Unearthing the opportunities for geotourism contained within the building stones of the Quality Lighthouse Hotel, Bunbury, Western Australia.

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BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE

This thesis is presented for Bachelor of Science honours in

Environmental Management and Sustainability

College of Science, Health, Engineering and Education

Murdoch University

2020

I declare that:

a) The thesis is an account of my own research, except where other sources are acknowledged.

b) The extent to which the work of others has contributed to the thesis is clearly stated in each chapter and certified by my supervisor.

c) The thesis contains as its main content, work which has not previously been submitted for a degree at any other university.

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Acknowledgements

Associate Professor David Newsome

Thank you for allowing me to take part in the writing of a book chapter for Routledge's Tourism Cities and having confidence in my ability to produce an interesting and readable manuscript despite having limited geotourism knowledge at the time. Thank you for entrusting me with addressing the reviewer's comments in our Geoheritage journal article, these experiences have been invaluable to my educational growth. Finally thank you for sharing your enthusiasm and knowledge of Geotourism during the writing of my thesis, book chapter and journal article.

Professor Neil Lonergan and Dr James Tweedley

The independent study unit I completed with you which required me to write the report "Maximising survival of restocked prawns in the Swan-Canning Estuary: determining the influence of habitat on predation (2015)" taught me how to write a detailed scientific report to publishable standard (HD) and gave me a glimmer of what I might be capable of in the future.

Mum and Dad

Thank you for teaching me the value of education, a love of reading and an appreciation for the wonders of the natural world. You have always believed in me and encouraged me to continue learning.

Murdoch University Vice-Chancellor Scholarship

The University's grant of $500 is acknowledged and gratefully appreciated, thank you.

Abstract

Geotourism associated with urban environments can draw tourists to natural geoheritage features such as caves, outcrops of significant geology and cultural sites located close to or within cities. Geotourism experiences that lend themselves to the appreciation of geology in the urban environment often involve observing the varieties of building stones and structures in the built environment and capitalising on historic or iconic structures, which are major tourist attractions in world cities. Inspired by the diverse geology contained within the stone walls of the Quality Lighthouse Hotel, Bunbury WA, the purpose of this thesis is to provide a geotourism focused interpretation of three urban sites with potential geological interest within the city of Bunbury. Initially, four international case studies are presented to highlight the spectrum of geotourism experiences offered within the urban environment. Secondly, the abiotic features, geology, geomorphology and deep time of the four key building stones of the Quality Lighthouse Hotel are considered. The closing sections detail the cultural inspiration and influence that the stones have had on diverse groups of people who have participated in shaping the city of Bunbury. Cultural topics featured include mid-century architecture, European settlement and Noongar people's connections with and uses of the Southwest regions' landscape and geology.

Keywords: Building stones, architecture, cultural values, visitor, engagement, urban geology, Geotourism, deep time, interpretation, Aboriginal Culture.

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Publications arising from this research.

Richards, S.J., Simpson, G.D., and Newsome, D.,2020. Appreciating geology in the urban environment. In Routledge Handbook of Tourism Cities (pp520-539). Routledge. https://doi.org/10.4324/9780429244605-36

ISBN 9780367199999.

Richards, S.J., Newsome D and Simpson G.D., 2020. Geology, architecture, engaging the observer and geotourism potential of the Lighthouse Hotel Rock Wall, Bunbury, Western Australia. *Geoheritage*.

DOI 10.1007/s12371-020-00503-1

CHAPTER 1 Introduction

The global geotourism phenomenon

Internationally, geotourism is a flourishing tourism market which seeks to engage the visiting public with the crucial influence that geology has on the abiotic, biotic and cultural aspects of a site, region or country (Newsome and Dowling 2010; Reynard and Brilha 2018; Dowling and Newsome 2018). Geotourism is about inspiring visitors by presenting them with an interpretation of geological and geomorphological material in an accessible manner. If presented appropriately to the visitor, regardless of the scope of their geological knowledge, people can better appreciate landscapes, the geomorphological and geological processes that led to their formation and gain a better understanding of the vast eons of time required to produce stone, rock outcrop or landform that previously may have gone unnoticed (Dowling and Newsome 2010; Rutherford et al. 2015; Richards et al. 2020).

Four diverse international urban geosites in China, Poland, England and Scotland are reviewed to highlight the numerous forms of geotourism, its management and type of visitor experiences available

- The Hong Kong UNESCO Global Geopark, China is a showcase of the region's volcanic geology with sites in the geopark dating from 20—410 million years old (myo). Spaning over 150km² the park contains two hotels and five visitor centres. The management of the park is holistic with strategies based on sustainability principals which include education, local engagement, improvement of rural communities, science popularisation and conservation of geoheritage (HKUGGp 2018).
- Wieliczka Salt Mine, Kraków, Poland is 13 myo and is considered to be the largest underground museum in Europe. Listed as a UNESCO list of World Heritage Site and maintained by the National Heritage Board of Poland, it has been suggested that it could become the world's first subterranean geopark (Alexandrowicz and Alexandrowicz 2004).

- Arthur's Seat and the Salisbury Crags, Edinburgh, Scotland are the remains of volcanic activity dated at 345 million years ago (Mya). In recognition of the fact that Arthurs Seat is one of the most studied volcanoes in the world, it was designated a Site of Special Scientific Interest (SSSI) in 1986 (Scottish Natural Heritage (SNH) 2011).
- Whitby, England is a city that is home to a showcase of the abiotic, biotic, and cultural values which can be found within geotourism. Situated on coastland which was exposed in Jurassic times (190-175 Mya), it is rich in plant and animal fossils and has a geotourism history dating back to the 18th Century (Brindle 2010). It is the location of Whitby Abbey, a famous monastery built in the 9th Century, which was the setting for Bram Stoker's novel Dracula. The myths (geomythology) which flow from this vampire tale have recently inspired a global cultural event celebrating Gothic culture (Love 2019; Paylor 2013).

Currently, the purpose of *every* visitor surveyed by Tourism WA who visits WA is to experience some of the natural assets available within the state. However, only 11% of visitors expressed an interest in educational, cultural or historical tours (Tourism WA 2020b) This research, therefore, considers the importance of understanding visitor motivations to experience niche tours and attempts to understand how providing a variety of interpretive methods can enhance the significance and meaning of tourism experience to a broader range of visitors (Barrow 2013; Dowling 2011; Dowling and Newsome 2018).

We posit that the 2.75 billion years of Earth history displayed in the local ferruginous duricrust, basalt and granite building stones which fortify the foundation and envelope the external walls of the Quality Lighthouse Hotel (hereafter referred to as the Lighthouse Hotel), located in the regional town of Bunbury, Western Australia (WA), presents the opportunity for development and marketing of an urban geosite. Also, it provides the opportunity to expand and rejuvenate the existing heritage trails within the City and Southwest region. Additionally, there is potential for geomythology and geotourism to diversify or enrich the offerings of Aboriginal cultural tourism, with the prospects of

attracting international geotourists to the region (Dowling and Newsome 2006; Pforr et al. 2014).

To progress such a potential tourism opportunity in Bunbury (WA) and using the Lighthouse Hotel as a focal point, this thesis explores the nature of the stones that comprise the buildings and walls of the Hotel. The first step is to provide context for the stones, including the sites of origin, the period of deep time when the stones were created and the different geological conditions under which they were produced. Additionally, this work provides a cultural narrative which links each of the different stones to some of the people and cultures who have been connected to and influenced by the type of building stones which are contained within the walls of the Lighthouse Hotel. Beginning with the youngest type of stone, ferruginous duricrust, and the most recent cultural story from the 1970s this work provides an account of the geological and cultural connections that radiate from the Lighthouse Hotel. It explores the scope for highlighting various elements of Bunbury and its environs as a potential geotourism destination.

Aims and objectives of the research

The objective of this thesis, therefore, is to explore potential geotourism sites within the city of Bunbury which offer the opportunity to expand on the existing eco centred, sustainable tourism offered in the city and greater South West region of WA. Through identifying the geomorphology, geology and the deep time of some key building stones within Bunbury and linking them to a selection of cultural narratives which reach beyond the city into the Southwest region the aim is to discover if Bunbury has sufficient points of geological interest to become the launchpad for a regional geotourism trail of international standard.

Structure of the thesis

Chapter 1 Introduction: Introduces the reader to the concept of geotourism and the three main factors abiotic, biotic and cultural, which are influenced by geology. Four diverse international geotourism attractions that are detailed in Chapter Two are outlined, and the rationale for selecting the Lighthouse Hotel as the focus of this thesis is also presented.

Chapter 2 Appreciating geology in the urban environment: Provides an account of four international urban geotourism attractions where geology and landscape are the key features of city tourism. Each geosite is interlinked with the history and culture of the region. The purpose of the Chapter is to provide examples of how tourism can be enhanced via the recognition and promotion of urban geology as distinct attractions for tourism cities. Accordingly, this chapter presents case studies from Hong Kong (China), Kraków (Poland), Edinburgh (Scotland), and Whitby (England). Each of these case studies considers key aspects of the attraction, including the supporting geology, and provides an account of what tourists can derive from this particular type of geotourism experience.

Chapter 3 Methodology: Describes the location and key tourism visitation data for the Bunbury region. Methods used to identify potential geosites and, the stones contained within Light House Hotel rock wall are discussed and an account of the wide-ranging documentary sources consulted in the process of conducting the research.

Chapter 4 Indicative geotourism resources and linked cultural insights: Comprises a results section about key geotourism resources**.** The chapter goes on to provide an account of the geology of four types of stone; ferruginous duricrust, basalt, granite and gneiss, which are prominent features in the walls of the Lighthouse Hotel. In addition to identifying the point of origin of each type of stone, and the deep time in which it was formed, a cultural narrative details the influence that geology and geomorphology have had

on the inhabitants of Bunbury and the greater Southwest region. The aesthetic qualities generated by form and geological process are briefly addressed.

Chapter 5 Potential for geotourism product development in Bunbury and the Southwest region: Contains a discussion of the results in the context of the potential for geotourism product development in Bunbury, initially based on a specific urban geosite. The chapter explores: who are geotourists, what are their motivations and what sort of engagement and interpretation do they require? The next part of the discussion considers the prospects for targeted geotourism in Bunbury and the Southwest region. Considering Bunbury's recent multimillion-dollar waterfront renewal there appears to be a need for Bunbury to renew and refresh some of its existing tourism offerings. Foremost is the urban and regional Heritage trails, and this thesis shows that the inclusion of elements of geotourism, has the potential to enrich existing tours and provide for a greater understanding and added value to many of the sites included in the present trails. The merits of nominating the Bunbury Basalt as a Global Heritage Stone Resource are discussed and the benefits of re-imagining the Lighthouse Hotel as a geotourism themed destination are considered. The concluding section of the discussion focuses on Aboriginal Cultural tours and some of the reasons for the large discrepancies between visitor intention to participate in Aboriginal Cultural Tours and actual participation. A case is made for geomythology, using elements of geology to give a unique perspective to Dreamtime stories in the Southwest region.

Chapter 6 Conclusions and Recommendations: Concludes the thesis.

CHAPTER 2 Appreciating geology in the urban environment

2.1 Introduction

Geotourism is a rapidly expanding form of natural area tourism with increasing attention being paid to the appreciation of landscapes where interesting landforms and rock outcrops can be viewed and visited (Dowling and Newsome 2006a; Raveloson et al. 2018). It is not, however, only in national parks, wilderness areas, or in other protected areas that landscape and geology can be appreciated as part of a tourism experience (Palacio-Prieto 2015; Del Lama 2018). While public interest in building stones, historical buildings and prominent rock outcrops in cities have always been tourism attributes, in recent times there has been a more concerted focus on geology in the urban environment as a tourism product in its own right (Del Lama et al. 2015; Del Lama 2018; Górska-Zabielska and Zabielski 2018; Richards et al., in press).

City administrators and tourism specialists now promote geological outcrops, prominent features and landscape phenomena, and geological features of the built environment as places to visit and learn about, thus adding value to tourist visits and diversifying the things tourists can experience when visiting a town or city. Furthermore, the recent literature on geotourism highlights various cities around the world as actual and potential geotourism destinations (Górska-Zabielska and Zabielski 2018). For example, Del Lama (2018), describes the value in Sao Paulo, Brazil of visiting churches for their geological values with the focus is on geological history and its connection with history and local culture. However, cities in Japan capitalise on their volcanic history and legacy of volcanic activity via hot spring and spa (onsen) tourism (Erfurt 2018). Reflecting the attraction of volcanos and hot springs, tourism associated with onsen has a long history in

Japan, and there are an increasing focus and expansion of the associated activity of wellness tourism at such sites (Erfurt-Cooper and Cooper 2009; Erfurt-Cooper 2014; Simpson and Newsome 2017). Urban geotourism attractions thus range from upstanding relief with clear rock exposures (The Rock, Gibraltar), clear geomorphological features such as river valleys and gorges (Tennessee River Gorge, Chattanooga, USA), building stones (Stepping Stones, Perth, Western Australia), monuments to natural disasters (Tsunami Memorial Park, Phuket, Thailand), built environment such as old churches and graveyards (Sao Paulo, Brazil), through to museums and information or visitor centres that display rocks and minerals and provide significant educational content on Earth history (Geology Museum, Bandung, Indonesia).

This Chapter provides an account of urban destinations where geology and landscape are features of city tourism and interlinked with history and culture. Its purpose is to provide examples of how domestic and international tourism can be enhanced via the recognition and promotion of urban geology as distinct attractions for tourism cities. Accordingly, this Chapter presents case studies from Hong Kong (China), Kraków (Poland), Edinburgh (Scotland), and Whitby (England). Each of these case studies is designed to set the scene and considers key aspects of the attraction, including supporting geology, and provides an account of what tourists can derive from this particular type of city experience.

2.2 Hong Kong UNESCO Global Geopark, China

Established in Europe, but fully embraced and developed in China, as a tool for achieving the United Nations Sustainable Development Goals (UNSDGs) to alleviate

poverty, geoparks have become important tourist destinations throughout the world (Dowling and Newsome 2018; UNWTO 2019). The Hong Kong UNESCO Global Geopark (HKUGGp) sits within what many perceive as an essentially urban area with the wider territory being rich in geotourism assets (Ng et al. 2010).

The HKUGGp encompasses an area of approximately 150 km^2. Internationally significant geology contained within the HKUGGp includes volcanic hexagonal rock columns (Figure 2.1) formed during the middle to Late Mesozoic Era (100—200 million years ago (Mya)) and sedimentary rock formations deposited from the Devonian Era (355—410 Mya) to the Paleogene Era (65—20 Mya). The included geosites thus represent a complete geological history of Hong Kong.

Figure 1. Outcrop of hexagonal columns in rhyolitic lava, Hong Kong Geopark. Such features impress not only geologists and dedicated geo-tourists but the

general tourist who is interested in natural phenomena. Lava is rarely seen on such an impressive scale. Photograph by D Newsome.

Creation of the HKUGGp was a three-stage process that involved overcoming initial resistance from some local academics and conservationists, who mistakenly feared that the creation a geological theme park would encourage visitors into environmentally sensitive sites and expose the geoheritage area to an unacceptable level of risk from activities such as visitors collecting rock souvenirs (Cheung 2016). Also, there was a mistaken belief that rocks and landforms did not require the same level of protection as flora and fauna (Dowling and Newsome 2010). Moreover, without adequate conservation measures, Hong Kong's unique geological formations were at risk of being engulfed by fast-paced urban development pressures.

Despite the resistance from some quarters, the Hong Kong National Geopark was created in 2009. To overcome the real and perceived threats to the geoheritage of the area, the government implemented a system of accrediting professional geo-tour guides (geoguides) that was combined with education and an active media campaign (Cheung 2016). This proactive geoconservation activity preceded acceptance of the site as a member of the Global Geoparks Network (GGN) in 2011 as a precursor to becoming the HKUGGp in 2015. The objectives for HKUGGp include conservation, education, and sustainable development of geoheritage within the geopark. The sustainability focus of the HKUGGp includes local engagement, improvement of rural livelihoods, science popularisation and geotourism. This holistic focus was previously neglected in favour of biological conservation (Dowling and Newsome, 2010).

To facilitate geoconservation and education goals, there are nine geotrails, two boat tours and five visitor centres within the geopark. To gain accreditation, geoguides undertake specialised training and are assessed regarding their geological knowledge, interpretation skills, and awareness of geoconservation (Ng and Choi 2009). The HKUGGp has official partnerships with two geohotels, which mandates that the businesses promote the conservation of nature and cultural heritage, science transfer and service excellence. The geohotels endorse HKUGGp via information displays and by promoting available geotours. The hotel restaurants offer geo-themed menus and a dedicated television channel promotes geopark destinations in guest rooms (HKUGGp 2018). Hotel staff undertake regular familiarisation field trips and undergo specialised training, to ensure they can provide visitors with up to date information (HKUGGp 2018).

Hong Kong was one of the first places in the world to fully embrace geotourism in a peri-urban setting. As such, the HKUGGp is considered a flagship geotourism enterprise. Although residents within the geopark agree very strongly with the conservation and educational principals of the GGN, as they apply to the geoheritage of the park, there has been a conflict with management regarding the distribution of resources and community attitude to biological and environmental conservation (South China Morning Post 2015). Conversely, it is reported that visitors to HKUGGp have a greater appreciation of the biological and cultural heritage within the geopark, rather than the geological heritage sites (Guo and Chung 2019). This indicates that HKUGGp management and tour operators need to promote a greater awareness of the important links and connections between the abiotic, biotic, and cultural values of the geoheritage within the park (Dowling and Newsome 2018). On a positive note, research by Cheung (2016) indicates that geopark visitors are willing to pay higher prices for better quality guided tours.

The HKUGGp hosts approximately 1.5 million visitors per year, which makes the geopark a key urban tourism asset for Hong Kong (GGN 2017; GovHK 2018; Guo and Chung 2019). Visiting tourists and residents enjoy a wide range of geo-themed artistic, community events, and educational experiences, geo-themed food and beverages, information centres, community engagement, school visits, and tours and trails through the geopark (HKUGGp 2018). Crowding beyond destination carrying capacities is, however, becoming the scourge of tourism in many natural areas and UNESCO listed sites, including in urban geosites (Newsome et al. 2012). Hong Kong authorities are proactively managing the geopark to avoid the impacts of over-tourism to protect both the geoheritage of the HKUGGp and visitor satisfaction with their geopark experiences (Dowling and Newsome 2017; Fowler 2018).

2.3 Wieliczka Salt Mine, Kraków, Poland

The geology of the Wieliczka Salt Mine (WS Mine) in Kraków originates from the Miocene Epoch (13.6 Mya). The Wieliczka salt deposit, derived from the evaporation of saline water, is the result of colliding tectonic plates that formed the Carpathian Mountain range and the pre-Carpathian Basin or Carpathian foredeep (Czapowski 1994). The Wieliczka salt deposit is accessible today due to orogenesis (mountain-building processes) uplifting tectonic plates into the pre-Carpathian basin strata, to create thrust-folds that increased the original thickness of the salt layers (Burliga et al. 2018). The location of the WS Mine, at the front of the Carpathian Orogenic Belt, affords a unique opportunity for the geotourist to view the structural detail and plate tectonics of salt-bearing complexes that can only be readily studied in sections exposed in an underground mine (Hallett 2002).

The WS Mine was an important and profitable salt mining operation from the 13th-century until the closure of its underground mining operations in 1996 (Rozycki and Dryglas 2016). Previously the mine was declared a UNESCO World Heritage Site in 1978 and a Polish Monument of History in 1994 (Alexandrowicz et al. 2009). However, the WS Mine was placed on the List of World Heritage in Danger in 1988, when the excessive extraction of brine and rock salt and increased humidity threatened natural geoheritage values and artworks at the site (UNESCO World Heritage Centre 1998). The installation of more efficient dehumidifiers, the cessation of commercial extraction of crystalline salt, and a change in site management saw the WS Mine being removed from the List of World Heritage in Danger in 1998 (UNESCO World Heritage Centre 1998; WS Mine n.d.a)

The mine is now considered to be the largest underground museum in Europe (WS Mine n.d.a and n.d.b). It extends to a depth of 327 m and contains 287 km of passageways and chambers. Currently, only 2% of this labyrinth is accessible to the visiting public. Attractions at the mine include displays featuring the development of mining techniques in Europe from the 13th century to the 20th century, an underground lake, four chapels, and a multitude of statues carved from the rock salt by miners and contemporary artists (Hallett 2002). The story of the WS Mine is the result of centuries of commercial mining operations, hundreds of years of health treatments based on the mineral brine and environmental management, such as the dehumidification of air underground, and the operation of an underground tourist route existing since the early 19th-century. The WS Mine is, therefore, a good example of geotourism and conservation of geological and historical assets working in unison to provide economic and social benefits for a connected city. The social networking platforms Lonely Planet (n.d.) and Trip Advisor (2019a) and online booking

service Viator (2019a) all rank the WS Mine Guided Tour in the top three things to do when visiting Krakow.

The mine also contains a legally protected abiotic nature reserve called the Crystal Grottoes Cupola. This site consists of two Crystal Grottoes, which are considered ‘priceless’ and ‘unique on a global scale’ (Lipecki et al 2016, p.1; WS Mine n.d.b). However, as the salt crystals are vulnerable to leaching via fluctuations in humidity, these grottoes are not open to the public (Lipecki et al 2016; Alexandrowicz et al. 2009). The underground Chapel of the Blessed St Kinga exemplifies the adaptation of the WS mine for cultural purposes. Constructed from a disused mine chamber between 1895 and 1925, the entire chapel (walls, floor, altar, balcony, bas-reliefs, and chandeliers) is carved from salt (Hallett 2002).

Alexandrowicz and Alexandrowicz (2004) suggested that the WS Mine has the potential to become the world’s first subterranean geopark. They recommended expanding on the current cultural aspects of the WS Mine tours by promoting the unique geology and plate tectonic processes that produced the salt-bearing complexes that were exploited by the mining process. The benefits for the WS Mine that would follow on from becoming part of the UNESCO GGN include rigorous management practices, planning, and policy to protect the area from damage and to promote sustainable development aligned to the UNSDGs (Dowling and Newsome 2006b; UNWTO 2019). If a geopark is realised, the local community could gain additional economic benefits that accrue from being part of the rapidly expanding global geotourism network (Dowling and Newsome 2018).

An estimated 1.7 million people visited the WS Mine in 2017 (WS Mine n.d.c). Visitor health and safety are addressed with warnings regarding the number of stairs (800),

the cool temperature (14°C) and the risk of claustrophobia. The guided tours are conducted in groups of up to 30-40 people, with multiple tours running consecutively. The commentary for the tour focuses on the history of salt mining, the miners themselves, and the cultural aspects of the WS Mine (Trip Advisor 2019b). In addition to these highly successful cultural and geotourism experiences, the WS Mine also continues to offer health and wellness experiences based on the mineral brine and spa opportunities available at the site (WS Mine n.d.d). Further, the operation has expanded into offering on-site accommodation; conference, meeting and training facilities; wedding ceremonies and receptions; and artistic and cultural events and festivals. The decade long inclusion of the WS Mine on the List of World Heritage in Danger demonstrates the need to actively protect and manage the geoheritage of urban geodiversity to conserve the abiotic and cultural values of geotourism destinations (Dowling and Newsome 2018). Crowding during the peak tourist session is emerging as an issue at the WS Mine (UNESCO World Heritage Centre 2019). This will require an assessment of visitor management approaches to minimise the impacts of over-tourism at this increasingly popular urban geotourism destination.

2.4 Arthur's Seat and the Salisbury Crags, Edinburgh, Scotland

Arthur's Seat and the Salisbury Crags (hereafter referred to as 'the Crags') are an iconic part of the Edinburgh cityscape. The readily identified lion-shaped hill is a unique, valuable, and easily accessible urban geotourism resource. Noted Edinburgh native historian and writer Sir Walter Scott captured the essence of the view from Arthur's Seat. His prose has often been re-published in the noted Black's [Travel] Guides, produced by the Edinburgh based brothers Adam and Charles Black (1842, 1943), and more recently by

Historic Environment Scotland (HES 2018) in their annual Statement of Significance for Holyrood Park

> *If I were to choose a spot from which the rising or the setting sun could be seen to the greatest possible advantage, it would be that wild path winding around the foot of that high belt of semi-circular rocks, called Salisbury Crags,… the prospect commands a close-built, high piled city stretching itself out beneath. When a piece of scenery so beautiful yet so varied - so exciting in its intricacy yet so sublime- is lighted up by the tints of morning or of evening and displays all that variety of shadowy depths, exchanged with partial brilliancy, which gives character to even the tamest of landscapes, the effect approaches near to enchantment.*
> (Scott 1818 cited in HES 2018, p 17)

Dominating the skyline of central Edinburgh (Figure 2.2), the group of hills located in the western portion of Holyrood Park, of which Arthur's Seat is the highest point (251m), are the eroded remains of a strato-volcanic dome that erupted and decamped during the Carboniferous period (Edinburgh Geological Society (EGS) n.d.a; HES 2018; McAdam 1986; Monaghan et al. 2014). Formed from the core of the volcano, Arthur's Seat is the eroded remains of the Lion's Head Vent that initiated the eruption of Arthur's Seat volcano 341 Mya (McAdam 1986; Monaghan et al. 2014). The secondary Crow Hill peak is the eroded remains of a lava lake associated with the later and larger Lion's Haunch Vent that remained active until 335 Mya (McAdam 1986; Monaghan et al. 2014). The adjoining Whinny Hill formed from the cone of Arthur's Seat volcano (McAdam 1986; HES 2018).

Figure 2.2. View of Arthurs Seat towering over the city of Edinburgh. Photograph from Trip Advisor 2020.

After the volcano became extinct, it was buried under thousands of metres of sediments, which became the Abbey hill Shales (McAdam 1986; McAdam and Clarkson 1996). Approximately 325 Mya, some 10-25 million years after the Arthur's Seat Volcano became extinct, that sedimentary layer trapped an intrusion of magma rising through the old vents to create the dolerite sills of the Crags (EGS n.d.b.; McAdam 1986; McAdam and Clarkson 1996).

The sedimentary and igneous rock of this area have been eroding for the past 300 million years and most dramatically over the past 2 million years when the land surface was denuded by growing and melting ice sheets of the Pleistocene Ice Ages (EGS n.d.b.; McAdam and Clarkson 1996). At the last glacial maxima, 20,000 years ago, the 1km thick ice sheet that covered the area of current-day Edinburgh stripped softer sedimentary rock

away from the basalt of Arthur's Seat and the dolerite sills of the Crags (EGS n.d.b; McAdam and Clarkson 1996). That ice sheet melted rapidly as the Earth warmed and torrents of meltwater washed the eroded sedimentary rocks and other glacial till into the sea or low-lying swamps and bogs (EGS n.d.a; EGS n.d.b).

The result is that hundreds of millions of years of geological processes have mixed, fused, and eroded the igneous and sedimentary rocks of Holyrood Park to produce Arthur's Seat and the Crags. Those processes have created abundant geological features, including sills, dykes, faults, slickensides, vesicles, distorted strata, lava lakes, roche moutonnée, and glacial striate (EGS n.d.; HES 2018; McAdam and Clarkson 1996; Monaghan et al. 2014). In recognition of the geological importance of the Arthur's Seat Volcano, it was designated a Site of Special Scientific Interest (SSSI) in 1986 (Scottish Natural Heritage (SNH) 2011). The SSSI citation notes, "The small composite volcano of Arthur's Seat, of Lower Carboniferous period, is one of the most studied volcanoes in the world. All the parts of a typical strato-volcano are well displayed, and the sequence of eruptions can be traced with a continuity unique in Britain" (HES 2016; SNH 2011).

There are several relatively easy routes available to ascend Arthur's seat, including the 4.8 km hike that takes visitors past Lang Rig (Long Row) and along which visitors can observe the remains of basalt lava flows generated by the Arthur's Seat Volcano and the much the younger Salisbury Crags dolerite sills. This route to the summit incorporates Hutton's Section that is named after James Hutton (1726—1797), the 'father of modern geology' (HES 2018). Hutton's Section displays the junction between existing sedimentary sandstone layers and the overlying dolerite, which was exposed by the quarrying of the Crags for building stone and road base. In 1788, Hutton proposed that molten magma was

pushed up to the surface of the earth from below, through ancient sedimentary layers to create younger crystallised igneous rocks (EGS n.d.; HES 2018). As can be observed by visitors today, this site provides visual support for Hutton's theory of an Earth that was far more ancient than the Old Testament based age of 6,000 years previously declared by the Archbishop of Armagh and Primate of Ireland James Ussher (Dean 1981). The EGS publish several guides for walking tours that explain and celebrate both the geology of Arthur's Seat and the Crags and the natural and built environment geology in the broader Edinburgh urban landscape that can be seen from the summit (EGS n.d).

From a cultural perspective, the 360-degree views of Edinburgh visible from the summit of Arthur's Seat provided the perfect location for one of the four prehistoric or Dark Age hill forts that can be found in Holyrood Park (HES 2018). Remnants of hill fort defences are visible to the east of Arthur's seat and on the adjoining Crow Hill. The landscape to the east side of Arthur's Seat also features 15 rows of terraces that are considered some of the best-preserved remains of medieval cultivation in the Scottish Lowlands (Lothians). The terraces provide historical insight into agricultural practices of the era (HES 2018). Several other constructed cultural and historical geotourism features are also visible from the summit of Arthur's Seat. There is the architecture of Holyrood Palace (1540), Holyrood Abbey (1128), and St Anthony's Chapel (1300—1500). Tourists can look across to the iconic Edinburgh Castle that is constructed on the exposed core of the earlier Castle Rock Volcano (350 myo). Also, the former Salisbury and Camstane Quarries (1530—1831), from which dolerite was extracted to build the walls of Holyrood Palace (Miller 2012), are visible from Arthur's Seat.

In addition to geology, archaeology, architecture, and history, the landscape around Arthur's Seat and the Crags has biotic, aesthetic and natural heritage values. Management of Holyrood Park (259 ha) is carried out by the Historic Scotland Ranger Service, which also coordinates teams of specialist volunteers (HES 2018). These Park Rangers and volunteers specialise in survey work including identifying rare and unusual plants. Overall, they have identified 350 plant species in the park, 60 of which are rare. Volunteers are also engaged for brief periods to perform specific tasks, such as clearing invasive weed species. Park Rangers liaise with the local community and wider public, providing talks and activities on topics such as nature conservation, historical aspects, geology, archaeology, and general cultural and environmental stewardship (HES 2018).

For more than two years, visitors have ranked Arthur's Seat as Number 1 on the TripAdvisor 'Top Attractions in Edinburgh' (Pile 2017; Trip Advisor 2019c). In addition to the self-guided walking tours described above, a multitude of companies and sole operators market tours of Arthur's Seat to target a diverse range of niche markets, including fully guided geologically focused tours that are provided by the EGS and private operators (EGS n.d.e; Miller n.d.; Trip Advisor 2019c, Viator 2019b). The TripAdvisor ranking and the multitude of commercial tour options highlights the importance of Arthur's Seat and the Salisbury Crags for tourism in Edinburgh and the significant role that geotourism can play in creating tourism cities that deliver the UNSDGs. However, the economic and social value that visitors to Author's Seat contribute to Edinburgh and the wider Scottish community was identified as a knowledge gap in a recent review by the HES (2015), with more information about park users being required to optimise both site management and visitor satisfaction.

2.5 Geoconservation at an urban geodiversity hotspot, Whitby, England

Settled by Danish seafarers in the early middle ages and recorded in the Doomsday Book as 'Witebi', modern Whitby is a small regional town located at the mouth of the River Esk on the North Yorkshire coast in northeast England (Atkinson 1879; Dade and Carter 2015; English Heritage (EH) n.d.). Although originally founded on fishing, mining of ores and gems, wooden shipbuilding, and whaling, Whitby has a long history as a geotourism destination. This history of geotourism, when combined with its significance as a cultural centre grounded by its local geology and its geoconservation endeavours identifies Whitby as a geodiversity hotspot (Bétard and Peulvast 2019; Chrystal 2019; Brindle 2010; EH n.d.; Historic England (HE) 2015; Walton 2014; White 2019).

In the two decades since their inception, the concepts of geodiversity, geoheritage and geoconservation have focused on the natural abiotic components of the landscape (Gray 2018a and 2018b; Kubalíková et al. 2017). While contested by some authors, the concept of geodiversity within the abiotic environment complements the term biodiversity that describes the variability of biotic organisms (Sharples et al. 2018; Bétard and Peulvast 2019). Given the correspondence between the terms geodiversity and biodiversity, the recent work of Bétard and Peulvast (2019) promotes the concept of 'geodiversity hotspots'. Analogous to the 'biodiversity hotspot' concept formulated by Myer and others (2000), Bétard and Peulvast (2019) defined geodiversity hotspots to be 'geographic areas that harbour very high levels of geodiversity while being threatened by human activities'.

Although Whitby is rich in natural geodiversity consideration of the cultural geomorphology of Whitby further increases the geoheritage values of this regional city as an urban tourism destination. A cultural geomorphology perspective considers a landscape in terms of 'all the natural and anthropogenic factors it contains' (Panizza and Piacente 2009, 36), which corresponds with the 'secondary geodiversity' concept advanced by Kubalíková et al 2017). In this case study, we consider the geodiversity and geoheritage of Whitby in terms of both the natural and secondary geodiversity. Both of which can be experienced by traversing the coastal portion of the 177 km Cleveland Way is a National Trail (National Trails 2019). The trail follows the coast from Filey, north through Whitby, then at Saltburn-by-the-Sea, where it turns inland and across the heath of the Yorkshire Moors to finish Helmsley.

Easily observed in the steep coastal cliffs around Whitby, the natural geodiversity of the area consists of rocks formed from sediments deposited during the Early and Middle Jurassic Epochs (Cox and Sumbler 2002; North Yorkshire Moors National Park (YMNP) n.d.; Simms et al. 2004). As the supercontinent Pangea began to break up in the Late Tirassic and Early Jurassic, the expanding Tethys Sea inundated the Cleveland Basin, on which Whitby is situated, and the depositional environment changed from fluvial to marine (Simms et al. 2004). The three geological formations from that epoch are the Staithes Sandstone (190—185 Mya), the Cleveland Ironstone (185—182 Mya), and the Whitby Mudstone (175—165 Mya). The Cleveland Ironstone and the Jet Stone and Alum Shales beds of the Whitby Mudstone formation are the most significant strata from a geotourism perspective. Sea levels fell during the transition from the Early to Middle Jurassic (175—165 Mya), changing the sediment deposition mechanism in the Whitby area from marine to deposition in a variable fluvial-tidal environment of broad coastal swamps and river deltas

(Coxmya et al. 2002; Whyte et al. 2007). River flows and tidal currents waxed and waned across a coastal environment, considered to be akin to the current Niger Delta in West Africa, thus giving rise to the different sequences of sandstones, siltstones, mudstones and limestones of the Ravenscar Group (Livera and Leeder 1981; Whyte et al. 2007).

The geology of Whitby is rich in fossil remains from the age of the dinosaurs, as immortalised in popular culture through the Jurassic Park/World franchise of movies from the late-20th and early-21st-century (Newsome and Hughes 2017, Padian 1988). As a result, the coast of North Yorkshire, including the area of Whitby, is known as the 'Dinosaur Coast' and frequent allusions to those movies appear in materials promoting the area (Parkes 2019; YMNP n.d.; Yorkshire Post 2015). The mudstones that formed from the abiotic and biotic sediments deposited in the marine environment of the Early Jurassic are extremely rich in fossilised biotas such as ammonites, belemnites, bivalves, fish, reptiles, and fossilised plant remains (Joint National Conservation Committee (JNCC) 2010; Whitby Museum n.d.). Because the Middle Jurassic rocks, which are observed in the upper layers of the coastal cliffs and the eroded boulders and scree resting on beach platforms around Whitby, are the product of shallow nonmarine depositional environments, bivalve molluscs and fossil plant remains are common, but the remains of large fauna are rare (Whyte et al. 2007). Those conditions were, however, ideal for capturing and preserving dinosaur footprints, including those of early crocodilians, sauropod dinosaurs, early stegosaurian dinosaurs, and carnivorous theropod dinosaurs, to name a few (Whyte et al. 2007). Fish and reptile fossils extracted from the cliffs at Whitby were among the first specimens commercially exploited for sale to collectors. Local geologists and palaeontologists were so concerned about the rate of fossil extraction and the loss of geoheritage during late 18th and early 19th centuries that the Whitby Museum was formed to retain a collection of fossils in

Whitby (Whitby Museum n.d.). Primarily because of its fossil geodiversity, much of the natural geoheritage around Whitby is now conserved and protected by statutory designation as geological Sites of Special Scientific Interest (JNCC 2014; TVRIGS 2014). Accelerated erosion of this coastal geoheritage, arising from the projected rapid sea-level rise that is being driven by anthropogenic climate change, will pose a significant geoconservation challenge for the Whitby fossils throughout the 21centuary and beyond.

The Early Jurassic Jet Stone also provides a case study for the ABCs of geotourism promoted by Dowling and Newsome (2017) and the significance of geodiversity, geoheritage and geoconservation in the urban environs of Whitby. Jewellery made from Whitby Jet has been discovered at Neolithic, Celtic, Roman, and Viking archaeological sites from Ireland to Rome (Dean 2007; Stevens 2017). Made from a material 1000 times rarer than diamonds, Whitby Jet jewellery is carved from pieces of the fossilised trunks of trees related to the Monkey Puzzle tree (*Araucaria araucana*) that today grows on the lower slopes of the south-central Andes in Chile and Argentina (Parkes 2019; White 2019). Growing in the Jurassic forests of Pangea and Gondwana with dinosaurs wandering past, those trees were ancestors of the living-fossil genus Araucaria, which continental drift has dispersed across modern rain forest habitats from South America, through the Pacific Islands, and on to eastern Australia (Flenley 1984; Parkes 2019; White 2019). Modern mining and production Whitby Jet jewellery commenced in the early 1850s, which coincided with the Victorian period of mourning and austerity of dress following the deaths of the Duke of Wellington in 1852 and the Prince Consort Albert in 1861 (Stevens 2017; White 2019). Demand for jet jewellery declined rapidly after the death of Queen Victoria and the industry and geoheritage value of that element of Whitby's geodiversity was all but lost in the 20th-century. The last remaining Victorian jet workshop was rediscovered about

20 years ago in the attic of a derelict house (Campbell 2010; Heritage Jet 2018). Tourist interest in the salvaged and reconstructed workshop first resulted in the creation of The Whitby Jet Heritage Centre and then led to economic development through a resurrected Whitby Jet jewellery industry (Huddersfield 2013; Heritage Jet 2018; Tucker n.d.). A purpose-built museum combining displays of gothic Victorian jewellery and curios and the largest fossilised trunk of Whitby Jet ever discovered was opened in 2019 (Parkes 2019).

Geotourism in Whitby dates to the 18th century when half a century before the railway arrived, wealthy health-conscious Georgians would travel to the town to enjoy the medicinal and tonic qualities of the iron-rich chalybeate springs arising from groundwater in contact with the Cleveland Ironstone (Chrystal 2019; Brodie 2012; Walton 2014). Whitby and the iron-rich springs retained their image as a seaside health spa in the Victorian era and on into the early 20th-century (Yorkshire Post 2004; White 1998 and 2019). As with many British seaside resorts, tourist visitation to Whitby declined in the second half of the 20th-century, causing the springs and infrastructure that supported the spa-based geotourism to be forgotten (White 2019; Yorkshire Post 2004). Similar to the Victorian jet workshop mentioned above, the last remaining art-deco decorated Victoria Spa House, which was built in 1860 replacing an earlier spa building built in the 1830s, was also rediscovered in the early 2000s (Historic England (HE) 2019; Yorkshire Post 2004). Now protected as a Grade II Listed Building, this geoheritage site is also drawing tourists to visit the conserved urban geoheritage of Whitby (HE 2019; Yorkshire Post 2004; Whitby Gazette 2010).

In terms of the geoheritage of the built environment in Whitby, the most famous landmark is Whitby Abbey (Figures 2.3 and 2.4). Located on the opposite bank of the River Esk to the town, Whitby Abbey, and associated monastery buildings was a centre of

learning and focal point of political attention with a long history of ruin, re-use, and renewed attention. Established by the Anglo-Saxon King of Northumbria in 657, the first monastery was a double priory house (housing both monks and nuns) that was led by Abyss (and later Saint) Hilda (Brindle 2010; EH n.d.; HE 2015). That first monastery is reported to have consisted of forty small chapels and cells (*monasteria vel oratoria*) that were constructed from local stone (Harrison and Norton 2012; Page 1923). Remains of that geoheritage are shown as buried archaeology associated with the 'Anglian Monastery' in the 20th-century map by Clapham (1952). The monastery was first abandoned in the late 9th-century, probably because of repeated Viking raids, with several sources stating that raiders sacked the monastery circa 867 (Atkinson 1879; Brindle 2010; EH n.d.; Harrison and Norton 2012; HE 2015; Page 1923).

Figure 2.3. Headstones located in the cemetery area outside Whitby Abbey. Made from sandstone derived from local quarries. Sedimentary bedding planes are visible as

faint diagonal lines. Weathering of the rock surface over hundreds of years has obliterated the names and dedications that originally marked the surface of these headstones. Photograph by D. Newsome.

The monastery buildings remained in ruins for the next 200 years, until a decade after the Norman Conquest. Supported by the Norman baron William de Percy and granted charters by William the Conquer, in 1077 a community of monks reoccupied the ruined buildings of the first monastery to found Benedictine Priory they called the monastery of St Peter (Atkinson 1879; English Heritage n.d.a; Harrison and Norton 2012; Page 1923). Internal politics, and possible attacks by pirates, resulted in the site again being abandoned a few years later, only for members of the same community of monks to return in 1090, to complete construction of a stone Benedictine Abbey in 1109 (EH n.d.; Harrison and Norton 2012; Page 1923). The stone abbey was rebuilt in the Gothic style in the mid-13th-century, building of the naïve commenced in the 14th-century, but was completed in the 15th-century (Clapham 1952; EH n.d.; Page 1923). The abbey and other buildings on the site remained intact after the Dissolution of the Monasteries by Henry VIII and on into the 18th-century until large sections collapsed circa 1732 and 1736 (EH n.d.; HE 2015).

Figure 2.4. View of Whitby Abbey and cliffs on the nearby coastline. Some of the rocks forming the cliff line are rich in fossils. Fossil collectors and beachcombers can find fossilised plant remains and an array of fossilised animals including dinosaur remains. Photograph by D. Newsome.

The building stones of the abbey, however, tell a much older story that dates back to the start of the Middle Jurassic Epoch approximately 165-170 Mya (White 2019; Whyte et al. 2007). Middle Jurassic sandstones from quarries on the coast and across the North Yorkshire Moors near Whitby have been used in the construction of many buildings and monuments (NYMNP n.d.; White 2019). Faint impressions of ancient sedimentary strata are visible in the headstones that punctuate the surroundings of Whitby Abbey (Figure 2.3). Many of the headstones, intended as memorials of human death, thus reveal more about the geology of Whitby than about the people buried there! Furthermore, due to the effects of weathering caused by decades of on-shore winds carrying salt-laden spray from the nearby

coastline, the headstones reveal a rugged honeycomb pattern on their surface (Figure 2.3). The sandstone building blocks of Whitby Abbey are under similar attack in the harsh coastal conditions, so English Heritage has commenced conservation work to maintain the structural integrity and geoheritage values of the abbey, which demonstrates the importance of geoconservation for historic ruins that are icons of a tourism city (Brindle 2010).

While the ruined Gothic abbey dominates the skyline of the town, the Dissolution of Monasteries under Henry VIII contributed far more to shaping the landscape and geodiversity of Whitby than the later ruins of the Gothic abbey. In the middle ages, alum was an important mineral used in the manufacture of paper and textiles for medicinal purposes (NYMNP n.d.; Appleton 2018). In medieval times, alum was sourced mainly from Italy and the Popes tightly controlled its extraction and export from Italy and importation from Turkey under the threat of ex-communication (Nef 1936; Günster and Martin 2015). When Henry VIII split from the Catholic Church and dissolved the monasteries, supplies of alum became restricted, causing both Henry VIII and Elizabeth I to champion the search for, and production of this valuable mineral, in England (Nef 1936; Jecock 2009). There are reports that alum may have been mined around Whitby from the mid-16th century, which, based on reports from the mid to late 19th century, resulted in the mines owner Sir Thomas Chaloner and his miners being excommunicated by the Pope (Curtis 1829; Fox-Strangways 1892 cited in Hobbs et al. 2012; Hobbs et al. 2012; Murray 1867). Those restrictions lead to mining of the Alum Shales of Whitby for 250 years from the reign of Queen Elizabeth I in the mid-15th century, until a synthetic form of the mineral was produced in the mid-19th century under the reign of Queen Victoria (Appleton 2018, White 2019). The Alum Shales were mined on a massive scale, resulting in the complete removal of headlands and creation of broad beach platforms that created ‘spectacular, almost lunar, the scenery at places such

as Sandsend and Ravenscar', which are located to north and south of Whitby (NYMNP n.d.; White 2019). In another coincidence, it was the mining of alum that lead to the discovery, extraction and exploitation of the fish and reptile fossils from the Early Jurassic Period discussed earlier.

The importance of Whitby Abbey and the town centre in the cultural and historical context are further exemplified by its use by Bram Stoker as the setting for his vampire novel Dracula, which was written in 1897. A century after the Dracula novel was published, the mythology of the vampire has become the inspiration for a festival that has become a global event which has grown into one of the largest biannual celebrations of Goth culture on the planet (Love 2019; Paylor 2013). The festival, which is focused on the Victorian Spa Pavilion in an ironic link to the origins of geotourism in Whitby, was instigated with the support businesses and community as a means of re-invigorating the tourism industry and economic livelihood of the town (Farr 2017; Paylor 2013). The contribution of this cultural phenomenon inspired by the geomythology of Whitby Abbey and its vampire connections has been responsible for re-invigorating geoheritage linked tourism, demonstrated by Whitby having been voted the best seaside resort in Britain in 2006 and the estimated £1.1 million per annum that is contributed to the local economy (Farr 2017; BBC News 2012). Images from around the abbey and streets that show the built environment of Whitby feature heavily in the promotion and social media surrounding the festival. Further, the Dracula-Whitby geomythology link is now generating academic consideration of the Goth-based cultural aspects of the geoheritage of Whitby (Dobson 2018; Goulding and Saren 2009). Recognising the need to protect the geoheritage values of the built environment and viewscapes that generated the tourism described here and above, the local government

authority adopted the Whitby Conservation Area – Character Appraisal & Management Plan in 2014 (Scarborough Borough Council 2019).

This case study illustrates the breadth of the geodiversity, both natural and secondary, available at regional urban destinations such as Whitby. As highlighted, the natural geodiversity of Whitby and the geo-assets of the built environment provide the foundation for cultural, historical and geological tourism experiences, which are the keys to the future prosperity of the community. Other regional centres could catalogue the geo-assets to be found in the built environment and natural areas of their urban environments and look to Whitby as an example of how the abiotic, biotic, and cultural values of those sites could be leveraged to work towards the UNSDGs through geotourism. However, this case study also illustrates the past, present and future threats to the geoheritage of Whitby from erosion, overexploitation, or simply from being forgotten. We postulate that analogous with biodiversity hotspots, the regional urban geotourism destination of Whitby is a global geodiversity hotspot that requires careful ongoing management to ensure the sustainability of both its internationally significant geotourism industry and the geoheritage on which that industry depends.

2.6 Future considerations and recommendations for further policy development

There are several challenges concerning simultaneously protecting and promoting geoheritage in urban environments. Many landforms are affected by long-established town planning policies and urbanisation often leads to damage and destruction of important

landforms and geosites. An extreme example of this is the complete modification of mountains by flattening the landscape to build new cities in mountainous regions in China (Li et al. 2014).

Many authors have reported that geoconservation and public awareness are vital precursors before geotourism can be fully implemented in the urban environment (Bennett et al. 1996; Dowling and Newsome 2018). Reynard el al. (2017) maintain that structured mapping and inventory programmes be put into place to identify and document urban geotourism resources. Geotourism itself is seen to need further and more active promotion and this can be implemented via electronic media that contains specific geology and landscape content. Such an example of geoheritage and geotourism promotion in the modern context is the thematic map forwarded by Sacchini et al. (2018). GIS databases, geology and landform maps and tourist trail and activity maps provide a rich avenue of research for the promotion of urban geotourism into the future. Further, for example, Reid (1996) specifies a code of practice regarding conserving geoheritage alongside urban development. Reid (1996) thus states that developers need to engage in early dialogue with urban managers, consult registers of geological sites and engage with geologists. Moreover, a full impact assessment should be undertaken before planned urban development and mitigation measures implemented to prevent damage or loss of geoheritage. Reid (1996) goes on to point out that where urban planning applications affect previously recognised and existing geoheritage sites, planning permission should be refused, or granted subject to avoiding damage or designation of an alternative and conserved geological site.

Barker (1996), noting that wildlife conservation has many similarities with geo-conservation, emphasises the importance of engaging with the social and psychological

aspects of nature conservation and extending these human dimensions to urban geotourism. It was recognised more than 20 years ago that urban geoheritage and geotourism need to be linked in with floral and faunal amenities, history, archaeology and culture (Bennett et l., 1996). Today many aspects of these factors have now been fully incorporated as a part of geotourism more broadly, as well as in the urban environment (e. g. Gordon 2018 a, b).

As a final message, and a vital aspect that needs attention in the future, is the management of geological values in urban areas, particularly where the geology is promoted as a tourism attraction and recreational resource (Dowling and Newsome 2017; Richards et al. 2020). The careful and appropriate design of tourism infrastructures such as access, viewing facilities, and educational signage is essential to reduce degradation from visitor impacts and require appropriate levels of planning and funding by city authorities. A fully considered visitor management strategy, that includes the training and employment of guides, will help to ensure that sustainable urban geotourism will become a feature of many tourism cities into the future.

2.7 Conclusions

This Chapter has highlighted that natural geology, landscape and the geological attributes of buildings either currently form or can form marketable tourism attractions in their own right. Such attractions include, but are by no means limited to, buildings and building stones; landscapes and streetscapes; sequences of sedimentary and other rocks; rock outcrops, mineral deposits, fossils; interpretive and educative displays of geological materials and earth processes; and cultural events connected to geoheritage. The key to geotourism success, as in all nature-based tourism ventures, lies in the provision of high-quality information and engagement. Geotourism in the urban environment offers the tourist

an opportunity to learn about the composition of the Earth and the processes that shape it. Each exposure the visitor has to rocks and the landscape demonstrate an environmental history and human connections with landscape, such as geological controls and evidence as to how rocks have influenced soils and land use. The contemporary geotourist wants to be inspired and learn about the Earth. Although iconic buildings and landscapes can be very photogenic and rock outcrops aesthetically pleasing it is in *knowing* that brings elevated levels of visitor satisfaction. Furthermore, city officials and town and tourism planners are becoming increasingly aware that geological features can be promoted as diversified urban tourism products.

This chapter has explored the diversity of international geotourism and introduced four urban geotourism centres, highlighting aspects of their geoheritage, geoconservation and the cultural events they generate. The following chapters are an account of several potential geotourism opportunities in the City of Bunbury. Inspired by the walls of the Lighthouse Hotel, the scale of this investigation, though smaller than the preceding examples, is no less important to our understanding of how the Earths' geological processes influence our lives and why access to a geotourism perspective of Bunbury is a valuable, yet unrealised, asset.

1This chapter is a modified version of the following publication:
Richards, S., Simpson, G.D. and Newsome, D. (2020). Appreciating geology in the urban environment. In: A. Morrison, and A. Stefaniak, (eds). *Routledge Handbook of Tourism Cities*, Routledge: Abingdon, United Kingdom.

CHAPTER 3 Methodology

3.1 Study Area

Listed as WA's third-largest city, the Bunbury-Geographe region has a population of 102 000 people (Australian Bureau of Statistics 2017). Visitor numbers to Bunbury between 2015—2017 averaged 434,300 people per year the greater South West area (including Bunbury, Busselton, Augusta-Margaret River, Boyup Brook, Bridgetown-Greenbushes, Capel, Collie, Dardanup, Donnybrook-Balingup, Harvey, Manjimup, Nannup) experienced an average of 2,494,100 tourists during the same period, indicating the potential to attract a further two million visitors to Bunbury in the future (Fig 3.1.1) (Tourism Western Australia 2018).

Fig. 3.1 Australia's Southwest region indicating the location of Bunbury and other towns referred to within this thesis. Map courtesy of CinefestOZ (2020).

3.2 The Lighthouse Hotel site visit

The identification of the Lighthouse Hotel as a site which contained a diverse range of key building stones of geotourism potential was conducted during an initial scoping visit to Bunbury in 2019. Identification of the stones used to build the Lighthouse Hotel was undertaken during a follow-up site visit later in 2019. A photographic record of the building and surrounding landscape was also captured to elucidate the masonry processes and architectural style incorporated in the construction of the hotel (Fig 3.2.1).

Fig 3.2. Photographic record capturing the stones and architecture of the Lighthouse Hotel Bunbury. Photograph by S. Richards.

3.3 Documentary Research

Journal articles and technical reports about ancient and modern architectural styles and stonemasonry techniques were sourced for relevant information regarding the architectural style of the Lighthouse Hotel. Data and photographs of the Lighthouse Hotel were obtained from site visits, social media pages, such as '*Memories of Bunbury*'. Historic government records from the WA State Library were researched to inform the history of the Hotel, its builder and architect. Social media sites including TripAdvisor and Facebook were also searched to assess visitor preferences in the urban setting. Information on the geology of granite, gneiss, basalt and laterite duricrust was derived from journal articles and mapping data obtained from journal articles and documentation published by Geoscience Australia and the City of Bunbury. The most recent data from Tourism Western Australia and the Australian Bureau of Statistics were accessed to inform visitor and population statistics.

Information regarding the Elaap Wardandi and Noongar people's connections to the land and their use of the landscape and various geological materials sourced from the southwestern part of WA was gathered from documents and academic thesis's written by Noongar scholars. This information is contained within the Murdoch University repository and South West Aboriginal Land and Sea Councils publications. National, state and local government resources including Trove, WA Museum, Wheatbelt NRM, were also reviewed to source Noongar language which was used to identify the geology, landscape features and rocks of the Southwest region documented in Chapter 4 section 4.3.3.

CHAPTER 4 Key Geotourism Resources

4.1 Introduction

Geotourism was defined by Hose (1995) as geology-based tourism designed to provide tourists with knowledge and understanding of the geology and geomorphology of a site beyond an appreciation of its natural aesthetics. During the last 22 years, the concept of geotourism has been broadened to include geoconservation, geoheritage, geodiversity and sustainability (Hose 2000; 2008). The National Geographic Society was the first to specify wider geographic perspectives, culture and aesthetics as essential elements of geotourism, defining it as

> *tourism that sustains or enhances the geographical character of a place – its environment, culture, aesthetics, heritage, and the well-being of its residents* (National Geographic 2005).

However, National Geographic did not stipulate geology in its definition. Later, Dowling (2013) and then Dowling and Newsome (2018) clarified the geological aspects by uniting the geological and geographical definitions, viewing geotourism as both a form of tourism and an approach to tourism. It has been proposed that geotourism is best interpreted through three fundamental components thus abiotic, biotic and cultural, which comprise the total human environment. Abiotic elements include geology and climate, how these elements shape a landscape and influence the plants and animals (biotic) which exist in the landscape. These factors, in turn, influence the Culture of people who inhabit the area (Dowling and Newsome 2018).

The following three sections the Lighthouse Hotel (4.2), Bunbury Basalt (4.3) and Karta/Kaart Koombarra (4.4) represent an investigation into three potential

geotourism sites in Bunbury and attempt to address two of Dowling and Newsome's (2018) fundamental aspects of geotourism namely the abiotic and the cultural components. The complex abiotic systems (geomorphological process) from which the feature stones (see sections 4.1.2, 4.2.2 & 4.3.3) at each site originated and the eon or era (representing the deep time) in which they were formed, and the landscape or landform (source) that they came from are discussed under the headings of Site Description, and Geology and Geomorphology) (Table 4.1). A third subsection contains a cultural narrative which is connected to the geology of each site and this format is repeated for the key geotourism sites identified.

The cultural narratives begin with the memoir of Roman Kozyrski, a Polish post-war immigrant who arrived in Australia in 1948 and was instrumental in building the Lighthouse Hotel in 1972. The second narrative is an account of the journey by British lieutenant Henry Bunbury and Pindjarup Noongar man Nonangs overland to Geographe Bay in 1836, arriving in the Southwest region that would subsequently be called Bunbury. The concluding section (4.3), Karta/Kaart Koombarra (Marlston Hill), uses publications by Noongar people and archaeologists to bring to light to some of the connections between Noongar people and the geology and geomorphology of the Southwest region. Noongar and English language is used in this section to describe some of the landscape features of Bunbury and the Southwest region.

The aim of this chapter, therefore, is to indicate the abiotic and cultural scope of geotourism potential in the city of Bunbury and potentially for the greater Southwest region.

Table 4.1. Era, origin and processes which contributed to the formation of the stones from which the Lighthouse hotel was built.

Stone Type	**Source of the stones**	**Deep Time**	**Dynamic earth (Forms of geology)**	**Complex System (Geological Process)**
Ferruginous Duricrust	Darling Scarp	5.3—2.6 Mya Pliocene	Formation of ferruginous duricrust	Australia reaches the dry equatorial latitudes.
Laterite Profile	Darling Scarp	66—20 Mya Paleocene	Deeply weathered products of granite, dolerite and gneiss from the laterite profile.	Chemical weathering giving rise to complex clay, iron and aluminium rich duricrusts Australia drifting towards the equator, experiencing wet, subtropical climate.
Bunbury Basalt	Wyalup Beach Gelorup Quarry	Flow 1 130—137 Mya Flow 2 123Ma Cretaceous	Formation of columnar jointed basalt	Continental separation caused by tectonic plate drift to the north-east. Volcanic activity associated with the breakup of Gondwana and separation of India from WA.
Greenbushes Pegmatite	Greenbushes	2577 Mya Proterozoic	Deep crustal granite emplacement	Batholith emplacement associated with crustal plate movement
Logue Brook Granite	Logue Brook Dam	2612 Mya Archean	Deep crustal granite emplacement	An additional phase of magmatic activity and granite emplacement deep within the Earth's crust
Gneiss derived from the Balingup Metamorphic Belt (BMB)	Various mines and dams within the BMB	3200—2577 Mya Archean	Granite is metamorphosed into gneiss	Heat and pressure due to tectonic plate movement resulting in rock deformation
Granite from the western edge of the Yilgarn Craton in the vicinity of the Darling Scarp	Unwanted material from coal mines at Collie and other mines and dams within the BMB	3200 -2750 Mya Archean	The Yilgarn Craton represents an ancient crustal landmass up to 4000 Mya. The western edge is the youngest section of the craton.	The exact mechanism for the formation of the Craton remains unclear. However, granites are usually derived from batholith emplacement during crustal plate movement. Complexity is related to the amalgamation of different 'blocks' of crust and subsequent separation through rifting

4.2 The Lighthouse Hotel

4.2.1 Site description

The Lighthouse Hotel sits high on the crest of a modified Holocene (0.01Mya) dune of Quindalup Sand (Anand and Paine 2002; Laliberté et al. 2012). The high vantage point, on which the hotel is located, affords views to the west towards the Cretaceous (130—137 Mya) Bunbury Basalt outcrop (Meffre et al. 2017), east across the Pleistocene (0.01—2.6 Mya) limestone-based Spearwood Dunes and the older Bassendean Sand (Gozzard 2007) and still further east to the Darling Scarp and the western edge of the Archean (2500—-4600 Mya) Yilgarn Craton (McArthur and Bettenay 1974). Inspired by this landscape, builder Roman Kozyrski incorporated stone from some of these locations to showcase the *Best of the West* in the hotel complex that he envisaged in the early 1970s (Wallace 1985). The imposing retaining wall upon which it sits is predominantly made of the indurated weathering products of granite and gneiss (Table 4.1). This material in Western Australia is commonly referred to as ferruginous duricrust, the geology and geomorphology of which is discussed later in this section. (Figure 4.2.1).

Figure 4.2.1. The Lighthouse Hotel, featuring the rubblestone masonry and Ferruginous duricrust of its retaining wall (foreground), ashlar stonework (top left) and arched window frame, reflecting 18th and 19th-century rustication techniques. Photograph by S. Richards.

4.2.2 Geology and geomorphology of ferruginous duricrust

The laterite profile from which ferruginous duricrust originates is found throughout much of South Western Australia. It is formed via a deep chemical weathering process of the gneiss and granite that comprise the geology of the Yilgarn Craton (Anand and Paine 2002). This deep, chemical weathering process began 66.0–56.0 mya in the Paleocene when the Australian continent was drifting north towards the equator. Climatic conditions during this period were subtropical, and the southwest landscape was dominated by rainforest. The formation of ferruginous duricrust began in the Pliocene era, 5.3–2.6 mya,

by which time Australia had drifted into the equatorial latitudes and was experiencing warm, arid weather conditions (Table 4.1) (Pernreiter et al 2018). Exposure to both wet and dry climatic conditions over millions of years has established a well-developed laterite profile in the South West (WA) region (Anand and Butt 2010; Wells et al 2019).

The section of laterite profile which is displayed in the retaining walls of the Lighthouse Hotel is an iron and aluminium oxide, rich product found in the uppermost part of many laterite profiles (Eggleton 2001). Ferruginous duricrust, colloquially known as 'hard cap' due to it being extremely hard, caps the laterite profile (Wells et al 2019; Anand and Butt 2010). Iron, aluminium and clay materials have been cemented by repeated cycles of wet and dry conditions over millions of years to form ferruginous duricrust. Wormlike voids, lenticular cavities and nodule formations are visible within the orange and red duricrust of the Lighthouse Hotel. These worm-like, geode and pisoidal shapes are formed during the weathering process when water seeps down through decaying plant roots and leaches into the laterite profile (Eggleton 2001).

4.2.3 Roman Kozyrski and mid-century modernist architecture

The story of the builder, owner, and manager of the hotel, Roman Kozyrski, is as interesting and varied as the architectural legacy that his foresight bequeathed the city of Bunbury. Kozyrski, a Polish immigrant from Lubatrof, came to Western Australia at the age of 29 in 1948. Under the terms of the Immigration Act 1901-1940, he was required to work for the Australian Government for two years. Although he had no prior experience in construction Kozyrski was sent to Collie, WA to work as a concrete labourer for the Public Works Department, where his ability to speak English gained him a senior position as an interpreter within a work gang of ten other Polish migrants. After his government service in

1950, Kozyrski began work at the Black Diamond and Ewington coal mines. Here he earned enough money to buy his first truck and began working as an independent contractor. By 1953 he owned 4 trucks and had 3 men working for him carting dirt from the open cut coal mines. However, the industry's move to underground mining, a reduction in coal production and a six-month-long railway worker strike (1952) forced him to him expand his focus. In addition to the earthmoving, he began carting timber from Northcliffe (WA). In the late 1950s, due to his son's respiratory problem, the decision was made to move his family from Collie to the coastal town of Bunbury. Here his earthmoving business flourished, and his company was responsible for the development of many roads and subdivisions in Bunbury and the greater south-west region (Wallace 1985; Memories of Bunbury 2019).

Kozyrski brought the land which the Lighthouse Hotel would be built on late in the 1960s, a former Boys Hostel (1949 — 1952) (Memories of Bunbury 2019). The Carey street site was ideally situated, overlooking picturesque Wyalup Beach to the west, the city of Bunbury to the east and Leschenault Inlet to the north. The foundations for the Lighthouse Hotel were laid in 1972 using stone sourced from local quarries (Wallace 1985; Memories of Bunbury 2019).

Designed by Perth Modernist Architect, Reginald Stuckey (Government Gazette 1970; Memories of Bunbury 2019), the architectural style of the Quality Lighthouse Hotel stems from the extensive use of the ancient masonry technique identified as 'Rustication' and the mid-century modern style of building design (Giorgi and Matracchi 2017). Rustication is the masonry art of building with raw stone. The technique has its origins in ancient Roman and Greek architecture, examples of rustication are evident in the Hellenistic Period (323 — 31 BC). Earlier examples are still visible in the original stonework of the Carcer Tullianum,

Rome (which is now the Mamertine Prison) (640—616 BC) (Trip Advisor 2019a; Kantor-Kazovsky 2011; Poppeliers and Chambers Jr 2003). Extensively used during the Italian Renaissance period (14th to 17th century), the purpose of rustication is to give a structure the appearance of huge strength and antiquity (Betti and Galano 2012; Kantor-Kazovsky 2011).

In the mid-18th century, rustication was adopted by American architect Henry Hobson Richardson (1838—1886), who used diverse architectural styles in his buildings (Meeks 1953). His inspiration came from distinct traditions such as the English Arts and Crafts movement and ancient Roman methods (Poppeliers and Chambers Jr 2003). Labelled as 'Richardson Romanesque' this architectural style was later to influence the renowned 20th-century architect, American Frank Lloyd Wright (1867-1959). Wrights 20th Century modernist school of architecture was based on the principle 'buildings should serve to honour and enhance the natural beauty surrounding them' (Biography.com 2019; Koning & Eizenberg 1981). This philosophy led to eight buildings designed by Wright, including the iconic Guggenheim Museum (New York), being listed by UNESCO World Heritage as cultural examples of outstanding universal value (UNESCO 2019). Wrights novel application of natural material with modern design techniques was the forerunner of the mid-century modern architecture style later reflected in the design of the Lighthouse Hotel (Fig 4.2.2).

The rustication technique and the Richardson Romanesque style are evident in many 20th century Australian buildings, evidenced by arched window frames and raw stone facia, however, this style of building design was not always compatible with Australia's harsh climatic conditions (Orth 1975). During the 1950 and 60s, internationally renowned

architect, Robin Boyd (1919—1971) adapted Wrights 20th century modernist style to suit Australian conditions. Like Wright, the use of hard-wearing, environmentally harmonious and locally sourced materials was integral to his signature style (Goad 2015). Boyd's design philosophy is reflected in architect Reg Stuckey's modernist design for the Lighthouse Hotel and encompasses owner/builder Roman Kozyrski's vision of building the Lighthouse Hotel as a showcase for the wealth of natural building resources available in the greater Bunbury region (Quality Hotel Lighthouse 2018; Memories of Bunbury 2019).

Figure 4.2.2 Richardson Romanesque style arched doorway featuring ashlar (finely cut) stonework and rubblestone (uncut stone) wall (right) of the Lighthouse Hotel. Photograph by S. Richards.

Composed of 12 500 tons of natural materials (Quality Hotel Lighthouse 2018), the Lighthouse Hotel is built using a combination of masonry techniques. The lower retaining wall was constructed using rubblestone masonry practices, whereby amassed rocks of granite, gneiss, ferruginous duricrust and basalt are cemented together to form a solid foundation. The external feature walls and arched windows of the hotel are examples of ashlar polygonal stonework, also utilising granite, gneiss ferruginous duricrust and basalt, the stone is planed level on three sides, with the external face left raw (Lucas 1982) (Fig 4.2.2).

4.3 Bunbury Basalt

4.3.1 Site description

Basalt is a fine-textured, iron-rich, grey/black coloured, igneous rock formed from volcanic lava flows which have cooled rapidly at or close to the Earth's surface (Geology.com. 2019). Visible from the Lighthouse Hotel, the original basalt quarry is located on Wyalup beach in Bunbury. Commencing in 1896, the quarry provided road and house building material for Bunbury and the greater Southwest region until it closed in the 1960s (Heritage Council 2018; InHerit 2017a). The basalt utilised at the Lighthouse Hotel was quarried from the Gelorup quarry located 8km south-east of Bunbury (Allerding 2019).

4.3.2 Geology and geomorphology

The origin of the Bunbury Basalt is thought to have been a hotspot which existed beneath eastern Gondwana before its break-up (130—80Ma) (Wilde 1999). The break-up of Gondwana led to the formation of what are now the continents of India and Australia, this major geological event is associated with the eruption of

the Bunbury Basalt (Mcloughlin 2001). There are two lava flows in the Bunbury region and both traverse in a south-easterly direction within the confines of the Bunbury trough (Table 4.1; Figure 4.3.2.) (Geoscience Australia 2019).

Rapid cooling of a first lava flow, estimated to be 130—137 Mya, resulted in the hexagonally jointed columnar basalt formations which are visible at Wyalup beach. Columnar jointing forms as a result of even cooling throughout the molten rock, contraction of the lava as it cools results in hexagonally shaped columns (Fig. 4.3.1). Small pocketed holes can be seen in the basalt where gas escaped during the cooling process (inset Fig 4.3.1).

Figure 4.3.1. Bunbury Basalt at Wyalup Beach showing hexagonal-shaped columnar jointing formed by the rapid cooling of volcanic lava and circular gas pockets (inset). Photograph by S. Richards.

The second lava flow occurred 123 Mya and basalt is still quarried from nearby Gelorup (Zuh et al 2009). The initial flow follows the Darling fault in a south-easterly direction through the South West to the coast at Northcliffe (WA) (Olierook et al 2016). The second runs parallel to the Wyalup flow, following a more serpentine route south before entering the Busselton fault (Fig 4.3.2).

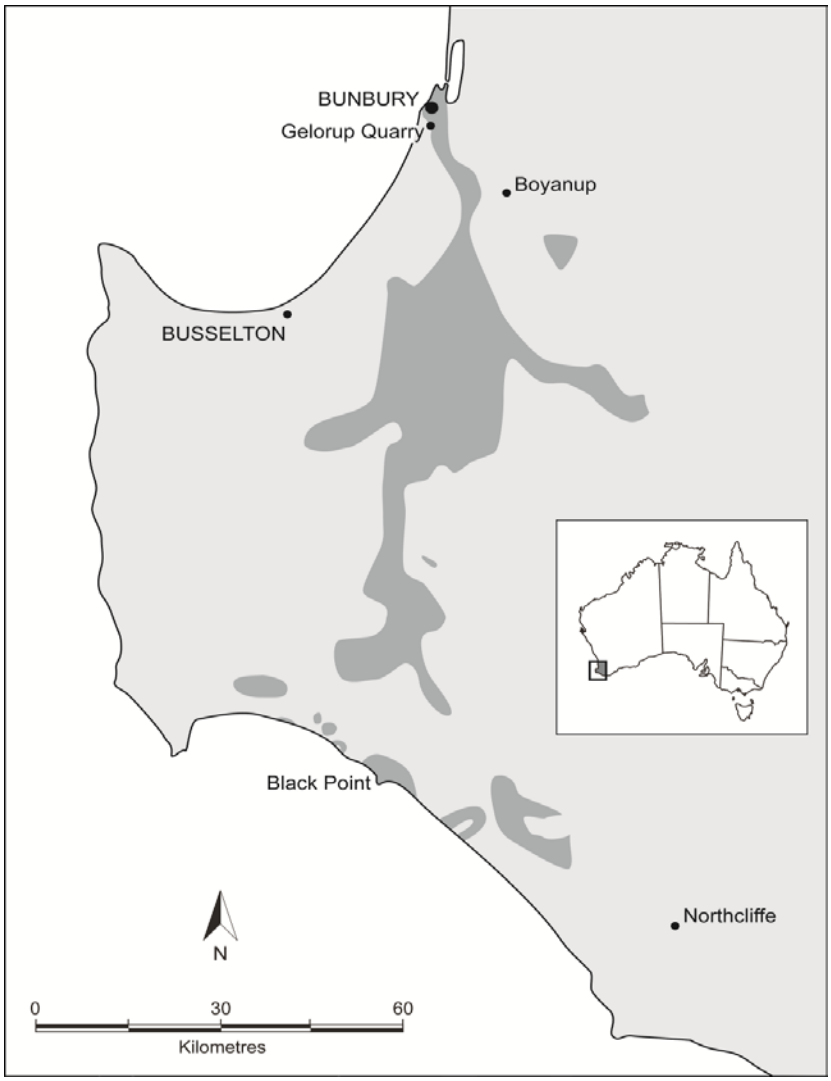

Figure 4.3.2. Map indicating the underground occurrence of basalt, and the location of outcrops at Bunbury and Black Point where exposures of columnar jointed Bunbury Basalt can be viewed.

4.3.3 Connection to culture: European settlement

French explorer Captain Nicolas Thomas Baudin anchored the vessel *Le Geographe* in what is now Geographe Bay in 1803. Baudin named the nearby Leschenault Inlet, Port Leschenault after the expedition's botanist, Jean Baptiste Louis Claude Theodore Leschenault de la Tour. In 1836 lieutenant Henry Bunbury, guided by Pindjarup Noongar man Monang, trekked overland from the Swan River colony to a small settlement at Vasse, near Wannerup Inlet south of Busselton. The purpose of his exploration was to investigate suitable locations for agriculture, roads, bridges and shipping. Bunbury's expedition returned to the Swan River colony via the west coast, spending time camping and hunting at Port Leschenault. He made note of the columnar basaltic rock extending to the sea, stating that he had seen no other sign of volcanic activity in the colony (Fig 4.3.3). In recognition of Bunbury's service to the government the Governor of the Swan River colony, Sir James Stirling, renamed the settlement 'Bunbury' (Trove 2020).

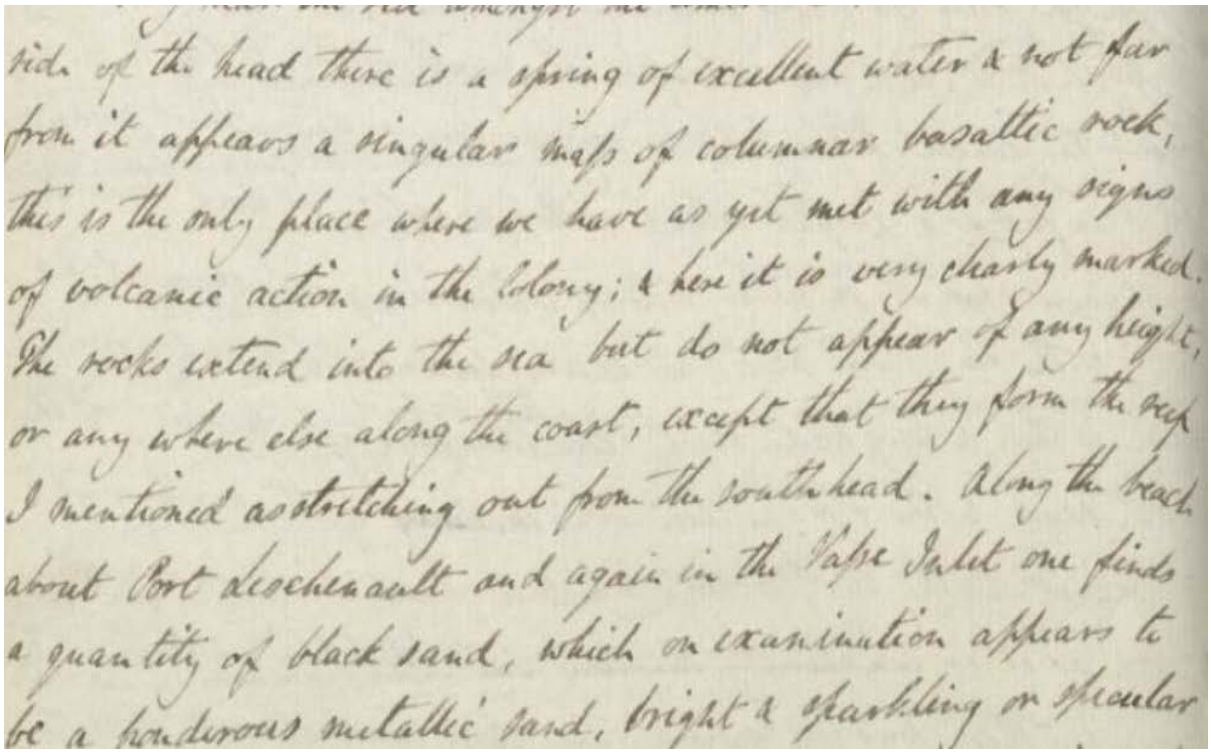
side of the head there is a spring of excellent water & not far
from it appears a singular mass of columnar basaltic rock,
this is the only place where we have as yet met with any signs
of volcanic action in the Colony; & here it is very clearly marked.
The rocks extend into the sea but do not appear of any height,
or any where else along the coast, except that they form the reef
I mentioned as stretching out from the south head. Along the beach
about Port Leschenault and again in the Vasse Inlet one finds
a quantity of black sand, which on examination appears to
be a hondurous metallic sand, bright & sparkling or specular

Figure 4.3.3. Extract from Lt. Bunbury's journal noting the columnar basalt at Wyalup Beach.

In 1897 renowned WA Government Engineer, C Y O'Connor, recommended Basalt from the original Wyalup Beach quarry to be used as the foundation stone of the Bunbury breakwater which still protects Bunbury's inner harbour today (InHerit 2017). More recently a 26 m basalt waterfall was constructed at Boulters Heights in honour of the Queen Mother visit to Bunbury in 1966 (InHerit 2017). Several other examples of the basalt stones' utilisation can be found in monuments, walls and as sections of buildings throughout Bunbury including the basalt rock walls at the Paisley Centre and a rare example of a whole building constructed from basalt can be seen at Bungalow Cottage (Visit Bunbury 2018; InHerit 2017b; Bunbury Block Retaining 2015).

4.4 Karta/Kaart Koombarra (Marlston Hill)

4.4.1 Site Description (0.01mya Holocene —2800 mya Archean)

Located a short on the walk north of the Lighthouse Hotel are Karta Koombarra (Big Hill) and the Marlston Hill Lookout Tower which offers 360° views over the city of Booligup/ Bulligup/Bullyup (Bunbury) (Inherit 2017; Boorloo Boodja 2016). Looking to the yabini (eastern) bokadja/mumbakiy (horizon) a visitor can see, the mangin (western) edge of the Yilgarn Craton, defined by the Darling Fault and the escarpment of the Darling Range (Fig 4.3.2). Visible to the dorang (south) are the basalt formations at Wyalup beach (Rocky Point), the yulura (northern) vista encompasses Koombana Bay, the Teedemup area (North Beach) and the entry to the darbal/derbal elaap (Leschenault Estuary) (Boorloo Boodja. 2016; Wheatbelt Natural Resource Management 2010).

Figure 4.4.1 View of Koombana Bay from Karta Koombarra, the western edge of the Yilgarn Craton is visible in the distance. Photograph by S. Richards.

4.4.2 Geology and geomorphology of granite and gneiss from Leschenault Inlet to the Darling Range.

The geology of the Yilgarn Craton is complex, comprising distinct types of granite and gneiss derived from the deep intrusive igneous activity and altered into various gradational types by regional metamorphism (Table 4.1). These rocks are also intruded by younger igneous rocks mostly dolerite. The granite rocks of the Yilgarn Craton began to solidify 3700 Mya and now form the eastern horizon of most views from Bunbury. The part of the Yilgarn Craton called the South West Terrane is dated to between 3200 and 2600 Mya and is defined by the Darling Fault and the escarpment of the Darling Range (Cassidy et al. 2006; Moles et al. 2019). Part of this terrane now comprises the Balingup metamorphic belt (BMB 3200 — 2800 Mya; Moles et al. 2019) which is located east of Bunbury and is formed by the deformation and metamorphosis of the older rocks and

emplacement of the youngest granite on the western margin of the Yilgarn Craton between 2800 and 2600 Mya (Cassidy et al. 2006).

Within the BMB are the black and white porphyritic Logue Brook Granite (2612 Mya) and the coarse cream or pink pegmatitic granite (2577 Mya) of the Greenbushes area (Myers 1997; Wilde and Nelson 2001; Jahns 2007). (Figure 4.4.2).

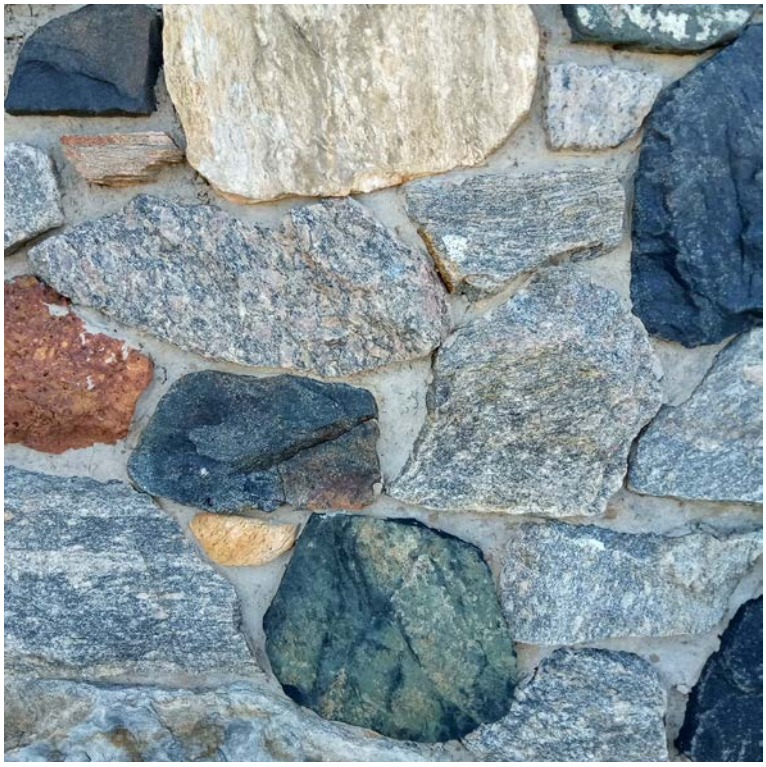

Figure 4.4.2 Section of the Lighthouse Hotel rock wall displaying basalt (fine-grained black rocks with no crystals discernible to the naked eye) and granites, some of which have been altered into a mild banded arrangement of minerals as a result of metamorphism. Porphyritic granite (centre left above the basalt) shows large pink crystals of orthoclase feldspar. Photograph by S. Richards.

Although the external appearance of granite and gneiss is similar, and their mineral composition is virtually identical, closer inspection of the gneiss reveals black (Mica), white (Plagioclase) and often pink (Orthoclase) mineral banding which distinguishes it from the granular appearance of granite. Granite and gneiss originate because of tectonic plate movement with granite forming deep underground. Crystals in granite are visible due

to the slow cooling of molten rock that originated at depths of 2-40km below the surface of the Earth. Due to realignment of the earth's crust associated with tectonic plate activity, the granite was subjected to intense heat and compression that resulted in deformation, recrystallization and foliation (layering) of the different minerals within the granite resulting in the formation of gneiss (Fig 4.3.2) (Myers 1997). Augen gneiss is one example of metamorphoses of porphyritic granite. It is visible as distinct, white, eye-shaped quartz set in the blue/grey banded gneiss (Fig 4.3.3) (Wilde and Nelson 2001).

Figure 4.4.3. Gneiss in the Lighthouse Rock Wall. Note the banded texture of the rock. Metamorphic alteration of porphyritic granite has resulted in the formation of Augen gneiss. Photograph by S. Richards.

4.4.3. Connection to Culture: Elaap Wardandi Noongar people's connections to Booligup/ Bulligup/Bullyup (Bunbury) Boodjar (country)

The Wardandi Elaap people belong to the Noongar nation, a collection of fourteen Aboriginal cultural groups who occupy land ranging from Jurien Bay in the north of WA, east to Moora and following line south-east to the coast near Esperance (Lullfitz et al 2017; South West Aboriginal Land and Sea Council 2016). Noongar people have lived on this boodjar for at least 48,000 years (Lullfitz et al 2017).

> *Elaap culture is about reading and participating in the language of landscape. People are known by the features of their home-place, for example, Derbalung Noongar (estuary people), Bilgur Noongar (river people), or Buyungur Noongar (people of stony ground or stony hills).* (Wooltorton, Collard, and Horwitz 2014).

In Noongar culture, there is a period of deep time called Nyitting, an extremely cold period which predates the most recent glacial maximum (24ka —18ka) (Veth, Ward, and Ditchfield 2017). During this period the WA coastline was located up to 40km west of where it is presently. The inundation of many traditional lands during the Mid Holocene warm period (6000 ka) (NOAA 2020) and the associated climatic changes create difficulty for archaeologists to piece together a precise understanding of coastal Aboriginal people's life and culture before 6000ka (Glover 1984). However, Noongar oral history and artefacts uncovered at Wadjemup (Rottnest Island) place Noongar people on that boodjar, before the Mid Holocene (Fig 4.4.4) (Dortch and Morse 1984; Moore 1842). Excavations at Devils Lair, a cave at Cape Leeuwin, south of Bunbury contain artefacts of quartz, bone and opal which date back 33 000 years. The opal is thought to have come from amygdales (mineral filled gas holes) in the Bunbury Basalt (Glover 1984).

BIDJIGURDU, *subst.*—An island. The natives have a tradition that Rottnest, Carnac, and Garden Island, once formed part of the mainland, and that the intervening ground was thickly covered with trees; which took fire in some unaccountable way, and burned with such intensity that the ground split asunder with a great noise, and the sea rushed in between, cutting off those islands from the mainland. This is a savage's description of an eruption of subterranean fire; and although there are not many indications of volcanic action in the neighbourhood, yet some recent observations of the officers of H. M. S. *Beagle*, during an examination of that part of the coast, and of the group of the Abrolhos Islands, would rather tend to confirm than to overthrow this opinion.

Figure 4.4.4 Exert from George Fletcher Moore's book Descriptive Australian Vocabulary detailing Noongar people's oral history of the inundation of the W.A. coast (1842).

According to modern geological theories the Leschenault Estuary system was formed in the Mid Holocene era (Wooltorton, Collard, and Horwitz 2014). However, many Noongar people believe that the landscape its bilyas (rivers) kattas (hills) and boordas (valleys) were created by the Waugal/Wogarl, a mythical serpent-like creature who is strongly connected to rivers, estuaries and rock pools throughout Noongar boodjar. Noongar clans have their interpretation of how the Waugal created the landscape. According to Nannup (2002), the hills and valleys first created by the Wogarl were then added to by a spirit woman who had gathered children in her hair to protect them. The children were plucked from her hair by coolbardi (magpie) spirits and rained down across Noongar boodjar, becoming stone when they hit the earth.

Stones of granite, gneiss and quartz have provided Noongar people with tools, shelter, food and water. According to Lullfitz et al. (2017), gnamma's (water-holding depressions in granite outcrops) were used by Noongar people as a water source and as a

lure to attract animals for hunting. The gnamma is formed in two ways, either along cracks or joints in the granite caused by chemical weathering (discussed in section 4.2.2) or small, rounded depressions become eroded by acid produced by decomposing vegetation. The process of cleaning rotting vegetation from the gnamma scrapped away decayed granite and over thousands of years, this process increased the gnamma's depth. Watershed at the base of the outcrops provides an ideal habitat for Quandong and Kurrajong trees to grow, providing fruit, wood and medicines to Noongar people. The habitat and fruit supplied by the trees also attract birds and other animals for hunting (Bindon 1997).

Tools for hunting and preparing food utilised granite, gneiss and quartz. Small depressions in granite outcrops were used for grinding seed and hammers were made from small granite pebbles. However, the extremely fine crystalline nature of granite means it does not flake to a sharp edge and therefore is not useful for making sharp tools (Bindon 1997). Archaeological exploration near Northcliffe (Fig 4.2.2) by Dortch and Gardiner (1976) discovered artefacts made from three varieties of quartz, gneiss and basalt, they observed the following;

> *Clear and milky white quartz was quarried from veins in the Pre-Cambrian rocks of the district or collected as pebbles from the beaches. Clear quartz crystals and a form of translucent quartz with a yellow tinge are also found on archaeological sites. The Aborigines made use of local gneiss, either in the form of beach pebbles or fragments taken from outcrops and including a form of highly siliceous gneiss resembling quartzite. Other stone used for tools includes amphibolite which occurs in the Archean metamorphic rocks in the north and east of the district (J. Clarke, pers. comm.), and a black glossy rock similar to obsidian which is found as vein filling in the basalt exposed at Cape Beaufort. There are relatively rare basalt artefacts, the nearest known source of this being Cape Beaufort. We have also collected a few pebbles and fragments of a whitish-grey quartzite which probably comes from local Pre-Cambrian rocks.*

European settlement caused critical disruption to Aboriginal people's traditional way of interacting with boodjar, traditions and languages were disrupted and, in some cases, destroyed. Many Aboriginal people were displaced from their traditional boodjar however, Dreamtime stories of Noongar people's culture are still held within the collective minds of many people. The landscape and stones of Booligup/ Bulligup/Bullyup and the greater dorang Mangin boodjar. (south-west country) embody spiritual, emotional and aesthetic values to Wardandi and Elaap people (See Table 2 for additional Noongar Language which connects people to landscape formations and culture).

Table 2 Noongar language for some geological formations of the landscape and traditional tools (Forster 2018; Woolarton et al 2014; Wheatbelt Natural Resource Management 2010).

Landscape formation	**Noongar language**	**Tool**	**Noongar language**
Rock	Booyee /Nyeedoup	Red Ochre	Wilgee
River	Bila/Bilya	White Ochre	Yoort
Bare Hill	Jindalee	Yellow Ochre	Yoont
Collie River near the mouth	Bila Borrigup	Language of Elaap people	Burong wongi
Preston River near the mouth	Bila Barajillu	Magic stone	Mobran
Hole in granite outcrop containing water	Gnamma	Hammer	Katj
Pool of water	Kep wari	Small axe	Kotj
Dirt/sand/clay	Yalya / yaly	Bone	Kwetj/djular
Cave	Yorakal/Kornt	Quartz for lighting fire	Bilying
Ground/earth	Budjar/budjara boodjar	Knife	Darp
Path/trail	Bidi	Flint spear	Djimbarl

4.5 Concluding remarks

Although the account of the geology of the Lighthouse Hotel and other sites provided here contains a brief scientific explanation of origin and context, we also

reiterate the aesthetic qualities of form and process (National Geographic 2005). The colours exhibited by the rocks are a function of reflectance, lustre and mineral form and subsequent weathering that has changed the chemical nature of the minerals. Oranges and reds in the duricrust are iron oxides, greys and whites in the gneiss are feldspars, and black rocks, such as the basalt, are rich in iron and magnesium. The form of the basalt as exhibited in hexagonal jointing shows structure and symmetry in the rocks. Gas holes in the basalt are expressed as pockets and cavities further adding to the aesthetic appeal and natural art of the rocks (Fig. 4.2.1). Recognising the natural aesthetic of the rocks is one of the first things that a visitor to the Lighthouse Hotel will appreciate. The geotourism connection is then the *why* and *how* the stones are like that. The science then can take us further into an appreciation of 'meaning' and the stories that the Lighthouse Hotel walls can reveal. Such stories include how geology and geomorphology inspired the building of the Lighthouse Hotel, how the presence of lateritic duricrust and basalt shaped how land could be used when farming and mining took place in Western Australia. There are cultural stories of the importance of granite outcrops and other high points in the landscape to Aboriginal people and of how the early European explorers, with the guidance of Aboriginal people, ventured into the interior, using granite outcrops as places to obtain food and water. These connections arising directly from an understanding of the geology of the stone wall are in line with the views of Pereira and Van den Eynde (2019) and Cooper (2019).

CHAPTER 5 Potential for geotourism product development in Bunbury and the greater South West region

5.1 Introduction

This study began by exploring the global geotourism phenomena via case studies of four diverse international urban geosites in China, Poland, England and Scotland. These studies not only presented multiple ways to interpret the natural geology of a city they highlighted the diverse forms of stone and landforms which offer geotourism values to a city. This knowledge led the author to seek a suitable site for the study of urban geotourism potential in Western Australia. The stone walls of the Lighthouse Hotel in Bunbury had previously attracted the attention of a recognised geotourism professional, Associate Professor David Newsome, who suggested they warranted further investigation as a potential geotourism opportunity. In addition to the identification of the geology and geological history of the stones contained in the mid-century designed walls of the Lighthouse Hotel, this thesis developed three cultural interpretations to showcase the influence that each type of stone has had on the people and heritage of the city of Bunbury.

The results of this investigation found that the city of Bunbury contains numerous geotourism products which are yet to be recognised. Exploring the geotourism and architectural values of the walls of the Lighthouse Hotel led to an investigation of associated geosites, including basalt quarries, a basalt waterfall, granite landforms and numerous stone buildings within the city which offer further geotourism products. The cultural narrative which flowed from each type of stone at the Lighthouse Hotel developed the connections between geotourism and the cultural heritage of Bunbury and the Southwest region.

To understand the geotourism potential that the stones and these cultural interpretations offer it is essential to first know who the audience for this category of tourism will be, and who is visiting WA the Southwest region and Bunbury? What is a visitor's reason or motivation to visit a geosite and participate in geotourism? How can geology be best presented to engage the visitor with the wealth of information that is generated from something that initially appears to be 'just a rock wall'? The answers to these questions determine the best way to present the geology of each site to give it meaning and significance to the visitor (Barrow 2013).

Five years of visitor research by WA Tourism (2020) shows that intra-state tourists consistently account for over 80% of the total visitors to Bunbury yet only 31% nominated sightseeing and 'looking around' in their top five leisure activities. International tourists, however, were far more inclined to 'sightsee/look around' (82%) and visit national or state parks (71%). Interestingly, neither intra-state nor inter-state visitors listed visiting national or state parks as a top-five leisure activity (WA Tourism 2020a). Yet a 2018 visitor expectation and experience survey of all visitors to WA found that 100% of visitors indicated WA's natural assets were their main reason for visiting and the favourite aspect of their trip. International visitors are slightly more (16%) interested in cultural, educational, or historical activities than other visitors (11%). Notably, 82% of visitors expressed interest in Aboriginal tourism however, only 26% participated. Of the 56% of people who did not participate in Aboriginal tours, half (23%) said they were unaware that any Aboriginal tourism experiences were available (WA Tourism 2020b).

Natural area tourism is a broad category which incorporates geotourism, ecotourism, wildlife tourism, and adventure tourism. The visitor focus when participating in these forms

of tourism is mostly the abiotic and biotic factors of a natural area (Newsome, Moore and Dowling 2013). Yet, Geotourism also includes cultural and urban elements, therefore the tourists' motivation and expectations from a geotourism experience can vary according to who is visiting the natural area (Dowling and Newsome 2018). McKercher (2002) identified five types of ecotourists and their motivations for visiting a natural site, this model has since been modified to identify types of geotourist (Table 3) (Dowling 2011; Dowling and Newsome 2018).

Table 5.3. Types of geotourists and their motivations to participate in geotourism.

Type of geotourist	**Motivation/Education**
Geo expert	Highly informed, professionals
Geo specialist	Highly informed about geology, but not the site.
Amateur geologists	Interested in geoheritage but not engaged in the field
Interested visitor	Not aware of the geosite before the visit but open to learning about geosites/geoheritage.
Aware visitor	More interested in visual/viewscapes than geology
Unaware visitor	No previous knowledge

Meeting the expectations of diverse types of geotourist requires a variety of interpretation methods (Dowling and Newsome 2018). Well-designed interpretive panels and brochures will contain a level of information to meet the educational level of geological information to inform most visitors. However, visitors who are classed as Geo expert, Geo specialist or Amateur geologist may require a depth of knowledge which can only be provided by specialist guides or guidebooks (Dowling 2011; Migoń and Pijet-Migoń 2017). The Geo expert and Geo specialist are also more likely to undertake international travel to visit specialised or unique geosites (Boley, Bynum and Nickerson 2013).

The type of interpretation available about a geosite can be determined by the location of the site and motivation of the visitor to obtain it. Interpretive panels erected at the geosite offer instant and permanent access to information, however, the depth of material presented can be limited by the size and design of the panel and they can intrude into the viewscapes of an area (Dowling Newsome 2018; Różycka and Migoń 2018; Newsome, Moore and Dowling 2013). Brochures and flyers are usually free and can contain greater quantities of information but obtaining them can be restricted by their availability or a visitor centre's operating hours. Availability of information is also a restriction when there is a requirement for specialised guidebooks. More recently mobile phone apps have been developed to present geotrails and their geology in an interesting, accessible manner, links to further detailed information are contained within such apps and this format meets the motivations and interests of a wide variety of visitors (Dowling and Newsome 2018). Dedicated geotour guides offer the opportunity for a very detailed geotourism experience but, the case studies of the HKUGGp, Wieliczka Salt Mine, and Arthur's Seat emphasise the importance of training and education to enable skilful delivery of geological interpretation which adjusts to visitors' diverse levels of geological knowledge is essential for a quality geotourism experience. The cities of Hong Kong, Whitby and Edinburgh also have visitor centres and museums dedicated to their region's unique geology and geomorphology and the cultures that stem from the geological landscape.

5.2 Stone Walls and beyond, opportunities for geotourism in Bunbury and the Southwest region

Although 100% of all visitors surveyed by Tourism WA (2020) found the State's natural assets the favourite aspect of their trip this is not reflected by the percentage of visitors to Bunbury who sightsee or visit the state or national parks in the Southwest region. The low

participation in these aspects of tourism by intra-state visitors can be explained by Butler's (1980) tourist area life cycle model which details five stages that a tourism destination experiences. He states that a tourist destination begins with an exploration of the site or region by a few visitors leading to the involvement of tourist businesses and development of the tourist attraction which then becomes a consolidated fixture, with the potential to lead to stagnation from generic, mass-marketed tourism arising from familiarity and lack of rejuvenation. It is at the point of stagnation that an area can decline or be rejuvenated (Butler 1980). Bunbury has been a popular summer destination for visitors since the late 18th century, however, after more than 200 years of tourism, it had reached Butlers 5th stage, stagnation, and required rejuvenation (Bunbury Historical Society 2020; Butler 1980; Transforming Bunbury's Waterfront, ND).

To enable the rejuvenation of Bunbury, the WA State government invested more than 30 million dollars in a three-stage project to transform the waterfront of the city, with a focus on reinvigorating tourism within the city (Transforming Bunbury's Waterfront ND). The redevelopment of the waterfront reinterprets the existing natural and constructed features of Bunbury and highlights the importance of informed interpretation of a region's attractions. In hand with the waterfront redevelopment, the City of Bunbury has rebranded as Bunbury Geographe and BunGeo, expanding the visitors gaze beyond the city into the Geographe region (Hospers 2011). Promotion of rejuvenated tourism in the region is presented as an 'audacious renaissance', promoting the 'undulating hills (and a mountain), fertile valleys and quaint towns' of the surrounding region (Visit Bunbury 2018). The geomorphology and geology of these undulating hills and fertile valleys are the sources of much of the stone and cultural heritage from which the city of Bunbury was built. Interpretation, identification and presentation are the keys to inviting the visitor to see beyond the surface of the viewscapes

and gain a deeper understanding and appreciation of not only BunGeo but the Earth (Dowling and Newsome 2018).

This research identified four opportunities to include and promote geotourism within the BunGeo region. Firstly, the connection of BunGeo's geology and geomorphology to Bunbury's well-established heritage trail offers multiple sites to expand the depth of heritage interpretation offered to the visitor. Presently the City's walking trail describes the purpose, architecture and the names of European settlers associated with many of the City's original buildings. Visitors have the option of participating in a guided tour or a self-guided tour, with free brochures available from the Bunbury Visitor Center (Visit Bunbury 2018). Learning about the type of stones that a building is constructed from, the region the stone came from, the age of the stone and the processes that created the stone is an opportunity to refresh and enrich the visitor's appreciation of the building (Górska-Zabielska & Zabielski 2019). Pereira and Van den Eynde (2019) also stress the importance of correctly identifying heritage stones in cultural tours and museums to advance the visitors understanding of geoheritage and cultural heritage. The concept of geoheritage walking trails which focus on building stones is familiar in Australia with self-guided geological and geoheritage walking trails established in Perth (2014), Brisbane (2012) and at Parliament House, Canberra (1996) (Dowling and Newsome 2018).

The second opportunity for the introduction of geotourism via the interpretation of building stones and landscape features is presented within the regional self-drive discovery trail dedicated to the working life of European settlers which encompasses thirty locations in the Southwest region. (Working life heritage trail 2014). Self-drive geotrails are a tourism highlight of the Murchison region of WA. The region features a network of geosites

including rock formations, mines, Aboriginal culture and even a meteor impact site. The self-drive geotrails enable visitors to experience the rich geological diversity of the region at their leisure and according to personal motivations (Australia's Golden Outback 2019). Self-drive geotourism trails are strongly recommended by Migoń1, Różycka1, and Michniewicz1 (2016) as a method to direct visitors to sites offering the best examples of a region's distinctive geology. Internationally, geotrails became recognised in the 1980s in the United Kingdom, their purpose was to raise awareness of how geological material has been used throughout time and to inform people of the Earths geomorphological processes and deep time required to create each type of stone.

Gaining international recognition of one or more of the stones that contributed to the heritage and culture of BunGeo presents the third opportunity to develop a geotourism product in Bunbury. Recognition of the links between cultural heritage and geology is a project being undertaken by the International Union of Geological Sciences (IUGS) which honours specific types of stone and their contribution to culture. (De Wever, Baudin, Pereira, et al. 2017). Examples of stone which have gained Global Heritage Stone Resource (GHSR) designation from the IUGS for their widespread use in human culture include Carrera marble from Italy and Portland stone from England (Global Heritage 2019). Within Australia Cooper (2019) advocated Adelaide Black Granite as a potential GHSR for its use in the walls and floors of Parliament house and extensive use in monuments throughout Australia and internationally. The requirements of the International Union of Geological Sciences (IUGS) for GHSR recognition include (Cooper 2019)

- historic use for at least 50 years;
- wide-ranging geographic application;
- utilisation in significant public or industrial projects;
- common recognition as a cultural icon, potentially including association with national identity or a significant individual contribution to architecture;

- ongoing availability of material for quarrying; and
- potential benefits (cultural, scientific, architectural, environmental and/or commercial) arising from GHSR designation.

Of the four types of stone used in the construction of the Lighthouse Hotel, Bunbury Basalt has the greatest potential of obtaining international standard meriting GHSR designation, as it meets all six GHSR requirements (Section 4.2 Bunbury Basalt outlines the details which make this stone's potential GHSR).

Finally, the geology and architecture of the Lighthouse Hotel lend themselves to becoming a geotourism highlight in Bunbury. By adopting some of the strategies used by geohotels in Hong Kong, such as including interpretive panels on the external stone walls, education of staff and in the production of geo-themed food, beverages and décor the Lighthouse Hotel could become the centre of geotourism for the BunGeo region.

These opportunities for traditional geotourism products if implemented in Bunbury and the Southwest region and will satisfy the motivations of diverse classes of geotourists. Additionally, including geoheritage information within existing urban and regional heritage trails via brochures and/or interpretation panels, will expand and refresh the heritage values of existing tourism assets. Thirdly obtaining GHSR designation for the Bunbury Basalt has the potential to attract dedicated international geotourists (e.g. Boley, Bynum and Nickerson, 2013). The results of this investigation into three of Bunbury's potential geotourism products, namely Laterite duricrust, Bunbury Basalt and Granite provide the basis for a selection of detailed guided tours.

5.3 Connecting Aboriginal cultural tourism with geotourism

To engage visitors with tourism it is essential to understand what sort of experience they are seeking from their visit. As previously noted, 82% of visitors to WA expressed an interest in participating in Aboriginal Cultural tourism but only 26% of people took part in a tour (WA Tourism 2020b; Ruhanen and McLennan 2015). Moreover, the finding that although 12% of people intended to participate in Aboriginal tourism but only 2% did reflects the disconnect between intention to participate and actual participation. Ryan and Huyton (2000) found that visitors with an active interest in Aboriginal Culture also have a strong interest in nature and adventure experiences, however, they report that not all visitors who experienced Indigenous tourism have an interest in Aboriginal culture, yet they do have a strong interest in nature, sightseeing and services.

A study of the demand for Indigenous tourism at the Grampian / Gariwerd National Park (GGNP) in Victoria by Espinosa, Fluker, and Jing (2016) found that connection with culture and land are the most important reasons for visitor participation. The second most important motivation was learning, particularly about 'Australian/Aboriginal culture/history'. The largest collection of Indigenous rock art in south-eastern Australia is located within the GGNP and visitors have the option of visiting the caves independently and/or participating in tours offered by the Brambuk Indigenous Cultural Centre. Interestingly, the rock art and guided tours were perceived by visitors as unique, and authentic, but the cultural centre was identified as a generic display of cultural artefacts, lacking in unique or endemic connection to the region. (Espinosa, Fluker, and Jing 2016). Amoamo and Thompson (2010) suggest that, within the Maori context, homogenised images limit the richness and diversity of the culture.

There are 40 Aboriginal Cultural tours offered by the Western Australian Indigenous Tourism Operators Council (Table 4). Most of these tours promote Dreamtime legends of how

Country was created and share elements of Aboriginal people's history and culture via tours to historical and/or sacred sites. Dreamtime stories tell of the creation of Country, of how geographical features of the landscape, the plants, and the animal came to be on the land. They are also the foundation for many Aboriginal people's spirituality and artistic inspiration (Nannup 2003). Natural geological highlights such as; caves, landscape, stone artefacts and tools are only mentioned by three of the eight Aboriginal Cultural tour operators in southwest WA. In other regions of WA rock art, caves, sand art, tunnel caves, gorges or fossils are mentioned in a quarter of all cultural tours (WAITOC 2019). Viewing a landscape through the lens of Aboriginal Culture invites the visitor to embrace the spiritual, artistic and emotional connections which can be generated when people belonging to Country (Gordon 2019).

Table 5.4 Regional breakdown of Cultural tours offered by Aboriginal people in WA.

Southwest	Perth	Wheatbelt	Goldfields	Coral Coast	Pilbara	Kimberley
8	6	2	3	1	1	19

Gordon (2019) also explores the diverse ways that "western" and "eastern and indigenous" cultures connect with the landscape and how both approaches bring meaning and value to areas of geological significance. The Hong Kong UNESCO Global Geopark (HKUGGp), China (Ch 2.2) adopts a holistic approach to geotourism incorporating cultural heritage and nature conservation along with 'western' science-based explanations' of the geology of the region, (Scottish Natural Heritage 2011; HKUGGp 2018). Geomythology examines western science and Indigenous knowledge to reinterpret the stories of Ancient cultures and folklore to give a greater cultural perspective on major geological events such as volcanoes or meteorite impact craters (Kirchner and Kubalíková 2015). Elements of geomythology can be seen in the exert from Moore's (1842) book regarding Aboriginal people's story of the creation of Rottnest and Garden Islands (Fig. 4.4.3). Geomythology

was used very successfully to engage visitors with geology in Whitby (Chapter 2), generating a biannual festival to celebrate the mythical vampire, Dracula.

This dualistic approach to geological interpretation, employing both scientific and Indigenous knowledge was investigated by Zeppel and Muloin (2008) who researched Aboriginal cultural interpretations of wildlife tourism within 33 zoos, wildlife parks and tours which were operated and managed by both Indigenous and non-indigenous groups. Zeppel and Muloin (2008) found that managers were inclined to focus on the scientific aspects of the tours such as biology and ecology, while family involvement, traditional uses and creation (Dreamtime) stories were a priority for Indigenous staff. Interpretations included the use of Aboriginal language and Dreamtime stories on signs, brochures and displays as well as verbal presentations. Although they found that Aboriginal cultural interpretation enriched the visitors' experience and importantly “Indigenous input has the potential to expand and alter visitor understandings of Australian wildlife”. Zeppel and Muloin (2008) agree with Amoamo and Thompson (2010) when they state that there is a greater emphasis on Aboriginal cultural practice rather than specific Aboriginal knowledge of the wildlife which they say may reflect a dilution of detailed Aboriginal knowledge.

A study of Indigenous tourism experiences in Australia by Holder and Ruhanen (2017) noted that the key aspect of cultural tourism is professionally qualified and educated guides. This is reflected in the preceding case studies (Chapter 2), which articulated that correctly trained and educated tour guides are a priority to facilitate the interesting and informative presentation of geology. Geotourism offers Bunbury and the Southwest region opportunities to expand the interpretation of existing heritage and Aboriginal cultural tourism through an

informed interpretation of the geology and geomorphology that influence many aspects of human culture (Dowling and Newsome 2018).

The cultural narrative presented in section 4.4, Katta Koombarra, discussed some of the strong ties between Aboriginal culture and the geology of Bunbury and the Southwest region. However, the scientific (western) interpretation of these connections within Aboriginal Cultural tourism is limited. With 360° views of Bunbury and the Darling scarp, the lookout tower at Katta Koombarra has an existing infrastructure for the installation of a series of interpretive panels. It is a prime site from which to engage visitors with Noongar Dreamtime stories of the scarp and Leschenault estuary and the geology and geomorphology of Bunbury and the Southwest region. There is further scope for Aboriginal Cultural tour operators to use western science to enhance visitors understanding of the significance of special cultural sites, stone tools or Dreamtime legends. A visitor may have a greater appreciation of a traditional stone tool or the ochre used in Aboriginal art when the geological aspects which make it unique to the region, such as the age of the stone, how the stone was formed, and the region of its origin is known.

5.4 Concluding remarks

Bunbury and the Southwest region have numerous geosites and geology focused products which offer several opportunities to promote geotourism either as a standalone tour or to give greater depth and significance to existing heritage and Aboriginal cultural tourism. Promoting the unique aspects of the geology, geomythology and geomorphology found in Bunbury and the Southwest region will attract a diverse range of geotourists to the region. Maximising visitor satisfaction with any geotourism experience requires appropriate

interpretation and educated tour guides. The walls and architecture of the Lighthouse Hotel are excellent foundations to build a dedicated geotourism facility from which to expand geotourism into Bunbury and the southwest region.

5.5 Further Considerations

The feature stones of this thesis, Laterite Duricrust, Basalt and Granite, account for a considerable amount of the southwest geomorphology yet, Tamala limestone (80 ka) which much of the southwest coastline is comprised merits further discussion, as does Donnybrook sandstone (144—132 Mya), which is a feature stone of many buildings in WA (Wilde. and Walker 1982). The abiotic and cultural aspects of the three stones were investigated as potential geotourism features of Bunbury but, the addition of the third 'ABC' of geotourism, the biotic will further enhance the range of geotourism opportunities (Dowling and Newsome 2018). The southwest of WA is a global biodiversity hotspot, due to the influence that geology has had on the development of many plant species, this merits further discussion through the lens of geotourism (Newman, Dixon and Ladd 2011). Additionally, many Aboriginal Cultural tours involve preparation of food, 'bush tucker' made from native plants and animals, providing an interpretation of the ways that geology and geomorphology influence the availability and habitat of different food sources is an opportunity to help visitors understand the depths of Aboriginal culture and connection to Country (WAITOC 2019; WA Tourism 2020).

Time and distance prevented the author from applying for approval from Murdoch University's Human Research Ethics Committee (HREC) to interview Noongar Elders. Therefore, all content regarding Aboriginal people, culture and language contained in this

manuscript is sourced from published material (Murdoch University 2018). Aboriginal people's history before European colonisation was passed to the next generations through stories, song, dance and art, for cultural, political and social reasons much of this history is not yet recorded or published and some cases have been lost forever (Zeppel and Muloin 2008). The cultural knowledge of some people from the Wardandi, Elaap and other Noongar clans regarding the significance of some of the geology and geomorphology of the Southwest region will be a valuable contribution to building the foundations of geotourism in Bunbury and the Southwest region.

There are 180 schools within a 2.5-hour drive from Bunbury and consideration should be given to developing geotourism interpretation to suit primary and senior high school children (WA Dept. Of Education 2018). Additionally, a site visit to the Bunbury Museum discovered that regional geology is under-represented within the facility. From a whole of state perspective, a network of geotrails, expanding on the existing Murchison network linking the Southwest, Wheatbelt, Goldfields, Pilbara and Kimberly regions is highly recommended.

CHAPTER 6 Conclusions and recommendations

The objective of this research was to investigate the geotourism opportunities presented by the building stones of the Lighthouse Hotel. Geotourism is a rapidly growing form of tourism which encompasses the abiotic, biotic and cultural elements of the Earth, it is distinct from Eco-tourism as it can be undertaken in urban and rural settings. To understand the diversity and scope of geotourism products and opportunities that may be available in Bunbury, four international cities with facilities, tours, museums and cultures dedicated to promoting their geodiversity were presented.

This report focused on the abiotic and cultural elements of geotourism contained within three types of stone present in the walls and foundations of the Lighthouse Hotel, and the potential they offered to the City of Bunbury as geotourism products. Initially, the abiotic factors of geology, geomorphology and deep time of each type of stone were identified. This led to further research to discover how the stones of the Lighthouse Hotel had influenced the cultures of diverse people in Bunbury and the Southwest region. Beginning with the history of post-war migrant and builder Roman Kozyrski and his quest to create a building that showcased the natural beauty of the Southwest region, the cultural influence expanded to include the history of mid-century modern architecture, ancient masonry techniques and the architecture of the Lighthouse Hotel. The source or point of origin of the Bunbury Basalt and the Granite stones at the Lighthouse Hotel expanded the Cultural narrative beyond its walls to Wyalup Beach (Rocky Point), Karta/Kaart Koombarra (Marlston Hill), the Yilgarn Craton and the Darling Scarp. Some of the significance, meaning and use that the stones had on/to European settlers and Noongar people were described to link local cultures with regional geology.

The stones and stories discovered were of great interest to the writer and experienced geotourists, yet to understand the geotourism opportunities they present to Bunbury tourism it is essential to understand who is visiting Bunbury and the Southwest region, will these products be of interest to them? Accordingly, who visits Bunbury, the classification of geotourists, their motivations and the level of interpretation each type of visitor required was discussed. Two factors stood out from this discussion, the first is that over 80% of visitors to Bunbury are from within WA, however, only 30% of the visitors state that sightseeing is a priority when visiting, secondly, 82% of visitors to WA who expressed an interest in participating in Aboriginal Cultural tourism only 26% of people took part. This suggested that reinterpreting tourism in the city and surrounding Southwest region is desirable to motivate visitors to reengage with local and regional assets.

Highlighting the abiotic and cultural features unique to Bunbury and the Southwest region through geotourism presents such an opportunity. Incorporating geology and geomorphology into existing urban and regional heritage walk and self-drive trails, rebranding the Lighthouse hotel as a dedicated geotourism destination and obtaining GHSR for the Bunbury Basalt were proposed. Additionally, if presented by a trained geoguide, or emphasised with detailed interpretation panels, there are numerous geosites within the city and the surrounding region which will be of great interest to all levels of geotourist.

The large disparity between a visitor's intention to participate in Aboriginal cultural tours and actual participation has been evident in Australia for over a decade. An argument has been presented that the western science of geology and geomythology can be used to

enhance the visitors understanding of the uniqueness of Aboriginal people's deep and longstanding connections to different aspects of Country. Implementing this concept within Aboriginal cultural tours of Bunbury and the Southwest region requires detailed consultation with the Noongar people who operate tours, and with elders from the Wardandi and Elaap communities and further research into the opportunities or consequences that geomythology presents to Indigenous tourism.

Visitor satisfaction surveys of existing heritage and Aboriginal cultural tours in the south-west offer the opportunity to gain insights into the ways that geotourism may enhance the significance and meaning of a visitor's experience. Further investigation to expand the inventory of geotourism products, including geosites, geomythology and geoheritage in the Southwest region are required to expand and refresh the focus and value of tourism in the southwest of WA.

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