

# Annual Report\* of IGCP Project No. 440

\*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: **RODINIA ASSEMBLY AND BREAKUP**

Duration and status: 1999–2003, active

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## 1. Website address(es) related to the project

<http://www.tsrc.uwa.edu.au/>

<http://www.geol.lu.se/>

## 2. Summary of major past achievements of the project

During the first year of the project (1999) we established the project structure, including setting up regional working parties and country working groups. We also established cooperation with other IGCP projects including 368, 411, 418, 419, and 420. There are also plans to hold future joint meetings with IGCP 453. We organised four symposia or field workshops, including one on *Mesoproterozoic Continental Assembly and Subsequent Break-up* during the 10<sup>th</sup> European Union of Geosciences conference, one field workshop in Kitwe, Zambia, jointly with IGCP 418 and 419, an international symposium and field workshop on *Geodynamic and Tectonic Evolution of China and Related Gondwana Crustal Fragments* in Yichang, China, jointly with IGCP 368 and 411, and a symposium on *The role of supercontinents in earth history: Assembly and dispersal of the Rodinian supercontinent (1300?–750 Ma), and impacts on the Proterozoic biosphere, hydrosphere and crust-mantle system* at the Geological Society of America Annual meeting in Denver, Colorado, USA. Many scientific ideas were exchanged and new collaborative research projects set up during those meetings.

During 2000, a significant number of scientific contributions by project members appeared in international journals. These include a special issue of *Precambrian Research* entitled *Neoproterozoic of Australia* (Guest Editor: Malcolm R. Walter, Vol. 100, published in March 2000), in which 17 scientific articles/reviews were devoted to the latest progress in understanding the Neoproterozoic successions in Australia and their global correlations, Neoproterozoic palaeoenvironment, new high-quality palaeomagnetic results from both Australia and China, and implications for Rodinia configuration and breakup. A special issue of *Gondwana Research* (Vol. 4, No. 1, January 2001) on *Crustal Evolution in South and Southeast Asia* has been published (Co-editors: S. Hada, M. Yoshida, Z.X. Li, and X. Wang). This special issue was based on papers that were presented at the Yichang field symposium. In addition to these special issues, several important findings were reported in various papers published in international journals by project members (see publication list in 2000 Annual Report), and a large amount of preliminary results and ideas was presented and discussed at scientific meetings co-organised by the Project.

During 2000, we progressed well in developing the legends for the Rodinia maps, and co-organised special sessions/symposia in three major international meetings: (1) a special session on *Assembly and Dispersal of Rodinia and Gondwana Supercontinents in Western Pacific* (sessions T31B and 32A) at the AGU Western Pacific Geophysics Meeting, Tokyo, Japan, (2) a special symposium on *Precambrian Supercontinents* at the 15<sup>th</sup> Australian Geological Congress, Sydney, Australia, and (3) sessions at the 31<sup>st</sup> International Geological Congress, Rio de Janeiro, Brazil.

The project made some scientific breakthroughs in late 2000 and 2001. One is the emerging evidence that argues against a coherent East Gondwana during Rodinia time. The other is new palaeomagnetic evidence that indicates that the SWEAT fit could not have existed at ca. 1.07 Ga.

In addition to a large number of individual papers in international journals, two *Precambrian Research* special issues and one *GSA Special Paper* were published in 2001 reporting the latest research related to Rodinia. One *Precambrian Research* Special Issue was co-edited by the late C.McA. Powell (the late Project co-leader) and J. Meert (Vol. 110). The volume contains 18 papers on the early Neoproterozoic history of Rodinia and its subsequent breakup, especially in Siberia, East Greenland, the East African orogen, Seychelles and NW India, the Congo and adjacent South America. The second special issue (Vol. 111) on *Rodinia and the Mesoproterozoic earth–ocean system* was edited by L.C. Kah and J.K. Bartley. They dedicated the volume to the memory of Professor Powell for his tireless efforts in uniting scientists worldwide to the cause of Rodinia. R.E. Ernst and K.L. Buchan co-edited a *GSA Special Paper Series* (volume No. 352) on *Mantle plumes: their identification through time*. This is a timely volume as a number of members are currently working on the possible relationship between mantle plumes (or a superplume) and the breakup of Rodinia.

A series of multidisciplinary geological-geophysical studies of the crust in the western part of ProBaltica (= East European Craton) strongly suggest that this craton did not come together until after ca. 1.8 Ga (see EUROBRIDGE special issue of *Tectonophysics* 339, 2001, edited by S.V. Bogdanova, R. Gorbatshev, R.A. Stephenson and A. Guterch).

The project also made progress in the making of the Rodinia maps. It was decided that the project will produce continental tectonic maps, at 1:2 million scale where possible, but with the main focus being the production of the 1:10 million GIS-based Rodinia map.

The project sponsored a number of successful international conferences/symposia during 2001, at which members exchanged their latest results and ideas: (1) *The Irkutsk field workshop on "Assembly and breakup of Rodinia", held in Irkutsk, Russia, between 23 July and 4 August, 2001*, (2) *The Chris Powell Memorial Symposium on "From Mountains to Basins: Rodinia at the Turn of the Century", held at the Tectonics Special Research Centre, Perth, Australia between 30 September and 2 October 2001*, (3) *The international symposium on "The evolution of Rodinia and Gondwanaland and the formation of Asia", held at Osaka between 26 and 30 October, 2001* (co-sponsored by IGCP Projects 386, 411 and 440). In addition, IGCP 440 was involved in a chiefly IGCP 418-sponsored field symposium in Durban, South Africa, between 8 and 21 July.

### **3. Achievements of the project this year**

#### *3.1 List of countries involved in the project (please \*indicate the countries active this year)*

Argentina, Australia\*, Austria, Belgium\*, Botswana\*, Brazil\*, Canada\*, China\*, Congo-DRC, Denmark\*, Finland\*, France\*, Germany\*, India\*, Ireland, Japan\*, Republic of Korea\*, Kuwait, Madagascar\*, Malaysia, Mexico\*, Mongolia\*, Namibia\*, New Zealand, Norway\*, Russia\*, South Africa\*, Spain, Sri Lanka\*, Sweden\*, Switzerland, Taiwan\*, Tanzania\*, The Netherlands\*, U.K.\*, USA\*, Vietnam\*, Zambia\*, Zimbabwe\*.

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

*(Meetings are not considered as scientific achievements, they should be listed under heading 3.3.)*

With the rapidly accumulating new scientific results by over 300 members, it is extremely difficult to summarise all scientific achievements in this brief report. Following are a few scientific highlights achieved by some of the major working groups/working parties.

**a. New age constraints on the Grenville-age Maud Belt**

New, precise U-Th-Pb SHRIMP zircon data have been reported from two parts of the Grenville-age Maud Belt in Dronning Maud Land, East Antarctica. Metamorphic zircon overgrowth, Pb-loss in zircon cores and syn-tectonic granite intrusions are bracketed between c. 1090 and 1060 Ma. This age range is seen as the best estimate for high-grade metamorphism and continent-continent collision in this area. It also sheds new light on the significance of palaeomagnetic data from Coats Land, that is now interpreted to represent the southern foreland of the Maud Belt and might have been an individual microplate in Rodinia.

**b. Meso- to Neoproterozoic evolution of the Siberian margins**

Significant progress was made in understanding the Meso- to Neoproterozoic evolution of the southern, southwestern, eastern and northern margins of the Siberian Craton. Major achievements include:

- Neoproterozoic mafic dyke swarms and sedimentary rocks as indicators of rifting event and passive margin development along the western part of the southern Siberian margin. The new results that were obtained by employing petrochemical, isotope geochronological, palaeontological and palaeogeographical approaches show that: (1) the Neoproterozoic dykes and sills were formed at early stages of intracratonic rifting, and (2) the Neoproterozoic sedimentary sequences of the Baikal and Karagas Groups evolved from an early rift stage to a passive margin setting;
- Petrochemical and isotopic features together with U-Pb zircon and Sm-Nd ages of the Neoproterozoic granitoids at the western and northern margins (Central Taymir and Yenisey Ridge) strongly suggest that: (1) several accretionary events between 940 and 880 Ma in the Central Taymir terranes, although it is still unclear whether they were relevant to the Siberian craton because there is a suture younger than 600 Ma between them; (2) ca. 880 and 760 Ma granitoids, and the previously obtained data on ca. 1.0 Ga ophiolites within the Yenisey terranes and the ca. 1.3 Ga island arc, suggest the existence of an active margin of Siberia during the Neoproterozoic.

The current results point to different tectonic settings around Siberia during Rodinia assembly and breakup. It is likely that western, northern and eastern margins of Siberia faced ocean, whilst the southern margin may be connected to another continental block. This connection was broken after the deposition of the Karagas and Baikal Groups. The eastern part of the southern margin could have been juxtaposed to either an ocean or a continent.

**c. The Baltic story: possible continental collisions at 1450 and 550 Ma**

Major achievements were made during 2002 on two aspects:

- Field and analytical studies, including U-Pb zircon, Sm-Nd and Ar/Ar datings and AMS analysis, were carried out on the so called “anorogenic” A-type granitoids of ca. 1500–1450 Ma in southern Sweden, on the Danish island of Bornholm. Drill

core materials to the east in Poland, Lithuania and Belarus were also used to assess the scale of that event. The first results that will soon be published show that these syn-kinematic intrusions were emplaced along EW-trending shear zones/lineaments developed in a compressional/transpressional regime. As demonstrated by Ar/Ar datings, simultaneous regional heating of the crust extended over a large part of the craton. This development is interpreted as the result of a collision (i.e., the “Dano-Polonian orogeny”) between ProBaltica and another continent, possibly Amazonia. In contrast to the southern margin of Laurentia, the Mesoproterozoic tectonic fabric in Baltica is sharply discordant to the orientation of the Paleoproterozoic orogenic belts. This questions the previously proposed Laurentia-Baltica fits during the Paleo- and Mesoproterozoic.

- Major advances in understanding the tectonic evolution of the eastern margin of Baltica between 700 and 550 Ma have culminated in the organization of a Geological Society (London) Memoir due to be printed in early to mid-2003. Manuscripts are currently being reviewed. This volume will contain 20 manuscripts characterizing the Timanian orogenesis (ca. 650 to 550 Ma) and defines the ocean-continent collision that formed the orogen.

#### **d. East Asia in Rodinia: tighter constraints on the timing of collision and breakup**

Members of the East Asian Working Party made some breakthroughs in 2002 in providing tighter age constraints on events that are related to Rodinia assembly and breakup in the region. New studies revealed that convergent tectonic regimes along both the southern and northern margins of the Yangtze craton persisted until ca. 900 Ma. With 1000–900 Ma metamorphic events widely reported in other Grenvillian orogenic belts around the world, it is possible that the assembly of Rodinia did not finish until ca. 900 Ma.

An extensional tectonic regime started from at least ca. 830 Ma in the region, including South China, Tarim, and part of Korea. Continental rifting and associated bimodal magmatism occurred widely between ca. 830–750 Ma, and they are temporally comparable to those in many other parts of Rodinia such as Australia, Laurentia, India and southern Africa. It has been speculated that these events might be related to a Rodinian superplume that led to the breakup of the supercontinent at ca. 750–700 Ma. Many of these new results will be published in early 2003 in a *Precambrian Research* special issue entitled “Precambrian Tectonics of East Asia and Relevance to Supercontinent Evolution” (see contribution list).

#### **e. Mesoproterozoic and Neoproterozoic of Africa re-defined: implications for Rodinia and Gondwana Supercontinents**

It has been widely believed that the final amalgamation of Rodinia happened at ca. 1 Ga, whereas the break-up of that supercontinent occurred at ca. 0.8–0.75 Ga. The dispersed Rodinian fragments reassembled in a different pattern at ca. 0.6–0.5 Ga during the assembly of Gondwana. The members of the IGCP 440 Working Party in Africa made major breakthroughs in 2001 and 2002 by showing that plate convergence along some of the margins of African cratons, with the development of island arcs, started at ca. 0.9–0.85 Ga. One can thus argue that the assembly of Gondwana locally, started before the break-up of Rodinia. During 2002, the African IGCP 440 Team consolidated their scientific findings through (1) acquiring new precise geochronological age determinations allowing to constrain better the timing of both Mesoproterozoic and Neoproterozoic events in Africa, and (2) producing GIS

maps of the Mesoproterozoic and Neoproterozoic of Africa. Some of the outcomes of these studies include:

- The discovery of a major subduction-related igneous event between ca 1.38–1.37 Ga in almost all of the major segments of the Kibaran orogenic system of Africa located between the Congo and Tanzania cratons. Similar events are recorded north of the Zimbabwe craton and within the Namaqua belt at the southwest of the Kaapvaal craton;
- Widespread 1.2–1.0 Ga I-type felsic igneous rocks in cratons adjacent to the orogenic belts in central and southern Africa. Mafic magmatism related to the ca. 1.05 Ga Umkondo igneous event is part of this broader magmatic province. Petrological/geochemical investigations do not provide evidence supporting an “active” plume origin for this magmatism; rather, it was closely related to plate convergence, most probably a continental collision process. The Kibaran tin-granites represent the last igneous event related to the final stage of Rodinia amalgamation in this region.

These new data raise a number of major questions which are the focus of internal debates by members of IGCP 440 in Africa before correlations with other Kibaran-age orogenic systems in the world.

#### **f. Compilation of the geodynamic map of the supercontinent Rodinia**

Significant progress was made in the compilation of the 1:10 million Rodinia geodynamic map. A revised map legend was distributed to members of the Rodinia Map Advisory Committee at the beginning of the year, and placed on the Project web site for members’ comments. Individual scientists have been invited to compile the regional map sheets. By November, draft maps had been made for Baltica, India, Northern Laurentia, Siberia, and South China, and major progress was made by compilers for Africa, East Antarctica, South America, southern Laurentia, Tarim, and North China. During a week-long workshop at the Tectonics Special Research Centre in Perth in mid-November, both the legend and the format of associated data tables were finalised. It is anticipated that all map sheets will be finished during the first half of 2004, and will be displayed and used for testing Rodinia reconstructions at a special session during the 2003 GSA meeting at Seattle (see section 4. Activities planned). Current map compilers for each continent/craton are (in alphabetical order): **Africa**–A.B. Kampunzu, J.P. Milesi and co-workers; **Antarctica**–I. Dalziel, I. Fitzsimons and J. Jacobs; **Australia**–J. Myers; **Baltica**–S. Bogdanova and V. Pease; **Greenland**–F. Kalsbeek and K. Thrane; **India**–M. Pandit and others; **Laurentia**–A. Davidson, K. Karlström and G. Ross; **Siberia**–D. Gladkochub, S. Pisarevsky and V. Vernikovskiy; **South America**–B.B. de Brito Neves and R. A. Fuck; **South China**–Z.X. Li; **Tarim** and **North China**–S. Lu and co-workers. There are also members who are responsible for compiling specific databases, such as mafic dyke swarms (R. Ernst), glacial deposits (D Evans) and mineral deposits (C. Finn and others).

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

##### ***3.3.1 Sessions on the GAC-MAC Saskatoon conference (27–29 May 2002) and the post-conference field trip to the southwestern Grenville Province (30 May–7 June 2002): Aspects of Rodinia assembly exemplified in the Grenville province***

As one of the three major activities sponsored by IGCP 440 in 2002, the symposium and field trip in Canada was successful. The GAC-MAC meeting was well attended

by both local and overseas scientists, including many members of IGCP 440. At the IGCP 440-sponsored special session SS20 on “Aspects of Rodinia assembly exemplified in the Grenville Province”, convened by Dr. A. Davidson (Geological Survey of Canada), seven oral and two poster papers were presented covering topics such as the history of the Mesoproterozoic Central Metasedimentary Belt, record of pre-Grenvillian continental arc in the Central Gneiss Belt, distribution and significance of the 1.24 Ga Sudbury dyke swarm, intrusive rocks in the Grenville belt, crustal architecture in western Grenville, and the Grenville Front as a limit of intracontinental subduction. Other interesting sessions at the meeting relevant to IGCP 440 include the John Lewry Symposium on collisional tectonics of the continental interior of Canada (SY1), Precambrian basins of North America (SY2), and relationships and links between tectonics and volcanism (SS14).

The post-conference field trip (No B6) and a two-day indoor symposium during the field trip, took place between 30 May and 7 June. The field excursion, led by Dr. A. Davidson (Geological Survey of Canada), Dr. R.M. Easton (Ontario Geological Survey), Dr. L. Corriveau (Geological Survey of Canada), and Professor J. Martignole (Université de Montréal), ran a transect across the southern Grenville Province between Sudbury and Montreal. Two days were set aside during the field trip for an indoor workshop on Grenvillian belts around the world and relevance to the assembly of Rodinia, as well as for an IGCP 440 business meeting. Around 20 oral and poster papers were presented covering:

- The Proterozoic tectonics of Baltica;
- The Sveconorwegian orogen (with UHP rocks) in Baltica;
- Meso- to Neoproterozoic evolution of eastern Siberia and Rodinia reconstruction;
- Major Meso- to Neoproterozoic events in northwestern China;
- A Grenvillian belt in South China and relevance to Rodinia;
- Subsurface Grenville Province in midcontinental USA;
- Regional-scale Grenville UHT metamorphism in the basement of Peruvian Andes;
- Various aspects of the Canadian Grenville Province.

An IGCP 440 business meeting was held, at which the status of the project and matters related to the making of the Rodinia map were discussed. The event was attended by sixteen scientists from Australia, Canada, China, USA, Sweden, and a number of local geologists and students.

### ***3.3.2 IGCP 440 Sessions at the IAGOD Symposium (22–26 July 2002) and the post-symposium field trip to the Sinclair-Namaqua Mesoproterozoic province (27 July–4 August 2002)***

This was one of the major sponsored IGCP 440 events in 2002 and was very successful. The scientific sessions were held in Windhoek as part of the 11<sup>th</sup> Quadrennial IAGOD Symposium which was held at the same time as the Geocongress 2002 (22–26 July 2002). The IGCP projects scientific sessions that were held during that symposium were well attended and represented the backbone of this symposium, attended by about 400 delegates from all the continents. The IGCP 440/418 joint sessions included 40 papers (oral presentations and posters) covering various aspects of Mesoproterozoic and Neoproterozoic geology, geochronology and ore geology. Extended abstracts related to this symposium were compiled on a CD-ROM. The project had decided to convene an add-on field workshop to the Mesoproterozoic of Namibia and this excellent field trip was led by Drs Hoffmann, Thomas and Schreiber of the Geological Survey of Namibia.

The field workshop started with a one-day (27 July) indoor technical session during which 13 additional papers were presented by project members on the Mesoproterozoic of Africa, America and Europe. This session was held at the Geological Survey of Namibia. The technical meeting concluded with a project business meeting. At the business meeting all map compilers were urged to finalise at least a first draft in the coming months, which would be discussed in detail at the November workshop. The issues of project leadership were also discussed at the meeting. In addition, a Special Issue of the Journal of African Earth Sciences devoted to invited review papers on the Mesoproterozoic Kibaran orogenic system of Africa is under preparation (Guest Editors: Kampunzu A.B., Hanson R., Key, R., McCourt S., Tack L.). The papers are currently under review and the volume will be sent to press in 2003. This volume will include a CD-ROM map of the Mesoproterozoic of Africa and a map of the NE Kibaran belt.

The fieldtrip through the Mesoproterozoic Sinclair and Namaqua sequences in southern Namibia was held between 28 July and 4 August. The trip included traverses through Mesoproterozoic terranes of central and southern Namibia as described in an excellent 62-page field guidebook, including a map of Mesoproterozoic terranes in Namibia prepared by the leaders. The trip started off in the Rehoboth inlier, which includes Mesoproterozoic granitoids. The excursion progressed southwards through various isolated, and separately described sequences attributed to the Mesoproterozoic Sinclair terrane. The Sinclair sequences are transected by major shear zones, and abruptly pass into the high grade Namaqua metamorphic complex in southern Namibia. One of the main outcomes of this field workshop is the fact that the characteristics of the Mesoproterozoic terranes in Namibia do not match those of the Grenvillian belt to which it have been correlated by some workers. Furthermore, the lithological and geochronological data support the linkage between the Mesoproterozoic terranes exposed in Namibia and those exposed in central Africa, within the Kibaran-type area.

### ***3.3.3 The Rodinia map compilers workshop, Perth, 11–15 November 2002***

Ten map compilers, covering Australia, Baltica, East Antarctica, Laurentia, Siberia and South China, plus a number of researchers and students from the Tectonics Special Research Centre, participated in the week-long informal workshop in the Tectonics Special Research Centre (TSRC) in Perth in mid-November. The purpose of the workshop was for members responsible for the compilation of the 1:10 million Precambrian tectonic maps of various cratons to report on progress, exchange ideas, and standardise map format using ArcView or Arc/Info. Both the map legend and related data tables were finalised at the workshop (on display at the TSRC/IGCP 440 web site, <http://www.tsrc.uwa.edu.au>), and significant improvement was made to a number of draft map sheets, the Siberia one in particular. The project leadership was again discussed amongst members.

The following milestones were set for the compilation of the Rodinia map:

- December 2002: some draft maps to be sent to members of the Rodinia Map Advisory Committee for comments. Individual compilers and other members working in the region are encouraged to work together on their maps through either regional workshops or electronic communication;

- 6–11 April 2003, during the EGS-AGU-EUG Joint Assembly at Nice, France: Regional map compilation should be almost finished, and map compilers attending the Assembly will hold an informal workshop to comment on and exchange the map sheets;
- 2–5 November 2003, GSA meeting at Seattle: A thematic session on Rodinia maps/reconstructions has been proposed, at which individual maps will be presented and displayed, and various Rodinia reconstructions will be debated;
- March or April 2004: A workshop will be held, possibly at the TSRC in Perth, to debate further and finalise the Rodinia reconstructions to be used for the Rodinia map.
- 20–28 August 2004, the 32<sup>nd</sup> IGC in Florence: An IGCP 440 final symposium has been organized, at which the pre-print Geodynamic map of Rodinia will be presented before final publication at the end of 2004.

An agreement has also been signed between IGCP 440 and the TSRC regarding the ownership and future maintenance of the digital Rodinia map (members who wish to view the agreement can contact the Project Secretary).

Members of the project were also involved in organised additional national/international events related to Rodinia assembly and breakup:

#### ***3.3.4 China Working Group national symposium on the positions of Chinese blocks in Rodinia, Tianjin, 11–13, January, 2002***

Approximately 40 Chinese geologists attended this symposium, presenting their research results, and discussing future collaboration between different groups from both China and overseas. 2002 is the second year of a major research project on Rodinia, funded by the Chinese National Natural Science Foundation to three multi-institutional groups. In October Professor Lu Songnian and Dr Z.X. Li met to exchange progress and ideas on the compilation of the Chinese parts of the Rodinia map, and planned to hold a local workshop on the topic during early 2003.

#### ***3.3.5 A special session on “Planet Earth–structure and dynamics: Supercontinents through geological times” (Convenors: W. Cavazza, I. Dalziel and T. Torsvik) at EGS XXVII General Assembly, Nice, France, April 2002***

Around 20 oral and poster presentations reported new palaeomagnetic and geological data on various continental blocks, and new ideas for the reconstruction of Rodinia Supercontinent were discussed.

#### ***3.3.6 Nordic Working Group meeting, May 2002***

In May 2002 the Nordic Working Group (NWG) had its annual meeting. The principal goal was to beta-test the conversion of the IGCP 440 Rodinia tectonic legend using the Fennoscandian Geologic Map legend. About 10 participants of the NWG attended this meeting. Due to funding from Swedish UNESCO, this meeting included Norwegian, Finnish, and Russian representatives. The conversion was successful and tasks for the future were defined, including obtaining databases for the rest of Baltica, hiring a person(s) with GIS expertise, and concluding the conversion for all of Baltica.

#### ***3.3.7 The PPO-Asia Symposium, Sapporo, Japan, 5–7 September 2002***

A two-day symposium (with a one-day mid-conference field excursion) on Precambrian blocks, Palaeozoic orogens, and their roles in the assembly of Asia, was held at Hokkaido University, Sapporo, Japan. The symposium, initiated by the late Professor Teruo Watanabe, leader of the IGCP 440 Japanese Working Group, was his memorial symposium. Seventy scientists from eight countries participated in the symposium, with the topics of 46 papers ranging from Rodinia to Gondwanaland and to Asia, and all tectonic processes related to their evolution. The one-day field excursion examined spectacular local volcanoes and landscape created by a recent earthquake. Dr Y. Osanai from Okayama will replace the late Professor T. Watanabe as the new leader for the Japanese Working Group.

#### *3.4. Educational, training or capacity building activities*

The project continues to encourage and support students to participate in all aspects of its activities, including international collaborative primary research, all national and international meetings and workshops, field trips, and map compilation. For example, about ten M.Sc./Ph.D. related to the Mesoproterozoic and Neoproterozoic of Africa are in progress. Their work represent the contribution of IGCP 440 to capacity building in Africa. This is happening in about every continent.

#### *3.5. Participation of scientists from developing countries*

This project has now over 300 registered participants from 40 countries (see section 3.1), with a majority coming from developing countries. A significant proportion of the project funds for 2002 were used to support the involvement of scientists from developing countries (countries in Asia and Africa, Russia etc.) to participate in the project's activities.

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

breakup of Rodinia. An incomplete list is being updated annually at the TSRC web site (<http://www.tsrc.uwa.edu.au>, under IGCP 440).

#### **IGCP 440-sponsored Journal Special Issue:**

- 1) A *Precambrian Research* special issue on "Precambrian Tectonics of East Asia and Relevance to Supercontinent Evolution" (Guest Editors Z.X. Li, M. Cho, and X.H. Li; *in press*)
- 2) A *Tectonophysics* special issue in honour of the late Professor Chris Powell on a wide range of issues reflecting Chris' broad interests (Editors K. Sircombe and M.W. McElhinny; expected to be published in 2003)
- 3) A special issue of the *Journal of African Earth Sciences* devoted to invited review papers on the Mesoproterozoic Kibaran orogenic system of Africa is under preparation (Guest Editors: A.B. Kampunzu, R. Hanson., R. Key., S. McCourt, L. Tack). Expected to be published in 2003, with an attached CD-ROM map of the Mesoproterozoic of Africa and a map of the NE Kibaran belt.
- 4) A *Gondwana Research* special issue on "Assembly and Breakup of Rodinia and Gondwana", based on papers presented at the Osaka symposium, October 2001 (Guest Editors M. Yoshida and others; expected to be published in 2003)
- 5) A *Geological Society of London Special Publication* 206 on "Proterozoic East Gondwana: Supercontinent Assembly and Break-up" (Editors M. Yoshida and B.F. Windley) (*in press*)

Contents:

## **Introduction**

Yoshida, M., Windley, B.F., Dasgupta, S. Proterozoic East Gondwana: supercontinent assembly and break-up. Geol. Soc. London, Spec. publ., 206.

## **Tectonics of Rodinia and Gondwana: Continental growth, supercontinent assembly and breakup**

Condie, K. C. Supercontinents, superplumes and continental growth: The Neoproterozoic record.

Windley, B.F. Continental growth in the Proterozoic: a global perspective

Pisarevsky, A., Wingate, M.T.D., Powell, C.McA, Johnson, S., and Evans, D.A.D. Models of Rodinia assembly and fragmentation.

Yoshida, M., Jacobs, J., Santosh, M. and Rajesh, H.M. Role of Pan-African events in the Circum-East Antarctic Orogen of East Gondwana: a critical overview.

## **Australia and Gondwanaland**

Wingate, Michael T.D. and Evans, David A.D. Palaeomagnetic Constraints on the Proterozoic Tectonic Evolution of Australia.

Fitzsimons, I.C.W. Proterozoic basement provinces of southern and southwestern Australia, and their correlation with Antarctica.

## **India within Gondwanaland ensemble**

Dasgupta, Somnath and Sengupta, Plulak. Indo-Antarctic correlation: a perspective from the Eastern Ghats Granulite Belt, India.

Dobmeier, Christoph J. and Raith, Michael. Crustal architecture and evolution of the Eastern Ghats Belt and adjacent regions of India.

Braun, Ingo and Kriegsman, Leo M. Proterozoic crustal evolution of southernmost India and Sri Lanka

## **Antarctica and its role in the Gondwanaland assembly**

Harley, S.L. The Archaean to Cambrian crustal development of East Antarctica: metamorphic characteristics and tectonic implications.

Zhao, Y., Liu, X.H., Liu, X.C. and Song, B. Pan-African Events in Prydz Bay, East Antarctica and its Inference in the East Gondwana Tectonics

Bauer, W., Thomas, R.J. and Jacobs, J. Proterozoic to Cambrian history of Dronning Maud Land in the context of Gondwana assembly.

Jacobs, J., Klemd, R., Fanning, C.M., Bauer, W. and Colombo, F. Extensional collapse of the late Neoproterozoic/early Palaeozoic East Antarctic orogen: evidence from central Dronning Maud Land.

## **The East African Orogen**

Johnson, Peter R. and Woldehaimanot, Beraki. Development of the Arabian-Nubian shield: perspectives on accretion and deformation in the northern East African Orogen and the assembly of Gondwana.

Kusky, T. & Matsah, M. Neoproterozoic Dextral Faulting on the Najd fault system, Saudi Arabia, preceded Sinistral Faulting and Escape Tectonics Related to Closure of the Mozambique Ocean

Collins, Alan, S., Johnson, Simon, Fitzsimons, Ian C.W., Powell, Chris McA, Hulscher, Bregje, Abello, Jenny and Razakamanana, Theodore. Neoproterozoic deformation in central Madagascar: a structural section through part of the East African Orogen.

Fernandez, Alain and Schreurs, Guido. The tectonic evolution of the Proterozoic Itremo Group metasediments in central Madagascar.

Grantham, G.H., Maboko, M. and Eglington, B.M. A review of the evolution of the Mozambique Belt and implications for the amalgamation and dispersal of Rodinia and Gondwana.

**IGCP 440 Field guides & abstract volumes**

Davidson, A., Easton, R.M., Corriveau, L., Martignole, J., 2002. *Transect of the southwestern Grenville Province*. Field Trip B6 Guidebook, GAC-MAC Saskatoon 2002 Local Organizing Committee, 114 p.

*From Plains to Shield: the making of a continent's interior*. GAC-MAC Joint Annual Meeting, Abstracts volume 27, University of Saskatchewan, Saskatoon, Canada, 2002, 138 p.

*International Symposium on the Amalgamation of Precambrian Blocks and the Role of the Palaeozoic Orogens in Asia (PPO-Asia)*. Memorial Symposium for Professor Teruo Watanabe, 5–7 September, 2002, Hokkaido University, Sapporo, Japan, GRG/GIGE Miscellaneous Publication No. 16, 116 p.

**Refereed journal articles**

Bylund, G., Pisarevsky, S.A. Remagnetisation in Mesoproterozoic dykes from the Protogine Zone, southern Sweden and the Sveconorwegian Loop. *Geologiska foreningens i Stockholm forhandlingar (GFF)*, 124, 11–18.

Cawood, P.A., Landis, Ch. A., Nemchin A.A., Hadaá S., 2002. Permian fragmentation, accretion and subsequent translation of a low-latitude Tethyan seamount to the high-latitude east Gondwana margin: Evidence from detrital zircon age data. *Geol. Mag.*, 139, 131–144.

Cecys, A., Bogdanova, S., Jansson, C., Bibikova, E., Kornfelt, K-A. 2002. The Stenshuvud and Taghusa granitoids - new representatives of Mesoproterozoic magmatism in southern Sweden. *GFF (Geologiska foreningens i Stockholm forhandlingar)*, 124, 149-162.

Cenki, B., Kriegsman, L.M., Braun, I., 2001. Melt-producing and melt-consuming reactions in the Achankovil cordierite gneisses, South India. *J. Metam. Geol.*, 20, 543–561.

Collins A.S., Windley B.F., 2002. The Tectonic Evolution of Central and Northern Madagascar and its place in the Final Assembly of Gondwana. *J. Geol.*, 110, 325–329.

Duebendorfer, E.M., 2002. Regional correlation of Mesoproterozoic structures and deformational events in the Albany-Fraser orogen, Western Australia. *Precamb. Res.* 116, 129–154.

Halverson, G.P., Hoffman, P.F., Schrag, D.P., Kaufman, J.A., 2002. A major perturbation of the carbon cycle before the Ghaub glaciation (Neoproterozoic) in Namibia: Prelude to snowball Earth? *Geophys. Geochem. Geosyst.*, 3, on-line 10.1029/2001GC000244.

Hoffman, P.F., 2002. Carbonates bounding glacial deposits: evidence for snowball Earth episodes and greenhouse aftermaths in the Neoproterozoic Otavi Group of northern Namibia. *International Assoc. Sedimentologists Field Excursion Guidebook, Auckland Park, South Africa*, 1–49

Hoffman, P.F., Schrag, D.P., 2002. The snowball Earth hypothesis: testing the limits of global change. *Terra Nova*, 14, 129–155.

Jacobs, J., Thomas, R.J., 2002. A titanite fission-track profile across the SE Archean Kaapvaal craton and the Mesoproterozoic Natal Metamorphic Province, South Africa: evidence for differential cryptic Meso- to Neoproterozoic tectonism. *J. Afr. Earth Sci.*, 33, 323–333.

Jin, W, 2002. The late Palaeoproterozoic orogeny in the North China Craton. *Gond. Res.*, 5, 95–100.

- Li, Z.X., Li, X.H., Zhou, H., Kinny, P.D., 2002. Grenvillian continental collision in South China: New SHRIMP U-Pb zircon results and implications for the configuration of Rodinia. *Geology*, 30, 163–166.
- Li, X.-H., Li, Z.X., Zhou, H., Liu, Y., Kinny, P.D., 2002. U-Pb zircon geochronology, geochemistry and Nd isotopic study of Neoproterozoic bimodal volcanic rocks in the Kangdian Rift of South China: implications for the initial rifting of Rodinia. *Precamb. Res.*, 113, 135–155.
- Lu, S., Yang, C., Li, H., Li, H., 2002. A group of rifting events in the Terminal Palaeoproterozoic in the North China Craton, *Gond. Res.*, 5(1), 123–131.
- Lu, S., Wang, H., Li, H., et al, 2002. Redefinition of the “Dakendaban Group” on the northern margin of the Qaidam Basin. *Geological Bulletin of China*, 1, 19–23.
- Lu, S., 2002. Discussion on the new subdivision of the Neoproterozoic in China. *Geological Review*, 48(3), 242–248.
- Lu, S., 2002. A review of major problems of Precambrian research. “Proceedings of Precambrian and Quaternary”, Geological Publishing House, 1-11.
- MacNiocail, C., van der Pluijm, B. A., Van der Voo, R., McNamara, A., 2002. Discussion and reply: West African proximity of Avalon in the latest Precambrian. *Geol. Soc. Am. Bull.*, 114, 1049–1052.
- Maloof, A.C., Kellogg, J.B., Anders, A.M., 2002. Neoproterozoic sand wedges: crack formation in frozen soils under diurnal forcing during a snowball Earth. *Earth Planet. Sci. Lett.*, 204, 1–15.
- Pandit, M.K., Sial, A.N., Sukumaran, G.B., Pimentel, M.M., Ramasamy, A.K., Ferreira, V.P., 2002. Depleted and enriched mantle sources for Palaeo- and Neoproterozoic carbonatites of southern India: Sr, Nd, C-O isotopic and geochemical constraints. *Chem. Geol.*, 189, 69–89.
- Paulsson, O., Andréasson, P-G. 2002. Attempted break-up of Rodinia at 850 Ma: geochronological evidence from the Seve-Kalak Superterrane, Scandian Caledonides. *J. of Geol. Society, London*, 159, 751-761.
- Powell, C.McA., Pisarevsky, S.A., 2002. Late Neoproterozoic assembly of East Gondwanaland. *Geology*, 30, 3–6.
- Schrag, D.P., Berner, R.A., Hoffman, P.F., Halverson, G.P., 2002. On the initiation of a snowball Earth. *Geophys. Geochem. Geosyst.* 3, on-line 10.1029/2001GC000219.
- Tohver, E., van der Pluijm, B. A., Van der Voo, R., Rizzotto, G., Scandolara, J. E., Palaeogeography of the Amazon craton at 1.2 Ma: Early Grenvillian collision with the Llano segment of Laurentia, *Earth Planet. Sci. Letters*, 199, 185–200, 2002.
- Vernikovskiy, V.A., Vernikovskaya, A.E., Sal'nikova, E.B., Kotov, A.B., Kovach, V.P., 2002. Postcollision granitoid magmatism in the Transangara region of the Yenisey Ridge: An event 750–720 Ma BP. *Doklady Earth Sci.* 384, 362–366.
- Vernikovskaya, A.E., Pease, V.L., Vernikovskiy, V.A., Gee, D.G., Kireev, S.B., 2002. Geochemistry and petrology of Neoproterozoic granites of the Mamont-Shrenk terrane, Central Taimyr. *Geochem. Int.*, 40, 435–446.
- Vernikovskaya, A.E., Vernikovskiy, V.A., Sal'nikova, E.B., Datsenko, V.M., Kotov, A.V., Kovach, V.P., Travin, A.V., Yakovleva, S.Z., 2002. Yeruda and Chirimba granitoids (Yenisei Ridge) as indicators of Neoproterozoic collisions. *Russian Geology and Geophysics*, 43, 259–272.
- Wingate, M.T.D., Pisarevsky, S.A., Evans, D.A.D., 2002. Rodinia connections between Australia and Laurentia: no SWEAT, no AUSWUS. *Terra Nova*, 14, 121–128.
- Yuan, G., Wang, H., Lin, H. et al, 2002. Zircon U-Pb age of the gabbros in Luliangshan Area on the northern margin of Qaidam Basin and its geological implication. *Progress in Precambrian Research*, 25(1), 36–40.

- Zhang, W., 2002. The relative positions of South and North China Blocks in Neoproterozoic age and its tectonic significance. "Proceedings of Precambrian and Quaternary", Geological Publishing House, 12–22.
- Zhao, Y., Liu, X., Liu, X., Song, B. 2003. Pan-African Events in Prydz Bay, East Antarctica, and its inference in the East Gondwana tectonics. In: Yoshida M., Windley B. F. (eds), Proterozoic East Gondwana: Supercontinent Assembly and Breakup. Geol. Soc. London, Special Publications, 206, 231–245.
- Zheng, H., Powell, C.McA., Li, Z.X., 2002. Onset of aridity in southern Western Australia — a preliminary palaeomagnetic appraisal: Reply. *Global and Planetary Change*, 32, 283–286.

### *Articles in press*

- Bauer, W., Jacobs, J., Paech, H.-J., 2002. Structural evolution of the Proterozoic basement of central Dronning Maud Land. *Geologisches Jahrbuch*, B96, in press.
- Collins, A.S., Fitzsimons, I.C.W., Hulscher, B., Razakamanana, T., 2002. Structure of the Eastern East African Orogen in Central Madagascar. *Precamb. Res.*, in press.
- Jacobs, J., Thomas, R.J., 2002. The Mozambique Belt from an East Antarctic perspective. In: Gamble, J. A.; Skinner, D. N. B.; Henrys, S. ed. Antarctica at the close of a millennium. Proceedings of the 8th International Symposium on Antarctic Earth Sciences. Royal Society of New Zealand Bulletin 35, in press.
- Jacobs, J., Bauer, W., Schmidt, R., 2001. Geologischen Expedition in die Heimefrontfjella 2000/01. *Berichte der Polarforschung*, in press.
- Khain, E.V., Bibikova, E.V., Kröner, A., Zhuravlev, D.Z., Sklyarov, E.V., Fedotova, A.A., Kravchenko-Berezhnoy, I.R., 2002. The most ancient ophiolite of the Central Asian fold belt: U-Pb, Pb-Pb and Sm-Nd evidence from the Dunzhugur Complex, Eastern Sayan, Siberia, and geodynamic implications. *Earth Planet. Sci. Lett.*, in press.
- Khain, E.V., Bibikova, E.V., Salnikova, E.B., Kröner, A., Gibsher, A.S., Didenko, A.N., Degtyarev, K.E., Fedotova, A.A., 2002. The Palaeo-Asian ocean in the Neoproterozoic and early Palaeozoic: New geochronological data and palaeotectonic reconstructions. *Precamb. Res.*, in press.
- Li, Z.X., Li, X.H., Cho, M., 2002. Precambrian tectonics of East Asia and relevance to supercontinent evolution: introduction. *Precamb. Res.*, in press.
- Li, Z.X., Li, X.H., Kinny, P.D., Wang, J., Zhang, S., Zhou, H., 2002. Geochronology of Neoproterozoic syn-rift magmatism in the Yangtze Craton, South China and correlations with other continents: evidence for a mantle superplume that broke up Rodinia. *Precamb. Res.*, in press.
- Li, X.H., Li, Z.X., Ge, W., Zhou, H., Li, W., Liu, Y., Wingate, M.T.D., 2002. Neoproterozoic granitoids in South China: crustal melting above a mantle plume at ca. 825 Ma? *Precamb. Res.*, in press.
- Liu, X., Zhao, Z., Zhao, Y., Chen, C., Liu, Xiaohan. 2002. Pyroxene exsolution in mafic granulites from the Grove Mountains, East Antarctica: constraints on the Pan-African metamorphic conditions and evolution. *European Journal of Mineralogy*, in press.
- Liu, X., Zhao, Y., Liu, X., 2002. Geological aspects of the Grove Mountains, East Antarctica. Proceedings of the 8th International Symposium on Antarctic Earth Science, in press
- McElhinny, M.W., Powell, C.McA, Pisarevsky, S.A., 2003. Palaeozoic terranes of Eastern Australia and the drift history of Gondwana. *Tectonophysics*, in press
- Mikhalsky, E.V., Jacobs, J., 2002. Orthogneisses from central Dronning Maud Land: geochemistry and some petrogenetic implications. *Geol. Jahrbuch*. B96, in press.

- Paech, H.-J., Bauer, W., Jacobs, J., Markl, G., Piazzolo, S., 2002. Comparison of the geology of central Dronning Maud Land, East Antarctica, with other regions of the Gondwana supercontinent. *Geol. Jahrbuch*, B96, in press.
- Sklyarov, E.V., Gladkochub, D.P., Mazukabzov, A.M., Menshagin, Y.V., Watanabe, T., Pisarevsky, S.A., 2003. Neoproterozoic mafic dike swarms of the Sharyzhalgai metamorphic massif (southern Siberian craton). *Precambrian Research*, in press.
- Wang, J., Li, Z.X., 2002. History of Neoproterozoic rift basins in South China: implications for Rodinia breakup. *Precamb. Res.*, in press.

### *3.7. Activities involving other IGCP projects or the IUGS*

Project leaders continued to organise international activities in collaboration with other IGCP projects. For instance, the Namibia scientific sessions were organised in the framework of IAGOD and the field workshop was jointly organised with IGCP 418. The PPO-Asia Symposium at Sapporo was jointly organised with IGCP 411 and 420. The project is also jointly publishing journal special issues with other IGCP projects.

## **4. Activities planned**

### *4.1 General goals*

The main tasks for the project in 2003 are:

- Continue to obtain and publish high-quality data (e.g., in geochronology, petrology, palaeomagnetism, structural and basin history, etc.) in relation to the assembly and breakup of Rodinia, and
- Complete the 1:10 million tectonic maps for major continental blocks.
- Conduct geological correlations between blocks identified in various continents using the new map sheets, and together with geophysical constraints, test various Rodinian reconstructions..

### *4.2. Specific meetings and field trips (please indicate participation from developing countries)*

#### **Planned activities for 2003**

Two field symposia have been planned for 2003:

##### ***1) International workshop and field excursions in Sri Lanka on “The role of Sri Lanka in Rodinia and Gondwana assembly and breakup”, 30 March to 4 April 2003***

A one-day workshop was planned at the Institute of Fundamental Studies (IFS), Kandy, which will be followed by a five-day field excursion. Both the Grenvillian and Pan-African basement geology of Sri Lanka will be examined, and proposed correlations with southern India, East Antarctica and East Africa will be discussed. Participants will stay in Kandy for the first four nights and stay overnight in Pollonaruwa on the fifth night to give participants the opportunity to visit the world-famous cultural site in the area. For more information, please contact Wilbert Kehelpannala ([kvwilbert@hotmail.com](mailto:kvwilbert@hotmail.com)), Alfred Kröner ([kroener@mail.uni-mainz.de](mailto:kroener@mail.uni-mainz.de)), or look at the web site <http://www.tsrc.uwa.edu.au>, under the IGCP 440 upcoming events.

**2) South China field symposium on assembly and breakup of Rodinia, 9–18 October, 2003**

An 11-day event is being organised in eastern South China, with a two-day indoor symposium in the coastal ancient capital of Hanzhou, followed by a seven-day field trip through central Zhejiang Province, northeastern Jiangxi Province, finishing at the scenic Huangshan mountain in southern Anhui Province. Geological outcrops examined will include late Mesoproterozoic to earliest Neoproterozoic volcanic arcs and possible ophiolitic complexes, back-arc to foreland basin deposits (all related to Rodinia assembly?), 820–750 Ma bimodal magmatic complexes (plume-induced?), and coeval continental rift successions possibly related to the breakup of Rodinia. Costs are set at ca. US\$300 after subsidisation by sponsors. More details can be found at the web site <http://www.tsrc.uwa.edu.au>, under the IGCP 440 upcoming events, or contact Professor Shihong Zhang at [shzhang@cugb.edu.cn](mailto:shzhang@cugb.edu.cn). Deadline for expressions of interest to participate in the field trip (limit of 30) is 28 February 2003.

**3) EGS-AGU-EUG Joint Assembly, Nice, France, 06–11 April 2003**

Regional map compilers for the Rodinia map will hold an informal workshop to comment on and exchange the map sheets.

**4) Urals joint field expedition, 22 July–3 August 2003:** A Pilot Field Workshop “Baltica Passive Margin Magmatism” will be organized by Professor Victor Puchkov ([puchkv@anrb.ru](mailto:puchkv@anrb.ru)).

**5) A special session on Rodinia maps and reconstructions at the GSA meeting at Seattle, 2–5 November 2003:**

This will be the first time that all map sheets compiled for the 1:10 million Rodinia map will be presented and displayed, and various Rodinia reconstructions will be debated.

**4. Project funding requested**

2003 will be the last funding year for this large project, and maximum possible funding from UNESCO/IGCP will be crucial for the project to achieve its goals.

<i>Event</i>	<i>Funding request (USD)</i>
International workshop and field excursions in Sri Lanka on “The role of Sri Lanka in Rodinia and Gondwana assembly and breakup”, 30 March to 4 April 2003	3500
South China field symposium on assembly and breakup of Rodinia, 9–18 October, 2003	3500
Facility renting for the informal workshop of regional map compilers for the Rodinia map during the EGS-AGU-EUG Joint Assembly, Nice, France, 06–11 April 2003	500
A special session on Rodinia maps and reconstructions at the GSA meeting in Seattle, 2–5 November 2003 (funds will be used for supporting members from developing countries to attend the event)	3000
Project Secretary administrative costs	500
<hr/>	
<b>Total Budget Required USD 11,000</b>	

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

N/A

**7. Attach any information you may consider relevant**

- 1) Final legend and notes for the 1:10 million geodynamic map of Rodinia;
- 2) Brief CVs of Drs Z.X. Li (new Co-leader) and S. Pisarevsky (new Project Secretary), appointed after consultations with members at project business meetings (and some emails).