A Pre-Liminary Study :
Potential Economic Tailing Exploring by Geophysical Logging Method in Bangka

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Abstract

In Bangka-Belitung Provinces, PT Timah TBK hold 120 mining concession permit (IUP) which is about 428,378.98 Ha. Mining activities begun significantly at colonial era (before 1945) and continued until recent day. The massive mining activities produced abounded remains tailing (mineral processing residue). The selective mining on tin ore caused the other potential economic mineral were neglected. Hence, this study is aimed to reorganize and manage the potential economic mineral at tailing area that's distributed in mining consesion permit of PT Timah TBK .
Study area are located in Air Rirung (Bangka Regency) and Air Nudur (South Bangka). Both are comprised of tailing material (loose sediment). Geophysical logging tools (GammaRay and Density Log), elemental analysis (using XRF handheld portable) and grain size analysis (sieving) are applied to identify the interest tailing area. Low density and high Gammaray indicate dominantly clay content in coarse sand, while high density and low Gammaray indicate little or no clay content in coarse sand. Furthermore, GammaRay detected Thorium (Th) and Uranium (U) content that come from monazite mineral. The heavy mineral (ilmenite) is distributed on bottom of each layering (stage). By element to element correlation, stannum (Sn) shows good correlation to Fe-Ti and Ce-Y-La-Th-U. Comparing to Gammaray, at fraction -#200 Th and Y shows good positive corelation to GR log, while at fraction +#200 Th and Y shows good negative correlation. In spatial distribution, the heavy mineral and coarse grain are deposited near from the source while the light mineral and fine grain relatively are deposited faraway from the source. Using IDW Method, the potential REE in monazite mineral are estimated of 8.0 tonnes in Air Rirung and 1.6 tonnes in Air Nudur.

Keywords :
Tailing, geophysical logging, correlation, spatial distribution, heavy mineral, monazite

A. PRELIMINARY

A.1. Background

In Bangka-Belitung Provinces, PT Timah TBK hold 120 mining concession permit (IUP) which is about 428,378.98 Ha. Mining activities begun significantly at colonial era (before 1945) and continued until recent day. The massive mining activities produced abounded remains tailing (mineral processing residue). The selective mining on tin ore caused the other potential economic mineral were neglected. Hence, this study is aimed to reorganize and manage the potential economic mineral at tailing area that's distributed in mining concession permit of PT Timah TBK.

The Government entrust the mining industry sector (company) through Regulation of the Minister of Energy and Mineral Resources No.26/2018 to apply and develop the mineral conservation principle without neglecting the good mining practice. PT Timah TBK commit to conform on government regulation.

A.2. Objectives :

This study is aimed to reorganize and manage the potential economic mineral at tailing area that's distributed in mining concession permit of PT Timah TBK .

A.3. Location :

The preliminary study are located at Air Rirung (Bangka Regency) and Air Nudur (South Bangka). These location are the mined out area which have the other potential mineral to be developed.

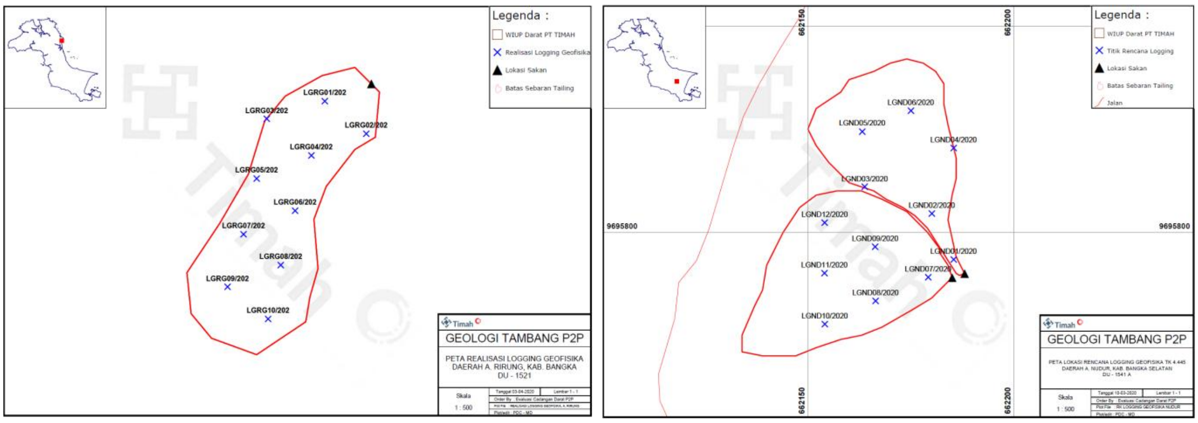


Figure 1. Research Location Air Rirung (*left*) and Air Nudur (*right*)

B. DATA AND METHOD

B.1. Data

1. Geophysical logging data

Geophysical logging data consist of Gammaray log and Density Log. There are 12 drill point data in Nudur and 10 drill point data in Air Rirung

2. Drilling sample

Sediment samples are obtained from tailing by using Bangka Drill. There are 7 holes of Bangka drill in Nudur and 6 holes in Rirung.

B.2. Method

B.2.1. Data Collecting

Data used in this study consist of two grouped : direct data (drilling) and indirect data (logging). Drill sample are composited by 1 meter, while geophysical logging are scanned by 1 cm. But then geophysical data are simplified and composited in one meter.

B.2.2. Data Processing

The numeric/ quantitative data are processing in Micromine 2020 Licensed software and Mirosoft Excel, while the text/ qualitative data are reported in Microsoft Word.

B.2.3. Sample Preparation and Analysis

1. Geophysical Log

Gammaray log identify the radioactive content in material. Generally, high radioactive content indicate dominantly clay sediment, otherwise low radioactivity simplify as sand particle sediment. In other hand, density log imply how dense material is. High density indicate the clay material and low density indicate porous material (sand particle).

Gammaray and density log are interpreted and integrated wholly to build vertical stratification and lateral distribution. Furthermore, Gammaray log are used to delineate the potential economic mineral such as monazite.

2. Bangka Drilling

Bangka drilling sample (direct data) are used to control and assure the quality (QAQC) of geophysical log data (indirect data). In case particle size, drilling samples (each 1 meter composite) are treated in laboratory to obtain the particle size distribution. The sample are sieved on mesh +#10, +#20, +#48, +#200, -$200. Mesh +#10 until +#20 are categorized as coarse sand material, mesh +#48 until +#200 are categorized as medium to fine sand material and mesh -#200 are categorized as clay material. Furthermore, these particle group are analyzed to observe the element composition (by XRF Handheld Portable) and the mineral composition (by grain counting analysis).

3. Integrated Interpretation

The integrated interpretation conclude the potential economic mineral in vertical and lateral distribution of tailing area

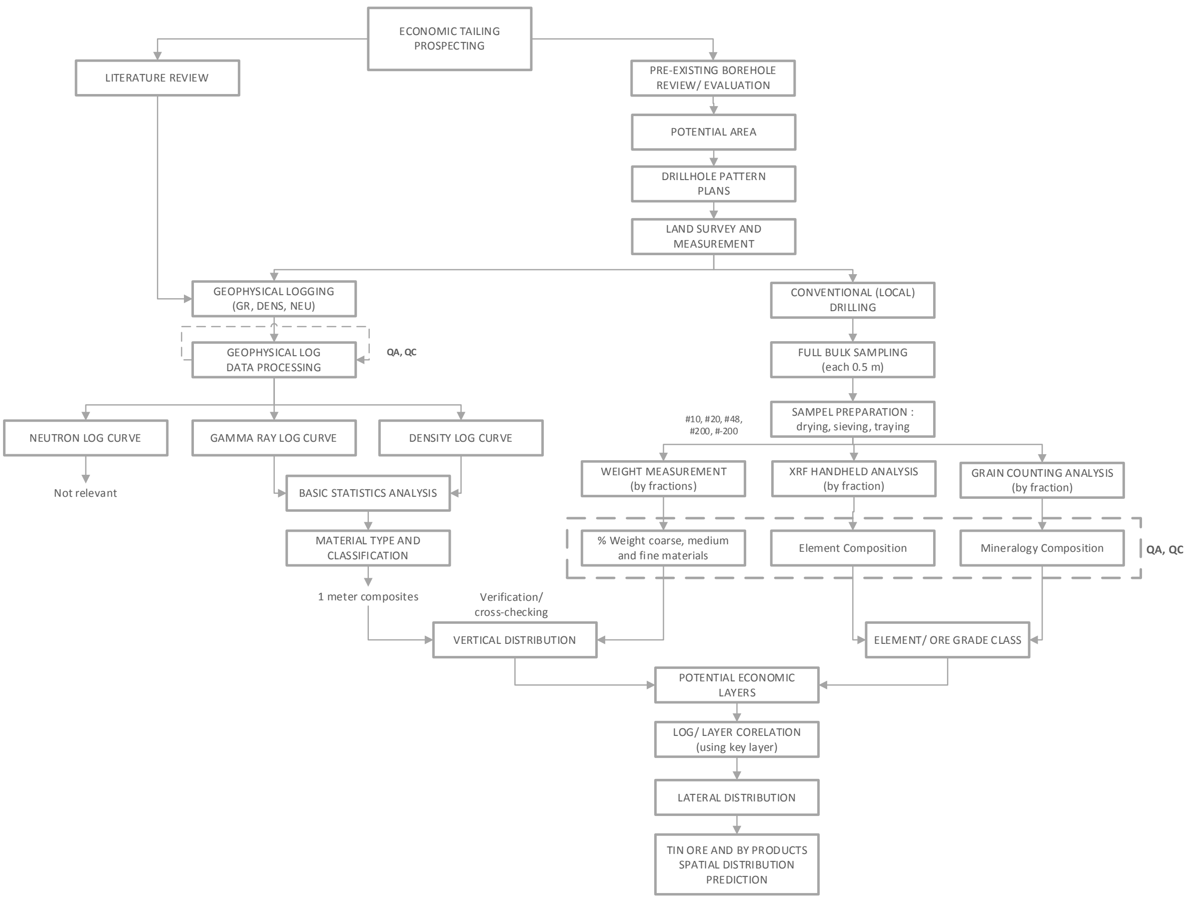


Figure 2. Research Diagram Flowchart

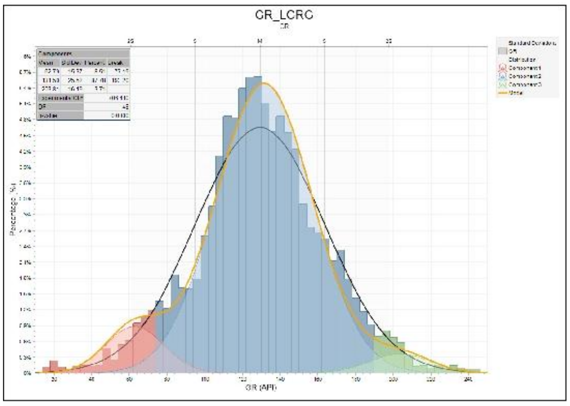
C. RESULT AND DISSCUSS

C.1. Grain Size Analysis

According to statistical analysis of Gamma Ray (GR) values (Figure 3), at least there are 3 group domains such as 0 - 125 API (classified as coarse sand grain dominated), 125 - 183 API (classified as sand grain dominated by fine sand) and greater than 183 API (classified as sand grain dominated by clay material). These indirect data interpretation are compared to direct data (drill sample) for reliable information (QAQC). Drill Samples are treated in laboratory. The dry material are sieved all together to obtain the fraction by grain size. There 5 fraction (grain size class) such as mesh #10, mesh #20, mesh #48, mesh #200, and mesh #-200). Compared to previously classification (indirect data), the fraction classification mesh #10 - #20 are classified as coarse sand, mesh #48 - #200 are classified as medium to fine sand and mesh #-200 is classified as clay material.

As shown Figure 4 and Figure 5, the interpreted grain size (from geophysical logging data) have the good correlation to material grain size (by %weight composition). Coarse grain composition dominated are shown by low API (Gamma Ray value), and vise versa higher clay composition in combination material are shown by higher API. This implies that the geophysical Gamma Ray (indirect data) are able to substitute drilling method (direct data).

Gamma Ray Distribution



Value		Label
	X	Coarse Sand
0.00		Coarse Sand
125.84		Medium to Fine Sand
183.67		Clay

Figure 3. Statistical Analysis of Gamma Ray Values

C.2. Vertical Distribution of Sediment Material

Generally, in each individual hole describe that the sediment deposition occurs in several time. In natural, the heavy and coarse material should be deposited near from the sources, vice versa the light and fine material deposited far away the sources.

Air Rirung

There 10 holes labeled with Code Id from LGRG01 to LGRG10. LGRG01 is located near from the sediment sources (from sakan “conventional mineral processing tools”), while LGRG10 is the farthest from the sources. In term of vertical distribution, it tends to form fining upward pattern even though sometimes shows coarsening upward pattern. The clay material are found in the LGRG09 and LGRG10. Generally, the coarse to fine sand material are dominated in the tailing area in Rirung (Figure 4).

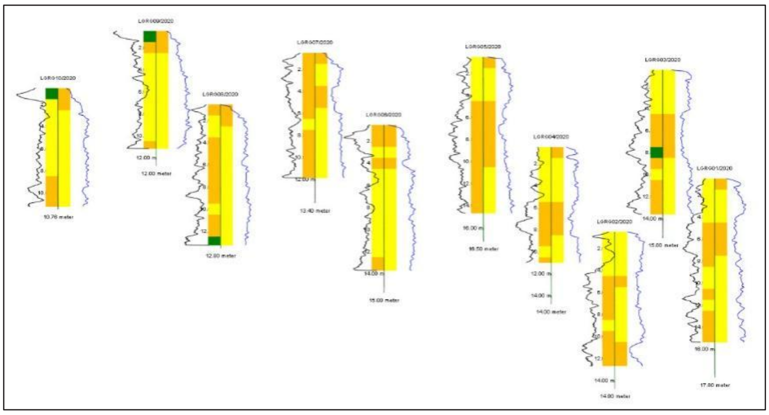


Figure 4. Vertical Distribution of Sediment Material in Air Rirung

Air Nudur

There 12 holes labeled with Code Id from LGND01 to LGND12. LGND01 and LGND02 are the nearest from the sources, while LGND05 and LGND12 are the farthest from the sources. Vertically, coarse sand sediment are abundance. The anomaly occurs at hole LGND08, which show the clay sediment distributed thickly. It is approximated as the in situ material (undisturbed material).

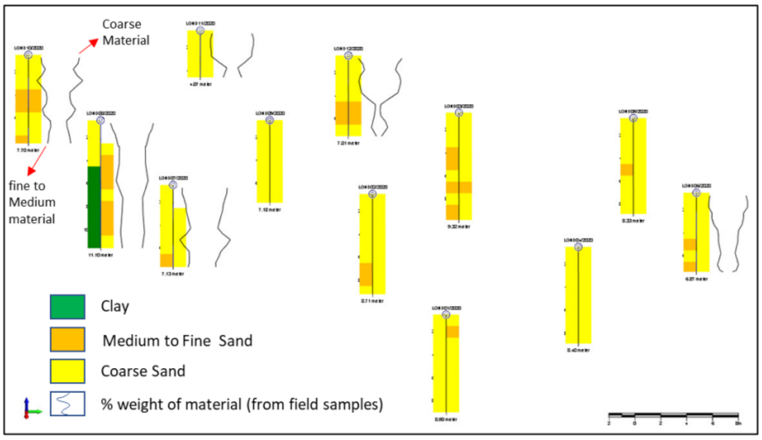


Figure 5. Vertical Distribution of Sediment Material in Air Nudur

C.3. Elemental Analysis

C.3.1. Correlation Coefficient among Elements

The element grade of all samples (each 0.5 meter representative) are analyzed by using XRF Handheld portable 2-3 times each grain size (fraction). The element grade are plotted into borehole and combined to interpreted materials. Some elements used in this study are Sn, Fe, Ti, Zn, Pb, Mn, Ce, La, Th, U. The heavy elements like as Sn, Fe and Ti are used to describe the sediment deposition process, while Ce, La, Th and U are related to monazite mineral which is the main object discussing in this study. Among Ce, La, Th and U elements have good correlation at fine grain and coarse grain. And also Sn, Fe and Ti elements have good correlation in fine and coarse grain (as shown Table 1 and Table 2).

Table 1. Correlation Coefficient among Elements At Fine Grain

	Sn	Fe	Ti	Zn	Pb	Mn	Ce	Y	La	Th	U
Sn	1.00										
Fe	0.95	1.00									
Ti	0.82	0.81	1.00								
Zn	0.39	0.46	0.48	1.00							
Pb	0.49	0.56	0.58	0.57	1.00						
Mn	0.74	0.75	0.60	0.24	0.27	1.00					
Ce	0.85	0.86	0.71	0.36	0.51	0.54	1.00				
Y	0.96	0.97	0.84	0.50	0.61	0.66	0.88	1.00			
La	0.91	0.94	0.71	0.44	0.57	0.65	0.88	0.94	1.00		
Th	0.95	0.93	0.71	0.40	0.45	0.70	0.85	0.95	0.92	1.00	
U	0.89	0.89	0.85	0.56	0.65	0.61	0.80	0.94	0.84	0.84	1.00

Table 2. Correlation Coefficient among Elements At Coarse Grain

	Sn	Fe	Ti	Zn	Pb	Mn	Ce	Y	La	Th
Sn	1.0									
Fe	0.8	1.0								
Ti	0.9	0.9	1.0							
Zn	0.4	0.6	0.6	1.0						
Pb	0.9	1.0	0.9	0.7	1.0					
Mn	0.1	0.2	0.2	0.0	0.2	1.0				
Ce	0.5	0.6	0.5	0.4	0.6	-0.1	1.0			
Y	0.9	1.0	0.9	0.6	1.0	0.0	0.7	1.0		
La	0.2	0.4	0.3	0.5	0.3	-0.1	0.7	0.4	1.0	
Th	0.8	0.9	0.8	0.5	0.9	0.0	0.6	1.0	0.3	1.0

C.3.2. Gamma Ray to Elements Correlation Coefficient

In fraction +#200 between Gamma Ray and Th or Y have good positive correlation while in fraction -#200 between Gamma Ray and Th or Y have good negative correlation. It implies Gamma Ray is useful tool in detecting Th or Y element (or Th, Y mineral bearing). Gamma Ray to Y #+200 element show correlation coefficient 0.81; to Y #-200 show -0.75; to Th #+200 show 0.82 ; and to Th #-200 show -0.82.

According to the element grade of Th and Y, mesh #-200 has greater grade than mesh #+200. The finer material accumulate more Th and Y element. As mentioned previously, monazite mineral has the main role in contributing some elements (ex. Th and Y). It means monazite in finer particle (#-200) is more abundance than in coarser particle (#+200). It is a consideration in processing issue.

Sn +200#	Sn -200#	Y +200#	Y -200#	Th +200#	Th -200#	GR
116	94	33	119	46	165	93.28
46	324	7	278	21	308	61.69
96	327	5	267	22	331	52.47
89	417	7	268	18	342	37.62
37	254	5	204	13	288	22.08
61	232	5	208	19	295	55.57
70	228	7	204	31	295	95.57
49	88	34	106	54	193	146.76
56	78	44	102	75	196	158.64
77	72	58	124	83	194	162.47
64	85	44	104	83	176	153.49
65	74	35	99	57	171	159.33
63	85	44	118	72	186	149.03
43	76	47	126	67	170	125.47
41	54	36	110	57	155	140.02
61	75	31	106	53	138	124.56
65	66	37	104	54	142	125.63
60	82	27	118	43	172	123.43
30	206	12	228	12	232	127.42
68	86	77	134	93	151	130.02
91	72	73	151	69	153	173.61
54	88	63	145	75	168	180.19
73	85	57	151	65	169	155.51
62	71	63	118	86	173	152.17
50	74	55	137	63	160	140.12

	Sn +200#	Sn -200#	Y +200#	Y -200#	Th +200#	Th -200#	GR
Sn +200#	1.00						
Sn -200#	0.11	1.00					
Y +200#	0.10	-0.77	1.00				
Y -200#	0.06	0.95	-0.66	1.00			
Th +200#	0.08	-0.80	0.93	-0.77	1.00		
Th -200#	0.07	0.96	-0.79	0.90	-0.77	1.00	
GR	-0.09	-0.85	0.81	-0.75	0.82	-0.82	1.00

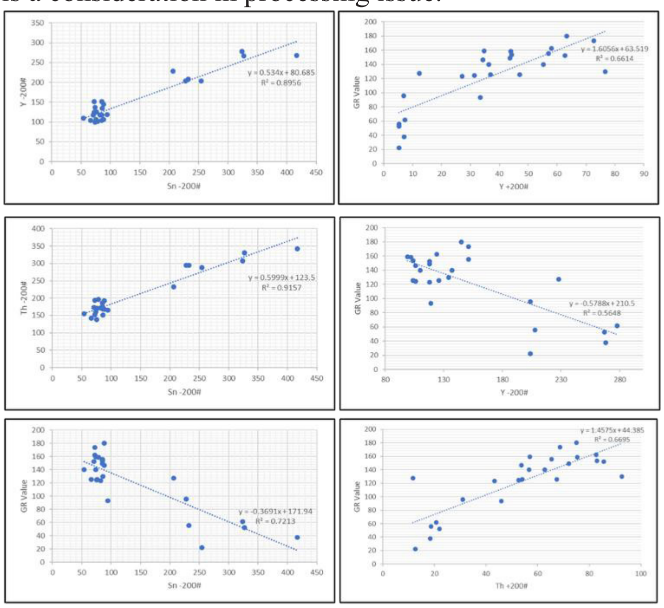


Figure 6. Correlation Coefficient Gamma Ray vs Some Elements

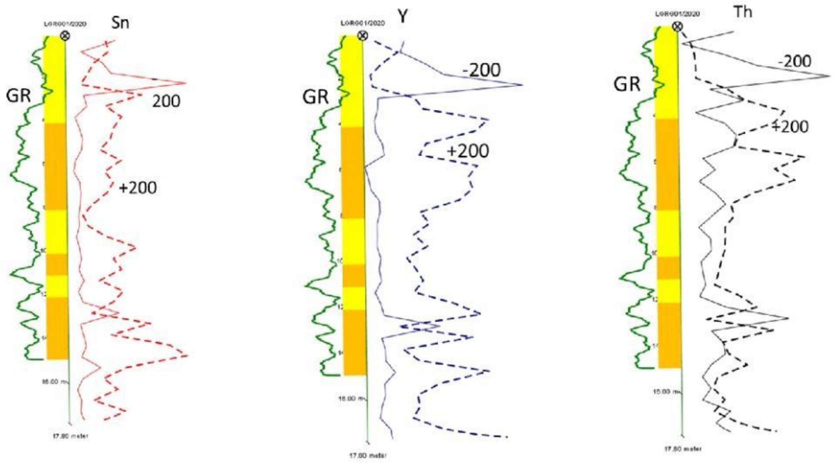


Figure 7. Curve Visualization of Gamma Ray vs Some Elements

C.4. Spatial Distribution
The schematic model of tailing distribution after mineral processing activity (using 'sakhan') is shown Figure 8. By gravity concept in the nature case, the heavy and coarse materials should be deposited near from the sources and respectively, the light and fine materials should be deposited farther. In Air Rirung and Air Nudur are described below.

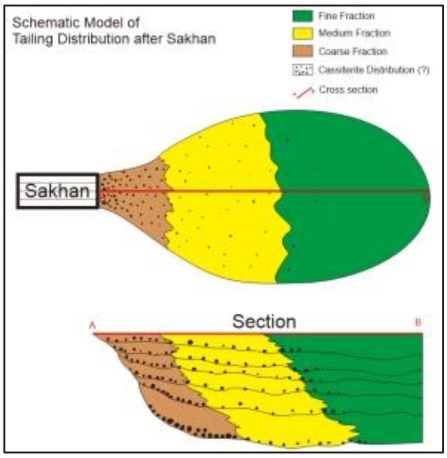


Figure 8. Schematic Model of Tailing Distribution After Mineral Processing Activity

Air Rirung
In section A-A' shows that the sediment material flow to West direction. The heavy mineral (Sn and Ti) relatively dominated in Northeast. Even so the coarse material change gradually to West to be finer material in all elevation. At least, there are 3 times sediment deposition occurs in this section. In section C-C', the coarse material change gradually to North to be finer material. In the top elevation, in the end of section (LGRG10) is found clay material. The deposition direction is little different from area section A-A'. It indicates the deposition environment is different both of them.
In context Gamma Ray Value, coarse sand dominated relates to low Gamma Ray and fine monazite (# -200), respectively mixed coarse sand relates to high Gamma Ray and coarser monazite (#+200). In the other word, finer monazites are distributed near from sources, and the coarser one are distributed farther away from the sources. In section A-A', finer monazite are accumulated dominantly in East direction, and respectively. While in Section C-C', finer monazite are accumulated dominantly in North direction, and respectively.

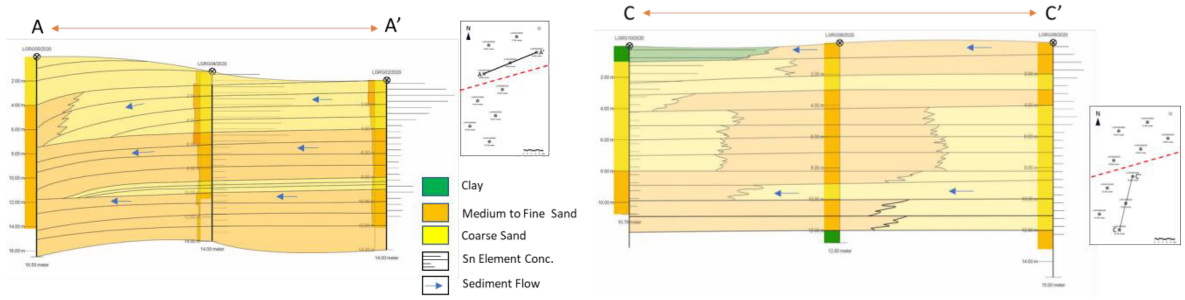


Figure 9. Spatial Correlation in Air Rirung

Air Nudur

In section A-A' and B-B'show that the sediment material flow in some direction. The change of direction indicated there are some sediment sources. In Section A-A', the first deposition (bottom elevation) sediment flow to North, but in the second deposition event (top elevation) the sediment flow direction change to South. It also occurs in section B-B', first event from Northwest to Southeast and the second event change to be from Southeast to Northwest. But in B-B' Section, coarse material are distributed dominantly in the central part of section.

In context Gamma Ray Value, finer monazites are distributed near from sources, and the coarser one are distributed farther away from the sources. In section A-A', at first event the finer monazite are accumulated dominantly in South direction, and second event the finer monazite are accumulated dominantly in North direction. While in Section B-B', at first event the finer monazite are accumulated dominantly in Northwest direction, and second event the finer monazite are accumulated dominantly in Southeast direction.

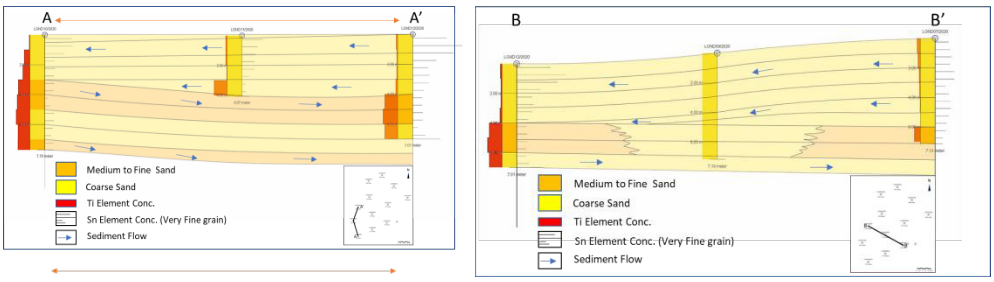


Figure 10. Spatial Correlation in Air Nudur

C.5. Mineral Potential Estimate

Monazite mineral potential are estimated using Inverse Distance Weight (IDW) method. The grade values are in range of <134 ppm to >548.7 ppm in Rirung Area and in range of < 22.1 ppm to >293.7. Air Rirung. The classification are grouped 7 classes each location as shown by Figure 11. Micromine software is applied in this monazite potential estimation. Figure 11 and Table 3 are shown the results of potential estimation. The potential REE in monazite mineral are estimated of 8.0 tonnes in Air Rirung and 1.6 tonnes in Air Nudur.

Tabel 3. Potential REE in Monazite

Location	Volume Total (m^3)	Density	Tonase (ton)	Grade REE (ppm)	Total REE (ton)
Air Rirung	22438	1.4	31413	254.67	8.0
Air Nudur	10344	1.4	14481	107.60	1.6

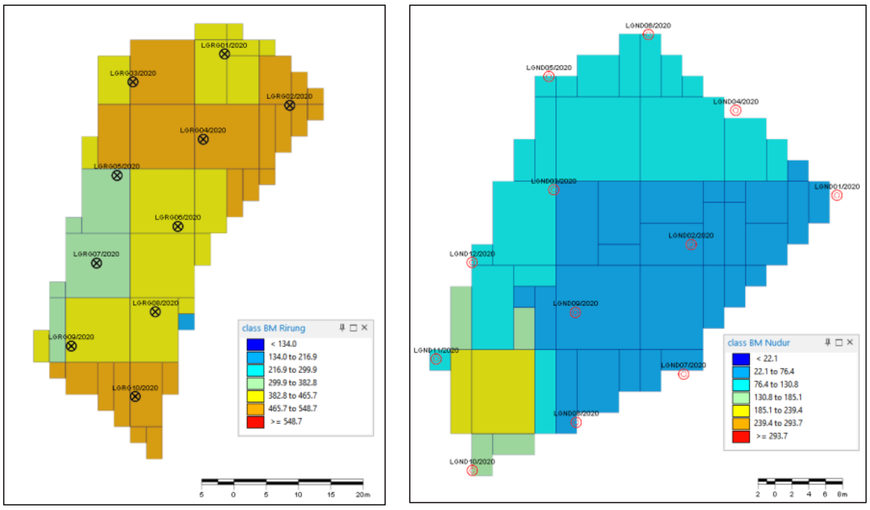


Figure 11. Block Model of Potential REE in Monazite (*Left*: Air Rirung, *Right*: Air Nudur)

D. CONCLUSION

Some conclusions in the preliminary study of potential economic tailing exploring by geophysical logging method are :

1. Normally, Tailing sediments are distributed following the sediment depositional system, which the coarse material and high specific gravity should be deposited around or near the source (in this term Sakan);
2. Coarse sand dominated relates to low Gamma Ray and fine monazite (# -200), respectively mixed coarse sand relates to high Gamma Ray and coarser monazite (#+200);
3. The potential REE in monazite mineral are estimated of 8.0 tonnes in Air Rirung and 1.6 tonnes in Air Nudur

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