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QUALITATIVE ASSESSMENT OF COMPRESSIONAL STRESSES WITHIN THE SOUTH CASPIAN MEGADEPRESSION AND THEIR IMPACT UPON STRUCTURE FORMATION AND HYDROCARBON GENERATION

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Summary. As a result of convergence of the Iranian and Anatolian plates the South Caspian marginal continental basin had already been formed in the end of the Eocene. The South Caspian mega-depression (SCMD) is partitioned into a series of structural units of various scale that have certain evolutionary autonomy against uncompensated subsidence of the depression. In the article from west to east the following structural elements of the SCMD have been considered: the Kur and Gabyrry interfluvial depression, the Lower Kur and the Baku archipelago depressions, the western half of the Absheron-Balkhan residual subduction zone, represented in Azerbaijan mainly by the Absheron archipelago, and the Turkmen shelf owing to the Godin massif by its formation. Based on dimension ratios of local uplifts within the structural elements of SCMD we tried to assess qualitatively the compressional stresses in these areas, their trend and impact upon a number of geological processes. For this purpose, isomorphic maps of the abovementioned structural units, charts reflecting the morphology of local uplifts have been constructed and analyzed. The research results made it possible to establish a direct relationship between compressional stresses, structure formation, mud volcanism and oil and gas content. It is established that the South Caspian depression has been developed as an uncompensated sedimentary basin surrounded by collision and residual subduction zones, subjected to intense compressional stresses and characterized by subsidence and deposition. There is direct relation between the extent of mud volcanism and intensity of compressional stresses in the structural units under study: the former one is the indicator of the latter one. Absence of mud volcanism on the Godin massif is associated with absence of the favorable paleogeographic environment and compressional stresses. Compressional stresses in the intermountain depressions have positive impact upon their oil and gas content, that is, compressional stresses, mud volcanism and hydrocarbon generation are associated with geostructural units.

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Introduction

Study of the geodynamic environment of the formation of the South Caspian depression (CSD), which is the central water area segment of the South Caspian mega-depression (SCMD), and the geodynamic chart of the lithospheric plates surrounding it (Fig. 1) indicates that till the end of the Miocene the water area of the South Caspian was one of the deepest depressions of the Thetis ocean, located between the Iranian and Eurasian plates. As a result of convergence of the Iranian and Anatolian plates the South Caspian marginal continental basin had already been formed in the end of the Eocene (Гамкрелидзе, 1982).

The Greater and Lesser Caucasus collisions were subjected to upheaval and convergence in the Late Miocene, caused by formation of two subduction zones in the region. One of them is oriented north-

wards beneath the Greater Caucasus, whereas the second one – southwards beneath the Lesser Caucasus (Зоненшайн и др., 1990; Ахмедов, 1987). Such a geodynamic environment puts the SCMD under the great compressional stresses (Fig. 2).



Fig. 1. Geodynamic borderlines (in red) and force line directions (the black arrows) between lithospheric plates within the central segment of the Mediterranean folding belt (after N.R. Narimanov)

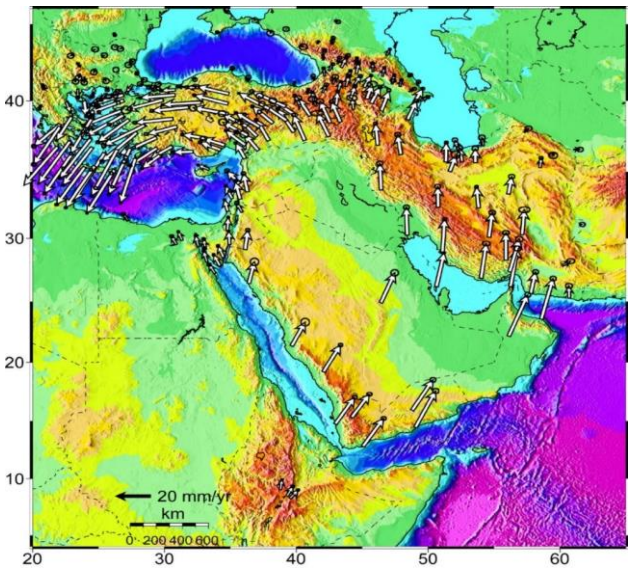


Fig. 2. Map showing decimated GPS velocities relative to Eurasia (Reilinger et al., 2006).

Velocity fields from wide-scale GPS surveys clearly show north-northwestward movement of the Earth crust of Azerbaijan and adjacent area of Caucasus.

The most prominent feature of the velocity field is the velocity drop at survey points perpendicular to the Greater Caucasus nappe (GCN) (i.e., KURD and MERD and BILE and SHIK). The survey points indicate velocity drop all along the GCN. We consider movement of the Earth surface north-northeastward as a cause for stress accumulation in this nappe. Additionally, there is potentially horizontal movement within the Kur depression and the Lesser Caucasus from west to east, i.e. along the mountain belt.

Taking into account that the South Caspian depression is subjected to compressional stresses from south, west and north (Fig.3), compressional stresses of various extents develop in each of its structural units as a function of thickness of the sedimentary cover, its lithologic composition, depth of the basement and other factors. As a result, the local uplifts of various shape and size are formed in them. Thus, by studying morphological properties and relations of local uplifts that evolved in each of the SCMD structural units it is possible to qualitatively assess intensity of compressional stresses in the area and establish their impact direction. It should be noted, that F.A.Kadirov, R.T.Safarov studied deformation of the earth crust in Azerbaijan and bordering areas using GPS (Кадиров, Сафаров, 2013). Meanwhile, distribution, trending and intensity of the compressional stresses within the SCMD are qualitatively defined as described below.



Fig. 3. The main impact directions of compressional stresses in the South Caspian depression (after N.R. Narimanov)

Objectives

Based on dimension ratios of local uplifts in the Kur-Gabyrry interfluvial depression, Absheron, Baku archipelagos, the Lower Kur depression and the Turkmen shelf of the SCMD, authors tried to assess qualitatively and study the trend of compressional stresses in these areas and their impact upon a number of geological processes. For this, isomorphic maps of the abovementioned structural units, charts reflecting the morphology of local uplifts have been constructed and analyzed.

Methods

It is known that folds complicated by mud volcanism refer to diapir structures. They developed in the regions of the mobile Pacific and Alpine-Himalayan fold belts, where compressional stresses are widespread (Рахманов, 1987; Алиев и др., 2015; Кадиров и др., 2014). When diapir folds are formed, they are isometric if not subjected to compressional stresses. Nevertheless, if the evolution of the diapir is however slightly affected by compressional stresses, then a short brachyfold is formed, and if more strongly affected, a long brachy- or linear folds are formed. That is why the morphology of diapir and other fold types is a function of intensity of compressional stresses that affect them during their evolution. The proposed method for a qualitative assessment of the intensity of compressional stresses in this area is based on the analysis of the morphology of diapir and other folds.

Being the final stage of mud diapir evolution in the sedimentary cover, mud volcanism is associated with high shale content of the sedimentary cover rich in organic matter (OM), deep heat flow and high intensity of compressional stresses in the region.

Results

Since the Kur-Gabyrry interfluvial depression, situated in the west-north-west of the SCMD, is formed in the area where the Greater and Lesser Caucasus collisions are the closest to each other, impact of compressional stresses developed therein upon folding is greater. The isomorphic map drawn for the structural unit under consideration (Fig. 4) shows general orientation of contours from west-north-west to east-south-east, relatively dense breadthways contours and their greater values (7.0-3.4). All this indicates highly developed compressional stresses in the area. The morphological chart also depicts prevalence of long brachyfolds and their west-north-west – east-south-east orientation (Fig. 4).

Linear arrangement of a large number of salsas, gryphons, mud volcanoes of the Kur-Gabyrry interfluvial depression alongside Caucasus range, their genetic relation (Рахманов, 1987) to overthrusts in particular indicate the major role of compressional stresses in evolution of the uplifts themselves. Distribution of various fault types, mud volcanoes of different forms, on the other hand, can be assessed as a result of activity of compressional stresses. So there are a lot of large-amplitude overthrusts that complicate the structural and tectonic pattern of the region. However, the reservoir rocks on the footwalls screened by the hanging walls may have preserved their oil and gas potential. Only 2 uplifts out of 17 local ones in the Kur-Gabyrry interfluvial depression are complicated by mud volcanoes. However, there are over 100 gryphons, salsas and mud hills in the area (Рахманов, 1987; Алиев и др., 2015). A low number of mud volcanoes is associated with relatively little thickness (11-13 km) of the sedimentary cover with low shale content. The isomorphic map (Fig. 4) of the depression shows that the intensity of developed compressional stresses is high enough and isoline values vary between 3.4 and 7.0. The background of compressional stresses in that case is high. The table shows that 3 local uplifts out of 17 are oil bearing, the rest are potentially hydrocarbon bearing (Нариманов, 2005a,b).

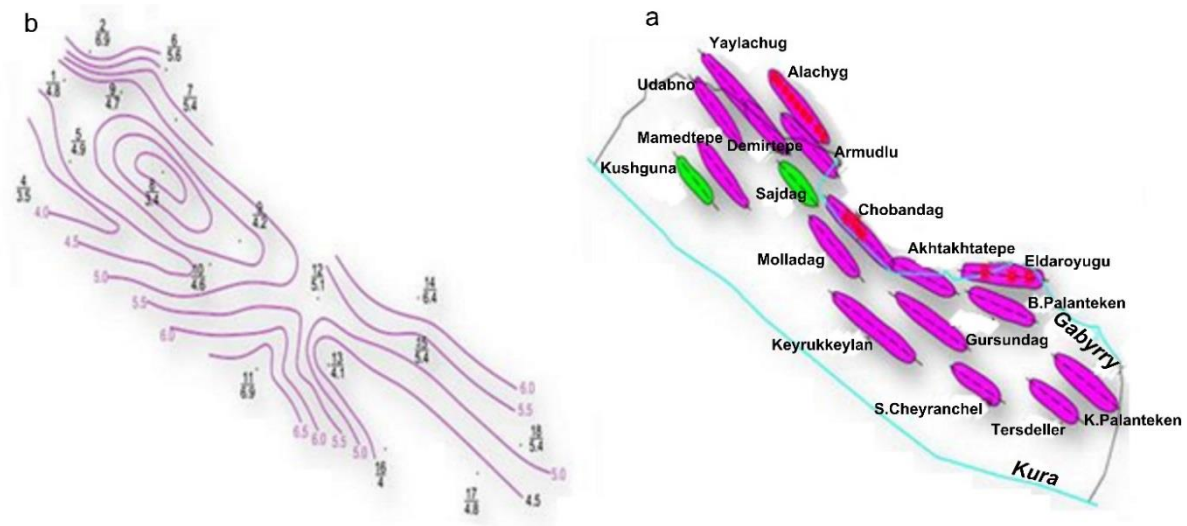


Fig. 4. a – isomorphic map, b – morphology and attitude of local uplifts of the Kur-Qabirry interfluvial depression

Table

Local uplifts of the structural units of the South Caspian mega-depression with proved oil and gas content

N	Number of folds	Oil and gas				
		Oil bearing	Gas bearing	Oil and gas bearing	Potentially hydrocarbon bearing	Mud volcanoes
1		Kur-Gabyrry interfluvial depression				
	17	3	-	-	14	2
2		Absheron oil and gas bearing province				
	51	21	4	7	19	53
3		Oil and gas bearing province of the Baku Archipelago				
	21	3	1	3	14	13
4		Lower Kur oil and gas bearing province				
	17	10	2	2	3	10
5		Godin massif				
	14	-	-	-	-	1

The Lower Kur depression is wider than the Kur-Gabyrry interfluvial depression and since it is remote from the Greater and Lesser Caucasus, Talysh collision zones, impact of compressional stresses developed in them is less than that in the Kur-Gabyrry depression. The isomorphic map (Fig. 5) drawn for this area depicts relatively dense isolines in the north with mainly long brachyfolds evolved, and rarer isomorphic lines in the south with short brachymorphic local uplifts, all of which indicate intense compressional stresses in the north part of the Lower Kur depression than that in the south part (Fig. 5 a, b). 10 out of 15 local uplifts under consideration are complicated by mud volcanoes (Table), numerous salsas and gryphons have evolved here. The isomorphic map of the depression (Fig. 5, a) shows that its isolines are not regularly spaced and their values vary between 2.3 and 4.9. This is indicative of relatively even areal distribution of compressional stresses. However, the isoline values suggest that the intensity of compressional stresses increases from the central part of the area northward. This is possibly caused by adjacency of the northern part of the Lower Kur depression to Alat-Langabiz tectonic zone with relatively intense compressional stresses. In the depression 10 out of 17 local uplifts are oil bearing, 2 – gas bearing, the rest are potentially hydrocarbon bearing (Table). Despite relatively weak compressional stresses in the Lower Kur depression in comparison with the Kur-Gabyrry interfluve, numerous mud volcanoes and higher oil and gas potential of the former one are associated with relatively greater thickness of the sedimentary cover (9-20 km) and wide-spread pelitic facies the source rocks composed of. Due to continuous uncompensated subsidence of the basin the source rocks have been buried into more favorable temperature and pressure environment.

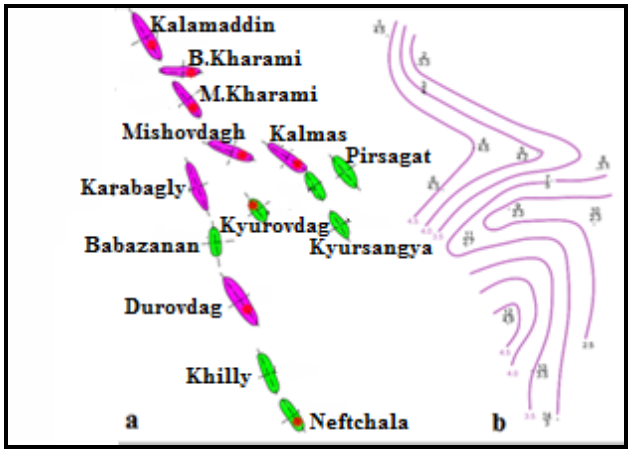


Fig. 5. a – morphology of the local uplifts; b – isomorphic map of the Lower Kura depression

Compressional stresses in Baku Archipelago had an impact on evolution of local uplifts, as well as upon formation of a regional uplift of sublongitudinal orientation that constitutes the western slope of the South Caspian basin and is located between the Lower Kur depression and Baku Archipelago (Фейзуллаев и др., 2016). Compressional stresses in the Baku Archipelago are of the east-northeastern trend. Active buckling and bending mechanisms of folding had an impact upon formation of mainly brachyfolds and that is indicated by density of contours on isomorphic maps. It is a common knowledge that mud volcanoes indicate actual compressional stresses, since, as mentioned above, mud volcanism is widespread in the Alpine-Himalayan fold belt and along the western mobile subduction zone of the Pacific basin, where compressional stresses are well-developed (Алиев и др., 2015). The structural units studied in the article refer to the SCMD situated in the central segment of the Alpine-Himalayan fold belt. As a rule, regions complicated by mud volcanism mostly have higher oil and gas potential. One

may infer that compressional stresses in negative geostructural units of regions with active geodynamic and tectonic environment constitute an entity with mud volcanism and hydrocarbon potential. From that perspective, 13 out of 21 local uplifts of the Baku Archipelago are complicated by mud volcanoes, 3 – oil bearing, 1 – gas bearing, 3 – oil and gas bearing, the rest refer to potentially hydrocarbonaceous structures (Table). Isoline values on the isomorphic map that depicts intensity of compressional stresses in the Baku Archipelago vary between 2.5 and 6.1 (Fig. 6).

From geodynamic point of view the Absheron-Balkhan structural mega-saddle that makes up the north-northeastern slope of the SCD is a structural and tectonic manifestation of non-classical subduction zone. It is a common knowledge that the residual or non-classical subduction takes place here due to the South Caspian microplate sliding beneath the Middle Caspian block (Ахмедов, 1987; Фейзуллаев и др., 2016; Перспективы нефтегазоносности…, 2015). It should be noted that in such cases buildup of compressional stresses is more intense than a linear movement between the plates. Compressional stresses that impact the Absheron-Balkhan structural mega-saddle in the sublongitudinal direction (Fig. 2) are relatively more intense than those within the SCD. The low intensity of compressional stresses in SCD is related to the mentioned collisions in the west and east of the Absheron-Balkhan residual subduction that prevent the normal flow of the process within the latter one from completion and turning into collision (Фейзуллаев и др.,, 2016). Nevertheless, structural and tectonic layout of the region, complication of the structural mega-saddle by overthrusts, even nappes and latitudinal tectonic strike-slip faults, sublatitudinal orientation of local uplifts suggest intense enough compressional stresses of sublongitudinal trend (Fig. 7). Comparison of isomorphic maps of the areas under investigation reveals that isoline values of the Absheron isomorphic map cover wider range (2.1-9.0) and the lines are more densely drawn. Predominant formation of the widespread mud volcanoes in the Absheron Archipelago on the structures situated along the mega-saddle axis indicates relatively more intense compressional stresses in the archipelago. There are 53 mud volcanoes on 51 structure of the Absheron Archipelago, that means that some folds are complicated by 2 mud volcanoes. Isoline values of the archipelago's isomorphic map ranging between 2.1-9.0 imply more intense compressional stresses relative to the Baku Archipelago. As mentioned above, this is caused by the Absheron-Balkhan structural mega-saddle being, from geodynamic point of view, a residual subduction. From table 21 folds out of 51 within the archipelago are oil bearing, 4 – gas bearing, 7 – oil and gas bearing, the rest are potentially hydrocarbon bearing. Thus, 32 local uplifts within this structural unit are hydrocarbon bearing and 19 are prospective (Нариманов, 2005a,b).

a) b)

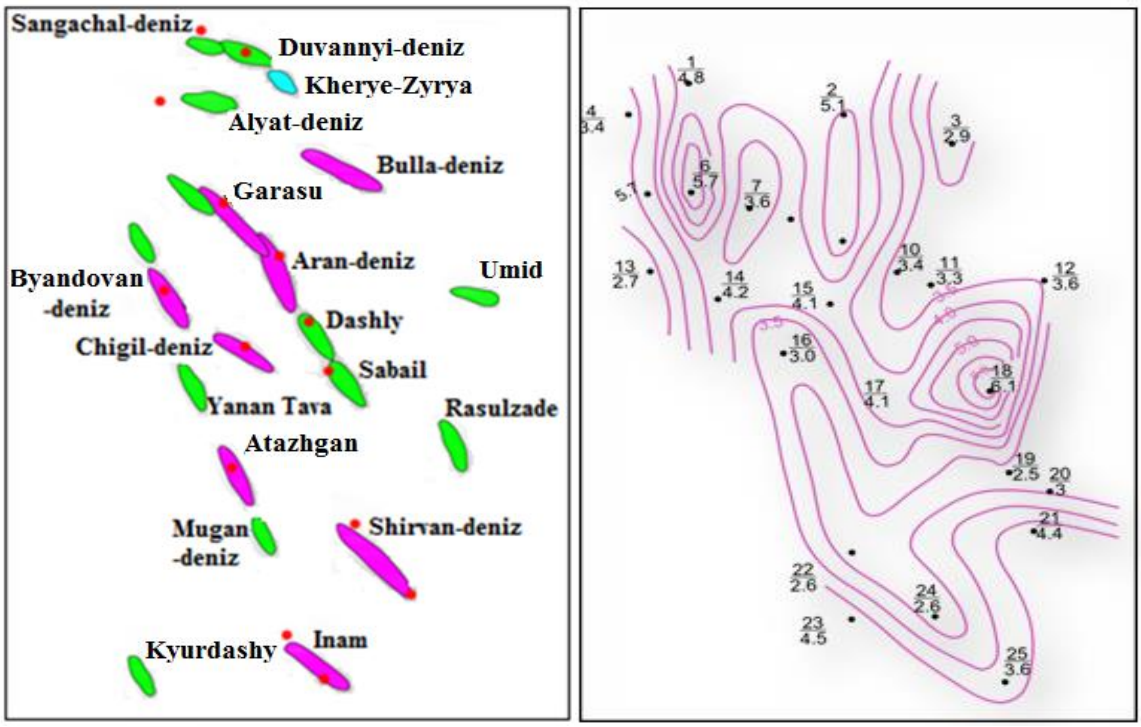
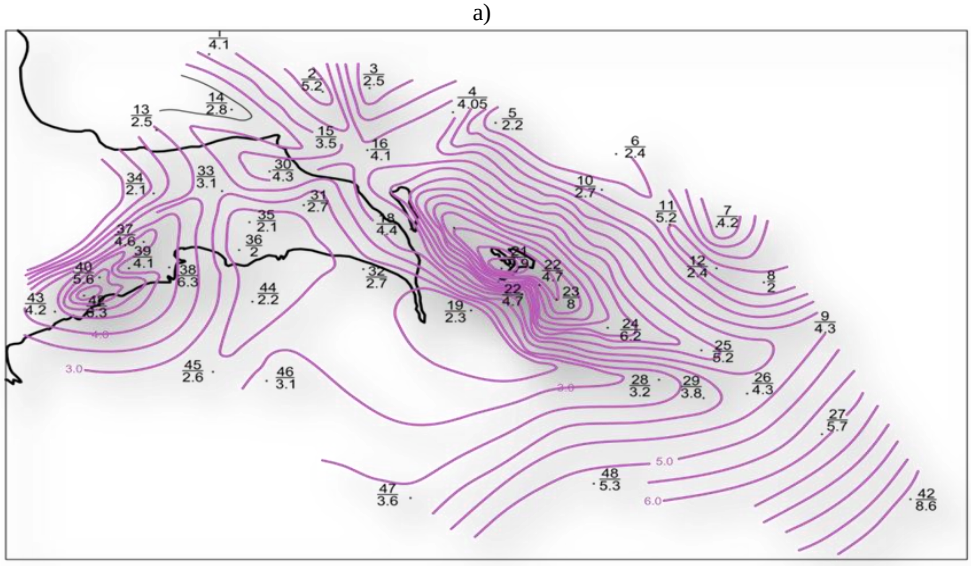


Fig. 6. a – isomorphic map; b – morphology and attitude of the local uplifts of the Baku Archipelago

a)



b)

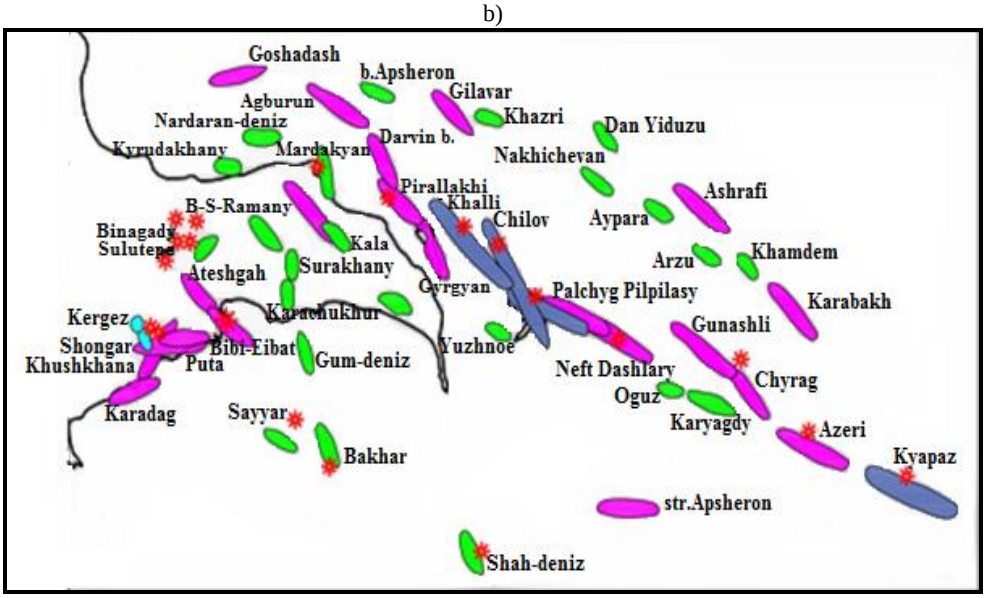


Fig. 7. a – isomorphic map; b – morphology and attitude of the local uplifts for the Azerbaijani part of the Absheron-Balkhan structural mega-saddle (Absheron Ridge)

The Godin massif that constitutes the basement of the Turkmen shelf is the hypsometrically considerably uplifted block of the crystalline basement and its sedimentary cover is represented by the late Mesozoic, mainly the Cenozoic rocks.

Most probably one of the reasons that caused uplifting of Godin massif was the geostatic pressure drop developed by the sedimentary cover on and around the massif under compressional stresses within the SCD. Relatively high geostatic pressure gradient developed between the sedimentary layers accumulated on and around the Godin massif allows us to suppose the impact of the gradient upon its vertical movement. The continental denudational environment of the massif had mainly lasted from the Paleozoic to the Late Cretaceous. By the end of Cretaceous its isostatic attitude corresponded to the one of the South Caspian seafloor and continued to evolve under the same paleogeographic environment. Accumulation started from the Late Cretaceous. Thickness of the sedimentary cover is just 8-10 km (Лебедев, 1987), whereas it is 25 km and above in the SCD which is westwards. Since the relatively higher hypsometric level of the crystalline basement of the Godin massif screens off compressional stresses developed in the SCD sedimentary cover directed towards the former one, its local uplifts have mainly been formed through bending. The local uplifts are relatively little developed and of the brachy- and isometric shape, scattered around the area with no pattern observed in their attitude. This case is described on the isomorphic map drawn for the area with very rare isolines and their low values (Fig. 8).

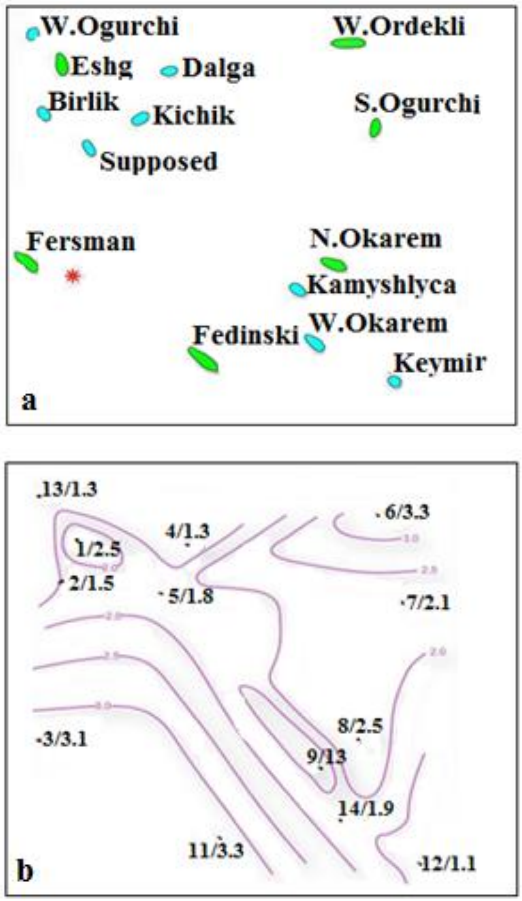


Fig. 8. a – morphology and attitude of the local uplifts; b – isomorphic map of the Turkmen shelf

The isomorphic map (Fig. 8b) shows isoline values ranging from 1.3 to 3.3. There is no mud volcanism on the Godin massif. There is only one mud volcano associated with a deep fault in the southern edge (Лебедев, 1987). Regarding oil and gas content of the local uplifts referring to the Godin massif of the Turkmen shelf – there have been no hydrocarbon fields discovered until now. This is the reason why all of the local uplifts discovered on the Godin massif refer to a group with unknown hydrocarbon potential (Narimanov, 2005 a,b). Relatively thin sedimentary cover of the area and the unfavorable paleogeographic environment for organic matter to develop, as well as absence of compressional stresses prevent from voicing an objective opinion on the oil and gas content of the area.

Since the deposition process taking place under compressional stresses within the space surrounding the massif had a positive impact upon formation of the sedimentary cover, increase in geostatic pressure caused more rapid subsidence of the megagraben-like seafloor (Буряковский и др., 1991). With the exception of the Godin massif of the Turkmen shelf this situation, having increased compressional stresses in the basin, intensified plicated dislocation in the sedimentary cover through buckling (Мамедов и др., 1995).

Evolution of the Greater and Lesser Caucasus collisions and their convergence causes intensification of compressional stresses along the slopes of the South Caspian megadepression. The Iranian plate undergoing bending deformation formed favorable conditions for formation of the western slope of the South Caspian depression, thus promoting its geographical isolation from the Kur depression (Фейзуллаев и др., 2016).

Great thickness (over 14 km) of the Miocene-Quaternary sediments of mainly shaly content paved the way for formation of diapir structures and most of them have been complicated by mud volcanoes. That is why, with the exception of the SCD Godin massif, the folding process in the Oligocene-Pliocene sediments happens due to expelling rheologically active Oligocene-Miocene depositional complexes towards the core of the folds that evolved in the underlying layers. It is well-known that the majority of the local uplifts of the Baku and Absheron archipelagos, pre-Elborz depression started their evolution no later than the end of the Miocene. From this aspect we can infer that 2500-3000 m thick Middle and Upper Miocene sediments generated there the geostatic pressure necessary for triggering the bending mechanism (Буряковский и др., 1991). However, long and short brachyforms of the majority of folds developed in the sedimentary layer indicate simultaneous involvement of an even more intensive buckling mechanism along with the bending in their formation. This is caused by rheologically more active Oligocene-Quaternary sediments and intensification of compressional stresses during the geologic period under consideration. In this connection, in the Baku Archipelago as a model, one can see that the rate of folding processes is a function of time and it commonly increases. This case is clearly seen from the variation of the evolution rate of some folds of the Baku Archipelago through geological time (Буряковский и др., 1991).

The studied local uplifts of the Baku Archipelago show that they developed simultaneously with deposition. This is typical of diapir structures. However, it should be noted that the fold evolution rate was not constant during the evolution period. Thus, whereas their evolution rate grows from the north-west to the south-east in Pliocene, to the contrary dramatic rate increase is observed in Quaternary from the south-east towards the north-west. This situation shows increase of the fold evolution rate north-westwards through geologic time. This is, naturally, associated with distribution properties of compressional stresses in the Baku Archipelago where mud volcanoes are wide-spread and this shows their attenuation in southwards.

Varying evolution rate for local uplifts is typical of other units of the SCMD (Lower Kur depression, Absheron Archipelago etc.) as well.

Mud volcanism wide-spread in the Alpine-Himalayan fold and mobile Pacific belts are associated with subduction and collision zones where compressional stresses are widely developed (Алиев и др., 2015). This shows that mud volcanoes can be considered as an indicator of compressional stresses, i.e. they are indicators of compressional stresses built up in the thick sedimentary cover of clayey content. A compressional stress environment has established in the SCMD since the Upper Miocene and has had a direct impact upon the deposition process. The rate of the latter one in the sedimentary basin varies as a function of time and space (Буряковский и др., 1991).

According to Buryakovski et al., while the deposition rate in the central part of the South Caspian is 0.4 mm/year, it is 3-4 mm/year on its shelf and 6 mm/year in the mouth of the Kur River (Мамедов и др., 1995). However, it is well-known that the thickness of the Pliocene deposits alone reaches 6-7 km towards the center of the South Caspian depression. This is typical of the layers lying above as well. At the same time, thickness of the Middle and Upper Miocene deposits grows towards the western slope of the depression (Ягубов и др., 1971), despite the thickness of the deposits lying above decreasing in the same direction and they bend in the form of a regional uplift. This is caused by Paleogene-Miocene deposits forced out underneath the Lower Pliocene deposits (Буряковский и др., 1991). This process occurred no later than in the Lower Pliocene. Besides, this is confirmed by decreased thickness of the Lower Pliocene deposits towards the crestal part of the abovementioned regional uplift, i.e. this regional uplift extending in sublongitudinal direction started its evolution during formation of the Lower Pliocene sediments. These factors show that compressional stresses of sublatitudinal trend established in the western slope of the SCD have been active in the Baku Archipelago and the central part of the South Caspian since the end of the Upper Miocene. Presence of these stresses causes agglomeration of the non-compacted deposits in the central, that is, deeper part of the basin even these days. Periodic transportation of the deposits accumulated on the continental slope of the South Caspian basin as turbidity currents towards the center of the basin is a special case of this process. As we can see, just that very case causes increase in the thickness of the Miocene-Quaternary deposits towards the deeper part of the basin, in spite of the deposition rate being relatively weak in the deeper part rather than in other parts (Мамедов и др., 1995). At the same time, as already mentioned, since the complex graben shape of the basin's crystalline basement is more susceptible to compressional stresses, this increases its subsidence rate even more and causes formation of syndepositional brachyform diapir type structures complicated by mud volcanoes before inversion.

Thus, despite being surrounded by active collision zones and being a negative geostructural unit, the South Caspian depression is still evolving as an inter-mountain non-compensated basin with intense subsidence and sedimentation.

Complex graben-like structure of the crystalline basement of the South Caspian basin, resulting from complication by non-uniformly scaled dense faults and deep fractures networks, increases its susceptibility to compressional stresses and growing geostatic pressure. Geostatic pressure also has a positive effect on the intensity of compressional stresses and, as a result, the seafloor is subject to more rapid subsidence. This led to establishing of an environment favorable for evolution of mainly syndepositional diapir folds in the sedimentary cover and it is well-known that such folds are of great hydrocarbon potential. This is due to the fact that the formation of mud diapirs is associated with the high content of clay in the section and generation of hydrocarbons in high-quality source-rock under corresponding temperature and pressure.

Based on high clay content of sedimentary cover in the SCD, particularly of its Oligocene-Quaternary section, and, in this connection, widespread mud diapirism and volcanism, we can come to the conclusion that the sedimentary complexes of the abovementioned intervals should be rich enough in organic matter (OM). To study that we tried to clarify percentage variation of OM in rock complexes and its relation to geodynamic environment (Ягубов и др., 1971; Нариманов, 2003). Build-up of compressional stresses in the SCD, burial rate of deposits, tectonic and seismic activity, complication of the basement by faults have considerable impact on hydrocarbon generation and their accumulations. Meanwhile, it is well-known that oil and gas generation can only be provided by favorable temperature and pressure environment and deposition process associated with continuous subsidence of a sedimentary basin. The average deposition rate from the Later Mesozoic to Oligocene in the South Caspian basin was 50 m/mln.year and this process occurred in oceanic environment in absence of compressional stresses (Соколов, 1985). In Oligocene – Later Miocene the region, already in marginal marine environment, is described as having seen the onset of compressional stresses and the deposition rate was 135 m/mln.year. This rate provides accumulation of the OM up to 2% in potential source rock

(Feyzullayev et al., 2002). The deposition rate in Pliocene-Quaternary reaches 1400-1600 m/mln.year. This rate establishes necessary conditions for accumulation of up to 10-15% of OM in potential source rock. As one can see, the deposition rate in the SCD, which was delimited by collision and residual subduction zones in Pliocene-Quaternary, and amount of OM accumulated in mainly clayey deposits, are directly related to compressional stresses. Potential source rock layers of the Upper Cretaceous, Maykop and Productive Series (PS) are the main rocks capable of generating commercial oil and gas in Mesocenozoic sediments. However, it should be taken into consideration that the PS has not completely subsided into the main hydrocarbon generation zone that is the reason why the hydrocarbons it generated could not fully saturate its reservoir rocks. This situation allows us to make an assumption that the PS reservoir rocks have been saturated not only by hydrocarbons generated by PS sediments, but by Oligocene-Miocene deposits even more so. On the other hand, catagenetic maturation of OM, along with the formation temperature, depends on dynamic processes accompanied by mud volcanism that causes additional heat flow (Feyzullayev et al., 2002), i.e., compressional stresses are one of the driving forces of dynamocatagenesis in hydrocarbon generation. As we can see, in geodynamically and tectonically active intermountain depressions compressional stresses, mud volcanism and oil and gas content are closely associated processes.

As to the Godin massif of the Turkmen shelf, in spite of the relatively high temperature gradient, absence of compressional stresses and dynamocatagenesis due to weak tectonic activity in the sedimentary cover the possible source rocks has low hydrocarbon generation potential. On the other hand, here paleogeographic environment shows that at shallow depths high water and deposit mobility cannot be considered as a favorable setting for enough OM accumulation. However, compressional stresses in sedimentary layers surrounding the Turkmen shelf and the Godin massif and, in association with that, tectonic processes could cause migration of the part of fluids to the Turkmen shelf and the Godin massif.

Correlation of the extreme value differences of the isomorphic curves for the SCMD structural units under consideration enables establishing the structural units with more intense compressional stresses. From this point of view the Absheron-Balkhan residual subduction zone tectonically represents a structural mega-saddle and long brachy- and linear folds have developed in its Azerbaijan segment. At the same time, here the extreme value differences of the isomorphic curves are greater than on the other structural units and is 6.9. This shows that the extreme value differences of the isomorphic curves for the SCMD structural units are directly related to the intensity of compressional stresses. On the other hand, it's well-known that the greater extent of compressional stresses is typical of subduction and collision zones. Thus we can conclude that based on an isomorphic map of any area it is possible to qualitatively assess the extent of development and distribution properties of compressional stresses.

Conclusions

The South Caspian depression has been evolving as an uncompensated hydrocarbon bearing basin surrounded by collision and residual subduction zones, subjected to intense compressional stresses and characterized by subsidence and deposition.

There is direct relation between the extent of mud volcanism and intensity of compressional stresses in the structural units under study: the former one being the indicator of the latter one. Absence of mud volcanism on the Godin massif is associated with absence of the favorable paleogeographic environment and compressional stresses.

Compressional stresses in the intermountain depressions have positive impact upon their oil and gas content, that is, compressional stresses, mud volcanism and hydrocarbon generation are associated with geostructural units.

It is possible to qualitatively assess compressional stresses within the geodynamically and tectonically active intermountain depressions using an isomorphic map of the area.

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КАЧЕСТВЕННАЯ ОЦЕНКА ИНТЕНСИВНОСТИ СЖИМАЮЩИХ НАПРЯЖЕНИЙ В ЮЖНО-КАСПИЙСКОЙ МЕГАВПАДИНЕ, ИХ ВЛИЯНИЕ НА СТРУКТУРООБРАЗОВАНИЕ И ГЕНЕЗИС УГЛЕВОДОРОДОВ

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Резюме. Изучение геодинамических условий образования Южно-Каспийской впадины (ЮКВ), являющейся центральным сегментом акватории Южно-Каспийской мегавпадины (ЮКМВ), показывает, что до конца миоцена акватория Южного Каспия была одной из самых глубоких впадин океана Тетис, расположенной между Иранской и Евразийской плитами. В результате сближения Иранской и Анатолийской плит уже в конце эоцена сформировался Южно-Каспийский окраинный континентальный бассейн. Южно-Каспийская мегавпадина расчленена на ряд разновеликих структурных элементов, автономно развивающихся на фоне некомпенсированного прогибания ее ложа. В статье с запада на восток рассмотрены следующие структурные элементы ЮКМВ: впадина междуречья Куры и Габырры, Нижнекуринская впадина, впадина Бакинского архипелага, западная половина Абшерон-Прибалханской остаточной субдукции, представленной на территории Азербайджана преимущественно Абшеронским архипелагом, и Туркменский шельф, обязанный своим образованием массиву Година. На основе соотношений размеров локальных поднятий в пределах рассмотренных структурных элементов ЮКВМ авторы попытались дать качественную оценку сжимающих напряжений в этих областях, их тенденции и влияния на ряд геологических процессов. С этой целью были построены и проанализированы изоморфные карты указанных структурных единиц, отражающие морфологию локальных поднятий. Результаты исследований позволили установить прямую зависимость между сжимающими напряжениями, структурообразованием, грязевым вулканизмом и нефтегазоносностью. Дана качественная оценка интенсивности сжимающих напряжений по отдельным структурным элементам и установлен характер влияния этих напряжений на структурообразование и нефтегазоносность в пределах рассмотренных структурных элементов. Установлено, что Южно-Каспийская впадина развивалась как некомпенсированный бассейн, окруженный зонами коллизии и остаточной субдукции, подверженный интенсивным напряжениям сжатия и характеризующийся погружением и осадконакоплением. Между степенью развития грязевого вулканизма и интенсивностью сжимающих напряжений в пределах исследуемых структурных единиц существует прямая зависимость: первая является индикатором второй. Отсутствие грязевого вулканизма на массиве Година связано с отсутствием благоприятной палеогеографической обстановки и напряжений сжатия. Таким образом, напряжения сжатия в межгорных впадинах положительно влияют на их нефтегазоносность, то есть напряжения сжатия, грязевой вулканизм и образование углеводородов связаны с геоструктурными единицами.

Ключевые слова: *грязевой вулканизм, сжимающие напряжения, Абшеронский архипелаг, нефть, газ*

CƏNUBİ XƏZƏR MEQAÇÖKƏKLİYİNDƏ SIXILMA GƏRGİNLİKLƏRİNİN İNTENSİVLİYİNİN KEYFİYYƏTCƏ QİYMƏTLƏNDİRİLMƏSİ, ONLARIN STRUKTURƏMƏLƏGƏLMƏ PROSESLƏRİNƏ VƏ KARBOHİDROGENLƏRİN GENEZİSİNƏ TƏSİRİ

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Xulasə. Cənubi Xəzər meqaçökəkliyinin (CXMÇ mərkəzi seqmenti olan Cənubi Xəzər hövzəsinin (CXH) formalaşmasının geodinamik şəraitinin tədqiqi göstərir ki, Miosenin sonuna qədər o, İran və Avrasiya plitələri arasında yerləşən və Tetis okeanının ən dərin çökəkliklərindən biri olmuşdur. İran və Anadolu plitələrinin yaxınlaşması nəticəsində artıq Eosenin sonunda Cənubi Xəzər kontinent kənarı hövzə kimi formalaşmışdır. Cənubi Xəzər meqaçökəkliyi yatağının kompensasiya olunmamış çökməsi fonunda avtonom şəkildə inkişaf edən bir sıra müxtəlifölçülü struktur elementlərə bölünür. Məqalədə qərbdən şərqə doğru CXMÇ-nin aşağıdakı struktur elementləri nəzərdən keçirilir: Kür və Qabırrı çaylararası çökəkliyi, Aşağı Kür çökəkliyi, Bakı arxipelaqı çökəkliyi, Azərbaycan ərazisində əsasən Abşeron arxipelaqı ilə təmsil olunan Abşeron-Balxanyanı qalıq subduksiyasının qərb hissəsi, Qodin massivinin hesabına yaranan Türkmənistan şelfi. CXMÇ-nin nəzərdən keçirilən struktur elementləri daxilində yerli qalxımların ölçülərinin müqayisəsi əsasında, müəlliflər bu ərazilərdə sıxılma gərginliklərini, onların xarakterini və geoloji proseslərə təsirini keyfiyyətcə qiymətləndirməyə çalışmışlar. Bu məqsədlə baxılan struktur elementlər daxilində yerləşən qalxımların morfologiyasını əks etdirən xəritələr qurulmuş və təhlil edilmişdir. Tədqiqat nəticəsində sıxılma gərginlikləri, strukturəmələgəlmə, palçıq vulkanizmi və neft-qazlılıq arasında birbaşa əlaqənin olduğu müəyyən edilmişdir. Müəlliflər tərəfindən CXMÇ-nin ayrı-ayrı struktur elementləri üzrə sıxılma gərginliklərinin intensivliyi keyfiyyətcə qiymətləndirilmiş və həmin gərginliklərin strukturların formalaşmasına və neft-qazlılığa təsiri müəyyən edilmişdir. Beləliklə, Cənubi Xəzər hövzəsi toqquşma və qalıq subduksiya zonaları ilə əhatə olunmuş, intensiv sıxılma gərginliklərinə, gömülməyə və çöküntütoplanmaya məruz qalan, kompensasiya olunmayan hövzə kimi inkişaf etmişdir. Tədqiq olunan struktur vahidlərdə palçıq vulkanizminin inkişaf dərəcəsi ilə sıxılma gərginliklərinin intensivliyi arasında birbaşa əlaqə mövcuddur: birincisi ikincinin göstəricisidir. Qodin massivində palçıq vulkanizminin olmaması əlverişli paleocoğrafi şəraitin və sıxılma gərginliklərinin olmaması ilə əlaqələndirilir. Dağlararası hövzələrdə sıxılma gərginlikləri neft-qazlılığa müsbət təsir göstərir, yəni sıxılma gərginlikləri, palçıq vulkanizmi və karbohidrogenlərin əmələ gəlməsi geostruktur vahidlərlə bağlıdır.

Açar sözlər: *palçıq vulkanizmi, sıxılan gərginliklər, Abşeron arxipelaqı, neft, qaz*