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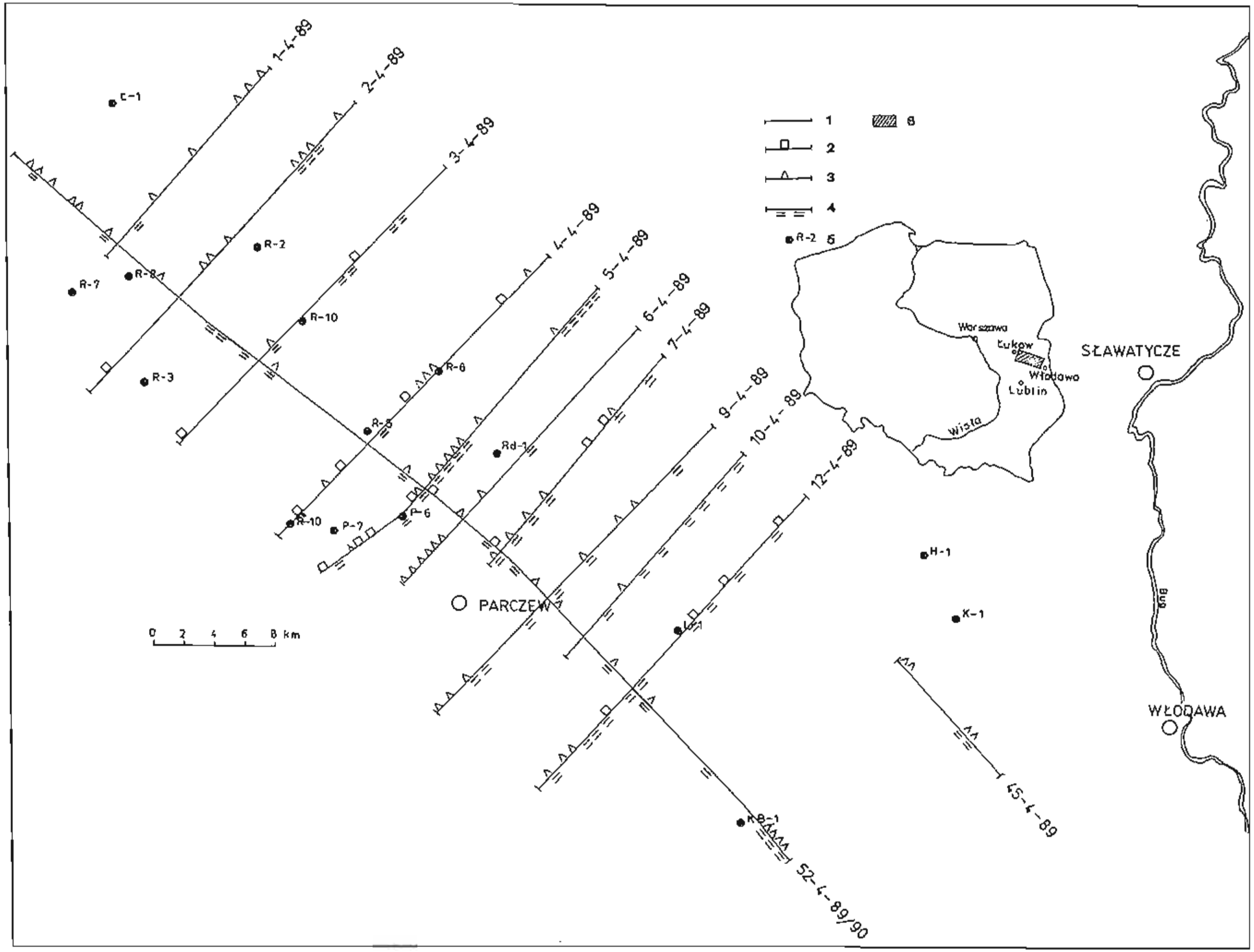
Faults in the Cretaceous and its base as displayed on seismic sections through the Lublin area (east Poland)

An analysis of wave images with respeet to surfaee conditions has been carried out with the aim of defining the possibility of identification of tectonic disturbance zones in the Cretaceous formation. It has been noticed that the surface conditions are very similar over the entire survey area. This fact practically eliminates their impact on results acquired. First of all, changes in seismic record can be influenced by subsurface factors, in particular by tectonics. Faults occurring in the Palaeozoic complex can, in most cases, be detected within the Cretaceous formation. The fault throws in the Cretaceous are not large, sometimes fissure zone can appear instead of faults. On the seismic sections such fissure zone often occur in places of depressions in the Cretaceous boundary, that are eonnected with breaks in correlation of waves reflected from the Jurassic and Palaeozoic formations.

INTRODUCTION

Determination of tectonic disturbance zones on seismic sections is an important phase of interpretation work. Criteria applicable to determination of faults are well known, but other questions cannot always be uniformly defined; this deals with the width of the fault zone, the dip of the fault plane, and most of all the depth interval. Determination of this last parameter, namely the depth interval, makes an important contribution to recognition of geological structure and can have an important bearing on exploration, not limited only to hydrocarbons. It seems reasonable to take under careful consideration the question of fault identification in the Cretaceous formation based on results of a reflection survey carried out in the area between Łuków and Włodawa, the results of which are contained in the final report of this survey (J. Brauer, W. Kulig, 1991).

The objective of the reflection survey was to determine tectonics of the Palaeozoic complex but not the Mesozoic. For this reason, the methodology of both the field and interpretation work was aimed at solving that particular geological task. This fact slightly


1-4-89
2-4-89
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12-4-89
45-4-89
52-4-89/90
1
2
3
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R-2
R-3
R-6
R-7
R-10
Rd-1
P-6
P-7
H-1
K-1
0 2 4 6 8 km
PARCZEW
SŁAWATYCZE
WŁODAWA
Bug
Warszawa
Łuków
Włodawa
Lublin
Wisła

impedes the analysis of tectonics in the Cretaceous formation. Nevertheless, a key Cretaceuos boundary does exist on the seismic sections; the boundary is connected with the bottom part of the Cretaceous (top of the Albian). On the sections there are also fragmentarily visible shallower boundaries within the Cretaceous. The possibility of identifying faults or fissure zone (being in fact zones with increased density of fractures in the Cretaceous formation) will be analysed in relation to the tectonics of the Palaeozoic complex and to the surface conditions that might affect the character of the recorded wave image.

SURFACE CONDITIONS

Knowledge of surface conditions facilitates the analysis of wave image on the seismic sections. This fact is of prime importance in the case of sections contained in the final report (J. Brauer, W. Kulig, 1991), the more so as the sources have been activated at the land surface. The more important parameters that characterize the surface conditions also include thickness of the Low Velocity Zone (LVZ). Thicknesses of the LVZ were defined based on special measurements taken at each 1.5 km (on average) along all seismic profiles. Routes of profiles are shown in Figure 1, whereas the results of LVZ measurements are presented on selected profiles shown in Figure 2. All values that are illustrated by particular diagrams were calculated for receivers only. Calculated values were connected to each other; in this way continuous diagrams were obtained for particular parameters. Values interpolated for areas between the receivers on the diagrams turned out to be close to actual ones and were used to define the static corrections required for the purpose of analysing the seismic sections.

A record on sections of reflecting boundaries indicates that input data as accepted for calculation of static corrections were sufficiently accurate. Undoubtedly, insignificance of the variation in the LVZ and in velocity of wave propagation in the zone facilitated the calculation of those static corrections.

This is confirmed by diagrams "a" and "b" in Figure 2. The LVZ thickness (diagram "a") varies insignificantly and most often is in the range of 2–6 m. The smallest thickness (of 2–4 m) can be found on section 12-4-89. On short segments of some sections such as 4-4-89 and 5-4-89/90 the thickness of the LVZ can reach 7–8 m while on section 45-4-89 it can be equal to 8–10 m at most.

P-wave velocities within the LVZ are shown on diagram "b" in Figure 2 and on the histogram of values recorded on all sections subject to analysis (Fig. 3). Based on that data a conclusion can be drawn that velocities are of similar range, and in general, they are low. Velocities in the range of 300–400 m/s make up about 70% of the section length; they appear

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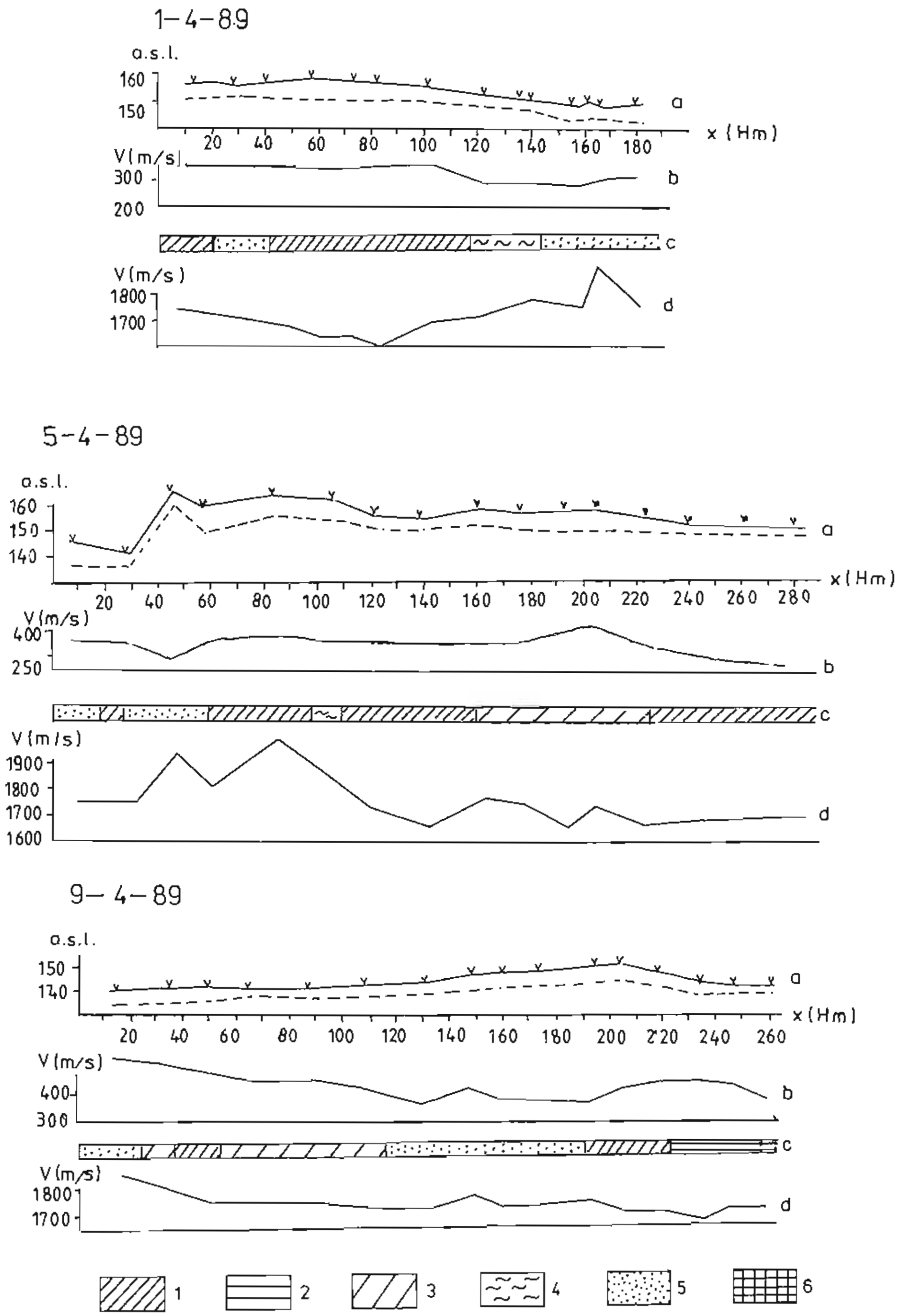
Fig. 1. Location of seismic sections selected for analysis, shot points and reasons for their omission

1 — seismic sections, 2 — buildings, 3 — forest, 4 — wet terrain, 5 — boreholes, 6 — investigated area

Lokalizacja profili sejsmicznych wybranych do analizy z zaznaczeniem miejsc i przyczyn opuszczenia punktów wzbudzania fal

1 — profile sejsmiczne, 2 — zabudowania, 3 — las, 4 — teren podmokły, 5 — otwory wiertnicze, 6 — obszar badań


1–4–89
a.s.l.
160
150
a
x (Hm)
20 40 60 80 100 120 140 160 180
V(m/s)
300
200
b
c
V(m/s)
1800
1700
d
5–4–89
a.s.l.
160
150
140
a
x (Hm)
20 40 60 80 100 120 140 160 180 200 220 240 260 280
V(m/s)
400
250
b
c
V(m/s)
1900
1800
1700
1600
d
9–4–89
a.s.l.
150
140
a
x (Hm)
20 40 60 80 100 120 140 160 180 200 220 240 260
V(m/s)
400
300
b
c
V(m/s)
1800
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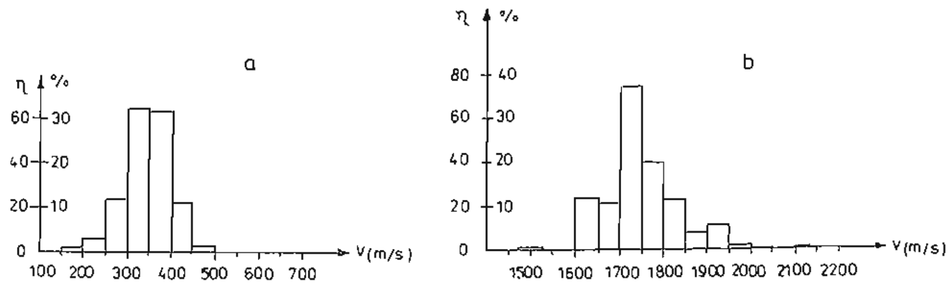

Fig. 3. Histograms of velocities for P-wave propagation: a — in the Low Velocity Zone (LVZ), b — in the LVZ base

Histogramy prędkości przebiegu fal podłużnych: a — w strefie małych prędkości (SMP), b — w podłożu strefy małych prędkości (SMP)

mainly in the western and central parts of the area, the eastern limit of which is delimited by section 9-4-89. Almost 19% of the section length is covered by velocities less than 300 m/s; they were recorded along almost all of section 12-4-89 and along large segments of sections 10-4-89 and 52-4-89. Velocities exceeding 400 m/s appear in small number; their appearance is mainly connected with the central and southern sectors of the survey area.

Lithology of surficial deposits and their elastic properties are closely related to velocities of wave propagation through the LVZ. The lithology of deposits for selected sections is shown in Figure 2, and a composite presentation of deposits having been met along the routes of all analysed sections is presented in Table 1. Information on lithology, with some simplification, is based on a map of surficial deposits compiled on the scale of 1:200 000. This information indicates that the seismic sections run across differentiated area. Sands and gravels dominate along sections running across the west sector of the survey area (sections: 1-4-89, 2-4-89, and 3-4-89), though glacial tills and muds also make an important contribution to the lithology. Peats and clays are missing in this area. In the central sector of the area there are glacial tills along profiles 4-4-89, 5-4-89, 6-4-89, and 7-4-89 whereas sands and gravels are limited here. Clays become important in the east sector of the area in the profiles designated 9-4-89, 10-4-89, and 12-4-89. If surface sources are to be used here then it seems advantageous to locate the profiles on cohesive soils. Glacial tills and clays

Fig. 2. Setting-up of parameters characterizing the surface conditions for selected profiles

a — thickness of the Low Velocity Zone (LVZ); floor of the LVZ marked with a dashed line; b — velocity of P-wave propagation in the LVZ; c — surficial deposits along the profiles; d — velocity of P-wave propagation in the base of the LVZ; 1 — glacial till, 2 — clays, 3 — alluvium of glacial tills and other deposits, 4 — silts and muds, 5 — sands and gravels, 6 — peats

Zestawienie parametrów charakteryzujących warunki powierzchniowe wybranych profili

a — miąższość strefy małych prędkości (SMP); spąg SMP — linia przerywana; b —prędkość rozchodzenia się fal podłużnych w SMP; c — utwory powierzchniowe występujące na trasach przebiegu profili; d — prędkość rozchodzenia się fal podłużnych w podłożu SMP; 1 — glina zwałowa, 2 — iły, 3 — aluwia glin zwałowych i innych osadów, 4 — mułki, namuły i mady, 5 — piaski i żwiry, 6 — torfy

Table 1

Participation of particular soils (by percent) in surface deposits along the routes of seismic sections

Profile	Glacial till	Sand, gravel	Alluvium	Peat	Clay	Silt, mud
1-4-89	50	32	–	–	–	18
2-4-89	16	56	8	–	–	20
3-4-89	34	48	–	–	–	18
4-4-89	71	17	–	2	–	10
5-4-89	58	16	21	–	–	5
6-4-89	45	9	9	14	16	7
7-4-89	65	–	–	11	12	12
9-4-89	20	39	25	4	12	–
10-4-89	9	–	29	14	48	–
12-4-89	12	21	–	13	54	–
45-4-90	–	–	90	–	10	–
52-4-89/90	36	31	26	–	7	–

are such in the area under discussion. It is obvious then that the surficial deposits may affect the intensity of recorded waves and to some extent their image.

Velocities in sands and gravels as well as in glacial tills within the LVZ interval are of similar values. Thus, the conditions of wave generation in sections running through the area covered with the aforementioned deposits should also be similar. Accordingly, a conclusion can be drawn that the thickness of the LVZ has a decisive influence on intensity of the recorded image. However, it seems reasonable to suggest that more comprehensive analysis of parameters under consideration be performed in order to better justify that conclusion. Such an analysis should deal with more differentiated parameters since in the survey area both the LVZ and velocities characteristic for this zone are subject to insignificant variations.

If the thickness of the LVZ in the survey area and the velocities of wave propagation within the LVZ are differentiated in an insignificant way and both factors affect the quality of acquired results including those illustrating the structure of the Cretaceous formation, then it is reasonable to take into consideration the velocities of wave propagation below that zone. The velocities are illustrated by Figure 2 (diagram "d") and a histogram which is a composite of values for all sections under consideration (Fig. 3b). The lowest velocities, 1500 m/s, were recorded along two segments of profile 12-4-89, whereas the maximum velocities, exceeding 2000 m/s, were recorded along profile 45-4-89. However, the range between 1700 and 1800 m/s is the most common. Segments of profiles having the same velocity ranges are relatively short. This fact suggests frequent changes in elastic parameters of formation underlying the LVZ in the horizontal profile. It is difficult to determine interrelations between the wave velocity in the LVZ and in the underlying formation. It is possible to observe, in places with the lowest velocities in the LVZ, the maximum values in the underlying formation. An inverse situation is also likely to occur although a direct relation due to rather low thickness in the LVZ could be expected. In general, ranges of changes in velocity in the LVZ and in the underlying formation are close to each other. For example, over 90% of the velocities in the LVZ are of the range of 250–450 m/s whereas approximately 90% of the velocities in the underlying formation are contained in the range from 1600 to 1850 m/s.

Differences in land surface elevations are insignificant, and dominant are elevations from 150 to 165 m a.s.l. Elevations over 165 m a.s.l. can be found on profile 45-4-89 and in the southeastern segment of profile 52-4-89/90. The lowest elevations, not exceeding 150 m a.s.l., occur in the area where segments of profiles designated 1-4-89 and 2-4-89 were delimited and in the zone of intersection between profiles 3-4-89 and 52-4-89/90.

A factor called multiplicity of profiling is an important parameter with an important effect on quality of acquired results (J. Brauer, W. Kulig, 1991). It is difficult to determine segments of sections with decreased multiplicity of profiling since a substitute spacing was applied where difficulties appeared in locating the shot points. Therefore, some segments were distinguished in Figure 1 to show that it was not possible to locate the shot points there; some reasons for these incidents are also given. From the description of selected parameters that characterize the surface conditions, a conclusion emerges that they are relatively stable over the entire survey area. It is quite certain that stable conditions facilitate analysing of wave image on seismic sections; the point to note is that this also offers the possibility of recognizing zones of tectonic disturbance in the Cretaceous formation.

FAULTS DISTURBING THE PALAEOZOIC COMPLEX

It seems reasonable to assess the possibility of recognizing zones of tectonic disturbance in the Cretaceous formation with reference to the tectonic image of the Palaeozoic contained in the final report (J. Brauer, W. Kulig, 1991).

Information was included in the report that some disturbances appearing on the routes of boundaries, such as breaks in correlation, phase shift, sudden changes in record, distortion in boundaries, wave interference, etc., were employed to recognize faults in the Palaeozoic complex and only some faults in the lowest sequence of the Cretaceous. No doubt, the factors cited are the main criteria to be applied for recognizing zones of tectonic disturbances. There are some places on the seismic sections where changes of wave image are clearly visible; these places have been marked with a character N due to the uncertainty whether the changes were distinct enough to be the basis for identification of faults. The location of faults identified on the sections and disturbing mainly the Palaeozoic complex and to some extent the Cretaceous boundary are shown in Figure 4. In this figure there are also shown those faults that were plotted on the geological map scaled 1:200 000 contained in the rep ort of this seismic survey (J. Brauer *et al.*, 1988). The faults disturbing the Cretacaous boundary were principle plotted on section 52-4-89/90; they will be discussed in further sections of this paper.

To recognize faults occurring in the Palaeozoic complex is, in most cases, an easy task. However, determination of their depth intervals and, above all, their course lines was significantly more difficult. Therefore, directions of faults' courses could be determined for some faults on short stretchs only; the Hanna Fault in the southeastern sector of the survey area is an exceptional case.

As can be concluded from Figure 4, frequency of fault occurrence on the sections is uniform over the entire survey area, independent of fault orientations. Lesser frequency can

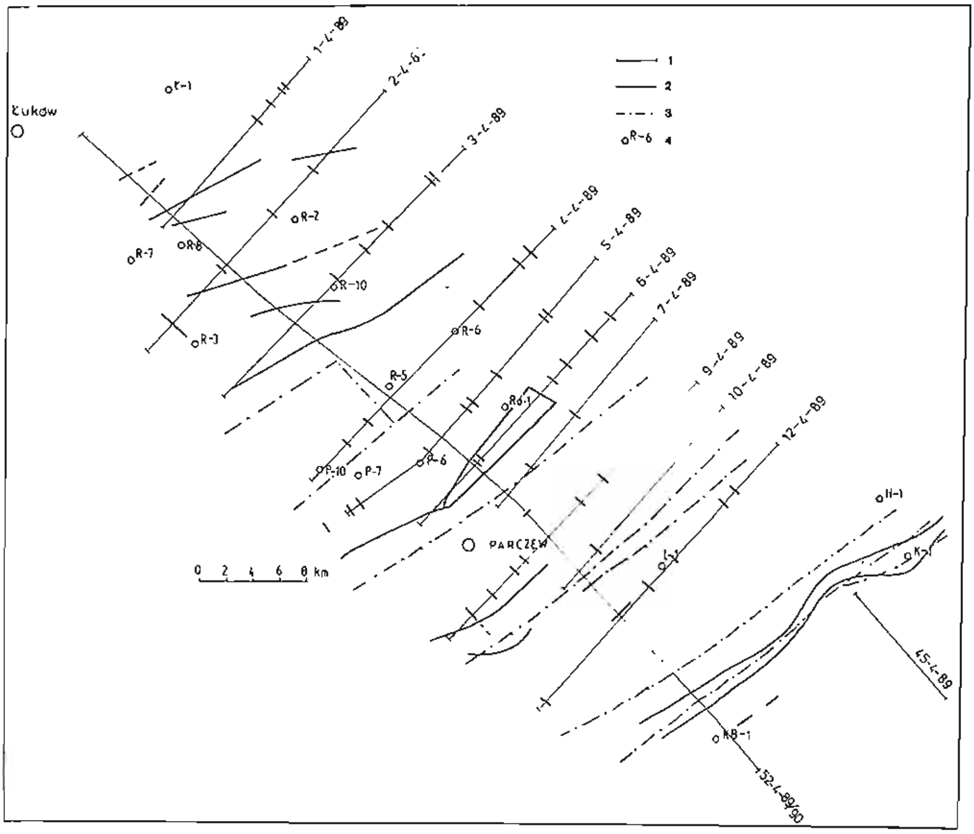

Fig. 4. Seismic sections with faults in the Palaeozoic complex

1 — seismic profiles; faults determined by: 2 — J. Brauer, W. Kulig (1991), 3 — J. Porzycki (1984); 4 — boreholes

Profile sejsmiczne z uskokami w utworach paleozoicznych

1 — profile sejsmiczne; uskoki według: 2 — J. Brauer, W. Kuliga (1991), 3 — J. Porzyckiego (1984); 4 — otwory wiertnicze

be observed on sections 7-4-89, 10-4-89, and on the northeastern segment of section 9-4-89 only.

The faults that disturb both the Palaeozoic complex and the Cretaceous boundary can be identified on more than one section; it is also possible to identify their directions of strike. In addition, they have been considered as the boundaries of particular blocks distinguished due to different Palaeozoic stratigraphy. This is in agreement with the drilling data (J. Brauer, W. Kulig, 1991). The Łuków Block is given here as the example; the Permian occurs in this block and the crystalline basement is elevated to its maximum here. The dislocation zone, composed of two faults I and II on the section 52-4-89/90 (Fig. 5), makes up the southern boundary of the block.

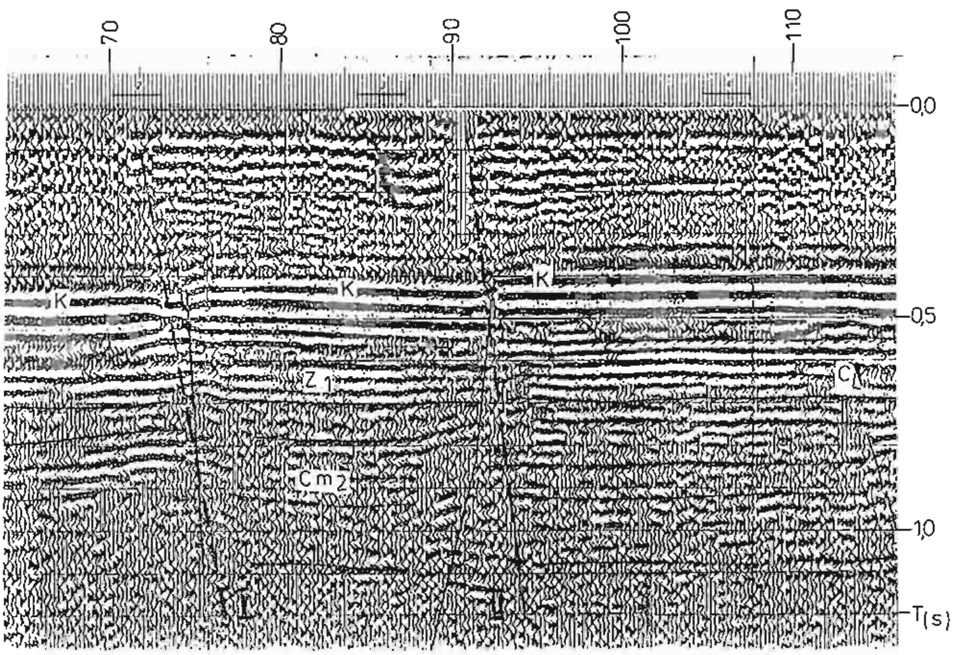

Fig. 5. Example record of fault II being the limit of the extent of the Permian formation

Solid lines — faults determined by J. Brauer, W. Kulig (1991); dashed lines — faults determined by the author of this paper; K, J, Z_1, C_H, C_L, Cm_2 — seismic boundaries; N — zone of discontinuity in wave correlation

Przykład zapisu uskoku II będącego granicą zasięgu utworów permskich

Linie ciągłe — uskoki według J. Brauer, W. Kuliga (1991); linie przerywane — uskoki według autora; K, J, Z_1, C_H, C_L, Cm_2 — granice sejsmiczne; N — strefa nieciągłości korelacji fal

Deep boreholes R–8, R–2, R–10, R–7, and R–3 have been located within the Radzyń Block. This block is characteristic because of the occurrence of a wedge-out zone in the Silurian formation. In the area of the Parczew Depression other wells have been drilled, including those designated R–5, R–6, R–10, P–6, and Rd–1. Drilling data provides information that the Silurian and Cambrian are of increased thickness in this area.

Missing Middle Cambrian formation in the central and eastern sectors is the characteristic feature of the Przewłoka – Lubiczyn Block. The Hanna Fault makes up the southwestern limit of this block, and it separates this tectonic unit from the Włodawa Depression where a complete sequence of Lower Palaeozoic rock has been penetrated in the borehole KB–1.

However, uniform determination of faults' directions may be difficult. For example, the faults which mark the limit for the occurrence of the Permian formation, namely fault III on section 52-4-89/90 (Fig. 5) and that on section 1-4-89 (Fig. 7), should be of NW–SE orientation, but this expectation is in discord with information contained in the final report (J. Brauer, W. Kulig, 1991).

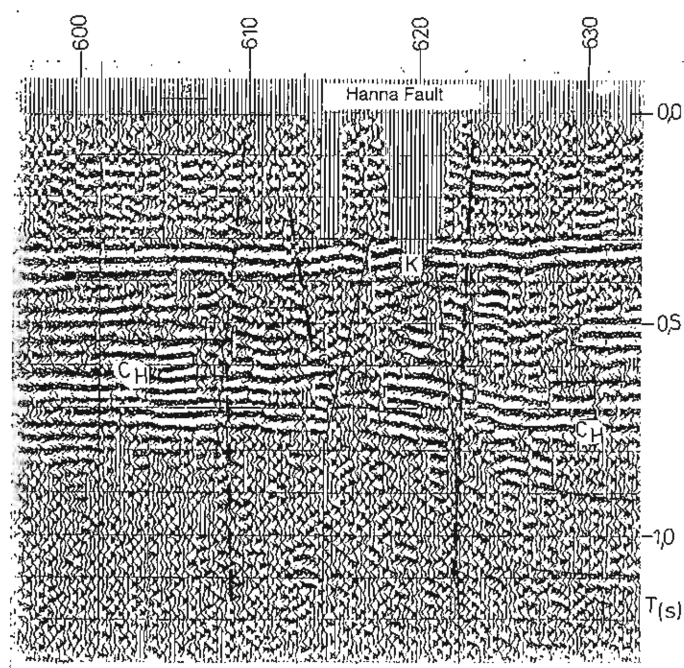

Fig. 6. Fragment of section showing the Hanna Fault
For explanations see Fig. 5
Fragment przekroju obrazujący uskok Hanny
Objaśnienia jak na fig. 5

ZONES OF TECTONIC DISTURBANCES IN THE CRETACEOUS

The term "zone of tectonic disturbance" is offered here to stand for both the fault zones with displacement along the fault planes and simply fissured zones of the massif. The latter can also be observed in the case of occurrence of faults with insignificant throws that are difficult to identify at the frequencies used during recording and processing. It is worth remembering that the frequency band has been selected with the aim of determining the seismic boundaries in the Palaeozoic.

It is not difficult to recognize faults disturbing the seismic Cretaceous boundary when their amplitudes are scores of metres; furthermore, the same criteria can be applied as those employed for tracing the faults in the Palaeozoic complex. This is proved in Figure 5, which clearly shows two faults disturbing the Cretaceous boundary as well as the Palaeozoic complex. However, determination of depth intervals for the zones of tectonic disturbance in the Cretaceous is more difficult. If faults I and II, disturbing both the Palaeozoic and Cretaceous boundary, were extended toward the surface in the same direction as that shown on the sections contained in the final report (the solid lines), then they should be expected to run through those segments of sections where no breaks are observed in correlation of waves reflected from the shallow Cretaceous boundaries. This suggests that the upper

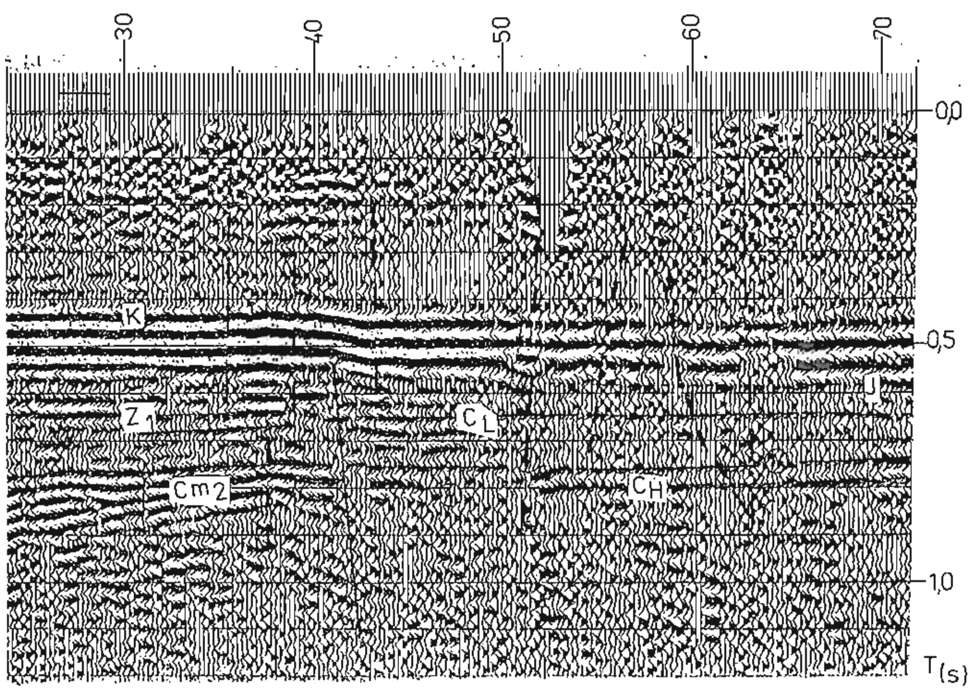

Fig. 7. The wave image for a segment of profile 1-4-89 with complex tectonics
For explanations see Fig. 5
Obraz falowy uzyskany na odcinku profilu 1-4-89 o złożonej tektonice
Objaśnienia jak na fig. 5

sequence of the Cretaceous formation above the Cretaceous boundary has not been disturbed by faults I and II.

However, if the directions of faults I and II were slightly changed until their course were consistent with the dashed lines (Fig. 5), then the said faults could be situated within the interval of the Cretaceous formation, in places where breaks are observed in the wave correlation. This leads to the conclusion that breaks in correlation result from the occurrence of zones of tectonic disturbances in the upper sequence of the Cretaceous formation. This fault zone interpretation seems to be likely.

Figure 6 is given here as an example of the wave image which provides a basis for determination of the Hanna Fault. The fault disturbs the Palaeozoic, Jurassic, and Cretaceous boundary as well. Missing record in the closest vicinity of station pole 620 due to the omission of a few shot points makes it difficult to recognize this fault in the Cretaceous formation. Thus, a question arises whether there are any circumstances offering a basis for extending the depth interval of that fault to the Cretaceous? Considering a decreasing fault amplitude, equal to approximately 100 m for the Carboniferous base and 40 m for the Jurassic formation, it is reasonable to adopt an idea that if this fault disturbs the upper sequence of the Cretaceous then its throw would be equal to that in the Jurassic or less. This is a small amount of throw and therefore it should not significantly affect the character of the seismic record. Fragments of Cretaceous boundaries within the time interval of 0.1–0.2 s in the Hanna Fault sector do not indicate the occurrence of large throws. However, circumstances exist making it possible to determine additional faults (dashed lines) that can be considered as associated with the Hanna Fault, and to some extent as the limit of this fault's zone. Such an interpretation of the Hanna Fault confirms the idea that the tectonic disturbance does exist within the entire thickness range of the Cretaceous.

Figure 7 has been presented here to show both fragments of profile 1-4-89 with a fault in the Palaeozoic complex (station pole 40, solid line) and the flexure bend in the Mesozoic complex. It is noteworthy that this fault makes up a boundary of the Permian formation (the boundary Z_1); beneath the Permian the fault plane is a contact zone for the Cambrian and the Carboniferous. This is evidence of the importance of this fault.

The eventual influence of this fault on the tectonics of the Cretaceous formation must be considered. The Cretaceous boundary within this segment of the seismic section is defined by four phases in the southwestern part of this fault and by only three phases in its northeastern part. Besides, the third phase (counting downward from above the fault) exhibits only a small shift in the record time within the Palaeozoic. The remaining two shallower phases are characterized by a flexure bend. However, more detailed image analysis allows observation of an unimportant phase shift of the wave identified with the Cretaceous boundary. Places with such shifts have been shown on the flexure using the dashed lines. An overlapping of diffraction waves or a small fault zone width can be the reason why breaks are missing in correlation of Cretaceous boundary on the flexure. After all, the principal fault zone within the Palaeozoic interval is narrow. On the other hand, extention of dashed lines that limit the flexure toward lesser depths locate them in the zones of breaks in correlation of boundaries within time interval of 0.1–0.3 s. The said breaks may result from faults with small throws or simply from fissure zones.

The change in the image is also visible outside the flexure under consideration, in the right-hand segment of the section (Fig. 7, station poles 50–60). A small vertical shift of the Cretaceous boundary can also be seen, along with reduction in its dynamics, in places marked with the dashed lines. The Jurassic boundary is difficult to identify within the segment of section between station poles 32 and 64. In the segment between station poles 50 and 70 of the same section there is a lack of waves reflected from the Cretaceous formation above the Cretaceous boundary. The change in the seismic record on the discussed segment of section has primarily been influenced by subsurface factors, although the thickness of the LVZ is slightly increased here. The tectonic factor seems to be fundamental in controlling the character of the image acquired.

Interesting are the changes in the character of the seismic record near station pole 320 in the segment of section limited by the dashed lines (Fig. 8). The changes are manifested by total disappearance of waves reflected from the Cretaceous formation within the time interval from 0.07 to 0.35 s. The first two phases making up the Cretaceous boundary are continuous, but the third phase shows a break in correlation and a change in frequency. The Jurassic boundary is missing in this zone. The change in image can also be noticed within the Palaeozoic interval.

The width of the zone with the change of record is subject to decrease with depth; it is equal to approximately 1300 m in the case of the most shallow Cretaceous boundaries

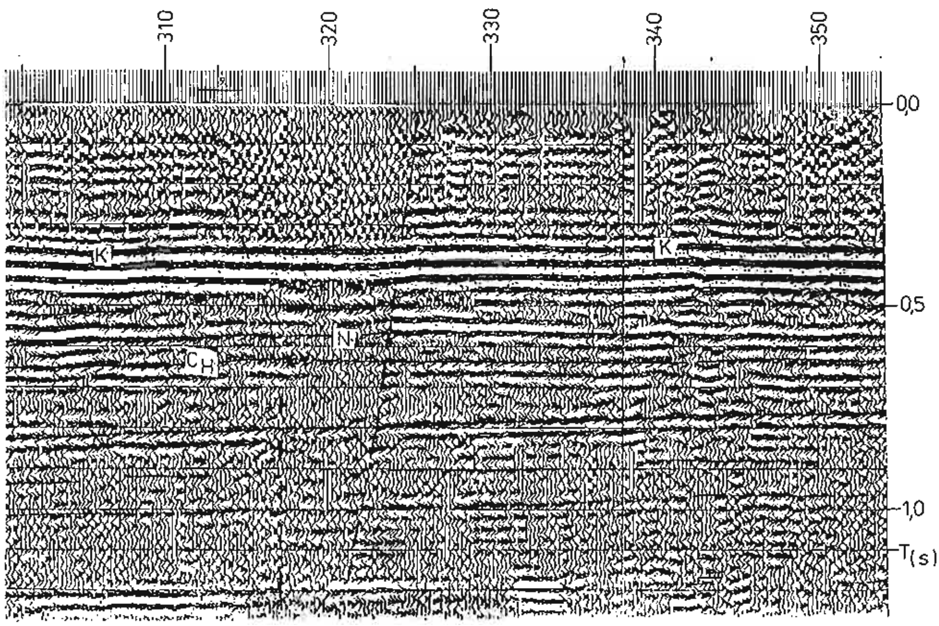

Fig. 8. Changes in the wave image indicating the occurrence of zone of tectonic disturbance
For explanations see Fig. 5
Zmiany obrazu falowego wskazujące na występowanie strefy zaburzonej tektonicznie
Objaśnienia jak na fig. 5

whereas approximately 300 m in the deepest Palaeozoic complex. The change in width of the zone indicates that this zone is under the influence of subsurface factors, not surface ones. This is because velocities within the LVZ and its base do not deviate much from those outside the dashed lines. Also, the lithology of the Quaternary formation is similar over a longer segment than that with the change in the record. If the subsurface factors are of decisive character then the question arises what factors? It seems obvious that the change in the character of the record is caused, first of all, by the presence of a disturbance zone. Vertical shift of boundaries is small, thus the 1st and 2nd phases of waves connected with the Cretaceous boundary can be of continuous character at the employed frequency band, and the change in the dip of the Cretaceous boundary can be interpreted as a fissure zone. The increase of thickness of the Cretaceous formation within the zone can indicate a local erosional washout existing in the Jurassic formation which subsequently has been filled in with Cretaceous deposits.

A small depression of the Cretaceous boundary and associated change in the character of the seismic record within the zone appointed with the dashed lines have been presented in Figure 9. Reflections shallower than the Cretaceous boundary are missing here. The deep waves have fewer phases and decreased record dynamics. The zone becomes wider upward from 1 km at 0.5 s to approximately 1.2 km at 0.1 s.

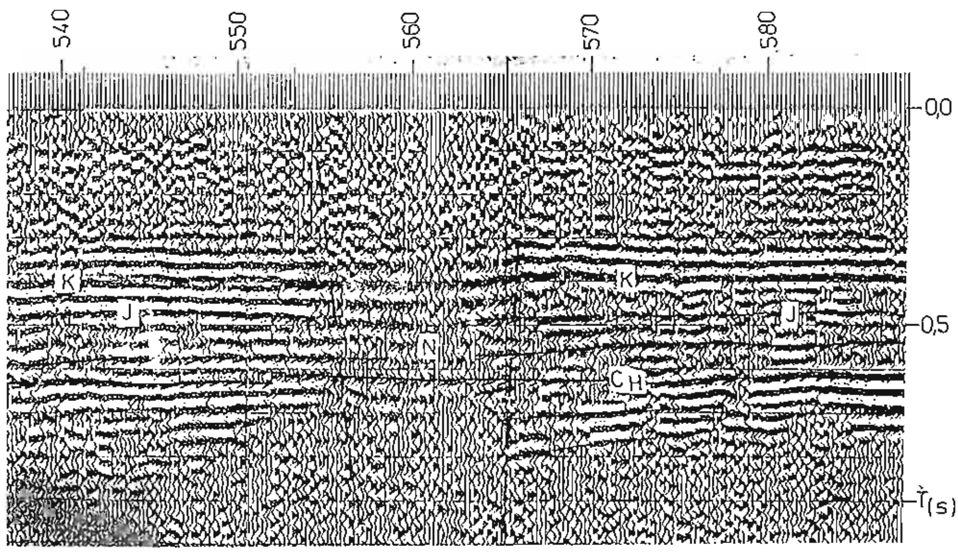

Fig. 9. Segment of section; the change in seismic record due to subsurface factors is clearly visible
For explanations see Fig. 5
Odcinek przekroju o wyraźnej zmianie zapisu sejsmicznego spowodowanej czynnikami wgłębnymi
Objaśnienia jak na fig. 5

Some shot points have been omitted in the zone under consideration due to wet terrain and the occurrence of peats at the land surface. For such reasons conditions were disadvantageous for wave generation. Accordingly, it is further concluded that these two factors important for wave generation would have changed the character of the record within the zone. Then it would be assumed that the image on both sides of the zone would be similar. Contrary to expectation it is not. On the left side of the zone the wave phase considered to be of primary importance for delimitation of Cretaceous boundary occurs at 0.4 s between station poles 453 and 552; in addition, it is disturbed by interference. The two earlier phases are more dynamic. The two phases are very intensive between 0.4 and 0.5 s. The second phase is considered to be the Jurassic boundary. Generally speaking, a set of waves occurs in the time interval of 0.3–0.7 s on the section, on its left-hand side from the change in record. A very shallow boundary in the time interval of 0.10–0.17 s can be observed on the right side. The wave connected with the Cretaceous boundary is very sharp. No reflecting boundaries can be determined in the time interval of 0.4–0.5 s. The waves reflected from the Palaeozoic complex are very clear in this segment of the section, although some breaks in correlation and a vertical shift in phases suggests the occurrence of faults to be likely. Thus, the images on both sides of the zone under discussion are different and circumstances exist that justify considering the zone with the change in record between dashed lines (Fig. 9) as a zone that originated as the result of tectonic disturbances in which the Cretaceous formation was also been involved.

The change of image, similar to that discussed for the two segments are also visible on other sections.This may indicate that more faults occur than was suggested in the report (J. Brauer, W. Kulig, 1991). In addition, an idea can be expressed that the majority of faults defined in the Palaeozoic also disturb the Cretaceous formation.

The throws of faults in the Cretaceous formation are small and difficult to determine at the range of frequency used for this survey. Sometimes the zones of tectonic disturbance consisting of fissure zones mass can simply take place of faults.

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Tadeusz KRYNICKI

USKOKI W KREDZIE I JEJ PODŁOŻU NA PRZEKROJACH SEJSMICZNYCH NA LUBELSZCZYŹNIE

Streszczenie

W celu określenia możliwości rozpoznania stref zaburzeń tektonicznych w utworach kredowych, dokonano analizy obrazu falowego w nawiązaniu do warunków powierzchniowych. Stwierdzono, że warunki powierzchniowe są bardzo zbliżone na całym obszarze, co praktycznie ogranicza ich wpływ na uzyskiwane wyniki.

Na zmiany zapisu sejsmicznego rzutują przede wszystkim czynniki wgłębne, a szczególnie tektonika. Uskoki występujące w kompleksie paleozoicznym mogą być w większości przypadków rozpoznawane w utworach kredowych. Zrzuty uskoków w kredzie są niewielkie, a niekiedy mogą to być strefy rozluźnienia masywu skalnego. Te ostatnie występują często na przekrojach w miejscach zagłębień granicy kredy, połączonych z przerwami korelacji fal odbitych od utworów jurajskich i paleozoicznych.