Hydrogen-Based Microbial Ecosystems in the Earth

Todd O. Stevens and James P. McKinley (1) report finding hydrogen gas (H₂) of possible geochemical origin, and they propose that this H₂ supports lithothrophic methanogenic bacteria that are physiologically active beneath the Columbia River plateau.

Methanogenic bacteria are ubiquitous in the biosphere’s anaerobic habitats (for example, in soils and sediments), and the ability to use H₂ as an electron donor for carbon dioxide reduction to methane is almost universal among methanogens (2). In order for methanogens to be linked to photosynthesis, H₂ is usually produced by an anaerobic microbial food chain responsible for the decay of photosynthetically produced plant materials. But H₂ production is also commonly associated with geothermal activity. Furthermore, a variety of habitats where geothermal H₂ is emitted have been shown to support methanogenic bacteria (2, 3). These previously described microorganisms do precisely what was postulated for the microbial community beneath the Columbia River plateau: They grow in anaerobic habitats at the expense of abiotic H₂. Thus, as a strictly physiological phenomenon, the subject of Stevens and McKinley’s report is not unique.

There are, however, three ecological aspects of the work that merit attention: (i) The proposed H₂ source for methanogenic life was neither biogenic (from an anaerobic food chain) nor geothermal; (ii) C isotopic ratios suggested that methanogenesis was occurring in situ, within the basaltic subsurface deposits; and (iii) lithotrophy (regardless of its aerobic or anaerobic basis) has not been previously reported in subsurface environments. Given the diversity of microbial biogeochemical reactions and efforts by scientists to describe them (4), it is important to place new discoveries within the scholastic context of microbial ecology.

Eugene L. Madsen
Section of Microbiology,
Division of Biological Sciences,
Cornell University,
Ithaca, NY 14853–8101, USA

REFERENCES
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Response: Madsen raises a point about the significance of the microbial communities that we reported within the Columbia River Basalt Group (CRB) (1). Certainly, we are not the first to propose that microorganisms can gain energy from oxidation of geochemically produced H₂. Some investigators have even proposed hydrogenotrophy-based ecosystems in the subsurface environment (2). To our knowledge, however, actual evidence for in situ hydrogenotrophic...
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Derek R. Lovley and Francis H. Chapelle

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