

James Dwight Dana in New South Wales, 1839-1840

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"A sandstone bluff, from one hundred and fifty to two hundred feet in height, forms the North and South Heads of Port Jackson. The rock lies in nearly horizontal beds, brought out in bold relief by the partial removal of occasional softer beds, or by natural excavations along the junction of the several layers. Passing the narrow entrance between the capes, the same light gray or grayish-yellow sandstone is seen bordering the bay throughout its extent, stretching far away around its deep sinuous coves, and advancing into prominent headlands that often confine the view to a small portion of this large expanse of waters. The sandstone usually presents a low bluff front to the bay: the upper layers retreat either by terraces or a gradual slope, into rounded elevations covered with a sparse growth of shrubbery or forest trees. These slopes continue in many places to the water's edge, especially at the head of the coves, where they terminate below in a broad sand-beach, or a small marsh, more or less changed to meadow-land by washings from the adjoining declivities." (Dana, 1849, p. 449.)

In these terms, James Dwight Dana described Sydney Harbour, which he entered aboard the U.S. man-of-war *Peacock* on 29 November 1839. Dana was then twenty-six, and destined within the decade to succeed Benjamin Silliman as Professor of Natural History at Yale and to become for the next half century the dominating figure of American geological science.

Dana had already demonstrated his great ability as a mineralogist before he arrived in Australia in 1839. He had studied geology and mineralogy under Silliman at Yale, but the opportunity of foreign travel prompted him to abandon his studies before graduation in 1833 and to take the post of mathematical instructor on the Mediterranean cruise of S.S. *Delaware*. It was not, however, mathematics but geology that stimulated his perceptive mind, and Dana's description of a visit to Vesuvius posted to

Silliman from abroad, won him a personal assistantship to the Professor on his return in 1836. Two years later he published *A System of Mineralogy*, widely regarded as his most original work, and a classic of mineralogy.

It was Asa Gray, Professor of Botany at Harvard, who persuaded Dana to join the United States Exploring Expedition as geologist and mineralogist in 1838. Commissioned under Captain Charles Wilkes, the Expedition was the first hydrographic and scientific survey to be undertaken by the United States Government in the international sphere, and had as its object the exploration and survey of the Antarctic coastline, the Pacific Islands and the north-west American coast, and the preparation of scientific reports. Its carefully selected corps of civilian scientists included, in addition to Dana, two men of considerable reputation in their fields, Horatio Hale, the philologist, and Dr. Charles Pickering, chief zoologist to the Expedition and a former Curator of the Academy of Natural Sciences.

The six vessels sailed from Norfolk, Virginia, in August 1838, and after a sixteen months' cruise of South American waters and the Pacific, the flagship *Vincennes* and the sloop-of-war *Peacock* carrying the scientific contingent arrived off Port Jackson on 29 November 1839 at 8 p.m. Their arrival was unexpected, and no pilot met them at the entrance of Sydney Heads, but Wilkes was anxious to avoid loss of time and to catch the favourable wind. Thus on a dark night, unknown to the harbour authorities and relying on their own charts to negotiate the channel, the two ships stole silently into harbour and at 10.30 p.m. "quietly dropped anchor off the Cove, in the midst of the shipping, without anyone having the least idea of our arrival" (Wilkes, 1852, p. 208).

When the people of Sydney looked abroad the following morning, they were astonished to see two men-of-war anchored among their shipping directly below the Fort. "What a scrape should we have been in", exclaimed one citizen in his diary, "had there been war" (Clarke, Diary, entry 4 Dec. 1839).

Despite their unorthodox arrival, the residents greeted the Squadron with hospitality and enthusiasm. There was much in the Colony that reminded the visitors of home: "The acquisition of wealth", Captain Wilkes noted, "seems the only object of exertion here, and speculation was as rife as we had left it in the United States" (Wilkes, 1852, p. 211). The officers observed the arrival of a convict ship and were struck by the healthy aspect of the disembarking passengers. "They were treated in all respects", Wilkes recorded in some wonder, "as if they were free" (p. 277).

Dana did not remain long in the town and the day after their arrival accepted the invitation with Dr. Charles Pickering, to visit the estate of W. Stephens at Puenbuen, some 120 miles from Newcastle near the source of the Hunter River (Pickering, 1850). The two scientists travelled by steamer to Newcastle and thence overland up the Hunter Valley through Maitland, Patrick Plains and Muswellbrook to Stephens' station, and it was here that Dana began his careful examination of the Australian landscape and, in his own words, sought "to gratify but partially, in a geological point of view the curiosity which so strange a land may well excite" (Dana, 1849, p. 458).

To the small coterie of scholars and scientific amateurs in the Colony, cut off from the currents of discovery and research, the advent of the civilian corps of the United States Exploring Expedition offered the stimulating opportunity for discussion and scientific exchange. "I wish I could meet with Mr. Dana", the Rev. W. B. Clarke wrote in his diary on December 16th. Next morning, the Expedition's Chaplain introduced him to the geologist, back that day from the country, on board the *Peacock*.

William Branwhite Clarke was a graduate of Cambridge, where he had studied geology under Professor Adam Sedgwick, and was already known in geological circles in London when poverty and long delay in Church preferment drove him to accept a parish in New South Wales. He had arrived in the Colony in May 1839 with the eager recommendations of his colleagues of the Geological Society of London to turn his particular attention to the coal deposits of Australia and to investigate the stratigraphy of this little known land. With the exception of Charles Darwin, who called briefly aboard the *Beagle* in 1836, Clarke was the first university trained geologist to reach Australia, where his pioneering work over vast tracts of New South Wales was to earn him the title of the "Father of Australian Geology" and a

Fellowship of the Royal Society towards the close of a long and energetic life.

His meeting with Dana who, while fifteen years his junior, had already demonstrated the quality and originality of his mind, gave an exhilarating start to Clarke's geological researches in the Colony and was the beginning of a long friendship maintained by correspondence until the end of the clergyman's life. It is indeed Clarke's diary, which he kept faithfully during his first two years in Australia and into which he poured his graphic impressions of Colonial life, that provides the main source of information of Dana's now forgotten visit to New South Wales.

Three days after their first meeting Dana and Clarke were together again at the elaborate luncheon given by the United States Squadron on the lawns at Fort Macquarie, where, under marquees decked with flags and evergreens, they met another scientific visitor, the Polish Count Strzelecki, who arriving in the Colony in April 1839 with the avowed intention of conducting a mineralogical survey of New South Wales, had just returned from an excursion across the Blue Mountains to Bathurst and told Clarke and Dana that he had found "the geology of that country very tame" (Clarke, Diary, 20 Dec. 1839). It was a verdict the clergyman was to remember with interest when Strzelecki asserted his claim to have discovered gold in the region, as the rushes of 1851 precipitated a lively scramble for priorities in the early discovery of Australian gold. Clarke's own interest was more than academic; he too had found traces of gold in the mountains in 1841.

It was also in Clarke's company that Dana visited the house of Mr. (later Sir Charles) Nicholson where, Clarke enthusiastically reported, "Dana and I went all over the geology of America and Europe" (Diary, 23 Dec. 1839). From there they drove to Elizabeth Bay to call on W. S. Macleay. "The ride from Sydney to South Head", Dana wrote later (*op. cit.*, p. 450), "... may be recommended as offering strong attraction to the lover of the beautiful in nature, especially as the noble bay throws its own life into many of the fine views". Alexander Macleay's home, set in its spacious garden of rare shrubs and creepers, flowers and imported trees, afforded delight to many visiting scientists to New South Wales. Yet, from their own records, it appears that the geologists found keener satisfaction in the coal traces they identified in the rocks behind the garden and in the ripples of sand shale on the shore

than in the botanist's paradise of the home at Elizabeth Bay (Clarke, Diary, 23 Dec. 1839 ; Dana, 1849, p. 461).

On Boxing Day, the ships of the United States Exploring Expedition weighed anchor and stood to sea to begin their cruise of the Antarctic. James Dana, however, with other members of the scientific corps, remained behind, and it was during these next two months of leisure in the Colony that his major geological work was done. At the beginning of the New Year, he travelled to Wollongong by steamer with the Expedition's artist, Mr. Drayton, and here on 2nd January Clarke joined them, riding overland from his rectory at Parramatta in anticipation of meeting his friends. During the several days the two geologists spent in Wollongong, they closely examined the coastline, where they found fossils of shells and wood in abundance in the argillaceous sandstone cliff ; they found also a raised beach in which they marked *Trochus australis*. On their last evening they were invited to attend a corroboree of tribes drawn from as far afield as Moreton Bay, and Clarke in his Diary records his "feelings of wild sublimity as fire after fire blazed up and I found myself among at least one hundred native savages in a state of perfect nudity and looking most unearthly" (Clarke, Diary, 6 Jan. 1840).

Next day they were on their way to Kangaroo Valley in the company of a guide. Clarke has left a lively record of this excursion on horseback through the fertile valleys and steep defiles, where the richness of the forest made "a sort of moonlight" and the shadowy groves offered a cool retreat from the midsummer heat. "This bush riding has quite an air of romance about it" he recounts in his Diary (7 January 1840).

You gallop along over a green but not level turf, studded with splendid trees through which you wind your way . . . Suddenly you come upon some dry water course with lofty banks, the bed of which is strewn with large fragments of rocks over which and through which one must ride . . . Then, again, you cross rivers full of water, gliding along under a canopy of branches and having a thick jungle of ferns upon their edges, affording spots of most cooling aspect amidst the sultry heat of a noon-day . . . Occasionally we had to leap innumerable trees fallen across [the route] so that the ride had more of the character of a steeple chase than anything else and frequently recalled to my mind our boyish game of "follow the leader" as we saw

the stockman guide cantering along in the van without slackening his speed, over this, through stumps, suddenly disappearing down a steep hump and then suddenly rising again up the opposite bank.

In this fashion they crossed the Macquarie River and ascended the rapidly rising slope of Illawarra mountain to the vertical wall of rock which topped its last three hundred feet. Here, clambering "on all fours sometimes, dragging our horses after us, we gained the summit, where we had a splendid view of the lake and sea and mountains and the deep defiles with thick forests which we had passed. Just at the summit we passed a trap dyke" (Clarke, Diary, 6 Jan. 1840).

By nightfall, they had made the zigzag descent into Kangaroo Valley which Dana characterized as "a narrow patch of land . . . scarcely averaging three miles in breadth, lying between abrupt mountain walls, from one thousand to eighteen hundred feet in height" (Dana, 1849, p. 452). Dana, Clarke reported, thought the sea had occupied the valley "as a gulph" but he had abandoned this false deduction when he came to write up his Report on the Geology of New South Wales. Clarke's own opinion was that it had recently been a fresh water lake from which the barriers had been burst. In Kangaroo Valley the travellers were received hospitably at Mr. Meare's station where, reassured by the comfort of a great log fire, they slept soundly after their long ride. Neither mosquitoes nor bugs, Clarke was happy to report, troubled their repose ; "a few fleas only danced a welcome to the Kangaroo Grounds".

During the next days, Dana and Clarke were engaged in an intensive exploratory investigation—the first to be undertaken in any detail—of the Illawarra region from Broughton's Head to Coolangatta Mountain and along the coast to Black Head and Kiama ; a spectacular area of basalt interstratified with the sandstone and cutting the shoreline in deep, intersecting dykes. At Broughton's Head they came upon the "trap", "the very rock", wrote Clarke, "we had been in search of", and they were to trace its outcrop in the Coolangatta Mountain down to a deep dyke running through the beach at Black Head. The two men evidently differed in their opinion of "trap". Clarke reports an argument with Dana over a particularly hard specimen found at the river mouth at Black Head "but we at last agreed that it was true trap". Dana wrote later, "It is doubtful whether the igneous rocks under

consideration are wholly *basalt*, or are in part *trap*, that is, whether they always contain augite with the feldspar or sometimes hornblende. Some ambiguous rocks may be referred to either variety" (1849, p. 497). He himself adopts basalt throughout his Report.

At Black Head they came upon the rich fossil beds of shells and wood which they had met earlier at Wollongong. "Our surprise was great", Clarke noted, "to find the whole of the low cliff which forms Black Head and the flat rocks below filled out with innumerable concretions as at Wollongong, shells and corallines and with masses of granitic and porphyritic rock embedded and divided by iron seams in every direction. Many of the shells were completely agatered." Here too they found a fossil tree, whose exposed part measured three feet long by seven inches wide.

Although many had seen the Blow Hole at Kiama by 1839, Dana and Clarke were the first to observe and record this phenomenon in geological terms (Clarke's long diary entry is recorded by Jervis, 1945, p. 34). Both men sketched the columnar basalt rising in beautiful order from the sea (Dana's elegant sketch is reproduced in his Report), and both pronounced it the very Staffa of New South Wales. The wildness of the coastal scenery where the sea hollowed out the basalt flows and dykes and hammered noisily against the narrow channels it had carved clearly attracted the two men and Dana writes evocatively of

a dark cavern, eight or ten feet high, [which] extends into the cliff a hundred yards or more. The sea dashes in below and may be heard hurrying on, for a while becoming nearly still—when suddenly a sound like thunder roars through the cavern as the water strikes the farther walls, and a few rays of light are seen amid the darkness, sparkling from scattered foam (Dana, 1849, p. 496).

At Kiama the two geologists parted; Clarke to find his way overland through the Illawarra Mountain back to Parramatta; Dana to travel a short distance south, returning along the coast to Bulli and Mount "Keerah", where he examined the coal measures before turning inland to complete his homeward journey by way of Appin and Campbelltown. On 16 January he reached Clarke's home at Parramatta and the following day rode out with his friend to inspect the Prospect intrusion. It was Clarke's last Diary entry about the American. "Mr. Dana and I rode to Prospect . . .

Examined the basalt and traced a dyke of syenite, black and hard all along the ridge" (Clarke, Diary, 17 Jan. 1840; cf. Dana, 1849, p. 516).

From his own evidence, Dana appears to have spent the remainder of his stay in the Colony in the Hunter River District in a meticulous investigation of the coal deposits at Nobby Island and Telegraph Hill, and at Lake Macquarie. From James Steel, Superintendent of the Coal Works at Newcastle, he received substantial help, and he made the acquaintance of the Rev. C. P. Wilton, one of the early promoters of Australian science. Wilton was the founder and energetic president of the Newcastle Mechanics' Institute whose object was the encouragement of colonial science, and it was among the geological collection at the Institute that Dana saw the one fossil specimen of marine life found in the upper Newcastle coal beds. He himself observed none *in situ* and of the many plant remains he encountered in the formations he reports that the simple leaved *Glossopteris Browniana* made up four-fifths (1849, pp. 482-3).

By the middle of March 1840, the American Squadron had returned from the Antarctic, where the discovery of Wilkes Land commemorates their work, and after a week's refitting in Sydney, they sailed for New Zealand on March 19. The scientific members, followed aboard the *Peacock* a few days later, and, in the last stage of their journey were wrecked off the mouth of the Columbia River. The company, however, escaped in the boats with their reports and specimens and returned overland to Washington in June 1842.

It was not for ten years after his Australian visit that James Dana published his Report on the Geology of the Expedition, with its masterly chapter on the geology of New South Wales. In the same year of 1849, he was appointed to the Chair of Natural History at Yale. Despite the briefness of his visit, Dana made a number of important contributions to the foundations of Australian geological science. Having travelled with him through the basaltic region of the Illawarra it is instructive to turn to the highly lucid account he has left of this fortnight's geological reconnaissance which provided a firm starting point for later detailed surveys of that area.

The basaltic rock occurs both in layers interstratified with the sandstone, and in dikes. By its occurrence, both underlying some layers below the coal, and also protruding through the Sydney sandstone,

it appears to be of different ages. The alternation of sandstone and basalt may be seen in many of the cliffs from Black Head to Point Bass, six miles north of Kiama . . . At Black Head, the basalt does not occur in the cliff itself, but may be seen overlying the argillaceous sandstone a few hundred yards back. Going to the northward from this cape, the basalt soon appears capping the bluffs, and dipping with the sandstone below to the northward and westward. This layer of basalt, further north, dips to the water just north of Stony Cove, three miles south of Kiama, where the lower sandstone layer is no longer in sight. The next bluff north is wholly basaltic. The next beyond is capped with red sandstone; this rock does not appear on the following cliff (at Kiama), which is very low, but composes the whole of the next one, with the exception of a small basaltic portion near the water's surface at the south end. The basalt thus dips beneath the water like the layer of sandstone before mentioned. Continuing our course northward, in the next cliff, the sandstone becomes capped with a second layer of basalt. Farther on the sandstone disappears and leaves the basalt alone.

There are hence, in this coast section, two distinct layers of sandstone, and two of basalt interstratified with them; they disappear in succession as we go northward from Black Head, excepting the upper basalt (Dana, 1849, p. 499).

More important however were the conclusions Dana formed from his examination of Kangaroo Valley of the origins of the deep walled gorges of New South Wales. Writing five years after the publication of Darwin's thesis that these gorges were original escarpments of the sandstone (Darwin, 1844), Dana dismissed Darwin's conclusion and argued for the effects of running water in denuding the soft rock over long periods of geological time. In doing so he substantially anticipated modern views of valley making in New South Wales.

It is, however, in his observations of the coal measures of the Colony that Dana made his most enduring contribution to the geology of New South Wales. Publishing a decade after the collection of his material it was inevitable that he was anticipated to some extent, but his stratigraphical and lithological descriptions of what he called the "Sydney sandstone", the coal formation and the sandstone below the coal from the Hunter Basin to Wollongong and

Dapto, indicate the extraordinary grasp and accuracy of Dana's evidence and the penetration he was able to bring, even as a very young man, to his geological work. The palaeontological findings of others, notably Morris, Lonsdale and McCoy, he incorporated in his Report.

Significantly, Dana's evidence appeared at a time when serious conflict had developed in geological circles on the age of Australian coal. Dana's former companion, W. B. Clarke, from his own extended researches in the Colony, challenging the widely held view that Australia was a country of recent geological age, had asserted the greater age of the Illawarra and Newcastle coal formations of New South Wales than those of Europe and India. He assigned them to the Devonian or lower Carboniferous; and he further argued that the marine beds of fossiliferous sandstone underlying the coal and those of predominantly plant fossils above were conformable with the coal seams and belonged to the same geological period. (Evidence before N.S.W. Legislative Committee on Coal, 1847, and published note, 1848.) But the Cambridge palaeontologist, Frederick McCoy, from the evidence of Clarke's own fossils from the Illawarra and the Hunter, insisted that a vast interval of geological time separated the lower Carboniferous marine deposits beneath the coal, the coal seams themselves and the beds above whose plant fossils, he considered, most nearly resembled the coal fields of India and the true Oolitic fields of Europe. McCoy's verdict rested on the absence of animal remains in the upper beds of sandstone. From his sanctuary at the Woodwardian Museum he maintained, and was to continue to maintain for many years after he came to Australia to assume the Melbourne University Natural History Chair, that the lower marine beds and the beds of plant fossils above the coal were not conformable and belonged to widely different geological systems (McCoy, 1847).

Into this arena of conflict, Dana brought positive evidence from his own observations in the Colony of the conformability of the Australian coal beds. Both in the Illawarra-Wollongong area and at Nobby and Telegraph Hill, he had found the sedimentary deposits below and above the coal conformable and passing in gradual transition into one another in an unbroken series (Dana, 1849, pp. 459, 484).

He supported the earlier judgment which Morris had given on Strzelecki's specimens in 1845, that the flora of the southern hemisphere differed from the northern at the "carboniferous period" (Strzelecki, 1845). Louis Agassiz,

moreover, in his identification of Dana's reproduction of the Newcastle fossil fish found in the overlying sandstone, referred it to the upper Carboniferous or transition Permian, and in Dana's analysis, this best accorded with the observed facts. Dana therefore concluded his survey of the N.S.W. coal deposits in the following terms (1849, p. 495) :

While the coal plants point to the upper carboniferous, or still higher, the fossils below the coal seem to correspond most perfectly with the lower carboniferous epoch. Yet the conformity and continuity of the series of beds, (including the sandstones below the coal, and the coal layers) observable in various places, the frequent occurrence of conifer logs, like those of the coal beds, in the fossiliferous sandstones at different localities, together with the characters of the fossil fish, leave little doubt that the whole is of one prolonged age, referable to the upper carboniferous, or partly the lower Permian era.

It was an accurate and timely contribution to the elucidation of the history of the Permo-Carboniferous systems in New South Wales.

As soon as W. B. Clarke read Dana's Report, he wrote at once to his old friend to compliment him on his work and to re-establish contact between them. Dana's reply from New Haven is dated 1 September 1851 (W. B. Clarke Papers).

I was much gratified with the reception of your excellent letter of 19 December last, and glad to feel assured that we might carry on a correspondence although half the globe lies between us. It was a pleasure to know that with all your opportunities for investigation so thoroughly pursued, you find reason to confirm in the main the ground I have taken respecting New Holland geology. My time there was short, but it was spent most agreeably and most instructively to myself; and that Illawarra District is a perfect gem of a place for Geology as well as for landscape beauty; it is one of the loveliest spots on the Globe. I shall look forward with great interest for the published account of your labours, in which you have made so many and important discoveries.

Of McCoy's work, Dana observed a tactful restraint. "I was satisfied McCoy had made some errors as to localities", he commented. "You will set us all to right in whatever is wrong through haste, inadvertence or imperfect

knowledge . . . Those places we visited together are remembered by me with deep feelings of pleasure."

James Dana's next letter to Australia is dated 1854. He had followed some accounts of Clarke's recent researches into the gold fields of New South Wales, and looked forward to receiving the Report which Clarke had promised him.

I trust you will reap some golden results from your labours on behalf of the Gold in Australia. I should enjoy very much another ride over the hills and through the valleys of the country. Will you never come to Yankee land? I should be much pleased to see you here. I wish that you would write a work on the geology of New South Wales and publish it at Government expense. I know you have had this in view. And how long before it will be accomplished? You must have a vast amount of material for such a work, and it would make a most valuable contribution to Science—Australia is the land for queer things, and therefore a grand place for Scientific Exploration. I should rejoice to take it up with you if and if—and if—there are three ifs, and one long one beside.

Clarke had sent Dana a drawing of a fossil fish from Parramatta which the American geologist had forwarded for identification to Agassiz. The enclosed reply to Dana, found among the Clarke Papers, is in Agassiz's hand, and reports that the aging palaeontologist had journeyed to Cambridge, Massachusetts, to consult his own work on fossil fishes "not having looked at the subject for many years and wanting to give a precise answer to the enquiries of Mr. Clarke, as the subject is so highly interesting". Agassiz identified the fish positively as belonging to the Oolitic series. "I am satisfied", he wrote, "they are of more recent date than he [Clarke] supposes. This would however render his investigations only more important in a geological point of view."

Dana's own opinion on the age of the Australian coal measures was to undergo some change as later fossil evidence came to light. In a letter to Clarke of 15 January, 1858, he observed, "I think you will have to lift the Australian coal measures up to the Triassic at least. The Illawarra fossils below the coal may be Permian, and the coal itself Triassic." "How I should enjoy another stroll over your hills and into your valleys!" he concluded this letter, "But I have done roaming."

It was a theme that was to run through all Dana's letters to New South Wales. As late as 1872, he confided to his old friend, "The few weeks of intercourse which I had with you in Australia were amongst the happiest days of my life and I shall never forget your kindness, or the scenes we enjoyed together". Dana's last letter is dated 3 January 1876; Clarke was then 78 and within two years of his death. It was thirty-six years, Dana reminded him, since they had met, and he closes their long correspondence with words which marked his own firmly held faith in the purposes of God: "... the verses you enclosed and for which I thank you, show that you are ready for whatever is in store, having that blessed hope that makes even death a victory."

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