South Australian
HERITAGE COUNCIL

SUMMARY OF STATE HERITAGE PLACE

Entry in the South Australian Heritage Register in accordance with s14(1)(a) of the *Heritage Places Act 1993*

NAME: Munro Karst **PLACE NO.:** 26606

ADDRESS: First Nations of the South East Country
407 Hynam Caves Road
Mount Light SA 5271
CT 6100/748, D88823 A100, CR 5677/773, H440700 S487, CT 6100/749 D88823 A101, Hundred of Jessie

STATEMENT OF HERITAGE SIGNIFICANCE

Munro Karst offers a high potential to yield new scientific information about the Hynam Range and early Pleistocene cave development and biodiversity of the South East region. Located on the Hynam Range, in the Naracoorte area of the South East region of South Australia, its location is significant as the Hynam Range is probably the oldest of a series of Pleistocene coastal ridges that extend from Naracoorte to the modern coast. These ridges have been heavily degraded by natural erosion and land use since European colonisation but preserve a record of landscape evolution, ancient sea levels, regional uplift, and glacial to interglacial climate cycles over the last two million years. Preserved within the Munro Karst is a large, mostly intact limestone cave system that is rare on the Hynam Range and is potentially older than any others in the region, including those within the World Heritage listed Naracoorte Caves.

The combination of associated features preserved within the Munro Karst, such as large caves with multiple levels of passage, subaqueous speleothems, bedded calcite raft deposits, calcite and gypsum minerals, sediment deposits, solution pipe infills, and vertebrate fossil breccias is rare for the South East. Scientific investigation of the cave system would improve understanding of the natural history of South Australia, specifically its speleological, palaeontological and geological history.

RELEVANT CRITERIA (under section 16 of the Heritage Places Act 1993)

(c) it may yield in formation that will contribute to an understanding of the State's history, including its natural history

Munro Karst provides a window into a poorly understood area of the broader Naracoorte karst landscape (the Hynam Range) and offers a unique opportunity to reveal the age and evolution of the area via scientific research. Careful analysis of the structure of the caves and karst, dating of associated sediments and speleothems, and identification of vertebrate fossils would enable reconstruction of the earliest history of cave formation and biodiversity in the region and will contribute to an understanding of karst geology, palaeontology and the evolution of caves systems in South Australia.

The following outlines the aspects of the State's speleological, geological and palaeontological history demonstrated by Munro Karst.

Pleistocene landscape evolution – determining the precise age of the Hynam Range via the Munro Karst will confirm whether it is a) Pleistocene and b) the oldest in the series of Pleistocene dunes. This knowledge would fundamentally improve our understanding of the early Pleistocene history of the region as this is not represented by any known sites in the region. It would also provide important context for understanding the World Heritage Naracoorte Caves and the development of the Naracoorte Ranges.

Cave and karst development – Munro Karst may provide evidence in the Naracoorte and broader South Australian context for cave and karst development. Munro Karst contains multiple lines of evidence that can help elucidate the age of the system and how the caves formed including structure and form, along with sediments, speleothems and cave minerals that can be dated using numerical dating techniques to yield precise ages. This would provide the 'missing link' in knowledge about the earliest development of caves in the region and State and expand on recent related research focussed on the Naracoorte Caves.

Pleistocene climate – Dating of speleothems preserved in the quarry, using Uranium-series dating, would elucidate the age and timing of climate oscillations, such as glacial to interglacial cycles, that can be deduced from the same materials via geochemical analysis. If the caves are of early Pleistocene age this would greatly enhance the past climate record obtained so far from Naracoorte Caves. This would be the oldest speleothem palaeoclimate record obtained from the State. Cave minerals, sediments and fossils can also provide further evidence for past climates.

Biodiversity and evolution - Vertebrate fossils within sediments and breccia deposits of Australian vertebrate faunas within Munro Karst potentially encompass the early Pleistocene (2.58 to 0.77 Ma). The hardened fossil breccia solution pipe infill deposits are also not known from any other caves in South Australia. Analysis of the species composition of the fossil samples from Munro Karst would greatly enhance the understanding of Pleistocene biodiversity in the Naracoorte region and the State. If they are early Pleistocene, they would be the oldest vertebrate fossils found in caves of the region and represent a time period not covered by any other cave site in South Australia. The range of species present at the time of accumulation, their ecology and relationship to other deposits can all be studied from these deposits.

The information that is likely to be yielded by scientific investigation of Munro Karst has not been previously documented or available from other sources because:

- Caves previously found on the Hynam Range are typically quite small or are heavily degraded by visitation, exploration, and land use practices (agriculture, rubbish dumping). Because of these factors, no other caves on the Hynam Range contain suitable materials with enough integrity and intactness for scientific investigation at the level of detail required to produce rigorous results.

- Munro Karst and its associated caves contain such a high diversity of features and materials for study that it is well placed to address the research themes outlined earlier. In the specific context of the Hynam Range and South East Region this is not provided by any other site; therefore, the level of scientific investigation that can be undertaken at Munro Karst has not been possible on the Hynam Range before.

- There has been little to no peer-reviewed, published research about the Hynam Range and its associated features. The age of the range and associated caves has only been estimated previously and not been tested using modern analytical techniques. Therefore, the information that Munro Karst can potentially yield is not currently available elsewhere.

Munro Karst preserves the largest remaining intact area of surface karst along the Hynam Range, as much of the dune is naturally eroded or destroyed by land use. The Munro Karst retains the level of intactness and integrity required to yield information through scientific investigation. Although portions of the cave system have already been quarried, and despite a long history of agricultural land use, a large section of cave is preserved and is likely larger than currently known and in pristine condition for scientific study. There is also enough material to allow preservation of representative samples for their intrinsic value. This is important to

maintain with limited access and carefully regulated research as they are representative of a system that is largely gone along the Range, or in poor condition.

DESIGNATION

Entry in the South Australian Heritage Register in accordance with S14(7)(a)(i) and s14(7)(b) of the Heritage Places Act 1993

STATEMENT OF DESIGNATION

Designated Place of Speleological Significance

Munro Karst contains multiple karst and cave features which hold high value for speleological research. Included among these are speleothems, sediments and fossils that can be dated using numerical techniques to elucidate the age of the cave system and preserved fossil faunas.

Caves at Munro Karst may represent the earliest period of development in the Naracoorte area as they are positioned on the Hynam Range, which is of uncertain age but potentially up to two million years old. Therefore, the caves and associated fossils and speleothems may yield the only early Pleistocene cave deposits in South Australia.

The intact nature of much of the Munro Karst provides a rare representative area of surface karst that is largely degraded along the Hynam Range. The caves of the site are the largest, intact caves along the range and provide high scientific value for understanding cave development and karst landscape evolution in the State.

Elements of Significance:

Elements of heritage significance include (but are not necessarily limited to):

- Caves within the site, including cave walls, floors, roof and entrances.
- Speleothems (calcite, gypsum) within the caves and quarry rockpiles including but not limited to flowstone, stalactites, stalagmites, columns, sub-aqueous crystal deposits, moonmilk, calcite covered root speleothems and other cave mineral features.
- Cave features including undisturbed sediments (naturally deposited), undisturbed cave floors and rock piles, *in situ* fossils (embedded in walls and trace fossils), natural collapses and rockfall formations.
- Surface karst features such as pavements, calcrete, cave entrances, and runaway holes.
- Vertebrate fossils, fossil breccias, solution pipe sediment fills.
- Evidence exposed and preserved in the quarry walls and floor, including but not limited to cave entrances, cave passages, solution pipes and their sediment infill, sediment deposits within exposed cave passages, calcite, calcified tree roots, limestone rocks, marine fossils, intact limestone rocks.

- Rock piles and limestone rubble with evidence of fossils, breccias, and cave minerals or features.

Elements not considered to contribute to significance of place include (but are not necessarily limited to):

- Built structures.
- Fences, agricultural and residential infrastructure.

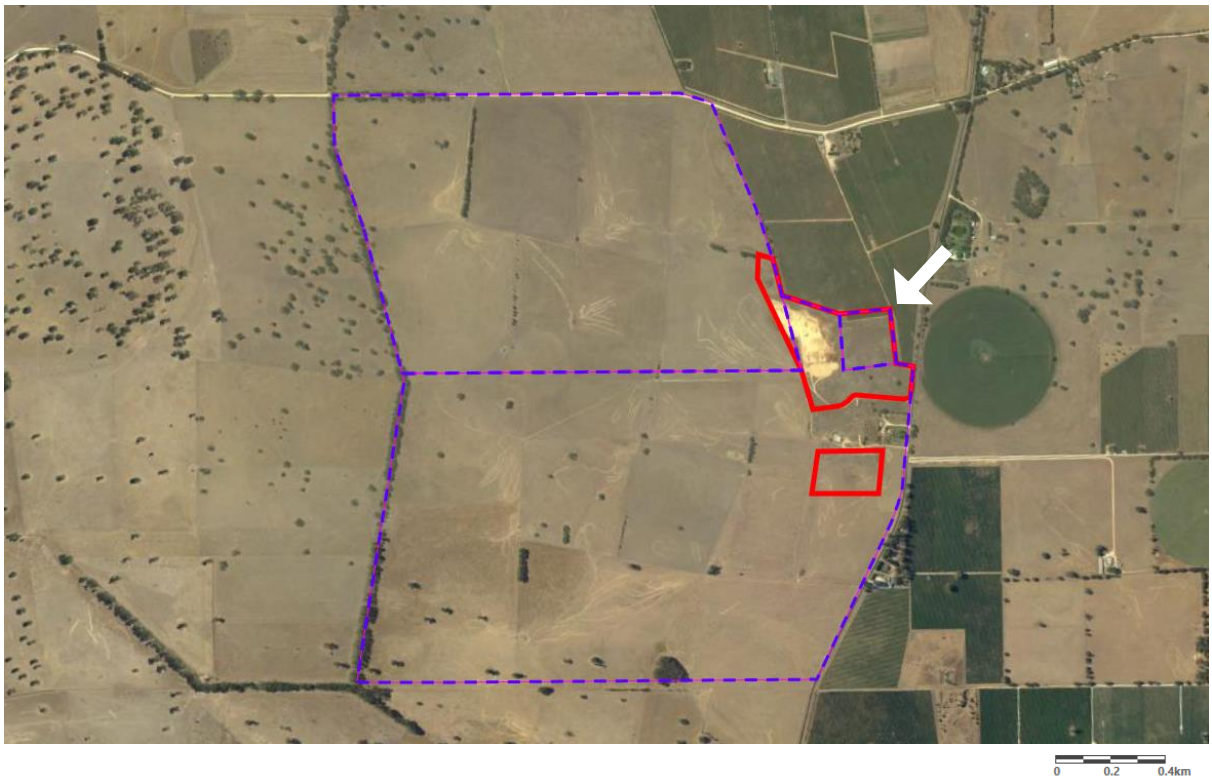
SITE PLAN, PHYSICAL DESCRIPTION & ELEMENTS OF SIGNIFICANCE

Entry in the South Australian Heritage Register in accordance with s14(2)(a) of the *Heritage Places Act 1993*

Site Plan

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271



Munro Karst, 407 Hynam Caves Road, Mount Light, 5271, South Australia.
CT 6100/748, D88823 A100, CR 5677/773, H440700 S487, CT 6100/749 D88823 A101
Hundred of Jessie

LEGEND **N ↑**

Parcel boundaries (Indicates extent of Listing)

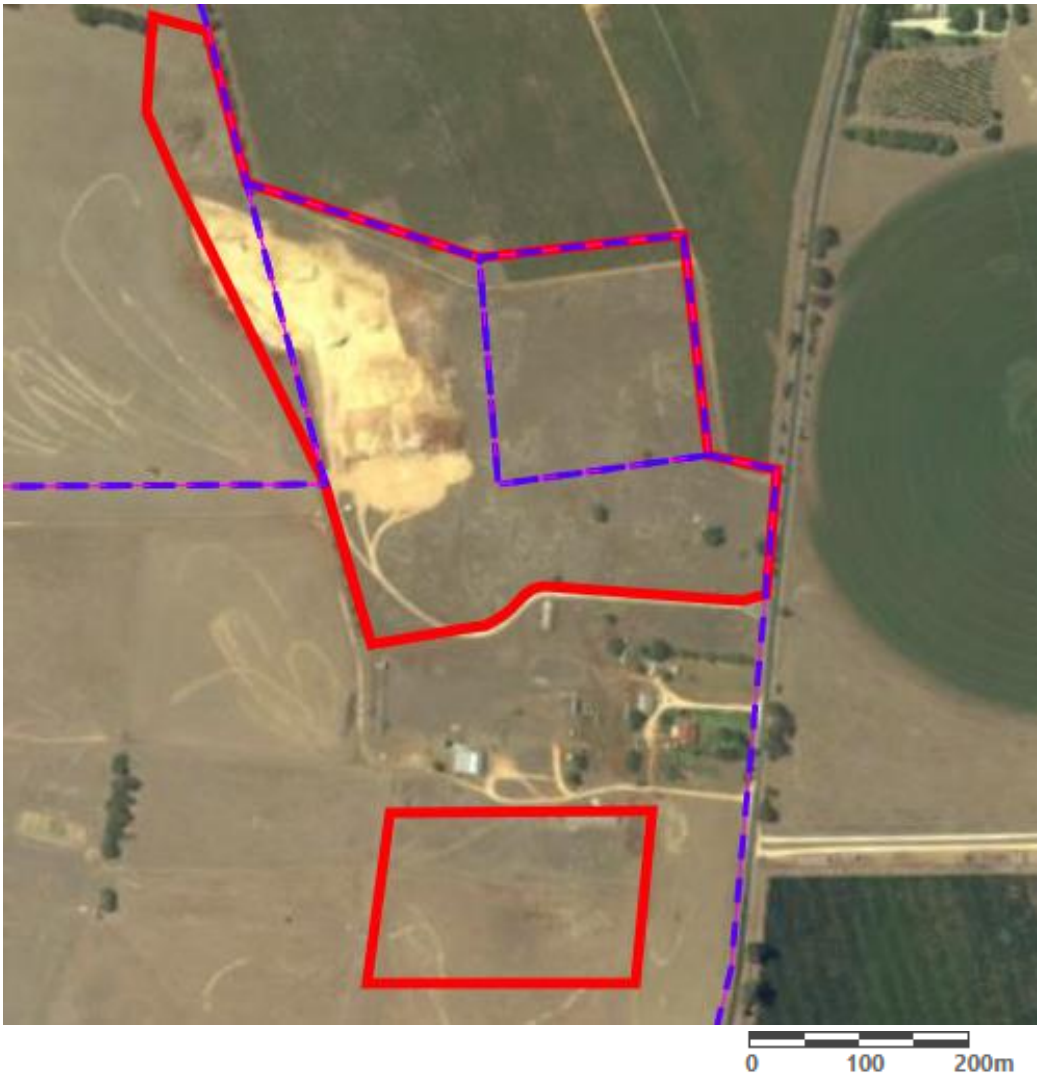
Outline of Elements of Significance for State Heritage Place – Red outline is indicative of elements of significance, noting imperfect alignment of aerial imagery with parcel cadastre.

Provisionally entered & Designated by the South Australian Heritage Council on 23 August 2024
Confirmed by the South Australian Heritage Council on 10 April 2025
Designation retained by the South Australian Heritage Council on10 April 2025

Site Plan - Detail

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271



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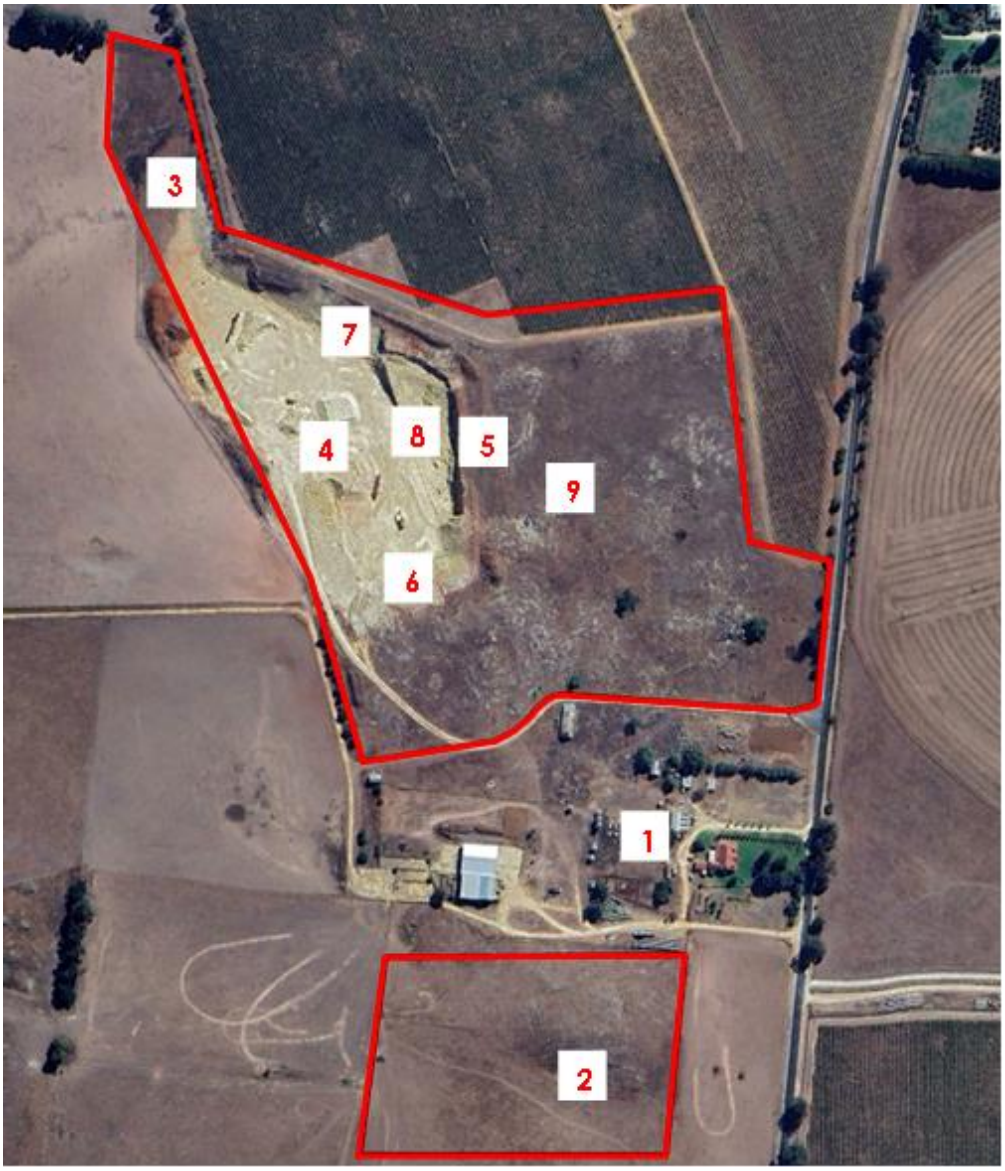

1: Homestead and associated buildings, 2: Runaway hole, 3: Runaway hole, 4: Quarry, 5: NE quarry face with exposed cave entrances, solution pipes, sediment infills, 6: S quarry face with evidence of cave passage, 7: Rockpiles with fossil breccia, 8: Quarry floor with exposed cave passage, fossil and speleothem rubble. 9: Area of surface karst

LEGEND **N ↑**

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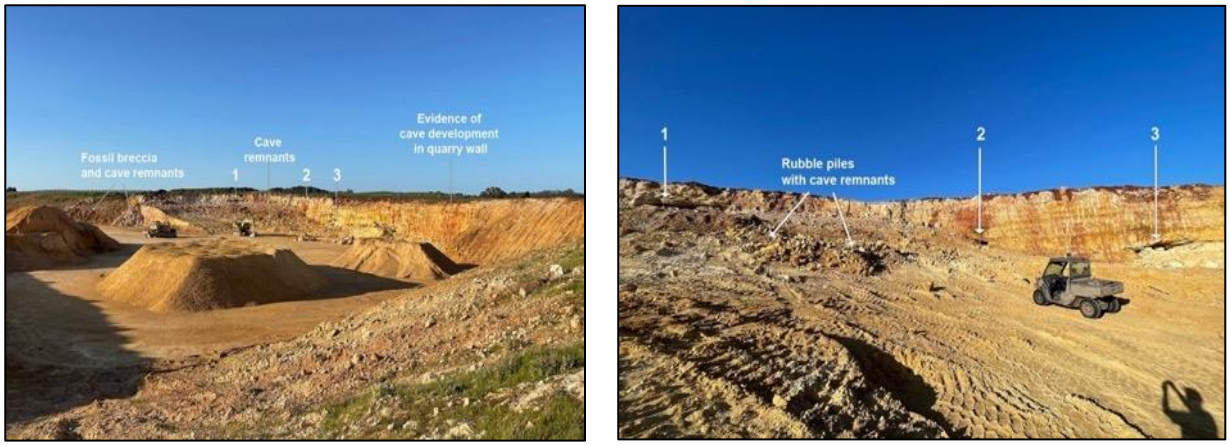
Physical Description

The Munro Karst site is located on the Hynam Range in the Naracoorte area of the South East region of South Australia. The site is situated on an agricultural property, part of which has been used for limestone quarrying over the past decade. The property occurs in an area that is characterised by limestone caves and surface karst features such as limestone pavements and runaway holes. The proposed Heritage Place encompasses a limestone quarry and adjacent intact karst landscape. Both the quarry and intact karst area contain significant values.

Caves

Large cave passages have been exposed by quarrying in three positions on the northeastern face of the quarry. Additional, cave passages were uncovered along the southern face and floor of the quarry. These represent a large, interconnected cave system. Prior to this there was no record of large caves at the property; however, surface karst features, and runaway holes were well known there prior to quarrying. These are often indicators of cave development below the surface and are important to karst hydrology.

The caves contain vertebrate fossils, sediments and speleothems, along with evidence of ancient cave development processes. The Munro cave system is likely to be extensive, with currently accessible caves representing approximately 60m of passage, 1 to 4m in height. There may be at least 100m of passage in the currently



Munro Quarry showing holes leading to caves on the north-eastern wall – numbered 1, 2 and 3, position of rubble piles, and other features mentioned in the text (above and below).

Source: E. Reed, 2023.

accessible portions and the system probably extends into the area of the karst that has not been quarried. Surface karst evidence indicates this is the case.

The Munro Karst caves evident in the northeastern face of the quarry are described here as cave entrances 1,2,3 but note that these are breaches of the system due to quarrying and not natural entrances. There are also smaller breaches into the cave system evident on the southern face of the quarry, and natural entrance pathways in the intact surface karst areas. The following describes the accessible portions of the cave on the northeastern face of the quarry.

Cave entrance 1 – the largest of the accessible entrances, it leads to a cave chamber that is around 160m^2 with a ceiling height of around 1.5m. The central part of the chamber consists of rock piles, with fossil-bearing sediment deposits evident on the floor and along the cave walls. There are also areas of clay-rich sediments. Calcite speleothems (flowstone, stalagmites and stalactites) are present in the chamber, along with gypsum crystals on some of the limestone rubble. A singular feature of the chamber is a large area of fossil tree roots (also known as rootsicles or arborites)[1] on the ceiling, that have developed into branching calcified root casts and calcite stalactites. The walls of the cave are covered with moonmilk in places, which is a white, micro-crystalline calcite deposit.

Features of the cave associated with entrance 1 include:

- An extensive area of calcite covered tree root speleothems known as rootsicles or arborites.
- Calcite stalactites, flowstone, stalagmites and moonmilk.
- Gypsum mineral formations on the sediment floor and rock surface.
- Sub-aqueous calcite mineral formations.
- Vertebrate fossils preserved within sediments on the floor of the cave, and within rubble and sediments at the entrance.
- Sediments on the cave floor including quartz, carbonate and clay-rich materials.

Cave entrance 2 – leads to an extensive portion of cave development totalling >60m of passages and chambers, much of which has a ceiling height of >1.8m. The entrance hole, broken into during quarrying, is approximately 2m wide and around 0.7m high. In the quarry wall above the hole is a large sediment infill deposit, along with calcite raft and sub-aqueous crystal deposits indicating past water levels.

Within the cave associated with entrance 2 are two distinct leads connected by a large chamber with upper and lower levels. The deeper section that leads on from the right of the entrance connects back to entrance 3 at the southern end. The left lead reveals an extensive section of cave passage that has multiple passages branching off from a central long passage that runs in a northerly direction. This

passage has at least three distinct levels, which represent interconnected but different periods of cave development. Solution features (formed by ground water during cave development), are clearly observable on the cave walls and ceiling, along with sub-aqueous calcite crystal pockets. The lower level contains pristine sediment deposits and unusual calcite crystal clusters on the cave wall and rockpiles. Clay-rich sediments are present on the cave floor and adhering to the walls in places.

Cave entrance 3 – connects with the cave passages described above; however, it is unsafe for entry into the cave due to damage from quarrying. Part of the passages leading from this entrance are accessible from entrance 2. A large slab of white calcite flowstone is visible to the left of the hole but has mostly been quarried away. This flowstone overlies cave sediment deposited near the entrance. Entrance 3 is approximately 4m wide and around 0.5m high.

Features of the caves associated with entrances 2 and 3 include:

- Large, cave passages and chambers.
- Sediment infill deposit, calcite raft and sub-aqueous crystal deposits at the entrance in the northeastern face of the quarry.
- Flowstone and other calcite speleothems.
- Multi-level cave passage.
- Solution features on the cave walls and ceiling, along with sub-aqueous calcite pockets.
- Pristine sediment with associated calcite crystal clusters on the cave wall, rockpiles and sediment surface.
- Sediments on the cave floor including quartz, carbonate and clay-rich materials.

Fossils

Rockpiles throughout the quarry contain remnants of cave floors, speleothems, and fossil deposits. In the northern rockpile there are remains of hardened, fossil bone rich breccias derived from sediment infills of solution pipes and fissures. Vertebrate fossils are easily discernible in the breccias. A fossil tooth from a kangaroo was found in the breccia along with cranial material from small mammals and postcranial material from large mammals. Given the number of solution pipes evident in the quarry wall, it is likely that further breccias are preserved in the un-quarried portion of the site.

Within the caves, vertebrate fossil bones are present within cave sediments and on the floor surface in places, particularly in the cave associated with cave entrance 1. Marine invertebrate fossils are visible in the limestone in the quarry and cave walls.

As approximately 60% of the cave system remains undisturbed and from current evidence it is likely that undescribed species of short-range endemic cave invertebrate faunas are present.

Palaeontological features include:

- Hardened fossil breccia containing vertebrate fossils and representing ancient solution pipe fills.
- Fossil bones within sediments and on the surface of the cave floors and within rockpiles.
- Invertebrate fossils within the limestone of the quarry walls, rockpiles, and cave walls.

Other features of the quarry, and Surface karst

Calcite speleothems and rare bedded calcite raft sections have been found in rockpiles within the quarry. These features are also seen in the quarry walls and caves. Extensive development of solution pipes and fissures with associated sediment fills are visible in the exposed walls of the quarry. Entrances to a large cave system are present in the northeastern face of the quarry (as described in the previous section), and smaller openings have been uncovered in the southern face. Additional, small cave passages are visible in the northeastern face at a higher level than the previously described caves.

Extensive evidence of karst and cave development is present in Munro quarry and the adjacent block of land. On the land surface in the block adjacent to the quarry there is evidence of cave entrances, vadose (underground, above the water table) water flow pathways, limestone boulders, and runaway holes. On the southern side of the homestead there is a large, intact runaway hole, and another on the northern end of the quarry. The latter was filled in during quarrying and requires restoration, but the former is still active and intact. In karst landscapes, these features are characteristic of extensive subterranean development and key components of the groundwater hydrological system. Intact karst pavements of weathered limestone are present on the surface in the area adjacent to the quarry.

Features of the surface karst and quarry include:

- Rockpiles – contain evidence of calcite speleothems including bedded calcite raft deposits.
- Solution pipe and fissure development with associated sediment infills. Some of these contain vertebrate fossils as evidenced by remnant fossil breccia found in the rockpiles.

• Entrances to a large cave system, and smaller openings to cave passage evident in the quarry walls and floor.

• Extensive and largely intact surface karst features including pavements, evidence of past water flow (karren), cave openings, solution pans, and runaway holes

Elements of Significance:

Elements of heritage significance include (but are not necessarily limited to):

- Caves within the site, including cave walls, floors, roof and entrances.
- Speleothems (calcite, gypsum) within the caves and quarry rockpiles including but not limited to flowstone, stalactites, stalagmites, columns, sub-aqueous crystal deposits, moonmilk, calcite covered root speleothems and other cave mineral features.
- Cave features including undisturbed sediments (naturally deposited), undisturbed cave floors and rock piles, *in situ* fossils (embedded in walls and trace fossils), natural collapses and rockfall formations.
- Surface karst features such as pavements, calcrete, cave entrances, and runaway holes.
- Vertebrate fossils, fossil breccias, solution pipe sediment fills.
- Evidence exposed and preserved in the quarry walls and floor, including but not limited to cave entrances, cave passages, solution pipes and their sediment infill, sediment deposits within exposed cave passages, calcite, calcified tree roots, limestone rocks, marine fossils, intact limestone rocks.
- Rock piles and limestone rubble with evidence of fossils, breccias, and cave minerals or features.

Elements not considered to contribute to significance of place include (but are not necessarily limited to):

- Built structures.
- Fences, agricultural and residential infrastructure.

HISTORY, CHRONOLOGY, SITE DETAILS & PHOTOGRAPHS

Entry in the South Australian Heritage Register in accordance with s14(1)(a) of the *Heritage Places Act 1993*

History of the Place

Geological history

The Naracoorte and Hynam areas are situated in the western portion of the Otway Basin which is a rift basin formed during the late Mesozoic as Gondwana broke up and Australia separated from Antarctica.[2] From the Late Eocene (~37 Ma) through the Middle Miocene (~15-12 Ma) the Gambier Limestone, a fossiliferous carbonate, was deposited through the region when it was covered by a shallow cool marine environment.[3] The Middle Miocene Naracoorte Limestone is the uppermost member of the Gambier Limestone. Significant uplift across south-eastern Australia, combined with a marine regression in the Late Miocene to Pliocene (~12 to ~5.3 Ma) marked the end of deposition for the Gambier Limestone.[4] This was followed by a period of erosion and karstification (development of karst) of the exposed limestone.[5] Tectonism during the same period may have resulted in movement of the underlying Kanawinka Fault which displaced the limestone in the Naracoorte area.[6] A high sea-stand at around 10 Ma flooded the area again[7] and quartz-rich shoreline sediments were laid down during the Early Pliocene ~5.3 to 3.6 Ma.[8]

The fault scarp is overlain by Pleistocene beach dune deposits of the Bridgewater Formation (Figures 3 and 4), which incorporate a series of stranded coastal ranges that record sea level changes and regional uplift during the Pleistocene from around 1.3 Ma.[9] The Naracoorte East Range is dated between 1.1 Ma and 0.9 Ma[10], and the Naracoorte West Range is thought to be between 0.88 Ma and 0.78 Ma old and these ranges extend from Naracoorte to the present coast. However, these ages remain uncertain.[11]

Cave development in the Naracoorte area commenced at least 1.34 Ma before present.[12] The most extensive caves are located along the Kanawinka Fault escarpment, overlain by the Pleistocene Naracoorte East Range. The orientation of cave passages in the area is strongly controlled by NW/SE joints associated with the fault. The caves developed just inland of the ancient shoreline via dissolution at margin of the sea and freshwater (groundwater) lenses.[13] After sea levels dropped, the caves drained and remained dry due to regional uplift. Extensive speleothem development commenced at least 1.34 Ma. Over time, entrances formed in the caves via collapse and dissolution of the limestone to form solution pipes.[14] Recent research suggests that most of these opened after around 600 ka before present[15] and the oldest reported fossil deposits from Naracoorte Caves are ~528 ka.[16]

East of the Naracoorte East Range is the Hynam Range (location of Munro Karst). Several caves are known from the Hynam Range, but none of them contain fossil deposits comparable to the Naracoorte Caves. Bone deposits found in the Hynam caves represent recent deposits and no Pleistocene material has been reported to date. Munro Karst, however, contains fossil material preserved in hardened fossil breccias representing ancient solution pipe fills and contains material that is likely to be of Pleistocene age. The most recent age estimate for the Hynam Range is older than around 0.99 Ma and potentially up to 2 Ma[17] and the hypothesised maximum age of the Hynam Range is within the Gelasian Stage (2.58Ma to 1.8 Ma) of the early Pleistocene. However, the age of the Hynam Range remains speculative in the absence of numerical dating using modern techniques.

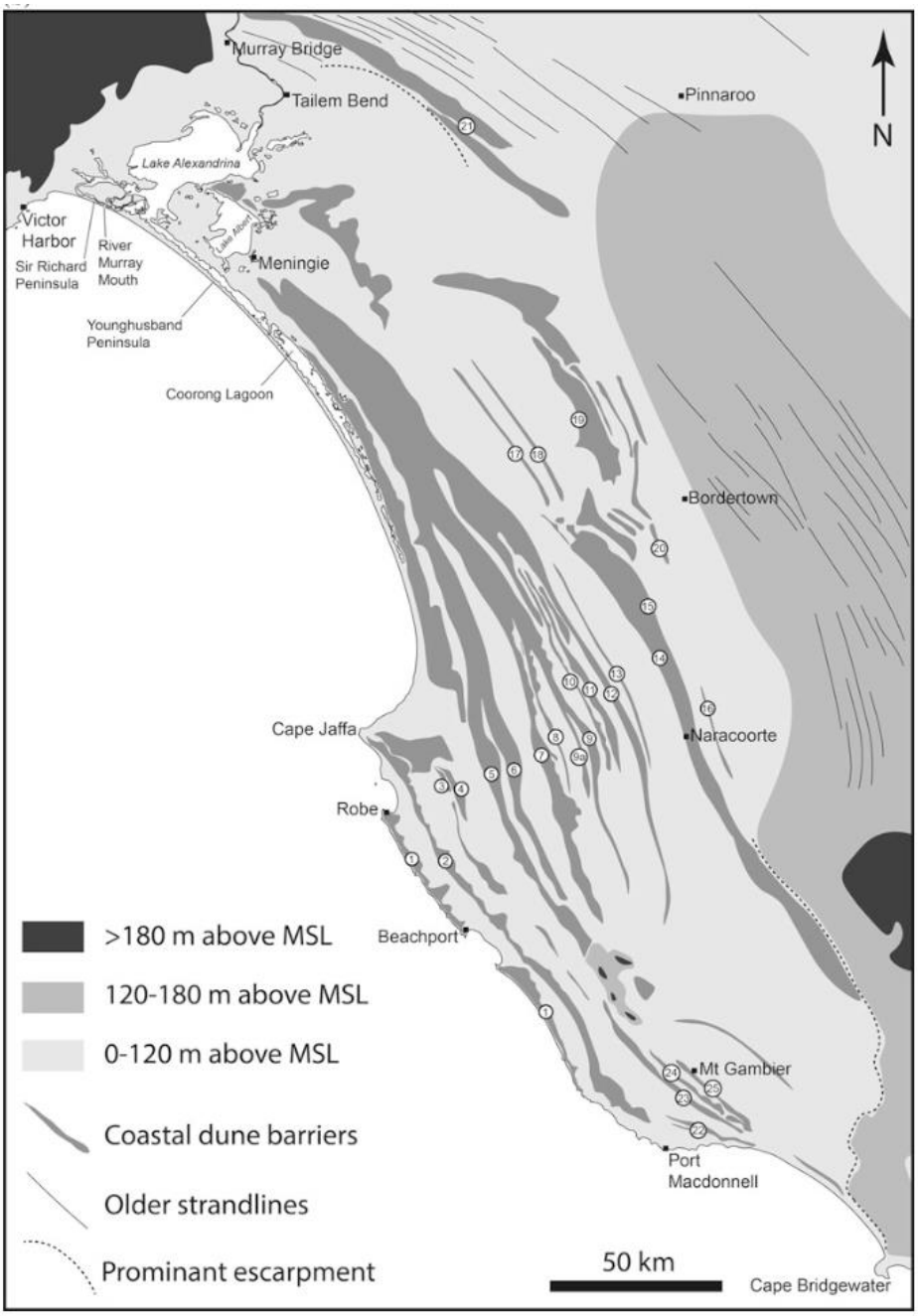


Figure 3. Pleistocene coastal barriers of the Coorong Coastal Plain. Relict coastal barrier landforms in the transect from Robe to Naracoorte are indicated; 14. West Naracoorte Range; 15. East Naracoorte Range; 16. Hynam Range.

Source: Murray-Wallace, 2018.

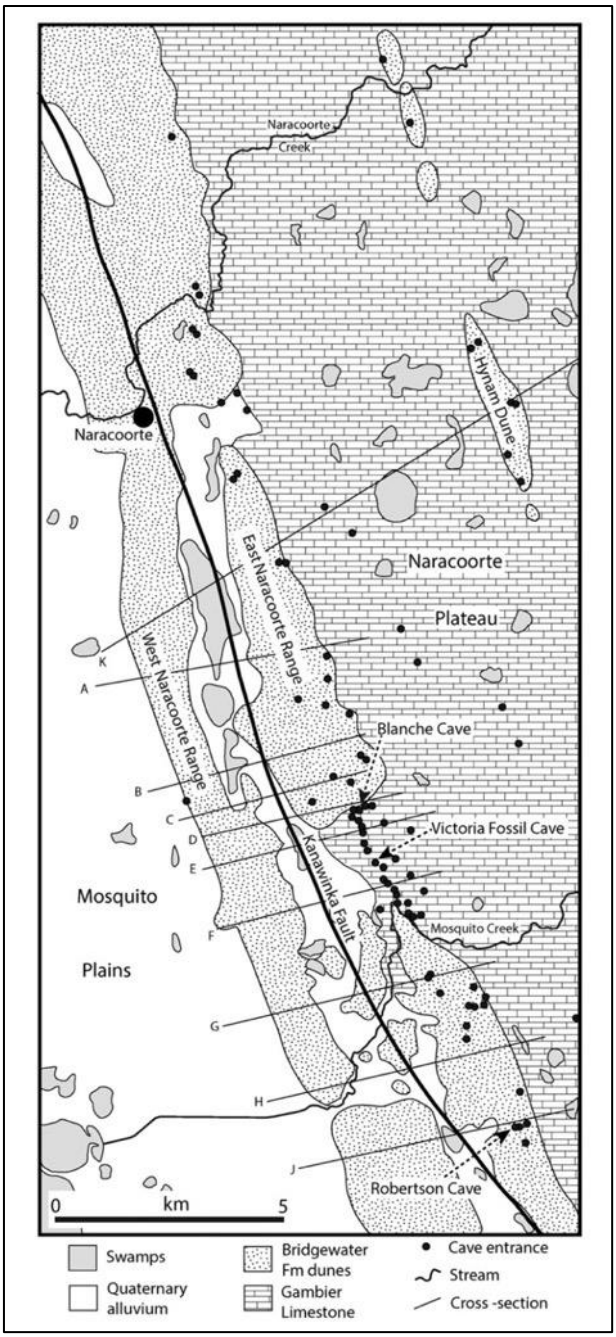


Figure 4. Quaternary dune ranges at Naracoorte and Hynam. The Hynam Range, Naracoorte East and Naracoorte West Ranges are indicated on the figure.

Source: adapted from White and Webb, 2015.

Human and recent history

Munro Karst is found on First Nations of the South East Country. Thus far, evidence of First Nations occupation has not been found within the cave.

European colonisation of the Naracoorte region began in the 1840s and the area rapidly became a centre for agricultural production – primarily wool, cereal crops and meat.[18] Significant changes were made to the natural landscape as a result, including extensive land-clearing, and drainage of wetlands. Caves were known from the mid-1840s and became popular attractions for visitors and locals.[19] Some caves were heavily damaged by unregulated tourism and exploration.[20] In other instances, caves were destroyed, impacted by quarrying, or used as rubbish dumps. During the 20th Century, the availability of heavy machinery allowed for more extensive quarrying and ripping of the limestone for construction, agriculture and viticulture. Ripping of limestone in areas of shallow soils resulted in the destruction of surface karst, leaving few of these areas intact today.

The Munro Karst site was probably used for agricultural purposes since early in the European history of the area. Fortunately, land use practices at the property have facilitated the preservation of parts of the surface karst which remain intact within the Munro Karst property.

Quarrying commenced at the property in 2012 (based on Google Earth imagery) and has remained active until recently. The quarry and associated lease is the main area of the Munro Karst. The quarrying activities were conducted to produce limestone rubble, largely for construction and road building. Evidence of caves within the area was uncovered during quarrying from at least 2022.[21] This evidence included cave passages, speleothems, sediments and fossils.

In September 2023 local cave experts were invited to visit the site to inspect the caves. During the visit, fossils and other significant values were discovered and documented. Small samples of speleothems and fossil breccia were collected with permission. To date there has been no intensive scientific investigation of the site. The work that has been conducted so far includes documentation of cave features, minor sample collection and qualitative interpretation of site history and cave development based on visual and material evidence preserved at the site. A sample of fossil breccia (Figure 5), sampled in September 2023, is currently being prepared for dating at the University of Adelaide OSL (optically stimulated luminescence) dating laboratory. It is expected that results will be forthcoming later in 2025. The date obtained for the sediment component of the breccia will provide an age for the vertebrate fossils contained within it.

Figure 5. Fossil breccia from Munro Karst. A large fossil bone is visible in the centre of image, with smaller fossils visible preserved within the surrounding rock.

Source: S. Bourne, 2023.

Chronology

Year	Event
37-12 Ma	Late Eocene to Middle Miocene – the Gambier Limestone formed in the South East region when the area was covered by shallow cool water seas following final separation of Australia from Antarctica. The limestone formed from the calcareous shells and skeletons of marine invertebrates.
~12-2.58 Ma	Late Miocene to Pliocene (~12 to 5.3 Ma) end of Gambier Limestone deposition. Followed by erosion and karstification of the limestone and tectonism which displaced limestone in the Naracoorte area. High sea-stand at ~10 Ma, with deposition of shoreline sediments during Early Pliocene (~5.3 to 3.6 Ma).
2.58 Ma	Beginning of the Pleistocene Epoch
2 Ma	Deposition of the Hynam Range (unconfirmed, hypothesised age)
1.34 Ma	First evidence of cave development in the Naracoorte region. U-Pb dating revealed that the oldest known speleothems in caves along the Naracoorte East Range and the Naracoorte Plateau are at least 1.34 million years old.
~1.3 Ma	Sea-level changes and regional uplift reflected in series of coastal ridges deposited throughout the Pleistocene and extending from the Naracoorte

	East Range (oldest) towards the present coastline youngest Robe Range (~105 to 82 ka).
1.1 to ~900 ka	Deposition of the Naracoorte East Range
~780 to 880 ka	Deposition of the Naracoorte West Range
600 ka	Estimated timing of cave opening and earliest fossil accumulation for the Naracoorte Caves complex based on pollen and charcoal preserved in dated speleothems.
528 ka	Oldest dated vertebrate fossils from the Naracoorte region. These fossils were reported from Cathedral Cave within the Naracoorte Caves World Heritage Area.
~50 ka	First Nations arrival into the South East region.
1840s	European colonisation of the area and onset of agriculture. Caves become popular attractions in the South East.
1858	First written record of vertebrate fossils from caves at Naracoorte by Julian Tenison-Woods.
1952	Hynam Dune mapped and defined by Reg Sprigg. Said it was oldest and may be Pliocene in age, though at the time, the Pliocene was defined as ending 1.8 Ma rather than the understood 2.58 Ma today.
1977	Munro family acquired the property
2012	Quarrying commenced
2022	Caves uncovered in the quarry.
2023	Caves reported by landowners and visited by scientists. Preliminary samples removed for dating
2024	22 August - Munro Karst nominated for State Heritage listing. 23 August - Munro Karst provisionally entered as a State Heritage place in the South Australian Heritage Register and Designated as a place of Speleological Significance.

References

Books and Chapters

Belperio, A.P. (1995) Quaternary: Coastal and marine sequences. pp. 219-239. In. J.F. Drexel and W.V. Preiss. Geological Survey of South Australia, Bulletin 54, The Geology of South Australia. Volume 2 The Phanerozoic. Newstyle Printing, Adelaide.

Murdoch, J. and Parker, H. (1963) History of Naracoorte. The Naracoorte Chamber of Commerce, Naracoorte.

Murray-Wallace, C.V. (2018) Quaternary History of the Coorong Coastal Plain, Southern Australia. An archive of environmental and global sea-level changes. Springer Nature, Switzerland.

Murray-Wallace, C.V. and Woodroffe, C.D. (2014) Quaternary Sea-level Changes: a global perspective. Cambridge University Press, London.

Reed, E.H. (2023) Australia's fossil caves: underground archives of past biodiversity. pp. 297-312. In. Webb, J., White, S. and Smith, G. Eds. Australian Caves and Karst Systems. Springer Nature, Switzerland.

White, S. (2023) Otway Basin. pp. 189-200. In. Webb, J., White, S. and Smith, G. Eds. Australian Caves and Karst Systems. Springer Nature, Switzerland.

Journal Articles

Arnold, L.J., Demuro, M., Power, R., Priya, Duval, M., Guilarte, V., Weij, R., Woodhead, J., Bourne, S. and Reed, E.H. (2022) Examining sediment infill dynamics at Naracoorte Cave megafauna sites using multiple luminescence dating signals. *Quaternary Geochronology*, *70*: 101301.

Ayliffe, L.K., Marianelli, P.C., Moriarty, K., Wells R.T., McCulloch, M.T., Mortimer, G.E., Hellstrom, J.C. (1998) 500 ka precipitation record from southeastern Australia: Evidence for interglacial relative aridity. *Geology,* 26: 147 - 150

Idnurm, M. and Cook, P.J., 1980. Palaeomagnetism of beach ridges in South Australia and the Milankovitch theory of ice ages. *Nature*, *286*(5774): 699-702.

Li, Q., McGowran, B. and White, M.R. (2000) Sequences and biofacies packages in the mid-Cenozoic Gambier Limestone, South Australia: reappraisal of foraminiferal evidence. *Australian Journal of Earth Sciences*, 47: 955-970.

Macken, A.C. and Reed, E.H. (2013) Late Quaternary small mammal faunas of the Naracoorte Caves World Heritage Area. *Transactions of the Royal Society of South Australia*, 137: 53-67.

McDowell, M.C., Bestland, E.A., Bertuch, F., Ayliffe, L.K., Hellstrom, J.C. , Jacobsen, G.E., and Prideaux. G.J., 2013. Chronology, stratigraphy and palaeoenvironmental interpretation of a Late Pleistocene to mid-Holocene cave accumulation on Kangaroo Island, South Australia. *Boreas*, 42: 974–994.

Moriarty K.C., McCulloch M. T., Wells R.T. and McDowell M. C. (2000) Mid-Pleistocene cave fills, megafaunal remains and climate change at Naracoorte, South Australia: towards a predictive model using U/Th dating of speleothems. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 159:113 – 143.

Prideaux, G.J., Prideaux, G. J., Roberts, R. G., Megirian, D., Westaway, K. E., Hellstrom, J. C. & Olley, J. M. (2007). Mammalian responses to Pleistocene climate change in southeastern Australia. *Geology*, 35: 33–36.

Reed, E.H. and Bourne, S.J. (2000) Pleistocene fossil vertebrate sites of the South East region of South Australia. *Transactions of the Royal Society of South Australia*, 124: 61-90.

Reed, E. and Bourne, S. (2013) 'Old' cave, new stories: the interpretative evolution of Blanche Cave, Naracoorte. *Journal of the Australasian Cave and Karst Management Association*, 90: 11-28.

Smith, G.K. (2022) Rootsicles, roots and caves. *Helictite*, 47: 1-12.

Sprigg, R.C. (1947) Early Cambrian (?) jellyfishes from the Flinders Ranges, South Australia. *Transactions of the Royal Society of South Australia*, 71: 212-224.

Sprigg, R.C. (1979) Stranded and submerged sea-beach systems of southeast South Australia and the aeolian desert cycle. *Sedimentary Geology*, *22*: 53-96.

Sprigg, R.C. (1988) On the 1946 Discovery of the Precambrian Ediacaran Fossil Fauna in South Australia. *Earth Sciences History*, 7: 46-51.

Weij, R., Woodhead, J., Sniderman, K., Hellstrom, J., Reed, E., Bourne, S., Drysdale, R. and Pollard, T. (2022) Cave opening and fossil accumulation in Naracoorte, Australia, through charcoal and pollen dated speleothems. *Communications Earth and Environment*. 3, 210.

Weij, R., Sniderman, J.M.K., Woodhead, J.D., Hellstrom, J.C., Brown, J.R., Drysdale, R.N., Reed, E.H., Bourne, S., Gordon, J. (2024) Elevated Southern Hemisphere moisture availability during glacial periods. *Nature* 626, 319–326 (2024).

Wells, R.T., Moriarty, K. and Williams, D.L.G. (1984) The fossil deposits of Victoria Cave, Naracoorte, South Australia: the geology and fauna. *Australian Zoologist*, 21: 305-333.

White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte, Southeastern Australia. *Geomorphology*. 229: 58-72.

Reports and Theses

Sprigg, R.C. (1952) The Geology of the South-east Province of South Australia, with Special Reference to Quaternary Coast-line Migrations and Modern Beach Developments. *Department of Mines Geological Survey of South Australia Bulletin No. 29.* K.M. Stevenson, Government Printer, Adelaide.

Tenison-Woods, J.E. (1866) Report on the geology and mineralogy of the South-Eastern district of the colony of South Australia, or that country lying between the River Murray, the 141st meridian of longitude, and the sea. Government Printer, Adelaide.

Newspapers

Tenison-Woods, J.E. (1858) South Australian Geology No. 3: The Caves at Mosquito Plains. The South Australian Register, March 29th, 1858.

SITE DETAILS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

FORMER NAME:	Munro Quarry Caves	
DESCRIPTION OF PLACE:	An area of limestone karst landscape that contains a cave system and palaeontological deposits.	
REGISTER STATUS:	Nominated – 22 August 2024	
	Provisionally Entered into the South Australian Heritage Register – 23August 2024	
	Designated as a Place of Speleological Significance 23 August 2024	
LOCAL HERITAGE STATUS:	NA	
CURRENT USE:	Agriculture (grazing)	
	1977 to current	
	Limestone quarry	
	2012 to current	
PREVIOUS USE(S):	Agriculture	
	Prior to 1977	
LOCAL GOVERNMENT AREA:	Naracoorte Lucindale Council	
LOCATION:	**Street No.:**	407
	Street Name:	Hynam Caves Road
	Town/Suburb:	Mount Light
	Post Code:	5271
LAND DESCRIPTION:	**Title Reference:**	CT 6100/748, D88823 A100; CR 5677/773, H440700 S487; CT 6100/749 D88823 A101
	Hundred:	Jessie

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Cave entrance 1 showing the rubble at the entrance and the access point to the left.

Source: E. Reed. 2023

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Left: Gypsum crystals on the cave floor. Right: Fossil bone preserved in the sediment on the cave floor (gloved finger for scale).

Source: E. Reed, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Calcite decorations formed on tree roots. Cave entrance 1 is visible at rear, Munro karst.

Source: S. Bourne, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Calcite stalactite decorations formed on tree roots, Munro karst.

Source: S. Bourne, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

View within the chamber looking towards cave entrance 1, Munro karst. Sediment deposits are preserved along the left wall and under the rubble floor. These contain vertebrate fossils.

Source: E. Reed, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

View of the left wall of the chamber in the cave associated with cave entrance 1. The wall is covered with white, calcite moonmilk.

Source: E. Reed. 2023

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Cave entrance 2 showing the hole that was exposed and the infill breccia of red sediment.

Source: E. Reed, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Infill sediment and calcite fills above entrance 2 (left). Detail of the fill showing sediment and calcite crystal casing (right).

Source: E. Reed, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Cave associated with entrance 2. Multi-level cave development (top left). Large passage development heading north from entrance 2 (top right). Cave ceiling showing solution features (bottom left). Sub-aqueous calcite crystal pocket in ceiling (bottom right).

Source: E. Reed, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Lower level of the cave leading from entrance 2. Pristine sediment floors and clusters of white calcite crystals on the walls are shown.

Source: S. Bourne, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Deposit of white calcite flowstone overlying sediment adjacent to cave entrance 3.

Source: E. Reed, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

Fossil breccia remnants found in the northeast rockpile. White coloured fossil bones are clearly visible within the hardened red sediment (top left and right). Fossil kangaroo tooth (bottom left). Bedded calcite crystal raft deposit (bottom right).

Source: E. Reed, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271

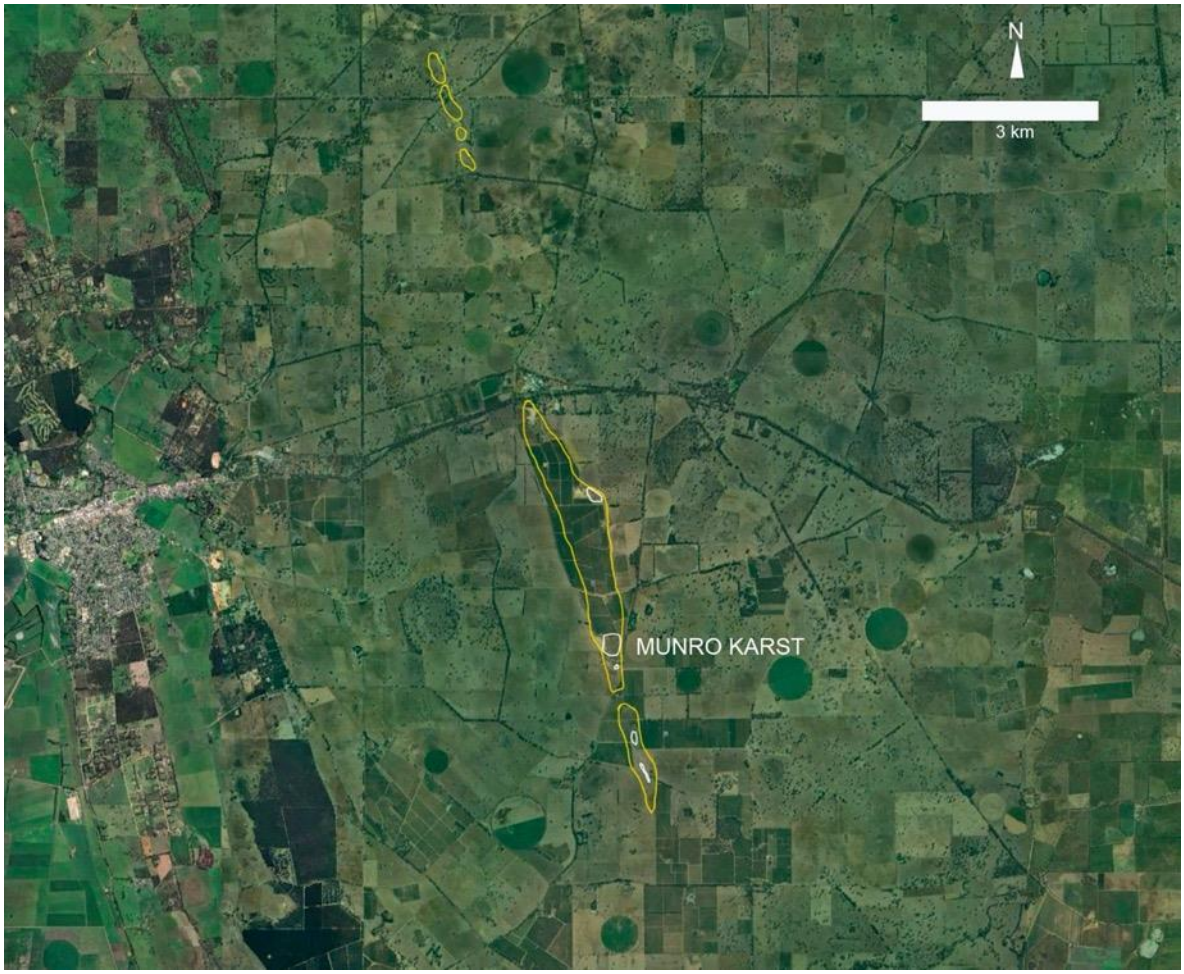
Surface karst features in the block adjacent to the quarry. Surface pavement and solution features are visible.

Source: E. Reed, 2023.

PHOTOS

Munro Karst **PLACE NO.: 26606**

407 Hynam Caves Road, Mount Light, SA 5271



Map showing the approximate extent of the Hynam Range (yellow) and areas of surface karst along that range (white). Munro Karst is indicated, clearly showing the largest portion of remaining surface karst on the range. Adapted from Google Earth imagery.

Source, E. Reed 2024.

[1] Smith, G.K. (2022) Rootsicles, roots and caves. *Helictite*, 47: 1-12.
[2] White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte, Southeastern Australia. *Geomorphology*. 229: 58-72.

Provisionally entered & Designated by the South Australian Heritage Council on 23 August 2024
Confirmed by the South Australian Heritage Council on 10 April 2025
Designation retained by the South Australian Heritage Council on10 April 2025

[3] Li, Q., McGowran, B. and White, M.R. (2000) Sequences and biofacies packages in the mid-Cenozoic Gambier Limestone, South Australia: reappraisal of foraminiferal evidence. *Australian Journal of Earth Sciences*, 47: 955-970; and White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte.

[4] White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte.

[5] White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte.

[6] White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte.

[7] White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte.

[8] Belperio, A.P. (1995) Quaternary: Coastal and marine sequences. pp. 219-239. In. J.F. Drexel and W.V. Preiss. Geological Survey of South Australia, Bulletin 54, The Geology of South Australia. Volume 2 The Phanerozoic. Newstyle Printing, Adelaide.

[9] Belperio, A.P. (1995) Quaternary: Coastal and marine sequences; and Idnurm, M. and Cook, P.J., 1980. Palaeomagnetism of beach ridges in South Australia and the Milankovitch theory of ice ages. *Nature*, *286*(5774): 699-702; and White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte; and Murray-Wallace, C.V. (2018) Quaternary History of the Coorong Coastal Plain, Southern Australia. An archive of environmental and global sea-level changes. Springer Nature, Switzerland.

[10] White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte.

[11] Weij, R., Woodhead, J., Sniderman, K., Hellstrom, J., Reed, E., Bourne, S., Drysdale, R. and Pollard, T. (2022) Cave opening and fossil accumulation in Naracoorte, Australia, through charcoal and pollen dated speleothems. *Communications Earth and Environment*. 3, 210.

[12] Weij, R., Woodhead, J., Sniderman, K., Hellstrom, J., Reed, E., Bourne, S., Drysdale, R. and Pollard, T. (2022) Cave opening and fossil accumulation in Naracoorte, Australia, through charcoal and pollen dated speleothems.

[13] White, S. and Webb, J. (2015) The influence of tectonics on flank margin cave formation on a passive continental margin: Naracoorte.

[14] Arnold, L.J., Demuro, M., Power, R., Priya, Duval, M., Guilarte, V., Weij, R., Woodhead, J., Bourne, S. and Reed, E.H. (2022) Examining sediment infill dynamics at Naracoorte Cave megafauna sites using multiple luminescence dating signals. *Quaternary Geochronology*, *70*: 101301.

[15] Weij, R., Woodhead, J., Sniderman, K., Hellstrom, J., Reed, E., Bourne, S., Drysdale, R. and Pollard, T. (2022) Cave opening and fossil accumulation in Naracoorte, Australia, through charcoal and pollen dated speleothems.

[16] Prideaux, G.J., Prideaux, G. J., Roberts, R. G., Megirian, D., Westaway, K. E., Hellstrom, J. C. & Olley, J. M. (2007). Mammalian responses to Pleistocene climate change in southeastern Australia. *Geology*, 35: 33–36.

[17] Murray-Wallace, C.V. and Woodroffe, C.D. (2014) Quaternary Sea-level Changes: a global perspective. Cambridge University Press, London; and Murray-Wallace, C.V. (2018) Quaternary History of the Coorong Coastal Plain, Southern Australia. An archive of environmental and global sea-level changes.

[18] Murdoch, J. and Parker, H. (1963) History of Naracoorte. The Naracoorte Chamber of Commerce, Naracoorte.

[19] Reed, E. and Bourne, S. (2013) 'Old' cave, new stories: the interpretative evolution of Blanche Cave, Naracoorte. *Journal of the Australasian Cave and Karst Management Association*, 90: 11-28; and Reed, E.H. (2023) Australia's fossil caves: underground archives of past biodiversity. pp. 297-312. In. Webb, J., White, S. and Smith, G. Eds. Australian Caves and Karst Systems. Springer Nature, Switzerland.

[20] Reed, E. and Bourne, S. (2013) 'Old' cave, new stories: the interpretative evolution of Blanche Cave, Naracoorte.
[21] Munro family personal communication.