

PRECAMBRIAN GEOLOGY OF FINLAND KEY TO THE EVOLUTION OF THE FENNOSCANDIAN SHIELD

EDITED BY

M. LEHTINEN, P.A. NURMI, O.T. RÄMÖ



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PREFACE

The Fennoscandian (or Baltic) Shield represents the largest outcropping domain of Precambrian bedrock in Europe, covering more than a million km² throughout Norway, Sweden, Finland, and northwestern Russia. This book focuses on Finland, which occupies the central part of the shield and which, since the advent of modern geology in the 19th century, has been instrumental in a number of fundamental insights and advances in understanding Earth processes. Wilhelm Ramsay, who was the Professor of Geology and Mineralogy at the University of Helsinki in 1899–1928 and who introduced the term Fennoscandia, made an outstanding contribution to the understanding of alkaline rocks through his studies of the Devonian Kola province in the northeasternmost part of the shield. Meanwhile, J.J. Sederholm, Director of the Geological Survey of Finland in 1893–1933, pioneered the application of actualistic principles to Precambrian terrains and the systematic study of Precambrian granites, introducing the concepts of migmatites and anatexis in 1907, and published acclaimed monographs on orbicular textures and the rapakivi granite association. Pentti Eskola, who succeeded Ramsay in the Chair of Geology and Mineralogy at Helsinki in 1929–1953, is particularly renowned for defining the metamorphic facies concept, based initially on the Orijärvi district near Helsinki, and which now underpins studies in metamorphic petrology worldwide.

Further developments in analytical chemistry and elemental and isotope geochemistry, by Th.G. Sahama and Kalervo Rankama, paved the way for isotopic calibration of Precambrian rocks and events, which has been essential to attaining our present understanding of crustal evolution. Concurrent advances in geophysical techniques and instrumentation, while driven mainly by exploration applications, have played an equally significant role in mapping the country in recent decades, especially in poorly exposed areas, by providing detailed airborne survey as well as deep seismic sounding data. As a consequence, the Finnish part of the Fennoscandian Shield can rightfully be considered as one of the best-documented Precambrian terrains in the world.

This compilation provides the first modern account of the geology of Finland. The seventeen chapters of the book have been written by geologists and geophysicists who have actively contributed to the research in their respective fields. In addition to a general overview chapter on the Precambrian of Finland and an account of the history of Finnish bedrock research, the book contains twelve chapters on specific lithologic and crustal entities (the Archean in the eastern part of the country; Paleoproterozoic supracrustal belts, mafic and

ultramafic intrusions, mafic dike swarms, ophiolites, and granitoid rocks; the rapakivi granites in their type terrain, and subsequent supracrustal successions and mafic magmatism; Neoproterozoic/Phanerozoic kimberlites, carbonatites, and alkaline rocks), as well as chapters on Paleoproterozoic tectonic evolution, carbon isotope stratigraphy, and the paleomagnetically defined drift history of the shield. The aim of the book is thus to provide the international geological community with an up-to-date account of the geologic framework and conceptual interpretation of the bedrock of Finland and to serve as a basis for future research. The book will also be a valuable reference for exploration activities, which at present are focused on gold, platinum-group metals, nickel, and diamonds in particular.

This book would not have been possible without the contribution from the Geological Society of Finland (the society published a precursor to this book in Finnish in 1998¹), the commitment of the authors, and help from devoted reviewers (Andrey Bekker, Walter Boyd, Carl Ehlers, Sten-Åke Elming, Roland Gorbatshev, Eero Hanski, Yrjö Kähkönen, Jarmo Kohonen, Asko Kontinen, Raimo Lahtinen, Laura Lauri, Matti I. Lehtonen, Arto Luttinen, Hannu Makkonen, Satu Mertanen, Heikki Niini, Hugh O'Brien, Richard W. Ojakangas, Juhani Ojala, Heikki Papunen, Riku Raitala, Peter Sorjonen-Ward, Matti Vaasjoki, Pär Weihed, Alan Woolley). We would also like to thank Kent Condie, the Series Editor, for accepting this volume to be included in Elsevier's *Developments in Precambrian Geology Series*, and Patricia Massar and Friso Veenstra for excellent collaboration in technical and administrative matters. Our special thanks go to Sakari Haapaniemi, who patiently manufactured the final electronic manuscript of the book in the course of an overly long and tedious editorial process.

Martti Lehtinen

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OVERVIEW

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Cover page: Paleoproterozoic migmatic and gneissic granodiorite containing gabbro fragments cross-cut by tiny granite pegmatite dikes (in the background). Porkkalanniemi, Kirkkonummi, ~30 km west of Helsinki. Photo: Jari Väätäinen.

The bedrock of Finland belongs to the Precambrian East European craton of northern and eastern Europe and northwestern Russia. Precambrian crystalline rocks crop out only in the northern and southwestern parts of the craton, in the Fennoscandian and Ukrainian shields, respectively; elsewhere they are covered by platform sediments. In Sweden and Norway, the Fennoscandian Shield is delimited by the Caledonides. In Estonia in the south and Russia in the south-east, the Precambrian bedrock plunges at a shallow angle under Phanerozoic sedimentary rocks.

The most important events during the evolution of the Finnish bedrock occurred at 2800–2700 Ma and 1900–1800 Ma. In those times, continental crust was segregated from the Earth's mantle in two major (probably multiphase) orogenies. The resultant Archean and Paleoproterozoic crust of Finland is divided into 25 areas with characteristic lithologic traits. This chapter gives an overview of Finland's bedrock and its evolution from the Mesoarchean to the present time.