Stability of intermediate N valence species in the context of prebiotic hydrothermal chemistry

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The condition of the emergence and development of life is one of the major scientific questions of all times. Up to now the focus has understandably be on the chemistry of carbon in reduced conditions adequate for the formation of prebiotic organic compounds. Only few studies have addressed the behavior of nitrogen in such reducing environments, in spite of its key role in the natural formation of the elementary bricks of biological macromolecules.

N_2, NH_3 and NO_3^- are the main stable molecules in deep geological fluids. Here, we explore the stability and chemical properties of less well-known intermediate N valence species such as hydrazine (N_2H_4) and azide (N_3^-), as possible reaction intermediates in the natural synthesis of nitrogen bearing organic molecules. This is achieved through laboratory experiments under hydrothermal conditions and in-situ Raman spectroscopy measurements. While these compounds were identified as trace in experiments using quenched spark discharge through a reduced atmosphere [1], there is still a serious lack of thermodynamic data that impedes any simulation of water-rock interaction processes (excepted in the particular fields of industrial applications such as rocket propulsion, car airbags, aqueous circuits of nuclear reactors).

The presented results will covered various properties:

- Standard potential of the N_2/N_2H_4 couple up to 250°C by in-situ pH-Eh measurements and chemistry monitoring [2],
- Volatility of hydrazine up to 250°C
- Identification of the intermediate N-bearing compounds involved in the nitrate and N_2 reduction by H_2,
- Decomposition rate of hydrazine with temperature,
- Determination of the azide stability field as a function of temperature and pH by in-situ Raman spectroscopy [3].

Our preliminary results provide original quantitative data that may place better constraints for the prebiotic synthesis of amino groups and on the geochemistry of nitrogen in an abiotic geosphere.

[1] Folsome C.E. *et al.* (1981) *Nature* **294**, 64-65; [2] Million-Picallion L. *et al*. (2015) *J. Solution Chem*. **44**, 1900-1919; [3] Truche *et al*. (2016) *G.C.A*. **144**, 238-253.