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Measuring the Bioenergetics of a Hyperthermophilic Methanogen

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To better understand early Earth environments and guide our search for life elsewhere, we must constrain the range of environmental conditions on early Earth that would have been necessary to support early life. Thus, calculating the energetic requirements of early life on Earth would improve habitability models. Given that nitrogen is required for all life on Earth and is not usable as N2 gas, having a better understanding of the energetic implications of biological fixation is necessary. Hyperthermophilic methanogen, FS406-22, is an ideal candidate to represent the needs of life on the early Earth, since it shares metabolic strategies believed to have been employed by the last universal common ancestor (LUCA) and can fix nitrogen. Here, we use microcalorimetry, chemical analyses, and thermodynamic modeling to determine the energetic cost of FS406-22 incubations under fluctuating nutrient conditions from 65-85C. The preliminary results suggest consistent energy consumption at 76C regardless of nitrogen source; however, there may be significant differences in how this energy is divided into biosynthesis. Understanding the thermodynamics of growth under varying temperatures and nutrient conditions will further constrain the limitations of life, forming the selection of target sample sites.