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Granites in Crustal Evolution and Metallogenesis: Introduction

The MAGMA (acronym for Magmatismo Granítico e Mineralizações Associadas, in Portuguese) Symposium was held in Rio de Janeiro in August 2000 during the 31st International Geological Congress with W. Edryd Stephens and A.N. Sial as the convenors. Not merely a rerun of the first MAGMA sponsored by the Brazilian Academy of Science, held in Rio in 1993, this Symposium aimed to update the status of knowledge on granitic rocks and mineralizations they may host. A total of 127 contributions (representing 21countries) bear testimony to the overwhelming response. The Symposium started with a talk by W. Edryd Stephens on the status of granite studies, accomplishments in granite science and remaining unsolved problems related to this fascinating theme. He also narrated some of the broad aspects of the granitology, historical perspective, and present and future pathways on granite research. These introductory remarks were followed by five key-note addresses focussing on different aspects of contemporary research in granitology. Bernard Bonin started the series of talks by providing a planetary point of view on granites, a theme, doubtless of broad interest, not usually discussed in Granite Meetings. Carlos W. Rapela followed with a contribution on the origin of coeval TTG, I- and S-type granites in Argentina, related to crustal extension, elaborating a very provocative model. Bernd Lehmann discussed a metallogenetic model for porphyry systems in the central Andes. The petrologic and geochemical variations in granitoids of the Ryoke magmatic arc in Japan were discussed by T. Kutsukake and Miguel A. Parada detailed the magmatic evolution and exhumation of the Cretaceous Caleu pluton in the coast range of Central Chile, a case where a pluton in a stratified magma reservoir can be vertically sampled for more than one kilometer.

Recent advances in the fields of isotope geochemistry, geophysics, and experimental petrology have significantly contributed in resolving the long standing 'granite problem'. Isotopic data have made it possible to precisely infer the nature of source and to quantify the contamination processes, while geochemical trends offer an insight into petrogenetic evolution. Geophysics has proved to be a very useful tool in understanding the dynamics of melt migration and emplacement under the given stress regime. This issue aims to offer the current status of the 'granite problem' through topical themes of granite studies. It constitutes a compilation of thirteen selected papers that cover granite petrology and geochemistry, deformation tectonics and related mineralization in South America, Asia and Europe. The first paper of this issue by B. Bonin and co-authors provides a commentary on extraterrestrial granites and geochemical details on Lunar and Martian rocks. A comparison of extraterrestrial granites with the most predominant lithology of the earth's crust seems to be a matter of scientific curiosity as the telluric planets and the asteroid belt display the same internal structure (metallic inner core and silicate outer crust). The 4.4–3.9 Ga old Lunar granites show significant K/Ca enrichment and low REE abundance consistent with an origin through silicate immiscibility. Presence of dry mineral assemblage has led to postulate the granites may not be essentially 'wet'. Though no granites have been found in Mars, the rocks of intermediate composition (~62% SiO_2) can be considered to be analogous to the terrestrial continental crust. M.A. Parada and co-authors have described the magmatic evolution and exhumation of the Cretaceous Caleu pluton, Central Chile. They have identified three zones formed through a common isotopically depleted source, but each zone has followed an independent evolutionary path. T. Kutsukake has described two temporally distinct (100–85 and 85–75 Ma) I-type, peraluminous to metaluminous granitoids from SW Japan that represent the magmatic front of a late Cretaceous continental arc magmatism. Geochemical data support the genesis through dehydration melting of amphibolite or hydrous melting of tholeiitic basalt. Necessary heat for melting was provided by basalt underplating. Ian McReath and co-authors have described three temporally indistinguishable A-type Umarizal granite plutons NE Brazil, emplaced during the post-collisional, extensional phase of Neoproterozoic Brasiliano orogeny. The Sr isotopic signatures suggest a significant crustal contribution, and the granites have been envisaged to evolve through a complex set of petrogenetic processes. The granitoids in the Precambrian Aravalli craton (NW India) occur at various stratigraphic levels from Archaean to end-Proterozoic. Despite a lack of authentic geochronological information on most of these granitoids, they have been successfully utilised to understand the Precambrian evolution of Aravalli terrane. Manish A.

Mamtani and co-authors have described the structural relationships of banded gneisses and Godhra Granite from the southern Aravalli Belt, suggesting the derivation of the granite from banded gneiss during deformation. Anil Maheshwari and co-authors have described geochemical trends of Neoproterozoic granitoids from SW Aravalli craton to discriminate collisional I-type and post-collisional A-type granites. C.M. Wiedemann and co-authors have described the 580–480 Ma post-collisional to late orogenic, high-K, metaluminous, allanite-titanite-bearing granitoids from the Araçuaí-Ribeira belt in eastern Brazil to ascertain their role in defining the architecture of the belt. They have envisaged partial melting of the crust, initiated by replacement of lithospheric mantle by hot asthenospheric mantle. The mantle exchange resulted from lithospheric mantle delimitation and slab break-off following crustal orogenesis. J.N. Rossi and co-authors have identified two peraluminous mafic and felsic facies in the Ordovician Capillitas granitic batholith, NW Argentina, and postulated that the granitoids were evolved from different batches of a melt derived from a common, recycled metasedimentary source. Spatial distribution of these granites has been termed as the NW Argentinean analogue of the I- and S line of eastern Australia. Marco A.F. Ferreira and co-authors have focussed on the 580 Ma-old ultrapotassic syenites from NE Brazil. The geochemical parameters are consistent with an early fractionation of pyroxene-titanite-apatite assemblage. Nd-isotopic signatures relate to an enriched mantle source of Palaeoproterozoic age. The authors propose a shallow level emplacement of a high-density anhydrous melt. A.F. da Silva Filho and co-authors have provided Nd-isotopic data on Neoproterozoic granites of the Pernambuco-Alagoas terrane, NE Brazil, and recognized two different domains, based on the modal Nd ages of 1.8 to 2.4 and 1 to 1.5 Ga, respectively. The granites of Garanhuns domain do not show any Meso- to Neoproterozoic crustal additions, while those from the Água Branca domain include substantial Meso- to Neoproterozoic contributions with a Paleoproterozoic component. G. Dias and co-authors have utilised the Sr–Nd isotopic characteristics to model the source composition for Late Hercynian (300–320 Ma) granitoids and coeval gabbronorite-granodiorite from NW Portugal. The isotopic data point toward interaction between felsic and enriched mantle-derived mafic magmas, leading to slightly peraluminous to slightly peralkaline compositions. Granitoids were evolved from fractional crystallization of such hybrid magma.

Granites have also been associated with a number of economic occurrences of several metals, such as W, Sn, Li, Mo etc. A. Almeida and co-authors provide a general account of mineralization associated with three Hercynican (311–299 Ma) granitoids in NW Portugal. The Cabeceiras de Basto is a two-mica peraluminous granite specialised in Sn, Li±W mineralization. The ore segregation has been related to the fractional crystallization of a melt derived from a heterogenous source. The emplacement of the Vieira do Minho and Vila Pouca do Aguiar plutons have induced thermal metamorphism that was capable of generating convective fluids and contributed to spatially associated Sn, W and Au mineralization as heat source. A-type granites, though significant in defining the tectonic setting, have usually not been the target for any mineral exploration. However, H.T. Costi and co-authors describe Sn mineralization hosted by sodic episyenites from the A-type Água Boa Granite, NW Brazil. The Sn mineralization is attributed to metasomatic episyenitization of the rapakivi facies of the Água Boa granite that was favoured by a temperature gradient and high fluid-rock ratios. The episyenitization has been accomplished through albitization of K-feldspar, albite infilling of vugs, and deposition of late quartz and cassiterite. The late hydrothermal alterations can be related to a low temperature, silica saturated, meteoric or meteoric+magmatic fluid.

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