Mineralogical Content of Productive Series Shales of Western Portion of South Caspian (Example, Bulla-Daniz Area)*

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Abstract

Shales of South Caspian Basin are of great scientific and practical importance to specify the matter of correlation, stratigraphy, paleogeography, etc. Moreover, clay minerals have signs of the conditions in which they formed and subsequently transformed. Shales play an important role in the Productive Series (PS) sedimentary section of the South Caspian Basin (SCB). They dominate around 70-80% of the total stratigraphic section. The Productive Series in the region of the Baku archipelago is represented by the upper and lower part.

Lower Part

The lower part of PS of the Baku archipelago is represented by sand and shale alternation and in comparison with the upper part is observed by the excessive sand percentage. The shales in this part are generally massive, sometimes layered, calcareous and often consist of small mixtures of sand and silt materials. The shales in the lower part are polymineral and include montmorillonite, illite, kaolin and chlorite. In the clays of the lower section of the Baku archipelago one can observe small changes in percentage of montmorillonite and illite not only in the part, but within the area too. Thus, the decrease in the content of montmorillonite and increase in illite occurs in a southwest direction within Sangachal – Daniz – Bulla Daniz. The grain-size analysis of shales demonstrates that the shales in the lower part of PS (below PS horizon V) are rather badly levigated, they are substantially concentrated by the silt fraction, and the sand content is minor. The association of clay minerals of the lower part of the upper part differs from the upper one - the basic rock-forming mineral in the light fraction is anemoclasts (67.5%) which dominate over quartz (21.0%); the availability of pyrite (97%) is observed in the heavy fraction and all stable and non-ferrous low-stable minerals entirely disappear.

Upper Part

The upper part of the upper section of PS is represented by the dominance of shales to which sand bands are subjected, whereas the lower part of the upper PS (Balakhani suite and Pererive suite) is mainly represented by sands and sandstones. The shales of Pererive suite very much differ from clays of both the lower and upper part of PS regarding quantitative composition. Here the content of illite prevails over that of montmorillonite. The upper part of the upper part of PS (horizon V) is mainly represented lithologically by shales interbedded with sand and silt strata. As per our research, in the upper part of the upper section (horizon V) limonite (67.0%) dominates in the mineralogical makeup of the heavy fraction, then comes magnetite – ilmenite (14.5%). Leucoxene and pyrite are minor, 3.5% and 1.5% respectively. The content of the stable minerals accounts for 3.5%. The nonferrous low-stable components are sufficient: 3.8% of mica, 3.0% of augite–malacolite, 1.0% epidote–zoisite, and in lesser amounts at 0.5% and 0.7% respectively of glauconite and hornblende.

Thus, the difference in the type of sediments that is peculiar to the lower and upper parts of the upper part of PS (of Absheron type for the lower part, Gobustan for the upper part of the upper part of PS) indicates the different recharge areas and drift of terrigenous materials at these stages of the deposition of sediment. Thus, at the early stage of deposition of sediments of the upper section of PS (the lower part of the upper section of PS) all the region of the modern Baku archipelago was submerged and the recharge area was a distant north province, at the later stage (the upper part of the upper section of PS) of deposition of sediment of the upper part of PS, the drift zone was the region near to the Greater Caucasus and Lesser Caucasus, as well as the Talysh Mountain system laid by rocks, heavily enriched with effusive material within which magmatic, effusive and sedimentary strata of mesocainozoic complex collapsed and delivered the sediments into the basin, widely developed in PS rocks: feldspars, pyroxenes, hornblendes, effusive, carbonate and clay anemoclasts, quartz, mica, stable minerals, etc.

Mineralogy

The poly-mineral composition of the South Caspian PS shales and the compound character of clay mineral disposition in the section and the area are connected with the difficult conditions of sediment accumulation in the basin of medium-Pliocene age (PS) and the availability of several powers of supply. As per many researchers' data, the sediment accumulation occurred under the conditions of the fast rising of undersurface structures of the Greater and Lesser Caucasus and the substantial compensating immersion of the basin bottom and the inflow of the terrigenous material being increased.

Irrespective of the downwarping of the basin bottom, its mode was shallow allover. The autogenic montmorillonite that is spread in PS of the Baku archipelago is a product of transformation of volcanic glass due to diagenesis under the alkaline reductive sea conditions. In most cases montmorillonite is an illite composition of shales which mainly indicates and alkalescent neutral medium of sediments. According to Kh.A. Alizada's and M.B. Kheirov's data, the transformation of volcanic glass into montmorillonite occurred according to the scheme:

volcanic glass → beidellite → mixed layered clay formations beidellite → montmorillonite of montmorillonite series

The montmorillonite prevails in the clays of the upper part of PS of the region researched. They are found in quantities in the southern part of the Baku archipelago. The content of illite in shale of the upper part varies from 30% to 40% and is minimal where the content of the montmorillonite is maximal. The contents of clay minerals in the shale of the upper part also agree with the data of the chemical analysis where the content of SiO_2 varies from 47.0% to 51.0 %; K_2O – 1.90-3.0%; Al_2O_3 – 17.0-24.0%; Fe_2O_3 – 0.5-12.0%; MgO – 1.2-6.7%; CaO – 1.5-2.70 %. The content of MgO in the southern part is more (more than 4%) than in the northern part. The allocation of MgO conforms to the development of magnesian silicates. The accumulation of MgO in clays is caused by the processes of diagenetic dissolution of pyroxenes which come from the Lesser Caucasus. The passage from Pererive suite to the upper section is characterized by the abrupt increase in the content of montmorillonite and the decrease in illite.

The content of montmorillonite in PS shales without any marked catagenetic changes in the depths exceeding 5 kilometres indicates that the autogenic formation of montmorillonite on the basis of volcanic glass generally occurred in the diagenesis. The wide spread occurrence of autogenic Na-Ca montmorillonite in PS sediments of the Baku archipelago indicates of reducing alkaline environmental conditions and the inflow of Na-Ca sediment accumulation - feldspars and volcanic glass - into the basin, from which it is first generated. The ions of Na^+, Mg^{2+} and Ca^{2+} that is included into the formation waters of the Baku archipelago also facilitate the formation of the autogenic montmorillonite.

The structural difference of 2M hydromica spread in PS shales do not usually form in sea conditions, and consequently is of an allotogenic origin, kaolin is also allotogenic, for the autogenic formation of which the alkaline reductive sea conditions are unfavorable. The chlorite is spread in PS clays of the Baku archipelago and chiefly of an allotogenic origin. The first sign of its autogenic formation is observed in deeper parts of the Baku archipelago only.

The magnesian silicates of the Baku archipelago is probably related to the fact that at that time this region was a shallow area that had island sandbanks of high salinity. The abrupt increase in the content of 2M1 illlite in Pererive suite age is related with the northern sediment supply that delivers its stated big difference into the basin.

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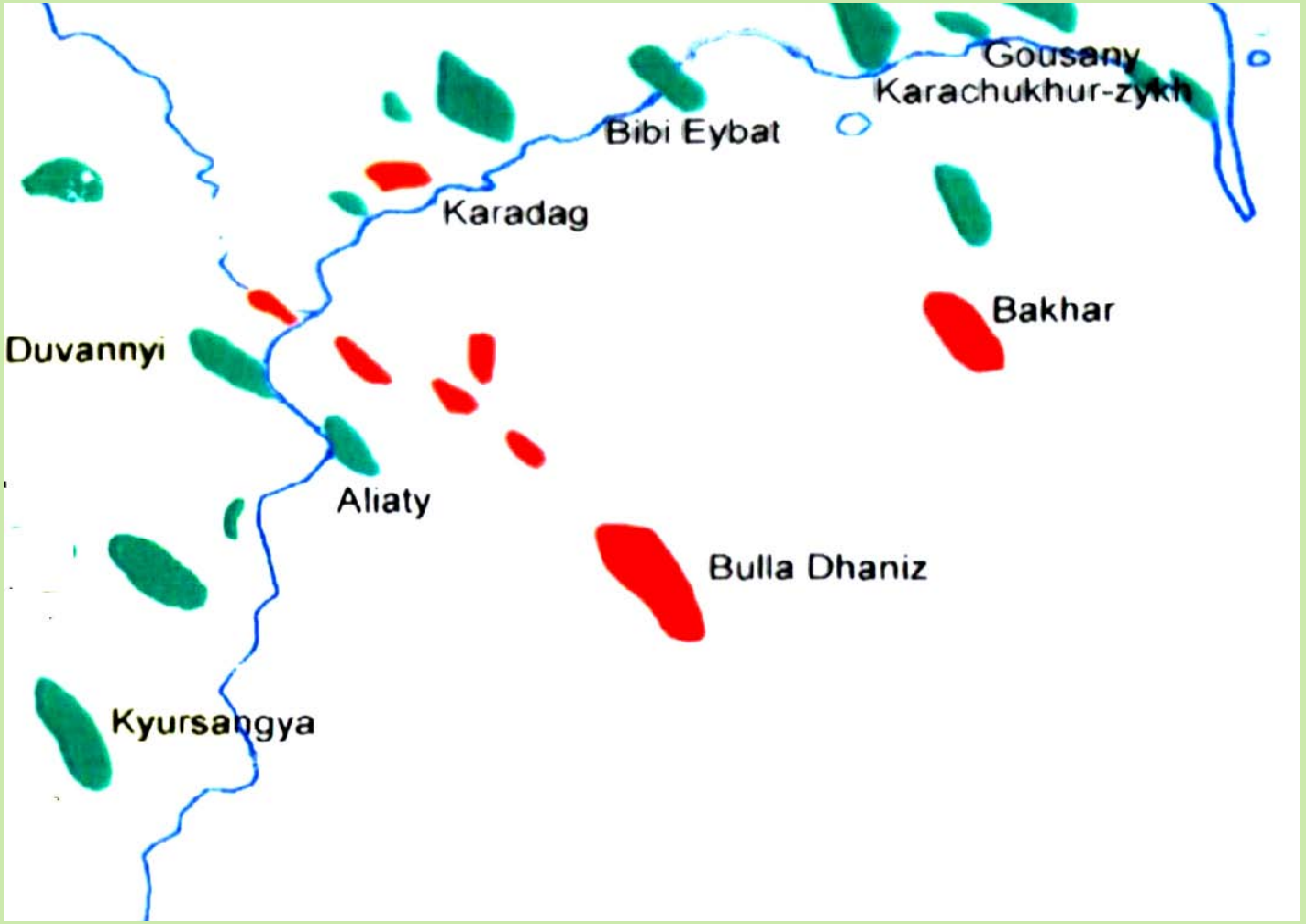
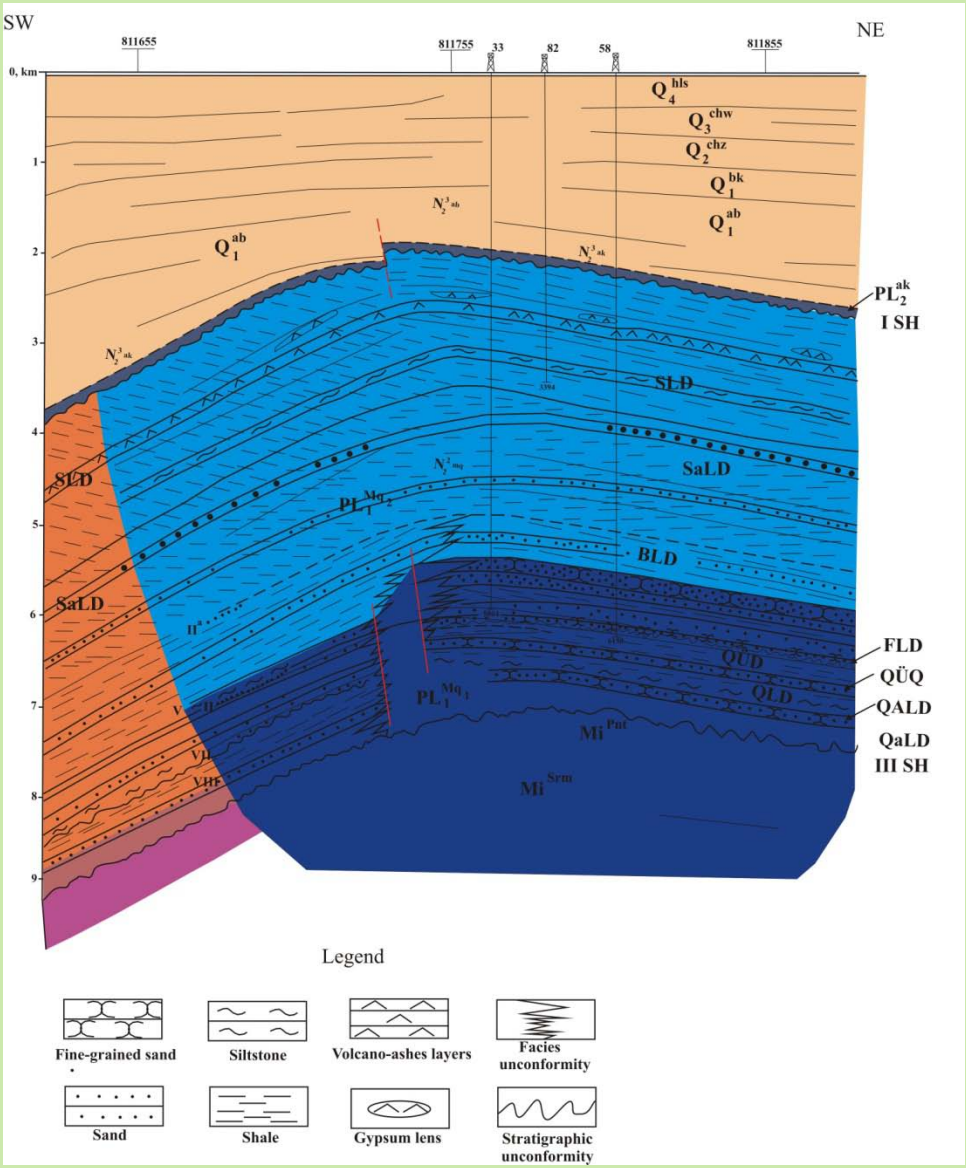
Western Flank South Caspian area

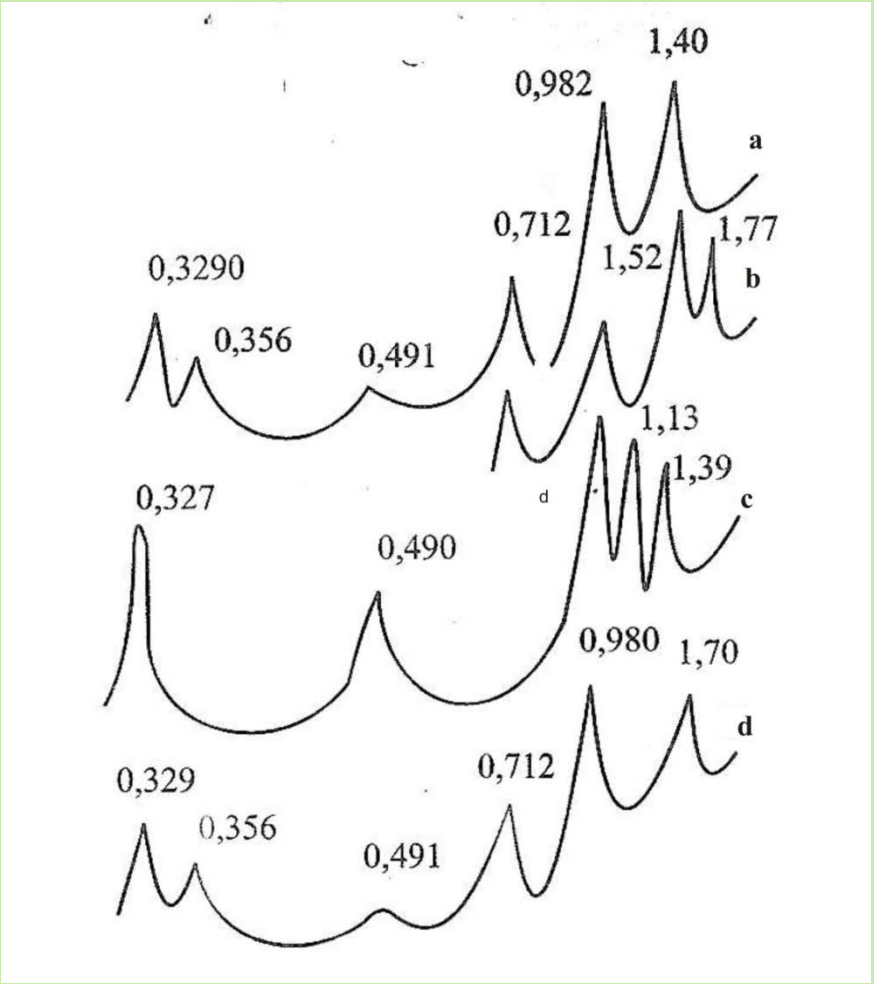


Geology profile of Bulla-Daniz
Ch. Khalifa-zade,V.Mursalov, E. Abdullaev



X- ray diffractograms of clay of the Productive Series

a- rock sample
b- sample, subjected to glycerin treatment
c- rock sample, after heating 580^0 C
d- sample, subjected to HCl treatment



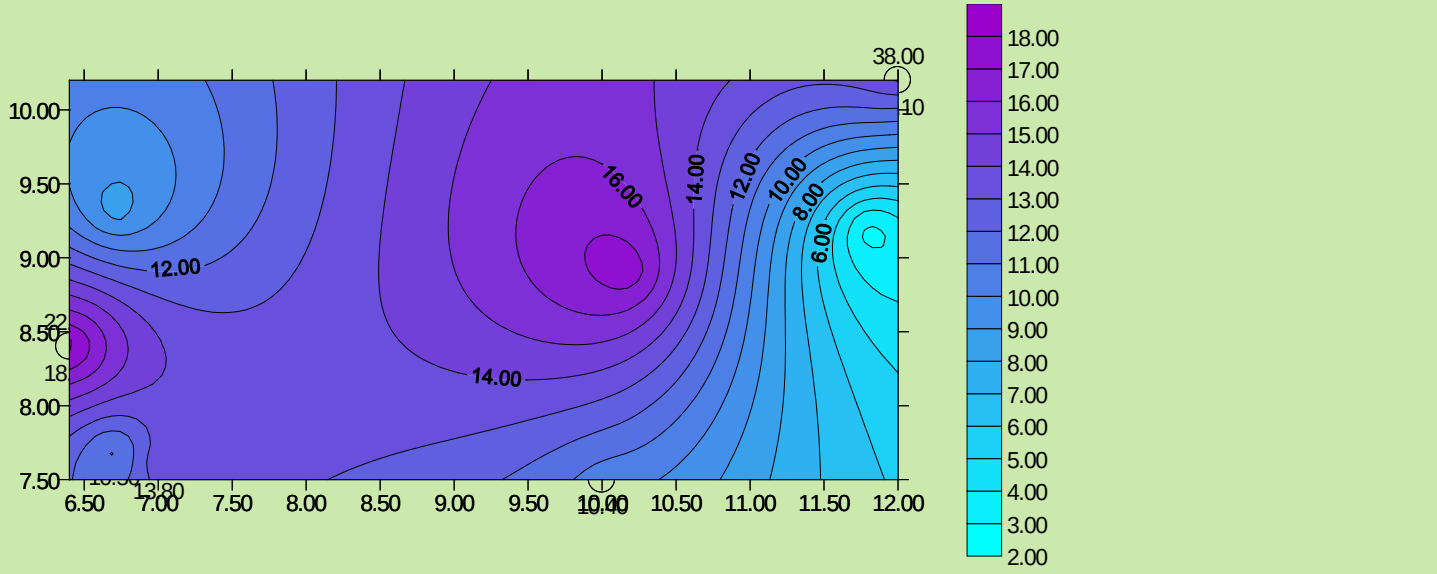
Percantage content of clay minerals in the shales of the Productive Series

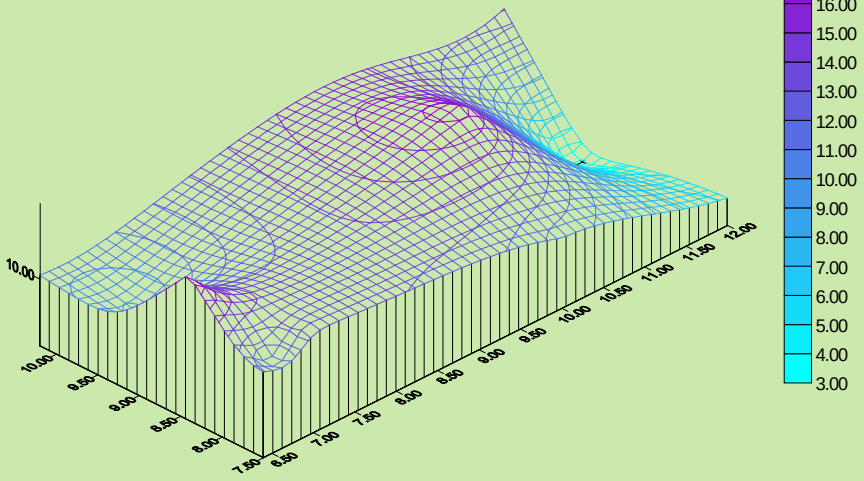
	Field name	Borehole number	Sampling interval, m	Clay mineral content, %			
				Hydromica	Smectites	Kaolinite	Chlorite
1	Bulla Daniz	52	4141-4148	35-45	25-35	15-25	5-15
2	--	--	4325-4329	35-45	10-20	25-35	10-20
3	--	57	2300-2303	30-40	30-40	20-30	5-10
4	--	--	2626-2631	30-40	30-40	10-20	10-20
5	--	--	3505-3510	10-20	60-70	10-20	5-10
6	--	--	4477-4478	15-25	55-65	5-15	5-15
7	--	--	4753-4758	10-20	60-70	5-15	5-15
8	--	59	3325-3330	20-30	40-50	10-20	10-20
9	--	--	4289-4294	25-35	30-40	15-25	10-20
10	--	--	4740-4794	20-30	40-50	25-35	10-20
11	--	21	5211-5219	30-40	40-50	15-20	0-5
12	--	--	5241-5247	35-45	40-50	5-10	--
13	--	45	5273-5277	40-50	20-30	15-20	5
14	--	--	5298-5301	45-55	20-30	10-15	5
15	--	--	5351-5355	45-55	15-25	20-30	5-10

Result of petrography analysis of shales of Bulla – Daniz field

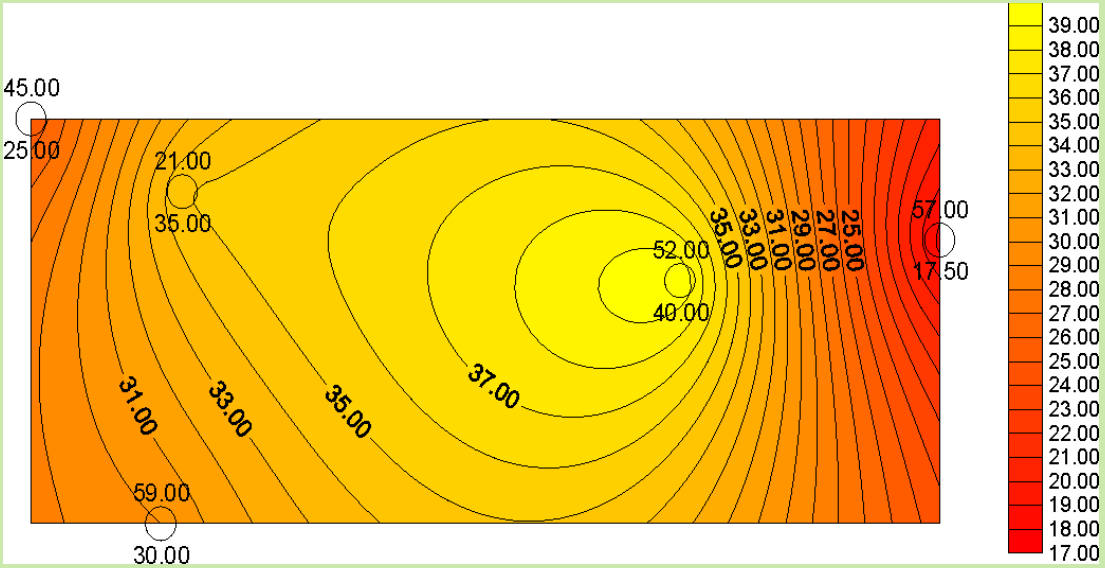
Types rock / Components	Clay rock	
	Limits content	Average
Content of $CaCO_3$	8,4-15,2	11,3
Fraction >0,25 mm	0,0-0,50	0,25
0,25 – 0,1 mm	0,19-5,52	2,69
0,1 – 0,01mm	14,82-37,44	27,48
< 0,01mm	58,24-84,99	69,58
Light fraction	100-98,0	98,90
Quarts	0-24	9,3
Feldspars	0-23	9,3
Rock fragment	57-100	81,3
Glauconite	0-1	0,1
Heavy fraction	0-2,0	1,10
Pyrite	0-82	21,4
Magnetite, illmenite	1-51	19,4
Gidrooksili iron	2-83,5	36,4
Stable mineral	0-11	4,7
Staurolite, disthene	0-0,5	0,1
Titanite, picote	0-1	0,2
Mica	1-8,5	4,8
Hornblende	0-3	0,9
Augite, diopsid	0-6	1
Epidote, zoisite	0-2	0,6
Glauconite	0-4	1

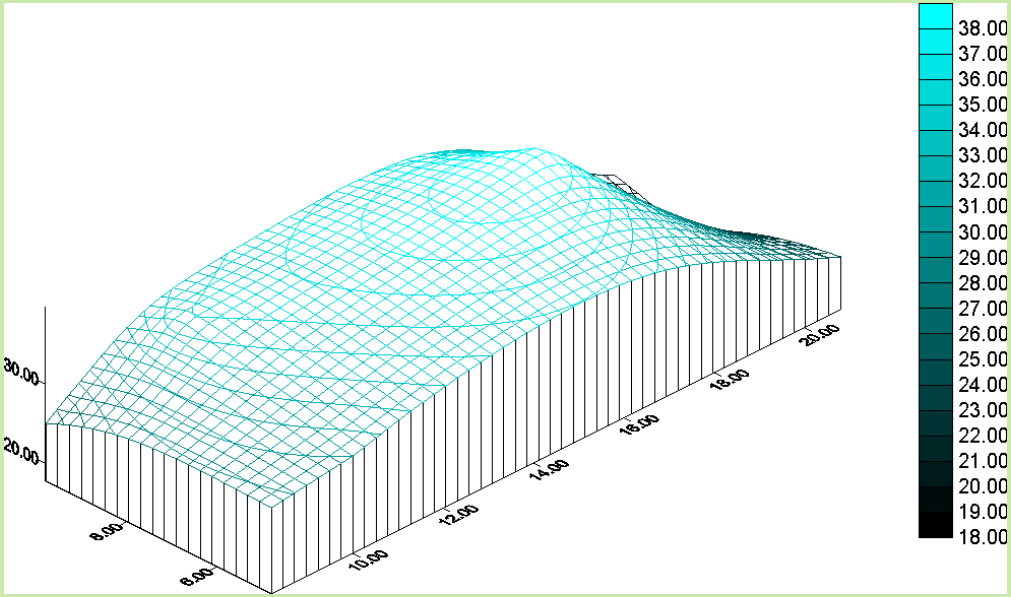
Carbonate content in rocks at V horizont of Bulla-Daniz field



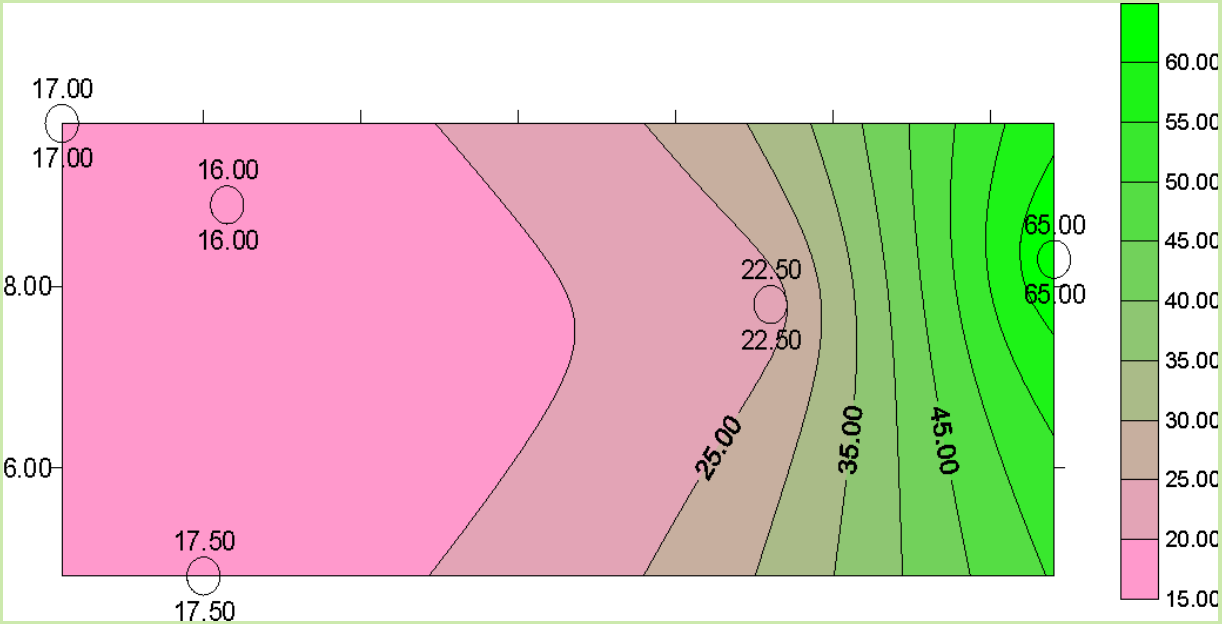


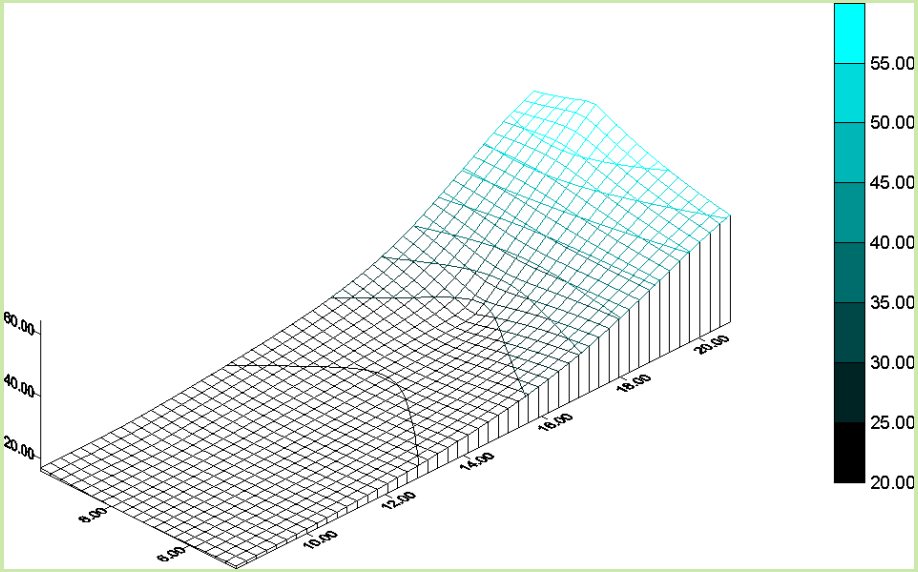
Map of distribution illite in rocks at V hor. of Bulla-Daniz field





Map of distribution smectite in rocks at V hor. of Bulla-Daniz field





Thank you for attention