PUNCTUATED HABITABILITY AND SCENARIOS FOR THE SEARCH FOR LIFE ON MARS. F. Westall[1], F. Foucher[1], J.L. Vago[2] and the ExoMars Landing Site Working Group, N. Bost[1], F. Gaboyer[1], K. Hickman-Lewis[1], K.A. Campbell[3]. [1]CNRS-CBM, Orléans, France (frances.westall@cnrs-orleans.fr), [2]ESA-ESTEC, Noordwijk, The Netherlands, [3]Univ. Auckland, New Zealand.

Introduction: Our premise is that environmental conditions on Mars were punctuated in time and space and that life could only have emerged on the planet during the earlier, more habitable Noachian era [1]. This premise leads us to the conclusion that it is unlikely that martian life could have evolved beyond the chemotrophic stage and that any forms of life will be strictly co-located with their mineral substrates (in the case of lithotrophs) and nutritious, hydrothermal fluids (in the case of organotrophs).

Implications of punctuated habitability for Mars: While habitable conditions at the surface of Mars degraded during the Hesperian (perhaps even as early as only several hundred years after planet formation), it is likely that chemotrophs on early Mars could have infiltrated the subsurface environment through the myriad of impact and tectonic fractures, and hydrothermal veins (provided the fluids were not too hot). This means that viable cells, either frozen in the cryosphere or inhabiting liquid aquifers, could have survived in the subsurface up to the present day.

Punctuated habitability scenarios: It is possible that impact fractures and associated hydrothermal activity could have tapped into the refuges holding viable cells and transported them to newly created surface aqueous habitats where they could colonise and replicate, at least for the length of temporal existence of the ephemeral habitat. In another scenario, one could envisage rocks from an inhabited location, containing viable cells within fractures or even fluid inclusions in salts, being transported by impact to yet another, briefly habitable location. Thus, although Mars was habitable mostly during the pre-Noachian and Noachian, colonization of younger Hesperian to even Amazonian ephermeral habitats cannot be excluded.

Recolonisation of a habitat could lead to a situation where a geological context in which fractures in rocks already containing fossilized biosignatures (morphological and/or organic etc.) could be overprinted by a younger, or several younger generations of viable microbes, as summarized in Figs 1 and 2.

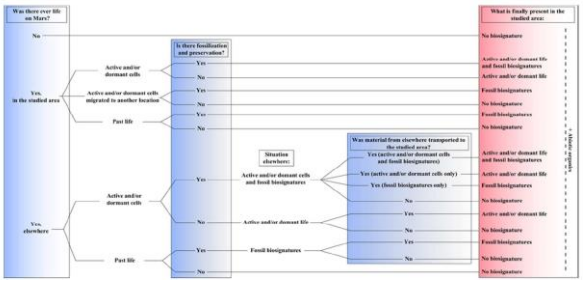

Fig. 1. Scenarios for the search for life at a given location on Mars taking into account the notions of local habitability, fossilization and preservation, and transportation

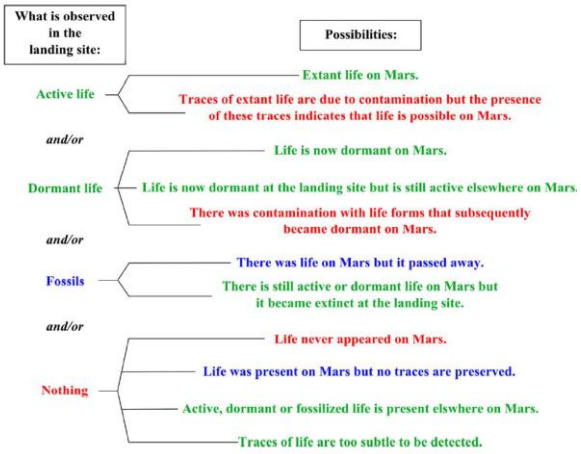

Fig. 2. Demonstrating the possibilities for interpreting the presence or absence of biosignatures at a particular landing site on Mars.

Conclusions: The phenomenon of punctuated habitats, recolonization of rocks containing fossil biosignatures, and colonization *ex novo* of new, ephemeral habitats increases the possibility of finding traces of at least fossil biosignatures and possibly extant life in specific, very localized habitats. Thus, while the ancient Noachian rocks may contain somewhat more extensive, fossiliferous formations, those from the younger Hesperian and Amazonian eras are likely to be extremely localized. The scenarios for the search for martian life described here are important in planning *in situ* mission search strategies.

References:

[1] Westall, F. et al. (2015) *Astrobiology*, *15*, 998–1029.

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