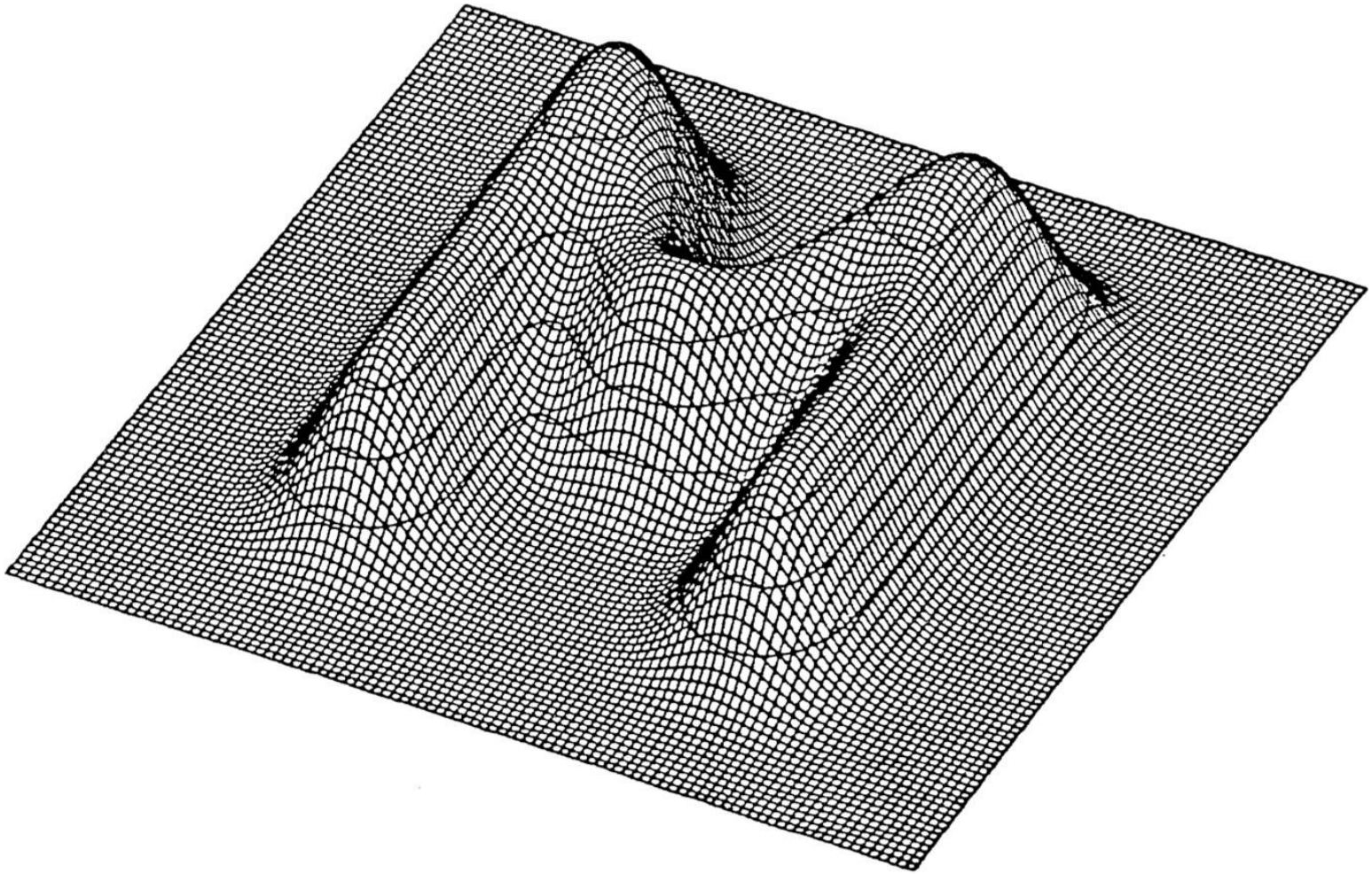

Figure 3.3: $t = 0.001$

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Example in 2D

$$\alpha^2\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)=\frac{\partial u}{\partial t}$$

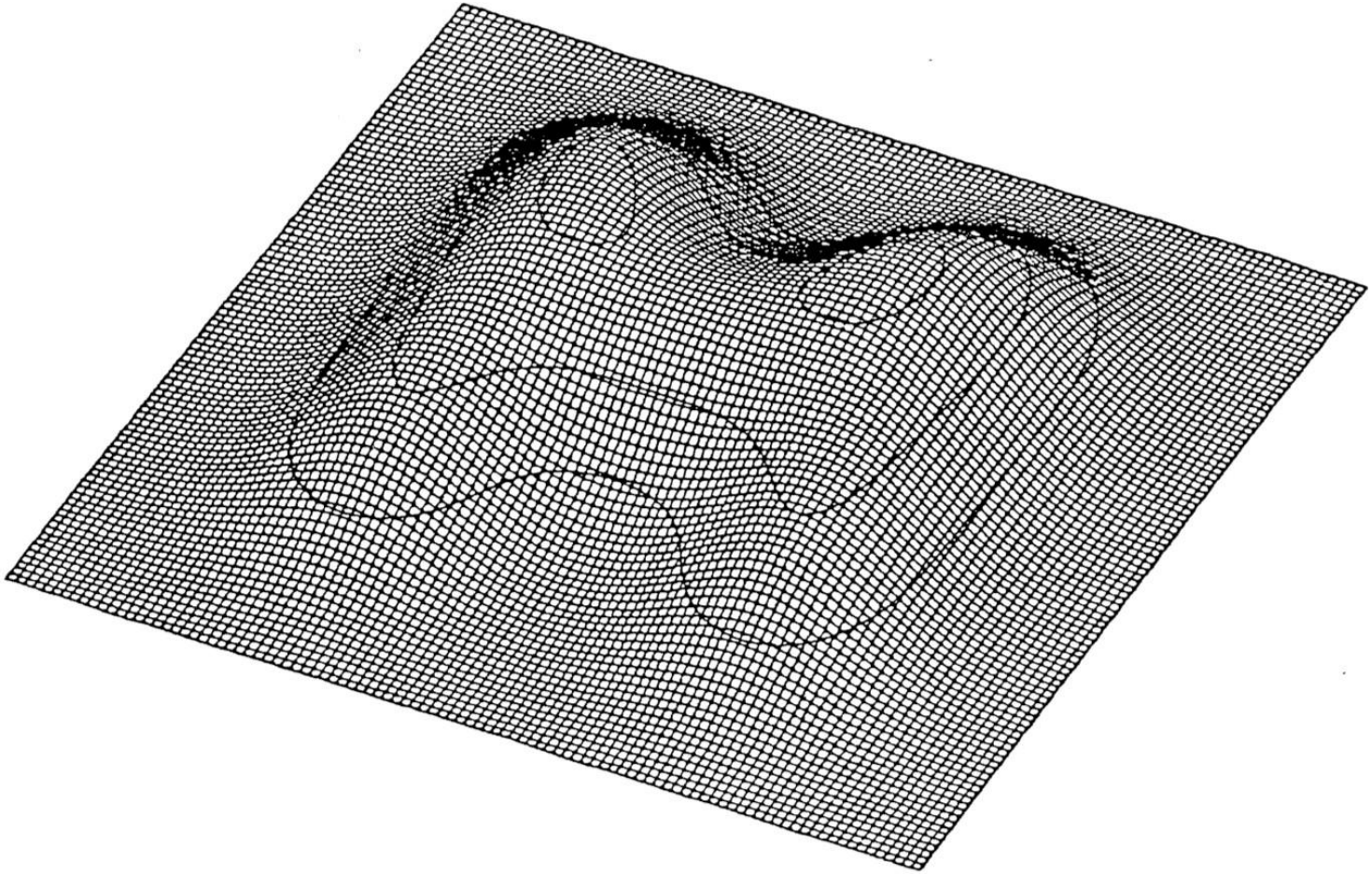

Figure 3.4: $t = 0.004$

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Example in 2D

$$\alpha^2\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)=\frac{\partial u}{\partial t}$$

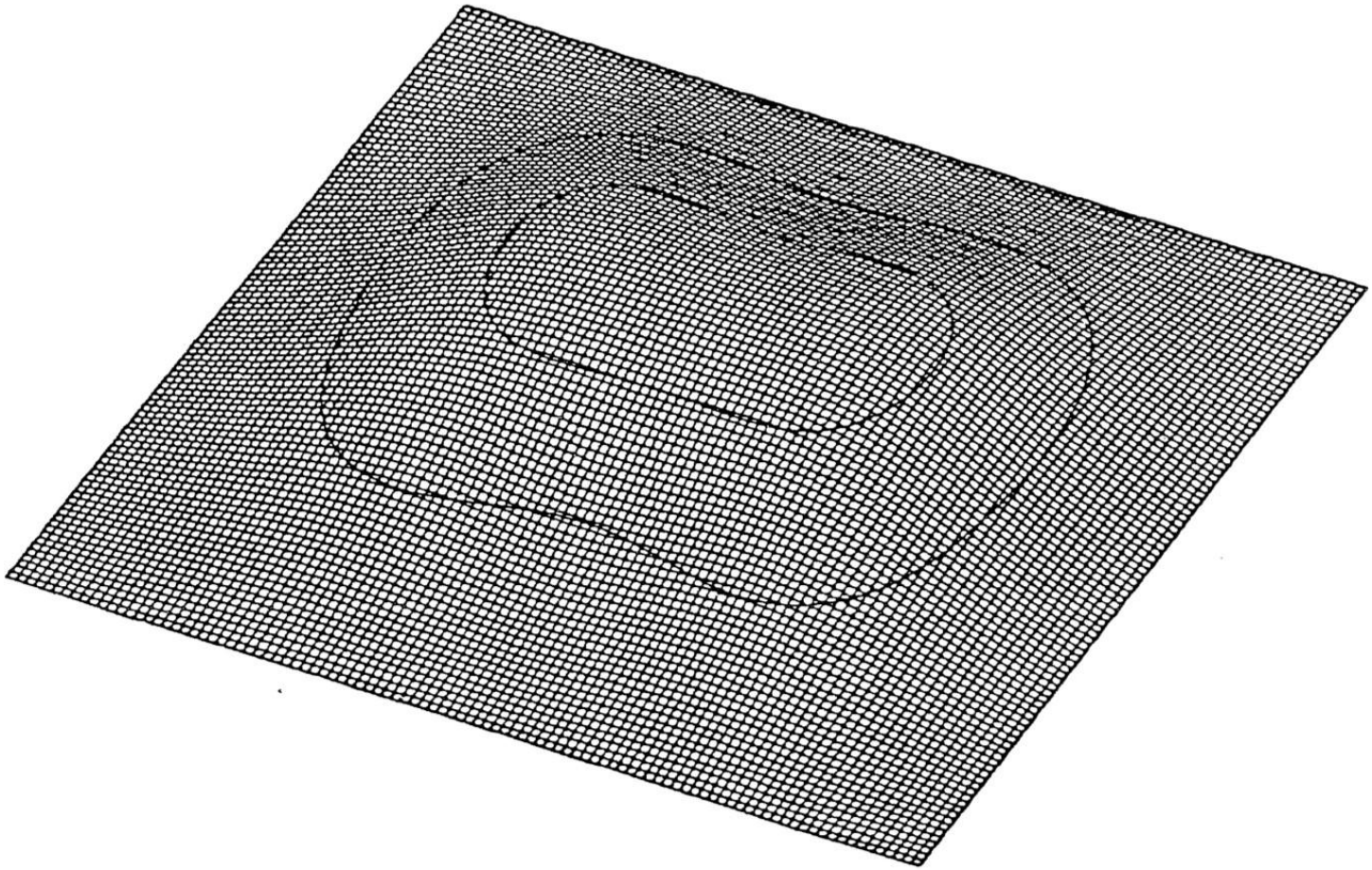

Figure 3.5: $t = 0.01$

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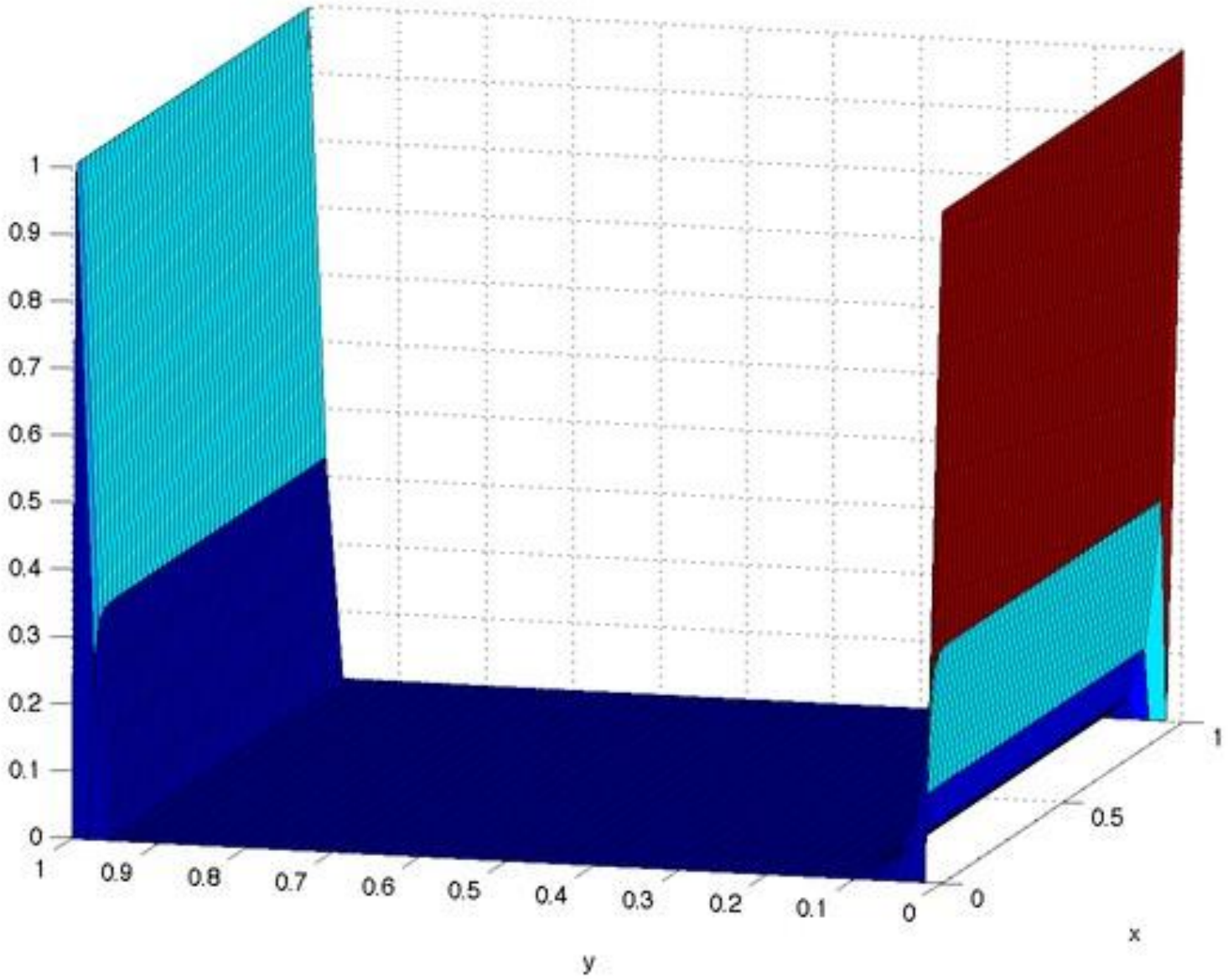
Method 1: Jacobi Method



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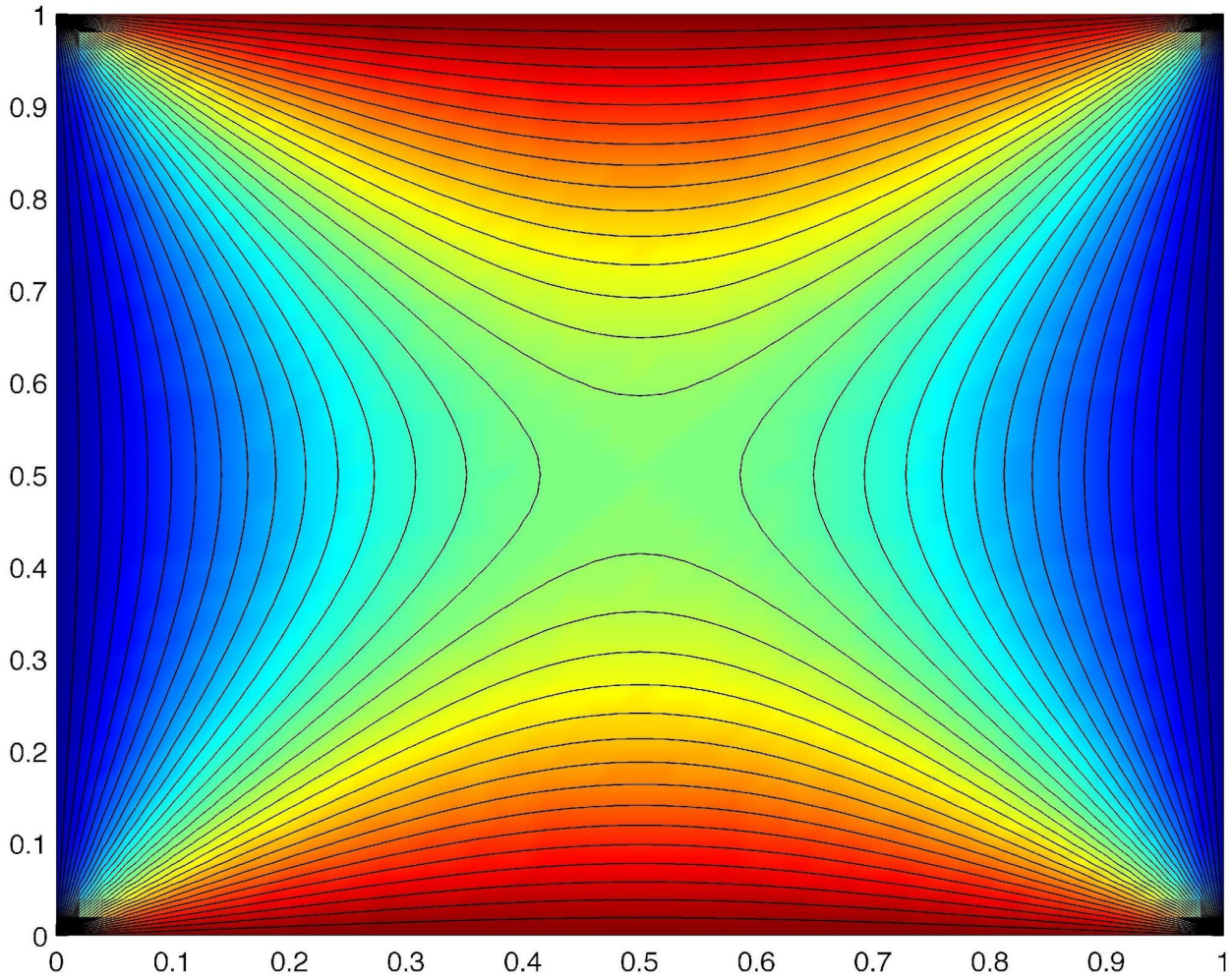
Contour Plot of the Stationary State



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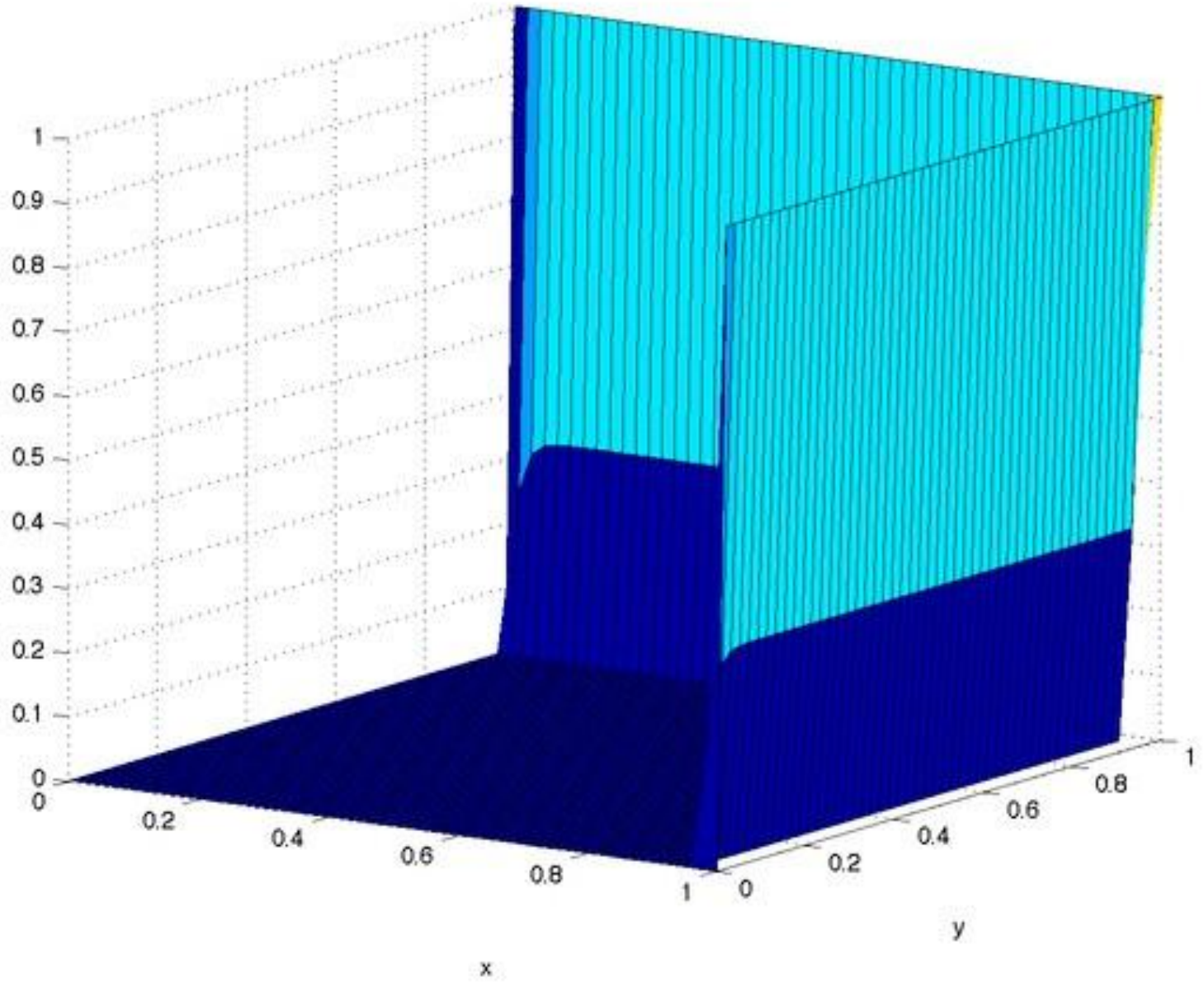
Different boundary conditions



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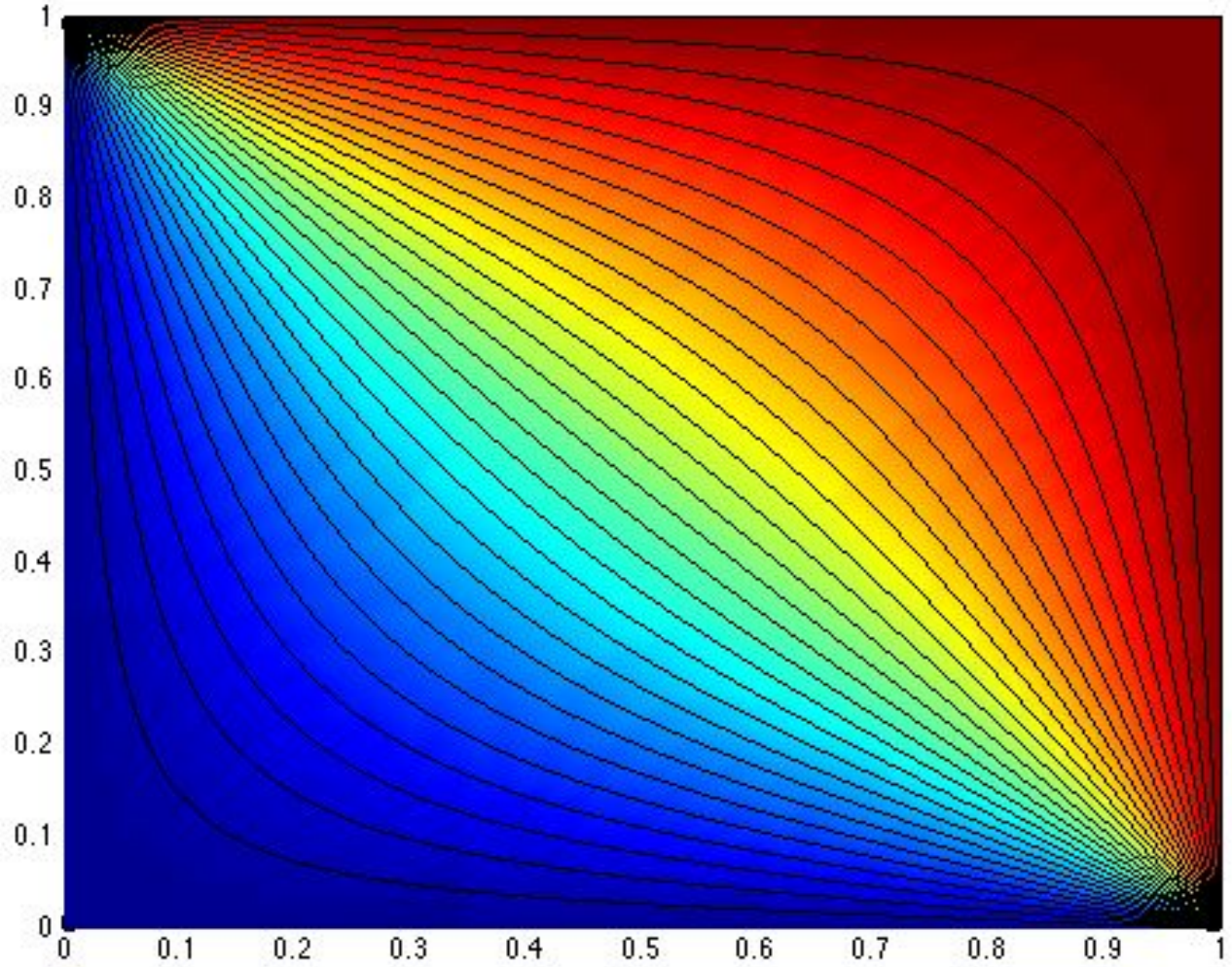
Contour Plot of Stationary State (Different boundary conditions)



What processes contributed to this formation?

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Figure 1. Aerial photograph of a landscape near Orland, California, showing quasiperiodic valley spacing of roughly 100 m. Photo by J. Kirchner.

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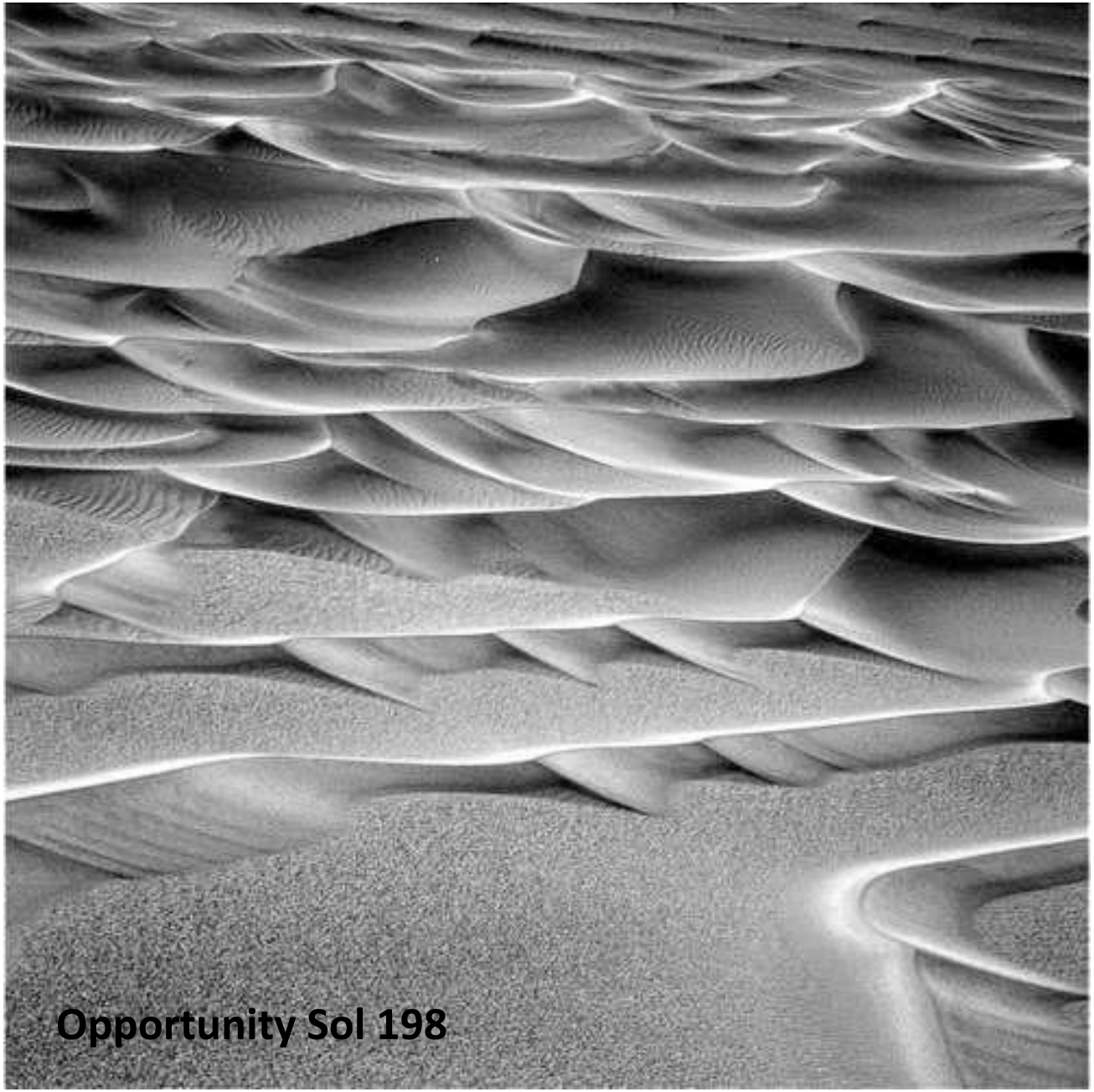
Erosion: Sand dunes on Mars



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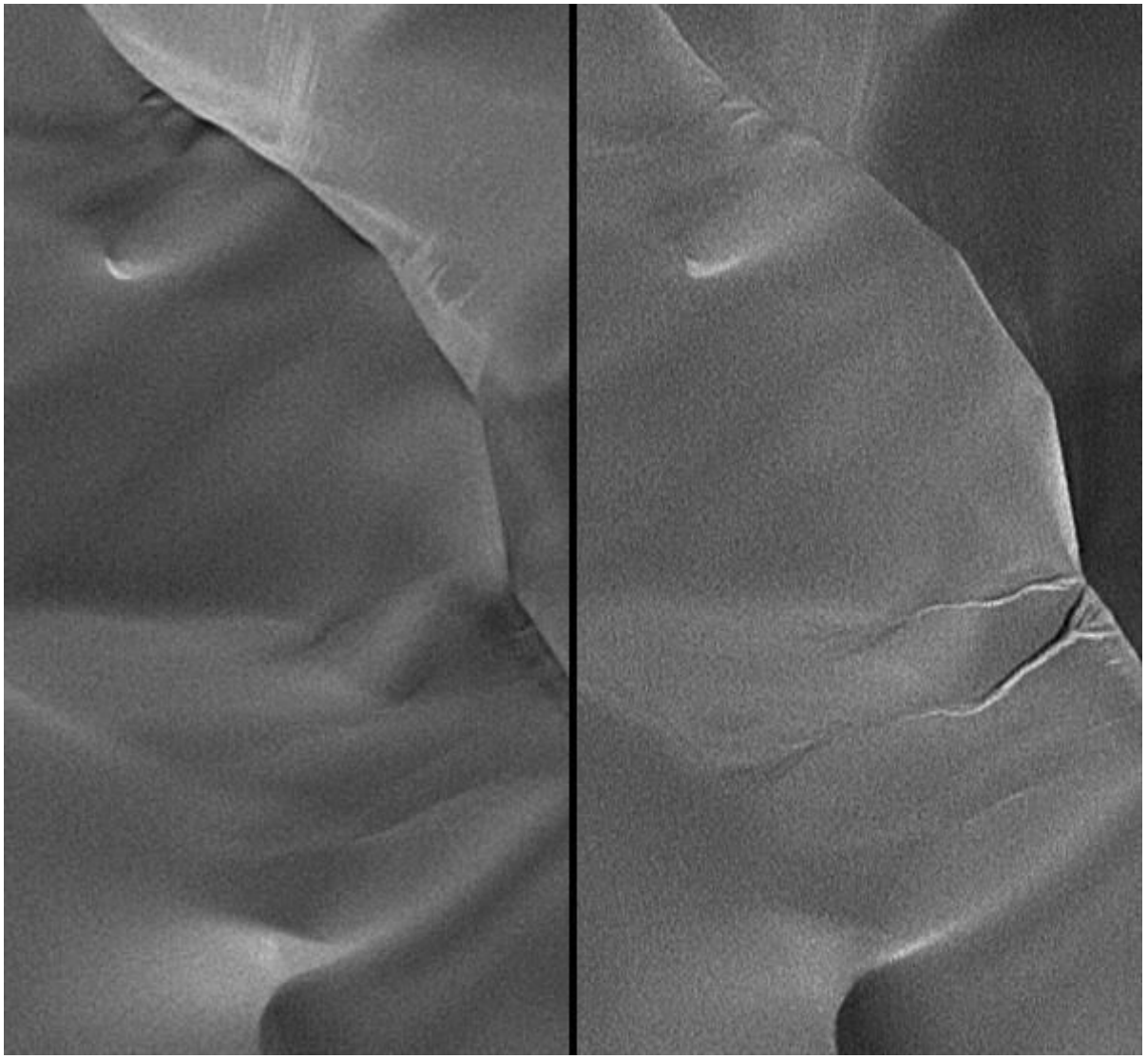
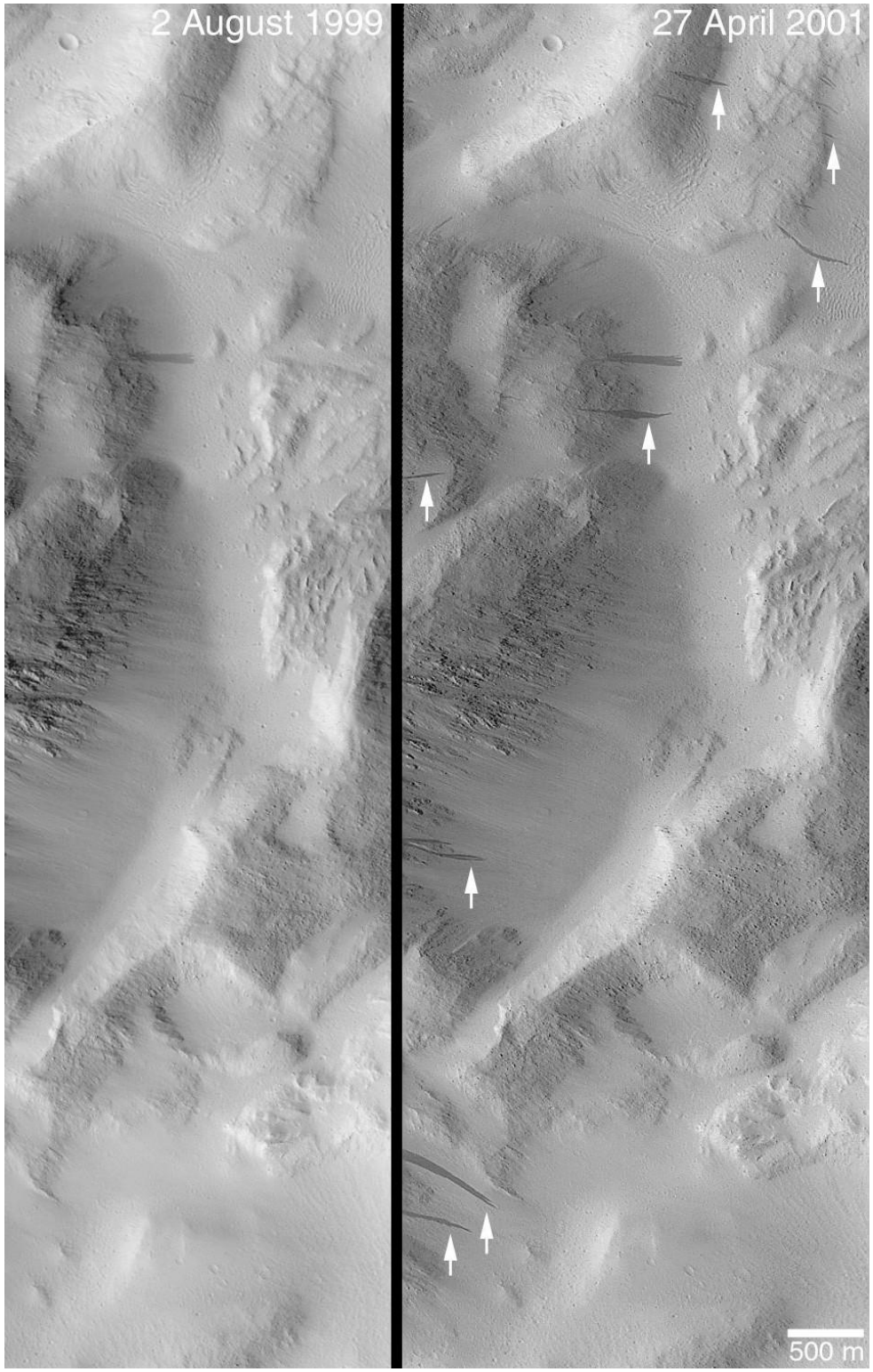
Sand dunes are common (wind affects landscape)



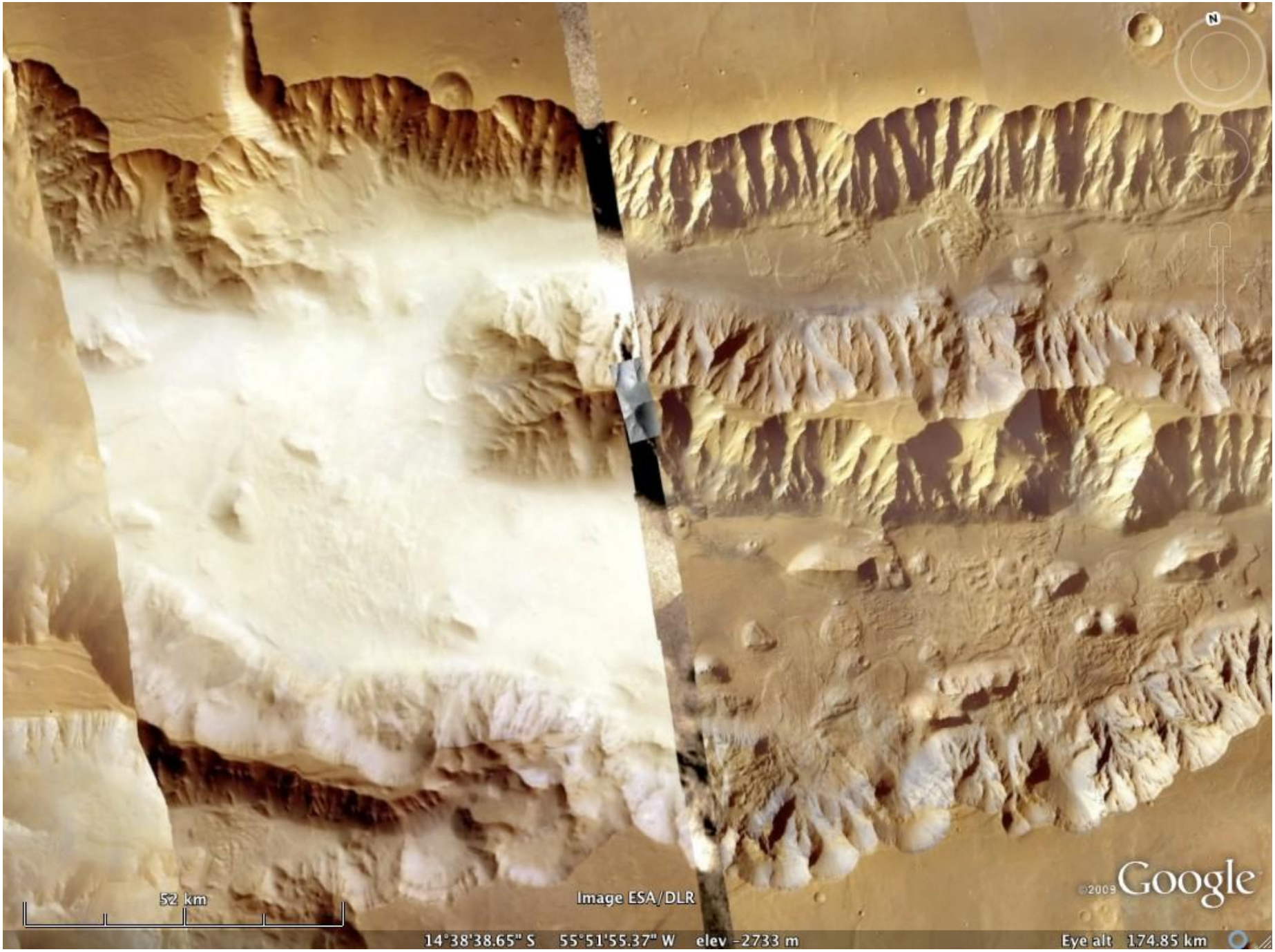
NASA/JPL/MSSS

July 2002 April 2005

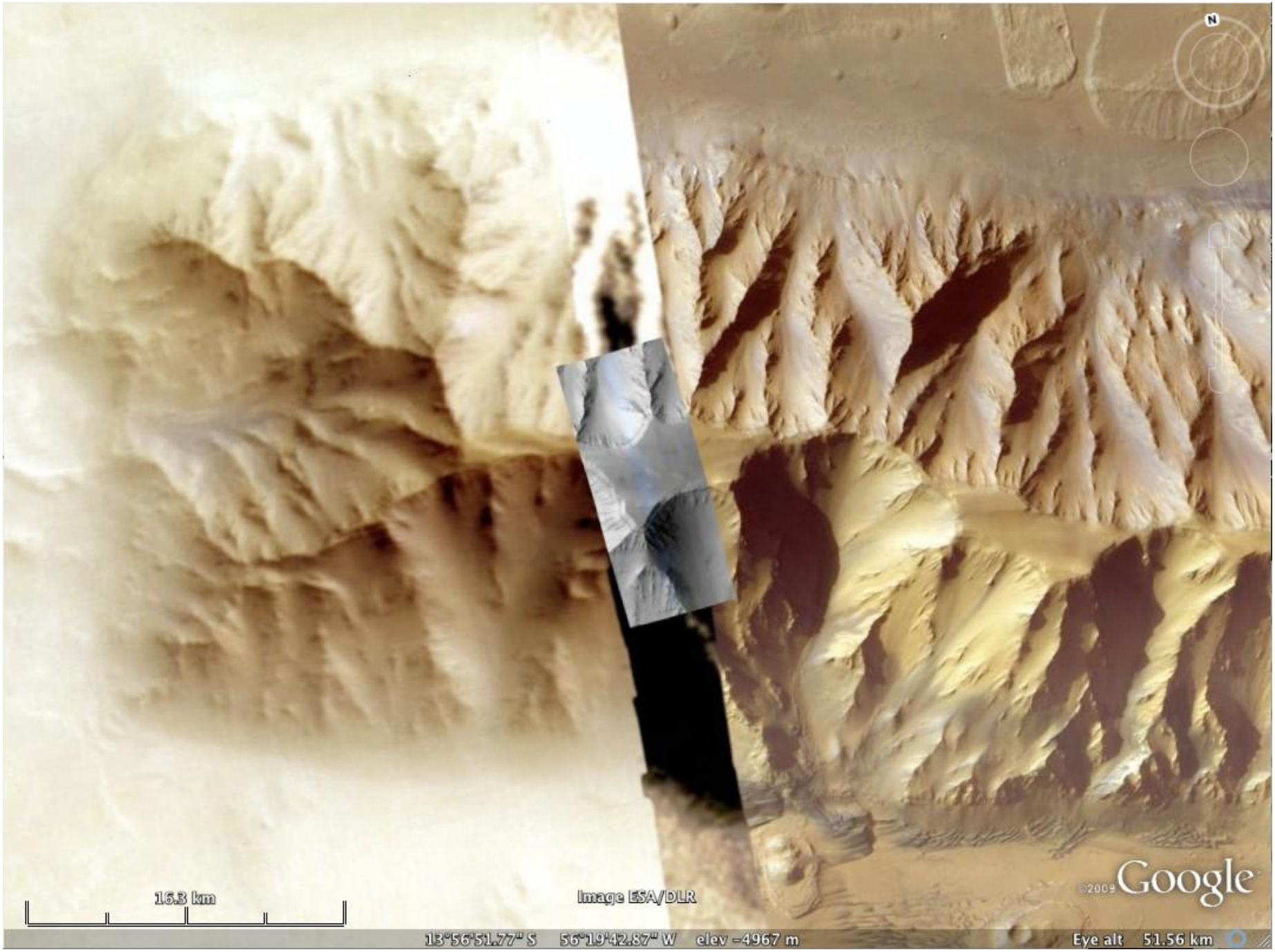
Mars has an active surface



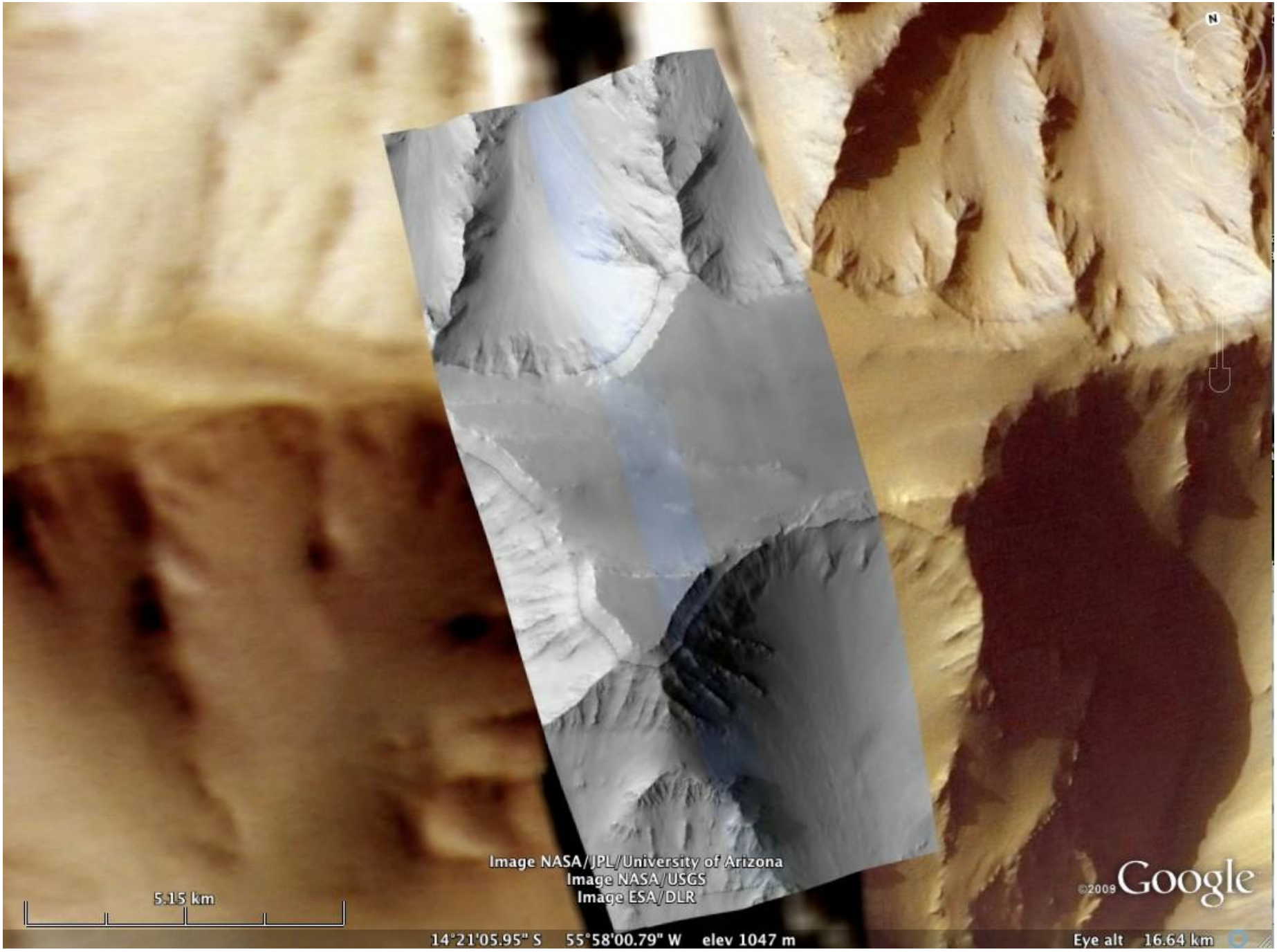
Slope streaks



Eastern Valles Marineris: layered outcrops − Deposits of sediments from water?



Eastern Valles Marineris: layered outcrops − Deposits of sediments from water?



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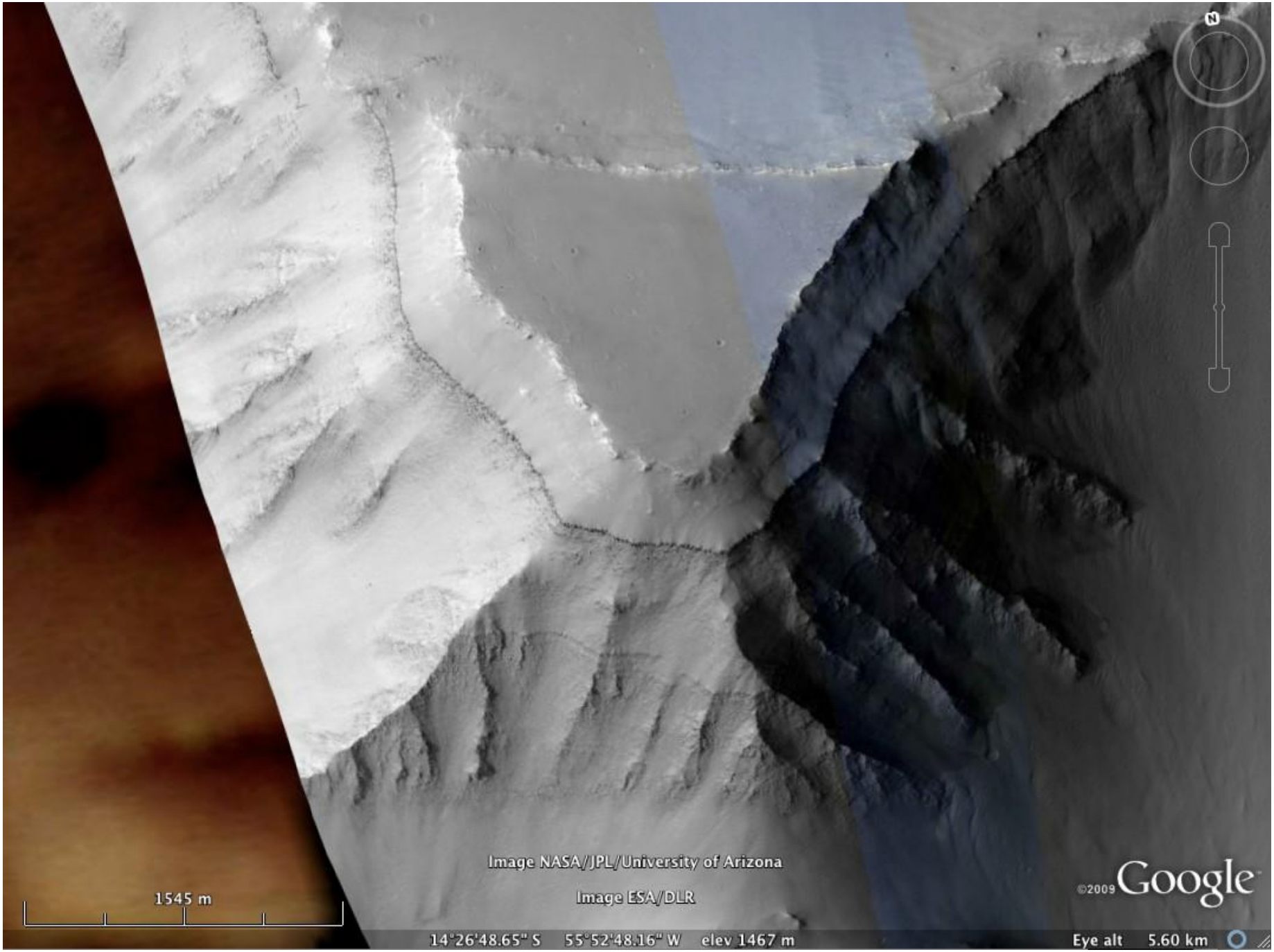

Eastern Valles Marineris: layered outcrops − Deposits of sediments from water?

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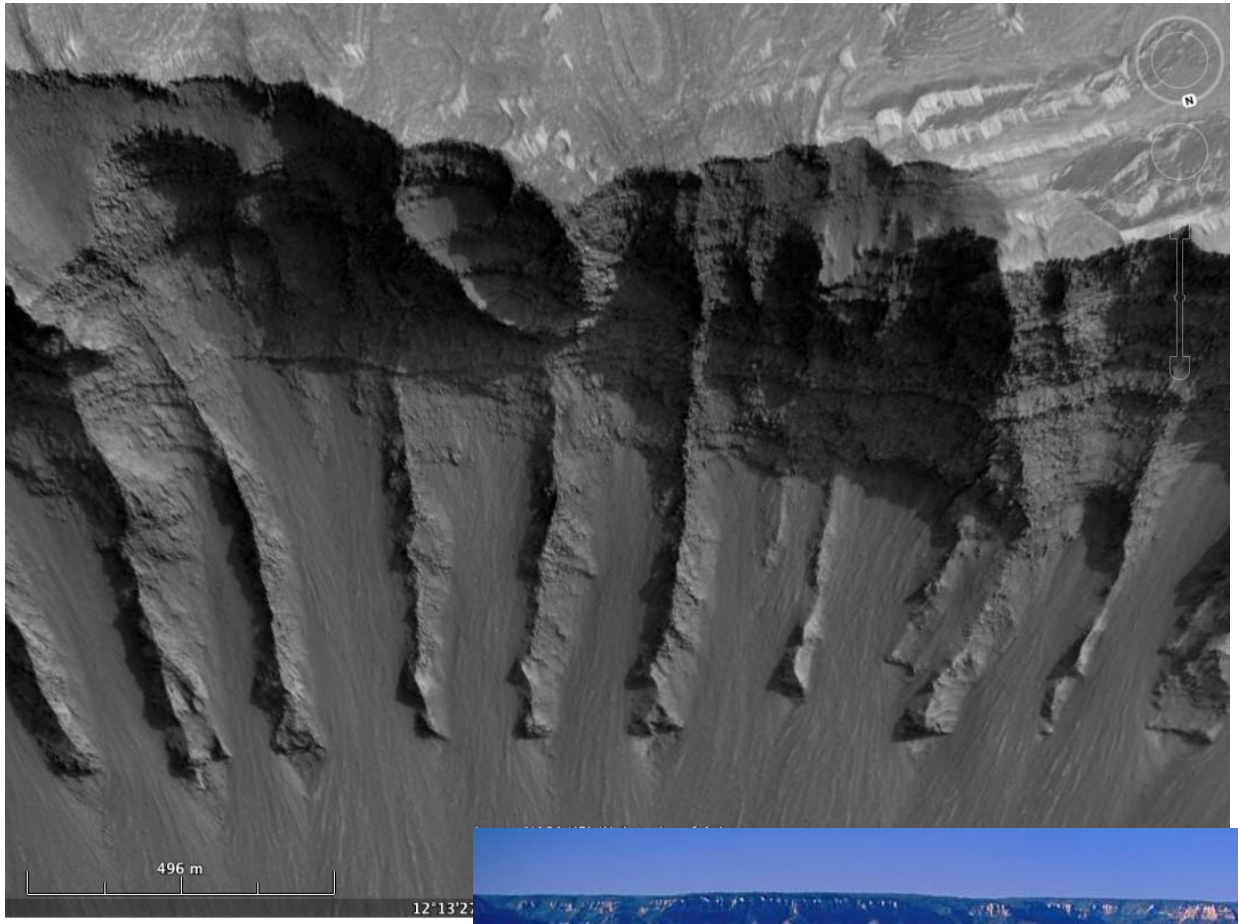
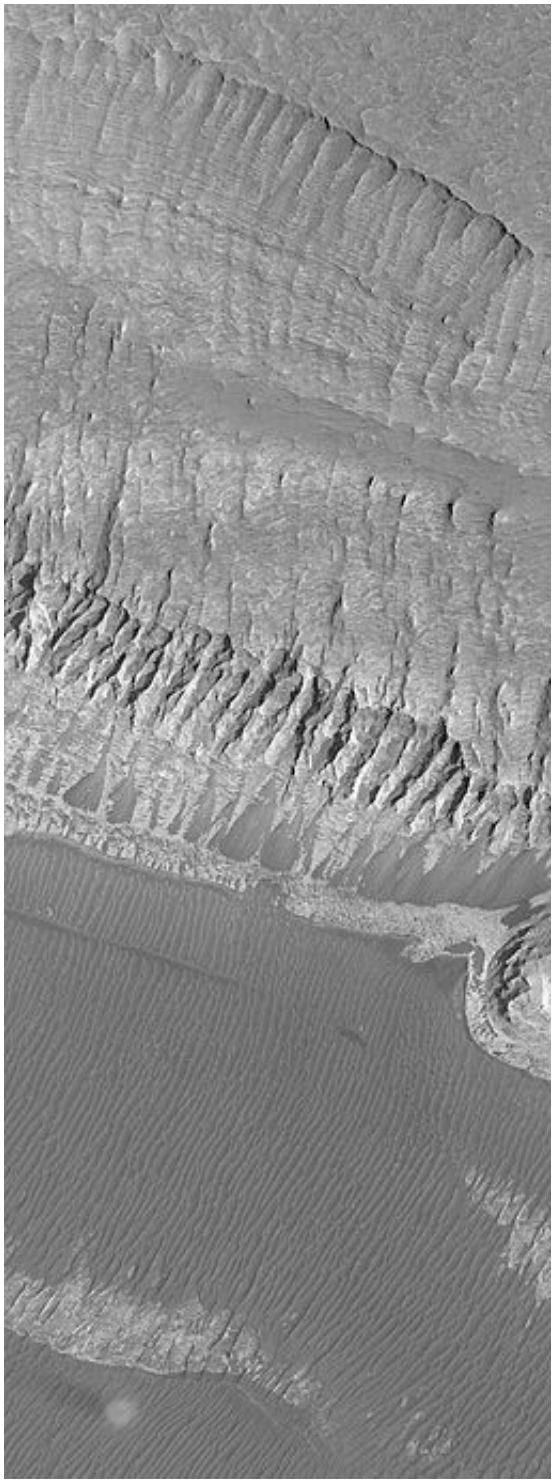
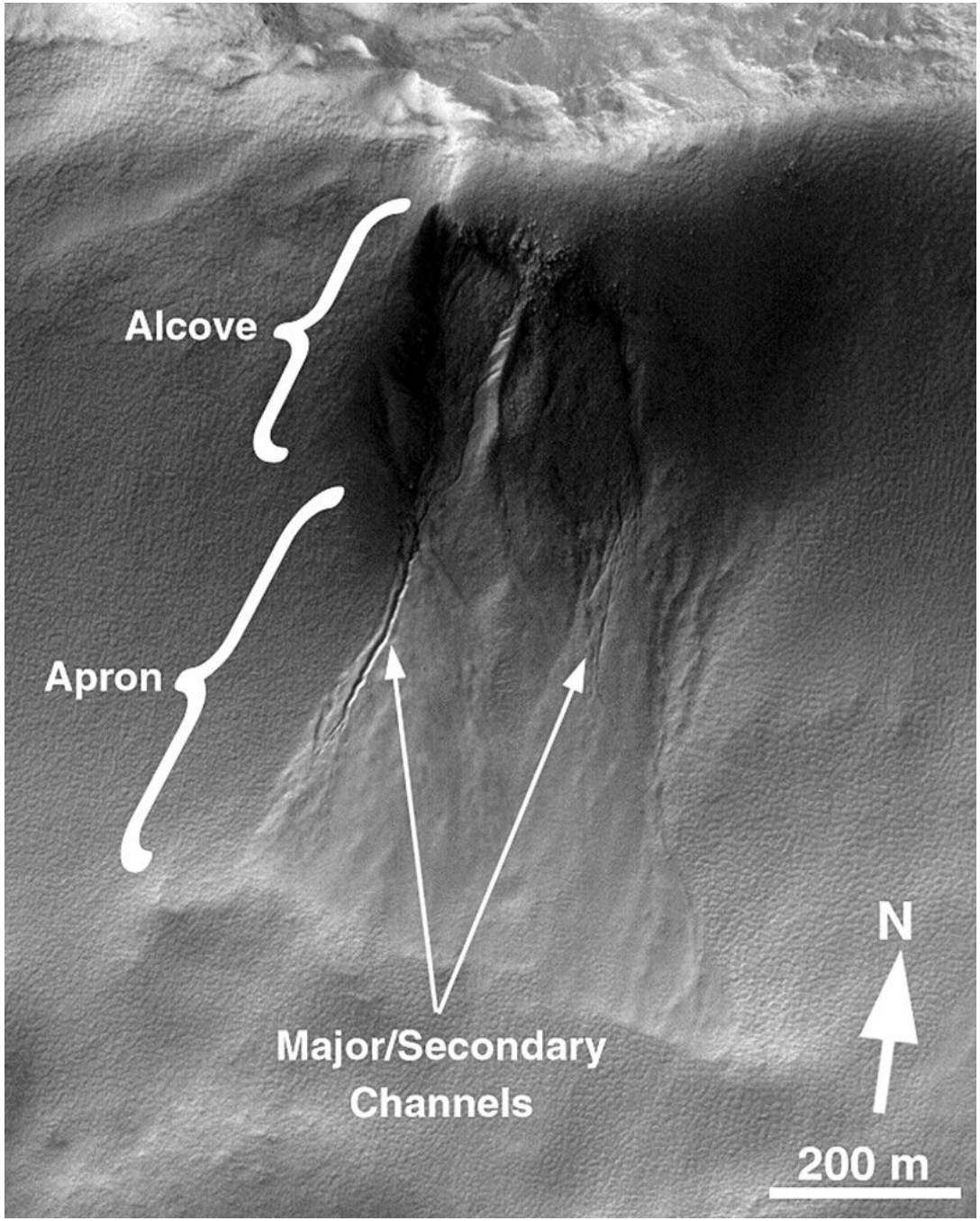




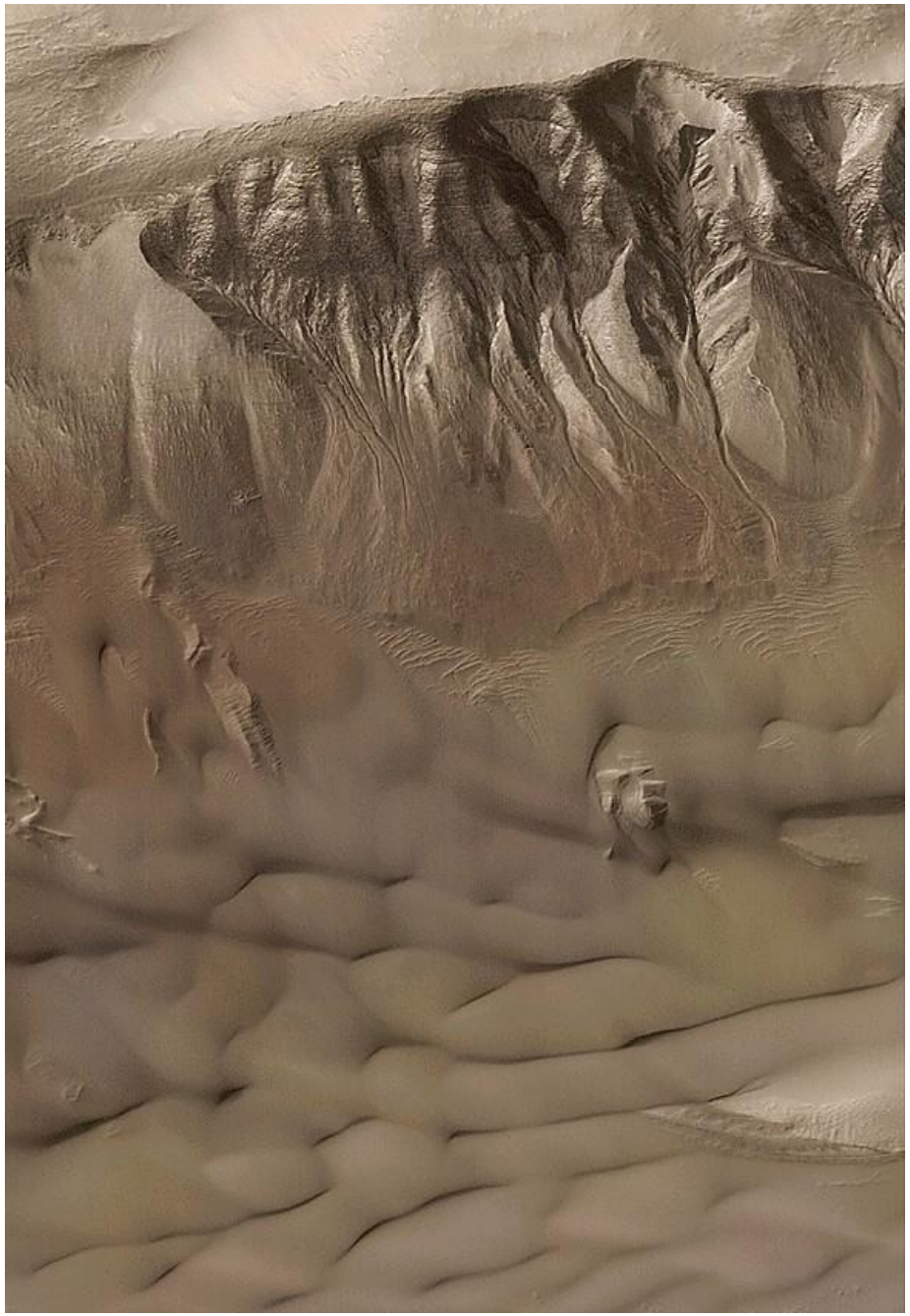
Layered structure in Grand Canyon vs. Valles Marineris on Mars

Deposits of sediments from water?



Martian gullies

Recent surface water??



Mars Gullies

Recent surface water??

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A landslide on Mars in action!

NASA/JPL |

Hang Onto Your Hat
This false-color image released by NASA shows an active avalanche on Mars. Taken by the Reconnaissance Orbiter on Feb. 19, 2008, the image shows tan clouds billowing away from the foot of a towering slope, where ice and dust have just cascaded down.

Mars Reconnaissance Orbiter (HiRISE)

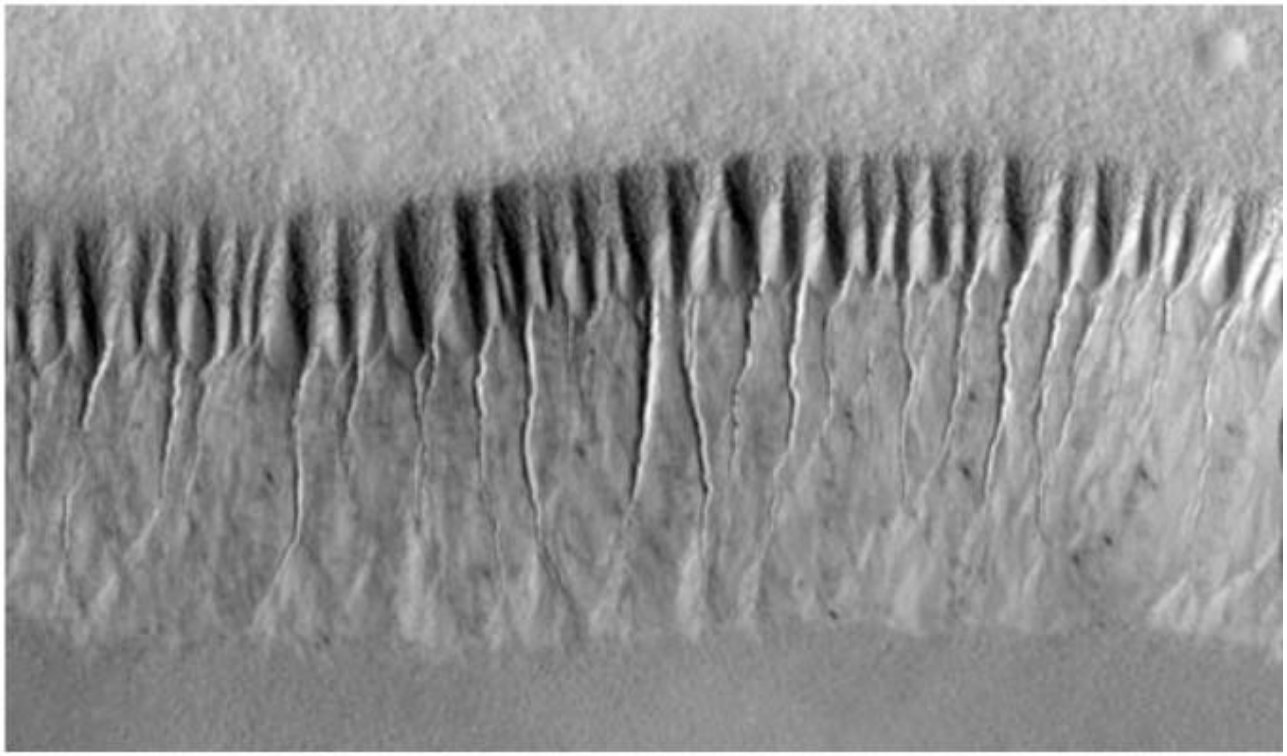

Figure 3. Detail of Mars Orbiter Camera image R0502476 showing evenly spaced erosional features incised into a debris slope at the edge of a depression near 70.7°S, 355.7°W. Image width is approximately 6.5 km. The rim of the depression is toward the top of the image; the floor is toward the bottom. Valleys, channels, and depositional fans appear to have been created by repeated debris flows [*Malin and Edgett*, 2000]. The convex profiles of the intervening ridges may be a signature of slope-dependent creep driven by cyclical deposition and sublimation of ground ice [*Perron et al.*, 2003]. Image courtesy of NASA/JPL/MSSS.