

八郎潟干拓地における高濃度リン地下水中のリン酸濃度の時空間変動 Spatio-temporal variation of phosphate concentration at a high P concentration ground- water in the Hachirogata polder

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[Aim] The present study was conducted to elucidate spatio-temporal variation of phosphate (PO_4) concentration and the PO_4 release mechanism at a high PO_4 concentration groundwater in the Hachirogata polder, Akita, Japan.

[Materials and Methods] The study site was at a pristine wilderness area after the land reclamation in southwest part of the Hachirogata polder. Groundwater samples were collected once a month from December 2013 to December 2014 from seven groundwater wells at a depth of 3.1, 4.3, 5.6, 6.6, 12.4, 19.5, and 45.0 m, respectively. The 30 m (ϕ 5 cm) boring core sample was collected from near the wells in Feb. 2013. We measured water temperature, pH, and electrical conductivity (EC) using a pH/EC meter (D-54, Horiba, Kyoto, Japan) and measured oxidation-reduction potential (ORP) using a ORP electrode (D-55, Horiba) on site. The water samples were also filtered through a 0.45 μm membrane filter on site. The concentrations of PO_4 in the groundwater were determined using an autoanalyzer (QuAAtro2-HR, BLTEC, Osaka, Japan). The fresh boring sediment was extracted twice with distilled water (soil:water, 1:2.5 for pH and 1:5 for EC), and pH and EC of in the extract were determined using pH/EC meter (LAQUA F-74BW, Horiba). Water soluble P were determined using an autoanalyzer (QuAAtro2-HR, BLTEC, Osaka, Japan). Sediment samples were digested with a combination of $\text{HF-HNO}_3\text{-HClO}_4$ acids in Teflon beakers at 180 $^\circ\text{C}$ and element concentration in solutions were determined by ICP-OES (iCAP 6000, Thermo Fisher Scientific).

[Results and Discussion]

TP content in sediments increased in clay and silt layers while PO_4 content increased in sandy layers. This indicated that clay and silt layers were a P sink/source and released PO_4 was moving in sand layers. Sediment EC increased in clay layer and drastically increased from 21 m deeper layer likely influenced by sea water. Groundwater ORP showed a moderately reducing (-113 ± 42 mV) environment in all the wells. PO_4 concentration in groundwater was ranged from 5.7 to 18.2 mg L^{-1} , and the highest concentration was observed at the well of 6.6 m depth (18.2 ± 0.7 mg L^{-1}) at sandy layer, the second was at the well of 12.4 m depth (10.2 ± 0.9 mg L^{-1}). Positive correlation was observed between PO_4 and F^- concentrations in groundwater ($r = 0.96$, $P < 0.01$, $n = 7$), indicated fluorapatite would be a PO_4 source. At the well of 6.6 m depth, Cl^- concentration was the lowest (29.8 ± 2.9 mg L^{-1}) value and was similar to the lake (Lake Hachiro) water (20.6 mg L^{-1}), suggesting that freshwater was preferentially flowing into the land through groundwater around the depth. At the well of 6.6 m depth that had little fluctuation of water qualities all year round, Na^+ , bicarbonate and carbonate ion were higher but Ca^{2+} concentration was lower compare to other wells. At the well of 12.4 m depth that had a large fluctuation of water qualities, PO_4 , pH, Na^+ , bicarbonate and carbonate ion, and Fe increased while Ca^{2+} and ORP decreased when Cl^- concentration decreased from 72 to 33 mg L^{-1} during May to Oct. 2014. These phenomena indicated PO_4 release induced likely by Na-saturated sediment might be due to release of P associated with oxide surfaces or to dissolution Ca-P at clay layer by increasing pH and dissolution of CaCO_3 (from shell) by inflowing freshwater to the groundwater.

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