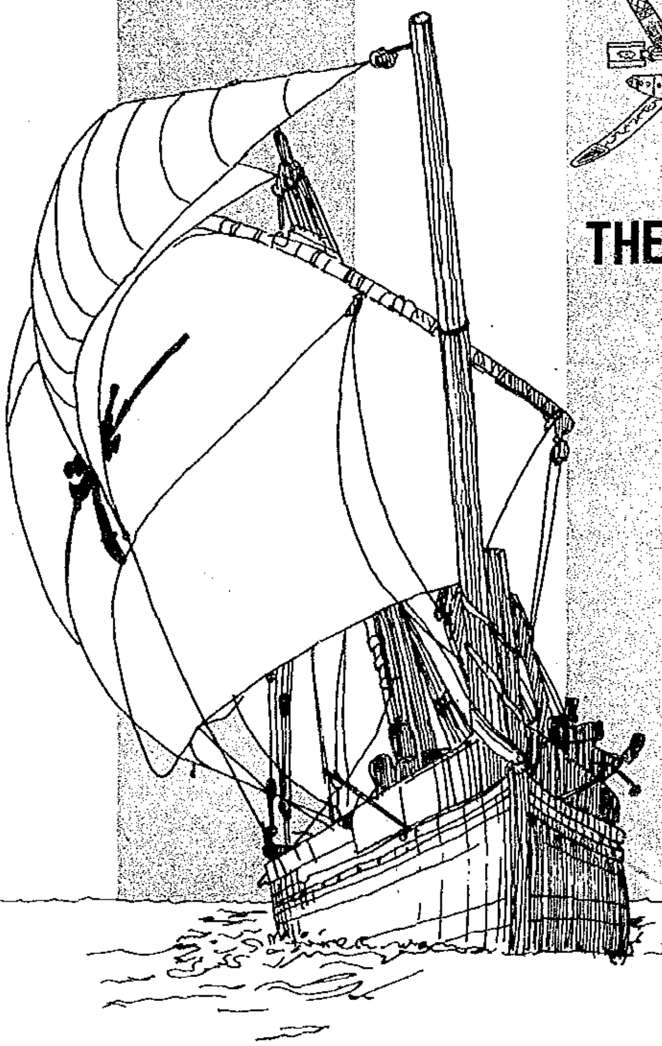
社会開発調査部報告書

No. 52

FINAL REPORT

NEW PORT DEVELOPMENT PLAN IN SOHAR

VOLUME (III) FOR THE STUDY ON THE PORT DEVELOPMENT FOR NORTHERN OMAN



OCTOBER 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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FINAL REPORT NEW PORT DEVELOPMENT PLAN IN SOHAR VOLUME (III) FOR THE STUDY ON THE PORT DEVELOPMENT FOR NORTHERN OMAN OCTOBER 1990 J.I.C.A.

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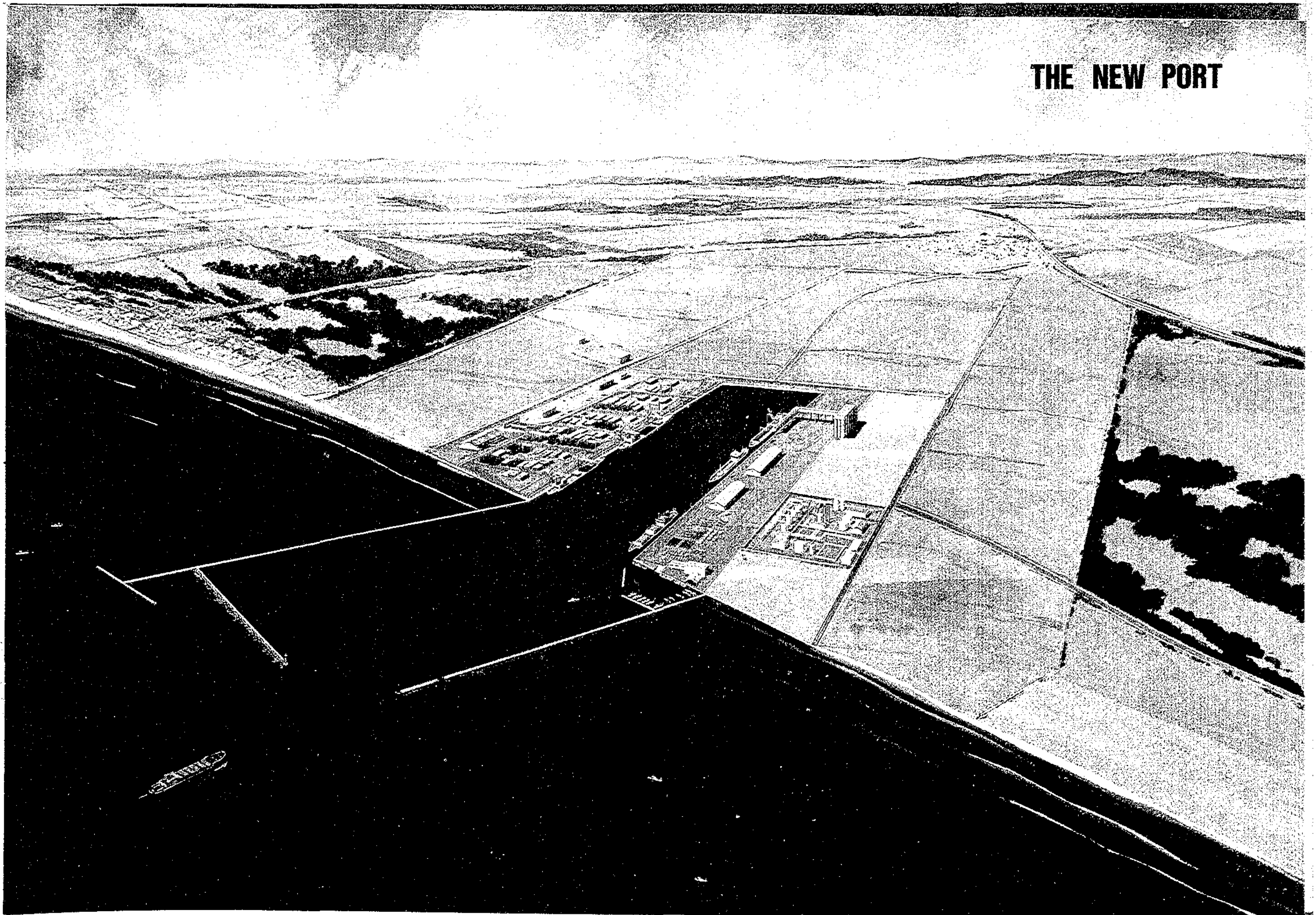

THE NEW PORT

THE STUDY ON THE DEVELOPMENT

FOR NORTHERN OMAN

VOLUME I THE STUDY ON THE DEVELOPMENT FOR NORTHERN OMAN

VOLUME II MINA QABOOS DEVELOPMENT PLAN

VOLUME III NEW PORT DEVELOPMENT PLAN IN SOHAR

SUMMARY

ABBREVIATIONS

CA	Capital Area
CD	Chart Datum
CES	Consulting Engineering Service (India) Private Limited
CFS	Container Freight Station
CMA	Compagnie Maritime d'Affretement
CRT	Cathode Ray Tube
CY	Container Yard
DC	The Development Council
DL	Datum Water Level
DWT	Dead Weight Tonnage
FCL	Full Container Load
FTZ	Free Trade Zone
G.C.	General Cargo
GCC	The Gulf Co-operation Council
GDP	Gross Domestic Product
GDP(R)	GDP for Regression Analysis
GNP	Gross National Product
G.S.	Ground Spot
G/T, GRT	Gross Tonnage
H	Wave Height
Ho	Deep Water Wave Height
H1/3	Significant Wave Height
IBRD	International Bank for Development and Reconstruction
IMO	International Maritime Organization
JAFZ	Jebel Ali Free Zone
JICA	The Japan International Cooperation Agency
J¥	Japanese Yen
L	Wave Length
LAT	Low Astronomical Tide
LCL	Less Than Container Load
LNG	Liquid Natural Gas
L.W.L.	Low Water Level
MAF	Ministry of Agriculture and Fishery
M.H.W.L.	Mean High Water Level
MMSCF	Million Standard Cubic Feet

MMSCFD	Million Standard Cubic Feet per Day
M.L.W.L.	Mean Low Water Level
MOC	The Ministry of Communications
MRO	Million Omani Rial
M.S.L.	Mean Sea Level
MT	Empty Container
MTBE	Methyl Tertial Butyl Ether
MTD	Metric Tonnes per Day
MTPA	Metric Tonnes per Annum
MW	Mega Watt
NYK	Nippon Yusn Kabushikigaisha
OBAF	The Oman Bank for Agriculture and Fisheries
OCDI	The Overseas Coastal Area Development Institute of Japan
ORC	Oman Refinery Company
PAMAP	The Public Authority for Marketing Agricultural Produce
PMB	Port Management Body
PSC	The Port Services Corporation
R.O	Omani Rial
Ro/Ro	Roll on/Roll off
SMDS	Shell Middle Distillate Synthesis
SPT	Standard Penetration Test
TEU	Twenty-foot Equivalent Unit
TRS	Transshipment
UAE	The United Arab Emirates
US$	The United States Dollars
ϕ	Angle of Internal Friction

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RECOMMENDATIONS

Recommendation

(1) Considering the expandable space of Mina Qaboos and the future demand forecast of cargoes, it is unavoidable to construct a new port in northern Oman. However, other factors favouring the new port development should be mentioned:

i) The port could act as a substantial tool for carrying out and further expanding the work of industries located in the hinterland of the port.

ii) It is generally recognized that ports stimulate economic activities, thus promoting the development of the adjacent region.

iii) Oman will be left behind other countries if a new port is not built in the very near future, because it faces the challenge of port expansion in various neighboring countries.

iv) The nation can obtain an asset that will contribute to expanded productivity, thus maintaining the competitiveness of manufacturing sector over the period of the economic analysis.

(2) The new port should be in Majis, considering the various factors such as space availability, ground surface conditions, locational relation to the existing towns, construction costs and the potential functions of the new port.

(3) With regard to preservation of the environment, the highest priority is given to minimizing the impact on the environment during both site selection and actual planning of the new port at the selected site. The environmental aspects of the project should be kept in mind in the detailed design and construction stages.

(4) The transfer crane system should be adopted at the container terminal in the new port as well as at Mina Qaboos due to ease of maintenance of equipment, such as obtaining the parts for the equipment, and of operator training.

(5) The management body of the new port may be a corporation, a large portion of the capital of which will be owned by the government but independent from the existing PSC. This is because a large part of

investment should be borne by the government, and the PSC cannot bear the huge deficit envisaged at its initial stage, although the body will be self sustaining in the long term.

(6) For the new port, an enormous tasks have to be done before port inauguration as well as during its first few years of operation. In order to carry out these tasks, it might be a good idea to make a detailed study of recruitment and training. Under the circumstances, where difficulty is envisaged in recruiting a sufficient number of experts for higher-ranking officials of the PMB, it may be advisable to hire foreign experts with much port management experience, preferably including a general manager, with a view to assisting in the smooth operation of the port and also to transfer port management expertise in the inauguration period.

(7) The new port should make an intensive effort to "sell" the port. For new comers it is absolutely true that without such efforts the port will not survive. However, it should be emphasized that publicity can only do a little on its own. Reputation accompanied by substance is more effective. Form the customers' viewpoint the best substance is sure and speed cargo movement. To attain this, quick customs, immigration and quarantine (CIQ) procedures are also vital.

(8) The new port and Mina Qaboos should cooperate with each other and coordinate their activities in many fields. It may be advisable to establish a national port council under the Ministry of Communications consisting of exectives of the PSC (Mina Qaboos) and of the port managing body of the new port with a small secretariat.
Anther facet of coordination relates to various projects of the region. Some means of linking all the relevant bodies should be developed. Relevant bodies include municipalities, regional branches of central organizations dealing with housing, education, energy, customs, quarantine and immigration, the industrial estate authority, the governing body of the free trade zone and the petro-chemical factory.

(9) There are still questions to be solved. Another study, which may be named as the study for preparation for the new port at Sohar, will be useful in finding solutions to some of the questions including fixing exact

timing based upon economic indices forecasts and information regarding related projects at the time. Also, detailed plans of ancillary services and plans for recruitment and training structure may well be a part of the study. Taking into account the time schedule for the new port construction, the study should be concluded by 1997.

CHAPTER 1 NATURAL CONDITIONS

Chapter 1. NATURAL CONDITIONS

1.1 General Features in the Northern Part of Oman

1.1.1 General Features of Coastal Line

Coastal line in the Sultanate is divided characteristically as shown in Fig.1-1-1. General features in the northern part of Oman are as follows.

(1) Sector II Batinah Coast

The almost entirely homogeneous Batinah Coast is Characterised by an intensely cultivated coastal plain extending inland for up to 10 km from either the sea's edge or inland from extensive, sometimes very wide sabkha (unvegetated, low-lying salt flats) areas. The beaches along this coastline are composed primarily of fine-grained, terrigenous sand with shoal areas extending out to 2 km offshore. These beachs are almost always backed by a fringe of dunes and dune-grass vegetation, with either date plantations or halophyte scrub/sabkha areas inland.

The Batinah Coast begins in Fujarah (UAE) in the north and continues south to the mangrove khawr at Qurum. Several other khawrs occur along this coast and are its most interesting feature. During periods of good rainfall these khawrs are important resting-areas for migratory wildfowl, nursery grounds for juvenile coastal fish, and feeding areas for numerous other marine and terrestrial fauna.

Within three of the more permanent khawrs there are extensive stands of the black or dwarf mangrove, Avicennia marina, and associated fauna and flora.

Most of the Batinah Coast is densely populated and the local populations are substantially dependent on agriculture and fishing.

With the exception of some locally known sabkha areas, vehicle access to all coastal areas of the Batinah is excellent. Roads suitable for heavy vehicle traffic connect coastal villages to the main dual carriageway at regular intervals along the entire coastal plain.

(2) Sector III Capital Area

This sector includes several habitats typical of other areas along the Oman coast. The section between Ras Suwadi and Qurum is a continuation of the typical sand beach environment characteristic of the Batinah Coast, whereas the Damaniyat islands form a unique environmental unit. These islands have well developed coral communities in the shoal areas around them and along some of the northern subtidal cliff faces, and halophyte vegetation. They are also an important bird nesting site and possibly one of the largest Hawksbill Turtle nesting sites in the world.

The coastline from Qurum to Ras Abu Daud is composed of both sedimentary and igneous rock cliffs interspersed with numerous bays and coves, including Al Fahal, Muttrah and Muscat Harbours. This section of the coastline also contains the major recreational beaches in the Capital Area including the very popular private and public beaches at Qurum, Ras Al Hamra, Bustan, Bandars Jizzah and Khayran and Khawr Yiti.

Vehicle access to coastal areas along this sector is generally good between Qurum and Bandar Jizzah and extends from Yiti to Asifa via a relatively rough track. There is virtually no vehicle access between Asifa and Quryat.

(3) Sector IV Daghmar to Ras Al Hadd

The coastal area along this sector is composed primarily of undercut sedimentary rock cliffs of varying heights with sand/gravel beaches at the mouths of the numerous wadis which cross the coastal plain. There are two major and one minor khawr along this sector as well as the long coarse-grained white sand beach at Ras Al Hadd.

This sector of Oman's coast is very scenic and of significant historical and ecological importance. In addition to the ruins at Qalhat, other historical sites are known at Quryat, Sur, Ras Al Hadd, and Ras Junayz. Sur and its associated villages is the largest and most important population and administrative centre in the region.

There are four major habitat types along this coastline undercut sedimentary rock cliffs (1-100m. high); Khawrs; sand/gravel beaches with wave-cut platforms extending offshore; and coarsegrained shell beaches. Vehicle access to coastal areas in this sector is generally good.

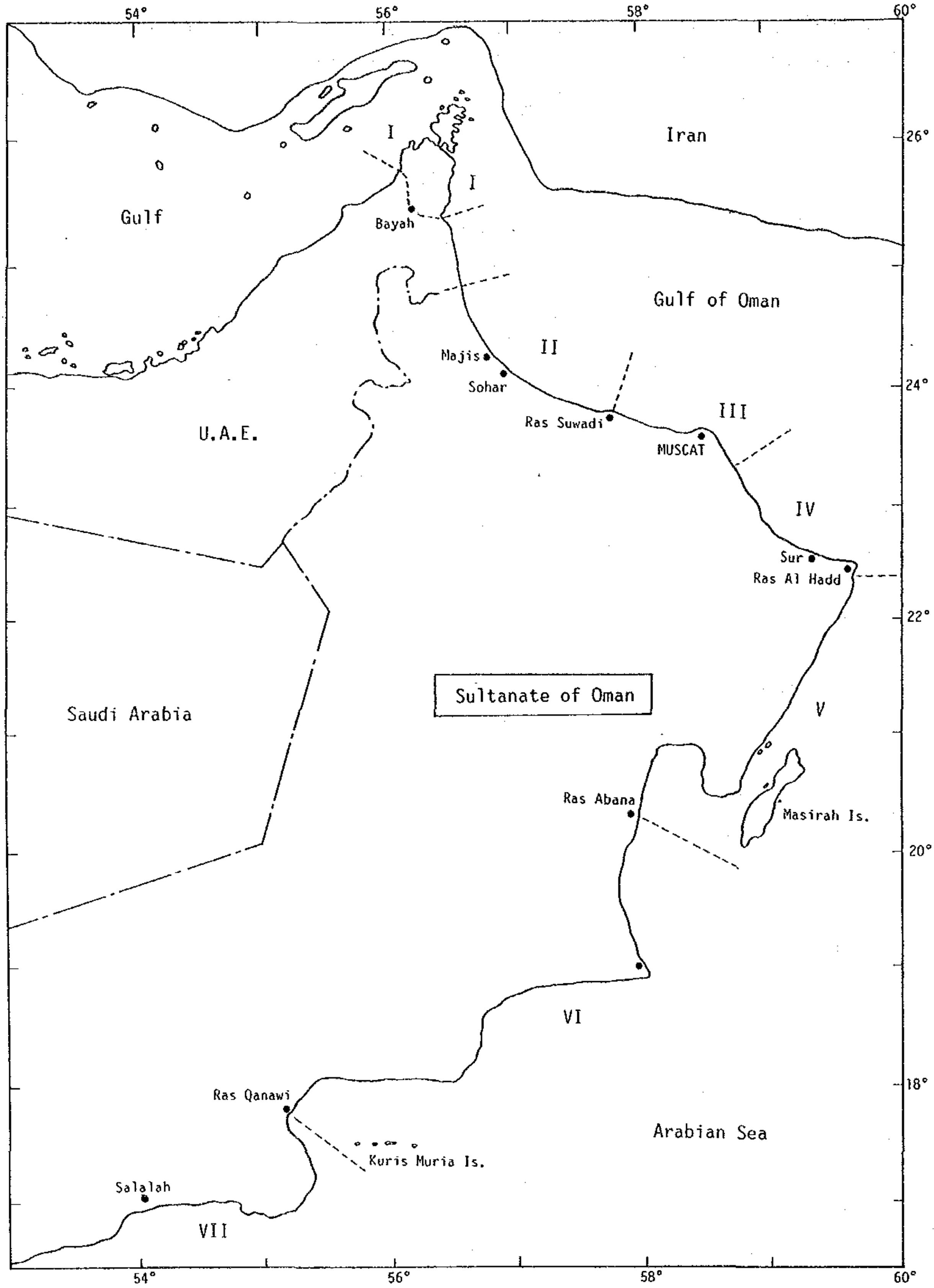


Fig.1-1-1 Coastal Zoning in Oman

1.1.2 Geology

(1) The Surface Geology of Oman

The geology of Oman has been extensively investigated in recent years and is described in a number of pulications (Reference Nos. 1,2 & 3). The principal interest has related to the search for petroleum, and stratigraphic studies have penetrated to considerable depths in many parts of the counyry (Reference Nos. 4 & 5). Following the upsurge in construction a number of reports have been published on surface geology and aggregate resources in the Middle East, including some by P.G.Fookes (Reference Nos. 6 & 7). which include Northern Oman in their compass. Economic geology is very actively studied at present and for specific works projects it may be possible to obtain information from the appropriate authority, in particular the Ministry of Petroleum and Minerals, Directorate General for Technical Affairs, and the Ministry of Electricity and Water, Public Authority for Water Resources.

A simplifies map of the surface geology is shown in Fig.1-1-2. The principal feature in the north is the cresent of Mesozoic limestones which have been intruded by ultrabasic igneous rocks to form the backbone of the Hajar Mountains. These extend from the Musandam Peninsula in the extreme north to the coast east of Muscat and further east to Ras Al Hadd; the highest part, the limestone massif of jabal Akhadar lies to the southwest of Muscat.

In the south, the hills surrounding the Salalah Plain are formed of somewhat younger sedementary rocks, and there are some precambrian outcrops in the extreme south. On the east coast bordering Masirah Bay, the Huqf Group consists of Cambrian sedimentary rocks.

Much of the central area of the country consists of desert gravel plain and sandy desert of recent origins merging westwards into the Rub'al Khali. The Salalah Plain in the south is formed of wadi outwash sands and gravels and earlier conglomerates. The Batinah plain in the north and the fertile coastal strip also consist of recent alluvial deposits.

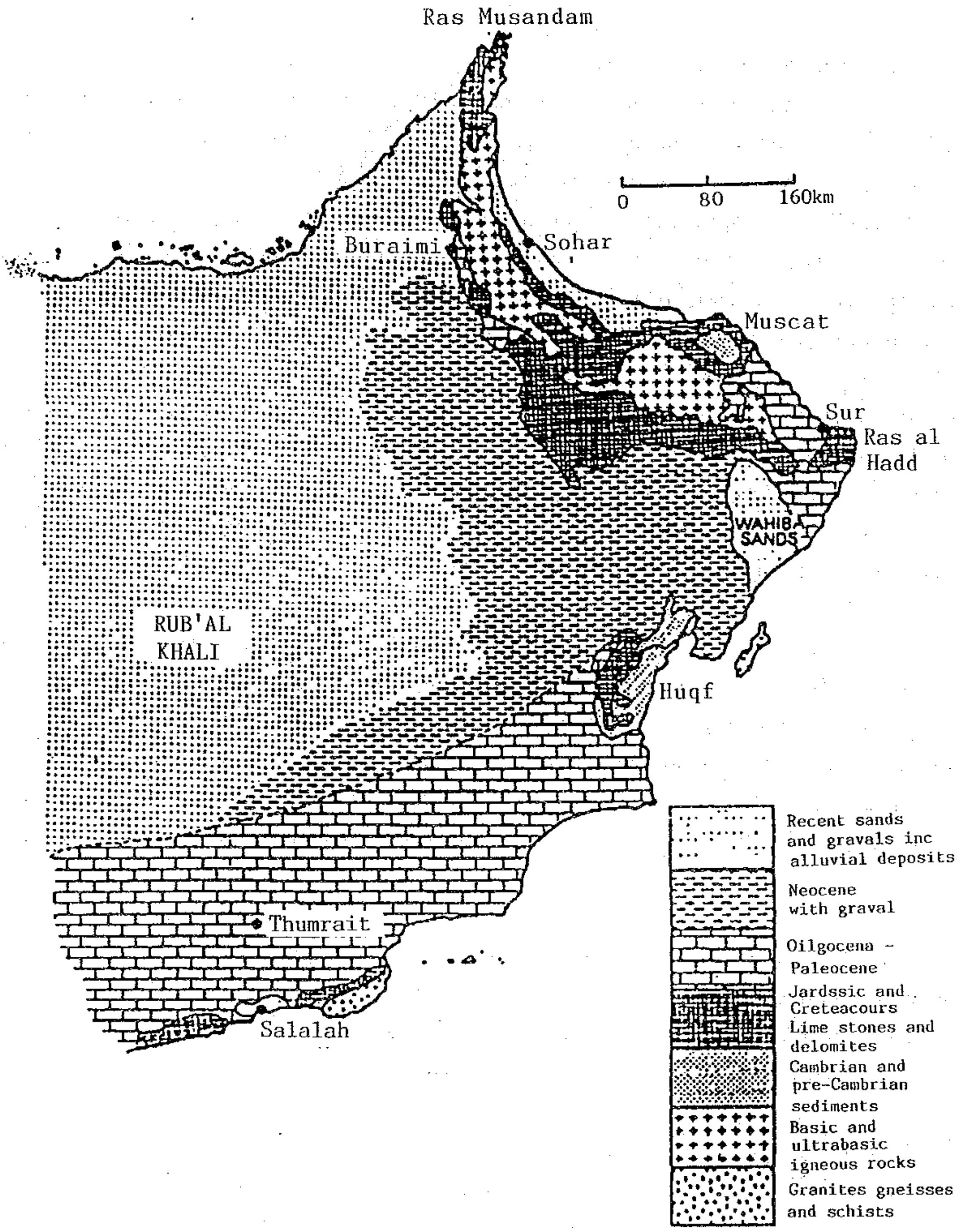


Fig.1-1-2 Surface Geology of Oman

The Hajar mountains to the north form a broken and rocky range, broadening from north to south and comprising Jurassic and Cretaceous limestones and dolomites, and the dark coloured igneous intrusions of periodites gabbros and basaltic lavas. Much of the rock is fissured and weathered, and jagged peaks are a feature of the scenery. The slopes are covered with screes and loose boulders. Amoung the more striking features are the wadis, which intersect the foothills, often forming narrow steep-sided channels, gouged out by the flash floods that severe rainstorms bring to the mountains, much of the outwash has been deposited along the channels, and wadi gravels, which are free of salts and often have good natural grading, provide some excellent building aggregates in the Oman.

Outwards from both sides of the Hajar mountains the outwash materials gradually become finer and lighter in colour, running from thick layers of boulders and gravel into the sandy plains of the UAE on the west with some areas of shallow-water evaporate deposition, and into the alluvial maritime Batinah plain to the northeast.

The Jabel Al Qamar and Jebel Qara which surround the Salalah plain in the south consist mainly of younger and softer Tertiary limestones and the hills show a somewhat gentler topography than the rugged mountains of the north. Flash flooding following violent rainstorms occasionally occurs and while much of the drainage is to the northwest, there are shallow wadis to the sough also and severe flooding has occurred in recent years in Salalah.

Although in the interior of the country there are salt domes and evaporite deposits, and regions of high water table with salt contamination, there is little call for construction in these areas and sabkha and duricrust do not constitute the severe foundation and material-contamination problem that they do along the Gulf Coast from the UAE west and northwards.

(2) Geology of the Batinah Coast

The geology of the Batinah Coast is constituted of sediments ranging from late Tertiary to Recent in age. They are bounded to the south by the Northern Oman mountains and to the north by the Gulf of Oman. Limestones and dolomites of the Hajar Super-Group form the high mountains which divide the catchments that drain into the Gulf of Oman, from those of the Interior. The Hajar Super-Group is overlain structurally by the Hawasina and Semail nappes, which in turn are overlain unconformably by Tertiary limestones. Together, these formations form a monoclinal fold, dipping beneath the sea and constituting the structural framework of the Batinah Coast. A schematic geologic section through the Batinah is shown in Fig.1-1-3.

The Batinah sedimentary material is composed of a series of coalescing alluvial fans divided into a piedmont zone and a coastal plain. The piedmont zone is characterized by a series or alluvial terraces composed of coarse detritus which has been variably cemented, and well demarcated active wadi channels containing uncemented sands and gravels. On the coastal plain, a broad classification of the sediments has been established which recognizes three units, Upper gravels, Clayey Gravels and Cemented Gravels. It should be noted that the Cemented Gravels unit includes marls and white clays which contain very little gravel now, but are believed to be the weathered derivations of much coarser sediments. Although the classification often breaks down on a micro-scale, it appears to have validity at a regional level.

(3) Geology of the Coast area between Muscat and Sur

The oldest strata outcropping in the coastal region between Muscat and Sur are the Pre-Permian basement plutonic rocks which have been subjected to both local and regional metamorphism. Their presence is almost entirely due to major thrust zones along their flanks and they are in general surrounded by younger rocks. While they have been subjected to major crustal movements, they can be described as autochthonous i.e. while they may be intensely folded and faulted, they have moved comparatively little from their original area of deposition.

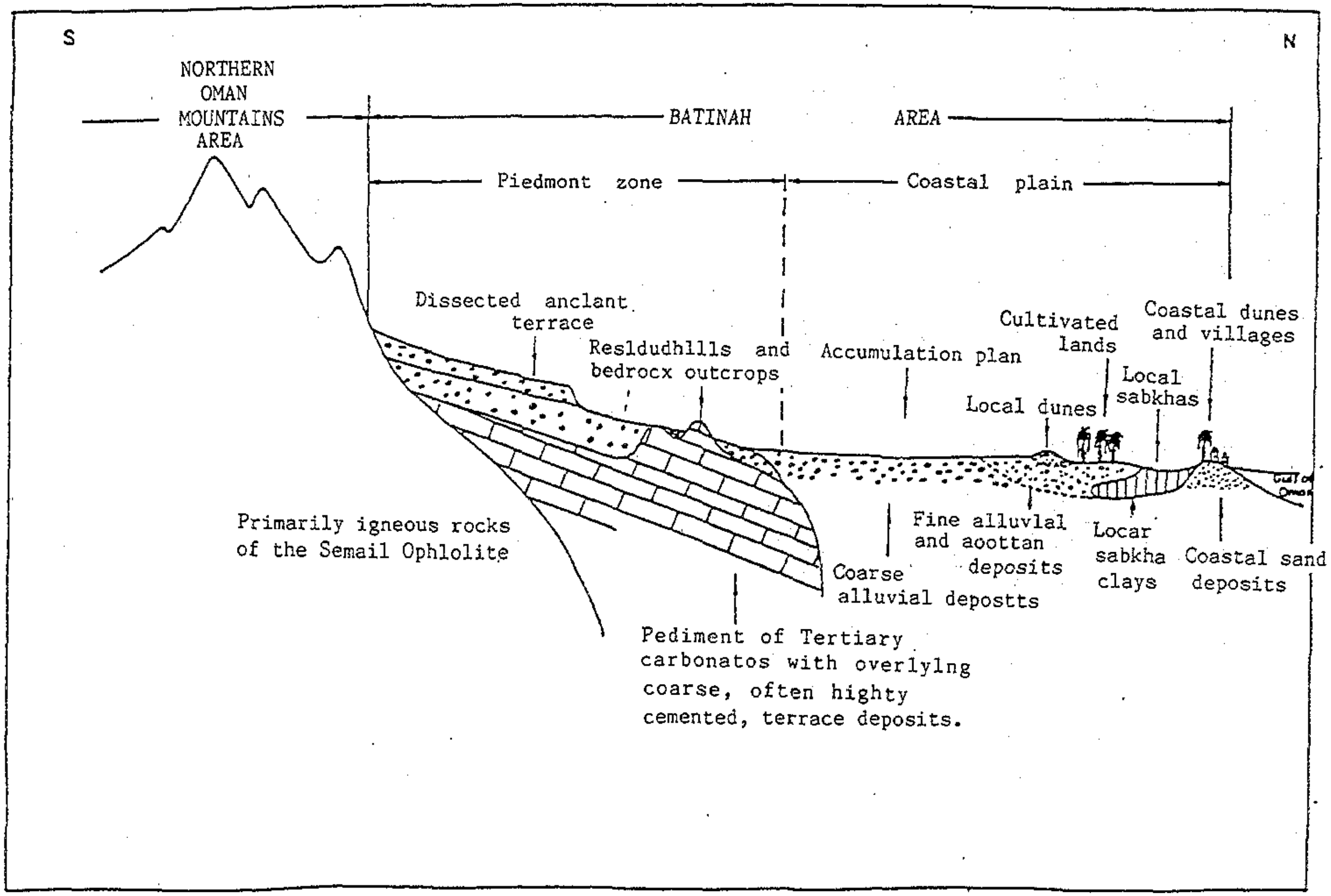


Fig.1-1-3 Schematic Geologic Cross Section of the Batinah

The Pre-Permian strata form almost the entire coastal region between Muscat and Quryat. In Muscat, they consist of plutonic peridotites, but elsewhere are almost entirely dolomitic limestones with some quartzites.

The coastal region south of Quryat consist entirely of Tertiary deposits. These were formed at a time when the present mountain zone was low lying or submerged and thus they contain very little terrigenous material and in general dip away from the mountain flanks. They consist in the main of shallow marine limestone with much dolomitisation and many evaporitic horizones. The lowest member of the sequence is the Damman formation which is predominantly a limestone sequence with marine faunas. Above it is the Rus formation which consists of an evaporitic series of anhydrite and gypsum with lesser marls and dolomites followed by a cyclic sequence of dolomites and limestones with minor evaporites of the Umm re Radhuma formation. The evaporitic content decreases towards the mountains due to original deposition and subsequent solution and in some areas there is no development attributable to the Rus.

1.1.3 Seismicity of the Area

There is a moderate risk of earthquakes in the northeastern part of the country (See Reference 10), bordering on the Gulf of Oman, and a fairly low risk elsewhere. The eastern and western Hajar Mountains, together with the zagros mountains of southwestern Iran form a great mobile belt, most of the activity being concentrated on Iranian side, with some tremors in the sea round the Straits of Hormuz, so the Musandam Peninsula is the most susceptible part of Oman. The interior of the Arabian Peninsula is comparatively stable, its rigidity being determined by the Pre-Cambrian basement, and the influence of this dominated the seismicity of Oman. The map in Figure 1-1-4 shows two areas that have been defined following a study of the limited historical records, instrumental data obtained from the Global Seismology Unit in Edinburgh, and knowledge of the tectonics. In area A, damaging earthquakes (Modified Mercalli intensity VII or greater) may occur within the lifetime of permanent buildings. Area B shown on the map is not itself expected to be subject to damaging earthquakes but would be affected by strong distant earthquakes which could cause intensities up to V to VI. No special precautions would be required in area B for ordinary structures although there is the possibility of damage to structures with natural periods of vibration greater, for example, than I second, from distant earthquakes, and liquefaction could occur in weak soils.

The regulations in current use make no reference to design earthquakes. The framework and general configuration of most multi-storey buildings may well be found to satisfy such needs. Wide span buildings may require special attention. Consultants working in the Capital Region indicate however that no special allowance is normally made for earthquakes in the design of major structures.

Area indicated	intensity (Modified Mercalli 1958)
A (Major event)	V11 or greater
B (Minor event)	V or VI

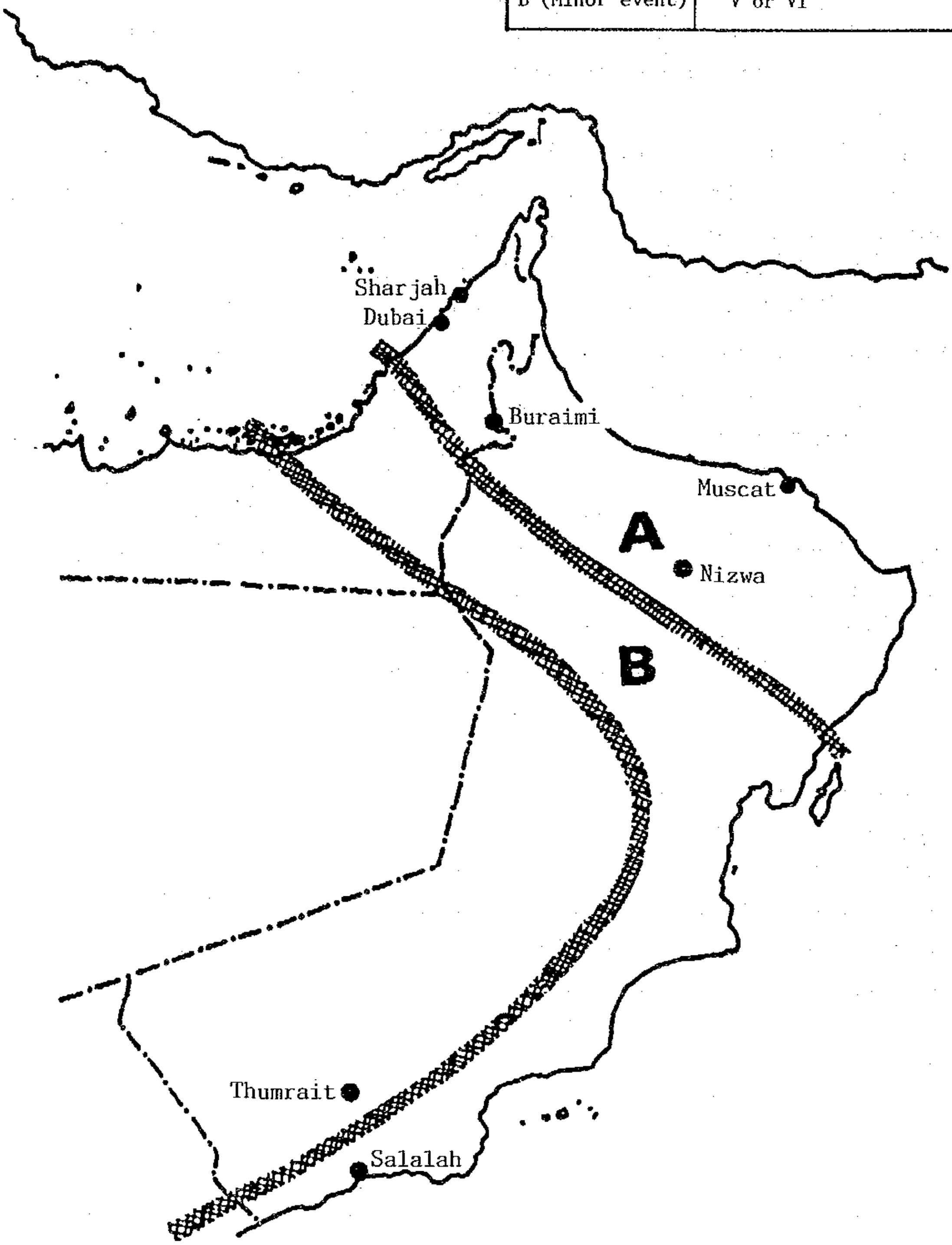


Fig.1-1-4 Seismicity of Area

1.1.4 Meteorology

(1) Temperature

Northern Oman is located in the sub-tropical zone. The monthly average temperatures of Seeb varies from 21°C to 36°C and the maxima vary from 25°C to 41°C, and the minima from 17°C to 32°C.

(2) Precipitation

Precipitation has been recorded in the Sultanate in every month, but most rainfall in central and northern Oman occurs as a result of synoptic situations of cyclonic or frontal types, and mainly during the winter from November to April.

The topographic effect of the northern Oman mountains and Ras Al Jibal results in the highest average rainfall in the Sultanate falling on the mountains. Such rainfall is the principal source of groundwater for the Batinah Coast, the Musandam peninsula, and the interior.

Annuall rainfall is shown in Fig.1-1-5. The monthly rainfall of Seeb and Sohar are shown in Table 1-1-1. and Fig.1-1-6. The yearly total rainfall of Seeb is 85mm, which is less than that of Sohar. Generally, the Sultanate has little and irregular, but sometimes heavy, rainfall. A monthly maximum total rainfall of 235.3mm was recorded at Majis with a daily maximum of 110.3mm.

Table 1-1-1 Monthly and Mean Rainfall at Seeb and Sohar

(in millimeters)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Seeb	17.3	14.1	16.3	7.3	11.6	1.6	0.4	0	0	0	13.7	2.1	84.8
Sohar	12.7	37.1	8.8	14.8	2.9	0	0.5	0.8	0	5.6	2.4	9.8	95.4

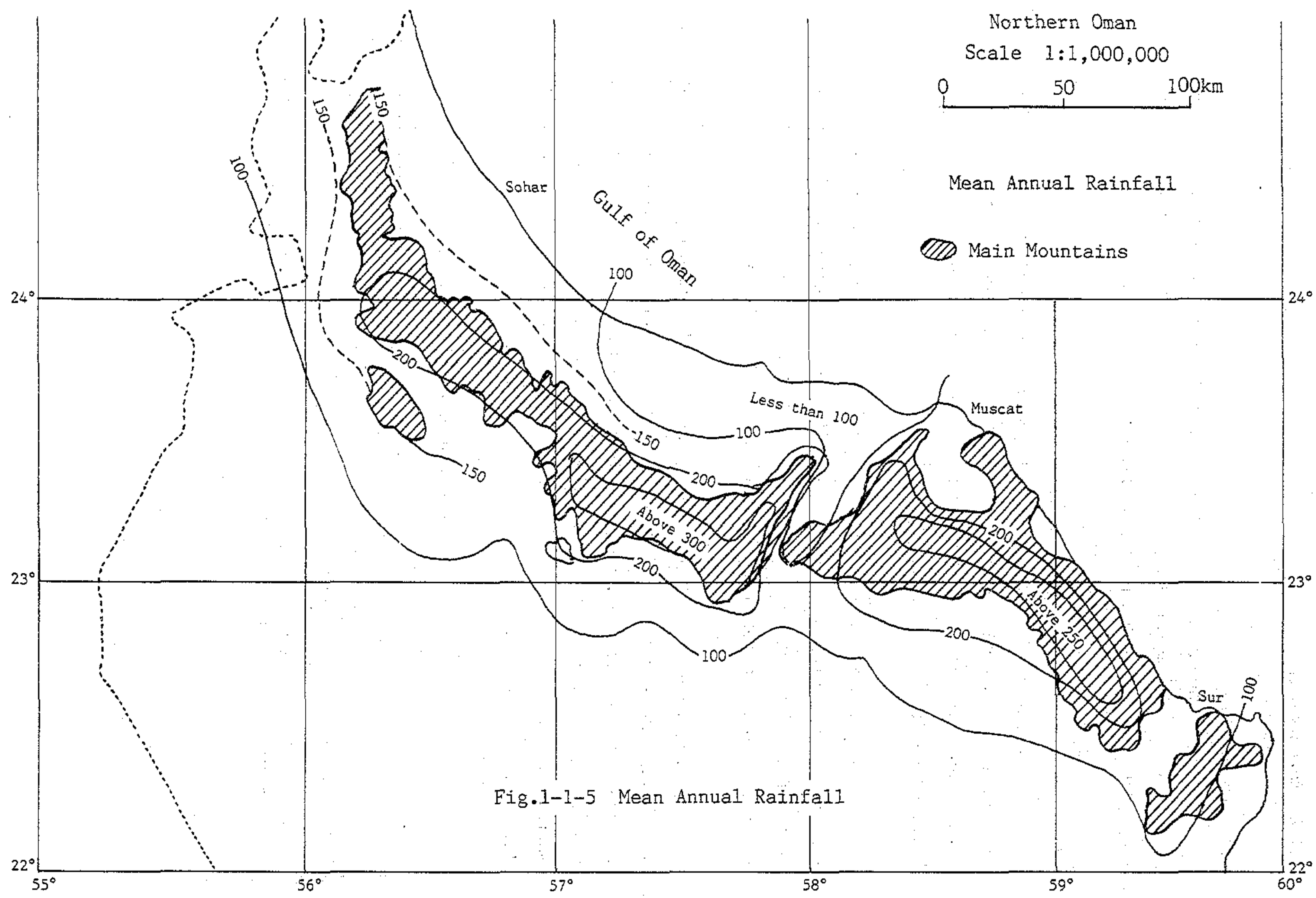


Fig.1-1-5 Mean Annual Rainfall

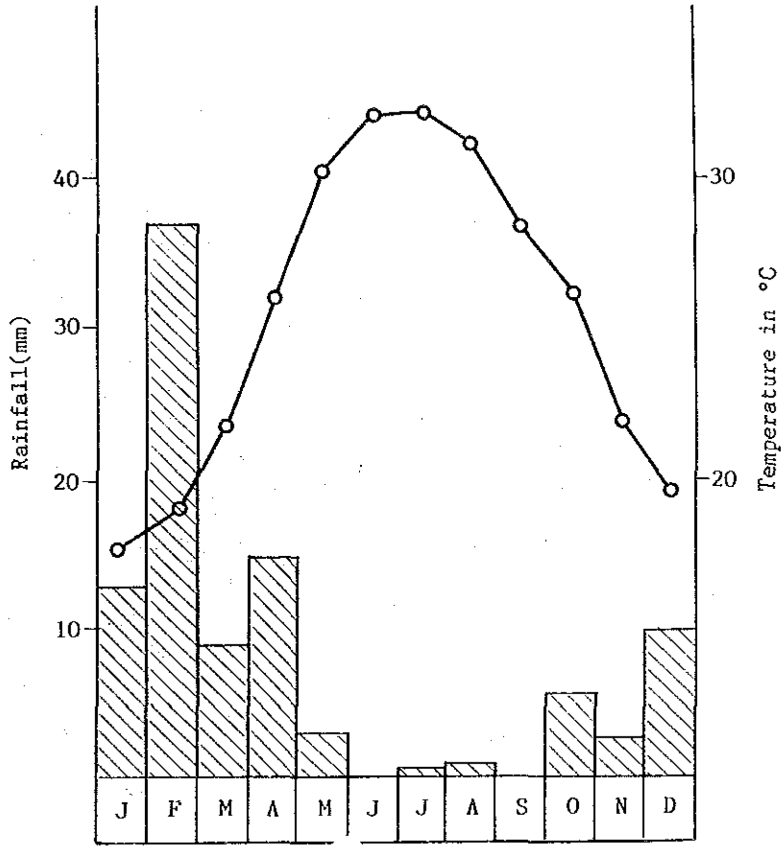
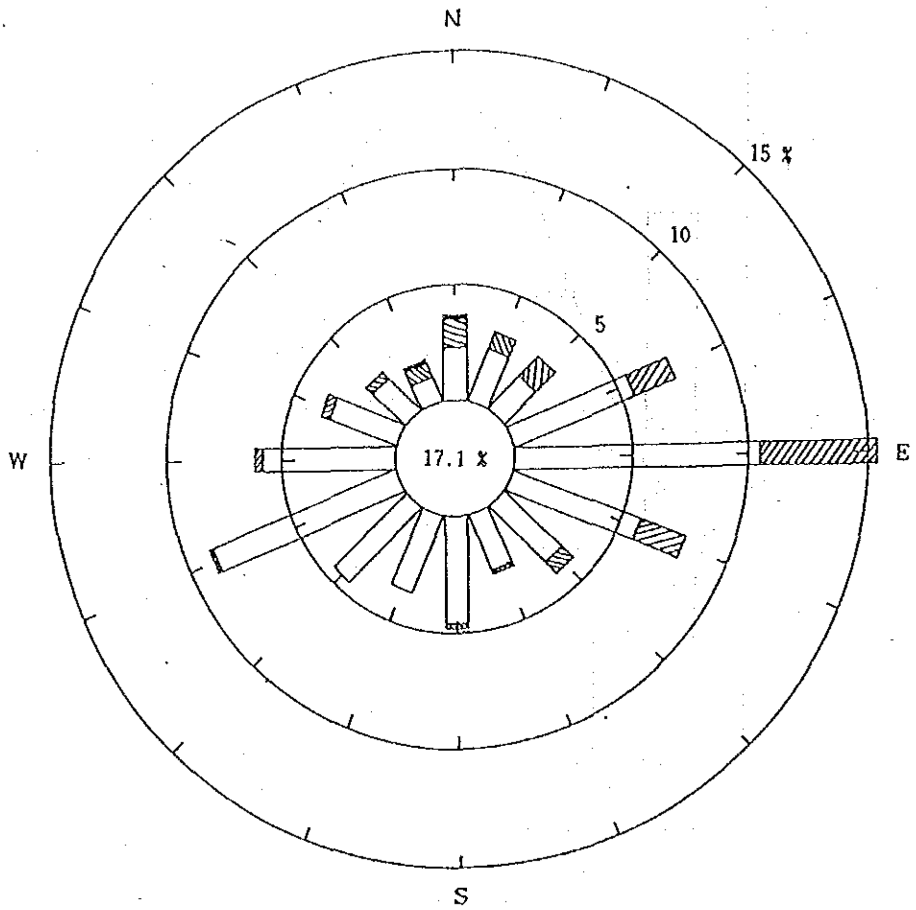


Fig.1-1-6 Monthly Rainfall at Sohar

(3) Wind

The prevailing wind direction is E-ENE throughout the year except in winter when it is S-W. According to the 1988 data, about 55% of the wind at Seeb is from sea to land and 20% from land to sea, while 25% calm. The wind data of Seeb and Sohar are shown in Table 1-1-2. The wind rose at Majis for 3 years (June, 1986 - Dec.1988) is shown in Fig.1-1-7. The predominant wind direction in the winter months is east and in the summer months is west.



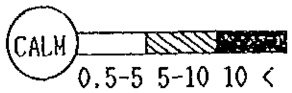


Fig.1-1-7 Wind Rose at majis Jan.1986 - Dec.1988

Table 1-1-2 Annual Wind Summary (Seeb and Sohar in 1988)

DIRECTION	CALM	350-010	020-040	050-070	080-100	110-130	
Seeb / % Speed	24.5 0	7.2 7.5	10.2 7.0	16.6 8.6	4.5 5.0	1.3 3.3	
Sohar / % Speed	15.0 0	4.3 8.5	5.2 6.9	8.6 6.7	14.3 7.5	10.6 6.9	
DIRECTION	140-160	170-190	200-220	230-250	260-280	290-310	320-340
Seeb / % Speed	1.4 3.1	3.2 3.8	6.9 6.1	7.6 5.0	7.1 5.3	3.9 7.0	5.5 8.4
Sohar/ % Speed	4.5 5.4	5.5 3.9	4.8 3.9	11.2 4.4	6.6 4.5	5.4 6.0	3.2 7.7

Note/Speed (Knots), DIRECTION:degrees from the North

Cyclones are not frequent within 160km of the Oman coast. Only two cyclones have been recorded the Muscat coast since the year 1879, but there has been no evidence of a cyclone affecting the Muscat coast in the last 40 years.

1.1.5 Hydrography

(1) Tides

The predicted tidal levels for Muscat together with Seeb, Wudam, Sohar are as follows:

	Muscat	Seeb	Wudam	Sohar
Highest astronomical tide	+3.1	--	--	--
Mean high water spring	+2.7	+2.3	+2.5	+2.3
Mean high water neap	+2.4	+2.0	+2.4	+2.0
Mean sea level	+1.9	+1.5	+1.8	+1.5
Mean low water neap	+1.6	+1.2	+1.5	+1.2
Mean low water spring	+0.8	+0.4	+0.8	+0.4
Lowest astronomical tide	0			

The above figures are taken from the Admiralty tide tables for 1988.

The tide is semi-diurnal, i.e., high and low water occur twice daily, but the tides are unequal. The diurnal influence appears to be greatest during times of neap tide, when the tidal range is relatively small. It is apparent that there is little difference in tidal range along the Batinah coast.

(2) Waves

Waves heights in the northern part of Oman are generally not so great. The wave heights of the Batinah Coast are smaller than at Sur.

Waves have been measured by super sonic wave system 5km offshore at Mina Qaboos since 1984. According to these data, the frequency of wave less than 0.5m (significant wave height) is 85%. Wave direction is not measured, therefore, wave direction were forecast by using the data on wind direction. The derived frequency distribution of wave height is shown in Table.1-1-3(1),(2) and Fig.1-1-8(1),(2). According to the these data, prevailing wave directions of more than 0.5m (significant wave height) are WNW and ESE.

Table.1-1-3 (1) Wave Frequency

(%)

DIR H1/3(m)	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	TOTAL
0.5	10.7	16.7	4.0	1.7	1.9	0.8	0.8	2.8	12.0	20.1	12.1	83.5
0.6	0.4	1.7	0.7	0.1	0.1	0.3	0.0	0.1	0.7	2.2	0.6	7.0
0.7	0.3	0.9	0.4	0.1	0.1	0.0	0.0	0.1	0.1	0.6	0.3	3.0
0.8	0.2	0.6	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.6	0.1	2.2
0.9	0.1	0.8	0.0	0.2	0.2	0.0	0.2	0.0	0.1	0.2	0.1	2.0
1.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
1.2	0.0	0.6	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	1.2
1.4	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.5
1.6	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
TOTAL	11.7	21.8	5.9	2.2	2.6	1.2	1.0	3.2	13.0	23.8	13.4	100.0

NOTE/DIR:WIND DIRECTION
H1/3 :SIGNIFICANT WAVE HEIGHT

Table 1-1-3(2) Wave Frequency by Period

( )%

T(Sec) H1/3(m)	≤4.4	4.5 ~5.4	5.5 ~6.4	6.5 ~7.4	7.5 ~8.4	8.5 ~9.4	9.5 ~10.4	10.5 ~11.4	11.5 ~12.4	12.5 ~13.4	13.5 ~14.4	14.5 ~15.4	15.5≤	kei
≥0.4														449 (67.8)
0.5		11 (1.7)	19 (2.9)	14 (2.1)	9 (1.4)	8 (1.2)	4 (0.6)	10 (1.5)	1 (0.2)	3 (0.5)	5 (0.8)		6 (0.9)	90 (13.6)
0.6		11 (1.7)	18 (2.7)	10 (1.5)	1 (0.2)	1 (0.2)	2 (0.3)	5 (0.8)	1 (0.2)		2 (0.3)	1 (0.2)		52 (7.8)
0.7		10 (1.5)	9 (1.4)		1 (0.2)							2 (0.3)		22 (3.3)
0.8		6 (0.9)	3 (0.5)	3 (0.5)	3 (0.5)				1 (0.2)	1 (0.2)				17 (2.6)
0.9		3 (0.5)	8 (1.2)	2 (0.3)							1 (0.2)			14 (2.1)
1.0			3 (0.5)											3 (0.5)
1.1~1.2			10 (1.5)											10 (1.5)
1.3~1.4			2 (0.3)	1 (0.2)			1 (0.2)							4 (0.6)
1.5~1.6			2 (0.3)											2 (0.3)
1.7~1.8														
1.9≤														
kei		41 (6.2)	74 (11.2)	30 (4.5)	14 (2.1)	9 (1.5)	6 (0.9)	16 (2.4)	3 (0.5)	4 (0.6)	8 (1.2)	3 (0.5)	6 (0.9)	663 (100.0)

Note: Observation Periods: 1986.6, 1987.7-12, 1988.1-12, 1989.1-5,
H1/3: Significant Wave Height
T : Wave Period

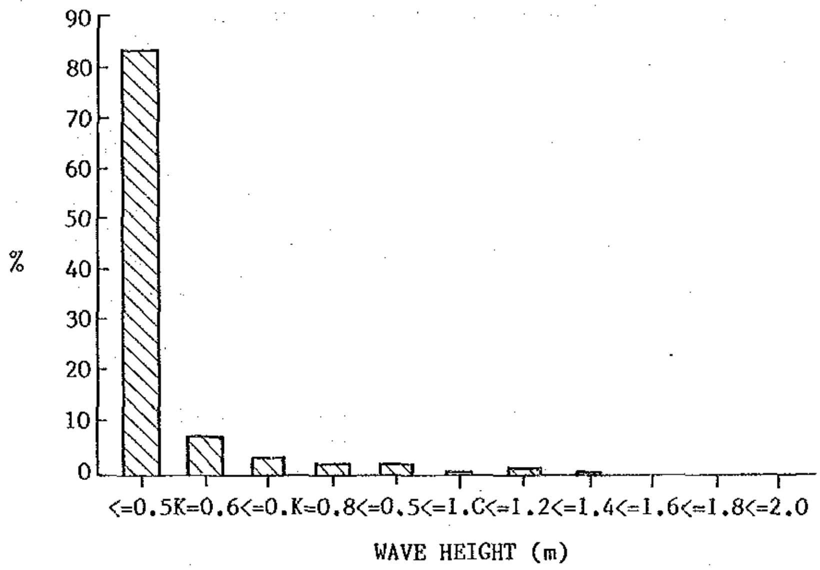


Fig.1-1-8(1) Wave Frequency Distribution at Muscat by Height

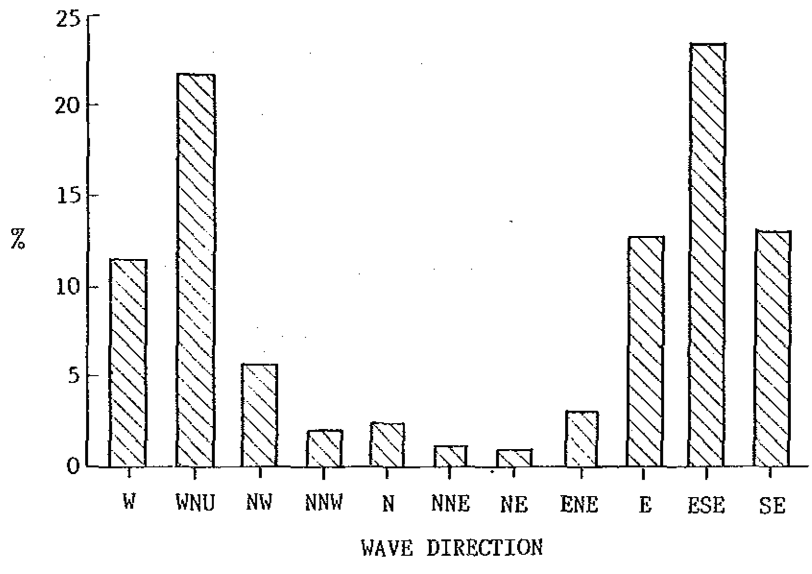


Fig.1-1-8(2) Wave Frequency Distribution at Muscat by Direction

1.2 Comparison of Natural Conditions at Majis and Sur

1.2.1 Sea Bottom Profile

The sea bottom profiles of potential sites (Majis, Khaburah, Suweiq, Masnaah, Muraysi, Haradi, Quriyat and Sur) are shown in Fig.1.2.1. The slope of sea bottom and offshore distance to the level of -5m, -10m, -15m and -20m of water depth for the potential sites are shown in Table 1-2-1 and Fig.1-2-1.

Table 1-2-1 Sea Bottom Profile

Water depth / Site	- 5m	- 10m	- 15m	- 20m
	d (slope)	d (slope)	d (slope)	d (slope)
Majis	0.9km(1/180)	1.8km(1/180)	2.8km(1/200)	4.4km(1/320)
Khaburah	-	2.4km(1/240)	-	6.5km(1/410)
Suweiq	0.9km(1/180)	1.8km(1/180)	3.5km(1/340)	5.6km(1/420)
Masnaah	1.0km(1/200)	2.5km(1/300)	4.3km(1/360)	6.1km(1/360)
Muraysi	1.0km(1/200)	2.5km(1/300)	6.0km(1/700)	9.7km(1/740)
Haradi	0.9km(1/180)	2.3km(1/280)	4.4km(1/420)	6.3km(1/380)
Quriyat	0.4km(1/80)	0.7km(1/60)	-	1.0km(1/30)
Sur	-	-	-	-

note/d:distance from shoreline

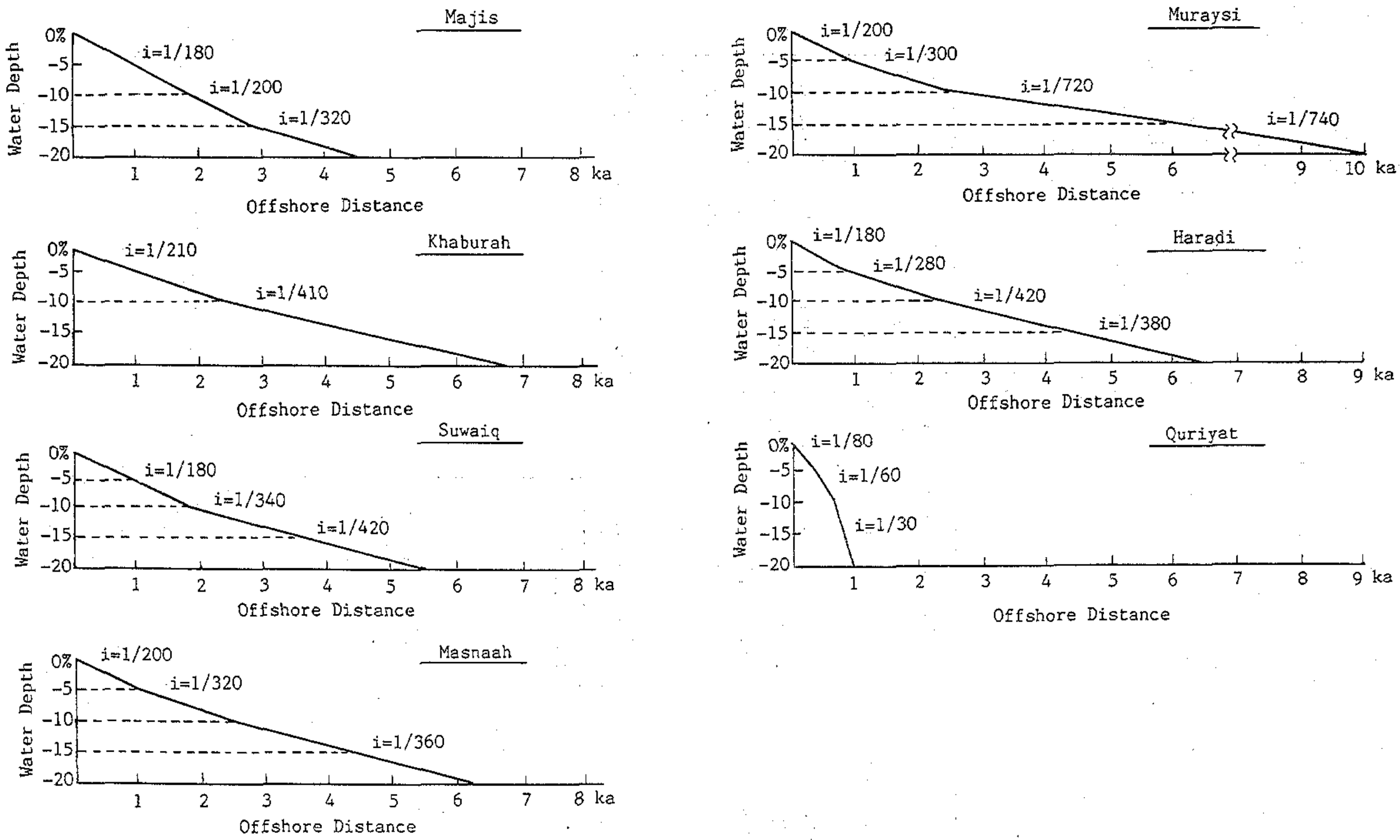


Fig.1-2-1 Sea Bottom Profile of Each Potential Site

1.2.2 Wave, Tide and Current

Table 1-2-2 summarizes the values of wave height, tide level and current velocity at the eight sites.

The predicted wave heights were obtained from the Majis Jetty report and the current velocity is based on data recorded at Wudam Naval Base in December 1981 and January 1982. The tidal level data were obtained from tide tables.

Table 1-2-2 Hydrographic Characteristics

Site	Majis	Khaburah	Suweiq	Masnaah	Muraysi	Haradi
Wave height	3.7m	3.7m	3.7m	3.7m	3.7m	3.7m
MHHW MLHW MHLW MLLW	+2.3m +2.0m +1.2m +0.4m	+2.3m +2.0m +1.2m +0.4m	+2.5m +2.4m +1.5m +0.8m	+2.6m +2.5m +1.6m +0.8m	+2.6m +2.5m +1.6m +0.8m	+2.6m +2.5m +1.6m +0.8m
Maximum tidal current	0.3m/s	0.3m/s	0.3m/s	0.3m/s	0.3m/s	0.3m/s

Site	Quriyat	Sur
Wave height	5.5m	5.7m
MHHW MLHW MHLW MLLW	+2.5m +2.4m +1.5m +0.8m	+2.0m +1.8m +0.9m +0.2m
Maximum tidal current	0.45m/s	-

note/Wave height:50 years return period significant wave height
MHHW:Mean High High Water
MLHW:Mean Low High Water
MHLW:Mean High Low Water
MLLW:Mean Low Low Water

1.2.3 Sand Drift

The direction and estimated rates of littoral drift at the eight potential sites were obtained from the Majis Jetty and Udam Naval Base reports. They are shown in Table 1-2-3. Also it is understood that no significant maintenance dredging will be reqired for the channel approach, if the water depth is between -7.0m and -15.0m.

Table 1-2-3 Littoral Drift and Maintenance Dredging

Sites	Majis	Khaburah	Suweiq	Masnaah	Muraysi	Haradi
Direction	northward	northward	northward	northward	northward	northward
Littoral drift rates	12,000 m3/y	12,000 m3/y	33,000 m3/y	33,000 m3/y	33,000 m3/y	33,000 m3/y
Maintenance dredging (-7.5m - -15m depth)	little	little	little	little	little	little

Sites	Quriyat	Sur
Direction	westward	westward
Littoral drift rates	-	-
Maintenance dredging (-7.5m - -15m depth)	little	little

1.2.4 Wadis

Below in Table 1-2-4 are listed the names of Wadis and their distance relative to the proposed site location. The locations of wadis are shown in Fig.1-2-2.

Table 1-2-4 Wadi

Site	Majis	Khaburah	Suweiq	Masnaah	Muraysi	Haradi
Name and distance of wadis	N:Wadi Bani Umar al Gharb ;6km S:Wadi Suq ;3.5km	N:Wadi Hawasinah ;4.5km S;Wadi Mabrah ;1.5km	S:Wadi al Hawqayn ;1km	N:Wadi Aysh ;1.5km S:Wadi al Abyad ;5km	N:Wadi Hifri ;0.5km	N:Wadi al Ajal ;3km

Site	Quriyat	Sur
Name and distance of wadis	N:afa ;2km S:Munayzif ;2km	S:Fulayi ;4km

note/N:North S:South

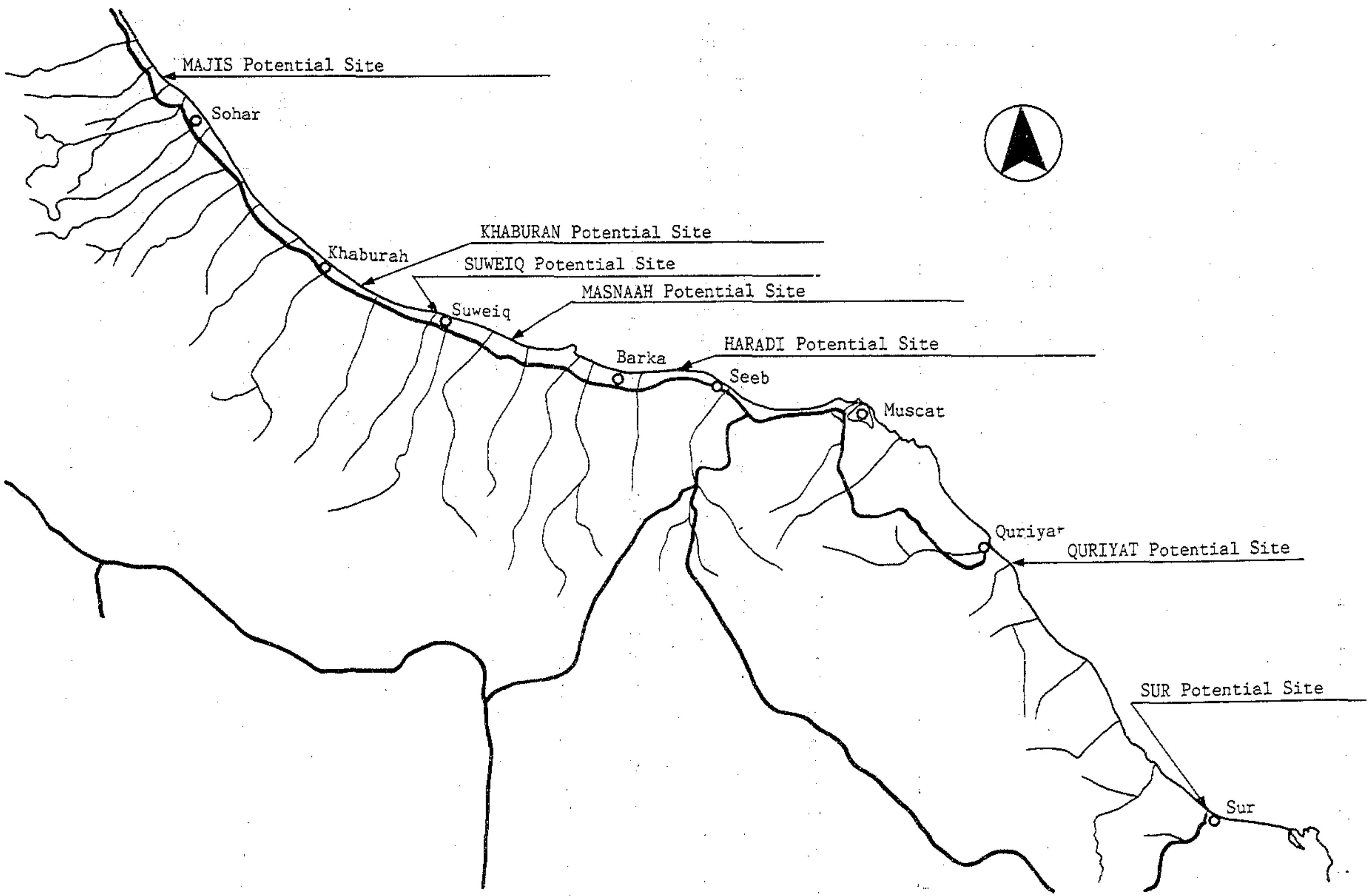


Fig.1-2-2 Map Showing Wadi Locations

1.2.5 Shoreline Conditions

A common feature of the eight sites is the presence of fine to medium sandy beaches along the shore line except of Suwayq and Sur where rock and coral reefs are exposed at some locations. (refer to Table 1-2-5)

Table 1-2-5 Shoreline Conditions

Sites	Majis	Khaburah	Suwayq	Masnaah	Muraysi	Haradi	Quriyat	Sur
Shoreline conditions	sandy	sandy	rocky	sandy	sandy	sandy	sandy/ gravel	coral

1.2.6 Sea Bottom Material

The sea bottom materials at the six sites of the Batinah coast are fine to medium sand with some shells. The mean grain size diameter (d50) varies between 0.1mm to 0.4mm.

The sea bottom material at Quriyat is constituted of sand and gravel.

1.2.7 Sub-soil Conditions

The subsoil conditions encountered at Majis Jetty are charactaristic of other sites along Batinah Coast (Majis-Khaburah-Suweiq-Masnaah-Muraysi-Haradi).

The subsoil shows an intercalation of granular material of noncemented, weakly cemented and cemented sand, gravel and silts with some shells and some zones of coral.

In general, the N values obtained from the standard penetration test are very low ($N<10$) above the level of -10m from chart datum and become high to very high ($N>25$) below that level.

The material at Quriyat shows an intercalation of granular material of noncemented and cemented, sand, gravel and silt, with clay in some locations. Soil above -10m or -12m from chart datum is considered medium dense to dense becoming very dense thereafter.

1.3 Natural Condition of Majis Potential Site

1.3.1 Sub-soil, Topographical and Marine Surveys.

In order to complete the studies on the port Development in Northern Oman, JICA Study Team made a site investigation to evaluate and assess the sub-soil, marine and topographical conditions of Majis potential site.

The following tasks was carried out for the geotechnical, topographical and marine investigations at the locations shown in Fig.1-3-1.

- 4 offshore boreholes up to 25.0m deep below the sea bed.
- Boreholes on land up to 15.0m deep.
- Laboratory tests.
- Hydrographic surveys.
- Current measurements.
- Tidal observations.
- Sea bed sampling and testing.
- Topographic surveys.

Boring on-land was done by using CRALIUS D-750drilling equipment. Off-shore boring was done from a jack-up barge by using RODIO SR-60 drilling equipment. Laboratory tests included unit weight, specific gravity, moisture content, grain size distribution, Atterberg limits and rock core compression tests.

Tidal obsevations were carried out for 30 days. Tidal current observation was carried out for 15 days by using a current-meter continuously. Seabed material sampling was carried out at 30 points. Samples were analysed for grain size distribution. The sounding area was 20km x 5km. The topographic survey area was 3km x 3.4km.

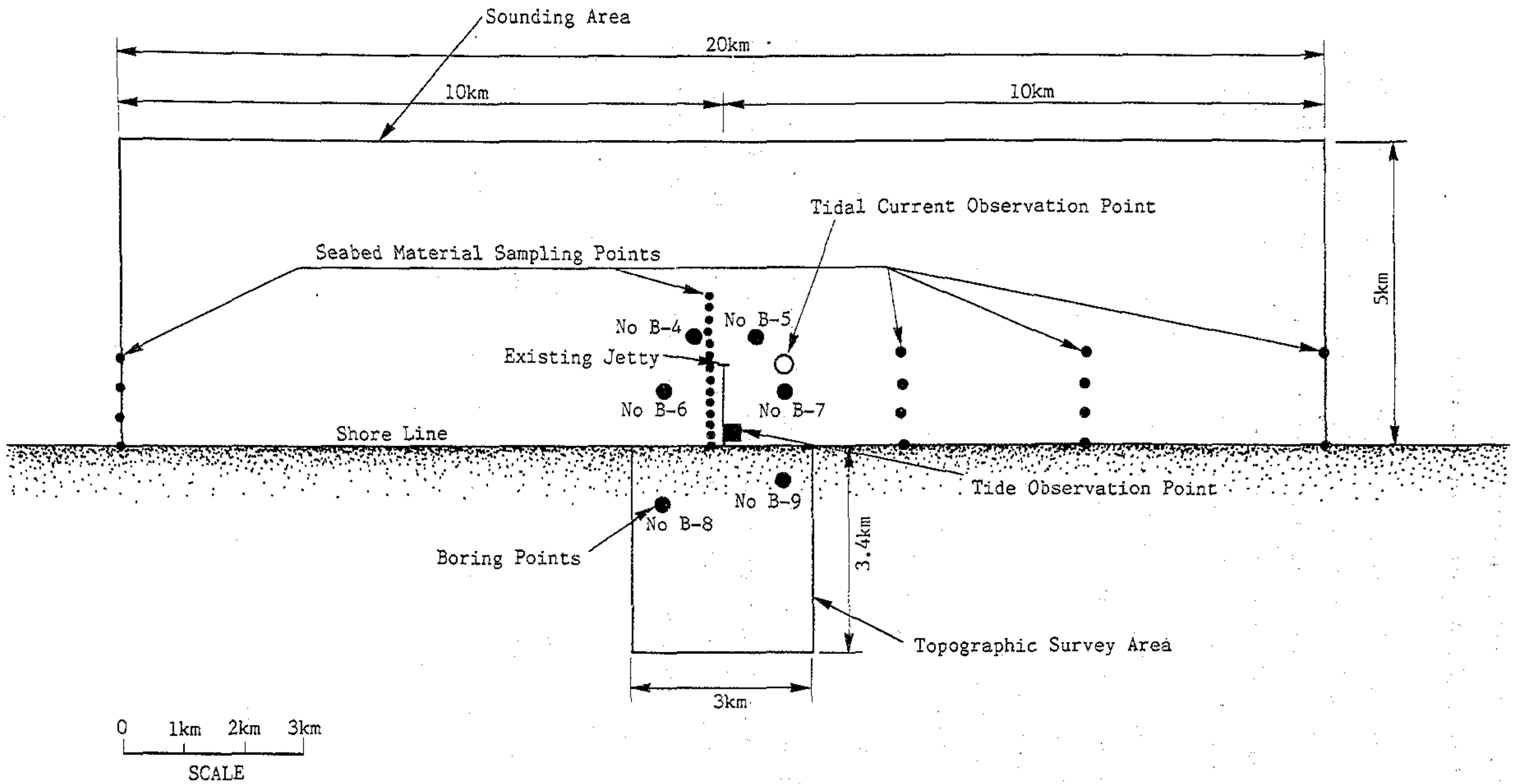


Fig.1-3-1 Location Map of Natural Condition Survey at Majis

1.3.2 Sub-soil Condition

(1) Existing Geotechnical Data

A site investigation work was carried out at the Majis Jetty location during January 1980. The purpose of the sub-soil survey was to assess the sub-soil conditions along the proposed jetty and to determine the foundation parameters. Sixteen boreholes were performed to a depth ranging between 14.4m and 30.0m form sea-bed level.

At the sea bottom, a loose recent shelly sandy beach material is noted underlain by an organic, very loose, silty shelly sand of 3.0m to 5.0m thickness. Underlying this strata are deposits of calcareous of weakly cemented and cemented beds of granular material of silt, sand and gravel and/or a mixture of these. They are encountered down to 21-23 meters depth below sea-bed level. Some coral pieces are also noted at different depths. The frequency of cemented beds increases with depth and it is understood to be continuous below 23.0m depth from sea-bed level.

Along the Majis Jetty for a distance of about 1200m from shore line it is found that SPT values are very low (less than 4) for the sea bottom material down to the level of -10.0m from chart datum. Between the distance of 1200m and the distance of 1800m towards the sea, the low value of STP (around 4) was found down to the level of - 15.0m form chart datum. In general, the SPT value become more higher (N>40) below the two mentioned depths (-10.0m) and (-15m). But in some boreholes and between the level of -16.0m and -22.0m from chart datum the SPT value was found between N=20 and N=30.

Location of boreholes relative to the Majis Jetty and the sub-soil stratigraphy of the material encountered in boreholes together with the SPT values are shown in Fig.1-3-2 and Fig.1-3-3 respectively.

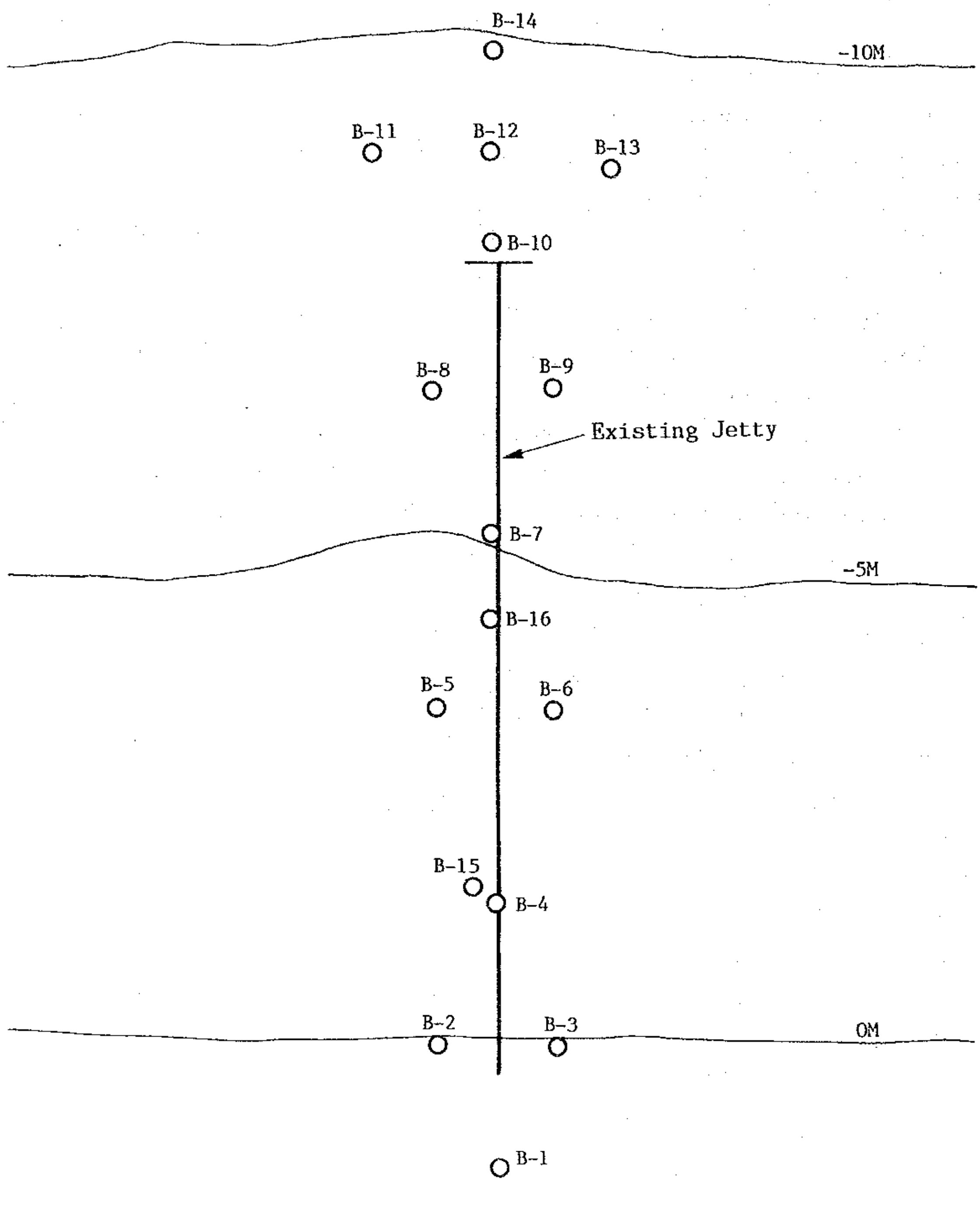


Fig.1-3-2 Location of Boreholes through Majis Jetty

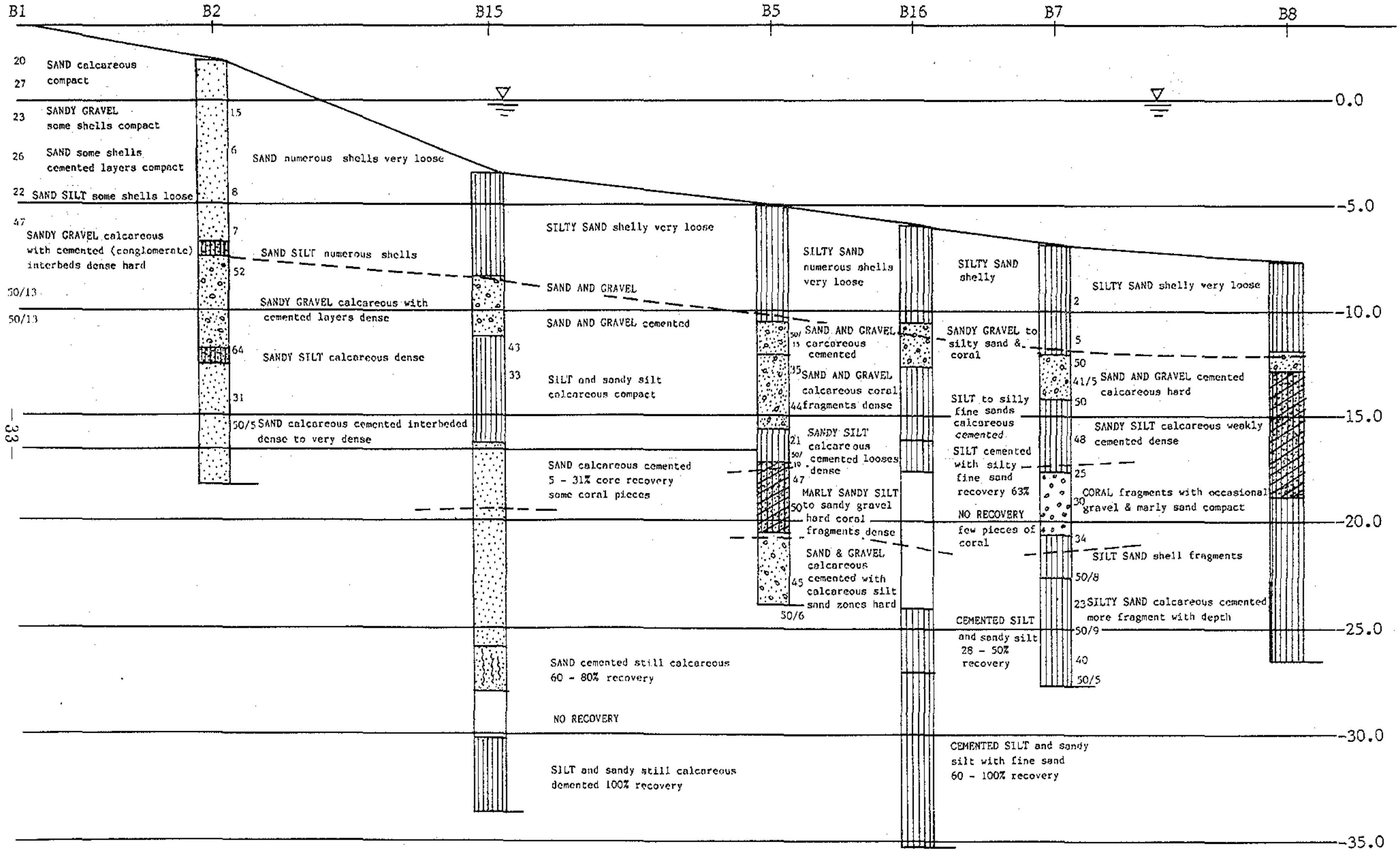


Fig.1-3-3(1) Soil Stratigraphy at Majis Jetty

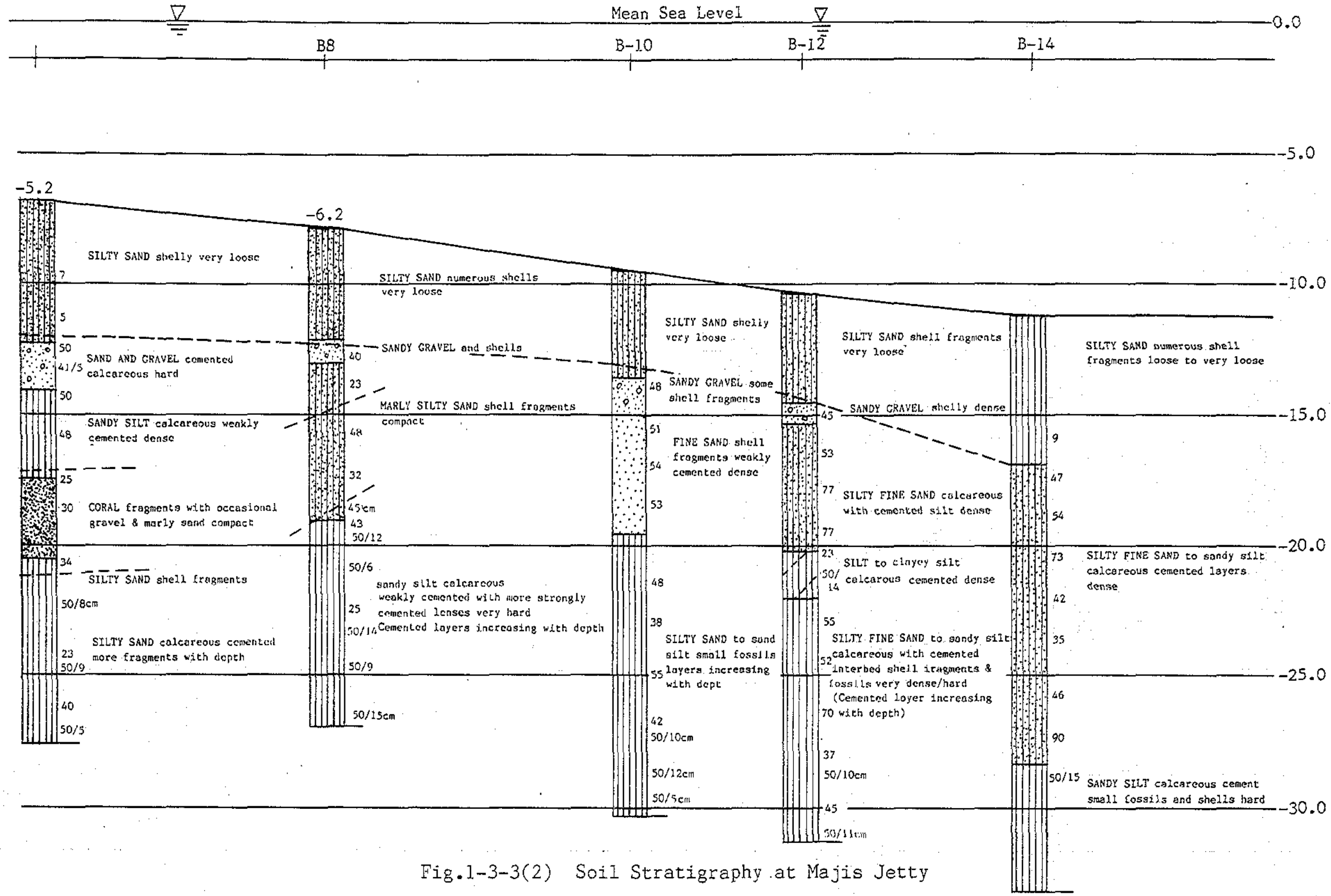


Fig.1-3-3(2) Soil Stratigraphy at Majis Jetty

(2) Sub-Soil Investigations

(a) General:

Rotary drilling technique with water/bentonite flush were used for advancing the hole in soil and in rock. Standard Penetration Tests were conducted almost at every 1.0m or 2.0m intervals in soil and at about 2.0m interval in weak rock. Disturbed samples were taken continously and few undisturbed samples using shelly tube sample were possible to be collected in some stratas . Rock cores were also obtained in relatively hard strata.

Boring on-land was performed by using the drilling equipment of type CRALIUS D-750. Off-shore boring was done through a jack-up barge by using the drilling equipment of type RODIO SR-60. The location of boreholes are shown in Fig.1-3-4.

(b) Sub-Soil Conditions:

The sub-soil stratigraphy for the drilled off-shore boreholes could be summarized as follows:

Below the sea-bed a layer of 3.0m to 6.0m thickness of very loose silty fine SAND with some shells is noted (SPT Value is around zero).

It is underlain by an intercalation of non-cemented, weakly cemented and cemented beds of granular material. This strata is constituted predominantly of SAND and SILT with some clay and gravel and some shells or a mixture of these in different composition and degree of cementation. The SPT value is found variable between N=10 and N=30 and the strata could be considered, in general, as medium dense. However, in some locations the SPT value is found higher than 30 (N>30) and it could be attributed to the cementing effects at that location or to the presence of gravel and some boulders. Also, it is noted that in areas where the silt concentration is found very high, the SPT value is around N=9 (Borehole No.7 at 14.0m depth from sea-bed level). The above atrata is considered to be extending to the level of -25.0m from Chart Datum near the shore line (Boreholes 6 and 7) and to the level of about -27.0m from Chart Datum far from shore line, in the other two holes (Boreholes 4 and 5).

Below the above two levels (-25.0m) and (-27.0m) a relatively dense to very dense cemented layer of silty fine to medium SAND (SILTY SANDSTONE) with occassional shells and oceasionnal gravels and pebbles, is noted. In some places sandy SILTSTONE is present.

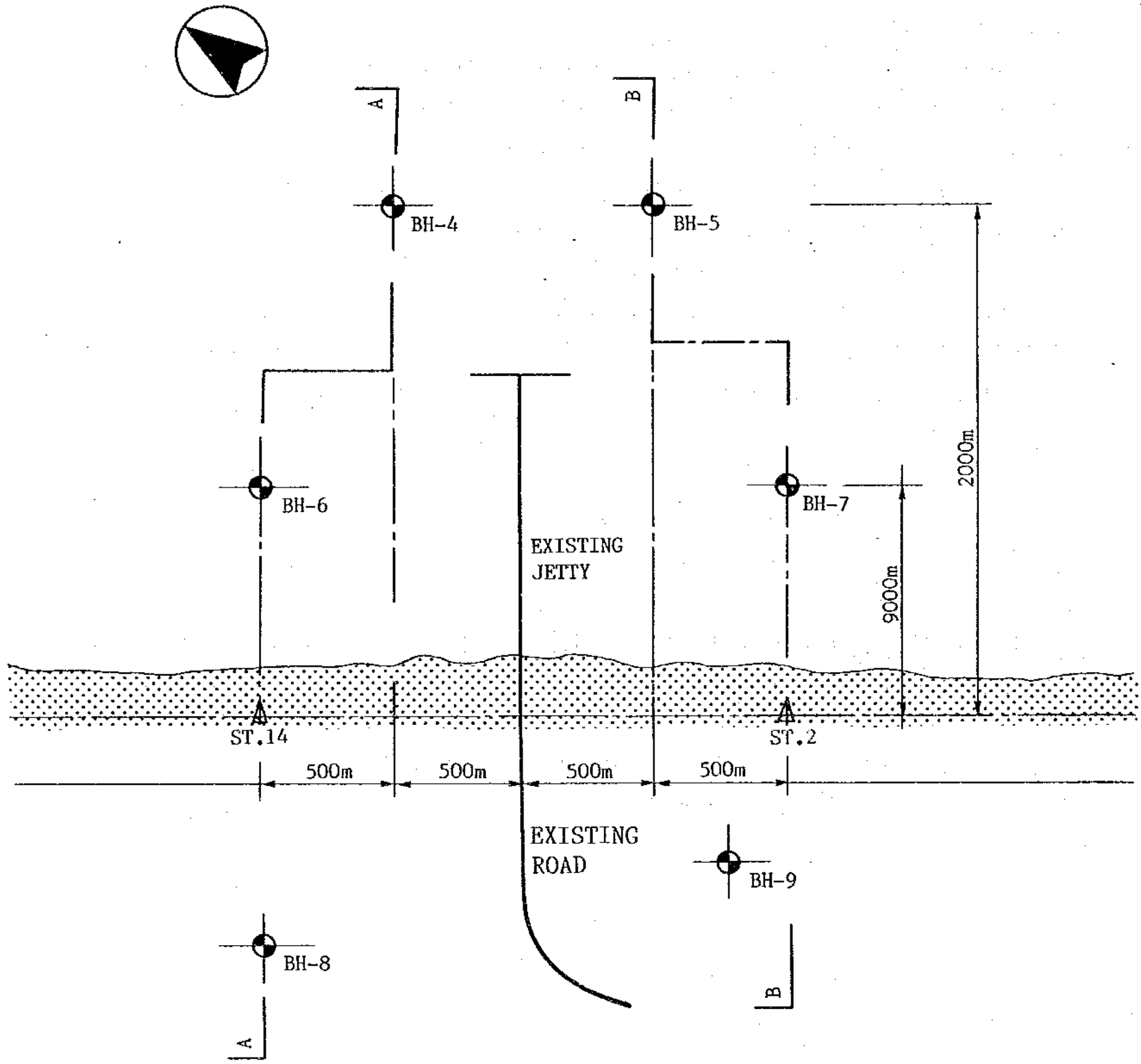


Fig.1-3-4 Location of Boreholes

The sub-soil stratigraphy at the location of on-land boreholes No.8 and 9 consists of an intercalation of weakly cemented and cemented, granular material of SAND, SILT and GRAVEL with some clay and some shells. Also a mixture of these grannulars in different compositions and degree of cementation are noted at different depths within the strata which is extended from the ground level down to 15.5m depth (maximum drilled depth). The SPT value is found very low (N<4) in borehole B-8 between 2.8m and 4.6m from ground level and therefter become more higher with depth. It exceeds the value of 50 blows (N>50) below the level of 7.6m from ground level, continously down to the bottom of the hole at 15.0m depth.

In borehole B-9, the SPT value could be assumed equal to N=11 between ground level and 2.5m depth and it varies between N=25 and N=50 below 2.5m depth down to the bottom of the hole.

The SPT results conducted at different depths are summarized, in Table 1-3-1.

The cross section of the sub-soil findings including the SPT results relative to Chart Datum, is presented in Fig 1-3-5.

Table.1-3-1(1) Results of Standard Penetration Tests

BH No.	Depth at Start of Test (m)	Seating drive Blows for 150mm Penetration	Test drive Blows for 300mm Penetration 150mm	150mm	Penetration after limiting blows(mm)	N Value
4	1.0	6	5	9	300	14
	2.0	2	1	–	300	1
	3.5	16	19	30	300	49
	4.5	22	45	5	170	>50
	5.1	19	20	31	300	51
	6.0	11	12	24	300	36
	7.0	18	12	8	300	20
	9.0	8	9	21	300	30
	10.0	4	8	13	300	21
	11.5	15	25	26	300	51
	13.5	8	9	12	300	21
	15.7	4	5	11	300	16
	17.7	12	30	20	230	>50
	19.7	20	25	25	240	>50
	22.0	18	25	25	270	>50
5	1.0	4	6	6	300	12
	2.0	1	–	–	300	0
	3.0	4	2	3	300	5
	4.2	9	6	12	300	18
	5.0	8	14	17	300	31
	7.0	17	37	13	200	>50
	9.0	22	50	–	140	>50
	11.0	7	10	13	300	23
	13.0	9	12	26	300	38
	15.0	9	14	18	300	32
	17.0	12	21	29	250	>50
	19.5	19	28	22	230	>50
	22.0	18	26	24	250	>50
6	1.0	1	–	–	300	0
	2.0	2	–	–	300	0
	3.8	1	–	–	300	0
	5.0	8	9	8	300	17
	6.0	7	5	10	300	15
	7.2	9	11	17	300	28
	9.0	6	8	9	300	17
	11.5	6	11	12	300	23
	13.0	6	11	22	300	33
	16.4	17	38	12	200	>50
	18.0	24	42	8	230	>50
	20.1	20	28	22	240	>50
	22.0	19	28	22	240	>50
	24.0	17	20	20	300	40

Table.1-3-1(2) Results of Standard Penetration Tests(cont)

BH No.	Depth at Start of Test (m)	Seating drive Blows for 150mm Penetration	Test drive Blows for 300mm Penetration 150mm	150mm	Penetration after limiting blows(mm)	N Value
7	1.0	2	1	-	300	1
	2.0	3	1	-	300	1
	3.0	1	1	-	300	1
	4.0	3	3	13	300	16
	5.0	11	14	16	300	30
	6.0	9	13	18	300	31
	8.0	9	11	21	300	32
	10.0	13	21	26	300	44
	12.0	9	11	10	300	21
	14.0	11	2	7	300	9
	16.0	9	17	35	300	52
	18.0	20	52	-	150	52
	20.0	16	21	27	280	48
	22.0	15	27	23	250	>50
	24.0	18	25	25	270	>50
8	1.0	4	19	17	300	36
	2.0	10	12	13	300	25
	3.0	3	2	2	300	4
	4.0	2	1	2	300	3
	5.0	14	25	25	300	50
	6.0	16	21	29	240	>50
	7.0	5	18	14	300	32
	8.0	31	32	18	260	>50
	9.0	15	34	16	220	>50
	10.0	13	32	18	230	>50
	11.0	11	17	29	300	46
	12.0	18	37	13	200	>50
	13.0	50	-	-	-	>50
	14.0	50	-	-	-	>50
	15.0	50	-	-	-	>50
9	1.0	4	5	6	300	11
	2.0	4	5	6	300	11
	3.0	7	10	14	300	24
	4.0	11	14	19	300	33
	5.0	9	12	17	300	29
	6.0	14	17	20	300	37
	7.0	8	20	24	300	44
	8.0	15	35	15	210	>50
	9.0	8	25	25	240	>50
	10.0	8	40	10	190	>50
	11.0	11	16	21	300	37
	12.0	8	12	13	300	25
	13.0	4	10	16	300	26
	14.0	7	16	23	300	39
	15.0	9	18	32	260	>50

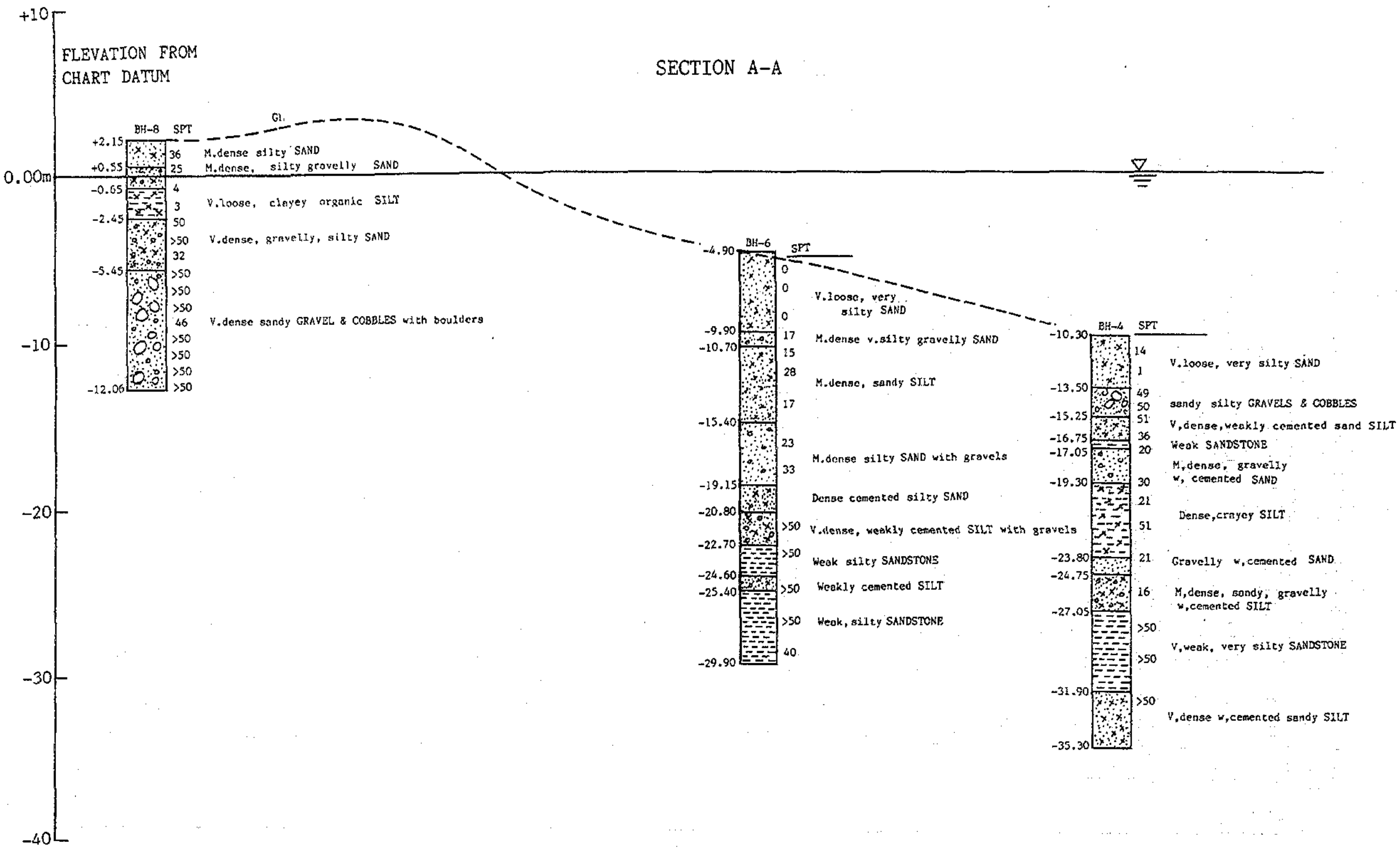


Fig.1-3-5(1) Geological Profile (A-A)

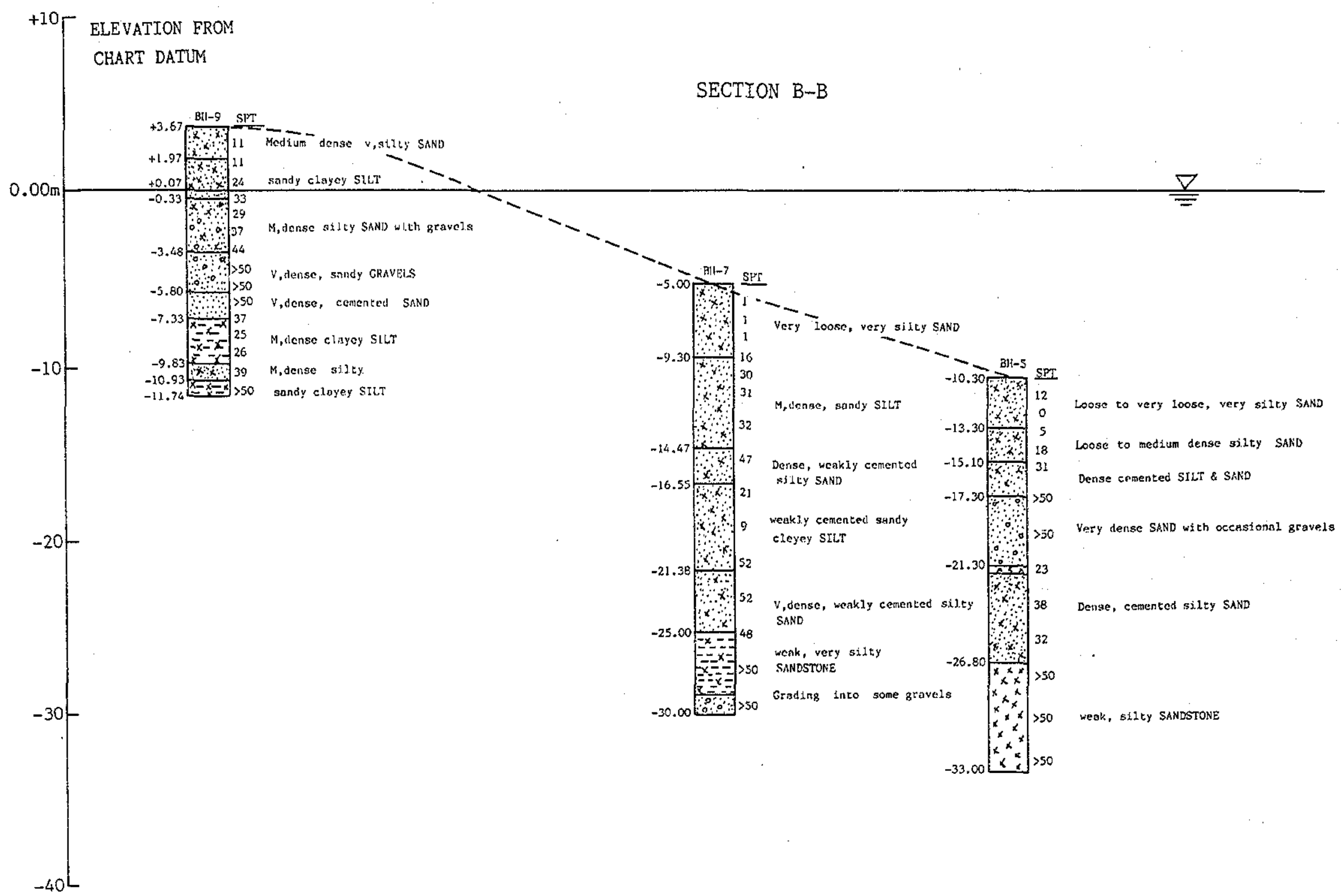


Fig.1-3-5(2) Geological Profile (B-B)

(c) laboratory testing

Total of 42 samples of soil and rocks have been selected for laboratory testing. The laboratory work began on February 3,1990 and completed on February 28, 1990. The following tests were performed:

- On-soil(disturbed): physical proprety tests including unit weight, specific gravity, moisture content, gain size analysis and atterberg limit tests.
- On-soil (undisturbed): physical proprety tests, unconfined compression and consolidation tests.
- on-rock: physical property tests and unconfined compression tests.

The laboratory test results are summarized in Table 1-3-2(1)~(3).

Table 1-3-2(1) Laboratory Test Summery

Hole No.	Depth (m)	SAMPLE DETAILS		CLASSIFICATION TESTS											CONSOLE-DATION		U.C.S.	
		Type	Description	% 0.425	PI %	PL %	LL %	MC %	α Mg/m³	% Clay	% Silt	% Sand	% Grave	SG	m_v m²/MN	C_v m²/yr	Load at failure (KN)	C.S. N/mm²
BH-4	2.00-2.55	SPT	Silty sand with some gravels	74	Nil	Nil		24.8	1130	5	25	55	15	2.66				
BH-4	3.50-3.95	SPT	Sandy gravels	22				13.5	1350	3	9	27	61	2.54				
BH-4	5.10-5.55	SPT	Silty sand with gravels	49				18.2	1140	3	23	44	30	2.57				
BH-4	6.00-6.45	SPT	Very silty SAND with gravels	58	12	22	34	24.4	1110	5	34	40	21	2.58				
BH-4	9.45-9.60	SPT	Sandy clayey SILT wiht some gravel	82	24	32	66	35.8	920	18	53	14	15	2.43				
BH-4	12.50	Core	Clayey SILT & SAND with some gravel	81	31	34	65	32.3	1720	18	35	35	12	2.37	0.09	2.603	0.75	0.14
BH-4	20.30-20.60	Core	Very silty SAND with gravels	75	18	27	45	24.1	1900	5	23	47	25	2.39			5.06	1.12
BH-5	2.00-2.50	SPT	Silty SAND with some gravels	70	Nil	Nil	30	26.5	1160	4	24	61	11	2.65				
BH-5	3.00-3.45	SPT	Soightly silty SAND with some gravels	63	Nil	Nil	29	22.1	1180	4	16	68	12	2.60				
BH-5	5.00-5.45	SPT	Sl.clayey SILt & SAND with some gravels	84	13	24	37	25.3	1060	11	37	41	11	2.52				
BH-5	17.00-17.40	Core	Sl.clayey, v.silty SAND with occ. gravels	83	20	27	47	25.1	970	12	34	45	9	2.54				
BH-5	20.00-20.20	Core	Silty SAND with some gravels	71	16	29	45	21.2	1750	6	26	53	19	2.33			5.94	1.24
BH-5	20.70-20.90	Core	Silty SAND with some gravels	66	20	28	48	19.8	2010	4	27	53	16	2.41			8.43	1.86
BH-5	6.60-6.75	Core							2260								1.10	0.30

note;

PI Plastic index
PL Plastic limit
LL Liquid limit
MC Moisture conte
α Bulk density
FR frost susceptibility
PH acididy
SI sulphate
SG Sp. gravity
CL chloride
UCS Unconfined Compressive strength

Consolidation

m_v and c_v given for a loading increment of 100 KN/m² above assumed effective overburden pressure

Table 1-3-2(2) Laboratory Test Summery

Hole No.	Depth (m)	Type	Description	% 0.425	PI %	PL %	LL %	MC %	α Mg/m³	% Clay	% Silt	% Sand	% Grave	SG	m_v m²/MN	c_v m²/yr	Load at failure (KN)	C.S. N/mm²
		SAMPLE DETAILS		CLASSIFICATION TESTS											CONSOLE-DATION		U.C.S.	
BH-6	3.50–4.00	SPT	Silty SAND	67	Nil	Nil	32	28.8	1110	7	24	63	6	2.78				
BH-6	6.00–6.45	SPT	Silty SAND with gravel	65	9	25	34	21.3	1150	5	23	49	23	2.58				
BH-6	8.00–8.40	Core	Very silty SAND with occ. grabels	82	23	23	46	22.8	2010	8	32	42	11	2.56	0.092	3.096	1.31	0.27
BH-6	9.00–9.45	SPT	Sl. clayey SILT & SAND with some gravels	73	18	27	45	25.6	1020	12	34	36	18	2.42				
BH-6	10.30–10.50	Core	Sandy, sl. clayey SILT with some gravels	73	29	37	66	27.5	1910	10	44	26	20	2.38	0.088	5.238	3.56	0.75
BH-6	14.60–14.80	Core	Very solty SAND with occ. gravels	75	16	26	42	24.9	1910	6	27	48	9	2.49			3.50	0.73
BH-6	21.00–21.25	Core	Silty SAND wiht some gravels	71	13	28	41	23.2	1970	4	23	56	17	2.48			4.19	0.92
BH-6	18.90–19.10	Core							2650								16.75	3.51
BH-7	3.00–3.45	SPT	Silty SAND	66	Nil	Nil	30	28.8	1120	5	23	68	4	2.78				
BH-7	5.00–5.45	SPT	Sl. clayey very silty SAND	83	11	37	38	25.8	1020	10	32	54	4	2.72				
BH-7	5.45–5.65	Core	Very silty SAND	86	10	26	36	23.2	2000	7	31	54	8	2.72	0.039	4.160	1.47	0.31
BH-7	8.80–9.00	Core	Silty SAND with occ. gravels	75	15	26	41	21.8	1950	6	24	55	15	2.54	0.144	6.779	2.30	0.50
BH-7	12.60–12.90	Core	Clayey SILT	98	33	35	68	39.5	1720	30	63	7	-	2.40	0.850	2.44	0.72	0.15
BH-7	23.20–23.30	Core	Silty SAND with some gravels	72	16	30	46	23.4	1920	4	26	52	18	2.50			5.43	1.20

note;

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CL chloride
UCS Unconfined Compressive strength

Consolidation

m_v and c_v given for a loading increment of 100 KN/m² above assumed effective overburden pressure

Table 1-3-2(3) Laboratory Test Summery

Hole No.	Depth (m)	SAMPLE DETAILS		CLASSIFICATION TESTS											CONSOLI-DATION		U.C.S.	
		Type	Description	% 0.425	PI %	PL %	LL %	MC %	α Mg/m³	% Clay	% Silt	% Sand	% Grave	SG	mv m²/MN	Cv m²/yr	Load at failure (KN)	C.S. N/mm²
BH-8	3.00-3.45	SPT	SILT & SAND with occ.gravels	83				41.7	1230	4	42	41	13	2.48				
BH-8	3.50-4.00	UDS	Clayey SILT & SAND with occ. gravels	77	15	19	34	21.1	1970	14	33	46	10	2.52	0.264	2.14	0.22	*.0.05
BH-8	5.00-5.45	SPT	SAND with some gravel	47	Nil	Nil	25	18.4	1320		6.1	73.9	20	2.78				
BH-8	7.00-7.45	SPT	Sl.silty SAND with gravels	51				14.3	1520	4	11	55	30	2.68				
BH-8	11.00-11.45	SPT	Silty sandy GRAVELS	31				7.5	-		21	22	57	-				
BH-8	12.00-12.35	SPT	Sl.silty sandy GRAVELS	23				9.7	-		14.5	26.5	59	-				
BH-9	1.00-1.45	SPT	Sl.clayey sandy SILT with some gravels	71				32.5	630	13	48	21	16	2.48				
BH-9	2.00-2.45	SPT	Slightly silty SAND	85	Nil	Nil	23	12.0	1130		9.8	89.2	1	2.77				
BH-9	5.00-5.45	SPT	Slightly silty SAND	94	Nil	Nil	33	25.8	1106	2	14	82	2	2.66				
BH-9	11.00-11.45	SPT	Sl. clayey very silty SAND	93	6	23	29	24.2	1080	6	31	57	4	2.58				
BH-9	13.00-13.45	SPT	Sandy, slightly clayey SILT	86	13	28	41	38.8	930	18	48	32	2	2.45				
BH-9	15.00-15.43	SPT	Silty SAND with occ. gravels	73				20.6	1130	3	23	59	15	2.56				
BH-9	9.80	Core							1880								4.63	0.97
BH-9	11.65-11.90	Core							1730						0.043	2.45	3.69	0.13

note;

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Consolidation

m_v and c_v given for a loading increment of 100 KN/m² above assumed effective overburden pressure

1.3.3 Marine Conditions

(1) Shoreline Conditions

The proposed site at Majis is about 2.5km north of Majis, about half-way along the 400km long section of the Oman coast facing the Gulf of Oman. The coast is intersected by a considerable number of wadi mouths, mostly to the south, the largest of which, Wadi Sallan, located 10km south of the site. The protruding form of the coast on either side of this wadi mouth suggests that sand and silt are discharged from it and other wadis further south in greater volumes than can be transported away by waves and currents. It appears that the accretion associated with the wadis extends 35km south of the mouth of Wadi Sallan and only about 11km northwards to 1km beyond the Site. The asymetry of this deposit is an indication of a net northward littoral drift. However, recently a dam has been constructed in Wadi Sallan and sediment discharge from this fource is likely to be very small in future.

(2) Tides

Tidal observation was carried out to estimate the datum level to design the crown heights of port facilities. Tidal levels are shown in Fig.1-3-6.

The tidal harmonic constants calculated by computer are summarized in Table 1-3-3. The tidal diagram is shown in Fig.1-3-7. Datum level was determined by using the harmonic constants.

(3) Wave

Wave conditions such as wave height and direction have to considered in selecting the port location and determining the port layout. The workability of a port and the necessity for a breakwater in particular are greatly influenced by wave conditions. They affect not only the structure of breakwaters but also the construction costs.

(a) Ordinary waves

Wave records obtained at Muscat in the 4 years from 1986 to 1989 and wind records for the same period at Majis were prepared. By using these wave records and wind directions, the frequency distribution of wave directions and wave heights at Majis were estimated and are shown in Table 1-3-4. The frequency distributions of wave heights and periods are shown in Table 1-3-5.

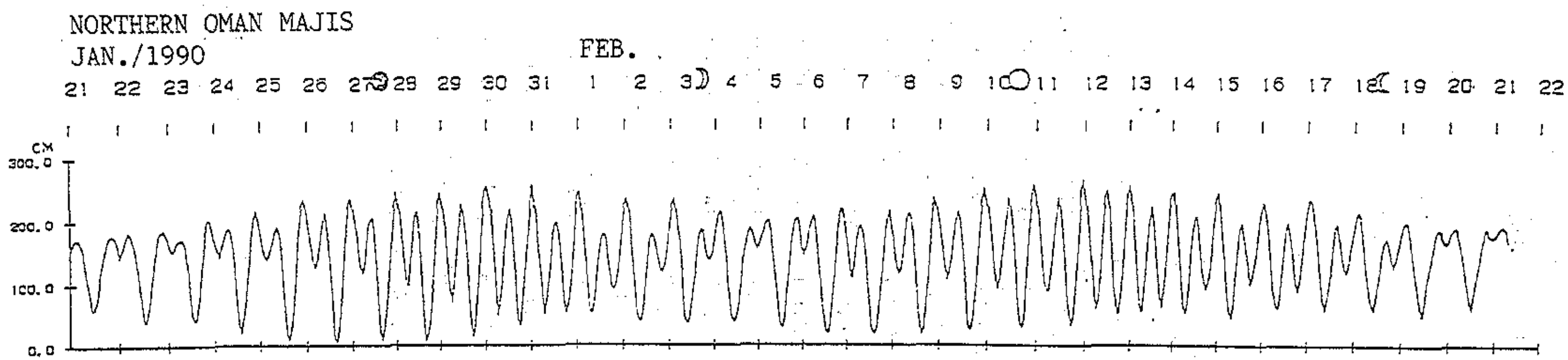


Fig.1-3-6 Observed Tidal Level

Table 1-3-3 Tidal Harmonic Constants

**** ANALYSIS OF TIDAL HARMONIC CONSTANTS ****

AREA ; NORTHERN OMAN
STATION ; MAJIS
TIME ZONE ; -4.00
LATITUDE ; 24 25 18 N
LONGITUDE ; 56 42 50 E
DURATION ; JAN.21.-FEB.21,1990
METHOD OF ANALYSIS ; T.I.METHOD FOR A MONTH

SYMBOLS	H (CM)	K (DEG.)	G (DEG.)	SYMBOLS	H (CM)	K (DEG.)	G (DEG.)
MM	4.30	148.7	150.9	KS	6.52	314.9	321.8
MSF	3.30	62.9	67.0	2SMS	0.89	42.3	53.0
Q1	7.49	29.1	26.0	MO3	2.07	294.9	296.5
Q1	17.31	43.8	42.9	M3	0.49	0.2	4.0
M1	0.94	70.2	71.5	MK3	1.92	162.1	168.1
K1	35.97	41.6	45.0	MN4	2.04	55.4	58.3
J1	1.92	33.4	39.1	M4	2.07	98.9	103.9
OO1	1.69	103.2	111.1	SN4	1.41	60.7	67.6
P1	11.91	41.6	44.7	MS4	1.71	153.1	162.2
MU2	1.68	337.3	335.7	2MN6	1.15	14.0	19.4
N2	12.84	256.8	257.2	M6	0.60	357.9	5.4
NU2	2.49	256.8	257.5	MSN6	0.87	91.5	100.9
M2	65.14	277.0	279.5	2MS6	1.06	122.8	134.4
L2	5.88	265.0	269.6	2SM6	0.62	240.2	255.9
S2	23.96	314.9	321.4	A0	1.405(METER)		

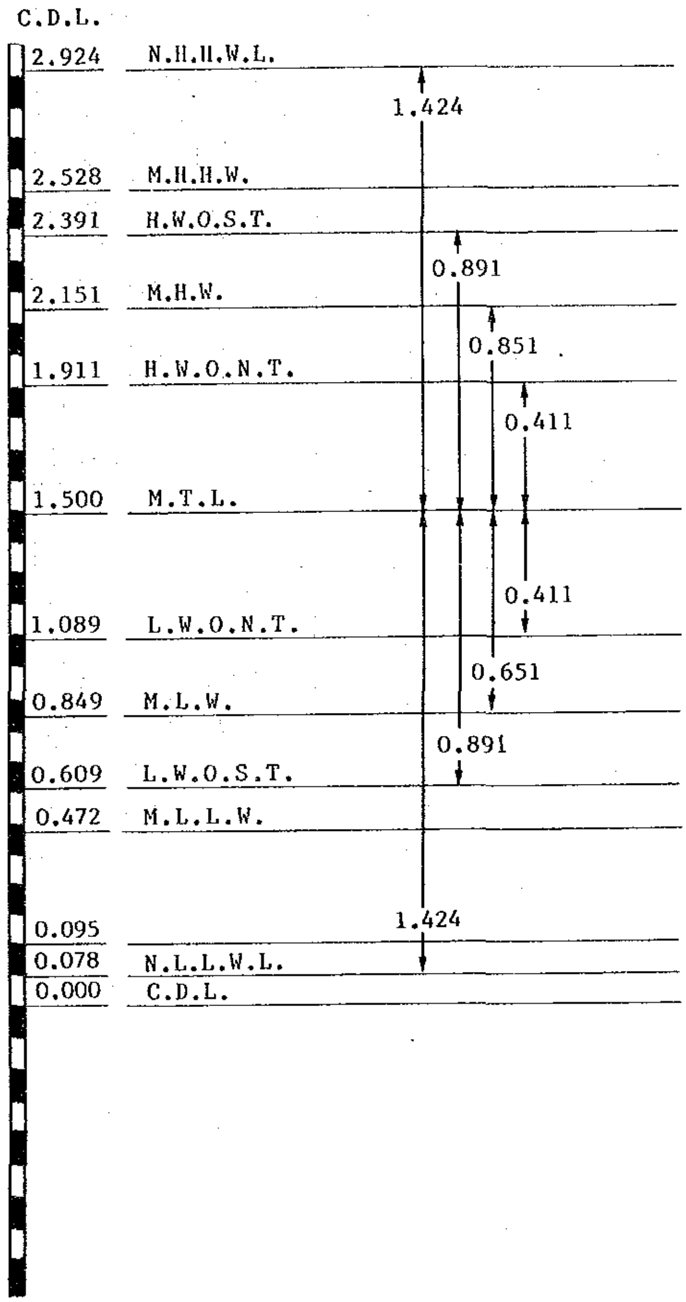


Fig.1-3-7 Tidal Diagram at Majis

Table.1-3-4 Probability of Wave Height in Different Directions;

(1986.6, 1987.7-12, 1988.1-12, 1989.1-5)

Wave 5 Direction H1/b(m)	NNW	N	NNE	NE	ENE	E	ESE	SE	Total
≤0.4									449 (67.7)
0.5	4 (0.6)	4 (0.6)	3 (0.5)	4 (0.6)	14 (2.1)	48 (7.2)	11 (1.7)	2 (0.3)	90 (13.6)
0.6	6 (0.9)	5 (0.8)	3 (0.5)	4 (0.6)	5 (0.8)	22 (3.3)	6 (0.9)	1 (0.2)	52 (7.8)
0.7	3 (0.5)	5 (0.8)	1 (0.2)	3 (0.5)	3 (0.5)	5 (0.8)	2 (0.3)		22 (3.3)
0.8	4 (0.6)	1 (0.2)		2 (0.3)	1 (0.2)	8 (1.2)	1 (0.2)		17 (2.6)
0.9	1 (0.2)	5 (0.8)		1 (0.2)	2 (0.3)	4 (0.6)	1 (0.2)		14 (2.1)
1.0		2 (0.3)	1 (0.2)						3 (0.5)
1.1-1.2	2 (0.3)	4 (0.6)	1 (0.2)		1 (0.2)	1 (0.2)	1 (0.2)		10 (1.5)
1.3-1.4		1 (0.2)				2 (0.3)	1 (0.2)		4 (0.6)
1.5-1.6		2 (0.3)							2 (0.3)
1.7-1.8									
1.9 ≤									
Total	20 (3.0)	29 (4.4)	9 (1.4)	14 (2.1)	26 (3.9)	90 (13.6)	23 (3.5)	3 (0.5)	663 (100.0)

NOTE : H1/3 : Daily Mean Significant Wave Height ( ) : Percentage

Table.1-3-5 Probability of Wave Height and Wave Period

(1986.6, 1987.7-12, 1988.1-12, 1989.1-5)

T(Sec) H1/3(m)	≤4.4	4.5 ~5.4	5.5 ~6.4	6.5 ~7.4	7.5 ~8.4	8.5 ~9.4	9.5 ~10.4	10.5 ~11.4	11.5 ~12.4	12.5 ~13.4	13.5 ~14.4	14.5 ~15.4	15.5≤	kei
≥0.4														449 (67.8)
0.5		11 (1.7)	19 (2.9)	14 (2.1)	9 (1.4)	8 (1.2)	4 (0.6)	10 (1.5)	1 (0.2)	3 (0.5)	5 (0.8)		6 (0.9)	90 (13.6)
0.6		11 (1.7)	18 (2.7)	10 (1.5)	1 (0.2)	1 (0.2)	2 (0.3)	5 (0.8)	1 (0.2)		2 (0.3)	1 (0.2)		52 (7.8)
0.7		10 (1.5)	9 (1.4)		1 (0.2)							2 (0.3)		22 (3.3)
0.8		6 (0.9)	3 (0.5)	3 (0.5)	3 (0.5)				1 (0.2)	1 (0.2)				17 (2.6)
0.9		3 (0.5)	8 (1.2)	2 (0.3)							1 (0.2)			14 (2.1)
1.0			3 (0.5)											3 (0.5)
1.1~1.2			10 (1.5)											10 (1.5)
1.3~1.4			2 (0.3)	1 (0.2)			1 (0.2)							4 (0.6)
1.5~1.6			2 (0.3)											2 (0.3)
1.7~1.8														
1.9≤														
kei		41 (6.2)	74 (11.2)	30 (4.5)	14 (2.1)	9 (1.5)	6 (0.9)	16 (2.4)	3 (0.5)	4 (0.6)	8 (1.2)	3 (0.5)	6 (0.9)	663 (100.0)

Note : H1/3 : Daily Mean Significant Wave Height
T : Wave Period

The prevailing wave directions are N and E. The predominant height of wave is less 0.4m with occurrence of 68% and the predominant wave period is 4 sec with occurrence of 68%. (Fig.1-3-8)

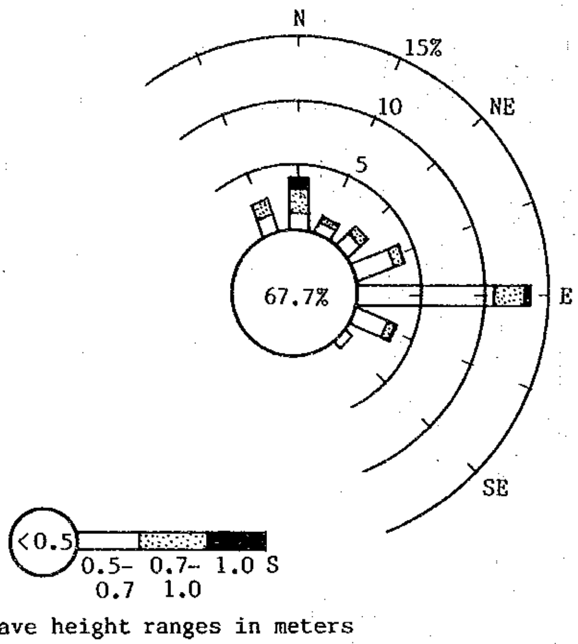


Fig. 1-3-8 Wave Rose of Majis Coast (1986 - 1989)

Wave directions affecting the new port are NNW, N, NNE, NE, ENE, E, ESE, and SE. Fig.1-3-9 shows exceedence probability of wave height outside the harbour based on the observation data.

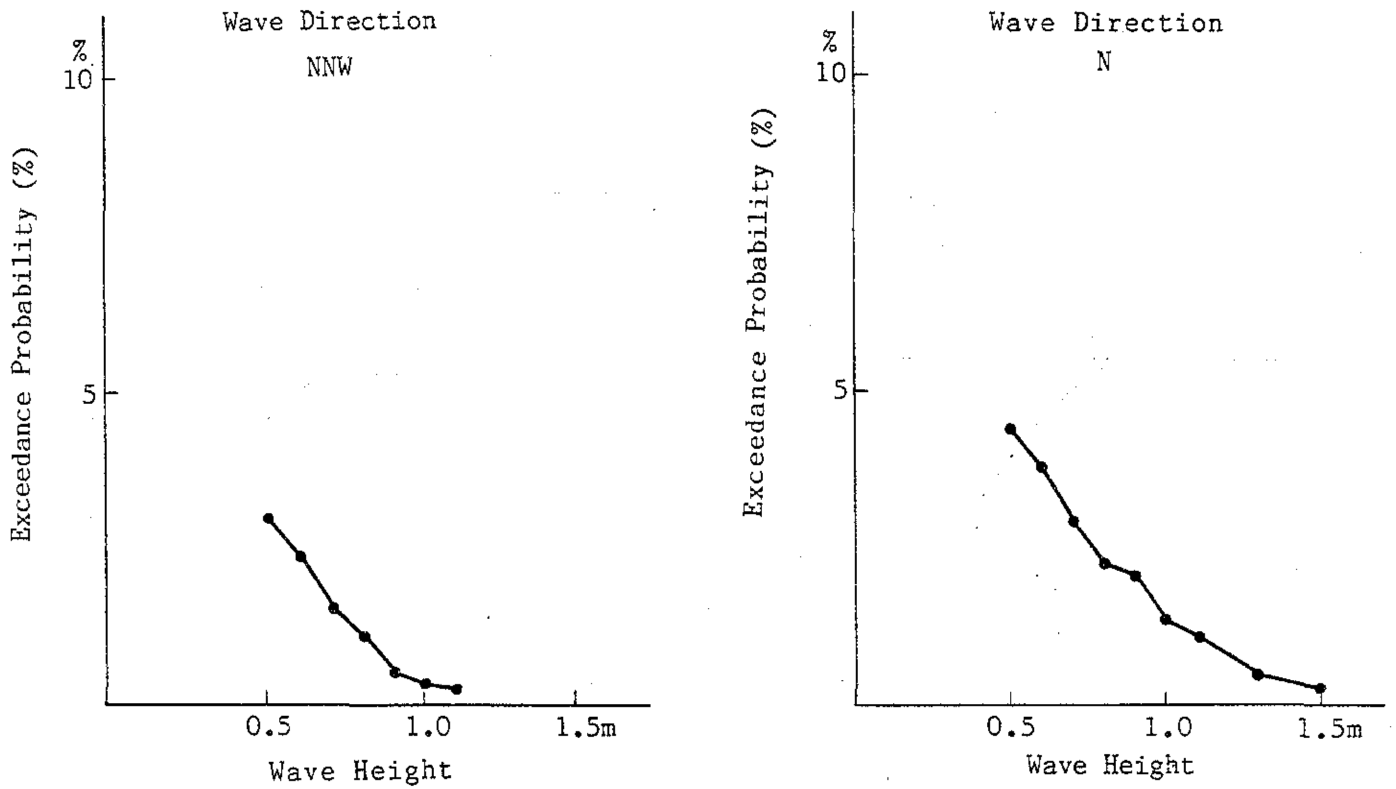


Fig.1-3-9(1) Exceedance Probability of Wave Height outside Harbour(%)

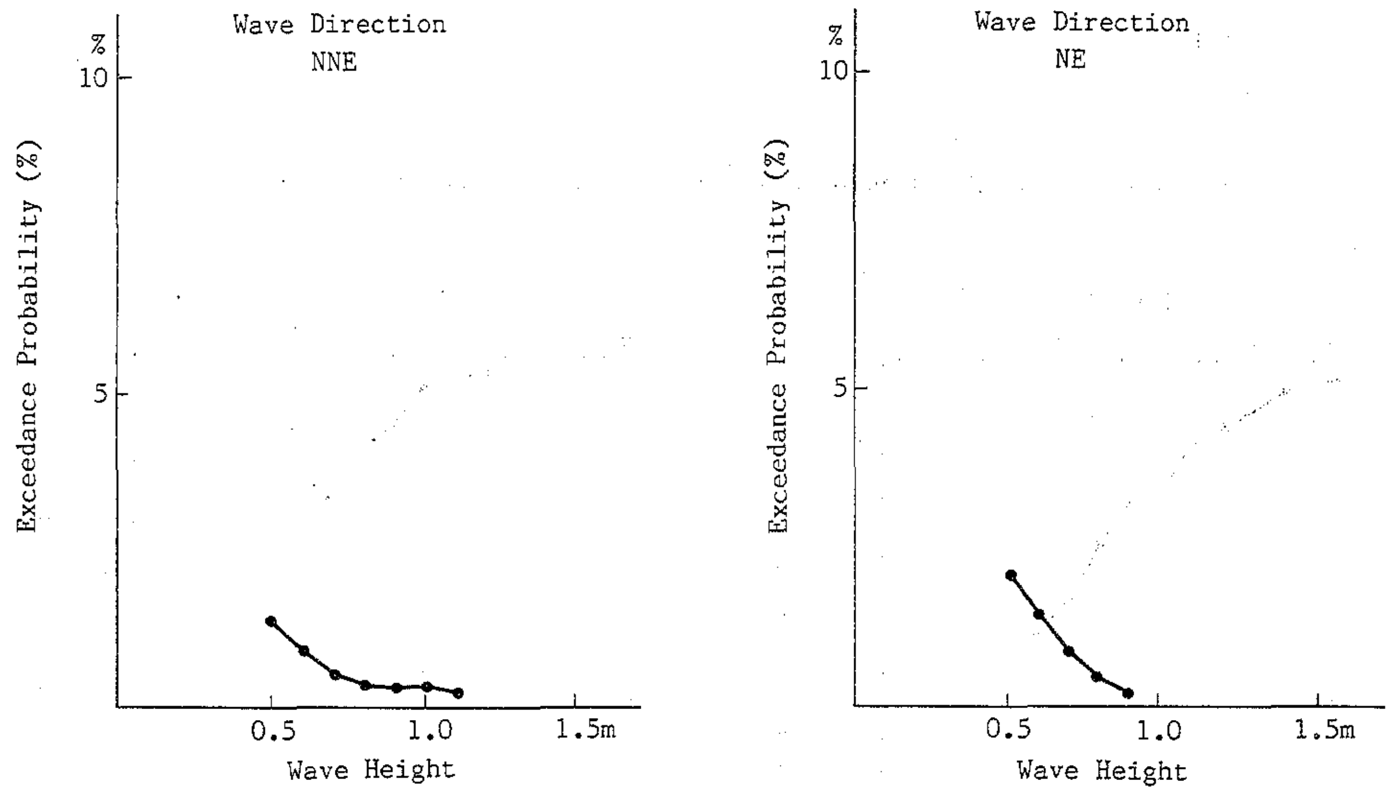


Fig.1-3-9(2) Exceedance Probability of Wave Height outside Harbour(%)

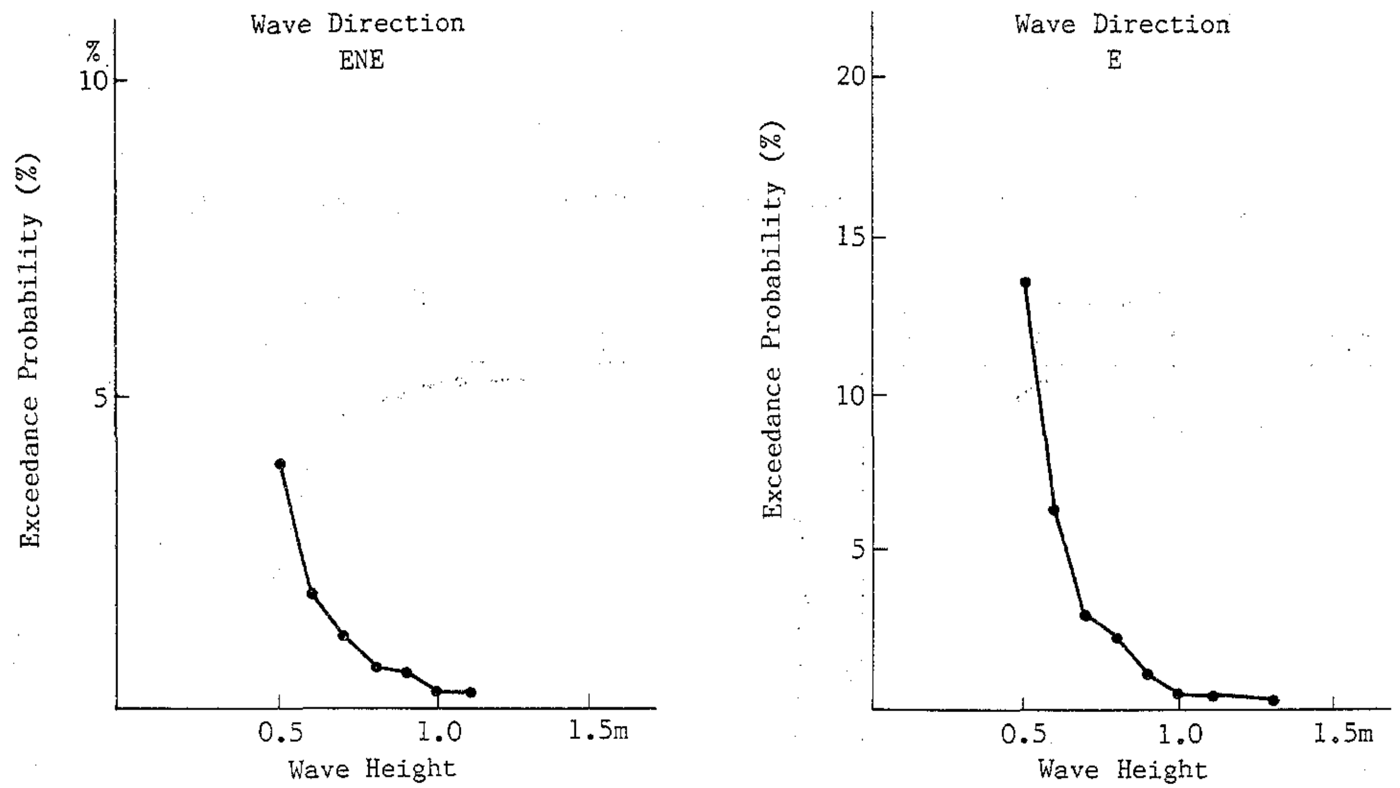


Fig.1-3-9(3) Exceedance Probability of Wave Height outside Harbour(%)

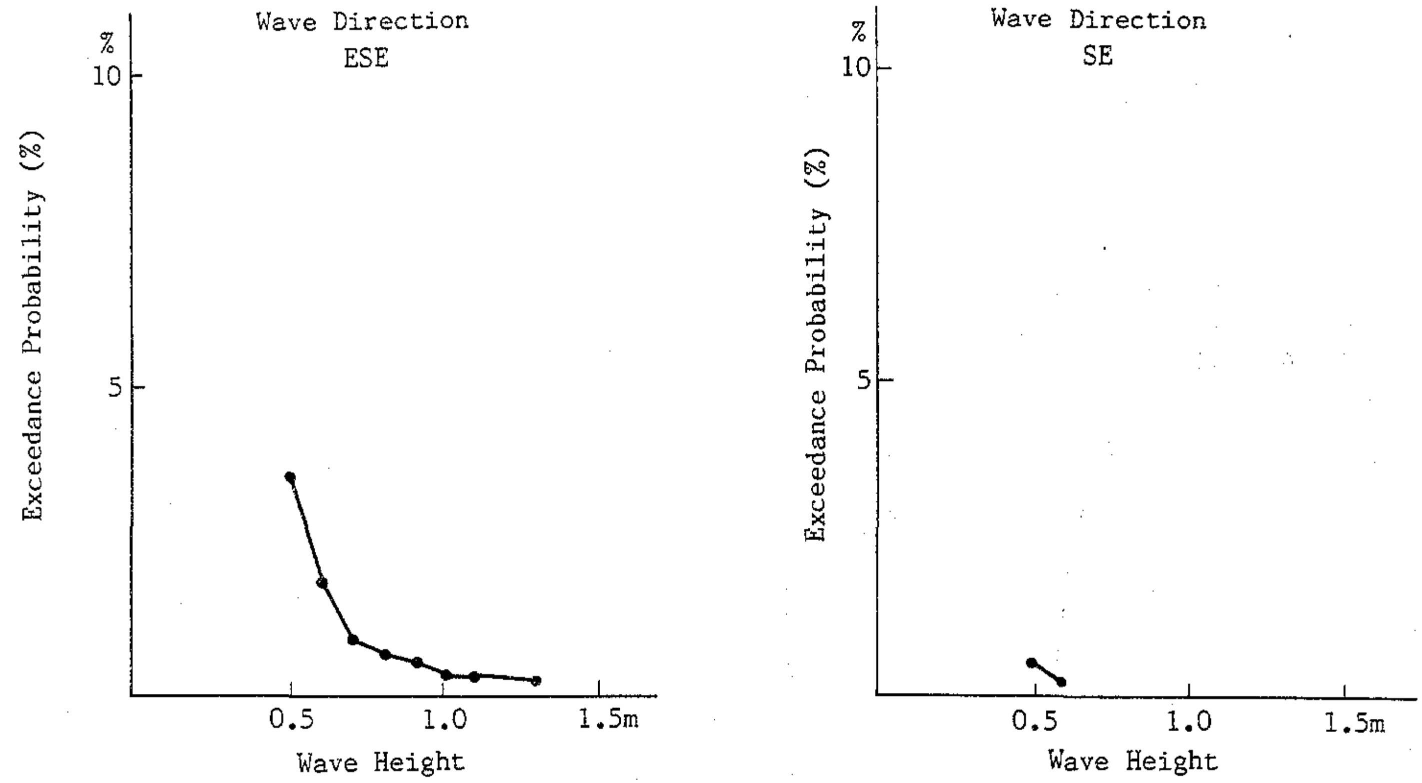


Fig.1-3-9(4) Exceedance Probability of Wave Height outside Harbour(%)

(b) Storm waves

The design wave height can be estimated based on the waves measured offshore Mina Quaboos.

Significant wave heights and return periods for the new port (deep water) are shown in Table 1-3-6.

Table 1-3-6 Significant Wave Height and Return Period for the New Port (Deep Water)

Item / Wave Condition	Return Period in Years		
	10	50	100
Significant Wave Height in Meters	4.2	5.3	5.9
Wave Period in Seconds			12

The desired service period of the breakwater will be 50 years. The probability (% risk) of exceedance of design wave height should be less than 50%. Thus, return period of the design wave height for the breakwater should be 100 years.

The design wave was estimated as follows:

i. Design Deep Water Wave

Wave Direction	:E
Wave Height	:HO =5.9m
Wave Period	:T =12.0 sec
Wave Length	:LO =225m
Slope of Sea Bottom	:tan α =1/200
H.W.L	:+2.4m

ii. Equivalent Deep Water Wave Height (HO')

HO'=HO x Kr=5.9 x 0.86=5.2m

iii. Design Waves

Design Depth	:h =9.9m(7.5+2.4m)
Significant Wave Height	:H1/3=5.2m
Maximum Wave Height	:Hmax=7.7m

A wave refraction diagram (E, 12.0 sec) is shown in Fig 2-3-12.

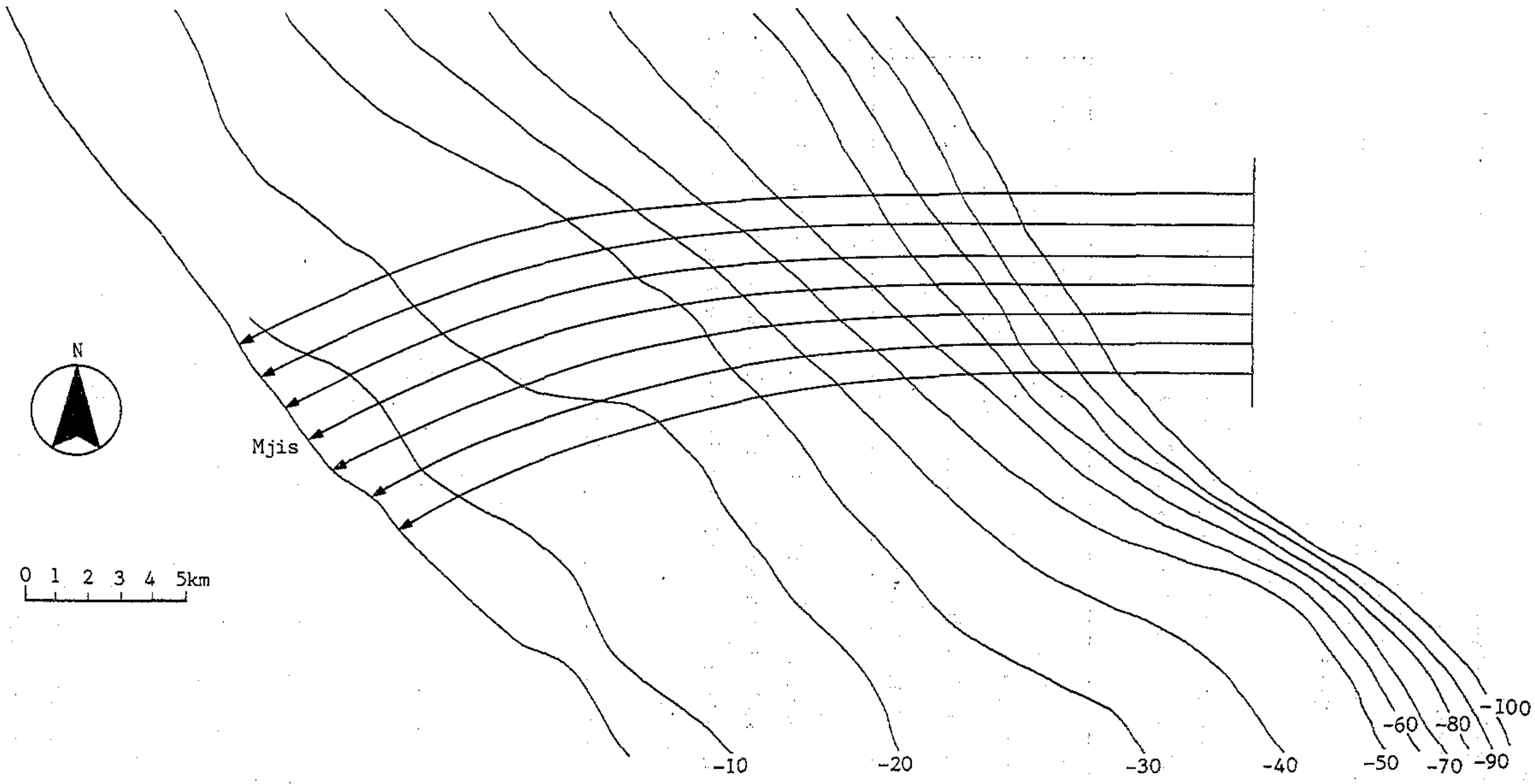


Fig.1-3-12 Diagram of Refraction (E,12 sec)

(4) Tidal current

Current observation was carried out to know the current characteristics (velocity and direction) for maneuverability of vessels, port construction work and siltation. The observation was performed for 15 days continuously by using a selfrecording current meter at the point shown in Fig 1-3-13.

Current velocity and direction of observation were shown in Fig 1-3-14. As shown in this figure, the tidal current velocity was found to be less than 0.1m/sec at about 2m above the seabed. Primary directions of tidal currents are NW and SE.

So the influence of tidal currents on port construction and operation will be negligible. And the influence of tidal currents on siltation will also be small.

(5) Coastal Sediment Aspects

The Majis coast is characterized by flat beaches and nearshore bottom slopes; and relatively low levels of wave and current energy which are insufficient to disperse much of the sediment discharged from the mouths of wadis south of the site.

Seabed material sampling was carried out at 30 points as shown in Fig 1-3-1 and grain sizes were measured for littoral drift analysis.

The diameter of seabed material gradually decreases towards the offshore under the sorting action of the waves whereby the finer material is carried furthest.

The median diameter of seabed material is shown in Fig 1-3-15. As may be seen in this figure, the seabed materials decrease in size gradually with depth from 0m to 3m. Therefore, the seabed material is mostly moved by waves. The seabed material from 4m to 13m in depth is very fine and its median diameter is almost constant. Therefore,it seems that seabed material from 4m to 13m in depth is not moved so much.

From the report of Majis jetty study it was found that the net rate of movement near the site is about 12,000m3/yr in a northwards direction, with gross rates of 18,000m3/yr northwards and 6,000m3/yr southwards. These are very low rates.

The net littoral drift would be fully trapped by any solid structure likely to be contemplated. The waterline would advance about 100-200m seaward after 50 years.

It was estimated that the maximum recession after 50 years could be 20-30m; that the total length of shore affected might be about 4km in 50 years.

At sheltered basins, or dredged areas, finer-grained sediment deposits are likely to be so dispersed that they are not likely to necessitate significant or frequent maintenance. At Wudum port, the existing navigation channel is subjected to a deposition rate of about 8 centimeters per year.

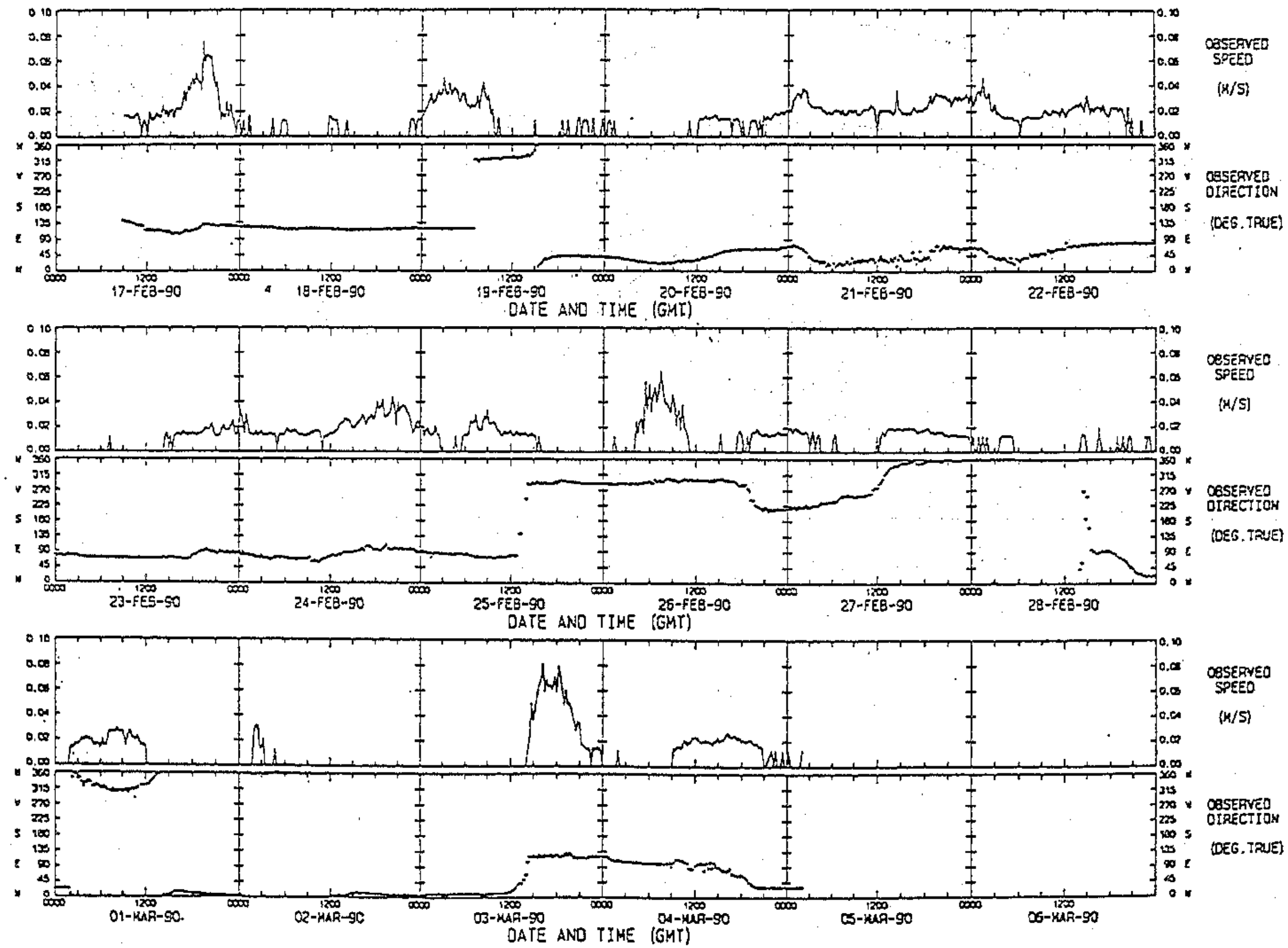


Fig.1-3-13 Observed Tidal Current

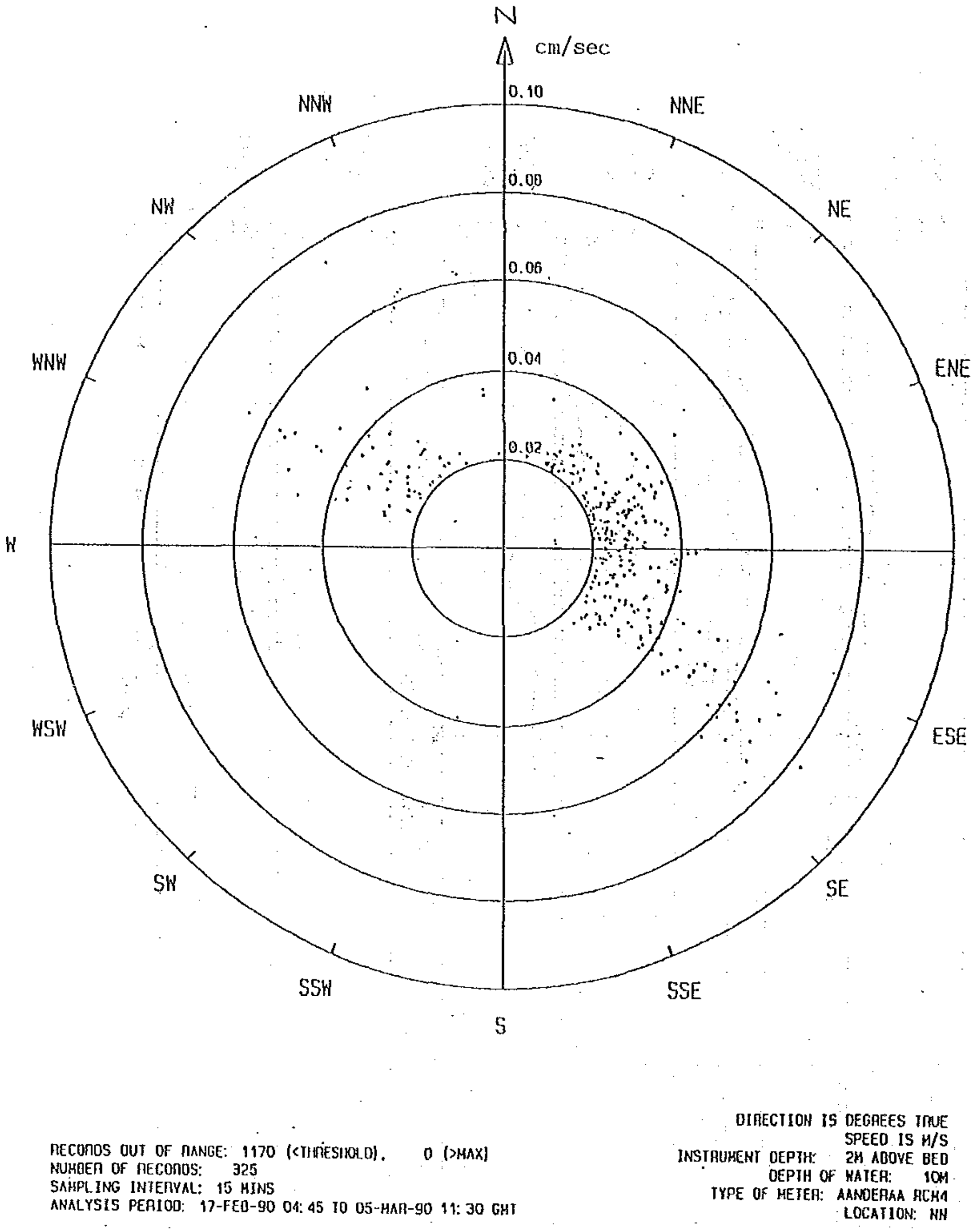


Fig.1-3-14 Current Velocity and Direction

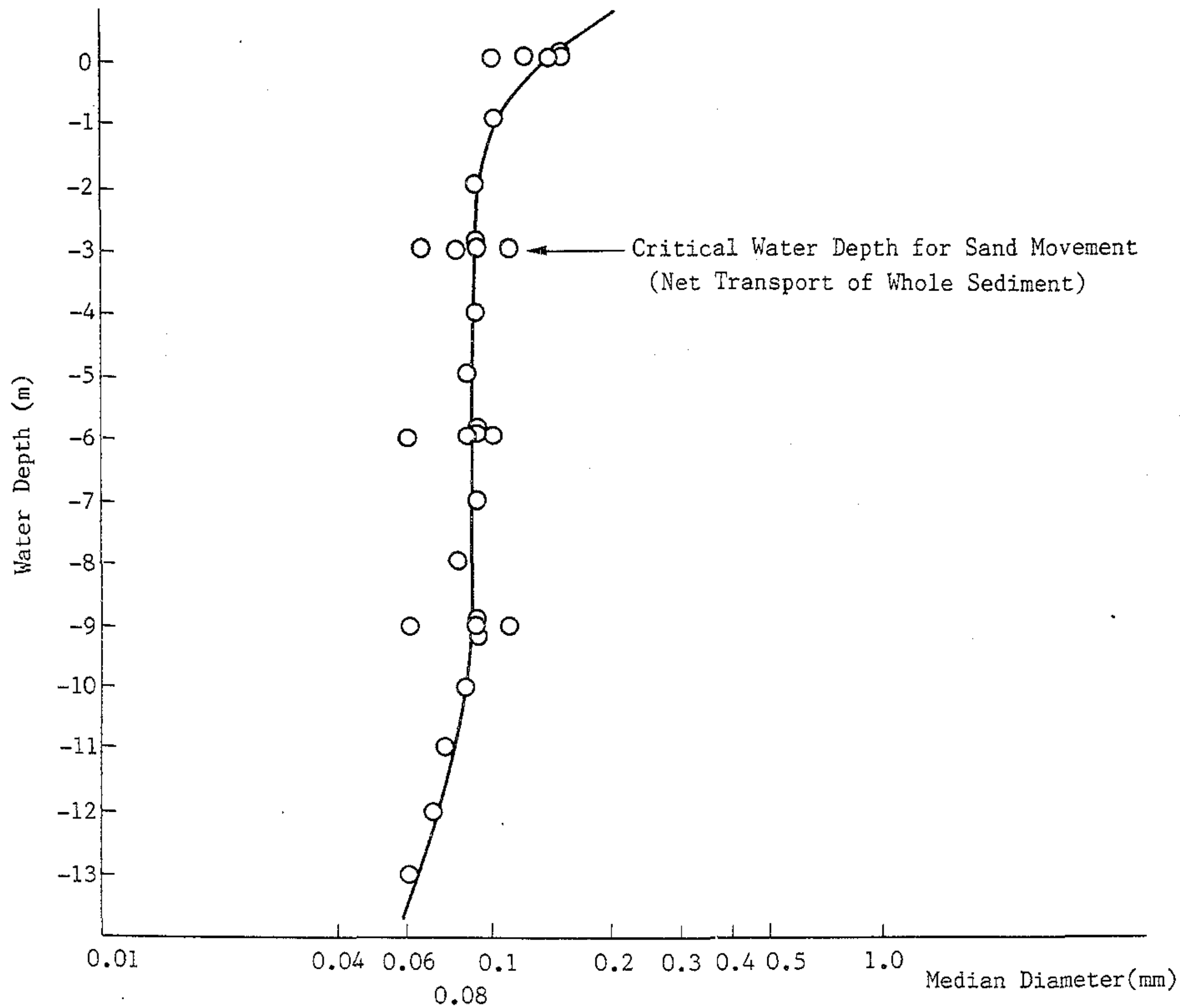


Fig.1-3-15 Mediam Diameter Distribution of Sea Bed Material

CHAPTER 2 SOCIO-ECONOMIC CONDITIONS

Chapter 2 PRESENT SOCIOECONOMIC CONDITIONS IN THE NORTHERN PART OF OMAN

2.1 General

In this section, the Sultanate is divided into the following seven main administrative regions as defined in the Statistical Year Book issued by the Development Council. Some regions are divided into two sub-areas if necessary.

(1) Muscat Region:

This includes the capital of the Sultanate and is the most densely populated area, since it is the centre of commerce and industry. The main wilayats of this area are the Governorate of Muscat and the Wilayat of Quriyat.

(2) Janubiah Region:

This area occupies nearly one-third of the State. Salalah, located on the Arabian Sea Coast and the regional centre of this area, has a central administrative office with Directorates and Departments of all the ministries in Muscat. There are eight wilayats, i.e., Salalah, Thamrait, Taqa, Rokhyut, Mirbat, Shalim, Sadah and Dhalqut.

(3) Dakhiliah Region:

This area is located between Dhahirah Area on the west and Sharqiya Area on the east and forms a central plateau from Jebel Al Akhdar in the north towards the desert in the south. The valleys of Sumail and Al-Halfein form a natural gap in the Al-Hajar mountain range and provide a traditional trade route between Muscat and the Area. There are nine wilayats, i.e., Nizwa, Bahla, Adam, Al Hamra, Haima, Manah, Sumail, Izki and Bidbid.

(4) Sharqiya Region:

This area is divided into the following two areas: One is located at the inner part of the eastern Hajar mountain range and forms a sandy plain penetrated by Wadis. It is also located between the Arabian Sea on the southeast and the Wahiba Sand on the south. There are six wilayats, i.e., Ibra, Al-Mudhaiby, Bidiya, Al-Qabil, Dimaa and Tayin. The other is located at the coastal part of the eastern Hajar mountain range and consists of five wilayats, i.e., Sur, Masirah, Ja'alan Bani Hassan, Ja'alan Bani Bu Ali and Wadi Bani Khalid.

(5) Dhahirah Region:

The area is bordered in the north by the UAE and is separated by Jebel Al Koor in the south. This area contains five wilayats, i.e., Al-Buraimi and Mhadha in the north and Ibri, Yanqul and Dhank in the south.

(6) Musandam Region:

This area is located in the northern mostpart of the Sultanate and separated from the rest of Oman by the UAE and faces the Straits of Hormuz. There are four wilayats, i.e., Khasab, Bukha, Daba Al Biya and Madha.

(7) Batinah Region:

This area is divided into two main parts, i.e., North Batinah and South Batinah.

North Batinah: This area consists of six wilayats i.e., Sohar, Shinas, Liwa, Saham, Khabura and Suwaiq. This coastal plain is bordered by the UAE on the north and situated between the coast and the western Hajar mountain range.

South Batinah: This area is located on the east side of the Hajar mountain range between the border of the UAE in the north and the Wadi Al Maawel in the south. There are six wilayats, i.e., Rustaq, Nakhl, Wadi Al Maawil, Awabi, Musanaa and Barka.

2.2 Population and Employment

Based upon the present estimated population of 1,500,000 by the Development Council, the population of Batinah Region is calculated at about 436,000 at present, i.e., 29.1% of the total population in the country. Fig.2-2-1 shows the percentage of regionwise population. Due to the efforts of the development of medical services, the infant mortality rate has sharply declined to 30 per thousand as compared to 110 in the early 70s. The government is working to reduce the rate to 15 to 20 per thousand in the near future. Population by age and development of medical services are illustrated in Fig.2-2-2 and Fig.2-2-3.

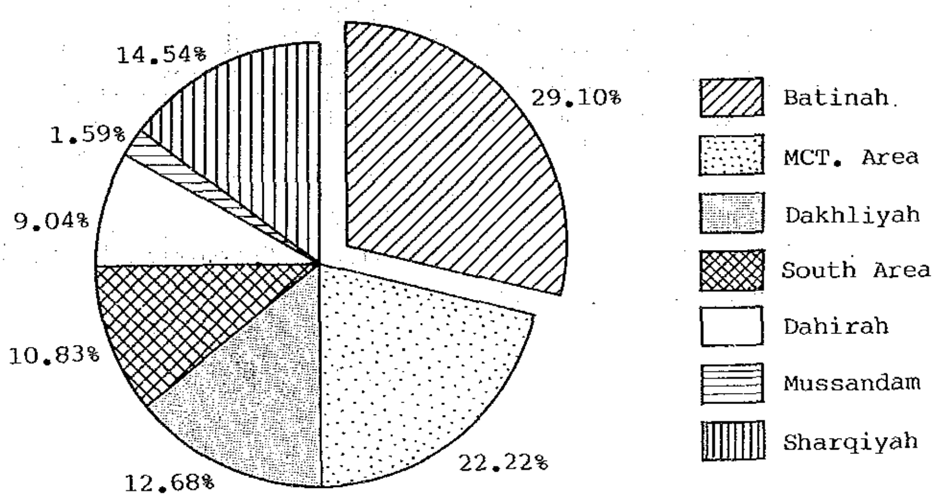
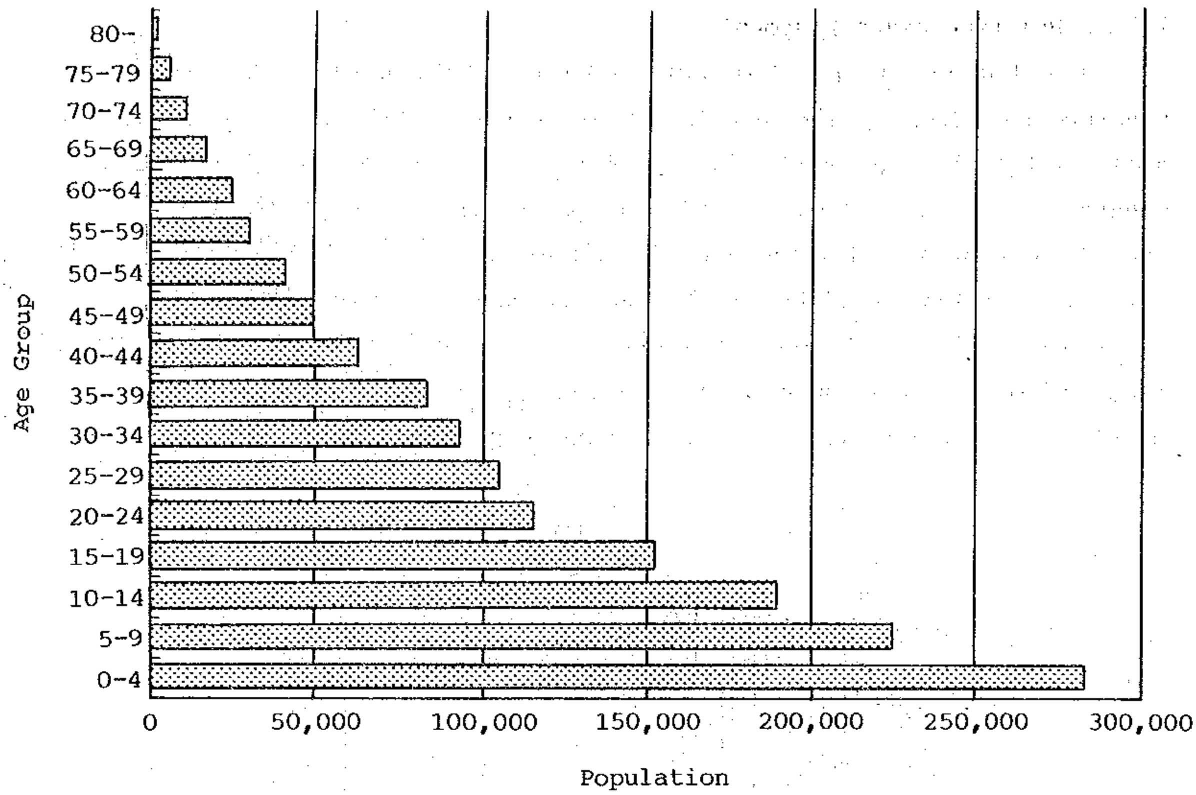
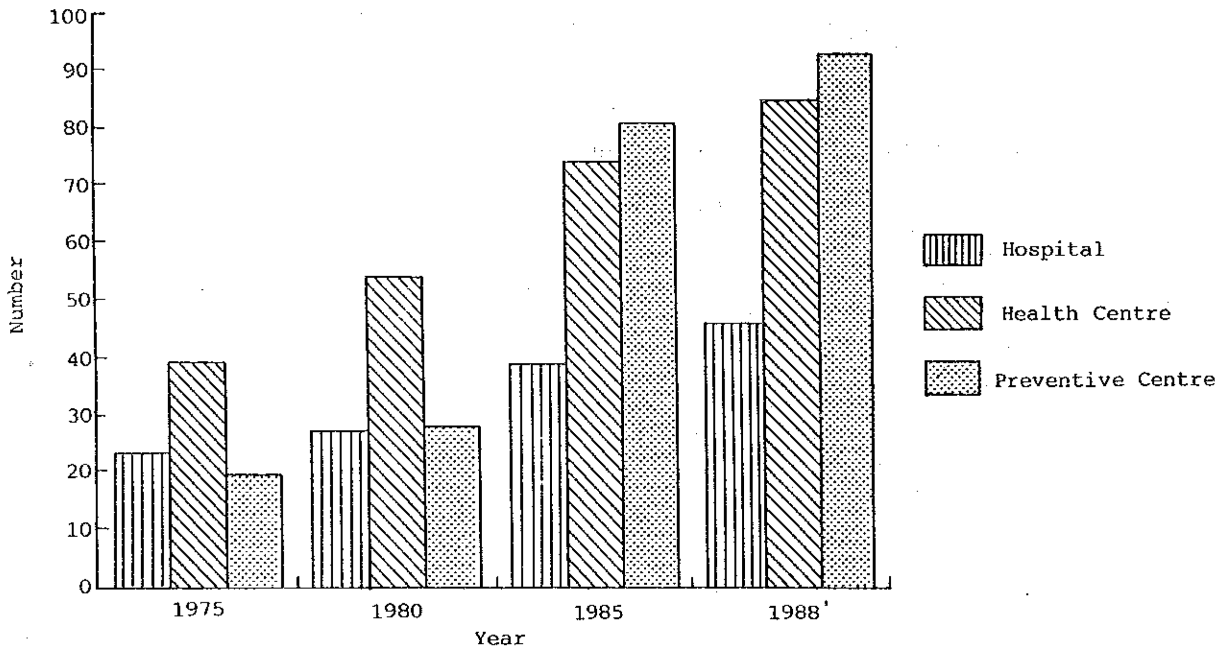


Fig. 2-2-1 Population in 1989 (Based on Estimated Total of 1.5 million)



Source: Recent Economic Development and Prospects, World Bank,
September 12, 1988

Fig. 2-2-2 Population by Age



Source: Statistical Year Book, Development Council

Fig. 2-2-3 Number of Hospitals and Health Establishements

The wilayat-wise population with the population at Center Cities in Batinah Region is shown in Table 2-2-1 below.

Table 2-2-1 Wilayat-wise Population in Batinah Region

Wilayat	Population	at Center	%
North Batinah			
Shinas	36,703	(4,071)	11.1
Liwa	16,918	(2,147)	12.7
Sohar	68,641	(11,132)	16.2
Saham	52,035	(7,753)	14.9
Khaburah	39,336	(23,425)	59.6
Suweiq	63,438	(16,505)	26.0
South Batinah			
Rustaq	49,654	(13,697)	27.9
Nakhl/Maawil	20,839	(15,077)	72.3
Musanaa	36,458	(5,369)	14.7
Barkah	46,124	(12,017)	26.1
Awabi	6,332	(2.683)	42.4
Total	436,478	(113,876)	28.5

Source: Development Council

Among these 12 wilayats, Sohar has the largest population. Accordingly, various civil service organizations are concentrated in this area. Based upon the significant role of Sohar, the Sohar Structure Plan was formulated in 1986. The objective of the Plan is to establish Sohar as the regional centre of the north Batinah coast as well as the major centre for urban employment in the region. According to this report, 35% of those people who are economically active have their jobs outside the wilayat and their main destinations are the Capital Area (45%) and the UAE and Buraimi (55%), commuting on a weekly basis. As clearly indicated in Fig.2-2-2, drastic population growth started with of the renaissance of Oman and this trend will continue due to remarkable efforts on the improvement of medical services in the whole country. On the other hand, the participation of Oman women in economic activity will increase in the near future. Table 2-2-2 shows the number of Omain employees by sex in the civil services.

Table 2-2-2 Civil Service Employees by Sex

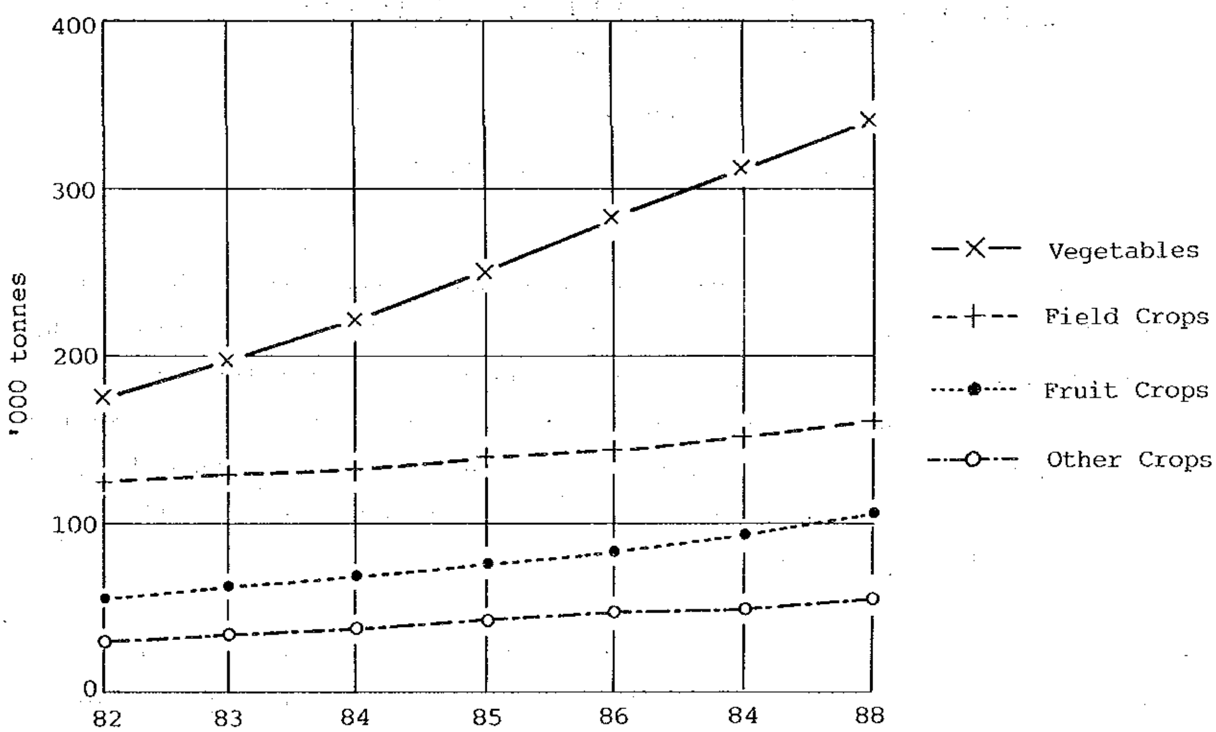
	1985	1986	1987	1988
Male	35,763	36,918	38,791	40,800
Female	2,992	3,305	4,186	4,774
% of Female	7.7	8.2	9.7	10.5

Source: Statistical Year Book, Development Council

Taking into account these trends and the concentration of population in the capital area at present, the creation of employment opportunities in the region is a critical issue.

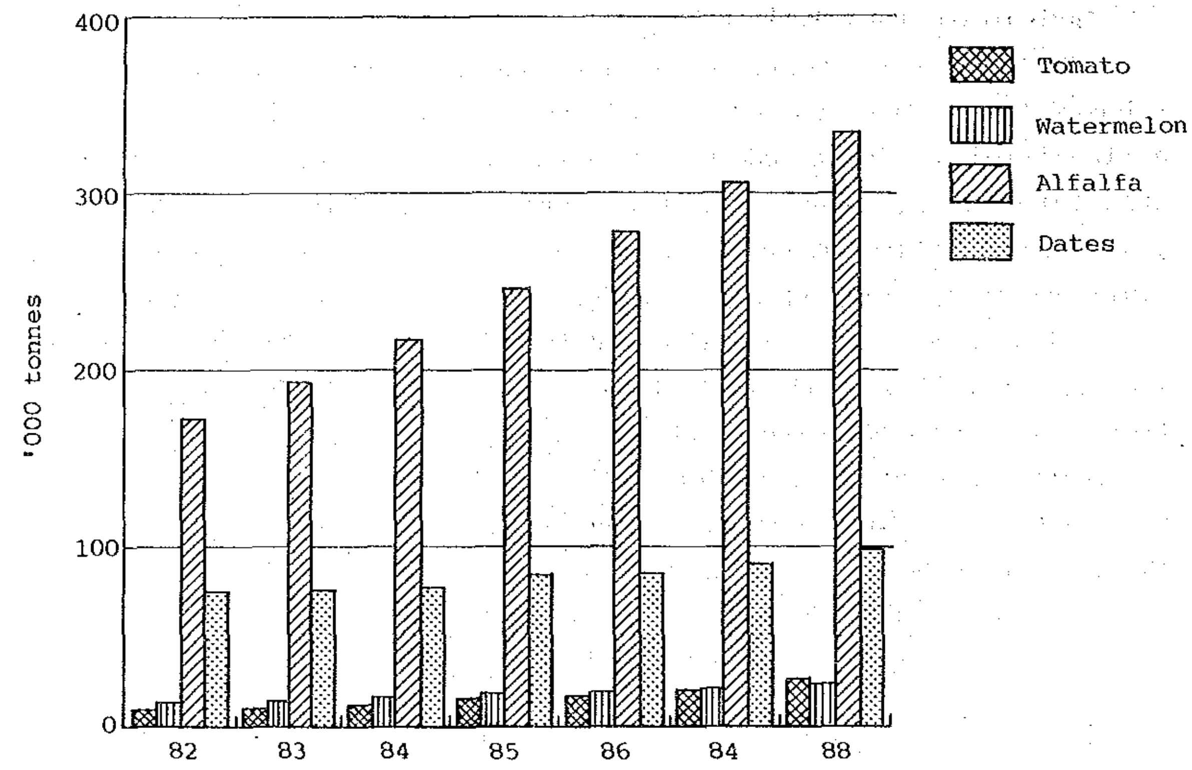
2.3 Agriculture and Livestock Sector

The total agricultural land area in Oman is about 100,000 hectares, of which 54,641 hectares are estimated to be cultivated. Production volume of agricultural products was 662.8 thousand tonnes in 1988. Of this cultivated area, about 32,303 hectares, i.e., 59.1%, are used for production of fruit crops; 9,647 hectares, i.e., 17.7%, for field crops; 6,040 hectares, i.e., 11.1%, for vegetable crops. These various crops' production volumes are 161.2 thousand tonnes, i.e., 24.7%; 339.8 thousand tonnes, i.e., 51.3%; and 105.4 thousand tonnes, i.e. 15.9%, respectively. Field crops have been remarkably increasing in recent years followed by vegetable crops, as shown in Fig.2-3-1. On the other hand, fruit crops, of which dates are main traditional products in Oman, have remained stable as shown in Fig.2-3-2.



Source: Statistical Year Book, Development Council

Fig.2-3-1 Volume of Agricultura Products



Source: Statistical Year Book, Development Council

Fig.2-3-2 Volume of Main Products

The Government established a number of agricultural research stations and agriculture extension service centres, which totaled 42 in 1988. The area of extension fields, which are set up at private farms for cultivation of various crops under the guidance of the Research Centres to familiarize farmers with advanced agriculture methods and techniques reached 1,558 fiddans in 1987. The government subsidized farmers by providing them with improved seeds, transplants, insecticides and fertilizers.

The Oman Bank for Agriculture and Fisheries (OBAF) was established in May 1981 with its capital of 19 MRO subscribed by the Government 98.9%. The objectives of the Bank are as follows:

(1) Extending short-medium- and long-term loans to Omanis or to national establishments engaged in the fields of Agriculture and Fisheries.

(2) Participation in the capital of national companies.

(3) Extending technical and consulting assistance to Omanis and to national companies.

The number of loans granted reached 6,694, amounting to 22.8 MRO till the end of 1988.

The Public Authority for Marketing Agricultural Produce (PAMAP), which was established in order to provide incentives to farmers for increasing agricultural produce and supplying the necessary volume of the produce with the appropriate prices, started collection and distribution services in 1986. The PAMAP has now 6 collection and distribution centres and 12 distribution centres in the country.

Regarding the value of reported agricultural products, 4.9 MRO was exported in 1985 and 4.8 MRO in 1988. Of the exports in 1985, 81.9% were to GCC countries, of which 64.8% were exported to the UAE. In 1988, the total value of exports to GCC countries decreased to 56.6%, of which 67.7% were exported to the UAE. Exports to other countries increased 43.4% in 1988 compared to 18% in 1985. On the other hand, exports of live animals reached 5.8 MRO in 1988 compared to 1.3 MRO in 1985, and 98.9% were exported to the UAE.

According to the results of the First Agricultural Suvey in 1978/79, 50.6% of the total area under cultivation is located in Muscat and Batinah Region followed by 10.4% in Sharqiya and Ja'alan. Another result of the survey indicates that 33.5% of the total area used for vegetable crops is in the Batinah Region and 25.8% in the Dakhiliah Region, and 24.9% of the total area of field crops is in Batinah and 22.2% in Dakhiliah. Regarding the population of goats and sheep, Mascut and Batinah Regions have the largest shares, at 25.8% and 44.8%, respectively.

2.4 Fisheries Sector

Oman, with its 2,100 Km long coastline, has huge potential in terms of fishery development. From the beginning of the First Five Year Plan, the Fisheries Sector has been continuously given development priority as well as agriculture, mining and manufacturing. The long-term development strategy for fisheries focused on various steps as summarized below during the First and Second Five Year Development Plans, taking into consideration this sector's importance as a course of income and employment for a sizable portion of the Omani labour force:

(1) Establishing the Fishermen Fund for fishermen to buy modern fishing boats and motors;

(2) Development of infrastructural facilities such as landing facilities, cold stores, ice plants and workshops;

(3) Organizing of a marketing network;

(4) Training of fishermen and assistance in the maintenance of equipment;

(5) Establishing the Marine Sciences Fisheries Center and setting up of a statistical data collection system.

The Fishermen Fund helps fishermen to buy boats and motors at a subsidized cost or at no cost in some cases. The total amount of subsidies granted to fishermen reached 1,389 TRO during 1985 to 1988, of with 30.0% was allocated to the Sharqiya Region, 26.7% to the Batinah Region, 25.3% to the Janubiah Region and 17.3% to the Muscat Region. The total amount during 1980 to 1985 was 3,754 TRO. Table 2-4-1 shows the regional distribution of fishery-related factors during 1984 to 1985. Among these regions, Batinah plays a significant role in fisheries and this indicates that the region can develop more fishing activities in the future.

In 1977, MAF granted a concession to the Korean Fisheries Company for fishing along a coast-line of 60 nautical miles, provided that the Sultanate should receive 30% of the catch. The company landed a catch of 10.2 thousand tonnes in 1988.

Table 2-4-1 Statistical Survey on Fisheries, 10th July 1984 - 9th July 1985

	Settlements with at least 10 boats	Fishing boats	Traditional Fishermen	Fish catch in tonnes
Muscat	31	1371	1820	12560
Janubiah	23	901	1370	14100
Northern Sharqiya	15	815	2040	18710
Southern Sharqiya	13	531	910	11960
Batinah	100	4968	4060	29580
Musandam	19	610	1500	1950
Total	201	9196	11700	88860
Offshore Trawlers	N.A.	13		12320
Grand Total	201	9209	11700	101180

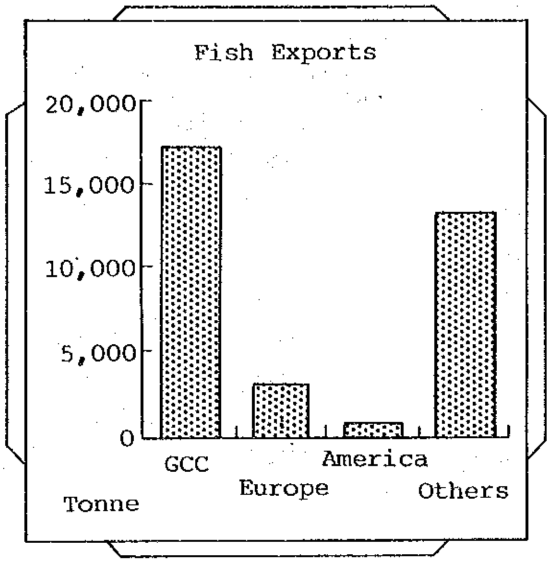
Note: 1) Figures are rounded to the nearest 10 fishermen
2) Figures are rounded to the nearest 10 tonnes
Source: Statistical Year Book, 1989

The Government assisted in the establishment of the Oman National Fisheries Company in 1980 and participated in its equity to the extent of 20%, and sold the Muttrah Project including trawlers to the company at a reduced price. The volume of fish landed by the company reached 4 thousand tonnes in 1985. However, it decreased to 2.8 thousand tonnes in 1988.

Regarding the development of storing and marketing processes, the Government has established Fishing Centres with cold storage facilities along the coast-line.

The volume of catches has increased remarkably in recent years, from 95 thousand tonnes in 1985 to 166.1 thousand tonnes in 1988, of which 92% was landed by traditional fishermen.

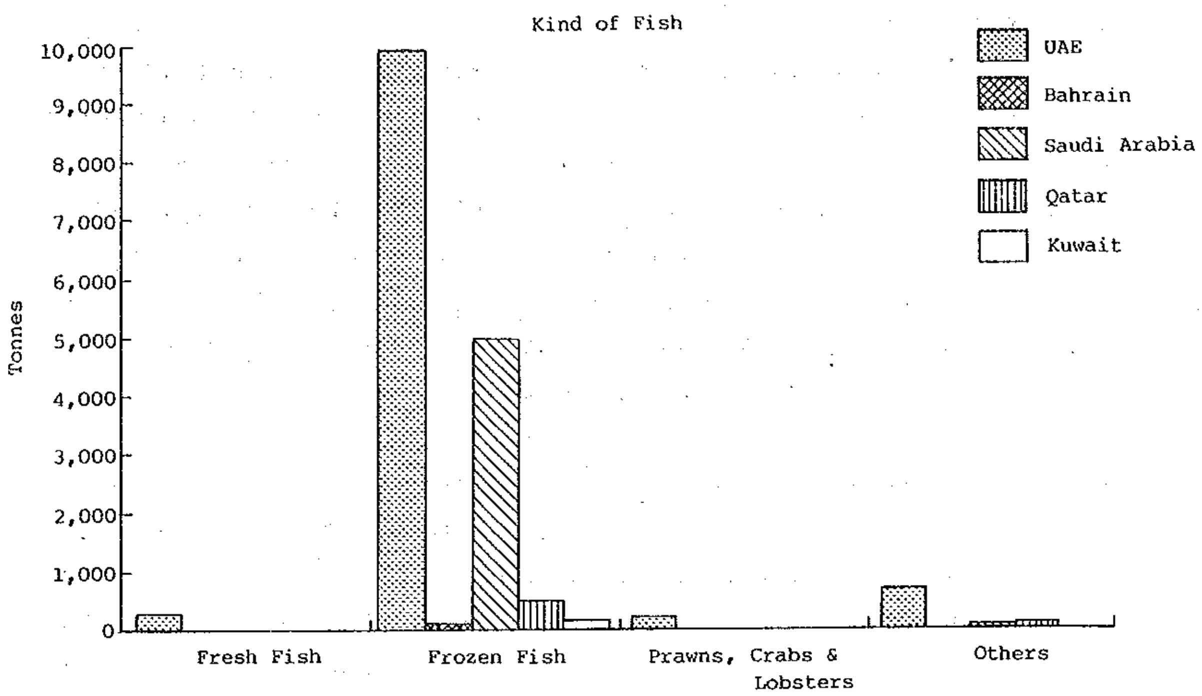
The total volume of exports of fish was only 7.5 thousand tonnes in 1980 and increased remarkably to 19.5 thousand tonnes in 1985 and 35.2 thousand tonnes in 1988. The value of fish exports reached 18.9 MRO in 1988 compared to 2 MRO in 1980 and 8.8 MRO in 1985.



Source: Statistical Year Book, 1989

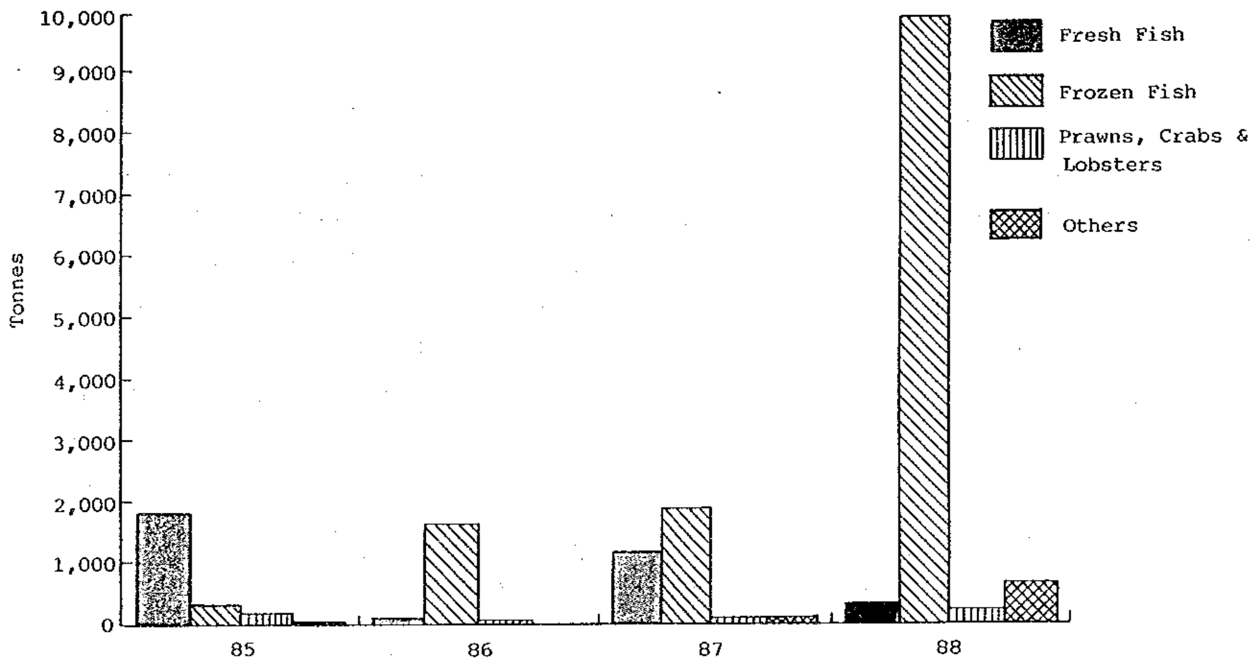
Fig. 2-4-1 Fish Exports in 1988

Fig.2-4-1 shows the destination-wise distribution of fish exports, of which 100% of fresh fish was exported to GCC countries, 40.8% of frozen fish to other countries except these of the GCC, Europe and America, 57.4% of prawns, crabs and lobsters to America. As far as this GCC market is concerned, the UAE imported 97% of fresh fish, 63% of frozen fish and 95.6% of prawns, crabs and lobsters. Fig.2-4-2 illustrates the importance of the UAE for Omani fisheries, and Fig.2-4-3 indicates the physical distribution has been changed from fresh fish to processed ones in recent years. This trend has developed new markets in the UAE and in Saudi Arabia.



Source: Statistical Year Book, 1989

Fig. 2-4-2 Fish Exports to GCC Cuntries by Type in 1988



Source: Statistical Year Book, 1989

Fig. 2-4-3 Fish Exports to the UAE

2.5 Industrial Sector

After the discovery of oil and the beginning of the modernization of Oman in 1970, the private sector started investing in industrial activities. However, most of the private-sector investment was concentrated in the trading and real estate fields because the construction of infrastructure and social utilities was the main priority of that period. During the period of the First Five-Year Plan, small- and medium-size industries were established and they were also engaged mainly in producing construction and building materials.

During the Second Five-Year Plan, the Government provided subsidies to the private sector in the form of grants and long-term loans which were interest-free and repaid within 20 years with a grace period of 5 years to productive projects in agriculture, fisheries, industry, mining, quarrying and traditional handicrafts. The Government also participated in the establishment of an animal feed factory. The Oman Oil Refinary Project was accomplished at a total cost of 42.2 MRO and started its work in November 1982. In 1983, the Sohar Mining Complex which was set up with total cost of 69.5 MRO, started operations. Also, two import substitute cement factories were established during this period, one at Rusail owned by the Government and the other at Salalah with production capacties of 624 thousand tonnes and 220 thousand tonnes per year, respectively.

The government established the Oman Development Bank in 1979. The bank extends medium- and long-term loans to Omani companies. These loans are used for financing capital expenditure. Until the end of 1988, 48.7 MRO loans were extended to various companies and participation in the equity reached 934 thousand RO. The repayment period of long term loans in 10 years with interest rate of 6% for the project in the capital area and 4% outside the capital area. The maximun sum of the loan should be 50% of the project cost.

The most important targets and policies of the industial sector during the Third Five-Year Plan are summarized as follows:

(1) To give a strong stimulus to the private sector to invest in industry, particularly by allocating and regulating financial support to the private

sector.

(2) To give higher priority to industrial projects that utilize local raw materials; the food and beverages industries, which include the benefit of a relative advantage in export market; and industries that can use a higher percentage of local manpower.

(3) To encourage foreign investors to participate in projects which contribute to the economic development of the country.

Based upon the above targets, establishment of new industrial areas has been authorized in Nizwa, Sur, Raysut and Sohar.

The Rusayl Industrial Estate Authority was established in 1983 in order to develop and manage the Rusayl Industrial Estate, which lies 45Km from central Muscat with 100 hectares of land. The infrastructure facilities are provided by the Authority such as roads, gas, water, electricity, telecommunications and a waste water treatment plant. Shops, supermarkets, a cafeteria, a bank, post office, a health clinic are also available on the Estate. The site is divided into various sizes of building plots which can be leased out for a period of 25 years with an option of another 25 years. Advanced factories are also prepared, with sizes ranging from 300 to 4,482 sq. meters, and leases are 25 years. The area can accommodate about 100 factories and there were 43 operating factories in November 1989. The Authority has already acquired 650,000 sq. metres of land which will accommodate an additional 50 factories.

In order to encourage industrial firms, various incentives are offered to industrial firms as follows:

(1) provision of interest-free Government loans to industry in addition to loans provided by the Oman Development Bank. According to Royal Decree No.40/87, industrial interest-free loans should be settled as annual installment for a period of 10 years with a grace period of 5 years. Priority should be given to projects that aim at exporting, producing foodstuffs or these that depend on local raw materials. The maximum sum of the loan should be 100% of the paid capital in the capital area and 125%

outside the capital area. The conditions of granting loans are that at least 25% of the company's capital should be covered by public subscription; at least 75% of the project capital should be owned by Omanis during the validity period of the loan or at least 51% of the project capital provided that the project is regarded as supporting the national revenue.

(2) exemption from customs duties on imports of equipment and raw materials required for production;

(3) tariff protection through imposition of customs duties on imported goods similar to local products or prohibition or restriction of their importation taking into consideration the sufficiency of local production with regard to quantity and quality and the interest of the consumer. Protection fees on the competitive foreign products to the national products are, for instance, as follows; Bananas (25%), Seeds (20%), Dried lemons except those of GCC origin (100%), Cement similar to local products (50%), Carton boxes similar to local products (20%), Pipes (20%) and so on.

(4) exemption from all current taxes, including Income Tax or any tax which may be imposed in the future for a period of five years which could be renewed;

(5) exemption on locally manufactured products mean for export form any taxes imposed on them;

(6) Priority shall be given in granting Government lands to industrial firms;

(7) Priority shall be given in Government purchases of products manufactured by local industries, including a 10% reduction in price of the purchased product;

(8) All Government authorities concerned should facilitate the necessary procedures including immigration formalities such as entry visas, residence and work permits for expatriates;

(9) The Ministry of Commerce and Industry may agree with the authorities concerned on reducing the costs of electricity, water and fuel for industrial installations,

Table 2-5-1 shows the number of registered industrial establishments by region in the five years to 1988. Of these regions, 29% of the total number of companies were located in Batinah as of 1988.

Table 2-5-1 Number of Registered Industries by Region

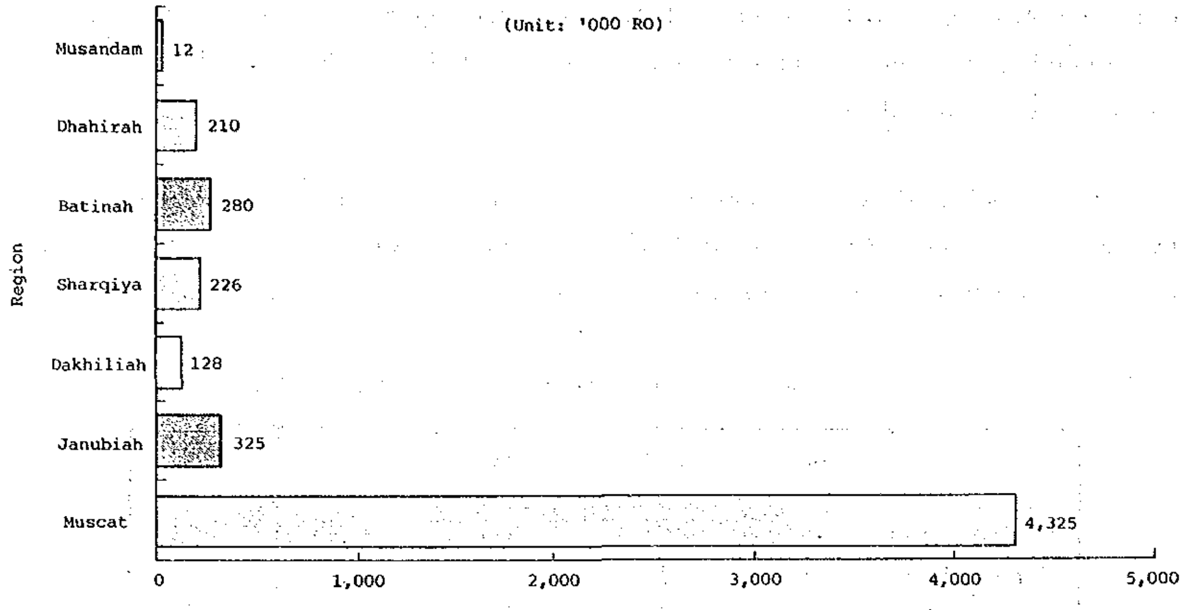
	1984	1985	1986	1987	1988
Muscat	376	422	521	653	593
Janubiah	161	200	201	216	221
Dakhiliah	226	271	324	344	374
Sharqiya	563	636	724	768	829
Batinah	536	621	792	860	921
Dhahirah	134	152	185	207	223
Musandam	11	12	12	12	12

Source: Statistical Yearbook

On the other hand, as indicated in Fig.2-5-1, 78.5% of the total capital of registered manufacturing industries in 1988 was concentrated in the Muscat Region.

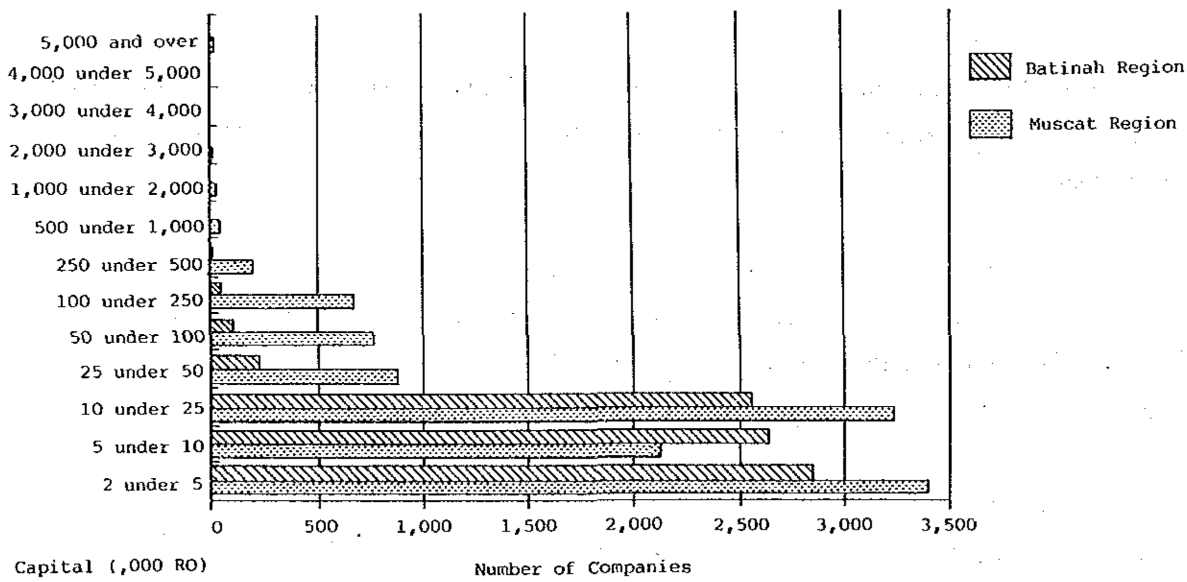
Table 2-5-2 shows the average number of workers per registered industrial establishment by region and Fig.2-5-2 shows the number of companies and establishments by capital both in the Muscat and Batinah Regions in 1988.

These data indicate that there is potential for industrial investment in the Batinah Region. However, the scale of investment is limited to small and medium-size industries at present and employment opportunities are accordingly not enough to absorb the existing labour force.



Source: Statistical Year Book

Fig. 2-5-1 Total Capital of Registered Manufacturing Industries in 1988



Source: Statistical Year Book

Fig. 2-5-2 Number of Companies by Capital at the End of 1988

Table 2-5-2 Average Number of Workers

	1984	1985	1986	1987	1988
Muscat	10.0	16.8	16.1	15.7	13.1
Janubiah	11.1	4.4	18.0	19.4	3.0
Dakhiliah	3.9	5.7	3.3	3.7	3.2
Sharqiya	3.9	3.9	3.6	3.2	3.7
Batinah	4.6	4.2	9.1	4.0	3.5
Dhahirah	5.3	5.4	3.7	5.0	2.8
Musandam	6.0	2.0	--	--	--

Source: Statistical Year Book

Table 2-5-3 shows industrial establishments with a capital investment of more than 150,000 RO in the Batinah Region.

Table 2-5-3 Industrial Establishment over 150,000 Ro in Batinah Coast

Region	Name of Company	Volume of Products	Commodity
Barkah	Al-Manuka Ice Plant	4,000 tonnes	Ice
	Said Salim Said	2,000 c.m.	Sea sand Wash
	Al-turki Cement Products	1,150,000 Tonnes	Aggregate & Sand
	G & B Oman	200,000 Tonnes	Aggregate & Sand
Mussanah	Consolidated Contractors	130,000 Tonnes	Aggregate & Sand
	Al-Bastan Corpo Diary	1,500,000 L	Laban & Yoghurt
		1,200,000 L	Ice Cream
		1,200,000 L	Fruit Juice
Suweiq	Packing Co.,Ltd.	2,000 Tonnes	Cardboard
	Al-Nasr Trade & Cont.	25,000 Tonnes	Marble
		15,000 Tonnes	Marble Chips
		31,800 sq.m.	Marble Tiles
Khabrah	Boats Manu. Co.,Ltd	300 Nos	Fishing Boats
Sohar	National Gas	8,000 Tonnes	LPG
	Abdullah Ali Al-Kashira	350,000 Tonnes	Aggregate & Sand
	Sohar Trade & Cont. Est.	120,000 Tonnes	Aggregate & Sand
	Al-Salami & Al-Kashry Td.	250,000 Tonnes	Concrete Blocks
	Oman Mining Co.	20,000 Tonnes	Copper Cathodes
		36 Tonnes	Anode Slimes
	Oman Abrasives	60,000 Tonnes	Shetblast Abrasives

Source: MOCI ;Industrial Establishment with Capital Investment more than 150,000 RO, Batinah Coast

2.6 Oil, Gas and Minig

Table 2-6-1 shows crude pertoleum production and uses over four years.

Table 2-6-1 Production and Uses of Petroleum

	1985	1986	1987	1988
Production	181.8	204.3	212.5	226.6
Uses				
Export	164.8	187.5	197.1	211.9
Sales to ORC	18.1	19.4	15.4	18.6
ORC Bunker	7.1	6.5	5.2	6.8

Unit: Millions of Barrels
ORC - Oman Refinery Company
Source: Statistical Year Book

The continuous decline in oil prices during the Second Five Year Plan period resulted in a recession of economic activities. In order to continue an economic growth in the country, various measures were applied. One such measure was to continue selling crude oil to the ORC at a price higher than the export price. As a result of this policy, the consumer prices of petroleum products have remained at the level of July 1982 until now. Super Motor Spirit, for instance, is 118 baizas per liter in the Muscat Region and 120 baizas between Saham to Falaj Al-Qabail in the Batinah Region. Not only the fixed price but also the difference of prices among regions seems to have a serious impact on future development. Table 2-6-2 and Fig.2-6-1 indicate the higher prices of various supply among GCC countries especially the UAE.

A natural gas pipeline runs from the Jibal Fields to the electric power station in Ghobra and in the Rusayl Industrial Estate in the capital area. It is also used in Oman Mining Company. The main targets of the natural gas sector are to continue the rational use of associated gas and to consider the natural gas as the principal source of energy in Oman.

The Oman Mining Company started to producte copper cathodes from 1983 and sales of the product reached 1.6 thousand tonnes in 1988. These copper cathodes are mainly exported to the Far East, namely, Taiwan (76.7%), Japan (8%) and Korea (2.9%) as of 1988.

Fig.2-6-2 shows the distribution of various minerals in Batinah based upon the data of the 1985 Economic Atlas.

Table 2-6-2 Comparison of Supply Price in the Industrial Estate

Unit: Omani Baiza

	OMAN	U.A.E.	BAHRAIN	SAUDI ARABIA	QATAR	KUWAIT
Land Rent (M^2.Year)	500	562	650	7	103	277
Electricity (Kwh)	20	8	16	5	7	2
Water (M^3)	660	354	308	188	231	242
Fuel						
Reg. Gas (l)	112	85	81	25	58	55
Super Gas (l)	118	92	103	53	61	69
Kerosene (l)	118	80	25	20	52	55
Diesel Oil (l)	114	57	71	12	58	82
Fuel Oil (l)	115	35		15		
LPG (Kg)	102	115	102	48		58
N/G (M^3)	28/29	27	6	6	2	0.6

Source: PSC

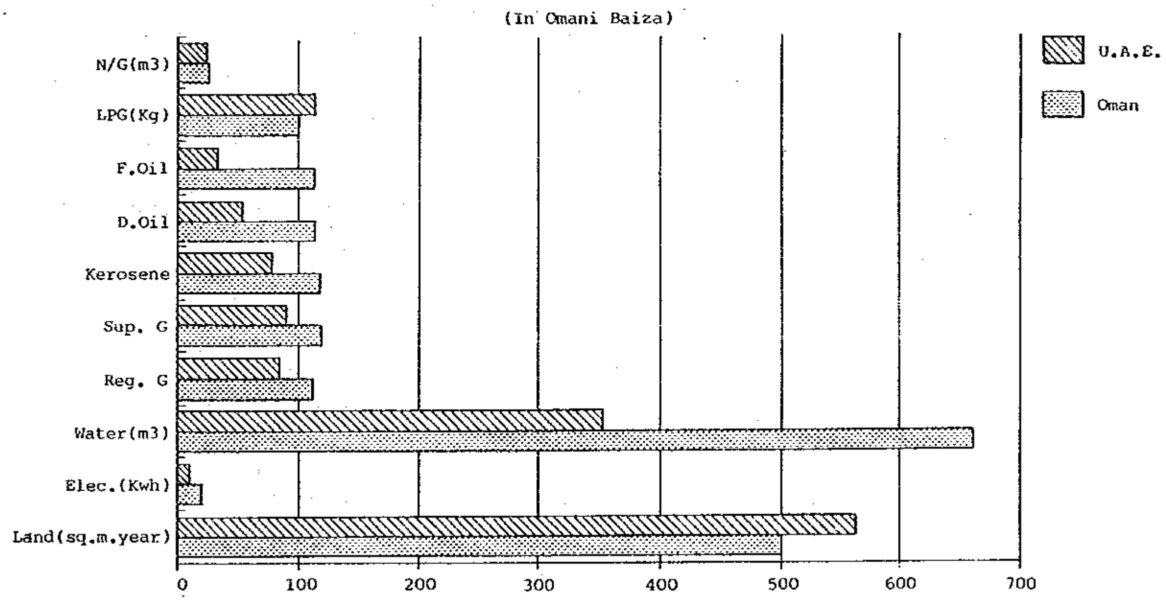
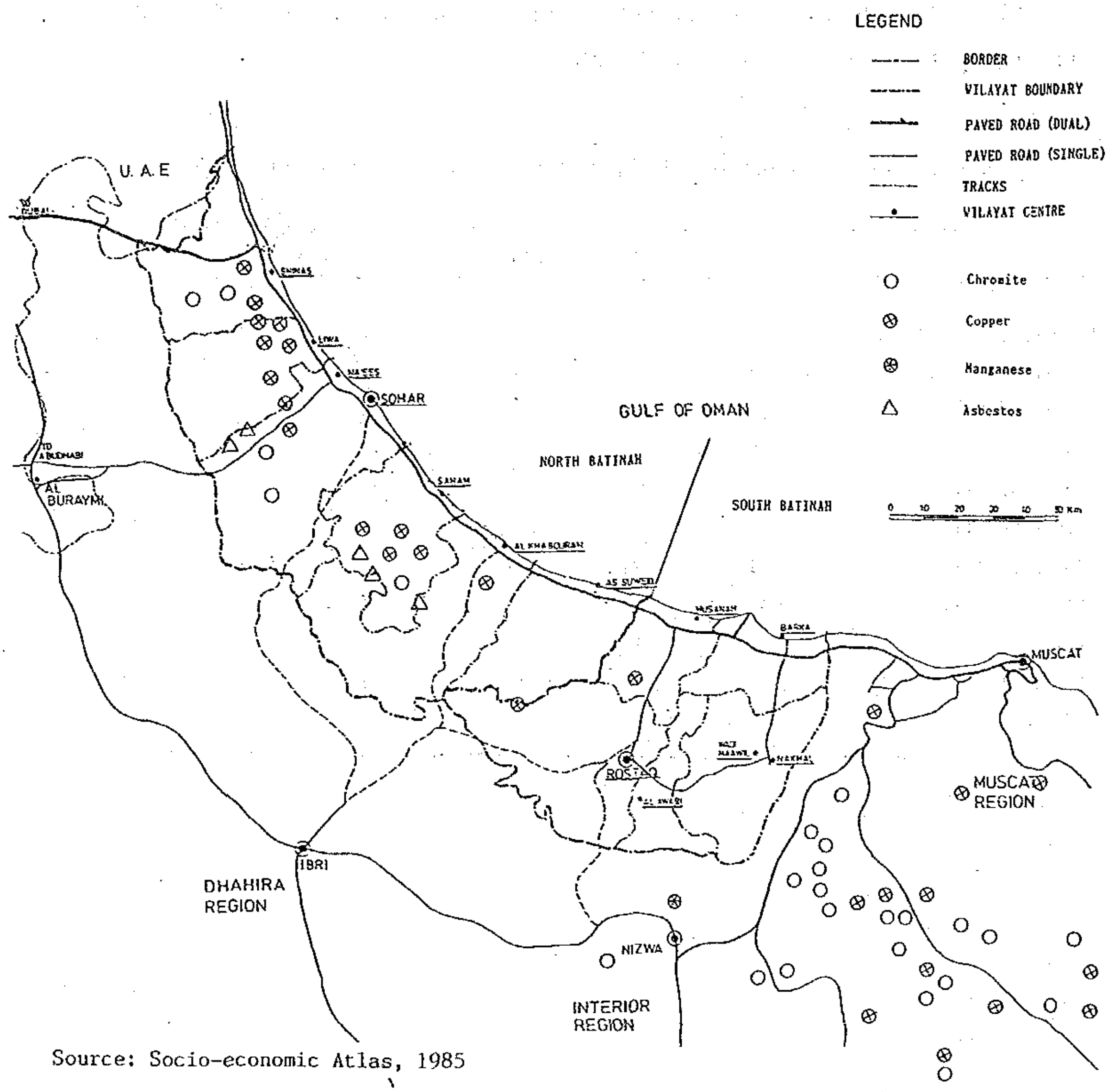


Fig. 2-6-1 Comparison of Supply Price



Source: Socio-economic Atlas, 1985

Fig. 2-6-2 Distribution of Minerals in the Northern Part of Oman

2.7 Infrastructure

(1) Water Resources

Ground water is the main natural source of water in Oman and agriculture relies on underground water through wells which are commonly used in Batinah and Southern Regions. The traditional falaj system of irrigation is used mainly in the Interior Region. However, saline groundwater from seaside intrudes into groundwater, especially in Batinah, due to to agricultural development and spreading of motor-pumps to small farm units. In order to improve the level of the groundwater, the Government is undertaking the construction of recharge and flood-control dams. The important targets of the water resources sector during the Third Five-Year Plan are, therefore, to implement a program of construction recharge dams and flood control dams and furthermore, to implement research, drilling and exploration for new natural water resources and to expand the government assistance in repair of the existing 11,000 falaj systems, canals and about 5,000 wells.

Under the Master Plan prepared by the MAF, 58 recharge dams are to be constructed in various wadis of the country to add about 80 million cubic meters annually to ground storage. Six of these recharge dams Al Kkawd, Hilti Salahi, Wadi Quriyat, Wadi Jizzi, Wadi Tanuf and Wadi Ghul have already been completed or will be soon completed. The scheme in Batinah includes construction of four dams, namely, Wadi Bani Kharus, Wadi Maawil, Wadi Rubkah and Wadi Taww.

(2) Roads

At the end of 1980, the total length of asphalt roads was 2,157 Km, of which only 55 km was dual carriageway. During the Second Five-Year Plan, a total of 281.8 MRO was invested in road construction and asphalt roads reached the length of 3,701 Km in 1985. In 1988, total length was extended to 4,247 Km, of which 401 Km was dual carriageway.

This dual carriageway is mainly located along the Batinah coast from Muscat to the border of the UAE and connected with the highway system to Dubai. Public passenger transport is available from Muscat to Dubai two times a day by the Oman National Transport Company. In addition to this, there is a single carriageway road from near Sohar to Buraimi. This road is also connected with the highway to Abu Dahbi. Fig.2-7-1 shows the road network of the northern part of Oman.

(3) Electricity

In order to cater to the growing demand for electricity, the Government has made a great effort to develop the capacity of electric power supply. The most important projects are Al Ghobra Station, with a capacity of 287 MW, and Rusayl Electricity Station, with a capacity of 500 MW. Another important project was constructed in the copper mining factory near Sohar, with a capacity of 166 MW. These stations are utilizing the natural gas though the pipeline from Yibal Gas Field. The following table shows the increase in the capacity of Government power stations.

Table 2-7-1 Installed Capacity of Government Stations

(Unit: MW)

	1985	1986	1987	1988
Muscat	536.9	537.0	787.0	787.0
Janubiah	81.3	81.3	82.0	95.7
Dakhiliah	35.4	45.0	51.0	51.2
Sharqiya	50.1	72.2	82.5	86.0
Batinah	153.8	181.3	193.4	193.4
Dhahirah	40.0	21.0	—	--
Musandam	26.5	26.5	26.5	29.4

Source: Statistical Year Book

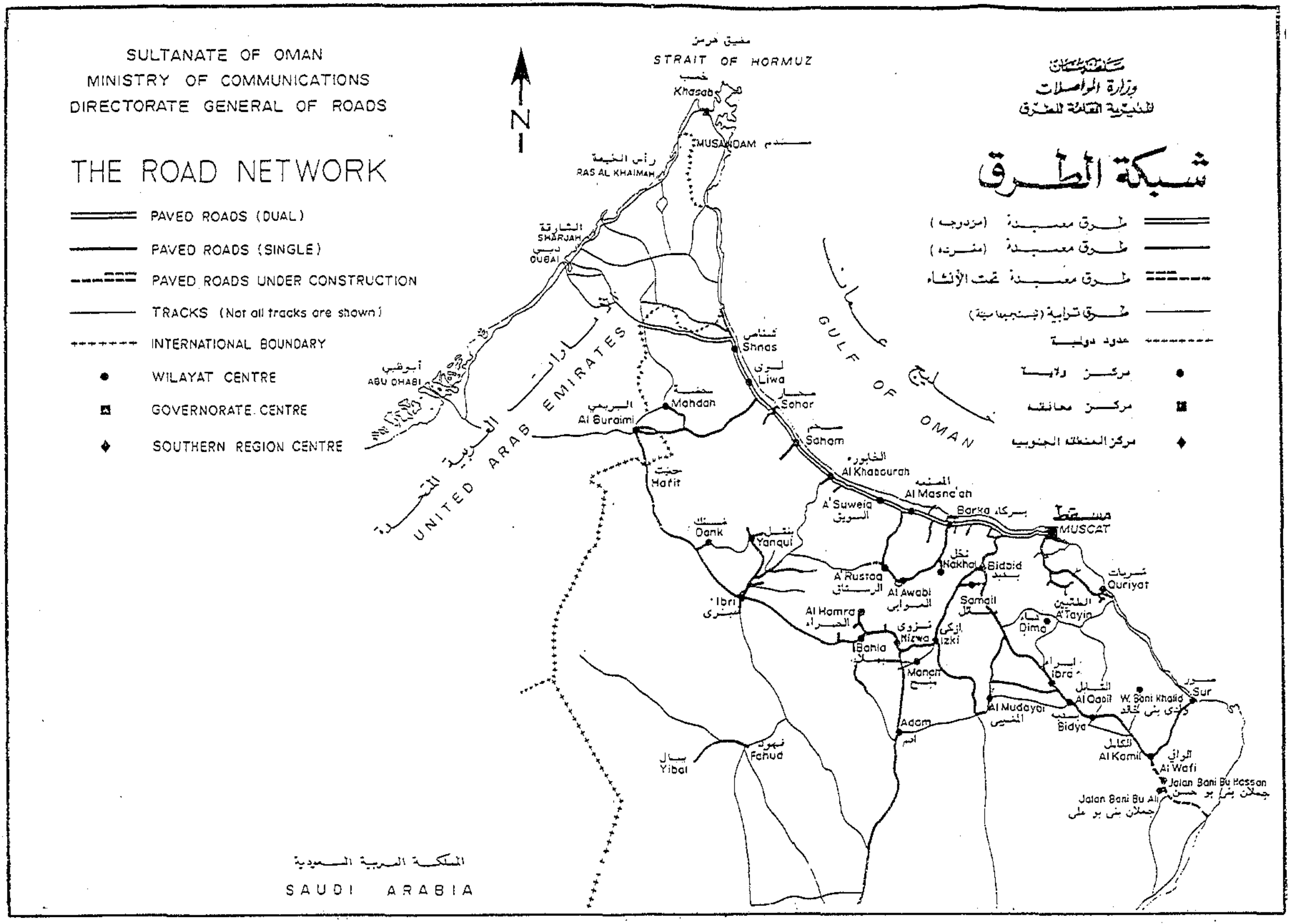
The important policies of the electricity sector are as follows:

(1) To increase the existing total capacity of power generation in the government power stations;

(2) To expand the programme of rural electrification;

(3) To continue to consider natural gas as the principal source of energy in the areas close to the natural gas pipelines;

(4) To rationalize electricity consumption.



Source: MOC

Fig. 2-7-1 Road Network in the Northern Part of Oman

CHAPTER 3 DEMAND FORECAST

Chapter 3. DEMAND FORECAST

3.1 Socioeconomic Indices

3.1.1 Present Socioeconomic Situation

(1) Population

Since no census has ever been held in Oman, estimates of the Nation's Population are based upon supposition. The population growth rate and population by age are also items for which no firm figure is available.

According to the World Bank estimates, the population was 1,242,000 in 1985 and 1,345,000 in 1987. Some Government officials say that the population of Oman at present is 2,000,000 which seems to be a little high. For planning purposes in the Development Council, the population is assumed to be 1,500,000 for 1989 and the Study Team has adopted this figure.

(2) Gross Domestic Product (GDP)

Oil production began in 1967. Before then, the economy of Oman was based substantially upon agriculture and fishing, but it was not until 1970, when Sultan Qaboos Bin Said came to power, that the income from oil was invested in the country's economic development. Subsequently, Oman's economy expanded considerably. According to estimates by the World Bank, between 1970 and 1985 the country's gross national product (GNP) increased, in real terms, by 9.5% per year.

Under the Second Five-Year Development Plan (1981-1985), at the outset of which oil prices reached close to US$ 40/barrel compared to less than US$ 13.5/barrel five years earlier, emphasis was placed on diversification of the economy, improving infrastructure and encouraging private sector activity.

At the same time, oil output was raised to nearly 500,000 b/d in order to compensate for the price decline thereafter. Oil prices declined to a level of about US$ 27/b by 1985. Between 1981 and 1985, GDP in real terms increased at an annual rate of 14.5%. The manufacturing and agriculture/fishery sectors had growth rates of 34.4% and 13.2%, respectively. The share of the oil sector in the GDP declined from 58.5%

in 1981 to 47.5% in 1985 (at current prices).

However, at the beginning of the Third Five-Year Development Plan, which continues to emphasise private sector import substitution industries, expansion of social services and improvement of agriculture and fisheries, oil prices fell to less than US$ 10/barrel (July 1986) and a consequent decline in oil revenues led to critical financial problems in the Government of Oman.

Government expenditures in 1987 were reduced by 12.3% form the 1986 level. Even though the Government decided to step up oil production from 498,200 b/d in 1986 to 582,300 b/d in 1987 and 619,100 b/d in 1988 in order to increase oil revenues, between 1985 and 1988 GDP annual growth rate in real terms was only 1.7% and nominal GDP showed a minus growth rate of -5.5%. Under these circumstances, the manufacturing and agriculture/fisheries sectors had rather high growth rates of 9.0% and 7.6%, respectively, while construction, which has suffered a severe set-back, had a growth rate of -20.1%, while government services remained at 2.0%. The share of the oil sector of the GDP declined continuously to 39.2% in 1988 (at current prices).

The annual sectoral GDP from 1978 to 1988 at current prices is shown in Table 3-1-1 and GDP at 1978 constant prices is shown in Table 3-1-2.

There is no official figure available concerning GNP. The World Bank estimated Oman's GNP per capita at US$5,830 in 1987.

Table 3-1-1 Gross Demestic Product by Sector (at Current Prices)

(Unit:Million Rial Omani)

Year	Total	Oil	Agriculture Fisheries	Manufacuturing	Consturction	Trade, Hotels, Restaurants	Real Estate, Banking, etc	Government Services	Others
1978	946.9	493.8	30.7	8.5	71.4	104.0	100.1	109.2	29.2
1979	1,289.9	719.7	40.3	11.5	86.1	137.1	123.1	137.9	34.2
1980	2,063.5	1,280.5	52.6	15.6	117.8	188.3	162.8	194.6	51.3
1981	2,490.5	1,456.1	62.1	27.0	144.9	251.3	206.6	260.5	82.0
1982	2,613.6	1,402.0	66.1	39.6	169.8	299.5	231.2	305.0	100.4
1983	2,739.9	1,370.7	80.6	49.7	187.4	315.7	250.1	360.0	125.7
1984	3,046.7	1,427.8	89.0	72.1	226.9	369.0	275.9	423.9	162.1
1985	3,453.8	1,639.1	93.7	82.3	242.2	428.0	295.9	477.9	194.7
1986	2,800.4	1,024.6	95.9	103.1	220.8	383.2	281.2	495.8	195.8
1987	3,002.6	1,362.0	105.4	111.5	137.0	327.3	260.3	509.9	189.2
1988	2,919.3	1,143.7	123.6	122.7	119.4	388.8	269.4	535.2	216.5

Source: "Statistical Year Book 1985-88" (Development Council)

Table 3-1-2 Gross Demestic Product by Sector (at 1978 Constant Prices)

(Unit:Million Rial Omani)

Year	Total	Oil	Agriculture Fisheries	Manufacuturing	Consturction	Trade, Hotels, Restaurants	Real Estate, Banking, etc	Government Services	Others
1978	946.9	493.8	30.7	8.5	71.4	104.0	100.1	109.2	29.2
1979	987.5	461.0	40.6	10.5	74.6	117.5	111.0	137.9	34.9
1980	1,047.1	438.4	49.0	12.5	91.4	139.0	125.5	144.6	46.7
1981	1,225.6	493.6	49.7	20.6	107.1	180.4	143.5	170.2	60.5
1982	1,367.1	494.9	54.1	30.2	142.3	224.6	162.4	176.6	81.9
1983	1,585.3	583.6	64.2	37.8	174.7	238.6	179.1	203.9	103.5
1984	1,850.6	623.4	70.4	55.9	221.3	286.9	215.6	235.6	141.4
1985	2,105.2	750.5	81.7	67.3	239.3	316.9	239.6	248.1	162.1
1986	2,175.2	850.7	79.1	81.0	235.4	250.5	248.3	239.1	191.3
1987	2,095.4	905.7	83.8	84.3	144.5	191.9	226.1	259.7	199.5
1988	2,215.5	974.5	101.8	87.2	122.0	210.5	227.4	263.0	229.1

Source: "Statistical Year Book 1985-88" (Development Council)

3.1.2 Future Socioeconomic Framework

(1) Population

In the absence of a census, it is impossible to correctly estimate the future population growth rate. The Study Team, therefore, adopted an annual growth rate of 3.5%, which is assumed to be that used for planning purposes in the Government.

Table 3-1-3 Population in 1995, 2000 and 2010

(Unit: Thousands)

Year	1995	2000	2010
Population	1,844	2,190	3,089

(2) Gross Domestic Product (GDP)

Since the Fourth Five-Year Development Plan is now in the course of preparation and is to be published in late 1990, there are no authorized or published figures concerning future GDP. However, after some interviews with officials of the Development Council, it was found that the GDP growth rate between 1991 and 2000 will be an estimated 5.0% per annum on condition that the oil price is US$ 18/barrel from 1991 to 1995 and US$ 20/b from 1996 to 2000. Taking this into consideration, the Study Team has estimated that the annual growth rate of the GDP of Oman will be:

i) 5.1% from 1991 to 1995
ii) 5.0% from 1996 to 2000
iii) 5.0% from 2001 to 2010

(In this estimate the growth rate of the manufacturing and agriculture/fishery sectors is more than 10%, the highest of all the sectors, while the growth rate of government services remains at 4%. The rate of inflation by sector is determined with reference to those of the past years. The price of oil is estimated at US$ 18/b in 1995, US$ 20/b in 2000 and US$ 24/b in 2010. Oil production remains at the same level as in 1988.)

The results of the estimate are shown in Table 3-1-4. (All figures are in current prices).

Table 3-1-4 Estimated GDP in 1995, 2000 and 2010 (at Current Prices)

(Unit:Million Rial Omani)

Year	Oil	Agriculture Fisheries	Manufacuturing	Consturction	Trade, Hotels, Restaurants	Real Estate, Banking, etc	Government Services	Others	Total
1995	1,440.9	238.0	240.8	156.0	617.2	373.2	699.3	305.9	4,071.3
2000	1,600.8	395.7	400.3	190.1	870.5	489.4	852.4	391.5	5,190.8
2010	1,899.9	907.0	917.7	282.4	1,731.8	841.6	1,205.9	641.3	8,427.6

3.2 Demand Forecast

3.2.1 Methodology

Two methods are used to forecast the cargo volume to be handled at ports.

The first method is to forecast the total volume as a whole by statistical correlation between the cargo volume and socioeconomic indices of the hinterland or by the past cargo volume trend (Hereinafter, this method is called the "total demand forecast").

The second method is a cumulative method which forecasts the volume of each major commodity group individually based upon the forecast of supply and demand in the hinterland or based upon analysis of the past cargo trend. The total cargo volume is then forecast by a summation of the forecast volumes for each commodity (hereinafter, this method is called the "commodity-wise demand forecast").

In this Study, both methods are used to forecast the local trade cargo (imports/exports), while only total demand forecast is applied to the transshipment cargo, of which the breakdown by commodity is not known.

The forecast of cargo volume is prepared for the years 1995, 2000, 2010 and 2015, given that the target years of the master plan of a new port and the development plan for Mina Qaboos are, respectively, 2015 and 1995-2000. The forecast in 2015 is made by extrapolation from that in 2010.

3.2.2 Premise

In this chapter the total demand for both of Mina Qaboos and a new port in Northern Oman is forecast on the premise that superior ports will be provided in Oman with enough handling capacity, high efficiency and price competitiveness.

It is assumed that the ports in Oman will be attractive to the port users and be competitive with the major ports in the UAE (e.g., Port Rashid, Jebel Ali Port, Port Khor Fakkan, Port of Fujairah and so forth) after the extension and improvement of Mina Qaboos and development of a new port. Port traffic between Mina Qaboos and a new port will be allocated later.

3.2.3 Hinterland

Taking into consideration the fact that there is no international port in Oman other than Mina Qaboos and that major imported cargoes are distributed across the country from Muscat, the Study Team has taken the whole country as the hinterland of Mina Qaboos and a new port.

3.3 Total Demand Forecast

The total demand forecast is conducted separately for import, export and transshipment cargoes.

3.3.1 Import Cargo

The total import volume of Oman is to be forecast first. After estimating what percentage of imports will enter through Mina Qaboos and a new port (hereafter this percentage is called "the share of the ports"), the cargo volume which will be handled at Mina Qaboos and a new port is forecast.

(1) Total Import of Oman

The imports of a country are closely related to its socioeconomic indices, in particular gross domestic product (GDP), or gross national product (GNP). For the purpose of analysing this correlation, GDP (or GNP) at constant prices should be used in order to remove the effects of price inflation.

In Oman, GDP figures at 1978 constant prices are available as well as at current prices. However, it can be easily determined that in the case of Oman, GDP at constant prices does not indicate the real economic situation of the country. To put it concretely, even in 1986, when the steep decline in oil prices gave a severe shock to the economy of Oman, where the Oil sector accounts for about 40% of total GDP and oil revenues account for about 80% of government revenue, GDP at constant prices showed a steady increase of 3.3% per year, although GDP at current prices plunged 18.9%.

Therefore, GDP at constant prices should not be adopted as an explanatory variable. Hence, the Study Team has adopted the summation of the following two items as GDP for regression analysis. (Hereinafter this GDP for regression analysis is called "GDP (R)")

(i) GDP of the oil sector at current prices.

(ii) Total GDP at 1978 constant prices exclusive of the oil sector.

GDP (R) and total import cargo volume of Oman between 1978 and 1988 are shown in Table 3-3-1.

Table 3-3-1 GDP (R) and Imports of Oman

(Unit: Million Rial Omani, '000 tonnes)

Year	① GDP at current prices (Oil)	② GDP at 1978 constant prices (exclusive of Oil)	GDP (R) (①+②)	Import of Oman
1978	493.8	453.1	956.9	1,584.7
1979	719.7	526.5	1,246.2	1,644.8
1980	1,280.5	608.7	1,889.2	1,960.5
1981	1,456.1	732.0	2,188.1	2,590.2
1982	1,402.0	872.2	2,274.2	3,036.8
1983	1,370.7	1,001.8	2,372.5	2,758.6
1984	1,427.8	1,227.2	2,655.0	2,852.9
1985	1,639.1	1,354.7	2,993.8	3,121.5
1986	1,024.6	1,324.6	2,349.2	2,121.8
1987	1,362.0	1,189.7	2,551.7	1,562.4
1988	1,143.7	1,241.0	2,384.7	1,524.9

Based upon "Statistical Year Book 1985-88" (DC)

The correlation between Oman's total import and GDP (R) for 1979 through 1988 can be expressed by the following equations:

$$Y = 0.9362\ X_1 - 1{,}246.68\ X_2 + 614.34$$

Where, Y : Total imports of Oman ('000 tonnes)

X_1: GDP (R) (two-year moving average)

X_2: Dummy variable (=1 from 1986 on)

$$\left[\begin{array}{l} r = 0.9624 \\ \text{F-value} = 43.9 > F(2,7;0.005) = 12.404 \\ \text{Durbin - Watson's Ratio} = 2.007 \end{array}\right]$$

Note: Taking into consideration that the economic structure and situation of Oman has changed since 1986 (oil prices are estimated to remain at a low level and the growing domestic industries like cement have come to satisfy the domestic demand to some extent), a dummy variable has been introduced.

Table 3-3-2 shows the estiated results of future GDP at 1978 constant prices by sector (exclusive of the oil sector).

Table 3-3-2 Estimated GDP in 1995, 2000 and 2010 at 1978 Constant Prices (Exclusive of Oil Sector)

(Unit:Million Rial Omani)

Year	Agriculture Fisheries	Manufacuturing	Consturction	Trade, Hotels, Restaurants	Real Estate, Banking, etc	Government Services	Others	Total
1995	164.9	144.0	143.6	271.7	274.3	299.1	281.7	1,579.3
2000	242.3	211.6	162.5	330.6	325.7	330.3	326.6	1,929.5
2010	433.9	378.9	208.0	489.3	459.5	383.3	438.9	2,791.8

Total imports of Oman in 1995, 2000, 2010 and 2015 are shown in Table 3-3-3 and the past trend and future forecast of imports of Oman are shown in Fig. 3-3-1.

Table 3-3-3 Total Imports of Oman in 1995, 2000, 2010 and 2015

(Unit: '000 tonnes)

Year	1995	2000	2010	2015
Total Imports of Oman	2,146	2,622	3,699	4,393

(2) Share of Ports

The quantity of imports by points of entry is shown in Table 3-3-4. This table shows that Mina Qaboos accounts for 40 - 60% of the country's total imports and that more than 30% of imports (almost 50% in 1985) enter by road (most of them are from the UAE, Dubai in particular).

Although Mina Raysut handles about 10% of Oman's imports, it is not likely that the share of this southern port will increase hereafter.

Dubai, which is a successful trading center and has been established as the main distribution center in the Middle East, will remain the distribution center in this region. However, taking into account that 30 - 40% of the timber and 40 - 60% of the steel imoported by Oman now enter by road, it is very likely that the percentage of imports that will enter Oman through Mina Qaboos and a new port will increase to a certain extent after

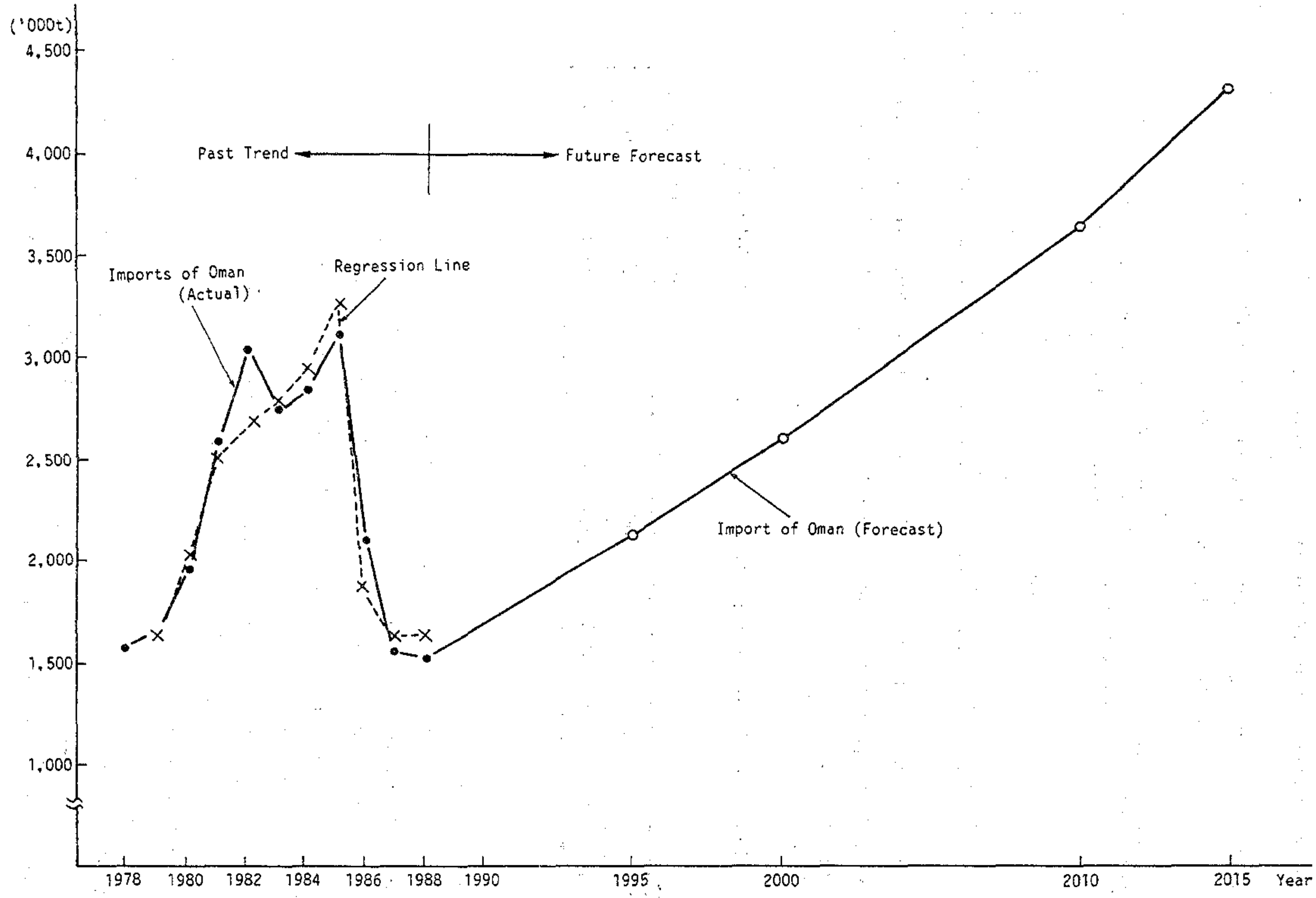


Fig. 3-3-1 Past Trend and Future Forecast of Oman's Imports

the extension and improvement of Mina Qaboos and the development of a new port. Since Mina Qaboos handled 58.3% of Oman's total imports in 1988, there is a possibility that the share of the ports will rise to 75% by the year 2000. (68% is estimated for 1995.)

Table 3-3-4 Quantity of Imports by Points of Entry

(Unit: '000 tonnes, %)

Point of Entry	1988		1987		1986		1985		1984	
I. By Seaports	1,062.0	69.7%	1,059.9	67.8%	1,188.8	56.0%	1,565.2	50.1%	1,537.2	53.9%
A. Mina Qaboos	888.2	58.3%	899.3	57.6%	997.4	47.0%	1,248.8	40.0%	1,205.1	42.2%
B. Raysut	173.5	11.4%	159.5	10.2%	190.1	9.0%	200.1	6.4%	208.7	7.3%
C. Al Fahal	0.0	0.0%	0.0	0.0%	0.0	0.0%	108.9	3.5%	119.8	4.2%
D. Other Ports	0.3	0.0%	1.1	0.1%	1.3	0.1%	7.4	0.2%	3.6	0.1%
II. By Land (on the border of)	451.3	29.6%	491.4	31.4%	916.2	43.2%	1,535.0	49.2%	1,299.5	45.6%
A. Katmat Milaha (UAE)	28.2	1.9%	54.6	3.5%	213.5	10.1%	502.7	16.1%	383.7	13.4%
B. Wajaja (UAE)	337.2	22.1%	298.4	19.1%	461.1	21.7%	857.5	27.5%	743.9	26.1%
C. Wadi Al Jizzi (UAE)	12.4	0.8%	57.0	3.6%	120.5	5.7%	40.0	1.3%	32.6	1.1%
D. Hafeet (UAE)	72.5	4.8%	76.2	4.9%	118.3	5.6%	128.2	4.1%	137.0	4.8%
E. Others	1.0	0.1%	5.2	0.3%	2.8	0.1%	6.6	0.2%	2.3	0.1%
III. By Air	10.7	0.7%	11.2	0.7%	16.8	0.8%	21.3	0.7%	16.2	0.6%
A. Seeb	7.1	0.5%	6.2	0.4%	10.4	0.5%	15.5	0.5%	10.8	0.4%
B. Salalah	0.2	0.0%	0.3	0.0%	0.3	0.0%	0.5	0.0%	0.8	0.0%
C. Others	3.4	0.2%	4.7	0.3%	6.1	0.3%	5.3	0.2%	4.6	0.2%
Total	1,524.0	100%	1,562.5	100%	2,121.8	100%	3,121.6	100%	2,852.9	100%

Source: "Quarterly Bulletin on Foreign Trade Statistics, June 1989" (Development Council)

The import cargo volume that will be handled at Mina Qaboos and a new port in 1995, 2000, 2010 and 2015 is shown in Table 3-3-5:

Table 3-3-5 Import Cargo Volume in 1995, 2000, 2010 and 2015

(Unit: '000 tonnes)

Year	1995	2000	2010	2015
Cargo volume	1,459	1,967	2,774	3,295