HEAT CAPACITY MAPPING MISSION

NASA INVESTIGATION HCM-034

THERMAL MAPPING, GEOTHERMAL SOURCE LOCATION, NATURAL EFFLUENTS AND PLANT STRESS IN THE MEDITERRANEAN COAST OF SPAIN

SEPTEMBER 30, 1979

FIRST PROGRESS REPORT

SUBMITTED BY:

PRINCIPAL INVESTIGATOR: Dr. Ing. Rodolfo Núñez de las Cuevas
Director del Instituto Geográfico Nacional

AGENCY: Instituto Geográfico Nacional
General Ibáñez de Ibero, 3. Madrid-3 - SPAIN

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Principal Investigator: DR. RODOLFO NUÑEZ DE LAS CUEVAS
INSTITUTO GEOGRAFICO NACIONAL
MADRID. SPAIN.

Co-Investigators:

Dr. Fernando López de Sagredo
Servicio de Fotogrametría y Fotointerpretación. Universidad Politécnica de Madrid.

Dr. D. Joaquín Meliá Miralles
Departamento de Física Fundamental
Universidad de Valencia.

Prof. D. Pedro Herranz Araujo
Departamento de Estratigrafía y Geología Histórica. Universidad Complutense de Madrid.

Prof. D. Jesús Paredes Perlado
Centro de Estudios Hidrográficos. Madrid.

Prof. D. Antonio Parrilla
Instituto Español de Oceanografía. Madrid.

Dr. D. J. Luis Picón
Centro de Investigación UAM-IBM. Madrid.

Dr. D. J. Luis Labrandero
Instituto de Edafología. CSIC. Madrid.

Dr. F. González Bernáldez
Cátedra de Ecología
Universidad Autónoma de Madrid.

Coordinator:

Antonio Martínez de Aragón
Instituto Geográfico Nacional. Madrid.

HCM-034

First Progress Report

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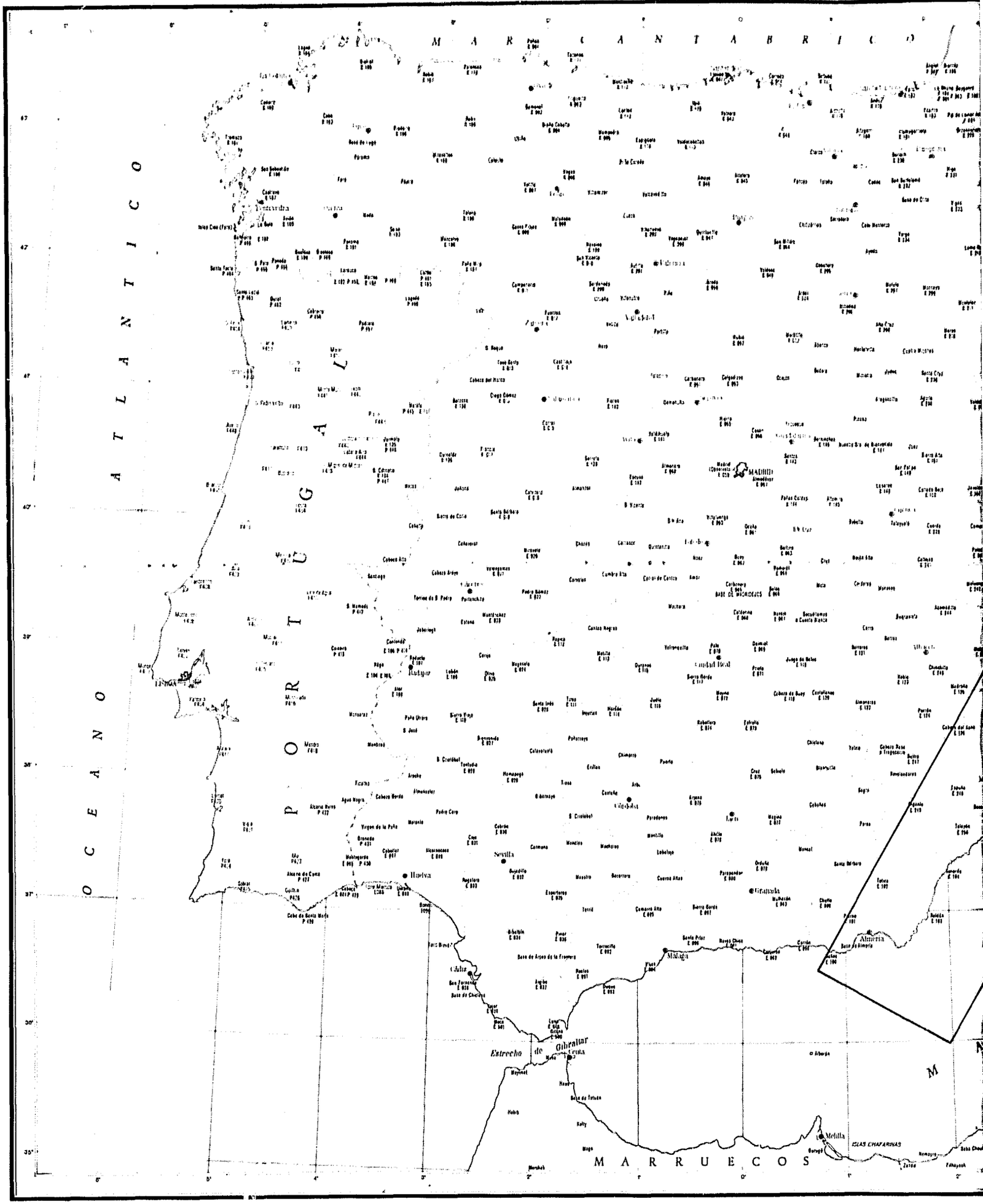
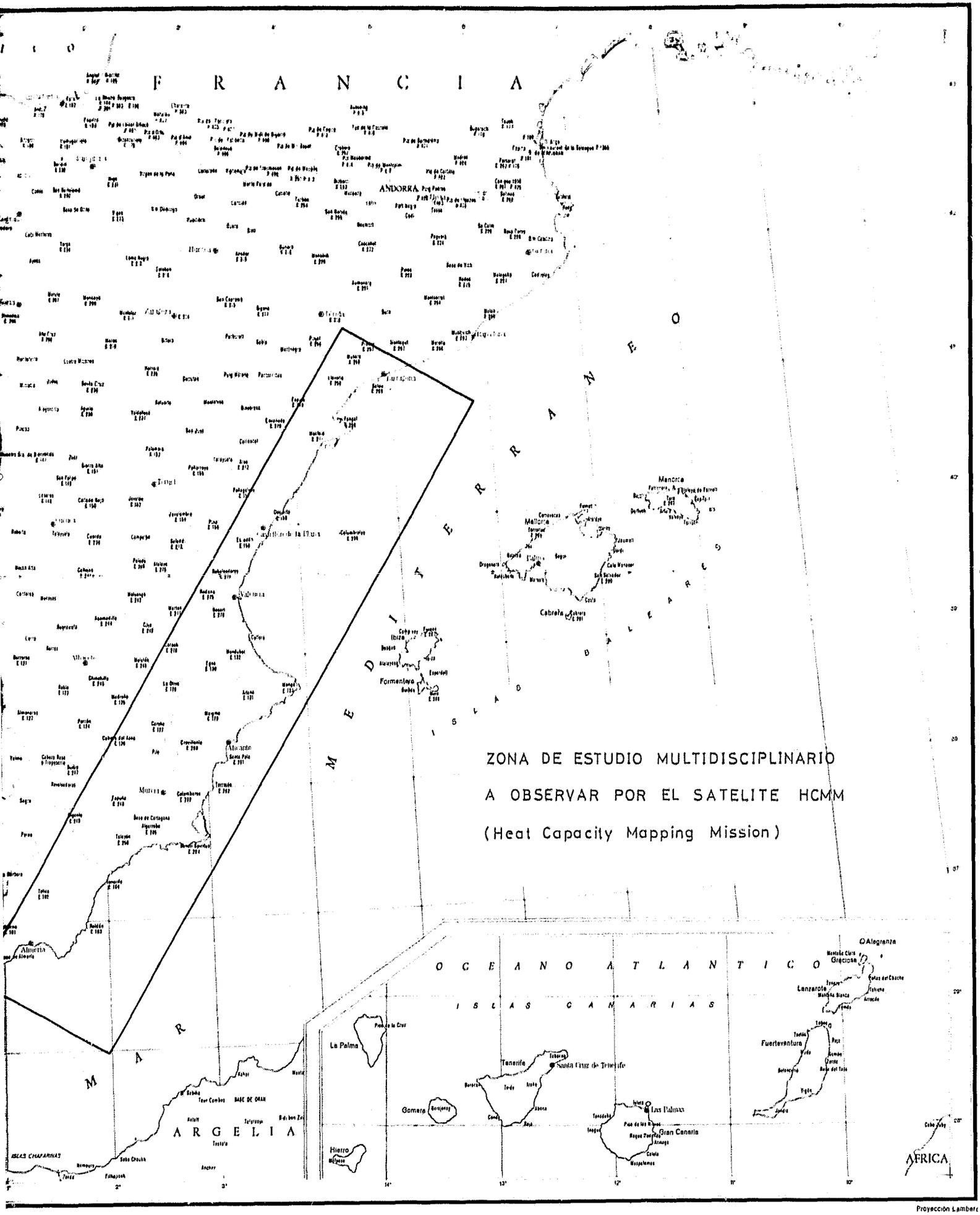
PRESIDENCIA DEL GOBIERNO

RED GEODESICA FUNDAMENT



Edición 1975

FOLDOUT FRAME



Escala gráfica

40 80 120 160 200 Kilómetros

Proyección Lambert

FOLDOUT FRAME 2

INTRODUCTION

In this Report, the quality of the first (until July 30, 1979) photographic images received from NASA is evaluated, as well as its suitability to different thematic studies: Agriculture, Geology, Natural Effluents, Physical Oceanography and Thermology.

The main conclusion of these evaluations is that HCMM photographic products are of very low interest by themselves, given its poor quality (small dynamic range, lack of contrast, noise, ...) and scale.

Since photographic enhancement techniques have proved almost useless with the NASA delivered positives, Instituto Geográfico Nacional decided to enhance digitally the HCMM data, by areas of interest, in a process taylored to each coinvestigator needs. The first results are shown in the second report.

There is expected that HCMM enhanced data will be of great interest, at least in Geology and Oceanography, for broad studies at small scales.

We must say here that we receive HCMM data from NASA with long delays: As of September 30, we are still receiving May 78 positives, and haven't received any positive from December 78 on. CCT's are received three months after being requested.

Another anomaly has been the one year postponement of the real beginning of the experiment.

These delays have caused that some of the former coinvestigators in the Instituto Geográfico Nacional proposal, have given up, and although some others have been added, the costs incurred in the delay year will not be recoverable.

Antonio Martínez de Aragón
HCMM-034 Coordinator.

REPORT OF THE HCMM

PHOTOGRAPHIC PRODUCTS

Instituto Geográfico Nacional
Sección de Teledetección.

It has been received part of the HCMM information necessary to carry on with the investigation proposed in the colaboration agreement between NASA and the I.G.N. The study done with the received images allows to obtain the next conclusions:

1) In some images stands out horizontal bands of different densities, probably provocated by a defective calibration of the sensor, for which reason it is impossible to make a good interpretation.

2) The pixels are perceptible as grain in many of the images, appearing noise as saw tooth.

3) It has been verified that when the IR and visible postives are superposed in an image composite aditive viewer, to perform the correlations between both thermic and albedo responses, the points located at the center of the image can be superimposed with some difficulty. It was not possible to do this with the points located at the edge of the images.

4) The best work's scale is 1/2.000.000, since from 1/1.000.000 scale, the image loses a lot of quality, causing difficulty by having an individual sight of each pixel, instead of a whole information.

5) Although the positives ought to be contrasted at NASA'S IPF it has been proved, that cause of a failure of the sistem, or any other reason, they are not. To improve them, following steps have been taken.

a) Obtainment of a negative by contact. Normal negative

b) Obtainment of the maximun and minimun densities with a microdensitometer. With these values they were computed the medium density, the contrast and the modulation.

c) Obtainment, with those values, a new negative, contrasted by a logEtronics equipment.

d) Obtainment, in this negative, of the values described in the step b. and

e) Comparation of these last ones with the values obtained in the normal negative.

There has been exposed some examples in table 1.

However, this is a very limited system and now we are working with digital data (CCT) to improve the images, according to the techniques that are explained in the report to which this one is enclosed.

6) To continue with the investigation plan and to keep with the foreseen terms, it is necesary to receive in a very short time at least the images and the CCT of a complet anual cicle.

It has not been received any image of date later than December 1978.

7) Recently the french Lannion station have sent good quality quick look images, up to the 21 September 1979 date, whose relation is enclosed.

Image Number	NEGATIVE WITH OUT CONTRAST					NEGATIVE WITH CONTRAST				
	Maximun density dM	Minimun densi. dm	Medium $\frac{-}{d}$	Modul. $\frac{dM-dm}{dM+dm}$	Contr. $\frac{dM}{dm}$	Maxim. density dM	Minim. densi. dm	Medium densi. $\bar{d}$	Modul. $\frac{dM-dm}{dM+dm}$	Contrs. $\frac{dM}{dm}$
191-13270-1	1.57	0.13	0.850	0.847	12.077	1.48	0.10	0.790	0.873	14.800
18 -13160.1	1.30	0.16	0.730	0.781	8.125	1.27	0.12	0.695	0.827	10.583
16 -12520-2	1.06	0.17	0.615	0.724	6.235	1.48	0.18	0.830	0.783	8.222
157-02050-3	1.47	0.33	0.900	0.623	4.455	1.87	0.05	0.960	0.948	37.400
7 -01570-3	1.60	0.39	0.995	0.608	4.154	2.14	0.10	1.120	0.911	21.400

TABLA Nº. 1

HCMM

IMAGENES DE LANNION

QUICK LOOK

Recibi año,día	Canal	Fecha	Hora	Calidad	%Nubes	
4[illegible] - 79 -117						
4[illegible] - 79-117	IR.D	27.abril.79	12.39.44.GMT	B	40%	Málaga, Ibiza, Delta Ebro
	VIS	"	"	R	"	"
335 - 79-111	IR.D	21.abril.79	12.26.58.GMT	M	75%	Delta Ebro.Mallorca. Barcelona
	VIS	"	"	R	"	
4[illegible] - 79-116	IR.D	26.abril.79	12.21.53.GMT	R	70%	Franja costera D.Ebro Cabo Nao. Menorca.
	VIS	"	"	R	"	
098 - 79-095	IR.D	5.abril.79	12.27.07.GMT	R	80%	
	VIS	"	"	R	"	
0[illegible] - 79-089	IR.D	30.marzo.79	12.16.32.GMT	R	90%	
	VIS	"	"	M	"	
809 - 79-143	IR.D	23.mayo.79	12.27.45.GMT	M	20%	Cabo Nao.Creus.Mallorca, Costa interior
				M		
1483 - 79-121	IR.D	1.Mayo.79	12.15.49.GMT	-		
	VIS.	"	"	R	90%	
37 3 - 79-137	IR.D	17.mayo.79	00.55.22.GMT	B		
	VIS	"		O		
3883 - 79-148	IR.D	28.mayo.79	12.21.23.GMT	B	30%	Pirineos, I.Baleares
	VIS		"	O		
38 4 - 79-144	IR.D.	24 mayo	12.45.33.GMT	R	40%	Interior
	VIS.	"	"	R	"	
4401 - 79-032	IR.D	21 febrero	12.28.21GMT	B	20%	Pirineos hasta Cabo Nao
	VIS	"	"	O		

	Canal	Fecha	Hora	Calidad	%Nubes	
340 - 79 - 213	IR.D	1.agos.79	12.27.27.GMT	B	10	Casi entera - con Mallorca.
	VIS			B	10	
3698 - 79 - 203	IR.D	12.Jul. 79	12.38.GMT	B	30%	Huelva - Delta Ebro.Coruña.
	VIS	"		B	"	
771 - 79 -208	IR.D.	27.JUl.79	12.33.00GMT	B	5%	Coruña.Pirineos
	VIS	"		B	"	Gibraltar. D. Ebro.
994 - 79 - 223	IR.D.	11 agos-to 79	12.16.11.GMT	0	10%	C.Gata a Cabo Creus
	VIS	"		B	"	
401 - 79 - 183	IR.D.	2 julio 79	13.08.23 MGT	B	10%	Gijón a Gibraltar.
	VIS			R	"	
209 - 79 - 170	IR.D	19 junio 79	12.29.70.MGT	0	-	Gijón. C.Creus C. Gata.
	VIS	"	"	B	%	
693 - 79 - 202	IR.D	21 ju--lio 79	12.20.12.MGT	B	5	Bilbao.C.Creus C.Gata. Baleares.
	VIS	"	"	B	"	
443 - 79 - 186	IR.D	5 julio 79	12.24.53.MGT	B	15	
	VIS			R		
624 - 79 - 198	IR.D	17 julio	12.45.02.MGT	B	5	Casi toda España.
	VIS	"		B	6	
113 - 79 - 030	IR.D	30 enero	00 57.52.GMT	R	40%	Cabo de Gata a Delta Ebro.
	VIS	"		0		
0431 - 79 - 185	IR.D	4 julio 79	12 06.57.GMT	R	70%	
	VIS	"		R		
032 - 79 - 181	IR.D	30 junio 79	1232.33.GMT	B	10%	Gijòn a Gibraltar.
	VIS			R		

	Canal	Fecha	Hora	Calidad	% Nubes	
69 15-79-219	IR.D	7 agosto 79	12.40.01.MGT	O	-	Casi toda España
	VIS	"		R	20	
142-79-233	IR.D	21 agosto 79	12.03.35.GMT	R	30%	Delta Ebro.C.Creus. Baleares.
	VIS	"		R	"	
172-79-235	IR.D	23 agosto 79	1240.14 GMT	B	20	Casi toda España.
	VIS	"		B	"	
38 7-79-182	IR.D	1 julio 79	12.5o.3o. GMT	R	90	Casi toda España.
	VIS	"		R	"	
439-79-186	R.D	5 julio 79	01.04.31 GMT	B	10%	Norte paralelo Madrid
	VIS	"		O	-	
41 L-79-054	IR.D	23 febrero 79	13.04 23 MGT	M		Casi toda España.
	VIS	"		R	10%	

DIGITAL PROCESSING FOR HCMM SATELLITE DATA

Instituto Geográfico Nacional
Sección de Teledetección

Since May 1979 three HCMM digital images (two night passes and a day one) all of them containing information of the East coast of Spain (Valencia), have been received.

All the tasks up till now have been done working mainly with one of these images (number A0067 - 02300 - 3), a night thermal infrared image dated July 2 1978.

Due to the poor quality of the negatives received together with the tape it was necessary to generate new ones. This step was done by using the image recorder "Dicomed" with enhanced data.

Four zones have been selected within this image:

Zone 1, 2 East coast of Spain
Zone 3 Gibraltar
Zone 4 Alboran Sea
Zone 5 Granada.

See figure 1.

- Radiometric characteristics.
  In the present image (A0067 - 02300 - 3).

Ninety seven per cent of the information is contained between levels 27 and 65 (corresponding to -1.5°C and 12.5°C, apparent temperatures, respectively), having the largest population at level 6 (11.3°C).

Zones selected within the image have the following characteristics:

- Zone 1. Ninety seven percent of the pixel values are distributed within 26 - 63 (dynamic range) showing a maximum

of population at 61. The histogram shows two different peaks, each one corresponding to ground and sea responses respectively. Level 61 belongs to Mediterranean sea water (figure 2).

- Zone 2. As it can be observed from the map this zone contains only the ground responses of zone 1. The dynamic range is. 21 to 53 (-4°C to 8.5°C) having a maximum of population at 42 (4.5°C).

- Zone 3. Contains the southern part of the Iberic peninsule, from Huelva to Malaga including Gibraltar strait. Its dynamic range is 45 to 66 (4.7°C to 12.7°C).

- Zone 4. Contains Alboran sea and portions of spanish and moroccan coast.

  Its dynamic range is 41 to 65 having its largest population at 61.

- Zone 5. The last zone selected sourronds Granada. It h. a great interest due to the geothermal activity. Its dynamic range is 29 to 52 and it has a maximum of population at 46.

These zones within A0067 - 02300 - 3 frame. Have been radiometrically enhanced in order to obtain better quality images.

Photograph n^{er} 1 matchs raw data information from CCT. This photograph has been generated using image recorder Dicomed D-47.

This instrument assigns a different gray level to each digital count within a 0 to 255 range.

As the range ef this image is narrow, photograph 1 has a very coarse contrast.

The D-47 model the option of constraining the range to 64 levels (6 bits) from 0 - 63. Photograph n^{er} 2 shows the result when applying this option. Notice that in the left

lowest side of the photograph several black points appear. These points correspond to pixels with values over 63.

To get better quality results, two transformations have been applied to raw data from CCT:

- Linear transformation

$$j: \frac{255}{Max-Min} (i - Min)$$

$j = 0$ if. $j<0$
$j = j$ if. $0 \leq j \leq 255$
$j = 255$ if. $j>255$

where
j = corrected level
i = original level
Max = original level assigned to 255
Min = original level assigned to 0

- Uniform transformation

$$j = \frac{d(i)}{2} + \sum_{0 \leq k \leq i} d(k) \quad ; \quad d(i) = \frac{255}{P\Sigma} P(i)$$

where
P (i) = level i population
P_t = total population

Uniform transformation assigns the same number of point to equal intervals between 0 - 255.

Photograph number 3 was obtained after applying uniform transformation to the overall image.

Next photographs (number 4, 5, 6, 7, 8) were generated by applying this transformation to the five zones of this study.

Finally, photograph number 9 shows the result obtained when linear transformation is applied to zone 5.

Let's point out that in zone 5, uniform transformation reveals the noise present in the image.

A future task will be the evaluation of the noise and its further suppression.

Atmospheric soundings over the study zones will enable us to obtain corrected ground temperatures.

To perform these corrections NASA atmospheric correction computer program was adapted to IGN PDP 11/45.

By comparing corrected temperatures with apparent ones as well as with reference data, it is possible to test the goodnecs of the correction and in the same way to stablish the shift between both temperatures.

OBJECTIVES

In this project we intend to make the following tasks:

1.- Image enhancement.

We will apply a systematic enhancement to the images by using radiometric corrections to get better quality photographs.

In the same way several digital filters will be tested in order to suppress the noise and at the same time to evaluate the influence of this modification over raw data.

2.- Outputs.

In order to facilitate the data interpretation, several outputs (color and black and white) will be obtained:

- Temperature maps (day-night) with both apparent and atmospheric corrected data.
- Thermal inertia maps.
- Image classification maps (using available data).

- The developement of these tasks as well as the intermediate results will show wich of them presents a major interest when applied to our territory.

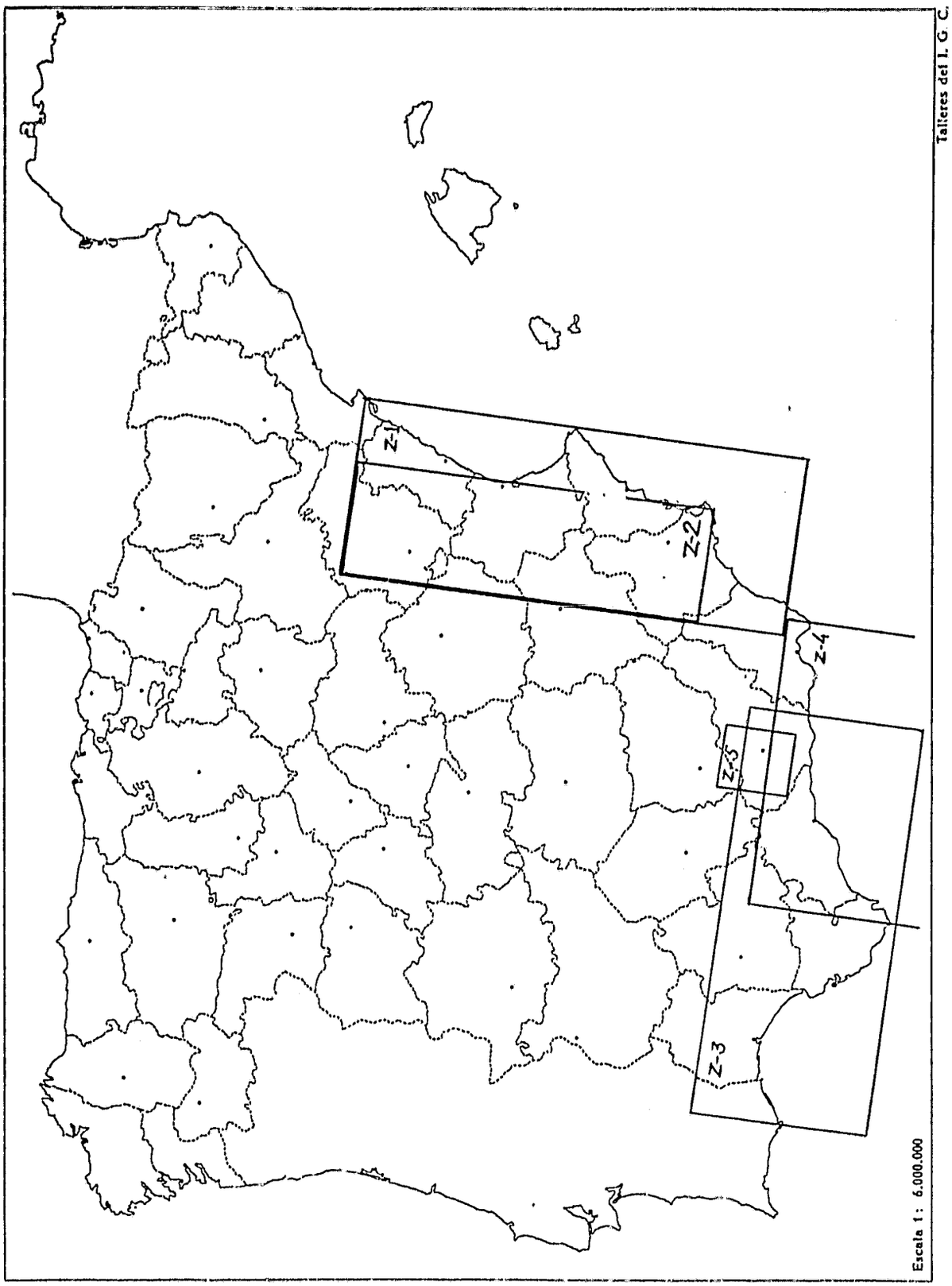


FIGURE 1.

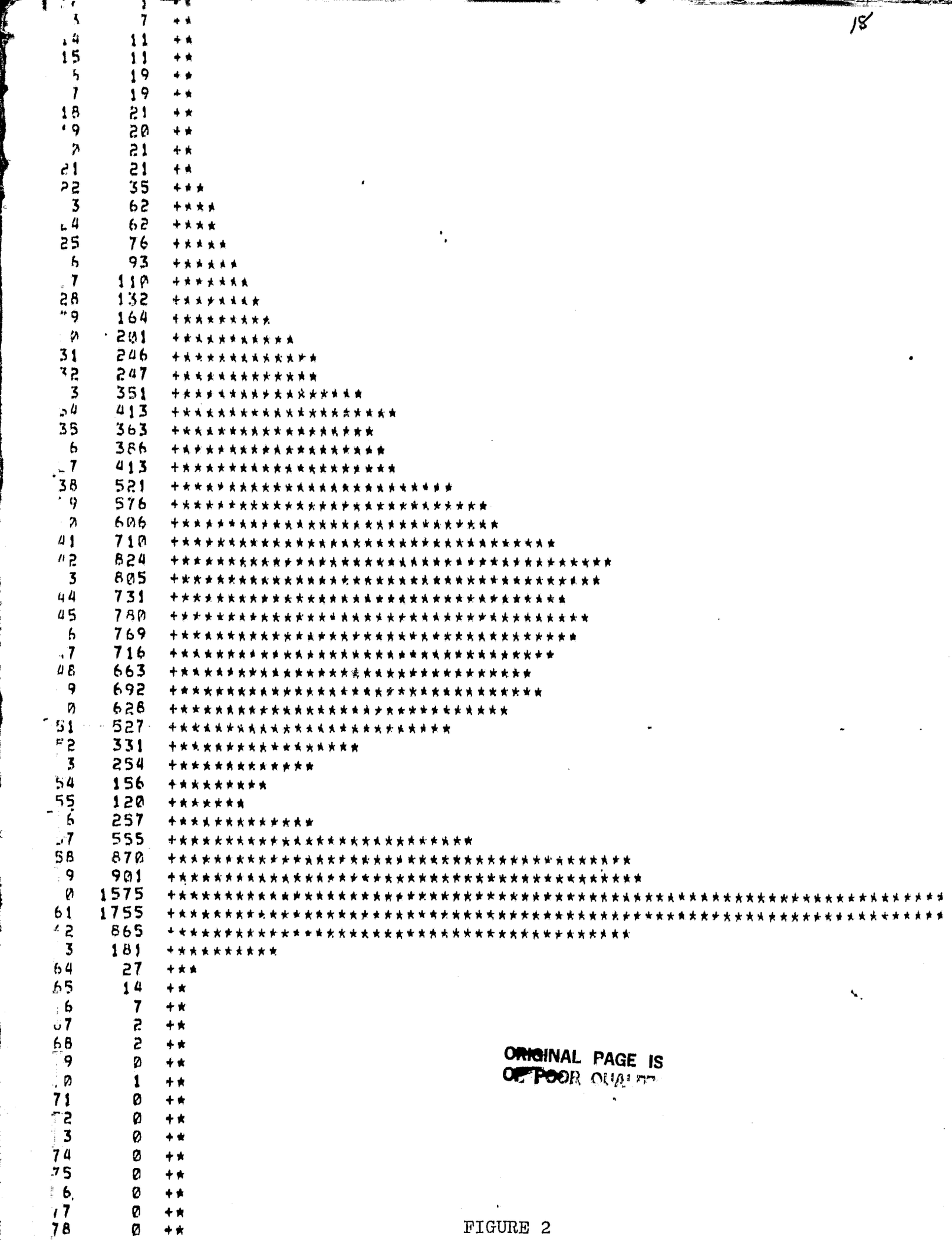
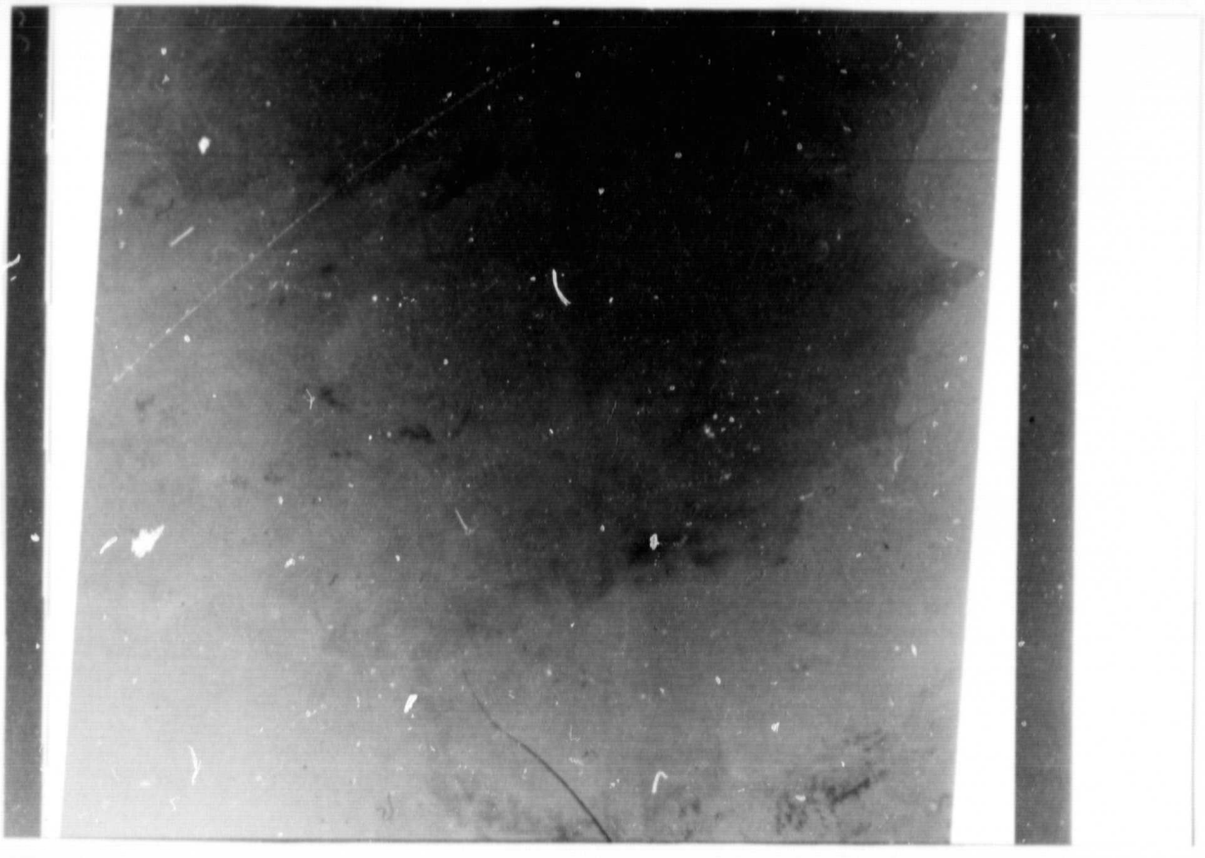
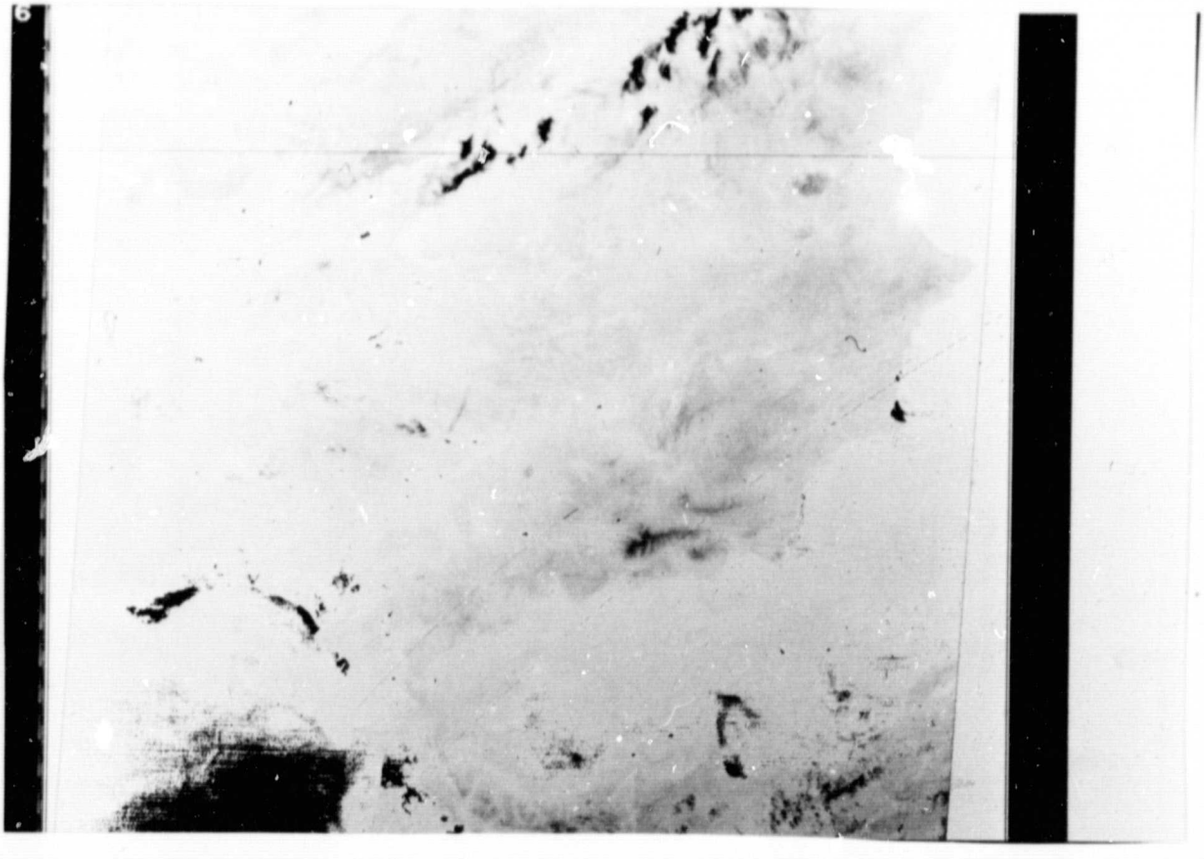


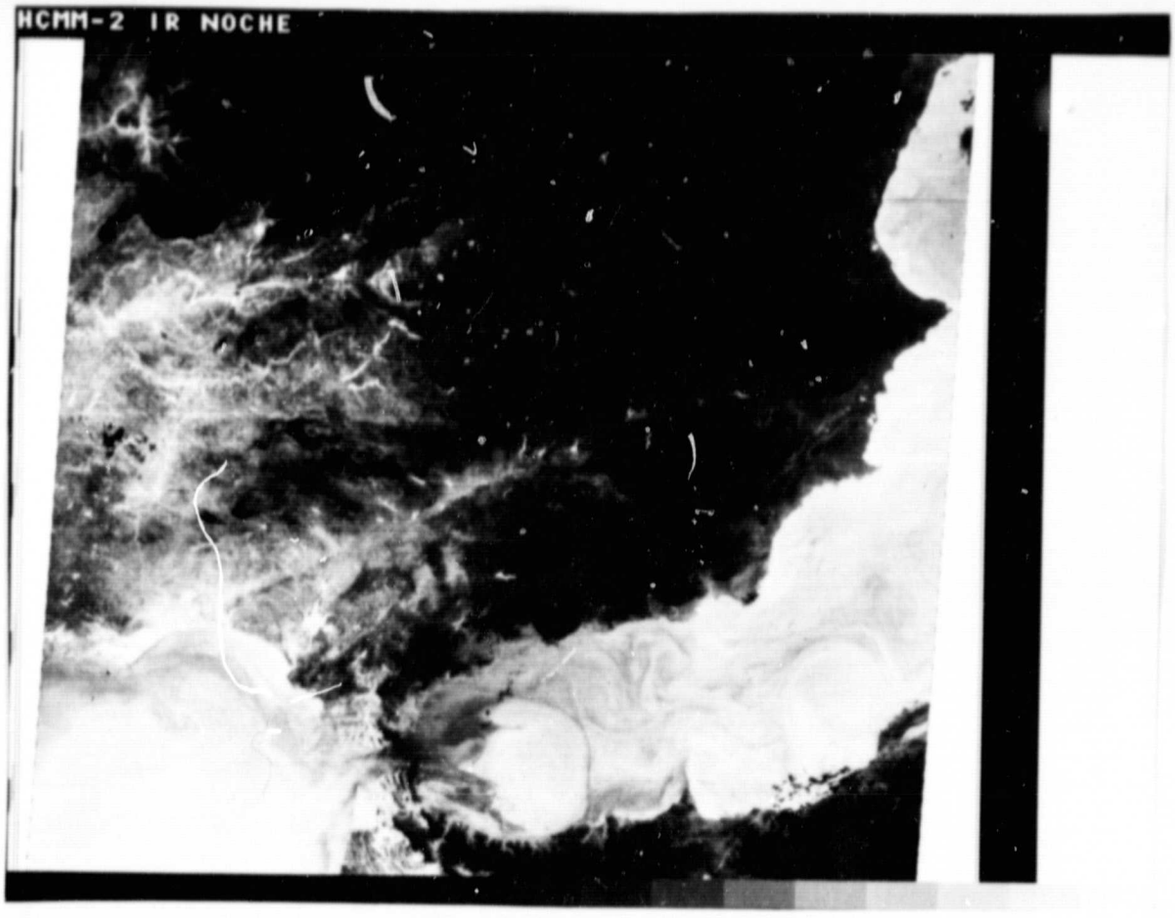
FIGURE 2



PHOTOGRAPHY 1

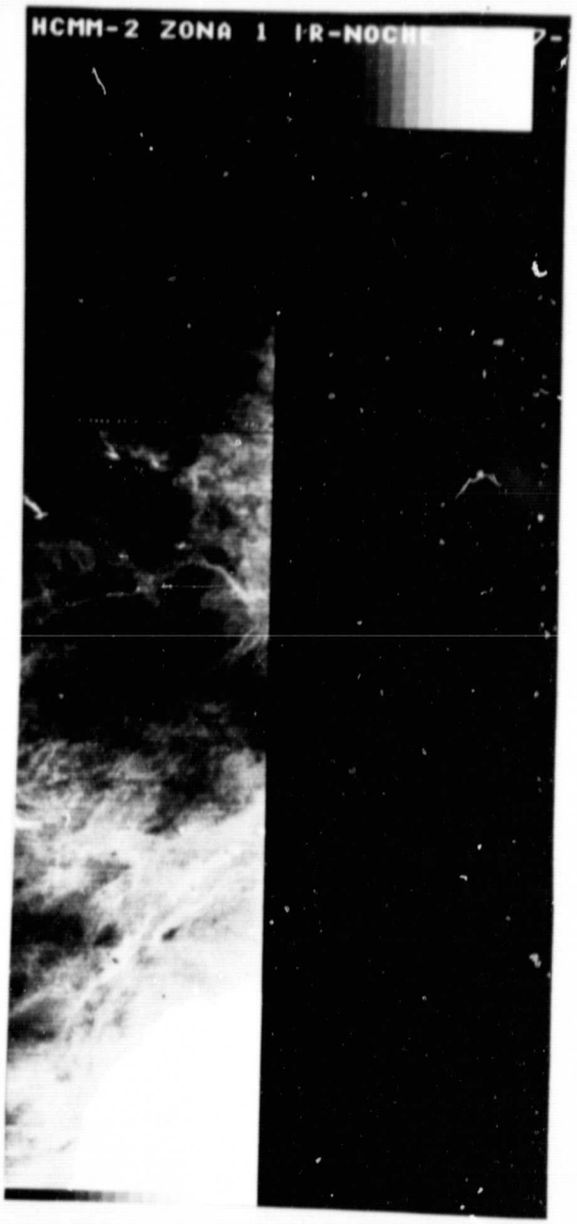


PHOTOGRAPHY 2

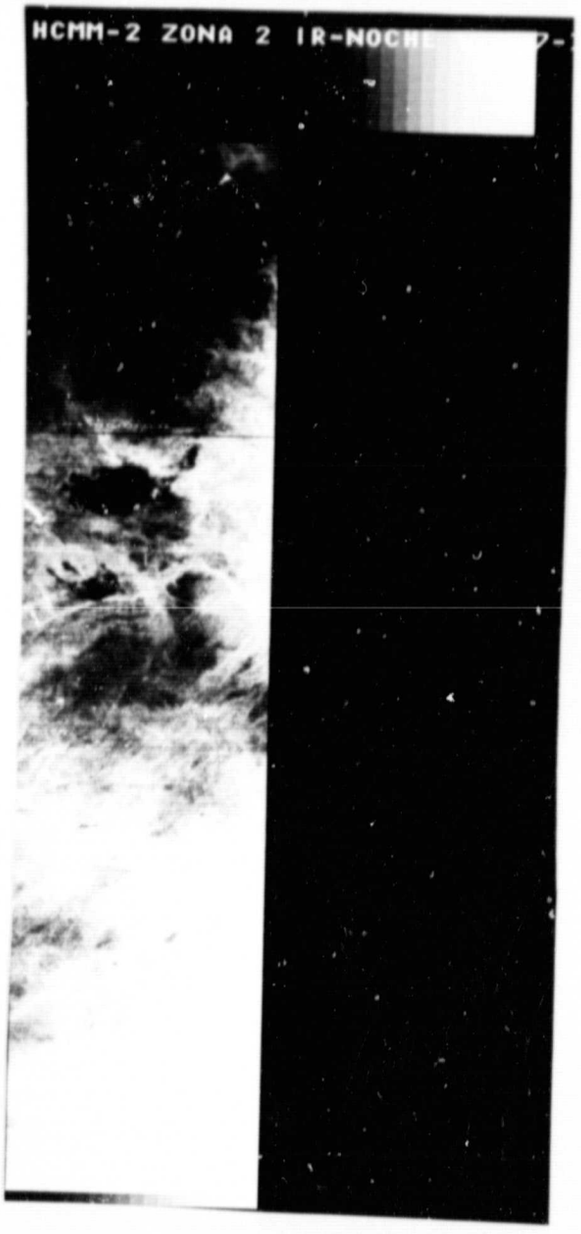


PHOTOGRAPHY 3

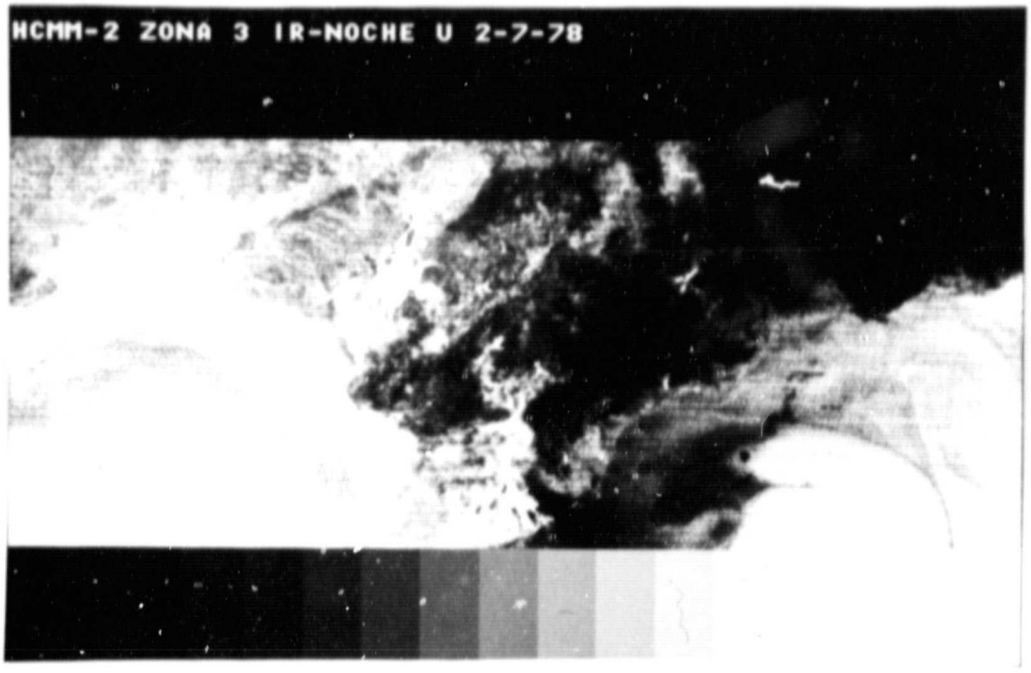
PHOTOGRAPHY 4



PHOTOGRAPHY 5

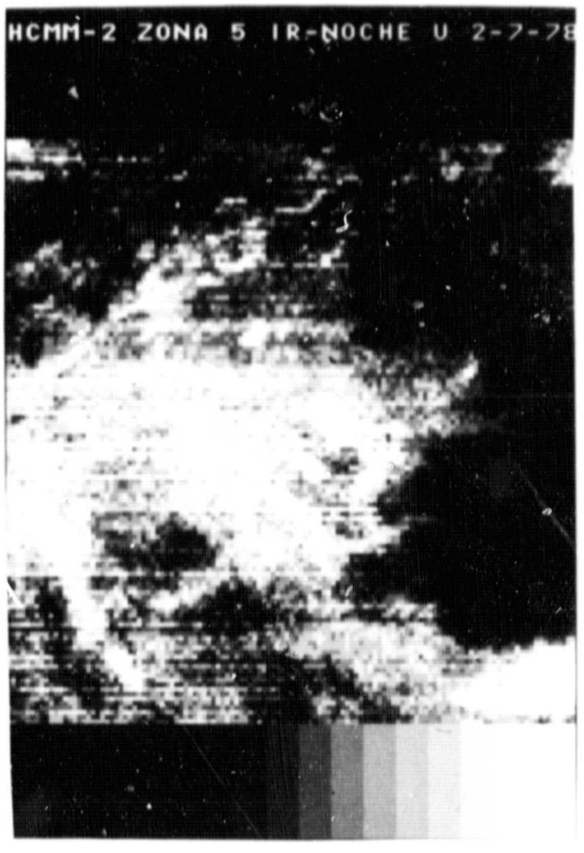


PHOTOGRAPHY 6



PHOTOGRAPHY 7

PHOTOGRAPHY 8



PHOTOGRAPHY 9

REPORT ABOUT THE HCMM SATELLITE IMAGES

Universidad Politécnica de Madrid
Servicio de Fotogrametría y Fotointerpretación

A study about the HCMM satellite images has been made in base to its usefulness to the objectives proposed in the initial plan investigation.

These objectives are:

- Knowledge of the soil surface temperature, in cultivated and forestry ground with or without vegetation.
- Study of the hidromorphism and the soil surface orientation and inclination, as modifing factors.

The study has been made, comparing the HCMM satellites images (visible chanel 550 to 1100 nm and Thermic Chanel 10500 to 12500 nm), with thematic maps as: Cultivated maps, soils maps, Geological maps, slopes maps and with the LANDSAT satellite images.

The study area is that one corresponding to the following National Topographic Maps at scale 1/50.000; numbers 668 Sagunto, 722 Valencia, 696 Burjasot, and 747 Sueca.

Remarks

1) The number of images avaible are very few, therefore the investigation is very restricted.
2) The image scale 1/4.000.000 is very small to our needs.
3) We have verified that the enlargement of the scale by fotographic methods does not improve the perception of details.

4) There have apeared in some images spots that could be interesant to identify on the terrain, for example: the spot located in the south of the Albufera, that possibly could be rice plantations.

5) The image quality of the study area, located in the left lower part of the image is worse then the central part of it, that corresponds to the Ebro depression.

Conclusions

1) Comparing the HCMM satellite images with the cultivated, geological and soils maps and with the LANDSAT images, we conclude that the information of the HCMM is very general and it has only interest at great areas level.

   Therefore, comparing the HCMM images and the cultivated Map of the seashore between Castellon and Gandia there may be perceived a great cultivated area but inside of it, it is imposible separate between the zones cultivated with fruits trees and those with rice or irrigated Land.

2) As a positive point, comparing the HCMM images with the slope Maps there is a great paralelism between these images and the terrain topograhy.

   It seems that HCMM sensor is fairly sensitive to temperature variations as the height changes and to the slopes oriented to the Norht and South.

Proposals

1) Taking into account that this judgment has been made concerning the information from a few number of images (taken on the other hand, in a short period of time) it would be necesary to make further studies with images over a larger period of time and analysing a greater number of images and comparing them with ground truth observations.

2) Treat to avail to the maximum the information given by the HCMM images (in general at the level of large areas, and the faculty to measure the temperatures with the height variation, in particular) and to intend to make thematic LANDSAT images, thematics maps, aerial photography and ground information.

GEOLOGICAL ANALYSIS

Universidad Complutense de Madrid
Facultad de Ciencias Geológicas
Dpto. de Estratigrafía y Geología Histórica.

An analysis based on geological criterias and following a methodology very similar to that used when doing conventional photointerpretation, will be carried out all over the following images.

*	A - A 0127 - 13360 - 1	DAY - VIS.	31 AUG 78
*	A - A 0127 - 13360 - 2	DAY - IR.	31 AUG 78
*	A - A 0157 - 02050 - 3	NIGHT-IR.	30 SEP 78
*	A - A 0087 - 02020 - 3	NIGHT-IR.	22 JUL 78
*	A - A 0120 - 13060 - 1	DAY - VIS.	24 AUG 78
*	A - A 0184 - 12590 - 3	NIGHT-IR.	27 OCT 78
*	A - A 0115 - 02200 - 3	NIGHT-IR.	19 AUG 78
	A - A 0185 - 13180 - 1	DAY - VIS.	28 OCT 78
	A - A 0185 - 13180 - 2	DAY - IR.	28 OCT 78
*	A - A 0185 - 13160 - 1	DAY - VIS.	28 OCT 78
*	A - A 0185 - 13160 - 2	DAY - IR.	28 OCT 78
*	A - A 0190 - 13090 - 1	DAY-VIS(NEGATIVO)	2 NOV 78
*	A - A 0190 - 13090 - 2	DAY-IR.(NEGATIVO)	2 NOV 78
	A - A 0191 - 13270 - 1	DAY-VIS(NEGATIVO)	3 NOV 78
	A - A 0191 - 13270 - 2	DAY-IR.(NEGATIVO)	3 NOV 78

(*means those images including more than a 20% of the study zone).

From a geological point of view the following foregoing conclussions have been achieved

- The most important geological results were obtained out of the study zone due to the following reasons:

  A great deal of the study area was located on alpine mountain ranges characterized by difficult tectonics, with mesostructural level, and by stratigraphic series showing a large

variation within a thin layer. It is by these reasons that a pixel contains severall folds, fractures and litostratigraphic units. This is clearly showed by an area containning part of Alicante, Murcia and Albacete provinces. On the other hand the best results were achieved either over large great morphological-structural units or stratigraphic ones (continental tertiary basins and hercynian mountain ranges).

- Since the study area includes a region with high density in population and having a major activity in industry, agriculture, communications and urban planning, the influence of human actions over the scene is very strong and sometimes these actions are independent from the geological substrate even acting against it. By these former reasons the geology is masked.

  Something different happens with non-populated areas in peninsula midlands. These areas with no more human action than grass farming, horticultural activities and forest, facilitate the identification of litologies in which they are seated.

- Every geological result achieved is conected with completion of fold traces in a regional scale (Toledo mountains and "Sierra Morena"), large fractures (cantabric and Iberic mountain range), fractures with rear reactivity affecting continental tertiary (Tajo, Duero and Ebro basins). The results are also conected with discrimination among compact litologies and rocks with high crystallization (Hercynian ranges, plutonic rocks parts of Alpine ranges), with a thermal behaviour different from that of the little consolidated terrigenous rocks (continental tertiary and quaternary recoverings).

  Both, the criteria used to perform this work and the results achieved by using it, will be discussed in the following paragraphs.

Visible band images

This images shows a coarser resolution than Landsat images, but due to the large area within a frame it is possible to study simultaneously a large area with similar atmospheric conditions, solar ilumination and state of seasonal vegetation.

Visual analysis and interpretation of these images showed that changes in litology can be deduced from changes in vegetation. Three types of vegetation can be distinguished.

a) All-kind-forest (coniferous, mediterranean, etc.) prairies, etc. Tones are dark-gray.

b) Horticultural terrain, irrigated land. Tones are medium gray with broad grains.

c) Cereals (excluding rice and corn), only dry gramineous harvested between middle July and late August.

These three types of vegetation are connected with the following morphological and geological elements.

a) Hercynian and alpine mountains with a very variable litology prevailing dense rocks with high cristallization; Abrupt forms between sea level and 2.000 meters altitude, over this height the ammount of arborescent vegetation drops considerably.

b) Seated on rivers'low terraces, coastal zones on quaternary deposits and as an exception rivers'high terraces or tertiary plains irrigated either by land channels or by any kind of water extraction system.

c) Mainly developed on terrigenous parts of continental tertiary basins (Duero, Ebro, Tajo) containning every kind of soil among clay, loam, sand and conglomerates. Also cereal stains appear on deposits over quaternary slopes, ancient aluvial fans, etc.

Notice that the continental tertiary basin of Badajoz (TIERRA DE BARROS) appear with a dark tone due to dark brown-redish soils and to the broad cultivation of niveyards (instead of cereals) with stubs in the upper stage of their development until november. Something similar occurs with Guadalquivir's tertiary oceanic depression filled by loams, clays, etc and showing large areas cultivated with vineyards and olive trees as well as with sunflower and cotton.

Morphology is mainly observed by looking at slope ilumination. The highest density of vegetation is in shadowed areas.

An image gathered on october 28th shows a small snow pack that increases the contrast.

Every system of regional fractures with morphological meaning appears in that image in which horizontal projection of solar rays form an angle between 20° and 60° with the direction of that system. As it is known, morphological analysis is strengthened by looking at these images from the north side.

Summaring, visible band images allow an indirect litoligical and structural control through vegetation.

Remember that dry cereals harvest has been carried out in later August and by these reasons areas dedicated to this cultive couldn't be discriminated from non productive areas.

Comparison of iluminated and non iluminated areas shows the morphology and principal fractures that can be deduced from here.

Day thermal images

This image reveals the largest ammount of difficulties for an in depth analysis due to the various factors that affect the anergy impiging into the sensor from a certain area.

Assuming ground level and known litologies, there are cases in which only assumptions about the ratio reflected energy/ emited energy are feasible.

In summer images, detection of low atmospheric masses with high density is possible.

On the other hand, the best geological results were achieved by using this kind of image (exactly 28th of october) and performing on it an empyrical analysis.

Every litology showing enough continuity on surface (even when there is not change in vegetation) is distinguishable in this image. Best results were obtained in Hercynian structures of eastern Toledo mountains and "Sierra Morena", increasing, in a net way, Landsat images quality.

It is not the goal of this report to give a description of the numerous results obtained.

Taking into account the morphology and fractures showed by it, strong contrast between sun iluminated slopes and shadowed ones enables a very aceptable control, although in high mountains areas it is impossible to discriminate between snow zones and rocky areas with the same temperature (within an image).

Finally, it must be noted that a comparison between visible and IR bands has been carried out with simultaneous images.

Since thermal IR almost ignore grass, that on the other hand is so well distinguishable using visible band, this grass can be eliminated during the analysis proccess by comparing both images.

Summarizing, it must be pointed out that IR images, gathered in autumn, and without important storms neither at satellite pass nor within the three days before it, give the best results from geological point of view, although it must be remarked again that the study zone shows poor results.

Summer images with sun in a vertical position (56°) and high ground temperatures, present very poor results mainly in the warmest areas.

Night thermal image

Different images gathered in very different metheorogical conditions were analyzed.

The results obtained vary a great deal and the importance of geologic substrate drops off to a second position except in a general sense.

We believe that it is here where a better resolution is missed and where the largest number of images, in different temperature ranges, would be necessary in order to perform the visual analysis.

Notice the general tendence of images to stratify gray levels in a paralell way to the stratification of quotas existing, an optimun resolution for litologies within those thermal strata and a very coarse one, even null, out of it. In other words "forms effect" overcomes strongly "litologic effect" and the importance of heat capacity and conductivity drops off to a second position. So that it is in plane zones of air's temperature where a connection between changes in radiation and changes in litology have been clearly observed.

In morphology, the strong emissive contrast between western and southern slopes gives sharper froms than northern and eastern ones.

This effect, that has an attenuation throughout the night, can't be analyzed more than once every night night due to orbital characteristics of the satellite.

In geology it seems undoubtely that only areas of sedimentary, metamorphic and igneous rocks, compact and highly crustallized with disperse terrigenous porosities or little compact materials, are distinguishable with HCMR resolution.

Within the broad range of the specific heats of these materials (diversificated even more if the very different absortion coefficients are considered) thermal conductivity is the principal factor controlled by these images. So, the most crystalline and dense rocks (generally the oldest ones) get colder rapidly, while disperse or little crystalline materials (mioceno-quaternary) having worse conductivity keep acumulated thermal energy for longer.

It would be interesting to analyze the cooling curves of different litological areas throughout the night to compare among them.

The effect of water-loving vegetation masks litological efects reducing, specially during summer, the emission level. A storm pass can be detected through soil moisture and lower temperature; the same happens with air masses as well as irregular diurnal insolation caused by clouds. Generally after a storm the contrast diminishes.

Among the human factors, it may be emphasized the clarity of the rice areas as black sports (S.SE of the La Albufera) and the unexpected scarce efect of the great cities.

Final considerations

The photogeological interpretation of images, may be an important aid for this methodical analysis, since geological ground truth is known with a superior detail than images resolution. It can be decided about possible local anomalies, not justified by agrobiological, meteorological and hidrological analysis and indicate with litological maps its possible justification. The low quality of negative on positive paper employed together with the broad range of reflectance and or emission levels, advise us to delay a deeper analysis of the images until the radiations levels maps are avaible for a larges number of images (even without correction of form

effect), or at least a peripheric net, dense enough, or in the worst positions standardized profiles in scan lines, easier to execute.

The most promising initial results in geology have been obtained with day IR in the autumn, (without an important atmospheric pertubation) the merge with the visible band image improves the results and solves the doubts about vegetation. Night IR images have an unequal geological utility depending on the anual season, on the time since sunset and on the meteorological conditions, the two days before and in the moment of taking the images.

To obtain a better benefit from the thermal images, it is necessary to use the meteorological bulletin with local air temperatures, rainfall, cloudiness, meteorological maps, between the date of the image and two days before, besides the hour of the sunset in the four angles of the images, or at least in the center of then, in the same reference horary than the night thermal dates.

APPLICATION OF THE HCMM SATELLITE DATA TO THE STUDY OF THE SUBTERRANIAN WATER DISCHARGES ON THE MEDITERRANEAN SEA.

Centro de Estudios Hidrográficos
Ministerio de Obras Públicas.

Introduction

In the thecnical proposal of HCMM investigation 034, "Thermal mapping, Geothermal source location, Natural effluents and Plant stress in the Mediterranean coast of Spain" dated September, 1, 1975 there was settled the colaboration of the Hidrographic Study Center, in the point number 3, "Natural effluents".

Until July 1979, this Center didn't receive any information from the HCMM satellite that could allow the study of its possibilities to the proposed plan. From this date and from the available images, have been selected the next ones:

0184-12590-3	Night	IR	-	22 Oct. 78
190-13090-1	Day	IR	-	2 Nov. 78
190-13090-2	Day	VIS.	-	2 Nov. 78

These images include the spanish eastern coast with it's eastern coast line free of clouds, from what we were able to study the tonality variations of the coast waters.

Image analysis

The image has been only analyzed on 37 x 39 cm. positive copies and from the analysis of three of them, the following considerations have been made:

1) In the A0184-12590-3 and images can be clearly seen the

thermic coast anomalies in the Rosas Gulf., in which the waters appear darker than beside the Gulf. This may be originated by marine currents.

2) It is appreciated a slightly dark tonality on the zones where the Llobregat (near Barcelona) the Ebro (in the delta) and the Jucar rivers flow into the sea. This allows to affirm that the rivers temperatures were colder than the sea ones in the moment of the images gathering.

3) The anomalies observed on the South of Cape Nao, image 184-12590-3 seems to be only the rush of two marine currents.

4) None of these images allows to identify the anomalies in the coast points where there are the most importants submarin discharges (in the coast from Vinaroz to Benicasim and from Burriana to Sagunto). On some zones, it can be seen a slightly darker tonality, but the ground resolution of the HCMM sensor does not allow to assume that these anomalies are the result of the discharges, because they are punctuals and with a discharge of only several hundred liters per second of water.

5) On the 190-13090 image (visible) the water is completly black and it is not possible to see any anomaly.

Conclusions

The image scale and the resolution of the HCMM detector are inadequate for the study of subterranean discharges into the sea.

Nevertheless it can be expected that with an enhancement of some partial zones, there may be obtained better results in the analysis of these zones.

STUDY THE CIRCULATION WATER ON THE ALBORAN SEA BY HCMM IMAGES.

Abstract

The Alboran Sea, west of the Mediterranean, is a very important body of water where circulation processes have influence on both the Mediterranean Sea and the North Atlantic Ocean. Surface Atlantic water enters the Alboran Sea by way of the Strait of Gibraltar and its circulation is dominated by an anticyclonic gyre. It is the purpose of this work to know if the data from the HCMM could help to the study of the variability of the gyre.

The Alboran Sea.-

This sea ocuppies the western most basin of the Mediterranean Sea, from Gibraltar to the 0°30'W, its average depth is of about 1000 m., and there takes place an important process of mixing between the Atlantic water that enters, remaining in the surface, through Gibraltar and the Mediterranean water that goes out, under the surface.

The main features of the surface circulation in the Alboran sea are the following, (fig. 1): A main, meandering current to the East with a mean velocity of one knot. Between the strait and the 3°W meridian there is a big anticyclonic gyre (40-50 miles wide). To the east of that meridian, the main curret passes by the south of the African coast, smaller than the former. Near the spanish coast there is a counter current and an upwelling zone in the coast of Malaga.

Lanoix (1974) has described the anticyclonic gyre in the Alboran Sea (fig. 2). Its character is unusual in a zone where the opposite sense would seem more probable considering

the strong inflow of surface Atlantic water which might be expected to turn to the right as it enters the Mediterranean in response to the Coriolis parameter. From the studies by Capart (1963)(fig. 3), Lanoix (1974), Cano (1978) and Cheney (1978)(fig.4) it looks like that the gyre is a permanent feature, but till now the frequency of oceanographic cruises has not been high enough to demonstrate it. A laboratory model experiment has been carried out in Woods Hole Oceanographic Institution (Whitehed and Miller (1979), that has produced a symilar gyre.

Objective.-

Our objective is to know how useful could be the data from the HCMM to study the variability of the gyre.

Method.-

We pretend to compare the data from the HCMM with the oceanographical data we have and shall take. For that reason we are planning periodical cruises to the Alboran Sea, with the "R. V. Cornide de Saavedra".

Altough our cruises take a wide range of oceanographical samples, for this program we shall use only the water surface temperature using bucket thermometers (±0,5°C), reversing thermometers (±0,02°C), XBT(±0,5°C) and CTD(±0,02°C).

After the data be corrected and cleared we shall plot the isotherms that give a fair picture of the limits and situation of the gyre. All this done we shall pick up those images of the HMCC that better fit our purpose, i.e. good and clear picture, synchronism, etc., and they will be processed to make them easily comparable with our data; we shall see if there is some kind of correlation between them and hope to

be able with the help of the HCMM image to monitor the variability of the gyre, at least seasonally.

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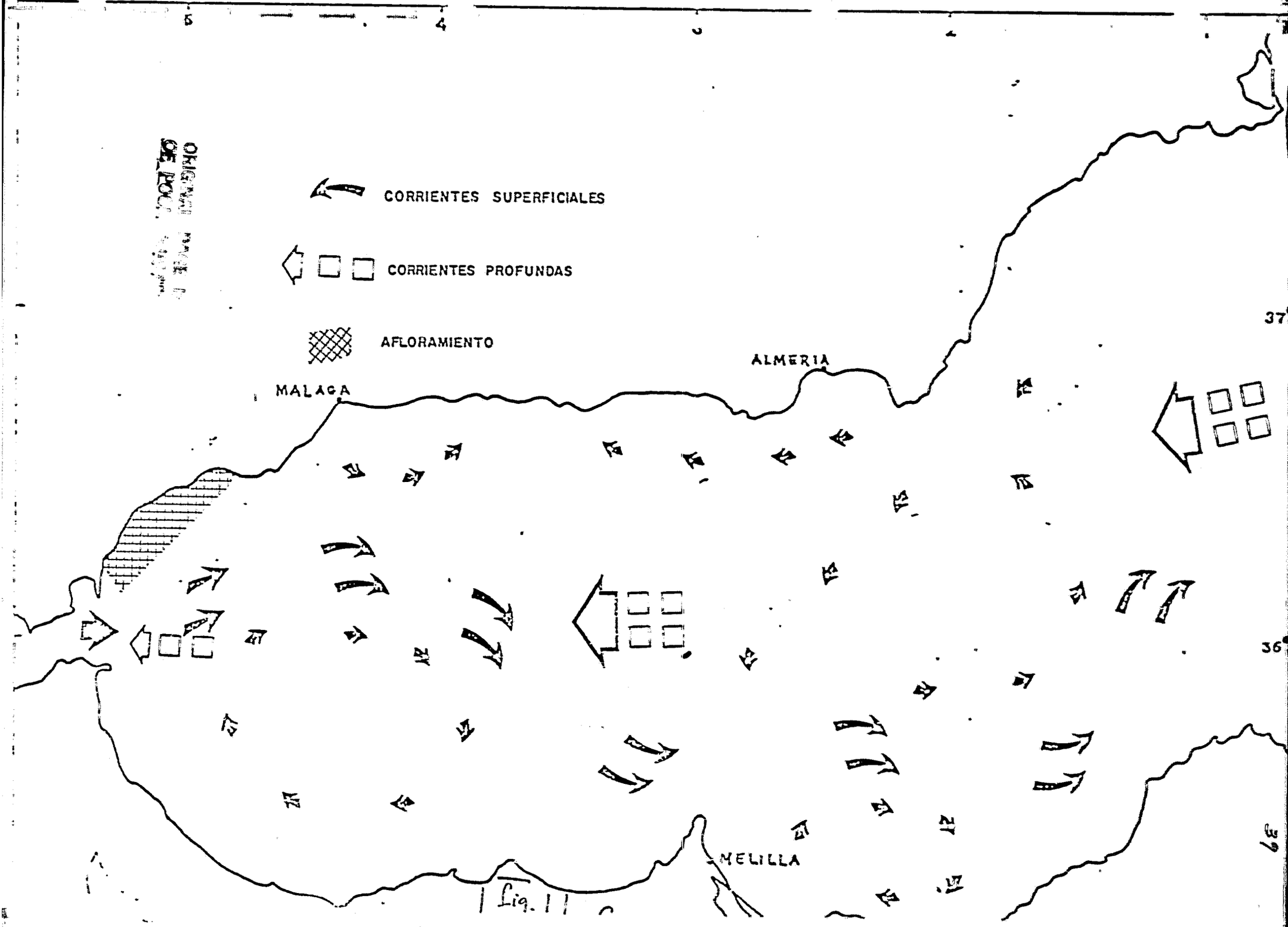
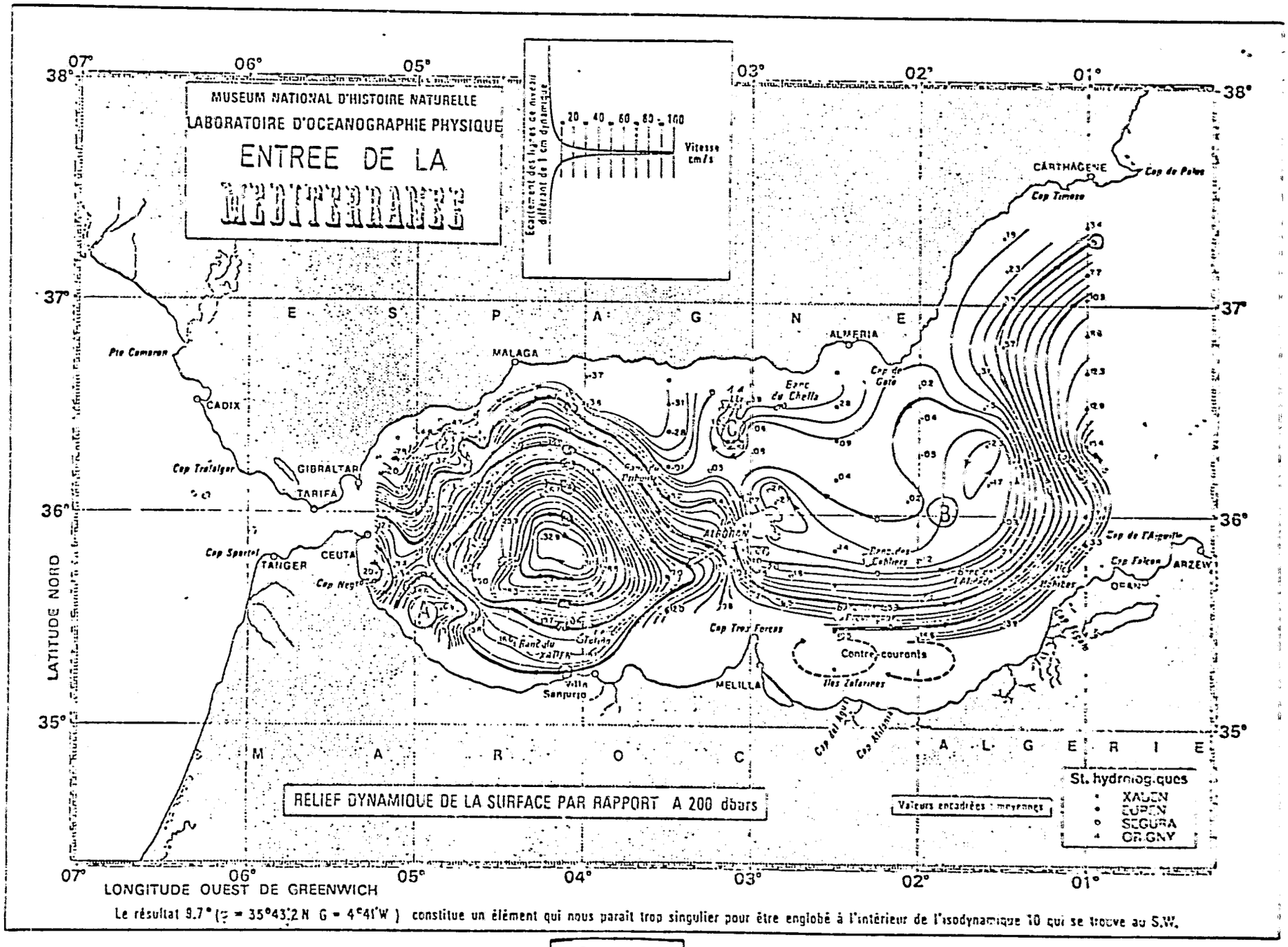

CORRIENTES SUPERFICIALES
CORRIENTES PROFUNDAS
AFLORAMIENTO
ALMERIA
MALAGA
MELILLA
37
36

Fig. 11



Le résultat 9.7 (φ = 35°43'2 N G = 4°41'W) constitue un élément qui nous paraît trop singulier pour être englobé à l'intérieur de l'isodynamique 10 qui se trouve au S.W.

FIG. 25

fig. 2

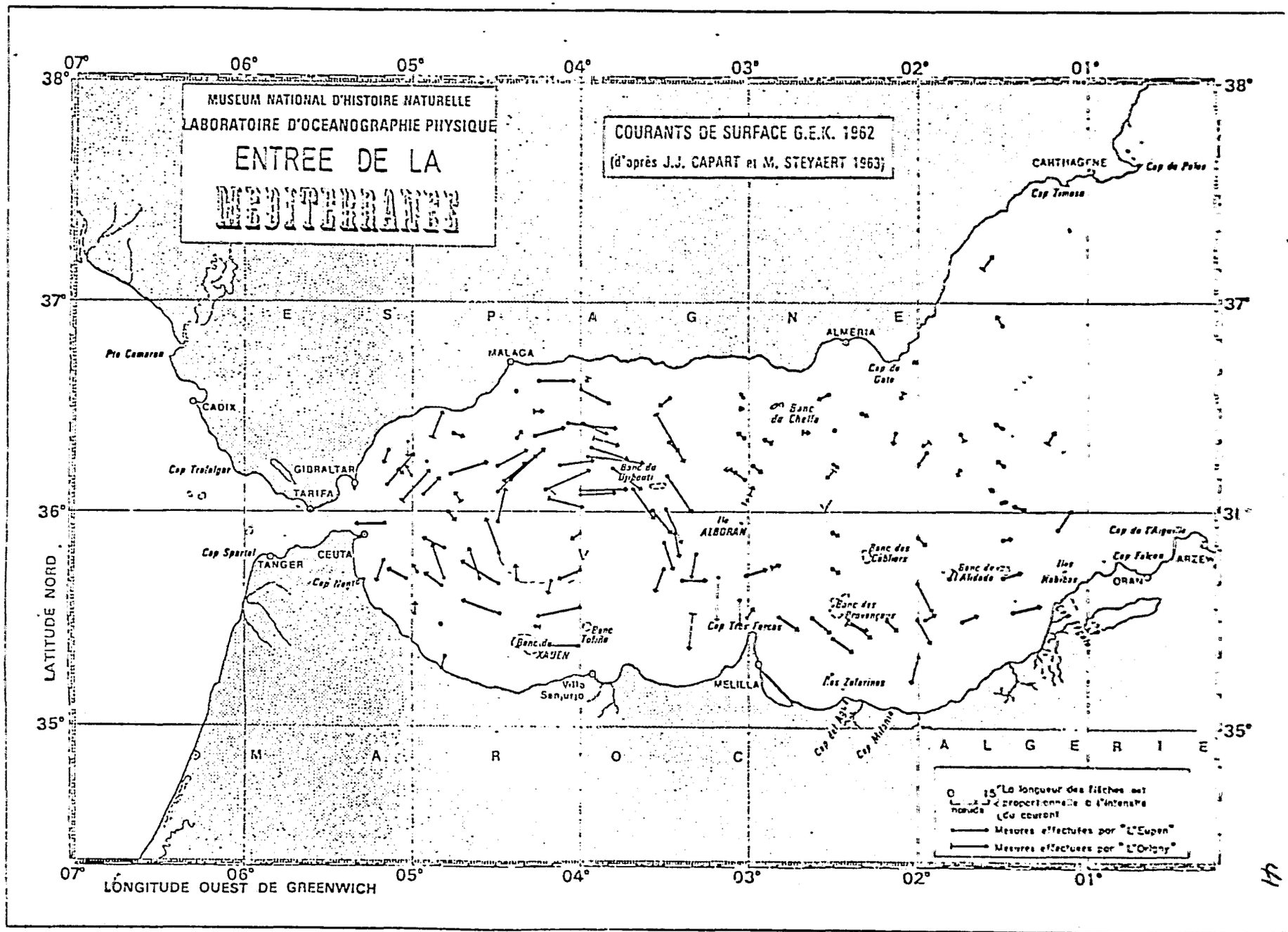


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FIG. 26

fig. 3

4

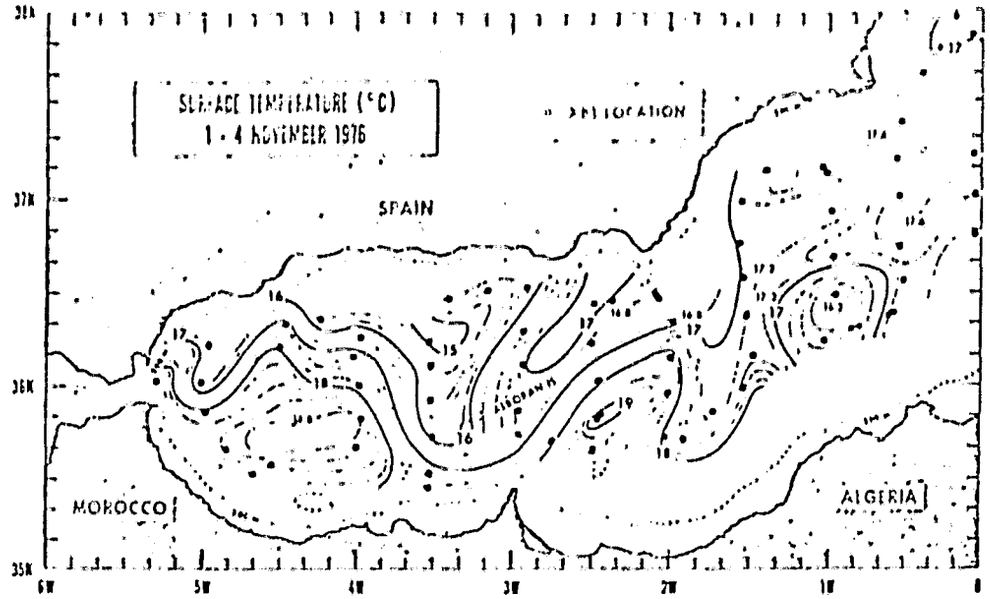

Fig. 2a. Map of temperature at the surface. The Alboran Sea Front corresponds to the 17°C and 15°C isotherms, respectively. Warmer temperatures are found south of the front. The meandering front creates a series of alternating anticyclonic and cyclonic cells.

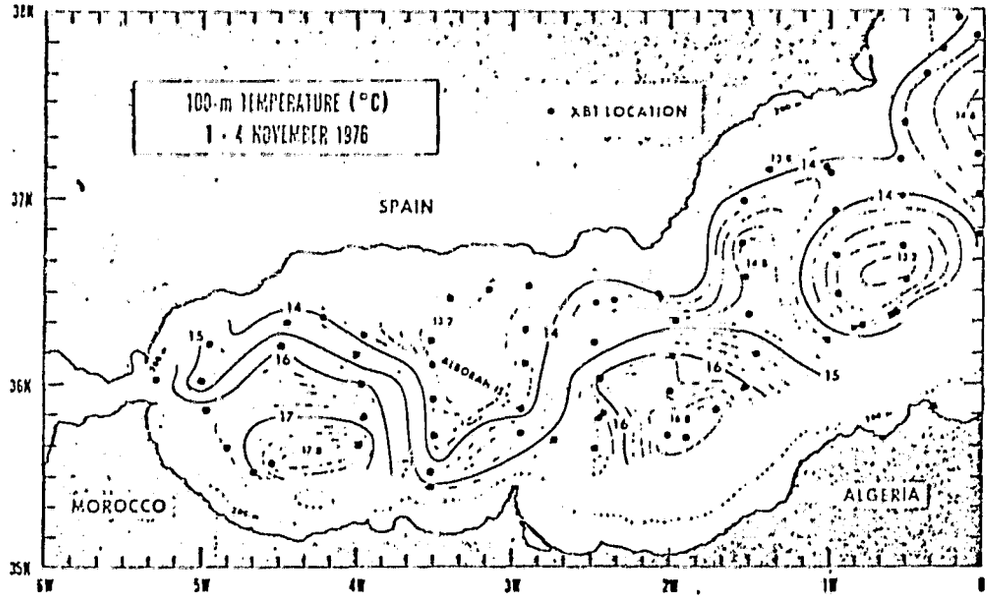

Fig. 2b. Same as Figure 2a for temperature at 100 m during November.

fig 4.

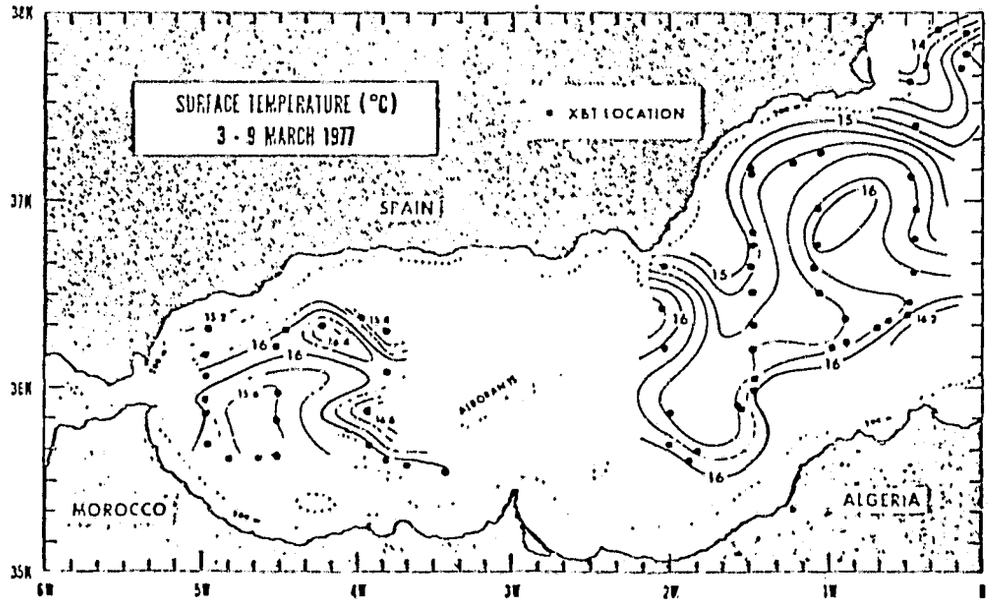

Fig. 3a. Map of temperature at the surface. In the western Alboran Sea, incoming Atlantic water appears as a surface temperature maximum, while at 100 m the front takes on its more common appearance.

Cheney R. E. JGRDA 83(C9) pp 4593
1978

PRELIMINARY REPORT

Thermology Department
Physics Faculty
University of Valencia

In the project of collaboration between the National Geographic Institute and the Thermology Department of the Physics Faculty of Valencia, made in May, 1978, in order to use the data provided by the HCMM satellite, three main investigation lines were considered:

1.- Evaluation of the data provided by the HCMM satellite.

2.- Study of the energetic interchanges between soil and air.

3.- Analisis of the changes caused by broad surfaces with a high soil humudity index.

The election of these work lines was partially made as a result of the experience that the Department had in former investigations in the Valencian region, some of them in the same zone, the Albufera, selected for the present project, that took place in the years 1977 and 1978. From these former investigations we could get some initial issues referring to the temperature evolution in the area at two different levels, 1,5m over the soil level and 0,20m under it.

From these previous results and from a first analysis of the photographies got by the HCMM satellite from the area and handed by the National Geographic Institute, we get to decide that its temperature resolution is not good enough to observe the temperature differences held in close up points of the same area.

As a consecuence it seems to be necessary to modify the initial work planning in what four measurement stations were to be

placed in a area situated in the south of Valencia and between this city and Cullera.

We have selected, ir order to make temperature measurements, two different areas with different soil type and vegetation. These differences are clearly distinguished on the grey intensity. One of them is in the north of the city and the other in the south, exactly in the Albufera as it was in the initial project. Both areas may be seen in the adjoining map.

In every one of the two zones will be situated two different stations only a few hundred meters from one another, so as to be able to evaluate the temperature fluctuations in the same area, because the satellite photographs show similar temperature for the same area.

With this new distribution of measurement station we hope to get final results as to the possibilities of the inicial project and to the application of the HCMM measurements to the agro meteorology.