Investigating geochemistry and the stable isotope (δ ^{18}O & δ ^{2}H) composition of Karde Carbonate lake water (NE Iran)

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Introduction

Karde dam's lake is a carbonate-precipitating and diamictic lake, which supplies irrigation and potable water for more than 4 million inhabitant of Mashhad city (NE Iran). In the following survey, Vertical (five depths 1, 5, 10, 15, 20) and temporal distribution of major cations and anions (especially nitrogen) in lakes water are investigated during 15 months (Jan 2010 to June 2011).

Results

The Calcite, Dolomite and Aragonite saturation index of lakes water and evaluation of Na, Mg, Ca concentration in lake, local ground water and rock samples in ternary diagram indicate that Na, Ca and Mg concentrations are mainly governed by incongruent dissolution of local carbonate (Mozdooran formation) and silicate (Neogen red formation).

Identification of dissolved minerals with ion activity (a) and $Log(aCa^{2+}/a(H^+)^2)$ versus $Log(aMg^{2+}/a(H^+)^2)$ graph for Carbonate minerals and $Log(aMg^{2+}/a(H^+)^2)$ and $Log(aCa^{2+}/a(H^+)^2)$ versus $Log(aNa^+/a(H^+)^2)$ for silicate minerals show that carbonate minerals "Calcite and Dolomite" and silicate minerals "Kaolinite, Laumontite and Clinochlore" are the dominate dissolved minerals within dam lake water. Vertical distribution of N in lake water shows significant increasing in NH_4^+ and NO_2^- concentrations with depth when the NO_3^- concentration decreases. Principal Component Analysis (PCA) of hydrochemical analyses revealed 3 components which explain 67% of the variance observed. In the first component, strong relationship between EC, TDS, Mg^{2+}, HCO_3^- and hardness reflect carbonate weathering. The variables in the second component are NH_3, NH_4^+, dissolved oxygen and depth. All the variables are directly related except dissolved oxygen which has inverse relationship with this component. This factor represents high Organic production in Karde dams' lake water. The third component shows relationships in the concentrations of Na^+, Ca^{2+}, SO_4^{2-} indicating the weathering of evaporative minerals especially gypsum ($CaSO_4$) and Glabuer's salt (Na_2SO_4) in the upper hand basin.

In the classical plot of δ ^{18}O vs δ ^{2}H, the isotopic signature of lake water samples (-6.82‰, -48.3‰) plot further to (LMWL) comparing to the local ground water (-8.21‰, -57.5‰) and upstream river (-8.7‰,-61.8‰) which appear to be controlled by evaporation loss of the lake water.

References

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Estimation of He diffusion coefficients in low permeability sedimentary rocks

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With a view toward establishing a deep geological repository for low- and intermediate-level radioactive waste, a geoscientific site characterization program has been conducted on the eastern margin of the Michigan Basin at the Bruce nuclear site. Drilling and collection of cores within an ~ 860 m near-horizontally layered Paleozoic sedimentary sequence, resting atop the Precambrian basement, has provided an opportunity for porewater and groundwater sampling and analysis with an unprecedented level of detail. This abstract presents a methodology for estimating diffusion coefficients for He in low permeability sedimentary rocks obtained from the drilling.

Drill core samples (76 mm diameter) of Ordovician shale and limestone were preserved in the field inside N_2-purged and vacuum-sealed bags; first polyethylene and then aluminized polyethylene. The samples were transported to the University of Ottawa where a sub core (6 mm diameter and ~ 20 mm long) was removed from the centre of the larger core and encapsulated in a stainless steel container at 1×10^{-2} Torr. Gas accumulating in the head space by room temperature (20 °C) diffusion was periodically sampled for He and Ne isotopic measurements using a MAPL 215-50 Noble Gas Mass Spectrometer. A typical experiment involved 5 gas measurements over a period of 24 hr. The measured He was corrected for air contamination using accompanying ^{20}Ne data. The time-series of He concentrations in the head space are treated as an out-diffusion experiment and numerical simulations were conducted to estimate the He diffusion coefficients by matching simulated out-diffusion profiles to the measured data. Simulations were conducted by running the reactive transport model MIN3P under the control of the parameter estimation code, PEST.

In general, there is a good match between the measured He data and the simulations (Fig. 1); D_p values ranging from 1 to 4×10^{-11} m²/s. However, samples from a 70 m interval that straddles the Blue Mountain Formation shale and the underlying Cobourg Formation limestone are an exception. This is a zone with high organic carbon content and the He release profiles suggest a delayed release of He – perhaps due to out gassing from an organic or petroleum phase.
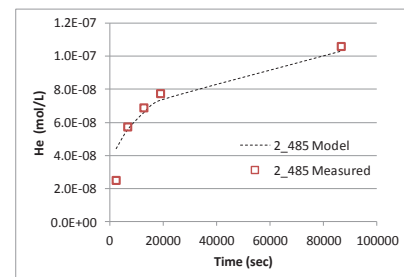

Figure 1. Example of He out diffusion showing measured He concentrations in the stainless steel container head space (open squares) and simulated out-diffusion profile indicating $D_p = 3.2 \times 10^{-11}$ m²/s.