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Precambrian Research 124 (2003) 105–106
Precambrian Research
www.elsevier.com/locate/precamres

Preface

Origin and evolution of Proterozoic Anorogenic Magmatism

Papers in this Special Issue of Precambrian Research come from a theme session at the EUG XI held in Strasbourg, France, April 2001. The session was entitled "Origin and evolution of Proterozoic Anorogenic Magmatism: implications for the evolution of the continental crust", attracted papers covering the subject of A-type magmatism, and was co-sponsored by IGCP Project 426 (Granite Systems and Proterozoic Lithospheric Processes). From the 23 papers presented (J. Conf. Abs. 6, 2001), 8 of them are included in this Special Issue of Precambrian Research.

A-type magmatism encompasses a rather large group of compositions which include the reduced rapakivi granites generally associated with massif-type anorthosites as well as the well-known anorogenic granites which include rather oxidised examples, both types of intrusions being characteristic of Proterozoic times. A better understanding of the petrogenesis (possible parental magmas and sources, differentiation processes, ...) of this magmatism can thus enlighten us about the Proterozoic lithospheric processes and about the mechanisms of progressive Earth differentiation. General consensus is reached on the fact that A-type magmatism occurs in non-compressive geological settings at the end of an orogenic cycle (post-orogenic or post-collisional granitoids), in continental rift zones or in oceanic basins. Moreover, authors agree that there is probably more than one way of generating A-type magmas and several processes have been proposed which are favoured in this Special Issue: basalt fractionation, melting of tonalitic or more felsic crust, combination of crustal and mantle sources. In light of these papers it appears that the observed compositions of A-type magmas range from metaluminous to peralkaline and crystallisation conditions are also quite variable in terms of oxygen fugacity and water content. Nevertheless, it appears that despite this variability, Proterozoic anorogenic granitoids, rapakivi granites and granitoids associated with anorthosites and related rocks are mainly metaluminous and have all in common characteristic geochemical features: i.e. high $FeO_t/FeO_t + MgO$ as well as high contents in K_2O and incompatible elements. To take into account this peculiar signature, we thus suggest that these magmas be referred to as ferro-potassic A-type.

At about 1.0–0.9 Ga, the south-western Baltic (or Fennoscandian) shield (southern Norway and Sweden) was intruded by a series of late ferro-potassic A-type granitoids related to the main Sveconorwegian orogenic episode. Using mineral, geochemical and isotopic data on a selection of these granitoids, Vander Auwera et al. propose that they were generated through extensive fractional crystallisation of basic magmas with assimilation of Rb-depleted material having negative ε_{Nd}. Moreover, considering that this series of granitoids is penecontemporaneous with the AMC suite of the Rogaland complex (930 Ma), the authors argue that both series have mafic parent magmas which differ in hydration state from the related mafic sources.

Bogaerts et al. performed a detailed petrological and geochemical study (major and trace elements, Sr–Nd isotopes) of the Lyngdal granodiorite and associated plutons (Tranevåg and Red Granite) which belong to the series of ferro-potassic A-type granitoids presented by Vander Auwera et al. in the same issue. The Lyngdal plutons are sub-alkaline, metaluminous granitoids with high $FeO_t/(FeO_t + MgO)$ ratio and K_2O content, displaying a continuous trend from quartz monzodiorite to granite (~56–72 wt.% SiO_2). Quantitative modelling of the differentiation process indicates that extracting a cumulate of gabbroic composition

doi:10.1016/S0301-9268(03)00083-4

from the quartz monzodiorite can drive the liquid to granitic compositions. The Lyngdal plutons are more oxidised and enriched in H_2O relative to classical rapakivi granites linked to anorthositic complexes.

New Sr–Nd isotopic data acquired on jotunites and felsic rocks from the Rogaland AMC suite (Norway) are documented by Bolle et al. The authors interpret these data as reflecting a mixing of crustal contaminants with a more isotopically primitive source. The crustal end-members of that mixing array are represented by moderately to strongly LILE-enriched high-grade gneisses from the pre-Sveconorwegian basement of southernmost Norway and a primitive end member corresponding to gabbro-norites from the lower crust.

New U–Pb geochronological data on A-type plutonic rocks, on bimodal volcanic rocks interlayered with clastic sediments, and on detrital zircons from sediments within the Telemark supracrustal rocks of the Sveconorwegian orogen are presented by Bingen et al. These new data indicate an overlap in time between the 1.19–1.13 Ga Early Sveconorwegian magmatism, intermontane basin formation and the Early Sveconorwegian 1.15–1.12 Ga granulite facies metamorphism in the Bamble sector. This overlap is interpreted as evidence of a thermal pulse in the crust linked to an upflow of the asthenospheric mantle. An analogy between the 1.19–1.13 Ga evolution of the western part of the Sveconorwegian Province and the Cenozoic evolution of the Basin and Range province in NW USA is proposed.

Scoates and Chamberlain report new U–Pb zircon ages for several monzonitic intrusions in the Laramie anorthositic complex, which indicate that all of the intrusive rocks in this complex were emplaced and crystallised in less than 10 million years. These new data integrated with available geochemical data enable the authors to propose that the ferro-dioritic parents of most monzonitic and related rocks were extracted from anorthosite at depth and contaminated during ascent through Archaean crust prior to emplacement.

New petrologic, geochemical and isotopic data acquired by Anderson et al. on the Red Mountain pluton outcropping in the northern part of the Laramie anorthosite complex (Wyoming, USA) show that this intrusion is characterised by very high FeO_t, K_2O and REE contents. These data favour high temperature ($\approx$1000 °C) and low oxygen fugacity (FMQ-1 to -2) differentiation. Moreover, the authors suggest that these granitoids were derived by fractional crystallisation of ferrodiorites which are themselves considered as residual after differentiation of parental tholeiites.

The paper of Skridalite et al. consists of new petrographical and geochemical data on Early Mesoproterozoic silicic, intermediate and mafic rocks which intruded along an EW lineament in the metamorphic bedrock in the buried western part of the East European Craton in Lithuania and Poland. The authors propose to relate these magmatic rocks to the AMCG suite of rocks.

New experimental data acquired on two compositions of the Wangrah Suite (Lachlan Fold Belt, Australia) by Klimm et al. place important constraints on the differentiation processes and conditions of crystallisation of A-type magmas, notably the importance of plagioclase and orthopyroxene as early crystallising phases and the H_2O undersaturated but not exceptionally H_2O-poor nature of the magma. In addition, the Phanerozoic age of the Wangrah Suite shows that even if A-type magmatism is characteristic of the Proterozoic period, it is not restricted to it.

Special thanks go to the following colleagues whose thoughtful reviews helped greatly to improve the papers. The reviewers are in alphabetical order: T. Andersen, L. Ashwal, J. Bédard, B. Bonin, D. Holm, B.-M. Jahn, G.N. Eby, W. Collins, D. Corrigan, J.C. Duchesne, G. Dunning, R. Emslie, S. Fourcade, R. Frost, B. Landenberger, J. Longhi, H. Martin, A. Nutman, R. Patino Douce, G. Poli, T. Rämö, T. Sisson, R.J. Thomas, K. Thrane, O. van Breemen, R. Wiebe.

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