

Is sulfur comproportionation a catabolism ‘missing in nature’?

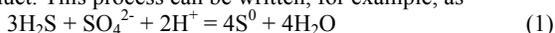
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Based on calculations of reaction energetics, anaerobic ammonia oxidation with nitrite (later termed anammox) was posited to fuel certain chemolithotrophs ‘missing in nature’. It was confirmed as a microbial process decades later, first in a sludge reactor [2] and then in nature [3]. Anaerobic oxidation of methane (AOM) was hypothesized based on methane and sulfate concentration profiles in marine sediments and on a modest negative free energy change [4]. Other geochemical evidence for AOM in methane-sulfate transition zones followed [5-7]. The apparent lack in nature of energetically favorable complete ammonia oxidation puzzled biologists for decades [8]; comammox bacteria were ultimately identified, cultivated, and characterized [9-10], but their environmental distribution and ecological significance are still speculative [11]. Here, we use a thermodynamic approach to predict the existence of another novel microbial catabolism—sulfur comproportionation—the anaerobic oxidation of sulfide with sulfate, yielding an intermediate oxidation state sulfurous product. This process can be written, for example, as



or



The reverse of (1) and (2), sulfur and thiosulfate disproportionation, are confirmed microbial catabolisms, but whether the forward or reverse directions are energy yielding depends in large part on the geochemistry of the environment. Sulfur comproportionation can be exergonic over a wide range of temperature, yielding as much as ~50 kJ/mol from (1) under acidic conditions; maximum likely energy yields from (2) are lower, but this redox process may still represent a missing catabolism in nature across a broad range of temperature, pH, and other geochemical conditions.

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