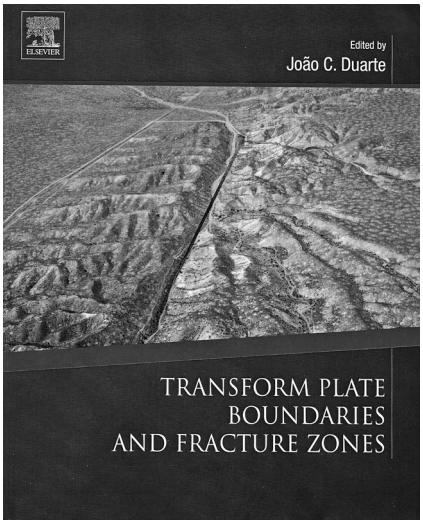
sciendo

Geologos 26, 2 (2020): 175–177
DOI: 10.2478/logos-2020-0016

GEOLOGOS

Transform plate boundaries and fracture zones, by J.C. Duarte (Ed.), 2019. Elsevier Inc., Amsterdam. 478 pages. Paperback: price €137,55, ISBN 9780128120644.



In considering the major tectonic zones on Earth that are connected with plate boundaries, a clear subdivision into three subtypes would be an obvious first thought. Convergent, divergent and transform plate boundaries are now listed in every modern handbook in earth sciences, even at the lowest educational levels. Still, the transform boundary type, also referred to as the conservative type, usually takes last place in this sequence. Seemingly, this reflects its minor position in reference to the types represented by destructive and constructive plate boundaries and linked to subduction zones and rifts. The two last-named are now deeply rooted in the mind set of university students, but also amongst the general public, while the transform, strike-slip faults and fractures zones at their extensions, to many still constitute the most mysterious, occasionally forgotten tectonic structures of global scale and significance. Yet, the earthquakes they trigger (e.g., in Turkey, New Zealand and California) make us realise the important, occasionally threatening and disastrous role that transform fault zones play in reshaping the face of our planet.

Certainly, the views that scientists, mostly specialists in tectonics, hold are much more sophisticated. They are fully aware of the relevance that transform boundaries have for full recognition of global tectonic mechanisms, and for proper modelling of the puzzle of plate patterns, both in the past and in the future. As mentioned in the present tome, the notion of transform faults, introduced by John Tuzo Wilson (1965), was critical for formulating the plate tectonics theory, because these features are indispensable for accommodation of the motions of lithospheric slabs. The present monograph is devoted exclusively to transform plate boundaries and illustrates the state-of the-art up to the year 2019, following more than fifty years after Wilson's seminal paper. This book bears evidence of the justified need to sum up current knowledge of conservative plate boundaries in a single publication. Almost 40 authors, top-level specialists from all around the globe, are responsible for this compilation of 18 independent, yet complementary chapters, totalling more than 450 pages. In the preface, the editor, J.C. Duarte, emphasises that this constitutes the first complete overview of transform boundary issues ever published.

This monograph covers a wide range of topics and methodologies related to our understanding of transform plate boundaries, as well as deformational features and processes that occur in these tectonic domains. Research results presented include classic tectonic and structural studies, but also geodynamics, seismology, geophysics, geomorphology, numerical and analogous modelling, studies of mineralisation, geohazards and history of science. Regional examples described refer to localities all over the globe, and from both continental and oceanic settings, including classic areas of tectonic research, such as the Mediterranean, the Himalayan region, the Caribbean, California, the East Pacific Rise and the Atlantic Ocean. The most prominent transform zones, such as the San Andreas Fault, the North Anatolian Fault and the Dead Sea Fault systems find the place they deserve, i.e., in separate, dedicated chapters. Step by step, the book takes the reader along different aspects of the geology of transform boundaries, starting from more general issues and ending with overviews of specific re-

gional examples. At times, the contents of the various chapters raise questions about their order; there are some surprising jumps in the topics presented. However, as this monograph is a loose compilation of totally independent chapters, their sequence does not have a great impact on the overall perception of the tome.

It opens with an interesting chapter on the eminent 20th century German geologist Franz Lotze. According to the author, Lotze's innovative tectonic concepts preceded (by almost 30 years), Wilson's independent discovery of transform faults, as well as the entire plate tectonic theory. Contributions by F. Lotze and E. Suess (also mentioned in this chapter) are especially close to my heart, being of central European origin: in large part, this region was shaped by Meso-Cenozoic fault tectonics which rebuilt the late Palaeozoic Variscan orogen. Some illustrations (Fig. 6A–C) are missing from this chapter, which slightly hinders proper understanding of Lotze's concepts. The second chapter discusses mid-ocean ridge transform faults (RTF), with reference to seismicity of these plate boundaries. The complexity of RTFs and their relatively low and non-uniform seismic activity is thoroughly outlined. Different models of zone (patches) distribution with seismic and aseismic slip are analysed. The topography and morphology of oceanic transform faults and fracture zones are the topics of Chapter 3; it shows that the geometry of these features is strictly dependent of changes in direction of plate motions and far-field stresses coupled with them. Local-field stresses may often play an important role as well and be responsible for the surface expression and structural pattern of specific transform boundaries. The next chapter returns to the issue of seismic behaviour of oceanic transform fault systems, but now the focus is on their intraplate lateral fracture continuations, with examples of specific earthquakes observed along these zones. A distinctly different mode of thinking about transform faults and related fracture zones is presented in Chapter 5, dedicated to the mineralisation issue. The occurrence of sulphide deposits at mid-ocean ridges (MOR) results from the activity of hydrothermal fluids and manifests itself at the surface by well-known vents. The oceanic transform faults and fractures zones, while connected with MORs, are not strictly linked with magmatism and related hydrothermal processes. However, the compilation table included in this chapter reveals that the mineralisation of transform forms, not restricted to just sulphides, is definitely not uncommon. Chapter 6 again touches the topic of seismicity at oceanic transform faults, this time using a regional example, the East Pacific Rise, which is analysed in detail. The case study of another oceanic transform plate boundary, between the Arabian and Indian plates (Chapter 7), is an example of pure tectonic analysis, based on high-quality seismic profiles and precise bathymetric maps. The methodologically similar content of Chapter 8 refers to the last oceanic transform structure, located in the most classic area of marine tectonic studies, i.e., the Atlantic Ocean. The Gloria Transform Fault is a part of the fracture zone that stretches between the Azores and Gibraltar. Geohazard risks, namely the tsunamigenic potential of this transform, are evaluated (and estimated as low-level). From Chapter 9 onwards, the continental transform boundaries become the main topic of this tome, heading off with an elegant and comprehensive overview of our knowledge of continental transform faults. By the way, I think a similar chapter is missing from the first section of the book, devoted to oceanic transforms. The authors of Chapter 9 use their own, original terminology for tectonic zones related to strike-slip and extensional zones (keirogens and taphrogens); time will tell if these terms will become widely accepted by the academic world. Chapter 10 is devoted to the most famous of transform boundaries, the San Andreas Fault System. The application of novel techniques (e.g., lidar, GPS) is stressed as a significant means of progress in tectonic studies and earthquake prediction for this highly populated area in California that is endangered by catastrophic seismic events. A markedly different attitude to research dedicated to transform faults is seen in Chapter 11, which discusses the Karakoram Fault that cuts across the Himalayan collisional orogen. In addition to the analysis of geomorphological data, the authors also use microtectonic observations at the microscopic thin-section scale, made on rocks coming from the deeper, mylonitised sections of the fault zone studied. Chapter 12 discusses the fairly novel idea of stretching transform faults, by using several examples from the Mediterranean region, including the Tyrrhenian basin and Calabrian arc. The following chapter strictly concerns the latter area, and includes results of analogous modelling using granular materials. The authors discuss potential interrelationships between strike-slip tear faults and thrusts generated during the development of the Calabrian accretionary wedge. Chapter 14 also homes in on the Mediterranean, in particular on the Aegean region and its tectonic evolution from the Pliocene up to the present day. In the next portion of this monograph (Chapter 15) we move to the northern Caribbean and its complex plate boundary with the North American slab, inclusive of two large-scale strike-slip fault systems responsible for numerous seismic

events. Geographically interrupted, the remaining chapters (16–18) describe three subareas of the Mediterranean region that are shaped by the presence of transform faults: the Marmara Sea (cut by the western part of the North Anatolian Fault), the Dead Sea (bounded by the eponymous fault system) and ancient oceanic crust of Cyprus, represented by the Troodos ophiolite. In the last-named example, the exhumed, fossil oceanic transform fault zone is discussed. The final chapter loops with that part with which the book opens. This time, research was concentrated on plastically deformed crystalline rocks that form the lower oceanic lithosphere – peridotites and serpentinites, as well as on brittle breccias from the upper part. The study aimed to contribute a general explanation of the complex seismic behaviour in transform fault areas.

Each of the chapters in the present volume, written by different authors, should be treated as an independent entity and can be read separately, without any loss resulting from omission of other portions. As a whole, this monograph is an astounding compendium of the current state of knowledge of transform faults and fracture zones, both in general terms and where the most instructive regional examples are concerned. This voluminous overview appears to be addressed mainly to researchers who work in this field of tectonic studies. However, it can also be a valuable, yet demanding, source of data for postgraduate students who are interested in global tectonics. This monograph should be on the bookshelves in libraries of all high-level academic and research institutions in tectonic studies. It also deserves to be on the desks of geoscientists who work on our understanding of the Earth's lithosphere dynamics: not only tectonicists, but also seismologists, geophysicists, igneous petrologists, economic geologists, oceanologists and others. In the words of the editor, this tome can truly be a good starting point and inspiration for studies in the comparatively new and challenging topic of conservative plate boundaries and their role in the lithospheric system: in numerous chapters of this book, there are plenty of open questions to be found.

Reference

Wilson, J.T., 1965. A new class of faults and their bearing on continental drift. *Nature* 207, 343–347.

Wojciech Stawikowski
Adam Mickiewicz University, Poznań, Poland
e-mail: wojst@amu.edu.pl