National Rock Garden

Celebrating the Geological Heritage of Australia

Newsletter No. 21

June 2021

The National Rock Garden is proudly supported by the Geological Society of Australia and the Australian National University and the Minerals Council of Australia

www.nationalrockgarden.org.au

Exciting news: the NRG is going places!

Brad Pillans, Director, National Rock Garden

On Friday 4 June, after more than 12 months of behind-the-scenes negotiations, an agreement was signed with the ACT Government to relocate the NRG to a new site within the National Arboretum Canberra (NAC). The agreement was signed by Scott Saddler AM, Executive Branch Manager of the NAC, and myself, during a small ceremony at the NAC, and witnessed by Christine Callen (NAC) and Mike Smith (NRG).

After acknowledgement of the Ngunnawal traditional custodians, Scott Saddler, himself a proud Wiradjuri man, welcomed the NRG Directors (Michelle Cooper, Mike Smith, John Bain and myself) and representatives of STEP, the Southern Tablelands Ecosystem Park. STEP has a garden (Forest 20) adjacent to the proposed NRG site (Forest 13).

In his welcome speech, Scott Saddler, noted that the partnership between the two national organisations – the NAC and the NRG - “will build on the natural synergies between geology and biology, and provide an important link for increased visitor engagement. Diversifying storylines of geology and flora will help visitors to better understand that trees, soil, water and rocks are all essential and inter-dependent elements of the living world”, he said.

Forest 13, within the NAC, is about one hectare in area and is located on Forest Drive (the main access road in NAC), just 100 metres north of the NAC visitor centre and carparks. To complement the NRG display of large iconic rocks from around Australia, Weeping Wilga (Geijera parviflora) trees will be planted in an indigenous pattern in Forest 13, said Mr Saddler.

The National Arboretum Canberra attracts around 700,000 visitors annually, including more than 30,000 school students in facilitated programs. “It is a place for conservation, education, science research, recreation, reconciliation and tourism”, said Mr Saddler, goals that align very well with the aspirations of the National Rock Garden.

In my reply, I thanked Scott for his warm welcome and noted that while land plants have only been present for around 10% of the 4.6 billion years of Earth history, the proposed NRG rock displays will be able to tell the deep-time story of the NAC trees as part of the evolution of all life on Earth.

Brad Pillans (left) and Scott Saddler (right) before and after the signing of the agreement to relocate the NRG to the National Arboretum Canberra. Images courtesy M. Cooper.

Brad Pillans (left) and Scott Saddler (right) watch as Mike Smith (second from left) and Christine Callen (second from right) sign as witnesses to the agreement between the NRG and the National Arboretum Canberra. Image courtesy M. Cooper.

Over the coming months, NAC and NRG will work closely with Canberra-based landscape architects, Harris Hobbs Landscapes, to develop an exciting landscape design for Forest 13, with a view to moving the first rocks on site before Christmas. Forest 13 is only 1 km from our current site, and appears to be logistically straightforward, using cranes and trucks, but we shall see…

More on this in the next Newsletter!

Forest 13, the new home of the National Rock Garden at the National Arboretum Canberra. Image courtesy M. Cooper.

New donation enables selection & transportation of famous rock

Mike Smith, Director, National Rock Garden & Lance Black, Retired Geochronologist

A large financial contribution to the National Rock Garden is enabling the delivery of a large boulder of **Middledale Gabbroic Diorite** (see www.nationalrockgarden.com.au/rock-collection-2/featured-rocks/show/19) to the ACT later this year. The donors have watched the steady progress of the NRG Steering Committee over recent years, have attended a rock launch, and brought their grandchildren to the present display.

The first step, entailing the selection of an appropriate specimen, was completed in the second week of April this year. The authors visited the property near Temora which was identified in 1998 by Geoscience Australia (GA) as hosting a reliable rock source of isotopically undisturbed zircon crystals which are very important for geological research work.

The aim of this recent field trip was to meet with the property owners who had previously agreed to donate a large boulder from their land to the National Rock Garden. Our task was to measure the physical dimensions of a range of diorite boulders and to calculate their probable weight using the density of 2.79 gm/cc provided by GA staff for this rock. Numerous large boulders had been uplifted from the farm paddocks and pushed to the edges of the fields, making our job relatively easy.

Image of diorite boulders on the edge of field at Temora. Image courtesy M. Smith.

The selected NRG specimen is shown below, and has an estimated weight of the order of 7-8 tonnes. Once a smooth face has been polished, its crystal texture will be an attractive feature.

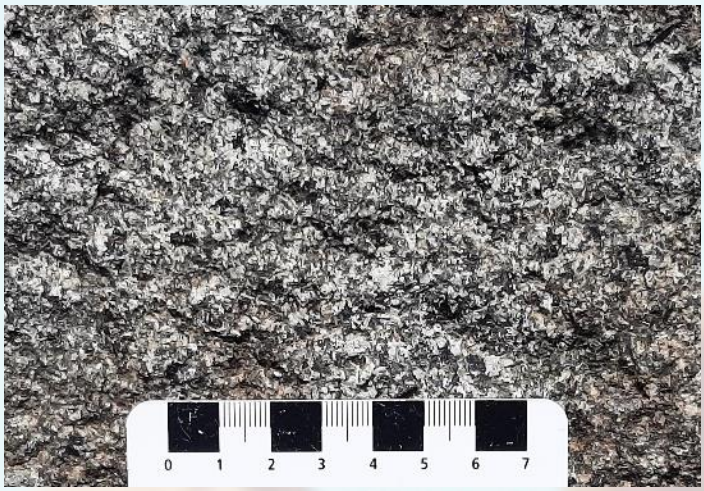
The specimen chosen for the NRG, with Lance Black providing scale. Image courtesy the authors.

The Middledale Gabbroic Diorite has been proven to be a source of zircon crystals that permit reliable U-Pb isotopic dating. Now known as geochronology standard TEMORA-2, the zircons have become an extremely important world-wide reference material for geological dating (read more on GA's website).

These zircons have been impervious to chemical interaction since the crystallisation of their host diorite 417 million years ago. In particular, the proportion of radioactive isotopes and daughter products is identical for all of the zircons, allowing the age measured for each crystal to be compared directly with the measured age of crystals whose age is not known.

One particular type of instrument that can undertakes these age comparisons is known as the SHRIMP, short for Sensitive High Resolution Ion Microprobe, designed, and built at the Australian National University for several decades. One of these instruments was installed at GA at the end of 2007. You can read a full description of the operation of the GA SHRIMP, and about the many complex geoscience issues that may be resolved by the use of the SHRIMP facility in AusGeo News and on the GA website.

The donation of funding for the uplift, transport and preparation of this large rock for display is another positive step in the development of the National Rock Garden in Canberra. The diorite is important from the perspective of the scientific use of rocks, in contrast to the more general use of rocks for large scale construction of buildings, for monuments and in sculpture.



The dominant minerals in the diorite are plagioclase, hornblende, pyroxene, ilmenite and haematite. Image courtesy M. Smith.

There are charnockite rocks in Sri Lanka!

Thusitha Nimalsiri, Geoscientist

During March, I was provided with a tour of the National Rock Garden's Federation Rocks by NRG director Mr Mike Smith. I found the large specimens to be very diverse, demonstrating a wide range of geological evolution from river sands to chemical sediments, volcanic lavas to crystalline igneous rocks, with polished faces being very effective in displaying the detailed texture of the mineral assemblages. The Federation Rocks, representing each of Australia's states and territories, are now complemented by three more igneous rocks, a tonalite, a microsyenite and a norite. These names might reinforce the common concept that geologists speak a strange language of their own. However, each of these newer rocks all have a good story: representing the pylons of the Sydney Harbour Bridge, the columns of Queen Victoria Building and beautiful sculptures and gravestones.

My first NRG specimen—the Moruya Tonalite. Image courtesy M. Smith.

I was a little surprised when Mike led me across a broad paddock, with the warning 'Watch out for snakes'. We traversed the long grass without incident and arrived at what was described as the storage area of the Rock Garden. There was a rather strange white rock and some vaguely familiar brown rocks.

The white rock was a rhyolite from Bulahdelah in NSW, a volcanic formation that had experienced severe invasion by hot fluids, which flooded the original volcanic material with a sulphate mineral called alunite.

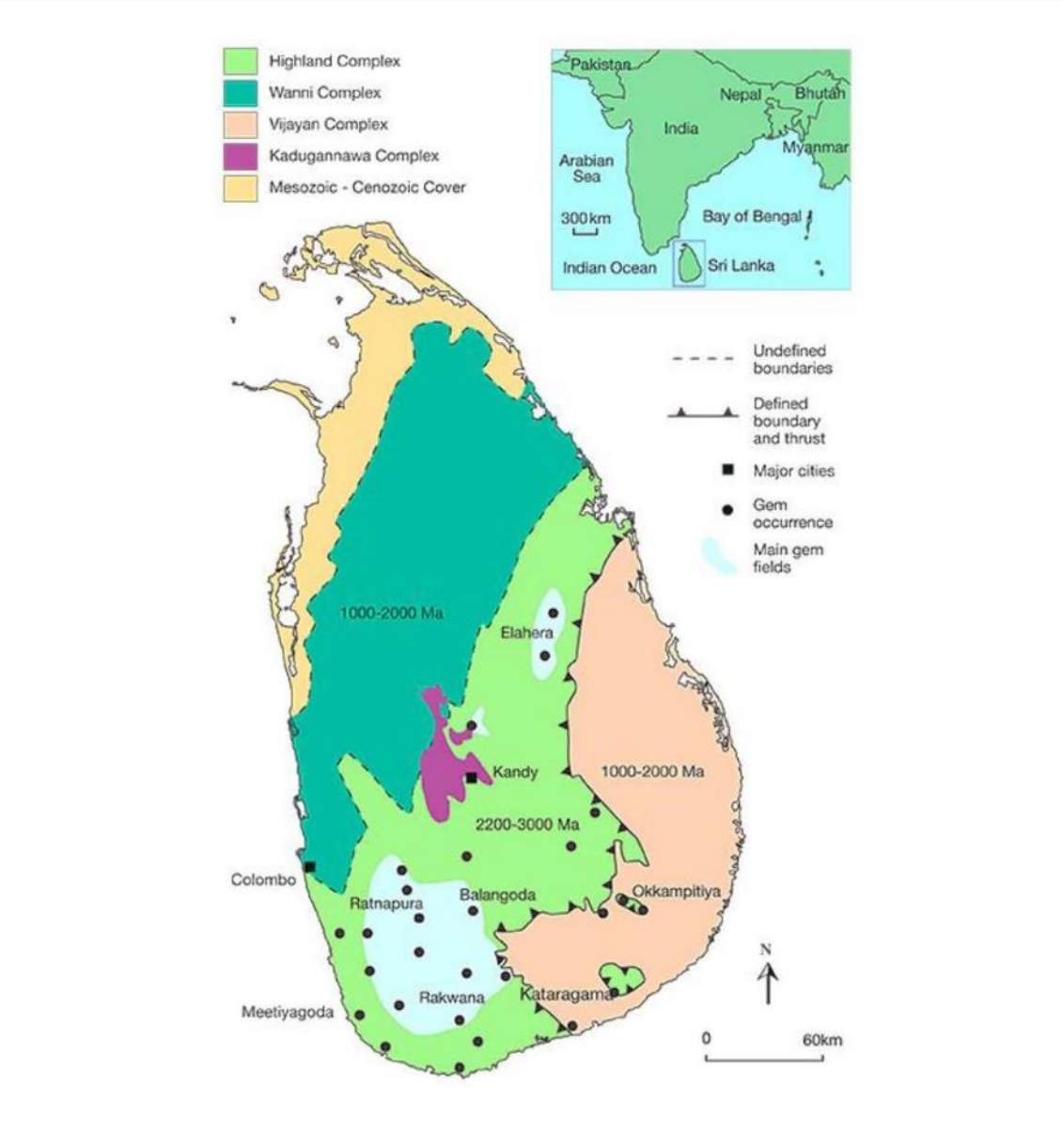
Mike was especially keen to praise the NRG's two brown rocks. He told me that these two six and seven tonne specimens are charnockite which we have brought to the Australian Capital Territory all the way from Antarctica! He said 'These rocks are very rare, so we are delighted to have them in the National Rock Garden'.

Thusitha Nimalsiri inspecting one of the two Mawson Charnockite blocks at the NRG storage site. Image courtesy M. Smith.

I said to Mike ‘I know this rock – it is very common in my home country of Sri Lanka, which has a basement made up of high-grade metamorphic rocks of Proterozoic age’.

Sri Lanka has a central spine called the Highland Complex, which is shown in light green in the geological map below. This elevated region is the largest unit of Sri Lanka and forms the backbone of the Precambrian rocks. In fact, more than 90% of the rock units found in Sri Lanka are crystalline metamorphic rocks of Precambrian age (Sumanarthna, 2020). These rocks have experienced high temperatures and high pressures resulting in part in the generation of charnockite rocks.

Panorama of charnockite gneiss in the Highland Complex of Sri Lanka. Image courtesy E. Lakmali.



Geological Map of Sri Lanka, showing the Highland Complex in light green. (From Sumanarathna, 2020.)

Readers may ask 'What is the relationship between the NRG charnockite rocks from Antarctica and my charnockite rocks in Sri Lanka?' and that is an excellent question, which takes us to the story of Gondwana.

Gondwana was a supercontinent that existed from the Neoproterozoic Era (more than 540 million years ago) which contained portions of the land areas we are familiar with today as Antarctica, Australia, India (plus Sri Lanka), Africa, and South America. It was formed by the accretion (joining together) of several cratons (old and stable parts of Earth's two topmost layers, the crust and the uppermost mantle.). Eventually, Gondwana became the largest piece of continental crust of the Paleozoic Era, covering an area of about 100,000,000 km2 about one-fifth of the Earth's surface.

A useful depiction of a reconstruction of Antarctica, India, Sri Lanka and Madagascar at approximately 240 million years ago is presented in Figure 8 of the technical paper by Ratheesh-Kumar et al (2020).

Outcrop of massive charnockite in the Highland Complex of Sri Lanka. Image courtesy E. Lakmali.

The break-up of Gondwana initiated at about 180 million years ago (during the Jurassic Period) when the western half of Gondwana (Africa and South America) separated from the eastern half (Madagascar, India, Australia, and Antarctica). The South Atlantic Ocean opened about 140 million years ago as Africa separated from South America. Geologic research has demonstrated that examples of spectacular occurrences of charnockite occur in crustal segments of East Gondwana (comprising India, Sri Lanka and Antarctica). The available geochronologic (geological dating) studies indicate multiple events of charnockite formation at ~2500, 1000, and 500 Ma in these crustal domains. All of these times of charnockite formation are before the breakup of Gondwana (starting at 180Ma).

This means that the occurrences of charnockite in Sri Lanka and Antarctica, though vastly separated now, were once part of the same geological terrain, and that they were actually joined up as large swathes of similar rocks.

About the Author

Thusitha Nimalsiri completed a B.Sc. degree in Geology at the University of Peradeniya, in his home country of Sri Lanka, where he also received a M.Phil. degree from the University of Peradeniya. The awarding of an International Research Scholarship enabled Thusitha to undertake a PhD program at Macquarie University during December 2016 to December 2019. He is currently employed in geotechnical engineering, based in Bathurst NSW.

References

Ratheesh-Kumar, R. T., Dharmapriya, P. L., Windley, B. F., Xiao, W. J., & Jeevan, U. (2020). The tectonic "umbilical cord" linking India and Sri Lanka and the tale of their failed rift. Journal of Geophysical Research: Solid Earth, 125, e2019JB018225. https://doi.org/10.1029/2019JB018225

Sumanarathna, A. R., 2020. Geology of Sri Lanka. https://www.researchgate.net/profile/Aravinda-Sumanarathna/publication/340226752_Geology_of_Sri_Lanka/links/5e7de49692851caef4a22728/Geology-of-Sri-Lanka.pdf

For more about the Gondwana connection between Sri Lanka, Antarctica, Madagascar and India, all having charnockites related to the same tectonic event, see these papers:

Leo M. Kriegsman, L. M. (1995). The Pan-African event in East Antarctica: a view from Sri Lanka and the Mozambique Belt. Precambrian Research, 75(3–4), 263-277. https://doi.org/10.1016/0301-9268(95)80010-F

Yoshida, M., & Santosh, M. (1994). A tectonic perspective of incipient charnockites in East Gondwana. Precambrian Research, 66(1–4), 379-392. https://doi.org/10.1016/0301-9268(94)90059-0

Dissanayake, C., & Chandrajith, R. (1999). Sri Lanka—Madagascar Gondwana Linkage: Evidence for a Pan-African Mineral Belt. The Journal of Geology, 107(2), 223-235. https://doi.org/10.1086/314342

Eleven tonne block of Tarana Granite on the move towards the ACT

Mike Smith, Director, National Rock Garden

Our NRG Newsletter issue number 20 described six “Aspirational Rocks” which we are working on bringing to Canberra for the NRG during the next 6 to 18 months. Another rock which has always been a high priority for the Rock Garden is Tarana Granite. While we do not have the necessary approvals to place more rocks right now, we have been using temporary storage locations to commence the movement large rocks such as the Mawson Charnockite specimens last year. Our Tarana Granite specimen is another example.

The Carboniferous-age Tarana Granite is a pink, medium-grained granite, composed largely of quartz and feldspar with minor biotite. It is quite famous as the colourful lower half of the Sydney Opera House, as shown below.

Tarana Granite is the orange-coloured material of the lower walls of the Sydney Opera House. Image courtesy M. Smith.

Tarana Granite is an important monumental stone, including at the ANZAC Memorial in Hyde Park in Sydney. For many decades, Tarana granite was extracted, crushed and laid as the platform surface for all of the railway stations in NSW which did not have an asphalt seal.

The author in one of the quarries of Tarana Granite showing many cut blocks. Image courtesy M. Smith.

Central West geologists Max Rangott and Colin Bembrick assisted in the selection of potential blocks for the NRG. Ultimately a block which had been cut to the shape of a rectangular prism was chose. The block, calculated to weigh 11 tonnes, was uplifted by Southern Highlands contractor Kraneworx during late November 2020, as shown in the image below.

The NRG's block of Tarana Granite is loaded onto a truck for transportation. Image courtesy M. Smith

This specimen is currently being stored on a farm near Marulan, where it can be readily picked up and moved to the National Arboretum Canberra later this year.

The NRG's block in temporary storage with local stonemason quoting on display preparation. Image courtesy M. Smith.

If you have an idea for a newsletter story, or there is a rock that you would like to see featured in a future NRG newsletter, please let us know via email or Facebook.

Talking about time: The Geological Time Scale

Brad Pillans, Director, National Rock Garden

The Geological Time Scale (GTS) is one of the great achievements in the Earth Sciences. It represents the formal subdivision of the rock record of Earth's history into standardized global time units as an aid to international communication. The International Commission on Stratigraphy (ICS) is the organization responsible for maintaining and updating the time scale and latest updates can be downloaded from their website: www.stratigraphy.org. On the next page, the latest version of the time scale is reproduced with permission of ICS. The major time intervals (chronostratigraphic units) of the GTS are familiar to all geoscientists and many members of the general public—who hasn't heard of the Jurassic Period, for example, when dinosaurs ruled the world?

Principles of the GTS

Geologists use relative age terms such as 'Cretaceous' in the same way that historians use relative age terms such as 'Renaissance' or 'Ming Dynasty'. Indeed, until the advent of modern numerical dating methods, the GTS was a relative timescale, based on the stratigraphic principle of superposition (younger sedimentary rocks overlie older sedimentary rocks) and the evolutionary sequence of fossils.

However, geologists have long recognized that a term such as 'Cretaceous' can have two subtly different meanings:

1. as a chronostratigraphic or 'time-rock' unit (e.g. rocks of the Cretaceous System)
2. as a geochronologic unit or 'time' unit (e.g. the time interval of the Cretaceous Period).

Thus each chronostratigraphic unit of the GTS has an exactly equivalent geochronologic unit and we are taught to refer to Lower Cretaceous rocks, but Early Cretaceous time! In many ways, the dual time and time-rock nomenclature is confusing, but while there have been recent proposals to abandon it, that time (pardon the pun) has not yet come. Mostly you can ignore the two different meanings and simply say that a rock or fossil is 'Cretaceous', and leave it at that!

An ongoing goal of ICS, is that each chronostratigraphic and corresponding geochronologic unit of the GTS should be formally defined at its base by what is called a Global Stratotype Section and Point (GSSP), or Global Standard Stratigraphic Age (GSSA). More than 80% of the ~90 stage-level divisions of the Phanerozoic are defined by GSSP's, or "golden spikes", placed in carefully chosen rock exposures around the world to precisely mark agreed boundaries between rocks of different named units. Note that the GTS is a hierarchical classification, so that, for example, the GSSP for the base of the Paleocene Series/Epoch, is also the GSSP for the base of the Paleogene System/Period and the base of the Cenozoic Erathem/Era.

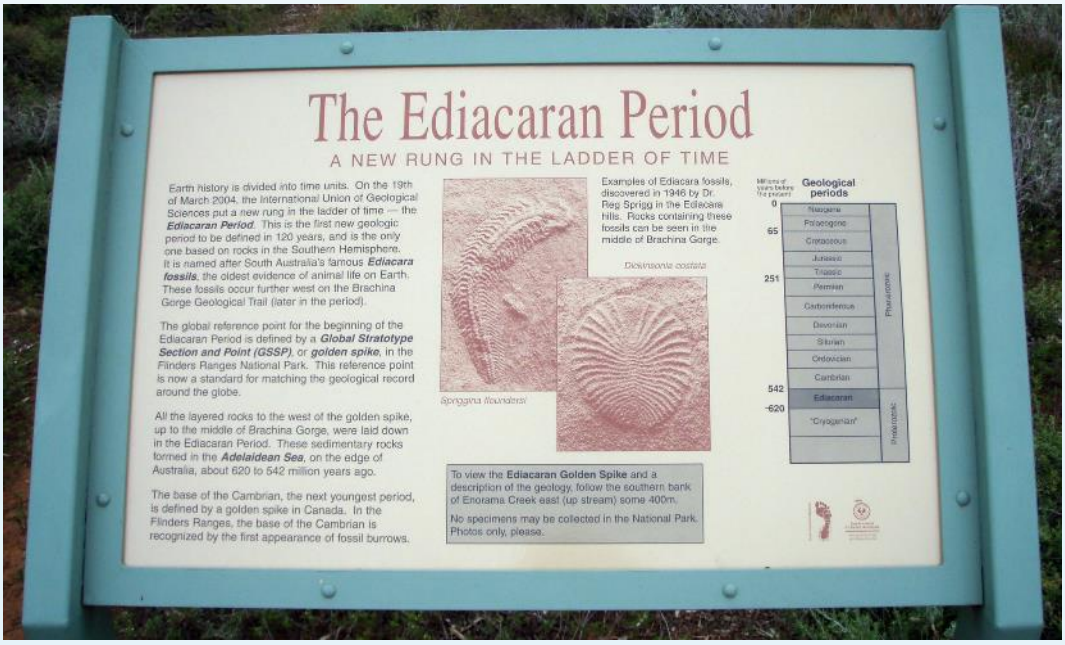
As well as assigning a rock or a fossil to one of the GTS intervals, it is also helpful to know how old it is in years and we give both on the plaques of our display rocks in the NRG. The science of dating rocks (geochronology) is improving all the time and numerical ages for all Phanerozoic chronostratigraphic units are continually being refined. The GSSPs don't generally change, once they are established, but the boundary ages themselves are not fixed in the same way as they are for GSSAs in the Precambrian.

Close-up view of the Ediacaran GSSP. The line on the small metal disc, which is parallel to the sedimentary layers in the outcrop, marks the precise boundary between the base of the Ediacaran Period and the top of the underlying Cryogenian Period, with an estimated age of 635 million years. Image courtesy B. Pillans.

Only one GSSP is defined in the southern hemisphere and it's in Australia

The youngest subdivision of the Neoproterozoic, the Ediacaran System/Period, is notable on two counts: First, it is the only unit to be defined with a GSSP in Australia (and the Southern Hemisphere), and second it is the only unit of the "Precambrian" to be defined with a GSSP. All the other Precambrian units are defined on time using GSSAs, though other GSSPs may well be established in the future, as the complexities of Precambrian rocks are unraveled.

The Ediacaran GSSP, or golden spike, is located in a rock outcrop in Brachina Gorge in Flinders Ranges National Park. The site is publicly accessible and well worth visiting for anyone interested in geological history—all readers of this newsletter, surely!

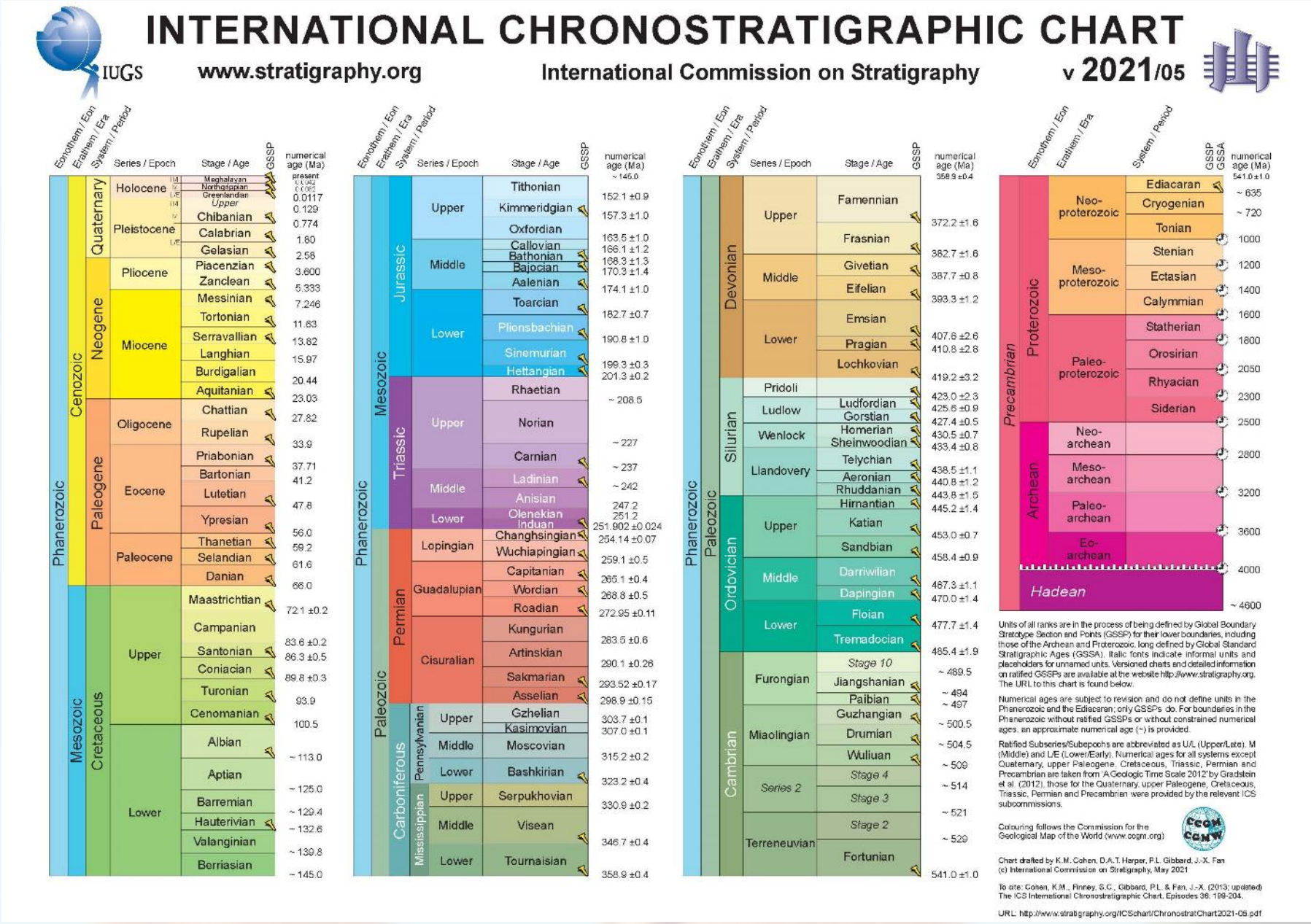


Information sign in Brachina Gorge, for the Ediacaran Period. Image courtesy B. Pillans.

Ediacaran GSSP, with yellow pole pointing towards the 'Golden Spike', Brachina Gorge, Flinders Ranges NP, South Australia Image courtesy B. Pillans.

Fun fact: Brad Pillans is a voting member of the International Commission on Stratigraphy. Dr Who may be called a Time Lord, but Brad is too!

Major subdivisions of the international Geological Time Scale, updated in May 2021. Reproduced with permission of the International Commission on Stratigraphy.



WE WOULD REALLY APPRECIATE YOUR FINANCIAL SUPPORT

Although work by committee members and friends of the National Rock Garden is voluntary, we nevertheless incur the regular costs of an incorporated entity. We therefore seek donations from individuals who recognise the importance of geoscience and geoscience education to the future of Australia.

The signing of the contract with the ACT Government for the re-location of the National Rock Garden into the very prominent Forest 13 block at the National Arboretum Canberra provides security of tenure for the Rock Garden and enables us to move more rocks into the ACT. We will incur substantial costs, including for transport and delivery of rock specimens, preparation of specimens for display, creation of descriptive plaques for the rocks, and maintenance of the NRG site. We will be encouraging corporate contributions for the transportation of larger rocks from interstate. Our immediate task is initiating the Landscape Design process, for which we have already selected a contractor with strong experience within the Arboretum.

Please make a tax deductible donation:

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Please mail/email this information to: National Rock Garden Trust Inc. c/- Geological Society of Australia, Level 2, Peats Ferry Road, Hornsby, NSW 2077

Email: brad.pillans@anu.edu.au

Cheques can also be made out to the National Rock Garden Trust and sent to the address above.

Feedback and further information

We welcome feedback and suggestions on the development of the National Rock Garden and would love to hear from you! Email us at: brad.pillans@anu.edu.au or michelle.cooper@ga.gov.au.

Tax deductible

The National Rock Garden is a registered Charity and all donations are tax deductible. Making a donation to the National Rock Garden is a great way to reduce your tax and feel good too! To donate, please complete the form on the previous page or phone (02) 9290 2194.

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Keep up with the latest NRG news, rock movements, rocks of the month and a whole lot more. Like us on Facebook:
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Newsletter compiled and edited by Mike Smith and Michelle Cooper.