Marie Tharp: The lady who showed us the ocean floors

Gary W. North *

North Arrow, Ltd., US Geological Survey 43685, Augusta National Terrace, Leesburg, VA 20176-3979, United States

Article info
Article history:
Received 11 January 2010
Received in revised form 24 May 2010
Accepted 31 May 2010
Available online 8 June 2010

Keywords:
Ocean floors
Marie Tharp
Bruce Heezen
William E. Tharp
Heinrich Berann
Mapping

Abstract
Marie Tharp and Bruce Heezen of the Lamont-Doherty Earth Observatory of Columbia University are best known for creating the first maps of the ocean floors. Bruce sailed the oceans collecting the data and overseeing the projects, but the person who turned the precision depth recordings and other geoscience data into the two-dimensional views of the bottoms was Marie. Meticulously, she sketched the features that comprise the ocean floors, aligned the data according to the orientations of the fracture zones, and identified volcanoes, earthquake epicenters, faults and sea mounts. Marie's discovery of a deep valley centered along the axis of the Mid-Atlantic Ridge and her linkage of the major crustal plates for over 64,000 km (40,000 miles) around the Earth, showed us, and thus confirmed, the concept of plate tectonics and crustal movement. How Marie came to her place in history, what she was like, and how her life unfolded are the subjects of this paper.

1. Introduction

In the Earth sciences there has always been a historical connection between soils and geology. In Marie Tharp's case, the unique connection is that of father and daughter. Her father, William E. Tharp, was a soil surveyor and Marie was a geologist. Throughout her youth, she traveled with "Papa Tharp", as she called him, from the northern states in the summer to the southern states in the winter, as he made Soils maps for the Bureau of Soils of the US. Department of Agriculture (see paper by Landa, this volume, focused on W.E. Tharp).

In 1995, Ralph Ehrenberg and James Flatness of the Geography and Map Division of the (US) Library of Congress were contacted by Marie Tharp of Nyack, New York. Marie was looking for a home for the cartographic materials that she and her working partner, Dr. Bruce C. Heezen, had developed as part of their 30 years effort to map the ocean floors. The two of them had worked at the Lamont-Doherty Earth Observatory of Columbia University and had produced the first maps of the world's ocean floors. Dr. Heezen died in 1977 and Marie had, in her possession, thousands of items resulting from their work. Thanks to Ralph, Jim, and later Ron Grim, Steve Cuculo, and the current chief of the division, John Hébert, those materials now reside with the Geography and Map Division for use by students, scholars, and the general public.

In 1995, I retired from the US Geological Survey and formed North Arrow, Ltd. a spatial data consulting company. On a visit to the library, I met with Ralph Ehrenberg and he showed me boxes and tubes of Tharp materials that were in need of being organized and indexed. Having spent my career in the Earth sciences and retiring as Assistant Chief of the National Mapping Division, I submitted a successful proposal to the library to unpack and organize the materials. To assist me, I hired Robert G. Rhodes, a geographer and retired Army Colonel. It was estimated that there were 5000–7000 items, and that the effort would take about a year to complete. The initial number of items turned out to be over 40,000; and new items acquired before and after Marie's death continue to flow in. Working with Marie for 9 years, and then serving as an executor of her estate for three more years, has provided me with an insight into her life and work that few biographers get to have.

2. Marie Tharp

Who was Marie Tharp? During my research I came across a quote, generally attributed to Ralph Waldo Emerson, which states: "Do not follow where the path may lead, go, instead, where there is no path and leave a trail." That describes Marie and the trail that she left changed the way we view a significant part of our planet (Fig. 1).

To most people, Marie appeared to be a shy and quiet person, although colleagues speak about her temper, her swearing and her arguments with Bruce. They tell of ink bottles and erasers

---

1 The framed copy of this quote from Marie's home was distributed in 1973 by Continental Publications.
being thrown around the room, and maps being torn up. I first met her in 1997. I was asking her why a certain set of data look different from other similar information and she said: “It was just bad data from the profiler.” I asked what was wrong with the profiler and she replied: “The f...ing thing just would not work.” That from a 77-year old lady who wore long dresses and field boots. She always suffered foot problems, and from the time she first started working at Columbia, she went to Macy's where they took casts of her feet and made custom field boots. The long dresses covered them up to some degree, but everyone noticed them. After working with her for a few years, we got her to try on some Nike's; she made the switch to modern footwear and was deeply thankful for her increased ability to move around.

Born in 1920, Marie grew up when there were few women in the sciences, and due to her upbringing and nature, she always gave Dr. Heezen all the credit for their work. She always sold herself short, and said she could not write or speak. When she answered the phone she often sounded quiet, lost and lonely until I would say: “Get your bathing suit and flippers on, we're going water skiing on the Hudson today.” She would laugh and perk up immediately.

In the fall of 1997, the Library of Congress honored her as one of the four outstanding cartographers of the 20th century. During the preparation for a taped interview, I asked her who she was. She replied, “I am an American. We moved so often during my early years that I have no alliances. Even so, there were special places like the Pinney Woods down south, the big dam at Muscle Shoals, Serpent Mound, the likes of which I had never seen before or since. There were also weekends of sightseeing in the winter season in Washington, D.C. every 4 years which happily, for me, coincided with the inaugural parades of Coolidge and Hoover.” She went on by saying: “And on the eastern coast, the fabulous fall colors which are draped over the hills like a heavenly tapestry are fairly unique as the land gets flatter and the trees fewer as one approaches the midwest, wheat fields, and grazing lands up to the Rockies. But then, as I say, every place had something special and yet we belonged nowhere.”2 This, I believe, is a fitting example of her feel for the land and of how her nomadic childhood helped to shape her life.

3. Background and education

Marie Tharp was born in Ypsilanti, Michigan in 1920. Her mother, Bertha Newton (1880–1936), was a German and Latin teacher, and her father, William Edgar Tharp (1870–1959) became a soil surveyor in 1905. Marie went to schools in Alabama, the District of Columbia, Indiana, Iowa, Michigan, Mississippi, Louisiana, New York, and Ohio. She attended Ohio University in 1938 where she majored in English. She said she did not know what she wanted to do, and that there were only three things a girl could do. You could become a teacher, but her mother had already done that. You could become a secretary, but she thought that would be boring. Or you could become a nurse, but the sight of blood made her sick. So it was English, although she did take art and music as well as a couple of geology courses which she really enjoyed.

In December of her senior year, she was walking by a bulletin board and saw a notice that the University of Michigan was offering a masters degree in geology for women only. Not only did you get a degree but you were guaranteed a job in the oil business. She headed to the registrar's office and they discovered that, because of her summer school courses, she had enough credits to graduate. So in January 1943 she graduated and headed to Ann Arbor to become a member of what became known as “The Petroleum Girls.” It was war time and geologists were badly needed, as most men were being drafted into the Army. After 2 years at Michigan, which included half a year in field camp in Jackson Hole, Wyoming, she got her Master of Arts degree in geology. After graduation, she headed to Tulsa, Oklahoma with the Stanolind Oil and Gas Company. They were not sure what to do with a woman because she certainly could not go to the field with the men, so they put her to work in the office. She transferred data from well logs and did some drafting, but she was bored. To fill her time, she enrolled in night school at the University of Tulsa, and received a bachelor of science degree in mathematics in 1948.

Ms. Tharp next appears at Columbia University in New York looking for a job. For many years I asked her why she came to Columbia? She would pause and quietly tell me that Columbia was the center of geologic research and she came because of its reputation. One day I was working with some of her early map sheets and I came across one that had been signed, in her hand-writing, as Marie Flanagan. I called her and asked, “Who was Marie Flanagan?” There was silence and she asked: “Oh Gary, how did you find out?”2 I told her about the map, and she later erased the name during a visit to the Library of Congress. While at Ohio University, she had fallen in love with a violinist named David Flanagan and returned to Ohio from Tulsa to marry him in 1946. He had been drafted when they were in college, was released on a medical discharge, and later was accepted for course work at the Juilliard School of Music in New York. He had suffered battle fatigue and a nervous breakdown, and even though they were married, they spent little time living together. He had an apartment in New York near Julliard, and that is how Marie came to Columbia. She said she was ashamed of this period in her life, and always wanted to keep it quiet. To a friend, she said the marriage had been annulled, but divorce papers were found in her safety deposit box following her death.

On the day she showed up at Columbia, she was directed to Dr. Maurice Ewing, the head of the geology department; but since he was at sea, she had to wait a couple of weeks for an interview. When she finally met him, his first question was: “Can you draft?” She drew a perspective view of a profiling instrument and that drawing is part of the library's collection. Her first assignment was to operate a Monroe calculator for Frank Press who was a Ph.D. graduate student. Dr. Press completed his degree at Columbia in 1949, and after taking a faculty position at the California Institute of Technology, later became President Carter's Science Advisor (1977–1980) and the president of the National Academy of Sciences (1981–1993). During Marie's first year at Columbia she met a graduate student named Bruce C. Heezen, who would become her life-long working partner.
4. Bruce C. Heezen

Bruce Heezen was a turkey farmer from Iowa who got a degree in geology from the University of Iowa. During his junior year, he attended a lecture by Dr. Ewing, who was visiting the Iowa City campus. Ewing offered him an internship at the Woods Hole Oceanographic Institution in Massachusetts for the following summer. Bruce’s taste for oceanography and the sea was a lasting one, and he applied to graduate school at Columbia since Dr. Ewing had moved there from Woods Hole. At Columbia, he received his masters and doctorate degrees as a geologist and sedimentologist.

Bruce and Marie were part of a small group that moved to an estate on the Hudson River which had been donated to Columbia during Dwight Eisenhower’s presidency of the institution. It first became known as the Lamont Observatory and later, in the 1960s, it became the Lamont-Doherty Observatory. Today, it is known as the Lamont-Doherty Earth Observatory. Marie always talked about the group and said: “The group was working hard, 20 hours a day, because during the war, everyone had to work at research to beat the Germans. It was the Ewing-group that helped to beat the Germans. Research helped win the war.”

While Bruce was at sea, Marie worked on the six tracks of data that stretched across the North Atlantic Ocean. She turned the depth data into profiles as if you were looking at the depths from an oblique angle (Fig. 2). As she studied these profiles, she noticed that there was a valley along what had become known as the Mid-Atlantic Ridge. She also plotted the known locations of undersea earthquakes, and discovered that they coincided. Dr. Paul Jeffrey Fox of Texas A&M University’s College of Geosciences and a former colleague of Tharp and Heezen has said that: “When Marie made her initial correlation (early 1950s), plate tectonics had not been formulated. Continental drift was a theory at that time and was largely discredited by most northern hemisphere geologists, and geophysicists. The significance of Marie’s correlation was that the existence of a belt of recent seismicity that correlated with a deep valley that defined the axis of the Mid-Atlantic Ridge, indicated that the ridge axis was the locus of ongoing tectonic activity and not a relic feature that was long dormant. If the axis of the Mid-Atlantic Ridge was tectonically active and defined a center line down the length of the North Atlantic, this could be interpreted as the axis of a dynamically active feature where new sea floor was created. At that time, what is now known as the world-encircling Mid-Oceanic Ridge System was no more than a series of isolated ridges found in the Atlantic Ocean, Indian Ocean and southeastern Pacific. In 1956, Heezen and Ewing, using a global compilation of earthquake epicenter data demonstrated that the earthquakes defined a narrow and continuous belt of earthquakes that wrapped, like the seam of a baseball, through the global ocean linking the disparate ridge segments. They proposed, based on Marie’s correlation of earthquakes with the axis of the Mid-Atlantic Ridge in the North Atlantic, that the narrow belt of earthquakes defined the existence of yet to be discovered ridges that linked together to form the most continuous feature on the planet.”

Since plate tectonics was only a theory at this time, there were strong arguments as to whether the continents were fixed in place or whether they floated or drifted. Consequently, scientists were grouped and referred to as “drifters” or “non-drifters.” For almost a year, Marie tried to convince Bruce of what she had concluded. She said that he was horrified and said it could not be. “He said it looked too much like continental drift and he could not sponsor this concept because he would be fired. It was unacceptable.” She went on to say: “Plate tectonics was not invented or even named

3 This quote came from Dr. Paul Jeffrey Fox of Texas A&M University’s College of Geosciences. Dr. Fox studied at Columbia University (Ph.D. 1972) with Marie Tharp and Bruce Heezen, and has clarified such things, in his paper, as: Frank Press’s background, the naming of the observatory, precision depth recorders, Marie’s role with Bruce and Dr. Ewing, and Marie’s correlation of earthquakes along the Mid-Ocean Ridge System.
at that point, and continental drift was very taboo since their boss, Dr. Ewing, was a non-drifter. Bruce, at first, referred to the concept as continental displacement rather than continental drift.

With time, Bruce became convinced and was quoted in a 1974 popular-press book "The Floor of the Sea" by William Wertenbaker as saying: "I discounted it as girl talk and did not believe it for a year." Marie and Bruce took a rubber globe, the size of a basketball, and superimposed all the plate boundaries that she had drawn covering the oceans, and then went to Princeton to make a presentation of their findings. At the end of their lecture, Dr. Harry Hammond Hess, a geophysicist and head of the Department of Geology, was quoted as saying: "Young man, if what you say is true, you have shaken the foundations of geology." Subsequent rock dating tests indicated that new molten materials did rise along these plate boundaries and the rocks got older as they moved away in both directions. If this was the case, however, why were not the oceans rising? That was answered with the identification of the deep subduction trenches like those near Puerto Rico and Java, where one plate slides under the other.

6. Heinrich Berann

In 1977, the World Ocean Floor map was published as the first comprehensive look at what the floors of the oceans would look like if you removed all the water (Fig. 3). To assist them in compiling this work, Marie and Bruce worked with Heinrich Berann, an Austrian painter who had been employed by the National Geographic Society (NGS) to paint alpine perspectives of Yosemite, Yellowstone, Denali and the Grand Canyon National Parks. The painter and the pair of scientists partnered to create Marie and Bruce’s individual ocean insert maps that were done for the NGS magazine. Berann was a master of painting topographic landscapes and nudes. National Geographic discovered him when Berann’s daughter saw a magazine with alpine paintings and wrote them that her father could paint better than whoever had done the paintings for the magazine. A year later, a representative of NGS visited Berann in Austria and the rest is history. Marie spent a lot of time in Austria working with Berann and his assistant, Heinz Vielkind, transferring her pen and ink sketches of the floors to a master base map of the world which was then air brushed to create the colorful and smooth topography that we see on the map. National Geographic used their data on all their atlases, globes and maps for many years. Marie often said: “National Geographic made us famous.”

Times were not always good at Lamont for the team. For an extended period of time, a deep academic rift developed between Bruce and Marie on one side, and Dr. Ewing on the other. Bruce was not allowed to sail on Lamont vessels, and they were not allowed to see recent profile data. Marie lost her job at Lamont and ended up working for the US. Navy’s National Ocean Survey for 4 years. She told me: “I didn’t even know what had happened until I got my first Navy paycheck.” She simply continued working on the projects that the Navy was already funding. Marie referred to this time as the harassment period.

7. The End

In 1977, Bruce had an opportunity to take a cruise on what was then, a secret nuclear research submarine called the NR-1. While off the coast of Iceland, he had a fatal heart attack, which for Marie, was the end of her world. She regretted that he never got to see the final printing of their World Ocean Floor map, although he had seen the color proofs prior to his NR-1 cruise. Marie simply said: “He just went and died.”

---

Fig. 2. Portion of an original map of the Atlantic Ocean near the Cape Verde Islands drawn by Marie Tharp.

---

Lisa Horman, a writer for an Austrian magazine, *The Tirolerin*, interviewed Marie on her last trip to Austria and wrote: “Two great passions decided Marie’s life, the fascination of the deep seas, and her affectionate partnership with Bruce Heezen. A love story that gave new knowledge to the world.”5 They never married, and this is the only description of their personal relationship that I have found.

Because of her love for Bruce and her desire to save, for posterity, the results of their historic work, their collection of materials is now housed with the Geography and Map Division of the Library of Congress as part of the world’s largest map collection. Marie helped design the framework for indexing and accessing the materials. Items are arranged by primary and secondary data categories and by ocean. The primary category consists of the original, raw data, with the secondary category being the derived data. Of the 40,000 items that were processed, 23,200 are described in computerized files, and 12,518 went to other institutions or parts of the library. A total of 6½ years of work was expended in organizing the collection.

During her later years, Marie received credit for the work that she so rightly deserved. In 1978, she and Bruce received the National Geographic Society’s Hubbard Medal; in 1996, the Society of Women Geographers honored her as one of the 20th Century’s Outstanding Cartographers; in 1997, the Phillips Society of the Library of Congress honored her as one of the 20th Century’s Outstanding Cartographers; in 1999, she received the Woods Hole Oceanographic Institution’s Pioneers in Oceanography Award; and in 2001, she received Columbia/Lamont’s first Honors Award.

Perhaps the recognition that pleased her the most, however, was when her maps were included in the American Treasures of the Library of Congress exhibition to celebrate the centenary of the Thomas Jefferson Building, in May, 1997. There, along with Lewis and Clark’s maps, items that Abraham Lincoln had in his pocket the night he was shot, and personal items from George Washington and Thomas Edison, she saw her drawings and maps. She broke into tears and said: “I wish Bruce and Papa could see this. How did it all happen?”2

In the early 2000s, David T. Sandwell of the Scripps Institution of Oceanography and Walter H.F. Smith of the National Oceanic and Atmospheric Administration published a map of Sea Floor Topography using bathymetry derived from satellite altimetry data (http://www.ngdc.noaa.gov/mgg/bathymetry/predicted/explor-e.HTML). When you take a transparent overlay of this map and lay it over Marie’s work, it fits nearly perfectly. How could she have comprehended what those thousands of miles of ocean floors looked like? I often asked her how she drew features in areas where there was no data. She would just sit back, laugh, and say: “I faked it, or we put a big legend over the area.”2 Extrapolate would be a better word. People tell of how Bruce would return from a cruise and take out the electric eraser and erase part of what Marie had drawn when he was away. Marie would draw it back, he would erase it again, and she would draw it as she knew it should be. Bruce would finally give in. Dr. Paul Jeffrey Fox told me: “If it had not been for Marie Tharp, there would have been no physiographic maps, and Bruce’s reputation would have been diminished.”3

The most fitting tribute to Marie and her work comes directly from Bruce, who in a letter written in 1976, stated: “So over the last ten or fifteen years, what people think the bottom of the ocean looks like, that is, what most scientist and informed laymen think it looks like, is what Marie Tharp thinks it looks like.”2

---

5 From a speech by Lisa Hormann regarding her article titled: “Das Gesicht der Tiefe” about Marie and Bruce in the January 1996 issue of the Tirolerin magazine.
Shortly before her sudden death in 2006, I asked her if she had a satisfying life. She said: “It has been a very satisfying life! I feel as if I fulfilled my ambitions and made a contribution. I felt compelled to work at something where I could make a contribution. And, of course, I was privileged to work with Bruce on a small team at the very beginning of a science. This was our basic philosophy, Bruce and I, that one picture is worth a thousand words.”

A picture, a map, or a path. The lady who showed us the proof of plate tectonics and crustal movement, certainly went where there was no path and left a trail—a trail that all current geologists and oceanographers can thank her for.