ON THE USE OF MICROCOMPUTERS IN GEOPHYSICAL PROSPECTING AND SEISMOLOGY

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The volume and type of data generated during geophysical surveys has increased greatly during the last twenty years. On the other hand, the recent performance improvements and price reductions of field and office computers, combined with the increasing ability of geophysicists to acquire or create software for processing and interpreting ground geophysical data have increased the cost efficiency of handling these data in an automated maner.

INTRODUCTION

Since the introduction and rapid growth of the microcomputer industry in the mid 1970's, the geophysical industry has been quick to make use of this technology, as microprocessing capability built into exploration geophysical equipment, and more recently, as small stand-alone microcomputer systems which can be used for interpretation in the office or in the field.

In the field, microcomputers (Fig.1), are used to record and store survey data, on either cassette or solid state data loggers, depending on the hardware used. Once entered, field data can be manipulated to give a hard copy output either as listings or as profiles. Depending on the type of survey, the field computers are also used to carry out the necessary calculations and corrections, to reduce the raw field data to their final format.

As an interpretation aid, the microcomputer is used to model the geophysical results in terms of geological models to provide quantitative values to the anomaly parameters. In most of the cases, all the modelling and interpretation routines developed are interactive programs which allow the geophysicist maximum input to all phases of the computer manipulation. Thus, constraints based on the geologic knowledge can be input to the computer aided geophysical interpretation.

Some of the techniques developed in other fields and in particular communication theory may be adopted to operations with geophysical measurements. The major developments in the theory of signal analysis and processing which acompany the recent rapid growth in electronic methods of communication are enhanced by the enormous increase in digital computing facilities. On the other hand recent availability of microprocessors and solid state memory permits the design of instrumentation to collect data efficiently and in a manner entirely compatible with the computer hardware and software which will later be used in their treatment.

The application of microcomputers in geophysical prospecting are so many and so extremely deverse that presenting a review paper on the subject is difficult. It is certainly impossible to make an exhausting survey of such a subject. The following remarks are therefore confined to a discussion of the basics of processing different kinds of geophysical measurements by microcomputers, and are followed with a few characteristic applications with which the authors have had some personal experience.

More specific details about the application of

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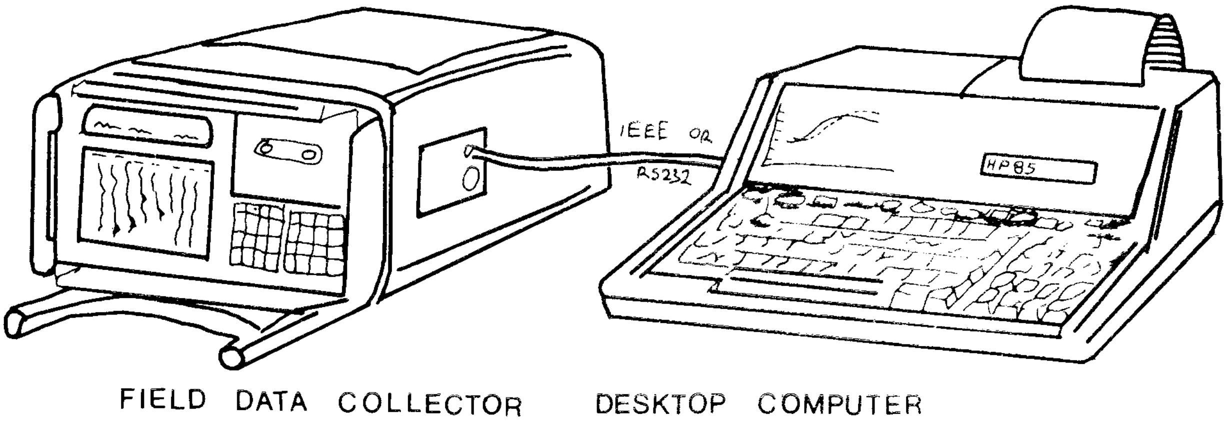


FIGURE 1: *Field data collection system with tape recorder and personal computer.*

microcomputers in various specialized geophysical applications will be given in a series of papers which will follow the present introductory one.

CERTAIN ASPECTS ABOUT THE PROCESSING OF GEOPHYSICAL MEASUREMENTS BY MICROCOMPUTERS

1. Geophysical signal sampling and reconstruction

A microcomputer has to work with discrete values or numbers, rather than with continuous geophysical signals. Whenever a continuous signal is to be represented by a set of samples, a number of important considerations must be taken into account. These involve the precission with wich the signal should be sampled and how often the samples should be taken. If the sampling rate is too low, useful information will be lost, and if it is too high, an unnecessarily large number of samples will have to be stored or processed.

The minimal sampling rate for adequate digital representation of a continuous signal is formally specified in the so called "sampling theorem" which states that the sampling frequency must be at least twice that of the highest frequency which is desired to be maintained in the sampled digitized signal. A very important implication of the sampling theorem is that not only frequencies higher than the limit imposed by the sampling rate will be lost, but they will produce a false signal which will appear as a much lower frequency. This effect is described as alliasing (Lynch 1973).

2. Digital filtering of Geophysical data

The processes of smoothing, differentiating, integrating and removing noise from geophysical measurements are very common options. Often such processes are linear transformations on the data and here is where the great importance of digital filters comes, since a digital filter is a linear combination of the input data, and possibly the output data, and includes many of the operations that are performed when processing a geophysical signal.

In most of the cases a geophysical signal may be defined as the sum of a great number of individual components, each being the result of an impulse generated by some formation condition. Factors which distort the geophysical ideal signal, such as random impulses, equipment and environmental noise, formation fluids, etc. will each have their particular effect on the response. To a certain extent, the effect of each may be determined and separated and we must do this processing in order to understand what the recording signal reveals about the underlying phenomena that gave rise to the observations; digital filters are the main processing tools.

Since the recorded analogue geophysical signal can be represented by a number of equally spaced samples P_n of some property P(x,y,z) it is these quantisized samples that are available for the processing that we do. Suppose that the sequence of numbers P_n is such a set of equally spaced measurements of some geophysical property P(x,y,z). If the parameter Y_n is computed by the formula

$$Y_n = \sum_{k=1}^{\infty} c_k p_{n-k} + \sum_{k=1}^{\infty} d_k y_{n-k} \qquad (1)$$

then this formula defines a digital filter. Various special cases of the above formula occur frequently and correspond to a great variety of digital filters, (Hamming 1977, Davis 1973, Kulhanek 1979).

In the case were all the coefficients d_k of the y_{n-k} terms are zero the filter is called nonrecursive; otherwise it is a recursive filter. A familiar example of a nonrecursive filter is the widely used m-terms smoothing average filter

$$Y_n = \left(\sum_{i=1}^{m} p_i \right)/m \qquad (2)$$

On the other hand, an example of a recursive filter is the trapezoid formula for numerical integration

$$Y_{n+1} = Y_n + \frac{1}{2}(P_n + P_{n+1}) \qquad (3)$$

From the above it can be seen that a digital filter is very easy to be programed in a microcomputer. A detailed discussion of the various geophysical and seismological applications of digital filtering will be given in some of the following papers, since it is out of the scope of the present work.

MAGNETICS

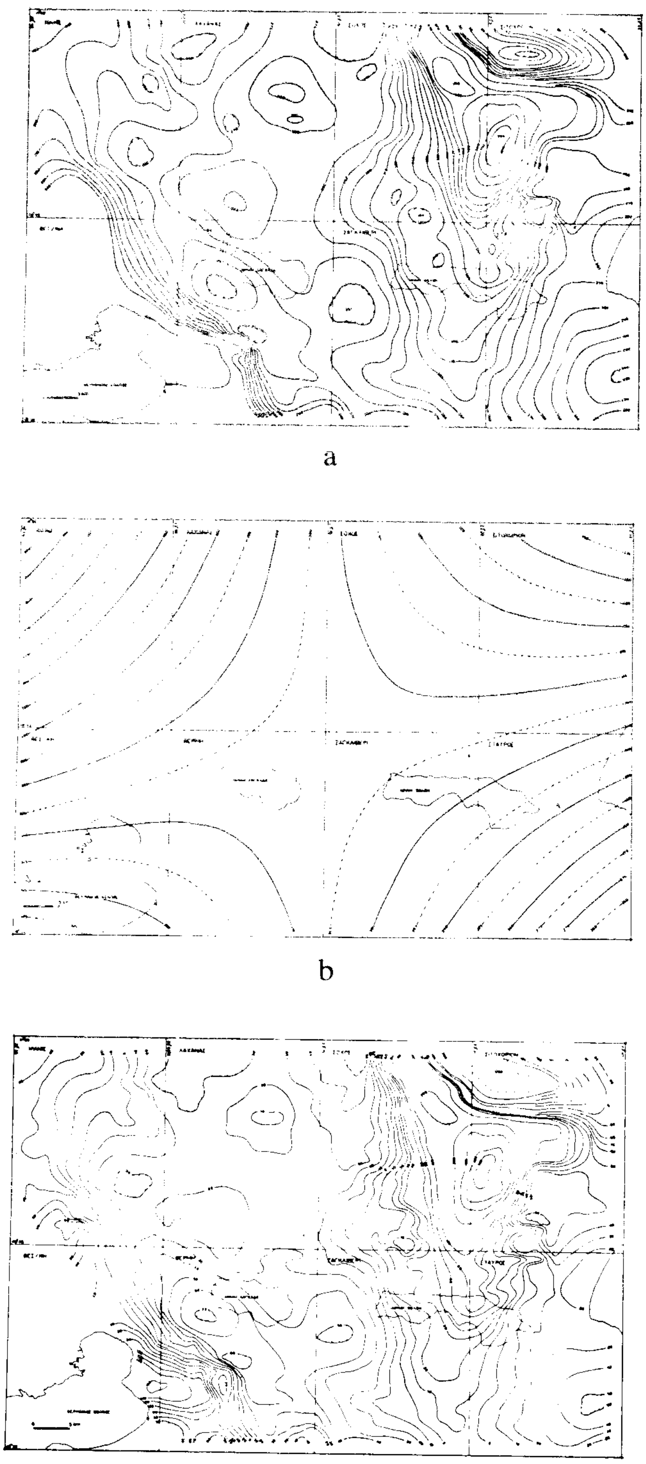
Magnetic surveying is carried out using microprocessor controlled portable field magnetometers which store the magnetic field data, the line number, and the automatically updated station number in a solid state memory, as well as a timing device which records the time of the readings.

These magnetometers have capacity equal to a full day's work. The survey is run with a microprocessor controlled base station recorder which records the magnetic field data and the time of reading at pre-set intervals throughout the day. Software built into the base station recorder has the capabilty to reduce the field data to a pre-set datum, and to correct for diurnal variations.

To correct the field data from one day's surveying takes approximately 10-15 minutes. The corrected data is generally output onto a small portable printer. It can also be transfered onto a microcomputer through a serial RS232 interface and stored on magnetic cassete tape. This can be programmed to give profile plots, and a data listing with the magnetic values spaced along the printer output to the survey scale. A map can therefore be constructed with no manual plotting, such that field contouring of the magnetic data can be done easily and interpretation can keep pace with the data acquisition.

The ability to store data on cassettes or data loggers allows for interpretation of the data using pre-written routines for modelling of anomalous features and trends. From the modelling, depth and susceptibility values can be calculated on a daily routine basis.

Upon return from the field, the data stored on the cassettes can be transfered from the field microcomputer onto a large mainfraim system for further data processing and final presentation. The storing of the data on magnetic tape or disc, facilitates easy retrival of the data, allowing large scale data processing such as filtering, spectral analysis (Fig. 2a,b,c) and reduction to pole to be completed quicly and cost effectively. Magnetic susceptibility maps can also be produced, and is a very useful presentation as an aid to geologic maps.


a

b

c

FIGURE 2: *a. Low pass filtering of the magnetic field.*

b. General geomagnetic field represented by a second degree polynomial.

c. Local geomagnetic field calculated from the difference between (a) and (b)
(Data from Thanasoulas 1983, the processing was performed with a Commodore-Pet, 8bit, 64K microcomputer)

GRAVITY

Gravity surveys are conducted using standard gravity equipment. The data recording, however, can be facilitated with a microcomputer or even a programable calculator such as the HP41-CV or the TI-59 equiped with a detachable memory module. An input routine prompts and requires that at each gravity station, the reading, line number, station number, time, instrument height, and tidal correction to be keyed in by the operator and stored. Subsequently, the data can be dumped onto a cassette tape for storage. A program already stored into the computers memory can accept the stored station information as input and computes automatically the relevant gravity corrections. The corrected data is then also stored on cassette tape, and a printout of data listings and/or a profile plot of the data can be produced in minutes, allowing the geophysicist to try a great number of Bouguer densities.

In addition to the standard 2D and 3D modelling we can easily make composite gravity profiling from sectional geological models. The composite models can be composed of a great number of individual units with different densities (Fig.3), which depict different geologic units. The model can be changed until a satisfactory fit s found. This system of modelling is considered to be rather more effective than simple modelling of individual anomalies since the sectional profiling will obviously more accurately represent the geologic environment.

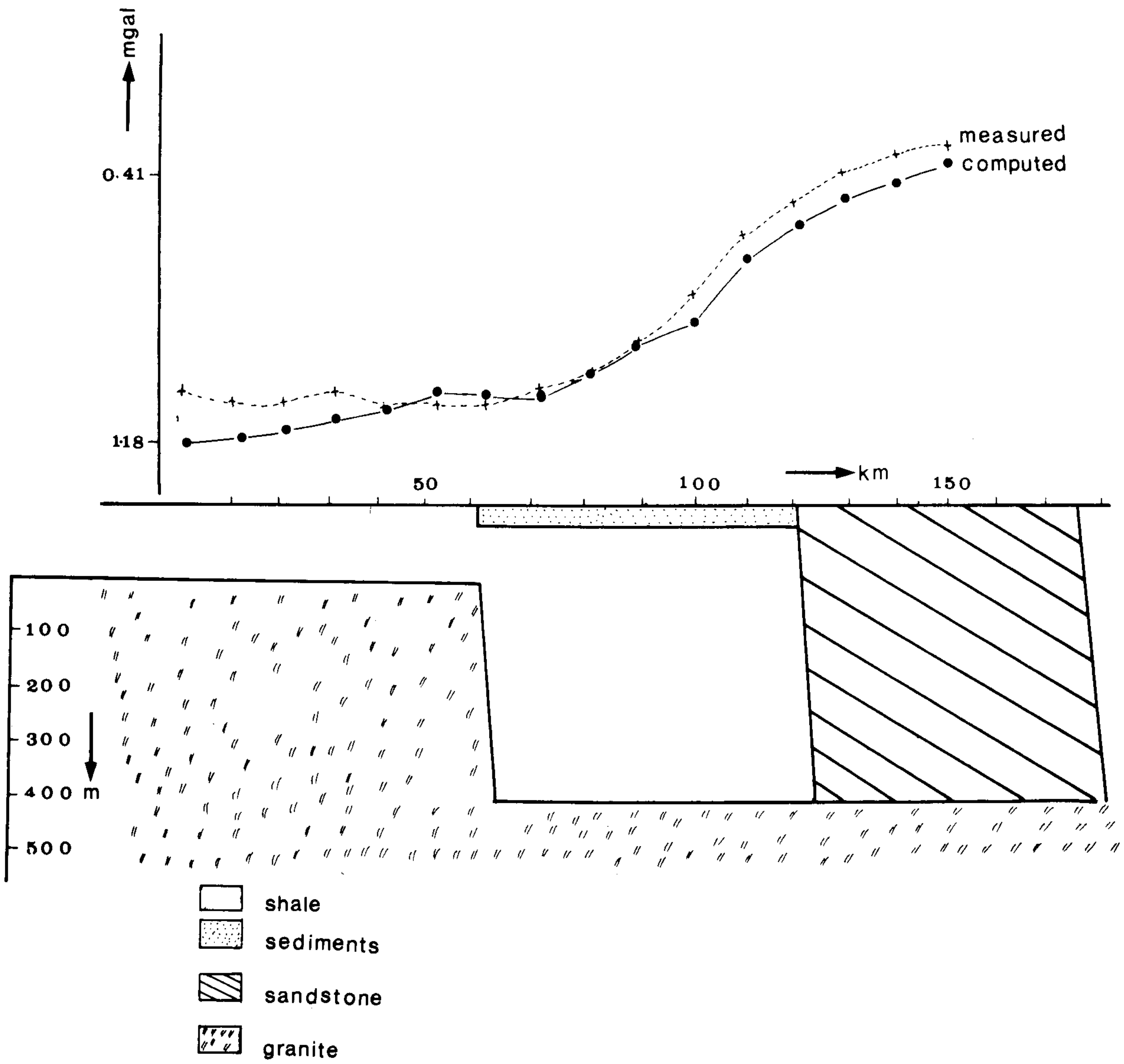
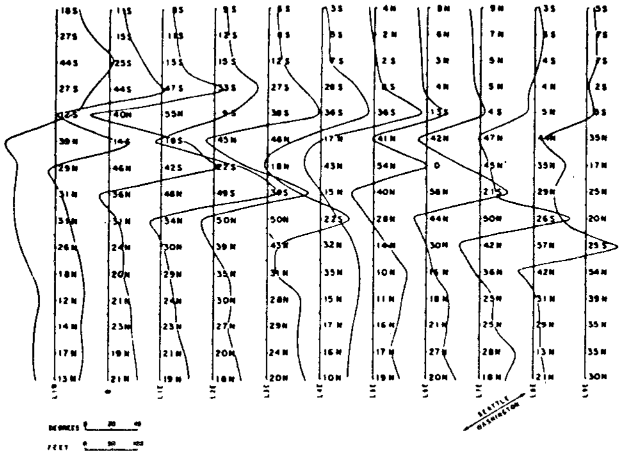


FIGURE 3: *Measured and microcomputer modelled Bouguer gravity anomalies across a fault in SW-England. The 400m downthrow was confirmed by other geophysical methods as well. (Data from Tselentis 1979, the processing was performed with a New-Brain, 8bit, 32K microcomputer)*

ELECTROMAGNETIC

For electromagnetic surveys, such as VLF, horizontal loop, transient EM, a significant amount of time is required to manually post and plot data. Although small, portable plotter / printers can handle only a limited number of profiles, several sets of profiles can be spliced together (Fig. 4a,b) to form a good quality drafted map which is ready for reproduction on completion of the project.

There are many routines which can be used in the field to manipulate data such as Fraser Filter for VLF, topographic corrections for horizontal loops. For a large data volume survey such as time domain electromagnetics, several new receiving units are microcomputer controlled. The survey data is stored on a digital cassette tape and the complete decay curve along with the relevant header information is recorded. Retrieval of the data can be via tape reader and printer. The output data can be dumped via standard ports to a small portable microcomputer. Software developed for the field computers can present the data as profiles, or normal decay curves. For time domain soundings, an inverse programme can be used to give resistivity values at each channel. These resistivity values can be presented as a pseudosection and contoured.



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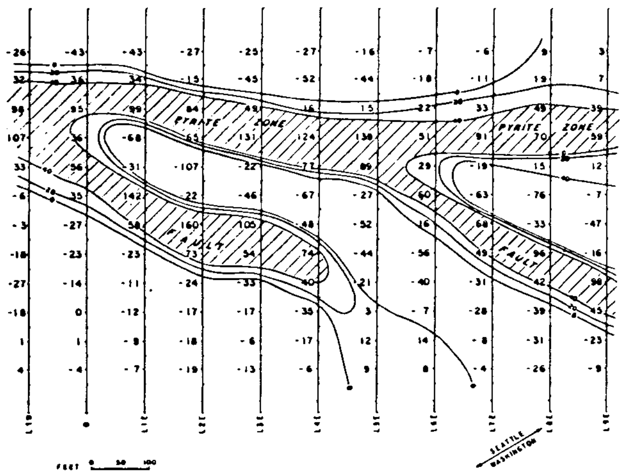

b

FIGURE 4: *a. Dip-angle data in the vicinity of a mine. The arrow defines the VLF-EM primary field direction.*
b. Filtered data computed from the map of Fig. 4a. (Data were taken from Fraser 1969 and reprocessed with a New-Brain microcomputer)

INDUCED POLARIZATION

When using a microprocessor - controlled recording system IP data is stored either in cassette format or in solid state memory. Where possible, therefore, the receiving system can be interfaced directly with a small computer using standard RS232 entry ports.

Software development allows the computer to calculate the apparent resistivity and this along with a polarizability value is output as normal pseudosections. The advantage of having large volume survey data, such as IP, digitally stored is that many different aspects of the data not normally considered due to time constraints can be viewed for example, filtering of pseudosections or plotting ratios of chargeability channels (Fig.5). This presentation can be useful in assessing rate of decay and can give a qualitative feel for the polarizability of the geology.

Additionally, when using the newer units, often phase and amplitude data are automatically collected

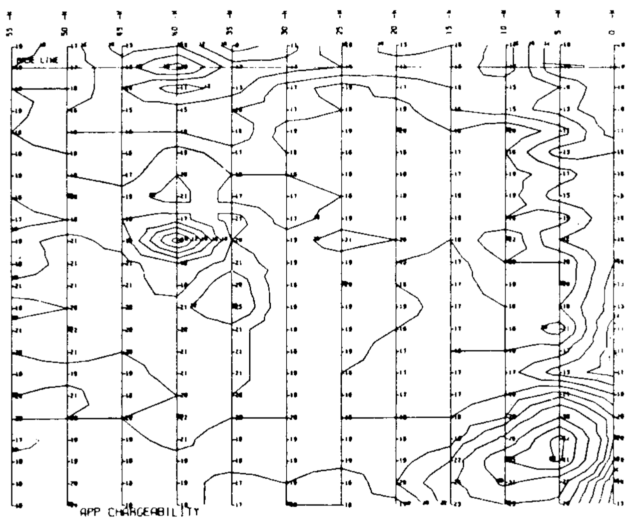

FIGURE 5: *Chargeability map plotted by a New-Brain microcomputer and a Graphtec portable plotter.*

and available along with the time domain chargeability values. This data is often not inspected and considered manually, due to the shear volume information. Computer handling of the data has largely eliminated the time required to reduce the data to useable format and the geophysicist can now include this data for interpretation on a routine basis. Modelling of IP data include inverse modelling of IP pseudosections and modelling topography and thus correct for topographic noise.

RESISTIVITY METHODS

The purpose of resistivity methods is to investigate the change of the formation resistivity with depth. To attain this, it is necessary to arrange the measurements in such a manner that, at different measurements, the value of the measured potential difference is affected by the formation resistivity at differing depth ranges.

The technique of the interpretation of resistivity sounding measurements has passed through a phase of stormy development (Koefoed 1979), during the past decade. In particular the introduction of the application of the linear filter method (Gosh 1970) to resistivity sounding interpretation has made the computations that are essential to an exhaustive interpretation of the measurements amenable to execution at a reasonable low cost. This, together with the introduction of microcomputers have completely changed the face of resistivity sounding interpretation. Formerly, most of the interpretation was done by approximate methods, and only large organizations could afford an exact interpretation. At present, an exact (Fig.6), interpretation of the data is within the scope of every user of resistivity methods if he has in his position a cheap microcomputer.

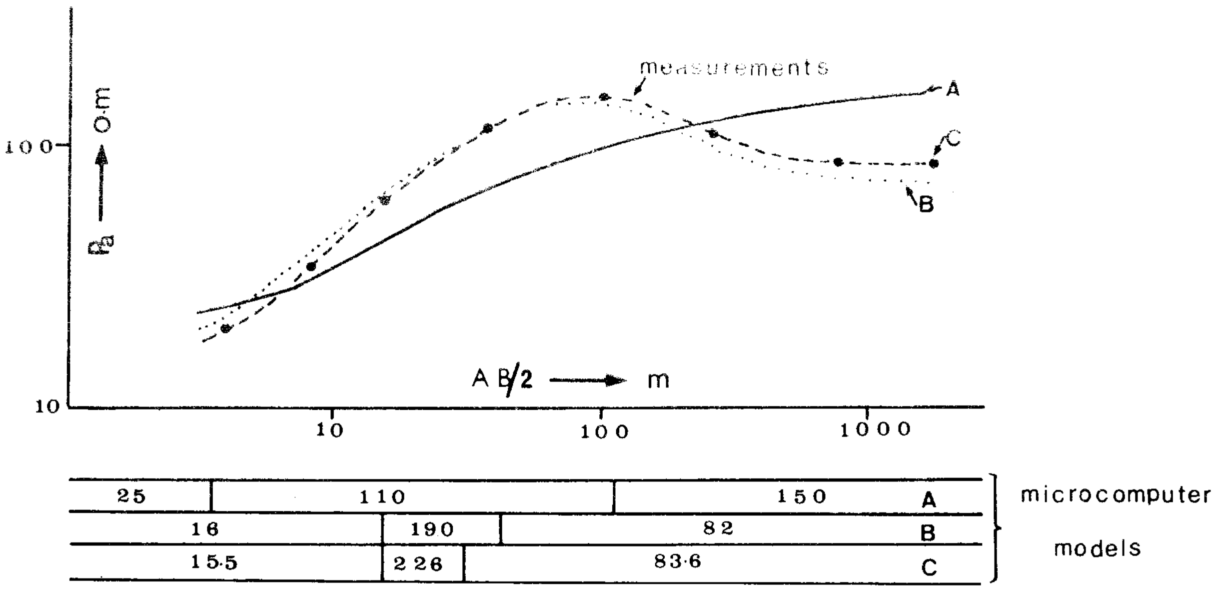

FIGURE 6: *Microcomputer interpretation of an apparent resistivity curve. (Data from Thanasoulas 1983, the processing was performed with a Commodore-Pet microcomputer)*

SHALLOW SEISMICS

Conventional shallow seismic work like refraction, reflection, crosshole or special shearwave surveying aim to determine the spatial distribution of seismic wave velocities in the subsurface and relate them to such geologic and petrophysical parameters such as rock type, porosity, weathering, jointing water saturation and elasticity.

Shallow seismic work calls for considerable flexibility and reliability when choosing recording parameters. The recent use of microcomputers has opened new fields of interpretation, which calls for both accurate digital signal records, and accurate records of the operational parameters used.

A trully portable system must have, not only appropriate digital recording facilities, but also means for checking and interpretation of the tape records, preferable in the same unit. A solution to this has been made with the recent introduction of microprocessor systems for field operation using a menu based monitoring program. By the use of a menu system for operation control, selection of instrument setups for different seismic applications are extremely fast. These instrument set-ups includes different geophone and shot layouts, field notes as well as the digital signal conditions for 24 amplifiers, and their data sampling and stacking. All sets of parameters are stored in a continuous memory unit for retrieval or change by the operator even if the unit has been switched off.

There are numerous interpretation methods, ranging from very simple in basic assumptions and ease of use to the complex, and most of these have been incorporated into computer programs. Recently the new introduced generalized reciprocal method (GRM) has proved to have many advantages compared with the previously published ones (Palmer 1979). This method is ideally suited to processing by digital computer (Fig. 7a,b) and the processing routine used with GRM offers significant advantages in the management of time, costs, and expertise.

REGIONAL SEISMICITY

The recent introduction of powerful portable computers, permits various analytical methods to be widely applied both to "wave" and "source seismological" problems. Either aiming to estimate the error involved in the measurements as in the case of hypocentral determination or treating with stochastic phenomena such as earthquake sequences.

More than that, the on site statistical approach of seismological data by microcomputers gives the opportunity to correlate the observed tectonic features of a given region with seismological data and connect in this way cause and effect parameters of seismic activity.

Microcomputer graphics have much to offer in

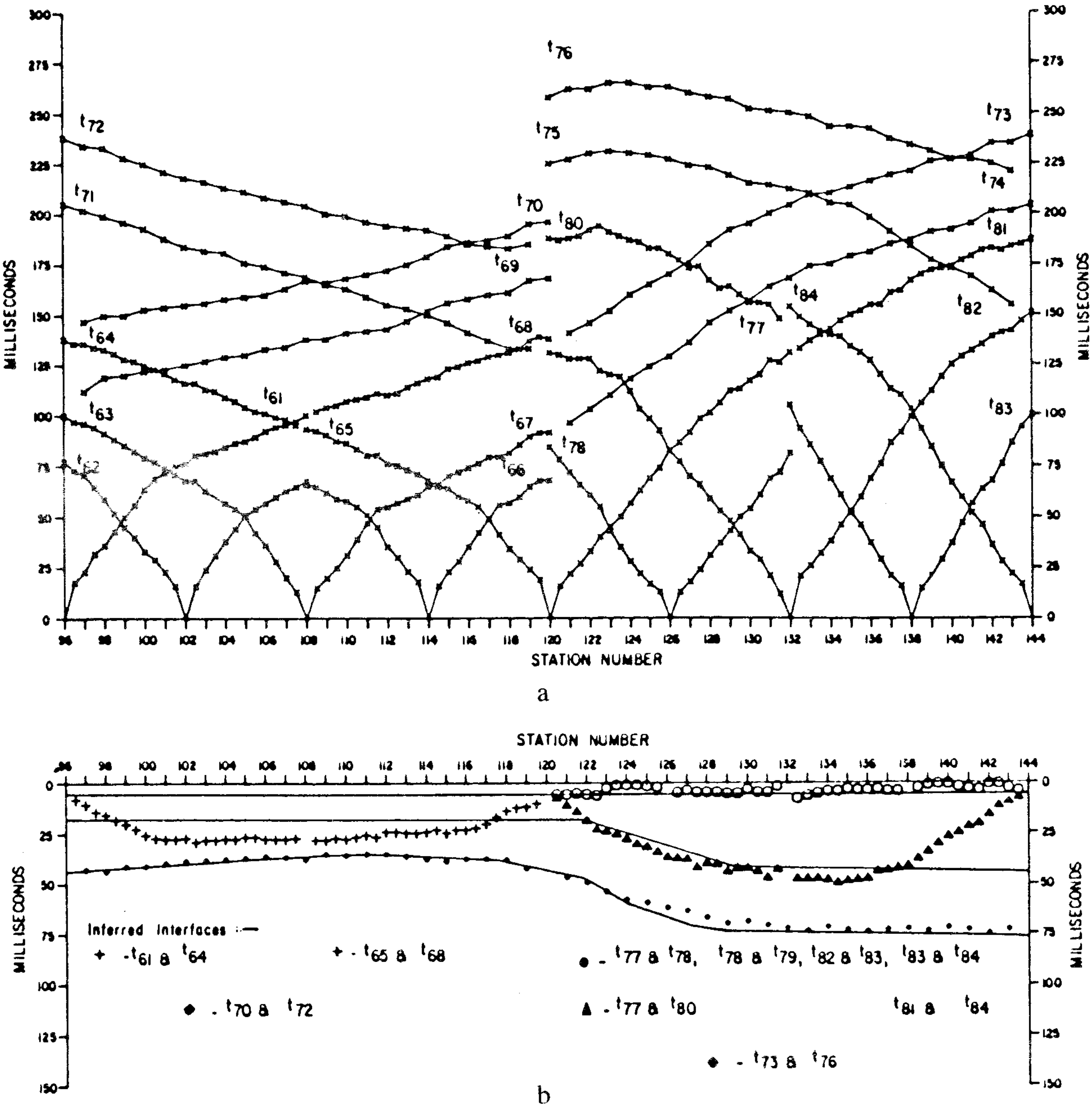

FIGURE 7: *a. Refraction travel time curves.*
b. Time sections derived from data shown in Fig. 7a using the GRM method. (Data from Palmer 1979)

assisting seismologists to interprete their data, not only as a labour saving drafting tool to prepare traditional graphics but also as a path to new graphic displays (Fig.8). Hystograms, spatial and depth distribution of earthquakes, cumulative frequency plots etc. can be produced in a matter of minutes.

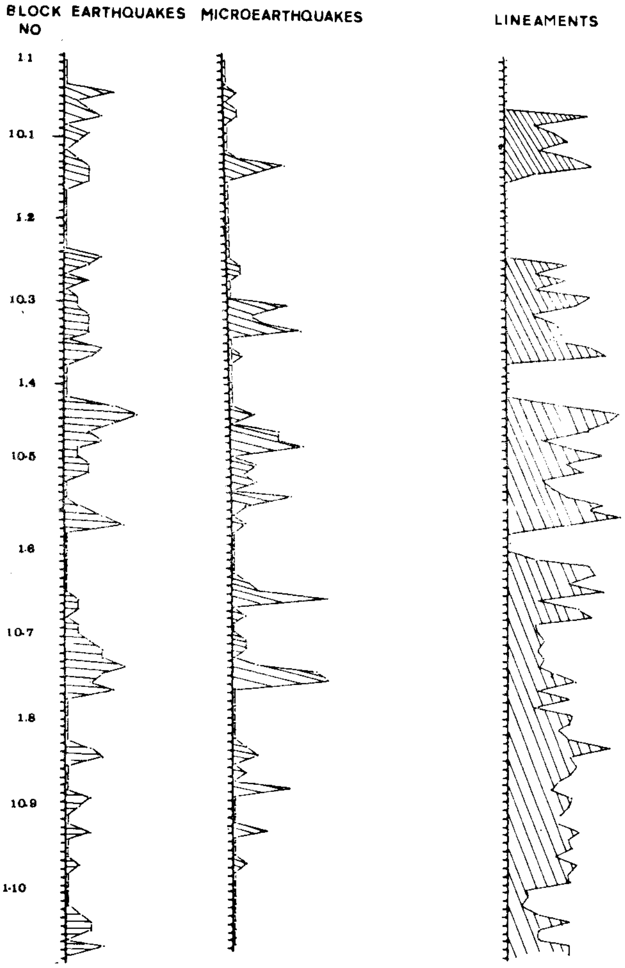

FIGURE 8: *Geoparameter earthquake, microearthquake and Landsat lineaments logs for Epirus. Each data point corresponds to the total number of earthquakes, microearthquakes and total length of lineaments of a particular 0.1°×0.1° square of the area. The processing was performed with a New-Brain microcomputer. (Data from King et al 1983 and Macropoulos et al 1985)*

Microcomputers have tremendous applications in field seismological studies, particularly in bridging the gap between field and office. Even for the case that the microcomputer used is not suitable for treating very large data sets or performing very complicated analytical calculations it can be used as a terminal and be connected to a main frame computer via telephone line.

MICROTERMORS

Microtremors are the ground vibrations with amplitude about 0.1-2 micron which are caused by the activity of artificial distrubances, i.e. traffic, machines, wind, etc. It has been found (Kanai and Tanaka 1961), that the period distribution of microtremor depends upon the characteristic nature of the underground.

The recent advantage of microprocessor technology has now, come to a point where the on site processing of microtremor data can be performed on a routine basis. Observations are usually made by use of two horizontal short period seismometers and a horizontal long period one. From the amplifier the signals of the microtremors observed are fed through an analogue / digital converter to a microcomputer for spectral analysis. The results of analysis are expressed in power spectra to obtain the appropriate information on frequency characteristics of microtremors. Furthermore, theoretical spectra can be calculated by the microcomputer for comparison with the observed ones, Fig.9.

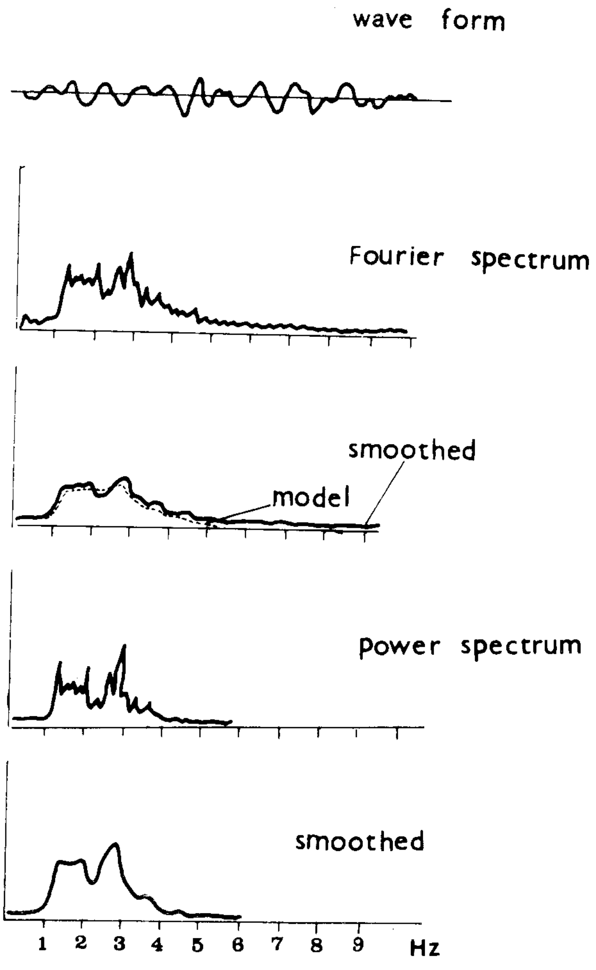

FIGURE 9: *Example of microtremor's analysis results. (Data from Drakopoulos et al 1978, reprocessed with a New-Brain microcomputer)*

APPLICATION EXAMPLE

On site processing of resistivity logs by a microcomputer for the location of fissure zones in an aquifer

The use of electrical resistivity well logs is now an almost universal adjunct to standard groundwater drilling practice. It is clear that if electrical well logs can be used for the evaluation of the hydraulic characteristics of an aquifer, they will provide a valuable tool to supplement cheaply information obtained by more laborious and expensive pumping tests.

The authors found that in certain cases the direct evaluation of the formation's geoelectric parameters can provide an indication of the aquifer's hydraulic properties. In the following example the process followed for the automatic evaluation of a new useful log, known as T-L (Transerve - Longitudinal), log from normal resistivity logs will be illustrated (Tselentis 1983, 1985 a,b).

It is known that a resistivity log could be interpreted in terms of a series of beds, each having a specific thickness and resistivity, thus it would be relatively easy to compute transverse and longitudinal resistivity values for any specific section H, of the formation encountered by using the following equations

$$P_{tr} = \sum_{i=1}^{n} (h_i \, . \, P_i)/H \qquad (4)$$

$$P_l = \sum_{i=1}^{n} (h_i/P_i)/H \qquad (5)$$

where h_i is the thickness of layer i and P_i its resistivity.

The procedure used here is based on the fact that the sums involved in equations (4) and (5) were not ordered, thus if there are several beds with the same resistivity they could be replaced by a single bed having the same resistivity, and thickness equal to the sum of the thicknesses of the single beds. By sampling a specific secton H, of the log, randomly one can estimate the equivalent portion of the section having any particular resistivity, and from this construct a resistivity frequency distribution, with a density function N(p). The transverse and longitudinal resistivities may now be computed as follows:

$$P_{tr} = \left(\int_{o}^{\infty} P \, . \, N(P)dP\right)/H \qquad (6)$$

$$P_l = H/\left(\int_{o}^{\infty} (N(P)/P)dP\right) \qquad (7)$$

A computer algorithm was designed to perform all the above operations and Fig.10 shows diagramatically the way in which the data were manipulated.

It is very important when processing data by a microcomputer to find the optimum way in which these programs can be combined for a fast and effective evaluation of the desired geophysical parameters. A critical factor during this process is the general memory structure of the microcomputer (memory map) which is used, since the operator has to define which parts of the memory will contain the data, the programs and the intermediate and final results.

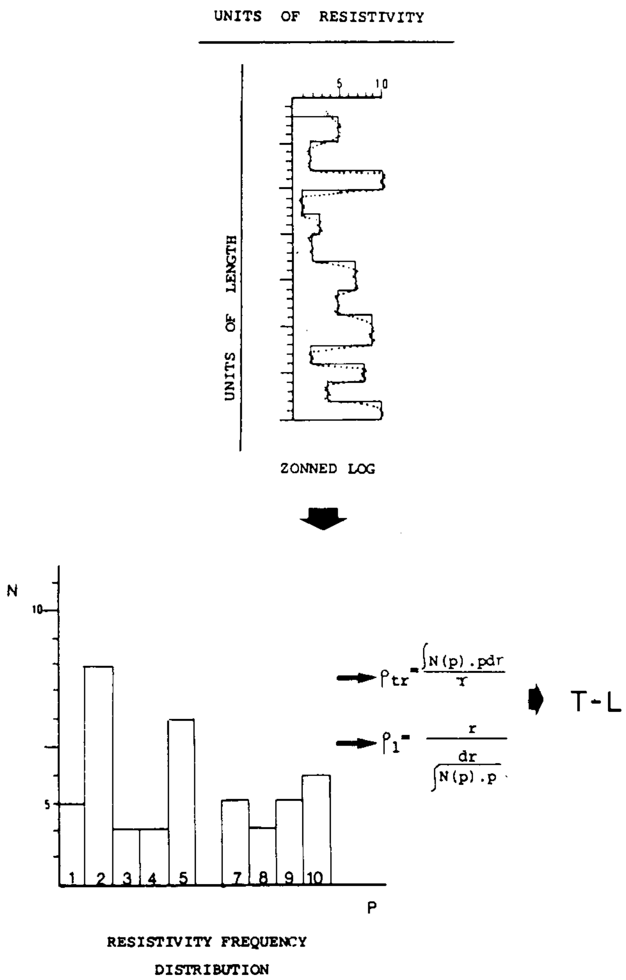

FIGURE 10: *Graphical representation of data processing.*

Fig.11 is a representation of the operations followed during the processing of the log data in the present example. By refering to this figure it is seen that the data from the digitized logs, kept in memory locations $D_{1,2..}$ can either be used directly with the programs kept in memory locations $P_{1,2...}$, or in the case that filtering is necessary pass through a filtering process. For example suppose that LOG1 is a normal

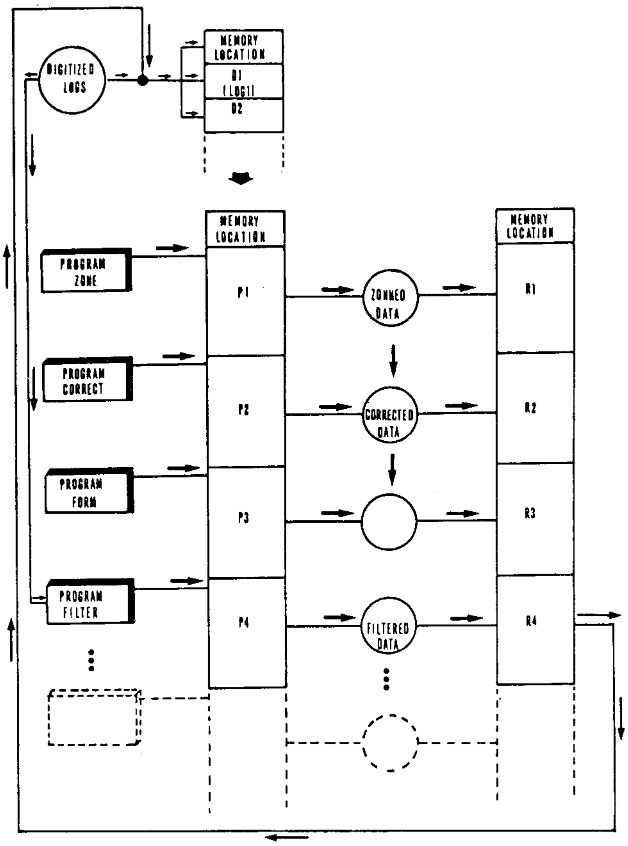

FIGURE 11: *Operation of the software package.*

16" resistivity log. The data can either be filtered with the help of program "FILTER" or pass directly through a zonation process performed by program "ZONE". Next program "CORRECT" could be used to compensate for changes of the fluid conductivity. The data are then ready for the evaluation of the geoelectric parameters of the formation through a process (see Fig.10), performed by program "FORM". Obviously the data from all the intermediate stages could be storred in memory locations $R_{1,2...}$, or send to an output device such as magnetic tape, disk, printer or plotter.

Fig.12 shows the results obtained after applying the above procedure to a 16" normal resistivity log from a well in a fractured Chalk aquifer in SE England. It is obvious that the difference between transverse and longitudinal resistivities tends to decrease versus depth and this is shown more clearly when a regression line has been fitted through the data. This result was well in agreement with the well known fact from other wells in the area that the degree of fissuring of the aquifer was decreasing with depth. A heat puls flowmeter (Tselentis 1984), run in this particular well confirmed the concentration of fissure zones in the top 80 meters.

Fig.13 representes the T-L log derived by the above process, for another well in the same area. The

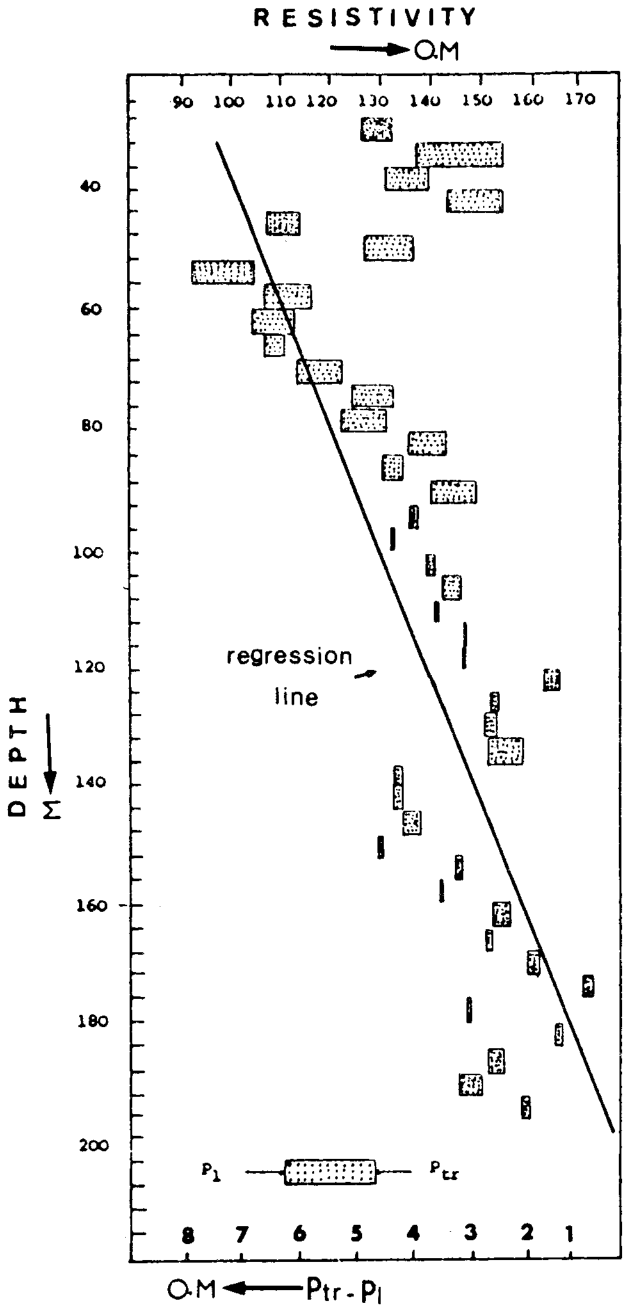

FIGURE 12: *Calculated difference between Transverse and Longitudinal resistivity vs-depth for a fissured Chalk aquifer in SE-England.*
(Data from Tselentis 1985, the processing was performed with an Acorn-Atom, 8bit, 16K microcomputer)

obtained T-L log suggests that there is a change in the geoelectric properties of the formation at the depth of fifty and eighty meters. Since the formation is homogeneous (Chalk), one would suspect the existence of fissure zones at the above levels. A differential temperature log run in the same borehole confirmed the existence of a fissure zone at the depth of fifty meters and a similar feature was recorded at the depth of seventy six meters. The caliper log on

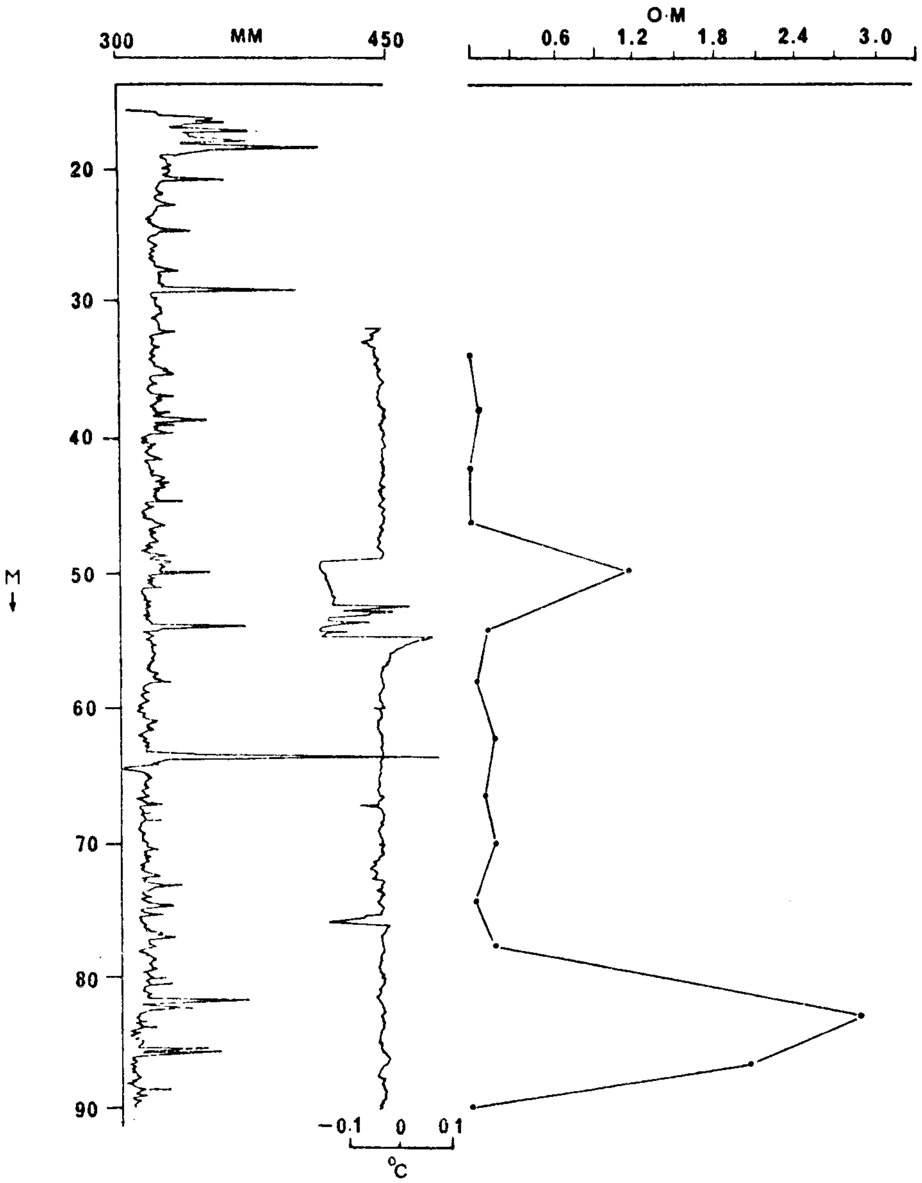

FIGURE 13: *Caliper, differential temperature and T-L log for a fissured Chalk aquifer in SE England. (Data from Tselentis 1985, the processing was performed with an Acorn-Atom, 8bit, 16K microcomputer)*

the other hand confirmed the existence of the fissure zones suggested by the T-L log and a number of some other borehole enlargements.

The processing of the data was caried on site, using an ACORN ATOM (8-bit, 16K) microcomputer which was connected to the logging unit via an Analogue / Digital interface. All the necessary for the processing programs were kept on EPROM (Erassable Programable Read Only Memory) modules.

CONCLUSIONS

As microcomputers have come into common use, geophysicists are taking much more of an interest in the computer processing of their data.

Digital data acquisition systems are now being operated in conjuction with small computers by geophysicists for interpretation and production of maps of reduced data during and immediately after completion of the surveys. Besides the advantage of fast and accurate data reduction they offer the possibiliy of applying complicated corrections, correlations and filtering processes to the data for little added cost.

Numerous examples have been given in the present paper but more specific applications will be given in a series of following papers.

REFERENCES

DAVIS, J.C. 1973: Statistics and data analysis in geology. J. Wil. pub. 550pp.

DRAKOPOULOS, J., LEVENTAKIS, G., ROUSOPOULOS, A. 1978: Microzonation of Korinthos. Anali di Geofisica, vol. XXXI. pp. 51-95.

FRASER, D.C. 1969: Contouring of VLF-EM data. Geophysics, vol. 34,6. pp. 958-967.

GHOSH, D.P. 1970: The application of linear filter theory to the direct interpretation of geoelectrical resistivity sounding measurements. Geophys. Prospect., 19. pp. 192-217.

HUMMING, C. 1977: Digital filters. Prentice Hall Pub. 212 pp.

KOEFOED, O. 1979: Resistivity sounding measurements. Elsevier pub. 276 pp.

KULHANEK, O. 1977: Digital filtering in geophysics. Elsevier pub. 243 pp.

KING, G.C.P., TSELENTIS, G., GOMBERG, G., MOLNAR, P., ROECHER, S., SINVHAL, H., SOUFLERIS, C., STOCK, J., 1983 Microearthquake seismicity and active tectonics of northwestern Greece. Earth and Planetary Science Letters, 66. pp. 279-288.

LYN, P.A. 1973: An introduction to the analysis and processing of signals. McMillan pub. 222 pp.

MAKROPOULOS, C., TSELENTIS, G., THANASOULAS, C. 1985: Seismicity and tectonics of Epirus. Under publication in Ann. Geol. Pays. Hellen.

PALMER, D. 1979: The generalized reciprocal method of seismic refraction interpretation. SEG pub. 104 pp.

THANASOULAS, C. 1983: Geophysical study of Mygdonian basin and the surrounding area. Ph. D., Thesis Thessaloniki Un. 146 pp.

TSELENTIS, G. 1979: On the gravity of the area east of Okehampton - SW England. M.Sc. dissertation, Leeds Un. 103 p.

TSELENTIS, G. 1983: Assessment of hydraulic conductivity of a fractured chalk aquifer using borehole geophysical loging. Ph. D., Thesis, Imperial College of Science and Techn. London Un. 479 pp.

TSELENTIS, G. 1984: An investigation of the principles of operation of the Heat - Pulse flowmeter. Journal of Hydrol. 69. pp. 335-349.

TSELENTIS, G. 1985a: A study of the hydrogeophysical properties of fissured aquifers using a double porosity model. Under publication in Jr. of Hydrology 78.

TSELENTIS, G. 1985b: T-L Log. A new logging technique indicative of fracture zones. Under publication in Geoph. Prospect

ΠΕΡΙΛΗΨΗ

Η εφαρμογή των μικροϋπολογιστών στην γεωφυσική και την σεισμολογία

από τους Γεωφυσικούς

ΓΕΡ. ΤΣΕΛΕΝΤΗ και ΚΩΝ. ΘΑΝΑΣΟΥΛΑ

Η πρόοδος στον χώρο της μικροηλεκτρονικής που ξεκίνησε πριν λίγα χρόνια έχει φθάσει σε ένα τέτοιο σημείο ώστε να επιτρέψει την παραγωγή φθηνών φορητών μικροϋπολογιστών με απεριόριστες υπολογιστικές δυνατότητες και χωρητικότητα μνήμης.

Ασφαλώς μεταξύ των πολλών κερδισμένων είναι και οι σεισμολόγοι - γεωφυσικοί οι οποίοι λόγο της φύσης της δουλειάς των είναι αναγκασμένοι να εκτελούν ένα μεγάλο αριθμό υπολογισμών κατά την διάρκεια της προσπάθειάς τους να ξεχωρίσουν την χρήσιμη σεισμολογική - γεωφυσική πληροφορία μέσα από τις συνήθως παραμορφωμένες από τον θόρυβο μετρήσεις.

Στην εργασία αυτή, αναφέρονται μερικές εφαρμογές μικροϋπολογιστών στην συλλογή και την επεξεργασία σεισμολογικών και γεωφυσικών μετρήσεων.

Το πρώτο κεφάλαιο εξετάζει μερικά βασικά προβλήματα που παρουσιάζονται κατά την επεξεργασία γεωφυσικών μετρήσεων με μικροϋπολογιστή, όπως η συχνότητα δειγματοληψίας, η απομάκρυνση του θορύβου κ.λ.π. Στην συνέχεια αναπτύσσεται η μεθοδολογία της εφαρμογής μικροϋπολογιστών σε κάθε μία από τις γνωστές γεωφυσικές μεθόδους και παρουσιάζονται τα σχετικά πλεονεκτήματα που προκύπτουν. Στο τέλος κάθε μεθόδου υπάρχει και ένα παράδειγμα επεξεργασίας με μικροϋπολογιστή.

Τέλος, παρατίθεται ένα γενικό παράδειγμα εφαρμογής μικροϋπολογιστού που δείχνει τον τρόπο χρήσης ενός φορητού μικροϋπολογιστή στην εξαγωγή των υδραυλικών χαρακτηριστικών του υπεδάφους από ηλεκτρικές μετρήσεις LOGGING.

Κατά την επεξεργασία των διαφόρων παραδειγμάτων χρησιμοποιήθηκαν οι μικροϋπολογιστές NEWBRAIN 8BIT, 32K, COMMODORE-PET, 8BIT, 64K, ACORN-ATOM, 8BIT, 16K.