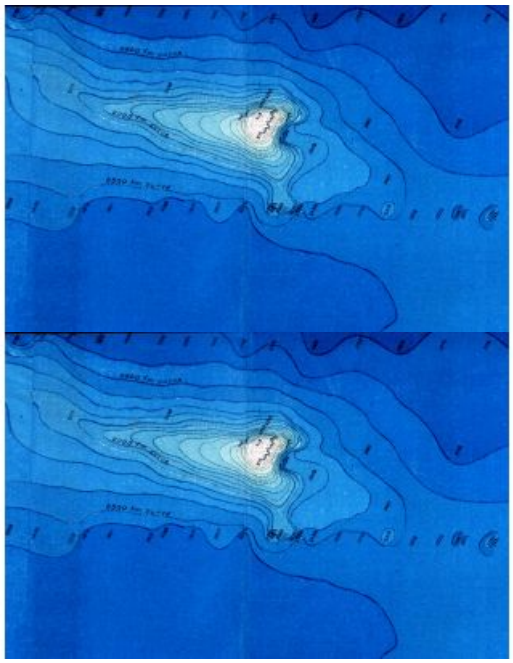
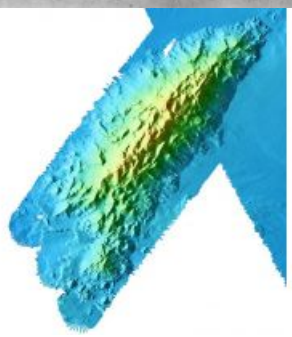
Mountains in the Sea





It is hardly possible to discuss the configuration of the deep ocean bed without eventually using the term ‘seamount’. Today, the existence of tens of thousands if not over 100,000 seamounts is taken for granted. However, in the not so distant past, their existence was unknown and not even suspected.

In 1878, Alexander Agassiz, one of the greatest oceanographers of the nineteenth century, wrote: “The monotony, dreariness and desolation of the deeper parts of the submarine scenery can scarcely be realized. The most barren terrestrial districts must seem diversified when compared with the vast expanse of ooze which covers the deeper parts of the ocean – a monotony only relieved by the fall of dead carcasses of pelagic animals and plants, which slowly find their way from the surface to the bottom, and supply the principal food for the scanty fauna found living there.”

Even as Agassiz was writing these words, there had already been whisperings of how wrong he was. In 1869, the Swedish corvette *Josephine*, with scientists Prof. F. A. Smitt and Dr Axel Vilhelm Ljungman directing operations, was engaged in an ambitious project to conduct deep-sea dredging operations between Europe and North America. On 2 July, it deployed its dredge approximately 200 nautical miles west of Cape San Vincent, Portugal, on a trip that it was assumed would travel at least 2,000 fathoms vertically and take an hour or so to reach the bottom. However, after a few minutes the dredge rope stopped paying out and slack was noticed in the line. The dredge had struck bottom at a little over 100 fathoms. It had landed on what has become known as Josephine Seamount, the first seamount discovered as a direct result of oceanic exploration. It is doubtful that either Smitt or Ljungman ever realized the significance of their discovery.

Deep-sea Sounding Methods

Four years later, Lieutenant George Belknap on the *USS Tuscarora* began a revolution in deep-sea sounding methods by being the first to successfully use Sir William Thomson’s piano-wire sounding machine while conducting a telegraph cable survey in the North Pacific Ocean. This expedition discovered the first known stand-alone seamounts in the Pacific Ocean. The first of these was a peak on the Gorda Ridge off the coast of northern California. It rose nearly 700 fathoms above the surrounding seafloor. Subsequent to that discovery, the *Tuscarora* sailed south to San Diego and thence to Honolulu. This first leg netted indications of a seamount when a 500-fathom jump occurred between soundings of 2159 fathoms at latitude 26 22 N 137 22 W and a subsequent sounding of 2650 fathoms approximately 40 nautical miles distant. Another seven were sounded upon as the *Tuscarora* traversed the Mid-Pacific Mountains, the Marcus-Wake Seamount Group, and the Ogasawara Plateau region of the western Pacific Ocean. Amazingly, many of Belknap’s soundings can be found on the most recent edition of NOAA Chart 530 of the North Pacific Ocean.

The first USS Tuscarora was a sloop of war in the United States Navy during the American Civil War.

The scientific community took little note of Belknap’s work. The majority of his soundings also recovered bottom samples. On virtually all seamounts that he sounded on in the western Pacific Ocean, coral fragments were recovered indicating that these peaks were once in shallow water. This was both a clue as to the age of the mountains as well as evidence supporting Darwin’s theory of island subsidence versus John Murray’s theory of upward accretion of coral reefs. The scientific community argued over aspects of Darwin’s theory for over 75 years following the *Tuscarora* expedition until vindicating Darwin.

In 1875, Commander Henry Erben relieved George Belknap as commanding officer of the *Tuscarora*. His initial orders took him from San Francisco to Honolulu and on to Samoa. On this route, he discovered and developed a great seamount, now known as Erben Seamount. For many years this was the largest known seamount in the Pacific Ocean. In discussing these discoveries,

Rear Admiral Daniel Ammen, a hydrographer and Chief of the Bureau of Navigation, related that the *Tuscarora*'s soundings across the Pacific revealed "a dozen or more submerged elevations, veritable mountains 'full many a fathom deep.' In fact, these soundings furnish the first extended and undeniable development of extraordinary and abrupt inequalities in the depths of the sea far away from land."

Curiously, the contemporaneous Challenger Expedition apparently did not discover any seamounts. John Murray, the editor of the Challenger Reports, seemed to have been more concerned with 'deeps' than with submarine peaks as his maps from the expedition had many named deeps but few named bathymetric highs.

In spite of these successes, few additional undersea peaks were added to knowledge of the seafloor over the next decade. An exception was a sounding expedition across the Atlantic in 1878 in which the USS *Gettysburg* after passing over Josephine Seamount approaching the Straits of Gibraltar, sounded on Gorringe Ridge with its accompanying peaks of Gettysburg Seamount and Ormonde Seamount. The ridge was named for the captain of the *Gettysburg*.

1893 depiction of Erben Seamount in a surprisingly modern appearing map appearing in a report detailing a cable survey by the United States Fish Commission Steamer Albatross.

Telegraph Cable Surveyors

British telegraph cable surveyors developed the Lucas Sounding Machine, a type of piano-wire sounding machine in the mid-1880s and discovered a few more peaks. Among them were Dacia Bank, Seine Bank and the Coral Patch – all discovered in the same region as Josephine Bank. Seine Bank was discovered by the breaking of a cable on a line previously surveyed with a spacing of 25 miles. When laying telegraph cable between soundings of 2400, 1967 and 2332 fathoms, the cable suddenly parted. When checking the depth, it was found to be 100 fathoms. Thus, Seine Bank was discovered and named for the unfortunate cable ship. Faraday Seamount and Minia Seamount in the North Atlantic Ocean were discovered in 1882 and 1903 respectively by the cable ships *Faraday* and *Minia*. These seamounts were in the path of the preferred telegraph cable route between Ireland and Newfoundland.

As a result of such experiences, George Littlehales of the United States Navy Hydrographic Office wrote a paper in 1890 titled 'The average form of isolated submarine peaks, and the interval which should obtain between deep-sea soundings taken to disclose the character of the bottom of the ocean'. After a somewhat convoluted mathematical analysis, Littlehales concluded that in average ocean depths, a minimum sounding interval of 10 miles was required to discover features that would approach the near surface. This in fact would find most large seamounts on a survey trackline, although many smaller features would remain unknown. Given the technology of the times, this was infeasible as the time required was prohibitive. As a consequence, only about 20,000 deep-sea soundings were made prior to the advent of acoustic sounding, an average of one per 7,000 square statute miles throughout the world's oceans. Few additional seamounts were discovered in this period.

In 1922, this all changed when the USS *Stewart*, equipped with a Hayes sonic depth finder, crossed the Atlantic, passed through the Mediterranean, through the Suez Canal, and on to the Far East for service from bases in the Philippines and China. Curiously, it did not encounter one stand-alone seamount on this initial transit, but in March of 1924, while transiting from Manila to Hong Kong, soundings showed a rapid decrease from 2,140 fathoms to 300 fathoms. A short development followed which revealed a relatively flat-topped peak with depths less than 200 fathoms. William Morris Davis (1850-1934), the Harvard geologist and geographer, was given access to the soundings and produced the first contour map of a seamount based on acoustic soundings and dubbed it the Stewart Bank. He foresaw the revolutionary aspect of acoustic systems and observed: "Clearly a new era of oceanic exploration and discovery is opening, when so admirable a use of a most ingenious instrument may be made…."

Seamounts

The famous German Meteor Expedition, and follow-on German expeditions, discovered a number of south Atlantic seamounts including Spiess, Schmidt-Ott, Merz, Meteor and the north Atlantic seamounts – Echo, Altair and Great Meteor. While German scientists were exploring the Atlantic, the United States Coast and Geodetic Survey embarked on a programme to survey the United States West Coast and the Gulf of Alaska. Year after year until the beginning of World War II, C&GS ships marched down the west coast with systematic surveys and also followed a systematic series of tracklines crossing the Gulf of Alaska. These surveys netted San Juan, Rodriquez, Davidson, Guide and Pioneer Seamounts off the California coast, and a number of seamounts named after C&GS officers in the Gulf of Alaska. The United States Navy was also active during this period. In particular, a fleet oiler, the USS *Ramapo*, made 65 transits of the North Pacific between 1929 and 1940 and made tens of thousands of soundings. Soundings of the *Ramapo* and other naval vessels provided much of the material for Navy Charts 5485 and 5486, which had numerous seamounts among other features. However, few of these Pacific seamounts were named at the time of discovery. This outpouring of effort in the early years of acoustic sounding netted approximately 200 seamounts.

Bathymetric map of Davidson Seamount.

In spite of its use in this article to describe mountains in the sea discovered by early surveyors, the term seamount was not widely used until 1938, when the United States Board on Geographic Names designated a large undersea mountain Davidson Seamount. This mountain was discovered by the C&GS ship *Pioneer* in 1933. Citation for the official name read: "Davidson Seamount: a submarine elevation in mountain form which rises from a depth of 1900 fathoms to within 729 fathoms of the surface, near lat. 35°43'30" N., long. 122°43'10" W., about 75 miles west of Point Piedras Blancas, California, in the Pacific Ocean. Named in honour of George Davidson (1825-1911) of the US C&GS who, as chief of party and later in charge of all Coast Survey operations on the Pacific Coast, was active in charting the waters of the west coast." This note goes on to add: "The generic term 'seamount' is here used for the first time, and is applied to submarine elevations of mountain form whose

character and depth are such that the existing terms bank, shoal, pinnacle, etc. are not appropriate." Since 1938, over 1,100 additional seafloor features have been termed seamount while more than 150 have been designated by the related terms tablemount and guyot.

Harking back to the words of Alexander Agassiz, by the advent of World War II much had been done to show that the submarine landscape was not as monotonous, dreary, and desolate as Agassiz had envisioned. In fact, there was growing proof that the landscape was in the words of the nineteenth century oceanographer, Matthew Fontaine Maury, as "rugged, grand and imposing" as any scenery to be found on Earth. A start had been made on exposing Maury's "very ribs of the solid earth, with the foundations of the sea."

This article continues - see also Mountains of the Sea - II.