National Rock Garden

Celebrating the Geological Heritage of Australia

Newsletter No. 23

May 2022

A step closer to rocks in the Arboretum and the quest for a zebra rock shirt

Famous rock travels to the ACT

The National Rock Garden needs younger rocks

The French connection

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How you can help the NRG

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

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A step closer to rocks in the Arboretum and the quest for a zebra rock shirt

Brad Pillans, Director, National Rock Garden

Over the last several months we have been working closely with landscape architects, Harris Hobbs Landscapes, to finalise the design of our new site in the National Arboretum Canberra. As I write this introduction, I am pleased to report that the landscape design has been forwarded to the National Capital Authority for final approval, after which we can proceed to engineering drawings and engage a construction company to undertake the site works.

Optimistically, we would like to have rocks on site by the last quarter of this year, including an inauguration ceremony. However, much will depend on the weather, and with above average rainfall forecast for the winter months, some construction activities could be delayed. We hope not!

In the meantime, we continue to promote the rock garden and identify suitable rocks for display. As described in the article by Mike Smith and Lance Black later in this issue, we took delivery of a new rock in April—a beautiful boulder of diorite, from Temora, zircons from which are used as an international standard for uranium-lead dating. Acquisition of the rock was possible through a generous private donation. Please contact me if you would like to sponsor a rock, we have many other great rocks to choose from!

I recently gave a talk about the rock garden to members of the ANU Emeritus Faculty. As part of my 'show and tell' I brought along some hand-specimens of a few of my favourite rocks, including zebra rock. One of my ANU friends, Verna Rosling, showed almost extra-sensory perception by wearing a shirt that exactly matched the red and white stripes of the zebra rock specimen that I had on the table. "I'd love a shirt like that. Where did you get it?" I asked Verna. She replied that she had bought it about 18 months previously at SABA, in Canberra, so I made a bee-line for the shop a few days later. Sadly, I was informed that red and white stripes were very much last year's colour and that they had no further stock. I also tried Sportscraft, knowing they sell the same lines as SABA, but the story was the same. I had visions of buying zebra rock shirts for NRG volunteers to wear at NRG events, but it was not to be – at least not yet… Perhaps we will find zebra rock shirts somewhere else. Please let me know if you spot any!

[For more information on zebra rock, see NRG Newsletter No. 22.]

Verna Rosling in her zebra rock shirt, holding a well-camouflaged hand specimen of the real thing. Image courtesy Brad Pillans.

National Rock Garden—Newsletter No. 23

A recent episode of the ABC TV program, Four Corners, investigated the new critical minerals mining boom and concluded that Australia is in the box seat to exploit a surge in worldwide demand. A critical mineral is a metallic or non-metallic element that is essential for modern technologies, economies or national security, and has a supply chain at risk of disruption. One such element is lithium and fortunately Australia is well endowed with lithium resources. Australia currently accounts for around 50% of world production, including the world's largest hard rock lithium mine -, Greenbushes in southwest WA. The NRG is negotiating to acquire a large block of ore from the Greenbushes mine.

One of the geologists who featured on the program was my ANU colleague, Prof John Mavrogenes, who summed things up as follows:

'There's no question we have some tough decisions to make and this view that the green view is anti-mining is naïve, because if we're going to go green, we're going to have to get a bunch of these critical metals and we're going to have to do it smartly, and we're going to have to produce a lot of them.'

For those of you who missed it, you can view the full *Four Corners* episode here.

One of the challenges that faces the NRG is how to display rocks that don't occur at the surface – for example the reservoir rocks of our major oil and gas fields. Such rocks can only be obtained by deep drilling but the drill cores that are retrieved are typically less than several centimetres in diameter. Perhaps we could assemble many core offcuts in a kind of mosaic display, either on a wall or a path at the NRG. I would welcome your suggestions…

Recently, one of my PhD students, Alysha Jones, came up with a new way of displaying drill cores—by baking a cake. Yes, I know, it sounds a bit whacky, but… Each year at ANU there is a competition called 'Bake Your PhD' in which PhD, Masters and Honours students are invited to represent their research area with a cake. The entries are judged by look and taste, and this year Alysha won with a long layer cake inspired by the layered sediment cores she is studying from Lake George. The judging panel was headed by ANU Vice Chancellor, Brian Schmidt, and the winner's prize was an inscribed cake stand.

Perhaps we could instigate an annual rock cake competition at the National Rock Garden!

Left: ANU PhD student, Alysha Jones, holding one half of her prize-winning core cake. Right: Both halves of the core cake. Images courtesy ANU.

Famous rock travels to the ACT

Mike Smith, NRG Steering Committee, and Lance Black, Geochronologist

Introduction

During April 2022, a large boulder of Middledale Gabbroic Diorite was collected from farmland near Temora and delivered to Canberra. Numerous large boulders had been moved from the farm paddocks and pushed to the edges of the fields to facilitate ploughing, planting and harvesting. In May 2021, the authors met the property owners who agreed to donate a really big boulder from their land to the National Rock Garden (NRG). The rock contains five dominant minerals: plagioclase, hornblende, pyroxene, ilmenite and haematite. Many years before, experts from Geoscience Australia conducted studies of this rock and recognised the diorite as a reliable source of isotopically undisturbed zircon crystals—these small mineral grains are very important for geological research work.

The NSW Rock Selection Subcommittee was tasked with finding the funds for the transportation of the rock to the ACT, the preparation for display by polishing a face of the specimen, and installing a stainless-steel plaque. A very generous donation has been made by a couple who have watched the steady progress of the NRG Steering Committee over the years, have attended a previous rock launch, and brought their grandchildren to the Federation Rocks display. This donation enabled the selected NRG specimen, weighing approximately 6 tonnes and shown here, to be raised from the ground using a crane truck.

Loading the specimen chosen for the NRG. Image courtesy John Henderson.

Prior to being uploaded, the rock was rigorously washed while suspended above the ground. The property owners provided a fire-fighting truck with a tank of local bore water which achieved this task very efficiently.

Cleaning residual soil from the diorite boulder using a fire-fighting truck. Image courtesy Lance Black.

The Temora Independent

Celebrating 135 years of publication

Print Post Approved 100003061

Friday, April 8, 2022 Vol. 136, No. 26

Former Geoscience researcher Lance Black (left) and National Rock Garden Director Mike Smith pictured with Temora's now famous ancient rock formation.

IT'S A WORLD FIRST

MORE than 20 years after it was first uncovered, an ancient rock formation found only in our Shire, will have a sample displayed on the national stage.

On Wednesday, former geologists, district residents and stakeholders travelled to the district property 'Woodlands' to watch a sample of the Middledale Gabbroic Diorite being extracted.

The rock is not found anywhere else in the world except here and is estimated to be millions of years old.

The sample is estimated to weigh between five and eight tonnes and will be exhibited in The National Rock Garden which is set to be a permanent feature of the National Arboretum in Canberra.

When the formation was first discovered on Harry and Marlene Wenscke's property during the 90s, it immediately caught the nations attention. The rock contains tiny zircon crystals, now known as "the Temora reference", and are used by more than 100 geochemical and geochronology laboratories around the world. The local zircons are highly prized by geochronologists the world over, because they are so perfectly formed, and have neither lost nor gained any elements since crystallisation 417 million years ago.

They are virtually as pure now as they were then and that's what makes them so special.

■ Continued page 4

Hoskins St flooding in the spotlight

TWELVE months after a significant and the nearby Trizalone Creek con- stage of the NSW Government's is still underway but we're some time

The collection of the large boulder was attended by a reporter from The Temora Independent and the resulting front page article was published by the newspaper two days after the event. The text on page 4 of the newspaper focusses on the historic collection of specimens from the farm paddocks in this area.

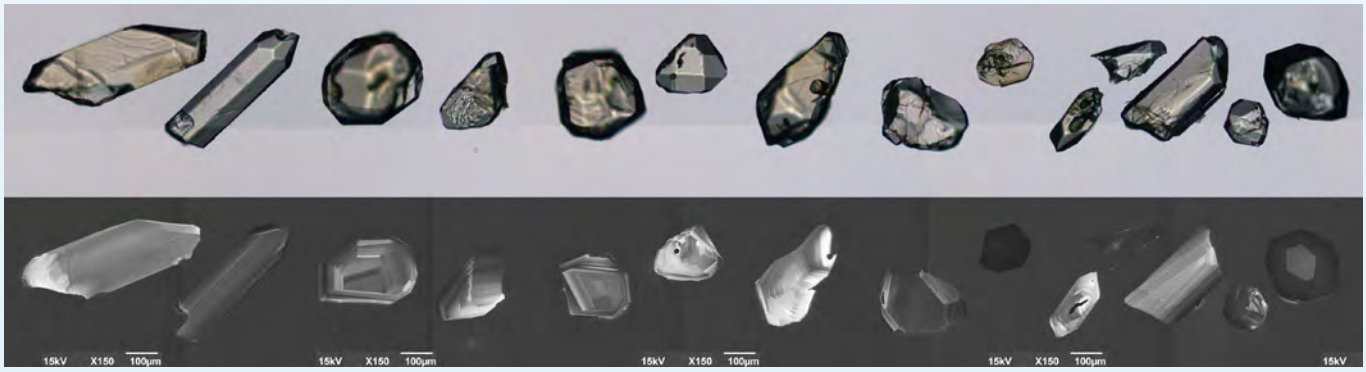
Rock uplift makes a front page story in The Temora Independent, 8 April 2022.

Scientific importance of this rock

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.

The crystals are typically between 200 and 400 microns on their longer axis. Some examples of TEMORA-2 zircon crystals are shown in the image below. Note the 100 micron scale bar on the lower side of the image (100 microns is equivalent to one tenth of a millimetre).

The upper panel of the image shows a photomicrograph of zircon crystals illuminated in transmitted light. The lower panel shows the same zircon crystals imaged via a process called cathodoluminescence, which reveals growth zoning of the zircons.



Representative crystals of the TEMORA reference zircon, extracted from the Middledale Gabbroic Diorite. Image courtesy David DiBugnara, Geoscience Australia.

These zircons have been impervious to chemical interaction since the crystallisation of their host diorite 417 million years ago. Specifically, 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.

A panoramic view of the Shrimp IIe instrument at Geoscience Australia. Image from the GA website.

Placement in the National Arboretum

The NRG Steering Committee has been given approval to store a number of rocks inside the grounds of the National Arboretum Canberra, until we receive formal approval of our landscape design, when they will be moved to their final destination. After uplift and washing on the farm property, the rock was driven to the ACT and placed in our storage site as shown below.

The large rock already on the ground, in front of the green cabin of the truck is the 12 tonne boulder of Marlborough chrysoprase that was delivered a few years ago with the help of a Federal Government heritage grant.

Unloading of the NRG's new specimen of Middledale Gabbroic Diorite at the temporary storage site. Image courtesy Brad Pillans.

Conclusion

The donation of private funding for the uplift, transport and preparation of this large rock for display is a very positive step in the development of the NRG in Canberra. Many of the NRG's rocks are significant because of their use for large scale constructions (such as Sydney Town Hall, Opera House and Harbour Bridge, and Canberra's new Parliament House), for monuments (such as the ANZAC Memorial in Hyde Park and the Canberra Foundation Stone in the ACT) and in sculpture (such as our Adelong Norite specimen).

The newly arrived diorite is very significant from the perspective of the scientific use of rocks. It will be placed in the Geoscience Knowledge cluster of the NRG's display.

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.

The National Rock Garden needs younger rocks

Andy Spate, AM

Australia has significant suites of rocks dating from the Eocene Epoch through to virtually the present (Holocene Epoch)—more than 120 Ma (Ma = million years) younger than the youngest in the NRG collection. The young rocks I am most interested in are the limestones shown in yellow on the map in Figure 1.

Let's start with some silly statistics: the average age of rocks currently on display in the NRG is 1073 Ma years. The oldest is ~2700 Ma, the youngest is Tasmanian dolerite at 179 Ma. The median is 1970 Ma. Let's have something like the Nullarbor Limestone at about 16 Ma and a piece of the aeolian calcarenite at about 0.2 Ma!

Table 1. The current National Rock Garden specimens

Unit	State	Age (Ma)
Tumbiana Formation	WA	2700
Orbicular granite	WA	2686
Brockman Iron Formation	WA	2450
Mt Goyder Syenite	NT	1825
Oolano Metasomite	SA	1760
Skillogalee Dolomite	SA	750
Bendigo metasandstone and Ballarat quartz	VIC	480
Canberra Limestone	ACT	430
Middledale Gabbroic Diorite	NSW	417
Chinaman Ck Limestone	QLD	407
Moruya Tonalite	NSW	379
Tarana Granite	NSW	312
Hawkesbury Sandstone	NSW	247
Tasmanian Dolerite	TAS	179

Two suites of important younger rocks are not yet represented in the National Rock Garden. Both of these are of international significance as I will outline below.

Firstly, some 220,000 km^2 of limestones of Oligocene to Miocene age can be found on the Nullarbor Plain (more than 3% of Australia's land area) and the surrounding Eucla Basin. The sequence includes the Pliocene/Pleistocene Roe Calcarenite as well as at least five limestone units spread across the Basin both stratigraphically and spatially. The karst* features and related values—including very significant megafaunal remnants and interesting younger faunal records are outstanding. There are also highly significant anthropological and archaeological sites. It has been argued that the Nullarbor Plain is of World Heritage significance (Davey et al 1992—see reference note). However, the proposal to list it was confounded by differing land management practices in South Australia and Western Australia.

Similar aged limestones can be found in south-east South Australia and western Victoria hosting such sites as the World Heritage Naracoorte Caves, celebrated for their vertebrate sub-fossil assemblages. These limestones are often overlain by the much younger limestones described below.

*Karst is a distinctive topography in which the landscape is largely shaped by the dissolving action of water on carbonate bedrock (usually limestone, dolomite, or marble).

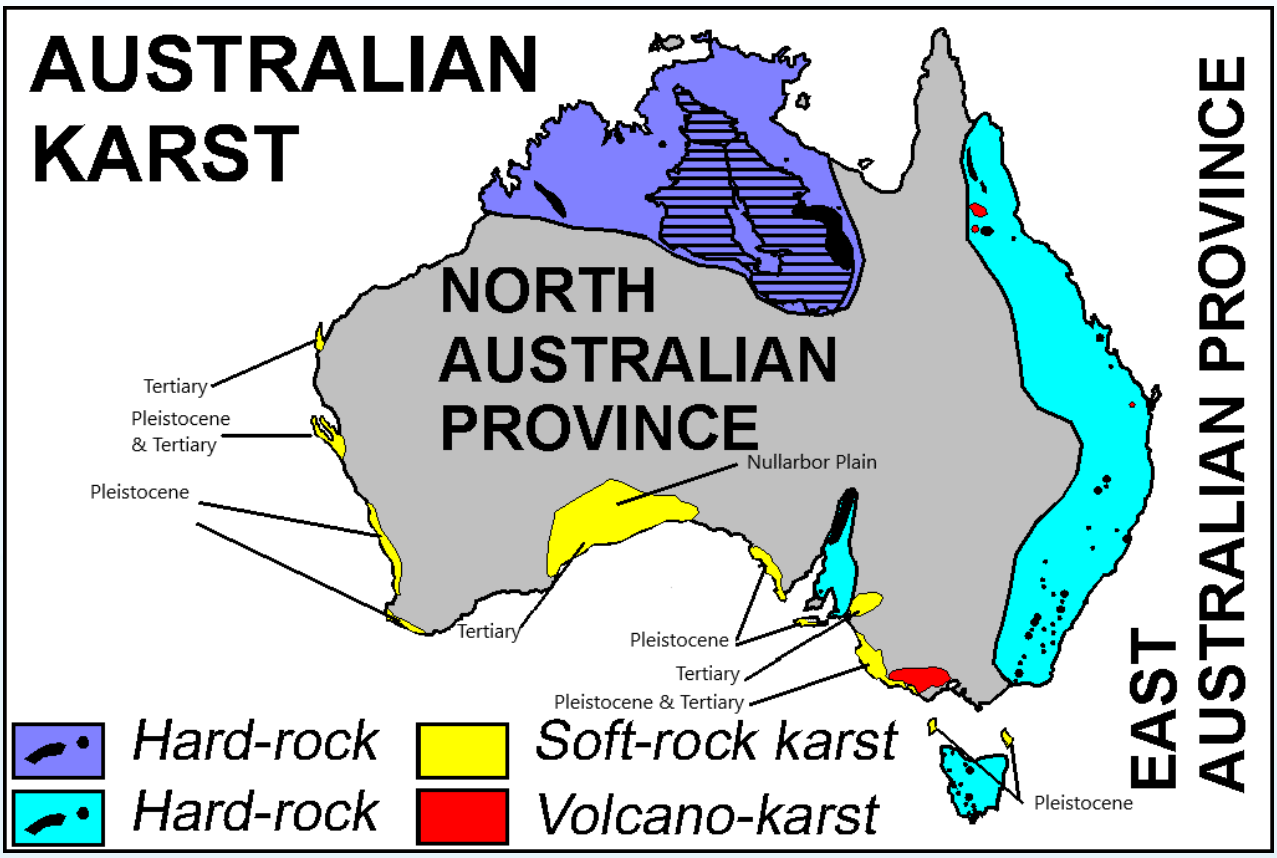


Figure 1. Map of Australian carbonate rocks and volcanics hosting karst or lava tubes. Where 'Pleistocene & Tertiary' is shown there are caves and other karst features present in both units. The Pleistocene Neds Beach Calcarenite on Lord Howe Island is not shown. Base map © the Late K.G. Grimes.

An extensive suite of young limestones, dating to the Quaternary Epoch, is found along the coasts of Western Australia, South Australia, Victoria, Tasmania and on Lord Howe Island off the New South Wales coast. These limestones are dune limestones—formed by calcareous sands blown off the sea floor during glacial sea level lows. Australia has more of these aeolian calcarenites than elsewhere around the globe. And possibly more caves than the rest of the world? Again, they contain significant past-climate and bushfire records, as well as sub-fossil faunas, invertebrate faunas, anthropological and archaeological values. As at Naracoorte and in the Gambier area, show cave attractions make a significant contribution to the local tourism economies from Margaret River to Yanchep north of Perth.

Neither of these limestone types are represented as yet in the NRG collection although there is a piece of the 18 Ma Naracoorte Limestone awaiting transport to Canberra. We need both this specimen and some examples of the aeolian calcarenites as well as the Nullarbor limestones for Canberra to emphasize that not all of Australia is super old!

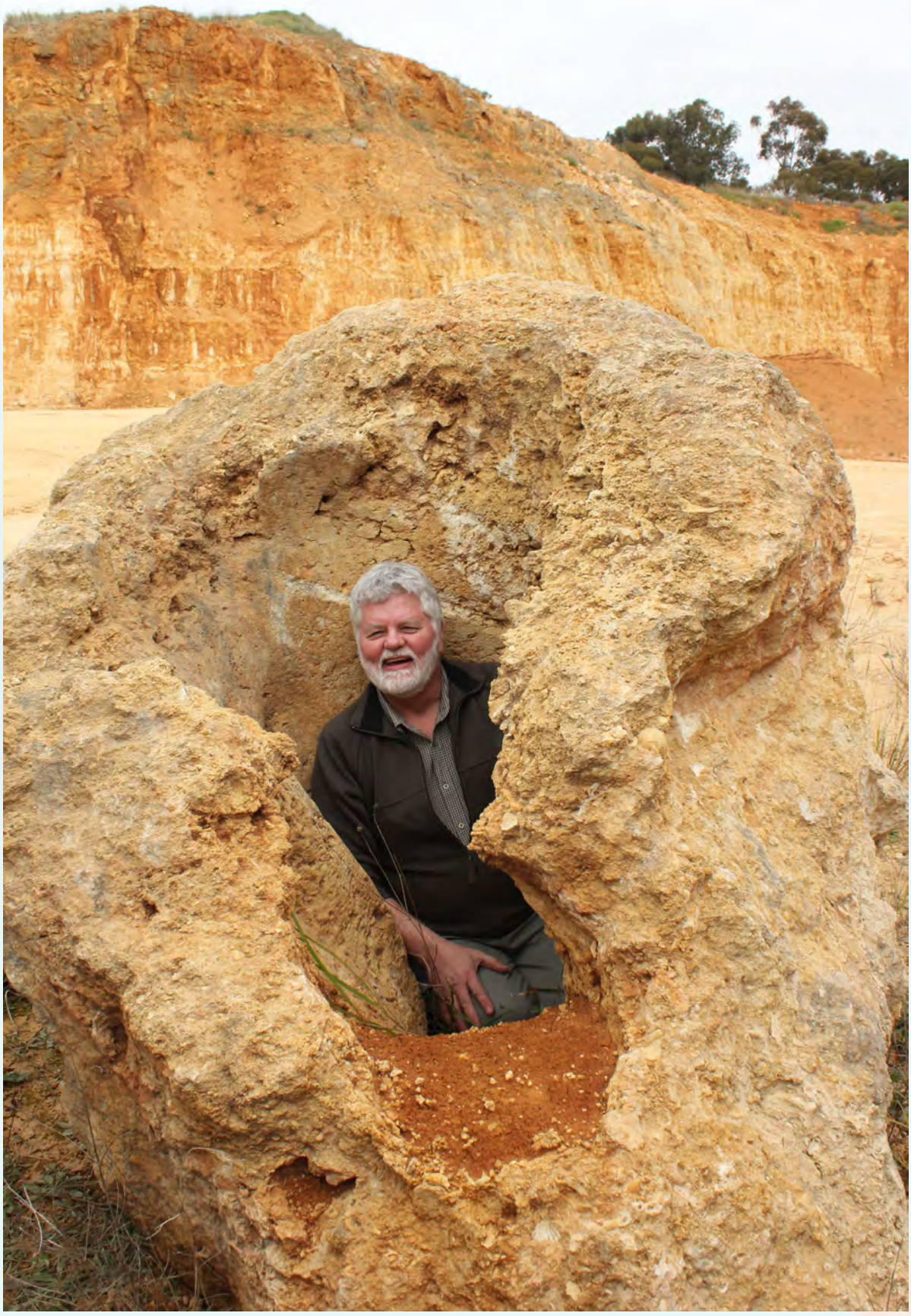


Figure 2. Solution tube in the Naracoorte Limestone (mid Miocene) from Henschkes Quarry, Naracoorte. This is the specimen proposed for the NRG. Note the Terra Rossa soil infill, now unfortunately washed from the tube. Ian Lewis—pictured for scale. Image courtesy Frances Williams, SA Field Geology Club.

Figure 3: Cross section of solution tubes from Gartners Quarry, near Coonawarra, SA. These are in the Bridgewater Formation dated to about 750,000. This young, calcareous aeolinite overlies the Naracoorte and Gambier Limestones which are 33–15 Ma in age. Note the Terra Rossa soils. Image courtesy Brad Pillans.

Where might we get samples of these younger limestones to place in the National Rock Garden? As shown in Figure 2, we do have a sample of the Naracoorte Limestone Member awaiting transport to Canberra from Henschkes Quarry, Naracoorte, SA. The non-profit Australasian Cave and Karst Management Association Inc. (ACKMA) has pledged $1000 to help support the move to Canberra.

Obtaining a sample from the Nullarbor presents far more difficulties. The obvious starting point might be the roadside quarries along the Eyre Highway—but is the lifting and trucking equipment available? The other place might be the Rawlinna Limestone Member (Miocene) at the Loongana Quarry on the Trans-Continental Railway. Whilst this unit does not have some of the karst-related values of other Nullarbor limestone units it could still make its point.

Fragile specimens of the young calcarenites of the Bridgewater Formation from South Australia and Victoria could be obtained from quarries in those regions. But again, we need someone in those places to find a sample. Another candidate calcarenite is the Tamala Limestone in Western Australia, which is of particular historic significance, being one of the rocks that was described and studied by mineralogists aboard the 1801–03 French expedition of discovery, led by Nicholas Baudin (Mayer 2009). ACKMA may well support the transport of a sample from the Nullarbor and/or one of the calcarenites.

Acknowledgements

The author would like to thank Ian Lewis and Brad Pillans for their very useful input to this article.

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Davey A.G., Gray M.R., Grimes K.G., Hamilton-Smith E., James J.M. and Spate A.P., 1992. World Heritage significance of karst and other landforms in the Nullarbor region, A commissioned report to the Commonwealth Department of The Arts, Sport, The Environment & Territories, Applied Ecology Research Group, Faculty of Applied Science, University of Canberra

***Note**: Whilst this report is obviously very dated, ongoing work by many scientists (including a growing number of peer-reviewed scientific papers) and devoted cave explorers and documenters is adding greatly to our knowledge and significance of the Nullarbor.*

Mayer, W., 2009. The geological work of the Baudin Expedition in Australia (1801-1803): the mineralogists, the discoveries and the legacy. Earth Science History, 28: 293-324. Available at https://openresearch-repository.anu.edu.au/bitstream/1885/20167/2/01_Mayer_The_Geological_Work_of_the_2009.pdf

The French connection

Brad Pillans, Director, National Rock Garden

The 1801–1803 French expedition of discovery, led by Captain Nicholas Baudin, explored large parts of Australia's western and southern coasts (Fig. 1). The expedition, comprised of two ships (Géographe and Naturaliste), sailed from Le Havre in October 1800, having been approved by none other than Napoleon Bonaparte himself, then First Consul of France. According to the list of crew members, there were 22 'Naturalists' and 'Savants' on board, 14 of whom had formal scientific qualifications. Two of the scientists, Louis Depuch and Joseph Charles Bailly, were trained mineralogists—we would call them geologists, today—and they were the first professionally educated geologists to visit Australia (Mayer 2009).

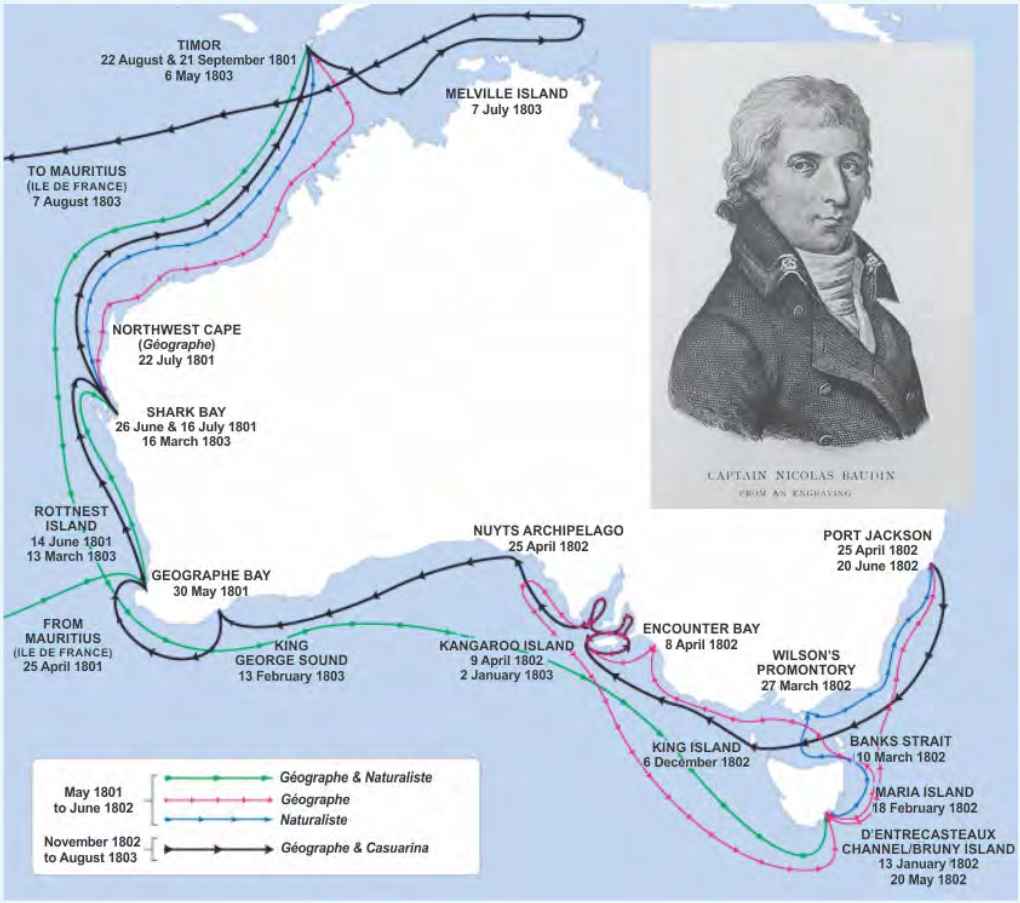

Figure 1: Map showing the routes of the Baudin expedition ships, 1801–1803 (after Sankey 2011). Inset: Captain Nicolas Baudin. Image courtesy State Library of South Australia, B 5793.

Sadly, Depuch did not survive the voyage (neither did Baudin) and it was left to Bailly and the expedition zoologist, François Péron, to report the results of the geological discoveries, on return to France. In 1806, Péron was asked by the French Government to write the official history of the voyage, but he died in 1810, having only completed the first volume. Naval Officer Louis Freycinet was then asked to finish the task and completed the work in 1816.

At the time, the science of geology was in its infancy, but Depuch and Bailly made many valuable observations of rocks in Australia. One of the rock types that they studied, was Tasmanian dolerite, the rock we chose as the Tasmanian state rock in our NRG Federation Rocks display. They wondered whether it might be a type of granite, then settled on it being a type of basalt, but neither suggestion turned out to be correct. We now know that the dolerite was intruded at shallower crustal levels than granite, but it is not a volcanic rock (like basalt) because it did not reach the surface.

One of the other rock types that they studied, was what we now know as Tamala Limestone, in Western Australia, which is a type of limestone formed by cementation of coastal dune and beach deposits (see the article by Andy Spate, in this issue). I would be very pleased if we could obtain a block of Tamala Limestone for display in the NRG—to celebrate the 'French Connection'.

In 1803, the Baudin expedition also spent time around Kangaroo Island, where one of the crew carved the following inscription on a rock near present-day Hog Bay: 'Expedition de decourverte par le commandant Baudin sur le Geographe 1803.' (Expedition of discovery by Captain Baudin of the Geographe 1803.)

Hallam Tennyson, son of the famous English poet, Lord Alfred Tennyson, visited the spot with his family one hundred years later (image below), at the end of his term as governor of South Australia. At the time (1903), the state was celebrating the centenary of the meeting of Baudin and Matthew Flinders at Encounter Bay. The inscribed rock, now known as Frenchman's Rock, was subsequently removed from the site, for safe keeping, and is now displayed in a glass case at the Kangaroo Island Visitor Centre in Penneshaw. A replica rock has been placed at the original site.

In mid-1902, the first Governor General of Australia, Lord Hopetoun, resigned, and Tennyson, as the senior state governor, became Administrator of the Government (effectively, acting Governor General) from 17 July 1902 to 9 January 1903. He then served a one-year term as Governor General until he departed from Australia in January 1904. He retired to the Isle of White as 2nd Baron Tennyson, having inherited the title on the death of his father, Alfred (1st Baron Tennyson), in 1892.

Lord Hallam Tennyson and family, visiting Frenchman's Rock, in 1903.
Image courtesy State Library of South Australia, PRG 280/1/3/181.

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Mayer, W., 2009. The geological work of the Baudin Expedition in Australia (1801-1803): the mineralogists, the discoveries and the legacy. Earth Science History, 28: 293-324. Available at https://openresearch-repository.anu.edu.au/bitstream/1885/20167/2/01_Mayer_The_Geological_Work_of_the_2009.pdf

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Road cuttings: A window to ancient landscapes

Ken McQueen, National Rock Garden Steering Committee

The Snowy Monaro Regional Council is currently upgrading and sealing the Bobeyan Road from near Adaminaby to Shannons Flat and the ACT border. Recent construction work in several cuttings has exposed Cenozoic clays and gravels, which are probably part of an old paleolake known as Lake Adaminaby. This ancient lake formed by damming of the upper part of the Murrumbidgee River at about 20–25 million years ago. Subsequently it dried out and was partially eroded as the landscape continued to evolve. Interestingly, one of the cuttings also contains large blocks of silcrete (silicified gravels), which can be seen embedded in-situ within the sediments. These blocks also show surrounding zones of partial silicification providing evidence of how the silcrete formed by a process of progressive introduction of silica-rich fluids (i.e. containing dissolved silica), either from groundwater or the old lake waters and sediments.

One of the cuttings with silcrete blocks (at left) in gravels. Image courtesy Ken McQueen.

A group of interested earth scientists met with Arthur Wilkinson, the Chief Engineer in charge of the project, to discuss the possibility of obtaining a large block of the silcrete for display in the National Rock Garden and also to preserve sections of the cutting for further scientific study and as an educational site.

Detail of one of the large silcrete blocks (grey) and enclosing gravels (brownish). Image courtesy Ken McQueen.

The Federation Rocks display at the National Rock Garden

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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BSB: 082-057
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Signature: ……

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 over $2 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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Newsletter compiled and edited by Michelle Cooper.