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Not My Fault: Good news from another world

Lori Dengler/For the Times-Standard
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I've been obsessed with disasters for the past few weeks and so it is a relief to report on good news. InSight successfully landed on Mars. The Interior Exploration using Seismic Investigations, Geodesy and Heat Transport probe is now firmly sitting atop the broad plains of Elysium Planitia near the Martian equator and about to start an unprecedented series of geophysical experiments.

This is the first space probe devoted entirely to geophysics, or rather areophysics (areo as in Ares relating to Mars) and as a geophysicist, it gives me a little thrill to see my discipline worthy of such a complex and intricate experiment.

I first became aware of geophysics in 1965. I was a sophomore at UC Berkeley taking an introductory geology course to meet a general education requirement. Never in my wildest dreams did I imagine majoring in science, let alone a field that required lots of physics and math. It was taught by Howell Williams, the preeminent volcanologist of his day. On the first day of lecture, Professor Williams explained that earth science was as firmly rooted in the arts as to the hard sciences and the ability to imagine in three dimensions and appreciate the beauty of earth structure was as important as running computer programs or successfully completing complex calculations. I was hooked.

We have aimed a lot of hardware at the red planet. NASA's Mariner 4 flyby in 1965 provided the grainy black and white images that first began to reveal the surface of this alien world. Of 56 missions to Mars, 26 actually succeeded in sending back information. They included flybys, orbiters, landers and rovers. Eight, including InSight, are still operating.

The flybys and orbiters provided information about the gravitational and magnetic fields of the planet and surface topography. Landers and rovers are the "feet on the ground," providing information about the composition and characteristics of the surface material. The Viking Program of the mid 70s successfully deployed two landers and the first surface images of the planet. They both included seismic sensors, but had problems. Viking 1's instrument didn't deploy properly and Viking 2's was operational, but affixed to the lander's leg, it primarily picked up vibrations from the wind and movement of the lander itself.

The rovers, Spirit, Opportunity and Curiosity, are my favorites. Like Pixar's Wall-e for real, they plodded away in their lifeless world, sampling soil, crushing a rock and painstakingly logging every detail. Curiosity is still operating. Over their combined 26 years (23 years longer than their original missions), they logged 45 miles of the Martian surface. That might not seem like a lot by earth standards, but it is an incredible feat considering the controlling signals come from 140 million miles away (plus or minus 100 million miles depending on the time of year), and it takes 4 to 24 minutes for the radio commands to travel back and forth.

The rovers compiled an impressive amount of information about Mars, confirming the presence of water in the past and conditions that may have enabled microbial life many millennia ago. But the rovers are confined to the surface, to examining outcrops along their path and scraping at most a few inches below the surface. InSight will reveal the deeper picture.

There are three primary instrument clusters on InSight: SEIS the seismometer package, HP3 the temperature probe, and RISE the system that tracks orbital variations. SEIS consists of two different seismographs. One will detect very small motions and high frequencies to characterize the near surface. The other is a very broad-band (both short and long periods) instrument capable of recording marsquakes, meteor impacts or even the creaking produced by the planetary interior as Mars continues to cool. These seismic inputs should be sufficient to constrain the structure of the planet and answer whether Mars, like earth, has both an inner and outer core and what their dimensions are.

The temperature probe HP3 consists of a "mole," a self-hammering probe that can penetrate 16 feet beneath the surface. It will measure the heat flowing out of the planet and thermal properties of the near-surface material. This allows scientists to make estimates about the sources of heat and the thermal evolution of the planet. The hammering as the probe inserts itself also provides a small seismic signal for the SEIS package.

RISE is a sophisticated telemetry unit with antennas and transmitters/transponders capable of sending and receiving signals from earth so that the position of the landing site can be measure very precisely. All planets

"wobble," small perturbations in the axis of rotation relative to the mass of the body. This wobble, forced by moons, other planetary bodies, and seasonal motion of the atmosphere, provides information about whether the core is liquid or solid.

The first actual data from these instruments won't be arriving until next year. It will be a slow process selecting the best spots to situate the seismometers and temperature probes. NASA and the Jet Propulsion Laboratory will first make an exact duplicate of the InSight landing spot and place a duplicate model of the lander so that each motion of the robotic arm can be carefully tested in the laboratory before sending commands to Mars.

And then the floodgates will open providing a new picture of a very old world. Professor William's words from 1965 still ring loud and clear. Studying Earth or Mars combines both art and science and I am looking forward to a heavy dose of both in 2019.

Lori Dengler, PhD, is an emeritus professor of geology at Humboldt State University, and an expert in tsunami and earthquake hazards. For questions or comments about this column and requests for free copies of the preparedness magazine "Living on Shaky Ground," leave a message at (707) 826-6019 or email Kamome@humboldt.edu

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