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Reconstruction of the evolution of the Alpine-Himalayan orogen - an introduction

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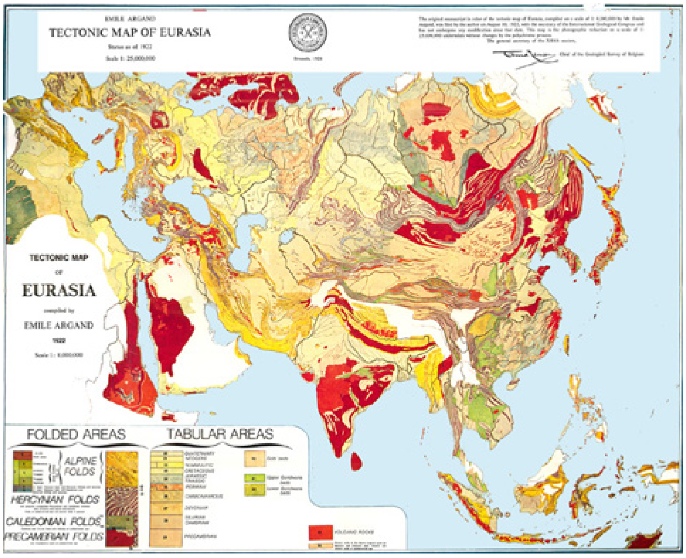
PREFACE

The Alpine-Himalayan belt is a young orogen suturing Gondwana-derived fragments with Eurasian continental crust. Its general structure, as a continuous belt of Mesozoic and Cenozoic deformation from Spain to Southeast Asia is described in the pioneering work of Argand (1924) (Figure 1). Further southeast, in the southwest Pacific, the orogenic belt is partly submerged but probably stretched as far as New Zealand (Figure 2).

Figure 1. Tectonic map of Asia

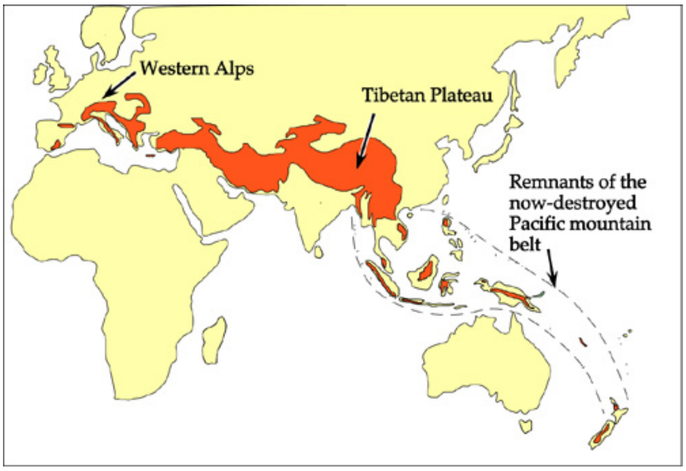


The tectonic map of Asia produced by Emile Argand (1924).

The advent of plate tectonics 35 years ago provided an explanation for the large-scale plate kinematics associated with Alpine-Himalayan orogeny. However, when it comes to details, plate tectonics has proved to be insufficient to reconstruct this complex system. In reality, the Alpine-Himalayan orogen has been subjected to numerous processes involving motions of smaller continental ribbons, retreating subduction systems, back-arc extension and accretion of magmatic arcs. In order to reconstruct the Alpine-Himalayan system, we need to analyse data derived from multidisciplinary sources and develop sets of spatio-temporal constraints. We can then test these constraints against a set of possible alternative reconstructions. Examples are the works of Dercourt et al. (1986; 1993; 2000) and Stampfli et al. (2001), which are extremely valuable to the reconstruction community.

This volume includes ten contributions on the reconstruction of the tectonic evolution of the Alpine-Himalayan orogen (see locations of study areas in Figure 3). The first paper by Martínez-Martínez & Azañon presents results of their study in the westernmost part of the Alpine-Himalayan orogen, the Gibraltar Arc. The authors provide evidence for two episodes of orthogonal extension in this region, and they discuss the significance of such events in terms of the regional kinematics and the evolution of the Alboran Sea. In the same region, Sánchez-Gómez et al. present structural and metamorphic analysis related to the emplacement of mantle peridotites within the Rif-Betic orogen. The authors argue that these peridotites were emplaced as a single slab during an Oligocene/Early Miocene suturing.

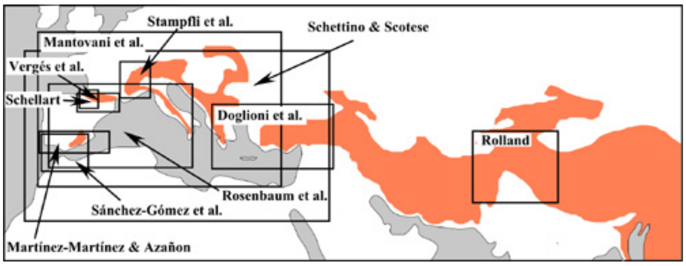
Figure 2. The Alpine-Himalayan orogen



The Alpine-Himalayan orogen stretches from Spain to New Zealand (after Lister et al., 2001).

Two contributions deal with the Pyrenean Mountains that formed a collisional plate boundary between Iberia and Europe until the Oligocene (Srivastava et al., 1990). Schellart presents results of a structural and sedimentological study of the western termination of the axial zone in the southern Pyrenees. These results provide the means for the construction of balanced cross sections and for crustal shortening calculations. Vergés et al. provide a comprehensive review of the tectonism in the Pyrenees since the Cretaceous. The authors analyse stratigraphical cross sections and lithospheric-scale transects, and discuss transitions between crustal shortening and extensional regimes.

Figure 3. Location map



Location map of areas discussed in this issue.

A plate reconstruction of western Tethys is presented by Stampfli et al., with an emphasis on orogeny in the western Alps. The latter is probably the most studied segment of the Alpine-Himalayan belt, but is still controversial as far as tectonic reconstruction is concerned.

Three contributions present large-scale tectonic reconstructions of the Mediterranean Sea. Rosenbaum et al. focus on the kinematics of the western Mediterranean since the Oligocene as inferred from various spatio-temporal constraints. The resulting animation movie emphasises the role of subduction rollback, back-arc extension and accretion of allochthonous terranes. Relationships between subduction systems and back-arc extension are also addressed by Mantovani et al., who propose an extrusion model driven by the convergence of the confining plates to explain the occurrences of slab migration throughout the Mediterranean region. Schettino & Scotese present a Jurassic-Cretaceous reconstruction model for the Mediterranean region using constraints for the motion of the major plates. These authors make the controversial suggestion that the kinematics of smaller microplates involved in Mediterranean tectonics can be determined from variations in the relative velocities of the larger plates.

The difficulty in applying rigid-body plate reconstructions in the eastern Mediterranean is discussed in the paper of Doglioni et al.. The authors present velocity fields of plate motions that show differential convergence rates of Africa with respect to Europe, which may account for widespread extension in the Aegean Sea.

Lastly, the contribution of Rolland provides an analysis of the tectonic evolution of the NW Himalaya. The author uses structural, metamorphic, geochemical and geochronological data to constrain a reconstruction model of India-Asia convergence and accretion of the Karakoram-Lhasa block onto the Asian margin. Interestingly, Rolland's 'ribbon accretion' model is not dissimilar to that proposed for convergence in the Mediterranean segment of the orogen.

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