

Analytical development for identifying femtomole-level organophosphorus compounds using IC/HRMS for organic astrochemical samples

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Phosphorus (P) -bearing organic molecules are believed to have played a pivotal role in the emergence of life on Earth; however, their origin and chemical evolution in cosmic environments remain poorly understood. Observations, meteoritic analyses, and laboratory simulations indicate that organophosphorus species can form abiotically under interstellar and asteroid conditions and may have been delivered to the early Earth [1–3]. However, the structural diversity and formation pathways of these molecules in astronomy have not been comprehensively characterized, limiting our understanding of phosphorus chemistry from the interstellar medium to the Solar System. To address these undescribed issues, we have developed a highly sensitive analytical method capable of identifying organophosphorus species using ion chromatography/high-resolution mass spectrometry (IC/HRMS) [4]. This technique enables the detection of femtomole-level organophosphorus compounds from matrices containing various interfering molecules (Fig. 1). By applying this approach to organic astrochemical samples, the molecular diversity and reaction networks of phosphorus species formed in interstellar ices, protoplanetary disks, and asteroids can be revealed. These results will provide new insights into the astrochemical evolution of primordial phosphorus and its potential contribution to the inventory of prebiotic molecules on the early Earth.

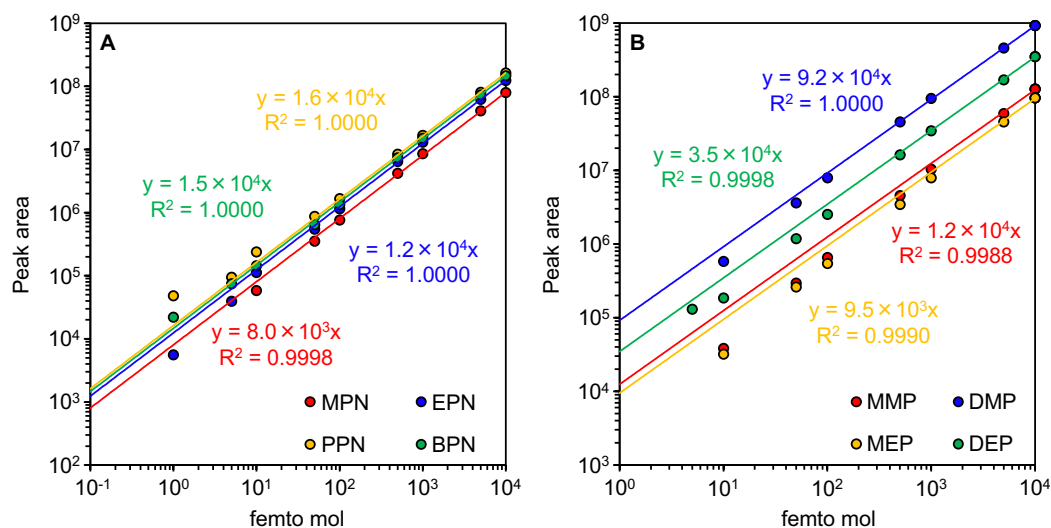


Figure 1: Calibration curves of organophosphorus standards [4]. The left and right figures show alkyl phosphonates and alkyl phosphates, respectively. Abbreviations: MPN, methyl phosphonate; EPN, ethyl phosphonate; PPN, propyl phosphonate; BPN, butyl phosphonate; MMP, monomethyl phosphate; DMP, dimethyl phosphate; MEP, monoethyl phosphate; DEP, diethyl phosphate.

References

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