



Annual Report* of IGCP Project No. 648

***NOTE: MAXIMUM LENGTH OF THE TEXT REPORT IS 5 (FIVE) PAGES (starting from question 1). SINGLE SPACE, 12 POINT FONT. REPORTS EXCEEDING THIS LENGTH WILL BE RETURNED TO THE AUTHOR(S) WITH THE REQUEST OF REDUCING THE TEXT TO THE ABOVE STANDARD.**

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 by 01/12/2016

A LIST OF PUBLICATIONS HAS TO BE ADDED AS AN ANNEX.

***REMINDER: IF THIS IS THE FINAL YEAR OF YOUR PROJECT, PLEASE SUBMIT A REVIEW ARTICLE ABOUT YOUR PROJECT TO THE IUGS JOURNAL 'EPISODES'.**

The scientific information in this report will further be used for publication on the IGCP website hosted at UNESCO (please feel free to attach any additional information you may consider relevant to the assessment of your project).

IGCP project short title: SUPERCONTINENT CYCLES AND GLOBAL GEODYNAMICS

Duration: 5 years

Please tick this box if the report is for a Project on extended term (OET):

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Date of submission of report: 23 December 2015

Signature of project leader(s):



(Zheng-Xiang Li on behalf of all co-leaders)

Guidelines for Annual Report

Please use the following headlines to report the present status and scientific achievements of your project (write N/A where not applicable) and explain abbreviations you use in your report.

1. **Website address(es) related to the project:** <http://geodynamics.curtin.edu.au/igcp-648/>

2. **Summary of major past achievements of the project:**

- 3D modelling results demonstrating the dominant influence of plate subduction after supercontinent assembly in the generation of mantle plumes (e.g., Hassan et al., 2015; Heron et al., 2015);
- a proposed seafloor-spreading-aligned reference frame for plate motions that better matches observations and clarifies subduction dynamics (Becker et al., 2015);
- new understandings of plate motion speed and geodynamic processes during supercontinent assembly (e.g., Artemieva et al., 2015; Jagoutz et al., 2015);
- a new synthesis on the evolution of supercontinent Nuna and related mineralization events (e.g., Pehrsson et al., 2015);
- palaeoecological consequences of supercontinent breakup (Corsetti et al., 2015);
- over 100 peer-reviewed publications reporting new geological and palaeomagnetic findings that help to constrain supercontinent cycles and related dynamic processes.

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

3.1. *General scientific achievements*

Project members made numerous significant scientific findings over the past year including:

- Establishing a consensus on the structure of the global geotectonic database, and near completion on updating the global palaeomagnetic database;
- 3D modelling results suggest rapid bursts of hotspot motion due to the interaction between plate tectonics and deep mantle convection (Hassan et al., 2016) and abrupt plate accelerations that shape rifted continental margins associated with supercontinent breakup (Bruce et al., 2016);
- Precise geochronological dating of large igneous provinces that was critical to testing hypothesized central connections between large continents (i.e., North America, Northern Europe, and Siberia) in ~1.5-billion-year-old supercontinent Nuna, which additionally and provocatively suggests that only minor reorganization may have accompanied the subsequent transition from Nuna to ~900-million-year-old supercontinent Rodinia (e.g., Ernst et al., 2016; Evans et al., 2016);
- Generation of a wealth of critical new palaeomagnetic data that greatly increase our confidence in emerging consensus reconstructions of both supercontinents Nuna and Rodinia (e.g., multiple papers published in two special volumes Supercontinents, etc.).

3.2. *List of IGCP project meetings/symposia and IGCP related meetings/symposia with exact attendance (if possible) and number of countries*

- 1) IGCP 648 at the 35th International Geological Congress, Cape Town, South Africa, 27 August – 4 September 2016 (see event report). About 30 papers were presented by members from well over a dozen countries, and audience number in the oral session fluctuated between 100 and 50 through the day. The project provided financial support for three members from underdeveloped countries and one female student. Also see link to Cape Town IGCP 648 session.
- 2) IGCP 648 at the 2016 GAC-MAC at Whitehorse, Canada, 1-3 June 2016 (see event report). Audience of the session ranged between 100 and 50, with number of nationalities estimated at about 10. The project provided financial support for one member from an underdeveloped country and one student.
- 3) IGCP 648 at the Australian Earth Sciences Convention, Adelaide, 26–30 June, 2016 (see event report). The majority of the invited speakers were young researchers. Audience of the session ranged between 100 and 50, with number of nationalities estimated at about 10.

Members also attended conference field excursions and workshops. The project provided financial support for one member from an underdeveloped country and one female student.

- 4) 2016 August 18–20, 7th International Dyke Conference, Beijing, China ([see event report](#)). A total of 120 participants from around 15 countries participated in the event.

3.3. *Educational, training or capacity building activities related to the IGCP project and IGCP project participants.*

Training to graduate and undergraduate on supercontinent cycles and global geodynamics are routinely carried out by members in classrooms and at conferences and workshops. We particularly encouraged and preferentially supported students to attend projected-sponsored symposia, workshop, and meeting special sessions. For instance, an IGCP 648 database workshop was conducted at the [35th IGC](#). A [field symposium on Orogenesis during Supercontinent Cycles was conducted in Xi'an, China](#) for students and young researchers. Capacity building activities are carried out by members throughout the world. These include the enhancement of geochronology capacities (e.g., those in China, Australia and Russia). Many palaeomagnetic laboratories are buying or upgrading their 2G magnetometers with a newly available automated sample handling system – the RAPID system (e.g., the Curtin Uni laboratory). We are also trying to establish better interfaces between geological and palaeomagnetic databases and the GPlates reconstruction software, and are upgrading the Global Palaeomagnetic Database.

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

Algeria, Argentina, Australia*, Bangladesh*, Belgium, Botswana, Brazil*, Cameroon, Canada*, China*, Czech Republic, Denmark, Egypt*, Finland*, France*, Germany, India*, Iran*, Italy, Japan, Republic of Korea*, Malaysia, Mexico*, Morocco*, Netherlands*, Namibia*, New Zealand, Nigeria, Norway*, Oman, Pakistan*, Poland*, Portugal, Russia*, Senegal*, Singapore, South Africa*, Spain, Sweden*, Turkey, Ukraine*, U.K.*, USA*

3.5. *Participation of scientists from developing countries, and in particular young and women scientists: exact number and please describe how this project specifically benefited women scientists, young scientists and/or scientists from developing countries*

	<i>Total number of scientists</i>	<i>Number of male scientists</i>	<i>Number of female scientists</i>
<i>Number of participating scientists</i>	170	125	45
<i>Number of young scientists/students (<35 years old)</i>	40	27	13
<i>Number of scientists from developing countries</i>	37	30	7

We encouraged researchers from underdeveloped countries and young and female researchers (including students) to join the project and participate project activities. This is reflected in the financial support provided to members to attend the first project field workshop, with support preferentially given to members of those categories (see financial report form).

3.6. *List of the 5 most important publications (including maps) of this year*

a) *could not have been published were it not for this project*

b) *related to this project*

Brune, S., Williams, S.E., Butterworth, N.P., Müller, R.D., 2016, Abrupt plate accelerations shape rifted continental margins, *Nature*, 536, 201-204.

Ernst, R. E., Hamilton, M. A., Soderlund, U., Hanes, J. A., Gladkochub, D. P., Okrugin, A. V., Kolotilina, T., Mekhonoshin, A. S., Bleeker, W., LeCheminant, A. N., Buchan, K. L., Chamberlain, K. R., and Didenko, A. N., 2016, Long-lived connection between southern Siberia and northern Laurentia in the Proterozoic, *Nature Geoscience*, doi:10.1038/ngeo2700

Hassan, R., Muller, R.D., Gurnis, M., Williams, S.E., Flament, N., 2016, A rapid burst in hotspot motion through the interaction of tectonics and deep mantle flow, *Nature*, v. 533, p. 239-242.

Puetz, S.J., Kent, K.C., Pisarevsky, S.A., Davaille, A., Schwarz, C.J., Ganade, C.E., 2016, Quantifying the evolution of the continental and oceanic crust, *Earth-Science Reviews*, v. 164, p. 63-83.

Evans, D.A.D., Li, Z.-X., Murphy, J.B., 2016, Four-dimensional context of Earth’s supercontinents, Geological Society, London, Special Publications, v. 424, p. 1-14.

3.7. *Activities involving other IGCP projects, UNESCO, IUGS or others*

This project is building on three past IGCP projects (#440, #509 and #597), and is collaborating with two current IGCP projects (#589 and #628) in building a global geotectonic database for reconstruction, data-mining, mineral studies, and other interdisciplinary applications (free for all).

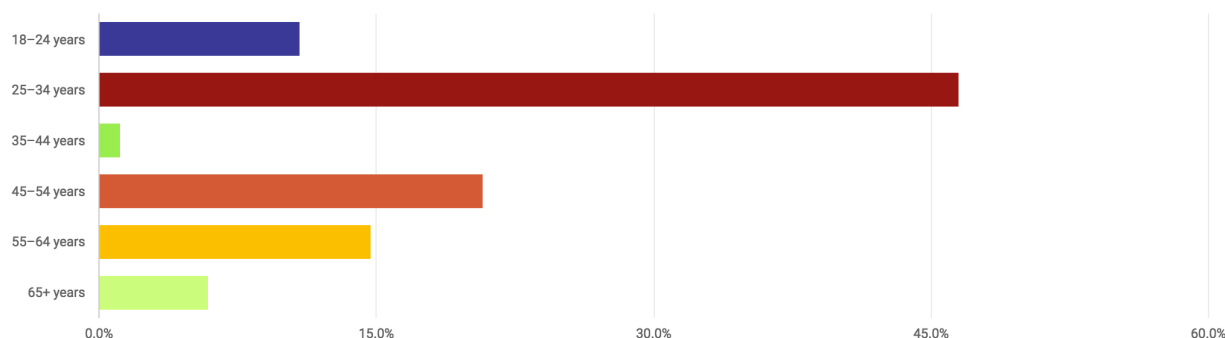
3.8. *Scientific Legacy: Is there a need for storage of publications, field data, and other results of the project? Do you have a clear vision concerning where the data would be stored and who will be the custodian?*

One of the major scopes of the project is to establish global geological, tectonic, mineral deposits, and palaeomagnetic databases that are easily manipulated using plate reconstruction software such as GPlates. Databases will be hosted at both the University of Saskatchewan (Canada) and Curtin University (Australia), and will be made freely available to anyone once they are established. They will be maintained by research groups in the respective universities and a small group of core researchers from around the world.

3.9. *What tangible improvements has your project obtained? (Besides publications, we are interested to hear about improvements to research, scientific contacts, policy implications, etc)*

We have set up thematic working groups including database/software development, geodynamics, tectonic reconstructions, mineral deposits, and palaeoenvironments. Collaborative relationships with other IGCP projects have been established, and we are in the process of setting up continental working parties, starting from Asia and Australia where the groundwork for database establishment is already in place, to focus on collaborative development of the global database, and publishing thematic volumes focusing on research outcomes using the database and reconstruction/data-mining software.

Research networking is being achieved through meetings, workshops, email discussions, and website information exchanges. We are still working toward attracting more researchers from underdeveloped countries to join the project. This year, the IGC in South Africa provided an excellent such opportunity for us to achieve this. Also, the project selected a new secretary, Ross Mitchell, an early career scientist at Curtin University working with project Co-Leader, Zheng-Xiang Li. On top of existing responsibilities, Mitchell has started a “SixFortyEight” videoblog that reports significant research accomplishments made by the project, with viewership aimed at both the community itself and the wider public as well. Analytics indicate that viewership of the vlog is geographically diverse, serving to increase the level of engagement of researchers from underdeveloped countries. Also, the vlog appears to be successful in achieving its chief purpose of increasing the activity and interest of early career scientists in the project, where almost 50% of the viewers range between 25-34 years in age:



3.10. *What kinds of activities in respect to the benefit of society and science outreach has your project undertaken?*

The global geotectonic and mineral deposit databases that we are establishing, and the tool kits that we are developing to be freely available to anyone who wishes to carry out temporal-spatial analysis of global ore-forming events, will benefit the broad community by providing better exploration tools for mineral and petroleum resources. The palaeogeographic reconstructions we develop are used by climate modelers for modeling past and future climate changes and geologists studying the changing earth and its associated ore deposits. Outreach activities are carried out by many individual members through media interviews (see 3.11 below), writing popular science articles, and posting research findings online and on social media. Also, the new vlog by project secretary Mitchell appears to offer a new and innovative way for the project members to connect with each other and the greater public at the same time.

3.11. *What kind of public information (media reports, etc) has your project generated? And how do you evaluate their impact?*

Many project members routinely report their new science findings in the mass media. Members from the University of Sydney School Of Geoscience regularly release their research through media releases at <http://www.earthbyte.org/category/news/>. Such releases by many of our members cause a significant impact and are used by media outlets around the world, e.g.:

- Sydney News article about abrupt hotspot motion:
<http://www.nature.com/nature/journal/v533/n7602/nature17422/metrics>
- The Science Show (ABC Radio National) on supercontinents and supercomputers:
<http://www.abc.net.au/radionational/programs/scienceshow/big-data-and-super-computers-help-solve-hawaiian-geological-eni/7695400>
- Quartz article about breakthroughs in supercontinent research:
<http://qz.com/577842/scientists-have-used-groundbreaking-technology-to-figure-out-how-the-earth-looked-a-billion-years-ago/>

Many projects members also routinely participate in community outreach programs that produce a significant impact on the community, e.g.:

- Professor Joseph Meert (University of Florida) participates in Community Outreach Program “Talk Science to Me”.
- Senior Researcher Åke Johansson (Swedish Museum of Natural History) answers questions on geology from the public here at the museum and is also involved with the outreach activity, “Geology Day”, as chairman of the national board, and locally at the museum.
- Postdoctoral researcher Icaro Frois Dias da Silva (University of Lisbon) ran two workshops at the UNESCO Center for Arts on local ecotourism and geology for ceramicists.
- Early Career Research Associate Chris Spencer (Curtin Uni) has hundreds of thousands of views on YouTube videos about field geology, maintaining a regular and popular social media presence as #TravelingGeologist.
- Project secretary, Ross Mitchell, started a vlog that reports major advances of IGCP 648.
- Distinguished lecturer Paul Hoffman gave a [short course on Snowball Earth](#) at Curtin Uni
- Prof. Zheng-Xiang Li and young members of his group are interacting with two year-9 school classes in a semi-rural region on tectonics, geodynamics, and career in scientific research in general.

4. **Activities planned**

4.1. *General goals*

- 1) To improve the understanding of the existence, configuration, and evolution of pre-Pangaea supercontinents and the possible cyclic nature of supercontinent dynamics.
- 2) To establish or improve GIS-based databases, globally consistent in scale, that will be used for testing the supercontinent and global geodynamic models, for Earth resource analysis and exploration, and for other interdisciplinary applications (e.g., life evolution and climatic changes).

- 3) To model global-scale geodynamics to test/refine relationships between plate tectonics/supercontinent cycles and mantle dynamics.

4.2. *Tentative list of specific meetings and field trips (please list the participating countries)*

Our main event for 2017 is the "Rodinia 2017: Supercontinent Cycles and Global Geodynamics" conference and field excursion 11–21 June 2017. The indoor conference will be held during 11–14 June in Townsville of northern Queensland, Australia. This will be followed by a field excursion to the Mt Isa region. We selected this locality for the field conference because northern Queensland has some of the most spectacularly preserved Paleoproterozoic terranes that hold key clues about the configuration and evolution of supercontinents Nuna (Columbia) and Rodinia (i.e. the speculated 1.8 Ga vs. 1.6 Ga collision of northern Queensland with northwestern Laurentia to form Nuna).

In addition, we plan to conduct at least two workshops on the construction of the IGCP 648 global geotectonic and mineral deposit database. The first one will be held in Beijing to focus on the Asian sector of the database, and the second one just before the Rodinia 2017 conference in Townsville. For the second one, we intend to invite key contributors from different countries and continents to attend. The year ahead will focus on database development and dissemination.

We will also organise or contribute to other meeting sessions on project-related themes.

5. Project funding requested

Annual budget at a level of USD 10,000/a:

- Partial support for researchers from underdeveloped countries to participate in the database construction workshop as well as the Rodinia 2017 and field excursion:
\$1000/each x 4 = \$4000
- Partial support for other researchers from underdeveloped countries to participate in the Rodinia 2017 and field excursion:
\$800/each x 2 = \$1600
- Partial support for PhD students (2 or 3 women) to participate in project activities:
\$700/each x 5 = \$3500
- Administration costs \$900

Total \$10,000

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

N/A

7. Financial statement (\$ USD only)

The IGCP Scientific Board would like to be informed how the IGCP funds were used.

See Form III

8. What additional funding besides the IGCP seed funding has your project obtained thanks to the IGCP label? Please estimate the budget received for meetings, research or other and identify the source.

The Rodinia 2017 conference has received A\$5000 sponsorship from the ARC Centre of Excellence for Core to Crust Fluid Systems, and A\$2500 from the Geological Society of Australia. Project Co-Leader, Zheng-Xiang Li, built the pending IGCP project in his 2014 project application, and was awarded an A\$2.9 million grant by the Australian Research Council in 2015. Ricardo Arenas, whose team includes several IGCP members, was awarded a \$127,000 grant by the Spanish Research Project for four years (2017-2020) that includes a four-year postdoc contract. Bobo Weber was awarded a \$550,000 grant by CONACYT for infrastructure for a TIMS lab. We anticipate to see many more grant successes by members in the coming years.

9. Attach any information you may consider relevant

N/A