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CONSIGLIO NAZIONALE DELLE RICERCHE
ISTITUTO PER LA GEOFISICA DELLA LITOSFERA

20133 MILANO.
Posta: I. G. L. - Via Bassini, 15
Tel.: (02) 299098 - 2363690 - 230960

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HEAT CAPACITY MAPPING MISSION (HCMM) PROGRAM

INVESTIGATION HCM - Ø5Ø

STUDY OF GEOLOGICAL STRUCTURE OF SICILY AND OTHER ITALIAN AREAS

P.I.: Roberto CASSINIS
Istituto per la Geofisica della Litosfera
Consiglio Nazionale delle Ricerche
Milano (Italy)

SECOND PROGRESS REPORT - JANUARY 1980

prepared by:

Roberto CASSINIS, P.I.
Giovanni Maria LECHI, Co-Investigator

Pietro Alessandro BRIVIO, Physics
Renzo MORETTI, Software
Eugenio ZILIOLI, Geology and Environment

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I - FOREWORD

We refer to part one of our first progress report - Aug.1979 as far as the general objectives of the survey, the choice of the best areas and their description, the equipment used for data processing, as well as the procedures and general software employed.

This report will be entirely dedicated to the first evaluation of A.T.I. on one of the selected test sites.

At the end of November 1979, we received two CCT'S whose images (ident.numbers [redacted] AA0059014103-AA0059123702-AA0059123701) containing the recording of the complete pass of June 24, 1978 (visible + night/day I.R.). These tapes are the only material so far received that can allow the computation of A.T.I., i.e., the main objective of the survey.

The test area where data have been processed. was selected primarly on the base of the quality of the image as well as of the homogeneity of night/day meteo conditions. Moreover, also the geological, morphological conditions as well as the vegetation canopy seem quite adequate to try a first evaluation of A.T.I.

II - TECHNIQUES

II.1 - Data handling and software

The quality and the scene covered by the June 24 pass is illustrated in Fig.1 (quick looks of visible and night/day I.R.). The detailed investigation area is indicated by an arrow.

The application of the algorithm suggested by NASA for the computation of A.T.I. gives the results illustrated by the image shown in Fig.3 .

Nine levels of thermal inertia are shown inland.

In order to minimize the effect of the errors of registration a resampling program has been designed and not yet ~~actually applied~~ fully developed. Each original pixel was subdivided into nine "subpixels" whose values depend on the surrounding pixel; a suitable quadratic function was studied in order to reach the best fitting with the original distribution.

In such a manner we obtained a new set of images where the "geometrical resolution" is actually improved.

The image shows a very good definition not only in geometrical resolution but also in A.T.I. function resolution.

This resampling technique to the A.T.I. will be better evaluated on the near future.

III - ACCOMPLISHMENTS

III.1 - Description of the first sub-test area for A.T.I. (Gulf of Orosei, East Sardinia) (Fig.2)

The free-cloud window, resulting from the first complete day-night available pass of HCMM on Sardinia, offers some interesting features and aspects for an explorative analysis even though a preliminary approach remains. It extends to the eastern [redacted] part of the island facing to the Gulf of Orosei: meaning geolithological units and different kind of morphology are present. Because of the main topic of the investigation, i.e. the rock-type discrimination, a first correlationship between thermal irradiance and topography or surficial occurrences (vegetation, altitude etc.) was mandatory, to settle the possible and elementary ambiguities which could come from. Such a correlation has been built and followed along two significant [redacted] geologic cross-sections in the window as shown in Fig.2.
Traces are justified by the need of comparing different topographic and geologic trends; two coastland morphologies also have been taken under consideration: the steepened calcareous cliffs and the flat alluvial lowlands.
Geological setting of the area concerns mesozoic and paleozoic sedimentary units submitted to low folding agencies and modeled by a compressional system of reverse faults. Hercynian granites, porphyries and basalts outcrop somewhere, after their crossing in different ages, through the sedimentary formations.

III.2 - Description of the results

As we have already said above a first attempt of evaluation has been made by cross-section profiles of different meanings, i.e. the geological, topographic, IR irradiance and thermal inertia have been compared one another.

III.2.1 - Areal distribution of A.T.I.

The image of Fig.3 shows the areal distribution of A.T.I. as displayed by the monitor of the employed computer system.
The results are displayed in 6 bit way using the refresh memory planes (64 gray levels) while the computations are developed in 8 bit way; hence, there is a

sort of data compression during the display-phase.

For this fact the B&W image doesn't represent the whole information content, having assembled the 256 levels into groups of 4.

The 14 resulting levels shown in the profile have to be considered then as 14x4=56 levels full range.

III.2.2 - Thermal inertia profiles and their comparison with morphology, geology and thermal I.R.

Night thermal irradiance profile does not seem to be in appropriate agreement with the topographic one, but Scala Manna Mnt. surroundings (see Sect.A-A'). The general trend of the thermal profile along the two sections mantains some correspondances that could be summarized as follows:

- eruptive rocks (either extrusive and igneous) look like have relative higher irradiance values.

  Porphyries, in particular, are well contrasting whereas flat morphology occurs.
- Shales and associated rocks appear to be causing the decreasing of the values. This fact is well clear when porphyries extrusions are closed to the shales.
- Generally, mesozoic carbonatic formations, as well as the alluvial sands and gravels, mantain lower values up to reach the relative minima.

  Such a consideration is also well fit within the neighbour of Scala Manna Mnt. (see sect.A-A').
- A negative spike (see section B-B') corresponds ~~with~~ to the contact between giurassic and cretaceous dolomitic limestones.
- Positive ~~spikes~~ highs seem to have a general rule of discriminating the boundaries of the outcropping formations.

Thermal inertia profiles appear smoothed in comparison with the thermal irradiance's, as we really expected.

Given the large differences between water and land, we have introduced two different scales. Giving a quick look at the A.T.I. profile, few notes can be drawn:

- Sea-water maintain the largest values, as expected
- Brackish waters of Tortolì Pool are well identified, in contrast with the surrounding alluvial deposits
- Differenceseems to be maintained between dolomites (higher A.T.I.) and limestones (lower) especially where a contact exists.

- An unexplainable peak appears within granites outcrop, eastward Isalle Creek (see Sect.A-A') as well as in the Section B-B', even though lower in amplitude. Perhaps a concentration of silica occurs.
- A general trend, but not everywhere confirmed, seems to give the A.T.I. profile a decrease in correspondance of eruptive rocks.

  In general, lithological contact seem to have larger influence on A.T.I., than proper faulting in homogeneous formations.

  However, these conclusions are hardly justifiable.

  A comparison with Landsat bands spectral reflectivities is lacking and we hope

to be able to make it in order to calculate, in this way, the vegetation influences and its actual distribution, even though, we think, it should be very low and well defined in space.

Final conclusions need more particular observations in different sites to have larger spectrum of data and cases.

III.3 - New data provided by HCMM

This is the first report containing computed A.T.I. data. However a role of the new parameter in geological exploration seems already possible, at least as complementary information to the thermal radiance.

IV - FUTURE WORK

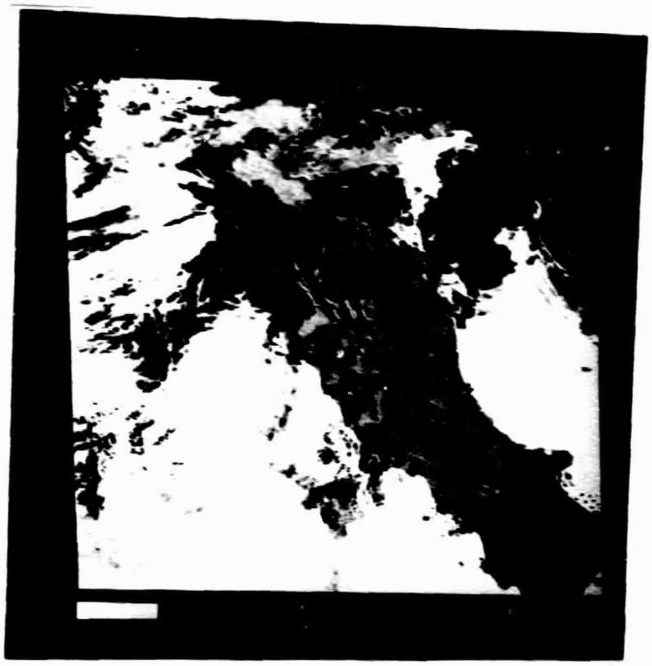
The preliminary information given by A.T.I. clearly suggests the need of additional data and processing as well as of immediate accurate collection of ground truth.

In the near future, ground surveys will be done along the traces of the profiles of Fig.4 in order to explain the A.T.I. anomalies.

Meantime, A.T.I. should be computed in other test areas in order to test its effectiveness in different geological and environmental situations.

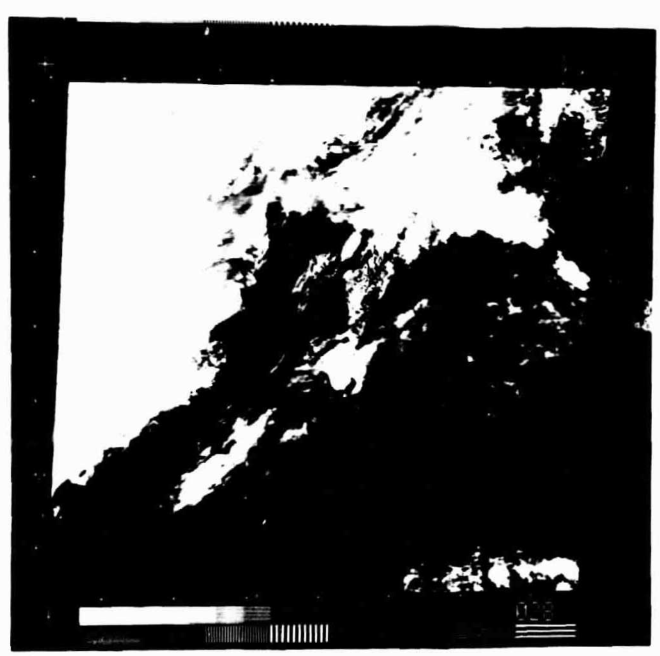
The CCT'S so far available, as shown by the quick looks of Fig.1, do not seem to give other possibilities outside Central Sardinia, where geology does not change appreciably in respect to the studied area of Fig.2.

Therefore we hope to receive another complete pass usable in some other test sites among the selected ones (viz., Tuscany or Southern Sardinia).



(a)

(b)



(c)

Fig.1 - Quick looks at CCT AA0059123701-AA0059123702 (a,b) day visible and night I.R. and CCT AA0059014103 (c) night I.R. June 24, 1978 pass.

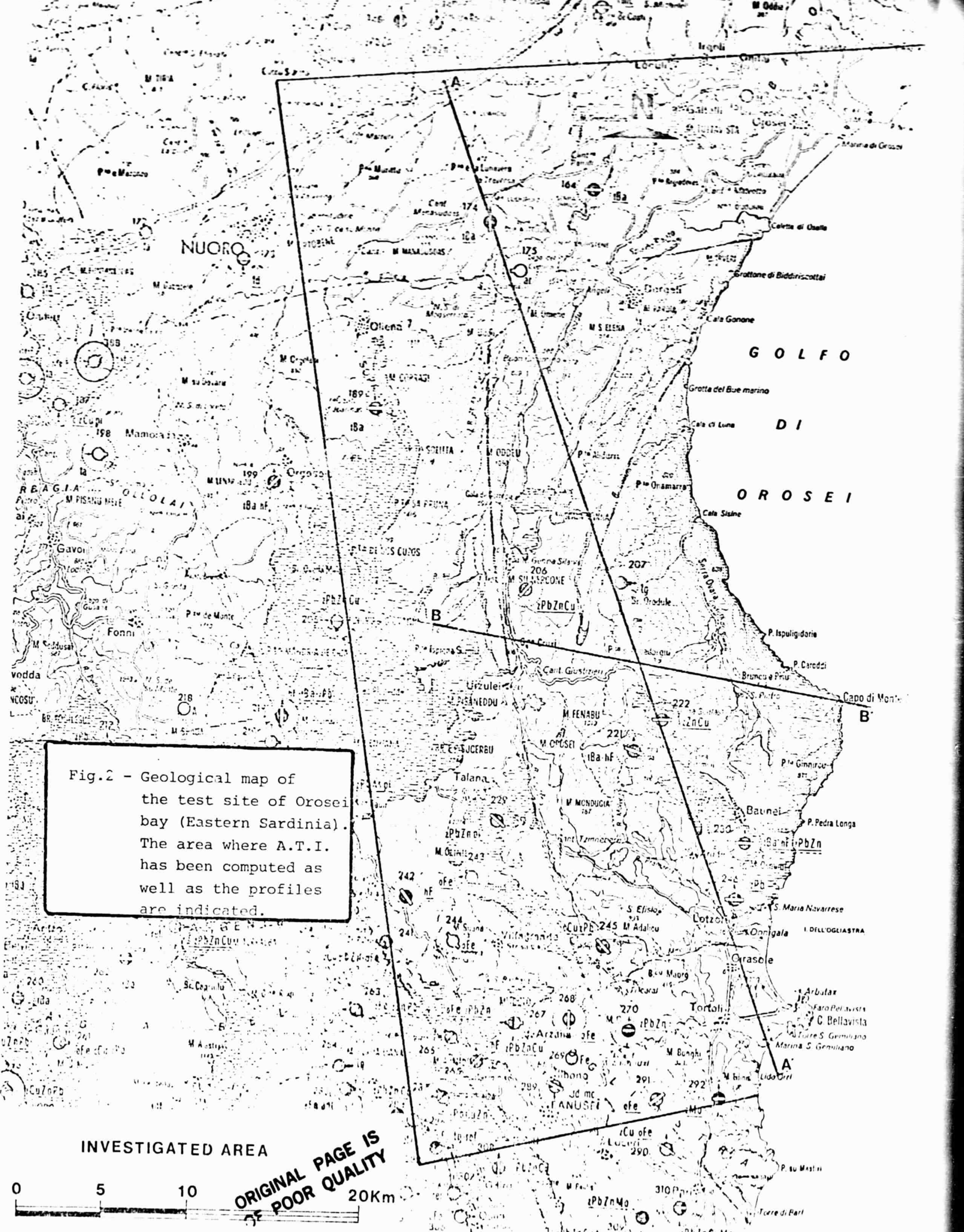


Fig.2 - Geological map of the test site of Orosei bay (Eastern Sardinia). The area where A.T.I. has been computed as well as the profiles are indicated.

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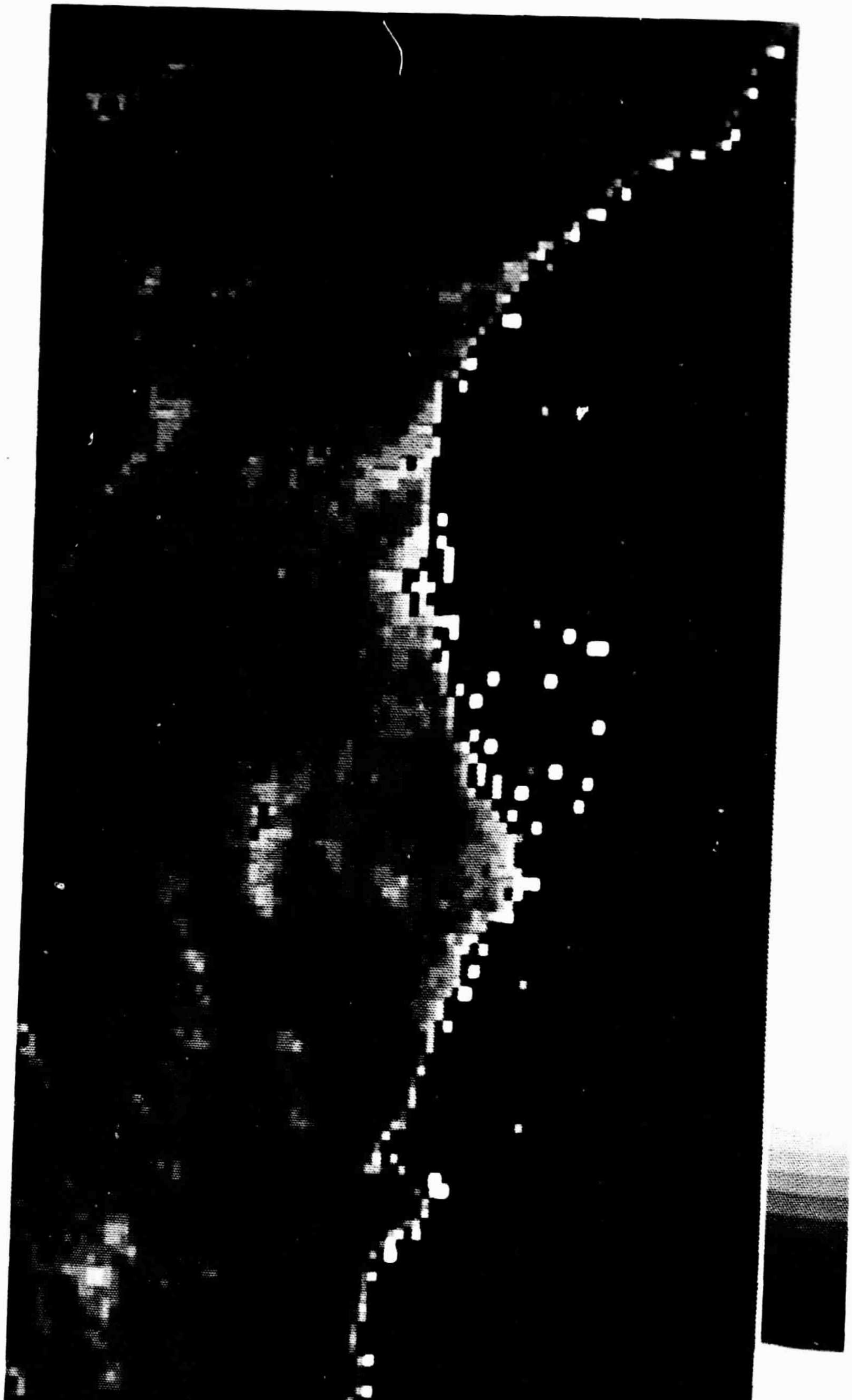

Fig.3 - A.T.I. areal distribution in the area of Fig.2 as displayed by the monitor of the computer system.

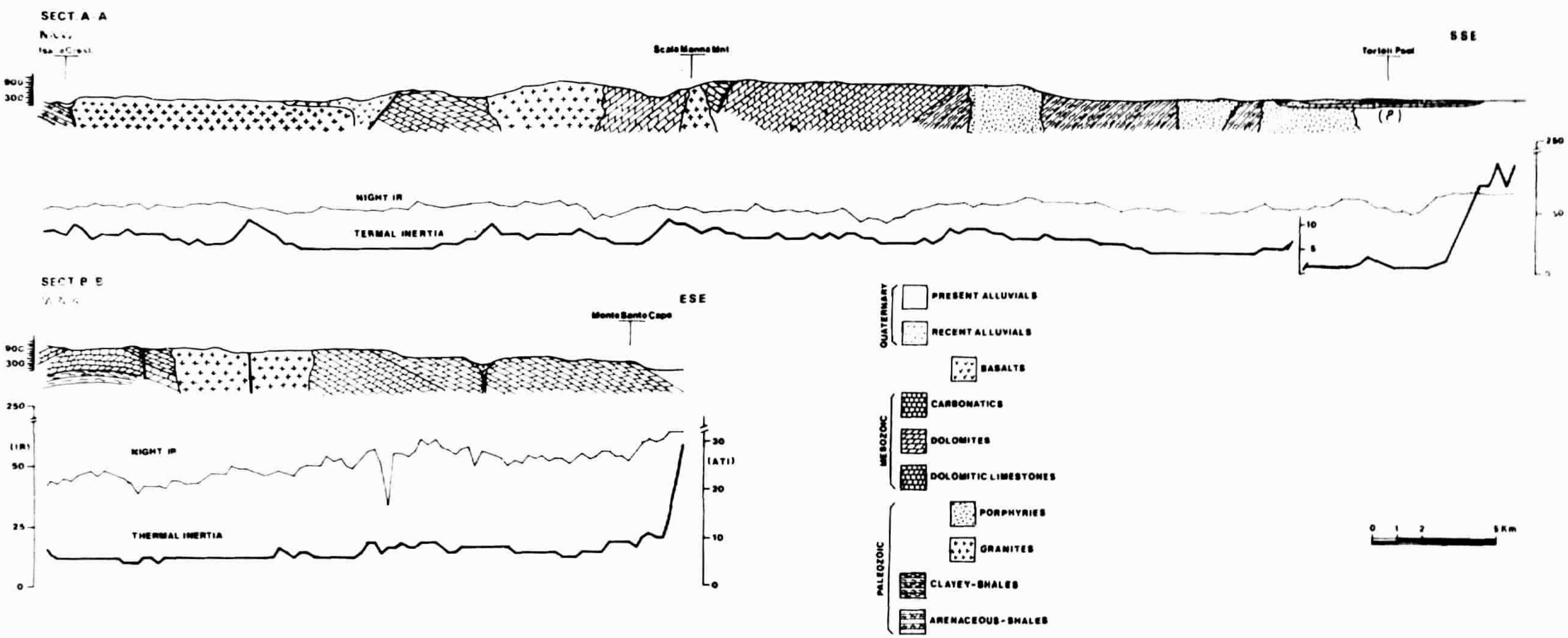

Fig.4 - Profiles (see for position Fig.2). Geology, thermal I.R. and A.T.I. comparison.