SEDIMENTARY REDOX GEOCHEMICAL PALEOENVIRONMENTS AND PRESERVATION OF POTENTIAL BIOSIGNATURES INFERRED FROM MINERAL ASSEMBLAGES IN LACUSTRINE SEDIMENTARY STRATA OF MOUNT SHARP, GALE CRATER, MARS. M. A. Velbel[1,2], [1]Michigan State University, Department of Earth and Environmental Sciences (East Lansing, MI 48824-1115; velbel@msu.edu), [2]Smithsonian Institution, National Museum of Natural History, Division of Meteorites, Department of Mineral Sciences (Washington, DC, USA; VelbelM@si.edu),

Introduction: How oxidized or reduced are the sediments of Mars? How favorable to the preservation of organic matter and molecular biosignatures were the redox conditions of the depositional and post-depositional (burial diagenetic) environments? This presentatikon introduces a simple form of a long-used classification of sedimentary redox conditions, as a possible prospecting tool for mineral-organic associations that may favor preservation of OM in sediments from Jezero crater.

A classic and novel Geochemical (paleo-redox) Classification of (depositional and early diagenetic) Sedimentary Environments. The Berner (1981) classification [1] and its complementary early descendants (e.g., [2]) use the identification of early diagenetic mineral hosts of redox-sensitive elements (including C) as the basis for classification, mapping specific indicator minerals onto one of the environmental redox categories of recent and ancient sedimentary environments. In early versions of such classifications, the presence of OM is (along with identifications of early diagenetic mineral hosts of redox-sensitive elements) one of the observables used to classify the sample's chemical (paleo)environment. In table form, Berner's classification (interpretation) of sedimentary redox environments (Table 1 in [1], left column) is based on (inferred from) observations of early diagenetic host minerals for redox-sensitive elements (Fe, Mn, S) (Table 1 in [1], right column). The current state-of-the-science uses (wet chemical) selective chemical extractions of, for example, Fe and S species and/or elemental or isotopic abundances of redox-sensitive trace metals to place individual specimens of modern or ancient mudrocks on a classification diagram, from which the redox (paleo)environment is inferred. Selective chemical extractions from and isotopic analyses of Mars' mudstones will be possible once samples are returned, but other proxies for redox state must be measured by Mars 2020 instruments to prospect for OM-bearing samples on Mars.

In translating redox paleoenvironmental classification of terrestrial sedimentary to Mars, it is assumed that the physical chemistry of the redox ladder involves the same elements and range of redox conditions on both planets.

To apply the Berner (1981) classification and its descendants to mudstones on Mars, mineral hosts of redox-sensitive elements and ions are identified (e.g., by XRD as on *Curiosity*) or inferred (e.g., by PIXL elemental associations or ratios integrated with VISER Vis-NIR multichannel photometry or spectroscopy on Mars 2020 rover *Perseverance*) to map individual sample analyses onto Berner's (1981) [1] table or Maynard's (1982) [2] discrimination diagram. Observed or inferred indicator minerals are interpreted to indicate corresponding paleoredox conditions. The likelihood of preservation of OM in a sample will be inferred from the Tables [1] and corresponding field on the discriminant diagram [2] in which the proxy data for each sample plot. In the proposed application of these redox classification schemes, OM is treated as the main potential molecular biosignature target for which Mars 2020 rover *Perseverance* is "prospecting".

The next section illustrates proof-of-concept by retrospective application of the proposed approach to CheMin-detected minerals at Gale crater.

Preliminary application to the sedimentary strata of Gale crater. Applying the diagnostic-mineral criteria of [1] to MSL Curiosity CheMin (XRD) mineral identifications at Gale crater suggests that multiple stratigraphic intervals with distinctly different Fe-mineral assemblages are each consistent with a Berner (1981) [1] paleogeochemical environment category. What this means for potential molecular biosignature preservation depends in part on which minerals formed during the diagenetic stages of eogenesis (interaction of detrital assemblages with pore waters under the influence of the depositional system), mesogenesis (physical compaction, and chemical reactions between minerals and pore fluids chemically evolved by reactions between minerals within the stratum and in adjacent and enclosing strata at T and P higher than the depositional environment, and telogenesis (chemical reactions between minerals and meteoric water.

Chlorinated hydrocarbons, interpreted to be products of pyrolytic reactions between Martian chlorine and organic carbon derived from Martian (e.g., igneous, hydrothermal, atmospheric, or biological) or exogenous (meteoritic, cometary, interplanetary dust) sources, have been reported from the Cumberland drill hole in the Sheepbed mudstone (Freissenet et al. 2015), consistent with the favorable paleo-redox conditions inferred for these mudstones from the Berner (1981) classification [1].

Berner's (1981) sedimentary redox paleoenvironment classification [1] places the Bradbury Group strata of the Yellowknife Bay Formation at the level of the Selwyn section (Sheepbed Member, drill holes John Klein and Cumberland) in categories favorable to the preservation of organic matter (OM) in general and organic chemical molecular biosignatures in particular), if the sulfides are detrital or early diagenetic (eogenic). Later, deeper (burial) diagenesis (mesogenesis) of the Selwyn section and strata as far up-section as Marias Pass was anoxic non-sulfidic post-oxic, on the evidence of the diagenetic origin of mixed-valence minerals ferrian saponite and magnetite. The depositional and diagenetic environments of these strata were less favorable to the preservation of OM. Nevertheless, organic molecules have been reported from farther up-section (basal Pahrump Hills Member of the Murray Formation; drill holes Confidence Hills and Mojave). Mineralogical observations place strata still farther up-section in Berner's (1981) oxic (± sulfatic) chemical paleoenvironment [1], unfavorable for OM preservation.

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References: [1] Berner R. A. (1981) *JSP*, *51*, 359-365. [2] Maynard J. B. (1982) *JSP*, *52*, 1325-1331.