The quest for limestone in colonial New South Wales, 1788–1825

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Abstract: In the absence of people with scientific qualifications in the newly established colony of New South Wales, Australia, the search for essential commodities, such as limestone, became the task of a few educated laymen, which included military officers and surgeons. The first discovery of calcareous rocks was made in the colony's outpost at Norfolk Island, which was a boon to that settlement but of limited benefit to the larger establishment at Sydney. For many years the major supply of lime for building came from shells collected from beaches and Aboriginal middens. Attempts to cross the Blue Mountains, long unsuccessful, succeeded in 1813 and led to the discovery of significant deposits of limestone. They provided lime for the needs of inland towns but did not supply Sydney until after the introduction of improved quarrying methods, lime manufacture, and building of roads. The first geological observations in New South Wales were made by people with no formal knowledge of geology, who were motivated by the necessity to find basic materials essential to the success of their settlement. Their efforts provided a crude inventory of rock types, which was improved by contributions from occasional visitors with a scientific background.

Limestone was first discovered in mainland New South Wales in 1815, more than 27 years after the founding of the convict colony. The reasons for this long delay lay partly in the geologically unfavourable and topographically difficult terrain that surrounds the site of the first European settlement, and partly in the reluctance of the colonial power to send people with the relevant scientific knowledge to the colony. As a consequence, the first attempts to explore the unknown land for earth resources fell to the initiative of a few military and medical officers, who, at best, had only a rudimentary knowledge of geology. They were motivated, not so much by a desire to make scientific discoveries, but by simple necessity. As the years passed, a small number of travellers with a scientific education, some of them attached to expeditions of discovery, visited New South Wales, and provided preliminary scientific appraisals of its geology.

The main objective of the British Government in 1787 in sending a fleet of 11 ships, carrying more than a thousand convicts, military and government officials to the shores of SE Australia, was to establish a remote settlement for its convicts and thereby ease the pressure on its overflowing gaols and prison hulks. Being despatched with a finite supply of food, seeds, and a range of inadequate tools, it was expected that the land in which they were to settle would supply them with all the remaining necessities of life.

Assorted gentlemen in search of limestone

The new arrivals, in 1788, had fixed on Sydney Cove, in Port Jackson, to establish the first European settlement in the colony of New South Wales, whose boundaries at that time were defined as extending westward as far as 135° of longitude (Fig. 1).¹ The colonists soon realized that most of the trees that grew in abundance around their encampment quickly blunted their saws and axes and did not yield timber suitable for the building of houses. They accepted that they needed to look to the rocks for most of their construction materials. Within weeks of their arrival they were fortunate to find an outcrop of excellent clay for brick making at the head of Long Cove, now Darling Harbour, only about a mile and a half from their settlement (Collins 1798, p. 17). However, their search for limestone to make lime for mortar and to enrich the poor sandy soil of their vegetable gardens remained frustratingly unsuccessful.

Among the pioneers who ventured beyond their tiny establishment at Sydney Cove to examine rocky outcrops and debris for the required substances were Watkin Tench (1759–1833) and William Dawes (1762–1836), both lieutenants of marines, the colony's surgeon-general John White (1757?–1832) and its first Governor, Captain Arthur Phillip (1738–1814) (Cunningham 1996). All were well-educated men by the standards of

and agricultural subjects, suggested that the white clay used by the natives for body paint, would be suitable for the making of china (Vallance 1986, p. 152).

However, Watkin Tench and his fellow explorers soon discovered that the sandstone Cook had observed was the dominant rock type of the land surrounding their little settlement. Governor Phillip notified the Secretary for the Colonies in London that 'The stone of this country is of three sorts: Freestone, which appears equal to Portland stone, a bad firestone, and a stone that appears to contain large proportions of iron. We have good clay for bricks, but no chalk or limestone has yet been found'.⁶ Phillip used the term 'freestone' for the thick beds of sandstone that crop out around the harbour, which could be cut with relative ease from the quarry face and worked to provide building stone. The 'bad firestone' he referred to could probably be equated with the white clay that Mongez had observed. According to Lawson, this material represented the leached part of the shale rocks that are interbedded with the sandstone sequence (Lawson 1972). The iron was probably a form of limonite associated with the sandstone.

Tench described the methods the prospectors used in their unsuccessful search for calcareous rocks: 'To find limestone many of our researches were directed. But after repeated assays with fire and chemical preparations on all the different sorts of stone to be picked up, it is still a *desideratum*' (Flannery 1996, p. 230). Surgeon White agreed with Cook and Phillip that 'the stone of this country is excellent for building' but added the proviso 'could any kind of cement be found to keep it together'. His disappointment at the failure of their experiments led him to make the premature prediction that 'there is not any limestone (I believe) in New South Wales' (White 1962, p. 119).

Although the colony's first 'geologists' were unable to recognize limestone on sight, they were clearly familiar with the use of 'chemical preparations', most likely simply the use of acid, to help in the recognition of the stone. It was probably Surgeon White who supplied the chemical substances and who knew how to identify limestone. The medical inventories of surgeons at the end of the eighteenth century included vitriolic (sulphuric) acid, sometimes used in dilute form to treat a malignant fever, as well as nitric acid (Keevil 1957–1963, 2, p. 229).

The effect of acids on limestone was well known. *Chambers Dictionary* of 1787 stated: '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.'

The lack of rock lime perforce directed the efforts of the newcomers to the use of sea shells. It is not known who among the small community was aware that shells, when burnt, provided excellent lime to make mortar. In England, with its large resources of limestone, there was little need to use shells, but a number of the naval and military personnel at Sydney Cove had been to India or to the West Indies where the burning of shells to make lime was commonly practised. The method must also have been known to a wider public through the pages of the 1771 edition of the *Encyclopaedia Britannica*.

The task of collecting shells from nearby beaches was given to some of the women in the settlement. In the words of Tench, 'the female convicts have hitherto lived in a state of total idleness, except a few who are kept to work in making pegs for tiles and picking up shells for burning into lime' (Flannery 1996, p. 77). This activity marked the beginning of what would become one of the young colony's early industries.

However, such labour was slow and time-consuming and it yielded little raw material for their primitive kiln. As White informed us: 'the governor, notwithstanding that he had collected together all the shells which could be found for the purpose of obtaining from them the lime necessary to the construction of a house for his own residence, did not procure a fourth part of the quantity which was wanted' (White 1962, p. 119). At first, the lack of boats and convict overseers limited excursions to more distant beaches where shells were more plentiful. When such forays became possible, Aboriginal kitchen middens, often found at the mouths of natural caverns, supplemented the shells gathered on the beaches (O'Hara 1817, pp. 50–51). Even with this additional supply lime remained a scarce resource.

Frustrated by the lack of lime for the building of adequate houses and public stores, White blamed Captain Cook 'for having led them to suppose that oyster and cockle shells might be procured in such quantities as to make a sufficiency of lime ... but this is by no means the case. That great navigator, notwithstanding his usual accuracy and candour, was certainly too lavish of his praises on Botany Bay' (White 1962, p. 145). The criticism was undeserved. Cook's journal entries on this matter were accurate but had been embroidered by Hawkesworth⁷ in his account of the navigator's voyages. It was this embellished version that White had read.

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Sydney Cove occupies a roughly semicircular area of undulating lowland, the Cumberland Plain, which extends for about 60 km or 37 miles westwards before rising to form the formidable barrier of the Blue Mountains (Fig. 2). In order to expand their tiny territory and to search for resources such as limestone, it seemed necessary to explore and cross these mountains. Several tentative incursions into this rugged range during the 1790s came to a halt in the mountains' thickly wooded valleys and against the steeply rising sandstone cliffs.

In the absence of offers from members of the established community to engage in the tiresome and seemingly unrewarding task of inland exploration, John Hunter (1737–1821), who in 1795 had succeeded Phillip as Governor, allowed John Wilson (?1770–1800), an illiterate former convict who had served his time, to lead a small party on two journeys to the interior in January and March of 1798. The small band of adventurers included John Price, one of the Governor's servants, who kept a journal of their travels.¹³ Instead of heading west, as most of the early explorers had done, Wilson chose to follow a southwesterly direction along a more easily traversed land corridor between the coastal ranges and the Blue Mountains (Fig. 2). During the second of these journeys he and his party reached a point about 125 miles (200 km) to the SW of Sydney. Theirs was the first inland expedition to travel beyond the near horizontal strata of the Sydney Basin terrain onto the deformed basement rocks of what is today referred to as the Palaeozoic Lachlan Fold Belt. Their path took them across the Blue Mountains at their easily negotiated southern end. They believed that they 'saw plenty of coal and limestone'¹⁴ during their first journey, and that they crossed over ground that was 'covered with limestone and a kind of marble'¹⁵ on their second excursion.

Although Wilson was an excellent bushman, his scientific credentials, and those of the other members of his party, were negligible. Nevertheless, it seems reasonable to assume that a person, said to have been born in Lancashire, England, would recognize coal. It is highly likely that this band of untutored adventurers discovered the first inland outcrop of coal in New South Wales, a short distance to the west of Colo Vale (Fig. 2). The coal seams that crop out there are part of the Permian Illawarra Coal Measures which had first been described in the preceding year in coastal cliff exposures, at what is now Coal Cliff, by the explorer and surgeon George Bass (1771–1803) (Branagan 1972, p. 12). The party's record of this find has gone largely unremarked in the literature. Cambage (1920, p. 6) was sceptical of their claim and suggested that their route may have taken them a few miles to the east of the locality where

the coal appears at the surface. Given the sketchy record in their journal with regard to direction and distances travelled, this issue is debatable.

With respect to the claim by Wilson's party to have found limestone, it is clear that they were mistaken. Cambage suggested that the specimens they brought back to Sydney may have been samples of trachyte (Cambage 1920, p. 25). This rock type, of Tertiary age, crops out along their probable routes a short distance to the south of Mittagong and near Colo Vale (Fig. 2). It is possible that the greyish colour of the weathered trachyte pebbles and outcrops reminded the collectors of a similar coloration they had seen in limestone in England. Their misidentification of the rock may have persuaded Governor Hunter that their claim to have found coal, of which they do not seem to have collected specimens, might be equally false. He took no action to check out their discovery and, in doing so, may have deprived some of the least educated among the colony's subjects of some minor fame in the annals of geological exploration in Australia.

Mounds of shells and musings about their origin

Meanwhile, the citizens of Sydney continued to depend on sea shells as a source of lime. With the continued arrival of convicts, as well as some free settlers, their resources and collecting skills increased. They became better at locating shell mounds at beaches around Sydney and had more small boats for transporting them to their kilns. Governor Hunter was able to report that shells had been found 'all around the harbour in considerable quantities' and to declare that workmen were covering the decaying and crumbling houses with lime to 'ensure their lasting at least twenty years to come'.¹⁶ His statement proved to be wildly optimistic. A coating of lime did not for long prevent the poorly built houses from further deterioration, nor did the supply of shells prove equal to the demand.

In 1800, the former Lieutenant King, now a post-captain, succeeded Hunter as Governor of New South Wales. The colony's growing population, that had now reached 5000, required increasing amounts of raw materials for building. King recognized the urgent need to explore beyond the settled surroundings of Sydney for these essential commodities.

First, in 1801, King sent his Lieutenant-Governor, Colonel Paterson (1755–1810), in a small naval vessel, the *Lady Nelson*, to the mouth of the Coal River, today's Hunter River and the site of Newcastle. Coal had accidentally been discovered in the vicinity by escaping convicts in

Later scientific investigations suggest that there was truth in both of the popular opinions referred to by Wentworth. Recent archaeological surveys (Dyall 1971) have revealed the presence of large clusters of Aboriginal campsites, marked by heaps of discarded shells, along ocean beaches and in the Hunter River estuary. The extensive shell accumulations, 'without either sand or earth', which Paterson encountered near the water's edge, represented most likely a series of overlapping middens. They would have been the first and most easily obtainable deposits of shells which, within a few years of their discovery, were collected by

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Fig. 3. Adolarius William Henry Humphrey (1782–1829), His Majesty's Mineralogist in New South Wales, from 1803 to 1812 (Photograph courtesy National Library of Australia, Canberra).

into the mountains. During one of his own brief excursions to the eastern margin of the Blue Mountains, Depuch in the company of fellow geologist Bailly had reached the point where the Grose and Nepean Rivers join to form the Hawkesbury River (Fig. 2). There they observed pebbles and boulders of a 'large variety of granite' which the rivers had brought down from the highlands.²⁵ Vallance and Branagan have also commented on the observations at this locality by the two Frenchmen (Vallance & Branagan 1968, Branagan 2002). Although they applied the term granite to a wide range of crystalline rocks (Plomley *et al.* 1990), Depuch's assumption, that the higher and more central parts of the range included igneous rocks of differing composition, proved to be correct. We are aware today that even pebbles from granite exposed on the western side of the Blue Mountains are transported to the eastern side by some of the rivers, including the Kowmung and Cox's Rivers (Fig. 2). In his report to the Governor, Depuch made use of his own field observations to declare that Barrallier had not reached the centre of the chain of mountains as, had he done so, he could not have missed the 'numerous varieties of granite' which must crop out there.²⁶

The views held by the French geologists concerning the formation and classification of rocks reflected, in large part, those of Abraham Gottlob Werner (1749–1817). In his best known and most influential work, published in 1786 (Werner 1786, 1971), Werner grouped crustal rocks into four categories. The Primitive, or first-formed rocks,

including the majority of igneous and metamorphic rocks, were deposited by precipitation in a primeval ocean and contained no fossils. Overlying these, and also deposited in an aqueous environment, were sequences of stratified rocks, often fossiliferous, the Flötzgebirge of Werner and referred to as the Secondary by Depuch. The younger alluvial deposits consisted largely of unconsolidated sediments and were derived mainly from the erosion of older rocks. In what Werner considered a minor category, he included rocks of volcanic origin, whose extent he thought to be limited. When exploring the West Australian coastal regions in 1801, Depuch had already recognized these four categories of rocks and believed them to constitute all of the 'exterior part of the globe'.²⁷ He accepted therefore that the 'granites' brought down by the rivers from the Blue Mountains, belonged to the Primitive or oldest rocks in the region and formed the core of the range. The layered sedimentary rocks of the Sydney Basin, that flanked this central core, were of a younger age and part of the Secondary, a term already in use for such rock types before Werner proposed his system of classification (Oldroyd 1996, pp. 80–82). Depuch had attended the lectures of Déodat de Dolomieu (1750–1801) at the Ecole des Mines in Paris. The celebrated geologist followed the neptunian views of Werner in explaining the origin and formation of the major crustal rock types (Mayer 2005). With respect to the formation of basalt, however, Dolomieu disagreed with Werner, ascribing their origin instead to the outpouring of subterranean lavas. Depuch closely followed Dolomieu's teaching in his interpretation and classification of the rocks he examined in Australia.

On his second and much longer journey, during November and December 1802, Barrallier did indeed encounter and collect specimens of 'granite'. Unfortunately, by the time of his return, the French ships had left Port Jackson. For a description of the rocks and minerals the expedition brought back we depend on Barrallier's journal entries, as none of the specimens is known to have been preserved.²⁸ The young explorer had been able to greatly increase his knowledge of geology during his conversations with the French geologists and with the zoologist Péron, who had a wide understanding of natural science. A comment in Barrallier's journal, stating that he believed he had passed the centre of the mountains as he did not find any more granite but only sandstone,²⁹ is evidence of how well he attended to the teaching of his mentors, though it is hard to know today what might have been his 'centre'.

Barrallier penetrated further westward into the mountains than anyone before him (Fig. 2).

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considered the property of government, neither Governor Hunter nor his successor, Governor King, who had been given Phillips' original one-third share in the herd, wanted the animals to be interfered with. The presence of the cattle therefore effectively limited the colony's expansion to the southwest. After King's departure in 1806, prominent settlers such as the influential John Macarthur (1766–1834) who had been granted large leases in the area, discouraged movement through his land (Cunningham 1996, pp. 87–88). Although a few individuals moved into the new country and established small farms, it was not until 1820 when Governor Macquarie journeyed to Lake George, first sighted by Europeans earlier in the same year, that official settlement commenced in that area. Less than two months after Macquarie's visit Charles Throsby Smith (1798–1876) found small deposits of limestone at the site of present-day Canberra. In the following year his uncle, the surgeon, explorer and major landholder, Charles Throsby (1777–1828), discovered larger deposits on the Queanbeyan River, to the south of Lake George (Fig. 2) (Mayer 2000, pp. 20–23).

Appointment of a mineralogist

The prospects for a more coordinated appraisal of the colony's resources received a boost with the surprise appointment, in 1803, of A. H. W. Humphrey as government mineralogist. Lord Hobart in a letter to Governor King³⁵ saw the appointment as 'the most efficacious aid in ascertaining the mineral productions of your Government'. He described Humphrey, who was given the title of 'His Majesty's Mineralogist', 'as a person in every respect well qualified for the duty' and 'that the results of his labour will be productive of considerable benefit to the settlement'. King was, however, to be disappointed both by the ability and the commitment of Humphrey. Vallance (1981) gives a thorough account of the mineralogist's background and his work in the colony. It appears that, rather than being trained in science, Humphrey derived his knowledge of mineralogy from his involvement in his family's business activities as collectors and dealers in minerals.

The Colonial Office in London, aware of the discoveries of coal and of reports that deposits of iron had been found in New South Wales, started to take a greater interest in the resource potential of its distant colony. The understandable fears expressed by Governor Phillip in 1788, when the tiny community was fighting for its survival, that the finding of minerals and precious metals 'would be the greatest evil that could befall the settlement',³⁶ had given way to a belief that such

discoveries might benefit both the colonial power and its distant colony.

Officialdom in London seemed, however, to have formed the view that the search for Earth resources would be just as well accomplished by a knowledgeable mineral collector as by a trained scientist. This is born out by the yearly salary of only £95-5-0 paid to Humphrey, one that might have been appropriate for a prospector but was well below that due to a scientifically trained mineralogist (Vallance 1981, p. 109).

The establishment of a new settlement in Van Diemen's Land by Lieutenant-Governor Collins, with whom Humphrey had arrived in the colony, meant that the mineralogist commenced his official duties at the newly founded town of Hobart, in 1804. Governor King impatiently awaited his arrival in Sydney where he hoped Humphrey would give particular attention to making 'observations' in the Blue Mountains, in which endeavour he [King] would 'assist his researches to the utmost in my power'.³⁷ It was not until 1805, close to the end of King's tenure as governor, that Humphrey arrived in Sydney. His main activity there seems to have been selecting specimens of iron ore for shipping to England. Nothing came of the plans King had for him. By 1807 Humphrey was back in Hobart.

It is clear that Humphrey found life as a landholder and settler in Tasmania more congenial and much more financially rewarding than the duties expected of 'His Majesty's Mineralogist'. During the nine years he spent in the employment of government he displayed little enthusiasm for geological work, apart from a brief period after his arrival in the company of the botanist Robert Brown (1773–1858) (Vallance 1981, p. 114; Vallance & Moore 1982, pp. 32–33; Vallance *et al.* 2001, p. 462). In a letter to England written in 1803, he revealed his awareness of the colony's lack of limestone. He noted that it 'has not been discovered at Port Jackson, though no pains, as I am informed, have been spared by the Governor of that Colony to find so valuable and useful a Substance' (Vallance 1981, p. 129). But Humphrey seemed little inclined to contribute towards this effort. One historian comments: 'It is impossible even to figure the role of A. W. H. Humphrey, the mineralogist, at this time. We have seen that he was capable of active bush exploration, but nothing remains to mark his own specialised operations. In later years he did useful work as a police magistrate' (Giblin 1939, 2, pp. 33–34).

The mineralogist had got himself into trouble with the government as early as 1806 when, in Sydney, he had entered into a liaison with Harriet Sutton, a convict girl whom he persuaded to come with him to Tasmania. Despite a Government

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Macquarie to request, as the first governor had done, that all transport ships coming to the colony be ballasted with limestone.⁴³ Like that of his predecessor, Governor Phillip, Macquarie's call met with little success. Following the discovery of limestone near Hobart, he also urged the Colonial Secretary to send a skilful mineralogist to the colony to find limestone in New South Wales.⁴⁴ This request was also ignored. It was not until 1823 that John Busby (1765–1857) was appointed as civil engineer and mineral surveyor.

There is no doubt that most of the colony's inhabitants were as aware as the Government itself of the urgent need for limestone. Encouraged by the prospect of a reward, many must have kept their eyes open for likely looking rocks as they travelled through the countryside. Sir H. Hayes Browne, one of the colony's gentlemen convicts, who had been transported for the interesting crime of abducting an heiress, was one who believed he had succeeded. Writing to Governor Macquarie he informed him that he would take him to the spot where he had found limestone and modestly added that he would think himself 'amply rewarded by discovering so valuable an acquisition to a rising colony should it prove successful'.⁴⁵ As the spot he referred to appears to have been close to Sydney, his geological knowledge seems to have been wholly deficient.

Limestone find brings praise and censure to discoverer

The major breakthrough came in 1813, when three enterprising colonists succeeded in crossing the Blue Mountains in a westerly direction and descended to open country of undulating topography. The explorers Gregory Blaxland (1778–1853), William Lawson (1774–1850) and William Charles Wentworth (1790–1872) had chosen a route, long used by Aborigines, which followed the ridges of the range rather than the valleys, as previous expeditions had done. At the end point of their journey they found themselves on granite rocks of the Lachlan Fold Belt and close to the Great Divide.

In the same year, the Governor dispatched his assistant-surveyor, George William Evans (1780–1852) (Fig. 4) with a small party to explore the newly discovered land. He was the first European to make a complete crossing of the mountains and to reach the western plains. Following the success of this expedition, Macquarie had a road built over the mountains. In 1815, the hands-on Governor, in the company of Evans and the Surveyor-General John Oxley (1783–1828) travelled to the western plains himself to assess the new country.

Fig. 4. George William Evans (1780–1852), surveyor and explorer (Photograph courtesy Mitchell Library, Sydney).

He was pleased by the sight of the vast stretches of much needed grazing land and selected a site for what was to become the city of Bathurst. His one complaint was 'that neither coals nor limestone have been discovered in the western country; articles in themselves of so much importance, that the want of them must be severely felt, whenever that country shall be settled'.⁴⁶ His concerns with regard to limestone soon proved to be unfounded.

Surprisingly, the Governor chose George Evans rather than the latter's superior, John Oxley, to continue the exploration of the country west of Bathurst. It may be that the success of Evans' first journey persuaded the Governor to entrust him with the performance of this new task. Some 45 miles SW of the new town site the surveyor, following along the banks of a creek, found 'pure lime stone of a misty grey colour'. He named the small stream Lime Stone Creek.⁴⁷ The deposit he discovered there (Fig. 2) is now recognized as part of the Cliefden Caves Limestone of Ordovician age (Lishmud *et al.* 1986, p. 101).

The long search, which had begun with the tentative efforts of the first colonists and had been pursued, almost obsessively at times, by both private individuals and by those who explored on behalf of the Government, had at last brought results. A grateful Governor complimented Evans on his discovery and rewarded him with £100 and

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discovered on one of these journeys occurs in scattered deposits of what is now known as the Early to Middle Devonian Limekilns Group (Lishmud *et al.* 1986, p. 247) and this produced the first rock lime in New South Wales. Production may have started soon after the discovery was made, but had certainly commenced by 1823.⁵⁴

Another Frenchman, René Lesson (1799–1849), the surgeon of the visiting French vessel *Coquille*, visited the area in 1824 and commented on the significance of these new finds: 'They have discovered ... the mineral substance that seems to be lacking in New Holland, limestone, the greatest need of which is experienced by the English for the construction of their buildings, since the coast does not produce sufficient shells to meet requirements. The lime derived from it is very adhesive and consequently rated highly; only it is very expensive' (Mackness 1965, part 2, p. 71).

It had taken some 35 years since European settlement for the first rock lime to be produced in New South Wales. With the spread of agricultural settlements and the growth of new towns west of the ranges from the 1820s onwards, other deposits of limestone were discovered in the rocks around Sydney outside the strata of the Sydney Basin. Although the cost of transport prevented their full exploitation for some time to come, they eventually met all the needs of local communities.

By the middle of the nineteenth century, advances in technology and transport and the availability of persons skilled in the industry, made it possible to utilise the vast limestone deposits beyond the Blue Mountains for the requirements of Sydney. This led to the phasing out of burning shells that had sustained the colony's building trade for so many years.

Conclusion

For nearly half a century after the foundation of the colony of New South Wales the casual search for essential Earth materials was largely undertaken by a small number of its citizens, who had little or no geological learning. The military and naval officers, surveyors, surgeons, settlers, and even convicts, who engaged in this work sometimes succeeded in their endeavour by diligent application and a keen interest in the natural world, and sometimes by luck. It was not until the 1830s and 1840s that professionally-trained geologists, some of them permanent residents, carried out more extensive mineral surveys of the then much more widely settled continent of Australia.

The literature rarely mentions the names of the mostly untutored pioneers who made the first observations of a geological nature in New South Wales.

This article gives some recognition to the geological work carried out by the dedicated early observers who explored the unknown land of New South Wales in search of limestone. Although their efforts were often motivated by need rather than by the nobler objective of scientific enquiry, their finds stimulated further interest in Earth science and made important economic contributions to the progress of the colony.

I am very grateful to D. Branagan and to D. Oldroyd for their comments and helpful suggestions from which I have greatly benefited. The latter has generously supplied me with a copy of the typescript of his paper published in this book. I also thank P. Wyse Jackson for help with editorial matters. I am greatly indebted to R. Barwick, in the Department of Earth and Marine Sciences at the Australian National University, for giving freely of his time in preparing the graphics for the two maps, Figures 1 and 2. I also thank G. Macauley for his generous help with the illustrations. G. Baglione, the curator of the Lesueur collection at the *Le Havre Muséum d'histoire naturelle*, has kindly sent me a number of manuscripts relating to the Baudin expedition. It is a pleasure to acknowledge here the professional help received from the staff of both the Australian National Library in Canberra and the Mitchell Library in Sydney. The former institution granted permission to publish Figure 3, and the latter Figure 4.

Notes

¹Governor Philip's first commission. *Historical Records of Australia*, 1, pt.1, 1–2.

²Cook, J. Journal on H.M.S. *Endeavour*. MS in National Library of Australia, Canberra.

³Cook, Journal on H.M.S. *Endeavour*, 26 April 1770, p. 241; Hawkesworth (1773) has quoted this observation unchanged.

⁴King, P.G. 1788. Journal, 14 January. *Historical Records of New South Wales*, 2, Appendix C, pp. 538–589. King's own observations recorded in his journal leave no doubt that he had read Hawkesworth's book.

⁵Cook, Journal on H.M.S. *Endeavour*, 3 May 1770, p. 246. Hawkesworth (1773) has changed this to 'the stone is sandy and might be used with advantage for building'.

⁶Phillip, A. to Lord Sydney, 9 July 1788. *Historical Records of New South Wales*, 1, 146.

⁷Hawkesworth 1773, p. 248; Hawkesworth had changed Cook's journal entry, Journal on H.M.S. *Endeavour*, p. 248: 'On the sand and mud banks are oysters, mussels and cockles...' to 'On the banks of sand and mud there are great quantities of oysters, mussels and cockles...'

⁸King, P.G. to Phillip, A. 29 December 1791. *Historical Records of New South Wales*, 1, 574–575.

⁹Phillip, A. to Lord Sydney, 28 September 1788. *Historical Records of New South Wales*, 1, 189–190.

's opinion of the items by M. Barrallier, Nov Further papers, 71 (in Sydney, CY 906.

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ber 1805. *Historical* 25–226.

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uary 1803. *Historical* 7–48.

8 September 1788. *Vales*, 1, 190.

rch 1804. *Historical* 31.

17 November 1812. 587.

16 November 1804. *Vales*, 5, 485.

ber 1807. *Historical*

er 1808. *Historical* Probably a private an (see note 188,

- ⁴²Foveaux, J. to Macquarie, L., 17 January 1810. *Historical Records of New South Wales* 7, 274.
- ⁴³Macquarie, L. to a Gentleman, 30 June 1813. *Colonial Secretary's Index*, in Mitchell Library, Sydney, Reel 6043; 4/1728, pp. 86–87.
- ⁴⁴Macquarie, L. to Lord Bathurst, 28 April 1814. *Historical Records of Australia*, 8, 159.
- ⁴⁵Sir Hayes Browne, H. to Macquarie, L., 11 July 1810. *Colonial Secretary's Index*, in Mitchell Library, Sydney, Reel 6042; 4/1725, p. 250.
- ⁴⁶Macquarie, L. to Lord Bathurst, 24 June 1815. *Historical Records of Australia*, 8, 575.
- ⁴⁷Evans, G. W. 1815. Journal of his expedition. *Historical Records of Australia*, 8, 611–619.
- ⁴⁸Macquarie, L. to Lord Bathurst, 18 March 1816. *Historical Records of Australia*, 9, 60–61.
- ⁴⁹Lord Bathurst to Macquarie, L., 18 April 1816. *Historical Records of Australia*, 9, 114–117.
- ⁵⁰Weatherburn (1966). Evans left England at the age of eighteen for the Cape of Good Hope where he worked in the Naval Storekeeper's Department. He arrived at Sydney in 1802 and commenced work as a surveyor in the following year. Given his short period of formal education it is likely that he built on his limited skills by practical experience.
- ⁵¹Lord Bathurst to Macquarie, L., 30 January 1817. *Historical Records of Australia*, 9, 203.
- ⁵²Lord Bathurst to Macquarie, L., 18 April 1816. *Historical Records of Australia*, 9, 115–116.
- ⁵³Macquarie, L., 24 October 1818. General Order. *Colonial Secretary's Index*, in Mitchell Library, Sydney, Reel 6047, 4/1741, p. 67.
- ⁵⁴Cunningham, A. 1823. Journal and account of my daily travels from Bathurst to Liverpool Plains in New South Wales. MS in Mitchell Library, Sydney.

References

- ABELL, R. S. & FALKLAND, A. C. 1991. The hydrology of Norfolk Island, South Pacific Ocean. *Bureau of Mineral Resources, Geology and Geophysics, Bulletin* 234.
- BEMBRICK, C. 1980. Geology of the Blue Mountains, Western Sydney Basin. In: HERBERT, C. & HELBY, R. A guide to the Sydney Basin. *Geological Survey of New South Wales, Department of Mineral Resources, Bulletin* 26, 137.
- BIGGE, J. T. 1822. *Report of the Commissioner of Inquiry into the State of the Colony of New South Wales*. London.
- BRANAGAN, D. F. 1972. *Geology and Coal Mining in the Hunter Valley 1791–1861*. Newcastle History Monograph 6, Newcastle Public Library, Newcastle.
- BRANAGAN, D. F. 2002. Australian stratigraphy and palaeontology: the nineteenth century French contribution. *Comptes rendus, Palevol*, 1, 657–662.
- CAMBAGE, R. H. 1920. Exploration beyond the Upper Nepean in 1798. *The Royal Australian Historical Society*, 6, 6.
- CARNE, J. E. & JONES, L. J. 1919. The limestone deposits of New South Wales. *Mineral Resources New South Wales*, 25, 4.
- COLLINS, D. 1798. *An Account of the English Colony in New South Wales*. T. Cadell and W. Davies, London. [Australian edition 1975. A.H. and A.W. Reed, Sydney].
- CUNNINGHAM, C. 1996. *The Blue Mountains Rediscovered—Beyond the Myth of Early Australian Exploration*. Kangaroo Press, Kenthurst.
- DAVID, T. W. E. & ETHERIDGE, R. 1890. The raised beaches of the Hunter River delta. *Geological Survey of New South Wales, Records*, 2, 37–52.
- DYALL, L. K. 1971. Aboriginal occupation of the Newcastle coastline. *Hunter Natural History*, 3, 154–157.
- FLANNERY, T. (ed.) 1996. *Watkin Trench 1788*. The Text Publishing Company, Melbourne.
- GIBLIN, R. W. 1939. *The Early History of Tasmania*. Methuen, London.
- HAWKESWORTH, J. 1773. *An Account of the Voyages Undertaken... for Making Discoveries in the Southern Hemisphere*, 3 Volumes. Printed for W. Strahan & T. Cadell, London.
- HOSKING, J. S. & HUEBER, H. V. 1954. The limestones of Tasmania and their industrial development. *Commonwealth Scientific Research Organisation*. Melbourne.
- HUNTER, J. 1795. *An Historical Journal of the Transactions at Port Jackson and Norfolk Island*. Stockdale, London.
- KEEVIL, J. J. 1957–1963. *Medicine and the Navy, 1200–1900*, 4 Volumes. E. & S. Livingstone, Edinburgh.
- LAWSON, W. 1972. A history of industrial pottery production in New South Wales. *Journal of the Royal Australian Historical Society*, 57, 17–39.
- LISHMUD, S. R., DAWOOD, A. D. & LANGLEY, W. V. 1986. *The Limestone Deposits of New South Wales*. 2nd edn. Geological Survey of New South Wales, Mineral Resources, 25.
- MCQUEEN, A. 1993. *Blue Mountains to Bridgetown—The Life and Journeys of Barrallier, 1773–1853*. Published privately.
- MACKNESS, G. (ed.) 1965. *Fourteen Journeys over the Blue Mountains 1813–1841*. D.S. Ford, Sydney.
- MAYER, W. 2000. In search of a 'considerable river': Retracing the paths of the early explorers to Lake George, the Limestone Plains and the Murrumbidgee. *Canberra Historical Journal*, 45, 15–24.
- MAYER, W. 2005. Deux géologues français en Nouvelle-Hollande (Australie): Louis Depuch et Charles Bailly, membres de l'expédition Baudin (1801–1803). *Travaux du Comité français d'histoire de la géologie*, 3^e série, 19, 95–112.
- O'HARA, J. 1817. *The History of New South Wales*. Printed for the author and sold by J. F. Hamilton, London.
- OLDROYD, D. 1996. *Thinking about the Earth: A History of Ideas in Geology*. Athlone, London.
- OXLEY, J. 1820. *Journal of Two Expeditions into the Interior of New South Wales, 1817–8*. John Murray, London.
- PEARSON, M. 1981. Simple lime-burning methods in nineteenth century New South Wales. *Archaeology Oceania*, 19, 112–115.
- PÉRON, F. 1809. *Voyage to the Southern Hemisphere*. Printed for Richard Phillips by B. McMillan, London.

Four Centuries of Geological Travel

The Search for Knowledge on Foot,
Bicycle, Sledge and Camel

Edited by
P. N. Wyse Jackson

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Four Centuries of Geological Travel

The Search for Knowledge on Foot, Bicycle, Sledge and Camel

Edited by
P. N. Wyse Jackson

In the last four centuries geologists have traversed the globe, searching for economically important materials or simply to satisfy their intellectual curiosity. Geologists have often been at the vanguard of scientific exploration.

The microscopist Robert Hooke explored the Isle of Wight, and Charles Darwin the Cape Verde islands and parts of South America. The volcanic wonders of Italy and central France attracted native and foreign visitors including Lyell and Murchison. The Tyrrell brothers faced great hardship in northern Canada, as did the actor and mineralogist Charles Lewis Giesecke in Greenland. The development of Sydney, Australia depended on finding limestone for building. French geologists relied on camels in the Sahara, and Grenville Cole

trusted his tricycle to carry him across Europe.

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The Grand Canyon dissecting the Colorado Plateau, drawn by artist-geologist William Henry Holmes. Note the geologists on horseback in the left foreground. (See paper by A. R. Orme, p. 281.)