Geomorphology 237 (2015) 65–78

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph

Active faulting at the Corinth Canal based on surface observations, borehole data and paleoenvironmental interpretations. Passive rupture during the 1981 earthquake sequence?

Ioannis D. Papanikolaou [a,c,*], Maria Triantaphyllou [b], Aggelos Pallikarakis [a], Georgios Migiros [a]

[a] Mineralogy–Geology Laboratory, Department of Natural Resources Development and Agricultural Engineering, Agricultural University of Athens, Iera Odos 75, 118-55 Athens, Greece
[b] Hist. Geology–Paleontology Department, Faculty of Geology and Geoenvironment, National and Kapodistrian University of Athens, Panepistimiopolis 15784 Athens, Greece
[c] UCL Hazard Research Centre, Department of Earth Sciences, University College London, WC 1E 6BT, London UK

ARTICLE INFO

Article history:
Received 1 June 2012
Received in revised form 20 October 2014
Accepted 28 October 2014
Available online 27 November 2014

Keywords:
1981 earthquake sequence
Kalamaki
Isthmus
Ruptures
Saronic Gulf
Geodesy

ABSTRACT

The most important active fault that crosses the Corinth Canal is studied in detail, involving surface observations, borehole data and paleoenvironmental interpretations. This fault intersects and/or is parallel and at short distances from major infrastructure facilities such as the Athens–Corinth highway, the railway and the Corinth Canal. It is a secondary structure accommodating displacement between the other major E–W trending active faults. It exerts an influence on the topography and the stratigraphy, backtilting Middle Pleistocene sediments on its immediate footwall, showing also significant synsedimentary activity. It has a short length (~5.5 km) and is not expected to produce extensive primary surface ruptures and large displacements (<14 cm). Borehole data and correlation between the footwall and hangingwall horizons, indicate that only minor displacement of several meters has been accumulated over the last 175 ka, implying a low slip-rate (~0.04 ± 0.02 mm/year). Paleoenvironmental interpretations based on borehole data show a very complex sedimentation history during the Middle and Upper Pleistocene that involves subaerial exposure, coastal, lagoonal, shallow marine environments and possibly even some lake sediments. There is strong evidence that this fault was passively ruptured up to 6 cm during the 1981 earthquake sequence and questions emerge on whether part of its throw can be attributed to such a mechanism.

1. Introduction

The Corinth Gulf is one of the fastest extending regions worldwide (up to 20 mm/year that diminishes to 8 and 4 mm/year towards its eastern end (e.g. Billiris et al., 1991; Briole et al., 2000)). Our study area lies eastwards from the major active faults that have shaped the present-day eastern part of the Corinth Gulf, at the Corinth Isthmus that divides the Corinth and Saronic Gulfs. In particular, it lies towards the eastern tip of the Corinth Canal (Fig. 1). The Corinth Canal, a major infrastructure project constructed in 1893, is 6.3 km long, 8 m deep and with up to 60 m high slopes that often experience landslides (Marinos and Tsiambaos, 2008; Papantoniou et al., 2008).

The Canal offers a unique opportunity to visualize the faults, forming an impressive mega-trench. More than 40 faults can be recognized, most of them normal and oblique normal (Philippson, 1890; Freyberg, 1973) and marine upper Pleistocene sediments are faulted with intrabasinal fault blocks in the order of a few hundred meters wide (Collier et al., 1992). Some of the faults are overlain by undeformed late Pleistocene strata and are clearly not a hazard threat. These faults form an anticlinal type of structure with fault planes dipping westwards and eastwards from the central horst, towards the Corinth and Saronic Gulfs respectively. Most of these faults do not displace the topography and are of limited length, therefore are considered as secondary structures with low slip-rates. However, towards the eastern tip of the Canal we traced a significant ENE–WSW trending fault that downthrows towards the SSE and appears to displace the modern ground surface. The hazard potential of this fault and its role within the tectonic framework of the area are studied in detail, based on surface observations, the analysis of borehole data and published geodetic data. In this paper, we have analyzed borehole data that were recovered near the Canal up to 70 m depth, reaching up to 50 m below present day sea level, providing an unprecedented dataset. Finally, we re-examine some geodetic data which show strong evidence that this fault was passively ruptured during the 1981 earthquake sequence.

2. Study area — tectonic framework

The Corinth Isthmus has been constantly uplifted approximately 0.3 mm/year over the last 200 kyrs (Collier et al., 1992; Dia et al., 1997). Our

* Corresponding author at: Mineralogy–Geology Laboratory, Department of Natural Resources Development and Agricultural Engineering, Agricultural University of Athens, Iera Odos 75, 118-55 Athens, Greece.
E-mail addresses: i.pap@aua.gr, i.papanikolaou@ucl.ac.uk (I.D. Papanikolaou).

http://dx.doi.org/10.1016/j.geomorph.2014.10.036
0169-555X/

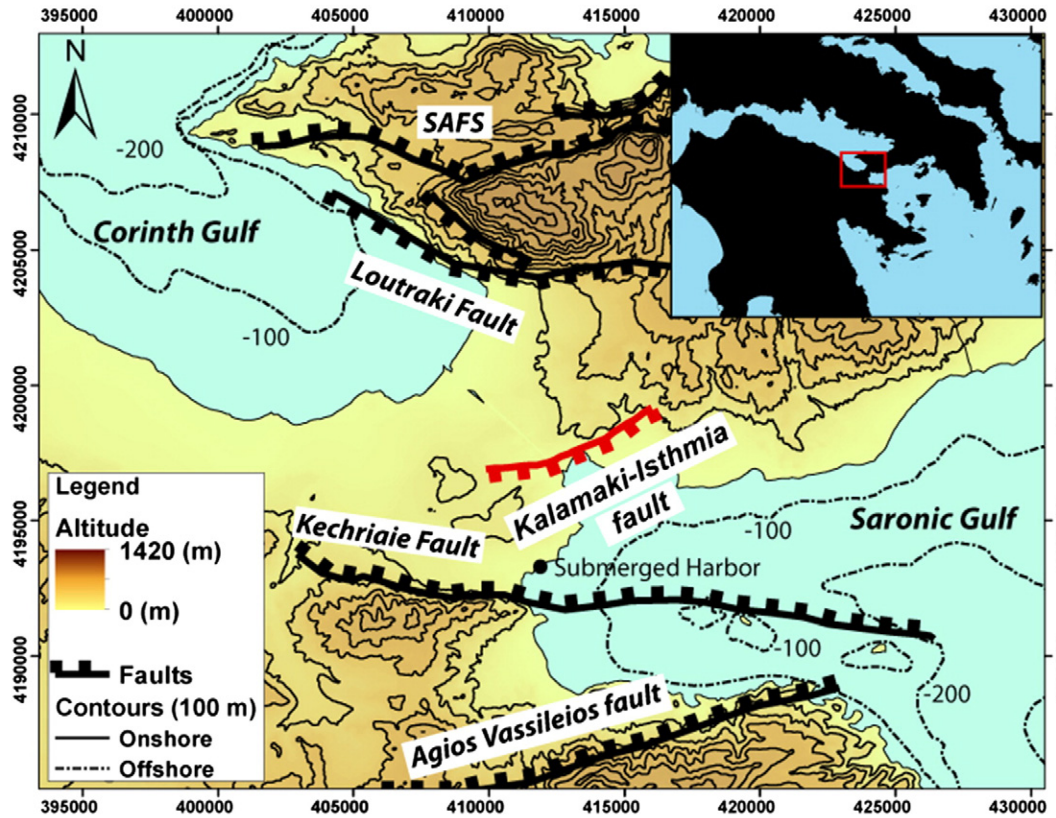

Fig. 1. Digital elevation map, showing the major faults in the study area.

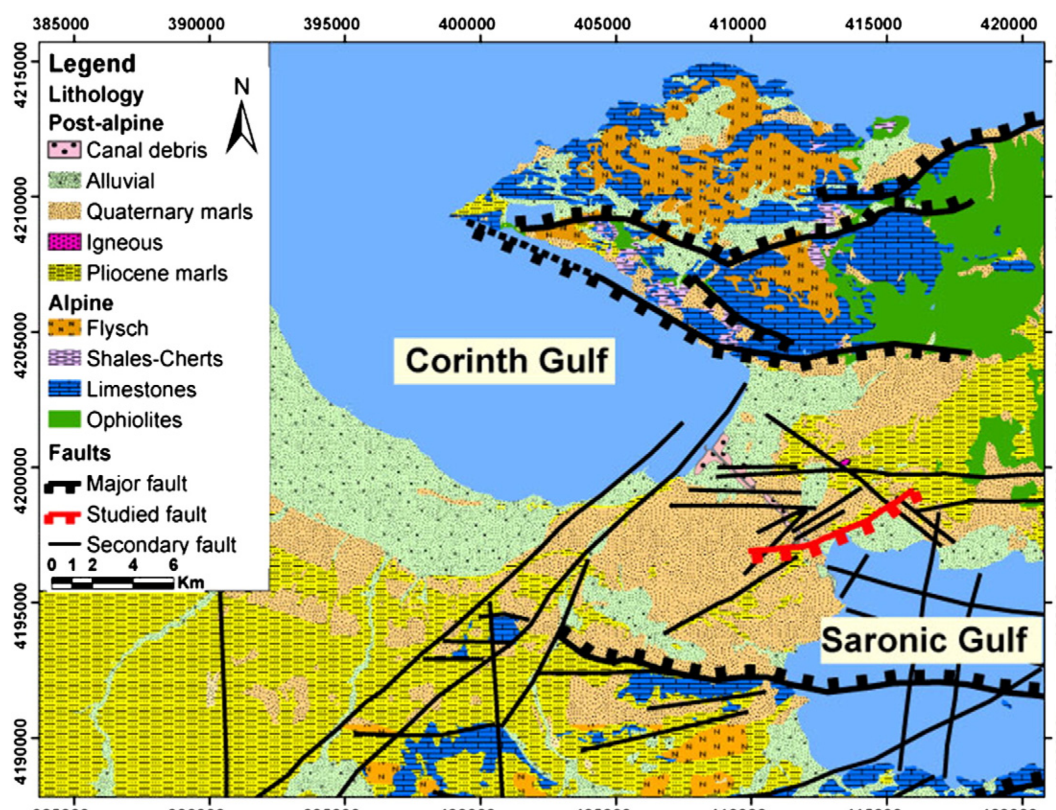

Fig. 2. Simplified geological map showing the major and secondary faults as well as the studied active fault (modified from Bornovas et al., 1972, 1984; Gaitanakis et al., 1985; Papanikolaou et al., 1989, 1996; Roberts et al., 2009).