

*Histoire Structurale du Golfe de Gascogne/Structural History of the Bay of Biscay.*

J. Debyser, X. Le Pichon and L. Montadert (Editors). Editions Technip, Paris, 1971, 2 vols., Fr.Francis 180.00.

The two volumes covered in this review are the proceedings of a Symposium held in Paris from 14 to 16 December 1970, jointly organized by the Institut Français du Pétrole and the Centre National pour l'Exploitation des Océans (CNEXO). The Symposium was recommended by the Scientific Committee of Oceanic Research (SCOR) Working Group No. 31.

Some statistical data about these volumes are: (1) they contain 43 contributions, divided over 6 sections; (2) 34 papers are in French, 9 in English; (3) there are 95 authors, two-thirds of whom are from French Universities and industry; the other contributors came mainly from the United Kingdom, U.S.A., Spain and The Netherlands.

The symposium was mainly a presentation of geologic and oceanographic facts, which makes the volumes extremely valuable. In addition, attempts were made to analyze the data and develop significant hypotheses. Although the majority of the papers is written in French, the editors have taken every effort to publish a bilingual book; the titles, captions to figures and several notes are all presented in English and French. The organization of the book into six sections is attractive and logical and is as follows: (I) Structure of the Hercynian basements in Western Europe and the Iberian Peninsula; (II) Paleomagnetic data; (III) The Continental margin north of the Bay of Biscay; (IV) The Secondary and Tertiary basins in Aquitaine and the Pyrenean range. Links with the Bay of Biscay; (V) The Secondary and Tertiary basins in Northern Spain. Links with the Bay of Biscay; (VI) The Oceanic Area.

It is impossible in this review to discuss all 43 contributions; instead, an attempt will be made to give a brief discussion of the opinions on the origin of the Bay of Biscay. The consensus of opinion is that the Bay of Biscay originated from continental drift/plate tectonic processes. Most authors support the following course of events in the Pyrenees and Bay of Biscay area:

(1) During the Triassic and Earliest Jurassic a period of tension occurred, predating the break up of the assembled configuration of the (present-day) Atlantic-bordering continents;

(2) Between Middle Jurassic and Paleocene, and most probably during Early and Middle Cretaceous times, the Bay of Biscay was created; while the Iberian and European plates moved away from each other. This motion can be described by a relative rotation of the Iberian plate over an angle of  $30^\circ$  around a pole (pivot point) somewhere in Western Europe (Le Pichon favours specifically  $50.0^\circ\text{N}$ ,  $3.28^\circ\text{E}$  for this pole);

(3) In Early Tertiary, mainly Eocene, times a compressional stage prevailed, related to the mutual north-south approach of Africa, the Iberian plate and Europe; this is the orogeny of the Pyrenees and the westward continuation thereof (Cantabria and the continental margin off northern Spain between  $3^\circ$  and  $9^\circ$  W). In fact some authors (Boillot et al.; Sibuet and Le Pichon; Le Pichon et al.) consider the trench off the northern Spanish

coast to be a fossil trench related to a southward dipping subduction zone;

(4) In late Oligocene/Miocene times there occurred a stage of mainly normal faulting accompanied by diapirism.

In spite of the abundant wealth of evidence from classical geology, paleomagnetism, marine magnetic-, gravity- and seismic surveys, and other oceanographic research, several minor questions remain to be solved and many differences of opinion need to be resolved. One of the more apparent discrepancies is the amount of rotation of the Iberian plate, discussed in the above mentioned stage 2: estimates vary from  $35^\circ$  (deduced from paleomagnetic research reported by Zijdeveld and Van der Voo, and earlier coastline fitting) or  $30^\circ$  (supported by marine magnetic anomalies: Williams; Le Mouel and Le Borgne; Schouten et al.), and plate tectonic arguments (Le Pichon et al.) to  $25^\circ$  (favoured by Mattauer on the basis of his geological studies in the Pyrenees) or even  $10-20^\circ$  (favoured by Montadert and Winnock on the basis of a supposedly large-scale subsidence of marginal continental crust in the Bay of Biscay). Previously published theories by some French authors, in favour of "oceanization" or complete subsidence of a continental-crust segment in the entire Bay of Biscay area seem to have been discarded. All authors in these two volumes seem to agree qualitatively, if not quantitatively, on a rotation of the Iberian Peninsula.

While reading the books, one becomes aware that the area is one of the most extensively studied in the world and that this multidisciplinary report is an exciting example of modern earth-science research leading to fully acceptable hypotheses. At the same time the books serve to pinpoint the work still to be done.

It is superfluous to recommend these volumes to those actually involved in research on this area, since they will undoubtedly have heard about it, if not have contributed to it. We do recommend the books, however, to all libraries etc., notwithstanding the expense. It seems that the high cost of the two paperbound volumes, printed in off-set, is one of the few drawbacks that can be mentioned at this time.

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*Numerical Analysis in Geomorphology, an Introduction.* J. C. Doornkamp and C. A. M. King. Edward Arnold Ltd., London, 1971, 372 pp., £4.00.

The format of this volume is rather unusual. It is divided into four chapters each of which covers a major field of geomorphological study. The first chapter is entitled "Drainage Basins", and includes separate subtopics such as stream networks, and basin morphometry; a further division of the subtopic includes usually a case study of a particular region, a discussion of the nature of the data and its collection and conversion to numerical form and a discussion of an array of statistical techniques, illustrated by application to one or several sets of real, geomorphological data. Statistical techniques include a wide array of modern methods. The second major subdivision is entitled ,