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Seismotectonics and Neotectonics of the Gulfs of Gökova-Kuşadası-Sığacık and Surrounding Regions (SW Turkey): Earthquake Mechanisms, Source Rupture Modeling, Tsunami Hazard and Geodynamic Implications

Seda Yolsal-Cevikbilen (1), Özgür Karaoglu (2,3), Tuncay Taymaz (1), and Cahit Helvaci (2)

(1) Istanbul Technical University, the Faulty of Mines, Geophysical Engineering Department, 34469, Maslak, Istanbul, Turkey, (2) Dokuz Eylül University, Department of Geological Engineering, 35160, Buca, Izmir, Turkey, (3) Yüzüncü Yıl University, Department of Geological Engineering, 65080, Van, Turkey

The mechanical behavior of the continental lithosphere for the Aegean region is one of the foremost interesting geological disputes in earth sciences. The Aegean region provides complex tectonic events which produced a strong heterogeneity in the crust (i.e. large thrusts and exhumation shear zones or extensional detachments) as such in among most continental regions. In order to investigate mechanical reasons of the ongoing lithospheric-scale extension within the region, we must tackle all of the existing kinematic and dynamic agents: (1) roll back of the subduction slab and back arc extension; (2) westward extrusion of the Anatolian micro-plate; (3) block rotations of the Aegean region and western Anatolia; and (4) transtensional transform faults. Furthermore, seismological studies, particularly earthquake source mechanisms and rupture modeling, play important roles on deciphering the ongoing deformation and seismotectonic characteristics of the region. Recently, many moderate earthquakes occurred in the Gulfs of Gökova, Kuşadası, Sığacık and surroundings. In the present study, we examined source mechanisms and rupture histories of those earthquakes with Mw > 5.0 in order to retrieve the geometry of active faulting, source characteristics, kinematic and dynamic source parameters and current deformations of the region by using teleseismic body-waveform inversion of long-period P- and SH-waves, and broad-band P-waveforms recorded by GDSN and FDSN stations. We also checked first motion polarities of P- waveforms recorded at regional and teleseismic stations and applied several uncertainty tests to find the error limits of minimum misfit solutions. Inversion results revealed E-W directed normal faulting mechanisms with small amount of left lateral strike slip components in the Gulf of Gökova and NE-SW oriented right lateral strike slip faulting mechanisms in the Gulf of Sığacık. Earthquakes mostly have N-S and NW-SE directed T- axes directions which are consistent with the geology and seismotectonic structures of the region. Further, the major and well-known earthquake-induced Eastern Mediterranean tsunamis (e.g., 365, 1222, 1303, 1481, 1494, 1822 and 1948) were numerically simulated and several hypothetical tsunami scenarios were proposed to demonstrate the characteristics of tsunami waves, propagations and effects of coastal topography. For simulation of tsunami generation, we used nonlinear shallow-water mathematical models (i.e. TUNAMI-N2, AVI-NAMI and NAMI DANCE) with a given GEBCO – BODC bathymetry data. Synthetic tsunami wave amplitudes were calculated by proposing several hypothetical tsunami scenarios for historical tsunamigenic earthquakes occurred along the Hellenic Subduction Zone and Dodecanese Islands. Illustrative examples depicting the characteristics of tsunami wave propagation, and effects of coastal topography and of near-shore amplification were also given. Finally, potential tsunami risk in future along SW Anatolian coasts that will be related to destructive earthquakes (M > 7.0) occurred along the Hellenic subduction zone and near the deep Rhodes-Dalaman Trough is clearly verified.