**THE ROLE OF ULTRAVIOLET LIGHT AS AN IONIZING RADIATION SOURCE IN THE DEVELOPMENT OF IN-SITU OPTICAL DATING TECHNIQUES FOR MARS.** M. J. Detschel[1,2] and K. Lepper[1]; [1]Optical Dating and Dosimetry Lab, Department of Geosciences, North Dakota State University, 218 Stevens Hall, Fargo, ND, 58105, [2]Department of Physics, North Dakota State University, 218 South Engineering, Fargo, ND 58105; marissa.detschel@ndsu.edu; ken.lepper@ndsu.edu

**Introduction:** Optical dating has been suggested as a potential chronometric dating technique for in-situ dating of the geomorphologic features of the surface of Mars [1,2]. The atmosphere of Mars is comprised primarily of carbon dioxide and lacks a substantial ozone layer, allowing ultraviolet (UV) radiation as low as 200 nm or less to reach the surface of the planet [3]. The short wavelength UV region includes ionizing radiation.

Ionizing radiation plays a major role in OSL dating, providing the energy to free electrons from atoms in the crystalline lattice of sediment grains. Some of these electrons gather in defects inherent in the lattice of the grains, becoming trapped or localized. The longer wavelengths in the ultraviolet range include energies capable of detrapping these electrons via optical stimulation. These detrapped electrons can then recombine with charge carriers of the opposite charge resulting in photon emission. Therefore, the UV radiation that reaches the surface of Mars can drive two of the major processes of optical dating: charge trapping resulting in dosimetric signal accumulation and detrapping resulting in signal resetting. In developing optical dating techniques with respect to martian sediments, further insight into this dual role of UV radiation needs to be taken into account.

**Methods:** Optically stimulated luminescence (OSL) measurements were performed on a group of mineral samples that were initially dosed with ultraviolet radiation from a deuterium source (200 to 400 nm). The samples tested included quartz, a group of feldspars, synthetic and natural sulfates, and a martian soil simulant (JSC Mars-1). Samples were given timed initial doses of ultraviolet radiation from the deuterium source, ranging from 15 minutes (~1000 J) up to 180 minutes (~12,000 J). Data were collected using a Risø DA-15 OSL/TL system after each of the timed doses. Stimulation occurred in either the blue portion of the visible light range at 475 ± 25 nm (BOSL) or in the infrared at 830 ± 10 nm (IRSL). The resulting signals were monitoring in the UV range at 340nm$\Delta$80 (Hoya U-340). A correction for sensitivity change used in terrestrial optical dating procedures was utilized for these measurements [4,5].

**Preliminary Results and Discussion:** Upon exposure to the deuterium source, two main characteristics of the samples' responses to the ultraviolet radiation were investigated – signal yield and dose response. Signal yield illustrates the relative efficiency of the mineral samples tested to respond to ionizing radiation from the ultraviolet source by dosimetric processes described previously; ionization to generate charge carriers and trapping of charge carriers in defects. Dose response measures the OSL signal response of the samples to increasing exposures of ionizing radiation.

The mineral samples showed considerable variation in signal yield in response to exposure to the ultraviolet radiation (Fig. 1). The sanidine, albite, and anorthite feldspars generated some of the highest signal yields of all the samples tested. Quartz and the anhydrous sulfates, anhydrite and thenardite, also produced moderately high signal yields. In comparison, the hydrated sulfates, gypsum, hexahydrite, and kieserite, showed very low signal yields.

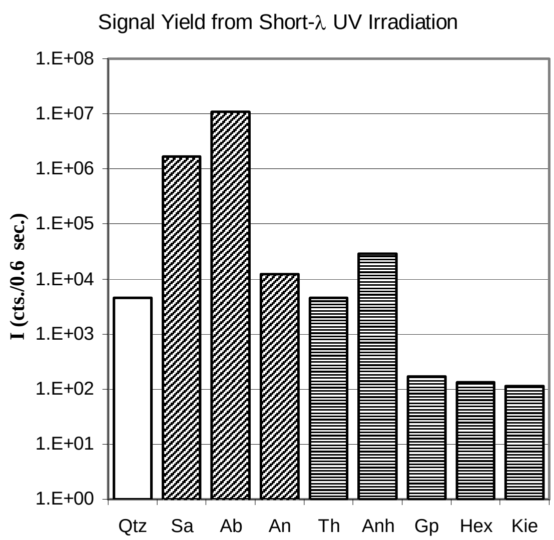


Fig. 1. Background-subtracted signal yield for all samples tested after exposure to ultraviolet radiation from the deuterium source for 120 minutes (~8000 J). OSL measurements were conducted with blue-light stimulation and UV signal monitoring (BOSL/UV). Samples include quartz (Qtz), sanidine (Sa), albite (Ab), anorthite (An), thenardite (Th), anhydrite (Anh), gypsum (Gp), hexahydrite (Hex), and kieserite (Kie). The feldspars have columns with diagonal lines and the sulfates have columns with horizontal lines. JSC Mars-1 is not included because UV irradiation did not produce a BOSL/UV signal.

All of the feldspar samples tested responded to the ionizing radiation of the deuterium source, generating a monotonically increasing OSL signal response with increasing ultraviolet radiation dose (Fig. 2). The measurements were corrected for sensitivity change using the terrestrial SAR method [4,5] and normalized with respect to the dose response at 30 minutes (~2000 J).

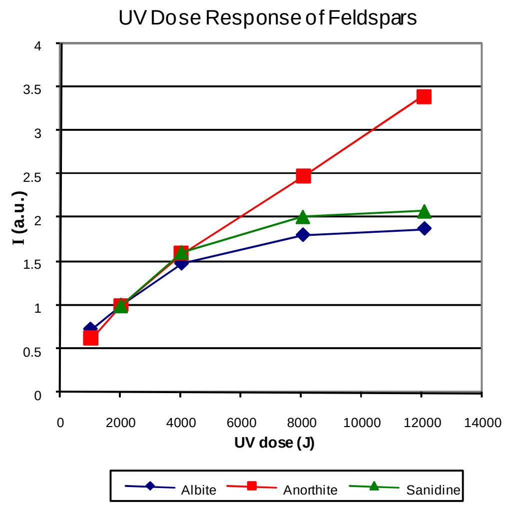


Fig. 2. OSL dose response of albite, anorthite, and sanidine feldspar samples after exposure to the deuterium source for timed increments (Exposures given in units of Joules based on lamp output in the wavelenth range of 200-400 nm.) OSL measurements were conducted with blue-light stimulation and UV signal monitoring (BOSL/UV).

The anhydrite also exhibited an increasing monotonic OSL dose response (not shown). Thenardite yielded a static dose response to the UV radiation, showing a similar signal response with each increasing exposure to the source. The hydrated sulfates showed very little dose response to the ionizing radiation. JSC Mars-1 did not respond to the source. The quartz yielded an erratic dose response, possibly due to the small size of the measured sample set.

**Future Work**: In the present work, the response of the samples to ultraviolet radiation from a deuterium source was investigated. A solar simulator with a UV-enhanced xenon bulb will eventually be introduced to the optical setup, creating a combined UV/visible exposure environment for the samples. The spectra that reaches the surface of Mars includes not only UV radiation, but also visible radiation, and, therefore, by combining these two sources, the samples are subjected to a simulated martian spectra. A series of neutral density filters will also be incorporated into this combined exposure environment to adjust for Mars' greater distance from the sun and to simulate the presence of dust in the Martian atmosphere. This combined setup will provide further insight into the effect of Mars' solar spectrum on the development of in-situ optical dating techniques for Mars.

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**References:** [1] Lepper K. and McKeever S.W.S. (2000) *Icarus* 144, 295-301. [2] McKeever S.W.S. et al. (2006) *Radiat. Meas.* 41, 750-754. [3] Patel M.R. et al. (2002) *Planetary and Space Science*, 50, 919-927. [4] Murray A. and Wintle A.G. (2000) *Radiat. Meas.* 32, 57-73. [5] Murray A. and Wintle A.G. (2006) *Radiat. Meas.* 41, 369-391.