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A German Contribution to South Atlantic Seabed Studies, 1938-39

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Abstract: The Third German Antarctic Expedition (1938–39) aboard the MV "Schwabenland" was one of the first three scientific expeditions to use echo-sounding to map the sea floor. Their echo-sounding data came mainly from the South Atlantic, where they (1) made the first discoveries of the submarine channels that form the heads of Antarctic submarine canyons, (2) made the first axis-parallel bathymetric profile down a mid-ocean ridge to display its rugged nature for the first time, (3) confirmed the probable existence of a median rift in the South Atlantic branch of the mid-ocean ridge, and (4) discovered that the floor of the South Polar Basin was more or less flat, a characteristic later recognized as typical of abyssal plains. The full significance of the echo-sounding profiles was not realized until much later – an example of the data from new technologies being ahead of the hypotheses necessary to explain them. The expedition's geographer, Ernst Herrmann, an expert in volcanic studies, interpreted the mid-ocean ridge, apparently for the first time, as a volcanic construction. Subsequent studies show that the ridge is not build like a volcano with younger rocks atop older ones, but evolves laterally through sea-floor spreading in which younger rocks are focused along the ridge crest and older ones further away. Although Herrmann was right about its rocks being volcanic in origin, he got no credit for his imaginative proposal, largely because it was not widely read outside Germany by those active in studies of mid-ocean ridges. In honour of the expedition, a South Atlantic seamount was named after the ship, and Antarctic submarine canyons were named after both the ship and the expedition leader, Captain Alfred Ritscher. In 2011 two further submarine canyons were named to commemorate expedition personnel, the Herrmann Canyon, after the leader of the echo-sounding team, and the Kraul Canyon, after the ship's ice pilot, Captain Otto Kraul.

Zusammenfassung: Die dritte Deutsche Antarktisexpedition (1938–39) an Bord des MS "Schwabenland" war eine der drei ersten Expeditionen, die mit einem Echolot den Meeresboden kartierte. Die meisten Echolotdaten der "Schwabenland" wurden im Südatlantik aufgenommen, wo die Expedition (1) die ersten submarinen Kanäle entdeckte, die den Anfang von antarktischen submarinen Canyons bilden, (2) das erste axenparallele bathymetrische Profil entlang eines mittelozeanischen Rückens aufnahm, um erstmals dessen zerklüftete Natur darzustellen, (3) die mögliche Existenz eines zentralen Grabenbruchs im südatlantischen Zweig des Mittelatlantischen Rückens bestätigte, und (4) entdeckte, dass der Boden des Südpolar-Beckens mehr oder weniger flach war, eine Charakteristik, die später als typisch für Tiefseebecken erkannt wurde. Die wahre Bedeutung der Echolotprofile wurde jedoch erst viel später erkannt. Dies ist ein Beispiel dafür, dass Daten, die mit einer neuen Messmethode gewonnen werden, den Hypothesen, die man für ihre Deutung braucht, weit voraus sein können. Der Expeditionsgeograph Ernst Herrmann, der zugleich ein Spezialist für Vulkanstudien war, interpretierte offenbar als erster den Mittelatlantischen Rücken als vulkanische Bildung. Nachfolgende Studien zeigten, dass der Rücken zwar nicht wie ein Vulkan mit jüngerem Gestein über älterem Gestein aufgebaut ist, sondern sich durch die Spreizung des Meeresbodens mit jüngerem Gestein an den Seiten der Kammregion und dem älteren in größerer Entfernung davon entwickelt hat. Obwohl Herrmann richtig lag mit seiner Deutung des Mittelatlantischen Rückens als einer vulkanischen Bildung, wird er nicht für seine anschauliche Deutung des Rückens als Linienvulkan geehrt. Das lag wohl hauptsächlich daran, dass seine Idee im Umfeld des Zweiten Weltkrieges außerhalb von Deutschland nicht bei denen bekannt geworden war, die sich mit dem Mittelatlantischen Rücken beschäftigen. Zur Ehrung der Expedition wurde später ein mittelatlantischer Tiefseeberg nach dem Expeditionsschiff und je ein submariner Canyon nach dem Schiff und dem Expeditionsleiter Alfred Ritscher benannt. Um weiterer Expeditionsmitglieder zu gedenken wurden 2011 zwei submarine Canyons nach Herrmann, der das Echolotteam leitete, und Otto Kraul, dem Eislotsen des Expeditionsschiffs, benannt.

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INTRODUCTION

In the 1920's Germany had become the leader in the new technique of scientific echo-sounding, which built on advances in the use of sonar developed in the First World War. The German research vessel "Meteor" was the world's first to make scientific use of this technology, applying it on the German Atlantic Expedition of 1925-1927 to the South Atlantic. The result was the first detailed topographic map of the South Atlantic (MAURER & STOCKS 1933), which was incorporated into the Atlantic bathymetric map of the time by STOCKS & WÜST 1935; Fig. 1). Echo-soundings were also collected from the South Atlantic, by the MV "Schwabenland", en route to and from Antarctica as part of the third German Antarctic Expedition in 1938-39 (STOCKS 1939, HERRMANN 1941, RITSCHER 1942, SCHUMACHER 1958). MV "Schwabenland" was equipped with two hull-mounted Atlas Werke echo-sounders to enable it to make soundings at close-spaced intervals while underway. The soundings were recorded manually, and taken as close as 5 minutes apart where the topography changed rapidly. The process allowed a near continuous record of the shape of the seabed beneath the ship – a bathymetric profile – to be recorded along the ship's track. Owing to the outbreak of war in 1939 the data were not fully published in fine detail and at large scale until 1958, as a German contribution to the results of the International Geophysical Year of 1957-1958 (SCHUMACHER 1958).

The only other ship undertaking scientific echo-sounding in the South Atlantic at that time was the British research ship "Discovery II", which did so south of Cape Town from 1933-1939 (HERDMAN 1948). Byrd had used a sonic depth sounder in the Antarctic in December 1928 (ROSE 2008), apparently more as a safety measure than to map the seabed.

In due course the MV "Schwabenland's" new and high-resolution data would help to improve the bathymetric maps of the South Atlantic.

HEADS OF SUBMARINE CANYONS

The ship's main work area was along the coast of what the Norwegians called Dronning Maud Land and what the German expedition named Neuschwabenland between longitudes 5° W and 16° E (HERRMANN 1941, RITSCHER 1939, 1942). Detailed echo-soundings collected close to the margin of the coastal ice shelf between 68° S and 70° 20' S revealed a sea floor of broad ridges and valleys extending out to sea (Fig. 2). Recent multi-beam bathymetric surveys of the continental margin there by the RV "Polarstern" show that these valleys are the upper reaches of submarine canyons (Fig. 3, H.-W. Schencke,

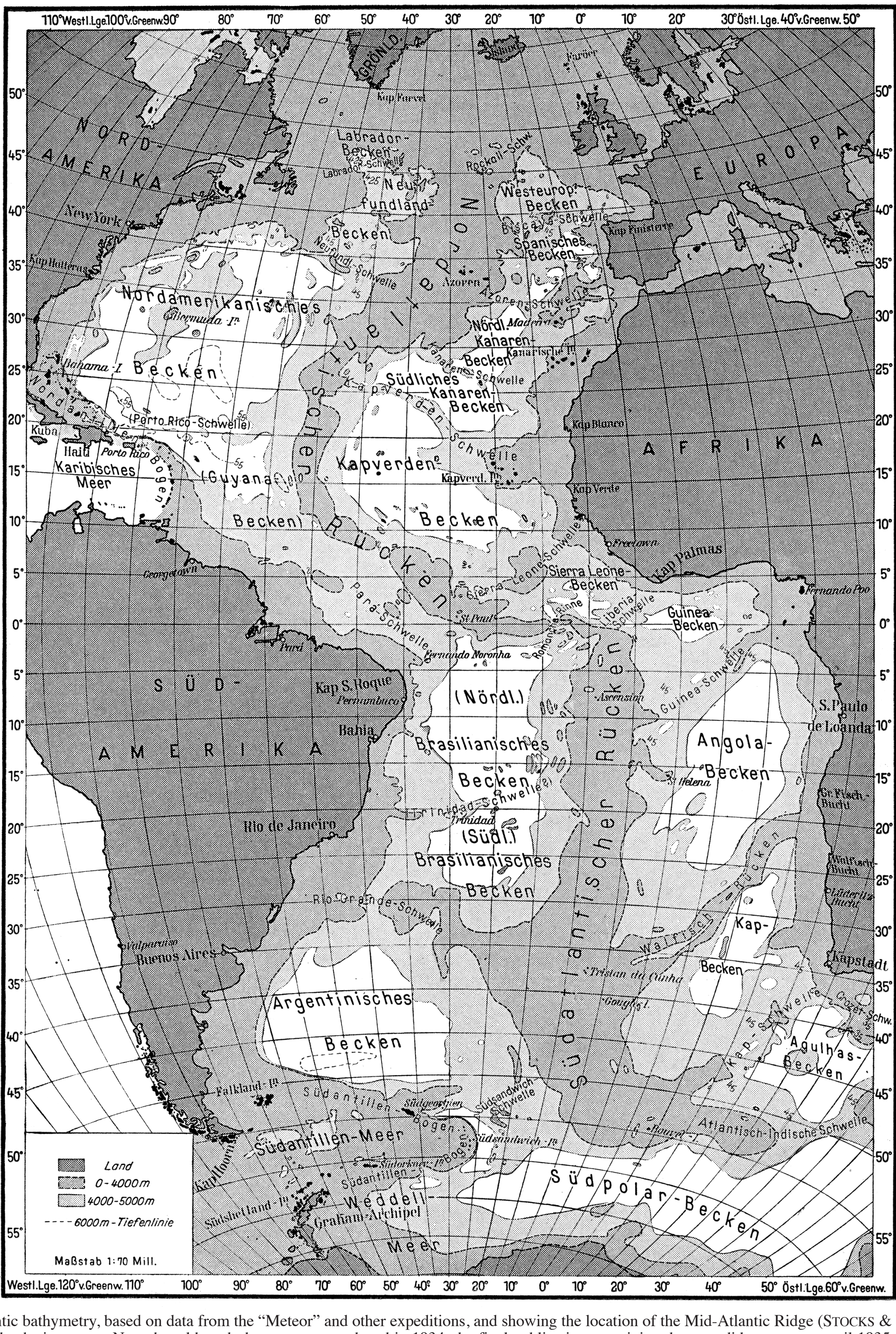

Fig. 1: Atlantic bathymetry, based on data from the "Meteor" and other expeditions, and showing the location of the Mid-Atlantic Ridge (STOCKS & WÜST 1935, Beilage 1); depths in metres. Note that although the map was produced in 1934, the final publication containing the map did not appear until 1935. The abyssal plain forms the floor to much of the South Polar Basin (Südpolar-Becken).

Abb. 1: Atlantische Tiefenverhältnisse auf Grund von Daten der "Meteor" und anderer Expeditionen (STOCKS & WÜST 1935, Beilage 1). Sie zeigt den Verlauf des Mittelatlantischen Rückens; Tiefen in Meter. Obwohl die Karte 1934 erstellt wurde, kam die abschließende Publikation einschließlich der Karte erst 1935 heraus. Die Tiefseebecken bilden größtenteils den Boden des Südpolar-Beckens.

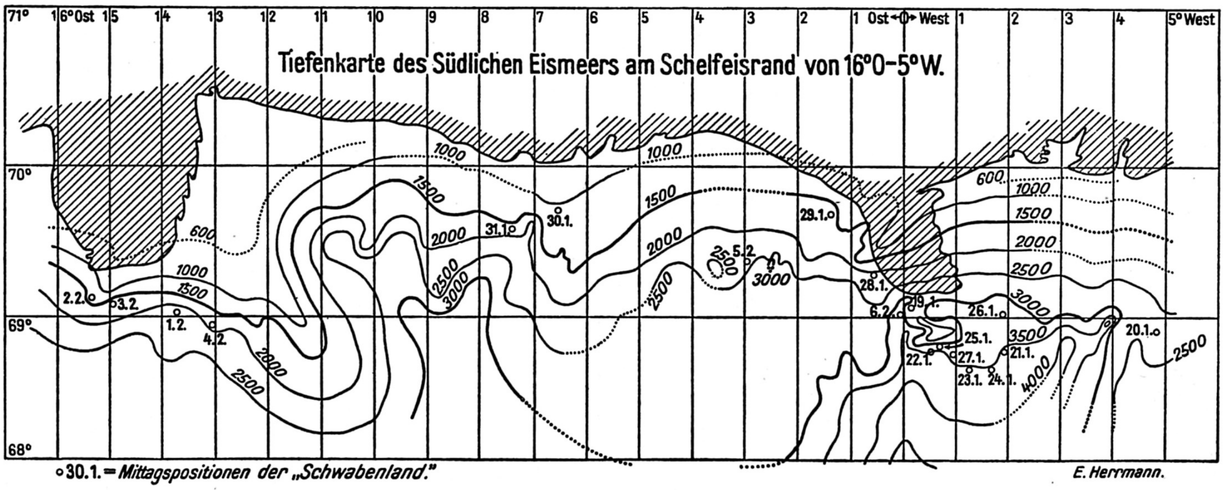

Fig. 2: "Schwabenland's" bathymetric map showing troughs and ridges off the coast of Dronning Maud Land (Neuschwabenland) (HERRMANN 1940 p. 431). A coloured version was published by HERRMANN (1939), and a black and white version in HERRMANN 1941. Depths in metres; ice edge shaded.

Abb. 2: Tiefenkarte der "Schwabenland" mit Trögen und Rücken vor der Küste von Dronning Maud Land (Neuschwabenland) (HERRMANN 1940 S. 431). Es wurden eine farbige Version (HERRMANN 1939) und eine schwarzweiße Version (HERRMANN 1941) veröffentlicht. Tiefen in Meter; Lage der Eiskante schraffiert.

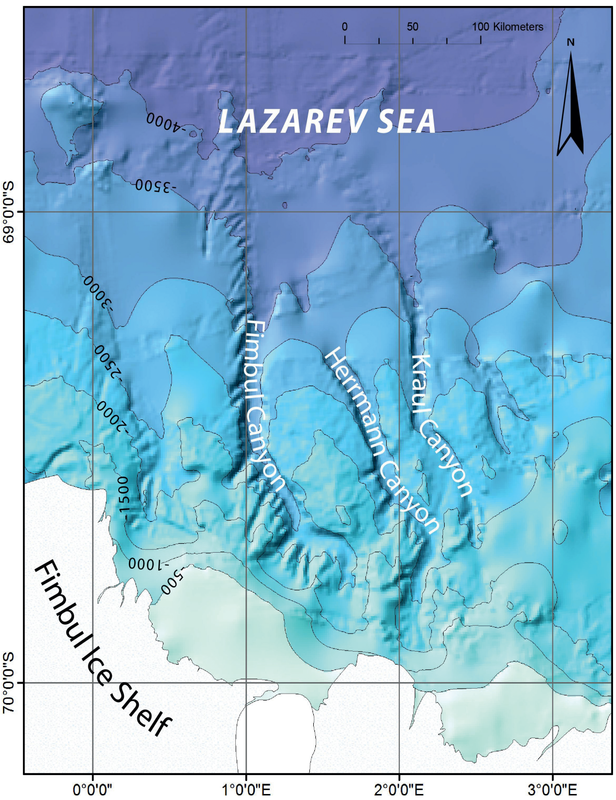

Fig. 3: Bathymetric map showing locations of submarine canyons on the continental slope in the Lazarev Sea, seawards of the Fimbul Ice Shelf of northern Dronning Maud Land (Neuschwabenland). Provided by Hans Werner-Schencke, depths in metres.

Abb. 3: Tiefenkarte mit submarinen Canyons am Kontinentalabhang in der Lazarev Sea vor dem Fimbul Ice Shelf im nördlichen Dronning Maud Land (Neuschwabenland). Zu Verfügung gestellt von Hans-Werner Schencke, Tiefen in Meter.

pers. comm. 2010). The canyons were most likely carved by dense flows of turbid water laden with sediment derived from glaciers that dumped their loads onto the continental shelf when sea level was low during ice age advances, most recently 20,000 years ago at the Last Glacial Maximum (LÜDECKE & SUMMERHAYES 2012). Those flows ended up as turbidity currents that deposited their loads on the adjacent Weddell Abyssal Plain.

As pointed out by LÜDECKE & SUMMERHAYES (2012), the MV "Schwabenland" was one of the first research vessels to recover an echo-sounding profile across an abyssal plain. Echo-sounding Profiles II and IIIa (Fig. 4a, b, and c) both cross the deep Atlantic-Indian-Antarctic Basin between Bouvetøya and the Maud Rise (Südpolar-Becken on Fig. 1), and showed that it had an almost flat bottom at a depth of around 5400 m. With the benefit of knowledge of the seabed that has arisen since those days, and knowing that this was the largest expanse of flat seabed on any of the MV "Schwabenland's" profiles, it might seem surprising that the expedition's geographer, Ernst Herrmann, did not offer some opinion about its origin, not least since he had been trained as a geologist. He began studying geology, mineralogy, geography and physics at the University of Berlin in 1917 and completed a PhD (Dr. phil.) at the Mineralogical-Petrographical Institute there in 1923 "On Twinning in Rock-Forming Plagioclase" ("Über Zwillingsverwachsung gesteinsbildender Plagioklase"). After that he became an assistant (Volontärassistent) at the Institute, before eventually ending up as a geography teacher, science writer and science radio broadcaster. However, at the time of the expedition abyssal plains had not yet been recognized by the reigning experts (e.g. see SHEPHERD 1948). They were first noted on echo-sounders during Maurice Ewing's 1947 mid-Atlantic ridge expedition to the North Atlantic and during the 1948 Swedish deep-sea expedition to the Indian Ocean (HEEZEN & LAUGHTON 1963). Moreover, Herrmann's geological interests tended to be focused on volcanoes rather than on sedimentary systems.

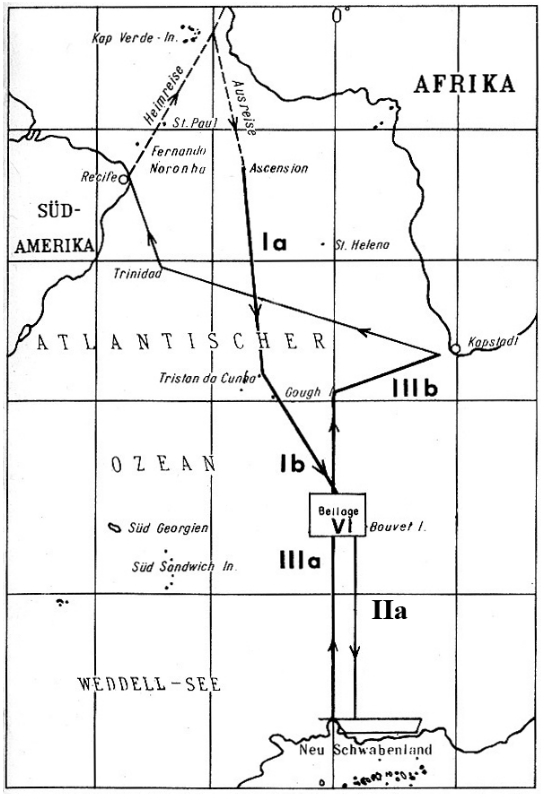

Fig. 4a: Location map of echo-sounding profiles (SCHUMACHER 1958); profile II (not labelled) shown in Fig. 4b is to the east (right) of profile IIIa.

Abb. 4a: Lage der Echolotprofile der "Schwabenland" im Südatlantik und Weddell-See (SCHUMACHER 1958); das hier nicht markierte Profil II der Abb. 4b liegt östlich (rechts) von Profil IIIa.

We can infer from the existence of the Weddell and Enderby Abyssal Plains in the Atlantic-Indian-Antarctic Basin that Antarctica is a significant source of sediment, which is brought to the coast by glaciers rather than rivers, and thence makes its way to the deep sea through submarine canyons and by deposition from melting icebergs. Examination of the GEBCO chart of the region (not shown) indicates that the MV "Schwabenland" crossed the eastern end of the Weddell Abyssal Plain, which shows signs of abyssal hills between Bouvetøya and Maud Rise. The GEBCO chart suggests that the Weddell Abyssal Plain is fed from the west, where its turbidity current deposits (known as turbidites) have buried the abyssal hill topography of the basin floor, and that the turbidites thin to the east, where burial of the hills is not yet complete (LÜDECKE & SUMMERHAYES 2012).

In honour of the expedition ship, one canyon just east of the survey area at 66° 35' S, 18° E, was subsequently named Schwabenland Canyon, and another, slightly further east at 68° S, 30° E, was named Ritscher Canyon in honour of the leader of the expedition, Captain Alfred Ritscher. In 2011, the GEBCO Sub-Committee on Undersea Feature Names (SCUFN) of the International Hydrographic Organisation and the International Oceanographic Commission agreed to name two further canyons after key members of the ship's party – the Herrmann Canyon, to commemorate Dr. Ernst Herrmann, who ran the ship's echo-sounding programme, at 69° 48.6' S, 2° 07' E, and the Kraul Canyon, to commemorate the ship's ice pilot, Captain Otto Kraul, at 69° 43' S, 2° 30' E (see Fig. 3).

THE MID-ATLANTIC RIDGE

Lead-line soundings from ships had established by 1912 the fact that in most of the oceans there was a broad central topographic rise that came to be named the mid-ocean ridge, and which was known to extend as far as 50° S in the South Atlantic (Murray & Hjort 1912). The Mid-Atlantic Ridge in the South Atlantic was mapped by the RV "Meteor" as the South Atlantic Ridge (Südatlantischer Rücken; Fig. 1), and shown to end at the island of Bouvetøya, near 55° S, which Herrmann referred to as the last buttress of this undersea range (Herrmann 1941). Further south lay a deep ocean basin, the South Polar Basin (Südpolar-Becken; Fig. 1).

The MV "Schwabenland" provided the first ever echo-sounding transect along the length of a mid-ocean ridge anywhere in the world – an extremely rugged north-south transect close to the ridge crest between Ascension and Tristan da Cunha (Fig. 5). Neither HERRMANN (1941) nor SCHUMACHER (1958) attempted to interpret these soundings. More recent data show that the Mid-Atlantic Ridge is cut at intervals of about 50 km by E-W trending fracture zones, many associated with narrow E-W deeps (like the Romanche Trench, which lies close to the equator north of Ascension Island). It seems probable that it is these lateral deeps that are visible cutting the N-S profile (Fig. 5) and accounting for the rugged nature of the topography. MV "Schwabenland" also added a diagonal southeast to northwest profile across the ridge, between Cape Town and Recife in northeast Brazil (Fig. 6), complementing the suite of east-west profiles collected across the ridge by the RV "Meteor". Prominent in the middle of this profile is a deep V-shaped cleft, the median valley also seen on several of the RV "Meteor" profiles.

On the basis of some samples of volcanic material collected by the RV "Meteor", along with the association of the Mid-Atlantic Ridge with volcanic islands like Ascension and Tristan da Cunha, HERRMANN (1941), who specialised in volcanic studies, speculated that the ridge was an enormous linear volcano fed by lava rising through a fissure (Fig. 7). Others before him had speculated that the drifting apart of the continents had filled the floors of the newly opening ocean basins with basalt (TAYLOR 1910, WEGENER 1929, HOLMES 1928), and that the mid-ocean ridge might have a basaltic character, but Herrmann appears to have been the first to mention in the literature that the ridge was a continuous volcanic structure. The notion that the ridge had something to do with volcanism had been put forward a few years earlier by Hans Cloos, professor of geology at the Universities of Breslau (1919-1926) and Bonn (1926-1951), who had proposed in 1936 that the Mid Atlantic Ridge was a gigantic graben system like those forming the Rhine Graben in Europe or the East African Rift Valley – in effect a broad and massive swell with a collapsed central rift associated with volcanoes, an example of which is visible in Iceland where the mid-ocean ridge protrudes above the ocean surface (CLOOS 1936). Herrmann later called on Cloos's conjecture to support an expanded version of his own idea (HERRMANN 1948). He was on safe ground in the sense

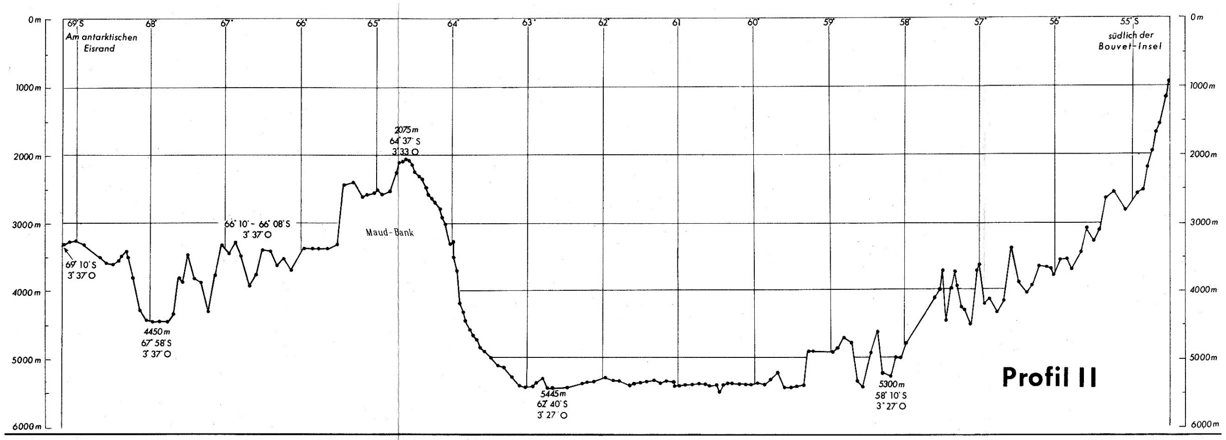

Fig. 4b: Echo-sounding Profile II (modified from SCHUMACHER 1958) across the deep Atlantic-Indian Antarctic Basin and its abyssal plain, between the Atlantic-Indian Ridge (at right) and the Maud Rise ("Maud-Bank" at left), ending near the Antarctic coastal ice shelf. The abyssal plain is the almost flat sea floor between latitudes 59° 30' S and 63° S; depths in metres.

Abb. 4b: Echolotprofil II (modifiziert aus SCHUMACHER 1958) reicht über den Atlantisch-Indischen Rücken südlich der Bouvet-Insel (rechts), die Tiefseeebene des Südpolar-Beckens, der "Maud-Bank" (linke Bildmitte) bis zum antarktischen Eisrand (links). Die Tiefseeebene des Südpolar-Beckens (vgl. Abb. 1) erstreckt sich als fast ebener Meeresboden zwischen den Breiten 59° 30' S und 63° S; Tiefen in Meter.

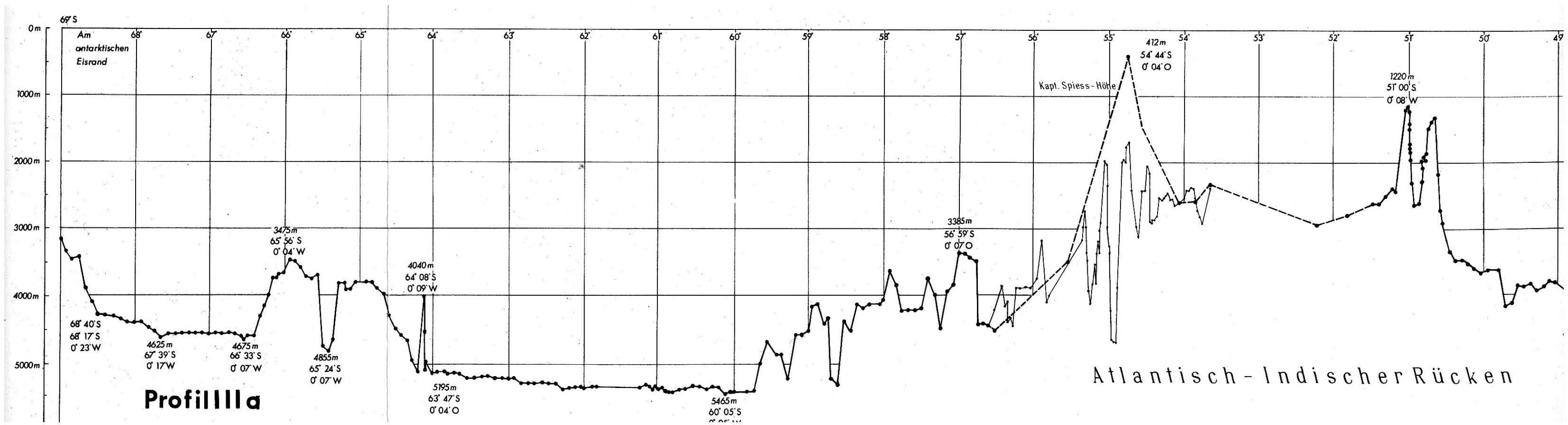

Fig. 4c: Echo-sounding Profile IIIa (modified from SCHUMACHER 1958) from the Atlantic-Indian Ridge near Bouvetøya (54° S, Kpt. Spiess-Höhe; right) to Antarctica (left), across the almost flat abyssal plain between latitudes 59° 30'S and 64° S; depths in metres.

Abb. 4c: Echolotprofil IIIa (modifiziert aus SCHUMACHER 1958) über den Atlantisch-Indischen Rücken südlich Bouvetøya (54° S, Kpt. Spiess-Höhe rechts) bis zum antarktischen Eisrand (links), über die fast flache Tiefseeebene zwischen den Breiten 59° 30' S and 64° S; Tiefen in Meter.

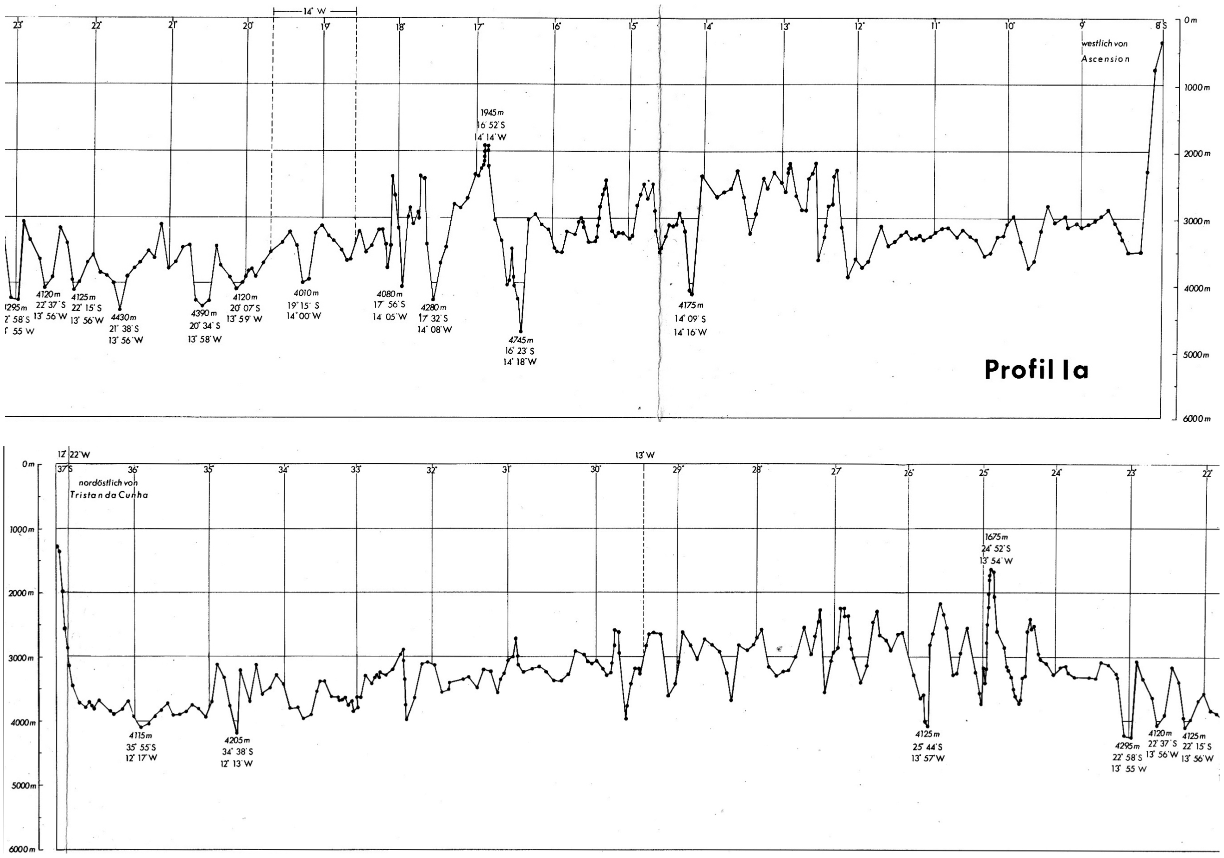

Fig. 5: The first echo-sounding profile down the Mid-Atlantic Ridge in the South Atlantic, from west of Ascension in the north (upper panel at right) to Tristan da Cunha in the south (lower panel at left; modified from SCHUMACHER 1958, profile Ia). For location of Profile Ia, see Fig. 4a. To estimate the location of the profile in relation to the topography, compare the position of Profile Ia (Fig. 4a) with the position of the Mid-Atlantic Ridge (Fig. 1).

Abb. 5: Das erste Echolotprofil entlang des Mittelatlantischen Rückens im Südatlantik von westlich Ascension im Norden (obere Bildleiste rechts) bis Tristan da Cunha im Süden (untere Bildleiste links; modifiziert aus SCHUMACHER 1958, Profil Ia; Profilverlauf siehe Fig. 4a. Um die Lage des Profils in Bezug auf die Topographie einschätzen zu können, vergleiche die Position von Profil Ia (Fig. 4a) mit dem Verlauf des Mittelatlantischen Rückens (Fig. 1).

that at the time of the expedition nothing was known about the geology of the ridge (SVERDRUP et al. 1942). It was not until 1947 that Maurice Ewing undertook a sampling cruise to the Mid-Atlantic Ridge in the North Atlantic that demonstrated its basaltic and partly volcanic character (EWING 1948); by then geophysical data had begun to confirm that the ocean floor was underlain by basalt (Shepard 1948). Ewing was able to demonstrate that the median valley of the ridge was probably a fault-bounded graben, as suggested by Cloos.

Since then it has become clear that the world-encircling mid-ocean ridge is not the kind of super-giant volcanic structure implied by Herrmann's sketch (Fig. 7). It is closer to the model of Cloos – a giant swell topped by a rift. Even Cloos did not realise what the real mechanism was.

Following the seafloor spreading hypothesis that lies behind plate tectonic theory, an invention of the 1960s, we now know that lava wells up along the ridge crest through vertical fissures that fill with basalt, so pushing apart the crust on either side. As a result the youngest crust lies in the ridge crest zone, while the seafloor becomes progressively older as one moves away from the ridge crest on either side (HESS 1962, VINE & MATTHEWS 1963). If Herrmann was correct, the youngest rocks should be near the surface, the older rocks deeper down, as in a typical volcano. That is not the case. Similarly, if Herrmann was correct most of the lavas of the ridge would be pillow basalts extruded onto the seabed, not vertical dykes of basalt intruded into the ocean crust. Even so,

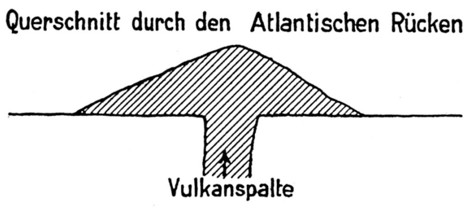

Fig. 7: Herrmann's cross-section model of the volcanic origin of the Mid-Atlantic Ridge (HERRMANN 1941 p. 165). Note the similarity to a cross section through a volcano, implying youngest rocks at the top and oldest at the bottom, which is not what we actually find.

Abb. 7: Herrmanns Model zum vulkanischen Ursprung des Mittelatlantischen Rückens im Querschnitt (HERRMANN 1941 S. 165). Beachte die Ähnlichkeit zum Querschnitt durch einen Vulkan wo die jüngsten Gesteine oben und die ältesten unten angeordnet sind, was jedoch nicht den angetroffenen Tatsachen entspricht.

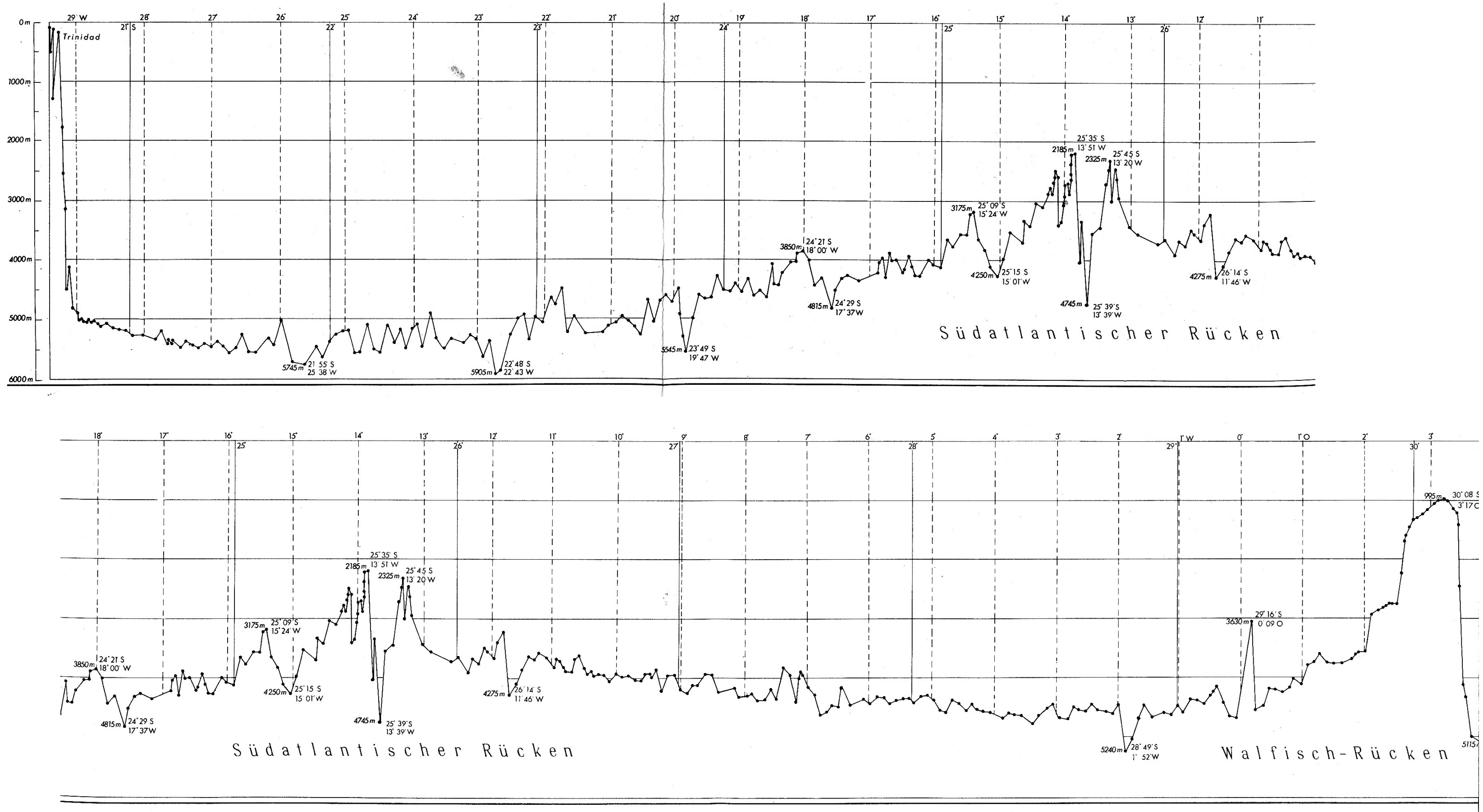

Fig. 6: SE to NW cross-section of the Mid-Atlantic Ridge from the deep Cape Basin at far right (lower panel), over the Walvis Ridge (Walfisch-Rücken, at right) and mid-ocean ridge (Südatlantischer Rücken, at centre), to the island of Trinidade off the coast of Brazil, upper panel at left (Profile IVa modified from SCHUMACHER 1958). For location of line IVa, see Fig. 4a (label not given). Note the deep cleft at the axis of the mid-ocean ridge – this is the central rift valley or graben.

Abb. 6: Profilquerschnitt von Südost nach Nordwest über den Mittelatlantischen Rücken vom tiefen Kap-Becken (untere Leiste ganz rechts) über den Walfisch-Rücken (rechts) und den Südatlantischen Rücken (Mitte), zur Insel Trinidad vor der brasilianischen Küste (obere Leiste links). Profil IVa, modifiziert aus SCHUMACHER 1958). Für die Lage der Linie IVa, siehe Fig. 4a (ohne Etikett). Man beachte den tiefen Einschnitt – den Zentralgraben – entlang der Achse des Mittelatlantischen Rückens.

despite his lack of hard data Herrmann had made an insightful guess and got it partly right. Herrmann's papers dealing with the topic were ahead of their time, but unfortunately were not distributed widely enough to impact the thoughts of seabed researchers – a community to which Herrmann himself did not belong.

As Cloos and Ewing both pointed out, there is a steep-sided, fault-bounded, median rift valley, or graben, along the mid-ocean ridge crest in many places. The RV "Meteor" profiles from the South Atlantic first brought this rift to the attention of marine scientists in the late 1920s. Following Ewing, SCHUMACHER (1958) proposed that the deep valley seen on the RV "Meteor" and MV "Schwabenland" profiles was a median rift like that in the North Atlantic. One of Ewing's graduate students, Bruce Heezen had found the valley on other parts of this global ridge and proposed it was a more or less continuous rift valley (HEEZEN 1960). Unfortunately they were not aware of Schumacher's work, published in German about 20 years after the expedition, so his suggestion was ignored. Noting that the valley did not occur on all the RV "Meteor" profiles, SHEPARD (1963) thought it was unlikely to be a continuous feature. But, we now know that transverse faults (fracture zones) cut the ridge at right angles and in many places may obscure or block the median valley making it appear a less continuous feature than it really is.

BANKS AND SEAMOUNTS

Almost any echo-sounding profile in the early days was likely to find some new seabed feature, and MV "Schwabenland's" profiles were no exception. Between Bouvetøya and Cape Town along the Greenwich Meridian (Profile IIIa, Fig. 8), "Schwabenland" discovered a shallow bank at 45° 58' S, 00° 11' E, with a depth of 1575 m. They wanted to name it *Behm Bank*, after the German inventor of scientific echo-sounding, but that name was later given to another Antarctic bank, near the southern end of the Weddell Sea, so the new bank is now named Schwabenland Seamount in honour of its discoverers. It is part of a small group of seamounts including Herdman Seamount, at 45° 20' S 00° 30' E, discovered by "Discovery II" and named for the ship's Chief Scientist Henry Herdman.

At around 41° 58' S on the Greenwich Meridian, RV "Schwabenland" crossed another large seamount. Knowing that RV "Discovery II" had crossed this bank in May 1936, they named it Discovery Bank (Fig. 8). It is part of a large ENE-WSW trending chain of submarine volcanoes that was named Discovery Tablemount in 1963, and renamed the Discovery Seamounts in 1993 according to the Gazetteer of the General Bathymetric Chart of the Oceans (GEBCO). The name Discovery Bank now applies to a shallow bank on the Kerguelen Plateau. The Discovery Seamounts seem to have been created by volcanic emissions from an underlying hotspot (THOMSON et al. 1983).

The report of the German naming of Discovery Bank appeared in the published text of George Deacon's 9 January 1939 address to the Royal Geographical Society on the investigations of RV "Discovery II" (DEACON 1939). As pointed out by LÜDECKE & SUMMERHAYES (2012), that seems odd, because MV "Schwabenland" did not cross the bank until March 1st. The solution to this conundrum must lie in changes made to the manuscript of the talk before it was published in late March 1939, by which time news of the Germans' intent to name the bank Discovery Bank had reached Deacon – probably when MV "Schwabenland" docked in Cape Town on March 6-7.

CONCLUSIONS

The topography of the deep sea-floor emerged gradually over time, as through a fog. The MV "Schwabenland's" echo-soundings helped to refine later bathymetric maps of the South Atlantic, but it would be years before the geological significance of many of the features mapped there was recognised, because until the early 1960s little was known about the processes shaping the deep sea-floor (SVERDRUP et al. 1942, SHEPARD 1948). The discovery of channels around Antarctica was significant from our later perspective, but at the time

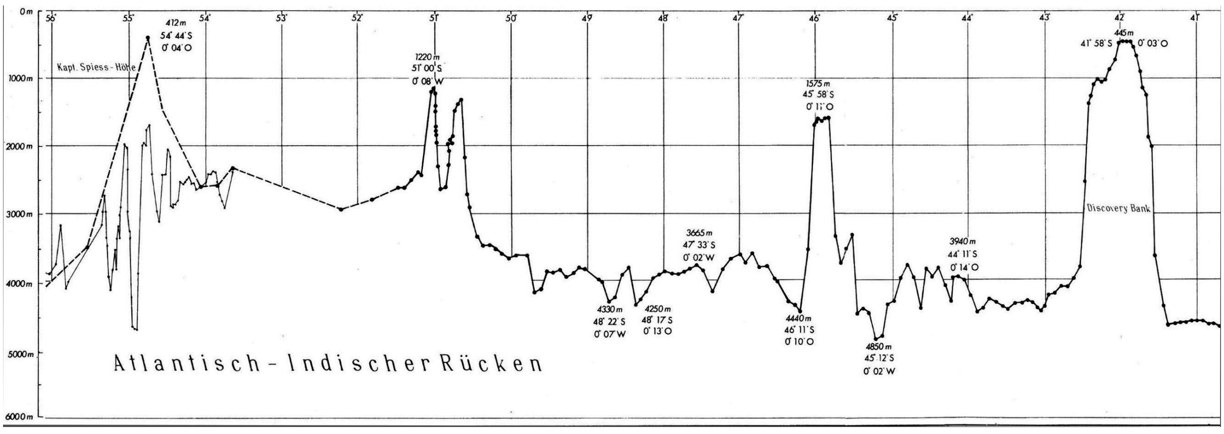

Fig. 8: Northward extension of echo-sounding Profile IIIa (Fig. 4c) from Atlantic-Indian Ridge near Bouvetøya (54° S) to the north across Schwabenland Seamount (near 46° S) and Discovery Bank (42° S) (modified from SCHUMACHER 1958); depths in metres.

Abb. 8: Nördliche Verlängerung des Echolotprofils IIIa (Fig. 4c) über den Atlantisch-Indischen Rücken nahe Bouvetøya (54° S) nach Norden über den Schwabenland-Tiefseeberg (nahe 46° S) und die Discovery Bank (42° S) (modifiziert aus SCHUMACHER 1958); Tiefen in Meter.

did not inspire speculation about their probable causes. Today we recognise them to be pathways for the transport of glacial debris from the ice sheets to the almost flat abyssal plains of the deep sea. The discovery of isolated seamounts (banks, as they were then known, and which we now know to be submarine volcanoes), equally failed to inspire the German scientists to feats of geological interpretation, but again this reflected the general state of knowledge at the time. Herrmann's main, though completely overlooked, contribution to geological understanding of the deep sea floor was his interpretation of the Mid-Atlantic Ridge as a gigantic linear volcanic construction, something that was half right. Almost twenty years later Schumacher recognised that both MV "Schwabenland" and RV "Meteor" had discovered what was probably a more or less continuous median valley along the Mid-Atlantic Ridge crest, yet his observation was ignored and the geological interpretation of that feature was left to the British and the Americans (e.g. HILL 1960, HEEZEN 1960).

We can draw two conclusions from this study. The first is that in science the meaning of measurements made with new technologies is not always clear in the early stages, when there is no hypothesis to explain them. As pointed out by LÜDECKE & SUMMERHAYES (2012), when exploring remote and unknown regions, like Antarctica or the deep ocean floor, the data often arrive before the explanation – as in this case. It was the picture of the shape of the ocean floor built up through many ocean expeditions like this one that eventually stimulated Ewing to take the samples in 1947 that would show what the mid ocean ridge was made of. That in turn led, with many other observations like those of earthquakes and heat flow, to Hess's explanation in 1962 of how the ridge was formed. Similarly, it was the gradual realisation that there were abyssal plains all over the deep ocean basins, which led to their explanation (first in 1948) as repositories of sediment supplied by submarine canyons. MV "Schwabenland's" sounders were ahead of their time!

The second conclusion is that publication of novel research may not always reach the audience best suited to make much of it, so that credit is not given where it is due. In this case, despite training as a geologist, Herrmann was acting as a geographer and his geological ideas were not being published in primary geological journals of the kind that might have been read internationally by the growing community of seabed scholars. Things might have gone better for disseminating his ideas had World War II not intervened.

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