A new concept of the junction nature of the Caspian Sea basin and Mugodzhar

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Received 15 August 2006; accepted 18 October 2006; published 27 December 2006.

[1] A new version of the collision of mobile belt with suboceanic plate is discussed by the example of the relations between collision structures of the southern termination of Ural (Mugodzhar) and preorogenic structures of the Caspian Sea basin located in the inner angle of the East-European platform. Structural geological and geophysical data are given and analyzed. The suture character of Hercynian boundary structures is revealed in the junction zone of Mugodzhar and the Caspian Sea basin. *INDEX TERMS:* 1744 History of Geophysics: Tectonophysics; 3040 Marine Geology and Geophysics: Plate tectonics; 3060 Marine Geology and Geophysics: Subduction zone processes; 8150 Tectonophysics: Plate boundary: general; *KEYWORDS:* suboceanic plate, mobile belt, collision, and edge junction.

Citation: Richter, Ya. A. (2006), A new concept of the junction nature of the Caspian Sea basin and Mugodzhar, *Russ. J. Earth. Sci., 8,* ES5005, doi:10.2205/2006ES000201.

Introduction

[2] There are grounds to believe that the Caspian Sea basin, whose crust belongs rather to suboceanic than continental type, is neither a part of the ancient East-European platform nor an epicratonic element and can be considered as a relatively young sedimentary basin [*Egorkin,* 1998; *Kostyuchenko et al.,* 1999, 2000; *Richter,* 1997, 2003]. This deeply submerged structure with anomalously thick sedimentary complex up to 18–22 km most likely represents one of "basalt windows" inside the continental crust [*Kunin,* 1976]. Thus the problem of the relation between Ural mobile belt and the Caspian Sea basin is brought up at a new level. This junction area is located at the southern continuation of collision structures of the Urals western slope and its foredeep extending along the eastern margin of the East-European platform. The junction area of the Caspian Sea basin and the southern part of Hercynides of Ural folded belt has a number of features of the deep structure that at present have not received of adequate explanation.

Discussion

[3] Mugodzhar, the southern end of South Ural, notably differs in a number of features of tectonic structure, magmatism and metamorphism from the structures of Ural folded belt. It does not have marginal structures of the East-European platform opposite it in the west because to the south of latitude 51°N these structures are replaced by edge zone of the Caspian Sea basin, which is in essence the old continental passive margin, and farther to the south by structures of the central part of this basin. This area, which is defined as the junction zone of the Caspian Sea basin and Mugodzhar hereinafter, shows peculiar features of the geological structure and geodynamic evolution. Many of them had been known long before but were not adequately interpreted owing to the conventional understanding of the Caspian Sea basin nature assumed to be a part of the East-European platform.

[4] This basin due the lack of reliable geological and geophysical data on its deep structure was considered as continuation of the basement of East-European platform. Such an approach to this most difficult problem keeps up to the present and is reflected in the latest geodynamic reconstructions for the South Ural [*Puchkov,* 2000].

[5] We propose an alternative concept of the geological structure and development of the junction area of the eastern edge of the Caspian Sea basin and Mugodzhar as a part of Ural folded belt (Figure 1).

[6] Not all of the so-called structural formation zones of South Ural have continuation in Aktyubinsk area of Ural and Cis-Ural region including Mugodzhar. Moreover, none of these zones from Uraltauskiy anticlinorium to Kizilo-Urtazymskaya zone of Magnitogorsk megasynclinorium is traced to the south of city Aktyubinsk latitude. They successively thin out (are structurally truncated) along the major Ural fault, major suture of the folded belt, dividing it into two sectors: paleocontinental (externides) and pale-

ISSN: 1681–1208 (online)

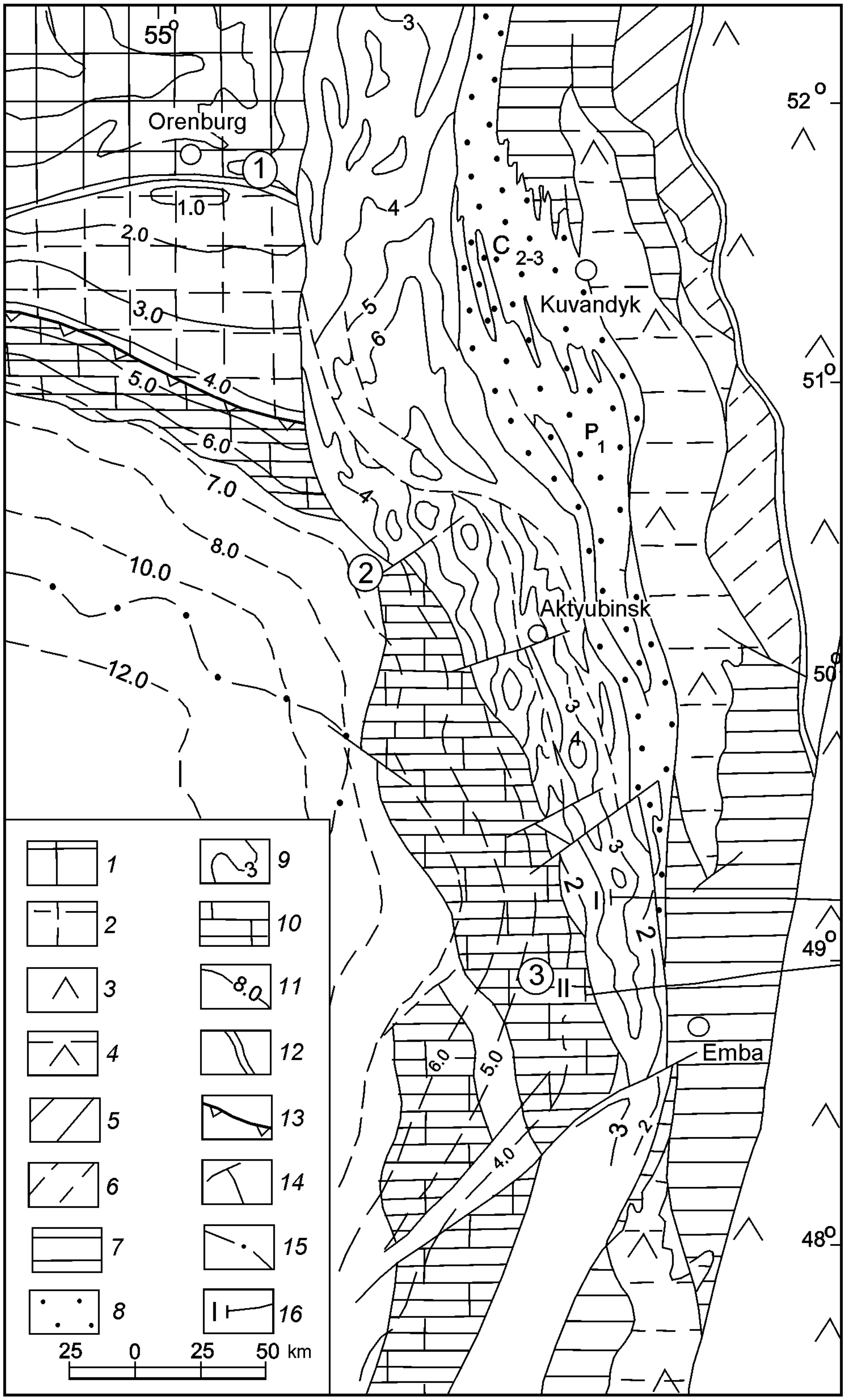

Figure 1. Structure-tectonic scheme of the junction area of South Ural, Mugodzhary and the Caspian Sea basin. Symbols: 1 – East European platform; 2 – Sol'-Iletskiy subsided block; Ural folded belt: 3 – internides; 4–8 – externides: 4 – marginal allochthons; 5 – Uraltauskiy anticlinorium (antiform); 6 – Kempirsayskiy anticlinorium and Khabarninskiy synclinorium; 7 – Zilairskiy (in the north) and

ooceanic (internides). The southern continuation of this suture, i. e. Kempirsaysko-Daulskiy fault (and Prisakmarsko-Voznesenskaya macro melange zone accompanying it) are also truncated by straight West Mugodzharskyi fault, which extends obliquely from north-northeast at latitude somewhat father to south of 50°N and is a continuation of dislocation system in the axial part of Magnitogorskiy megasynclinorium. Owing to this fact at the front of the collision were brought structures of Magnitogorskiy megasynclinorium eastern side and Mugodzharskiy microcontinent (median massif), which is located farther to the east. In this case, neither structures typical of sutures, no indications of folding and cleavage accompanying it common in intense compression zones are noted. In West Mugodzharskaya zone abutting the fault, which predominantly is composed of Middle Devonian greenstone modified basaltic lavas, such dislocations are practically missing and uniform monoclinal bedding prevails; among the rocks, primary volcanogenic structures and specifically fragments of sea rift valley are still retained [*Ivanov et al.,* 1973]. Generally West Mugodzharskaya zone is a large terrain of oceanic crust (in modern structural plan of South Ural it is an autochthonous tectonic unit). A feature of the zone is relatively low extent of island-arc stage volcanic rocks; on the other hand, in a number of syncline plunges (primarily in Berchogurskaya syncline) Late Givetian–Early Frasnian beds of volcanogenic molasses and olistostromes overlay oceanic basalts with sharp angular unconformity; up the section the former are replaced by the thick flyschoid formation of Zilairskaya suite, whose upper horizons belong to Early Carboniferous. These facts suggest that the first episode of the terrain accretion with the Caspian Sea basin margin took place as early as at the end of the Middle Devonian and subsequently common conditions of sedimentation took shape at the junction vast area under which thick beds of volcanogenic-terrigenous sediments were formed.

[7] To the west of the suture of major Ural fold at the area of junction of the Caspian Sea basin and Mugodzhar to the south of 51°N latitude, Uraltauskaya zone, which is very important from geodynamics point of view, tectonically wedges out (anticlinorium or antiform of the same name). At its continuation after the "neck" of Khabarninskiy synclinorium, Kempirsayskiy anticlinorium (antiform) is located, which wedges out to the south of the Oysylkara river valley and similar to Uraltauskiy anticlinorium shows combined scaly and nappe structure.

[8] Thus a structural zone similar to them is not traced to the south of city Aktyubinsk latitude (Figure 1). Zilairskiy synclinorium (synform) structurally conjugated with Uraltauskiy anticlinorium to the south in Aktyubinsk area of Ural continues as Kosistekskiy synclinorium (synform). Similar to Zilairskiy synclinorium, the ophiolite and island-arc complexes of the Ordovician–Middle Devonian occur there that compose tectonic plates in Sakhmarian margin allochthon. The southern continuation of Kosistekskiy synclinorium up to 48°N latitude has allochthon structure as well, where under Mesozoic–Cenozoic cover, ophiolite complex rocks and ultrabasites of Daul'skiy rock mass were established from drilling and geophysical research data. Thick accumulations of greywacke-flyschoid formation of Zilairskaya suite of the Upper Devonian–Lower Carboniferous are abundant there, thus marking the position of the foredeep of that time. This foredeep and autochthon formation of Zilairskaya suite were formed at the accretion stage of Ural mobile belt structures at the East-European continent margin. However to the south between Mugodzhar and the Caspian Sea basin the rocks of greywacke-flyschoid formation are widespread in the junction zone up to South Embinskoye uplift. It suggests that in the junction area accretion processes went on as well but this time above the zone of the Caspian Sea basin oceanic plate subduction under the complex of tectonically scaled oceanic and island-arc structures joined with Mugodzhary micro continent.

[9] In more western zone, the so-called linear folding zone framing the paleocontinental sector of South Ural a bit to the north from city Kuvandyk, the subsidence is noted of rock complex of greywacke-flyschoid formation in the southward direction under thick beds of flyschoid terrigene-siliceous-carbonaceous formation of the Lower–Middle Carboniferous and marine carbonaceous terrigene molasses of the Upper Carboniferous–Lower Permian. Farther to the south on the left bank of the river Ural, Carboniferous deposits in the molasse formation section are replaced by Lower Permian deposits, subsiding under them in the southward direction. From there and to latitude of the River Ilek (in the upstream) in town Kandagach latitude area, Aktyubinskiy trough was separated in this band [*Avrov and Dal'yan,* 1970; *Gridasov et al.,* 1976]. It was assumed to be a part of gigantic South Ural periclinal trough encircling in the Late Paleozoic the southern continuation of the Ural mountain structure [*Yanshin,* 1962]. In the west, it is separated from the Caspian Sea basin by Martukskiy buried fault established from geophysical data [*Avrov and Dal'yan,* 1970] as a border line, to the west of which the linear orientation of folded structures is not noted but mosaic pattern of geophysical anomalies distribution prevails, which is typical of areas of salt-dome tectonics. The total thickness of sediments of flyschoid and lower (marine) molasses in this trough reaches 4.5–5.0 km [*Zamarenov,* 1970], which considerably exceeds the thicknesses of synchronous structures in Cis-Ural foredeep and the eastern area near the side of the Caspian Sea

Kosisteksko-Aksuyskiy (in the south) synclinoria; 8 – West Ural zone of linear folding and thrusts; 9 – Cis-Ural foredeep (figures in circles – 1), Aktyubinskiy (2) and Ostansukskiy (3) troughs; Caspian Sea basin: 10 – carbonaceous platforms C_2-P_1; 11 – isohypse of subsalt Paleozoic complex Π_{II}; The rest of symbols: 12 – Major Ural fault (suture); 13 – Artinskian side scarp of Caspian Sea basin; 14 – tectonic dislocations; 15 – border of Khobdinskiy gravitational maximum; 16 – position of seismic profiles obtained with the use of common depth point [*Kan,* 1994].

basin. For example, the thickness of Upper Carboniferous rocks in the east of the basin (in areas Zhanazhol and Alibekmola) is not more than 260 m, and in Cis-Ural trough it amounts about 2200 m. In Aktyubinskiy trough, Paleozoic sediments underlying molasse formation form a system of gently sloping steps divided by faults and descending from east to south towards the Caspian Sea basin and also gently sloping southwards. It is significant that this trough is at 80 km to the south from city Aktyubinsk latitude and in its turn is replaced by Ostansukskiy trough, where thickness of synchronous formations considerably decrease (in Ostansukskiy area they are less by factor 2.5–3) and farther to south at settlement Kenkiyak latitude Pre-Kungurian shearing starts to manifest itself markedly and the thickness of Pre-Kungurian rocks decreases to the first hundreds of meters. In Ostansukskiy trough, it is established that terrigenous rocks of early orogenic marine C_2m-P_1 molasse of thickness up to 2600 m overlap shallow-water shelf carbonaceous (C_1v-C_2b) deposits in such structures as Baydzharykskaya, Karnakskaya and Alibekmolinskaya synclines belonging to the eastern edge of the Caspian Sea basin. To the east of this zone, in the eastern Ostansukskiy trough, the same molasses overlays more deep-water sediments of the same age. Thickness distribution of Kungurian stage and overlaying Permian structures seems to be absolutely different. It increases from east to west and from north to south from 3–4 km to 5–6 km, suggesting the growth of the Caspian Sea basin as the result of subsidence of the framing outer zones of Aktyubinsk area of Ural region, Aktyubinskiy and Ostansukskiy troughs [*Gridasov et al.,* 1976].

[10] Aktyubinskiy trough similar to Cis-Ural trough was formed as orogenic structure; Upper Paleozoic sediments that filled it at the end of Permian–beginning of the Triassic were crumpled into linear folds overturned westwards under lateral pressure from the east. A feature of Ostansukskiy trough is gentle folds of platform type that were formed in all probability at the same time; they are located along the same linear faults as folds located to the north of Aktyubinskiy fault. This may mean that in the absence of lateral pressure of any significance in Ostansukskiy trough, step-like lateral subsidence prevailed with block rotation moving on listric faults. Along the plane of each listric fault, the rotating block (step) edge lifted up and above this edge swell-form complication of step fold formed in the sedimentary beds overlapping the steps. In swell-form bends local anticline typical structures were formed. At the same time in the eastern part of Ostansukskiy trough more significant rises took place, which formed deep pre-Kungurian gap.

[11] To the west of Ostansukskiy trough, an interruption in sedimentation of great duration, which was accompanied by deep erosion of sediments accumulated before, is characteristic of the whole eastern edge zone of the Caspian Sea basin. This interruption embraced a considerable part of the Carboniferous, the whole Late Carboniferous (locally with the beginning of the Early Permian) and intervals of Middle Carboniferous, which is indicated by Artinskian–Sakmarian rocks of the Lower Permian overlapping different horizons of carbonaceous complex of Moscovian and Bashkirian stages. This carbonaceous complex forms large "island" uplifts, which are plateau-form areas of shallow shelf; carbonaceous accumulations thickness there ranged from 400 m to 600 m (areas Zhanazhol, Tortkol', Aransay, Alibekmola) and reached 2000 m at Kozhasay and Sinel'nikovskaya areas. Many of them can be compared in their size with the so-called carbonaceous "platforms".

[12] These areas of abundant carbonaceous sediments correspond to fairly large homogeneous geological bodies of considerable thickness and size of the order of 30×100 km (Temirskiy "ledge", Enbekskiy and Zharkamysskiy "arches"). Together they form Zharkamyssko-Enbekskaya zone bent eastwards in a kind of arc [*Botneva et al.,* 1990; *Krylov et al.,* 1994]. Its overall size in north-south is up to 300 km and in easr-west direction it amounts to 100 km. Just to the southeast on the Ostansukskiy trough continuation, one more zone, where Carboniferous–Early Permian carbonaceous sediments are abundant, is located. It is Zhanazholskaya zone extending for 300 km as a narrow band to the southwest and passing there into external structures of South Embinskoye marginal uplift. To the west towards the Caspian Sea basin, carbonaceous platforms of Zharkamyssko-Enbekskaya zone are cut off with ledges reaching the height of several hundreds meters with dip angles of 10–15° and more. Bodies of clinoforms composed of Artinskian terrigenous rocks of gray color formation with conglomerate in the basement generally lean against the ledges. The thickness of individual bodies of those clinoforms reaches 800 m. The total thickness of Pre-Kungurian terrigenous formation of C_3-P_1 age reaches 3–4 km in the east of carbonaceous platforms where rocks of this formation compose Ostansukskiy trough abutting the folded structures of Mugodzhar. In the axial area of the trough, the section of this formation from top to bottom is increased by uniform terrigenous rocks of C_2m-C_3 age of thickness up to 2 km.

[13] Thus to the south of Cis-Ural foredeep close to its continuation, that is Aktyubinskiy trough, the edge zone of the Caspian Sea basin is located with buried carbonaceous platforms typical of it as well as the deeply subsided narrow Ostansukskyi trough composed of terrigenous sediments and contacting the structures of Mugodzhar along Sakmarian-Kokpektinskiy fault. From recent geophysical research data [*Kan,* 1994], the area of junction of Mugodzhar and the Caspian Sea basin is notably different from more northern Orenburg and Bashkiria areas of Ural and abutting structures of South Ural. In seismic profiles obtained with the use of common depth point (Figure 2) between Ostansukskiy trough and more eastern Kosisteksko-Aksuyskaya and Western Mugodzharskaya zones along Sakmarian-Kokpektinskiy fault, a subvertical tectonic contact is marked to the depth of the carried out interpretation of the order of 8–10 km. Along this tectonic suture, heterogeneous structure-matter complexes of completely differing types are brought together, which on the western side belong to the Caspian Sea basin including Ostansukskiy trough and on the other side belong to the zone of external structures of South Ural (Mugodzhar). In this case, in Kosisteksko-Aksuyskaya zone it is established that Middle Paleozoic volcanogenic Uralide complexes overlap the thick deformed complex of predominantly terrigenous rocks, which are conventionally referred to the Cambrian-

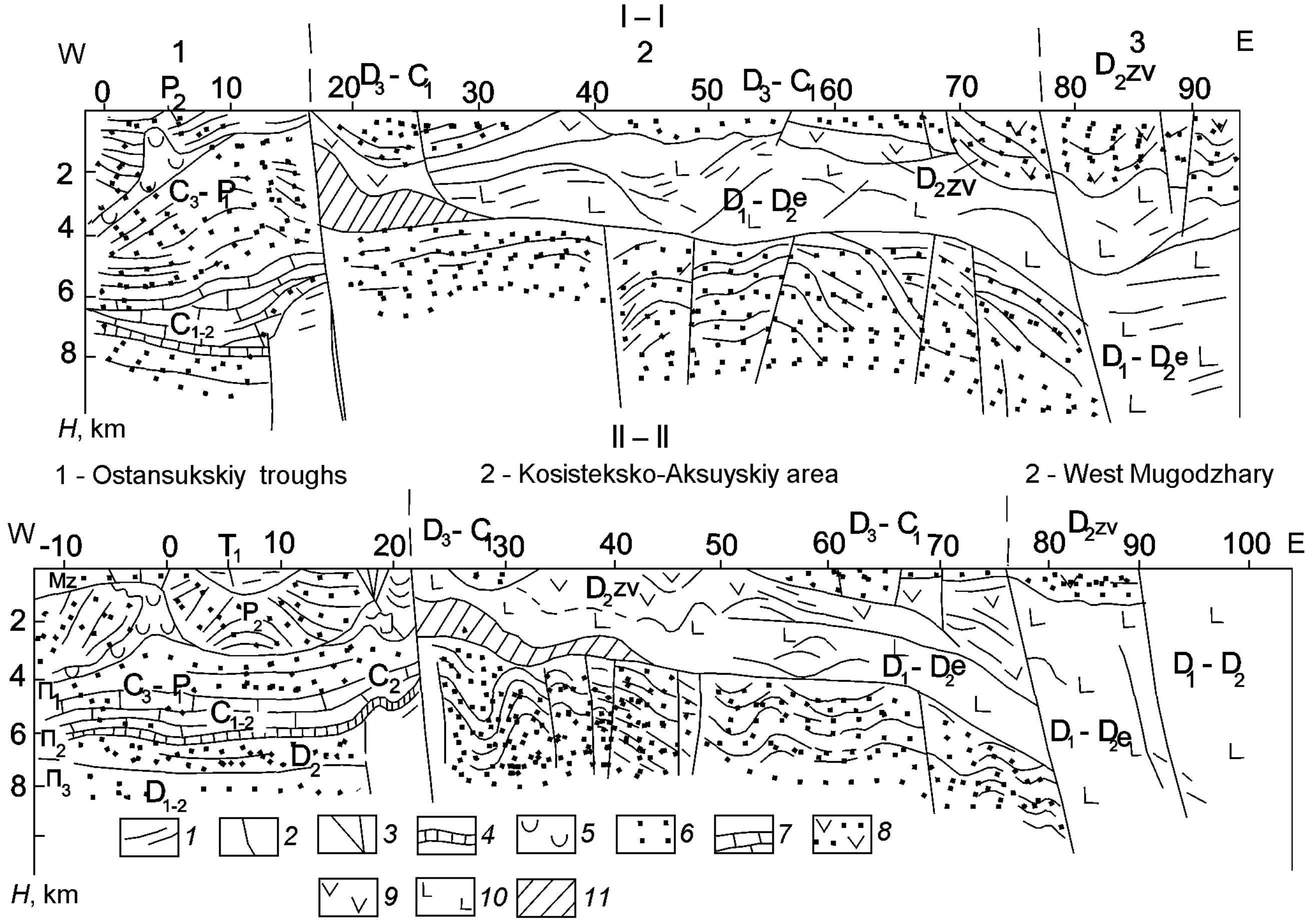

Figure 2. Geological and geophysical sections of western Mugodzhar region along seismic profiles obtained with the use of common depth point method 657-A (I–I) and 918-A (II–II) from data by *Kan* [1994]. Symbols: 1 – reflecting horizons and areas; 2 – Sakmarsko-Kokpektinskiy fault; 3 – other faults; 4 – basement of orogenic complex C_3-P_1; 5 – salt-bearing sediments of Kungurian stage P_1; 6 – terrigenous sediments; 7 – carbonaceous sediments; 8 – sedimentary-volcanogenic deposits; 9 – volcanogenic complexes of differentiated composition; 10 – volcanogenic basic complexes; 11 – ultrabasic rocks and serpentinite.

Ordovician [*Kan,* 1994]. Their thickness along with Riphean formations that may underlie them is estimated as 5–7 km. However this pattern, in our opinion, corresponds more to tectonic overlap of one complex (terrigenous) with another (volcanogenic), which is characteristic of Zilairskaya zone of external structures with its large allochthons of volcanogenic rocks. Therefore we correlate this zone with Zilairskiy synclinorium and not with Uraltauskiy anticlinorium and we also believe that the thick lower structural stage composed of terrigenous rocks is not of the Cambrian-Ordovician but is younger and can be compared to the complex of sediments of Zilairskaya suite of the Upper Devonian–Lower Carboniferous abundant in Kosisteksko-Aksuyskaya zone.

[14] To the west, in the zone of Ostansukskiy trough, the surface of reflecting horizon Π_3, which is interpreted as the base of complex D_{1-2}, which is likely to overlay the Lower Paleozoic complex, is located at depths of 7–8 km going down to the east towards the tectonic suture with Kosisteksko-Aksuyskaya zone of uralides. Similar subsidence is noted of the reflecting horizon Π_2-Π_2^1 corresponding to the surface of Visean-Bashkirian sediments. Paleozoic sediments bed confined between the horizons Π_1 (the top of Sakmarian-Artinskian sediments P_1) and Π_2-Π_2^1 belongs to the early orogenic marine molasse of C_3-P_1. Its rocks are opened by deep boreholes (П-11 Northern Ostansuk, П-26 Baydzharyk, П-27 Dzhurun, П-30 Dzhilansaid, Г-15 Karnak and others). Visean-Bashkirian rocks of carbonaceous shelf formation occur in the base of this rock bed. The total thickness of the Middle Paleozoic preorogenic complex in this area is 4000–5000 m, which testifies to considerable subsidence of its territory and apparently to a rapidly developing trough before the beginning of the collision. From data obtained with the

use of seismic refraction and common depth point methods the surface of base of preorogenic complex or the surface of "crystalline basement" as it is given by the cited author subsides stepwise in the eastern direction from Temirskiy arch, reaching the depth of 11–12 km [*Kan,* 1994].

Conclusion

[15] The features of the deep structure discussed above make this area markedly different from more northern areas of Ural region and the western slope of the Ural, where foreland fold-thrust complexes and allochthon complexes of Ural internides overlaying the ancient crystalline basement of East European platform are widespread.

[16] Thus along subvertical Sakmarian-Kokpektinskiy fault dividing Ostansukskiy trough and Kosisteksko-Aksuyskaya zone of uralides a marked tectonic contact that is a marginal suture is traced between the largest tectonic structures of the Caspian Sea suboceanic basin (plate) and Ural folded belt. To the north approximately at latitude of $49^\circ 40'$ N, the linear structure of marginal suture widens and is replaced by fold-thrust dislocations of Aktyubinskaya area of Cis-Ural foredeep. At the same time on the eastern side of the suture, fold-thrust structures are encountered of the external zone of uralides, western Ural zone of linear folding, composed of marine molasse rocks C_2-P_1. It is notable that to the south, the molasse formations occur on the other side of the marginal suture in Ostansukskiy trough and are not known in Kosisteksko-Aksuyskaya zone of uralides. Ostansukskiy trough may be assumed to have been set in the Middle Carboniferous on the suboceanic basement of the Caspian Sea plate in the course of converging to and colliding with island arcs that underwent accretion and microcontinents of Ural mobile belt. One can now appreciate the significance of the continental interruption of immense duration that embraced the Late Carboniferous and the Early Permian and is represented at the area of eastern edge zone of the Caspian Sea basin to the west of Ostansukskiy and Aktyubinskiy troughs. It corresponds to the collision time of its plate and Ural mobile belt structures. One may assume that the collision of Ural mobile belt structures to the south of latitude 51°N went on differently from the collision along the ancient passive margin of the East European continent. It took place at the front of collision with suboceanic plate that later on was transformed into the basement of the Hercynian Caspian Sea basin. The suboceanic lithosphere of this plate moved therewith under island-arc constructions of the southern continuation of Ural mobile belt. Specifically the persisting general eastward tilt of preorogenic complex surface in Ostansukskiy trough testifies to this effect as well as the occurrence in the Kempirsayskiy anticlinorium section base of thick beds of differentiated volcanic rocks of the island arc set as early as in the Early Paleozoic. The deep-sea trench formed in the course of subduction and the marginal swell framing it from outside bordered the basin of the would-be Caspian Sea basin and predetermined the accumulation of a thick series of Middle Paleozoic deep-sea terrigenous sediments. In the marginal swell, rises took place; owing to the rises in the conditions of medium and shallow depths large carbonaceous masses ("platforms") were formed which were deeply eroded at the end of the Middle Carboniferous and Late Carboniferous.

[17] The situation discussed above can be related to the so-called "butt-end" junctions of heterogeneous structural elements of the Earth's crust: the Caspian Sea basin edge zone of east-west extension "is jointed" in the east to the Ural folded belt structures of north-south extension. How does this affect the geological structure of Ural? And why is it so? We tried to draw attention to some features of the geological structure of Ural at the continuation of the Caspian Sea basin edge zone (latitude 51–50°N) and to show that besides the expected "reflection" of this zone on the western slope of South Ural owing to its continuation at the level of the platform crystalline basement, which may be traced from geophysical data, such features are revealed among others that cannot be accounted for by the zone influence. From geodynamics viewpoint it becomes important that the case of suboceanic plates collision with subduction structures of mobile belt be discussed, its mechanism be established and corresponding models be developed.

References

Avrov, P. Ya., and I. B. Dal'yan (1970), Aktyubinsk area of Ural region, *Geologia SSSR, XXI*(1, Book 2), 72.

Botneva, T. A., M. K. Kalinko, and O. S. Komissarova (1990), Justification of the most efficient direcions of oil and gas prospecting in the Caspian Sea region syneclise, in *Geological Foundations of Construction of the Caspian Sea Region Oil and Gas Extracting Complex,* p. 126, Nauka, Moscow.

Egorkin, A. V. (1998), Velocity structure, composition and discrimination of crustal provinces in the former Soviet Union, *Tectonophysics, 298,* 395.

Gridasov, Yu. M., I. B. Dal'yan, L. P. Traynin, A. Shlezinger, and A. L. Yanshin (1976), The relationship between the Caspian Sea basin and Aktyubinsk periclinal trough, *Bull. MOIP. Dep. Geol., LI*(5), 48.

Ivanov, S. N., V. G. Korinevskiy, and G. P. Belyanina (1973), The relics of rift oceanic valley in Ural, *Dokl. AN SSSR, 211*(4), 939.

Kan, V. P. (1994), New data on the deep geological structure of western Mugodzhary region from data of seismic research with the use of depth point method, *Geology of Oil and Gas, 5,* 28.

Kostyuchenko, S. L., A. V. Egorkin, and L. N. Solodilov (1999), Structure and genetic mechanisms of the Precambrian rifts of the East-European Platform in Russia by integrated study of seismic, gravity and magnetic data, *Tectonophysics, 313,* 9.

Kostyuchenko, S. L., L. N. Solodilov, and A. V. Egorkin (2000), The features of structure and physical fields of the Earth's crust and the upper mantle of individual regions of Eurasia, in *Neotectonics, Geodynamics and Seismicity of Northern Eurasia,* edited by A. F. Grachev, p. 294, "Probel", Moscow.

Krylov, N. A., V. P. Avrov, and Z. V. Golubeva (1994), The geological model of subsalt complex of the Caspian Sea basin and oil and gas presence, *Geology of Oil and Gas, 5,* 35.

Kunin, N. Ya. (1976), New global tectonics, oil science and geophysical indications of former oceanic structures in modern continents, in *Geodynamics and Useful Minerals,* p. 25, VINITI, Moscow.

Puchkov, V. N. (2000), *Paleogeodynamics of South and Middle Ural,* 146 pp., Dauriya, Ufa.
Richter, Ya. A. (1997), Is the Caspian Sea basin a relic of Paleozoic ocean?, in *Nedra Povolzh'ya i Prikaspiya,* Issue 12, p. 2, "Nauchnaya kniga", Saratov.
Richter, Ya. A. (2003), *The Outline of Regional Geodynamics of the Caspian Sea Basin and Its Framing,* 86 pp., "Nauchnaya kniga", Saratov.
Yanshin, A. L. (1962), Major features of the tectonics of the Upper Paleozoic sediments of Mugodzhar periphery in the context of oil and gas presence prospects estimation, in *Geological Structure and Oil and Gas Presence of the Eastern Caspian Sea Basin and Its Northern, Eastern and Southeastern Framings,* p. 56, Gostoptechizdat, Moscow.
Zamarenov, A. K. (1970), *The Middle and Upper Paleozoic of the Southeastern Framing of the Caspian Sea Basin,* 138 pp., Nedra, Leningrad.

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