Kirkuk Journal of Science Vol. 20, Iss. 2, p. 1-13, 2025 doi:10.32894/kujss.2025.158808.1203

Ashdagh Anticline Shape Indications from Western Zagros Fold Thrust Belt in Kurdistan Region (N. Iraq)

Adel O. Abdullah [1,*], Fadhil A. Lawa [2], Salim Hassan Al-Hakari [2]

[1] Department of Applied Geology, College of Science, Kirkuk University, Kirkuk, Iraq.
[2] Department of Earth Sciences and Petroleum, College of Science, University of Sulaimani, Sulaymania, Iraq.
*Corresponding author : adilabdalla@uokirkuk.edu.iq

Article Information

Article Type:
Research Article

Keywords:
Ashdagh Anticline; Fold analysis; Western Zagros; Kurdistan Region of Iraq.

History:
Received: 9 April 2025
Revised: 7 June 2025
Accepted: 11 June 2025
Available Online: 30 June 2025

Citation: Adel O. Abdullah, Fadhil A. Lawa, Salim Hassan Al-Hakari, Ashdagh Anticline Shape Indications from Western Zagros Fold Thrust Belt in Kurdistan Region (N. Iraq), Kirkuk Journal of Science, 20(2), p. 1-13, 2025, https://doi.org/10.32894/kujss.2025.158808.1203

Abstract

The Ashdagh anticline, located in the Low Folded-Thrust Zone of the northwestern Zagros Fold-Thrust Belt in the Kurdistan Region of Iraq, exhibits complex structural geometry influenced by thrust-related deformations. This study uses detailed surface geological observations, manually constructed geological sections, and stereographic projections. Furthermore, the interpreted subsurface seismic data has been utilized to build eight structural cross-sections that traverse the anticline strike. The anticline displays asymmetry, characterized by a steeper forelimb, a narrow crestal area, and a hinge line with convex curvature oriented to the northwest toward the hinterland and southeast toward the foreland depocenter. The main result shows that the variations in fold geometry along the strike are caused by structural segmentation resulting from the Strike-slip and thrust faulting. It also enhances the Comprehension of the folding style and structural framework of the studied area, offering valuable insights into the Tectonic developments of the Low Fold Thrust Zone, within the Western Zagros Fold Thrust Belt.

1. Introduction:

The western Zagros Fold-Thrust Belt (WZFTB) is a significant geological structure formed by the continuous collision of the Arabian and Eurasian (Iranian) tectonic plates, a process that has been occurring since the late cretaceous period [1], [2], [3]. This belt is characterized by a thick sequence of folded and faulted successions, ranging from 7 to 12 km in thickness, composed of Paleozoic to Cenozoic sediments with varying lithological competence [4],[5], [6].

The present morphology of the WZFTB is characterized by prominent folds that trend northwest to southeast, with their scale and shape significantly shaped by the rheological characteristics of the Phanerozoic stratigraphic column. The belt is further divided into four subparallel tectonic zones, each with distinct structural characteristics Figure 1 The Low Folded Zone in Kurdistan region and Iraq including the study area, holds importance. Especially concerning hydrocarbon reservoirs. This zone is bounded by the High Folded Zone to the northeast and the Mesopotamia Foredeep to the southwest. The Zagros foreland basin subsided due to the combined loads of the surface topography and the subducting slab during the early Miocene and was affected by dynamic topography due to the Neotethys horizontal slab tear propagation during the middle-late Miocene. This tear propagation was associated with a northward mantle flow above the detached slab segment in the NW and a focused pull on the attached portion of the slab in the SE [7].

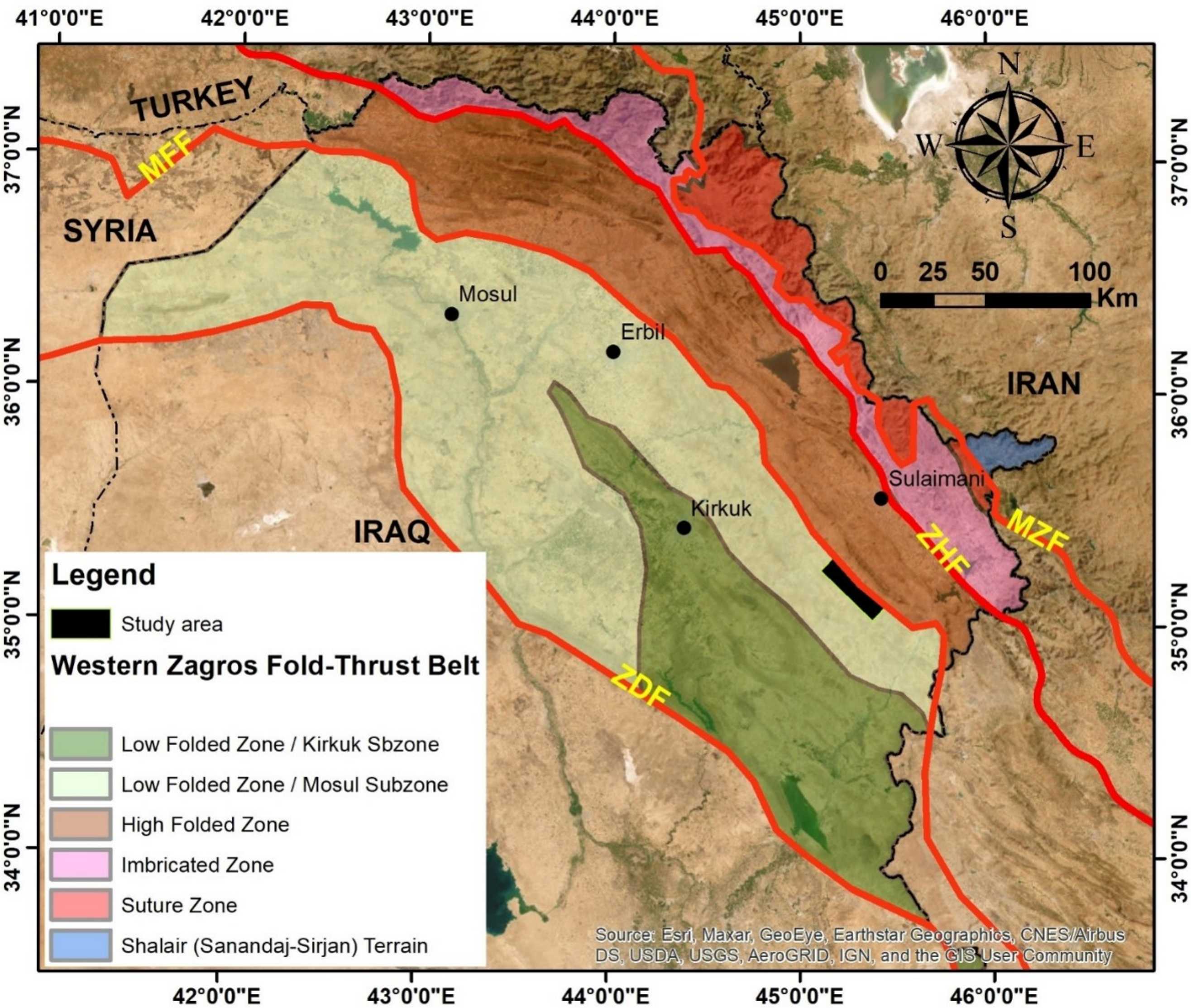


Figure 1. Tectonic division of Iraqi Western Zagros Fold Thrust Belt, modified from [1].

The region is characterized by folds that are topped with Miocene strata. A significant décollement horizon is represented by the Fatha Formation, which consists mainly of evaporitic deposits interspersed with substantial layers of Paleocene shale and marl [8].

The Ashdagh anticline is a significant geological structure, situated alongside the Khwelen and Qarawais anticlines within the Low Fold-Thrust Zone, as described by [9] in [10]. It forms part of an echelon fold pattern within the larger Sangaw structure, which extends over 65 km in strike direction and spans approximately 10 km in width [11]. This structure is located southeast of Sangaw township in the Garmiyan province, approximately 45 km south-southwest of Sulaimani city Figure 1 & 2a.

The geometry and structural style of folds, such as the Ashdagh anticline, are critical to understanding the tectonic and deformation history of the region. Recent advancements in hydrocarbon exploration, engineering stability and assessing potential hazards. have renewed interest in the structural analysis of such folds [12], [13], [14], [15]. Although several studies have depicted the Ashdagh anticline with varying dimensions and structural styles [9], [16], [17], [18], significant uncertainties remain regarding its detailed structural configuration. This lack of comprehensive analysis has left gaps in our understanding of the fold's geometry and its implications for regional tectonics.

This study aims to address these uncertainties by conducting a detailed geometrical analysis of the Ashdagh anticline. By examining its fold shape, structural style, and deformation patterns, this research seeks to enhance our understanding of the tectonic evolution of the Low Folded Thrust Zone. The findings are expected to contribute not only to the academic field of structural geology but also to practical applications in the hydrocarbon industry and water resource management in the Garmiyan province.

2. General Geology of the Study area:

The Ashdagh anticline is a complex and highly deformed structure located within the Low Fold-Thrust Zone of the Western Zagros Fold-Thrust Belt. Unlike most other structures in this zone, which typically exhibit simple geometries and fold shapes [15], [19]. The Ashdagh anticline is characterized by intricate deformation patterns influenced by numerous faults. The anticline is bounded to the west by the Qarawais anticline, to the north-northeast to southeast by the Darbandi Bazian-Sagrma-Qaradagh anticline series, and to the south by the Kurdamir subsurface anticline Figure 2a. The Chami Sangaw River flows north-south along the eastern flank of the anticline, where it shifts course and cuts through the structure. Additionally, the Awa Spi River originates from several springs in the southeast part of the anticline and flows southwestward out of the study area. The area is characterized by significant karst formations, such as sinkholes, caves, collapses, and natural bridges, which have developed due to the interaction of sulfuric water with the underlying rock layers. Additionally, oil seepage has been detected in the Darzila water tributary, suggesting the movement of hydrocarbons from deeper geological layers [9].

The Ashdagh anticline, along with the Khwelen and Qarawais anticlines, forms part of an echelon fold pattern within the larger Sangaw structure, a prominent feature in the Low Fold-Thrust Zone. This structure rises to a peak elevation of 1350 meters above sea level, over 600 meters higher than the surrounding terrain. It is separated from the High Folded Zone by the Sangaw syncline, a broad synclinal depression approximately 8 kilometers wide. Although the area has likely been extensively explored by oil companies, the data remains confidential and inaccessible for scientific research. Consequently, the subsurface geology of the Ashdagh anticline has been interpreted based on a conceptual model of the Western Zagros Fold-Thrust Belt [20]. The stratigraphy of the Ashdagh anticline has been the subject of extensive research, with numerous studies documenting its exposed succession [9], [21], [22], [23], [24], [25], [26], [27] ,[28]. The stratigraphic sequence comprises several Paleogene formations, ranging from the Late Eocene (Avanah Formation) to recent deposits. These units exhibit varying mechanical properties and thicknesses, which significantly influence the structural expression of the anticline. More competent carbonate units, such as the Avanah, Bajwan, Anah, and Jeribe formations, form a prominent ridge along the fold, while the mechanically weaker Fatha Formation, dominated by evaporites and interbedded marl-clastic sediment, occupies the eroded limbs of the structure. Overlying these Paleogene units are Neogene deposits, represented by the Injana and Mukdadiya formations, which are present on both limbs of the anticline Figure 2b & c, while the Bai Hasan formation recorded in the SW limb but not recorded in the NE limb. These clastic-dominated units display upward-coarsening and thickening sequences, reflecting changes in depositional environments over time. The interplay of these lithological variations has played a critical role in shaping the structural and geomorphological characteristics of the Ashdagh anticline. The preserved lithostratigraphic units document variations in provenance and bed competency structure. Furthermore, they exhibit a trend of increasing coarseness from fine-grained deposits in distal areas to coarse-grained deposits in proximal regions [3]. The detailed stratigraphic description of the Ashdagh anticline is shown in Figure 3 It's important to mention that the expose succession manifests the variations from the TMSAP. 10 to TMSAP. 11, which is also the Time for the Miocene deformation in the Zagros Fold thrust belt [3], [7], [29], [30].

3. Material and Methods:

To analyze the fold style and shape of the Ashdagh Anticline, a combination of field data collection and remote sens-

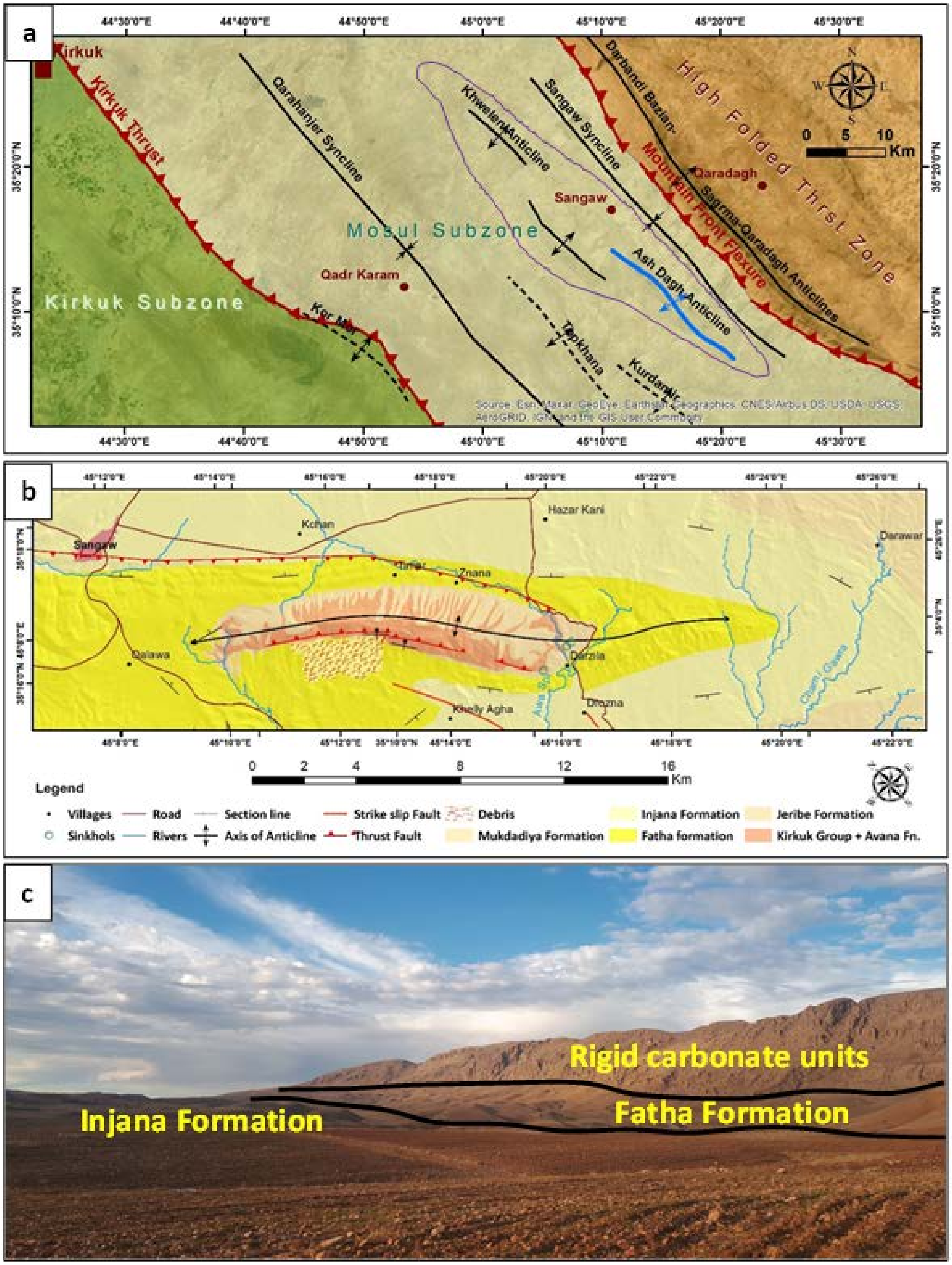


Figure 2. a: Ashdagh Anticline and surrounding structures (modified from [17]). b: Geological map of Ashdagh Anticline. c: Field photo of the southwestern limb of Ashdagh Anticline.

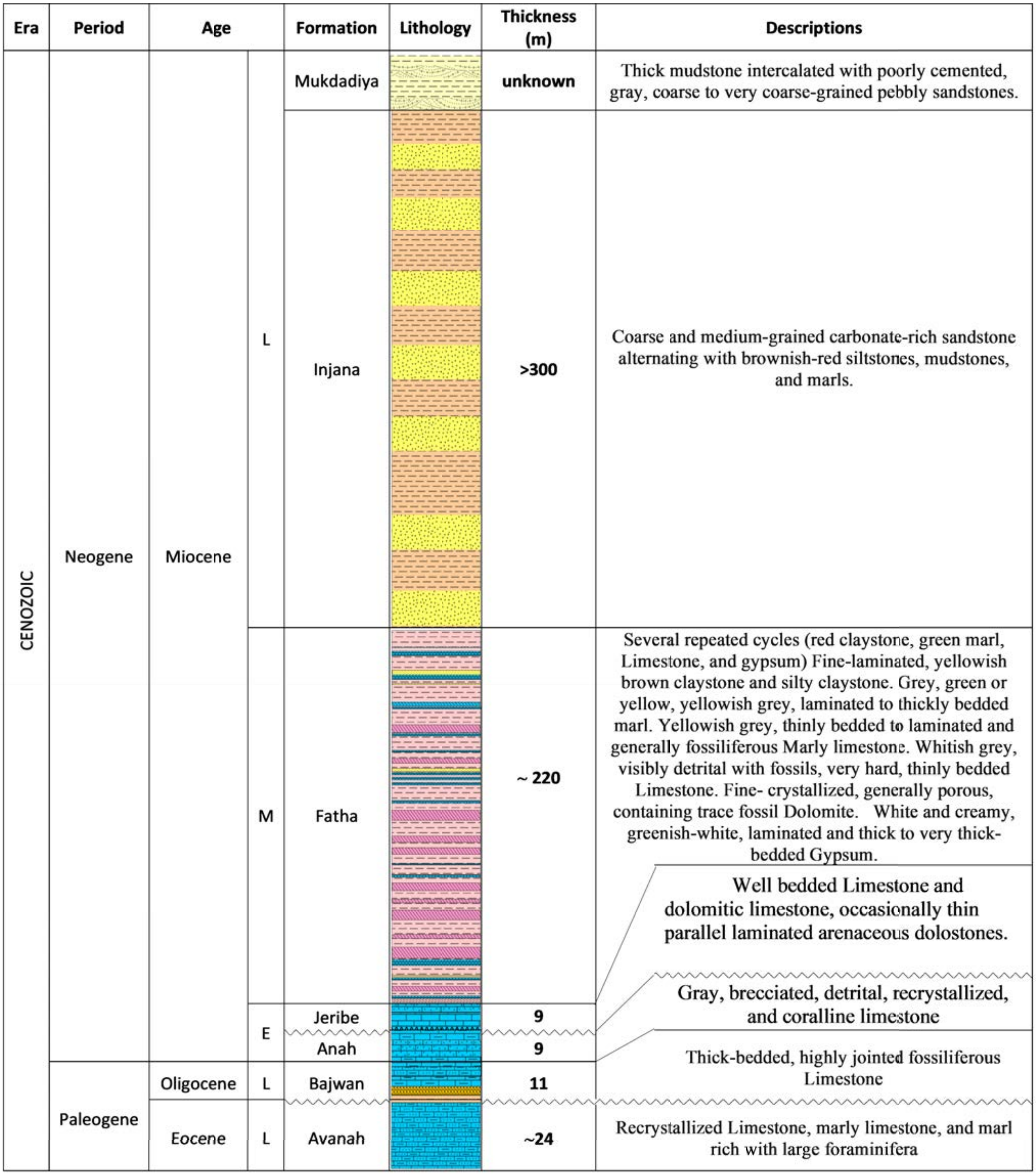


Figure 3. Stratigraphic Column of Ashdagh Anticline.

ing techniques was employed. Structural and stratigraphic data were gathered through extensive fieldwork along eight traverses across the fold axis. Field measurements were plotted on a comprehensive topographic base map at a scale of 1:10,000. A new geological map and structural cross-sections were created utilizing Surfer 14 and ArcMap 10.8, which incorporated Digital Elevation Model (DEM) data alongside field observations. Additionally, eight stereographic projections of the anticline were produced and examined with the aid of Stereonet 11 software. All geological information was thoroughly analyzed, and the parameters related to fold styles were meticulously calculated and interpreted. The new geological map and cross-sections were created at a scale of 1:250,000.

4. Results:

The Sangaw is a major fold structure with NW-SE oriented and double plunged fold axis, which is located near the Zagros Mountain Fold Flexure (MFF) and covers a part of Low Folded Thrust Zone of ZFTB. The Ashdagh anticline, which is a component of the significant Sangaw structure, extends approximately 20 kilometers in length and has a width of around 4 kilometers, with a crest elevation of approximately 1,350 meters.

The hinge line of the Ashdagh Anticline exhibits a convex curvature, oriented toward the foreland in the southeastern and the hinterland in the northwestern. A significant shift in the axial trend and fold geometry corresponds to the intersection of the structure with a system of strike-slip faults. These fault systems play a crucial role in structurally segmenting the anticline.

The structural evolution of the Ashdagh Anticline has been significantly influenced by three thrusts with opposite vergences and parallel to the anticline's hinge line disturbing the geometry of the Ashdagh structure. Two of them are forelimb thrusts (Fore thrusts), while the remainder are back limb thrusts (back thrusts). The first fore thrust, a blind fault with no surface expression, has displaced the main body of the anticline over a small syncline situated between the Ashdagh and Qarawais anticlines. This indicates significant subsurface deformation, which adds to the overall structural intricacy of the area. The second fore thrust is located between the crestal segment and the southwestern limb of the anticline. In the map view, the thrust exhibits either straight or very gently curved traces directed towards the hinterland Figure 4.

The back thrust fault affects the back limb of the structure, which brought the Avanah Formation over the upper part of the Fatha Formation for about 8km lateral length. The SW limb is steeper than the NE limb which makes the vergency of this anticline toward the SW direction. The hinge line is arcuate with the inner ward (hinterland) convex shape. The fold plunged Northwestern near Sangaw township which makes an echelon pattern with Qarawais Anticline, while the southeastern plunge is dissected by the Awa Spi fault, which is indicated as lineament. The anticline on the NE side separated from the Darbandi Bazian- Sagrma- Qaradagh anticline Sangaw Synclines. The Ashdagh Anticline exhibits an asymmetrical cross-sectional geometry characterized by a steeply dipping southwest (SW) forelimb and a foreland-vergent orientation. The SW forelimb is notably shorter and steeper than the northeast (NE) back limb, as observed in cross-sections BB and CC. In several sections (DD, EE, and FF), the anticline assumes a box-shaped geometry with a broad hinge zone. Thrusting activity has significantly influenced the structure, resulting in the exposure of the Avanah Formation and the Kirkuk Group as prominent fault scarps along the forelimb. Near both plunges of the anticline (sections AA and GG), the fold geometry transitions to a more rounded and broader box-shaped form in cross-section Figure 5 & 6.

The geometrical analysis of the Ashdagh Anticline was conducted along eight representative profile traverses using stereographic projection, incorporating 219 bedding plane measurements (RHR) , labeled AA through HH, to capture the variability in fold geometry across the structure Table 1. Each profile was systematically classified according to multiple fold classification schemes, including the Ramsay and Huber classification, Fleuty's classification, Richards' classification [31], and dip direction/dip angle measurements. The results indicate a diverse range of fold styles along the anticline. Sections AA and HH exhibit broad, upright, and symmetrical folds, classified as Class 1A and 1B under Ramsay's scheme, with interlimb angle of approximately 152^o and 160^o, respectively, consistent with Fleuty's designation of upright folds. In contrast, sections BB and CC display tighter, more asymmetrical folds with interlimb angle of 76^o and 68^o, classified as Ramsay Class 2 and Class 1C/2, respectively. These folds are inclined to upright according to Fleuty's classification and reflect steeply dipping axial planes. Intermediate profiles such as DD, EE, and FF show open, upright folds with moderate asymmetry (Class 1B), with interlimb angle ranging from 91^o to 115^o, highlighting gradual changes in fold tightness and symmetry along the structure. Section GG is characterized by a gentle asymmetrical fold with a 142^o axial plane dip, classified as Ramsay Class 1A/B, illustrating a transition between symmetrical and asymmetrical fold forms.

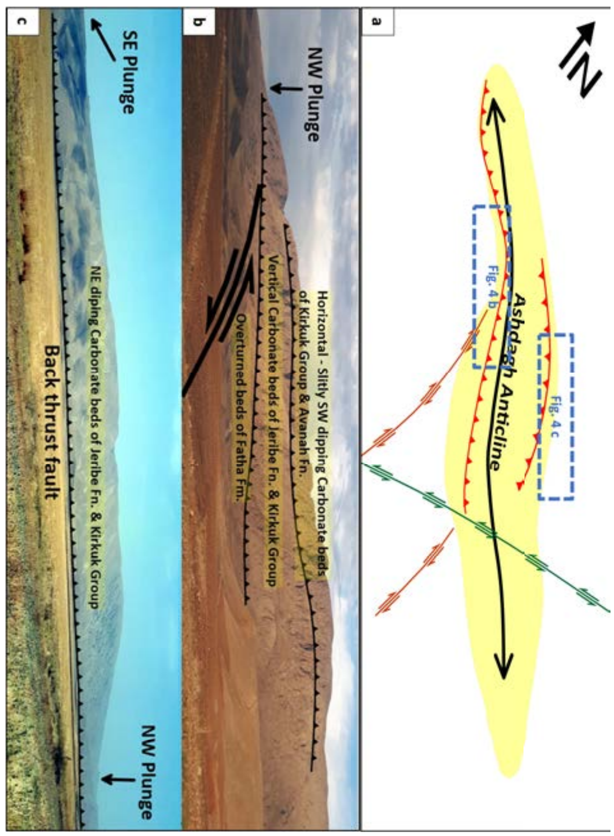


Figure 4. a: Faults across Ashdagh Anticline, b: Field photo of SW limb of Ashdagh Anticline, show the two main front thrust c: Field Photo of NE limb of Ashdagh Anticline.

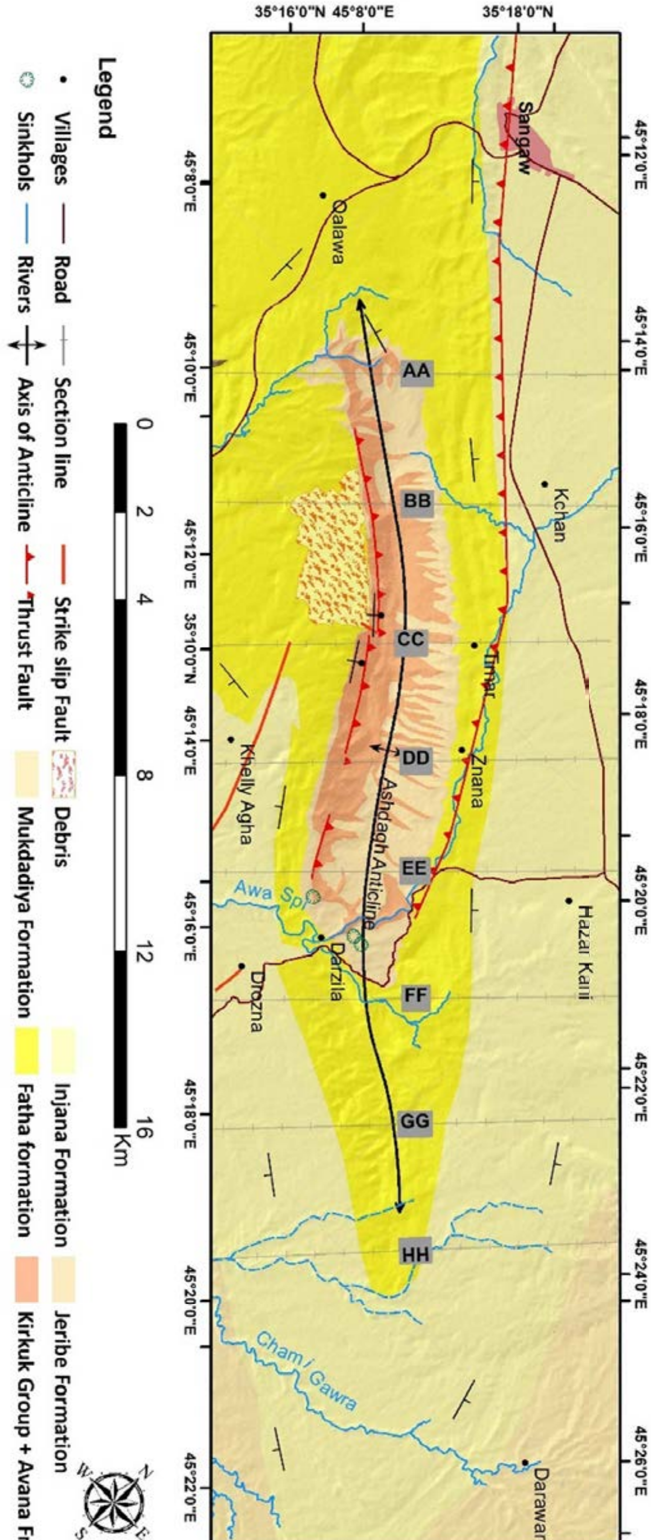


Figure 5. Geological map of the Ashdagh Anticline shows the location of 8 profile sections.

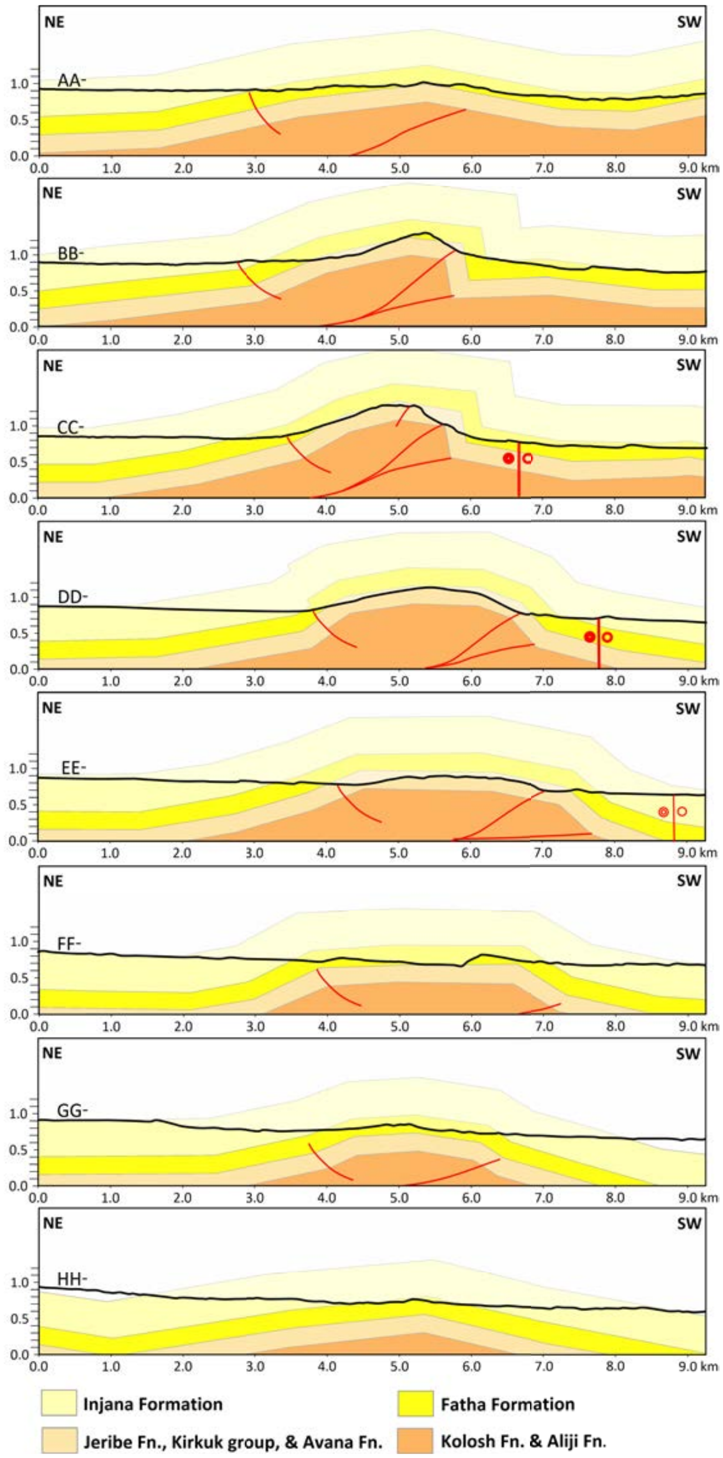
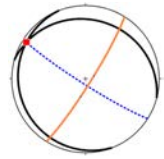
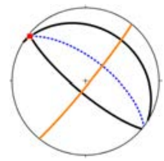
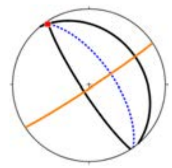
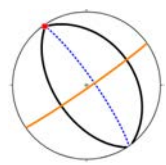
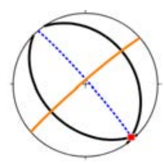
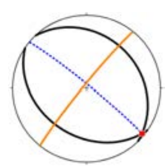
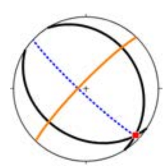
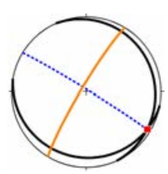


Figure 6. 8 profile sections (AA to HH) normal to the strike of Ashdagh Anticline.

Table 1. Geometrical analysis of Ashdagh Anticline.

AA-	Avg. NE limb Avg. SW limb Axial plane Fold axis Interlimb angle	285/24 159/14 122/84 302/06 152		Asymmetrical, Horizontal – Upright
BB-	Avg. NE limb Avg. SW limb Axial plane Fold axis Interlimb angle	302/27 130/78 307/65 309/04 76		Horizontal – Steeply inclined
CC-	Avg. NE limb Avg. SW limb Axial plane Fold axis Interlimb angle	320/30 147/82 325/64 326/04 68		Horizontal – Steeply inclined
DD-	Avg. NE limb Avg. SW limb Axial plane Fold axis Interlimb angle	322/36 147/57 325/81 325/2 91		Asymmetrical, Horizontal – Upright
EE-	Avg. NE limb Avg. SW limb Axial plane Fold axis Interlimb angle	325/32 134/40 319/86 139/04 108		Asymmetrical, Horizontal – Upright
FF-	Avg. NE limb Avg. SW limb Axial plane Fold axis Interlimb angle	316/28 124/36 309/85 129/04 115		Asymmetrical, Horizontal – Upright
GG-	Avg. NE limb Avg. SW limb Axial plane Fold axis Interlimb angle	328/26 123/33 133/84 134/07 142		Asymmetrical, Horizontal – Upright
HH-	Avg. NE limb Avg. SW limb Axial plane Fold axis Interlimb angle	336/07 120/14 301/87 121/5 160		Asymmetrical, Horizontal – Upright

*The bold black lines are limbs; the blue dotted lines are the axial plane; the small red squares are the fold axis.

5. Conclusion:

The Ashdagh Anticline represents a geologically intricate fold located in the Low Fold-Thrust Zone of the Western Zagros, characterized by complex deformation patterns shaped by various faults and thrusts. It spans roughly 20 kilometers in length and reaches a width of around 4 kilometers. The structure exhibits an asymmetric shape, featuring a steeply inclined southwest (SW) forelimb and a more gradually dipping northeast (NE) backlimb, with interlimb angles that vary from open to gentle. The hinge line exhibits a convex curvature, directed toward the foreland in the southeast and the hinterland in the northwest. The axial surface has a slight dip, varying between southwestward in certain locations and northeastward in others. The anticline is interrupted by both strike-slip and thrust faults, resulting in differences in the geometry of the folds. Variations in stratigraphy, especially the mechanical differences between carbonate and clastic units, have significantly influenced the structural and geomorphological features of the fold. Although there has been considerable oil exploration in the area, the availability of subsurface data is still limited, necessitating the use of conceptual models for geological analysis. The combined application of classification methods and dip measurements reveals a complex fold architecture within the Ashdagh Anticline, which likely reflects variations in local deformation conditions and mechanical stratigraphy.

Funding: None.

Data Availability Statement: All of the data supporting the findings of the presented study are available from corresponding author on request.

Declarations: **Conflict of interest:** The authors declare that they have no conflict of interest.

Ethical approval: This research did not include any human subjects or animals, and as such, it was not necessary to obtain ethical approval.

Author Contributions: Adel O. Abdullah conducted the field data collection, performed the analysis, interpreted the results, wrote the manuscript, and carried out proofreading. Fadhil A. Lawa and Salim Hassan Al-Hakari supervised the research and reviewed the manuscript.

References

[1] S.F. Fouad. Tectonic map of iraq, scale 1:1000 000, 2012. *Iraqi Bulletin of Geology and Mining*, 11(1): 1–7, 2015, doi:10.17656/jzs.10477.

[2] S. Ali, M. Mohajjel, K. Aswad, S. Ismail, S. Buckman, and B. Jones. Tectono-stratigraphy and structure of the northwestern zagros collision zone across the iraq-iran border. *European Association of Geoscientists Engineers*, 2014, doi:10.3997/2214-4609.20143580.

[3] R.I. Koshnaw, D.F. Stockli, and F. Schlunegger. Timing of the arabia-eurasia continental collision—evidence from detrital zircon U-pb geochronology of the red bed series strata of the northwest Zagros hinterland, Kurdistan region of Iraq. *Geology*, 47(1): 47–50, 2019, doi:10.1130/g45499.1.

[4] M. Alavi. Structures of the Zagros fold-thrust belt in Iran. *American Journal of Science*, 307(9): 1064–1095, 2007, doi:10.2475/09.2007.02.

[5] V. Ditmar. Geological conditions hydrocarbon prospects of the republic of iraq (northern central parts), 1971.

[6] M. Abdullah and M. Mutib. A new comprehension of the basement undulation in the north of Iraq resorting to geomagnetic investigation. *Türkiye Jeoloji Bülteni*, 62(3): 275–292, 2019, doi:10.25288/tjb.540954.

[7] R.I. Koshnaw, J. Kley, and F. Schlunegger. The miocene subsidence pattern of the nw Zagros foreland basin reflects the southeastward propagating tear of the neotethys slab. *Solid Earth*, 15(11): 1365–1383, 2024, doi:10.5194/se-15-1365-2024.

[8] S.F. Fouad. Western zagros fold–thrust belt, part I: The low folded zone. *Iraqi Bulletin of Geology and Mining*, 5: 39–62, 2012.

[9] Z. Stevanovic and M. Markovic. Hydrogeology of northern iraq. *Climate, Hydrology, Geomorphology, Geology, Ed. "Field documents", FAO, Erbil*, 1: 130, 2003, doi:10.1007/s10040-008-0331-0.

[10] A.A. Omar, F.A. Lawa, and S.H. Sulaiman. Tectonostratigraphic and structural imprints from balanced sections across the north-western Zagros fold-thrust belt, Kurdistan region, NE Iraq. *Arabian Journal of Geosciences*, 8: 8107–8129, 2015, doi:10.1007/s12517-014-1682-6.

[11] D.S. Mackertich and A.I. Samarrai. History of hydrocarbon exploration in the Kurdistan region of Iraq. *GeoArabia*, 20(2): 181–220, 2015, doi:10.2113/geoarabia2002181.

[12] M.B. Fattah, J.H. Al-Zubaydi, and M.T. Zainy. Structural analysis for slope stability assessment of selected sites at shurshirin valley, zurbatiyah region, eastern Iraq. *The Iraqi Geological Journal*, 290-300, 2023, doi:doi.org/10.46717/igj.56.2f.19ms-2023-12-25.

[13] W.N. Kent. Structures of the kirkuk embayment, northern iraq: foreland structures or zagros fold belt structures? *GeoArabia*, 15(4), 2010, doi:10.2113/geoarabia1504147.

[14] Z. Maleki, M. Arian, and A. Solgi. Structural style and hydrocarbon trap of karbasi anticline, in the interior fars

region, zagros, iran. *Solid Earth Discussions*, 6(2), 2014, doi:10.5194/sed-6-2143-2014.

[15] J.M. English, G.A. Lunn, L. Ferreira, and G. Yacu. Geologic evolution of the iraqi zagros, and its influence on the distribution of hydrocarbons in the kurdistan region. *AAPG Bulletin*, 99(2): 231–272, 2015, doi:10.1306/06271413205.

[16] Kh.A. Ma'ala. Geological map of sulaimaniyah quadrangle, at scale of 1:250 000. *Sulaimani Journal for Pure and Applied Sciences*, 1(1): 151–161, 2016, doi:10.17656/jzs.10477.

[17] A.A. Iurkiewicz and Z.P. Stevanovic. Reconnaissance study of active sulfide springs and cave systems in the southern part of the sulaimani governorate (ne Iraq). *Carbonates and Evaporites*, 25(3), 2010, doi:10.1007/s13146-010-0024-3.

[18] V.K. Sissakian and S.F. Fouad. Geological map of sulaimaniyah quadrangle, scale 1:250 000. *Sulaimani Journal for Pure and Applied Sciences*, 1(1): 151–161, 2016, doi:10.17656/jzs.10477.

[19] S.Z. Jassim and J.C. Goff. *Geology of Iraq*. Dolin, Prague and Moravian Museum, Brno, Printed in the Czech Republic, 1^{st} edition, 2006.

[20] M. Zebari, P. Balling, C. Grützner P. Navabpour, J. Witte, and K. Ustaszewski. Structural style of the nw zagros mountains and the role of basement thrusting for its mountain front flexure, kurdistan region of Iraq. *Journal of Structural Geology*, 141, 2020, doi:10.1016/j.jsg.2020.104206.

[21] S.O.A. Kharajiany. Sedimentary facies of oligocene rock units in ashdagh mountain-sangaw district-kurdistan region-ne Iraq. *Unpublished thesis, College of Science, University of Sulaimani*, 2008.

[22] R.C. Van Bellen, H.V. Dunnington, R. Wetzel, and D.M. Morton. Lexique stratigraphique international. 03 10 asie, (Iraq),. *Reprinted by permission of CNRS by Gulf PetroLink, Bahrain*, 333, 1959-2005, doi:doi.org/10.2113/geoarabia100239.

[23] S.O. Kharajiany. The middle oligocene rock strata (tarjil formation) in ashdagh mountain, sangaw district, sulaimani governorate, kurdistan region, ne Iraq. *Journal of Zankoy Sulaimani-Part A (JZS-A)*, 15(3), 2013, doi:10.17656/jzs.10262.

[24] F.A. Ameen Lawa and A.A. Ghafur. Sequence stratigraphy and biostratigraphy of the prolific late eocene, oligocene and early miocene carbonates from zagros fold-thrust belt in kurdistan region. *Arabian Journal of Geosciences*, 8, 2015, doi:10.1007/s12517-015-1817-4.

[25] R.A. Abdula, M.S. Nour Mohammadi, G.R. Rashed, and N.Q. Saleh. Petrography and microfacies study of jeribe formation (m. miocene) in ashdagh mountain, kurdistan region, Iraq. *Iraqi Bulletin of Geology and Mining Journal*, 13(1), 2017.

[26] F.A. Lawa, B.O. Qader, and A.I. Fattah. Biostratigraphic analysis of the oligocene-early miocene successions from sulaimani area, kurdistan region, Iraq. *The Iraqi Geological Journal*, 53(2D), 2020, doi:10.46717/igj.53.2d.2ms-2020-10-24.

[27] F.A. Ameen, A.I. Fattah, and B.O. Qader. Microfacies and depositional environment of the upper oligocene and lower miocene successions from Iraqi kurdistan region. *Kuwait Journal of Science*, 47(4), 2020.

[28] I.M. Ghafor and P.M. Ahmad. Stratigraphy of the oligocene-early miocene successions, sangaw area, kurdistan region, NE-Iraq. *Arabian Journal of Geosciences*, 14(6), 2011, doi:10.1007/s12517-021-06697-0.

[29] F.A. Lawa, H. Koyi, and A. Ibrahim. Tectonostratigraphic evolution of the nw segment of the zagros fold-thrust belt, kurdistan, NE Iraq. *Journal of Petroleum Geology*, 36(1), 2013, doi:10.1111/jpg.12543.

[30] R.G. Thannoun, H.G.M. Adeeb, and A.S. Al-Jawadi. Extractions morphotectonic features using satellite data processing and dem-derived spatial models. *The Iraqi Geological Journal*, 88-107, 2015, doi:10.46717/igj.55.1a.7ms-2022-01-26.

[31] M. Fleuty. The description of folds. *Proceedings of the Geologists' Association*, 75(4), 1964, doi:10.1016/s0016-7878(64)80023-7.

مؤشرات شكل طية أشداغ المحدبة من حزام طي وتصدع زاكروس الغربية في إقليم كوردستان (شمال العراق)

عادل عمر عبدالله [1*] ، فاضل احمد امين [2] ، سالم حسن سليمان [2]

قسم الجيولوجيا التطبيقية، كلية العلوم، جامعة كركوك، كركوك، [1] العراق.

[2] قسم علوم الارض و النفط، كلية العلوم، جامعة السليمانية، السليمانية، العراق.

[*] الباحث المسؤول: *adilabdalla@uokirkuk.edu.iq*

الخلاصة

تظهر طية أجداغ المحدبة، الواقعة في منطقة الطيات المنخفضة - الدفعية من حزام طيات زاغروس الشمالي الغربي في إقليم كردستان العراق، ،والتى تمتاز بهندسة تركيبية معقدة متأثرة بالتشوهات المرتبطة بالصدوع لدفعية. تستند هذه الدراسة إلى ملاحظات جيولوجية سطحية مفصلة، ومقاطع جيولوجية مرسومة يدويًا، وإسقاطات مجسمة. علاوة على ذلك، استُخدمت بيانات الزلازل تحت السطحية المُفسّرة لإنشاء ثمانية مقاطع عرضية هيكلية تعبر مضرب الطية المحدبة. تُظهر الطية المحدبة عدم تناسق، يتميز بطرف أمامي أكثر انحدارًا، ومنطقة قمة ضيقة، وخط مفصلي ذو انحناء محدب موجه إلى الشمال الغربي نحو المناطق الداخلية والجنوب الشرقي نحو مركز التساقط الأمامي. تُظهر النتيجة الرئيسية أن الاختلافات في هندسة الطيات على طول المضرب ناتجة عن التجزئة الهيكلية الناتجة عن انزلاق باتجاه المضرب او باتجاه صدع الدفع. كما أنه يعزز فهم أسلوب الطي والإطار الهيكلي لمنطقة الدراسة، مما يوفر رؤى قيمة للتطورات التكتونية لمنطقة الطي المنخفض، داخل حزام الطيات في الجزء الشمالي الغربي من حزام طيات زاغروس.

الكلمات الدالة : طية آشداغ، تحليل الهندسي للطيات، حزام طي وتصدع زاكروس الغربي، اقليم كوردستان العراق.

التمويل: لايوجد.

بيان توفر البيانات: جميع البيانات الداعمة لنتائج الدراسة المقدمة يمكن طلبها من المؤلف المسؤول.

اقرارات:

تضارب المصالح: يقر المؤلفون أنه ليس لديهم تضارب في المصالح.

الموافقة الأخلاقية: لم ينضمن هذا البحث اي تجارب على البشر او علي الحيوانات، بالتالي لم يكن من الضروري الحصول على موافقة اخلاقية.