CRISM: Exploring the Geology of Mars

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Exploring the geology of Mars is similar to the way that we look at the rock record on Earth. One way we do this is by analyzing stratigraphy – or studying the layers of ancient rocks that record changes through time.

The Grand Canyon, for example, exposes over a billion years of the Earth's history. This history is recorded in the layers of rocks, which tell geologist about the ancient environments that once existed on Earth.

Valles Marineris is considered "The Grand Canyon of Mars" and is a planetary geologists' playground.

If we project Valles Marineris onto the Earth's globe, it would stretch across the entire continental United States. It runs ~4 miles deep and therefore exposes some of the most ancient crust on Mars.

How Valles Marineris was formed remains a point of debate among scientists, but would provide important insight into the history of Mars.

It appears to have formed as a result of the enormous stress that the Tharsis bulge –the largest volcanoes in the solar system – places on the crust. This massive load caused stresses that pulled apart the crust and basically ripped it open. Recently, however, it has also been hypothesized that while it was rifting open, it also experienced strike-slip faulting, like we see in California with the San Andreas fault.

If Valles Marineris simply pulled apart, we would expect the geology on the North and South side of the canyon to match each other. If significant strike-slip faulting occurred then the rocks would be offset from one another, and the North and South side would not match. We target the CRISM instrument to observe the walls of Valles Marineris to see the different primary and secondary minerals that are exposed.

The secondary minerals, or alteration minerals, show us how that primary material altered or weathered in presence of water on ancient Mars.

We can find these signatures of primary and secondary minerals in the CRISM spectral images by looking for key absorptions at infrared wavelengths that help us identify the minerals that make up the rocks.

Using the CRISM data we can put together a very simplistic geologic profile of the rock record exposed in Valles Marineris, like the geologic profile of the Grand Canyon.

Most of the canyon wall shows secondary minerals that form in the presence of water only at lower temperatures.

However, using CRISM we have found a very localized region to the West, where you see magma dikes that cut through the crust and secondary minerals that must have formed at higher temperatures. These higher temperature minerals are exposed on both the North and the South side of the canyon walls.

So what do these secondary minerals and their location tell us about the “Grand Canyon of Mars”?

Well, the CRISM data tells us something about the formation of Valles Marineris. Because we see these special high temperature minerals directly across from each other on the North and South walls, we know that the formation of Valles Marineris is inconsistent with strike-slip faulting. So by mapping out these minerals with CRISM, we can see that Valles Marineris formed dominantly through extension, or rifting of the Mars crust.