

## **SUMMARY OF STATE HERITAGE PLACE**

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### **REGISTER ENTRY**

**Entry in the South Australian Heritage Register in accordance with the  
*Heritage Places Act 1993***

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**NAME:** Ajax Mine Fossil Reef **PLACE NO.:** 26390

**ADDRESS:** 13 km southeast of Leigh Creek, Flinders Ranges, SA  
CL 1437/24, Block 693, Out of Hundreds (Copley)

**DESIGNATED AS A PLACE OF PALAEOLOGICAL AND GEOLOGICAL  
SIGNIFICANCE**

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### **STATEMENT OF HERITAGE SIGNIFICANCE**

The former Ajax copper mine is the location of one of the most significant finds of archaeocyath fossils in the world. Archaeocyaths (ancient cups) were some of the earliest known marine sponges with mineral skeletons which lived in the Lower Cambrian period, around 525 million years ago. These organisms proved highly successful, and over a 10 million year period diversified into a huge array of different forms and over 100 species, playing a dominant role in constructing the Earth's first reefs.

The large ridge of fossiliferous limestone located at the former mine is known throughout the world as the Ajax Limestone. Remarkably in the context of such finds, the Ajax Limestone contains a sample of almost every archaeocyath species known to have existed within the Australian-Antarctic province, and has a diversity which is far in excess of any other assemblage in the province. In addition to this representativeness, the limestone also contains over 100 type species – species that define a genus. This means that the site is one of the key points of reference for those studying the earliest stages of development for Life on Earth.

### **STATEMENT OF DESIGNATION**

The Ajax Mine Fossil Reef is a place of exceptional palaeontological and geological significance. It is the only archaeocyathan terrane of its kind in Australia and displays a number of unique qualities. In particular, it is the type locality for the majority of described Australian-Antarctic archaeocyath species and genera. Its significance is

enhanced by the fact that it contains so many type species. A type species is selected to represent and define a genus; with the characters of a genus being determined by reference to its type species. Every genus has one, and only one, type species, and Ajax mine has over 40 type species from the Cambrian period, more than anywhere else in the Australian-Antarctic region. This makes it a place with qualities that are both exceptional and irreplaceable, and one which provides a unique insight into the variety and appearance of fauna of the Lower Cambrian period.

The Fossil Reef is also of outstanding geological significance, having made a considerable contribution to the history of geological science in Australia including supporting the development of methods for the study of fossils. It is also significant for its contributions to the process of global correlation, including matching the geological record of Cambrian age rocks from all continents, and searching for base metals such as copper, lead and zinc in rocks of this age around the globe. The site has been listed by the Geological Heritage Subcommittee of the SA Division of the Geological Society of Australia (GSA) as a Geological Heritage site (file FR 41).

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

#### ***(c) it may yield information that will contribute to an understanding of the state's history, including its natural history.***

The former Ajax Mine Fossil Reef yields information that makes a significant contribution to our understanding of the state's, and indeed the world's natural history.

Archaeocyaths are highly ornate and thus particularly easy to see at this location. This is one of the few sites where their delicate lime skeletons have been replaced by silica, without significant loss of detail. Silica being harder than the rest of the limestone, weathers out at the surface and enables these fossils to be easily recognized in the field.

Taxonomically, the Ajax Mine archaeocyathan fauna is significant according to several measures. Firstly, 110 valid archaeocyath and allied species are recorded from the Ajax Mine locality – a diversity far in excess of any other Australian-Antarctic archaeocyathan assemblage. Secondly, Ajax Mine is the type locality for 107 of these (ie 97% of the total for this locality). (By comparison, the second most diverse archaeocyathan locality in the Australian-Antarctic province is the nearby Mount Scott Range, with 62 known valid species, among which 37 (60% of the total) claim that locality as their type locality).

Thirdly, at the genus level, the Ajax Mine Fossil Reef bears the greatest number of genera represented by named species within the province, at 52 genera (48 archaeocyaths + 3 radiocyaths + 1 acanthinocyathide). (The second, with 38 archaeocyath genera, is Mount Scott Range). Fourthly, from a global perspective, whereas it is impractical to compile species numbers for all individual localities in other provinces, one measure of global significance is provided by the forthcoming *Treatise on invertebrate paleontology* compilation of Debrenne et al. (in press). A

tally of numbers of type species by locality discloses that Ajax Mine is the type locality to 36 type species, easily the greatest number of any locality worldwide. (The next most diverse localities by this criterion, with 10 type species each, are Mt Wright, NSW and Shivelig-Khem River, Tuva, Russia).

Among archaeocyath-bearing formations globally, the Ajax Limestone has yielded 42 type species, making it the most diverse formation worldwide. (The second most diverse formation is in Russia (25 type species). Hence, by every available measure, Ajax Mine and the Ajax Limestone are the most diverse and significant archaeocyath sites in the world.

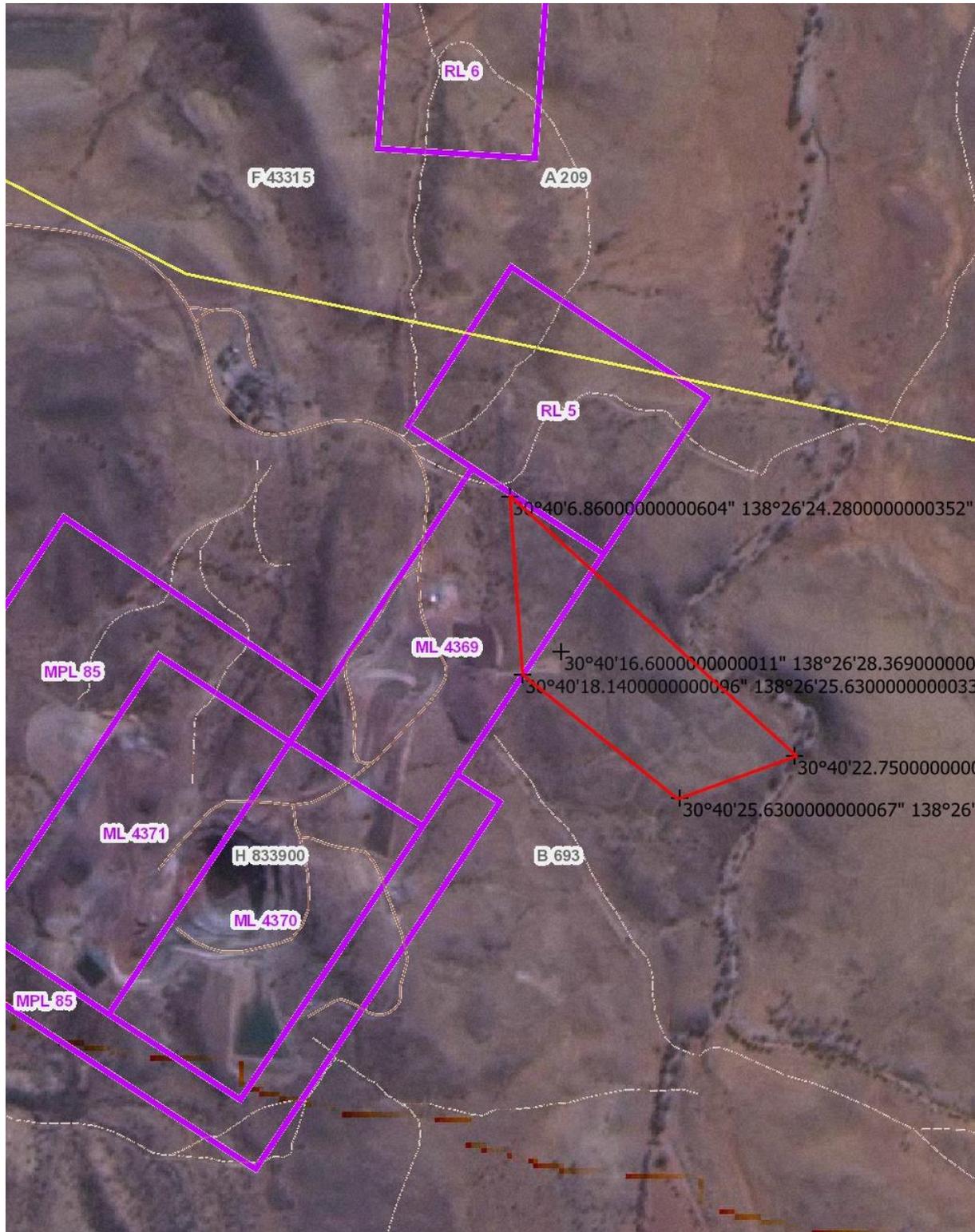
Thus, the Ajax Mine Fossil Reefs are not only significant for their contribution to the understanding of the origins and evolution of life, but also for their stratigraphic value. The species of archaeocyaths and other shelly fossils in the Ajax Limestone are keys to geological correlation both within Australia to Northern Territory, western New South Wales, south of Adelaide, the Kimberley region of WA, and globally into Siberia, Antarctica, North America, Spain and many other regions. These archaeocyath species are vital for understanding the temporal changes in ocean chemistry and bio-accumulation of minerals.

The Ajax Mine Fossil Reef site is durable and can readily be conserved for both future scientific study and also visitation for geotourism. Growing interest in the interpretation of geological phenomena is an important hook for the development of sustainable tourism.

# SITE PLAN

Ajax Mine Fossil Reef  
13 km southeast of Leigh Creek, Flinders Ranges, SA

FILE NO: 26390



Site plan showing location of Ajax Mine Fossil Reef (red outline) and mining tenements current in 2012 (purple outlines). DEWNR 2013

## COMMENTARY ON THE LISTING

### Description and notes with respect to a place entered in the South Australian Heritage Register in accordance with the *Heritage Places Act 1993*

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#### Physical Description

The Ajax (Beltana) Mine fossil reef is located in the northern Flinders Ranges, South Australia. Ajax Mine, a disused small copper mine, has lent its name to a nearby low, fault-bounded ridge of Ajax Limestone bearing a rich diversity of archaeocyaths, an extinct group of early Cambrian fossil sponge-like organisms that are valuable biostratigraphic indicators within that epoch. The rock succession on the ridge dips steeply to the west. To the east, the unfossiliferous Woodendinna Dolomite is succeeded by the unfossiliferous lower Ajax Limestone, that in turn is overlain by archaeocyath-bearing upper Ajax Limestone on the western side of the low ridge.

The archaeocyath-bearing portion of the ridge is partly within mining lease ML4369, currently operated by Perilya Freehold Mining Pty Ltd (Fig. 1). The company has developed the nearby Beltana pit, from which it extracts willemite (zinc silicate ore) on an episodic campaign basis. Exploration drilling is ongoing, with focus on the stratigraphically underlying Woodendinna Dolomite, the principal exploration target.

The Extent of Listing is defined on the attached site plan.

The components identified as being intrinsic to the heritage significance of the Ajax Mine Fossil Reef comprise:

- Ridge of Ajax Limestone bearing a rich diversity of archaeocyaths

#### History of the Place

##### ***Identification and recognition of significance of place***

This is a classic fossil locality, discovered prior to 1890 by prospector W.B. Greenwood (Cooper & Jago 2007b). T. Griffith Taylor (University of Sydney) visited the locality, in the company of Walter Howchin and Douglas Mawson (University of Adelaide) in February 1906, and the collections obtained were the principal basis for his foundational monograph on South Australian archaeocyaths (Taylor 1910). This was Mawson's first field visit to the Flinders Ranges (Cooper & Jago 2007a).

Subsequently the Bedford brothers, spearheaded by Robert Bedford (Kyancutta Museum), led several expeditions by motor truck to sample the locality during the 1930s, and described their collections in a series of pioneering monographs (R. Bedford & J. Bedford 1936, 1937, 1939, R. Bedford & W.R. Bedford 1934, 1936). The remarkable selective silicification at the locality, noted by Taylor (1908) and unique among Australian archaeocyathan terranes, permitted acid etching of samples to reveal the archaeocyaths in three dimensions, without recourse to the preparation of thin sections. Ajax Mine has thereby become the type locality for the great

majority of described Australian archaeocyath species and genera, and for this reason is known worldwide among palaeontologists dealing with the Cambrian.

### ***Fossil Interpretation***

Archaeocyaths were a distinctive group of early multi-celled organisms that lived by filtering microscopic food particles through two walled porous cone-shaped skeletons. They were exclusive to shallow, clear and warm Cambrian coastal settings that today would support coral reefs. These fossil reefs and mounds are found in Cambrian rocks on almost every continent including Antarctica. As such they are important for reconstructing the ancient geography of continental fragments during the so-called "explosion of animal life" on Earth from 580 to 500 million years before the present. In this 80 million year span, all known phyla of animals evolved after about 3000 million years of exclusively microbial life on Earth.

All archaeocyath species suffered extinction before the end of the Cambrian period. However, their association with needle-like spicules and similarity to living chambered sponges has resulted in their interpretation as early sponges. Arguably, archaeocyaths had the most complex and diverse skeletal architecture of any known sponge group, both fossil and living. Reluctance to acknowledge these fossils as evidence of sponges is in part due to the enduring premise that evolution tends to result in increasing complexity. In many cases, especially for invertebrate animals, loss of structural and organismic complexity is apparent in the history of life.

### ***State of preservation and protection of site***

The fossiliferous ridge currently adjoins an active mining operation, the nearby Beltana pit, being worked by Perilya Freehold Mining Pty Ltd (Freehold Mining 2007). For the present, no significant orebody has been identified on or beneath the fossiliferous ridge itself, but exploration drilling continues on and around the ridge. The drilling has already resulted in some destruction of the fossiliferous outcrop in and around drillsites. Furthermore, the possible exploitation of any future orebody discovery beneath the ridge could conceivably lead to further significant degradation or even destruction of the locality.

Impact assessment and special precautions to minimise disturbance to the natural surface should be applied to any future drilling or other operations proposed along the limestone ridge. In particular, there should be no new tracks created or existing tracks widened, and no further clearing or disturbance of the remaining outcrop within the proposed heritage area.

Considering that the site has been collected for over 100 years, damage is relatively confined. Most collecting has been from loose rock fragments on the margins of the ridge. The most obvious damage has been a single case of diamond-saw extraction for scientific thin section study of archaeocyaths by a former (now deceased) government geologist (see image attached). This sampling was necessary, although with hindsight some immediate remediation might have been done, or another site

chosen. This historical damage could be hidden by utilizing the holes for attachment of an interpretive sign.

## References

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## SITE RECORD

**Ajax Mine Fossil Reef**  
13 km southeast of Leigh Creek, Flinders Ranges, SA

**FILE NO: 26390**

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<b>FORMER NAME:</b>	Ajax Mine or Beltana Mine. AKA Ajax Limestone	
<b>DESCRIPTION OF PLACE:</b>	Limestone ridge bearing archaeocyath fossil reefs.	
<b>DATE OF COMPLETION:</b>	c325-315 million years ago	
<b>SA HERITAGE REGISTER STATUS:</b>	<b>Description:</b>	Provisionally entered 25 September 2013
<b>LOCAL HERITAGE STATUS</b>	N/A	
<b>CURRENT USE:</b>	<b>Description:</b>	Fossil reef near disused copper mine
	<b>Dates:</b>	N/A
<b>PREVIOUS USE(S):</b>	<b>Description:</b>	Cambrian reef
	<b>Dates:</b>	325 million years ago
<b>ARCHITECT:</b>	<b>Name:</b>	N/A
	<b>Dates:</b>	
<b>BUILDER:</b>	<b>Name:</b>	N/A
	<b>Dates:</b>	
<b>LOCAL GOVERNMENT AREA:</b>	<b>Description:</b>	Unincorporated
<b>LOCATION ACCESS:</b>	From main Adelaide-Leigh Creek Rd turnoff about 12km south of Leigh Creek township, E on unsealed road for about 2.5 km to the Beltana (Puttapa) zinc mine office and thence to the limestone outcrop.	
<b>LOCATION BOUNDARY:</b>	Elongate polygon 820 m SE-NW and maximum 170 m NE-SW as per site plan and Coordinates below	
	<b>Coordinates</b>	<b>Node</b> <b>Elevation</b>
	30°40'22.75"S 138°26'45.61"E	Ajax 1 290m
	30°40'25.63"S 138°26'37.34"E	Ajax 2 297m
	30°40'18.14"S 138°26'25.63"E	Ajax 3 304m
	30°40'06.86"S 138°26'24.28"E	Ajax 4 298m
	30°40'16.60"S 138°26'28.37"E	Pavement 308m
<b>LAND DESCRIPTION:</b>	<b>Title Ref.:</b>	CL 1437/24
	<b>Lot No.:</b>	Block 693
	<b>Section:</b>	Part Pastoral Lease 2498 Part Mining Tenements ML 4369, PELA 577, ELA 2013/00151
	<b>Hundred:</b>	Out of hundreds (Copley)

## PHOTOS

**Ajax Mine Fossil Reef**  
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View to north-east from Beltana spoil heap showing fossiliferous ridge incorporating Ajax Mine Fossil Reef. Crushed ore stockpile areas visible in middle ground. (P Kruse)



View south at Ajax Mine Fossil Reef. Observers clustered around a 100sq m pavement (J Gehling, 2005)

## PHOTOS

**Ajax Mine Fossil Reef**  
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Example of Archaeocyath fossils (oldest mineralized sponges) plus other small shelly fossils exposed in a natural pavement of the Early Cambrian Ajax Limestone within the Fossil Reef. Archaeocyath calcite skeletons have been replaced by silica and naturally etched out. (J. Gehling, 2012)

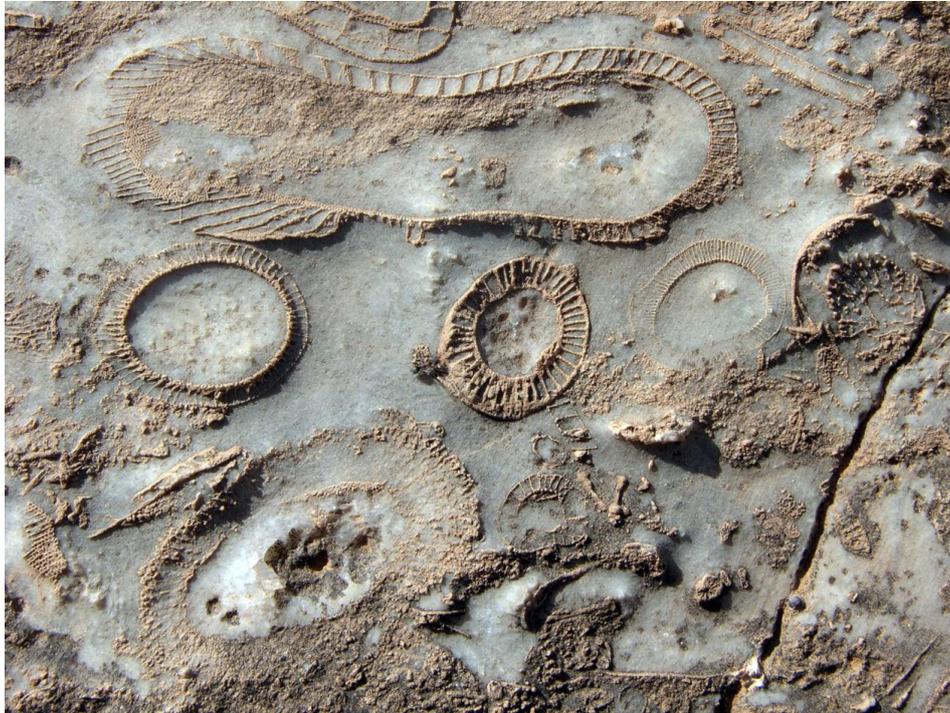


Detail of Cambrian Archaeocyatha in Ajax Limestone, Beltana  
(SA Museum collection: Griffith Taylor 1910).

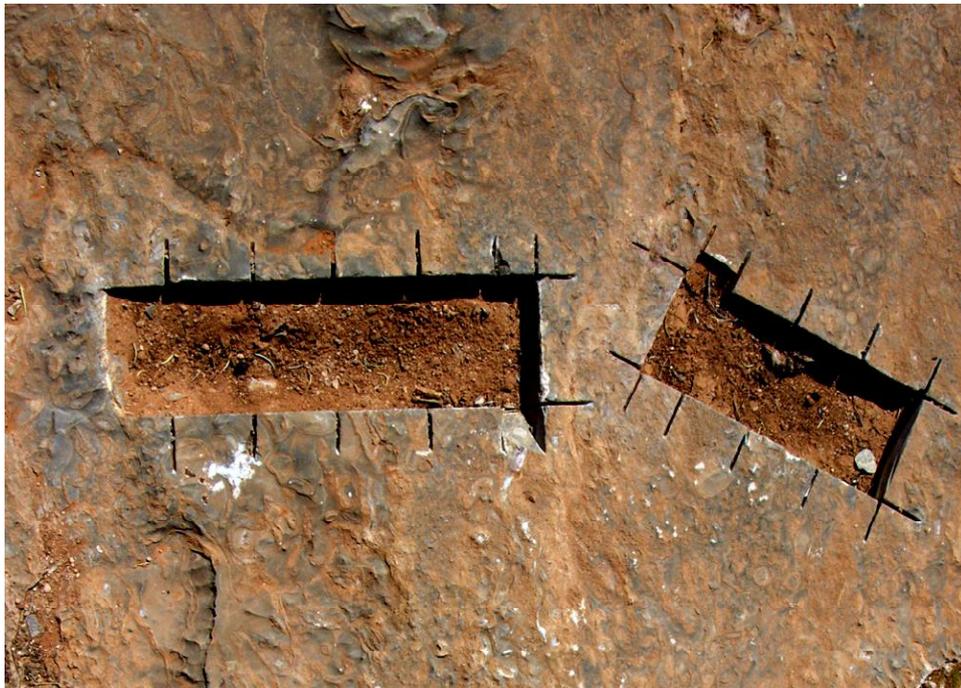
## PHOTOS

**Ajax Mine Fossil Reef**  
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Example of archaeocyaths from the natural pavements of the Ajax Limestone, on site near the old Ajax Mine. (Image: J. Gehling).

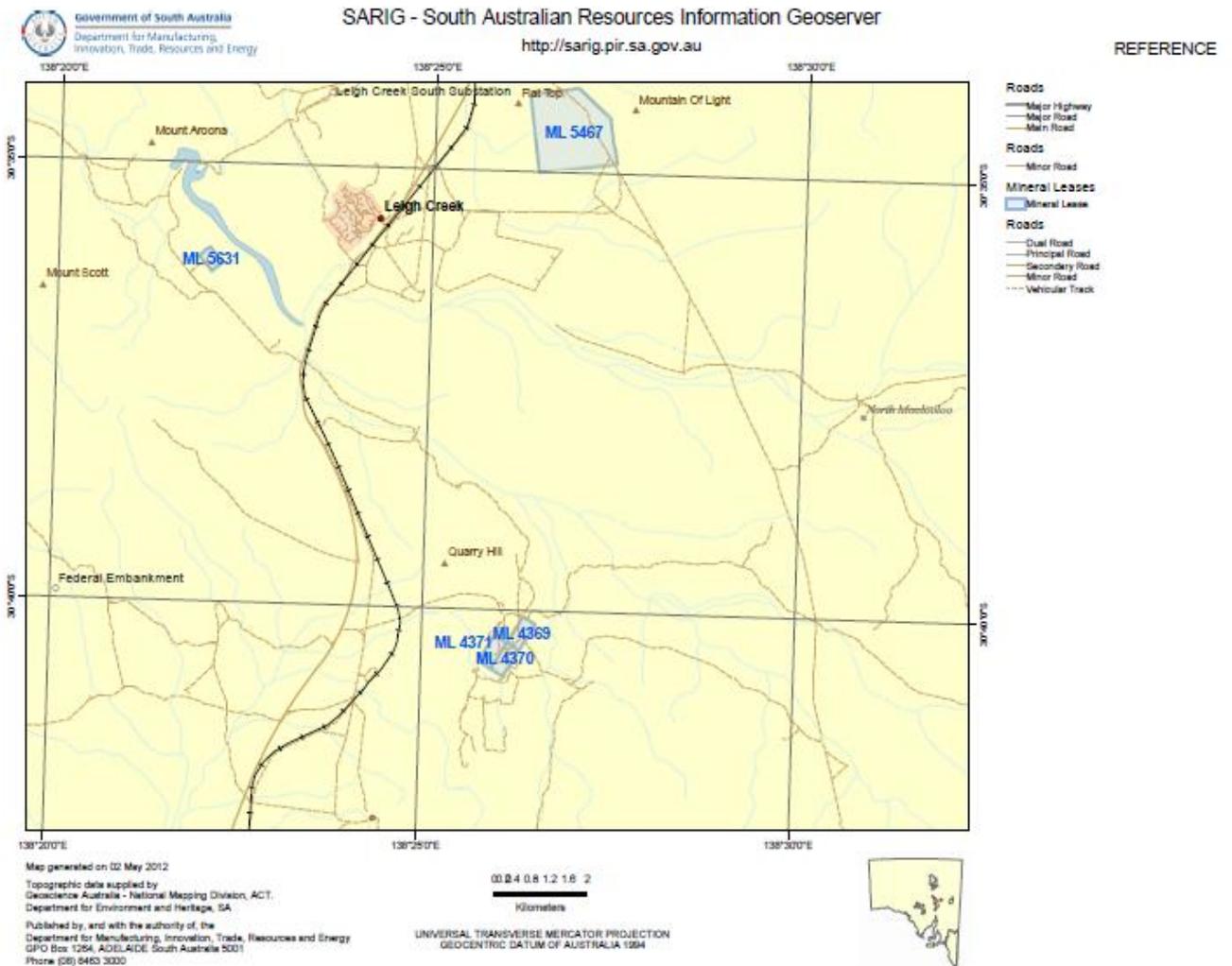


Damage to pavement caused by diamond saw sampling in mid 1980s (J. Gehling)

# LOCATION PLAN

**Ajax Mine Fossil Reef**  
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Locality plan of ML 4369 and Ajax (Beltana) Mine Fossil Reef