Resistivity Surveys to Detect Salt Cavities in Ban Non Sabaeng and Ban Champa Dong, Sakhon Nakhon Province, NE Thailand

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ABSTRACT

Land subsidences were reported in Ban Non Sabaeng School and Ban Champa Dong School near salt production areas in Nong Kwang subdistrict and Kud Ruea Kham subdistrict, Ban Moung district, Sakhon Nakhon province. Salt cavities were suspected underneath the schools as the cause of the subsidence. Salt water is pumped from underground and is dried in sunlight or is boiled to obtain salt. Salt water wells are drilled to depths of 40 to 60 meters. The upper salt layer is at depths of 3 to 6 meters. Resistivity surveys were conducted, along with drilling to 100-meter depths. A special technique using resistance compensation was used to get sufficient resistivity signals since the terrain had extremely low resistivity. Resistivity sounding using the Schlumberger configuration was used at the Ban Non Sabaeng School. Resistivity less than 1 ohm-meter was detected at depths of 50 to 80 meters. Drilling results showed that these depths were the top of a salt bed. Resistivity traversing using the dipole-dipole configuration was used at the Ban Champa Dong School. Low resistivity areas were detected and were interpreted to be salt domes.

KEYWORDS: Resistivity, Schlumberger configuration, dipole-dipole, Ban Non Sabaeng School , Ban Champa Dong School, subsidence, cavities.

BACKGROUND

Land subsidence is usually occurred within the area where salt-water (brine) is withdrawn from the ground.

Salt production areas are located in 5 provinces in the Northeastern part of Thailand, including Nong Khai, Udon Thani, Sakhon Nakhon, Maha Sara Kham, and Nakhon Ratchasima. The salt water was found at depth of about 40 to 150 meters.

Salt layer in these areas are generally at depth of about 300-1,000 meter (Japakasetr, 1978, Suwanich, 1986, Tabakh, Utha-aroon, Coshell and Warren, 1995). However salt was sometimes pushed by the weight of overlying sediments and formed salt domes (Talbot and Jackson, 1987; and Warren, 1989). Salt rises to shallower depths.

Villagers found the salty water and knew how to produce salt from it, by dry the solution in a open land blocks (similar to rice paddies) exposed to the sun light during summer period; or boil it (Figures 1 and 2). The salt water is naturally derived from dissolution of groundwater and salt layer. Villagers know the best way to do by placing PVC tube at 3 to 6 meters from the top of salt layer where it can stay there longer and maximum salt water be obtained. By pumping water this method salt is dissolved at top of the salt dome forming cavities.

Figure1. Salt pans.

Figure 2. Salt boiling plant.

Land subsidence occurs when salt cavities get large. Sinkholes, measured 10 to 20 meters in diameter and depth, are observed at ground surface (Solgosoom, 1988; Solgosoom, Laempulsup and Preechaluk, 1989). However, danger to lives has not been reported, according to slow process of the subsidence. In addition, they usually occur at pumping wells, located in the water ponds and low land, and generally in wet season when salt production is prohibited and villagers do not live in the areas.

Villagers then feared that subsidence might occur in their backyards and schools. Government sectors and scientists went to the area to determine the problems and seek for solutions. All the conventional geophysical surveys were tested to get the best responses. The objectives were to detect salt cavities. It was found that resistivity was the best to get representative profiles of the ground to illustrate to public how the subsidence could occur (Solgosoom and Suanburi, 1988; Solgosoom, Laempulsup and Preechaluk, 1989; Satarugsa and others, 2003). Resistivity sounding could detect a cavity under the major sinkhole north of Ban Non Sabaeng School (Solgosoom, Laempulsup and Preechaluk, 1989; Satarugsa and others, 2003).

Ban Non Sabaeng School, and Ban Champa Dong School, are located near salt production areas. Fear that there might be cavities under the school building started. There were a number of evidences to report (Figure 3). Department of Primary Industries and Mines (DPIM) and the Department of Mineral Resources (DMR) had to launch drilling and resistivity surveys to determine the problems and seek for a solution.

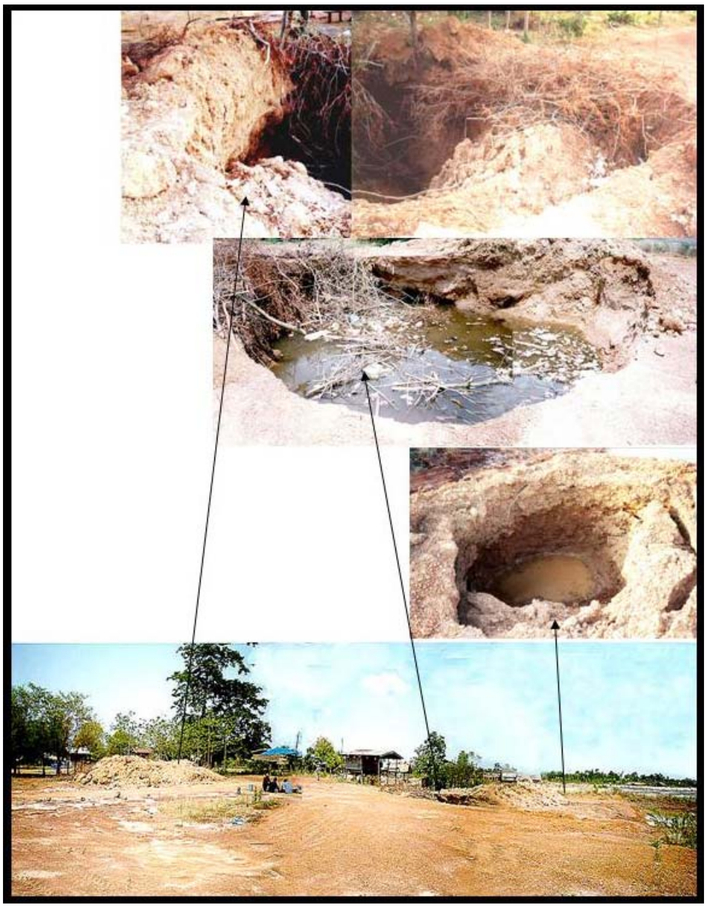

Figure 3. The major sinkhole, north of Ban Non Sabaeng School.

OBJECTIVES

To investigate cavities under Ban Non Sabang School and Ban Champa Dong School and nearby areas.

AREA OF INVESTIGATION

Ban Non Sabaeng School is located adjacent to the salt production area. Salt production of Ban Nong Kwang and Ban Non Sabaeng is confined to a low land area with an oval shape lying almost in NS direction. The size of the low land is about 5 kilometers long and 1 kilometers wide. The salt pans were once rice paddies, which were modified to salt drying pans quite nicely. The low land is filled with water in rainy season. Salt could be produced here only in dry season. The low land is surrounded by high land where villages, roads, temples and other public facilities are situated. Difference in elevation is about 3 meters. A salt dome is probably underneath the lowland. This is why the villagers can drill there and get salt water at shallow depth, at 40-60 meters. Villagers attempted to drill for salt water outside of this perimeter but could not get salt water.

Ban Champa Dong School is located among salt production areas. The nearest salt production is 1 kilometer west of the school. A salt production was once in the rice field behind the school. Salt water is confined to low land areas with diameters of 1-2 kilometers. Salt water could be also found at 40-60 meters depth.

EQUIPMENT

A resistivity meter, model: IRIS SYSCAL R2, with a supplement set of Dipole-Dipole configuration and Schlumberger resistivity sounding. A special technique using resistance compensation was used to get sufficient resistivity signals in the extremely low resistivity terrain.

METHODS OF INVESTIGATION

At Ban Non Sabaeng School, measured the resistivity of the ground using the Schlumberger configuration. Sounding resistivity data were obtained from 32 stations located in Ban Non Sabaeng School and around the major sinkhole, north of Ban Non Sabaeng School. The maximum spacing between electrodes (AB/2) was 320 meters. Depth data was 160 meters (Figure 4).

At Ban Champa Dong School, measured resistivity of the ground using the dipole-dipole configuration. The dipole-dipole frequency domain, spacing 40 m, was applied. Data was measured at n=6. Depth data was 240 meters. Resistivity data was obtained along the survey line of 9 kilometers, covering an area of 16 square kilometers (Figure 4).

Drilling was conducted to 100 meters in Ban Non Sabaeng School and Ban Champa Dong School. Four holes were drilled in Ban Non Sabaeng School and near the major sinkhole. One hole was drilled in Ban Champa Dong School. Cores of samples were collected. These samples are siltstone, anhydrite and salt.

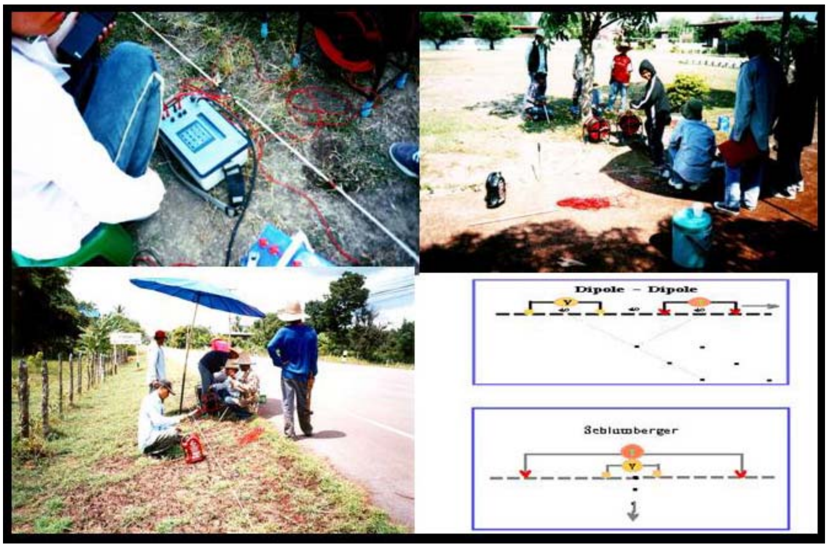

Figure 4. Resistivity survey at Ban Non Sabaeng School and Ban Champa Dong School.

RESULTS

1. Resistivity sounding in Ban Non Sabaeng School suggested depth to salt at 50-80 meters, laterite layer 3-5 meters was at the surface. The result is corresponding to drilling data, which revealed depth to salt at about 50-60 meters.

2. Resistivity sounding at the major sinkhole, in comparison to old data, suggested that the sinkhole moved southward direction, trending 170° , toward the village.

3. Results of reistivity survey at Ban Champa Dong showed that depth to salt was at about 65 meters. The results are corresponding to the drilling data, which revealed depth to salt at about 75 meters.

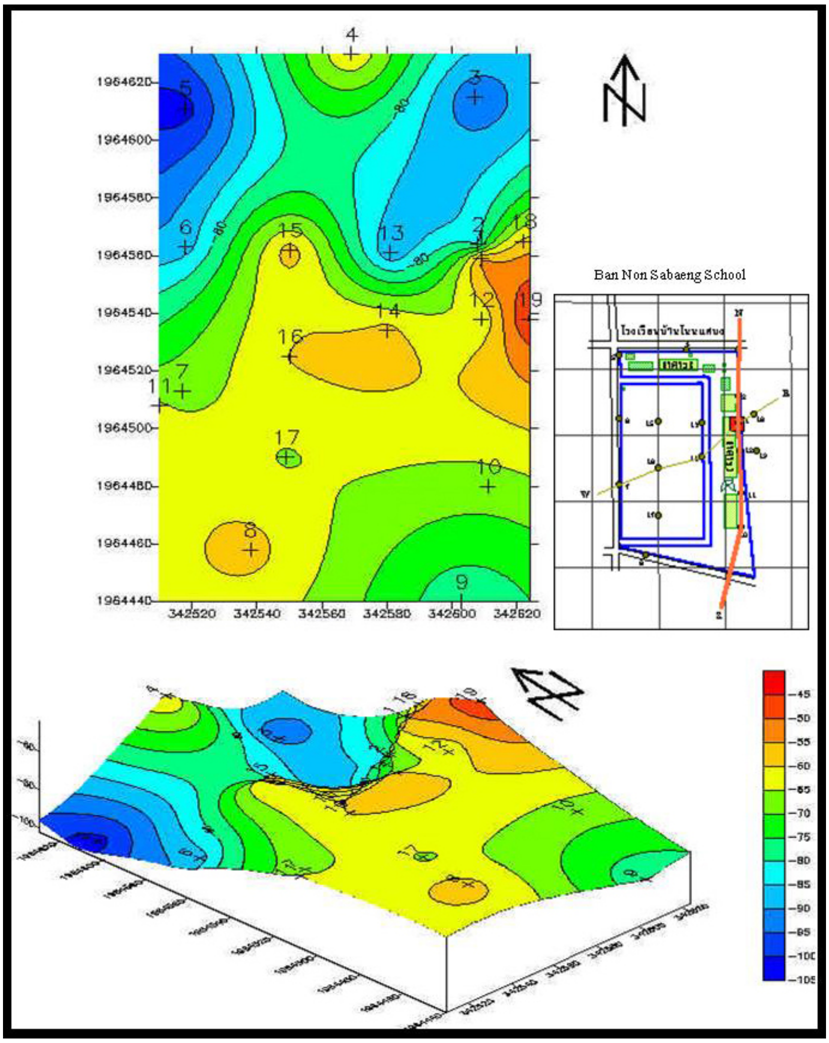

Figure 5. Resistivity map at Ban Non Sabaeng School.

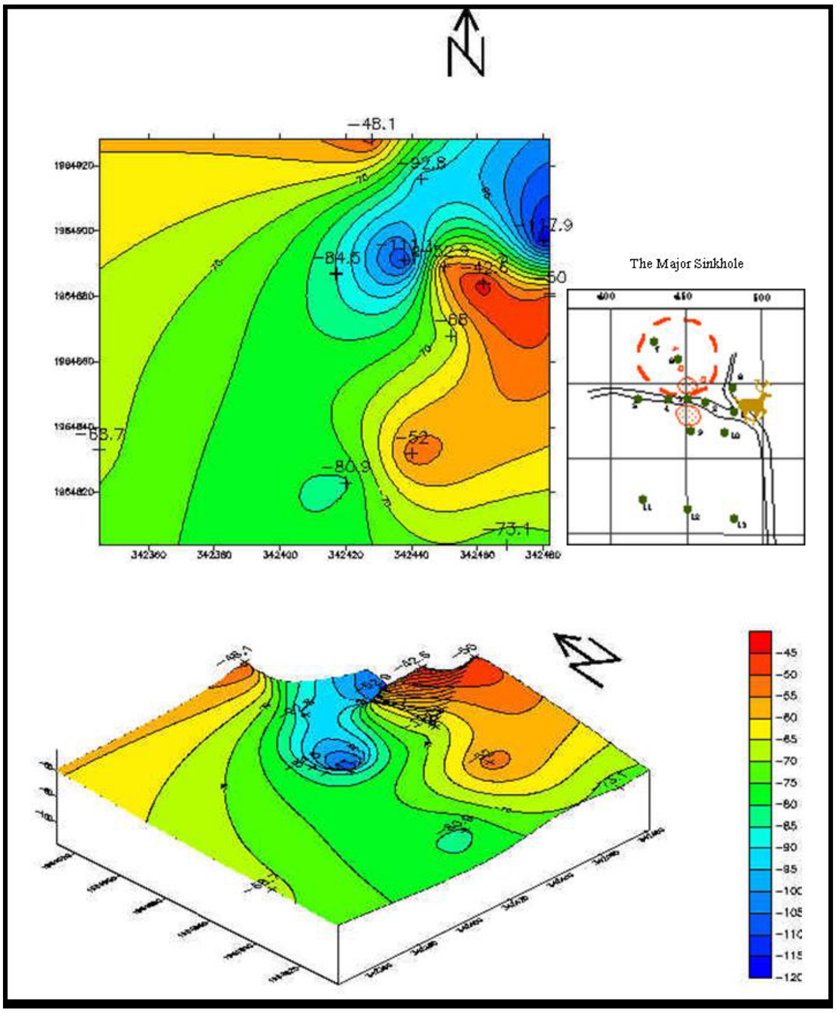

Figure 6. Resistivity map at the major sinkhole, north of Ban Non Sabaeng School.

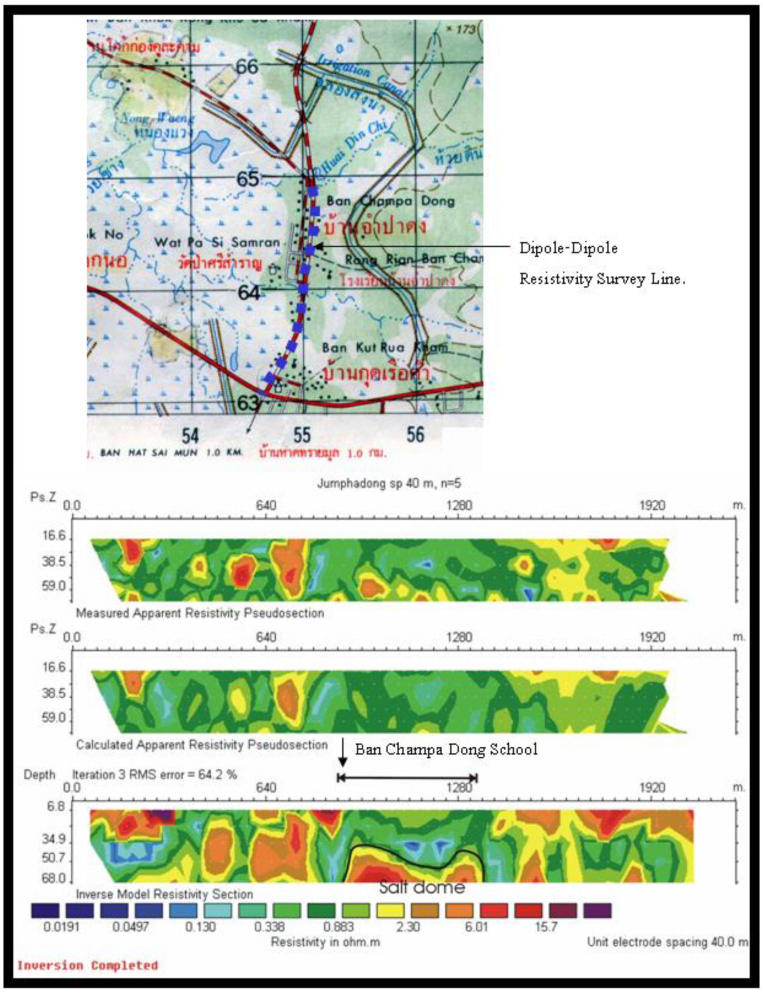

Figure 7. Resistivity profiles at Ban Champa Dong School.

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