KARANGBOLONG KARSTIC LIMESTONE AND ITS ENVIRONMENTAL DEVELOPMENT (JAVA, INDONESIA)

Soewarno Darsoprajitno(Indonesia)

The distribution of limestone in Java are dominantly located in the south coast and most of them had been suffered by karstic processes. The one that its environment has been studied is the Karangbolong karstic limestone in Kebumen, Central Java. The other karstic limestones were found in Merakurak (Tuban), East Java, with different topography and morphology. All that are main water catchers, accumulator and preservers, and so they can be used as an internally "natural water tanker", which situated closely to the economic highway system of Java. To talk about the preferable quality of the Miocene limestone for building material, it will be the reason why the negative impact is easily born.

The Miocene karstic limestone in Karangbolong has a particular hundreds conical hills and have an average height of about 300m above sea level. The body is fully occupied by the cavity system, and so the potential for water penetration are very high.

The surface of the hills are covered by dense forest as a function to decrease the running water in the rainy season, in order to enlarge the volume of the rain water to penetrate into the surface of the karstic limestone. At present the karstic water has been used by the people around it for daily needs. In the rainy season, the karstic water are spill out and mixed with rain water to overflow the lowland plain. it is suggested to develop the hilly karstic limestone of Karangbolong, because the people around there depend on the natural resources for their daily needs eternally. So based on the geological system, agriculture, social welfare etc., the protection and conservation of the karstic limestone of Karangbolong should be carried out. Because of this unique natural heritage, that is very useful for environmental development, it should be protected from the negative impacts that were caused by human interests.

INTRODUCTION

Study on karstology in Indonesia is being developed to fulfill the needs of national development in the realm of sciences, water supply and tourism. The investigation of caves that was carried out by the GRDC was restricted on geological disciplines to prepare data for further investigations. Limestones deposits are widely distributed in Indonesia

and generally come from Miocene age. Karstic limestones are attractive due to unique natural phenomena, such as underground streams, cave levels and other familiar features.

Karst topography may be found widely in Indonesia, however the Karangbolong caves is the most important one owing to its accessibility. Moreover it is very close to industrial centres and is actually affected by industrial development.

Systematically, the study on karstology is initiated by discussions among interested scientist, either in seminars or in the field. In these activities the GRDC geologists contributed their findings. The geological approach can be very useful in efforts to conserve all natural heritages. The GRDC has begun to carry out data collecting, geological mapping and other geological activities in and around well-known cave regions in Java.

At present the young geologists who interests on karstic geology, has been trained either in the field or to attend the discussions on karstic geology. As mentioned above, in Indonesia the karstic phenomena are distributed widely on the non-volcanic regions. Most of it are from Miocene limestone, like as that deposited in Karangbolong, Central Java. Some geologists and speleologists would like to develop a research station on karstology in Karangbolong.

THE GEOLOGY OF THE KARSTIC LIMESTONE IN KARANGBOLONG

Karangbolong is located near Gombong, Central Java, on the southern part of the South Serayu Mountain range. The karstic limestones cover an area between 7° 40′ - 7° 46′ South Latitude and 109° 23′ - 109° 29′ East Longitude. As mentioned Karangbolong can be reached by car or train and the facilities for the visitors are available. The karstic limestones stand out in an area of low rice field, and in the south it is bordered by the Indian Ocean.

Karangbolong shows an interesting geological setting and also numerous natural phenomena which may serve the sciences, tourism, agriculture and industry. The geological setting of Karangbolong region shows a structural trend northwards from south coast of Indian Ocean. Three stratigraphic units make up the hilly morphology: the Halang Formation, the Karangbolong Formation, and the Gabon Formation.

Stratigraphically the Karangbolong Formation overlies Gabon Formation. It predominantly consists of bedded coralreef limestones of Miocene age. Topographically the bedded corraline limestones of the Karangbolong Formation developed into karstic limestones. The limestone area presents a wealth karstological study.

The Halang Formation which forms the top consists of calcareous tuffs, tuffaceous sandstones and marls. The age of this formation is Late Miocene to Late Pliocene, Zone N17 to N21 of Blow (1969). Darwin Kadar (1986) proposed a new name for this formation Rawakele, after the name of a small village in the western part of the South Serayu Mountain range.

Stratigraphically, the oldest formation in the Karangbolong region is the Gabon Formation which is asigned to Late Oligocene to Early Middle Miocene age (Mulhadiyono, 1973). Formaly it was called "the old Andesite Formation".

The geological history of the Karangbolong region began to develop when tuffs and breccias deposited since the Late Oligocene. Probably, after transgression took place since the early Middle Miocene, the eroded Gabon Formation was overlain by corraline limestone deposits unconformably. This continued into the Late Middle Miocene, when regression initiated in the northern part where the Halang Formation was developed.

Tectonically the uplift of Karangbolong region was fairly simple in which the region was, as in common along the south coast of Java which represent the inner arc-trench basin. However, the tectonic movements that form the karst phenomena occurred during the last geological time, e.g. the Quaternary. In Karangbolong, where the bedded corraline limestone deposites has a thickness not less than 350 metres, developed hundreds of conical hills of the elevation of about 200 metres above sea level.

MORPHOLOGY AND THE KARST FORMATION

Limestone deposits are widely distributed in Indonesia and most of these have been exposed by erosion and denudation. The limestone hills in Indonesia have an average height not more than 500 metres above the surrounding. Distinctive conical hills by the hundreds like in Karangbolong are not so easy to be found.

The torrential rain water that comes down in November up to January annually in a tropical country like in Indonesia, developed the surface of the forestal limestone deposits by erosion and denudation (Syafei Manan, 1985). The forest covered karst topography looked very different from the exposed karst topography like in Karangbolong. I believe that in the development of the Karangbolong karst topography, the surface was not protected by forest since the uplift and erosion activities began to work.

Tectonically the Karangbolong region was developed by semicylindrically with an axis in the N-S direction. The tectonic movement made the corraline

limestone brittle, cracks and fissures characterise the limestone deposits. Consequently the alternating dry and rainy seasons altered the unprotected surface of the limestones into hundreds of sharpened peaks. I believe the development of the sharpened conical hills in Karangbolong is caused by the vertical erosion which was greater than the horizontal erosion. According to W.Penck 1953, 1954 (Sartono, 1964), the development of the conical hills is based on the following formula:

$$\text{Vertical erosion (Ev)} = \frac{\text{denudation (D)}}{\cos a}$$

$$\text{Horizontal erosion (Eh)} = \frac{\text{denudation (D)}}{\sin a}$$

Ev: amount of vertical erosion in unit of time.
Eh: amount of horizontal erosion in unit of time.
D : amount of denudation in unit of time, or the amount of retreat of the slope unit in unit of time.
a : angle of inclination of the unit in unit of time.

The CO_2-bearing rain water is very reactive to the limestones and affected the cracks and fissures deeply and widely. So the water-bearing limestones deposit made a dendritic waterways. Consequently collapsed ceilings, sink holes, caves and all calcite ornaments such as stalactites, stalagmites etc. are common. Lakes, rivers and water falls are also developed.

Karangbolong has a unique caves network that has an average height above the local area around it. The caves usually are inhabited by blinded water animals or winged animals which are protected by law The most important role of the Karangbolong cave system, is its function as a mighty natural water tank that supplies water for irrigation, industries or for domestic utility.

ECONOMIC AND ENVIRONMENTAL CONSIDERATION

Based on the geological information which were collected by GRDC geologists, Karangbolong has numerous potentials which can be used for supporting national development. Natural potentials that can be used are as follows:

1. Natural phenomena which may interest scientists, e.g. geology, biology, forestry, hydrology, speleology and ecology (Otto Sumarwoto, 1985).

2.Renewable karstic ground water can be used eternally for drink water, irrigation, industries, if the source is not destroyed.

3.Caves and other natural heritages for tourism. Caves for tourism can be classified into three categories i.e.:

- Caves for exploration and especially accessible for speleological activities.
- Caves for study and especially for scientists and students.
- Caves for recreation.

Economically the Karangbolong corraline limestone is qualified for portland cement raw materials. But the environment does not allow such exploration. The limestone quarry for portland cement raw material may destroy all natural potentials such as karstic water, cave animals, teak wood forest, tourist sites etc.

Finally the Government decided that Karangbolong region will be reserved for national park, or at least for natural science laboratory.

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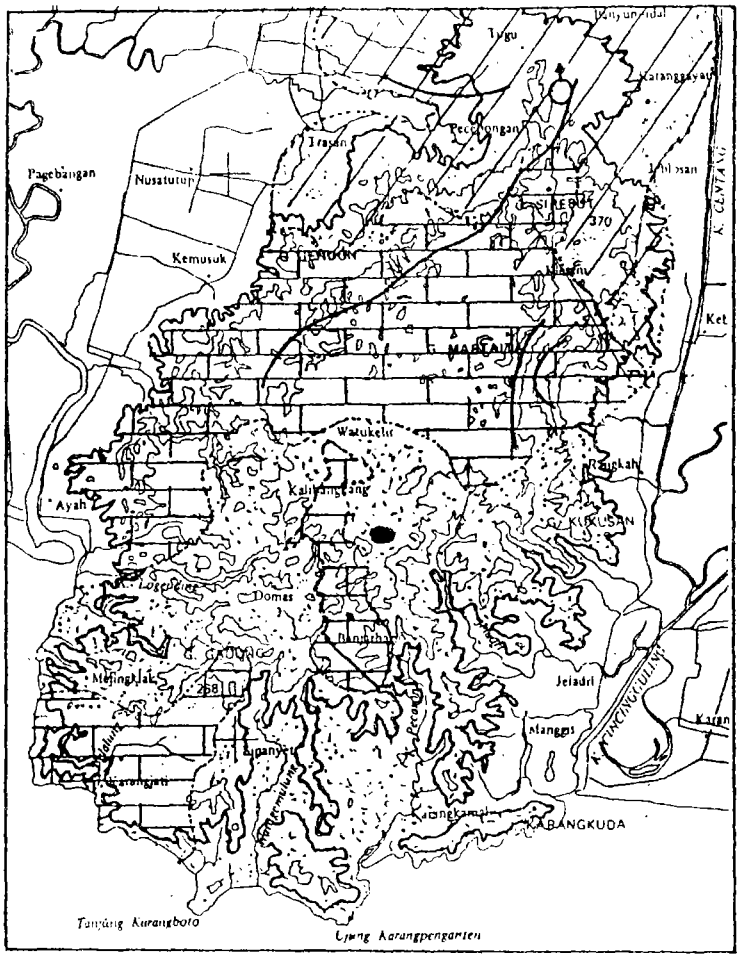

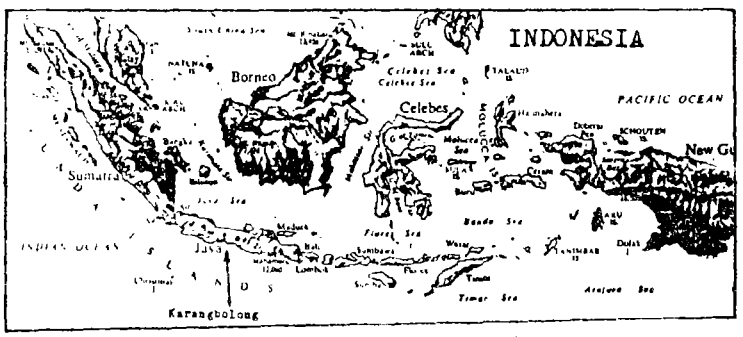

Map of Karangbolong Karstic Limestone
Kebumen (Central Java), Indonesia

Scale 1:100,000 (Dikdik K., Syukur, 1984)

- Halang Formation
- Karangbolong Formation
- Gabon Formation
- Magmatic Intrusion
- Fault
- Spring