The temperature relation of enzyme catalysis and product removal determine metabolic rates in sulfate reducing bacteria

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The temperature influence on reaction rates described by Arrhenius also applies to microbial metabolisms. At a certain point below the optimal growth temperature, metabolic rates diverge from those predicted by Arrhenius, increasing less than predicted. The mechanism leading to the discrepancy between expected and measured rates has been highly discussed. Recently, Ritchie (2018) suggested that diffusion or transport away from a reaction site may explain this discrepancy because these processes increase less with temperature than enzymatic reaction rates do. We measured growth rate, cell-specific sulfate reduction rates, and isotopic fractionation of stable sulfur isotopes over the whole temperature range of three species of sulfate reducing bacteria. We observe that sulfur isotope fractionation decreased with increasing temperature and reached a minimum around the same temperature that the discrepancy between predicted and measured metabolic rates became evident. At higher temperatures, sulfur isotope fractionation increased again, indicating a greater reversibility in the sulfate-reduction pathway, consistent with an accumulation of product at the enzymatic reaction sites. Thus, sulfur isotope fractionation offers insight into the enzyme-level processes of sulfate reducing microorganisms, provides a mechanistic answer to the longstanding relationship between temperature and sulfur isotope fractionation as well as leads to a better understanding of the limitations of microbial activity and the adaptation towards temperature.

Ritchie, M. E. (2018) *Scientific reports* **8**, 11105.