Matthew Flinders's Survey Practices and Records

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Contents

Introduction

The sad tale of Matthew Flinders's long confinement on Île de France (Mauritius) between December 1803 and June 1810 is well known. However, one fruit of that period is the material that assists in an analysis of his hydrographic survey practices. During this time he compiled or revised a great number of the fair sheets from his exploration of the Australian coast. He also finalized the *Memoir Explaining the Construction of the Charts of Australia* that is included in the edition of the journals kept in HMS *Investigator* in 1801–03 that will be published by the Hakluyt Society in 2014, the bicentenary year of his death.

While Flinders laboured at these tasks, Mr John Aken, late master of the *Investigator*, was employed in making a copy of the book in which Flinders had kept a record of the survey operations. This copy has been preserved in the archives of the UK Hydrographic Office,[1] a rare and precious survival of a field record from this period. It is entitled 'Bearings taken on board His Majesty's ship *Investigator* whilst exploring the coasts of Terra Australis; by Matthew Flinders Commander 1801, 2, and 3'. He generally referred to it as 'my bearing book' and summarized its contents in a footnote to chapter 2 of his memoir: 'all the bearings and angles that were taken, whether on shore or on board, entered in a regular chronological order; as also the boat-soundings, and occasional eye-sketches of particular parts'.

In the first part of this article the evidence in the *Memoir* and the bearing book will be used to assess Flinders's practices with the instrumentation available to him and to comment on the degree to which time constraints limited application of contemporary methodology for sea surveys. Over eighty manuscript survey sheets arising from this observational and computational work have survived. The second part of this article distinguishes the field records drawn up onboard the *Investigator*, the fair records produced at Île de France, and the drafts produced in London for the *Atlas* to accompany *A Voyage to Terra Australis*, noting references to them in Flinders's private journal and correspondence.

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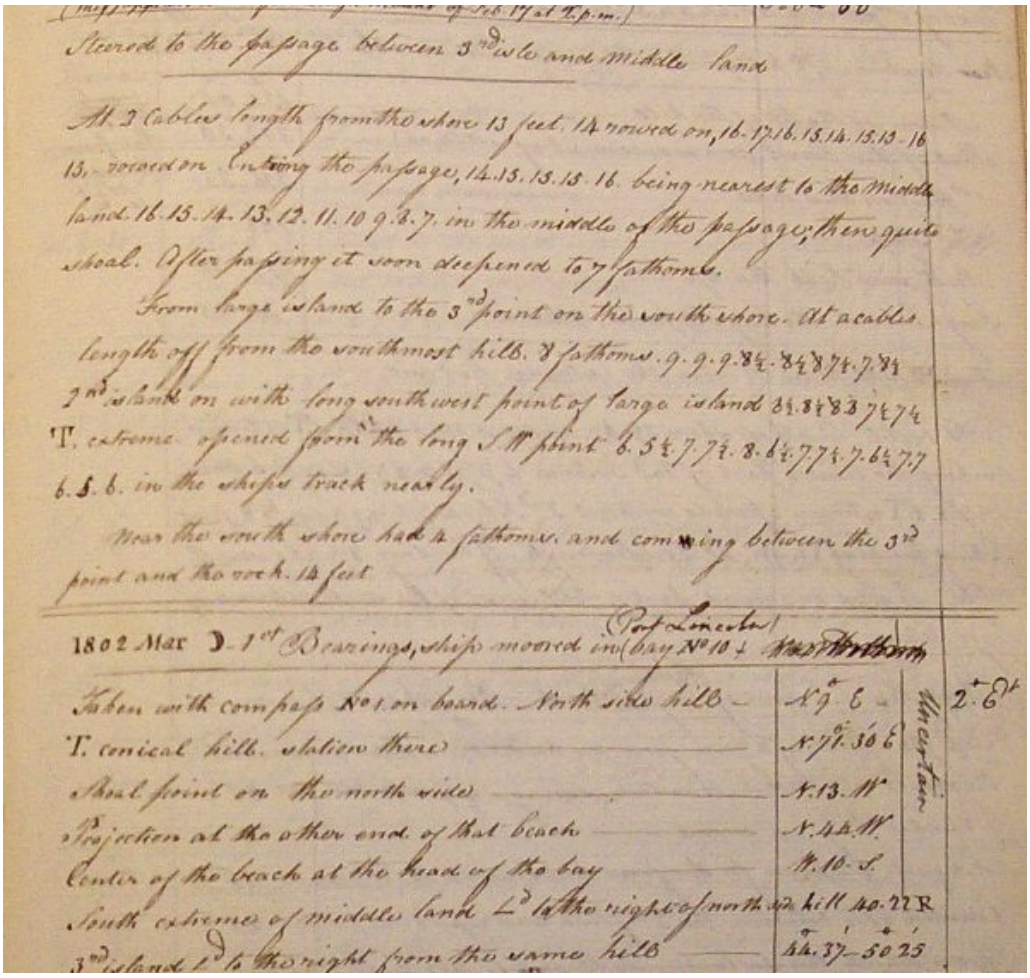
[1] UKHO Survey Data Books, Miscellaneous Books, No. 22, annotated on p. 237: 'Copied at the I of France by Mr John Aken, master of the Investigator, and compared with the original by Matthew Flinders 15 May 1805', available in the M series of the Australian and New Zealand Joint Copying Project. It is referred to hereafter as the Bearing Book. The whereabouts of the original is not known.


Steered to the passage between 3rd isle and Middle land

At 2 Cables length from the shore 13 feet. 14 rowed on, 16. 17 16. 15. 14. 15. 13. 16
13. rowed on Entering the passage, 14. 15. 13. 15. 16. being nearest to the Middle
land. 16. 15. 14. 13. 12. 11. 10 9. 8. 7. in the middle of the passage; then quite
shoal. After passing it soon deepened to 7 fathoms.

From large island to the 3rd point on the south shore. At a cables
length off from the southmost hill. 8 fathoms. 9. 9. 9. 8½. 8½ 8 7½ 7. 8½
2nd island on with long southwest point of large island 8½ 8½ 8 3 7½ 7½
T. extreme opened from the long S.W. point 6. 5½ 7. 7½. 8. 6½ 7 7½ 7. 6½ 7 7
6. 5. 6. in the ships track nearly.

Near the south shore had 4 fathoms. and coming between the 3rd
point and the rock. 14 feet

1802 Mar 1st Bearings, ships moored in (bay No 10 ± (Port Lincoln)

Taken with compass No 1 on board. North side hill	N 9° E	2° E
T. conical hill. shallow there	N 71° 30 E	
Shoal point on the north side	N. 13. W.	
Projection at the other end of that beach	N. 45. W.	
Center of the beach at the head of the bay	W. 10. S.	
South extreme of middle land L.d to the right of north hill	40. 22 R	
3rd island L.d to the right from the same hill	44. 37 – 50 25	

Figure 1: Part of a page from the 'Bearing Book' showing a record of soundings, and of bearings, with the applied correction for compass error in the right hand column.

The survey practices

Essentially, Flinders's mapping of the coast of the Australian continent during the voyages of 1801–03 comprises a 'running survey': a series of observations that an assiduous commander would undertake when traversing unknown or little frequented waters in order to fix the position of new lands or dangers he encountered. This was a discipline in which his old captain, William Bligh, was a master. In turn, Bligh had carried out such surveys under the eagle eye of Captain James Cook.[2]

The accuracy of a running survey depended on the precision with which the track of the ship could be laid down by dead reckoning between positions established by astronomical observations. The latitude of the ship was deduced from measurements of the altitude of heavenly bodies as they crossed the observer's meridian. Flinders discusses his measurements of the meridional altitude of the sun in some detail in chapter 3 of the *Memoir*. He states that, whenever circumstances and the altitude of the sun (70° or greater) permitted, he would observe a double measurement, observing the altitude of the lower limb and then turning to measure the supplement of the altitude of the upper limb from the opposite horizon. He describes how:

[2] Cook's survey procedures are described by Andrew David in A. C. F. David, chief ed., *The Charts and Coastal Views of Captain Cook's Voyages,* Hakluyt Society, Extra Series 43, 44 and 46, London, 1988–97, 3 vols.

> When the sun was so nearly vertical that the rapidity of his motion over the meridian would not allow time for taking two observations, my general custom was then to take one side whilst lieutenant Flinders took the other, and the mean result of both was considered to be the true latitude.[3]

Some of the larger angles recorded by Flinders took the observer to the limits of the graduated scale of the sextant, and he remarks in a footnote that the reflecting circles employed by the French were better suited for this measurement.

Longitude at sea could be obtained by the demanding method of 'lunar distances', which required dexterity in observation and considerable mathematical competence to complete the subsequent computations.[4] It required two observers to measure the altitude of the moon and of the sun or selected fixed star, while the principal observer measured the angular distance between the two bodies. A fourth observer noted and recorded the precise time of the observation. If the rate of the watch had been checked earlier in the day it could be used to calculate the local apparent time of the observation. Otherwise this was calculated from the observation of the sun or star. The corrected angular distances measured between the moon and the sun or one of ten fixed stars were compared with the values tabulated in the *Nautical Almanac* along with the times at which they occurred on the meridian of Greenwich. Difference in time gave the value of longitude.

As Flinders's work would show in areas which had been traversed by Cook during the latter's first voyage, the precision of deductions of longitude had been vastly improved with the availability of chronometers, provided that a careful check was maintained on their performance, i.e. the rate at which they might be running fast or slow. Flinders carried four chronometers and two pocket watches. The two chronometers manufactured by Arnold (Nos. 82 and 176), which had previously been allocated to Vancouver for his surveys, quickly became defective. Flinders was thus dependent on the two new chronometers made by Earnshaw (Nos. 520 and 543), and he analyses their performance in detail in chapter 4 of the *Memoir*.

To enhance the accuracy of his survey Flinders made regular landings at prominent points on the coast to make prolonged astronomical observations with the more precise instruments that had been supplied for use by John Crosley, the astronomer who had been appointed for the voyage but who had remained at the Cape of Good Hope because of ill health. A Ramsden Universal Theodolite with vernier scales that allowed the horizontal and vertical plates to be read to the nearest minute was used for the observation of altitudes and the more accurate determination of latitude. Three large eight-inch sextants with stands had been specially manufactured for the expedition by the great instrument maker Troughton. Flinders and his brother, to whom he delegated the bulk of the astronomical work, employed these to observe lunar distances. Substantial sets were obtained when time permitted. For example, fifty sets were obtained in Broad Sound, and whilst Samuel Flinders was marooned on Wreck Reef he observed no less than sixty. The sextants were also employed to measure equal altitudes of a heavenly body to derive the local time of the observed body's 'meridian passage' and thus, with observations spaced about seven days apart, to check the rates of the chronometers.[5] Whilst in Port Lincoln, Flinders employed the large telescope supplied for Crosley and observed an eclipse of the sun, but he considered that the intricate calculations for longitude

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[3] *Memoir Explaining the Construction of the Charts of Australia*, p. 15.

[4] The following description is based on the fuller account of the procedure in David, ed., *The Charts and Coastal Views of Captain Cook's Voyages*, I, pp. xxvii–xxviii. See also W. J. H. Andrews, *The Quest for Longitude*, Cambridge, MA, 1996, pp. 150–61.

[5] David, ed., *The Charts and Coastal Views of Captain Cook's Voyages*, II, p. xxviii.

would need subsequent re-computation by an astronomer.[6] In chapter 4 of the *Memoir* Flinders shows how these 'absolute' stations where the precise observations for latitude and longitude were made were the 'points of departure' for runs along the coast, with the chronometers being used to fix the longitude of 'relative' positions in between. The chapter gives a detailed account of how, after each run was closed at an absolute station, he calculated and applied proportionally what he terms an 'approximating correction' to the relative positions before plotting them on his survey sheets. All these observations that provided the framework of Flinders's survey were recomputed by Crosley after the voyage.[7]

As the ship passed along the intervening coast a sequence of compass bearings would be taken to edges of land or conspicuous features such as peaks in an effort to intersect prominent points and to establish the line of the coast in between. The precision of these observations was enhanced in discovery vessels by the issue of azimuth compasses fitted with a sight through which the feature could be observed and its bearing read on a scale, the zero of which had to be aligned with the north point of the compass. Flinders may have supplemented his bearings by measuring the horizontal angle between distinguishable features with a sextant as recommended by Alexander Dalrymple.[8]

The plotting of the intersection of three bearings, corrected for observed magnetic variation and deviation, would invariably reveal a 'cocked hat'.[9] Flinders took account of the observational errors that would contribute to the imprecision and that could be reduced to some extent by observational rigour, that is by correct identification of the target, careful sighting through the obstruction of sails and rigging, and swift observation whilst making adequate allowance for the motion of the ship and the time for the compass needle to settle.

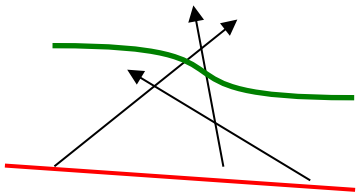

Figure 2: A cocked hat; ship's track in red, coastline in green, bearings in black.

The source of imprecision to which he would devote considerable study, particularly after his return to England, was the deviation caused by the residual magnetism in the ship. His deductions during this voyage are laid out in chapter 5 of the *Memoir*, which he expected to be scrutinized by the Astronomer Royal or other expert in view of his own 'very superficial and circumscribed knowledge upon the subject'. In 1799 Joseph Whidbey, veteran of the Vancouver expedition and Master Attendant at Sheerness Dockyard during the fitting out of the *Investigator*, had published in the *Naval Chronicle* his observations on the wide variation in compass readings depending on the amount of iron in different parts of a ship.[10] Flinders was thoroughly aware of this factor, removing the nearest guns from the quarter deck into the

[6] Flinders, *Memoir*, pp. 24–5.
[7] A. C. F. David describes similar practice by Vancouver in 'Vancouver's Survey Methods and Surveys' in R. Fisher and H. Johnson, eds, *From Maps to Metaphors: The Pacific World of George Vancouver*, Vancouver, 1993, pp. 51–69.
[8] Alexander Dalrymple, *Essay on Nautical Surveying*, 2nd edn, London, 1786.
[9] The term 'deviation' in this article did not come into usage until around 1820: A. E. Fanning, *Steady as She Goes: A History of the Compass Department of the Admiralty*, London, 1946, p. 421. The term 'cocked hat' seems to have first appeared in the latter half of the nineteenth century.
[10] *Naval Chronicle*, Vol. 2, Jul.–Dec. 1799, pp. 511–12.

hold, and identifying the biggest concentration of iron as the shot locker amidships. The significant development during this voyage was his observation that the deviation was at a maximum with the ship's head east or west by compass and that it disappeared when steering north or south. Thus the bearings listed in the bearing book and used for his plotting of the survey had been adjusted both for observed variation and by applying a correction depending on the ship's head. His proposal for a corrector bar on the binnacle would come later. He does, however, discuss the possibility of producing a table of corrections, and such a deviation card would emerge in the nineteenth century as iron ships were 'swung' for compass correction.

He noticed that his compass bearings ashore were also subject to local attraction where there was granite or iron-stone.[11] His observations for variation and for dip of the needle are accompanied by notes on the nature of the ground around his station. These were recorded on his survey sheets, the geological notes being particularly detailed in the Gulf of Carpentaria. Flinders also transcribed remarks on vegetation, native settlements and other matters to the sheets. This is consistent with the policy stated in the *Memoir* that the information in the final published chart should be 'sufficient for common sailing along the coasts'. The bearing book, recording bearings and vertical angles to the summit of conspicuous features, sometimes with illustrative sketch plans and views, also contained data on soundings and tidal streams for subsequent plotting.

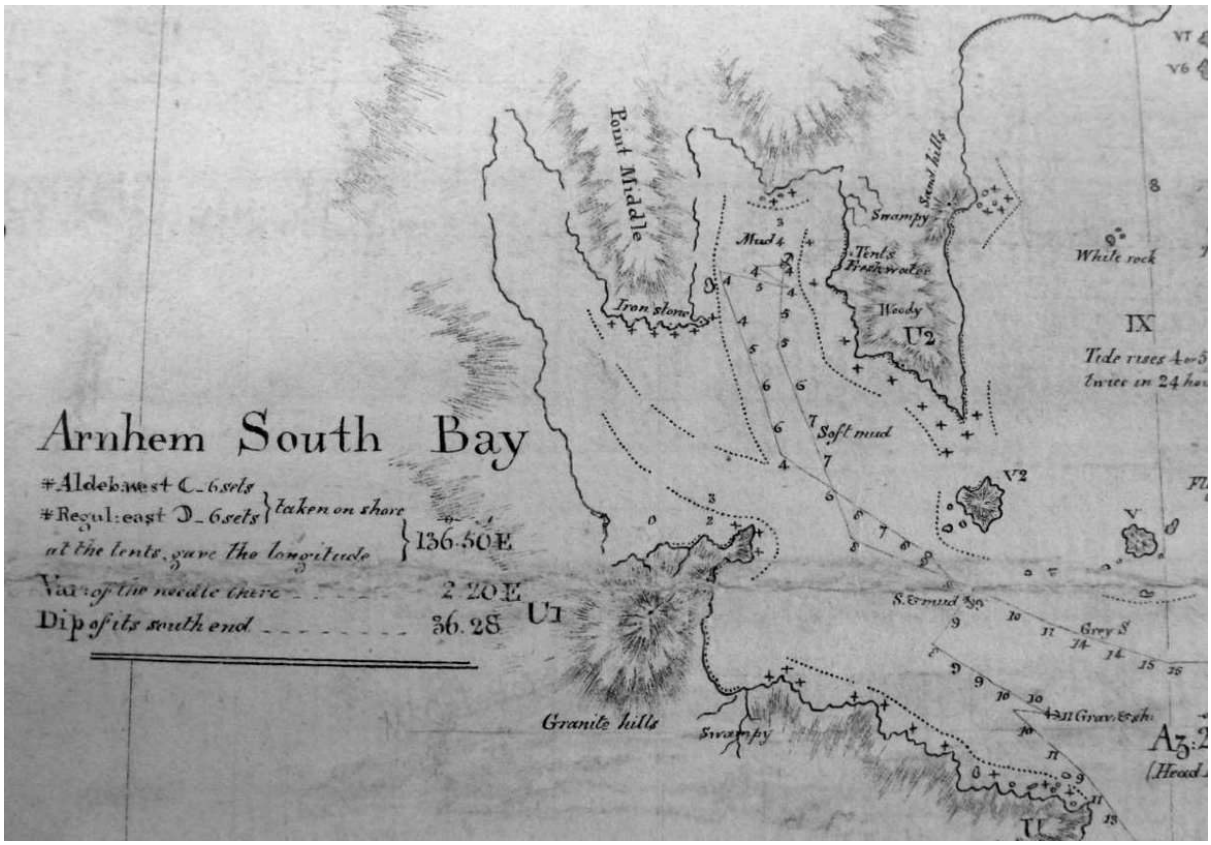

Figure 3: Annotation on a survey sheet in the Gulf of Carpentaria including geological information (TNA ADM 352/549).

[11] Flinders, *Memoir*, p. 56.

Where potential ports were encountered, a more detailed examination was usually undertaken. Flinders stopped at quite an early stage in his voyage to conduct the most intensive example of this work. His description in *A Voyage to Terra Australis* of his observations in King George's Sound[12] has led at least one recent biographer to describe it as a rigorous trigonometrical survey developed from a measured base-line and providing a network of stations by means of which soundings could be laid down by resection fixing.[13] However, careful analysis of the record in the bearing book shows this not to be the case.[14]

A fundamental stage in the conduct of a survey is the provision of scale. Where the orientation of any area that he was examining during passage off open stretches of coastline was broadly north–south, Flinders measured a base from the difference in latitude observed accurately on shore at its extremities. In his examination of Port Lincoln he had to settle for a measurement by sound, a procedure that was described in most contemporary manuals.[15] In King George's Sound the base-line was measured more precisely. It comprised a series of short legs probably measured with a chain, with the orientation of the legs established by theodolite observations at the turning points. However, the provision of scale by measurement of this base-line was almost the last operation that Flinders performed in this survey.

Furthermore, his theodolite operations throughout the survey in King George's Sound did not conform to a classical triangulation developed from a measured base. In such a survey an observer would start his observations at a particular station by aligning the zero of the base plate of his instrument on another station and measuring the angles to other stations and natural features from that 'zero'. In all his observations Flinders used magnetic north or south on the integral compass of his theodolite as the 'zero' for the angles. Thus he never observed a closed figure, i.e. all the angles in a triangle or quadrilateral summing to 180° or 360°, as would be the case in a standard triangulation system resulting in a network of accurately positioned 'sounding marks' that could be used to control boat-work by horizontal sextant angle fixing. He simply did not have the time for such work, and the station pointer, a three-armed protractor (designed to provide a graphical solution to the resection fix obtained from two horizontal sextant angles) which had been issued to John Crosley both for Broughton's voyage and for this one, was never employed.[16] Indeed the bearing book shows that Flinders completed the sounding work before any of his shore operations were undertaken.

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[12] Flinders, *A Voyage to Terra Australis*, I, pp. 53–7, 68–72.

[13] Miriam Estensen, *The Life of Matthew Flinders*, Crows Nest, NSW, 2002, pp. 180–81.

[14] R. J. Campbell, 'Matthew Flinders's Survey Methods: A Bicentenary Appraisal': unpublished paper presented at the 8th Anglo-French Naval Historian's Conference in 2001 and lodged at the National Maritime Museum.

[15] It was, for example, covered by Dalrymple, *Essay on Nautical Surveying*, pp. 13–14, and in Murdoch Mackenzie, *A Treatise of Maritim* [*sic*] *Surveying*, London, 1774, pp. 9–10. The interval was measured between the sight of the flash of a gun being fired at the other end of the base and the arrival of the sound of the report. Applying an assumed value for the speed of sound in air the length of the base could then be calculated.

[16] The station pointer was still a very new development with which few practitioners were familiar. Only a few of these instruments had been produced when Flinders sailed from England. Its utility would be demonstrated by Murdoch Mackenzie in the Thames estuary, with benefit of extensive shore control and ample time on task.

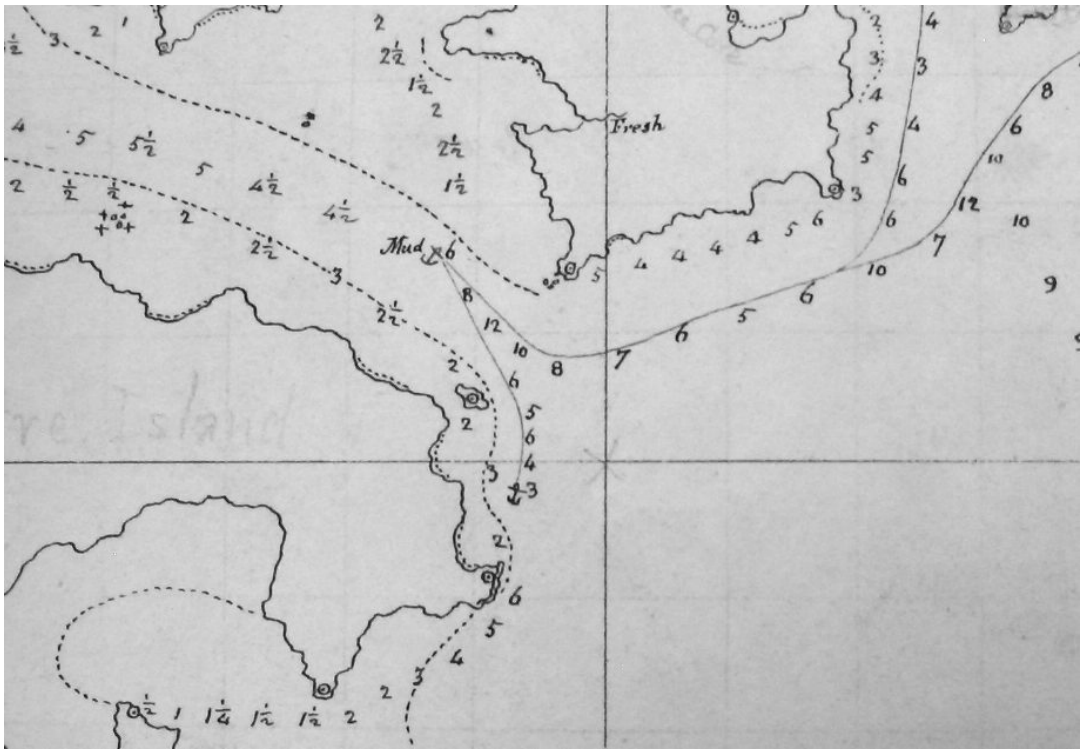

Figure 4: Extract from a rough field sheet showing soundings and the stations (circle with a dot in the middle) in the Sir Edward Pellew Group used to fix position and lay them down (TNA ADM 352/552).

As was commonplace in many boat surveys of this period the soundings were largely laid down by eye. Starting from the anchorage a compass course would be selected running on a natural feature as head-mark, and the soundings would be taken at regular intervals along the line. In one instance in King George's Sound Flinders fixed these soundings from the boat by measuring the angle between the ship at anchor and an edge of land. Where a natural transit between two edges of land was observed this would be recorded in the sequence of soundings in the bearing book. In some instances a sketch was made to assist subsequent plotting on the fair sheet. At Oyster Harbour in King George's Sound, Flinders occupied a shore station and used a theodolite and signal flags to direct the sounding boat for the survey of the bar. However, the record in the bearing book indicates that most soundings were roughly positioned by reference to prominent points on the shore and estimated distances off. Reference might also be made to features such as drying rocks that had been intersected from shore stations. This remained the practice in other locations which had not been visited or examined by Cook and where Flinders allowed time for sounding work, e.g. in Port Lincoln, Keppel Bay, Port Curtis and Shoal-water Bay, and to a lesser extent in the Gulf of Carpentaria and Arnhem Bay. In these later instances the sometimes extensive list of soundings in the bearing book can rarely be tallied precisely with the selected depths shown on even the larger scale manuscript survey sheets. However, the large scale plots drawn up in London for Spencer Gulf, particularly in the upper reaches,[17] do enable the stations ashore to be identified and the sounding selection to be followed.

Time constraints also limited the observations for the height of the tide that Flinders could make to reduce his soundings to a low water datum. To find this reasonably accurately would require a sequence of readings over the monthly cycle of spring and neap tides. The best that Flinders could do was to follow contemporary practice and note the time of high water and the maximum and minimum tidal range. In King George's Sound, observations by Samuel

[17] The National Archives (hereafter TNA) ADM 352/527.

Flinders over a period of sixteen days established the diurnal[18] nature of the tidal range on this part of the Australian coast, with high water occurring between 6 and 12 at night, with a maximum range of 3 feet 2 inches and a minimum range of 2 feet 8 inches. In effect this meant that only a very small reduction, if any, was needed to the sounding work, all of which took place in the middle of the day. Comparison of bearing book and fair sheet does indicate that Flinders may have made such a reduction. However, this comparison is not easy. Generally, he seems to have obtained many more soundings than he could plot at the scale of his final sheets and there are indications that he may have plotted values that had been extrapolated and generalised. However, the record in the bearing book of a later examination on the south coast does contain a clear direction in a list of soundings: 'Now high water, ½ fathom to be deducted'. During the extensive exploration of Keppel Bay he also had time to observe the tidal range and hence to record the deductions that he had applied to soundings as he took them.[19] His acute powers of observation are also apparent in the Gulf of Carpentaria where he shows awareness of the mixed tidal regime (i.e. semi-diurnal in part of the tidal cycle and otherwise diurnal) and included notes about this on his survey sheets.[20]

Flinders prided himself as a 'disciple' of Cook and Bligh. In his memoir he takes infinite care to explain his reasons for setting aside any work of the former, which he had 'held sacred', and he expresses particular admiration for the extraordinary results that the latter achieved in his open boat voyage. His own surveying voyage would provide schooling for Midshipman John Franklin, who accompanied his captain in the examinations by boat and assisted Samuel Flinders at the shore observatories. Franklin would be considered competent for a subordinate command in one of the first post-war discovery voyages despatched into the Arctic. The only indication of involvement of other young men in the survey work is a track chart of Torres Strait which is annotated 'Copied by K Sinclair, Midshipman of Investigator'.[21] Nothing is known of the subsequent career of the eighteen year old Kennet (*sic*) Sinclair. He did not pass for lieutenant.

Two others who did receive encouragement from Flinders were midshipmen Alfred Dale and Graves Seymour, fellow prisoners of war on Île de France who had been captured whilst in charge of a prize crew from the 36-gun frigate *La Dédaigneuse*.[22] He records that he 'had much pleasure in furnishing them with books and assisting their studies'. Both men, but particularly Alfred Dale, assisted Flinders 'in making copies of charts and memoirs, in calculating astronomical observations, etc.'. Dale had been rated midshipman in the *Clyde* by Captain Charles Cunningham, a commander who encouraged the collection of navigational data. Both young men had served under the distinguished hydrographic practitioner, Captain Peter Heywood, during their time in *La Dédaigneuse*. However, neither would go on to serve in the new cadre being built up by Thomas Hurd.[23]

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[18] In a diurnal cycle one high water and one low water occur in each period of 24 hours. In a semi-diurnal cycle, such as that around the British Isles, two high and two low waters are experienced in the course of 24 hours.
[19] Flinders, Bearing Book, pp. 94, 113, and 115.
[20] TNA ADM 352/548 and 549.
[21] TNA ADM 352/484.
[22] TNA ADM 36/16699 Muster Book Nos. 16 and 34 with 156.
[23] Flinders records their assistance in April 1805: *A Voyage to Terra Australis,* II. For Cunningham, see M. K. Barritt, *Eyes of the Admiralty*, Greenwich, 2008; and for Dale's subsequent career see W. R. O'Byrne, *A Naval Biographical Dictionary*, London, 1849, p. 258. References in A. J. Brown and G. Dooley, eds, *Matthew Flinders Private Journal 1803–1814*, Adelaide, 2005, show that the Dale family repaid Flinders's attention to their son, and suggest that they had a connection with Cunningham, to whom they introduced Flinders.

The records

Chapter 2 of Flinders's *Memoir* explains his cartographic policy and procedures in some detail, stressing his objective of producing charts which would 'contain every information necessary to the knowledge of, and safe navigation along, the coasts, without the aid of written accounts'. It includes an explanation of the scales that he adopted, sometimes, as in the case of his general chart, dictated by the stock of paper available to him whilst in captivity. He explains his policy on depiction of dangers with great clarity. He also expresses firm views on nomenclature, and explains his decision to leave selection of names until his return to England.[24] A large corpus of his work has survived, enabling his practice to be studied in some detail.

Over eighty manuscript survey sheets by Matthew Flinders, formerly in the archive of the UK Hydrographic Office,[25] are now in the ADM 352 series in The National Archives (TNA), Kew. The majority arise from this voyage and its sequel in the *Cumberland*. There was no formal system for receipt and accession in the period when they arrived in the Admiralty and were passed by the clerks to the Hydrographer's small staff. Indeed the pressure of wartime had given no latitude to assess and organize the backlog of deposited material which lay 'in promiscuous heaps in different rooms of the office, without any geographical order or arrangement and filthy with dust'.[26] When the first record of holdings in the Hydrographical Office was made in the early 1820s Flinders's sheets were entered in a haphazard sequence that has been transmitted to the ADM 352 numbering.

One element is easy to distinguish. In an appendix to the first volume of *A Voyage to Terra Australis*[27] Flinders explains how actual observations in the observatory at Greenwich had revealed inaccuracies in the predicted values of lunar distances in the editions of the *Nautical Almanac* used during the voyage of the *Investigator*. Consequently, the Board of Longitude had directed that all the astronomical observations from the voyage should be recomputed. This work was entrusted to John Crosley, who was assisted by Samuel Flinders. Over half of the surviving sheets pertaining to the voyage were produced during Flinders's intensive effort in London to re-plot his work with the corrected values of longitude. All the fair sheets drawn up by John Arrowsmith at a scale of 4 inches to a degree of longitude, from which reductions were made and engraved for the plates in the *Atlas* accompanying *A Voyage to Terra Australis*, have survived. Most of the fair sheets have associated rough sheets at large scale, including plots from areas of more intensive examinations. The latter are particularly valuable for clues on his surveying practice. Details are shown in the table below.

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[24] See Dany Bréelle, 'Matthew Flinders's Australian Toponymy and its British Connections', *The Journal of the Hakluyt Society*, Nov. 2013.

[25] These were listed with short descriptions in Hydrographic Department Professional Paper 13, 'A Summary of Selected Manuscript Documents of Historic Importance Preserved in the Archives of the Department', London, 1950, Part 6.

[26] UKHO Miscellaneous Letters and Papers, File No. 107(i), p. 2.

[27] Flinders, *A Voyage to Terra Australis*, I, pp. 258–9.

Atlas Sheet	ADM 352	HO Ref.	Associated Large Scale Plots	Notes
General Chart	478	y 46/2		On this sheet, unlike the 1804 fair sheet, Heywood's soundings in the Timor Sea (see below) have been included. They are inscribed at right angles to the track to distinguish them from Flinders's work.
S Coast I	537	y 51/10	538, 540, 541, 544 and possibly 542 and 543	542–4 are plots of the King George's Sound survey.
II	533	y 51/6	534 and 536	534 comprises two coastal strips on one sheet.
III	523	y 50/6	524-532 inclusive	527 can be tallied particularly closely to the record of the examination of the upper reach of Spencer Gulf in the Bearing Book (pp. 65–6).
IV	520	y 50/3	521 and 522	
V	505	y 48/9		
VI	510	y 49/4	504, 509, 511–16 and 518	518 is extensively annotated and shows squaring down.
E Coast I	501	y 48/5	500 and 503	500 is marked up with pencil references to Atlas plates.
II	499	y 48/3		
III	493	y 47/7	491–2, 494 and 497	An instruction to the engraver on 493 to omit part of the survey of Broad Sound was not obeyed. Large scale plots, and especially 491 and 494, show shore control stations very clearly, including that on Sea Hill Point on Curtis Island. All contain instructions to draughtsmen and notes on scale.
IV	486	y 46/10	488	Both sheets retain the pencil squaring showing how the reduction was made.
V	485	y 46/9		Coastline surveyed by Cook, which Flinders re-plotted to give weight to Cook's observation of Jupiter's satellites at Endeavour River. This was then reduced onto the revised General Chart.
N Coast I	480	y 46/4	482	Annotation by Flinders corrects the layout of the title of 480.
II	547	y 53/2	546 and 550–2	552 is the rough sheet for one of the four collector plans on the complex 551.
Timor	545	y 52/9	544 and y 52/10	Heywood's soundings (see below) are inserted at right angles to track.

The surviving sheets that were produced in the course of the voyage present a greater challenge. In his correspondence, journals and published account, Flinders records the despatch of several consignments to London. Copies of 'my chart of the south coast of Terra Australis, in six sheets; with three other sheets of particular parts, on a large scale' were brought to London by Lieutenant John Murray in September 1803. When Lieutenant Fowler took passage in the *Rolla* following the disaster at Wreck Reef he was entrusted with copies of 'four charts, being all of the East and North Coasts which there had been time to get ready'. In July 1804 Charles Lambert, owner of the captured East Indiaman *Althaæ*, took a packet of 'copies of the charts constructed here' on his release from Île de France. Mr Aken took home a consignment on release in 1805. Flinders told Sir Joseph Banks that it comprised sixteen sheets, but only thirteen sheets are mentioned in *A Voyage to Terra Australis*.[28] Finally, Flinders's servant John Elder took home an unspecified number of charts reconstructed on a larger scale.

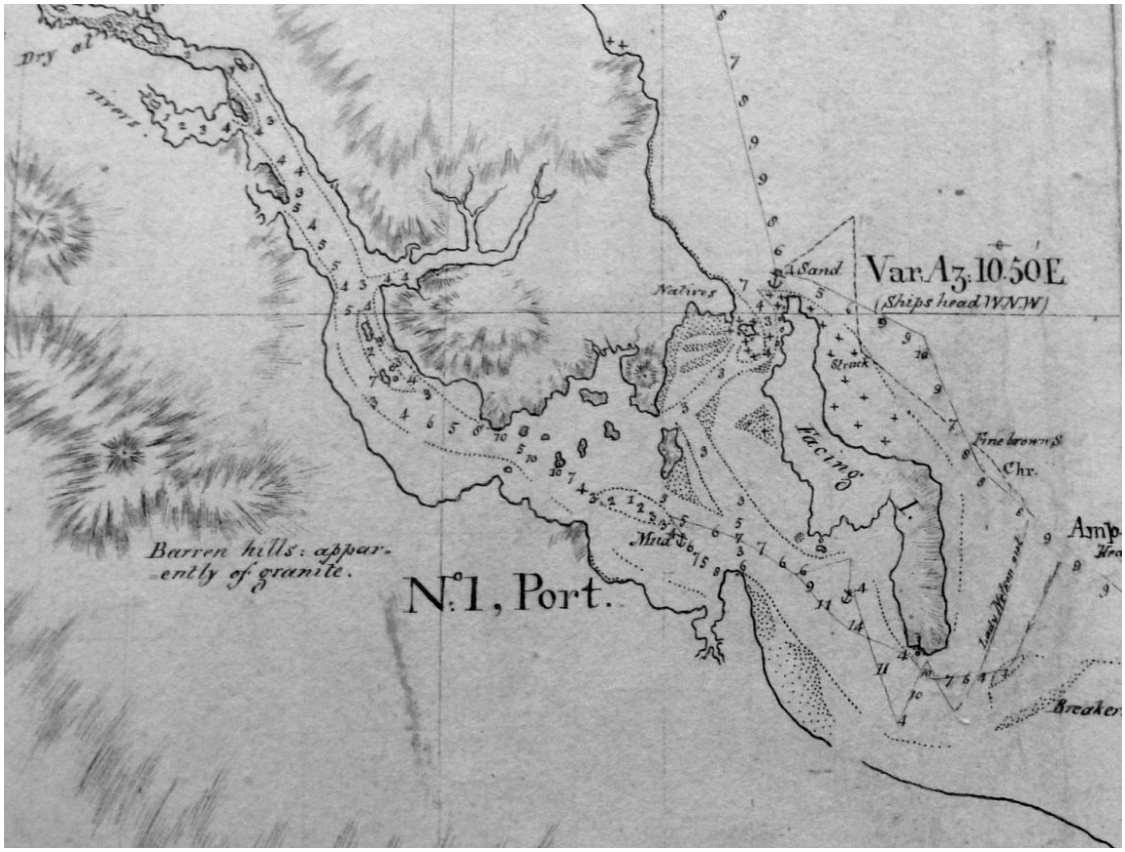

Figure 5: Extract from a sheet rescued from the wreck of the *Porpoise*, bearing sea-water stains (TNA ADM 352/495).

It seems likely that Flinders himself may have purged earlier copies of his work after his return to England. ADM 352/556 is a collection of plans of potential ports on the south coast between Spencer Gulf and Port Phillip with a legend recording the haunting loss of Mr Thistle and his boat party.[29] An annotation made later in London gives a cross-reference to a footnote in the *Memoir* discussing discrepancies in 'the first charts sent home', thus identifying this as

[28] *Historical Records of New South Wales*, Sydney, 1892–1901, vol. V, p. 623: letter dated 16 May 1805; Flinders, *A Voyage to Terra Australis*, II, pp. 339, 407, 411.

[29] The boat was lost with all hands while returning to the ship on 21February 1802, which gave rise to the naming of Cape Catastrophe, Memory Cove and the islands in the vicinity: Flinders, *A Voyage to Terra Australis*, Vol. I, pp. 135–8.

a survival from the three larger scale charts in the set entrusted to Lieutenant John Murray. There is a set of six charts at a scale of 4 inches to a degree of longitude covering the south coast, also with extensive annotations made later in London.[30] One of these (ADM 352/557) has a cross-reference to the *Memoir* confirming that these also were charts sent with Murray. Sheet number 6 in this series is the chart of Bass Strait that Flinders discusses at length in chapter 6 of the *Memoir*. He describes this ruefully as 'a piece of patchwork', and the component observations from his own voyages and those of Bass, Murray and others are listed in an annotation dated 16 March 1811. He was bitterly disappointed that the defects of the *Investigator* prevented a proper survey to improve the chart published by Arrowsmith in 1800. He had stressed the strategic utility of the strait and this was confirmed in his absence when the captain of HMS *Athenienne* received orders in May 1804 'to proceed with the East India Ships under his convoy, thro' Bass's Strait between Van Diemen's Land and New South Wales, to China, passing to the eastward of New Holland and the Philipinas'. The directions had been drafted by Alexander Dalrymple, who had 'made an abstract of Flinders on the S Coast of New Holland and mean to give also copy of his chart of Bass's Strait'.[31]

Two of the four charts of the east and north coast entrusted to Lieutenant Fowler can be identified with some confidence. ADM 352/553, labelled No.2, depicts the eastern half of the Gulf of Carpentaria. ADM 352/495 is a larger scale plot of the examination of Port Curtis (Port Gladstone) and Keppel Bay, annotated in pencil: 'The original, being thus injured at the wreck of the Porpoise'. ADM 352/496 is a replacement which may be the fourth chart carried by Fowler but is more likely to be a sole survival of the consignment sent with Lambert.

It is possible that Flinders took particular care to ensure the preservation of the work undertaken during his confinement on Île de France, and, indeed, most of the sheets that he mentions specifically in his private journal can be identified. ADM 352/477 is the modified 'General Chart' subsequently entrusted to Aken.[32] On his return to London Flinders transposed onto this sheet the soundings taken by Peter Heywood in the *Vulcan* in 1801 in the vicinity of the Great Sahul Shoal (Sahul Banks), thus filling one of the gaps in the coverage which the Admiralty had specified in their orders for the voyage.[33]

Aken also carried home nine coastal sheets at a scale of 4 inches to a degree of longitude. The surviving set of six sheets of the south coast have been identified as part of the consignment despatched from Port Jackson with Murray, although they do, with the general chart, reflect the conventions that Flinders wrote up on Île de France in the second chapter of his *Memoir*. Sheets 1 and 2 also show the track of the *Investigator* during the voyage from Timor to Port Jackson. However, these seem likely to have been added later at the same time as some notes comparing observations of variation in 1802 and 1803. Three other coastal charts all have unambiguous internal evidence dating their compilation to Île de France. ADM 352/498 and 487 cover the east coast from Port Stephens to Rockingham Bay. The latter carries a sheet number ('Sheet N$^{o.}$8') and a legend which explains that it is an abridgement from the original sheets at 12 inches to a degree of longitude, 'the opportunity of doing this during my present imprisonment being given by the repossession of a part of my books and papers'. Flinders also described in his private journal the amalgamation of parts of three

[30] TNA ADM 352/539, 535, 557, 555, 519, and 506.

[31] TNA ADM 1/3522: letter dated 25 May 1804; Dalrymple had by now published an Admiralty chart of Bass's Strait incorporating Flinders's work.

[32] The copy taken to England by Mr W. H. Robertson (Flinders, *A Voyage to Terra Australis,* II, p. 411) may be that numbered 554 and recorded as destroyed in Book A, the first listing of holdings in the Hydrographical Office.

[33] Brown and Dooley, *Private Journal*, pp. 360–61, where Flinders states that while seeking information from Sir Joseph Banks and Arrowsmith he obtained a 'late sketch of Capt. Heywoods'. For a full account of Heywood's survey and Flinders use of it see Andrew David, 'Peter Heywood and Northwest Australia', *The Great Circle*, 1, 1, 1979, pp. 4–14.

earlier sheets covering the north coast in a depiction of the Gulf of Carpentaria, and this sheet is at ADM 352/548. It carries particularly comprehensive notes on tides and weather, and also records the anchorages of the Malay trepang collectors. A legend on the chart dated 18 January 1804 states: 'The two original rough charts, which contained Groote Eyland and the parts of this coast north of it, having been lost in the shipwreck of H.M. armed vessel Porpoise, I have embraced the leisure afforded by a close imprisonment in this island to reconstruct the parts lost from my log and bearing books, before the recollection of them becomes too faint ... however ... as ... my books record 43 observed latitudes ... together with 871 bearings and angles taken onboard and 720 with a theodolite ashore, I hope no very great errors will be found.'

The three sheets at a larger scale that were entrusted to Aken can also be identified with reasonable confidence. The first is a rare survival of one of the working sheets plotted at 12 inches to a degree of longitude. It is ADM 352/490, showing the east coast from Cape Manifold to Broad Sound, an area of intensive investigation, and also Flinders's subsequent examination of the inner fringe of the Great Barrier Reef. ADM 352/483 is the first of Flinders's efforts to construct a chart of Torres Strait, another survey area to which the Admiralty had allocated a high priority. It is dated 10 February 1804. ADM 352/538 is a chart of D'Entrecasteaux's Archipelago (Archipelago of the Recherche), probably that on which he was working in the same period and bearing later additions made in London.

Figure 6: Extract from a sheet drawn up at Île de France with extensive annotations made in London during preparation of the Atlas to accompany *A Voyage to Terra Australis* (TNA ADM 352/481).

Three of the larger scale sheets that arrived in England with Elder in July 1807 can be identified. ADM 352/481 is the chart of Torres Strait on which Flinders worked in August 1806. The legend contains cross-references to chapter 7 of the *Memoir* which contains his

detailed account of how he adjusted earlier observations and combined them with his own. It also contains comment on the inhabitants of the islands and their produce. The sheet bears extensive annotations made on his return to London, including the allocation of names. He worked on another sheet, based on his own observations and those of earlier explorers, that covered part of Torres Strait and the Gulf of Carpentaria, and which was ready in time for Elder's departure. This is at ADM 352/479. The title declares that it is by 'M. Flinders, Commander in the Royal Navy, Prisoner in the Isle of France'. In the previous autumn he had worked on a sheet showing the west side of the Gulf of Carpentaria on a larger scale. This is at ADM 352/549 and is the only other 12-inch sheet that has survived. It contains his most comprehensive record of geological observations. The legend repeats the information on ADM 352/548 and comments:

> The continuance of my detention not allowing me to prosecute the examination of Australia actively, I have constructed these parts afresh, upon the present scale, and I hope with increased accuracy.

As in the case of Bass Strait, Flinders was very conscious of the strategic potential of the route through Torres Strait and he was confident that his charts and the directions in chapter 7 of the *Memoir* would enable 'any man of moderate judgment and experience, who is not over timid' to use it to 'conduct a ship from the Pacific into the Indian Ocean in three or four days, if favoured with the fair breezes and fine weather which usually prevail here between March and November'. He judged that six weeks could thus be saved on a passage from Port Jackson to India compared to the 'eastern route' round New Guinea, which was not without its own perils. A document in the UKHO archive[34] suggests that Flinders's remarks continued to be studied when steps were taken in the 1820s and subsequent decades to gather data for Admiralty Sailing Directions. It contains transcriptions of remarks from the circumnavigation, probably revised on return to London, of a detailed voyage report to the Admiralty from Coepang on 5 April 1803, and of 'information collected from the Malay Proas met with on Feb 17th 1803 near Cape Arnhem'.

Conclusion

The amount of original material in the form of journals, record books and manuscript charts arising from Flinders's voyaging round Australia, especially in the *Investigator* in 1801–03 is unmatched in the period. To a great extent this results from his enforced isolation on Île de France. Other distinguished hydrographic practitioners and careful record-keepers, such as Peter Heywood, were constrained by the demands of active front line service throughout the twenty-year conflict with Revolutionary and Napoleonic France.

However, there are other factors driving the detailed record that we have of Flinders's endeavours. The account in his 'Memoir' leaves little doubt that he was acutely conscious throughout of walking in big footsteps, not least of Cook, already a legendary figure:

> It is probable there are many others who, like me, have been so much dazzled by the celebrity of the name of Cook, as to attach the idea of incontrovertible accuracy to every chart that bears it ...[35]

[34] UKHO OD 76: Australia south and east coasts, and Torres strait, thence to Timor. Captain Matthew Flinders RN, HMS Investigator 1803.
[35] UKHO OD 779, f. 602.

Flinders was also haunted by a consciousness of unfinished business:

> In the charts which are here presented to the public, the judicious navigator, who may hereafter sail along the coasts of Australia, will doubtless find many errors and omissions; and the want of precision, which is but too apparent in very many parts, will also fall under the observation of the geographer, who shall examine the sheets with the eye of criticism. As an apology for these, I beg leave to observe, – that I was deputed to examine the coasts of a country, which, in superficial extent, is little inferior to all the kingdoms of Europe; and this, besides the accomplishment of some other objects, was expected to be performed in about four years, including the passages out and home, of near six months each, and the necessary times of refitting in harbour. If due allowance is made for the expedition with which the magnitude of this task made it necessary to move, I hope to escape the censure of those who may think that our investigation has not been sufficiently minute; and to satisfy the inquirers, who ask, why the grand object of the voyage has not been more fully accomplished than the general chart shows it to be ... It is hoped, that the decay of the Investigator, the shipwreck of the Porpoise, and my imprisonment in this island ... will be allowed as a sufficient answer to the question.[36]

In fact Flinders's work has earned the admiration of all who have aspired to follow in his footsteps.

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[36] UKHO OD 779, ff. 611–13.