Middle-East Journal of Scientific Research 15 (6): 846-852, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.15.6.2871

Stratigraphy of Neogen Deposits in Northern Iran

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Abstract: Paratethyan basin in northern Iran is constituted of Neogene deposits outcropping in Mazandaran and Dasht-e Moghan regions. Tectonic movements and eustatic sea level changes were the main factors in controlling the sedimentary regimes. The Paratethyan deposits in Mazandaran province are constituted of marine to Oligohaline sediments, ranging in age from Middle Miocene to Middle Quaternary and the age of Paratethyan deposits in Dashteh Moghan is Oligocene to Middle Quternary.

Key words: Paratethys · Dasht-e Moghan · Mazandaran · Neogene · Northern Iran

INTRODUCTION

During Early Oligocene, orogenic phases subdivided the Tethyan Ocean into different basins. The southern which was main basin i.e. Neotethys contained Mediterranean basin and a mountain chain ran in the west from the Alps, to the Himalayas in the east [1]. In the north of Tethys, a vast and intracontinental sea was formed which has been named by V.D. Lascarew (a French geologist) as "Paratethys" [2]. Paratethys extended from Bayern in the south western of Germany to Aral Lake in the Central Asia, located between 40° N and 50° N latitudes (Fig. 1).

The Neotethys was a completely marine basin, but Paratethys formed a marine to brakish basin during the passage of time [1, 3]. The subsequent tectonic movements occurred during Early Miocene subdivided the Paratethys into western (Pannovian) and eastern (Euine-Caspian) sub basins. Climate and sea level changes culminated in connection of Paratethys to open Oceans through waterways like Dardanelles [4, 5]. Ultimately, due to evolution of these channels several sedimentary cycles were formed. Each cycle was begun with migration of saline water bearing sea organism from open Ocean into the basin and ended with complete or partial regression of Paratethys and appearance of particular brackish water Fauna which finally caused grossly growth and spread of endemic fauna and flora. The extinction pattern of Fauna and Flora is according to the "Punctuated equilibrium" pattern model introduced by Eldrege and Gold [6]. Since implement of the so-called European scale to the Neogene deposits of Paratethys is involved by some difficulties a specific regional unified scale (Fig. 2) has been developed and Utilized for the Paratethys [2, 7, 8].

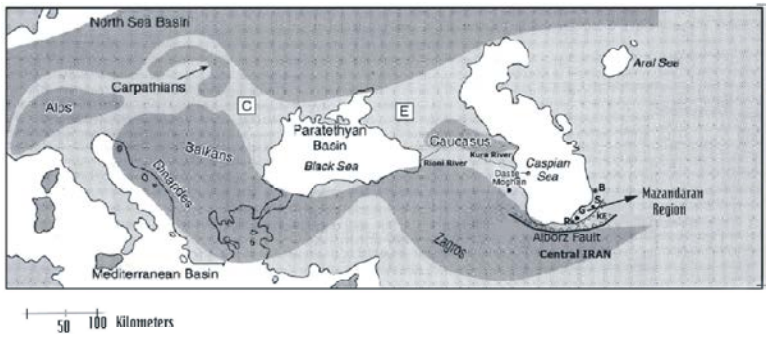

Fig. 1: Geological sketch map of Paratethyan Basin in the Miocene.Modified after jones [9]. B=Bandar-e-Turkman, C=Central Paratethys, E=Eastern Paratethys, G=Ghaem Shahr, KF=Khazar Fault, R=Royan, S=Sari

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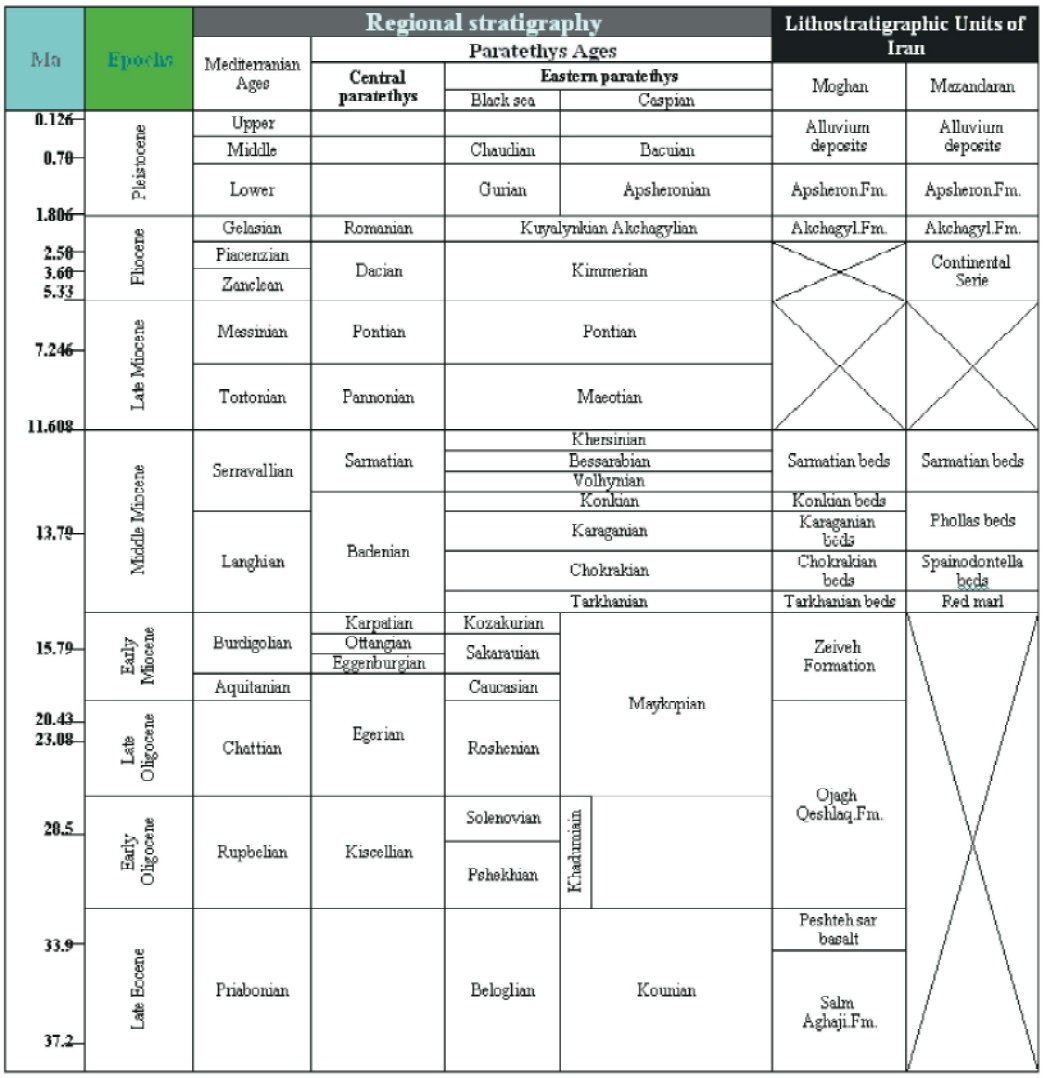

Fig. 2: Correlation scheme for regional stages of Paratethys and Mediteranean Area [7,8,10] and lithostratigraphic units of Northern Iran.

Paratethyan Deposits in Northern Iran: Paratethyan deposits in northern Iran, except to the Caspian Sea floor, outcrop at two regions namely Mazandaran and Dasht-e Moghan (Fig. 1). The Paratethyan deposits in Mazandaran province are constituted of marine to oligohaline sediments, ranging in age from Middle Miocene to Middle Quaternary while the Upper Miocene series is not seen due to operation of Attic orogenic phase. The oldest beds of Paratethyan basin in this area is seen to south of Alborz Fault. It is consisted of claystone, calcareous sandstone, white to light brownish weathered conglomerate and reddish to greenish-gray marl interbedded rarely with thin layers of oolithic limestone. Thickness of this unit is about 20 meters and underlain with an angular unconformity the Paleocene marls. Its stratigraphic position indicates the Tarkhanian stage [11, 12].

The thickness of Chokrakian beds is about 250 meters outcropping along the Tajan and Tarrud rivers in south of Sari and Qaem-Shahr cities. It is constituted of reddish to greenish-gray marls with rare and thin intercalations of microconglomerate, brown calcareous sandstone and limestone. Basal part of Chokrakian beds is constituted of a thin layer of basalt and a gysiferous bed with a thickness about 20 meters [13]. The Chokrakian marl contains marine *pelcypoda* such as *Chelamys*, indicating connection between Paratethys and open Seas.

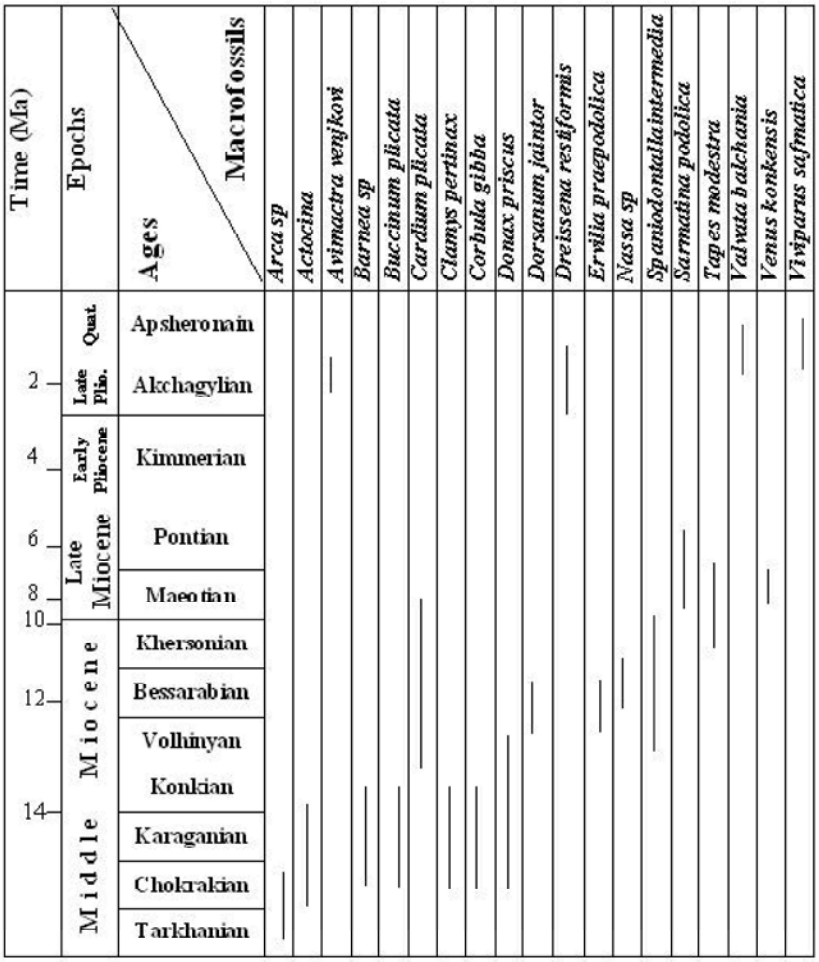

Fig. 3: Macrofossil range zone in Mazandaran Province/ modified from Sussli [12] and Maghfouri [16]

The Chokrakian beds areconformably overlain by an alternation of greenish claystone, marl, sadstone with thin intercalations of oolithic limestone, bearing *Pelecypoda* and *Gasteropoda* indicating the Karaganian stage. The thickness of these beds is about 120 meters (Fig. 3) and are equivalent to the *Spanidontella* beds in Azarbaijan [12].

Konkian beds are exposed along the Gland-e rud (south Royan city) consisting of fine-grained sandstone, brown calcareous clays.

Chokrakian assemblage in Mazandaran containing a number of *arca* and *chelamys*, indicating normal marine environment. But Karaganian contains semimarine fauna showing end of first cycle of Neogene. High energy conditions along the southwestern margin of the Paratethys led to the formation of oolithic and qoquina beds with a thickness about 120 meters, indicating a swift and agitated environment. These beds are equivalent to the Pholas beds [12] containg marine Fauna like *Venus* showing initiation of second cycle of Neogene. Konkian beds are comformably overlain by 450 meters of fine grained sandstone, gray marl and brownish to yellow claystone intercalated with microconglomrate. Presence of fauna in these beds denotes to the Volhynian age. They comformably overlain by a thick sequence of comglomerate interbdded with mudstone and sandstone which are called "Brown Beds or Continental Serie" [13]. They are equivalent of Chelkan or Kimmerian stage in Black Sea and also of first Ostrcoda biozone in Caspian Sea [14]. The upper Miocene deposit are not seen in these regions denoting to a hiatus from Late Middle Miocene (Khersonian) to Early Pliocene as a consequence of Attic orogenic phase and regression of sea level.

In the Republic of Azarbaijan, Ckelkan Series reserves about 26 billion barrel of crude oil [15], that is why it is called locally "Productive Series". Continental series is overlain by the Akchagyl formation that

indicate third sedimentary cycle of Neogene. Its widespread outcrop areobseved to the south of Sari and south of Qaem Shahr cities. In these regions Akchagyl is constiuted of about 100 to 120 meters yellowish mudstone, sandstone with intercalation of conglomerate and thin beds of gysiferous marl. Paleontologically Akchagyl Formation in Mazandaran belongs to the Lower-Middle Akchagilian substage [16]. The index fossil of Middle Akchagilian namely *Dreissena rostiformis Desh* is seen in the uppermost part of these beds.

Another outcrop of Akchagyl that contains marl and claystone is exposed in northern Babdre Turkman thickening about 19 meters and is underlain by Sanganeh Formation (Upper Cretaceous) uncomformably [17].

Akchagyl Formation is overlain by gray marl beds with a thickness of about 1 to 2 meters. This beds are considered as equivalent of Apsheron Formation. Since the region is covered by compressed forest, the outcrops are seen only along the quarries formed due to Tajan and Glandrud riveres activities. The post Apsheronian deposits are mostly developed in north of the Mazandran fault which can only be studied in explorative drilled work [18].

Neogen Deposits in Dasht-e Moghan: Dasht-e Moghan located in northwestern Iran, formed a part of Kura Rioni region (Fig.4). Kura River is located to the west of Caspian Sea while the Rioni River is located to east of Black Sea. It also forms a part of Transcaucasus depression which is located between Great and Less Caucasus.

Dasht-e Moghan is made up of sediments which have been subjected to simple folding system, trending west to east. Towards north the sediments get younger. This region encompasses one of the most completed Paratethyan successions in Iran. In Dasht-e Moghan flyschoid sediments accumulated during Paleocene to Late Miocene without any angular unconformity. Attic is the first recognized orogenic phase influenced the region. This phase is considered as agent of the strong angular unconformity occurred between Upper Miocene and Upper Pliocene. The Miocene deposits which are known as "Zieveh Formation" overlies Oligocene lithounites. Thickness of Zieveh formation is about 4000m and is consisted of conglomerate, pink and violet reddish and silty clays including numerous thin layers of feldspatic sand and white siltstone. Lignite is abundant in the joints of strata and gypsum (isolated crystals, beds or nodules) always present [19]. The silty clays intercalated by beds (every 1 to 5m) or lenses of gray bluish aphanitic limestone. Abundant presence of evaporates (gypsum) in the lower Zeiveh Formation on one hand and on the other hand lacking fauna in this formation denoting to sedimentation in a almost closed basin.

Intercalations of fine-grained tuffaceous sandstone cemented generally with argillaceous material is widespread. Fragments of *ostrea* sp and fish teeth (Odontaspis sp) have been found in the conglomerate members. Plant remnants fossils of wood and leaf prints are highly abundant throughout the formation. Zeiveh Formation is overlain by Tarkhanian deposits. Of significance is absence of upper part of the Zeiveh formation in Northern Iran.

Tarkhanian deposits is consisted of an alternation of clays and tuffaceous sandstone denoting to a succession of short tectonic movements (probably Styrian movements, 15.5Ma). Because of eustatic sea level changes and consequently temporary connection to the open sea, micro faunas namely *Sigmoilina mediterranensis* and *Glbigerina tarkhanensis* appeared. This sequence is considered as the equivalent to the base of IV cycle in Cenozoic [20]. During the foregoing connection an endemic abundance also occurred in spread of macrofauna (Fig4).

The thickness of Tarkhanian beds is about 300 meters in Moghan. It is consisted of highly ferruginous brownish claystone, intercalated with sand and sandstone. Base of Tarkhanian is made up of ferruginous and fossiliferous brownish clay bands. At the Chokrakian and Karaginian stages due to the regression of the sea, waterways joining the sea and open Oceans were closed. This stage is equivalent to final phase of IV cycle in Paratethys [2, 10]. So widespread fossils such as *sijgmolina tchokrakian*, appeared in Tchokrakian beds which is consisted of greenish clay and marl containing intercalation of fine sandstone. At the beginning of knokian and the base of V cycle, due to the connection of Paratethys to the oceans, the sea organism reappeared (fig10). konkian beds are consisted of grayish marl and thin beds of platy dolomitic limestone. These beds are overlain transitionally by Sarmatian beds. This boundary exhibits top of the fossilliferoue sandstone beds containing *Spaniodontolla*. The average thickness of Sarmatian beds is about 2400 meters and made up of gray_brownish clays and intercalated with gypsiferous and lignite bearing feldspatic sandstone [21, 22].The upper limit of Sarmatian constitutes the main unconformity of the Aktahagylian stage.

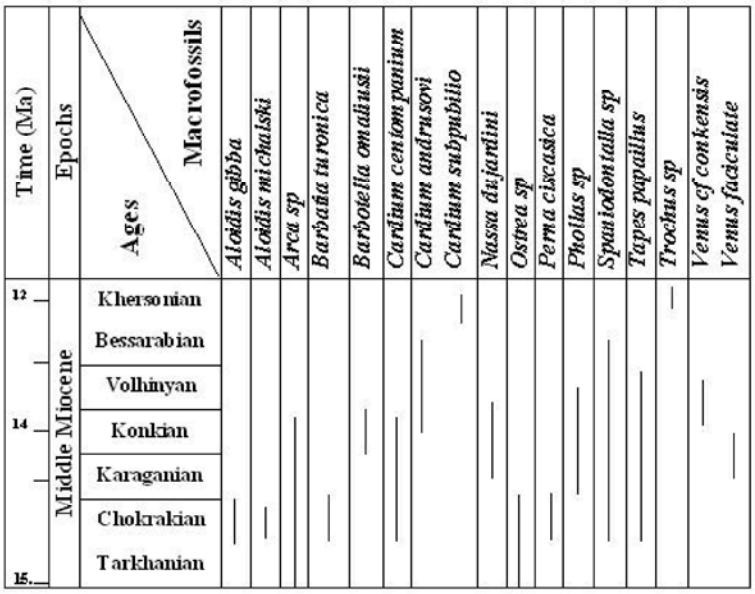

Fig. 4: Selected macrofossil range zone in Dasht-e Moghan/ modified from William *et al.* [19], Gillet [24] Maghfouri [25] and Zavarei and Maghfouri [23].

In Dasht-e Moghan like other parts of Paratethys Sarmatian can be divided into three sub-stages, which are age wise Volkhynian, Bessarabian and Khersonian (Fig. 11).The Volkhynian beds which are poor in fossills, rare species of *Mactra* aff. *andrusovi* kolesn, *Tapes* aff. *aksajicus* are seen.

Macrofossils are very rare in the bottom while are abundant in the upper part of Bessarabian beds [19]. Index microfossils of Khersonian substage are not seen in these beds while macrofossil like *Mactra bulgaria* and *Mactra crassicolis* are abundant allowing to differentiate the Middle and late Sarmatian. On the account of the late Miocen orogenic phase, the uppermost part of the Miocene (Maeotian and Pontain) and Lower and Middle Pliocene(Kimmerian) have not been formed .

Akchagylain beds are made up of light pinkish marl, fossiliferous sand and thick beds of coarse grained and black conglomerate and six intercalations of tuff. The conglomerate is dominately consisted of basalt and obsidian pebbles. The thickness of Akchagyl beds is about 200 meters. Paleontologically it is said that the Akchagyl formation is linked to the Middle Akchagylian sub-stage [23].The Late Pliocene sea level changes and or Wallachian movements also caused major a regression in Dashte- Moghan . The fluvial and lacustrin sediments probably equivalent to Apsheron Formation are covered the Akchagyl Formation.

The Apsheron Formation is consisted of reddish sand, silt and marl with a thickness of about 200 meters which is devoid of fossils. The Middle Quaternary (Passadenian) orogenic phase caused another main angular unconformity at the base of fan and alluvial deposits which horizontally coverd the Apsheron Formation.

DISCUSSION AND CONCLUSION

The Paratethian deposits in the mazandran with the age of Middle Miocene to Apsheroinan are located between the Alborz fault to south and Khazar fault to the north. Orogenic movements were the main controlling factor in formation of marine basin in northern Iran during the Neogene time. Incidentally, in southern regions i.e. south of Alborz Mountain and Central Iran and Zagros Mountain,the remnants of Neotethys were closing .This event is indicated by widespread of regressive and molassic deposits, Upper Red Formation and Fars Group, covering respectively the Qom formation in Central Iran And Alborz and the Asmari Frmation in Zagros regions. On the contrary, during the Pleogene in these regions,particularly in southern Albors the marine condition was prevailed while in northern regions namely Mazandaran continental condition was met. Due to uplifting of the Alborz mountain and consequently rapid erosion of this landmasses and their transportation and delivery to the Paratethys basin thick layers of clastic sediments were formed while because of less content dissolved ions in

water body of Southeastern Paratethys limey formation has not been formed. Locally and sometimes due to prevailing evaporation condition some eavaporite could be formed. Exhaustively the eustatic sea level changes were the main factors controlling the sedimentary regime and the type deposits in Mazandaran. The tectonic movements during the Late Miocence (Rhodanian, 7Ma) and Middle Quaternary (Passadenian, 0.6Ma) played the main role for sedimentation gaps. the Daste-Moghan. Therefore in the later area a great hiatus is seen between the Sarmation and Akchagylian. The Paratethyan deposits of Dasht-e moghan is older than that of Mazandaran region and most probably it's Oligocene deposits belongs to the Paratethys Facies. Late Eocene orogenic movements (Pyrenean, 34Ma) which influenced other part of Iran caused the depression of Moghan region and eventually creation of Paratethyaian basin. The thickness of the Neogene sediments in Dasht-e Moghan is more than those of in the Mazandran. In the Moghan region the Paratethys deposits containing a number of tuff intercalations which probably derived form Qaradagh and other volcanoes located in nearby Caucasus lanmass. Unlike to the Mazandaran, because of fossils content of the deposits it can be inferred that the Moghan Paratethys basin was deeper. Though here also the limey formation are rare but comparatively they are thicker than those of Mazandaran region. Paleontologiccal studies reveal that the Neogen deposite in Mazandran can be included in the Tarkhanian-Akchagylin stages while in Dashte-Moghan can be included in Causaian-Sakaraulian and Apsheronian stages.

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