Earth Accretionary Systems in Space and Time

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Earth Accretionary Systems in Space and Time

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Preface

Accretionary systems are the result of plate tectonics and form at sites of subduction of oceanic lithosphere. They consist of magmatic arc systems along with material accreted from the downgoing plate and eroded from the upper plate. These long-lived systems have contributed significantly to crustal growth through Earth history and are the most important 'factories' for generating, recycling and maturing continental crust (e.g. Condie 2007; Foster *et al.*). These systems received less attention in the past than shorter-lived collisional systems resulting from continental amalgamation.

In 2003 a group of international scientists interested in accretionary systems established a forum for discussion entitled ERAS (EaRth Accretionary Systems in space and time), following the philosophy that an integrated, multi-disciplinary and comprehensive programme of research in selected accretionary systems of all ages will provide a common framework to better understand their development. Recognition of the importance of accretionary systems has been hindered by the lack of a unifying model, with different possible evolutionary paths, to explain their evolution, or recognition of a common suite of processes that operate in many of these systems. The first field workshop of ERAS was held in Taipei, Taiwan, in May 2004, organized by Bor-ming Jahn, followed by a field excursion to the Coastal Range on the west and SW coast of Taiwan to view a modern accretionary orogen as it actively undergoes arc–continent collision. ERAS was formally established in 2005 as a 5 year Research Project under the International Lithosphere Program (ILP) as Task Force 1 and has since organized thematic sessions at several international conferences. A second field workshop was held in Kochi, Japan, in September 2006, organized by Kimura Gaku, Yukio Isoztaki and M. Santosh, and sponsored by the Japan Society of Promoting Sciences, followed by a field trip to central Shikoku and Inuyama to study aspects of ocean-floor stratigraphy and accretion tectonics.

The first four papers of the volume discuss general aspects of accretionary systems, and the following 10 contributions deal with specific terranes or orogenic belts, beginning with the early Archaean in West Greenland and ending with the Cenozoic in SE Asia. **Cawood *et al.*** provide an overview of accretionary systems through Earth history, defining types of accretionary orogens, discussing driving mechanisms, and emphasizing that these systems have contributed significantly to the growth of continental lithosphere. **Brown** reviews regional metamorphic processes in orogenic systems and emphasizes the complexity of metamorphic assemblages that may originally have evolved in accretionary systems but were subsequently overprinted during collisional orogeny, the final fate of many accretionary belts. **Clift *et al.*** discuss sediment recycling and crustal loss in subduction zones and argue that net crustal growth predominantly occurs through accretion of oceanic arcs to passive continental margins. **Scholl & von Huene** argue that volumetrically small or missing accretionary masses along modern subduction zones are due to subduction erosion and sediment subduction, and that recycling losses of lower plate crust during plate convergence may lead to disappearance of geological evidence for accretionary processes.

The regional contributions begin with an account by **Nutman *et al.*** on what is probably the oldest preserved accretionary system in West Greenland, the 3.87–3.60 Ga Itsaq Gneiss Complex. These authors relate the episodic formation of a voluminous tonalite–trondhjemite–granodiorite gneissic suite to an Eoarchaean subduction zone with short-lived episodes of mantle wedge melting and subsequent melting of subducted crust. **Polat *et al.*** compare Archaean crustal growth processes in southern West Greenland and the Superior Province of Canada, and use petrological and geochemical arguments to suggest that these terranes constitute large subduction–accretion complexes formed during Phanerozoic-style plate convergence. **St. Onge *et al.*** using a different approach, also compare Archaean and Palaeoproterozoic tectonic processes in West Greenland and northeastern Canada, and develop a generalized evolutionary scenario for the period 2.7–1.8 Ga on the basis of tectonostratigraphic, structural and age data. Their model of crustal accretion during the growth of northeastern Laurentia in the Palaeoproterozoic may be comparable with the growth of the upper plate Asian continent prior to collision with India. **Lahtinen *et al.*** describe one of the best documented examples of later crustal growth and accretion in the Palaeoproterozoic from the Svecofennian orogen in Scandinavia. They use published geological and geophysical data to document magmatic growth episodes between 2.1 and 1.8 Ga with additions of *c.* 2.1–1.8 Ga microcontinents and juvenile arcs and major Andean-type vertical magmatic additions at 1.9–1.8 Ga.

This was followed by tectonic accretion and reworking of the older rocks at 1.7 Ga. **Snyder *et al.*** use several geophysical methods to argue that much of the continental crust underlying the Canadian Cordillera consists of a thick Proterozoic sedimentary package shed off the Canadian shield along a passive margin between 1.84 and 0.54 Ga and forming a prograding wedge. This implies that the tectonically overlying Phanerozoic accreted terranes are only a few kilometres thick.

Moving to the Phanerozoic, **Colpron & Nelson** discuss the early evolution of the North American Cordillera and argue for a Caribbean- or Scotia-style subduction system between northern Laurentia and Siberia in the mid-Palaeozoic. They postulate that upper mantle flow out of the shrinking Iapetus–Rheic oceans opened a mid-Palaeozoic 'gateway' between Laurentia and Siberia, which progressively developed and led to propagation of subduction along western Laurentia. **Tizzard *et al.*** discuss arc imbrication and thick-skinned collision of the oceanic Stikinia arc terrane in Yukon, Canada, as it is accreted into the Cordilleran orogen during development of a Jurassic crustal-scale shear zone. **Foster *et al.*** review the tectonic history of the Australian Lachlan orogen and provide geochemical data for a Cambrian marginal oceanic basin that formed the basement for a thick Palaeozoic turbidite fan.

The last two papers of the volume provide examples of accretionary processes along the southeastern margin of Eurasia. **Hall** summarizes the evolution of the Indonesian Archipelago and the Philippines, which consist of a continental core of blocks rifted off Gondwana and surrounded by subduction zones for much of the Mesozoic and Cenozoic. This is a mountain belt in the process of formation and serves as a modern example of a complex accretionary orogen exemplifying episodic crustal growth. Finally, **Morley** portays the Tertiary tectonic evolution of Thailand and eastern Myanmar from an oblique subduction back-arc orogen to a highly oblique collisional margin resulting from collision of India with the Burma block.

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Reference

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