The Magnetic Earth

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As a geologist with expertise in oceanic basalts, I was invited to join the 1975 research activity of the drill ship "Glomar Challenger" which inaugurated the International Phase of Ocean Drilling (IPOD). The task was to retrieve core samples of basaltic rocks from the central Atlantic Ocean from a water depth of 4 – 5 km. The programme required the re-entry of the holes drilled as the drill bits were expected to need replacement in order to achieve the hoped for depth in the hard basaltic rock.

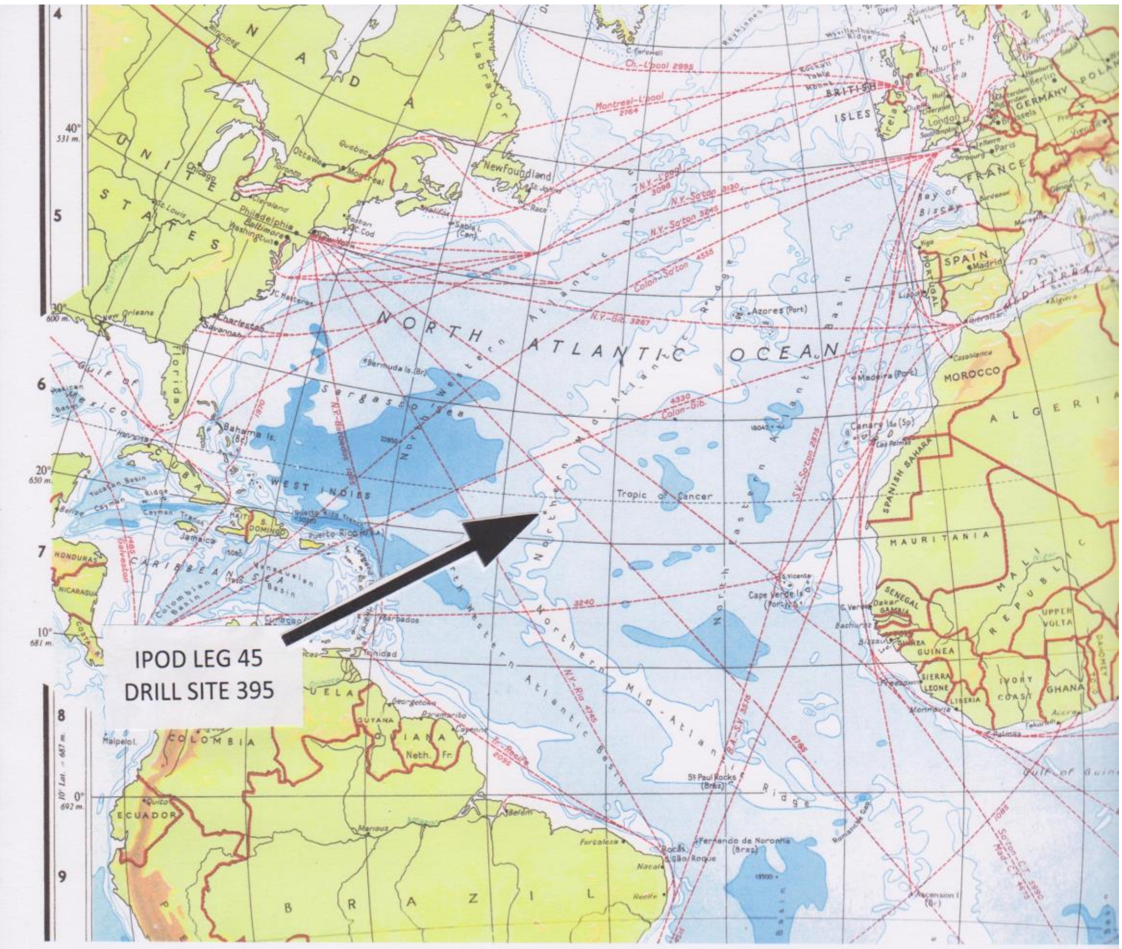


Fig. 1. Map of the Atlantic Ocean showing the locality of the drill site (Hole no. 395)

The ship sailed from Puerto Rico in December 1975 for the first "deep drill" site to obtain cores from basement basaltic rocks. We spent two months on site so my Christmas 1975 was spent at 22 degrees N and 46 degrees W in the middle of the Atlantic on the "Glomar Challenger" as a member of the scientific team.

Fig. 2. The Glomar Challenger. The drill ship named after HMS Challenger, and the Challenger Expedition (1872-76) which initiated the study of the oceans.

Fig 3. On board the Glomar Challenger, en route eastwards in the Western Atlantic with 6 km of drill pipe.

The cruise successfully recovered a total of 221 metres of basaltic core material from a water depth of 4.5 km. The “Glomar Challenger” was so named after the expedition of HMS Challenger of 1872 – 76. This was the first scientific survey of the ocean floor and the initiation of oceanography research. The extensive collection of samples recovered in 1872 – 76 is held in the Challenger Collection of the Natural History Museum, London. The Glomar Challenger was retired in 1985 and replaced by the JOIDES Resolution which is still active in deep sea research.

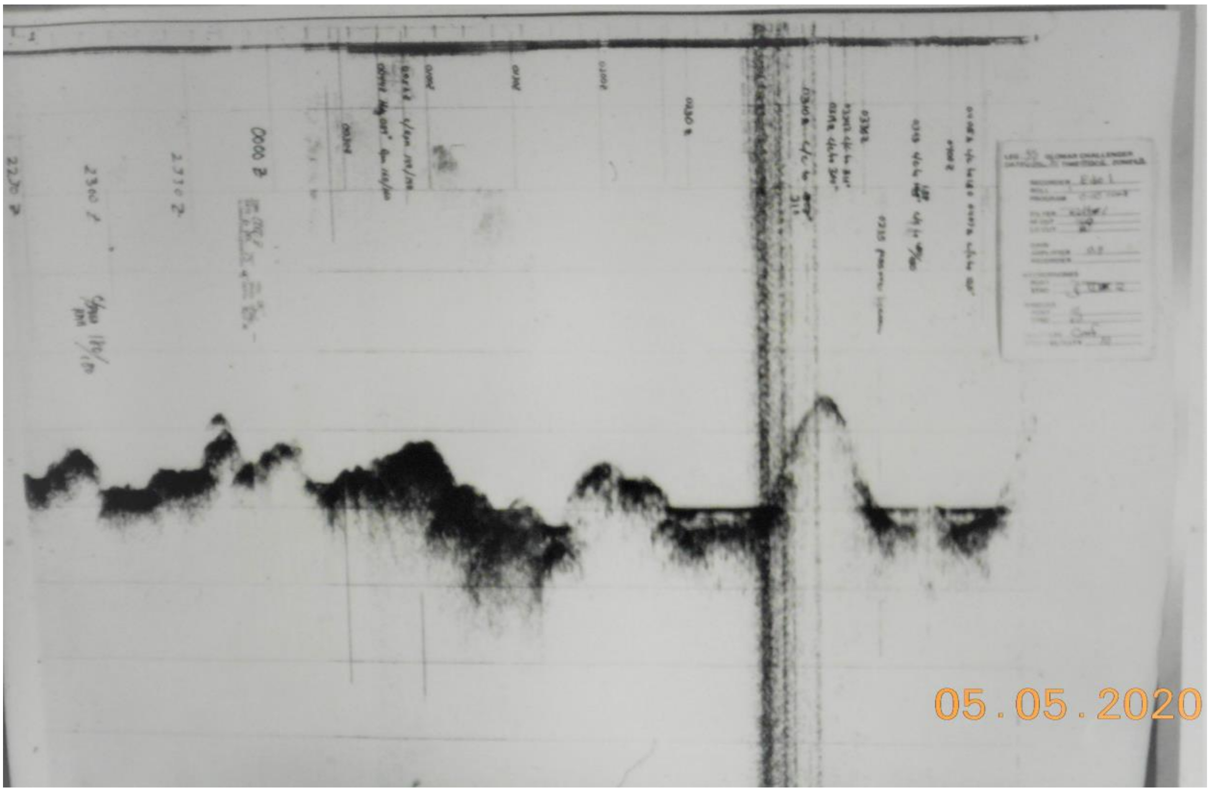
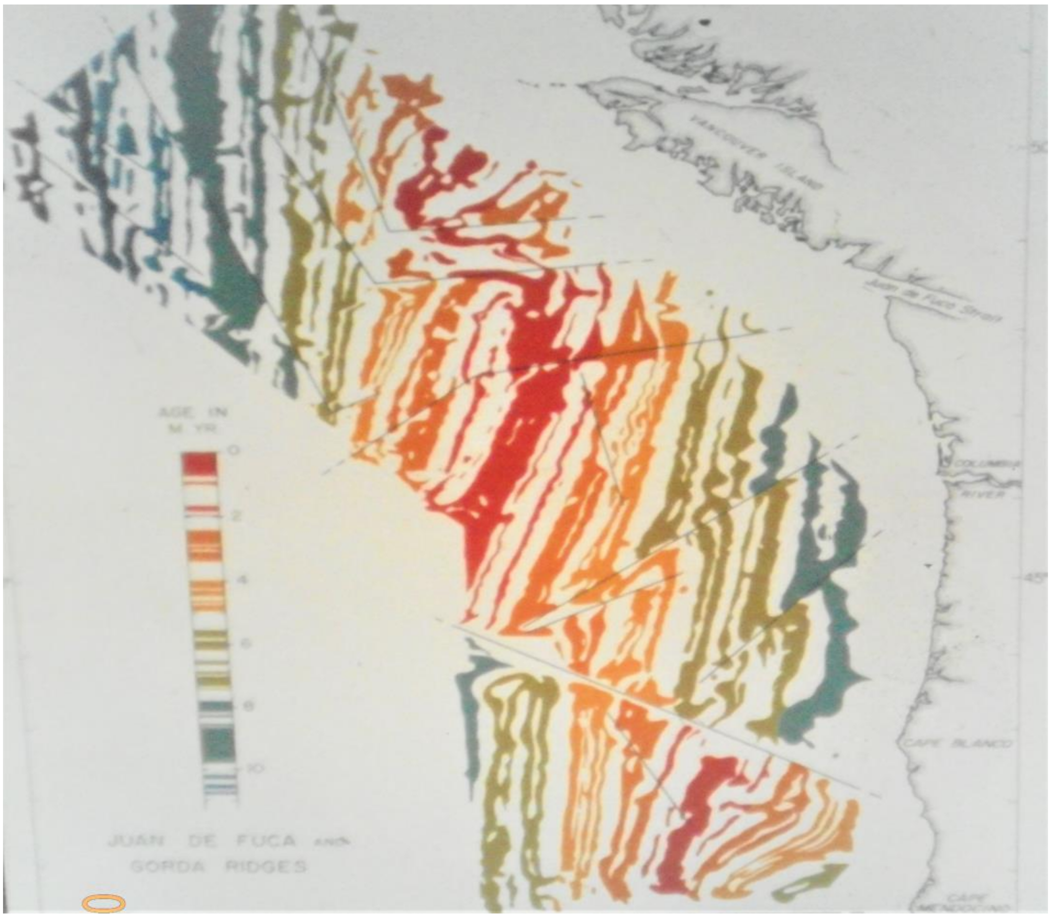


Fig. 4. Sonar trace of drill site 395 showing sediment ponds (horizontal levels) essential to permit drill pipe to locate in one position and not to wander during hole initiation. Vertical scale is travel time, not altitude.

The Earth is a large magnet and the magnetic field is created by the iron core. The polar north/south distinction has varied over millions of years as the Earth’s magnetic field has reversed many times. More recently this timescale has been used to date the formation of the current deep oceanic rocks and thus contribute to our understanding of the plate tectonic structure of the Earth’s crust. The Atlantic Ocean is now known to have begun to form relatively recently, only 180 million years ago.

The measurement of the magnetisation of the rocks forming the floor of the oceans began in the early 1950s. The technique consists of towing a magnetometer behind a ship recording the variation in the magnetic field. This variation is small but shows when the rocks at the bottom of the sea are magnetised in the same direction as the present Earth's field or opposite this (reversed). The US military wanted to detect submerged submarines through their magnetic signature so their data was classified. In the late 1950's this data became available to academic geologists who mapped the change in magnetic field direction shown by seaborne surveys. The liquid basalt lavas, as they cooled, were magnetised in the direction of the Earth's prevailing magnetic field and retained this once solid.



5. Juan de Fuca Ridge, North Eastern Pacific. This was the first indication of the "spread" of volcanic rocks in the deep ocean. The red zone is the ridge crest with the colour coded earlier rocks shown on either side. This shows how the ridge rocks were divided by the movement of the tectonic plates.

The magnetic data when combined with the reversal timescale provide an accurate age for the submarine volcanic rocks. This is evidence of the movement of the tectonic plates over time and allows the determination of their rate of movement. The plate tectonic story is confirmed without doubt: it just needed some rocks recovered from accurate deep sea floor locations to check on these ages. This is what the programme successfully achieved.

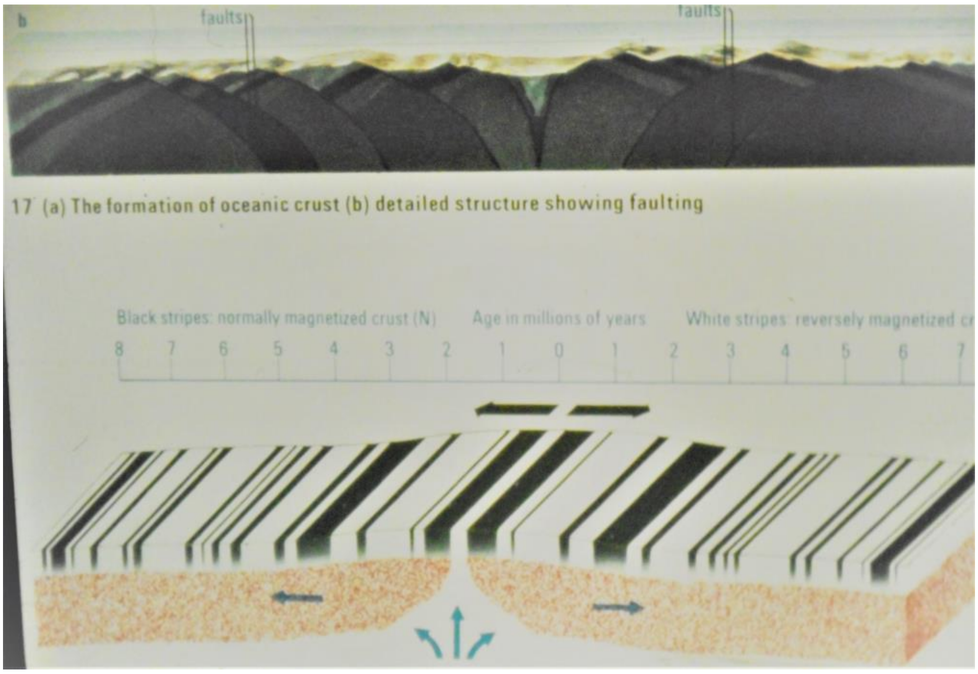


Fig. 6. A diagram of the crust of the Earth at an oceanic ridge. It shows the tectonic movement and the dates of extrusion of the volcanic rocks of the ocean floor. The black bands show magnetisation in the direction of the present magnetic field, the white bands are for the reversed field.