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Am 16. Juni 1970 verstarb in Boulder, Colorado, SYDNEY CHAPMAN im Alter von 82 Jahren. Er war Träger der *Emil-Wiechert-Medaille* der Deutschen Geophysikalischen Gesellschaft. Aus Anlaß der Verleihung der Medaille am 22. September 1969 in Göttingen hielt SYDNEY CHAPMAN im Rahmen einer gemeinsamen Feier der Akademie der Wissenschaften zu Göttingen und der Deutschen Geophysikalischen Gesellschaft den nachfolgend abgedruckten Vortrag. Seine sehr persönlichen Bemerkungen am Beginn und am Ende des Vortrags sind weggelassen worden.

Geophysics and Germany, Men and Enterprises

By S. CHAPMAN

Geophysics has many branches, and in the short time available to me I can mention only some few of its highlights, and chiefly those relating to geomagnetism, the part I know best. In the study of its history I owe much to the learned and distinguished German historian of geophysics, HELLMANN. He collected and republished several of the most important early writings on geophysics, with commentary. He told how our first evidence of the recognition that in general the magnetic compass does not point truly northward comes from the mid-15th century, and consisted not in written accounts, but in marks on geographic maps and on sundials for travelers (to tell the time), then often provided with a compass in order to orient them properly. In the production of such sundials and compasses Nürnberg and Augsburg were prominent centers. GEORG HARTMANN, Vicar of St. Sebald's, Nürnberg, was an expert in their construction. A letter written by him in 1544 to the Duke ALBRECHT of Prussia has been preserved, in which he mentions that in 1510 he had measured the magnetic declination in Rome; it was 6^0E (whereas at Nürnberg it was 10^0). This is the earliest recorded land measurement of the compass direction. In the same letter HARTMANN told how he had noticed a tilt of 9^0 to the horizontal of a pivotted compass needle that was balanced horizontally before being magnetized. This is our first record of a recognition of the magnetic dip, though HARTMANN did not go further and find that the true dip was about 70^0. It was independently discovered and measured by NORMAN in London in 1576.

More than two centuries later, geomagnetism was among the many interests of the great ALEXANDER VON HUMBOLDT, whose fame in his time, I have read, was second only to that of NAPOLEON. In his extensive and adventurous scientific travels of 1799—1803 in South America, he carried with him, besides thermometers and a barometer, also magnetic instruments. Timing the swing of a dip needle, he was the first to show that the earth's magnetic force is weakest near the equator. He became ardently interested also in the transient variations of the compass direction. On his return to Berlin in 1806/07 he sometimes invited his friends to a magnetic party to observe with a microscope the small variations of the compass; he gave the name *magnetic storm* to occasions when the changes were specially large and irregular.

HUMBOLDT saw the interest and scientific value of observing the magnetic changes regularly in many places. His example was followed by his friend ARAGO in Paris, by KÜPPFER in Russia, and others, and also in Peking, which he visited in his Asian journey of 1829 in the service of the Russian Czar. He also helped to turn the interest of GAUSS to geomagnetism.

GAUSS (1777—1855), who has been called the prince of mathematicians, was director of the Göttingen Sternwarte, and a leading light of this University and its Academy. During the decade beginning in 1832 he was intensely and most fruitfully occupied with geomagnetism, in which his greatest achievements were threefold. He showed how to measure the magnetic force absolutely and not merely relatively, as in HUMBOLDT's American measurements, which assumed the constancy of his dip needle. This was a landmark in the history of physical measurement. Second, he developed instruments by which eye readings could be conveniently made of the changes not only of the compass direction, but also of the horizontal and vertical intensity. Also, to avoid the need for the observer to be close to the magnetic needles, while watching their small movements through a microscope, GAUSS introduced the new invention of POGGENDORFF, the long-time editor of the *Annalen der Physik:* Light from a fixed lamp was reflected on to a distant scale from a small mirror fixed to the moving needle. Third, GAUSS expressed the observed measurements of the magnetic field at many places over the earth in terms of spherical harmonic functions, and thus confirmed mathematically GILBERT's inference, in 1600 A. D., that the field comes from within the earth.

Thus GAUSS set up in Göttingen the first complete magnetic observatory. In this work he had the enthusiastic gifted help of his young colleague WILHELM WEBER (1804—1891). Their plans were closely followed in other countries, and an international *Magnetic Union* based on Göttingen was set up. Observatories were established in many parts of the world, where on most days eye readings of their instruments were made at the hours of Göttingen time, and oftener on selected days chosen by GAUSS. It was one of the great eras of progress in the subject.

A few years before this period began, an unknown young apothecary of Dessau, HEINRICH SCHWABE, started to make daily observations of the spots on the sun, a study much neglected, though open to any European from the time of GALILEO and SCHEINER. SCHWABE observed assiduously from 1826 onwards, and by 1844 he suspected the existence of a variation in their number, with a period of about 10 years. Later HUMBOLDT asked SCHWABE for his further observations, to 1850, of the number of spots that had appeared each year, and published them in his famous book *Cosmos.* This made SCHWABE's discovery of the sunspot cycle widely known, and within about a year the same periodicity was found in the earth's transient magnetic changes. LAMONT, director of the magnetic observatory at München, was one of those who shared in this new discovery. This was a striking event in the history of science. The seasonal changes on the earth had long been known to depend on the *geometrical* change of the inclination of the earth's axis of rotation relative to the sun, in the course of the earth's annual orbit. But the approximately parallel changes of the sunspot cycle and the geomagnetic variations showed that the earth is affected also by *intrinsic* changes on the sun's surface. They influence both the quiet-day changes and the irregular magnetic disturbances. In later years BARTELS associated these two effects with changes in the sun's ultraviolet radiation, absorbed high in our atmosphere, and in its particle radiations, which were then only hypothetical. Since the present age of space exploration began 12 years ago, their flow is regularly observed, and is known as the solar wind.

BARTELS, trained at Göttingen under MEINARDUS after World War I served at the Potsdam magnetic observatory under ADOLF SCHMIDT, director there from 1902 to 1929. SCHMIDT was one of the foremost and most enlightened observatory directors of his time, and BARTELS received further valuable training from him. SCHMIDT was a man of great scholarship and excellent intuition and understanding regarding geomagnetism, both to learn new truths and to reject errors widely held in his time. Potsdam became the main German magnetic observatory, and retained this standing during BARTELS' directorship after SCHMIDT retired.

The magnetic observatory that GAUSS and WEBER set up here in Göttingen was put underground, to reduce its temperature variations. Its instrumental equipment was developed under its later directors WEBER, LEJEUNE-DIRICHLET and SCHERING. The observatory took part in the 1st International Polar Year, but its activity and relative importance declined for a time.

Around 1900 the present Institute of Geophysics was built under the guidance of EMIL WIECHERT, the first holder of a new chair of geophysics, to which he was appointed in 1898. He adorned this chair and brought new high distinction to Göttingen as a centre of geophysical research until his death in 1928. I shall speak later of his work and that of his successor G. ANGENHEISTER senior, who directed the Institute until his death. In 1945 BARTELS became in turn the professor of Geophysics and director of the Institute, and restored its old fame as an important centre of geomagnetic research and international leadership. He did not believe that a university observatory should issue regular yearbooks of magnetic observations, but he was deeply and daily interested in the transient changes of the earth's magnetic field, and often discussed them both with his staff and students, and in print. His many papers concerning them were cogent, illuminating and original. His best-known contributions to geomagnetic science were his statistical studies and the new indices of magnetic disturbance, local and planetary, that he devised and produced. He also portrayed them graphically in striking and enlightening diagrams which he distributed each half-month. These were and are widely distributed; they receive a warm welcome and careful attention at many observatories, institutes and universities throughout the world.

BARTELS had great social gifts, including a pleasant wit that was appreciated by all who heard him; it was sometimes a valuable means of calming feelings during controversies at international scientific gathering and leading to agreed solutions. Thus he played a notable part in the international science of his time. He was also a good cooperator, often writing joint papers, and, in happy collaboration with me, our book GEOMAGNETISM.

In these respects there was much contrast between him and his great predecessors ADOLF SCHMIDT of Potsdam and EMIL WIECHERT of this University and Academy. They were good and helpful to their students and assistants, but their work was done silently, and alone. They were somewhat withdrawn from the world, rarely relaxing to take part in social occasions. BARTELS once told me how artful students could sometimes lighten their examination difficulties by playing upon WIECHERT's gentle soul to induce him to soften the rigours of his tests of their proficiency.

Geophysics is a many-branching subject, and each director of an Institute of Geophysics may be expected to impress upon it, during his period of office, the mark of his own special interests. WIECHERT, before he came to Göttingen, was known for his works on electrodynamics and cathode rays. But here, soon being put in charge of geophysics, and given the opportunity to plan the building of a new Institute, intended for research and to supplement his wide-ranging courses of lectures, he gave priority, in the equipment and activity of the Institute, to seismic studies and to the measurement of atmospheric electricity. The magnetic observations were for a time intermitted, though the house and instruments were transferred to the new site from their old site at the Sternwarte. Under his assistant GERDIEN the Institute took an important part in the advance of our knowledge of atmospheric electricity, but his personal love was for seismology. At that time it was generally considered a branch of geographical studies; he transformed it into one of the principal subjects in geophysics. He studied the principles of measurement of earthquake waves, and designed the astatic pendulum, which was widely adopted over the globe. With his instruments and his theoretical insight in interpreting the seismic observations he made the fundamental discovery that the earth has two main different parts, which are now called the core and the mantle. Then he became a pioneer in the study of the outher layer of the mantle by artificially made waves, at first by dropping from heights up to 14 meters an iron ball weighting 4 tons. His pupil MINTROP developed the method further, using explosives. The waves were recorded by portable seismographs taken to different distances to determine the travel times and infer the paths and the nature of the subterranean materials traversed by the waves. This work was an early stage in the development of the enormously economically important applied science of geophysical exploration of the earth for valuable minerals and oil. The reclusive but far-seeing scholar in the hilly woods above Göttingen thus had a worldwide impact on his and later generations.

He saw that his experiments and theories of the transmission of elastic waves through the solid earth could be applied also to the atmosphere; and he used explosions to study the abnormal propagation of sound to heights of order 40 km, where the sound waves are reflected back to the ground, beyond a zone in which the noise of the explosion, carried by waves near the earth's surface, is no longer heard.

Despite his retiring habits, he was one of the founders of the Deutsche Seismologische Gesellschaft in 1922, which two years later broadened its scope and became the Deutsche Geophysikalische Gesellschaft. WIECHERT was the president successively of the two bodies, from 1922 to 1925, and then became the honorary president of this Society until his death. It was a fitting memorial to his leadership and vision for geophysics in Germany and the world that his name was associated with the Medal bestowed for the fifth time here in his well-beloved Göttingen today. Despite several offers of chairs elsewhere, he remained faithful to this lovely and historic city to the end of his life. In the work of this Deutsche Geophysikalische Gesellschaft his influence continues to this time.

He also influenced geophysics beyond the equator, by the support and later guidance he gave to the proposal made by the geographer HERMANN WAGNER, with the enthusiastic backing of ADOLF SCHMIDT, before the Geophysikalische Kommission of the Göttingen Academy, for the remarkable enterprise of establishing a geophysical observatory at Apia on the south sea island of Samoa. With substantial government financial support the observatory was established in 1902, initially for a period of 5 years.

Its life was renewed successively, and it continued in fruitful operation until after World War I it was taken over by New Zealand. Its superintendents were first WAGNER, then O. TETENS and F. LINKE and G. ANGENHEISTER, who worked in Samoa for some years and then at Göttingen and Potsdam before he succeeded WIECHERT here in Göttingen. The observations made there were many-sided and were made on the lines followed at Göttingen, as earlier in the time of GAUSS. There were seismometers, magnetometers, meteorological and atmospheric electric instruments among others. Many important reports were issued on the observatory work, including a long climatological report by TETENS and LINKE. The lunar atmospheric tide there was studied by WAGNER and later by myself.

Another direction in which the influence of the seismic work pioneered by WIECHERT, appeared, was to the study of the depth of glaciers and inland ice in Greenland, proposed by MEINARDUS, WAGNER's successor here in Göttingen and the teacher of BARTELS, to the famous meteorologist ALFRED WEGENER. Before his untimely death in Greenland, he ventured boldly outside the field of his main work to propound the theory of continental drift—Kontinental-Verschiebung, namely that far greater changes had occurred on the surface of the earth than geologists had up to that time dreamt of—though from the time of LEONARDO DA VINCI there were those who thought that there had been rises and falls of the continents, and, as the Alps strongly suggest, much folding and thrusting of one layer above or under another. But WEGENER proclaimed that Africa and America had once been united, and indeed that all the continents had once formed one great land mass, which later broke up and drifted apart. The theory was put forward on somewhat scanty evidence, and for many years was ridiculed and rejected by many earth scientists. In recent years it has gained remarkable support from widespread studies of palaeomagnetism by the record preserved in the magnetism of sedimentary and some igneous rocks, of the earth's long magnetic history. This has led to the acceptance of WEGENER's ideas by a large number of workers in the earth sciences, though there are some firm opponents who remain unconvinced.

The contribution of Germany to aeronomy has been great and varied. Besides the work of WIECHERT and GERDIEN in atmospheric electricity and the study of abnormal sound propagation already mentioned, an outstanding pioneer investigation of the ozone layer using a balloon-borne spectrograph was made by ERICH REGENER, whose son has followed worthily in his father's footsteps, in New Mexico. JULIUS BARTELS became successor as head of REGENER's Institute which is now part of the Max-Planck-Institute at Lindau.

Finally I must mention the great contribution by Germany to oceanography through its Atlantic Research expedition of the Deutsche Marine vessel METEOR during the years 1925—27. It was a worthy successor to the CHALLENGER expedition. Planned by ALFRED MERZ, who began but was not spared to complete its work, this enterprise enriched oceanographic knowledge by a long series of volumes reporting on the many aspects of its work. It was a nautical research expedition of which this country can be justly proud.