

## BETTER HERITAGE INFORMATION SUMMARY OF STATE HERITAGE PLACE

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### COMMENTARY ON THE LISTING

Description and 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 information contained in this document is provided in accordance with s14(6) and s21 of the *Heritage Places Act 1993*.

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**NAME:** Tufa Waterfall, Bunkers Conservation Reserve **PLACE NO.:** 14802

**KNOWN AS:** Tufa Waterfall (designated place of geological significance), Bunkers (Private) Conservation Reserve

**ADDRESS:** Adnyamathanha Country  
Near Skull Rock Track  
Bunkers Conservation Reserve,  
Flinders Ranges 5434  
CR 5852/605 D55290 A100  
Outside of Hundreds

### CONFIRMED IN THE SOUTH AUSTRALIAN HERITAGE REGISTER:

9 October 1997

### STATEMENT OF HERITAGE SIGNIFICANCE

The sub-fossil Tufa Waterfall is a prime example of its type and is considered to be superior to others in Europe and Australia. 'Tufa' is a form of limestone precipitated from calcium-rich water, which creates delicate rock structures. The landform was created during the Late Pleistocene-Holocene (100,000 to 10,000 years ago) by the movement of calcium-rich water from nearby springs between red, Precambrian cliffs (approximately 717-660-Million-years-old). The presence of the fossil waterfall suggests a wetter environment than is currently known in the now arid Flinders Ranges. The uncommon and approximately 20-35-metre tall tufa deposit features three

overhanging tiers, containing two large caves with decorations within and provides abundant opportunity for palaeoenvironmental research.

## **STATEMENT OF DESIGNATION**

### **Designated Place of Geological Significance**

The approximately 100,000-10,000-year-old Tufa Waterfall is a 'sub-fossil' deposit of calcium that was created by the precipitation of carbonates from calcium-rich water, likely from a nearby spring. Over thousands of years, a 20-35m tall white calcium deposit between red Pre-Cambrian (approximately 717-660-Million-year-old) cliffs was formed, creating a striking location. The formation of the recognised geological monument is unusual and within the tufa are two large caves, both of which contain cave decorations such as stalactites, stalagmites and cave corals. The waterfall is of national significance and through research, offers the potential to alter our understanding of the climatic and geological development of the State.

### **Elements of Significance:**

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

- Large tufa waterfall,
- Tiered calcium carbonate /limestone deposits,
- Two decorated caves,
- Cave decorations including but not limited to uncommon cave decorations such as flowstones and cave coral,
- Remaining palaeochannel waterway,

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

- Built structures including buildings, signage and trails

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

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

The Tufa Waterfall is an excellent example of an uncommon geological formation and is considered to be a better example of tufa waterfall than found in Europe and other parts of Australia. As such, it was recognised as a Geological Monument in 1994 by the Geological Society of Australia's South Australian Branch.

Tufa waterfalls require high concentrations of calcium accumulation to form and are typically located in tropical or subtropical environments. Consequently, though tufa

deposits are not generally considered rare, tufa waterfalls are uncommon in South Australia due to the drier climate. The large size of the Tufa Waterfall has created an opportunity for the development of caves and speleothems within the tufa itself, including cave formations such as cave coral and flowstones. There are few opportunities to study tufa waterfalls in South Australia, particularly those with caves and cave formation, as a result the Tufa Waterfall in the Flinders Ranges provides an excellent opportunity for climate and geological research.

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

Tufa Waterfall is likely to yield information about South Australia's natural history and in particular the State's geological development and changes to the climate. Tufa waterfalls are most often found in tropical or subtropical environments and the formation of the Tufa Waterfall in an area that was believed to be arid at the time of the waterfall's formation is unusual.

If the flow of calcium-rich water to create the waterfall was a result of groundwater, this would imply that the climate during the time of deposition 100,000 to 10,000 years ago was significantly wetter than what is seen today. Little research has been conducted to answer the climatic questions that the formation of the Tufa Waterfall poses.

Additional dating and climatic data can be garnered through research on the cave decorations found within the waterfall. Consequently, Tufa Waterfall's caves and associated decorations also have the potential to yield detailed information about the changes to the climate and precipitation in central Australia thousands of years ago, creating a clearer understanding of the aridification of the State.

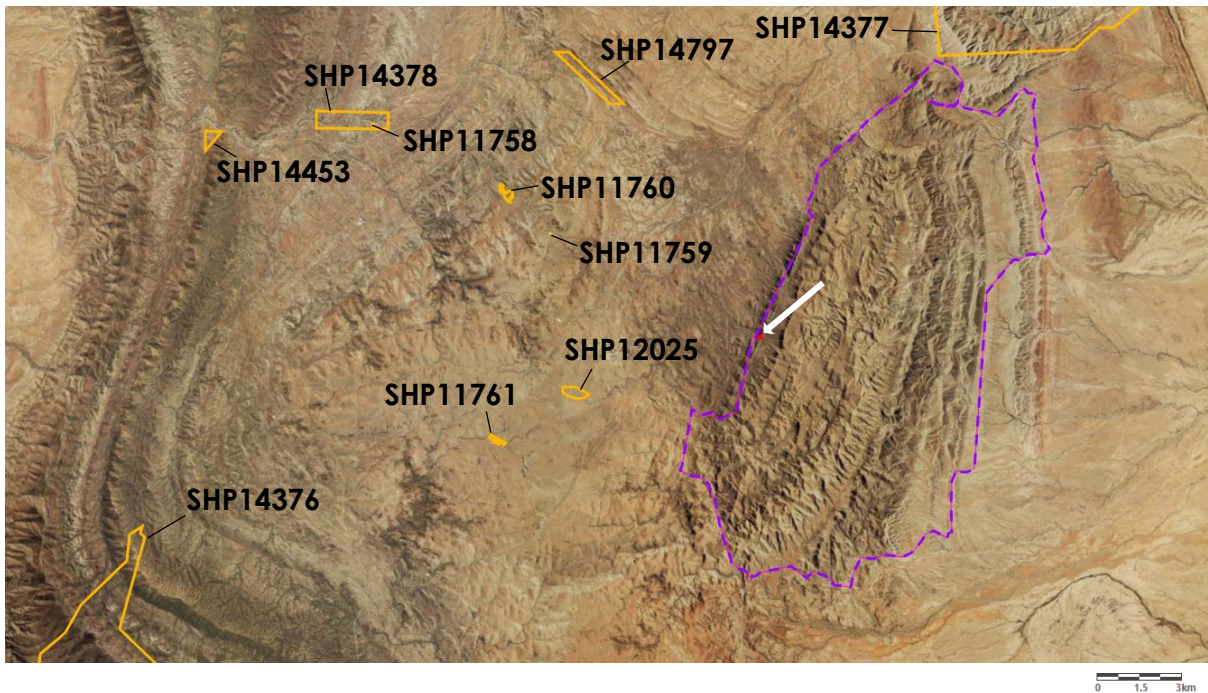
While Tufa Waterfall has experienced some deterioration due to visitors climbing on it, this damage has not impacted the place's intactness and ability to yield information about the history of the State. The uncommon and unusual qualities of the Tufa Waterfall could result in a reassessment of our understanding of environmental changes in South Australia over geological time.

# SITE PLAN

Tufa Waterfall

PLACE NO.: 14802




Bunkers Conservation Reserve, Flinders Ranges



Flinders Ranges showing location of Ikara-Flinders Ranges National Park, Bunkers Conservation Reserve (purple) and Tufa Waterfall (red dot), (CR 5852/605 D55290 A100 Outside of Hundreds).

N ↑

## LEGEND

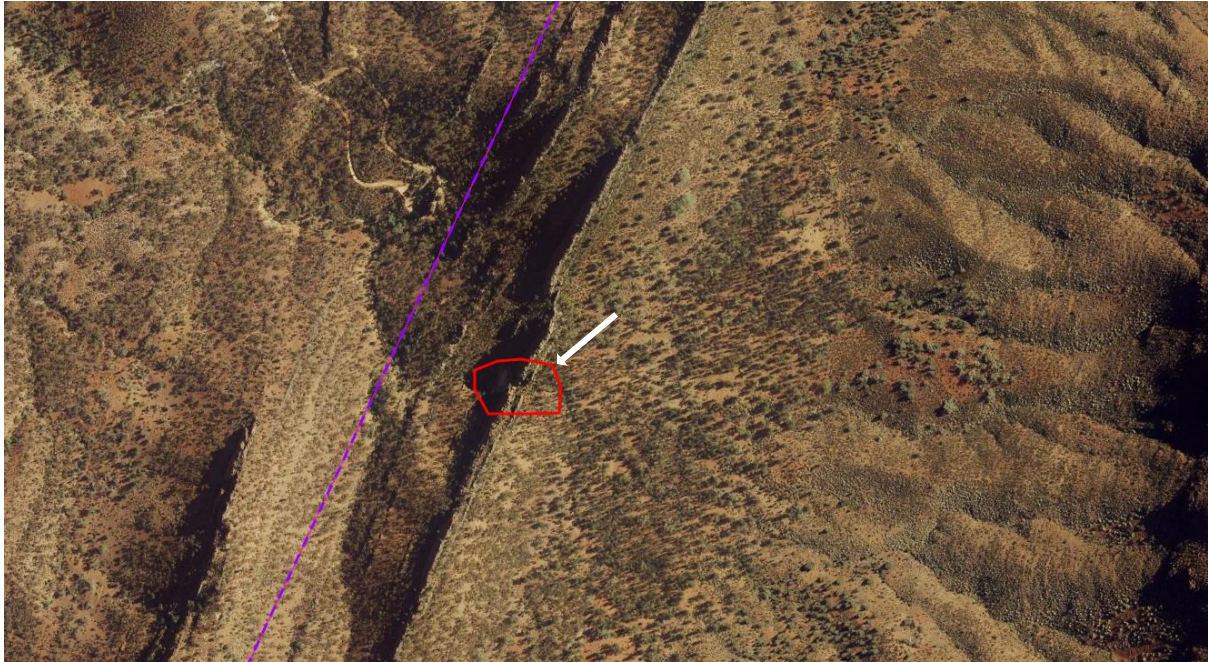
-  Parcel boundaries (Indicates extent of Listing)
-  Existing State Heritage Place(s)
-  Outline of Elements of Significance for State Heritage Place

# SITE PLAN

Tufa Waterfall

PLACE NO.: 14802




Bunkers Conservation Reserve, Flinders Ranges



Flinders Ranges including Ikara-Flinders Ranges National Park and the Bunkers Conservation Reserve and Tufa Waterfall (circled in red), (CR 5852/605 D55290 A100 Outside of Hundreds).

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## LEGEND

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

## PHYSICAL DESCRIPTION

The Tufa Waterfall is located at the base of Mt. Caernarvon in the Loves Mine Ranges and lies within the Bunkers Conservation Reserve (The Bunkers), a private conservation area leased to the Yellow Foot Rock Wallaby Preservation Association. The Bunkers Conservation Reserve contains, at least, portions of both the Loves Mine and Bunkers Ranges within its approximately 140km<sup>2</sup> area.<sup>1</sup>

The Tufa Waterfall, also known as Skull Rock, is a 20<sup>2</sup> to 35 metre-high<sup>3</sup> formation of tufa limestone, named for its distinctive appearance.<sup>4</sup> Tufa is a type of limestone that precipitates out of water, creating calcium carbonate deposits that often form cave systems. The waterfall is a light grey-pink colour that contrasts with the older red Precambrian<sup>5</sup> sandstone cliffs from the Umbertana Group<sup>6</sup> that surround the waterfall adding to its distinctive appearance.

Two caves have formed within the waterfall and are catalogued as 5F65 Black Cave and 5F66 Outflow Cave. The caves contain typical cave decorations such as speleothems, including flowstones and cave corals.<sup>7</sup>

Black Cave (5F65) is a small cave with an entrance approximately 1m wide and 0.8m high. Once inside, the cave opens up to a 3m by 2m chamber that is decorated with shawls and flowstones. The ceilings are approximately 2.5m high and are blackened by soot from smoke.<sup>8</sup>

Outflow Cave (5F66) is the larger of the two caves and forms the mouth of the skull.<sup>9</sup> The entrance is 6m wide and 3m high, inside the cave ceilings are up to 15m in height. The cave is fragile but is highly decorated, containing 'stalagmites, stalactites, shawls and cave coral.<sup>10</sup>

### Elements of Significance:

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

- Precambrian sandstone cliff face,
- large tufa waterfall,
- tiered calcium carbonate/limestone deposits,
- two decorated caves,
- cave decorations including uncommon cave decorations such as flowstones and cave coral,
- remaining palaeochannel waterway,

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

- Built structures including buildings, signage and trails

## HISTORY OF THE PLACE

The underlying geological formation of the place, the Umberatana Group, was created as a result of a shallow marine sedimentation<sup>11</sup> during the Sturtian glaciation, which occurred ~717-660 Million years ago in the Neoproterozoic. The Tufa Waterfall is flanked by red Precambrian<sup>12</sup> sandstone cliffs from this group. <sup>13</sup> During the Neoproterozoic, it is believed the planet experienced 'snowball Earth,' in which nearly the entire earth was covered by polar ice sheets, causing mass extinctions of living organisms. Evidence of changes caused by snowball Earth such as to sea levels and glaciations, referred to as the Sturtian and the Marinoan glaciations are recorded within the Umberatana group at this time.

Some time after, the Tufa Waterfall likely began formation 100,000 years ago by a flow of steady calcium-rich water over many years, which slowly deposited the calcium carbonate and layers of sediment. The place is named for its appearance, where the tufa rock formation has created many grooves that give the appearance of a waterfall frozen in rock.<sup>14</sup> It is referred to locally as 'The Skull', 'Skull Rock' or 'Skull Cave,'<sup>15</sup> as the many cavities within the waterfall face resemble a large skull.<sup>16</sup> Colloquially, it is also known as 'the home of the Phantom' referring to the cave of the same name in the 'Phantom' comic series.

The original source of the calcium-rich water that allowed for directed water flow to create the 'waterfall,' cannot be found.<sup>17</sup> However, some have hypothesised that groundwater, potentially emanating from a spring,<sup>18</sup> was the main source of water leading to the formation of the waterfall.<sup>19</sup> This hypothesis holds implications for the Pleistocene and early Holocene climate, as Tufa waterfalls commonly form in tropical or subtropical environments.<sup>20</sup> It suggests that when the Tufa Waterfall was forming 100,000 to 10,000 years ago, there may have been a far wetter climate than the expected arid environment which has been developing over the past ~15 Million years.<sup>21</sup> In-depth dating of the cave and associated decorations has not been undertaken, however, research could determine the date or potential environmental changes<sup>22</sup> that may have occurred when the waterfall was under active formation.

The source of mineral precipitation required to form tufa is also not fully understood. It was previously believed that precipitation of the minerals that make up the waterfall were caused by microbes,<sup>23</sup> somewhat like the formation of stromatolites. However, recent research has demonstrated that tufa is formed through a process called inorganic carbon outgassing, in which hydrological changes increase the concentration of calcium minerals for deposition.<sup>24</sup>

There is evidence of occupation by First Nations People within the caves. Notably, the smoke-darkened ceiling in Black Cave indicates the use of the cave by First Nations People prior to the arrival of Europeans. As a result, the waterfall is recognised as a site

of significance under the *Aboriginal Heritage Act 1988*.<sup>25</sup> Petroglyphs have also been located in other areas of Bunkers Conservation Reserve, though it is not known whether any are present within the boundaries of the State Heritage Place.

After European arrival, the area surrounding the Tufa Waterfall was occupied under Pastoral Leases from the 1850s. In 1956, the Bunkers land parcel was purchased by the Reynolds family. Better access to the Waterfall was facilitated by an upgraded mining track in 1987. Since then, increased visitation and attempts by members of the public to climb the falls has caused some damage to the formation.<sup>26</sup>

In 1994, the place was recognised as a Geological Monument by the Geological Society of Australia's South Australian Branch. In 2001, the Natural Heritage Trust purchased The Bunkers land from the Reynolds Family. This same year, the Bunkers Conservation Reserve was gazetted and opened. The park has since been privately operated by the Yellow-Footed Rock Wallaby Preservation Association Inc.<sup>27</sup> As a result, permission is required to access the reserve. Low impact mineral exploration has been undertaken within the reserve both before and after gazettal.<sup>28</sup>

## CHRONOLOGY

Year	Event
Sturtian (717-660Ma)	Umberatana Group geological sequence development and deposition.
Pleistocene-	Formation of the Tufa Waterfall. <sup>29</sup>
Holocene (100,000-10,000 years ago)	Tufa Waterfall believed to have last been active ~20,000-10,000 years ago <sup>30</sup> First Nations People living on Country and likely using the cave after formation as complete
1850's	Various Pastoral Leases granted in The Bunkers area.
1956	The Bunkers land parcel is purchased by the Reynolds family. <sup>31</sup>
1987	Mining track upgraded to allow easier access to the site. Evidence of damage caused by visitors attempting to climb the falls, notably scuffs and damage to the formation. <sup>32</sup>
1990	Tufa Waterfall identified to Heritage Branch.
1993-1994	Mining exploration license granted within what is now the State Heritage Place.
1994	Tufa Waterfall is recognised as a Geological Monument known as 'FR 38 Loves Mine Range – Fossil Waterfall' by the Geological Society of Australia's South Australian Branch.



1995	Tufa Waterfall identified to Heritage Branch a second time in the Flinders Ranges Heritage Survey.
1997	12 June Tufa Waterfall provisionally entered and designated as a place of geological significance in the South Australian Heritage Register. 9 October confirmed in the South Australian Heritage Register.*
2001	The Natural Heritage Trust purchases The Bunkers land from the Reynolds Family. 29 March, Bunkers Conservation Reserve gazetted <sup>33</sup> 4 October, officially opened <sup>34</sup>
2007-2009	Mining Exploration license granted within the SHP
2011-2016	Mining Exploration license granted within the SHP
2012	Wally Klau prepared a list of birds spotted in the Bunkers Conservation Reserve <sup>35</sup>
2014	Dr Tim Steele – prepared 'Bunkers CP Historical Plant List' (Using data from 1985-1999 plant surveys) <sup>36</sup>
2015	Goat Browse Assessment report created June 2015 <sup>37</sup>
2018-Present	Mineral Exploration license granted within the SHP. Renewal applied for in September 2023
2020	Survey of insects and reptiles found within the Conservation Reserve conducted. <sup>38</sup>

\*The Tufa Waterfall was provisionally listed under the *Heritage Act 1993* that came into effect on 15 January 1994. Under Section 17 (3)(a) of the *Heritage Act 1993*:

17—Proposal to make entry in Register

(3) The Authority may designate a place provisionally entered in the Register as—

(a) a place of geological or palaeontological significance;

Hence, the State Heritage Place was designated in June 1997, prior to its confirmation as a State Heritage Place in October 1997.

## REFERENCES

### Scientific papers

BHI Summary of State Heritage Place: 14802

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Confirmed in the South Australian Heritage Register on 9 October 1997

Designated as a Place of Geological significance on 12 June 1997

The South Australian Heritage Council endorsed the content of this BHI - SSHP on 23 May 2024

Chen, J., Zhang, D.D., Wang, S., Xiao, T. and Huang, R. (2004) 'Factors controlling tufa deposition in natural waters at waterfall sites', *Sedimentary Geology*, Vol. 166, pp.353-366.

Lawrence, R.E. (2009), 'The Geological Context of Caves in the Flinders Ranges', *South Australian Geographical Journal*, vol. 108, pp.59-78.

Zhang D.D., Zhang, Y., Zhu, A., Cheng, X. (2001), 'Physical Mechanisms of River Waterfall Tufa (Travertine) Formation', *Journal of Sedimentary Research*, Vol. 71, no. 1, pp.205-216.

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Department of Climate Change, Energy, the Environment and Water (2022), 'Terrestrial CAPAD 2022 SA summary', *Collaborative Australian Protected Areas Database (CAPAD) 2022*, Australian Government.

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Kraehenbuehl K, Lawrence, R.E. and Flavel S. (1997) 'Caves of the Flinders Ranges Guidebook for the 21<sup>st</sup> conference of the Australian Speleological Foundation Quorn South Australia 1997', (Eds. Kraehenbuehl P), South Australian Speleological Council.

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McBriar E.M. and Hasenohr P.V. (1994) 'Geological Monuments in South Australia Part 8', On behalf of the *Geological Monuments Subcommittee of the SA Division of the Geological Society of Australia Incorporated*, pp.57-63.

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Steele, T. (2014), 'Bunkers CP Historical Plant List From 1985-1999 plant surveys', for the Yellow Footed Rock Wallaby Preservation Association Inc. From: <<https://www.yellowfoot.org/Dr%20Tim%20Steele%20-%20Bunkers%20Historical%20Plant%20List.pdf>>.

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Yellow Footed Rock Wallaby Preservation Association Inc. (2021), Newsletter May 2021, Year 20, Vol 30. From: <[https://yellowfoot.org/Newsletters/YF\\_Newsleter\\_May2021.pdf](https://yellowfoot.org/Newsletters/YF_Newsleter_May2021.pdf)>.

## **Books and Book Chapters**

White, W.B., Culver, D.C. and Pipan, T. (2019), 'Encyclopedia of Caves' *Academic Press*, Third Edition.

Williams, M. (2014), '14 - Speleothems and tufas in arid areas', in *Climate Change in Deserts: Past, Present and Future*, Cambridge University Press, Cambridge, United Kingdom, pp.245-257.

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## SITE DETAILS

**Tufa Waterfall**

**PLACE NO.: 14802**

**Bunkers Conservation Reserve, Flinders Ranges**

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**DESCRIPTION OF PLACE:** Sub-fossil tufa waterfall within Bunkers Conservation Reserve

**DATE OF CONSTRUCTION:** Cliff Surrounds - ~717-660 Million years ago  
Tufa Waterfall - ~100,000-10,000 years ago

**REGISTER STATUS:** Provisional Entry 12 June 1997  
Designated 12 June 1997  
Confirmed 9 Oct 1997

**CURRENT USE:** Conservation Reserve (29 March 2001-Present)  
Mineral and Opal Exploration Licences, EL 6263 (2018-Present)

**LOCAL GOVERNMENT AREA:** Pastoral Unincorporated Area

**LOCATION:**

<b>Street No.:</b>	NA
<b>Street Name:</b>	NA
<b>Town/Suburb:</b>	Flinders Ranges
<b>Post Code:</b>	5434

**LAND DESCRIPTION:**

<b>Title Reference:</b>	CR 5852/605 D55290 A100
<b>Hundred:</b>	Outside of Hundreds

## PHOTOS

**Tufa Waterfall**

**PLACE NO.: 14802**

**Bunkers Conservation Reserve, Flinders Ranges**

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**The Tufa Waterfall also known as Skull Rock as seen from the viewing area. Note the distinct difference in colouration to the surrounding cliffs.**

Source: DEW Files

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**Bunkers Conservation Reserve, Flinders Ranges**

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- <sup>1</sup> Yellow Footed Rock Wallaby Preservation Association Inc. (N.D.), 'Public Access'. From: <<https://www.yellowfoot.org/Public%20Access.htm>>; and Flinders Uni Speleological Society Inc. (2007), 'Skull Rock, Flinders Ranges', *FUSSI*, Newsletter, Vol. 19, no. 2, p. 12.
- <sup>2</sup> Lawrence R.E., (1997) 'Geology and Caves of the Flinders Ranges', *Proceedings of 21st Conference of the Australian Speleological Federation 1997*, 1997 Australian Speleological Federation Conference Papers, pp.93-111.
- <sup>3</sup> McBriar E.M. and Hasenohr P.V. (1994) 'Geological Monuments in South Australia Part 8', On behalf of the *Geological Monuments Subcommittee of the SA Division of the Geological Society of Australia Incorporated*, pp.57-63.
- <sup>4</sup> Lawrence R.E. (1997) 'Geology and Caves of the Flinders Ranges'.
- <sup>5</sup> McBriar EM and Hasenohr P.V. (1994) 'Geological Monuments in South Australia Part 8'.
- <sup>6</sup> Department for Energy and Mining (N.D.), South Australian Resources Information Gateway (SARIG) Map, Government of South Australia. From: <<https://map.sarig.sa.gov.au/>>; and McBriar E.M. and Hasenohr P.V. (1994) 'Geological Monuments in South Australia Part 8'.
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- <sup>13</sup> Department for Energy and Mining (N.D.), South Australian Resources Information Gateway (SARIG) Map; and McBriar E.M. and Hasenohr P.V. (1994) 'Geological Monuments in South Australia Part 8'.
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- <sup>21</sup> McBriar E.M. and Hasenohr P.V. (1994) 'Geological Monuments in South Australia Part 8'.
- <sup>22</sup> Williams, M. (2014), '14 - Speleothems and tufas in arid areas', in *Climate Change in Deserts: Past, Present and Future*, Cambridge University Press, Cambridge, United Kingdom, pp.245-257.
- <sup>23</sup> White, W.B., Culver, D.C. and Pipan, T. (2019), 'Encyclopedia of Caves' *Academic Press*, Third Edition.
- <sup>24</sup> Chen, J., Zhang, D.D., Wang, S., Xiao, T. and Huang, R. (2004) 'Factors controlling tufa deposition in natural waters at waterfall sites'; and Zhang D.D., Zhang, Y., Zhu, A., Cheng, X. (2001), 'Physical Mechanisms of River Waterfall Tufa (Travertine) Formation', *Journal of Sedimentary Research*, Vol. 71, no. 1, pp.205-216.
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- <sup>26</sup> McBriar E.M. and Hasenohr P.V. (1994) 'Geological Monuments in South Australia Part 8'.
- <sup>27</sup> Yellow Footed Rock Wallaby Preservation Association Inc. (N.D.), 'Public Access'; and Flinders Uni Speleological Society Inc. (2007), 'Skull Rock, Flinders Ranges'.
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