United Nations
Educational, Scientific and
Cultural Organization

Annual Report* of IGCP Project No. 587

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by 01/12/2015

IGCP project short title:

IDENTITY, FACIES AND TIME – THE EDIACARAN (VENDIAN) PUZZLE

Duration: 2010-2015, 2016

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

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ANNUAL REPORT

1. Website address: http://monash.edu/science/about/schools/geosciences/precsite/html

2. Summary of major past achievements of the project

See website, which details each year of IGCP587 plus its precursor IGCP493.

This project has from the beginning aimed to extend the work begun by IGCP493 (2003 -2009) in attempting to locate additional material from areas with a sparse Ediacaran biotic record (South America, Middle East, Siberia, Mongolia, Iran), but with marked palaeobiogeographic interest; to closely compare those settings (using sedimentology and detailed basin analysis, carbon and oxygen isotope input, palaeogeography) with faunas from some of the most abundant Ediacaran biotas have been collected. This project has allowed the proposers and associates to increase significantly the data base (and stimulate further discussion and joint research) of some of those less biodiverse, yet specimen abundant, assemblages, such as those in Namibia, Newfoundland, the Flinders Ranges of Australia and the White Sea in Russia, as well as classic sites in the Ukraine, China, and NW Canada. The project has attempted t to push further back in time and examine older assemblages as well as slightly younger in the Cambrian. IGCP587 has put much effort into involving students and non-scientists, artists, documentary makers (including Sir David Attenborough and the BBC), as well as seasoned researchers in this project in the hope of markedly increasing the amount of material from some of the lesser known locales, refining the dating of all of these locales, and popularizing the research results to a broader audience. By understanding the sequence and more precise timing of biotic events during the Neoproterozoic and their drivers, wisdom concerning our future predictions of climate and habitability of the Earth is a natural by-product and a road-map for behaviour of humans.

3. Achievements of the project this year only

Petrographic and Geochemical Analysis of the latest Neoproterozoic carbonate sequences in southern Africa by Jay Kaufman/Les Krisfeld and their teams from the University of Maryland and Monash University. The emphasis for this project is to better understand the driver(s) of the Ediacaran Shuram Excursion, the most negative carbon isotope anomaly in Earth history. Field observations and carbon isotope measurements of calcite nodules lined with silica cements (Fig. 1) in the Mara Member of the Nama Group in southern Namibia (Fig. 2) suggest an early authigenic origin associated with the oxidation of methane within the sulfate-methane transition zone of sediments. These measurements suggest that the release and anaerobic oxidation of methane (with sulfate) from gas hydrate deposits in the middle Ediacaran may explain the unique carbon cycle anomaly, which neatly subdivides the period and may have paved the way for the evolution of Ediacaran animals.

Fig. 1: Silica- and pyrite-lined calcite nodules in dolomicrite from the Mara Member of the Nama Group in southern Namibia. The carbon isotope compositions of the nodules suggest an authigenic origin from the oxidation of organic matter, including methane, near the sediment/water interface through microbial sulfate reduction. This may be evidence of Earth's earliest methane cold seep environments, and is similar to field and laboratory measurements of similar nodules in Shuram equivalent strata of South China by Kaufman and colleagues (in review; GSA presentation and abstract).

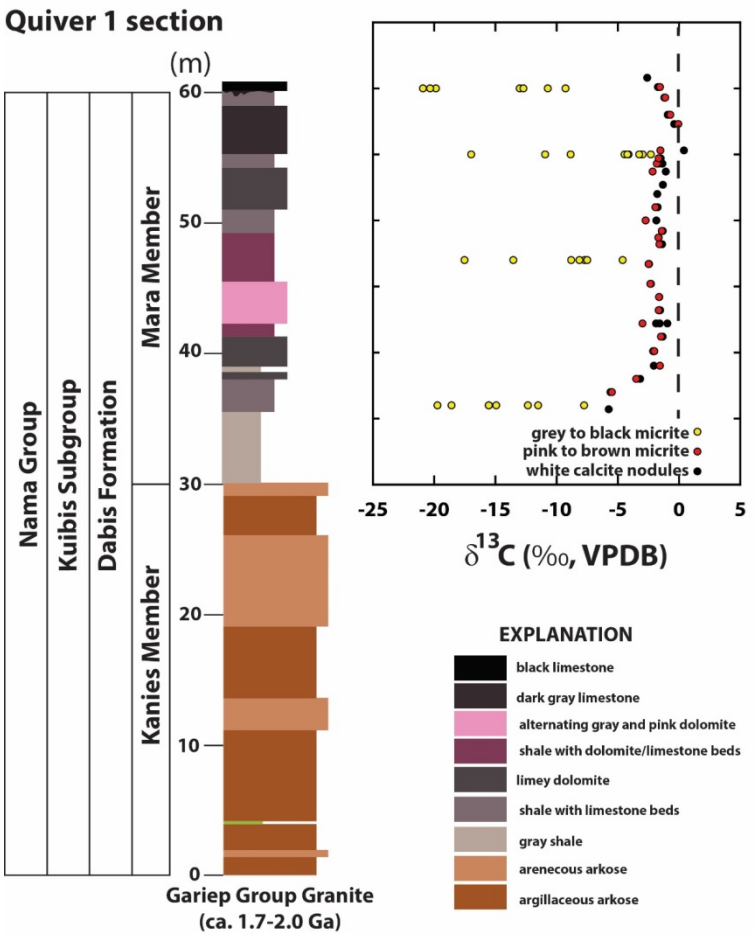

Fig. 2: Measured stratigraphy and carbon isotope compositions of micrite, dolomicrite, and calcite nodules in the Mara Member at the Quiver locality in southern Namibia. The strongly negative $d^{13}C$ values of the nodules supports their origin as authigenic precipitates and suggests that the oxidation of methane and organic matter through microbial sulfate reduction may explain the enigmatic Shuram Excursion.

Synchrotron Imaging of Namibian Ediacarans. Three, four-day sessions at the Australian Synchrotron in Melbourne involved the scanning of several specimens of Rangea, Pteridinium and Ernietta from the Nama Group of Namibia. Other surface scans of Rangea were carried out at Monash University and currently the internal structure of the synchrotron scans is underway. The

surface scans have made it possible to provide 3d prints to a number of museums around the world where original material is not present.

Detailed planning for the preconference field trip of the International Geological Congress in the Nama Group – and production of the field guide and logistics for this trip that will take place in August of 2016.

3.1. General scientific achievements

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

a. **Published** a significant number of papers as a direct result of activities related to IGCP587 – see appendix for a selection.

b. **Submission of a UNESCO World Heritage Proposal for Mistaken Point**, Canada. Thomas, R., and Narbonne, G.M. 2015, Mistaken Point: Nomination for inscription on the UNESCO World Heritage List, 165 pages + 650 page appendix. (also noted in 3.7).

Fig. 3. IUCN site visit in early October, 2015 to Mistaken Point

c. One outstanding achievement is the **capture of the cover of *Current Biology*** by the Precambrian art of Peter Trusler. *Beothukis* appeared on the cover of a special issue of Current Biology "History of Life on Earth" (05 October 2015).

d. Cui, H., Kaufman, A.J., Xiao, S., Zhu, M., Zhou, C. and Lui, X.-M., 2015. **Redox architecture of an Ediacaran ocean margin**: Integrated chemostratigraphic ($\delta^{13}C$–$\delta^{34}S$–$^{87}Sr/^{86}Sr$–Ce/Ce) correlation of the Doushantuo Formation, South China. *Chemical Geology* **405**: 48-62.

3.2. List of IGCP project meetings/symposia and IGCP related meetings/symposia

***27 Sept. 2015*.** Full two day **Workshop presented at the Geological Survey of Iran** (Tehran): The Oldest Record of Animal Life on Earth. *The Rise and Demise of the Ediacarans in the Neoproterozoic*. Workshop for researchers and university lecturers.

Participants in this project attended several professional meetings where they presented posters, invited keynotes and oral papers. IGCP587 researcher presented and **Invited Keynote Address** at the Lund Centre for Studies of Carbon Cycle and Climate Interactions noting the importance of past climate changes as pertinent information for future predictions, Lund, Sweden Sept. 2015.

Main effort in 2015 was **preparation for the preconference field trip on the Nama Group**, late Neoproterozoic, in Namibia prior to and part of the International Geological Congress to be held in Cape Town. Further planning was undertaken for a **symposium related to research directly associated with IGCP587** at the IGC in 2016.

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

Hinder, G., Vickers-Rich, P., van Schalkwyk, P. & Schneider, G., in press. A Worldclass Canyon and Late Proterozoic "Ghosts", Superlatives of the Nama Group. ***Heritage Volume for International Geological Congress***, Cape Town, South Africa 2016.

Vickers-Rich, P., Trusler, P. & Alcober, O., 2014-2015. *Dinosaurs Dawn to Extinction*. ArtScience Museum, Singapore, **Exhibition Catalogue**: 141 pp. This exhibition held at the ArtScience Museum in Singapore had one hall dedicated to the Precambrian and early Phanerozoic which showcased research carried out under the banner of IGCP587. It investigated times before (including the Precambrian) and after the reign of the dinosaurs. Several 100,000 visitors attended this exhibition and more than 900 staff were involved in the planning and setup of this 4000m2 exhibition. Several teaching modules accompanied the exhibition, including several on topics related to IGCP587.

Helen Boynton reported on a renewed project of both **scanning and producing new moulds** of material preserved in the Blackbrook Formation, Charnwood forest, noted in an article in the September issue of *Charnia*, page 3. This insures cast material can be distributed to collections around the world and assists in keeping records where erosion or even vandalism can destroy critical fossils. Aaron Bowers continues his exploration of the Charnwood area, with ever new finds.

Fig. 4. Painting of Charnwood outcrop by Tina Negus. See article in Appendix about the discovery of the Charnwood fossils in Leicester.

IGCP587 researcher Trevor Ford was presented an **Honorary Doctorate by Derby University** for his work on the Charnwood Forest ediacarans.
http://www.leicestermercury.co.uk/Geologist-90-awarded-honorary-doctorate services/story 28086080-detail/story.html

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

Argentina, *Australia, Brazil, *Canada, *China, Czech Republic, *Germany,* India, *Iran, Iraq, Ireland, Italy, Japan, *Namibia, The Netherlands, Poland, *Russia, *Saudi Arabia, Spain, *Sweden, *South Africa, Taiwan (Republic of China), *Timor-Leste, *United Kingdom, *Ukraine, Uruguay,* 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*

See 3.4 above. Data not available for meetings.

3.6. ***List of the 5 most important publications***

Carbone, C., Narbonne, G.M., Macdonald, F.A., and Boag, T., 2015. New Ediacaran fossils from the uppermost Blueflower Formation, NW Canada: Disentangling biostratigraphy and paleoecology. *Journal of Paleontology,* 89: 281-291.

Darroch, S.A.F., Sperling, E.A., Boag, T., Racicot, R.A., Mason, S.J., Morgan, A.S., Tweedt, S., Myrow, P., Erwin, D.H. and Laflamme, M., 2015. Biotic replacement and mass extinction of the Ediacara biota*. Proceedings of the Royal Society B*.

Gold, D. A., Runnegar, B., Gehling, J.G., and Jacobs, D.K., 2015. Ancestral state reconstruction of ontogeny supports a bilaterian affinity for *Dickinsonia*. *Evolution and Development* 17 (6), 315–397.

Ivantsov, A.Yu., Narbonne, G.M., Trusler, P.W., Greentree, C., and Vickers-Rich, P. (in press) Elucidating *Ernietta*: Exceptional specimens from the Ediacaran of Namibia. *Lethaia*.

Sperling, E.A., Carbone, C., Strauss, J.V., Johnson, D.T., Narbonne, G.M., and Macdonald, F.A., 2015, Oxygen, facies, and secular controls on the appearance of Cryogenian and Ediacaran body and trace fossils in the Mackenzie Mountains of northwestern Canada. *Geological Society of America, Bulletin*, available online 05 November 2015, doi: 10.1130/B31329.1

See attached selected bibliography for 2015, as an appendix.

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

NeoproterozoicSubcommission
https://www.jcu.edu.au/mailman/listinfo/neoproterozoicsubcommission Prof. Guy Narbonne served as the Chair of the newly formed IUGS/ICS Working Group on a Terminal Ediacaran Stage. He represented our IGCP project at the International Commission on Stratigraphy Congress (Graz, Austria) where I gave talks on “Towards a Terminal Ediacaran Stage” and “New Developments at the Basal Cambriarn GSSP, Fortune Head, Newfoundland, Canada”. Prof. Kaufman is also a member of this subcomission and attended the meeting in Graz, Austria.

Jim Gehling, Jay Kaufman, and Guy Narbonne (all Project leaders of IGCP587) are voting members of the IUGS-ICS Ediacaran Subcommission. Narbonne is Chair, Gehling and Kaufman are voting members, and Vickers-Rich is a corresponding member of the IUGS-ICS Working Group on a Terminal Ediacaran Stage. These responsibilities are directly related to the theme of our IGCP project and to our proposed activities OET next year. They also show clear linkage between our IGCP project and the mandates of IUGS.

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?*

In most all cases, fossil material is stored in the country of collection, in such places as geological surveys (e.g. Namibia, in the Namibian Geological Survey where there has been a concerted effort to curate and outfit the museum there with storage racks, furniture, filing systems), or museums (the South Australian Museum and Museum Victoria in Australia) , or government institutes (such as the Paleontological Institute, Russian Academy of Sciences). There has also been significant effort in the case of paleontological specimens to scan both external and internal structures and produce 3d prints and data files and these made available to institutions around the world. More of this is to be encouraged.

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)*

Iran
Field trip into the Erborz Mts of northern Iran and the Yazd area with the Iranian Geological Survey was one of the highlights of 2015, paving the way for further engagement in future. The Iranian Geological Survey provided all of the ground support, vehicles and local staff as well as the

connections with district governance and mining companies that gave free access to locales that had not been explored before or only in the 1980's by foreign researchers.

South Australia
Ediacara research in South Australia has continued with further excavations at the National Heritage Listed Ediacara Fossil Site at Nilpena, a new site in the northern Flinders Ranges of South Australia, and for the first time, at the historic discovery site in the Ediacara Conservation Park. At Nilpena, our teams from University of California, Riverside and the South Australian Museum, have excavated, inverted and reassembled 24 beds for palaeoecological analysis, since 2003. In four excavation sites, this has produced serial beds for assessment of heterogeneity of benthic assemblages of these late Ediacaran benthic assemblages. Ediacaran fossil sites across the Flinders Ranges are being studied to assess onshore to offshore variations in faunal assemblages. Bedding excavations have proven to be the only effective means of assessing the body fossil composition of beds at all scales, since taxa vary from less than 5mm to more than two metres in dimensions. Research has been led by Jim Gehling, and Mary Droser with Diego Garcia-Bellido recently joining the research group along with several post-doctoral fellow, Lidya Tarhan, and graduate students including, Scott Evans, Christine Hall, Felicity Coutts, and Lily Reid. Visiting researchers to SA Museum and the Flinders Ranges Ediacara sites have included Guy Narbonne, Alex Liu, Alex Dececchi. Doug Erwin, Jon Antcliff and Jennifer Hoyal-Cuthill.

The iconic Ediacara fossil: ***Spriggina floundersi*** has been proposed as a candidate for the **fossil emblem** of the state of South Australia in acknowledgement of its interpretation as the first known Ediacaran organism with a head, and in honour of the late Reg Sprigg, who first realized the Ediacara biota in 1947, and for his pioneering geological and environmental achievements.

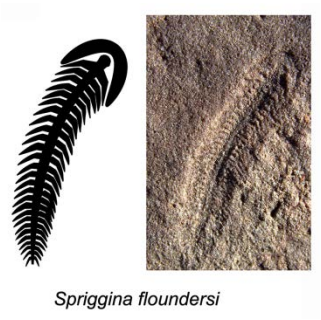

Fig. 5. *Spriggina floundersi*

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

Submission of a UNESCO World Heritage Proposal for Mistaken Point, Canada. Thomas, R., and Narbonne, G.M. 2015, Mistaken Point: Nomination for inscription on the UNESCO World Heritage List, 165 pages + 650 page appendix.

A proposal to have Farm Aar declared as a Namibian National Heritage site, jointly presented with the Namibian Geological Survey, Ministry of Mines and Energy, was successful, and this listing was successful in 2014. Now there is effort to follow this up and apply for UNESCO heritage listing. Farm Aar along with Swartpunt and the surrounding area is by far the most prolific area for the last occurrence of large metazoans, unshelled, globally and the richest site on the African continent – a project tentatively titled – the *Cradle of Modern Animalia*. A small museum is currently in place on Farm Aar, and there is growing effort to set up a heritage museum in the town of Aus, near Farm Aar. Significant local and national interest is current and the possibility of permanently setting aside Farm Aar as a Heritage site staffed by locals and open for limited and controlled eco-tourism is underway. With the locals and national heritage organizations a long term history of this region is being compiled with emphasis on the geological aspect of this heritage.

28 October 2015. **Science Café Lecture, Singapore Science Centre*, *Singapore***. *When Life Got Really Big and Snowball Earth* (P. Vickers-Rich)

29 October 2015. ***Scientist in Residence for a Day, Singapore***. Public interaction with kids and the general public. Singapore Science Centre (P. Vickers-Rich)

July 2015-July 2017. Exhibition Wildlife of Gondwana on show at the National Wool Museum in rural Victoria, Geelong, Australia. This exhibition showcases current research on the Precambrian with inclusion of documentaries produced on the field work carried out by IGCP587 participants.

Fig. 6. Trusler discussing the reconstruction of *Rangea* from Namibia with David Attenborough, information used in First Life and on show at the exhibition in Geelong.

2015. **Exhibition *Upstream-Downstream***: ***The Flow on of the Scientific Art of Peter Trusler*** in the Fossil and Mineral Museum, Bathurst, New South Wales, Australia showcased several of the Ediacaran reconstructions made by Trusler as part of IGCP587.

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

Each of the exhibitions produced significant media, which impacted on the local community and encouraged attendance to both of the exhibitions on show during 2015 and ongoing.

4. Activities planned

Planned Meetings

Palaeo Down Under2. July 2016. Association of Australasian Palaeontologists (AAP) is organizing a ***Palaeo Down Under 2*** **conference** at the University of Adelaide in South Australia from July 10-15. The conference is preceded by a **Field Excursion** to key Cambrian localities of Kangaroo Island, the Fleurieu Peninsula and the **Cambrian** and **Ediacaran** of the Flinders Ranges from July 3-9.

International Geological Congress, August 2016. Excursion SA_Pre2 Nama Group geology and Ediacaran fossils Coinciding with the late stage of the orogenys that welded together the Gondwana supercontinent, a huge sedimentary basin developed in southern Namibia and accommodated the molasse derived from the uplifted orogenic areas. The shallow sea that formed would become the scene of early life growing up, as more complex creatures developed in a World that hitherto only knew single-celled live. As a result, the Nama Group hosts the fossil remains of some of the World's oldest known multi-cellular organisms, the metazoan communities of the so-called Ediacaran age. This field trip is specifically aimed at studying the environments of the life forms of the Ediacaran fauna in the Nama Group sediments of the terminal Proterozoic (terminal Ediacaran). The trip will concentrate on the south of Namibia, and the sedimentology of the Nama Group will be explained on the way from Windhoek. The terminal Ediacaran fossils at the national heritage site of farm Aar, other important outcrops, and will be shown. The excursion will also include a scenic visit to the Fish River Canyon.
Field Trip Leaders: Pat Vickers-Rich, Guy Narbonne
Start/end: Windhoek
Date: 5 days, 21-25 August 2016
Cost: $Namibian 13,890.00http://www.35igc.org/Page/206/ExSAPre2-Nama-Group-geology-and-Ediacaran-fossils

5. Project funding requested:

No funding requested. OET request so that the final year of this project will be 2016 in association with the International Geological Congress, Cape Town.

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

OET requested in order to prepare a successor project and to have the final meeting of participants at the International Geological Congress in Cape Town during 2016.

7. Financial statement ($ USD only).

No funds were requested from UNESCO.

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.

a. Funds from donations and in kind support to underwrite two field trips from August-November in the Elborz Mountains as well as the Yazd region of Iran (in conjunction with the Iranian Geological Survey) and a second in southern Namibia (Nama Group) (in conjunction with the Namibian Geological Survey**. $35,000+.**

b. Exhibition income from *National Wool Museum* where *Wildlife of Gondwana Exhibition* in place from **July 2015 to July 2016** highlighting Neoproterozoic material from South and Western Australia, Namibia, Russia, much collected as a result of expeditions carried out under IGCP493 and 587. Much of this was used to underwrite further field work and development of educational materials highlighting results of IGCP projects. **$Aust. 70,000 with another $50,000 due in late 2016** for the exhibition to continue until July 2017. A further **$15,000** income gained from the Bathurst exhibition, and a significant part of this funding used to underwrite field work of students.

c. ***20 November – 5 December 2015.*** **Timor-Leste (Dili, Aileu, Baucau).** Funded by a UNESCO grant for $US18,000 Timor-Leste's Long History & Geology Exhibition: School Visits Program provided professional development for primary and secondary teachers and training for the curators of the O Mundo Perdido Exhbitions established by the Monash Science Centre/PrimeSCI! in the capital Dili in the UNESCO Headquarters, in the Public Library in the highland town of Aileu (a joint project with the Moreland City Council VLGA) and at the Don Bosco Catholic Centre in Baucau. Also presented at the SESIM teacher network in science education for the country districts of Timor, funded by another UNESCO grant of $25,940 and managed by the UNESCO Office in Timor. Research that was carried out by IGCP 587 participants was on show in these exhibitions.

9. Attach any information you may consider relevant (See Attached Documents)