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AIRBORNE EXPENDABLE BATHYTHERMOGRAGH SURVEYS, 1981, WESTERN TAS--ETC(U)
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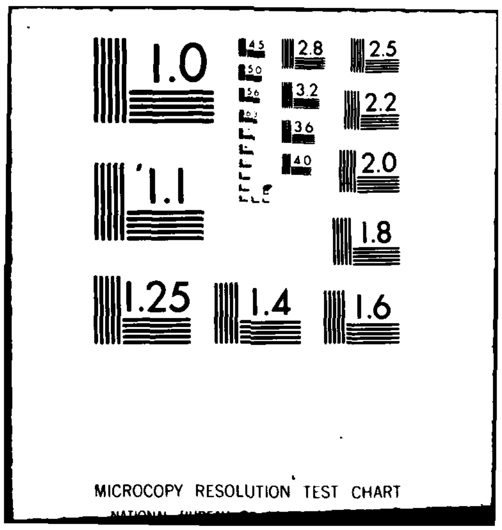
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RANRL TECHNICAL MEMORANDUM (EXTERNAL) No. 2/82

AIRBORNE EXPENDABLE BATHYTHERMOGRAGH SURVEYS, 1981, WESTERN TASMAN SEA

BY

P.J. MULHEARN

COPY No. 7

MARCH 1982

DEPARTMENT OF DEFENCE

R.A.N. RESEARCH LABORATORY

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P.J. MULHEARN

ABSTRACT

On four occasions in 1981 AXBT surveys were conducted in the western Tasman Sea in support of the RAN's ocean analysis scheme. The results of these surveys show that the limited number of probes used (18 to 20 on each occasion) were able, in conjunction with other routinely available data, to delineate the main oceanographic features in the region. The depth of the sound speed maximum was more variable in winter than in summer, but throughout the year, vertical sound-speed gradients below the maximum were weakest within warm-core eddies and north of the Tasman Front.

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CONTENTS

1. INTRODUCTION

Oceanographic conditions in the western Tasman Sea are dominated by the East Australian Current and its warm-core eddies, which are very variable features in both space and time. Because of the strong thermal contrasts caused by these features and the large variations in mixed-layer depth associated with them, they have a marked effect on sonar propagation. In recent years the R.A.N. Research Laboratory (RANRL) and the meteorological/oceanographic officers at the Naval Air Station (NAS) Nowra have been establishing a scheme for keeping track of the principal features in the western Tasman, and this system is now operational (Mulhearn,1981). Data are obtained fron infra-red satellite imagery, RAN fleet XBTs, research cruises, satellite-tracked buoys and, from 1981, airborne expendable bathythermographs (AXBT's). The AXBT surveys which were performed every two months from March to September 1981, inclusive, are discussed here. Previous AXBT surveys in this area are reported in Lawrence (1980). Because of the limited number of probes available, interpretation of the AXBT data often relies on information from the additional sources discussed above.

2. AXBT SYSTEM DESCRIPTION

The AXBT's were dropped in a predetermined pattern by RAAF Orion aircraft and the data sent back as sound-speed profiles with some temperature information. The AXBT (AN/SSQ36 sonobuoy) is a cylindrical package approximately 12.4 cm in diameter and 91 cm long. It can be launched from a standard sonobuoy launch tube from which it parachutes to the sea-surface, jettisons its parachute and deploys an antenna. After approximately a minute a thermistor probe is released which sends a signal by fine wire back to the surface float which transmits the temperature profile by radio to the aircraft where the data is converted to a graphical sound-speed profile and a digital temperature output. Detailed descriptions of AXBT systems are in Sessions and others (1976) and Sessions and Barnett (1979).

3. AXBT FLIGHT PATTERN

Generally AXBT's were taken every 0.5^{o} lat. between 31.5^{o}S, 155^{o}E and 37.5^{o}S, 151^{o}E and from 31.5^{o}S, 153.5^{o}E and 33.5^{o}S, 152^{o}40'E, for 13 March, 13 May, 9 July and 22 September 1981. For the last two surveys drops were also made near 34.3°S, 152.5°E.

4. OCEANOGRAPHIC BACKGROUND

In December 1980 eddies Maria and Leo combined near Eden to form eddy "Mareo" in which the well-mixed core of Maria overlay the cooler core of Leo. This new eddy "Mareo" then migrated in a generally north-west direction between March and September. Interaction with the Tasman Front is apparent in July and the eddy appears to be north of the front by September.

5. RESULTS

A. Survey of 13 March 81

Charts of sea-surface temperature (SST), temperature at depth of 250 m (T_{250}) and surface mixed-layer depth (L_D) are shown in Figs. 1, 2 and 3. It can be seen that the SST data give a poor representation of the deeper structure and that the mixed-layer depth is fairly uniform throughout the area except around 32°S, 154°40'E. This survey was taken towards the end of the summer heating period and the SST pattern was not simply related to deeper features. The sound-speed cross-section in Figure 4 shows weak gradients within the eddy and north of the Tasman Front but strong gradients both vertically and horizontally at the Tasman Front and on the southern edge of the eddy. (Units of ft. and ft/sec are used here for convenience because of the way the data was obtained).

B. Survey of May 1981

In this survey eddy Mareo has not moved greatly, but a cyclonic cold-core eddy has appeared to its north-east (such an eddy was observed in March (Mulhearn, 1981b)) and the Tasman Front appears to move south-east from Sugarloaf Point to north of the cold eddy with a warm return flow near 32.25°S, 154.5°E (see Fig. 6). Again SST is (Fig. 5) not a good indication of deep structure, although surface mixed-layers are generally deeper than in March (Fig. 7). The sound-speed section in Fig. 8 shows a deeper sound-speed maximum south of the Tasman Front, with smaller vertical gradients in the warm-core eddy than in the cold-core eddy immediately to its north. Within the East Australian Current loop, vertical sound-speed gradients are again weak.

C. Survey of 9 July 1981

At this time the broad SST pattern (Fig. 9) was a much better guide to deeper structure (Fig. 10) than it was earlier. It appears that the mixed-layer structure (Fig. 11) is complicated by the interaction between the Tasman Front and eddy Mareo. The sound-speed cross-section (Fig. 12) shows deep sound-speed maxima within the eddy and north of the Tasman Front with weak sound-speed gradients in both these areas.

D. Survey of 22 September 1981

On this occasion the eddy Mareo had moved well within the Tasman Front, but weak anticyclonic and cyclonic features can be seen further south (Fig. 14). Because the season is becoming warmer SST (Fig. 13) is, once more, not a good indicator of deeper structure and mixed-layer depths (Fig. 15) are becoming much shallower. A sound-speed section could not be presented because of the loss of the profiles.

6. SUMMARY AND CONCLUSIONS

AXBT surveys made during 1981 in support of NAS Nowra's ocean-analysis scheme are presented here. With normally available environmental data they showed up the main oceanographic features quite well. They demonstrate that when summer heating is important the presence of eddies seems to have little effect on the depth of the sound-speed maximum but that vertical sound-speed gradients away from fronts are much weaker than those near them. The broad scale SST pattern appears to be a poor indicator of deeper structure in summer, but infra-red satellite images having better spatial resolution than ship or aircraft surveys, do indicate that eddies and fronts are detectable throughout the year because of advective effects. (Nilsson and others, 1981). More detailed data on fronts may indicate that depths to sound-speed maxima are drastically affected in their vicinity.

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ACKNOWLEDGEMENTS

Thanks are due to the aircrews of the Orion aircraft who took these measurements and to the staff of the RAAF base at Edinburgh, S.A.

FIGURE CAPTIONS

Figure 1. Sea-surface temperature pattern 13 March 1981. (contours are every $1^{o}C$).

Figure 2. Temperature at 250 m depth 13 March 1981. (contours every $1^{o}C$).

Figure 3. Surface mixed-layer depth 13 March 1981. (contours 25 m).

Figure 4. Sound-speed cross-section from $31.5^{o}S$, $155^{o}E$ to $37.5^{o}S$, $151^{o}E$. (Contours every 10 ft/sec). ...sound-speed maximum. (Points are labelled with last 2 digits of sound speed values for speeds > 5,000 ft/sec and with last 3 digits for speeds < 5000 ft/sec).

Figure 5. S.S.T. pattern of 13 May 1981 (contours every $1^{o}C$).

Figure 6. Temperature at 250 m of 13 May 1981 (contours every $1^{o}C$).

Figure 7. Surface mixed-layer depth of 13 May 1981 (contours every 25 m).

Figure 8. Sound-speed cross-section from $31.5^{o}S$, $155^{o}E$ to $37.5^{o}S$, $151^{o}E$ (contours every 10 ft/sec), 13 May 1981; ...sound-speed maximum. (Points are labelled with last 2 digits of sound-speed values).

Figure 9. SST - 9 July 1981 (contours every $1^{o}C$).

Figure 10. Temperature at 250 m of 9 July 1981 (contours every $1^{o}C$).

Figure 11. Surface mixed-layer depth 9 July 1981 (contours every 50 m).

Figure 12. Sound-speed cross-section of 9 July 1981 from $31.5^{o}S$, $155^{o}E$ to $37^{o}S$, $151^{o}E$. (Contours every 10 ft/sec); ... sound-speed maximum.

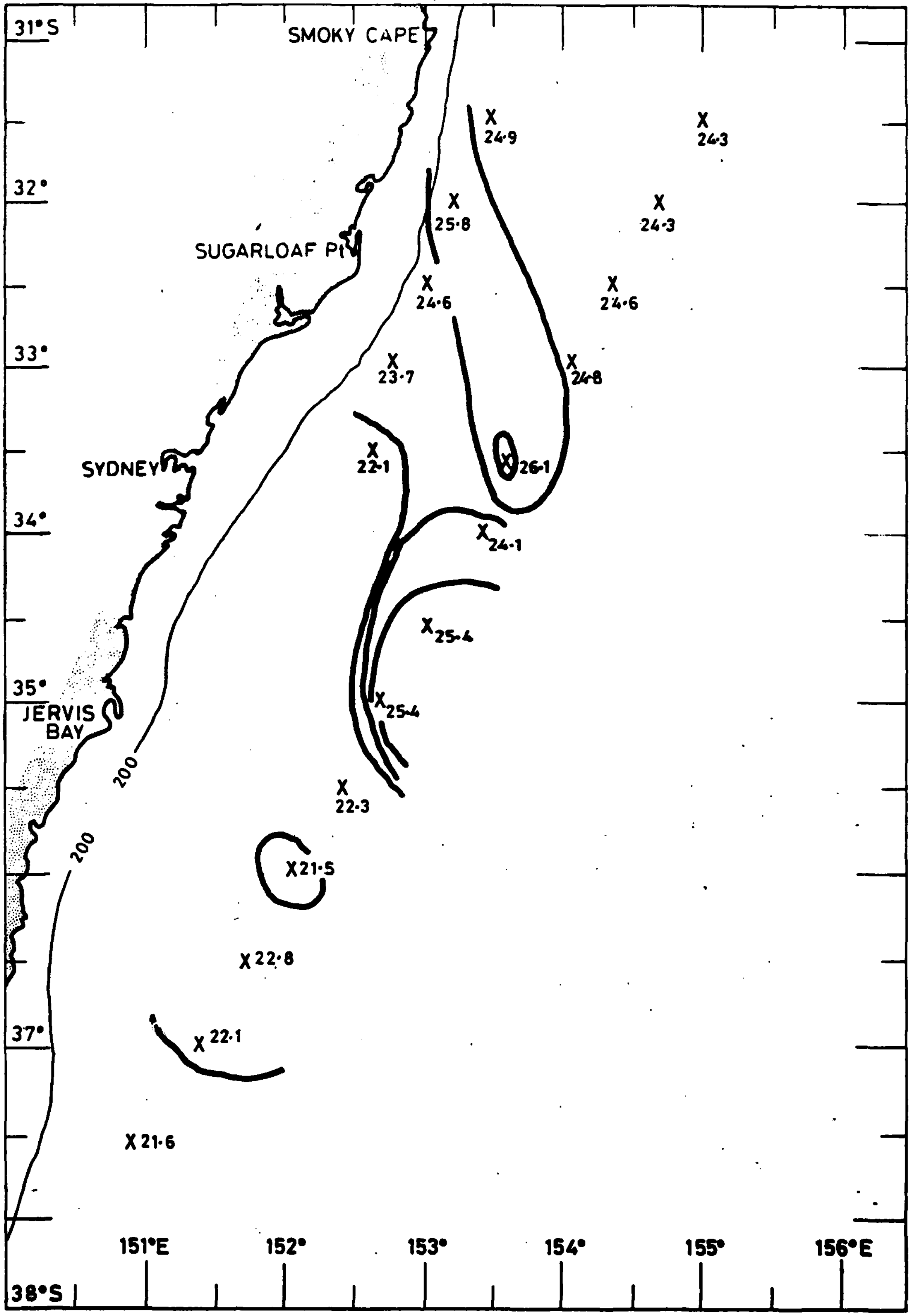

Fig. 1. Sea Surface Temperature pattern 13 March 1981.

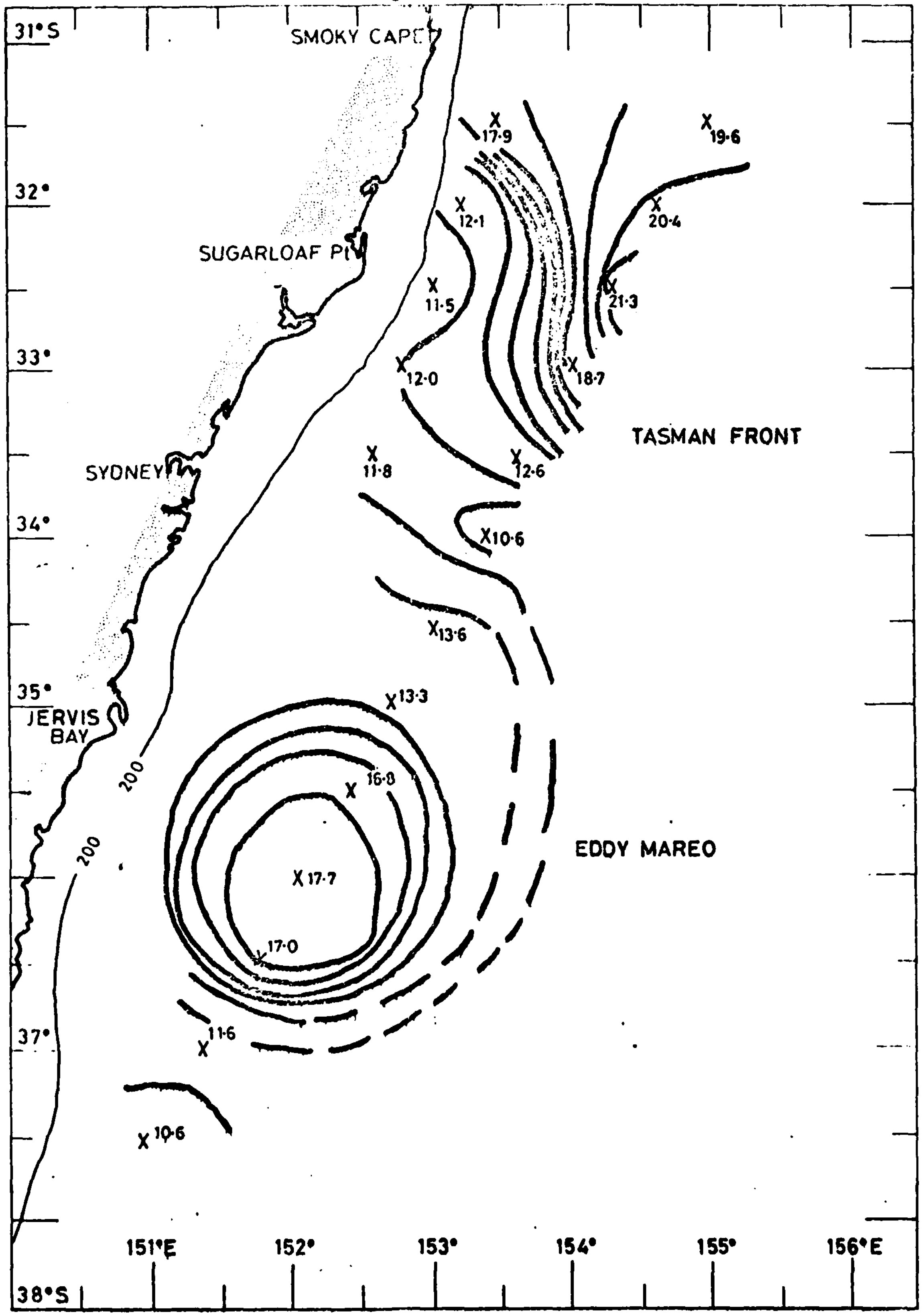

Fig. 2. Temperature at 250m depth. 13 March 1981.
(Contours every 1°C)

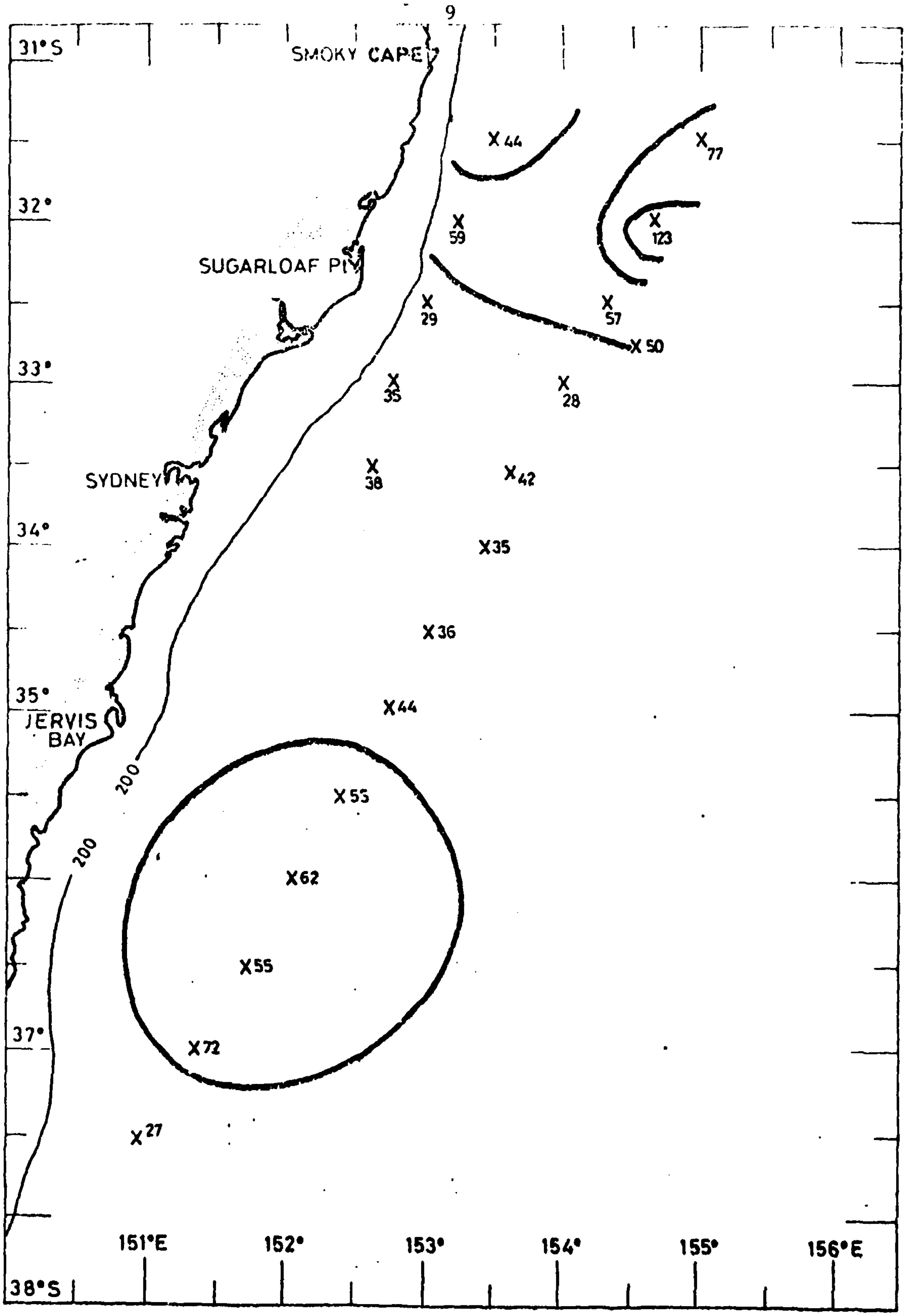

Fig. 3. Surface mixed-layer depth. 13 March 1981.
(Contours 25m).

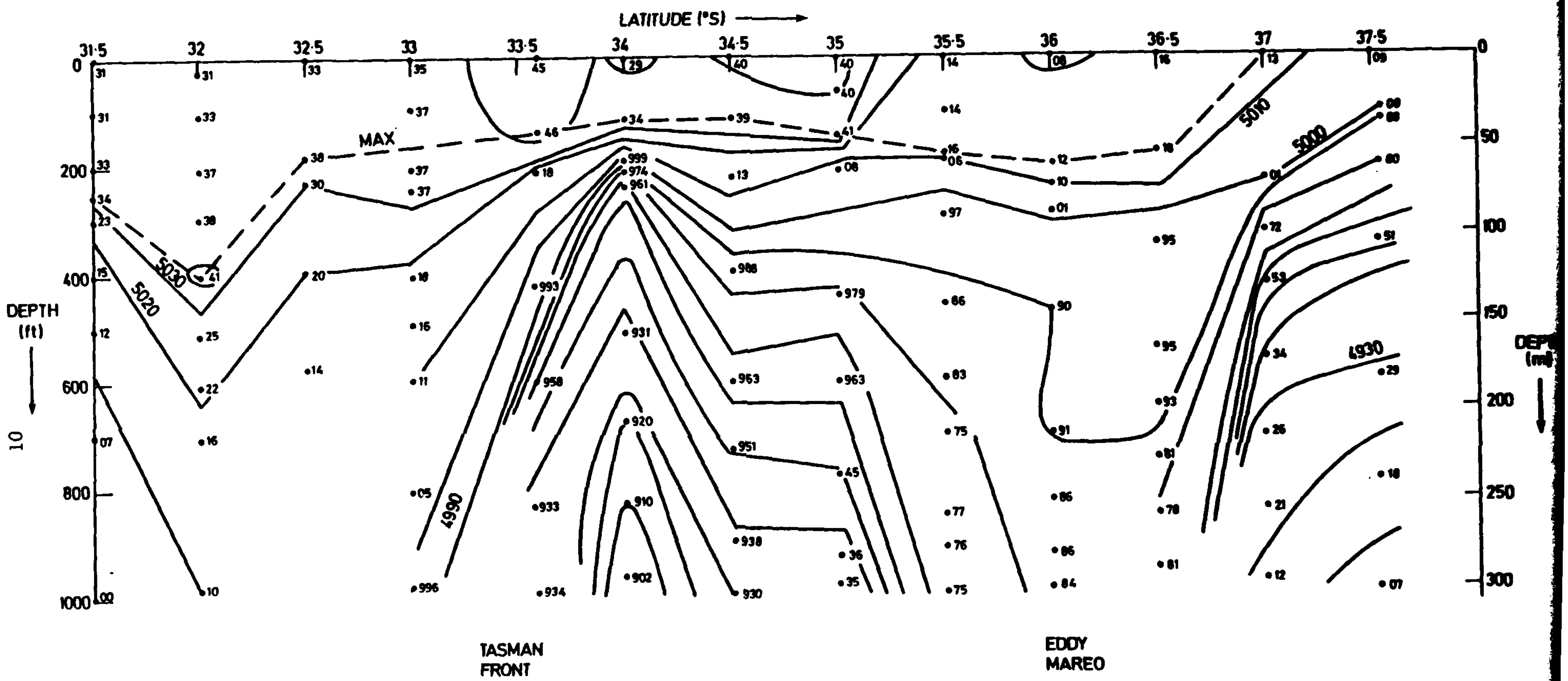

Fig. 4. Sound-speed cross-section from 31·5°S, 155°E to 37·5°S, 151°E (contours every 10 ft/sec). 13 Mar. 81; --- sound-speed maximum. (Points are labelled with last 2 digits of sound-speed values for speeds >5000 ft/sec and with last 3 digits for speeds <5000 ft/sec).

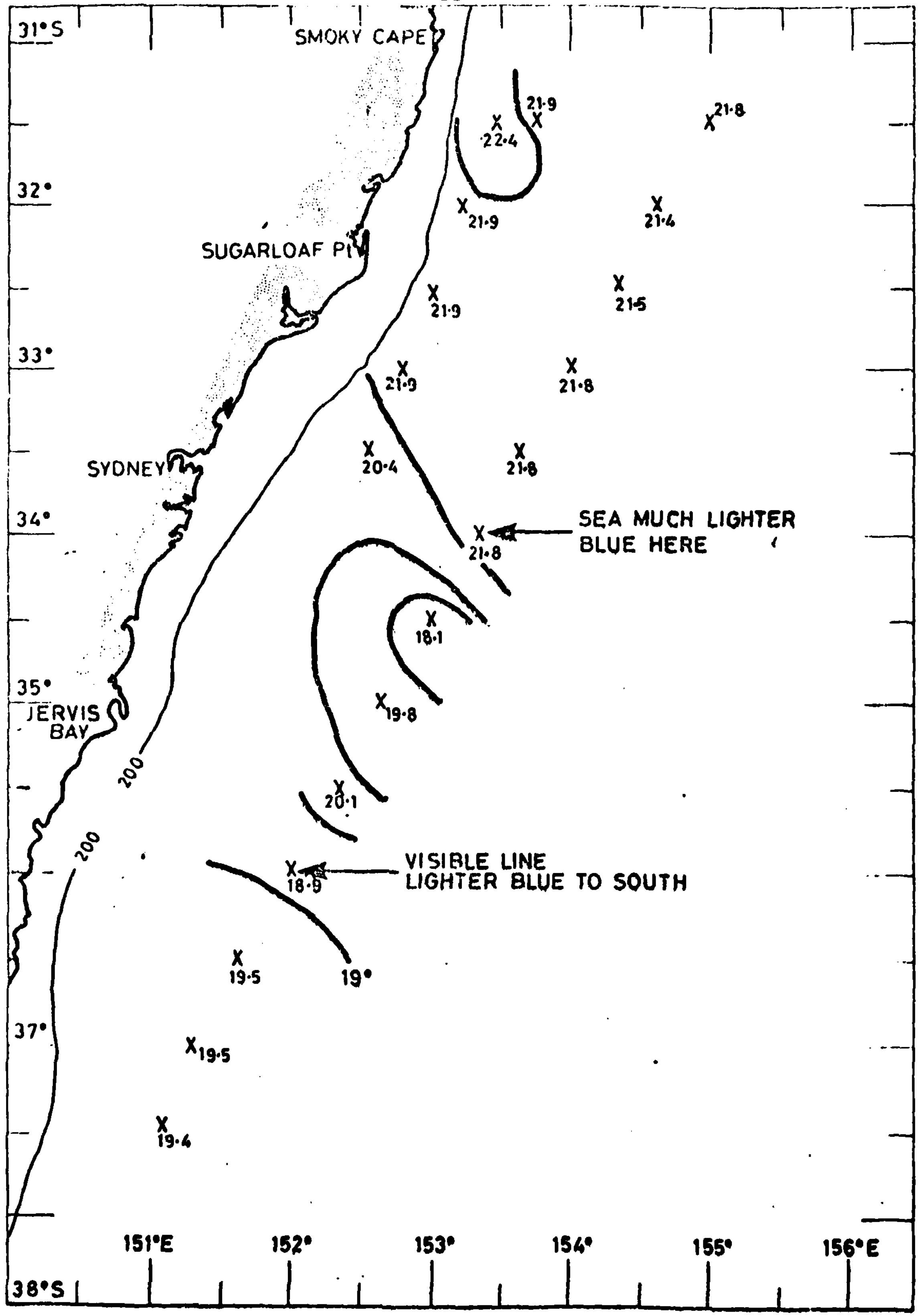

Fig. 5. SST pattern of 13 May 1981. (Contours every 1° C)

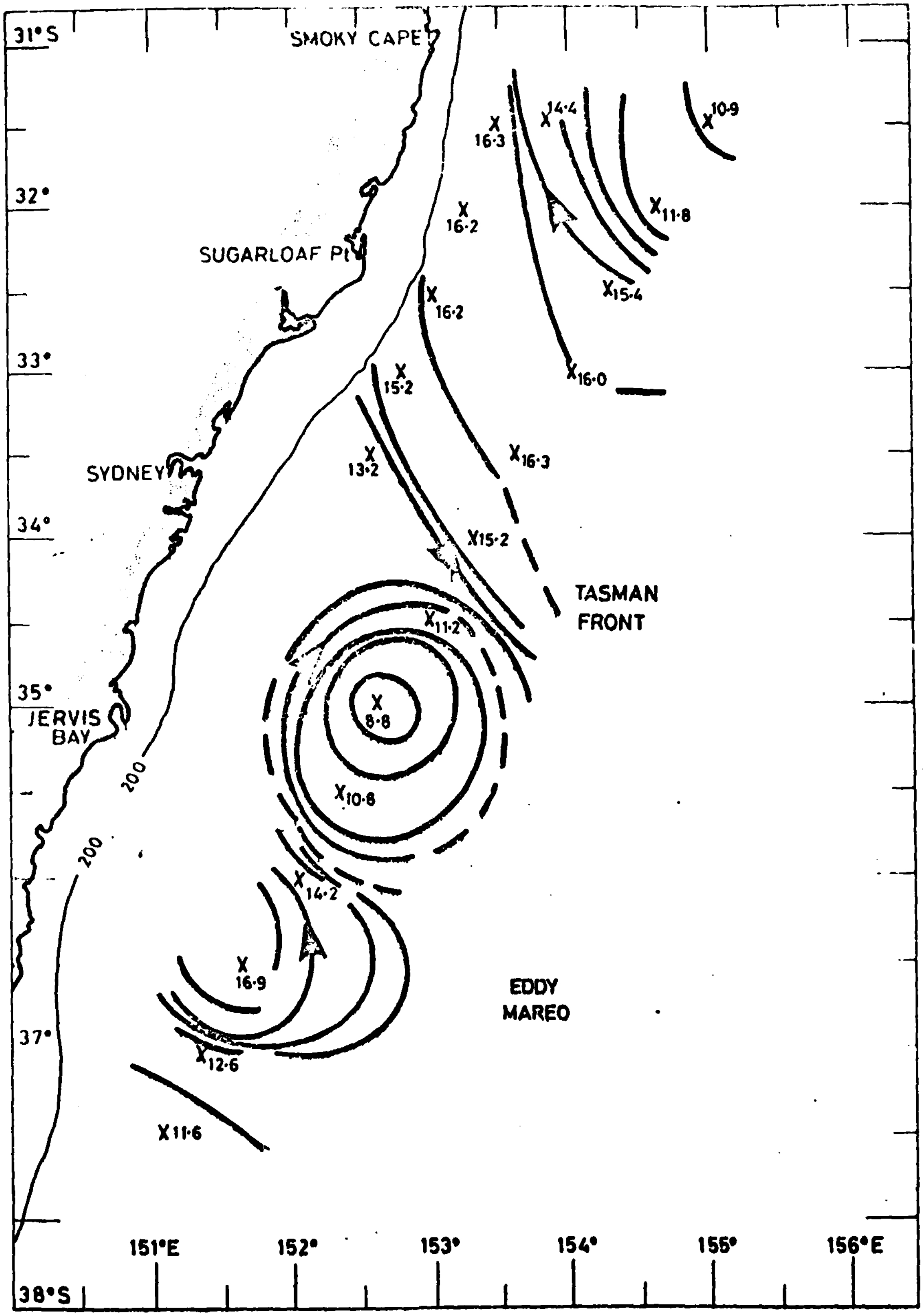

Fig. 6. Temperature at 250m of 13 May 1981.
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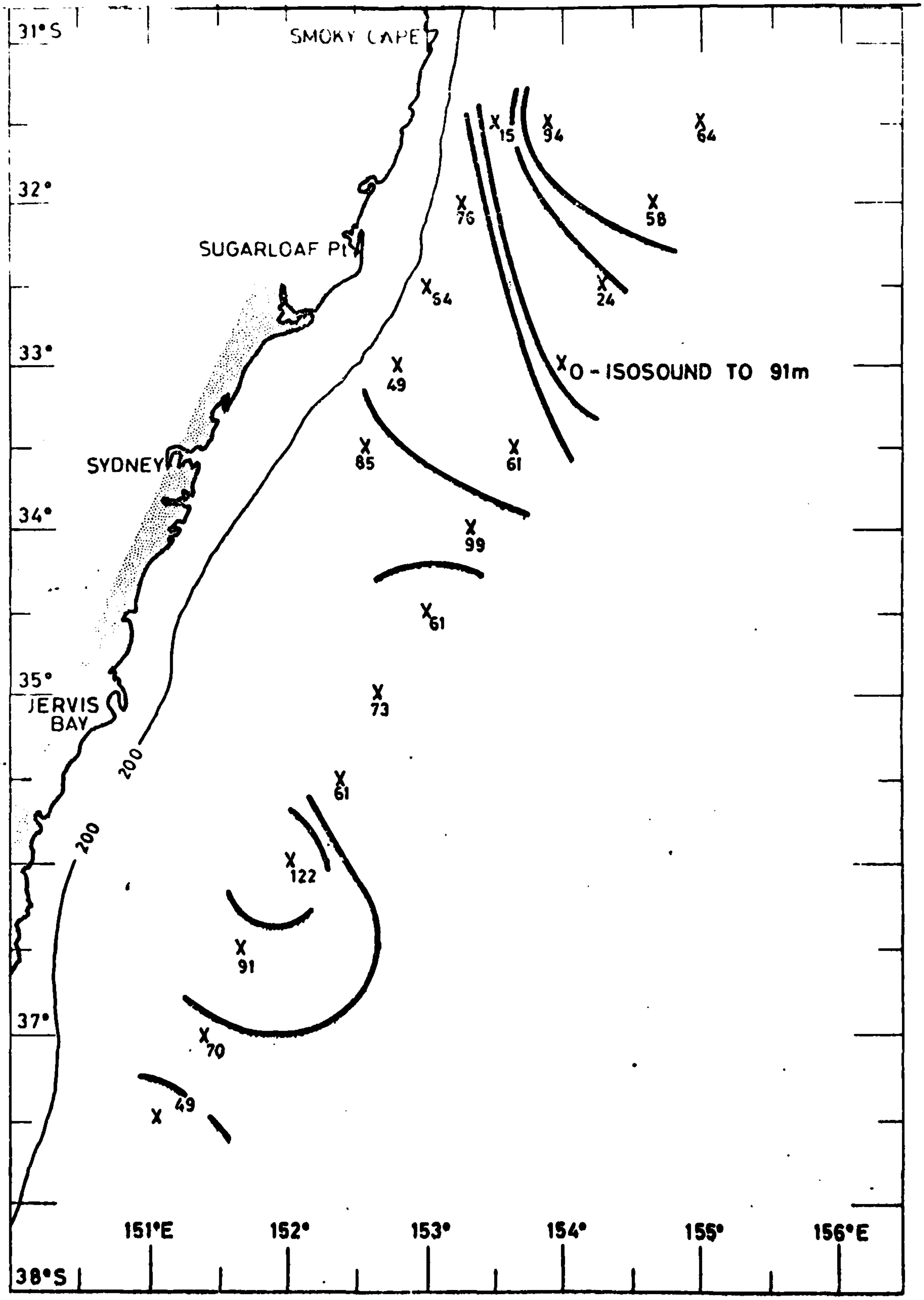

Fig. 7. Surface mixed-layer depth of 13 May 1981. (Contours every 25m)

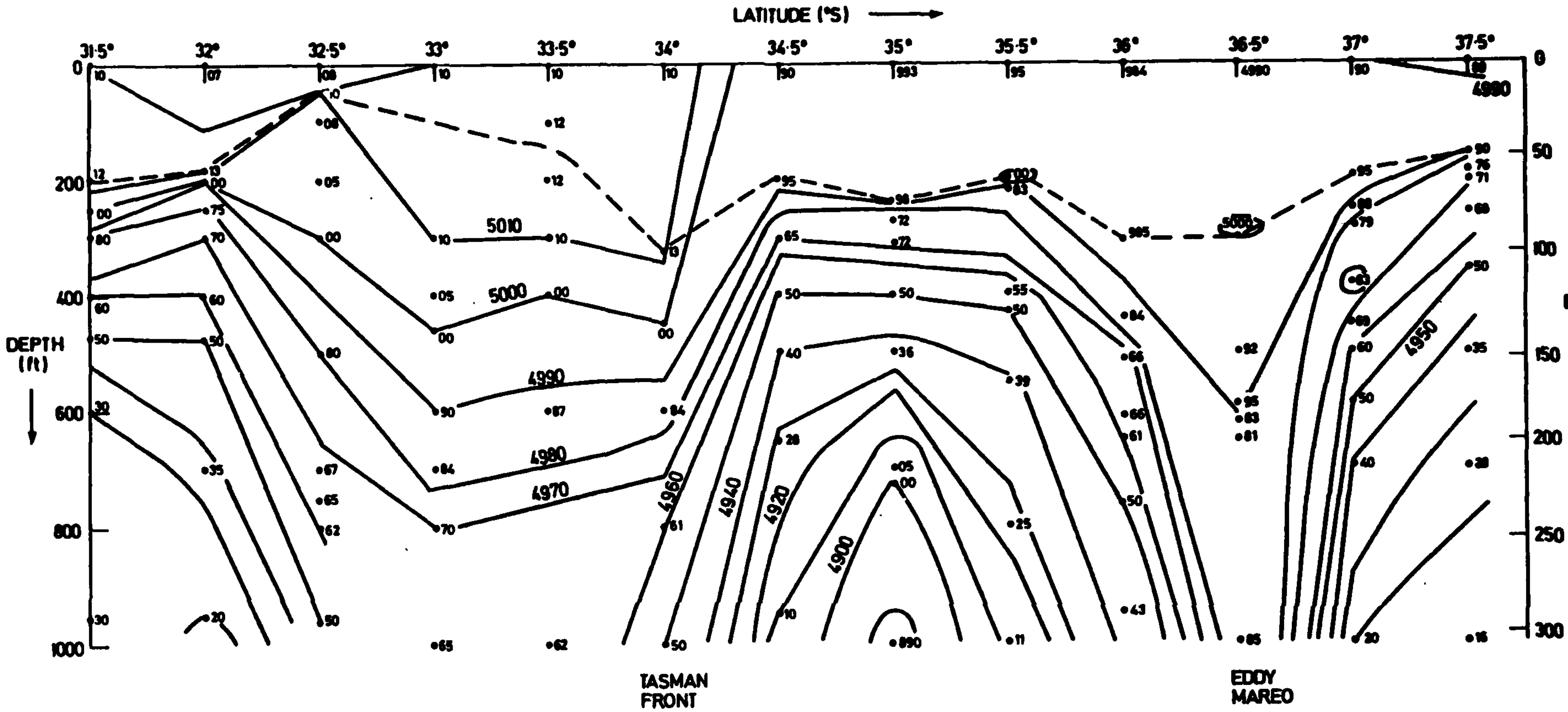

Fig.8. Sound-speed cross-section from 31·5°S, 155°E to 37·5°S, 151°E (contours every 10 ft/sec). 13 May 81; --- sound-speed maximum. (Points are labelled with last 2 digits of sound-speed values).

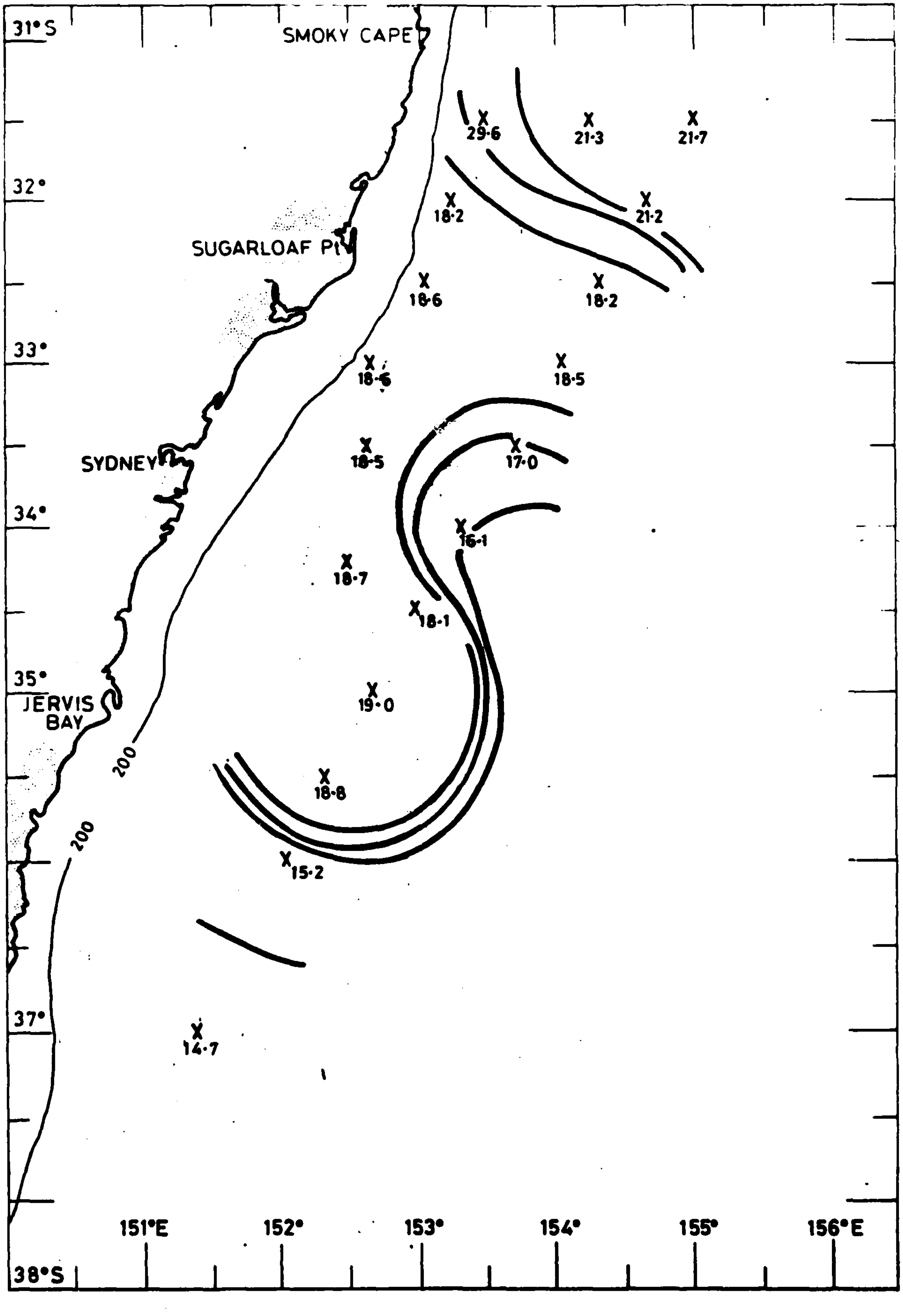

Fig. 9, SST - 9 July 1981 (Contours every 1°C)

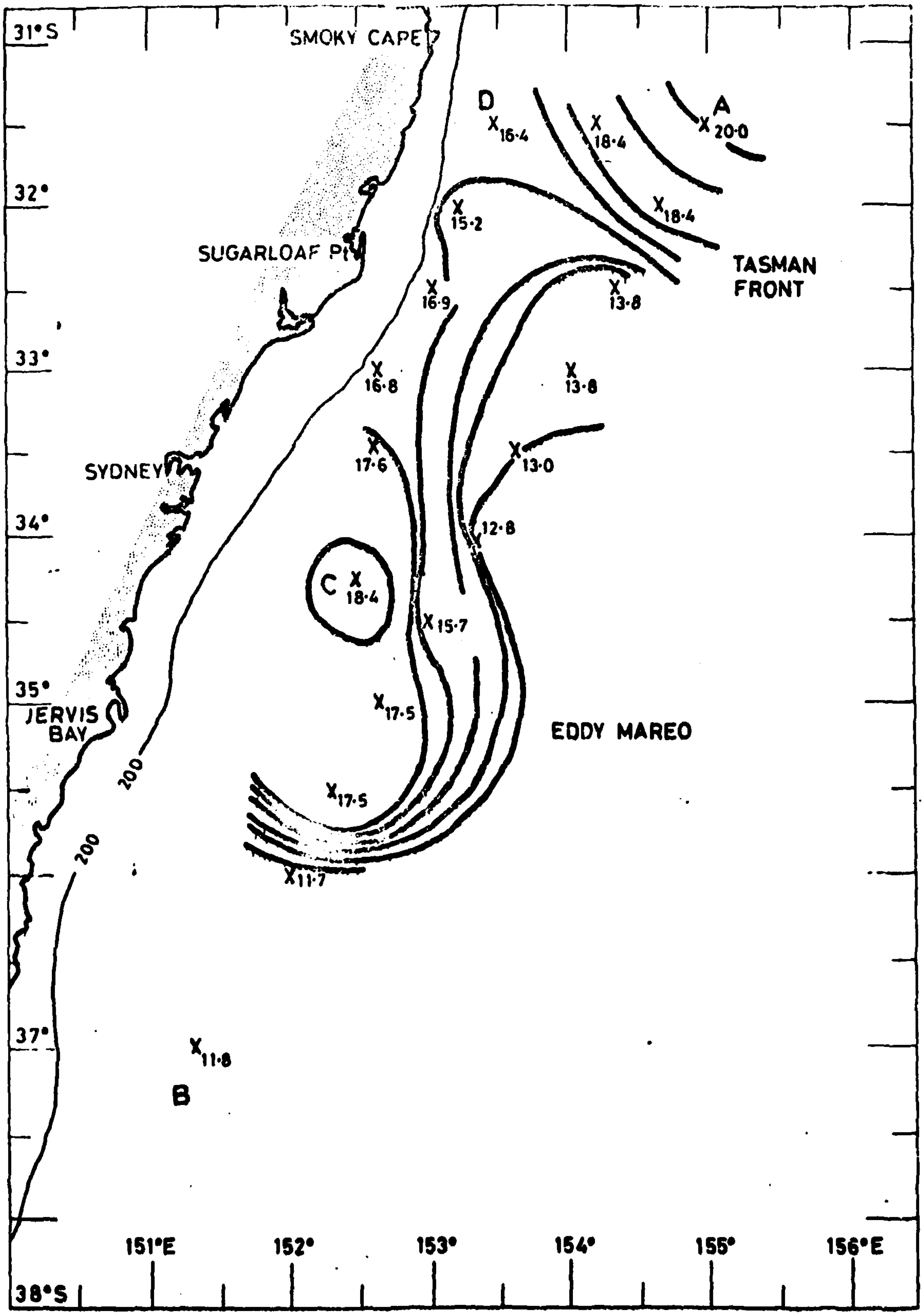

Fig. 10. Temperature at 250m of 9 July 1981 (Contours every 1°C)

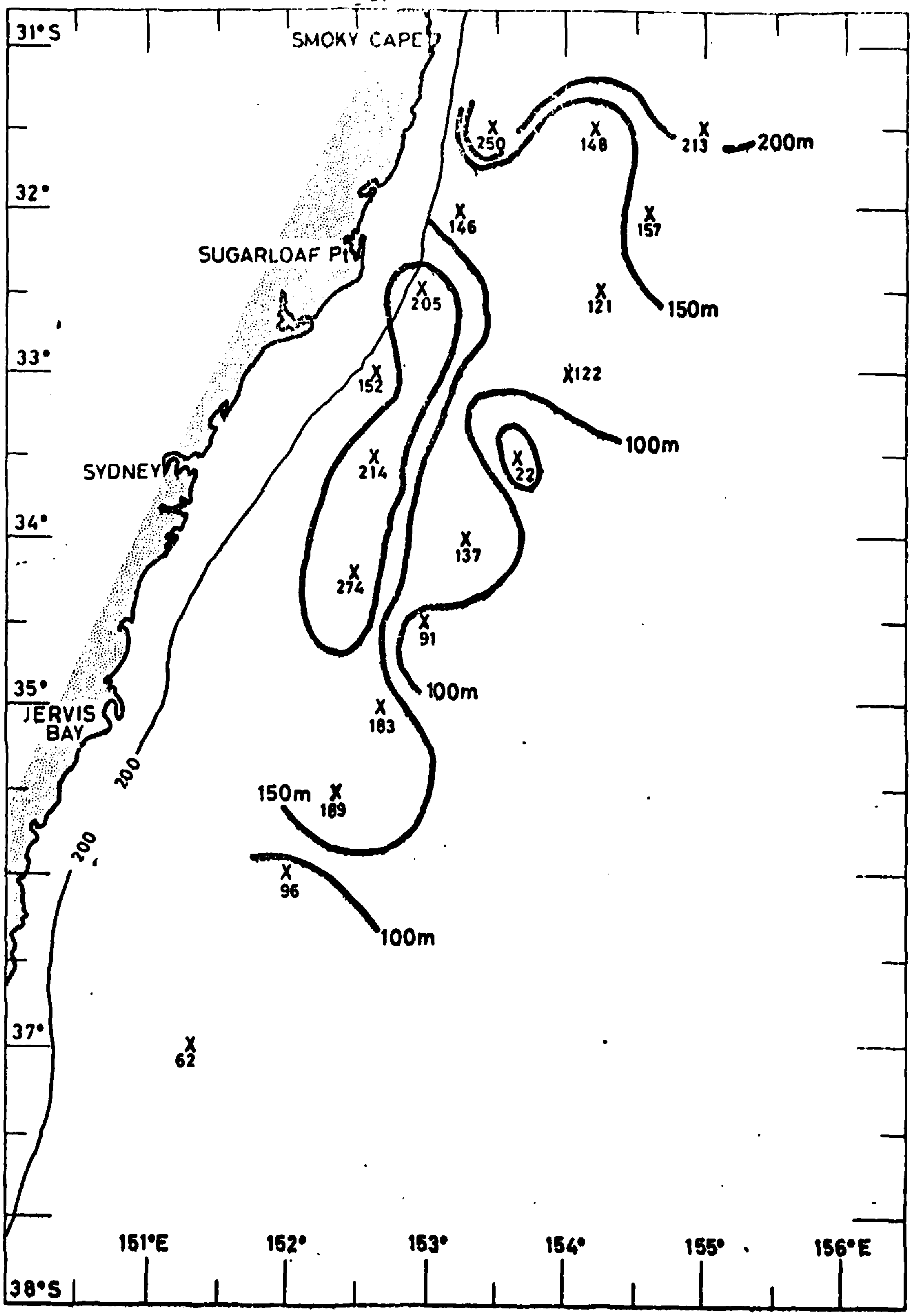

Fig. 11. Surface mixed-layer depth 9 July 1981 (Contours every 50m)

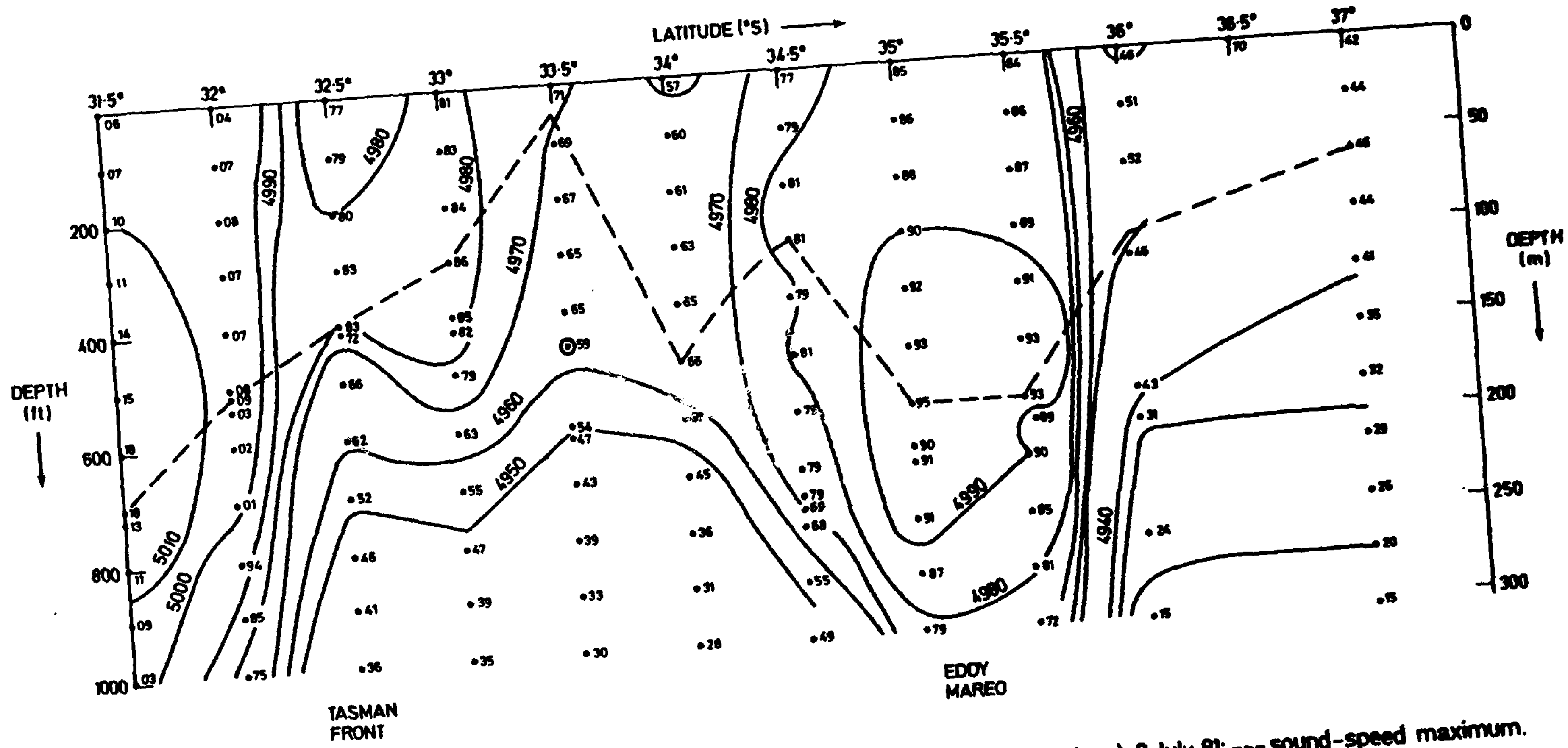

Fig. 12. Sound-speed cross-section from 31·5°S, 155°E to 37°S, 151°E (contours every 10 ft/sec). 9 July 81; --- sound-speed maximum.

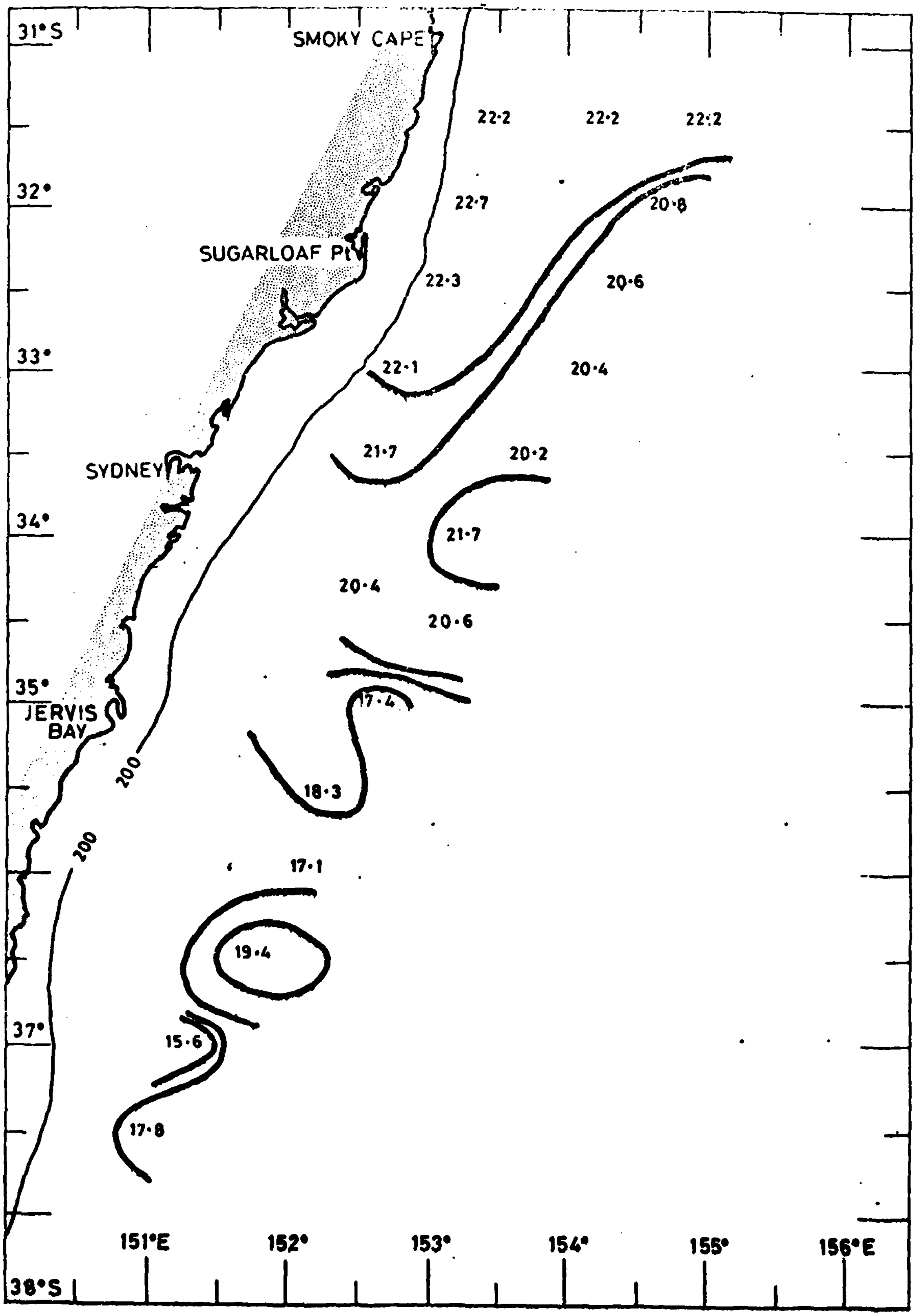

Fig. 13. SST of 22 September 1981 (Contours every 1°C)

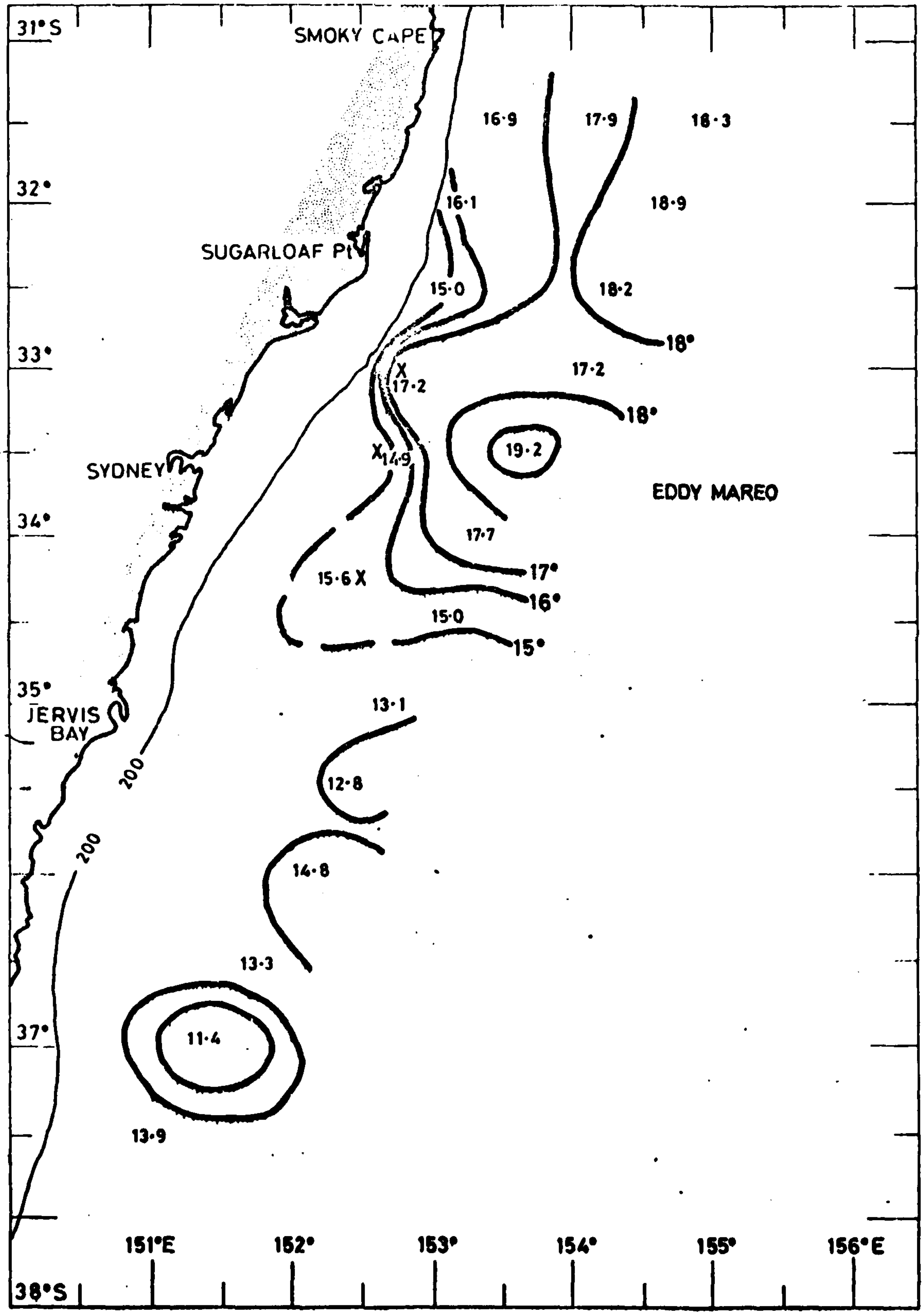

Fig. 14. Temperature at 250m depth of 22 Sept. 81. (Contours every 1°C).

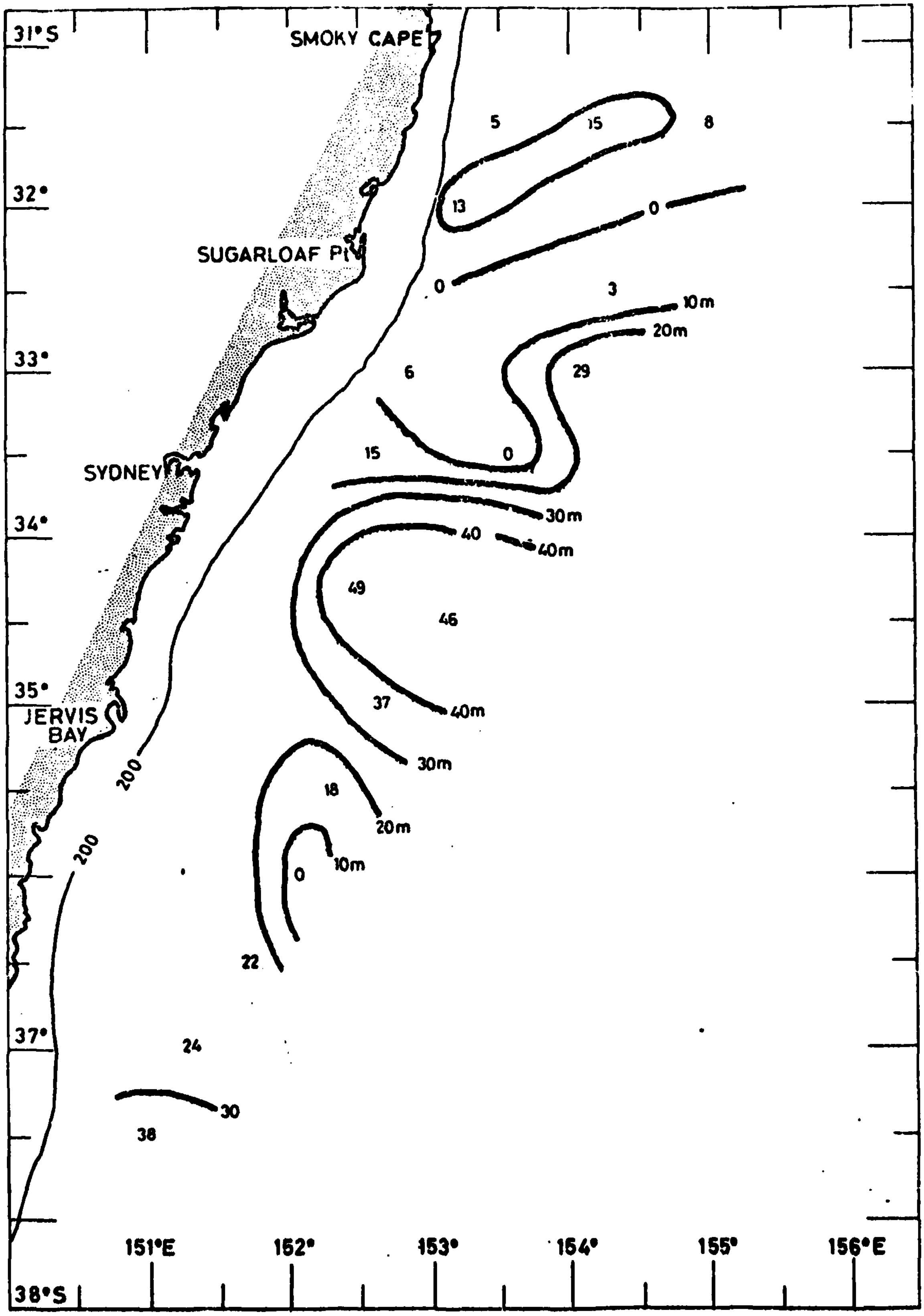

Fig. 15. Surface mixed-layer depth of 22 Sept. 81. (Contours every 10m).

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