**MAGMATIC INTRUSIONS INTO SULFUR-RICH SEDIMENTS ON THE COLORADO PLATEAU: AN ANALOG FOR MARS EXPLORATION.** J.R. Crandall[1], S.L. Potter-McIntyre[1], S.P. Schwenzer[2], and J. Filiberto[1,2], [1] Department of Geology, Southern Illinois University Carbondale, 1259 Lincoln Road, Mailcode 4324, Carbondale, Illinois, 62901, USA (Jakecrandall@siu.edu). [2]School of Environment, Earth, and Ecosystems Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK.

**Introduction:** Mafic magmatism is a prevalent geologic process on Earth, and is a principal source of subsurface geologic change and energy influx on post-Noachian Mars [1]. While rare on Earth, the intrusion of mafic magmas into sulfur-rich soils and rocks is expected on Mars due to the observation of widespread high sulfur concentrations in Martian soils [2, 3]. On Mars, soils have been found to be rich in sulfur. Respectively, soil samples from Gusev Crater and Gale Crater contain between 4-8 weight percent, and 4-7 weight percent $SO_3$, though ammounts as high as 31 weight percent have been measured in Gusev crater [3,4,5]. With widespread sulfur-rich sediments and evidence of magmatism both ancient and young, mafic intrusions into rocks and sediments bearing significant quantities of sulfur species is expected on Mars [1,3,4]. Processes associated with the magmatic intrusion of a sulfur-rich host, including degassing and alteration, may provide the requisite energy and nutrients for biological activity [4,6].

On Earth, well exposed mafic dikes intrude the sulfur-rich sedimentary formations of the Jurassic San Rafael Group. Approximately 200 dikes, sills, and breccias can be found in proximity to the San Rafael Swell in Utah, and represent an Earth analog for a scenario of mafic magma intruding sulfur-rich sediments [7]. Here we will investigate such an analog; a mafic dike intruding the sulfur-rich Jurassic Carmel Formation of the San Rafael Group.

**Mafic Dikes on the Colorado Plateau:** Mafic intrusions into sulfur-rich host material are rare on Earth, but a well-exposed suite exists in the San Rafael Swell, Utah. A dike swarm and associated sills and breccias were intruded into the San Rafael Group from approximately 3.7-4.6 Ma [7,8]. These intrusions are likely synchronous with nearby mafic volcanism occurring along the margin of the Colorado Plateau [7,8]. The dikes are well-exposed, generally less than 2 km in outcrop length, and possess a log-normal mean thickness of 103 cm within the Carmel Formation (Fig. 1) [7]. The dikes of the Carmel Fromation strike parallel to joints observed in the massive sandstones of the stratigraphcally lower Glen Canyon Group, suggesting magma ascention along these joint sets [7].

Contact metamorphism and alteration of wall rocks occurs locally along many of the dikes [9]. High-temperature magmatic hydrothermal alteration is found throughout the dikes within the sulfur-rich Carmel Formation (Fig. 2).

**Methods:** During the 2016 summer field season, samples of a mafic dike and host rock were collected near Cedar Mountain, Utah. The sampled dike is approximately 1 meter wide, and intrudes the Jurassic Carmel Formation. Samples collected include: dike material, altered sediments, gypsum/anhydrite nodules, and unaltered host rock.

Ongoing analyses of these samples are via multiple methods to determine the alteration history of the dike and associated sulfur-rich host material. Thin sections will be made to aid in petrologic analyses. Phase identification and bulk chemistry will be achieved through the use of X-ray diffraction (XRD) and X-ray Fluorescence (XRF).

Using XRD, XRF, and thin section analyses, we will investigate the geochemistry and mineralogy of the unaltered Carmel formation, the mafic dike, and altered rocks associated with the intrusion.

**Implications:** This site will act as an analog for Martian sites where the interaction between sulfur-rich deposits and mafic magmatism and/or hydrothermal activity has been investigated, such as Gusev Crater and Gale Crater [10,11,12,13,14]. Mars Exploration Rover Spirit (MER-A) analyzed Home Plate in Gusev crater, leading to the interpretation of the feature as a hydrothermally altered pyroclastic deposit of alkalai basaltic composition [10,11]. Mars Science Laboratory Curiosity (MSL) has recently analyzed sulfate-bearing nodules and veins in Gale Crater [15]. The study of terrestrial analog sites where mafic dikes intrude and alter sulfur-rich host materials is critical for further exploration of the surface of Mars. From these analogs, we can begin to further our understanding of the relationships between the geochemistry and petrology of the magmatic rocks, the water-sediment-magma interactions, and the mobility of elements such as sulfur.

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**Figure 1.** Mafic dike intruding the sulfur-rich Jurassic Carmel Formation. The dike is sub-vertical, and extends to the top of the outcrop.

**Figure 2.** Image showing the spatial relationship between the dike (left; blue arrow), baked zone (center-right; red arrow), and host rock (Carmel Formation, upper right; green arrow) approximately representing the orange box in figure 1.