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Working on Mars: Translating Planetary Field Science to Our Distant Lands

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The landscape conveys an impression of absolute permanence. It is not hostile. It is simply there untouched, silent, and complete. It is very lonely, yet the absence of all human traces gives you the feeling you understand this land and can take your place in it.

Edmund Carpenter, quoted by Lopez (1986, frontpiece)

Today hundreds of planetary scientists—geologists, biologists, chemists, meteorologists, and others—are working on Mars (Clancey 2012). They live on Earth of course, working through distant robotic laboratories that they collaboratively program to take panoramas and micro-photographs, dig and analyze the composition of soils and rocks, and move together over kilometers of martian terrain.

These first remote field expeditions on another planet have been anticipated and prepared in "analog missions" on Earth—field studies of remote locales that resemble the desert plains, craters, and periglacial landscapes of Mars (Cockell 2004). At places such as Devon Island in the Northern Canadian Arctic (Figures 1 and 2), the American southwest, and Rio Tinto of Spain, we learn how acid pools affect the chemistry of rocks, how depositions by wind and running water form over eons, and the erosion effects of glacial rivers (Clarke 2006). Then seeing similar land formations and chemistry on Mars, we translate back to the processes we have studied first-hand on Earth—inferring by analogy three billion years of geology and climatology on a supposedly "alien" planet. Similar analog science guides our interpretation of the volcanic lava pools of Io, the icy geysers at the south pole of Enceladus, the 100 km deep salty ocean of Europa, and the liquid methane eroded river valleys of Titan. Despite being incredibly far—requiring months or years to reach with today's rockets—these foreign landscapes are recognizably familiar and understandable because all that we have learned from the physics, chemistry, and meteorology of Earth translates directly to other bodies in the solar system—and beyond to the 100 billion other stars in our galaxy.

Because these places are so far, we visit them only through robotic laboratories, which fly by the planet or moon, orbit it, or land on its the surface. Broadly speaking, these explorations remind us of early explorers traversing the oceans and continents of Earth. The acquisitive intentions of Anglo-European explorers aside, these historical analogies remain culturally part of Western civilization—space flight is often related to "voyages of discovery" and our spacefaring ships are named after famous vessels such as "Endeavour." The Mars Exploration Rover scientists named many places they encountered after places sighted and named by Captain James Cook and other explorers. Socio-historical analogy plays a strong role in anticipating the colonization of Mars as well; members of the Mars Society consider for example how layout of towns, economics, and politics might relate to those on Earth (Zubrin 2008).

Figure 1: Pascal Lee and John Schutt in the Valley of the Moon, Devon Island, July 1998. Credit: NASA Haughton-Mars Project/Clancey.

One might expect that the exploration of Mars is going to be different from Earth because today's technology and years of repeated investigation enable reconnaissance in increasing detail and depth. In part this is true, but the facts are sparse and uncertain. We landed Spirit at Gusev crater a decade ago believing it to be a dry lakebed, but we found only volcanic basalt until we climbed out of the basin. Today with improved orbital reconnaissance, we more confidently drive Opportunity, the twin Mars Exploration Rover, to ridges of Endeavour crater whose outcrops have been targeted by spectral analysis from orbit as containing clays, evidence of fresh water in the past.

Figure 2: View of camp from the river—"Parry wrote of the pleasure of staring at a stone in the snow, for the relief it gave the eye" (Lopez 1986, p. 351). Credit: NASA Haughton-Mars Project/Clancey.

Nevertheless, our reach, our vision, and our analysis are far more limited than might be expected: We landed Phoenix in 2008 in the martian arctic on what might be water ice covered by a thin layer of soil, with no ability to scrape more than a few centimeters deep. A team of 75 scientists controlling Spirit investigated an area of about two soccer fields for over three years, never seeing or learning what laid beyond the hills they dubbed "the promised land." Even today at Gale crater, a more advanced robotic laboratory, Curiosity, lacks the instruments to identify molecular forms of life. The very soils we see and hold in the rover's shovel might contain DNA or something similar, but we cannot know it. Technology is reducing what is unknown, but most of our questions about the landforms and potential biology of this eerily familiar place remain unanswered (Hartmann 2003).

The remote lands of Mars and other planetary bodies are known by scientists and engineers in more ways than scientific descriptions might suggest. Scientists are able to apprehend the landscape through virtual presence—embodied in rovers they move through the terrain and manipulate soils and rocks (Figure 3). Through a robotic vehicle's arms and tools, complemented by a kind of virtual reality software that allows systematically mapping photographs to named places and objects, people can project ourselves imaginatively into the body of the rover. Indeed, scientists and engineers must do this to know what is reachable and viewable and how to precisely deploy the instruments. In this manner, one geologist said he has “two boots on the ground,” and personally experiences the mission as “being there in the scene” (Clancey 2012, p. 100).

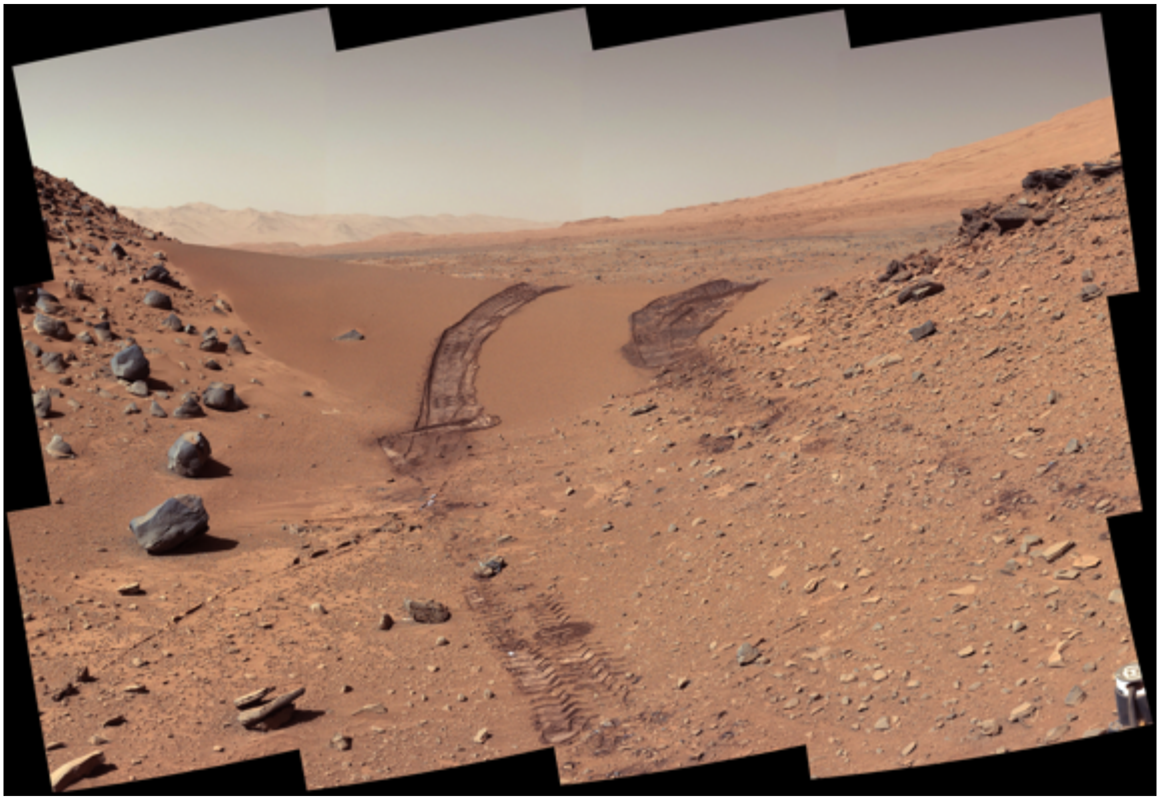

Figure 3: Mars Science Laboratory climbing the ramparts of 5.5 km high Aeolis Mons, Sol 538 (image white balanced for an Earth-like sky). Credit: NASA/JPL-Caltech/MSSS, http://photojournal.jpl.nasa.gov/catalog/PIA17944 (accessed 20 February 2014).

Although the rovers are often called “robotic geologists,” this name refers perhaps more properly to the people who control the tools and travel on Mars through a remotely programmed system—indeed, they have become cyborgs with spectral eyes and laser probes. Rather than being replaced by machines and isolated from their work, planetary scientists are physically grounded in the landscape, personally involved in mind and body—with six wheels, stereo vision, and a variety of instruments for “tasting” the dust and minerals of Mars. The mission team is collectively the mind of the robot.

But we are on Mars emotionally, too. We appreciate the view from the top of a hill (Figure 4) and take pictures sometimes “just because they’re cool” (Steven Squyres, MER Principal Investigator, quoted in Clancey 2012, p. 213).

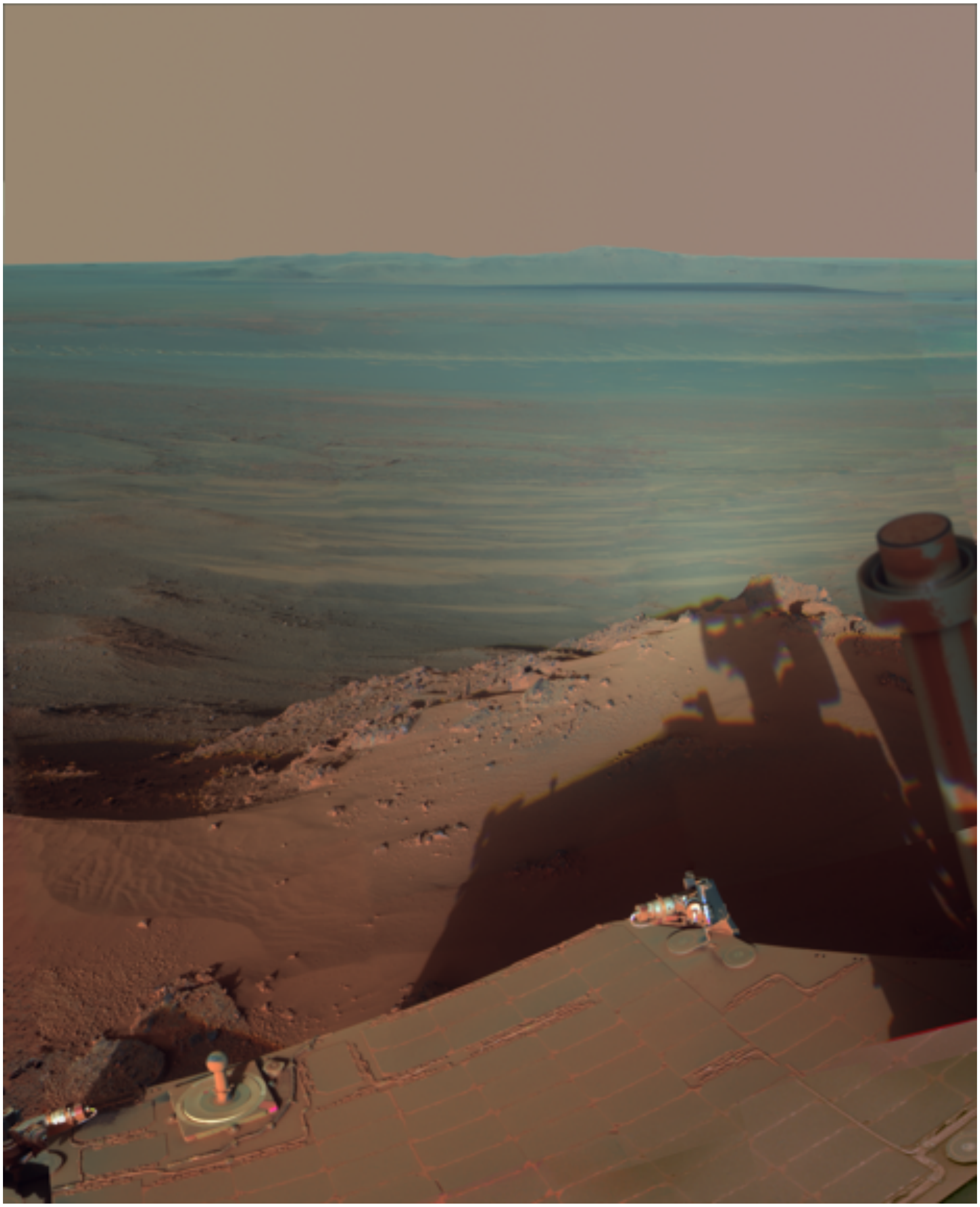

Figure 4: “Late afternoon shadows at Endeavour crater on Mars,” Opportunity Sol 2888—“The view is presented in false color to make some differences between materials easier to see, such as the dark sandy ripples and dunes on the crater's distant floor.” Credit: NASA/JPL-Caltech/Cornell/Arizona State Univ., http://photojournal.jpl.nasa.gov/catalog/PIA15684 (accessed 27 February 2014).

As on Earth, a view sometimes brings us up short in our tracks, dazed by a visual aesthetic—one that at first does not "remind" but is rather simply taken for itself, known but ungraspable, seen and felt (Figure 5).

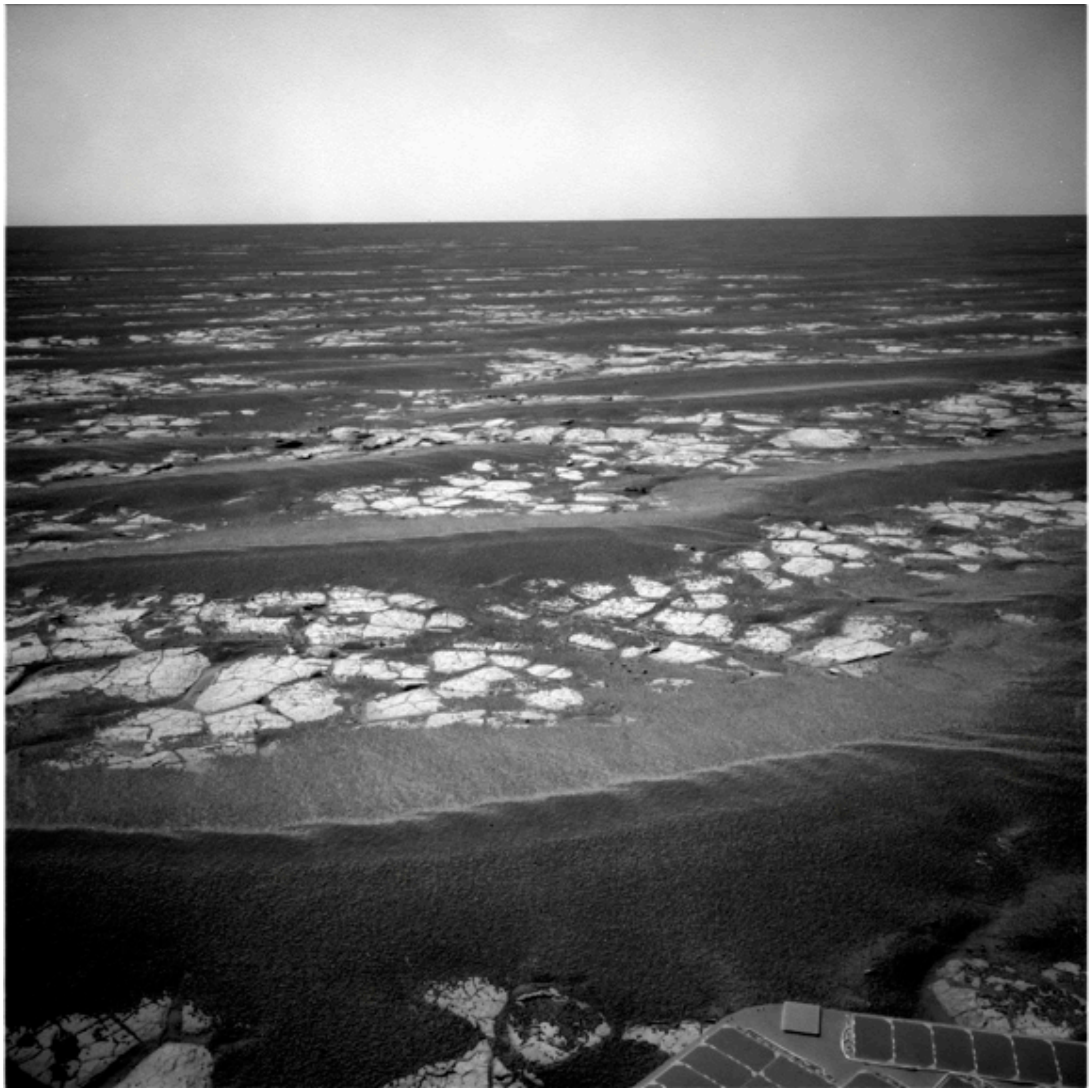

Figure 5: View from Opportunity paused on Meridiani Planum about one-third through a multi-year, 16 km traverse from Victoria to Endeavour crater. Credit: JPL Mars Exploration Rover Mission, "Opportunity: Navigation Camera: Sol 1930," http://marsrovers.jpl.nasa.gov/gallery/all/1/n/1930/1N299526557EFFA3PEP0743R0M1.JPG (accessed 1 July 2009).

Perhaps it is the openness, the unseen horizon that beckons. We have similar experiences on Earth—a glance to one side, perhaps up an unmarked ravine that no one we know has ever traversed and that we are passing by, a way not taken, a place here at hand that we leave behind undefiled, unstudied (Figure 6). A landscape seen but untraveled is not yet known.

Figure 6: Ravine seen while passing on an all-terrain vehicle, Devon Island, July 1999. Credit: NASA Haughton-Mars Project/Clancey.

Orbiting and roving laboratories enable us to transcend our physical bodies and the great distance, engaging the equally boundless adaptivity of our imagination. The surface of Mars is now present to us and we inhabit it, conducting our field work by translating what we have learned on Earth, and forging new ways of working together.

The Sun, our personal star, lights and warms our distant lands, still a commons nobody owns—the plains and canyons of Mars, tiny asteroids we already orbit and sample, the icy moons of Saturn that tempt return travel. We know these territories better than the Vikings knew North America or the Pacific Islanders and even Cook knew the Pacific. Probing telescopes and curiosity extend our reach to the inhabitable planets around other stars, driven to find places like Earth and signs of life. We locate ourselves in the Milky Way Galaxy, an increasingly known physical space of millions and very probably billions of Earth-like planets (Borucki 2010). And that transcendental perspective gives new meaning to where and who we are—and what we might yet become.

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