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Mapping of Nickel Laterite Sources Using Geographical Information Systems (SIG), Case Study: Koninis Region, Central Sulawesi Province

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ABSTRACTS

Nickel is one of the stainless metal minerals whose use at this time is very large so the demand is also very high. Nickel exists in 2 types, namely Sulfide and Laterite. Nickel laterite is a weathering process of ultramafic rocks. The Banggai geological sheet map, especially Bunta, contains ultramafic rocks, so it is necessary to map laterite nickel resources. This study aims to determine the distribution, determine the levels of mineral elements contained, and determine the estimated laterite nickel resources in the research area. The research method was carried out by collecting field data using the Global Positioning System and testing the sample content using X-ray Fluorescence Portable and then analyzing it using the Geographic Information System application. The results showed that the distribution of laterite nickel was found in the ultramafic unit area with elevations between 110 – 170 m extending from north to south in the study area with an area of 29.25 ha, the Ni content for Cut Off Grade (COG) was 1.6% and Fe 34.29% with a thickness of 3 m and obtained an estimated (hypothetical) nickel laterite resource of 1,140,750 tonnes.

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INTRODUCTION

Nikel adalah salah satu mineral logam tahan karat yang kegunaannya pada saat ini sangat besar (Sapulete, S.M., 2012; Apria J. et al., 2016). Hal ini dikarenakan permintaan global untuk Stainless Steel cenderung tumbuh sekitar 6% pertahun dan juga merupakan salah satu hasil tambang di Indonesia yang memiliki cadangan cukup banyak yang menurut penelitian sampai saat ini Indonesia mempunyai cadangan sampai 3,2 Milyar ton atau 5% dari cadangan nikel diseluruh dunia, (Ningsih, S.A., 2014; Arif A., 2018).

Nikel terdapat dalam 2 tipe, yaitu Sulfida dan Laterit, untuk tipe Sulfida keterdapatannya di alam sangat besar dibandingkan dengan tipe Laterit, namun produksi tipe laterit lebih besar (Puspitasari, D., 2015; Purnomo H., 2018). Hal ini dikarenakan keterdapatannya sangat mudah dibandingkan dengan tipe sulfida, (Mustika R et al., 2015; Jafar, N., et al., 2022).

Nickel laterite is a weathering process of ultramafic rocks (Rafsanjani, R., 2016; Rifki, M. et al., 2022). The geological map of the Banggai sheet, especially the Bunta area, has Ultramafic rocks so further research is needed (Geological Map of the Banggai Sheet).

This study aims to determine the distribution area, levels of mineral elements contained and nickel laterite resources in the research area.

METHODS

The research was carried out in Koninis Village, Bunta District, Luwuk Banggai Regency, South Sulawesi Province. The research methodology is carried out by direct mapping in the field, taking and analyzing samples and then Source estimation is carried out.

The target area in this study is a 50 ha site (Figure 1). Mapping is carried out by traversing the lateralization prospect areas with the Global Positioning System (GPS) tracking. GPS is a tool used to record coordinates above the earth's surface by utilizing the help of satellite signals (Bakri, S. et al.,

2022). Surface sampling was carried out at locations that were considered to have good to good lateralization. The average sampling distance is 300 – 500 meters with a weight of 2 kg (Figure 2). In areas where laterization prospects are found, vertical sampling is also carried out using the test well method. The coordinate points for sampling were also taken using GPS and then physically described before being brought to the preparation site for later analysis using Portable X-Ray Fluorescence (XRF). XRF is a quantitative mineral characterization tool (Bakri, S., & Sanwani, E., 2019).

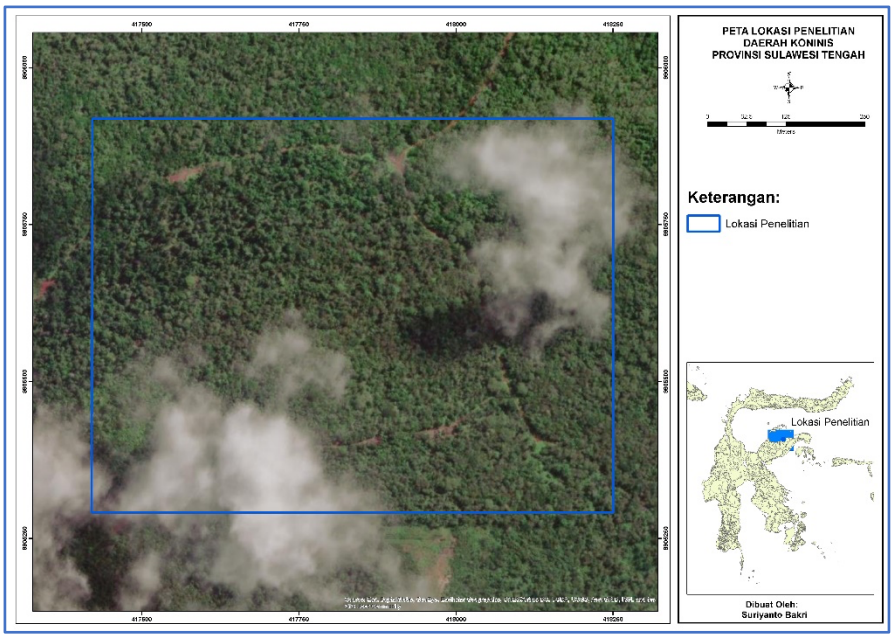

Figure 1. Research target area map

Figure 2. Research sampling

Laterization prospect areas were analyzed using a Geographic Information System (GIS). GIS is a mapping information system application based on geography or geospatial data Robi'in, B, 2016; Thamsi, A.B. et al 2019; Tambengi, N., & Kumaat, J.C. 2020; Bella, R. A. et al., 2022). Resource estimation is done by analyzing the extent of the prospect of laterization with a description of the samples in the field and the results of qualitative analysis.

In general, research starts from library research on campus permits in the local area and field surveys. Samples from the field are then sent to the laboratory for analysis. Field and laboratory data were analyzed to get a conclusion. The research design from the beginning until a conclusion is reached can be seen in Figure 3 below.

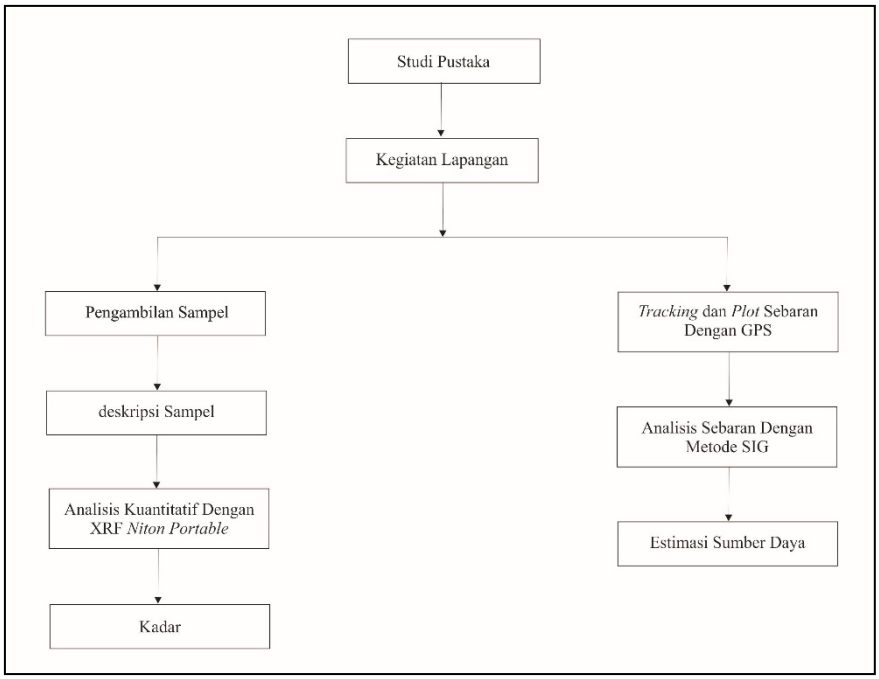

Figure 3. Research methodology flowchart

RESULTS AND DISCUSSION

Mapping Location Analysis

The research area has an area of 50 ha which is dominated by ultramafic rock units with an area of 44 ha and the rest are alluvial units with an area of 6 ha. The topography of ultramafic rock units is hilly to mountainous with elevations between 110 meters - 170 meters above sea level, while the topography of alluvial rock units is a sloping to hilly area with an elevation of 80 meters - 100 meters.

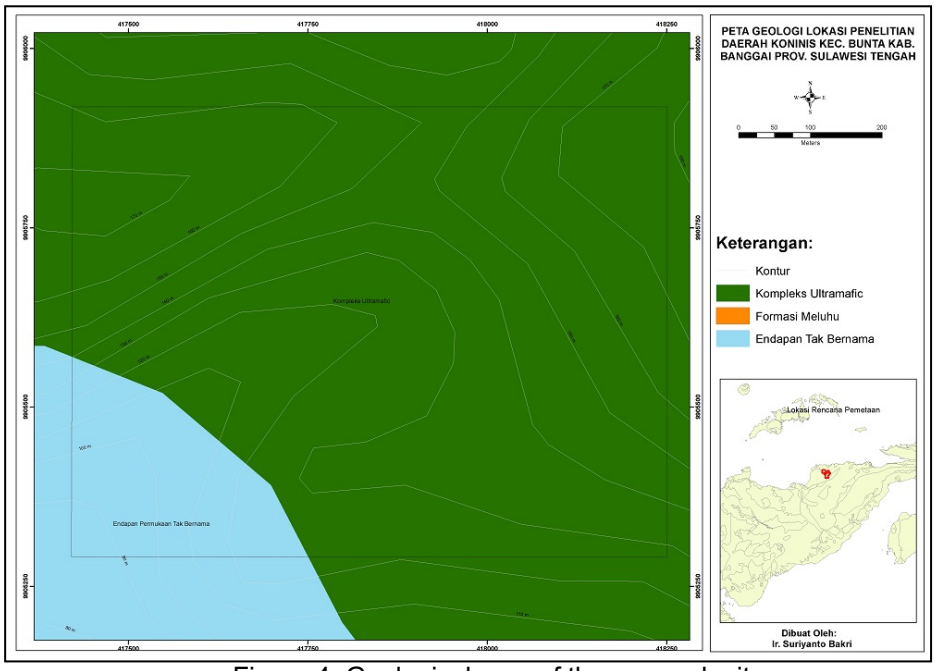

Figure 4. Geological map of the research site

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Determination of mapping access starts from a location that is easily accessible, namely from the southwest direction of the research area then crosses to the northeast end and returns to the initial location (Figure 4)

A good laterization area was found with a field description: brownish red color, high magnetic properties (Figure 5. a) and a good laterization area with a field description: reddish brown color, moderate magnetic property (Figure 5. b) and a poor laterization area with field description: yellowish brown color, low magnetic properties (Figure. 5.c). In addition, non-laterized areas were also found with field descriptions: black in color and not magnetic (Figure 5.d).

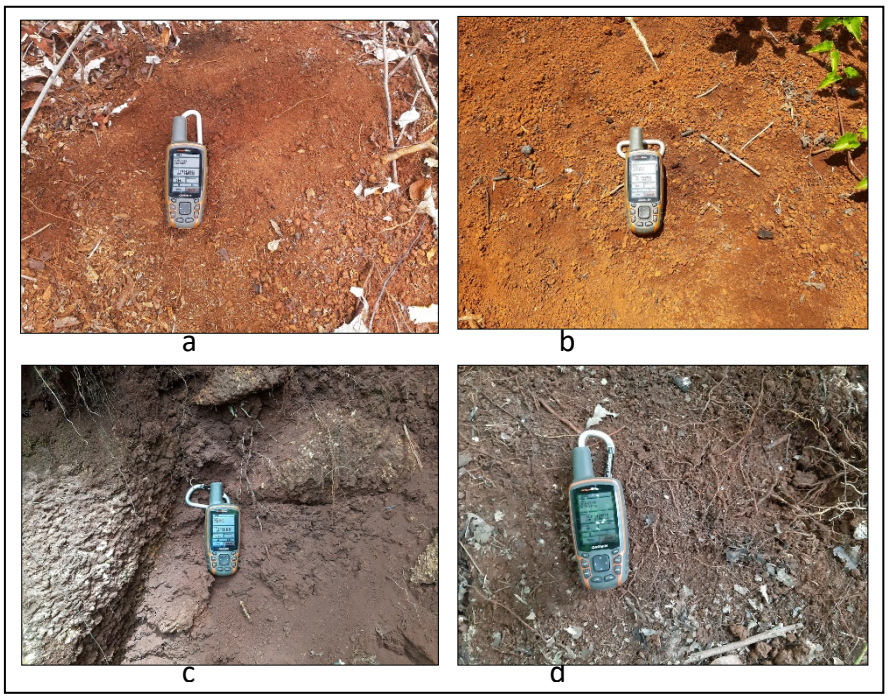

Figure 5. Surface appearance of the research site

Laterite Nickel Distribution Analysis

Three laterization groups were found which were then grouped based on physical color, namely red brown covering an area of 29.25 ha; reddish brown area of 8.80 ha; and yellowish brown area of 5.95 ha of the ultramafic unit area, so that the total laterization area is 44 hectares.

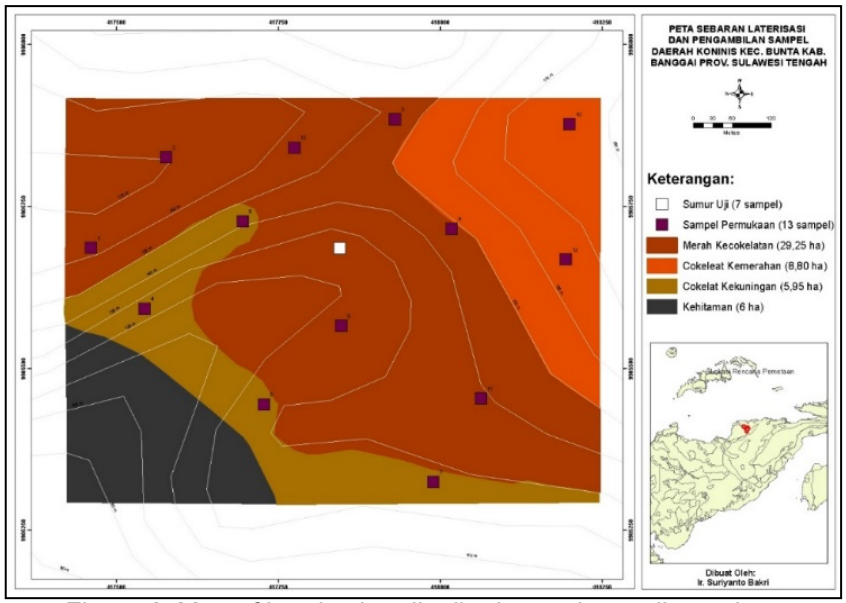

Figure 6. Map of laterization distribution and sampling points

In the laterite nickel distribution area, 13 points of surface samples were taken with 1 sample and 1 test well point of 7 samples, so the total samples taken were 10 samples (Figure 6).

Grade Analysis

Sample quantity analysis was carried out using a Niton Portable X-ray fluorescence (XRF) beam. Analysis of the quality of each sample can be seen in the following table (Table 1).

Based on the results of the analysis, the average surface sample contains 0.5% Ni and 28.39% Fe. Meanwhile, the test well samples had Ni content between 0.52 – 1.71 and Fe between 48.4 – 6.82% (Table 2). Based on the Ni content of the test well samples for Cut Off Grade (COG) Ni 1.6%, an average thickness of 3 meters was obtained.

Table 1. Results of surface sample quantity analysis

NO	Sampel ID	Ni (%)	Fe (%)	SiO2 (%)	MgO (%)
1	SP_01	Ni_0.74	34.44	2.56	15.16
2	SP_02	Ni_0.55	40.86	2.88	14.18
3	SP_03	Ni_0.75	34.80	1.03	14.20
4	SP_04	Ni_0.21	11.27	2.80	15.91
5	SP_05	Ni_0.48	16.44	2.83	14.15
6	SP_06	Ni_0.22	13.46	2.67	14.21
7	SP_07	Ni_0.12	15.16	2.83	15.48
8	SP_08	Ni_0.86	48.48	2.95	15.20
9	SP_09	Ni_0.76	36.90	2.47	15.43
10	SP_10	Ni_0.5	23.45	1.10	15.90
11	SP_11	Ni_0.52	35.11	1.56	14.40
12	SP_12	Ni_0.27	23.28	1.57	14.36
13	SP_13	Ni_0.55	35.44	1.12	14.33

Table 3. The results of the analysis of the quantity of the test well samples

NO	Hole_ID	Sampel_ID	From	To	Zonasi	Ni (%)	Fe (%)	SiO2 (%)	MgO (%)
1	TK_01	ST_01	0.00	1.00	TP	0.52	48.40	2.77	14.08
2	TK_01	ST_02	1.00	2.00	LIM	0.82	41.24	2.04	13.90
3	TK_01	ST_03	2.00	3.00	LIM	1.20	46.06	3.80	13.88
4	TK_01	ST_04	3.00	4.00	Trans	1.35	27.36	3.32	13.70
5	TK_01	ST_05	4.00	5.00	Trans	1.39	30.55	11.96	14.03
6	TK_01	ST_06	5.00	6.00	Trans	1.44	20.00	17.42	14.20
7	TK_01	ST_07	6.00	7.00	SAP	1.66	7.47	22.62	15.67

Source Analysis

Calculation of laterite nickel Sources is limited to areas that have a high laterization distribution and test wells have been carried out (29.25 ha). Calculation using Cut Off Grade (COG) Ni 1.6% and density 1.3 ton/m^3.

The calculation method uses the tonnage calculation method, namely using the volume formula multiplied by density.

The calculations are as follows:

Volume = Area x thickness average cog 1.6%
= 292.500 m^2 x 3 m
= 877.500 m^3

Tonase = Volume x density
= 877.500 m^3 x 1,3 ton/m^3
= 1.140.750 ton

CONCLUSION

Based on the research that has been carried out, it can be concluded that the prospect area for the distribution of nickel laterite is located in the ultramafic unit area with an elevation between 110 meters - 170 meters that extends from north to south of the study area of 29.25 hectares. The estimated (hypothetical) nickel laterite source is 1,140,750 tons with a Cut Off Grade (COG) of 1.6% Ni and 34.29% Fe with a thickness of 3 m.

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