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Analysis of nutrient-carrying minerals from Tempe Lake sediment

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Abstract. This study aims to determine the fertility of sediment in Tempe Lake from nutrient-carrying minerals. This study used transect method with sediment sampling from northern, southern, and eastern part of Tempe Lake. Analysis of minerals used X-Ray Diffractometer. The results show that nutrient-carrying minerals from eastern of Tempe Lake has biotite (35.6%), anorthite (7.1%), and olivine (6.8%), from northern has biotite (29.2%), olivine (20.7%) and pyroxene (9.1%), and from southern has pyroxene (88.6%), and amphibole (3.4%). The percentage of nutrient-carrying mineral content in the southern part of Tempe Lake is higher than the percentage of the total amount in the North and East parts, so that it is potentially used as ameliorant material for infertile soils.

1. Introduction

The lake is a place of accumulation of sediment and water from the highlands to the lowlands, as well as Tempe Lake which is located in Wajo, Soppeng, and Sidrap Regencies in South Sulawesi Province, with the number of sediments increasing each year. There are 23 rivers that supply Tempe Lake which show fluctuations in lake changes [1].

Tempe Lake floodplain area is used by local communities as agricultural land, especially for crops (corn, cassava, soybeans and green beans), paddy fields and horticulture (tomatoes and watermelons), Tempe Lake land use is carried out by the community in turn so that each people get the chance to farm and benefit [2]. This shows that the floodplain of Tempe Lake is very potential to be used as agricultural land. The deposits number of Tempe Lake which is increasing every year should be able to be used by local communities to improve agricultural lands outside the Lake area, but due to limited information about the potential fertility of the Tempe Lake sediment, so that the community does not want to move and is still focused for planting around the lake only. Fertile soils or sediment can be identified with a large or small amount of nutrient-carrying minerals contained in them [3]. This study aimed to analyse nutrient-carrying minerals contained in Tempe Lake sediments, so that they can be used as a source of soil amendments elsewhere.

2. Materials and methods

The geographic coordinate of Tempe lake was 119°50'00"E – 120°5'00"E and 4°00'00"S – 4°10'00"S. Sediment sampling used transect method from the river's edge perpendicular to the lake. The position



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of transect taken at the North (TS1B, TS2B, and TS3B), the South (TS1C, TS2C, and TS3C), and the East (TS1A, TS2A, and TS3A) of Tempe Lake (Figure 1). The sediment sampling was composite and analysed with X-ray Diffractometer (XRD) and mineral identification with Kerr method [4].

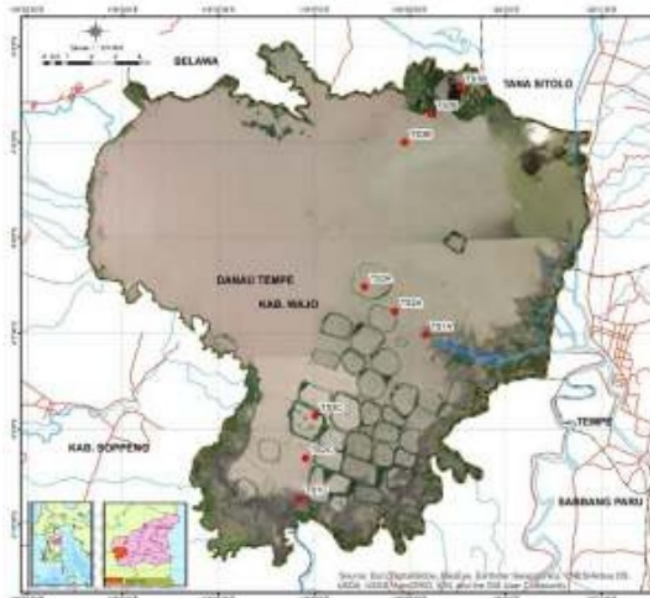


Figure 1. Location of study and sampling site

3. Results

Sediments taken from the eastern part of Tempe Lake indicate the presence of nutrient-carrying minerals namely; biotite, anorthite, and olivine (Figure 2). The presence of biotite minerals with the percentage of 35.6% and the lowest is the olivine mineral with percentage of 6.8% (Table 1).

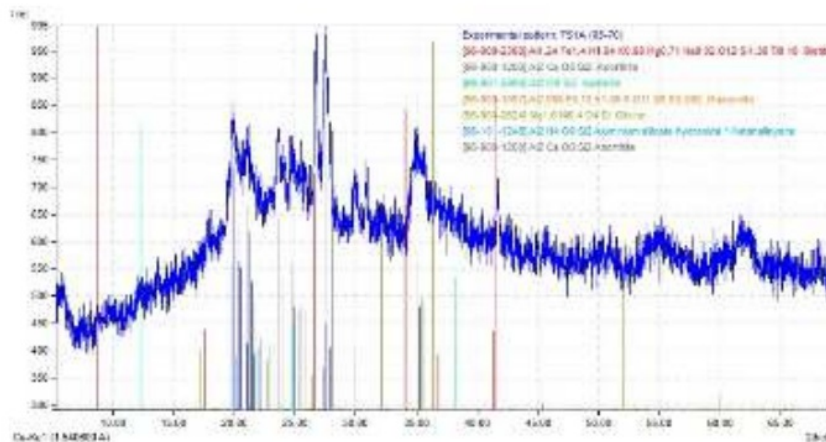


Figure 2. X-ray Diffraction pattern of sediment sampling from East Tempe Lake.

Table 1. Composition mineral from sediment in East of Tempe Lake

Chemical Formulation	Mineral	Percentage %
$KMg_{2.5}Fe_{0.5}AlSi_3(OH)_{10}(OH)_{1.75}F_{0.25}$	Biotite	35.6
$Al_2Si_2O_5(OH)_4$	Kaolinite	17.4
$KAl_3Si_3O_{10}(OH)_{1.8}F_{0.2}$	Muscovite	15.4
$Al_2Si_2O_5(OH)_4$	Halloysite	14.8
$Na_{0.05}Ca_{0.95}Al_{1.95}Si_{2.05}O_8$	Anorthite	9.1
$Mg_{1.6}Fe^{2+}_{0.4}SiO_4$	Olivine	7.2

Sediments taken in the northern part of Tempe Lake indicate the presence of nutrient-carrying minerals in the form of; biotite, olivine, and pyroxene (Figure 3). The content of biotite minerals with a percentage of 29.2% and the lowest is the mineral pyroxene with percentage of 9.1% (Table 2).

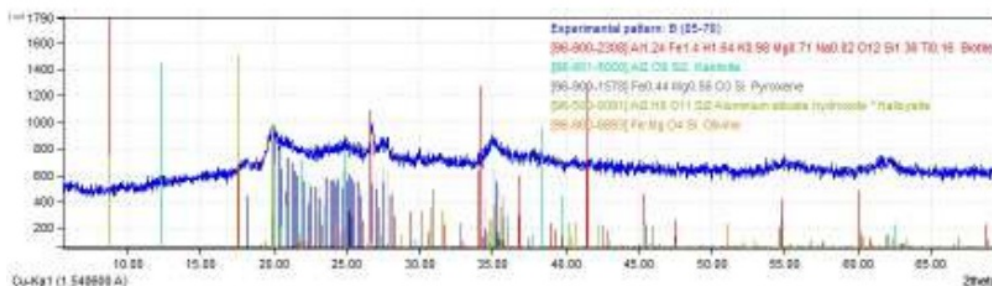


Figure 3. X-ray Diffraction pattern of sediment sampling from North Tempe Lake.

Table 2. Composition mineral from sediment in North of Tempe Lake

Chemical Formulation	Mineral	Percentage %
$KMg_{2.5}Fe^{2+}_{0.5}AlSi_3(OH)_{10}(OH)_{1.75}F_{0.25}$	Biotite	29.2
$Al_2Si_2O_5(OH)_4$	Kaolinite	24.3
$Mg_{1.6}Fe^{2+}_{0.4}SiO_4$	Olivine	20.7
$Al_2Si_2O_5(OH)_4$	Halloysite	16.7
$(Na, Ca)Mg_3Fe^{3+}_{1.2}Al_{0.6}Si_{0.2}(SiO_4)_3$	Pyroxene	9.1

Sediments taken in the southern part of Tempe Lake indicate the presence of nutrient-carrying minerals in the form of; pyroxene, biotite, and amphibole (Figure 4). Pyroxene mineral content with the percentage of 88.6% and the lowest is the amphibole mineral with percentage of 3.4% (Table 3).

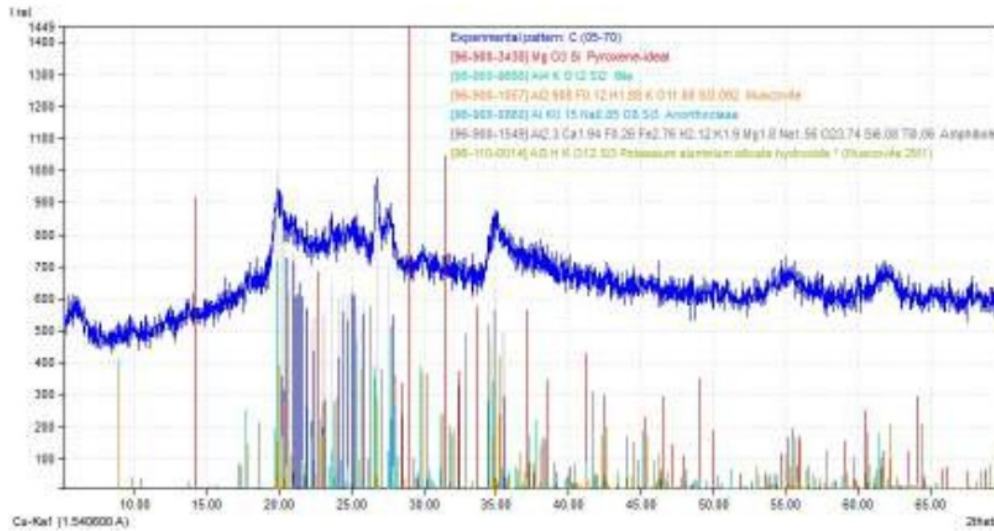


Figure 4. X-ray Diffraction pattern of sediment sampling from South of Tempe Lake.

Table 3. Composition mineral from sediment in South of Tempe Lake.

Chemical Formulation	Mineral	Percentage %
$(Na, Ca)Mg_3Fe^{3+}_{1.2}Al_{0.6}Si_{0.2}(SiO_4)_3$	Pyroxene	88.6
$K_{0.6}(H_3O)_{0.4}Al_{1.3}Mg_{0.3}Fe^{2+}_{0.1}Si_{3.5}O_{10}(OH)_2 \cdot (H_2O)$	Illite	4.7
$KAl_3Si_3O_{10}(OH)_{1.8}F_{0.2}$	Muscovite	2.2
$Na_{0.75}K_{0.25}AlSi_3O_8$	Anorthoclase	1.1
$Ca_2Mg_2Al_{0.75}Fe^{3+}_{0.25}(Si_7AlO_{22})(OH)_2$	Amphibole	3.4

4. Discussion

Nutrient-carrying minerals are primary minerals that are formed at high temperatures so that they become very unstable at the earth's current temperature, resulting in easy weathering and releasing of the cations they contain [3,5]. The order of the primary minerals according to their formation temperature is; olivine> anorthite> pyroxene> amphibole> biotite> feldspar> muscovite. The weathering rate of primary minerals is inversely proportional to the temperature of its formation. The hydrologic process in Tempe Lake also affects the level of mineral weathering, the higher the temperature of mineral formation, the easier it is to decompose by water [6].

Primary nutrient-carrying minerals are still present in large quantities and can function as nutrient-supplying minerals for plants (Table 1-3). The primary minerals in the northern part of the Tempe Lake are sourced from the Bila River through the parent rock of Tertiary Oligocene Lava (Tol) Formation [7], namely basalt igneous rock as carrier of pyroxene and olivine mineral, and andesite rocks as a carrier of biotite and pyroxene minerals. The presence of secondary minerals from kaolin group originates from the source rock of the Tmc Formation [7], namely conglomerate sedimentary rocks that are interbedded with sandstones and shale.

Nutrient-carrying minerals from the southern part originate from the Tangae and Waronga rivers through the Tmpw (Tertiary Miocene-Pliocene Walanae) Formation, and most of the Tmsv (Tertiary

Miocene Soppeng Volcanic) Formation [8]. The percentage of pyroxene mineral content of 88.6% is produced from the Soppeng volcanic rock (Tmsv) derived from basaltic-andesitic lava, while the presence of illite and muscovite secondary minerals is produced from the Walanae Formation sandstone.

Nutrient-carrying minerals in the eastern part of Tempe Lake are influenced by the Walanae River which is also an outlet of Tempe Lake. The mineral content of olivine and anorthite is sourced from basalt fragments from the Walanae Formation (Figure 5). Percentage of mineral content of olivine and anorthite is only found in small amounts, because these two minerals are more easily weathered than minerals pyroxene and biotite. Biotite, and muscovite minerals are sourced from the Walanae Formation sandstone, while the kaolin group secondary minerals are produced from the Walanae Formation claystone.



Figure 5. Sandstone from Walanae Formation with fragmental of basaltic rock as sources of olivine and anorthite minerals

Nutrient-carrying minerals from Tempe Lake sediment in the south with a large percentage of pyroxene minerals, which is 88.6%. This mineral is classified as easily weathered if it reacts with water, and is easily decomposed in slightly acidic soils [9], so it is very potential to be used as a nutrient-carrying mineral for plants and can be used as ameliorant for infertile soils in Indonesia which is predominantly acidic pH.

5. Conclusions

Nutrient-carrying mineral from Tempe Lake was pyroxene, biotite, olivine, anorthite, and amphibole. The percentage of nutrient-carrying mineral content in the southern part of Tempe Lake is higher than the percentage of the total amount in the North and South parts, so that it is potentially used as ameliorant material for infertile soils.

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