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Facies Implication of GERCUS Formation with The Bathymetry and Tectonic Activity of Van-Pyrenean Phases in Haibat-Sultan Mountain, Iraqi Kurdistan Region.

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ABSTRACT

The Eocene red clastic strata are represented by molasses facies of Gercus Formation and well exposed at **Haibat-Sultan** Mountain**.** A sequence of about 88m thick of the formation is located in the middle part of the Mountain. Detailed investigations including field, petrographic investigations which are linked between bathymetric fluctuation and depositional environment. The sequence is generally found to be shallowing upward facies which start from deep marine (Kolosh Formation) to continental environment passing through shallow marine. Petrographic studies revealed the presence of a high rate of terrigenous grains; the most abundant clasts are sedimentary rock

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fragments such as limestone and chert. There are less abundant clasts derived from igneous and metamorphic rocks like quartz, feldspar, and micain addition to authigenic grains of glauconite are also represented. The pore space between grains are filled by red clay with carbonate cement.The provenance consisted mainly of Balambo,Tanjiro,Shiranish,and Aqra Formations while the Igneous and metamorphic grains are reworked from ophiolte and metamorphic ource areas that cropped out on the Hinterland near Iraq-Iran border. Gercus Formation in this area is deposited in four depositional environments: fluviatile environments(river environment), alluvial fan (shore line) , delta, and shore face environments. The deposition and fluctuation influenced by **paleo-slope** and regional tectonism of Van–Pyrenean phases. The Middle Part of this Formation **interfingers** with the Avanah Formation (Carbonate Rocks) which was deposited during the rising of sea level.

1. Introduction:

The Middle-Eocene sequence, in the Iraqi Kurdistan Region, is well exposed, as Gercus Formation, at the boundary between High and Low Folded Zones. In the studied area the Chnarok section is selected for investigation across the scarp slope of the Haibat-Sultan Mountain (Figs.1 and 2). The Gercus Formation was first defined and described by T. H. Maxson (1936 cited in Bellen et al., 1959) from the Gercus region of the southern margin of Turkey. Later Wetzel (1948) defined a supplementary type section in the Dohuk Governorate and named it “Dohuk Red Bed Series”. Several Cenozoic formations exposed within the studied area along the scarp slope of Haibat Sultan mountain which are, from older to younger, Kolosh, Khurmala, Gercus, Avanah, and Pila Spi Formations (Fig. 2). Gercus Formation received relatively less attention and few areas have been examined such as Shaqlawa area (Al-Qayim et al., 1994), Aqra area (Al-Qayim, 1995), Sulaimani area (Ameen, 2006); Dohuk area (Baziany, 2009). Therefore, updating information about the Gercus Formation is urgent issue.

The Gercus Formation has been studied by Al-Qayim et al., (1994); and Al-Rawi, (1980) who mentioned that it consists of 205m of red claystone and subordinate sandstone horizons, and they are believed to represent fluvio-deltaic facies of the Middle-Late Eocene cycle of North-East Iraq. They added that its upper contact with the overlying Pilaspi Formation is sharp and characteristically marked by a thick horizon of conglomerate and breccias.

Al-Mashaikie et al., (2014) concluded that the depositional environment of the Gercus Formation is a turbidite facies that consists of cyclic repetitions of red mudstone, sandstone, and some lenses of conglomerate and pebbly sandstone. In contrast to the latter study, Hussain and Aghwan, (2015) emphasized on the aeolian, fluvial and lacustrine facies associations as the main constituent of the Gercus Formation. It is added that aeolian facies consists of deflation lags/desert pavements, aeolian sand sheet, aeolian dune, aeolian bimodal and interdune deposits.

Karim et al., (2018) refused the deep marine turbidities and desert erg system of the latter two studies they found out that the formation has deposited in distal alluvial fan and fan delta.

According to Al-Rawi, (1983) the Gercus Formation in northeastern Iraq comprises a river series of related red and drab beds deposited under an arid to semi-arid climate. Al-Qayim & Al-Shaibani, (1991) hypothesized that the Gercus Formation sediments were deposited on a clastic-dominated tidal flat. Ameen, (1998) classified, based on the primary lithological distribution, into three segments which are lower, middle, and upper parts. Al-Rawi, (1980) indicated that less amount of feldspar in sandstone rocks is due to replacement by calcite mineral, or changed to sericite mineral. The aim of the present study is a updating the geological study of the Gercus Formation in the studied area, the determination of the main properties of petrography, types of grains and matrix, and the description of the depositional environments of the Gercus Formation.

2. Geology of the Area:

The Haibat-Sultan Mountain consist of the southern limb of a huge double plunging anticline called Kosrat Anticline, the direction of the strike in this area is towards Southeast–Northwest (120-300) degrees. The southwestern side of the mountain consists of a dip slope along with the strata of Pila Spi Formation, Kirkuk Group and

Lower Fars Formation are exposed along with the Upper, Middle and lower slopes of this side respectively.

The dip of strata on this side is nearly equal to the slope of the earth's surface which is about 40 degrees toward the southwest. The northeastern side of the mountain consists of a scarp slope (30 degrees) along which formations such as Gercus, Avanah, Khurmala and Kolosh plus Formations are daylighted by erosion (Figs. 1, 2 and 3). The mountain, as a ridge, is shaped by resistance beds of Pila Spi Formation which are exposed along the peak of the mountain and upper southwestern slope. According to (Karim et al., 2020), the Kirkuk Group (Oligocene) cropped out along the middle slope and shows unconformity and paleokarst which is represented by paleosoil and limestone conglomerate and solution breccia (Fig. 2).

According to the present tectonic condition of Iraq by **Jassim & Goff, (2006),** the studied area is located nearly at the boundary between the High and Low Zone. During Paleocene- early Eocene, the studied area was affected by Van Orogeny at the end of the Early Eocene, and Pyrenean orogeny which cause the fluctuation of sea level (regression of sea level and uplifting of adjusted paleo high by which Gercus Formation was deposited. Gercus Formation crops out through a continuous belt extending at foot of a mountain chain from Derbandikhan to Zakho. Its outcrop covers a large area of HFZ because of its presence and is deposited in a typical red molasse sequence.

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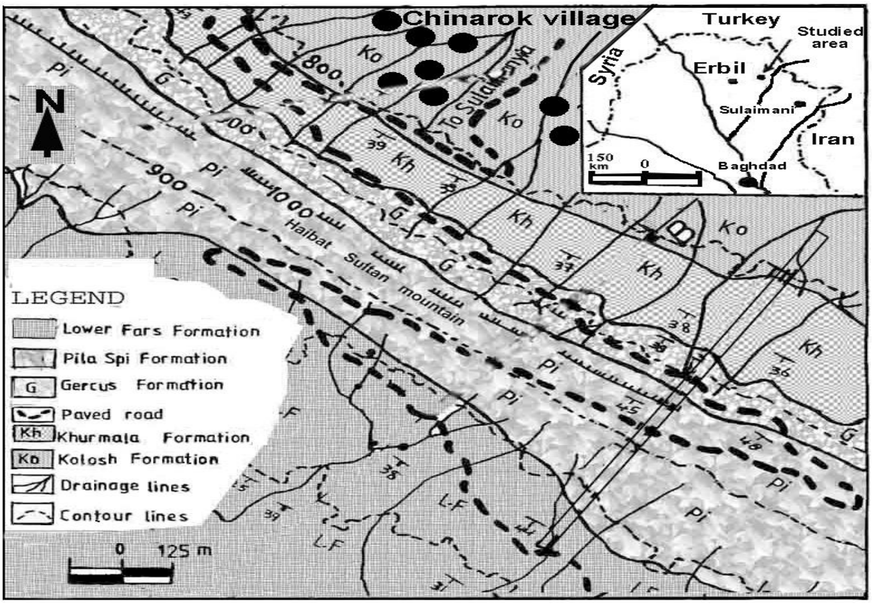

Figure (1): Location and geological map of the studied area

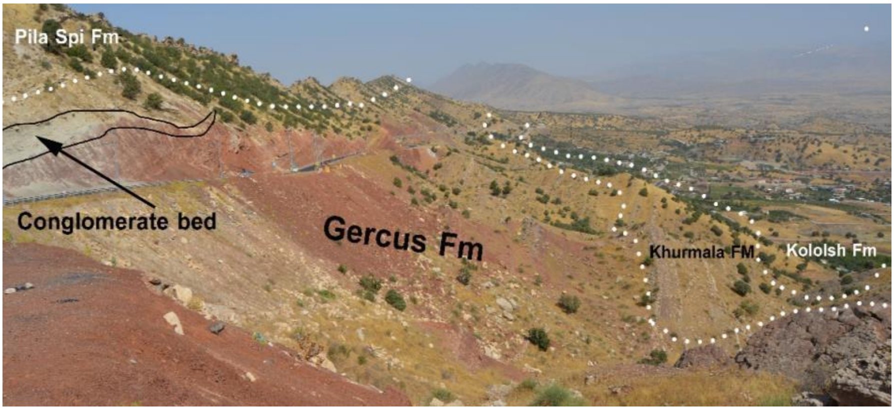

Figure (2): Geological cross-section of the Haibat Sultam Mountain passing through Chinarok Village (from Ameen, 2009) , Avanah Formation in this picture was covered by soil.

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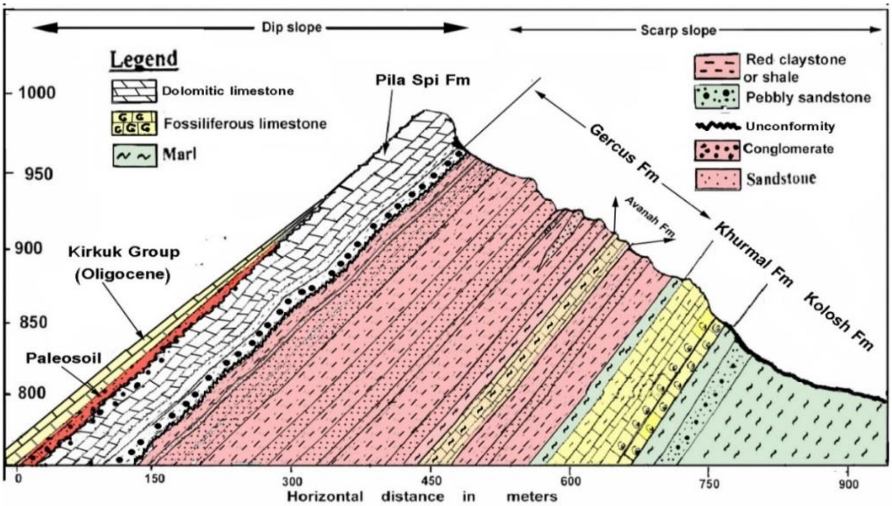

Figure (3): Outcrop of view of the northeastern limb of the Haibat-Sultan Mountain, in which display the stratigraphic position of the Gercus Formation near the Chinarok village.

3. Materials and Methods

The studied section on the Haibat-Sultan Mountain near Chnarok village differs from the other outcrops due to the intercalation of several sand beds and siltstone with red claystone and white color limestone that represent different environments such as terrestrial and marine ones. The current study deals with field observation and detailed petrographic interpretation.

The study area is located in Koya district, near the southern border of the High Fold Zone. The study area is focused on a section restricted to latitudes (36° 06' 52.9" N) and longitudes (44° 39’ 10.9" E). Exactly 20 samples were selected from the sandstone layers of the studied section and the same numbers of thin sections are prepared to study under a polarizing microscope in addition to a detailed field study of the beds and their hand specimens using lens 10X and dilute HCL. The fieldwork included drawing a geological map, cross sections and stratigraphic column (Figs.1 and 2) in addition to taking suitable photographs of the field features (Figs. 3,4 and 5).

This is to indicate the different **lithofacies** and its implication with the sea level fluctuation which is influenced by paleo slop and regional tectonic activity.

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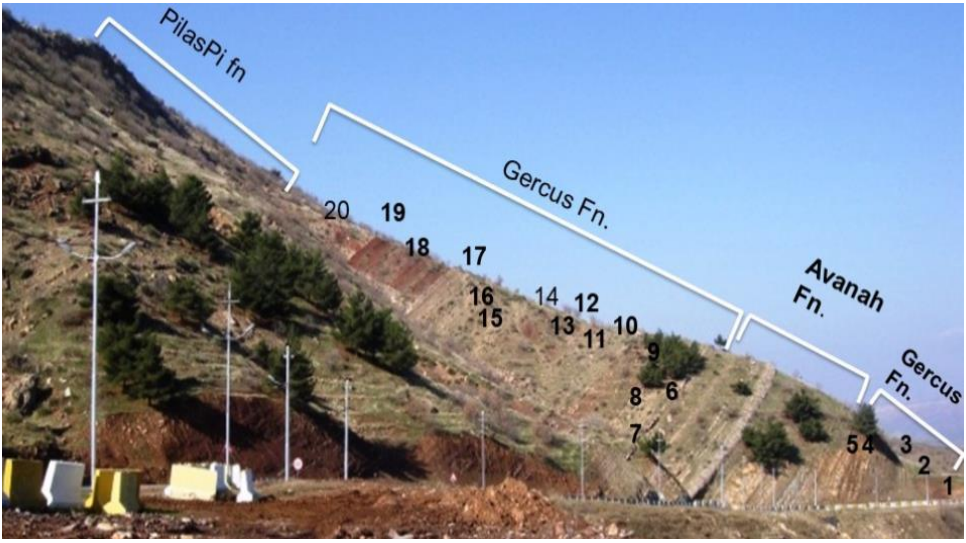

Figure (4): Outcrop of Gercus Formation along the northeastern limb of the Haibat-Sultan Mountain, which shows the location of the geological columnar section and the sample's locations

4. Result

4.1. Stratigraphic Succession of the studied Area

4.1.1. Khurmala Formation (late Paleocene early Eocene)

This formation is composed of carbonate rock (limestone, dolomite, and calcareous shale) and its outcrop locates at the lower slope of the scarp slope of the Haibat Sultan Mountain. The fossils content such as miliolid and gastropods indicate that it was deposited in the shallow restricted platform and shelf lagoon, because of uplifting the area it was overlaid by both shoreface and alluvial deposit of Gercus Formation. (Fig.3 and 6).

4.1.2. Gercus Formation (Early-Middle Eocene)

This formation occupies the middle slope of the scarp slope of Haibat-Sultan Mountain, in some places it extends to near the crest of the mountain on the NE side. This formation is made up mostly of red clastic rocks including claystone, siltstones, and sandstones, with a few thin horizons or lenses of the conglomerate (Figs. 3 and 5). Morphologically it forms a badland due to the alternation of soft and relativity stiff packages of beds (Fig. 2). The lower part of this formation is represented by the thick layers of red mudstone with some band of siltstone and silty mudstone however the upper part contains layers of crossed bed sandstone intercalated with silty mudstone and (Ameen, 2006) found mud cracks in this part. In the middle part of the Gercus Formation, a carbonate unit occurred which is called Avanah Formation.

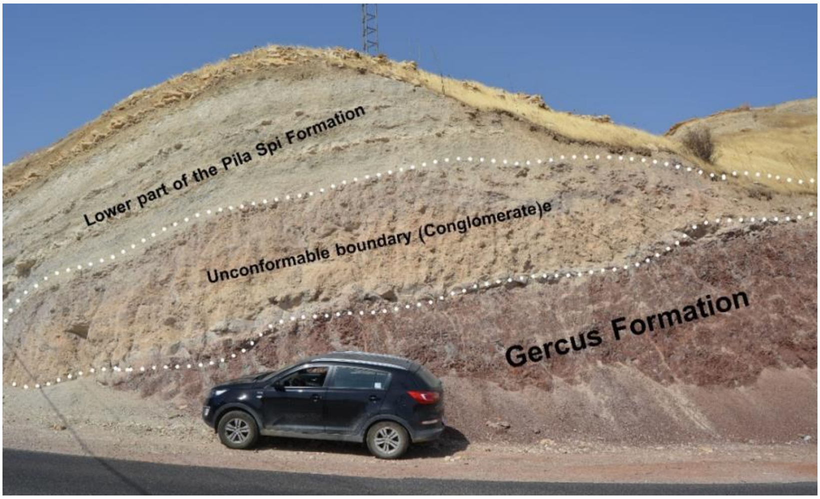

Figure (5): Top of the Gercus Formation which shows a conglomerate bed (tongue) with about 2 m thick.

4.1.3. Avanah Formation

This formation in the studied area represents a yellowish-white to light brown marly limestone and fossiliferous dolomitic limestone which is well-bedded, fractured, and interbedded with shale and sandy limestone. This formation occurs as a tongue within Gercus Formation and its thickness is about (16 m) (Fig. 4 and Fig. 6). In contrast to other areas such as (Shaqlawa area), in the studied area this formation is characterized by intercalation between grey to black shale with dolomitic limestone and marly limestone (Figs. 4 and 6).

The lower and upper contacts of the formation are marked at the base and top of the limestone unit respectively, the depositional environment of the formation is expected to be a lagoon due to the presence of shale lithology within the formation (Fig. 4 and Fig. 5).

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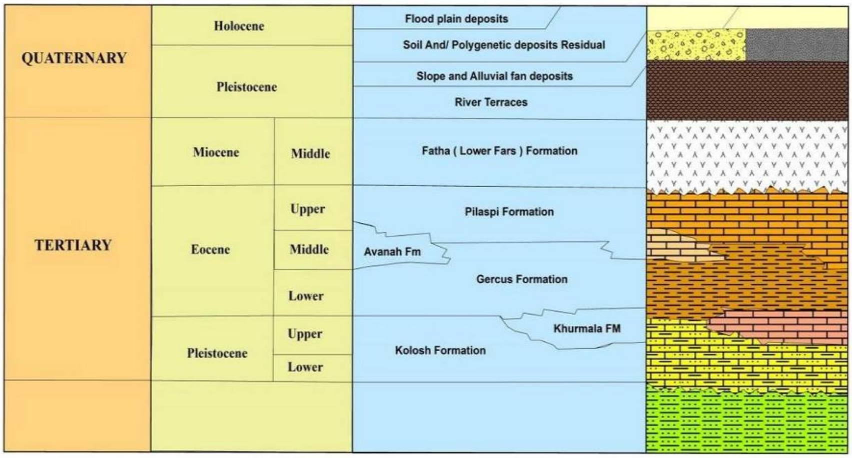

Figure (6): A stratigraphic column shows the relation of the formations in the studied area

4.2. Petrography

The petrographic study is carried out on 20 thin sections from the Gercus Formation which is mainly compost of red mudstone, siltstone, calcareous sandstone, pebbly sandstone, conglomerate lenses, and dolomitized calcareous mudstone, (Fig. 7). Clastic rock of this formation mainly contains a substantial quantity of rock fragments with a few amounts of matrix materials and some pore spaces, which is normal for most shallow clastic environments (Pettijohn et al., 1987).

Generally, the main rock fragments have carbonate and silicate origins such as limestone, dolomite, chert, and quartz grains. The other grains are composed of mica, feldspar, glauconite, shale, and a small amount of igneous and metamorphic clasts (Fig. 8). The rock fragments are mostly derived from the land which is composed of carbonate and clastic rock of Lower Cretaceous formations and older rocks such as Qulqula Radiolarian and Avroman Formations.

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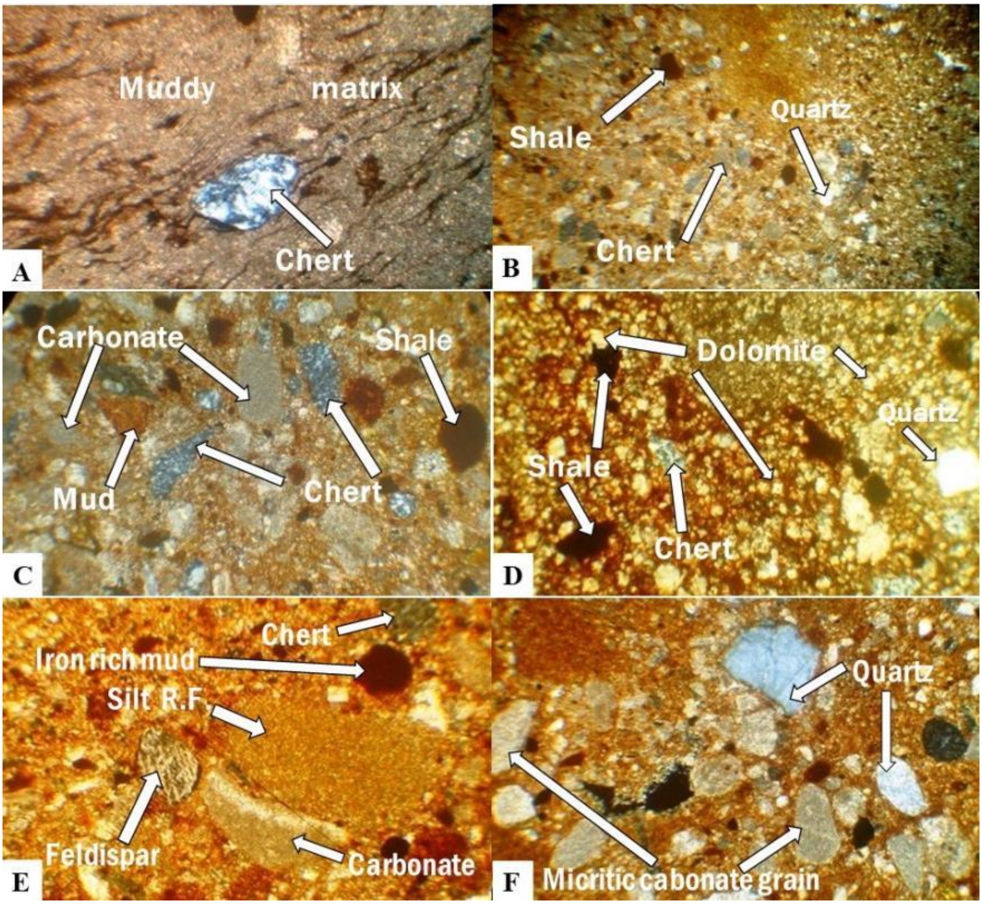

Figure (7): Different lithology of Gercus Formation (A): Silty mudstone with grains of chert and rock fragment (sample no.1) XN -40X, (B): Siltstone of different grains of rock fragment (sample no.3) XN -30X, (C): Sandstone different grains of rock fragment (sample no. 4) XN -40X, (**D**): Dolomitized calcareous mudstone several grains of rock fragment (sample no.5) XN-30X, (**E**): Pebbly Sandstone with different grains of carbonate, feldspar and siltstone rock fragments (sample no. 4) XN-30X, (**F**): Coarse Sandstone with grains of carbonate rock fragment and monocrystalline Quartz (sample no. 4) XN-30X.

4.2.1. Rock fragments

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A large amount of limestone and calcareous mudstone grains are found in clastic rocks like sandstones, siltstones, silty mudstones, purple argillaceous shales, and calcareous shales. All grains may be derived from recycling from the early Cretaceous Jurassic and Triassic formations that were cropped out at provenance which are mainly Avroman, Qulqula Radiolarian Formations and Jurassic metamorphic rocks and the distance of transportation between the positive area and the Gercus basin was not sufficient to allow the carbonate grain to disintegrate. Therefore, the rate of carbonate fragments is more than the others, (Fig7 and 8). The lithic arenite calclithite of (Folk, 1974) ,is an abundant rock of sandstone in Haibat-Sultan because of the presence of a large number of carbonate grains (Aziz et al., 2021).

Silicate rock fragments are the second component of the Gercus Formation, such as chert, quartz and glauconite grains. Polycrystalline quartz is more than others, especially in the upper part of the formation, most of these grains were derived from the metamorphic rock to the metamorphosed felsic igneous rocks inside Ophiolites complexes and they usually occur as sub-rounded to sub-angular sand grains (Fig. 8D). Monocrystalline quartz grains are derived from the non-metamorphosed felsic igneous rocks (granitoid and granodioritic bodies) and hosted in the Gercus basin after erosion. Accordingly, this repetition, reworking, and changes in the pattern of deposition are due to tectonic activity in the basin and source area. in the Eocene quartz grains are common, especially monocrystalline one and persistent in their distribution aerially and quite common in the lower part of the section, (Fig. 7E and 8A).

Chert particles are distinguished by their content of fine size quartz crystals and rather consistent crystal size. Chert is formed from a variety of sources, the majority of which are sourced from sedimentary rocks. Internal crystal structure, size, and morphology may assist determine the source rock of chert grains, according to (Blatt et al., 1980). Fine-grained chert, coarse-grained chert, and specular, silty chert grain are derived from the sedimentary rock, (Blatt et al., 1980), (Figs. 7 and 8).

The other silica detrital grains are glauconite that may be mixed in all proportion with ordinarily sand and they appear as grass green grains with 0.3 -1 mm in size. Most glauconite grains are marine; therefore, they are developed authigenesis in the basin of Gercus Formation after deposition . It was mentioned by (Pettijohn, 1975) that glauconite formation appears to have occurred during the Cretaceous epoch. At the same area near the core of Kosrat Anticline, there was a layer of about 1-1.5 m, of glauconitic limestone (condensed section) stratigraphically located at the contact between Kometan and Sheranish Formations of deep marine environment. The exposure of this layer at provenance is may has some contribution in supplying some detrital glauconite grains.

Feldspar grains are relatively less abundant in sandstone layers of Gercus Formation, and relatively decrease upward through the section, grains have sub angular shapes and mainly of Ca-feldspar type, strongly affected by alteration, (Fig. 8). However, feldspar is sensitive and unstable to chemical alteration and physically tends to be broken and abraded up during transportation. (Fig.7 E and 8C)

Individual sheet or platy shape grains of mica, mostly muscovite represented in the middle part (Fig. 8B) because muscovite is more resistant to weathering, sometimes thin sheet shape grains are associated with quartz and feldspar grains. Most of the biotite grains are altered and dissolved during transportation and weathering, so it was changed to matrix materials in between the individual grains.

4.2.2. Rock matrixes

The matrixes of sandstone of the formation are mainly of micritic type and have a low percentage as compared to clasts which is unexpected for mud-dominated sequences. Possibly the deposition of these sandstones took place in coastal environmental conditions where they could have sorted out the fine detritus, (Fig.8).

4.2.3. Rock cement

Carbonate cement is very dominant and has a high amount in most of the examined samples (20%) and becomes abundant in the upper part of the section. It is related to a good amount of micritic matrix, which has been changed to calcite cement by diagenetic recrystallization processes that reduce the matrix overall amount. Iron oxide cement notably exists and occurs as a thin coating to the detrital grains or fillings of some void spaces or as impregnation of the porous argillaceous detrital grain, (Fig.7 and 8).

4.3 The main lithofacies of Gercus Formation

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According to the petrographically analysis and compared with the Folk, (1974) lithofacies classification, there are two main lithofacies can be recognized in the Gercus Formation: the mudstone lithofacies and carbonate lithic - arenite sandstone(Calclithite) lithofacies. The mudstone in the field reveals its repetitive with red claystone and intercalated with siltstone layer while in lithofacies examination it is highly calcareous (dolomitized) or fine grain mudstone. The sandstone beds in the field are sometimes exposed as a pebbly sandstone lens, and associated with the little conglomerate tongue at the top of the formation (Fig.5). The microfacies of this sandstone are mostly laminated or cross-bedded litharenite, and based on the rock type predominantly can be called calcarenite, and chert arenite (Fig. 9).

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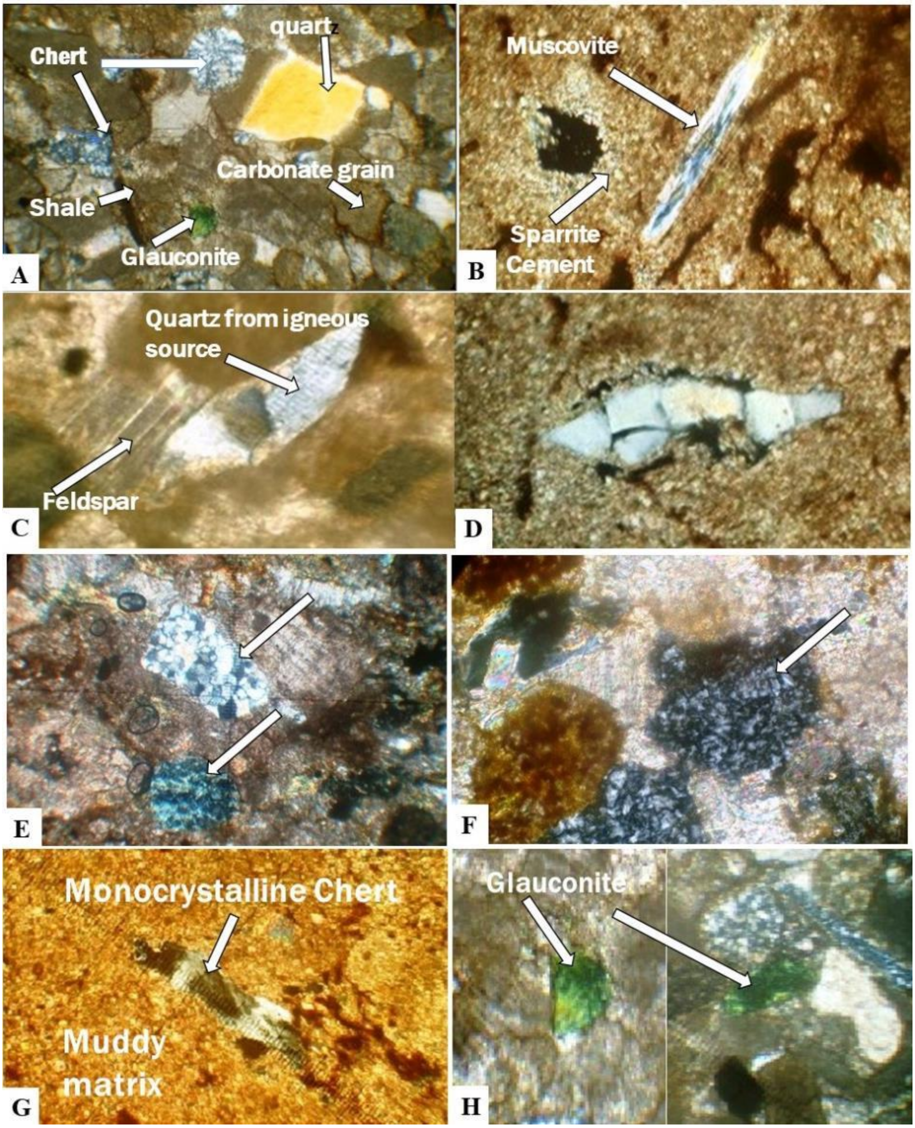

Figure (8): Different mineralogy of Gercus Formation, A) Mineral terrigenous grain; Monocrystalline quartz, Chert, Glauconite, carbonate grain, shale. XN (Sa. No.3)-40X, (B): Detritus Muscovite grain, XN (Sa. No.4)-60X, (C): Feldspar grain and quartz from igneous source rock XN (Sa. No. 10)- 60X, (D): Polycrystalline quartz from a metamorphic source rock, XN, (Sa. No.7)-60X, (E & F): Chert and carbonate grains in a sparry cement (1-polycrystalline quartz chert 2-spicular chert 3-fine crystalline chert 4-elongate sutured chert grain (sample no.11) XN-30X, (G): Undulatory

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extinction of a monocrystalline chert grain in a muddy matrix (sample no.18) XN-40X, (H): Glauconite grains in cherty sandstone (sample no.14) XN-40X

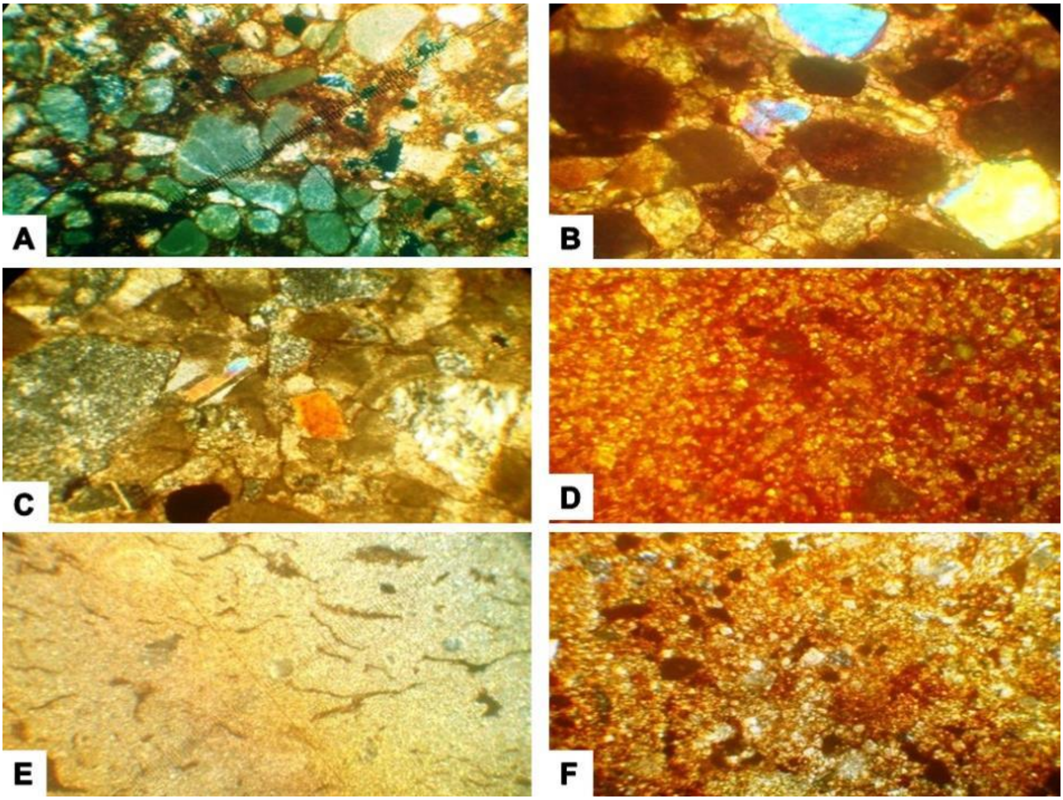

Figure 9: Calcarenite with different grains carbonate (A) Sample no. 12- XN 30X, **Pebbly** sandstone with quartz grains (B) Sample no. 16-XN. 20X, Chert arenite (C) Sample no.10-XN. 32X, Dolomitized red mudstone (D), Sample no. 11_XN. 40X, Fine grain clay stone (E) Sample no. 6 -XN. 40 X, Silty mudstone (F) Sample no. 17-XN. 40 X.

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5. Tectonic Setting and provenance

The Gercus Formation is important for its lithology which represents the first proven occurrence of terrestrial sediments in the High Folded Zone in the geologic history of Iraq. From Triassic to Middle Eocene no similar lithologies are present in the stratigraphy of High and Low Folded Zones. This presence indicates intense tectonic uplift in the foreland basin and on the hinterland by which high contrast topography was generated and a mixture of different clasts arrived at the basin. This mixture results from dissection of the recently elevated provenance which comprised of sedimentary, metamorphic and igneous rocks (Fig.10). Due to the topography, the clasts are ungular and badly sorted (Figs.7 and 8).

The Gercus Formation is underlain by Khurmala Formation with a gradational contact due to gradual uplifting under the influence of the tectonic activity of Van Orogeny. The upper thick layers of a conglomerate of the upper part of the Gercus Formation form its upper contact with the Pila Spi Formation, which overlaid it unconformably at the upper part, and represented by the presence of basal conglomerate (1.4 m thick) between the two formations. The thickness of the conglomerate changes laterally for about more than 2m in some areas and according to Bolton, (1956) this basal conglomerate comprises chert and carbonate pebbles, that came from Radiolarian chert and chert nodules related to early Cretaceous and Jurassic ages which uplifted under the influence of Pyrenean Orogeny (Fig. 6).

During Eocene, the whole area of northern Iraq was uplifted relatively speedily by which deep basin of Kolosh Formation transformed to shallow carbonate of Khurmala (Sinjar) Formation succeeded by more uplift by which the studied area changed to transition between marine and terrestrial environments. This is due to the dissection of the foreland, hinterland and cropping out of the different rocks and started to weather and erosion, supplying a voluminous quantity of detritus to the Gercus basin in the periphery of the foreland basin.

Generally, the uplift is accelerated during the deposition of the Gercus Formation and reached its culmination stage during the deposition of the conglomerate at its top below Pila Spi Formation (Figs.3 and 4). At this stage, the uplift rebounded and subsided to a shallow marine basin in which Pila Spi and Avanah Formations are deposited. Due to This rebound, the clastic influx to the foreland basin ceased,

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however, **Karim et al., (2008)** attributed this cessation of clastic influx to the development of another basin in the Thrust Zone in which Walash-Naoperdan Group Deposited.

5.1. Depositional environment

The development of sedimentary basins depends mainly on tectonics which has affected the studied area due to its location in the Zagros foreland basin. This basin was formed by Van and Pyrenean orogeny which uplifted the submerged paleo high to form the land provenance(development of the continental crust) and supply clastic sedimentary rocks, Trifonov and Sokolof,(2o18), Haq,et al., (1988) Jassim, and Goff (2006) Once a basin was formed, the surrounding land shed erosional debris which is carried and deposited as sandstone and red claystone.

In the foreland basin, as a part of the Tethys basin, Gercus Formation (Middle Eocene) deposited as a molasses sequence comprises predominantly calcarenite sandstones (Al-Rawi, 1980). It is deposited after Kolosh Formations in Shallow marine (shoreface, beach, delta, and alluvial). It shows interbedded mudstones with lenses of conglomerate and pebbly sandstone, most of the terrigenous material reworked from the adjacent paleo high, trending southeast-northwest and it was represented at the NE edge of the Arabian Plate uplifted. Sa’ad et al., (2014).

5.2. Delta environment

Deltas are a common local environment of shorelines that have been formed during river or stream flowing into marine. When developed, the delta environment became a small basin for receiving land material, (Figs. 10 and 11), its microscopic facies and component are seen in (Figs. 7 and 9). The delta is surrounded by land therefore this land became the source supplying and shorelines affected by fluctuation of sea levels and commonly referred to as submerged shorelines which is applicable for studied area (Chnarok section) at Late-Paleocene (Thanetian-58.7 m. y. ago). The fluctuation are obvious in Cenozoic cycle chart that was drawn by Haq et al., (1988). This environmental area matched with facies zone no.9 of Wilson, (1975) and Flugel, (1982). The term "submerged" refers to how shorelines generally follow the shape of pre-existing landscapes that have been gradually submerged by rising sea levels.

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Because of global sea-level rise, a river valley that existed near the shoreline in the past would now be filled with seawater. A bay or estuary can be formed by a submerged river valley (Fig. 10).

5.3. Fluviatile environments (River environment)

During the regression of sea level along the shoreface, coarse pebble and gravel will deposit in some channels as bedload which form the lenses of conglomerate that was present in the Gercus outcrop (Fig. 5 and 10). Because of the rapid velocity of the flooding discharge, river deposits exhibit imbricated and badly sorted clasts of gravel cobbles.

5.4. Alluvial environment

It's also present as a thick bed of red mudstone. The alluvial depositional environment is detected within the Early-middle Eocene and represented during the deposition of most parts of the upper red clay layers of the studied section reflecting a lateral migration environment. The fan, alluvial plain, and delta are the three types of alluvial environments. Sand is present in all three, but it may be overshadowed in the fan by coarser debris, finer silts, and clays; and in the delta by finer silts, and clays(Pettijohn et al., 1987). This kind of environment is mentioned by(Awad & Alsultan, 2020) during their study for stratigraphic analysis of the Gercus Formation in Dohuk area.

5.5. Shoreface environment

This environment is subjected to high wave energy at the upper shoreface and it's characterized by medium to coarse-grained sand which is well sorted. The middle part of the Gercus Formation in the Chnarok area was recognized by carbonate layers of about 40-70cm thickness interbedded with layers of red silty claystone and shale which are the indicator of sea-level fluctuation under the reactivation of tectonic movement from time to time, where the wave starts to touch the bottom wash the clay and silt to drive to the deeper part of the basin and limestone deposited below base wave, (Fig. 10 and 11).

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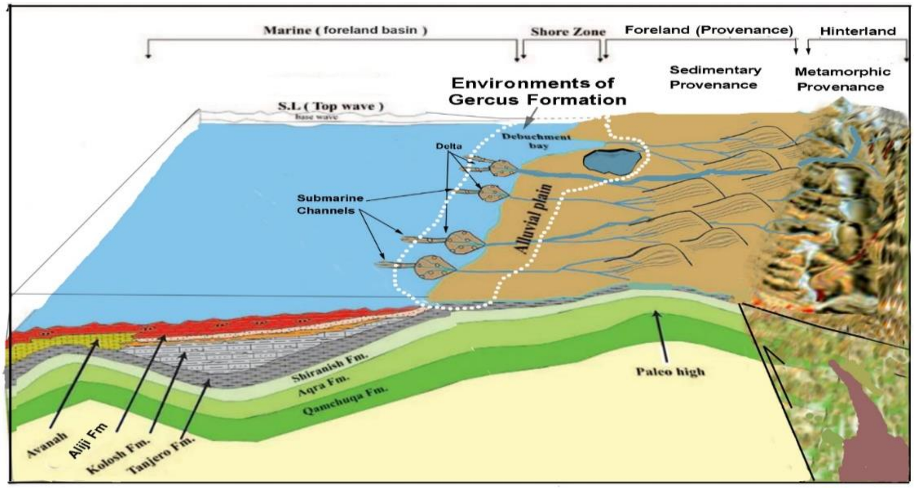

Figure 10: A Generalized tectonic model displays the location and depositional environment of the Gercus Formation during the Eocene time.

6. Bathymetric analysis

The purpose of the bathymetric analysis is to examine the accurate relationship between different lithologies of the Formation such as calcareous sandstone, red mudstone, sandstone limestone and conglomerates. These lithologies resulted from the major depositional process, the eustatic sea level fluctuation (transgression and regression) and tectonism (Fig.11). The red layer of thick mudstone is characterized by silty-claystone; such occurrences of red mud could be the result of regression and exposing the backshore area and deposition of fine red clastics on the flood plain of the delta plain.

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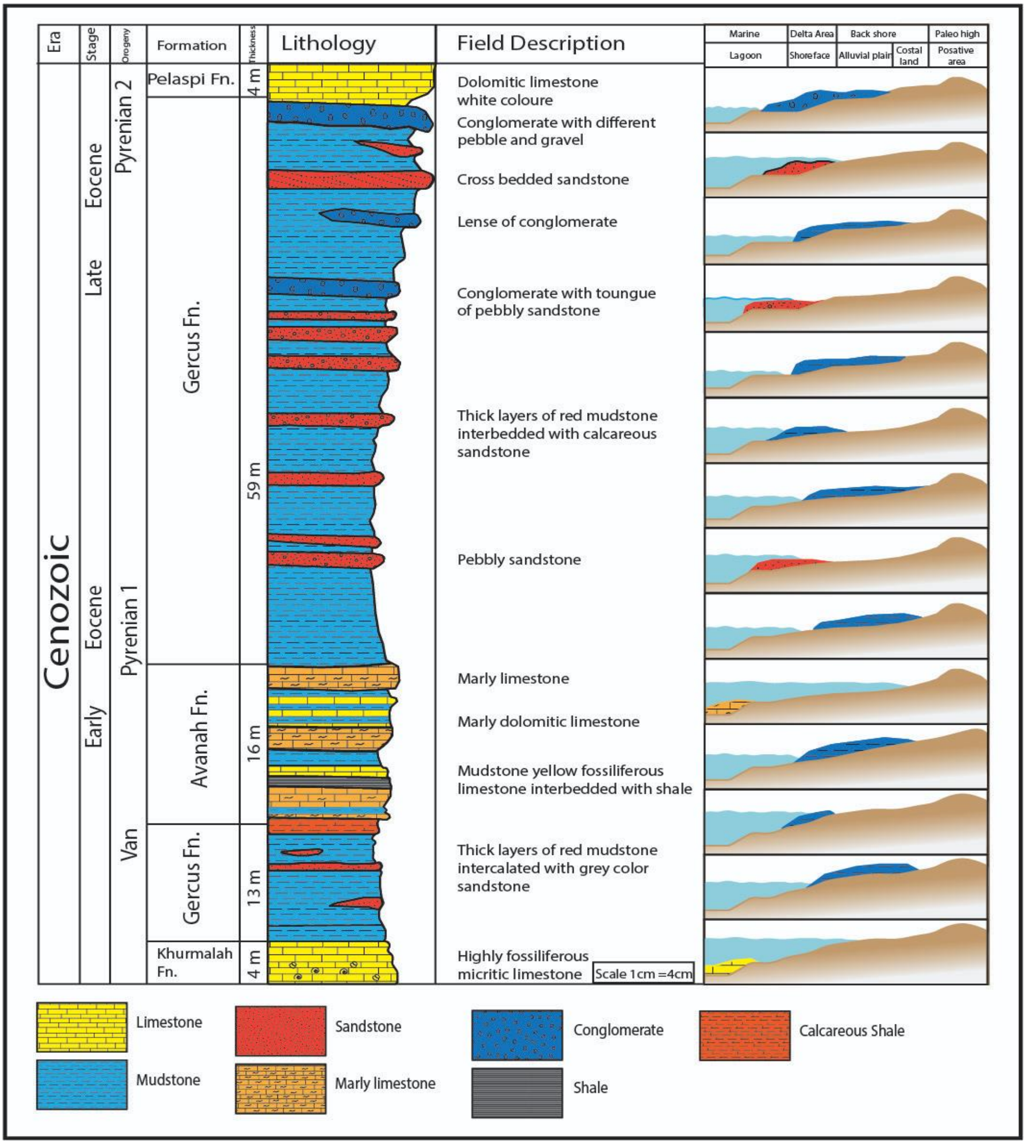

Figure 11: Stratigraphic column of the Chinarok section shows, sample locations, seal level changes and bathymetric analysis by interpretation between sedimentary environments and their relationship to stratigraphic section developed during transgression and regression.

The transgression was fast which lead to consequent preservation and deposition of delta and shoreface sequence of coarse sandstone and pebbly sandstone or some lenses of the conglomerate. During large floods, it is possible that some

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conglomerates, of limited distribution, may have deposited in the distributary channels and now appear as lenses in the middle part of the formation. While the conglomerate at the top of the formation has wide and regional distribution in nearly all sections in the High Folded. Therefore, it is considered as unconformity and deposited during major regression. The presence of thick red mudstone, pebbly mudstone, sandy mudstone, and thin siltstone indicate more a shallowness and exposing the backshore and filling by the eroded material of paleo high during flooding. The continuous fluctuation of sea level during deposition of Gercus Formation was happen under the effect of local tectonic movement Van and Pyrenean Orogeny.

7. Discussion and conclusion

This study demonstrated that the positive area was of two types, the first one was near one which is composed of carbonate rocks. The evidence for this is more abundance of the carbonate grains and their matrixes than other grains in all thin sections. Due to the nearness of transportation between the positive area and basin, the wearing was not sufficient to allow the carbonate grain to dissolve. The second positive land (provenance) is far one which consisted of chert, metamorphic and igneous rocks (Fig.10).

The lithological study in field and laboratory examination of the slides under the microscope show that there was sea-level fluctuation during the deposition of Gercus Formation and resulted in different environments of deposition which are fluvial, alluvial, delta, and shoreface environments. To illustrate the detailed image of the depositional environment and its provenance in the studied area, a three-dimensional sketch (model) has been drawn in (Fig. 10). The grains that are derived from the igneous and metamorphic source are less abundant and were reworked from faraway Ophiolite complexes' provenance. The study has the below conclusions.

1. Gercus Formation in the study area red clastic rock mostly consists of carbonate rock fragment Chert, poly and monocrystalline quartz, mica, feldspars, and other rock fragments, cemented mostly by red clay, silt, and carbonates.

2. Lithologically consists of thick layers of red mudstone intercalated with sandstone, siltstone, and some lenses of the conglomerate. Sixteen meters of fossiliferous and sandy limestone, marl, and dolomite of Avanah Formation interfinger with Gercus Formation.
3. The ratio of carbonate fragments is more than the other lithic fragments since the most dominant lithology at provenance is consisted of carbonate rocks. The distance of transportation between the positive area and the Gercus basin was not sufficient to allow the carbonate grain to dissolve.
4. The sources of chert grains are radiolarites while other particles (quartz, feldspar, mica …etc.) are derived from Ophiolite complexes.
5. The Gercus Formation was formed in a shallow foreland basin that served as a transition between a shallow marine shelf face and the continent. A brief regressive pulse occurred near the end of the Gercus Formation in the middle Eocene. It passed from the deep narrow rapidly subsiding trough of Kolosh flysch to the shallow restricted lagoon of Kurmala Formation and fluvial Gercus Formation.
6. The studied succession of the Gercus Formation was deposited in four different environments, fluvial environments, alluvial environments, delta, and shoreface environments.
7. Glauconite that occurs in Gercus Formation is grown inside the bain by authigenesis process.
8. The frequent occurrence of mudstone and sandstone or intercalation relation between them under the bathy metric change (sea level fluctuation) case consequent deposition of Gercus Formation.

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چەسپاندنی پارچە نیشتەتیەکانی پێکهاتەی جەرکەس لەگەڵ قوڵاییەکانی دەریا و چالاکی جوڵە زەمینەیەکانی خولی وان و پایرینیەن لە چیای هەیبەت سلتان – هەرێمی کوردستانی عێراق

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پـوختـه:

چینه بەردە سوەرکانی چاخی ئیۆسن خۆی دەنوێنی وەک پارچە مۆلاسیەکان لە پێکهاتەی جەرکەس . ئەویش بە ڕونی دەردەکەوێت لە چیای هەیبەت سلتان. لە زەنجیرە چینێک بە ئەستوری ٨٨م لە ناوەندی چیاکە . لیکۆلینەوەی تەواو بریتی بوو لە کارە کێلگەییەکان و لێکدانەوەی پترۆگرافی، وە لێکدانەوەی نیوان ڕودانی بەرزبونەوە و نزمبوونەوەی ئاستی ئاوی دەریای ئەوکات و شوێنی نیشتنەکان.

زنجیرە چینەکان بەگشتی وا خۆی دەنوێنێ کە لە کاتی نیشتیان ئاستی رووی دەریا دابەزیووە و قوڵاییەکەی تەنک بۆتەوە، کە لە سەرەتادا لە دەریایەکی قوڵەوە دەستی پێکردووە کە پێکهاتەی کولوش تیانیشتووە بەرەو نزمبونەوە و کەم قوڵی چووە.

لێکدانەوە بیتروگرافیەکان وا پیشادەدات کە ڕێژەیەکی زۆر لە دەنکۆڵە بەردیەکان وشکایی، زۆرترین دەنکۆلەکانی بریتین لە پارچە نیشتەنی وەک لایمستون و چێرت. بەڵام ڕێژەیەکی کەم لە دەنکۆڵەکانی بەردی ئاگرین گۆڕاو وەک کوارتز و فلدسپار و مایکا. دەنکۆڵە دوبارە گەڕاوەکانی گلۆکونایت کە لە جەرکەسدا هەن لە چینە بەردەکانی کریناسی سەرینەییەوە هاتووەکە بەرزاییە وشکەکانی تەنیشتیەوە هاتووە.

بۆشایی نیوان دەنکۆڵەکانیش پر بۆتەوە بە خۆڵی سور لەگەڵ ماوەی کلس لەحیم بووە. ناوچە بەرزەکانی وشکانی پێک دێت بە شێوەی سەرەکی لە پێکهاتەکانی بالابمۆ و تانجیرۆ و شیرانیش و عەقرە. پیک هاتەی جەرکەس لەم ناوچەیە لە ژینگەیەکی نیشتەنی رووبار و دەشتەپانکەییەکانی کە ناراوەکان و دەلتاکان و وە ڕووی بەرەو دەریای کەناراوەکان. ئەمانەش لە ژێر کاریگەری لێژییەکۆنەکانی و جوڵە زەمینەییەکانی ناوچەکە لە جولەی وان – پارینیەن. لە ناوەندی نیشتەنی جەرکەس پێک هاتەی ئاقانە تێکهەلکێش بووە لە ژێر کاریگەری بەرزبوونەوەی ئاستی ئاوی دەریا ئەوکات.

تدعيم الأجزاء الرسوبية لتكوين الجركس مع أعماق البحر ونشاط الحركة الأرضية لدورتي وان و پايرينين في جبل هيبت سلطان - إقليم كردستان العراق

الملخص:

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يتم تمثيل الطبقات الصخرية الحمراء في العصر الأيوسيني بسحنات دبس السكر من تكوين جركس ومكشوفة جيدًا في جبل هيبت سلطان. يوجد تسلسل يبلغ سمكه حوالي 88 مترًا من التكوين في الجزء الأوسط من الجبل. تحقيقات مفصلة بما في ذلك التحقيقات الميدانية ، الصخرية التي ترتبط بين تذبذب قياس الأعماق وبيئة الترسيب. تم العثور على التسلسل بشكل عام على أنه سحنات صاعدة ضحلة تبدأ من أعماق البحار (تكوين كلوش) إلى البيئة القارية التي تمر عبر البحار الضحلة. كشفت الدراسات البتروغرافية عن وجود نسبة عالية من الحبوب الأرضية. أكثر الكتل الصخرية وفرة هي شظايا صخرية رسوبية مثل الحجر الجيري والصخور. هناك عدد أقل وفرة من الصخور المشتقة من الصخور النارية والمتحولة مثل الكوارتز والفلدسبار والميكانيك بالإضافة إلى حبيبات الجلوكونيت الأصلية. تملأ مساحة المسام بين الحبوب بالطين الأحمر مع الأسمنت الكربوني ، وتألف المصدر بشكل أساسي من تكوينات (Balambo و Tanjiro و Shiranish و Aqra) بينما يتم إعادة تشكيل الحبوب النارية والمتحولة من مناطقنا الأفيونية والمتحولة التي نمت في المناطق النائية بالقرب من العراق - حدود إيران. يتم ترسيب تكوين الجركس في هذه المنطقة في أربع بيئات ترسيبية: البيئات النهرية (بيئة النهر) ، والمروحة الغرينية (خط الشاطئ) ، والدلتا ، وبيئات مواجهة الشاطئ. تأثر الترسب والتقلب بمنحدر باليو والتكتونية الإقليمية لمراحل فان-بيرينيه. يتداخل الجزء الأوسط من هذا التكوين مع تكوين الأفانا (صخور الكربونات) التي ترسبت أثناء ارتفاع مستوى سطح البحر.