Chapter 1
Introduction

1.1 Overview

Geophysical methods have played an important role in mineral resources development projects in the past. Both ore deposit and hydrocarbon explorations have benefited from the use of this methods. Nowadays, the world is beginning to confront a shortage of mineral resources because of greatly increased exploitation and, consequently, as yet, very little recycling. The affect on natural resources has been to decrease known reserves. In the past, the surface expression of many natural resources was of large dimensions, making them relatively easy to discover. This made geophysical methods seem not necessary.

Till now, most of these kinds of resources have been found and the remaining are relatively small and deposits with low grade. To find these kind of mineral deposits, more complicate equipment and analyzing tools have been developed.

Electrical method is one of the most popular geophysical methods used for mineral exploration. This method can be done in two ways: either by surface contact or by non-surface contact. The first is the direct current resistivity method and the second is the electromagnetic method. The surface contact method is a direct way of observing the subsurface response of either natural or artificial electric field. In case of artificial field, an electric current is sent into the ground by at least two current electrodes and the result is observed at two potential electrodes.

Whereas the non-surface contact method, the electromagnetic method, concerns the generation of an electromagnetic wave into the ground. During propagation, this wave interacts with subsurface materials, conductor and nonconductor, leads to change in both amplitude and phase. Both conventional resistivity method and electromagnetic method are used to investigate bulk resistivity of subsurface bodies, normally used for massive bodies with lower resistivity than the surrounding.

Nowadays, as states above, mineral deposits are both deeper and lower grade, therefore high resolution and high performance instruments is needed. Because of its low concentration, the resistivity seldom different to the host rock so the conventional resistivity methods are failed to detect. *Hallof* (1967) and *Seigel* (1967) pointed out an example of mineral deposit with no resistivity contrast, thus there are unaffected with electromagnetic method.

However, new method had to be introduced to investigate such low grade ore bodies, called the induced polarization method. It concerns with polarization effect occurs from an interaction between ionic-metallic interface of metallic mineral and subsurface solution under an externally artificial force. Therefore, this technique less involves with bulk resistivity of investigated bodies. The induced polarization method gives high responses, particularly, with disseminated ore bodies that conventional resistivity surveys might not detect.

This geophysical method also has various application in field of (1) ground water investigation (*Vacquir et al.*, 1957; *Bodmer et al.*, 1968; *Draskovits et al.*, 1990), (2) study an effect of clays-bearing rocks (*Nelson et al.*, 1982; *Vinigar and Waxman*, 1984) and on soil sample (*Vanhala and Soininen*, 1995), (3) environmental application (*Olhoeft*, 1985; *Vanhala et al.*, 1992), (4) hydrocarbon surveys (*Sternberg and Oehler*, 1990), and (5) engineering application (*Anderson et al.*, 1990).

Generally, most geophysical method, in mineral exploration, used to investigate for high conductive minerals buried in high resistive host rock. Those methods consider the bulk volume characteristics of anomalous bodies. Whereas, induced polarization method, the responses come from internal interaction of mineral grains and subsurface solution, so this method seems to be different in its virtual responses with different mineral deposit. By this assumption, one might investigate sources of polarization effect due to their characteristics by studying in laboratory or, elsewhere, in field investigating. *Fraser et al.* (1964) studied conductivity spectra of several kinds of mineralized rocks that are different in their spectra. The qualitative interpretation was expressed as shape of response spectra as; concave up, linear, and convex down. While, *Pelton et al.* (1978) attempted to discriminate source of polarization effect by using spectral induced polarization technique. There is not too much work that concerns with the method of how to identify type of mineral deposit. Most of the papers stated only the success of using induced polarization method in mineral exploration or its application.

In this study the induced polarization used as a prominent rule to classify the polarization response of different sources. However, the new examining method can be applied to test the parameter of induced polarization response in order to study an influence of the parameter which might be distinctively characterized on the selected minerals.

1.2 Study areas

The study was carried out at locations in three provinces, especially, in northern Thailand. These locations are (1) Mae Chong, (2) Khao Khi Nok, and (3) Pong Nok Gaew. The location of those study areas are shown in Figure 1.1.

Mae Chong area is located at Ban Mae Chong, Li district, Lumphun province, the upper part of northern Thailand. This area is selected because of its sulphide mineralization.

Khao Khi Nok area is located at Ban Pa Khai, Thong San Khan district, Uttaradit province, the southeastern part of northern Thailand. This area is selected in order to represent graphite mineralization.

Pong Nok Gaew area is located at Ban Pong Nok Gaew, Chondan district, Phetchabun province, the lower part of northern Thailand. This area is chosen due to clays mineralization.

1.3 Objective of this study

The induced polarization method has certain advantages in metallic mineral investigation. It is a particularly useful technique in an area of disseminated mineralization, whereas other geophysical methods are less effective. A major problem, though, in using electrical surveys

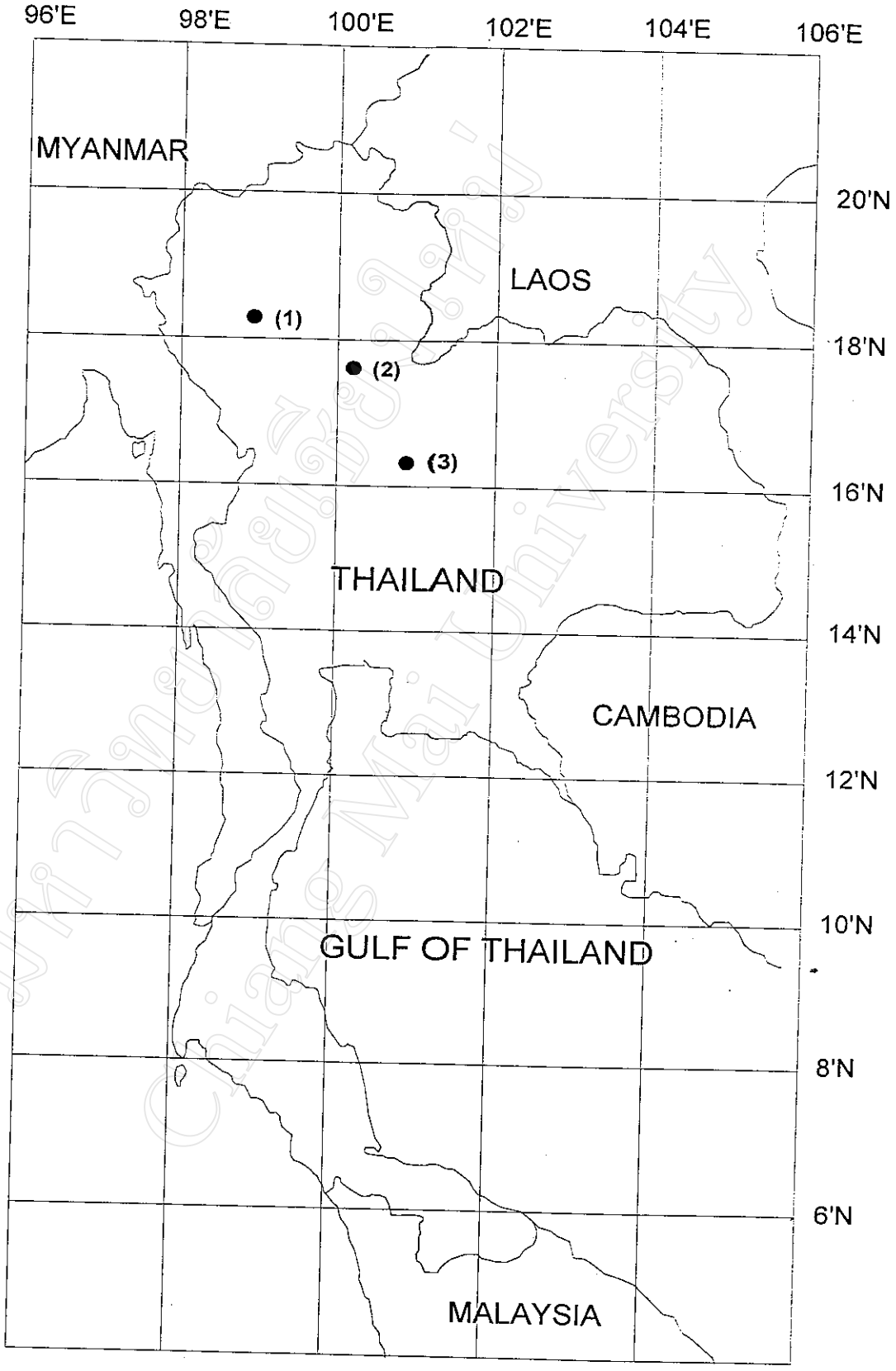

Figure 1.1 Location map of three study areas; (1) Mae Chong, (2) Khao Khi Nok, and (3) Pong Nok Gaew.

in mineral exploration is knowing beforehand what kind of the deposit is to be surveyed. For example, sulphide, graphite, and clays can all give high induced polarization responses which rather difficult to separate by the conventional methods. Therefore, a study was made of the induced polarization response of each of these types of minerals to try to find other ways of analyzing them.

In Thailand, via using induced polarization technique to identify types of mineralization has never been done before. And moreover, Thailand is located in tropical area which has thick weathering layer cause in highly conductive overburden. It can cause a mysterious problem in an electrical prospecting even an induced polarization method.

However, there are some relevant study attempt to eliminate this effect that manifests in Thailand. First literature is using of various kind of array configuration in direct current resistivity in the dissertation of *Techawan* (1995). This research used scaled tank model in order to simulate an effect of conductive overburden involving in each array configuration of electrical resistivity survey and applied those array to practical field survey in northern Thailand. Whereas, after that time, *Neawsuparp* (1996) used an electromagnetic modeling method to correct an error occurred in the airborne electromagnetic (AEM) data. The related parameter was input to compute the response as an output for new construction of interpretative diagram. Thenafter, *Neawsuparp* (1996) applied his diagram to evaluate old set of ground electromagnetic data in northern and eastern Thailand with successive result.

Furthermore, he used the diagram to re-interpret old set of AEM data and found more new potential areas which was overlooked in the past time.

However, consequently, those study used the different technique of prospecting that can not be compared with this work. Also it can not compare to the previous work of an attempt to discriminate type of mineralization, mostly done in different geologic condition in other country.

The method described herein is only the feasibility of the way to find out the differences in some portion of considering minerals. Furthermore, Cole-Cole modeling technique, base on *Cole and Cole* (1941), which was popularly used in frequency domain rather than time domain, will be applied to study it effectiveness. However, in this study, this technique involves in some part of analysis method. While the main purpose of this study approaches to decay characteristic of each minerals that existing

1.4 Method of investigation

As an initial step, a knowledge of the geology and mineralization of each of the three study locations is necessary. This includes compilation of previous investigations, both geological and geophysical, that will provides the background information for the study.

Induced polarization data sets are gathered and, thenafter, an appropriate data set will be selected for using in data processing purpose. Selected data from the three mineralized areas be processed to obtains both conventional and complex resistivity parameters. These parameter used in order to locate anomalous zone, via compare with the vicinity.

Conventional parameters are plotted for all pseudodepths, from n=1 to n=6, where n is equal to spread number of dipole separation. Anomalous zones were first located by these parameters. After that, complex resistivity parameters, base on Cole-Cole relaxation model, are calculated from the data. The decay curve was done curve-fitted by computer software, especially written for this purpose, to observe these parameters. This represents a dispersion model causes from an induced polarization effect of subsurface bodies.

Thereafter, a decay curve data will be selected from non-anomalous and anomalous portions and drawback to observe the decay characteristics. Furthermore, the effect of various factor used during data acquisition will be analyzed to obtains the change in decay characteristic of the induced polarization response in order to optimize the data quality and correct an error that will occurs in an analyzing stage.

Thenafter, apparent resistivity and apparent chargeability of each mineral will be plotted to observe their relationship. Via plotting apparent chargeability against apparent resistivity, the relationship are made of each of ten slices, apparent chargeability, versus apparent resistivity. Each ten slices of each n-pseudodepth plot against their apparent resistivity will be done thereafter.