Chapter 5: Measuring and Charting

The dominant British orientation in the teaching of Australian history and science, together with the iconic status of James Cook and Matthew Flinders, has hampered the recognition of foreign contributions, none moreso than that of the d’Entrecasteaux expedition. This neglect was assisted by the deaths en route of the commander and prominent officers, the contemporary Napoleonic wars and the delayed publication of the journal of d’Entrecasteaux compiled and edited by Rossel in 1808, but never translated into English until 2001. Contrast this with Labillardière, whose account was twice published in English translation during 1800.

The recent Australian-based publications on the expedition by Frank Horner (1995) and Edward Duyker (2001, 2003), following upon Hélène Richard’s (1986) Paris-based study, have resurrected interest in this significant maritime episode. Following discussion of the expedition’s botanical research, it is time to consider the physical sciences.

The expedition left Brest equipped with state-of-the-art navigation and geomagnetic equipment. Items included for each ship were a telescope to observe eclipses of Jupiter’s moons and an azimuth compass, a minutely divided mariner’s compass fitted with vertical sights, used for taking the magnetic azimuth of a heavenly body. A navigational marine chronometer, only perfected during the later eighteenth century, was the essential tool for Rossel to determine longitude at sea.

At this period (and until 1911) French time was based on the Paris meridian, not Greenwich, so it was 2° 20’ east of Greenwich. To ascertain the local meridian of longitude a chronometer reading was taken at local noon, as indicated by the sun being at its highest point in the sky, north or south. Then each hour by which this determination of local noon differed from Paris noon (as kept by the chronometer) indicated a longitude difference from Paris of 15°.

The scientific instruments included an inclination compass by the hydrographer (then termed geographer) Jean-Claude Borda (1733–99). This instrument was like a regular compass but mounted in a vertical plane, allowing the pivotal magnetic needle to dip and so measure the magnetic ‘dip’ (or ‘inclination’). Measurements of magnetic dip were important for charting Earth’s magnetic field.
The dip needle used by Rossel.

The dip needle instrument used by Rossel to measure magnetic intensity. Illustrated by Rossel, D’Entrecasteaux journal, 1808

The dip needle also could be used for the more advanced and, at the time, new purpose of measuring the intensity of the magnetic field. For this latter purpose the dip needle was deflected from its steady position, and the period of its oscillation or ‘time of vibration’ measured. This period of oscillation is less in a stronger magnetic field. It is relevant that timing the oscillating dip needle in this manner was greatly facilitated by having the chronometer for reference.
Importantly for the quality of this expedition’s navigation and charting, the ships were supplied with other adaptations by Borda. One instrument was an astronomical reflecting or repeating circle, an instrument for measuring angles, in which accuracy was obtained by repeated measurements of horizontal angles on a graduated circle. Its value was referred to in ship’s log entries, as on *Espérance*, 16 May 1792, in fixing the precise location of Observatory Point: ‘The large number of observations of meridian elevations of the sun and stars taken with the astronomical circle of Ms Borda have given 43° 32´ 23˝ south latitude.’\(^1\) Each vessel also carried reflective circles, another Borda design, which permitted two stars to be sighted simultaneously through two telescopic sights, one mounted above, the other below the graduated circle, without needing to zero the instrument. It is worth noting that this expedition was equipped for survey and charting needs with alternative equipment to those expeditions led by Captain Cook, which relied upon sextants.

Upon their arrival in Recherche Bay, the first requirement was to erect a tent to house astronomical instruments. It was pitched behind the beach at Observatory (now Bennetts) Point. It was vital to take land-based astronomical readings in order to determine the accurate latitude and longitude, employing the chronometer.

**de Borda’s ‘cercle répétiteur’ (left) and ‘cercle de reflexion’ (right).**

Left: ‘Cercle répétiteur’ [Cercle hydrographique] developed by Jean-Charles de Borda, called the ‘repeating circle’ by British mariners. Musée national de la Marine, Paris [PH 42170 No. inv. : 11 NA 60 D]

Right: De Borda’s ‘cercle de reflexion’, Anonymous, 1837. Musée national de la Marine, Paris [PH 170643 No. inv. 11 NA 22]
By 26 April 1792, the tent was erected and the instruments installed. A reason for haste was to observe the eclipse of one of Jupiter’s moons, presumably upon that night. Rossel underestimated the time required to install and check the instruments, with the result that they were not ready for Jupiter when the time arrived. It all proved too stressful for young and enthusiastic ensign Achard de Bonvouloir, who had made involved mathematical calculations in advance of the actual passage. Labillardiè re cruelly reported that Bonvouloir became ‘so affected by the disappointment that he wept like a child’. A year later and aboard ship, Bonvouloir and Labillardiè re had a verbal tiff during which Bonvouloir showed his emotional nature by hurling two bottles at his adversary. He was hauled away before he could take any further action.3

D’Entrecasteaux proved less affected by the failure to observe Jupiter, reporting that weather conditions prevented observation of four occurrences when stars were concealed (‘occultation’). A number of other observations were successful, however, providing data which indicated that the ship’s chronometers were accurate. This ‘assured us of the reliance of these two methods in fixing the position of the places we were approaching’.4 An observatory was set up again during their 1793 visit, when the longitude was possibly determined with greater precision. Making allowances for the Paris meridian, their resolution of latitude and longitude accords well with modern determinations. In 1792 their readings were 43º 32´ S latitude and 146º 57´ E longitude; the position of Observatory Point is actually 43º 32´ 41˝ S and 146º 54´ 15˝ E. All these observations and calculations were standard procedures, comparable to those carried out at the observatory established by Lieutenant William Dawes in 1788 at Sydney. On his third voyage, James Cook used portable tent observatories, with a large astronomical regulator clock standing inside.5 Although not strictly research, provision of precise latitude and longitude, whether on land or sea, was a charting requirement.

Rossel was responsible for an innovative study, which resulted in the first global magnetic intensity survey, and which showed that intensity strengthened away from the equator. Measurements taken at Observatory Point in 1792 and at an observatory on Rocky Bay in 1793 provided crucial data for a global set of six magnetic intensity measurements taken both north and south of the equator and in equatorial latitudes.6

According to F. E. M. (Ted) Lilley, the procedure which Rossel followed was new and employed the Borda vertically mounted ‘inclination’ compass. As well as measuring the steady angle of dip, Rossel timed how long an oscillation of the dip needle took, when it was deflected from its steady position. In Recherche Bay the oscillation times of less than two seconds (see Table 1) were measured accurately by a technique involving a long series of oscillations lasting some three minutes. Taking the same dip needle to different parts of the globe was
important, at that stage of the development of science, to obtain magnetic intensity measurements that were correct relative to each other. In modern technical terms the relationship is that magnetic intensity is inversely proportional to the square of the period of oscillation.\(^7\)

Rossel presented his results as follows:

By comparing the experimental results obtained during the expedition with each other it is evident that the oscillations of the needle were more rapid at Paris and Van Diemen’s Land than at Surabaya in the isle of Java and at Amboyna; and therefore the magnetic force is greater near the poles than at the equator.\(^8\)

Table 1 summarises his results:

<table>
<thead>
<tr>
<th>Station</th>
<th>Date</th>
<th>Latitude</th>
<th>E Longitude</th>
<th>Magnetic Dip</th>
<th>Time of vibration (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brest</td>
<td>September 20, 1791</td>
<td>48° 24’ N</td>
<td>356° 34’</td>
<td>71° 30’ N</td>
<td>2.02</td>
</tr>
<tr>
<td>Teneriffe</td>
<td>October 21, 1791</td>
<td>28° 28’ N</td>
<td>343° 42’</td>
<td>62° 25’ N</td>
<td>2.081</td>
</tr>
<tr>
<td>Van Diemen’s Land</td>
<td>May 11, 1792</td>
<td>43° 32’ S</td>
<td>146° 57’</td>
<td>70° 50’ S</td>
<td>1.889</td>
</tr>
<tr>
<td>Amboyna</td>
<td>October 9, 1792</td>
<td>3° 42’ S</td>
<td>128° 08’</td>
<td>20° 37’ S</td>
<td>2.403</td>
</tr>
<tr>
<td>Van Diemen’s Land</td>
<td>February 7, 1793</td>
<td>43° 34’ S</td>
<td>146° 57’</td>
<td>72° 22’ S</td>
<td>1.850</td>
</tr>
<tr>
<td>Surabaya</td>
<td>May 9, 1794</td>
<td>7° 14’ S</td>
<td>112° 42’</td>
<td>25° 20’ S</td>
<td>2.429</td>
</tr>
</tbody>
</table>

Lilley, from whose articles all the above information is drawn, took a lead in urging the commemoration of the bicentenary of this internationally significant episode in the global history of geomagnetism. As a consequence of his and Alan Day’s efforts, this was achieved. On 11 May 1992, precisely 200 years since the first experiment at Recherche Bay, a party of 21, representing the Specialist Group on Solid-Earth Geophysics of the Geological Society of Australia, visited Observatory Point, oscillated a dip needle and fixed a plaque to an adjacent dolerite outcrop. The French, who had nailed an inscription to a tree near Coal Pit Bight in 1792, would have considered this action an appropriate one. That senior scientists so gathered in 1992 provided independent testimony to the significance of this place over a decade before other heritage considerations became controversial.\(^9\)

Rossel and his assistant Bonvouloir teamed with Beaupré, the principal marine surveyor, and Miroir-Jouvency to assist the production of a series of charts of exceptionally accurate detail and attractive format. These maps represented a significant and lasting result of the expedition.

In 1807 Beaupré published a fascinating folio-sized atlas of 39 large maps made during the course of the expedition.\(^10\) Eight of these were surveyed while the ships were moored in Recherche Bay, or immediately following their
departure. Most significant was their discovery and charting of D’Entrecasteaux Channel, six years before Flinders and Bass established the existence of Bass Strait. In ignorance of knowledge of Bass Strait, d’Entrecasteaux assumed that this newly charted channel, which he made sure that his hydrographers surveyed throughout, would become the major shipping lane for all eastern Australia-bound craft. Bass Strait was soon to offer a shorter and speedier alternative.

Beautemps-Beaupré’s chart of Rocky Bay, southern Recherche Bay.

Beautemps-Beaupré’s chart of Rocky Bay, the 1793 anchorage; Cockle Creek at bottom. Published in Atlas du voyage de Bruni-Dentrecasteaux …, Depot general des cartes et plans de la marine et des colonies, Paris, 1807. National Library of Australia [map ra82-s8].

Kermadec agreed with his commander, again in ignorance of Bass Strait. The Channel, he wrote, ‘is formed by a series of huge bays which offer to the astounded view of the mariner a spectacle at the same time as grand as it is admirable’. ‘Moreover,’ he continued, ‘one is sure of finding … anchorages such that it is impossible to wish for any better whatever may be the nature of one’s need for repairs.’ Besides, he continued, Adventure Bay did not offer such shelter or endless resources and is situated on ‘an island entirely separate from the mainland by the strait we have discovered’.11 Their discoveries certainly had cut mainland Tasmania down to size.

Aged only 25, Beautemps-Beaupré (henceforth Beaupré) was a brilliant and meticulous hydrographer. He seems to have worked ceaselessly, often in open boats in all weathers and overnight, apparently commanding the willing assistance and respect of the crews. He obviously held a high opinion of his own methods and results, but that cannot be denied. This serious surveyor must have proved a contrasting character in the society of the great cabin to the outgoing, voluble and caustic tongued Labillardière.
In a lengthy and detailed exposition of his hydrographic surveying techniques, which were an appendix to Rossel’s 1808 edited version of the journal of d’Entrecasteaux, Beaupré acknowledged his mentors. He had worked for six years constructing marine charts under the distinguished direction of Claret de Fleurieu, minister of marine, and Jean-Nicholas Buache, chief hydrographer in the Dépôt de la Marine. Not only was Beaupré well connected, Buache was his cousin. Yet it was the quality and innovative nature of his work rather than personal influence that resulted in a celebrated career crowned with the award of Grand Officer of the Legion of Honour.

Beaupré’s techniques were so relevant to nineteenth century maritime surveying that, in 1823, his published account was separated from the Rossel publication and translated into English by Richard Copeland, a Royal Navy Captain, who had the approval of the Lords Commissioners of the Admiralty.

Beaupré faced up to three major problems of maritime surveying in that era, a time when so many new discoveries were being made that virtually the entire Pacific Ocean needed mapping. The first complication was the impossibility of establishing a conventional terrestrial base line if the ship simply sailed past a land mass and nobody set foot ashore. Secondly, there were so many possible errors in dead reckoning (currents, winds, variations in course steered) that it was useless for accuracy. Another quandary was that magnetic compass bearings often were inaccurate. He had experienced these errors while mapmaking in France. His conclusion was warmly supported by Matthew Flinders, who experimented with using the compass on different places on a ship. Flinders quoted Beaupré in support of the unreliability of compass bearings in surveying.

Beaupré’s solution was to rely upon astronomical measurements rather than terrestrial bearings, abandoning the use of the mariner’s compass. Rossel and his team were involved at this point, using the chronometer to determine their position. Beaupré cited his trigonometrical survey of Santa Cruz Island to exemplify his methodology, reproduced by Copeland in his translation. He acknowledged five days of cooperation from Rossel and Bonvouloir in calculating latitude and longitude from astronomical observations as they sailed near Santa Cruz, while he noted variations in the magnetic needle.

His major innovation was to adopt the reflecting circle for measuring the angular distances from each landmark instead of taking compass bearings. This required many trigonometric calculations and the resulting chart consisted of a network of triangular lines as the framework for his chart of coastlines. He worked exhaustively, immediately drafting a working map, adding careful sketches of coastal features. This procedure meant that each day’s observations were consolidated into an easy reference chart, corrected by latitude and longitude observations. A final chart would be prepared for publication in France.
Beaupré wrote: ‘If a chart is constructed on the evening of the day of the survey, any errors which may have imperceptibly crept into it ... are readily detected.’

A sad footnote is merited to this brilliant hydrography at Santa Cruz. Vanikoro (named Recherche Island by d’Entrecasteaux) was visible and accurately mapped by Beaupré. It was about 64 kilometres distant, the closest that this search was to approach La Pérouse’s wreck site. Survivors may have been alive at this time, because recent research has established that some crew must have lived ashore.

Once the ships anchored in Recherche Bay, Beaupré and assistants were on constant duty. He and Jouvency were given the task to survey Port du Nord and take soundings of the depth of water in the bay. A meticulous map resulted, including the anchorages of the two ships and ‘jardin’, indicating the location of Delahaye’s 1792 garden. D’Entrecasteaux acknowledged their chart as drawn with great precision. The chief role of the observatories set up by each vessel was to allow astronomical observations from a solid base to fix longitude and to rate the chronometers. This drew upon lunar tables that set the moon’s location at 12-hour intervals and the care that Rossel and his staff lavished upon their observations.

On 26 April Crestin commanded an oared boat that took Beaupré to the southern region of Recherche Bay, where they anchored in the following year. They spent a night in the boat, returning with a sounding record and a ‘precisely detailed’ plan drawn by the hydrographer. Despite this, the map of the southern harbour published in 1807, is credited to Jouvency, who was entrusted with conducting a more detailed survey during 1793.

Crestin and the two hydrographers set out again on 30 April to reconnoitre the coastline to the north-east. They returned four days later, unfortunately because they had no rations left, thus preventing testing their belief that they had found a passage to the north-east. They had indeed sailed up the D’Entrecasteaux Channel. D’Entrecasteaux correctly suspected that this was a strait and therefore that Adventure Bay was part of an island, separated from Tasmania. It determined him to pursue further survey of a region ‘which seemed to offer such great advantages to navigation’. Upon sailing out of the harbour d’Entrecasteaux decided to order a comprehensive survey of the channel and of its islands from Bruny to Maria. According to Labillardière, the D’Entrecasteaux Channel was so named on 17 May 1792.
Beaupré’s chart of D’Entrecasteaux Channel.

Beaupré’s chart of D’Entrecasteaux Channel showing triangular lines of sight. Flinders praised this as the best survey in any new country. Published in Atlas du voyage de Bruny-Dentrecasteaux …, Depot général des cartes et plans de la marine et des colonies, Paris, 1807. National Library of Australia [map ra82-s6].
'The axe had never sounded'

The surveyors were busy during these few days in mapping remaining areas, going some distance up the Huon River, named after Kermadec. Beaupré and Rossel combined to fix the location of Observatory Point and the exact position of the southern opening of the strait. This exacting task was finished on 27 May. All astronomical observations, bearings, coastal sketches and soundings made from both vessels were consolidated. ‘On this basis a chart of the strait was prepared on board the *Recherche* by Ms Beaupré.’ Despite frequent bad weather conditions, this formidable task, which surveyed the hitherto unknown embayed coasts and islands of an area more than 70 kilometres long by up to 30 kilometres broad, was completed within one month.\textsuperscript{20}

Both Captains were impressed. In paying tribute to Beaupré, Kermadec wrote: ‘The intelligence and care he has brought to this work is an assurance of its great perfection. It is difficult to give an idea of the exactness he has put into all his operations.’ D’Entrecasteaux was fulsome in his praise that Beaupré had ‘inspired us with the greatest confidence in the work’. ‘I could not praise enough [his] zeal and intelligence,’ he had observed previously, ‘the detailed map he has drafted with the greatest precision … He has been assisted by all the officers and pilots aboard.’\textsuperscript{21}

\textbf{View of Rocky Bay from 1793 watering place.}

View of Rocky Bay from 1793 watering place. The ships anchored in the centre of this image. John Mulvaney, 2006
During the 1793 visit, d’Entrecasteaux took the opportunity to refine their knowledge of the strait. Having sailed the two craft into the Channel, Beaupré was sent with de Welle to further explore the Huon River and the western side of Bruny Island. Another boat commanded by Willaumez was sent to explore the north-eastern area of the strait. It was then that the Derwent River was located, named by Willaumez as Rivière du Nord. ‘I do not believe,’ d’Entrecasteaux wrote with gratification, ‘that such a large number of excellent anchorages exists in such a small space, anywhere in the world.’

Two decades later, Matthew Flinders provided authoritative and independent evaluation of the quality of the hydrographic survey. His long imprisonment on Ile de France provided him with reasons for belittling French initiatives, so his praise is all the more to be accepted. This discovery, survey and charting of D’Entrecasteaux Channel is a major criterion in the national status of Recherche Bay, which served as the base for this painstaking survey. Flinders wrote as follows:

The charts of the bays, ports and arms of the sea at the south-east end of Van Diemen’s Land, constructed on the expedition by Mons. Beaupré and assistants, appear to combine scientific accuracy and minuteness of detail, with an uncommon degree of neatness in execution; they contain some of the finest specimens of marine surveying, perhaps ever made in a new country.

ENDNOTES

1 Duyker and Duyker (eds and trans), Bruny d’Entrecasteaux: voyage to Australia and the Pacific, 2001: 2 for list of equipment.
3 Labillardière, Voyage in search of La Pérouse, 1800: 100, 139.
5 Greenhill, James Cook, the opening of the Pacific, 1970: 27.
10 Beaupré, Atlas du voyage de Bruny-d’Entrecasteaux, 1807.
12 Copeland, An introduction to the practice of nautical surveying, 1823, translation of Beaupré, 1807.
14 Copeland, An introduction to the practice of nautical surveying, 1823: 46.
15 Ibid.: 53.
16 Duyker and Duyker (eds and trans), Bruny d’Entrecasteaux: voyage to Australia and the Pacific, 2001: 35.
‘The axe had never sounded’

17 Ibid.: 39.
19 Labillardière, Voyage in search of La Pérouse, 1800: 124.
23 Flinders, A voyage to Terra Australis, 1814, vol. 1: xciii.