Sözlü sunum

Active tectonics of the Aegean Sea: source rupture processes of recent earthquakes and synthesis of the international EGELADOS and COLUMBOS projects

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There are currently many proposed models for the deformation styles and active tectonics of the Aegean–Anatolian plate. Many authors have studied this region applying different geophysical methods, geodetic and palaeomagnetic studies and field observations. Paleomagnetic studies suggest that several distinct domains existed in western Turkey with a clockwise rotation in Karaburun peninsula (~-43 ± 26°) in the past 17 My or less confirming earlier results and counterclockwise rotation (~30°±13) since 7 My in Izmir. GPS velocity field vectors confirm that western Anatolia moves to the W-SW direction with counterclockwise rotation around a pole in the Sinai. Between Karaburun peninsula and northern part of Izmir, east-west shortening and north-south extension are observed from the rates of principal and shear strains along with rigid - body rotation rates and it is thought that they are closely related to right-lateral faulting and a clock wise rotation.

Recent Earthquakes in the Sigacik Gulf

Sığacık Gulf is located on the southern part of the Karaburun peninsula and it lies between the headlands of Doğanbey Burnu and Teke Burnu in western Anatolia which has a very complex and rapidly changing tectonic structure due to the relative motions of surrounding tectonic plates. We examined the source mechanisms and rupture histories of a three moderate size earthquakes occurred in the Sığacık Gulf along with their aftershocks, and those occurred in surrounding regions of Izmir using teleseismic long-period and broad-band P- and SH- body-waveforms recorded by GDSN stations. This area is characterized by N-S and NE-SW trending active strike slip faults which are observed in previously reported studies. Inversion results indicate that NE-SW oriented right-lateral strike-slip faulting and uniform rupture propagation on the fault plane are observed dominantly in a good agreement with the geology and tectonic structure of the Sığacık Bay region.

During 17–31 October 2005 there have been 839 earthquakes (M>2.4) occurred in the Sığacık Gulf as reported by BU-Kandilli Observatory. Distribution of epicenters of recent earthquakes are concurred southern part of the Gülbahçe Fault bordering the east of the Karaburun peninsula. We calculated related earthquake moment magnitudes for all events using Kanamori's equation,. Inversion solutions were also constrained by P-wave first motion polarities recorded at near field stations. Source parameters indicating NE-SW oriented right lateral strike slip faulting and uniform rupture propagation on the fault plane are observed dominantly in a good agreement with the geology and tectonic structure of the Sığacık Gulf. Earthquake focal depths are shallow and vary between 10 and 15 km. The distribution of P-wave first-motion polarities on the equal-area projection of the lower focal hemisphere is consistent with the minimum misfit solutions. Obtained source parameters are similar to those reported by USGS and Harvard CMT moment tensor catalogs. Most of the earthquake epicenters are concentrated along the southern part of the Gülbahçe-Karaburun and Seferihisar faults whereas no seismic activity observed on the northern segment of these faults during 17–31 October 2005. It is most likely to be related to the secondary sub-faults of these strike-slip fault zones in

the Sığacık Gulf. Source mechanism solutions show NE-SW trending right-lateral strike slip faulting mechanism with small normal component. Also field observations pointed out some syn-sedimentary deformational structures that are composed of N40°-70°E- and E-W trending cracks and sand volcanoes occurred along the Sığacık Bay following these earthquakes and these cracks are trending in consistent with the main fault segments. T axes directions obtained from source mechanism solutions in this study show NE-SE extension in the gulf.

Outline of the EGELADOS Project

The EGELADOS project is a passive seismic experiment in the Hellenic Subduction Zone that is conducted within the framework of the Collaborative Research Center 526 "Rheology of the Earth" at Ruhr-University Bochum. Its aim is to investigate earthquake activity and earth structure along the forearc and in the island arc of the Hellenic subduction zone. Besides scientists from Ruhr-University Bochum, several scientists from universities and research institutions in Greece, Turkey and Germany collaborate within the project

Using seismic waveforms from a dense, temporary network of broad-band ocean-bottom and land seismographs to be deployed on the Peloponnes peninsula, the South-Aegean Sea and adjacent Turkey, we will perform a detailed investigation into the elastic and anelastic properties of the Hellenic subduction zone. Particular targets will be (1) the contact zone between the subducted African lithosphere and the overlying Aegean mantle, including crust and uppermost lithosphere beneath the forearc, (2) the mantle wedge above the slab extending from the Cretan Sea to beyond the volcanic arc of the Cyclades and (3) lateral variations in properties of the slab itself. Target (1) is motivated by the finding that parts of the contact zone are aseismic indicating weak coupling and low stress. Exhumed HP-LT rocks indicate the existence of a low-viscosity subduction channel within which material transported downwards into the mantle during subduction may be pushed back to subcrustal levels by forced return flow. With target (2) we aim at mapping structural connections between the active volcanoes at the surface, fluids rising from the subducted slab and dehydration-related seismicity. Target (3) is selected to test the hypothesis that along-strike variations of slab properties cause the lateral variation of the dip and the segmentation of the downgoing slab. The search for detailed structure in these target areas will be supplemented by a high-resolution tomographic image of the whole region providing us with the necessary structural background information. Such a model is also essential for accurate earthquake location. Primary method of investigation will be the modelling and inversion of seismic waveforms from regional earthquakes based on Born scattering theory, coupled-mode scattering theory and fully numerical modelling.

Outline of the COLUMBOS Project

Active tectonic processes along the African-Eurasian collision zone are associated with catastrophic events including earthquakes, major volcanic eruptions, and tsunamis. Understanding how these processes can affect the eastern Mediterranean is of increasing scientific and public interest. The region includes a frequently crossed international sea traffic corridor and dense population centres. Furthermore, most of the small volcanic islands in the Aegean are major tourist attractions that contribute significantly to the wealth of this region.

One of these Aegean islands is Santorini, which is a major explosive volcano and possibly one of the most dangerous volcanoes in Europe. During the past 150 million years, Santorini has had 12 major eruptions, and several of them ejected large columns of ash and debris high into the atmosphere. It is widely believed that the eruption of Santorini about 3600 years before present (B.P.) destroyed the Minoan civilization of Crete.

In addition to the volcanic island, there are several submarine volcanic seamounts in the Aegean Sea. One of them, the Columbo seamount, is about eight kilometers northeast of Santorini, and recently has attracted attention due to the high earthquake

activity of the Hellenic subduction zone. This activity is concentrated in an area northeast of Santorini, within the so called Santorini-Amorgos zone. The earthquakes occurred in the upper crust at a depth of 3–15 kilometers and are considered to be related to evolving volcanism and related magma or fluid migration. Whereas the potential risk of future eruptions of the Santorini volcano is well recognized by scientists and by Santorini residents, the Columbo underwater volcano never has reached a level of public risk perception

The combined interpretation of multichannel seismic, gravity and magnetic profiles as well as seismological and tiltmeter data could help with unraveling the impact of tectonic and magmatic processes on the seafloor and adjacent islands.This research could represent a significant step towards an improved risk assessment for the Santorini-Columbo volcanic complex and, consequently, for the residents of the central Aegean region.

Key words: Active tectonics, Aegean Sea, seismotectonics

Acknowledgements

We thank the Incorporated Research Institute of Seismology Wilber II for their data support. We used GMT software to prepare figures, and SAC2000 for basic earthquake data processing. This study was supported by Istanbul Technical University (İTÜ) Research Fund, and Scientific and Technical Research Council of Turkey (TÜBİTAK). TT thanks support given by the Turkish Academy of Sciences (TÜBA), in the framework of their Young Scientist Award Programme (Tuncay Taymaz: TÜBA-GEBİP/2001-2-17).