

## Seeking signs of Martian life and caching samples for potential return to Earth

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If life emerged and flourished on Mars then recognizable textural and chemical evidence likely can be recovered from fine-grained clastic or well-cemented chemical sedimentary units known to be exposed at the surface. The presence of rhythmic stratigraphic sequences indicates that Martian depositional systems were sensitive to climate change, increasing the inventory of sedimentary and diagenetic materials available for sampling along an exploration transect. Building on the technical and operational heritage of Spirit and Opportunity, a mission is proposed for a new generation of Mars rover capable of exploring, sampling, and caching a diverse suite of rocks from outcrops [1]. The name Mars Astrobiology Explorer-Cacher (MAX-C) reflects the dual purpose of conducting *in situ* science and making concrete steps towards the future return of samples to Earth. MAX-C would enable scientists to evaluate paleo-environmental conditions, to characterize the potential for preservation of physical and chemical biosignatures, and to examine multiple sequences of geological units in a carefully orchestrated search for evidence of past life and/or prebiotic chemistry. It is critical that samples addressing the life questions be taken from strata crosscut or bounded by datable igneous units so as to constrain the timing of tectonic, magmatic, and climatic processes evolving in tandem with putative biogeochemical cycles.

High-fidelity contextual interpretation of data from MAX-C relies on integration of meter to submillimeter texture (optical imaging), mineral identification, and major element content with possible supplementation by organic carbon detection. Arm-mounted instruments are the means to investigate abraded rock surfaces using co-registered 2-D maps of visual texture, mineralogy and geochemical properties. If microbial life was manifest at some time on Mars then evidence at sub-millimeter scales is highly desirable to facilitate complex decisions related to sample acquisition, encapsulation, and caching. Ultimately, a cache could be placed on the ground or retained on the rover for recovery by a possible future sample return mission.

[1] MEPAG MRR-SAG (2009) Mars Astrobiology Explorer-Cacher: A potential rover mission for 2018. Final report from the Mid-Range Rover Science Analysis Group posted at <http://mepag.jpl.nasa.gov/reports/>.

## Molecular simulations of electrokinetic phenomena at the solid-liquid interface

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In the last 10 years we have been studying by molecular dynamics (MD) the structural and dynamic properties of aqueous solutions in contact with metal-oxide surfaces, mainly rutile [1-3]. We will present the results of our equilibrium and non-equilibrium MD simulations focusing on the molecular level origin of electrokinetic phenomena - electroosmosis and electrophoresis. We will comment on the asymmetry of the density profiles of cations and anions at positive and negative surfaces, discuss the properties of the diffuse and shear layers, if definable at all on the molecular scale, and present our zeta potential predictions from molecular simulations. Our results of zeta potential are in qualitative agreement with experimental data [5]. However, our molecular explanation is rather contradictory to at least some of the commonly used theories of the solid-liquid interface including the common double- or triple- layer models. We observe that the composition and structure at the interface, influenced by the surface charge, are the key factors, while the electrostatics of the aqueous solution is rather independent of the surface charge.

This debate is an important step in validating/challenging the theories of the solid-liquid interface and making as close link as possible between molecular simulations and experiments, which will ultimately lead to a deeper understanding of the solid-liquid interface.

[1] M. Předota, A. V. Bandura, P. T. Cummings, J. D. Kubicki, D. J. Wesolowski, A. A. Chialvo, and M. L. Machesky (2004), *J. Phys. Chem. B* **108**, 12049-12060. [2] M. Předota, Z. Zhang, P. Fenter, D. J. Wesolowski, and P. T. Cummings (2004), *J. Phys. Chem. B* **108**, 12061-12072. [3] M. Předota, P. T. Cummings, and D. J. Wesolowski (2007), *J. Phys. Chem. C* **111**, 3071-3079. [4] M. L. Machesky *et al.* (2008), *Langmuir* **24**, 12331-12339. [5] M. V. Fedkin, X. Y. Zhou, J. D. Kubicki, A. V. Bandura, S. N. Lvov (2003), *Langmuir* **19**, 3797-3804.