

Olo-Oloho Nickel Laterite Exploration in the Pakue District, North Kolaka Regency of the South-East Sulawesi Province, Indonesia

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인도네시아 남동부 술라웨시주 북 코라카시 파우케지역의 니켈 라테라이트 탐사

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1. Introduction

The major discoveries of nickel laterite mines in South and Southeast Sulawesi regions, such as PT. Inco mining operations in Soroako (more than 180,000,000 tonnes of nickel laterite at an average of 1.68% Ni) and PT. Aneka Tambang mining operations in Pomalaa (more than 200,000,000 tonnes of nickel laterite at an average of 1.80% Ni), have strongly supported that the Olo-Oloho nickel laterite prospect which is situated in the similar geological provinces have a good potential for medium scale high-grade nickel laterite deposit mining operation development.

The Olo-Oloho nickel laterite prospect is located nearby Olo-Oloho village, Pakue District of North Kolaka Regency, South-East Sulawesi Province (Fig. 1) and the property is officially controlled by PT. Pulaurusa Tamita under an Exploration Mining Right or *Kuasa Pertambangan Eksplorasi*. This Exploration Mining Right covers an area of 250 hectares and its validity dates are from February 18, 2008 up to February 18, 2010.

The detailed exploration work in the Olo-Oloho prospect includes a grid-line survey, a topographical survey, a concession block boundaries survey, and a geological mapping and test pitting program at 100 m × 100 m spacing with some 50 m × 50 m

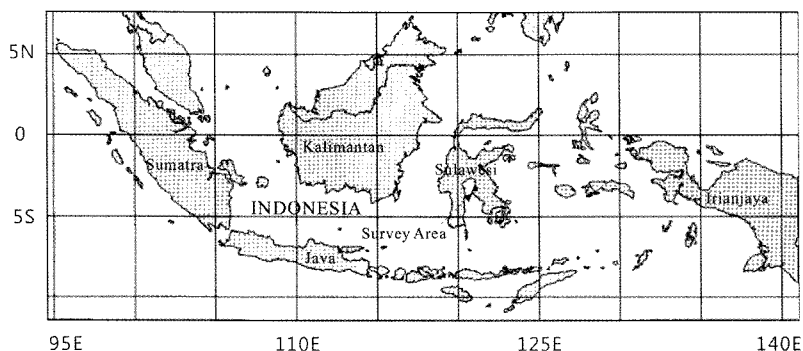


Fig. 1. Location of the survey area.

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spacing pits, with a combination in-fill core drilling program at 50 m × 50 m spacing and 25 m × 25 m spacing grade control drilling within the mapped target area.

The main objective is to carry out a detailed exploration work program and to generate a medium scale, high-grade nickel laterite mining operation - production and to create a cash-flow to support the further exploration - development in North Kolaka Regency and other potential nearby prospect areas.

2. Nickel Exploration Activities

Exploration activities included:

- 1) Logistics and infrastructure survey including government relations, manpower, accommodation, road access, land transportation, travel agent, forwarding agent, contractors and other related matters;
- 2) Grid-Line and topographical survey consisting of a grid-line survey, a topographical survey, and a boundary survey over the concession block area of 250 ha;
- 3) Geological mapping consisting of lateritic soil mapping, rock float mapping, and outcrop mapping including land use status mapping within the surveyed grid-line block area;
- 4) Hand auger drilling consisting of drilling and sampling at 200 m spacing along the ridge system and 100 m spacing within the surveyed grid-line system to determine the horizontal distribution of the nickel-bearing laterite (limonite and saprolite types) and the Ni, Co and Fe contents;
- 5) Pitting at 100 m × 100 m spacing consisting of test pitting and sampling at 200 m × 200 m spacing within the surveyed grid-line system to generate and determine an indicated resource potential within the exploration target area for a further follow-up detailed 50 m × 50 m spacing exploration core drilling program, including detailed geological mapping to outline the nickel-bearing laterite deposits;
- 6) Core drilling at 50 m × 50 m spacing consisting of core drilling and core sampling activities within the indicated resource potential block area within the 100 m × 100 m spacing pitting program block area to determine and/or outline the measured resource potential to outline the mining blocks;
- 7) Core drilling at 25 m × 25 m spacing consisting of core drilling and core sampling activities within

the measured resource target block area for nickel-grade control to support the mining development operations;

8) Sample handling and Assaying by XRF;

9) Nickel ore reserve calculation parameters including the sample point (test pit), area of influence, thickness of limonite or saprolite ore types, volume, specific gravity of limonite ore and saprolite ore, tonnages of limonite ore and saprolite ore in wet metric tonnes (WMT) and ore grades (Ni %, Co %, Fe %, Cr₂O₃ %, SiO₂ % and MgO %).

3. Regional Geology

The nickel laterite ore deposits in Indonesia were discovered in Jayapura Papua, Siduarsi Papua, Kebar plain West Papua, Waigeo Islands West Papua, Gag Island West Papua, Gebe Island North Moluccan, Halmahera North Moluccan, South-East Sulawesi regions and South-East Kalimantan.

The nickel ore is derived from weathered ultrabasic rocks of peridotite, harzburgite, serpentinite and dunite of the Upper Mesozoic to Early Tertiary Age. These ultrabasic rocks are highly fractured to various degrees from widely spaced jointing to extremely mylonitized or tectonically brecciated with a serpentine or a chlorite matrix at many places and are strongly related to tectonic activities or plate tectonic collision activities in the Southwest Pacific region, particularly in Indonesia. These tectonic activities have played an important role in Indonesia and have produced significant mineral deposits (Fig. 2).

Tectonically, most of the economic deposits are located and related to zones of interactions of the Pacific Plate and the Australian Plate which moves from the southeast to the northwest direction, particularly New Caledonia to Papua New Guinea and further to Papua Indonesia, as strongly indicated by the Major Fault Zone which continues to South-East Sulawesi province through the Sinistral Strike Slip Fault system.

Based on the geological characteristics of the Pre-Tertiary sequences, the Olo-Oloho nickel-bearing laterite survey area is situated at the margins of two geological provinces, namely Tinondo and Hialu. Those are considered to be strongly separated by the Major Fault system.

The basement of the Tinondo geological province,

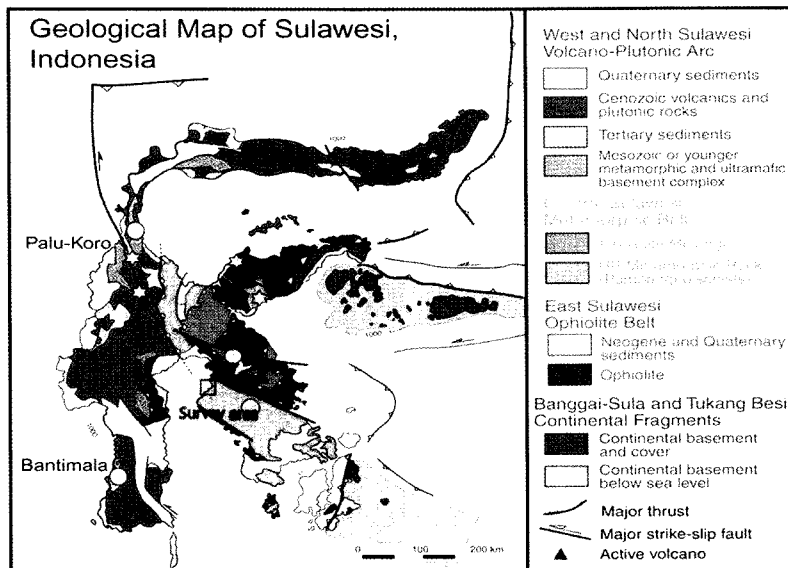


Fig. 2. General geology and tectonic map of the Sulawesi province.

characterized by continental shelf deposits, consists of paleozoic metamorphic rocks with a suggested carboniferous age. The unit is covered by micaceous schists, quartz schists, chlorite schists, slates, phyllites and gneiss.

The Paleozoic marbles interfinger with Paleozoic metamorphic rocks. The magmatic activity occurred in the Permo-Triassic and produced quartz aplites, quartz latites and andesites.

The Paleozoic metamorphic rocks including marbles unit is intruded by these intrusive bodies or stocks.

Hialu geological province is characterized by oceanic crust deposits and the oldest unit is the Ophiolite Complex which consists of peridotite, harzburgite, serpentinite, dunite, gabbro and basalt. The Ophiolite Complex is probably from the Jurassic-Cretaceous Age and it is unconformably overlain by the Matano Formation which consists of calcilutite with intercalations of shale and chert.

The Matano Formation was deposited in a deep-sea depositional environment in the Late Cretaceous Age. The Late Miocene to Early Pliocene molasses deposit constitutes the Pandua Formation which consists of polymict conglomerate and sandstone with interbedded siltstone. This formation unconformably overlies the older rock units of both Tinondo and Hialu geological provinces.

The sequence continued with the deposition of the Alangga Formation which consists of sandstone and conglomerate and the Quaternary coral reef. They were deposited in the Pleistocene to Recent times, and subsequently these units were covered by alluvium which consists of rivers, swamps and coastal deposits.

Faults and structural lineaments are generally trending northwest-southeast. The fault is a sinistral strike slip fault system which was probably still active until recent times. These faults have separated the Tinondo and Hialu Geological Provinces.

4. Results of Geological Exploration

4.1. Grid-line and Topography Survey

The total of the surveyed grid-lines are 6,128m in length, consisting of a 700m base line and 5,428 m cross lines.

The cross lines consist of 15 lines of variable length spaced at 50 m distance. During work on the grid-lines, data for the topographic map was also collected. The grid-lines and topographic survey covered an area of approximately 28 hectares of land.

4.2. Exploration Geology

Geological mapping was conducted during and

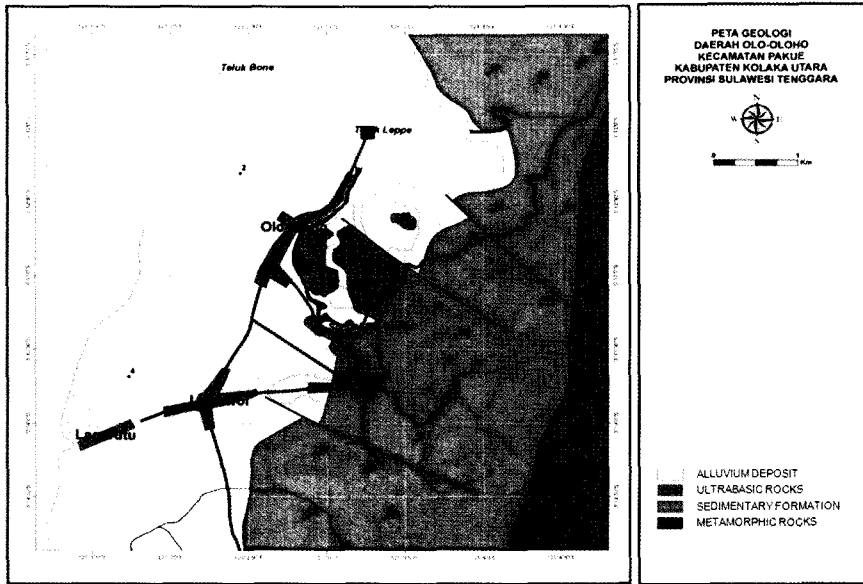


Fig. 3. General geology of the Olo-oloho area.

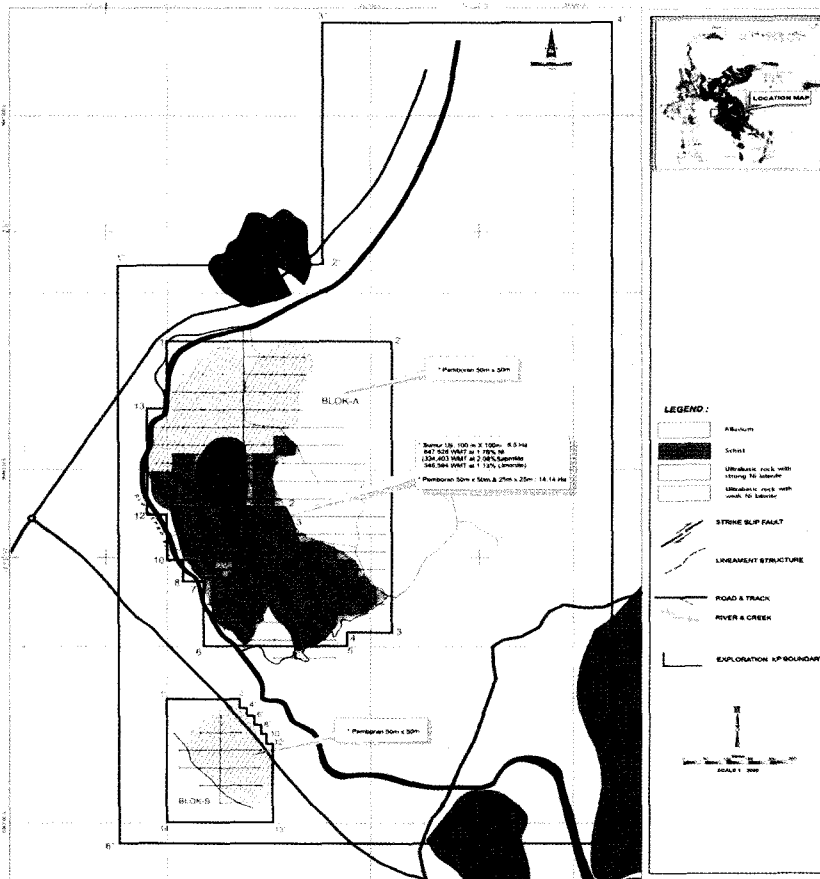


Fig. 4. General geology of the survey area including exploration right, exploitation right and mining block (blue box).

after the pitting program. The mapping was conducted along the baselines, gridlines, and creeks and from pits data. Vegetation types were also used as guides to identify the lithology. For example, the cocoa and clove trees are not growing well in the lateritic soil area, but these vegetation types grow well in the metamorphic schists, alluvial and alluvium areas.

The Olo-Oloho exploration area of 250 ha has been mapped and has successfully determined a nickel-bearing potential target area (Figs. 3 and 4).

The area (32.40 ha) consists of so called Pasantren block (8.48 ha) and Olo-Oloho block (24.40 ha) of a nickel-bearing laterite zone (Fig. 5).

From the area, a total of 8.50 ha have been tested by pitting at 100 m × 100 m spacing to determine indicated resources, and these indicated resources within an area of 8.50 ha have been tested by drilling at 50 m × 50 m spacing which covers a total area of 14.14 ha. The 50 m × 50 m spacing drilling, has been followed-up with a detailed 25 m × 25 m spacing definition drilling or grade-control drilling and has outlined high-grade nickel pockets (Pockets 1 and 2, approximately 7.80 ha; Fig. 6).

4.3. Rock Facies

The oldest rock exposed in the Olo-Oloho survey

area is schist, which belongs to the carboniferous metamorphic rocks, covering an area of approximately 2.7 hectares. Schist occurs as window in the ultrabasic rocks. The Cretaceous ultrabasic rocks unconformably overlay the carboniferous schist. It is believed that the ultrabasic rocks were thrust-faulted over the carboniferous rocks during the Paleocene to Eocene period.

The ultrabasic rocks in the Olo-Oloho are divided into:

- the laterite zone of deeply weathered ultrabasic rocks
- the ultrabasic rocks with thin laterite

The laterite zone is distributed roughly in NS direction, covering an area of 14.14 hectares, and occurs in the western part of the Olo-Oloho area.

The Quaternary alluvial deposits are related to the modern Olo-Oloho River, unconformably overlaying the ultrabasic rocks.

The schist unit is considered to be an isolated block which has been pushed up or emplaced by the ultrabasic body, while the low laying flat area is covered by the alluvial deposit.

4.4. Structures

The ultrabasic rocks are strongly fractured and locally serpentinized along fracture zones and contain high-grade nickel. The straightness of the

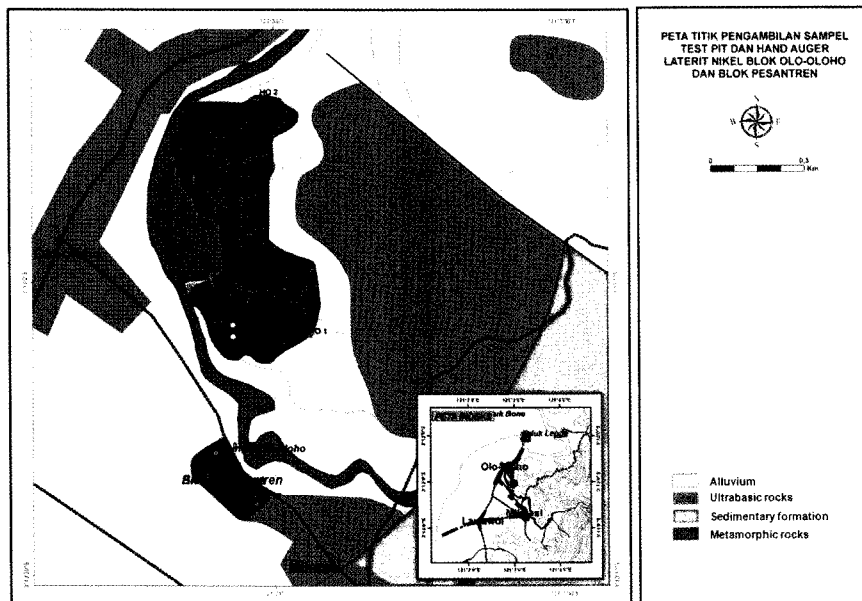


Fig. 5. The nickel laterite zones in the survey area.

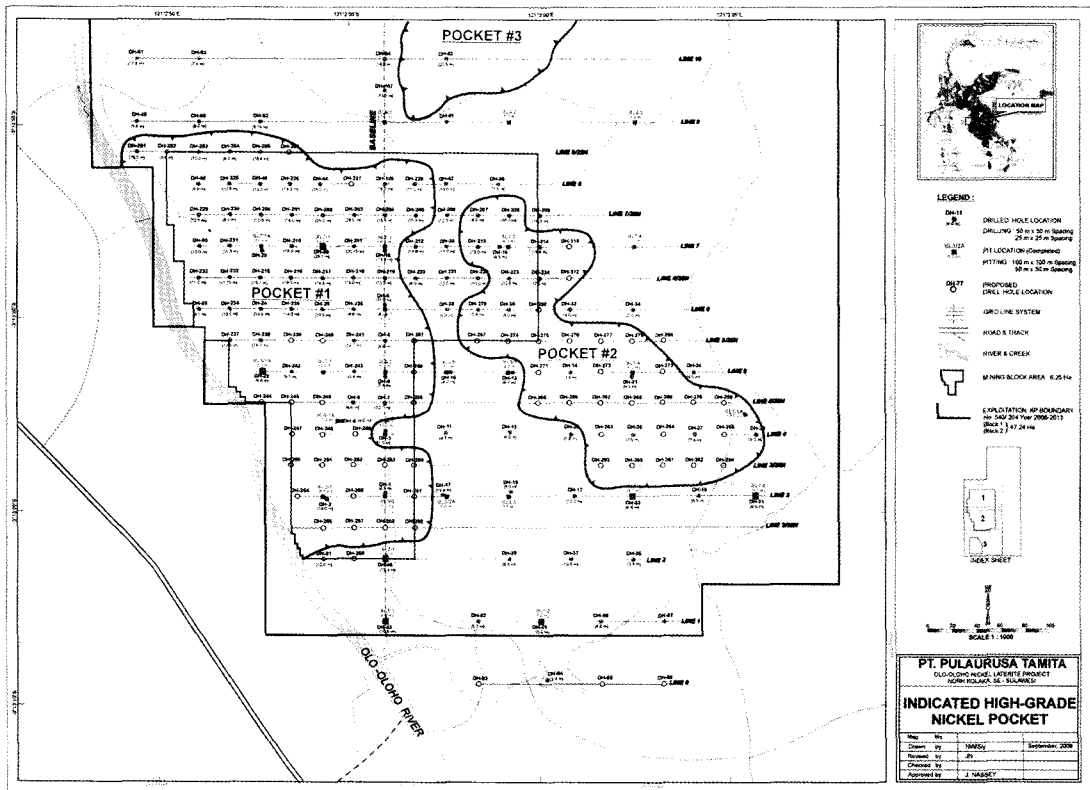


Fig. 6. Showing 50 m × 50 m spacing and 25 m × 25 m spacing drilling pattern and the determined high-grade nickel pockets.

modern Olo-Oloho River suggests that part of the river is flowing along the fault zone.

A north-northeast trending fault cuts the lateritic area which is interpreted based on the distribution pattern of the alluvial deposits along the Olo-Oloho river tributaries including the local morphology of the area. The isolated schist in the laterite area is considered to be related to this fault system.

It appears that the isolated nickel-bearing laterite area is controlled by a zone of NNE-trending strike-slip fault and may be followed by a late stage normal fault, possibly after the lateritization process in the ultrabasic rock body.

Due to the late stage normal fault, which may have formed the thick nickel-bearing laterite pocket associated with the down-faulted block, a wholly lateritized and highly fractured ultrabasic body has resulted. The higher level of the lateritic deposit in this area is considered to be originally related to the up-thrown faulted block which has been eroded down to the down-faulted block.

4.5. Mineralization

The weathering of the ultrabasic rocks has released the iron, magnesium, silica, nickel, cobalt, and chrome from the original rocks.

The iron, chrome, and cobalt were concentrated on the upper part of the weathering profile (limonite type), while nickel, magnesium, and silica were moved downwards and concentrated on the lower part of the profile (saprolite type).

The results of the pitting program and the assaying showed that the high-nickel grade zone (> 2.00% Ni to > 3.00% Ni) was distributed in a form of pocket (Pocket 1, 2, and 3).

5. Evaluation of Exploration Results

5.1. Pitting at 100 m × 100 m Spacing

A total of 24 pits (average depth 5.67 m; area of influence 22.00 ha) at 100 m × 100 m spacing were dug and 23 pits were sampled, while 1 pit was not sampled because the pit intersected the

bedrock at 1 m depth.

The high-grade zone is discovered in 9 pits (average depth 7.44 m; area of influence 8.50 ha; Pocket 1) and also 6 pits out of the above 9 pits are unbottomed and still have a good potential for additional tonnage. The pits locate in the west part of the base line, between cross-line 2 and cross-line 8 (Fig. 6).

The indicated resource of the high-grade zone is as follows;

- *Limonite Ore* = 346,594 WMT @ 1.13% Ni
- *Saprolite Ore* = 334,403 WMT @ 2.18% Ni

The estimate for indicated resource is 346,594 wet metric tonnes (WMT) grading 1.13% Ni, 0.19% Co, 41.18% Fe, 3.44% MgO, 18.90% SiO₂ and 2.02% Cr₂O₃ for the limonite and is 334,403 WMT grading 2.08% Ni, 0.05% Co, 16.43% Fe, 17.75% MgO, 27.89% SiO₂ and 1.12% Cr₂O₃ for the saprolite.

5.2. Pitting at 50 m x 50 m Spacing

Some of the 50 m x 50 m pits were dug around the 100 m x 100 m spacing pits which contain garnierite (> 2.00% Ni) which occurs in many nickel laterite deposits. The other 50 m x 50 m spacing pits were dug along the base line to get some information on the lateral distribution of the nickel grade.

5.3. Drilling at 50 m x 50 m Spacing

A total of 66 drill holes, comprising 628.65 meters of drill core, and 1343 assayed samples (containing drilling samples at 25 m x 25 m spacing), were used for the estimate. These drill holes cover approximately 14.14 ha of the currently delineated laterite area.

The high-grade zone is discovered in between Line 5 and Line 8 of the western part of the base-line and also there is a very interesting hole in the Pocket 3, which has returned an average grade of 2.38% Ni from a depth of 9 m to 20.5 m (saprolite ore zone).

The measured resource is as follows;

- *Limonite Ore* = 248,137.5 WMT @ 1.16% Ni (*Low Grade Limonite*)
- *Saprolite Ore* = 298,280.0 WMT @ 1.49% Ni (*Low Grade Saprolite*)
- *Saprolite Ore* = 506,800.0 WMT @ 2.18% Ni (*High Grade Saprolite*)

5.4. Drilling at 25 m x 25 m Spacing

A total of 54 drill holes (average depth 13.30 m, area of influence 7.3 ha), comprising 1,319.25 meters of drill core, and assayed samples, were used for the estimate.

The high-grade zone is discovered in between Line 2 and Line 8.

The measured resource (Pockets 1 and 2) is as follows;

- *Limonite Ore* = 860,377.70 WMT @ < 1.00% Ni to > 1.80% Ni
- *Saprolite Ore* = 237,608.25 WMT @ > 1.00% Ni to > 1.80% Ni
- *Saprolite Ore* = 399,928.13 WMT @ > 2.00% Ni to > 3.00% Ni

The total resource of nickel-bearing laterite deposit is 1,497,914.08 WMT (Pockets 1 and 2), consisting of 860,377.70 WMT of limonite ore and 637,536.38 WMT of saprolite ore including 506,800 WMT @ 2.18% Ni.

6. Discussion and Conclusion

The formula used for nickel resource estimates is as follows; Area of Influence x Ore Thickness x Specific Gravity (SG) = Ore Tonnage in Wet Metric Tonnes (WMT).

The specific gravity of the limonite ore is 1.6, while 1.5 is used for saprolite ore resource. Tonnage is reported in wet metric tonnes (WMT), applicable for direct shipping ore (DSO) operations, and not in dry metric tonnes (DMT), applicable to any processing operation.

The exploration results have outlined the high-grade nickel ore zone in the 3 pockets and the total potential area is approximately 18.80 ha.

The untested exploration target may cover an area of approximately 11.00 ha from 55.72 ha of the exploitation mining right area.

The total tonnage of nickel-bearing laterite in Pocket 1 and 2 of the Olo-Oloho Project area is 1,497,914.08 WMT; consisting of 860,377.70 WMT of limonite ore and 637,536.38 WMT of saprolite ore (including 506,800 WMT @ 2.18% Ni) plus 151,406.25 WMT @ 2.08% Ni (Pocket 2, uncompleted 25 m x 25 m spacing drilling) and 45,000.00 WMT @ 2.33% Ni (Pocket 3, uncompleted 25 m x 25 m spacing drilling). The measured resource is 703,206.25 WMT @ 2.196% Ni.

Assume that the remaining 11ha area with an estimated average depth of 8.50 m may generate an additional geological resource of 1,449,250.00 WMT. The estimated geological resource of the Olo-Oloho nickel-bearing laterite deposit is approximately

3,786,070.75 WMT, including a measured resource of 703,206.25 WMT @ 2.196% Ni.

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