A-type granites and related rocks through time

R. DALL'AGNOL[1], C.D. FROST[2] AND O.T. RÄMÖ[3]

[1]Centro de Geociências, Universidade Federal do Pará, Caixa Postal 8608, 66075-100 – Belém – PA – Brazil (robdal@ufpa.br)
[2]Department of Geology and Geophysics, University of Wyoming, Laramie WY 82071 USA (frost@uwyo.edu)
[3]Department of Geology, P.O. Box 64, FI-00014 University of Helsinki, Finland (tapani.ramo@helsinki.fi)

A-type granites (including their volcanic equivalents) and related rocks form a conspicuous part of the granite spectrum. They have been recognized only relatively recently and they are characterized by several attributes that clearly set them apart from other granitic rocks. A-type granites were originally defined as relatively dry (anhydrous), and they have high contents of alkalis and most high field strength trace elements. They commonly have been emplaced in an extensional tectonic regime not directly related to lithospheric convergence (i.e., they have been considered 'anorogenic' or 'post-tectonic'). These granites also span almost three billion years of Earth's history and they are associated with a varying set of mineralization types (e.g., Sn, F, Nb, Ta, Au, Fe, U, and REE).

A new IGCP Project that will focus on the classification, petrology, geochemistry, tectonic significance, and metallogenic importance of the A-type granites is being proposed. The overall aim of the project will be to correlate the petrology, geochemistry, and metallogeny of A-type granites in various tectonic settings through the geologic time. It is clear that no single mechanism can account for the wide range of petrotectonic associations registered by the A-type granites, and one prime aim of the project will be to comprehensively scrutinize petrogenetic scenarios, and whether or not they show secular variation with geologic time.

A-type granites: definitions, facts and speculations

BERNARD BONIN

UMR 8148 'IDES', Université de Paris-Sud, F-91405 ORSAY CEDEX (France) (bbonin@geol.u-psud.fr)

The current alphabetical scheme of classification for granites includes the S-, I-, M-, A-, and C- types. Though A-type granites are known as a discrete group since a long time, the term was coined for the first time in 1979 in the famous Loiselle & Wones abstract, which was not followed by a paper clarifying the ideas of the authors about the nature and origin of this specific type. Various definitions based on petrological and/or chemical criteria were offered, with "A" standing for "anorogenic", "alkalic" (in Iddings and Shand senses), "anhydrous", and even "aluminous". These definitions will be evaluated and the large variety of associated rocks emphasized.

A-type granites occur in geodynamic contexts ranging from within-plate settings to plate boundaries, though their locations and times of emplacement are not random. Rare in the lower crust, in which they are replaced by some charnockitic suites, they are fairly common at shallower depths, especially at the subvolcanic level where they typically form ring complexes rooting caldera volcanoes. Characteristic features include hypersolvus to transsolvus to subsolvus alkali feldspar textures, iron-rich mafic mineralogy, bulk-rock compositions yielding alkali-calcic to alkalic (in Peacock sense) affinities, high LILE + HFSE abundances, and pronounced anomalies due to high degrees of mineral fractionation. Isotopic features evidence sources containing a significant mantle input.

Experimental data show that A-type magmas contain dissolved OH-F-bearing fluids, i.e. they are not anhydrous, form under reduced as well as oxidized conditions, and yield high-temperature liquidus, so that anhydrous iron minerals, such as fayalite, crystallize early. Though many published geochemical models imply solely crustal derivation, no convincingly A-type felsic liquids were experimentally produced from crustal materials, nor have any leucosomes of A-type composition been detected within migmatitic terranes. As they occur within continents as well as on the ocean floor and because of the nature of associated igneous suites, A-type granites are likely to come from mantle-derived transitional to alkalic (in Iddings sense) mafic to intermediate magmas.

Interestingly, the uncommon felsic materials found in the meteoritic and lunar record yield dominantly A-type features. Contrary to the more common S- and I- types of granite, A-type granites are, therefore, not typical of Earth and were produced in planetary environments that differed markedly from those prevailing currently on Earth.