The Depths of the Pacific on the East Coast of Japan, with a comparison of other Oceanic Depths.

Read before the Asiatic Society of Japan at Yokohama,

October 15, 1890.

by

Rear Admiral George E. Belknap U. S. Navy.

National Oceanic and Atmospheric Administration

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THE DEPTHS OF THE PACIFIC ON THE EAST COAST OF JAPAN, WITH A COMPARISON OF OTHER OCEANIC DEPTHS.

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BY

REAR ADMIRAL GEORGE E. BELKNAP, U. S. NAVY.

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Mr. President, Ladies and Gentlemen:

In the late spring of 1874, I had the honor of laying before your learned Society a paper on Deep Sea Soundings. H. M. S. Challenger was at that time engaged in making her famous voyage of deep sea exploration round the world, and the U. S. S. Tuscarora, under my command had just arrived in this bay on a similar work so far as pertained to depths, currents, character of bottom soil, and ocean temperatures.

The main object of the Tuscarora expedition was, however, to determine the feasibility of a cable route across the mid North Pacific from the coast of California to this port, via Honolulu and the Bonin Islands, and on the homeward run to survey a second route from a point on the east coast of Japan on a great circle running through the Aleutian chain of islands, and ending at Cape Flattery at the entrance of Puget Sound.

The mid Pacific line of survey had been successfully run and the Tuscarora entering Yedo Bay on the morning of the 22nd April, anchored off Yokohama that afternoon—a welcome haven of rest after much hard work and anxiety.

After a few weeks of needed recreation on the part of the officers and crew, and the season favorable for resumption of the survey had arrived, the Tuscarora put to sea on the 10th of June to begin the line of soundings on the Northern route.

From what had gone before, it was anticipated that the work ahead would prove to be comparatively light and easy, and all hands were jubilant over the thought of the holiday

promise that seemed to be in store. No excessive depths—the greatest 3,287 fathoms—not quite 3¾ statute miles—had been found in the line just completed, where, if in any part of the Pacific, it might have been expected very deep water would be disclosed; and from the Bonin Islands to the entrance of Yedo Bay the greatest depth found was 2,435 fathoms. It was also known that up to that time the soundings of the Challenger in the South Pacific had not exceeded 2,900 fathoms; indeed, in all her deep sea work in that region of ocean, she never sounded beyond that depth.

But a rude awakening was soon to occur, for hardly had the ship gotten a fairly good offing when, at a distance of only 100 miles from the coast, a sounding was made in 3,427 fathoms, the waters having deepened more than 1,800 fathoms in a run of 30 miles.

The next cast was still more startling, for when 4,643 fathoms of wire had run out it broke without bottom having been reached.

This was in the Kuro-Siwo or Black Stream of Japan, and the current was so strong that the wire, in spite of all that previous experience could suggest, was swept under the ship, finally parting under the strain. The purposes of the survey and amount of wire on hand would not admit of continued experiment, nor was it believed that a cable could be laid in such deep waters, encountering so strong a current. The ship was therefore headed in shore to run up the coast and begin a new line. The great circle was taken up again in Latitude 40 degrees North, but here the water also deepened rapidly, and at the third cast from the initial curve of departure, the lead dropped to 3,439 fathoms, followed by depths of 3,587 fathoms and 3,507 fathoms, 40 and 80 miles further on. Then, in the next 40 miles the lead was found to drop to the great depth of 3,440 fathoms, and the Miller Casella Thermometer came up a perfect wreck from the resultant pressure! The next six soundings, at intervals of 40 miles apart, revealed depths of 4,356, 4,041, 4,234, 4,120, 4,411 and 4,655 fathoms respectively. The total time occupied in making the cast in 4,356 fathoms, and getting back a bottom specimen was 2h. 26m. 57s.

Good specimens had been brought up from four of these depths, and in one other the specimen cup had struck solid rock. At the last two and deepest of these casts the wire had parted.

In the first instance the accident was due to over confidence and carelessness in reeling in, but in the last and deepest cast the wire fairly pulled in two, being part of a new batch of wire received at Yokohama and not so strong as the wire originally supplied.

In view of these remarkable depths developed, the conclusion was irresistible that the great circle route would have to be abandoned and a new line of less depth adopted if it could be found. It was therefore determined to run back to Hakodate for a fresh supply of coal, then to shirt the Kuriles for a considerable distance before heading over for the Aleutian chain.

These deep soundings had been made under exceptionally favorable conditions—light wind, smooth sea and gentle swell. No sinker could have dropped straighter into well than the wire ran down in these four or five miles depths.

"Deeper than e'er plummet sounded"

had no meaning here. The great bard wrote at a time when the depth of the sea was an impenetrable mystery. Yet his fine dictum remained good until the latter half of this century, for from the beginning until within a very recent period the ocean depths had remained an unanswered problem which in every phase and epoch of civilization had baffled the skill and patience of the seaman, the quest and genius of the philosopher, the curosity of the idler and the impracticability of the dreamer.

But now the veil had been lifted and the problem had been happily solved.

The appliances in use to-day for measuring the depths are so simple, so accurate in their working—that no doubt lingers to question the results obtained.

Hakodate was left on the 20th of June, and skirting the Kuriles until Lat. 48 degrees N. was reached, the course was laid across to Aggatou of the Aleutian group. The water deepened rapidly again and a depth of 3,754 fathoms was found about 110 miles West of Cape Lopatka, whence the bed rises

and forms a ridge between that point and the Aleutians like the "Dolphin Rise" on the so-called cable plateau in the North Atlantic. The depression near the Aleutians, and only 70 or 80 miles from land, revealed a depth of 4,037 fathoms, thus giving us another surprise on the Northern line. The depth on the summit of the ridge was 1,777 fathoms.

Turning back now to the series of depths ranging from 3,500 fathoms to 4,000 fathoms and upwards, to the Southward and Westward of this ridge, it is seen that a trough or basin of extraordinary depth and extent is developed along the East coast of Japan and Kurile Islands and under the Black Stream, of greater extent than any similar or approaching depression yet found in any other region of the great oceans.

In her passage from Yokohama to Honolulu in 1875, the Challenger found a depth of 3,950 fathoms some 200 miles due East from Cape King, and 3,560 fathoms 160 miles further on. Thence Eastward 1,700 miles or until nearly up to the meridian of the Hawaiian Islands, her soundings were all less than 3,000 fathoms.

Her first two soundings after leaving Yokohama probably indicated somewhere near the beginning of this great depression of the ocean bed at its Southern part, and an inspection of the chart with the positions of all these deep soundings plotted, leads to the reasonable inference that this deep submarine valley extends along the coasts in a parallel direction for more than 700 miles with a probable width of some 250 miles.

Now taking the deepest cast of 4,655 fathoms or 27,930 feet which is something more than five and a quarter statute miles, the deepest water yet found—its marvellous character will be more vividly apprehended if we consider the fact that could the great mountain of Japan—the noble Fuji-Yama—be slid off into this deep basin, another mountain of like mass and height might be piled on top of its peaks and yet its doubled height would still be nearly two thirds of a mile under water.

But interesting as are the facts so far disclosed in the development of this wonderful valley in the ocean's bed, the story is by no means yet complete. Further research would doubtless reveal still greater depths, define the boundaries of the great

depression and determine the varying directions, strength, depth, breadth, length and temperatures of the great Black Stream.

For many years the Government of the United States employed its Naval officers and officers of the Coast Survey in investigating the extent, depth, volume and other physical characteristics of a similar river in the ocean—the Gulf Stream which sweeps along its Atlantic Coast. Many facts and phenomena of interest and importance were thus added to our knowledge of the physics of the sea and much credit accrued to all engaged in that research.

The officers of the Japanese Navy would confer like lustre upon their own service and country and benefit to the world, were they permitted to do a similar work in their own Kuro Siwo. In surveying the coasts and harbors of the empire they have made an excellent showing; the exploration of the Kuro Siwo and the deep valley under it, would undoubtedly yield rich results; it would also add notably to the experience of the Japanese officers and men in hydrographic work, and give them a confidence in that direction possibly not heretofore felt

This region of the Pacific has been named by the German Geographer Petermann "The Tuscarora Deep," and there would seem to be no more promising field for oceanic investigation than these waters laving the East coast of Japan present to-day. There surely could be no better school for seamen than prolonged cruises for deep sea research.

In passing to a comparison of other ocean depths with this deep water off the Japanese coast, let it be noted that at the Eastern end of the Aleutian chain, a depression similar to the one discovered at its western extremity was developed though not quite so deep. The Tuscarora found there a depth of 3,664 fathoms, and in 1888 the U. S. Fish Commission steamer Albatross sounded some 200 miles W. S. W. from the position of that cast and parallel with the coasts of the Aleutians, in a depth of 3,820 fathoms. These soundings, eighty and ninety miles from the land, represent depths of over four miles, and from the rugged formation of the group and the facts which recent hydrographic researches have established, it is more

than probable that this depression skirts the entire length of the chain on its Southern or Pacific side. This therefore is another section of the North Pacific that would most likely well repay further investigation.

To account for the soundings quoted from the Fish Commission, let me digress here a moment to say that the United States Commission of Fish and Fisheries, have two steamers—the Fishhawk and the Albatross—engaged in the Atlantic and Pacific, to determine the species, the habits, haunts and breeding places of the finny tribes inhabiting the waters within the jurisdiction of the United States and in neighboring proximity thereto; and in the transplanting of food fishes from one locality to another whenever the necessary conditions will admit of it.

These vessels are manned by officers and men of the Navy, and soundings, trawling, dredging, the taking of temperatures and the multifarious duties of the naturalist, go on continuously. Hence it comes about that in the prosecution of this beneficent work much hydrographic information is furnished the Government.*

*Since presenting this paper to the Society intelligence has been received of the arrival of the Albatross at San Francisco on the 26th ultimo from a season's exploration in Behring's Sea.

Lieut. Comdr. Tanner, U. S. N., Commanding that vessel, reports that the principal work done was the examination of the codfish and halibut banks in that sea from Ounimak Pass to Bristol Bay, and the determination of the 100 fathoms line along the Northern coasts of the Aleutian Group, carrying it Westward to the 175th Meridian.

The return trip was made along the Southern coasts of the chain and deep sea soundings had "off and on," confirmed the theory advanced to the effect that there is a submarine trough or valley running parallel with the Aleutian Group on its Pacific side from 3,000 fathoms to 4,000 fathoms in depth. This trough Commander Tanner estimates to be some 30 miles in width.

He also says, "When the discovery of the deep water near the Eastern end of the Group was made by Captain Belknap in 1874, it was quite a mystery. It was a question with the Geologists whether it was an isolated hole or a trough lying parallel with the islands."

On that point the writer would remark that from the great depths found at both ends of the chain in 1874, he has never had any

doubt but that systematic investigation in that region of the North Pacific would disclose a deep depression of the ocean bed along the South coasts of the Aleutians, similar to the great submarine valley developed by the lead along the East coasts of Japan.
It may not be amiss to add that the Albatross found the cod banks to cover a very extensive area in Behring's Sea along the shores of the Alaskan peninsular and that the fish will compare favorably as to quality with the Atlantic species besides covering a much greater extent of range.

Oct. 24, 1890. G. E. B.

As stated in my paper read before your Society in May 1874, the deepest reliable sounding made anywhere in the ocean up to that time, was a sounding obtained by the Challenger in a depth of 3,875 fathoms some 80 miles North of the Virgin Islands in the North Atlantic.

In 1876 the U. S. S.Gettysburg got soundings in that immediate locality in depths of 3,595 fathoms and 3,697 fathoms. Two or three years later, 75 miles West from the Challenger's deep cast and 70 miles North of Puerto Rico, the U. S Coast Survey steamer Blake brought up a good specimen of the bottom soil from the extraordinary depth of 4,561 fathoms or only 94 fathoms less than the Tuscarora's deepest sounding off the coast of Japan. The Blake also got other depths in that vicinity of 4,529 and 4,223 fathoms.

This deep depression in the North Atlantic, apparently circumscribed in extent, has been named the International Deep.

A few years since a German ship of war got a depth of 3,825 fathoms about 500 miles S. E. by S. from Bermuda. No other depths approaching by a thousand fathoms this great depression, have so far been found in any other region of the Atlantic either North or South of the equator.

About midway between Bermuda and the Virgin Islands a depth of 3,370 fathoms has been found, and less than 40 miles west of Bermuda a depth of 2,650 fathoms has been measured. The greatest depth yet sounded in the South Atlantic is 3,284 fathoms. That depth was found by two ships of the United States in different localities, the Essex and the Wachusett.

There are perhaps no other regions of the great oceans where the depth and contour of their bed has been so thoroughly determined and mapped out by the lead as the sections of the North Atlantic comprising the enclosed seas of the Gulf of Mexico and the Caribbean. This exploration which included trawling, dredging and the determination of currents and temperatures, and other points of scientific interest and value, was mostly conducted by Commanders Sigsbee and Bartlett, U. S. N. Associated with Sigsbee for two or three seasons was Mr. Alexander Agassiz of Cambridge, Mass., upon whom the mantle of his illustrious father, the late Prof. Louis Agassiz, has so worthily fallen.

In the Western part of the Gulf of Mexico, a comparatively shallow body of water, there is an extensive basin of 2,000 fathoms depths and more.

The Western part of the Caribbean, too, has a long, narrow, submarine trough with depths of upwards of 3,000 fathoms, and not more than 25 miles from the island of Grand Cayman in this locality, the great depth of 3,428 fathoms exists.

These depressions have been named the Sigsbee and Bartlett Deeps respectively.

Some of the channels leading into the Caribbean through the West Indian chain of islands from the Atlantic, disclose wonderful depths. At the entrance of the Anegada Passage, for instance, there is a depth of 3,045 fathoms or 3½ miles.

For some two and a half years past H. M. Surveying Ship Egeria has been engaged in surveying certain sections of the South Pacific. Captain Wharton, R. N., the Hydrographer to the Admiralty, states the purposes of the survey to be as follows:—"The time having arrived in the general interests of navigation for a systematic examination of the bed of the Pacific Ocean between New Zealand and the Sandwich Islands, in order to verify or disprove the many doubtful dangers reported, as well as to fix the positions of and to survey such groups of islands as lie on the track between the British possessions of Canada and Australasia—there being a growing desire to see these countries united by submarine cables—H. M. Surveying Vessel Egeria was selected for this service, and

arrived in New Zealand, April, 1888." Vide Reports Hydrographic Department, Admiralty, 1888-89.

The Egeria has achieved remarkable results. Up to the period when she began work, the deepest water yet found South of the Equator either in the Atlantic or Pacific was a sounding of 3,367 fathoms or a depth of 3¾ miles off the coast of Peru in July 1881, by the U. S. S. Alaska then under the writer's command. This cast had been made about 100 miles West of Callao Bay. But now the Egeria was to take away the palm for such supremacy, for in August 1888, that vessel under the command of Captain Pelham Aldrich, R. N., had the good fortune to sound in a depth of 4,428 fathoms Lat. 34 degrees 37 minutes South ' ong. 175 degrees 08 minutes West. Twelve miles South of that position the ship got another cast in 4,295 fathoms. These soundings were in the vicinity of the Friendly and Cook Islands the nearest land, Tongatabu, being some 360 miles distant.

The total time occupied in making the deepest of these casts and hauling back the specimen tube was 3 hours 15 minutes.

In June of the next year, 1889, the ship now under the command of Commander C. F. Oldham, R. N., found the still more remarkable depth of 4,530 fathoms. This was in Lat. 17 degrees 04 minutes S., Long. 172 degrees 14 minutes W., or about 170 miles N. E. 3-4 E. from the nearest island of the Friendly Group.

On this occasion the satisfaction of bringing back a sample of the bottom soil was not had. The sinker would not detach and the wire broke from the excessive strain when attempt was made to reel it in. Only those who have experienced similar mishaps in deep sea soundings can take in and appreciate the disappointment and vexation of such untoward moments and happenings!

The Challenger had, in March 1875, found a depth of 4,475 fathoms in Lat. 11 degrees 24 minutes N., Long. 143 degrees 16 minutes East or about 150 miles S. W. by S. from Guam of the Ladrone Islands—the deepest water yet found by her in all her researches of three and a half years in the great oceans. The next deepest water found by her in the North Pacific was

about 500 miles North of the centre of the Hawaiian Group where a cast was made in 3,540 fathoms. North of that position and in a distance of 600 miles she made four other casts in considerably lesser depths, the deepest and most Northern in 3,125 fathoms.

The sounding line used on board the Challenger was of the best Italian hemp, specially prepared for the expedition. The No. 1 size, mostly used, was one inch in circumference—with breaking strain of 14 cwt.

The Egeria discarded the hempen line and used galvanized wire of guage 20. For those who have seen the workings of both line and wire in great depths, there can be but one conclusion, viz:—that the soundings with wire are the more accurate and are made with greater facility—together with a saving in time and lessening of labor.

Perhaps there is no need to recall the fact that the Tuscarora, in making her survey, used the admirable machine invented by Sir William Thomson of Glasgow University, for sounding with piano wire—the first extended use of the apparatus after its conception and construction by its distinguished inventor.

That machine, in modified forms, is now used exclusively for deep sea work on board the vessels of the United States whether of the Navy, Coast Survey or Fish Commission services.

It may be said in passing, that every man with the least strain of genius in his composition is a bit of a crank. No sooner does such a man get hold of an invention or creation of another than he sets about at once to improve, tinker or modify it.

This simple machine, devised by Sir William Thomson, forms no exception to such practice, though, from the experience of the writer, but few modifications of the machine were needed for its beautiful working, except in the direction of strength, which the inventor himself recognized after he had once experimented with it at sea.

Some of the modified machines now in use are so different from the original apparatus that Sir William would hardly believe the sense of his own eyes could he see them, but the

principle which governs them all and gives to them their incomparable value, is a conception solely his own.

The Tuscarora had been at first supplied with a duplicate apparatus for sounding with rope. It consisted of a heavy iron reel and dynamometer with donkey engine accompanied by forty odd miles of rope of varying sizes. Its use was soon discarded.

The modest little Thomson machine in its snug iron tub seemed absurd in contrast, but like David and Goliath of sacred story, the little drum, which with five miles of wire wound upon it weighed no more than 140 pounds was the easy victor.

Lieut. now Lieut. Commander Geo. A. Norris, personally attended the management of the machine, and one never tired watching the workings of the reel at its place in the gangway, so noiseless and perfect in its action, and the wire so fine that it could hardly be seen from the poop deck in cloudy weather or when passing clouds threw shadows over the ship. Sometimes, at the approach of evening, the writer stood in the cabin doorway watching in the deepening twilight the movements of the drum, and could detect easily the moment of striking bottom, although the revolutions could only be distinguished by certain discolorations on the sides of the drum as they struck the eye in passing round. At night too, the gleams of the lantern flashing on the drum, only needed for the reading of the counter and the noting of the splices, recording the amount of wire out, revealed its motions and indications at the far ends of the ship equally well.

The apparatus for the automatic detachment of the sinkers when bottom is struck, and the tubes, cups or cylinders for bringing back specimens of bottom soil in use on board the ships of Her Majesty and the United States, are the inventions of British and American Naval officers and others of their respective services.

Every now and then it is announced in the newspapers and periodicals that eight and nine miles depths have been found in the Indian Ocean. Such announcement is based on the reports of sporadic attempts at deep sea sounding some thirty-

five or forty years ago, when guess-work entered largely into the efforts of that period.

As a matter of fact, the Indian Ocean is shallower than the other great oceans. The deepest water, indeed, that has been discovered in that ocean, save one depth of 3,080 fathoms off the coast of Sumatra and near the Keeling Islands, is in the great bight that indents the south coast of Australia. Soundings made by a German ship of war in that region developed depths of from 2,800 fathoms to 3,063 fathoms and quite close to the land.

In my former paper I said, "The theory has been that the greatest depth in the Pacific would be found in its eastern part, but so far, the line of soundings run by the Tuscarora across the mid north Pacific, would seem to prove to the contrary, the deepest water having been found near the Bonin Islands."

I may say now that up to this sixteen years later period, the greater depths have all been found in the Western parts of both the Atlantic and the Pacific. The theory then, by the demonstrations of the lead, must be regarded as reversed.

Another theory was also broached some years ago to the effect that great depressions in the ocean bed, probably corresponded to elevations of like extent on the great continents and in proximinity to them.

From the great mass of data, clear and indisputable, now in our hands, I venture the opinion that such proposition must be amended to conform to the evidence now before us, that, as a rule, the deepest water is found, not in the central parts of the great oceans but near, or approximately near the land, whether of continental mass or island isolation.

The popular belief has doubtless been that the greatest depths would naturaly be found in mid ocean, but the results of deep sea exploratio n, notably during the past twenty years, show that such belief is incorrect.

As has been intimated in other parts of this paper, different sections of the great oceans have been given special nomenclatures on Physiographic maps published since the completion of the explorations of the Challenger, Tuscarora, Blake and other vessels. The German Geographer Petermann introduced

nomenclatures as follows, viz: Challenger Rise, Challenger Deep, Nares Deep, Thomson Deep, Jeffreys Deep, Carpenter Deep, Tuscarora Deep, Belknap Deep and Miller Deep. To a Physiographic map in Appleton's Physical Geography published in New York in 1887, the writer suggested the following additions to such nomenclatures, viz: Enterprise Rise, Barker Rise, Alaska Rise, International Deep, Alaska Deep and Norris Deep. The suggestion was adopted.

Glancing back in review, it will be seen that the Tuscarora found the first depths of 4,000 fathoms and approaching 5,000 fathoms; that the Challenger discovered the next great depression, considerably upwards of 4,000 fathoms in the bed of the North Pacific; that the U. S. coast survey steamer Blake developed the 4,500 odd fathom's depth in the North Atlantic, at a locality first indicated by the Challenger's sounding's, and that lastly the Egeria now comes forward with her great depths of more than 4,000 fathoms discovered in the South Pacific

These four vessels are the only ones that so far have discovered such deeps, but the work of oceanic survey is progressing in some quarter of the globe all the time, and in order that the primacy in depths may be maintained for the North Pacific off the coast of Japan—so far as our searchings with the lead over the vast waste of waters can determine it—the suggestion is again urged upon the officers of the Japanese Naval Service to take up the waiting threads of investigation that seem to beckon them to action along their own coasts, in waters of rare interest and rich promise.

The impartial student of ocean literature will accord merited prominence to Great Britain and the United States in what has thus far been accomplished in deep sea exploration, whether as regards the amount of work done, its scope, scientific grasp and value, commercial importance of results or thoroughness of execution.

It seems hardly necessary to add that this breaking of the spell of the depths and successful interrogation of its secrets, has been due principally to the diligent effort, dogged purpose,

undaunted energy inventive genius, and ready adaptation of ideas and methods from whatever source, towards the accomplishment of desired ends, so notably characteristic of the kindred peoples of the British Isles and of the United States.

"I'll put a girdle round about the Earth"

was no idle boast; it has already been practically done. To-day, over the continents and along through the deeps, runs the fine girdle of copper wire through which flash the happenings of the day and the forecasts of the morrow. "On the wings of morning" our questions may fly through its magic thread to the uttermost parts of the earth, and the shades of evening bring back reply. That we are enabled to do this wondrous thing is due, in great part, to the happy solution of the problem of the depths, and to the fact that the contour of the ocean bed and the character of its soil, have been so satisfactorily made known to us. For this achievement in the compelling of one of the great and mysterious forces of Nature to minister to our daily use and welfare, our thanks, it is submitted, are due to the seaman as well as to the scientist. (Cheers.)

TABLE FOR CONVERTING FATHOMS INTO FEET AND MILES.

1	Fathom	—	6	feet	—	0	Miles
110	"	—	660	"	—	$\frac{1}{8}$	"
220	"	—	1,320	"	—	$\frac{1}{4}$	"
440	"	—	2,640	"	—	$\frac{1}{2}$	"
660	"	—	3,960	"	—	$\frac{3}{4}$	"
880	"	—	5,280	"	—	1	"
1 760	"	—	10,560	"	—	2	"
2,640	"	—	15,840	"	—	3	"
3,520	"	—	21,120	"	—	4	"
4,400	"	—	26,400	"	—	5	"
4,655	"	—	27,930	"	—	$5\frac{1}{2}$*	"

*Plus 15 ft.