4th Intercontinental Geoinformation Days

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Evaluation of structural elements in the collision zone by remote sensing method

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Keywords
Suture zone
Satellite image
Fault
DEM
QGIS

Abstract

Topographic and linear data are precisely linked to the tectonic structure of the region. This relation can be identified both in the field and in satellite images. As it is recognized, high topographic areas are formed with the effect of the compression regime in the zones where different continents are sutured. There are traces of the suture zone in the northeast of Kahramanmaraş. Because of the closure of the Neotethys Ocean, a collision zone developed in and around Çağlayancerit, located in the northeast of Kahramanmaraş. Units in the Arabian Autochthonous and Taurus Orogenic belts came together in this district. Thrust belts and faults have been observed in this vicinity. This structural event has developed linearity and topographic elevations, respectively. When the data obtained in the field and the digital elevation method (DEM) data of the region are checked out together in the QGIS environment, the topographic elevations in the collision belt are approximately higher than the areas in the south. As a result of the north-south compression, the thrust lines formed definite linearity. Each different characterized fault in the region controlled the morphology immediately.

1. Introduction

Many geological studies utilise lineament and topographic components as ancillary indicators (Guild, 1974; Masoud et al., 2007). Depending on the geological development of a region, basins and orogenic belts are observed. In this situation, regional lineaments and morphological data have their ultimate form under tectonic and sedimentation control (Oakey, 1994; Fichler et al., 1999; Austin and Blenkinsop, 2008).

Remote sensing (RS) and geographic information systems (GIS) are platforms for map-based evaluation of geological structures. With technological advances and recent developments in spatial analysis techniques, large-scale linearity and morphological analyses have become relatively practicable (Masoud and Koike, 2011). These studies use numerical data such as satellite images and Digital Elevation Model (DEM). Such studies interpret morphological and linear structures (Morris, 1991; Süzen and Toprak, 1998; Tripathi et al., 2000).

In terms of its geological structure, Kahramanmaraş is a complex region where different tectonic units are observed together. Many thrust and fault zones associated with the closure of the southern branch of the Neotethys Ocean are observed in this region (Şengör and Yılmaz 1981). Suture belts were formed by the closure of this ocean and the convergence of the Tauride and Arabian plates as a result (Robertson and Dixon 1984; Robertson et al., 2012). With the depletion of the ocean floor, allochthonous units were thrusted onto the Arabian platform in the south, and a suture belt was formed between these two continents (Yılmaz, 1984; Yılmaz et al., 1987). Gül (1987) explained that the collision of the Anatolian and Arabian plates occurred in the Late Cretaceous and that a compressional regime was active in the region during the Paleocene-Early Eocene period. Yılmaz and Yiğitbaş (1990) stated that as a result of the movement of the Arabian continent towards the Anatolian plate between the Late Cretaceous-Miocene, the region gained a nappe character.

Rigo De Righi and Cortesini (1964) divided the tectonostratigraphic units in the Southeast Anatolian Region into four primary tectonic belts: the Taurus Orogenic Belt, the Margin Fold Belt, the Folded Belt, and the Foreland, respectively. On the other hand, Gül (2000) described Kahramanmaraş and its vicinity as Orogenic Belts. Yalçın (2012) mapped the rocks of different origins in Çağlayancerit and its west and revealed the deformation structures of the region. This region still has an active fault, such as the East Anatolian Fault (EAF). It

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Cite this study

Yalçın, C. (2022). Evaluation of structural elements in the collision zone by remote sensing method. 4th Intercontinental Geoinformation Days (IGD), 5-8, Tabriz, Iran

is recognised that this main fault affects many morphological formations. In this region, distinctive morphological structures have cropped up due to the coexistence of rocks belonging to two different plates and the presence of different tectonic sequences on the thrust zones.

2. Method

The study area is located in the Çağlayancerit region, approximately 60 km northeast of Kahramanmaraş province (Figure 1a), in the Eastern Taurus Orogenic Belt. This region and its vicinity were named Engizek Askuşağı by Gül (2000) (Figure 1b). Just south of this belt is the marginal fold belt of the Arabian plate.

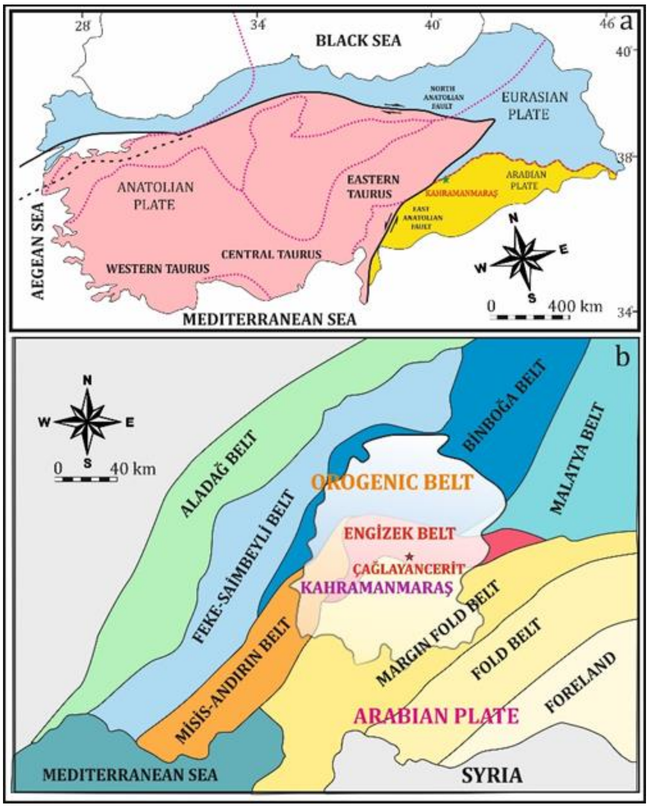

Figure 1. a) Tectonic location of the study area (Modified from Işık, 2016) b) Location of the study area according to tectonic belts. (Modified from Gül, 2000).

The DEM image of this geologically significant region has been downloaded from the United States Geological Survey (USGS) website. Aspect and slope maps of the region were created by evaluating the downloaded images in the QGIS environment. In addition, active faults in the region are placed on these images.

2.1. Geological background

Different stratigraphic sequences have emerged due to the coexistence of rock groups of different origins in the study area and allochthonous rocks overlying nappes and younger rocks in large areas. Allochthonous rocks, Suture Belt and Autochthonous units were defined from north to south (Yalçın, 2012). In the study area, the tectonic slices present an imbricated structure and the units belonging to different plates come together, indicating a very complex structural position in the region (Figure 2). According to the structural elements examined, it can be said that the region has been under the influence of an N-S oriented compression for a long time.

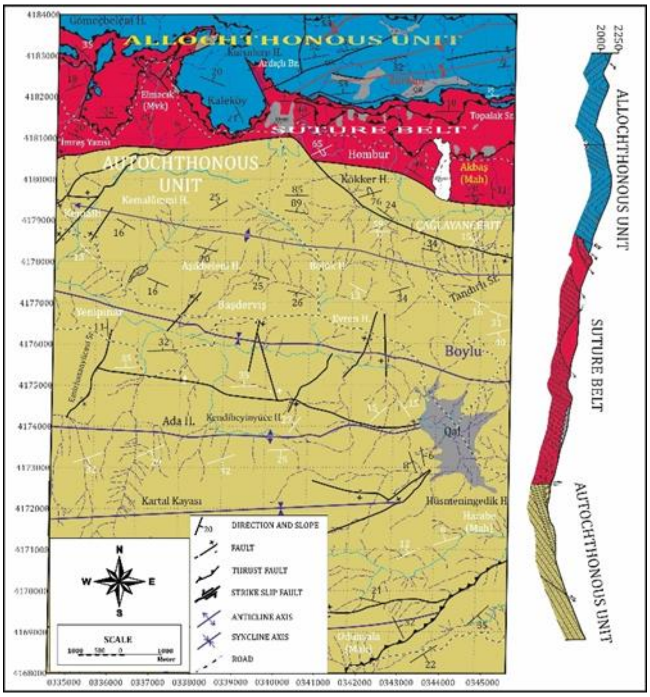

Figure 2. Structural map of the study area (Modified from Yalçın, 2012).

2.2. Remote sensing

Topographical approaches were obtained with the DEM image of Çağlayancerit and its vicinity, a tectonically active region and an important belt where two different continents collide. The downloaded DEM images were evaluated in the QGIS environment, an open-source Geographical Information System.

The DEM data downloaded on the Google Earth image and the active faults in the region were overlapped (Figure 3). Considering that there are different active and inactive faults in and around Çağlayancerit, the region's morphology is quite rugged, and the topographic elevations are relatively lower in the southern areas. According to these images, some important lineaments have been determined, which are structures generally affected by faults.

The images of the region generally obtained by remote sensing were evaluated in the QGIS environment, respectively, as follows.

1. DEM data was classified and coloured in the QGIS environment with a single band pseudocolour application (Figure 4a).
2. The relief image for the slope map of the region and the slope image on it were overlaid, revealing the slope map (Figure 4b). The red coloured areas represent the areas with the highest topographic elevation.
3. A view map of the region was created. According to the field studies, it has also been revealed with satellite images that the slopes generally face

south because there are thrusts from north to south (Figure 4c).

4. A 3D map of the region was created to obtain a more understandable image. The most important linearity obtained according to this image belongs to EAF. Other important linearities are thrust zones and dip-slip faults that form the boundary of the thrust front and autochthonous units (Figure 4d).

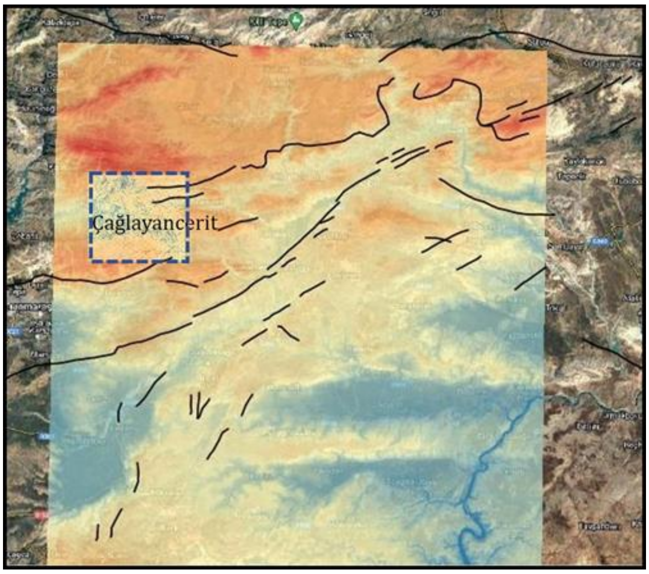

Figure 3. Satellite and DEM image of the study area.

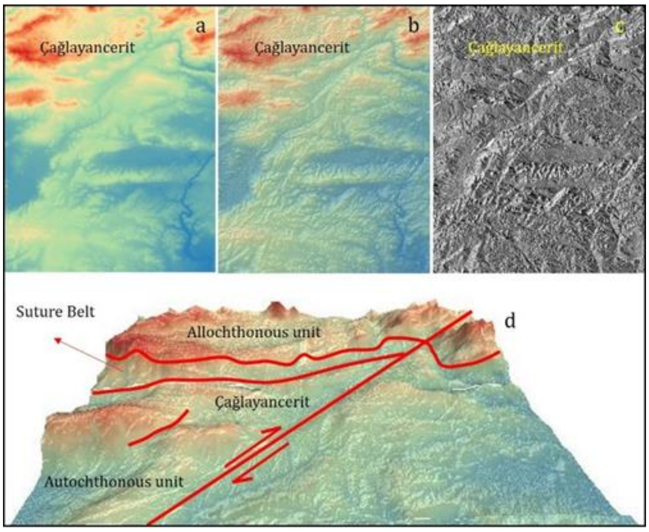

Figure 4. a. DEM b. slope, c. aspect and d. 3D image of the study area.

3. Results

In the research prepared by Yalçın (2012), it was stated that the units belonging to the collision belt in Çağlayancerit and its west came together, and deformation structures belonging to different periods developed in the region. The region's structural elements and surroundings were re-evaluated in this study with remote sensing methods. Topographic data and linear structures reveal that tectonic forces in the region are effective in geomorphology. In supplement, the faults in the structural map obtained in the field study are in harmony with the satellite images.

4. Conclusion

The maps prepared for tectonic and structural purposes can still be verified with remote sensing methods in today's technology. Morphological changes are the most common, especially in tectonically active areas where different continents come together. Very high topographic data is obtained in the thrust belts. In this study, the units of the Arabian Autochthonous and Taurus Orogenic belts collided, and then the position of the EAF was evaluated together. DEM and field data can be compared by evaluating them in the GIS environment. In such studies, other remote sensing methods such as hydrological factors, lithology and shading should be applied and detailed.

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