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Ironborn: Fe distribution in geothermal fluids and its influence on the biosphere

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In geothermal environments, geochemistry often determines the boundary conditions within which life operates1. Recently, studies have demonstrated how different geochemical environments, sampled through deeply-sourced seeps across various geological settings, constrain the distribution of microbial taxa, as well as the genes associated with relevant metabolic functions2,3. However, the role of geothermal environments and trace element availability in driving protein distribution remains poorly understood4. Iron is the 4th most abundant element in Earth's crust and one of the most fundamental elements for biological systems, as it is associated with numerous metabolic reactions across all the various domains of life. For this reason, iron is tightly coupled to the evolution of the biosphere over deep time5. Additionally, the availability of iron in geothermal environments within different geological settings (e.g., variable rock types and tectonic contexts) is still poorly constrained. In the present study, we apply a novel sampling strategy across large-scale geological gradients6 encompassing geothermal environments in different tectonic settings, including Costa Rica, Argentina, Chile, and Italy arc/back-arc systems, as well as the Iceland spreading center. Through high resolution geochemical analysis, coupled with metagenomics on more than 50 deeply-sourced springs, we constrain the presence, diversity, and abundance of iron-related proteins to geothermal iron availability within different geological settings.

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