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Effect of tectonics on relief in the southern part of the Lublin region

Analysis of wave image recorded on seismic profiles has shown that configuration of land surface is dependent on tectonics. Zones of tectonic disturbances frequently overlap depressions in ground surface, sometimes are consistent with places where a change is observed in a slope of ground surface. This suggests that faults occur in the entire complex of Cretaceous sediments. However, amplitudes of their throw are not large. Results of reflection survey should be employed in order to recognize the tectonics of Cretaceous deposits. Data dealing with measurements of Low Velocity Zone should be included in this task.

INTRODUCTION

Determination of relation of tectonics to relief of land surface is still in the centre of interest (M. Harasimiuk, A. Henkiel, 1975; W. Jaroszewski, A. Piątkowska, 1988); despite this fact, the matter in question remains unsolved. There are different reasons of such the situation, but the omission of seismic data creating an important source of information on zones of tectonic disturbances seems to be one of the most important. Therefore, it is purposeful to consider whether and to what extent the faults delimited on the seismic profiles or the changes in the character of reflection boundaries have their impression on the relief in the southern part of the Lublin region. The region mentioned here is convenient for such type of analysis since numerous seismic profiles have been surveyed in this region of diversified morphology. However, it is difficult to present abundant seismic data in one publication. Therefore, attention will be directed to selected seismic profiles contained in the report of J. Brauer *et al.* (1988) and presented in Figure 1.

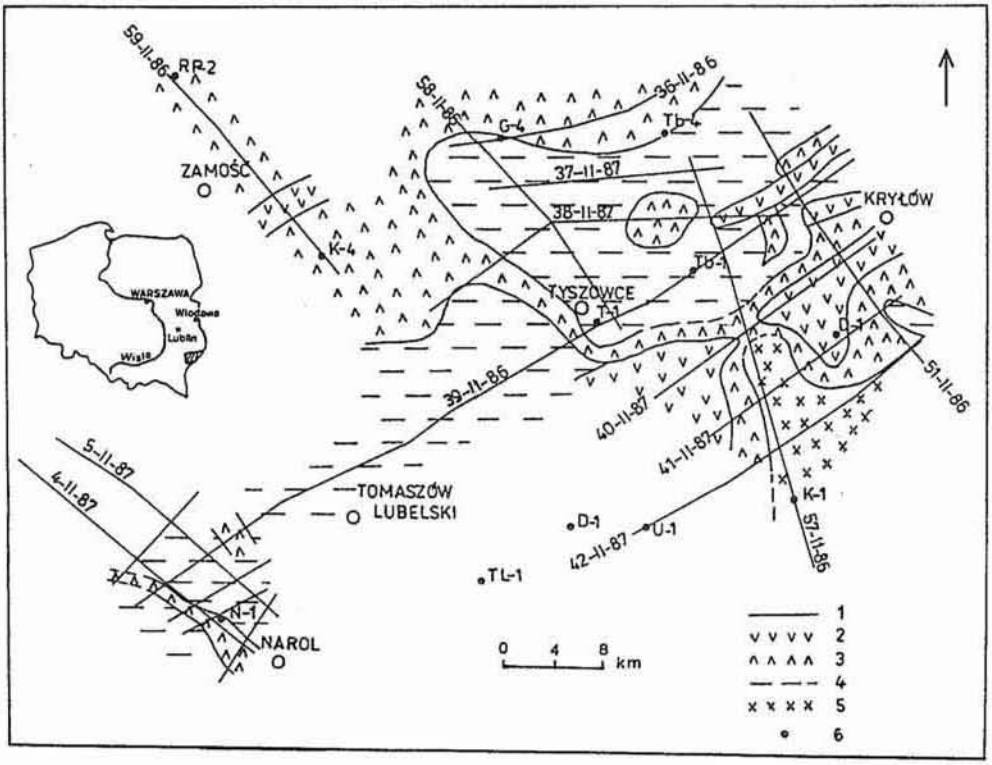

Fig. 1. Location of seismic profiles against the background of a sketch showing distribution of velocity of wave propagation in the formation below the bottom of the Low Velocity Zone (LVZ)

1 — seismic profiles; areas of wave velocity: 2 — < 1700 m/s, 3 — from 1700 to 1900 m/s, 4 — from 1900 to 2100 m/s, 5 — > 2100 m/s; 6 — boreholes

Lokalizacja profili sejsmicznych na tle szkicu rozkładu prędkości przebiegu fal w utworach poniżej spągu strefy małych prędkości (SMP)

1 — profile sejsmiczne; obszary o prędkościach fal: 2 — < 1700 m/s, 3 — od 1700 do 1900 m/s, 4 — od 1900 do 2100 m/s, 5 — > 2100 m/s; 6 — otwory wiertnicze

RELIEF ON SELECTED SEISMIC PROFILES

During seismic surveying the relief of land surface is, in principle, assessed in respect of access to shot points and receivers of compressional waves by vehicles (including those with recording devices). In principle, a number of measurements of the Low Velocity Zone (LVZ) in regions of highly diversified morphology is being increased which is aimed at accurate computing of statistical corrections.

Insufficient consideration is directed in the seismic reports to the issue of relation between changes in the wave image and the land surface configuration. For that reason, criteria applicable to determination of relation between morphologic forms of land surface and the tectonics are lacking; in part, this can be explained by the fact that the Cretaceous formation occurring not deep has not been a target of seismic survey.

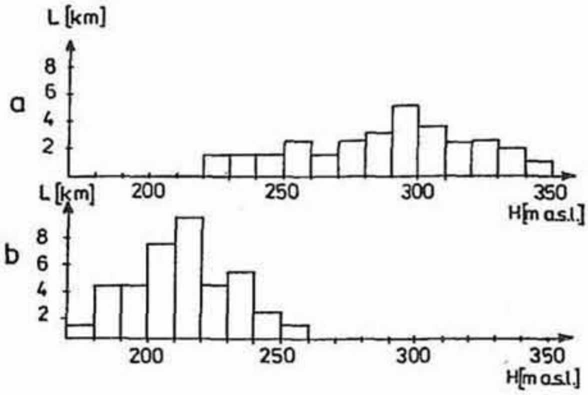

Fig. 2. Histogram of altitudes of land surface on the profile 39-II-86
a — southwestern segment, b — northeastern segment
Histogram wysokości powierzchni terenu na profilu 39-II-86
a — odcinek południowo-zachodni, b — odcinek północno-wschodni

A cover of the Cretaceous formation in the southern Lublin region is composed of loose sediments developed as sands, clays, loams, and loesses. They mask small morphologic forms of the Cretaceous sediments. This is evidenced by the cases where shot holes located at a distance of 15–20 m from each other encounter a top of the Cretaceous at different depths (sometimes different by several metres).

However, configuration of land surface will be related mostly to the Cretaceous sediments composed of delimed gaizes and marls in the western part and chalks in the eastern part of the region. Assumption that the Cretaceous sediments are fractured and loosened in the fault zones lead to the conclusion that they will be more tractable to process of erosion. Consequently, the fault zone should be, first of all, associated with depressions in land surface. Due to variable parameters of faults, and to some extent of complicate nature of processes of erosion, depressions in land surface will develop different forms and size. Vertical movements of rocks in the fault zones may cause contacts of Cretaceous rocks of different lithology, consequently of variable resistance to processes of erosion. This may lead to different slopes of land surface on both sides of faults as well as to asymmetry of slopes of depression.

Dislocations in the study region are of NE–SW and NW–SE orientation. The first ones are more frequent and are characterized by bigger amplitudes of throw. In general, amplitudes of faults in the Cretaceous are not large.

With respect to the fact that recognition of the Palaeozoic complex was the aim of investigation, no effort was in principle made to delimit the faults in the Cretaceous formation above the K boundary which is linked with its bottom part.

It should be noted here that some of the tectonic zones in the region covered by this study will disturb not only the K boundary but also the entire interval of the Cretaceous sediments. Zones of tectonic disturbance should primarily affect the relief despite partial softening of sharpness of erosional forms by loose sediments of the cover of Cretaceous

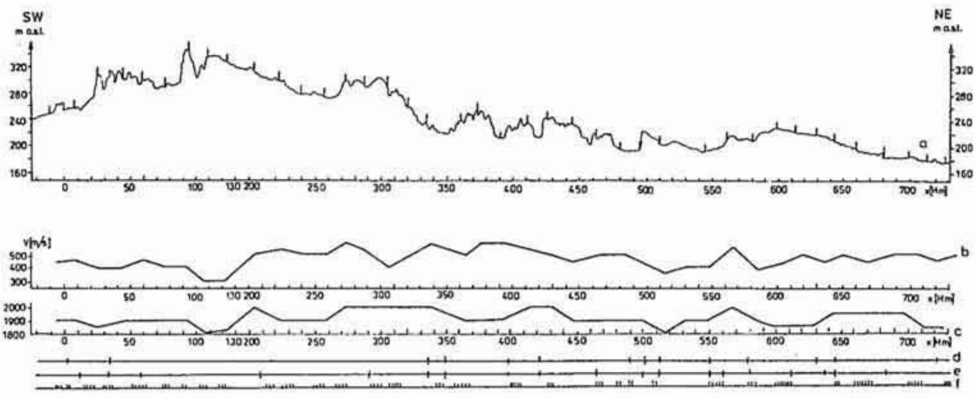

Fig. 3. Surface relief and near-surface conditions on the profile 39-II-86, with tectonic zones marked out

a — morphology and points of LVZ measurements (vertical dashes), b — wave velocities in the LVZ, c — wave velocities in the base of LVZ, d — location of faults that have been delimited on seismic profiles contained in the report by J. Brauer *et al.* (1988), e — faults and zones of tectonic disturbance in the Cretaceous sediments, frequently extended to the Palaeozoic complex, delimited by the author, f — segments of profile where a part of shot points has been omitted

Rzeźba terenu i warunki przypowierzchniowe z zaznaczeniem stref tektonicznych na profilu 39-II-86

a — morfologia terenu i punkty wykonanych pomiarów (kreski pionowe) strefy małych prędkości (SMP), b — prędkości fal w SMP, c — prędkości fal w utworach podłoża SMP, d — lokalizacja uskoków wyznaczonych na przekrojach sejsmicznych zawartych w dokumentacji J. Brauer i in. (1988), e — uskoki i strefy zaburzeń tektonicznych w osadach kredowych, mające często przedłużenie w kompleksie paleozoicznym, wyznaczone przez autora, f — odcinki profilu, na których opuszczono część punktów wzbudzania

formation. As there are two directions of faults, it is well grounded to analyse land morphology on profiles running possibly perpendicular to the faults.

Locations of reflection profiles contained in the report (J. Brauer *et al.*, 1988) are presented in Figure 1. With respect to its length, and respectively to its course through the area of different geological structure and of variable near-surface conditions, the profile 39-II-86 seems to be particularly useful. With respect to land altitudes, the profile was subdivided into two segments, with a station pole 380 being a conventional boundary. The southwestern area is elevated over 250 m a. s. l. (Fig. 2a) whereas the northeastern segment of the profile is characterized by altitudes less, in principle, than 250 m a.s.l. (Fig. 2b).

The relief along the profile 39-II-86 is shown in Figure 3. A vertical scale has been exaggerated here to accentuate the land relief. Morphology is much more diversified in the southwestern part of profile than in its northwestern part. A segment of profile between the station poles 20 and 70 is characterized by alternating narrow elevations and depressions. Difference in elevation between the highest and the lowest values does not exceed 12–15 m except for the station pole 30, where the difference reaches 25 m.

A considerable depression in land surface occurs in the area of station poles 100–110. Starting from the station pole 120, the land surface occurs to be inclined towards NE. A slope is variable here, with the smallest angle in the vicinity of station pole 260 (there is a change in continuity of station pole pattern on the segment of profile between the station poles 130 and 200; nevertheless, the continuity of the profile was maintained). A profile segment between the station poles 300 and 490 is characterized by distinct alternation of elevations and depressions. Particularly strongly marked in morphology is a depression near the station pole 490, which constitutes a valley of the Huczwa river. Farther to NE, the land surface is of weak differentiation, and morphologic forms are of gentle slopes.

Changes in slopes are visible in the station poles 640 and 670 while less distinct are in the vicinity of station pole 700. Important to note is the fact that distinct depressions or elevation of land surface are lacking in this part of the profile.

As mentioned before, there are also faults of SW–NE orientation in the area under consideration, that have bigger amplitudes in comparison with the faults of NW–SE orientation. Therefore, a basis exists to consider that the influence of tectonics upon configuration of land surface should be observable on the profiles 59-II-86, 58-II-86, 57-II-86, and 51-II-86, all of NW–SE orientation. Altitudes of land surface observed on these profiles are shown in Figure 4.

The profiles 51-II-86 and 58-II-86 occur within the area of relatively small altitudes of land surface, in principle not exceeding 230 m a.s.l. Insignificantly higher altitudes characterize the profile 59-II-86; participation of high altitudes essentially increases on the profile 57-II-86. Changes in altitudes along the run of particular profiles are shown in Figures 5 and 6.

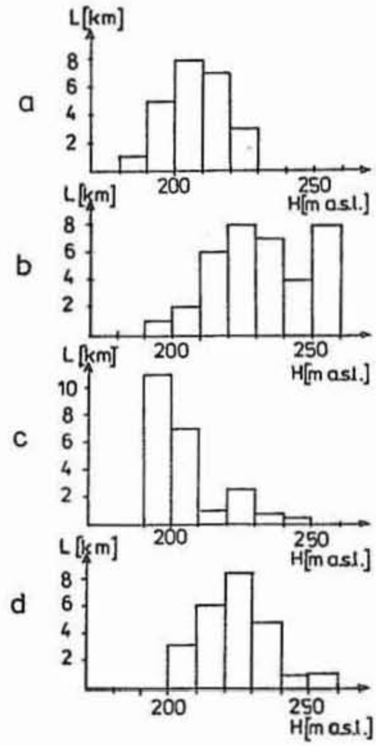

Fig. 4. Histogram of altitudes of land surface on the profiles: a — 51-II-86, b — 57-II-86, c — 58-II-86, d — 59-II-86
Histogramy wysokości powierzchni terenu na profilach: a — 51-II-86, b — 57-II-86, c — 58-II-86, d — 59-II-86

Extended depressions, with minimal altitude values at the station poles 30, 50, and 100, are visible on the NW segment of the profile 59-II-86 (Fig. 5A). Depressions in morphology also occur in the SE segment of this profile, but they are relatively narrow and of variable slope, and sometimes their slopes are of different length as for instance at the station pole 194.

The profile 58-II-86 (Fig. 5B) is situated within the area of gentle configuration. Distinguishable geomorphologic forms occur in the vicinity of station poles 40, 60, 80, 110, 150, and 205.

With the increase of altitudes towards SE, several depressions can be observed on the profile 51-II-86 (Fig. 5C); clearly visible are those occurring in the vicinity of station poles 10, 70, 125, 160, 197, and 220. On the basis of general character of geomorphology, division of this profile into 4 segments is well grounded; the segments are contained between the following couples of station poles: 10 and 70, 70 and 125, 125 and 160, as well as 160 and 230.

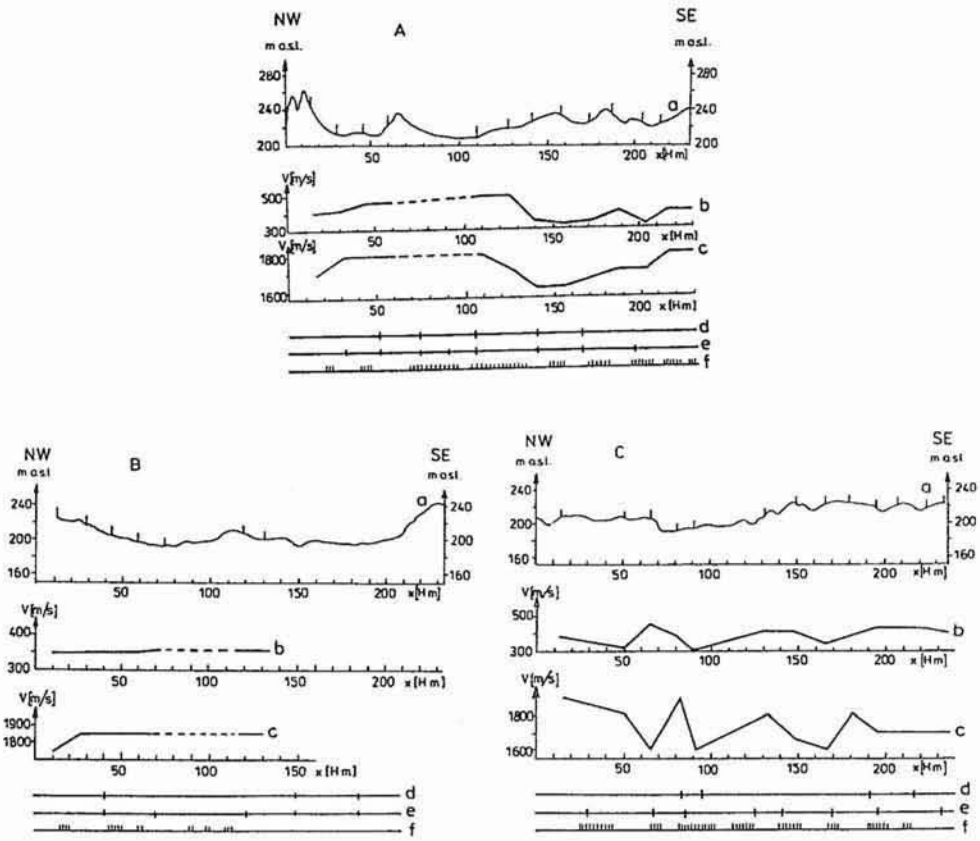

Fig. 5. Surface relief and near-surface conditions with tectonic zones marked out on the profiles: A — 59-II-86, B — 58-II-86, C — 51-II-86

For explanations see Fig. 3

Rzeźba terenu i warunki przypowierzchniowe z zaznaczeniem stref tektonicznych na profilach: A — 59-II-86, B —58-II-86, C — 51-II-86

Objaśnienia jak na fig. 3

In respect to the surface relief, the profile 57-II-89 (Fig. 6) can be subdivided into two segments bordering on the station pole 150. Morphology in the NNW segment is poorly diversified, though small depressions or changes in slope can be observed in the land surface. They occur in the vicinity of station poles 10, 40, 65, 90, 110, and 150. Against the background of two extended overdeepings between the station poles 195 and 265 as well as 265 and 330, local depressions are visible such as those in the vicinity of station poles 220, 240, and 290.

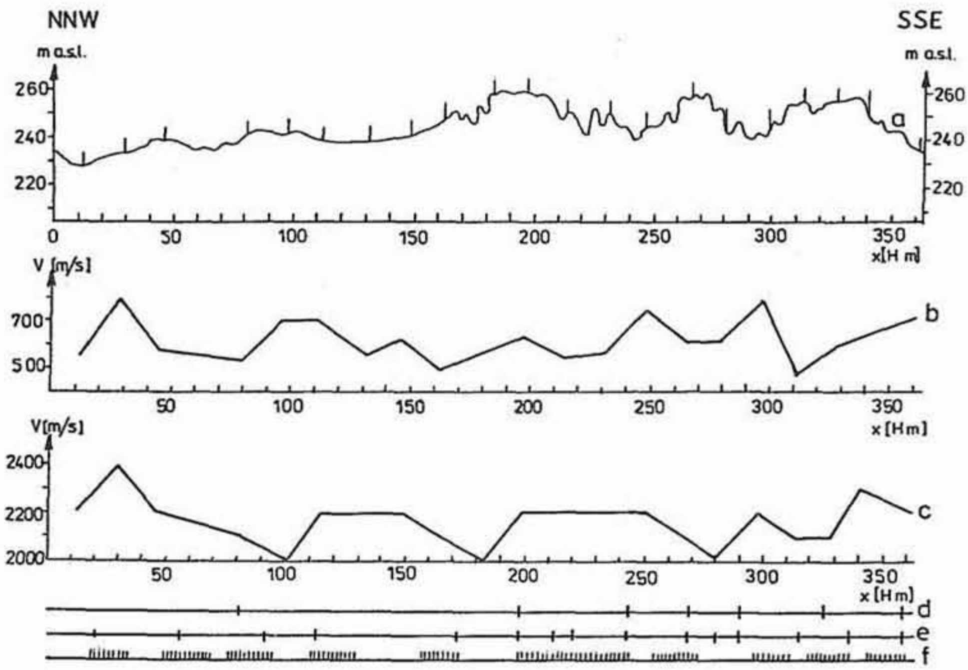

Fig. 6. Surface relief and near-surface conditions on the profile 57-II-86, with tectonic zones marked out
For explanations see Fig. 3
Rzeźba terenu i warunki przypowierzchniowe z zaznaczeniem stref tektonicznych na profilu 57-II-86
Objaśnienia jak na fig. 3

NEAR-SURFACE CONDITIONS OF SEISMIC SURVEY AREA

Parameters determined on the basis of data obtained from measurements of the LVZ — namely thickness and velocity within the LVZ — should be considered the near-surface conditions.

Sites where measurements of the LVZ (velocities and thicknesses) were carried out have been shown in Figures 3, 5 and 6. The measurements were distributed possibly regularly on particular profiles, except for the profile 51-II-86 (Fig. 5C). Figure 7 illustrates a compilation of velocity of wave propagation in the LVZ as recorded on the profile 39-II-86. Independently of altitudes, they group in the range of 400–500 m/s. Explanation to this fact consists in similar velocities of wave propagation in unsaturated sands, clays, and loesses, thus in surficial sediments lithologically different; for all of them, velocities are in the range of 200–700 m/s. Figures 3, 5 and 6 show the velocities of wave propagation along selected profiles in the LVZ as well as in the substratum of the LVZ.

On the profile 39-II-86, the velocities in the formations underlying the LVZ are most often equal to 1900–2000 m/s; they are independent of altitudes (Fig. 7). On the other hand, dominant on the profiles 59-II-86 and 51-II-86 are velocities slightly less than those just

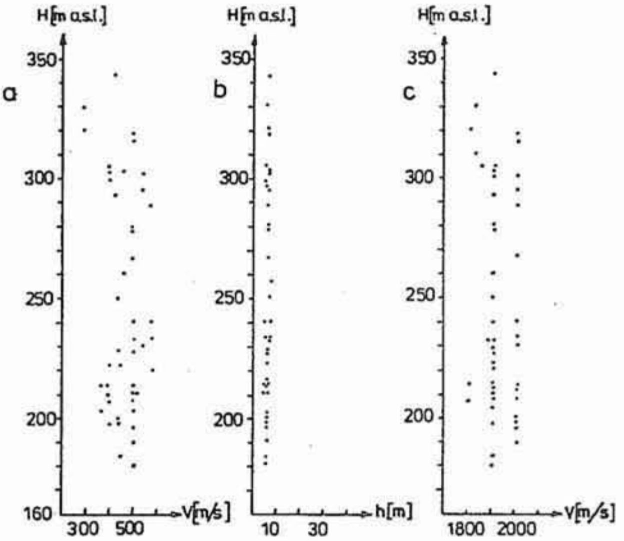

Fig. 7. Compilation of velocities of wave propagation in the LVZ on the profile 39-II-86
a — wave velocities in the LVZ, b — thickness of LVZ, c — wave velocities in sediments being the base of LVZ
Zestawienie prędkości rozchodzenia się fal w SMP na profilu 39-II-86
a — prędkości fal w SMP, b — miąższość SMP, c — prędkości fal w utworach poniżej SMP

mentioned. They are higher on the profile 57-II-86. Again, no correlation could be found with altitudes of land surface (Fig. 8).

There are some cases where a local reduction in velocity can be observed in places of depressions in the land surface. On the profile 39-II-86, such correlation occurs in the vicinity of station poles 30, 105, and along the segment limited by the station poles 360–390 (Fig. 3). Agreement between segments with lowered morphology and the changes in velocity is also observed on other profiles including the 57-II-86 one, near the shot points 175, 280, and 320.

Figure 1 presents the distribution of velocity of wave propagation in the formations underlying the LVZ. The most diversified display of wave velocity distribution is observed in the southeastern part of the area. Comparison of velocities of wave propagation in the LVZ and in the underlying formations sometimes reveals the fact that velocities in both are consistent. A segment between the station poles 105-120 on the profile 39-II-86 is given here as the example of the case since low velocities were recorded here (Fig. 3).

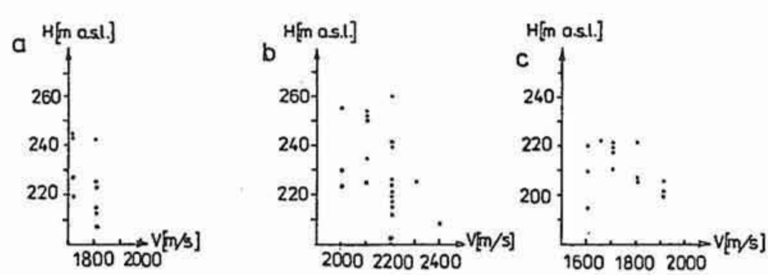

Fig. 8. Velocities of wave propagation in sediments being the base of LVZ on the profiles: a — 59-II-86, b — 57-II-86, c — 51-II-86
Prędkości rozchodzenia się fal w utworach poniżej SMP na profilach: a — 59-II-86, b — 57-II-86, c — 51-II-86

Loss of water used in shot hole drilling can be the basis for assessment of the near-surface conditions in an indirect way. Water loss was the reason for the reduction of total number of planned holes to be drilled in group pattern, and for the omission of shot points as well. A method of replacement shot points was applied to maintain multiple coverage. A total number of replacement shot points used on some profiles was as high as 40% and more (for instance: 44% on the profile 57-II-86, 41% on the profile 51-II-86). Sometimes, due to land development and bad off-road conditions unaccessible to vehicles it was impossible to drill some shot points.

Segments of profiles, where holes were not drilled or their number was reduced, have been presented in Figures 3, 5 and 6. In principle, it is impossible to determine the reasons of difficulties in locating the holes on the basis of data contained in the report (J. Brauer *et al.*, 1988). However, an assumption can be made that loss of water during drilling which happened on a part of profile segments was due to the increase of fissuring in the Cretaceous formation. In turn, the increase of fracturing should be visualized by the reduction of velocity of wave propagation in sediments underlying the LVZ.

MORPHOLOGIC FORMS VERSUS CHANGES IN THE WAVE IMAGE

It is most common that changes in the wave image on the seismic profiles are caused by tectonic disturbances. They can also be induced by not very careful introduction of corrections eliminating the influence of heterogeneity occurring below the LVZ. Since thickness of LVZ changes insignificantly as concluded from Figure 7b, then the basis exists for conclussion that probable heterogeneity of the medium, which would affect the accuracy of computed corrections should occur deeper, considerably in the Cretaceous formation. Heterogeneities in the Cretaceous formation that might influence the velocity of wave propagation through the topmost part of Cretaceous, thus also the accuracy of computation of corrections, should be connected with the zones of tectonic disturbances or the zones of rock looseness being the zones of increased degree of fissuring of sediments.

Among parameters characterizing the faults and first of all, possibly reflecting in the relief of land surface, one should mention a throw and a width of a zone affected by break-up of rocks or fracturing only. In general, these parameters are defined on the seismic profiles with sufficient accuracy. However, it should be noted that insufficient care is taken when defining a width of the fault zone.

Two dislocations were determined in the southwestern part of the profile 39-II-86 (Fig. 9), where they are situated in the vicinity of the station poles 0 and 30 (J. Brauer *et al.*, 1988). The authors of the report are of the opinion that the dislocation occurring at the station pole 0 does not disturb the Mesozoic formation, while in the vicinity of the second one a distinct gap is observed in correlation of the J and K Mesozoic boundaries. The occurrence of a fault in the vicinity of the station pole 30 can be utilized to explain the reduction of velocity of wave propagating through the near-surface sediments (Fig. 3). Based on the obtained wave image in the interval of Mesozoic rocks in the vicinity of station pole 0, whose bottom is defined by a seismic boundary at approx. 1.1 s, a fault can be determined here (Fig. 9).

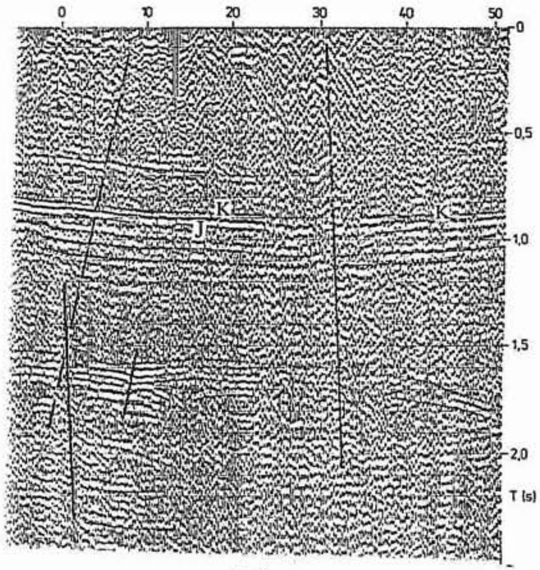

Fig. 9

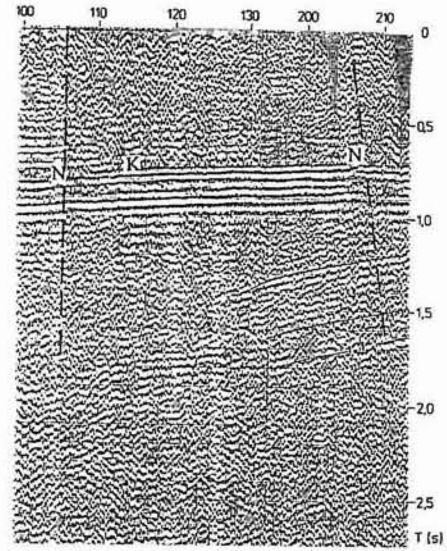

Fig. 10

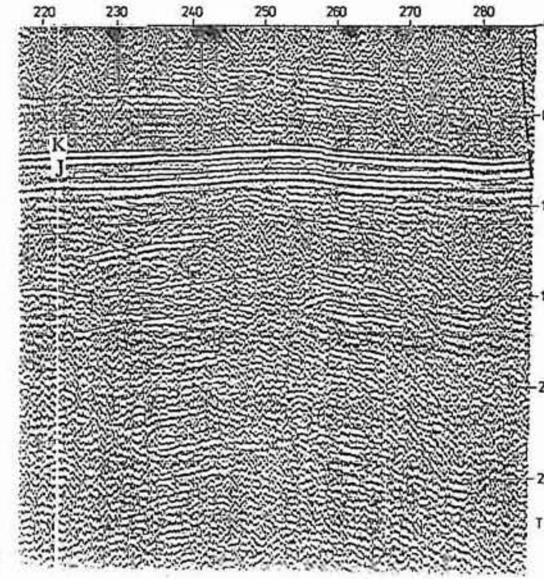

Fig. 11

Fig. 9. Fragment of profile 39-II-86 with faults showing relationship with the surface relief
Solid lines — faults, after J. Brauer *et al.* (1988); dashed lines — faults and zones of tectonic disturbance, after the author; K, J — seismic boundaries
Fragment profilu 39-II-86 z uskokami wykazującymi związek z rzeźbą powierzchni terenu
Linie ciągłe — uskoki według J. Brauer i in. (1988); linie przerywane — uskoki i strefy zaburzeń tektonicznych według autora; K, J — granice sejsmiczne

Fig. 10. Zones of discontinuity in wave correlation in depressions of land surface, on the profile 39-II-86
N — zone of discontinuity in wave correlation; other explanations see Fig. 9
Strefy nieciągłości korelacji fal w miejscach zagłębień terenu na profilu 39-II-86
N — strefa nieciągłości korelacji fal; pozostałe objaśnienia jak na fig. 9

Fig. 11. The anticline on the profile 39-II-86, over which altitudes of land surface are decreasing
For explanations see Fig. 9
Antyklina na profilu 39-II-86, nad którą maleją wartości rzędnych terenu
Objaśnienia jak na fig. 9

Depressions in the land surface correspond to place of fault occurrence in the discussed part of the profile 39-II-86. Similar relations between the surface relief, wave image, and changes in velocities of the LVZ and its bottom part are observed between the station poles 107–112 of this profile (Fig. 10). Characteristic here is the dissapearance of both the K boundary and shallower boundaries that are connected with the Cretaceous deposits. The occurrence of a fault in the vicinity of the station pole 107 is very likely. Though a consecutive fault between the station poles 200–210 has not been reflected by a depression in the land surface, however, it appears in the place where a change in the land slope can be observed.

A fragment of profile 39-II-86 delimited by the station poles 230–265 contains a distinct anticlinal form which is composed of Palaeozoic and Mesozoic formations (Fig. 11). Despite continuous Jurassic and K boundaries, a small flexural bend in the area of station pole 260 seems to be induced by a fault. Thus, the occurrence of depression in the land surface can be interpreted as the occurrence of fault. A relatively wide zone (the station poles 220–260) of increased fissuring is also evidenced by results of measurements of the LVZ. Hence, it can be concluded that in this case the formation above the anticline will be characterized by increased degree of fissuring.

An agreement is observed between the location of delimited faults (J. Brauer *et al.*, 1988) and the changes in morphology on the segment of profile 39-II-86 between the station poles 330–350 (Fig. 12). In spite of irregular distribution of shot points on this profile, the obtained results manifest the existence of fault. A marked influence of the tectonic zone on the relief of the land surface is also evidenced at the station pole 390.

Though the authors of the report (J. Brauer *et al.*, 1988) did not determine faults in the vicinity of station poles 470 and 474 on the profile 39-II-86 (Fig. 13), nevertheless their existence is very likely here. In turn, a fault occurring in the Palaeozoic formation in the vicinity of station pole 490 may be delimited in other way, and then it would overlap a valley of the Huczwa river the boundary of which is pointed out by the station poles 475–495 (Fig. 3).

Four faults (J. Brauer *et al.*, 1988) have been plotted in the northeastern part of profile 39-II-86 (Fig. 14), more or less from the station pole 600; the four disturb the Lower and Middle Palaeozoic formations. Nevertheless, gaps in correlation of Cretaceous boundaries can be observed in the vicinity of these faults. It should be noted that a change on slope of land surface occurs in places of gaps in correlation such as in the vicinity of the station poles 625, 635, and 675 (Figs. 3, 14).

Due to distinct depressions in the land surface, the profile 59-II-86 (Fig. 5A) seems to be particularly useful in determining the probable influence of tectonics on relief on the profiles of NW–SE orientation (perpendicular to the profile 39-II-86). Figure 15 illustrates an example of wave image as recorded on a segment of this profile being limited by the station poles 30 and 80. In the vicinity of station pole 50, the fault disturbs the Palaeozoic and Jurassic formations and the K boundary as well. It should be noted that opposite directions characterize the throw of limbs defined from the boundaries J and K. It is a sort of peculiarity here, since in general in the Lublin region — the direction of displacement along the fault plane of Mesozoic (Jurassic and Cretaceous) formations is consistent.

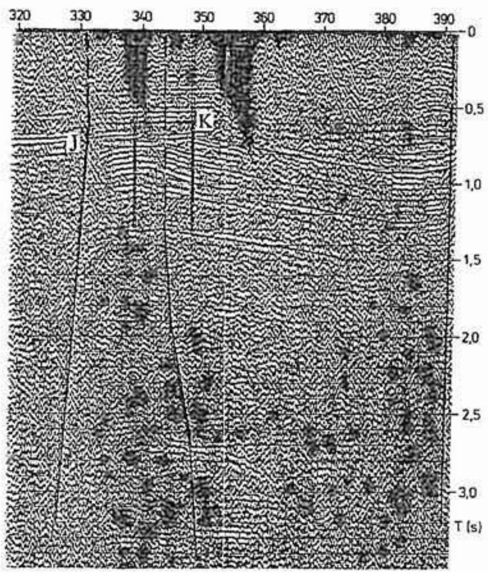

Fig. 12

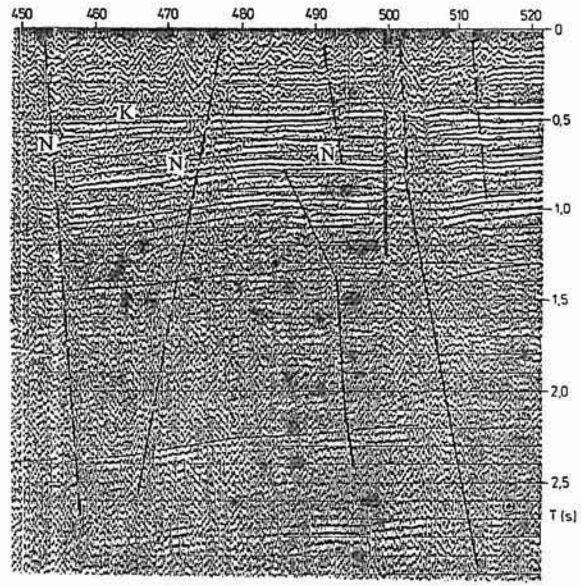

Fig. 13

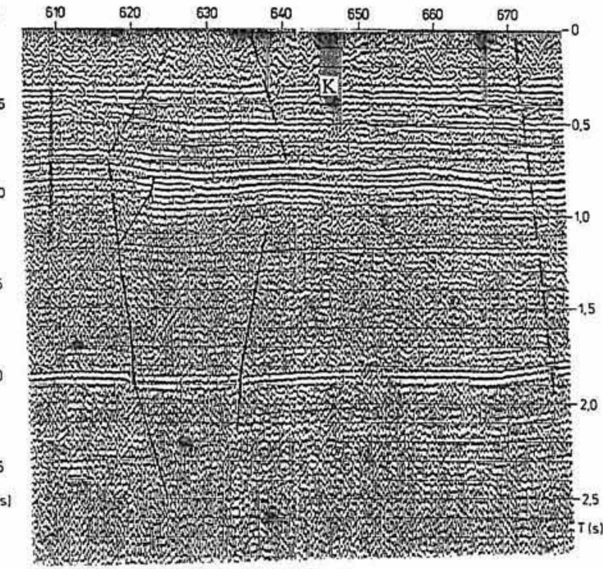

Fig. 14

Fig. 12. Extension of faults to the Cretaceous complex, locating them in depressions of the land surface, on the profile 39-II-86
Przedłużenie uskoków na kompleks kredowy, lokalizujące je w obniżeniach powierzchni terenu, na profilu 39-II-86

Fig. 13. A complex tectonic image of the Tyszowiec area on the segment of profile 39-II-86 of diversified morphology
Złożony obraz tektoniczny w rejonie Tyszowiec na odcinku profilu 39-II-86 o urozmaiconej morfologii

Fig. 14. Faults in places of change in slope of land surface, on the profile 39-II-86
Uskoki w miejscach zmian nachylenia powierzchni terenu na profilu 39-II-86

Figs. 12–14 — for explanations see Figs. 9 and 10
Fig. 12–14 — objaśnienia jak na fig. 9 i 10

It is very likely that a fault of small amplitude or a tectonic zone of rock looseness occurs on the profile 59-II-86 between the station poles 33 and 36. A depression in the land surface is also observed in this place.

The profile 59-II-86 (Fig. 16) between the station poles 80 and 120 is characterized by a small overdeeping of the boundary J and K combined with parallelism of these boundaries, and even with a change in frequency of dominant wave reflected from the Mesozoic formation and in part, waves connected with the Carbonifeous complex. One can expect that changes in wave image are induced by interaction of a fault branching out within the time interval of 0.9–1.14 s (Fig. 16) on the Mesozoic boundaries. The wave image indicates that a tectonic zone exists also in the area of the station pole 90.

All of the faults occur within a broad depression delimited by the station poles 90–140 (Fig. 5A). A change in the seismic record on a segment of profile 59-II-89 from the station poles 160 and 170 induces the possibility of extending the zone of tectonic disturbance to complex of the Mesozoic sediments (Fig. 17). A depression in the land surface occurs here, and the velocities of wave propagation in the LVZ and below are small (Fig. 5A); this may indicate the increase in degree of fissuring of the Cretaceous rocks.

The results obtained in the vicinity of station pole 150 on the profile 58-II-86 (Fig. 18) is a convincing example of relation between tectonics and the surface relief. A width of the fault zone is approx. 1 km; of the same width is the depression in the land surface. Though lack of measurements in the LVZ within the discussed part of the profile does not allow determination whether the depression in morphology is associated with the reduction of velocity in near-surface formation, however, the disappearance of energy can be observed within the interval of Mesozoic and in part even Carboniferous sediments. Such low energetic background, at sustained multiple coverage, can be connected with increased fracturing in the vicinity of station pole 150, which could facilitate erosion of Cretaceous sediments, and with development of depression in the land surface (Fig. 5B). A gap in continuity of correlation of Mesozoic boundaries, combined with the decrease of intensity of seismic record, occurs in the area of station poles 180–190 (Fig. 18). However, no considerable differences in the land altitudes are observed here (Fig. 5B). The authors of the report (J. Brauer *et al.*, 1988) delimited a fault in the Lower Palaeozoic within this segment of the profile. This fault can be extended to the Devonian and Carboniferous sediments, and when taking into account the afore-mentioned change in the intensity of record — also to the Mesozoic complex. The land altitudes increase from — more or less — the station pole 190; this trend becomes very clear from the station pole 210. The K boundary shallows by approx. 25 m south-westwardly. The same direction is followed by the increase of land altitudes. Thus, the places where change of slope is taking place can be caused by the presence of a tectonic zone.

Figure 19 presents the example of results acquired on the profile 57-II-86 between the station poles 260 and 330. Recorded reflection boundaries, connected with the Cretaceous sediments, are characterized by a low dynamics of record, even gaps in their correlation can be observed. Waves reflected from deeper boundaries, mostly of Carboniferous and Cambrian age, were helpful in recognition of three faults, the first one between the station poles 260 and 270, the second — in the vicinity of station pole 290, and the third — at the station pole 326 (J. Brauer *et al.*, 1988). The possibility of extention of the first fault upward is fully real. However, a fragment of profile, restricted by the station poles 260–270, is

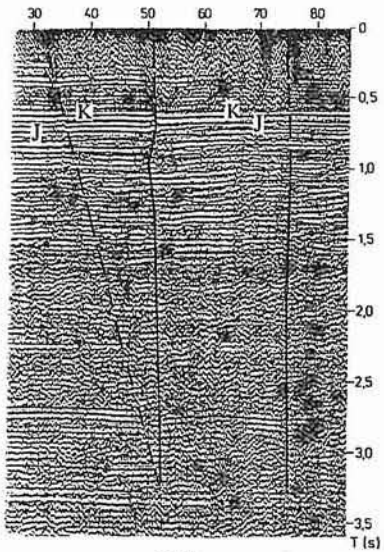

Fig. 15

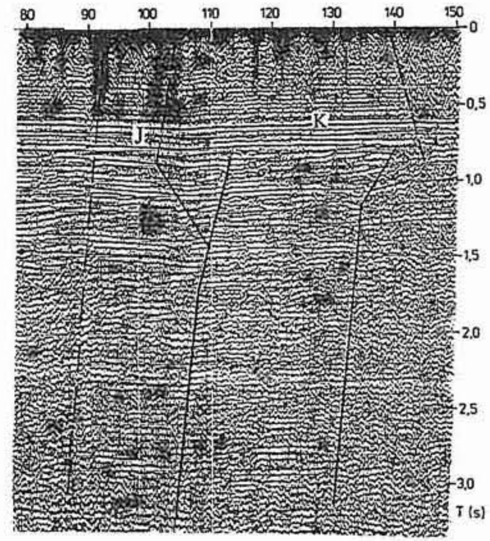

Fig. 16

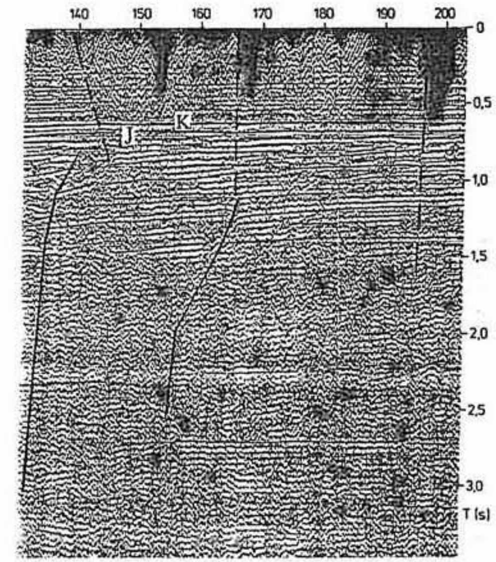

Fig. 17

Fig. 15. Depressions or changes in slope of land surface, associating the faults on the profile 59-II-86
Zagłębienia lub zmiany nachylenia powierzchni terenu towarzyszące uskokom na profilu 59-II-86

Fig. 16. Faults overlapping depressions in land surface on the profile 59-II-86
Uskoki pokrywające się z zagłębieniami terenu na profilu 59-II-86

Fig. 17. Segment of profile 59-II-86 with faults that reflect themselves as changes of altitudes of land surface
Wycinek profilu 59-II-86 z uskokami odzwierciedlającymi się w zmianach wysokości terenu

Figs. 15–17 — for explanations see Fig. 9
Fig. 15–17 — objaśnienia jak na fig. 9

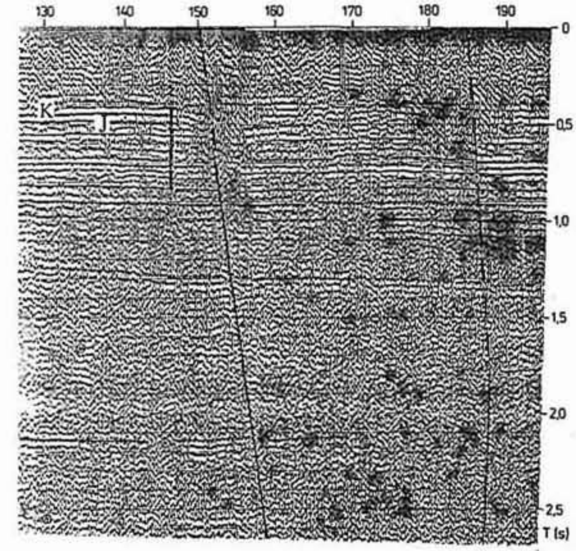

Fig. 18. Zones of tectonic disturbance on the profile 58-II-86, occurring on segments of diversified relief of land surface

For explanations see Fig. 9

Strefy zaburzeń tektonicznych na profilu 58-II-86 występujące na odcinkach o urozmaiconej morfologii terenu

Objaśnienia jak na fig. 9

characterized by higher altitudes of land surface; this is a sort of curiosity as the majority of faults under discussion is connected with depressions. The fault occurring in the area of station pole 290 is vertical (J. Brauer *et al.*, 1988). The wave image indicates that it can be extended to the Mesozoic complex and localized in the lowered morphology of land surface (Fig. 6).

The faults, that in principle disturb the Palaeozoic formations, and faults or tectonic zones of looseness — fissuring are illustrated in Figures 3, 5 and 6. Tectonic zone that can be delimited in the Cretaceous sediments also on the remaining profiles shown in Figure 1 most often overlaps the depressions in the land surface. However, not every one depression

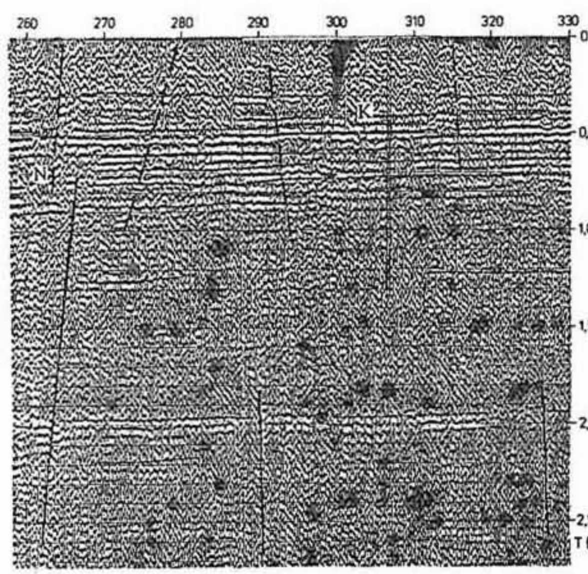

Fig. 19. Wave image on the profile 57-II-86, indicating influence of tectonics on morphology of land surface

For explanations see Figs. 9 and 10

Obraz falowy na profilu 57-II-86 wskazujący na wpływ tektoniki na morfologię terenu

Objaśnienia jak na fig. 9 i 10

is associated with the tectonic disturbances. If the seismic survey would be employed to recognize also the Cretaceous formation, then it would be possible to delimit the auxiliary tectonic zone, particularly in the vicinity of faults disturbing the Palaeozoic complex.

CONCLUSIONS

The results of reflection survey acquired in the southern part of the Lublin region indicate that tectonics has an important bearing on relief of land surface. Most often the zones of tectonic disturbances overlap the depressions in morphology. It is observed that in the disturbed zones the velocities are decreased (though not always) in formations underlain by the LVZ; mainly, this should be connected with the increase of fissures in the Cretaceous formation. An analysis of reasons of irregular sitting of shot points on the profiles surveyed with the use of explosives can be useful when delimiting the faults in the Cretaceous sediments.

The application of data of the reflection method is indispensable in the geomorphologic studies in the southern part of the Lublin region and in studies of relation of tectonics and lineaments.

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Tadeusz KRYNICKI

WPŁYW TEKTONIKI NA RZEŹBĘ TERENU POŁUDNIOWEJ LUBELSZCZYZNY

Streszczenie

Rozpatrzono zmiany charakteru zapisu fal sprężystych na profilach refleksyjnych. Przeanalizowano prędkości rozchodzenia się fal w utworach przypowierzchniowych występujących w przedziale od 180 do 350 m n.p.m. Prędkości nie wykazują zróżnicowania w zależności od wysokości pomiaru. W zagłębieniach powierzchni terenu dochodzących do 20 i więcej metrów niezależnie od wysokości ich usytuowania nad poziomem morza obserwuje się często zmniejszenie prędkości przebiegu fal w utworach przypowierzchniowych, połączone niekiedy z obniżeniem intensywności zapisu granic odbijających wiązanych z osadami kredowymi. Takie zmiany obrazu falowego występują przeważnie na odcinkach, na których wyznaczono uskoki w kompleksie paleozoicznym. Wskazuje to, że strefy zaburzeń tektonicznych można także wyznaczać w osadach kredowych. Strefy te w wielu przypadkach pokrywają się z zagłębieniami powierzchni terenu.