Facies Study of Lake Deposits Formation (Qpl) To Determine Deposition Environment of Ancient Limboto Lake: a Preliminary Result

A K M A Amin¹, M Sakakibara², Y I Arifin¹, N Akase¹

¹Geological Engineering Major, Department of Earth Science and Tehnology, Faculty of Mathematic and Science, State University of Gorontalo, 96128-170711 Gorontalo, Indonesia.
²Research Institute of Humanity and Nature, 603-8047 Kyoto, Japan.
³Faculty of Collaborative Regional Innovation, Ehime University, 790-8577 Matsuyama, Japan.

Corresponding Author: mubarrack95@gmail.com (mubarrack amin)

Abstract. Limboto Lake located in the Gorontalo Province is a part of the places where the disclosure of various types of rocks as well as various tectonic deformations, the genesis of this lake is a low basin included in shallow lake type or type of flood plain. Development of Limboto Lake starts from the existence of the Neogene extension exactly on slab-rollback extension of the Banda embayment in Early Miocene, rapid uplift and subsidence near Gorontalo Basin in Late Miocene. Various problems that occur in the Limboto Lake both silting and susceptibility to lake water flows allegedly related to the tectonic activity that ever happened even today. This study reports new determination about the ancient environment of Limboto Lake. The purpose of the study is the facies study of the Lake Deposits Formation (Qpl) to determine the depositional environment of ancient Limboto Lake in Gorontalo Basin against its influence on the current Limboto Lake. The environment facies identified in the Gorontalo Basin are marine deltaic facies and shallow marine carbonate facies (carbonate rimmed shelf). The evidence found by stratigraphically features is: (a) Marine Deltaic Environment: (1) Lithologies: mainly sandstones (compositionally dominate immaturely) through muddy sandstones, sandy mudstone to mudstone; also the presence of lignite; compressed weakly and in the form unconsolidated, (2) Texture: not diagnostic, average sorting and rounding sand grains, (3) Structure: cross-lamination and wave-lamination of various types in the sandstones, flat-bedding, and channel common. Finer sediment show flasher, wavy bedding and are heterolithic. Some sediment containing rootlets; (b) Shallow-Marine Carbonate Facies: (1) Lithologies: Skeletal packstone-wackestone, and mudstone, (2) Texture: diverse, (3) Structure: cross-lamination, parallel-lamination, wave-lamination, desiccation crack; in the reef limestone is massive and unbedded, with intense bioturbation. Based on the ancient environment determine to encourage the high activity of silting Limboto Lake because the material around the lake easily detached.

1. Introduction
Limboto Lake located in Gorontalo Province is a part of the place where the disclosure of various types of rock one of sedimentary rocks as well as various tectonic deformation [1]. Development of Limboto
Lake starts from the existence of the Neogene extension exactly on slab rollback extension of the Banda embayment in Early Miocene, rapid uplift and subsidence near Gorontalo Basin in Late Miocene [2]. Limboto Lake is a low basin included in shallow lake type or type of flood plain with a high sedimentation process [3].

The erosion and sedimentation activities of Limboto Lake to present are so high that it threatens the existence of the lake and causes silting and flooding the lake to the nearest area to be generated [3]. The problem is allegedly caused by the compositions of lake consist of sedimentary rock formations and affected by shearing fault zone related to the tectonic activity that occurred in Limboto Lake [4][5]. The study aims to generated the facies of the Lake Deposits Formation (Qpl) and its compositions to determine the depositional environment process of Limboto Lake and its influence on the current Limboto Lake.

![Figure 1](image)

**Figure 1.** Historic sedimentation process prediction[3].
2. Data and Method
The method used in the research is Measuring Section of stratigraphic (MS) was performed to determine the spread of lithologic strata in profile to generate a stratigraphy section and description of the sedimentation stage with a stratigraphy profile [6],[7],[8],[9],[10],[11]. The description of lithology with petrology features of sedimentary rock within stratigraphy profile, sedimentary structure; fossil; and regional geology.

Analysis was conducted to find out the composition of strata lithology distribution, the mechanism of sedimentation and the settling environment, then analyzed after stratigraphy reconstruction and classified according to the sediment sedimentation facies and concluded the environmental influence of sedimentation of ancient Limboto Lake to silting lake which becomes one environmental the problem even can cause extinction the lake.

3. Result and Discussion
The environments facies identified in the Gorontalo Basin is shallow marine carbonate Facies (Carbonate Rimmed Shelf), marine deltaic facies and meandering stream environment [5].

Shallow-marine carbonate facies (carbonate rimmed shelf) consist of skeletal rocks of wackestone (or calcarenite), mudstone with tuff, and intercession of sandstones and claystone, and reef limestones. Sediment texture in sandstone is diverse, generally cross-lamination, parallel-lamination, wavelamination, desiccation crack with wackestone containing flame structure, based on characteristics interpreted in a lagoonal environment. Other depositional subfacies environmental are reefs where it massive and unbedded textured limestone (rudstone) and intense bioturbation, containing fossil
bivalves, ammonoids, bryozoans but not indicated up to species. While other carbonate rimmed shelf depositional subfacies are supratidal which is characterized by the presence of mudstone lithology with tuff, the mudstone is brown and easily detached, quite different from mudstone the tuff is relatively compact with fine grain size and chalcareous [6],[10],[11]. It is estimated to be the Pliocene-Early Holocene age [7][8].

The marine deltaic environment is dominated of claystone and sandstone, locally with containing lignite. mainly sandstones (compositionally dominate immaturity) through muddy sandstones, mudstone to sandy mudstone, weakly compressed and in the unconsolidated form. There are several subfacies depositional environments that can be interpreted, among others, a swamp where there is a relatively compressed weak, black green claystone, many containing remnants of roots, reef fragments, and some undifferentiated fossils, some mixed with sand grains, slight bioturbation while sandstone is relatively cracked, brown, fine-sand, consisting of quartz and lignite. Interdistributary bay is characterized by unconsolidated sandstone dispersion with many parallels laminate structures, cross laminations, generally normal grading with relatively medium-sand grain size, bioturbation and relatively brownish black claystone and many units containing residual roots. Next is tidal flat, which is indicated by the intersection of sandstone and claystone, there is a parallel lamination, wave lamination structure with relatively fine-sand sandstones. The final subfacies is the distributary channel, characterized by sandstones and locally clay, relatively of fine-coarse sand, locally very coarse-sand to possible pebble, generally with normal grades, there are parallel lamination and cross lamination structures with dark clay [9],[11]. As well as estimated to be Pliocene-Holocene age[7][8].

Meandering Stream Environment consists of silt deposits, sand and gravel, based on geomorphological and lithological data can be divided into several depositional environments in the form of flood plain, river terrace and channel fill. Deposits on these facies are of Holocene age [7],[8].

Based on depositional environmental facies data and lithological characteristics scattered around ancient Limboto Lake consists of sedimentary rocks which easily detached with a predominant composition of clay, silt, gravel-glazed sand and locally strongly influence sedimentation activity at Limboto Lake at present. This is reinforced by tectonism activity in the Basin around the Lake which is rapid uplift and subsidence in the Miocene-Holocene [2] so that the lithology around the Lake has not experienced intense compaction and litification. In general, the overall state of lithology around the Lake is a contributor to sedimentary material, so that it has the potential to produce environmental disasters and to overcome these needs a good and integrated treatment of these collections [3].
Figure 3. Regional Geology and Stratigraphy of Limboto Basin [7],[8].
4. Conclusion

The environment facies identified in the Gorontalo Basin of Ancient Limboto Lake is Marine Deltaic Facies and Shallow Marine Carbonate Facies (Carbonate Rimmed Shelf). Evidence’s has found by Stratigraphically Features is: (a) Marine Deltaic Environment: (1) Lithologies: mainly sandstones (compositionally dominate immature) through muddy sandstones, sandy mudstone to mudstone; also the presence of lignite; compressed weakly and in the form unconsolidated, (2) Texture: not diagnostic, average sorting and rounding sand grains, (3) Structure: cross-lamination and wave-lamination of various types in the sandstones, flat-bedding and channel common. Finer sediment show flasher, wavy bedding and are heterolithic. Some sediment containing rootlets; (b) Shallow-Marine Carbonate Facies: (1) Lithologies: Skeletal packstone-wackestone and mudstone, (2) Texture: diverse, (3) Structure: cross-lamination, parallel-lamination, wave-lamination, desiccation crack; reef limestone: massive and unbedded, bioturbation intense. Based on ancient environment determine to encourage the high activity of silting Limboto Lake and it is reinforced by tectonism activity in the Basin in the Miocene-Holocene so that the lithology around the Lake has not experienced intense compaction and lithification. Generally, the overall of lithology around the Lake is a contributor to sedimentary material, so that it has the potential to produce environmental problems of the lake and to overcome these needs a good and integrated treatment of these collections.
Appendix

Figure 4. Correlation Stratigraphy of near Limboto Lake
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