The Use of Ammonium and Trace Metals in Identifying Low Redox Environment Zone at Indonesian Coastal Alluvial Groundwater

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Reduction and oxidation (redox) conditions in the aquifer are essential factors; those can determine the behavior of chemicals in the groundwater system. Nowadays, researches concerning the low redox (reduction) environment are growing significantly since some pollutions occur under this condition. The study was taken place in Indramayu, Indonesia. The area is an alluvial plain located on the North Coast of West Java Island. The groundwater in the alluvial area is compelling to study because it has a large aquifer storage capacity but unfortunately vulnerable to contamination. Moreover, the contamination will get severe under reduction environment. The primary objective of this study is to understand groundwater vulnerability by identifying the reduction environmental zone in the study site.

In this research, we used combined chemical parameters: ammonium (NH_4^+-N), dissolve manganese (Mn^{2+}) and ferrous (Fe^{2+}), to trace reduction condition in the groundwater. NH_4^+-N is one form of nitrogen compound that usually arise under reduction condition. Other parameters that arise with the reduction process are Mn^{2+} and Fe^{2+}. Therefore, in this investigation, we assumed the use of NH_4^+-N, combined with the concentrations of Mn^{2+} and Fe^{2+} elements, are able to identify groundwater reduction environment.

Totally, there was ten soil taken from 2 boreholes located at the south and north of the research site and 20 water samples collected from groundwater (18) and river (2). The soil samples were analyzed for NH_4^+-N and C/N ratio parameters. These data were used to explain further about NH_4^+-N presence in groundwater. Additionally, the water samples were analyzed for NH_4^+-N, $Mn^{2+,}$ and Fe^{2+} concentrations. The aquifer materials consist of sandstone, claystone, and sandy claystone. The NH_4^+-N concentrations were ranged from 0.82 until 3.37 mg / L. However; there was no clear relationship between the soil’s depth and compositions with NH_4^+-N concentrations. The soil samples had low C/N ratios, with values of 8.00 to 12.19. This is indicating that N-organic in the soil potentially experiences mineralization, one that produces NH_4^+-N. Furthermore, NH_4^+-N in water samples were detected as the dominant nitrogen form at most sites. Similarly, Mn^{2+} was detected at almost all locations. Moreover, the concentrations of Mn^{2+} were high (> 0.05 mg / L), around 0.07 - 12.8 mg / L, at 16 locations. High concentrations of Fe^{2+} (> 0.3 mg/L), were found in groundwater at 6 locations. The concentrations were ranged from 1.39 to 9.91 mg/L. The presence of NH_4^+-N along with high Mn^{2+} contents indicated that almost all locations experienced reduction condition at a zone of manganese reduction. Moreover, at 6 locations, the reduction process was stronger and lead to becoming ferrous zone. This was shown by NH_4^+-N existence as dominant nitrogen form and high concentrations of Fe^{2+} as well as Mn^{2+}.

Keywords: Ammonium, Manganese, Ferrous, Reduction, Coastal Groundwater, Indramayu

