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Nitrogen and phosphorus molecules and minerals on the prebiotic earth may have enabled pre-biochemical reactions

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Phosphorus is a critical element in modern ecosystems and plays a central role in biochemical functions. Our understanding of prebiotic reactions of phosphorus—forming critical biomolecules—is stymied by the assumption that poorly soluble phosphate minerals such as fluorapatite were the primordial source of prebiotic phosphorus. If, instead of calcium phosphate minerals, nitrogen-phosphorus compounds were present on the early earth, then these compounds may have been superior reactive phosphorus sources on the early earth. For example, diamidophosphate, $(H_2N)_2PO_2^-$, has been demonstrated to bear superior phosphorylating power compared to phosphate (1). This compound phosphorylates a multitude of organic substrates, and may even promote dimer formation as a result of the P-N bond, which is high energy (2) but relatively kinetically stable.

The formation of N-P molecules and minerals on the early earth is an understudied subject. The mineral struvite, $MgNH_4PO_4*6H_2O$, has historically been used for phosphorylation reactions (3), but its presence on the early earth has not been demonstrated. However, ammonium phosphates may be present in asteroid samples (4), possibly indicating their ready formation on an early earth. The mineral schreibersite may also react with ammonium to generate N-P molecules (5). Here I show further evidence of N-P molecule formation by ammonolysis of P-O-P bonds, specifically phosphorus compounds with a lower redox state than phosphate. Environments leading to these molecules may have been much more widespread on the early earth, enabling prebiotic phosphorylation reactions more readily than the slow release of low-energy phosphate.

- Gibard et al. (2018) *Chem*. **10**, 212-217.
- Pasek (2020) *Rev*. **120**, 4690-4706.
- Handschuh and Orgel (1973) *Science* **179**, 483-484.
- Feng et al. (2021) *ACS Earth Space Sci.* **5**, 1647-1656.
- Gibard et al. (2019) *Chem. Int. Ed.* **58**, 8151-8155.