EARLY DISCOVERERS

EARLY DISCOVERIES OF THE EFFECTS OF ICE ACTION IN AUSTRALIA

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ABSTRACT. The effects of past glaciation in what is now Australian territory were first recognized on Macquarie Island, probably by David Ramsay, in 1821. The recognition by Darwin in 1836, and reporting by Milligan in 1848 of ice-transported pebbles and boulders in late Palaeozoic marine rocks in Tasmania, showed on the one hand participation in and on the other familiarity with the controversy in Great Britain at that time the origin of erratics and drift currents. Reports by Clarke (1852), Daintree in 1859, Selwyn (1860), and Gould (1860) of participation in and on the other hand familiarity with the Journal of Glaciology, Vol. 33, No. 114, 1987

BACKGROUND

The relatively early dates of recognition of traces of late Palaeozoic and Quaternary glaciation in Australia, including Tasmania, has interesting historical connections with the mid-nineteenth century geological controversy that surrounded the establishment of the glacial theory in the British Isles.

As early as 1723, a Swiss naturalist, Scheuchzer, attributed to glaciers the ability to carry stones, some of great size, an ability accepted by Hutton and Playfair at least for Alpine glaciers. However, in areas such as southern Finland and the British Isles, such large stones were commonly attributed to either cataclysmic torrents of water or to transport by icebergs at higher stands of the sea (Chorley and others, 1964, chapter 13). The idea that ice (glaciers) had previously been more extensive seems to have been first expressed by a Swiss guide, Perraudin, in 1815 and taken up by Venetz in 1821 in a paper read before the Swiss Society of Natural Sciences (Chorley and others, 1964, p. 193) but did not gain currency until much later under the influence of Agassiz. Although Louis Agassiz had convinced William Buckland in 1838 that the glaciers of Switzerland had been more extensive, it was not until 1840 when Agassiz visited Scotland that the possibility of former extensive glaciation in Scotland was publicly stated. On 22 September 1840, Agassiz addressed Section C of the British Association "On glaciers and boulders in Switzerland", and it was presumably as part of the discussion of this paper that Agassiz claimed the likelihood that Scotland had been glaciated. Following the meeting, Agassiz and Buckland made a field excursion through the British Highlands and both were convinced of the evidence for former glaciation.

Agassiz then visited Ireland and returned south through England to London where, on 4 November 1840, he claimed that the British Isles had been enveloped in a thick ice sheet in his paper on 'Glaciers and the evidence of their having once existed in Scotland, Ireland, and England' to the Geological Society of London (Agassiz, 1840–41; Davies, 1968). However, he failed to win acceptance for the theory amongst senior British geologists, many of whom espoused the concept that the glacial drifts were the products of sea ice during marine submergence rather than a land-based glacier (Chorley and others, 1964; Davies, 1968). It was not until 1850 when A.C. Ramsay read a paper on "The geological phenomena that have produced or modified the scenery of North Wales", published in 1852 as "On the superficial accumulations and surface markings of North Wales" (Ramsay, 1852), and 1859 when he published "The old glaciers of Switzerland and North Wales" (in John Bull, 1859), that many British geologists once again began to take the glacial theory seriously. In the next 15 years, major publications by Jamieson (1862) and Geikie (1863) in Scotland, Close (1866) in Ireland, and Croll (1875) caused the land-ice theory to gain supremacy in the British Isles even though it had been introduced more than a quarter of a century previously.

Amazingly, in the far-off newly explored land of Australia, evidence for two periods of glaciation widely separated in time had been recorded before the glacial theory had gained widespread acceptance in the British Isles.

THE EARLY RECORDS

As early as 1821, the effects of glaciation had been recognized on what is now Australian soil. On 3 September 1821, Edward Wollstonecraft, merchant and landowner of Sydney, New South Wales (Stephen, 1967, p. 631), wrote to Captain Thomas Raine of Surry asking him to enquire into the natural history of Macquarie Island (lat. 55°S., long. 159°E.), and included the comment "I trust that Dr. Ramsay will ... take many of them [queries] in hand". Wollstonecraft's main interest was in furs and oil derived from animals living on and around Macquarie Island. Raine replied to Wollstonecraft in January 1822 inter alia "On top of the island are many lakes ... probably glacial ... evidence everywhere that the island has been covered by ice in the
past" (Goddard, 1940, p. 305). Ledingham and Peterson (1984) reviewed work on the glacial lakes on Macquarie Island and raised the possibility of other origins.

When Charles Darwin examined the Permian marine rocks with "very few rounded pebbles" (see Banks, 1971, p. 9) near Hobart Town (lat. 42°53'S., long. 147°20'E.), Tasmania, in 1836, (R.N., p. 21) "There is a resemblance at Hobart Town between the older strata [i.e. Permian] and the bottom of the sea near T. del Fuego". He had already noted the action of sea ice in depositing such blocks in marine sediments near Tierra del Fuego. This note was not, however, published by Darwin.

The earliest published record of the effects of ice transport in Tasmania, and probably in continental Australia, is that of Joseph Milligan, who explained the presence of a granite boulder in clay formed by "drift" of rocks with "very few rounded pebbles" (see Banks, 1971, p. 305). Ledingham and Peterson (1984, p. 18) noted that such boulders, as noted by Darwin and Milligan, are common in marine late Carboniferous and Permian rocks in Tasmania. All are markedly larger in grain-size than the enclosing marine sediment, some are demonstrably dropstones, and a very few are faceted and striated. All observers have recognized them as dropstones, most regarded them as having been transported by and dropped from icebergs. Recently, however, deposition from some form of sea ice has received increasing support (Banks and Clarke, in press).

Although Murray (1843, p. 203) had published claims of evidence of ice action (in the form of moraines in the Pyrenees, north-east of Ararat, Victoria) prior to Milligan, his evidence has not been substantiated.

In March 1852, Clarke inferred the former presence of glaciers on Mount Kosciuszko (lat. 36°29'S., long. 148°18'E.) in the Australian Alps from "more than one unmistakable bloc perché..." (Report XI, pt. I; reprinted 1860, p. 225), thus providing the first subsequently substantiated evidence of Quaternary glaciation in continental Australia (e.g. David and others, 1901). This inference was not published until 1860.

In the meantime, W.A. Tully had made a privately sponsored expedition into western Tasmania in the summer of 1858-59. After his return he reported drift of quartz and greenstone between Derwent Ford and Mount Arrowsmith (lat. 42°13'S., long. 146°04'E.), and spoke of quartz "drift" of two ages in western Tasmania (Courier and Hobart Town Gazette, 26 April 1859). On 2 May, in commenting on W.A. Tully's report (Hobart Town Gazette) wrote that the "drifts" seem rather to be local detritus... probably they are partially moraines, the product of snow and ice of a colder epoch than at present".

It is noteworthy that many surveyors had worked in glaciated country in Tasmania prior to 1859. At least two people with a geological background, Milligan in 1842 and Strzelecki a little later, had been through the area where Tully reported drift and Charles Gould subsequently reported possible glacial effects. Neither reported glaciation.

In the following summer, Charles Gould, Geological Surveyor of Tasmania, saw large numbers of greenstone (dolerite) boulders in the Cuvier Valley (lat. 42°07'S., long. 146°10'E.) of central Tasmania which he interpreted as having possibly been transported by glacial action and noted the resemblance of "an enormous accumulation of boulders which choked the lower end of the valley and, somewhat like a dam, extends completely across it" (Gould, 1860, p. 11) to a terminal moraine. Gould held back from regarding the geological origin as clear because he did not find polished, grooved, or striated surfaces. These effects, as those in the Mount Kosciuszko area, resulted from Quaternary glaciation (see, for example, also Buckland, 1843). Gould, however, failed to recognize as tillite the "brecia" at the base of the Upper Palaeozoic series from the Eldon Range and from the area between Lake St Clair (lat. 42°07'S., long. 146°11'E.) and Frenchman's Cap, a "brecia" which Gould (1860, p. 12) noted as "a peculiar set of the amphibic rocks recorded by Strzelecki (1845, p. 74) in the area.

The resemblance of rocks at Bacchus Marsh, Victoria (lat. 35°57'S., long. 144°43'E.) to glacial deposits had been recognized in 1859 by Richard Daintree, a discovery not made public until 1861. Then, in 1860, A.R.C. Selwyn (1860, p. 4) recognized striated pavements, in the Inman Valley (lat. 35°33'S., long. 138°27'E.), of South Australia, as caused by glacial action. In the following year, he reported the discovery of the glacial deposits at Bassheath Marsh (Selwyn 1861, p. 183-84). The glacial effects at Bacchus Marsh were then and those in Inman Valley subsequently recognized as late Palaeozoic. Selwyn (1861, p. 184) attributed the Bacchus Marsh deposits to "marine glacial transport". Subsequent discoveries to the end of last century have been reviewed by David (1896).

THE DISCOVERERS

It is not quite clear who discovered the glaciation on Macquarie Island. Certainly, Thomas Raine received and answered the request concerning the natural history. The surgeon on Surry, Dr David Ramsay, accompanied the ship on the visit to Macquarie Island (Goddard, 1950, p. 304). It is difficult to see where Raine would have gained knowledge of glaciation during his education at Westminster School and his maritime training. He was already an officer in Surry by the age of 21. His family background - his father was a lawyer, his mother a parson's daughter - does not suggest any pronounced interest in natural history, and the site of his home (Newcastle-upon-Tyne) and school (Lancaster) suggests at best a conventional or chance acquaintance with glaciated country.

Dr David Ramsay, on the other hand, was born in Perth, Scotland, situated not far to the east or to the south of glaciated country, and received his medical education at the University of Edinburgh (M.D., 1817). It might be recalled that it was at Edinburgh that James Hutton received his medical education. Edinburgh was the home of John Playfair, Professor of Natural Philosophy, 1805-19, Hutton's publicist early in the nineteenth century, and a centre of active controversy with Playfair (1802) taking the Huttonian stand and a centre of considerable scientific activity. Robert Jameson, the Wernarian stance (Chorley and others, 1964, p. 74-75). It may be noted that both Hutton and Playfair accepted the role of glaciers in transporting large boulders (Chorley and others, 1964, p. 193). David Ramsay's father, John, maintained a collection of specimens which he donated to the nation. David himself possessed a library including books on comparative anatomy, plants, entomology, and a book entitled Studies of Nature by I. Pierre. After establishing himself in Sydney he is known to have purchased insects (Broome, 1960, p. 23). Finally, the probabilities, Ramsay is thought to have been the discoverer of glaciation on Macquarie Island. Even so, the recognition was a remarkably early one and not entirely explicable on known information. Perhaps the controversy at the University of Edinburgh fixed young Ramsay's interest, and excursions in his home territory fostered it.

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glaciers to explain erratics in Scotland (Davies, 1968, p. 267-68) during his lectures. Certainly, prior to 1840, Jameson was publishing translations of works on glaciation by de Charpentier and Agassiz in *The Edinburgh New Philosophical Journal*. There is no evidence that Milligan attended Jameson's classes but he was making geological observations (1832) soon after his return to Tasmania as a surgeon to the Van Diemen's Land Company. He collected fossils from Ordovician limestones on the Gordon River when he accompanied Sir John and Lady Franklin to western Tasmania in 1842. He was closely associated with Sir John Frankland, Lieutenant-Governor of Van Diemen's Land, a noted Arctic explorer, a Fellow of the Royal Society, and one-time Council Member of the Geological Society of London (*Proceedings of the Geological Society of London*, 1830, No. 15) — in the Tasmanian Society. Milligan was one of a number of Tasmanian residents who collected plants for W. Hooker and his son J.D. Hooker (Hooker, 1859, p. CXVII; Burns and Skemp, 1961; Hodginot, 1967). Indeed, a plant genus, *Milligonia*, was named in his honour by Hooker (*Philosophical Journal*). Hodginot, 1967) . Indeed, a plant genus, *Milligonia*, was named in his honour by Hooker (*Philosophical Journal*).

**The Discoveries in Context**

The discovery of glaciation on Macquarie Island is remarkably early. It cannot plausibly be connected with the work of Perraudin and Venetz in Switzerland as noted earlier. David Ramsay may have been familiar with the works of de Saussure (1779-96) but, even so, the statement in Raine's letter goes beyond the postulations of de Saussure. Ramsay had, incidentally, considered taking up medical studies in Paris (McMartin, 1967), so presumably was familiar with French. What early work there was on glaciation emphasized ice movement, and glacial transport and deposition of large rocks, but not the formation of glacial lakes (Chorley and others, 1964, p. 191-94). The Macquarie Island discovery did not reach the scientific world until Brangan noted it, but it had little influence on the subsequent controversy in Britain. It is hardly surprising that Darwin recognized the effects of deposition from floating ice in the Permian rocks near Hobart. His friendship with Lyell, his reading of Lyell's *Principles ...*, and his own work on the icecap of Tierra del Fuego and elsewhere (Darwin, 1839, 1842) provided a more adequate background. His failure to publish early in the 1840s his deduction as to the origin of the Tasmanian rocks may have been due to a hesitancy to invoke an ancient glaciation. A.C. Ramsay (1852) in his own work suggested such until the early 1850s and only in 1855 did he write that Darwin recognized a glaciation (Permian) significantly older than the present one. Although the inferred Permian glaciation of the West Midlands of England had not been substantiated, it is interesting that late Palaeozoic glaciation was soon to be established in Australia, which was never visited by Ramsay.

Milligan's (1849) explanation of the granitic boulder at Southport was entirely in keeping with the iceberg theory, initiated in the early 1830s and the most popular theory at the time.

The recognition of glaciation on Mount Kosciusko by Clarke in May 1852 is not surprising as he was, in effect, a practising geologist, clearly familiar with the contemporary British geological concerns. What is perhaps surprising is that he opted for the glacier rather than for the marine ice explanation, the latter being more popular at that time. It is faintly possible that he had heard of Ramsay's views on glaciation in Wales (read 26 March 1851) but, as the paper was not published until after 16 June 1852 and would not have reached Clarke until some months later, he may not have been aware of the paper when he wrote his letter. Even if he did read the paper, he may not have been influenced to adopt a glacier explanation, as the main thrust of Ramsay's 1852 paper was towards an iceberg explanation, although he did postulate glaciers to produce moraines in North Wales. It is more likely that he was aware of the work of Agassiz or his co-scholars in continental Europe, or of the paper by Buckland (1841) on glacial effects in Snowdonia.

How Tully used the word "drift" is not quite clear, whether in the original sense of Murchison (1839, Vol. 1, p. 69), or quoted in Gay and others, 1972, p. 211) for diluvium, most geologists regarded it as glacial, but regarded by Murchison as marine, or in the more general sense of any superficial deposit as seems more consistent with his text. Clarke, in commenting on Tully's discovery, certainly postulated a glacial origin but did not make the basis of his postulate clear. Gould came to the conclusion that there was no evidence that glaciers affected the earth's surface prior to the time of the glacial event. He concluded that the glacial event was due to a change in the earth's climate which caused the glaciers to advance and retreat. This view was supported by many other geologists, such as Lyell and Agassiz.

Gould, Daintree, and Selwyn all recognized evidence of terrestrial glaciation. Such an explanation was becoming more popular in Britain following publication of Ramsay's
paper on Permian glacial deposits in 1855. Furthermore, all three had had direct connections with Ramsay, Gould, and Daintree as students at the Royal School of Mines, where Ramsay taught and Selwyn was his assistant in the Geological Survey at a time when Ramsay’s views on glaciation were being developed. Another two of the early discoverers, David Ramsay and Joseph Milligan, had connections with the University of Edinburgh and Robert Jameson. It is interesting to note that the glacier theory was being actively advanced in Australia (Clarke, Daintree, Selwyn, and Gould) at a time when it was being strongly opposed by some geologists in the British Isles, notably Murchison, and when Charles Lyell had reverted largely to the iceberg theory.

The debt owed to A.C. Ramsay has been expressed in the appreciative action by Charles Gould of honouring his name in Mount Ramsay (lat. 41°55’S., long. 145°30’E.) in western Tasmania. It is ironical that Mount Ramsay bears no sign of glaciation, whereas other mountains named after British geologists by applying the names to Mount Murchison, Mount Lyell, and Mount Owen; others followed with Mounts Tyndall, Geikie, Sedgwick, Jukes, Huxley, and Darwin. All of these mountains bear signs of Quaternary glaciation (Colhoun, 1985) and one of them, Mount Sedgwick, also of late Palaeanozoic glaciation (Banks and Ahmad, 1962).

The history of the early discoveries of the effects of ice action in Australia involves an active protagonist of the marine glacial theory in Charles Darwin and others with close connections in person or by correspondence with participants in the glacial debate in Great Britain. Such connections explain the otherwise surprising earliness of the discoveries in a continent so newly opened to European influence and with so few scientifically inclined or trained people.

Darwin, Milligan, Daintree, and Selwyn saw evidence of late Palaeanozoic glaciation, and recognized its age, but the evidence was slender and the discoveries too early in that not until 1855 did Ramsay first even hint at such ancient glaciation. David Ramsay, Clarke, and Gould first noted evidence for Pleistocene glacier action in the only three areas to show such within continental Australia and its Dependencies.

The early discoveries were predominantly of ice-transported sediment, the exception being that of glacial lakes on Macquarie Island. Gould drew attention to glacial land forms and Selwyn to glacial erosional effects. This precluded the otherwise surprising earliness of the discoveries in a continent so newly opened to European influence and with so few scientifically inclined or trained people.

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