

overlain by roughly horizontal Old Red Sandstone beds) first recognized by James Hutton, revealing to him the vast time spans involved in the making of the Earth. This is now a place of pilgrimage for geologists. Also appearing are well-known personalities such as Drs Peach and Horne of north-west Scotland fame, and indomitable lady geologists such as Dame Ethel Shakespeare, Dr Gertude Ellis (who worked with Lapworth) and Rachel Workman McRobert, who studied the igneous rocks of the Eildon Hills and elsewhere. Thus, the history of geological exploration of the area is well covered.

In general, and admitted by the authors, the rocks of this area do not appear very exciting at first glance. For a start, they are poorly exposed in the rounded grass and heather-covered uplands and, where they are seen, they consist largely of shales and gritstones (greywackes). Nevertheless, this book reveals a rich assemblage of rocks laid down in widely varying environments and it is clear that many years could be spent exploring the area. Not only are there shales and gritstones, but rocks of the deep ocean floor (cherts and pillow lavas), debris flow deposits containing exotic fossiliferous limestones, desert sandstones and a rich collection of igneous rocks, from the massive Cheviot andesitic volcano, cored by granites, the intermediate-sized Eildon Hills, to a plethora of explosion pipes, small plugs, dykes, basaltic lavas and pyroclastics. Rock types include trachytes, phonolites and peralkaline rhyolites. Even mantle nodules can be found. Truly, there is something for everyone and this book adds an additional layer to the rich story of the Borders—a geological borders ballad in the words of the title.

Several chapters are rich in background information. Chapter 4 gives a clear exposition of what it is necessary to know about plate tectonics. Chapter 6 is entitled 'The birth and death of Iapetus' telling about the ocean which once existed before the Atlantic was born. Chapter 9 deals with planktonic organisms, chiefly graptolites, and this is followed by a description of the Moffat shales, where Lapworth first studied these organisms. Chapter 7 describes deposits interpreted as being formed in association with a tsunami. A series of chapters then cover Devonian volcanoes and desert sandstones formed when the area was close to the equator. Carboniferous volcanoes are then described and there is a brief reference to dykes belonging to the Mull swarm and intruded only about 60 million years ago in connection with the birth of the Atlantic Ocean. Finally, the narrative ends with a description of the Pleistocene glaciers and their effects on the landscape, not forgetting sea-level changes.

The book is well written and very well illustrated, both with coloured diagrams and photographs. Although written by two authors, both of whom

are well known in their fields, the style is uniform. Typographic errors were not spotted, but I did find exclamation marks too frequent for my taste, often giving a rather overblown tone (e.g. 'Clearly there is more to mud than meets the eye!', p.35). Are mass flow events, such as Storegga, the result of tsunamis (p.125), or the other way round? On p.163, why does the Borders first appear in quotation marks? I was not entirely clear of the meaning of the legend in fig. 15.15. Why are there two colours for peralkaline trachyte and sanidine trachyte? Does this mean that there are two varieties of each of these rocks? While we are told that peralkaline rocks have aegirine and riebeckite which have beautiful green and indigo-blue colours in thin section, it might have been helpful to tell the reader about the distinctive chemical compositions, the reason why these minerals form.

I thoroughly enjoyed reading the book and certainly learned a lot. However, I do have some difficulty in knowing quite who the target group might be. The answer is probably the dedicated amateur and that is why so much basic geological information is given. It would greatly enrich the experience of those who come for the romantic associations and historical sights: the pele towers and abbey ruins, adding another rich layer to this experience. Also, the professional geologist wanting to learn about the area will also be well served. For these people who would be willing to pay this price I can heartily recommend it.

The Roof at the Bottom of the World: Discovering the Transantarctic Mountains, by Edmund Stump, 2011, Yale University Press, New Haven and London, US \$29.95 (Hardcover), 272 pages, ISBN 978-0-300-17197-6, eBook ISBN 978-0-300-17846-3

Rasoul Sorkhabi (University of Utah) writes Popular images of Antarctica are of a vast, white continent with its marching penguins. People know little about the rocks and mountains of that continent. *The Roof at the Bottom of the World* focuses on the mapping and geographical discovery of the Transantarctic Mountains (TAM), a 3000-km long and 200-km wide range that separates the East Antarctic shield from West Antarctica. The TAM form a rift-shoulder uplift on the East Antarctic margin along which West Antarctica has undergone tectonic extension and continental thinning. This Late Cretaceous–Early Eocene rifting event was superimposed on an earlier mountain range, the Ross Orogen formed in the Cambrian. This new book covers the areas of the TAM from North Victoria Land through McMurdo Sound as far south as Ohio Range. Beyond this point, the TAM split into two branches; one continuing to the Pensacola Mountains and the other running toward

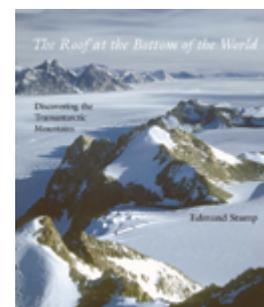


Fig. 5. The Roof at the Bottom of the World: Discovering the Transantarctic Mountains.

the West Antarctic Ice Sheet in a series of nunataks (isolated rock massifs within an ice cover).

Every geologist becomes hooked to a mountain range because it is in the mountains that rocks are exposed and aspiring geologists are trained. Edmund Stump has studied the TAM since 1970 when he was a graduate student; he has made thirteen expeditions Antarctica. A professor of geology at Arizona State University, Stump is also author of *The Ross Orogen of the Transantarctic Mountains* (Cambridge University Press, 1995, paperback 2005). He is thus well positioned to write this first book on the exploration history of his beloved mountains.

Through seven chapters, the book offers a tour, in space and time, of the historical expeditions that have shaped our knowledge of the TAM. The chapters include the discoveries along Coastal Victoria Land (Chapter 1), crossing and exploration of Victoria Land (Chapters 2 and 3), discoveries in the Central TAM (Chapter 4), discoveries in the Queen Maud Mountains (Chapter 5), exploration of Scott Glacier (Chapter 6), and the International Geophysical Year (IGY) and its aftermath (Chapter 7). Major expedition stories include those of James Clark Ross (1839–1843 on the ships *HMS Erebus* and *Terror*); the Southern Cross Expedition (1898–1900) led by Carsten Borchgrevink; the *Discovery* Expedition (1901–1904) led by Robert Falcon Scott and Albert Armitage (with Hartley Ferrar as the field geologist and youngest member of the staff); the *Nimrod* Expedition (1907–1909) led by Ernest Shackleton (during which Edgeworth David reached the South Magnetic Pole); Roald Amundsen's South Pole Expedition (1910–1912), the *Terra Nova* Expedition (1910–1912) led by Scott; the Imperial Trans-Antarctic Expedition (1914–1916) led by Shackleton; and Richard Byrd's first expedition (1928–1930, with Laurence M. Gould as Geologist) and second expedition (1933–1935, with Quin A. Blackburn as Geologist).

By 1940, the TAM had been fairly explored and known, and countries like the United Kingdom, USA, Soviet Union, New Zealand, Australia, and France were marking the ground by dropping flags and other means to establish territorial claims. While these political and exploration efforts continued after World War II, the IGY changed the mood and direction. Sponsored by 67 countries and various international scientific organizations, the IGY (1957–1959) made Antarctica a hub for global science and cooperation. The Amundsen–Scott South Pole Station was thus established as a permanent structure for researchers. Even after the IGY, several countries carried on their exploration activities in Antarctica. The signing of the Antarctic Treaty in 1961 designated this continent as a military-free zone for international science. It was

also in 1961 that a US geographical group suggested the name 'Transantarctic Mountains' for this continental scale orogen. The Topographical Division of the US Geological Survey conducted a comprehensive mapping of the TAM (aerial photography combined with ground control), which resulted in the publication of twenty-nine 1:250 000 sheets in 1964–1965.

One of the valuable contributions of this book is that the author has used these USGS maps to depict the traverse routes of the pioneer explorers in the TAM. These maps are enhanced by superb photographs, selected from over six thousand shots of the TAM that the author has taken over the years. The geographical mapping set the stage for the modern geological studies of the TAM from the 1960s to present day. The history of these recent geological studies should make another interesting volume and which remains to be written.

Although this book is essentially a narrative history, sidebars give Stump's personal touch to his book: here we read interesting stories from his field work, mountain climbing, and encounters in the TAM. Being a popular science book, the reader will not see scholarly footnotes or references to minute facts in the text (although a list of relevant bibliography is given at the end of the book). Three appendixes, on the rock cycle, geological time, and glossary of geological terms, are helpful to the non-geologist reader. Should the book go a second edition, inclusion of a chronology of milestone events and a biographical dictionary, 'who's who', of major players in the exploration of the TAM will also be useful.

For a large-format, hardcover book filled with 144 photographs and maps, the price of this publication is highly reasonable and should attract individual buyers. Antarctica is the last continent humans set foot on. Stump's poem that concludes the book gives a sense of otherworldliness about the TAM: the emptiness of the mind that the air and vista of this 'splendid disruption at the end of the Earth' brings to its observer.

This is a fabulous book for Antarctica lovers, both geologists and non-geologists. It highlights the little-known rocky face of Antarctica. And this is no small matter: That continent's highest point, Mount Kirkpatrick, is 4528 m tall—a roof at the bottom of the world (for those of us living in the northern hemisphere). The book also gives a historical sense as to how major glaciers and summits in the TAM came to be named Ross, Scott, Shackleton, Nimrod, Byrd, Markham, Nansen, and so on. I learned from the book that there is one summit in the TAM that has not been climbed yet, but even if someone conquers it, that mountain has already been named after a geologist, Gould.