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Tectonophysics 420 (2006) 473–491
TECTONOPHYSICS
www.elsevier.com/locate/tecto

Morphotectonic evolution of the New Caledonia ridge (Pacific Southwest) from post-obduction tectonosedimentary record

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Received 13 June 2005; received in revised form 3 April 2006; accepted 13 April 2006
Available online 5 June 2006

Abstract

The tectonostratigraphic and geomorphic study of two post-obduction fluvial sedimentary systems on mainland New Caledonia and imaged offshore on seismic reflection lines provides a new perspective on the post-orogenic evolution of the New Caledonia ridge. Relations between sedimentary sequence boundaries, erosion surfaces and faults, both on land and on offshore seismic reflection profiles indicate that an episode of extensional tectonics initiated in the Early Neogene led to the disruption and collapse of the island landsurface previously shaped during a Latest Oligocene phase of planation. Microtectonic analysis further suggests early slip on the normal faults was associated with ridge-normal extension. A later set of faults accompanied ridge-parallel to ridge-oblique extension that is interpreted to result from a shift toward a transtensional regime driven by the initiation of east-verging subduction of the Australian plate beneath the Pacific plate starting at least in the late Mid-Miocene.

Keywords: New Caledonia; Aggradation; Incision; Fault-slip data; Planation surface; Seismic reflection; Normal faulting; Transtension

1. Introduction

Insular landscapes are sensitive gauges of the geomorphic responses to base level change. Because of the small distance separating divides and shelf edges of islands, their drainage network may rapidly adapt to climatically or tectonically driven relative sea level change. The continental ridge supporting New Caledonia island has emerged and has been rising since the end of the Paleogene orogeny that affected the Southwest Pacific. With more than 1500 m of inland relief and 2000 m bathymetry of its adjacent basins, the New Caledonia ridge is a particularly relevant case study of the interactions of tectonic deformation, eustasy and isostasy (Dubois et al., 1974a). Here we present the results of combined onshore geomorphic, stratigraphic, and structural analysis of post-orogenic fluvial sediments and offshore seismic reflection data across the New Caledonia ridge and its margins. This allows assessment of the Late Oligocene to Neogene paleogeography and tectonostratigraphy of the ridge and its margins and adjoining basins in a context of post-obduction extensional tectonics.

2. Geological background

2.1. Geodynamic setting

New Caledonia lies on the northwestern extension of the Norfolk ridge that forms, with the Lord Howe rise

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0040-1951/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.tecto.2006.04.004

and the Fairway ridge (Fig. 1a) the three main elongated continental fragments that drifted away from the Australian continent as a result of Gondwana breakup in the Late Cretaceous (Dubois et al., 1974b; Crawford et al., 2003; Lafoy et al., 2005). The New Caledonia ridge is flanked by two oceanic basement-floored basins (i.e., the Loyalty Basin, to the northeast and the New Caledonia Basin to the southwest; Fig. 1). The curved D'Entrecasteaux ridge (Fig. 1b) represents the northerwestern extension of the New Caledonia ridge (Maillet et al., 1983). These ridges and basins are carried by the Australian plate that has been subducting beneath the Pacific plate along the Vanuatu trench (Fig. 1) since at least the Mid-Miocene (Auzende et al., 1995). The eastern part of the Australian plate has undergone a Cenozoic orogeny that led to the obduction of several ophiolitic bodies along a belt stretching from New Guinea to New Zealand (Aubouin et al., 1977; Fig. 1).

New Caledonia Island (Grande-Terre; Fig. 1b) displays the largest of these ophiolites. It is a nappe made of lithospheric mantle (Avias, 1967; Aubouin et al., 1977; Prinzhofer et al., 1980; Paris, 1981) that is now preserved in several massifs throughout the island (Fig. 2). The nappe, which roots to the NE along the northeastern margin of the ridge, is interpreted as the mantle lithosphere underlying the Loyalty Basin (Collot et al., 1987).

2.2. Outline of the tectonic evolution

Pre-Late Cretaceous Gondwana basement rocks of New Caledonia have undergone the Early Cretaceous Rangitata (Neo-Cimmerian) orogeny (Paris, 1981). Late Cretaceous rifting linked to the onset of Gondwana breakup initiated shallow water sedimentation until the Mid-Eocene. In the Late Eocene, the New Caledonia ridge and its sedimentary cover were overthrust by the large volcano-sedimentary Poya nappe (Aitchison et al., 1995). This unit is an intermediate-mafic basaltic mélange developed from

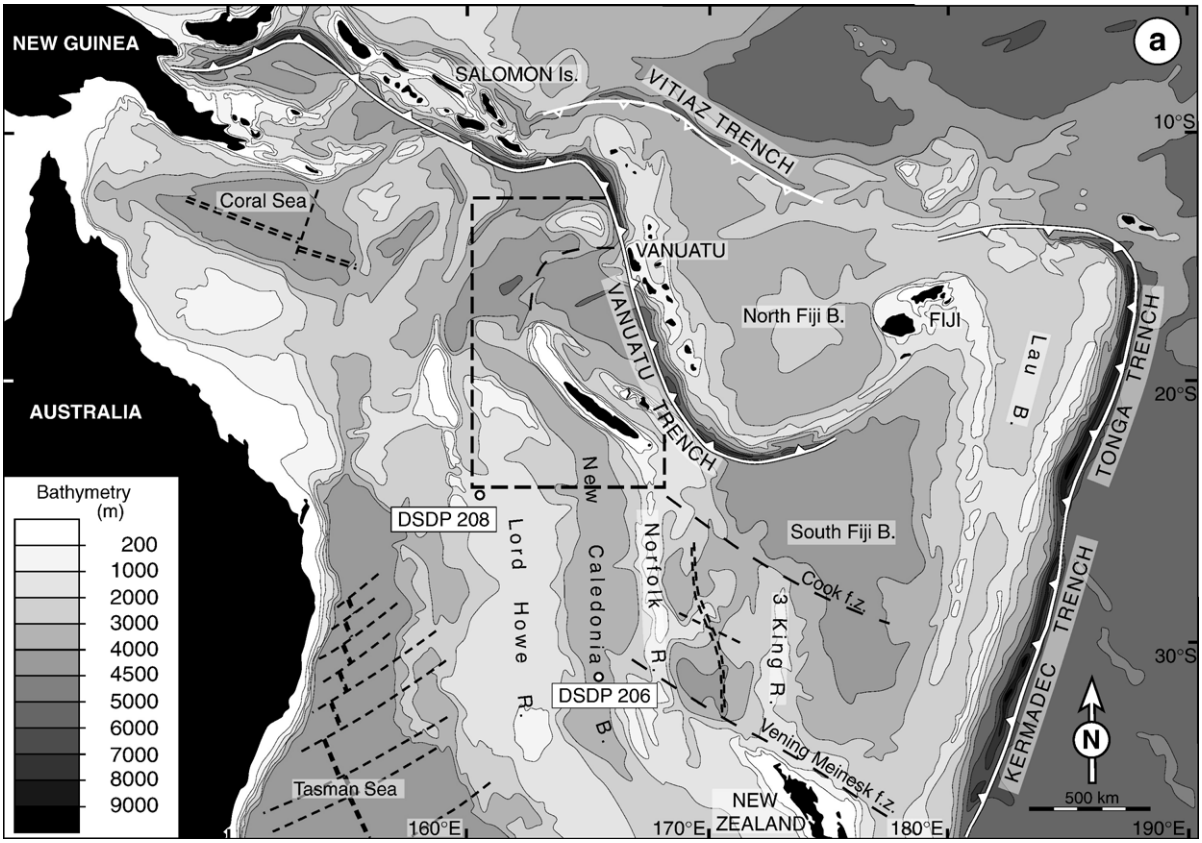

Fig. 1. (a) Geodynamic setting of New Caledonia. R — rise or ridge, B — basin, f.z. — fracture zone. DSDP site 206 and 208 are shown. (b) Morphology and post-Eocene structures of the New Caledonia archipelago and surrounding regions. The fault pattern is compiled after Maillet et al. (1983), Mignot (1984), Rigolot (1989), Dupont et al. (1995) and Lafoy et al. (1995). Frame of (b) is shown on (a).