

IGCP PROJECT (2003-2007)

PROJECT: IGCP493 (Updated 3 March 2008)

THE RISE AND FALL OF THE VENDIAN BIOTA (EDIACARAN PERIOD)

<http://www.earth.monash.edu.au/PreCsite/index.html>

1. DISCIPLINE

1 (Stratigraphy, sedimentology, palaeontology, fossil fuels).

Related to **3** (Mineral deposits, petrology, volcanology, geochemistry).

2. SHORT TITLE OF PROJECT

THE RISE AND FALL OF THE VENDIAN BIOTA (Ediacaran Period)

3. FULL TITLE OF PROJECT

THE RISE AND FALL OF THE VENDIAN BIOTA: PALAEOENVIRONMENTAL, PALAEOCLIMATIC AND PLATE TECTONIC CONTROLS ON THE PRESERVATION AND BIODIVERSITY OF THE VENDIAN BIOTA WITH A COMPARISON OF GONDWANA AND NORTHERN ASSEMBLAGES

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6. SCALE OF THE PROJECT

Global

7. BRIEF OUTLINE OF PROJECT (RESUME)

As so eloquently pointed out in the introduction to IGCP Project 478, the Proterozoic and early Phanerozoic, especially “the Neoproterozoic-Early Palaeozoic saw the occurrence of some of the most significant events in Earth history” which included a glaciation on a global scale, dramatic changes in the composition of oceans and atmosphere, marked changes in continental configuration and, from the point of view of this IGCP proposal, the appearance and great increase in biodiversity of metazoans culminating in the appearance of a variety of hard tissue skeletons that marks the end of the Proterozoic and beginning of the Phanerozoic.

This project, which is intimately linked with IGCP 478 and IGCP512, is particularly interested in the precise timing of Proterozoic events, the effects that these changing environments, climates, global chemistry and palaeogeography had on the development and diversification of animals, culminating in the spectacular Eciacaran/Vendian faunas, best represented along the Winter Coast of the White Sea in Russia, the Flinders Range of South Australia, the deserts of southern Namibia and the coastal outcrops of Newfoundland.

This project aims to locate additional material from areas with a sparse Ediacaran biotic record (South America in particular), but with marked palaeobiogeographic interest, to closely compare their settings (sedimentology, carbon and oxygen isotope signatures, palaeogeographic positions) with those of the best known Ediacaran biotas. This project aims to allow the proposers and associates to gain further experience (and stimulate further discussion and joint research) with those less biodiverse assemblages in Namibia, as well as

classic sites in the Ukraine, Siberia, the Urals. - and with other older assemblages such as those in the Bangamall Basin of Western Australia and the Western United States, where some of the oldest probable records of multicellular organisms have been reported. In doing so, the proposers wish to bring together researchers from many disciplines to examine and gain experience with the Ediacaran assemblages worldwide, to involve students and non-scientists, in particular artists, in the hope of markedly increasing the amount of material from some of the lesser known locales and refining the dating of all of these locales – so to understand the sequence of biotic events during the Neoproterozoic and their drivers.

Parallel to our investigations concerning the megascopic multicellular and microscopic biota, the work of several associates of this proposal (Beresford, Bierlein, Cartwright, Cas, Schaefer, Wilde) will be investigating the geochemistry of the sediments for clues to changing climate and ocean chemistry and the involvement of microfauna in the deposition of major ore bodies of mid to late Proterozoic age (see attached Proposal (Item 17) *Geochemical Impoverishment of the Biosphere and the rise of Complex Life*).

8. ESTIMATED DURATION OF PROJECT

5 years

9. TENTATIVE WORK SCHEDULE AND RESULTS EITHER ACHIEVED OR EXPECTED

Year 1. (2003) Australia, Russia and Southern Africa

(original schedule, but see Annual Report for 2003)

- ☛ **Field workshop** on White Sea, Winter Coast and Souz'ma, Summer Coast, Russia field guide prepared.
- ☛ **Fieldtrip** to significant Australian locales (Flinders Ranges, South Australia and Macdonnell Ranges of the Northern Territory) examining sedimentology, biostratigraphy, taphonomy of multicellular eucaryote assemblages. Field guide prepared.
- ☛ Detailed **photography of locales and stratigraphy**. Met with local community groups to plan how public outreach centers, educational material could be prepared concerning the Precambrian sequence in the Flinders. Discussed and proceeded with plans to study new material available from the Flinders sequence and to open up a quarry in the Cambrian in cooperation with the South Australian Museum.
- ☛ Determination of **student projects** that can be offered to Ph.D. candidates in 2004.

- ☞ **Field trip** to Namibia jointly with IGCP478 in Cape Town, presented papers at Geosciences Africa conference in Johannesburg, South Africa meeting with primary and secondary education staff at Monash University Africa, Johannesburg campus to plan education kits on the Precambrian sequence for pre-Tertiary students. In cooperation with IGCP478. Visit to Namibian Geological Survey in Windhoek (Dr Gabi Schneider, K.-H. Hoffmann).
- ☞ **Preliminary report** on comparisons between the two most biodiverse Ediacaran assemblages (Flinders Ranges and White Sea) and determination of detailed projects to be undertaken over the next 4 years.
- ☞ Begin collaborative work on **popular book** describing biotas of the Precambrian as well as **touring exhibition**, the book due for submission in 2004 (see attached outline), the exhibition to be launched in 2005 in cooperation with the Monash Science Centre (Melbourne), the Queen Victoria Museum (Launceston, Tasmania) the South Australian Museum (Adelaide), and the Paleontological Institute (Moscow).
- ☞ Set up **website** for IGCP493 (<http://www.earth.monash.edu.au/PreCsite/index.html>)

Year 2. (2004). South America, Namibia, North America and Australia

(original schedule, but see annual report for 2004)

- ☞ **Reconnaissance trip** to the Puncoviscana Formation in Argentina with Drs. Guillermo and Florencio Acenolaza (Universidad de Tucuman, Tucuman) and to late Neoproterozoic rocks in Rio Negro Province.
- ☞ Continued **writing a highly illustrated popular book** on the origin and early evolution of life and the first animals, emphasizing the Ediacaran assemblages, within a setting of changing environments, climate and continental arrangements (book proposal and outline accepted by John Hopkins Press). Contracted as of Dec. 2004 with delivery date of manuscript now late 2005). Publications grant successful with Monash University Publications Committee to assist with colour work..
- ☞ **Description and publication** of any new material that results from investigative work in Russia, Australia and Namibia.
- ☞ **Research program** at Smithsonian Institution (March-April) to confer with E. Yochelson on 1.4 million year old metazoan remains from North America and Australia, visit to National Geographic Society to discuss **grant possibilities**.
- ☞ With Geological Survey of Namibia **prospect** Nama Formation in Namibia to try to increase both sites and biodiversity of this important, but low

biodiversity Ediacara fauna. Set up programs that will involve **student projects** of Namibian students.

- ☛ Investigate the possibility of **opening up Cambrian Burgess Shale-like faunal quarry** on Kangaroo Island, South Australia in cooperation with Monash Science Centre (Monash University) and the South Australian Museum. This will be both a source of research and provide material for Precambrian exhibition, illustrating post-Ediacaran radiation of metazoans.
- ☛ Attend **International Geological Congress** and present papers. Hold 2-day **workshop of IGCP493** at Prato campus of Monash University, Prato. Define student projects as joint work between Monash University, South Australian Museum and the Paleontological Institute, Russian Academy of Sciences, Moscow. Publication of papers resulting from this workshop to be published by the Geological Society of London as a Special Paper – publication expected in 2006 (Editors: Patricia Vickers-Rich and Patricia Komarower).
- ☛ Develop **undergraduate course** that deals with Precambrian biostratigraphy, global events, palaeoecology and the development of complex life that can be taught both in Australia and Russia and can be used as a shortcourse, emphasizing the events and biota of the Ediacaran/Vendian time period. Topic already incorporated in to School of Earth Science curriculum as part of ESC2032/ESC3232 undergraduate courses.
- ☛ Set up a number of **student projects** involving Australian, Russian and Namibian graduate students on cooperative projects dealing especially with metazoans, acritarchs and stratigraphy of critical sites..
- ☛ Present papers at **scientific conferences** in Russia (St Petersburg, Moscow – celebration meetings for the 90th birthday of B. S. Sokolov), the Origin of Animals Symposium (at UCLA, Los Angeles) organized by B. Schopf and Geoscience Africa in Johannesburg. Give a series of popular lectures in Namibia, South Africa, Australia and the United States.

Year 3. (2005) Russia, Australia, Japan, Canada

- ☛ Secure funding and construct **new storage cabinets** (50) from private donations, then organize and **curate the Vendian and Tommotian collections** at the Paleontological Institute of the Russian Academy of Sciences, Moscow. Employ, in part, students to carry out the curation.
- ☛ **Organize and catalogue the Boris Sokolov library** at the Paleontological Institute, RAS, Moscow using private donations and student curators.

- Completion by the end of 2005 of an **international exhibition** on the evolution of life in the Archean and Proterozoic, with an emphasis on the Neoproterozoic Vendian assemblages worldwide and the dramatic changes that occurred across the Neoproterozoic-Palaeozoic boundary. Exhibition will open first in Japan at the Fukui Prefectural Museum in western Honshu during July 2006 and other venues are being sought at the end of that show in October of 2006.
- Field excursions** in the White Sea of Russia to provide detailed sedimentological analysis of the Vendian/Ediacaran-bearing rocks. Further investigation of the possibilities of gaining lengthy well cores for microfossil analysis by labs in Russia, Western Australia and Sweden.
- Field expedition** to the Central Urals and preliminary discussions for further work in the Ukraine.
- As part of the North American Paleontological Convention held at Dalhousie University, Halifax Nova, Scotia from 19-26 June 2005, IGCP 493 and the Ediacaran Subcommittee ran a symposium entitled: **Ediacaran Paleobiology: Paleontological, Molecular, Embryological, and Ecological Constraints** chaired by Jim Gehling and Guy Narbonne, at which 16 papers were presented.
- Development of **educational and outreach programs** including two public symposia in conjunction with Dr. Terufumi Ohno at the Kyoto University Museum. (P. Vickers-Rich to be in residence at the Kyoto University Museum, Japan for 3 months for this project). Workshop to discuss the Asian record of Late Proterozoic biota in Kyoto.
- Submission of final manuscript for **The Beginning of Animalia** to Johns Hopkins University Press, Washington by the end of 2005.
- Launch of **Australia Post stamps** on the Australian Ediacarans (titled Creatures of the Slime). This project was initiated in 2004 by Patricia Vickers-Rich and Kay Hamilton in 2004 and Melbourne reconstruction artist Peter Trusler was employed by Australia Post to render the art work for 6 stamps and accompanying educational material. A childrens` book was written in consultation with Gehling, Fedonkin and Vickers-Rich and a school`s guide was prepared by Kathleen Smith, both of the Monash Science Centre. Stamps were launched in April 2005 at the Pacific Explorer stamp expo in Sydney with over 100,000 people attending over a 4 day period. Art work will be available for use in exhibition and later research and outreach publications.
- Opening of the second stage of the **Origin Energy Ediacaran Gallery** at the South Australian Museum, Adelaide.

- ☞ Opening of a **preliminary exhibition** of Beyond the Edge at the Monash Science Centre in Melbourne.
- ☞ The Premier of South Australia, the Hon. Mike Rann, **opened the Global Stratotype Section and Point** marking the base of the recently announced Ediacaran Period on April 16, 2005. It represents the first step in a formalized subdivision of the Proterozoic Eon in the Global Time Scale. The **Ediacaran GSSP** is positioned at the base of the Nuccaleena Formation in Enorama Creek, near the Brachina Gorge Geological Trail, in the Flinders Ranges National Park, South Australia. The event, which was arranged by the South Australian Museum as part of its **Out of the Glass Case** program to take the museum to the regions of South Australia, was attended by a broad cross-section of geologists from universities, government departments, Geoscience Australia, the mineral and fossil-fuel industry, together with South Australian Government ministers and heads of departments for Minerals and Energy in Primary Industries and Resources, South Australia, Environment and Heritage, and the South Australian Tourism Commission. Interpretive signage was funded by Primary Industries and Resources, South Australia.
- ☞ Several members of IGCP493 too part in the **World Summit on Evolution** sponsored by the National Science Foundation and the Universidad San Francisco de Quito, on San Christobol, Galapagos presenting papers on “Evolution in the Archean” and serving as commentator on “Recent Evolution in the Phanerozoic Eon.” One of the co-leaders of IGCP493 is on the editorial board of the University of Chicago Press proceedings volume for that conference and art work generated by IGCP493 artist Peter Trusler will form a part of that publication.

Year 4. (2006) Australia, Russia, Japan, China, Switzerland and Argentina

- ☞ **Field visits** to locales in Australia and Russia with postgraduate students to supervise projects begun earlier in IGCP program; trips also to familiarize researchers with collections and field contexts.
- ☞ **Attend Fourth annual meeting of IGCP Project 478** begin prospecting for metazoans in areas and sequences visited by this group in South America.
- ☞ **Launch traveling exhibition** at the Fukui Prefectural Dinosaur Museum in July, add new specimens that result from field efforts and develop further educational kits that are up to date with new information gained during duration of this IGCP Project. A public and research symposium will be held coincident with this opening as will the launch of a number of “commercial products” with educational tags that will generate funding for research.
- ☞ **Symposium** in Japan (Kyoto University Museum and the Seto Marine Biological Laboratory, Japan) for IGCP 493 (see notice under meetings – The Elujsive

Ediacarans – Where Did They Come From and Where Did They Go?) from 28 to 31 January. Two public symposia will be held, one for teachers and students and a second for the general public. These outreach lectures will be for disseminating the results of IGCP493 and will involve a number of the participants in this project, who will also contribute to the research symposium.

- ☞ During March-April staff and students from the Paleontological Institute, Moscow will be **in residence** at Monash University to collaborate on research, prepare for the traveling exhibition on the Ediacara fauna to open in Japan July, 2006) and to visit the collections of the South Australian Ediacaran collections and visit the Flinders Ranges.
- ☞ During May and June a **joint exploration program** will be carried out in the Nama Group of Namibia by the Geological Survey of Namibia, Monash University and the Paleontological Institute of the Russian Academy of Sciences, and ongoing program began in 2003. Leaders are K.H. Hoffmann, Patricia Vickers-Rich and Mikhail Fedonkin.
- ☞ During July there will be **joint participation in both the 2nd annual meeting of IGCP512** at the “Snowball Earth” symposium in Acsona Switzerland and both the South China field workshop organized by Zhu Maoyan as well as with the International Commission for Stratigraphy Ediacaran Subcommittee Symposium in China organized by Gehling, Xiao and Sheilds, held at the International Palaeontological Congress in Beijing, China.
- ☞ During May and June of 2006 a **joint exploration program** will be carried out in the Nama Group of Namibia by the Geological Survey of Namibia, Monash University and the Paleontological Institute of the Russian Academy of Sciences, and ongoing program began in 2003. Leaders are K.H. Hoffmann, Patricia Vickers-Rich and Mikhail Fedonkin. Staff and students from all of these institutions will also be involved.

Year 5. (2007) Russia (White Sea and Moscow), Taiwan, Japan

- ☞ Submit **general article to World of Science, UNESCO**, to summarize current research on Ediacaran biotas; other **popular articles** to be submitted.
- ☞ **Conference** to summarize results of IGCP493 project in Moscow, Paleontological Institute. Presentation of post-graduate results at Moscow conference. **Field trip guide** to the Zimmie Gory, White Sea, northern Russia locales and **conference proceedings** produced for this meeting.
- ☞ Fieldtrip guidebook published on the Mistaken Point Fossils of Newfoundland, Canada.

- ☛ Begin planning for a **production of a documentary** of field work and results, which will have been video taped during the full five years of the IGCP programme. An Australian/German production company has expressed strong interest an expression of interest has been submitted for filming during Year of Planet Earth. The Monash University Multimedia Unit (Melbourne) has expressed strong interest and has the capacity to produce a CD-Rom/DVD presentation will also be available from 2006 onwards.
- ☛ Launch the Wildlife **Wildlife of Gondwana Exhibition**, which showcases material collected by expeditions associated with IGCP493. Supported by an Australian Federal Visions grant and launched at the National Museum of Natural Sciences in Taiwan.
- ☛ Conference presentations and public lectures provided by members of IGCP493: Russia (Moscow), Greece, Japan, South Korea, Singapore, Newfoundland and other venues in Canada, USA, China, Australia, UK, Iraq, Egypt, etc.
- ☛ IGCP493 extended for another year through 2008, with no funding (OET – on extended terms). Planning for Symposium at the IGC in Oslo, schedule for August 2008.

11. RESULTS EXPECTED OF PROJECT.

For most years, a detailed field guide will be produced with description of the geological situation, the biostratigraphic controls, a systematic description and discussion of the biota, and the sedimentology /taphonomy of each of these areas with Ediacaran sequences (2003-2004, the Flinders Ranges of Australia; 2005, the Avalon sequence in Newfoundland; 2006, expected for Namibia; 2007, expected for the White Sea, Russia.

In addition to this carbon and oxygen isotope studies will be carried out and appropriate sediments will be analyzed for microfossil content, with emphasis on acritarchs. Studies by researchers involved in this project will not be restricted to the Ediacaran but to other time periods of the Proterozoic, investigating especially the climatic changes occurring between the major glaciation just prior to the Ediacaran; and the possible effects this may have had on nurturing the development of Vendian faunas (**theoretical sciences**). Other researchers in this project will be investigating the relationship between major ore deposits and biotic instigators, with an eye towards future mineral exploration techniques (**applied sciences and technology**)

In parallel with the scientific publications (which also will include description and analysis of any new material discovered), a popular book and a traveling exhibition will be completed (**benefit to society**). The first edition of the book should be available in 2006 or early 2007 and this will be updated as new material is found. This book, which is being published by Johns Hopkins Press, Washington) will accompany an exhibition entitled *Beyond the Edge: The Beginning of Animalia* along with a detailed, bilingual catalogue. The

exhibition is scheduled to premier at the Fukui Prefectural Dinosaur Museum in western Honshu on the 18th of July 2006 and several other institutions have expressed interest in hosting it. The exhibition is a joint venture between the Monash Science Centre (Australia), the Paleontological Institute (Moscow, Russia) the South Australian Museum (Adelaide, South Australia, Australia), the Western Australian Museum (Perth) and the Kyoto University Museum (Kyoto). As more material is added (particularly that from South America), the exhibition will be enhanced and expand. The institutions involved have a commendable reputation in touring international exhibitions and have worked together in the past.

Finally, a conference summarizing the results of this project and to which a wide variety of scientists working on Precambrian sequences globally will be invited, will be held in 2007 at the Paleontological Institute, Russian Academy of Sciences, in Moscow. This conference will not only produce a conference publication but will provide a forum for a number of researchers and research students from Gondwana to meet and discuss common issues with research colleagues from Northern Hemisphere countries. The conference will also officially launch the newly curated and housed collections at the PIN and the data base accompanying this.

Thus, there will be results in the theoretical and applied sciences and exchange of ideas as well as a community outreach program with the publication of a highly illustrated and non-technically written book by Fedonkin, Vickers-Rich, Gehling and Grey and a traveling exhibition (with a duration of 2-3 years). The traveling exhibition will be enhanced by a catalogue, teaching modules for schools and the general public, public lectures by experts (Fedonkin, Gehling, etc.), media exposure – with the message of using events of the past to assess the future.

12. THE FOLLOWING SEQUENTIAL RESULTS ARE EXPECTED

(original proposal, not updated for 2003-2004 results)

2003

- Field guide to White Sea (Russia) and Flinders Range (Australia) Ediacaran/Vendian sites and biotas (**academic publication**)
- Preliminary manuscript on popular book on Precambrian life, environments, climate, continental reconstructions, and history of work on Precambrian biotas.
- Determination of a number of student projects to begin in 2004, supervised by proposers
- Set up Website on IGCP493

2004

- Field Guide to Australian and Russian sites producing Ediacaran biotas; summary of entire Precambrian biotas for both continents (**academic publication**)
- Publication of scientific papers on any new finds during field work

from 2003-2004 (**academic publications**)

- Preparation for submission of popular book (highly illustrated) on Precambrian life – with emphasis on Ediacaran biotas (**popular publication**)
- Preparation of major exhibition on Precambrian life, emphasizing Ediacaran and early Phanerozoic biotas (**traveling popular exhibition**)
- Publication of high quality catalogue and teaching modules to accompany exhibition (**popular publication**)
- Preparation of Abstract volume for Prato (Italy) Workshop: *Abstract Volume for the Workshop Meeting 2 of IGCP493 (UNESCO). The Rise and Fall of the Vendian Biota*, Monash University, Melbourne: 111pp.

2005

- Update on Australian field guide (**academic publication**)
- Symposium volume on Ediacaran biotas of the World (academic publication) based on symposium at Kyoto University (late 2005 or early 2006)
- Presentation of results of student projects as poster and oral papers at Kyoto symposium.
- Begin work on documentary covering the field excursions to all sites visited by staff taking part in this IGCP – examining work on the biotas of the Precambrian. The Australian ABC Catalyst Programme has expressed interest as well as the National Geographic Channel. Filming will be carried out from 2003 onwards.
- Preparation of popular article to National Geographic Magazine (which has shown interest; Fedonkin and Vickers-Rich are long term Research Committee grantees) (**popular publication**)

2006

- Open and manage traveling exhibition and use as a forum for public lectures and education programmes in all areas visited
- Publication of student project results in international journals (**academic publication**)
- Publication of new material discovered on field visits (**academic publication**)

2007

- Major publication of results from work in all Ediacaran sites on global scale and summary of Ediacaran biotas (**academic publication: The Rise of Animals: Evolution and Diversification of the Kingdom Animalia, Johns Hopkins University Press, Washington**)
- Summary symposium on Ediacaran biotas and Precambrian life at Monash University campus in Prato – Abstracts and full publication of papers presented. Submitted as possible complete volume of Precambrian Research (**academic publication: The Rise and Fall of the Ediacaran Biota, Geological Society of London,**

Special Publication 286)

- Continue work on documentary
- Publish **proceedings of the IGCP493 symposium** at the Geological Institute in Moscow along with **field trip guide** to field trip run in association with this symposium
- Open a second **exhibition** that features the specimens and research results of IGCP493 – first two venues in Taiwan and in 2008 a tour of Australian museums organized.

12. THE PRESENT STATE OF ACTIVITIES IN THIS FIELD

(state of the art when original proposal was submitted in 2002, not updated for 2003-2004)

Studies of Precambrian biotas have been a hot topic in scientific journals over the past two decades and are a topic popular with the general public. The scientific literature is vast, and the reference list accompanying this section gives some idea of the breadth of discussion on this topic. Much of the discussion has centered around the origin and early evolution of life extensively covered in such summary compendia as Schopf and Klein (1992) and almost weekly articles in such journals as Science and Nature or other international journals (e.g. Whitfield, 5 Dec. 2002; Martin and Russell, 2002). There is also a growing literature on the later stages of evolution of multicellular eucaryotes (see summary references attached). This field is in a rapid state of expansion and discovery. What is currently missing, however, is a thorough summary of the biodiversity of this later record (in particular the Vendian biota) and a comprehensive summary of the geological context of that biota on a world scale. This kind of understanding and subsequent summary publications involve the cooperation of a number of geoscientists with a variety of skills in palaeontology, geochemistry, tectonics, sedimentology, taphonomy amongst other specialties and that is what this IGCP project is about. This project proposal is closely related to IGCP 478 and both gains from and contributes to activities undertaken in that project (and others that relate to that project as outlined in the IGCP 478 proposal document that has been generously made available to our group by Dr Claudio Gaucher, Departamento de Paleontología, INGEPA, Facultad de Ciencias, Iguá, Uruguay).

This IGCP project proposed could help remedy that lack and bring about productive interaction and enhancement of other current IGCP projects, from many angles – academic, applied and in particular popularizing in many forms all of these projects to a very broad audience in addition to generating significant basic research and outcomes related to exploration geology.

NOTE: Since this project was proposed the following are a few of the excellent references which have appeared that are helping fill the gaps in knowledge of the Neoproterozoic and its biota:

Clapham, M. E., Narbonne, G. and Gehling, J. G., 2003. Paleocology of the oldest known animals communities: Ediacaran assemblages at Mistaken Point, Newfoundland, *Paleobiology*, 29: 527-544.

Eriksson, P.G., Alterman, W., Nelson, D. R., Mueller, W. U. and Cantuneanu, O., 2004. The Precambrian Earth: Tempos and Events. *Developments in Precambrian Geology*, 12, Elsevier.

Gradstein, F., Ogg, J. and Smith, A., eds., 2004. *A Geologic Time Scale*. Cambridge.

Grey, K., 2005. Ediacaran Palynology of Australia. *Memoirs of the Association of Australasian Palaeontologists*, 31: 1-439.

Narbonne, G., 2005. The Ediacara Biota: Neoproterozoic origin of Animals and their Ecosystems. *Annual Review of Earth and Planetary Sciences*, 33: 421-442.

Seckbach, J., ed., 2004. *Origins. Genesis. Evolution and Diversity of Life*. Kluwer Publications.

Valentine, J. W., 2004. *On the Origin of Phyla*. University of Chicago Press.

EXEMPLARY REFERENCES

(original proposal references, 2002)

Awramik, S.M. 1981. The pre-Phanerozoic biosphere - three billion years of crises and opportunities. In: Nitecki, M.H., editor. *Biotic Crises in Ecological and Evolutionary Time*. Academic Press, New York: 83-102.

Awramik, S.M. 1971. Precambrian columnar stromatolite diversity: reflection of metazoan appearance; *Science*, 174: 825-827.

Ayala F. J. and Rzhetsky A. 1998. Origin of the metazoan phyla: Molecular clocks confirm paleontological estimates. *Proc. Natl. Acad. Sci. U. S. A* , 95 (2): 606-611, January 20, 1998.

Bengtson, S. (ed.). *Early Life on Earth*. Nobel Symposium 84. Columbia University Press, New York.

Brasier M.D., Green O.R., Jephcoat A.P., Kleppe A.K., Van Kranendonk M.J., Lindsay J.F., Steele A., and Grassineau N.V. 2002. Questioning the evidence for Earth's oldest fossils. *Nature*, 416: 76-81.

Brasier M. D., and J. F. Lindsay 1998. A billion years of environmental stability and the emergence of eukaryotes: New data from northern Australia. *Geology*, 26 (6): 555-559.

Brito Neves, B.B., Campos Neto, M.S, and Fuck, R.A. 1999. From Rocinia to western Gondwana: An approach to the Brasilino Pan African Cycle and orogenic collage. *Episodes* 22 (3): 155-166.

Bromham L., Rambaut A., Fortey R., Cooper A., Penny D., 1998. Testing the Cambrian explosion hypothesis by using a molecular dating technique. *Proc. Natl. Acad. Sci. U. S. A.*, 95 (21): 12386-12389, October 13, 1998.

Brocks J. J. et al., 1999. Archean molecular fossils and the early rise of eukaryotes. *Science*, 285 (Aug. 13): 1033.

Buick, R. 2001. Life in the Archean. In: Briggs D.E.G. and Crowther P.R., eds. *Palaeobiology*: 13-21.

Canfield D.E. 1998. A new model for Proterozoic ocean chemistry. *Nature*, 3 Dec 98 396:450.

Canfield D.E. and Teske A. 1996. Late Proterozoic rise in atmospheric oxygen concentration inferred from phylogenetic and sulphur-isotope studies. *Nature*, 382: 127 – 132.

Carmichael, W.W. 1994. The toxins of the cyanobacteria. *Scientific American*, January: 78-86.

Chumakov N.M. 2001. General trend in climatic change on Earth during past 3 billion years. *Doklady Akademii Nauk*, 381 (5): 1-4. (in Russian and English).

Collins A.G., Lipps J.H., Valentine J.W. 2000. Modern mucociliary creeping trails and the body plans of Neoproterozoic trace-makers. *Paleobiology*, 26(1): 47-55.

Copper A. and Fortey R. 1998. Evolutionary explosions and the phylogenetic fuse. *TREE*, 13 (4): 151-156.

Crimes T.P. and Fedonkin M.A. 1994. Evolution and dispersal of deepsea traces. *Palaios*, 9 (1): 74-83.

Droser, M.L., Jensen, S., Dehling, J.G., Myrow, P.M and Naronne, G.M. 2002. Lowermost Cambrian ichnofabrics from the Chapel Island Formation, Newfoundland: Implications for Cambrian substrates. *Palaios* 17: 3-15.

Eerola, T.T 2001. Climate change at the Neoproterozoic-Cambrian transition. In: Zhuravlev, A.Y. and Riding, R. (eds.). *The Edology of the Cambrian radiation*. Columbia University Press, New York: 90-106.

Farmer, J.D. 1992. Grazing and bioturbation in modern microbial mats. In: Schopf J.W. and Klein C., eds. *The Proterozoic Biosphere. A Multidisciplinary Study*. Cambridge University Press, Cambridge: 295-297.

Fedonkin, M. A., 1966. Geobiological trends and events in the Precambrian biosphere. In: Walliser, O.H. (ed.). *Global events and event stratigraphy in the Phanerozoic: Results of the International Interdisciplinary cooperation in the IGCP- Project 216, Global Biological Events in Earth History*. Springer-Verlag, Berlin: 89-112.

Fedonkin, M.A. 1985. Precambrian metazoans: the problems of preservation, systematics and evolution. *Philosophical Transactions of the Royal Society, London* 311: 27-45.

Fedonkin, M.A., 1996. The oldest fossil animals in ecological perspective. In: Ghiselin, M.T. and Pinna, G. (eds.). *New perspectives on the history of life. Memoirs of the California Academy of Sciences*. 20: 31-45.

Fedonkin, M. A. and Waggoner, B. M., 1997. The Late Precambrian fossil *Kimberella* is a mollusk-like bilaterian organism. *Nature*, 388: 868-871.

Fedonkin M.A. and E.L. Yochelson, 2002. Middle Proterozoic (1.5 Ga) *Horodyskia moniliformis* Yochelson and Fedonkin, the Oldest Known Tissue Grade Colonial Eukaryote. *Smithsonian Contribution to Paleobiology*, 94, 29 pp.

Garrett, P. 1970. Deposit feeders limit development of stromatolites. *American Association of Petroleum Geologists Bulletin*, 54: 848.

- Garrett, P. 1970. Phanerozoic stromatolites: non competitive ecologic restriction by grazing and burrowing animals. *Science*, 169: 171-173.
- Gehling, J., G., 1999. The case for Ediacaran fossil roots to the metazoan tree. *Memoirs of the Geological Society of India*, 20: 181-223.
- Gehling, J. G., Harbonne, G.M. and Anderson, M.M. 2000. The first named Ediacaran body fossil: *Aspidella terranovica* Billings 1872. *Palaeontology* 43: 427-456.
- Germis, G.J.B., 1995. The Neoproterozoic of southwestern Africa, with emphasis on platform stratigraphy and paleontology. *Precambrian Research* 73: 137-151.
- Graxhdankin, D. V. and Bronnikov, A. A., 1997. New locality of the Late Vendian soft-bodied organisms remains on the Onega Peninsula. *Kolandy Ross. Akademy Nauka*, 357 (6): 792-796.
- Grey K., Williams I. R. 1990. Problematic bedding-plane markings from the Middle Proterozoic Manganese Subgroup, Bangemall Basin, Western Australia. *Precambrian Research*. 46: 307-327.
- Grotzinger J.P., Watters W.A., and Knoll A.H. 2000. Calcified metazoans in trombolite-stromatolite reefs of the terminal Proterozoic Nama Group, Namibia. *Paleobiology* 26(3): 334-359.
- Hagadorn, J. W. and Waggoner, B. 2000. Ediacaran fossils from the southwestern Great Basin, United States. *Journal of Paleontology* 74: 349-359.
- Han T.M. and Runnegar B. 1992. Megascopic eukaryotic algae from the 2.1-billion-year-old Negaunee Iron-Formation, Michigan. *Science*, 257: 232-235.
- Heckman D.C. et al., 2001. Molecular evidence of early colonization of land by fungi and plants. *Science*, 293: 1129-1133.
- Hoffman, P. F., Kaufman, A. J., Halverson, G. P., Schrag, D. P. 1998. A Neoproterozoic Snowball Earth. *Science* 281: 1342-1346
- Holland H.D. 1994. Early Proterozoic atmospheric change. In: *Early Life on Earth* (ed. S. Bengtson), pp. 237-244. Columbia University Press
- Horodyski, R.J. 1982. Problematic bedding-plane markings from the Middle Proterozoic Appekunni Argillite, Belt Supergroup, north-western Montana. *Journal of Paleontology*, 56: 882-889.
- Ivantsov, A. Y., 2000. *Vendia* and other Precambrian "Arthropods." *Paleontological Journal*, 35 (4): 335-343.
- Ivantsov, A. Y. and Fedonkin, M. A., 2002. Conulariid-like fossil from the Vendian (Russia): A metazoan clade across the Proterozoic/Palaeozoic Boundary. *Palaeontology*, 45 (6). In press.
- Jensen, S., Gehling, J.G. and Droser, M.L., 1998. Ediacaran-type fossils in Cambrian sediments. *Nature* 393: 567-569.
- Jenkins, R. J. F., 1992. Functional and ecological aspects of Ediacaran assemblages. In: Lipps, J.H., Signor, P.W., eds. *Origin and Early Evolution of the Metazoa*. Plenum Press, New York: 131-136.
- Kaufman, A. J., Knoll, A. H. and Narbonne, G.M., 1994. Isotopes, ice ages, and terminal Proterozoic earth history, *PNAS* 94: 6600-6605.
- Kennedy, M. J., et al. 1998. Two or four Neoproterozoic glaciations? *Geology* 26: 1059-1063.
- Kerr, R.A. 2002. Earliest signs of life just oddly shaped crud? *Science*, 295 (5561): 1812-1813.

- Knoll A.H. 1992. The early evolution of eukaryotes: a geological prospective. *Science*, 256: 622-627.
- Knoll A. H. 1994. Proterozoic and early Cambrian protists: evidence for accelerating evolutionary tempo. *Proc Natl Acad Sci U S A* 1994 Jul 19; 91(15):6743-6750.
- Lasaga A.C. and Ohmoto H. 2002. The oxygen geochemical cycle: dynamics and stability. *Geochimica and Cosmochimica Acta*, 66, (3): 361-381.
- Lipps, J. and Signor, P.W. (ed.). 1992. *Origin and Early Evolution of the metazoa*. Plenum Press, New York.
- Logan G.A., Hayes J.M., Hieshima G.B., and R.E. Summons. 1995. Terminal Proterozoic reorganization of biogeochemical cycles. *Nature*. 376: 53-56.
- Martin, M.W., Grahdankin, D.V., Bowring, S.A., Evans, D.A.D., Fedonkin, M.A. and Kirschvink, J.L. 2000. Age of Neoproterozoic bilaterian body and trace fossils, White Sea, Russia: implications for metazoan evolution. *Science* 288: 841-845.
- Martin, M.W. and Russell, M.J., 2002. On the origins of cells: a hypothesis for the evolutionary transitions from abiotic geochemistry to chemoautotrophic prokaryotes, and from prokaryotes to nucleated cells. *Philosophical Transactions of the Royal Society of London, B* (published on line).
- Narbonne, G.M. and Gehling, J.G. 2002 (in press). Life after Snowball: the oldest complex Ediacaran fossils. *Geology*.
- Narbonne, G.M, Saylor, B.Z. and Grotzinger, J.P. 1997. The youngest Ediacaran fossils from southern Africa. *Journal of Paleontology* 71: 953-967.
- Ohmoto H. 1997. When did the Earth's atmosphere become oxic? *Geochem. News* 93: 26-27.
- Porter S.M. and Knoll, A.H. 2000. Testate amoebae in the Neoproterozoic Era: evidence from vase-shaped microfossils in the Chuar Group, Grand Canyon. *Paleobiology*, 26 (3): 360-385. (742 Ma old, oldest morphological evidence of heterotrophy).
- Ramos, V.A. and Keppie, J.D. 1999. *Laurentia-Gondwana connections before Pangea*. Geological Society of America, Special Paper 336.
- Schopf, J.W. and Klein, C., 1992. *The Proterozoic Biosphere. A Multidisciplinary Study*. Cambridge University Press, New York.
- Schubert J.K. and D. J. Bottjer (1992). Early Triassic stromatolites as post-mass extinction disaster forms. *Geology*, 20: 883-886.
- Semikhatov M.A. and Raaben M.E. 1994. Dynamics of the global stromatolite diversity in the Proterozoic. Part 1. North Eurasia, China and India. *Stratigraphy. Geological Correlation*, 2 (6): 10-32.
- Semikhatov M.A. and Raaben M.E. 1994. Dynamics of the global stromatolite diversity in the Proterozoic. Part 2. Africa, Australia, North America, and general synthesis. *Stratigraphy. Geological Correlation*, 4, (1): 26-54.
- Sokolov, B.S. and Iwanowski, A.B. (eds.). *The Vendian System. 1. Paleontology*. Springer-Verlag, Berlin.
- Sun Weiguo, Wang Guixiang and Zhou Benhe. 1986. Macroscopic worm-like body fossils from the Upper Precambrian (900-700 Ma), Huainan district, Anhui, China and their stratigraphic and evolutionary significance. *Precambrian Research*, 31: 377-403.
- Vickers-Rich, P. and Rich, T. H., 1999. *Wildlife of Gondwana*. Indiana University Press, Bloomington, pp. 1-304.

- Vologdin, A.G. 1962. Oldest Algae of the USSR. Publishing House of the USSR Academy of Sciences, Moscow. (In Russian).
- Wade, M., 1968. Preservation of soft-bodied animals in Precambrian sandstones at Ediacara, South Australia. *Lethaia*, 1 (3): 238-267.
- Wade, M., 1972. *Dickinsonia*: Polychaete worms from the Late Precambrian Ediacara Fauna, South Australia. *Memoirs Queensland Museum*, 16 (2): 171-190.
- Waggoner, B. 1999. Biogeographic analyses of the Ediacara biota: a conflict with paleotectonic reconstructions. *Paleobiology* 25: 440-458.
- Walter 1994. Stromatolites: the main source of information on the evolution of the early benthos. In: Bengtson, S.(ed.). *Early Life on Earth*, Nobel Symposium 84, Columbia University Press, New York: 270-286.
- Walter, M.R. and Heys, G.R., 1985. Links between the rise of the Metazoa and the decline of the stromatolites; *Precambrian Research*, 29: 149-174.
- Wang, G.-X. 1982. Late Precambrian Annelida and Pogonophora from the Huanian of Anhui Province. *Bulletin of the Tianjin Institute of Geology and Mineral Resources*, 6: 9-22. (In Chinese).
- Whitfield, J., 2002. New theory for origin of life. *Nature*, on line. <http://www.nature.com/nsu/021202/021202-3.html>
- Wood, R. A., Grotzinger, J.P. and Dickson, J.A.D. 2002. Proterozoic modular biomineralized metazoan from the Nama Group, Namibia. *Science* 296: 872-875.
- Wood V. et al., 2002. The genome sequence of *Schizosaccharomyces pombe*. *Nature*, 415 (6874): 871-880.
- Wray G. A., Levinton J.S., Shapiro L.H. Precambrian divergences Among Metazoa. *Science*. 1996 274: 568-573.
- Yochelson, E.L. and Fedonkin, M. A., 2000, A new tissue-grade organism 1.5 billion years old from Montana. *Proceedings of the Biological Society of Washington*, 113: 843-847.

There is also a vast literature in Russian which will be incorporated into the IGCP project and published in English.

13. PARTICIPATION

See Item 4, above. More than 81 researchers and their research teams and students will be involved in this project. We plan to add more as the project expands in contact with each during the five years of field work and as student projects develop. The researchers include both those with long records of work in the Ediacaran as well as added new researchers who will bring novel expertise and skills. It will also serve as a forum to train new students, often from either less developed nations or from those in current Southern Hemisphere institutions, that because of financial constraints are unable to attend international symposia in the Northern Hemisphere.

14. LOCATION OF MAJOR FIELD ACTIVITIES

Winter Coast, White Sea, Russia; Siberia, the Ukraine, the Urals – all in Russia, the Flinders Range, South Australia, Australia. In addition, locales in Namibia, possibly Newfoundland, NW Argentina, Uruguay and Brazil and other regions of Australia

(Kangaroo Island, Bangamall Basin of Western Australia, the Macdonnell Ranges of the Northern Territory of Australia) as well as sites in Western North America will be visited to try to expand the known record and to increase understanding of the sedimentary environments preserving the Ediacaran faunas.

15. LOCATION OF MAJOR LABORATORY RESEARCH

School of Geosciences, Monash University, Melbourne, Victoria 3800, Australia;
Paleontological Institute, Russian Academy of Sciences, Moscow; Russia; South
Australian Museum, Adelaide, South Australia, Australia.

16 –17. ATTACHMENTS AND OTHER CONSIDERATIONS