

## High resolution profile of surface water incursion into an arsenic-bearing aquifer in Cambodia

L. A. RICHARDS<sup>1\*</sup>, B. E. VAN DONGEN<sup>1</sup>, D. MAGNONE<sup>1</sup>,  
C. SOVANN<sup>3</sup>, C. J. BALLENTINE<sup>2</sup> AND D. A. POLYA<sup>1</sup>

<sup>1</sup>School of Earth, Atmospheric and Environmental Sciences,  
University of Manchester, Manchester, M13 9PL, UK  
(\*correspondence: laura.richards@manchester.ac.uk)

<sup>2</sup>Department of Earth Sciences, University of Oxford, Oxford,  
OX1 3AN, UK

<sup>3</sup>Department of Environmental Science, Royal University of  
Phnom Penh, Cambodia

More than 140 million people worldwide are exposed to dangerous concentrations of arsenic in drinking water [1]. In shallow aquifers typical of South and Southeast Asia, arsenic is naturally mobilized from sediments into groundwater following the reductive dissolution of arsenic-bearing minerals, a process requiring metal reducing bacteria and organic carbon [2] [3]. Although the mechanisms controlling arsenic mobilization are generally understood, a critical but unresolved issue is unequivocally establishing the influence of surface waters which may be drawn down to depth via large scale groundwater withdrawal [4] [5]. If this surface water contains bioavailable organic matter critically implicated in arsenic release, surface water ingression may be exacerbating the release of arsenic at depth.

This study thus aims to develop a high resolution profile of surface water incursion into a well-characterized, arsenic bearing aquifer in Kandal Province, Cambodia. A series of borehole clusters have been installed along vertical and horizontal groundwater flowpaths, allowing a high resolution profile to be established. The transect incorporates features which may lead to natural ground-surface water interactions such as areas of sand-dominated lithology, ponds, and seasonal variations in monsoonal flow patterns, even in the absence of large-scale groundwater withdrawal. A suite of geochemical (*e.g.* As, Fe, SO<sub>4</sub>, HS, NH<sub>4</sub>, NO<sub>3</sub>, NO<sub>2</sub>, PO<sub>4</sub>, Mn) including isotopic (*e.g.* <sup>3</sup>T/<sup>3</sup>He, δ<sup>18</sup>O, δ<sup>2</sup>H) tracers are used to assess the recharge sources of the groundwater. These results have implications on understanding the relative importance of surface-derived sources in arsenic release, and thus contribute to the mechanistic understanding of a critical threat to public health.

[1] Smedley & Kinniburgh (2002), *Appl. Geochem.*, **17**, 517-568. [2] Charlet & Polya (2006), *Elements*, **2**, 91-96. [3] Islam *et al* (2004), *Nature*, **430**, 68-71. [4] Harvey *et al* (2002), *Science*, **298**, 1602-1606. [5] Lawson *et al* (2013), *Env. Sci. Technol.* **47**, 7085 - 7094.