Biomarker lipid diversity as a function of growth conditions in *Rhodospirillum rubrum*

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Sedimentary rocks of all ages abound with geostable lipids of microbial origin, but many of these biomarkers lack known organismal sources and a clear environmental context. Here we use *Rhodospirillum rubrum*, a metabolically versatile, genetically tractable alpha-Proteobacterium, to explore the diversity of its polycyclic triterpenoids as a function of growth conditions.

By using comprehensive two-dimensional gas chromatography [1], we detect a number of bicyclic, tetracyclic and pentacyclic triterpenoids derived by the enzymatic cyclization of squalene in *R. rubrum* and produced in amounts comparable to squalene and diploptene. These tentatively identified compounds include bicyclic polypodatetraene, malabaricatriene, euphadiene, adianene, fernene, and scalarane. The greatest abundance and diversity of non-hopanoid polycyles are observed when microbes grow photolithoautotrophically under anaerobic conditions, while the least abundance and diversity occurs during heterotrophic growth in the dark under aerobic conditions.

Although certain organisms, such as *Arabidopsis thaliana*, contain multiple triterpene cyclases that engender a diversity of polycyclic lipids [2], *R. rubrum*'s genome contains only a single gene encoding a squalene-hopene cyclase. Some of the observed diversity of sedimentary microbial triterpenoids could thus be attributed to a small number of enzymes operating under a range of environmental and physiological conditions.

[1] Ventura (2007) *PNAS* **104**, 14260-14265. [2] Lodeiro (2007) *J. Am. Chem. Soc*. **36**, 11213-22.

Biodegradation of solvent extractable coal-associated organic matter by a methanogenic microbial consortium

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Methane from unconventional natural gas reservoirs represents an increasingly important source of domestic energy in several countries including the United States. The US has considerable reservoirs of this natural gas, some of which is sorbed to subsurface coals and held in place by *in situ* hydrostatic pressures. For many of the coalbed methane reservoirs, the isotopic composition of the gas and the site's geologic history implicate a microbial origin for the methane. In light of these factors, we investigated the potential for extant coalbed methanogenesis as well as the ability for solvent extractable coal-associated organic matter to support methane production. Methane production was measured in laboratory incubations containing either crushed coal or chloroform-extracted organic matter inoculated with a methanogenic consortium previously shown to degrade coal. Incubations containing the coal-free organic extracts demonstrated methane production levels well above those observed for the unextracted coal. In contrast to earlier preliminary work, there was not a clear correspondence between methane production and the amount of extractable organic matter for a given coal. Thus, quality and bioavailability, and not quantity of coal-associated organic matter in providing carbon and energy sources supporting methanogenesis are likely critical factors influencing the process of methane production in coalbeds.