Available online at www.sciencedirect.com
ScienceDirect
Tectonophysics 466 (2009) 377–394
TECTONOPHYSICS
www.elsevier.com/locate/tecto

Consequences of continental subduction on forearc basin and accretionary wedge deformation in SE Taiwan: Insights from analogue modeling

Jacques Malavieille *, Ghislain Trullenque [1]

Laboratoire Dynamique de la Lithosphère, UMR 5573, University Montpellier 2, place E. Bataillon, 34095 Montpellier Cedex 5, France

Available online 22 November 2007

Abstract

In southeastern Taiwan a slice of forearc basement belonging to the Philippine Sea Plate upper-plate is suspected to subduct under the Luzon arc as a consequence of the transition from oceanic to incipient continental subduction. Effects on the morphology, deformation, geometry of structures and tectonic evolution of the orogenic wedge in the collision area are numerous. This study examines the impact of forearc lithosphere subduction on forearc basin and accretionary wedge deformation. A morpho-structural analysis of the geological features observed onland and offshore allows describing in detail the complex deformation suffered by the area. A combined approach by analogue modeling is applied to better understand the phenomenon. Comparison between nature and experimental results shows that subduction of a forearc basement slice induces intense shortening and concomitant deformation in the forearc domain. Such process involves deformation of the forearc basin previously developed in a setting of oceanic subduction. Sediments of the forearc basin are involved in the growth of a new thrust ridge backthrusted against the basement slope of the volcanic arc edifice. Sediments coming from the growing orogenic wedge are trapped in the trough developed between its backpart and the topographic high of the new rising ridge. A syn-collisional orogenic basin develops which structural evolution characterizes the progressive shortening of the forearc domain. Most of the deformation and tectonic events recorded offshore or onland in the complex area south of Taiwan can be explained using results of our specific modeling which well describe the tectonic processes associated with continental subduction under a volcanic arc.

Keywords: Taiwan; Continental subduction; Forearc deformation; Syn-collisional orogenic basin; Analogue modeling

1. Introduction

In convergent settings, the transition between oceanic and continental subduction induces major changes in the mechanical boundary conditions at plates boundary. Simple geological comparison from south to north of Taiwan shows that a large piece of the oceanic accretionary system is missing in the domain involving continental subduction, where remnants of the volcanic arc edifice (coastal range) are directly juxtaposed with metamorphic continental rocks of the central range. Such setting is difficult to reconcile with classical arc-continent collision models. Recent works, some based on physical and numerical modeling at lithospheric scale (Chemenda et al., 1997; Tang and Chemenda, 2000; Chemenda et al., 2001; Boutelier and Chemenda, 2003), others based on geological and geophysical observations onland and offshore Taiwan (e.g., Malavieille et al., 1999, 2002; McIntosh et al., 2005), have demonstrated that an important tectonic process occurs which is characterized by subduction of a forearc lithosphere slice under the oceanic lithosphere constituting the upper-plate. At the beginning of the process, the subduction of the continental margin strongly increases the stress and strain in the upper-plate (Shemenda, 1994; Lallemand, 1999; Tang and Chemenda, 2000), sometimes involving failure and then subduction of a lithosphere sliver from the forearc domain. The effects of these deep processes on morphology, internal structure and tectonic evolution of the accretionary wedge-forearc basin system are numerous but scarcely studied until now. Using sandbox models, we have studied the impact of this geodynamic process on deformation at the scale of the accretionary wedge. We model a setting in which a continental margin is subducting under an oceanic lithosphere bearing a mature volcanic arc, inducing subduction of forearc lithosphere. The results of the modeling are compared with geological observations from southeast Taiwan and a new interpretation is proposed for the

* Corresponding author.
E-mail address: malavie@gm.univ-montp2.fr (J. Malavieille).
[1] Presently at: Faculty of Earth Sciences, Utrecht University, P.O. Box 80.021, 3508 TA Utrecht, The Netherlands.

0040-1951/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.tecto.2007.11.016