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Investigation of Environmental Change Pattern in Japan

(Investigation of Variations in the Prominent Oceanic Current, Kuroshio)

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Investigation of Variations in the Prominent Oceanic Current, Kuroshio

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Abstract

Out of the monochromatic prints of the scenes obtained by Landsat-2, the two scenes were selected to analyse variations in the oceanic condition especially in the coastal areas. Interpretation of the patterns in these scenes was made by comparing with the oceanographic data obtained at that time in the areas concerned. The CCT was used for the quantitative comparison and also to analyse patterns in the smaller area such as river mouth. The composite color image was succesfully used to depict the states of river water spreading from the mouth.

1. Introduction

Some of the monochromatic prints of the scenes obtained by Landsat-2 show some patterns other than clouds which suggest variations in the oceanic condition, especially in the coastal area. In the present study the two scenes were selected to analyse these variations, that is "Ise-bay" and "Kumano-nada". Interpretation of the patterns was made by comparing with the oceanographic data obtained at that time in the areas concerned. The CCT was used for the quantitative comparison and also to analyse patterns in the smaller areas such as

river mouths. The composite color image was succesfully used to depict the state of river water spreading from the mouth.

2. Techniques

The monochromatic prints of band 4 were mainly used for interpretation of the water mass distribution. The CCT data were processed with the computer,NEAC 2200/500 of the Hydrographic Department to produce density maps and correlation graphs between different bands. The composite color images of CCT were composed by the Image processer of NEC Research Institute in cooperation with the staff of the Institute.

3. Accomplishments

The oceanographic data necessary to the study were colleced for the coastal area and the Ise Bay from the Local Fisheris Observation Stations of Wakayama, Aichi and Shizuoka Prefectures, and for the offshore area from the Hydrographic Department, the Meteorological Agency and some of universities. The station and date of these oceanographic observations are shown in Fig.1. Based on these data the seveal kinds of distribution chart were prepared to compare them with the patterns in the band 4 prints, that is, the distribution chart for temperature (surface and 100m layer), surface velocity, transparency and surface salinity (Fig.2,3,4,5,6,7 and 8).

From the scenes of "Ise-bay" and "Kumano-nada" prominent waters which seem to have comsiderably different density from the surrounding waters are seen near the mouths of Tenryu River and of Kumano River, respectively. To analyse these areas more in detail the CCT was used, and investigations were made on the spreading or diffusion of river waters and on the relevancy between the patterns of river water and

the offshore kinematic conditions as well.

The oceanographic condition of the coastal area is often influenced by the variation of path of the Kuroshio, which is a very strong current flowing from the west to the east in the southern offshore area of Japan and in the present study it was necessary to make these offshore kinematic conditions clear. In the preceding few months from the date of scenes the Kuroshio had been changing its path as shown in Fig.9 which is based on the bi-weekly oceanic reports of the Hydrographic Department. In August 1975 the large scale meandering pattern of the Kuroshio was settled in the offshore area enclosing a large cold water mass of 150 miles in diameter, and a part of the Kuroshio water of high temperature was flowing into the area of present investigation along the northern margin of the cold water mass. This influence of the Kuroshio water was obvious from the fact that the temperature of 100 m layer (18 to 19°C) was about 2°C higher than the average temperature of the area (16 to 17°C) with the standard deviation of about 2°C, although it was not clear from the surface temperature distribution because of the uniformly high temperature distribution over the while area which was useal in that season of the year.
No surface current (GEK) data was available in the coastal area, however the offshore current distribution (Fig.4) seemed to support above interpretation.

4. Significant results

(1). Identification of water mass and relevancy with offshore conditions

No information of the sea surface was available from the bands 6 and 7, the CCT count of which were all less than 4 and 2 respectively except cloud area, and these bands were used to separate sea from

land and cloud, however it was confirmed that the band 4 and 5 had some information as to the sea surface such as spreading of coastal waters or eddy-like motion of surface water. Interpretation of these information with the available data of oceanographic observation is as follows.

(a). It can be concluded that the front line along the coast from Kumano-nada to Shiono-misaki in the monochromatic prints (Fig. 10 and 11) and in the pseud-color images (Fig.12 and 13) is a boundary between coastal waters and offshore water as the results of comparison with the distribution charts made from the actual oceanographic observation. That is, the front line corresponds to the equi-value lines of 25 m in transparency, 33.6‰ in salinity and 2.5 in water color scale, where the transparency of 25 m and the water color scale of 2 are the characteristic values of very clean water which has very low contents of plankton and nutrient. The oceanographic data used here were obtained at practically same date when the Landsat-2 photographs were taken.

(b). The Landsat prints suggest that the coastal water from Ise bay spreads to Atsumi Peninsula and that the offshore water approaches to 5 miles from the coast from Hamana Lake to Tenryu River, however, comparison with the oceanographic distribution charts does not give so good coincidence as the case (a). This could be attributed to a time lag of about one week between field observation and Landsat scenes and to a change of sea state which might happen during that period. A small portion of slightly different density 10 miles off Atsumi Peninsula in the prints might correspond to the intrusion of offshore water, salinity of which was higher than 34.00‰ (Fig.8).

(2). On the eddy-like pattern off Shiono-misaki

Out of the scenes of "Kumano-nada" only band 4 gives a clear eddy-like pattern off Shiono-misake, although no evidence to consider the pattern as a real information from sea surface was obtained as far as the CCT count of each band was concerned. There was no oceanographic observation of the area at that period, however it was observed that the flow axis of Kuroshio off Shiono-misaki had moved to far north in early September from its position in late August about 60 miles off Shiono-misaki, and that a oceanic front was formed in the area with Kuroshio. It is highly possible from these situation that the eddy-like pattern had separated from coastal water by the variation of Kuroshio axis. It was also recognised that each one of the six sensers had slightly different sensitivity as was seen from the density maps which were made separately by using the informations of each senser, although the differeces of count were only one or two at the marginal portion of the pattern (Fig.20 and 21).

(3). Analysis of the Ise Bay water

Almost whole area of Ise Bay was considered to have been covered by rather polluted water from the oceanographic data of the region, which gave salinity values less than 30‰, high water color scale of 6 to 8 and transparency less than 5 m. The CCT counts of band 4 were all less than 13 for the region and also indicate less upward radiation from the sea surface which was not so very clean.

(4). On the patterns near the mouths of Tenryu River and Kumano River

The sea surface informations could be recognised in the two river mouth region from the prints not only of band 4 but also of bands 5 and 6. The CCT and a color image procceser were used to investigate the relevancy among different bands and the spreading and diffusion of the river water into the ocean.

The pseud-color images gave clear representation as to the land

part, the shore-lines, the sandy zones in the river beds (Fig.14), the spreading area of the river water (Fig.15 and 16) and the boundary of the coastal and offshore waters. The oceanographic data gave same direction of the river water spreading.

For the Tenryu River region the density counts were divided into four groups (Fig.17) and the correlation graphs among different bands were prepared for each group (Fig.18 and 19), where the counts which are considered to represent the most clean water throughout whole area are shown by rectangulars. These graphs show that the count ranges 16 to 37 for band 4, 8 to 42 for band 5 and 2 to 19 for band 6. The correlations between band 4 and 5 and between 4 and 6 give relatively linear relation and the surface radiance of band 5 and 6 decrease towards the offshore area more rapidly than that of band 4.

5. Publication

No.

6. Problem

No.

7. Data quality and delivery

No.

8. Recommendations

No.

9. Conclusion

The information of band 4 was effectively used for analysis of the sea condition of a region where the different types of waters are adjucent to each other, especially the waters having different plankton density such as the coastal and offshore waters, however the difference in the CCT count is very small even in a clearly developed boundary and the linear correspondence to the sea truth data was not obtained in wider range. The thermal infra-red information could be combined for a better analysis of this kind.

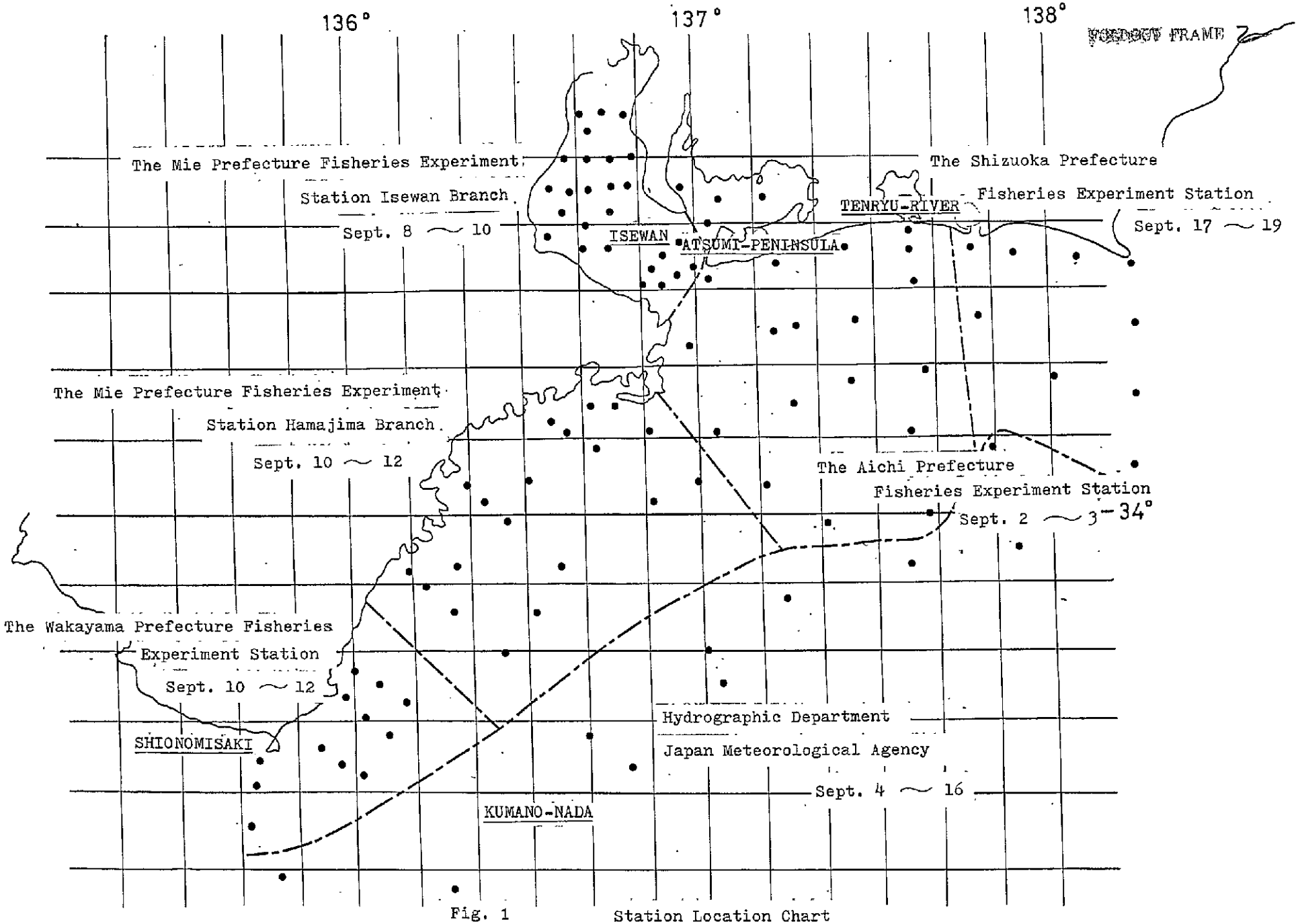

Fig. 1 Station Location Chart

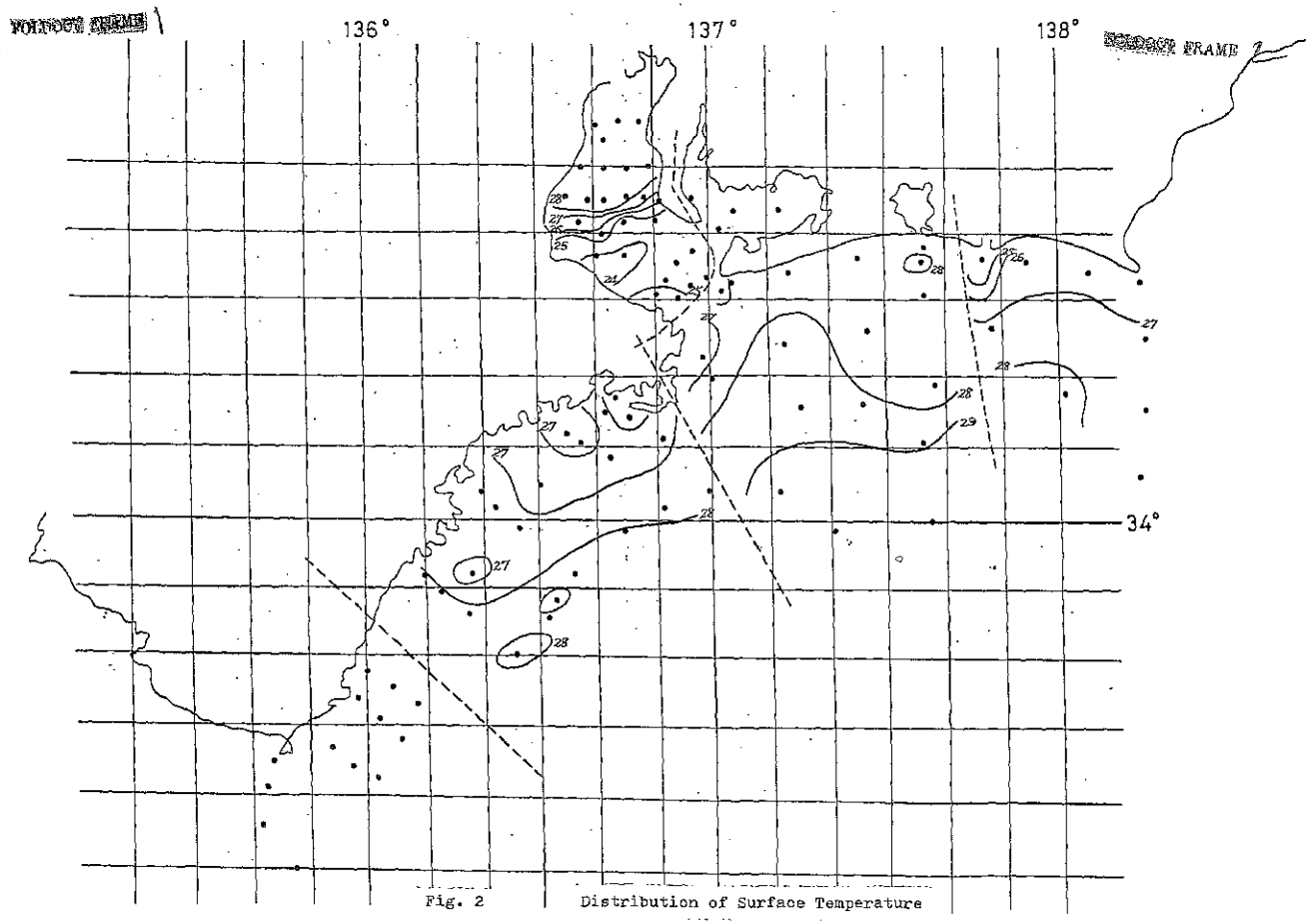

Fig. 2 Distribution of Surface Temperature

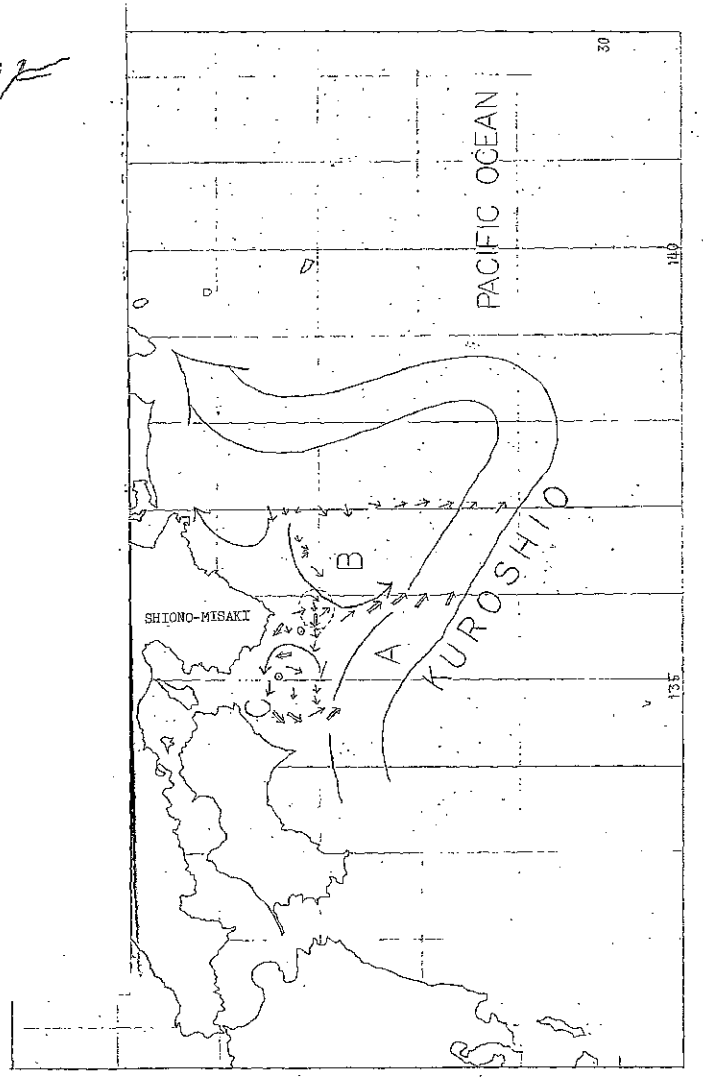

Fig. 4 Surface Current by GEK, Aug.14-Sep.3,1975

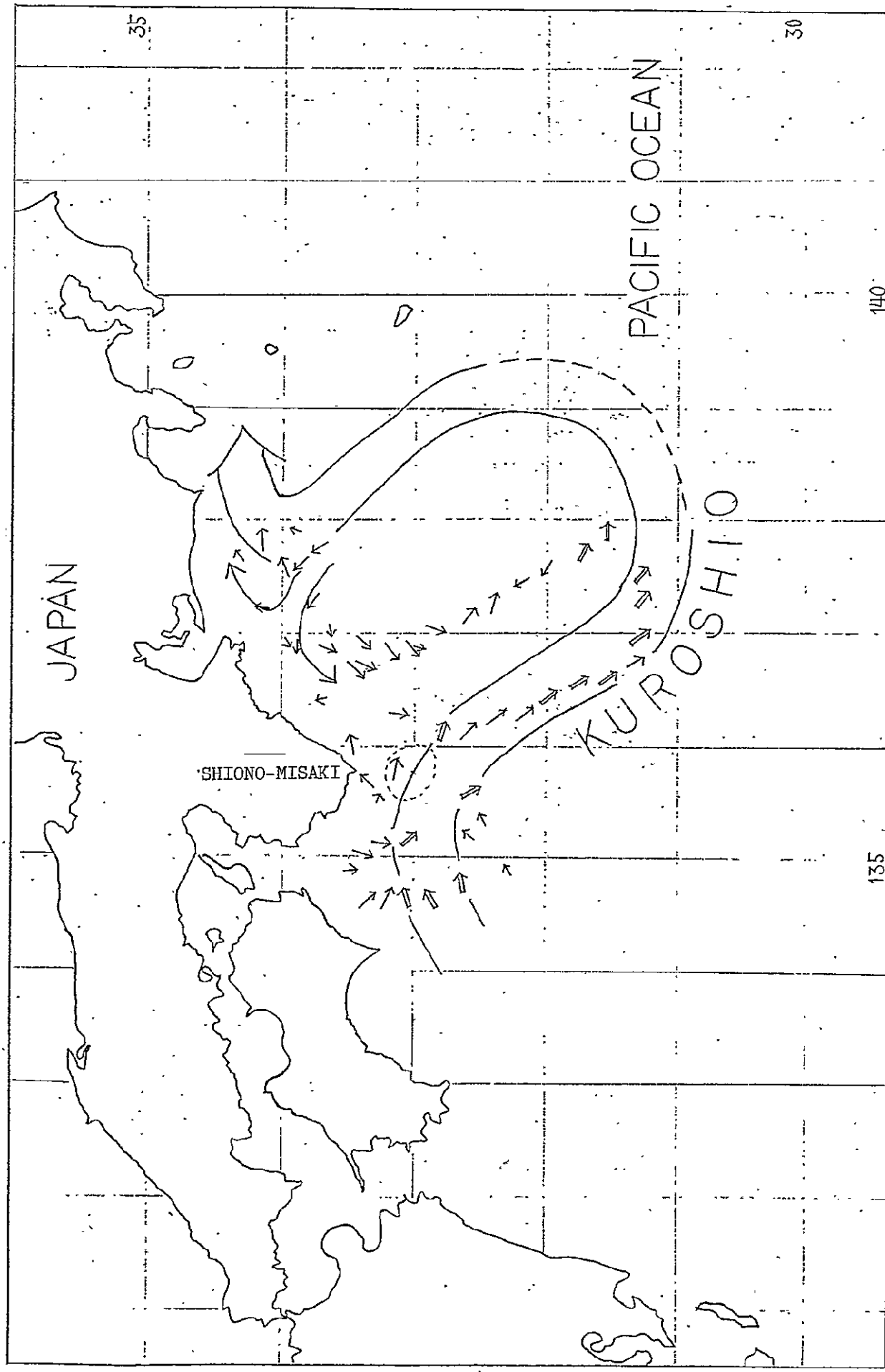

Fig. 5 Surface Current by GEK, Sep.8-16,1975

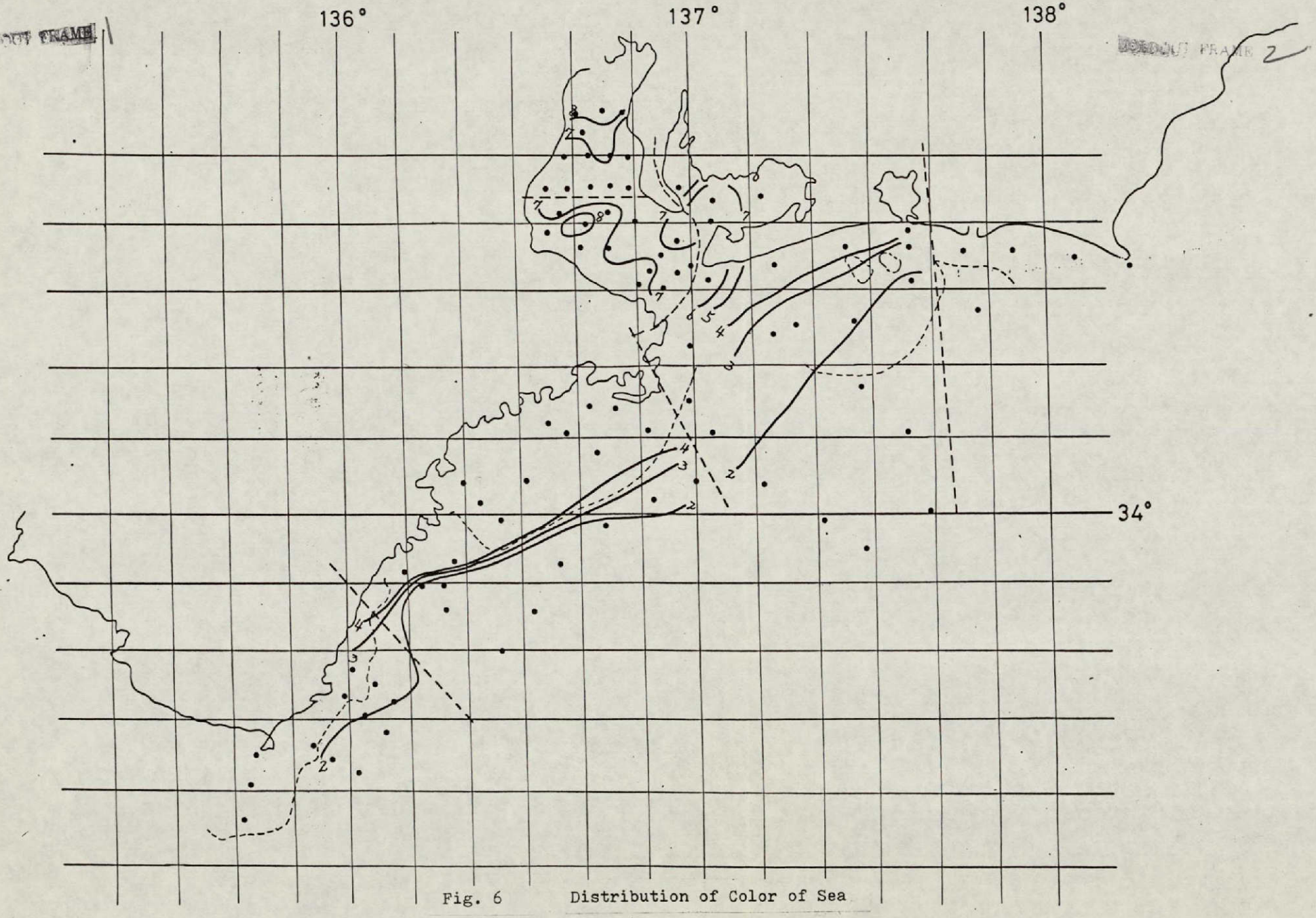

Fig. 6 Distribution of Color of Sea

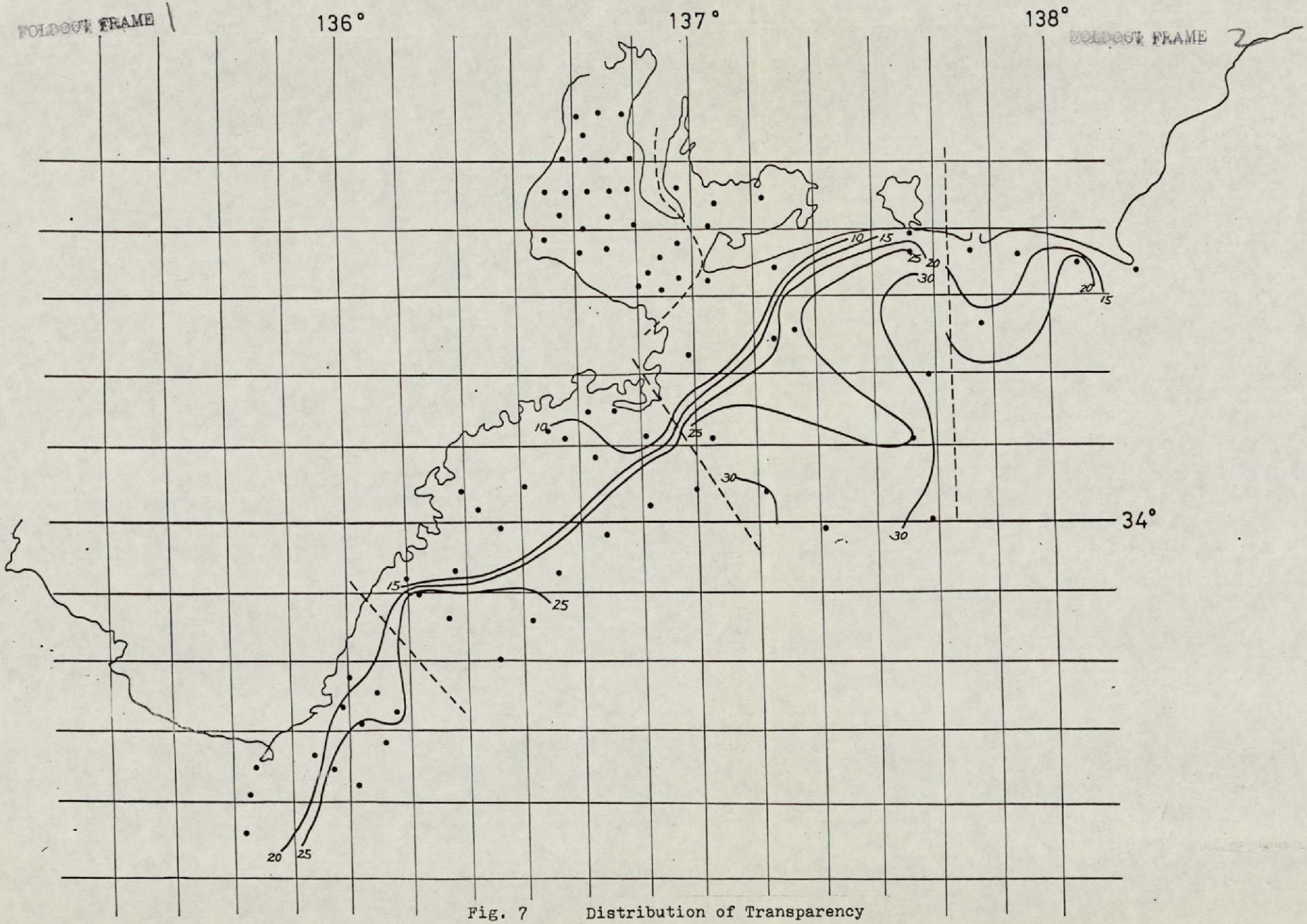

Fig. 7 Distribution of Transparency

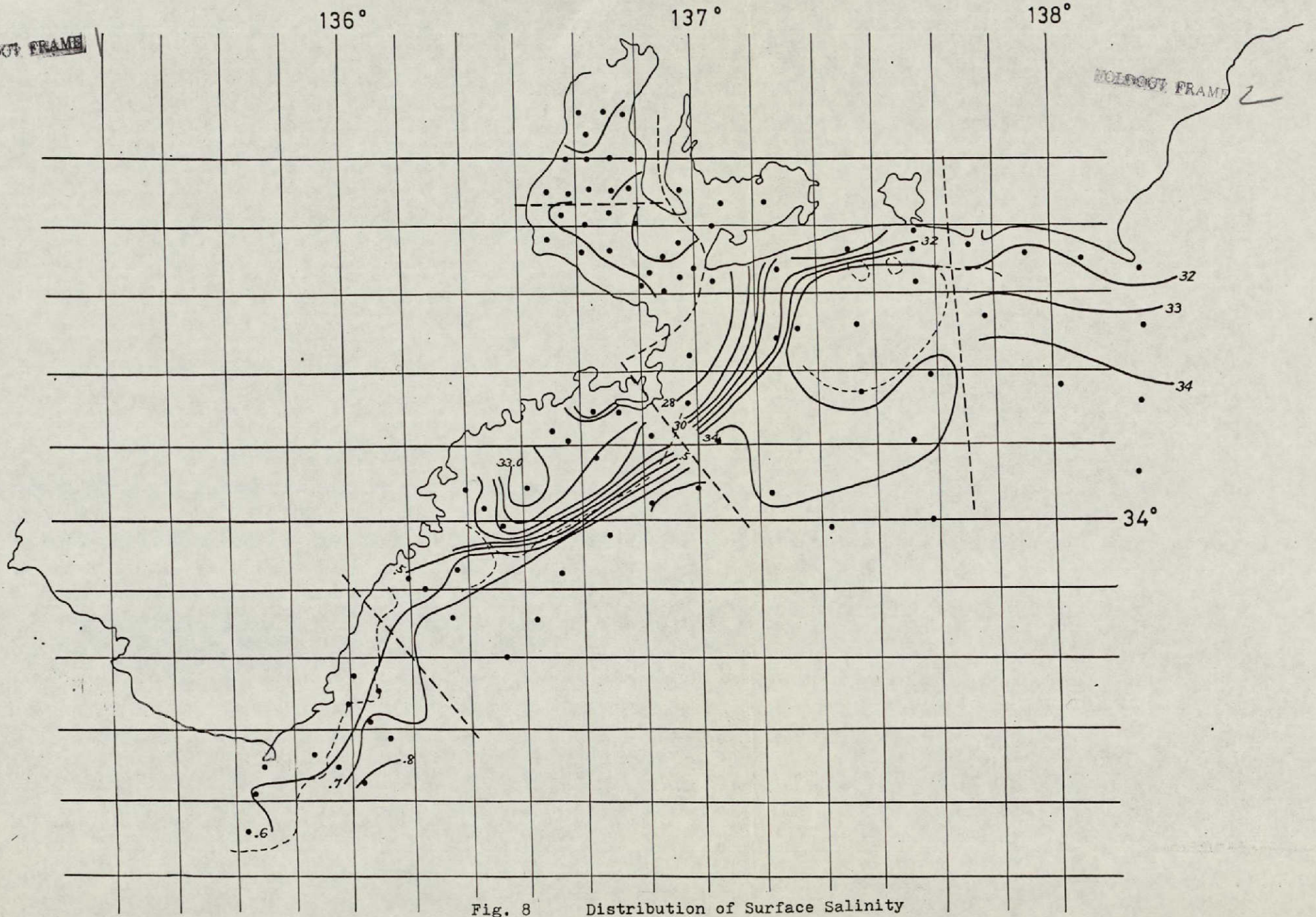

Fig. 8 Distribution of Surface Salinity

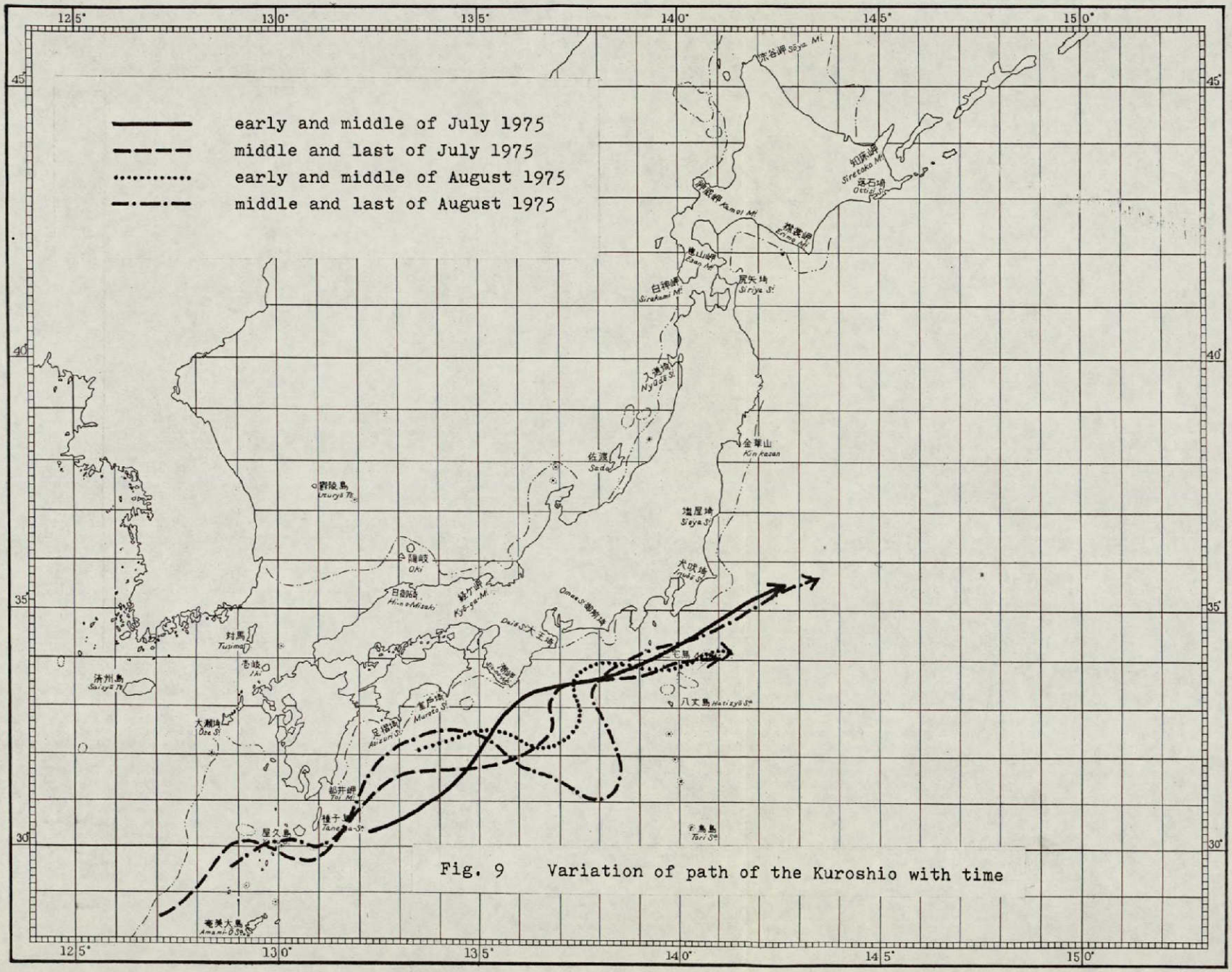

Fig. 9 Variation of path of the Kuroshio with time

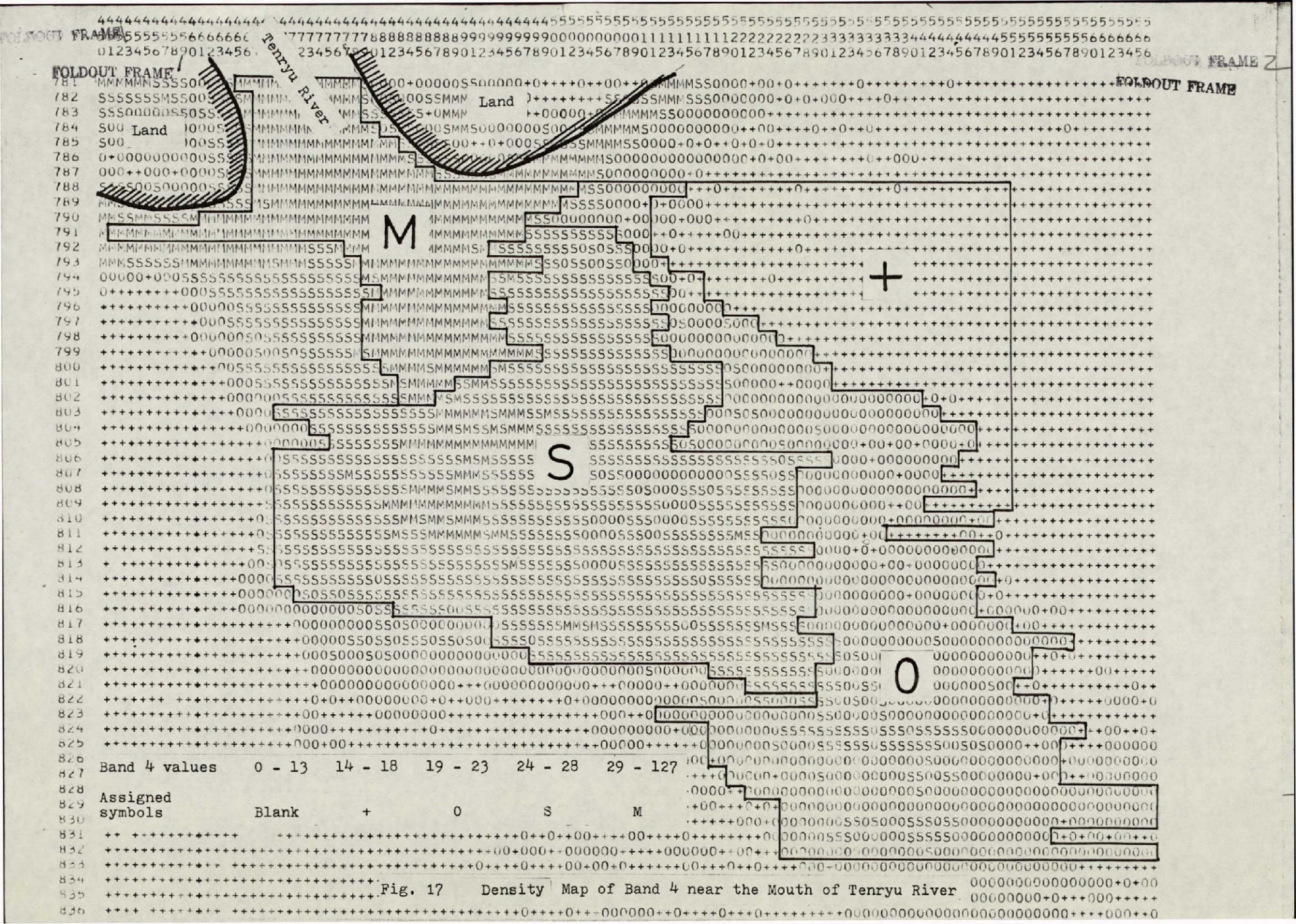

Fig. 17 Density Map of Band 4 near the Mouth of Tenryu River

Fig. 10 Band 4 image enlarged from 70mm negative film (Isewan)

Fig. 11 Band 4 image enlarged from 70mm negative film (Kumano-nada)

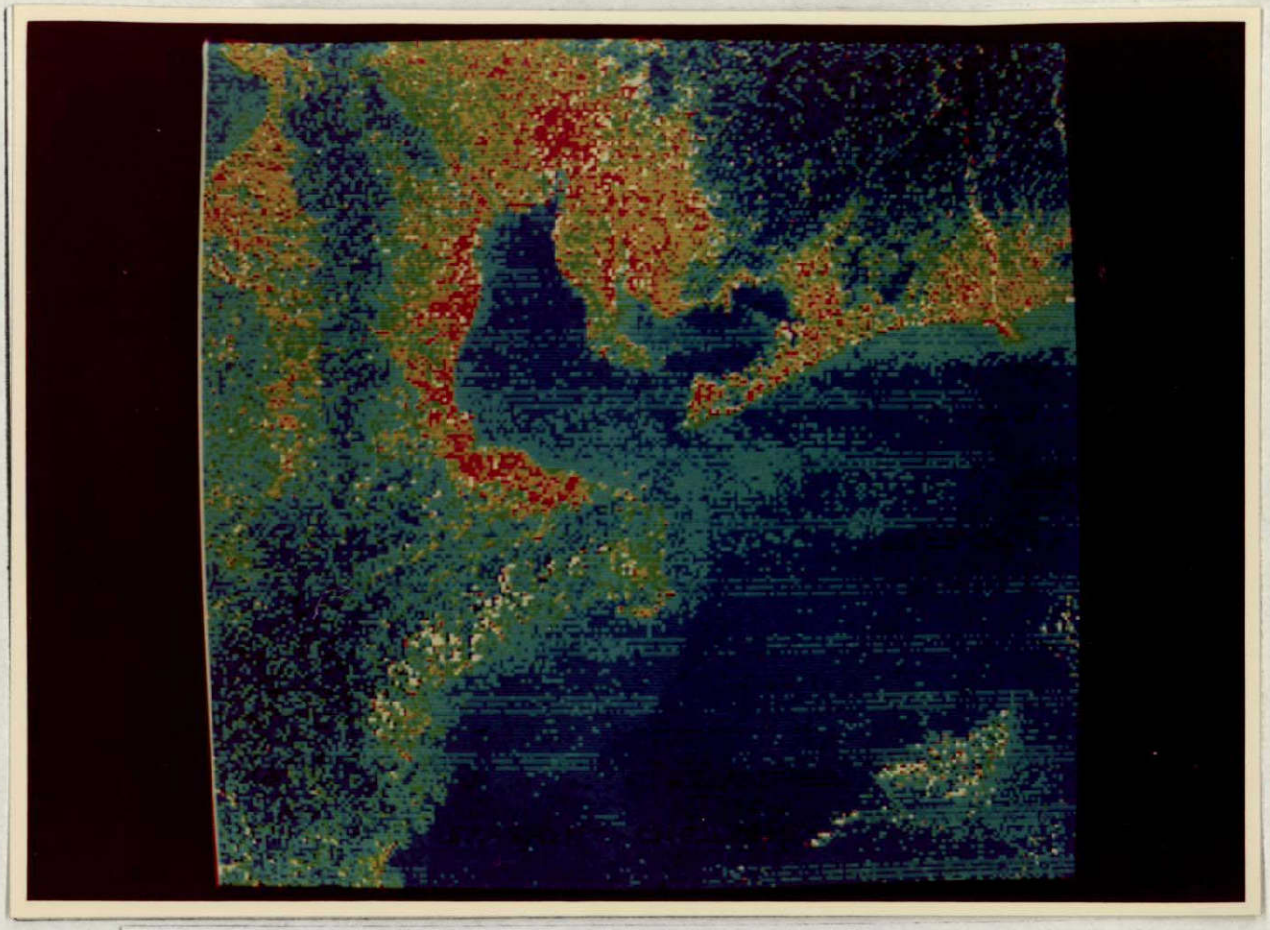

Fig. 12 Pseudo-colors image of MSS band 4 (Isewan)

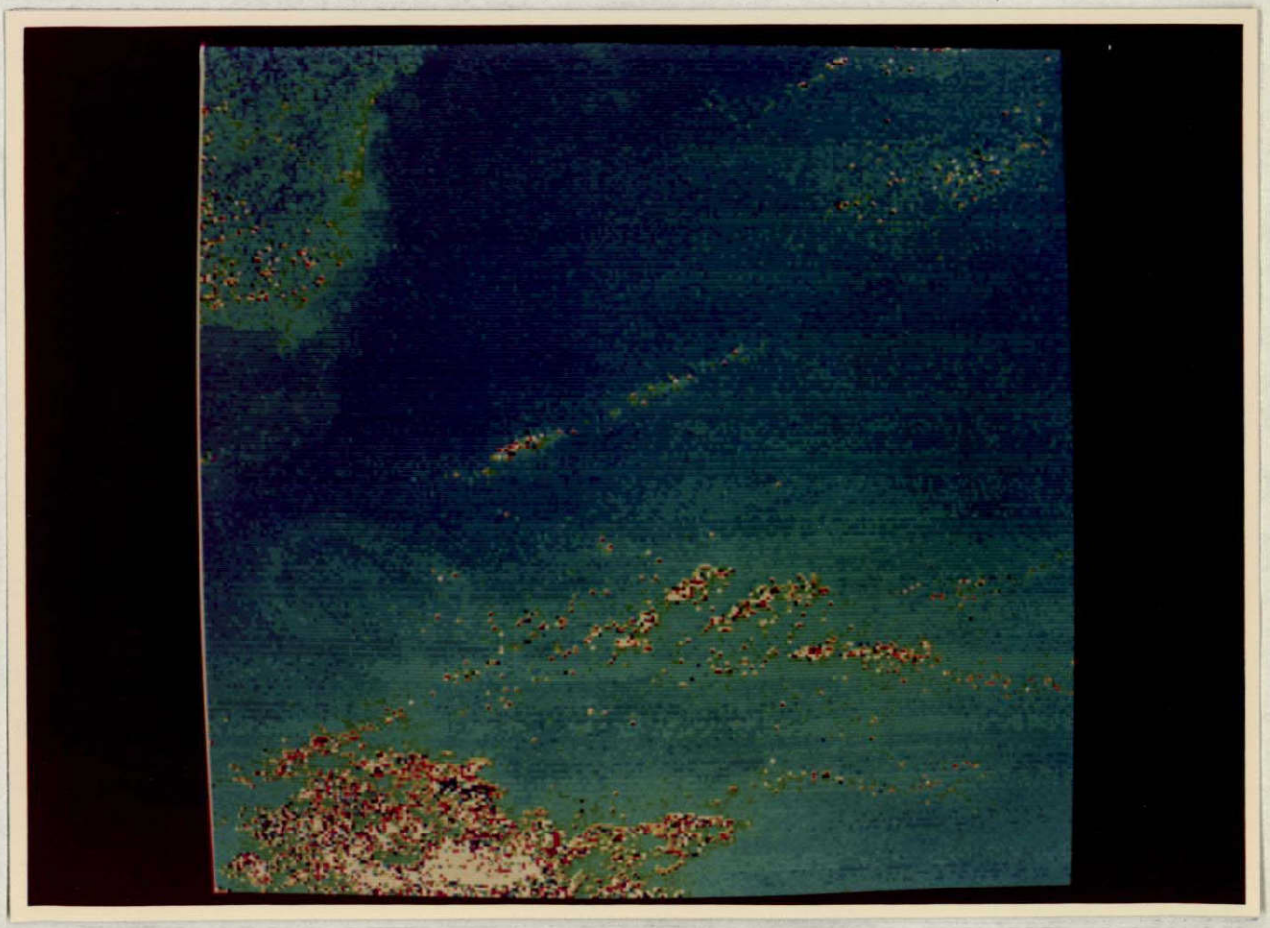

Fig. 13 Pseudo-colors image of MSS band 4 (Kumano-nada)

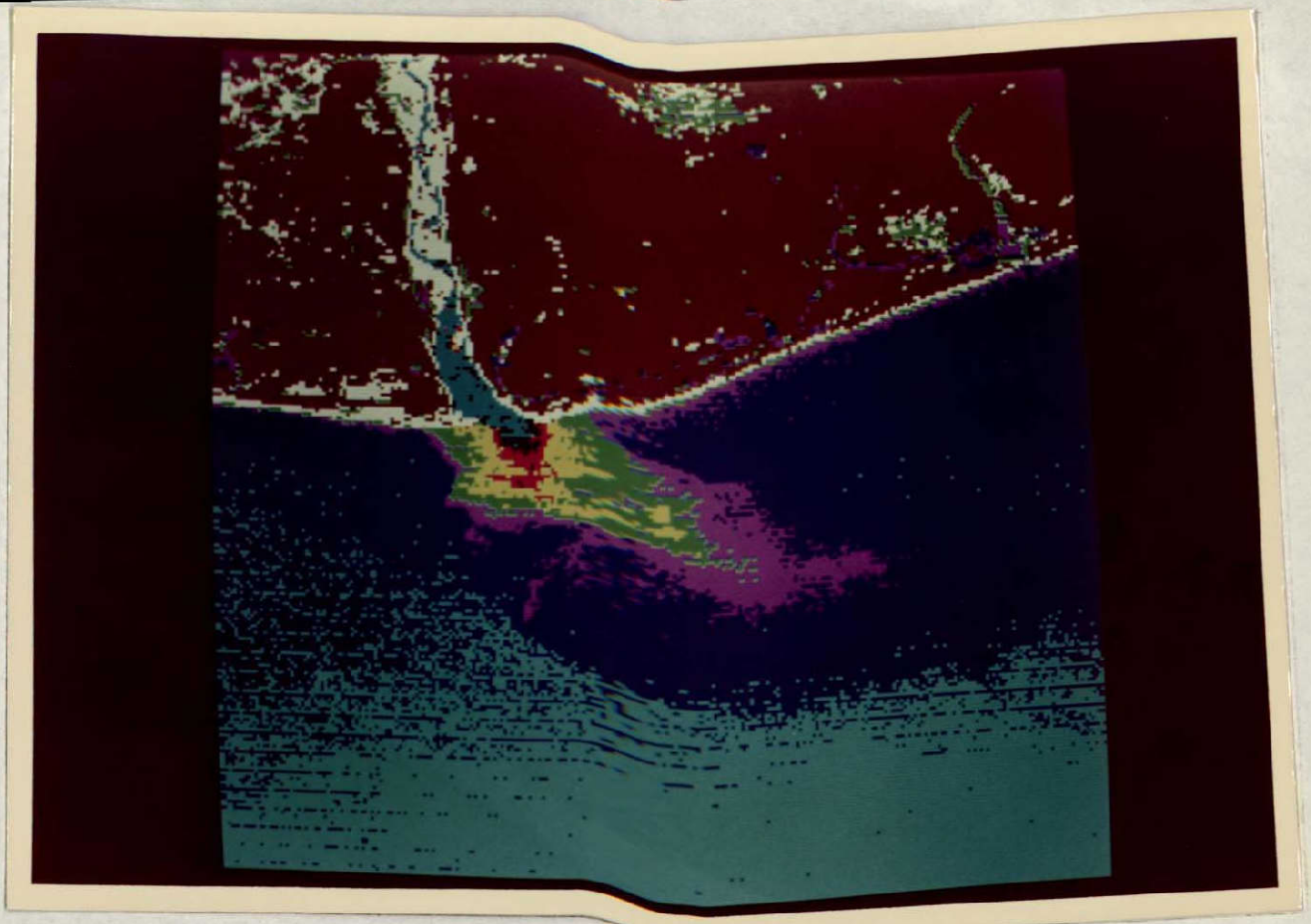

Fig. 14 Composed color image of Mss band 4,5 and 7 (Tenryu River)

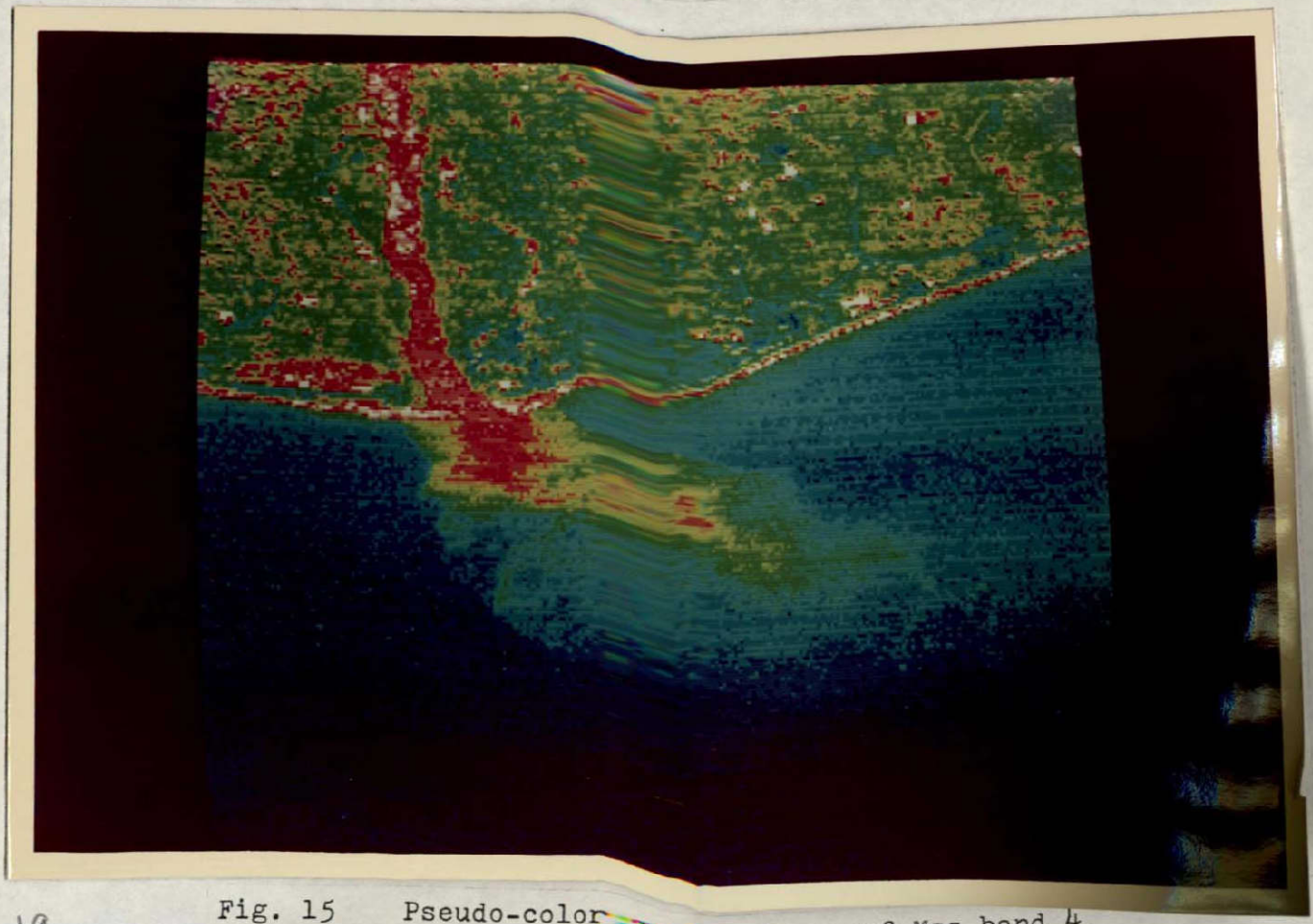

Fig. 15 Pseudo-colors image of Mss band 4

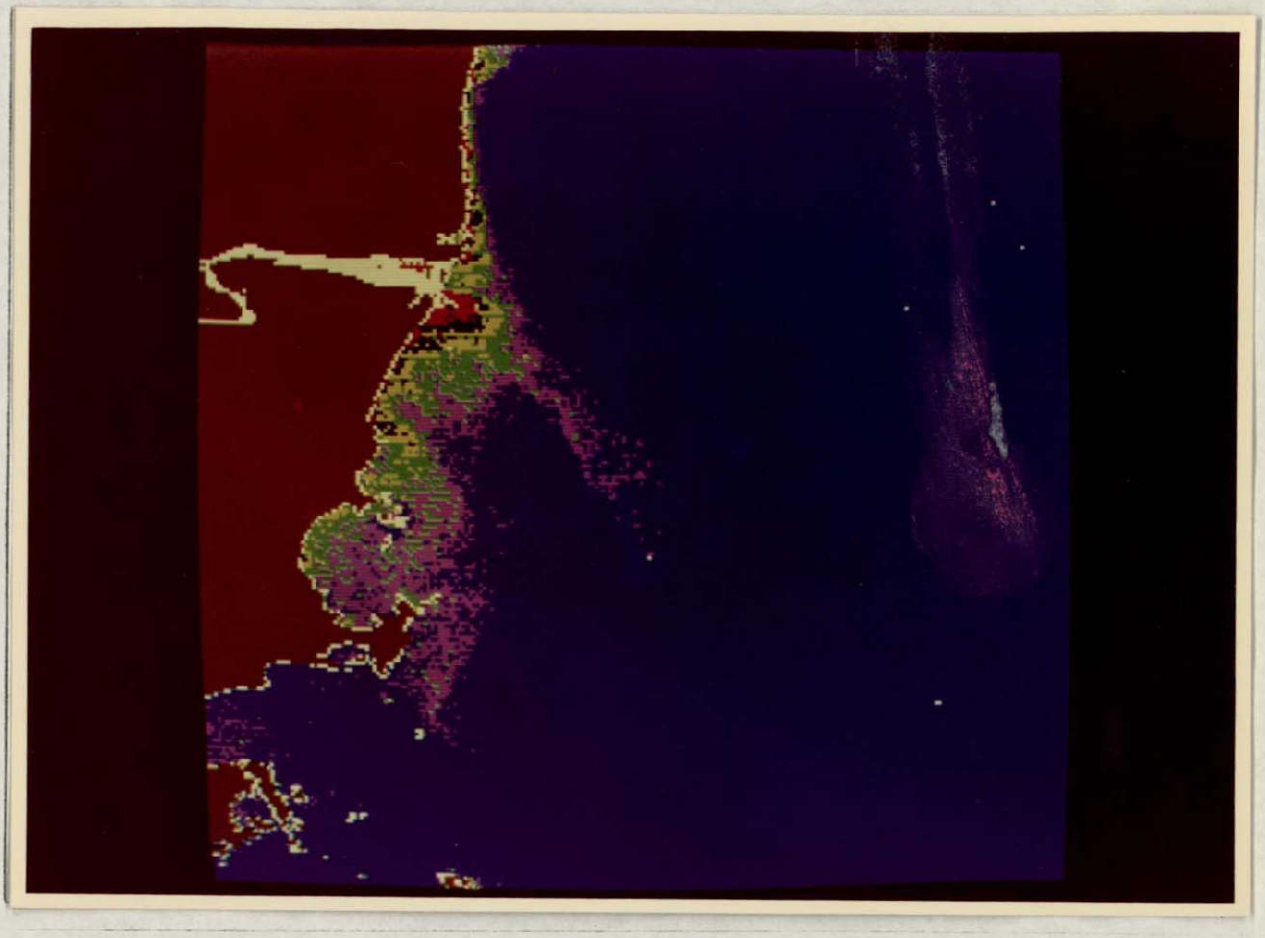

Fig. 16 Composed color image of Mss band 4,5 and 7 (Kumano River)

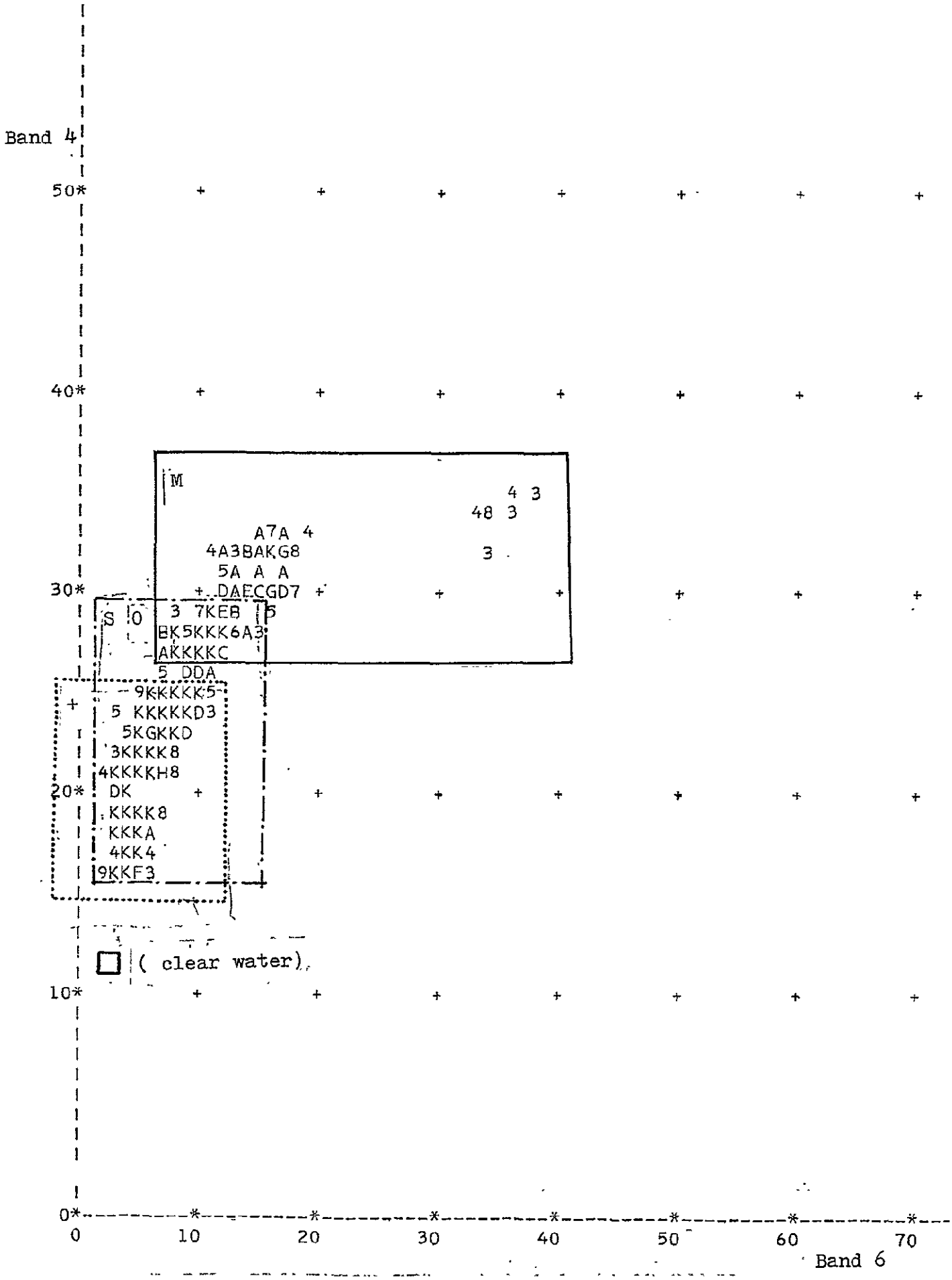

Fig.19 Density correlation between Band 4 and 6 sampled from the Mouth of Tenryu River (Fig. 17)

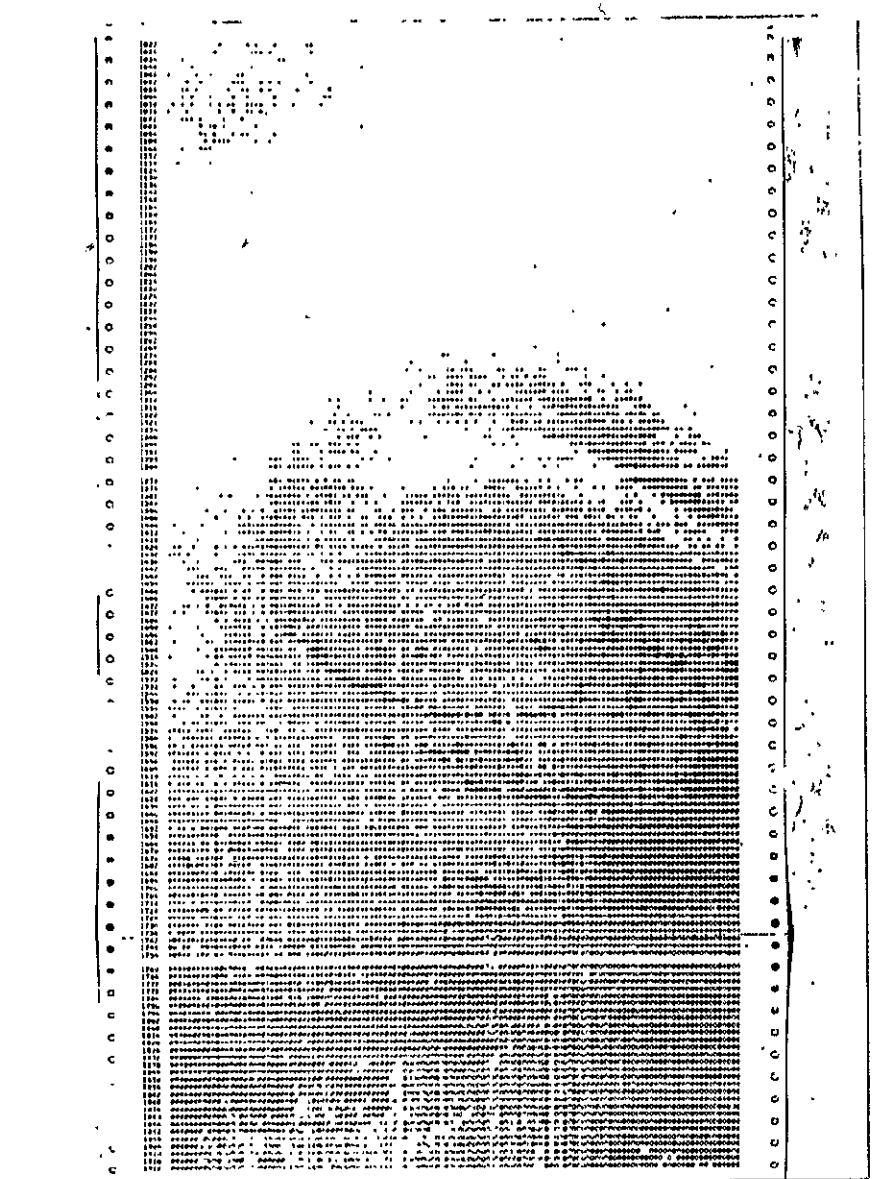

Fig. 20 Band 4 density map depicted from every 6th lines of CCT data

(Specified by line No. 6N+2)

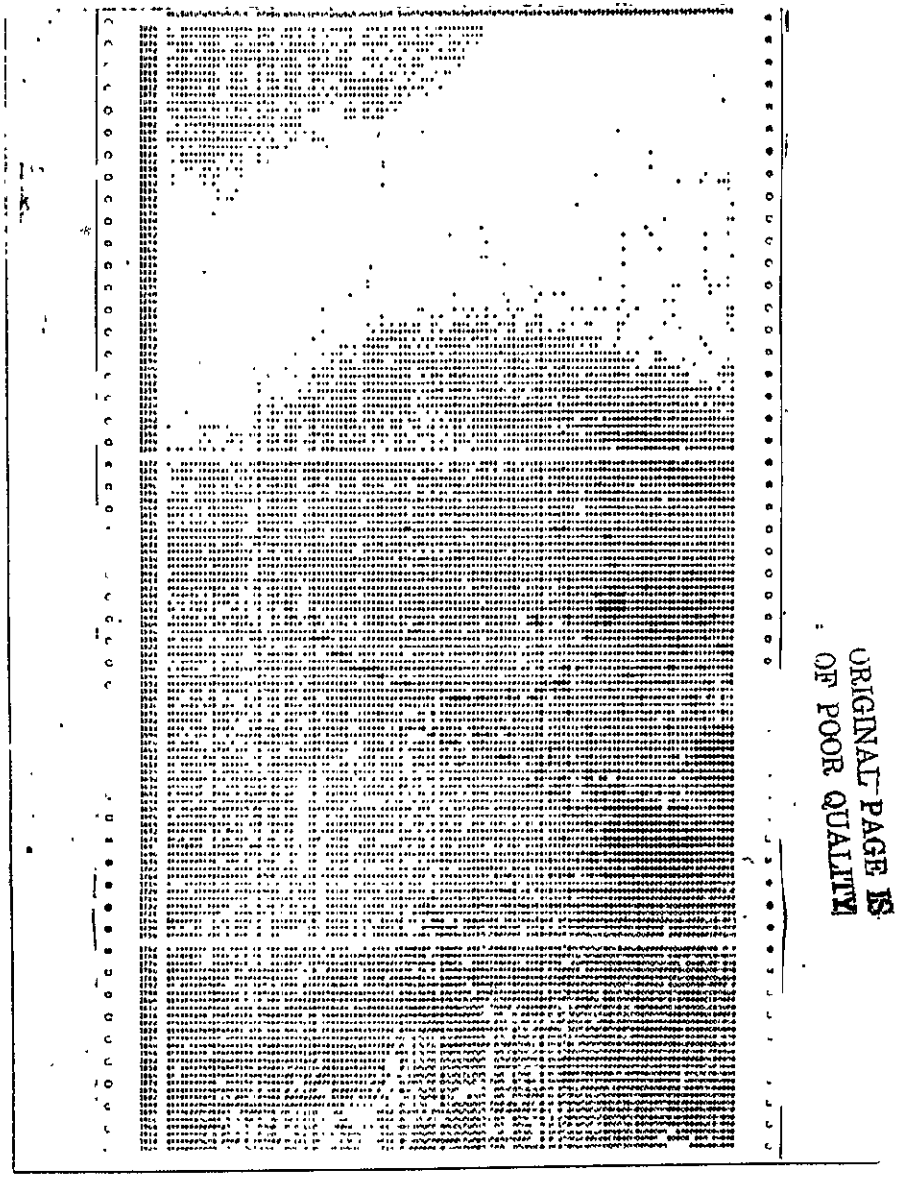

Fig. 21 Band 4 density map depicted from every 6th lines of CCT data

(Specified by line No. 6N+4)