Utilization Of Sulfates And Hydroxide Minerals As A Determinant Of The Acidity Of Water On Mars. A. J. Stein[1] and K. M. Bushick[2], and A. R. Oliver[1]. [1]Durham Public Schools, Durham, NC 27702, [2]Durham Academy Upper School, Durham NC 27705

Introduction: Through multiple means of data collection, it has been established that ancient Mars was host to liquid water [1]. As it has been determined that liquid water is a necessary component for life, it is instrumental to determine as much about this water as possible. One such characteristic of water that is critical to determine is the pH [2, 3]. Although microbial life can live in a varied array of pH, more advanced and evolved life requires a more balanced form of water.

Although acidity is just one of many characteristics of water that can be determined through experimentation, the pH can tell us many things, including the type of microbial life that may have evolved on Mars [4]. Two indicator compounds that could hint at either baseness or acidity are, respectively, hydroxide (OH) minerals and sulfates [5].

The data used in experimentation is from the CRISM spectrometer onboard the Mars Reconnaissance Orbiter (MRO). The CRISM data is provided through the program JMARS. JMARS allows users to access data from a variety of instruments, such as CRISM, THEMIS, and data taken from the Viking missions [6]. By looking at a physical map it is apparent where water was, and where it flowed, both to and from.

To provide evidence for or against this conclusion, we hypothesized that the river channels would appear to be acidic.

Analytical Approach: Using data stamps from CRISM onboard the MRO and rendered through the JMARS application, we were able to compare the concentration and amount of substances on Mars in specific locations. For our purposes we targeted river systems where water would have been flowing and primarily looked at hydroxide minerals and monohydrated sulfates. To increase the accuracy of the experiment, it is necessary to collect data from a large range of rivers: big, small, wide, narrow, and all across the Martian surface. However there was a restriction as CRISM data is limited and only present in some locations.

Data stamps were rendered all across the path of the river, first for monohydrated sulfates and second with the hydroxide minerals. The rendered stamps showed both concentration and amount of the substance that was measured by CRISM. By comparing the two substance, supplemented by some renderings of zeolite sulfates, there can be a visual measure of the quantity of one matched to the quantity of the other in the same location.

Results: An analysis and comparison of sulfates and other basic minerals led to an understanding that the pH that existed on Mars thousands of years ago trended towards acidic [1, 2, 3, 7]. Another point that was not part of the initial experiment but should be noted is that there was typically a greater density of minerals and other substances on the inside of a river bend, which is similar to rivers on Earth.

There were still fair amounts of hydroxide minerals, which would somewhat balance the acidity of the water that the sulfates show. With this knowledge, we can deduce that water on ancient Mars was not an extreme acid, but rather more mild. However, there are many other substances that were not measured that could change further the acidity of the water. Although the water is at a more balanced pH, it is still more acidic than water on earth.

The distribution of numerous substances on Mars is varied with locations. First, the areas that had higher concentrations of hydroxide minerals were away from the river channels, while there was a depletion of these minerals inside the river channels (Figure 1).

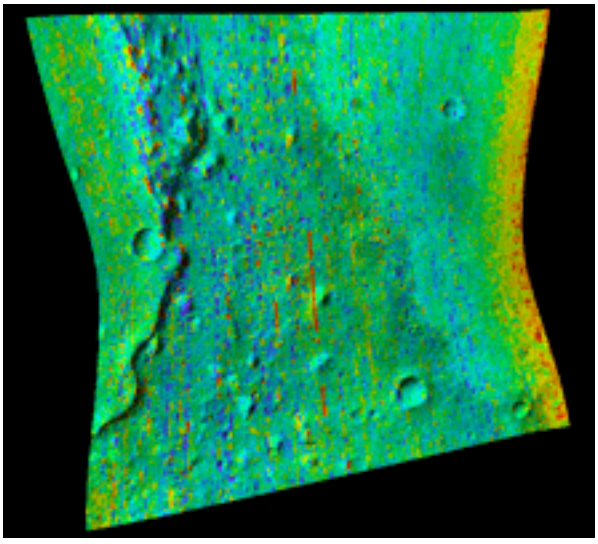

Figure 1: *FeOH and MgOH deposits in a river channel (314.429E, 11.422N). Warmer colors indicate higher concentrations. Blue and red lines are noise.*

The reverse was seen with monohydrated sulfates, which were found in higher concentrations inside the river channels, while having less of a presence in the surrounding environment.

This negative correlation between the monohydrated sulfates and the hydroxides assists the conclusion that the water on Mars trended towards acidity (Figure 2).

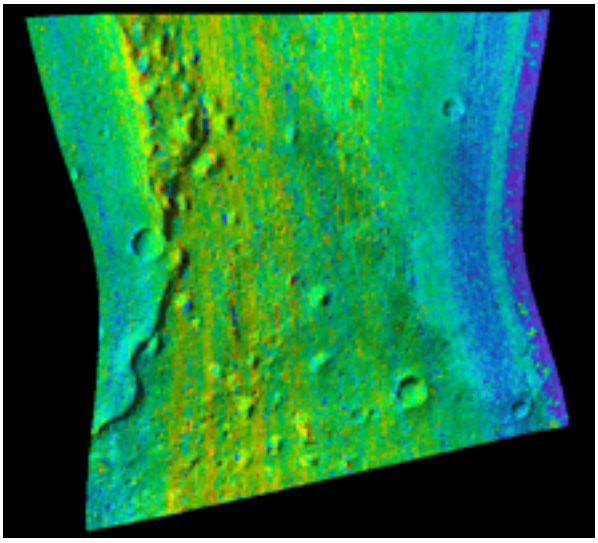

Figure 2: *Monohydrated sulfates in the same river channel as Figure 1 ((314.429E, 11.422N). Warmer colors indicate higher concentrations. Their polar disposition supports the established hypothesis.*

On a broader scale, however, the distribution of minerals and other substances is even throughout the land surface of Mars.

Future Work: In future studies it would be beneficial to conduct more in-depth research utilizing more substances in the same area. It is also required to first determine how much each of the individual substances factors into the pH of the water. As MRO continues to orbit Mars and more data stamps are available, it will be possible to explore and compare some of the more plain areas of Mars to more dramatic features such as volcanoes and rivers. In addition a comparison of sea bed versus river bed would be a good point to further explore to see if there is a great difference between the two, like fresh and salt water here on Earth.

Acknowledgments: The Image Analysis group, part of the MONS team would like to thank the directors, Howard Lineberger, Sam Fuerst, and Charles Payne. In addition we would like to thank MONS mentor Nathan Sanders for his assistance throughout our research. Finally we would like to thank the Student Science Enrichment Program and the Burroughs Wellcome Fund for generously providing funding for MONS, which allows us to continue to research and explore the Martian surface.

References: [1] Tosca N. J. et al. (2008) *Science, 320*, 1204-1207 [2] Skok, J. R., et al. (2010). *Nature Geoscience, 3,* 838-841. [3] Hurowitz J. A. et al. (2010) *Nature Geoscience, 3*, 323-326. [4] Squyres S. W. et al. (2008) *Science*, *320*, 1063-1067. [5] Turner, R. C. (1965). *Soil Science, 1*, 14-19. [6] Ehlmann, B. L. et al. (2008). *Nature Geoscience, 1*, 355 – 358. [7] Bibring J. P. et al. (2006) *Science, 313,* 1899-1901.