MINERALOGY AND SEDIMENT DISTRIBUTION BASED ON GRAIN SIZE ANALYSIS IN THE KAPUAS AREA, CENTRAL KALIMANTAN

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ABSTRACT

The Kapuas region of Central Kalimantan is notable abundance of heavy minerals, which are sourced from the Schwaner Mountains. These mountains are characterised by a diverse range of igneous and metamorphic rocks, which have been identified as a significant source of heavy mineral-producing rocks. The aim of this study was to determine the sediment grain size distribution and the presence of heavy minerals in the study area. Sediment sampling locations were carried out at four points using shallow drilling techniques, specifically hand drills. The research methods used include grain size granulometry analysis and grain count analysis using polarized microscopy. The results showed that the grain size within the study area ranged from coarse sand to fine sand. The observed sediment transport mechanism is bedload for coarse sediments and suspension for fine sediments. The mineralogical composition of the sediments in the study area contains heavy minerals including rutile, ilmenite, cassiterite, biotite, hematite, zircon and chalcopyrite. The mineralogical composition of the sediments reflects the origin of the source material which ranges from intermediate igneous and metamorphic rocks. This suggests that the region has experienced a complex and dynamic geological history.

Keyword: Grain Size, Granulometric, Sediment Distribution, Mineralogy, Heavy Minerals, Kapuas

1. INTRODUCTION

Central Kalimantan is one of the islands in Indonesia that is rich in geological resources, especially those related to heavy minerals in alluvial placer deposits (Setijadji et al., 2014). The Kapuas area located in Central Kalimantan Province is composed of metamorphic and granitic rocks that are part of the Sepauk Tonalite which plays a role in the formation of quartz sand rich in heavy minerals (Herman, 2007). The process of weathering and erosion of mineral-rich igneous rocks, followed by uplift through river systems, may result in the concentration of heavy minerals in alluvial deposits in the Kapuas lowlands.

Mineralogical investigations and sedimentary deposits in the region provide invaluable insights into ongoing geological processes and potential natural resource discoveries. In sediment analysis, sediment grain size is a very important parameter. This is because sediment grain size reflects the transportation process and functions as an indicator of the depositional environment (Boggs, 2006). In addition, the mineralogical composition of the sediment can provide information on the origin of the sedimentary material and the chemical conditions of the sediment (Tucker, 2001).

Detailed analysis of the grain size and mineralogical characteristics of sediments in the Kapuas area, Central Kalimantan, can provide invaluable insights into the dynamics of the depositional environment and its geologic history.

2. LITERATURE REVIEW

2.1 Geology of Research Area

The study area, as shown on the geological map of the Buntok sheet, is underlain by the Dahor Formation (Fig. 1). The Dahor Formation consists of sandstone of varying densities, interbedded with siltstone, shale, lignite and limonite. The formation is not aligned with the underlying formations of Pliocene - Pleistocene age.

Based on Bemmelen (1949), the area under study is situated within the Schwaner Mountains. During the Paleozoic – Mesozoic orogenis of teh Schwaner Mountains, sedimentation and the intrusion of old granite occured. he southern part of the mountain range is composed of thick deposits of flysch

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sedimentary rock, as well as acidic volcanic intermediates that were subsequently intruded by Cretaceous-aged granite (Herman, 2007).

Sedimentary deposition continued throughout the Pliocene, accompanied by an increase in coarse components, which produced quartz- and zircon-rich sand deposits with clay inserts, quartz pebble conglomerates, and sandstone pebbles derived from the northeast. These deposits exhibit cross-bedding, a distinctive stratigraphic feature.

2.2 Granulometric Analysis

Granulometric analysis is a method used to analyze grain sizes distribution. In this analysis, a number of statistical parameters are employed for the characterization of grain size distribution, including sorting, mean, skewness, and also kurtosis value.

2.2.1 Mean

The mean is the statistical term used to describe the average of all grain size present within a given sample. The average value of grain size reflect the characteristics of settling energy by water or wind in the transportation of sedimentary materials (Richard, 1922). The mean is calculated using the following equation:

$$\text{Mean} = \frac{p16 + p50 + p84}{3}$$

2.2.2 Sorting

The process of sorting described the distribution grain size within sediments. The standard deviation value used in the sorting calculations is derived from cumulative curve through the use of the following equation:

$$\text{Standard Deviasi} = \frac{p84 - p16}{3} + \frac{p95 - p5}{6.6}$$

Table 1 Classification of Sorting *(Folk & Ward, 1957)*

Standard Deviasi (φ)	
< 0.35	Very Well Sorted
0.35 – 0.50	Well Sorted
0.50 – 0.71	Moderately Well Sorted
0.71 – 1.00	Moderately Sorted
1.00 – 2.00	Poorly Sorted
2.00 – 4.00	Very Poorly Sorted
>4.00	Extremely

2.2.1 Skewness

The degree of asymmetry exhibited by a given curve is reflected in its skewness. It indicates wheter the curve is skewed towards coarse or fine grain size. The skewness value can be calculated using the following equation:

$$\text{Skewness} = \frac{p16 + p84 - 2p50}{2(p84 - p16)} + \frac{p5 + p95 - 2p50}{2(p95 - p5)}$$

Table 2 Classification of Skewness *(Folk & Ward, 1957)*

Skewness (φ)	
> +0.30	Strongly Fine Skewed
+0.30 to +0.10	Fine Skewed
+0.10 to -0.10	Near Symmetrical
-0.10 to -0.30	Coarse Skewed
< -0.30	Strongly Coarse Skewed

2.2.1 Kurtosis

Kurtosis is used that indicate the height or steepness of the peaks in a grain size distribution. Kurtosis value is calculated using the following equation:

$$\text{Kurtosis} = \frac{p95 - p5}{2.44(p75 - p25)}$$

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Table 3 Classification of Kurtosis *(Folk & Ward, 1957)*

Kurtosis (φ)	
< 0.67	Very Platykurtic
0.67 – 0.90	Platykurtic
0.90 – 1.11	Mesokurtic
1.11 – 1.50	Leptokurtic
1.50 – 3.00	Very Leptokurtic
> 3.00	Extremely Leptokurtic

2. RESEARCH METHOD

The research methodology involved field sampling and laboratory analysis. Sediment sampling location were identified at four point through the use of shallow drilling techniques, using hand auger. Two methods of analysis were employed: granulometric and grain counting analysis.

Granulometric analysis was used to dertermine the distribution of sediment grain size, with sieve number 10, 18, 35, 60, 140, and <140. Grain counting analysis was used to identification the type of minerals in a given sample, using a binocular stereo microscope.

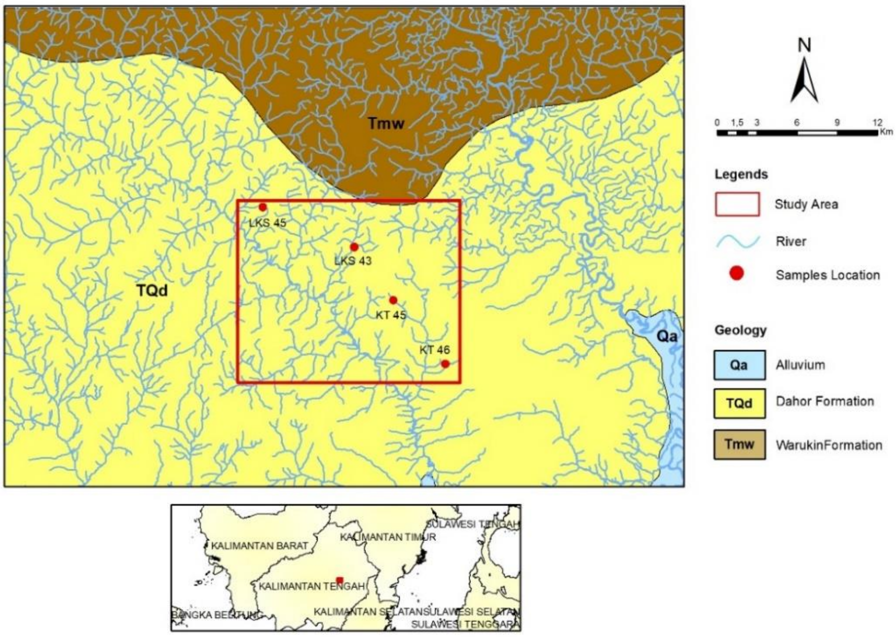

Figure 1 Simplified Geology Map of Kapuas Area (Modified from Regional Geological Map of Buntok – Central Kalimantan part (Soetrisno et al., 1994) showing the study area

4. RESULTS AND DISCUSSION

4.1 Grain Size Characterization

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Table 4 Granulometry Analysis Results

Sample Code	Mean Size	Std. Dev	Skewness	Kurtosis	Mean Class	Std. Dev. Class	Skewness Class	Kurtosis Class
LKS 43	0.78	0.88	0.34	0.72	Coarse Sand	Moderately Sorted	Strongly Fine Skewed	Platykurtic
LKS 45	2.06	1.23	-0.27	0.47	Fine Sand	Poorly Sorted	Coarse Skewed	Very Platykurtic
KT 45	1.98	1.07	0.01	0.52	Moderately Sand	Poorly Sorted	Near Symmetrical	Very Platykurtic
KT 46	1.92	1.18	-0.17	0.48	Moderately Sand	Poorly Sorted	Coarse Skewed	Very Platykurtic

Granulometric analysis was conducted at four points, namely LKS 43, LKS 45, KT 45, and KT 46, which were distributed throughout the study area (Table. 4). The samples, classified according to average size class, range from coarse sand size to fine sand size. The standard deviation value associated with sorting indicates that the majority of the samples are poorly sorted. The results of the analysis of the skewness value which describes the level of dominance of the sample grains size is dominated by the negative of coarse skewed class at LKS 46 and KT 46. The positive of strongly fine skewed class at LKS 43 and KT 45 is included in the near symmetrical class. The kurtosis value of the four sample points illustrates the dominating sediment classification, namely very platykurtic. This suggests that the distribution of sediment size within the study area is consistent.

4.2 Mineralogy

The result of the grain mineralogy analysis indicate the presence of quartz, feldspar, rutil, cassiterite, biotite, hematite, ilmenit, zircon, chalcopyrite, and lithic fragments within the study area.

Based on their density, these minerals can be devided into light and heavy minerals. Minerals with a density >2.86 g/cm^3 in siliciclastic sediments are called heavy minerals (Ali, 2021).

Table 5 The Weight Percentage of Minerals in Study Area (Description: Bt = Biotite, Ccp = Chalcopyrite, Ccs = Cassiterite, Fsp = Feldspar, Hem = Hematite, Ilm = Ilmenite, Rf = Rock Fragment, Rt = Rutile, Qz = Quartz, Zr = Zircon)

Sample Code	Minerals Percentage (%)										Total
	Qz	Ilm	Zr	Rt	Fsp	Cst	RF	Hem	Ccp	Bt	
LKS 43	92.73	2.773	0.031	0.324	1.71	0.57	1.78	0.06	0.01	-	100
LKS 45	96.95	0.47	0.11	0.96	0.89	0.05	0.01	0.54	0.01	-	100
KT 45	97.52	0.06	-	0.121	1.7	0.12	0.257	0.1	0.103	0.02	100
KT 46	95.71	0.624	0.004	0.014	3	0.24	0.283	-	-	0.096	100

Quartz minerals are classified as light minerals. The result showed the dominance of quartz in all research samples, with a total weight percentage of more than 90%. The highest value found in KT 45. The durability of quartz is such that it is resistant to weathering processes when transported over long distances. The abundance of quartz minerals indicates the presence of felsic sources (Tucker, 2001). The heavy minerals in the study area consist of rutile, ilmenite, cassiterite, biotite, hematite, zircon, and

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chalcopyrite. In all samples, the total weight percentage of heavy minerals was less than 4%.

5. CONCLUSION

Research conducted in the Kapuas area has identified three different sediment types, which are classified according to their respective grain sizes. The sediment types are fine sand, medium sand and coarse sand. The sediment transport mechanism is bedload for the coarse fraction and suspension for the fine fraction. These sediments are interpreted to have been deposited in a fluvial or deltaic environment with varying transport energy. Observed variations in grain size, sorting, skewness, and kurtosis indicate changing conditions of transport and deposition. Heavy minerals identified in the study area include rutile, ilmenite, cassiterite, biotite, hematite, zircon and chalcopyrite. The presence of these minerals indicates the source rock is sourced from acidic to intermediate igneous and metamorphic rocks.

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