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# Officers and learned gentlemen: the first investigations into the geology of New South Wales and Van Diemen's Land (Tasmania), 1788–1843

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**Abstract**. In the absence of qualified individuals in the newly founded penal colony of New South Wales, the first geological investigations were carried out by untrained persons and were driven by the urgent need to find raw materials for the building of houses and stores. The discovery of mineral deposits during the colony's early years were largely a matter of chance. The wide range of opportunities available in the growing colony soon attracted free settlers and long-stay visitors, some of whom possessed considerable geological knowledge. They recorded the results of their investigations in short publications which provided brief overviews of the geology in the areas they had investigated. In later years explorers traversed wide expanses of the country's interior and recorded aspects of its geology, leading, in one instance, to the preparation of the first comprehensive geological maps of New South Wales.

**Key words**: colonisation, amateur geologists, geological surveys.

## INTRODUCTION

In 1788, the *First Fleet* of 11 ships carrying more than 850 convicts, military personnel and officials arrived in Sydney Cove charged with the establishment of a penal settlement (Fig.1), (Phillip, 1789; Collins, 1798,1802). Except for the ships' surgeons, none among the new arrivals had qualifications in any of the sciences. In the early years after the colony's founding, it fell therefore to a small number of educated individuals, among them military officers and clergymen, to carry out the first surveys of the flora, the fauna, and the available mineral resources in the unknown land. The absence of a person with geological expertise was soon acutely felt when these inexperienced surveyors attempted to find limestone urgently needed for the building of houses and stores.

Repeated requests by the colony's first governors to authorities in London to send out someone suitably experienced in mineral prospecting were unsuccessful. Officials in the Colonial Office regarded the settlement primarily as a convenient destination for its convicts and seemed to give less thought to the potential of the distant land as a source of mineral wealth. However, before leaving England with the *First Fleet*, Lieutenant Watkin Tench remembered "to have frequently heard it asserted, that the discovery of mines was one of the secondary objects of the expedition." Referring to claims by several individuals in the settlements of "ore seen in many of the stones picked up here", he expressed his disappointment when he wrote: "I cannot quit this subject without regretting, that someone capable of throwing a better light on it, is not in the colony" (Tench, 1789, p.122).

However, it is possible that the authorities in London would have heeded the pleas of their representatives in the colony more speedily, had there been a ready number of persons with geological knowledge in the homeland who were willing to travel to New South Wales. At the time, no appropriate structured degree courses were offered at either of the universities of Oxford or Cambridge. Students may have attended geology lectures as part of a broader curriculum of studies in the natural sciences or in other subjects, an and may have added to their knowledge through studies in the field. Those who rose to eminence in the emerging science were according to Porter (1977, p. 132) "only marginally involved in the practical deployment of geology". Such tasks often fell to land surveyors, then commonly referred to as mineral surveyors or "practical men", who in the course of their work noted and recorded the succession of strata and their aerial extent, as well as the location of mineral deposits. Eminent among these was William Smith (1769–1839), who had started out as a surveyor and whose work led to the creation of the first geological map of England. He would later earn the epithet "Father of English geology".

Following reports of the discovery of significant deposits of coal and claims that iron ore had been found, English officialdom, in 1803, accepted that someone with knowledge in geology should be sent to the colony and report on these mineral discoveries. However, they did not choose to send a "practical man" from the small pool of experienced mineral surveyors, having formed the view that the task could just as well be accomplished by a knowledgeable mineral collector (Mayer, 2007, p. 335). In the event, the chosen candidate, A.W.H. Humphrey (1782–1829) made few contributions to the knowledge of the colony's geology and, after some years of service, resigned his position and retired to a farm in Van Diemen's Land (renamed Tasmania in 1856). The lack of geological expertise in the colony's early years prompted Vallance (1986, p. 155) to state that "the cause of mineral discovery in Australia

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**Fig. 1. Sydney Cove, 1788**

Oil Painting by Algernon Talmage, Mitchell Library, State Library of New South Wales, Sydney

during the 1790s, at least in information made known, seems to have been better served by the colony's relatively unsophisticated residents".

The growing prosperity of the colony in the decades that followed, based largely on its agricultural production and mercantile potential, brought increasing numbers of free settlers as well as officials to the colony. Some of these newcomers had at least a basic knowledge of geology and an interest in the country's natural history. They were among the first to make observations and to record their findings of the geology of coastal outcrops and the then accessible inland parts of New South Wales and Van Diemen's Land. Later, others would venture farther inland to examine the country's geology and to produce its first geological maps.

In this article I briefly describe the search for and discovery of essential earth resources, and early geological investigations, in the colony carried out by individuals who, although they lacked academic qualifications, were motivated, first by necessity, then by curiosity and a desire to discover the country's geological constitution. The self-tutored geologists whose work is discussed below represent a small number of a larger group of men whose pioneering work laid the groundwork for geological surveying in Australia. Only passing reference is made in this article to the seven French expeditions of discovery which visited Australia between 1792 and 1840. Their accompanying scientists and naturalists made important contributions to the early knowledge of the continent's geology (Mayer, 2009, 2023).

## FIRST GEOLOGICAL OBSERVATIONS AND SURVEYS

In the first weeks and months after the fleet's arrival in this unexplored land, scouting parties, consisting of naval officers, surgeons, and administrators, were sent out to assess the nature of the country along the shores of the settlement and in its hinterland (Fig. 2). It became quickly clear to them that the massive layers of sandstone, often rising as steep cliffs around the harbour they had entered, represented the predominant rock type of their immediate surroundings and the main lithology of what would later be named the Sydney Basin (Fig. 3).

During their forays into the interior, they traversed a wooded lowland, before any further progress was abruptly halted by the formidable barrier of the Blue Mountain range (Figs. 2 and 4). The mostly sandy soil they noted near their settlement did not hold out much promise for abundant harvests of vegetables and grain, nor, as they would soon discover, did the rocks of the surrounding region yield the material they were most in need of.

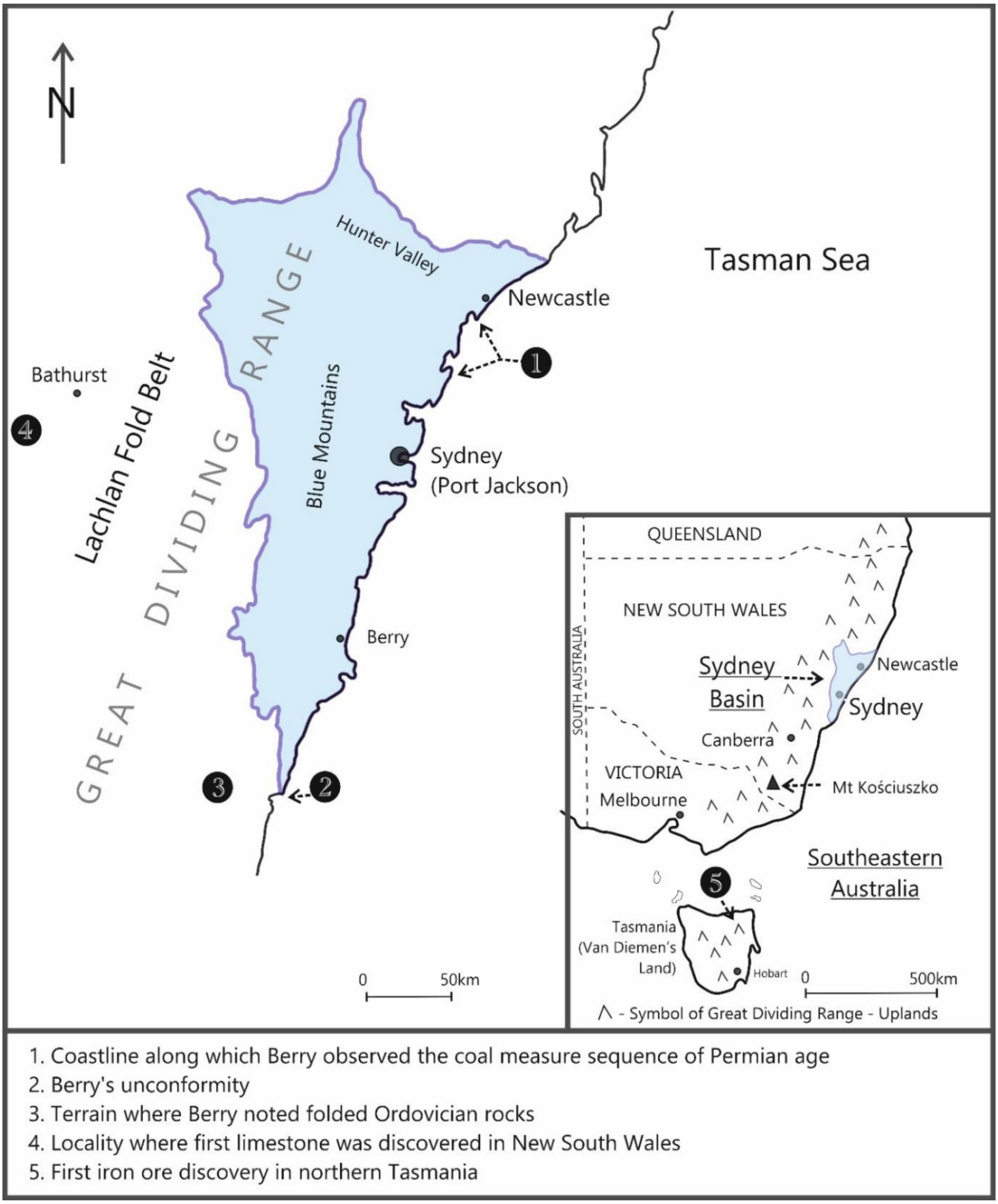



**Fig. 2. Outline map of the Sydney Basin and southeastern Australia**

**Fig. 3. Massive sandstone layers forming cliffs along the shores of Sydney Harbour**

Note: The then lieutenant James Cook named the harbour Port Jackson in 1770 but did not enter it. The name was used for many decades and was even applied to the settlement itself

**Fig. 4. View of the Blue Mountains, New South Wales**

The upland forms part of the Great Dividing Range which closely follows the eastern Australian coast and extends from Victoria through New South Wales as far north as Queensland (Fig. 2)

## MILITARY OFFICERS IN SEARCH OF LIMESTONE

Having arrived with a supply of provisions, though only sufficient to meet their needs for several months, the colonists' most urgent task was the building of houses and stores. Following the discovery of excellent clay for brick making, close to their settlement (Collins, 1798, p. 17), they were in urgent need of limestone to make cement. None among the exploring parties knew how to recognise this rock in the field. One or more of the *First Fleets*' eight surgeons may have been aware that the application of acid to the surface of limestone produced a reaction. Such information could also have been found in the pages of *Chambers Cyclopaedia* of 1787 or in an earlier edition, a copy of which may have been in the library of one of the ships. The entry under the heading 'Lime' states that:

**Fig. 5. Lieutenant Watkin Tench**

**Fig. 6. Lieutenant-governor William Paterson**

It may easily be determined whether a stone will calcine, by letting fall a few drops of aqua fortis, or any strong acid, on the stone, which will boil and dissolve a part of it, if the stone is calcinable; but will lie upon the stone, like oil, and not ferment, if it will not calcine (Chambers, 1787).

A ship surgeon's medical chest at the time held more than 50 pharmaceutical compounds. In addition to sulphuric and nitric acid – the former used in dilute doses to treat "malignant fever" – they included such staples as opium, calomel, camphor, castor oil, gentian, turpentine, vinegar, and wormwood (Keevil et al., 1957–1963).

When the marine lieutenant Watkin Tench (1758–1833) (Fig. 5) and William Dawes (1762–1836) set out in their search for this urgently required resource they carried with them what Tench described as a "chemical preparation" (Flannery, 1996, p. 230), probably a small bottle of sulphuric or nitric acid.

As the strata of the Sydney Basin includes no limestone, all their efforts were in vain. However, it was well known at the time that lime could also be obtained from the burning of seashells. The beaches around Sydney Harbour provided a steady but eventually inadequate supply of shells to meet the needs of the growing settlement. With this acute shortage in mind, the colony's new governor Phillip Gidley King (1758–1808) sent his deputy, Lieutenant-governor, Colonel William Paterson (1755–1810; Fig. 6), who was an experienced naturalist and a Fellow of the Royal Society, on an exploring expedition to the estuary of the Hunter River, the site of today's Newcastle (Fig. 2). His instructions were to pay particular attention to the occurrence of limestone or shells. A search of the river's estuary resulted in the finding an abundance of the latter. In a letter to King, Paterson had good news to tell when he wrote that, "the quantity of oyster shells on the beaches inland is beyond conception". The large shell middens he had found would guarantee an adequate supply of lime for the colony's needs for many years.

It was not until 1815, after a route had been found across the Blue Mountains, when the surveyor George Evans (1780–1852) discovered limestone cropping out on the banks of what is now known as Limestone Creek, near today's inland city of Bathurst (Fig. 2; Mayer, 2007). Further deposits on the western side of the Blue Mountains and closer to Sydney were soon discovered. However, the steepness of the terrain made the transport of the lime over of the range unprofitable and Sydney continued to rely on shell lime. The value of the commodity to the government can be gauged by it imposing a £5 fine for the illegal removal of shells from beaches. Parties setting off on exploring trips to the interior carried bottles of acid in their luggage in the hope of discovering limestone.

## COAL – AN ACCIDENTAL FIND

The first discovery of coal in Australia occurred in 1791 under most unusual circumstances. The convicts William and Mary Bryant, together with seven others, stole the governor's cutter and set off on a hazardous but successful voyage to Timor. Near today's Newcastle, they found "large pieces of coal", of which they "took some to the fire and they burned exceedingly well" (Branagan, 1972, p. 11). While the news of this accidental discovery did not reach the colony for many years, the presence of many coal seams in sedimentary strata along parts of the New South Wales coast would not long escape the notice of the colonists. Fishermen collected samples of coal to the north of Sydney, in 1796, while in the following year shipwrecked sailors brought back pieces of coal they had picked up on the coast to the south. Governor Hunter dispatched the surgeon explorer George Bass (1771–1803) to confirm the latter discovery. He reported the presence of an abundance of coal in cliff exposures (Vallance, 1975, p. 30), now included as part of the Permian Illawarra Coal Measures. Also in 1797, Lieutenant Shortland, in pursuit of escaped convicts, sailed into an uncharted river, since named after the then Governor Hunter, where he found large quantities of "good quality coal" (Branagan, 1972, p. 14). Colonel Paterson, in 1801, when in search of limestone and shells at the mouth of the Hunter River, had also noted coal seams and recommended the best sites for mining (Turner, 1982. p. 15). All these northern discoveries are now recognised as part of the Newcastle Coal Measures of Permian age.

Independent of the colony's government and its citizens, coal had been discovered in Van Diemen's Land as early as 1793 by the botanist Jaques Billardière (1755–1834), a member of the French voyage of discovery led by Bruni D'Entrecasteaux (1737–1793), which visited Australia in 1792–1793. Some ten years later a second French expedition in the two corvettes *Géographe* and *Naturaliste*, under the command of Nicolas Baudin (1754–1803), arrived in Sydney. Among its complement of savants were Louis Depuch (1774–1803) and Joseph Charles Bailly (1777–1844), graduates, respectively, of the École des mine and the École Polytechnique, and the first academically qualified geologists to visit Australia.

The former institution, founded by Louis XVI in 1783 and re-established after the Revolution in 1794, was one of the most highly regarded mining schools in Europe. Among its staff were the crystallographer and mineralogist René Haüy (1743–1822) and the geologist Déodat de Dolomieu (1750–1801). The lecture notes taken by Depuch's fellow student Jean Nicolas Brochin (1768–1833; Brochin, 1796), give an insight into Dolomieu's teachings on aspects of contemporary knowledge of geology as part of the three-year course.

Between 1796 and 1800, Bailly was a student at the newly founded École Polytechnique, where the main emphasis was the teaching of civil and military engineering. Bailly had chosen the latter stream but resigned from the military at the conclusion of his course. Jean Hassenfratz (1755–1827), who then was the county's inspector of mines and taught at both above institutions, was involved in the design of the curriculum's geology content with an emphasis on mines and mining and the building and maintenance of fortifications (Callot et al., 1993).

Depuch and Bailly discovered the first kerosene shale in the colony, in 1802, at the foot of the Blue Mountains. Knowing that the coal strata cropped out in both the Newcastle region to the north and in cliffs of the Illawarra district to the south and aware that the sandstone layers they observed dipped at a very shallow angle, they predicted that coal would be encountered in bores at no great depth below the surface of Sydney (Mayer, 2009, 2023). In their assessment of the region's geology, they were the first to infer the presence of a basin structure.

Small tonnages of the coal were soon mined from outcrops in the estuary of the Hunter River, and a settlement that was established there in 1801 grew into the town of Newcastle. The export of coal also started in 1801 with shipments to Bengal and to the Cape Colony. It was cheaper to send coal to these destinations from New South Wales than shipping it from England. Mining of coal at Newcastle on a regular basis did not start until 1804 (Turner, 1973). In future years the Hunter Valley would become one of Australia's major coal mining regions.

## IRON ORE

During their walks along the harbour shores, both convicts and their masters noted rocks with reddish-brown or ochrous coloration and assumed these to represent deposits of iron. The number of such discoveries in the Sydney region soon led to the belief among its citizens that iron was very common in the colony (Collins, 1798, p. 148). By the turn of the century, it had also become clear to authorities in Sydney that the colony possessed large deposits of coal, particularly in the area at the mouth of the Hunter River (Fig. 2). The availability of both coal and what was presumed to be iron ore in accessible areas, separated by no great distance, prompted suggestions that furnaces should be built to smelt the ore. Governor King's hopes of a major industrial development in the colony were however disappointed when, in 1802, he asked the visiting French geologists Depuch and Bailly to examine the ironstone. They concluded that it would "by no means yield a sufficiency of metal to make the working of it an object" (Mayer, 2011). The imagined iron ores were mostly limonitic coatings on sandstone.

Some three years later King sent Paterson to the northern part of Van Diemen's Land (Fig. 2) to establish a settlement. From there, Paterson recorded the finding of iron ore near his encampment. Several early proposals to mine the deposit were unsuccessful. It was not until the 1870s that mining commenced, only to be abandoned after some years as being unviable. The iron-bearing deposit was eventually identified as a covering of laterite over ultrabasic rocks (Mayer, 2011). It was not until the second half of the 20$^{th}$ century that large iron ore deposits were discovered and exploited in Western Australia, which made the country one of the leading exporters of the ore (Blainey, 1974)

## THE GENTLEMAN GEOLOGISTS

By the 1810s the settlement at Sydney Cove had grown into a small town and over the next few decades would become transformed into the thriving city of Sydney Town (Fig. 7). The increasing prosperity of the colony of New South Wales, which then also included Van Diemen's Land, the first settlement there being founded at what is now Hobart, in 1803, attracted many newcomers. Among them were clergymen, naturalists, and well-educated, often wealthy individuals with an interest in and with varying degrees of knowledge of geology. They surveyed and recorded the geological character of parts of south-eastern Australia and recorded their findings. The geological contributions of three of these gentlemen are discussed in the section below.

## THE CLERGYMAN

Thomas Hobbes Scott (1783–1860) was born near Oxford where he entered university in 1813 at the advanced age of 30 to commence theological studies. He graduated with a BA in 1817 and MA in 1819. He first came to Australia in 1819, as secretary to a commission of enquiry, which gave him the opportunity to travel widely in New South Wales and Van Diemen's Land and to observe the county's geology. He returned to England in 1821 and took holy orders. Three years later he was back in Sydney following his appointment as archdeacon of New South Wales.

It is likely that during his student days he attended the very popular non-curricular lectures given by William Buckland (1784–1856). Buckland had been appointed to the readership in mineralogy at Oxford University in 1813. Between 1814 and 1818 he gave annual lectures in mineralogy and geology in which he described the order of succession of geological formations that made up the structure of the earth, from the lowest to the highest and attempted to correlate the strata of England

**Fig. 7. Sydney in the early parts of the nineteenth century**

Drawing by Frederick Garling, from the collection of the State Library of New South Wales

with those on the continent (Rudwick, 2005, p. 539). He used the then current terms "Secondary" for mostly layered strata that frequently contained fossils and "Primary" for harder, less differentiated rocks found below the former (Rudwick, 2005, pp. 90–97). His lectures attracted audiences of between 30 and 60 men, most of them being graduates (Edmonds 1979, pp. 33–34). Their popularity attested to a wide interest on the part of attendees of mature age to hear about aspects of the new science of geology, which tended to conflict with religious doctrine (Edmonds and Douglas, 1976). Scott may have read the book on the same subject by Phillips (1775–1828; 1816), written for a more general readership but with content based on Buckland's lectures. Soon after his return to England, Conybeare and Phillips published their very influential book on the geology of England and Wales (Conybeare and Phillips, 1822) which would also have come to his attention. Although Scott did not mention either authority in his brief article, it is clear from his writing that he possessed a basic knowledge of mineralogy and geology.

In 1824 Scott published a short communication entitled, "Sketch of the geology of New South Wales and Van Diemen's Land" (Scott, 1824, p. 462), in which he provided a summary of the geology of the area around Newcastle, Sydney, including the Blue Mountains, and part of Van Diemen's Land. Scott's work as the right-hand man of the enquiry's commissioner, coupled with a busy travel schedule, would not have given him many opportunities to survey and study the colony's geology in any detail and to observe the superposition of formations at outcrop. Some of the statements in his account may have relied on information supplied by others and have contributed to some erroneous conclusions.

The clergyman appears to have been the first to acknowledge, in an English language publication, the wide distribution of the New South Wales coal deposits. He referred to them as "an uninterrupted series of coal measures", although they crop out for a considerably shorter distance along the New South Wales coast than he assumed. He was clearly unaware that some 20 years earlier the two visiting French geologists were better informed and reached more accurate conclusions (Mayer, 2009, p. 307).

Perhaps based on Buckland's references in his lectures to rock formations in Britain being correlatable with those cropping out on the continent, Scott may have assumed that such correspondences could also be applied to rock sequences in Australia. He identified, for example, the rocks forming vertical cliffs on the eastern side of the Blue Mountains (the Hawkesbury Sandstone of Triassic age) as Old Red Sandstone (Devonian). As the distinction between the Old and New Red Sandstone was still in doubt at the time, correlation with the latter (Triassic) would have been closer, although the marked difference in colour between the British and Australian formations should have made Scott hesitate before making the link. His comment on "primitive rocks" he observed on the western side of the mountains suggest that he considered them to underly the sandstones which form the greater part of the range. Following his examination of isolated geological outcrops in Van Diemen's Land he concluded that they were "conformable to that of the [Australian] continent" and therefore assumed that their coal deposits (Triassic) were age-equivalent to those he had observed on the mainland (Permian).

## THE SURGEON/MERCHANT/FARMER

Alexander Berry (1781–1873; Fig. 8) was a man of many parts. Born in Fife in Scotland, he studied medicine at St. Andrews University from 1796 to 1798 and at the University of Edinburgh from 1798 to 1801. After time as a ship's surgeon, he turned his sights to commerce and became a successful merchant, making several trading voyages. These activities brought him to Australia in 1807, where he set up a major mercantile enterprise and, on finding suitable land for farming to the

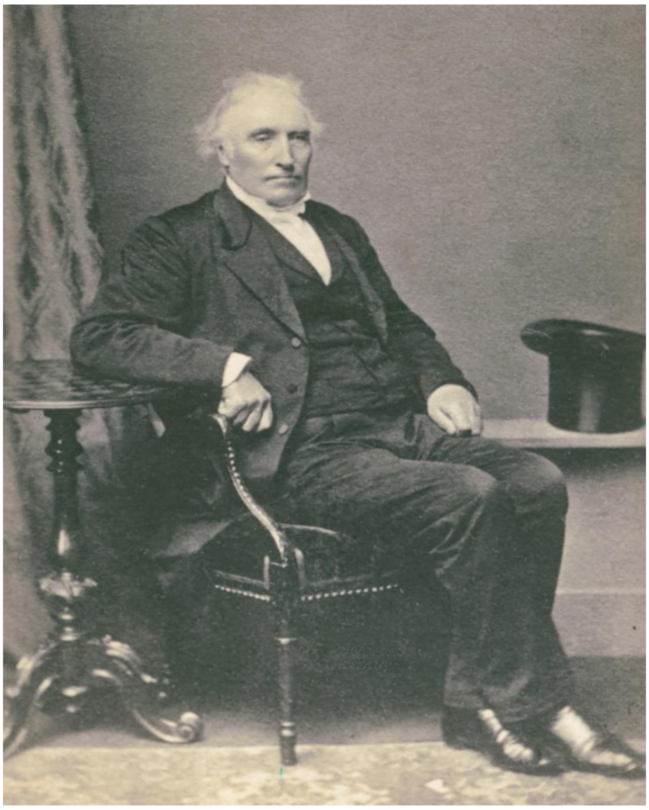


**Fig. 8. Alexander Berry**

south of Sydney, was granted a large tract of land where he eventually settled. The small town that grew up there now bears his name (Fig. 2).

Berry was a well-read man, having by the time of his death amassed a library of some 2,000 books. He had a particular interest in geology and spent much time in the field examining and recording the nature of geological outcrops, particularly in cliffs along the New South Wales coast (Fig. 2). He presented his thoughts and speculations on the geology he had observed in an address to the recently formed Philosophical Society of Australia, in 1822 (Berry, 1822, 1828), "the first geological work prepared and presented in Australia" (Vallance, 1975, p. 24). Unlike Scott, he made no attempt to equate the strata he observed with sedimentary formations in England but rather regarded the country's geology as new ground.

To the north of Sydney, Berry noted perpendicular cliffs of seemingly horizontally bedded sandstone and noted their regular thickness and siliceous composition. At intervals these gave way to gaps now occupied by sandy beaches and lagoons. It seemed to him that "at no very remote period" these openings "may have formed the entrance of bays and arms of the sea". This astute interpretation of the formation of coastal inlets (Fig. 9) made Berry the first to suggest that along this coast sea-levels had been higher in geologically recent times, an episode later recognised as the Holocene marine transgression in southeastern Australia (Murray-Wallace and Woodroffe, 2014).

As he was walking along the shores to the south of Newcastle, Berry was astonished when the horizontal sequence of sandstone and coal seams he had followed for many miles, were "abruptly terminated by suddenly bending downwards, and sinking below the level of the sea", (Fig. 10). Elsewhere along his coastal walk, it appeared to him that "the crust of the earth had been broken, and a bold and regular section forced upwards" (Fig. 11). These first sightings in the field, of minor folding and faulting in the Permian coal measures, provided Berry with proof of James Hutton's views that geological features underwent changes over long periods of time. It made him think that "Dr Hutton would have given much for a single day's walk along this shore. Here we see at one glance the progress of some of the most interesting operations of nature – the work of many ages" (Berry, 1822, 1828).

James Hutton's book, *Theory of the Earth*, (1788; 1795) can be regarded as laying the foundation of the emerging science of geology. In it Hutton proposed that the operation of continuous processes have led to gradual changes that shaped the earth over millions of years. Berry may have read the book during his student days at Edinburgh, Hutton's hometown, where his work was widely discussed in academic circles. The very large library Berry established at his country estate in New South Wales would most likely have contained Hutton's book, as well as Playfair's (1802) summary, which made the former's work more widely known.

**Fig. 9. Narrabeen Lagoon and inlet a short distance to the north of Sydney**

**Fig. 10. Closeup of Nobby's Coal Seam, on the coast to the south of Newcastle (part of the Upper Permian Newcastle Coal Measures), photo supplied by Christopher Morton**

Note that the nearby locality where Berry saw the coal seam "sinking below the level of the sea" is now covered by rock falls

**Fig. 11. The Upper Permian Newcastle Coal Measures, south of Newcastle**

Nobby's Coal Seam can be seen at its base, displaced by a normal fault. Photo supplied by Christopher Morton

Continuing his southward walk, Berry noted "highly indurated puddingstone", (Fig.12), and "petrifactions of trees and branches". The latter are the remnants of *Glossopteris* trees thought to have been snapped off near their base by shock waves from an erupting volcano (Fig. 13) and buried horizontally, as they fell, under a layer of volcanic ash (Fig.14) (Diessel, 2012, pp. 326–327).

On a later excursion, Berry noted that the sandstone strata extended from the coast inland to the Blue Mountains. He was unaware that the outcrops of the Permian layers he had seen near Newcastle (Fig. 2) were close to the northern margin of the Sydney Basin and did not perceive that they dipped at a very shallow angle of less than 5 degrees towards the south. In his travels he had therefore ascended the stratigraphic order and now found himself among outcrops of (Triassic) sandstone, the dominant rock type of the Sydney Basin. He also noted that "whinstone" (Tertiary basalt) overlies the sandstone in places.

A visit to an area south of Sydney presented him with further evidence of the transformation of rock sequences when he noted the now familiar near-horizontal beds he had previously examined in coastal outcrops to the north (Permian strata of the Sydney Basin) to overly a deformed succession of rocks (Late

**Fig. 12. Berry's "puddingstone"**

An outcrop of the Belmont Conglomerate Member part of the Boolaroo Subgroup of the Newcastle Coal Measures)

**Fig. 13. Base of a Glossopteris tree trunk felled by a radiating blast from the shock wave of an erupting volcano, n tuff of the Reid's Mistake Formation of the Newcastle Coal Measures**

Ordovician) with marked discordance (Fig. 15). He described the older rocks as greywacke, mica schists and slates, and very perceptively referred to them as the "basis of the country". Venturing farther inland, he noted beds and veins "twisted in all direction", in the deformed rocks and ascribed these features to their "exposure to intense heat". Berry's application of Hutton's concepts to rocks in Australia prompted Vallance (1975, p. 24) to refer to him as "as a professed Huttonian".

**Fig. 14. Fragments of Glossopteris tree trunks in a horizontal position in tuff of the Reid's Mistake Formation of the Newcastle Coal Measures; photo Pam Bannerman**

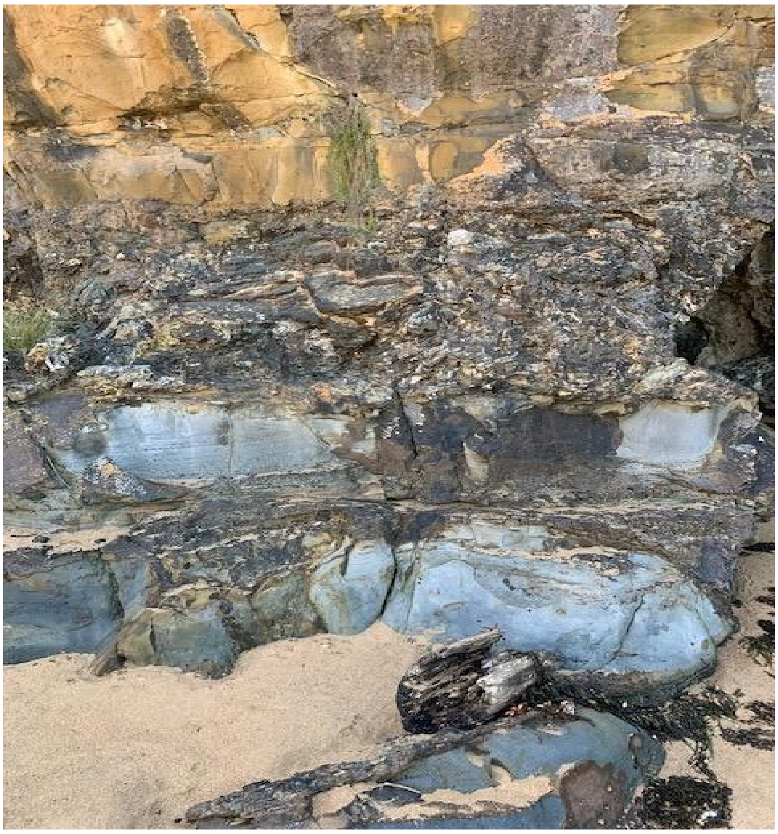


**Fig. 15. Myrtle Beach Unconformity**

The deformed basement rocks of Late Ordovician strata are overlain by Permian sandstones of the Sydney Basin. Note the breccia at the base of the sandstone layers, eroded from the Ordovician basement rocks following uplift

## THE EXPLORER/GEOLOGIST

The Polish explorer Paweł Strzelecki (1797–1873; Fig.16) was the first to make a detailed geological survey of large inland areas of southeastern Australia. Over a period of four years, between 1839 and 1843, he travelled mostly on foot in New South Wales, Victoria, and Van Diemen's Land, mapping their geological formations and collecting specimens. He recorded his findings on a series of geological maps and in a book (Fig. 17) published in London (Strzelecki, 1845), which was highly acclaimed at the time, and which would serve as a reference work for more than 40 years.

Strzelecki was born in Głuszyna near Poznań in Poland in 1793 to parents who may have been part of the Polish nobility – he sometimes placed 'de' in front of his name and in various counties he would later visit was referred to as Count Strzelecki. We know little about his education, but he does not seem to have received any formal training in geology and was most probably self-taught. According to Heney (1961) he may as a young man have visited the mines of Saxony which would have introduced him to Werner's scheme of ordering rock types into specific categories that also reflected their origins (Werner, 1786). Branagan (1986, p. 375) believes that this newly gained insight is evident in much of Strzelecki's geological writing.

After leaving Poland in 1829, Strzelecki travelled widely in Europe, North Africa, and the Americas. Little is known about how he spent his time in Britain, where he probably resided there during most of the years 1830 to 1834. His assumption of the title 'Count' may have given him ready entry into British Society and enabled him to meet people of renown in the sciences, including in the field of geology. He may have attended lectures on geological topics and would have familiarised himself with the current literature. He also appears to have visited Edinburgh where he would almost certainly have met Robert Jameson (1774–1854), the professor of natural history at Ediburgh University and a supporter of Wernerian ideas.

The succinct appraisal of Strzelecki by his niece, and first biographer, Narcyza Żmichowska, in referring to his stay in Britain as the period when, "the prince's bailiff, of dubious character, was made over into an English gentleman, into a geographer, an explorer and discoverer" (Żmichowska, 1876, p. 540; Heney, 1961, p. 40). The reference to the "prince" is a reminder that, when in his twenties, Strzelecki had worked as Prince Sapieha's estate manager in Poland. There can be no doubt, however, that when Strzelecki left England for North America in 1834, he did so with a sound knowledge of geology.

Information about his travels over the next five years, when he traversed the American continents from north to south and back, is rather sketchy. According to Heney (1961, p. 45) he carried out geological work in Canada, visited the mines at Minas Gerais in Brazil and the mineral-rich region of Mendoza in Argentina, and may have collected specimens for later sale. On his way to New Zealand and Australia in 1839 he stopped over in Hawaii and visited the volcano of Kilauea. Being asked by an American missionary to record his observation, he gave a detailed description of the forms of the lava flows and of the minerals that had crystallised following the cooling of the magma. In his account he

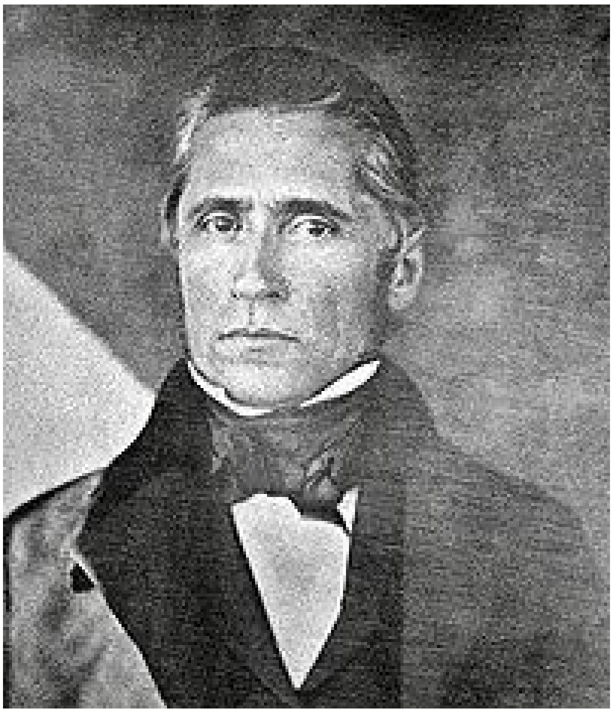
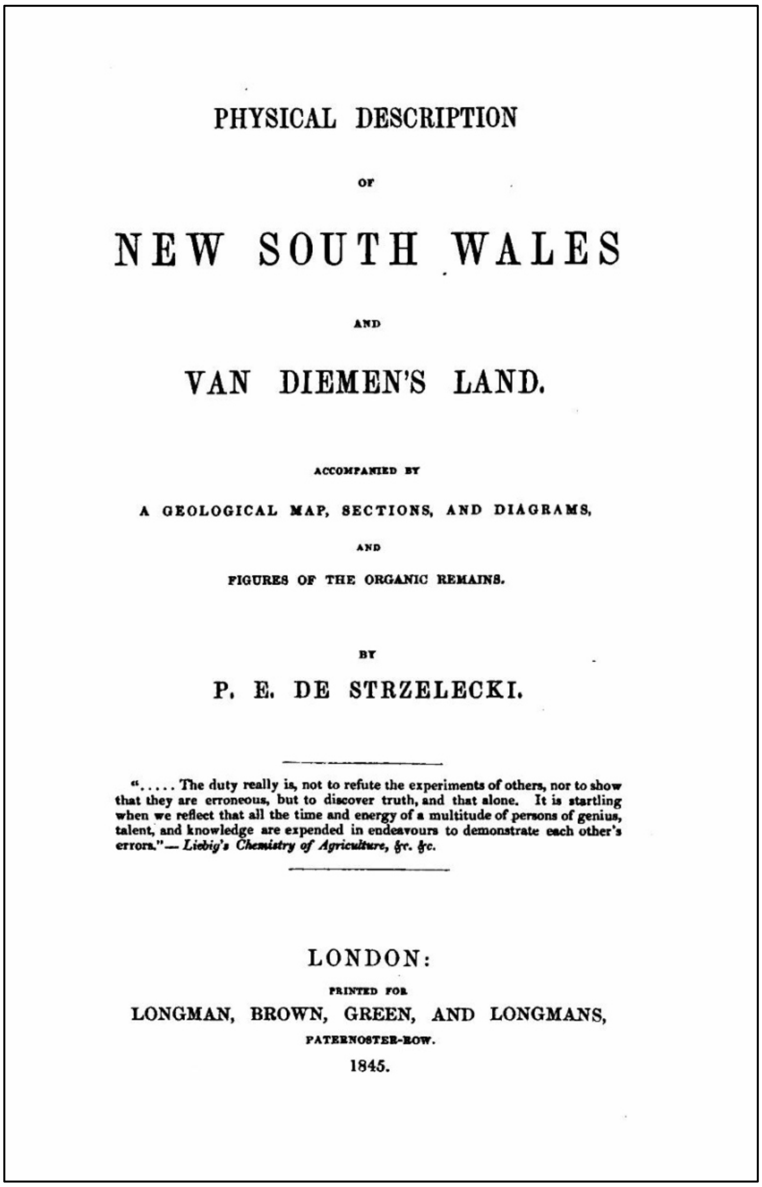


**Fig. 16. Paweł E. Strzelecki**



PHYSICAL DESCRIPTION

OF

NEW SOUTH WALES

AND

VAN DIEMEN'S LAND.

ACCOMPANIED BY

A GEOLOGICAL MAP, SECTIONS, AND DIAGRAMS,

AND

FIGURES OF THE ORGANIC REMAINS.

BY

P. E. DE STRZELECKI.

"..... The duty really is, not to refute the experiments of others, nor to show that they are erroneous, but to discover truth, and that alone. It is startling when we reflect that all the time and energy of a multitude of persons of genius, talent, and knowledge are expended in endeavours to demonstrate each other's errors."— *Liebig's Chemistry of Agriculture, &c. &c.*

LONDON:

PRINTED FOR

LONGMAN, BROWN, GREEN, AND LONGMANS,

PATERNOSTER-ROW.

1845.

**Fig. 17. Title page of Strzelecki's book published in 1845**

(https://books.google.pl/books/about/Physical_Description_of_New_South_Wales.html?id=pRgFAAAAMAAJ&redir_esc=y)

agreed with Sir Humphry Davy's view that the formation of volcanoes can be attributed to a central source of heat (Davy, 1828, pp. 241–250).

When Strzelecki arrived in Sydney in 1839, he brought with him a thorough background in geology and was well equipped to follow his declared ambition of conducting geological surveys (Mozley, 1964, p. 186). By chance he was joined in Sydney in the same year by two scientists with considerable training in the subject. The Rev. William Branwhite Clarke (1798–1878) had studied geology under Adam Sedgwick in Cambridge and emigrated to New South Wales to better himself financially and to improve his health. He was the first academically educated geologist to settle in the colony and would make major contributions to Australian geology over the next three decades (Grainger, 1982; Organ, 1990). James Dwight Dana (1813–1895) arrived in Sydney as mineralogist of the American Exploring Expedition. He was able to spend three months in New South Wales while the expedition sailed to Antarctica. He spent most of this time studying the sedimentary sequences of the Sydney Basin and was the first to attribute a Permian age to part of its coal deposits (Dana, 1849, p. 495).

Strzelecki seems to have met both Clarke and Dana only once. The occasion was an elaborate lunch hosted by Charles Wilkes, the captain of the American Exploring Expedition, in Sydney. The Polish explorer had just returned from an excursion across the Blue Mountains to Bathurst. In answer to their question on his impressions of what he had seen on his journey, he replied, according to Clarke, that "the geology of that country is very tame" (Clarke, 1839; Mozley, 1964, p. 186). In his book he would recall his initial disappointment with the geological nature of the land and the absence of mineral deposits when he wrote of a "scarcity of simple minerals … such as might have discouraged the most ardent and persevering mineralogist". But as his work progressed, he was able to state that "although the scope for extensive mineralogical research was thus narrowed, the country was soon found to present a vast field for a most exciting and interesting geological investigation" (Strzelecki, 1845, p. 51–52).

It is regrettable that there was no further contact between the three men, as they might have benefited much from sharing information. Organ (1990, p. 4) believes that Clarke "was something of a loner" and collaborated with few others, while Dana spent little more than three months in the colony. The fact that the trio conducted their fieldwork in different parts of the country did not help to facilitate meetings. Dana (1849), who did not publish the account his own geological surveys in New South Wales until some ten years later, referred several times to passages in Strzelecki's book, which had appeared in 1845.

Strzelecki spent much of the next four years engaged in surveying the geology of New South Wales and Van Diemen's Land. While essential supplies were carried by packhorses, he himself walked, and according to his estimate covered a distance of some 7,000 miles. The explorer later wrote that when he started his survey he had "entered eagerly on a geological examination of New South Wales" and that he had regarded it "as a *terra incognita*", and which he surveyed "without guide or guidebook". He added, however, "as I had not the good fortune to be acquainted with any of the previous observations upon the geognosy of the country" (Strzelecki, 1845, pp. 51–53).

Although he had already visited the Blue Mountains and seen the near-horizontal formations which form part of the Sydney Basin, Strzelecki appears to have started his survey to the west of the range. There he would have found the older, deformed sedimentary rocks, with a north-south orientation and the igneous rocks that intruded them, all part of the Lachlan Fold Belt of Cambrian to Devonian age (Fig. 2). He described the mapping technique he used as follows:

"The mode adopted in the inquiry was as simple as is the geological configuration of the country. From the circumstances of the masses of the strata assuming with few exceptions, a direction from NE to SW, the determination of their horizontal and vertical positions was accomplished by means of a series of zig-zag sections, made across the country, and by examination of the flanks of the dividing range, against which the different strata abutted" (Strzelecki, 1845, p. 52).

Strzelecki method of periodic zig-zag traverses would have been less time-consuming than that of following successive boundaries, a practice favoured by Murchison (1839) and his fellow geological surveyors, given the greater distances that would have needed to be covered in Australia when following successive formation boundaries.

When the explorer arrived in Van Diemen's Land he noted "such striking correspondence of parts of the explored tracts of NSW, that as I went on could not resist to extend my inquiry … and thus I joined that island and N–SW in one geological survey (Strzelecki, 1845, p. 52–53). He had correctly identified the southward extension of rocks of the Lachlan Fold Belt across Bass Strait to eastern Tasmania.

The plotting of the detailed information he had collected resulted in a geological map that was an astonishing 25 feet (7.62 m) long and 5 feet (1.52 m) wide. In colouring the map and sections he did not rely on conventional practice but, as he claimed, used "a novel method, not perhaps, as Montaigne says, "the best, but which is my own" (Strzelecki, 1845, p. 54). He employed four different colours in both dark and light shades, the dark version denoting the mineralogical character of the rock, the lighter colour its geological features. In addition, he used superimposed symbols "small distinct marks", to identify the lithologies within each major sequence (Strzelecki, 1845, p. 55). The map that was later published with his book has been reproduced in a much-reduced format and only shows the uniform colours for each of the epochs into which he chose to divide the rocks he had mapped (Figs.18–20).

In his *First Epoch*, the most extensive in terms of the area of the land its constituent rocks covered, Strzelecki placed "all the phenomena connected with the irruption of crystalline rocks amidst the submarine crust of the earth, by which a tract of land appears to have been raised, so as to preclude any further accumulation of marine deposits" (Strzelecki, 1845, p. 71). These included granitic rocks and the deformed unfossiliferous strata resting on them. They equate today to schists, as well as sedimentary and intrusive rocks ranging from the Proterozoic to the Devonian in age. He included in this epoch the rock units exposed in the Australian Alps, formed in large part of granitic rocks (Ordovician-Devonian; Fig. 19).

Strzelecki's *Second Epoch* comprised sedimentary rocks overlying those of the first epoch but including the remains of organic life. Many of the rocks of this epoch are now known to be time equivalents with those in the *First Epoch*.

Strzelecki recognised basin-shaped localities in which the strata of his *Third Epoch* were deposited (Fig. 20). These included the Permian Coal Measures and Triassic sandstones which now occupy much of the Sydney Basin (Fig. 2). As many of his field observations were made in the Newcastle area, he named it the Newcastle Basin. His geological map is the first that shows the outline of most of the Sydney Basin, the existence of which had been inferred as early as 1802 by the visiting French geologist and was hinted at by Scott and Berry and Bass.

Alluvial and beach deposits, at times stratified and loosely consolidated, as well as cave deposits, constitute his *Fourth Epoch*.

After completing the first part of his mapping campaign, that had taken him across southeastern New South Wales to present-day Victoria, Strzelecki had acquired a good understanding of the country's geology. He published a report of his surveys and his early thinking in instalments in the *Port Phillip Gazette* between 10 and 27 June 1840, reprinted in the *Sydney Morning Herald* on 19 August 1841. In mapping the rock sequences of this large area, he had recognised four age divisions. He would soon change the first set of names he had chosen for these divisions to a second version as follows:

Alluvial/Alluvial deposits
Secondary/New Red Sandstone Group
Transition/Transition Series
Primitive/Primary Series

The naming he had proposed clearly suggest a continuing attachment to the ideas of Werner (1786). It also gives a hint of his adherence to the view of world-wide sedimentation in the oceans, when he assumed a sandstone sequence in eastern Victoria to represent distant outcrops of the New Red Sandstone.

By the time Strzelecki returned to England, in 1843, Werner's system of classifying rocks and his views on their formation had few followers. There had been much progress in mapping strata and determining their relative ages. Geological systems in Europe were being formally recognised and named, and a time scale was taking shape. Strzelecki soon realised that it would have been impossible for him to assign with confidence all the strata he had mapped in Australia to the Systems, now Periods, that had been recognised in Europe. He therefore argued that the new terminology "… cannot as yet be applied to Australian rocks without involving questionable analogies …" (Strzelecki, 1845, p. 53). To overcome this problem, he devised


**Fig. 18. Geological map of Van Diemen's Land (Tasmania) including Flinders Island**

The legend for the four epochs proposed by Strzelecki is shown in the top left corner. North for all maps is approximately along compass bearing 070 (from the private collection of Piotr Krzywiec)

his own scheme and ordered the rock units he had mapped into four epochs "in the stratigraphic order in which they presented themselves to our investigation, beginning with those which belong to the remotest epoch" (Strzelecki, 1845, pp. 71–150).

Strzelecki's first epoch included the crystalline and metasedimentary rocks of his former Primitive category but now also contained the rock formations he had earlier assigned to the Transition, a term he discarded. He divided the Secondary category of one of his earlier schemes, assigning the fossil-bearing strata that cropped out in extended, often linear, outcrops to the second epoch and the strata deposited in basin-shaped structures to the third Epoch.

Other than giving credit to those who had first named rock types, Strzelecki rarely refered in his writings to contemporary or past researchers in geology or related fields. However, based on his description and interpretation of the geology of the country he examined, it is fair to assume that his reading on the subject was extensive, though perhaps somewhat selective, and that he had at least some familiarity with current thinking about the history of the Earth.

At the time Strzelecki was writing his book, two of the most widely known theories about Earth's history were those proposed by James Hutton (1795) and Georges Cuvier (1826). Hutton postulated that the processes that shaped the Earth occurred in a uniform, repetitive pattern, bringing about small incremental changes over the ages, a theory that later became known as Uniformitarianism. In contrast, Cuvier's theory, known as Catastrophism, claimed that the Earth has periodically been subjected to sudden violent events that have transformed and shaped its surface.

There is no indication from Strzelecki's writing that he was conversant with the work of Hutton, or if so, that he accepted its premises. He was however clearly familiar with Cuvier's theory of catastrophism. In the concluding remarks to his outline of the

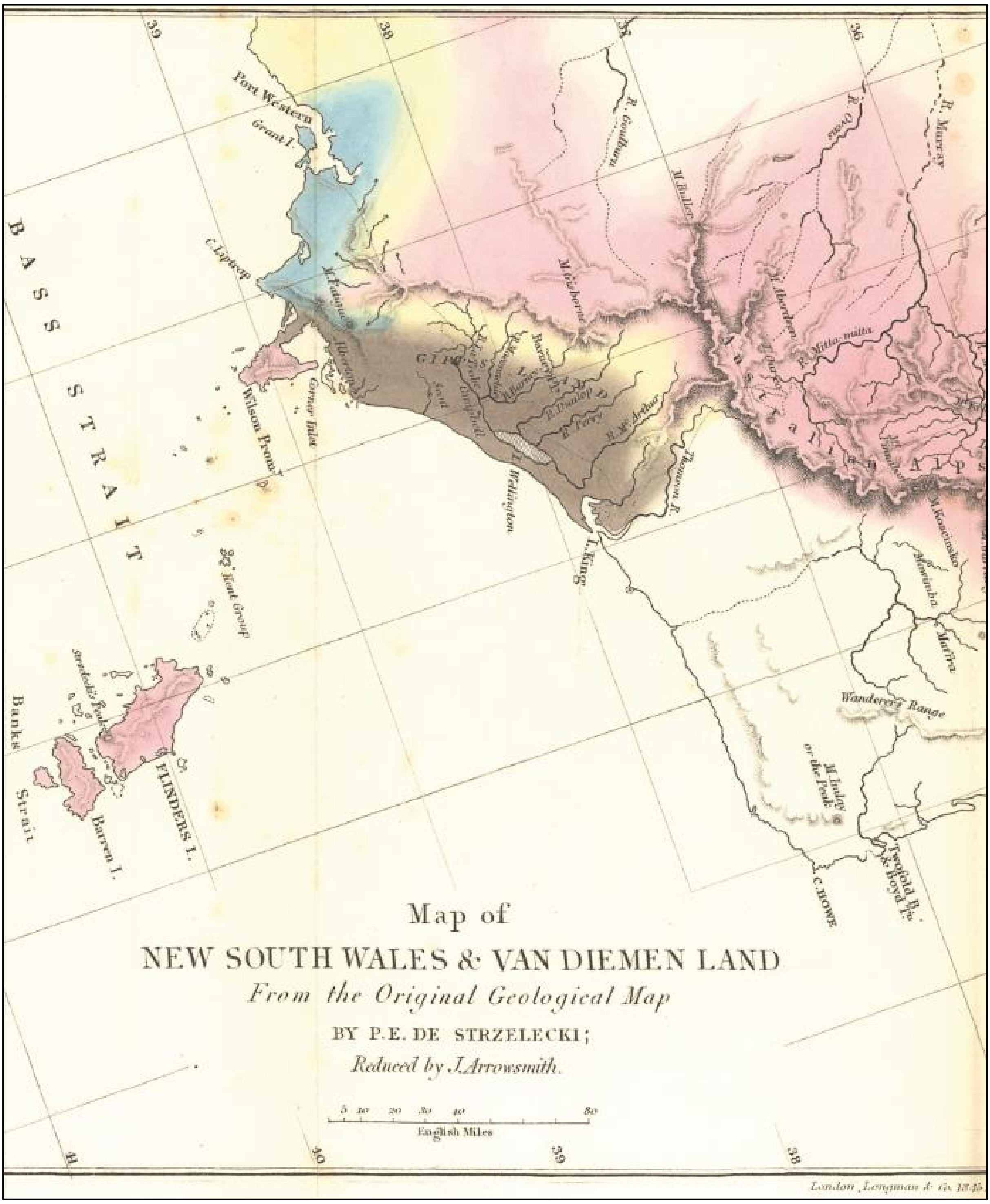



**Fig. 19. Geological map of part of southeastern New South Wales and Victoria**

Mt. Kościuszko in the Australian Alps is marked on the right side of the map (from the private collection of Piotr Krzywiec)

country's geology he states that: "The main phenomena are referrable to epochs of terrestrial revolution; some relating to periods marked by partial quiescence, and the deposition of sedimentary rocks; some to perceptible changes in the condition of the organic life inhabiting the sea; some others, again, to catastrophes which swept from the surface of the earth all its animal and vegetable kingdom" (Strzelecki, 1845, p. 70). However, as Vallance (1975, p. 32) has noted, while each of Strzelecki's epochs are "separated by a revolution", he does not consider it to be "Cuvierian catastrophism". What Vallance was probably referring to was Strzelecki's belief that catastrophic changes had occurred at specific times, while at the same time proposing what seemed to be orderly natural processes leading to the formation of the mountains.

In the synthesis of his geological survey of southeastern Australia, Strzelecki identified a continuous inland chain of mountainous terrain extending from Van Diemen's Land into New South Wales (the Lachlan Fold Belt; Fig. 2), composed of crystalline rocks at their base, and trending in a predominantly NE-SW direction. He regarded this "mountain chain" as the axis

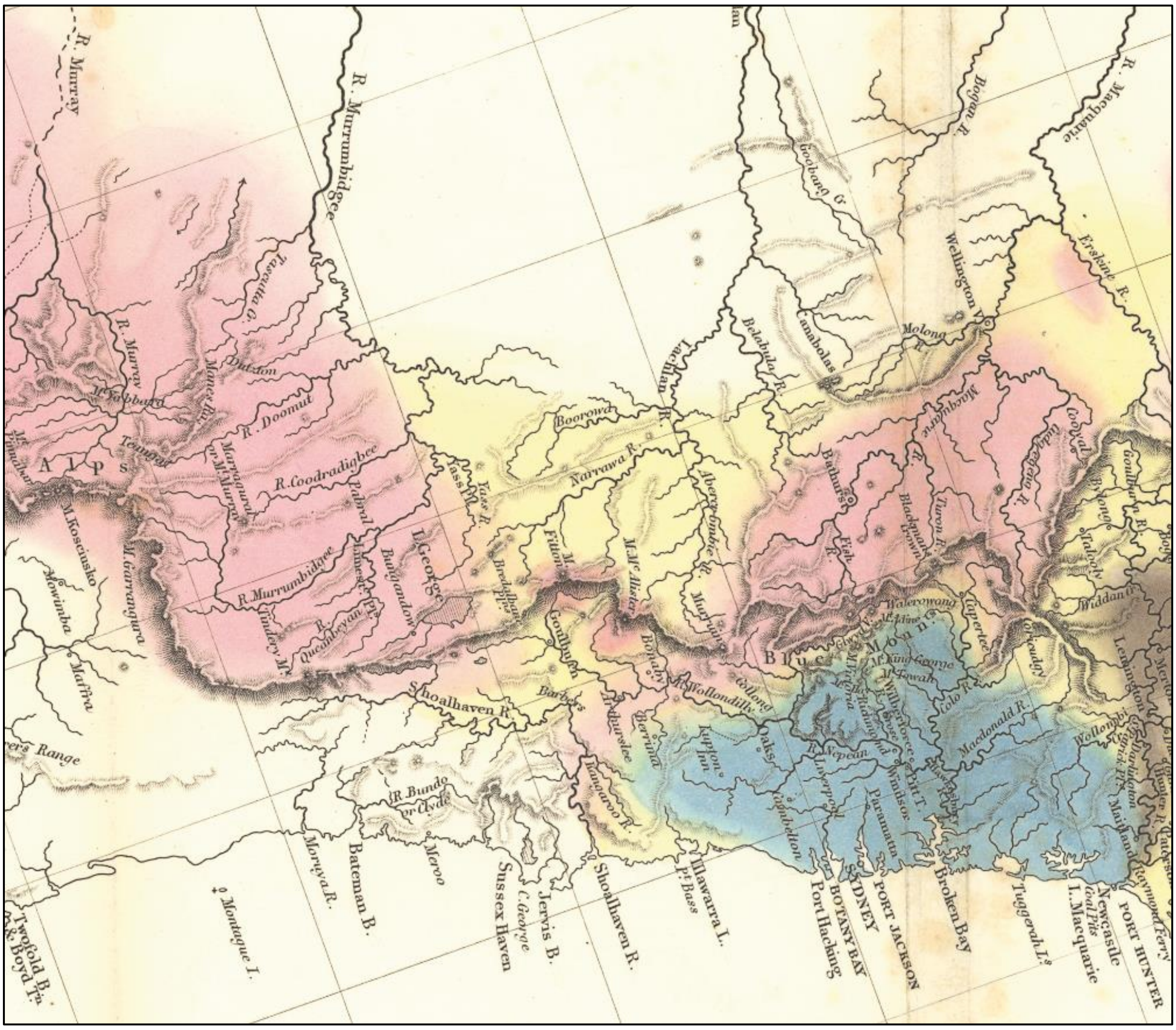



**Fig. 20. Geological map of the area from Newcastle in the north to Mt Kosciusko in the south**

The map traces the outline of the Sydney Basin in blue (from the private collection of Piotr Krzywiec)

of perturbation [disruption, disturbance] along which the ground was "up heaved". While this upheaval was "uniform in direction" … "the movement was not synchronous, on the whole line, but was exerted during four different and distinct epochs". He further contends that the differences in the height of peaks "proves that the uplifting movement was exerted with different degrees of intensity". Strzelecki's interpretation of the formation of the mountains by repeated uplift of the same chain in a linear direction and over intervals of time does not accord with the view of single and sudden chaotic events at unpredictable locations. Strzelecki described in some detail the volcanic rocks forming part of the rock sequence he had examined and believed that there was a connection between the "chain of mountains" and "a series of volcanoes … operating along a longitudinal fissure of the earth" (Strzelecki, 1845, pp. 150–151). He implied that volcanic activity was the driving force that had periodically elevated the chain of mountains.

As early as the 1820s Élie de Beaumont was carrying out fieldwork in the European Alps that would in time lead to the formulation of a new theory on the origin of mountains. In a talk to his colleagues, presented at the French Academy of Sciences in 1828, he presented a variety of evidence he had gathered in the Alps, including his conclusion that there must have been several episodes of mountain building over geologic time. In the following years, and after much additional fieldwork, he refined this concept but did not publish his work until 1852 (Élie de Beaumont, 1852). Knowledge of Élie de Beaumont's startling new ideas would have circulated widely in the scientific community, both in France and elsewhere in Europe. It is highly likely that Strzelecki had heard of his work, and it may have influenced, even encouraged, him to propose the formation of a mountain range in Australia that involved repeated upheaval of the land over geological time.

In his extensive travels across the interior of New South Wales, Strzelecki also entered territory that is now part of the state of Victoria. He named its fertile eastern region Gippsland after the governor who had facilitated his journey of exploration.

In the concluding remarks of his book's mineralogy section, Strzelecki strongly recommended the establishment of Geological Surveys in both Van Diemen's Land and in New South Wales. He made the point that these organisations should be conducted by the government and not by private individuals. Geologists carrying out surveys should be able to do so in an official capacity that would provide them with unrestrained access to the land (Strzelecki, 1845, pp. 156–157).

In his travels Strzelecki climbed Australia's highest mountain and named it Mt Kościuszko (Fig. 21) in honour of the Polish-Lithuanian national hero Tadeusz Kościuszko (1746–1817).

**Fig. 21. Mt Kosciusko, Australia's highest peak (2,228m), was named by Strzelecki**

He is also credited with the discovery of gold-bearing quartz in the interior of New South Wales, although others claimed to have done so before him. When acquainting Governor Gipps with his find, the latter was concerned that the news would cause unrest among the thousands of convicts in the colony and decided not to make it known. The rich goldfield was rediscovered some 12 years later.

Strzelecki's work in Australia has been recognised with the naming of several geographic features that bear his name. They are:

- The Strzelecki Ranges, in Victoria
- Mount Strzelecki, in the Northern Territory
- Strzelecki Peak, on Flinders Island
- Strzelecki Creek, in South Australia
- Strzelecki Highway, in Victoria
- Strzelecki Track, in South Australia
- Strzelecki Desert, in South Australia
- Strzelecki Scenic Lookout, near Newcastle in New South Wales

A statue of Strzelecki has been erected in the small town of Jindabyne in New South Wales at the foot of the Australian Alps (Fig. 22).

## CONCLUSION

For more than half a century after the founding of the colony of New South Wales in 1788, no one with an academic qualification in geology resided in this distant land and contributed to investigations of its geology. In the absence of such a person, the naval officers who traversed the ground around their settlement in search of urgently needed limestone deserve to be acknowledged as the country's first geological surveyors.

In the early years of the colony, life was precarious, with survival and the maintenance of order uppermost in the minds of successive governors. The search for mineral resources was not a priority of the local authorities nor of the colonial office in London. Discoveries of note, such as of coal deposits, were largely accidental. There was little interest in examining the country's geology until the late 1810s and 1820s, by which time the colony had become prosperous and well-educated individuals, some with a good knowledge of geology, spent long periods in the country or took up permanent residence. Their interest and curiosity were aroused by extensive outcrops of strata along seacoasts and by noteworthy geological phenomena farther inland. The records that observers such as Scott and Berry left represent the first informed descriptions of the country's geology.

Several members of expeditions mounted in the following two decades to explore the interior of the land made sketchy geological observations. However, it was Strzelecki who first recorded his observations of large regions on maps and produced a comprehensive synthesis of their geology.

The Polish explorer's suggestion that Geological Surveys be established was first heeded in the newly founded colony of Victoria. There, gold had been discovered in 1851, and a Geological Survey was established in the following year. Van Diemen's Land, which had become a separate colony, independent of New South Wales, in 1825, appointed a mineral surveyor in 1859. The mother colony of New South Wales lagged behind its offsprings when it founded its own Geological Survey in 1875.

Almost two and a half centuries have passed since the arrival of the Europeans at Sydney Cove in Port Jackson. The population of the tiny settlement has increased in that time from less than one thousand to more than six million. The shoreline of Sydney Cove where the first newcomers stepped ashore is marked on the wide pavement that encloses the Sydney Opera House (Fig. 23).

When dispatching successive fleets carrying convicts to New South Wales, officials in the Colonial Office in London saw no need to include scientific personnel among the ships' complements. They could not have foreseen the presence of the mineral riches in or on the ground of the new land, which have since been explored and exploited, contributing greatly to the wealth of the country and its people. Watkin Tench and his inexperienced team have in more modern times been followed by

**Fig. 22. Statue of Paweł Strzelecki in Jindabyne at the foot of the Australian Alps**

geological surveyors attached to surveys in every Australian state as well as to a federal agency. Every part of the continent and its islands has been mapped and the geology described in detail (Johns, ed., 1976). Alexander Berry would most likely be astonished could he hear that the Huttonian concepts he favoured and applied to strata on the coasts of New South Wales are still debated some 200 years later. Our present-day knowledge of geology and the processes that have shaped the Earth have greatly advanced in the intervening years, but it is sobering and perhaps instructive to reflect on the pioneering work of the much less informed early practitioners of the science.

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**Fig. 23. Sydney Cove in 2023 (renamed Circular Quay in the 1830s)**

The paved aera surrounds the Sydney Opera House on the left (not shown in the photo)

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