EARTH & MARS

STEPHEN E. STROM

Nature uses only the longest threads to weave her patterns, so that each small piece of her fabric reveals the organization of the entire tapestry.

Richard Feynmann

EARTH& MARS

I have spent most of my professional life as an astronomer, searching out patterns encoded in the light from distant stars in the hope of understanding how our sun and solar system came to be. Over the past four decades, I have spent countless hours perched on remote mountaintops, looking upward mostly, but also contemplating the desert below.

Over that time, I became drawn to, then seduced by the changing patterns of desert lands sculpted by the glancing light of the rising and setting sun: light that reveals forms molded both by millennial forces and yesterday's cloudburst into undulations of shapes and colors. In response, I began what has become three decades long devotion to capturing images of those remarkable patterns and the rich history they encode.

COVER: IMAGE 1: ♂ 36:09+ 109:31+

These images represent both a 30-year visual exploration of the American landscape and the remarkable photographs produced by martian orbiters, rovers and landers launched over the past two decades by NASA and its European counterpart, ESA (the European Space Agency). Tens of thousands of these images are available in digital form in public domain archives, which as an experiment, I decided to examine from the perspective of an artist rather than an astronomer. In doing so, I tried to imagine myself standing on the surface of Mars, or on a high martian mountain and searching for patterns which evoke the same powerful emotional response as a tellurian landscape.

As a scientist, I could not help but be drawn to the commonality of patterns manifest in the martian and terrestrial images: lands shaped by ancient and active volcanoes, by powerful winds, and by water—in the case of Mars, water that once may have flowed abundantly, but today is scarce and hidden below the crust of the planet's surface, released only for brief moments by the heat released by impacts with asteroids or by subsurface volcanic flows. That these patterns are manifest on vastly different scales on different planetary surfaces speaks to the profound beauty inherent in forms which result from the action of universal physical laws over time and space; the interaction of the elemental: **fire**, **earth**, **water**, and **air**.

As an artist, I find that the images raise questions about the aesthetic resonance of these photographs: why did these patterns call to me so strongly? Is it the rhythmic repetition manifest in the ripples that are the inevitable byproduct of the motion of air over a sand surface? Is it the fractal character of the channels produced by ancient martian rivers as well as the 'spider-like' patterns produced by the interaction of carbon dioxide with the martian soil? Is it the inherent simplicity or universality of these patterns, or some shared perceptual sensitivity to regular or 'ordered' chaotic patterns?

I invite the viewer to explore these images and the questions they raise, and hope that you will be as moved as I by the power of each photograph and viewpoint to reveal the multi-level beauty of two worlds.

As a starting point for visual exploration, I have chosen to group the images by the fundamental forces which shaped the **earth** on both planets, forces that find poetic and physical resonance with the classical elements: **fire** (the patterns—flows and upheavals —produced by volcanic activity); **water** (the surface wrinkles produced by glaciers, and the molding of river channels, sediment, and canyons); and **air** (the ongoing and past rearrangement and erosion of the land by wind). Because I hope to encourage a true exploration, I am providing the viewer only a modest guide: the latitude and longitude of each of the terrestrial and martian images.

A key ("Images" page) provides additional information for those eager to know "which is Earth?" "where was this image taken?" and "what am I seeing?" If you have invested time in exploring and contemplating these images, I welcome your impressions. Send them to info@stephenstrom.com.

May the images evoke what the late essayist Ellen Meloy described as a "geography of infinite cycles, of stolid pulses of emergence and subsidence, which, in terms geologic and human, is the story of the earth itself," and of Mars, too.

STEPHEN E. STROM

FIRE

Both Earth and Mars show evidence of volcanic activity: lava domes, planes of now-cooled molten rock (magma), hills comprised of volcanic ash. This suggests that both planets were once fiery balls of magma surrounded by a thin, cool crust. Volcanoes erupt when magma located below the crust bursts through to the surface as lava. While volcanoes are still active on earth, most volcanic activity on Mars appears to have ceased 200 million years ago. Because Mars is a smaller, lower mass planet, the heat content of its core and mantle is lower than on earth, and astronomers believe that as a result, Mars cooled more rapidly and as a result, lacks significant subsurface magma today.

Images 2, 3, 5 illustrate the varied consequences of volcanic activity on earth: respectively the center of a volcanic cinder cone, a hillside of volcanic rock and ash, eroded over millennia by ocean currents. **Image 4** illustrates what appears to be lava hills, perhaps eroded by water (though scientists are still searching for the true origin of these mounds).

IMAGE 2

⊕ 44:40+ 120:17+

IMAGE 3

⊕ 20:43+ 156:10+

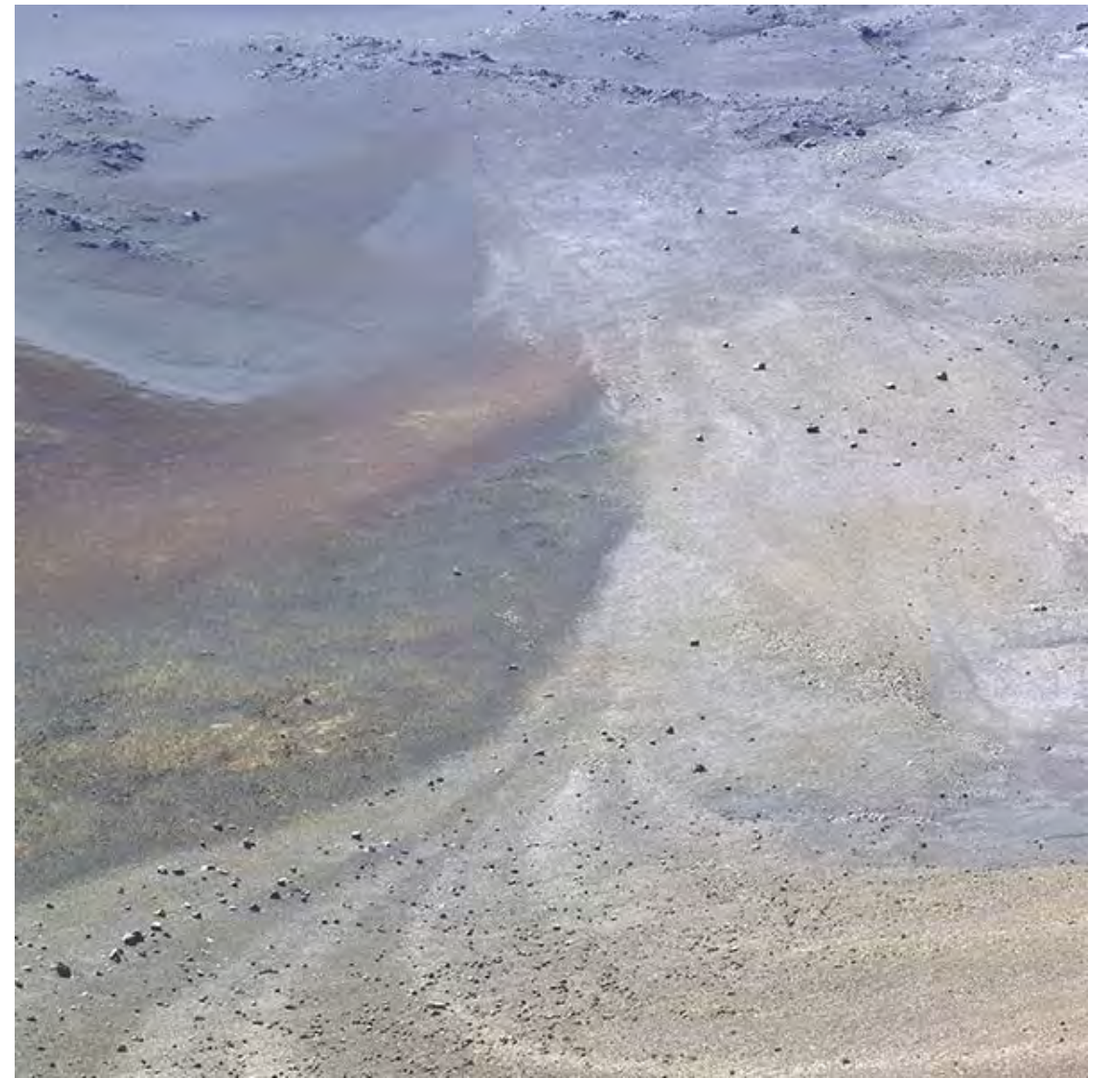


IMAGE 4

♂ 11:12– 172.30+

IMAGE 5

⊕ 48:39+ 123:09+

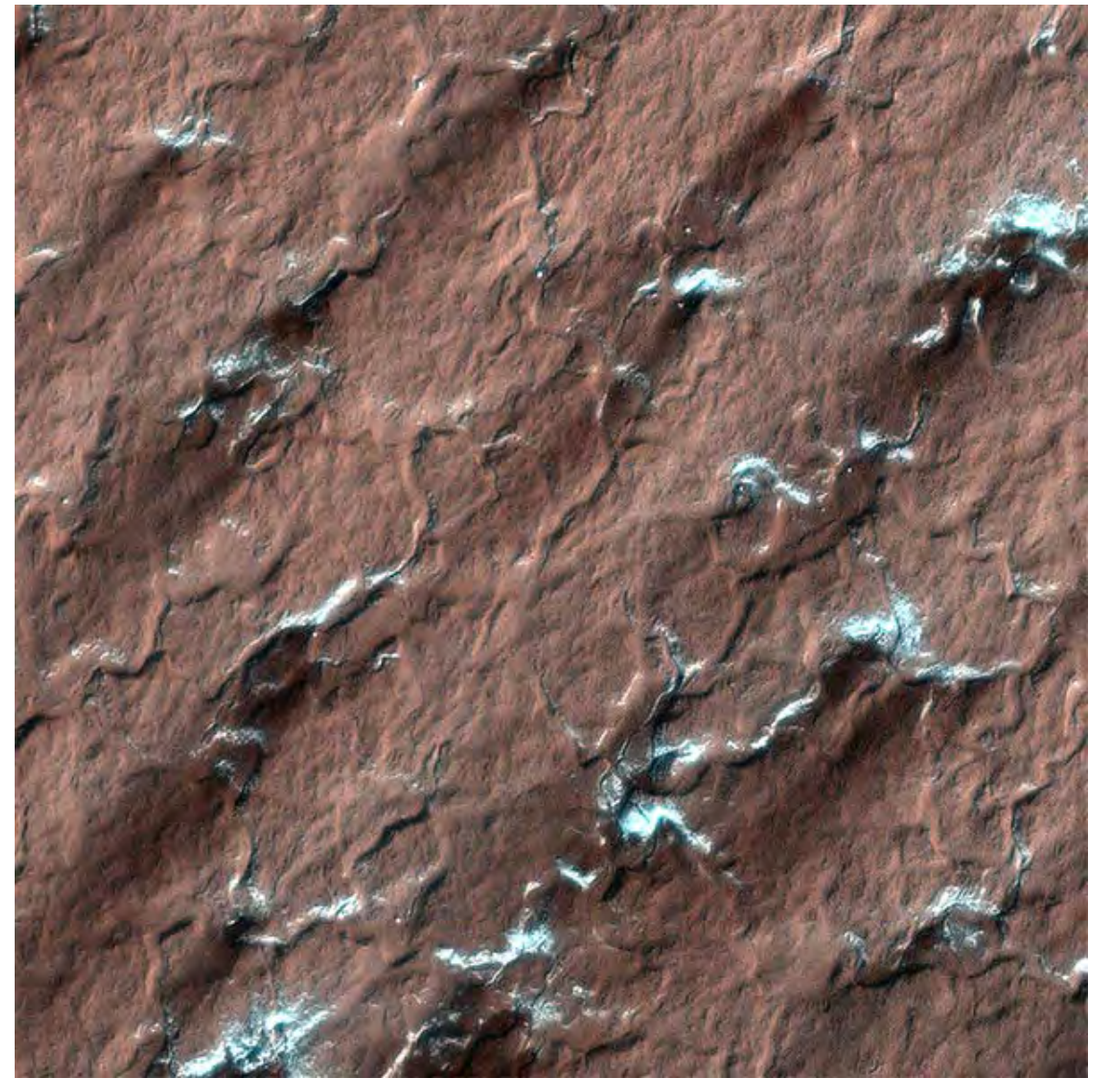
EARTH

IMAGE 6

♂ 85:48– 106:00–

IMAGE 7

♂ 87:00– 98:54–



Along with volcanic and tectonic activity, the forces of wind and flowing water mold the thin, cool crust of a planet. This surface is where life arose on Earth, and perhaps where life, albeit primitive, may once have taken form on Mars. On both planets, the earth (crust) is subject to ongoing reshaping, ever-changing as a result.

Images 6 and 7 illustrate the complex patterns produced on the martian surface as seasonal carbon dioxide ice warms, and evaporates from below, scouring dust from the surface, where it is carried away by powerful polar winds. The channels carved by the escaping gas are radially organized and have been dubbed "spiders." The dark, v-shaped patterns are evidence of the scouring effects of outgassing and ambient wind, **image 6**. The remaining carbon dioxide ice is visible in the spider-like crevices, **image 6**, and on the higher terrain, **image 7**.

WATER

IMAGE 8

⊕ 44:20+ 124:06+

IMAGE 9

♂ 35:00- 155:36+

Water covers more than 70% of the Earth's surface, and is constantly reshaping earth and rock on scales ranging from continental to microscopic. River channels, gullies, smoothed mountain ranges, water-carved canyons, sedimentary deposits, and the rounded rocks at ocean side provide vivid evidence of the combined power of water and time. These same features are found on Mars, suggesting that Mars once had rivers and lakes. Now, what water there is, seems restricted to subsurface regions, released as a liquid following the transient heating resulting from collisions with incoming meteors, but like water from a desert storm, gone within hours or days.

Images 8 and 9 provide dramatic evidence of water's role in shaping deep gullies on Mars. **Image 9** illustrates how volcanic clays on Earth are sculpted by water as evidenced by the larger scale flow and smaller scale analog of a gully.

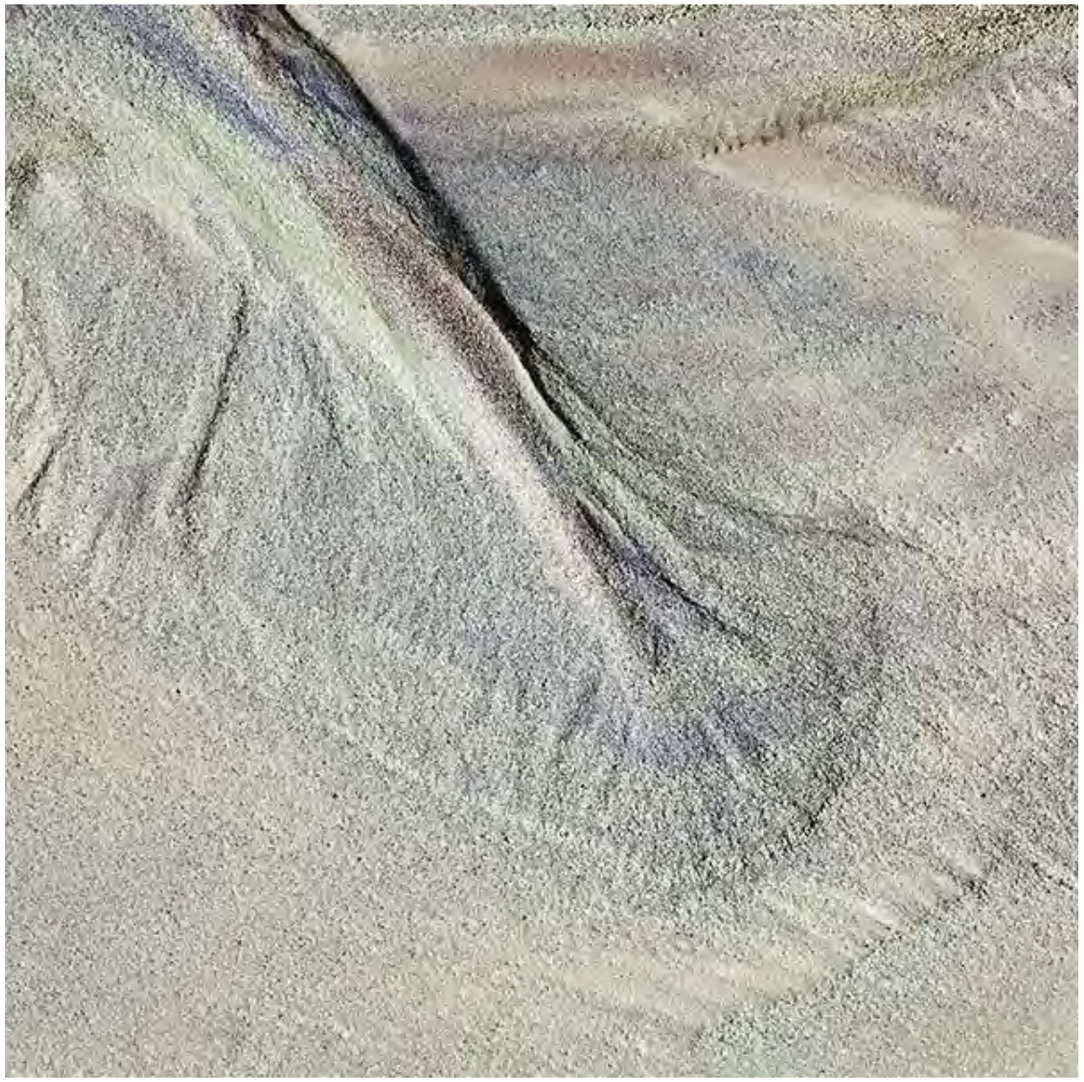


IMAGE 10

⊕ 44:34+ 119:38+

Image 10 illustrates the erosive effects of ocean water on sand producing a series of gullies eerily reminiscent of those observed on Mars, **Image 11**.

IMAGE 11

♂ 35:06– 37:36+

AIR

Both Earth and Mars have atmospheres. The much thinner martian atmosphere is dominated by carbon dioxide gas, while on Earth, life-sustaining air is comprised primarily of nitrogen and oxygen. Differences in temperature on each planet's surface produce temperature and pressure differences in the surrounding atmosphere. As a result, "air" on both planets flows from areas of high to low pressure, producing both steady global and transient local winds. On Mars, typical winds are 5–10 mph, but velocities as large as 300 mph have been observed.

The surfaces of both planets bear witness to the effects of wind, erosion, and reshaping of surface features over time. Perhaps the most dramatic evidence of the sculpting power of wind on Earth and Mars are dunes. **Images 12–15** illustrate the action of aeolian forces in producing regular patterns on Earth and Mars: both large dune fields (tens of kilometers in size) and small ripples (average peak-to-peak distance is 0.1 meter).

IMAGE 12

♂ 47:12– 19:30–

IMAGE 13

♂ 47:48– 30:42–

IMAGE 14

⊕ 32:49+ 106:15+

IMAGE 15

♂ 47:54− 30:24−

IMAGES

Image	Title	Planet	Latitude	Longitude	Scale (m)
1	Ice and Mud Pattern, Canyon de Chelly	♂	36:09+	109:31+	5
Fire					
2	Mudhill detail, Painted Hills, Oregon	⊕	44:40+	120:17+	50
3	Haleakala Crater, Maui, Hawaii	⊕	20:43+	156:10+	1,000
4	Mounds in ancient crater	♂	11:12–	172.30+	500
5	Eroded rock, Johns Island, Washington	⊕	48:39+	123:09+	1
Earth					
6	Cryptic terrain, South Pole	♂	85:48–	106:00–	1,000
7	Spider pattern, South Pole	♂	87:00–	98:54–	700
Water					
8	Sand Pattern, Yachats, Oregon	⊕	44:20+	124:06+	1
9	South of Sirenum Fossae Crater	♂	35:00–	155:36+	1,000
10	Mudhill detail, John Day State Park, Oregon	⊕	44:34+	119:38+	2
11	Gully, Western Hale Crater	♂	35:06–	37:36+	500
Air					
12	Dunes and Volatiles	♂	47:12–	19:30–	100
13	Sand Dune, Proctor Crater	♂	47:48–	30:42–	500
14	Dune detail, White Sands, New Mexico	⊕	32:49+	106:15+	10
15	Dune detail, Proctor Crater	♂	47:54–	30:24–	700

⊕ = Earth ♂ = Mars

In coordinates, + refers to north latitude and/or west longitude.

Scale is based on length of one side of the dimensions of terrain captured by the photograph in meters. (Scale is approximate.)

There is no logical way to the discovery of these elemental laws. There is only the way of intuition, which is helped by a feeling for the order lying behind the appearance.

Albert Einstein

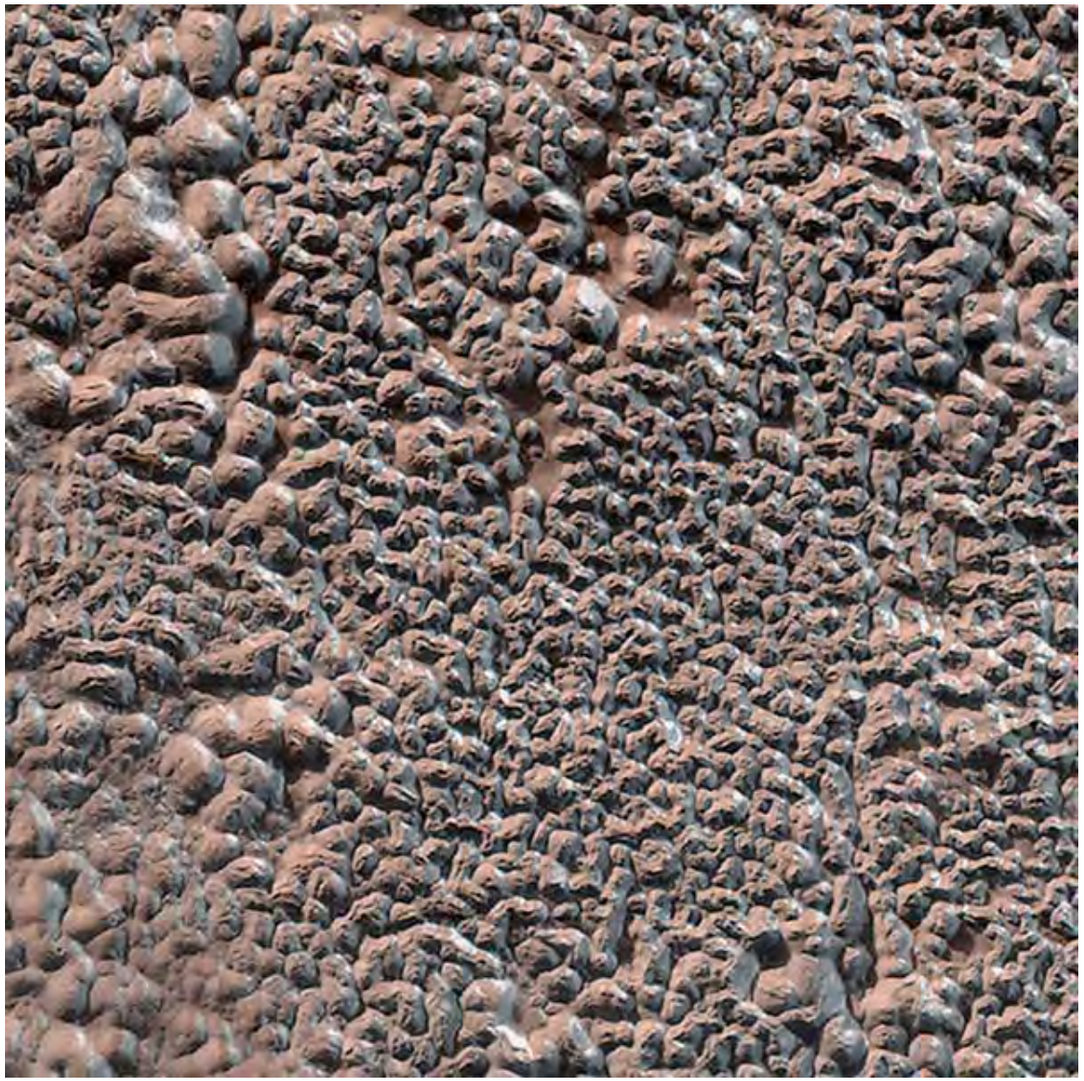


IMAGE 16

♂ 41:54 – 105:24+

Flows and Land Forms, Icaria Planum, approximate **scale = 700 m**

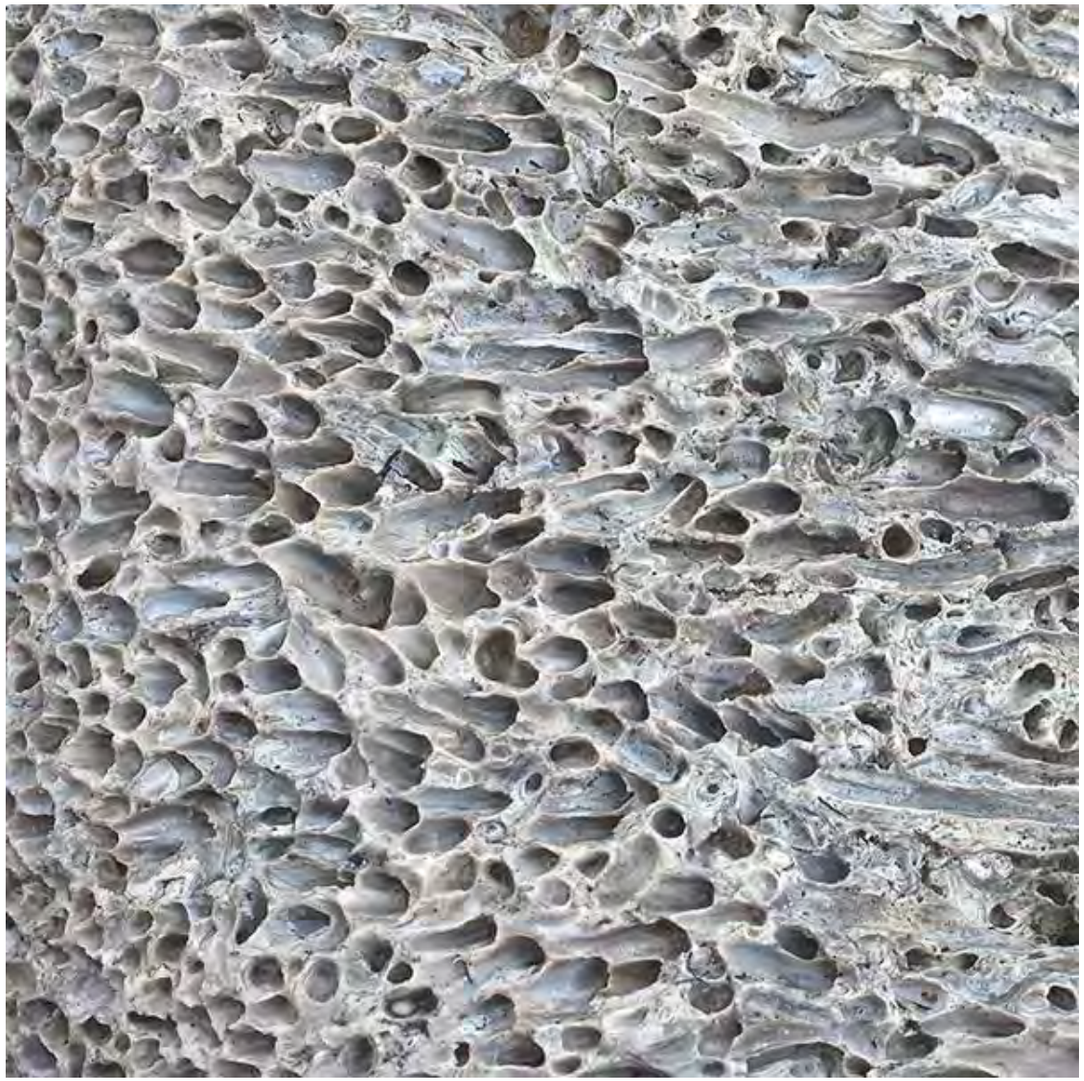


IMAGE 17

⊕ 44:28+ 121:11+

Eroded Volcanic Rock, Smith Rock State Park, Oregon, approximate **scale = 1 m**

SCALE

Nature is painting for us, day after day, pictures of infinite beauty.

John Ruskin

ABOUT THE PHOTOGRAPHER

Stephen Strom studied both the history of photography with Keith McElroy, and silver and non-silver photography in studio courses with Todd Walker and Harold Jones at the University of Arizona. His work, largely interpretations of landscapes, has been exhibited widely throughout the United States and is held in several permanent collections including the Center for Creative Photography in Tucson, Arizona; the University of Oklahoma Art Museum; the Mead Museum in Amherst, Massachusetts; and the Museum of Fine Arts in Boston.

BOOKS PUBLISHED BY THE UNIVERSITY OF ARIZONA PRESS

Secrets from the Center of the World, a collaboration with Muscogee poet Joy Harjo
Sonoita Plain: Views of a Southwestern Grassland, a collaboration with ecologists Jane and Carl Bock
Tseyi: Deep in the Rock Reflections on Canyon de Chelly, co-authored with Navajo poet Laura Tohe

OTHER TITLES

Otero Mesa: Preserving America's Wildest Grassland, published by the University of New Mexico Press
Earth Forms, published by Dewi Lewis Publishing

It is a geography of infinite cycles, of stolid pulses of emergence and subsidence.

Ellen Meloy, *Last Cheater's Waltz*

Stephen E. Strom

info@stephenstrom.com

stephenstrom.com

ACKNOWLEDGEMENTS

The National Aeronautics and Space Administration (NASA)
The European Space Agency (ESA)
The Jet Propulsion Laboratory
University of Arizona Lunar and Plantary Labratory (LPL)

Design by studiosolis.com