

Application of Stoichiometric method in the assessment of groundwater chemistry in a coastal region having complex contamination sources

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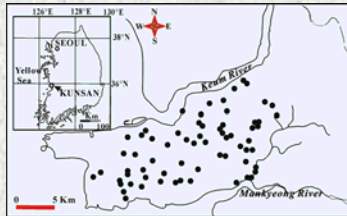
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ABSTRACT

Groundwater chemistry in a coastal region having complex contaminant sources was investigated. Water analysis data for 197 groundwater samples collected from the uniformly distributed sixty-six wells were used. Due to the complexity of groundwater chemistry, the samples were classified into four groups based on Cl and NO₃ concentrations and were evaluated based on the reaction stoichiometry. The results explained the importance of mineral weathering, anthropogenic activities (nitrification and oxidation of organic matters), and Cl-salt inputs (seawater, deicer, NaCl, etc.) on groundwater chemistry. It was revealed that mineral dissolution is the major process controlling the water chemistry of the low Cl and NO₃ group (Group 1). Groundwaters high in NO₃ (Groups 2 and 4) are acidic in nature, and their chemistry is largely influenced by nitrification, oxidation of organic matters and mineral dissolution. In the case of chloride rich waters (Group 3), groundwater chemistry is highly influenced by mineral weathering and seawater intrusion associated with cation-exchange reactions.

Study area

Fig. 1. A map shows the well location in Kunsan city, Korea. It has complicated land use characteristics, mainly consisting of agricultural, urban/residential, and forest areas.



Groundwater groups and geochemical process

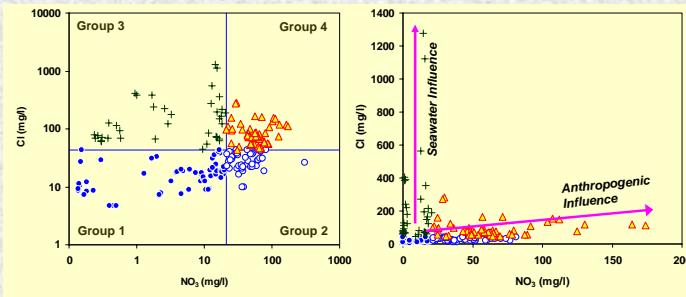


Fig. 2. Groundwater samples were classified into four groups

Anthropogenic contamination

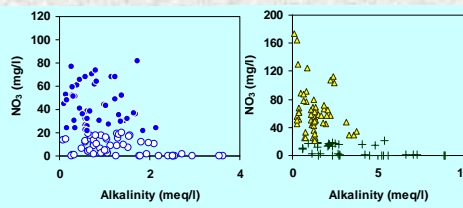


Fig. 3. The negative relationship between alkalinity and nitrate indicates that high concentrations of nitrate in Groups 2 and 4 might be derived from ammonium oxidation and/or aerobic decomposition of organic matter.

Mineral weathering

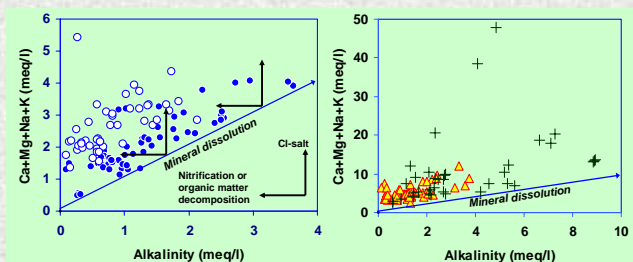


Fig. 4. Group 1 samples are plotted most closely to the 1:1 mineral dissolution line and imply that dissolution of minerals is the most important chemical process for Group 1 (Kim, 2003).

Stoichiometric assessment for the chemical processes

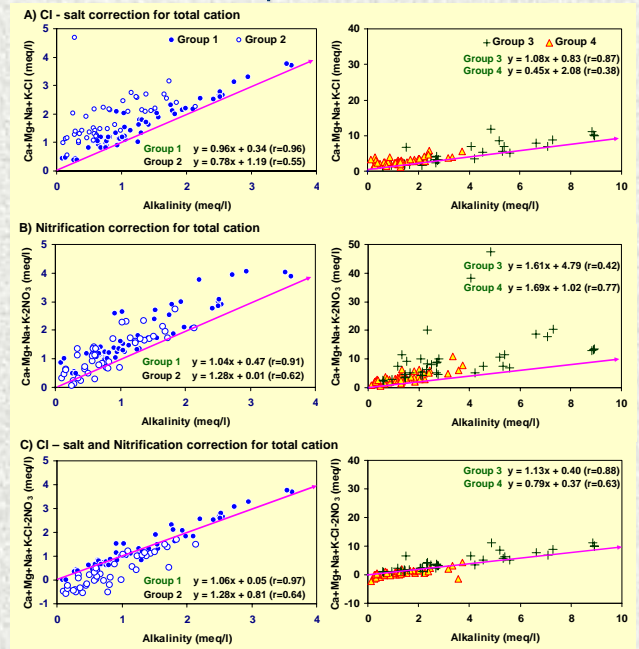


Fig. 5. Plots of total cation corrected for Cl-salts (a), nitrification (b), and Cl-salts and nitrification (c) with respect to alkalinity. The shaded lines in the figure represent the stoichiometric relation for mineral dissolution.

Table 2. Calculation results for the contributions of various chemical processes to the concentrations of total cation and nitrate. Units = meq/l

	Total Cation			Nitrate		
	Cl-salt	Mineral weathering	Total	Nitrification	Oxidation of organic matter	Total
Group 1	0.49±0.28 (25±13%)	1.61±0.83 (75±13%)	2.09±0.90	0.07±0.08 (71±40%)	0.06±0.09 (29±40%)	0.12±0.11
Group 2	0.83±0.25 (33±11%)	1.76±0.61 (67±11%)	2.59±0.69	0.20±0.18 (32±29%)	0.52±0.33 (68±29%)	0.71±0.28
Group 3	5.95±7.53 (50±20%)	4.65±2.97 (50±20%)	10.60±9.16	0.10±0.12 (80±39%)	0.15±0.81 (20±39%)	0.26±0.80
Group 4	2.56±1.36 (48±12%)	2.68±1.02 (52±12%)	5.24±1.82	0.37±0.31 (42±33%)	0.64±0.56 (58±33%)	1.01±0.53

Conclusion

- The stoichiometric analysis results suggested that groundwater chemistry in the study area is controlled by mineral dissolution, oxidation of ammonium and organic matters and seawater intrusion associated with cation exchange reactions.
- Mass balance approach based on the reaction stoichiometry is a useful tool for the geochemical assessment of groundwater in the area having complex contamination sources.

References

- Kim K (2003) Long-term disturbance of ground water chemistry following well installation. Ground Water 41:780-789.

Acknowledgements

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