APPLIED NEOTECTONIC MAPPING TO THE CIVIL ENGINEERING: FAULT ACTIVITY MAP OF THE BOLONIA AREA (THE GIBRALTAR STRAIT TUNNEL, SOUTH SPAIN)

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Abstract

A map of Fault Activity has been developed for preliminary engineering planning related to the construction of an underwater fixed link-route between Africa and Europe at the Gibraltar Strait Sector, in South Spain (The Gibraltar Tunnel). The criteria management is mainly focused on the establishment of the seismic or aseismic character of individual fault traces. From this study, the Cabo de Gracia strike-slip fault (NE-SW) can be catalogued as active during at least the last 128 ka BP, and as a probable seismic source of moderate events (Mb ≤ 5), with relevant incidence in the ancient Roman city of Baelo Claudia (AD 40-60 and AD 350-395).

Keywords: Neotectonic mapping, fault activity, ground Instability, Gibraltar Strait, Spain

Preliminary planning for the establishment of a permanent link-route between Europe and Africa (Gibraltar Strait Tunnel), promoted by the EU and supported by the National Companies SECEG S.A. (Spanish) and SNED (Moroccan), was completed in 1995. Among the set of research projects carried out during this phase, a neotectonic analysis of the Gibraltar Strait was developed devoted to the implementation of an onshore 1:100.000 Neotectonic Map of the Spanish coast (1). Research was mainly focused on the identification of regional neotectonic hazards related to the construction and future use of a high-sensitive installation like an underwater tunnel of more than 20 km long and therefore to identify those areas subject to potential (pure and induced) seismotectonic hazards. For this last topic detailed fault mapping (sc. 1:25.000) of selected pilot zones was also performed.

One of the selected areas was the Bolonia Bay (Cádiz). Late Quaternary faulting, large landslides, and swelling clayey units occur at this small sector of the Gibraltar Strait coast, constituting an excellent zone to test the performance of detailed mapping of neotectonic hazards. Mapping has been focused on the identification, and preliminary characterisation, of potentially active faults and unstable terrains for later engineering planning. Map presented here is mainly based on the neotectonic mapping guidelines established for the Spain (2 and 3) and France (4) and consequently it came from the integration of neotectonic, seismic, and paleoseismic data, on a graphic background generated by the Quaternary geology and geomorphology (Fig. 1).

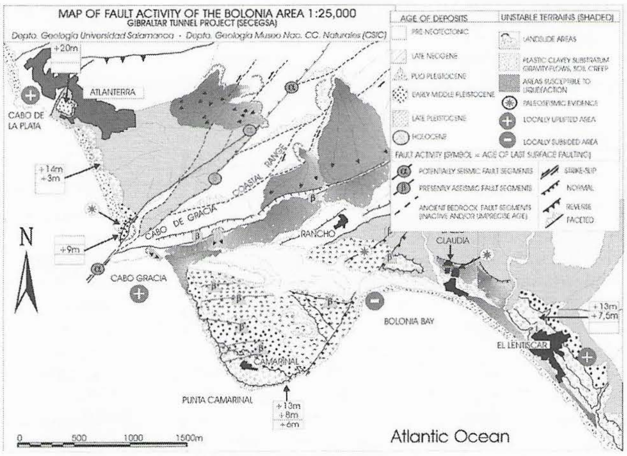

Fig. 1. Pilot Fault Activity Map of the Bolonia area.

The final purpose is the development of comprehensive methodology for the graphic representation (chart-format) of geohazards related to ground conditions, seismicity and fault activity. For this the age of the last deformational event, and slip rates (where possible) are taken into account, but their classification as active or inactive structures is avoided. In the map, the different fault segments have been differentiated according to the age of the last known deformational event: Late Pleistocene-Holocene (circles); Middle-Early Pleistocene (pentagons); Plio-Pleistocene (triangles); Pliocene, and Pre-Pliocene (no symbol). In addition, fault segments of different ages have been subdivided into two categories, α and β faults following the proposals of (4) and (5). *α fault segments* are seismic (or seismogenic) segments, in other words, fault segments which can be linked to present seismic activity and display deformations in Late Quaternary deposits and/or landforms. *β fault segments* are presently aseismic segments, but displaying evidences of paleoseismic deformations (of Quaternary age) and therefore potentially seismic segments.

Aside from these linear seismotectonic hazardous features, the uplift/subsidence trends of the different coastal sectors have been also highlighted by means of specific symbols, in order to illustrate the more recent vertical behavior of the different coastal sectors (Fig. 1). Finally, as evidenced by the geomorphic analysis, landscape dynamics holds a major sensitivity to more localized phenomena of both, mass-movements favored by the occurrence of low-cohesive bedrock clayey units (Almarchal and Facinas fms), and near-surface liquefaction on unconsolidated littoral sandy deposits and deep weathered Pliocene conglomerates. Since the recognition of unstable grounds is critical for large-scale engineering planning, units prone to suffer surface-destabilization by an expected moderate earthquake have been also highlighted in the map through specific patterns. As indicated by several authors (6 and 7) 0.16g are large enough to promote slope failure close to the coast, but also near-surface destabilization on unstable ground, as evidenced by the geologic, geomorphologic and archeological records (7).

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