ORGANIC MATTER IN SNC METEORITES: IS IT TIME TO RE-EVALUATE THE VIKING BIOLOGY EXPERIMENTAL DATA? D. M. Warmflash[1], S. J. Clemett[2] and D. S. McKay[1], [1]Mail Code SN, NASA Johnson Space Center, Houston, TX 77058 (dwarmfla@ems.jsc.nasa.gov), [2]Lockheed Martin Space Operations, Houston TX 77058 (simon.j.clemett1@jsc.nasa.gov).

The two Viking landers, which set down on Mars in 1976 have been the only craft to date to carry experiments designed to the direct search for microorganisms. Each of the two landers carried a package of three biology experiments, each designed to detect a different aspect of metabolism that may or may not be present in microorganisms if such life forms exist on the surface of the planet. The instruments consisted of the Pyrolytic Release Experiment (PR), the Gas Exchange Experiment (GEx) and the Labeled Release Experiment (LR) [1]. While the PR and GEx unambiguously obtained negative results with respect to life forms, results the LR were positive based on criteria established before launch [2]. However, largely in light of the failure of a fourth instrument, a mass spectrometer – gas chromatograph (GC-MS), to detect organic matter, the LR responses were later interpreted to have been produced by inorganic chemical oxidants presumed to exist in the Martian regolith [3].

More recently, evidence has begun to grow supporting the possibility that the Viking GC-MS would not have detected certain carboxylate salts that could have been present as metastable oxidation products of high molecular weight organic species [4]. Additionally, despite the instrument's high sensitivity, the possibility had remained that very low levels of organic matter, below the instrument's detection limit, could have been present. Such low levels of organic matter would not be inconsistent with the presence of very low levels of microorganisms [5]. Other considerations include the compound's vaporization under pyrolysis, its ability to pass through the entire instrument, masking by co-eluting compounds and whether the effluent divider or inlet valve shutdown is triggered by compounds such as water or CO_2 [6]. Since the strength of the GC-MS findings was considered enough to dismiss the biology packet, particularly the LR results, any subsequent evidence suggesting that organic molecules may in fact be present on the Martian surface necessitates a re-evaluation of the Viking LR data. Future lander missions will include advanced instrumentation such as, a mass spectrometer to look for isotopic signatures of biogenic processes and the detection of methane produced by methanogenic bacteria. The identification of Mars samples already present on Earth in the form of the SNC meteorites [7] has now provided us with the ability study samples of the Martian upper crust several decades in advance of any planned sample return missions. Whilst contamination issues are of serious concern the presence of indigenous organic matter in the form of polycyclic aromatic hydrocarbons has been detected in the Martian meteorites ALH84001 and Nakhla [8, 9, 10], while there is circumstantial evidence for carbonaceous material in Chassigny [11]. The radiochronological ages of these meteorites are 4.5 Ga, 1.3 Ga, and 165 Ma respectively [12] representing a span of time in Earth history from the earliest single-celled organisms to the present day.

Given this perspective on organic material, a biological interpretation to the Viking LR results can no longer be ruled out. In the LR experiment, a solution containing ^{14}C labeled organic compounds was injected into soil samples. The detection of radioactivity in the overhead space would indicate that one or more of the substrates had been chemically converted into a carbon-containing gas. To serve as a control, some samples were heated enough to destroy most known terrestrial microbes so that an indication for life would be a positive response from unheated samples and a negative response from heated samples [13]. On Mars, the LR results had met minimum criteria for a biological interpretation [2] but due to the GC-MS results, the LR responses were later attributed to putative soil inorganic oxidants [3]. Since the time of Viking, studies have been carried out with the objective of determining an oxidant or combination of oxidants that might exist on Mars and have produced the observed kinetics of the LR response. To date, no such agent has been found that produces all aspects of

the LR results on Mars [14, 15]. Therefore, in light of the SNC meteorites data and their implications for the possibility of organic matter near or on the Martian surface, it is concluded that inorganic and biological explanations for the Viking LR data should now be considered equally plausible until more complete studies of the Martian surface are carried out.

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