

## THEME 2: THE DYNAMIC INTERFACE

### Session 2.1: Mineral Surface Reactivity

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The reactivity of mineral surfaces, particularly that at mineral-fluid interfaces, has an enormous influence on geochemical systems. The focus of this session is on the elucidation of relationships between the structure at surfaces and interfaces of natural materials, including the atomic, electronic, and topological structure, with their reactivity and physical properties. Experimental and theoretical research, integrating any of the various theoretical concepts and microscopic or spectroscopic tools of mineral surface science, physical chemistry of surfaces, solid state physics, electrochemistry, or crystal chemistry, is particularly encouraged. Possibilities include, but are not limited to, studies based on scanning probe, X-ray, electron or optical microscopies and spectroscopies, and molecular or mesoscale modeling studies of various kinds. Scientific themes welcomed include thermodynamics and kinetics, electron transfer, mechanisms of dissolution and growth, nano-particle reactivity, transport phenomena, and sorption reactions of inorganic, organic, and microbial interfacial systems.

### 2.1.11

## Mineral surface catalysis in models for the emergence of life

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Models for spontaneous synthesis of biomolecular precursor species have met with remarkable success on a laboratory scale. However, to gain geochemical plausibility they need to overcome a series of natural obstacles that make most schemes fall short. Foremost among these impediments are the extreme dilution expected for reactants and the unmet need for overcoming activation energies for constructive reactions. As originally proposed by V.M.Goldschmidt [1], reactions at the interface between surface active minerals and dilute solutions of organic source molecules appear capable of resolving these problems, a suggestion that has been expanded at the conceptual level particularly by A.G. Cairns-Smith

The fact that most source molecules of interest in an evolving RNA world are negatively charged or neutral has led to experimental exploration of the role of cationic surface active minerals such as the family of mixed valence double layer metal hydroxide (DLH; LDH) minerals as concentrators and condensation catalysts for simple aldehydes and aldol phosphates to form pentose products like ribose phosphate, the R in RNA [2]. The reaction pathway leads through the formation of even simpler, tetrose based precursors such as threose phosphate, shown by Eschenmoser and collaborators to have remarkable evolutionary properties.

Remaining problems under study and discussed here concern the formation of glycosidic bonds with nitrogen bases, ligation to form oligonucleotides without artificial means for phosphate activation and, most crucially, the creation of functional information in oligomerizing RNA precursor molecules.

### References

- [1] Goldschmidt, V.M., Geochemical aspects of the origin of complex organic molecules on the Earth, as precursors to organic life (1947). Posthumously published by N.W. Pirie, ed; New Biology 12, 97-105, (1952)
- [2] References in: [www.arrhenius.ucsd.edu](http://www.arrhenius.ucsd.edu) (2004)