Journal of Structural Geology, Vol. 11, No. 6, pp. 779 to 781, 1989
Pergamon Press plc. Printed in Great Britain

BOOK REVIEWS

Two volumes on the Himalayas and Tibet

Shackleton, R. M., Dewey, J. F. and Windley, B. F. (editors), 1988. *Tectonic Evolution of the Himalayas and Tibet.* Philosophical Transactions of the Royal Society of London, Series A. 325 pp. Price £65.

This book reviews recent work on the world's highest mountain range and highest plateau and is based on a meeting held at the Royal Society in November 1987. Not all the papers given at the meeting are included here; one appears in the separate volume on Tibet from the same source. However, the present book is reasonably comprehensive in its coverage of topics, including Tibet. Two rival models for the deep structure are given. One by A. Hirn shows a Moho beneath the Himalaya and Tibet that is not flat or horizontal and the crust is not homogeneously thickened. Instead the lithosphere is imbricated and crustal thickening takes place in steps. P. Molnar provides a valuable critique of the step model which he regards as being inadequately documented. Molnar favours a smooth, N-dipping Moho and cites focal depth, fault plane solutions and body wave propagation data in support. Molnar considers that the existence of underthrust Indian shield beneath Tibet is not proved. Likewise the conclusion that important variations in crustal thickness occur under Tibet is not well established. However lateral heterogeneity is clearly shown by body and surface waves. Low velocity regions in the upper mantle of N. Central Tibet indicate partial melting which is also shown by late Cenozoic vulcanism in that region.

Palaeomagnetism and palaeontological evidence bearing on the pre-collision history of the terranes is reviewed by J. Lin and D. R. Watts and by A. B. Smith, respectively. Lin and Watts argue that the Lhasa terrane and Kohistan were attached to India in the Carboniferous and that Cathaysia existed as a composite continent dividing the Tethys Ocean. Lin also gives a palaeomagnetic test for the huge rotations of Indo-China involved in the Tapponnier 'expulsion' model. Smith gives a valuable discussion of endemism across East Asia and reviews the significance of the various sutures recognised there. The Cimmerian Continent (most of Cathaysia) was an integral part of Gondwanaland in the early Permian until it rifted away on the Zangbo line. Thus Smith concludes that Palaeotethys must have existed north of Tibet.

Several papers deal with the structural and metamorphic evolution of different sectors of the Himalaya and Karakoram. A. J. Rex, M. P. Searle, R. Tirrul, M. B. Crawford, D. J. Prior, D. C. Rex and A. Barnicoat, and M. P. Searle, D. J. W. Cooper and A. J. Rex depict the Karakoram as an Andean arc which underwent low-pressure metamorphism in Jurassic times. The Kohistan–Ladakh island arc was accreted to the Karakoram in mid Upper Cretaceous times prior to eventual collision with the Indian continent in the Eocene. These authors invoke large-scale underthrusting of India as a cause of the uplift of the Karakoram. Both the Karakoram and the Himalaya show an important phase of post-collision metamorphism *ca* 45–35 Ma. Searle *et al.* opt for a 'folded isograd' model to explain inverted metamorphism.

M. P. Coward, R. W. H. Butler, A. F. Chambers, R. H. Graham, C. N. Izatt, M. A. Khan, R. J. Knipe, D. J. Prior, P. J. Treloar and M. P. Williams use balanced cross-sections to demonstrate nearly 500 km shortening across the N. Pakistan sector. Their study includes an interesting application of 'wedge' theory to Himalayan thrusts. Critical wedge taper is lower in N. Pakistan than elsewhere, reflecting the supposed low basal shear strength of the wedge. Taper has been maintained by 'back steepening' and back thrusting within the wedge. K. V. Hodges, M. S. Hubbard and D. S. Silverberg describe two prograde metamorphisms of Tertiary age in the Himalaya—an early high P and T event associated with collision and a later moderate P, high T event related to the emplacement of leucogranites. These authors think that the famous inverted metamorphism of the Himalaya results from different causes in different places, reflecting the differing character of the Main Central thrust. K. S. Valdiya discussing the evolution of the Kumaun Himalaya, also stresses the concept of two metamorphic events in the Higher Himalaya.

P. Le Fort reviews the granites of the Himalaya and Karakoram. Four major plutonic belts of Mesozoic–Cenozoic age are described: the earlier are Andean-type belts (Karakoram–Kohistan) related to ocean subduction while the later belts, covering a much shorter time-span, are related to intracontinental subduction on the Main Central thrust. During movement on this thrust fluid released from the footwall promoted anatexis in the hot hanging wall.

Lastly, P. C. England and G. A. Houseman discuss the application of continuum deformation of a thin viscous sheet to the Himalaya and Tibet. They focus on the problem of the recent E–W extension in Tibet. This they attribute to loss of the lower part of the continental lithosphere, that is the upper thermal boundary layer, which is replaced by hot asthenosphere. This process has caused 3–4 km uplift.

The editors and the Royal Society are to be commended for producing this excellent volume which will serve as a 'state of the art' review of what one contributor calls the "world's great laboratory". Certainly anyone interested in the operation of the earth's processes on the grand scale will find much inspiration in this book. The general reader will appreciate the introductory chapter provided by B. F. Windley. There is a selection of the discussions from the meeting, including an extended exchange on the use of balanced cross-sections in metamorphic orogens. The one serious complaint is that the price is so high.

M. R. W. Johnson

Edinburgh, U.K.

Chang Chengfa, R. M. Shackleton, J. F. Dewey and Yin Jixiang (editors/leaders) 1988. *The Geological Evolution of Tibet—Report of the* 1985 *Royal Society–Academia Sinica Geotraverse of the Qinghai-Xizang Plateau.* The Royal Society, London. 413 pp. Price £95.

A major consequence of the post-collision northward motion of India by over 2000 km has been the creation of the world's highest plateau. Tibet has roughly a double thickness of continental crust but its lithosphere is only three-fifths the thickness of the Indian lithosphere. There are at least three well-known hypotheses to explain the excess of continental crust beneath Tibet.

(1) The underthrusting of Indian continental crust beneath that of Asia.

(2) India, acting as a rigid indenter, penetrating Asian lithosphere which underwent lateral extrusion.

(3) A separate 'indentation' model in which Asia responds by viscous vertical plane strain: horizontal shortening and vertical stretching in advance of the 'bull-dozing' Indian continent.

Set against these inspiring hypotheses is the scanty knowledge of a long-inaccessible region. The history of geological research in Tibet is a short one—Littledale (1896) noted the young volcanics. Sven Hedin (1915) made sample collections and Norin (1946) was the first to map and to record folds and thrusts. Chinese geologists must take the credit for opening the present phase of activity—it was they who identified the ophiolites which follow the several sutures which cross Tibet. But apart from the Franco-Chinese expeditions, this book marks a landmark in the development of Earth science work in Tibet, and is anyway a notable achievement in international co-operation. The book is based on a geotraverse in 1985 organized by the Royal Society and the Academia Sinica, a multidisciplinary study around the road section between Lhasa and Golmud. Ten scientists from the U.K. and U.S.A. and 15 from China took part. The Chinese did important preparatory work. The results are presented here in 14 chapters, plus a coloured 1:125,000 geological map and microfiche 1:100,000 maps showing locations of structural data. Copies of the maps along with satellite imagery are stored in the British Museum of Natural History. Type specimens of fossils are kept in Nanjing.

The subject matter, chapter by chapter, is as follows: Stratigraphy (Yin Jixiang, Xu Juntao, Liu Chengjie and Li Huan): Palaeontology