RECENT FRENCH BATHYMETRICAL OPERATIONS IN THE ANTARCTIC OCEAN

(1) The establishment and maintenance of a French Polar Expedition scientific station in Adélie Land caused the polar despath-vessel *Commandant-Charcot*, commissioned by the Navy, to cross the entire width of the Antarctic Ocean six times during the three winter seasons of 1948-49, 1949-50, and 1950-51.

Although ice conditions prevented the actual Antarctic continent from being reached during the first voyage, such was not the case during the two that followed, when the ship was able to remain on station opposite the shores of Adélie Land.

Advantage was taken of each passage to carry out various scientific operations, particularly oceanic soundings during the entire voyage, as often as they could be made. During periods at anchor, it was possible to make coastal surveys. The French Polar Expeditions party, on the other hand, was able to contribute to bathymetrical investigations by means of a motor-boat in its possession which obtained soundings in the vicinity of Port-Martin.

The results of these operations have been communicated to the French Navy Hydrographic Office for insertion on Antarctic Ocean charts. They will prove to be a valuable addition to previously recorded soundings originating from earlier French and foreign surveys; however, in accordance with prevailing chart usage, the origin of the various soundings will not be evident on the charts.

It may therefore be of interest, owing to its importance, to give a detailed account of the French contribution resulting from these recent operations to knowledge of the Antarctic Ocean. The three appended plates, which are on a scale from 2 to 5 times smaller than the corresponding charts, show a selection of soundings summarizing the results obtained.

They represent :

— The Antarctic Ocean area located between Adélie Land on the one hand and Tasmania and New Zealand, on the scale of 1 :12 000 000;

— Adélie Land approaches, on the scale of 1 :2 400 000;

— Port-Martin approaches, on the scale of 1 :75 000;

— Port-Martin anchorage, on the scale of 1 :20 000.

Various details with regard to equipment and methods used in obtaining soundings will moreover be given, as well as information on accuracy of measurements.

(2) The *Commandant-Charcot* had three sounding machines at its disposal, of which two were for deep-sea sounding purposes : one was an instrument of the

WEA.1 Asdic type, with a 45-degree reflector added for beaming the ultrasonic waves downwards; the other consisted of a hydrophone connected to a Boulitte recorder for detecting detonation echoes near the sea surface. Soundings in shallow depths were carried out by an NJ3 magnetostriction sounder.

Ultrasonic sounding (Asdic). Asdic equipment enabled depths of more than 4 500 meters to be reached when the ship was stationary but the range decreased while the vessel was under way, owing to echo interference due to propeller action or to the flow of water along the hull. This decrease in range largely depended on the speed of the ship and sea conditions: in heavy weather, the noise of the water and the air-bubbles passing under the vessel made sounding practically impossible; but under good weather conditions at a speed of 8 knots, it was generally possible to take soundings at depths of 4 000 meters.

The degree of accuracy obtained when taking readings of soundings was from 40 to 50 meters during normal operation, i.e. when the echo was clear, but the error in valuation appreciably increased with a weaker echo, especially when echoes could only be detected with difficulty by automatic transmission, and the latter had to be replaced by manipulated signals. This occurred frequently at depths in excess of 3 500-4 000 meters, according to the state of the sea, when echo perception was entrusted insofar as possible to two observers for checking purposes. Soundings that were not entirely reliable were rejected.

As the rate of sweep of the Asdic apparatus was moreover apt to be irregular, it was soon found necessary to take measurements by chronograph of the rate of sweep corresponding to each particular sounding. This could not be done easily while the recording apparatus was operating, so that a large number of the Asdic soundings were obtained without recording, and in estimating depth figures, a further roughly equivalent amount had to be added to the approximation obtained from the depth readings, which meant that the margin of doubt for deep-sea soundings was about 100 meters.

Depths obtained have naturally been corrected for depth of submersion of the sounding machine and for the difference between the actual speed of sound in water and the standard speed adopted: this latter correction was supplied by Table HD 282 (2nd edition, 1939).

Sounding by detonation. There was no time to equip the ship's hull with a hydrophone for the *Commandant-Charcot*'s first expedition, and in sounding by detonation a hydrophone submerged alongside the ship's hull was used. This arrangement involved stopping the vessel when carrying out soundings, however, and was therefore only used during the return voyage outside Antarctic waters.

During the two expeditions that followed, the hydrophone was placed in the ship's hull, first in the tank of the NJ3 instrument, then in a more easily accessible adjacent compartment; experience showed that following a certain period of submersion there was a marked decrease in the hydrophone's insulation, and that it had to be replaced. During the 1950-51 expedition, three replacements had to be used.

Detonation was carried out by exploding 10-second fuse detonators thrown about 10 meters away from the ship. Under these conditions, the bomb signal offsets on the Boulitte recording tape were present in large quantities; the echo offsets could not always be detected on the recorder and were listened to with headphones; double echoes were only very rarely perceived.

Sounding by detonation was resorted to whenever the Asdic sounding-machine showed itself to be inadequate or when it was desired to check the latter's indications. Comparisons made between the two methods were extremely satisfactory up to 3 500 and 4 000-meter depths, and discrepancies between soundings obtained simultaneously were very slight. In 1951, for instance, between Noumea and Tonga Tabu, a depth of 3 995 meters was found by Asdic and 4 005 meters by hydrophonic recording. Only during the first expedition were fairly large differences discovered, but these do not apply to the Antarctic Ocean, where, as we have already mentioned, no soundings by detonation were carried out at that time; during the other expeditions differences remained below the 100-meter marks.

Ultrasonic sounding (NJ 3). Deep-sea soundings were carried out at 4-hour to one-quarter-hour intervals, depending on the extent in depth and the evidence as to irregularities of submarine relief, but as soon as the vessel reached less than 400-meter (or 200-meter) depths, the NJ 3 sounder was started at the same time as the Asdic machine, and was used to obtain continuous records as long as sea conditions permitted and the instrument did not become overheated.

The NJ 3 sounder was used in 1951 to carry out a survey on the scale of 1 :25 000 covering the approaches to Port-Martin, in order to obtain detailed information regarding the channel to the anchorage. It was based on a triangulation connected with the basic positions determined in 1950 by the *Expéditions Polaires Françaises* survey.

(3) *Survey of Port-Martin Anchorage.* This survey was carried out in 1951 by a party from the *Commandant-Charcot* in the shallow water areas, and by a party from the *Expéditions Polaires Françaises* in the deeper areas. Motor launches were used. The former party used a 5-kg. fish lead and took soundings following the subtense method at average intervals of 50 meters. Irregularities of the rocky bottom and the impossibility of reducing the speed of the launch to under 3 knots prevented investigation of depths extending down beyond 30 meters to the west and north of the anchorage.

This area was examined by the Polar Expedition party, which had a Diesel motor boat 6.20 meters long equipped with an MS 21 F ultrasonic sounder with a depth range of 180 meters. Actually, owing to frequent heavy weather, which made such expeditions dangerous and prevented a great many of them, the survey could not be entirely completed.

Soundings were marked at Port-Martin by means of signals set up by the party from the *Commandant-Charcot* and based on the Polar Expedition triangulation. Depths were reduced to a datum plane approximating LLW, through use of tidal observations by tide gauge and tide recording.

(4) *Principal Results Obtained.* — In addition to their value in chart construction and in fulfilling navigational requirements, the soundings obtained help to clarify the general scheme of submarine relief in the Antarctic Ocean.

On Plate I, half-way between Tasmania and the Antarctic continent, traces of the broken ridge extending from SE to NW are clearly apparent, with outlying epicentres of numerous seismic disturbances.

Plate II also shows a fairly steep rise in the Antarctic continental shelf off Adélie Land, along a line appreciably parallel to the coast. This continental

shelf is from 120 to 150 km. wide; depths of from 300 to 400 meters appear over large areas, but the relief seems to be very broken: there are deep furrows in certain spots, as over as extensive area along the coast a short distance away from it, or there are small but deep basins. Other furrows, which it has not been possible to illustrate in the annexed plates, have been attributed to erosion of the surface relief of the bottom by the repeated friction of icebergs.

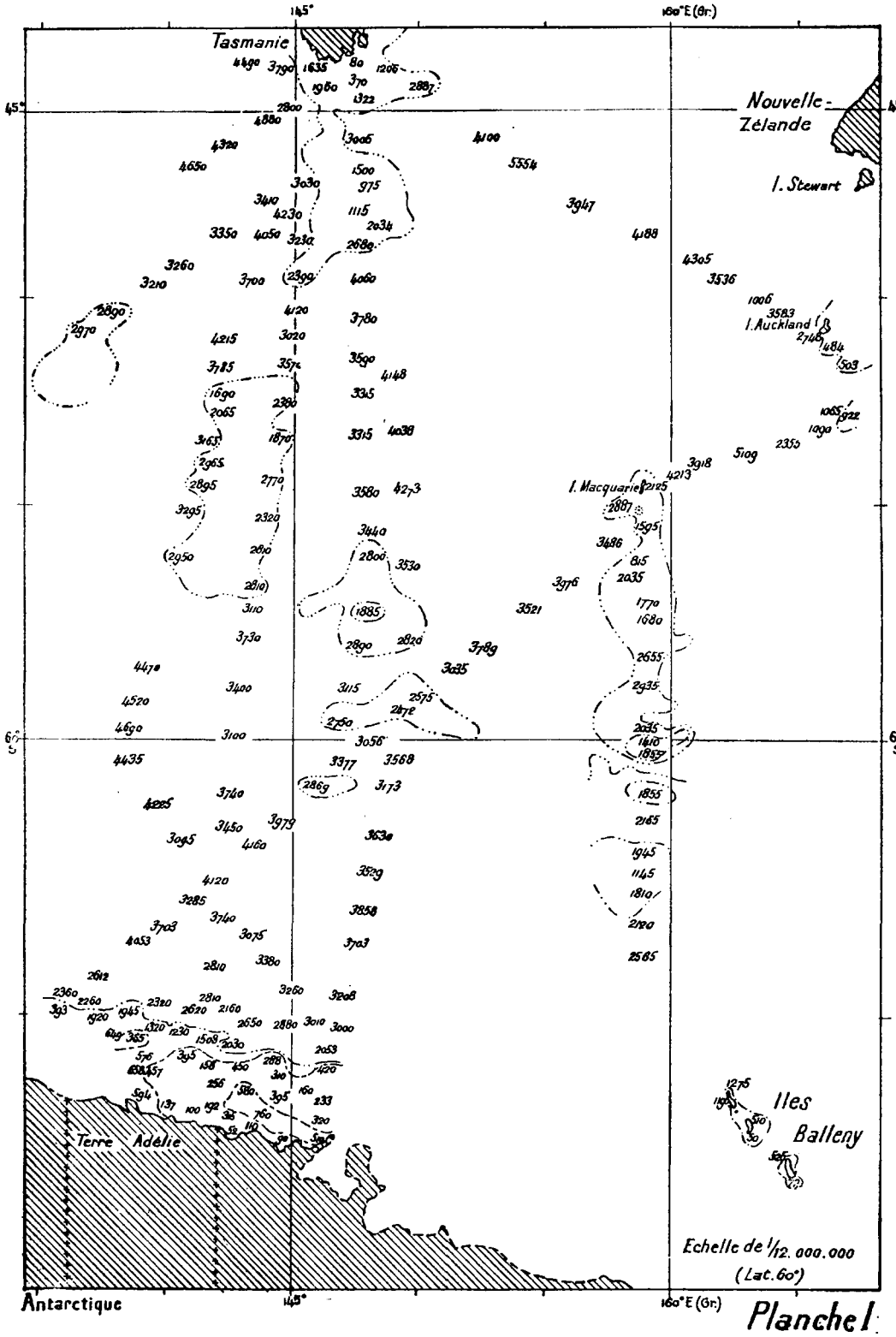
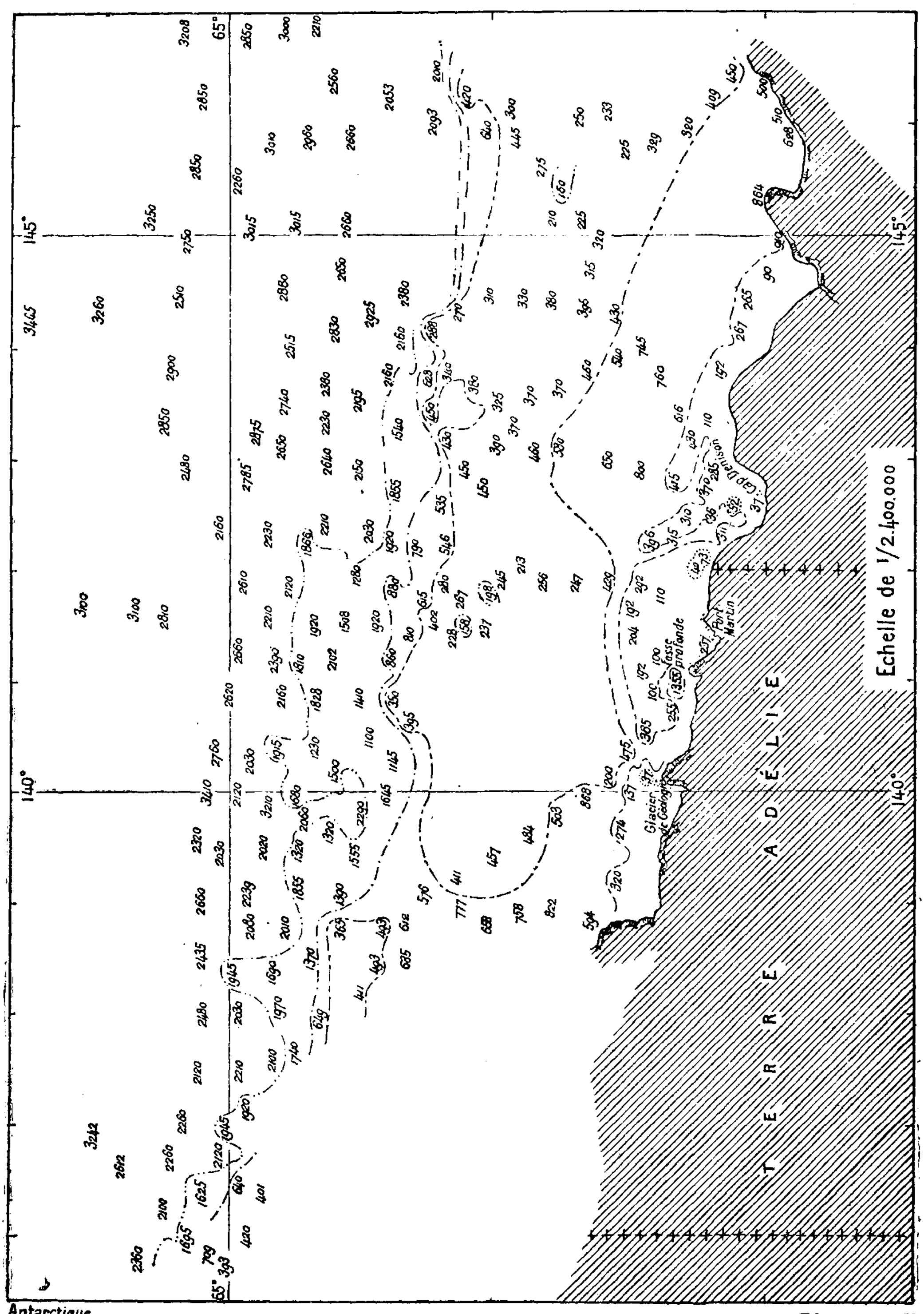
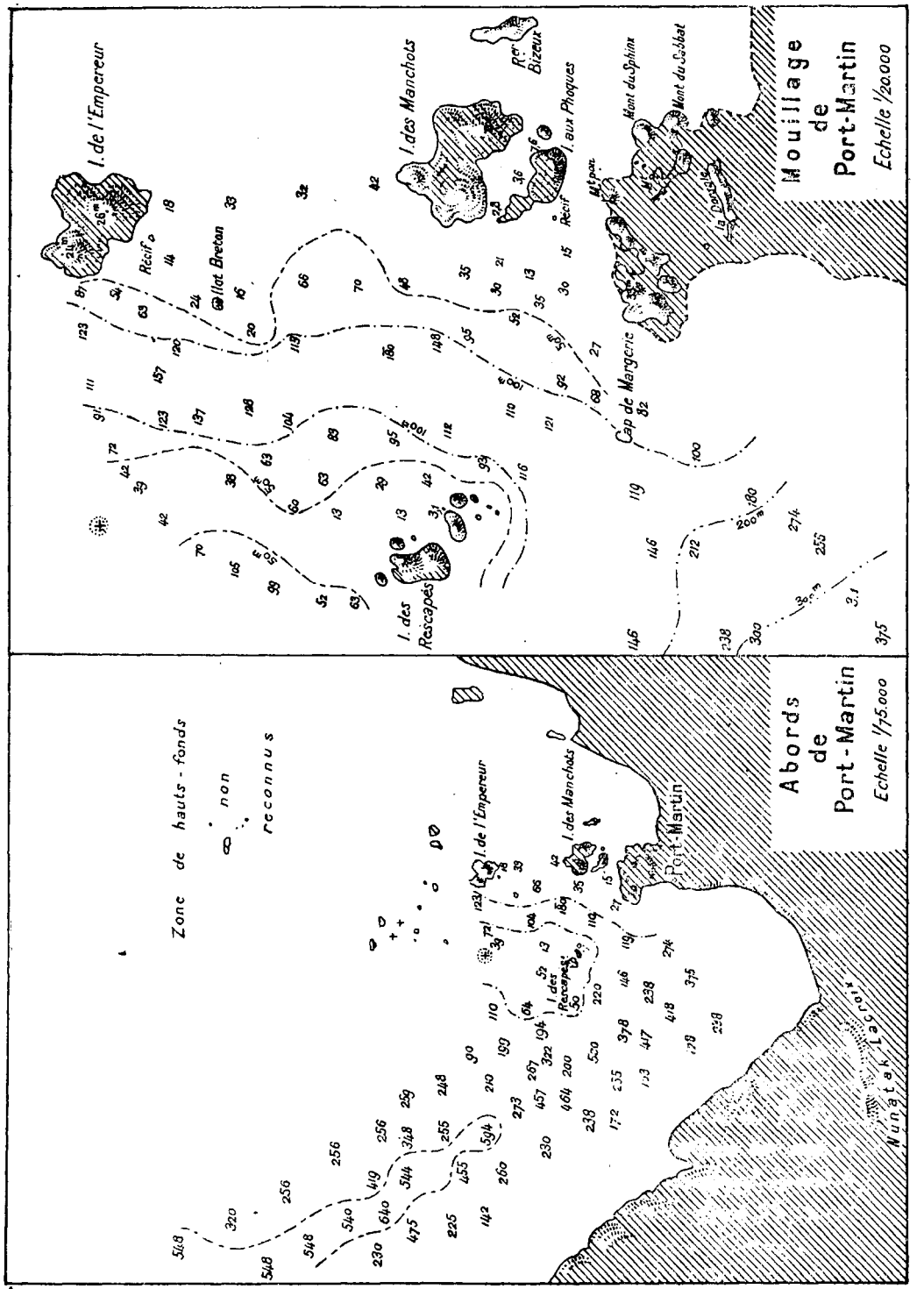

145°
160°E (Gr.)
Tasmanie
Nouvelle-Zélande
45°
I. Stewart
I. Auckland
I. Macquarie
60° S
Terre Adélie
Antarctique
Iles Balleny
Echelle de 1/12.000.000
(Lat. 60°)

Planche I



Antarctique

Planche II.



Antarctique

Planche III