IS THERE DENITRIFICATION IN LONG ISLAND GROUND WATER?

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Introduction

Ground water provides drinking water for more than one-half of the people in the United States. However, this important national resource is vulnerable to contamination. Nitrate is soluble in water that can pass through soil to the water table and persist in shallow ground water for decades. Major sources of nitrate in watersheds of the U.S. include fertilizers, animal manure, sewage and atmospheric deposition. Elevated concentrations of nitrate in drinking water are a cause for concern. Ingestion of nitrate by infants can cause low oxygen levels in the blood, a potentially fatal condition. Other adverse health effects potentially related to ingestion of nitrate in drinking water include spontaneous abortions and non-Hodgkin's lymphoma. The U.S. Environmental Protection Agency (USEPA) has set a maximum contaminant level (MCL) of 10 mg/L nitrate as nitrogen (N) in drinking water (U.S. Environmental Protection Agency, 1995). According to Suffolk County Water Authority (SCWA), 66% of supplying wells in Suffolk County are rated as having a high or very high susceptibility for nitrate contamination and 23% have median susceptibility. Only 10% of wells have low susceptibility for nitrate contamination. Reduced contaminant ratings in the central and eastern parts of Suffolk County are due primarily to lower population densities.

An important consideration in calculating the susceptibility of nitrate contamination is to what extent denitrification, the breakdown of nitrates to nitrogen gas, may be occurring in Long Island's groundwater. Oxygen and nitrogen isotope data for groundwater from the Northport area (Bleifuss et al., 2000) and also in other parts of Long Island (Leamond et al., 1992; Stackelberg, 1995) suggest that denitrification is not an important process. In this study we are looking at Eh-pH diagrams to evaluate the potential for denitrification in Long Island groundwater.

Methods

Denitrification means the gaseous loss of nitrogen by either biological or chemical mechanisms. Denitrification is more likely if there is high organic matter in the soils, low oxygen concentration and neutral or even alkaline pH. Eh represents the oxidizing character of the groundwater. The lower the Eh value, the higher potential there is for denitrification. Previous research (Langmuir, 1997) suggests that the calculated Eh based on NO_3^-/NH_4^+, NO_3^-/NO_2^- and NO_2^-/NH_4^+ redox pairs generally gives a higher Eh as compared to field measurements on the same sample (Fig. 1). The Eh calculated on the basis of dissolved on oxygen is significantly greater than the measured value. The Eh based on the NO_3^-/NO_2^- pair gives a somewhat higher value, the NO_2^-/NH_4^+ a less high value, and the NO_3^-/NH_4^+ pair gives a value closer to that of the field measurements but usually higher than the field measurements (Fig. 1).

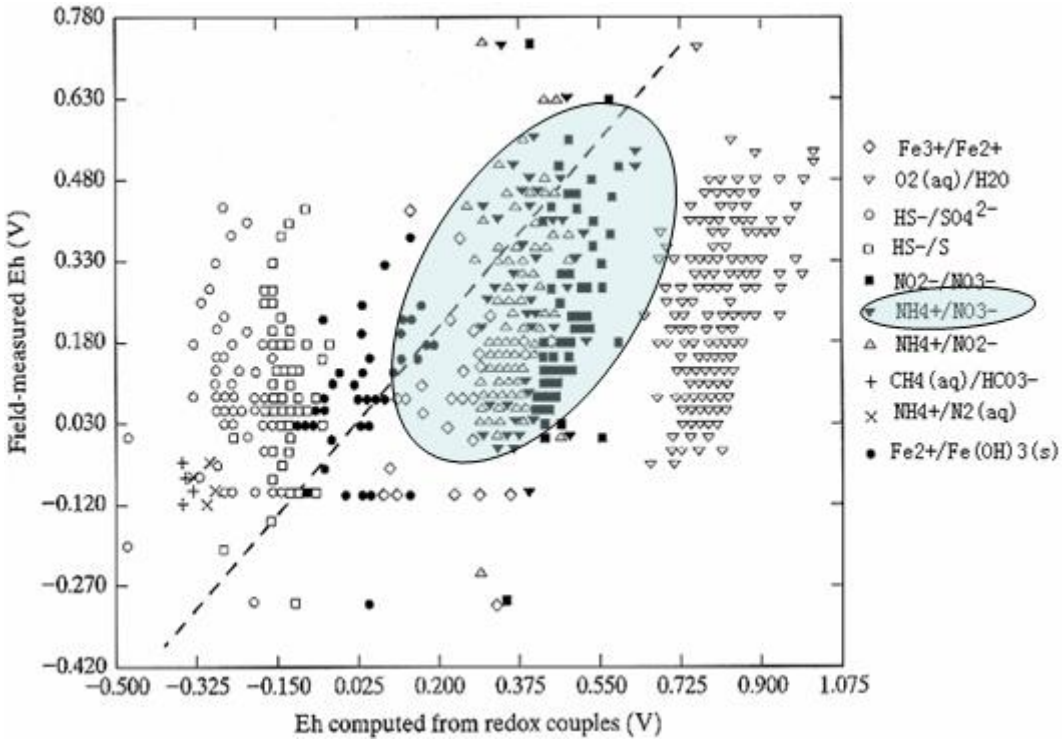

Fig. 1. Comparison of field-measured groundwater Eh value and potentials computed from the concentration of individual redox couples. The field includes most of the Eh values based on the NO_3^-/NH_4^+ pair. From Langmuir (1997)

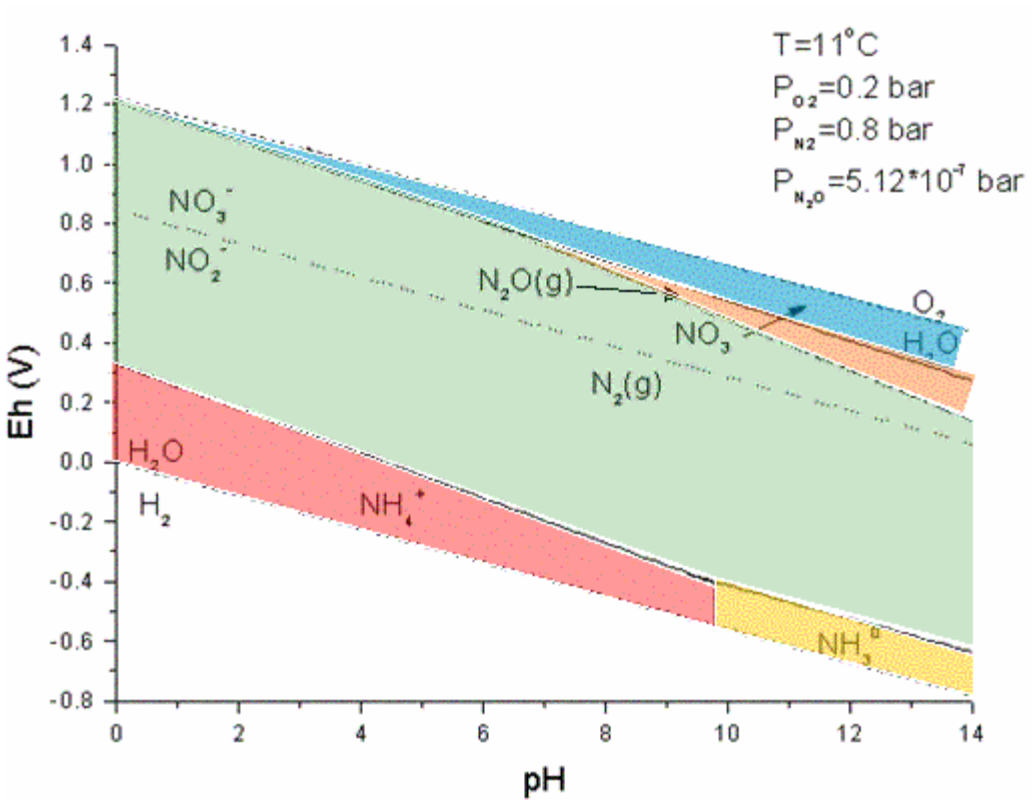

Fig. 2 Fields of the nitrogen species on an Eh-pH diagram. The boundary for the NO_3^-/NO_2^- pair occurs in the nitrogen gas field. There is no stability field for nitrite. In most reactions nitrate first converts to nitrite before converting to gaseous nitrogen.

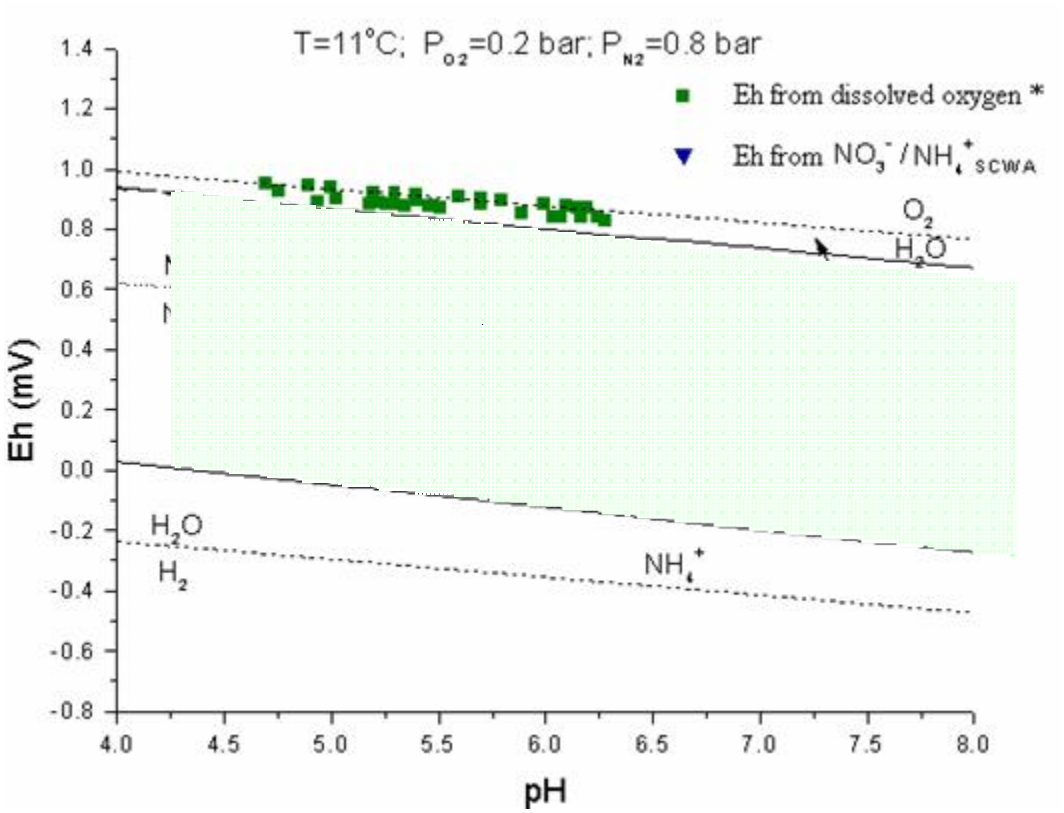

Fig 3. Eh-pH diagram with a more restricted pH range than that shown in Fig. 2 with the calculated Eh based on NO_3^-/NH_4^+ for SCWA groundwater data and for dissolved oxygen for SCWA water in the Northport area (Bleifuss et al, 2000). The nitrogen gas field is shown in light green.

Results

We calculated the Eh of Long Island ground water based on the NO_3^-/NH_4^+ pair for SCWA groundwater data (Fig 3.). All the data lie within the stability field of N_2, well below the stability field of NO_3^- and near the NO_3^-/NO_2^- boundary. The data may lie near this boundary because NO_3^- must usually first be converted to NO_2^- before it is converted to N_2 gas, which means there is a potential for denitrification in Suffolk County groundwater. We also put the calculated data for dissolved oxygen on the Eh-pH diagram (Fig 3.) which cluster around the higher stability limit of O_2/H_2O. These results are consistent with those shown in Fig. 1 (Langmuir, 1997). These data suggest that there is potential for denitrification in Long Island's groundwater, but they do not allow us to evaluate whether there is denitrification or the extent of any such denitrification.

References Cited

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