

**THE TRANSANTARCTIC MOUNTAINS – ROCKS, ICE, METEORITES AND WATER.** Gunter Faure and Teresa M. Mensing. 2011. Dordrecht, Heidelberg, London, New York: Springer. xxvi + 804, illustrated, hard cover. ISBN 978-1-4010-8406-5. £153.

This massive book comprises 801 pages and has 20 chapters in themed sections on: Exploration and Characterization, The Basement Rocks, Gondwana: Growth and Disintegration, and Fire and Ice. Unusually for a book of its size, it is a single work of the authors, rather than an edited compilation. In this it is impressive and the subject matter benefits somewhat from a coherent approach and treatment.

Part I of the book presents the exploration of the continent and the characteristics of its physical attributes, as well as what it is like to live and work there. This part of the book consists of two chapters, the first outlining the historical and twentieth-century exploration of Antarctica up to the International Geophysical Year. The second presents the continent in its extremes and provides an introduction to living and working on the continent via the US Antarctic Programme. Volcanoes, weather and its effects, and the ozone hole are singled out for special treatment. Part II of the book, 'The Basement Rocks' moves on to coverage of the basement rocks. It consists of seven chapters, that cover basement rocks of southern Victoria Land and northern Victoria Land, the geology of the central Transantarctic Mountains, the Queen Maud Mountains, the Horlick Mountains, the far Eastern Mountains, and culminates with a chapter on the tectonic evolution from Rodinia to Gondwana. This part of the book is slightly peculiar in that it covers southern Victoria Land first, moving northwards to northern Victoria Land, before leapfrogging back south to the central Transantarctic Mountains and beyond. Part III of the book is entitled 'Gondwana: Growth and Disintegration'. This part of the book is structured differently to the section on basement rocks. Rather than subdividing the subject by geographical area, the subdivisions are based on lithostratigraphical and geological subdivisions. It consists of six chapters covering the lithostratigraphy of the Beacon Supergroup, as well as its stable isotopes fossils and mineral deposits, the Jurassic volcanic rocks including the Ferrar group and Kirwan volcanics and finishes with a chapter on the transition from Gondwana to Antarctica. Part IV of the book, entitled 'Fire and Ice', consists of four chapters and deals with the post Mesozoic geological history of the Transantarctic Mountains including the Cenozoic volcanoes of the McMurdo volcanic group and glaciation of southern Victoria land. It also ranges more widely, covering the history of the East Antarctic Ice Sheet and the very important subject of Antarctic meteorites. The book finishes with a one-page chapter, Chapter 20, called 'Antarctica in Retrospect', which sums up the journey the reader has followed through the book. The book is completed by an author index, and a strange numerical subsection subject index, with a numbering scheme that is close to the chapter numbering of the book (close enough to be initially confusing but not particularly useful). An

alphabetical index would have been preferable, and a geological timescale.

Overall the book left me feeling unsatisfied. In the preface the authors state that 'This book presents an integrated overview of all aspects of the Transantarctic Mountains in easily readable form.' From the perspective of readability, this is largely achieved, although there is a strong contrast between the sections on geochronology, which are highly technical, if focussing on outdated techniques, and other aspects of the text, tectonics in particular.

For example, in Part II, Chapter 3 looks at the basement rocks of the Dry Valleys (referred to as 'Ice-free valleys' in the book), in the area between the Ferrar and Koettlitz glaciers, and in Brown Hills. There are rock distribution maps but it would have been helped had there been insets showing where these areas lay on the Transantarctic Mountains for those readers not intimately familiar with the range. Although there is much focus on the relationships of lithostratigraphic units, broad metamorphic grade and the many intrusive rocks, almost no structural information is provided. Similarly, there is a disappointing lack of geological maps. The only synthesis map of any detail is of the rocks of western Wright Valley, Fig. 3.8, and it lacks a single dip or strike reading. Considerable detail is presented in terms of radiometric dating, with some useful appendices explaining how the various methodologies work. In many ways, there is far too much detail in the radiometric age section as the information is presented without the context of locations presented on a geological map, or a table or column of relative events. Only an expert with intimate knowledge of the ranges described would be able to make sense of this. Fortunately, Section 3.5 provides a simplified geological history of southern Victoria Land, in a style that, although welcome, is at odds with the highly technical complexity of the preceding sections. Despite the simplicity of the text, some cartoon figures would have enhanced the presentation.

Equally, Chapter 4 describes the basement rocks of northern Victoria Land, which consist of the Wilson, Bowers and Robertson Bay terranes. This is a complex area and the book provides a good summary of the major tectonostratigraphic units and their histories. The various stratigraphic units and their relationships are described at a useful level of detail and quantitative age data is presented and discussed where available. There is a strange mix of colour and monochrome geological maps. Although many of the highest peaks are listed in the text and a physiographic map is presented, the locations of the peaks are not shown. As before, few localities are represented on maps and what maps there are lack location insets. The literature citation includes few works more recent than 1995, although more than 40 papers have been published on the basement geology of northern Victoria Land since then. This chapter does benefit from a Tectonics section that provides some rudimentary structural geology information, although the 'questions' identified as requiring answers lack any on timing of tectonic events. The chapter benefits strongly from the discussion of alternate models for the formation of the terranes of northern Victoria

Land. The chapter concludes with a useful summary, favouring the terrane accretion model. Illustration of this model, similar to that provided for the subduction-accretion model, would have been useful.

Parts II and III of the book end with synthesis chapters, which summarise all that has been presented. This is a strong aspect of the book, although unfortunately the synthesis chapters are often unnecessarily limited in scope. For example, Part II of the book ends with Chapter 9: 'From Rodinia to Gondwana'. This chapter provides a useful synthesis, but it would have been helpful to have seen a more detailed discussion of the basement rocks of the Transantarctic Mountains in a Rodinia and SWEAT context. How do the Neoproterozoic sedimentary rocks there compare with the Belt-Purcell and Windermere Groups of western North America, for example? The extension of the Ross Orogeny to other continents is also barely mentioned. The synthesis chapter for Part III, is the oddly titled 'Break-up of Gondwana and Assembly of Antarctica'. Although the 'break-up' of Gondwana is unequivocal, Antarctica could hardly have been said to have 'assembled'. The chapter begins with a half-baked and seriously out-of-date presentation of the 'plume hypothesis'. Asthenospheric plumes are invoked, for example, when the best evidence and modelling indicates that mantle plumes originate at the D'' layer at the core-mantle boundary. Alternative hypotheses are not considered. Although a very good historical context is provided in terms of bibliography, the chapter is slightly marred by the fact that there are key references missing post-dating the mid-1990's. This may seem like a pedantic point, but it is not, many of the fundamental insights and advances in understanding of the evolution of Gondwana have come from the new techniques and methodologies that have been developed in the past 15 years. The silicic Chon Aike rhyolite province in the Antarctic Peninsula and southern South America, for example, is related to subduction in the chapter, whereas new geochronological and isotope evidence show that it is another expression of the magmatic activity associated with Gondwana break-up. Too much significance is afforded the suggestion of a Transantarctic Fault zone, and only very brief discussion is presented of the much more scientifically soundly based concept of the West Antarctic Rift System in the context of Transantarctic Mountains uplift. In the context of the discussion of the relationship between the Swanson Formation of MBL and the Robertson Bay Group of Victoria Land, no mention is made of the proposed terrane hypothesis for MBL, which supersedes earlier suggestions of transcurrent movement along a Transantarctic Fault zone. Apatite fission track evidence for uplift of the TAM is presented but more recent thermochronological evidence from other mineral and isotope systems is omitted. Overall, this chapter left me feeling confused as to what might be the cause of TAM uplift.

The style of each part of the book is different. For example, in Part III, the book shows strongly with Chapter 11, which, rather than subdividing the Transantarctic Mountains into geographical areas, focuses on so-called 'Special Topics' of the Beacon Supergroup. The first of these is 'Isotopic studies of carbonate rocks' and looks at strontium, oxygen and carbon (including carbonate), followed by a general summary of the evidence and implications of Permian glacial and glaciomarine sediments in Antarctica. Associated global sea-level fall is mentioned in relation to Gondwana glaciation, although the authors omit the fundamental importance of glacio-eustatic variation in sea-level in driving the cyclic changes that made possible the accumulation of voluminous coal measures in the

Northern Hemisphere. Palaeontological finds, vertebrate and palaeobotanical, are also treated as a special topic, and although there are no illustrations of the tetrapod material (apart from a glum-looking plaster cast of *Lystrosaurus*), several plant fossils are shown, including *Glossopteris*, and are treated in some detail. The Permo-Triassic extinction receives cursory treatment (although with no references more recent than 2004). There is a brief section on Permo-Triassic climate, which is rather weak and ignores Mesozoic and early Cenozoic evidence for temperate high latitude climates driven by variations in atmospheric CO<sub>2</sub>. The chapter finishes with a section on Antarctic mineral deposits, including a discussion of the Convention on the Regulation of Antarctic Mineral Resource Activities (also known as CRAMRA) combined with a summary of the literature on metalliferous and fossil fuel deposits. An interesting section summarises various surveys for radioactive minerals in Antarctica in the 1970's and 80's and the record of pre-Test Ban Treaty radioactivity in the snow and ice record. Coal is the fossil fuel resource for which Antarctic records are most complete and the chapter finishes with a summary of the literature on Antarctic bituminous coal.

In Part IV, the book really shines with Chapter 18, entitled 'Meteorites on Ice', which deals with the revolutionary discovery of abundant meteorites in blue-ice areas of East Antarctica. The chapter is unfortunately marred by the lack of insets on location maps, making it very difficult for the reader without a detailed geographic knowledge of the Transantarctic Mountains to know where the localities are. This chapter is singular in having a relatively up-to-date bibliography (some references date from 2008), and is, however, one of the best chapters in the book. The chapter includes a historical summary of the first discoveries of meteorites in Antarctica and a useful summary of the classification of meteorites. It covers the physical properties of Antarctic meteorites with simple guidelines for scientific collecting defined by ANSMET. The outstandingly productive and important locality of Allan Hills and the number, mass distribution and classes of meteorites found is dealt with in some detail. Chemical and physical weathering of meteorites, and chemical weathering products such as evaporite and clay minerals, is discussed in the context of the progressive disintegration of meteorites at the Antarctic ice surface. Trace element variation produced by weathering and the halogen content of Antarctic meteorites are given detailed treatment in the context of the non-pristine nature of Antarctic meteorites, unlike what might be generally assumed.

Overall, in terms of content and integration, if you are a lithostratigrapher, or a geochronologist then the treatment of your subject is certainly comprehensive: isotope geologists and geochronologists may find the historical treatment of results derived using earlier techniques such as K-Ar and Rb-Sr a useful reference, but will be frustrated by the paucity of presentation of data from newer methodologies such as Ar-Ar or Lu-Hf, and high-precision *in situ* techniques such as TIMS and SIMS for U-Pb in particular. Cosmogenic exposure age dating, despite its manifest value, is almost entirely omitted. Many disciplines receive very light or no treatment. From the point of view of structural geology, tectonics, metamorphic geology or palaeontology the book is disappointing. For example, any analysis or attempt at synthesis for the Ross Orogeny is omitted, and there is no discussion of how it relates to coeval orogenesis in other parts of Gondwana. Another frustration is the patchy coverage of the literature. For example, in Chapter 19, on the glaciation of Southern Victoria Land, only eight references of

250 are more recent than 1999 and four of these are books. The chapter omits any reference to the ANDRILL project, for example. Any future editions, if these are planned, must invite more authors covering a range of discipline areas to avoid omissions and ensure up-to-date literature coverage.

For a book that is in its very essence tied together by geography, its maps constantly let the reader down. The lack of comprehensive distribution maps for major rock subdivisions and an absence of location insets on those location maps presented is a constant source of frustration when reading and using the book. On the other hand, large tables of data are presented at the end of each chapter, which provide a very useful

reference. The only significant omission here is representative geochemical data for the volcanic rocks.

To conclude, the book is extremely ambitious in its aim to synthesis our knowledge of one of the more intriguing and important mountain ranges on Earth; however, apart from its excellent treatment of some subject areas, for example, lithostratigraphy and meteorites, *Transantarctic Mountains – Rocks, Ice, Meteorites and Water* does not quite hit the mark. (Alan P.M. Vaughan, Workpackage Manager Continental Interiors, Environmental Change and Evolution, British Antarctic Survey, High Cross, Madingley Rd., Cambridge CB3 0ET.)