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PALEOZOIC SEDIMENTATION CONDITIONS AND RESERVOIR FORMATION IN SOUTHEASTERN PART OF PRE-CASPIAN BASIN

During the Late Paleozoic a southeastern part of the pre-Caspian Basin was a part of large sedimentation basin with tropical climate conditions.

The major factors of carbonate sedimentation in this particular basin were:

- water depth, as there was the eustatic rise of sea level during the Early Carboniferous, Moscovian, Asselian Stages and the sea level fall in Bashkirian, Kasimovian, Gzelian and Artinskian Ages;
- addition of terrigenous and pyroclastic material.

In terms of stratigraphic completeness of pre-salt deposits in the southeastern part of pre-Caspian Basin the following areas can be delimited:

A. Axial part of the Karaton-Tenguiz zone has reduced stratigraphic type section and used to be a high during the Turnaisian to Artinskian Stages.

B. Peripheral parts of Karaton-Tenguiz zone, Southern and Southern Emba zones, minor part of Matken-Ushmolinsk and Atyrau-Zhukat zones feature the deposit omissions during the periods of sea level fall.

C. Part of Matken-Ushmolinsk and Atyrau-Zhukat zones have the complete stratigraphic type section and used to be a sunken part of the basin.

Turnaisian Stage

Data on Turnaisian deposits in the south-east of pre-Caspian Basin are so inadequate that it is possible to only approximately delineate carbonate and terrigenous sedimentation areas. It is assumed that during the Early Carboniferous these zones are inherited from Turnaisian period to Visean and Serpukhovian period. Carbonate type section can be seen in Karaton-Tenguiz and Southern zones. For instance, in the wells Karaton 1, 3, 5, 7 foraminifer complexes were identified in the four Turnaisian horizons, and in the wells Southern 2 (5434 - 5513 meters interval) and Southern 3 (5493 - 5501 meters interval) the foraminifer complexes were established in Kizelian horizons. In other well logs of Karaton-Tenguiz zone Turnaisian deposits are omitted in the type sections of large uplifts probably located in the central parts. To the east of Karaton-Tenguiz zone there is a facies replacement of Turnaisian carbonate deposits with terrigenous type section and very few wells tapped that. In the Southern Emba zone Turnaisian deposits were tapped by the wells Zhanasy 10 and 11 and Turesay 4, and there they constitute a part of terrigenous deposits which survived pre-Jurassic washout. In the Matken-Ushmolinsk zone Turnaisian deposits were tapped by the wells Tortay P-1, Akkuduk-Alahay P-1.

Visean Stage

During the Visean period terrigenous sedimentation was taking place in Southern Emba, Matken-Ushmolinsk and Atyrau-Shukat zones. In the Southern Emba zone and southern part of Matken-Ushmolinsk zone it was a sedimentation of clays and sandstones with interlayers of mixed sand and gravel. Their fragmental part is represented by quartz and jasper rocks, occasionally by clays and limestones. In terms of texture properties terrigenous deposits pertain to turbidity current deposits and their sedimentation occurred in the relatively abyssal environment. Proximal nature and presence of limestones with the Lower Carboniferous fauna in the fragmental part indicate that sedimentation took place in the proximity of removal

source assumed to exist in Mynsyalmas subzone. Typical feature of southeastern part of the pre-Caspian Basin is an intensive addition of pyroclastics. The deposit thickness and composition alteration patterns aid to establish the pyroclastics frontal addition in the direction from south-east to north-west with source of it being outside the basin. Pyroclastic differentiation towards the same direction can also be established: lithoclastics (close to the source) - crystalloclastics - vitrocrystalloclastics - vitroclastics. Lithoclastics was added to Southern Emba zone which was an unstable sedimentation zone so that terrigenous and pyroclastic material deposited there would continuously slide into the southern part of Matken-Ushmolinsk zone.

The argillaceous and sand sedimentation was taking place in the northern part of Matken-Ushmolinsk zone and, probably, in Atyrau-Shukat zone. They typically have graywacke composition and graded bedding thus enabling to associate them with distal segments of deposits formed by turbidity currents. The second half of Visean period created conditions within the Turesay - Southern Molodezhnaya zone for carbonate sedimentation related to considerable lessening of terrigenous material addition. Tortay 12 and Turesay 3 well logs indicate carbonate deposits of 200 to 360 meters composed of wackestones and mudstones. Clay interlayers constitute another of their typical features.

Karaton-Tenguiz and Southern zones during the Visean used to be the area of intensive carbonate sedimentation predetermined by the carbonate platform that was formed in the Late Devonian - Turnaisian period and experienced differential tectonic movements during the Visean period. Omission of lower part of Visean deposits in the north-east of Tenguiz indicates the outcrop of carbonate platform part to the day surface. In general, in these zones of the shelf shallow water environment the intensive bentogene carbonate sedimentation took place. There are areas where sedimentation was occurring in the active hydrodynamic environment. Presence of packstones as well as grainstones and, occasionally, oolite grainstones serve as the evidence of that. However, there were the areas with tranquil hydrodynamic conditions which hosted the sedimentation of mudstones with clay bands and various content of pyroclastic material (wells Tenguiz 6, 22, 44). During the second half of the Visean period the organogenous

buildups started growing to become up to 400 meters thick. Their framework is composed of moss animals, stromatopores and calcaccrous algaee. Bioherm limestones would typically have massive and slightly breccicated texture and large presence of stromatotactoid cavities. The formation of organogenous buildups was accompanied by periodic forcing of their roof into the tidal zone, its partial disintegration and train formation. The slopes of these structures became a place for gritstone type limestone sedimentation with micronodule mixtures as their cement. Along the lateral line inwards the basin in the southern parts of Karaton-Tenguiz zone the shelf shallow water deposits are replaced with alternating terrigenous and carbonate terrigenous deposits (200 -- meters thick) due to the intensive addition of terrigenous material to these areas. In the northern parts of the zone remote from terrigenous material addition there is sedimentation of terrigenous carbonate deposits (supposedly 100-200 meters thick).

Serpukhovian Stage

Serpukhovian Stage is represented by carbonate and terrigenous deposits. Carbonate type section is present in Southern Emba, Southern and Karaton-Tenguiz zones. During the Serpukhovian age under the conditions of transgression stabilization and weakening of tectonic processes, there was a notable lessening of terrigenous material addition from the adjoining land and development of carbonate deposits and bioherm mixtures participating in the bioherm mass formation. Bioherm masses have been analyzed in the eastern and north-eastern parts of Tenguiz, and also in the wells Bekbulat 1, Tortay 12. Bioherm masses have complex structure and consist of small bioherm bodies accreting onto each other concurrently with continuous bowing of basin bottom. They are formed mostly with calcaccrous algae. Occasionally moss animals and corals play the role of reef-builders. More diversified fauna used to inhabit the structure slopes - in crinoidal "meadows". In the second half of Serpukhovian Stage the bioherm masses were subjected to recurrent disintegration creating fragmental limestone trains. At the same time it is typical for Southern Emba zone to have high facies variability, especially in Southern

Saztobe subzone where against the background of normal carbonate sedimentation the well South Saztobe 3 tapped volcanogene fragmental and tufogene carbonate deposits 185 meter thick. Another typical trait of this subzone is carbonate sedimentation with addition of argillaceous, occasionally sandstone material from the south. This allows to assume that carbonate sedimentation in Southern Emba zone occurs only in the high areas under the conditions of plane terrigenous sedimentation. This would better explain why terrigenous deposits happen to be the abyssal analogue of Serpukhovian carbonate deposits.

It is typical for South Emba zone to have stratigraphically complete sections, while for Karaton-Tenguiz zone - omission of Zapaltube horizon which was seen in the very few well logs.

In Matken-Ushmolinsk and Atyrau-Shukat zones there is a terrigenous type of Serpukhovian deposits 200-400 meters thick and represented by clays and aleurolites, infrequently by sandstones and vitroclastic tuff. Volcanism indications are fewer in comparison with the Visean period. However, pyroclastics composition and its spread patterns point to volcanic centers inherited through Serpukhovian period. Terrigenous material spring is located on both southeastern and eastern margins of the basin. The southern part of Matken-Ushmolinsk zone (a well Ravninnaya 7) normally have the detritus of lime-secreting algae and moss animals moved from Southern Emba zone.

Bashkirian Stage

Bashkirian Stage in the south-east of pre-Caspian Basin has three section types: carbonate, transitional and terrigenous carbonate. Carbonate section is developed in Karaton-Tenguiz and Southern Emba zones. In the latter the carbonate Bashkirian deposits are developed in a range from Southern Saztobe to Sarykym with their southern margin being steep slope of older terrigenous Carboniferous deposits adjoining, in their turn, Devonian deposits. In the Southern Emba zone the Bashkirian deposits were identified on a basis of foraminifer and conodont complexes in the lower portion of Bashkirian Stage within Voznesenskian, Krasnopolaynskian and North Keltmenian horizons in the Tortay 12, Southern Emba 9, 13, Southern

Molodezhnaya P-1, Urtatau-Sarybulak 3, Southern Saztobe P-1, 1, 3, Saztobe P-2, Bekbulat 1 well logs and not seen in Turesay 3 well log.

Voznesenskian horizon is represented by limestones which differ, in terms of composition and gamma ray and neutron gamma ray logs, from underlying Serpukhovian deposits by having lower clay content related to cessation of argillaceous material addition. Beginning of Bashkirian age is associated with the sea basin regression and considerable areal enlargement of carbonate sedimentation occurring in extremely shallow waters and active hydrodynamic environment. Concurrently, terrigenous material was coming from the central part of Southern Emba zone and that can be seen from the presence of gritstones and conglomerates in the lower parts of Bashkirian deposits.

Voznesenskian and North Keltmenian horizons were defined on a basis of foraminifers in the most well logs. The boundaries of these horizons are determined on a basis of sharp alteration of foraminifer complexes.

The transitional type (sand plus gravel) of Bashkirian deposits was identified in the Tortay 23, Karaoy P-1, P-2 and Saztobe 2 well logs and is composed of coarse-fragmental rocks with sandstone and aleurolite interlayers.

Formation of coarse-fragmental rocks with the Late Bashkirian fauna indicates the continuation of sea level fall in the second half of Bashkirian period and complete shoaling of the basin. That results in disintegration and redeposition of Upper Devonian and Lower Carboniferous terrigenous deposits in Mynsualmas subzone.

Terrigenous carbonate type section is universally identified outside the Southern Emba and Karaton-Tenguiz zones and represented by interbedded argillites, limestones and sandstones with various content of silicium and total thickness of 20 to 70 meters. These deposits are accumulated in the shelf sunken segments. In terms of composition they are based on carbonate ooze and detritus of lime secreting organisms removed from carbonate platforms. Also present are plankton and organic material - foraminifers and siliceous sponges. In most cases these deposits are characterized by foraminifer and conodont complexes developed in the wide time interval: Okskian

horizon of Viscan Stage - Voznesenian horizon of Bashkirian Stage. In Matken-Ushmolinsk and Atyrau-Shukat zones the logging (neutron gamma ray logging, gamma ray logging and acoustic logging) gives distinct characteristics of the Bashkirian deposits. The bottom of Bashkirian deposits coincides with the bottom of the lower bed of compact rocks (limestones) against the background of overlying argillaceous deposits. The reflecting horizon P-2 is confined to the bottom of Bashkirian deposits.

Within the Karaton-Tenguiz zone the Bashkirian deposits lie on Serpukhovian deposits with stratigraphic unconformity manifesting itself through omission of the Upper Serpukhovian (encountered in a very few wells) and Voznesenian horizons. In Tenguiz wells 41 and 43 located in the peripheral parts, and in the well Karaton 1 there are no Bashkirian deposits. This and the presence of redeposited fauna complexes enable to assume the dewatering of Karaton-Tenguiz zone during the Bashkirian period. Full section of Bashkirian deposits in the central part of Tenguiz, not found in other Caspian Paleozoic highs, brings about the hypothesis of development of local structures negative in relation to general uplift (subsidence due to karst formation). Central parts of Tenguiz would typically have carbonate deposits of shoal and beach facies. These are well graded, large oolite grainstones, packstones alternating with horizons of limy gritstones having large fragments of corals and algae. Presence of oolites and almost total absence of ooze are deemed to be evidence of the basin extreme shoaling (depth - first meters). Active hydrodynamic conditions led to the undulated and fine layered limestone texture.

Primary granular reservoir type is typical for most of the oil and gas fields of pre-Caspian Basin confined to Bashkirian deposits (Kenkyak, Kozhasay, Zhanazhol, Darinsk, Rostoshinsk, Astrahan, Tenguiz, Korolev, Tazhigali). Commercial oil flowing from Bashkirian deposits is known to occur in the well Karashungul P-1.

Moscovian Stage

Moscovian Stage in the south-east of pre-Caspian Basin (except for Karaton-Tenguiz zone) is universal. Carbonate and terrigenous carbonate sections are identified. Carbonate type section is developed

in Southern and Southern Emba zone. Argillaceous limestones and argillites in shelf shallow water limestones allow to assume more "marine" nature of the deposits in these areas than in the first half of the Bashkirian period. Moscovian age brings the commencement of large eustatic rise of the sea level. In the Southern Emba zone (Turesay - Southern Molodezhnaya subzone) there is a widespread development of oolite limestones, gritstones beds without argillaceous material and limestone beds colored with hydros ferric oxide which indicates the dry land nearness (Minsyalmas subzone). Carbonate type section is clearly characterized by four foraminifer zones which are correlated clearly with horizons of Moscovian Stage of Russian platform. Carbonate sedimentation in these zones was taking place on the carbonate platforms of considerable size under the shallow water conditions thus causing high productivity of various lime secreting organisms and forming carbonate rocks up to 600 meters thick. Dry land area in Southern Emba zone caused fresh water addition and diagenetic transformation of limestones into dolomites. Terrigenous carbonate type section is present in Matken-Ushmolinsk and Atyrau-Shukat zones, as well as in Karaoy subzone which is a transition area from shelf shallow water deposits to shelf abyssal deposits. In these areas consedimentation growth of subsequent tectonic structures had substantial influence on deposit thickness and lithological composition. In these areas Moscovian deposits typically have irregular interbedding of dark argillites, limestones from packstones to mudstones, siliceous rocks (spongiolites, siliceous limestones), tuffites, tufaceous rocks, gritstones and sandstones. It is normal for these deposits to have high bitumen content related to mass concentration of phyto algae. Analysis of conodont and fusulinids complexes clearly indicates the presence of all four horizons of Moscow Stage except for wells 10 and 120 on the Elemes area and wells 2, 3, 8 on Ravnina area where upper part of Moscovian deposits was washed out. Part of conodont complexes varies in terms of age. For example, Bashkirian and Serpukhovian conodonts are encountered together with Moscow conodonts and that is due to washout of older deposits in Southern Emba zone and micro fauna addition into more sunken areas.

Omission of Moscovian deposits in Karaton-Tenguiz zone is caused by the subsequent washout with evidence of that seen in the

presence of their outliers on the paleohighs of the pre-Caspian Basin, such as Astrakhan and Temir domes. On the other hand, if local nature of Bashkirian sedimentation is an acceptable assumption, then it is fair to assume that in Moscovian age territory of this zone was also outside the sedimentation area.

Upper Carboniferous

The Upper Carboniferous has complex structure. In the Southern, Karaton-Tenguiz, Southern Emba zones (excluding Turesay-Southern Molodezhnaya subzone) there was no Upper Carboniferous sedimentation. On the rest of the territory carbonate and terrigenous carbonate type sections were established. The Upper Carboniferous deposits distribution patterns in terms of layers and lithological composition, as well as presence of redeposited Moscovian fauna indicate considerable eustatic rise of sea level at the boundary between the Middle and Late Carboniferous. Carbonate deposits form narrow wedge-shaped band in Turesay- Southern Molodezhnaya subzone and partially in Urtatau-Sarybulak-Sarykym subzone and were tapped by the wells Sarykym 1 and 2, Turesay 3 and 2a within the Kasimovian Stage.

Analysis of conodont and fusilinids complexes exhibits substantial development of terrigenous carbonate section within Kasimovian and Gzelian Stages in the Matken-Ushmolinsk zone. Another typical feature of this zone - redeposited Moscovian, less frequently Bashkirian and Serpukhovian fauna in the Upper Carboniferous deposits over the large territory from the well Karachungul P-1 till the well Sarcask 3 (remote from the paleohighs) and it gives the reason to assume existence of local sources of Middle Carboniferous fauna. It is interesting to note that in Kasimovian deposits the Late Moscovian species were found, while in Gzelian - Early Moscovian

Appearance of areas of fauna and sedimentation material removal, as mentioned earlier, is related to regional eustatic fall of the sea level. Such areas of removal (dry land areas) were encountered by the wells Elemes 8, 10, 120, and also Ravninaya 2, 3, 8. In these wells Asselian deposits lie on Lower Moscovian deposits. The fact that in the

mixed complexes the Bashkirian and Serpukhovian conodonts were found indicates the erosive shear in these segments. Generally, in Matken-Ushmolinsk zone the Upper Carboniferous deposits are represented by shelf shallow water argillaceous carbonaceous facies. In the proximity of land areas, under the extreme shallow water conditions with a lot of lime secreting organisms, there was formation of grainstones and packstones (the wells Elemes 9, Ravninaya 1) or interbedded packstones (40-60 %), wackestones, mudstones, sandstones and argillites (the wells Airshagyl 3, Karachungul P-1, Tortay 4). Their thickness varies from 0 to 50 meters, rarely reaches 100 meters. Farther from the shore zone those are replaced with argillaceous carbonaceous deposits represented by alternating packstones (20-49 %), wackestones, mudstones and argillites 50-100 meters thick. In the most sunken parts of the basin the argillaceous carbonate sedimentation was occurring. Argillites, tuffs and aleurolites increase their content in the section (60-80 %). Mudstones and wackestones occur as well. For argillaceous deposits it is typical to have admixture (5-20 %) of fusulinids and organic detritus chaotically distributed in the principal mass. These argillaceous carbonate deposits were tapped by the well Ushmola 10.

Due to the shallow water basin expansion during the Late Carbonifereous, the carbonate sedimentation becomes more developed than in Moscovian and Asselian periods. Argillaceous carbonate deposits have clear description in the well logs (gamma ray and neutron gamma ray logging) as they include the compact limestone beds and are distinctly seen against the background of more argillaceous deposits of Moscovian and Asselian Stages.

Asselian Stage

Asselian period of sedimentation is associated with commencement of large sea transgression caused by eustatic rise of the sea level. Typical trait of Asselian period is the addition of large quantities of terrigenous material related to Ural Hercynides and Karpinsky ridge orogenesis taking place outside the Basin.

Asselian deposits have three type sections: carbonate (bioherm - shelf shallow water), argillaceous carbonate (slope) and argillaceous (abyssal shelf). Carbonate deposits in Asselian period were formed as a

belt along the northern part of Southern Emba Zone (Karaoy and Urtatau-Sarybulak-Sarykum subzones).

In comparison with Middle and Late Carboniferous the boundary of carbonate sedimentation area is shifted into the Basin. In these subzones under the shallow water conditions the bioherm masses were formed to have a thickness from 400-500 to 900 meters (the well Urtatau-Sarybulak 3). Their framework consist of blue and green algae, accompanied by moss animals, fusilinids, occasionally corals and serpulae. Concurrently with their own growth, the bioherm masses are subjected to washout and that is expressed through the presence of packstone beds in the bioherm limestones. In the areas subjected to intensive penetration of coarse-fragmental material the bioherm limestones were formed with clastic material admixture resulting even in the formation of coarse-fragmental rocks in the limestones. Such deposits have been analyzed in the well 23 and turned out to be 690 meters thick.

Bekbulat-Altynkulash subzone hosted the formation of behind-reef platform carbonate deposits which later on were intensively dolomitized. On a basis of fusulinids analysis Carbonate section is found to be represented by all biostratigraphic zones of Asselian Stage. For the lower zone it is typical to have admixture of redeposited Kasimovian species.

Carbonate section gradually transforms into argillaceous carbonate one (southern part of Matken-Ushmolinsk zone - 5 km band) composed of argillaceous deposits containing members (20-50 meters) of limy conglomerate-breccia, gritstones, sandstones composed of algae limestone fragments. Cementing material contains large quantities of fusulinids, moss animals, corals, crinoids.

This type deposits were tapped by the wells Tortay 6, 9, 11, 19, 21, Saztobe 1 and reach 500-600 meters thickness. In these wells the lower segment of Asselian Stage is represented by gamma-active member (10-40 meters thick) composed of interbedded argillites and argillaceous limestones. This member is present in Matken-Ushmolinsk, Atyrau-Shukat zones and peripheral parts of Karaton-Tenguiz zone. In gamma-active member there is, together with Asselian fauna, the older fauna of Upper Carboniferous, Moscovian and Bashkirian, and that indicates the various depth of pre Asselian

washout. For gamma-active member deposits it is characteristic to have higher organic content up to 10 % which absorbs the radioactive elements. Therefore this member can be clearly seen in the well log as having high radioactivity (gamma ray logging), high density (neutron gamma ray logging) and serves as logging bench mark horizon. Since the gamma-active member has regional distribution and contains compact carbonate rocks, there is a reflecting horizon P2 confined to it. Upper and middle zones can be distinguished in an argillaceous carbonate type section on a basis of fusulinid complexes.

Argillaceous type section was established in Matken-Ushmolinsk, Karaton-Tenguiz and Atyrau-Shukat zones and has homogeneous argillaceous composition reflected by homogeneous records of gamma ray logging, neutron gamma ray logging. Thickness of argillaceous Asselian deposits varies from 50 to 400 meters. Due to the fact that no fusulinids were found over the most part of these zones, the biozone delineation was done on a basis of conodont complexes analyzed within three zones corresponding to the fusulinid biozones of the carbonate type section. In the reduced thickness segments (50-100 meters) the biostratigraphic studies revealed the species typical for the upper biozone allowing to accept the model of Asselian deposits transgressive structure as a basis.

Sedimentation of Asselian deposits in Karaton-Tenguiz zone (in the central part the thickness is 10-140 meters) was taking place under the shallow water conditions with limited addition of argillaceous material and therefore has certain distinctive features. Most part of the terrigenous material was added to the basin by gravitation currents which were rounding the paleohighs. The Paleozoic uplift areas were exposed to addition of fine argillaceous material (suspension) which was suppressing the development of lime-secreting organisms but constituted only minor part of total sedimentation material volume. In such circumstances the rock building role was assumed by plankton organisms, including radiolarians, inhabiting entire basin. Out of the fauna variety typical for shelf shallow waters only the most conditioned would survive: brachiopods, ostracods, gastropods, trilobites, ammonoids. So, under the conditions of intensive addition of terrigenous material, in the paleohighs areas including Karaton-Tenguiz zone the carbonate sedimentation area tends to shrink

substantially and shift towards the northern part of Karaton-Tenguiz zone. In that part the well Pustynnaya P-10 tapped crinoid limestones 60 meters thick, and the well Karaton 1 encountered algae concretions.

Large problem concerning the southeastern part is the lateral replacement of bioherm structures (400-900 meters) with argillaceous deposits up to 400 meters thick which cannot be classified as traditional abyssal carbonate analog. On the other hand, it is hardly possible to have formation of bioherm structures in the course of intensive addition of terrigenous material. However, both processes did actually occur and this leads to a hypothesis regarding the existence of terrigenous material barrier and formation of reeefal structures in those areas of Southern Emba zone which were protected from clastic material.

Sakmarian Stage

Facies environment of Sakmarian sedimentation is very similar to Asselian though has a number of distinctive features. It is assumed that Sakmarian sedimentation constitute together with Asselian a single sedimentation cycle. There are carbonate and terrigenous types of Sakmarian deposits. Carbonate type section was determined on a basis of fusulinid complexes in the wells Sarykum 1 and 2, Saztobe 2 and 4, Tinishtyk 1 and supposedly in the well Karaoy P-2 and is represented by the limestones dolomitized and anhydratized to various extent.

Argillaceous section of Sakmarian deposits is assumed to exist in Matken-Ushmolinsk zone and to reach the thickness of up to 400 meters. Such areas are similar to the Lower Permian deposits in the eastern part of the pre-CaspianBasin where Sakmarian deposits were positively identified on a basis of conodont, fusilinid, spore and pollen complexes.

Artinskian Stage

During the Artinskian period the sea regresses and the basin becomes salinized. This results in substantial decrease of lime secreting

organisms productivity. Artinskian deposits are not present universally. They are omitted in Southern Emba, Southern zones and central part of Karaton-Tenguiz zone. Artinskian deposits are adequately studied in Matken-Ushmolinsk zone where they are represented by interbedded gritstones, sandstones and argillites with their content ratio varying from one well to another. Artinskian deposits are unmistakably seen on logs due to the presence of compact coarse-fragmental rocks. The reflecting horizon P 1/1 is confined to the Lower Artinskian deposits. Sedimentation basin in the southeastern part of the pre-Caspian Basin is divided into two parts by the zone of paleohighs located along the line Pioncerskaya-Elemes-Ravninnaya-Akuduk where there are no Artinskian deposits.