GEODYNAMIC EVOLUTION OF THE SOUTH CASPIAN BASIN

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The South Caspian Basin with its present shape and petroleum systems was formed as a result of the interaction of major Eurasian, Indian and Arabian plates and numerous microplates starting from the Triassic.

Late Triassic

In the Late Triassic, the Paleo-Tethys Ocean continued subducting under the southern margin of Eurasia, and the Transcaucasus, Talesh – Alborz (Western and Central Iran), Central Caspian, Herat and North Pamir Block collided with the Scythian-Turan margin of the Eurasian Continent. The Scythian-Turan Platform is a name used by CIS geoscientists to described terrane accreted to Eurasia during the Late Paleozoic Hercynian orogenies between Ukraine and Afghanistan. The captured Paleozoic oceanic crust of the North Caspian (Peri-Caspian) Basin constitutes boundary between Scythian and Turan parts of the Platform. Subduction of the Paleo-Tethys produced the Early Cemmerian volcanic arc along the southern margin of Eurasia, and resulted in back-arc extention which influenced most of the Scythian-Turan platform.

During the Late Triassic time the older Permian-Triassic rifts turned into oceanic and aulacogenic basins which facilitated the establishment of seaways within the southern Scythian-Turan platform.Marine deposits have been identified in crimea, Fore-Caucasus, Manych, and Mangyshlak and in western and southern Turkmenia. The northern part of the Scythian-Turan plate received terrestrial sedimentation or was in a non-depositional environment.

The collision of the microplates with the southern margin of Eurasia resulted in the compressional events which were recorded in major deformation of the Permian-Triassic deposits, the formation of the Mangyshlak and Badkhyz-karabil fold zones and the general uplift of the Fore-Caucasus and Middle Asia regions.

The Lut (Eastern Iran), Farah (Central Afghanistan) and South Pamir microcontinents were approaching the Eurasian margin from the south. The Central Turkey (Sakhariya and Kirsehir), Lesser Caucasus, and Southern Iran (Sanandaj-Sirjan) were rifted from the Gondwanian, African-Arabian margin.

Early-Middle Jurassic

During the latest Triassic-Early Jurassic the Lut, Farah, and Southern Pamir microcontinents collided with Eurasia and were sutured to the Turan Platform. The compressional events were recorded in Southern Kopet Dagh (Aghdarband) area in nortwestern Iran, in the Herat area in Afghanistan and in the Pamir Mountains between CIS, Afghanistan and Western China (Trim).

The remnants of Paleo-Tethys still existed between Tarim and Quantang microcontinents. The northward drift of Central Turkey (Sakhariya and Kirsehir), Lesser Caucasusi Southern Iran (Sanandaj-Sirjan) and south central Afghanistan (Helmand) plates from the African-Arabian-Indian margin toward Eurasia divided Neo-Tethys into two branches. The northern-Sevan-Akera-Qaradagh ocean was subducting under the western part of the Scythian-Turan platform. The

southern - Pindos ocean (name from the Pindos mountains in Greece) was spreading between the Gondwanian margin and series of microplates.

After the phase of Late Triassic-Early Jurassic compression, the rifting regimewas re-established within the Scythian-Turan platform between Eastern Black Sea and Western Turkmenia and continued through Middle Jurassic time. Most of the former rift systems that had developed during Late Permian-Triassic time were reactivated and new rift systems originated. In the western and central part of the platform, the Early-Middle Jurassic rifting primarily concentrated in the Greater Caucasus basin. Rifting somewhat influenced the Indol-Kuban basin, and the Terek-Caspian trough developed as a subsidiary rift of the Greater Caucasus rift system. In the eastern part of the Scythian-Turan platform, the Early-Middle Jurassic rifting intensely influnced the Amu-Darya and Afghan-Tadjik regions.

Lower-Middle Jurassic deposits within the Scythian-Turan Platform are represented by sandy-clayey coal-bearing formations which unconformably overlie Paleozoic and Mesozoic sequences. The deltas were formed on the nortern margins of Albroz plate. The epicontinental sea with carbonate deposits covered the Lut block and southern margin of Talesh-Albroz blocks.

In the Middle Jurassic Aalenian, the Pontides plates (Pontides) collided with the southern margin of Eurasia. Compressional event related to this collision continued true out Bathonian and is documented by Pre-Bajocian and Pre-Callovian deformation in Crimea and the Western Fore-Caucasus.

From Middle Jurassic Bajosian time, sedimentary basins within the Caucasus-Caspian-West Turkmenistan area underwent post-rift subsidence with marine clastic deposits. The fluvio-lacustrin and lacustrin clays and sandstones were deposited in the Southern part of the Turan Platform. Shoulder uplift and deformation a companied the post rift and pre-back arc spreading.

Late-Jurassic-Early Cretaceous

During the Callovian-Oxfordian, the Scythian-Turan platform was primarly and isolated shelf containing a series of relatively deep troughs. Post-rift subsidence of sedimentary basins, which had started within the platform in the Middle Jurassic Bajocian, continued and was accompanied by a global rise of the sea level.

The tectonic setting change in the Kimmeridgian-Tithonian, when the Turan Platform underwent general uplift as a result of the collision of the south-central Afghanistan (Helmand) and Qantang microcontinent with the southern edge of Eurasia.

The subduction trench pulling effect along the southern margin of East Pontides, Transcaucasus, Talesh and Albroz plates formed Greater Caucasus-Protocaspian back-arc basin underlain by the oceanic crust.

The depositional environment within the Scythian-Turan platform during Callovian-Oxfordian was favorable for accumulation of oil-pron source rocks in the Indol-Kuban, East Manych, Mangyshlak, Terek-Caspian, Murghab, Afghan-Tadjik and possibly Proto-South Caspian basins. The configuration of troughs and uplifted sedimentary platforms created conditions for restricted sea water circulation and anoxic depositional environments.

The Callovian section in the basins is composed of marine mudstones and shales with lenses of organic limestone and sandstone. In the Indol-Kuban, Terek-Caspian, Murghab and

Afghan-Tadjik basin, the Oxfordian section primarly consists of organic carbonates and carbonate muds. Organic rich shales accumulated in deeper troughs, which were surrounded by barrier reefs. In the East Manych and Mangyshlak basins, which were located in the inner part of the Scythian-Turan shelf zone, Oxfordian deposits consists of organic rich shales, mudstones, siltstones and marls. A Carbonate platform developed to the south of the East Manych and Mangyshlak basin, at the northern margin of the Greater Caucasus-South Caspian deep-water basin.

Kimmeridgian-Tithonian time was manifested by evaporite sedimentation over the uplifted southern margin of the Scythian-Turan platform. Evaporites form a perfect regional seal over Callovian-Oxfordian reservoirs, and provide exceptionally favorable conditions for preservation of hydrocarbon accumulations.

During Tithonian-Berriasian time rifting started along the northern and eastern margin of the Lut block. This rifting was followed by sea-floor spreading during Barremian-Hauterivian and formation of the Sistan Ocean. On the southern Neotethian margin the opening of central Atlantic caused easternward movement of African-Arabian Plate. The Taurus (southern Turkey Plate was rifted from Africa-Arabia during the reopening of the Eastern Mediterranean Sea.

Late Creaceous-Eocene

From the Early Cretaceous through the Paleocene, the Scythian-Turan platform was characterized by a relatively stable tectonic setting and was not influenced regionally by either compressional or extensional events. The Neo-Tethys Ocean was subducting under the southern Eurasian margin. The Jurassic Greater Caucasus – Proto Caspian and Cretaceous western Black Sea oceanic basins, separated subduction-related volcanic arcs, which successively developed along the Neo-Tethys northern margin from the Scythian-Turan platform. The Greater Caucasus – Proto-Caspian ocean was connected with Sistan Ocean, which separated Lut from Afghanistan and Kopet-Dagh area. Deep-water seaways connected these basins to the Tethys Ocean. The Greater Caucasus ocean achieved the maximum width, approximately 400-600 km during Late Cretaceous time.

During the Late Cretaceous-Paleocene time Kirsehir and Sakhariya plates collided with Pontides. Lesser Caucasus approached Transcaucasus and Talesh area. The northeastward movement of Arabian Plate and Sanandaj-Sirjan terrane significantly reduced and partly closed the Sevan-Akera-Qaradagh Ocean. At the same time obduction (Oman ophiolites among the others) occured on the Northeastern margins of the Arabian plate.

During the Eocene time Lesser Caucasus, Sanandaj-Sirjan and Makran plates were sutured to Transcaucasus- Talesh- Southern Caspian- Lut system.

The subduction zone was locked and jumped to the Scythian-Turan margin. The western segment of this subduction was located along the northern margin of the Eastern Black Sea, on the Greater Caucasus area and south off the Apsheron Peninsula and ridge. The major transform fault system in the Western Turkmenistan basin area separated eastern and western segment of subduction. This fault system is buried deeply below West Turkmen Basin Neogene sediments. The eastern segment was located along the South Kopet Dagh margin approximately 200-300 km south from the Apsheron ridge.

The subduction jump produced the trench pulling force, which influenced all plates between Black Sea and Sistan Ocean in Afghanistan. The timing of movement initiation and

movement velocity is different for different plates. This difference caused the origin of several major strike slip faults of SW-NE direction, which cut both continental crust and Jurassic-Cretaceous oceanic crust. The most important are Arks fault, which separates Lesser Caucasus block and Transcaucasus block from Talesh plate, and Lahijan fault within Alborz Maintains. The extension of Lahijan fault, which separated South Caspian Microcontinent from South-West Caspian Basin, is buried deeply below South Caspian Neogene sediments. The northward movement of South Caspian Microcontinent resulted in rifting between SCM and Alborz plate.

Beginning with Eocene time the southeastern part of Turan Plate and adjacent Afghanistan area was strongly affected by the India-Eurasia collision. To the south, the Arabian plate slowly converged with Eurasia closing the remnants of the Pindos Ocean along the Sanandaj-Sirjan margin (Zagros Suture).

The Jurassic-Cretaceous oceanic crust of the Eastern Black Sea – Greater Caucasus Basin was subducted under the overriding Scythian plate. The northward movement of the Shataki Rise block caused opening of the Eastern Black Sea. The northward movement of the Transcaucasus block caused the collision and formation of the Greater Caucasus orogenic belt.

A marine environment spread throughout the Scythian-Turan platform and adjacent areas during Cretaceous-Eocene time, though climatic factors and global variations of sea level controlled deposition. Terrigenous deposits accumulating on the platform during the Early Cretaceous are overlain by Late Cretaceous carbonates. Paleocene-Eocene time was characterized by mixed deposition of clastic and carbonate rocks.

Oligocene-Miocene

The most recent stage of tectonic history of the South Caspian region and adjacent patform started in Oligocene time and was related to the collision of the Indian and Arabian continents with Southern Eurasia.

Compressional events in Central Asia and the Neo-Tethys region resulted in the general uplift of the Scythian-Turan platform.

The South Caspian part of the Greater Caucasus – Sistan oceanic system underwent the reorganization during Oligocene Middle Miocene time. The northward movement of the South Caspian Microcontinent resulted in rifting between SCM and Alborz plate.

The southwestern part of the South Caspian basin was reopening while the northwestern part was gradually reduced in size. The South Caspian Microcontinent separated the southwestern part of the South Caspian basin and the western Turkmenistan area.

The clastic sedimentation was predominant during this time. The plate’s convergence in the Greatest Caucasus area caused the influx of the large amounts of sediments in form of proximal and distal flysch including large submarine slumps. The sedimentation rate exceeded subsidence and basins were filled.

The main part Neotethys was closed. The Neotethys remnants, foreland basin of the Alpin orogens and reorganized Greater Caucasus – Caspian basin with the adjacent parts of the Scythian-Turan platform formed the Paratethys sea. The Paratethys was isolated from the world ocean. This isolation and persistent low pressure system during Oligocene-Early Miocene time generated favorable condition for deposition and preservation of the organic-rich shales. The

Makeup formation containing several layers of organic-rich shales was deposited in north of Greater Caucasus, in the Terek-Caspian Basin, Kura Basin, and perhaps in the parts of South Caspian Basin. The South Caspian Microcontinent was probably emerged during the Oligocene-Early Miocene and received a minimum amount of sediments, so we can expect the absence of the Makeup formation in this area.

Pliocene-Quaternary

During the Pliocene-Quaternary time the collision of Indian continent and Lut plate with Eurasia caused deformation of the Central Asia region. The system of NW-SE transform faults was developed. These faults were a predominant plate tectonic force in the Turan platform, Kopet Dagh area and strongly influenced the South Caspian region. The deformation connected with the SE-NW strike slip faults were observed in Great Balkhan Area, Apsheron ridge, South Caspian area, Alborz Mountains, and Kura Basin. The N-S strike slip movement system was probably still active, but dramatically reduced. The subduction zone south of the Apsheron ridge became passive perhaps at the end of Miocene because of this SE-NW movement of the lithospheric plates. The collision between South Caspian Microcontinent and Scythian-Turan plate was never concluded. The remnants of the Jurassic-Cretaceous back-arc system oceanic and attenuated crust in the Cheleken and South West Caspian basin as well as Tertiary oceanic and attenuated crust in the Alborz basin and part of the South West Caspian Basin were locked between adjacent continental plates and orogenic systems.

Maximum subsidence of the South Caspian Basin took place mainly during the Pliocene, when more then 8000 m to 10000 m of sediment known as Productive Series and Variegated Series were deposited. The isolation of the Paratethys-Caspian Sea caused changes in the water salinity. Generally the sediments in the South Caspian area, as well as in the adjacent basin on the Scythian-Turan platform, in West Turkmenia and Kura Basin well deposited in the marginal marine environment. The Paleo-Volga, Paleo Amu-Daria and Paleo-Kura rivers delivered majority of sediments.

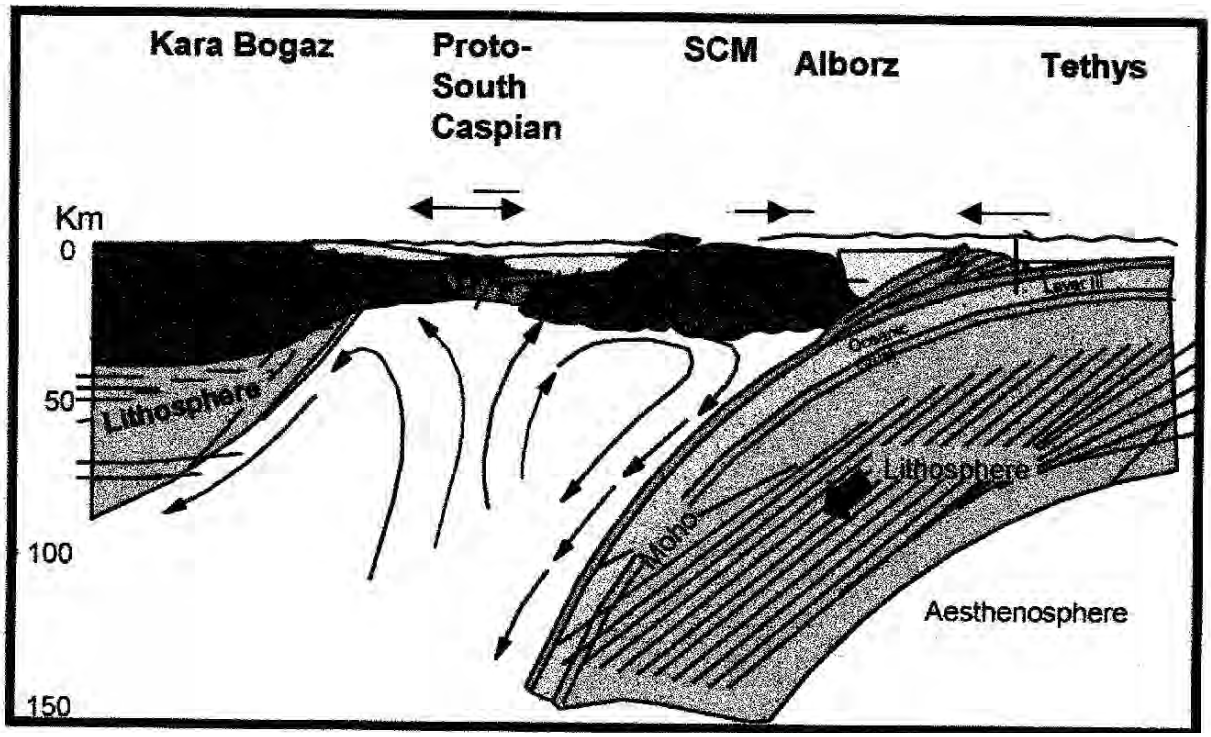

Figure 1. Model of crustal extension and subduction of the South Caspian area, Jurassic.

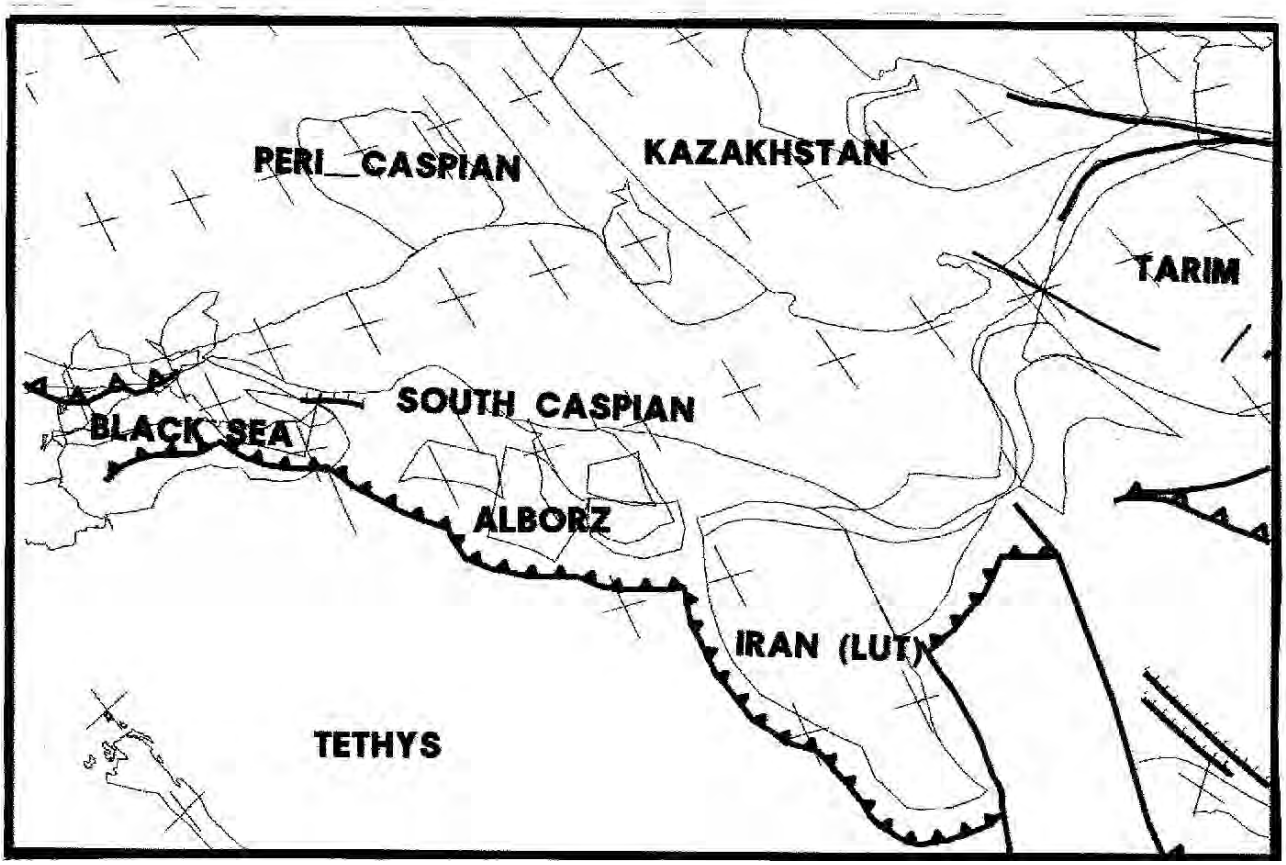

Figure 2. Paleogeography of the Caspian area, Jurassic.