South Australian
HERITAGE COUNCIL

BETTER HERITAGE INFORMATION
SUMMARY OF STATE HERITAGE PLACE

Enorama Diapir Geological Monument

Enorama Diapir Geological Monument SHP 16229, c. 1997.

Source: DEW Files

ENTRY IN THE REGISTER

Description or notes with respect to a place entered in the South Australian Heritage Register in accordance with either the *South Australian Heritage Act 1978* or the *Heritage Places Act 1993.*

The South Australian Heritage Council may correct errors or inaccuracies in the Entry in the Register in accordance with s21 of the *Heritage Places Act 1993*.

NAME: Enorama Diapir Locality – Diapir Reef Complex, Flinders National Park (original) **PLACE NO.:** 16229

Enorama Diapir Geological Monument (proposed)

ADDRESS: Ikara-Flinders Ranges National Park, Flinders Ranges 5434

CR 6228/876 D93043 Q65, CR 6228/877 D90825 Q61

Outside of Hundreds

CONFIRMED IN THE SOUTH AUSTRALIAN HERITAGE REGISTER:

09 October 1997

DESIGNATED AS A PLACE OF GEOLOGICAL SIGNIFICANCE:

12 June 1997

S16 CRITERIA SATISFIED UNDER *HERITAGE PLACES ACT 1993*

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

COMMENTARY ON THE LISTING

Additional information provided as a part of the content of the South Australian Heritage Register in accordance with s14(6) of the *Heritage Places Act* 1993 'hold information in association with the Register'.

KNOWN AS:	Enorama Diapir Locality - Diapir Reef Complex, Flinders Ranges National Park [Designated as a place of geological significance] [original]
	Enorama Diapir Geological Monument, Ikara-Flinders Ranges National Park [Designated as a place of geological significance] [proposed]
ADDRESS	Adnyamathanha Country

STATEMENT OF HERITAGE SIGNIFICANCE

This updated and enlarged site contains clear exposures of the contacts between the Enorama Diapir and the algal reefs which grew along its shores about 640 million years ago when the Diapir was an island. These relationships demonstrate that the Enorama Diapir had intruded up through the sea floor to be above sea level at that time. This information is of considerable significance to the debate on the origin of the diapirs of the central Flinders Ranges, and, in particular, on their subsequent movements.

Validated 22 February 2000

STATEMENT OF HERITAGE SIGNIFICANCE (Proposed)

The Enorama Diapir Geological Monument contains clear exposures of the contacts between the Enorama Diapir and the algal reefs embedded within the younger Enorama Shale. These reefs grew along Enorama Diapir's shores following its intrusion upwards through the sea floor around 640 million years ago. Exposures of the Etina Formation, including stromatolites and eroded material from the diapir, are also present. The contacts between the Enorama Diapir, the Cryogenian-aged reef complex, and the dolerite boulder bed is considered to provide tangible evidence of the evolution of the diapir and its subsequent movement in the central Flinders Ranges.

STATEMENT OF DESIGNATION (Propossed)

Designated Place of Geological Significance

The Enorama Diapir Geological Monument has contacts with the Etina Formation and the Enorama Shale. The two geological formations provide an excellent opportunity for research into the origin of Flinders Ranges diapirs and the effect of diapir development on the surrounding geology. The Etina Formation contains well-developed stromatolites and a dolerite boulder bed, located at the contact of the formation and the diapir. Their presence supports a hypothesis of phases of erosion and 'pulses' of diapir development. The younger Enorama Shale contains unusually aged algal reef complexes from the Elatina glaciation associated with, and showing evidence of, the potentially phased growth of the diapir during a time of sea level rise. It is highly likely that additional research on the diapir and surrounds will provide valuable information into the development of not only the Enorama diapir but also other diapirs within the Flinders Ranges.

Elements of Significance:

Elements of heritage significance include:

- Boulder bed,
- Diapiric breccia, including basalt and surrounding geology,
- Stromatolites and reefs associated with the Enorama diapir,
- Sediments of the Etina Formation and Enorama Shale.

Elements not considered to contribute to significance of place include:

- Human-made objects, trails and roads, vegetation, fencing and signage.

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

It yields information that will contribute to an understanding of the State's natural history because the site contains a number of features of considerable importance to research and debate concerning ttye nature, origin and age of the diapirs of the Flinders Ranges. (Criteria statement considered at provisional entry, not reconsidered at confirmation. If proposed criteria statement is approved by the SAHC this will be deleted from this document.)

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

Several features of the Enorama Diapir Geological Monument are considered to potentially yield information that contributes to our understanding of the origins of diapirs and their effect on surrounding geological formations, and the evolution of Cryogenian-aged reefs within the Flinders Ranges.

Protected by Ikara-Flinders Ranges National Park, the Enorama diapir and its surrounds have a high level of intactness. The dolerite (intrusive igneous rock) boulder bed in the Etina Formation demonstrate contact with the diapir breccia of the Enorama diapir. The bed, a result of the erosion of the diapir, may provide insight into the diapir's origin and movement during the Elatina glaciation (ending approximately 635 Ma) and whether sediment present is a result of diapiric development or other geological movement. Recent research has provided some new insights into the origin of diapirs within the Flinders Ranges and it is considered highly likely that the Enorama diapir will continue to yield further information. Exposures of the boulder bed within the Etina Formation are well exposed, providing an excellent opportunity for research on diapir development despite the diapir itself having poor exposure.

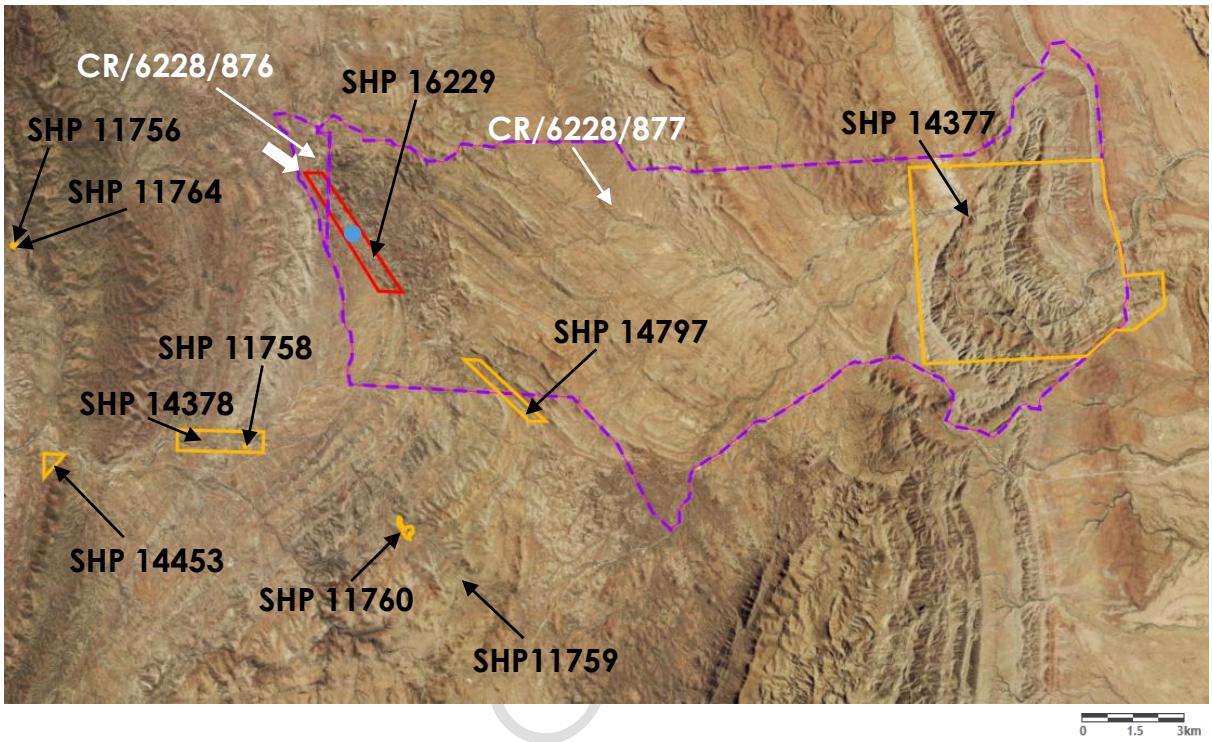
Additionally, the reef complex present at the Enorama diapir is unusual in that it depicts the building and collapse of a reef closely coupled with the development of a diapir, demonstrating the evolution of the landscape and ecosystem at the time of deposition. Algal reefs are also well preserved, notably the original texture despite dolomitisation of the sediment.

Combined, these features demonstrate a high potential to contribute to an understanding of the development of diapirs in South Australia, a poorly understood and complex geological feature and also the evolution and effect of diapirs on the surrounding landscape captured in-situ.

SITE PLAN

Enorama Diapir Geological Monument **PLACE NO.: 16229**

Flinders Ranges SA 5434



Enorama Diapir Geological Monument, Adnyamathanha Country, Ikara-Flinders Ranges National Park, Flinders Ranges SA 5434, Outside of Hundreds
CR 6228/876 D93043 Q65, CR 6228/877 D90825 Q61

N ↑

LEGEND

Parcel boundaries (Indicates extent of Listing)

Existing State Heritage Place(s) (Late Precambrian Shales (SHP 14453), Stromatolites in the Precambrian Trezona Formation (SHP 14378), Mail Station and Rubbish Dump (SHP 11758), Shop, Blacksmith (SHP 11759), Dingley Dell Homestead Site (SHP 11760), Eddie Pumpa Outstation (SHP 11764), Hayward Homestead (SHP 11756), Oraparinna Diapir Locality, Flinders Ranges National Park (SHP 14797), Wilkawillina Archaeocyatha Site (SHP 14377), Tufa Waterfall, Bunkers Conservation Reserve (SHP 14802)).

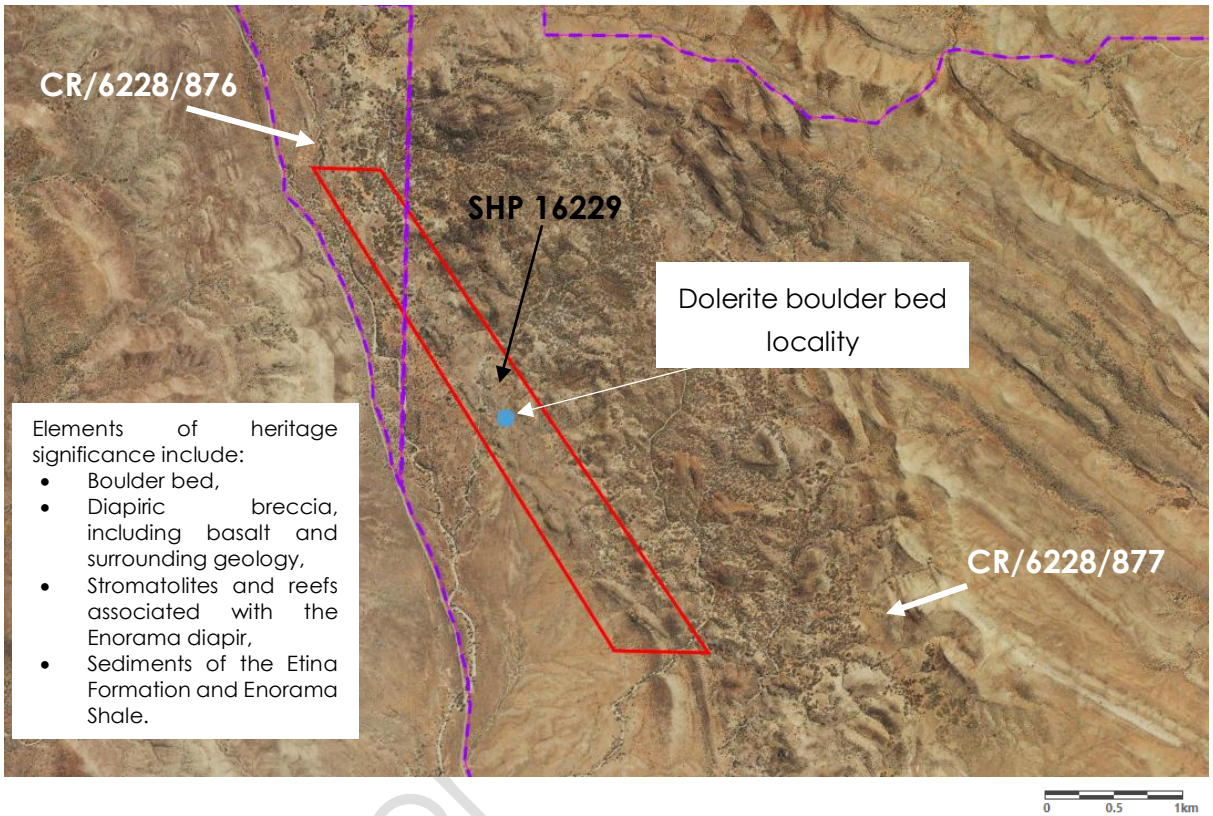
Outline of Elements of Significance for State Heritage Place

Approximate location of dolerite boulder bed (Flinders Ranges Heritage Survey 1995)

SITE PLAN - DETAIL

Enorama Diapir Geological Monument **PLACE NO.: 16229**

Flinders Ranges SA 5434



Enorama Diapir Geological Monument, Adnyamathanha Country, Ikara-Flinders Ranges National Park, Flinders Ranges SA 5434, Outside of Hundreds
CR 6228/876 D93043 Q65,CR 6228/877 D90825 Q61

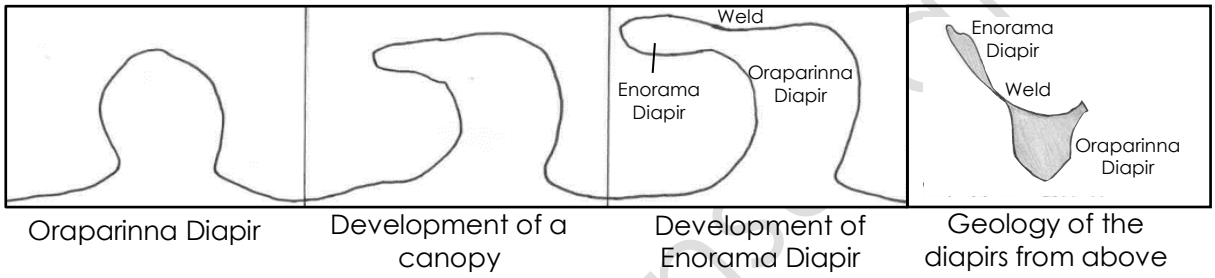
N ↑

LEGEND

- Parcel boundaries (Indicates extent of Listing)
- Outline of Elements of Significance for State Heritage Place
- Approximate location of dolerite boulder bed (Flinders Ranges Heritage Survey 1995)

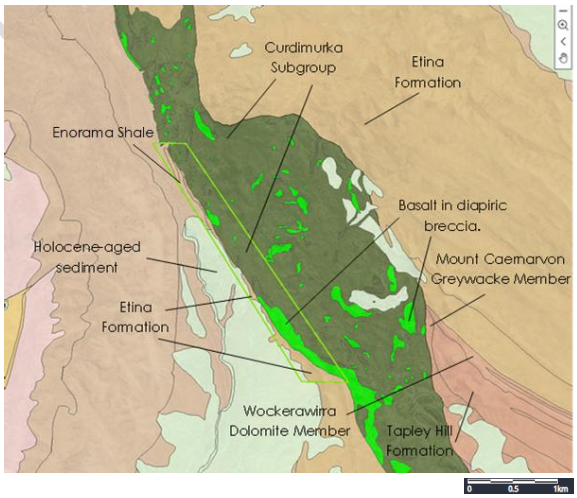
PHYSICAL DESCRIPTION

The Enorama diapir, as well as the nearby Oraparinna diapir, are found along a 'north-south striking antiform structure' which also extends through the Blinman diapir further north.[1] 'Antiform' refers to the shape of altered geology and is characterised by an upward arching of rock layers or strata. The Oraparinna and Enorama diapirs are generally recognised as salt diapirs,[2] formed when salt flows upwards by gravity or tectonic forces creating domes in the landscape.[3] The Enorama diapir is a dyke-like extension of the Oraparinna diapir[4] and the Enorama and Oraparinna diapirs are connected by a weld turned vertical, nearly 90 degrees upward.[5] It has been estimated that the Enorama diapir has influenced and deformed an approximated 4,000 metres of sediment.[6]



Development of the Oraparinna Diapir, weld and Enorama Diapir. 2025.

Most notably, the Enorama Diapir Geological Monument contains the contact between the Elatina glaciation (ending approximately 635 Ma), the aged Etina Formation, the slightly younger Enorama Shale, and outcrops of diapiric breccia. Also present are the Willouran (~827-802Ma) Curdimurka subgroup, the main body of the Enorama diapir, and several Sturtian aged (~720-660Ma) formations such as the Wockerawirra Dolomite Member, Tapley Hill Formation and Mount Caernarvon Greywacke Member.



Geology of the Enorama diapir interpreted from SARIG (N.D.).

The Etina Formation contains well developed stromatolites as well as bands of asbestos and conglomerate rock. These stromatolites can predominantly be found on the south-western flank of the diapir.[7] Closer to the diapir, there is a notably steep dip forming structures of fanning conglomerate around the diapir (bald-cap structures)[8] indicating multiple phases of diapir erosion and movement.[9]

The contact between the Enorama diapir and the Etina Formation documents the previous geology of the place. The Etina Formation contains a clearly exposed boulder bed that becomes finer further from the diapir. These include conglomerate rocks believed to be from the Enorama diapir, broken off with movement and weathering of the diapir.[10] Geologists speculate that the contact may have been a cliff with the boulder bed within the Etina Formation being a result of eroded rocks from erosion of the cliff.

The Enorama Diapir Geological Monument also records contact between the Enorama Shale and the Enorama diapir. The Enorama Shale overlies the Etina Formation and is therefore slightly younger. The shale contains evidence of Precambrian algal reefs as well as a 'dolerite boulder bed' formed as the diapir was eroded. The remains of the reefs are now dolomitised, likely altered by diagenesis and the diapir.[11]

Elements of Significance:

Elements of heritage significance include:

- Boulder bed,
- Diapiric breccia, including basalt and surrounding geology,
- Stromatolites and reefs associated with the Enorama diapir,
- Sediments of the Etina Formation and Enorama Shale.

Elements not considered to contribute to significance of place include:

- Human-made objects, trails and roads, vegetation, fencing and signage.

HISTORY OF THE PLACE

Geological history

Diapirs are intrusions of ductile, pressurised material that are forced or enter upwards into pre-existing and often more brittle rocks. The material that comprises a diapir is normally less dense than the surrounding material, causing vertical intrusion through buoyancy. Common forms of diapirs are the result of shales, or low-density evaporites, such as salt, that rise and penetrate layers of host rock along faults or other weaknesses.[12] When large enough, this movement causes an uplift of rocks in the surrounding areas, creating a dome-shaped protrusion in the natural terrain. Although

Elatina Formation	Elatina glaciation	Young
Trezona Formation		
Enorama Shale	Inter-glacial	
Etina Formation		
Sunderland Formation		
Tapley Hill Formation	Sturt glaciation	
Tindelpina Shale member		Old

rare, the material some eventually exposed at through

diapir can, in locations, become the surface erosion.

The Neoproterozoic Era (1 Ga-541 Ma) includes the Tonian, Cryogenian and Ediacaran Period and saw the evolution of some ancestors of green algae and seaweed, extreme glaciation events and evolution of some of the earliest examples of multicellular life.[13] The Enorama diapir and surrounding geology record many of these events and examples of evolution within its fabric.

Very basic stratigraphy of relevant Cryogenian sediments in the Central Flinders Ranges. Adapted from: Schmidt et al. 2009, Williams et al. 2008.

The Curdimurka Subgroup, a part of the larger Callanna Group makes up the diapiric material. The Curdimurka Subgroup is Willouran (~827-802Ma) in age and was most likely deposited in a lake or coastal mud or sandflats known as sabkhas.[14] The rock sequence makes up a majority of the Enorama diapir and was forced upwards when the diapir began its formation. Recent research suggests that the reefs associated with the diapir may be up to 800 Ma, though investigations are still ongoing.[15]

Both the Enorama and the Oraparinna diapirs were formed during the Neoproterozoic Era, particularly in the Cryogenian.[16] Prior to the introduction of the term 'Cryogenian', South Australian geology used the nomenclature for two time periods, the older

'Sturtian' (~720-660 Ma) and the younger 'Marinoan' (~650-635 Ma), both of which are characterised by glaciations with the same names. Currently (2026), the terms 'Sturt' and 'Elatina' are used for the glaciations respectively.

A 2013 study of the Enorama salt diapir weld proposes that the earliest recorded diapiric events in the area likely occurred early in the Sturt glaciation, with salt movement forming the central 'nucleus' of the Oraparinna diapir.[17] During this time, diapiric breccia pushed upwards through the overlying sediment, approximately 650 Ma.[18] It wasn't until the boundary between the Sturt and Elatina glaciations, about the time of deposition of the Sunderland and Etina formations, that the Enorama diapir was also formed. The Enorama diapir is recognised as a secondary diapir to the Oraparinna diapir.[19] Over time and more intense folding and faulting in a mountain building phase about half a billion years ago (Delamerian orogeny) portions of the diapiric breccias and basaltic rafts were exposed at the surface in the region of the locality.

The Enorama diapir rose at the same time as the sedimentation of the associated Etina Formation,[20] which rests atop some of the diapiric breccia. The Etina Formation, Enorama Shale and several other formations depict shallow waters that supported stromatolites and a reef complex as well as deeper water environments resulting from the movement of the Enorama diapir.[21] As it rose, the Enorama diapir pierced through the seafloor and likely formed an island, allowing for reefs to form on the southern and western side of the intrusion.[22] The conglomerate pieces within the Etina and Enorama Shale demonstrate that these formations were being deposited while the diapir was actively moving.

The Enorama Shale is also believed to be an age between the Sturt and Elatina glaciations.[23] Overlying the older Etina Formation, the shale was likely developed due to an increase in water depth.[24] At the same time as the Enorama Shale was being deposited, algal reefs were developing on the rising diapir's margins.

Potential extensions of the ~800 Ma reefs,[25] approximately ~640 million years old, in the Enorama Shale proves that the diapir intruded through the sea floor and above sea level at the time of reef deposition and development. This allowed the algal reefs to continue to build along the western edge of the diapir as it continued to push through the surrounding rock, eventually forming a 'refuge' around a small island in the Precambrian-aged ocean. This enabled stromatolite and reef[26] growth in shallow waters as the diapir rose and the remaining deep water areas allowed for deposition of deep ocean sediment.[27]

Rising sea levels, erratic diapir movement and deposition of the Enorama Shale eventually killed and buried these reefs.[28] Parts of the island formed by the emerging diapir were eroded, and boulders of breccia were broken off, contributing to a conglomerate that fans out away from the diapir[29] in what is now called a 'basic

boulder bed' or 'dolerite boulder bed' of diapiric material. The dolerite outcrop at the site is surrounded by deformed beds of shales, interbedded with dolomicrite and sandstones. The dolerite often contains evaporite minerals and minerals that may have replaced salts in sandstone. Along with the erosion of the diapir, the boulder bed is believed to have been formed by the repeated uplifting, cementing together, and erosion of smaller grained materials over time to become larger boulders.[30] Evidence indicates that more than eight phases of erosion and therefore movement of the diapir occurred.[31]

The Enorama diapir experienced further rising and one of these erosional periods during the Elatina (Marinoan) glaciation, however the exact cause of this remains unknown[32] Some geologists propose that the boulder bed was the result of other forms of flow like basic intrusions and lava flow or tectonic movement, rather than diapiric movement.[33] Eventually, portions of the diapiric breccia and associated reefs and basalt were exposed at the surface where the Enorama Diapir Geological Monument is found.

Human History

The Enorama Diapir Geological Monument is located on Adnyamathanha Country. Adnyamathanha People lived on the land and possessed a great understanding of the natural landscape and terrain. They had close contact with neighbouring Aboriginal Peoples including for mining and trading ochre. In the 1840s and 1850s, when colonisation of the Far North commenced, many violent encounters occurred between the colonists and Adnyamathanha People. The Adnyamathanha People were noted as being particularly skilled in their use of the landscape to hide and ambush colonial settlers. While there were deaths on both sides, many more Adnyamathanha People were killed.[34]

By 1853, rations were being distributed to the Adnyamathanha People, who due to the control and degradation of the land caused by European practices found it difficult to find sufficient food. During the Victorian gold rush, some Adnyamathanha People were employed by pastoralists, however, droughts in the 1890s resulted in many pastoralists leaving the land. In the 1930s, a mission was constructed at Nepabunna and many Adnyamathanha People were relocated to live there.[35]

The Adnyamathanha People's determination and cohesion was evident into the 1930s when Anthropologist AP Elkin visited the community. He noted that traditional ceremonies, language and culture remained despite the devastating and lasting effects of colonisation.[36]

In 1945, the Flinders Ranges National Park was gazetted encompassing the entirety of the Enorama diapir. Little research into the diapir itself was conducted until the mid-1900s. There was a large increase in interest in diapir structures in the 1960s, notably

on formation and abundance of diapirs in the Flinders Ranges. In 1981, the 'Enorama Diapir Dolerite Boulder Bed', which is largely included within the current State Heritage Place, was one of several diapirs recognised in the publication 'Geological Monuments in South Australia' by the SA Division of the Geological Society of Australia.

In 1995, the 'Enorama Diapir Locality' (UNG-LR-10) was recommended for inclusion as a local heritage place in the Flinders Ranges Heritage Survey. On the 18th of March 1997, additional research was produced and formally presented to the State Heritage Authority on 10 April. On 12 June, the diapir was provisionally entered in the South Australian Heritage Register and designated as a place of geological significance as 'Geological Site: Enorama Diapir Locality - Diapir Reef Complex, Flinders Ranges National Park.'. It was confirmed as a place of geological significance in the South Australian Heritage Register on 9 October 1997.

The origin of the 'Enorama' name is currently (2026) unknown.

Aboriginal Cultural Considerations

The *Heritage Places Act 1993* makes provision for the identification, recording and conservation of places and objects of non-Aboriginal heritage significance. The protection and preservation of Aboriginal heritage is provided for under the *Aboriginal Heritage Act 1988*. Contact the Aboriginal Heritage Unit for listings.

CHRONOLOGY

Year	Event
4-1.6Ga	Archaean–Palaeoproterozoic age.
1Ga	Neoproterozoic begins.
850-800Ma	**Deposition of the Callanna Group/ Curdimurka Subgroup.** **'Willouran' time.** **~800Ma potential earliest formation of reefs associated with Enorama diapir.**[37]
~720 Ma	Cryogenian Period begins. Period of glaciations. Sturt glaciation (700-665 Ma). **Tapley Hill Formation**, Wockerawirra Dolomite and Mount Caernarvon Greywacke Member deposited.[38] **Enorama Shale, Etina Formation and Sunderland Formation deposited between the Sturt and Elatina glaciations, potentially continued to be deposited into the Elatina glaciation**.[39] Elatina ('Marinoan') glaciation which, while the start is poorly understood, is believed to have ended ~635Ma.

635-538 Ma	Cryogenian Period ends, along with the Elatina glaciation. 635-538 Ma encompasses the Ediacaran Period. Deposition of the sequence overlying the Oraparinna and Enorama diapirs continues.
538 Ma	Neoproterozoic (Including the Ediacaran) ends. The Cambrian Period starts. Deposition of the sequence overlying the Oraparinna and Enorama diapirs continues into Lower or Middle Cambrian and was deformed by the Delamerian Orogeny.
~500 Ma	**Delamerian Orogeny. Folding of sedimentary rocks of the Flinders Ranges.**
1945	Flinders Ranges National Park gazetted.
1972 and 1976	The boundary of the Flinders Ranges National Park is expanded to include the Oraparinna and Enorama diapirs.
1981	The diapir is recognised as a Geological Monument known as the 'Enorama "Diapir" Dolerite Boulder Bed Locality' (FR.27 (ii)) by the SA Division of the Geological Society of Australia.
1995	**The 'Enorama Diapir Locality' is partially recognised in the Flinders Ranges Heritage Survey undertaken by Austral Archaeology and Donovan and Associates for the Department of Environment and Natural Resources. The place is recommended for local heritage listing. Co-ordinates provided within the survey denote a much smaller polygon.**
1996	1 May, the diapir is identified to the SA Heritage Branch after further research by the SA Division of the Geological Society of Australia.
1997	18 March, updated information is sent to the State Heritage Authority (currently known as the South Australian Heritage Council) regarding the Enorama diapir locality 10 April, updated research is formally presented to the State Heritage Authority. **12 June, the diapir is provisionally entered in the South Australian Heritage Register (the Register) and designated as a place of geological significance* as 'Geological Site: Enorama Diapir Locality - Diapir Reef Complex, Flinders Ranges National Park.'** **9 October, the diapir is confirmed in the Register as Enorama Diapir Locality – Diapir Reef Complex, Flinders National Park.**
2011	Flinders Ranges National Park is co-managed by Parks SA and the Adnyamathanha Traditional Lands Association RNTBC.

2016 Flinders Ranges National Park is renamed to Ikara-Flinders Ranges National Park.

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SITE DETAILS

Enorama Diapir Geological Monument **PLACE NO.: 16229**

Flinders Ranges SA 5434

DESCRIPTION OF PLACE:	Diapir, including dolerite boulder bed, diapiric breccia, and stromatolites	
HISTORIC THEME/S	Theme 1 Natural Environment 1.1 Tracing climatic and topological change	
AGE OF FORMATION:	Predominantly around the Elatina glaciation (~650Ma)	
REGISTER STATUS:	Provisionally Entered 12 June 1997 Designated 12 June 1997 Confirmed 9 October 1997	
CURRENT USE:	Geological Site	
LOCAL GOVERNMENT AREA:	Pastoral Unincorporated Area	
LOCATION:	**Street No.:**	NA
	Street Name:	Ikara-Flinders Ranges National Park
	Town/Suburb:	Flinders Ranges
	Post Code:	5434
LAND DESCRIPTION:	**Title Reference:**	CR 6228/876 D93043 Q65, CR 6228/877 D90825 Q61
	Hundred:	Outside of Hundreds

REVISIONS

Date	Changes
13 February 2026	SAHC modified template to include an image at the beginning of the document.

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