TIDAL OBSERVATIONS IN ARCTIC WATERS

Notes by T. H. Manning and by R. W. Rae

Notes on the Tides Along the South Hudson Bay and West James Bay Coasts—*By T. H. Manning*

Acknowledge of the time of high and low water and of the tidal range is always important for coastal travel by boat or canoe. Along the south shore of Hudson Bay and the west coast of James Bay such information is essential, for, except in the mouths of the large rivers, dry land can be reached at high tide only, and at many places there is over a mile of tidal flat at low tide.

In 1947, while engaged in establishing astronomical control positions for the Geodetic Survey of Canada, I travelled by canoe from Moosonee

On the south coast of Akimiski Island, 23 June 1947, waiting for the tide to rise. At low tide no water could be seen when standing up in the canoe.

to York Factory and around Akimiski Island. We took no exact tidal readings but, as all our movements were conditioned by the tides, my diary contains fifteen casual observations on the time of high tide at fourteen places. Other information on the tides along this coast is so scant that these rough observations seem worth recording. The third column in the following table lists my 1947 observations of high tide in Central Standard Time; the figures in the last column and on the map give the difference to the nearest quarter hour between the time (CST) of high tide at the places listed and the time at which the peak of the same undulation passed Churchill as given in the 'Tide tables' for 1947 (1946).

Place	Date of observation	Time of high tide in hours (CST)	Difference between times of local high tide and Churchill high tide to nearest quarter hour*
Goose River	August 18	1300	4 hours
Little Cape	August 3	1500	$6\frac{1}{4}$
Cape Henrietta Maria	July 26	1030	$8\frac{3}{4}$
Lake River	July 18	1745	$10\frac{1}{2}$
"Lat. 53°45"	July 15	0330	$11\frac{1}{2}$
Raft River (Swan River)	July 14	0230	$11\frac{3}{4}$
	July 8	2230	$11\frac{3}{4}$
Houston Point	July 1	1830	12
E. coast Akimiski Island	June 29	1730	13
Cape Duncan	June 28	0700	16
S. coast Akimiski Island	June 23	1730 (?)	$18\frac{3}{4}$
Mouth of Attawapiskat River	July 6	1830	21
Lowaski	(Derived from Dowling, 1904, p. 11F)		20
Albany	(Derived from 'Tide tables', 1946)		$18\frac{1}{4}$
Long Ridge Point	June 16	2130	$17\frac{1}{2}$
Big Piskwanish	June 12	1900	$17\frac{3}{4}$
North Point	June 6	1430	$17\frac{3}{4}$
Ship Sands	(Derived from 'Tide tables', 1946)		$19\frac{1}{2}$

* In reconverting these figures to obtain the time of high tide at any of the southern James Bay places, it must be remembered that, when the difference between the time of high tide at any given place and at Churchill is greater than the difference between the times of succeeding high tides at Churchill, the time of the earlier high tide must be used, since the times here given are those for the crest of what is assumed to be the same tidal undulation as it passes the places listed.

The time differences between the local high tide and the Churchill high tide are clearly of a very approximate nature, since not only are the original observations very rough (an error of half an hour is quite likely), but they were made under varying wind conditions at different lunar phases without any certainty that all the places have the same tide type. Nevertheless, the figures do show in a rough way the progress of the tidal undulation along the Hudson Bay coast from Churchill to Cape Henrietta Maria and into James Bay.

In speaking of the tides in James Bay, Lower (1915, p. 42 and diagram) gives the following generalized picture of the progress of the tide down James Bay, but unfortunately he does not indicate the detailed observations on which it is based. Our records, however, confirm his statement, except that the steadily increasing tidal interval along the southern Hudson Bay coast and around Cape Henrietta Maria indicates that the tide probably reaches James Bay from the northwest rather than from the northeast.[1]

"The tide enters the bay from the north, travelling from the straits in a southwesterly direction. It spreads uniformly over the entire body until it reaches Agumiski island and Neakwow [Ekwan] point. At these

[1]Lower's account was written before Flaherty published his description of the Belcher Islands. A glance at a modern map will show that these islands are likely to interfere with a tide from the northeast.

Difference between observed times of local high tide and Churchill high tide to the nearest quarter hour.

places it splits; that portion of the water that comes to Neakwow point divides, the main stream turning north and flowing along the coast toward the cape. The rest penetrates between Agumiski and Neakwow, flowing on down the strait. At the same time, that portion of the main tide that had gone down the east shore of Agumiski, travels southward until it reaches the "Cock" [Cockispenny Point], and there divides in its turn, part of the water going on south to Moose river and part turning north, penetrating the Albany, flowing along the coast, becoming pursed up in the narrowing strait between Agumiski and the mainland, and finally meeting the northern half of the tide in the neighbourhood of the Manowinan islands. The results are: (a) Four high tides a day around the Manowinan islands; these come in pairs and the crest of each member

Looking southwards from the mouth of the Raft River, near high neap tide, 1 September 1947. The mud and sandflats near the sea show white; the areas of short grass covered by the higher spring tides are grey; the long grass and sedge marshes are darker, and still darker are the patches of dwarf willow and birch; the nearly black lines, upper right hand corner, are ancient strand lines now wooded with spruce and willow.

of the pair is not far apart. That is, shortly after tide A has begun to ebb, tide B becomes full. (b) A tide race of considerable violence in the strait. The currents are so strong here that a sound of considerable depth has been hollowed out. . . ."

The even progress of the tide along the west coast of James Bay is interrupted by Akimiski Island and the two Twin islands which reduce the width of the bay by about half. The four hour delay between the time of high tide at Houston Point and at Cape Duncan is probably due to the damming effect of this constriction. Sixty miles south of Cape Duncan across the wider bay at Halfway Point, the tide is apparently only about one and a half hours later, although along the coast to north and south of there the tidal interval increases rather rapidly. The difference of an hour and a half between the time of high tide at North Point and at Ship Sands may in part be due to the influence of the Moose River at the latter place. At Moosonee, the tide is 1 hour 31 minutes later still ('Tide tables', 1946). At Fort Severn, we thought it was one to two hours later than at the mouth of the Severn River. At Fort Albany,

Cape Duncan, Akimiski Island, looking south at low tide, 1 September 1947. Gullery Island in distance. The arrow points to the Geodetic Survey's tablet and beacon.

Attawapiskat, and Weenusk, similar delays are to be expected.

When we were at an island, possibly one of the Manowinan Islands mentioned by Lower (see above), about 5 miles north of the mouth of the Attawapiskat River, we observed a halt of half an hour or so in the ebb. This probably occurred about two hours after the tide was high, but unfortunately the details were not recorded.

In the quotation from Lower given above, reference is made to the rapid tidal currents between Akimiski Island and the mainland. Off Cape Duncan, at the other end of Akimiski Island, they are almost equally strong, and for 3 or 4 miles west of the point the usual James Bay mud has been swept away, leaving clear water and boulder shoals. Captain William Coats (Barrow 1852, p. 53) says that the tides near the south and east part of Akimiski Island set nearly northeast and southwest, and that the ebb runs pretty briskly to the eastward.

The 'Tide tables' for 1947 (1946) give the rise of tide at Nelson as 14 to 16 feet at springs, and 11 feet at neaps. This rise probably decreases gradually towards Cape Henrietta Maria, where Anderson (1914) gives the rise of spring tides as 9 feet, and that of neaps as 6 feet. The 'Tide tables' give the spring rise at Ship Sands as $8\frac{1}{4}$ feet, and the neap rise as $5\frac{3}{4}$

feet. At intermediate places in James Bay there does not appear to be any great variation from these figures, but because of the wide tide flats, estimates of the range are almost impossible at most places on the west side of James Bay. In Akimiski Strait the action of a double pair of tides may reduce the range. Coats (Barrow, 1852, p. 27), Low (1888, p. 32J), Dowling (1904, p. 11F), Lower (1915, p. 42), and Manning (1948, p. 40) have all observed that continued northerly winds give rise to exceptionally high tides, while southerly winds produce abnormally low tides in James Bay. The same is true along the shallow south Hudson Bay coast, and at the mouth of the Severn River an old Hudson's Bay Company's schooner can still be seen inland on the grass where it was driven by a northerly wind and an exceptionally high tide many years ago.

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Tidal Observations at Resolute Bay and Isachsen—*By R. W. Rae*

During the summer of 1949 an attempt was made by the staff of the weather station at Resolute, N.W.T. (74°41 N., 94°55 W.) to determine the tidal range in Resolute Bay. The following account describes the methods used and gives a brief summary of the results obtained.

The site for the tide marker (Fig. 2) had to be chosen with some care to avoid drifting ice. There was no pier or wharf on the bay to which the marker could be attached and it was necessary to mount it on a wooden platform which was weighted in position with rocks and gravel. By the second week in July a sufficiently wide shore lead had formed in the bay ice, and the tide marker was installed at a point near the mouth of a small creek where it was surrounded on three sides by gravel bars (Fig. 1). It was hoped that any drifting ice would ground

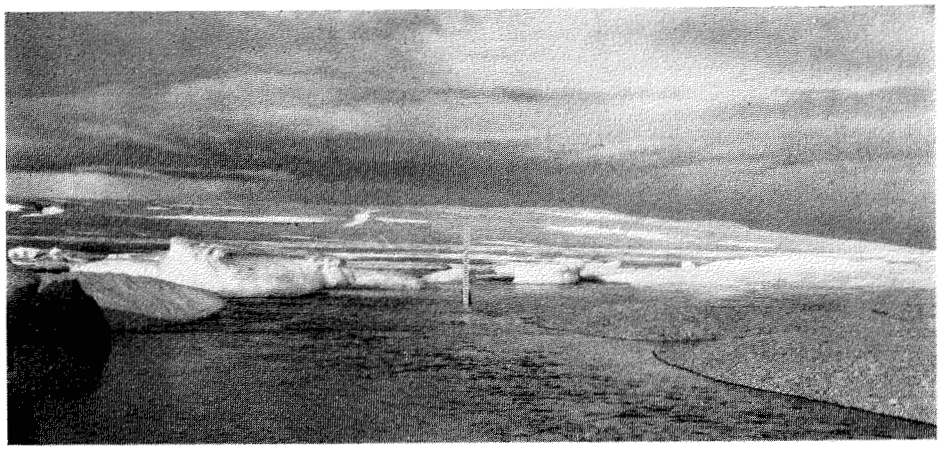

Fig. 1. The tide marker in Resolute Bay.

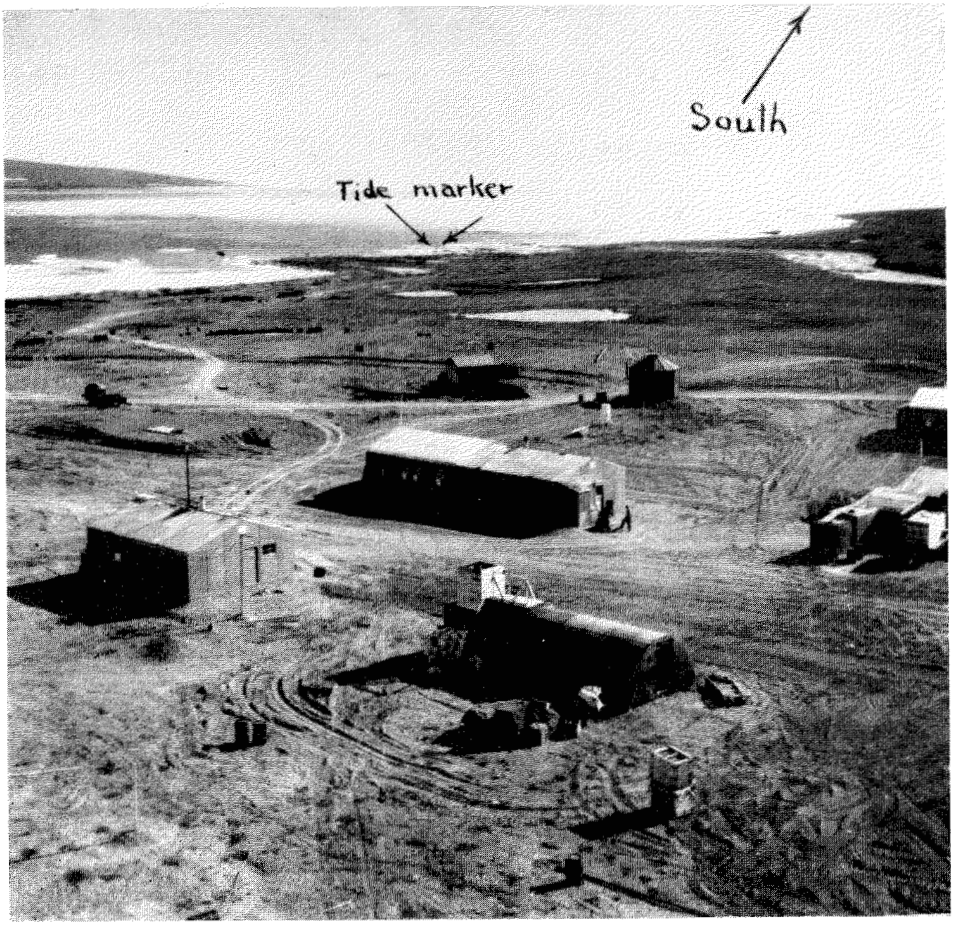

Fig. 2. The weather station at Resolute, showing position of the tide marker.

on these bars before reaching the marker. This was found to be the case and the marker was dislodged by ice on a few occasions only during the summer, although there were numerous large blocks of ice in the vicinity almost continuously. Whenever the marker was shifted by ice it was reset as closely as possible in its previous position, a geodetic bench mark on the beach nearby being used as reference. On August 16, a huge block of ice upset the marker and it was not possible to re-erect it until August 22. On August 28, drifting ice tore the marker from its platform and it was only found on September 4, some two miles from its original location. Owing to the lateness of the season, the marker was not remounted after this accident.

Readings were made with a high-powered telescope mounted beside the door of the operations building in the camp area. Since there was continuous daylight during almost the entire period, it was necessary to visit the beach only when visibility was poor or when drifting ice obscured the marker. An attempt was made to obtain several readings near each high and low tide with a few intermediate readings. This could not always be done, for occasionally other duties interfered with the tidal observations, or the marker was obscured by fog, snow, or drifting ice.

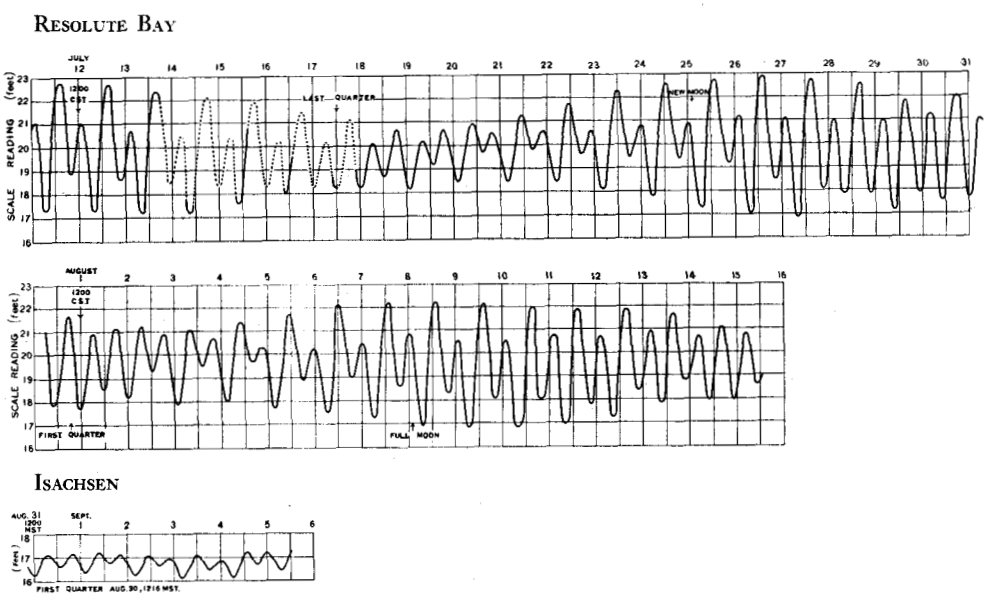

Fig. 3. Tidal readings at Resolute and Isachsen.

Fig. 3 shows the magnitude of tidal readings taken in July and early August plotted against the time of observation. Where insufficient readings are available to draw in the curve with certainty, the line is dotted. Phases of the moon are also shown.

A thorough analysis of the results is being made by the Hydrographic

Service of Canada. However, the following general points may be noted from Fig. 3.

1. The spring tides occur approximately one day before to two days after new and full moon.
2. The neap tides occur approximately one day before to three days after the moon's quarters.
3. There is an inequality in range between the two tides of the day and the intervals of time between successive high tides and successive low tides do not remain constant.
4. The minimum range, which occurs at the neaps, is less than half the maximum range, which occurs at the springs.
5. The maximum tidal range is approximately six feet.

This type of tide is described by the Hydrographic Service as "a mixed tide, primarily synodic, with a considerable diurnal inequality". The declinational effect can be seen clearly by studying the tide curve in relation to the moon's position with respect to the celestial equator, which was as follows

July	9	Maximum south declination
	16	Moon on equator
	23	Maximum north
	29	Moon on equator
August	5	Maximum south
	12	Moon on equator

Tidal readings were also taken at Isachsen, N.W.T. (78°47 N., 103°32 W.) during the first week in September. These readings are plotted in Fig. 3. The maximum range in this period was less than 1 foot 6 inches. If it had been possible to obtain readings near the time of a full or new moon, somewhat larger tidal ranges would undoubtedly have been recorded, but in any case it appears that the tidal range at Isachsen is only about one-half as large as at Resolute.

Although it is realized that the observations obtained at Resolute and Isachsen are limited, they nevertheless provide some data for places from which little tidal information was available previously.

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Editorial Note on Tidal Observations at Resolute Bay by Mr. R. W. Rae

The records obtained by Mr. R. W. Rae at Resolute Bay can be supplemented by those taken on board the *Sophia* at Assistance Bay (74°38 N., 94°15 W.) some ten miles to the east. In 1850-51 Captain

William Penny led his two ships, the *Lady Franklin* and the *Sophia*, to Baffin Bay and Barrow Straits in the search for the crews of the Franklin expedition. The winter of 1850-51 was spent at Assistance Bay, south-east Cornwallis Island, and throughout this period tidal readings were taken. The first reading was made on October 1, the last on April 12 "in consequence of all hands, with the exception of two or three persons, having to leave the ships on travelling parties" (Sutherland, Appendix, p. clxxxvi)[1]. The record thus "extends over nearly six months and a half, and shows the time of high and low water and the rise and fall throughout the whole of that time, with the exception of two or three short intervals arising from derangement of the gauge, or from extremely violent weather. It is computed from the register of the gauge kept on board the 'Sophia' . . . The gauge was read off every hour, and, as frequently as it could be accomplished the exact time of slack tide was observed, and noted together with the rise or fall since the preceding low or high water." (Sutherland, Appendix, p. clxxix)

The tide gauge "was prepared and set a-going on board the 'Sophia', under the superintendence of Mr. Manson, chief mate. . . . The arrangement was a line securely anchored at the bottom, ascending perpendicularly, through a hole which had to be kept open in the floe, up to the projecting end of the trisail boom, which, from being the ridge of the awning, was eight feet from the quarter-deck, and thence forward and down to the deck by means of two easy-going pulleys. To this descending part a weight lighter than that at the bottom was attached, and as the ship rose and fell with the ice which surrounded her, thus responding freely to the advancing or receding tide, so did the weight against a graduated scale, which could be read off to half an inch. . . . The tide gauge was beneath the awning; this was a great comfort with coarse weather, since it could be read off, in the depth of winter, by the assistance of the decklight. It was necessary, however, to go into the open air, to clear the hole in the floe through which the line passed; and this was all the more urgent in very cold weather, because then the coating of ice in it was so thick as to derange the indications of the weight against the scale. This opening was called the 'fire-hole', from the circumstance that water from it would be useful in the event of fire breaking out on board the ship." (Sutherland, Vol. 1, pp. 384-385).

Throughout the period of observations Assistance Bay was ice-covered, the thickness increasing gradually from 2 feet 2 inches in October to 7 feet in April. The type of tide and the tidal range recorded at Assistance Bay appears to be comparable with Mr. Rae's observations at Resolute Bay.

[1]Sutherland, Peter C. 'Journal of a voyage in Baffin's Bay and Barrow Straits, in the years 1850-1851'. 2 vols.; lii + 506 pp. and 363 + ccxxxiii pp., London, 1852.