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SURFACE MORPHOLOGY and ACTIVE DEFORMATION OF THE YENİKÖŞK FAULT ZONE, EASTERN LAKE VAN

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Abstract

The 23 October 2011 Mw 7.2 Tabanlı (Van) earthquake represented a critical turning point in understanding the seismotectonic framework of the Van Basin; the unexpected rupture of the Van Fault immediately south of the Yeniköşk Fault revealed the presence of additional contractional structures in the region and underscored the necessity for a detailed morphotectonic analysis of the Yeniköşk Fault. This study examines the morphotectonic characteristics, segment geometry, and deformation behavior of the Yeniköşk Fault within the current compressional tectonic regime by integrating digital elevation models, SWAT profiles, drone imagery, and detailed field observations. Five principal segments—Yeşilköy, Ziyaret, Kireç, Özkaynak, and Çerkezkaya—were identified along the fault trace, each displaying distinct deformation patterns. The presence of well-preserved fault scarps, fault-front depressions, and elevated local relief values, particularly within the Özkaynak and Çerkezkaya segments, indicates that the eastern part portions of the fault accommodate more intense and localized deformation. Topographic profiles acquired both parallel and perpendicular to the fault demonstrate uplift and block tilting associated with thrust faulting, providing evidence for sustained Holocene activity. Collectively, the results show that the Yeniköşk Fault constitutes a key structural component of the contractional regime governing the eastern Lake Van Basin and suggest that the fault possesses significant potential to generate future surface-rupturing earthquakes.

Keywords: Lake Van, Yeniköşk Fault, Morphotectonics, Thrust Fault

1. Introduction

The Eastern Anatolia region constitutes one of the most prominent areas where the compressional tectonics generated by the continental collision between the Arabian and Eurasian plates can be clearly observed (Şengör and Yazıcı, 2020). Following the complete consumption of the last remnant of oceanic lithosphere in Eastern Anatolia during the Late Miocene, the collision that initiated along the Bitlis–Zagros Suture Zone approximately 13 million years ago established the fundamental framework of the region's present-day geodynamic structure (Şengör & Kidd, 1979; Dewey et al., 1986; Şaroğlu & Yılmaz, 1986; Okay et al., 2010). This collision produced intense crustal shortening, crustal thickening, and substantial uplift, resulting in the development of the Eastern Anatolian High Plateau, which has risen by nearly 2 km since the Middle Miocene and continues to undergo active uplift today (Şengör et al., 2008; Yılmaz et al., 1987). The compressional tectonic regime created by this continental collision serves as the primary driver of regional deformation (Şengör and Yazıcı, 2020). Much of the associated shortening is accommodated by the westward extrusion of the Anatolian Plate, which is transferred along the dextral North Anatolian Fault (NAF) and the sinistral East Anatolian Fault (EAF) systems (Şaroğlu & Yılmaz, 1986; Yılmaz et al., 1987). Geodetic measurements indicate that Eastern Anatolia does not behave as a single rigid block; instead, deformation is partitioned among the Lesser Caucasus Tectonic Block, the Turkey–Iran Plateau, and the Central Iran Block (Reilinger et al., 2006; Djamour et al., 2011). Within this broad tectonic framework, the Van region is situated in the transitional zone between the Turkey–Iran Plateau and the Lesser Caucasus Block, and its location renders it highly susceptible to elevated deformation rates and complex tectonic processes (Copley and Jackson, 2006; Reilinger et al., 2006; Djamour et al., 2011). Due to its proximity to numerous active fault zones, Van is one of the most seismically active regions in Türkiye (Emre et al., 2018; AFAD, 2025). Both historical and instrumental earthquake records demonstrate a high level of seismic hazard for the region (Ambraseys, 2009; AFAD, 2025).

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The present-day deformation in the Van region is governed by a complex tectonic environment involving the interplay of thrust faulting with significant strike-slip components, including both right-lateral and left-lateral motions (Özkaymak et al., 2012; Koçyiğit, 2013). In this context, the major active fault systems mapped within the Van Basin and its surroundings (Figure 1) include the Çaldıran Fault, the Van Fault Zone, the Erciş Fault, the Başkale Fault Zone, the Yeniköşk Fault, the Saray Fault Zone, the Dorutay Fault, the Hasantimur Lake Fault, the Southeastern Anatolian Thrust Zone, and the Başkale Fault (Şaroğlu et al., 1992; Özkaymak et al., 2012; Koçyiğit, 2013; Emre et al., 2018; Mutlu, 2025). Throughout both historical and instrumental periods, the Van region has experienced numerous destructive and moderate-to-large earthquakes, confirming that it constitutes one of the most hazardous seismic zones in Eastern Anatolia (Ambraseys, 2009; AFAD, 2025). The 23 October 2011 Mw 7.2 Tabanlı (Van) earthquake represents a critical turning point in understanding the seismotectonic evolution of the Van Basin (Özkaymak et al., 2012; Koçyiğit, 2013; AFAD, 2011). Prior to this event, the fault responsible for the main shock was neither documented in the scientific literature nor shown on active fault maps. Post-earthquake geological and geophysical investigations revealed that the rupture occurred along the Van Fault Zone (Emre et al., 2012; Koçyiğit, 2013; Mackenzie et al., 2016; Emre et al., 2018). To date, four major destructive earthquakes have been recorded in the Van region (AFAD, 2025).

Northwest of Van, the Malazgirt district was heavily affected by the 28 April 1903 M 6.3 earthquake, which resulted in significant loss of life, with 2,803 fatalities and severe damage to approximately 12,000 structures, making it one of the most devastating historical seismic events in the region (Eyidoğan et al., 1991; Bikçe, 2016; Tanış, 2018). The 1930 Salmas earthquake (Ms ≈ 7.6; AFAD, 2025) was another major destructive event, causing total destruction in nearly 60 villages and 40 churches and resulting in 2,514 deaths. The earthquake produced a well-preserved surface rupture with several metres of displacement, offering critical morphotectonic evidence of the active tectonics shaping the region (Tchalenko and Berberian, 1974). The Çaldıran Fault (ÇF), one of the principal active fault systems in Eastern Anatolia, forms the southern boundary of the Lesser Caucasus together with the eastward-continuing North Tabriz Fault (NTF). The ÇF has generated numerous destructive earthquakes throughout historical and instrumental periods, including the 24 November 1976 Mw 7.0 earthquake, which resulted in 3,480 fatalities, 497 injuries, and severe damage to over 9,000 structures (Toksöz et al., 1977; 1978 Erdoğan et al., 1983; Eyidoğan et al., 1991; AFAD, 2025).

Historical chronicles document that the Van Basin has been repeatedly affected by large earthquakes since the Middle Ages (Ambraseys, 2009; Ambraseys & Finkel, 1995). Events such as the AD 1110 Vaspurakan earthquake, the 1208 and 1246 Ahlat earthquakes, the 1276 Ahlat–Erciş earthquake, the 1646 Van earthquake, the 1881 Teğut event, and the 1896 Van earthquake all demonstrate the persistent seismicity and long-term deformation affecting the basin. These earthquakes produced widespread destruction, secondary effects such as abnormal lake waves, ground fissures, landslides, and significant changes in settlement patterns, highlighting the long-term tectonic activity governing the region. The 2011 Mw 7.2 Van earthquake further revealed the existence and activity of the previously unmapped Van Fault, which dips northward and caused uplift of the Erciş Block, resulting in severe structural damage. The unexpected emergence of this fault underscored the necessity of detailed investigations of other active structures within the Van Basin (Özkaymak et al., 2012; Koçyiğit, 2013). Among these structures, the Yeniköşk Fault, located approximately 5 km parallel to the Van Fault, plays a critical role in the neotectonic evolution of the region (Emre et al., 2012; Akköprü, 2018; Emre et al., 2018). Given its southeast -dipping thrust geometry, a future rupture on the Yeniköşk Fault would be expected to deform and uplift the Van Block, similar to how the Van Fault uplifted the Erciş Block in 2011. This highlights the importance of the Yeniköşk Fault for seismic hazard assessment and regional deformation models.

The primary aim of this study is to characterize the morphotectonic features and geometric segmentation of the Yeniköşk Fault (Figure 1) and to evaluate its role within the Eastern Anatolian compressional regime and its potential contribution to future seismic hazard. Identifying the morphological traces of the fault, segment boundaries, and possible rupture behaviors will help clarify the active tectonic architecture of the Van Basin and contribute to distinguishing fault systems that may rupture independently or in conjunction with the Van Fault.

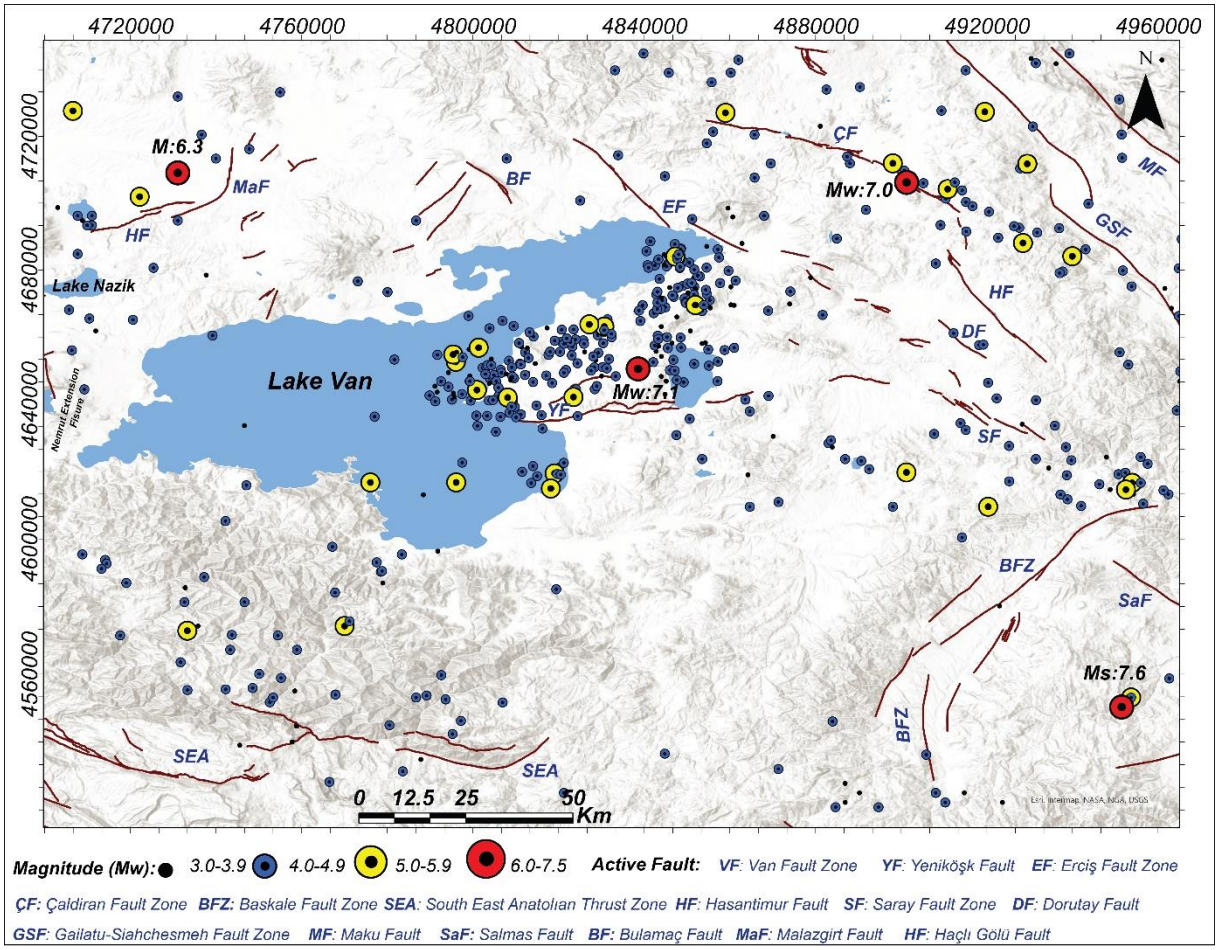

Figure 1. Active faults and instrumental-period earthquakes of Van Province and its surroundings (Fault data modified from Emre et al. (2012; 2018); instrumental earthquake catalogue compiled from AFAD (2025)).

2. Material and Methods

In this study, a multi-source dataset and an integrated analytical framework were employed to delineate the morphotectonic characteristics and geometric segmentation of the Yeniköşk Fault. Digital Elevation Models (DEM), field observations, drone-based visual data, and SWAT-derived topographic profile analyses were jointly evaluated to identify the surface morphology, changes in fault strike, segment boundaries, and tectonic relief features along the fault zone. The DEM, which forms the primary basis of the study, was generated from 5-m-resolution contour data to characterize the morphological elements of the regional topography. DEM-derived products—including profiles—were analyzed to map lineaments, fault scarps, tectonic ridges, and uplift–subsidence domains associated with deformation along the fault. These analyses enabled the classification of morphological discontinuities on a segment-by-segment basis. To further examine the surface morphology of the fault zone, SWAT-based (Topography) topographic profile analyses were applied. This approach was used to identify slope breaks, uplifted block surfaces, and transitional stress zones between adjacent segments. The SWAT profiles were interpreted in conjunction with longitudinal, cross-sectional, and slope–length profiles extracted from the DEM, allowing for a quantitative assessment of the morphotectonic evolution and segmental behavior of the Yeniköşk Fault.

All datasets were compiled within a GIS environment (ArcGIS Pro), where the variations in segment strike, slope relationships, morphotectonic classifications, and geomorphic indicators were analytically compared. This integrated approach enabled characterization of the morphotectonic attributes of the Yeniköşk Fault and allowed for the scientific definition of all fault segments with improved accuracy.

3. Results and Discussion

The Yeniköşk Fault is a tectonic structure extending from the vicinity of Yeşilköy in the northern part of Van Province to the village of Kasımoğlu in the east (Emre et al., 2012; Akköprü, 2018) (Figure 2). The fault was first delineated in detail within the scope of the Active Fault Map of Türkiye by Emre et al. (2012), and it holds a significant position within the active neotectonic framework of the region. With an approximate length of 14 km, the Yeniköşk Fault represents a southeast-dipping thrust fault zone and constitutes one of the principal surface expressions of the compressional regime affecting the eastern margin of Lake Van. The fault extends parallel to both the Van Fault and the Karasu River throughout its mapped trace (Figure 2). The morphotectonic map presented in Figure 2 demonstrates that the surface topography of the study area is strongly controlled by active tectonic processes. The region comprises two principal morphological domains: a high-relief mountainous terrain to the south and a lower-relief plateau–valley system to the north. The southern block forms a prominent uplift zone characterized by steep slopes, abrupt topographic gradients, and peaks such as Çingene, Ziyaret, Meşe, and Ami, which reach elevations of 2000–2200 m. In contrast, the northern sector along the Karasu Valley exhibits low-gradient, broad valley floors and extensive erosional surfaces, reflecting a markedly subdued geomorphic expression. The boundary between these contrasting morphological units corresponds to a distinct tectonic lineament shaped by the Yeniköşk Fault, which delineates zones of uplift and subsidence and represents the dominant structural element governing landscape evolution within the area. The Yeniköşk Fault, clearly depicted on the map, exerts systematic control on surface morphology along its trace. Elevated, high-relief uplifted blocks occur to the south of the fault, whereas comparatively lowered and erosionally modified topography characterizes the northern block. Figure 2 further reveals that the Yeniköşk Fault operates in conjunction with the parallel Van Fault to organize the regional compressional regime into two major thrust belts. While the Van Fault governs the development of the higher mountain ranges to the south, the Yeniköşk Fault defines a secondary thrust zone farther north, indicating that crustal shortening in the eastern Lake Van region is partitioned between these two active fault systems. This structural arrangement highlights that the eastern margin of Lake Van is shaped by a complex, multi-strand thrust system operating within an active compressional tectonic environment.

In this study, the Yeniköşk Fault was subdivided into five subsegments based on variations in strike and distinctive morphological indicators observed along its surface trace. From west to east, these subsegments are defined as: (i) the Yeşilköy Segment, (ii) the Ziyaret Segment, (iii) the Kireç Segment, (iv) the Özkaynak Segment, and (v) the Çerkezkaya Segment (Figure 3).

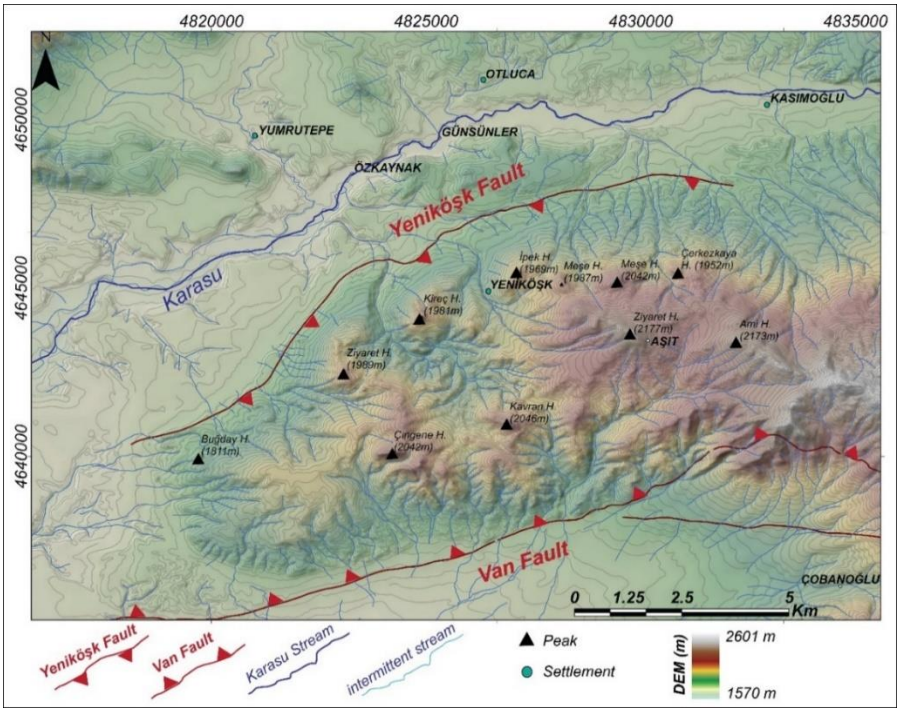

Figure 2. Morphology map of the Yeniköşk Fault and its surrounding area. Fault traces are modified from Emre et al. (2018).

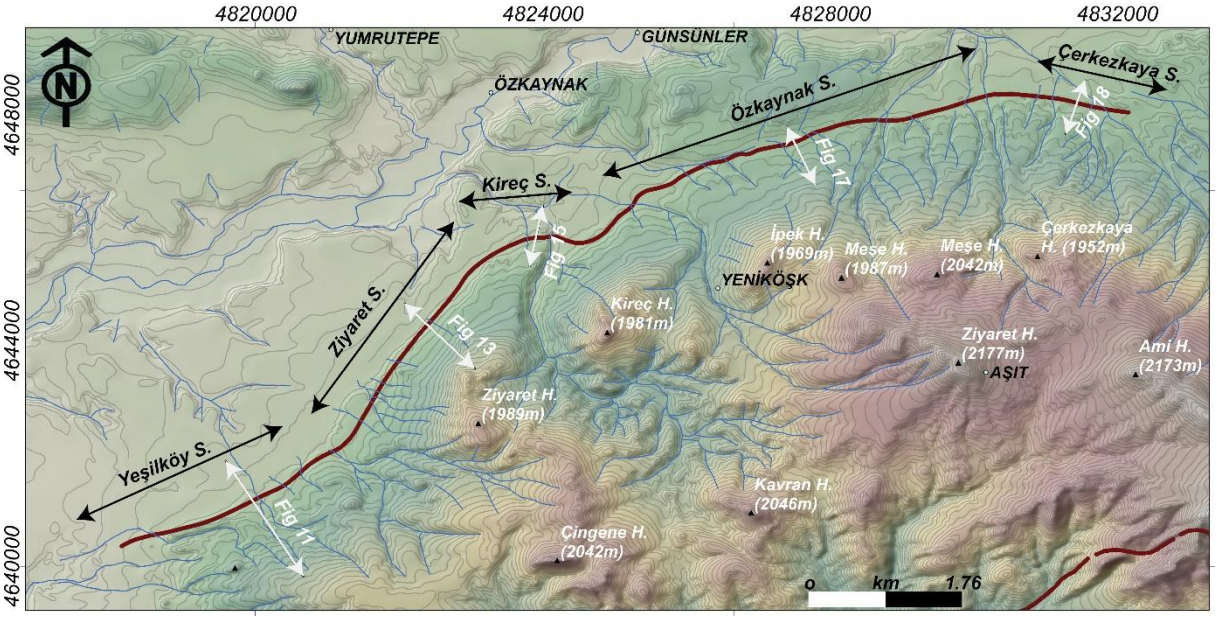

Figure 3. Topographic expression of the subsegments of the Yeniköşk Fault.

The detailed geological map presented in Figure 4 reveals a strong relationship between lithological heterogeneity and active tectonic deformation along the Yeniköşk Fault. This lithological diversity indicates that the fault zone has undergone a long-lived and multi-phase tectonic evolution. In the southern part of the fault zone, Upper Oligocene–Lower Miocene sandstone–mudstone–limestone alternations and Eocene carbonate units are widely exposed. These mechanically competent lithologies have accommodated significant deformation, resulting in pronounced topographic expressions along the fault trace. In contrast, younger Pliocene and Quaternary deposits dominate the northern block of the Yeniköşk Fault and are characterized by broad valleys and low-relief geomorphic surfaces. This lithological contrast plays a key role in controlling the morphological asymmetry observed between the northern and southern fault blocks. The occurrence of Upper Cretaceous mélange and associated volcanic–sedimentary rock assemblages in the mapped area reflects a geological history marked by oceanic closure processes and high-pressure tectonic environments. The map further illustrates that the Yeniköşk Fault, together with the parallel Van Fault, organizes the regional compressional regime into two distinct thrust zones. While the Van Fault controls the development of high-relief mountain ranges to the south, the Yeniköşk Fault defines a secondary thrust belt to the north, indicating that crustal shortening in the eastern Lake Van Basin is partitioned between these two major structures. This structural configuration highlights the active tectonic architecture of the region as a complex, multi-strand thrust system.

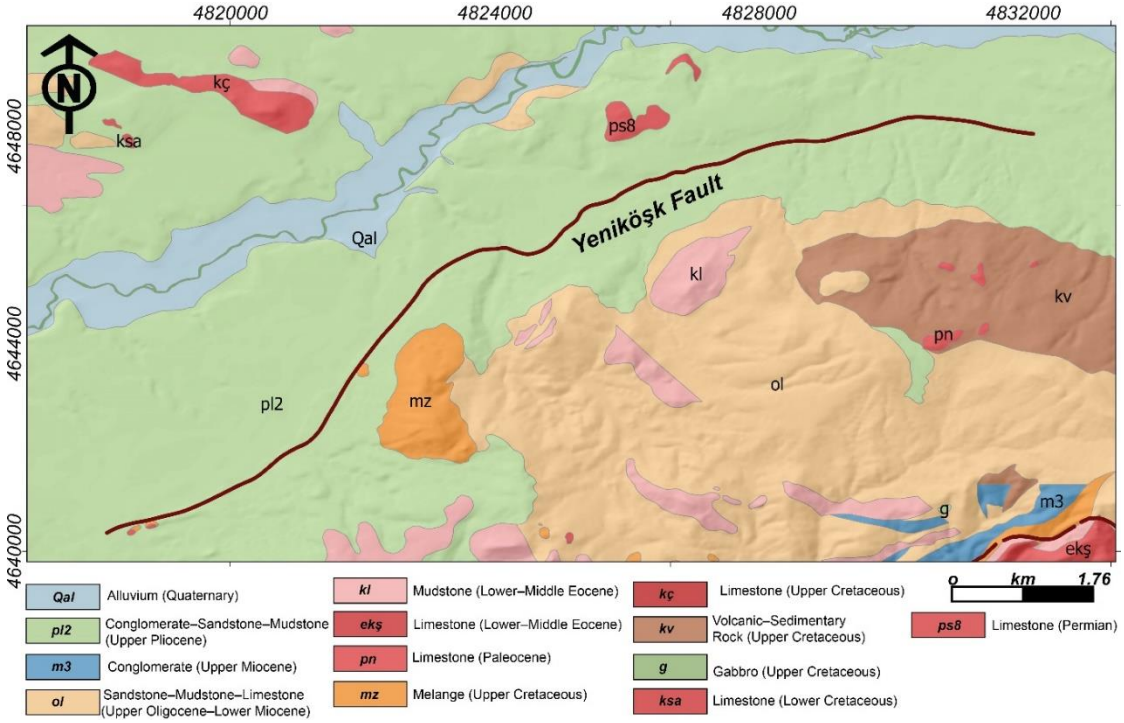

Figure 4. Geological map of the study area (modified from Ateş et al., 2007; MTA, 2011).

The five morphotectonic segments identified along the Yeniköşk Fault exhibit distinct structural variations based on changes in fault strike (Figure 3). Topographic profiles parallel to each of these geometric segments were extracted for detailed analysis. The Yeşilköy Segment, which follows the fault trace from west to east, exhibits a general E–NE orientation with an azimuth of approximately 060°–070°. The SWATH profile obtained along this segment illustrates a topographic pattern extending for about 2,9 km from the southwest toward the northeast (Figure 4). Elevation values begin at approximately 1709 m at the western end of the segment and increase steadily eastward, reaching nearly 1767 m (Figure 5). Two prominent topographic highs occur in the central part of the segment; these features may represent surface expressions of heterogeneous displacement along the thrust plane or secondary fault/fold structures that developed parallel to the main fault zone.

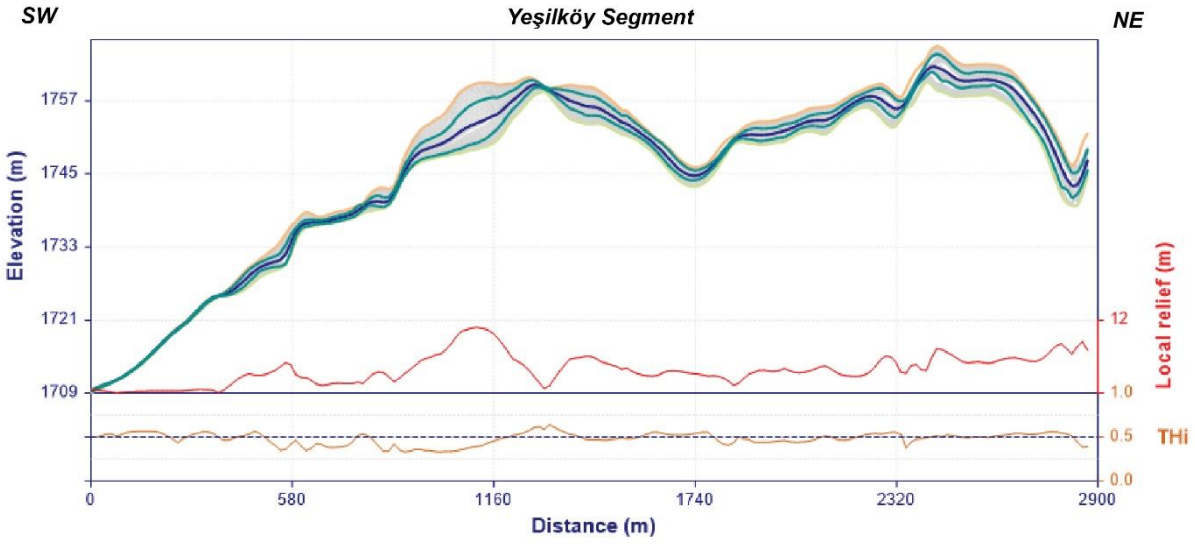

Figure 5. Topographic profile extracted parallel to the Yeşilköy Segment.

The Ziyaret Segment, which follows the Yeşilköy Segment to the east, displays a pronounced NE orientation and extends along an azimuth of 040°–050°. The SWATH profile extracted along this segment reveals a distinct morphotectonic organization extending for approximately 3.2 km in a SW–NE direction (Figure 6). At the beginning of the profile (0–600 m), elevation values vary only slightly between 1747 and 1754 m, indicating a relatively stable topographic character with low relief. However, between 1200 and 1500 m, elevations rise sharply to 1768–1775 m, forming a well-defined topographic high. From the central portion of the segment toward the eastern end, the topography exhibits rhythmic undulations up to approximately 2600 m along the profile. These systematic oscillations reflect the presence of tectonically controlled uplift–subsidence sequences expressed at the surface.

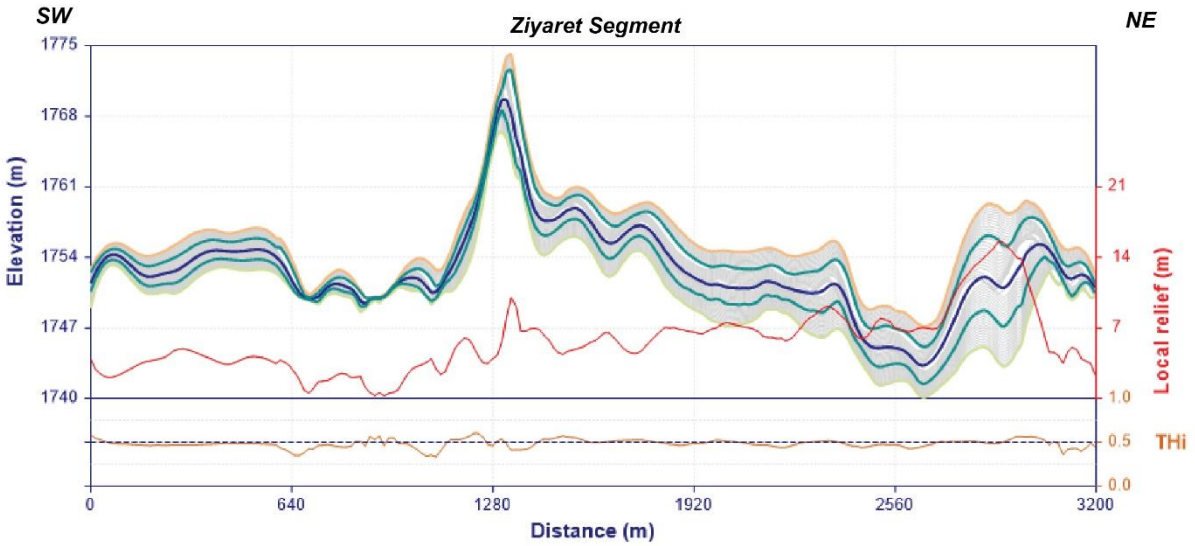

Figure 6. Topographic profile extracted parallel to the Ziyaret Segment.

The Kireç Segment, located in the central part of the fault, exhibits an approximately east–west orientation with an azimuth of 080°–090° (Figure 7). The topographic profile extracted along this segment reveals a characteristic morphotectonic structure extending for approximately 1100 m in a W–E direction. In the western portion of the profile, the topography displays a relatively stable plateau-like surface with elevations between 1744 and 1753 m. The absence of significant relief in this area suggests that tectonic influences in the western end of the segment are weak or secondary. A deeply incised valley formed by the Kireçlik Stream occupies the central part of the profile between approximately 440 and 660 m This depression indicates that the topographic gradient along the segment has been effectively modified by fluvial incision. The sharply defined valley floor morphology implies that the surface has been uplifted and tilted under tectonic control rather than solely by lithological or erosional factors, prompting the stream to rapidly incise and shape its channel in response (Figure 7).

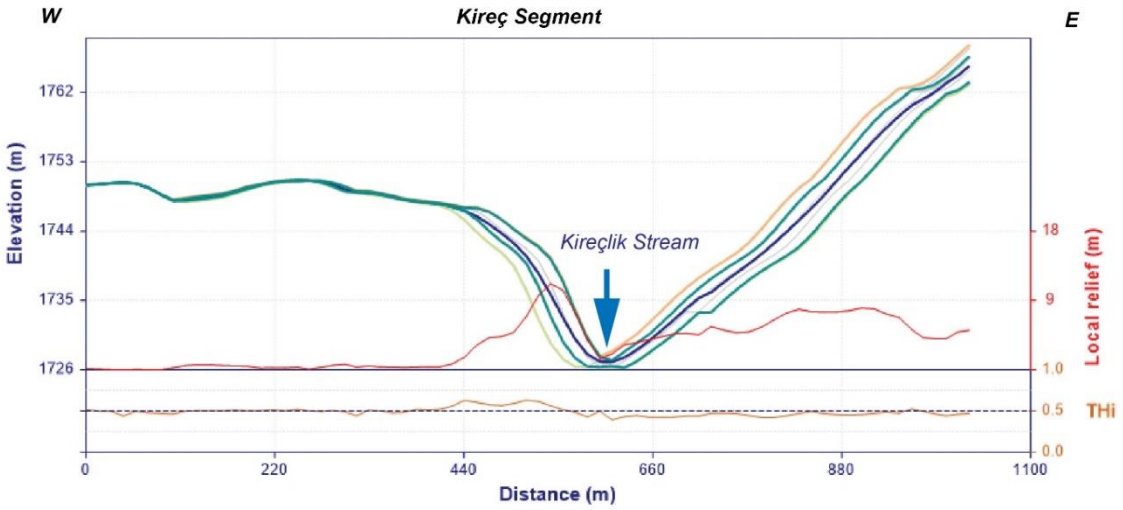

Figure 7. Topographic profile extracted parallel to the Kireç Segment.

The Özkaynak Segment exhibits an ENE orientation with an azimuth ranging from 070° to 080°. The SWATH topographic profile extracted along this segment reveals a complex surface morphology extending for approximately 5.1 km in a SW–NE direction, characterized by pronounced tectonic and morphological heterogeneity (Figure 8). At the beginning of the profile (0–1000 m), the topography displays minor fluctuations between 1764 and 1770 m, indicating relatively subdued relief. Between 1000 and 2000 m, the profile shows a well-defined depression zone, where elevations decrease to approximately 1746 m. This localized negative topographic area suggests that fluvial incision has intensified in response to tectonic tilting, producing a surface expression of differential uplift along the segment. From 2000 to 3000 m, the profile corresponds to a prominent structural uplift zone, marked by a sharp increase in elevation to 1768–1772 m over a short distance. This abrupt rise likely reflects the presence of an active thrust-related fold, a positive flower structure, or uplifted blocks developing along or adjacent to the fault plane of the Özkaynak Segment. The 3000–4200 m portion of the profile is characterized by high-frequency uplift–subsidence sequences, indicating a zone of intense deformation and structural irregularity along the segment (Figure 8).

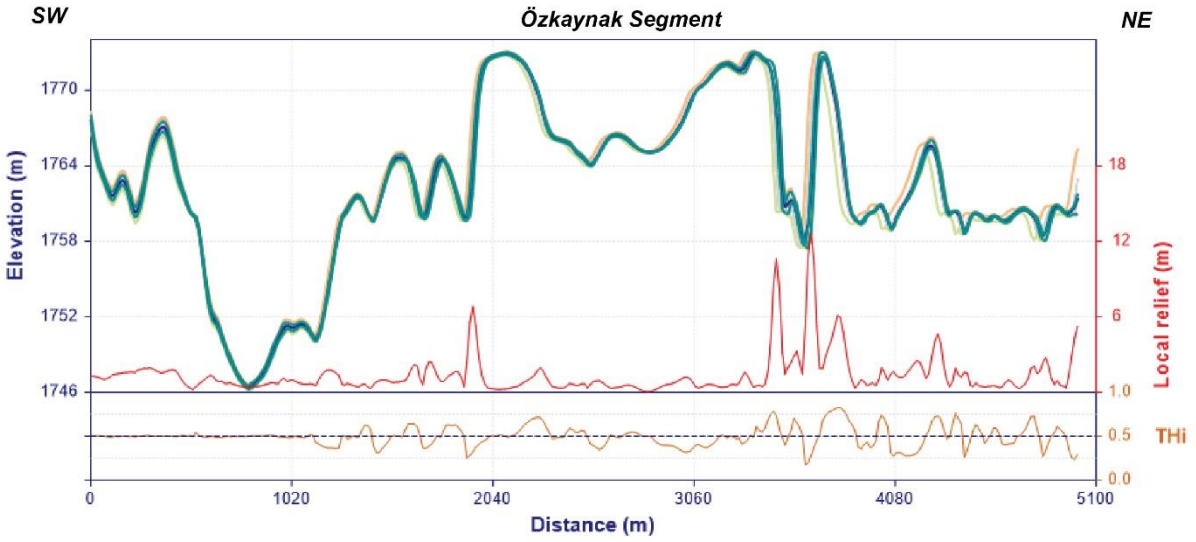

Figure 8. Topographic profile extracted parallel to the Özkaynak Segment.

The Çerkezkaya Segment, located at the easternmost part of the fault, exhibits a W–NW orientation and extends along an azimuth of 280°–300°. The SWATH topographic profile obtained along this segment reveals a highly rhythmic and multi-crested morphotectonic structure extending for approximately 1.4 km in a NW–SE direction (Figure 9). At the northwestern end of the profile, elevation values begin around 1765–1769 m and fluctuate over short distances, forming pronounced topographic highs and depressions. Along the profile, three major uplifted highs (ridges) and two intervening depressions (valleys) are observed. This alternating sequence of uplift and subsidence indicates the presence of multiple deformation zones within the segment and demonstrates that deformation is not confined to a single primary fault plane.

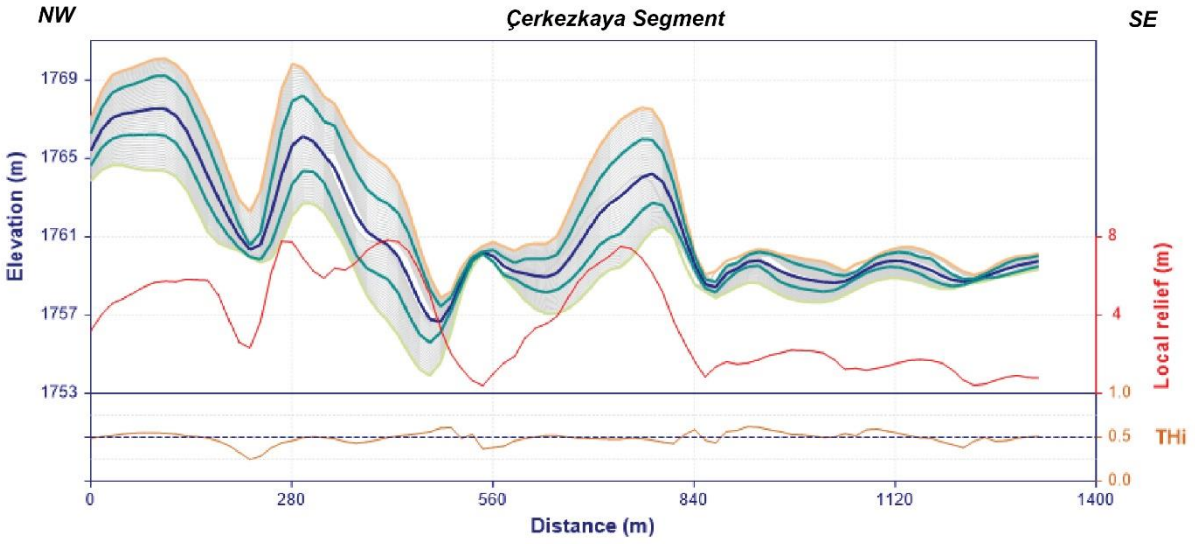

Figure 9. Topographic profile extracted parallel to the Çerkezkaya Segment.

The topographic profile extracted perpendicular to the Yeşilköy Segment (Figure 10) clearly reveals the tectonic surface morphology of the western portion of the Yeniköşk Fault Zone. Elevation values along the profile start at approximately 1860 m and systematically decrease across the segment, indicating the development of a tectonically controlled morphological tilt (tilted block) (Figure 11). The prominent slope break (fault scarp) marked on the profile represents the surface expression of tectonic deformation associated with the Yeşilköy Segment. This scarp is characteristic of southward-directed surface tilting commonly observed in thrust fault systems. The distinct break in slope, occurring at elevations of approximately 1740–1750 m, is interpreted as the surface manifestation of repeated faulting events during the Holocene–Late Quaternary period (Figure 11).

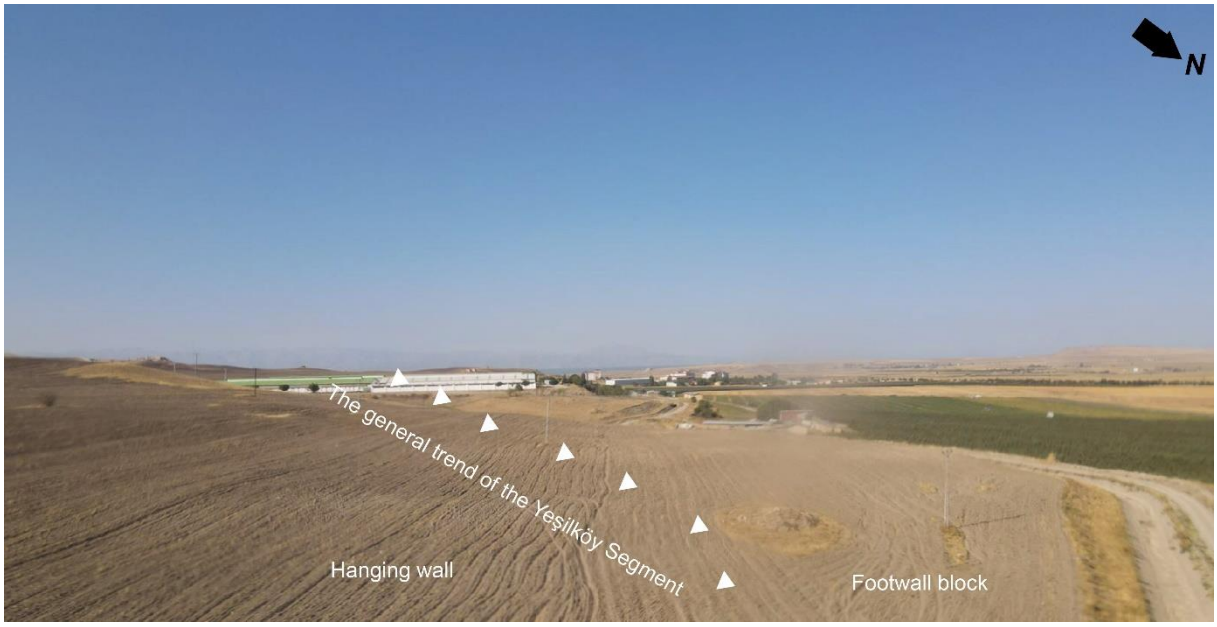

Figure 10. Drone imagery showing the general trend of the Yeşilköy Segment.

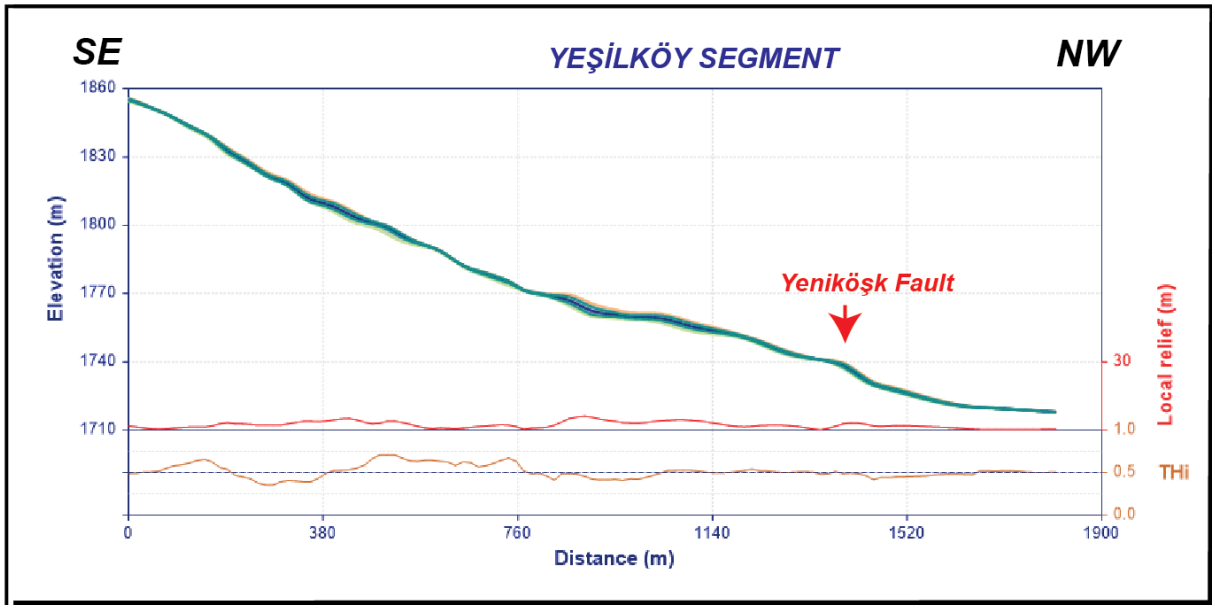

Figure 11. Cross-sectional topographic profile extracted perpendicular to the Yeşilköy Segment.

The topographic profile extracted perpendicular to the Ziyaret Segment (Figure 12) clearly demonstrates that surface deformation in this part of the Yeniköşk Fault Zone is pronounced and strongly controlled by tectonic processes. Elevation values along the profile start at approximately 1930 m and systematically decrease from the southeast toward the northwest, indicating the development of a unidirectional and continuous tectonic tilt (tilted surface). This tilting pattern is fully consistent with the southeast-dipping thrust geometry that characterizes the Ziyaret Segment (Figure 13). The fault scarp identified along the profile represents the most distinct morphological evidence of surface faulting within this segment. The sharp break in slope observed at elevations of approximately 1730–1740 m indicates that the fault has reached the surface during the most recent geological period, most likely during the Holocene, and reflects youthful morphotectonic activity. The clarity and sharpness of this scarp further suggest relatively high deformation rates operating along the Ziyaret Segment (Figure 13).

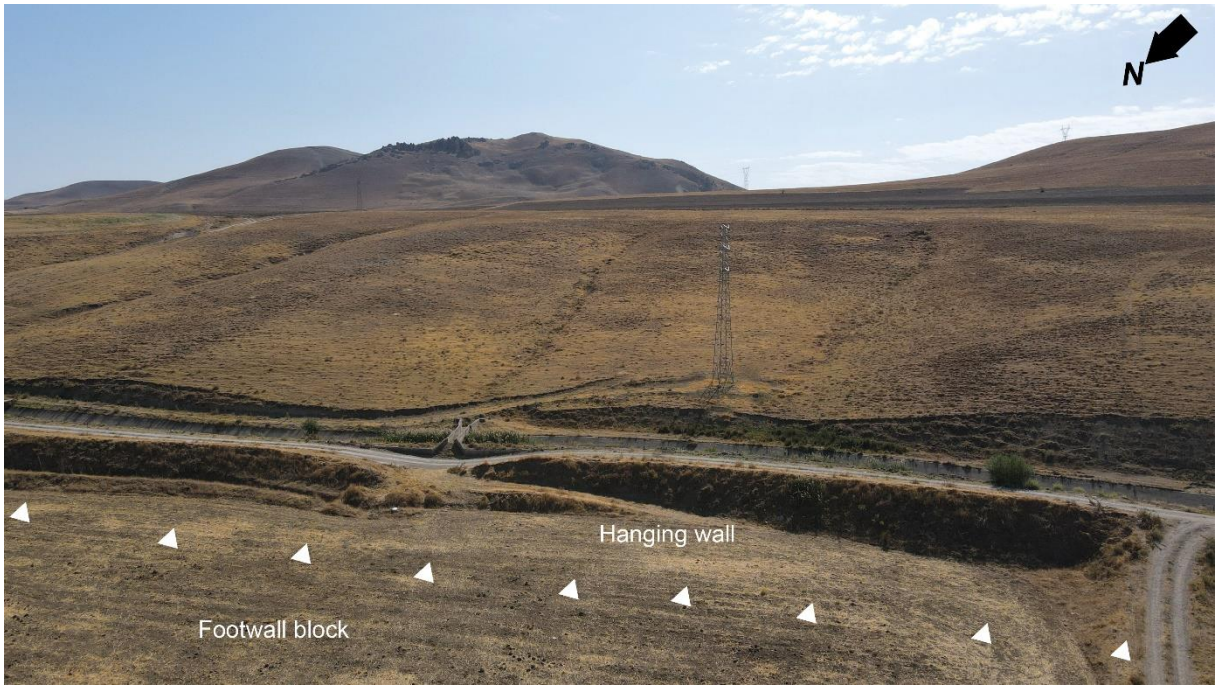

Figure 12. Drone imagery showing the fault scarp of the Ziyaret Segment.

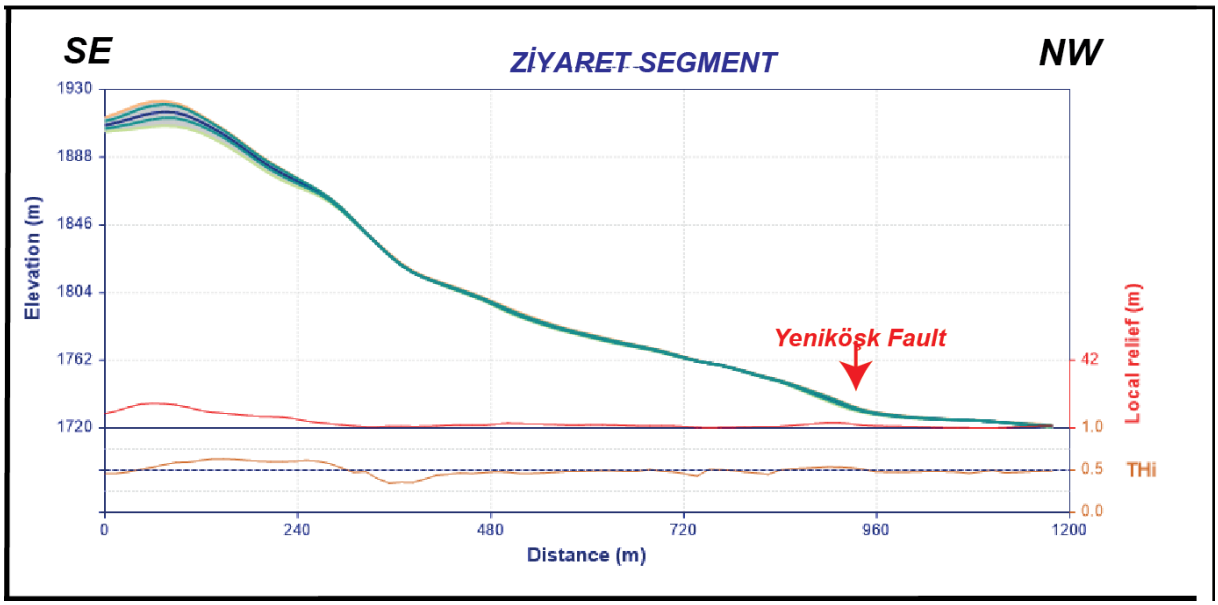

Figure 13. Cross-sectional topographic profile extracted perpendicular to the Ziyaret Segment.

The topographic profile extracted perpendicular to the Kireç Segment (Figure 14) reveals that the morphology of this part of the Yeniköşk Fault Zone is distinctly tectonically controlled and exhibits an asymmetric surface configuration. Elevation values along the profile begin at approximately 1769 m and consistently decrease northward, indicating the presence of a monoclinal fold or a tectonically tilted block geometry (Figure 15).

The fault scarp identified on the profile represents the most prominent morphological evidence of surface deformation along the segment. The sharp break in slope observed at an elevation of approximately 1732 m has produced a fault-front bench extending for nearly 43 m.

This abrupt change in gradient clearly marks the location of the scarp and strongly supports the occurrence of a young surface-rupturing event—likely during the Holocene—along the Kireç Segment. The geometry of the scarp further indicates a southeast-dipping thrust structure consistent with the overall tectonic setting of the segment.

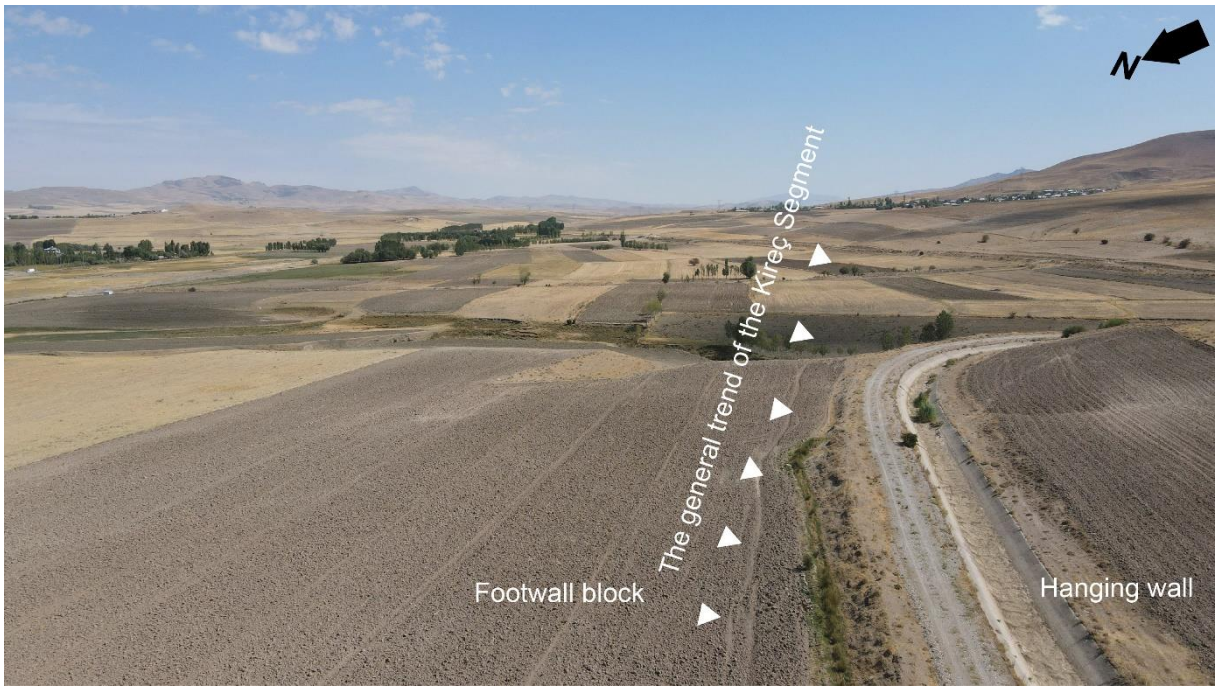

Figure 14. Drone imagery showing the surface expression of the Kireç Segment.

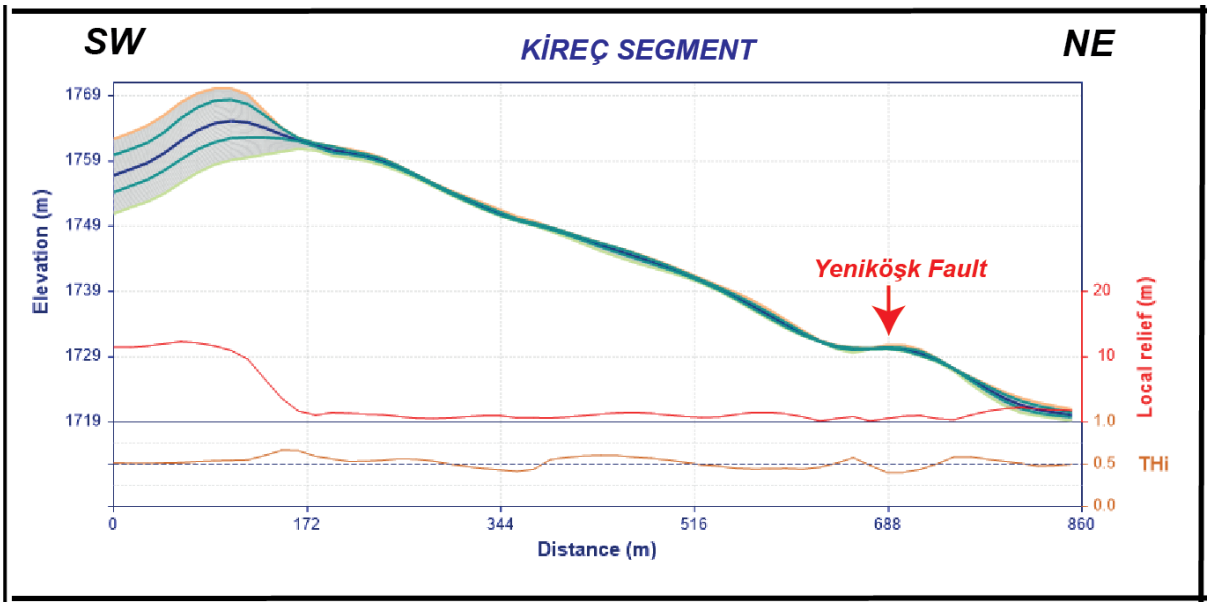

Figure 15. Cross-sectional topographic profile extracted perpendicular to the Kireç Segment.

The Özkaynak Segment exhibits a distinctly expressed thrust morphology at the surface, displaying morphotectonic features such as a sharp fault scarp and a fault-front (hanging-wall) depression, as clearly shown in Figure 16. The south-dipping geometry of the segment, together with the mechanical break formed by the fault at the surface, indicates that the hanging wall is positioned at relatively higher elevations. The linear and sharply defined continuity of the scarp demonstrates that the Özkaynak Segment preserves a well-developed, youthful surface morphology characteristic of an active thrust fault (Figure 16).

Figure 16. Drone imagery showing the surface expression of the Özkaynak Segment.

The cross-sectional topographic profile obtained along the Özkaynak Segment clearly reveals the characteristic vertical deformation components produced at the surface by a thrust fault. The overall behavior of the profile demonstrates that the segment is shaped by active tectonic processes and preserves a well-defined morphotectonic signature (Figure 17). The abrupt decrease in slope observed between approximately 340 and 700 m, followed by a sharp depression, is interpreted as a prominent fault scarp generated by the surface expression of the Yeniköşk Fault. The rapid descent of the profile toward the footwall after the scarp is consistent with the asymmetric topography typically associated with thrust fault systems.

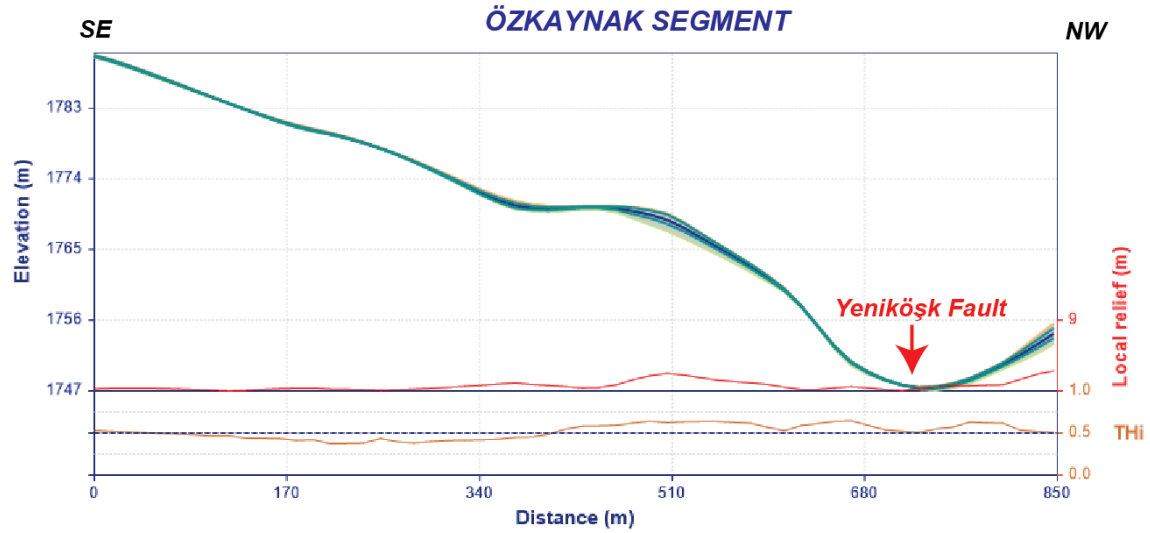

Figure 17. Cross-sectional topographic profile extracted perpendicular to the Özkaynak Segment.

The cross-sectional topographic profile obtained along the Çerkezkaya Segment clearly illustrates the deformation characteristics at the easternmost end of the Yeniköşk Fault Zone (Figure 18). A distinct topographic break (fault scarp) is observed between approximately 600 and 650 m along the profile. This sharp morphological expression indicates relative uplift of the hanging wall and corresponding subsidence of the footwall (Figure 18). The abrupt and well-defined geometry of the scarp suggests that the surface deformation is geologically young and has not yet been significantly modified by erosional processes. Immediately in front of the scarp, a small bowl-shaped topographic depression is observed within the hanging wall. This feature indicates that the segment hosts a complex deformation zone that produces not only uplift but also localized subsidence (Figure 18).

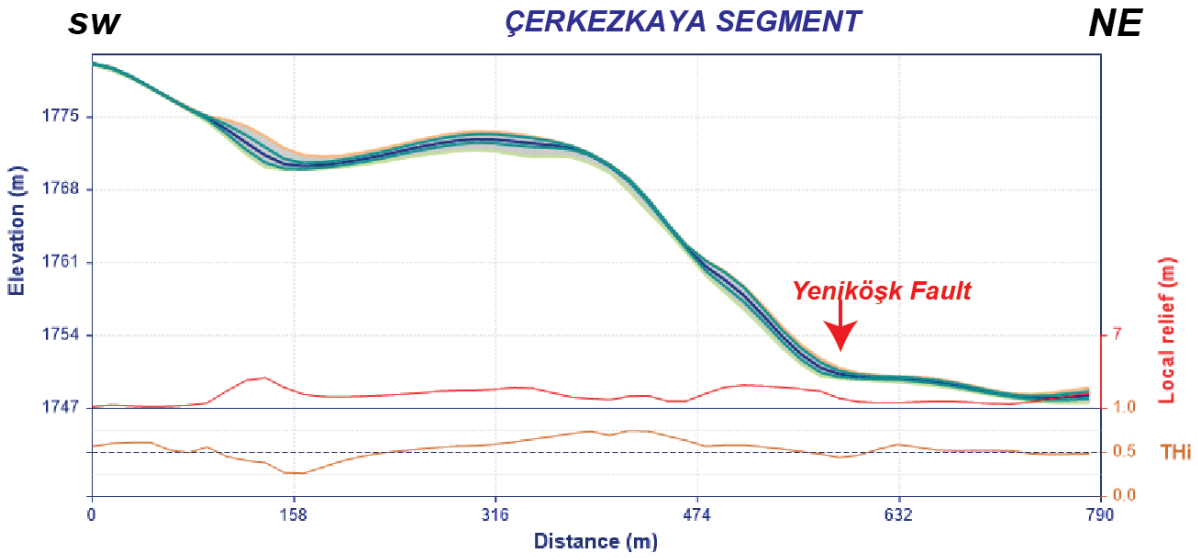

Figure 18 Cross-sectional topographic profile extracted perpendicular to the Çerkezkaya Segment.

The SWAT profiles obtained from the northern and southern sections of the Yeniköşk Fault Zone reveal clear morphological differentiation and the spatial distribution of tectonic deformation at the segment scale (Figure 19). The topographic profile from the northern section displays relatively smooth and low-amplitude morphological oscillations.

The main geomorphic and tectonic observations derived from this profile indicate that: (i) elevation changes along the profile are moderate in magnitude and continuous, with limited abrupt drops or sharp rises; and (ii) this pattern suggests a more rigid block behavior and a more coherent structural geometry within the northern segment. In contrast, the southern segment exhibits a markedly more complex topographic character compared with the northern section, reflecting a region subjected to more intense tectonic modification. The elevation profile contains numerous abrupt depressions, topographic highs, and bowl-shaped features. In particular, the deep V-shaped incisions observed near the central portions of the segment reflect rapid uplift and subsidence processes occurring in proximity to the active thrust surface (Figure 19).

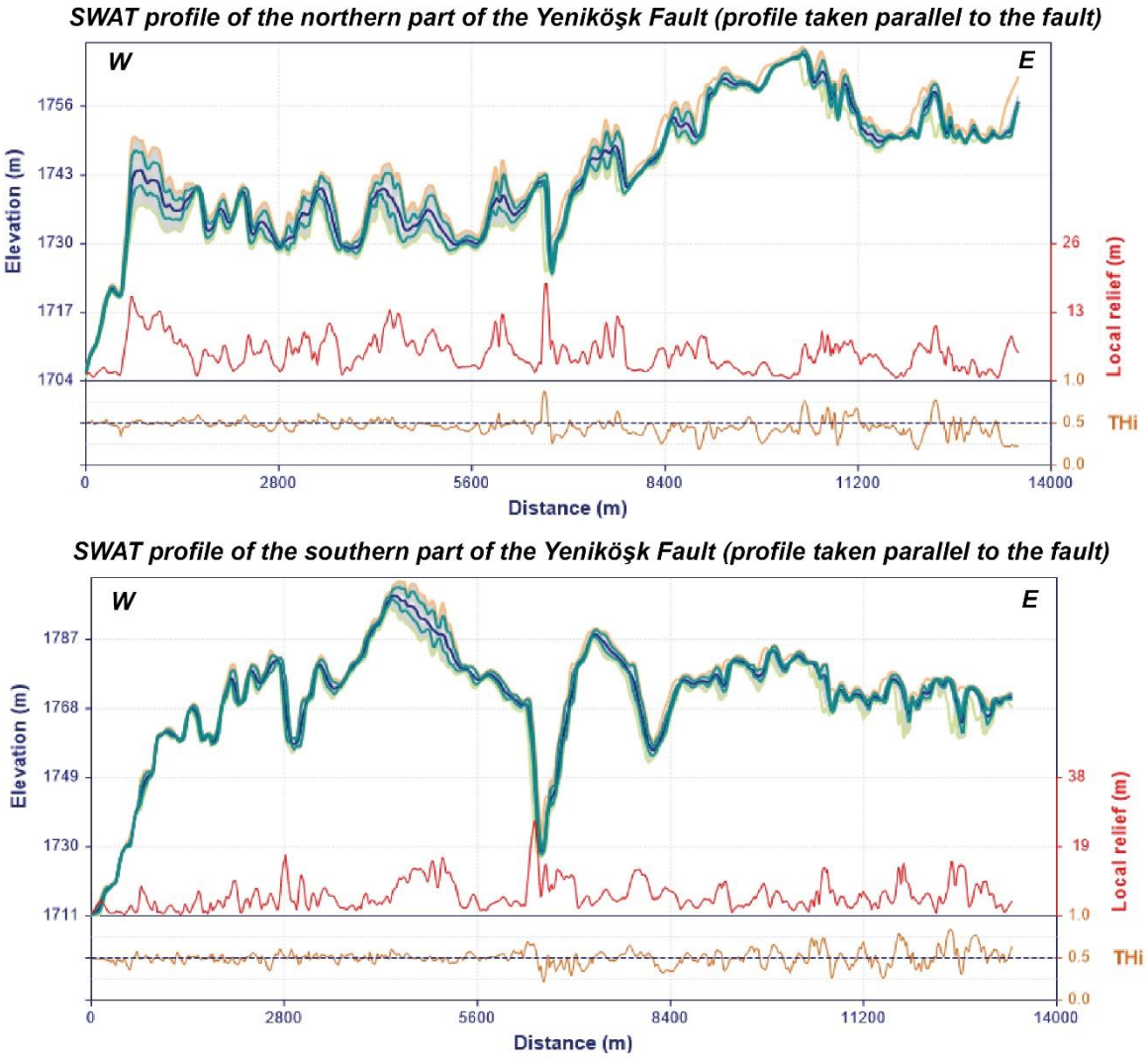

Figure 19. General view of the topographic profiles extracted parallel to the northern and southern segments of the Yeniköşk Fault.

SWAT profiles obtained along the northern and southern sections of the Yeniköşk Fault reveal a pronounced morphotectonic differentiation between the footwall and hanging-wall blocks. The footwall block is characterized by relatively low to moderate topographic undulations and a narrow range of low-amplitude local relief values. This morphological simplicity indicates a predominantly block-scale and structurally more coherent behavior. Consistently, the relatively homogeneous distribution of topographic profile values along the footwall suggests structural continuity and limited deformation.

In contrast, the hanging-wall block exhibits moderate to high-amplitude topographic variations, with a broader range and markedly elevated local relief values, indicating a much stronger surface expression of tectonic deformation. The high degree of heterogeneity observed in the topographic profiles implies increased fracture density and enhanced structural complexity within the hanging wall. The integrated assessment of morphological and structural indicators demonstrates that the hanging-wall block is more fragmented, develops a more pronounced fracture network, and consequently displays significantly higher morphotectonic activity compared to the footwall block. SWAT profiles extracted parallel to the fault further show that deformation along the Yeniköşk Fault is spatially variable, with clearer signatures of recent active tectonism particularly preserved in the hanging wall. This analysis provides critical insights into the contrasting behaviors of the footwall and hanging-wall blocks and forms an important basis for reconstructing the morphotectonic evolution of the fault zone and for assessing its potential seismic hazard.

4. Conclusıon

Van Province and its surroundings constitute one of the regions where active compressional tectonics are clearly manifested by destructive earthquakes recorded during the instrumental period. The 1976 Mw 7.0 Çaldıran and the 2011 Mw 7.2 Van earthquakes clearly demonstrate the activity of major fault systems in the region; in particular, the 2011 Van earthquake revealed that the Van Fault operates as an active thrust system. The north–northwestward dip of the Van Fault and the south–southeastward dip of the Yeniköşk Fault indicate that crustal shortening in the eastern Lake Van Basin is accommodated by multiple oppositely dipping thrust faults. This study investigates the morphotectonic characteristics, segmental geometry, and tectonic significance of the Yeniköşk Fault by integrating digital elevation models, SWAT profiles, drone imagery, and detailed field observations. The results demonstrate that the Yeniköşk Fault represents one of the principal surface expressions of the compressional tectonic regime affecting the eastern Lake Van Basin and plays a significant role in accommodating ongoing deformation. At the regional scale, the Yeniköşk Fault functions as an active thrust zone within the stress field generated by the Arabia–Eurasia continental collision and contributes, together with the Van Fault, to crustal shortening and surface uplift. Its southeast-dipping thrust geometry further indicates that the Yeniköşk Fault Zone exerts a controlling influence on differential uplift between the Van and Erciş blocks.

Morphotectonic analyses reveal that the Yeniköşk Fault is composed of five distinct segments—Yeşilköy, Ziyaret, Kireç, Özkaynak, and Çerkezkaya—each exhibiting unique deformation characteristics. The Yeşilköy and Ziyaret segments display large-scale surface tilting and well-developed fault scarps, representing clear examples of youthful thrust-fault morphology. The Kireç Segment is characterized by fluvially incised valleys developed in response to tectonic tilting and asymmetric relief patterns. The Özkaynak Segment preserves exceptionally well-defined indicators of recent deformation, including a sharply expressed fault scarp and a fault-front depression. The Çerkezkaya Segment exhibits a complex deformation zone marked by multiple uplift–subsidence sequences and a dense fracture network, reflecting localized strain concentration at the eastern termination of the fault.SWAT profiles extracted parallel to the fault reveal pronounced spatial variability in deformation, showing that the southern portion (hanging wall) of the Yeniköşk Fault exhibits higher heterogeneity, increased fracture density, and stronger morphotectonic activity compared to the northern portion. Topographic profiles extracted perpendicular to the fault document fault scarps, monoclinal flexures, fault-front depressions, and asymmetric block tilting, indicating that recurrent surface ruptures during the Holocene have not yet been significantly modified by erosion and remain well preserved. Taken together, these findings demonstrate that the Yeniköşk Fault is an active thrust system characterized by heterogeneous deformation distributed along its segments. The fault possesses the potential to generate future surface-rupturing earthquakes and, together with the Van Fault, constitutes a fundamental component of the regional contractional tectonic regime. The morphotectonic results emphasize the necessity of detailed paleoseismological investigations to better constrain the seismic behavior of the Yeniköşk Fault and to improve seismic hazard assessments for the Lake Van Basin.

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