Case History No. 9. 10. Bangkok, Thailand, compiled by Soki Yamamoto, Rissho University, Tokyo, Japan

9.10.1 GEOLOGIC FORMATIONS AND GROUND WATER

The Lower Central Plain, approximately 120 kilometres in width and 200 kilometres in length, was originally formed by the accumulation of clastic sediments more than 2,000 metres thick in the fault/flexure depression since Tertiary time (Figure 9.10.1).

The ground surface of Bangkok is entirely underlain by blue to gray marine clay up to 30 metres thick, known as the Bangkok Clay. The upper 15 metres of the Bangkok Clay, generally called the Bangkok Soft Clay, is very soft and highly compressible. The lower part, referred to as the Bangkok Stiff Clay, which is rather stiff and less compressible, extends to an average depth of 25-30 metres. The water in these clays is very saline and salty.

The water-bearing formations of Bangkok consist mainly of sands and gravels with minor clay lenses. They are similar in occurrence and composition but can be zoned according to the geoelectrical properties (Figure 9.10.2) into 8 principal artesian aquifers, separated by thick confining clay or sandy clay layers; namely:

Bangkok Aquifer (50 m zone),
Phra Pradaeng Aquifer (100 m zone),
Nakhon Luang Aquifer (150 m zone),
Nonthaburi Aquifer (200 m zone),
Sam Khok Aquifer (300 m zone),
Phaya Thai Aquifer (350 m zone),
Thon Buri Aquifer (450 m zone),
Pak Nam Aquifer (550 m zone).

Aquifer characteristics of three aquifers are listed in Table 9.10.1. These aquifers generally extend the full width and length of the Plain. Most wells in Bangkok penetrate the second, third and fourth aquifers because they are highly productive, with a Coefficient of Transmissibility of 40-130 m^2hr (150,000-250,000 gallons per day per foot), and yield water of relatively excellent quality. The first aquifer, immediately beneath the Bangkok Clay, gives saline water whereas the fifth and sixth aquifers are not popular due to their greater depths and water of inferior quality. The seventh and the eighth have been proved to yield fresh water but have been tapped by only few wells. The sediments at depths from 650 metres to the metamorphic basement rocks at about 2,000-3,000 metres have been indicated by electric well logging to yield brackish to saline water. In the northern part of the Lower Central Plain, however, fresh ground water could be obtained from the first aquifer.

Ground water has been exploited for domestic supply in Bangkok for the past six or seven decades, but heavy utilization began in 1957 when the surface water for domestic and industrial use could not meet demand. For many years, about one third of the total public water supply in Bangkok has come from the aquifers (Table 9.10.2.).

It is estimated that the present total pumpage for domestic and industrial use is as high as 700,000 m^3/day. This pumping rate exceeds the safe yield and brings about an acute problem of water level decline. At an early stage of development, the water level was about at the ground surface but it gradually fell until cones of depression developed in many areas. In 1958-1959 the water level in the center of Bangkok was about 8-9 metres from the ground surface while that in the suburbs was 4.5-6 metres. Since 1967 a remarkable change of water level could be observed. During 1968-1969 the depth to water level in heavily pumped area was 22-25 metres, and 10-12 metres in the suburbs. At present the general depth to water level is 30 metres while that at the center of the cone of depression is in excess of 33 metres (Figure 9.10.3). The annual rate of decline in the water level is now as high as 3-4 metres for the 100-metre, 150-metre and 200-metre aquifers. In the 50-metre aquifer the water level is also falling about 1 metre a year due to the interception of recharging water at the northern part of the Plain. The consequences of heavy pumpage are not only the over-draft of aquifers but also the salt water encroachment into the southern part of the Bangkok Metropolis and the possibility of land subsidence.

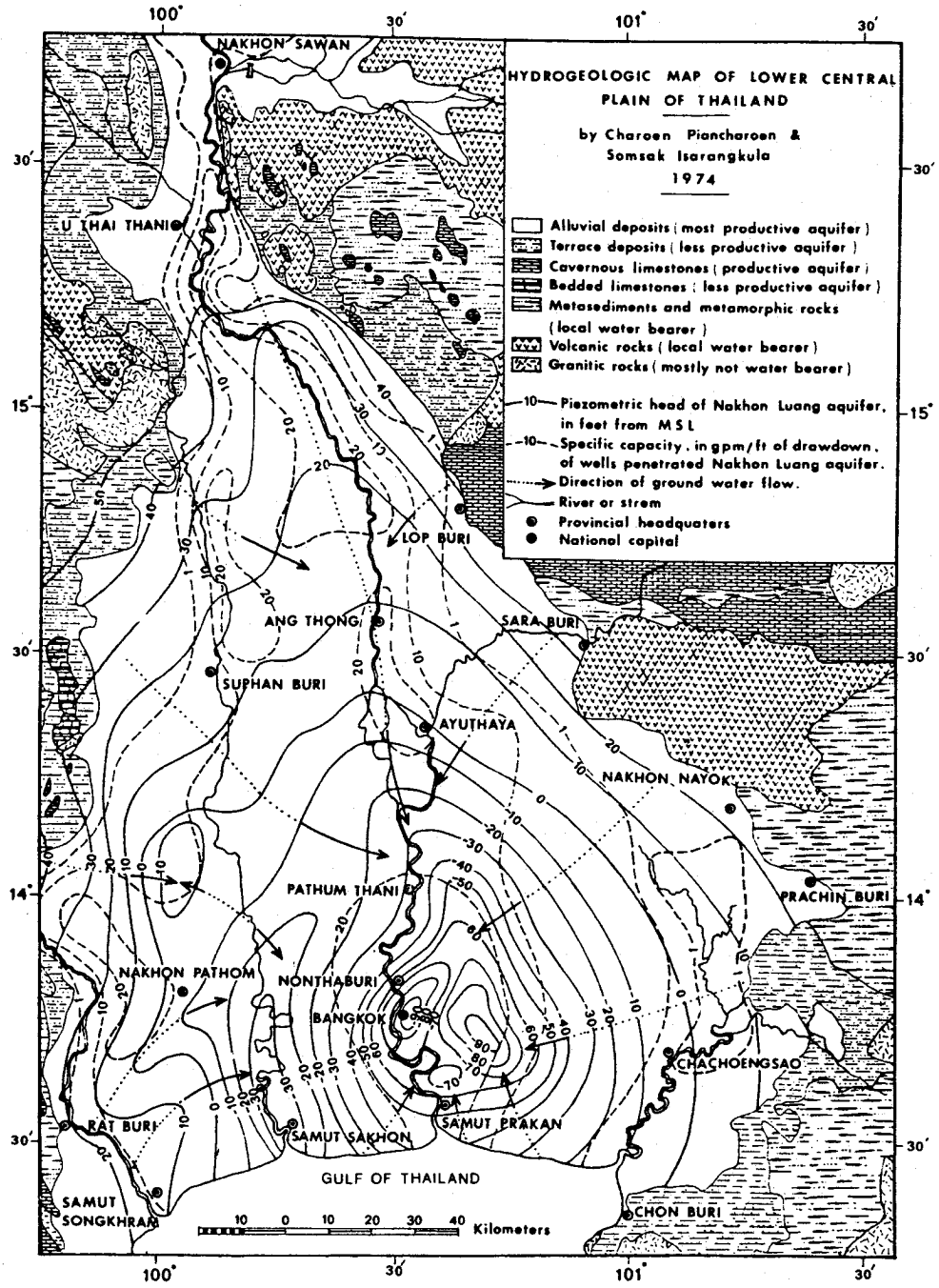

Figure 9.10.1 Hydrogeologic map of the Lower Central Plain of Thailand (after Piancharoen, 1977, Figure 1).

9.10.2 PROBLEMS OF LAND SUBSIDENCE

There is no serious damage due to land subsidence in Bangkok at the present time although flooding in localized areas is believed to be a result of a reduction in the altitude of the ground surface. However, the possibility of land subsidence due to the effect of deep well pumping has been spoken of by soil scientists for many years but no definite scientific proofs could be issued. No systematic investigation or observation leading to a reliable quantitative expression of subsidence behavior has been made to date.

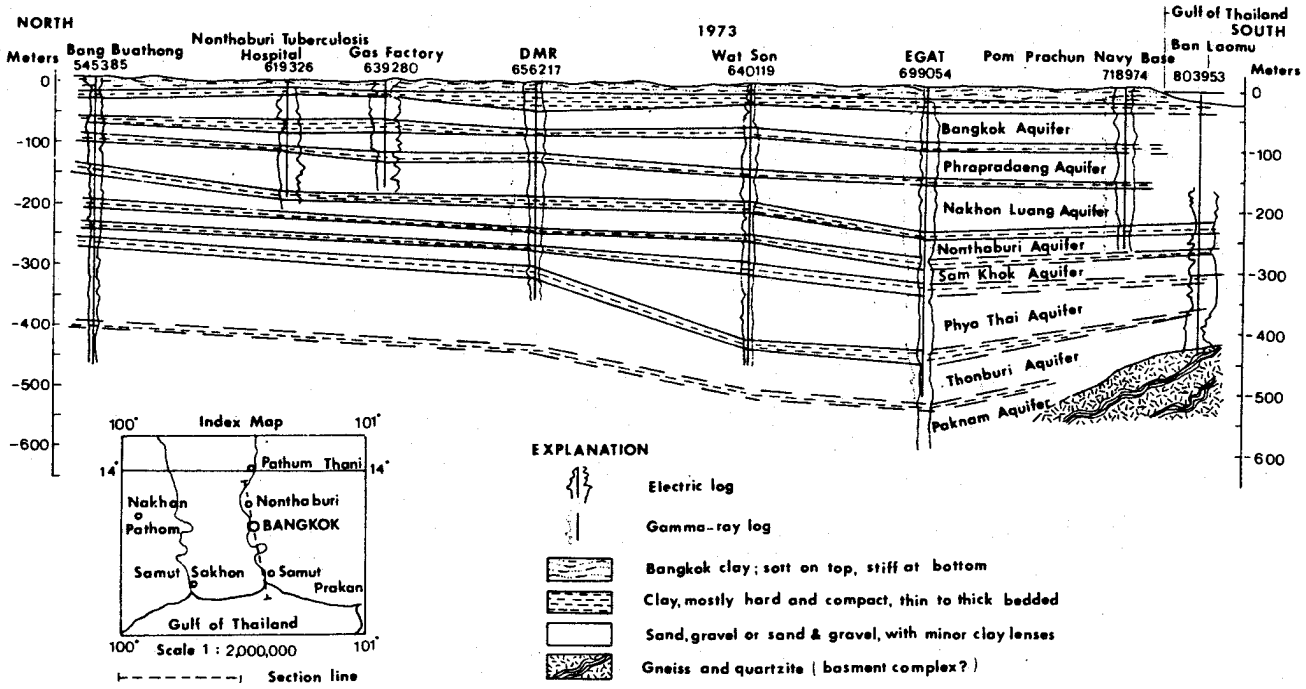

Figure 9.10.2 Hydrogeologic north-south section of the Lower Chao Phraya Delta showing principal aquifers of Bangkok Metropolis (correlated by electric and gamma-ray logs) (after Piancharoen, 1977, Figure 2).

9.10.3 INVESTIGATION PROGRAMS

Since the tests and accompanying evidence are far from conclusive, the problem of land subsidence and whether Bangkok is sinking is still debatable. Many geologists and hydrologists believe that the present deep well pumpage, mostly below 150 metres, has no effect on land subsidence, and if there is any subsidence external loads are to blame. Local flooding is also believed to be due to poor drainage in Bangkok. Three projects are now being submitted for consideration; namely, the leveling in the Bangkok Metropolitan Area for the investigation of land subsidence, the investigation of land subsidence caused by deep well pumping, and the development and management studies of ground water resources in the Bangkok area. These programs will be interrelated and aimed for completion within four years with a total budget of about 1.5 million U.S. dollars.*

9.10.4 SELECTED REFERENCES

PIANCHAROEN, C. 1977. Ground water and land subsidence in Bangkok, Thailand. IAHS. Pub. No. 121, pp. 355-364.

PIANCHAROEN, C., and C. CHUAMTHATSONG. 1978. Ground water of Bangkok Metropolis, Thailand. IAH Memoire, Vol. XI (Budapest), pp. 510-528.

---

* According to Dr. Prinya Nutalaya of the Asian Institute of Technology, progressive protrusion of water-well casings has been noted in Bangkok (oral communication to Joseph F. Poland, September 1978). This would suggest the beginnings of sediment compaction and land subsidence.

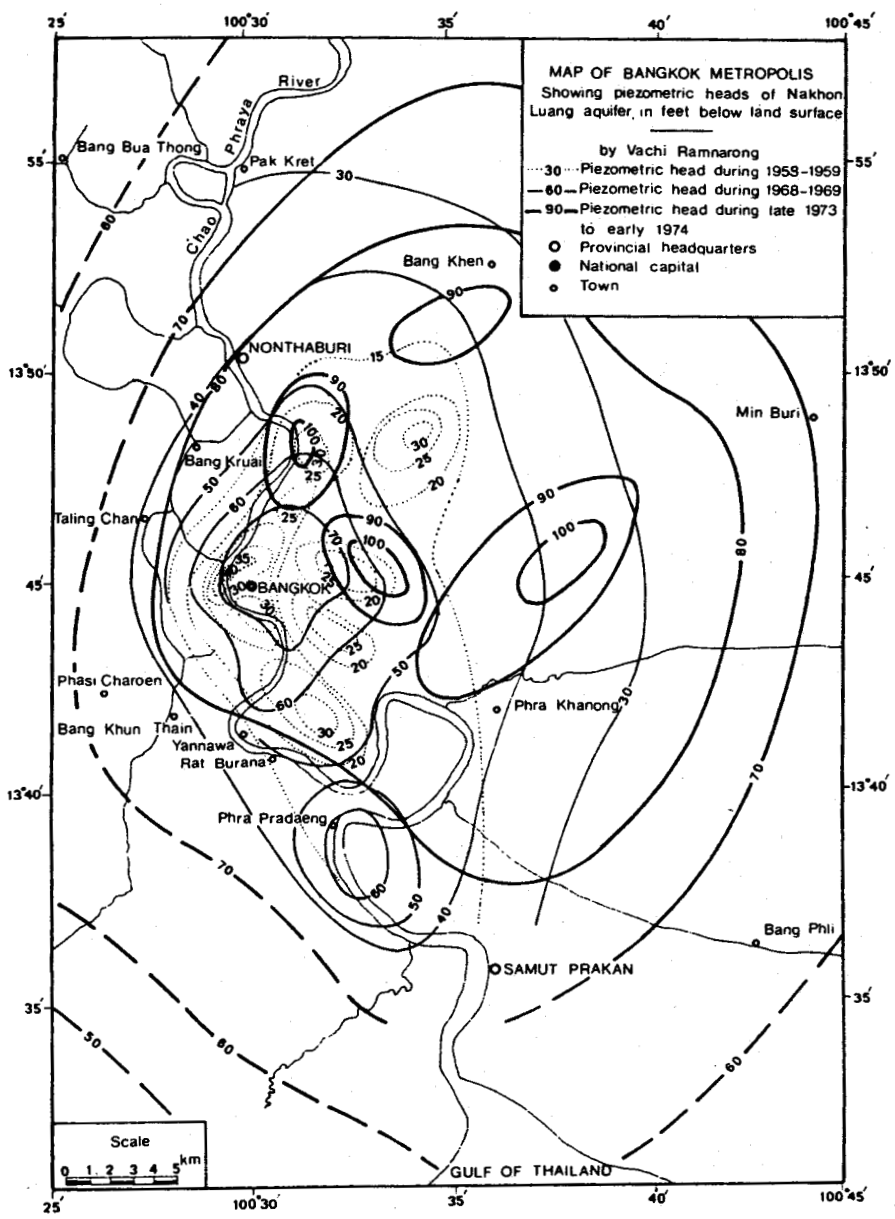

Figure 9.10.3 Water level map of the Nakhon Luang Aquifer (after Piancharoen, 1977, Figure 3).