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Vertical discontinuities in the Earth's crust of the TESZ in Poland — gravity data

Axes of horizontal gradient anomalies of the gravity field in Polish segment of the TESZ have been calculated and related to the geological structures (faults, fault zones) in the crust. The most important gradient zones in the TESZ area are longitudinal N1–N4 and N6 discontinuities, and transversal N9–N11 and N13 discontinuities. The formers define the boundaries of the TESZ while the latters emphasize its transversal segmentation. Longitudinal discontinuities in northwestern Poland are in fairly good accordance with crustal fractures recorded by the DSS data. In central and southeastern part of the country they do not conform in many places. The fundamental difference in the pattern of crustal blocks on both sides of the N13 discontinuity is significant.

INTRODUCTION

EUROPROBE — international scientific cooperation program aimed at the studies of geological evolution of Europe contains, as one of its major tasks, the investigations of the Trans-European Suture Zone (TESZ).

The deep Earth's crust investigation in Poland have been carried out mainly with use of deep seismic soundings (DSS), whereas the deep seismic reflection survey has been performed on a small scale only. DSS research initiated and carried on intensively by A. Guterch and his team (A. Guterch *et al.*, 1983, 1984, 1986, 1994), complemented by geological interpretation of seismic results, has reached such a stage, that elaboration of substantial program for further geophysical and geological investigation became indispensable. Prepared program, supported by the Ministry of Environmental Protection, Natural Resources and Forestry, has been recognized as the Ministry recommendation in the deep geophysical and geological investigation domain (A. Guterch *et al.*, 1995).

The potential field methods have been used only as a complementary investigation. Results of such studies were a source of independent information on a small scale only,

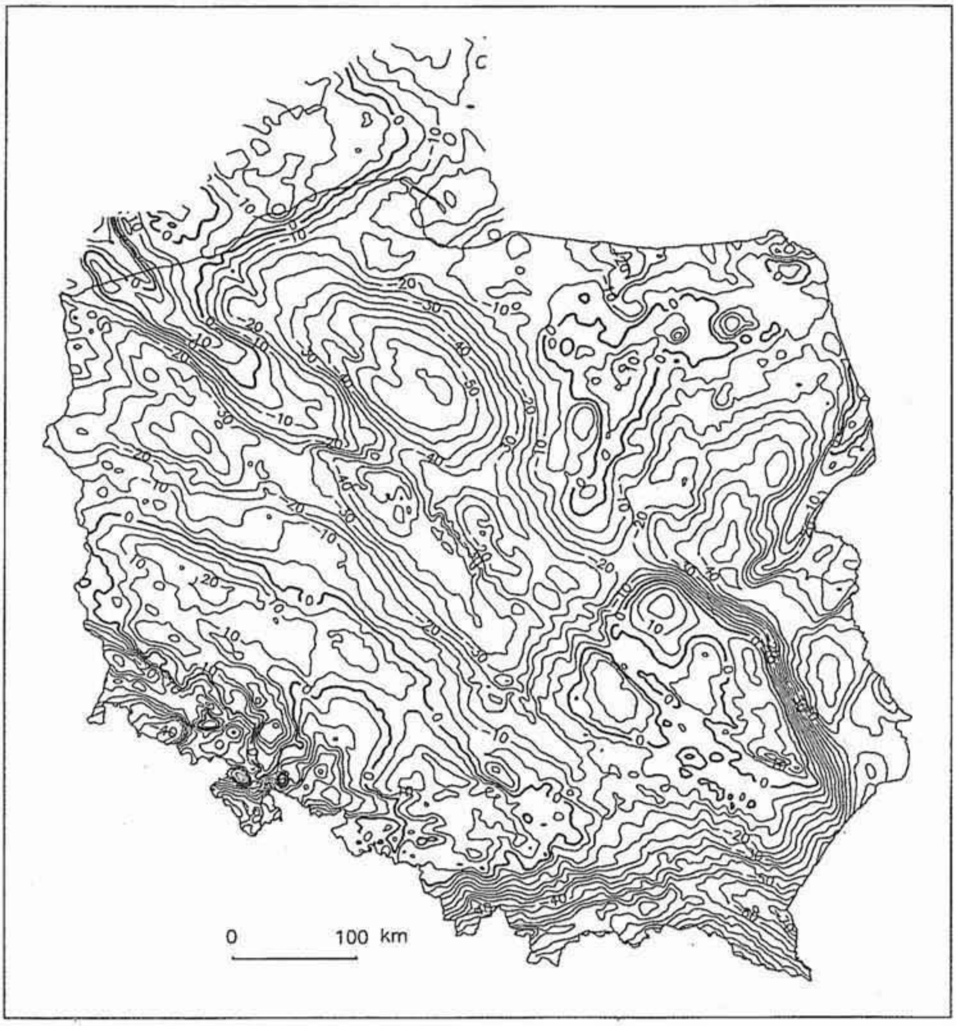

Fig. 1. Bouguer anomalies in Poland; isolines every 5 mGal
Anomalie Bouguera; izolinie co 5 mGal

used to limiting the ambiguities of the constructed seismo-structural models, and tectonic interpretation as well. The possibilities of comprehensive interpretation of all the geophysical data exist now in Polish Geological Institute which has at its disposal the following scientific tools:

— gravity data base,
— magnetic data base ready during the next year,
— advanced software for data processing and interpretation,

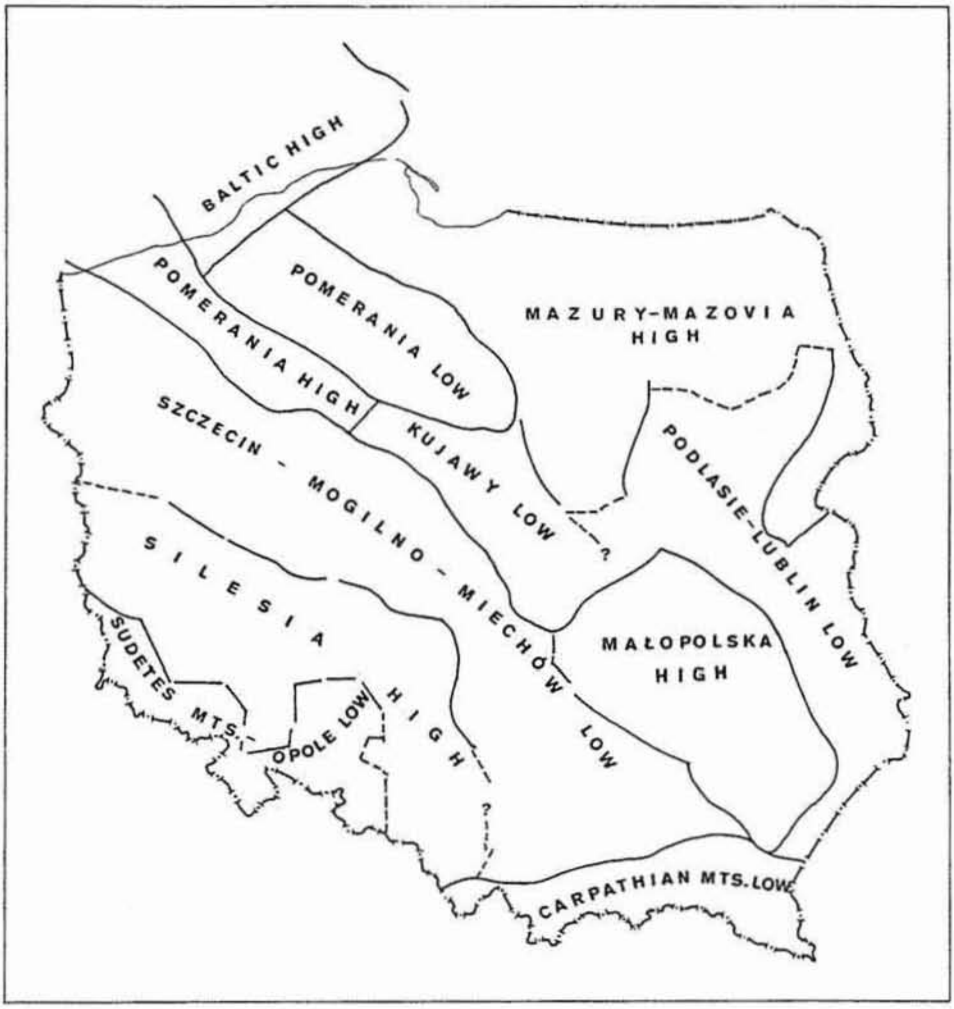

Fig. 1a. Subdivision into gravimetric units
Podział na jednostki grawimetryczne

— synthetic and regional scientific geological reports,

— experienced geophysical and geological staff.

As an example of extensive information contained in the gravity data but not fully utilized so far the authors present the pattern of major discontinuities in the Earth's crust acquired from the analysis of gravity anomalies.

DETERMINATION OF THE GRAVITY DISCONTINUITIES IN THE EARTH'S CRUST

A concept of the gravity discontinuity may be explained as a linear zone defined by quick changes of the gravity field caused by horizontal variation of the rock densities. In the Bouguer anomaly map (Fig. 1) such features have been presented as the zones with considerable density of isolines. A quantitative representation of such condensation is the horizontal gradient value. It results from the definition that, if the gravity field increases, the horizontal gradient is positive, and if the gravity field decreases it is negative. Therefore we are able to speak about both the positive and negative anomalies of the horizontal gradient. In case of horizontal gradient anomaly with elongated shape, the anomaly axis can be distinguished. It is defined as a line connecting points with extreme gradient values on the sections perpendicular to anomaly trend. A modulus of the horizontal gradient is used to the location of the axes. In such a case, all considered anomalies are not negative, and the axes of horizontal gradient run along the local maxima of positive anomalies. An algorithm of the search for location of the horizontal gradient maxima has been described by R. J. Blakely, R. W. Simpson (1986).

Gradient maxima occur directly over near-vertical contacts that separate rocks of contrasting densities (L. Cordell, 1979). In case of inclined contacts the maximum gradient axis will be shifted from the top edge of the contact towards the direction of dip. The value of this shift depends upon the dip angle of the boundary and the depth to the top edge of the boundary below the observation level (V. J. S. Grauch, L. Cordell, 1987). Displacement of the gradient axes may also occur if the gravity data sampling is insufficient to define an anomaly or due to interference from neighbouring anomalies (V. J. S. Grauch, L. Cordell, 1987).

The horizontal gradient axes defined in this way can be related to tectonic structures (faults, flexures, folds) or to lithological variations. It is impossible to recognize the character of the structures, basing on the maximum horizontal gradient method only. Therefore we will use the discontinuity term in the gravity sense.

The axes of the horizontal gradient anomalies in the TESZ area and its adjacent regions were calculated using the gravity data base and the US Geological Survey software package (L. Cordell *et al.*, 1992). Because our studies were focussed on the determination of the deep rooted regional discontinuities, regional gravity anomalies have been used. Long wavelength regional anomalies have been separated from the Bouguer anomaly map using the upward continuation method (W. M. Telford *et al.*, 1990) which is the transformation of potential field data measured on a surface to a higher surface; this operation is effectively smoothing the anomalies and therefore is sometimes used to obtain the regional potential field anomalies. The Bouguer anomalies were extended to a level 24 km above sea level by the method of digital filtering (S. Wybraniec, Z. Petecki, 1995). Figure 2 shows the gravity field continued upward to 24 km and the locations of the maxima of the horizontal gradient (crosses). The size of crosses is proportional to the magnitude of the gradient.

The discontinuities related to them should be located in the lower crust, including the Moho zone. Figure 3 presents the location sketch of the discontinuities (continuous lines) on the background of the DSS results. The dashed lines define the axes of the horizontal gradient anomalies based on the original Bouguer anomalies (not continued upwards).

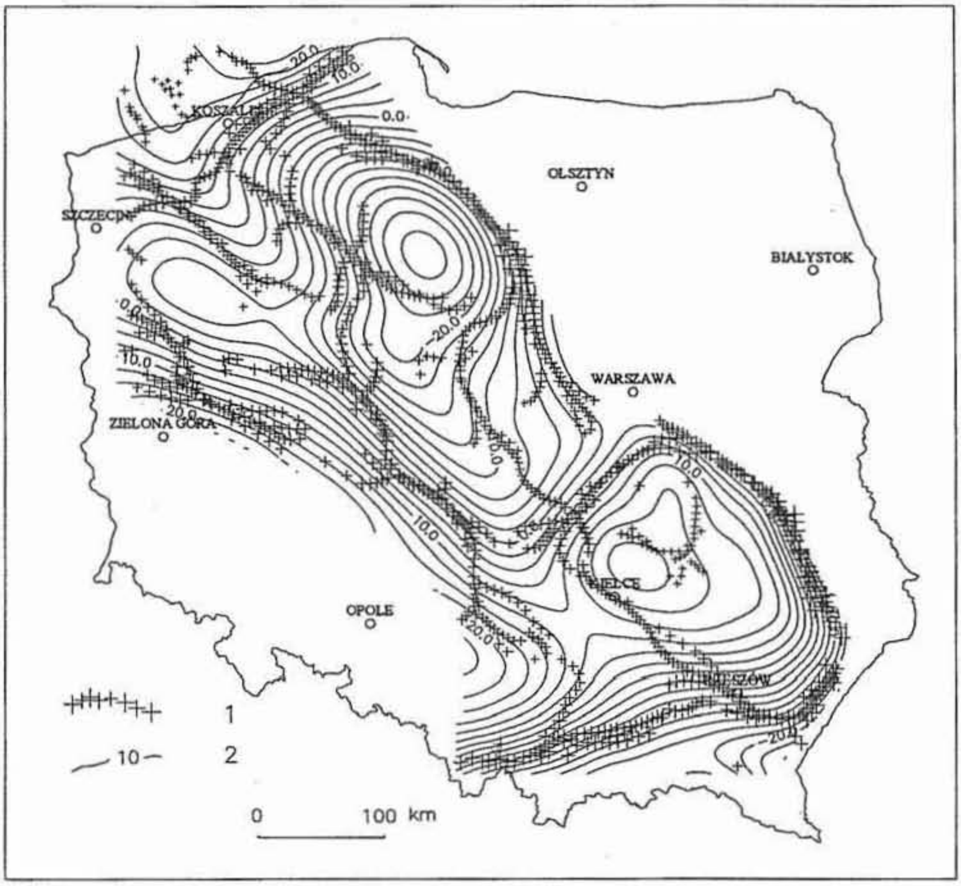

Fig. 2. Axes of horizontal gradient againts the background of Bouguer anomalies

1 — gradient axes (maxima of the horizontal gradient modulus), 2 — isolines of Bouguer anomalies [mGal] continued upward to 24 km

Osie gradientu poziomego na tle anomalii Bouguera

1 — osie (maksima) modułu gradientu poziomego, 2 — izolinie anomalii Bouguera [mGal] przedłużone w górę do 24 km

Because of inevitable influence of the shallow disturbances, the latter results indicate rather discontinuities existing in the upper crust. Inclined discontinuities exist probably wherever the continuous lines on the map run parallel and near to the dashed lines. It is, however, only an approximate information which cannot be used to the evaluation of the discontinuity inclination. Special software package is necessary for this purpose.

In the area indicated as ABCD (Fig. 3) additional lines of the gradient maxima, resulting from the interpretation of the anomaly field obtained after stripping off the Zechstein-Mesozoic gravity effects, have been presented.

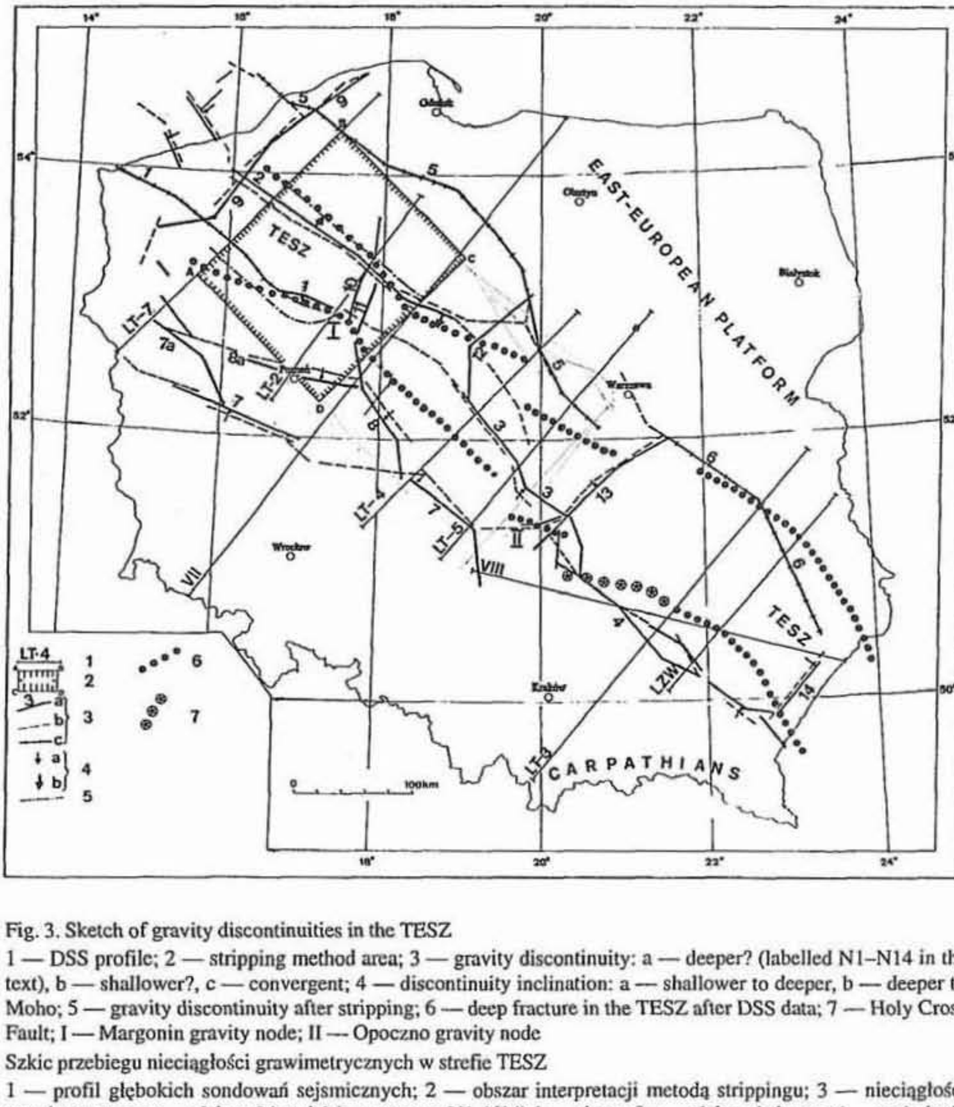

Fig. 3. Sketch of gravity discontinuities in the TESZ

1 — DSS profile; 2 — stripping method area; 3 — gravity discontinuity: a — deeper? (labelled N1–N14 in the text), b — shallower?, c — convergent; 4 — discontinuity inclination: a — shallower to deeper, b — deeper to Moho; 5 — gravity discontinuity after stripping; 6 — deep fracture in the TESZ after DSS data; 7 — Holy Cross Fault; I — Margonin gravity node; II — Opoczno gravity node

Szkic przebiegu nieciągłości grawimetrycznych w strefie TESZ

1 — profil głębokich sondowań sejsmicznych; 2 — obszar interpretacji metodą strippingu; 3 — nieciągłości grawimetryczne: a — głębsza? (w tekście oznaczone N1–N14), b — płytsza?, c — głębsza i płytsza; 4 — nachylenie nieciągłości: a — płytsza-głębsza, b — głębsza-Moho; 5 — grawimetryczna nieciągłość po strippingu; 6 — głęboki rozłam w strefie TESZ na podstawie GSS; 7 — uskok świętokrzyski; I — węzeł grawimetryczny Margonina; II — węzeł grawimetryczny Opoczna

PRELIMINARY CHARACTERISTICS OF MAJOR DISCONTINUITIES

The location of the major subsurface discontinuities and their relation to the fractures in the Earth's crust recorded by DSS data (A. Guterch *et al.*, 1983, 1984, 1986, 1994), as well as their possible connection mainly with the structures of the sedimentary cover, will be discussed.

Comparison of the gravity results with seismic data is reliable only along the seismic lines. Between the seismic lines, the location of fractures is based on the interpolation and, consequently, the accuracy of location is limited. On the contrary, the gravity data are distributed evenly and have the same reliability everywhere, so the obtained results seem to be more accurate and reliable. For interpretation purposes, information from regionalization of the gravity units (gravity highs and lows — Fig. 1a) (C. Królikowski, Z. Petecki, 1995) has been also used. The pattern of discontinuities is presented in Figure 3. Much more information was acquired in the area ABCD, where 3D interpretation has been carried out.

Figure 3 presents only such discontinuities, which are situated in the TESZ area in a broad sense. In principle, only the deep discontinuities of the regional character (continuous lines) are discussed. The more shallow discontinuities can be divided into two separate classes:

— the first one are such discontinuities that, as a rule, are accompanied with much deeper discontinuities (running parallel or identically to the latter),

— the second class are such discontinuities which form independent and frequently short lines of local character (not shown on the sketch), and longer lines, which frequently are a horizontal extension of the deeper discontinuities.

The **N1** discontinuity separates the Pomerania High from the Szczecin Low. It extends towards the NW into Germany (S. Grosse *et al.*, 1990), as far as the Mecklembùrg coast, where it is known as the Trans-European Fault (TEF)[1]. If we assume that the N1 is a continuation of the TEF, then it could be considered as a concealed edge of the East-European Craton, and simultaneously as a root zone of the Caledonian overthrusts onto this edge. In such circumstances the TESZ, in this segment, would be underlain by the cratonic crust.

The **N2** can be also traced, with small interruption, more northwestwards, where it enters the Baltic area. On the German maps it is treated as a southwestern border of the Baltic Shield. Thus it would be considered as a continuation of the marginal fracture of the craton. However, if the N1 plays such a role, then N2 should be rather considered as a fracture within the craton.

In its SE part the N1 terminates, at so-called Margonin node, at the intersection of N1 with N10 and N11 (I in Fig. 3) (A. Grobelny, C. Królikowski, 1988). The continuous line along the whole discontinuity, except a short section in the SE part, has the same location as the dashed line. It suggests that N1 is vertical.

Towards SW from N1, there occurs a discontinuity determined from the data after stripping; it also disappears at the Margonin node. This discontinuity is the axis of a weakly marked gradient, so its reliability is rather poor. Also the seismic modelling along the LT-7 profile (A. Guterch *et al.*, 1994) reveals only insignificant variation of the seismic velocities at this location.

[1] The source data (S. Grosse, W. Conrad, 1990) do not inform on the method of the horizontal gradient calculation, but we can assume a compatibility of such calculations, as the horizontal gradient anomaly axis has been determined explicitly in geophysics.

Analysis of the gravity data of the ABCD area suggest, that the Pomerania High is caused both by the uplifted Moho surface in the TESZ and the additional disturbing masses in the upper crust. The N1 can be considered rather as the influence effect of the southwestern edge of these masses than as the effect of Moho depth variation. The N2, in the shallow version (dashed line), would mainly determine the northeastern edge of the disturbance mass, and the continuous line — the crustal fracture with northeastern inclination. Southeast of the seismic line VII, the inclination probably changes.

In the vicinity of the N2, in similar manner as near to N1, another discontinuity obtained after stripping has been plotted; it conforms perfectly to fracture in the seismic data. It can be interpreted as the effect of a disturbing body in the upper crust and/or a lack of discontinuity inclination in the lower crust. The preliminary results of the gravity modelling in the area ABCD, in comparison with the model based on seismic velocities distribution, indicate the presence of additional masses in the upper crust between N1 and N2. Positive gravity anomaly of the Pomerania High can be partly explained by the presence of these masses.

In the Zechstein-Mesozoic complex the location of N1 conforms to the Świnoujście and Drawsko–Chodzież fault zones (R. Dadlez, 1979, 1987), that run along a chain of salt anticlines. The N2 is nearest to the Karlino, Szczecinek and Debrzno faults, also accompanying the belt of salt structures. Both the N1 and N2 can be simply assumed as the deep boundaries of the Mid-Polish Swell — a young inversion unit — that define it better than the conventionally assumed subcrops of the Upper Cretaceous base (R. Dadlez, 1980). At the same time the line obtained after stripping is nearly in accordance with the SW border of the Koszalin–Chojnice zone, defined by the Wierzchowo and Zamarte faults.

The transverse **N9** discontinuity is the border between the Baltic High, and the Pomerania Low and the Mazury-Mazovia High. Within the craton, this discontinuity is mainly of a petrological type (S. Kubicki, W. Ryka, 1982) marking the boundary between the granito-gneisses of the Pomerania massif, and more dense metamorphic or intrusive rocks over the Baltic area. However, as the N9 enters the TESZ area farther southwestwards, a tectonic character of this discontinuity can be also assumed. There, the N9 conforms to the border between the peri-Baltic Gryfice and Kołobrzeg blocks, and the blocks of the central part of the Pomeranian Swell (R. Dadlez, 1980, 1987). In the Permian-Mesozoic complex a contrast between them is expressed by the lack of salt tectonics over the peri-Baltic blocks, their relative smaller subsidence, and subsequent smaller inversion uplift. In the deeper basement, this contrast is recognized worse — over the peri-Baltic blocks there are much more Upper Carboniferous deposits with lower densities in comparison to the Lower Carboniferous and Devonian farther inland.

The **N10** and **N11** converge with the N1 in the Margonin node. Two tectonic lines of Chodzież–Włocławek–Warszawa and Chodzież–Brodnica converge also in this region (S. Marek, J. Znosko, 1983). Though the N10 and N11 are rather short lines and occur only in the TESZ area, nevertheless both the results of the anomaly analysis after stripping (A. Grobelny, C. Królikowski, 1988), as well as an existence of clearly defined gradient axes, indicate some tectonic complications in this area. There is a high probability, that shallowing of the Moho towards NW begins in this zone instead of in the area between the seismic lines LT-2 and LT-7. Therefore a reinterpretation of the LT-2 seismic line seems to be necessary. In the Permian-Mesozoic complex, both discussed discontinuities run roughly along the border between the Pomeranian and Kujavian branches of Mid-Polish Swell, although their course in relation to this border is oblique. This border is revealed in a considerable structural contrast and in difference of the inversion degree of both branches.

The **N8** is an extension of both the transverse N10 and N11 discontinuities towards south, as far as the junction with the N7 near the LT-4 seismic line. The western branch of this discontinuity — the **N8a** — which crosses the LT-2 seismic line, has no equivalent in the DSS results (A. Guterch *et al.*, 1986).

The **N7**, in its central segment, is in line with the Dolsk fault zone. Except its **N7a** branch, this discontinuity forms the boundary between the Silesia High and the Szczecin–Mogilno–Miechów Low (Fig. 1). In Germany, near the Polish-German border, an important crustal fracture has been marked on the LT-7 seismic line (A. Guterch *et al.*, 1994). However, this fracture has not been confirmed by the German gravity data (S. Grosse *et al.*, 1990). Lack of continuation of N7 in Germany has been also confirmed by the Bouguer anomalies distribution in this territory (S. Grosse, W. Conrad, 1990).

The both mentioned N7 and N8 discontinuities are situated beyond the TESZ and run inside the Variscan belt. The N8 which runs nearer the orogenic front, could represent the basement edge overthrusted by the Variscan thrusts, though east of Poznań it could represent even the Variscan front itself, what is suggested by its reverse inclination. The western segment of N7 shows some relation to the Wolsztyn Uplift, where the metamorphosed complexes of the older Variscan(?) structural stage appear from below the Carboniferous flysch.

The **N3** separates the Kujawy Low (with higher gravity values) from the Mogilno Low. The dashed line, originating from a narrow gradient zone visible in the Bouguer anomaly maps and connecting the N1 and N3, confirms rather shallow origin of the discontinuity. In this sense the N3 would correspond with the southwestern border of the Mid-Polish Swell.

The nature of **N12** is not uniform. Its southern segment appears within the Kujawy Low and is connected with a narrow gradient zone which encircles from the west the positive anomaly of the Kujavian Swell. As in the Pomeranian Swell, this anomaly (at least partly) could be caused by the additional disturbing body in the upper crust. The edge of such a body could contribute to the origin of the gradient zone. Contrarily, the northeastern segment of the N12 separates the Pomerania Low from the Kujawy Low, and is manifested in the Bouguer anomaly map as a very wide gradient zone, indicating its very deep origin. It could be interpreted as a deep fracture and/or as a petrological boundary at the craton edge. In this area, along the Włocławek–Sierpc line, a major fault has been marked on the structural-tectonic map of the crystalline basement (S. Kubicki, W. Ryka, 1982).

The **N5** forms the boundary between the Pomerania and Kujawy lows, and the Mazury-Mazovia High. Along all its length, the continuous line covers the dashed line indicating a vertical character of the discontinuity. The N5 is located entirely within the East-European Craton.

The **N13** is the boundary of the Kujawy Low and the Mazury-Mazovia High with the Małopolska High. We can see in Figure 3 that:

— the N6 terminates near to the intersection with the N13,

— the N5 also terminates close to the N13,

— at the crossing area of the N3 and N13 a fan-like branching of N13 and rapid disappearance of these branches occur.

All the above facts indicate the considerable width of the N13 and the existence of Opoczno gravity node at its SW end (II in Fig. 3). Along the N13 zone, according to the geological data (S. Marek, J. Znosko, 1983), an assemblage of "...en echelon faults of Tomaszów Mazowiecki–Rawa Mazowiecka, Grójec–Żyrów and Nowe Miasto–Warka has been located disappearing towards the south-west at the Radomsko tectonic rampart...". Significantly high gradient along the N13 line is an equivalent of the Grójec Fault, reflecting major geological differences on both sides of the line. Towards the south-east from the N13, the uplifted Małopolska Block occurs: within this block the most uplifted Palaeozoic core of the Holy Cross Mts. appears. In its northeastern part the Lublin Carboniferous Graben terminates precisely on this line, while in the southwestern part, a contrast between the complicated basement of the Nida Syncline and relatively monotonous Carboniferous field of the Fore-Sudetic Monocline is observed. The subsidence during the Permian-Mesozoic evolution was quite different on both sides of the line, and — as an effect of the late Cretaceous inversion — a differentiation has arisen onto the Holy Cross Mts.–Radom uplifted block and the deeply lowered blocks of Kujawy and Łódź. At the southeastern end of the line, in the area where it is branching, an important structural element called Radomsko rampart appears, separating the Nida Trough from the Łódź Trough. It can be generally assumed, that the gravity images obtained in this area as an effect of different transformations indicate the existence of a wide fracture zone in the Earth's crust. Its existence is also indirectly evidenced by the seismic results (DSS): the seismic crustal structure in central and southeastern Poland are quite different.

The **N4** forms the border between the Miechów Low, Carpathian Low and Małopolska High (Fig. 1a). On the seismic lines LT-3 and LZW this discontinuity seems to be splitted into two branches. A comparison with the seismic section of the LT-3 line (A. Guterch *et al.*, 1986) shows, that the N4 can be related to a major crustal fracture about 30 km wide inclined to the NE. The geological correlations of the N4 are different along its strike. In the northwestern segment, the N4 corresponds partly with the Holy Cross Fault. Farther to the south-east, near the point of splitting, it can be related to another submeridional Moho fracture, which separates the crust about 45 km thick, from that about 35 km thick. Holy Cross Fault is interpreted as a fundamental boundary in the Palaeozoic separating the Łysogóry Region of the Holy Cross Mts. from the Kielce Region. Interpretation of the second boundary is not clear, but judging from further continuation of the N4 to the SE, it seems that it is still the boundary between the uplifted and downfaulted Palaeozoic (the southwestern edge of the so-called Małopolska Massif).

This double discontinuity can be also explained in another way, if we consider a group of faults in the lower crust observed at that place on the LT-3 seismic line, as well as a zone of significant seismic disturbances inclined to the NE. In this situation, the southwestern branch of the N4 is localized over the SW edge of the fracture zone, while the second branch — over its NE edge. On the other hand, according to A. Guterch *et al.* (1986), the SW border of the TESZ (dotted line) has been localized along the neighbouring fault coincident with the Holy Cross Fault, where the Moho surface is thrusted down northwards by about 5 km (to the depth of 50 km). It seems rather, that the earlier discussed wide fracture zone is more probably the TESZ border fracture, than the smaller fault in the LT-3 section. There are no objections to interpret the seismic fault on the LZW line, related to dotted line in Figure 3, as the inner fault of the TESZ, because there are no data further to the SW.

The **N6** separates the Małopolska High from the Podlasie–Lublin Low. It is in full conformity with the TESZ border fracture marked on the LT-3 seismic line, while on the LZW seismic line there are no conclusive data to determine the course of this fracture. Only one of the seismic faults is in accordance with the N6.

South-east of Kock, the N6 changes its direction into more meridional. From the geological point of view, the N6 has an ambiguous origin, as in its NW part it is equivalent to the Czersk–Żelechów–Kock fault zone (A. M. Żelichowski, 1974) marking the north-eastern border fault of the Carboniferous Lublin Graben and runs within the East-European Craton. Towards south-east, the N6 runs obliquely through the Lublin Graben, approaches to the southwestern border fault of this graben, and terminates at the platform edge in the zone of the Caledonian deformation. It can be assumed, that igneous bodies with differentiated densities in the upper crust had contributed considerably to the origin of the N6.

The **N14** forms the southeastern border of the Małopolska High. This discontinuity is in full accordance with a fault interpreted on the VIII seismic line, which downfaulted the Moho surface from 52 to 65 km on the NW side. This fault is considered as vertical, but in the Ukrainian area, near the Polish border, the inclination of two faults is to the SE, just as in case of the N14. The N14 is one of transverse discontinuities of the TESZ.

CONCLUSIONS

1. The discontinuities interpreted from horizontal gradient axes have differentiated nature, reliability and meaning. They have been obtained as a result of the computer transformations, and are devoid of the subjective options, that are inevitable during the gravity modelling. We can therefore assume, that the results obtained in this way are characterized by high degree of objectivity, while the degree of the reliability of their correlation with the geological boundaries can be different. The continuous elongated axes with considerable values of the gradient modulus, undoubtedly reflect the discontinuities of the type of fractures, faults, and lithological variations in the crystalline basement. Most of the discontinuities with the NW–SE trend in the TESZ (from 1 to 6), as well as the transverse discontinuities 9, 13, and 14, and — despite its limited length — also discontinuities 10 and 11, belong to this type.

2. From the point of view of the general correlation between the seismic results (DSS) and gravity transformations, and their correlation with the main features of the geological structures, the following questions are worth noticing.

— The transverse segmentation of the TESZ becomes distinct. The borders of major segments are defined by the N10/N11 and N13.

— In the northwestern segment, the fracture delimiting the TESZ from NE is conformable generally with the N2. The interrelations between the shallower and deeper discontinuities, and the fracture in Moho, explicitly indicate the NE inclination of the possible crustal boundary. The fracture delimiting the TESZ from SW is roughly conformable with the N1, but more to the north-west, near to Baltic sea, both features diverge. According to the seismic results (LT-7), between the N1 and N2, the crustal thickness is about 35 km (of Palaeozoic type), while more to SE (LT-2) the thickness is about 50 km (thickened cratonic crust?). This inconsistency will be probably solved after the interpretation of the longitudinal seismic line TTZ-PL.

— In the middle segment, the relative accordancy of the N2 with the fracture delimiting the TESZ from the north-east is observed only at its northwestern end (seismic lines LT-2 and VII). Significant is the fact, that in this area the inclination of crustal boundary changes from the NE to SW. Farther to the SE (seismic lines LT-4 and LT-5), the gravity discontinuities (N3 and N5) do not agree completely with the location of Moho fractures bordering the TESZ.

— In the southeastern segment, the picture of the zone, called here TESZ as before, is quite different than NW of the N13. It is confirmed by the gravity results and by the DSS as well. The discontinuities N6 and N4 delimiting the TESZ are displaced to the NE along the transverse discontinuity N13 by about 20–50 km in relation to their supposed counterparts: the discontinuities N5 and N7-N8. In this area the equivalents of the important regional discontinuities, like the N2 and N3, has not been observed. There is also a lack of distinct correlation with the crustal fractures according to the DSS results. It exists in two points only (along the LT-3) being related either to the intra-cratonic fracture (N6) or to the N4. The Holy Cross Fault is not clearly recorded in the gravity results.

3. A detailed analysis of geophysical data along the particular lines is necessary, with the aim of explanation of the differences between the gravity and seismic discontinuities in the TESZ. As several faults within the TESZ have been marked on the seismic lines, it can be assumed, that at least a part of them should be reflected in the gravity as the gradient zones.

4. Parameters of the discontinuities, e.g. their depth and inclination, are one of the very important problems. Validity of this information for correlation between the deep and shallow geological structures, as well as for explanation of the tectonic evolution of the area is indisputable. A part of inclinations indicated earlier have only an approximate character, because they were not calculated with the use of special software.

5. The next problem which await solution is related to the methods of geological interpretation of the relatively positive gravity anomalies occurring in the TESZ. Assuming the uniform crustal density, the greater depths to Moho should cause relatively negative anomalies. If the models of the distribution of seismic velocities do not indicate the existence of boundaries with higher velocities in the crust, then the relatively positive anomalies can be explained by the igneous bodies (with increased densities), which because of their small dimensions are beyond the resolving capability of seismic method. The depths and geological formations in which such magmatic bodies can exist are the aim of the analysis carried out in the ABCD area (Fig. 3). This problem concerns the Mid-Polish Swell.

6. Determination of the relation between the velocities of the seismic P waves and rock densities has a fundamental significance for the comprehensive interpretation of geophysical data. Existing formulae have only empirical character and have been elaborated for different geological regions of the Earth. Elaboration of such a formula, which would interrelate both parameters, and would be true for the geological formations at the contact zone of the East-European Craton with the mobile Europe, seems to be essential and indispensable.

7. Presented results of the gravity data analysis, directed mainly to the delineation of crustal discontinuities, and their comparison with the results of DSS, testify that much

information, not used so far, is included in the gravity data. The spatial location of the particular elements of the geological structure based on the potential field analysis is more reliable and accurate than the depth location. The incorporation of the results derived from the different geophysical methods by the use of modern technology of data gathering, processing, interpretation and imaging, are essential for the recognition of the crustal model. Such venture would extend our knowledge not only on the structure of the Earth's crust, but also on the relation between the deeper crust and the Moho, and the upper crust including the sedimentary complex.

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NIECIĄGŁOŚCI PIONOWE W SKORUPIE ZIEMSKIEJ W STREFIE TESZ W POLSCE NA PODSTAWIE DANYCH GRAWIMETRYCZNYCH

Streszczenie

W artykule przedstawiono nieciągłości pionowe skorupy ziemskiej w strefie szfu transeuropejskiego (TESZ) na terytorium Polski, określone na podstawie analizy danych grawimetrycznych. Ich przebieg wyznaczają osie maksymalnych wartości modułu gradientu poziomego anomalii siły ciężkości przedłużonych w górę do poziomu 24 km. Wyznaczone w ten sposób nieciągłości odnoszą się do dolnej skorupy i granicy Moho (fig. 3). Równocześnie przedstawiono osie gradientu dla anomalii Bouguera (nie przedłużonych w górę) wiążąc je z nieciągłościami w górnej skorupie.

Nieciągłości grawimetryczne powiązano ze strefami dyslokacyjnymi uzyskanymi w wyniku głębokich sondowań sejsmicznych (DSS) oraz strukturami geologicznymi znanymi z badań geologicznych górnej partii skorupy. Najważniejszymi elementami tektoniki skorupy ziemskiej na obszarze TESZ są nieciągłości podłużne N1–N4 i N6 oraz nieciągłości poprzeczne N9–N11 i N13. Pierwsze wyznaczają granice strefy szfu, drugie akcentują jej podział poprzeczny na bloki o odmiennych własnościach fizycznych.

Nieciągłości podłużne w północno-wschodniej Polsce dość dobrze korelują się z głębokimi rozłamami zarejestrowanymi przez DSS. W środkowej i południowo-wschodniej Polsce obserwuje się znaczne odchylenia w przebiegu nieciągłości grawimetrycznych i sejsmicznych. Wśród nieciągłości poprzecznych do TESZ szczególne znaczenie ma nieciągłość N13, która oddziela bloki skorupy o zdecydowanie różnych cechach.

W artykule wymieniono zagadnienia, które wymagają rozwiązania przy równoczesnym wykorzystaniu danych uzyskanych innymi metodami geofizycznymi. Pozwoliłoby to na pełniejsze oświetlenie charakteru budowy skorupy w strefie TESZ.