GEOCHEMISTRY OF QUATERNARY AQUIFERS OF SRI LANKA; A STUDY FROM NORTHWESTERN COASTAL AREA

J.P. Jayasingha, H.A. Dharmagunawardhane and A. Pitawala

Department of Geology, Faculty of Science, University of Peradeniya

Introduction

Northwestern coastal belt of Sri Lanka is characterized by unconfined shallow sandy aquifers which are of Quaternary to Recent age. Due to high population, agricultural practices and less availability of potable surface water in the area, the demand for the groundwater is very high. Although the nutrient pollution of the groundwater of the area was studied (Lawrence *et al.*, 1986; Liyanage *et al.*, 2000), the chemical characteristics and vulnerability of aquifers have not yet been understood properly. This study therefore was aimed to understand the geochemical evolution and possible causes for deterioration of groundwater of the area.

Materials and Methods

Fifty eight (58) groundwater samples of shallow tube wells and dug wells collected from Kalpitiya Peninsular were analyzed for cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Fe^{3+} and Mn^{2+}) and anions (NO_3^{-}, PO_4^{-3}, Cl^{-}, SO_4^{2-} and HCO_3^{-}) using standard analytical techniques. Parameters such as electrical conductivity, pH, salinity, turbidity, temperature and total dissolve solid (TDS) were measured during sampling. Dissolved cations of water samples were measured on Perkin Elmer atomic absorption spectrophotometer and all the anions were measured using HACH DR/2400 spectrophotometer within 48 hours of sampling at the Department of Geology, University of Peradeniya. Data were statistically analyzed by using Pearson Correlation method.

Results and Discussion

Based on the chemical data, the groundwater of the area can be categorized into three different groundwater facie: the dominant Na-Ca- HCO_3- SO_4-Cl facies and Na –Ca - HCO_3 facies. The Na –Ca - SO_4 -Cl facies, though present, is not significant.

Elevated levels of nitrate in groundwater were recorded from intense agricultural areas. The positive correlation of nitrate with K^{+}, Ca^{2+} and Mg^{2+} indicates that agricultural practices may have released these cations into the groundwater other than those accumulated from the aquifer media. Unlike nitrate values, phosphate concentrations of analyzed samples do not show any relationship with the agricultural practices.

The aquifers in the area have very low amounts of carbonate materials as their constituents. Bicarbonate also show strong negative correlation with Ca^{2+} and nitrate ($r = -0.9$ and -0.81). Therefore, it can be assumed that the origin of the bicarbonate might mainly be a result of the dissolution of CO_2 from the atmosphere and root zone respiration with aquifer water during the irrigation and raining. Sulfate content in water is positively

correlated with Mg^{2+}, K^{+}, $Ca^{2+}$and Na^{+} (r = +0.74, +0.78, +0.81 and +0.71) and anions such as NO_3^- and Cl^- (r = +0.72 and +0.75) concentrations of water. Therefore, it can be suggested that the accumulation of sulfate in aquifer water may have been resulted from fertilizer application, sea salt sprays and decaying of organic matters. Chloride which was recorded in low concentrations has a significant positive correlation with Na^{+} (r = +0.93). This relationship indicates that the origin of both ions in groundwater should be the same source and possibly from sea salt sprays.

The pH of water in the area is neutral (varies between 6 and 8). The pH does not show any correlation among other parameters. Salinity shows significant positive correlations with Cl^-, SO_4^{2-}, $Ca^{2+}$and Mg^{2+}. (r = + 0.90, + 0.76, +0.84, and + 0.78). However, low salinity levels indicate that the impact of salt water intrusion on groundwater bodies of the area is not considerable.

Conclusion

The dominant water type of the area has been evolved from mixing of two end facies of Na^{+}-Ca^{2+}- HCO_3^- and Na^{+}-Ca^{2+}- SO_4^{2-}-Cl^-. The nutrient contamination of studied groundwater due to the agricultural activities is considerably high. The concentrations of most of other ions also depend on anthropogenic activities and sea sprays.

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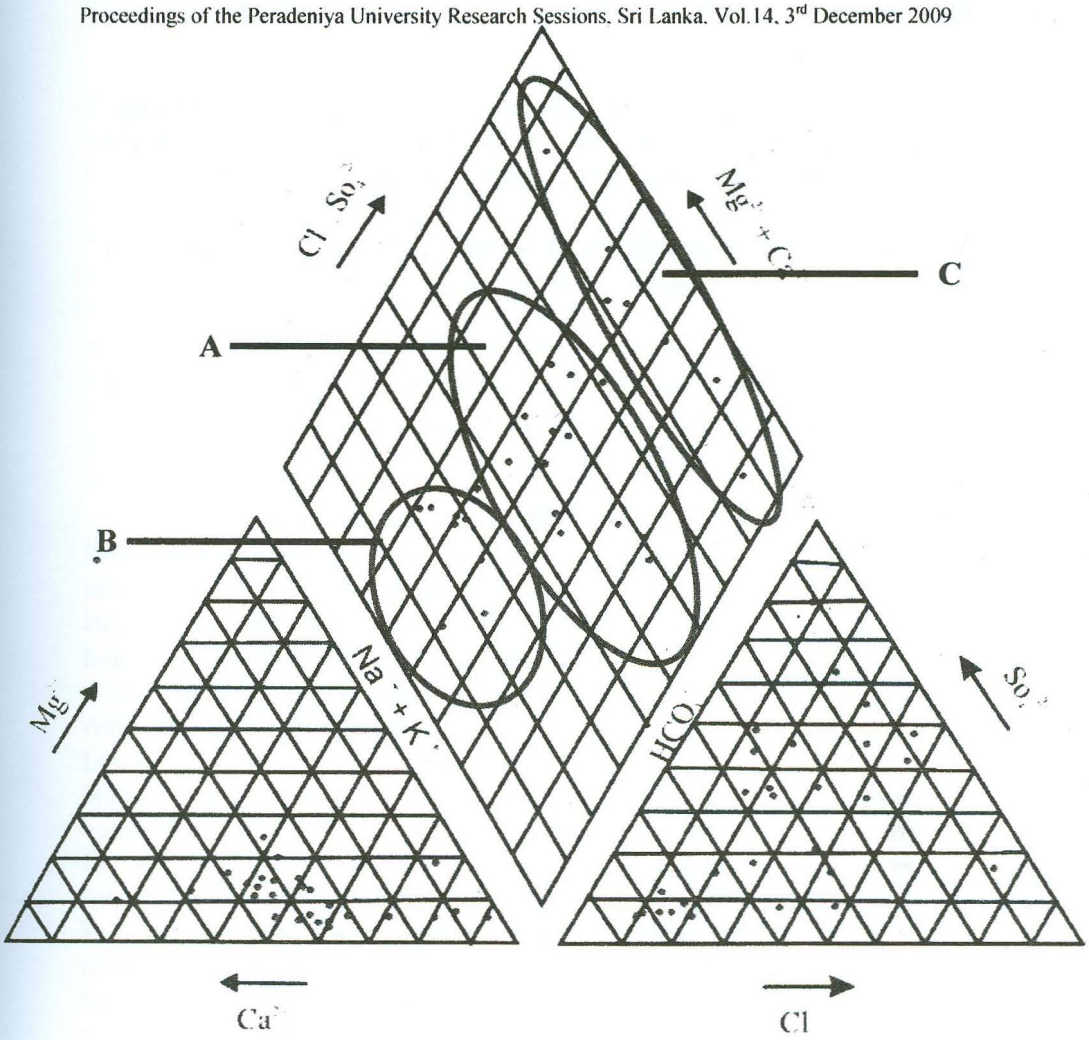

Figure 1. Piper diagrams showing different water types of the area, A- Na-Ca- HCO_3- SO_4-Cl facies, B- Na-Ca-HCO_3 facies and C- Na-Ca-SO_4-Cl facies

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