에너지공학, 제26권 제1호(2017)
Journal of Energy Engineering, Vol. 26, No. 1, pp.62~67(2017)
https://doi.org/10.5855/ENERGY.2017.26.1.062

A Brief Review on Limestone Sources and Oyster Waste Generation-Bantayan

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(Received 1 February 2017, Revised 21 February 2017, Accepted 23 February 2017)

Abstract

Limestone is an important commodity in Philippines. Limestone has numerous uses that range from agricultural applications to building materials to medicines. Many limestone products require rock with specific physical and chemical characteristics. Most limestone is biochemical in origin meaning the calcium carbonate in the stone originated from shelled oceanic creatures. In this paper, we reported the natural sources of limestone, geological formation of limestone and the oyster shell waste in Cebu, Bantayan, Philippines were reported. Due to the mining or quarrying in Cebu, Bantayan, in a limestone area poses the threat of groundwater pollution (since limestone is a porous geologic formation with a high transmissivity). The other environmental issue is oyster shell waste. The oyster shell waste is the major source of limestone. We developed and applied appropriate technologies for the extraction of limestone from oyster shell waste and utilizes as high value added material.

Key words : limestone sources, limestone origin, oyster shell waste, Bantayan, Philippines

1. Introduction

Limestone is an abundant mineral in the earth crust. Lime plays a key role in many air pollution control technologies. It is used to remove sulfur dioxide and hydrogen chloride from various flue gas emissions. Lime is also routinely used to treat municipal wastewater, industrial sludge's and animal wastes where it is used to neutralize pH, precipitate metals and control odors. It has wide range of advantageous applications in rubber, ceramic, cement and automotive industries. Lime is also used in the paper and pulp industry [(1)].

Limestone formation or deposition has occurred for over than 3 billion years, since the Precambrian times. Shallow seas provided the accumulated biological deposit of limestone. The bio-accumulation of calcium carbonate under sea waters at 25-30°C, which comprise shells, algae and corals. Tropical shallow seas having the ideal conditions for the formation of limestone. Now, globally, carbonate deposits formation at different ages are found (Fig.1).

The formation of carbonates and deposition began billions of years ago and still it is occurring today [(2)]. Limestone's were deposited on top of the Edwards formation, the tertiary and quaternary periods of the

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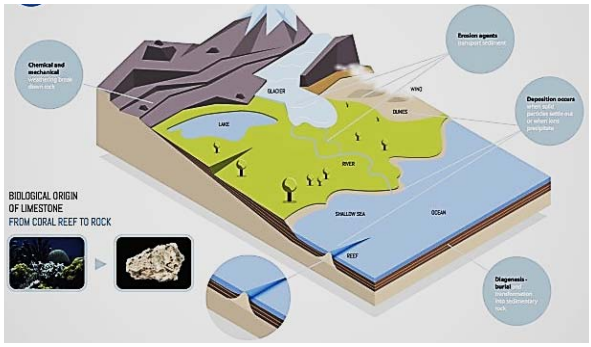

Fig. 1. Geological structure of limestone deposits

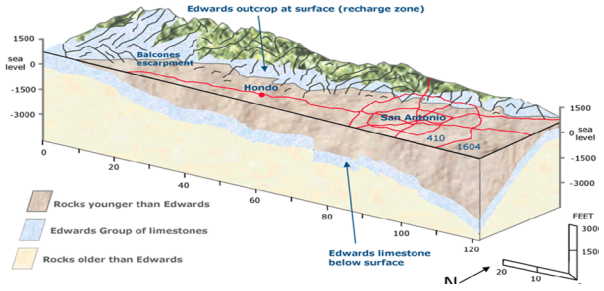

Fig. 2. Limestone origin and edward formation

Cenozoic era and its beginning about 70 million years ago, saw the revitalize of the rocky mountains by activity of tectonic plates colliding and overriding (Fig.2)[(3)].

Here, briefly reviewing the geological structure of limestone deposits and formations. It is surrounded by opposing subduction zones and it is characterized by several volcanic arc chains. There are several Igneous rock-related ore deposits are located near Cebu area. The volcanism and plutonism was happened since Pre-tertiary (>60). Philippine Fault and related structures control localization of many important deposits. The Manila and Negros trenches on the eastern boundary of the belt were created from the collision of the Palawan micro continental block with the Philippine Mobile Belt. The western border of the Philippine plate is a convergent boundary; however it is an ocean continent convert-gent plate boundary where the Philippine plate is subducting beneath northern Asia on the Eurasian Plate [(4)] (Fig.3).

The simplified geology of limestone deposits are showed in the Fig.4.

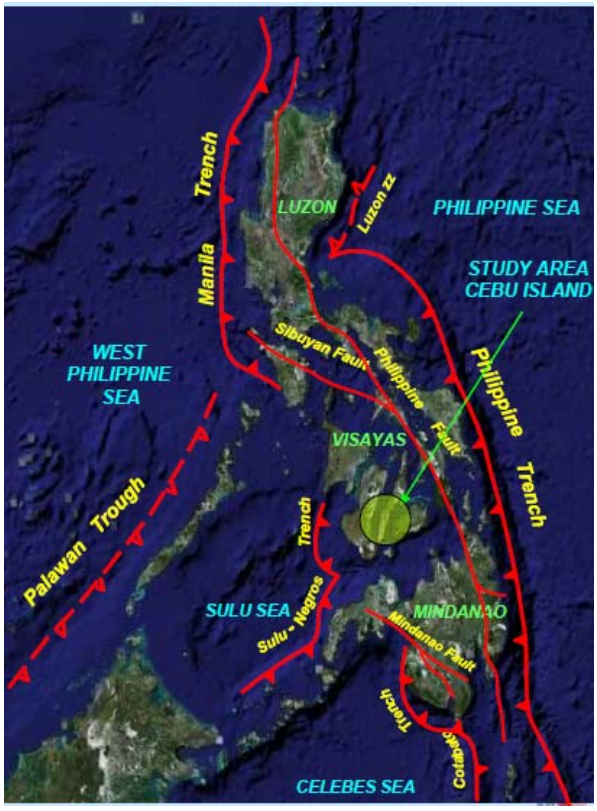

Fig. 3. Geological structure of limestone deposits

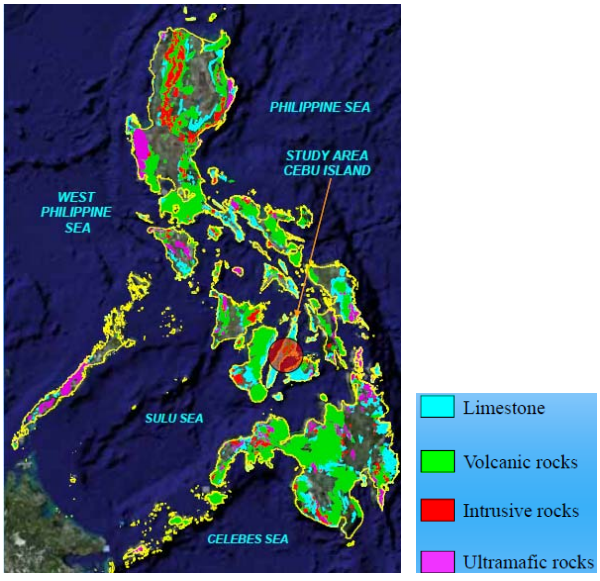

Fig. 4. Limestone and various rocks deposits in Philippines.

2. Geological structure of limestone deposits in Cebu city, Bantayan Island

The brief overview of geological structure and formation of limestone deposits in cebu city, bantayan island showed in the Fig.5. The Cebu city surrounded by mountainous and hillslopes - 75%, coastal area-15%, and maximum ground elevation-600masl. Karstic topography exist under most limestone/ carbonated rock types. Box pattern river drainage forms on old limestone areas, while younger limestone outcrop and older basement rocks shows dendritic and irregular pattern[4].

Limestone rock formation in El Nido and hanging coffins found in the limestone formations of echo valley in Sagada (Fig.6).

Limestone deposits in Philippines is nearly 1,800 hectares and also mining area is in Guimaras Island, Philippines. Philippine government for mining through a Mineral Production Sharing Agreement (MPSA) has been approved the mining area on March 3, 1993. The mining area is estimated that it contains at least 500 years of limestone deposit (2 million tons/year mining rate)[5].

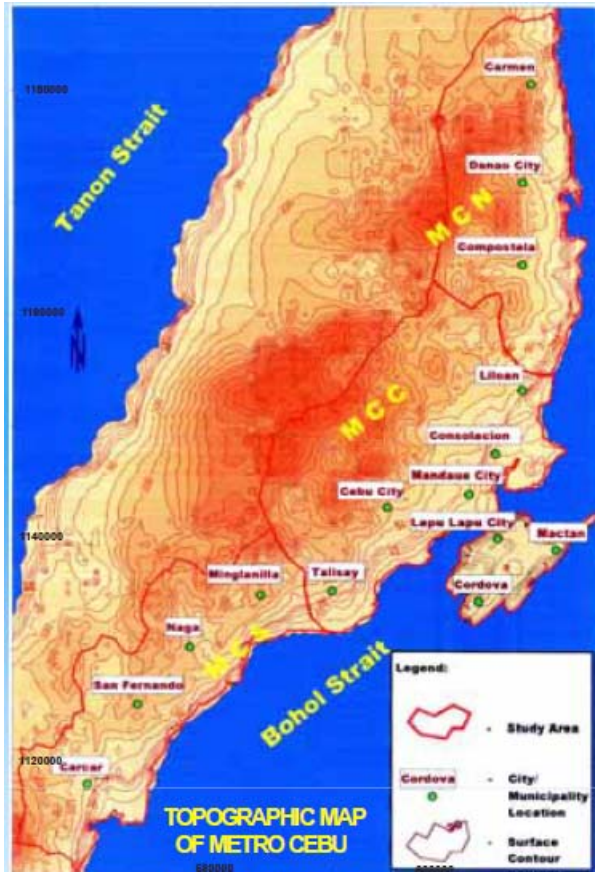

Fig. 5. Geological structure of limestone deposits in Cebu city, Bantayan Island

2.1 Environmental impact of limestone mining in Bantayan

There are several environmental impacts of limestone mining in Philippines. The quary operations of limestone needs clearing of vegetation and it may affect groundwater recharge and runoff. The accumulated runoff coming from the quarry area may went into a river outlet, leading to an increase in surface water volume, thus its potentially endangering people who are living downstream. The major problem with mining and quarrying in a limestone area poses the severe threat to the underground water pollution (the limestone is presented in Philippines is highly a porous geologic formation with a high transmissivity)[6].

- Limestone mining can affect ground water conditions. Limestone deposits often occur in association with karst, a topography where limestone slowly dissolves away underground. The deposits result in caves, sinkholes, and areas of rock fractures that form underground drainage areas (Fig.7).

Fig. 6. Limestone rock formation in Philippines.

Fig. 7. Sink holes in Philippines.

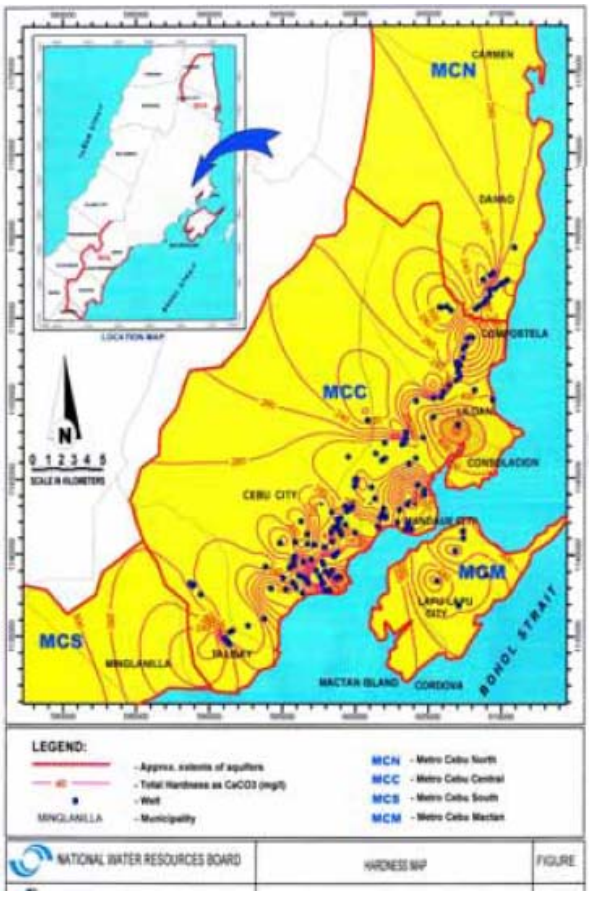

Fig. 8. Critical areas of ground water hardness levels in Cebu city, Bantayan Island

The other recent sinkhole in Santa Fe town in Bantayan Island was found. The sinkhole was around 40 feet wide and 4 feet profound. The Mines and Geosciences Bureau (MGB) of the Department of Environment and Natural Resources (DENR) has discovered five places in the nation having sinkholes. In the previous years, some strange sinkholes were found in a few zones [7].

2.2 Ground water pollution in Cebu City, Bantayan Island

The major water pollution problem is ground water contamination. The major sources of salt water and ground water pollution is domestic waste water (33~48%), agricultural waste water (29~37%) and from industrial waste water (15~27%). The ground water contains total dissolved solids are very high and also 58% of ground water samples contaminated with coliform bacteria, and needs treatment[8].

The hardness level of water is nearly 26% of industrial areas, (924.86lps out of 3,532lps) Mandaue City, Cebu City, Talisay Liloan and Campostela >300mgl. Organic decomposing process through bacterial action - human/animal waste, plant debris and Fertilizer. National Water Resources Board (NWRB) in 2004 was conducted feasibility studies with CEST consultants Inc. for the determination of the groundwater levels and quality of ground water. According to the climate data of Philippines, NWRB identified eight places are facing severe lower underground water levels [9] (Fig.8).

3. Oyster Shell Waste in Bantayan Island

Oyster and mussel shells are non-biodegradable.

Fig. 9. Oyster shell waste in Philippines

They pollute the land and underground water when discarded without treatment. At present, large amounts of shells waste are dumped near the seaside, which creates several serious environmental problems such as the emission of offensive odours and soil pollution from heavy metals contained in the viscera, considered as an environmental hazard. Oyster shell waste has become a serious problem, and in most cases, the shell waste is disposed of or dumped in fields and/or public water sources. Waste left to sit for a long time can create noxious odors as a consequence of the decay of the remaining attached muscles or the decomposition of salts into gases such as H_2S, NH_3, and amines.

Therefore, recycling of waste oyster shell is the alternative solution for avoiding the landfill problems. The ideal technology solution would be to convert the waste oyster shells to a high value added products that are both beneficial and economically viable, and eliminates environmental problem (Fig.9). Degradation of the natural resources causing a shortage of raw materials support the search for alternative materials as to waste seashells dumping in Philippines. So, a new appropriate technology

Fig. 10. Oyster shell waste utilizes by carbonation process (approapriate technology-KIGAM)

need to development for large-scale production materials in attempting to avoid large amounts of waste, especially mineral waste.

3.1. Appropriate technology solution for oyster shell waste–KIGAM

In Korea Institute of Geosciences and Mineral Resources (KIGAM), we developed a novel appropriate technology as a solution for the landfill problem with oyster shell waste. We applied a carbonation process for extraction of calcium carbonate from oyster shell waste. Oyster shell waste is a valuable major and alternative source of limestone (Fig.10).

In MIT, the oyster project is ongoing to study about the oyster populations in relation to acidity levels, a team of researchers has concluded that oysters-particularly their shells can play a significant role in reducing that acidity[10]. MOP is a $501c^{-3}$ non-profit dedicated to restoring water cleansing oysters to Boston Harbor after their being absent for decades. Each oyster can filter 30 gallons of water per day. The other major advantage of oyster reef can shelter more than 100 other species so they dramatically add to biodiversity.

4. Conclusions

Oyster shell wastes are highly rich mineral sources of calcium carbonate and alternative to limes-

tone. Waste product of oyster shells can be transformed into an effective treatment for coffee wastewaters. This treatment process is simple, economic ecofriendly a novel method for recycling waste oyster material to provide a beneficial product and promises to greatly reduce problems caused by mariculture in coastal regions. The antimicrobial activity of calcium carbonate from oyster shell waste for biological treatment and utilization as a fertilizers with economic ecofriendly in nature.

The appropriate technology reveals that oyster shell waste and limestone calcinated CaO is most effective to kill the bacteria, these process is simple and eco-friendly with cost effectiveness.

Acknowledgements

The authors are very grateful to the Korea Institute of Energy Technology Evaluation and Planning through the ETI program, Ministry of Trade, Industry and Energy (Project No. 2013T100100021) for financial support of this research.

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