

BERING: A PACIFIC COLUMBUS

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INTRODUCTION

BERING and his deputy CHIRIKOV not only dedicated 16 years of their lives to the exploration of the north Pacific, but also to a decisive improvement of Siberian maps. Through numerous hardships they showed a competence which is still, 250 years later, in the process of being recognized. This lack of recognition may be due to the premature death of BERING in 1741 and CHIRIKOV in 1748 or to the secrecy imposed by the Tsarist government. Anyway the prime objective of this contribution is to discuss the surveying capabilities of BERING and CHIRIKOV and compare them with those of COOK and LAPÉROUSE, who navigated the same waters 50 years later in the same pursuits, namely making quick surveys at sea without support from the shore. Apart from some Russian and English language sources the author in Paris had access to a sizable number of manuscripts from the astronomer J-N. DELISLE who created the St. Petersburg observatory in 1725, kept close ties with BERING's expeditions and shared in the preparation of the first atlas of Russia. These manuscripts were particularly useful for the collection of data on astronomical work performed by the two Bering expeditions in Siberia.

ASTRONOMICAL NAVIGATION DURING THE XVIIIITH CENTURY

To understand BERING's contribution to the cartography of Siberia and the North Pacific, it is first necessary to review the status of astronomical navigation during his time. Great improvements occurred in the XVIIIth century but although the foundations were laid at the end of the XVIIth century the results occurred

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mainly in the 1760's and 70's. The most significant developments were carried out by the governments of France and England. The Paris observatory was created in 1665, with a brilliant team headed by CASSINI, an Italian, and comprising PICARD, LA HIRE and ROEMER the last, a Dane, who was the first to find a close value for the speed of light by observing the satellites of Jupiter. In 1675, there followed the creation of the Greenwich observatory with FLAMSTEED in charge and NEWTON taking an active part. However navigators still had inadequate tools. For the determination of longitude, CASSINI had published tables of the Jupiter satellites movements in "La Connaissance des Temps" since 1690, but observations required a 40 magnifying power telescope and could be only accomplished ashore. Another solution would have been to transport time from a known meridian but there were no available time-keeper at sea. Last but not least, one could use the moon as a clock hand and the stars as the clock figures which meant taking lunar distances from known stars. This method was constantly used by COOK and LAPÉROUSE and many navigators after, but was not accurate enough before the 1770's. NEWTON had given his theory of lunar movement in 1713, but errors were too large and the same was true for angle taking instruments before the delivery of the first octants in the 1760's.

The inadequacy of navigation tools during the first half of the XVIIIth century was the cause of many ships being wrecked and entire crews drowned. This was sadly illustrated in 1707 when 21 ships of the British Royal Navy returned from Gibraltar to England and found themselves too far north when they changed course to the east to enter the Channel. As a consequence four of them struck rocks on the Scilly Islands and 2000 men perished including the Admiral, Sir CLOWDISLEY SHOVEL.

Responding to a petition by ships' captains and after a report of Sir Isaac NEWTON, President of the Royal Society, the British government in 1714 decided to give an important prize to whoever would provide a solution to finding longitude at sea with a precision better than 1° or even half a degree. In France, the following year, a private donation to the Academy was finally used for the same purpose. However, in England, it took 45 years for HARRISON to produce a reliable chronometer. This was tested at sea in 1762-64 and won the prize while, in France, LEROY had his chronometer tested at sea in 1768. During the 1770's and 80's, COOK and LAPÉROUSE went round the world with these instruments, improving greatly the accuracy of their navigation while sailing in the same waters as BERING and CHIRIKOV had sailed earlier in 1728 and 41. During that same period the accuracy of altitude-measuring instruments was improved by one order of magnitude and the same can be said for tables of the movement of the moon and Jupiter satellites. Finally the way to correct various errors such as refraction depression of the sea horizon, parallax etc ... only became known to navigators in the early 1750's.

In summary, while COOK and LAPÉROUSE had at their disposal accurate instruments and tables, enabling them to fix their position at sea within a very few miles, BERING and CHIRIKOV sailing in the area approximately 40 years earlier had only very limited tools to fix their position and the places they were surveying at sea as well as ashore. Their limited instruments and methods included at sea, speed by log line, time by sandglass, course by magnetic compass, periodically corrected for declination by sun azimuth (deviation from the presence on board of guns and other metallic objects was still unknown). Ashore latitudes were obtained by meridian sights with portable two-feet quadrants (Fig. 1). For longitudes they made use of Jupiter satellites observations only after 1733.

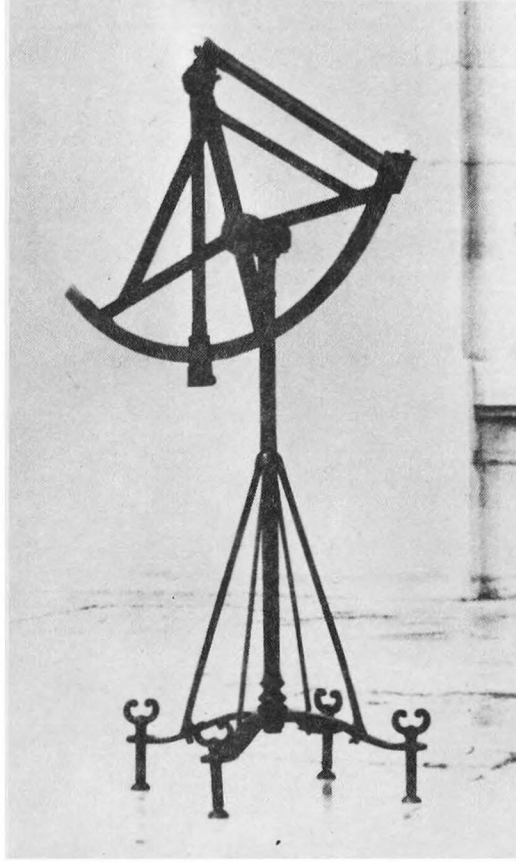


FIG. 1.- Portable two-foot quadrant similar to those used during BERING's expeditions for latitudes observations ashore (Observatoire de Paris).

PRE-BERING MAPS OF SIBERIA

Before entering the heart of the subject, it is interesting to look at what J-N. DELISLE thought the best map of northern Asia before BERING's first expedition. This was the Ph.J. von STRAHLENBERG map published in 1730 in Sweden but already drafted in Siberia in 1718 (Fig. 2). STRAHLENBERG was a Swedish officer and a prisoner of war in Siberia from 1711 to 1721. Kamchatka which had been recently discovered, is shown but extends southward to latitude 42°N instead of 51°N and Asia ends at longitude 155°E Greenwich instead of 191°E Greenwich, found by BERING with only an error of one degree of longitude (Fig. 3). On STRAHLENBERG map, the only place properly located in eastern Asia is Peking because of the astronomical work of the French and Italian Jesuits since the XVIIth century. Looking only at the longitudes of Yakutsk and Okhotsk one can see that BERING's determi-

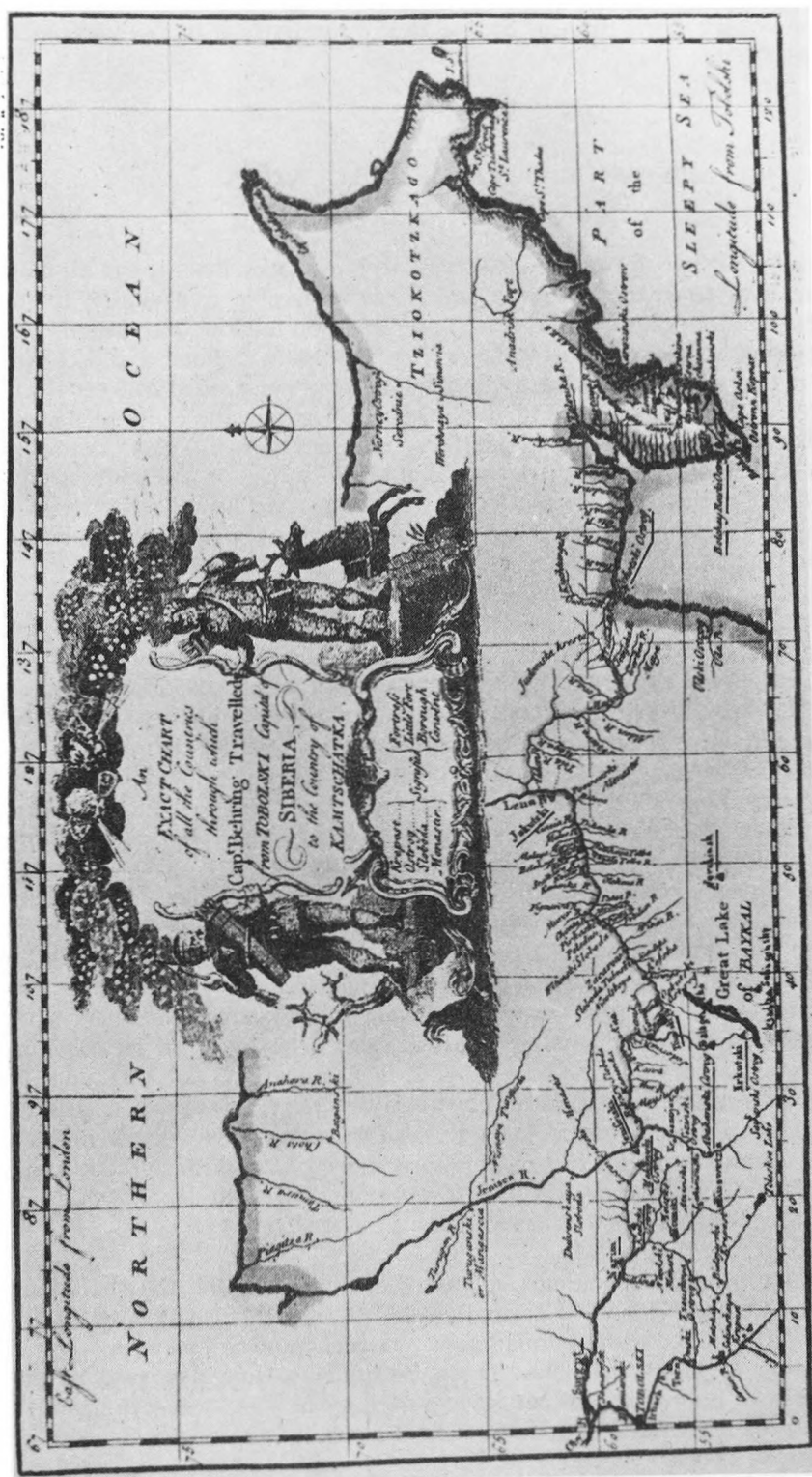


FIG. 3.- Map from the first BERING expedition (1725-29) published in 1744 in London by Harris; the same map had been published in 1733 in Paris by father Du Halde (locations of astronomical observations of the Bering's expeditions have been marked by a small triangle).

nations were closer to the truth by 8° and 11.5° respectively than the ones on the STRAHLENBERG map.

SIBERIAN GEOGRAPHICAL LOCATIONS

During his two voyages from Tobolsk to Kamchatka, BERING and his crew spent more than 10 years in Siberia and made a sizeable contribution to the cartographic knowledge of this region, a contribution seldom recognized. The itinerary chosen by BERING for his voyages from Tobolsk to Okhotsk and back was a network of rivers flowing east-west with very short portage needed between them. As a matter of fact from Tobolsk to Irkutsk was basically the route to Beijing. Before Irkutsk, BERING chose to use the Lena river and go to Yakutsk in order to reach the Okhotsk sea in Russian and peaceful territory (Fig. 3). We know from a letter of DELISLE to the comte de MAUREPAS that BERING and his officers navigated on these rivers the same way as at sea and kept a logbook with dead reckoning, latitude and magnetic declination measurements carefully recorded.

Thanks to British diplomats, Dr. John CAMPBELL was able to obtain a copy of the geographical coordinates of the main locations along the route and publish them with a map and an abridged report of BERING's first expedition in a revised edition of Harris in 1744. This record was also found in the manuscripts of J-N. DELISLE in the Archives Nationales, Paris. Latitudes and longitudes are shown in two separate tables which may be compared with more accurate determinations obtained during the second expedition and with modern data. (Tables 1 and 2). The first expedition obtained only three longitudes by moon eclipse. One observed by CHIRIKOV in Bolcheretsk Ostrog, Kamchatka, on 14 February 1728 is worth mentioning. Having no clock at his disposal, CHIRIKOV got the time of the eclipse by taking the altitude of Sirius. Unfortunately this eclipse was visible neither in St Petersburg nor western Europe and the tables of the moon's movement set up by HALLEY, refining NEWTON theory, were not accurate enough. The situation was unresolved until J-N. DELISLE, who was corresponding with many astronomers in the world, discovered that this same eclipse had been seen by J. de HERRERA in Carthage and Father BONAVENTURA SUAREZ, in Paraguay. As the longitudes of these two South American places were known relative to the Paris meridian, DELISLE was able to make a communication to the Russian Academy on November 1733 for the purpose of announcing the first reliable observation of longitude in the Russian Far East. The final result was $154^\circ 05' E$ to be compared with $156^\circ 37'$ today, a difference of $2^\circ 32'$ but only 9 minutes in time.

For the second expedition (1733-42), the brother of J-N. DELISLE, Louis DELISLE DE LA CROYÈRE came with several geodesists, in particular KRASHELNIKOV. They were well equipped with two quadrants, two clocks, and several telescopes for the observation of Jupiter satellites. These instruments were described in the extensive study of BERING expeditions made in 1851 by A. SOKOLOV. With them LA CROYÈRE and his team made astronomical fixes along the route from Tobolsk to Irkutsk; then on BERING's request, LA CROYÈRE went south and east of Lake Baikal, where there may have been an alternate route to the Pacific coast. This enabled him

during the winter of 1736 to fix the position of Kiachta on the Chinese border and Nerchinsk, also called Nipchou by the Chinese. It happened that when the emperor of China went to Nipchou in 1689 to sign a treaty with Peter the Great's Emissary, Admiral GOLOVINE, his assistant the Jesuit Father GERBILLON was able to make a latitude observation which we can compare with the one of LA CROYÈRE (Table 1). GERBILLON made an error in latitude of 13' in 1689 against 6' for LA CROYÈRE 47 years later but with the same instruments. Continuing his voyage, LA Croyère left KRASHELNIKOV in Yakutsk with BERING and went by the Lena to the Arctic coast. He wintered in Olenek where we have a latitude, but no longitude. Finally LA CROYÈRE went on board the SV PAVEL in 1741 and perished probably of scurvy, on the last day of the voyage. KRASHELNIKOV pursued his excellent astronomical work ashore in Kamchatka and Siberia.

Table 1

**Siberian latitude observations
during BERING two land travels, 1725-42**

	1725-28	1733-42	Times Atlas		
	(1)	(2)	(3)	(3-1)	(3-2)
Tobolsk	58°05'	58°12'	58°15'	10'	3'
Surgut	60°51'	61°17'	61°13'	22'	-4'
Narym	58°48'	58°54'	59°00'	12'	-6'
Makowski	58°03'	58°12'	58°12'	9'	0
Jeniseiski	58°20'	58°26'	58°27'	7'	1'
Balagansk		53°43'	53°45'		2'
Irkutsk		52°17'	52°18'		1'
Nerchinsk		51°56'	52°02'		6'
Nipchou (Nerchinsk)		51°49'	52°02'		(13')
Kiachta		50°20'	50°22'		2'
Kirensk/Kiringinskoi	57°50'		57°45'	-5'	
Yakutsk	62°08'	62°08'	62°10'	2'	2'
Olenek		73°14'	72°59'		15'
Okhotsk	59°13'	59°20'	59°20'	7'	0
Bolcheretsk ostr.	52°45'	52°54'.5	52°55'	10'	0.5'
Petropavlovsk		53°01'	53°03'		2'
Mean square er.				10.7	5.5

(1) HARRIS rev CAMPBELL 1744-48

(2) Ms LA CROYÈRE, Archives Nationales, 211-89

* obs from father GERBILLON in 1689; DU HALDE J-B Description de la Chine 1735

Altogether from 1733 to 1741 under the supervision of J-N. DELISLE, 23 latitudes and 15 longitudes were determined astronomically mainly by LA CROYÈRE and KRASHELNIKOV but sometimes by CHIRIKOV and BERING himself. Some of them

were published in 1753 (Novii commentarii Peterburgum); some others have been found in the manuscript papers of LA CROYÈRE in the Archives Nationales, Paris. In tables 1 and 2 a number of them are compared with modern data taken from the Times Atlas. The mean quadratic errors for latitudes are half of those from the first expedition namely 5.5 instead of 10.7. The explanation could lie in better quadrants fitted with a lunette and a more precise graduation or in the application of refraction corrections. For longitudes, it shows the superiority at that time, of observations of Jupiter satellites, rather than moon eclipses which furthermore were infrequent.

Table 2

Siberian longitude observations (E Gr.)
during Bering's two land travels 1725-42

	1725-29	1733-42***	Times Atlas		
	(1)	(2)	(3)	(3-1)	(3-2)
Ilmsk	104°56'**		103°50'	-1°6'	
Kirensk/Kiringinsko	109°13'**	108°13'	108°02'	-1°11'	-11'
Yakutsk	126°05'**	02'	129°50'	3°34'	11'
Bolcheretsk ostr.	154°05'	156°50'	156°37'	2°32'	4'
Okhotsk	144°19'**	143°11'	143°15'	-1°4'	4'
Petropavlovsk		158°33'	158°35'		2'
mean square er.					6.6'

* moon eclipses observed by CHIRIKOV. Arch. Nat. 2JJ80 and 2JJ77

** HARRIS rev J. CAMPBELL 1744

*** satellites of Jupiter observed by L. DELISLE DE LA CROYÈRE & A. KRASELNIKOV. Novii commentarii Ac.scientia, Peterburgum tome III 1750-51

THE VOYAGE OF THE SV GAVRIIL

Sailing from the mouth of the Kamchatka river, the SV GAVRIIL took a month to reach its farthest north and a little more than two weeks to return. We have a copy of the logbook (T.C. FEDOROVA) but only for the period 5-20 August 1728 and that is incomplete. SOPOTSKO has written a book to describe the voyages of two Soviet yachts in the wake of the SV GAVRIIL arranged to reconstruct the ship's track from bearings taken on landmarks. He had access to the original logbook but did not reproduce it. From SOPOTSKO, we learn that fog and clouds prevented BERING taking sun heights most of the time. On the whole trip only 4 meridian heights and 8 sun azimuth for declination were observed. In order to minimize dead reckoning errors, the location of these meridian heights helped the author select 6

places from a list of coordinates given by BERING in his first report (J-N. DELISLE manuscript copy of BERING report, Archives Nationales). These places have been marked on Figure 4 and are shown in Table 3 compared with modern data from International charts 512 and 814. The mean square error in latitude is 9.9 which is rather good considering the instrument used, probably a Davies quadrant.

Table 3
BERING's first expedition
sea voyage 1728. Latitude obs.

	Bering*	Ch 1085	
	Lat Nord	Lat Nord	
	(1)	(4)	(4-1)
South pt Kamchatka	51°10'	50°53'	-17'
Mouth Kamchatka river	56°03'	56°13'	+10'
Mys Thadeus	62°20'	62°17'	+3'
Mouth Sv. Krest, East	65°30'	65°28'	-2'
Mys Chukotka	64°25'	64°16'	-9'
NW pt Sv Lawrence	64°	63°50'	-10'
mean sq. error			9.9

* Archives Nationales, ms J-N. DELISLE 2JJ 80/6 (doubled checked with figures in Strahlenberg book, 1757. Repr by Carol Urness in BERING's first expedition. GARLAND Pub., New York 1987.

The whole Chukchi peninsula deserves a special discussion, particularly because of ocean currents which were not measurable at that time. On the way north the last observed latitude was 64°10'N on 9 August and the next one was 64°21'N on 17 August. This means that during the whole trip through BERING Strait, to the north of it and back they had to rely on dead reckoning in an area known for sizeable northerly currents in summer, currents which were not quantitatively measurable by them. We have tried to correct the BERING route and map with modern data. Recent simulation on an IBM computer 3090 and measurements of current in Bering Strait during the summer by J.C.J. NIHOUL et al (Fig. 5) have been used to find the proper correction as follows:

Cape Chukchi to Cape Dezhnev: 45 hours av.0.6kn= 27 miles to the north

Referring to KUSHNAREV we learn that on 13 August at 8 hrs (day starting at noon in the logbook) the ship reached latitude 65°30'N which corrected by 27' to the north for ocean current shows that they had reached Cape Dezhnev (66°01'N). This is also confirmed by the statement of BERING that the asiatic shore was now turning westward. He then called for a meeting with SPANBERG and CHIRIKOV to discuss future action.

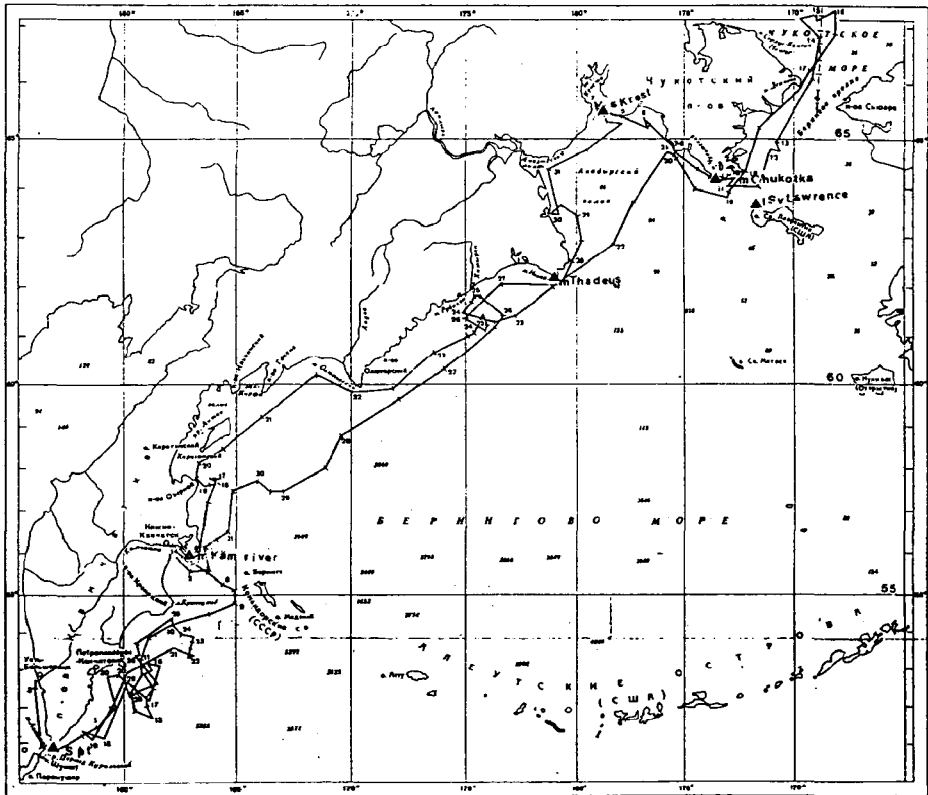


FIG. 4.- Map of the SV GAVRIIL track according to a voyage made by 2 Russian yachts in 1977 using the original logbook (Sopotsko A.A.); shore locations with latitudes shown in Table 3 have been marked by a dark triangle.

North of Cape Dezhnev the BERING chart shows a cape believed by COOK, and more recently by SOPOTSKO, to be Cape Serdze Kamen. It is indeed shown in the approximate latitude but 60 miles slightly east of north of Cape Dezhnev as in reality it is 75 nautical miles to the northwest. From 13 August at 8hrs and for the next 24 hours BERING steered a northerly course with a good wind from the ENE then alters to a NW course because of a change of wind, and finally at 6hrs 30 on the 14 he saw mountains 15 miles distant and bearings from 260° to 290° . From a reconstruction of the route these should be Cape Ikgur and Serdse Kamen but at 45 miles assuming 6 knots of current to the NW (Fig. 5). However, there is still an unexplained discrepancy between the logbook and the map where Cape Serdze Kamen is shown about 50 miles too far to the East (Fig. 6).

Several historians have argued that BERING did not discover his Strait because he never saw the American coastline due to the bad visibility that is frequent in the region. There was however ground for BERING to believe the existence of the american coast. During his stay in Ilimsk, CHIRIKOV had received information about a great forested land to the east from P.I. TATARINOV, who knew it from talks with the Chukchis. Even more convincing is the fact that on his return to St. Petersburg, BERING who was questioned by J-N. DELISLE on this issue,

answered that there were signs of land in the east of the Chukchi coast since birds were flying eastward and trees floating in the sea were larger than those growing on the Siberian coast.

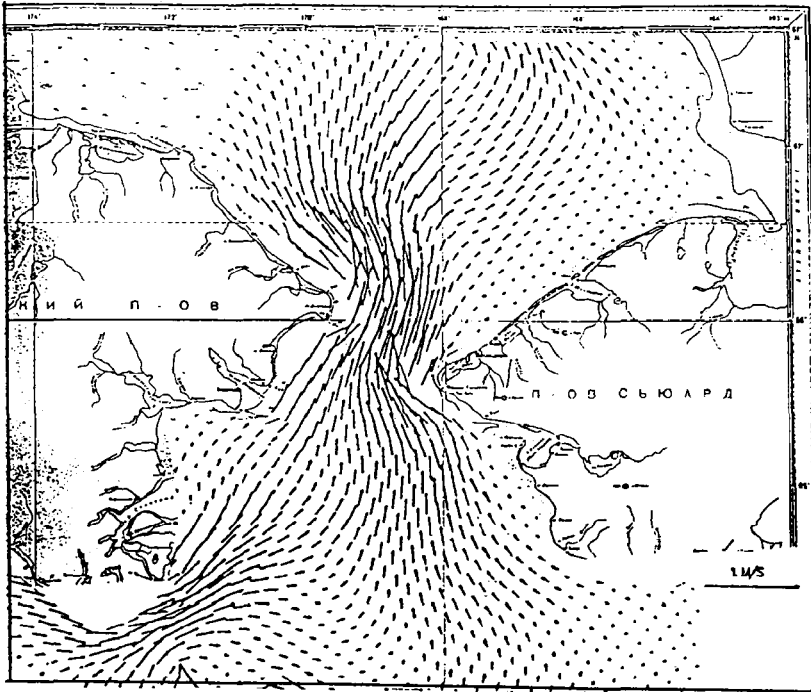


FIG. 5.- BERING Strait simulated ocean current from J.C.J. NIHOUL et al; superimposed on USSR chart 1085.

The best conclusion is given by COOK who stated "In justice to the memory of BERING, I must say that he has delineated the coast very well and fixed the latitude and longitude of the points better than could be expected from the methods he had to go by. This judgement is not formed from Mr. MULLER's account ¹ of the voyage or the chart prefixed to his book but from Dr. CAMPBELL's account of it in his edition of HARRIS collection and a map thereto annexed which is both more circumstantial and accurate than that of Mr. MULLER". When BERING came back to St. Petersburg in March 1730, he could report that he had most probably found a strait between Asia and America but also increased the size of Siberia by 36° of longitude or 1000 nautical miles at this latitude! This showed the necessity to increase the number of astronomical fixes before publishing new maps, a thesis constantly put forward by J-N. DELISLE despite some reluctance from KIRILOV and the senate.

¹ G.F. MULLER, an historian member of the Russian Academy of Sciences, published a map in 1754 and the first official report of BERING's two expeditions in 1758. The English edition was published three years later.

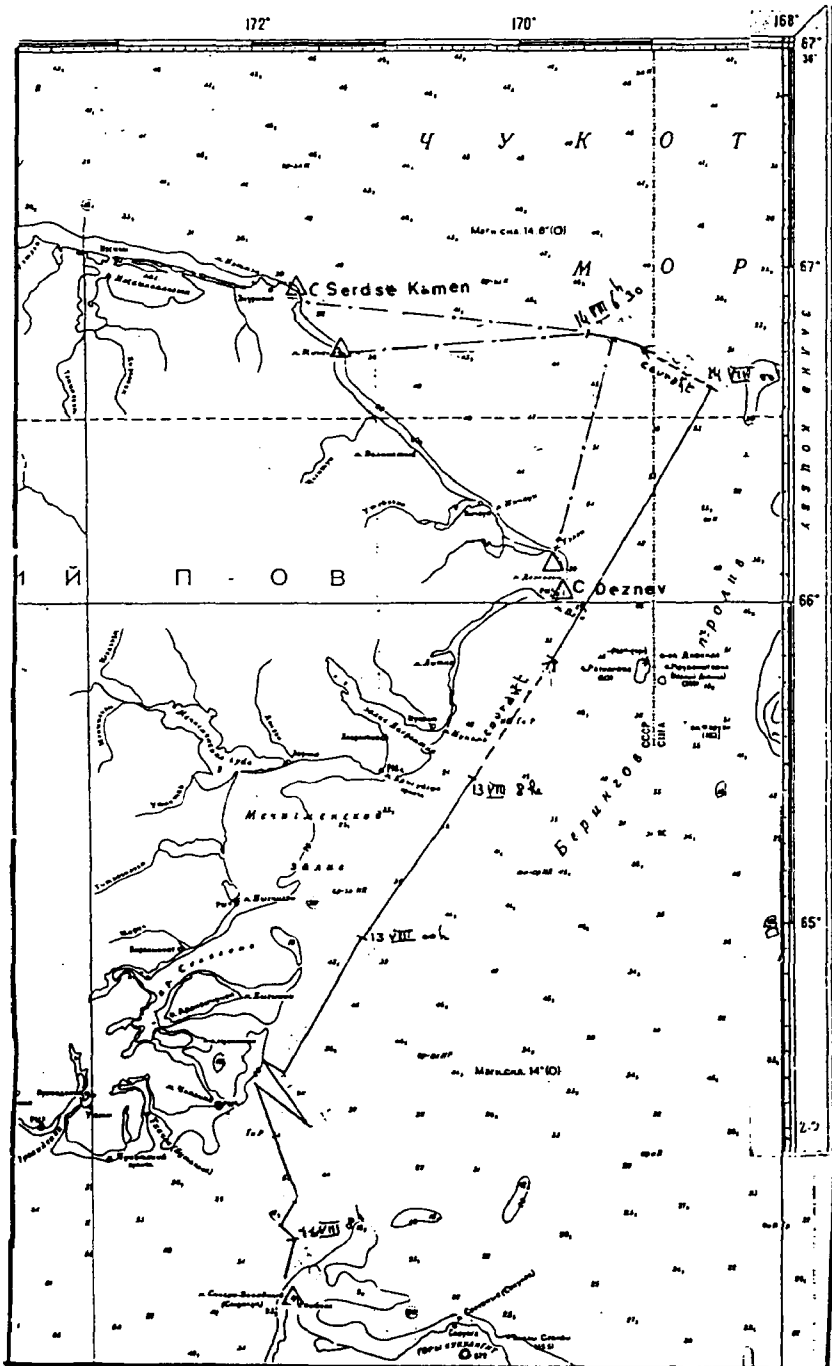


FIG. 6.- Chukchi coastline from USSR chart 1085.
 Course and bearings from SV GAVRIIL logbook; ocean currents from simulation Fig. 5.

COOK SURVEY OF BERING STRAIT, 1778

During his second voyage COOK had shown that if the Antarctic continent existed it should lie south of the polar circle. On his return, the Royal Society and the Admiralty decided to look for a North-West passage in the Arctic but from the Pacific side and COOK volunteered for a third voyage. COOK therefore became a direct successor to BERING. On board the RESOLUTION he had the book of Harris containing the map (Fig. 3) and report of BERING's first expedition. He also knew of his second voyage through G.F. MULLER's book and map published in England in 1761. After skirting the North-west coast of America and fixing the position of Nootka Sound by observations ashore with ninety sets of lunar distances, COOK surveyed the whole coast of Alaska and went through Bering strait up to 70°44'N where he was stopped by pack ice. Having also been unsuccessful towards the east he sailed westward to the north of the Chukchi peninsula and went as far as Cape Schmidt where he was again stopped by ice. He then proceeded back to Bering Strait passing Cape Serdse Kamen where he took astronomical observations (Table 4). In Bering Strait his survey closely follows the present day coastline (compare Fig. 7 and 5). A few locations are shown with data from USSR chart 1085 in Table 4. The agreement for Cape Deshnev (East cape) is really astounding: 1' in latitude, 2' in longitude all done at sea. Of course COOK had a full set of navigation tools at his disposal including lunar distances tables, Harrison chronometers, new brass octants, etc... but he was also a grand master in their use.

The mean quadratic errors in Table 4 illustrate the previous statement and also show that by 1776 we had entered a new era of maritime voyages which extended for the whole of the XIXth century, using basically the same navigation techniques.

THE DISCOVERY OF ALASKA

During the summer and autumn of 1741, BERING on the SV PETER and CHIRIKOV on the SV PAUL crossed the north Pacific ocean and discovered Alaska. We have the logbook of both ships published respectively in the Golder and Lebedev books (Fig. 8). This reference has proved essential as they are carefully kept with hourly measurements of speed and compass course, daily location at meridian time and difference of longitude estimated from Vaua, the lighthouse at the entrance of Petropavlovsk bay. Weather permitting they took meridian sights, on average twice a week, and of course sun azimuth for the determination of magnetic declination. Unfortunately after two weeks at sea the two ships became separated and proceeded independently until the end of the voyage.

Table 4

**Cook's astronomical observations
Bering strait - 1778**

	COOK *		Ch. 1085 USSR		(3-1)	(4-2)
	Lat. (1)	Long.Gr. (2)	Lat. (3)	Long. Gr. (4)		
Cape Serdze Kamen	67°03'	188°11'	66°56'	188°17'	-7'	6'
East cape - M. Dezhnev	66°06'	190°22'	66°05'	190°20'	-1'	-2'
C. Prince of Wales	65°46'	191°45'	65°39'	191°55'	-7'	10'
C. Stephens	63°32'.5	197°41'	63°32'	197°44'	-0.5'	3'
King Island	64°54'	191°53'	64°58'	191°55'	4'	2'
St Lawrence I. NW cape	63°50'	188°11'	63°46'	188°14'	-4'	3'
mean square er.					4.3	5.2

* COOK Third Voyage, vol. II map page 466.

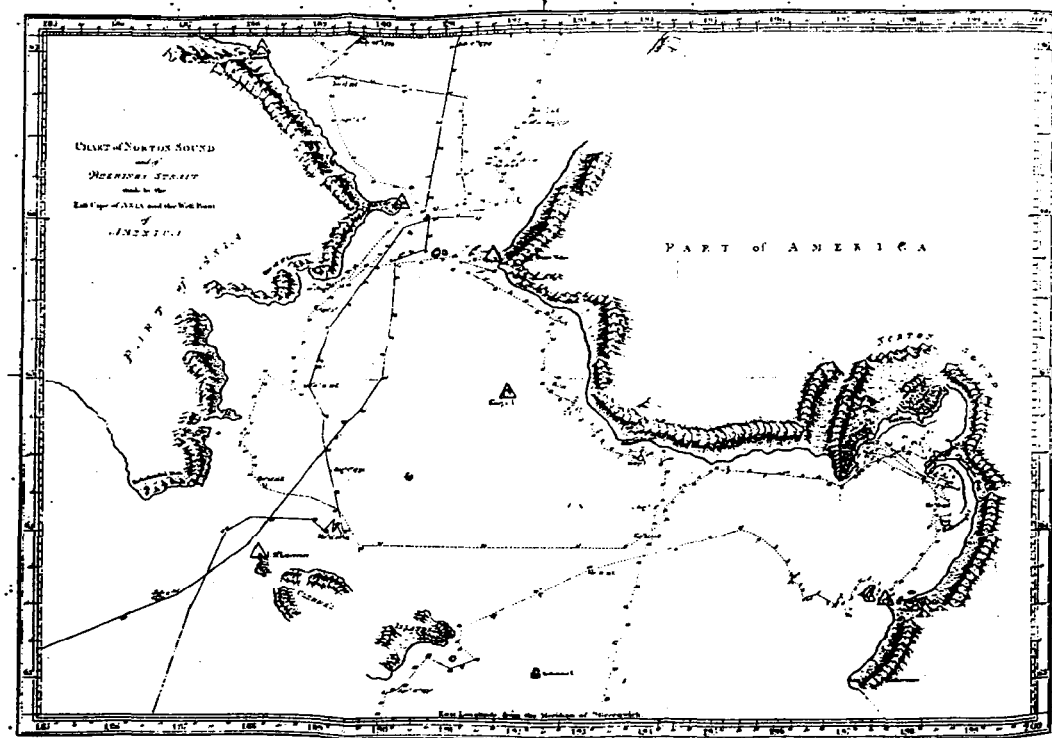


FIG. 7.- BERING strait according to Cook survey, Third voyage, 1777 (London 1785).

Neither BERING nor CHIRIKOV could establish camps on the American coast or islands which at the time was the only way to obtain longitude observations. BERING sent parties ashore to replenish their fresh water provisions at Kayak island and in the Shumagin archipelago (Fig. 9 and 10) but only for a few hours. As for CHIRIKOV, in the first days of his navigation in Alaskan waters he lost his yawl and a few days later his small boat either through an Indian attack or a shipwreck and was unable to go ashore anymore, if even to replenish his provision of fresh water. However on several occasions both ships anchored in the lee of several islands well identified in their logbooks and where their latitude determinations derived from recent meridian sights. The comparison of logbook latitudes and those of modern chart show a mean square error of 8.5 (Table 5) slightly better than during the SV GAVRIIL voyage. In the list of selected locations one of them may be subjected to discussion, Cape Cross, just north of the bay where CHIRIKOV is supposed to have lost his men. CHIRIKOV did not leave us a drawing of the area but from LEBEDEV we have identified the bay where he sent his men ashore just south of Cape Cross. GOLDER believes the bay to be rather Lisianski Strait which is 5 miles to the south! CHIRIKOV describes very accurately the peaks on which he took his bearings so that a trip locally should definitely provide a solution to this ambiguity.

Table 5

**Bering's second expedition
sea voyage 1741 - Latitudes observations**

	Chirikov	Bering	Int. chart 810 & 512	
	(1)	(2)	(3)	(3-2 or 1)
Cape Addington	55°36'*		55°27'	-9'
Cape Ommaney	56°15'*		56°10'	-5'
C. Cross, Yakobi Isl.	57°51'*		57°55'	4'
Adak Isl.	51°40'*		51°52'	12'
Agattu Isl.	52°32'*		52°25'	-7'
Kayak Isl. (anchor.)		59°39' or 49'**	59°55'	16' or 6'(4)
Shumagin Isl.		55°08'***	54°56'	-12'
Bering Isl.		54°52'****	54°57'	5'
mean sq. er.				8.5

* from SV PAVEL logbook in LEBEDEV D.M. The Voyage of A.I. CHIRIKOV, Moscow 1951.

** FROST O.W. The landing on Kayak island, July 20, 1741. BERING-CHIRIKOV conf. Anchorage, August 1991; see also GODELL II p. 99.

*** GODEL, BERING's voyage vol I p 141 & 149 1 Steller Journal, ed. Frost p. 90.

**** GODEL, BERING voyage vol I p 210 & vol II plate II.

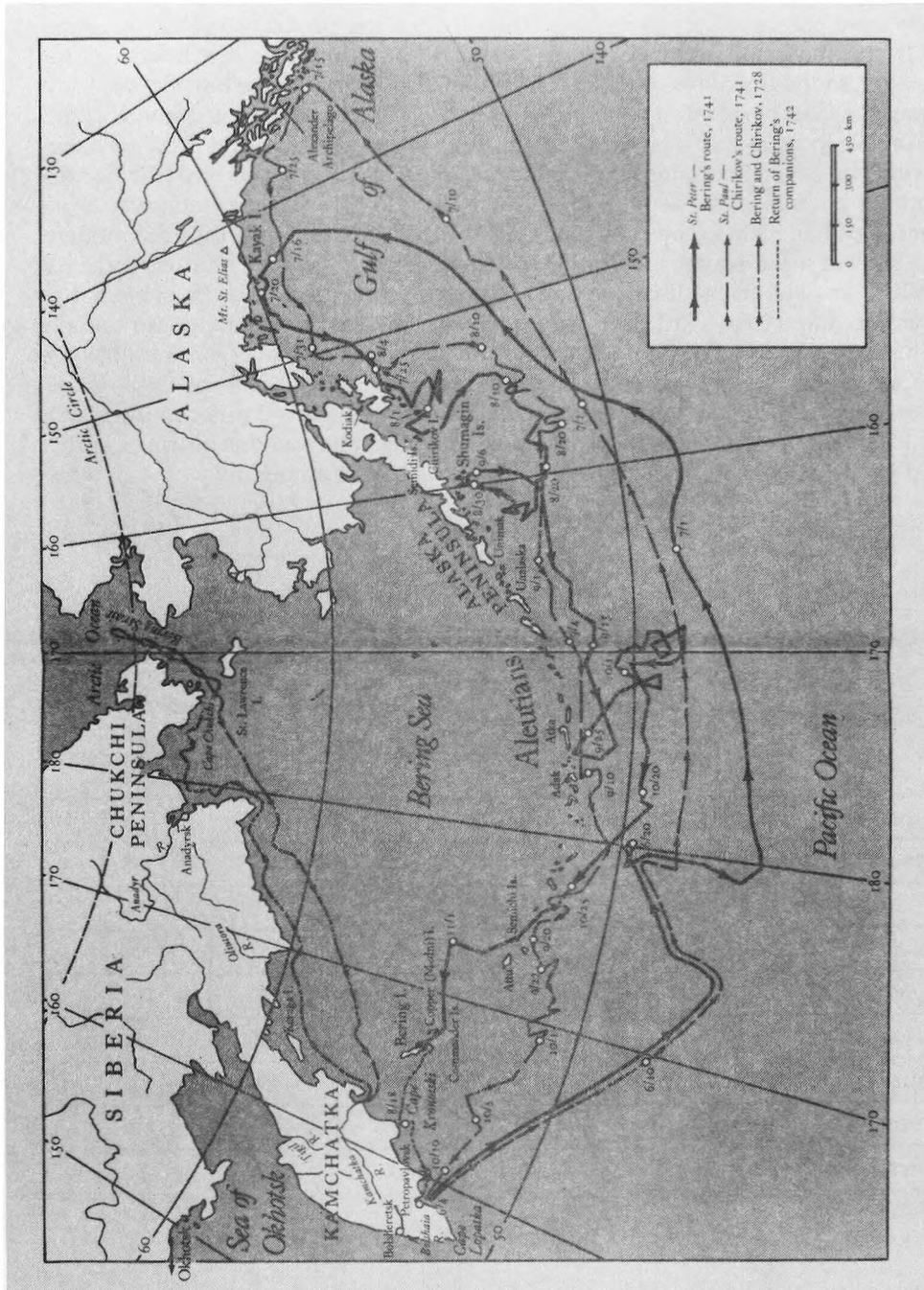


FIG. 8.- Track of the ST PETER and ST PAUL, across the Pacific and islands where they called (Dr O.W. Frost, in G.W. Steller, Journal of a voyage with BERING 1741-42, Stanford Un. Press).

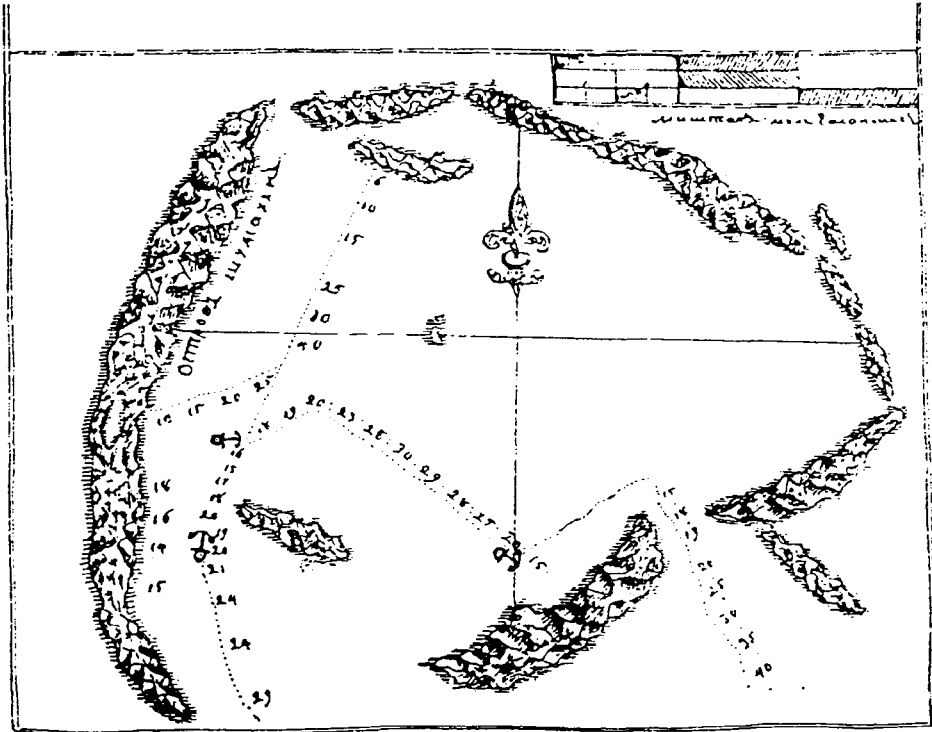


FIG. 9.- Shumagin archipelago anchorage, ST PETER logbook, T. Fedorova. Sounding in sazhen = 2.1 meters; distances in german miles = nautical miles). Note the three anchors marking the different SV GAVRIIL anchorages.

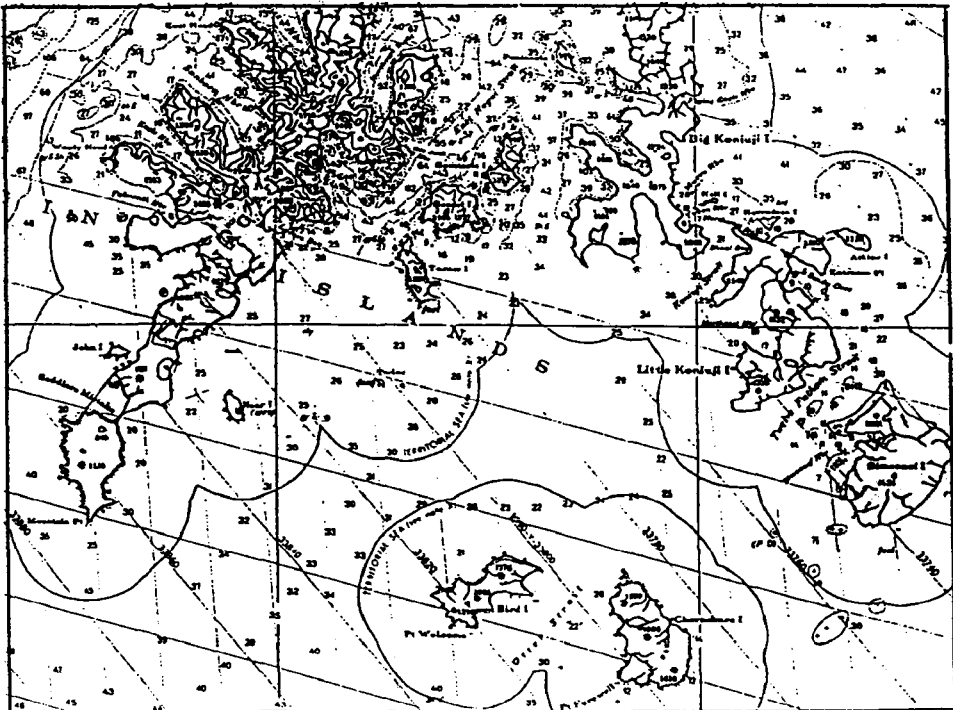


FIG. 10.- Shumagin archipelago, extract from chart US 16540, NOAA (soundings in fathoms).

As for the longitude of the American coast we are left with a comparison of dead reckoning and modern data and have selected the CHIRIKOV case because it is the voyage where ocean currents can be computed with less ambiguity than with BERING's track. Indeed when arriving close to Cape Ommaney, on 16 July, CHIRIKOV's longitude by dead reckoning, 41 days after leaving Petropavlovsk, is too short by 5°33'. During the same period, ships from western Europe crossing the Atlantic experienced the same kind of errors which were always a subject of anxiety for pilots. This discrepancy can only be explained by a combination of ocean current and log error. Computing the East-West component of the ocean current for the summer months on recent pilot charts results in a correction of +11°30' with a possible error of 10 to 20%. It looks therefore as if the log was too fast by about 10%.

LAPÉROUSE SURVEY OF THE NORTHWEST COAST OF AMERICA, 1786

LAPÉROUSE with two frigates, ASTROLABE and BOUSSOLE, had orders from King Louis XVI to survey the Northwest coast of America from Monterey to Alaska. This was to complement the discoveries of COOK described in the volumes of his third voyage, published just before the departure of LAPÉROUSE.

Furthermore there were commercial and geographical objective to possibly establish a trading post for selling furs to the Chinese in Canton, look for a possible North-West passage between the Pacific and Atlantic oceans and finally improve the mapping of the area, as COOK after leaving Nootka sound had mainly surveyed the north coast of Alaska and Bering Strait leaving 600 miles of unknown coastline north of Nootka. Unfortunately soon after his arrival in Alaska, LAPÉROUSE lost 21 men in two longboats at the entrance of Lituya bay (Port aux Français) due to a strong tidal race. This was in some sense a recurrence of the drama experienced by CHIRIKOV 45 years earlier. He left on 1 August 1786 and surveyed from the sea 1500 nautical miles of coast up to Monterey, where he arrived 12 September, (Fig. 11).

To analyze the accuracy of LAPÉROUSE survey, J. BOURGOIN has selected a number of conspicuous places (private communication) from a table of coordinates established at sea by DAGELET, the expedition astronomer, and compared them with data in international charts 801 & 810. These are shown in Table 6 where the mean square errors are very similar to those of COOK, namely around 3 nautical miles for latitude and 5 to 6 miles for longitude (translation of 8.5 of longitude at that latitude). There cannot be a better conclusion than the following paragraph taken from one of the last letters of LAPÉROUSE to France: "Suffice to say that the combination of our two methods, lunar distances and chronometers has completely solved the problem: we constantly navigated with less error in longitude than the one we had in latitude 10 years ago while observing with wooden octant and four times less than with backstaff."

Table 6

	LAPEROUSE			Cartes Internationales 801 et 810			
	Latitude Nord	Longitude Paris	Longitude Greenwich	Latitude	Longitude Greenwich		
	(1)	(2)	(3)	(4)	(5)	(1)-(4)	(3)-(5)
Port des Français - Lituya Bay	58°57'	140°05'	137°45'	58°38'	137°35'	-1'	+10'
C.Engaño - C.Edgecumbe	56°58'	138°24'	136°04'	57°00'.5	135°51'	-2'.5	+13'
C.Tschirikow - C.Ommaney	56°12'	137°13'	134°53'	56°10'	134°40'	+2'	+13'
Pte des Brisants - Cape Knox	54°14'	135°45'	133°25'	54°11'	133°05'	+3'	+20'
C.Hector - Cape St James	51°57'.5	133°37'	131°17'	51°55'	131°02'	+2'.5	+15'
Pte Boies - Brookes Pen	50°04'	130°27'	128°07'	50°08'	127°55'	-4'	+12'
C.Rond - Tillamsok Head	46°00'	126°14'	123°54'	45°57'	123°57'.5	+3'	-3.5
C.Perpetua - Hecate Head	44°06'	126°29'	124°09'	44°08'	124°07'	-2'	+2'
C. Blanc - C. Blanco	42°52'.5	126°49'	124°29'	42°50'	124°33'	+2'.5	-4'
Punta Gorda - C.Mendocino	40°33'.5	126°34'	124°14'	40°30'	124°25'	+3'.5	-11'
Pte des Rois - Pt Reyes	37°55'	125°29'	123°09'	37°59'	123°01'	-4'	+8'
Pte des Pins - Pt Pinos	36°39'	124°13'	121°53'	36°38'	121°56'	+1'	-3'
Mean quadratic error						3'.3	8'.5

CONCLUSION

BERING, COOK and LAPÉROUSE all died dramatically during their expeditions. This deprived us to some degree of their testimony, if not their results.

In the case of LAPÉROUSE the logbooks were lost with all the men in the shipwreck in Vanikoro. Fortunately the North Pacific surveys had been sent from Petropavlovsk with LAPÉROUSE's young Russian interpreter, J-B. de LESSEPS, who made the trip to Versailles in one year.

When COOK died in Hawaii, Captain KING completed the third voyage and looked over the publication of the results.

BERING's death on Bering island became known to CHIRIKOV the following year, when 46 survivors sailed back from BERING island to Petropavlovsk on a hooker locally built with the wreck of the SV PETER, but he had to stay in the Far East and came back in St Petersburg in 1746 only, to die two years later. The whole process of the publication of charts and reports was delayed and discouraged by secrecy imposed by the Russian Academy of science and further delayed in 1746 by the Tsarin Elizabeth personally when she ordered all charts and reports, manuscript or printed, to be gathered in her cabinet. The first public information in Russia came only in 1754 with the publication of a map and in 1758 with a book both edited by G.F. MULLER, an historian from the Russian Academy of Science who did not have the training of a cartographer.

J.N. DELISLE who had kept a keen interest on the geographical side of BERING's discoveries gave some information to Comte de MAUREPAS which was a prerequisite for his stay in Russia but he was unable to publish himself because of secrecy and possibly after his return in France in 1747 by his own inclination. His brother LA CROYÈRE who had done the voyage to America with CHIRIKOV had died the very day of his return in Petropavlovsk (1) and in his manuscripts the author found no trace of his observations on board the SV PAVEL. However, he left numerous manuscripts of his astronomical observations during his nearly ten years travel in Siberia but many were never published.

Even so, and from the little information available to them, COOK and LAPÉROUSE showed immense respect for their predecessors and expressed it both in words and in naming several of their own discoveries after BERING and CHIRIKOV.

Their respective astronomical observations at sea as shown in the previous tables 3, 4, 5 and 6 have been summarized hereunder in order to compare their accuracy:

Table 7

**Accuracy of astronomical observation at sea
North Pacific - mean square error**

	Latitude	Longitude
Bering 1725-28	9.9	—
Bering 1733-41	8.5	—
Cook 1778	4.3	5.2
Lapérouse 1786	3.3	8.5

It is easy to demonstrate what was stated at the beginning of this article: voyaging after 1770 COOK and LAPÉROUSE were able to measure longitude at sea with chronometers and lunar distances; the new octant permitted angle measurements with an accuracy of very few minutes of arc.

On the contrary BERING's expeditions took place forty years too early to benefit from these improvements in navigational instruments and methods which meant three to four times less accuracy in angle measurements and no longitude at sea. Nevertheless BERING and CHIRIKOV showed outstanding navigation abilities with the tools at their disposals.

Adding the work of their astronomers DELISLE DE LA CROYÈRE ¹ and KRASHELNIKOV to their own discoveries at sea up to Cape Serdse Kamen in the north and along the Aleutian islands up to southern Alaska in the West, this whole new area surveyed by BERING and CHIRIKOV from 1725 to 1741 represented a stretch of longitude equivalent to the whole of Canada. Finally as Columbus had been the discoverer of America 250 years earlier BERING was the founding father of Alaska, a Russian colony until 1867 and a State of the USA of great strategic and economic importance today.

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¹Louis DELISLE DE LA CROYÈRE is buried in Petropavlovsk and when calling there in 1787 LAPÉROUSE visited the grave and added a memorial plate.

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