WHERE THE MICROBES WERE. A. C. Allwood[1] [1]Jet Propulsion Laboratory, California Institute of Technology. 4800 Oak Grove Dr, Pasadena, CA 91109.

Introduction: An effective way to narrow the search for past life on Mars is to look for the kinds of geologic settings that are similar to environments on Earth that best preserve evidence of primitive microbial life. Signatures of ancient microbial life on Earth occur in a range of geologic settings, but a much smaller subset of environments host the vast majority of early microbial biosignatures. These taphonomic hotspots are rock successions that formed in highly habitable environments, where conditions through time were favorable for preserving signatures of life. Understanding what defines these hotspots is key to narrowing the search for life on Mars.

Being habitable is not enough. A growing body of evidence suggests that "habitable environments" on Mars have been plentiful in the past. Microbial life inhabits an enormous variety of environments on Earth, from high altitude to the deep ocean and deep crust, and virtually everywhere in between. Given life's ability to inhabit such diverse and extreme environments, it's no great leap of imagination to conclude that Mars through time must have offered an enormous array of potential places that could be habitable for life as we know it. However, degrees of habitability can vary enormously. An environment that allows life not just to survive, but to flourish, will favor dense biomass accumulations, community formation, persistence through time and environmental interactions that can leave an obvious and lasting impression in the rock record.

Preservation and recognition. Biosgnatures are more likely to occur in rocks formed in an environment where processes and conditions favored preservation of chemical, morphological, isotopic, organic or mineralogical traces of microbial activity. While preservation of these types of clues may be possible in a variety of settings, some geological environments are naturally dominated by processes that are inherently more likely to preserve a variety of biosignatures.

In addition, when trying to interpret the origin of any potential biosignatures that may be found, the geologic context is critical for testing alternate hypotheses. If the context is ambiguous or overly complex, the interpretation of biosignatures will be hampered. A robust, detailed understanding of the ancient environment provides a framework for interpretation of potential biosignatures.

Thus, evaluating the relative *degree* of habitability, potential for preservation of biosignatures, and intepretability of the geologic setting makes for a well-informed, targeted search strategy.

Where the microbes were on the early Earth. While life today inhabits almost every known environment on Earth, relicts of ancient microbial life on Earth occur in a much narrower range of environments. An even narrower subset of those environments hosts the vast majority of microbial biosignatures – especially from the early Earth. Most Archean and Proterozoic are associated with subaqueous sedimentary settings. Shallow oceans, lakes, hydrothermal vents and springs offered a highly habitable environment as well as a means of entombing and preserving fossil remnants of the inhabitants. The sediment-water interface in all of these environments would have offered chemical gradients for energy and a substrate where microbes could congregate, adhere, form biofilms, exhibit community behaviours, persist through time, and affect the sediments that were being deposited around them. The ongoing accumulation of sediment – especially if that included certain kinds of chemical (precipitated) sediments – inherently would have tended to favor burial and encapsulation of biosignatures.

Lakes and shallow marine environments were also sites for deposition of transported organics from habitable environments in the catchment area. Today, the sedimentary rocks of ancient lakes, oceans, hydrothermal vents and springs host a spectacular array of biosignatures from early Earth.