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Project VAHIIA: Volatile Analysis coming from the heating of interstellar/cometary ice analogs

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Studying organic volatile compounds (VOC) coming from the heating of cometary ice analogs through laboratory simulations is of great interest in understanding the reactivity that leads to the formation of the organic refractory residues available in interplanetary objects. They will enlighten us on conditions prevailing on the primitive nebula and during the formation of the Solar system and will support understanding and interpreting space mission data for comet surveys such as the ongoing Rosetta mission. Experimental simulations consist of irradiating and warming-up an ice analog under ultrahigh vaccum conditions reproducing astrophysical environments. To analyze the VOC formed in these conditions by gas chromatography (GC) coupled to mass spectrometry (MS), different analytical challenges need to be addressed such as: the low pressure under which the VOC are formed in the vacuum chamber (10-8 mbar) since their analysis by GC-MS is conducted at atmospheric or close to atmospheric pressures; and the low sensitivities due to slow desorption kinetics in the vaccum chamber while a narrow injection is needed to ensure the best GC efficiency. To overcome these challenges, we have developed an analytical interface called VAHIIA that links directly the cryogenic chamber where the VOC sublime to the GC-MS where they are analyzed (Figure 1). By this means, an online transfer of the compounds to the analytical instrument is ensured, maintaining the representativeness of the sample and avoiding compound losses, a common problem in multi-procedural methodologies for VOC analysis. This interface is constituted by a preconcentration unit allowing VOC enrichment and sample pressure increase in order to facilitate its transfer to the GC-MS, and of an injection unit allowing online gaseous sample introduction into the GC injector. The VAHIIA interface has been calibrated, optimized and validated and its performance is very satisfactory regarding trace VOC analysis from gaseous samples (detection limits are in the order of nanomole), not only in astrophysical applications but also in all systems requiring vacuum/cryogenic environments. In this short contribution, the VAHIIA interface is described, and the first results concerning the benefits of such a device in the analysis of cometary ice analogs are highlighted.