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Using stable isotope probing to dissect the microbial controls on arsenic speciation in SE Asian aquifers

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The contamination of groundwaters, abstracted for drinking and irrigation, by sediment-derived arsenic, threatens the health of tens of millions worldwide. Using the techniques of microbiology and molecular ecology, in combination with aqueous and solid phase speciation analysis of arsenic, we have used microcosm and axenic culture-based approaches to provide evidence that anaerobic metal-reducing bacteria play a key role in the reductive mobilization of arsenic in sediments collected from aquifers in West Bengal and Cambodia. The critical controls on these activities will by described, including the role of organic matter in promoting arsenic-mobilizing respiratory processes, alongside the diversity of organisms involved in mediating these transformations. The latter have been investigated using culturing experiments and stable isotope probing (SIP) techniques in combination with functional gene analysis, to identify the active fraction of subsurface microbial communities responsible for mobilizing arsenic. Using SIP we have shown that the introduction of a proxy for organic matter (^{13}C-labelled acetate) stimulated As(V) reduction in sediments collected from a Cambodian aquifer that hosts arsenic-rich groundwater. This was accompanied by an increase in the proportion of prokaryotes closely related to the dissimilatory As(V)-reducing bacteria *Sulfurospirillum* NP-4 and *Desulfotomaculum auripigmentum*. As(V) respiratory reductases genes (*arrA*) closely associated with those found in *Sulfurospirillum barnesii* and *Geobacter uraniumreducens* were also detected in active bacterial communities utilising ^{13}C-labelled acetate in microcosms. Thus, this

SIP study suggests a direct link between inputs of organic matter, and the increased prevalence and activity of organisms which transform As(V) to the potentially more mobile, and thus hazardous As(III) via dissimilatory As(V) reduction.