

Tracking solutes and water from subsurface drip irrigation application of coalbed methane produced waters

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Coalbed methane (CBM) currently accounts for ~7% of US natural gas production. Compared to traditional sources, CBM co-produces large volumes of water. Subsurface drip irrigation (SDI) is an emerging technology that beneficially uses pre-treated CBM waters (injectate) by emitting them into the root zone of agricultural fields to aid in irrigation. The method is designed to minimize impacts by storing salts in the vadose zone. Research objectives include tracking the injectate-derived water and salts at an SDI site on an alluvial terrace, adjacent to the Powder River, Wyoming. This research utilizes soil science, geochemical, and geophysical methods. Initial results from pre-SDI data collection and the first year of post-SDI operation will be presented.

Over the first year of the study, soil moisture significantly increased in the SDI areas and groundwater elevations in wells below the SDI fields increased by ~15cm (~45% of total SDI irrigation). The injectate is dilute with respect to most constituents (except, most notably, sodium adsorption ratio [SAR]) relative to the site groundwater. Large variations in soil water salinity (some samples much greater than groundwater) and SAR within the SDI fields suggest that, in general, SAR is buffered in the vadose zone by calcite and gypsum dissolution and that some readily soluble Na-rich salts may also be present in small portions of the site. Changes in chemical composition and specific conductivity along surface water transects adjacent to the site are minimal, suggesting that discharge to the Powder River from groundwater underlying the SDI fields is negligible.

Findings from this research provide a critical understanding of water and salt dynamics associated with SDI systems using CBM produced water. Information obtained from different parts of this heterogeneous site can be used to improve SDI and other CBM produced water use/disposal technologies in a variety of environmental settings of the PRB to minimize adverse impacts.

Groundwater composition of a rock waste pile of the uranium mine of Poços de Caldas, Brazil

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While the decommission strategies of the former uranium production centre of Poços de Caldas (Brazil) are being discussed and elaborated, several studies performed at the area [1-3] help to give insight about the geochemical processes inside the rock waste piles, which are basically related to the oxidative dissolution of pyrite. For instance, the chemical composition of the groundwater collected at the monitoring wells of waste rock pile 4 show that the oxidation inside the pile is not uniform. In the present study, we looked at the geochemistry of the underground water of three monitoring wells (PM-01, PM-03 and PM-04) and also from an artificial pond (BNF) which receives the drainage of the pile before neutralization. PM-03 has the shallowest water level (~25 m), pH 4.4 and chemical composition dominated by sulphate, fluoride, calcium, iron, aluminum, potassium and magnesium. PM-01 and PM-04 (> -46 m and -41 m, respectively) water samples were alkaline and near neutral and contained low quantities of dissolved ions. The behavior of rare earth elements (REE) was compared with previous data of the acid drainage of the Osamu Utsumi mine [4]. The $\Sigma\text{REE}=452$ $\mu\text{mol/L}$ of PM-03 is more than twice that measured in the above mentioned study, suggesting an intense weathering rate at the upper part of the waste pile. Furthermore the NASC (North American Shale Composite) REE normalized patterns of water samples show enrichment in LREE compared to the HREE. Negative and positive anomalies for Ce and Eu, respectively, were observed for the acidic PM-03 and BNF waters. The Eu positive anomaly was not previously observed [4] and is probably related to the complexation of Eu^{2+} by sulphate and fluoride, after its release from the host minerals. This suggestion will be further checked by modeling with a speciation code, considering the whole chemistry of the water samples.

[1] Fernandes *et al.* (1998) *Waste Manage.* **18**, 169–181.

[2] Fernandes *et al.* (2008) *J. Environ. Manage.* **87**, 59–72.

[3] Franklin (2007) *Doctorate Thesis, COPPE/UFRJ II.*

[4] Serrano *et al.* (2000) *Chem. Geol.* **165**, 167–180.