Preface

The geological, geochemical and geodynamic processes involved in the formation of oceanic and continental crust during the Phanerozoic are well understood within the frameworks of plate and plume tectonics. However, processes and the mode (steady-state versus episodic) of oceanic and juvenile continental crust generation in the Precambrian, particularly during the Archean, are less understood and more controversial because of the ongoing debate about whether or not modern plate tectonics operated prior to the Neoarchean. The Phanerozoic ophiolite record shows that ancient oceanic crust developed in various tectonic settings, such as mid-ocean ridges, arc–back arc–forearc regions, and rifted continental margins, during the Wilson Cycle evolution of ocean basins. Unequivocal ophiolite occurrences in the Archean record are rare in the literature, but are potentially more widespread in the greenstone belts than our current estimates and considerations. Similarly, how large amounts of continental crust were produced and how much of it was recycled back into the mantle in the Archean, what role mantle plumes versus plate tectonics played in continental crust formation during the early Precambrian are some of the outstanding questions regarding Earth's crustal growth and evolution.

Archean greenstone belts constitute a significant component of the Precambrian geology and provide a window into deep time. They consist mainly of mafic-ultramafic lavas, calc-alkaline-felsic volcanic and volcaniclastic rocks, and sedimentary lithofacies assemblages. Most greenstone belts are spatially associated with TTG (tonalite, trondhjemite, granodiorite) terrains. Competing models on the origin and evolution of greenstone belts have important implications for the Archean Earth. The role of plate tectonics in the evolution of Phanerozoic and Proterozoic crust is well established, but is a subject of debate regarding the Archean history. Crustal growth and differentiation through punctuated events (i.e. emplacement of mantle 'superplumes') versus continuous subduction processes and whether Archean crust was too weak and mobile to behave as in rigid plates are fundamental questions in geodynamics and in Earth history. Recent studies have documented the occurrence of boninites, adakites, Mg-andesites, high-pressure rocks, and ophiolites in some of the Archean greenstone belts, suggesting that Phanerozoic-like subduction zone tectonics may have been operating as early as 3.8 Ga. Geophysical findings also show that many greenstone belts can be interpreted as horizontal thrust sheets, rather than deep synclinal keels, indicating that their unexposed bottoms are most likely defined by major shear

zones, and that many greenstone belts were involved in some type of fold-and-thrust and/or listric extensional tectonics.

Well-preserved bioalteration textures in Archean marine volcanic glass suggest an endolithic mode of microbial life in the early Earth. What role did submarine volcanoes play during the origin of early life remains a significant question and is being addressed nowadays through the integrated studies of Archean oceanic crust. The recently conducted Barberton *Scientific Drilling Program* (South Africa) has been designed to shed some light on these questions.

This book has emanated from a series of scientific sessions we convened during the International Geological Congress (IGC-33) in Oslo in 2008 and at the Geological Society of America Annual Meetings in Portland (2009) and Minneapolis (2011). The main objectives of these sessions were to evaluate and to discuss the diverse datasets from the Archean Earth, specifically the greenstone belts, in order to better understand the nature and tempo of physical, chemical and biological processes involved in development of the Archean Earth and their implications for the planetary evolution and early life. The book mostly contains some of the papers presented in these sessions, and provides an integrated approach to the study of the evolution of the Archaean lithosphere and biosphere. The structural and geochemical make-up of both the oceanic and continental crust of the Archaean Earth is documented in some case studies of various cratons, and the implications of the Phanerozoic plate and plume tectonic processes for the Archaean geology are discussed in several chapters. The last four chapters in the book investigate the record of microbial life in the Archean Earth and the recently developed techniques of decoding this record to better understand the evolution of the early life in marine and in some extreme environments. All chapters are process-oriented and data-rich, and reflect the most recent knowledge and information on the Archean Earth. The interdisciplinary approach of examining the evolution of the Archean crust and life in this book sets it apart from previous publications on Precambrian geology, and makes it a unique contribution to our understanding of the early Earth and life. The book is intended for students (upper-level undergraduate and graduate students) and researchers in the academia and industry in earth and natural sciences.

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