National Rock Garden

Celebrating the Geological Heritage of Australia

Newsletter No. 25

May 2023

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

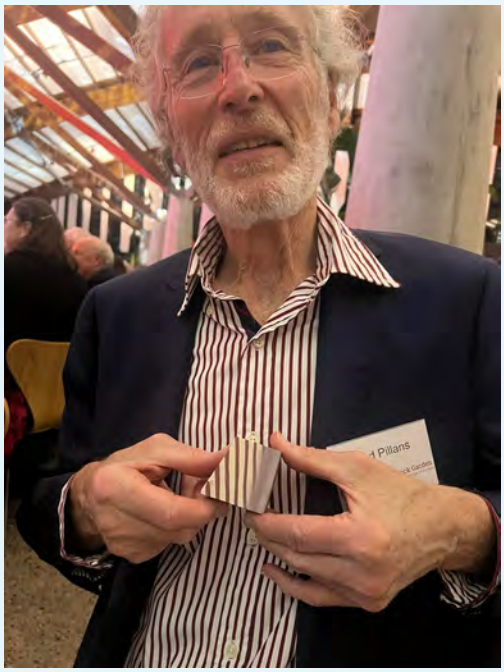
www.nationalrockgarden.org.au

Celebration all round

Brad Pillans, Director, National Rock Garden

In February we received good news—works approval was granted by the National Capital Authority for relocation of the National Rock Garden to its new site within the National Arboretum Canberra, including construction of paths and rock display pads as well as relocation and installation of rocks. Works approval then allowed us to seek tenders from construction companies to carry out the necessary landscaping. At the time of writing, tenders are being evaluated with a view to announcing the successful tenderer as soon as possible. With long-range weather forecasts by the Bureau of Meteorology indicating that we are moving from La Nina to neutral or perhaps El Nino weather patterns this year, we are optimistic that wet weather will not hinder construction activity in the coming months.

On Friday 5 May, the National Arboretum held a 10th anniversary dinner and generously offered 10 complementary tickets to NRG Steering Committee and Advisory Council members. Coincidentally, this year is also 10 years since the NRG opened its first display—the Federation Rocks—to celebrate the centenary of Canberra in 2013. A highlight of the dinner was a performance by renowned didgeridoo player, William Barton, accompanied by a string quartet from the Australian National University. Our thanks to Arboretum manager, Scott Saddler, for inviting us to be part of the celebration. The dinner was also an opportunity to show off my zebra rock shirt, complete with matching hand-specimen. A great way to get people talking about rocks!



Brad Pillans with his matching shirt and zebra rock hand specimen at the National Arboretum anniversary dinner. Image courtesy T. Kapitany.

In early March I spent a week on Norfolk Island, ostensibly a holiday with my wife, Sue, but as you will read later in the newsletter, I also investigated the possibility of obtaining a rock or rocks from Norfolk Island for the NRG. Then, in April, Sue and I spent a couple of weeks in New Zealand—another holiday, but the idea of a New Zealand rock for the NRG was discussed with Maori Elders and geological colleagues. More on that in the next newsletter.

I hope you enjoy the selection of rock stories in the rest of the newsletter. If you have a good rock story to tell, please let me know and perhaps we can include it in our next newsletter.

William Barton and an ANU quartet performing at the National Arboretum's 10th anniversary dinner. Image courtesy M. Cooper.

South Australian National Park opened for dawn of animal life fossils

Steve Hill, Chief Scientist, Geoscience Australia

People came from far and wide and with a strong sense of adventure and excitement to the outback station of Nilpena for the opening of the Nilpena Ediacara National Park on 27 April 2023. The crowd that gathered not only included government ministers, aboriginal elders and conservation stalwarts but a number of palaeontologists and geologists… this was obviously a bit different to the usual national park opening! The reason, of course, was that this national park has incredible geology, or more precisely its internationally significant fossil record that provides the world's richest and most diverse record of Ediacara fossils. These are the first multi-cellular creatures that ate, moved and sexually reproduced and therefore provide insight into the dawn of animal life on Earth some 550 million years ago.

The opening plaque is revealed at the repurposed former Nilpena blacksmiths shop by South Australia's Deputy Premier, Hon Susan Close, with assistance from Adnyamathanha elders Pauline McKenzie and Arthur Coulthard. Image courtesy S. Hill.

The fossils here were first discovered by Reg Sprigg AO in the 1946 and after some initial contention have gained significant international attention from researchers, palaeontologists and conservationists, including from NASA and Sir David Attenborough, and featured in the recent ABC TV and online profile – 'Set in Stone'. The fossil record here also supports the Global Boundary Stratotype Section and Point (GSSP), a.k.a. 'golden spike', for the base of the Ediacaran time period in nearby Brachina Gorge.

Spriggina, South Australia's fossil emblem. Image courtesy S. Hill.

Besides the fossils themselves, a highlight of the national park is an audio-visual experience that recreates the ancient ocean floor and projects onto one of the most fossiliferous beds found in the area (the bed is named 'Alice's Restaurant Bed' in reference to the Arlo Guthrie song from the late 1960s and that Prof Mary Droser's research team could 'get anything you want' as examples of the local fossils in this bed). The audio-visual experience is hosted in the rebuilt former blacksmith's shop and provides a virtual Ediacaran aquarium experience where identified fossils from the bed are brought to life through 3D animation technology. The park also manages near to 60,000 ha of country from near Parachilna westwards to Lake Torrens.

R–L: Ministers Boyer and Close experience the audio-visual presentation projected onto Alice's Restaurant Bed within the repurposed Nilpena blacksmiths shop. Image courtesy S. Hill.

Professor Mary Droser explaining the significance of some of the fossil beds. Image courtesy S. Hill.

The opening of the national park is a key step forward in support of UNESCO World Heritage status for areas of the Flinders Ranges, where since April 2021 it has been placed on Australia's tentative list for World Heritage. The area is also culturally significant to the Adnyamathanha people (meaning 'rock people') with traditional ceremonial sites, meeting places and middens located along creek beds and near groundwater springs. The site is also important for the state's pastoral heritage and has included restoration of the stone shearing shed, shearers' quarters and blacksmiths shop. To preserve the integrity of the fossils, access to the site is limited to pre-booked guided tours that can be arranged via the national park website, www.parks.sa.gov.au.

It was exciting to be at this opening partly because of having seen its changes and evolution over the years but most especially because it is a prominent public place where Earth Science and the work of Earth scientists are recognised and celebrated. A major challenge here has been to get the technical messaging to the public at the right level to best engage and enthuse people to want to learn more. A key aspect and learning has been the need for Earth Scientists to work with the project rather than only having a single-minded focus on communicating science (i.e. 'communicating with' rather than 'communicating to or at' people). The success here has also benefited from the leadership of South Australia's National Parks & Wildlife Services and the foresight of palaeontologists such as Jim Gehling and Mary Droser, and former land owners Ross and Jane Fargher.

Prof Mary Droser and Jason Irving (NPWS South Australia) examine some of the new visitor signage in Brachina Gorge. Image courtesy S. Hill.

The western rangefront of the Flinders Ranges, immediately to the east of Nilpena Ediacara National Park. Image courtesy S. Hill.

Owen conglomerate specimens moved to Hobart

Ralph Bottrill, Senior Geologist, Mineral Resources Tasmania

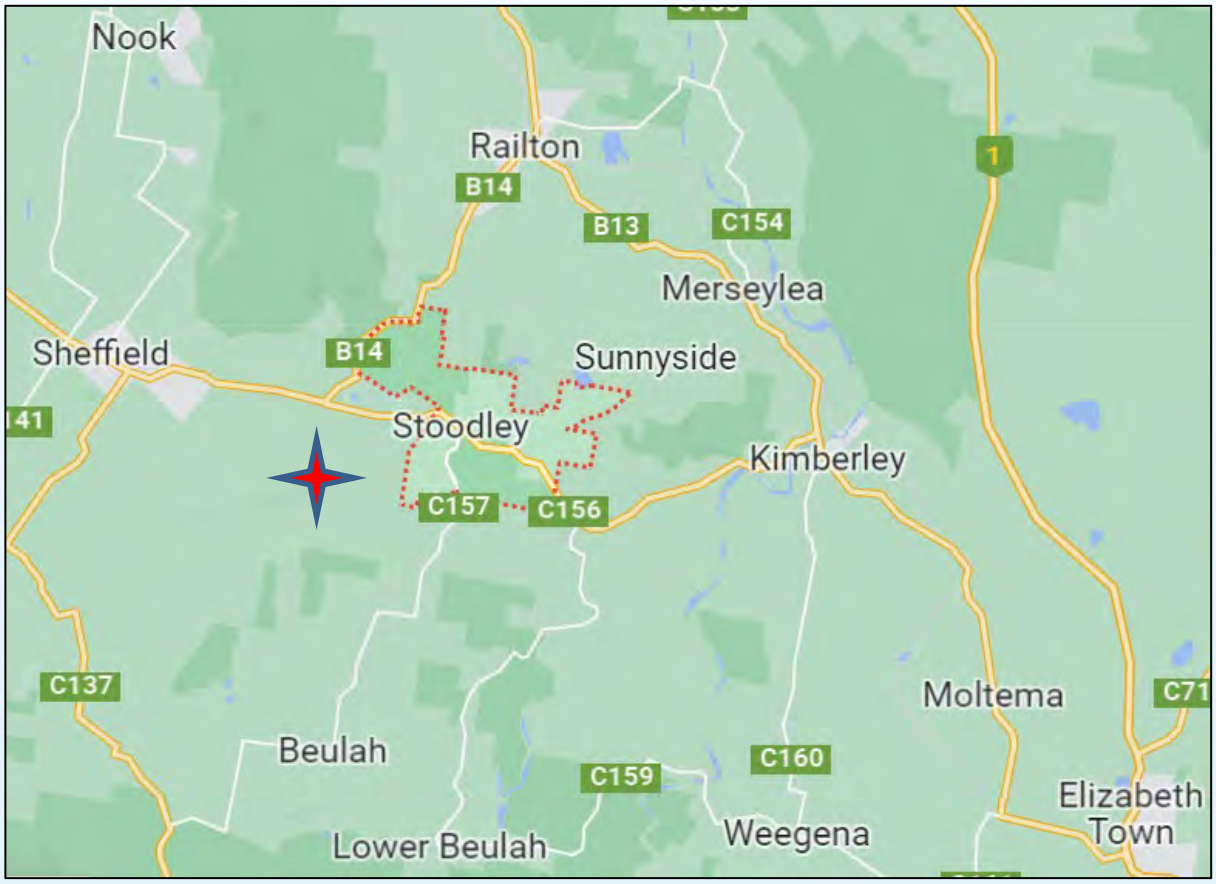
The Owen conglomerate is a thick sequence of coarse siliciclastic sediments deposited in western and northern Tasmania during the Late Cambrian to Early Ordovician Periods (Corbett, 2003 & Corbett et al., 2014). The sequence around the Sheffield–Deloraine area has been called the Roland Conglomerate, but it appears effectively identical and is considered so for the purposes of this project. It extends from the south coast of Tasmania to the Beaconsfield area near the north coast. Formally known as the Owen Group, this rock unit is part of the Wurawina Supergroup; usually overlying the Cambrian Mount Read Volcanics and equivalents, and is overlain by the Moina Sandstone and Gordon limestone and equivalents, all Ordovician sequences.

This rock is important because it forms the exposed backbone to some of Tasmania's major mountain ranges, particularly the West Coast Range, Black Bluff Range and the ranges around Black Bluff. They are closely associated with, although not directly hosting, the Mt Lyell copper deposits, and are also closely associated with the Beaconsfield gold mine.

Owen conglomerate forms substantial topographic features such as Mount Roland, an imposing monolith with a majestic presence at the north-western edge of Tasmania's central plateau (McQueen, 2022). Mount Roland has an elevation of 1,234 m above sea level and stands 10 km southeast of the small town of Sheffield in northern Tasmania.

The conglomerate blocks are characterised by typical rounded, white to grey and creamy coloured quartzite clasts to about 10 cm diameter, in a silicified red sandstone matrix (below). Commonly you can see small grains of black chromite and sometimes some green fuchsitic (chromian mica) patches.

Owen conglomerate boulder showing the typical white quartzite clasts in a red sandstone matrix. Field of view is about 1.2 m. Image courtesy R. Bottrill.



Location of Stoodley quarry (red star). Map data from Google Maps.

Three blocks of Owen conglomerate were recently extracted from the Stoodley Quarry, roughly 12 km NE of Mount Roland, in central north Tasmania, and brought to Hobart by Treloar Transport.

The NRG gratefully acknowledges Treloar's Stoodley Quarries of Devonport for donating these rocks to the National Rock Garden. This private company is a major supplier of construction materials (sand and gravel) in Tasmania.

The specimens are currently being stored behind secure fencing at the Core Library of Mineral Resources Tasmania at Mornington on Hobart's eastern shore, until funding is raised to ship the boulders to the ACT.

The NRG Steering Committee expects to move these rocks into the new NRG site within the National Arboretum Canberra in the 4th quarter of 2023.

Boulders of the conglomerate currently stored at Mineral Resources Tasmania. Image courtesy R. Botrill.

References

Corbett, K. D., 2003. Bedrock geological map of the Que River – Sheffield area, north-west Tasmania, 1:100 000 scale. Rosny Park, Tasmania: Mineral Resources Tasmania. https://www.mrt.tas.gov.au/products/database_searches/map_catalogue

McQueen, K., 2022. National Rock Garden on track to its new site at the National Arboretum Canberra, AIG Newsletter November 2022. https://www.aig.org.au/librar/newsletters/

Corbett, K.D., Quilty, P.G. and Calver, C.R. (editors), 2014. *Geological Evolution of Tasmania.* Geological Society of Australia Special Publication 24, Geological Society of Australia (Tasmania Division) 660 pp. https://www.utas.edu.au/__data/assets/pdf_file/0011/532982/GOTOrder.pdf

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 formation of the limestone Pinnacles, Nambung National Park, Western Australia

Rowena Duckworth, National Rock Garden Steering Committee

A few kilometres inland from the sparkling blue Indian Ocean, only three hour's drive north of Perth, WA, and within the picturesque Nambung National Park, lies the Pinnacles desert where abundant weathered rock spires rise eerily out of yellow sand dunes. The Pinnacles may be as old as half a million years, but no one knows quite how and exactly when these striking natural structures were formed.

The Pinnacles within Nambung National Park. Image courtesy R. Duckworth.

The calcarenite spires that stick out of the yellow sandy desert vary in size from several metres tall to knee-high or less, and up to 3m wide, and they resemble a petrified, paleolithic garden. They have various shapes: conical, cylindrical with rounded top, mushroom-like, and multiple peaks. Every structure seems to have its own unique, weather-beaten shape. They occur in dense fields with an average spacing between 0.5 and 5 metres, and the pinnacle tops often define a horizontal surface that decreases in direction northwards. The accumulation and erosion of the surrounding sand influence the relative height of the pinnacles. Connections can be seen between bases of certain adjoining pinnacles.

Not all the pillars are composed of the same material. Some pillars are formed of shells and algal structures, some are sandier with bedded dune sand structures, calcrete and paleosoil. Other pinnacles are composed of cemented pipe/tube fill. Several pinnacles contain all sorts of material mixed together.

Photo showing shells preserved in the pinnacles. Image courtesy R. Duckworth.

Photo showing algal structures in pinnacle. Stick for scale! Image courtesy R. Duckworth.

Many pinnacles are covered with a layer of carbonate cement, which can be localised and very thin (some millimetres), but it can also cover a large part of a pinnacle.

There are thousands of pillars, and all are formed of calcarenite of the Tamala Limestone. This unit extends from Shark Bay south to the southernmost point of Western Australia. It also extends in patches towards Albany along the southern coast. However, it is only here in the Nambung National Park that these pillar structures are seen. Due to ongoing erosion, transport and accumulation of sand, some pinnacles become covered while others are exhumed. Locals say oral history states that back in time the Pinnacles were totally covered in sand, and in the future, they will become buried again.

So how did the Pinnacles form? The raw material for the limestone of the Pinnacles came from seashells formed around 500,000 years ago when shallow seas covered the area. About 25,000 years ago the sea receded and these shells were broken down into lime-rich sands that were blown inland to form high mobile dunes. However, the way such raw materials formed the Pinnacles is the subject of debate and three theories have been proposed.

Due to their spectacular outcrop and easy access, the Pinnacles have attracted a good deal of scientific attention, but there is no consensus as to their origin. They have been variously interpreted as residual features resulting from widening and coalescence of solution pipes (e.g., Lowry, 1973, McNamara, 1995, Grimes, 2009, Lipar, 2009), the cemented infills of solution pipes (e.g., Playford et al., 1976, McNamara, 1983, McNamara, 1995, Grimes, 2009, Lipar, 2009, McNamara, 2009), zones of focused cementation (Grimes, 2009) or carbonate replacement of trees (Hearty and O'Leary, 2008).

The first theory states that they were formed as dissolutional remnants of the Tamala Limestone, i.e. that they formed due to a period of extensive solutional weathering (karstification). Focused solution initially formed small solutional depressions, mainly solution pipes, which were progressively enlarged over time,

resulting in the Pinnacle topography. Some Pinnacles represent cemented void infills (microbialites and/or re-deposited sand), which are more resistant to erosion, but dissolution still played the final role in Pinnacle development.

A second theory states that they were formed through the preservation of tree casts buried in coastal aeolianites, where roots became groundwater conduits, resulting in the precipitation of indurated (hard) calcrete. Subsequent wind erosion of the aeolianite then exposed the calcrete pillars.

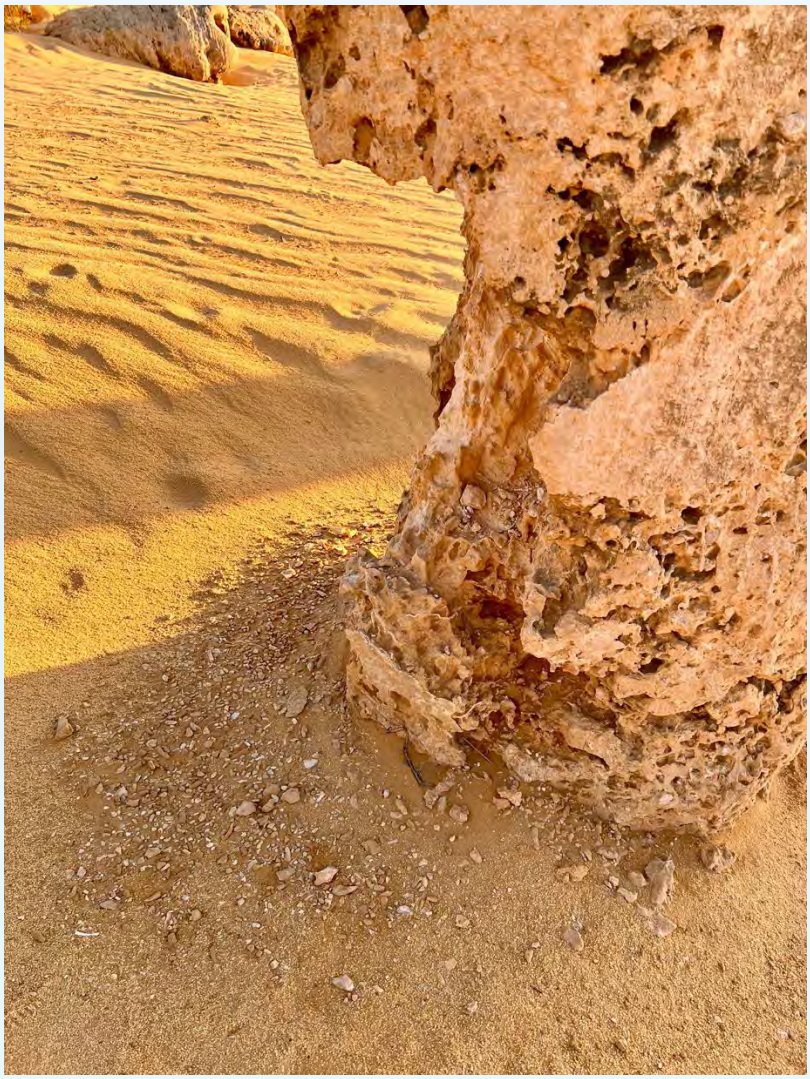


Photo showing dissolution of pinnacle. Image courtesy R. Duckworth.

A third proposal suggests that plants played an active role in the creation of the Pinnacles, based on the mechanism that formed smaller ‘root casts’ in other parts of the world. As transpiration drew water through the soil to the roots, nutrients and other dissolved minerals flowed toward the root. This mass flow process can result in the accumulation of nutrients at the surface of the root, if the nutrients arrive in quantities greater than that needed for plant growth. In coastal aeolian sands that consist of large amounts of calcium (derived from marine shells), the movement of water to the roots would drive the flow of calcium to the root surface. This calcium accumulates at high concentrations around the roots and over time is converted into a calcrete. When the roots die, the space occupied by the root is subsequently also filled with a carbonate material derived from the calcium in the former tissue of the roots, and possibly also from water leaching through the structures. Although evidence has been provided for this mechanism in the formation of root casts in South Africa, evidence is still required for its role in the formation of the Pinnacles.

Photo showing the hollow nature of some of the spires. Image courtesy R. Duckworth.

Another biogenic theory proposes that as vegetation began to consolidate the dunes, humic acid accumulated from the biological material in the soil. The resulting acidic seepage water leached calcium carbonate from the upper layers of the dunes which formed a limestone cap rock some distance below the dune surface. Once the calcium carbonate has been leached from the upper levels of the dunes the seepage water began dissolving the cap rock. At first channels were dissolved through the limestone of the caprock at points of weakness like cracks, joints or holes left by decayed roots, and the limestone was redeposited further down in the dunes in stalagmite-like formations. Eventually the caprock was dissolved resulting in the limestone columns surrounded by leached quartzite sand. At some time in the recent past windblown sand covered the consolidated dunes. The vegetation was smothered, then the sand moved on leaving the previously consolidated dune unprotected from the forces of erosion. The dunes were then moved away to expose the limestone columns.

Preservation of the pinnacles means that the pinnacle material was more resistant than the surrounding material. The stronger resistance was most likely a result of greater cementation of the carbonate. A minor percentage of pinnacles are not composed entirely of a resistant material but are simply coated by it on the surface wall, and their insides are hollow spaces or composed of less resistant material that is preserved because of the protection of the resistant surface wall. A layer of carbonate cement makes the structure of the material behind it unrecognizable. The layer has most probably been formed at the time when the pinnacles were already formed but still covered with sand.

Conclusions

The Pinnacles are small towers of calcarenite up to 5 m tall and up to 2 m wide with a variety of shapes. They have formed by erosion (especially water corrosion and wind erosion) of the surrounding material to leave the more resistant parts as pinnacles. Some of the pinnacle material is a primary calcarenite and its component layers, such as bedded dune sand, calcrete and paleosoil. Their stronger resistance is probably a result of stronger focused cementation, which could be partly triggered by plant roots with chemical and mechanical processes. Rhizoliths exposed in the pinnacle material indicate the presence of plant roots in the past. Other pinnacle material is shells, algal mats and secondary cemented pipes and tubes.

In the most recent paper published on these structures, Lipar and Webb (2022) stated that the pinnacles are organo-sedimentary structures with microbial cementation as the dominant process of lithification. This was based on detailed field work, morphometrical analysis of the pinnacles, thin section examination, and mineralogical, chemical and isotopic analysis of rock samples. They added that calcrete development and karstic weathering have subsequently modified the pinnacle shapes.

References

Grimes, K.G., 2006. Syngenetic karst in Australia: a review. Helictite, 39(2): 27–38. https://helictite.caves.org.au/pdf1/39.2.Grimes.pdf

Grimes, K.G., 2009. Solution pipes and pinnacles in syngenetic karst. In: Gines A., Knez M., Slabe T. & Dreybrodt W. (Eds.) *Karst Rock Features: Karren Sculpturing* (pp. 513–523). Ljubljana, Slovenia: Zalozba ZRC.

Hearty, P.J., 2003. Stratigraphy and timing of eolianite deposition on Rottnest Island, Western Australia. Quaternary Research, 60, 211222. https://doi.org/10.1016/S0033-5894(03)00063-2

Hearty, P.J., & O'Leary, M.J., 2008. Carbonate eolianites, quartz sands, and Quaternary sea-level cycles, Western Australia: A chronostratigraphic approach. Quaternary Geochronology, 3(1–2), 26–55. https://doi.org/10.1016/j.quageo.2007.10.001

Hearty, P.J., & O'Leary, M.J., 2010. Reply to 'Bastian L. V.'s Comment on Hearty P.J. & O'Leary M.J. 2008. Carbonate eolianites, quartz sands, and Quaternary sea-level cycles, Western Australia: A chronostratigraphic approach. Quaternary Geochronology, 3, 26–55. Quaternary Geochronology, 5(1), 78–81. https://doi.org/10.1016/j.quageo.2009.09.007

Lipar, M., 2009. Pinnacle syngenetic karst in Nambung National Park, Western Australia. Acta Carsologica, 38(1), 41–50. https://doi.org/10.3986/ac.v38i1.134

Lipar, M., & Webb, J., 2012. The formation of the pinnacles in Nambung National Park, Western Australia (abstract). 34th International Geological Congress, Brisbane, Australia. https://www.researchgate.net/publication/266081225_The_formation_of_the_pinnacles_in_Nambung_National_Park_Western_Australia

Lipar, M., & Webb, J.A., 2015. The formation of the pinnacle karst in Pleistocene aeolian calcarenites (Tamala Limestone) in southwestern Australia. Earth-Science Reviews, 140, 182–202. https://doi.org/10.1016/j.earscirev.2014.11.007

Lowry, D.C., 1973. Origin of the Pinnacles, Nambung, WA. Australian Speleological Federation Newsletter, 62, 7–8.

McNamara, K., 1983. *Pinnacles*. Western Australian Museum, Perth, W.A: Western Australian Museum

McNamara, K., 1995. *Pinnacles* (Rev. ed.). Perth, W.A: Western Australian Museum

McNamara, K., 2009. *Pinnacles* (Rev. ed.). Welshpool, W.A: Western Australian Museum

Playford, P.E., Cockbain, A.E., & Low, G.H., 1976. Geology of the Perth Basin Western Australia. Geological Survey of Western Australia Bulletin, 124, 311 pp. https://library.dbca.wa.gov.au/static/Journals/080326/080326-124.pdf

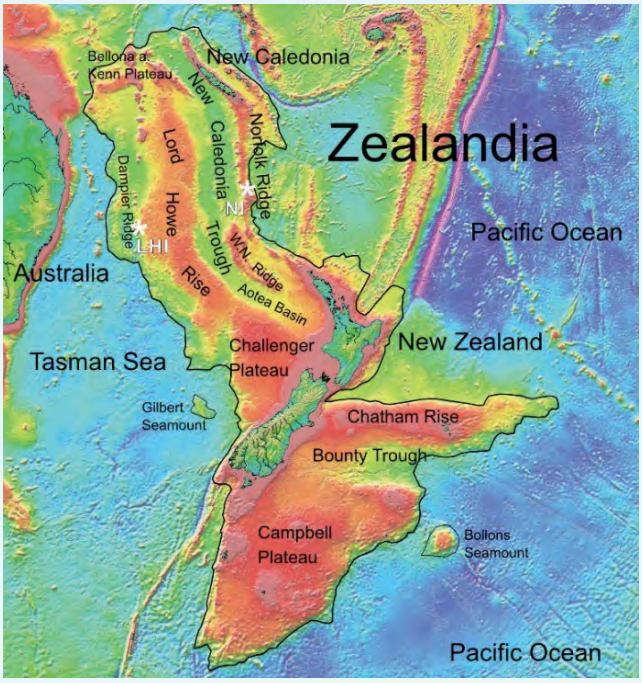
Norfolk Island: a little Aussie outpost in Zealandia

Brad Pillans, Director, National Rock Garden

People like dressing up on Norfolk Island, especially in 19th century uniforms, as my wife, Sue, and I discovered when we were there on holiday recently. Our visit coincided with Norfolk Island Founders Day, which included a re-enactment of the arrival of the first convicts (and soldiers) on 6 March 1788, led by Lieutenant Philip Gidley King, aka well-known local resident, Brooke Watson. This photo (Figure 1, right) shows me (not dressed for the occasion, sadly), with Brooke, after the flag-raising ceremony on Founders Day.

Figure 1. Brooke Watson and Brad Pillans at Founders Day, 6 March 2023. Image courtesy S. Pillans.

Norfolk Island is a little Aussie outpost that is closer to New Caledonia and New Zealand than it is to Australia. Indeed, the island, which is only 6 km in diameter and just over 300 metres above sea-level at its highest point, is part of the large, mostly drowned continent of Zealandia (Figure 2). Little is known about the rocks that occur underwater along the Norfolk Ridge, a major bathymetric feature that links New Zealand and New Caledonia. However, based on rock exposures in New Caledonia and New Zealand, the rocks of the Norfolk Ridge are presumed to be similar, i.e. sedimentary, and metamorphic rocks of Mesozoic age (Mortimer et al., 2021). Several seamounts (undersea volcanoes) occur on the western flank of the Norfolk Ridge—dredge samples from these have been dated to between 21 and 31 million years (Mortimer et al. 2021).



Norfolk Island and nearby, but much smaller Phillip Island, are the only emergent part of the Norfolk Ridge, and are largely built of basalt, erupted from sea floor volcano around 2 to 3 million years ago (Jones & McDougall, 1973). There are extensive outcrops of basalt in the coastal cliffs, and large basalt boulders occur on many beaches (Figure 3). Perhaps we could bring one or two to the National Rock Garden? More on that later…

With plentiful rainfall (1300 mm/year) and fertile basalt soils, it is no surprise that Norfolk Island is home to rainforest vegetation that shares many similarities with New Zealand. Throw in the endemic Norfolk Island Pine (*Araucaria heterophylla*) and the result is a stunningly beautiful, but distinctive ecosystem, devoid of native mammals, with birds as the dominant land animals. [Rats and rabbits came with Polynesian and European settlers, respectively].

Figure 2. Bathymetric map of Zealandia showing location of Norfolk and Lord Howe Islands, both of which are emergent sea floor volcanoes. The basalts on Lord Howe Island are around 7 million years old, whereas the rocks on Norfolk Island are 2–3 million years old. Blue colours = deep ocean, more than 3 km; red colours = less than 1 km deep. Image source: Wikipedia Commons.

Captain Cook 'discovered' Norfolk Island in 1774. Polynesian people had lived there hundreds of years before, but had abandoned the island by the time Cook arrived, leaving little trace except bananas (plantain or cooking bananas) that they had planted (Polynesian rats also stayed behind). Archaeological investigations subsequently revealed that Polynesian colonisation occurred in the 13th and 14th centuries, most likely from either New Zealand or the Kermadec Islands (Anderson & White, 2001). Stone artefacts, including adzes were made from local basalt, with obsidian being sourced from Raoul Island in the Kermadecs. Current research, led by archaeologists from the Australian Museum, is revealing further information on these artefacts (Vince, 2022).

Figure 3. Basalt boulders on Ball Beach, with Norfolk pines in the background. Image courtesy B. Pillans.

Within weeks of the First Fleet arriving in Australia in January 1788, Governor Arthur Philip ordered Lieutenant Philip Gidley King to lead a party of 15 convicts and seven free men to take control of Norfolk Island—they arrived on 6 March 1788 and that date is celebrated as Founders Day on Norfolk Island. More convicts (and soldiers) followed, and Norfolk Island operated as a penal colony until 1814, when it was abandoned, and all buildings were destroyed to prevent any inducement for other European powers (the French in particular) to move in.

Figure 4. View over the Kingston foreshore World Heritage precinct. Image courtesy B. Pillans.

From 1814 to 1824 the island was uninhabited, but then the British decided to have another go, and Norfolk Island was reoccupied as a place to send the worst convicts. This second penal settlement lasted until 1855, when the island was abandoned yet again. Most of the stone buildings in the historic Kingston area date to this period (Figure 4). In 1840, Alexander Maconochie became commandant of the penal colony and was known for his more humane treatment of the convicts—the Canberra jail is named after him—but after he left in 1844, commandants reverted to the former regime of brutal terror.

The next settlement began on 8 June 1856, as the descendants of Tahitians and the HMS *Bounty* mutineers, including those of Fletcher Christian, were resettled from the Pitcairn Islands, which had become too small for their growing number.

Today, the population of Norfolk Island is around 1,800, and the most common surname in the Norfolk Island phonebook is Christian! Tourism is the mainstay of the island's economy, as Sue and I can attest. A lasting impression is how friendly everyone is—a local custom is for drivers to wave to other drivers on the road. And there is no crime, no graffiti and people don't lock their cars or their houses. Our accommodation package included a complimentary hire car—I never did find the electronic key fob, but it was in the car, somewhere, and that was all that mattered, according to our hosts!

Norfolk Island was self-governing from 1979 to 2015, and Sue and I were fortunate to meet David Buffett, the last Chief Minister, while we were there (Buffett is also a Pitcairn name). The island is now administered by NSW, but there is also a curious Canberra connection—Norfolk Islanders vote in the Canberra-based Federal electorate of Bean, with David Smith as their MP.

A Norfolk Island rock for the National Rock Garden?

Last year, Mike Smith also visited Norfolk Island, and initiated discussion with David Buffett regarding the possibility of obtaining a rock or rocks from Norfolk Island for the NRG. David was very supportive of the idea and remains so after my visit this year.

There are two major rock types on the island—basalt and calcarenite. Basalt is overwhelmingly the dominant rock type, but on the south side of the island, there are extensive outcrops of calcarenite—a kind of soft limestone composed of fragments of shell and coral, which were washed up on the beach and later cemented by calcium carbonate derived from partial dissolution of the shell and coral fragments (Figure 5). The calcarenite was extensively used as a building stone for all convict-era buildings on Norfolk Island (Figure 4).

Figure 5. Calcarenite outcrops looking south to Nepean and Phillip Islands. Image courtesy B. Pillans.

Figure 6. An odd-shaped basalt boulder. Does it remind you of Kermit the frog? Image courtesy B. Pillans.

My recommendation is that we bring both basalt and calcarenite to the NRG, to represent Norfolk Island. Suitable large basalt boulders are readily available on beaches (Figures 3 and 6) and scattered through the interior of the island (Figure 7). However, outcrops of calcarenite only occur within the World Heritage listed area of the island, and on Phillip Island, more correctly referred to as an islet (area about four hectares), just offshore, both areas of which may present logistical difficulties for acquisition of a suitable specimen for the NRG. Alternatively, it may be possible to obtain a calcarenite building stone from a ruined building or stone wall elsewhere on the island.

Figure 7. Mike Smith inspects a large basalt boulder at an inland location. Image courtesy B. Smith.

Transport of Norfolk Island rocks to Canberra is also a logistical difficulty to be overcome. Supply ships come to Norfolk Island approximately monthly, and cargo is unloaded at one of two jetties, on opposite sides of the island, depending on sea conditions. However, the supply ship cannot dock at the jetties and a smaller boat is used to ferry cargo from ship to shore (Figure 8). I did not establish the maximum size/weight that can be loaded/unloaded, but cars were being unloaded when I was there.

Figure 8. The wharf at Cascade Bay on the north coast of Norfolk Island, with a supply ship moored offshore, waiting to be unloaded. Image courtesy B. Pillans.

References

Anderson, A., White, P. (Eds.), 2001. The Prehistoric Archaeology of Norfolk Island, Southwest Pacific. Records of the Australian Museum Supplement 27. Australian Museum, Sydney, 141 pp. https://doi.org/10.3853/j.0812-7387.27.2001.1334

Vince, C., 2022 (October 29). *Priceless archaeological artefacts found in Norfolk Island National Park by local citizen scientist.* Australian Museum. https://australian.museum/about/organisation/media-centre/archaeological-artefacts-norfolk-island/#:~:text=Norfolk%20Island%20National%20Park%20Manager,island%2C%E2%80%9D%20Mr%20Greenup%20said

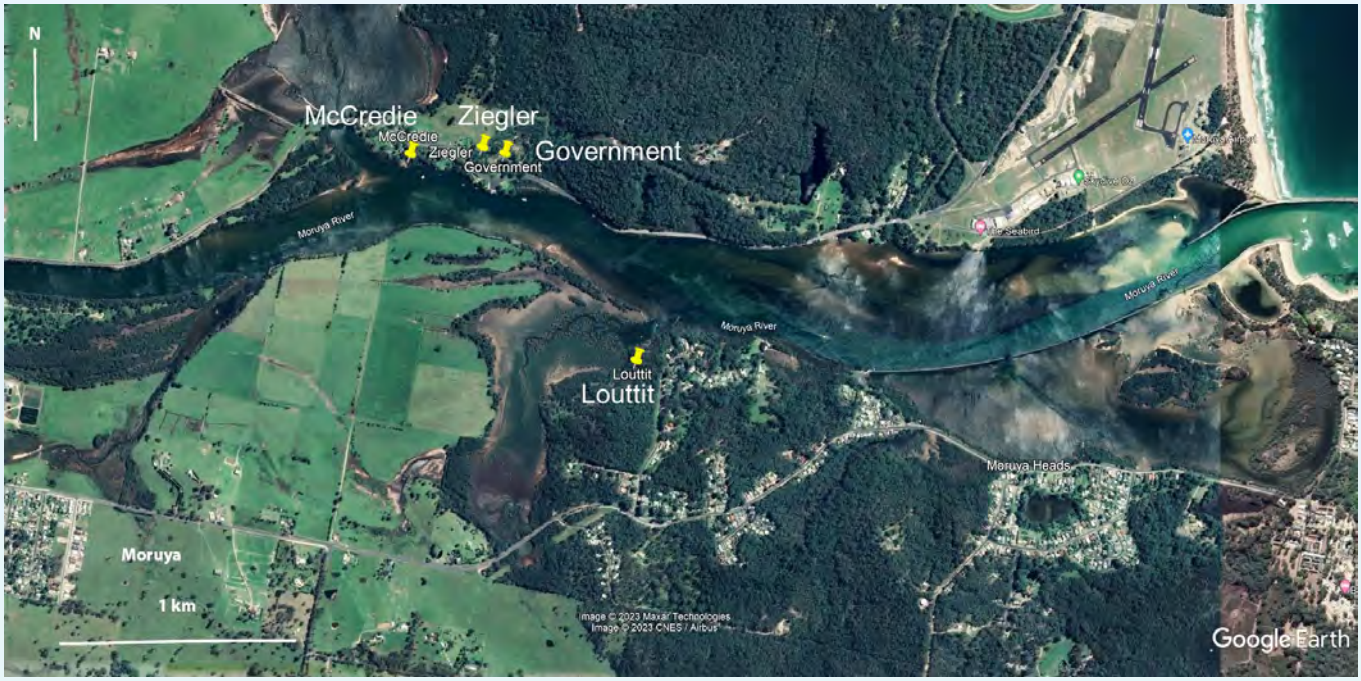
Jones, J.G., McDougall, I., 1973. Geological history of Norfolk and Philip Islands, southwest Pacific Ocean. Journal of the Geological Society of Australia, 20(3): 239–254. https://doi.org/10.1080/14400957308527916

Mortimer, N. et al., 2021. The Norfolk Ridge seamounts: Eocene–Miocene volcanoes near Zealandia's rifted continental margin. Australian Journal of Earth Sciences, 68(3): 368–380. https://doi.org/10.1080/08120099.2020.1805007

Moruya: a source of stone

Ken McQueen, National Rock Garden Steering Committee

The Moruya Tonalite (generally known as the Moruya granite) has been widely used as an ornamental and monumental stone, as well as for building and construction. The 'grey granite' is best known as the rock used to face the pylons of the Sydney Harbour Bridge in the early 1930s, but the rock has a much longer history of use. Local to Moruya, the granite was used extensively to construct breakwaters and training walls on the Moruya River. Master Pilot John Ross was the first to recognise its potential for wider application and in 1866 he suggested the granite could be used to pave the streets of Sydney to reduce erosion. Ross noted *'I do not think it is generally known that the banks of the Moruya River abound with granite of the finest quality, very easy of access… the citizens of Sydney may be pleased to know that there is an abundant supply of this stone so necessary for their streets and public buildings so easy to be got, and so near at hand.'* (Ross, 1866). Ross also sent samples of the granite to the Colonial Architect (Jurmann, 2019). Very little Moruya granite appears to have been used to pave the streets of Sydney, but it was used in many public buildings and monuments in Sydney and beyond.



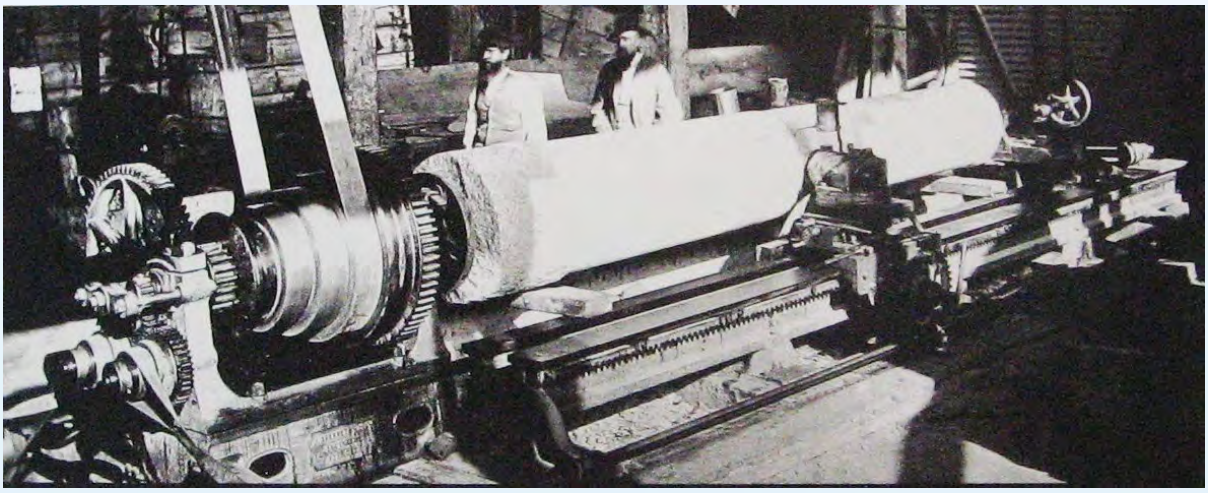
Google Earth image of the Moruya area showing the Moruya River and the locations of the granite quarries (yellow markers).

Multiple quarries were developed close to the Moruya River to supply stone over a long history of quarrying. The river provided convenient access for transport by coastal shipping. The first quarry was established around 1861 by Scottish brothers Joseph and John Louttit. The Louttit Quarry was located on the south bank of the Moruya River 2.6 km upstream from the river mouth. Initially rock was supplied for breakwaters and walls along the river. In 1867, John Young won the contract to complete a part of the masonry work for the new General Post Office in George Street, Sydney. To provide suitable granite for columns he took out a seven-year lease on the Louttit Quarry. To make the Moruya granite columns for the GPO, steam powered lathes and other machinery were introduced in Australia for the first time. The GPO was officially opened in 1874 and at the time was considered the finest buildings in Sydney. During this period Young also supplied Moruya some granite columns from the Louttit quarry for Saint Mary's Cathedral in Sydney.

Louttit Quarry in 2012. Image courtesy B. Pillans.

Face of the Louttit Quarry in 2012. Note lack of jointing and drill hole at the centre top. Face about 6 to 7 m high. Image courtesy B. Pillans.

In 1868 it was decided to construct a statue in honour of Captain James Cook, to be placed in Hyde Park, Sydney. Moruya granite blocks for the statue pedestal were provided from the Louttit Quarry. After much difficulty and adventure these blocks arrived on site in 1869 and the pedestal was erected, but it was another ten years before the statue was added (Jurmann, 2019). When Young's lease expired in 1874 the Louttit brothers continued operating the quarry, supplying stone for buildings in Moruya, including the Bank of New South Wales building in Vulcan Street. The Louttit Quarry operated until 1895 (Gibson et al., 2010).



Abernethy stonemason's lathe in use. Source: Moruya and District Historical Society.

Abernethy stonemason's lathe used for making granite column sections, Moruya Museum. Image courtesy K. McQueen.

The Ziegler Quarry was established on the northern bank of the Moruya River at Pompey Point by Henry Ziegler and his father-in-law Joseph Ard in 1864. Ziegler, a monumental mason, was born in Prussia and migrated to Australia in 1860, settling at Moruya around 1863. The Ziegler Quarry supplied monumental masonry but also building stone. At least three major buildings in Moruya were built with granite supplied by Zieglers, including the Wesleyan (now Uniting) Church, the Anglican rectory and the Roman Catholic Church. The quarry also produced some columns for Saint Mary's Cathedral in Sydney and in the early 1880s supplied 30,000 tons of 'stone cube' sets for the Government tramway (Gibson et al., 2010). Most of Henry Ziegler's sons went into the monumental mason business and in later years focussed on monumental work, particularly headstones, including the monument over the grave of Archdeacon D'Arcy in front of St Bede's Catholic Church in Braidwood (Jurmann, 2019).

Obelisk of Moruya granite from the Louttit Quarry on the corner of Campbell and Vulcan streets in Moruya. Image courtesy K. McQueen.

The McCredie Quarry, located further up the river from the Ziegler Quarry, was set up by Arthur and George McCredie of McCredie Brothers, architects, engineers and builders. In 1882 it was decided to extend the General Post Office building in Sydney to its second stage and McCredie Bros were engaged for the project. The extension included a colonnade of columns, and it was decided to use Moruya granite to match the columns in the other parts of the building. The McCredies purchased three acres of land at Pompey Point specifically to quarry the granite. On completion of the second stage of the GPO the McCredie Quarry supplied stone for the pedestal of the Queen Victoria statue in Sydney. This pedestal was erected in High Street between St James Church and Hyde Park in anticipation of moving the Queen Victoria statue from the Garden Palace to a new site. Before the move could be made, the Garden Palace and statue were destroyed on 22 September 1882 in a disastrous fire. The pedestal, like that for the Captain Cook statue, stood vacant for many years before a replacement Queen Victoria could be sculpted and enthroned (Jurmann, 2019). When the McCredie Bros constructed the Chief Secretary's Building in Macquarie Street, they incorporated Moruya granite columns in the entrance and twenty-five columns on the upper floor. They also included twenty Moruya granite columns on the ground floor of the Burns Philp Building.

The Government Quarry, also known as Dorman Long & Co. Quarry and the Public Works Department (PWD) Quarry, became the largest of the quarries at Moruya. A small Government quarry was established east of the Ziegler Quarry at Pompey Point in 1875 to supply granite for the breakwater at the north head of the Moruya River via a tramway. Between 1876 and 1885 rock from the quarry was used to build the breakwater. Following several serious accidents work ceased at the quarry in 1885 for many years, however it was later used up until 1924 to supply rock for training walls and riverbank protection (Gibson et al., 2010).

Southwestern side of Government Quarry, Moruya, in January 2023. Image courtesy K. McQueen.

In July 1923, Dorman Long and Co. Ltd won the contract to build the Sydney Harbour Bridge and began looking for suitable material to face the piers and pylons of the new bridge. Moruya granite was chosen because of its well-known quality, plentiful supply and ready access next to the Moruya River for loading onto boats. The company appointed a Scot, John Gilmore as the quarry manager and he arrived in Moruya in November 1924. Preparatory work began at the site of the Government Quarry, including construction of a new wharf. In May 1925, Dorman Long & Co purchased a larger area of land for the quarry for £1,200 and the work of quarrying, shaping and finishing the panels for the bridge began in earnest (Gibson et al., 2010).

John Gilmore sought masons and quarry workers to complete the large project at Moruya, ultimately employing over 200 of 13 different nationalities, including a large number from Scotland and Italy. To house the workers and their families, a small township called Granite Town was constructed just northwest of the quarry, with a school, co-operative general store, post office and public hall. Many single men lived in barracks closer to the river. The total population fluctuated with the work requirements, but in March 1927 it was 304 (Gibson et al., 2010).

View of houses in Granite Town ca. 1926. Source: NSW State Archives and Records.

Work on the Sydney Harbour Bridge project continued until early 1932. The quarry was then closed and all the moveable equipment and infrastructure from the quarry, work sheds and Granite Town were sold. Some of the workers moved to Moruya. The large project had been a significant industry and support for Moruya, particularly during the early years of the Great Depression. Over the seven years of quarrying, 173,000 blocks of granite were produced to face the piers and pylons of the Sydney Harbour Bridge as well as 152,910 cubic m of crushed stone. Although focus was on the bridge work, at least four other jobs of a monumental nature were completed during this period. These included the Cenotaph for Martin Place in Sydney, a pedestal for a statue at St. Mary's convent, Moruya, a war memorial for the town of Araluen and the Dorman Long & Co memorial in St. Michael's, Vaucluse erected by Lawrence Ennis, Director of Construction for the Bridge (Gibson et al., 2010; Yuin Moruya Community).

After the quarry closed its ownership reverted to the NSW Public Works Department and it lay idle until 1947 when it was re-opened to carry out further works on the breakwater and training walls of the Moruya River. The wharf had to be reconstructed and a new tramway laid. This work finally ceased in 1954 and since then the quarry has been worked very intermittently on an as needs basis to the present (Gibson et al., 2010).

The quarries and site of Granite Town were nominated as a significant engineering heritage site in 2010. The Historic Quarry Park was constructed over the area of the former masonry works at the Government Quarry and officially opened in 2017.

Remnants of jetty at Pompey Point on the Moruya River near Quarry Park and the Government Quarry. Image courtesy: K. McQueen.

Historic Quarry Park on the site of the former masonry works of the Government Quarry at Pompey Point. Constructed by the Moruya Rotary Club. Image courtesy: K. McQueen.

References

Ross, J., 1866. Letter to the Editor from John Ross. *The Empire* newspaper, 9 August 1866, p5. https://trove.nla.gov.au/newspaper/title/67

Jurmann, J., 2019. *Set in Stone: Moruya's place in the history of NSW*. Moruya and District Historical Society Inc., 36 pp. https://mdhs.org.au/pdfs/Set_in_Stone_Flyer.pdf

Gibson, J., Clarke, M., & Renwick, S., 2010. A nomination for the recognition of Moruya Granite Quarry Complex & Granite Town as significant engineering heritage sites. Presented to the Engineering Heritage Committee of Engineers Australia. Heritage Consulting, 42 pp. https://portal.engineersaustralia.org.au/system/files/engineering-heritage-australia/nomination-title/HRP.Moruya%20Granite%20Quarries.Nomination.April%202016.pdf

Yuin Moruya Community (n.d.). *Moruya Granite Quarry*. Yuin Moruya Community Storylines site. Retrieved 11 May 2023 from https://moruya.storylines.com.au/2015/06/15/moruya-granite-quarry/

The Federation Rocks display at the National Rock Garden

WE NEED 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, following the works approval granted by the National Capital Authority earlier this year, is to appoint, via tender, a construction company to undertake the site landscaping.

Please make a tax deductible donation:

BANK TRANSFER:

Account Name: National Rock Garden
BSB: 082-057
Account Number: 11-836-1338

CREDIT CARD:

Name: ……

Address: ……

Credit card: Visa: ……. MasterCard: ……. (Please tick one)

Credit card number: ……

Name on card: …… Expiry date: …… CVV: ……

Email address: ……

Phone number: …… Donation amount: $……

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 visit https://www.nationalrockgarden.com.au/support/.

Join our mailing list

The newsletter is circulated twice a year. New 'friends' are welcome and can be added to the email circulation list by contacting Brad or Michelle (details above), or by clicking the 'subscribe' button on the NRG homepage.

Follow us on social media

Keep up with the latest NRG news, rock movements, feature stories and a whole lot more:

https://www.facebook.com/pages/National-Rock-Garden

https://www.instagram.com/nationalrockgarden/

https://twitter.com/NatRockGarden

Newsletter compiled and edited by Michelle Cooper.