ORIGIN OF LAKE SINGKARAK IN THE PADANG HIGHLANDS (CENTRAL SUMATRA)

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ABSTRACT

Since long it has been accepted that Lake Singkarak in the Padang Highlands is nothing else but a remnant of a gigantic volcano - the Singkarak volcano-which once blew off its top to form a lake. Van Bemmelen though not referring to Singkarak Lake especially, explained the numerous depressions in Sumatra as the combined result of volcanic and tectonic activities, a phenomenon he called volcano-tectonic process which caused the formation of the socalled volcano-tectonic depressions.

A short visit to the lake area in the months of February and March (1970) convinced the author that the Singkarak lake is neither a volcanic ruin nor a volcano-tectonic depression in the sense of van Bemmelen.

Faulting evidences, morphology and the position of the Singkarak trough plus the distribution of volcanic products north and south of the lake lead to the conclusion that the Singkarak trough is a depression making part of the 1650 km graben zone which stretches from Sumatra's northern tip untill the Semangko valley in the SE. Field evidences suggest that the lake results from a damming process by volcanic material produced by the Marapi-Singgalang-Tandikat volcanoes in the north and by the products from the Talang volcano in the south.

INTRODUCTION

Sponsored by Caltex Pacific Indonesian Oil Company, the author had the opportunity to make a short excursion to the Padang Highlands in early 1970. The party consisted of Drs. Felix Haser and Tan Bock Kang from the University of Malaysia, Mr. Kamal from CPI-Oil Company and the author of this paper.

Weather condition during the trip was fairly satisfactory and thanks to the Landrover leased to the party by CPI, large distances could be covered though road conditions were generally deplorable. Most of the time however were spent in the areas around Lake Singkarak and around the Umbilin Basin.

The area of Lake Singkarak can be reached easily by car from Padang Pandjang which is situated right in the middle of two main cities of Bukit Tinggi and Padang (see Index Map). A small villa owned by Hotel Adilla near Umbilin and the guest house of the Umbilin coal Mine in Sawah Lunto served as comfortable basecamps. The road which connects Padang Pandjang and Solok which goes along the eastern shore of the lake is fairly good whereas an unpaved road only accessable by jeep goes along its western shore.

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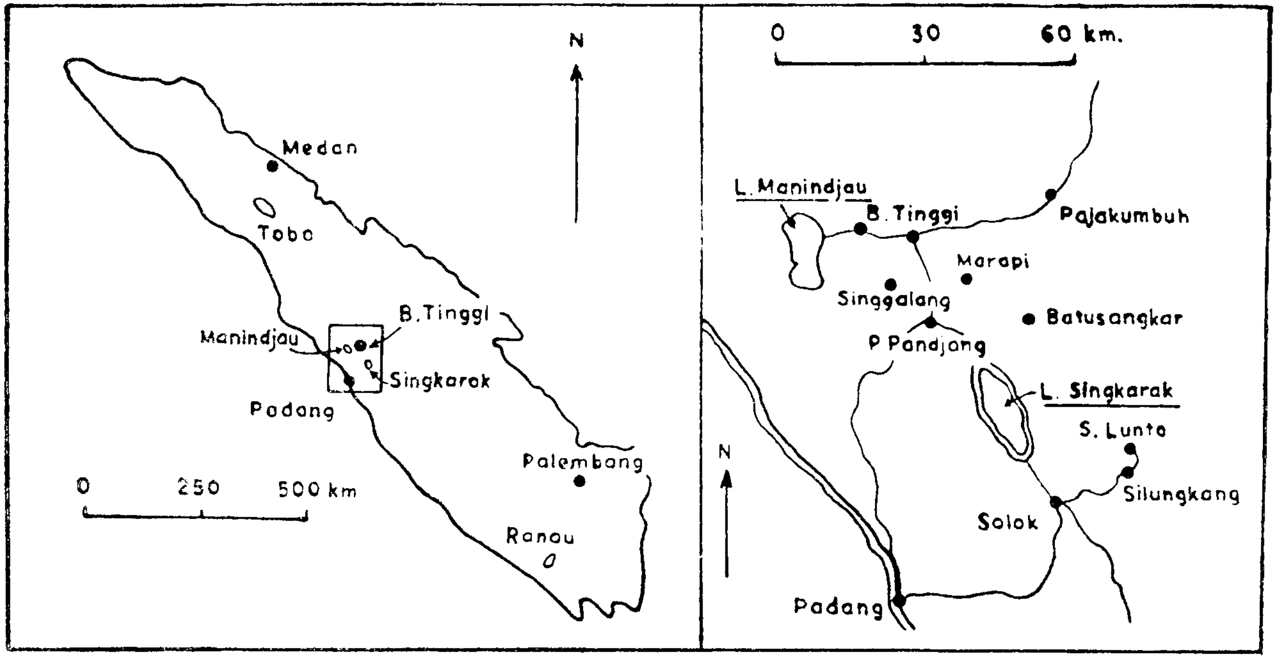

Fig. 1. **Index Map of Singkarak Area and Surroundings**

Generally, the geology is reasonably well exposed and by clear weather the morphology of the entire area can be observed from several points situated on mountain slopes which flanked both sides of the lake.

Herewith the author wishes to thank CPI-Oil Company for the aid and services rendered to him which made this trip possible. Special words of thanks are directed to Mr. Kropschot, Acting Manager Exploration Division of CPI-Oil Company who showed a keen interest in the geological problems of Central Sumatra in general, to Mr. Kamal whose connection and good relationship with the local authorities made the trip easier and last but not least to Dr. Felix Heser who helped the author clarifying many problems encountered in the field through useful discussions.

THE SUMATRA RIFT ZONE

The purpose of this paper is to discuss the origin of Lake Singkarak. Since it will be shown in the next chapter that it is directly connected with the main rift zone of Sumatra it is not out of place to give a short introductory discription of the Sumatra Rift Zone.

Previous authors such as Westerveld (1952), van Bemmelen (1949), Verstappen (1955, 1961) and Katili (1967, 1969) have ascertained the existence of a 1650 km fault zone which runs along the untire length of Sumatra from the Semangko Bay in the SW to the tip of Atjeh in the NE. This zone is called Semangko fault zone by van Bemmelen (1949) and Great Sumatra fault trough system by Westerveld (1952). Van Bemmelen (1949) as well as Westerveld (1952) ascribed vertical displacements to this faults zone, whereas Katili (1967, 1969), based on literature study offered evidences which suggest horizontal movements along this zone.

Geologic and tectonic history of the Sunda islands shows that as early as the Neogene the Sumatra and Sunda orogens were divided into longitudinal fault blocks by the development of an elongated graben zone and parallel structures of a similar kind, which cut through the Mesozoic fold sytem in North and Central Sumatra (van Bemmelen, 1949 and Westerveld, 1952).

Field evidences in the Padang Highlands and works of previous authors suggest that this fault zone is not a continuous one. Besides, vertical as well as horizontal movements occur along this zone. So it is more proper to call it Sumatra Rift Zone, analogous to the East African Rift Zone.

The graben structures originated by the collapse of the Barisan anticline which happened in the Tertiary. This is indicated by the existence of Paleogene beds with fish remains below old Miocene coal-bearing strata in the Padang Highlands (Musper, 1935). It indicates deposition in an isolated depression. In the Semangko Graben in South Sumatra, the existence of the graben structure at the end of the Tertiary is ascertained by the presence of late Paleogene deposits near Semangko Bay (Westerveld, 1952). The graben morphology is most couspicuous in the Semangko Valley and in the Padang Highlands. In the latter part the graben structure can easily be traced from the Muaralabuh Valley in the south untill as far as Sumpur-Rokan-Kiri Valley in the north.

Many parts of this graben zone becomes obscured by the extensive cover of pyroclastic sheets and volcanic mantels from the Quarternary volcanic activities. Along this zone, where it is free from volcanic cover, a large number of elongated depressions are found of which origin is largely still unknown. Most conspicuous are the Semangko Valley, the Kapahing Makakau Valley, the Ketahun Valley, the Kerintji Valley, the Muaralabuh Valley, the Singkarak-Solok trough, the Tangse Valley and the Atjeh Valley. The occurrence of a large number of fumaroles and hotsprings and earthquake epicenters in the Semangko Valley and the Tarutung-Angkola-Gadis depression, the Sumpur and Muaralabuh Valley, indicates that the faults bordering this graben zone are still active. In this paper only the Singkarak-Solok trough will be discussed in detail.

MORPHOLOGY AND STRUCTURE OF THE SINGKARAK TROUGH

The Singkarak-Solok depression consists of two parts, the elongated northwest-southeast trending Singkarak Trough which is about 40 km long and the rectangle shaped Solok Plain attached to it the southeast (Fig. 2)

According to the map sheet 36, Hind 1043 (Padang) issued by the US Army Map service, 2nd-Edition 1944, Lake Singkarak is about 20.7 km long with a maximum width of 7.5 km. Its present waterlevel has an elevation of 362 m above sealevel with a maximum depth of 268 m (Verstappen, 1961). According to Verstappen (1961) the bottom of the lake is flat. The topographic map sheets of Central Sumatra indicate that the lake is situated in the very lowest part of the Sumatra Graben of this section. Morphologically, Lake Singkarak does not look like a crater-lake, caldera or volcano-tectonic depression. It is quite different from the Manindjau depression in the north which is completely surrounded by steep craterwalls built of alternating layers of pyroclastics and lava flows. Its shore line is relatively very straight. Its western side is distinctly bounded by flat terraces and scarplets.

The Solok Plain is only slightly higher than the lake level. Its altitude ranges from 387 m above sealevel in the northwest to about 450 m in the southeast. From the bottom of the lake its altitude ranges between 293 to 356 m. In the southeast the floor of the Singkarak Trough rises abruptly to approximately 1,500 m above sealevel in the surroundings of Lake Baruh and Lake Atas which are at a distance of 35 to 40 km from the southern shore of Lake Singkarak respectively.

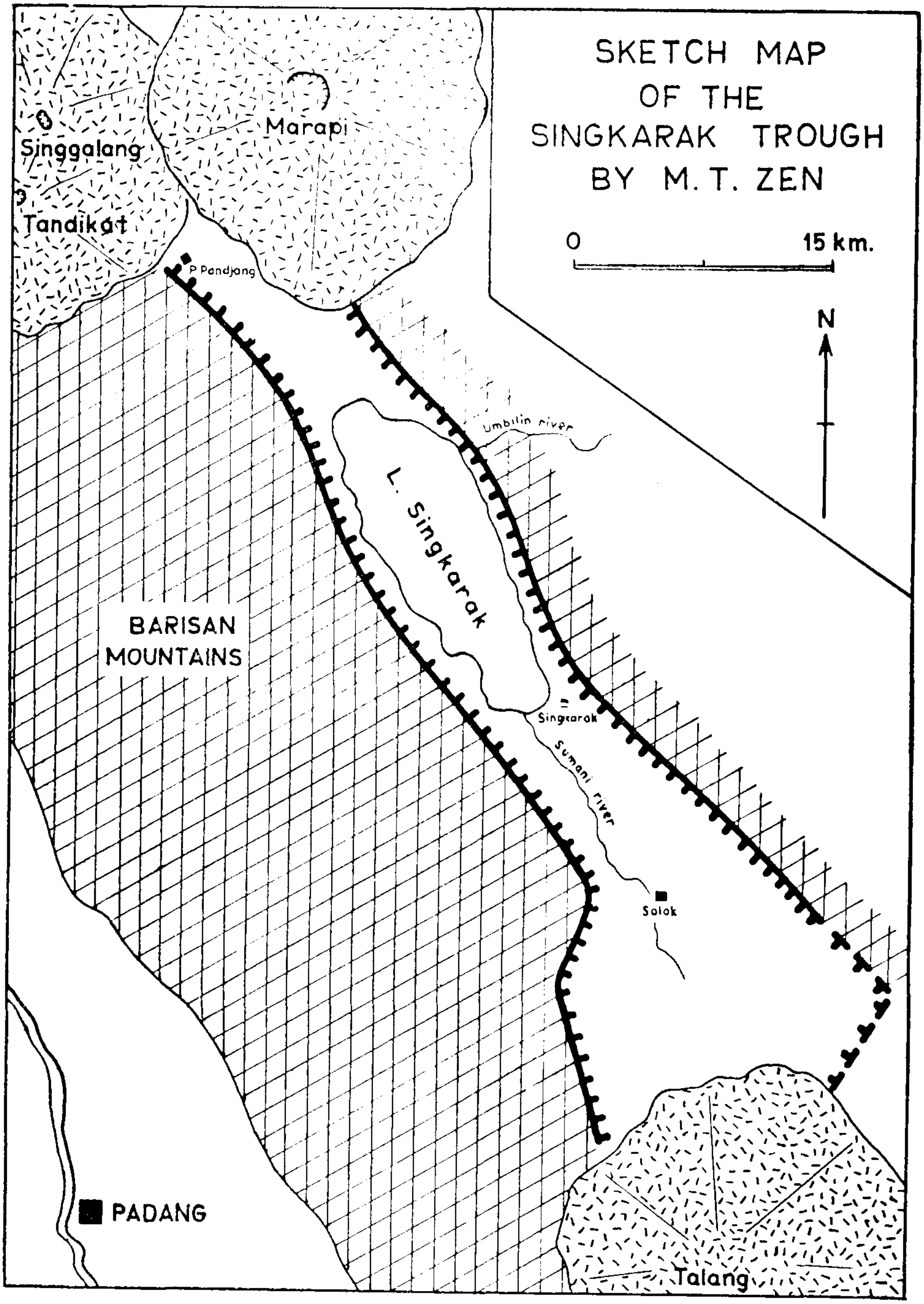

Fig. 2. Sketchmap of the Singkarak-Solok trough.

In the NW the floor of the trough rises more abruptly than in the South. An elevation of 1,180 m above sealevel is reached at a distance of only 19 km from the northwestern end of the Lake. This is the area where the products from the younger Marapi abud against the foot of the Singgalang volcano, forming a broad saddle which consists of pyroclastics and lava flows. To the north the terrain slopes gradually down towards the tuff plateau of Agam.

Most of the small rivers in this area flow towards the Singkarak lake, including those rivers in the Solok Plain, but the lake itself is being drained eastward by the Umbilin river which incises its course through the off shoot of Bukit Padang mountains. Valkenburg (1921) mentioned the existence of a dry valley to the east of Solok. Evidently the Solok Plain once drained eastward via this deserted valley and the Lasi-Pumuatan river which debauches into the Umbilin river many kilometers down-stream. The bottom of the dry valley is at 410 m above sealevel. It is more or less at the same elevation of the higher terraces of the Umbilin outlet of Lake Singkarak.

Most probably the Soemani river followed this dry valley formerly but was forced to flow towards the Lake later on by subsidence of the trough bottom.

To the east and west, the Singkarak Trough is bounded by steep fault scarps. A number of scarplets and terraces flanking the lake on both sides can be distinguished very clearly in front of the fault scarps.

Indications of normal faulting around Lake Singkarak are numerous. Along the road to Batusangkar which partly follows the Umbilin river 6 normal faults parallel to the lake are found within a distance of less than 2 km. The faults are indicated by a repetion of fine layered lake deposits and volcanics. Obviously the Umbilin river follows another transverse fault indicated by the presence of tilted younger limestone layers adjacent to the lake deposits not far from Air Tanang village.

Along the road from Singkarak village to Suilt Air several tilted blocks dipping towards the east are encountered in the surrounding of Panorama Lama.

Also along the west side of the lake indications of normal faulting are found. Slickensides are found nearly on all older rock surfaces exposed in small streams such as limestones, phyllonites and schists which are supposed to be of Permo-Carboniferous age (Musper, 1929).

In the small stream of Muarabuluh several faults are found running parallel to the lake. One, trending N 332E/45, brought the younger volcanics adjacent to the schists and dolomitic limestone which is of Permo-Carboniferous age. In this area, where exposures are plenty, strongly deformed rocks are found in many places.

According to the mayor of Singkarak (oral communication, 1970) the river of Muarabuluh did not exist before 1961. It came into being during a huge landslide wich caused a "Bergsturz" which swept many houses and school building into the lake. The mayor further stated that this type of phenomena occurs „quite" frequent around the lake area. If it is true this might indicate that the fault is still active in this region.

Travelling around the lake gives one the impression that volcanic products are not predominant in the "rock economy" of Singkarak. Rock fragment found on the shore are mostly older rocks like schists, shale, slates, gneisses, and dolomitic limestones.

The small terraces and scarplets on the westside between the villages Kota Baru and Saningbakar are overlain by a thin cover of young volcanics consisting of andesitic to dacitic lava boulders or tuffs which yield off light red soil when whethered. Also the hills on the southeast side of the lake are overlain by the same type of material. The light red cover of the terraces and scarplets are distict from both sides of the lake. The volcanics are not distinctly connected with a particular eruption center. So there is a possibility that they have been issued from fissures found on both sides of the lake. But there is no proof whatsoever for this assumption.

On the north end of the lake the graben is filled by pyroclastic flow deposits. It consists of sand, lapilli, scoriae lava fragments and ash.

These banks of pyroclastics show 14°-16° dip towards the lake. Good exposures are found in Sumur. The same type of deposits are also found in the village Batipu Atas (along the road from Batusangkar to Padang Pandjang). Here, the pyroclastics are obviously connected with the Marapi volcano. In this area exposures of lava flows alternating with pyroclastics are numerously found.

A pyroclastic flow deposit of the same structure are also found in the quarries of Batang Arus not far from Alahan Pandjang in the south. Since Mt. Talang is the closest active volcano in the region it is reasonable to assume that these pyroclastic deposits were produceed by the Talang volcano.

CONCLUSION

Evidences encountered until now suggest that the Singkarak-Solok trough is a graben. It is part of the Sumatra Rift Zone. Lake Singkarak itself came into existense by the damming process caused by volvanic material filling in both ends of the graben. It is quite evident that the graben came into existence prior to the volcanic phase which produced the pyroclastics.

REFERENCES

BEMMELEN, R.W. VAN. 1935 : Vulkano-tektonische depressies op Sumatra. 25e Ned. Natuurw. en Geneesk. Congress, Leiden.

——————— 1949 : The Geology of Indonesia. Martinus Nyhoff, Gov-Printing, The Hague.

KATILI, J.A. & HEHUWAT, F, 1967 : On the occurrence of Large Transcurrent Fault in Sumatra, Indonesia. Journ. of Geoscience, Osaka Cit. Univ. 10, p. 5 - 17.

KATILI, J.A. 1969 : Large transcurrent faults in Southeast Asia with special reference to Indonesia Bull. NIGM, v. 2, no. 3, p. 1 - 20.

MUSPER, K.A.F.R. 1929 : Beknopt verslag over de uitkomsten van nieuwe geologische onderzoekingen in de Padangse Bovenlanden. Verh. Jaarb. v.h. Mynw. N.I. p. 265 - 331

——————— 4935 : Die Fisch führende Breccien und Mergelschiefer-abteilung des Tertiares der Padanger Hochland (Mittel Sumatra) Verh. Geol. Mynb. Gen. Deel XI.

VALKENBURG, S. VAN 1921 : Geomorphologische Beschouwingen over de Padangse Bovenlanden. Jaarv. v.d. Top. Dienst. in N.I. p. 76 - 103.

VERBEEK, R.D.M. : Topografishe en geologische beschrijving v.e. gedeelte van Sumatra's-Westkust met Atlas 1883.

VERSTAPPEN, H. TH. 1955 : Geomorphic notes on Kerintji (Central Sumatra). Ind. J. Nat. Science, 11, p. 166 - 177.

——————— 1961 : Some „volcano-tectonic" depressions of Sumatra, their origin and mode of development. Proceedings Kon. Ned. Akad. v. Wetensch. Series 64, no. 3.

VOLZ, W. 1909 : Die geomorphologische Stellung Sumatra's. Geogr. Zeitscher.

WESTERVELD, J. 1952 : Quaternary volcanism on Sumatra. Bull. Am. Geol. Soc. Vol. 63. p. 561 - 594.

ZWIERZYCKI, J. 1919 : Geologische Kaart v. Sumatra. Bld VII.