

EFFECT OF pH AND PARTICLE SIZE ON THE
SOLUBILITY OF COPPER AND ZINC
IN RIVER SEDIMENTS

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IJAZAH: SARJANA MUDA SAINS DENGAN KEPUJIAN (KIMIA INDUSTRI)

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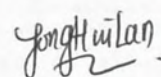
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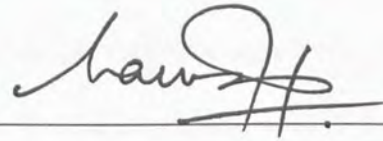
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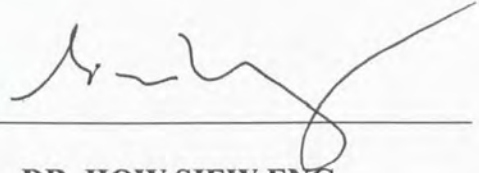
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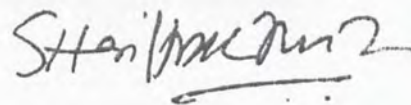
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ABSTRACT

This study was conducted to determine the effect of pH and particle size on the solubility of copper (Cu) and zinc (Zn) in river sediments. The sediment samples were collected from Bambang River and Mentaki River in Ranau and divided into three fractions according to particle size: $X \leq 0.25$ mm, $0.25 < X \leq 0.5$ mm and $0.5 < X \leq 1.0$ mm. Each fraction was extracted using aqueous solutions with pH ranging from 2.0 to 6.0, and also digested in concentrated nitric acid. The concentrations of Cu and Zn extracts and digests were analyzed using atomic adsorption spectrophotometer (AAS). The results showed that the solubility of Cu was the highest compared to that of Zn, which was 34.45 $\mu\text{g/g}$ obtained at pH 2 and particle size of ≤ 0.25 mm. The solubility of Cu and Zn increased as the pH and particle size decreased. The amount of soluble Cu and Zn were very low compared to the total concentration. The observed solubility of Cu and Zn in the sediment were under saturated with respect to the solid phases of CuO, Cu(OH)₂ and CuCO₃ and ZnO, Zn(OH)₂ and ZnCO₃.



**KESAN pH DAN SAIZ PATIKEL KE ATAS KELARUTAN
LOGAM KUPRUM (Cu) DAN ZINK (Zn)
DALAM SEDIMEN SUNGAI**

ABSTRAK

Kajian ini dijalankan untuk menentukan kesan pH dan saiz partikel ke atas keterlarutan logam kuprum (Cu) dan zink (Zn) dalam sedimen sungai. Sampel-sampel sedimen diperolehi dari sungai Bambang dan sungai Mentaki dari Ranau dan dibahagikan kepada tiga fraksi mengikut saiz partikel, iaitu ≤ 0.25 mm, $0.25 < X \leq 0.5$ mm and $0.5 < X \leq 1.0$ mm. Setiap fraksi diekstrak dengan larutan akueus dari pH 2 hingga pH 6 dan juga dihadam dengan asid nitrik pekat. Kepekatan logam Cu dan Zn dalam larutan ekstrak dan hasil penghadaman ditentukan dengan menggunakan spektrofotometer serapan atom (AAS). Hasil kajian ini menunjukkan bahawa kelarutan logam Cu adalah tertinggi berbanding dengan logam Zn iaitu 34.45 $\mu\text{g/g}$ yang diperolehi pada keadaan pH 2 dan saiz partikel ≤ 0.25 mm. Keterlarutan logam Cu dan Zn meningkat dengan penurunan pH dan saiz partikel. Namun logam Cu dan Zn yang terlarut adalah rendah dengan kepekatan jumlah. Nilai terlarut Cu dan Zn dalam sampel sediment didapati kurang tepu jika dirujuk kepada fasa pepejal mineral CuO , Cu(OH)_2 dan CuCO_3 serta ZnO , Zn(OH)_2 and ZnCO_3 .



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LIST OF SYMBOLS

%	Percentage
°C	Degree Celsius
g	Gram
mg	Milligram
mm	Millimetre
L	Litre
mL	Millilitres
mg/L	Milligram per litre
mol/L	Mol per litre
µg/g	Microgram per gram
µg/mL	Microgram per millilitre
>	More than
<	Less than
K _{sp}	Solubility product constant
K _d	Distribution coefficients
E _h	Redox potential
LogK°	Equilibrium constants
AMD	Acid Mine Drainage
AAS	Atomic Absorption Spectrophotometer



CHAPTER 1

INTRODUCTION

1.1 Relevance of Study

Sediments comprise of several components, including different mineral species as well as organic debris. Sediments represent one of the ultimate sinks for heavy metals discharged into the environment. More than 90% of the heavy metal load in aquatic systems is bound to suspended particulate matter and sediments. Therefore, sediments serve as a pool of metals that could be released to the overlying water and potentially cause adverse effects (Figueroa *et al.*, 2006).

Generally, heavy metals in solid phase (sediment) are in equilibrium with the metals in the solution phase. This equilibrium is dependent on several processes, namely adsorption, precipitation, desorption and dissolution. The significance of each process is dependent on several factors such as pH, redox potential (Eh) and temperature (Karshem and Singh, 2001).

The release of metals from the solid phase to solution phase is generally termed as mobilization. Mobilization of heavy metal in the solution is governed by two processes, namely desorption and dissolution. A change in pH will alters the



interaction between sediment components and subsequently affects metal distribution among sediment components (Yin *et al.*, 2001).

Heavy metals in sediments can be present in primary and/or secondary minerals (Wen *et al.*, 1998). The solubility of these metal-containing minerals is dependent on several factors including pH (Yin *et al.*, 2001) and Eh (Mansfeldt, 2004). For example, metal solubility decreased with increased pH and decreased Eh in the soil solution (Karshem and Singh, 2001). However, the actual solubility is dependent on the type of metal and type of mineral (Cappuyns *et al.*, 2007). In other words, the mobility of heavy metal can be dependent on the geochemical make-up of the sediment. Heavy metals can be distributed in various geochemical forms and particle sizes. The geochemical forms or fractions have varying solubility while the concentrations of heavy metals tend to increase as the grain sizes get finer (Singh *et al.*, 1999).

1.2 Objectives of Study

The objectives of this study were:

- a) To determine the effect of pH on the solubility of Cu and Zn from river sediments.
- b) To determine the effect of particle size on the solubility of Cu and Zn in river sediments.
- c) To compare the solubility of Cu and Zn in river sediments.
- d) To compare the observed solubility of Cu and Zn in the sediments with theoretical solubility of selected Cu and Zn minerals.



1.3 Scope of Study

This study focused on the solubility of two heavy metals, namely Cu and Zn, in sediments collected from 2 different river at Ranau, Sabah, namely Bambang River, Lohan River and Mentaki River. The main factors investigated were pH and sediment grain sizes. The concentration of Cu and Zn in solutions filtrates were analysed using Atomic Absorption Spectrophotometer (AAS). Subsequently, the observed Cu and Zn concentrations in the solutions were compared with the calculated solubility of selected Cu and Zn minerals to determine whether the selected mineral control the solubility of Cu and Zn in the sediments.



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