THE ROLE OF LARGE IMPACT CRATERS IN THE SEARCH FOR EXTANT LIFE ON MARS. H.E. Newsom1, 2. Earth and Planetary Science Dept., Institute of Meteoritics, Univ. of New Mexico, Albuquerque, NM, U.S.A.

Introduction: Large impact craters can provide conditions for access to material derived from deep life-containing groundwater reservoirs on Mars. Evidence for extant life on Mars. Current research on Mars habitability focuses on identifying conditions where microbial life could have evolved or flourished, and organic molecular evidence of pre-biotic or biotic activity. Finding extant life is a more difficult question, given the current climate that the Special Regions SAG [1] suggested is either too cold or too dry on the surface. However, the PREVCOM report [2] concluded the existence of favorable environments for microbial propagation on Mars, could not be ruled out. They argued that habitable environments could form due to a disequilibrium condition, for example by a landslide or impact. Examination of such environments from relatively recent in Mars history could lead to finding evidence that reservoirs containing extant life still exist on Mars. Deep aquifers have long been considered the most likely location for the current presence of life on Mars, and the detection of methane provides the most intriguing clue, but not definitive evidence for deep life.

Large Craters and access to deep reservoirs: Where to look then? Terrestrial analog studies and rover studies of craters on Mars show that large impact craters penetrated deep into Mars with likely connections to deep aquifers. Throughout Mars history heated lakes on Mars may have formed habitable Petri dishes where life could have potentially evolved in situ or flourished [3,4]. Lakes on Mars provided a habitat for organisms to flourish that evolved in another location on Mars, like deep aquifers or elsewhere in the solar system.

Lakes in craters formed by impacts could have remained liquid for many thousands of years, even under cold conditions like today [3], especially with a denser atmosphere during favorable obliquity conditions or an impact induced atmospheric pressure increase. Larger diameter impact craters have more heat to power hydrothermal systems from impact processes, resulting in longer-lived lakes [5]. Larger and deeper lakes will also take longer to freeze under cold conditions. By analogy to Earth, it is likely that their water supply included a connection to deep, long-lived aquifers, which could also have contained microbial life and allowed the rapid colonization of a lake, even after the sterilization of the target rocks due to the impact.

The discovery of phyllosilicates in ancient martian terrains, including Gale crater lake sediments suggests that the chemistry of surface water may have had a relatively neutral pH, conducive to propagation of terrestrial type life [6]. Furthermore, alteration materials in the relatively young basaltic martian meteorites suggest that water in aquifers equilibrated with basaltic rock in the deep crust will have a neutral pH [7].

Groundwater supply and access to deep life containing reservoirs: The supply of groundwater to a lake depends on the thickness of the penetrated aquifer, and regional conditions that constrain the available supply of water. The plausibility of supplying large volumes of groundwater to lakes from aquifers has been addressed by groundwater flow calculations [8]. The largest uncertainty in these calculations is the regional permeability, which can vary over many orders of magnitude, especially if faults associated with craters penetrate the aquifers. Assuming a plausible permeability Harrison and Grimm, [8] calculate a flood volume of approximately 200 km³ over a 30-day period delivered to a circular point source from a thick regional aquifer. This volume would fill a 70 km diameter impact crater to a depth of about 500 m in about 30 days. Shallow aquifers can also be accessed in craters, leading to late erosional features as seen on the Peace Vallis fan in Gale crater [9]. A recent denser atmosphere due to climate change may also have led to a better chance to preserve evidence of extant life from deep reservoirs [10].

Conclusions: Large impact craters can penetrate deep aquifers during formation and create deep radial and concentric faults, and topographic depressions, suggesting materials deposited on crater rims, central uplifts and on the floors of large impact craters are likely places to look for evidence of extant life [5]. The ongoing mission of Curiosity in Gale and the possible traverse of the Mars 2020 rover from the floor of Jezero crater and up the crater wall could allow access to evidence of relatively recent life, although finding actual extant life is exceedingly unlikely. Studies of large terrestrial craters (e.g. Chicxulub) should be encouraged by NASA to better understand their deposits and deep structures that may be important on Mars.