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THE ZAFARRAYA FAULT IN THE FRAME OF THE ACTIVE TECTONIC STRUCTURES OF THE CENTRAL BETIC CORDILLERA (SOUTHERN SPAIN)

CONTENTS

ABSTRACT

The internal zones of the Betic Cordilleras are deformed since Middle Miocene by kilometre-sized E-W oriented folds coeval with fault development. Faults are generally normal in the central transect. The Zafarraya Fault, responsible for the 1884 Andalucía Earthquake, is located at the northern limb of the Sierra Tejeda antiform, and could be interpreted as a collapse structure developed along the external arch of the uplifted fold. The set up of a GPS network in the Sierra Tejeda will allow us to study the present-day deformation relationships of folds and faults in the area.

KEYWORDS: Betic Cordilleras, Zafarraya Fault, Sierra Tejeda antiform, GPS network.

1. INTRODUCTION

The Betic Cordilleras, together with the Rif, constitute the western end of the alpine belt in the Mediterranean Sea. Deformations are widespread along a broad band related to the oblique convergence of the Eurasian-African plate boundary. Although there is a complex overprinting of alpine deformations, most of the present-day relief of the Betic Cordilleras has been built-up since the Tortonian.

The main structures that are active, or with recent activity, found in the central Betic Cordilleras are large-sized folds (WEIJERMARS *et al.*, 1985; JOHNSON, 1997) and faults (Fig.1). The folds, symmetrical or with northern vergence, produce a succession of mountain ranges and valleys. Although there are folds of different trends, there is a predominance of E-W oriented folds, roughly parallel to the coast line (Fig. 1). The fault system is complex and includes mainly NW-SE and E-W oriented sets with overprinted striae revealing the complex stress field evolution that has undergone the region.

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2. THE ZAFARRAYA FAULT AND THE SIERRA TEJEDA ANTIFORM

In the central part of the Betic Cordillera, the Zafarraya fault constitutes one of the structures with evidence of very recent tectonic activity (Figs. 1 and 2). There are reports of displacements along this fault during the 1884 Andalucía earthquake that destroyed part of the villages of the region (Zafarraya, Ventas de Zafarraya and Alhama de Granada, among others). MUÑOZ and UDÍAS (1981) consider this earthquake to have been of a magnitude between 6.5 and 7. Field studies determine that the fault has a total length of more than 15 km (Fig. 2). Its trend varies along the strike, approximately E-W to the south of Zafarraya and curves to a NW-SE orientation at its western end, where deformed rocks of the External Zones are found. The fault plane in the Zafarraya region dips 60° northwards, and its striae indicate that it is a normal fault (Fig. 2). Fault slip is of several hundred of meters. The fault develops in its hanging wall an endorreic related basin, the Zafarraya Depression, filled by sediments that range in age from Tortonian up to the Present. The basin is asymmetrical, and probably the main depocenter is located at the southern border, near the fault.

Southeast of the Zafarraya Fault is the Sierra Tejeda, constituting a great radious antiform with an E-W to ESE-WNW oriented axis and a periclinal end towards the west (Fig. 2). This antiform is associated with a positive elongated relief parallel to the fold axis. The southern limb of the antiform is deformed by a set of WNW-ESE oriented faults dipping towards the SW and with a normal and transcurrent regime; although they developed during the Neogene, there is no clear evi-

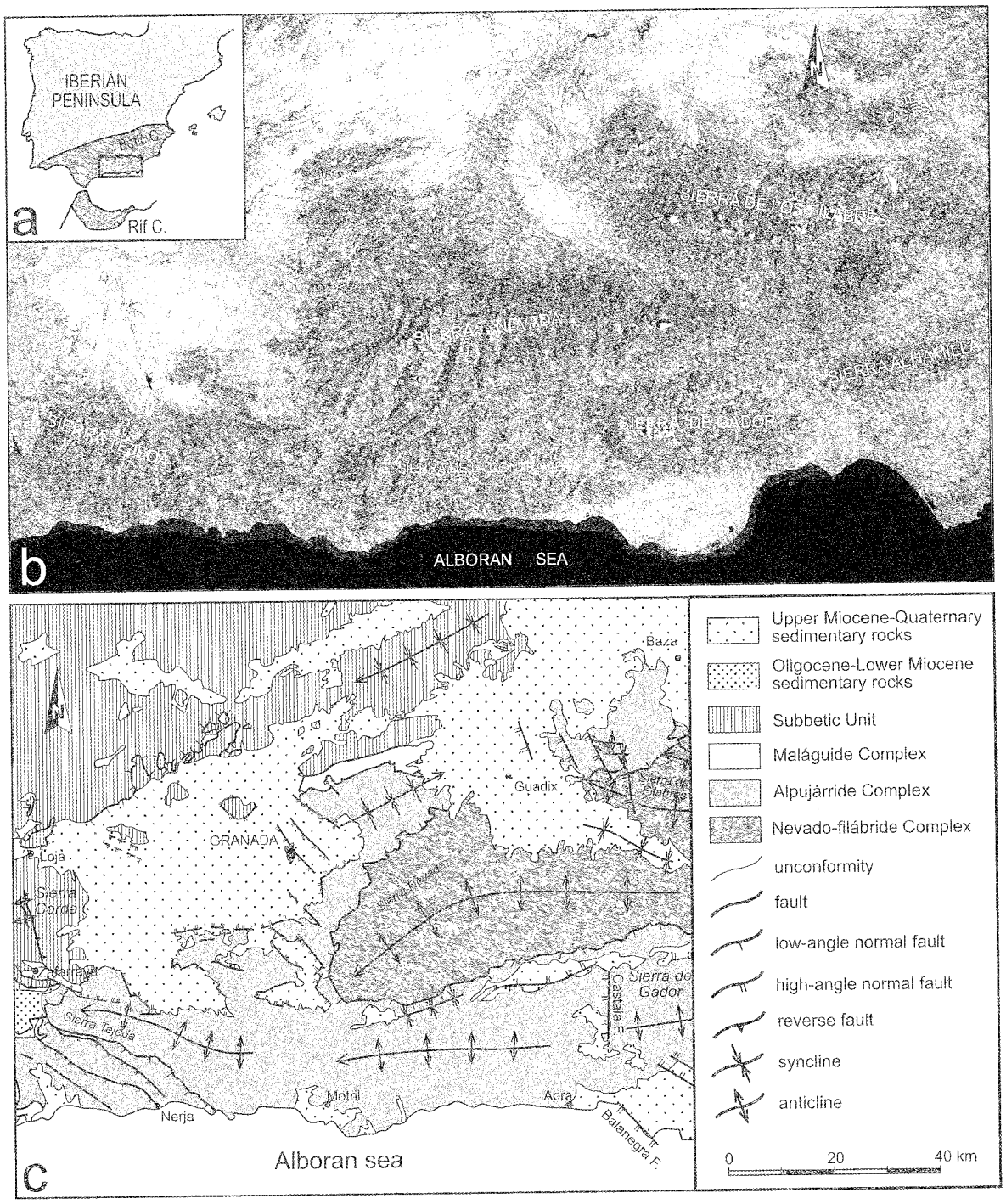

Fig. 1 - Main folds and faults in the central sector of the Betic Cordillera. a, location of the study area. b, satellite view of the region. c, tectonic sketch map.

dences of recent activity as the present-day coast line is not deformed (Fig. 1).

3. DISCUSSION AND CONCLUSIONS

In the central Betic Cordilleras, folds and faults developed together since Middle Miocene. Reverse blind faults —probably located at depth— and large folds are responsible for the relief uplift, and are directly associated with the oblique convergent character of the plate boundary. However the active faults that are recognised in the upper part of the crust in this transect of the Cordilleras are mainly normal and have large vertical displacements. They are grouped into two main sets. The E-W oriented faults, like the active Zafarraya Fault, are parallel to kilometre-sized fold axes. The NW-SE oriented fault set is orthogonal to the main trend of extension undergone the area.

In this setting, and in the frame of the COST 625 action, we are installing a geodetic network (Fig. 2) that includes 15 GPS observation points and may allow us to quantify the present-day deformation in the Zafarraya Fault and the Sierra Tejeda antiform. The proposed network features a local network in the Zafarraya area and a

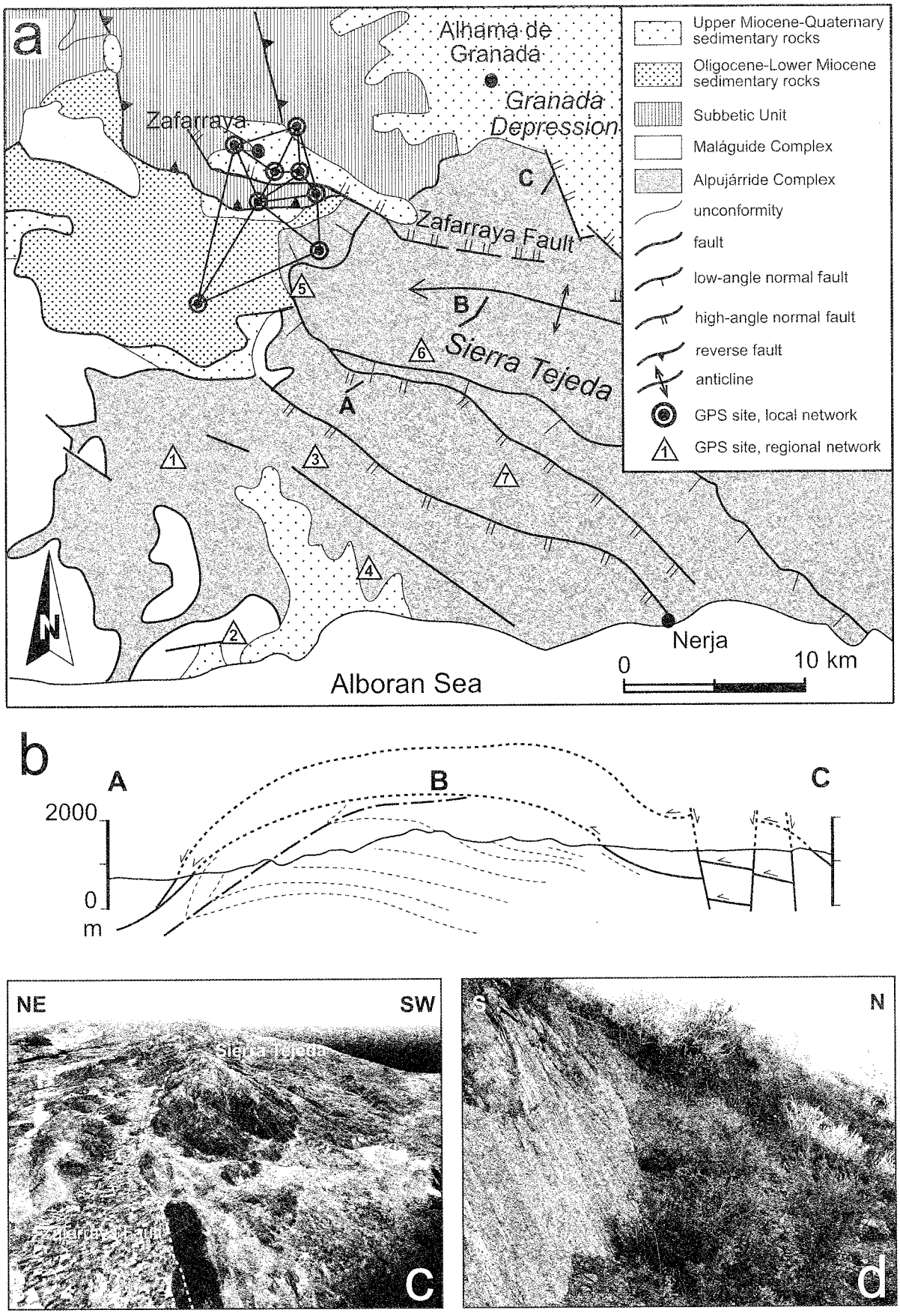

Fig. 2 - Zafarraya fault and Sierra Tejeda antiform. a, tectonic sketch and GPS geodetic network. b, cross section of Sierra Tejeda antiform. c, satellite restituted image of the Sierra Tejeda fold and Zafarraya fault. d, Zafarraya fault surface and associated colluvial wedge.

regional network that extends up to the coast line. In addition, several high precision levelling profiles will be done. The aim of the local network is to characterize the slip in the Zafarraya fault and to determine if there is a tectonic creep component. These data may help to relate the fault and the fold activity with the relief building in the region.

REFERENCES

JOHNSON C. (1997) - *Resolving denudational histories in orogenic belts with apatite fission-track thermochronology and structural data: an example from southern Spain*. Geology, **25**, 623-626.

MUÑOZ D. & UDÍAS A. (1981) - *El Terremoto de Andalucía del 25 de Diciembre de 1884*. Instituto Geográfico Nacional, Madrid.

WEIJERMARS R., ROEP TH.B., VAN DEN EECKHOUT B., POSTMA G. & KLEVERLAAN, K. (1985) - *Uplift history of a Betic fold nappe inferred from Neogene-Quaternary sedimentation and tectonics (in the Sierra Alhamilla and Almeria, Sorbas and Tabernas Basins of the Betic Cordilleras, SE Spain)*. Geol. Mijnb., **64**, 397-411.