

Fitton (p. 473) points out that the Benue trough is usually cited as an example of a 'failed' arm of an rRR triple junction. The author suggests that it is related to the Cameroon line or alkaline volcanic centres which originally was located where the Benue trough now is. Decoupling of the crust caused the eastward displacement. Comparison should be made with the paper by Browne *et al.* (p. 187) on the Ngaoundere rift.

Golobek *et al.* (p. 483) describe the Espanola basin of the Rio Grande rift and its development, using a sequence of diagrams. Lessons can be learnt for application to the Rio Grande rift. Mohr (p. 509) questions whether the thinning or attenuation of upper continental crust in the Western Afar resulted from block faulting and tilting (Morton-Black hypothesis) rather than direct dilatation in support of which he cites the presence of dyke-swarms.

Wood (p. 529) suggests that offsetting of rift valleys (rift jumps) should be seen as parallelling what happens to ocean rifts. It is not clear what the author has in mind regarding surface connection between the jumped segments. Where continental crust is exposed there does not appear to be visible evidence. He cites the example of Benue-Cameroon (refer to Fitton, p. 473).

Pollard *et al.* (p. 341) describe observations on surface deformation as related to dykes emplaced in volcanic rift zones and use observed data from Kilauea Volcano. Various cases are described. This is a useful and informative article combining observation of actual phenomena with theory (nature simulating modelling!).

Milanovsky is probably the leading figure in the study of rifting evolution in the earth's history. His extensive reviews of the subject of continental rifts, old and new, are classic accounts. It is therefore to be expected that his paper should be a comprehensive and balanced treatment of the subject, as indeed it is. He has not accepted plate tectonics but follows '... the concept of the pulsating Earth against the background of its general moderate and irregular expansion ...'. This hypothesis on some counts is not necessarily in conflict with plate tectonics. Indeed the expanding earth model is regarded by many as offering acceptable solutions to certain anomalies. This paper cannot be less acceptable because it is based on a divergent world view. The value of the paper is not affected.

Three final papers, on porphyry-molybdenum occurrence, mineral and gas accumulation in rift lakes, and geothermal resources, do not exhaust the economic possibilities of rifts and rift lakes. Most students of rifting mechanisms disregard economic possibilities.

The reviewer believes that this volume, in certain important aspects, is a considerable advance on any previous collection of papers on rifts and rift valleys. It probably contains a better blend of modelling and formulation of hypotheses, with access to new information and the results of painstaking research, than any recent compilation. It is probably unique in the largely successful intentions of the authors to involve contributors in the aim 'to give modellers direct exposure to the constraints imposed by some of the available data.' A few authors have obviously yet to appreciate that this is the only approach which a scientist can make. The article which, above most others, must for these reasons be commended is that by the late Professor Crough to whose memory this volume is dedicated.

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A coherent view of the geological evolution of Europe

Ziegler, P. A. 1982. *Geological Atlas of Western and Central Europe*. Elsevier (in collaboration with Shell International Petroleum). Amsterdam. 130 pp., 40 boxed enclosures. Price: US \$68.00, DFL 160.

Fifty or more years ago attempts to give an integrated view of the geology of Europe were not uncommon. But from then, until the publication in 1969 of M. G. Ruten's *The Geology of Western Europe* few syntheses in English appeared. During the last decade the tectonic effect of plate-tectonic models coupled with newly acquired subsurface and submarine data have stimulated the publication of several books concerned with Europe or large parts of it. Ziegler's exceptionally good-looking Atlas and accompanying commentary is clearly a by-product of the search for hydrocarbons. Shell International are to be applauded for permitting formerly confidential information to be included, subsidising publication (the enclosure box contains 37 A3-sized coloured maps) and encouraging Peter Ziegler to undertake the task of compilation and synthesis.

The seven chapters are: (1) Introduction, (2) Suturing of Pangea, (3) Permo-Triassic development of Pangea, (4) Pangean disintegration, (5) Late Cretaceous sea-floor spreading and onset of Alpine plate collision, (6) Cenozoic opening of the Norwegian-Greenland Sea, Alpine orogeny and Alpine late orogenic collapse system and (7) Thoughts on mechanisms of basin subsidence. There is also a 21-page list of references but, surprisingly, no index. The forty enclosures are grouped under five headings: (1) Tectonic and geological maps, (2) Palaeogeographic maps, (3) Isopach maps, (4) Stratigraphic correlation charts and (5) Legends. Enclosure 26, designed to be superimposed on the palaeogeographical maps, is a two-part transparent overlay showing political boundaries, rivers, towns and selected bathymetric features. Twenty-nine line drawings are included in the text.

Although according to its title coverage of the book is Western and Central Europe this is somewhat misleading. With the exception of a few brief asides the emphasis is firmly on Northwest and North Central Europe which, incidentally, is taken as extending as far east as Estonia (longitude 25°E). The geology of the North Sea is central to Ziegler's geographical scope as well as to many of his reconstructions. The Alpine deformation front is used as a convenient southern limit in many maps. From a temporal perspective Ziegler concentrates on history from the Late Silurian onwards, that is post-Caledonian events. Understandably, his principal tectonic concern is basin evolution and he tells a vivid story of basin superimposition and inversion. Ziegler recognizes five main stages in the Late Silurian to Recent evolution of Western and Central Europe and these he makes the headings of his Chapters 2 to 6.

Perhaps because they illuminated dark corners of my geological awareness the sections of the book I most enjoyed are those on Triassic rifts and Tethys transgression (3.2), Mid-Cimmerian revolution (4.3) and Late Middle and Late Jurassic polarization of the European rift systems (4.4). In these sections Ziegler analyses important episodes of crustal extension and demonstrates how normal and wrench faults bounding rifts controlled sedimentation, and how individual structures experienced episodes of activity and inactivity.

A temptingly easy target for a reviewer of a broad-ranging book such as this one is to see how it deals with some small patch familiar to him. In this respect Ziegler's maps generally emerge well from critical inspection but it is noticeable that the locations of some structures migrate from map to map or are incorrectly placed. For example, the Sticklepath fault shifts about 25 km west from Enclosure 3 to Enclosure 4 and on Enclosures 4, 19 and 20 the Jurassic Moreton-in-Marsh axis is shown about 60 km east-northeast of Moreton. These and other minor cartographic slips may be no more than artefacts of the drafting office.

The text is almost entirely free of typographical errors. Curiously, the spelling of Palaeozoic is American on Enclosure 1 but English on Enclosure 3.

My main reservation about Ziegler's approach is that he employs the concept of discrete deformation pulses having synchronously affected large regions and tectonic units which were formerly widely separated but are now juxtaposed in accretionary terranes. Thus names like Bretonic, Sudetic, Laramide, etc. crop up throughout the text. A shortcoming of the palaeogeographical maps, recognized by Ziegler, is that areas affected by Variscan and Alpine deformation have not been palinspastically restored. The reasons for this are understandable but avoiding the problems inherent in allowing for stratal and crustal

shortening diminishes their value. Furthermore, although the translatory effects of some major transcurrent faults are appreciated displacements on other terrane boundaries have been ignored.

However, despite the above reservations, the Atlas is an impressive and useful work. All readers of the *Journal of Structural Geology* are likely to find Ziegler's concluding chapter, 'Thoughts on mechanisms of basin subsidence' a stimulating and all-too-brief account. It comprises a set of generalisations, based not upon speculations about possible modes of lithosphere behaviour, but on a wealth of evidence that has been digested and synthesised. We should be grateful to Peter Ziegler for his efforts in compiling the Atlas.

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