(258)

The World Bank
INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
INTERNATIONAL DEVELOPMENT ASSOCIATION

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October 26, 1983

Mr. Brian Sucre
Chief, Petroleum Unit
Ministry of Energy and Mines
41 Brickdam & Boyle Place
Georgetown, GUYANA

Dear Mr. Sucre,

GUYANA - Petroleum Exploration Promotion Project, Cr. 1208-GUA

Further to our telex of October 5, 1983 confirming that the Association had no objection to Government's selection of ECL as Exploration Consultants, I now enclose for your information a copy of Mr. Ritter's letter of October 19 suggesting possible areas for reducing costs by eliminating some of the Ancillary and Support Services, particularly digitization.

I would appreciate your views on these comments, and on whether a date for contract negotiations with ECL has now been set.

Sincerely yours,

Christopher R. Poncia
Energy Department

Attachment

See pl. 85-01-22

ITT 440098 RCA 248423 WUI 64145

THOMAS F. RITTER
GEOLOGIST - EXPLORATION CONSULTANT
10243 Panther Ridge Trail
Dallas, Texas 75243

(214) 783-9610

October 19, 1983

Mr. Christopher R. Poncia
Room D 511
The World Bank
1818 H Street N.W.
Washington, DC 20933

Dear Chris:

In response to your request of October 5 for my comments on the ECL Guyana proposal I am pleased to report that after reviewing the complete April and July 1983 portions of said proposal that I can now agree even more emphatically with Dr. Sucre's choice in selecting ECL for this project. They have presented a well developed plan and one which, if carried out as presented, would fulfill the needs of the Guyanese completely.

However, as you have noted in the final paragraph of your letter, the ECL proposed budget (their Financial Proposal of July 1983) is somewhat greater than the budget proposed in the President's Report.

From my review, I have concluded that the costs for Professional Services (pages 5, 6 and 7 in the Financial Proposal) cannot be reduced overall, even though I am sure some portions will be increased while others will be reduced.

The same cannot be said for the Ancilliary and Support Services (pages 8, 9 and 10 of the Financial Proposal). It appears that the digitazion of all well logs, shot point locations, seismic profiles, etc., may be unnecessary, as much of it may not be needed, and what is needed could probably be carried out by more conventional methods. In addition, such an approach could lock the Guyanese into these types of maps and logs, which would mean continual foreign exchange costs in the future, when more conventional approaches, such as hand computer analysis of data and hand drafting, are more adaptable to the local populace and are also less expensive in Guyana.

Specific cases within this section that need to be reviewed are as follows:

1. Do the logs of all nine offshore wells need to be digitized at a cost of $30,000?

2. Do all shot points need to be digitized at a cost of $14,400? Or could a conventional map be constructed using the bases already available?

3. If the decision is made not to go digital, a downward revision would be made in the $102,400 cost of Geophysical Data Analysis. Just how much of a reduction could be made would have to be decided when one knew exactly what was needed. However, I doubt that eight horizons need to be mapped and I doubt that seismic depth maps are needed.

4. The $16,000 figure for log analysis will be needed, but rather than being done by computer it would be more appropriate to make the analysis by conventional methods with Guyanese personnel being taught these methods so that they can use them in Guyana without the need of a large computer.

5. The seismic reprocessing figure of $211,200 is probably high because it is doubtful that 800 kms. of line will need to be reprocessed over prospective area. As I remember the seismic data, it was generally very good, especially for a strucutral interpretation. However, I would expect the reprocessing for a stratigraphic interpretation to cost more than £220/km., so if 200 kms. of reprocessing is needed the figure of $70,400 may be low.

   In any case, if money is not available the reprocessing can be eliminated and, of course, it may turn out that no reprocessing will be required.

6. The geochemical analysis estimated cost of $46,288 appears to be for 20 outcrop locations and not for well cuttings as I would have expected. As we know from the general geology of the area that most of the onshore section is of continental to very-near-shore origin, I would recommend that no geochemical studies be made of outcrop sections, but that such moneys be spent on studies of selected wells. The cost should be less than half the figure proposed by ECL, because we know that studies have already been made on two of the offshore wells and we know that some of the wells are close together, in which case only one well need be analyzed.

From the above detailed analysis, I think it obvious that the Guyanese and ECL will be able to negotiate an agreement whereby a satisfactory hydrocarbon promotional study can be completed within the budgetary limits as spelled out in the President's Report.

Sincerely,

Thomas F. Ritter

Thomas F. Ritter

TFR:mmc

P.S. As I told you earlier today, until November 12 I will be at:

c/o Tom Boden
75B County Road
Riegelsville, PA 18017
Telephone: 215-838-9727

EM:14/117/3/1

MINISTRY OF ENERGY AND MINES,
PETROLEUM UNIT,
41 Brickdam & Boyle Place,
Georgetown.

1984-04-06

Dear Sir(s),

GUYANA - PETROLEUM EXPLORATION PROMOTION PROJECT

As you may know, the Government of Guyana is now undertaking a program for the promotion of Petroleum Exploration in Guyana, with the assistance of the World Bank Group.

For this purpose, the Government has now signed a contract with Exploration Consultants Limited, a petroleum exploration consultancy firm based in U.K., for assistance in the gathering and interpretation of available data and the preparation of a report regarding petroleum prospects in Guyana. The Government is also receiving advice in connexion with petroleum and fiscal legislation and model form contracts to facilitate petroleum investment in this country.

Since your company undertook a programme of petroleum exploration in Guyana, I would much appreciate any assistance that you may be able to provide to ECL in their work, and I have asked them to contact you in this regard.

If I may, I will keep your Company informed as implementation of our petroleum exploration promotion project proceeds.

Yours co-operatively,

.....

H. Rashid,
Minister of Energy & Mines.

(175)

Exploration Consultants Limited
Highlands Farm
Greys Road
Henley-on-Thames
Oxon RG9 4PS England

Telephone (0491) 575989
Telex 848776 ECL UK G
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Exploration and Production Consultants Geological studies Geophysical data interpretation Wellsite geology Seismic crew supervision Petroleum engineering Well test supervision Well log analysis Reservoir simulation Project management Economic studies

Received - 84-09-19

PETROLEUM EXPLORATION PROJECT

STATUS REPORT 1. 20 APRIL 1984

1. Contract was signed by S.R. Lawrence on behalf of ECL on 5th April.

2. S.R. Lawrence (Project Manager) completed preliminary data appraisal and organisation from 28th March onwards and left for UK on 10th April.

3. A. Soulsby (Geophysical Supervisor) and S. Pile (Geologist) arrived in Guyana 7th April.

4. Soulsby has examined and listed all seismic data in files and has extracted shot-point location maps and seismic profiles for shipment to the U.K. for digitising and photography. The majority of the data will be hand-carried, the rest air freighted. Data removed is on the attached sheet.

5. Topographic maps have been purchased from Lands and Surveys for accurate digitising of the coastline and rivers.

6. Aeromagnetic maps have been purchased from Geology and Mines for detailed interpretation of the coastal strip and Takutu Basin.

7. Pile has examined all available well logs and reports and has commenced organisation of a filing system.

8. Contact has been made with the Commissioner of Geology and Mines, samples from the offshore wells have been located and Pile will select material for shipment to U.K. for analysis.

9. Well logs have been selected for initial digitising and will be hand-carried to the U.K.

Future Action

1. Base map digitising and photography will commence in week of 23rd April and will continue for approx. 6 - 8 weeks in U.K.

2. Data organisation and filing will continue in Guyana (S. Pile) until end May. Also sample collection and shipping.

3. S. Lawrence (Project Manager) will return to Guyana in May to review progress with Pile and Ministry. Remaining data will be carried to U.K.

4. Letters of introduction will be sent to all previous operating companies, explaining role of ECL. These will be followed up by personal contact to establish working relationship and to attempt to retrieve missing data.

5. Visit to Suriname should be arranged to review operations in onshore producing area and to encourage exchange of technical information. This should coincide with visit of S Lawrence at end of May if possible (B. Sucre to organise).

6. In view of limited counterpart personnel, it is proposed that B. Sucre visit ECL in U.K. during June/July to participate in start of seismic interpretation phase. Also it is proposed that part of the seismic interpretation should be carried out in Guyana by P. Coster (Geophysicist) during August/September.

Travel to Guyana

S.R. Lawrence (Project Manager)	25 March
A. Soulsby (Geophysical Supervisor)	7 April
S. Pile (Geologist)	7 April
to U.K.	
S.R. Lawrence	10 April
A. Soulsby	20 April

GUYANA
PETROLEUM EXPLORATION
APPRAISAL

GUYANA BASIN

JUNE 1985

Oil Concessions
(Guyana)

ECL

4.3 Seismic Reprocessing

The objectives of initial seismic processing are essentially two fold:-

- to compile the raw recorded seismic field data into depth-point format, rather than shot-point format, and to perform the Common Depth Point stacking process so that a final stacked display may be produced for interpretation.

- to remove the unwanted secondary effects of the passage of the seismic signal through the earth such as the presence of multiple reflections and the disortion of the seismic waveform due to attenuation and dispersion effects.

The impetus leading to reprocessing within the oil industry is generally either to apply modern processing techniques to an older vintage of data, or to attempt to enhance routinely processed data over a defined prospect. The aims in reprocessing offshore Guyanese data were drawn more widely, but were limited to the field data held in the archives in Georgetown.

For the offshore area, the Ministry of Energy and Mines retain copies of digital field tapes only for the work done in 1981 and 1982 by Denison/Seagull. Any reprocessing exercise was therefore limited to these surveys. Within the budgetary constraints of the project, a small portion of the 1981 survey was selected for reprocessing with the following objectives:-

(a) To improve the quality of the final processed sections obtained by Denison/Seagull. The 1981 vintage processing is considered to be poor.

(b) To establish a processing routine which might have general application for the offshore area. This will enable the Ministry to supervise future work by operators and allow them to define minimum standards.

(c) By the availability of enhanced profiles, to optimise the structural interpretation in the area of the 'Abary' structure.

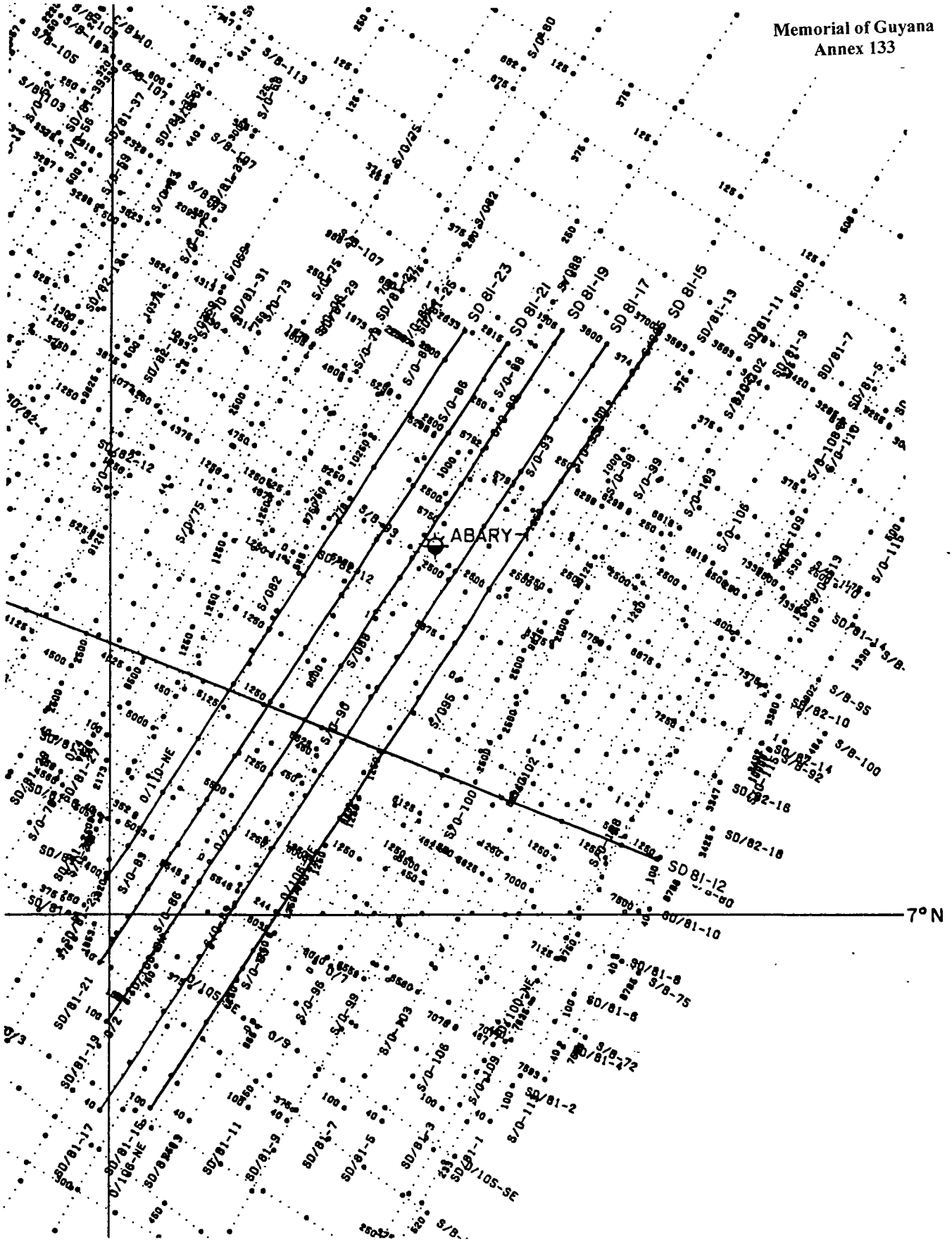
(d) By working through the processing sequence, to obtain a better understanding of the factors affecting the quality of the offshore data.

(e) By careful analysis of seismic stacking velocities, to acquire reliable data for depth conversion of time structure maps.

One hundred and fifty six copies of field tapes representing 350 kilometres of seismic data from the 1981 Denison survey were shipped from Guyana to the United Kingdom in October 1984. Supporting documents were obtained from Denison, and the data were reprocessed by Merlin Profilers (Processing) P.L.C. during November. They were awarded the contract after competitive bidding on the basis of cost, turnaround time and established professional reputation. Merlin have produced a comprehensive report which describes the parameter testing schedule and validates the final processing routine. This section makes some general comment on each of the chosen processes and compares the results with those obtained by Denison. The data used in this exercise are listed below:-

LINE	SP RANGE	KILOMETRES
SD-12	943 - 1995	26.325
SD-15	1272 - 3700	60.725
SD-17	3426 - 1601	45.175
SD-19	100 - 3306	80.175
SD-21	2839 - 40	70.0
SD-23	100 - 2633	63.35
	TOTAL	345.75

Figure 20 shows the location of the reprocessed profiles. Table 6 summarises the original processing and reprocessing sequences and parameters.



Oil Concessions
(Guyana)

Seismic Reprocessing Location Map

Figure 20

Guyana Project

File Organisation & Data-Base

ECL

Oil Concessions
(Guyana)

SECTION 2 DATA BASE (U.K.)

Conclusions and Recommendations

1. The scope of information available for use in geological studies has been expanded by a series of computer-based bibliographic searches.

2. Digital base maps, incorporating all data received to date, have been produced for well locations and seismic surveys and can be combined with digitised coastlines, rivers and political boundaries. This forms a comprehensive base map coverage for geological and geophysical interpretation studies.

4. Well Logs have been digitised for all of the offshore wells and now form a comprehensive well data base for use in interpretation and promotion.

5. Discussions should be initiated with the National Data Management Authority, to ascertain what computer facilities are required to generate maps, well logs, etc., in Guyana from magnetic tapes produced by ECL.

2.1 Scope of Existing Data

Usable geological data dates back to the last century with the works of Barrington-Brown. Many published works by the Directorate of Overseas Geological Surveys are recorded throughout the 20th Century, a reflection of the geological involvement in the former British Colony, British Guiana. More recently the era of McConnell and Martin-Kaye, as Directors of the Guyana Geological Survey, produced many notable reports and papers. Other published papers, located by computer search, are recorded in Appendix 4. Several reports are listed and stocked at the GGMC library, and include Bulletin 20, a report published jointly by the Geological Survey of British Guiana, and Trinidad Leaseholds Ltd on the Rose Hall borehole in 1941. The well stocked Library at GGMC are able to supply more obscure papers and bulletins, and a catalogue is available from the Librarian.

Well data available can effectively be divided into four categories, ranging from the earliest water wells, through shallow mineral boreholes to the more recent stratigraphic and petroleum exploration wells in the offshore basin. These categories will be discussed later.

Geophysical data can be put into two broad categories. Gravity/-magnetics includes the published Terra/U.N. Surveys of the early 1960's and 1970's, and the petroleum exploration surveys by Shell, offshore, and by Home Oil in the Takutu Basin. Seismic reflection surveys, for petroleum exploration purposes have been run offshore, along some of the major rivers, and in the Takutu Basin. These are discussed in more detail later.

2.2 Published Literature

Published academic work will form a framework for the regional setting of the geological interpretation.

A computerised keyword literature search was carried out via the Californian based Lockheed 'Dialog Information System', using Geosystems Inc. database 'Geoarchive', and a copy of the computer printout forms Appendix 4.

The search was performed in steps. Initially a whole Caribbean search was carried out, including southern North America, Central America, and northern South America. This search was limited by subject and date, namely 1982-present, and a total of 639 references were printed 'on-line' . The remainder of the references stored from 1972-1981 were retained for future reference, and 1502 references were later printed 'off-line'.

A second more specific search of Brazil and the Guianas, from 1972-1981 yielded a total of 550 references which were printed 'on-line'.
A further search was carried out specifically for Guyana, without restricting the data base. This formed a total of 144 references.

The printout was scanned for usable references and copies were obtained from library sources, and catalogued into the Guyana Project section. Standard library techniques were used for cataloguing and filing the various reports and papers obtained, and the universal decimal coding for library use is shown in Table 2.

Other reports, references and general text were obtained by normal library search and compilation techniques, and an initial total of nearly 300 references have been obtained for Guyana and surrounding areas. The total listing of references are available for selection of a pertinent bibliography, which will be included with the interpretation report.

TABLE 2. CLASS NUMBERS FOR GUYANA PROJECT SUBJECT HEADINGS

Class.No.	Subject(s)
55 (...)	Geology of (country)
550.3	Geophysics Seismology
550.38	Magnetism
550.4	Geochemistry
550.8	Exploration (geological and geophysical)
551.24	Tectonics
551.243	Structural Folding Faulting
551.3.051	Sedimentology Deposition Stratification
551.351	Sedimentary basins
551.4	Geomorphology
551.468	Coastal geology (fans,estuaries,canyons etc)
551.7	Stratigraphy Historical Geology
551.71	Precambrian
551.73	Palaeozoic
551.735	Carboniferous
551.736	Permian
551.76	Mesozoic
551.761	Triassic
551.762	Jurassic
551.763	Cretaceous
551.78	Tertiary
551.79	Quaternary
551.8	Palaeogeography
552.14	Diagenesis Sedimentary rocks
552.3	Igneous Rocks
552.4	Metamorphic rocks
552.5	Sedimentary Petrology
553.98	Petroleum Nat.Gas hydrocarbons
556	Hydrogeology Hydrology
56	Palaeontology
622.241	Boreholes Wells
622.276	Reservoir engineering
(210.5)	Continental margins
(261)	Atlantic Ocean N.Atlantic
(263)	W.Atlantic Gulf of Mexico
(264)	S.Atlantic
(6)	Africa
(728)	Central America
(729)	Caribbean
(8)	South America
(81)	Brazil
(87)	Venezuela
(881)	Guyana
(882)	French Guiana
(883)	Surinam
(-11)	East
(-12)	Southeast
(-13)	South
(-14)	Southwest
(-15)	West
(-16)	Northwest
(-17)	North

Comprehensive use was made of the facilities offered in Georgetown, namely the library section of the Guyana Geology and Mines Commission and the Guyana Lands and Surveys office.

The GGMC library proved to be well run and well stocked with all papers published by the Guyana Geological Survey, and a comprehensive supply of maps that have been produced. These maps included geological survey maps at varying scales, and interpreted and non-interpreted aeromagnetic contour maps. No further mention of GGMC library facilities is necessary here, since an up-to-date listing is available from the library.

The Guyana Lands and Surveys Office was able to supply topographic maps, of various scales, which were used in the generation of digital base maps. A listing of available maps is again available from the relevant office in Georgetown.

2.3 Well Data

The well data available for use in the interpretation phases of the project are listed in Appendix 2 and summarised in Tables 3 and 4. A well location map is shown in Figure 4.

Onshore there are seven stratigraphic boreholes, drilled by Shell Petroleum Co. in the mid 1960's. These are located on the coastal belt of the Berbice Basin, and all reach crystalline basement. These stratigraphic boreholes are supplemented by information from the Rose Hall-1 petroleum borehole, drilled in 1941, by Trinidad Leaseholds Ltd. Each of the above wells has an electric log of the boring, and the Rose Hall well is the subject of the Kugler report, Bulletin 20. In addition to these wells in the coastal basin, there is lithological information from the Shelter-Belt 3 water well, located near to Georgetown, and lithological and electric logs for the Nickerie-1 stratigraphic test, located in the Suriname coastal basin. Full details of the available data for onshore wells is shown in Table 3.

Information for the Takutu Basin is limited to data from wells Lethem 1 and Karanambo-1 drilled by Home Oil Co. in 1981 and 1982 respectively. Logs are also available for Tacutu-1, a similar test in the Brazilian part of the Basin. A listing of data at present available for the inland basin is also shown in Table 3.

Data are available from a total of nine offshore wells drilled between 1967 and 1976. A summary of the data is shown in Table 4. Of the offshore wells the best documented were the five drilled by Shell. Data from these wells includes Final Well Reports which include geological, biostratigraphic and engineering summaries. The two wells drilled by Deminex are fairly well documented, but the earlier wells, Guyana Offshore-1 and 2 have only petrophysical log data available at present, although there has been contact with Conoco in order to obtain other data, missing from Ministry files.

Oil Concessions (Guyana)

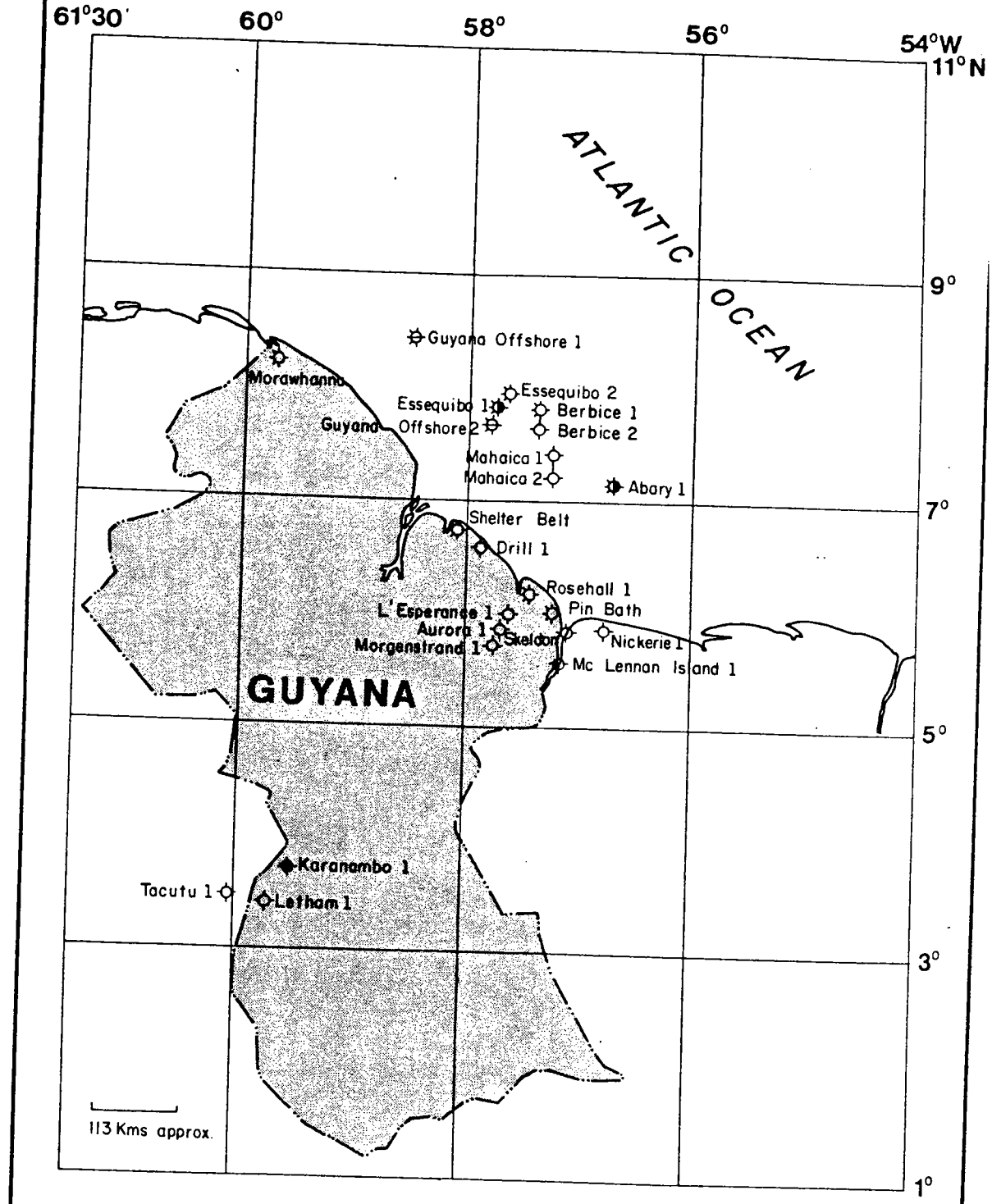
Stratigraphic information is limited throughout since very few published papers originating from Guyana deal with sedimentary rocks. This is a reflection of the economic importance of the Precambrian Guyana

TABLE 3. SUMMARY OF ONSHORE WELL DATA

WELL NAMES 1) ONSHORE WELLS	DRILL 1	ESPERANCE 1	KARANAMBO 1	LETHEM 1	McLELLAN 1	MORGANSTRAND 1	ROSE HALL 1	SHELTER BELT 3	SKELDON 1	a) SURINAM	NICKERIE 1	b) BRAZIL	TACUTU 1
S.P.	X	X			X	X			X				X
GR	X	X	X		X	X			X				X
BHC/ISF	X	X	X	X	X	X			X				X
IES/ES	X	X			X	X							
FDC	X	X	X	X									X
NEUTRON LOG		X	X	X									X
DLL/(MSFL)	X								X				X
ML/MLL	X	X			X	X			X				
VDL			X										
GEODIP			X										
DIPMETER		X	X		X	X			X				X
DIRECTIONAL LOG			X										
LITHOLOGY DESCRIPTION/MUD LOG			X	X				X					
COMPOSITE LOG/MONTAGE	X				X	X	X		X		X		X
CORE INFO/SST	X	X	X	X	X	X			X				
PALAEONTOLOGY			X	X									X
GEOLOGICAL/LABORATORY REPORT			X										X
ENGINEERING/DRILLING REPORTS	X	X	X	X	X	X			X				
TEST REPORTS			X										
WELL PROGRAM/PROGNOSIS			X	X									

TABLE 4. SUMMARY OF OFFSHORE WELL DATA

WELL NAMES 1) OFFSHORE WELLS	ABARY # 1	BERBICE # 1	BERBICE # 2	ESSEQUIBO # 1	ESSEQUIBO # 2	GUYANA OFFSHORE 1	GUYANA OFFSHORE 2	MAHAICA # 1	MAHAICA # 2
S.P.	X	X	X	X	X	X	X	X	X
GR	X	X	X	X	X	X	X	X	X
BHC/ISF	X	X	X	X	X	X	X	X	X
IES/ES		X				X	X		
FDC	X	X	X	X	X			X	X
NEUTRON LOG	X	X	X		X	X	X	X	X
DLL/(MSFL)	X		X	X	X			X	X
ML/MLL	X	X	X	X		X	X	X	X
CBL/CCL		X	X						
FIT/RFT									
DIPMETER	X	X	X	X	X			X	X
VEL. SURVEY		X	X		X			X	
LITHOLOGY DESCRIPTION/MUD LOG	X	X	X	X	X	X	X	X	X
COMPOSITE LOG/MONTAGE				X		X	X		
CORE INFO/SST				X					
PALAEONTOLOGY						X	X		
GEOLOGICAL/LABORATORY REPORT	X	X	X	X	X			X	X
WELL SUMMARY	X	X			X		X	X	X
FINAL WELL REPORT	X	X	X	X		X	X	X	X
ENGINEERING/DRILLING REPORTS		X	X		X				X
WELL LOCATION MAP			X	X	X		X		X
LOG INTERPRETATION									
WELL PROGRAM/PROGNOSIS	X	X	X	X	X			X	X
TEMPERATURE LOG	X	X	X					X	X



Oil Concessions
(Guyana)

820/A1/004

is limited to studies undertaken by Van Wijhe and Schietecatte for Shell Trinidad, on the seven stratigraphic boreholes drilled in the 1960's. They also integrated data from the Shelter Belt-3 and Rose Hall-1 wells, and Nickerie-1 in Surinam. Palynological studies were performed on samples from these wells, and integrated in papers published by Van der Hamen, Van der Hamen and Wymstra, and Leidelmeyer.

Biostratigraphic work was undertaken for each of the offshore wells. Information is in various forms, ranging from a detailed breakdown of faunal content to a simple biostratigraphic summary on Composite Logs, as for GO-1 and GO-2 wells.

In the Takutu Basin biostratigraphic summaries are available for Lethem-1 and Karanambo-1 wells, and a summary, on the Composite Log, is presented by Petrobras for their Tacutu-1 well.

Geochemical data are even more limited. Part results are available for the Takutu wells, but complete reports have been requested from Home Oil. Only the prospect analysis of Essequibo 2, in the offshore basin, shows a summary of geochemical results.

Subsurface results from a few scattered mineral boreholes are available for integration, but in the main, these are drilled on crystalline rocks, and their usefulness is therefore limited.

A series of water wells have been drilled in the coastal area, some of which have penetrated basement. Only limited geological information is available for these boreholes, and after producing microfiche archives, a fire destroyed both originals and microfiche. Much of the information however has been recorded by Bleakley and Worts, and are available from the GGMC library.

2.4 Geophysical Data

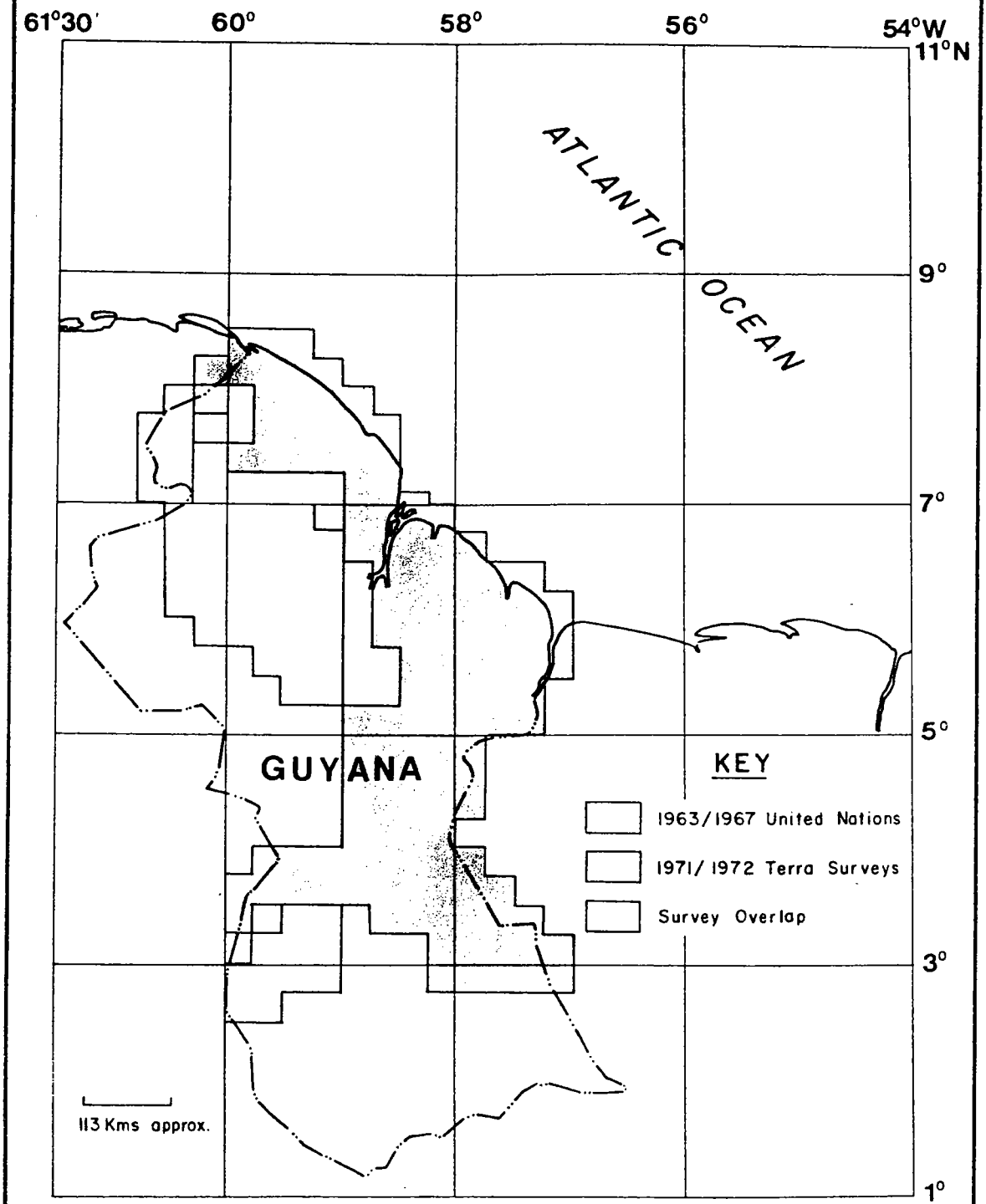
Geophysical data consists of gravity/magnetic and seismic data obtained by various sources during the phases of exploration activity since 1965.

2.4.1 Gravity/Magnetics

Data available at present are from three sources. Gravity/ Aeromagnetic profiles were acquired in the Takutu Basin supplementary to the seismic profiles obtained by Home Oil. Shell acquired gravity/aeromagnetic data along selected lines during their 1973 seismic survey, shot by GSI. The greatest aerial coverage is supplied by successive aeromagnetic surveys in 1962/3 and 1971/2. The former was carried out by Aero Service Corporation of Philadelphia U.S.A. as part of a United Nations Development Programme, and a full interpretation report is available at the GGMC library. The latter was carried out by Terra Surveys Ltd, Ottawa, Canada, under a Development Loan Agreement provided by the Canadian International Development Agency. Supervision of the survey was by the Geological Survey of Canada, acting on behalf of the Geological survey of Guyana, under Commissioner Dr. S. Singh.

Contour maps have been produced from the combination of these surveys and are available from the GGMC library at scales of 1:50,000 and 1:200,000 which is produced in a basic contour format, and an interpreted format. Figure 5 shows, in mosaic form, the coverage of these surveys. A report on acquisition parameters and map by map sheet interpretation is available at the GGMC library.

For interpretation purposes ECL have synthesized a 1:1,000,000 map, from the above survey map sheets redrafted at a contour interval of 100 gammas. This is a useful indicator of gross structural trends, and can be used in overlay form.



Oil Concessions
(Guyana)

2.4.2 **Seismic.**

The bulk of the geophysical data available are in the form of seismic sections. A total of approximately 20,000 line km of seismic data are available for on and offshore Guyana. Table 5 summarises the surveys undertaken, and Figure 6 shows the extent of seismic line coverage available for use in interpretation at the end of August 1984.

The various data and documention from seismic surveys have been provided to the Ministry as part of the contractual obligation as concession holders. Much of the available data have been supplied as enclosures (either interpreted or more often non-interpreted), to geological and geophysical reports. In some cases, a report has been provided with selected enclosures, and a full set of data supplied as part of the appendix to the report.

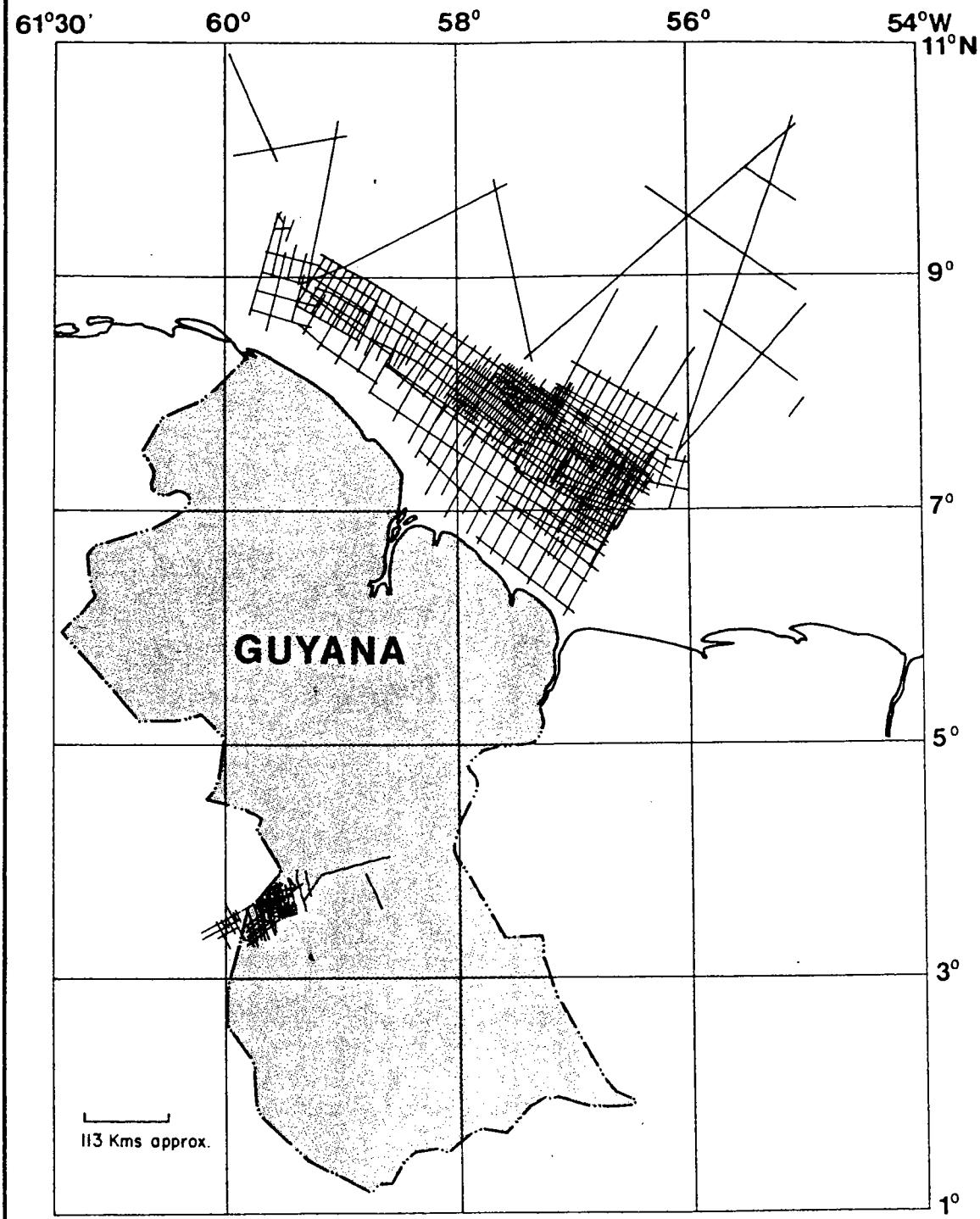
The organisational phase of the project allowed for identification of missing data. Owing to the haphazard storage and control of the data supplied to the Ministry over the years it was inevitable that some of the data were missing. By sorting and cataloguing the data stored at the Ministry, and then checking that listing against shot-point maps and data transmittals, a reasonable picture of missing data was established.

Each of the present, and former operators in Guyana was contacted by letter, sent from the Ministry, asking for cooperation in respect of supplying missing data. Contact was readily established with Conoco, Shell, Deminex, Home, Tricentrol and Denison Mines. Contact with Comoro (Resources Exploration International Ltd) and Oxoco has not been established. Ministry contact with Petrobras has assisted in obtaining information from the Brazilian section of the Takutu Basin.

Requests for essential data from the cooperating companies have so far been fruitful, and 90% of the data available for interpretation have been recovered. Table 6 summarises technical specifications of the seismic data catalogued by ECL at the end of August 1984.

TABLE 5 SUMMARY OF SEISMIC SURVEYS

COMPANY	YEAR	NO. OF SURVEYS	APROX. LINE KM.	REMARKS
Standard Oil of California	1958	1	1280.00	Offshore: Survey Not Available
Shell	1965-1975	6	6305.80	Offshore: Mostly available: Gravity/Magnetics with 1973 survey.
Conoco	1968-1971	2	2929.70	Offshore: Selected sections only: Some surveys in partnership with Shell. Sometimes duplicated.
Comoro	1971	?	?	Offshore: Line 3 and 3 ext. only
Oxoco	1971	1	851.6	Offshore: Mostly available
Caravel	1972	1	235.0	Onshore : River based Survey Takutu area.
Deminex	1973/4	2	4382.2	Offshore: All available
Tricentrol	1973	1	866.3	Onshore : All available
Home Oil	1979/80	2	1280.5	Onshore : All available
Petrobras	1979	1	182.6	Onshore: Survey in Brazil section of Takutu Basin Reprocessed by Sefel for Home Oil.
Denison/Seagull	1981/2	2	2135.1	Offshore: All available
	TOTAL NO. KM		21030.80	APPROX.



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COMPANY SURVEY DATE	RECORDED	PROCESSED	SURVEY	SOURCE	SPREAD	COVERAGE	SAMPLE	RECORD	INSTR.	PROCESSING
SHELL/1965 OFFSHORE	?	?	MARINE	?	?	?	?	4 SECS		OPTICALLY STACKED ANALOG.
CONOCO/1966-7 OFFSHORE			MARINE							
SHELL/CONOCO 1968 OFFSHORE	WESTERN G.C.	B.I.P.M.	MARINE	AG 2000 PSI	?	24 FOLD	4 MSEC	4.75 SECS	?	DECON/FILT
SHELL/1969 OFFSHORE	GSI	B.I.P.M.	MARINE	AG 2000 PSI	?	24 FOLD	4 MSEC	4.75 SECS	?	DECON/FILT
CONORO/1971 OFFSHORE	DELTA	SEISCOM	MARINE	MARINE VIB.	24TR.30GEO PER GROUP	24 FOLD	4 MSEC	6 SECS	DFS III	CDP STACK, STUF,DEPTH
CONOCO/1971 OFFSHORE	DELTA	SEISCOM	MARINE	MARINE VIB.	24TR.30GEO PER GROUP	12 FOLD	4 MSEC	5 SECS	DFS III	TVAC/1200% CDP STACK/ STUF.
SHELL/1971 OFFSHORE	GSI	GSI	MARINE	AIRGUN	48TR.10GEO PER GROUP	24 FOLD	4 MSEC	4.5-5 SECS	DFS III	NMO,STACK, TVD,VEL.A. FELT,MIG.
CARAVEL/1972 ONSHORE	?	?	RIVER							
SHELL/1973 OFFSHORE	GSI	GSI	MARINE	AG 1200IN^3	48TR.48GP	24 FOLD	4 MSEC	6-10 SECS	DFS IIIX2	TVD,FILT NMO STACK
TRICENTROL/1973 OFFSHORE	DELTA	SEISCOM	MARINE	MARINE VIB.	24TR.30GEO PER GROUP	24 FOLD	4 MSEC	5 SECS	DFS III	DECON,STACK TVF.
DEMINEX/1973/4 OFFSHORE	GSI/PETTY RAY	GSI/P.RAY	MARINE	AG 1200IN^3	48TR.30GEO PER GROUP	24 FOLD	4 MSEC	6 SECS	DFS IV	TVD,TVF,TVS NMO,VEL.A. BBF.
SHELL/1974 OFFSHORE	SSL	SSL	MARINE	AG 1200CU^3	3298M 60TR	24 FOLD	?	6 SECS	DFS	?
DEMINEX/1976 OFFSHORE	PETTY RAY	PETTY RAY	MARINE	AG 21975CM^3	2375M 48TR	23 FOLD	2 MSEC	6 SECS	DFS IV	TVD,TVD, VEL.A.
HOME/1979 ONSHORE	SEFEL	SEFEL	LAND	DYNAMITE	2700 M	12 FOLD	2 MSEC	4 SECS	SERCEL 338B	DECON,TIF, VEL.A.,TIF TVS,NORM, REV,MIG
HOME/1980 ONSHORE	SEFEL	SEFEL	LAND	DYNAMITE	2700 M	12 FOLD	2 MSEC	4 SECS	SERCEL 338B	DECON,FILT, VEL.A.,NMO, CDP STACK, FILT,TVS, COH,MIG NORM,REV.
PETROBRAS/1980 ONSHORE (BRAZIL)	GSI	SEFEL (RP)	LAND	DYNAMITE	2500 M	12 FOLD	4 MSEC	4 SECS	DFS V	FILT,DECON FILT,VEL.A. NMO,CDP ST. FILT,TVS, COH,NORM REV,MIG.
DENNISON/1981 WGC OFFSHORE	WGC	WGC	MARINE	AQUAPULSE	26TR.20GEO PER GROUP	24 FOLD	4 MSEC	6 SECS	DFS V	DECON,NMO STACK, DECON,DVF.
DENNISON/1982 OFFSHORE	WGC	WGC	MARINE	AG 760IN^3	2605 M 96TR.20GEO PER GROUP	24 FOLD	4 MSEC	6 SECS	LRS 888	DECON BEFORE STACK,NMO STACK,DECON AFTERSTACK, TVF.

TABLE 6: SEISMIC SURVEY TECHNICAL SUMMARY

Owing to the diversity of surveys to be integrated into the interpretation phase, and to maintain compatability, it was necessary to copy all seismic lines on one scale. This was carried out by photographing all paper copies to a vertical scale of 5cms per second, into reproducible form. Sepia copies, already in reproducible form were also rephotographed to maintain scale compatability, where necessary.

2.5 Data Base Generation

From the data sorted, compiled and catalogued from the Ministry and other sources, it was necessary to create a compatable set of base maps, at various scales for use in the interpretation.

Data received from Guyana either as published material or from proprietary sources were of several vintages, scales and projections and as part of the Phase (ii) operation of the project ECL have catalogued and organised the available data in such a way as to enable information to be viewed more efficiently, and readily.

This rationalisation involved the creation of three major types of computer file:-Boundary and coastline data in digital format, digital files for shot-point and seismic line locations, and magnetic well log tapes. These areas have provided easy reference points within the major fields of study and enabled the production of maps and plots at convenient working scales.

2.5.1 Coastline/Boundary Maps

The coastline, major river courses and political boundary of Guyana were digitised, utilising the ECL developed data base management program 'IMPAC', on a Data General MV4000 computer, through CALCOMP digitising tables.

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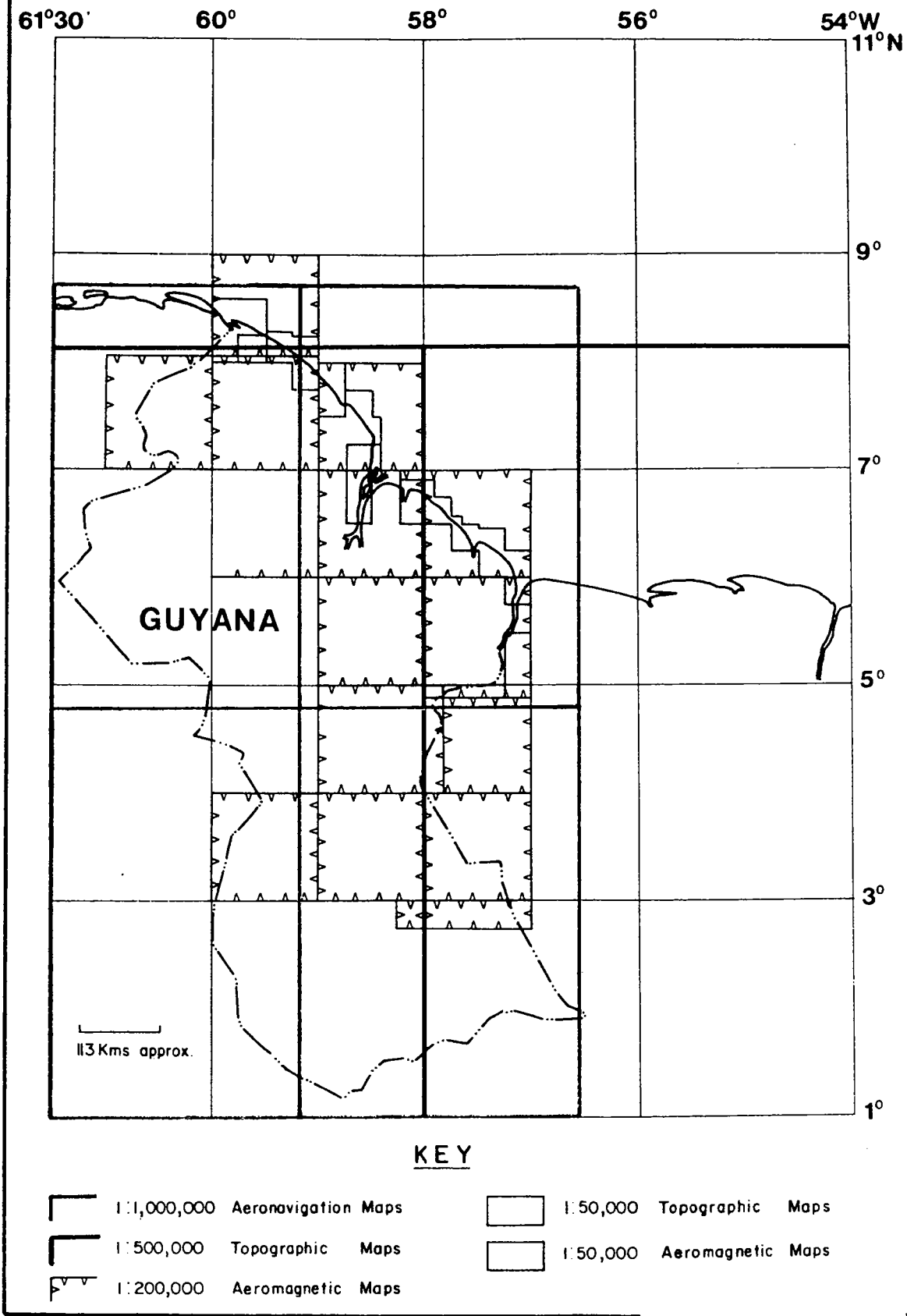
Input of data was from five major sources as listed in Table 7. A total of 86 maps were used in the construction of the data base. These maps formed a mosaic covering the entire area, as displayed in Figure 7. This system has been devised to provide the main working reference for the interpretation phases, and its limits are 54°W-61°30'W and 1°N-11°N.

Maps of the largest possible scale 1:50,000, were utilised to maintain as much detail and accuracy as possible. However, owing to the number of different map sources used for input to the data base, many of the 1:50,000 maps mistied from sheet to sheet. Paper stretch, due to storage in high temperature and high humidity is considered to be the main problem. The effect of the sheet-to-sheet misties has meant that

TABLE 7 COASTLINE DATA SOURCES

MAP SOURCE	MAP TYPE	SCALE	PROJECTION	NO.SHEETS USED
Lands & Surveys Dept. Guyana	Topographic	1:50,000	Universal Transverse Mercator	20
Guyana Geology & Mines Commission	Aeromagnetic	1:50,000	UTM	49
Guyana Geology & Mines Commission	Aeromagnetic Composite	1:200,000	UTM	11
Lands and Surveys Dept. Guyana	Topographic Composite	1:500,000	Transverse Mercator	4
United States, Defence Mapping Agency	Aeronavigational	1:1,000,000	Lambert Conformal Conical	2



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major river courses had to be digitised from 1:1,000,000 maps across these errors, and ultimately the data base was edited to reduce such errors.

The system was set up within the geographical coordinates previously quoted, comprising, a total of 380 individual 'cells'. Each 'cell' has the dimensions 20' (eastings) by 30' (northings). If there is no data input into an individual 'cell', it is termed 'null'. Thus from this system any scale map can be generated within the extreme coordinates, and at present maps at scales of 1:1,000,000 and 1:500,000 have been produced, as indicated in Table 8 and Figure 8. Examples of these maps at full scale are included as Enclosures 1 through to 5.

2.5.2 Well Location/Seismic Maps

A comprehensive suite of base maps, has been compiled showing well location and seismic data in relation to each other, upon a latitude and longitude graticule with a superimposed UTM metric grid. Data were digitised from proprietary map sources of various scales and vintages as outlined in Figures 9a through to 9d, obtained from the files of the Ministry of Energy in Georgetown, or obtained from the files of previous operators. No digital tape input was used.

Owing to the diverse nature of data input it was thought necessary to separate, seismic and well plots from the 'IMPAC' database management program used for the coastline maps, as previously discussed. This was thought to be the most economic use of time and resources. Thus shot-point and well locations were digitised using ECL's 'in-house' classification scheme. Map parameters used for each of the maps were as follows.

Spheroid	-	International
Projection	-	Universal Transverse Mercator
Central Meridian	-	57°W

The map data are held on file, see Table 9, and can be output at

TABLE 8 BASE MAPS

MAP NO.	SCALE	COORDINATES	MAP TYPE
1	1:500,000	61°30'W - 58°00'W 1°00'N - 6°00'N	Coastline, Political Boundary Major River Courses.
2	1:500,000	58°30'W - 54°00'W 1°00'N - 6°00'N	Coastline, Political Boundary Major River Courses.
3	1:500,000	61°30'W - 58°00'W 6°00'N - 11°00'N	Coastline, Political Boundary Major River Courses.
4	1:500,000	58°00'W - 54°00'W 6°00'N - 11°00'N	Coastline, Political Boundary Major River Courses.
5	1:500,000	61°30'W - 58°00'W 1°00'N - 6°00'N	Seismic Data/Well Location
6	1:500,000	58°30'W - 54°00'W 1°00'N - 6°00'N	Seismic Data/Well Location
7	1:500,000	61°30'W - 58°00'W 6°00'N - 11°00'N	Seismic Data/Well Location
8	1:500,000	58°00'W - 54°00'W 6°00'N - 11°00'N	Seismic Data/Well Location
9	1:1,000,000	61°30'W - 54°00'W 1°00'N - 11°00'N	Coastline, Political Boundary. Major River Courses.
10	1:1,000,000	61°30'W - 54°00'W 1°00'N - 11°00'N	Seismic Data/Well Location.
11	1:1,000,000	61°30'W - 54°00'W 1°00'N - 11'00'N	Compilation of above.

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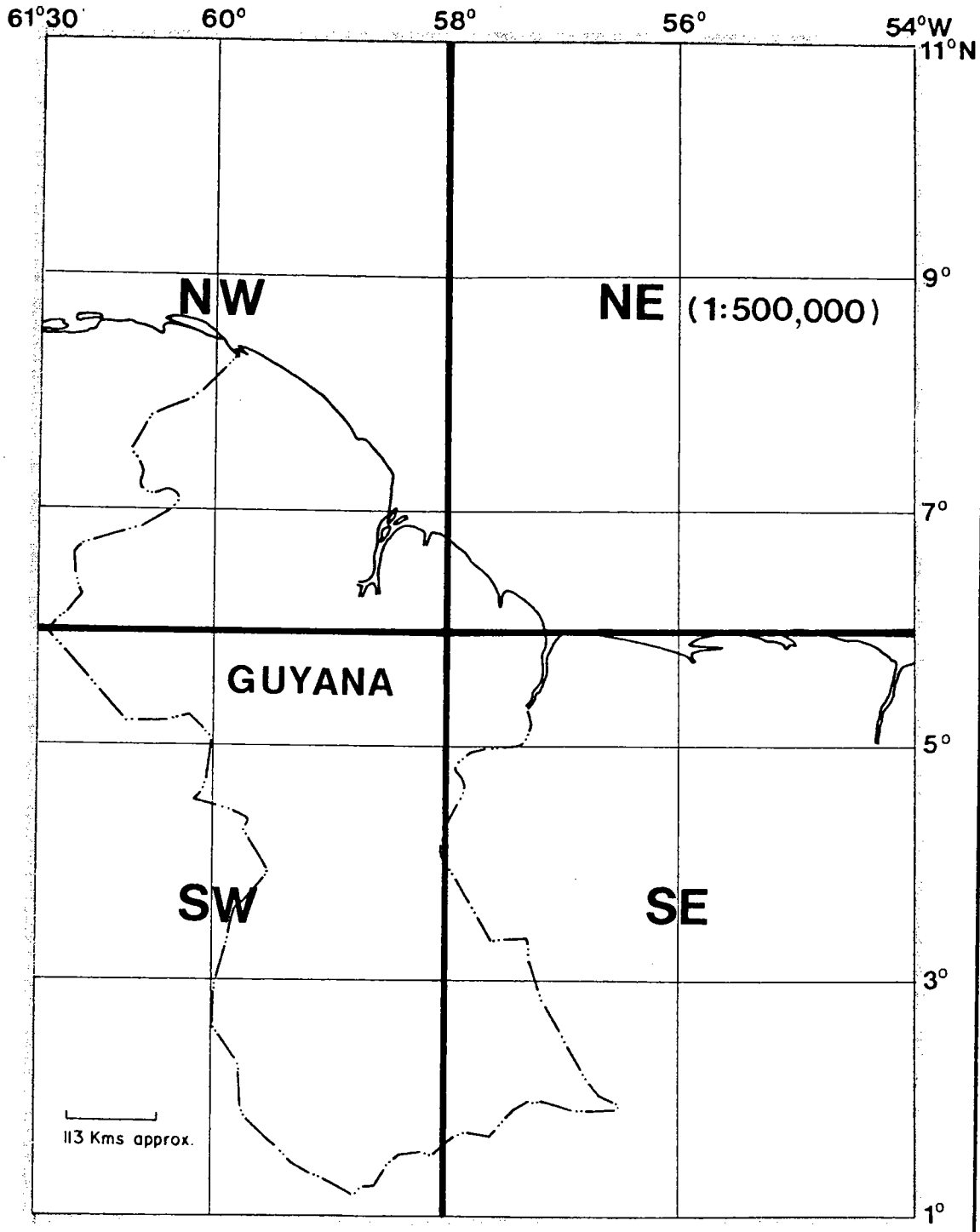

MAP COVERAGE AT 1:1,000,000

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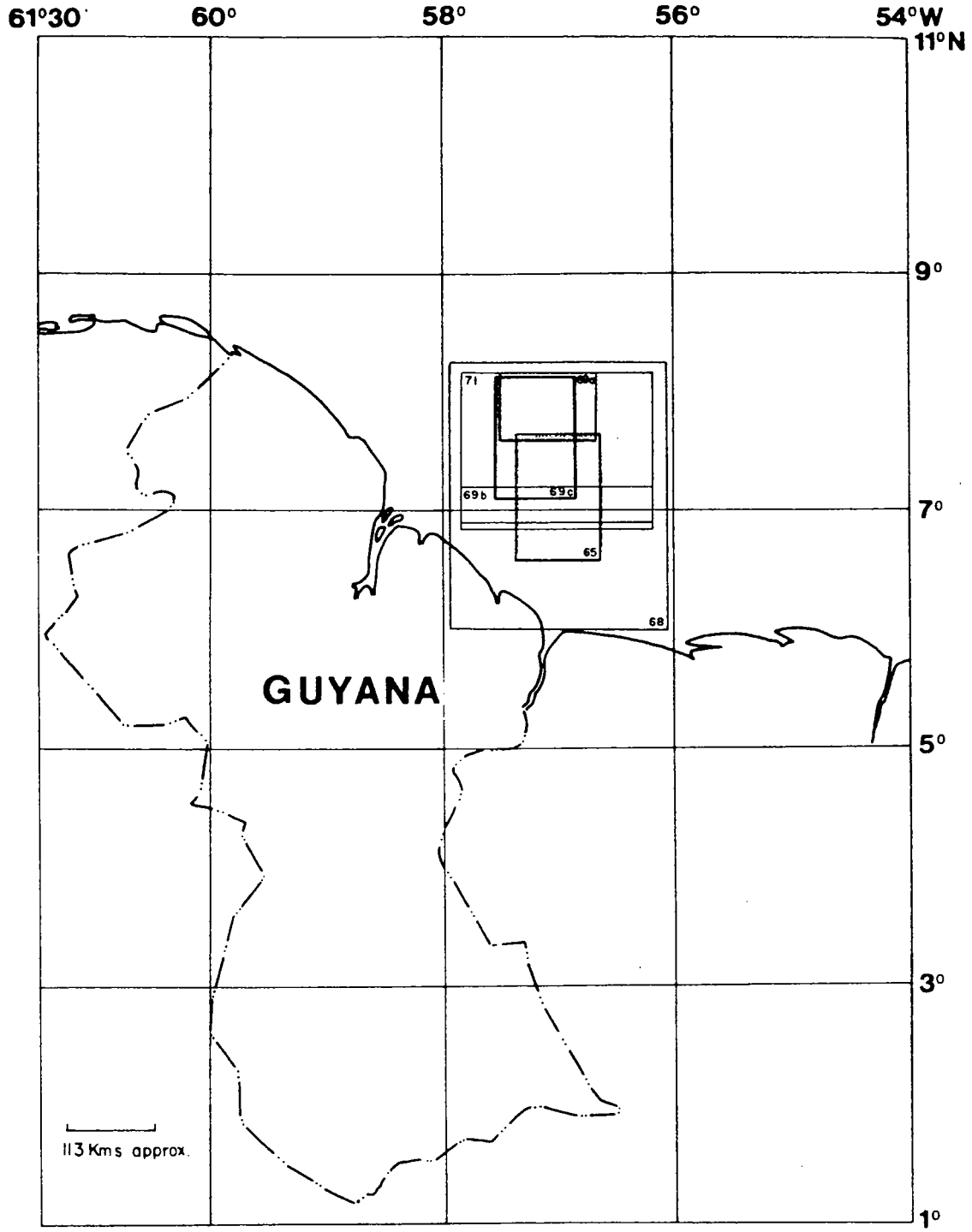

PROPRIETARY MAP INPUT

Shell 65	Shell 69b
" 68	" 69c
" 69a	" 71

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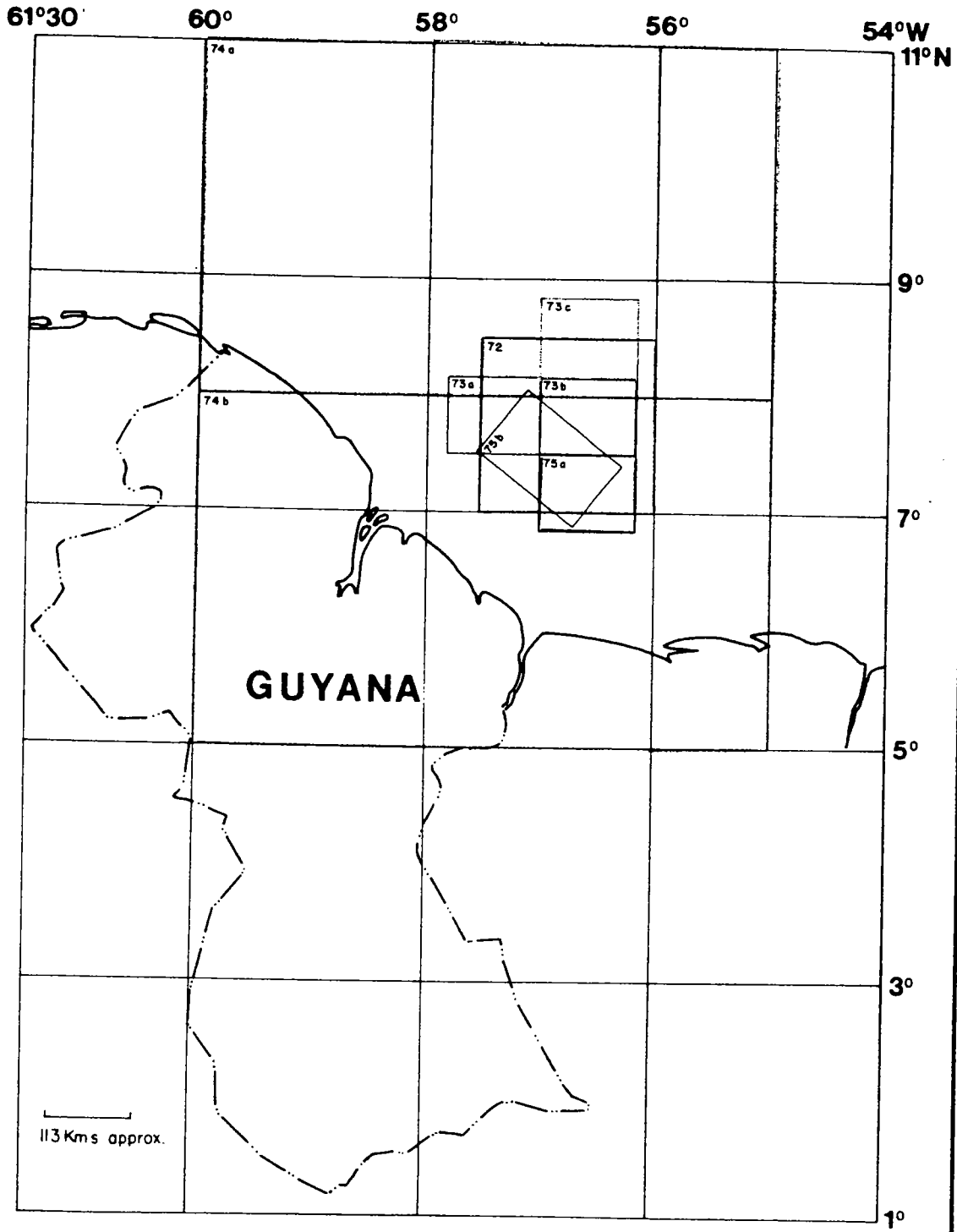

PROPRIETARY MAP INPUT

Shell	72	Shell	74a
"	73a	"	74b
"	73b	"	75a
"	73c	"	75b

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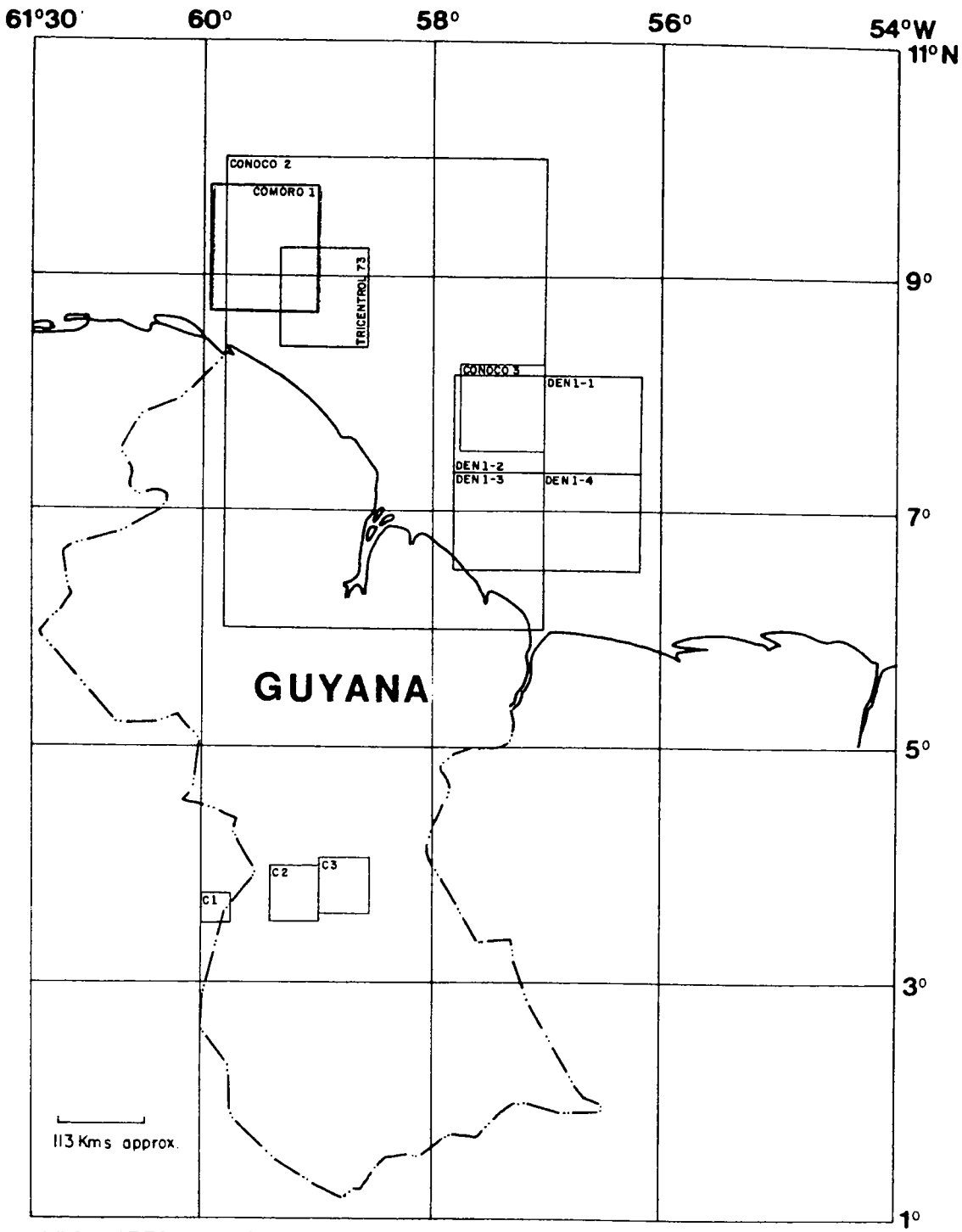

PROPRIETARY MAP INPUT

Denison 1-1	Caravel 1	Tricentrol 73
" 1-2	" 2	
" 1-3	" 3	
" 1-4	Conoco 2	
Comoro 1	Conoco 3	

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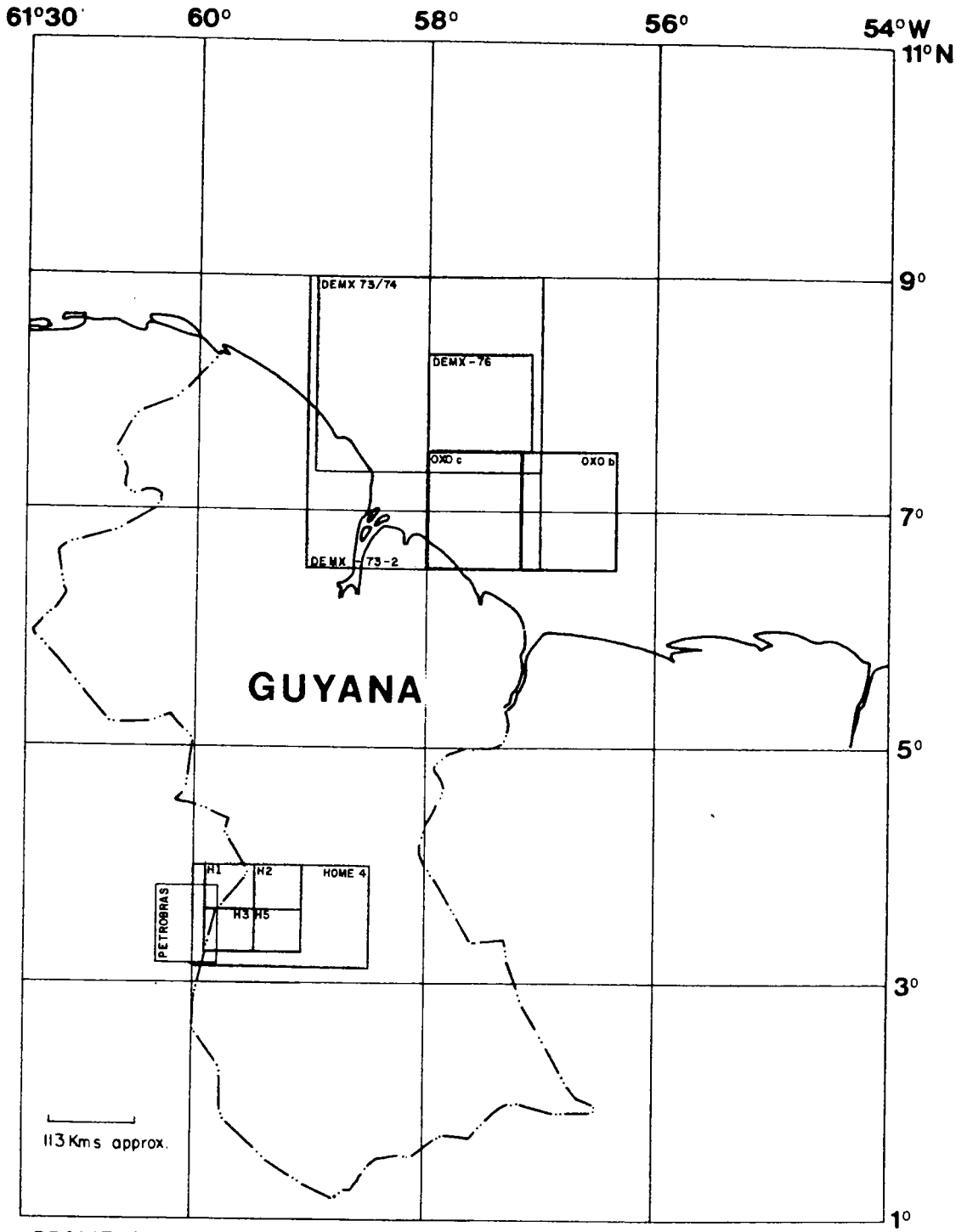

PROPIETARY MAP INPUT

Deminex 73-2	Petrobras
" 73-74	Home 1
" 76	" 2
Oxoco B	" 3
Oxoco C	" 4
	Home 5

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SEISMIC AND WELL LOCATION FILES
DIRECTORY : GUYANA

FILE NAME	DESCRIPTION
GUYCOMP.ME	Alphanumeric listing of eash seismic survey including calculation of line km.
GUYWELLS.ME	Text file containing the names and co-ordinates of important boreholes in Guyana including Brazilian section of Takutu. Digitised from oil company data.
SURWELLS.ME	Text file containing the names and coordinates of important boreholes in Surinam; Digitised from Petroconsultants activity maps.
CAR72.ME	Caravel seismic data, 1972 survey.
CON67.ME	Conoco seismic data, 1967 survey.
CON67A.ME) CON67B.ME) CON67R.ME) CON67S.ME)	Conoco seismic data, additions to main 1967 survey.
CON71.ME	Conoco seismic data, 1971 survey.
DEM73.ME	Deminex seismic data, 1973 survey.
DEM73A.ME	Deminex seismic data, additions to main 1973 survey.
DEM74.ME	Deminex seismic data, 1974 survey.
DENN81.ME	Denison/Seagull seismic data, 1981 survey.
OXOCO.ME	Oxoco seismic data, 1971 survey.
SHELL65.ME	Shell seismic data, 1965 survey.
SHELL68.ME	Shell seismic data, 1968 survey.
SHELL69.ME	Shell seismic data, 1969 survey.
SHELL69A.ME) SHELL69B.ME) SHELL69D.ME)	Shell seismic data, in addition to main 1969 survey.
SHELL71.ME	Shell seismic data, 1971 survey, part 1.
SHELL71A.ME	Shell seismic data in addition to main 1971 survey.
SHELL72A.ME)) SHELL 72C.ME)	Shell seismic data, 1971 survey, part 2.
SHELL 73.ME	Shell seismic data, 1973 survey.
SHELL 74.ME	Shell seismic data, 1974 survey.

and 1°N - 11°N, and can be contacted photographically with the coastline data held in the 'IMPAC' data base.

A comprehensive set of maps has been produced, at scales of 1:500,000 and 1:1,000,000, for regional studies as shown in Figure 8. Examples of these maps at full scale are included as Enclosures 6 through to 10. A composite coastline/seismic/well location map, at a scale of 1:1,000,000 is included as Enclosure 11.

Localised shot-point maps have been produced in three phases. An initial series of seismic base maps was produced at a scale of 1:100,000 for the offshore area with greatest seismic concentration, (see Table 10). Secondly a series of 1:50,000 seismic base maps was produced to include all of the shot-point information from the onshore Takutu Basin and its immediate surroundings. These maps are listed in Table 11. The final set of seismic base maps were produced at 1:100,000 for the offshore areas where seismic information is sparse. The maps are indicated by Table 12. Figure 10 depicts the overall coverage of each series. These maps will form the working scale for the seismic interpretation studies, and examples of part of the shot point maps at 1:100,000 and 1:50,000 are shown in figures 11 and 12 respectively.

2.5.3 **Well Log Digitising**

Petrophysical well logs, for each of the 9 offshore wells were digitised, using ECL's interactive log analysis and log data package 'CLAN'. Data input were from paper copies of logs, provided from the files of the Ministry of Energy and Mines, Georgetown.

Although some logs are available for the stratigraphic boreholes in the coastal belt it was decided not to put these to tape at the present time.

The two Home Oil wells, Lethem 1 and Karanambo 1, located in the Takutu Basin, have logs already recorded on magnetic tape, and copies of these tapes have been requested, for input to CLAN, which is compatable with both Schlumberger LIS and CSU. If the tapes from Home Oil are

TABLE 10 SEISMIC BASE MAPS (First Series)

OFFSHORE GUYANA

MAP NO.	SCALE	COORDINATES	
1	1:100,000	58°00'W - 57°20'W	6°00'N - 7°00'N
2	1:100,000	57°20'W - 56°40'W	6°00'N - 7°00'N
3	1:100,000	56°40'N - 56°00'N	6°00'N - 7°00'N
4	1:100,000	59°20'W - 58°40'N	8°00'N - 7°00'N
5	1:100,000	58°40'W - 58°00'W	8°00'N - 7°00'N
6	1:100,000	58'00'W - 57°20'W	8°00'N - 7°00'N
7	1:100,000	57°20'W - 56°40'W	8°00'N - 7°00'N
8	1:100,000	56°40'W - 56°00'W	8°00'N - 7°00'N
9	1:100,000	60°00'W - 59°20'W	9°00'N - 8°00'N
10	1:100,000	59°20'W - 58°40'W	9°00'N - 8°00'N
11	1:100,000	58°40'W - 58°00'W	9°00'N - 8°00'N
12	1:100,000	58°00'W - 57°20'W	9°00'N - 8°00'N
13	1:100,000	57°20'W - 56°40'W	9°00'N - 8°00'N
14	1:100,000	56°40'W - 56°00'W	9°00'N - 8°00'N
15	1:100,000	60°00'W - 59°20'W	10°00'N - 9°00'N
16	1:100,000	59°20'W - 58°40'W	10°00'N - 9°00'N
17	1:100,000	58°40'W - 58°00'W	10°00'N - 9°00'N
18	1:100,000	58°00'W - 57°20'W	10°00'N - 9°00'N
19	1:100,000	56°40'W - 56°00'W	10°00'N - 9°00'N
20	1:100,000	56°00'W - 55°20'W	10°00'N - 9°00'N
21	1:100,000	59°20'W - 58°40'W	10°30'N - 10°00'N
22	1:100,000	56°00'W - 55°20'W	10°30'N - 10°00'N
23	1:100,000	55°20'W - 55°00'W	10°30'N - 10°00'N

TABLE 11 SEISMIC BASE MAPS

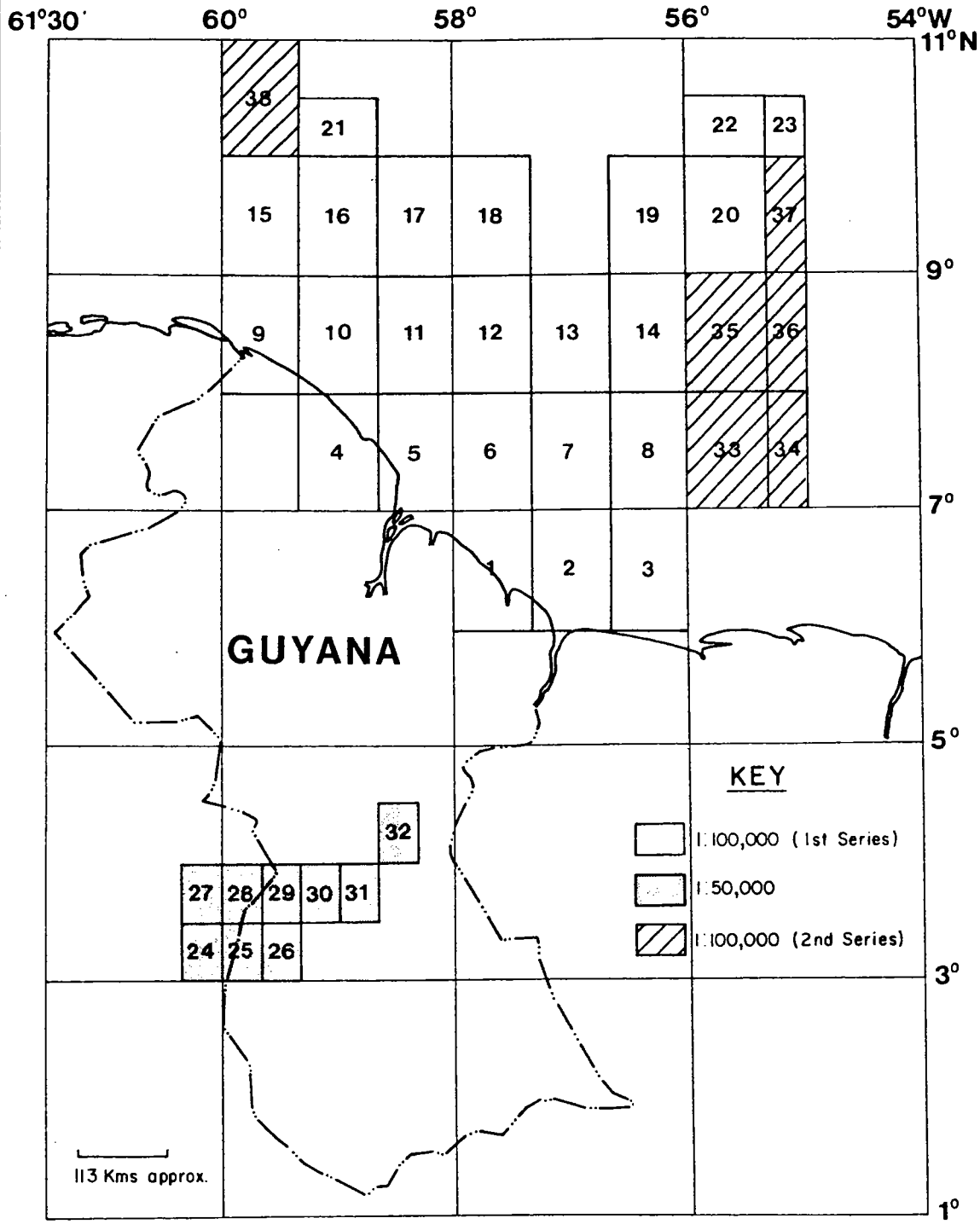
ONSHORE GUYANA

MAP NO.	SCALE	COORDINATES	
24	1:50,000	60°20'W - 60°00'W	3°00'N - 3°30'N
25	1:50,000	60°00'W - 59°40'W	3°00'N - 3°30'N
26	1:50,000	59°40'W - 59°20'W	3°00'N - 3°30'N
27	1:50,000	60°20'W - 60°00'W	3°30'N - 4°00'N
28	1:50,000	60°00'W - 59°40'W	3°30'N - 4°00'N
29	1:50,000	59°40'W - 59°20'W	3°30'N - 4°00'N
30	1:50,000	59°20'W - 59°00'W	3°30'N - 4°00'N
31	1:50,000	59°00'W - 58°40'W	3°30'N - 4°00'N
32	1:50,000	58°40'W - 58°20'W	4°00'N - 4°30'N

TABLE 12 SEISMIC BASE MAPS (Second Series)

OFFSHORE GUYANA

MAP NO.	SCALE	COORDINATES	
33	1:100,000	56°00'W - 55°20'W	7°00'N - 8°00'N
34	1:100,000	55°20'W - 55°00°W	7°00'N - 8°00'N
35	1:100,000	56°00'W - 55°20'W	8°00'N - 9°00'N
36	1:100,000	55°20'W - 55°00'W	8°00'N - 9°00'N
37	1:100,000	55°20'W - 55°00'W	9°00'N - 10°00'N
38	1:100,000	60°00'W - 59°20'W	10°00'N - 11°00'N



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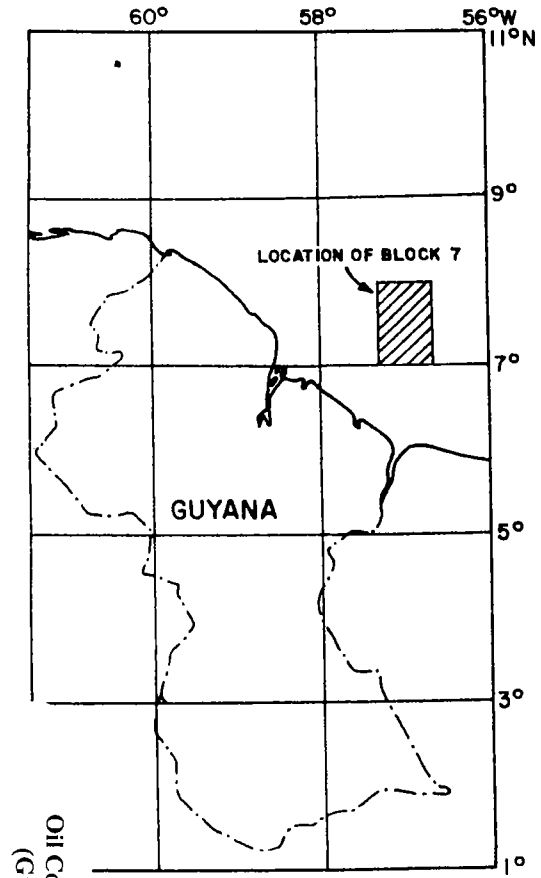

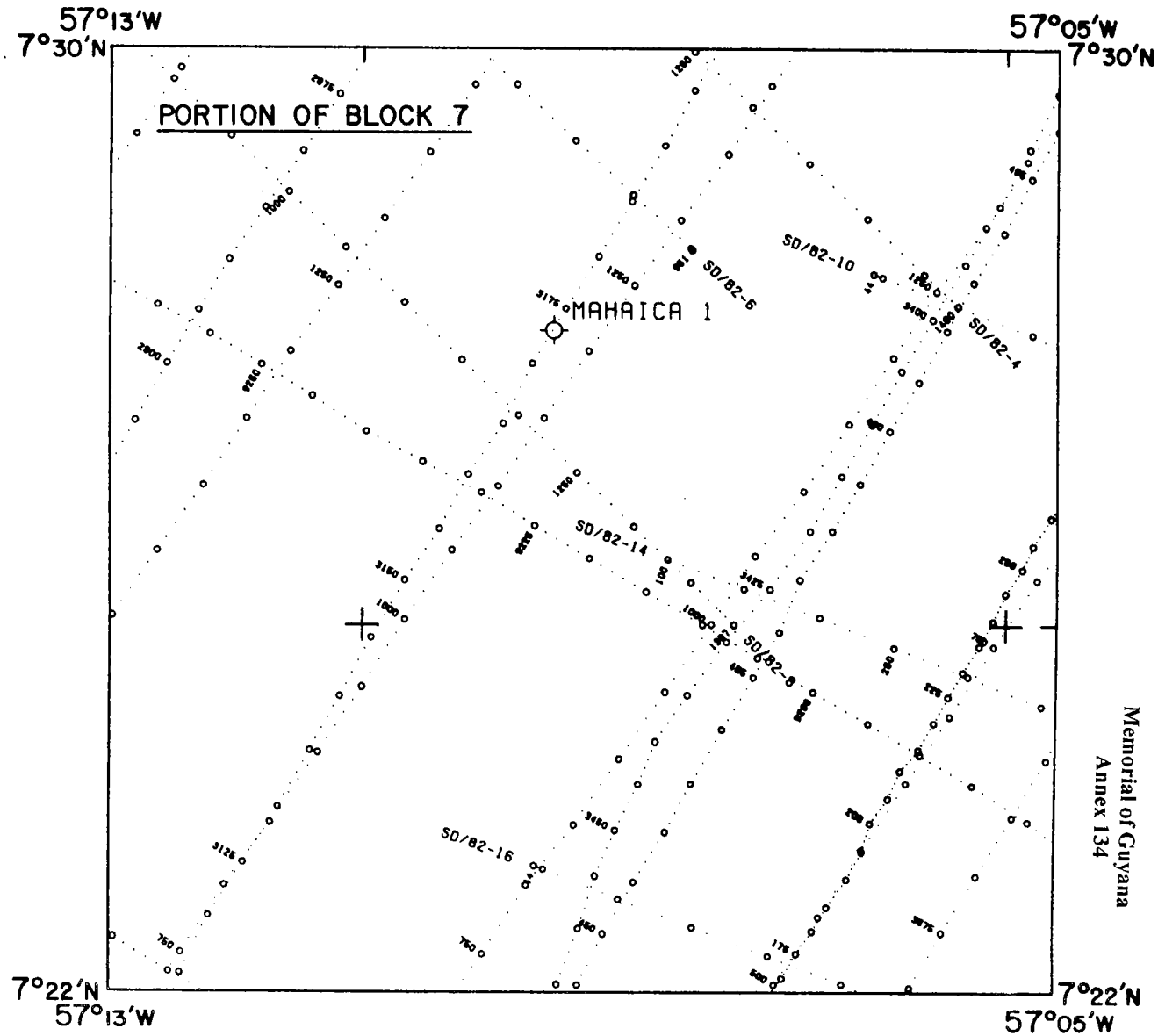

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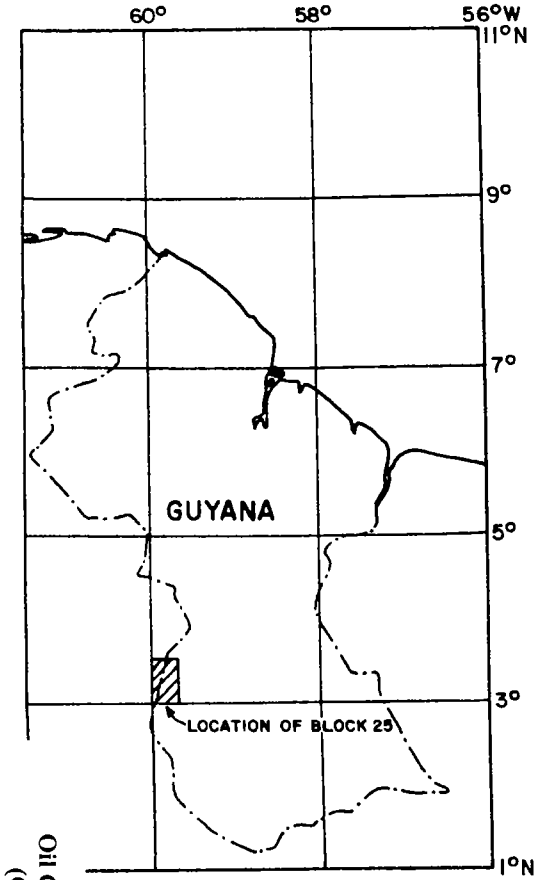

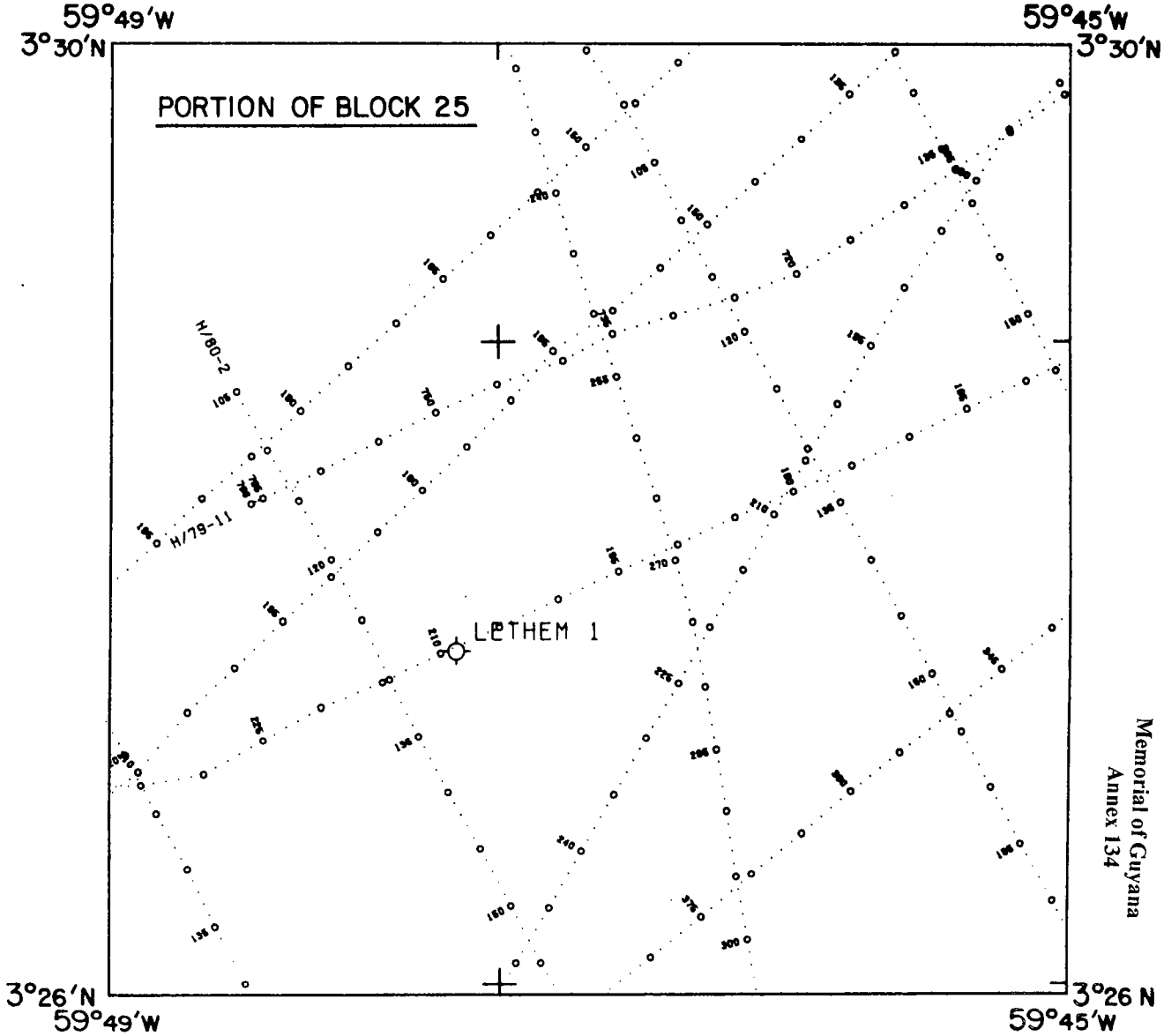

Oil Concessions (Guyana)

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paper copies held at the Ministry.

Digitising was performed on Calcomp digitising tables, utilised for the greatest possible accuracy. A priority order for digitising was requested by the interpretation staff, and was as follows.

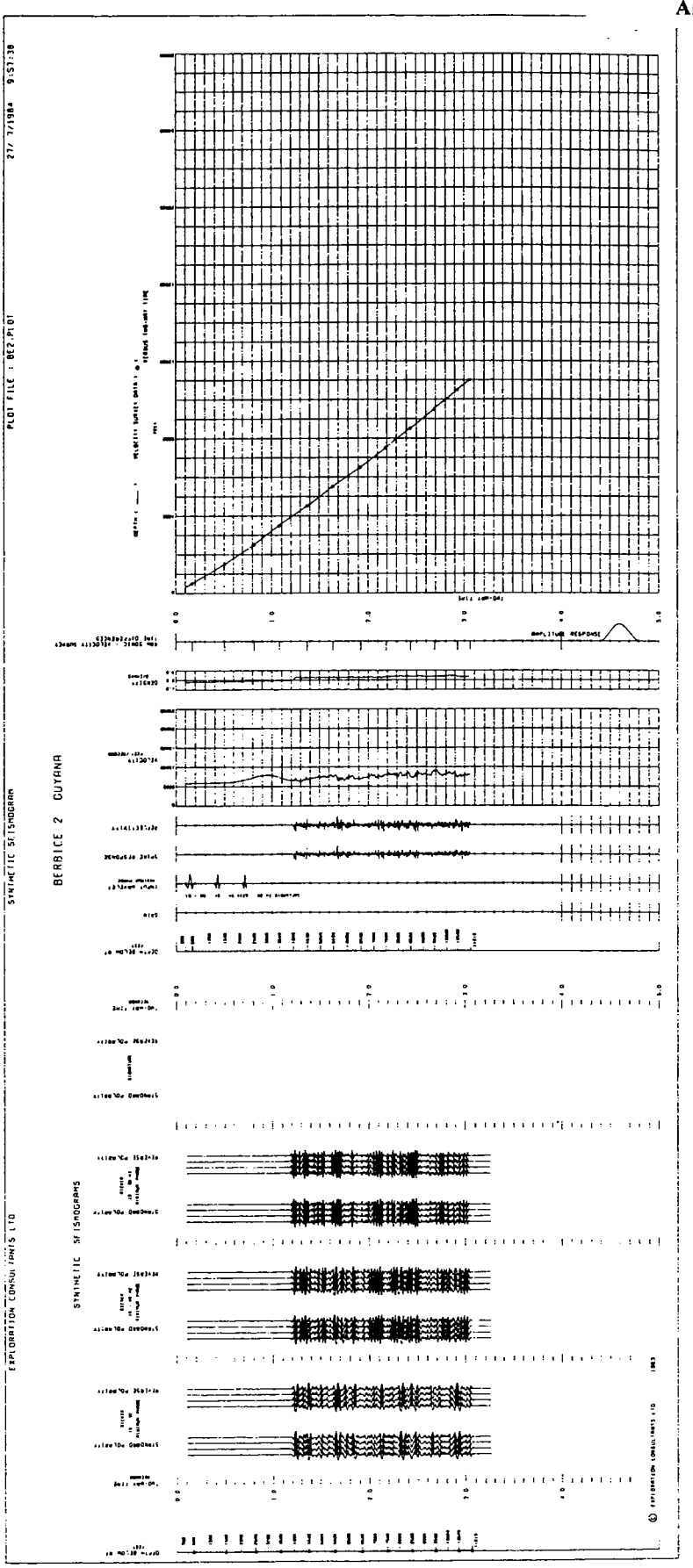
1) Gamma Ray and Sonic log curves
2) Density log curves
3) Neutron log curves
4) All Resistivity log curves

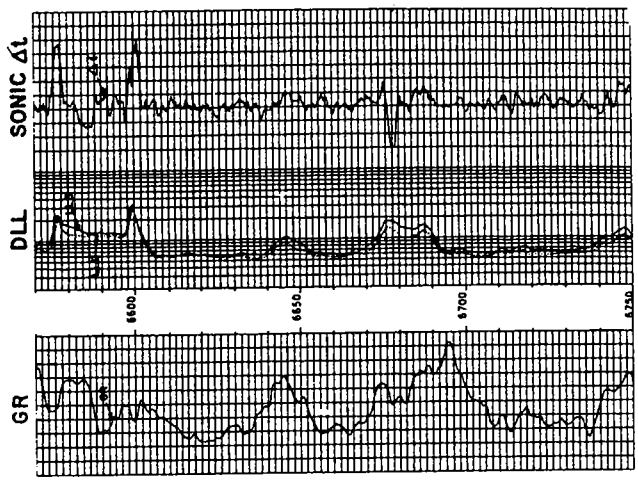
The above order was requested for two reasons. Firstly Gamma Ray/Sonic logs provide the most useful link between the geologist and geophysicist since the Sonic log is a velocity tool, and the Gamma Ray is an indicator of lithology. To aid interval velocity calculations, Integrated Transit Time 'pips' were digitised, and were played back with the sonic logs. Secondly, density logs were digitised, and when combined with sonic log values, generation of a synthetic seismogram was effected. These are an essential supplement to the geophysical interpretation.

Once the first two digitising runs were complete, a set of synthetic seismograms was generated for each of the nine offshore wells, at a vertical scale of 5 cms. per second, to be compatable with the rephotographed seismic sections. These synthetic seismograms now form part of the data base, and an example is shown in figure 13, for well Berbice-2.

Once each of the log curves have been digistised, playback can be on any scale and in any format. Thus older log runs can be generated in a modern format. For instance a resistivity log and sonic log can be played back on the modern RESISTIVITY/SONIC combination as shown in Figure 14.

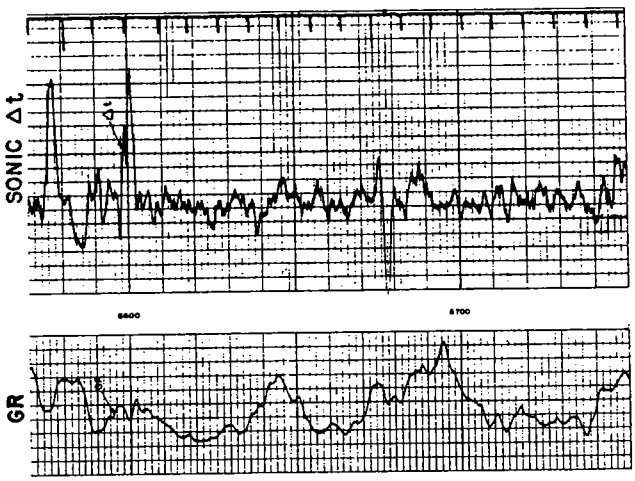
The digitised log curves can be supplied either as tape copies, paper or film prints, or as a digital print-out. Utilising digitised logs, Composite Logs are being compiled for addition to the data base at a later date.


PLOT FILE : BE2.PLOT
27/ 7/1984 9:57:38
SYNTHETIC SEISMOGRAM
BERBICE 2 GUYANA
SYNTHETIC SEISMOGRAMS
EXPLORATION CONSULTANTS LTD

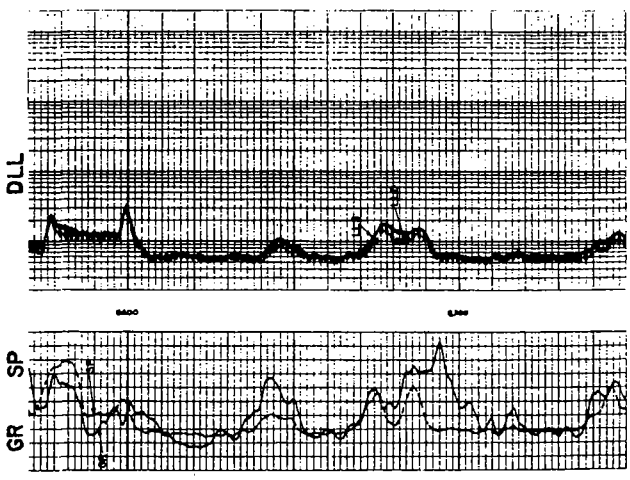


'CLAN' Digitised combination playback

WELL - MAHAICA 2



SCHLUMBERGER PAPER FIELD PRINTS



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2.6 Computer Facilities in Guyana

During the initial visit to Georgetown, it was discovered that a custom-built data centre had been established in Guyana. This, the National Data Management Authority (NDMA), under the management of Dr. Curt Choo-Kang, has complete computer facilities, based on a 1979 vintage IBM computer.

S.R. Pile of ECL, arranged a meeting with Dr. Choo Kang to discuss storage facilities for magnetic tapes of the 1981 and 1982 seismic surveys conducted by Denison/Seagull and supplied to the Ministry of Energy in Georgetown. The NDMA centre was willing to accept these tapes, and storage fees are at present being negotiated between NDMA and the Ministry of Energy.

ECL are looking into the compatibility of the equipment at NDMA with that of ECL at Henley on Thames, with a view to holding data base tapes, generated at ECL, at the NDMA data centre, for reproduction of the digitised data base in Georgetown. ECL will be pricing the necessary peripherals, if any, after further discussions with Dr. Choo Kang.