Researchers from the NAI JPL Icy Worlds team report that gradients of redox and pH in iron minerals can drive the formation of prebiotic organic molecules.

The early Earth had no atmospheric O$_2$ – which resulted in an ocean where iron could remain dissolved in the ocean and precipitate as highly reactive minerals. These iron hydroxides in seafloor sediments and hydrothermal chimneys range from more oxidized (red rust) to more reduced (green rust) – each having different ability to catalyze organic prebiotic reactions.

Simple organic precursors (in this case, pyruvate) can react with iron minerals and ammonia to make the building blocks of life, but the reaction outcome depends on how much oxygen is present.

**Partially oxidized iron minerals yield abiotic amino acid formation.** This reaction could occur on iron-rich early Earth seafloors, in vents, and also in any planetary environment where similar iron minerals may occur – such as Enceladus, Europa, or the subsurface of Mars.