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Linking geoheritage sites: Geotourism and a prospective Geotrail in the Flinders Ranges World Heritage Nomination area, South Australia

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ABSTRACT
The Flinders Ranges in the north and Mount Lofty Ranges in the south form a continuous highland chain extending ~1000 km in eastern South Australia. This region corresponds to outcropping rocks of the Neoproterozoic to Cambrian Adelaide Rift Complex. The semi-arid ranges of the north with their historic mining heritage and the agriculture and vineyards of the south are heavily promoted as iconic natural and cultural tourism attractions, increasingly combining with indigenous landscape stories. With the exception of Arkaroola and Kangaroo Island, these regions are linked by the 600 km Heysen Walking Trail and adjacent Mawson Cycle Trail. Research on the Ediacara fossil biota in the Flinders Ranges has raised public awareness of geological history and the early evolution of life on Earth and developed into a multi-site Flinders Ranges World Heritage Nomination project. This is supported by the South Australian Government as part of its Nature Tourism programme to provide opportunities for conservation, education, tourism initiatives and local employment, all of which are aspirations of the United Nations Educational Scientific and Cultural Organisation (UNESCO). South Australia has a World Heritage Fossil site at the Naracoorte Caves complex, which is a compact National Park with many staff and security for laboratories and underground fossil deposits. The multi-site World Heritage proposal for the semi-remote Flinders Ranges presents a very different approach for protection and public visitation. Following an emerging global trend for geotourism and developing geotrails, this paper proposes a 400-km loop geotrail across the region linking the nominated Flinders World Heritage elements with other ‘Geological Monuments’, listed State Heritage and historical sites. This strategy has the potential to involve wider community interest, engagement, support and involvement in its management. The concept would be a natural link to the Heysen and Mawson trails, both named after prominent South Australians with strong links to the Flinders Ranges landscape. It could be named the Ediacara Geotrail, Sprigg Geotrail or Arkaroo Geotrail after the indigenous dreamtime creator of the northeastern Flinders Ranges.

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Introduction and setting
The Flinders Ranges is the name given to the northern segment of a ~1000 km long north-south highland chain in eastern South Australia (SA) that resulted from neotectonic uplift of the Cambrian Delamerian Orogen. Sedimentary rocks deformed during the Delamerian Orogeny were deposited during the Neoproterozoic Era and Cambrian Period in the Adelaide Rift Complex (also referred to as the Adelaide Geosyncline) (Drexel et al., 1993; Preiss, 1987; Veevers et al., 1997). To the south, rocks of the Adelaide Rift Complex crop out in the Mount Lofty Ranges near Adelaide and extend southward along the Fleurieu Peninsula to Kangaroo Island. The ranges were named for the British navigator Captain Matthew Flinders, commander of the Investigator, who made their first European sighting in 1802. In a largely flat continent, mountain ranges are relatively rare and therefore prominent. The various range segments are valued as scenic andiconically South Australian and are heavily promoted as natural and cultural tourism attractions, e.g. on the SA Tourism website (2020). The rugged and colourful arid range scenery with the Indigenous and European settler history of the Flinders Ranges in the north contrasts with the settled agricultural and winery districts with their heritage townships of the Clare, Barossa Valley, Hahndorf and McLaren Vale districts in the south.

With the exception of Arkaroola and Kangaroo Island, the rock exposures of the Adelaide Rift Complex are linked by the 600 km Heysen Walking Trail and Mawson Cycle...
Trails, maintained by local community groups along them. These trails are named after two of SA’s most prominent historical figures—Sir Hans Heysen (artist) and Sir Douglas Mawson (geologist and Antarctic explorer). The artist painted the Flinders Ranges to international acclaim (1900s–1950s; Figure 1a). During a similar period, Mawson headed the Geology Department of the University of Adelaide and described much of the geology of the Adelaide Rift Complex, linking it to its southern continuation in Antarctica, which led to his three Antarctic expeditions in the early 1900s (Figure 1b) (Jacka, 1986; Thiele, 1983). However, an eminent geoscientist who recently walked the entire Heysen Trail reported that there is almost no geological interpretation along it or in its trail literature and maps except at two localised nodes (Burra and the Brachina Geological Trail) (R. Hillis, pers. comm. 2019). Some localised bushwalking leaflets contain a little more. The SA Division of the Geological Society of Australia [GSA (SA)] is planning to improve this situation with contributions from its Field Guides and geological heritage sites (‘Geological Monuments’) (Figure 2).

The discovery and detailed analysis of the Ediacara fossil biota and the strata containing it in the Flinders Ranges have raised public awareness of the geological story of

Figure 1  (a) ‘The Guardian of Brachina Gorge’ (1935). Watercolour painting by Sir Hans Heysen. Image by permission of The Art Gallery of South Australia. (b) Sir Douglas Mawson, geologist and Antarctic explorer, featured on an (historic) Australian $100 bank note with a backdrop of Flinders Ranges geological cross-sections. (Specimen note only. Source: Web Commons.)
early life on Earth (e.g. Gehling & Droser, 2012; Sprigg, 1947). Supported and instigated by the South Australian Government, a body of work was undertaken by leading Australian-based geologists and paleontologists at an Expert Workshop held in Adelaide on 1–2 August 2016. This has been developed into a Flinders Ranges World
Heritage Nomination (FRWHN) project encompassing the Ediacara Fossil Reserve, parts of nearby Nilpena Pastoral Station and multiple additional geological sites across the northern Flinders Ranges (Flinders Ranges: Preliminary statement of values, 2017). This multiple site nomination will potentially be South Australia’s second World Heritage location but with a focus on much earlier geology and paleontology than the extensive Quaternary fossils of the World Heritage Naracoorte Caves complex (Figure 3). The South Australian Government has recognised this unique asset by delivering significant support and coordinating the nomination process that provides opportunities for conservation, education, tourism initiatives and local employment, all of which are aspirations of the United Nations Educational Scientific and Cultural Organization (UNESCO), the overseer of the World Heritage programme. This will be of particular assistance to the small towns and communities of Arkaroola, Leigh Creek, Copley, Parachilna, Blinman, Wilpena, Hawker and Quorn of the Flinders Ranges. Just to the south is the ‘Iron Triangle’ mining and industrial hub of Port Augusta, Port Pirie and Whyalla (Figure 4e and 5). All these northern communities have been experiencing reduced employment opportunities owing to drought and changing mining and agricultural markets. The South Australian Government runs Heritage Tourism and Nature-based Tourism programmes to encourage increased visitation to these localities, contributing to rural economies and the State’s reputation as a destination of Australian tourism excellence. The FRWHN offers stimulating innovative strategies to retain and attract people to these areas.

One thousand kilometres to the southeast, the World Heritage Naracoorte Caves complex is contained in a small National Park area with many staff and security for laboratories and underground fossil deposits. By contrast, the FRWHN proposal covers multiple geological sites across a large region and requires a very different set of management approaches to protect the sites while encouraging public visitation. Following an emerging global trend for geotourism and developing geotrails, this paper proposes a 400 km loop geotrail across the region linking many of the nominated FRWHN serial sites. However, it suggests a strategy to also include other ‘geological monuments’, state heritage sites, mining heritage sites and cultural links to contribute to visitation appeal and to involve wider community interest, engagement, support and involvement in its management.
The proposal for the FRWHN is a compilation of ~34 separate geological sites, referred to in World Heritage jargon as ‘Elements’. These are arrayed between the Arkaroola Protection Area in the northeast of the Flinders Ranges and the Ikara-Flinders Ranges National Park, ~150 km to the

Figure 4. Flinders Ranges Natural and Mining Heritage sites. (a) Wilpena Pound (aerial). Image by permission of Tourism SA. (b) St Mary’s Peak and Sawtooth Ranges. Image courtesy Parks SA. (c) Blinman Mine cross- and long-sections. (d) and (e) Mining Trails publication cover and trails map. Sources: Mines and Energy (1996). http://www.samininghistory.com/sa-mining-heritage/ Images (c), (d) and (e) by permission of SA Department of Energy and Mining.

FRWHN

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Figure 4. Continued
southwest, which contains the renowned Wilpena Pound (Figures 2 and 6). The recorded geological history of this region spans ~1600 million years, commencing with deposition of sediments and intrusion of granites to form the basement of the Mount Painter and Mount Babbage inliers. This was followed by Neoproterozoic rifting, sedimentation and volcanism and deformation, metamorphism and hydrothermal activity in the Paleozoic under the influence of localised radiogenic heat from the basement granites.

The FRWHN specifically covers an ~350 million year rock record period that includes the origin of complex life on Earth and two major ice ages. During the Ediacaran Period (635–541 Ma) a huge meteorite impacted the Gawler Ranges region and spread debris into the Adelaide Rift Complex, followed by the rapid radiation of marine life, presented in the Ediacaran rock record (Gehling & Droser, 2012). The ~350 million year rock record period also includes the spectacular expansion of life in the early Cambrian (541–510 Ma) (Drexel et al., 1993; Preiss, 1987).

The ‘Elements’ are geosites identified as key sequential evidence for the ‘Dawn of animal life on Earth’ via a ‘continuous sequence of geological strata spanning the period when animal life first evolved’ (Ediacara website, 2020). ‘It is a time of glaciers, of mass oceans, of meteorites; of grand experiments in evolution [which led to] the rise of a habitable Earth’ (Irving, 2017). The World Heritage nomination will draw an international spotlight on this outstanding region and its communities.

**UNESCO and World Heritage in Australia**

In 1972, UNESCO declared an aim via Section 1 Article 2 of its Convention Concerning the Protection of the World Cultural and Natural Heritage to identify the outstanding universal values of ‘natural features, geological and
physiographical formation, natural sites and areas for their
science, conservation or natural beauty’ (UNESCO, 1972).
The ‘State Party’ (host nation) commits to ‘the identifica-
tion, protection, conservation, presentation and transmis-
sion to future generations of the cultural and natural
heritage’ (Section 2, Article 4). This is to be achieved with
the cooperation of three particular international advisory
organisations –

- International Union for Conservation of Nature (IUCN)
- International Centre for the study of the Preservation
  and restoration of Cultural Property (ICCROM)
- International Council of Monuments and Sites (ICOMOS)

IUCN provides an independent evaluation of natural
nominations once they have been submitted and before
the World Heritage Committee votes on inscribing the
place on the World Heritage list. It also focuses on World
Heritage management, community engagement and inter-
pretation and has seen the potential of three South
Australian sites for World Heritage listing—the Flinders
Ranges, Musgrave Ranges and the Nullarbor Plain, while
acknowledging the challenges of nominating and
managing such large semi-remote areas (Figgins et al.,
2012). ICCROM undertakes world-class initiatives in conser-
vation training, research and advocacy. ICOMOS provides
independent evaluation of cultural nominations and devel-
ops global Cultural Heritage Trails linking natural heritage
with landscape, history, ecological and indigenous inter-
pretation (Burra Charter, 2013). This advice satisfies the
Convention aims, guiding UNESCO to designate some
World Heritage sites as ‘Mixed’ Heritage.

In 2020, Australia has 12 natural sites from the tropics
to the Antarctic, four cultural sites primarily of convict his-
tory (none in free-settled South Australia!) and four mixed
sites with landscape and major indigenous components—
Kakadu, Uluru, Willandra Lakes and recently the Budj Bim
volcanic-aquaculture landscape (Figure 3) (Australian World
Heritage Website, 2020).

Several consist of multiple sites across sizeable areas—
Gondwana Rainforests, the Wet Tropics, the Blue
Mountains, the Cultural convict sites across five States and
the Riversleigh-Naracoorte (Qld-SA) Fossil sites. South
Australia’s only World Heritage site is in the Naracoorte
Caves National Park, supporting vital new research and
information about Australia’s Quaternary flora, megafauna

and past climate change. World-class interpretation is provided in cave tours, brochures, a website and through visits by school groups and the local community, delivering 40,000 visitors per year and fulfilling Australia’s host nation obligations for the site (Naracoorte Caves website, 2020). The strongest visitation themes are Interpretation and Education (the ‘E’ in UNESCO). The inspiring FRWHN ‘Dawn of Animal Life’ narrative of early planetary events merits an equally high standard of presentation.

Geological monuments and South Australian state heritage sites

South Australia has over 450 ‘Geological Monuments’ listed by the GSA (SA), eight National Heritage Sites (including the Ediacaran Fossil site, Burra and Moonta Mines) and the World Heritage site at the Naracoorte Fossil Caves. They are derived from a rich SA tradition of mining, geology and research since the 1840s. The ‘Monuments’ result from ~45 years of dedicated work by the GSA (SA) Geoheritage Subcommittee with support from the SA Department of Mines and its subsequent iterations. Their selection utilises a merit-points approach. The ‘Monuments’ are now termed ‘Geological Heritage sites’ (GSA website, 2020) and are included in map form on the South Australian Resources Information Gateway (SARIG) (Figure 2).

Only 54 of these geosites are listed on the SA State Heritage Register (Cresswell, 2019). This provides legal protection by requiring compulsory prior consultation with developers under the SA Planning, Development and Infrastructure Act (SA Heritage Register Website, 2020). Nominations from the GSA, the public or from within Government are processed by the State Heritage Unit of the SA Department for Environment and Water. The Register mainly represents the ‘Built Environment’ and cultural heritage with 2319 historical, agricultural, mining, industrial and archeological sites together with community buildings, churches, mansions, settler huts and gardens. However, the ‘Natural Environment’ is remarkably underrepresented with only ~100 natural sites, many of which have been nominated by the GSA (SA) Geoheritage Subcommittee.

Restoring the balance—‘built’ vs ‘natural’ state heritage

In concert with the SA Government’s Heritage Tourism and Nature-based Tourism initiatives (discussed below), an overdue need for better natural site protection and promotion has been recognised and the deficit of listed ‘Natural Heritage’ sites is now being addressed. Two recent innovations provide clarity for such nominations—‘GAPS’ heritage and multi-site ‘Places’. GAPS heritage significance is
assessed under four fields where applicable—Geological, Archaeological, Paleontological and Speleological criteria. Multi-site ‘Places’ allow greater flexibility in selection: commonly, only single-theme sites are nominated (e.g. Blinman Mine or Fitzgerald Shingle Ridge near Whyalla). A recent example engaging both methods has been the combined heritage ‘Place’ listing of those 19 caves of the Naracoorte Caves National Park with few or no fossils but with other distinct geological attributes (G and S of GAPs), significantly contributing to the regional geological story (Lewis, 2019). These strategies and the application of a Geoheritage Toolkit (Brocx & Semeniuk, 2009) can now be applied to future GSA ‘natural heritage’ geosite nominations in the Flinders Ranges and elsewhere.

Other Flinders Ranges heritage and geo-stories

Many Geological Monuments and State Heritage sites are found along the extent of the Adelaide Rift Complex (Figures 2 and 6). In the Flinders Ranges alone, ~50 are distributed from Arkaroola in the north to the Quorn region in the south. Beyond the FRWHN natural elements, they extend to mining heritage (Yudnamutana, Blinman, Ajax and Nuccaleena mines, the Leigh Creek coal fields and Aroona Dam), each with their own interesting stories. The National Trust recognises the significant value of stories to enhance regional attraction –

Excelling in the art of storytelling and using innovative presentation skills to connect the visitor to a desired time and place are essential for Australia’s heritage tourism attractions to compete on a global scale. (National Trust, 2018)

In general, Australian National Parks stories are biological, ecological and holistic in theme but lack explanation of the geology underpinning their existence; addition of their geological histories will notably enhance them. Many geosites also have a human dimension to their stories. It is a commonly reported experience among site interpreters that the public enjoy, appreciate and retain a story, which is broad, recognisable, fluent and memorable (Savannah Guides website, 2020) beyond dense scientific terminology. For example, the FRWHN is the setting for the fascinating human story of two eminent Flinders Ranges geologists, who differed significantly in the 20th century across South Australia. In the 1900s, Mawson linked the SA mountain chain geology to Antarctica but half a century later steadfastly disagreed with the emerging explanation of continental drift even while one of his most insightful geology graduates, Reg Sprigg, was identifying submarine canyons, the significance of the Arkaroola mineralogy and the Ediacaran fossils, all of which are now the focus of this World Heritage nomination project. Both men’s lives and achievements were remarkable (Jacka, 1986; Weidenbach, 2008). The displacement of the Mawson era by the Sprigg era in SA geology is an important human component of the Adelaide Rift Complex stories. These are further complemented by other stories of the Flinders landscape—its more recent geological history, the Adnyamathanha Indigenous Flinders Creation myths, the cameleers and early settlers (Alley & Nelson, 2018; Barker et al., 2014; Davies et al., 1996; Mines and Energy, 1996; Mountains of Memory, 2007; Tunbridge, 1988). All enhance the appeal of nature-based and heritage tourism.

The SA nature-based tourism initiative—‘Nature like nowhere else’

In 2016, the South Australian Government announced an initiative—‘Nature like nowhere else’—to promote ‘nature-based tourism’ across the state through improved public engagement with SA National Parks (Figure 4a, b) (Nature like nowhere else, 2016). Nature-based tourism generates ~$1B per year to the State’s economy, enhances employment opportunities in rural regions and has the capacity to forge cooperative business links with private enterprise, philanthropic and not-for-profit conservation organisations. This initiative is making a significant contribution to the FRWHN (SA Tourism ‘Plan 2030’ website, 2020).

The SA Government’s commitment to its nature-based tourism sector has been reinforced in 2020 by a special focus on two of the five proposed Flinders World Heritage ‘Component Parts’ (discrete areas). From a $22 M funding injection, $1M is to renew visitor infrastructure across Ikara-Flinders Ranges National Park, and $3M is targeted for a major visitor experience at Nilpena to showcase the state’s unique Ediacaran fossils (Good Living, 2020). At some vulnerable natural World Heritage sites, physical visitation has proven to be a threat to the original location and prompted the successful concept of accurate ‘site reproduction’ techniques. Outstanding examples are the famous Lascaux and Chauvet ancient cave art sites in France (Chauvet Cave website, 2020). This may be a suitable approach for potential interpretation of the Ediacaran Fossil site at Nilpena. A further $5M is being contributed to a Nature-Based Tourism Co-investment Fund and the World Heritage nomination is also supported by the private investment and non-profit sectors. In early 2020, substantial funding from the SA Government was supported by contributions from the non-profit Nature Conservancy (through the international Wyss Campaign for Nature) and the Flinders Ranges Ediacara Foundation to purchase a significant western portion of the Nilpena property (J. Irving, pers. comm.). This will be added to the Ediacara Conservation Park for permanent protection and conservation management by the South Australian Government. The Arkaroola Component is a self-funded privately run family enterprise whose majority land holding is within an area protected from mining under the state’s Arkaroola Protection Act 2012 (Irving, 2012), but will not benefit directly from this $22 M funding injection.
The South Australian Heritage Tourism Initiative

In recent decades there has been an increasing interest in the early settlement and mining activity that contributed to the establishment of the Australian colonies. Arising from this is a recognition of their heritage value to rural and mining towns for conservation and tourism, so appropriate broad strategies are being undertaken (Cegielski et al., 2003; Lomax-Smith & Heneker, 2016; National Trust, 2018; SA Heritage, 2019). Thus, while primarily focused on ‘built’ heritage, at its 100th meeting in 2019 the South Australian Heritage Council provided its expression of support for the Flinders Ranges World Heritage bid. The value of combining heritage themes and innovative methods to engage visitors has been identified by the SA State Heritage Unit.

Specialist tourism ventures, whether nature-based, adventure, Indigenous, historic, cultural or ecotourism, all rely strongly on heritage and heritage places, and that natural and cultural heritage underpin much of Australia’s tourism product. Experience in Australia and overseas shows the value of improving links between tourism and heritage places—as the quality and diversity of tourism products improves, heritage places are better cared for and regional development is stimulated. (SA Heritage, 2015).

The inaugural Australian Heritage Tourism Conference was held at the Adelaide Town Hall in May 2019 to address these aspects. It contributed to the formation of the SA Heritage Tourism Alliance, which is introducing the ‘SA Heritage Tourism Strategy’ with representation from the GSA and ICOMOS Australia (SA Heritage, 2019). This enables the linking of natural heritage (geological, paleontological, biological) with mining, settlement and associated cultural heritage and is particularly applicable across the multiple sites of the Flinders Ranges (Figure 4c–e) as a strategy under the banner of geotourism (Lewis, 2018).

Geotourism

Geotourism is an exciting and rapidly developing field of research, endeavour and application. Earlier definitions of geotourism were relatively straightforward: e.g. ‘has geology as a central focus and embraces geological tourism for dedicated geotourists as one of its essential components’ (Ollier, 2012). However, there are now broader definitions: ‘integrates geology, environment, culture, aesthetics and heritage’ (Martini et al., 2012); ‘sustains or enhances the distinctive geographical character of a place—its environment, heritage, aesthetics, culture, and the well-being of its residents’ (National Geographic website, 2020) and the Chinese Tourism Earth-Science perspective; ‘geological tourism with focus on geology and its interaction with ecology and culture’ (Chen et al., 2015). Recently in Australia the GSA’s definition is expanding to include ‘ABC’—the Abiotic, Biotic and Cultural (Dowling & Newsome, 2018) and now recognises that ‘geotourism is not geological tourism [but is a] holistic activity … which underpins all nature-based tourism’ (James, 2020).

Most importantly, ‘engagement with the cultural landscape is not ‘dumbing down’ the geology, but involves the enrichment of knowledge … there are many connections between geoheritage and cultural heritage that provide a basis for geotourism activities’ (Gordon, 2018). To Australian Indigenous people, their cultural heritage also includes natural and post-settler heritage (Bell & Johnston, 2008). UNESCO and ICOMOS identify the ‘combined works of nature and of man’ as Cultural Landscapes and Routes. Several Australian examples are Adelaide’s North Terrace Building Stones Trail, the Geocultural trails of the Sydney Rocks area and the Budj Bim indigenous adaptation of a western Victorian volcanic landscape (Brocx & Semeniuk, 2019; Cooper, 2013). A larger example is the designated ICOMOS Cultural Route of the Overland Telegraph Line from Adelaide to Darwin, which with indigenous help, followed the line of artesian mound springs and was successively developed by explorers, cameleers and construction teams to link Australia to the world by telegraph (ICOMOS, 2014). Geotourism is all about explaining, interpreting and telling the stories (narratives) of Earth’s landscapes to engage visitation and elevate appreciation, experience and education (National Trust, 2018).

Geotrails

Australia has a number of geotrails, most of which are short or of moderate length: examples are Canberra’s Geoscience geological time trail (1.1 km), Ulladulla NSW (2 km), Port Macquarie NSW (5 km), Brachina Gorge SA (20 km) and Cradle Coast Tasmania (four geotrail components ~40 km each). Some combine natural and cultural themes—e.g. the Newcastle Coastline geotrail (Gilmore, 2017). In South Australia, the Naracoorte Council has recently obtained a grant to begin a themed geotrail along the limestone range from the town for 8 km to the World Heritage Fossil Caves site, linking town, community and highway traffic to this outstanding natural site.

In contrast, the Dig the Tropic Geotrail crosses the State of Queensland for 1200 km east–west along the Tropic of Capricorn from the Great Barrier Reef towards with Mt Isa. Its varied features include the Capricorn Caves, Blackwater Coal Centre, Emerald Gem Fields, the Age of Dinosaurs Museum, an Artesian Spa and petrified wood sites south of Mount Isa’s major mining operations. NSW has been trialling a 150 km Modern Mining Trail connecting Cobar mine, Peake Hill Open Cut, Newcrest and Cowal Gold Mine with the Age of Fishes Museum and the Parkes Radiotelescope. The former Kanawinka volcanic/karst Geopark in western Victoria (Lewis, 2010) has converted to the more suitable format of Kanawinka Geotrails—multiple roadways covering 400 km between ~100 major geosites and the Budj Bim World Heritage cultural site (Portland PTA Website, 2020).
These geotrails are on a similar scale to travelling across the FRWHN region.

Geotrails are relatively easy to establish as they can be constructed around routes currently used by tourists—4WD, car, bike, walking and horse-riding trails—easily linking with accommodation destinations but not competing with or impacting on land management/access issues (Lewis & Robinson, 2017). Geotrails have been an emerging 21st-century trend linking serial geosites, natural and mining and cultural features, effectively linking geo-themes on a wide scale (Dowling & Newsome, 2018). Thus, they can significantly widen and enhance the appeal of a region to the visiting public. A well-constructed geotrail tells a story along its pathway, and several such initiatives are currently being undertaken by the NSW Geospatial Information & Visualisation unit (Meakin & Fleming, 2019). The GSA is embracing Best Practice Geotrails in Australia—‘Best practice geotrails aim to meld the geological heritage features of a region with a cohesive story. They should incorporate and package in the biodiversity and cultural components (including mining heritage) of the region through which the geotrail traverses’ (GSA website, 2020). The Flinders Ranges ‘Dawn of Life’ narrative is one of the planet’s great stories, very well suited to be presented along a geotrail.

A Geotrail proposal for the FRWHN area

Concept and proposed route

The broad concept is a central-northern Flinders Ranges Geotrail linking many of the ~34 eventual World Heritage geosites and including the human heritage of indigenous, mining and settler sites. The geotrail mainly uses existing tourist roads in a loop totalling ~400 km in length (Figure 6). The semi-outback road and airstrip networks provide direct access to the geotrail at many points along the time line. A selection of the many sites is summarised in the Supplementary paper (Appendix 1). A strict geo-time-travelling sequence would commence from the earliest geology at Arkaroola in the northeast. However, as Wilpena Pound in the south is the main entry point for visitors, the descriptions commence clockwise from there.

Protection issues

Not all sites of a finalised list may be made available to the public. While relevant to the nomination, some may be quarantined as being too sensitive for over-visitation or restricted owing to private lease or land ownership preferences and not included in publicly available material. Delicate decisions are sometimes required when finding a balance between protection and promotion of geoheritage sites (Lewis, 2019).

Located in Enorama Creek—and effectively part of the Brachina Gorge Geological Trail, the Ediacaran Global Boundary Stratotype Sections and Points (GSSP) or ‘Ediacaran Golden Spike’ site is a special location (Preiss, 2005). Being the only GSSP site in the Southern Hemisphere, it represents an internationally agreed upon reference point on the Nuccaleena Formation, a stratigraphic section of rock that defines the lower boundary of stages on the geological time-scale, representing the beginning of the Ediacaran Period. Although the set of authorised drill holes in the Nuccaleena Formation, near where the ‘disc’ for the GSSP is set, were drilled before the GSSP site was formalised, souveniring that has occurred there indicates a need for caution, including from sampling. For this reason, this geotrail proposal is initial, and the map only shows general locations.

Resources, signage, maps, apps and the web

As with the World Heritage nomination, the proposed geotrail would draw upon traditional material—Field Guides of Brachina and Bunyeroo Gorges (Hiern, 2015; Jenkins et al., 1993; Langsford, 2016), several valuable texts and guidebooks, current interpretive signage in various localities and an excellent series of geological maps and digital data produced by the Geological Survey of South Australia (GSSA), a section of the Department for Energy and Mining. A comprehensive on-line resource is the SARIG website, which stores extensive GSSA geological brochures, the GSA (SA) Geological Monuments and Field Guide information (SARIG website, 2020) but requires familiarity to access efficiently. In this semi-remote region, limited phone signal reception may mean that any Internet preparation for a day’s travel is accessed locally at small townships. Several important Apps enhance the available information (Australian Geology Travel Maps Website, 2020; Flinders Ranges Walks App, 2020; Heysen Walking Trail App, 2020). There is the potential to integrate these sources in the manner of Canada’s well-developed transnational geotrail network with e-information on many individual geosites spanning the North American continent. In 2012 a smartphone App ‘GeoTreat’ was made available to the GSA in Australia by the Nordic countries as a free service and has been trialled for the Sapphire Coast of southern NSW.

Innovations could be developed from adapting the GSA Brisbane Qld App, NSW GeoTours App, Weekend Geology App and SA Gawler Ranges and Hallett Cove Apps (Meakin & Fleming, 2019; Swann, 2019; GSA website, 2020; SARIG website, 2020). Various geosites along the geotrail would benefit from the immersive audio-visual technology available for Flinders Ranges National Parks and now being applied to the Naracoorte Caves World Heritage site and associated Tantanoola Cave (Georama website 1, 2020). Virtual Reality (VR) geotours are being developed in South Australia by UniSA’s Project L.I.V.E. (Learning through Immersive Virtual Environments) for Hallett Cove, Mount Gambier’s volcano and in partnership with the Nature Foundation for Witchelina geological site (Project LIVE website, 2020; Witchelina Virtual website, 2020). VR technology
for remote region geotrails (Goss et al., 2019) may significantly reduce concerns with on-site infrastructure and hardware maintenance. The GSA could be a national coordinator for such projects.

Geotrail versions

Successive sites along a large geotrail are not always ordered in a convenient time-event sequence. For this Flinders Ranges Geotrail proposal, following them in strict time order would involve costly and inefficient travelling and backtracking. A more practical strategy may be to explore geographically grouped features from several accommodation ‘nodes’ (e.g. Parachilna to Arkaroola then Wilpena). World Heritage geotrail package geotours with trained Geo-guides/interpreters (Savannah Guides website, 2020), Arkaroola staff, National Park Rangers and volunteers could coordinate day trips from these nodes to ‘edge-of-geotrail’ World Heritage sites such as Nilpena and Chambers Gorge (Figure 6). An exciting initiative would be the development of an Aerial geotrail tracing the settings of the Flinders World Heritage elements from above, either on a single long flight or a number of short flights from local airstrips at Arkaroola, Leigh Creek, Parachilna, Wilpena Pound, Rawnsley Park, Hawker and Quorn and coordinated with short on-ground site trips.

Modern tourism places emphasis on the ‘experience’ aspect of visitation, ranging from the engaging to the inspirational but underpinned by practical facilities (Osmond, 2017). A proposed Flinders Ranges Geotrail requires adequate access to suitable amenities, particularly in more remote areas. One baseline for these requirements is the ‘grey nomads’ sector, which is recognised in the Tourism research of rural areas as a significant and reliable yardstick for visitor planning purposes. Two recent practical innovations in South Australia enhance the outdoor experience for wheelchair visitors. The low-gradient Wheelchair Loop Walk at Naracoorte traces the World Heritage caves’ outline across the limestone surface for those unable to go underground on stairways and steps (Naracoorte Caves website, 2020). Similarly, the provision of 4WD wheelchairs enable exploration of low-gradient interpretive trails at Mt Remarkable in the southern Flinders Ranges (O’Dea, 2017).

At a motivational level, tourism studies have identified ‘experience seekers’ who, although a diverse group by age, country of origin or spending power ‘are typically looking for: (i) authenticity, (ii) interaction, (iii) points of difference, (iv) challenges and (v) learning opportunities’ (Pyle et al., 2020; ANL website, 2011). Along a proposed Flinders Ranges Geotrail, these might be provided by an empathic travel sequence following the ‘Flinders Heartbreak Trail’ of early settlement beyond Goyder’s Line of cropping limits (Mountains of Memory, 2007) or the experience of ‘Station Stays’ (Figure 5) (National Trust, 2016). Unusual explorations such as astronomy, Outback Opera, hot air ballooning travel and camel trains are excellent novel experiences to explore a landscape and its heritage. Geotrails offer possibilities and opportunities at many levels of interaction and engagement.

Enhancing the geotrail—cultural heritage and other SA trails

An emerging concept of ‘Geoarchive’ refers to the notion that

Earth, as a story-teller, has an archive of stories related to the evolution of Earth physically, geochemically, petrogenetically and structurally, and to the origin and evolution of life. The story of the development of the human race is also embedded within the archive of the Earth, with the landscape providing communities with a sense of place and the material resources to develop as a society. (Brocx, 2018)

Expressed another way, this framework and all the stories—geo, bio, historical and cultural—are the essence of geotourism. UNESCO and its official advisory bodies IUCN, ICCROM and ICOMOS encourage such combinations and contexts to be presented in their programmes to the broader public. Geotrails in particular have this capacity. An enhanced geotrail through the Flinders Ranges would lead the traveller from stories of the Early Earth and ‘Dawn of Life’ of prehistory through the Adnyamathanha/Indigenous landscape creation legends into exploration, cameleers, settlement, pastoralists, the struggles and successes of mining and agriculture, and the achievements of the likes of Mawson and Sprigg. It also has the potential to become a world-class ICOMOS ‘Cultural Landscape and Route’ (Burra Charter, 2013; ICOMOS, 2014) with a consequent appeal to a wider and more diverse international audience.

Linking to the great North and South—along and beyond the Adelaide Rift Complex

A high-profile Flinders Ranges Geotrail associated with World Heritage could be the launching pad to the north-west beyond the Flinders Ranges into the SA outback. Such extensions would include the Leigh Creek coal mine area, the Lyndhurst-Maree Historical Trail and the Nature Foundation’s Witchelina Station in the Willouran Ranges where a northwestern extension of the Adelaide Rift Complex is spectacularly exposed. From there it would extend to the Great Artesian Basin with its mound springs and the northern Opal Fields. These sites are variously linked by the Explorers Way drive and ‘The Ghan’ rail travel. To the northeast run the iconic Strzelecki Track and Birdsville Track leading from the Flinders Ranges to the Cooper Basin gas fields, the historic Burke and Wills Dig Tree site and the town of Birdsville (Figure 2). To the south, a link into the Heysen-Mawson trails connects with a 600 km network down the highland chain through Wilpena Pound, Dutchmans Stern, Alligator Gorge, Telowie Gorge and Mount Remarkable National Park. Further south, the Adelaide Rift Complex features ~130 Geological Monuments and State Heritage sites, including the National...
Heritage-listed Burra and Moonta Mines, the Sturt Gorge and Hallett Cove glacial relicts and the Tjilbruke’s Tears Indigenous coastal trail (spring sites) from Marino Rocks to Cape Jervis (Figure 2). Using a SA Tourism term, ‘linking the top and the tail’ of the Flinders-Mount Lofty Ranges chain equates in scale and concept to Queensland’s Dig the Tropic Geotrail, but with the special geological history of the Adelaide Rift Complex and international appeal of a Flinders Ranges World Heritage area.

Conclusion

A Flinders Ranges Geotrail can satisfy international geotourism aims and the SA Government’s Nature Tourism and Heritage Tourism objectives. It can utilise and credit more of the GSA’s listing of Geological Monuments and encompass other non-geological heritage sites. It could also promote UNESCO’s philosophies by incorporating the cultural and site aspirations of UNESCO’s advisory bodies IUCN and ICCROM, perhaps eventually as an ICOMOS Cultural Route. The geotrail would attract attention, raise public awareness and enjoyment and provide various benefits to local communities. Links to the north open up the geology of the inland (‘Outback’) and to the south along the Heysen–Mawson Trails to further tell the Adelaide Rift Complex stories, which even extend to Kangaroo Island. ‘Flinders Ranges Geotrail’ or ‘Flinders Ranges World Heritage Geotrail’ could be an acceptable name, but the ranges are already named after their European discoverer, and a landscape or cultural name may be more appropriate, however chosen. Perhaps a suitable name could be the Ediacaran Geotrail, Sprigg Geotrail, Dawn of Animal Life Geotrail or Arkaroo Geotrail after the indigenous Flinders Ranges creator.

Disclaimer

The FRWHN is being managed by the South Australian Government and refers to specific sites. Separate from this, geotrail concepts are one of the GSA’s geotourism initiatives in Australia. The proposal in this paper is independent of the FRWH Nomination and does not represent an official position of the SA Government in relation to World Heritage.

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