NEUMAYER IN AUSTRALIA: HIS SCIENTIFIC LEGACY

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Georg von Neumayer (1826-1909) is a major figure in the history of Australian and Antarctic science. He came to Australia twice, in 1852 and 1857–1864, the first time as a sailor and the second as the scientist who established the Flagstaff Observatory in Melbourne. He came here at a time when the scientific tradition was firmly established in Europe (its home) but new to Australia where there was little or no home-grown scientific establishment. His main contributions are in the fields of terrestrial magnetism, the early days of oceanography, and the potential of polar research. He built and managed the Flagstaff Observatory, conducted a magnetic survey of Victoria, visited Tasmania to re-measure the magnetic parameters at Rossbank Observatory, worked to identify the most efficient sailing routes for shipping between Europe and Australia and collaborated with other scientists and artists during his sojourn here. On return to Europe, he became a major influence in the Heroic Era of Antarctic exploration.

Key words: von Neumayer, Australia, oceanography history, Flagstaff Observatory

GEORG von Neumayer (1826–1909) (he was ennobled later in life) is a major figure in the history of Australian and Antarctic science but often is overlooked in Australian history dominated by the British role.

This paper examines briefly his work in Australia and his legacy. It is meant to complement other papers presented at the Royal Society of Victoria's symposium (28-29 May 1909) to commemorate the centenary of his death on 24 May 1909 and thus does not consider in detail the operation of the Flagstaff Observatory nor of his magnetic survey of Victoria which are the subject of Home (see pages 2-10) and Morrison (see pages 48-61). While mentioning his later very significant influence in the exploration of the sub-Antarctic, and ultimately the Heroic Era of Antarctic exploration, this aspect is not covered in detail.

NEUMAYER IN HIS TIME

Georg Balthasar Neumayer was born on 21 June 1826 in Kirchheimbolanden, Germany. Antarctica had been seen for the first time six years earlier and the first genuine scientific expedition to that continent (Henry Foster's *Chanticleer* expedition to measure gravity and terrestrial magnetic parameters at Deception Island (Webster, 1834) left Europe two years after Neumayer's birth. Ten days after Neumayer's fifth birthday, James Clark Ross (1 June 1831) reached the North Magnetic Pole (Dodge 1973) and thus Neumayer was raised in the era of ascendancy of magnetic exploration. Four months before Neumayer's death, T.W. Edgeworth David, Douglas Mawson and Alistair Forbes Mackay reached the 'vicinity' of the South Magnetic Pole (Mawer 2006) thus showing that the Gaussian model for the Earth's magnetic field stood up well.

Neumayer studied in the Gymnasium and Lyceum under Prof. F. Schwerd from 1842–1845, and from then until 1849 at the Polytechnic and Engineering Schools in Münich.

After early training in physics and engineering (see Home & Kretzer 1991 for details), Georg Neumayer, in August 1850, went to Rotterdam and bought a passage on *Luise* bound for Brazil to obtain experience as a sailor and to learn marine navigation. In April the following year, he was back in Hamburg to study navigation science under Christian Carl Rümker who had been in New South Wales in the 1820s as astronomer at the Parramatta Observatory. Rümker, on return to Germany, became director of the Hamburg Observatory and school of navigation. After studying and working in association with Rümker, Neumayer was granted his mate's certificate.

SCIENCE AND TECHNOLOGY IN EUROPE IN THE INTERVAL, 1850-1865 – NEUMAYER'S SCIENTIFIC NURSERY

Modern science and technology are dominantly European developments and Neumayer grew up in that ethos. It was a tumultuous time in science in Europe but there was little hint at the beginning of this interval, of the revolution that was to erupt in the middle of it (Gribbin 2002; Botting 1971).

At the beginning of this era, much of the scientific discipline terminology we now recognise had evolved. The term 'scientist' came into common use only in about 1830. Darwin had had his experience on H.M.S. *Beagle* and nations were heavily involved in maritime exploration in all relevant disciplines, including the earliest murmurings of oceanography.

Publication of Lyell's *Principles of Geology* (1830) had given a new way of looking at the Earth and science advanced from conducting small laboratory or local field-based experiments to applying the discoveries on a much larger scale. Field observations and the natural sciences became important, culminating in publication of Darwin's masterpiece which revolutionised biology. It was of the world outside the laboratory. Understanding the age of the earth and change with time now became serious pursuits. Earth was no longer conceived as a short-lived relatively static body but had a dynamism that needed to be documented, studied and understood. Data needed to be gathered from many parts of the world and integrated. This was not quite a new phenomenon as there had been gathering of magnetic data through the efforts of Columbus, Gilbert and Halley but generally the world was to be looked at in a different way. Magnetic phenomena were to the fore during Neumayer's formative years and his experience as a sailor enhanced his recognition of the need for a better understanding for navigation purposes, while the scientist in him had deeper reasons for gaining that understanding.

Medicine was advancing rapidly in a modern form. Ignaz Semmelweis (1818–1865) returned to Vienna and in 1855 advocated cleanliness as a means of overcoming childbed fever although this did not gain immediate favour. Louis Pasteur (1822–1895) promoted the germ theory and pasteurisation in 1862 and Joseph Lister (1827–1912)—almost an exact contemporary of Neumayer—in 1867 discovered the role of carbolic acid as a means of antisepsis.

William Perkin in 1856 discovered a means of manufacturing aniline dyes, a discovery with major long-term influence on colour and the plastics industry.

Within Europe, the ability to communicate with distant co-workers speedily was increasing greatly with the emergence of faster trains and especially the telegraph.

It was with this background that Neumayer came to Australia.

SCIENCE AND TECHNOLOGY IN AUSTRALIA, 1850–1865 – THE AREA HE INFLUENCED

At the time of Neumayer's work in 'Australia', the nation did not exist and would not for another 40 years. It had been settled by Europeans only 64 years before Neumayer first visited these shores and its population in 1851 was only some 450 000 in an area of 7.7×10^6 km^2. It consisted of a series of colonies with markedly differing governments and approaches to their citizens. By the time of Neumayer's second sojourn, its population had risen to 1.15 million, dominantly close to the coast (as now), mainly in response to the discovery of gold (Blainey 1966; Moyal 1986).

Australia had few scientific discoveries to its credit by the time Neumayer arrived. The early days of colonisation had included several governors such as Sir Thomas Brisbane and Sir William Denison with strong scientific interest and there had been a significant amount of coastal surveying in the time. Astronomy was to the fore early with the establishment of the Parramatta Observatory (1821–1847 or 1848) where Christian Carl Rümker had been in 1827–1830 when he was dismissed and returned to Germany. In the biological sphere, botany dominated over zoology until 1840. John Ridley had invented the wheat stripper in 1843 as an example of innovation relevant to the local conditions of agriculture. John Tebbutt established his own astronomical observatory at home in 1863 and had already discovered a comet orbit in 1861, but 'Australia' had no long-term tradition of learned societies. Several attempts had been made to initiate such societies (Fig. 1) but the Sydney-based Philosophical Society of Australasia lasted only in 1821–1822, and the Van Diemen's Land Scientific Society for two years from 1829 (the Royal Society of Tasmania came into being in 1843 and the Royal Society of Victoria some 11 years later, although there had been small, local antecedents, commonly with a horticultural emphasis). There was no tradition of scientific publication in 'the colonies' and universi-

Date	Event
1850	Australian Philosophical Society
1850s	state geological surveys (many short-lived)
1852	Sydney University
1853	Australian Museum incorporated
1853	von Mueller as Victorian botanist
1854	Philosophical Society of Victoria
1854	Victorian Institute for the Advancement of Science
1855	South Australian Observatory for Astronomy and Meteorology
1855	Brisbane Museum
1855	Melbourne University
1856	South Australian Museum
1858	Flagstaff Observatory
1859	Royal Society of Victoria
1861	Tebbutt ses the Great Comet
1862	Tasmanian Museum and Art Gallery
1862	Entolomological Society of New South Wales
1863	Tebbutt erstablishes his own wooden observatory at Richmond
1863	new Melbourne Observatory

Fig. 1. Development of scientific institutions about the time of Neumayer's tenure.

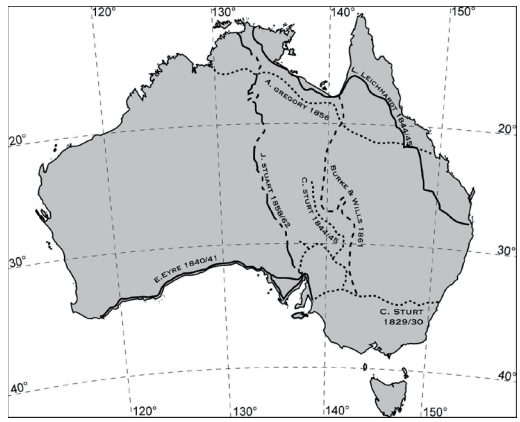


Fig. 2. Exploration of Australia immediately prior to and during Neumayer's tenure.

ties were yet to evolve along European models. The Australian (originally Colonial) Museum opened in Sydney in 1827 and the University of Sydney was the first, established in 1852. Thus there was little tradition of educating and training 'our own'. This lack of educational facilities and other expressions of interest in science were changing as Neumayer's second arrival in Australia loomed, as new state Royal Societies, museums and universities came to be. Many new societies and museums began and flourished.

Australian science at the time was dominated by geography (exploration) and adaptation of European practice (technology) to the new nation including making contact with the indigenous population about whom so little was known. The general outline of 'Australia' was emerging; its coastline was now known and exploration of the inland was underway (Fig. 2). Ludwig Leichardt—a scientist—in 1844/45, had pioneered a track from Sydney to 'Darwin' and Charles Sturt, at the same time, had penetrated to central Australia in the search for the inland sea, proposed by Edward John Eyre. Baron Ferdinand von Mueller accompanied Augustus Gregory's exploration from Victoria River in the Northern Territory to Moreton Bay in Queensland. Robert O'Hara Burke and William Wills would soon set out on their fatal expedition; Wills was well known to Neumayer who had hired him as a surveyor. There was a high failure rate among explorers but important geographical information was obtained and preconceptions dashed. Maps, understanding of the environment (not recognised by that name), landforms and rivers was advancing and Australia was of global interest. Some leading scientists came here from elsewhere and a few, such as Baron von Mueller, stayed. Australian animals and plants were subjects of global scientific interest but home-grown study was limited

The biggest event around that time was the 1851 discovery of gold and its influence on Australian population, global interest and the emergence of an independence movement. While various attempts had been made to introduce railways to Australia, it was not until 1862 that a rail link was established with inland mining towns of Ballarat and Bendigo and the age of rail reached Australia, 33 years after Stephenson's *Rocket* had set its first speed record. And in the 1860s, the Murray River was navigable.

It was a time of steadily decreasing isolation of Australia as different approaches were taken to improving communications between Europe and Australia; shipping became faster and the submarine cable and telegraph inched closer to us. Within Australia, communications were quickening and telegraphs were established between colony (later state) capitals. Sydney-Melbourne-Adelaide were linked by 1858; Tasmania via submarine cable in 1859; and Brisbane by 1861—all developments while Neumayer was here and he doubtlessly used all the systems.

The contrast with Europe was marked and Neumayer came with the evolving European approach at a time of change here.

NEUMAYER'S ACTIVITIES IN AUSTRALIA

Neumayer came to Australia twice and the activities in each visit were as different as they could be.

Late in 1851, after obtaining maritime qualifications, he was back at sea on the *Reiherstieg* which brought him to Sydney in August 1852, thus beginning his first sojourn in 'Australia'. Most of the crew deserted to try their luck on the gold diggings, mainly in Victoria's Bendigo goldfield. A new crew was put together and the ship traded the east Australian coast from Brisbane to St Vincents Gulf in South Australia. Neumayer stayed with the ship initially but eventually he sought, and was granted, release from the ship, allowing him to follow the earlier crew to spend two months in the quest for gold, apparently unsuccessfully, at the goldfields at Bendigo. Here, among other activities, he seems to have taught astronomy and navigation for the German community on the diggings but left to resume life at sea around the coast of Victoria before returning to Germany (again) departing Australia on 27 January 1854 as helmsman on *Sovereign of the Seas* (Morrison 2006). It is often stated that he came to Tasmania during this time (e.g. Chisholm 1965; McGregor et al. 1985; Moyal 1986**)** but there is no evidence to support this claim. The early maritime phase of his life was now over but his interests remained.

His second sojourn in Australia to conduct his major scientific contribution began with his arrival in Melbourne on *La Rochelle* (Captain Johann Meyer) on 27 January 1857. Travel to Australia had changed in the interim.

Neumayer had become convinced of the value of understanding the earth's magnetic field and of Southern Hemisphere observations for this subject. He saw Australia as an ideal site for pursuing this goal.

He had obtained funding from a series of sources, supported by Alexander von Humboldt, to establish what became the Flagstaff Observatory on Flagstaff Hill in Melbourne. The sources of funding included King Maximilian II, and possibly the British Association for the Advancement of Science, although the BAAS apparently has no record of this (Rupa Kundu pers.comm.) and Moyal (1986) suggested the Royal Society; and he was further supported by a Hamburg senator and shipping magnate Johann Godeffroy, who gave free passage to Melbourne for Neumayer and all his equipment. In transit, the voyage sailed between Heard Island and the McDonald Islands and, believing they had made a discovery, they named the islands the König Max-Inseln. They also named many specific islands and features but the prior discovery and knowledge meant these names had no validity. The name Meyer Rock remains and is named for the captain. This marked the first serious involvement in the Antarctic/sub-Antarctic for Neumayer. To get to Australia, he sailed via the Great Circle route which may account for Meyer's re-discovery of Heard Island and the McDonald Islands on 10 January 1857. The use of the Great Circle route was a new idea and its implementation followed publication in 1855 of Captain Matthew Fontaine Maury's, *The physical geography of the sea and its meteorology*. This, and his earlier involvement in marine life, may have influenced Neumayer's decision to study the passages of ships between Australia and Europe in addition to his magnetic studies. Maury (1806–1873) was also a strong supporter of Antarctic research and conducted experiments that were copied by Neumayer. It was also the time of transition to steam propulsion.

On arrival in Melbourne, he established observatories in Williamstown and on various lighthouses around the colony and in 1858 gained approval to use Flagstaff Hill as a site for the Flagstaff Observatory (Home & Kretzer 1991).

In Melbourne, he gained further support, both social and financial, from the German community including the artists Nicholas Chevalier and Eugene von Guérard, who became his friends and accompanied him on some of his ventures into the Victorian countryside (Morrison 2006).

While in Melbourne, Neumayer undertook a most ambitious project—the magnetic survey of Victoria covered in detail by Morrison (2006, 2009).

At the end of his Flagstaff Observatory period, Neumayer travelled to Tasmania for 10 days, at the request of Sir Edward Sabine, then President of the Royal Society, to re-measure the magnetic parameters of the Rossbank Observatory, established by James Clark Ross in 1840/41 and maintained by Joseph Henry Kay until 31 December 1854. Details of this trip are contained in Neumayer (1905) and Quilty (2007). Apparently the observations he made for the Royal Society were never published by that organisation but Neumayer did publish a summary of his Tasmanian travels in German (Neumayer 1905).

He calibrated his Tasmanian readings against his Flagstaff instruments and shortly afterwards sailed, initially to London on the *Norfolk* (Captain Tonkin), and then home. On that voyage, he conducted early oceanographic experiments by throwing bottles (Figs. 3, 4) with instructions for return, overboard.

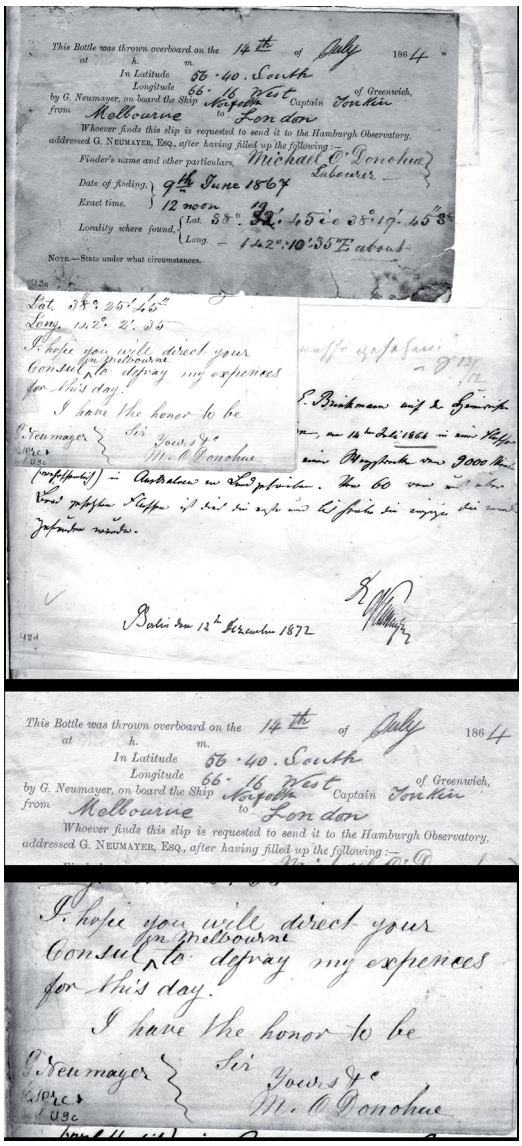


Fig. 3. Recovered record of one of the bottles (*flaschen*) thrown overboard by Neumayer in 1864. Note the spelling of 'honor' (lacking a 'u'), the quality of writing by one who describes himself as 'labourer', and the request for defrayment of expenses.

NEUMAYER'S AUSTRALIAN MARINE SCIENCE

While Neumayer was in Australia, there were significant developments in physical science in Europe that would have a major impact on Neumayer's later life. The background to this marine interest lies with Maury.

Almost traditionally, oceanography is stated to have commenced with the H.M.S. *Challenger* Expedition of 1873–1876, but a case can be made for that to be an evolutionary development from earlier history. One version of the beginning of the discipline can take it from Maury (1855). The parallels between the marine and polar interests and activities of Maury and Neumayer are striking.

Captain Matthew Fontaine Maury (1806–1873) joined the U.S. Navy in 1825 and saw active service until an accident in 1839 led to an onshore appointment. In 1842 he was superintendent of the Depot of Charts and Instruments of the Navy Department, based in Washington. At the time, there seemed to be no standards for charts of currents, nor of methods for taking meteorological measurements at sea. Thus, in 1853 Maury convened an International Oceano-

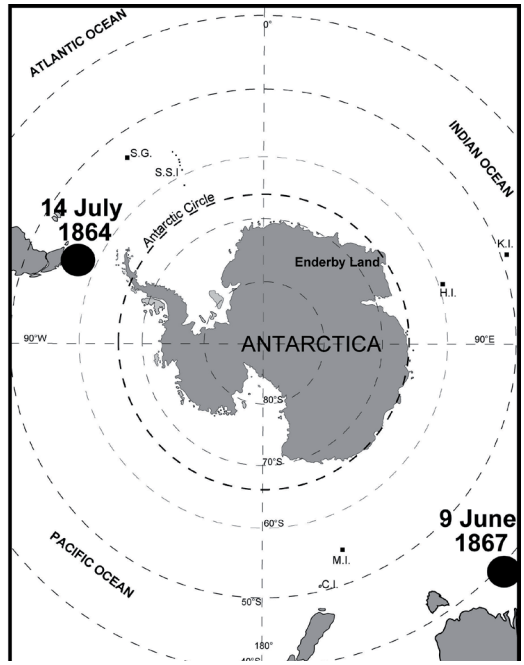


Fig. 4. Deployment and recovery locations of a bottle thrown overboard by Neumayer off South America.

graphic Conference in Brussels to standardise record-keeping of atmospheric and sea conditions. At this time, Neumayer was engaged in his phase as a sailor.

Maury was deeply religious and read in Psalm 8 the phrase variously quoted as 'whatever passes along the paths of the sea'. If there are paths in the sea (and there must be; the Bible says so) it was his job to find them. To this end, he experimented by throwing bottles over the sides of ships to track ocean movements, and studied ships' logs for information on weather, location, rate of passage etc. to identify the most efficient sailing paths for vessels sailing between various ports. These were 'the paths in the sea'. This approach was followed, virtually exactly, by Neumayer.

In Melbourne, Neumayer studied ships' tracks between Australia and Europe. As with Maury's research, this involved using daily ships' logs of approximately 300 voyages to plot details of position and weather conditions in an effort to determine the most efficient route between the distant continents. Maury (1855) in Chapter 17 (entitled 'Routes') referred to 'shortening of passages' and 'improvements in navigation'. The first edition of the book was published a few months after Neumayer returned to Germany from his first tenure in Australia and two years before he set sail to establish the Flagstaff Observatory.

As Neumayer left Australia for the last time in 1864, he presented the results of this work—a large scroll in a cedar cabinet—to the Melbourne Chamber of Commerce. The cedar cabinet is now located at the Melbourne Public Records Office, and is on display for attendees at the Neumayer Conference. In further parallels with Maury, Neumayer threw bottles over the side of the *Norfolk* and some of these were recovered, including that illustrated here.

Maury's influence did not stop there. In November 1860, Maury addressed the Royal Geographic Society in London in a paper entitled *On the physical geography of the sea, in connection with the Antarctic regions*, and demanded in very strident terms that Britain should re-enter Antarctic exploration for global reasons, warning that if Britain didn't, the United States would. But Britain had spent a great deal of money in the unsuccessful Arctic search for Sir John Franklin, and the United States was about to embark on its Civil War and thus ultimatums came to nothing.

INFLUENCE OF HIS AUSTRALIAN EXPERIENCE ON HIS LATER CAREER

Neumayer had a very wide range of interests, including art which, may, in part have taken the role that a camera would today. As an example, when he went on his surveys, artists who went on to become household names commonly accompanied him. Perhaps the best known of these was Eugene von Guérard (1812–1901) who accompanied Neumayer on several such ventures. Von Guérard had sketched in the Goulburn Valley in 1862 and joined Nicholas Chevalier (1828–1902) on a meteorological expedition, organised by Neumayer. Von Guérard was with Neumayer on the magnetic survey on Mt Kosciuszko in October 1862 when he produced some of his best-known work.

He missed no opportunity to have data taken by others. He had hoped that the ill-fated Burke and Wills expedition would gather scientific data from a vast and unknown part of Australia and he supplied scientific equipment to this end. He arrived late and missed the departure of the expedition from Swan Hill. He caught up with Burke and Wills north of the Murray River; they were some distance ahead of the main party. He had employed Wills as a surveyor earlier, had trained him in the use of instruments, and had observed him as he took readings. He accompanied the expedition for some distance and then accompanied Burke back to the main party. The scientific equipment was abandoned only a few days into the expedition so only some meteorological data were gathered.

He was instrumental in stimulating searches for Ludwig Leichardt and published at least two works on the subject (Neumayer 1868; Neumayer & Leichardt 1881).

AFTER AUSTRALIA

Throughout his professional life, Neumayer was interested in a broad range of issues that today would come broadly under the rubric of geophysics, such as astronomy and meteorology, but especially the earth's magnetic field and its poles. Magnetics was of global interest and this was further stimulated by the recognition that Australia was a good site for magnetic studies and already had one excellent observatory—Rossbank in Tasmania—established by James Clark Ross on his way to the Antarctic. Knowing that the South Magnetic Pole is south of Australia in the Antarctic may have stimulated further his interest in things Antarctic, a major part of his post-Australian

life. In this, he followed Maury who also had that interest, although Maury never had the chance to have a major personal influence on Antarctic science.

After his sojourn in Australia conducting onshore geophysical research, Neumayer returned permanently to Germany, where he took out his doctorate and eventually became director of the Hydrographic Office in Hamburg (Deutsche Seewarte) in 1876–1903, pursuing his maritime interests from there. He clearly had hopes of sailing to the Antarctic, but for a variety of reasons this did not happen. He had been chosen to lead an expedition to the Antarctic as a preliminary to the Transit of Venus expedition in 1874 but the outbreak of the Franco-Prussian War, and the death of his patron Admiral Tegethoff, prevented this hope coming to fruition. He was still very productive through other activities such as observation of the Transit of Venus in 1874 and a key role in the development of plans for the First International Polar Year of 1882–83.

He was granted Foreign Membership of the Royal Society 1899 (Fig. 5).

Shortly before his retirement from the Hydrographic Office in 1903, he was instrumental in guiding the geophysical program of the *Gauss* under Erich von Drygalski (Drygalski, 1989) which was a modern oceanographic program from a ship built for the purpose. The program was conducted in the Atlantic Ocean in transit, around southern South Africa, and in the southern sector of the Indian Ocean where the ship wintered. The observations down the Atlantic and around southern Africa established some of the understanding we now have.

He is commemorated in Germany by the Neumayer Medal (established by von Neumayer) and in Antarctica by the German research station Neumayer. The medal was recently awarded to Dr Jörn Thiede, immediate past director of the Alfred-Wegener Institute in Germany.

NEUMAYER'S LEGACY

Neumayer was one of a group of world class scientists who came to Australia during the 19th century and helped advertise Australia's scientific value and uniqueness to the world. He saw this region as a key one in global scientific terms.

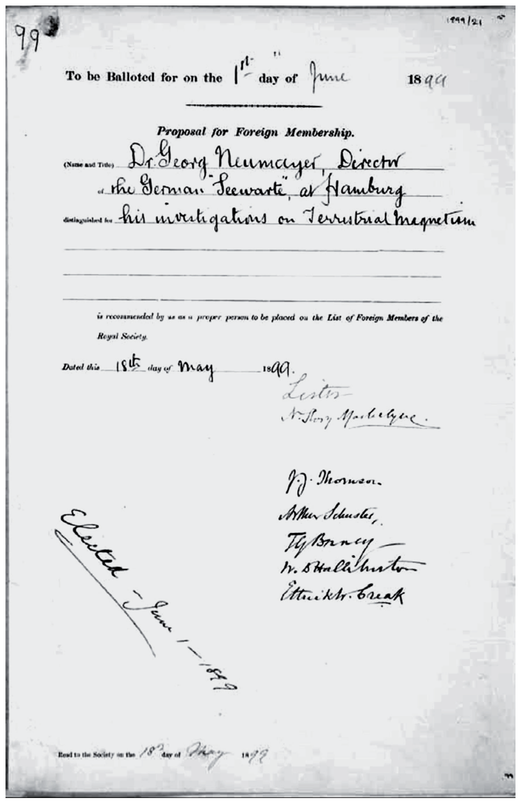
The Flagstaff Observatory set a standard for observatories in Australia. It was equipped to world standard and apparently adequately funded. It was directed by a leading scientist.

His magnetic survey of Victoria was the first of its type in this country and established a pattern that is still followed today.

He was a leader in proselytising for Antarctic science and influencing international interest in that region, and the results led to Australia, particularly Hobart, being used commonly during the Heroic Era of Antarctic expeditions. He was one of the stimulants for the Heroic Era, including the decision to divide the Antarctic into a series of 'quadrants' and to concentrate specific national programs in those quadrants..

His interest in Antarctic science, particularly geophysics, led to the First International Polar Year and the current (fourth) IPY can be seen as part of his legacy.

He was the first to apply emerging approaches to Southern Hemisphere oceanography, using the latest technology, and this practice is still followed today.


99 1899/21

To be Balloted for on the 1st day of June 1899

Proposal for Foreign Membership.

(Name and Title) Dr Georg Neumayer, Director
of the German "Seewarte", at Hamburg
distinguished for his investigations on Terrestrial Magnetism

is recommended by us as a proper person to be placed on the List of Foreign Members of the Royal Society.

Dated this 15th day of May 1899.

Lister
N. Story Maskelyne
J.J. Thomson
Arthur Schuster
T.G. Bonney
W. D. Halliburton
Ettrick W. Creak

Elected – June 1 – 1899

Read to the Society on the 18th day of May 1899

Fig. 5. Approval by the Royal Society of Neumayer's Foreign Membership.

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