THE SALT POTENTIALS IN INDONESIA

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Abstract

The salt deposits are unevenly distributed in the world. The most productive countries are China, USA and India. Indonesia experiences the salt deficit, due to the limited number of the deposits. The evaluation of the characteristics of salt deposit in the world reveals the Pre Tertiary association in semi closed marine environmental deposition. The geological condition in Indonesia does not favor such environment, therefore the salt deposits unlikely to occur. The saline solution in mud volcanoes in northern part of Java Island however indicates the possible saline deposits in Tertiary Kalibeng Formation with the thickness of approximatelly 3.000 meters. The saline seepages most probably have continuously been taking place since early Pleistocene or about a million years ago. The saline seepages in northern part of East Java might extend to the bottom of Madura Strait and enrich the salinity of the sea in the strait. The semi closed configuration of the strait contributes to the accumulation of salt. It is therefore suggested to expand the evaporating pools for salt production, among others by the reclamation of the shallow offshore area in the southern part of the island.

Keywords: salt deficit, mud volcano, saline solution, enrich the salinity, solar evaporating pools

INTRODUCTION

Salt is one of the basic needs for human life. A human body needs at least 6 grams of salt daily. Salt is unevenly distributed in the world. The most salt productive country is China with around 27% of the total world salt production. The second place in the row is the United States with around 17%. India produces almost 7%, whereas Germany and Australia produce respectively 5%. Indonesia is ranked number 37 behind the Philippine and Vietnam. The latter produces double to the Indonesian salt production (Table 1).

Salt is produced from the salt stone, salt deposit, brine, and subsoil and sea water. In the market two types of salt are known, namely consumption salt and industrial salt. The difference between those two types of salt is the concentration of NaCl. The consumption salt composes of less than 94% NaCl, while the industrial salt contains almost 100% NaCl. The consumption salt is used for condiment; the other is for preservatives and raw materials among others for pharmaceuticals and Chlor Alkali Plant (CAP). Salting the icy road consumed a lot of industrial salt.

Indonesia produces approximately 2.19 million tons of salt annually contributing about 0.24% to the world salt production. On the other hand the needs for domestic use are around 3.61 million tons a year. No wonder Indonesia has to import salt to fulfill the deficit. Between 2012 and 2016 the import fluctuated between 1.4 and 2.2 million tons with the average of around 2 million tons (Data Boks, 2017). This means that half of the domestic consumption is supplied from outside.

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The recent salt crises warned us the critical dependency on the imported salt.

DISTRIBUTION OF SALT DEPOSITS IN THE WORLD

Likewise minerals, salt are unevenly distributed in the world. The salt deposits concentrate in Central Europe, North America, China, Pakistan and India. The deposits also distribute in the Andean countries of South America and Australia (Figure 1). The map shows three types of salt potentials, namely rock salt or salt deposits (NaCl), potassium rich (K and others) and brine or saline solution.

Table 1. Rank of several salt producing countries (Salt Institute, 2017)

Rank	Name	Percentage (%) of the world production	Rank	Name	Percentage (%) of the world production
1	China	27.03	8	Chili	3.11
2	USA	16.82	9	Brazil	2.71
3	India	6.56	10	United Kingdom	2.29
4	Germany	4.59		Void	Void
5	Australia	4.17	29	Vietnam	0.43
6	Canada	4.17	35	Philippine	0.26
7	Mexico	4.17	37	Indonesia	0,24

The salt and potash deposits formed in the semi closed marine environment, where solar evaporation intensively took place. In general the deposition began with sodium salt and proceeded by K rich salt mixing with K carbonate. This type of salt is used widely for fertilizer and various glass industry.

The largest salt mine is Goderich in Canada operated by Sifto under Compass Mineral Company. The mine shafts extend more than 7.5 kilometers beneath Huron Lake. The oldest salt mine in Khewra, Pakistan is said to be discovered by Alexander the Great back in 326 BC. Geologically salt deposits are associated with continental shields, where old sediments of Pre-Tertiary age were deposited. In Germany and French salt deposits are mined from the Upper Permian and Jurassic sedimentary rocks with the age ranging from 225 to 250 million years old. In America the salt stones are found in Late Paleozoic sediments of Pennsylvanian age ranging between 280 and 310 million years old. The youngest salt deposits in Europe are mined in Ruhr Valley from the Eocene sediments with the age between 36 tand 50 million years old. Amadeus Basin in Mid Australia is the oldest known salt deposit with Pre Cambrian age of around 1.17 billion years ago.

Based on the characteristics of the salt occurrences it appears that the deposits are associated with Paleozoic and Mesozoic rocks and the continental shields. The semi closed shallow marine environment is most favorable for the deposition. The continental shield with the old morphological features produced the irregular emerged coastal line related to the isostatic mechanism of the continent. At the same time the Milankovich cycle might provide the rise and retreat of sea water in the Pre-Tertiary ages and the global arid atmosphere. The salt deposits could also form in the lakes such as presently take place in many places in Jordan, Utah and some other places in South America.

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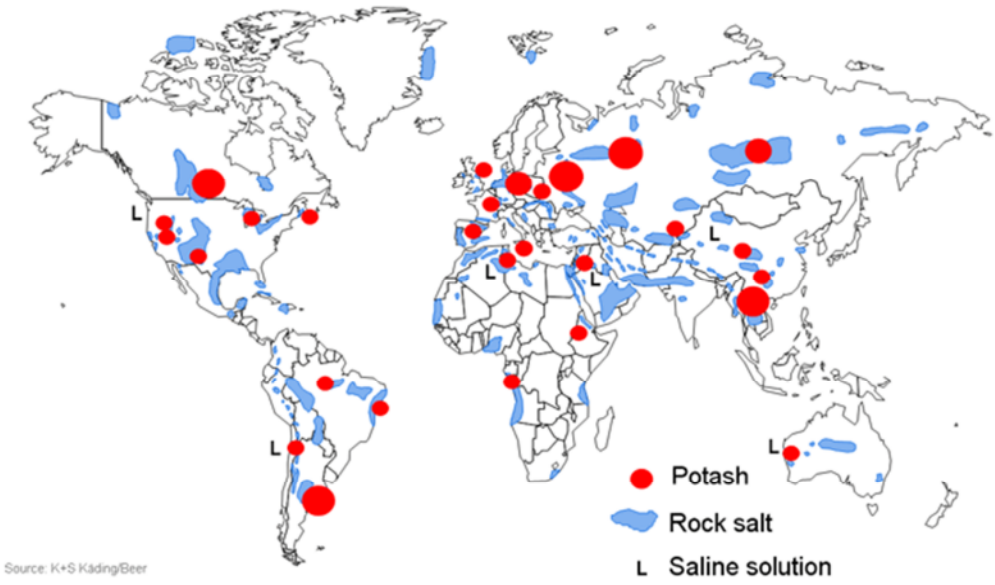

Figure 1. The distribution of salt potentials in the world (Source: Salt Institute, 2017, K-S Mining Company)

REVIEW ON THE SALT POTENTIALS IN INDONESIA

Geologically Indonesian region composes of young sedimentary and volcanic rocks, mostly of Tertiary and Quaternary ages. In places Mesozoic and Paleozoic rocks crops out in Sumatra, mostly in Kalimantan and Papua. The Mesozoic rocks exposed in Kalimantan consist of granitic and granitoids associated with past magmatism. Tertiary deposits consisting of marine and deltaic sediments overlay the rocks covering the eastern part of the island.

In Papua both the Pre-Tertiary and Tertiary sediments were strongly deformed resulting in the rugged Central Range morphology of the Island. The younger rocks of Early Tertiary intruded the older sequence. In addition the ophiolites squeezed by shiver regional faulting exposed in places mostly in the North. In the area called Bird's Head, the moderate tectonized sediments overlay the Pre Tertiary rocks.

The magmatic activities of Early Tertiary age dominate the geological condition of Sulawesi. The obducted ophiolites thought to be originated from Pacific Oceanic plate covers most of the East and Southeast tentacles of the Island. Sedimentary rocks patchy distribute in the island.

Sumatra Island composes mostly of Quaternary volcanic rocks. In places Mesozoic rocks consisting of granitoids and metamorphic rocks expose. The Mesozoic the granite tin belt distributes in the islands of Belitung and Bangka, East of Sumatra. The eastern part of Sumatra is vastly covered by sedimentary rocks of Tertiary age.

From the geological outline described above it may conclude that salt deposits unlikely to occur in the Pre-Tertiary rocks in Indonesia. However, the Tertiary sediments narrowly distributed along the North plain of Java Island known as Bogor Zone (van Bemmelen, 1949) show the evidence of salt potentials. The zone has already

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produced oil and gas for more than a century. Mud volcanoes associated with the diapirs frequently squeezed up in this zone. The rapid sedimentation during the deposition in Middle Tertiary trapped saline sea water in the sediments. The tectonic activity due to the Northward moving Indo-Australian plate pressed the basin to the elisional condition (Satyana & Asnidar, 2008). This area is the only location where the underground salt deposits are found. In seepages occurring in the hydrocarbon basins in Sumatra, Kalimantan and Papua, this evidence was not accompanied by mud volcano containing significant amount of salt. Despite the salt percentage is smaller than the average salt content in sea water, it appears that in the subsurface the salt or saline solution might be potential (Table 2). More over salt also contains iodine as the supplement in consumption salt (Muhamadsyah et al., 2012, Muhamadsyah, 2016).

Table 2. Salt contained in some mud volcanoes of Java

Name	NaCl (g/l)	Location	Reference
Sidoarjo	26.7	SSE of Surabaya, East Java	Zaennudin et al. (2010)
Gunung Anyar	19.3	In the vicinity of Surabaya	Zaennudin et al. (2010)
Kalang Anyar	12.8	In the vicinity of Surabaya	Zaennudin et al. (2010)
Kesongo	10.0	East of Grobogan, Middle Java	Burhanudinnur (2013)
Bledug Kuwu	15.0	East of Grobogan, Middle Java	Burhanudinnur (2013)
Ciuyah	20.1	SE of Kuningan, West Java	Muhamadsyah (2016)

The continuing seepage of the saline solution through mud volcanoes at least has taken place since Pliocene age or more than a million years ago. The evidence indicates a high potentials of the solution under the surface (Satyana, 2007). The origin of materials comes mainly from Upper Kalibeng Formation with the thickness of approximately 3.000 meters (Burhanudinnur, 2013). The continuation of this zone to the East leads to the possibility that the saline solutions had been occurring in the bottom of Madura Strait. Two diapirs were detected by seismic survey in the strait which indicate the possible saline solution seepages (Satyana & Asnidar, 2008). The continuing saline seepages for at least a million years ago undoubtedly enrich the salt concentration of the sea water of Madura Strait. The semi closed U-shape configuration of the strait help to keep the saline solution in the strait waters. The solar evaporation for salt production process in Madura Island therefore has found the best location. The significant expansion of the evaporating pools might is strongly suggested among others by land reclamation process, taking into account the availability of shallow offshore sea in the southern part of Madura Island.

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. Based on the geological characteristics of the salt deposits, it may conclude that the salt deposits unlikely to occur in Indonesia;
2. Solar evaporation of sea water is therefore the only option to produce significant amount of salt;
3. The saline solution in northern part of Java Island indicates a possible underground salt potentials;
4. The saline seepages at the bottom of Madura Straits and its semi closed configuration enrich the

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accumulation of salt concentration in the sea water;
5. The solar evaporation salt making process in Madura Island, therefore has found the best location.

B. Recommendations

1. Considering the relatively high concentration of sea water in Madura Straits that provides the best raw materials for the solar evaporation process, it is suggested to extend the evaporating pool coverage;
2. The reclamation of shallow offshore area in the southern part of Madura is recommended for the expansion of the evaporating pools.

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