Selenium and arsenic mobility in prospective shale-gas plays: Contamination and remediation potential

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Elemental Enrichments in Prospective Black Shales

The Carboniferous Clare Shales (west Ireland) and the laterally equivalent Bowland shale, England, are considered the most prospective unconventional shale gas plays in the British Isles, with TOC values for the sampled Clare Shales averaging 4.87% (n=14). Elemental analysis of the Clare Shales has found that these sequences are enriched in a number of potentially hazardous trace elements relative to average crustal and average shale values. Selenium (Se) and arsenic concentrations average 31.6ppm and 24.5ppm respectively (n=17), both significantly higher than average shale values of 1.3ppm [1] and 8.6ppm [2]. These values are similar to those found within the Bowland shales [3].

Trace Element Mobility and Fixation

Groundwater penetration and surface weathering of the Clare Shales has resulted in the natural liberation, mobilisation and re-precipitation of oxidised mineral phases at surface, similar to acid mine drainage (AMD) processes. Analysis of these precipitates demonstrates that Se and As are being mobilised under ambient groundwater conditions from the enriched black shales and preferentially encorporated within phosphate-bearing jarosite.

This direct evidence of trace element mobilisation by groundwater is important when considering these, and other enriched black shales as prospective shale gas targets. There is the potential for increased leaching of environmentally hazardous elements during hydraulic fracturing operations and potential remediation costs may need to be considered. The observed fixation of the leached elements Se and As within phosphatic oxides may provide an effective solution.

[1] Hu & Gao (2008) *Chem. Geol* **253**, 205-221. [2] Stüeken *et al.* (2015) *GCA* **162**, 109-125. [3] Parnell *et al.* (2016) *Appl. Geoch.* **66**, 82-87.