# Statistical Data Analysis of Lateritic soil in Hpa-an-Taunggalay Area, Hpa-an Township, Kayin State

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## Abstract

Laterite and lateritic soil are well exposed in Lower Myanmar. Lateritization is economically most important for the formation of iron and nickel ore deposits. The present research was investigated in the laterite and lateritic soil of the Hpa-an Township, Kayin State. The rocks of Taungnyo Formation (Carboniferous to Early Permian), Moulmein Limestone (Middle to Late Permian), Older Alluvium (Pleistocene) and Younger Alluvium (Holocene) covered in the study area with different relief. The rocks of the Taungnyo Formation are exposed at the northern part of the Zwekabin Range and southern part of the Hpa-an area. Moulmein Limestone is mostly composed at the Zwekabin Range with gentle dipping. The other isolated hills with karst topography are also composed of Moulmein Limestone. Most of the flatplain along the western and eastern part of research area are covered by reddish brown to yellowish brown colored, partly pale brown colored, thick lateritic soil. Lateritic soil samples are analysed by EDXRF as the laboratory work to know the containing elements in soils. The identification and analysis of lateritic soils were made by using SPSS 16 software. The analytical result were suggested that lateritic soil of the Hpa-an contains Si, Fe, Al, K, Ti, Ca, S, Mn, Sr, Cr, V, Zr, Cu, Zn,Y, Nb and Rb elements. According to correlation, iron vs aluminium, iron vs titanium, iron vs sulphur, iron vs vanadium and iron vs copper are positively correlated. Iron vs silica, iron vs strontium, iron vs manganese, iron vs zinc and iron vs rubidium are negatively correlated. According to the iron distribution map, the highest iron content area occurrs at the north-western part of the research area with greater than 40% of iron content. According to this study, iron distribution is reduced from north-western to south-eastern part. The origin of iron concentration may be derived from the some part of Taungnyo Formation or some igneous rocks. According to the silica distribution map is based on the silica content percentage in lateritic soil. The highest silica content area is occurred at the eastern part of the research area with greater than 70% of silica content. According to this study, silica distribution is reduced from east to west. The origin of silica concentration may be derived from the cherty limestone of Moulmein Limestone.

## Introduction

Laterite and lateritic soil are well exposed in Lower Myanmar. The present research was investigated in the laterite and lateritic soil of the Hpa-an Township, Kayin State. Laterite is suitable as a base, subbase and embankment for dam construction and is also beneficial to plant growth. Lateritization is economically most important for the formation of iron and nickel ore deposits. Laterite areas are used for discovery of economic minerals.

The research area is bounded between North Latitude 16°44' to 16°58' and East Longitude 97°31' to 97°43'. The study area is easily accessible by car, train and various kinds of vehicle because the most of the area are low-lying topography and fairly good condition of bedrock for road constructions.

The rocks of Taungnyo Formation (Carboniferous to Early Permian), Moulmein Limestone (Middle to Late Permian), Older Alluvium (Pleistocene) and Younger Alluvium (Holocene) covered in the study area. The rocks of the Taungnyo Formation are exposed at the northern part of the Zwekabin Range and southern part of the Hpa-an area. The rocks are mainly composed of clastic units; thin bedded, whitish grey to pinkish colored siltstone, partly light grey to dark grey siltstone intercalated with thinnly laminated shale, partly fine grained nodular sandstone.

Moulmein Limestone is mostly composed at the Zwekabin Range with gentle dipping. The other isolated hills with karst topography are also composed of Moulmein Limestone. The rocks

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consist of medium to thick bedded, light grey to grey colored micritic limestone, dolomitic limestone and brecciated limestone. Most of the flatplain along the western and eastern part of research area are covered by reddish brown to yellowish brown colored, partly pale brown colored, thick lateritic soil. Besides, light grey to yellowish grey colored silty soils of younger alluvium expose along the central part of this area, especially Thanlwin River.

## Methodology

It has studied a collection of all available geological Thesis and Papers.Topographic map interpretation is plotted on the UTM map no. 1697-9, 10, 13 and 14 of Survey Department (Ministry of Forestry). Topographic units as features, elevation contrast and topographic trends, drainage systems in relation with structural controlled features are described in these studies. By using the ArcGIS 10.1 (GIS software), the terrain analysis of the research area was made on the dem image with 30 meter resolution. Besides, samples collections are made by using the GPS methods to get the distribution of lateritic soil samples. And then, all of soil samples are tested with EDXRF as the laboratory work to know the containing elements in soils. The identification and analysis of lateritic soils were made by using SPSS 16 software. Moreover, the obtaining elements were drawn the element distribution map of the most common elements such as iron and silica.

## Results and Discussions

The chemical results of lateritic soils from the Hpa-an area were analyzed by the result of EDXRF are shown in Table (1). Besides, collected representative soil samples localities map is also illustrated in Figure (1). Correlations between iron and others elements were made by using SPSS 16 software.

Lateritic soil of the Hpa-an area contains Si, Fe, Al, K, Ti, Ca, S, Mn, Sr, Cr, V, Zr, Cu, Zn, Y, Nb and Rb elements. Most of the elements are lithophile elements which are located on the lateritic soil of Hpa-an area such as Si, Al, K, Ti, Ca, Mn, Sr, Cr, V, Zr, Y, Nb and Rb. These lithophile elements are occurred association to some chalcophile elements as Fe, S, Cu and Zn.

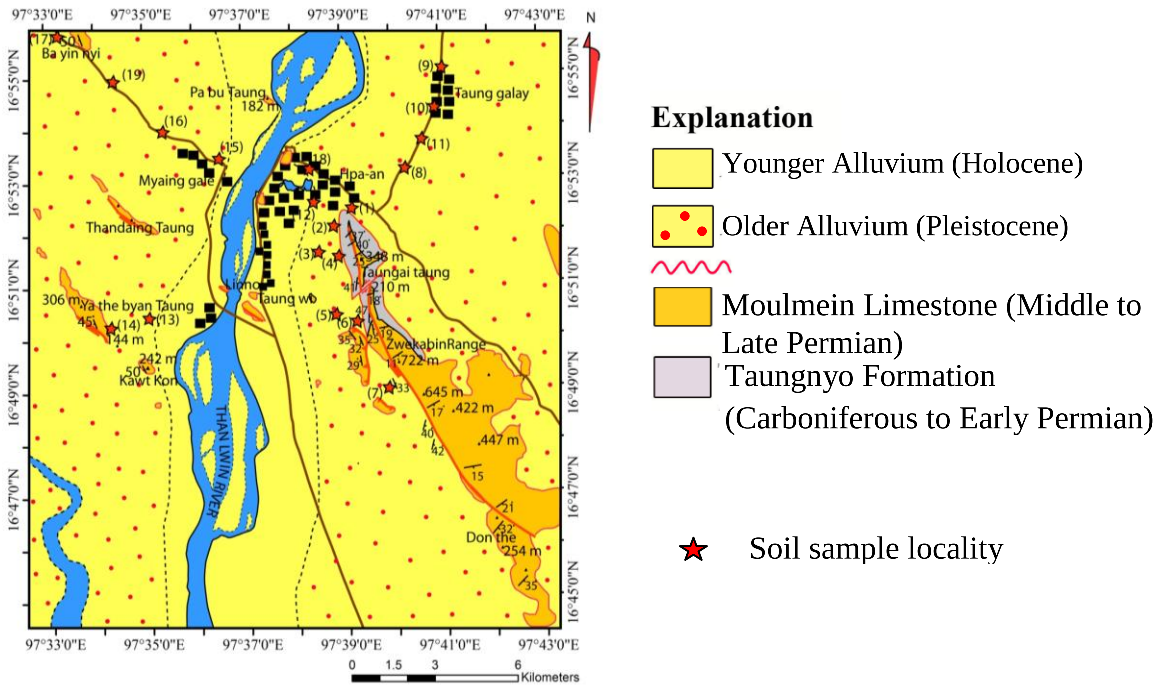


Figure (1) Geology Map showing soil sample localities of the research area

Table (1) Trace elements contents in soil samples of Hpa-an Area

| **Loc** | **Si** | **Fe** | **Al** | **K** | **Ti** | **Ca** | **S** | **Mn** | **Sr** | **Cr** | **V** | **Zr** | **Cu** | **Zn** | **Y** | **Nb** | **Rb** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 54.59 | 23.45 | 9.53 | 7.35 | 2.95 | 1.08 | | 0.21 | 0.06 | 0.05 | 0.10 | 0.37 | 0.06 | 0.08 | 0.05 | 0.02 | 0.06 |
| 2 | 69.77 | 8.35 | 9.35 | 8.14 | 3.26 | | | 0.15 | 0.08 | | 0.08 | 0.67 | 0.04 | | 0.04 | | 0.08 |
| 3 | 54.95 | 25.17 | 10.11 | 5.19 | 3.17 | | 0.50 | 0.07 | 0.04 | 0.07 | 0.11 | 0.38 | 0.06 | 0.07 | 0.05 | | 0.05 |
| 4 | 49.16 | 31.33 | 10.59 | 4.68 | 2.75 | | 0.73 | 0.11 | 0.08 | 0.08 | 0.12 | 0.28 | 0.07 | | 0.04 | | |
| 5 | 35.49 | 48.07 | 9.59 | 3.72 | 1.77 | | 0.83 | 0.09 | 0.14 | 0.09 | 0.09 | 0.08 | 0.06 | | | | |
| 6 | 51.47 | 33.48 | 8.31 | 3.16 | 2.23 | 0.40 | 0.52 | 0.10 | 0.05 | 0.10 | | | 0.06 | | 0.03 | | |
| 7 | 69.79 | 18.00 | 4.09 | 2.30 | 1.41 | 3.13 | | 0.84 | 0.10 | | 0.07 | 0.07 | 0.01 | 0.07 | | | 0.02 |
| 8 | 68.11 | 21.78 | 5.15 | 1.43 | 1.64 | 0.41 | 0.69 | 0.20 | 0.06 | 0.07 | 0.07 | | | 0.08 | 0.04 | | |
| 9 | 54.01 | 25.77 | 7.75 | 5.91 | 2.22 | 2.38 | 0.73 | 0.62 | 0.07 | 0.05 | 0.09 | 0.27 | 0.05 | 0.05 | 0.04 | | 0.00 |
| 10 | 36.72 | 36.89 | 14.06 | 8.07 | 2.60 | | 0.51 | 0.30 | 0.09 | 0.07 | 0.14 | 0.29 | 0.08 | 0.11 | 0.06 | 0.02 | |
| 11 | 59.61 | 22.43 | 8.01 | 4.79 | 2.63 | 2.66 | 0.60 | 0.40 | 0.05 | 0.08 | 0.08 | 0.40 | 0.07 | 0.12 | 0.05 | | 0.02 |
| 12 | 77.71 | 12.84 | 3.11 | 1.62 | 1.13 | 1.30 | 0.88 | 0.49 | 0.53 | 0.09 | 0.05 | 0.07 | 0.05 | 0.09 | 0.04 | | |
| 13 | 49.06 | 28.60 | 12.57 | 5.85 | 2.65 | | | 0.41 | 0.03 | 0.06 | 0.11 | 0.43 | 0.08 | 0.06 | 0.05 | | 0.04 |
| 14 | 51.55 | 26.01 | 11.62 | 6.12 | 2.99 | | 0.55 | 0.16 | 0.04 | 0.07 | 0.14 | 0.49 | 0.07 | 0.07 | 0.04 | | 0.10 |
| 15 | 44.06 | 34.66 | 12.26 | 4.06 | 3.25 | 0.53 | | 0.24 | 0.08 | 0.07 | 0.14 | 0.49 | 0.07 | 0.06 | 0.05 | | |
| 16 | 27.02 | 43.91 | 18.63 | 3.36 | 4.61 | 0.56 | 0.39 | 0.32 | 0.06 | 0.06 | 0.18 | 0.65 | 0.10 | 0.08 | 0.06 | 0.04 | |
| 17 | 35.78 | 37.83 | 15.68 | 5.35 | 3.79 | | 0.44 | 0.24 | 0.04 | 0.08 | 0.15 | 0.44 | 0.08 | 0.06 | 0.05 | | |
| 18 | 65.69 | 23.75 | 5.65 | 1.73 | 1.48 | 0.84 | 0.50 | 0.17 | 0.06 | 0.06 | 0.05 | | | | | | |

**Correlation between Elements of the Lateritic Soil in the Research Area**

Correlation between iron and silica are shown in Figure (2). The minimum and the maximum value of silica are 27.018 % and 69.788 %. The minimum and the maximum value of iron are 8.348 % and 48.07 %. The correlation coefficient value (r) is 0.865. The relationship of these two elements is strong. The line of regression shows negative relationship.

The scatter plot for the data of iron and aluminium is shown in Figure (3). The minimum value of aluminium is 3.111 % and the maximum value is 18.628 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.456. The relationship of these two elements is strong. The line of regression shows slope down to right to left, and these two elements are positive relationship.

The data of iron and potassium correlation are shown in Figure (4). The minimum value of potassium is 1.432 % and the maximum value is 8.14 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 1.315. The relationship of these two elements is fairly weak and the line of regression shows linear regression.

The scatter plot for the data of iron and titanium are shown in Figure (5). The minimum value of Titanium is 1.129 % and the maximum value is 4.606 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.142. The relationship of these two elements is fairly weak. The line of regression shows slope down right to left. The relationship between two elements is positive relationship.

The scatter plot for iron and calcium are shown in Figure (6). The minimum value of calcium is 0.396 % and the maximum value is 3.134 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.248. The relationship of these two elements is weak. The line of regression shows slope down left to right. The relationship between two elements is negative relationship.

The scatter plot for the data of iron and sulphur are shown in Figure (7). The minimum value of sulphur is 0.39 % and the maximum value is 0.833 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.213. The relationship of these two elements is weak. The line of regression shows positive relationship.

The scatter plot for the data of iron and manganese are shown in Figure (8). The minimum value of Manganese is 0.074 % and the maximum value is 0.843 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.094. The relationship of these two elements is fairly strong. The line of regression shows slope down to left to right. The relationship between two elements is negative relationship.

Correlation between iron and strontium are shown in Figure (9). The minimum value of Strontium is 0.034 % and the maximum value is 0.531 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.095. The relationship of these two elements is strong. The line of regression shows slope down to left to right. The relationship between two elements is negative relationship.

The scatter plot for the data of iron and vanadium are shown in Figure (10). The minimum value of Vanadium is 0.046 % and the maximum value is 0.18 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.422. The relationship of these two elements is strong. The line of regression shows slope down to right to left. The relationship between two elements is positive relationship.

The scatter plot for the data of iron and Copper are shown in Figure (11). The minimum value of Copper is 0.008 % and the maximum value is 0.097 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.361. The relationship of these two elements is strong. The line of regression shows slope down to right to left. The relationship between two elements is positive relationship.

The scatter plot for the data of iron and zinc are shown in Figure (12). The minimum value of Zinc is 0.05 % and the maximum value is 0.118 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.019. The relationship of these two elements is fairly strong. The line of regression shows slope down to left to right. The relationship between two elements is negative relationship.

The scatter plot for the data of iron and yttrium are shown in Figure (13). The minimum value of Yttrium is 0.03 % and the maximum value is 0.061 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.266. The relationship of these two elements is fairly strong. The line of regression shows slope down to right to left. The relationship between two elements is positive relationship.

The scatter plot for the data of iron and niobium are shown in Figure (14). The minimum value of Niobium is 0.02 % and the maximum value is 0.038 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.68. The relationship of these two elements is weak. The line of regression shows slope down to right to left. The relationship between two elements is positive relationship.

The scatter plot for the data of iron and rubidium are shown in Figure (15). The minimum value of Rubidium is 0.002 % and the maximum value is 0.099 %. The minimum value of iron is 8.348 % and the maximum value is 48.07 %. The correlation coefficient value (r) is 0.046. The relationship of these two elements is weak. The line of regression shows slope down to left to right. The relationship between two elements is negative relationship.

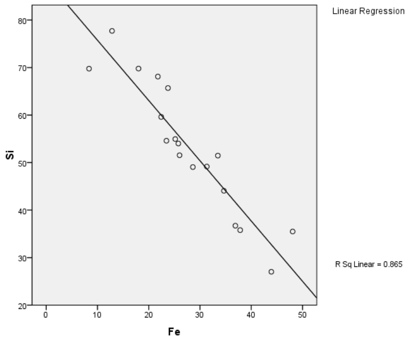


Figure (2) Correlation between Iron and Silica

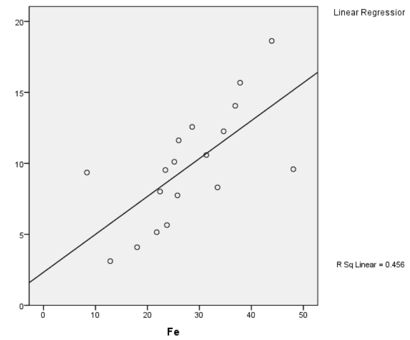


Figure (3) Correlation between Iron and Aluminium

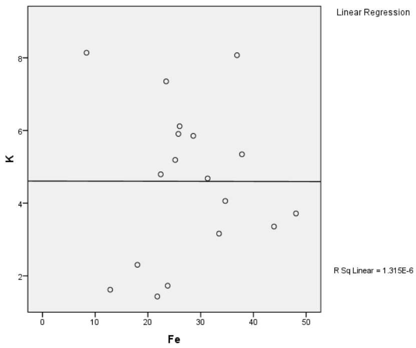


Figure (4) Correlation between Iron and Potassium

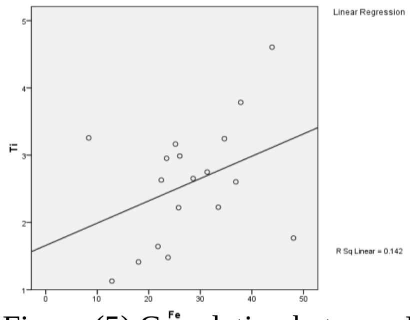


Figure (5) Correlation between Iron and Titanium

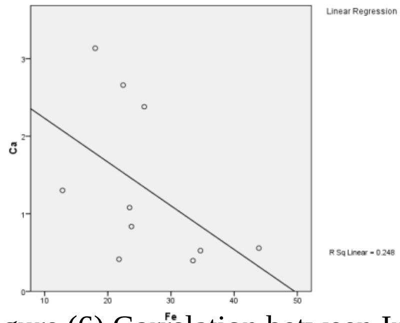


Figure (6) Correlation between Iron and Calcium area

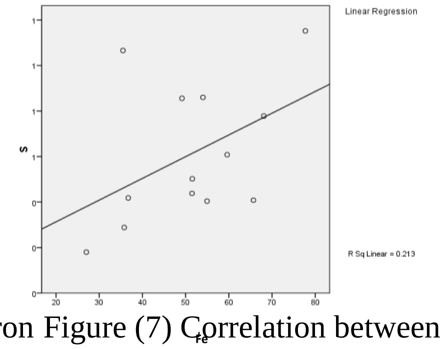


Figure (7) Correlation between Iron and Sulphur

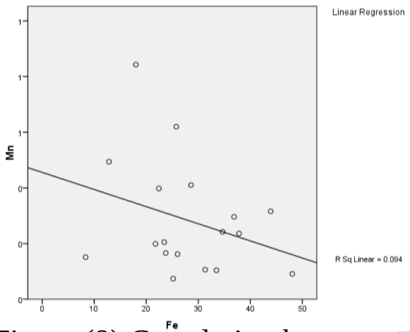


Figure (8) Correlation between Iron and Manganese

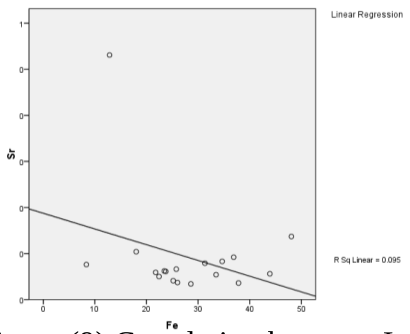


Figure (9) Correlation between Iron and Strontium

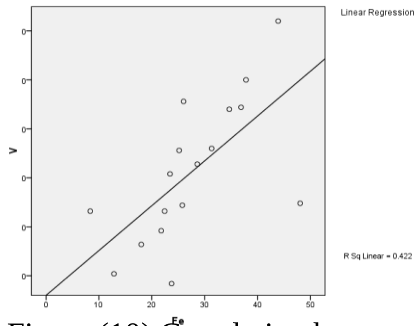


Figure (10) Correlation between Iron and Vanadium

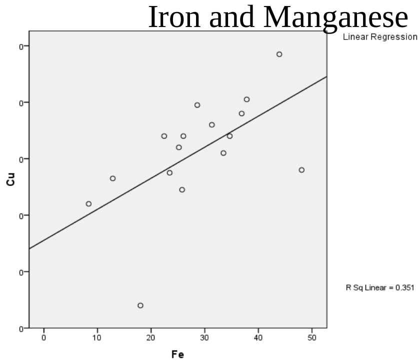


Figure (11) Correlation between Iron and Copper

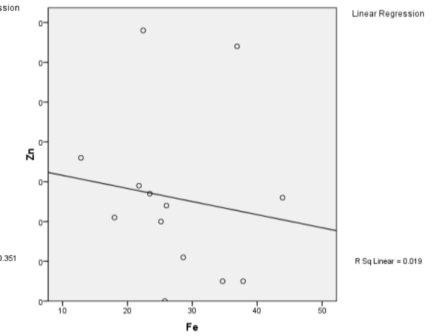


Figure (12) Correlation between Iron and Zinc

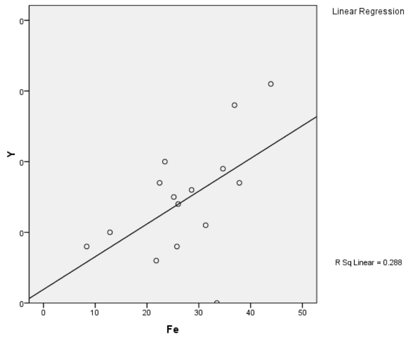


Figure (13) Correlation between Iron and Yttrium

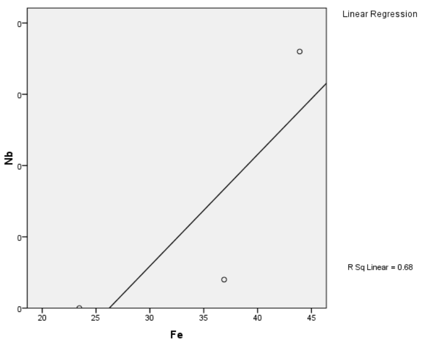


Figure (14) Correlation between Iron and Niobium

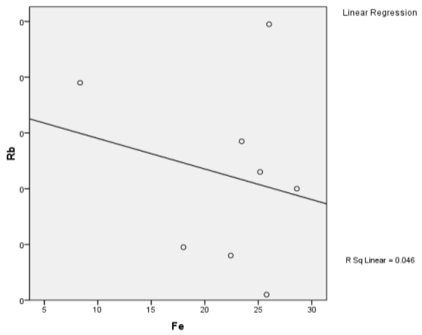


Figure (15) Correlation between Iron and Rubidium

**Iron Distribution of Lateritic Soil in Hpa-an Area**

The iron distribution map is based on the iron content percentage in lateritic soil. (See Fig. 16) The highest iron content area is occurred at the north-western part of the research area with greater than 40% of iron content. According to this study, iron distribution is reduced from north-western to south-eastern part. The origin of iron concentration may be derived from the some part of Taungnyo Formation or some igneous rocks.

**Silica Distribution of Lateritic Soil in Hpa-an Area**

The silica is the most prominent element among the elements of this study. The silica distribution map is based on the silica content percentage in lateritic soil which is also shown in Figure (17). The highest silica content area is occurred at the eastern part of the research area with greater than 70% of silica content. According to this study, silica distribution is reduced from east to west. The origin of silica concentration may be derived from the cherty limestone of Moulmein Limestone where Zwekabin range is mostly composed of the Moulmein Limestone.

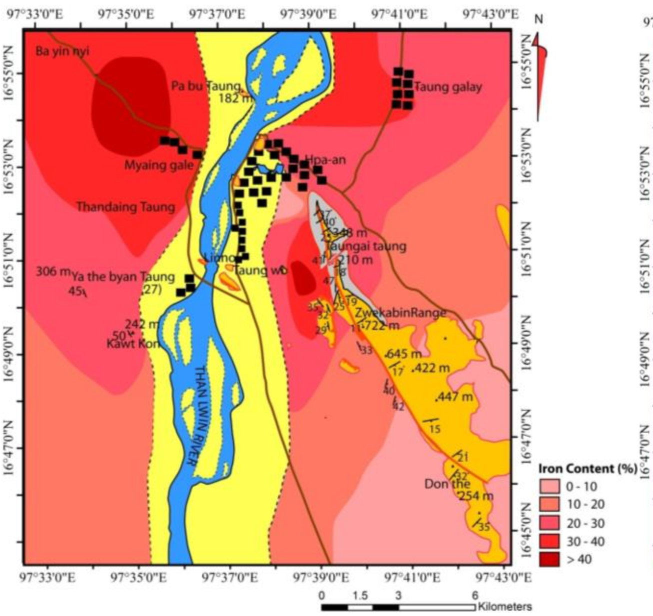


Figure (16) Iron distribution contour map of the research area

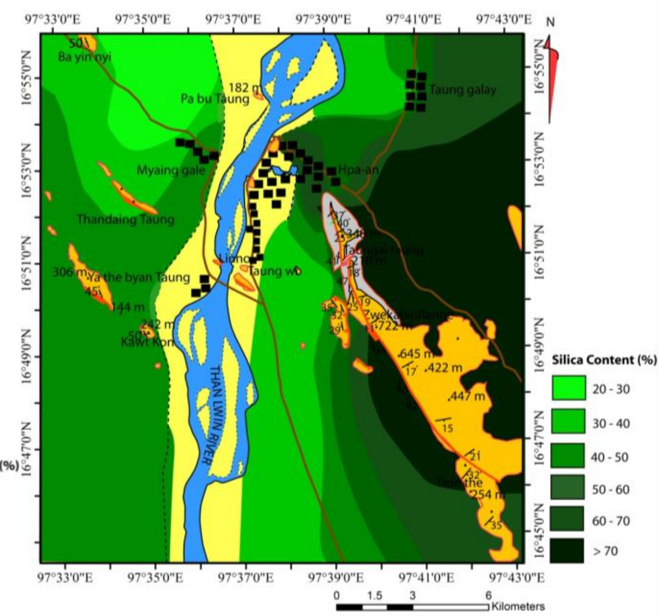


Figure (17) Silica distribution contour map of the research area

## Conclusion

Laterite is suitable for a base, subbase and selected course of a medium traffic road or airfield, embankment for dam construction and is also beneficial to plant growth. In the studied area composed of Taungnyo Formation (Carboniferous to Early Permian), Moulmein Limestone (Middle to Late Permian), Older Alluvium (Pleistocene) and Younger Alluvium (Holocene) in this area. Most of the lateritic soils are especially contained in Older Alluvium.

Lateritic soil of the Hpa-an area contains Si, Fe, Al, K, Ti, Ca, S, Mn, Sr, Cr, V, Zr, Cu, Zn, Y, Nb and Rb elements. Most of the elements are lithophile elements which are located on the lateritic soil of Hpa-an area such as Si, Al, K, Ti, Ca, Mn, Sr, Cr, V, Zr, Y, Nb and Rb. These lithophile elements are occurred association to some chalcophile elements as Fe, S, Cu and Zn. Among them, Si is the most common element composing in the lateritic soil as well as Fe is a second abundant distribution element.

According to the silica distribution map, silica is the most prominent element in the area. The highest silica content area occurred at the eastern part of the research area with greater than 70% of silica content. According to this study, silica distribution is reduced from east to west. The origin of silica concentration may be derived from the cherty limestone of Moulmein Limestone.

According to the iron distribution map, iron is the second prominent element. Besides, the highest iron content area occurred at the north-western part of the research area with greater than 40% of iron content. According to this study, iron distribution is reduced from north-western to south-eastern part. The origin of iron concentration may be derived from the some part of Taungnyo Formation or some igneous rocks.

Besides, lateritization is economically most important for the formation of iron and nickel ore deposits. Laterite areas are used for discovery of economic minerals. Lateritization altered from igneous and metasedimentary rocks essentially contained the radioactive minerals and other heavy metals. These metals are harmful to human health.

## Acknowledgements

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