Continental Extensional Tectonics
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FRONTISPIECE Albert Quennell
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Preface

A conference on Continental Extensional Tectonics was held at the University of Durham, during April 18 to 20 1985, under the auspices of the Geological Society of London and with financial support from The Royal Society. The meeting was well attended, in fact some people had to be turned away as the lecture rooms were packed. Forty-four papers were given as lectures, 44 as posters; this volume contains 39 of the papers presented.

The conference aimed to examine the geometry and mechanics of continental extension and their effects on basin development and plutonic and metamorphic processes. The resurgence of British interest in extensional tectonics has arisen from recent hydrocarbon exploration on the NW European continental shelf and North Sea, together with deep seismic reflection studies of British offshore basins undertaken by the BIRPS group and summarized in this volume by Cheadle *et al.* The importance of extensional tectonics in the Basin and Range region of the western USA has also been realized in the past few years and a large number of papers in this volume summarize the results of recent studies in this area. As can be seen, there is as yet no simple consensus of opinion on the geometry or driving mechanisms of Basin and Range extension. Other regions of crustal extension described in this volume, range from the Aegean and Red Sea to SE Australia and Antarctica. Some papers describe the geometry of extensional faulting as seen from earthquake seismology; others use analogue models. Several papers discuss the mechanisms of middle- to lower-crustal extension and the control on extension exerted by initial crustal thickness and geothermal gradient.

Papers by Allmendinger *et al.*, Beach *et al.*, Cheadle *et al.*, Gibbs and Kirton & Hitchen emphasize the recent advances in our understanding of continental extension based on seismic data, especially those shot to depths of 15 seconds (TWT) or over. Some of these data were obtained during commercial exploration programmes and we hope that in future there will be further growth in such cooperation and interchange of ideas and data between industry and academic institutions.

The organization in Durham fell to John Dewey and especially to Lois Karner who dealt with the detailed preliminary planning and day to day running of the conference.

The conference and this volume are dedicated to Bert Quennell who had long inspired work on the African extensional fields and had planned to present a paper on the North Tanzanian graben but who sadly passed away shortly before the meeting.

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Appreciation: A. M. Quennell—a prescient tectonician

Bert Quennell completed preparing his poster on the ‘North Tanzanian Graben Field’ on Sunday April 14th 1985, four days before the Continental Extensional Tectonics meeting. The next day he visited the doctor’s surgery about a routine matter and while there died suddenly but peacefully. He was 78 and anticipating, with that blend of excitement and anxiety more typical of a scientist 50 years younger, presenting his latest research findings to a large and well-informed audience. This book honours not only his more formal and unusually farsighted contributions but also his infectious enthusiasm for geology and total lack of pretension.

Albert Mathieson Quennell was born in Dunedin, Otago, on 27 November 1906 and although he only worked in New Zealand for two short periods after 1946 he remained a New Zealander all his life. Bert was educated at Otago Boy’s High School, Dunedin (1921–23) and then successively at King Edward Technical College, Dunedin (1923–27), the School of Mines, Otago University (1928–35) and Victoria University, Wellington (1936–37).

His initial vocational training led him to becoming a Member of the Institute of Civil Engineers (London), a qualification gained while working as an engineering cadet with the Otago Harbour Board. In 1931 he enrolled as a full-time student at Otago University, graduating in 1935 with two degrees, a B.Sc. in physics and geology and an Associateship of the Otago School of Mines in mining and geology.

During his student days he was taught by F.J. Turner, among others. An M.Sc. thesis, ‘The Physiography and Structure of the Porirua District’, prepared under the guidance of C.A. Cotton of Victoria University, followed in 1937. The influence of Cotton and growing to geological maturity among the youthful landscapes of New Zealand must have shaped Bert’s outlook and 20 years later enabled him to recognize the significance of tectonic landforms in Palestine.

After gaining his first degrees, Bert joined the New Zealand Geological Survey, initially at the grade of Geologist but later being promoted to District Geologist. He remained with the survey until 1946, but for the period 1937–39 he was seconded to work on petroleum exploration for the Shell Group, and from 1940 to 45 he served with the New Zealand forces in the Middle East and Italy. With the rank of Captain he commanded sound-ranging and field artillery units and was mentioned in despatches.

The first phase of Bert’s professional career can be thought of as ending in 1946, when, aged 40, he was appointed Assistant Director of the Lands and Surveys Department of what was then Trans-Jordan. He was returning to a land he knew, having triangulated the country in 1941 in preparation for an aerial survey. While there for the second time he conducted the first systematic geological survey of Trans-Jordan. His seminal paper on the Dead Sea rift did not, however, appear until 10 years later and after experience of the East African rift system. Another move followed in 1948, this time to the Tanganyika (now Tanzania) Geological Survey with whom he stayed until 1960, having become their Director. For the years 1960–65 he worked in Auckland as a consulting geologist; an occupation he would resume, again in Auckland, from 1967 to 1971. Between these two self-employed episodes he worked as mineral exploration Project Manager for the United Nations, initially in Nigeria (1965–67) and then in Sudan (1967–69).

In 1971, ostensibly having retired, Bert and Maidie, his wife, moved to Bristol in order to live near two of their four children. Soon after arriving in England he became a part-time Senior Scientific Officer with the Institute of Geological Sciences (now the British Geological Survey). His responsibilities were editing their Journal of Overseas Geology and Mineral Resources and preparing for publication related memoirs and maps. Because such work was only part-time and his remaining energy could not be entirely expended on perfecting his loudspeakers, he returned to thinking about the tectonics of the Middle East, especially the evolution of the Dead Sea rift. Not long after leaving the survey in 1974, Bert found another editing job; this time with Hutchinson Ross for whom he prepared two volumes in their ‘Benchwork Series’ (Quennell 1982, 1985), the second published shortly after his death.

It was while he was living in Bristol that I first met him. Bert became a frequent visitor to the university and a popular member of its geology department, in which he was an Honorary Research Associate. Seeing him in the corridor, the unsuspecting might have mistaken him for an unusually genial Somerset farmer come to enquire why his patch of the ‘Levels’ was sinking. Despite an easy affable charm and countryman’s physique he was, however, very much a scientist and, in its fullest sense, a student. His enthusiasm for extensional and strike-slip tectonics was
prodigious and characterized by a receptivity to new ideas.

Selecting for commentary a handful of publications from a lifetime's work is bound to result in a somewhat unbalanced view of a man's total output but I believe many would agree that Quennell's (1958, 1959) papers on the Dead Sea rift are those which will be most recalled by historians of geology. Both papers first surfaced at meetings in 1956: the one published in 1959 being read in early September at the International Geological Congress in Mexico and the 1958 article being delivered at the Geological Society at London on 12th December. In the 1959 article, Quennell argued from geological evidence that there had been two phases of left-lateral displacement along the Palestinian sector of the Dead Sea rift. The post-Senonian-pre-Miocene earlier phase achieved 62 km of slip, the later phase, beginning in the Pleistocene but still continuing, added another 45 km he thought.

To postulate at an international meeting in 1956 such large horizontal displacements must have taken professional courage at a time when undergraduates, at least, were still being required to write essays with titles such as 'The permanence of the ocean basins'. Not only did Quennell argue for a then radical amount of motion but he also provided us with the first description of a pole of rotation, concluding that the Arabian block had, relative to the Sinai-Palestine block, rotated 5.5° about a pole situated at 33° N, 24° E, approximately 1100 km distant from the fault zone. With wisdom of hindsight it is interesting to note that in the report of the discussion following the session in which Quennell spoke there was relatively little reaction to his ideas, other papers, now largely forgotten, seem to have excited more comment.

In the article published in 1958, Quennell explored the large-scale physiographic consequences of his model, and his fig. 1 contains a clear illustration of a feature that would now be called a pull-apart basin, although he preferred the older and less inelegant name, rhomb graben. When, much later, Quennell (1984) returned to the theme of the Dead Sea rift system at the Geological Society's meeting on 'The Geological Evolution of the Eastern Mediterranean' he integrated his original ideas with those expounded more recently by Israeli workers. At the same time, he argued that by the late Pliocene the entire length of the rift system, which stretches from the Red Sea to SE Anatolia, had become divided into three segments which operated independently. He proposed that the southern (Palestinian) and northern (Syrian) segments continued to be sinistral strike-slip faults, although with different amounts of displacement on them, but that the central (Lebanese) segment was principally a zone of oblique folding and thrusting with only the very young Yammoune fault transecting it.

In the context of the present debate about funding for geological research in the UK it is noteworthy that Bert's ideas on the Dead Sea rift arose from field work which was carried out in his leisure time.

While working for the Lands and Surveys Department Bert had met His Majesty King Abdulla. When news of his death reached Jordan a telegram of sympathy from Crown Prince Hassan was promptly despatched to Maidie. The local scientific community demonstrated its esteem by making him the first honorary member of the Jordanian Geologists' Association and by inviting him and Maidie to be guests at their first conference (Amman, 6–8 September 1982).

Bert Quennell showed his prescience not only by anticipating the importance of intracontinental transforms and poles of rotation but he also foresaw the significance of some of the criteria which it was later realized were necessary for identifying allochthonous (suspect) terranes. In an admirably concise two-page 'letter', Quennell & Hay (1964) documented the characteristics of the chaotic Tangihua Group of Northland, New Zealand; characteristics which they concluded indicated that the volcanic rocks of the group were derived from seamounts (now thought to be mainly of late-Jurassic age) surrounded by Late Cretaceous and Tertiary marine sediments. Quennell's & Hay's observations were later elaborated by other workers some of whom interpret the Tunghua Volcanics and surrounding sediments as being far travelled.

Selected bibliography


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