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Book Reviews

Continental extension

Coward, M. P., Dewey, J. F. & Hancock, P. L. (editors) 1987. *Continental Extensional Tectonics*. Geological Society of London Special Publications No. 28. Blackwell, London. Price £40, $115.

There has always been great interest among geologists in the continental rifts of East Africa, the Rhine, the Rio Grande and others. In the past dozen years or so the topic of extensional tectonics has broadened considerably from a study of such rifts and interest in it has grown to a very high level. This volume reflects very well the developments in the field and current thinking on crustal extension. It contains 39 of the 88 papers presented at the conference of the same title held in Durham in April 1985 under the auspices of the Geological Society of London. There are in aggregate 91 authors of the papers in the volume, and it is interesting to note that not one paper covers either of the classic areas of the Rhine Graben or East African Rift. These rifts, which have received so much attention in the past, represent incipient stages of continental extension. The papers in this volume largely deal with the effects of much greater extension, which leads ultimately to continental fragmentation.

The surge of interest in extensional tectonics is, I believe, due to several factors. First, in the mid-1970s the significance of the low-angle normal faults in the metamorphic core complexes of the Basin and Range province began to become clear. Second, deep seismic reflection studies of COCORP in the western U.S.A., BIRPS in the continental shelf around Britain and similar programs elsewhere have provided compelling evidence for the widespread existence of large low-angle faults in the middle crust, and these faults have been related to the type of structure seen at the surface in the Great Basin of the western U.S.A. Third, the increased understanding of fabric development in shear zones has provided the evidence for the existence of many low angle extensional ductile faults now exposed at the Earth's surface.

The volume is divided into five sections; the first deals with fault geometry and mechanics (10 papers), the second covers the very important Basin and Range province and East Pacific margin (16 papers), the third the NW European continental shelf (eight papers), the fourth the Middle East (three papers) and the last extension in thrust belts (two papers). The categories of course are not so clear-cut as this division may seem to imply, so that, for example, mechanical considerations are treated in papers in each of the five sections. Much of the material, as is often the case in conference proceedings, is not new, but there is also much that is.

In several papers on mechanics, in the first section, it is shown that lithospheric extensional strength is inversely proportional to crustal thickness and to heat flow, and that continental lithosphere is generally weaker than oceanic lithosphere. A specific analysis of Basin and Range structure suggests that Tertiary extension occurred because the crust had been previously thickened during Mesozoic orogeny.

The papers in the second section on Basin and Range extension give good expression to the wide range of views that have been proposed, and most of the key researchers who have worked in the region have papers here. The ideas on core complexes are well represented and the remarkable Tertiary mid-crustal detachment faults, separating brittle cover from ductile basement are nicely described. The various papers cover microstructures, large-scale structures and structures evident from seismic reflection data. Three papers examine active faulting and kinematics of crustal movement in the Great Basin and Rocky Mountain region.

The tilted block geometry of extensional faults and presence of detachment horizons so clear in the southwest U.S.A. are inferred in the NW European Continental Shelf around Britain; there are three papers on this and a fourth paper deals with gravity modelling. Seismic reflection data play a prominent role in establishing these structures, which are related to late Paleozoic and Mesozoic continental break-up. Other papers in this section consider the geometry of faults, sedimentation and basin development associated with rifting events of various ages in Britain and Norway.

Two papers in the short section on the Middle East deal with the kinematics of extension in the Suez rift and the Sinai triple junction and a third paper documents the complex pattern of faulting in western Turkey.

The final section on Extension in Thrust-belts contains just two papers, one dealing with evidence for extension in the Honshu fore-arc off Japan, based on DSDP results, and the second with extension in the Himalayan orogen. Both papers show that normal faulting can occur at high crustal levels, decoupled from thrusting presumed to occur at greater depths.

A few general themes can be drawn from these papers. A first of course is that detachment faults, separating upper 'brittle' crust from lower 'ductile' crust, may be very common. A second is that crustal extension frequently follows crustal compression and old compressional structures may become reactivated as extensional structures. It is also true that compression may follow extension and that old low-angle normal faults may become reactivated as thrust faults. A third is that the three-dimensional geometry of extensional fault systems, like thrust fault systems, can be very complex, making palinspastic reconstruction and balancing sections decidedly not a trivial exercise.

There is a wealth of material in this book. I would strongly recommend it to anyone interested in finding out about current ideas on the mechanics of rifting and continental extension or wanting good descriptions of extensional structures in several important areas.

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Methods of structural analysis

Marshak, S. & Mitra, G. (editors) 1988. *Basic Methods of Structural Analysis*. Prentice-Hall, Englewood Cliffs, New Jersey. 446 pp. Price £36.40, $46.90 (soft back).

This is another addition to the growing number of texts designed to act as structural geology course manuals (e.g. Ragan 1973, 1985, Ramsay & Huber 1983, 1987, Rowland 1986). It differs from these by its divisions into two main parts, the first written by Marshak & Mitra, and the second comprising eight chapters authored by eight contributors plus the editors, in varied combinations.

The book is divided into three parts. Part I, *Elementary Techniques*, contains eight chapters whose titles are: (1) Measurement of attitude and location, (2) Interpretation and construction of contour maps, (3) Geometric methods [1], (4) Geometric methods [2], (5) Introduction to stereographic projection, (6) Stereographic poles and rotations, (7) Calculation of layer attitude in drill holes and (8) Equal-area projection and structural analysis.

Part II entitled *Special Topics*, is made up predominantly of chapters by contributing authors. The chapter titles are (9) Interpretation of geological maps (L. B. Platt), (10) Analysis of data from rock deformation experiments (T. Engelder & S. Marshak), (11) Description of mesoscopic structures (G. Mitra & S. Marshak), (12) Analysis of fracture array geometry (A. Goldstein & S. Marshak), (13) Objective methods for constructing profiles and block diagrams of folds (S. Wojtal), (14) Introduction to cross-section balancing (S. Marshak & N. Woodward), (15) Analysis of two-dimensional finite strain (C. Simpson) and (16) Interpretation of poly-deformed terranes (S. Mosher & M. Helper).

Part III consists of four appendices; (1) Review of the key concepts of maps, cross-sections, diagrams and photos, (2) Basic trigonometry, (3) Suggestions for mapping geological structures and (4) Templates for plotting geological data.