AN ORIGIN OF LIFE IN TERRESTRIAL FRESH WATER HYDROTHERMAL POOLS.

B. F. Damer[1], D. W. Deamer[1], M. Van Kranendonk[2], T. Djokic[2]. [1]Dept of Biomolecular Engineering, University of California, 1156 High St. Santa Cruz CA 95064 email: bdamer@ucsc.edu, [2]ACA, University of New South Wales, Sydney Australia.

Introduction: A weight of evidence has been building in support of an origin of life on land, in fluctuating fresh water hydrothermal fields present on early volcanic landmasses. This evidence can be framed in both chemical and geological settings.

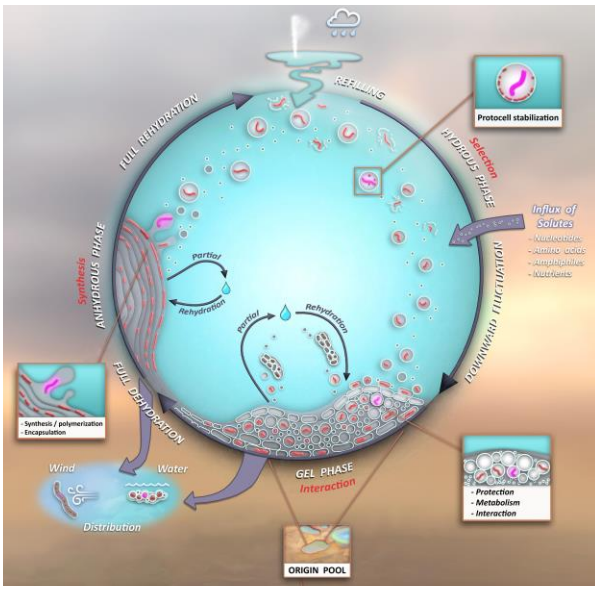

Fig 1. A chemical cycle supporting life's origins

Chemical Setting for Life's Origins: Pools on land favor the chemistry of life's origins as they provide a clear mechanism to concentrate the building blocks of polymers and membraneous structures self-assembled from amphiphilic compounds supplied from meteoritic infall and washed in by precipitation. When these pools dry down, membranes fuse and layer against mineral surfaces, further concentrating monomers in two dimensional spaces. As water leaves these spaces, condensation reactions form important biopolymers such as RNA and peptides [1]. Laboratory studies of this phenomenon have shown that the polymers become encapsulated in membranous vesicles budding off of the layers during pool rehydration. The resulting vesicles, called protocells, are then subject to combinatorial selection in bulk solution. During the next drying cycle, surviving protocells aggregate at the bottom of the pool to produce a hydrogel which favors interaction within and between protocells. These three phases (figure 1), all observed in the laboratory simulations, form a natural ratchet that moves encapsulated systems of polymers away from equilibrium and tests the stability of protocells. Beyond what is currently proven experimentally, we predict a stepwise selection of polymers representing the emergence of the functions of biology: membrane stabilization and pores, catalytic metabolism, heritable information, and ultimately protocell reproduction and the transition to a living system [2].

Fig 2. Geological setting supporting an origin and early evolution of microbial communities

Geological Setting for Life's Origins: Hydrothermal fields are rich environments providing chemical and heat energy, cyclic filling by geyser action, and a large number of "pools of fitness" having a variety of chemical, pH, mineral and temperature regimes. Such fields concentrate organic infall and also elements key to prebiotic chemistry, including B, Zn, H, N, and P. The emergence within these pools of a robust protocell aggregate able to grow and adapt through chemical evolution and then be distributed is the Woese progenote [3] on the transition to life. Evolution of progenote populations is driven by selective factors in various aqueous settings (figure 2) resulting in eventual adapation to lakeshores and shallow marine margins. Oceans are an extreme environment for early life due to salinity, divalent cations, high dilution and tidal forces and would be colonized by life well after its initial emergence. Recent stromatolite discoveries in the Pilbara in Western Australia and elsewhere reflect a vibrant and varied terrestrial microbial world in fresh water hydrothermal fields at 3.5 Ga [4] consistent with an origin of life in such a setting.

References: [1] De Guzman V, et al. (2014) *J Mol Evol*, 78, 251-262. [2] Damer B. F. and Deamer D. W. (2015) *Life*, 5, 872-875. [3] Damer B. (2016) *Life* 6, 21. [4] Van Kranendonk M. et al. (2015) *Proc. AbSciCon*.