

# Preface

One of the key areas of research in the Earth Sciences are processes that occur along the boundaries of the tectonic plates that make up Earth's lithosphere. Of particular importance are the processes of tectonic accretion and erosion along convergent plate boundaries. One of the principal mechanisms of accretion occurs when intra-oceanic volcanic arcs collide with the margin of a continent in what is called arc–continent collision. Arc–continent collision has been one of the important tectonic processes in the formation of mountain belts throughout geological time and continues today along tectonically active plate boundaries such as those in the SW Pacific or the Caribbean. Well-constrained fossil arc–continent collision orogens supply the third and fourth dimension (depth and time) that are generally missing from currently active examples where tectonic processes such as subduction, uplift and erosion, and the formation of topography can be observed. Arc–continent collision is also thought to have been one of the most important processes involved in the growth of the continental crust over geological time, and may also play an important role in its recycling back into the mantle via subduction. The integration of research between active and fossil arc–continent orogens provide key data for the understanding of how plate tectonics works today, and how it might have worked in the past. Understanding the geological processes that take place during arc–continent collision is therefore of importance for our understanding of how collisional orogens evolve and how the continental crust grows or is destroyed. Furthermore, zones of arc–continent collision are producers of much of the world's primary economic wealth in the form of minerals, so understanding the processes that take place during these tectonic events is of importance in modeling how this mineral wealth is formed and preserved.

Arc–continent collision orogeny is generally short-lived, lasting from c. 5 to 20 My, although much longer-lived regional events do occur. The duration of an arc–continent collision orogeny depends on a number of factors, among which the obliquity of the collision, the subduction velocity, and the structural architecture of the arc and the continental margin involved are of primary importance. In this book we define the onset of arc–continent collision as the arrival of the leading edge of the continental margin (continental crust to oceanic crust transition) at the subduction zone, something that is often difficult to identify in the geology of an orogen. Thinned, extended continental margins often reach 150–400 km in width and are highly structured. There is now widespread evidence that this thinned crust can be deeply subducted (>200 km) before being returned to the surface as high- and ultrahigh-pressure rocks. Dating these high-pressure rocks can provide important constraints on the timing of arrival of the continental margin at the subduction zone.

A further constraint can be supplied by the arc volcanics, whose geochemistry may record the entrance of continentally derived sediments, or the thinned continental crust itself, into the subduction zone. In currently active systems, imaging the subducted continental lithosphere with techniques such as seismic tomography can also provide key data for determining the timing of on-set of collision and the rates at which the continental crust is being subducted. With the arrival of thicker continental crust (c. 20–30 km thick) at the subduction zone the developing orogen is generally uplifted to above sea level where it begins to erode and provide sediment to a foreland basin and across the arc–continent suture zone and the forearc. As convergence continues, the active volcanic front generally shuts down shortly after the entry of the continental crust into the subduction zone, and volcanic activity can move away from the subduction zone to continue outboard of it for some time before stopping completely. During the final stage of collision, a change in the location of the subduction zone can take place, further marking the end of the arc–continent collision. The final result of the arc–continent collision is a significant change in the structural architecture, composition, and rheology of the continental margin.

The aim of this book is to bring together a series of papers that are dedicated to the investigation of the tectonic processes that take place during arc–continent collision. A further aim is to investigate how tectonic processes influence the large-scale geological characteristics of these accretionary orogens and their mineral wealth. Finally, specific examples of arc–continent collisions are investigated. These range in age from the Neoproterozoic to those that are currently active, covering a large portion of geological time. To advance these aims, a series of points are developed which we attempt to address where possible in each paper. These points are:

- The large-scale crust and mantle structure.
- The nature and role of the lithosphere and asthenospheric mantle in the dynamics and chemistry of the subduction and collision processes.
- Processes that take place deep within the subduction channel in pure intraoceanic subduction and during the subduction of the continental crust.
- The geochemical and petrological evolution of the arc both before and during collision.
- The nature of the continental margin and its response to the collision.
- The formation of topography and the erosion of the developing mountain belt to form a foreland and a suture forearc basin.
- Fore-arc subduction or accretion.
- The emplacement of ophiolites and ultramafic massifs.
- Metamorphism within the developing orogen.
- The possibility of changes in the location of the post-collision subduction zone.
- Place constraints on the duration of arc–continent collision orogeny.
- Recycling, or growth and destruction of the continental crust.

The book is organised in four sections. In the first section, numerical modeling and natural examples are used to look at the three main players involved in arc–continent collision; the continental margin, the volcanic arc, and the subduction zone. In the second section, natural examples of arc–continent collisions are described. In the third section, modeling of various aspects of arc–continent collision are presented. In the fourth section, we bring together the material presented in the previous sections addressing the series of points outlined above and, where possible, attempt to provide answers to them.

---

Finally, this publication was grant-aided by the Publications Fund of the National University of Ireland, Galway. Also, we would like to extend our thanks to those who kindly provided reviews of the papers. This is an IGCP 524 publication.

Barcelona, Spain  
Galway, Ireland

Dennis Brown  
Paul D. Ryan



<http://www.springer.com/978-3-540-88557-3>

Arc-Continent Collision

Brown, D.; Ryan, P.D.

2011, XII, 988 p. 241 illus., 221 illus. in color.,

Hardcover

ISBN: 978-3-540-88557-3