6.0

PROFILE OF GUJARAT STATE

6.0

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6.1 Location

The state of Gujarat which came into existence as a seperate State by bifurcation of erstwhile Bombay State, on 01-05-1960 is located in western part of India between 20° 6' N to 24° 4' N Latitude and 68° 10' E to 72° 28' E longitude.

It is bordered by the Arabian sea on the west, Pakistan on the north, Rajasthan and Madhya Pradesh on the north-east and Maharashtra on the south.

6.2 Area

Total geographical area of the state is 1,95,984 Sq.Km (19.6 Million ha.) which is 5.98% of country's total area(Area wise, it is the Ninth largest State in the Country). North to south length of the state is 600 Kms and east to west breadth is 500 Kms. Of the total geographical area, nearly 86680 sq km is covered by alluvial deposits and 1,09,394 Sq.Km. is covered by hard rock formations. About 2300 Sq.Km. area is under the effects of desert and 32024 Sq.Km. under the effect of salinity.

It is one of the important maritime states and has approximately 1600 km long coastline extending from Lakhpat in Kutch to Umargaon, Valsad in south which is 1/3 of country's total coastline. Out of this Saurashtra and Kutch has got about 1125 Km. coastline. 20912 Sq.Km. area is tribal and 53860 Sq.Km. is drought prone. Out of total state area only 13% area is suitable for drilling tube wells to tap potable water. Area under forest is 1.9 Million Ha. (10% of total area).

6.3 Population

As per 1991 census, the population of state is as under.

Total Population	41.20 million (4.88% of country's population.)
Decannial growth rate is	21.19 percent
Male	21.3 million
Female	19.9 million
Rural	65.50 percent
Urban	34.50 percent
Tribal	7.41 percent
Scheduled cast	4.92 percent
Effective literacy rate	Total - 61.29 percent
(excluding children of	Male - 72.54 percent
age group 0-6 years)	Female - 48.80 percent
	Rural - 53.09 percent
	Urban - 76.54

It stand at 9th number in the country for literacy rate.

It is the 10th largest state in the country with an average population density of 221 souls per Sq.Km. It is also the second most urbanised State in the country with 34.4 percent of its population living in urban areas.

6.4 Administrative set up

Administrative set up of the state is as under.

- Districts 19
- Talukas(Blocks) 184
- Villages 18275
- Towns 264
- Towns with population
  - > 1,00,000 21
  - > 5,000 37

Ahmedabad is the largest city with population of 2.2 Million. **Gandhinagar** is the capital of state which is newly built city situated 30 Km away from Ahmedabad.

6.5 Physiography

The state can be devided into five major physiographical groups as under.

- Hilly tracts covering eastern parts of the state and parts of Saurashtra and Kutch (300 to 1400m).
- Alluvial plains extending from Banaskantha in the north to Bulsar in the South. (20 to 150m).
- Upland of Saurashtra and Kutch (150 to 500m).
- The low lying saline coastal tracks (3 to 20m).
- The marshy and saline desert of Rann of Kutch.

The Sahyadri range (western ghat) occupies south eastern portion of the state forming parts of Dangs, Valsad and Surat districts.The satpura range forms the devide between Narmada and Tapi basins extending upto Bharuch district. Where as the Vindhyan range enters into the state of Gujarat in the eastern part of the Vadodara and Panchmahals districts and disappears into the plains of south Gujarat further west. The extention of Aravalli range spreads into Sabarkantha and Banaskantha districts. The rest of the state is a plain or undulating country with few isolated hills of Deccan besalts (Girnar, Pavagadh, Chotila etc.) and sandstone in Surendranagar and Kutch districts.

6.6 Climate

The climatic conditions over the state are mainly influenced by monsoon and subsequently by physiography. Climatically major parts of the state falls in sub-humid and semi-arid climate

merging in arid zone in the northern and north-western extremeties. The temperature in the state varies from 0°C in winter to 45°C in summer. The average temperature is 18.5°C.

6.7 Rainfall

The spatial distribution of rainfall is quite uneven. It is maximum in Southern part which gradually decreases towards north and north west part of the state. Indian Meteorological Department (IMD) has devided Gujarat into two climatic Sub-divisions, (a) Gujarat and (b) Saurashtra. The mainland Gujarat comprising twelve districts receives an average 97 Cm of rainfall in a year while Saurashtra region comprising of seven districts receives only 48 Cm of rain. Observations over last 50 years have shown that average rainfall in Kutch was 34 Cm and 180 Cm in Dangs. The number of rainy days in general also vary from 70 in South Gujarat to 10 in Kutch. The rainfall dependability varies from 70% in the south to 40% in North.

The north - western parts of the state are cronically drought prone where the erratic behaviour of rainfall results in frequent droughts.

6.8 Geology

The state can be devided into three major geographical units considering the geology of the region.

6.8.1 The Gujarat mainland

The Gujarat mainland comprises of extensive alluvial plains flanked by hilly terrain in the east. The thickness of the alluvial formation varies from 3.5 m. to 500 m. trending from north east to south west. This main land is formed of the successive deltaic plains by the deposition of Tapi, Narmada, Sabarmati and Banas rivers.

6.8.2 The Saurashtra peninsula

The Saurashtra peninsula is composed of besaltic rock of upper cretaceous age. The central part of the Saurashtra peninsula is elevated, hence the drainage is radial. The coastal part of the region is composed of lime stone of Gajbeds, which has facilitated the sea water intrusion through the cavities.

6.8.3 Kutch

Kutch is a centrally high plateau surrounded by dissected plateau and flat topped hills on all sides except east. This is of Jurrasic age. The Rann of Kutch is the remnant of a very late marine transgression which is undergoing rapid siltation.

The main geo-hydrological features of Gujarat are summarised in **Table 6.1**

6.9 Minerals in Gujarat

There are a good variety of minerals in the State. The minerals in the state are largely concentrated in the peripheral areas. The State occupies a prominent position in minerals map of India. A brief account of some of the important minerals occuring in the State is given in

Table 6.2. Since the minerals stata in the soil has got direct impact upon ground water percolating through them. It is therefore necessary to know the type of minerals occuring in the state and there locations.

6.10 Soils

The All India Soil and Land Use Survey Organisation has classified the soils in Gujarat into 7 groups as follows :

6.10.1. Black Soils

They are derived mainly from basalts but the Cretaceous sedimentary rocks and some meta-sediments and granites also give rise to these soils. Even in alluvial areas, in the inter dunal valleys and in shallow grounds, due to collection of organic waste, thin covers of black cotton soil are formed. Texture is clayey loam to clayey and reaction is neutral to alkaline.

6.10.2. Alluvial Soils

Very deep and of uniform nature. Vary from sandy to clayey loam. The permeability rate is very high to medium, depending upon texture. They are further sub-divided into coastal alluvial soils, alluvial sandy soils and alluvial sandy loam soils.

6.10.3. Saline-Alkaline Soils

These soils are formed due to sea water inundation and found all along the coast and in the low lands between Gulf of Kachchh and Gulf of Khambhat.

6.10.4. Desert Soils

These sandy to sandy loam soils are found mainly in Rann areas. The content of sodium chloride is very high.

6.10.5. Hilly Soils

Mainly erosional soils, light in nature and comprise washed away material along gentle valley slopes and foot hill regions.

6.10.6. Forest Soils

Soils with high organic matter, occurring in about 10% area (forest area). Texture is caly to clayey loam. Junagarh forest soils are neutral while Dangs forest soils are acidic.

6.10.7. Lateritic Soil

Found mainly on laterite and bauxite cappings of Kachchh and Saurashtra regions and in plateau regions of Dangs.

Out of this, the first four groups comprise major areas whereas the occurrence of last three are sporadic.

Most of the sourthen mainland has deep black soils. The central mainland has sandy loam soils in the Western parts and medium deep black soils in the eastern parts. The soils of the northern mainland range from sandy alluvium in the hilly areas along the Rajasthan border to sandy loam at the lower elevations. Coastal alluvium dominates along the bay of Cambay.

Along the Gulf of Cmabay and the Arabian Sea, coastal alluvium predominates while the soils along the Gulf of Kutch are sandy alluvium. The soils in kutch are generally derived from sandstones and lime stone and are coarse in texture with satisfactory internal drainage.

6.11 Hydrology

The state can be divided into three distinct hydrological groups.

6.11.1 Eastern hilly tract

The Eastern hilly tract occupied the Eastern and Southern part of the State. The area is highly undulating and major rainfall goes as runoff from the area. The ground water accumulates only in joint planes, cracks and fissures. The rocks at places are highly disturbed and fractured . The secondary porosity developed at some places. The rocks from the basement beneath the younger alluvial and secondary formation which constitute principal aquifers in the State. The basement rock out-crops in the Eastern hilly region are transmitting ground water by under flow along contact planes and out-crop areas of aquifers. The water level in this tract ranging between 10 to 15 m below ground level

6.11.2 Peninsular area of Saurashtra and Kutch

The western part of Gujarat is mainly occupied by Deccan trap basalt in Saurahtra, South Gujarat and Kutch regions. Deccan trap rocks in Saurashtra are either exposed or covered with thin alluvial layers. These rocks yield moderate quantity of ground water through open wells. The permeability of lava flows is low and varies widely. The younger basalts gives better yield in wells in camparison to older basalt, which is more compact. The zone of weathering of two successive flows forms ground water bearing horizons. Thickness of the individual flow varies in trap and as many as twenty flows are noticed within the depth of 100 to 150 m. The gases which escaped during the cooling of magma have formed vesicles and created the secondary porosity in the formation. There is a wide variation in the ground water yield factors the trap rack since it largely depends on the degree of weathering and saturated thickness of the formation. The water level in the formation varies between 15 to 30 m. below ground level

6.11.3 Alluvial tract

The alluvial tract extend from Banaskantha in north to Balsad in south. The deposits consist of well sorted fine to course grained material. Major number of deep tube wells are drilled in this tract and ground water exploitation is mainly confined in this alluvial zone. The contact between the eastern hilly areas and alluvial is well demarcated from north to south and is known as recharge area for deeper aquifers of central Gujarat. In this recharge area the thickness of alluvial ranges between 30 to 50 m. which increases towards south west, i.e. towards the discharge area where ground water occurs under semi-confined and confined condition. The explored thickness of

alluvial in this area is about 400 m. The water level ranges between 30 to 100 m. The deepest water level is in the central part of Mehsana district and in Ahmedabad city.

6.12 Aquifer characteristics

Broadly in Gujarat State, the aquifer system could be divided into two categories as under

- the hard rock aquifer and
- the alluvial aquifers

In turn, alluvial aquifers occur both under confined and unconfined conditions. The water table contours generally follow the pattern of the surface topography and in the alluvial plains of Gujarat, the ground water movement is from North-East to South West. Where as, in the region of Saurashtra, the ground water movement is of radial pattern. The occurrence of ground water in phreatic and confined aquifer conditions provide water at different depths with different yield and quality. The seasonal fluctuations in the water table are of the order of 2 to 3 meters.

6.13 Occurrence of ground water

Physiographically Gujarat can be divided into four distinct zones. Saurashtra; Kutch, North Gujarat and South Gujarat. Ground water conditions depend mainly upon physiography, geology, rainfall and extent of ground development. Ground water generally follows the topography of the area. Water level measurements of observation wells indicates that there is a wide variation in water levels due to a variety of factors like, occurrence of different geological formations, occurrence of different types of soil, variation in level ground water development, variation in topography, variation in rainfall and variation in ground water withdrawal.

Ground water conditions in the different zones can be briefly described as below.

6.13.1 Saurashtra Region

This region has a dome like structure and is composed of hard and massive rock where water can be found along fissures in nooks and crevices. Drainage is of radial type. Ground water is drawn through open wells, dug-cum-bore wells and borewells. Observations have shown that there is a slow and steady decline in water levels. The average decline for the period 1979 to 90 is 0.5 meters per year (Maira).

6.13.2 Kutch Region

This region also has a dome like structure and radial drainage. The rainfall is very poor and erratic. Most parts of the region have highly saline soils not suitable for ground water development except in central part of sand stone formation which is productive and suitable. Drinking water has to be transported through pipelines over long distance to areas outside the sandstone belt. A fall in water levels ranging from 1.0 to 2.0 m.. has been recorded.

6.13.3 North Gujarat Region

This region is formed of alluvium which is composed of alternative bands of sand and clay. Ground water is drawn through deep tube-wells. Water level measurements of deep tube-wells indicate a high decline of the order of over 3 meters per year. The main reason is overdrawal leading to a serious deterioration in water quality with large areas showing effects of high fluoride concentration. The northen and eastern borders of this region are semi-hilly and contiguous to the desert areas of Rajasthan where there is a virtual absence of sustainable and potable sources of ground water.

6.13.4 South Gujarat Region

This region has entirely different hydrological conditions due to the existence of perennial rivers and major dams. Apart from large scale availabilityof surface irrigationn, there is also an incidence of high rainfall leading to constant replenishment of ground water.

It can easily be seen that althrough the major part of Gujarat is dependent on groundwater for its requirement of drinking water, the position is not very comfortable because of dropping water levels and deteriorating water quality.

Ground water occurrence in Gujarat is given in the table 6.3.

The total ground water recharge in the State is 3844 million m^3.

6.14 Drainage

Narmada, Tapi and Mahi are the parenniel rivers of the state. Except these three rivers, all other rivers in the eastern part of the state originate on the western slopes of eastern hilly tracts. The rivers of North Gujarat disappears into the low lands of the Little Rann of Kutch, where as rest of the rivers join the Gulf of Cambay and the Arabian sea. The rivers of Saurashtra and Kutch have radial pattern.

The rivers of Gujarat are as under :

Major rivers	Narmada, Tapi, Mahi and Sabarmati
North Gujarat	Banas, Saraswati, Rupen and Hathmati
Cenral Gujarat	Vatrak, Mazam, Meshvo, Shedhi, Dhadhar and Viswamitri
South Gujarat	Minthola, Purna, Ambica, Par and Damanganga
Saurashtra	Machchu, Aji, Bhadar, Shetrunji and Bhogavo
Kutch	Rukmavati, Kharod and Bhukhi.

The average annual discharge of the three major rivers is as follow.

Narmada	-	18 million m^3
Tapi	-	18 million m^3
Mahi	-	8.6 million m^3

Total surface water resources of the state excluding Narmada basin are estimated at 46050 million m^3, of which the utilizable water resources are only 15,360 million m^3. The Narmada

Water Tribunal has allocated utilizable quantum of 11101 million m^3 to the State. Thus the total utilizable water resources will be 26,461 million m^3.

6.15 Industries

Gujarat ranges first among all States in industrial development.

- No. of working industries - 15200 (1992)
- No. of employees engaged - 7.77 million
- Productive capital - Rs. 11,348 crores
- Value of output - Rs. 24,080 crores
- Percent share of major industries

Type	%age
Chemical	12.2
Mining	11.1
Machinery	9.2
Metallurgy	8.4
Food Products	7.8
Cotton Textiles	7.6

6.16 Electricity

- Installled capacity (1993-94) 4891 MW
- Consumption by Industries 42.28%
- Consumption by Agriculture 38.53%
- Villages electrified (Number) 17985

6.17 Agriculture

- Net area sown 9.47 million Ha. (50.32%)
- Crop production (1993-94) 5.41 million ton
- Net cropped area per agricultural worker(1986-86) 1.42 Ha.
- Fertilizer consumption 0.72 million ton
- Total Live stock 19.7 million

6.18 Irrigation

- Net area irrigated 2.46 million Ha.
- Gross area irrigated 2.90 million Ha.
- Gross cropped area 1.07 million Ha.
- Percentage of gross irrigated area to gross cropped area(1985-86) 22.81

6.19 Socio-Economic Indicators (1993)

- Gujarat's economy is primarily based on agriculture which accounts for more than 40% of the State's income.
- Per capita income (1989-90) Rs 5405.00
- Per capita own tax revenue (88-89) Rs 455.00
- Net value added per amployee in factories (1986-87) Rs 37594.00
- Total Net State Domestic products Rs. 32,240 Crores
- Per capita Net State Domestic products Rs. 7,586
- Main workers 34.12% (22.9% Agri. workers)
- marginal workers 6.11%
- Infant mortality rate 67 per 1000 live births
- Hospital beds per 1 lakh population 179 (1992)
- Incidence of poverty 18.4% (1987-88)

6.20 References

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Table 6.1

Geo-hydrological features of Gujarat.

Sr. No.	Type of area	Sq. m.	% of area
1.	Rocky	93,302	47.6
2.	Probable recharge	3,815	1.9
3.	Suitable for Tube well construction	25,488	13.0
4.	Over developed	6,160	3.1
5.	Saline (Lime - stone)	1,550	0.8
6.	Saline (Sea coast)	43,095	21.98
7.	Low discharge (Shallow Tube well)	12,942	2.7

Table 6.2

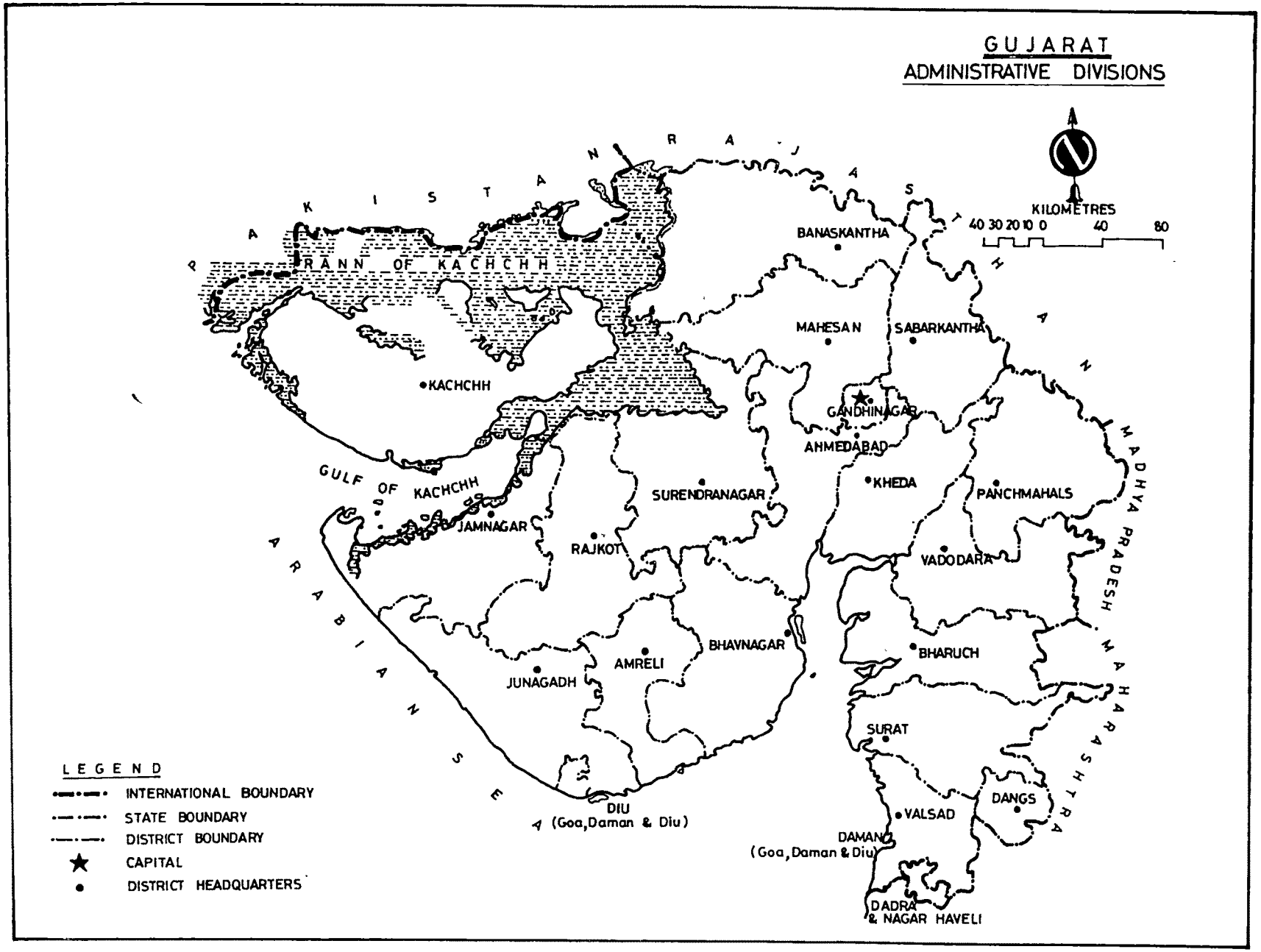
Important minerals occuring in Gujarat.

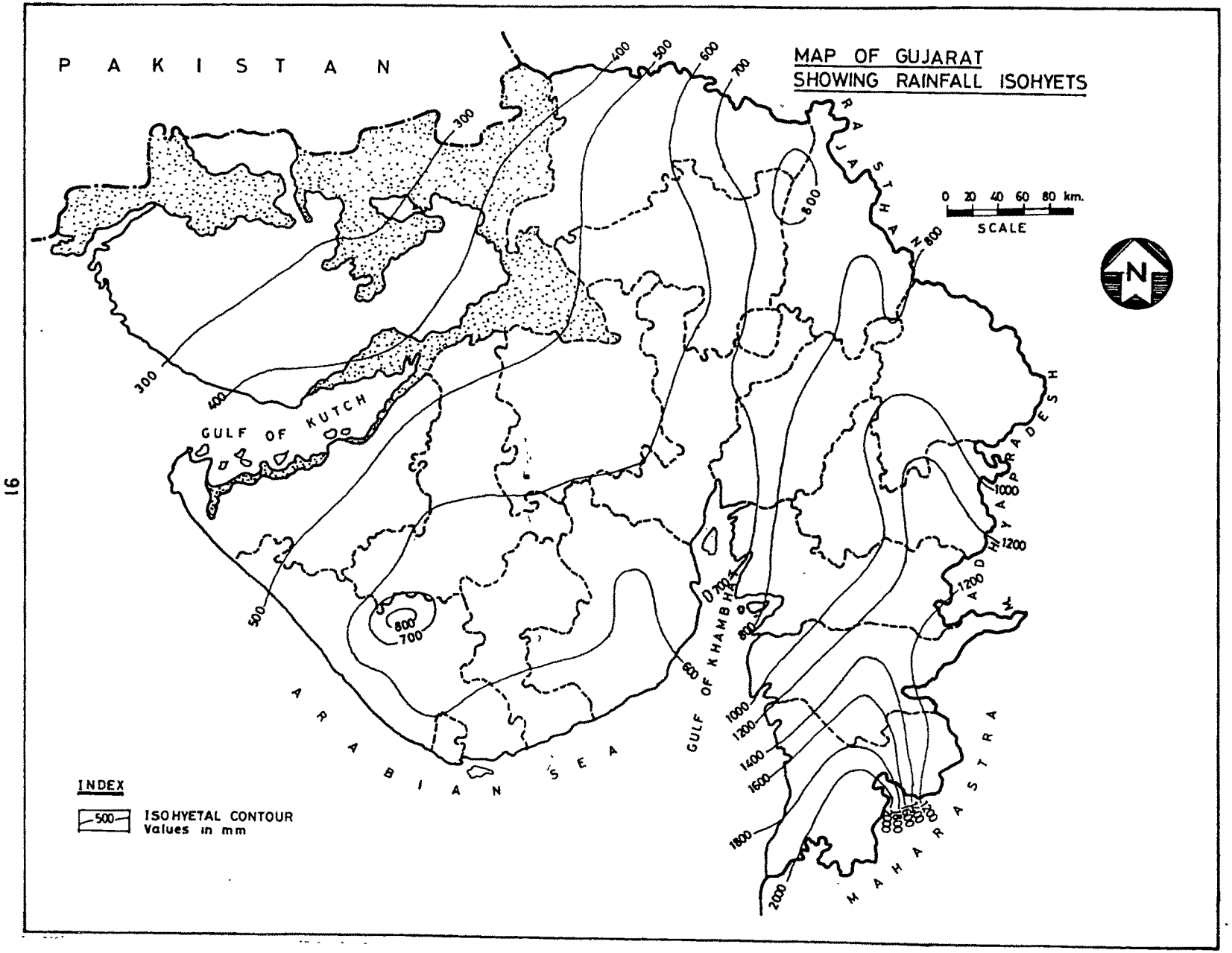
Sr No	Type	Chemical Composition	Location
01	Limestone	Calcium Carbonate ($CaCO_3$)	Kutch, Kheda, Amreli, Sabarkantha, Banashkantha, Junagadh
02	Dolomite	Calcium & Magnasium Carbonate Ca - Mg (CO_3)	Vadodara, Bharuch
03	Bauxite	Alluminium Oxide (Al_2O_3)	Kutch, Jamnagar, Kheda, Amreli, Junagadh, Sabarkantha, Bhavnagar, Valsad
04	China Clay	Aluminium Silicate ($Al_4Si_4O_{10}$)	Sabarkantha, Mehsana
05	Bentonite	Aluminium Silicate (Al_2O_3, $SiO_2(Ca,Mg)O$)	Kutch, Jamnagar, Rajkot, Bhavnagar
06	Base Metals	Salts of Copper(Cu) Lead(Pb) Zinc(zn)	Banaskantha(Ambaji)
07	Fluoride	Calcium Fluoride CaF_2	Vadadora
08	Chalk	Calcium Carbonate $CaCO_3$	Junagadh, Bhavnagar, Jamnagar, Kutch
09	Graphite	Carbon (C)	Panchmahals, Vadadora
10	Calcite	Calcium Carbonate $CaCO_3$	Jamnagar, Amreli, Bharuch, Junagadh

Table : 6.3

Ground water Occurrence in Gujarat

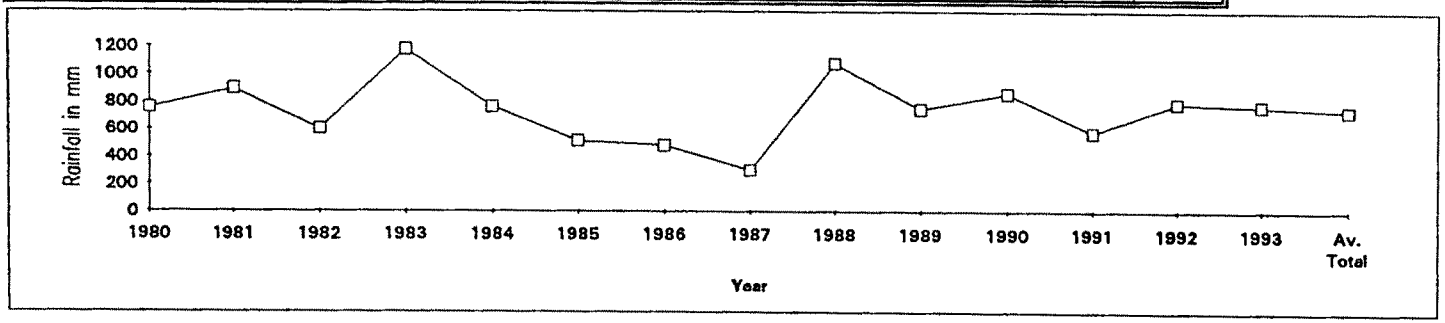
No.	Aquifer type	Hydrogeological Parameters Alluvial (Granular)	Hydrogeological Parameters Rocky(Consolidated)
A	Unconfined		
	Depth (m)	10 - 100	50 - 250
	Yield (lpm)	100 - 1000	100 - 250
	TDS(ppm)	500 - 6000	500 - 2000
B	Confined		
	Depth (m)	50 - 500	50 - 250
	Yield (lpm)	500 - 3000	500 - 1500
	TDS(ppm)	1500 - 4000	500 - 2000


GUJARAT
ADMINISTRATIVE DIVISIONS
KILOMETRES
40 30 20 10 0 40 80
PAKISTAN
RAJASTHAN
MADHYA PRADESH
MAHARASHTRA
ARABIAN SEA
RANN OF KACHCHH
BANASKANTHA
MAHESAN
SABARKANTHA
KACHCHH
GANDHINAGAR
AHMEDABAD
GULF OF KACHCHH
SURENDRANAGAR
KHEDA
PANCHMAHALS
JAMNAGAR
RAJKOT
VADODARA
BHAVNAGAR
BHARUCH
AMRELI
JUNAGADH
SURAT
DANGS
VALSAD
DIU
(Goa, Daman & Diu)
DAMAN
(Goa, Daman & Diu)
DADRA
& NAGAR HAVELI
LEGEND
INTERNATIONAL BOUNDARY
STATE BOUNDARY
DISTRICT BOUNDARY
CAPITAL
DISTRICT HEADQUARTERS


MAP OF GUJARAT
SHOWING RAINFALL ISOHYETS
P A K I S T A N
R A J A S T H A N
M A H A R A S T R A
M A D H Y A P R A D E S H
GULF OF KUTCH
GULF OF KHAMBHAT
A R A B I A N S E A
0 20 40 60 80 km.
SCALE
N
INDEX
500 ISOHYETAL CONTOUR
Values in mm

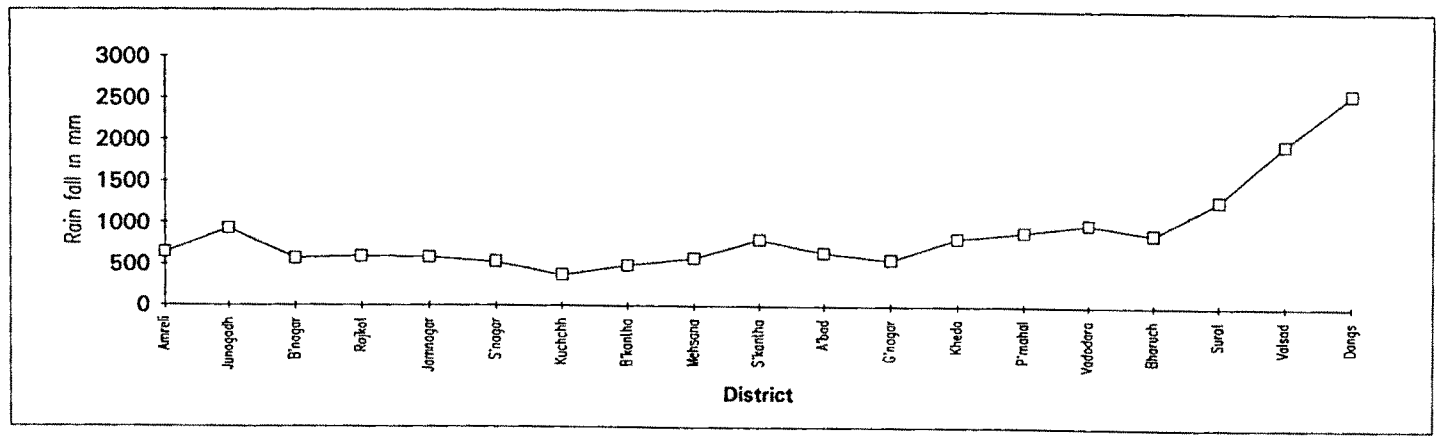
Year wise average rainfall (in mm) - Gujarat State

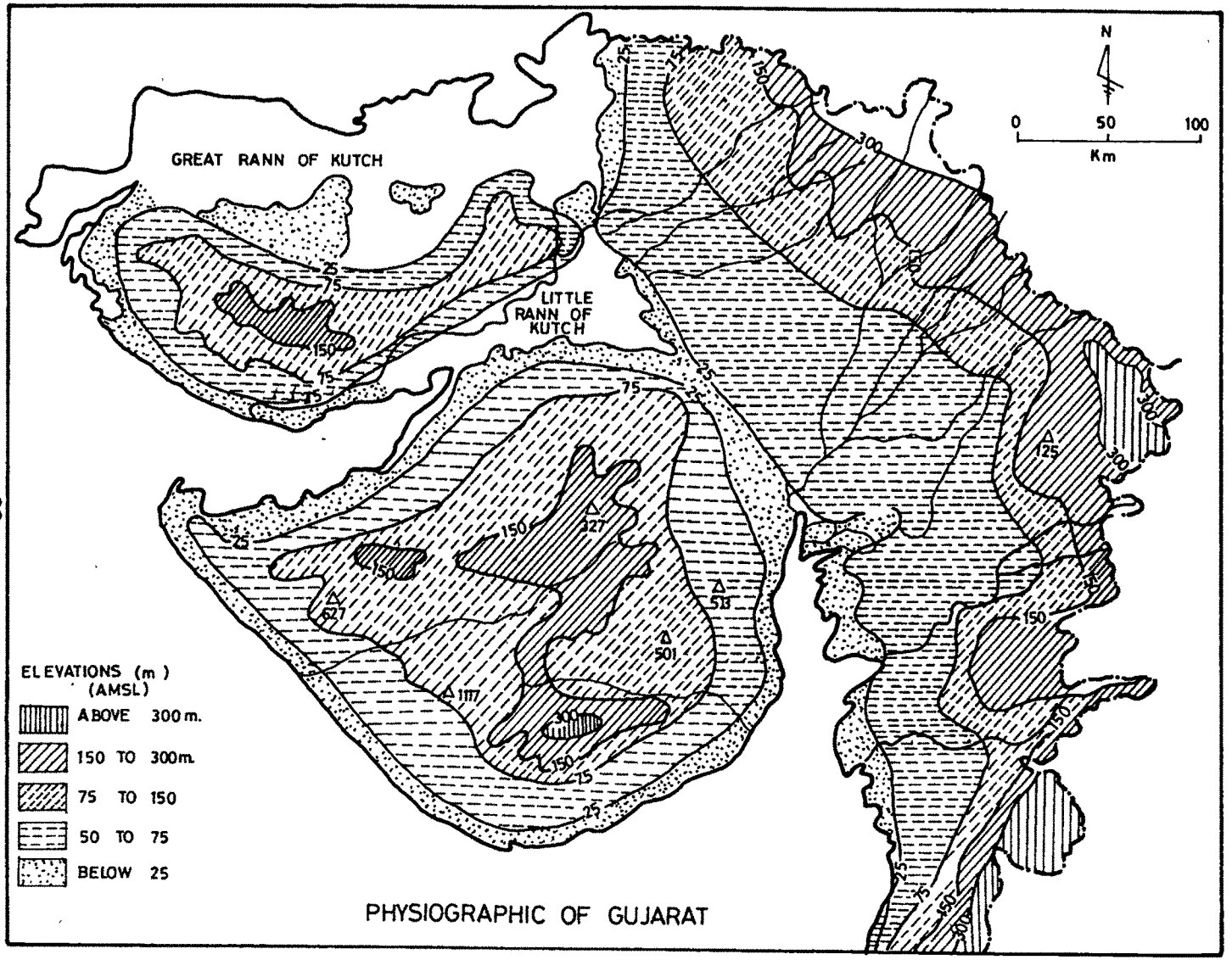
Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Av. Total
Rainfall (mm)	755.81	892.49	598.48	1176.51	761.11	513.45	483.16	299.57	1076.42	745.47	862.34	576.63	789.27	769.74	735.75

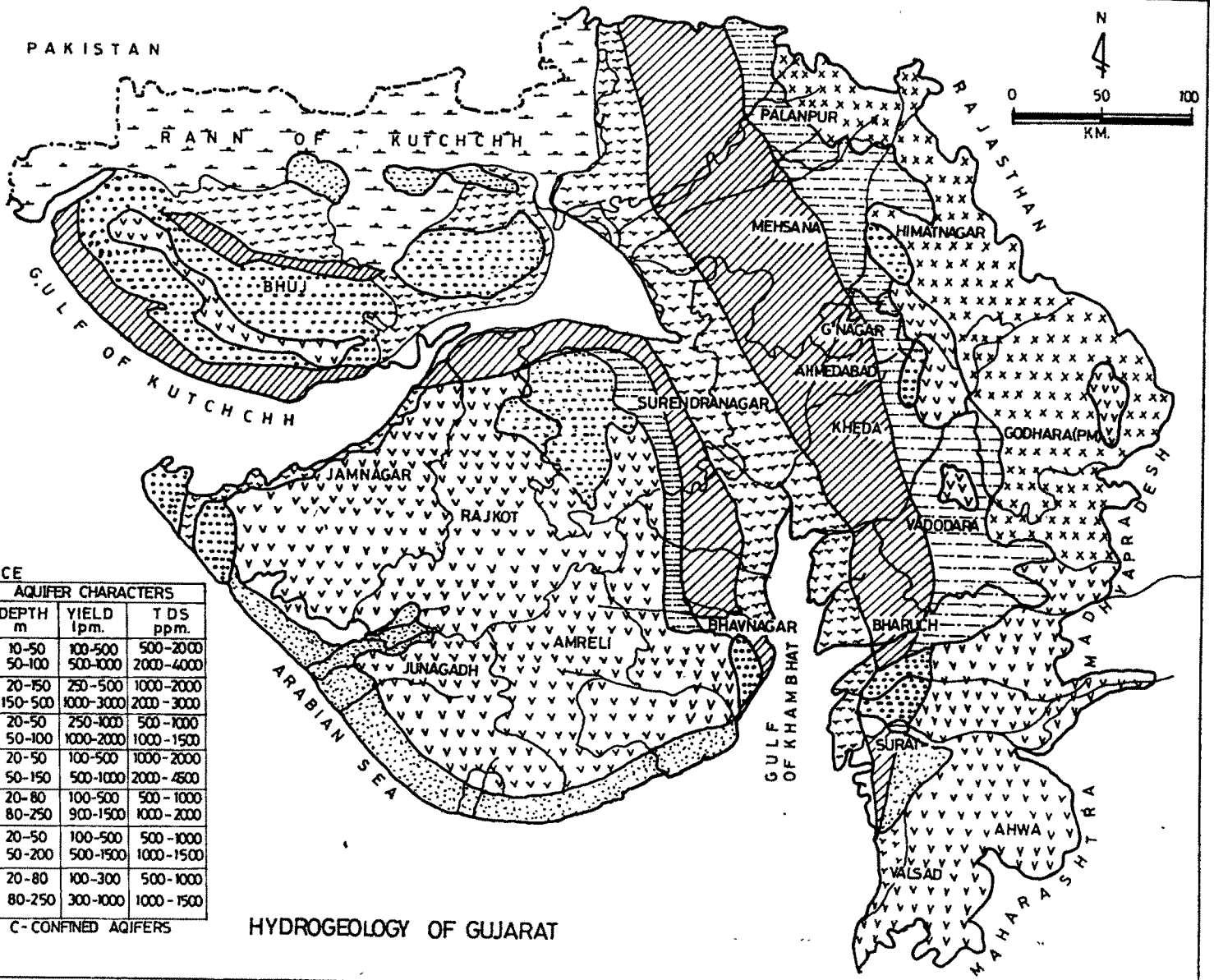


District wise average Rainfall (in mm) - Gujarat state

Amreli	Junagadh	B'nagar	Rajkot	Jamnagar	S'nagar	Kuchchh	B'kantha	Mehsana	S'kantha	A'bad	G'nagar	Kheda	P'mahal	Vadodara	Bharuch	Surat	Valsad	Dangs
641.68	933.68	576.73	593.38	589.74	531.93	371.18	490.15	578.01	804.01	649.21	561.08	822.82	899.71	999.09	878.03	1286.04	1965.87	2577.4




N
0
50
100
Km
GREAT RANN OF KUTCH
LITTLE RANN OF KUTCH
ELEVATIONS (m) (AMSL)
ABOVE 300 m.
150 TO 300m.
75 TO 150
50 TO 75
BELOW 25
PHYSIOGRAPHIC OF GUJARAT

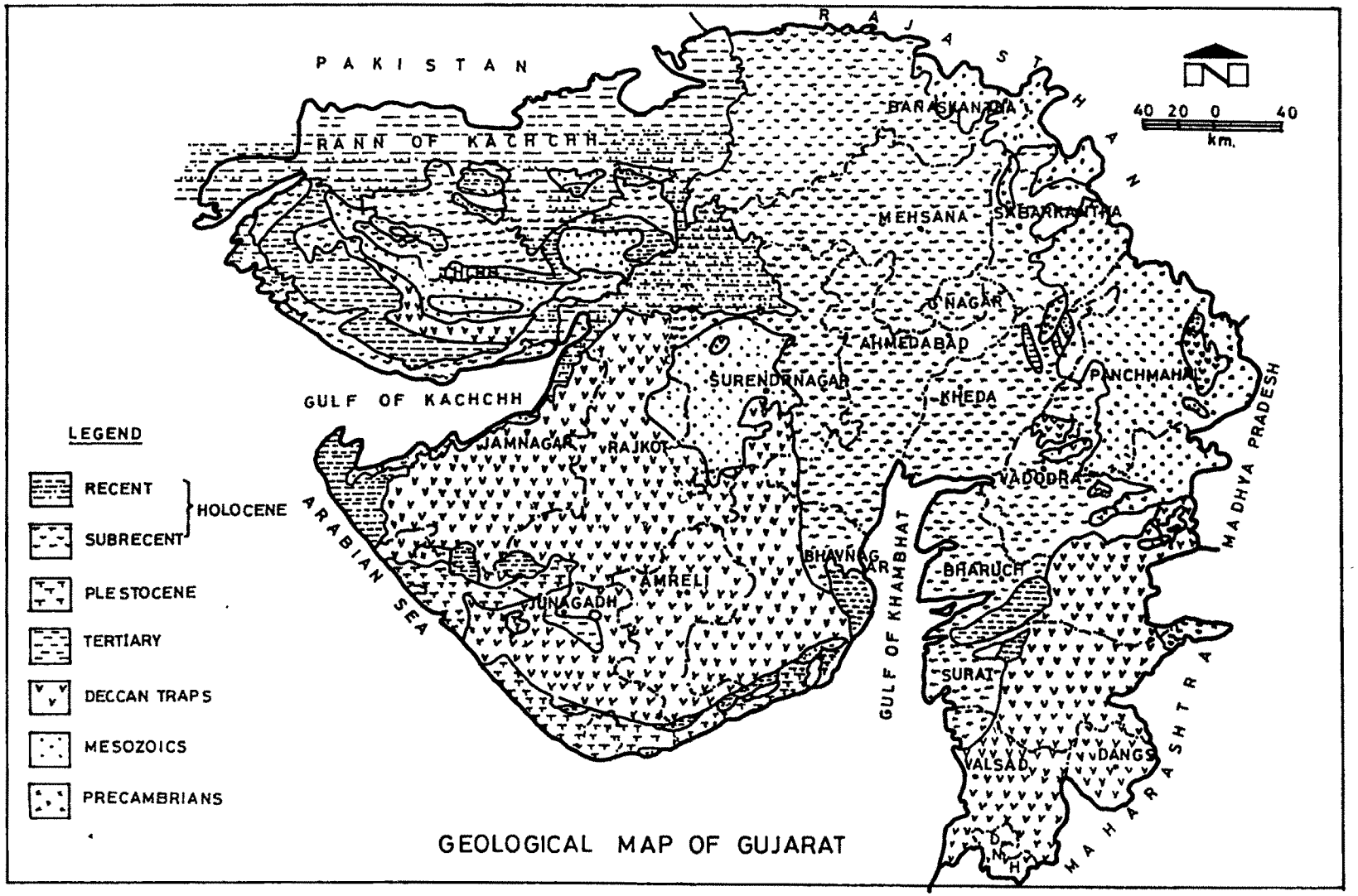


REFERENCE

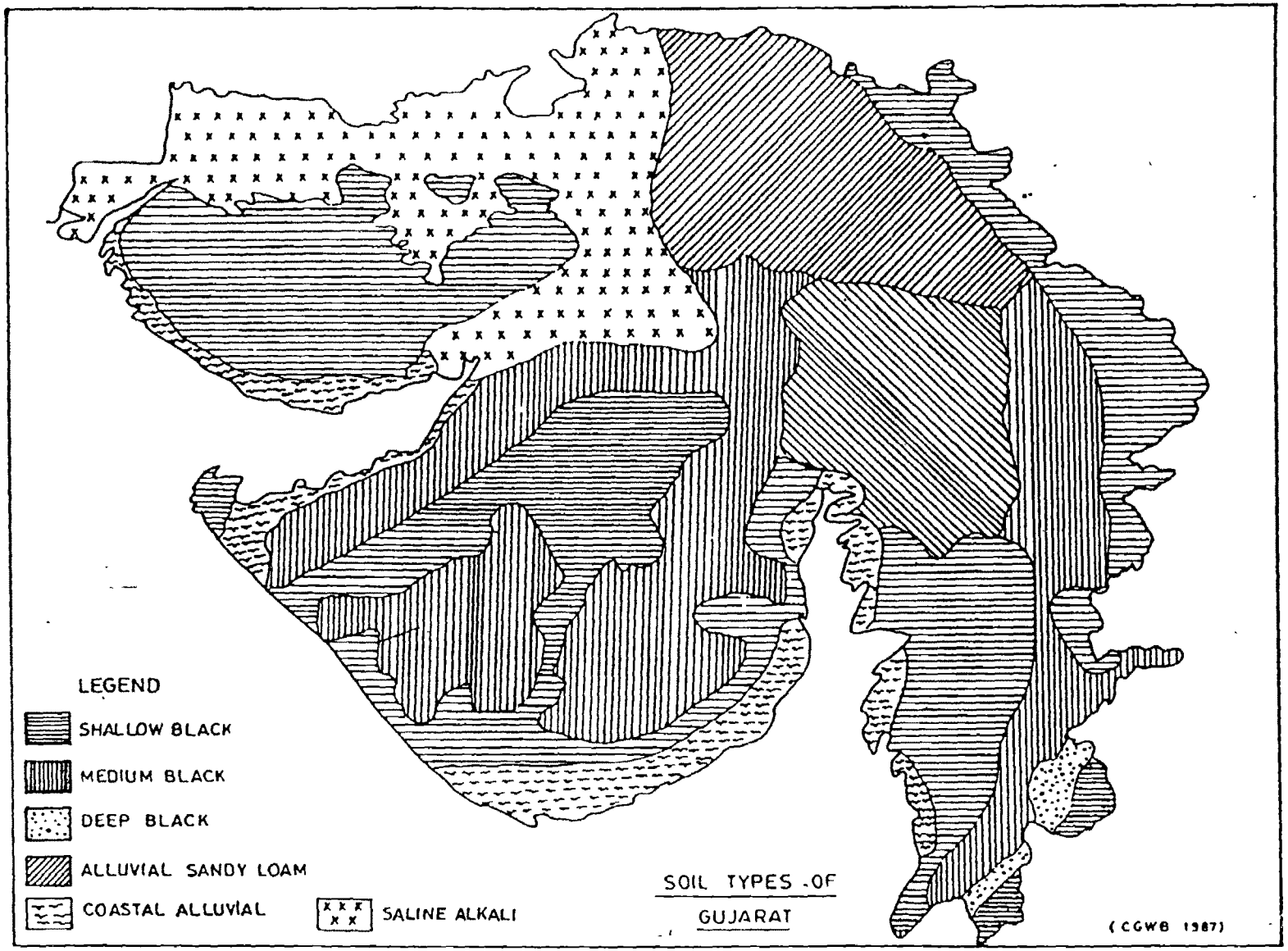
FORMATION (AREA %)	LITHOLOGY	SYMBOL	AQUI TYPE	AQUIFER CHARACTERS DEPTH m	YIELD lpm.	TDS ppm.
UNCONSOLIDATED (45%) RANNS 12%	COSTAL ALLUVIUM		P	10-50	100-500	500-2000
			C	50-100	500-1000	2000-4000
	LOW LEVEL ALLUVIUM		P	20-150	250-500	1000-2000
			C	150-500	1000-3000	2000-3000
	HIGH LEVEL ALLUVIUM		P	20-50	250-1000	500-1000
			C	50-100	1000-2000	1000-1500
SEMICONSOLIDATED (14%)	LIMESTONE AND CLAYS		P	20-50	100-500	1000-2000
			C	50-150	500-1000	2000-4500
	SAND STONES LATERITE		P	20-80	100-500	500-1000
			C	80-250	900-1500	1000-2000
CONSOLIDATED	TRAPPEAN BASALTS		P	20-50	100-500	500-1000
			C	50-200	500-1500	1000-1500
	PRECAMBRIAN CRYSTALLINES		P	20-80	100-300	500-1000
			C	80-250	300-1000	1000-1500

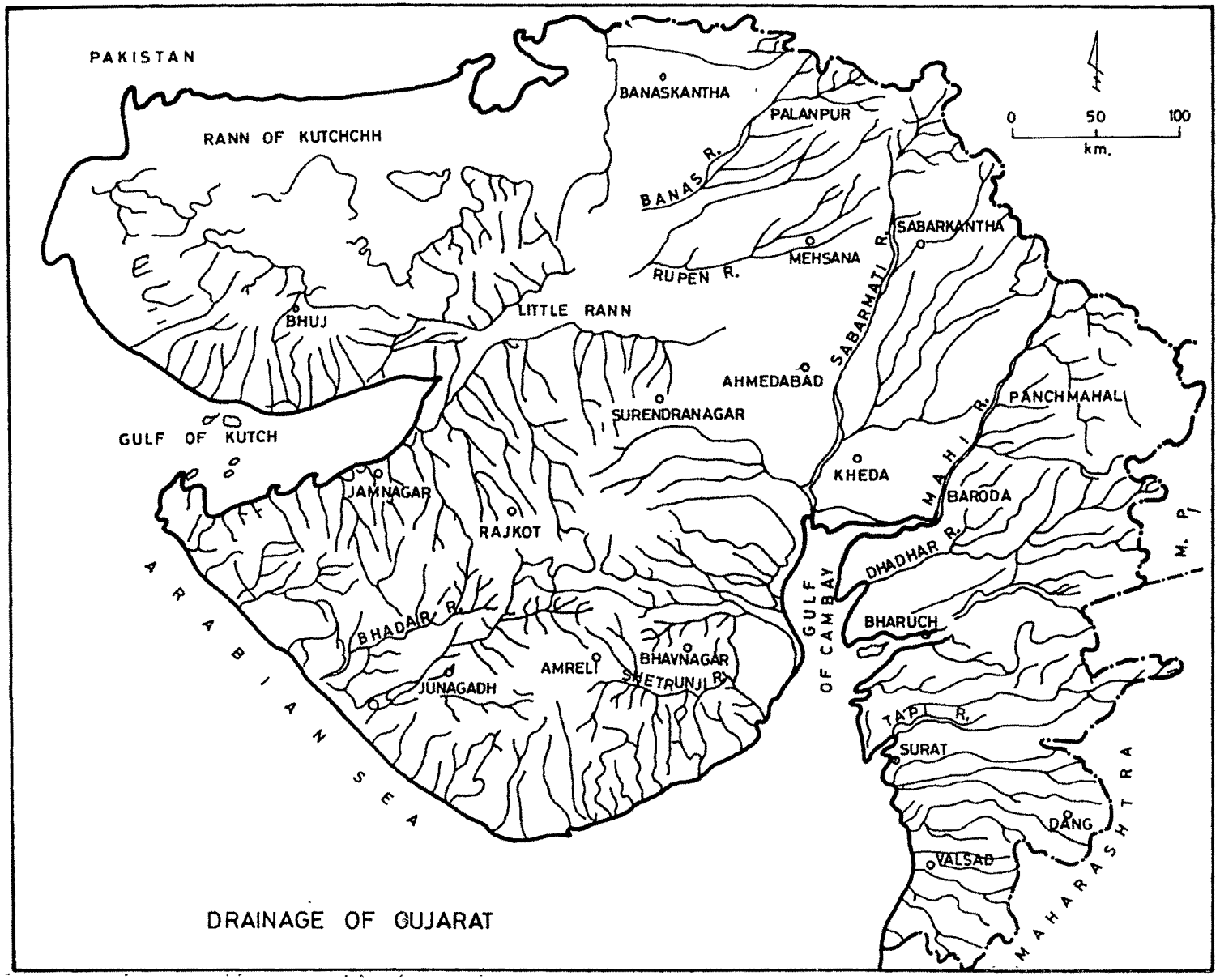
ABBRIVATION :- P-PHREATIC AQUIFER C-CONFINED AQIFERS

HYDROGEOLOGY OF GUJARAT



GEOLOGICAL MAP OF GUJARAT


LEGEND
SHALLOW BLACK
MEDIUM BLACK
DEEP BLACK
ALLUVIAL SANDY LOAM
COASTAL ALLUVIAL
SALINE ALKALI
SOIL TYPES OF
GUJARAT
(CGWB 1987)



DRAINAGE OF GUJARAT