Chemical characteristics of Phu Kradueng sandstone leaching in Khon Kaen Province

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Abstract

Khon Kaen Province is located on the Khorat group of which Khok Kruat and Phu Kradueng Formations obtain groundwater from fractures or cracks and most of locals use groundwater for consuming. The aim of this experimental study is to analyze chemical characteristics of Phu Kradueng sandstone leaching. Rock samples are collected in Nong Ruea District, Khon Kaen Province. Chemical characteristics of these sandstone cover the experimental study under acidity-base and temperature change conditions, titration, total dissolved solid (TDS), atomic absorption spectrophotometry (AAS) and evaluated by AquaChem software program. The dominated major ions results found are sodium (Na^+), Potassium (K^+), chloride (Cl^-), and bicarbonate (HCO_3^-) ions. The sodium ion is mostly found in 3 types of experiment. Potassium ions are found very high in 4ºC to 8ºC and 25ºC leaching. Chloride and bicarbonate ions are principally discovered. Heavy metals of iron (Fe), zinc (Zn), and manganese (Mn) are obtained in the range of 0.30-12.17, 0.005-0.128, and 0.02-0.72 mg/L, respectively. However, they are found less: cadmium (Cd), chromium (Cr), and copper (Cu). All samples in the experiment are presented high concentrations of iron. Chemical speciation relates to major cations and anions are evaluated by Piper diagram as shown in the chemical characteristics of this study present two water types of (1) Na-K-HCO_3-Cl (or K-Na-HCO_3-Cl) and (2) Na-Cl-HCO_3 and graphical diagrams of chemical processes in Durov diagram present dominated by Ca and HCO_3 ions in this study.

Keywords: Chemical characteristics, Phu Kradueng sandstone, Khon Kaen Province.

1. Introduction

Northeastern of Thailand is located on the Khorat group (Ward & Bunnag, 1964) and it has ability to be aquifers. They are divided into 2 groups: 1) aquifers from sediment deposits consist of Phu Phan, Mahasarakham and Phu Thok Formations and 2) aquifers obtained from fractures or cracks, which are Khok Kruat and Phu Kradueng Formations (Lertsirivorakul, 1999). They are mainly composed of sandstone, siltstone and shale.

Khon Kaen Province is a densely populated with a growing economy (Department of mineral resources, 2009). Therefore most of the groundwater in Khon Kaen Province is confined in fractures and cracks in the rocks (Srisuk & Lertsirivorakul, 1984). As a result, Khok Kruat and Phu Kradueng Formations are suitable for the experimental study. The leaching of rocks affects to acidity-base and solubility cause ion exchange in nature and occurs to change type of groundwater (Deju, 1971) and temperature change also affects the water absorption of sandstone (Lu et al., 2017).

The objective is to study chemical characteristics of Phu Kradueng sandstone leaching.

2. Study area

The sampling area is located in Nong Ruea and Chum Phae District, Khon Kaen Province, Thailand. It covers around 690 km^2. Their neighboring Districts are Phu Wiang, Ubolratana and Ban Fang.

3. Methodology

Methodology is related to the experimental study and chemical analysis in laboratory consisting of titration, total dissolved solids (TDS) and Atomic Absorption Spectrophotometry (AAS). Data evaluation is applied to AquaChem software program as described below.

3.1 The experimental study

The experimental study is composed of testing under acidity-base and temperature change condition. Condition of study are use demineralized water (pH 5.5 and pH 7.0) at 4-8ºC, 25ºC and 75-80ºC.

3.2 Titration and total dissolved solids (TDS)

Major anions comprise carbonate (CO_3^{2-}), bicarbonate (HCO_3^-) and chloride (Cl^-) used titration technique. Total dissolve solid (TDS) is analyzed by evaporating in a weighed dish and being dried to constant weight in an oven at 103-105ºC.

3.3 Atomic Absorption Spectrophotometry (AAS)

Major cations consist of sodium (Na^+), magnesium (Mg^{2+}), Potassium (K^+) and calcium (Ca^{2+}) and heavy metals are composed of Iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), cadmium (Cd), and chromium (Cr) which are determined by atomic absorption spectrophotometry (AAS) , 3300 Perkin Elmer, USA.

4. Results

The results of the study show that chemical characteristics of Phu Kradueng sandstone leach in Nong Ruea District, Khon Kaen Province. Additionally the chemical characteristics are apply to determine major ions and heavy metals which do the experiment by chemical analysis. So, they are divided class of the water type by AquaChem software program.

4.1 Chemical characteristics

The analytical results of Phu Kradueng sandstone leaching are composed of the total dissolved solids (TDS) in the range of 80-250 mg/L and major ions. Major cations consist of sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), and calcium (Ca^{2+}) as indicated in Figure 1. Major anions comprise chloride (Cl^-), carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-). The analytical results of minor parameters are iron (Fe), manganese (Mn) and zinc (Zn). These following heavy metals are found less: cadmium (Cd), chromium (Cr), and copper (Cu) as shown in Figure 2.

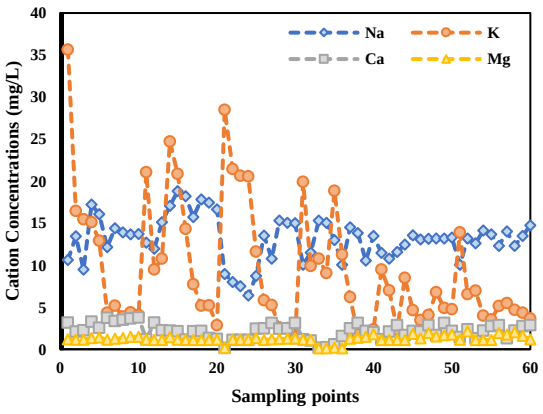

Figure 1. Concentrations of major cations.

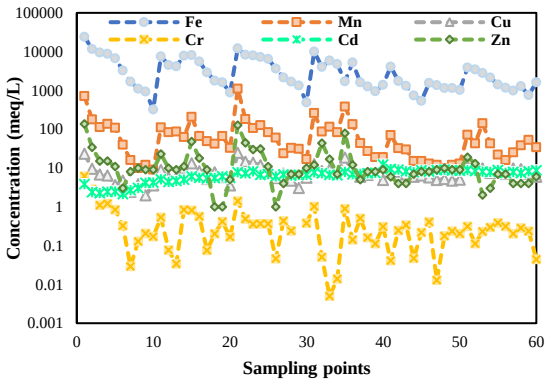

Figure 2. Concentrations of heavy metals.

Class of the water type of this study is indicated by plotting concentrations of major cations and anions in the Piper trilinear diagram. The chemical characteristics in the study area present two water types of (1) Na-K-HCO_3-Cl (or K-Na-HCO_3-Cl) and (2) Na-Cl-HCO_3 as indicated in Figure 3. The major cation and anion concentrations of the samples are plotted on a Durov diagram in Figure 4. Durov diagram benefits the interpretation of the evolutionary trends and the hydrochemical processes occurring in the groundwater system and it can indicate mixing of different water types, ion exchange, and reverse ion exchange processes.

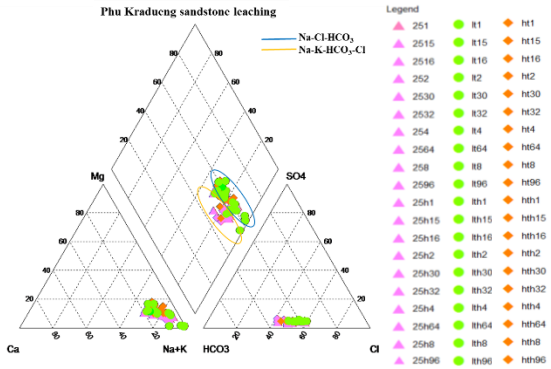

Figure 3. Chemical speciation of Phu Kradueng sandstone in Piper trilinear diagram.

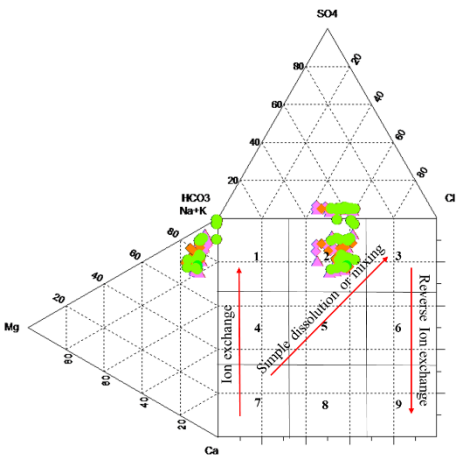

Figure 4. Chemical speciation of Phu Kradueng sandstone in Durov diagram (Lloyd & Heathcoat, 1985).

5. Discussions and conclusion

The dominated major ions in experimental study are sodium (Na^+), Potassium (K^+), chloride (Cl^-), and bicarbonate (HCO_3^-) ion. However, the sodium ion is mostly found in the range of 6.39-18.81 mg/L. The potassium ions are found very high in 4ºC to 8ºC and 25ºC leaching. The chloride and bicarbonate ions are principally discovered. Heavy metals of iron (Fe), zinc (Zn), and manganese (Mn) are analyzed and obtained the results in the range of 0.30-12.17, 0.005-0.128, and 0.02-0.72 mg/L, respectively. These following heavy metals are found less: cadmium (Cd), chromium (Cr), and copper (Cu). All samples in the experimental study present high concentrations of iron and over the groundwater quality standard (Ministry of Industry, 1997).

Chemical speciation relates to major cations and anions. Piper diagram shown the chemical characteristics of this study present two water types of (1) Na-K-HCO_3-Cl (or K-Na-HCO_3-Cl) and (2) Na-Cl-HCO_3. Graphical diagrams of chemical processes shown in Durov diagram present the domination of Ca and HCO_3 ions in this study.

6. References

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