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Gediz ve Büyük Menderes Grabenlerinin Doğu kesimlerinde 2020-2021 yılları arasında kabuk hareketinin PSInSAR yöntemiyle izlenmesi

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Anahtar Kelimeler
PSInSAR,
Graben,
Kabuk Hareketi.

ÖZ

Genel olarak Doğu-Batı doğrultulu normal faylar ile sınırlandırılmış bloklardan oluşan Ege Çöküntü Sistemi (EÇS) içerisinde aktif graben yapıları bulunmaktadır. TUBITAK 119Y180 nolu proje kapsamında, EÇS içerisinde bulunan Büyük Menderes ve Gediz grabenlerinin doğu kesimlerine ait aktif tektonik hareketlerin PSInSAR yöntemiyle izlenmesi amaçlanmıştır. Bu amaç doğrultusunda Ocak 2020-Haziran 2021 yılları arasında 37 adet 131 iz numaralı yükselen yönde Sentinel 1A uydu radar verisi temin edilmiş ve bu veriler SNAP ve STAMPS yazılımları kullanılarak değerlendirilmiştir. Değerlendirme neticesinde Büyük Menderes ve Gediz grabenleri içerisinde yer alan PS noktalarına ait Uydu bakış doğrultusunda yıllık hız değerleri ve standart sapma değerleri elde edilmiştir. Daha sonra her bir Persistent Scatter (PS) noktasındaki hız ve standart sapma değerleri kullanılarak anlamlı hız değerleri belirlenmiştir. Hız değerleri anlamsız çıkan PS noktalarında hız değerleri sıfır olarak alınmıştır. PS noktalarındaki anlamlı hız değerleri incelendiğinde özellikle Gediz grabeni doğu kesiminde yıllık -10 cm' ye varan LOS yönünde hareketler belirlenmiştir. Gediz grabenin aksine Büyük Menderes grabeninde 0-2 cm küçük hız değerleri elde edilmiştir. EÇS doğu kesiminde Gediz grabeninde genel kabuk hareketinden farklı asismik hareketler belirlenmiştir. Gediz grabeni deformasyon bölgesinde DB yönlü bir kesit hattı üzerindeki PS noktalarına ait hız değerleri 3B görselleştirilerek graben üzerindeki asismik hareket bölgeleri belirlenmiştir. Çalışma neticesinde EÇS' nin doğu kesimindeki kabuk hareketleri belirlenmiş ve bu sonuçlar ışığında Gediz grabeninde TUBITAK 119Y180 nolu proje kapsamında daha kapsamlı araştırmalara başlanılmıştır.

Monitoring of crustal movement in the eastern parts of the Gediz and Büyük Menderes Grabens between 2020-2021 years with PSInSAR method

Keywords
PSInSAR,
Graben,
Crustal Movement.

ABSTRACT

There are active graben structures within the Aegean Graben System (AGS), which is generally composed of blocks bounded by East-West trending normal faults. Within the scope of the TUBITAK 119Y180 project, it is aimed to monitor the active tectonic movements of the eastern parts of the Büyük Menderes and Gediz grabens in the AGS with the PSInSAR method. For this purpose, 37 Sentinel 1A satellite radar data in the ascending direction with trace number 131 was obtained between January 2020-June 2021 and these data were evaluated using SNAP and STAMPS software. As a result of the evaluation, annual velocity values and standard deviation values were obtained in the direction of the Line of Sight (LOS) the Persistent Scatter (PS) points located in the Büyük Menderes and Gediz grabens. Velocity values were taken as zero at PS points whose velocity values were insignificant. When the significant velocity values at the PS points are examined, annual movements up to -10 cm in the direction of LOS have been determined, especially in the eastern part of the Gediz graben. Contrary to the Gediz graben, 0-2 cm low velocity values were obtained in the Büyük Menderes graben. In the eastern part of the AGS, different aseismic movements from the general crustal movement were determined in the Gediz graben. In the deformation zone of the Gediz graben, the velocity values of the PS points on an EW-directed cross-section line were visualized in 3D and the aseismic motion zones on the graben were determined. As a result of the study, crustal movements in the eastern part of the AGS were determined and in the light of these results, more comprehensive studies were started in the TUBITAK 119Y180 project in the Gediz graben.

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1. INTRODUCTION

The Aegean region has E-W trending graben systems depending on N-S extensional tectonics (Dündar, 2010). Tectonic movements in the Western Anatolia Expansion Zone and these grabens have been monitored by different geodetic methods (Barka & Reilinger 1997, Aktug et al., 2009, Hooper et al. 2012, Poyraz et al. 2015, Poyraz & Hastaoglu 2020). In the light of these studies, the total expansion in the westernmost part of Turkey has been determined as approximately 20 mm/year, making it one of the fastest continental expansion areas in the world. There are different aseismic movements in the West Anatolian Expansion Region (WAER). This study, it is aimed to examine the current tectonic movements, especially on the Büyük Menderes and Gediz grabens. The study investigated whether there are different aseismic movements on the grabens from the WAER velocity field. As a result of the study, different aseismic movements from the WAER were determined especially on the Gediz graben. In the light of these determined aseismic effects, more detailed studies are carried out within the scope of the TUBITAK 119Y180 project.

2. METHOD

In the study, the current active tectonic movements of the eastern parts of the Gediz and Büyük Menderes grabens, which are located in the WAER, were tried to be determined. For this purpose, Sentinel 1A satellite radar data were evaluated and current velocity fields in the LOS direction were obtained.

2.1. Study Area

Western Anatolia represents one of the fastest expanding regions in the world with the highest seismic activity. In general, the N-S directional continental expansion rate is 30-40 mm/year (Oral et al. 1995). In Western Anatolia, seismicity is high about the graben structure, and the region shows agglomeration type activity with remarkable low-magnitude earthquake groups over time (Öztürk, 2014). Approximately E-W trending grabens (Edremit, Bakırçay, Kütahya, Simav, Gediz, Küçük Menderes, Büyük Menderes, and Gökova grabens) and their basin boundary active normal faults are the most outstanding features of the neotectonic determining system (McKenzie, 1978).

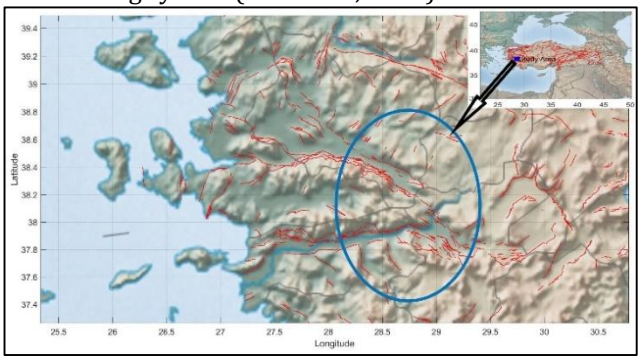

Figure 1. Study Area

The active tectonism of the Aegean is developing under the influence of two important geological events. One of these is the Aegean subduction system, and the other is the Arabian plate compressing Anatolia in the north direction. Therefore, the Aegean is a tectonically active region today (Dündar, 2010). Today, the LAGB is shaped at a 30-40 mm/year rate, with basins shaped under the influence of approximately N-S continental expansion (Le Pichon et al., 1995; Oral vd., 1995; Bozkurt, 2001).

2.2. Data Processing

Within the scope of the study, radar data of the ascending Sentinel 1A satellite with trace number 131, which includes the eastern parts of the Büyük Menderes and Gediz grabens, were evaluated. The data range covers the years January 2020-June and 2021. A total of 37 images were evaluated in 12-day periods.

The Sentinel-1A images in the IW mode used in this study are open access and obtained from the European Space Agency (ESA). To obtain the velocities in the LOS direction, the results were obtained in two different stages with two different software. In the first stage, SNAP software suitable for open access, which was supported and developed by ESA, was used. At this stage, splitting the images (Split), correcting the orbits of the satellites (Apply orbit files), matching the master and slave images (Back geocoding), deburst, obtaining the interferograms from each image pair, and in the last stage removing the topographic effects from the interferograms. (Topographic phase removal) procedures were performed. Then, the STAMPS EXPORT operation was performed to use the results obtained in the SNAP program as input data in the STAMPS software.

In the second step, the commonly used STAMPS software was used to obtain the velocities of the persistent scatterer (PS) points in the LOS direction. In this method, pixels affected by geometric and temporal correlation disorder and having a fixed amplitude value array are selected as PS points. Then, the temporal changes of these PS points are examined and the annual velocity values of the PS points in the direction of LOS are determined.

PS velocity values obtained from radar data of Sentinel 1A ascending 131 frame satellite radar data are presented in Figure 2 and standard deviation values are presented in Figure 3.

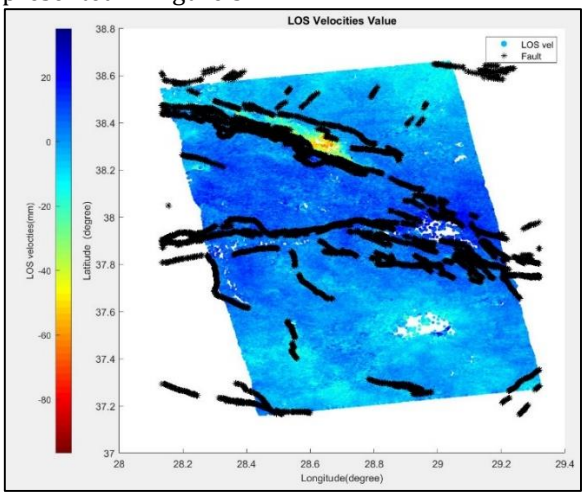

Figure 2. Sentinel 1A 131 frame Ascending LOS velocities

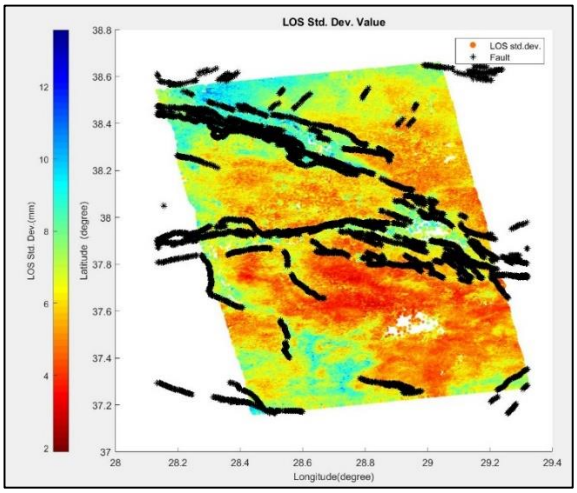

Figure 3. Sentinel 1A 131 frame Ascending LOS standard deviation

3. RESULTS

Today, Western Anatolia shows tectonic development under the control of two main active movements. One of these is the progression of the plate, bounded by the North Anatolian Fault and the East Anatolian Fault, in the west direction on average 20mm/year, starting from the Karlıova junction point. The vector of this escape is heading Southwest with a very sharp turn in Western Anatolia and advancing on the Greek Trench. On the other hand, Western Anatolia is also undergoing a N-S directional tension. Accordingly, the region is stretched 3-6 cm/year. As a result, Grabens, whose dominant structural elements in the geology of the region are E-W trending, develop. Continuous seismic activity is recorded on these faults (Dündar, 2010).

When Figure 2 is examined, subsidence velocity values of up to 10 cm/year were obtained in the LOS direction on the Gediz graben, different from the WAER general tectonic velocity field. Incorrect velocity values due to high standard deviation values at PS points cause errors in the interpretation of movements. Therefore, before assessing the velocity values, a significance test was carried out by using the velocity values and standard deviation values obtained for the entire study area, and significant velocity values were obtained. A significant velocity map is presented in Figure 4.

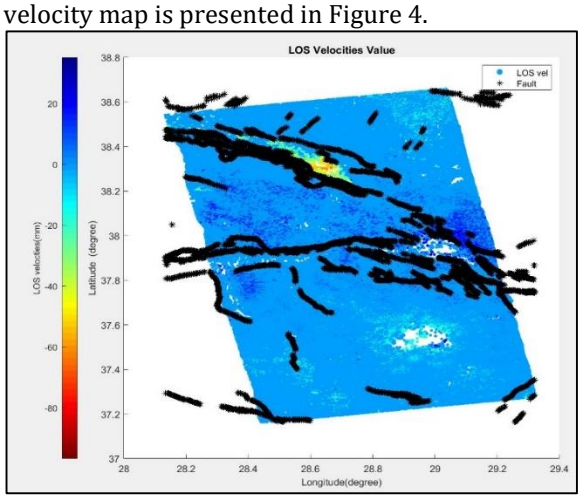

Figure 4. Sentinel 1A 131 frame Ascending LOS significant velocities

When Figure 4 is examined, significant velocity values ranging from -2 to -10 cm are observed, especially in the eastern part of the Gediz graben. On the other hand, values consistent with the WAER general tectonic velocity field are observed in the Büyük Menderes graben. As it can be understood from here, there are aseismic movements in the Gediz graben.

Koca et al. 2011, they stated that there were areal settlements (subsidence) that developed with the decrease of the groundwater level due to the drought problem and excessive water withdrawal between the years 2000 and 2010, and vertical displacements along the fault zone due to seismic activity around the Sarıgöl district located in the Gediz Graben. In addition, Poyraz et al. 2018, they determined annual subsidence of -90 mm/year from GNSS results at TRAZ (at Trazlar locality) located in the eastern part of the Gediz graben.

To examine the deformations in the Gediz graben in more detail, the velocity values of the PS points along the section line presented in Figure 5 were plotted in 3D. Thus, velocity fields on the graben were observed in detail from a three-dimensional perspective.

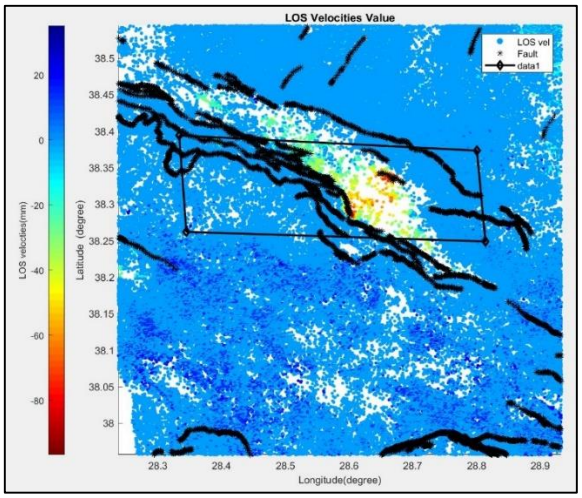

Figure 5. Profile area in Gediz Graben deformation zone

In Figure 6, a 3-dimensional section view of the PS points falling on the section line is presented. As it can be understood from here, seismic effects are observed especially in Delemenler and Yeşilyurt regions, which are located within the Gediz Graben.

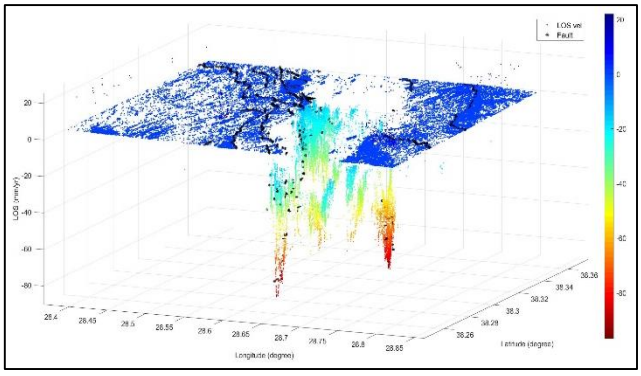

Figure 6. Profile area in Gediz Graben deformation zone

4. DISCUSSION

As a result of the work carried out, velocity fields were determined in the direction of LOS between the years of WAER 2020-2021. According to the results obtained, while no aseismic movements were observed in the east of the Büyük Menderes Graben, especially in the east of the Gediz Graben, aseismic movements were clearly observed. These observed aseismic movements vary between 2 cm and 10 cm in the annual LOS direction within the graben. As stated by Koca et al. 2011, the main reason for these movements is thought to be a real subsidence, which develops due to the decrease in groundwater level due to excessive water withdrawal, and vertical displacements along the fault zone due to seismic activity. In addition, as a result of the study carried out, it was revealed that this movement still continues.

5. CONCLUSION

The InSAR method allows monitoring of surface movements in very large areas. In this study, surface movements were observed in an area of approximately 13000 km^2. Thanks to the work carried out, the eastern part of the WAER was handled as a whole and the general movement character of the WAER was determined in detail in the movements specific to the Grabens. Thus, the general movements of the WAER and the movement characteristics of the grabens were compared. In this way, asimic effects in the grabens were clearly observed. In the light of these observations, 4 fixed GNSS points were established on the Gediz graben within the scope of TUBITAK 119Y180 project. At these points, 24/7 GNSS observations are still ongoing. In addition, within the scope of the same project, detailed time-series analyses of PS points are carried out and seasonal effects are tried to be revealed clearly.

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Author contributions

The authors contributed equally to this research article.

Conflicts of interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

Research and publication ethics were compiled within the study.

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