DISCOVERING MARS ONE SAMPLE AT A TIME.

> “THE VARIOUS LIFE-FORMS THAT MAY HAVE LIVED ON MARS CAN ALSO BE HYPOTHESIZED BASED ON THE TYPES OF ROCKS FOUND ON MARS.”

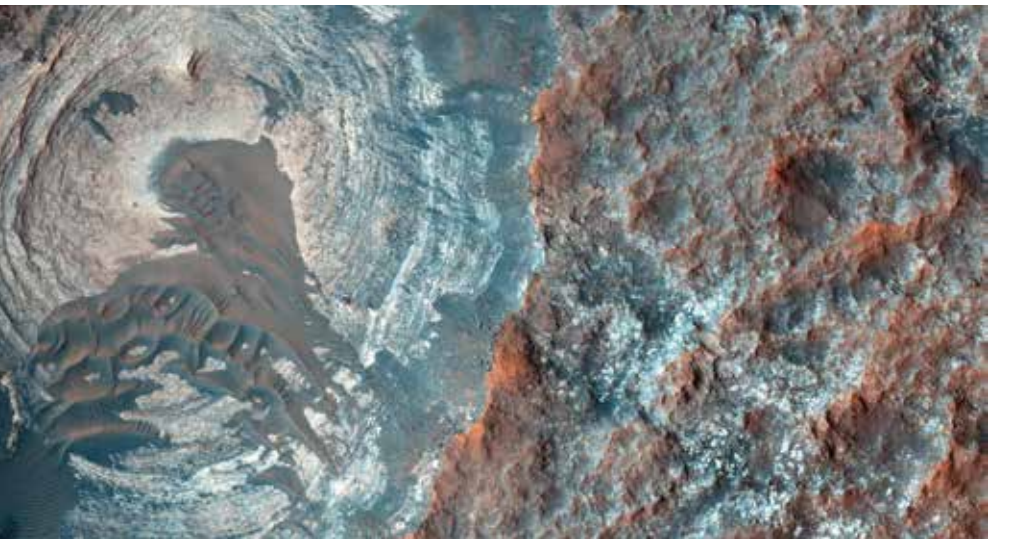
Mars is one of the most talked about and researched planets in our galaxy; humankind’s curiosity about the possibility of life outside of Earth is a driving force behind the efforts. Given that a human mission to Mars seems to be inevitable in the future, it is important to do as much research in advance to be best prepared for what may come. Orbiters give us global-scale views with information such as topography, chemistry, navigation, and other planetary observations; however, a lander is required to facilitate the collection of finer details. This would provide the opportunity to gain an understanding of the geological history of the planetary body, the current condition of the surface and if there is any life present. Landers need to be equipped with the appropriate instrumentation to answer these questions.

> “HUMANKIND’S CURIOSITY ABOUT THE POSSIBILITY OF LIFE OUTSIDE OF EARTH IS A DRIVING FORCE BEHIND THE EFFORTS.”

The old saying that “a picture is worth a thousand words” or “seeing is believing” means that images and imaging techniques are often the first prioritized sources of evidence acquired by a lander. Chemistry comes in at a close second, but by itself, chemistry does not always give a complete picture of the geological history of an area. Fortunately, the crystallography (specific arrangement of the atoms in crystalline solids) of a geographical area can indicate the chemistry, temperature, and pressure of formation. When minerals form, they solidify into different crystallographic forms. Some minerals can even indicate the relative humidity and temperature of the environment in which they are situated. Using crystallography to learn about rocks helps shed light on both long-term, and short-term geologic (even cosmologic) processes. The main tool used to understand crystallography is x-ray diffraction (XRD), and for this purpose, the Mars Science Laboratory (MSL) Curiosity lander (a rover), that landed on Mars in 2012, was equipped with CheMin: a transmission XRD instrument with limited x-ray fluorescence capabilities.

MARS’ POTENTIAL FOR LIFE?

Equipped with wheels, Curiosity was able to crawl across the surface of Mars and collect soil samples from different locations, passing them to the onboard CheMin instrument for analysis. Some of the initial Martian soil tested had a similar composition to soils found in Hawaiian volcanoes. In 2013, CheMin sampled rocks that contained clay minerals that are typically known to be the product of a reaction between fresh water and igneous minerals. This rock actually looks grey, rather than the typical red, as it is not fully oxidized and, as such, has the potential for being a source of energy for mirco-organisms. The various life-forms that may have lived on Mars can also be hypothesized based on the types of rocks found on



Mars. The CheMin XRD instrument is still proving valuable information to better understand Mars. As such, it is expected that future landers will also be equipped with XRD instruments.

GOING TO THE RED PLANET.

Dr. Roberta Flemming is leading a group of researchers from Western University's Department of Earth Sciences and the Centre for Planetary Science and Exploration, Brock University, and the University of Guelph, to create an even more advanced XRD instrument for future landers. "The Curiosity Rover on Mars crushes rocks into a powder, destroying critical information about the relationship between the minerals in the rock. Minerals tell us the story of the planet's geological history," says Flemming.

Flemming recognized the need for a better instrument and was recently funded by the Canadian Space Agency (CSA) to work on the development of a miniaturized *in situ* XRD (ISXRD) instrument. For the duration of the 18-month study, Flemming and her team from Western will be working with Martian-analogue rocks, minerals, and meteorites to test candidate miniaturized x-ray components and geometries made at PROTO.

The ISXRD instrument aims to eliminate the need for grinding and sifting, as these additional processes can cause the investigated sample to sometimes not be representative of the rock from which it actually came, which can affect the integrity of the results. This new XRD instrument also aims to have less motor movement and incorporate more effective detector technology to improve upon the current Martian XRD capabilities.

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