Evaluation of geochemical processes affecting groundwater chemistry in Namwon, Korea

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ABSTRACT

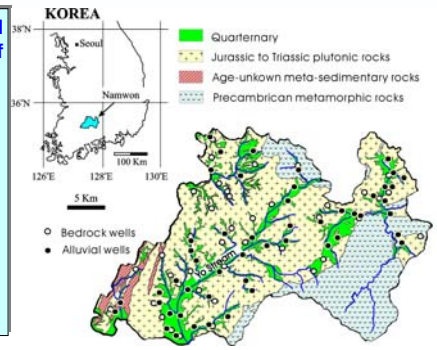
Groundwater chemistry in Namwon area, Korea, was investigated to understand the contribution of geochemical processes on groundwater chemistry. For this study, a total of 279 groundwater samples were collected from 93 wells distributed over the study area. The concentrations of nitrate, chloride, and sulfate indicate the significant influence of anthropogenic activities on groundwater chemistry in this region. Higher concentrations of major ions are generally encountered in the shallow alluvial wells, suggesting that these chemicals are originated from the surface contamination sources. Mass balance analysis based on reaction stoichiometry reveals that the water chemistry is regulated by three major chemical processes: weathering of silicate/carbonate minerals, input of Cl/SO_4 salts, and nitrate generating processes. The results show that mineral weathering is the most dominating factor regulating the groundwater chemistry. However, the groundwaters with the higher salt concentration indicate the larger mineral weathering effect, suggesting that some part of the mineral weathering effect is also associated with the anthropogenic activities due to limes applied to the cultivated lands and/or carbonates ($CaCO_3$) in the cement materials.

Fig.1. Map shows the well location and geology of the study area.

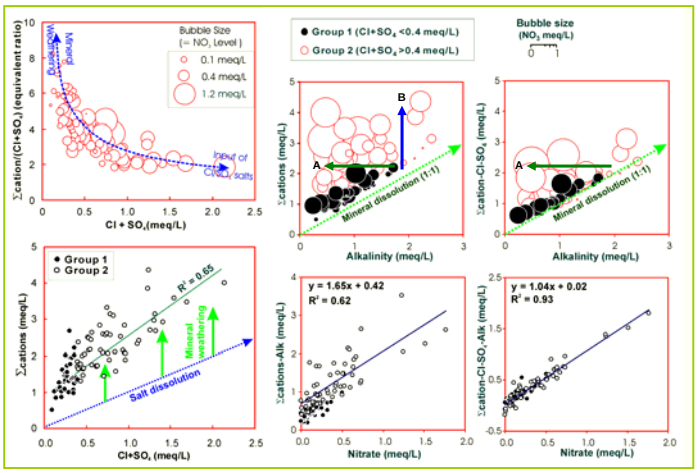
- Area = 753 km^2
- Total wells = 93
- Bedrock wells = 44
- Alluvial wells = 49

Land use

- Forest – 65 %
- Agriculture – 23%



Geochemical processes



- **Fig. 2 explains the various geochemical processes regulating the groundwater chemistry in the study site.**
- **The water chemistry of the study site is regulated by three major processes: Dissolution of carbonate and silicate minerals, Nitrate generating processes (Arrow 'A') and Cl+SO_4 salt input (Arrow 'B').**
- **Mineral weathering is the most dominant process controlling the water chemistry in the study area.**
- **The contribution of Cl+SO_4 salts to the total cation in the alluvial wells or Group 2 wells are generally higher than those in the bedrock wells or Group 1 wells.**
- **The alkalinity consumptions by the nitrate generating processes (oxidation of ammonium and/or organic matters) are generally higher in alluvial wells or Group 2 wells than the bedrock wells or Group 1 wells.**

Mass balance approach

Mineral weathering (MW) = Σcation–Cl-SO_4 (meq/l)
(=Alkalinity from mineral weathering)

Cl/SO_4 salt = Cl+SO_4 (meq/l)

Alkalinity consumed by nitrate generation (NG)
= (Σcation-Cl-SO_4)-Alkalinity (meq/l)

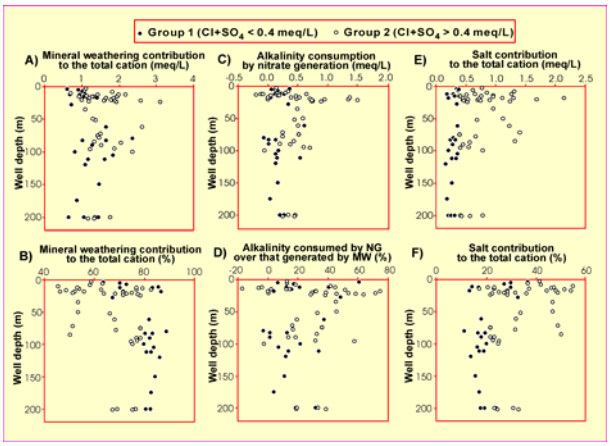


Fig.3. Contribution of various geochemical processes on water chemistry as a function of well depth.

Conclusion

- **The water chemistry of the study site is regulated by three major processes: Dissolution of carbonate and silicate minerals, Nitrate generating processes and Cl+SO_4 salt input.**
- **Mineral weathering is the dominant processes and explains 72 % (mean) of the total major cations dissolved in groundwater.**
- **The effects from Cl/SO_4-salt input and nitrate generating processes are generally significant in the shallow groundwaters.**
- **A simple mass balance analysis based on reaction stoichiometry is a good tool for geochemical studies.**

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