Life Detection, Philosophy and Criteria. A. Steele[1], J.K.W. Toporski, [1]Geophysical Laboratory, Carnegie Institution of Washington, 5251 Broad Branch Road, Washington DC., [2]Witec Inc, Ulm Germany,

Introduction: Fueled by recent discoveries delivered by NASA´s Mars Exploration Rovers (MERs) (e.g. Squyres et al., 2004), ESA´s MarsExpress (e.g. Bibring et al., 2004) and further augmented by previous debates on life on Mars within meteorites (McKay et al., 1996), planetary exploration has experienced a renaissance of the drive to search for evidence of life on Mars. This is exemplified by increasing interest in anticipated sample return missions from the Martian surface or anticipated robotic life detection missions such NASA's Astrobiology Field Laboratory concept (AFL) or the Mars Astrobiology Exploration and Caching Rover concept (MAX-C) (Beaty et al., 2005) or ESA's ExoMars (Vago et al., 2005). This challenging technological and scientific endeavor requires careful consideration of aspects relevant in life detection, regardless of whether through remotely operated robots or analysis of samples returned to laboratories on Earth. Critical aspects in life detection efforts on extraterrestrial planetary materials are tightly associated with our abilities to unmistakably identify possible evidence of life and further the ability to distinguish indigenous life from terrestrial contamination and the challenges this presents for Planetary Protection. Critical issues for life detection experiments in extraterrestrial materials are: What are the detection limits needed? Can we recognize unusual (or even unknown/undescribed) biological structures? Can terrestrial microbial life find a niche within extraterrestrial and/or meteoritic material? What are time spans that "simple" life could survive in such materials under any given condition? Finding answers to these questions is paramount in preparation for the upcoming challenges, and requires honing techniques and our understanding. One of the many possible approaches to help finding these answers is to study extraterrestrial materials on hand, i.e. meteorites, and examine these in laboratories to enhance our understanding of the potential habitability or possible (bio)dynamics of these systems. With respect to the future focus on Mars exploration, Martian meteorites represent suitable examples of materials to be studied for life detection purposes. An exemplifying study emphasizing the difficulties associated with this research was presented by McKay et al. in 1996 on evidence of possible relic biogenic activities in Martian meteorite ALH84001 (McKay et al., 1996). Multiple arguments were provided, each of which taken on its own would not be proof, but taken together, were interpreted as possibly indicating evidence of life. The publication of these observations prompted the scientific community to intense and persistent scientific discussions and extended research efforts, leading to numerous follow-on publications that sought to augment or attack each of these initial lines of evidence (e.g. Thomas-Keprta et al., 2000, 2001; Treiman, 2000; Golden et al., 2004), with the argument of biogenically produced magnetites still standing as a possible indicator of biogenicity. However, Steele et al., (2007) has shown that complex macromolecular carbon can be formed via abiotic reactions in the Martian meteorite ALH84001 accounting

The Nakhla meteorite has been shown to be contaminated with terrestrial microorganisms from the fusion crust through to its core (Toporski and Steele 2007). There is overwhelming evidence that the observed microorganisms are solely terrestrial in origin even though in few cases they are in close association with the mineral matrix. Care has to be taken in the interpretation of organic compounds in these meteorites until microbial contamination, which would obscure and distort the results, can be further classified. The challenge is to distinguish between the terrestrial organic material and possible indigenous Martian organics. For many years to come these Martian meteorites will be the only material available for analyses. They contain a wealth of information, which should not be summarily dismissed simply because they may be contaminated, but the issue of contamination should be carefully considered. The contamination in these meteorites provides us with the best model we have for testing life detection instrumentation and rationales on a truly Martian substrate before the possibility of receiving return samples from this planet. The characterization of these organisms and their metabolic/diagenetic products will also be crucial in the search for biogenic activity in other extraterrestrial samples. for some if not all of the McKay et al., (1996) observations.

Given all these studies no concerted and accepted protocol for the identification of indigenous life has emerged. Jakosky (personal communication) made the observation that effective life detection on Mars is a function of reliable and accepted data points verses community acceptance of these data. The ancient DNA community experienced a similar situation. There the community devised a set of scientifically rigorous protocols to verify data via several, sometimes competing, laboratories. It would seem prudent that the Astrobiology community combine to define protocols and procedures for the rigorous and unambiguous detection of life. Clearly defined criteria will; act as an aid to identify areas of research that need addressing, focus the community on investigations and measurements to be undertaken, provide a forum for discussion within scientific consortia during data collection and ensures that any release of data confirms to guidelines that can be justified to the public.

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