

Variations in D/H fractionation associated with microbial heterotrophy

XINNING ZHANG AND A. SESSIONS*

Environmental Science and Engineering, California Institute of Technology, Pasadena CA 91125, USA
(*correspondence: ALS@gps.caltech.edu)

Compound-specific D/H measurements are emerging as a useful tool for paleoclimatology, chemical oceanography, biogeochemistry, and geobiology. To date, most research has focused on describing the distribution of organic D/H ratios in nature, while the biological fractionations that underpin that variability have received less attention, particularly with regard to microbial heterotrophs. Here we describe culture experiments that examine lipid D/H in two aerobic soil bacteria, *Cupriavidus oxalaticus* and *C. necator*, with physiologically versatile carbon metabolisms growing on a range of organic substrates. The resulting fractionations (differences in δD values between lipids and water) cover a staggering range of nearly 500‰, even for a single organism, and depend primarily on the nature of the organic substrate being utilized (Fig 1). Organisms grown on oxalate and formate (which do not supply organic H) were strongly depleted in D. Those grown on substrates that are processed by the citric acid cycle (acetate, succinate) were strongly D-enriched, while those processed via glycolysis (fructose, pyruvate) were intermediate. We hypothesize that fractionations accompanying the production of cellular NADPH are the source of these variations, and that lipid δD values could be used as a tracer of metabolic processes in environmental samples.

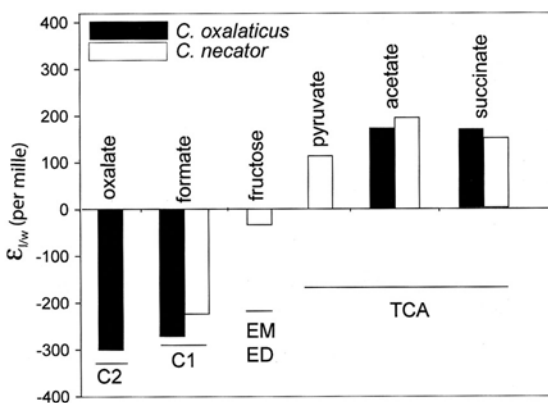


Figure 1: Lipid/water D/H fractionations for fatty acids from microbial cultures grown on defined substrates.

Microbial mobilization of adsorbed arsenate on Al^{III}- and Fe^{III}-hydroxide

XUOXIA ZHANG, Y.F. JIA*, L. XU AND R. PAN

Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang, China, 110016
(*correspondence: yongfeng.jia@iae.ac.cn)

Arsenic is present in aqueous environment predominantly in the form of As^{III} and As^V. Its mobility and bioavailability are largely controlled by its adsorption on the minerals widely occurring in aqueous environment. Microbial reduction of arsenate is considered an important factor in the remobilization of arsenic in groundwater systems. This paper investigated the effect of microbial activity on the fate of adsorbed arsenate on Al^{III}- and Fe^{III}-hydroxides in anaerobic environment.

The bacteria used in this study were isolated from the arsenic-contaminated soils at an abandoned smelter site. Arsenate-adsorbed hydroxide solids were prepared by equilibrating an arsenate solution with Al^{III}-, Fe^{III}-hydroxide at the M/As molar ratio of 100:1 in order to ensure a complete adsorption. After inoculation, the slurry was incubated under anaerobic condition and the concentration of As^V, As^{III}, Fe^{III}, Fe^{II} in both solution and solid phases were monitored with time.

The results showed that the arsenate (i.e. As^V) adsorbed on both Al^{III}- and Fe^{III}-hydroxides were quickly reduced to arsenite (i.e. As^{III}) by the microbes, whereas neither reduction nor release of arsenic was observed in the control. The reduction of As^V to As^{III} was also confirmed by direct evidence of XAS measurements. For the As^V-aluminum hydroxide system, almost all the adsorbed arsenic was released into the solution, indicating that aluminum hydroxide showed little affinity for As^{III}. In comparison, little arsenic was released from the As^V-ferric hydroxide system, although the adsorbed As^V was also significantly reduced to As^{III}. The reduction of Fe^{III} to Fe^{II} was observed after 21 days of incubation. The XRD patterns of the heat treated solid clearly showed the presence of magnetite in the solid.

Therefore, it is suggested from this work that remobilization of the adsorbed arsenate by microbial reduction strongly depends on the type of minerals.

[1] Islam *et al.* (2004) *Nature* **430**, 68-71.