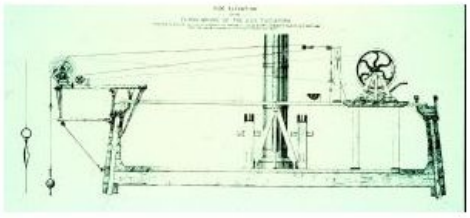
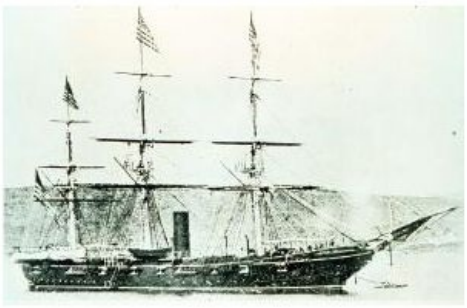
George Belknap and the Thomson Sounding Machine





Prior to the year 1874, the Pacific Ocean was a blank slate with regard to the nature and depths of its seafloor. A few sporadic soundings had been attempted in the 1850s and Alexander Dallas Bache, Superintendent of the US Coast Survey, had derived an average depth for the North Pacific Ocean of 2,000 fathoms from tidal marigrams that had recorded the tsunami signature of the great 1854 Japanese Tokai earthquake. This in itself was a remarkable feat but provided no indication of the nature of the seafloor and the location of individual bathymetric features. However, this was about to change due to the convergence of a new technology coupled with two remarkable expeditions. The first of these is well-known, namely the Challenger Expedition, which entered the Pacific in 1875 and obtained its deepest sounding in what is now known as the Mariana Trench on 23 March 1875. The second expedition, the Tuscarora Telegraph Sounding Expedition of the North Pacific Ocean commanded by Captain George E. Belknap on the USS Tuscarora, marked both the beginning of the scientific mapping of the Pacific Ocean sea floor and a revolution in sounding technology.

The success of the Tuscarora began with the experiments of the great physicist Sir William Thomson, later Lord Kelvin, who was the first to develop a successful piano-wire sounding machine. Prior to his investigations in the early 1870s, at least three attempts had been made to sound with wire, all of them failures. While developing his system, his friend and colleague J. P. Joule happened upon him and was astounded to see great lengths of piano-wire. On asking Thomson what he was doing, Thomson replied "Sounding." When Joule asked "What note?" Thomson responded, "The deep C."

Thomson's machine was based on the principle that "the art of deep-sea sounding is to put such a resistance on the reel as shall secure that at the moment the weight reaches the bottom the reel will stop." Kelvin first tested this machine in the Bay of Biscay on board his yacht, the Lalla Rookh, in June 1872. After twenty-five hundred fathoms of line had run out, Thomson felt a twinge of misgiving but "the wheel suddenly stopped revolving as I had expected it to do a good deal sooner. The impression on the men engaged was that something had broken, and nobody on board, except myself, had, I believe the slightest faith that the bottom had been reached … until the brass tube with valve was unscrewed from the sinker and showed an abundant specimen of soft gray ooze …. That one trial was quite enough to show that the difficulties which had seemed to make the idea of sounding by wire a mere impracticable piece of theory have been altogether got over."

With this proof of concept, Thomson sent a copy of the machine to the British navy for use on the Challenger Expedition. However, there were some design flaws remaining and its use was declined until the machine could be perfected. Simultaneously, Commodore Daniel Ammen, chief of the United States Navy Bureau of Navigation, ordered one of the machines from Thomson. This was subsequently placed on the USS Tuscarora which was in San Francisco in the summer of 1873. The ship was being outfitted to take a series of soundings across the Pacific Ocean "for scientific purposes, and for the purpose of determining the practicability of laying a telegraph cable between those points."

Under Commander Belknap, the machine was tested in August 1873 off San Francisco in depths approaching 2,000 fathoms. It was discovered that the reel had to be strengthened but with the construction of a new and larger reel, the machine was ready to use.

The original survey plan was to run a line of soundings from Cape Flattery, at the entrance to the Strait of Juan de Fuca, to Yokohama, Japan, via the great circle route through the Aleutian Islands. Winter weather closed in and this line was discontinued and a line of soundings was run to San Francisco. The Tuscarora thence sailed to San Diego and continued its work in January 1874. It proceeded to Honolulu, the Bonin Islands, and on to Yokohama. During these legs, the ship acquired 241 deep-sea depths, about a third of the accurate deep-sea depths then known. The deepest sounding made during this crossing was 3,287 fathoms. There was little reason to suspect

there were deeper areas in the ocean. However, in Belknap's words:

"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 3,247 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."

The ship was also in the Kuroshio Current at this point so he ran back inshore as he believed that both current and great depth at that point would preclude laying a telegraph cable. Picking up the great circle again at 40 degrees North, Belknap relates, "… 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 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 ship had discovered the Kuril-Kamchatka Trench, one of the great boundary trenches of the Pacific Ocean, as well as having discovered the deepest verifiable depths discovered up to that time. The deepest reliable depth measured up to that time, 3,875 fathoms, had been measured 80 miles north of the Virgin Islands by the Challenger in 1873 on its outward bound voyage and it would be almost another year before that expedition measured its deepest depth on the fringes of the Mariana Trench in 4,475 fathoms. Thus Belknap's measurement was the deepest depth yet measured and stood as a record for twenty years. Belknap was not yet done as when he proceeded north he was also the first to sound in the Aleutian Trench and made a number of deep soundings, the deepest being 4,037 fathoms. Thus in this one cruise, he was the first to sound in over 4,000 fathoms and discovered indications of two of the great trenches. The cruise ended in August 1874 off of Cape Flattery. The usefulness of Thomson's piano-wire sounding machine had been proved beyond a doubt and Belknap had established himself as one of the great ocean explorers of the 19th Century. Commemorating his work, the German geographer Augustus Petermann produced the first bathymetric map of the Pacific in 1877 and gave the names Tuscarora Deep to the Kuril-Kamchatka Trench area and the name Belknap Deep to an area south of the Hawaiian Islands. Neither name survives today.

Belknap's ocean exploration had not yet ended as in 1881 while in command of the USS Alaska, cruising off the west coast of South America, he sounded in the deepest water yet found south of the Equator in any ocean with a sounding of 3,367 fathoms off the coast of Peru. This was the first indication of the Peru-Chile Trench. He also sounded on the Chile Rise at this time. He named both after his ship - Alaska Deep and Alaska Rise. Fortunately for confused geographers and school children, these names were not retained.

The USS Alaska command ended Belknap's exploring days. He went on to become a rear admiral in the United States Navy. Looking back on his career as a whole, he was a remarkable individual who at various times in his career was warrior, sailor, scientist, surveyor, engineer, and diplomat – a 19th Century Renaissance man. In an address to the Asiatic Society of Japan at Yokohama in 1890, then Rear Admiral Belknap related in almost lyrical terms his experiences in deep ocean sounding with the Thomson sounding machine: "… one never tired of 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… 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…." With a few changes of words, that could also describe the modern sea surveyor mesmerised as the seafloor is revealed while our multibeam sounding systems do their work.

George Belknap was a sea surveyor and explorer of the first rank. Notches on his sounding plummet included the first sounding lines across the North Pacific Ocean, one of the first isolated seamounts (Erben Seamount) discovered and sounded out between California and Honolulu, first discovery of an oceanic trench - that being the Kuril-Kamchatka Trench, first soundings in the Aleutian Trench, first soundings in the Peru-Chile Trench, and the first soundings on what has come to be called the Juan de Fuca Ridge. Perhaps more importantly, while in command of the USS Tuscarora in 1874, he was the pioneer in the use of Sir William Thomson's piano-wire sounding machine. Until the advent of acoustic sounding instruments, machines based on Thomson's principles of operation were used to sound out and delineate most of the large features of the ocean basins.

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