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Abstract

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The Caspian base level, is about 26.5, below the Global sea level. The measured seasonal fluctuations, is over 0.4 m, although the maximum annual fluctuation is 0.34 m. The watershed basin of Caspian, is one of the most important basin of the Iranian plateau, and large volume of waters from Alborz and Azerbaijan mountains flow to this lake. The catchment area of the Caspian Sea is 3.1 million km2, which 256,000 km2 of this amount is located in Iran. In other words, the area of Caspian, is 6.5 times greater than Oral, 31 times greater than Baikal, and 90 times greater than Urmia lakes.

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Seismic Stratigraphy of the Caspian See Floor (Western Part of Sefidrud)

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2024

Seismic Stratigraphy of the Caspian See Floor

(Western Part of Sefidrud)

سرشناسه : محمدرضا انسانی، غلامرضا حسین‌یار، رضا بهبهانی –
Mohammad Reza Ensani, Gholam Reza Hossein yar, Reza Behbahani

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1-1- Introduction

The Caspian (Khazar) Sea, with an area of 347000 km^2 and about 77000 m^3 (cubic meter) water, is largest lake around the world (Mamedov, 1992). The Caspian Sea with a north-south trend, 1207 km length, and about 450 km width, is the largest water basin confined in the terrestrial land and consists 40% of the water volume of the world's lakes. Although, with attention to its geographical expansion, assumed as a sea, but due to the lack of hydraulic connection with open lakes, and comparing water composition of oceans, there is no similarity between Caspian and other open seas (Figure 1).

Figure 1: The geographical location of the Caspian Sea

The Caspian base level, is about 26.5, below the Global Sea level. The measured seasonal fluctuations, is over 0.4 m, although the maximum annual fluctuation is 0.34 m (Figure 2). The watershed basin of Caspian, is one of the most important basins of the Iranian plateau, and large volume of waters from Alborz and Azerbaijan mountains flow to this lake. The catchment area of the Caspian Sea is 3.1 million km^2, which 256,000 km^2 of this amount is located in Iran. In other words, the area of Caspian, is 6.5 times greater than Oral, 31 times greater than Baikal, and 90 times greater than Urmia lakes.

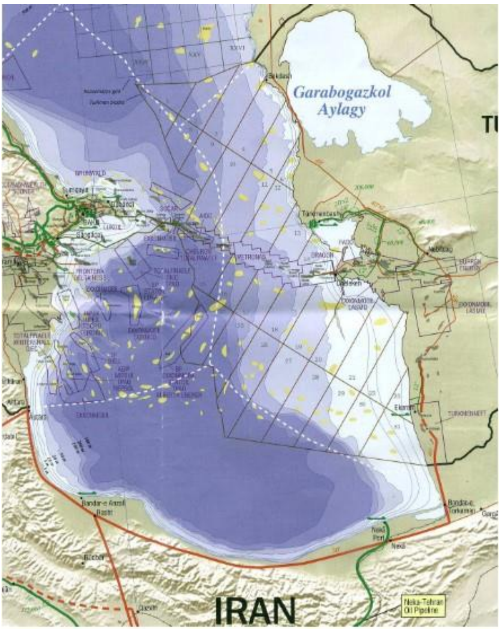


Figure 2: Caspian Sea depth

1-2- Geology and Structure of the South Caspian Depression

The area under study, is a part of Alborz mountains that located in the northern part of the Khazar (Alborz) Fault. The history of the Caspian Sea, in the frame of a closed sea basin, begin from the Lower Pleistocene. The Caspian Sea was a part of the Neo-Tethys Ocean. At present, Mediterranean Sea, Black Sea, Azov and Caspian are the remaining of Neo-Tethys Ocean. Alpine Orogeny in Neogene separated Black Sea, Caspian Sea and Azov from the open seas. Due to the early Pliocene orogeny and uplifting of the Caucasus terrane, the water connection between Caspian with Azov and Black seas closed. Afterwards geological, hydrological and biological history of the Caspian continued lake-type independently (Varushkenko et al., 1987). With late Pliocene orogeny, the present morphology of the Caspian formed.

Deep seismic sounding data suggest that the southern part of the South Caspian (the South Caspian depression) lacks a granitic layer and that the relatively thick undeformed sedimentary cover rests directly on a basaltic basement 15-20 km thick. The overlying sediments are 15-25 km thick, with a refracting interface within than at a depth of 8-12 km. The sediments below this interface are thought to be Mesozoic and Paleogene in age, and these above Neogene and Quaternary in age. The Pliocene – Quaternary increase in the subsidence rate of the South Caspian depression correspond to the uplift, folding, and thrusting of the bordering fold – thrust mountain belts.

The age of the basaltic basement of the depression is uncertain. According to same (Amurski et al., 1968) it is pre-Liassic (older than 195 Ma); and to others (Shikalibeily and Grigoriants, 1980) it is Jurassic and is overlain by Cretaceous volcanic rocks. Adamia (1975) and Adamia et al., (1979, 1980) believe that the basaltic basement extends eastwards to the southwestern fore – deep of the Great Balkan and to the eastern coastal region of the Southern Caspian Sea.

Many Russian earth scientists believe that the ocean – like seismic character of the depression basement resulted from basification of former continental crust imitated by down warping during the Tertiary period. It has also been suggested that the basement is a rampant of the ancient Tethys. (Dewey et al.,1973) According to Adamia et al., (1977, 1980) the oceanic like crust of the south Caspian resorts from Late Cretaceous-Early Paleogene rifting processes, with Middle Eocene basalts in the lower crust alone, and is not the relic of an older ocean.

The Caspian Sea forms a deep midland basin, with water depth up to 900 m, in the northern part of the Alpine-Himalayan orogenic belt, floored by the oceanic basement, is a relatively stable block, with minor deformation, surrounded by active fold-thrust belts of arcuate form (Talesh, Alborz and Kopeh Dagh

Mountains), which have undergone intense late Cenozoic crustal shortening. The basin is interpreted as a Neogene-Quaternary "compressional depression", bounded by multi-role mountain-bordering faults, and apparently floored by a late Paleozoic – Triassic or Late Mesozoic-Early Tertiary "modified oceanic crust" tranced along an old geosuture. It may be a relic of an old (Paleozoic-Triassic) ocean, or else a marginal sea developed behind a Mesozoic-Paleogene Ocean, and analysis of geological and geophysical data enables a scheme to be suggested. The general arcuate shape of the Alborz and the Talesh bordering mountain belts follows the pattern of the supposed rigid and thickened ocean crust of South Caspian depression (Berberian, 1982).

1-3- Subdivision of the Caspian Sea

The Caspian Sea basin, structurally is heterogeneous and its floor structural features are very close to its terrigeneous environment. Hence, based on the structural features, physical indicators, sea-floor topography and hydrology characteristics, the Caspian can be divided in to three Northern, Central and Southern basins (Figure 3).

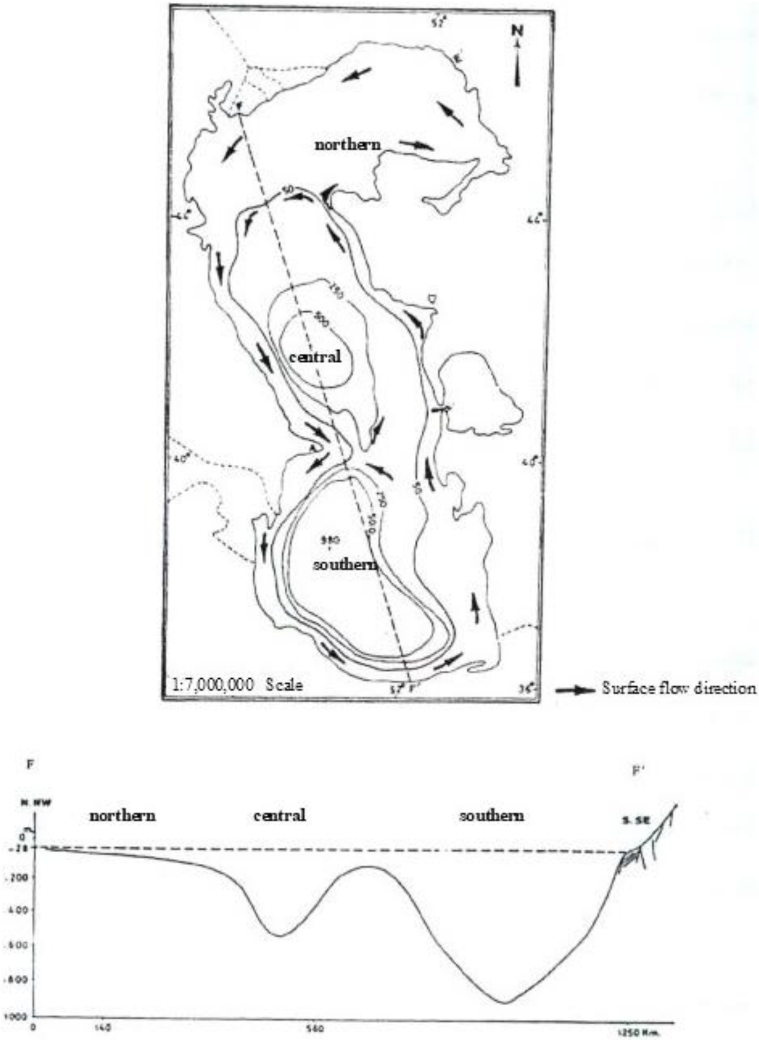


Figure 3: Hydrographic and bathymetry status of the Caspian, northern, middle and southern basins (with changes from Motamed.1997)

1-3-1- Northern Caspian

The total area of Northern Caspian is 91.942 km^2 with a water volume of about 397 km^3. The Northern Caspian containing 25% of total area of the Caspian, but to allocate only 5% of water. Maximum depth of water is 15-20 m. The northern Caspian is located north of a hypothetical line between the Cheleken is land and Tuyb-Karagan peninsula (Lebedev, 1991). Transgression and regression of the Caspian Sea water made a great effect in sea-floor morphology (Figure 3). Although at present Volga, Oral, Koma, Amba rivers are not flowing to the sea, but their old valleys can be seen in the floor of the Caspian.

1-3-2- Mid Caspian (central)

The total area of Central Caspian is about 138,000 km^2, which contained 35,000 km^2 of the mentioned area with about 100 m depth is located in the western part of the Caspian (Khain, 1994). Maximum depth of the Central Caspian is 788 m. The mean value depth of the Caspian, estimated to be 213 m. The water volume of the central Caspian is about 26.439 km^3. The western half of the central Caspian is located in the Epi-Hercynian orogeny zone, and Eastern part is located in the Alpin orogeny zone (Khain, 1994). The mid-Caspian valley is as ym metrical, i.e. the western part contains a narrow continental shelf with steep continental slop, otherwise, the eastern part is a continental shelf with a spread and mild continental slope (Solovev et al., 1962).

In the western continental shelf, the accumulative process, and in the eastern continental shelf, the erosive process is dominant (Lebedev, 1991). Depth in the border of continental shelf with continental slope is 70 to 110 m, and width of the eastern mid-Caspian continental shelf is 55 – 90 km, with a slope of 34.7º (Solovev et al., 1962). Width of the continental slope in the western part is 20 – 60 km, with a slope of 1 - 6º.

1-3-3- Southern Caspian

The total area of southern Caspian is about 148.640 km^2, which contained 39.3 percent of the area. Water volume of this part is 51.245 m^3, which contained 65.5 percent of total of the water volume. Maximum depth in this part (the Abikh Trough), is 1025 m, but the mean depth is 345 m (Lebedev, 1991). The southern Caspian is located in the Alpine orogeny belt. The width of continental shelf of the western part of southern Caspian is 15 - 60 km, with a dip of 6 - 11º. The width of continental shelf in the eastern part of the southern Caspian is more than 10 km. The width of continental shelf in the southern part of South Caspian is about 6 – 10 km, but is steep (Khain, 1994). There are many mud volcanoes in the western part of South Caspian. One of the most specific features of the floor in these parts are ridge and basins with a length 18 - 20 km. Mousavi Ruhbakhsh (2001) believes that this phenomenon is the result of the middle Pliocene folding.

1-4- Effective Factors for Caspian Sea-level Fluctuations

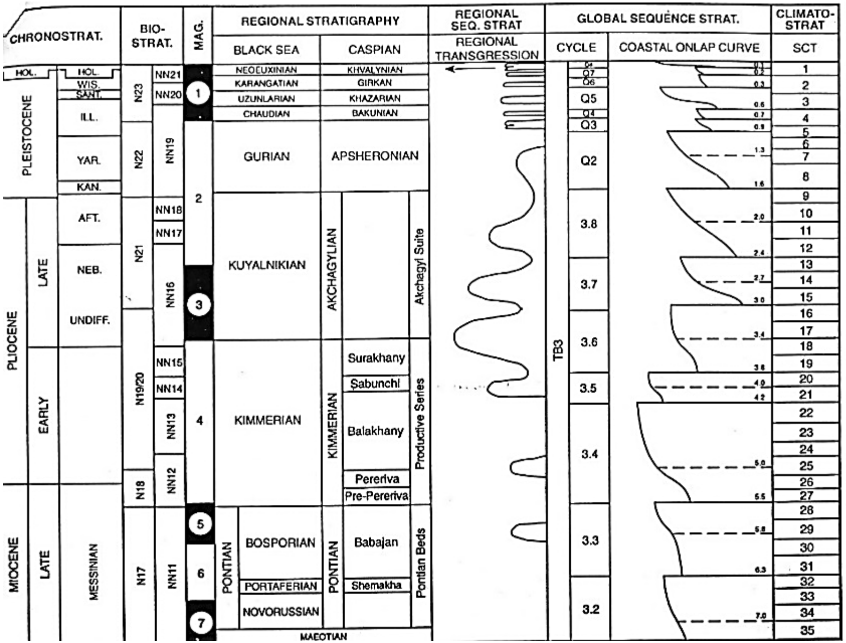
There are three main factors for sea-level fluctuations:

- Climatic change: In addition to some unimportant factors, most scientists are believing that 80 percent of the sea-level rise is due to climatic change.
- Glacial variations
- As a result of Divergent and Convergent movement of continental of Plates, the coastal regions either increased or decreased.

These phenomena are the result of either Glacio - eustatic or Isostasy factors. The first factor to arise either from spreading of non-spreading of glacial sheets in glacial and inter- glacial Periods.

I with respect to sea-level fluctuations, Ghanghormeh (1998) recognized eleven lake terraces along the Coastal Caspian. The age of terrace surfaces determind from +210 (260ka) to -17 (less than 8ka) since mid-Pliocene Caspiansea-level experienced several transgression and regression cycles (Table 1).

Table 1: Comparison of more fluctuating cycles of Caspian Sea water with glacial and interglacial periods in Europe (Lahijani, 2005)



1-5- Tectonic Units of South Caspion Basin and adjacent regions

The most important tectonic units of the Caspian and adjacent areas are Platforms, mountain ranges and magmatic arcs (Brunet et al., 2003) (Figure 4).

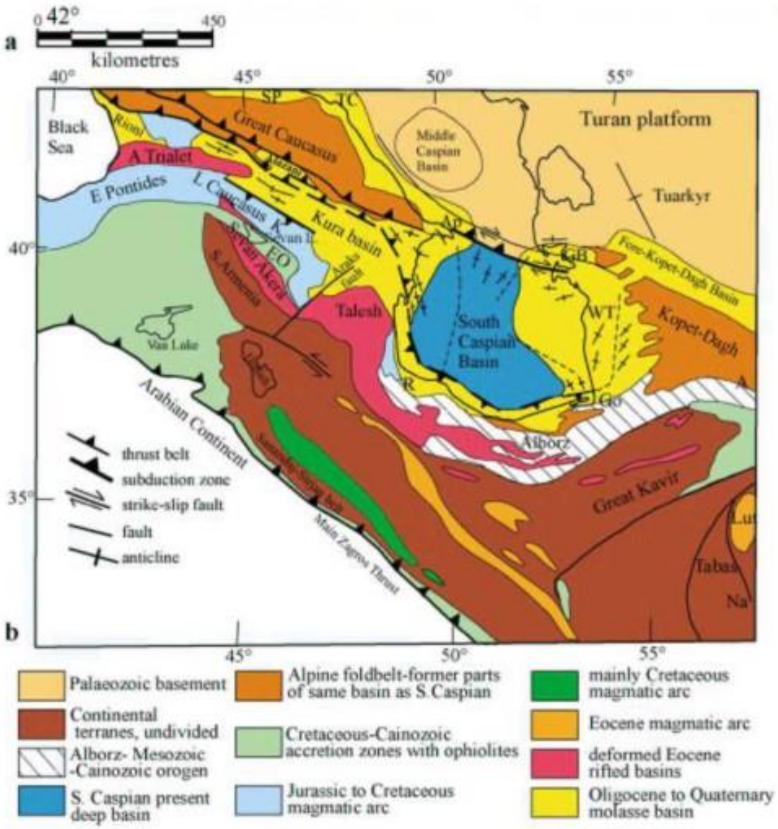


Figure 4: Location of the most important tectonic units around the South Caspian Basin (Brunet et al., 2003)

1-5-1- PLATFORMS

Two main platforms adjacent to the Caspians are Turan Platform in the east, and Sythian in the northwest. the Southern Parts of these platforms consists of fore Kopeh Dagh Basin and Great Caucasus.

1-5-2- MOUNTAIN RANGES

The mountain ranges environment of Caspian are as follows:

1-5-2-1-Great Caucasus

Shortening and closure of the Great Caucasus though as a manner of a back are basin opened during early Jurassic, and the Great Caucasus Mountains formed. Closure of the Great Caucusus Trough began mainly from the late- Gocene and the main phase of collision occurred in the Mid-Miocene, and original Uplifting was during prices Pliocene - Quaternary (Branat et al., 2003).

1-5-2-2-Alborz

The Alborz Mountains bordering the Southern Parts of the South Caspion depression. The Present Alborz fold-trust belt, were the site of two major fault-Controlled subsiding sedimentary basins during to Paleozoic and the early Mesozoic regional extensional phase, when the whole Iranian basement was attenuated and stretched. Apparently during of late Paleozoic -

Triassic time the Gondwanian fray meant (including Alborz and Talesh) Split from Gondwana land, crossed the Paleo-Tethys, and collided with the Asian block in what is now 1-5-2-3-Kopeh Dagh

The Kopeh Dagh, separated from the Alborz by the Paleo-Tothys Sutur Zone (Agh Darband) in Eocimmerian phase. Then a sedimentary basin with a 10km thick sequences of Jurassic- Tertiary sediments formed in to margins. During the Alpine Orogeny, to Kopeh Dagh (mainly from mid-Miocene) folded, and thrusted over the southern edge of the Turan Platform resulting the fore Kopeh Dagh basin in the northern part of the mountain range (Brun et al., 2003).

<u>1-5-2-3- Great Balkhan</u>

The Great Balkhan as a northwest continuation of the Kopeh Dagh is situated in the northeast of south Caspian depression. This mountain rage formed as a distinct up lift from Cretaceous and northward thrusted over the Turan platform (Brunet et al. 2003).

1-6- Major Basins around the south Caspian Depression

Foreland basins around the south Caspian Basin are: Treck Caspian molas basin, located northeast of the great Caucasus mountains, and Kopeh Dagh basin with 40-59km2 area, located in north Kopeh Dagh (Brunet et al., 2003). Pull apart basins around the South Caspian

Basin are: Achara -Torialet, Ervan-ordubad, Talesh and south Alborz.

1-6-1- The South Caspian Basin

The south Caspian Basin, constitute of deap and thick central basin, in south of Khazar Sea. This basin can be divided in several sub-units (Brunet et al., 2003; Figure 5), The first sub-unit, with a depth of 26km, located in the northern part of the South Caspian basin (Knappated., 2000). The Second sub-units Pre-Alborz trough, with more than 20km thickness, located in southeast of the South Caspian till north Alborz. The thickness of sediments in southwest of the South Caspian Basin, which is shown in basement depth map, varies between 20 km to 10kum. The western, offshore of the South Caspin Basin is very thick, but in the eastern part (between Alborz foreland trough and South of the Apsheron sedimentation centre), is about 15 km.

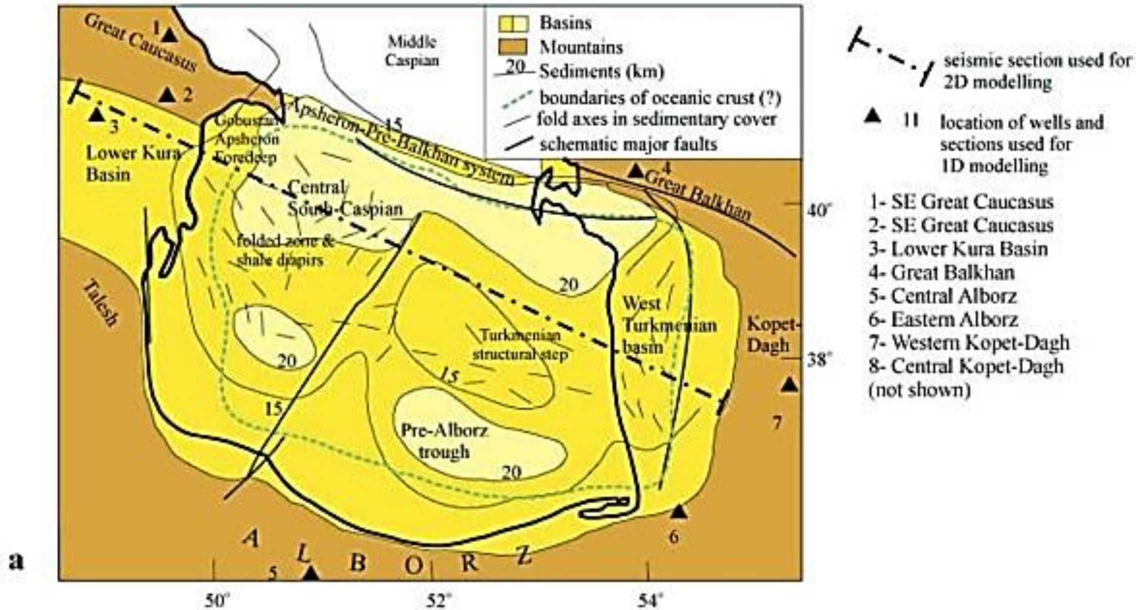


Figure 5: Division of the sub-basins of the South Caspian Basin (Brunet et al., 2003).

The deepest well drilled by the National Iranian Oil Company in the southeastern coastal plain of the Caspian Sea was abandoned in Lower Jurassic sediments at a depth of about 6km (Stocklin and Nabavi, 1973). It demonstrates the absence of the Mesozoic and (or) Cenozoic layer in the southeastern coastal plain of the Southeastern Coastal plain of the South Caspian Depression. Paleoreconstruction of the Iranian region based on de available Paleogeographic data (Berberian and King, 1981) indicates that if the basaltic layer is oceunic it could be a relic of either the Hercynian (closed in Triassic) and (or) the Mesozoic (closed in Cretaceous) ocean, or else a marginal sea developed behind an island are. The region has been mostly under compression at least since Pliocene - Pleistocene Times, and no long-term extension regime is known to have occurred in the area since them (

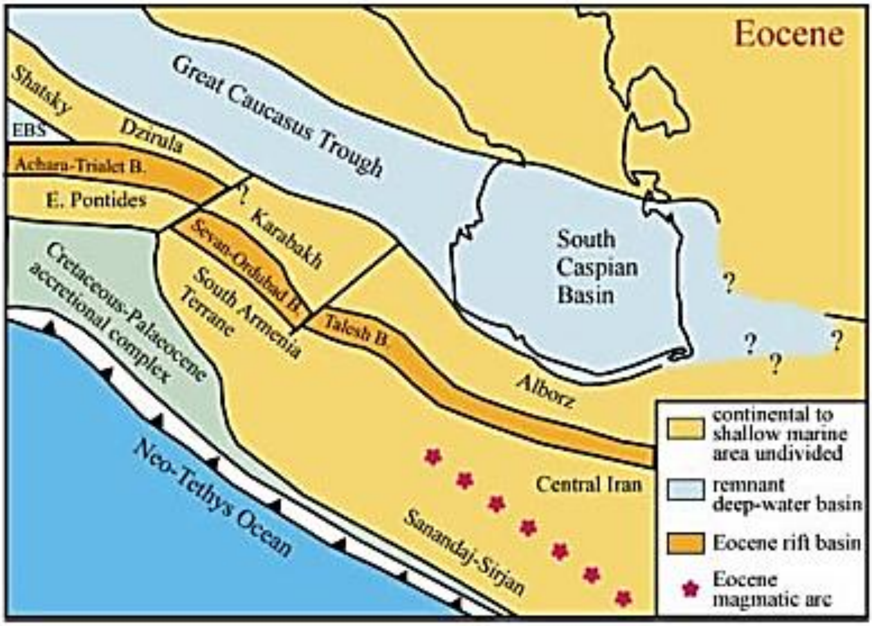
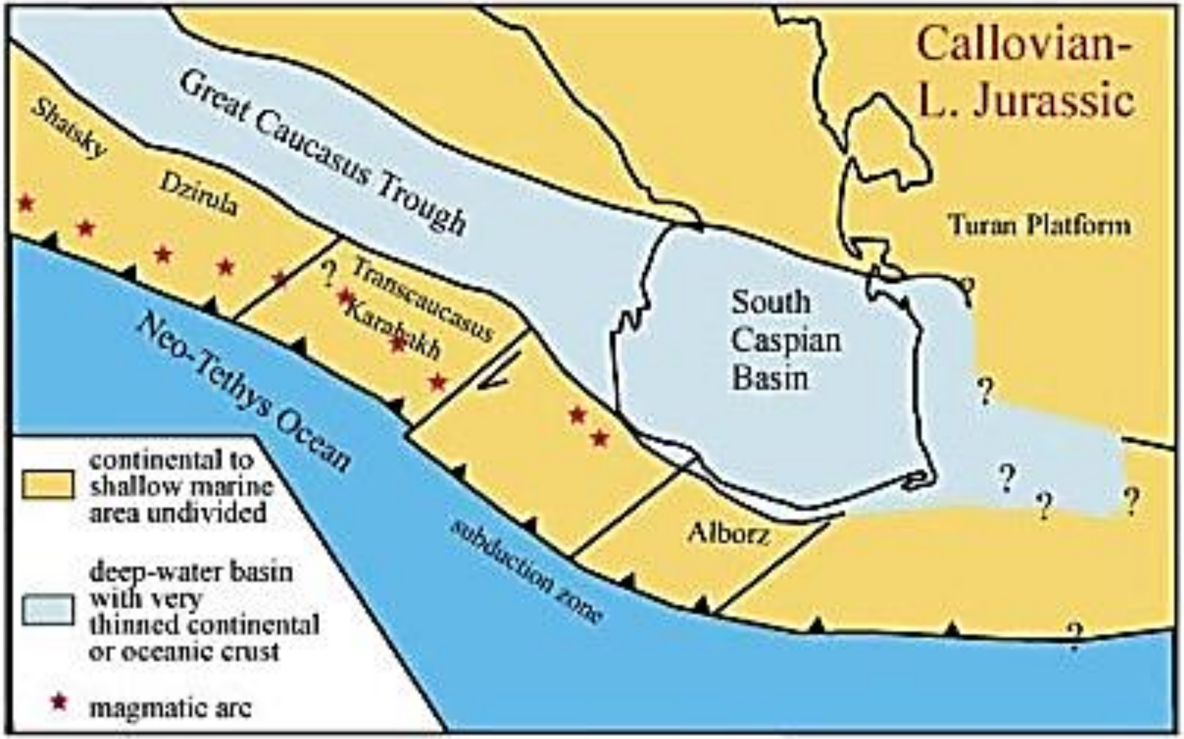


Figure 6).


Callovian-
L. Jurassic
Great Caucasus Trough
Shatsky
Dzirula
Transcaucasus
Karabakh
Turan Platform
South
Caspian
Basin
Neo-Tethys Ocean
subduction zone
Alborz
continental to
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area undivided
deep-water basin
with very
thinned continental
or oceanic crust
magmatic arc

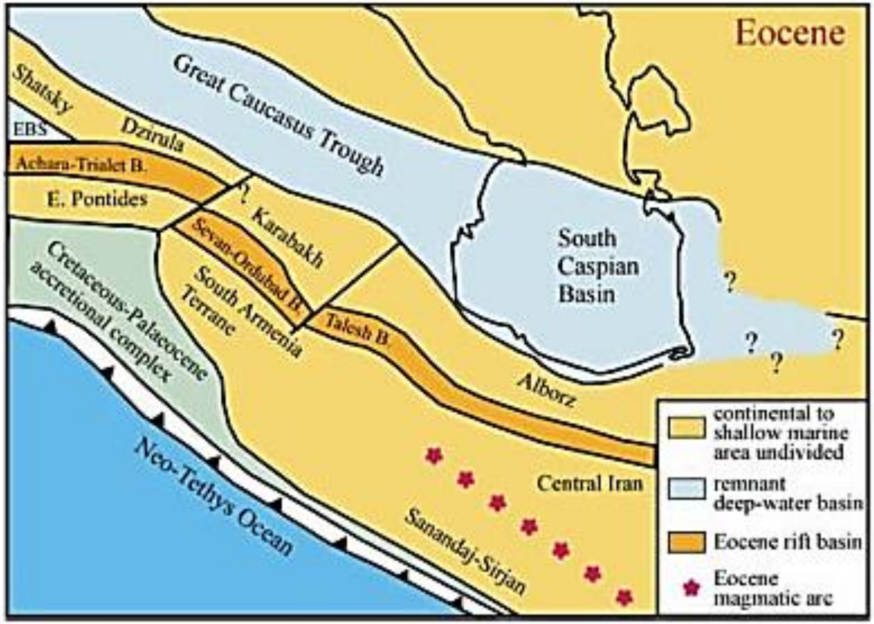

Figure 6: Preliminary reconstruction of the geodynamic position of the South Caspian Basin during the Late Jurassic and Eocene, EBS (Brunet et al., 2003).

It is believed that Sedimentation of South Caspian, began from Mid-late Jurassic. Thickness of Mesozoic sediments estimated up to 5km. However, with regards to uplifting of mountains around the South Caspian, in Oligocene, that reached to the peak in Plio-Quaternary Times, the Oligocene and younger deposits are the main source of South Caspian Sedimentation.

The Polo-Volga in north, and Paleo-Kura in west are the main sedimentary supply of the South Caspian Besin (Morton et al., 2003, Figure 7).

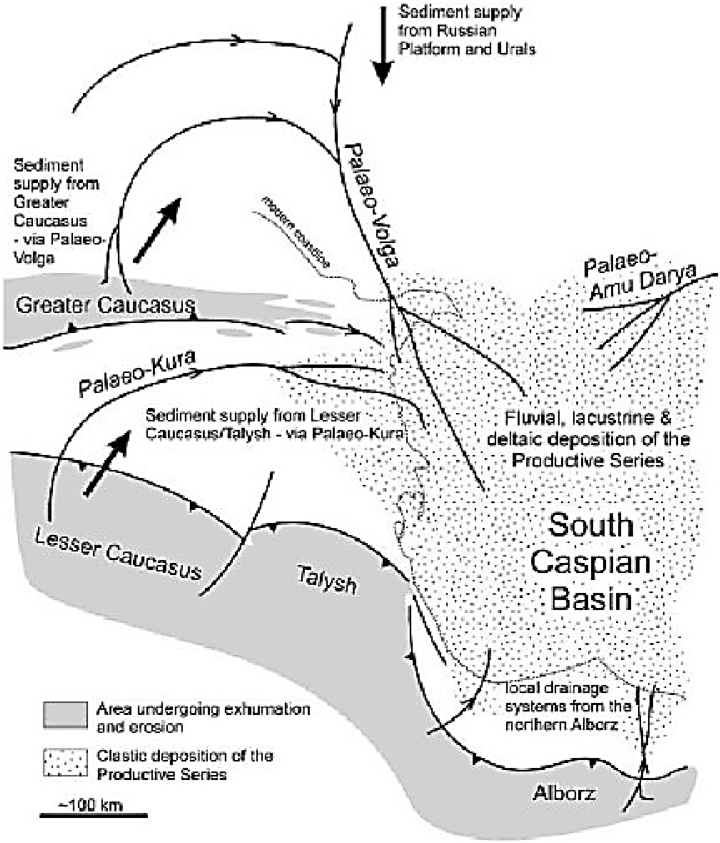

Figure 7: A simple plan of the sediment supply system of the South Caspian Basin (Morton et.al, 2003)

2- Method of Investigation

2-1- Method and materials

A German high resolution in this study, we used shallow penetration Sub Bottom Profiler, (SES-2000 standard models) for specifications of the seismograph instruments see (Table 2). Considering the location of area understudy and physiographic conditions of the sedimentary basin, a fiber glass ship with a length of 17m used for surveying.

Table 2: Specifications of SES2000

SES-2000standard	
Water depth range	1 … 500m
Vertical resolution up to	7cm
Penetration depth up to	50m
Primary frequency about	100kHz
Secondary frequency	4 …15 kHz
Pulse length	66 … 800 ms
Pulse repetition rate	$50s^{-1}$ up to
Transducer	0.2m ×0.2m / 15kg
Beam width	±1.8° @ 4 … 15 kHz
Beam steering	±16° roll (optionally roll and pitch)

Surveying of seismic lines carried out in an area of about 1000 km^2, west of Bandar-e-Anzali. Surveying accomplished in a regular network contain 40 lines, with a distance of about 2000 m (Figure 8).

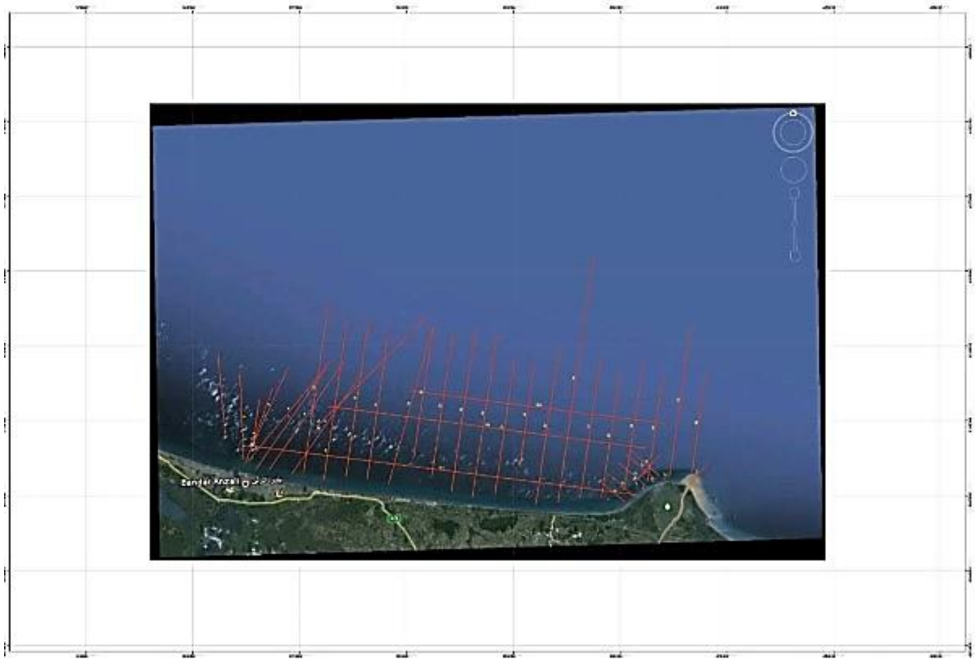

Figure 8: Location of surveyed lines

For data Processing we used ISE 2.92.16 and Vista soft wares. To Plot the surveyed lines, Arc GIS10 used.

2-2- Khazar fault System in the southern coast of the Caspian Sea

Some researchers believe that to Khazar fault is a progressive fold and fault structure, dipping north (e.g. Nazari and Ritz, 2002). Seismic investigations / the South Caspian Sea floor, carried out between Kiashahr and Bandar-e-Anzali in a framework of 50 seismic profiles, with 20 km length in N-S and E-W trends (Figure 8).

Profile 1-15-9

This profile is located near Bandar-e-Anzali. A clear feature in this profile is channel and fault structure (Figure 9). The rate of sedimentation in South Capran reported 2mm/yr (Leroy et al., 2013). Therefore, to consider obtained rate and thickness of the sedimentary units, it is possible to determine relative seismic age in profile 4 also, a E-W folding structure can be seen, which covered with no folded younger deposits (Figure 9).

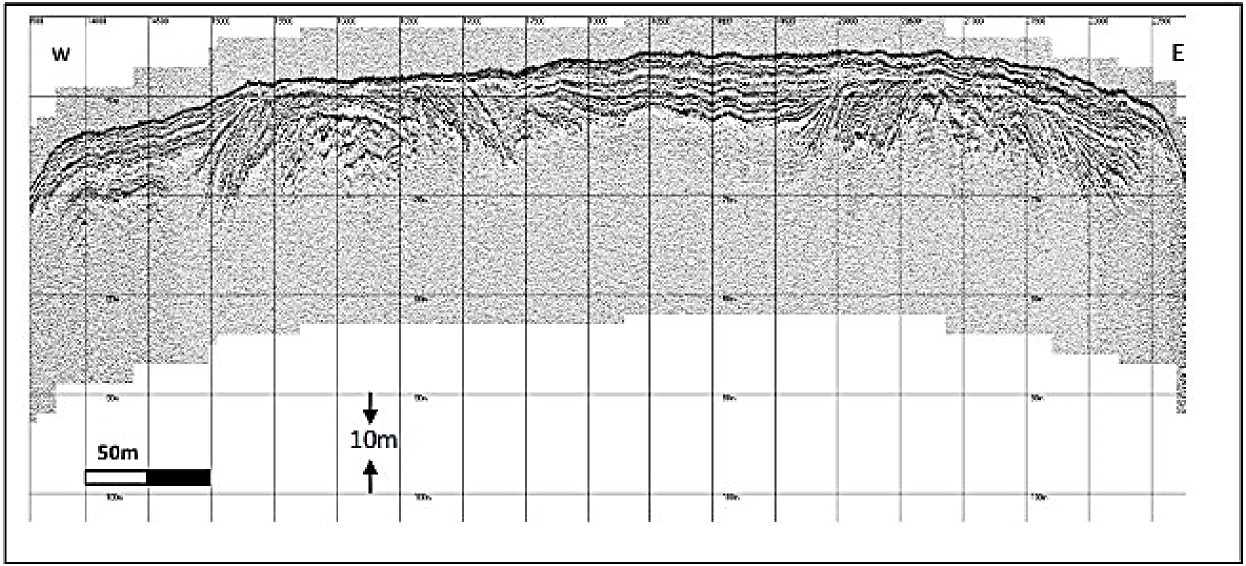

Figure 9- Folding of profile 4

Figure 10 & Figure 11 show normal faulting at the beginning of continental slope in profiles 32 and 33. Figure 12 in profile 30, shows the sea floor morphology between depths of 75m to 150 m. Probably this type of morphology, might be due to active tectonics.

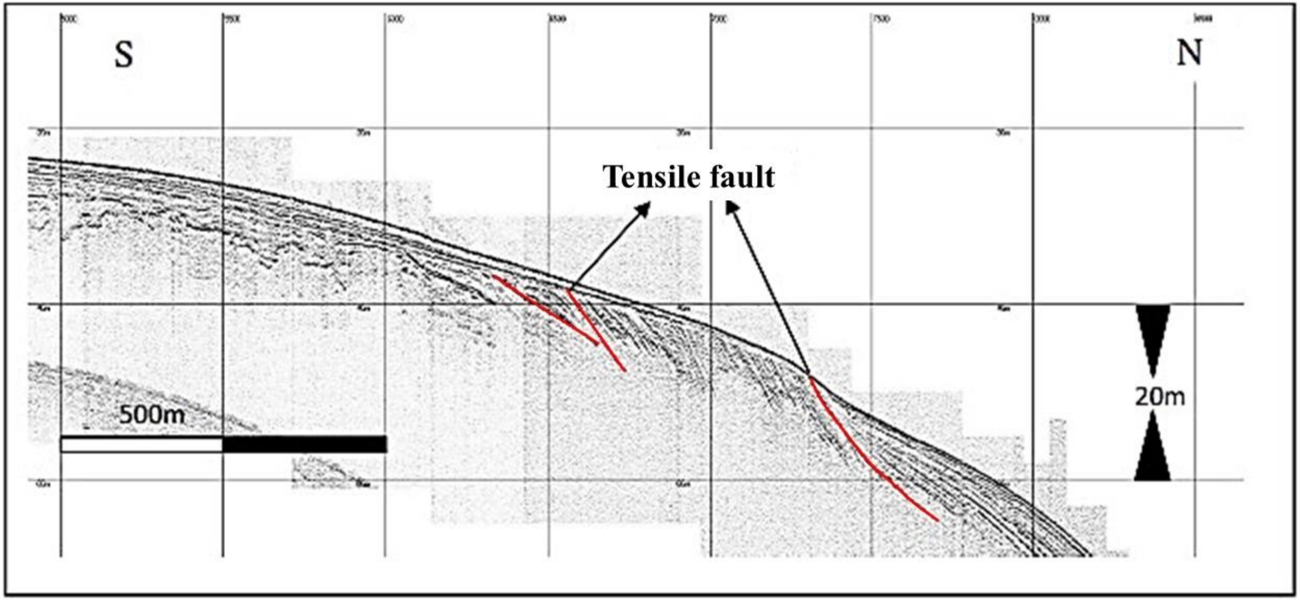

Figure 10- The difference in the layering slope of the sedimentary layers in the tensile (normal) fault, profile 33

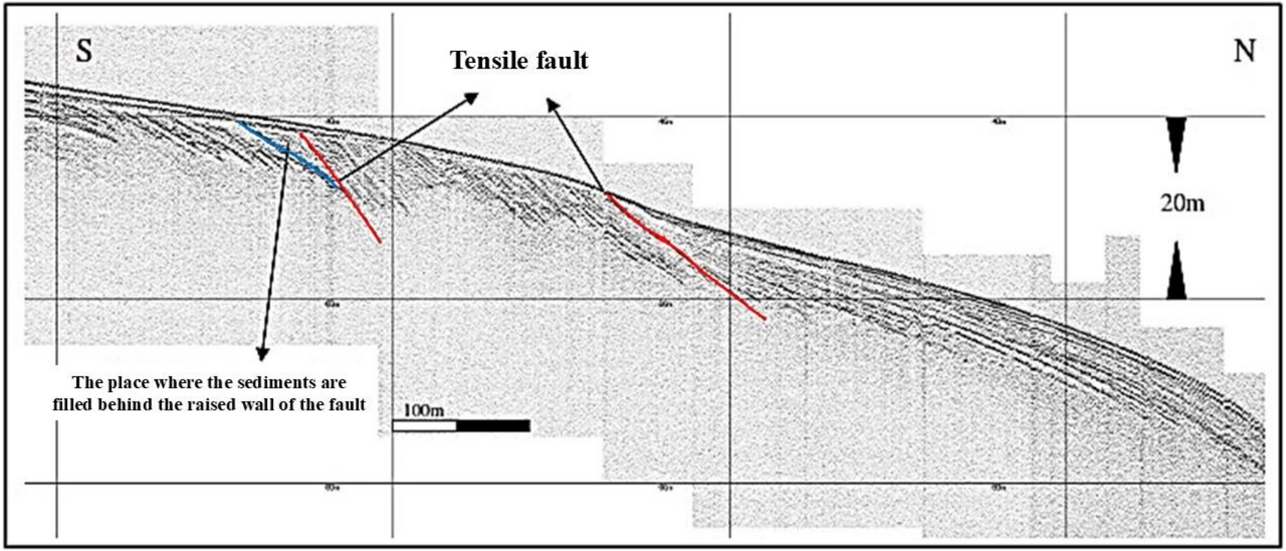

Figure 11- The difference in the slope of the layering of the sedimentary layers in the tensile (normal) fault, profile 32

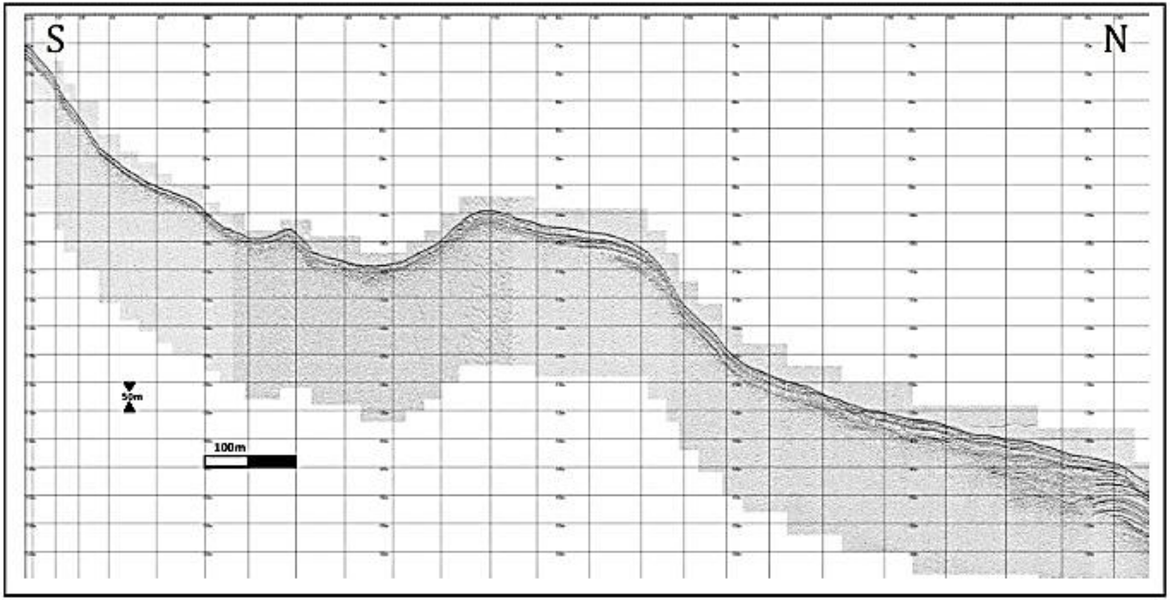

Figure 12- Morphology of the bed at the beginning of the continental slope of profile 30

3- SEDIMENTOLOGY

3-1- Introduction

The area under investigation in the Caspian Sea, geologically show a continental shelf condition, and major parts of the arrival sediments supply from the Alborz and the epirogenesis. The Sefid-Rud is the most important sediments supplier.

Surveyed seismic reflections, due to the environmental and geological conditions of the studied area, have little penetration depth, which make difficult to recognize the principle with planes of the sediment units. With heyards to cessation of seismic data, interpretation and analysis of obtained data will be presented for shallow and deep regions separately.

3-2- Shallow Zones

Based on the seismic data, seven seismic units recognized in this zone. The separation of units are on the base of geometrical structure stacking pattern, reflected, characteristics, planes nature and relations to each other (Figure 13).

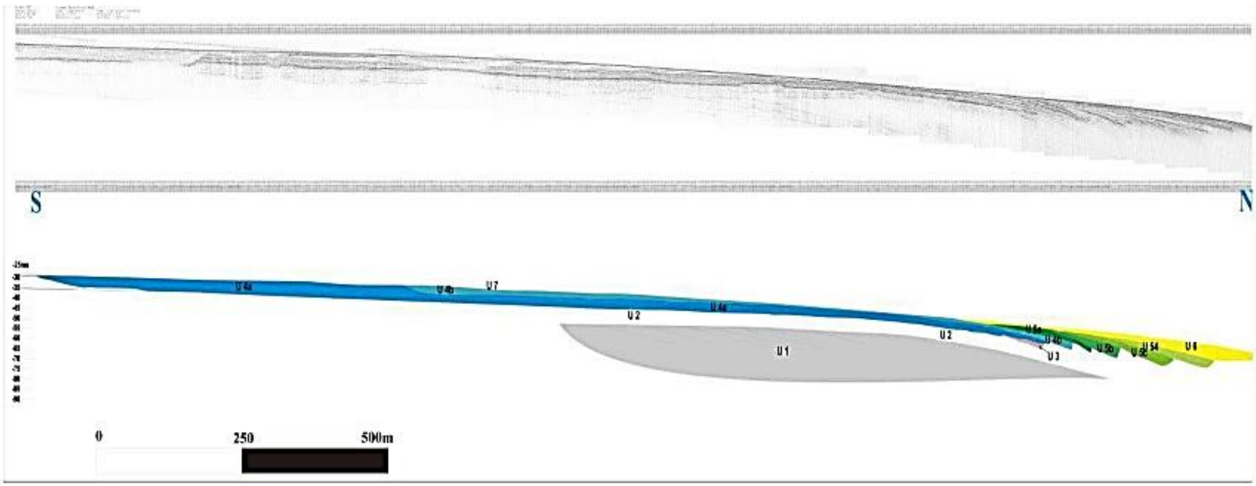

Figure 13- Expansion of seismic units on the shallow part of profile 30 and the position of the ancient and current shelf edge on it

UNIT 1

This is oldest seismic unit in the edge of continental shelf. The Lower boundary of this unit is not recorded in the seismic data. In some places, the effect of faulting in the edge of shelf is clear (Figure 10 & Figure 11). Due to the lack of seismic data reflectors, it is difficult to recognize sub-units of unity.

UNIT 2

Seismic unit 2 with a thickness of 5-10mm is located between units 1 and 3 and 4. Seismic reflectors of these units are parallel with a weak amplitude. Due to the fractionation of seismic reflections to lateral sides, it is not possible to determine the geometrical form and mature of boundaries of this unit in detail.

UNIT 3

Unit 3 is wedge shape forms, with low thickness and located between units 2 and 4. Lower boundary of unit 3, indicating a local erosional plane (Figure 13).

UNIT 4

Unit 4, included of two sub-units, and overlay units 2 and 3. In sub-unit 4a, seismic reflectors are parallel, showing a gradual sedimentation. The subunit 4b, show weaker amplitude, which is indicator of sediment environment change conditions and textural parameters (Figure 13). Unit 4, is a sea-level change marker, and it is possible to sea the displacement of this unit towards land. Both sub-units 4a and 4b thinned towards south.

UNIT 5

Unit 5, is contained of 5 sub-units. The stacking pattern of these units are oblique and their seismic reflectors terminated by a younger plane.

The transgression of sub-units (facies) towards basin without any vertical component or stacking, is a result of sedimentation gap in the terrestrial side. With regards to stacking pattern and detritic sedimentary environment of units, it is probable this succession become coarser upwards.

UNIT 6

The stacking pattern of unit 6, indicating sea level rise and facies transgression towards the land. This unit, after a sedimentary jap and an erorional has surface, formed on top of unit 5 and part of unit 4.

The expansion of unit 6 is low, that it means during sedimentation of unit 6 a graat part of the basin was either not covered by water or it was in an equilibration position.

UNIT 7

This is the youngest unit in the studied area, that amplitude of seismic reflections is intermediate and parallel to each other. The stacking pattern and development of unit 7, indicating a landward sediment arrival.

3-3- Deep Zones

UNIT 1

Consists of very weak seismic reflectors sediments. The Lower boundary of the unit is not recognizable, but its upper boundary with amplitude change of the seismic data is separable (Figure 14).

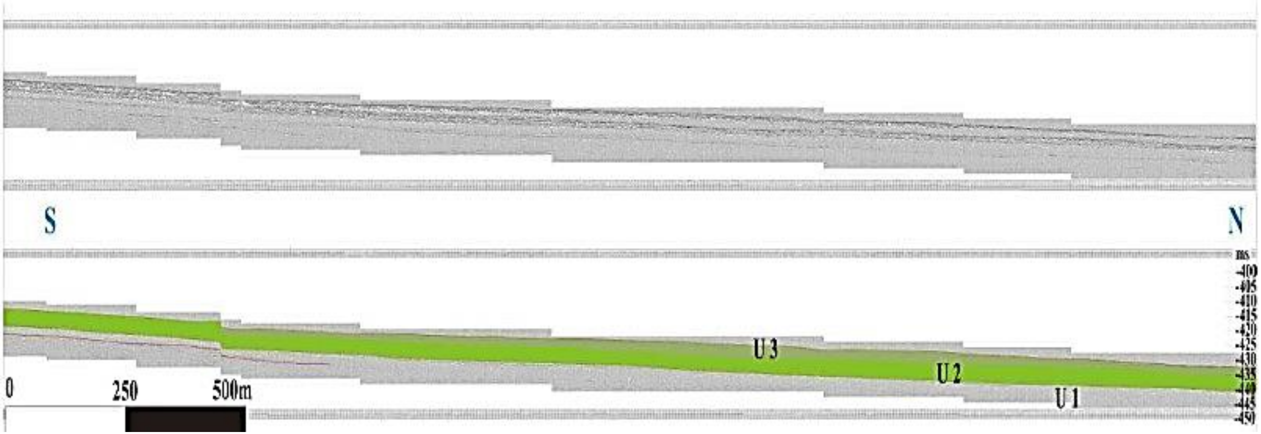

Figure 14- The location and spread of seismic units in the deep part of the basin on profile 30

UNITS 2 and 3

They have a similar seismic character, so that the seismic reflection in the lower part of units 2 and 3 are weak, but amplitude and frequency of reflections increased upwards. The boundaries of units 1,2 and 3 are clear, but due to the change of seismic characteristics laterally, it is not possible to separate boundaries.

UNIT 4

Unit 4, with parallel seismic reflection, and low amplitude it is recognizable in deep zones. More or less is wedge shape and its thickness decreased towards basin. Connection of seismic reflection is more or less good, and will be increased upwards. Also, amplitude and frequency of seismic reflections increased upwards (Fig-15). Upper boundary of unit 4 in a vast area with unit 5, is conformable.

UNIT 5

Most of the seismic reflections of unit 5 are parallel, but their amplitudes are weak. The thickness of this unit is low, and developed to the deep part of the basin. This unit overlying unit 4, and overlaid by unit 6 (Figure 15).

UNIT 6

Development and stacking pattern of unit 6 indicating a change in sedimentation Parameters and facies transgression of unit towards the basin the seismic characteristics of this unit is similar to units. Seismic reflections are parallel (Figure 15). The thickness and expansion of this unit is also similar to unit 5.

UNIT 7

This wedge shap unit overlying units 4,5 and 6. The seismic reflections are more or less parallel (Figure 15). The development of unit 7 is short, and it can be seen in foreland area.

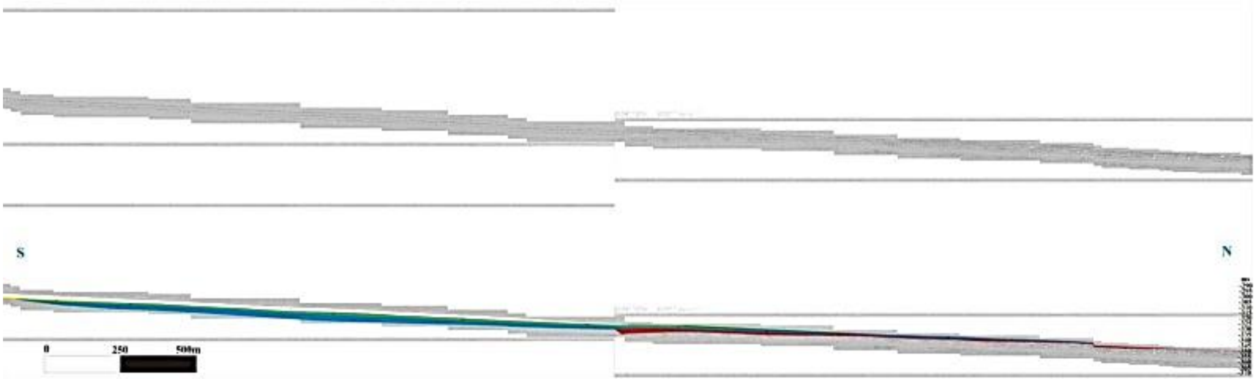

Figure 15- The location and spread of seismic units in the front slope area to the deep part of the basin on profile 30.

UNIT 8

This is the last and youngest seismic unit, that deposited in the deep zone of the studied area. The seismic characteristics of this unit is similar to units 4, 5 and 6, that means seismic reflections are weak in the lower party and more of less parallel in the upper parts (Figure 15).

3-4- The History of Fluctuations

The sea level fluctuations and the number of incoming sediments to the basin, and effect of different factors, caused several sedimentary and seismic units to be formed. With due to figures 10 and 11, it can be seen the position of shelf edge during the sedimentation of unity. Change in the position of the shelf edge is the result of normal faulting in this area. Deposition of unit 2, indicating relative rising of sea level in these periods. On the other hand, as unit 3 showing facies transgression towards to basin, is indicator of drawdown of the sea level. Further change and rising of the sea level and deposition of unit 4a is understanding, which continue by beginning of drawdown of the sea level (unit 4b). The stacking pattern of unit 5 indicating continuation of drawdown of the sea level. Further relative transgression of the sea level is forming unit 6, which with increasing sea level, unit 7 to be formed (Figure 16 & Figure 17).

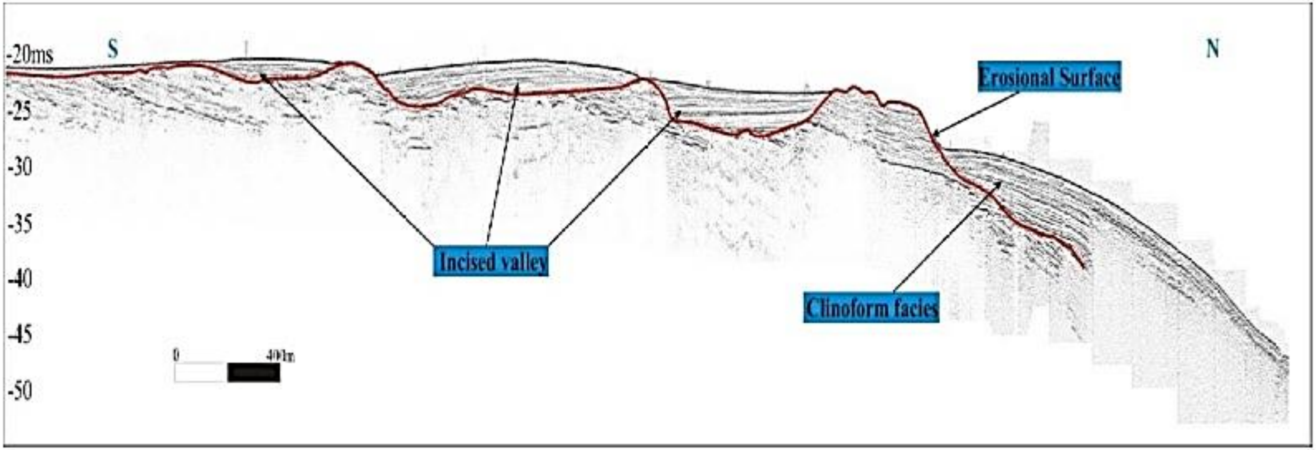

Figure 16- The erosion surface resulting from the sea retreat, which caused the erosion of part of the sediments and the resulting channels in the next stage profile 30).

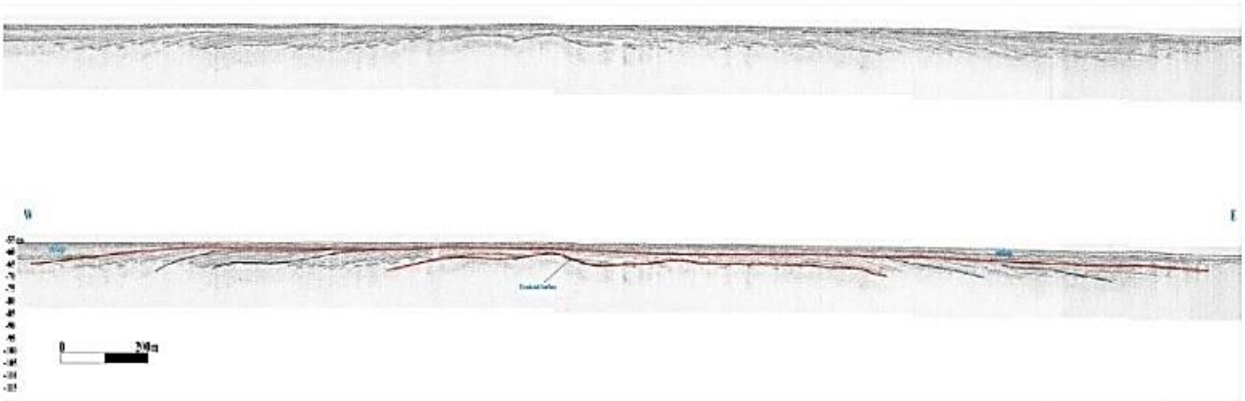

Figure 17- Changes in the water level have caused erosion and redeposition of the surface the spread of sediments in the shelf edge areas can be seen on profile 30.

3-5- Slump Structure

Due to the steeply dipping of the continental shelf, part of the sediments, either by slippage or faulting will be displaced. Seismic reflectors of this type of sediments are mixed up and irregular (See Figure 18 & Figure 19).

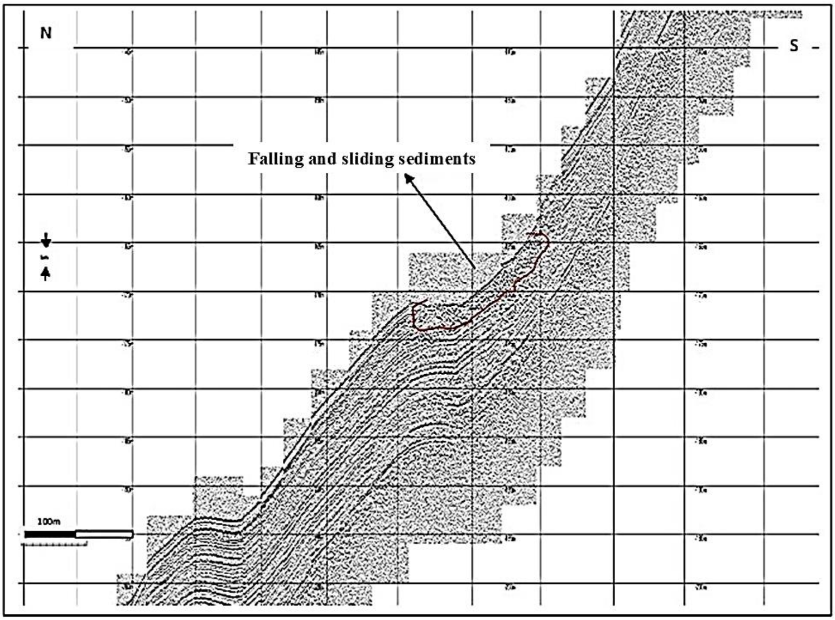

Figure 18- Falling and sliding sediments of profile 36

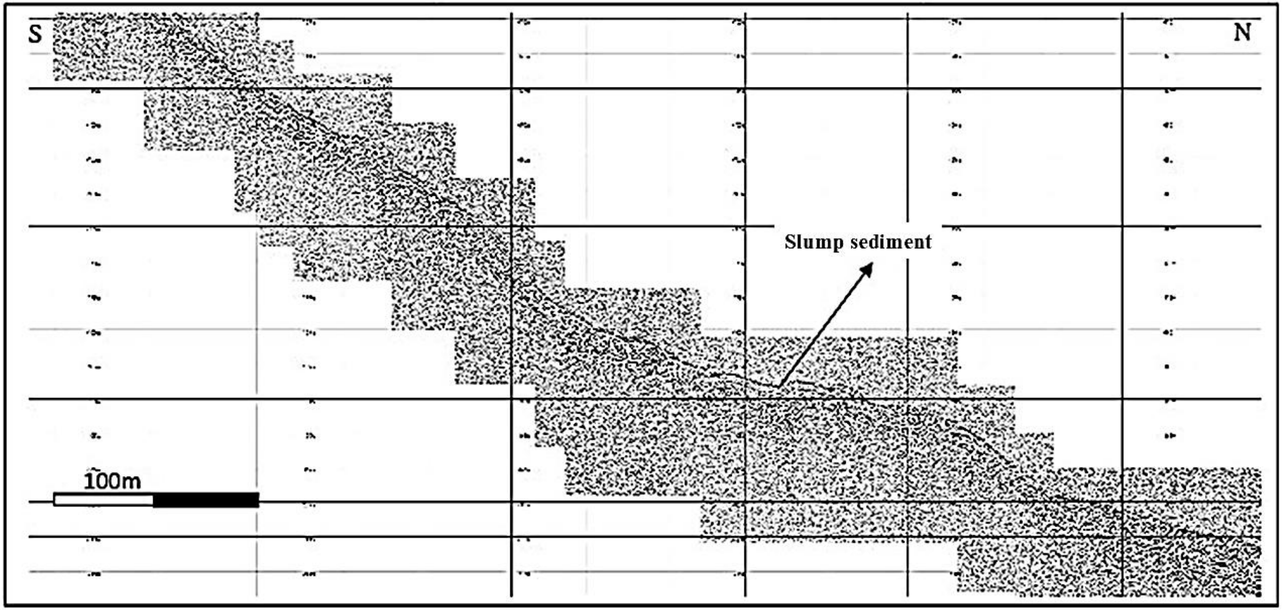

Figure 19- Slip sediments of profile 35

3-6- Deep-Sea Fans

At the beginning of the continental slope, with regard to development and transgression of slope towards the deep zone occurrence of deep-sea fans are common (Figure 20).

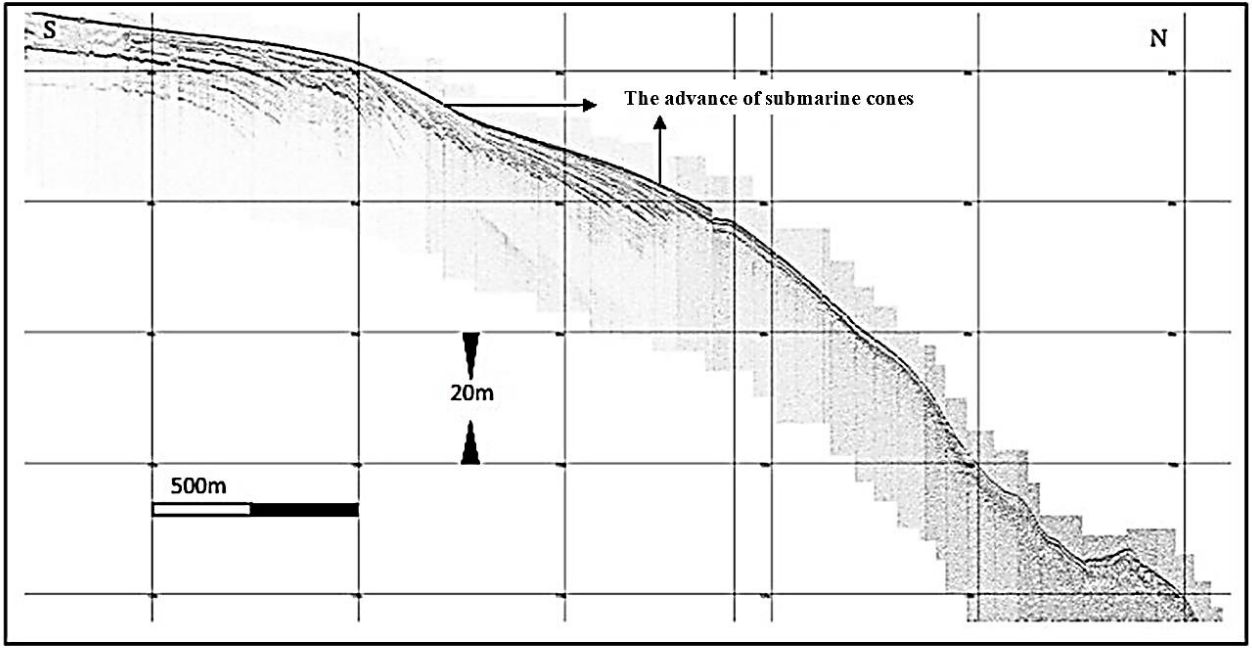

Figure 20- Evolution of submarine cones of profile 29

4- CONCLUSION

Based on the obtained data, we draw out the following conclusions:

- The area under study in the Caspian Sea, geologically is a continental shelf type, and major ports of the imported sediments, suppling from the Alborz Mountains. The Sefid Rud made important role for local sedimentation pattern. The shallow seismograph data in deep and shallow floor of Caspian together with sedimentological and tectonic evidences, reveal that change of the shelf edge is due to faulting.
- The stacking pattern of unit 5, show that relative drawdown of the sea level was consistence during deposition of this unit. The formation of this unit happened in the last drawdown of the relative sea level (-60m).
- The floor morphology from the continental slope basins from the depth of about 70m. and might be due to active tectonics of the area. and
- With regards to the rate of sedimentation and structural pattern, which indicating normal fault activity and steeply dipping of the shelf edge in the south Caspian basin occurrence of huge slump structures are natural phenomena. Occurrence of such events, may ed be followed by tsumami along the coastal zones.

Reference

ADAMIA, SH. A. 1975. Plate tectonics and the evolution of the Alpine system: Discussion. Geological Society of America Bulletin, 86, pp. 719-72.

ADAMIA, SH. A., LORDKIPANIDZE, M. B., and ZAKARIADZE, G. S. 1977. Evolution of an active continental margin as exemplified by the Alpine history of the Caucasus. Tectonophysics, 40(3/4), pp.183-199.

AMURSSKI, G. I., TIUNOV, K. V., KHR/KOV, B. A., and SHLEZINGER, k. E. 1968. Structure and tectonic position of the Great Balkhan. Akademii Nauk SSSR, 53 p.

Berberian, M., 1983, The Southern Caspian: a compressional depression floored by a trapped, modified oceanic crust. Canadian Journal of Earth sciences, v. 20, 163-183.

Berberian, M., 1983. The southern Caspian: A compression depression floored by a trapped, modified oceanic crust, Canadian Journal of Earth Sciences, 20, 163-183

Brunet, M. F., Korotaev, M.V., Ershov, A.V. , Nikishin, A.M., 2003. The South Caspian Basin: A review of its evolution from subsidence modeling. Sedimentary Geology, 156, 119-148

Brunet, M. F.; Korotaev, O.; Ershov, A. V.; Nikishin, A. M., 2003, The South Caspian Basin: a review of its evolution from subsidence modeling. Sedimentary Geology, v. 156, 119-148.

Caucasus. In The Alpine Middle East between the Aegean and the Oman transverses. Edited by Sh. A. Adamia et al. Colloque C5, 26th International Geological Congress,1980, BRGM, M6moire 115, pp. 131-132

DEWEY, J. F., PITMAN, W. C., RYAN, W. B. F., and BONNIN, J. 1973. Plate tectonics and the evolution of the Alpine system. Geological Society of America Bulletin, 84, pp.3137-3180.

Ghanghormeh, A, 1998 Investigation of the formation of terraces on the eastern shores of the Caspian Sea, Ministry of Energy, Water Research Institute, National Center for Caspian Sea Studies and Research, P 172.

Khain, V. E., 1994, Geology of the Northern Eurasia (Ex-USSR). The second part of the Geology of the USSR. Phanerozoic fold belts and young platforms. Gebruder Borntraeger, Berlin, 390 p.

Knapp, J. H.; Diaconescu, C. C; Connor, J. A., McBride, J. H; Simmons, M. D., 2000, Deep seismic exploration of the South Caspian Basin: lithospheric-scale imaging of the worldsworld deepest basin. Istanbul 2000, AAPG Inaugural

Regional International Conference, July 9- 12 2000, Istanbul, Turkey, 35-37.

Lahijani, A, H, 2005, Educational workshop on the effect of Caspian Sea water level fluctuations on coastal ecosystems, Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, P 47.

Lebedev, L., 1991, Oil and gas potential of the Caspian Sea. Petroleum Information Corporation, 66 p.

Mamedov, P. Z.; 1992, Seismostratigraphical investigations of geological structure of sedimentary cover of the South Caspian super depression and perspectives of oil- gas productivity. Ph.D.PhDPh.D.Thesis, Baku, 40 p.

Morton, A. M.; Allen, M.; Simmons, F.; Spathopoulos, J; Still, D.; Hinds, H.; Ismalzadeh, A; Kroonenberg, S.; 2003, Provenance patterns in a neotectonic basin: Pliocene and Quaternary sediment supply to the South Caspian. Basin Research, v. 15, 321-337

Motamed, A, 1997 Quaternary (geology of the fourth period), Tehran University Press, P 328.

Mousavi Ruhbakhsh, M., 2001, Geology of the Caspian Sea, Geological Survey of Iran, book editing plan, number 80, P 254.

Nazari, H., Ritz, J.-F., Oghbaei, Sh., 2006, a new look at the paleogeography and tectonic evolution of Alborz in Tethys. Volume 16, Number 64, Procedure 38-53, Earth Sciences Quarterly, Geological Survey of Iran.

Nazari, H., Ritz, J.-F., Talebian, M., Moosavi, A., 2005a. Seismotectonic map of the Central Alborz, Scale 1:250000, Geological Survey of Iran, Tehran

Nazari, H.; Ritz, J.-F., 2008. Neotectonics in Central Alborz, special issue, Vol 17 N. 1, Geosciences, Geological Survey of Iran

Sh.A. Adamia, T. Chkhotua, M. Kekelia, M. Lordkipani dze, I. Shavishvili, G. Zakariadze.; 1980, Tectonics of the Caucasus and adjoining regions: implications for the evolution of the Tethys ocean Volume 40, Issues 3–4, 6 July 1975,, 183-199

Shikalibeily, E. S.; Grigoriants, B. V., 1980, Principal features of the crustal structure of the South Caspian basin and the conditions of its formation. Tectonophysics 69, 113-121.

SHIKALIBEILY, E.SH., and GRIGORIANTS, B. V. 1980. Principal features of the crustal structure of the south Caspian basin and the conditions of its formation. Tectonophysics, 69, pp. 113-121.

Solovev, V. F.; Kulakova, L. S.; Lebedev, L. I.; Maev, E. G.; 1962, a major feature of geological structure in the middle, and Southern Caspy, South Geology.Complex Exped. Work, no. 7, 446-498.

Stocklin, J., 1974. Northern Iran: Alborz Mountains, Geol. Soc. Lon. Special pub. 4, 213-234

Varushenko, S. I.; Varushenko, A. N.; Klige, R. K.; 1987, Changing of the Caspian Sea regime and enclosed basin geological time, Moscow, Kauka, p. 240.