

INTERNATIONAL GEOSCIENCE PROGRAMME (IGCP)

Annual Report* of IGCP Project No. 510

*The information in this report will also be used for publication in 'Geological Correlation' (please feel free to attach any additional information you may consider relevant to the assessment of your project).

IGCP project short title: **A-type Granites and Related Rocks through Time**

Duration: **2005–2009**

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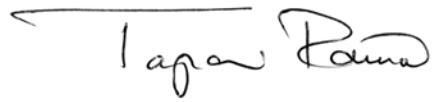
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Date of submission of report: 15 December 2006

Signature of project leader:



O. Tapani Rämö

on behalf of Roberto Dall'Agnol, Carol D. Frost, and Laurence J. Robb

1. Website addresses related to the project

The main website of the project:

<http://www.igcp-510.org>

Personal websites of project leaders:

R. Dall'Agnol: <http://www.abc.org.br/org/aca.asp?codigo=robdal>

C.D. Frost: <http://home.gg.uwo.edu/Person.aspx?ID=16>

O.T. Rämö: <http://www.helsinki.fi/geology/personnel/tramo.html>

L.J. Robb: <http://www.wits.ac.za/geosciences/egri/staff.htm>

2. Summary of major past achievements of the project

During the first year (2005), the project arranged three international meetings and managed to establish, for the first time, an active international consortium of researchers working in the field of A-type granites and related rocks. This will help to reach the main goals of the project on a truly global scale, and also pave the way for scientific breakthroughs.

3. Achievements of the project this year

3.1. *List of countries involved in the project (*countries active this year):*

The project is truly international in character and has participants from Europe, North America, South America, Africa, Asia, and Australia (in total, from 40 countries – see list below). The mailing list of the project includes currently ca. 400 individuals.

Argentina
Australia*
Austria
Belgium
Brazil*
Cameroon
Canada*
Colombia*
Czech Republic*
Egypt
Estonia*

Finland*
 France*
 Germany*
 India*
 Ireland
 Israel*
 Italy
 Japan
 Namibia*
 Netherlands
 Norway*
 People's Republic of China*
 Poland
 Portugal
 Republic of Korea
 Romania
 Russia*
 Slovakia
 South Africa*
 Spain
 Sweden
 Switzerland
 Taiwan
 Turkey*
 Ukraine
 United Kingdom*
 United States of America*
 Uruguay
 Venezuela
 Yugoslavia

3.2. *General scientific achievements (including societal benefits)*

In its second year now, the project is well underway pursuing its refined goals. An actively contributing international consortium of A-type granite researchers has been established, support from mining companies to the project has been enhanced, and a first scientific breakthrough regarding the petrogenesis of A-type associations has been realized:

(1) A new model for the petrogenesis of A-type granites and related rocks was presented by R. Martin (IGCP-510 publication #14 – Section 3.6). It was discussed at the August 2006 Belém workshop and will comprise a keynote at the upcoming Hutton Symposium on the Origin of Granites and Related Rocks in South Africa in July 2007.

(2) Exploration and mining companies (Companhia Vale do Rio Doce, Mineração Taboca, Falconbridge) have been recruited to promote the project. This collaboration was essential for realization of the August 2006 Pitinga and Carajás field trips. (see Section 3.1).

(3) Scientists from the less developed countries in Asia, China, Russia, Latin America, and Africa have been recruited to the project (cf. Section 3.1) and they

have actively contributed to the IGCP-510 proceedings volumes realized/in preparation thus far (Section 3.6).

(4) Young researchers (at the doctoral and post-doctoral level) have been involved in the project and we will actively recruit further individuals in the future.

Please note that the proceedings volume of the inaugural meeting of the project (a special session at the 15th V.M. Goldschmidt Conference in May 2005 in Moscow, Idaho) is currently in press. It will materialize as a special issue "A-type Granites and Related Rocks through Time" of *Lithos* (Elsevier B.V.) with C.D. Frost, O.T. Rämö, and R. Dall'AgnoI as the Guest Editors (cf. Section 3.6).

Please note also that 25 papers (Section 3.6) based on the presentations given at the 2006 Belém IGCP-510 A-type granite workshop will be considered for publication in a special issue of *The Canadian Mineralogist*. The issue will be edited by O.T. Rämö, R. Dall'AgnoI, and R. Martin, will comprise 20-25 full papers, and will be published by the turn of 2007/2008.

3.3. List of meetings with approximate attendance and number of countries

In 2006, the project arranged three international meetings:

(1) August 2-5: Field trip "Pitinga Mine" to the tin-mineralized granites and surrounding bedrock in northern Amazonia, Brazil. This was the third scientific field trip of IGCP-510 and was arranged by H.T. Costi (Museu Paraense Emílio Goeldi), J.M.T.M. Ferron (Paranema Group, Mineração Taboca S/A), and M. Prado (Paranema Group, Mineração Taboca S/A). The trip focused on the Paleoproterozoic (~1.82 Ga) Zr-Nb-Sn-mineralized A-type granites and their Paleoproterozoic country rocks in the Pitinga province on the southern flank of the Guiana shield in northern Brazil. The principal targets were the Madeira and Água Boa plutons. The trip was attended by 13 individuals from five countries (Brazil, Colombia, Finland, Canada, United States). A field trip guide was published (Dall'AgnoI et al., 2006; #13, Section 3.6.).

(2) August 6-9: This was the second annual meeting of IGCP-510 and it gathered together ~50 researchers from six countries (Australia, Brazil, Canada, Colombia, Finland, United States). The meeting was convened by R. Dall'AgnoI (Coordinator), C.M. Ferreira de Freitas (Secretary), and a comprehensive organizing committee. The meeting was technically organized as a workshop "A-type Granites and Related Rocks through Time" in conjunction with the symposium "Symposium on Magmatism, Crustal Evolution, and Metallogenesis of the Amazonian Craton". It gathered together a substantial number of earth scientists with A-type granites as a common denominator, those from Latin America (Brazil, Colombia) in particular, to discuss timely topics related to A-type granite suites and to plan further activities of IGCP-510. In the workshop, 24 oral and 22 poster presentations were given. An abstract volume was published (Dall'AgnoI et al., 2006; #13, Section 3.6.).

(3) August 10-15: This was the fourth scientific field trip of IGCP-510. It was arranged by R. Dall'AgnoI (Federal University of Pará), M.A. de Oliveira

(Federal University of Pará), J. de Arimatéia Costa de Almeida (Federal University of Pará), F.J. Althoff (Vale do Rio dos Sinos University – UNISINOS – Rio Grande do Sul state of Brazil), A.A. da Silva Leite (Companhia Vale do Rio Doce), D.C. de Oliveira (Federal University of Pará), and C.E. de Mesquita Barros (Federal University of Pará). The trip focused on Paleoproterozoic A-type granites (reduced and oxidized) and Archean TTGs, sanukitoids, leucogranites, and A-type granites, as well as associated iron, copper, and gold mineralization. The trip was attended by 23 individuals from six countries (*Australia, Brazil, Colombia, Finland, Canada, United States*). A field trip guide was published (Dall’Agnol et al., 2006; #13, Section 3.6.).

3.4. Educational, training or capacity building activities

In the six (2005, 2006) meetings of the project (technical sessions and field trips in northwestern United States and northern Brazil, field conference in Finland), doctoral and post-doctoral students from several countries have been actively involved. In Brazil, 17 graduate students from four different Brazilian universities and one from Australia participated actively in the 2006 meeting. In the future, we will promote the educational aspect of the project by recruiting further students especially from the less developed countries.

3.5. Participation of scientists from developing countries

A substantial fraction of the known (and presumably also the unraveled) occurrences of A-type granites are located in the less developed countries (Africa, Asia, Latin America etc.), and the project will actively continue to recruit new delegates from these regions. In the Belém meeting, researchers from different regions, representative of the principal universities of Brazil, participated actively. For the current IGCP-510 representatives from the developed countries, see Sections 3.1 and 3.3.

3.6. List of most important publications (including maps)*

The publication list of IGCP-510 currently includes 29 titles, most of the peer-reviewed original papers in international journals.

Peer-reviewed papers:

- 29 K.V. Kumar, C.D. Frost, B.R. Frost, K.R. Chamberlain (2006) The Origin of the Chimakurti-Errakonda-Uppalapadu Plutons, Eastern Ghats Belt, India: An Unusual Association of Tholeiitic, A-type and Potassic Alkaline Magmatism. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 28 D. Konopelko, G. Biske, R. Seltmann, O. Eklund, B. Belyatsky (2006) Post-collisional granites of the Kokshaal Range, southern Tien Shan, Kyrgyzstan: age, petrogenesis and regional tectonic implications. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 27 D. Boztug, Y. Harlavan, G.B. Arehart (2006) K-Ar age, whole-rock and stable isotope geochemistry of A-type granitoids in the Divrigi-Sivas region, Turkey. *Lithos* (A-type Granites and Related Rocks special issue, in press)

- 26 L.V.S. Nardi, J.P. Cid, M. de F. Bitencourt, L. Stabel (2006) Geochemistry and petrogenesis of post-collisional ultrapotassic syenites and granites from southernmost Brazil: the Piquiri Syenitic Massif. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 25 M. de L. da Silva Rosa, H. Conceição, M.J.B. Macambira, M.A. Galarza, M.M. Marinho, D. Correia Rios, B. Cruz Filho (2006) Age and genesis of blue sodalite syenite: Neoproterozoic anorogenic magmatism in the South Bahia Alkaline Province of NE Brazil. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 24 Z. Li, R.-Z. Hu, J. Peng, X.-M. Li, X. Bi (2006) The Relationship Between A-type Qitianling granites and the Furong tin ore-formation in Hunan Province, China. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 23 S.R.F. Vlach, G.A.R. Gualda (2006) Allanite and chevkinite in A-type granites and syenites of the Graciosa Province, southern Brazil. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 22 J. Hergt, J. Woodhead (2006) A-type magmatism in the Western Lachlan Fold Belt? A study of granites and rhyolites from the Grampians region, Western Victoria. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 21 A. Vernikovskaya, V. Vernikovskiy, M. Wingate (2006) Neoproterozoic A-type granites of the Yenisey Ridge fold belt, western margin of the Siberian Craton: geochemistry, geochronology and geodynamics. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 20 I. Haapala, S. Frindt, J. Kandara. (2006) The Cretaceous Gross Spitzkoppe and Klein Spitzkoppe stocks in Namibia Topaz-bearing A-type granites related to continental rifting and a mantle plume. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 19 Y. Li, C. Barnes, M. Barnes, C. Frost (2006) Grenville-age A-type and related magmatism in southern Laurentia, Texas and New Mexico, U.S.A. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 18 B. Bonin (2006) A-type granites and related rocks: evolution of a concept, problems and prospects. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 17 C.D. Frost, R. Dall'Agnol, O.T. Rämö (2006) Introduction to special issue—IGCP-510: A-type granites and related rocks through time. *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 15 Y. Katzir, M. Eyal, B.A. Litvinovsky, B.M. Jahn, A.N. Zanzilevich, J.W. Valley, Y. Beerli, I. Pelly, E. Shimshilashvili (2006) Petrogenesis of A-type granites and origin of vertical zoning in the Katharina pluton, Gebel Mussa (Mt. Moses) area, Sinai, Egypt. *Lithos* (in press)
- 14 R.F. Martin (2006) A-type granites of crustal origin ultimately result from open-system fenitization-type reactions in an extensional environment. *Lithos* 91,

- 12 P. Kaur, N. Chaudhri, M. Okrusch, J. Koepke (2006) Palaeoproterozoic A-type felsic magmatism in the Khetri Copper Belt, Rajasthan, northwestern India: petrologic and tectonic implications. *Mineralogy and Petrology* 87, 81-122
- 11 R. Dall'Agnol, D.C. de Oliveira (2006) Oxidized, magnetite-series, rapakivi-type granites of Carajás, Brazil: implications for classification and petrogenesis of A-type granites. *Lithos* (Granites and Crustal Anatexis special issue, in press)
- 10 R. Minghua, P.A. Omenda, E.Y. Anthony, J.C. White, R. Macdonald, D.K. Bailey (2006) Application of the QUILF thermobarometer to the peralkaline trachytes and pantellerites of the Eburry volcanic complex, East African Rift, Kenya. *Lithos* 91, 109-124
- 8 J.B. Whalen, V.J. McNicoll, C.R. van Staal, C.J. Lissenberg, F.J. Longstaffe, G.A. Jenner, O. van Breemen (2006) Spatial, temporal and geochemical characteristics of Silurian collision-zone magmatism, Newfoundland Appalachians: an example of a rapidly evolving magmatic system related to slab break-off. *Lithos* 89, 377-404
- 7 J.P. Calzia, O.T. Rämö (2005) Middle Miocene rapakivi granites of Death Valley. *Earth-Science Reviews* 73, 221-243.
- 3 L.S. Lauri, O.T. Rämö, H. Huhma, I. Mänttari, J. Räsänen (2006) Petrogenesis of silicic magmatism related to the ~2.44 Ga rifting of Archean crust in Koillismaa, eastern Finland. *Lithos* 86, 137-166.
- 2 D.B. Stoesser, C.D. Frost (2005) Nd, Pb, Sr, and O isotopic characterization of the Saudi Arabian Shield. *Chemical Geology* 226, 163-188.
- 1 B.A. Elliott, W.H. Peck, O.T. Rämö, M. Vaasjoki, M. Nironen (2005) Magmatic zircon oxygen isotopes of 1.88-1.87 Ga orogenic and 1.65-1.54 Ga anorogenic magmatism in Finland. *Mineralogy and Petrology* 85, 223-241.

Other publications:

- 16 C.D. Frost, R. Dall'Agnol, O.T. Rämö (2006) A-type granites and related rocks through time (special issue). *Lithos* (A-type Granites and Related Rocks special issue, in press)
- 13 R. Dall'Agnol, L.T. Rosa-Costa, E.L. Klein (Eds.) (2006) Symposium on Magmatism, Crustal Evolution, and Metallogenesis of the Amazonian Craton. Abstracts Volume and Field Trips Guide. Belém, PRONEX-UFFPA/SBG-NO, 150 pp.
- 9 O.T. Rämö, I. Haapala (2005) Rapakivi granites. *Elsevier Developments in Precambrian Geology* 14, 533-562.
- 6 O.T. Rämö, J. Halla, M. Nironen, L.S. Lauri, M. Kurhila, A. Käpyaho, P. Sorjonen-Ward, O. Äikäs (2005) EUROGRANITES 2005 - Proterozoic and Archean Granites and Related Rocks of the Finnish Precambrian. Eurogranites

2005 Field Conference, September 11-17, 2005. *Publications of the Department of Geology A1*, 130 pp.

- 5 C. Frost, M. McCurry, B. Christiansen, K. Putirka, M. Kuntz (2005) Extrusive A-type magmatism of the Yellowstone hot spot track, 15th Goldschmidt Conference Field Trip AC-4. *Field Trip Guide, University of Wyoming*, 76 pp. plus an appended map.
- 4 F.A. Podosek (Ed.) (2005) Goldschmidt Conference Abstracts 2005, A-type Granites and Related Rocks. *Geochimica et Cosmochimica Acta* 69 (10S), A79-A89.

* Numbers above refer to the assigned IGCP-510 publication number.

Please note also that editorial work for a *Canadian Mineralogist* proceedings volume of the IGCP-510 workshop in Belém has been launched, with O.T. Rämö, R. Dall'Agnol, and R.F. Martin as editors. Approximately 30 manuscripts will be considered for publication in this volume.

3.7. Activities involving other IGCP projects or the IUGS

The project has submitted a proposal together with the IUGS Subcommittee of Systematics of Igneous Rocks (SSIR; Professor Bernard Bonin, Chairman) for a joint SSIR-IGCP-510 symposium "Granite Classification – a Never-Ending Problem" at the 33rd International Geological Congress (Oslo).

4. Activities planned

4.1. General goals

The general goals of the project focus on correlating the petrology, geochronology, geochemistry, and metallogeny of A-type granites found in various tectonic settings through the geologic time and on a global scale. Specific themes that will be scrutinized include

- (1) age distribution, petrotectonic associations, and genetic models of A-type granites and related rocks;
- (2) their significance in metallogeny;
- (3) their bearing on granite typology and evaluation of hitherto proposed classifications; and
- (4) their overall role in the evolution of the Earth's lithosphere.

Future meetings of the project will target on all of these issues, with special focus on one or two of them at a time, depending on the overall lithologic framework that dominates each convention venue. The project will initiate a global-scale data base of A-type granites that will serve as a comprehensive base in pursuit of the goals of the project.

4.2. Specific meetings and field trips

The following symposia and field trips are planned and the agenda will be kept open for further timely meetings that might be proposed in the course of the project. Delegates from the less developed countries will be endorsed for all meetings.

The year 2007

The **Third Annual Meeting** will be arranged in conjunction with the 6th Hutton Symposium on Granites and Related Rocks that will be held in Stellenbosch, South Africa in July 2007. Regional field trips will run in South Africa and Namibia, featuring, for example, the A-type granites associated with the Paleoproterozoic Bushveld layered mafic intrusion.

A **Field Conference** will be arranged in the Colorado River extensional corridor–southern Death Valley–northern Mojave Desert region, focusing on the Miocene plutonic and subvolcanic A-type suites of the Basin and Range Province in the southwestern United States. The field conference will be followed by an IGCP–510-oriented thematic session at the Geological Society of America Annual Meeting in Denver in October 2007.

The year 2008

Possibilities for the **Fourth Annual Meeting** to be arranged in Australia/China will be examined. Viable field trip options include the Mt. Isa region, Olympic Dam in South Australia, and the Lachlan Fold Belt (Australia) and the Beijing region (China).

A joint **Technical Session** entitled “Granite Classification – a Never-ending Problem” with the IUGC Subcommittee of Systematics of Igneous Rocks at the 33rd International Geological Congress in Oslo (August 2008).

A four-day **Field Trip** to the Oslo Rift in August 2008. The field trip will be led by Professor Tom Andersen and Dr. Reidar Trønnnes (University of Oslo) and it will examine the geology and petrology of the classic Paleozoic anorogenic rocks of the Oslo Rift.

A **Field Trip** to Corsica in the Propriano-Bonifatto area in October 2008. This conference will be chaired by Professor Bernard Bonin (Universite de Paris-Sud) and will cover a varied collage of A-type suites: volcanic calderas, layered mafic chamber and a complete set of felsic rock types ranging from monzonite to syenite to alkali-feldspar granite, with hypersolvus to transsolvus to subsolvus alkali-feldspar mineralogy, and metaluminous to peraluminous or peralkaline compositions.

The year 2009

The **Fifth Annual Meeting** in Helsinki, Finland (chaired by O.T. Rämö). Regional field trips to the A-type granite suites in Finland, Russia, and Sweden.

5. Project funding requested

In order to grant the participation of the maximum possible number of delegates from the less developed countries in the 2007 symposiums and field trips in South Africa and southwestern United States, we request for maximum project funding for 2007. This would enhance the contribution to the project from such locations as Asia (central Asia, China), Africa (Cameroon, Ethiopia), and the rest of Latin America that are known to host a great number of vaguely studied A-type complexes.

6. Request for extension, on-extended-term-status, or intention to propose successor project

N/A

7. Financial statement

The IUGS/UNESCO funds allocated to IGCP-510 in 2005 (in total, \$US 4000) were dispatched as follows:

Support in partial reimbursement of expenses incurred upon participating in the 2006 Belém symposium and associated field trips (Pitinga, Amazonas; Carajás, Pará) to the following five individuals, in total \$US 3750:

Dr. Márcia Aparecida de S. Barros, Universidade Federal do Mato Grosso, BRAZIL (\$US 800)

Dr. Maria do Carmo Pinto Gastal, IGEO/UFRGS, Porto Alegre, BRAZIL (\$US 850)

Prof. Mauro Cesar Geraldies, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, BRAZIL (\$US 750)

Dr. Washington Barbosa Leite Júnior, University of São Paulo State - UNESP, Rio Claro, São Paulo, BRAZIL (\$US 850)

Dr. Alberto Lobo-Guerrero Sanz, Logemin S.A., Bogota, COLOMBIA (\$US 500)

The remainder of the IUGS/UNESCO funds (\$US 250) was used for administrative expenses (postage, telephone).

The Belém meeting received external support from the Federal University of Pará and Brazilian agencies (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES – ca. US\$ 12,000.00; Conselho Nacional de

Desenvolvimento Científico e Tecnológico – CNPq – ca. US\$ 7,000.00;
Financiadora de Estudos e Projetos – FINEP – ca. US\$ 4,000.00), private
companies (Companhia Vale do Rio Doce – CRVD – ca. US\$ 12,000.00;
Falconbridge – ca. US\$ 2,000.00). CVRD and Taboca Mineração gave also
logistical support for field trips, respectively, in Carajás and Pitinga.