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GENERAL REPORT
OF THE EXPEDITION

BY

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At the meeting of the Norwegian Geographical Society on November 10, 1908 Roald Amundsen presented a plan for a new polar expedition on which he intended to repeat Nansen's drift with the "Fram" across the Polar Sea in 1893—1896. Amundsen wanted to let his vessel enter the pack-ice to the north of Bering Strait and hoped that the drift of the ice would carry the vessel across the central part of the Polar Sea and nearer to the North Pole. The main scientific object of the expedition should be the study of the oceanography of the Polar Sea. Nansen's investigations had been undertaken at a time when oceanographic methods were still inaccurate and his observations, therefore, suffered from errors which at that time could not be avoided. In spite of the deficiencies of the observations, Nansen had been able to present a clear picture of the circulation in the Polar Sea, but he had also pointed out that it was highly desirable to obtain more accurate data and confirmation on several of his conclusions. In the time which had elapsed after Nansen's expedition oceanographic methods had been very much improved, to a great extent thanks to Nansen's efforts, and on a new expedition it should, therefore, be possible to find an answer to some of the open questions.

Roald Amundsen's plan was received very favourably. The Norwegian Government placed Nansen's vessel the "Fram" at his disposal and also contributed with a sum for repairs. Amundsen had expressly stated that the expedition should have a scientific character and that he, although he hoped to reach the North Pole, did not consider the attainment of reaching the pole as the goal of the expedition, but when it became known that Peary had reached the North Pole in April 1909, Amundsen was unable to obtain any further contributions to his expedition. In these circumstances Amundsen decided to attempt to reach the South Pole, because he had sufficient funds for such an undertaking, whereas he was unable to equip an expedition for a period of four or five years.

Amundsen succeeded in reaching the South Pole and shortly after his return he took up again his previous plan. He intended to sail the "Fram" to Bering Strait, but various circumstances led to postponements and finally, in 1914 the "Fram" returned to Norway, where an examination proved that the hull of the vessel had suffered so much from dry-rot during soujourns in the tropics that it would be connected with great expense to have her rebuilt.

The World War broke out and for a few years Amundsen had to abandon all plans for his expedition, but in 1916 he resolved to build a new ship and take this

to the region to the north of Bering Strait through the North East Passage. The author was asked to take charge of the scientific work on this new expedition and from September 1, 1917 until the departure of the expedition he was engaged in preparing himself for this task and in obtaining the necessary scientific equipment.

The main object of the expedition was, as already stated, to study the physical conditions of the Polar Sea, but along with the oceanographic work a number of other observations of interest to geophysics were to be carried out. These included among others meteorological, aerological and magnetic observations. A great part of the scientific equipment had been procured in the years 1912 to 1914 by the meteorologist B. J. Birkeland who at that time was to be in charge of the scientific work on the contemplated drift. Complete sets of instruments for magnetic observations were in 1918 supplied by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, but the other equipment had to be supplemented in various ways. Winches for use in hydrographic work and during ascents with kites and captive balloons had to be constructed and a number of minor articles had to be obtained. This was often connected with great difficulties because of the numerous restrictions which existed during the war.

On the expedition Amundsen was to make the magnetic observations with which he was thoroughly familiar after his experiences on the expedition through the North West Passage, 1903—1906. All the other observational work was entrusted to the author, but it was understood that during the drift he should obtain assistance from the other members of the party.

Amundsen's new vessel was launched on June 7, 1917 and was christened "Maud". The "Maud" was constructed by Mr. Chr. Jensen and built on the same lines as the "Fram", but was still rounder and had more beam.

The "Maud" left Vardø, Norway, July 18, 1918 with a total party of 9 men on board: Roald Amundsen, leader, Helmer Hansen, master of the ship, O. Wisting, mate, Dr. H. U. Sverdrup, in charge of scientific work, K. Sundbeck, first engineer, M. Rønne, sailmaker, P. Knudsen, second engineer, P. Tessem, carpenter and E. Tønnesen, A. B. All the members of the expedition except Mr. Tønnesen and the author had previously taken part in expeditions to the Arctic or the Antarctic. On August 17 Mr. G. Olonkin joined the expedition. Mr. Olonkin who was of Russian-Norwegian descent and a radio operator and engineer at the Russian wireless station at Jugor Strait, was to take Knudsen's place as second engineer, and Knudsen to act as A. B. We had no special cook on board and during the voyage in the summer of 1918 Knudsen, Tønnesen and the author alternated as cooks.

After the departure from Vardø the course was set for Jugor Strait, which is the southern entrance to Kara Sea. Ice was met with a few days after leaving Vardø, but it did not form any considerable obstacle before the Strait was reached. The Strait was full of ice and after an unsuccessful attempt to force the passage, the "Maud" had to remain in the western entrance until August 17.

After passing through Jugor Strait the "Maud" met with heavy ice in the Kara Sea and was delayed so long that Dickson Island, north of the Jenisei river, was not reached until August 31. A number of dogs and a supply of crude oil were taken on board there. The "Maud" left Dickson Island September 4, 1918, but again encountered great ice masses on September 6, on the western side of Nordenskiöld Archipelago. The "Maud" succeeded, however, in passing through the Archipelago, in rounding Cape Chelyuskin, the north-most point of the continent, and in proceeding about 20 miles farther east, but here the progress of the vessel was absolutely stopped by ice September 13. There was no harbour so the "Maud" had to anchor in an open bay about 200

metres from the shore line. New ice formed rapidly, in a few days the "Maud" was frozen in and preparations for the winter had to be made.

A roof was laid over the foredeck, a thick wall of snow and ice was built around the vessel in order to provide good insulation, and a house for the dogs was erected ashore. After a few weeks it was evident that there was no danger of the ice breaking up. Night watches were, therefore, not imperative for the safety of the expedition and in these circumstances Amundsen did not think it advisable to put the stress of constant watches upon the men.

The winter passed without any remarkable events. Much time was devoted to the construction of new sledges and preparation of new travelling equipment which should replace the old equipment from earlier expeditions.

During the spring months, April and May, a number of shorter journeys with dog sledges were undertaken in order to explore the most northerly peninsula of the continent and in May several hunting parties were sent out. On these journeys, which were undertaken by Hansen and Wisting and Knudsen and Sverdrup, sketch maps were made and meteorological and magnetic observations were taken. On one of the journeys Knudsen and Sverdrup spent three days at Cape Chelyuskin in order to determine the latitude of this point and the difference of longitude between Cape Chelyuskin and our winter-quarters.

Amundsen has been criticised because in the spring of 1919 he did not send out a party for exploring the Northern Land which we could, on clear days, see plainly from the crow's nest. The reason why he did not do this was that he himself was unable to undertake a long journey because during the winter he had suffered from a severe heart attack, and that he considered the crossing of the strait, separating the Northern Land from the mainland, as so dangerous owing to the constant movement of the ice, that he did not want to send any of his men.

In the spring of 1919 Amundsen resolved to send home by way of Dickson Island all observations obtained during the first wintering. He hoped that the ice conditions would permit the ship to enter the pack-ice to the north of Bering Strait and to begin the drift in the summer of 1919, and thought it advisable to let two men take the results of the first year's work to civilisation as soon as possible, mainly because the observations might be lost if the "Maud" were crushed in the ice. For that reason, in the middle of August all observations were packed in two packages and sewn up in oil cloth. One of the packages contained all original meteorological observations and registrations, upper air observations, tidal registrations and special observations. The other contained all magnetic observations and registrations, and information necessary for computations. Copies had been retained on board of all direct observations, but no copies had been made of the various registrations, nor had hourly values been tabulated from them. It was very unfortunate that the registrations had not been evaluated, but time had not allowed us to do so. It may, in this connection, be mentioned that during the first winter the time was by no means given to scientific work only, but several members of the party had been occupied in improving the polar equipment, in hunting, and in various other tasks, and that by far the greater part of the scientific work had been in the hands of the author. It had, in spite of this, been possible to tabulate values from all registrations, but we all thought that the two men were more certain to reach their destination than we were. The journey which they were to undertake was easier than many other successful journeys in the Arctic, but our ship might be crushed in the ice and returning with the sledges to the mainland might be impossible.

Tessem and Knudsen were selected to take back the observations. Tessem had

suffered from nervous headache during the winter and preferred to return instead of staying on with the ship. Upon Amundsen's question all members of the expedition volunteered to join Tessem, except the author who decidedly felt that his place was on board. Knudsen was selected because in 1914—1915 he had taken part in Otto Sverdrup's relief expedition with the "Eclipse" and knew part of the coast which should be followed, and had assisted in depositing provisions and fuel at three places on the coast.

In the summer of 1919 the ice broke at a distance of about one mile from the coast, and between "Maud" and the open leads solid fields of old unbroken ice remained. In the middle of August we started working our way through the ice and used 500 kg of powder for blasting the ice and widening cracks which were formed under the action of the wind. Finally on September 12 open water was reached and the "Maud" could proceed towards the east.

Tessem and Knudsen had in the meantime, built a hut on shore and had been equipped with tent, sledge, five dogs, provisions and fuel for about one year, rifles, ammunition, maps of the coast, compasses, watches and theodolite. They were instructed to start, if possible, for Dickson Island in the fall as soon as the ice was trustworthy but if in their own judgement it was not advisable to travel in the fall, they should wait until the next spring. They would be able to replenish their provisions and their fuel at the above mentioned three caches. The greatest distance was from the last cache at Cape Wilde to Dickson Island and this amounted to about 250 miles.

Tessem and Knudsen started as early as the fall of 1919, but they failed to reach Dickson Island. A search expedition sent out by the Norwegian Government in 1920 found a letter from Tessem at Cape Wilde. In this letter Tessem states that they have moved the depot further inland because it had been partly damaged by sea water, and that on November 15 they were to continue their journey. No more definite information as to their fate was obtained, but in 1922 a Russian expedition found the body of Tessem only 3 km from the Russian wireless station on Dickson Island and at some greater distance they found his belongings, and light was thrown over the fate of the two men. It is probable that Knudsen has been taken ill and died, and that his body has been burnt by Tessem because remnants of a big camp fire was found in which particles of burnt clothing, buttons and so on were scattered. Tessem has continued alone, but at a distance of about 50 km from Dickson Island he has abandoned his sledge and his equipment and continued on foot. The package containing the magnetic observations was found undamaged. A second package containing personal letters was also intact, but the package with the meteorological observations and the other data had evidently been torn to pieces by wild animals, because fragments of papers were scattered all over a small mound. Only 30 km from Dickson Island Tessem's ski and sleeping bag were found in an abandoned hut, and finally Tessem's body was discovered 3 km from the station. The body was lying under a precipice. It is possible that he has fallen down, or, that he, when keeping to the beach, has been overcome by exhaustion.

The tragedy of Tessem and Knudsen appears still greater in view of the fact that events developed in such a way that it would have been unnecessary to leave them behind. The "Maud" did not succeed in entering the drifting ice of the Polar Sea, but had to seek new winter-quarters on the coast. In the vicinity of Cape Chelyuskin and across Nordenskiöld's Sea the "Maud" met much more ice than previous expeditions have encountered at the same season, and on the east side of the New Sibirian Island there was only a narrow lead of open water between the heavy pack-ice and the coast. An attempt to penetrate to the north here had to be given up.

Amundsen resolved to go to Chaun Bay, inside of Ayon Island, but when Ayon Island was reached further progress was absolutely blocked by the ice. A strip of old ice, two miles broad, was found along the coast. The "Maud" was forced in some hundred yards between the ice floes where she stayed perfectly safe during the whole winter.

When the expedition came to Ayon Island a number of natives of the Chukchi tribe was living there. These natives belonged to the group of Chukchis who are reindeer nomades and spend the winters in the timbered inland, but the summers on the coast. A few of the natives knew some Russian words, and with Mr. Olonkin as an interpreter it was possible to communicate with them. It soon became apparant that they were very primitive and had been only in slight contact with civilisation. It would, therefore, be of considerable interest to learn as much as possible about their customs, and Amundsen suggested to me that I should join them when they left the coast, spend the winter among them and return with them to Ayon Island in the next spring. I agreed to this suggestion and spent seven and a half months among the natives. Besides learning their language and making extensive notes of their customs I took meteorological, magnetic and astronomical observations.

On board the "Maud" the party was reduced to four men, because Hansen and Wisting left the ship in December in order to travel all around the coast to the wireless station in Anadyr, from which station messages telling about the fate of the expedition should be sent to Norway. Tønnesen accompanied them in order to return to Norway via East Cape and Nome.

Hansen and Wisting returned to the "Maud" on June 14, 1920. On July 6 the ice had opened up so much that the "Maud" could leave and proceed to Nome in order to take on board new provisions before entering into the pack-ice. When Amundsen made known his intention of calling at Nome, he announced that every member of the expedition was free to leave the ship in Nome if he so desired. When leaving Norway it had been assumed that the expedition would last from three to five years, supposing that the ship could enter the drifting ice the first summer. It had, however, been necessary to spend two years on the coast and in these circumstances Amundsen thought it best that those who wanted to could leave the expedition. Only three of us, Wisting, Olonkin and myself, declared that we were willing so stay on, but Hansen, Rønne and Sundbeck preferred to return to Norway from Nome.

Nome was reached on July 27, 1920 and after a short stay the "Maud" again left for the Arctic on August 8, 1920 to make a third attempt to penetrate to the drifting ice. On departure from Nome we were only four men on board and Amundsen intended first to go to Cape Serdze Kamen, 110 km from East Cape, and take on board some natives with whom he had made arrangements when we passed the native settlement at the Cape on our way to Nome. This new attempt, however, failed completely because the ice conditions were worse than on any previous occasion. Heavy ice was encountered even in Bering Strait and it was only with great difficulty that Cape Serdze Kamen was reached on September 1. On this day the ice closed in around the "Maud" and accordingly winter-quarters for 1920—1921 had to be established at Cape Serdze Kamen. In the last struggle against the ice the propeller had been broken and the shaft damaged. In the following summer it would, therefore, be necessary to return to a port where repairs to the vessel could be undertaken.

The great reduction in the number of the members of the expedition had naturally, a considerable influence on the scientific work which was also hampered by the severe weather conditions during the first part of the winter. The ice broke up close to the shore several times in October and November, and it was not until the end of November that the "Maud" was frozen fast.

From January 31, 1921 to April 7 Wisting and the author undertook a sledge journey with dog teams along the coast of the Chukotsk peninsula to Holy Cross Bay, in order to take magnetic observations and study the customs of the natives on the coast, who are hunters and live in the same way as the Eskimos. After the return the author took a short trip to Pitlekai, a native village about 80 km west of the winter-quarters where A. E. Nordenskiöld had made magnetic observations during the "Vega"s wintering in 1878—1879.

In May 1921 Amundsen left the "Maud" and went to East Cape from which place he proceeded with the first trading schooner to Nome, and from Nome to Seattle in order to secure assistance for the "Maud" if that should be necessary. In the course of June we hired a crew of six young Chukchi and left the winter-quarters on July 1. We reached the northern entrance to Bering Strait under own power and here we met the U. S. Coast Guard cutter "Bear" which rendered us very valuable service by taking the "Maud" in tow through Bering Strait and as far south as past St. Lawrence Island. From St. Lawrence Island we sailed the "Maud" to Dutch Harbour on the Aleutean Islands and from there to Seattle. The motor could be used only when entering a harbour because the propeller had only one and a half blades and every time it was in use we were afraid that the bearings should be knocked to pieces. The natives had no experience as sailors and, therefore, the journey was very trying and strenuous for Wisting, Olonkin and myself. We reached Seattle on August 31 and shortly afterwards the "Maud" was laid up in Lake Union off Seattle Yacht Club.

During the years 1918 to 1921 the scientific work was not so extensive as could have been desired. It had been supposed that the ship would be able to begin the drift with the ice as early as at the end of the first summer, and it had not been anticipated that three years would be spent on the coast. The problems which presented themselves, therefore, differed from what we had expected. Furthermore, the author had no experience as to working under arctic conditions and this naturally was a considerable handicap during the first winter. During the two following winters much time was spent in travelling with the natives, or among the natives, and scientific work within the fields of geophysics was neglected. The reduction of the members of the expedition also influenced upon this work.

When the ship was under way under her own power each member of the expedition had a sailor's duty to perform and only occasionally could scientific observations be taken. Astronomic observations were taken regularly as far as necessary for the navigation. The positions of the winter-quarters, and the routes of sledge journeys, and the journey of the author with the Chukchi were determined, by means of astronomic observations. We had no wireless station on board when we left Norway in 1918, because it had been impossible for Amundsen to acquire a suitable set during the war. When determining the longitude we had, therefore, to rely upon our chronometers and watches. At the different winter-quarters the rates of the chronometers could be ascertained and the intervals when we were under way, were so short that we always knew the correction of our chronometers with sufficient accuracy. On the arrival in Nome in 1920 our adopted correction to our main chronometer was only 3 seconds wrong. On journeys away from the ship watches were used and the rates of these were determined by comparisons with our chronometers before and after the journey. During the soujourn among the Chukcki the author could determine the rates of his watches by observations at suitable intervals. At winter-quarters 1918—1919 a series of observations of the moon were undertaken in order to obtain an independent determination of the longitude and these observations gave results which agreed perfectly with those obtained by means of the chronometers and observations of stars and sun-

In May 1919 Mr. P. Knudsen and the author undertook a journey to Cape Chelyuskin which was situated at a distance of about 35 km from our winter-quarters, in order to determine the exact latitude and longitude of the most northerly point of the continent. The result was 77° 43·1′ N and 104° 17′ E, in good agreement with the Russian chart which was published in 1915. It may, in this connection, be added that in our experience the latest Russian charts are very accurate in the regions where the survey has recently been carried out.

On the journey between Vardø and Cape Chelyuskin magnetic observations were taken near the western entrance to Jugor Strait and at Port Dickson. Amundsen intended, as already mentioned, to undertake the magnetic observations himself and shortly after establishment of the first winter-quarters he selected a place for a magnetic observatory close to the shore line under a small hill. The building of a wooden house for absolute measurements was started on September 20, and on October 1 it was so far advanced that the first observations were taken in it. Amundsen was, however, prevented from taking part in this work because on September 30 he had the misfortune to fall and break his right arm close to the shoulder. The magnetic observations up to the end of November were made, therefore, by the author, at which time Amundsen was able to take over a part and later all of them. All observations were computed by the author.

A long and low building for a recording declinometer was attached to the magnetic observatory. The declinometer, which had been taken along for use in case wintering at the coast should be necessary, was installed in this building at the beginning of October and continuous records of the declination were obtained in the period from October 3, 1918 to August 9, 1919. The records, however, were not complete for this whole period, partly on account of the difficulties in making the clock run, and partly because some records were spoiled by formation of frost, or by light entering the room of the recorder after the snow had melted in summer. Helmer Hansen attended daily to this instrument and the author developed the records and determined scale and baseline values. During the winter Helmer Hansen and O. Wisting received instruction in taking observations of the magnetic inclination and of the total intensity with the dip circle. On sledge journeys in the spring of 1918—1919 Wisting took a number of observations with this instrument. Observations of the magnetic inclination were also made by Mr. P. Knudsen on the small islands between the mainland and the Northern Land in May 1919.

During the winter 1919—1920 the author brought the magnetic instruments with him when he joined the Chukchi and occupied a number of stations. After the return to the ship a series of observations were taken on Ayon Island.

At the third winter-quarters near Cape Serdze Kamen a snow-house with canvas roof for absolute magnetic observations was built ashore, but in December the house was completely buried by drifting snow. Later on, several observations were taken in a tent. On the sledge journey which Wisting and the author undertook along the coast of the Chukotsk Peninsula in February to April 1920 a number of stations were occupied, and at the end of April the author took a series of observations at the site of the magnetic observatory which A. E. Nordenskiöld had constructed near the native village Pitlekaj, during the wintering of the "Vega" in 1878—1879.

The declinometer was not used at the last two winter-quarters, because the party on board the ship was so small during these winters that the scientific work became very restricted.

Regular observations of the aurora were not made in any of these years, because we had no night watches. During the first winter the author took a small number

of photographs of the aurora, but wanted to save the greater number of the available plates for use during the drift. In 1920—1921, at Cape Serdze Kamen, an attempt was again made to obtain photographs of the aurora, but the highly sensitive plates had deteriorated to such an extent that no successful pictures could be taken.

Attempts at observing the atmospheric potential gradient were made in the winter 1918—1919, but they failed because no satisfactory insulation could be established by means of the inadequate equipment which had been procured during the war.

Meteorological observations were taken three or four times a day when the ship was under way. At the winter quarters ordinary observations were undertaken at the hours 8, 14 and 20. It would have been very desirable to distribute these observations evenly over 24 hours and take them with intervals of not more than four hours, but this was impossible since we had no night watches. At winter quarters the air temperature and humidity were recorded continuously in a meteorological screen which was placed either on posts at some distance from the ship, or on board in a place where the temperature was not influenced by the heat from the living quarters. A recording anemograph was mounted on the roof of the living house and in such a manner that the cups were seven metres above the ice. Two mercury barometers, one standard and one station barometer, were suspended in the chart room, which during the winters served as a laboratory and where a marine barometer and a barograph always remained mounted.

The upper air observations were commenced in February 1919. In this month and in March several ascents with captive balloons were undertaken. The balloons were filled with hydrogen which was generated from CaH_2 and water. At low temperatures the filling of the balloons was a very trying task which took a long time for which reason the number of ascents became very small. In the months March to July a number of kite ascents were undertaken. The kite reel had been mounted on the top of a small hill above the magnetic observatory. The kites were hauled down by hand except during the last ascents in June and July when a 5 HP Harley-Davison motorcycle motor was used. We had no shed for the kites and these, therefore, had to be assembled before each ascent and taken apart again when the ascent was finished. The instruments which were sent up with the balloons and kites were examined in the laboratory on several occasions. At the winter-quarters in 1919—1920 and 1920—1921 no ascents with kites or captive balloons were undertaken because in the first mentioned winter the author was away from the ship, and in the last winter the party of the expedition had been reduced to four men and, therefore, the scientific work became very limited.

Pilot balloons were let up in the spring of 1919. The results which were obtained were not quite satisfactory because the rubber balloons which had been bought during the war were of poor quality and could not be given a sufficiently greeat free lift. New pilot ballons had been sent to Nome and were received there when the "Maud" called at Nome in the summer of 1920. With these new balloons a number of ascents were undertaken at Cape Serdze Kamen, 1920—1921.

Pendulum observations for determining the acceleration of gravity were undertaken in June 1919. In the winter 1918—1919 the temperature distribution was examined in the snow drift alongside of the ship and in the ice underneath the snow drift. The measurements were undertaken by means of thermo-couples which had been constructed on board, but the results of these observations were lost with Tessem and Knudsen.

A few oceanographic stations were taken when the ship was under way in the different summers. In these periods we had always to proceed as fast as the ice conditions permitted and we could never stop for measurements. Opportunity for such measurements had to be taken when the progress was stopped by ice. The water

samples which were collected were examined in the laboratory after the establishment of winter-quarters.

In the autumn of 1918 we noticed that the fall and rise of the tides were considerable. In order the study the tides a heavy weight was lowered to the bottom and from this a wire was carried over a couple of blocks to the deck and a counter weight was attached to the other end. When the ship moved up and down with the tide, the counter weight would move relatively to the deck and the displacements were read off on a graduated staff. These readings were taken only in daytime since we had no night watches. In order to obtain continuous records Mr. Sundbek constructed a simple recording instrument which functioned perfectly during the whole winter. The wire was led through the ice in an iron tube which was filled with petrol in order to prevent freezing in of the wire. The tidal recorder was also used successfully at the winter-quarters of 1919—1920 and 1920—1921.

Finally it should be mentioned that several collections were brought home. On the sledge journeys in the spring of 1919 rock specimens from the Taimyr Peninsula were collected and in the following summer a number of plants were conserved. A few dredgings were undertaken in order to obtain some specimens from the bottom of the sea. Plants were also collected at Ayon Island in July 1920, but we left this island at such an early date that this collection became incomplete. The author brought back with him a considerable number of articles from the Chukchi when in May 1920 he returned from his soujourn among them, and in the following winter he obtained from the natives and from traders on the coast, a considerable number of ivory and stone implements which had been found in remnants of old dwellings. He also brought a few such articles from mounds which were examined on Ayon Island.

From this brief review it is evident that the investigations within the fields of geophysics were not so extensive as they could have been if circumstances had made it possible to devote more time to these researches. However, much valuable experience was gained during these years and the plans for the future work could be laid with greater care and the equipment could be supplemented in a better way than would otherwise have been possible.

As already mentioned, the "Maud" reached Seattle on August 31, 1921. At the end of October the author went to Washington D. C. where he spent five months at the Department of Terrestrial Magnetism of the Carnegie Institution, engaged in working up the results of the magnetic observations from the years 1918 to 1921. He also took the opportunity of obtaining several important additions to the scientific equipment. The Department of Terrestrial Magnetism supplied a complete set of instruments for absolute observations of the atmospheric potential gradient, and the U. S. Weather Bureau kindly placed four kites at the disposal of the expedition. Furthermore, nickel resistance thermometers for measuring the temperature of the ice at various depths were procured, and a portable highly sensitive galvanometer and an ammeter were obtained for use in connection with radiation measurements. The equipment for radiation measurements was increased by the addition of a newly constructed instrument, melikeron, which the Smithsonian Instution kindly lent us, and a Campell-Stokes sunshine recorder was placed at our disposal by the Meteorological Office, London.

Wisting and Olonkin remained in Seattle, but Amundsen paid a short visit in Norway. After his return he informed Wisting and myself that he intended to attempt a flight by airplane from Point Barrow Alaska to Spitsbergen and that he had engaged lieutanant O. Omdahl as pilot. He would take his airplane to Point Barrow on board the "Maud", and from Point Barrow the "Maud" should proceed towards the pack-ice under the command of Wisting in order to drift across the Polar Sea if possible. This

plan did not come as a surprise to us, because Amundsen had several times discussed such a plan with us in the preceding winter at Cape Serdze Kamen. To Amundsen the exploration of the great unknown area between Alaska and the North Pole had always been a fascinating task, and he wished to undertake this geographic exploration while the "Maud" was drifting with the ice and the scientific program within geophysics was carried out. The "Maud" was also equipped with a small airplane, a Curtis Oriole, which should be used for short flights from the ship in order to extend the geographic exploration on both sides of the route.

When these plans were discussed during the winter 1920 to 1921 I had on several occasions emphasized the importance of adding one man with scientific education to the party, in case Amundsen should decide to leave the ship. Amundsen had, therefore, made inquiries in Norway with the result that the young Swedish meteorologist Mr. Finn Malmgren was engaged as assistant scientist.

The necessary repairs to the "Maud" were undertaken in Seattle in the spring of 1922. During May new provisions, fuel, and equipment were taken on board and the men who had been engaged to take part in the expedition arrived. At the beginning of June the "Maud" was ready for returning to the Arctic in order to make the fourth attempt at entering the drifting ice.

The "Maud" left Seattle on June 3, 1922. Amundsen took a direct steamer to Nome where he joined the expedition and whence the departure took place on June 24. The "Maud" first called at East Cape in order to take on board a number of dogs, which in 1921 had been left there in care of a trader, and to set ashore three of the young natives who had acted as sailors in the preceding summer. Two of the natives had been sent home via Nome in the preceding autumn and one, Kakot, remained on board and should act as a cabin boy and cook's mate during the drift. From East Cape the "Maud" should proceed to Point Barrow, where Amundsen and Omdahl should take the big airplane ashore and remain until the following spring when the flight should be attempted. Ice conditions seldom permit any vessel to reach Point Barrow from the south before August 1 and we soon found the progress stopped by heavy ice. The "Maud", therefore, entered Kotzebue Sound where we stayed for about three weeks. The Curtis Oriole was taken ashore here and a few trial flights were undertaken. Amundsen had intended to examine the ice conditions along the coast by means of this airplane, but when the trading schooner "Holmes" anchored in Kotzebue Sound he decided to transfer the airplane to "Holmes" whose captain kindly promised to take it to Point Barrow. This arrangement would make it possible for the "Maud" to start on her voyage north at an earlier moment. The "Maud" left Kotzebue Sound on July 23, and on July 28 we met "Holmes" at Point Hope. Amundsen and Omdahl, who had remained on board the "Maud" left us here and went on board the "Holmes".

Later on the airplane was brought ashore at Wainright, south-west of Point Barrow, where Amundsen and Omdahl spent the winter. During trial flights in the spring of 1923 the airplane was found unsuited for the long flight and Amundsen had to give this up. He returned to Norway and made in 1924 an unsuccessful attempt at organizing a flight which should start from Norway, but in 1925 he received the assistance of Mr. Lincoln Ellsworth and started from Spitsbergen May 27 for a flight towards the north with two airplanes. They reached a latitude of 88° 45′, but one airplane was damaged by the ice shortly after the landing in a lane. After three weeks of strenuous work a runway had been prepared on the ice and on June 18 Amundsen, Ellsworth and their companions reached Spitsbergen in the one undamaged airplane. Finally in 1926 Amundsen and Ellsworth succeeded in crossing the Polar Sea from

Spitsbergen to Point Barrow with the airship "Norge" and in passing over the great unknown area of the Arctic.

The "Maud" left Point Hope on July 28, 1922 with a total number of eight men on board: O. Wisting, master of the ship and leader of the expedition, Dr. H. U. Sverdrup, in charge of scientific work, F. Malmgren, assistant scientist, G. Olonkin, first engineer, S. Syvertsen, second engineer, K. Hanssen, mate, O. Dahl, aviator, and Kakot, our Chukchi cabin boy. One of our comrades, S. Syvertsen, took ill in the spring of 1923. He died on July 8 and his body was buried in sailor fashion. Later on O. Dahl took his place as second engineer.

The pack-ice was met with at a short distance from Point Hope, but we succeeded in following leads and openings towards north-west until on August 8 we were closed in by the ice in the vicinity of Herald Island to the west of Wrangell Island.

For one year we drifted towards the west-north-west in a zigzag course depending mainly upon the wind and were at the beginning of September 1923 in latitute 76° 17′ east of De Long's Islands. We had, on the whole, drifted on the southern side of the route which was followed by the ill-fated "Jeanette" in 1879—1881, but had spent only one year in covering a distance on which the "Jeanette" had taken almost two years. In September 1923 we were, however, very close to the route of the "Jeanette" and we hoped to cross this and drift on the northern side of De Long's Islands, and perhaps to continue to Spitsbergen along a route more northerly than the one taken by the "Fram" in 1893—1896. However, continual northerly winds carried us 100 miles to the south, and the winter of 1923—1924 was spent drifting back and forth in latitude 75° north, to the southward of De Long's Islands.

At the end of February 1924 Captain Wisting received a wireless message from Amundsen asking him to get out of the ice, if possible, and return to San Francisco in the summer of 1924. We did not consider it possible that we would be able to get out of the ice, but thought that we would have to continue and would be carried across the Polar Sea very nearly along the route which the "Fram" had followed. In the spring and summer of 1924 we were again carried to the west-north-west, we passed between the two small islands, Wilkitsky Island and Schokowa Island, which had been discovered from the ice breaker "Taimyr" in 1913, and between Bennett Island and the New Siberian Islands. In this region the ice opened up so much that on August 9 we could move under the ship's own power after having drifted for two years.

During these years the "Maud" had been subjected to severe ice pressures, especially in October 1923 and in May and June 1924, but the ship had in every way answered to our expectations. The ice had always been forced underneath the ship and lifted her up instead of crushing her. An emergency equipment consisting of three sledges with provisions for 8 men and sixteen dogs for a period of 40 days, tents, sleeping bags, a solidly constructed canvas boat and other necessities had been prepared in the autumn of 1922 and were kept ready for use on the deck. On one occasion only, did we consider taking the sledges off the ship and be prepared for leaving it.

When on August 9 the "Maud" reached spaces of open water we first attempted to go around the New Siberian Islands on the eastern side, but we met heavy ice and had to return. The passage on the western side was free from ice and on August 20 we passed through Laptew Strait, separating the New Siberian Islands from the mainland. On our way along the coast to the east we encountered much ice and were repeatedly forced towards the shallow waters at the coast. On August 27 we finally reached Cape Baranow between the Kolyma River and Ayon Island, but there the progress was stopped. We found no passage along the land and failed in an attempt at finding leads at some distance from the land. When we returned towards

the coast from this attempt the ice had closed in more, and we were stopped at a distance of more than 10 miles from the coast. We had to seek a more sheltered place for winter-quarters and Wisting decided to return to the Bear Islands group to the north of Kolyma River, because there had been open water around these islands when we passed them. On our return we could, however, not get close to any of the islands and had to stop at a distance of 5 miles from the most easterly, the small Four Pillar Island. This island has its name from four conspicuous stone pillars, which are seen against the horizon when the island is approached from the southern or the northern side. In the U. S. Arctic Pilot the name is given as Light-house Island, probably because of a curious mistranslation from Swedish. The direct translation of the Russian name is Four Pillar Island and this name is, therefore, used here.

We were afraid that the position of the ship was very unsafe because there was no shelter. We expected that the ice might break up at any time and carry the ship away from the coast, but fortunately nothing serious happened. The ice broke once in the beginning of October, but she was not carried off, and later on the ship remained in exactly the same position until the beginning of July 1925.

It was a great disappointment to us that we had to spend another year near the coast, after we had succeeded in getting out of the drifting ice to the north of the New Siberian Islands. We had not expected to get out of the pack-ice, but we had felt quite confident that we should reach Bering Strait after our success, relatively early in the season. Ice conditions along the Siberian coast from Bering Strait to the New Siberian Islands are, however, very variable and it is not every year possible to navigate these waters. In the spring of 1925 we learned, through hunters from the Kolyma district who visited Four Pillar Island, that in the summer of 1924 the ice had formed an insurmountable obstacle to navigation to the east of the Kolyma River. An U. S. S. R. vessel, "Stavropol", which should bring supplies to the Kolyma district had been unable to reach her destination. Her progress had been stopped on the western side of Ayon Island and the supplies had been unloaded at the mouth of the Baranicha River. This unloading had taken place at the time when we reached Cape Baranow which is at a distance of only 90 km from Baranicha River. The "Stavropol" had returned towards Bering Strait in the first days of September, but had been stopped by the ice near the small Chalausow's Island which lies only about 290 km to the east of Ayon Island, and in a straight line about 460 km east of our winter-quarters at Four Pillar Island. In May we got in wireless communication with the "Stavropol", and the captain of the ship, Mr. Milovsorow, kindly left at his winter-quarters, a supply of lubricating oil of which we were short. We found this supply when we reached the island about three weeks after his departure.

On July 13, 1925 the ice had opened up so much between Four Pillar Island and the mainland that we could leave our winter-quarters and proceed towards the coast. The ice conditions were, however, still unfavourable between Cape Baranow and Ayon Island and we spent several weeks in waiting. On August 1 the ice was carried out, we passed Ayon Island and found the coast further to the east free from ice. After several shorter stops at various places on the Siberian coast, we finally reached Nome on August 22, 1925 and were again in touch with civilisation after an absence of three years and two months.

On October 5 we arrived at Seattle, Washington. The members of the expedition returned to Norway, and the "Maud" was sold to the Hudson Bay Company. The Company intended to use her for bringing cargo to and from trading posts on the northern coast of Alaska and Canada. Unfortunately her draft was so great that

navigation was difficult in the shallow waters along the coast, and she was, therefore, left in Cambridge Bay on Victoria Land. For several years she was used as a base station for supplies and as a wireless station, but in the summer of 1931 she was abandoned and now she is probably a total wreck. We, who have had the "Maud" as our home during more than seven years and who know that she could be trusted in all circumstances, regret deeply that this excellent ship should meet such a fate and that she no longer is available for polar work. Personally I am of the opinion that a drift-expedition should be repeated since it offers unusually great possibilities for scientific work, but I doubt that another attempt on drifting across the Polar Sea will be made in the near future, because the only suitable ship has been lost.

We had failed in drifting across the Polar Sea and in studying the oceanography of this sea, but we had accumulated a great number of scientific observations from other fields of geophysics.

When the ship was under way under her own power, the scientific work was very limited and restricted to ordinary meteorological observations because the ship had no special crew, and we had all of us to act as sailors. My duties were, for instance, to take care of the navigation of the ship and of the cooking. When we were drifting with the ice, the scientific work was, on the other hand, given much time and the scientists received assistance from every member of the expedition.

Astronomic observations were taken regularly from the very beginning of the drift in order to follow our route step by step. In winter and spring, when fine and cloudless weather prevailed, observations for position were taken two or three times a week, but in summer and autumn when low clouds were frequent, the observations were taken with irregular intervals according to the opportunities which were present. In summer, more than a week occasionally passed between two observations. Thanks to our radio station we could always receive time signals and the exact determination of longitude was, therefore, as simple as the determination of the latitude. At winter-quarters 1924—1925 a sufficient number of observations were taken to ascertain our position.

During the drift observations of the magnetic declination were generally made simultaneously with the astronomic observations. In order to determine the magnetic declination it was necessary to know the true bearing of a terrestrial mark, but owing to the constant motion of the ice the bearing of a mark on the ice changed continuously and had, therefore, to be determined at the time when the observation for declination was carried out. We, therefore, took the observations of declination simultaneously with the astronomic observations, the magnetic observer used the astronomic theodolite as a mark and the astronomic observer determined the bearing of the magnetic instrument. These observations of declination were undertaken by Malmgren, and the astronomic observations by the author, assisted by Mr. K. M. Hanssen.

Observations of the magnetic declination and total intensity were taken by Mr. Wisting twice a week by means of a dip circle provided with intensity needles, and about twice a month observations of the horizontal intensity by means of magnetometer were carried out by the author who made all computations. All the magnetic observations had to be taken on the ice at such a distance from the ship that the disturbing influence of the magnetic iron masses on board was eliminated. The first observations were taken without any other shelter than the protection against the wind which a large ice-hummock might give. Later on, when our surroundings became more solid, we built an ice-house which we used to call the "Crystal Palace". The ice-house was equipped with electric lights and a non-magnetic primus stove which in winter brought the temperature up to about — 25° when the outer temperature was

around — 40°. The magnetic and other observations were taken in this house during the first winter, 1922—1923. The instruments were the same as those which were used on the expedition 1918—1921 and had been loaned the expedition by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

Our "Crystal Palace" did not survive the arctic summer. It melted in June and in the summer we had to take the observations in a tent. This observation tent was used during the entire winter of 1923—1924, because a new "Crystal Palace" which had been built in October 1923, disappeared when the ice broke to pieces around the ship, and because later on our surroundings were frequently changing. Our tent undertook several independent excursions as the ice broke between the ship and the tent, and the parts on both sides of the crack were displaced in relation to each other.

Continuous records of the magnetic elements could not be obtained in the pack-ice because the ice fields were always moving, turning and twisting, making a permanent orientation impossible The conditions were different during the winter of 1924—1925 when we were frozen in close to the coast and surrounded by motionless ice. There we installed the recording declinometer, which had been used at Cape Chelyuskin, in a light-tight case within the small tent previously used. A large tent was used for the ordinary magnetic observations. Frequent observations of declination were undertaken, using a fixed mark, but the number of the other absolute observations was much reduced because the geographic position remained unaltered. Several inter-comparisons between the different instruments were undertaken both during the drift and at winter-quarters 1924—1925.

Comprehensive observations of the aurora were made in all winters. In the pack-ice, night watches were imperative because the ice could at any time break up. We used to stay up for two hours each and the watchman was instructed to make frequent notes regarding the form, amount and intensity of the aurora and its position on the sky. These night watches were also continued during the winter 1924—1925 when they were unnecessary for the safety of the ship, but important to the scientific work. Besides the direct observations we succeeded in taking several pictures of brilliant displays.

Atmospheric electric observations were confined to observations of the potential gradient. Such observations were taken in the ice-house in the winter of 1922—1923. They comprised daily readings and under favourable weather conditions eye-observations during 24 hours. The latter were undertaken in order to study the diurnal variation of the gradient over the Polar Sea. One of the most interesting results of the atmospheric electric work carried out on board the non-magnetic ship "Carnegie" during 1915—1921, was that this variation follows universal times over the oceans, the maximum value being reached simultaneously over all the oceans. We wanted to ascertain whether this law for the variation held good over the Polar Sea as well.

The 24 hourly readings confirmed the law, but we found that we would naturally save time, and materially increase the amount of data if we could record the gradient continuously. The author, therefore, asked our aviator, Mr. O. Dahl, who was an unusually able instrument designer and maker, to construct a recording electrometer. He succeeded in doing so and especially in overcoming the difficulties which the attainment of an electrostatic insulation presented. Our home-made recording electrometer was placed in an unheated room on deck and became covered with frost on the outside, but this circumstance did not influence the efficiency of the instrument. The records gave, however, only relative values of the gradient and in order to reduce them to absolute values, eye-observations were carried out from time to time on smooth ice at a sufficient distance from the ship. The electrometer rendered excellent service in

winter, but in summer we were unable to secure any observations, records or eye-readings, because a satisfactory insulation could not be maintained on account of the great dampness of the air.

From September, 1922 meteorological observations were taken regularly six times daily and from June 1, 1923 observations of the amount and form of clouds were in addition made every second hour. Continuous records of the barometric pressure were obtained for the entire period, and records of the temperature of the air, and the direction and velocity of the wind were obtained when we were drifting with the ice and at winter-quarters 1924—1925. A snow-gauge for measuring the amount of precipitation was constructed and placed on the ice at a suitable distance from the ship. The meteorological screen was placed on the roof covering the deck. We found, in agreement with the experiences on many previous expeditions, that at low temperatures the measurements of the relative humidity by means of hair hygrometer, or hair hygrograph, were unsatisfactory and gave very unreliable results. During the winter of 1923—1924 Malmgren, therefore, constructed a new ventilated psychrometer in which the ordinary thermometers were replaced by a series of thermo-couples which made possible an accurate determination of the temperature difference between the wet and the dry "bulbs". By means of this instrument he obtained excellent results in the winters 1923—1924 and 1924—1925. Malmgren, furthermore, undertook a special study of the formation of frost. He measured exactly the amount which was deposited on a circular disc which, by means of a wind vane was always facing the wind. Following his suggestions, Mr. Dahl constructed a recording instrument by means of which continuous records of the amount of frost which was deposited on a cylinder were obtained.

In the winter of 1923—1924 the author took a series of direct measurements of the temperature difference between the snow surface and the air at a distance of 80 cm above the ground. The results of these measurements were so interesting that we intended to record the differences continuously. For this purpose Mr. Dahl made a series of thermo-couples. One series of the joints was spread out fan-like on the snow and covered with a few snow crystals and the other series was spread out brush-like in a carefully constructed screen and so that they were about 80 cm above the surface. This instrument was mounted at a distance of about 20 metres from the ship, in a place where experience had shown us that drifting snow did not accumulate, and from there leads were carried into the laboratory where the thermo-current was recorded by means of a galvanometer contructed by Mr. Dahl. The galvanometer was of the moving coil type, the pen moved over a rotating drum and was pressed down at intervals of four minutes by means of an electromagnetic device. The latter was operated by means of a contact watch which Mr. Dahl had made from an alarm clock. Finally, it should be mentioned that a resistance thermometer was mounted in a small screen which was attached to the crow's nest. From this lead-covered cables were carried into the laboratory where the instrument for the readings was placed, and where during winter the temperature at the crow's nest was read off directly before or after reading the thermometers in the screen.

Measurements of the radiation from the sun by means of Ångströms pyrheliometer, and of the nocturnal radiation by means of Ångströms pyrgeometer, were commenced shortly after the beginning of the drift. After some time the measurements of the nocturnal radiation were preferably undertaken by means of the melikeron which had been loaned the expedition from the Smithsonian Institution, because the latter instrument gave greater deflections. In the spring of 1923 it was found that the melikeron, when covered with a glass hemisphere, was very suitable for measuring the

total radiation income in day-time. The thermo-current which the instrument rendered, was strong enough to be recorded continuously and Mr. Dahl, therefore, constructed a recording galvanometer, similar to the one which later on was made for recording the temperature differences, and by means of this instrument, continuous records of the radiation income were obtained in the greater part of 16 months. The duration of the sunshine was recorded during the greater part of the time when the sun was above the horizon by means of a specially constructed Campell-Stokes sunshine recorder which, with great courtesy, had been loaned the expedition from the Meteorological Office, London.

The temperature of the ice was made the subject of a special study. In the autumn of 1922 the resistance thermometers which had been acquired for this purpose were buried in the ice at various depths. The cables were carried into the ice-house, the "Crystal Palace", where the temperatures were read once a day. The place which had been selected was not very fortunate because drifting snow accumulated there, and changes in the snow cover led to considerable changes in the temperature distribution in the ice. At the end of the summer 1923 a new place was selected for the thermometers, but these were lost at the end of October, when the ice broke up. We had only two thermometers left, but in order to obtain measurements at a sufficient number of depths, we constructed a series of thermo-couples which was used successfully during the following winter. This time we had been fortunate in finding a location where the thickness of the snow cover changed little, and we obtained, therefore, good results. The thickness of the ice was determined at irregular intervals and in summer the melting of the ice was measured. In connection with the measurements of the temperature in the ice, which were made by the author, Mr. Malmgren undertook some special studies of the properties of the sea ice. He determined the specific gravity of various ice samples, the heat expansion of sea ice of different salt contents and made some experiments for determining the heat conductivity of the ice.

The upper-air work comprised ascents by means of pilot balloons and kites. The pilot balloon work was commenced in September 1922 and continued until June 1925. Ascents were undertaken on most of the clear days, and on a number of overcast days in these years. The first ascents were undertaken by Mr. Malmgren and the author jointly, but after some time Mr. Malmgren acquired so much experience that he was able to undertake the ascents alone and we then divided the work between us. In the dark season small paper lanterns were attached to the balloons and these could be seen at distances of about 25 km. When ascents with lanterns were undertaken, two observers were needed. The big kite reel for hauling down the kites was mounted on deck in November 1922 and a pulley was fastened to the ice at some distance from the ship in order to guide the wire in any desired direction according to the direction of the wind. We had two motors for hauling down the kites, one 6 HP one-cylinder crude oil Bolinder motor and one 5 HP two-cylinder Harley-Davidson motorcycle motor for petrol. The former was first taken in use, but after a short time the ignition head burst. We had only one spare ignition head and, therefore, we replaced the Bolinder motor with the Harley-Davison because we wanted to save the former for deep-sea oceanographic work. It took, however, a long time before we succeeded in making the motorcycle motor function at low temperatures and the kites had, therefore, to be hauled down by hand which meant strenuous work for four or five men for one to two hours. The greatest trouble with the Harley-Davison motor was that the magneto system did not give a sufficient spark. Mr. Dahl, therefore, replaced the magneto system with an induction coil, using the current from our 120 volt Delco light plant battery as the primary current. He also had to construct a new distributor and had to overcome a series

of difficulties which arose because of the inadequate material at his disposal. Finally, he succeeded in making the motor function perfectly in all circumstances, and during the last winter, 1924—1925, the kites were always hauled down by motor. All kite ascents were undertaken under the supervision of the author who examined the instruments before use and computed the records. During the ascents Messrs. Dahl and Hanssen assisted and when the kites had to be hauled down without motor, "all hands" were called.

Much time was given to the oceanographic work. In the summer half-year Mr. Olonkin collected specimens of the organisms living on the bottom of the sea. He preserved them and after our return they were distributed to specialists for examination. Samples of plankton were also collected. Daily soundings were taken by Messrs. Hanssen or Olonkin and in some periods soundings were made every hour in order to study the tides. A hole in the ice was kept open for the soundings. In winter time this hole froze over so rapidly that every morning Messrs. Hanssen or Olonkin had one half hour's work in removing the newly frozen ice, and cleaning the hole. Once a week an ordinary oceanographic station was worked. The temperature of the water was determined at various depths by reversing thermometers, and water samples were collected for investigation of the density, salinity, oxygen contents, and pH-values of the sea water. Speed was essential when the water samples were taken in winter at air temperatures below — 40°. After the water bottle was hauled up, it had to be detached from the wire as quickly as possible and the observer had to run headlong on board with it to prevent the contents from freezing. The water bottles were emptied in the laboratory where samples for the various investigations were taken and examined. The author determined the specific gravity by means of Nansen's hydrometer of total immersion, and Malmgren carried out titrations for determining the chlorine contents and the oxygen contents.

In the autumn of 1922 a few current measurements were made by means of the Ekman current-meter, but we soon found that this instrument was too difficult to handle at low temperatures. The moment it was hauled up for reading it became coated with ice and had to be taken indoors and heated before it could be lowered again. We needed an instrument which could be left lowered for weeks, recording the currents under the ice electrically in the laboratory. Mr. Dahl and the author succeeded in designing an instrument of this kind, which recorded direction and velocity of the currents by means of a single electric circuit. The instrument was suspended in a bifilar frame and recorded the direction relative to the orientation of this frame. Many difficulties had to be overcome and the first type which was constructed had to be changed materially, but after trials in February and March 1923 the instrument functioned in a satisfactory manner, and was kept in operation during the major part of fourteen months. The instrument showed that strong tidal currents were present under the ice, but in winter the ice itself took no part in the tidal motion. By lowering the instrument to various depths we could obtain a full knowledge of the tidal currents from the ice to the bottom. In the summer of 1924 our registrations of the tidal currents were supplemented by a number of hourly observations with the Ekman current-meter. These observations were undertaken in the region to the north of the New Siberian Islands, where strong tidal currents prevailed and where the ice took great part in the tidal motion. The motion of the ice was observed directly by letting down a lead to the bottom with so great speed that it stuck, and recording the length of wire which was hauled out in a given time and the bearing of the wire. In addition hourly soundings where undertaken and the rise and fall of the tide was so great that he character of the tide could be derived from these soundings.

The character of the tidal currents led the author to a theoretical investigation

of the influence of the rotation of the earth and the influence of the eddy viscosity upon the tidal currents. This investigation was concluded during the winter 1924—1925, and a manuscript was submitted for publication shortly after the return of the expedition.

As early as 1923 it was evident that the tidal wave reached the continental shelf from the north, and came directly across the Polar Sea from the Atlantic side without meeting any obstruction formed by masses of land. The late Professor R. A. Harris, of the U. S. A. Coast and Geodetic Survey, compiled and discussed, in 1911, all available tidal observations from the Arctic region. He arrived at the conclusion that the tidal wave within the region here dealt with travels practically parallel to the coast, and assumed, therefore, that a great area of land or very shallow water existed within the unknown area north of Alaska and Sibiria. His conception of the direction in which the wave proceeds seems, however, to be erroneous, and the tidal phenomena do not indicate the existance of extensive land masses between Alaska and the Pole. This conclusion was communicated to Amundsen by wireless in 1924 and was confirmed in 1926 when Amundsen and Ellsworth crossed the central part of the unknown area without seeing any land.

At Four Pillar Island, 1924—1925, the tidal recorder which Sundbeck had constructed at Cape Chelyuskin, was again taken in use and gave excellent results during six months. These results and the corresponding registrations at Ayon Island, 1919—1920, confirmed the conclusions which had been arrived at on the basis of the observations on the shelf in the years 1922—1924.

From this brief account of the scientific work in the years 1922—1925 it is seen that we extended our investigations, and increased our number of recording instruments according to the conditions which were encountered and the problems which presented themselves. We were able to do so thanks to several fortunate circumstances. During the years 1922—1925 we were always surrounded by the monotonous pack-ice which did not invite journeys away from the ship and where hunting was of small importance owing to the scarcity of animal life. In these circumstances the scientific work naturally was given much attention, and the two scientists received all desired assistance from the other members of the expedition. On board we had a good workshop which was equipped with all kinds of tools and in addition we had a considerable supply of various materials. Our greatest advantage was, however, that we had, in our aviator, Mr. O. Dahl, a man of unusual ability as an instrument designer and maker, who could make the utmost of any idea. Besides him, Mr. Olonkin was a well trained mechanic and these two rendered invaluable services to the extention of our scientific researches. Our number of recording instruments was increased by five, several instruments for direct reading were constructed and numerous improvements were added to old instruments. All the work with the new instruments was very stimulating, and the activities on the new fields helped much in breaking the monotony of the daily life, especially because each member of the expedition was interested in the advances.

The results of our scientific work are given in the present publication. In addition several publications have appeared which deal with the expedition or phases of its scientific work. The greater part of these papers deal with questions which are treated more fully in this and the following volumes, or they give abstracts of the complete discussions, but some contain information, which is not found in the present work. A complete list of all original communications is given below and in this list the papers or books, which contain additional information, are marked with an asteric.

It is not necessary to give a list of the contents of the present volumes. It may, however, be mentioned that it has been attempted to represent the observations and the results as fully as possible, but with due regard to economy.

Volume I b, containing the magnetic, atmospheric-electric and aurora results, represents a reprint from publication No. 175 of the Carnegie Institution of Washington (Researches of the Department of Terrestrial Magnetism). For the sake of completeness it has been included among the other volumes, dealing with the scientific results. I take great pleasure in recording the great obligation of the Expedition to the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, which has co-operated with the expedition since 1918 and has undertaken the publication of a considerable part of our observations.

The printing of the other volumes has been made possibly by contributions from the scientific funds: A/S Norsk Varekrigsforsikrings Fond, Statens Videnskapelige Forskningsfond av 1919 and Roald Amundsens Minnefond. It is my privilege to express my most sincere thanks for the obliging generosity, which has always been shown by the Boards of these funds.

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List of publications dealing with the "Maud"-Expedition, 1918—1925, and phases of its scientific work. The publications which are marked with an asteric contain information in addition to the contents of the present volumes.

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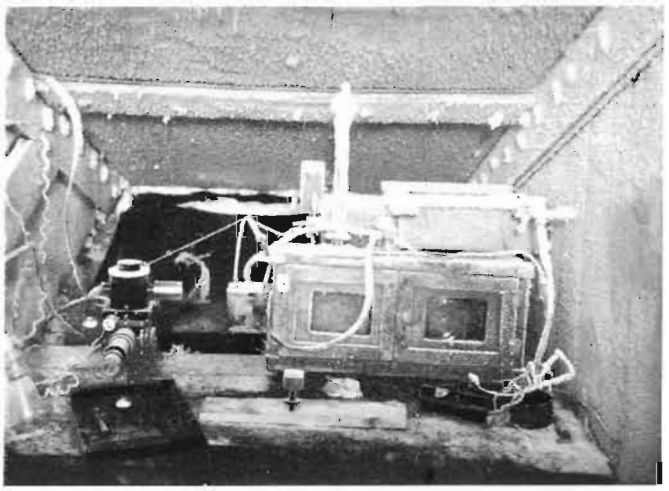

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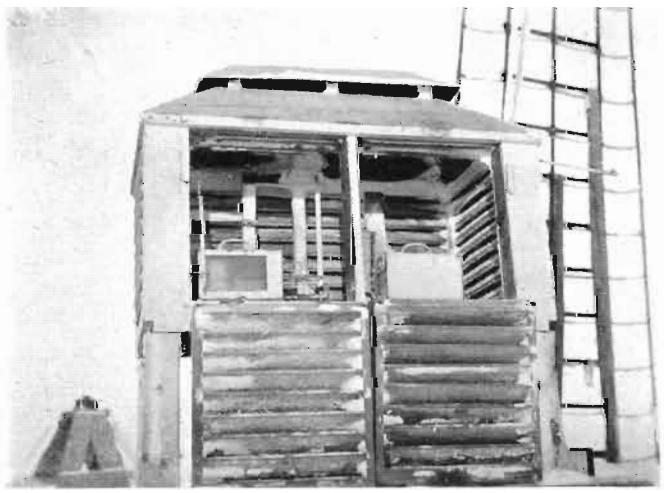

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1. Astronomic observation.
2. Observing magnetic inclination.
3. Observing atmospheric potential-gradient.
4. Recording electrometer.
5. Meteorological screen.
6. Snow gauge.

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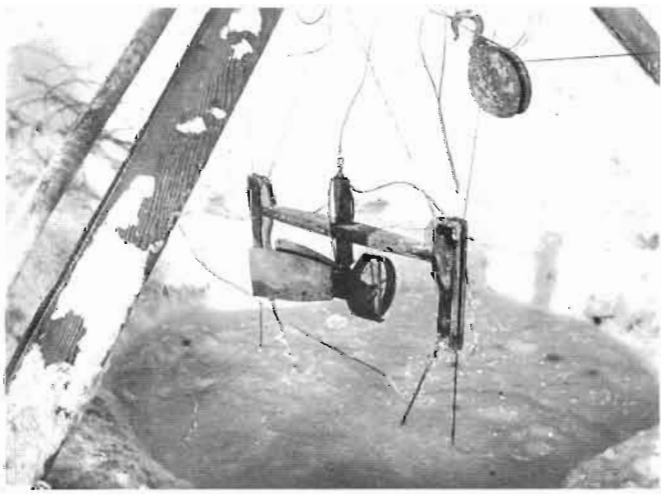

6

1. Assembling kite.
2. Aurora behind the "Maud".
3. Hoar-frost recorder.
4. Titrating in the laboratory.
5. Current recorder.
6. Recording unit of tidal gauge.