Volcaniclastic Deposits and Volcanic Activity of Inde Hill, Budalin Township, Sagaing Region

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Abstract

The study area is located in the Monywa District of the Sagaing Region. It covers approximately 120 sq. km. Geotectonically, the study area is mainly composed of sedimentary and volcanic rocks of Tertiary age. The sedimentary rocks are Irrawaddy Formation and Khabo Formation of sandstone, siltstone and mudstone. Volcanic rocks are olivine basalt (Inde hill). Basaltic tuff and volcaniclastic rocks are dominant in the area. The regional trend of the volcanic rocks is generally about NE-SW direction. Tephra deposits were founded at Inde hill. These pyroclastic deposits can reflected the type of volcanic eruption of the study area. The volcanic activities can be divided as least five major events. Each major event has been found minor episodes. The type of volcanism is strombolian type at Inde Hill. In accordance with the field relationship, the volcanic eruption of the study area occurred during Pliocene to Holocene time.

1. Introduction

The study area laid between N-22º 23′ 15″ to 22º 27′ 15″ and E- 95º 32′ 24″ to 95º 12′ 30″ in one inch to one mine scale topographic maps 84 N/3. The study area falls in the Monywa District of the Sagaing Region. Location map is shown in Fig. (1). It covers approximately 120 sq km. It is readily accessible throughout the year by car or motorcycle. Geotectonically, the study area lies in the Chindwin Basin which located in the western part of Central Cenozoic Belt. The study area is mostly a flat plain expect where the volcanic crater, volcanic hills and sedimentary ridges are present. Western and Eastern part of the study area is occupied by igneous rock units and the rest is comprised by the sedimentary rock units.

The main objective of this study is to known the type and nature of volcanic eruption. The detailed geological map of the area is shown in Fig. (2). The major rock sequence of the study area is shown in table (1) based on the stratigraphic position.

Table 1. Stratigraphic succession of the study area

Rock Unit	Age
Alluvium	Pliocene to Holocene
Younger Tephra-lithic tuff, coarse ash and Lapilli tephra	
Inde Basalt	
Irrawaddy Formation	Upper Miocene to Pliocene
Khabo Sandstone	Middle Miocene

The study area is mainly composed of sedimentary and volcanic rocks of Tertiary age. The sedimentary rocks are sandstone, siltstone and mudstone. Volcanic rocks are olivine basalt and microcrystalline augite basalt. The igneous rock units are spastically exposure over the sedimentary rock unit. The good exposures are found in car-road and stream section. Inde hill, eastern part of research area, yield good exposure of volcanic and pyroclastic rocks for systematic study. Moreover, volcanic rocks are better exposure than the sedimentary rocks which are exposed along the stream section and on the locally uplifted ridges. The regional trend of the volcanic rocks is generally about NE-SW direction.

Figure 1. Location map of the research area

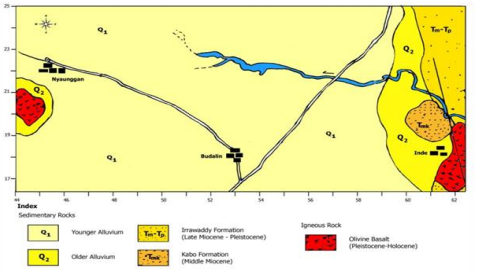

Figure 2. Geological map of the research area

2. Method of Research

Universal Traverse Marketer (UTM) map sheep No.2295-03 used as the base map for this research. Detail measurement of features of volcanic and volcaniclastic (pyroclastic) rocks as well as sedimentary rocks were made by using the measuring tape with Brunton compass and location of the feature and rock samples taken by GPS. Detailed studies were made the vertical section measurement of volcanic and pyroclastic rocks. This is done to known the nature of these rocks and estimated the intensity and type of volcanic eruption of ancient volcanoes. In the volcanic crater, random sampling was made along the radial traverse lines. Grain size percentages of these rocks are analysis to classify the volcaniclastic rocks.

3. Igneous Activity

3.1. Igneous Magnification

Inde hill has distance forms of igneous magnifestion such as volcanic craters, lava flows and tuff deposits. The lava flow had been capped on the ash fall and tephra deposits. This volcanic hill may be monogenetic basaltic volcano (tuff ring type) (in Reading, 1996) because pyroclastic deposits are relatively rising above the surrounded region. The eastern part of the crater was hill but slope down toward the west of the crater. So, the volcanic crater of Inde hill was curve shape.

3.2 Sequence of Volcanic Eruption

The study area lies in Central Volcanic Arc which is onshore volcanic arc. It constitutes the back-bone of the Central Cenozoic Belt. The volcanic of this arc are post Paleocene to Recent in age (Ali Akbar Khan, 2010). In the study area, basaltic and pyroclastic rocks are dominant. Tuff, coarse ash bed and lapilli tephra are main constituent in pyroclastic rock which are air fall deposits in nature.

The characteristic features of pyroclastic air fall deposits in the study area are as follows;

i. well bedded nature
ii. bedding planes are nearly horizontal
iii. bedding thickness decrease away from the site of eruption
iv. individual bed show good to moderate sorting
v. blocks and bombs were deposited relatively close to the site of eruption
vi. presence of basalt layering and lamination in tuff
vii. individual bed typically shows normal grading of constituent particles.

Pyroclastic rocks of Inde hill are air fall deposit with basaltic composition. They are transported through the air and fall back to the surface as air fall or fall out deposits. These pyroclastic beds are indicated that the style of volcanic eruption of Inde hill is strombolian type.

Section measurements of pyroclastic rocks were done at the north, northeastern and southern parts of Inde hill to know the nature of volcanic eruption of the study area as shown in Fig. (3). This volcanic sequence can be subdivided into five units according to bombs and blocks present, grain size and colour differences.

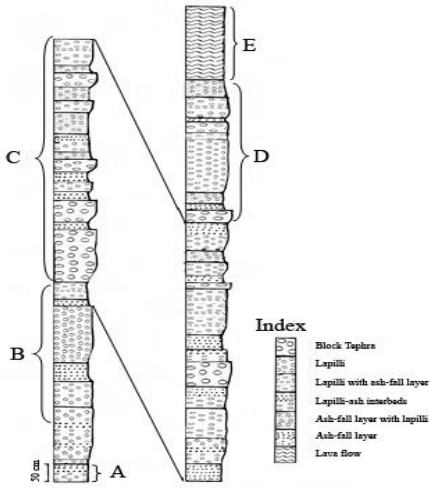

Figure 3. Section measurements of pyroclastic rocks of Inde hill

3.2.1. Unit A

This unit exposed at road cut section, NE of Inde Village. It consists of two layers of light to dark grey; lapilli tephra and coarse ash tuff are interbedded that are overlying by a thin ash bed. In each layer of lapilli tephra have been normal grading. Coarse ash beds are good sorting. It is about 1 m in thickness. The upper thin ash layer contains ash grains with a few lapilli grains.

3.2.2. Unit B

This unit is composed by five layers of pale grey to dark grey, well sorted lapilli tephra and ash fall beds are interbedded. The upper most part of this unit cap by the thin-bedded coarse ash layer. Near the volcano, this unit typically is 3 m thick and comprises many thin ash beds. The upper part of this unit intercalated by coarse pumice and lapilli grains. This unit directly

overlies the upper part of the unit A. Unit B is conspicuous in north and northeast flank of the Inde hill. Contact between unit B and unit C shown in Fig. (4).

Layer B_1 consists of several thin beds of yellowish grey to brownish grey pumiceous lapilli at the base of the unit B. Most pumice in this layer is more compact than that of other layer. The layer B_1 is indefinable chiefly as the basal coarse pumiceous layer of the unit B.

Layer B_2 consists of dark grey colored pumice and bombs as a single layer about 80 cm in thickness. The lapilli grains of this layer are loose and poor to moderate sorting. Volcanic bombs are present in the upper part of this layer. This layer is relatively highly weathered and brecciated than the other layer.

Layer B_3 is comprised by thinly bedded coarse ash layers which are yellowish to light grey in color. Individual bed is about 1 to 3 cm thick. This layer consists of rock fragments and small pumice grains.

Layer B_4 is a single layer which is light grey to grey in color, moderately sorted in grain size lapilli tephra. This layer is denser than the layer B_2. Small amount of rock fragments are presented in this layer. The thickness of this layer is about 55 cm thick.

Layer B_5 consists of poorly defined beds of coarse ash layers. Thinly bedded lapilli tephra beds are present in the upper part of this layer. Coarse ash beds are yellowish grey to buff color. Lapilli tephra are whitish grey colored and more friable than that of the ash beds. Coarse ash bed and lapilli tephra are moderate- to well-sorted in sorting.

3.2.3. Unit C

This unit is containing lapilli tephra and coarse ash beds of five layers. The thickness of lapilli beds is thicker than the upper part. But, the coarse ash beds are more abundance at the upper part. Volcanic bombs are present in the lower lapilli beds. Lapilli beds are light grey to dark grey and moderate to good sorting. Grain size of lapilli beds are decrease from lower part to upper part. The thickness of this unit is about 7 m.

Layer C_1 contains the lapilli tephra and ash fall beds. The lapilli tephra are coarse-grained and moderately sorted. These lapilli beds are light grey to dark grey in color. The thickness of lapilli tephra is about 150 cm. After the lapillli tephra, ash fall beds are follows. The thickness of individual ash fall beds about 2 to 3 cm and yellowish brown to buff color. These ash fall beds are good sorting. The grains sizes of layer C_1 are decreased upward.

Layer C_2 consists of lapilli and ash fall beds which are alternated. At the base of layer C_2 is lapilli tephra which is moderately sorted. Volcanic blocks are present in this bed and light grey to grey in color and about 60 cm in thick. Ash fall beds are present above the lapilli tephra. In some part of ash fall beds have been intercalated with thin lapilli layers. Ash fall beds are good sorting and buff color. The upper part of layer C_2 decreased both bedding thickness and grain size.

Layer C_3 is comprised by lapilli tephra and ash fall beds which are interbedded. Bedding thickness is decreased from base to top in this layer. At the base of this layer is a lapilli tephra which is coarse-grained and thicker than the other beds in this layer. Lapilli tephra are light grey to dark grey in color while ash fall beds are light grey to buff color. The middle part of this layer is ash fall beds. In some part of this beds have been intercalated by thin lapilli bed (about 2 cm). The upper part of this layer is ash fall beds and lapilli tephra are interbedded which are thinly bedded, well sorted and fine-grained than the lower part.

Layer C_4 is mainly composed by ash fall bed but lapilli tephra are intercalated between them. Ash fall beds are yellowish white in color but lapilli tephra are light grey in color. Ash fall beds are well sorted and medium bedded. However, lapilli tephra are moderately sorted and thinly bedded. Total thickness of this layer is about 140 cm.

At the base of layer C_5 is lapilli tephra which is moderately sorted, medium-bedded and light grey in color. Above this tephra, ash fall beds are followed. Ash fall beds are yellowish white, thinly bedded, well sorted and bedding thickness of this beds are equal. The upper part of this layer is made up by lapilli beds which are intercalated by ash fall beds. Grain size and bedding thickness of layer C_5 decreased from lower to upper part in Fig. (5). Above the layer C_5, unit D is followed comformably.

3.2.4. Unit D

Unit D is made up of three layers. Each layer is decreasing upward sequence in thickness. This unit is exposed at the southern flank of the Inde hill. Bedding thickness of lapilli tephra in each layer is thicker than the ash fall bed.

Layer D_1 is consisted of three beds as shown in Fig. (6). The lower part of layer D_1 is lapilli bed. It is light grey, medium bedded and moderately sorted. Ash fall beds, the middle part, are thinly bedded, well sorted, light brown in color and intercalated by thin lapilli tephra. The upper part of layer D_1 is lapilli beds which

are intercalated by ash fall beds. These beds are light grey in color and moderately sorted in grain size.

Layer D_2 is consisting of lapilli tephra and ash fall beds. Lapilli tephra are light brown and poorly sorted. Grain size in this layer decreases from lower to upper part. The upper part of this layer is ash fall beds which are light grey, well sorted and thinly bedded.

Layer D_3 is mainly composed of ash fall beds. However, lapilli beds are interbedded within the ash fall beds. Ash fall beds are light brown to brown in color but lapilli tephra are grey in color. Grain size decreases from lower to upper part. Volcanic bombs and fragments are also found at the upper part of this layer. Thickness of this layer is about 100 cm.

Figure 4. Contact between Layer C1 and B5

Figure 5. Thin bedded lapilli tephra beds (layer C5)

3.2.5. Unit E

This unit is basaltic flow about 200 cm in thickness. Some vent breccia found associated with this unit. The rocks are light grey in weathered surface and dark grey in fresh surface. Porphyritic texture is conspicuous in this basalt. The phenocrysts of olivine, augite and plagioclase embedded in the holocrystalline ground mass in Fig. (7) which is made up of feldspar laths, small grains of olivine, augite and magnetite.

Figure 6. Layer D1, coarser lapilli and coarse ash beds

Figure 7. Layer E, Olivine basalt of flow structures at the Inde hill

3.3. Nature of Volcanic Eruption

The volcanic eruption produced the Inde hill can be divided as least five major events. Minor episodes also have been found in each major event. In this minor episodes which produced alternate beds of lapilli tephra and coarse ash beds. The nature of the volcanic eruption of Inde hill may be explosive or pyroclastic eruption on the base of the following;

i. presence of generally well bedded pyroclastic beds
ii. presence of bombs and blocks at Inde hill and it neighboring areas in Fig. (8)
iii. presence of pyroclastic deposit units are closely associated with basaltic lava flow

Base on this fact, eruption of the fragmented mass through a vent into the surrounding atmosphere as a result and deposited around the Inde hill. Ash flow and Lahar deposits are not founded in this hill. The nature of volcanic eruption of Inde hill may be explosive type. But, the successive layers of lapilli and coarse ash beds throughout the thickness of the deposits which indicate that a series of explosive eruption extending over a period of time rather than to one violently explosive outburst.

Figure 8. Volcanic blocks in pyroclastic deposits at Inde hill

3.4. Type of Volcanic Eruption

The most crucial aspect of eruptions is behavior of gas and liquid phases of magma relative to each other. Basaltic to silicic magma tend to exhibit characteristic styles. At least, there are four poorly defined types of eruption which are Hawaiian, Strombolian, Vulcanian and Plinian (L.Wilson, 1980 in H.G Reading 1996). Type of volcanic eruption of Inde Hill more reliable to Strombolian type eruption base on as follow;

i. the volcanic eruption of the area is less than 5 km^2 in dispersal
ii. the sorting of the individual pyroclastic beds are moderate to good
iii. the volcanic cone is made up with interbedded of coarse ash beds and lapilli tephra
iv. absence of agglomerate beds in volcanic cone
v. absence of andesite
vi. the eruptions are fairly frequently and long time
vii. absence of welded tuff
viii. presence of unconsolided pyroclastic rocks
ix. the lava composition falls on calc-alkaline field (Chhibber, 1934).

3.5. Conclusion

The study area is situated in the Monywa District of the Sagaing Region. The study area is mainly composed of sedimentary and volcanic rocks of Tertiary age. Basaltic tuff and volcaniclastic rocks are dominant in the area. The volcanic eruption produced the Inde hill can be divided as least five major events. On the base on pyroclastic deposits and field relation with basaltic flow, type of volcanic eruption of Inde hill is Strombolian type. But, the successive layers of lapilli and coarse ash beds throughout the thickness of the deposits which indicate that a series of explosive eruption extending over a period of time rather than to one violently explosive outburst.

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