

Separation of arsenate and phosphate for the measurement of the isotope composition of the oxygen in arsenate

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The investigation of the isotopic composition of oxygen in As-oxyanions may offer some new insights into the development of arsenic enriched groundwaters [1]. A basic analytical requirement is, however, the quantitative separation of the various dissolved oxyanionic species which may coexist in the water. Among the several potentially interfering oxyanions the separation of phosphate and arsenate appears to be a challenging task due to their very similar chemical behavior.

In this study, tests were carried out using the anion exchange resin Amberlite IRA-400. 250 mL of solution containing 15mg/L of phosphate and 1 mg/L of arsenate was mixed with 1 g of resin, and stirred with 500 rpm at 21°C for 2 hours. It was found that IRA-400 adsorbed both arsenate and phosphate to 99.9%. Subsequently, experiments were carried out to strip selectively arsenate and phosphate. Using 1 mol/L CH₃COOH, HCl and HNO₃ arsenate was desorbed to 66.3%, 91.1% and 95.8%, respectively, but in the same time also some phosphate went into solution (60.1%, 4.9% and 5.0%, respectively). At lower pH (2 mol/L HCl or 2 mol/L HNO₃) the concentration of phosphate in the leachate was below detection limit, and 99% of the arsenate was released from the resin.

Because for the isotope analysis arsenate is precipitated as Ag₃AsO₄, the presence of large amounts of Cl⁻ ions in solution is disadvantageous due to the coprecipitation of AgCl. Therefore, for isotopic work 2 mol/L HNO₃ appears to be an optimal desorption agent for the selective release of arsenate and phosphate from Amberlite IRA-400. After the desorption experiments the resin could be regenerated under alkaline conditions by using 1 mol/L NaOH.

[1] Berner Z. Tang X. Norra S. Oxygen isotopy of arsenate/arsenite, A novel approach to constrain the source of As in groundwater. Goldschmidt 2010, A84.

Mineral CO₂ sequestration in mine waste rock: Column experiments

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Basic silicates are the main source releasing Ca, Mg and possibly Fe for carbonate mineral formation. This paper presents the results from column experiments using two waste rocks: type 1 and type 2 from the Kiruna iron mine, Sweden. The main objective of the test is to understand reactions rates and conditions necessary to scale up these experiments.

Ten columns holding 5-6 kg of these waste rocks, including a column with actinolite rich material, have been running at ~18°C, for 6-15 months, with water flow rates (0.3-2 ml/min). The columns are continuously injected with 2-3 ml/min CO₂, except one control column. The two types of waste rocks have similar chemistry and mineral composition (plagioclase + actinolite + quartz + biotite + muscovite + calcite + pyrite ± aptite); however, type 2 waste rock has a significantly higher magnetite content. Water samples have been collected weekly for all columns and regularly analyzed for major cations and anions, alkalinity and pH.

The main sources of cations are actinolite and calcite. Calcium concentration is relatively high (250-100 mg/l), during the first months possibly due to calcite dissolution and later due to actinolite dissolution. Magnesium and iron is low and indicates secondary mineral formation. Type 2 waste rocks have a high neutralizing capacity, with pH slowly dropping from 8 to about 5.5-6. Element release rate for the control column (no CO₂) is 1-2 orders of magnitude less than the other columns, indicating that carbonic acid is a effective leaching agent. There is a moderate to strong positive correlation between Ca, Mg and K release rate and pH and HCO₃⁻. Mass loading depends upon flow rate; however there is higher element concentrations in column with a lower flow rate. Up to 70% of the calcium has been removed within the first 14 months of leaching.