South Australian
HERITAGE COUNCIL

BETTER HERITAGE INFORMATION
SUMMARY OF STATE HERITAGE PLACE

Oraparinna Diapir Geological Monument

Oraparinna Diapir Geological Monument SHP 14797, c.1995.

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: Oraparinna Diapir Locality, Flinders Ranges National Park (original) **PLACE NO.:** 14797

Oraparinna Diapir Geological Monument (proposed)

ADDRESS: Ikara-Flinders Ranges National Park

Flinders Ranges 5434

CR 6228/877 D90825 Q61, CR 6228/876 D90343 Q66

Outside of Hundreds

CONFIRMED IN THE SOUTH AUSTRALIAN HERITAGE REGISTER:

9 October 1997

DESIGNATED AS A PLACE OF GEOLOGICAL SIGNIFICANCE:

12 June 1997

S16 CRITERIA SATISFIED UNDER *HERITAGE PLACES ACT 1993*

(b) it has rare, uncommon or endangered qualities that are of cultural significance

(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: Oraparinna Diapir Locality, Flinders Ranges National Park [Designated place of geological significance] [original]

Oraparinna Diapir Locality, Ikara-Flinders Ranges National Park [Designated place of geological significance] [proposed]

ADDRESS Adnyamathanha Country

STATEMENT OF HERITAGE SIGNIFICANCE

This discordant 'diapiric' breccia/sediment contact exposed at this locality is considered important in interpreting the origin of 'diapirs' within the Flinders Ranges. Associated crocidolite asbestos and conglomerate bands in the adjacent Etina Formation are also significant to this study. In addition, this area contains outcrops of characteristic Sturtian glacials, distinctive Holowilena ironstone and well developed Etina Formation stromatolites.

Validated 22 February 2000

STATEMENT OF HERITAGE SIGNIFICANCE (Proposed)

The Oraparinna Diapir Geological Monument demonstrates examples of contacts of diapiric breccia and the surrounding geology considered important in interpreting the origin of diapirs within South Australia. Conglomerate bands in the adjacent Sunderland Formation are also significant to this research. In addition, the locality contains outcrops of characteristic Sturt glacials from approximately 720-660 million years ago, distinctive Holowilena Ironstone and well-developed Etina and Sunderland Formation stromatolites. These features as well as the presence of crocodilite are well exposed making the locality a valuable source in understanding the geology of the Flinders Ranges and the origin of diapirs in South Australia.

STATEMENT OF DESIGNATION (Proposed)

Designated Place of Geological Significance

The Oraparinna Diapir Geological Monument includes areas where exposed breccia of the diapir makes contact with the Sunderland Formation, the Etina Formation and ironstones of the Holowilena Ironstone and early Cryogenian sediment deposited during the Sturt glaciation (720-660-million-years-ago). The relationship between the diapiric rock and the surrounding sediment is likely to contribute to our understanding of the geology of the Flinders Ranges and the origin of diapirs in South Australia. The presence of crocodilite associated with the now filled-in Oraparinna Asbestos Mine is also likely to contribute to an understanding of the development of this diapir and others within the State.

Elements of Significance:

Elements of heritage significance include:

- Exposed diapiric breccia
- Stromatolites and conglomerates within the Sunderland and Etina Formations,
- Glacial erratics and ironstones in the Holowilena Ironstone,
- Evidence of Sturt glaciation,
- Contacts between diapiric breccia and Sturt glacial sediment.

Elements not considered to contribute to significance of place include:

- Human-made objects, trails and roads, vegetation, fencing and signage.
- Infilled crocidolite (asbestos) shaft

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

(b) it has rare, uncommon or endangered qualities that are of cultural significance

It has rare, uncommon or endangered qualities that are of cultural significance. Indeed, the most important of these is the discordant 'diapiric' breccia sediment contact exposed at this locality which is considered important in interpreting the origins of 'diapirs' in 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.)

***(b) it has rare, uncommon or endangered qualities that are of cultural significance* (Proposed replacement statement)**

Situated between the Oraparinna and Enorama Diapirs, the Oraparinna Diapir Geological Monument is an uncommon grouping of geological formations featuring exposed 'diapiric' breccia, crocidolite asbestos and conglomerate bands, rocks and sediment from the Cryogenian Sturt glaciation including tillite, and Holowilena Ironstone and stromatolites.

This site provides a rare, excellent exposure of contact between diapiric material and the surrounding geology, demonstrating clear development of the diapir in an unusual way, reflected by only a few diapirs in the Flinders Ranges with the Enorama and Oraparinna diapirs being an excellent example.

While diapiric breccias and glacial sediments are not particularly rare in isolation, the combination of them here provides rare insight into diapiric development and influence on surrounding sediment. Examples of ironstones from the Holowilena Ironstone, conglomerate bands and stromatolites of the Etina and Sunderland Formations are also considered rare.

Holowilena Ironstone in association sediments of the Sturt glaciation demonstrates that the formation is of a younger age than many other iron formations in Australia (eg. Middleback Ranges (SA) and the Pilbara (WA)), making it unusual. Conglomerate bands demonstrate potential erosion and movement events of the diapir and the inflow of material, providing rare insight into the formation and movement of the diapir over time.

Both the Oraparinna and Enorama diapirs have a distinct and complex relationship with the surrounding geological formations. The Oraparinna Diapir Geological Monument includes several rare and common features that together produce a rare and highly culturally significant location containing unusual ironstones intrinsically linked with glaciations at the time of deposition, bands of conglomerate demonstrating movement and erosion of the diapir and stromatolites together with excellent exposures of diapir breccia.

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

This geology may yields information that will contribute to an understanding of the State's natural history. (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 information that will contribute to an understanding of the State's history, including its natural history* (Proposed replacement statement)**

The Oraparinna Diapir Geological Monument contains several geological features that are considered to potentially yield information that contributes to our understanding of the formation and development of diapirs and the complex geology surrounding them.

Specific features with a high potential to yield new knowledge about the geological formation of South Australia are:

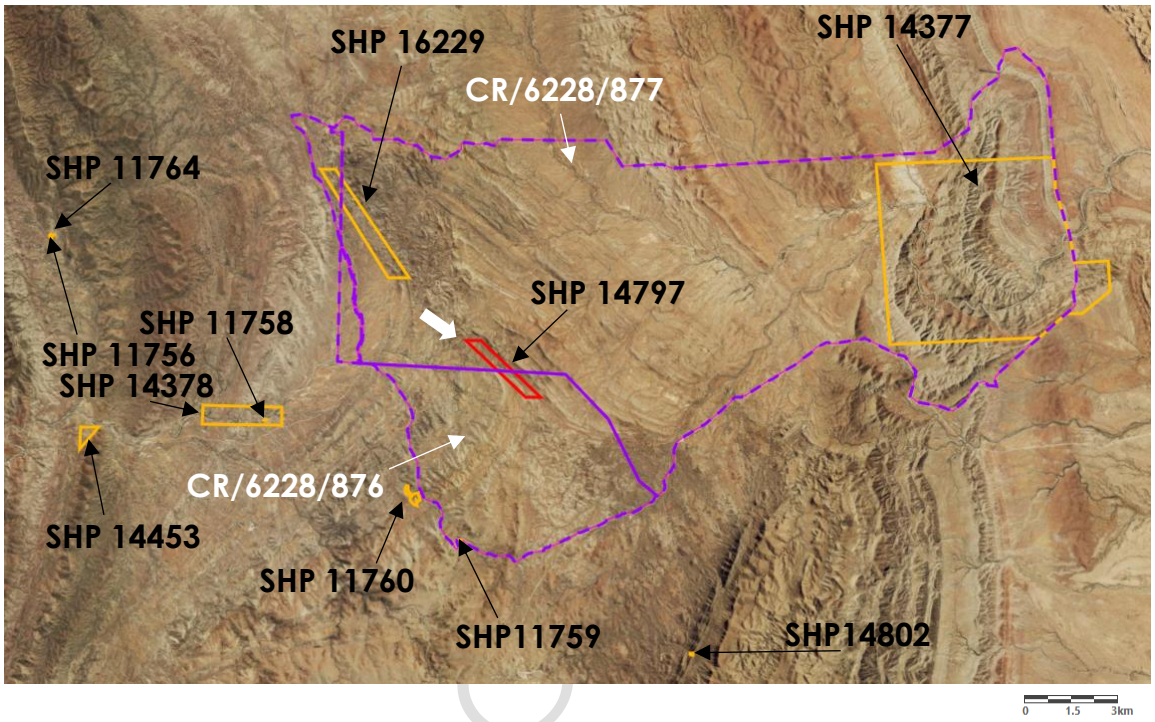
- Outcrops of characteristic Sturt glaciation sequence including the unusual and distinctive Holowilena Ironstone. This ironstone is younger than those more commonly observed, dating from approximately 680 Ma (million years ago).
- Exposures of diapiric breccia, particularly those in contact with sturt glacial sediment like the Holowilena Ironstone and Etina Formation are considered important in understanding how the diapir, and others in the Flinders Ranges, formed and developed. Contact between the diapiric breccia and the glacial rocks and ironstones have been the subject of ongoing geological research but remain poorly understood. Some researchers propose that the unusual presence of asbestos within the locality and the contact between the stromatolitic conglomerate of the Etina Formation may be able to provide insight.

Despite recent research efforts, little is known about the formation and development of many of the diapirs within the state and, more specifically, the Flinders Ranges. The Oraparinna Diapir Geological Monument has a high level of intactness making it a valuable source in better understanding the origins and development of diapirs and the complex geological formations surrounding them.

SITE PLAN

Oraparinna Diapir Geological Monument **PLACE NO.: 14797**

Flinders Ranges 5434



Oraparinna Diapir Geological Monument, Adnyamathanha Country, Ikara-Flinders Ranges National Park, Flinders Ranges SA 5434, Outside of Hundreds
CT 6228/877 D90825 Q61, CR 6228/876 D93043 Q66

*Includes: Late Precambrian Shales (SHP 14453), Stromatolites in the Precambrian Trezona Formation (SHP 14378), Hayward Homestead (SHP 11756) Mail Station and Rubbish Dump (SHP 11758), Shop, Blacksmith (SHP 11759), Dingley Dell Homestead Site (SHP 11760), Eddie Pumpa Outstation (SHP 11764), Enorama Diapir Locality - Diapir Reef Complex, Flinders Ranges National Park (SHP 16229), Wilkawillina Archaeocyatha Site (SHP 14377), Tufa Waterfall, Bunkers Conservation Reserve (SHP 14802).

N ↑

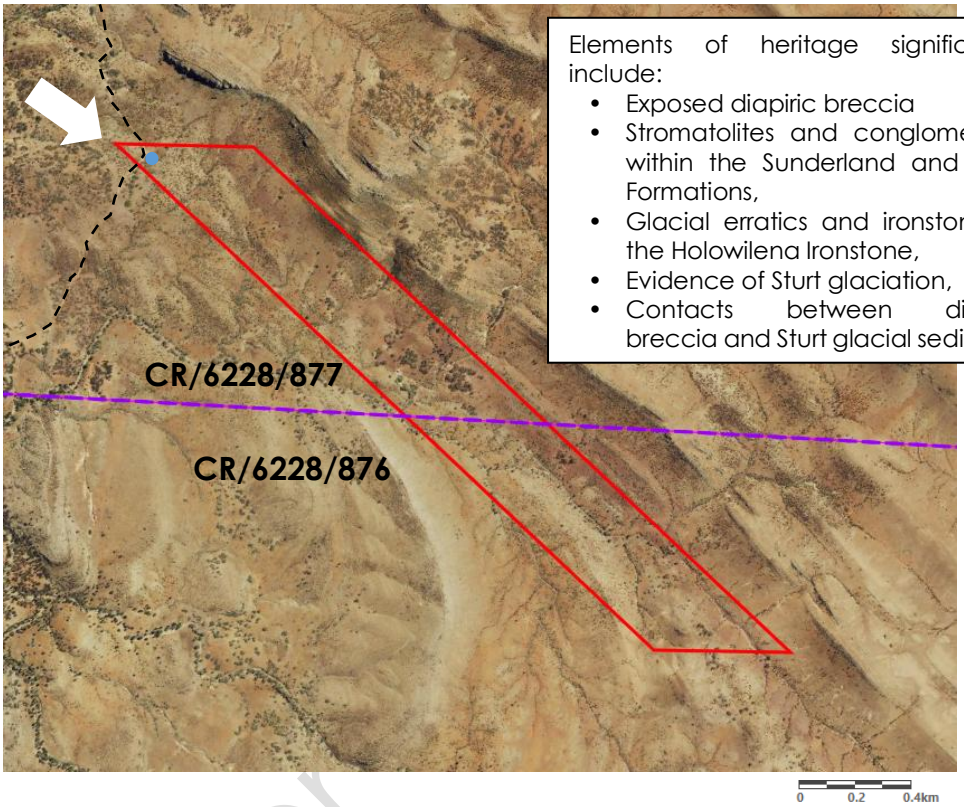
LEGEND

- Parcel boundaries (Indicates extent of Listing)
- Existing State Heritage Place(s)
- Outline of Elements of Significance for State Heritage Place

SITE PLAN (DETAIL)

Oraparinna Diapir Geological Monument **PLACE NO.: 14797**

Flinders Ranges SA 5434



Oraparinna Diapir Geological Monument, Adnyamathanha Country, Ikara-Flinders Ranges National Park, Flinders Ranges SA 5434, Outside of Hundreds
CT 6228/877 D90825 Q61, CR 6228/876 D93043 Q66

N ↑

LEGEND

- Parcel boundaries (Indicates extent of Listing)
- Outline of Elements of Significance for State Heritage Place
- Pantapinna Track (Often used for identifying the location place)
- Oraparinna Mine

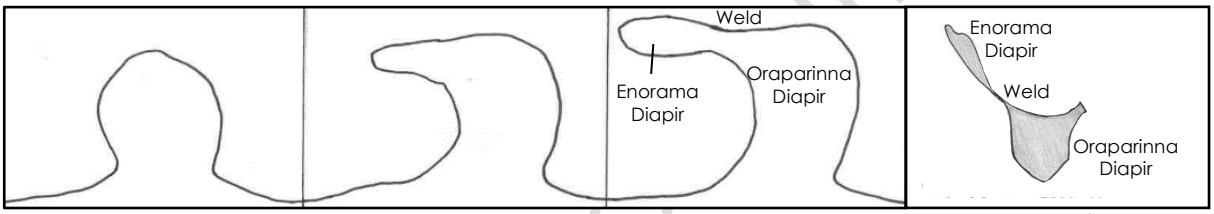
Historical documents previously retained a different SHP parcel which was altered with additional research before the place was listed. Due to the high attention to detail and specific GPS co-ordinates provided at the time of listing, it is clear there was specific intention to list the current extent of listing as is. As a result, the current extent of listing will be retained.

Ikara-Flinders Ranges National Park provides additional protections to the area's geology and landforms (Ikara-Flinders Ranges National Park Management Plan 2017) and surrounds.

PHYSICAL DESCRIPTION

The Oraparinna Diapir Geological Monument is situated between the Enorama and Oraparinna diapirs. Both diapirs are found along a 'north-south striking anticlinal structure' which also extends through the Blinman Diapir further north.[1] 'Anticline' 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 domes or diapirs,[2] formed when salt flows upwards, assisted by gravity anomalies or tectonic forces creating domes in the overlying strata.[3]

The Enorama and Oraparinna diapirs are connected by a salt weld. Here, the Oraparinna diapir, formed a canopy of sorts as it rose and met resistance from overlying rocks, forcing the diapiric material to develop to the North, thus forming the Enorama diapir. Eventually this weld turned vertical, facing nearly 90 degrees upward.[4] A portion of this weld forms part of the locality. The exposure of the Oraparinna Diapir is 'moderately good' but is overlain by outwash gravels and calcrete soil crust intervals.[5]

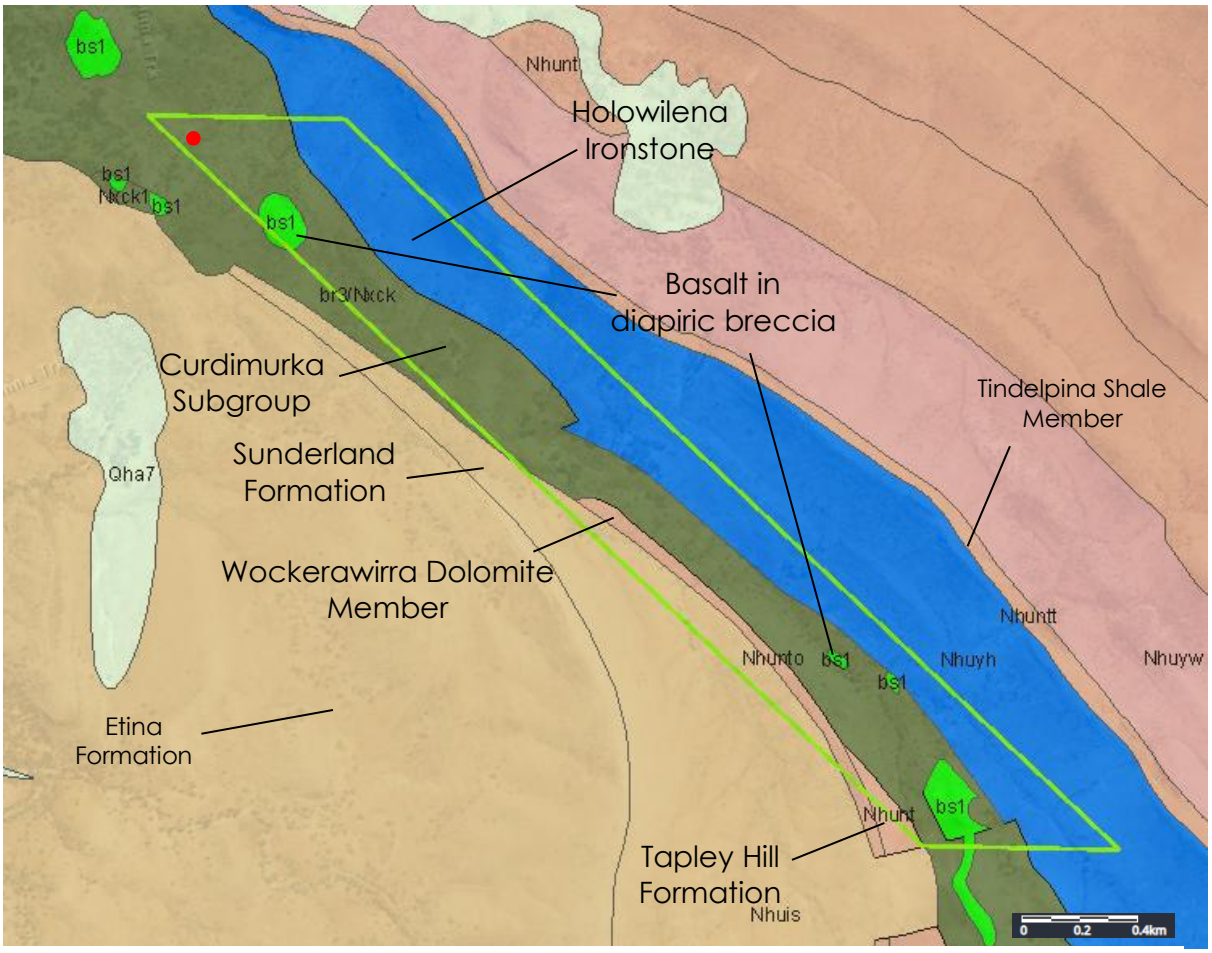


Development of the Oraparinna Diapir, weld and Enorama Diapir. 2025.

The diapir locality contains exposed contacts between typical Sturt glacial sediments (~720-660Ma[6] (Million years ago)), Curdimurka Subgroup (~827-802Ma[7]) and other geological formations. Here, the Sturt glaciation refers to the snowball earth glaciation that occurred during the Cryogenian period (~720-635Ma).

The locality contains the contact between the Curdimurka Subgroup (~827-802Ma), including siltstone, sandstone and dolomite with stromatolite inclusions and Yudnamutana Subgroup rocks (~720-660Ma) including Holowilena Ironstone, containing iron-inclusive siltstones, ironstone and some stromatolitic erratics.[8] Within the fragmented Curdimurka Subgroup rocks, basalts and related igneous rocks occur and there are also intrusions of basalt often as very large rafts or blocks. Breccia is a type of rock consisting of angular fragments of all sizes and other rocks cemented together. Diapiric breccias often contain dolomite or calcite and remnants of the other host rock.[9] The diapiric breccia of the Curdimurka Subgroup is well exposed within the State Heritage Place.[10]

In the southernmost part of the locality, the 'Willouran' Curdimurka Subgroup breccias are faulted against the Sunderland Formation, Wockerawirra Dolomite Member, Etina Formation and Tapley Hill Formations to the west.



Geological formations and inclusions making up the Oraparinna Diapir Geological Monument (green outline) from SARIG (N.D.) The red spot denotes the Oraparinna Mine.

The site demonstrates a distinctive grouping of glacial rocks associated with the Holowilena Ironstone[11] and stromatolites and siltstones within the Curdimurka Subgroup. The Holowilena Ironstone's formation is enigmatic and poorly understood. A vast majority of iron formations are Archaean–Palaeoproterozoic age (4-1.6 Ga) so the reappearance of much younger Neoproterozoic (1 Ga-541 Ma) iron formations is unusual and has been subject of recent research.[12] Also within the Holowilena Ironstone are stromatolitic dolomites (stromatolites that have been altered physically and/or chemically via a process called diagenesis), quartzite and jasper including jasper breccia.[13]

The Holowilena Ironstone (or Iron Formation) extends from these exposures to the east and southeast as far as the Olary region in the Northeast of the State where its equivalent has the name Braemar Iron Formation.

The Sunderland Formation which is faulted against it to the west and more recently replaced a large portion of the Wockerawirra Dolomite Member[14] is a sandstone/limestone formation that often contains conglomerates[15], oolites and stromatolites.[16] Though it is unknown whether Stromatolites are exposed within this formation within the SHP. The Etina formation also contacts the diapir to the west.[17] The Etina Formation contains well developed stromatolites as well as bands of asbestos and conglomerates. Exposures of the stromatolites are excellent and some are buried beneath conglomerate bands that demonstrate the history of the diapir's development. Similar stromatolites and conglomerate bands are exposed at the Enorama Diapir Geological Monument - Diapir Reef Complex (SHP 16229).

At the northern tip of the area on the western edge are the remnants of an asbestos mine. The mine is disused and appears to have little impact on the surrounding landscape, having been infilled previously. It is notable that asbestos is only found in the Flinders Ranges in diapirs but not in the surrounding host rocks.[18] It is possible that the asbestos may provide insight into the formation of the diapir as they suggest the previous presence of large volumes of salt,[19] of which many of the diapirs of the Flinders Ranges are believed to have been formed, though the salt no longer remains at the surface.

Elements of Significance:

Elements of heritage significance include:

- Exposed diapiric breccia
- Stromatolites and conglomerates within the Sunderland and Etina Formations,
- Glacial erratics and ironstones in the Holowilena Ironstone,
- Evidence of Sturt glaciation.
- Contacts between diapiric breccia and Sturt glacial sediment

Elements not considered to contribute to significance of place include:

- Human-made objects, trails and roads, vegetation, fencing and signage.
- Infilled crocidolite (asbestos) shaft

HISTORY OF THE PLACE

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.[20] When large enough, this movement causes an uplift of rocks in the surrounding areas, creating a dome-shaped protrusion in the natural terrain.

In locations where they do eventually become exposed either at the sea floor or on land, erosion results in conglomerates containing boulders and cobbles of the breccias. However, events where diapirs are exposed are generally rare. One of the reasons for highlighting Oraparinna and Enorama diapirs is that they exhibit these features.

The Curdimurka Subgroup is the oldest geological formation within the Oraparinna Diapir Geological Monument. It is locally regarded as 'Willouran' (~827-802 Ma) in age and was most likely deposited in lakes or coastal mud sandflats known as sabkhas.[21] The rock sequence makes up a majority of the Oraparinna diapir. Within the diapiric breccias, the basaltic igneous rocks are of the same age.

Both the Enorama and the Oraparinna diapirs were formed during the Neoproterozoic, particularly in the Cryogenian.[22] 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.

The 'Sturtian' likely allowed for the development of the Holowilena Ironstone as glacial rocks and tillite.[23] Tillite associated with ironstones contain erratics, rocks that have been transported by glacial movement, quartzite, stromatolites and igneous materials.[24] The contact between diapiric breccias and the Sturt glacial tillites of the Holowilena Ironstone is particularly significant at the Oraparinna Diapir Geological Monument having a high angle of contact rather than a subparallel intrusion that is more expected. For this reason, it is suspected to be a 'faulted diapir margin', altered by tectonic movement. Additionally, 'Sturtian' age ironstones are found in several other countries but are unusual.

The majority of known iron formations in Australia and around the world were formed during the Archaean–Palaeoproterozoic (~2.5 Ga)[25], then becoming near-absent in the geological record, only for them to reappear in the Neoproterozoic (~680 Ma)[26] in association with the Sturt glaciation and its equivalents. The reappearance of Ironstones is not well understood. The original ferrous shales and siltstones deposited as what would become the Holowilena Ironstone was partly altered by diagenesis into hematite and jasper. It is believed these were altered while the ironstones were being deposited or shortly after.[27]

The contact between diapiric breccia and the Sturt glacial tillite of the Etina Formation is also significant. Conglomerate bands from the movement of the diapiric material are present at the contact and are similarly seen at the nearby Enorama diapir.

A 2013 study of the Enorama salt diapir weld noted that the earliest recorded diapiric events in the area were likely early in the Sturt glaciation, with salt movement forming the central 'nucleus' of the Oraparinna diapir.[28] During this time, diapiric breccia

pushed upwards through the overlying sediment, approximately 650 Ma.[29] 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.[30] 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.

Human History

Oraparinna Diapir Geological Monument is a part of 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.[31]

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.[32]

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.[33]

The name 'Oraparinna' is believed to have Aboriginal language origins, meaning 'Tea-Tree River'. The diapir was named after the pastoral run managed by Septimus Boord from September 1851 onwards.[34]

Major scientific research did not occur in this location until the mid-1900s. Instead, early interest focused on the asbestos present at the site, prompting limited mining activities. The Oraparinna Asbestos Mine was in production between 1941 and 1942. It yielded approximately 100 tonnes of asbestos, particularly crocidolite. In 1945, the Flinders Ranges National Park was gazetted encompassing the current SHP and a vast majority of the Oraparinna diapir's main body. The occurrence of asbestos was thought to suggest the previous presence of large volumes of salt which would support the salt diapir model of buoyant evaporites allowing the breccia to rise and

intrude into overlying rocks. It was believed that, with comparison to other diapirs, insight into the emplacement of the Flinders Ranges Diapirs could be garnered.

In the 1960s there was a large increase of interest into the diapir structures, including the formation, and abundance in the Flinders Ranges. In 1981, several diapirs were recognised as 'Geological Monuments of South Australia' by the SA Division of the Geological Society of Australia including a majority of the Oraparinna Diapir Geological Monument. At that time, it was recognised as 'Enorama 'diapir' locality (i) – Oraparinna Asbestos Mine Area'. The initial, smaller polygon noted in the Geological Society of Australia documents would later be altered with the filling in of the Asbestos Mine. While focus moved away from the mine itself, the significance of the asbestos present was still recognised.

Several mines were present and continued in the main body of the diapir, outside of the locality, through the late 1900s and into the 2000s. Barite[35] and Zinc[36] mines in the main body of the Oraparinna diapir, outside of the SHP are still ongoing.[37]

In 2011, the Flinders Ranges National Park became co-managed by Parks SA and the Adnyamathanha Traditional Lands Association RNTBC. In 2016 the Flinders Ranges National Park was renamed Ikara-Flinders Ranges National Park.

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
4-1.6 Ga	Archaean–Palaeoproterozoic age. Most typical ironstones are deposited during this time.
1 Ga	Neoproterozoic begins.
850-800 Ma	**Deposition of the Callanna Group/ Curdimurka Subgroup during 'Willouran' time.**
~720-	Cryogenian Period begins. Period of glaciations. Sturt glaciation (700-665 Ma) includes the Holowilena Ironstone. Tapley Hill Formation, Wockerawirra Dolomite and Sunderland Formation and Etina Formation deposited during this period.[38] 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 mountain building phase
~500 Ma	**Delamerian orogeny. Folding of sedimentary rocks of the Flinders Ranges.**
1941	Oraparinna Asbestos Mine was in production.
1942	Oraparinna Asbestos Mine closes.
1945	Flinders Ranges National Park gazetted.
1948	Several reports on asbestos deposits at Oraparinna.
1972 and 1976	Flinders Ranges National Park expanded to include Oraparinna and Enorama Diapirs
1981	Partially recognised as a Geological Monument by the SA Division of the Geological Society of Australia. Originally as "Enorama Diapir – Oraparinna Asbestos Mine Area" in a small square polygon.
1995	**Partially recognised in the Flinders Ranges Heritage Survey. Co-ordinates provided within the survey denote a much smaller polygon, likely the same**

as the Geological Society of South Australia's polygon. Identified to the Heritage Branch the same year.

1997 **10 April, presented to Heritage Authority and noted that consideration of the then 'Enorama Creek Diapir Locality: Oraparinna Asbestos Mine' (FR 27 (i)).**

It was also noted that new co-ordinates for the Geological Monument polygon would be adopted and these should be considered for Heritage Listing. These updated co-ordinates reflect the current polygon for the State Heritage Place and for the Geological Monument ('Oraparinna Asbestos Mine Area, Enorama Diapir Area' FR27 (i)). **On this date, consideration was deferred to a later time.**

12 June, the Heritage Authority change the name for the proposed State Heritage Place from 'Enorama Diapir Locality' to 'Oraparinna Diapir Locality, Flinders Ranges National Park' and the updated co-ordinates are accepted. **The place is provisionally entered and designated as a place of geological significance.***

9 October, confirmed into the State Heritage Register as Oraparinna Diapir Locality - Flinders Ranges National Park.

2011 Flinders Ranges National Park becomes 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.

BIBLIOGRAPHY

Publications

Burg, J-P (2017), 'Structural Geology - Domes and Basins', Teaching Materials, *Eidgenössische Technische Hochschule Zürich (Federal Institute of Technology, Zurich)*. From: <https://www.files.ethz.ch/structuralgeology/jpb/files/english/12diapirs.pdf>.

Burns, KL, Stephansson, O & White, AJR (1977), 'The Flinders Ranges breccias of South Australia—diapirs or d'ecollement?', *Journal of the Geological Society*, Vol.134(3), pp.363-384.

Department of Environment and Natural Resources (1995), 'Flinders Ranges Heritage Survey, Volume 9, Geological Places', *Government of South Australia*.

Hoffman et al. (2017), 'Snowball Earth climate dynamics and the Cryogenian geology-geobiology', *Science Advances*, Vol. 3(11), 10.1126/sciadv.1600983.

Leach, DL, Song, Y-C & Hou, Z (2017), 'The world-class Jinding Zn–Pb deposit: ore formation in an evaporite dome, Lanping Basin, Yunnan, China', *Mineralium Deposita*, Vol.52(3), pp. 281-296.

Lechte, MA & Wallace, MW (2015), 'Sedimentary and tectonic history of the Holowilena Ironstone, a Neoproterozoic iron formation in South Australia', *Sedimentary Geology*, Vol. 329, pp.211-224.

McBriar EM, Giles, CW and Mooney, MD (1981), 'Geological Monuments in South Australia Part 4', On behalf of the *Geological Monuments Subcommittee of the SA Division of the Geological Society of Australia Incorporated*, pp. 106-109.

Priess, WV (1989), 'Excursion Guide to Diapirs of the Flinders Ranges, Specialist Group in Tectonics and Structural Geology Conference, Kangaroo Island, 2-3 February 1989', Department of Mines and Energy, Report Book no. 89/2, pp.1-41.

Primary Industries and Resources SA (2011), 'Geology of the Flinders Ranges National Park', Government of South Australia. From: <https://www.frc.sa.gov.au/__data/assets/pdf_file/0043/899368/geology.pdf>.

Rowan, M, Hearon, TE, Kernen, R & Giles, KA (2019), 'A review of allochthonous salt tectonics in the Flinders and Willouran ranges, South Australia', *Australian Journal of Earth Sciences*, Vol. 67(2), pp.1-27.

Rowan, MG & Vendeville, BC (2006), 'Foldbelts with early salt withdrawal and diapirism: Physical model and examples from the northern Gulf of Mexico and the Flinders Ranges, Australia', *Marine and Petroleum Geology*, Vol. 23, pp.871-891.

Telfer, D (2013), 'Formation of the Enorama Salt Diapir Weld, Flinders Ranges South Australia', *Honours Thesis*, University of Adelaide, Adelaide, South Australia.

Books

Brock P & Gara, T (2018), 'Colonialism and its aftermath, A history of Aboriginal South Australia', Wakefield Press, South Australia.

Websites

Australian Government (N.D.), 'Stratigraphic Unit Details – Sunderland Formation', Australian Stratigraphic Units Database. From: < https://asud.ga.gov.au/search-stratigraphic-units/results/17528>.

Australian Government (N.D.), 'Stratigraphic Unit Details – Tapley Hill Formation', Australian Stratigraphic Units Database. From: < https://asud.ga.gov.au/search-stratigraphic-units/results/17814>

Australian Government (N.D.), 'Stratigraphic Unit Details – Wockerawirra Dolomite', Australian Stratigraphic Units Database. From: < https://asud.ga.gov.au/search-stratigraphic-units/results/20340>.

Britannica, The Editors of Encyclopaedia (2016), "diapir". *Encyclopedia Britannica*. From: <https://www.britannica.com/science/diapir>.

Britannica, The Editors of Encyclopaedia (2018), "Ediacaran Period". Encyclopedia Britannica. From: <https://www.britannica.com/science/Ediacaran-Period>.

Britannica, The Editors of Encyclopaedia (2023), "Cryogenian Period". *Encyclopedia Britannica*. From: <https://www.britannica.com/science/Cryogenian-Period>.

Britannica, The Editors of Encyclopaedia (2023), "Tonian Period". *Encyclopedia Britannica*. From: <https://www.britannica.com/science/Tonian-Period>.

Department for Energy and Mining (N.D.), 'Barite', *Government of South Australia*. From: <https://www.energymining.sa.gov.au/industry/minerals-and-mining/mineral-commodities/barite>.

Department for Energy and Mining, South Australian Resources Information Gateway (SARIG) (N.D.), 'SA Geodata Database - Rock Sample Details; Sample 28290', *Government of South Australia*. From: <https://minerals.sarig.sa.gov.au/RockSampleDetails.aspx?SampleNo=28290>.

Department for Energy and Mining, South Australian Resources Information Gateway (SARIG) Map (N.D.), *Government of South Australia*. From: <https://map.sarig.sa.gov.au/>.

Manning, GH (2012), 'O', *A Compendium of the Place Names of South Australia*. <https://published.collections.slsa.sa.gov.au/placenamesofsouthaustralia/O.pdf> [accessed 18 February 2026].

Maps

Dalgarno, CR & Johnson, JE (1966), 'Parachilna Map Sheet, Australia 1:250,000', Geological Survey. From: <https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/plans/sarig1/image/DDD/200471-056>;

Reid, P & Preiss, WV (1999), 'Parachilna Map Sheet, Australia 1:250,000', Geological Survey. From: < https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/plans/sarig1/image/DDD/200471-056>.

SITE DETAILS

Oraparinna Diapir Geological Monument **PLACE NO.: 14794**

Flinders Ranges SA 5434

DESCRIPTION OF PLACE:	Exposed intrusive breccia between the Oraparinna and the Enorama Diapirs.	
HISTORIC THEME/S	Theme 1 Natural Environment 1.1 Tracing climatic and topological change	
AGE OF FORMATION:	Approximately 720-635Ma	
REGISTER STATUS:	Provisionally Entered 10 April 1997 Designated 10 April 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 6228/877 D90825 Q61, CR 6228/876 D93043 Q66
	Hundred:	Outside of Hundreds

PHOTOS

Oraparinna Diapir Geological Monument **PLACE NO.: 14794**

Flinders Ranges SA 5434

Exposed diapir southeast of the Oraparinna asbestos mine. c.1999

Source: DEW Files

REVISIONS

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

[1] Telfer, D (2013), 'Formation of the Enorama Salt Diapir Weld, Flinders Ranges South Australia', *Honours Thesis*, University of Adelaide, Adelaide, South Australia.
[2] Telfer, D (2013), 'Formation of the Enorama Salt Diapir Weld, Flinders Ranges South Australia'.
[3] Britannica, The Editors of Encyclopaedia (2016), "diapir". *Encyclopedia Britannica*. From: <https://www.britannica.com/science/diapir>.
[4] Rowan, MG & Vendeville, BC (2006), 'Foldbelts with early salt withdrawal and diapirism: Physical model and examples from the northern Gulf of Mexico and the Flinders Ranges, Australia', *Marine and Petroleum Geology*, Vol. 23, pp.871-891.
[5] McBriar EM, Giles, CW and Mooney, MD (1981), 'Geological Monuments in South Australia Part 4', On behalf of the *Geological Monuments Subcommittee of the SA Division of the Geological Society of Australia Incorporated*, pp. 106-109; and Dalgarno, C (2024) Personal Communication.
[6] Hoffman et al. (2017), 'Snowball Earth climate dynamics and the Cryogenian geology-geobiology', *Science Advances*, Vol. 3(11), 10.1126/sciadv.1600983.
[7] Rowan, M, Hearon, TE, Kernen, R & Giles, KA (2019), 'A review of allochthonous salt tectonics in the Flinders and Willouran ranges, South Australia', *Australian Journal of Earth Sciences*, Vol. 67(2), pp.1-27.
[8] Telfer, D (2013), 'Formation of the Enorama Salt Diapir Weld, Flinders Ranges South Australia'.
[9] Leach, DL, Song, Y-C & Hou, Z (2017), 'The world-class Jinding Zn–Pb deposit: ore formation in an evaporite dome, Lanping Basin, Yunnan, China', *Mineralium Deposita*, Vol.52(3), pp. 281-296.
[10] Department of Environment and Natural Resources (1995), 'Flinders Ranges Heritage Survey, Volume 9, Geological Places', *Government of South Australia*.
[11] Lechte, MA & Wallace, MW (2015), 'Sedimentary and tectonic history of the Holowilena Ironstone, a Neoproterozoic iron formation in South Australia', *Sedimentary Geology*, Vol. 329, pp.211-224.
[12] Lechte, MA & Wallace, MW (2015), 'Sedimentary and tectonic history of the Holowilena Ironstone, a Neoproterozoic iron formation in South Australia'.
[13] Telfer, D (2013), 'Formation of the Enorama Salt Diapir Weld, Flinders Ranges South Australia'.
[14] Department for Energy and Mining, South Australian Resources Information Gateway (SARIG) Map (N.D.), *Government of South Australia*. From: <https://map.sarig.sa.gov.au/>; and Dalgarno, CR & Johnson, JE (1966), 'Parachilna Map Sheet, Australia 1:250,000', *Geological Survey*. From: <https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/plans/sarig1/image/DDD/200471-056>; and Reid, P & Preiss, WV (1999), 'Parachilna Map Sheet, Australia 1:250,000', *Geological Survey*. From: < https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/plans/sarig1/image/DDD/200471-056>.
[15] Primary Industries and Resources SA (2011), 'Geology of the Flinders Ranges National Park', Government of South Australia. From: <https://www.frc.sa.gov.au/__data/assets/pdf_file/0043/899368/geology.pdf>.
[16] Department for Energy and Mining, South Australian Resources Information Gateway (SARIG) (N.D.), 'SA Geodata Database - Rock Sample Details; Sample 28290', *Government of*

South Australia. From: <https://minerals.sarig.sa.gov.au/RockSampleDetails.aspx?SampleNo=28290>.
[17] Dalgarno and Johnson (1994), 'Oraparinna', *Geological Survey South Australia*, Geological Atlas 1 Mile Series, Map Reference no. 670. From: <https://www.frc.sa.gov.au/__data/assets/pdf_file/0043/899368/geology.pdf>.
[18] McBriar EM, Giles, CW and Mooney, MD (1981), 'Geological Monuments in South Australia Part 4'.
[19] McBriar EM, Giles, CW and Mooney, MD (1981), 'Geological Monuments in South Australia Part 4'.
[20] Burg, J-P (2017), 'Structural Geology - Domes and Basins', Teaching Materials, *Eidgenössische Technische Hochschule Zürich (Federal Institute of Technology, Zurich)*. From: <https://www.files.ethz.ch/structuralgeology/jpb/files/english/12diapirs.pdf>.
[21] Telfer, D (2013), 'Formation of the Enorama Salt Diapir Weld, Flinders Ranges South Australia'.
[22] Rowan, MG & Vendeville, BC (2006), 'Foldbelts with early salt withdrawal and diapirism: Physical model and examples from the northern Gulf of Mexico and the Flinders Ranges, Australia'.
[23] Tilllite is rock formed from sediment transported by a glacier. This often includes blocks of both weathered and unweathered unsorted rocks in a fine sediment matrix and that isn't altered by other processes.
[24] Department of Environment and Natural Resources (1995), 'Flinders Ranges Heritage Survey, Volume 9, Geological Places'.
[25] Dalgarno, C (2024), Personal Communication.
[26] Dalgarno, C (2024), Personal Communication.
[27] Lechte, MA & Wallace, MW (2015), 'Sedimentary and tectonic history of the Holowilena Ironstone, a Neoproterozoic iron formation in South Australia'.
[28] Telfer, D (2013), 'Formation of the Enorama Salt Diapir Weld, Flinders Ranges South Australia'.
[29] Dalgarno, B (2024) Personal Communication
[30] Telfer, D (2013), 'Formation of the Enorama Salt Diapir Weld, Flinders Ranges South Australia'.
[31] Brock P & Gara, T (2018), 'Colonialism and its aftermath, A history of Aboriginal South Australia', Wakefield Press, South Australia.
[32] Brock P & Gara, T (2018), 'Colonialism and its aftermath, A history of Aboriginal South Australia'.
[33] Brock P & Gara, T (2018), 'Colonialism and its aftermath, A history of Aboriginal South Australia'.
[34] Manning, GH (2012), 'O', A Compendium of the Place Names of South Australia. <https://published.collections.slsa.sa.gov.au/placenamesofsouthaustralia/O.pdf> [accessed 18 February 2026].
[35] Priess, WV (1989), 'Excursion Guide to Diapirs of the Flinders Ranges, Specialist Group in Tectonics and Structural Geology Conference, Kangaroo Island, 2-3 February 1989', Department of Mines and Energy, Report Book no. 89/2, pp.1-41.
[36] Department for Energy and Mining, South Australian Resources Information Gateway (SARIG) Map (N.D.).
[37] Department for Energy and Mining (N.D.), 'Barite', *Government of South Australia*. From: < https://www.energymining.sa.gov.au/industry/minerals-and-mining/mineral-commodities/barite>.
[38] Australian Government (N.D.), 'Stratigraphic Unit Details – Tapley Hill Formation', Australian Stratigraphic Units Database. From: < https://asud.ga.gov.au/search-stratigraphic-units/results/17814>; and Australian Government (N.D.), 'Stratigraphic Unit Details – Wockerawirra Dolomite', Australian Stratigraphic Units Database. From: < https://asud.ga.gov.au/search-stratigraphic-units/results/20340>.