Anniversaries

Mapping the seafloor 70 years ago

MARIE THARP'S DISCOVERY OF THE MID OCEAN RIDGE RIFT VALLEY IN 1952

Sally Newcomb (USA)

One can hardly do justice to Marie Tharp in a paper of this length, as her life exemplifies so many strands of emerging science and disciplines as well as a sea-change in society as a whole. Her story points to the great value of the study of the history of disciplines, both in the broad sense of geology as a whole and the emerging subsciences of geophysics and more sophisticated seismology, as well as the newly coined oceanography. In a relatively short period knowledge of the ocean floor went from an assumed almost featureless abyssal plain to a worldwide complex of ridges, valleys and transform faults showing regularly reversing strips of magnetism. Accounts of Marie Tharp's life also show a progression. She was at first nearly invisible, a "computer" as then known as she took numbers and translated them to maps. She was not allowed to go on ships to collect data, was basically ignored in published papers and was rarely referenced in histories, but her career ended with a full and fair assessment of her place in the complex story.

Her upbringing was unusual for her time. She was born in Ypsilanti, Michigan in 1920. When her mother had married at 40 to her 50-year-old husband, she retired from teaching German and Latin. Marie's father was a soil surveyor for the United States Department of Agriculture, mapping in the south in the winter and the north in the summer. The family moved constantly, and she had attended almost two dozen schools by the time she graduated from high school. Unsurprisingly, she was more a companion to her father and mother than to school friends. Her bond to her father increased when her mother died when she was fifteen. Her first choice of major at Ohio University was literature, for which she received a B.A. in English and music, with 4 minors in 1943 (Barton 2002: 216). Because most men were in the armed services, in 1943 the University of Michigan offered girls degrees in geology so they could work in the petroleum industry. Marie finished with a master's degree and took a job in Tulsa in an oil company office. She disliked both the office and the micropaleontology other girls were doing, so went to Tulsa University and earned a B.S. in mathematics.

Here the story gets a bit more complex. Some biographies, and her own oral interviews mention only that, being bored in Tulsa she went to New York in 1948 and eventually found her job at the Lamont Laboratory of Columbia University.[1] Her work at Columbia quickly became compelling. On the strength of her degree in mathematics she was sent to Dr. Maurice Ewing (1906-1974) (founder of the Lamont Geological Observatory) who was puzzled about what she could do. When he inquired if she could draft, she told him she'd had a drafting job when at the University of Michigan, and so was hired.

[1] This omits the apparent fact of a violinist husband and his desire to study at Julliard in New York. They divorced in 1952 (Felt 2012).

Bruce Heezen (1924-1977) arrived about two weeks later as one of Ewing's graduate students. At that time, the department was on the Columbia University campus, but soon accepted the donation of an estate that became the, now, Lamont-Doherty Earth Observatory at Columbia University. Marie was soon working only with Heezen, drafting profiles of the ocean floor from data acquired from an echo sounder as a ship traversed the ocean. Heezen was very frequently at sea, collecting sonar lines across the north Atlantic which she translated into maps. These first maps showed a few individual tracks of the ships, filling in as more and more transits came into the records.

Fig. 1 M. Tharp drafting the seafloor maps: Photo credit: Lamont-Doherty Earth Observatory and the estate of Marie Tharp

This was an exciting time in the new science of oceanography as the maps became part of a complex and worldwide story. H. W. Menard (1920-1986), himself a geophysicist turned historian, wrote an excellent account of the surge of interest in all phases of the oceans in *The Ocean of Truth: A Personal History of Global Tectonics*, published in 1986. He recounted the story of the years of soundings via continuous echo recordings, seismicity, bathymetry, eventual magnetic surveys, and sea floor coring by many nations, all to increase during and after the Second World War with constantly improving instrumentation. The war itself was the cause of much of it in the attempt to detect enemy submarines, protect the submarines and shipping of the Allies, and eventually to detect nuclear explosions. The profiles that Heezen had collected since 1947 were an essential part of it all (Barton 2002: 215). By 1952 Tharp and Heezen added physiographic shading to give a better impression of the actual shape of the deep ocean floor. They had thousands of depth measurements from the Lamont ships, but soon added tracks from other sources. Marie noted that "we had interminable rows of sounding numbers, numbers that I was supposed to turn into highly detailed and complete seafloor profiles" (Tharp,M., Connect the Dots, 1999). This was not easy, but Marie enjoyed her position, the work, and the company and the social life (drinks at five) that came with it. She continued:

> Eventually, after the plotting, drawing, checking, correcting, redrawing and rechecking were done, I had a hodgepodge of disjointed and disconnected profiles of sections of

the North Atlantic floor. Plotted on a map, the ship's tracks looked like a spider's web, with the rays radiating out from Bermuda, where most of the research vessels took on supplies and water. Sometimes, the tracks zigzagged, as the ships fled from the paths of storms. (Tharp M. Connect the dots, 1999)

After six weeks more work, she had arranged the east to west tracks in order, north to south, and it was here that she saw that the only thing that lined up was a cleft in the middle of the ridges that had been revealed in the profiles. To Tharp it made sense that if material was forced up from below, the ridge would split apart. Heezen assumed there was an error, as he was an anti-drifter, or, like many of his time, saw no way for the sea floor to be expanding.

Better data kept coming in from the precision depth recorder (PDR) on Lamont's and others' ships. With an assistant for Tharp, it was all plotted to the same scale, 1:1,000,000. By then Heezen was working with Bell Laboratories in order to figure out why transatlantic cables were breaking. Heezen and Ewing had found turbidity currents in the deep ocean, activated by recorded earthquakes. Heezen engaged an assistant to map the earthquake epicenters, at the same scale as Tharp's mapping. At that point Heezen and Tharp noticed how closely the earthquakes followed the mid-ocean ridges. This had been previously noted, but Heezen saw that they actually fell in the rift valley. Plate tectonics on a world-wide basis was still in the future. Various explanations were proposed with various mechanisms: continental drift, sea floor expansion, subduction, were all conjectured. Ocean exploration was being carried out by multiple countries with different ships and instruments, in different oceans. Marie kept on mapping. Upwelling lava pushing the ridges apart made sense to her, but Heezen, Ewing, and many others were all opposed to expansion. Jacques Cousteau (1910-1997) did not believe the rift valley existed, and so towed a movie camera across it, thus proving its existence. It was at this point that one of the few early publications appeared that included Marie's name, the 1959 Geological Society of America's Special Paper 65, The Floors of the Oceans, with authors Heezen, Tharp and Ewing.[2]

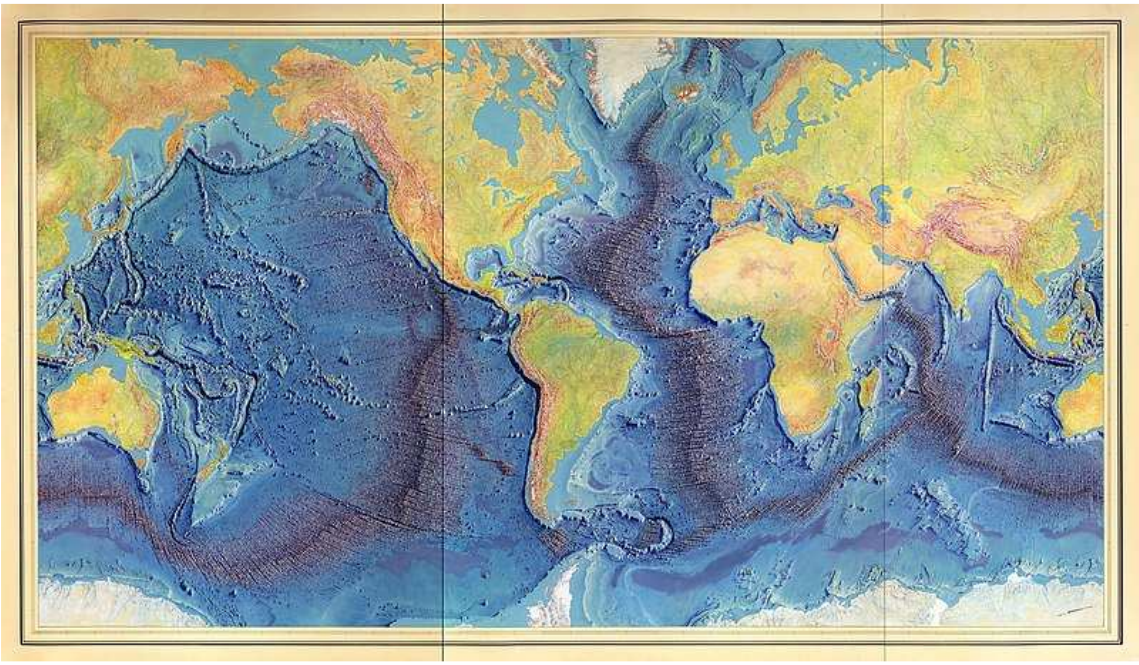

Fig. 2 Manuscript painting of the Mid-Ocean Ridge with rift axis by Heinrich Berann based on the scientific profiles of Marie Tharp and Bruce Heezen (1977). Source: Wikimedia Commons

[2] A separate study could be done about sources of funds for much of the oceanography work. GSA is prominent, but because of the military importance much of Lamont's budget was from the military.

By the mid 1960's the difficulties between Ewing and Heezen resulted in Heezen being banned from the Lamont ships. The positive result for Marie was that she was now able to accompany him on some voyages on other ships. He continued with his position at Columbia. Marie's position disappeared, but because Heezen had multiple grants with the U.S. Navy and elsewhere, she continued her work from her home with similarly funded assistants. Although eventually they regained data from the Lamont ships, there were still many sources from U.S. ships and those from Russia, Germany, and elsewhere. Barton (2002) followed details of the changes in representation of their seafloor map making as it progressed from the north to the south Atlantic and on to the Indian and Pacific oceans and, eventually, all of the world's oceans. It incorporated not just ridges and valleys, but also the transform faults offsetting them. Color was added via the work of the Austrian painter, Heinrich Berann (1915-1999). The National Geographic Society facilitated printing successive colored maps, culminating in the famous topographic map of the world's ocean floors on a single sheet (Barton, 2002: 223). From this time, publications and recognition for Marie were much increased. She had always been happy to let others give the oral papers. Marie and Heezen shared sea time collecting data, as well as traveling the world for conferences. The final world map of the sea floor wasn't published until just after his death in 1977.

The debate about what was actually happening on the ocean floor continued, but the anti-drifters and anti-expansionists were finally convinced. Plate tectonics became a unified theory of earth behaviour. Marie's work was fully recognized: in 1997 the Library of Congress named her one of the four great cartographers of the 20th century; in 1999 she received the Women Pioneer in Oceanography Award from the Woods Hole Oceanographic Institution; and in 2001 she was given the Lamont-Doherty Heritage Award. She facilitated getting Heezen's and her work in the Library of Congress. Lack of mention in some histories shows only the inattention of authors who omit this important part of a multifaceted story. To finish with Marie's comments:

> Scientists and the general public got their first relatively realistic image of a vast part of the planet that they could never see. The maps received wide coverage and were widely circulated. They brought the theory of continental drift within the realm of rational speculation.
> I worked in the background for most of my career as a scientist, but I have absolutely no resentments. I thought I was lucky to have a job that was so interesting. Establishing the rift valley and the mid-ocean ridge that went all the way around the world for 40,000 miles---that was something important. You could only do that once. You can't find anything bigger than that, at least on this planet. (Tharp M. Connect the Dots, 1999).

I have by no means read all of the biographies and heard or read all of the multiple oral interviews about Marie. One thing that comes through is honesty about her work, and her place in the larger story. The overall trajectory of her career was increasing responsibility and recognition. The following list is a small sample of what is available, but attempts to be a fair representation of it. The best full and fair biography is that of Barton, 2002 in the Oldroyd volume.

Acknowledgement
Corinne Mona at the A.I.P. Niels Bohr Archives was most helpful in providing access to books.

Further Reading

Baker, V.R. 1999. Essay review: Naomi Oreskes; *The Rejection of Continental Drift: Theory and Method in American Earth Science*. Earth Sciences History 18:2, pp. 321-335.

Barton, C. 2002. Marie Tharp, oceanographic cartographer, and her contribution to the revolution in the Earth Sciences. Pp. 215-228, IN Oldroyd, 2002.

Connect the Dots: See Tharp, *in* Lippsett Frankel, H. R. 2012. *The Continental Drift Controversy*. 4 V. Cambridge: Cambridge Univ. Press

Glen, W. 1982. *The Road to Jaramillo*. Stanford Univ. Press: Stanford, CA. ch.8.

Greene. M.T. 1999. Archival versus canned history. *Earth Sciences History* 18:2. Pp.336-343

Harrington, J.W. 1983. *Dance of* the *Continents*. Los Angeles: J.P.Tarcher, Inc.

Le Grand, H.E. 1988. *Drifting Continents and Shifting Theories*. New York: Cambridge Univ. Press.

Menard. H.W. 1986. *The Ocean of Truth.* Princeton N.J.: Princeton University Press.

Oldroyd, D.R. 1996. *Thinking about the Earth: A History of Ideas in Geology*. London: Athlone

Oldroyd, D.R. (Editor) 2002. *The Earth Inside and Out: Some Major Contributions to Geology in the Twentieth Century*. London: The Geological Society.

Oreskes, N. 1999. *The Rejection of Continental Drift: Theory and Method in American Earth Science.* New York: Oxford University Press.

Oreskes, N.1999. Living with uncertainty, learning from mistakes: Reply to Victor Baker and Mott Green. *Earth Sciences History*. 18:2, pp.344-350.

Oreskes, N. 2022. Operational oceanography. Pp. 102-109. *American Scientist* 110:2.

Sengor, A.M.C. 2018. Some notes on a history of ideas on rifts and extensional tectonics in general. *Earth Sciences History* 37:1, pp. 144-156.

Tharp,M. 1999. Chapter 2: *Connect the Dots*: Mapping the Seafloor and Discovering the Mid-Ocean Ridge. IN Lippsett, L. (ed.) *Lamont-Doherty Earth Observatory of Columbia, Twelve Perspectives on the First Fifty Years 1949-1999.* Palisades N.Y.:L.-D. Earth Observatory of Columbia Univ.

Tharp, M. 1999a. Reminiscences of Marie Tharp. Oral interviews located at the American Institute of Physics, College Park MD. They can be accessed by searching Marie Tharp Oral Interviews.

Wood, R.M. 1985. *The Dark Side of the Earth*. London: George Allen & Unwin

The Lamont-Doherty website at http://marietharp.ldeacolumbia.edu/aboout-marie-tharp has a great deal of information as well as links to important literature.

Publication online: Posted IUGS Website / INHIGEO Website Anniversaries
July 2022
IUGS E-Bulletin Issue 188, July 2022.

Author: Prof Sally Newcomb
Honorary Senior Member (USA):
IUGS International Commission on the
History of Geological Sciences (INHIGEO)

13120 Two Farm Drive
Silver Spring, MD 20904
USA
Email: senewcomb@earthlink.net

The full list of contributions to the INHIGEO Anniversary Series is available on the website:
http://www.inhigeo.com/anniversaries.html