CHAPTER 3

DATA ACQUISITION AND DATA PROCESSING

Electrical resistivity sounding using the Schlumberger array was designed to provide information on the variation in subsurface conditions with depth. Very low frequency electromagnetic method was used to determine if surface electrical techniques could be used to delineate horizontal and vertical extent of the conductive portions of the contaminant plume believed to be migrating from the landfill. Data processing uses raw data as input to establish models that can easily yield solutions or useful information. The anticipation solution of this study was the distribution of contaminant plume and its boundary. Geophysical modeling and graphic software were used in data processing. Combination of information from geological and hydrochemical data will result in the best interpretation and the optimal solution.

3.1 Data acquisitions

3.1.1 Electrical resistivity data acquisition

Forty-seven DC electrical resistivity soundings were collected, using an ABEM Terrameter SAS 300B, between October 10 and October 20, 2000. The sounding stations are shown in Figure 1.2. To obtain maximum coverage, the sounding stations were located around the landfill site. However, the large portions of stations were located along the eastern and southern sides in order to detect the contamination along the groundwater flow direction. There are some obstacles, paddy fields and houses in the study area that made measurements in a straight line or grid inconvenient and impossible. These problems also limited the electrode spacing and field operation so that it was decided not to use resistivity profiling in the study area.

Schlumberger electrode arrays were set up using half current electrode separations, AB/2, of 1, 1.5, 2, 3, 4.5, 7, 10, 15, 20, 30 and 45 meters, respectively.

The survey started with half potential electrode separation, MN/2, of 0.25 meter and was increased to 1.0 meter and 2.5 meters to avoid a decrease of instrument sensitivity when AB/2 increased. Some resistivity soundings were run in the southeast of the site and were rather far from the landfill. The resistivity values obtained from these were expected to be background values. A specific sounding was carried out in the landfill site using a maximum half current electrode separation of 70 meters. This was intended to represent an example from a seepage point in the contaminated area.

The instrument system used for data acquisition consisted of a resistivity meter (SAS 300B), four sets of electrode cables, steel electrodes, hammers, and various connectors. The procedures to carry out Schlumberger measurements are shown in Figure 2.1(b). The potential electrodes (M and N) and current electrodes (A and B) were first placed into the ground at specific distances. Then the resistivity meter, a Terrameter SAS 300B, was positioned half way between the potential electrodes. This position is the sounding location from which apparent resistivity values were obtained. Next, the terminals P1 and P2 were connected to terminals M and N using a good quality cable set. Then current electrodes A and B were connected to terminals C1 and C2, respectively. Following this, these cables were run in parallel adjacent to the resistivity meter and were arranged symmetrically with respect to the potential electrodes. Switching on the power started a measurement. After the values and the electrodes separations for the first separation were recorded, the procedure was repeated until measurements were recorded at all designed electrodes separation. Field data from all of sounding locations are shown in Appendix A. Table 3.1 is a summary of data acquisition.

3.1.2 Very low frequency elctromagnetic data acquisition

Very low frequency electromagnetic data were collected on October 19, 2000, using a WADI instrumentation system manufactured by ABEM. Survey planning was done after the resistivity survey. There were obstacles, as in the resistivity survey, that made measurements in grid pattern inconvenient and impossible. Nine selected lines were situated along the resistivity stations (Figure 1.2). Line 100 was located northwest of the site to help identify the boundary of leachate or contaminant that might be migrating in the northern part of the landfill. Line 200, 300, 400 and 500 were situated along the road adjacent to the power lines. These lines are south and southeast of the landfill in order to detect the boundaries of contaminant plume in these directions. Line 600, 700, 800 and 900 are in the eastern part of the site to assess the contaminated zones east of the landfill.

Field operation was done by stand on the first measurement point, facing the direction to move along the first measurement line. The instrument is then turned on and a suitable transmitting station was selected, the most suitable being 19.8 kHz for this survey. Then the signal strength and direction were checked. If no sufficiently strong signal can be found, another measuring directions must be chosen. The coordinates of the starting point, the distance between measurement points, and the distance between lines were entered. In this study the distance used between measurement points is 10 meters but no distance between lines was use because the lines are not in a grid pattern. The instrument was held steady while measurements were being made. Filtered values will automatically be cálculated and plotted. These steps were repeated until all of the points on a line were measured.

Table 3.1 Summary of data acquisitions.

ACQUISITION PARAMETERS	SURVEY METHODS	
	RESISTIVITY METHOD	VLF METHOD
Parameter measured	Apparent resistivity	Apparent resistivity (correlated with relative current density)
Instrument used	ABEM Terrameter SAS 300B	ABEM WADI VLF
Number of stations/lines	47 stations	9 lines, total length 1.84 kilometers
Field operation	Vertical Electrical Sounding (VES)	Profiling
Configuration/ Survey parameters	Schlumberger array, AB/2 minimum 1 meter, AB/2 maximum 45 meters	Measurement point spacing 10 meters, frequency 19.8 kHz.

3.2 Data processing

3.2.1 Electrical resistivity data processing

Resistivity data were processed using a personal computer. Electrical sounding was performed to provide information on the variation in subsurface conditions with depth. Sounding data were analyzed by plotting measured resistivity versus electrode spacing. These resistivity curves were correlated to theoretical model curves to determine the subsurface stratigraphy. In this study, the resistivity data were modeled using the RESIST87 modeling program to obtain one-dimensional resistivities. The depth and resistivity of contaminated zones were determined by fitting the curves between measured and calculated values. Four layers model was calculated to yield the best fit (minimum root mean square error). An example model is illustrated in Figure 3.1 and all models are shown in Appendix A. The series of individual sounding can be combined to generate either a resistivity profile or a map view of two-dimensional and three-dimensional resistivity. Maps of resistivity show areal distributions at a particular depth or elevation and can be thought of as horizontal slices through the earth. These vertical data were horizontally interpolated to create a grid. Color values were assigned based on the interpolated resistivity values and the desired contour levels. Vertical cross sections were traversed in both north-south and east-west directions. The geologic cross section was constructed by combining borehole data with geophysical and geological data.

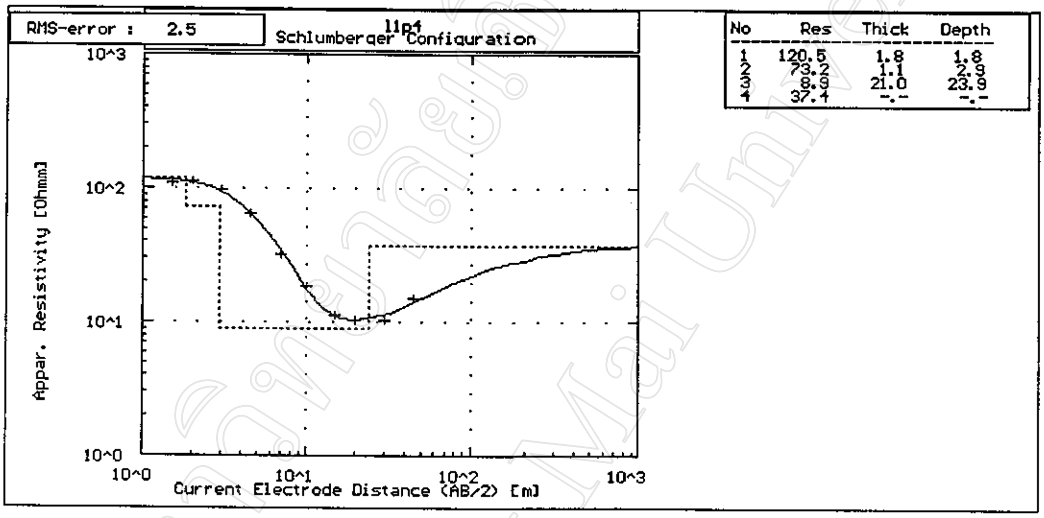

Figure 3.1 An example of resistivity modeling.

3.2.2 Very low frequency electromagnetic data processing

The measurement data were transferred to a personal computer for further processing and plotting. A computer interpretation program, SECTOR, and a communication cable are optionally available for this processing. The SECTOR program easily transferred data to the computer and presented data on the screen. The data were plotted in 4 mode -- original data plot (real and imaginary data), filtered data plot, multi-profile plot and a vertical cross section that provides a clear picture of current density in the ground. These data were filtered using a Karous-Hjelt filter and plotted at a selected depth near water table. The filter computes the approximated subsurface current density and gave rise to a given data profile. The resultant values are relative across the profile. Lower values of relative current density correspond to higher values of resistivity (Benson *et al.*, 1997). The examples of an original data plot, filtered data plot, and vertical cross section are shown in Figure 3.2.

3.2.3 Hydrochemical data processing

Hydrochemical data of shallow well water nearby the landfill site that were published by CMU-JICA (1992), Wisuthitarawong and Prawittarawong (1996), and Karnchanawong *et al.* (1997) were processed to enhance the geophysical data. Water samples data from the same season of various years, October, 1989, October, 1995, and November, 1997, were used to correlate with data from this, October 2000, study. Concentration maps of chloride and total dissolved solids were established to evaluate the groundwater quality. Electrical conductivity of water samples was converted to electrical resistivity. The resistivity is the reciprocal of conductivity. It was used to plot resistivity maps. These maps were integrated in the data interpretation. The chloride concentrations at various years were compared to identify the fluctuation, as well as total dissolved solids and calculated resistivity. These hydrochemical data were used to correlate and verify the geophysical data, due to the lack of borehole data. However, hydrochemical data of 1995 and 1997 were not sufficient to interpolate in a map. Consequently, small areas were mapped instead to make a reliable interpretation.

The schematic diagram of data processing is shown in Figure 3.3. The output of this processing indicated the hazardous area of groundwater contamination.

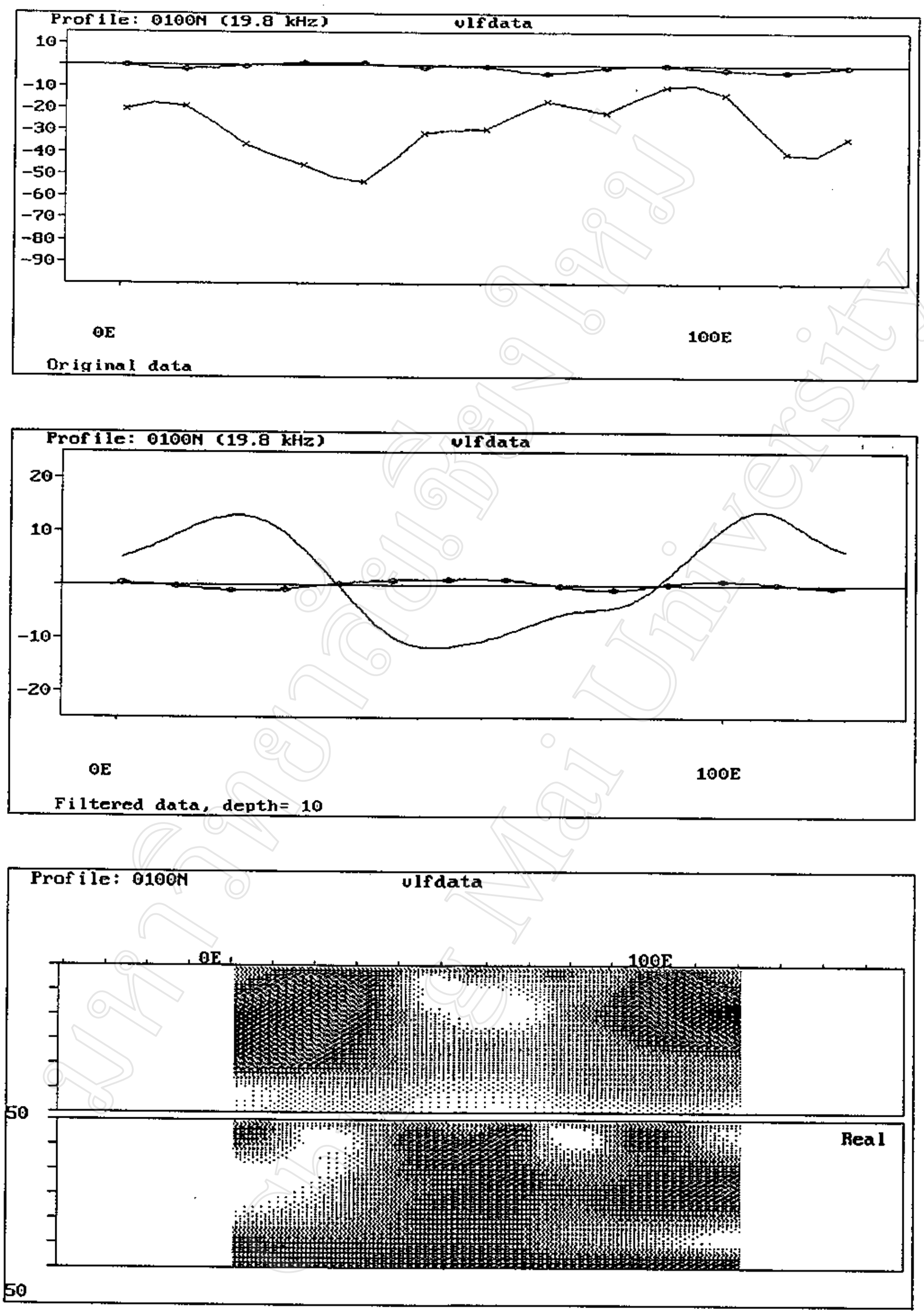

Figure 3.2 Examples of an original data plot, filtered data plot, and vertical cross section of VLF data.

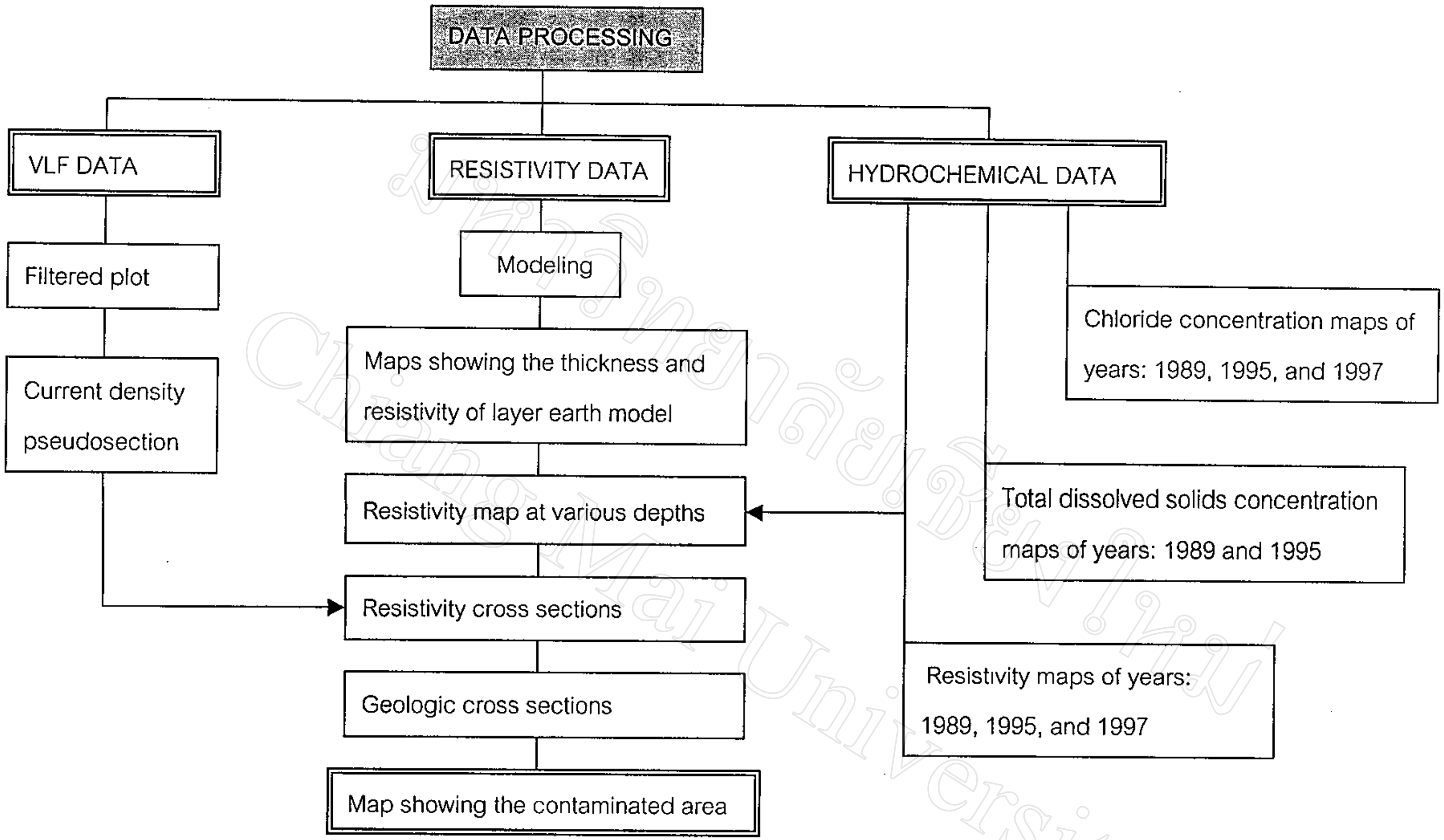

Figure 3.3 Schematic diagram of data processing.