

1 GEOPHYSICAL PROSPECTING

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The field work of ELGI for 1982 is presented in the map of *Fig. 1*.

In the framework of the topic “*Regional exploration of the Transdanubian Central Range*”, regional surveys, reconnaissance, and detailed exploration for coal and bauxite were carried out on contract partly with the Hungarian Geological Survey (MÁFI), partly with the respective mining companies. Twenty-two areas were investigated from which a few examples are presented.

In the framework of the “*Senonian brown coal exploration programme*” we continued the work in the area of Sümeg—Ukk—Gyepükaján, started in 1980. In *Fig. 2* the contour map of the Triassic—Jurassic basement is presented, constructed from all available geophysical and geological data. In the elevated area of Gyepükaján, 140 million tons of coal of heating value of 12 MJ/kg is forecast at a depth of 500–700 m.

The final report on the coal exploration of the *southeastern foreground of the Gerecse Mts.* was completed. We give a summary of the systematic geophysical exploration started in 1970. The gravity residual anomaly map of *Fig. 3* was constructed in 1974. It drew attention to the Mány (east)—Zsámbék area, where the minimum zone of E–W direction could be caused by a deep trough preserving the coal from erosion. This theory was proved by later geophysical and borehole data. Furthermore geophysics proved to be extremely successful in finding the optimum locations for boreholes. *Fig. 4* shows the contour map of the Triassic basement with the suggested boreholes (the suggestion was worked out in MÁFI–ELGI cooperation). After the first 10 boreholes were completed, a realistic view was attained about the coal reserves. In the next stage of exploration high resolution geophysical methods such as reflection seismics and multifrequency EM soundings (MFS) were used. These profiles—marked out according to the main structural features of the area—represented at the same time the basic network of the Exploration Information System (EIS). Altogether 9 EIS profiles were set up, from which the different maps were constructed by computer. One such map is presented in *Fig. 79*. The tectonic map of the area (*Fig. 5*) was constructed from all available geological and geophysical information. How geophysical methods were used and the process of geological interpretation are illustrated in *Fig. 6*. In *Table I* all borehole data are summariz-

ed which were located on the basis of geophysical information. On evaluating this, it must be taken into consideration that the task was to collect maximum geological information therefore, e.g. for delineating productive areas, boreholes had to be located on barren stretches.

High resolution seismic reflection was used in the *exploitation phase of coal exploration*, above the planned main tunnel of the Mány mine. The task was to determine the location and amplitudes of faults cutting through the coal seams. The result is presented as migrated time section coloured according to reflection amplitudes (Fig. 7). It was found that the planned tunnel crosses the main fault and several smaller faults. At the beginning of the cross section it approaches the surface of the Triassic basement, which means danger of water inrush.

From our *bauxite exploration* tasks a few examples are given. In *Tükrös-puszta*, along with the regional exploration of the south-eastern foreground of the Gerecse Mts., two boreholes hit bauxite, one hit coal in 1978. Thus the detailed exploration of the area seemed profitable. The results of gravity measurements in regular grid are given in Fig. 8/a. On the eastern part of the Bouguer anomaly map, at the edge of the bay-like minimum, is located borehole Tü—12 which hit both bauxite and coal. The filtered, second derivative-type gravity anomaly map of Fig. 8/b was of great help in planning further, higher resolution geophysical exploration. The average conductivity isolines of potential mapping (Fig. 8/c) reflect the basement contours fairly well, because of the favourable geoelectric model. Fig. 8/d shows the basement contour map constructed from all available geological and geophysical data. One can see several hollows in the basement which show potentiality for further exploration. In Fig. 9 an MFS profile is presented going through a borehole containing both bauxite and coal.

In *Bakonyoszlop*, geophysical exploration started in 1969. In 1982 we worked south of Csesznek. The case history of this area is given in Fig. 10. First the direction of structural lines and the very shallow areas were delineated by VLF measurements. The VLF phase difference map is essential in finding basement lows filled by Eocene or Oligocene sediments. From the two VLF maps and the average conductivity (\bar{S}) map of potential mapping the basement contour map was constructed. The boreholes, located on geophysical anomalies (A, B, C), proved the existence of the hollows and, furthermore, boreholes A and B hit bauxite. The changes of geophysical parameters and the geological interpretation are illustrated along profile DD'. From the parameters determined in boreholes a cross-plot was constructed. It can be seen that three different types of sedimentary sequence appear in the cross-plot.

In the vicinity of *Nyírád* most of the bauxite deposits are in contact with upper Cretaceous limestone, which lies above karst water level, thus they are easily exploitable. Mapping the surface of upper Cretaceous is complicated by

changing physical parameters both in the cover and in the target horizon. High resolution seismics and frequency soundings (MFS) gave encouraging results. In *Fig. 11* a part of an MFS section is given as an example. The upper Cretaceous horizon is traceable and two faults could be detected. It is worth noting that the relative resistivities of the Eocene and of the Cretaceous change along the profile.

The results of the detailed bauxite geophysical exploration of Csordakút are presented in *Fig. 12/b*, compared with the results of the former exploration phase (*Fig. 12/a*). Those areas which were declared to be perspective in 1978, proved to be true. *Fig. 13/a* is the 3D axonometric view of the contour map of *Fig. 12/b*. We find this axonometric plotting helpful in evaluating such complex structures. In *Fig. 13/b* those areas of the Triassic basement which are covered by bauxite are plotted in red. Thus the positions of the bauxite bodies become clear. Starting out from bauxite containing boreholes MFS profiles were measured for delineating the bauxite bodies. Three of these profiles are presented: in Profile *AA'* (*Fig. 80*) bauxite pinches out along a fault. It is noteworthy that on the left-hand side of the profile facies changes in the Eocene could be determined, to which is linked the pinching out of coal seams. In Profile *BB'* (*Fig. 14/a*) MFS measurements show bauxite deposits directly. In Profile *CC'* (*Fig. 14/b*) pinching out of the Eocene can be traced and it can be seen that bauxite is deposited in a tectonically preformed trough.

In *Northern Hungary* the integrated geophysical survey of the *Central and Western Mátra Mts.* was continued with the aim of regional structural- and ore exploration. The supplementary gravity network was completed in an area of about 200 km²; the former seismic profiles were continued in the southern direction; and IP measurements were carried out to delineate anomalous regions. On top of these, VES and MFS surveys were carried out to solve local problems of geological mapping. A location map is presented in *Fig. 15*. Gravity survey of the whole region is practically complete; only some areas which are non negotiable by car i.e. high mountainous terrain, remained for 1983. For map-construction, the terrain correction work was computerized. Processing is now in progress. A novelty in seismics was the introduction of the air gun energy source. *Figs. 16 and 17* show the same migrated time section shot by VIBROSEIS and air gun, respectively. Comparing the two it seems that air guns can be used for the exploration of the volcanic superstructure, although penetration of VIBROSEIS is deeper. The southern rim of the Mátra Mts. was investigated by Profile *Ma-2G/83* (*Fig. 18*). The most interesting feature in it is the sharp contrast between the two sides of the near-vertical line, around 70⁰⁰. This feature can be interpreted either as an intrusion or as a horizontal displacement. Exploration of shallow mineralization by the IP method was extended over the Central Mátra ore region (*Fig. 19*). It can be seen that where the number of hydrothermal veins is large, IP anomalies of considerable

amplitudes appear whereas on areas where only a few veins are present (*C* and *D*) no IP anomaly appears. Among the prospective areas (marked out by IP anomalies), there are formerly known mineralized zones (*A* and *B*), but the largest was not known up till now (*E*). The geophysical tasks connected with geological mapping comprised the tracing of the low-resistivity sedimentary layer underlying the high-resistivity andesites. In *Fig. 20/a* the VES profile, in *Fig. 20/b* the MFS profile is given. MFS measurements are less disturbed by horizontal inhomogeneities and they provide information from beneath the high-resistivity screening layer. On slopes of thick soil cover resistivity and magnetic profiling was carried out to separate layers of lava and pyroclastics. In *Fig. 21* it can be seen that widely varying resistivities can be correlated with such layers, but magnetic data are not interpretable because of the disturbing effect of andesite detritus covering the slopes.

In the framework of the “*Regional exploration of the Aggtelek–Rudabánya hills*” several different tasks had to be solved. A sketch of the location of geophysical surveys is given in *Fig. 22*. With seismics a methodological experiment series was commenced to find the appropriate field parameters for shallow structural investigation. All experiments had definite geological tasks as well. The location of seismic measurements is presented in *Fig. 23*: time section Ra-3/81 (*Fig. 24*) was shot for structural, Anh-2/81 (*Fig. 25*) served for anhydrite exploration. In the case of the latter, the separation of different structural units, and the defining of sedimentation characteristics represented a great deal of help in delineating prospective areas. In the uncovered geological map of *Fig. 26*, the structural units determined in the seismic cross sections are marked. Correlation of geological and geophysical data is satisfactory. The ground follow-up of some aeromagnetic anomalies was carried out by ΔT profiling. The causative bodies were computed (*Fig. 27*) and checked by the difference between measured and computed values (*Fig. 28*). The computation is regarded satisfactory as the difference never exceeds 10% of the measured anomaly. To help in geological mapping resistivity and magnetic profiling was carried out in two areas. In the area of Haragistya distribution and sedimentation conditions of the sequence younger than Anisian were explored by dipole-dipole profiling and a VES survey (*Fig. 29*).

In the south-western part of the *Bükk Mts.* is situated the largest ophiolite area of the Carpathian region. In recent times great advances have been made in learning its processes of evolution, both petrological and geochemical. As a result of geological mapping between 1979 and 82 a map of the scale of 1:20.000 was prepared (*Enclosure 1*), thus the tectonic picture became clearer as well. Two large tectonic units can be separated: the *synform of Szarvaskő* and the *plateau monocline*. The axis of the Szarvaskő synform dips to SW. In its build-up four tectonic nappes are involved (*Enclosure 2*), their formations can be grouped into three litho-statigraphic units. The stratigraphic succession

of the three units (*Fig. 33*) can be determined by their lithologic characteristics. There are no convincing palaeontological data, but the age of these formations can be assessed as middle Triassic – middle Jurassic. In the higher nappes of the Szarvaskő synform successively older members of the sequence appear, although in each nappe the succession is normal. In the evolution of the synform at least three stages can be separated: primary folding and development of schistosity, development of nappes, secondary folding and development of schistosity. These processes may have overlapped each other in time. The present shape of the synform shows a south-easterly direction of movement. The plateau monocline consists of a monotonic limestone sequence. Its stratigraphical position compared with the former three has not been clarified, but its age is probably in the same range. This unit got to its present location beside the evolved Szarvaskő synform by left-hand-side horizontal displacement from the east, and was later compressed against it from the north (*Figs. 35–37*).

Thus in structural exploration at least, three deformation phases can be separated in which the direction has changed but it has had a southern component all the time (*Fig. 38*.) In all three phases there existed plastic deformation too, but its role diminished from phase to phase. It is supposed that all three phases took place in the latest part of the lower Cretaceous, under a very thick cover. The characteristics of the deformations (*Fig. 34*) and the Prehnite-pumpellyite facies of metamorphism suggest that particular definition. The decreasing role of plastic deformation can be linked with the erosion of the cover.

The “*Regional study of the tectonics of Transdanubia*” continued with reflection seismics on the south-eastern rim of the Little Hungarian Plain and in the Transdanubian Central Range; with magneto-tellurics to trace the elevated zone of the high conductivity layer in the Transdanubian Central Range. Some of the formerly published seismic profiles were reprocessed. All data referring to the high conductivity layer in this zone of Transdanubia are summarized in *Fig. 39*. As a new result we can report that in most cases the surface of the high conductivity layer could be correlated with reflecting horizons. The most striking example can be seen in *Fig. 42*. The reflecting horizon of good energy in the time window of 2.0–2.5 sec can be traced even in profiles shot for coal exploration in the area (*Fig. 40*). We can publish, for the first time, Profile MK-3 which crosses the whole Transdanubian Central Range, with uniform processing and plotting (*Fig. 41*). Results of magneto-telluric soundings are plotted too. All these represent facts but for a unified tectonic interpretation even more data should be collected.

From our “*Water- and engineering geophysical projects*” three examples are presented. The “*Geophysical exploration of the alluvial cone of River Maros*” was completed in 1982. The most important geological results of surface geophysical survey were the horizontal and vertical delineation of the alluvial cone. The vertical build-up can be studied by geophysical profiles (*Fig. 43*) and by

the parameter maps of different penetration (Figs. 44–47). The horizontal delineation is given in Fig. 48, constructed from geophysical profiles and maps. The most important hydrological results are: determination of sedimentological conditions in an area of 1,600 km², within this area districts of different prospects regarding water yield were separated, and those areas were marked out where further investigation is needed before locating water works. An important question is, whether the porous reservoir rocks get enough fresh supply? It is evident that supply conditions are best where ancient rivers or tributaries existed continuously or with only a short break. The system of ancient tributaries building up the upper part of the cone can be studied by the resistivity map of smaller penetration (Fig. 49). The project had several methodological results as well. The most noteworthy are: finding regularities in the distribution of apparent polarizability and interpretation of ρ -P diagrams constructed from measurements in wells (Figs. 50 and 51).

As a result of the “*Geophysical exploration of the terrace and alluvial cone of River Rába*” the upper 250 m thick sediments, most important for water supply, could be separated into five layers, viz. terrace, alluvial cone, shaly marker, lower sandy-shaly sequence, shaly basement. The terrace and alluvial cone sediments can be counted as the upper water base, the lower sandy-shaly complex as the lower water base, when designing water works. The most favourable places of the water bases are marked out in Fig. 52, the hydrological classification of the terrace sediments and that of the alluvial cone are presented in Figs. 53 and 54, respectively.

A new and interesting topic is: “*Geophysical exploration of sliding surfaces*”. The high relief scarp of the Dráva river-bank was explored on contract with Yugoslavian and Hungarian water construction firms. The theoretical basis for using geophysics is that although the petrological composition of the sliding rock masses does not change, the physical properties of these masses differ from undisturbed parts. As a first step VES profiles are marked out on air photographs, perpendicularly to the banks. From the VES survey the geoelectric model is determined (Fig. 55/a). Next, the model is checked by engineering geophysical soundings, by which we get a high resolution picture of the uppermost 20–30 m thick layer (Fig. 55/b). It was determined that bulk density shows a definite difference between sliding and static parts. The character of sliding is different in the upper and lower section of the bank. There is no solution for the drainage of the scarp, thus it is constantly in a mobile state. To determine the hydrological causes of initiating sliding, further hydrological investigations are needed.

In oil exploration *reprocessing of reflection profiles of the Hajdú region* resulted in interesting seismic sections. Comparing the present section, processed by the SDS-3 program package on the R-35 computer, plotted by VERSATEC plotter (Fig. 57) and COROLLPRESS (Fig. 58) with the former one (Annual

Report, 1977, Fig. 36) one can see the striking difference in both the basement and the sedimentary fill. The overthrust, marked out in the basement, is verified by a nearby borehole. The effects of young tectonic movements can be traced nearly to the surface into the coloured section. Location of the profile can be seen in Fig. 56.

In the *Nógrád coal basin a reflection seismic survey* was carried out for the tracing of the coal seams westwards from the area under exploitation. A location map with geological information is presented in Fig. 59. The fault line of Sóshartyán-Szentkút divides the area. Two time sections are presented as examples. In Fig. 60 two horizons could be traced: the coal seam (thick line) and the surface of a deeper rhyolite tuff layer. In Fig. 61 all horizons appearing in the area are traceable. As a result of the survey of 1981–82 those districts can be separated where there is no point in drilling because the coal bearing formations lie beneath the level of economic exploitation (500 m).