

authors of the other four papers which relate to studies of parts of the British coast have set their work in a broader context. These papers provide accounts of: sediment mobility and erosion on a multibarred foreshore in S. W. Lancashire (W. R. Parker); cyclical changes at the entrance to Teignmouth Harbour, Devon (A. H. W. Robinson); a Holocene chenier plain in Essex (J. T. Greensmith and E. V. Tucker); and suspended sediment transport and deposition over the intertidal flats of the Wash (G. Evans and M. B. Collins). The only case study from outside Britain, of marine bars in Kouchibouguac Bay, New Brunswick by B. Greenwood and R. G. D. Davidson-Arnott, concludes with an evaluation of the specific results in the light of other studies of bar genesis and migration.

Apart from one brief contribution on coastal engineering problems the papers in the book fall into two groups: those discussed above are essentially sedimentological and geomorphological. The other four papers approach the complex problems of the nearshore zone from a more theoretical, hydrodynamic viewpoint and deal with waves and wave generated currents. P. D. Komar considers the two modes of generation of longshore currents – by an oblique wave approach to the shore line and by longshore variations of wave breaker height, and D. A. Huntly and A. J. Bowen compare the hydrodynamics of steep and shallow beaches. P. Holmes outlines methods of evaluating wave characteristics appropriate to the computation of littoral transport, and P. H. Kemp evaluates the effects of wave asymmetry in the nearshore zone and breaker area.

Taken overall, the book is a useful collection of papers which provides a sense of the complexity of the problems of the nearshore zone and indicates some of the ways in which research is progressing.

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## The Study of Trace Fossils

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Edited by Robert W. Frey  
*Springer-Verlag, 562 p., 1975.*  
 \$57.80

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This book was in the works a long time, and its publication was eagerly awaited by those of us interested in trace fossils. One thing that strikes the reader immediately on picking up a copy of this book is the intriguing dust-cover photo: a human footprint which, to the viewer's surprise, turns out to have six toes! The genesis of this strange print is not explained in the text; Frey frustrates us by thanking R. G. Bromley for the cover photo, and directing further inquiries to him.

In a way, that photo is symbolic of a lot of the significance of the study of trace fossils (also known as ichnology). Trace fossils are often mundane phenomena such as footprints or burrows, which sometimes may be attributed to a specific organism. All too often, however, trace fossils which we supposedly had under control either show up in the wrong place, or develop strange modifications; for example, a *Zoophycos* in the intertidal, a "shoreline-indicator" shrimp burrow in abyssal sediments, and a sixth toe on a human footprint. Frey's book is the first attempt to chart an integrated pathway through the pockmarked, burrowed, and fecal pellet-laden landscape of trace fossils.

The rationale of the book is set out in the prologue: rather than being a collection of papers on trace fossils, it is a genuine cooperative approach, by a number of specialists, to the study of trace fossils, emphasizing relationships with other disciplines. The book is organized into five major parts, with chapters written by most of the well-known workers in trace fossils and animal-sediment relationships. Part I, Introduction to Ichnology, contains chapters on the history and scope of ichnology, classification and preservation of trace fossils, and (a very useful, cautionary addition) false or misleading traces. Part II, The

Geological Significance of Trace Fossils, discusses aspects of their paleontological, stratigraphical, sedimentological and paleoecological significance. As in Part I, most of this is review material, albeit comprehensive, well-written review. There are some interesting observations in this section. Crimes points out that trilobite traces (often of a relatively simple nature) commonly occur well below the first occurrence of trilobite body fossils, and suggests that this is evidence for early, soft-bodied trilobites (although it seems to me that the tremendous hurdle involved in going from the hydraulic skeleton of the presumed polychaete-like ancestor to the external skeleton of the arthropods is not sufficiently discussed). Howard emphasizes that trace fossils are sedimentary structures, often containing valuable information on deposition rates and sediment characteristics, and Rhoads discusses how trace fossils may allow us to predict factors such as salinity, temperature, dissolved oxygen and mass properties of the sediment. This section basically emphasizes what is becoming apparent: the use of traces as guide or index fossils is limited, and hampered by lack of sufficient studies in the geologic record; on the other hand, traces as facies fossils are beginning to assume an importance greater, in many cases, than body fossils.

Part III, Selected Groups of Trace Fossils, contains a systematic review of the major groups of trace-producing organisms. This section contains some extremely interesting, even provocative, chapters. To choose a few from many; Sarjeant discusses plant trace fossils, and Voorhies vertebrate burrows; a fascinating chapter on "unusually large Burrows", by Bromley, Curran, Frey, Gutschick and Suttner, describes burrows for which we must seemingly postulate organisms up to nine m long, and only a half-centimetre in diameter! (Nemertean seem the only possible modern organism capable of assuming these dimensions.) The section concludes with related papers by Kennedy and Bromley, on the general topic of hardgrounds – a subject of increasing interest.

Part IV, Recent Aquatic Lebensspuren, could have been greatly expanded, for it is specifically these studies which allow us to develop trace

fossil models. Chamberlain has a fascinating chapter on freshwater traces, Dörjes and Hertweck discuss some of the fine work on shallow marine environments being done by the Senckenberg Institute, and Hollister, Heezen and Nafe present a brief, largely pictorial review of deep-sea traces.

Part V, *Techniques in the Study of Lebensspuren*, concludes the volume with a chapter on experimental methods by Elders, which must be the only discussion of burrowing by means of a hydraulic skeleton which neglects to refer to Clark (1964), and a useful omnibus techniques chapter by Farrow.

In general, the book is well-written and well-illustrated. Typographic errors are few, and an errata sheet is included, correcting some major omissions. It is difficult to decide what specific need this book fulfills. Copies should certainly be on every library shelf, and in the collections of most paleontologists. The book is a review volume, however, containing little that is new or startling to workers in the field. Many of the illustrations are reprinted from previously-published work. The main value of this book would seem to be as a supplementary reference for upper-level undergraduate courses in paleontology and sedimentology. Any professor suggesting that his students lash out more than \$60 for a supplementary text runs the risk of becoming a thin carbonaceous film.

*The Study of Trace Fossils* is a necessary and timely work, coming at a time when scientists in other disciplines are beginning to appreciate the sorts of data available from ichnological research. Many of the chapters, especially those by Howard, Rhoads, Chamberlain and Dörjes and Hertweck, also reinforce one of my own opinions, that the main value of the study of fossil and recent traces lies in the future. Much of "marine biology", especially density distributions and animal-sediment relationships, is now studied by geologists. I look forward to seeing more work on things like nutrient cycling, pollutant dispersal, and hydrocarbon reserves being done by scientists who refer to themselves as "ichnologists".

#### References

Clark, R. B., 1964. *Dynamics in metazoan evolution*: Clarendon Press, Oxford, 313 p.

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## Geological Hazards

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By B. A. Bolt, W. L. Horn,  
G. A. Macdonald, and R. F. Scott  
*Springer-Verlag, New York, Heidelberg,  
Berlin, 328 p. 1975.*  
\$25.80

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This book deals with major geological events which are hazardous to mankind. It is divided into eight chapters that consider hazards from earthquakes, volcanoes, tsunamis, landslides, ground subsidence, snow avalanches and floods, in order of presentation. This reviewer found the book to be well written, generally informative and even exciting in scope and method of presentation. Although the authors say the book has been prepared for the general reader and the college student at the introductory level, a pre-knowledge of basic geology is a definite advantage. The use of dramatic case histories adds an element of excitement to most chapters.

Chapter 1 (Bolt) presents a thorough summary of the many causes of earthquakes set in the proper perspective of plate tectonics. Interesting correlations and relationships between intensity and ground acceleration, rupture length and magnitude, horizontal to vertical acceleration ratios, attenuation curves, etc., add considerable depth to the generally descriptive presentation.

Chapter 2 (Macdonald) presents a longish but impressive portrayal of volcanic hazards with truly incredible statistics on resultant direct and indirect casualties. Volcanic mud flows derived from ash, tephra and rain or crater waters are most interesting as are the discussions of secondary hazards. One is left with a very pessimistic view of mitigation of volcanic hazards.

Chapter 3 (Bolt) on hazards from tsunamis lacks technical content to the great detriment to the chapter. Some clear explanation of the translatory nature of a tsunami is necessary to graphically explain how a one m high wave can "run up" to a 20 m + height recorded for some of the world's great

tsunamis. Terms used in the chapter are also poorly defined.

Chapters 4, 5 and 6 (Scott) deal with landslides, subsidence and snow avalanches and are the most technical in the book. The landslide and subsidence chapters are considered in terms of descriptive soil mechanics including the role of pore pressures and effective stresses. Although well done, the technical discussions are so brief and encompass so many variables that they are probably beyond those readers lacking some knowledge of mechanics. The technical approach is undoubtedly the correct one since the basic principle must be understood by those dealing with landslides in particular. The subsidence chapter is marred by a typographical error on page 207 related to the total and effective stresses and by the lack of discussion of subsidence by both salt dissolution and sand grain crushing at contact stresses in excess of grain strength. The reference lists are notably weak in all three chapters.

Chapter 7 (Horn) on flood hazards is a wordy discussion of the many geological and meteorological variables that influence flooding. The effects of rainfall, snow-melt, drainage basin characteristics, frequency of occurrence are briefly described followed by an interesting section on techniques to alleviate or prevent major floods. The most interesting part of the chapter is the case history section which vividly portrays the real hazards of floods as comparable to earthquakes and volcanism.

Chapter 8 on hazard mitigation and control is far too brief to carry any impact. In fact, the section on insurance was more interesting than the sections on risk and hazard maps. As a wind-up to a useful book, Chapter 8 is unsuccessful.

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