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Teisseyre-Tornquist tectonic zone: some interpretative implications of recent geological and geophysical investigations

ABSTRACT: On the basis of the borehole data, explosive seismic investigations and head flow measurements, the character of the Teisseyre-Tornquist zone is suggested as a pulsation crustal depression, the origin of which is associated with the eclogite—basalt phase changes within the "Moho layer". Because of that the Teisseyre-Tornquist zone cannot be regarded to be a hidden intracontinental rift or aulacogen.

The Teisseyre-Tornquist tectonic zone, called traditionally as a line but representing actually a long and narrow tectonic zone, was separating since the Vendian through Palaeozoic and Mesozoic areas widely different in geological development.

In the east and northeast, the boundary of those areas was delimited by a rigid high-elevated marginal escarpment of the crystalline basement of the East European Pre-Vendian platform. It was already repeatedly suggested (Znosko 1962, 1970, 1974, 1977; Marek & Znosko 1972, 1974) that the high-elevated escarpment of the basement coincided with the Teisseyre-Tornquist tectonic zone.

West of the Teisseyre-Tornquist zone, there are consolidated Caledonides that did not undergo Variscan regeneration. Further away to the west and southwest, there is the Central and West European Variscan front along with the stabilized Caledonides of the Holy Cross Mts and the basement of the present-day Miechów depression.

The area delimited by the rigid edge of the crystalline basement of the old platform in the northeast, and by the Variscan front in the southwest, should then show a considerable subsidence. This tectogenetic program is an effect of the morphological inversion of the Variscan geosyncline and the resulting formation of the Fore-Variscan deep.

The observed intense subsidence is then to be considered as inherited after the Late Carboniferous Central and West European Variscan fore-deep. The subsidence is obviously to be expected to be the most apparent relative to the old, fixed and stable East European craton on one hand, and to the continuously uplifted by isostasy and degraded Variscides on the other.

The area under discussion was called by Stille (1924) as the Paleoeurope (after its Caledonian consolidation), and later on as the South-Scandian regeneration foreland (Stille 1949). Znosko (1974) included it recently to the Caledonian Vistulicum meant in a much larger sense than in the original definition by Stille (1950).

The above cited conclusions follow from a general comparative analysis of the paleogeographic and tectonic characteristics. One may however ask whether these conclusions are compatible or not with the results of the recent geological and geophysical investigations.

The Teisseyre-Tornquist zone coincidence with a deep-fracture zone recognized after magnetic and gravimetric investigations has been for long well known. I discussed this problem in detail in my 1962 paper, with the observations and conclusions by Teisseyre (1893, 1921), Tornquist (1910), and Stille (1949, 1951) taken into account. The cited authors introduced the concept of Berdo—Narol—Radom—Scania tectonic line, or Tornquist line, or Grönland—Pontus line, or Baltic—Podolia lineament, supported subsequently by almost entirely consistent geophysical interpretations of the magnetic and gravimetic image of Poland (Pawłowski 1947, 1958; Dąbrowski 1957, Skorupa 1959).

The problem of this boundary important for both tectonics and paleogeography was recently discussed by Thierbach (1971) and Teschke (1975). Basing upon a detailed methodological and historical (Precambrian to Tertiary) analysis, the latter author confirmed entirely the reality of the Teisseyre-Tornquist tectonic line.

No doubt that Teisseyre (1893) was the first to recognize the tectonic significance of the discussed dislocation and hence, I proposed (Znosko 1969) to call it as the Teisseyre line, or Teisseyre-Tornquist line because of the long tradition of the name Tornquist line in geology.

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New geophysical data do not only confirm the reality of the Teisseyre-Tornquist line as a tectonic zone but also contribute to its geological interpretation. I mean here mostly the interesting measurements of heat flow and the revelational data on the structure of Moho layer achieved through the deep-seismic (*DSS*) sounding.

The data obtained by means of both the geophysical methods permit actually an analysis and more insightful conclusions on the considered area situated between the rigid edge of the old East European platform and the uplifted Variscide chain.

From a number of interesting papers and notes by Majorowicz (1975, 1976a,b, 1977 a,b) and Majorowicz & Plewa (1977) one can see that the distributional pattern of heat flow in Poland and the adjacent areas reflects precisely the main tectonic units. With respect to the present topic, the most important point is the repeated assertion by Majorowicz (1975) that low heat flow values occur east of the Teisseyre-Tornquist zone, whereas the values observed west of the zone are twice as high as the former (Fig. 1).

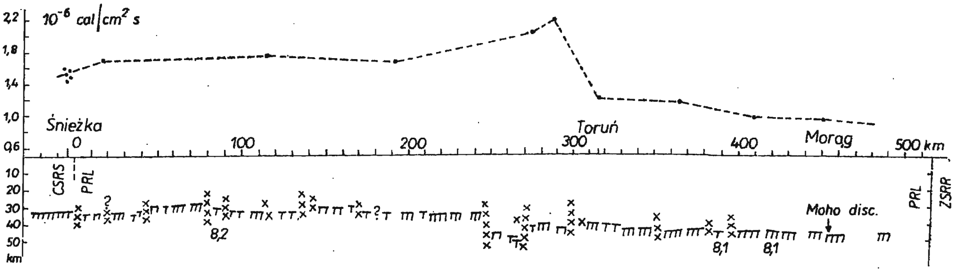

Fig. 1. Heat flow against the background of the Earth's crust structure along deep seismic soundings (*DDS*) international profile *VII* (after Majorowicz 1975)

Majorowicz concludes that the subcrustal component of the heat flow is more intensive in the Central and West European Paleozoic platform than in the East European craton. Indeed, this conclusion fits well to the geoisotherm maps obtained for the depths of 1 and 2 km, and to the pattern of geothermal gradient (°C/100 m) for the depth interval of 0.2 to 2.2 km.

No doubt that these conclusions on the heat flow and geoisotherm patterns are indicative of a major tectonic division of Poland along the Teisseyıe-Tornquist zone (Figs 2—3).

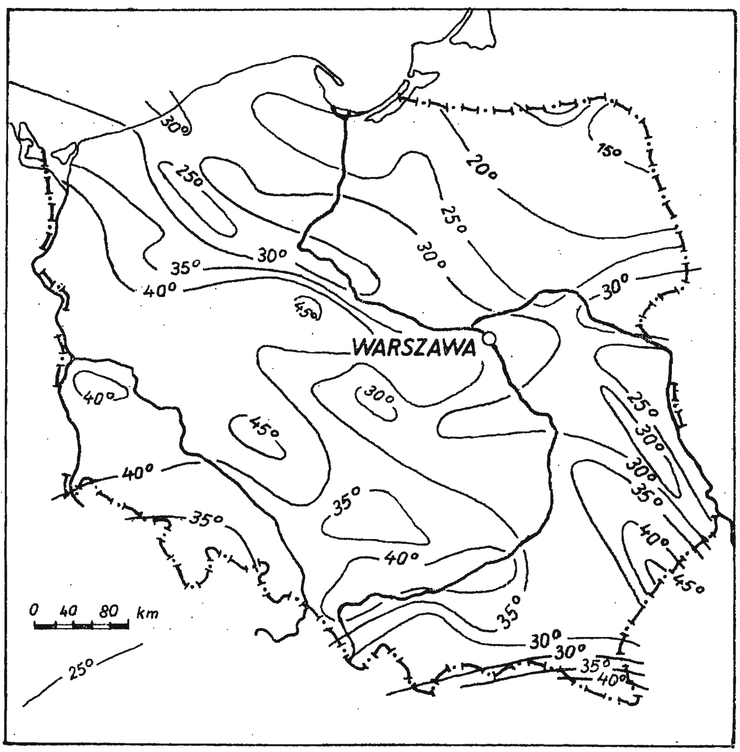

Fig. 2. Map of geoisotherm in centigrade degrees for a depth of 1 km (after Majorowicz & Plewa 1977)

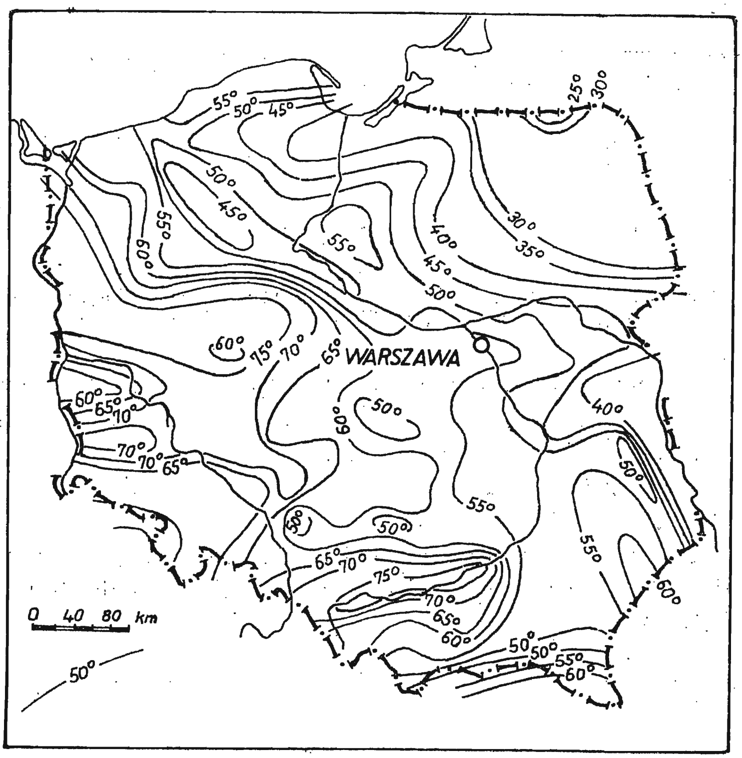

Fig. 3. Map of geoisotherms in centigrade degrees for a depth of 2 km (after Majorowicz & Plewa 1977)

The observations and conclusions of Majorowicz are also entirely consistent with the measurement of heat flow in the North Sea basin, Rügen Island, and the vicinity of Berlin, that is in the Paleo- and Mesoeurope (Harper 1971 fide Majorowicz 1972, Evans & Coleman 1974).

The argument from the observed heat flow pattern is that the Teisseyre—Tornquist zone is reflected in physical characteristics of the Earth, as a deep-rooted discontinuity zone separating two crustal blocks of widely different thermal regimes; the latter difference is indicative of a difference in cooling resulting from a difference in geological age and tectonic history. It is also noteworthy that areas different in geothermal regime can be distinguished within the Paleozoic platform, coinciding with the Caledonian Paleoeurope and Variscan Mesoeurope (Figs 4—5). This points to the existence of some thermal discontinuities inbetween and by implication, to some time and tectonic differences in the peak of their heating and the extent of their subsequent cooling.

Let us now review the results of deep-seismic sounding along the international profiles *VII* (the Alps, Toruń, Kaliningrad) and *VIII* (Ukrainian shield, Rawa Ruska, Staszów, Częstochowa), regional profiles *LT 2* (Poznań, Starogard Gdański),

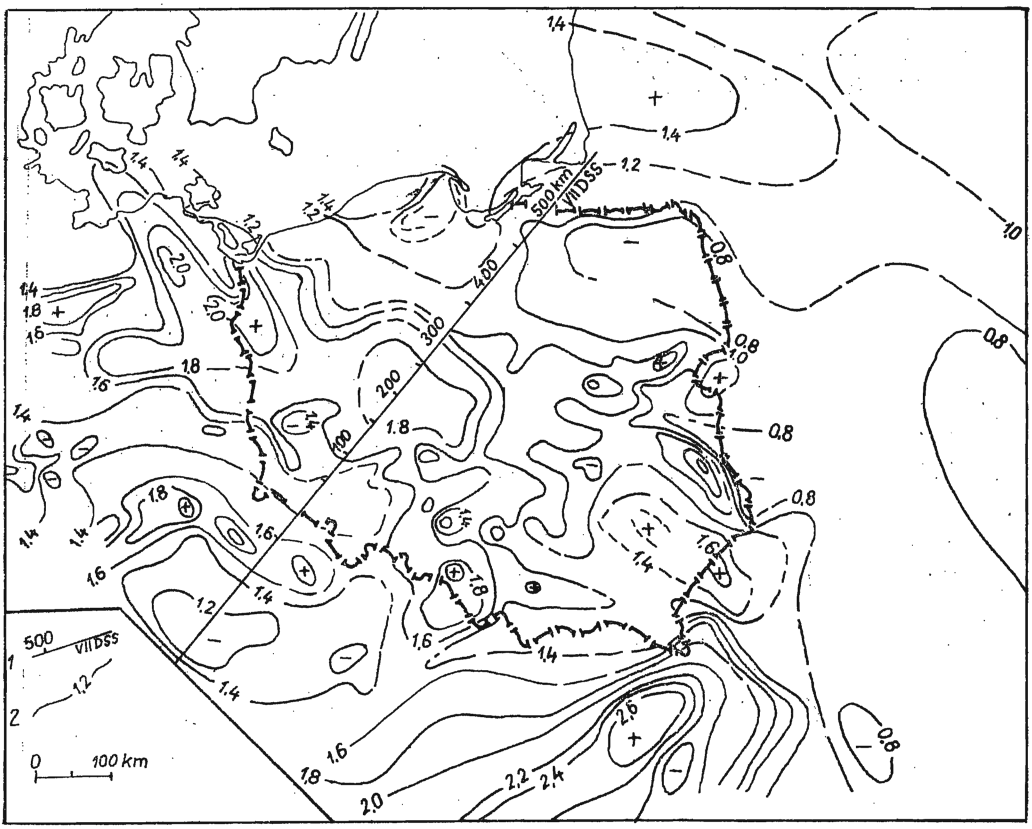

Fig. 4. Map of heat flow in Poland and in adjacent areas (after Majorowicz 1977)
1 — position of the international deep seismic profile *VII*; *2* — isolines of heat flow in 10^{-6} cal/cm^2. s

LT 3 (Terespol, Staszów), *C* (Starachowice, Radzyń Podlaski), and in the Fore-Sudetic monocline (regional system *M1—M9*) (Fig 6).

Judging from the seismic data, Guterch et al. (1975a, b, 1976, 1977), conclude that the Earth crust is highly variable in thickness in Poland. It attains 35—36 km in the Sudetes Mts. From the Fore-Sudetic block, the Sudetic one is clearly separated with the deep-seated Sudetic Boundary fault well reflected in the structure of Moho surface. The Earth crust is less than 30 km in thickness in the Fore-Sudetic block separated from the inner, southwest part of the Fore-Sudetic monocline with the deep-seated (i.e. below the Moho surface) Odra fault.

The Earth crust ranges from 30 to 32 km in thickness in the Fore-Sudetic monocline, while it ranges up to 36 km in the outer, northeast part of the monocline. A similar thickness of the Earth crust was also observed in the Silesia—Cracow monocline and the Miechów depression, Mogilno—Łódź depression, and Szczecin depression (Fig. 7).

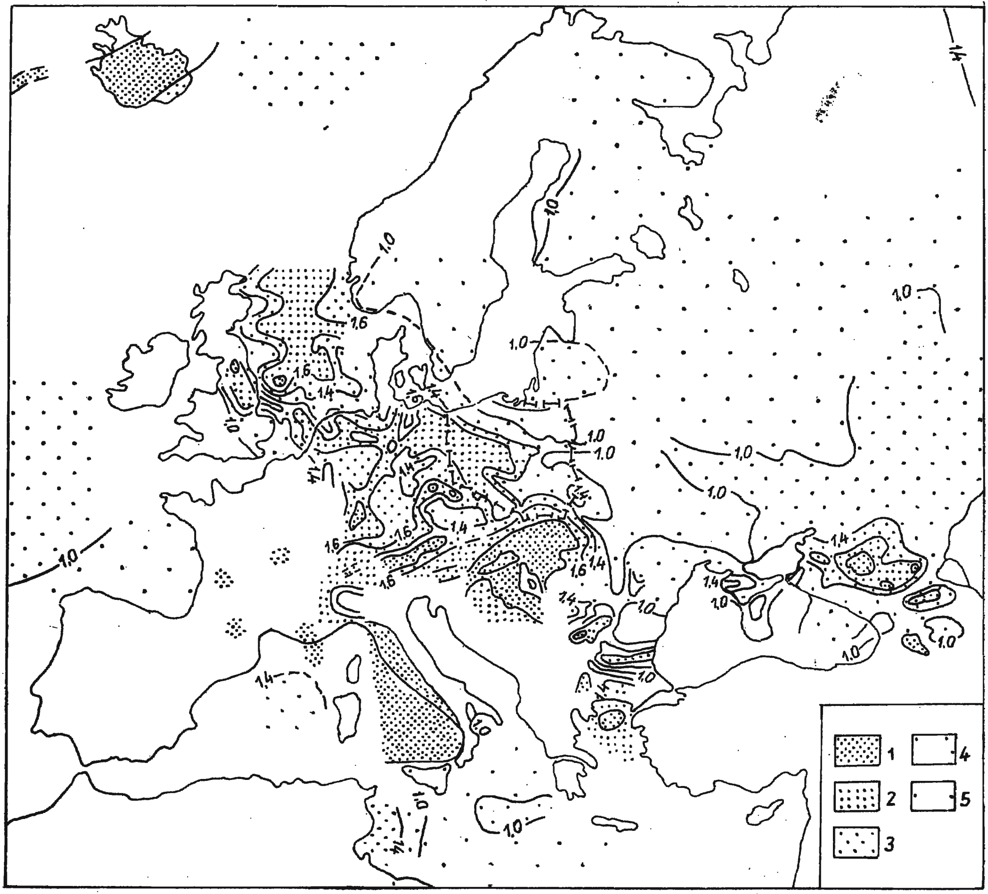

Fig. 5. Map of heat flow in Poland included to the map of heat flow in Europe (after Majorowicz 1977 a)
1 — Q ⊳ 2.0; *2* — 1.6—2; *3* — 1.4—1.6; *4* — 1.0—1.4; *5* — *Q* ⊲ 1.0 (in heat flow units 10^{-6} cal/cm²s)

The Teisseyre-Tornquist zone represents a clearly distinct segment of the Earth crust, with some 50 km in thickness in the northwest, and 50—55 up to more than 60 km in places in the southeast.

The Teisseyre-Tornquist tectonic zone, coinciding more or less with the Middle-Polish swell, is made very distinct at the crust and mantle boundary by very deep fractures reaching down to the upper mantle as well as by well developed transitional Moho zone. The latter zone appears also very distinct in the Fore-Sudetic monocline.

The Earth crust attains 38 to 40 km in thickness in the Fore-Carpathian depression, whereas its thickness is estimated for some 50 km in the Carpathians.

As emphasized by Guterch et al. (op. cit.), the outer, northeast fracture delimiting the Teisseyre-Tornquist zone makes an unequivocally defined boundary of

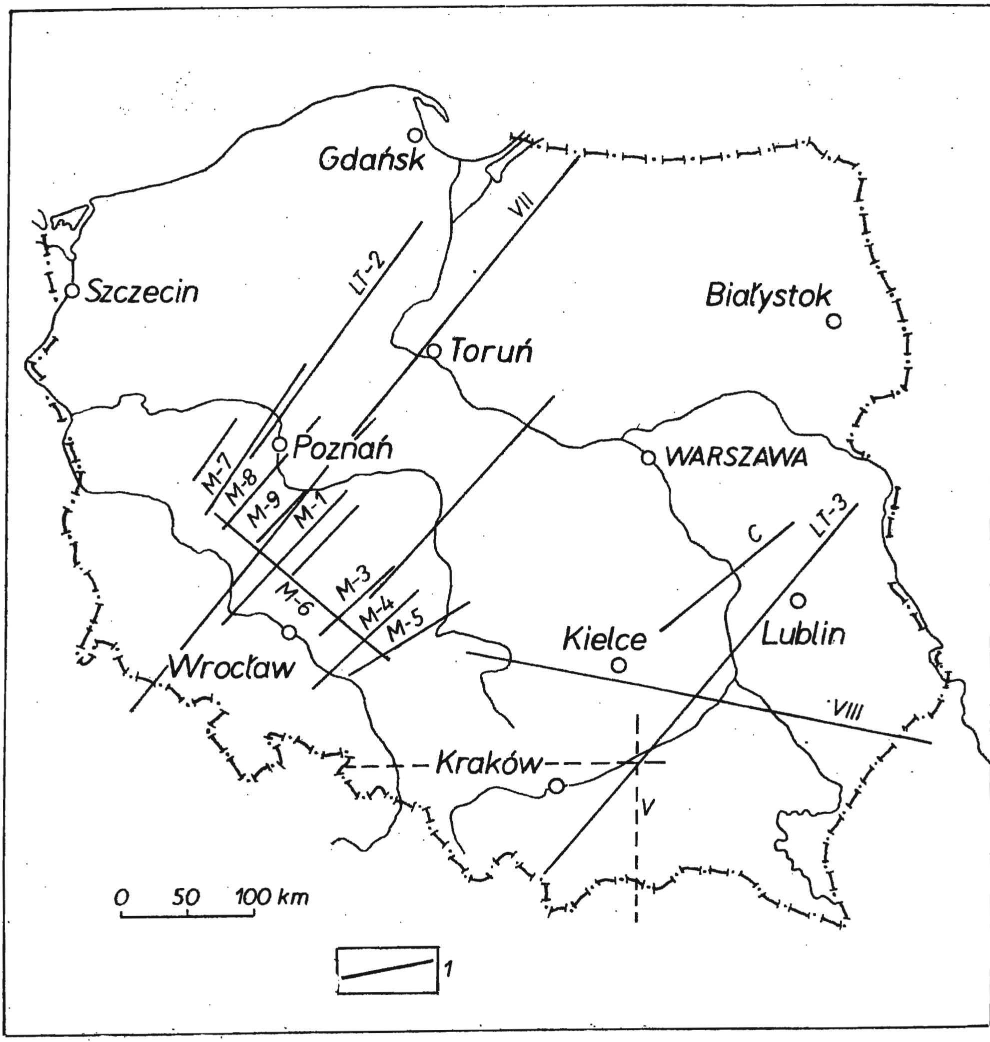

Fig. 6. Location of the seismic profiles in Poland (after Guterch 1977)
1 — international and regional *DSS* profiles

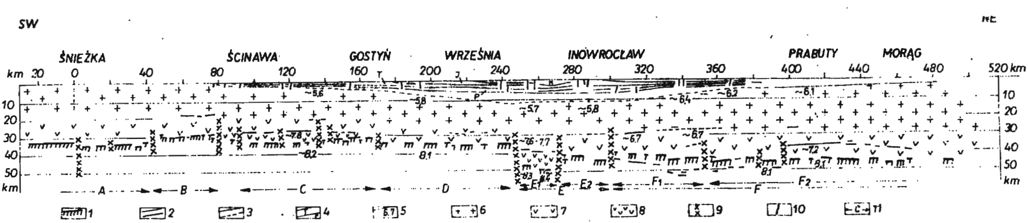

Fig. 7. Crustal structure along the *VII*th international *DSS* profile (after Guterch & al. 1975)

1 — Moho boundary, *2* — other boundaries, *3* — boundary of consolidated basement, *4* — stratigraphic boundaries, *5* — boundary velocity in km/sec., *6* — upper part of the crust, *8* — crust upper mantle transition zone, *9* — deep fractures and tectonic disturbances, *10* — geological faults, *11* — boundaries of crustal blocks the Pre-Vendian platform. In the latter area, the Earth crust ranges from 42 to 47 km in thickness.

To summarize briefly up the above presented observations, one may conclude that the intracrustal tectonic discontinuities coincide in general with the regional boundaries of large geological units.

Finally, it is of particular importance that a 3 to 8 km thick "Moho layer" has been recorded in the basement of the Fore-Sudetic monocline, and a similar but much thicker layer (10 to 12 km) in the Teisseyre-Tornquist tectonic zone (Figs 8—9).

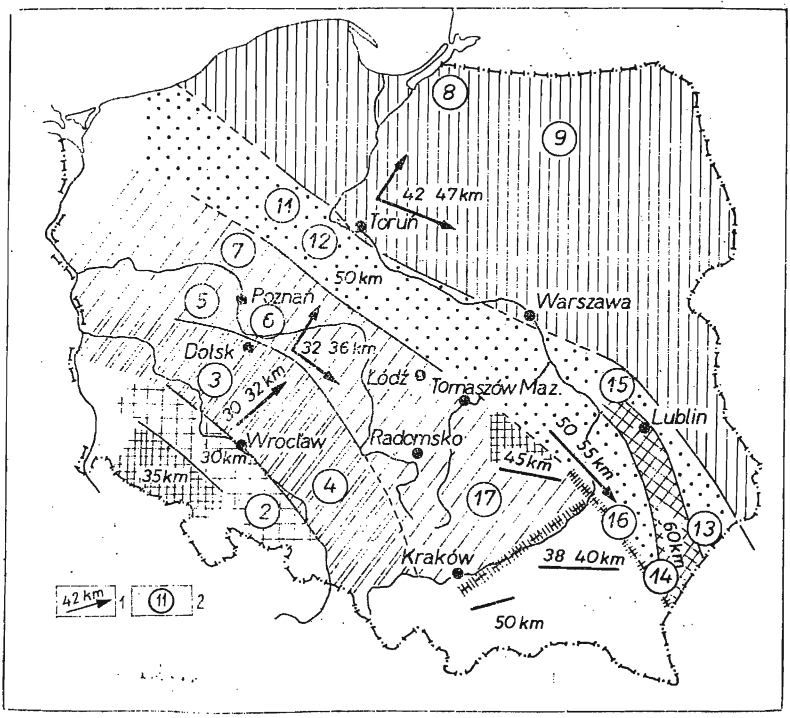

Fig. 8. Scheme of geotectonic division of the Polish area from studies of the Earth's crust and upper mantle by deep seismic sounding methods (after Guterch 1977)

1 — depth of the Moho discontinuity and directions of thickness of the Earth's crust, *2* — numbers of typical segments of cross-sections of the Earth's crust from different *DSS* profiles in Poland

It is commonly accepted that the "Moho layer" arises due to a phase transformation of basalt (or gabbro)-eclogite type. Guterch et al. (op. cit.) suppose that this is a twofold transformation: from basalt into granulite and thereafter, from granulite into eclogite.

One may here add that phase transformations within the Moho layer or surface are probably the causes for various geological phenomena, especially those at the platform developmental stage.

Accordingly to Guterch et al. (op. cit.), there are some distinctive tectonophysical characteristics of the Teisseyre-Tornquist zone making it unmistakably recognizeable among all the other crustal segments of Poland, which deserves

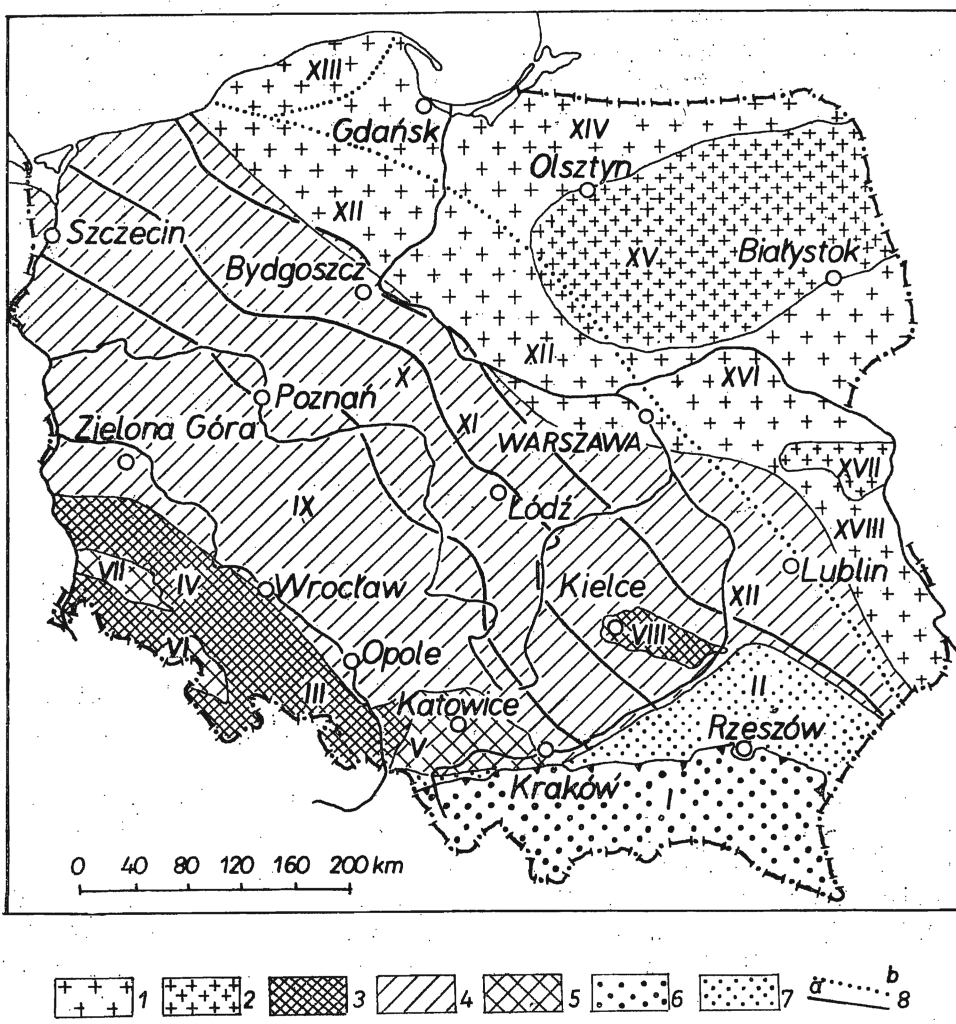

Fig. 9. Tectonic units of Poland (after Geological Atlas of Poland, 1: 2 000 000, 1968)

Precambrian Platform: *1* — subsided parts of the crystalline basement with a thick sedimentary cover, *2* — uplifted parts of the crystalline basement with a thin sedimentary cover. Areas of Palaeozoic foldings: *3* — Palaeozoides (Caledonides and Variscides) on the surface or under a very thin sedimentary cover, *4* — Paleaozoic Platform, *5* — Variscan orogenic depressions. Areas of Alpine foldings (Alpides): *6* — Carpathians, *7* — Carpathian Foredeep, *8* — boundaries of tectonic units: *a* — actual, *b* — conventional

I — Carpathians (Tatras, Pieniny Klippen Belt, Flysch Carpathians), *II* — Carpathian Foredeep, *III* — Eastern Sudetes (Moravo—Silesian chain), *IV* — Western Sudetes and the Fore-Sudetic Block, *V* — Silesia—Cracow Foredeep (Upper Silesian Coal Basin), *VI* — South Sudetic Intramontane Depression (Wałbrzych Coal Basin), *VII* — North Sudetic Intramontane Depression, *VIII* — Holy Cross Mts, *IX* — Fore-Sudetic Monocline and the Silesia—Cracow Monocline, *X* — Szczecin, Mogilno—Łódź and Miechów Troughs, *XI* — Middle Polish swell, *XII* — Marginal Trough, *XIII* — Łeba Elevation, *XIV* — Peribaltic Depression (Syneclise), *XV* — Mazury—Augustów Elevation (Anteclise), *XVI* — Podlasie Depression, *XVII* — Sławatycze Elevation (Horst), *XVIII* — Bug Depression (Syneclise)

Note: The western boundary of the Precambrian Platform should be regarded first of all as a deep-seated zone which borders a rigid block of the Precambrian consolidations. Some overthrusts of Paleozoik masses upon the Precambrian foreland may exist under a sedimentary cover; in such cases these masses overlap the deepseated boundary zone of the Precambrian Platform.

indeed a special emphasis. Furthermore, the deep fractures found in the considered zone are of a fundamental importance for definition of the margin of the East European Pre-Vendian platform. Guterch et al. (op. cit.) suggest also that the Teisseyre-Tornquist tectonic zone is actually a hidden graben with intra-continental rift marks.

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The above review of geological and geophysical data demonstrates clearly that the Teisseyre-Tornquist tectonic zone is a major tectonic boundary of a Pre-Vendian origin. It has been continuously separating two large geological regions widely different in their geological history, namely the East Europe and on the other hand, the Central and West Europe.

It was repeatedly stated that the Teisseyre-Tornquist tectonic zone was of a great importance for paleogeography and tectonics of the Vendian and Cambro—Silurian developmental stages of the Earth crust. One may also claim that this zone was of a considerable (if not insurmountable) significance for the Variscan and Post-Variscan developmental stages.

No doubt that the distribution pattern of the paralic Upper Carboniferous, developed partly at the foot of the Variscides and partly at the foot of the horst-like rejuvenated Caledonides, coincides in Poland to a great extent with the deeply hidden Teisseyre-Tornquist zone.

One has thus to consider which of the crustal blocks in Poland and which of the deep-seated fractures controlled actually the extent and branching of the Variscan geosyncline.

When taking into account both the geological data obtained from boreholes pierced in the Fore-Sudetic block and the Fore-Sudetic monocline, and the geophysical data, especially those provided by the deep seismic sounding, one may conclude that the blocks „*A*", „*B*", and „*C*" as distinguished by Guterch et al. (1975, 1977) in the deep basement, and coinciding with the Sudetes Mts, Fore-Sudetic block, and Fore-Sudetic monocline, respectively, made up the basement of the Variscan geosyncline.

The inner part of the geosyncline (the internides) would then be represented by the Sudetes Mts and the Fore-Sudetic block where the Variscan plutonism is clearly evidenced. This part of the geosyncline along with the internides arisen from it ("*A*" and "*B*" blocks) appear delimited in the basement by the deep fracture of the Odra river. The deep basement underlying the considered Variscan segment lacks any transitional zone and the Moho discontinuity separates the basaltic layer of the Earth crust directly from the eclogite (peridotite) of the upper mantle.

The block "*C*" equivalent to the Fore-Sudetic monocline and split into three subdivisions is delimited by the Dolsk deep fracture. There are no traces of any Variscan plutonism in this portion of the Variscides and hence, one may suppose that these are the externides. It is noteworthy that there is a 3 to 8 km thick "Moho layer" in the basement of the block "*C*", which may be regarded as a granulite layer at a transitional phase stage from the eclogite (peridotite) into the basaltic (or gabroic) layer of the Earth crust.

Accordingly to Pokorski et al. (1978), the Dolsk fracture may coincide with the outer boundary of the vast and continuous occurrence of the Lower Permian volcanics. Judging from the observations obtained from the international seismic profile *VII*, there are merely isolated, small and thin sheets of the Autunian volcanics outside, that is northeast of the Dolsk fracture.

Pokorski et al. (1978) claim that a 30 to 40 km wide belt of upland or plateau type occurred in the Autunian at the outer, northeast part of the block "*C*" where the granulite layer is the thinnest. The structure of that plateau comprises trachy-andesites and trachybasalts extending vastly and continuously. As shown in maps and atlases, the plateau coincides with an elevation in the Variscan basement situated between Myślibórz and Święciechowa on one side and Żakowa and Brenna on the other. The basement elevation lacks the Upper Carboniferous cover and sometimes the Lower Permian one as well, which results in the Zechstein deposits lying directly upon the Visean or even older metamorphosed rocks.

The inner, that is southwest part of the basement block "*C*" shows a thick granulite layer (up to 8 km in thickness) and is apparently related to the continuous occurrence of the Autunian extrusives attaining accordingly to Pokorski et al. (1978) 1,700 m in thickness or even more.

The Autunian volcanics do not in general surpass the Dolsk deep fracture. Nevertheless, it appears more sound to point to the Teisseyre-Tornquist tectonic zone as the northeast boundary of the Autunian volcanism, since a considerable but a little more acid than in the above discussed area, coeval volcanism has also been recorded in Wolin island and in the vicinity of Gryfice (the insofar known thickness of the latter volcanic sequences exceeds 100 m, but more than 1,000 m in thickness can be expected accordingly to Pokorski et al. 1978).

Isolated volcanic occurrences have also been reported from the Pre-Vendian East European platform (e.g. latites and diabases in the Podlasie depression, rhyolites at the western slope of the Mazury—Suwałki elevation, diabases in the Peribaltic syneclise) but it is to be emphasized that accordingly to Dr. W. Ryka (oral communication), those volcanics are widely different in petrography from the Autunian ones. Their geological age has insofar not been unequivocally determined. For the moment, one can only assess that the volcanics recorded in the Pre-Vendian platform are younger than Triassic. They may thus be correlated with the Autunian volcanics (Depciuch, Lis & Sylwestrzak 1975) but they may also be attributed to the Carboniferous, Devonian, or even Silurian as well.

As to the Autunian volcanics of the Sudeten Mts and the Fore-Sudetic monocline, one should note their considerable lateral spread. They may have actually originated in part or even entirely from melting of some pre-existing sedimentary rocks, as the laser investigations by Walenczak (1979) demonstrated that they comprise traces of organic matter and some relict structures after sedimentary rocks as e.g. siltstones and claystones.

One may therefore claim that the Autunian volcanics are the effect of a powerful heating that rejuvenated coevally the old granitoides and gneisses of the Bohemian

Massif. That conjectured heating imposed a "Variscan" age onto the Bohemian rocks, obtained by radiometric methods but remaining for long inexplicable.

With the Variscan heating that affected even the intra-geosynclinal massifs in the central (or axial) parts of the Late Paleozoic geosynclinal system taken into account, one may consequently suppose that the heating aureole expanding gradually and shifting outwards could have finally reached in the Autunian the marginal zones of the geosynclinal system, including the Variscan externides and even their fore-land.

It seems also reasonable to assume (along the same line of the argument) that the unquestionable and in fact widely accepted Variscan heating must have been related to a considerable supply of heat from the upper mantle to the Moho surface, which disturbed the previous basalt-eclogite phase equilibrium. Under a constant or at most slightly changing pressure, an increase in temperature is well known to result in a phase transformation from eclogite to basalt. This transformation goes directly when the temperature rises rapidly; while it goes indirectly, through a transitional, granulite stage, when the temperature increases relatively slowly.

The phase transformation of eclogite into basalt, be it direct, or indirect, through a granulite layer, is always followed by an increase in volume of the basaltic layer and a downward displacement of the Moho discontinuity. If the proposition by Belousov (1960) concerning a 10—15 or even 25% increase in basalt volume during the phase transformation of eclogite of the upper mantle into basalt of the Earth crust holds true, the transformation would be of a considerable, if not crucial, importance for explanation of the basement pulsations, especially at the stages of platform development.

Such a substantial change in volume at the boundary of the basalt-eclogite phase transformation would have to be the very cause of upper-lithosphere subsidence as well as basement swelling and by implication, lower-lithosphere uplift.

Under the conditions of a platform development, the secular pulsations at the basalt-eclogite phase boundary may actually be responsible for: (*i*) formation of tectonic discontinuities and hence, of crustal blocks; (*ii*) marine transgressions and regressions; (*iii*) subsidence and differentiation in sedimentary-rock thickness; (*iv*) facies patterns; (*v*) disturbance of an erosional base level; and (*vi*) reactivation of an intense erosion.

The insofar known characteristics of the development of the Paleozoic, and especially the Autunian, Saxonian, and Zechstein, as well as that of the Mesozoic may indeed support the above presented hypothesis.

The secular pulsation would then also be the immediate cause of the Autunian volcanism. If various deeply buried sedimentary formations have been indeed melted due to the widespread Variscan heating, as it is claimed above, the process must have also resulted in subaerial lava extrusions.

The process of melting and coeval formation of magmatic-volcanic chambers must have produced fractures of the Earth crust. Those fractures could then receive magmatic masses squeezed out of the magmatic-volcanic chambers by a static pressure of the overlying rocks as well as by a stress exerted by the underlying lithosphere portions due to the phase transformation of eclogite into basalt and an increase in volume of the latter. The volcanic extrusions would then be induced by a process analogous to the action of an immense bilateral press.

The ultimate cause of both these pressures was the same, namely the powerful Variscan heating. It is to be noted that the expanding basaltic layer, increasing in volume due to the phase transformation from eclogite, was allowed to grow upwards but never downwards.

The close relationship of the phase transformation from eclogite into basalt to the resulting pulsations of the Earth crust appears doubtlessly not only in the facies development of the Autunian and Saxonian and in all the Zechstein cyclothems (Pokorski & al. 1978, Wagner & al. 1978), but also in the Mesozoic facies and thickness pattern. Moreover, it is also reflected by the spatial distribution and development of the saline structures (Dadlez & Marek 1974). In fact, there are no saline structures outside the Dolsk and Teisseyre-Tornquist tectonic zones imposing thus strict limits to their lateral distribution.

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A number of questions arise from the above analysis. There is for the moment no satisfactory answer to some of these questions; in some cases, one is able to present a conjectural answer; there are also some problems virtually impossible to solve. Interrogation marks appear thus quite naturally, stimulating sometimes further research by focusing our attention and scientific effort at some specified points, the most important of which appear to me the following ones.

1° The transitional "Moho granulite layer" in the basement of the whole Teisseyre-Tornquist tectonic zone appears clearly distinct throughout the Early Permian. The slope of the Permian to Cretaceous sedimentary basins was persistently distinct and developed just upon that particular layer. One may thus conclude that it made up a boundary between depositional areas different in both sedimentary facies and thickness, situated one east and the other west of that persistent tectonic zone with a considerable bearing on paleogeography.

The problem to be solved is then whether or not the significance of the Teisseyre-Tornquist tectonic zone was the same in the Devonian to Carboniferous as it was beginning with the Permian. Was its influence upon the Devonian to Carboniferous facies distribution and thickness variability as significant as upon the Permo-Mesozoic ones, or even more preponderant? The latter supposition may indeed be justified, since the preponderant rôle of the Teisseyre-Tornquist tectonic zone in the controls of the Ordovician to Silurian sedimentary development appears already established beyond any doubt, and it seems also extremely plausible to assume it for the Vendian to Cambrian sedimentation. The Devonian and Carboniferous should not be exceptions to this long-term rule but this remains still to be proved.

2° Another important problem is the location of the Variscan fore-deep in Poland. This point has been discussed for some years but nonetheless, no satisfactory conclusion has been thus far achieved. New data obtained from the deep seismic sounding and boreholes permit a consideration of the problem in more detail. The outer boundary of the folded Culm is now known to have been shifted considerably to the north, much beyond what had been imagined as the outline of the marginal deep of the Variscan geosyncline filled up with the Culm (or flysch) formation.

Our tectonic and paleogeographic reconstructions tend consequently to displace the belt of the Lower Carboniferous paralic facies to the north and northeast of the Dolsk deep fracture.

We arrive thus at the basic question whether or not the paralic Lower Carboniferous and the limnic Upper Carboniferous with possible coal seams developed mostly within the Teisseyre-Tornquist tectonic zone, the apparent lability of which was due to the phase transformations from eclogite through granulite into basalt in the Moho layer.

Such a supposition may be indeed confirmed by the Carboniferous facies pattern recorded in the Lublin Upland explicable easily with the above proposed relationship taken into account.

Be this actually the case, the Sudetic fore-deep would coincide with the Teisseyre-Tornquist tectonic zone at its Pomerania—Kujawy part. Then, the morphologically rejuvenated but at the same time tectonically rigid Paleozoic core of the Holy Cross Mts would impose a bifurcation of the fore-deep. One of its branches could have been linked, across the present-day Radomsko elevation, with the Upper Silesian depression playing actually a role of a fore-montane depression for the Moravian—Silesian Variscide chain. The other branch could have continued at the Lublin Upland, having however losen the characteristics of a fore-montane depression because one can hardly regard the Holy Cross Mts fore-land as a fore-land of any Variscan mountain chain. In fact, the latter branch of the considered depression developed upon a rigified old basement as demonstrated by the rather moderate (contrasting with typical fore-deeps) thickness and non-molassic facies of both the Lower and Upper Carboniferous series.

3° Finally, the point that is worthy of much attention is the genetic relationship of the Middle Polish swell along with parts of the adjacent depressions to the Teisseyre-Tornquist tectonic zone.

The tectonic nature of the Middle Polish swell has been intensely discussed for some years, and various hypotheses have been put forth and thereafter hotly disputed. The hypotheses range from the opinion that the Middle Polish swell developed at the suture of the contact of the Pre-Vendian platform with the Paleozoic one; or that it was formed in place of the Danish—Polish aulacogen or trough; to the view of the swell as related causally to a pericratonic depression of the old platform.

When discussing the tectonic and geologic significance of the Teisseyre-Tornquist zone in formation of the Middle Polish swell and the adjacent depressions, I believe it is indispensable to point to incompatibility of the Teisseyre-Tornquist zone with intra-continental rift or aulacogen (= extinct but incompletely developed rift) as exemplified by their tectotypes, that is the Rhine graben and Dnieper—Donetsk aulacogen, respectively.

There is no way to prove that the Teisseyre-Tornquist zone occurs within an isochronous or even better, homogeneous platform plate and hence, one may conclude that the zone does not display the basic characteristics of the tectotype as defined by Shatski.

Furthermore, the recent progress in geophysical investigations has revealed that the structural characteristics of the Moho discontinuity (or layer) shown by aulacogens and rifts are quite reverse than those recorded in the Teisseyre-Tornquist zone. Consequently, the last zone should be differently interpreted and called in geological and tectogenetical terms. One may suppose that there are more tectonic zones of Teisseyre-Tornquist type. To recall the tectonic hypothesis put forth by Rich, I propose to regard the Teisseyre-Tornquist zone as resembling more closely an oscillatory crustal depression than a rift or aulacogen. I propose therefore to call it as the Teisseyre-Tornquist oscillatory zone, which term seems to me to be the most consistent one with the origin and nature of the zone.

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A comparison of the maps presented by Guterch (1977, fig. 2) and Dadlez & Marek (1974, fig. 8) to the geological map of Poland (without the Tertiary strata) shows a close, striking coincidence of the boundaries of the Middle Polish swell with those of the Teisseyre-Tornquist tectonic zone. This coincidence is to be observed at the Pomerania-Kujawy part of the structures, up to the transversal dislocation of Radomsko elevation in the southeast along with its prolongation in form of the Tomaszów Mazowiecki—Nowe Miasto fracture.

The conclusion to be drawn is that the Middle Polish swell grew up in its Pomerania—Kujawy part and up to the Tomaszów Mazowiecki—Nowe Miasto fracture, owing to twofold phase transformations of basalt-eclogite type through the transitional granulite stage.

At first, the entire segment delimited by the eastern margin of the Teisseyre-Tornquist tectonic zone in the northeast and by the Odra deep fracture in the southwest underwent an uplift. This resulted in accumulation of the Danian and Paleocene sediments exclusively in the eastern fore-land of the Middle Polish swell, accompanied by an erosion of the Mesozoic strata all over the Fore-Sudetic monocline.

At the second stage of the phase transformation, confined entirely to the limits of the Teisseyre-Tornquist zone, the Middle Polish swell alone was uplifted, whereas the adjacent Szczecin and Mogilno—Łódź depressions underwent a relative subsidence. This differential movements increased the erosion intensity, while at the same time inhibited it in the depressions.

The origin of the Miechów depression requires an explanation in this context. There is however no possibility of any reliable explanation until the depression will be covered with a network of deep seismic sounding profiles, as it is already the case of the Fore-Sudetic monocline.

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STREFA TEKTONICZNA TEISSEYRE'A-TORNQUISTA W ŚWIETLE NAJNOWSZYCH BADAŃ GEOLOGICZNYCH I GEOFIZYCZNYCH

(Streszczenie)

Na podstawie analizy wyników głębokich wierceń oraz pomiarów strumienia cieplnego i eksplozywnej, głębokiej sejsmiki można obecnie z większym prawdopodobieństwem dyskutować strukturę strefy brzeżnej starej platformy Wchodniej Europy i pogłębić jej geologiczną interpretację.

Okazuje się, że rozkład wartości strumienia cieplnego w Polsce i na obszarach przyległych dobrze odwzorowuje główne jednostki tektoniczne. Strefa Teisseyre'a-Tornquist'a jest strefą graniczną. Na wschód od niej, tzn. na platformie Wschodniej Europy, wartości strumienia cieplnego są małe a na zachód od niej, tzn. na platformie paleozoicznej Europy Środkowej i Zachodniej, wartości są duże. Zgodny z tym jest również rozkład geoizoterm dla głębokości 1 i 2 km oraz rozkład gradientu geotermicznego w interwale 0,2—2,2 km. Strefa Teisseyre'a-Tornquist'a jest głęboko zakorzenioną płaszczyzną nieciągłości pomiędzy dwoma blokami skorupy ziemskiej, które różnią się reżymem termicznym, wiekiem konsolidacji i tektoniką. Stąd różny jest stopień ich wychłodzenia.

Wykonane na obszarze Polski regionalne oraz międzynarodowe profile geofizyczne głębokiej sejsmiki eksplozywnej wykazały, że miąższość skorupy jest zróżnicowana od 30—60 km. Głębokie rozłamy, zakorzenione w płaszczu, wyodrębniają w Polsce bloki tektoniczne, które dobrze pokrywają się z dużymi jednostkami tektonicznymi. Powierzchnia Moho w niektórych strefach przekształcona jest w „warstwę Moho" o grubości od 3—12 km. „Warstwa Moho" tworzy się w wyniku fazowego przekształcenia eklogit-bazalt i zatrzymuje się na fazie przejściowej eklogit-granulit-bazalt. Transformacje fazowe powodują sekularną pulsację na granicy bazalt-eklogit i wywołują zwiększenie lub zmniejszenie objętości transformowanej masy. Zmiany fazowe i sekularne pulsacje bazalt-eklogit oraz bazalt-granulit-eklogit są odpowiedzialne za wiele zjawisk geologicznych na etapie platformowego rozwoju, w tym również za autuński wulkanizm.

Bardzo wyraźnie uwydatnia się segment skorupy, który pokrywa się ze strefą tektoniczną Teisseyre'a-Tornquist'a, w której miąższość skorupy i warstwy granulitowej jest największa. Jej właściwości tektonofizyczne są również bardzo charakterystyczne i odmienne od pozostałych segmentów skorupy w Polsce. Strefa Teisseyre'a-Tornquist'a ma fundamentalne znaczenie tektoniczne i reprezentuje sobą marginalną zonę platformy prewendyjskiej Europy Wschodniej odgraniczając ją od platformy paleozoicznej Europy Środkowej i Zachodniej, których historia rozwoju była odmienna. Granice rozprzestrzenienia górnego karbonu paralicznego w Polsce oraz rozwój rowu przedgórskiego waryscydów na obszarze Polski również były uzależnione od przemian fazowych bazalt-granulit-eklogit w strefie tektonicznej Teisseyre'a-Tornquist'a, z którą rów przedgórski waryscydów wydaje się pokrywać w zupełności podobnie jak i polaramijski wał środkowo-polski.

Strefa tektoniczna Teisseyre'a-Tornguist'a ma charakter rowu pulsacyjnego i dlatego nie może być uznawana za ukryty ryft intrakontynentalny lub za aulakogen.