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Low temperature alkaline pH hydrolysis of oxygen-free Titan tholins

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The largest moon of Saturn, Titan, is known for its dense, nitrogen-rich atmosphere. The organic aerosols which are produced in Titan's atmosphere are of great astrobiological interest, particularly because of their potential evolution when they reach the surface and may interact with putative ammonia-water cryomagma[1].

In this context we have followed the evolution of alkaline pH hydrolysis (25wt% ammonia-water) of Titan tholins (produced by an experimental setup using a plasma DC discharge named PLASMA) at low temperature. Urea has been identified as one of the main product of tholins hydrolysis along with several amino acids (alanine, glycine and aspartic acid). However, those molecules have also been detected in non-hydrolyzed tholins. One explanation is a possible oxygen leak in the PLASMA reactor during the tholins synthesis[2]. Following this preliminary study the synthesis protocol has been improved by isolating the whole device in a specially designed glove box which protect the PLASMA experiment from the laboratory atmosphere.

Once we confirmed the non-presence of oxygen in tholins, we performed alkaline pH hydrolysis of oxygen-free tholins. Then we verify that the organic compounds cited above are still produced in-situ.
Moreover, a recent study shows that the subsurface ocean may contain a lower fraction of ammonia (about 5wt% or less[3]), than the one used until now in this kind of experimental study[2, 4]. Thus, we have carried out new hydrolysis experiments which take this lower value into account.
Additional studies have provided new highlights on the bulk composition of Titan for various gas species. Indeed, the observed Saturn's atmosphere enrichment constrains the composition of the planetesimals present in the feeding zone of Saturn. The enrichment in volatiles in Saturn's atmosphere has been reproduced by assuming the presence of specific gas species[5, 6], in particular CO_2 and H2S. In the present study we assume that those gas species have been trapped in the likely internal ocean. Then by taking into account the plausible acid-alkaline properties of the water-ammonia ocean, we determine a new probable composition of the cryomagma which could potentially interact with deposited Titan's aerosols. They were also included in our hydrolysis experiments.

Taking into account these new data, four different hydrolyses have been applied to oxygen-free tholins. For each type of hydrolysis, we also follow the influence of the hydrolysis temperature on the organic molecules production.

References:

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