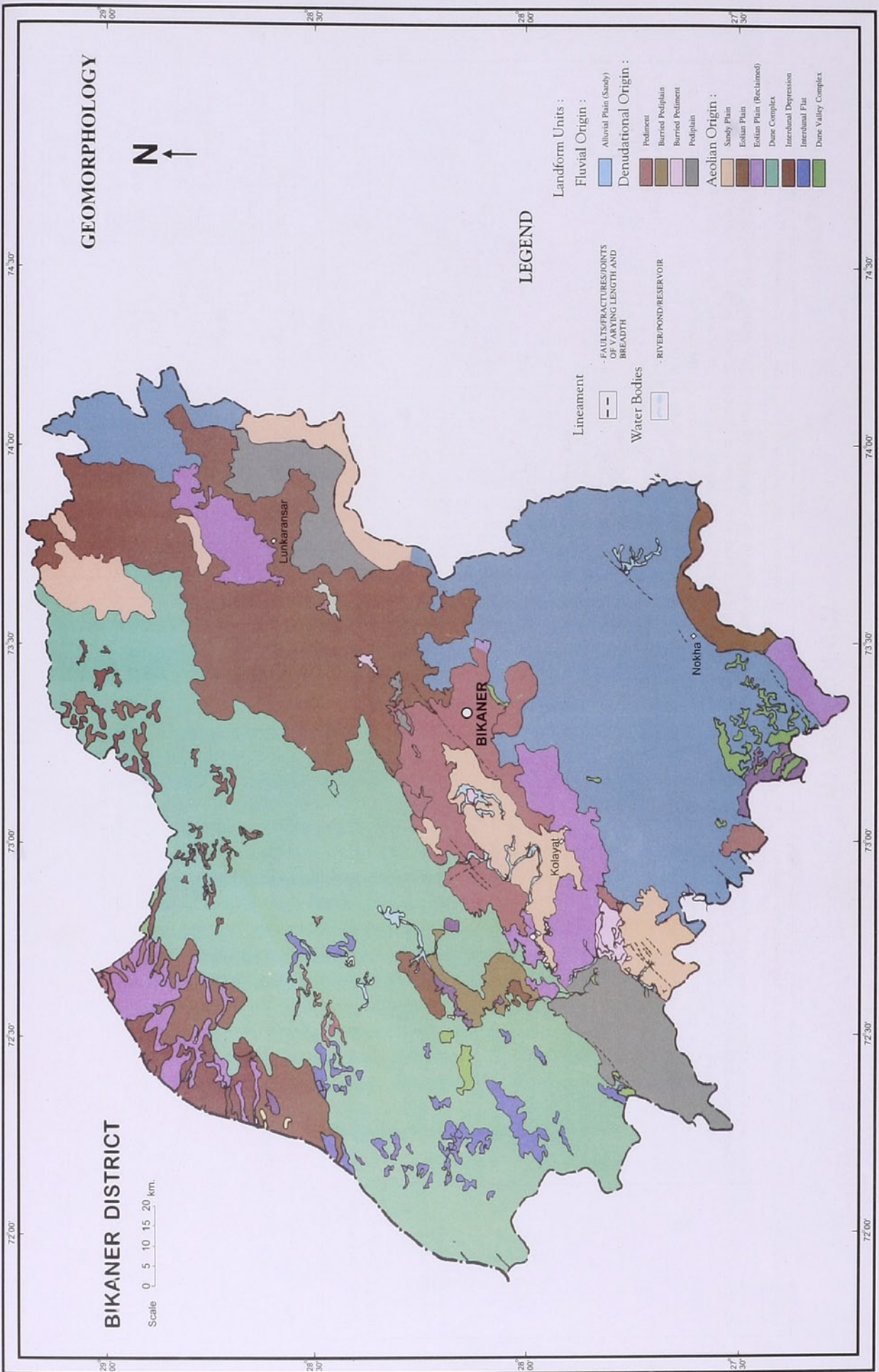


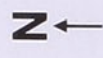
## GEOMORPHOLOGY

## DISTRICT—BIKANER

Landform Units	Symbol	Lithology / Material / Description	Occurrence in district	Land use/Land cover
<b>Alluvial Plain</b> Alluvial Plain (Sandy)	AP(S)	Flat to gentle undulating plain formed due to fluvial activity, mainly consisting of gravels, sand, silt and clay with unconsolidated material of varying lithology, predominantly sand.	Eastern part.	Kharif crop, open scrub, fallow.
<b>Denudational Origin</b> Pediment	P	Broad, gently sloping rock flooring, erosional surface of low relief between hill and plain, comprised of varied lithology, criss crossed by fractures & faults.	North and north east of Kolayat town & west of Bikaner.	Kharif crop, fallow, open scrub.
Burried Pediplain	BPP	Formed over varying lithology and comprises of shallow to thick over burden with criss cross fractures and faults.	Encircling Bikaner town.	Marginally Kharif crop, fallow.
Burried Pediment	BP	Pediment covered essentially with relatively thicker alluvial, colluvial or weathered materials.	Negligible in south.	Single crop (Kharif).
Pediplain	PP	Coalescence and extensive occurrence of pediment.	Serva village to south of Bikaner.	Marginal Kharif crop, fallow, open scrub.
<b>Aeolian Origin</b> Sandy Plain	SP	Formed of aeolian activity, wind blown sand with gentle sloping to undulating plain, comprising of coarse sand, fine sand, silt & clay.	Mainly from south to east, marginally in north east.	Marginally Kharif crop, land with or without scrub.
Eolian Plain	EP	Formed by aeolian activity occupying sand dunes of varying heights, size, slopes. Long stretches of sand sheet. Gentle sloping falt to undulating plain, comprising to fine to medium grained sand and silt. Also scattered xerophatic vegetation.	In north west, north east, marginally in south west and south.	Double crop, marginal Kharif, open scrub, fallow.
Eolian Plain (Reclaimed)	EP (R)	Gently sloping with sheet of sand or sand dunes. Scattered xerophytic vegetation.	North east of Lunkaransar town, negligible in north west and north.	Marginal Kharif crop, open scrub, fallow.
Dune Complex	DC	An undulating plain composed of number of sand dunes.	Predominant in western half.	Land with or without scrub.
Interdunal Depression	ID	Slightly depressed area in between the dunal complex showing moisture and fine sediments.	Negligible scattered in north west.	Single crop (Kharif), land with or without scrub.
Interdunal Flat	IF	Flat, narrow land between dunes.	Negligible scattered in northern and western part.	Double crop (Rabi / Kharif), fallow.
Dune Valley Complex	DVC	Clusters of dunes and interdunal spaces with undulating topography formed due to wind blown activity, comprising of unconsolidated sand and silt.	Scattered along eastern margin.	Land with or without scrub.



**GEOMORPHOLOGY**



**BIKANER DISTRICT**

Scale 0 5 10 15 20 km.

**LEGEND**

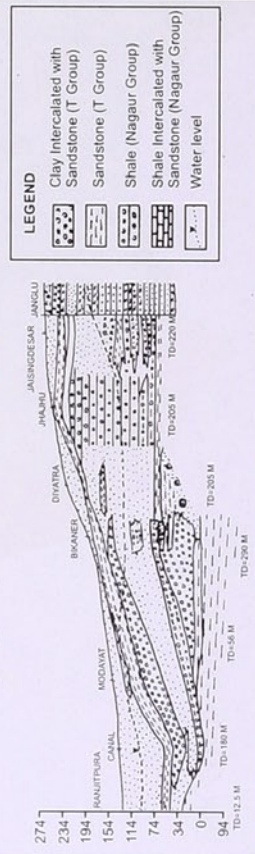
- Lineament**
- FAULTS/FRACTURES/POINTS OF VARYING LENGTH AND BREADTH
  - RIVER/POND/RESERVOIR
- Water Bodies**
- 
- Landform Units :**
- Fluvial Origin :**
- Alluvial Plain (Sandy)
- Denudational Origin :**
- Pediment
  - Burried Pediplain
  - Burried Pediment
  - Pediplain
- Aeolian Origin :**
- Sandy Plain
  - Eolian Plain
  - Eolian Plain (Reclaimed)
  - Dune Complex
  - Interdunal Depression
  - Interdunal Flat
  - Dune Valley Complex

# HYDROGEOLOGY

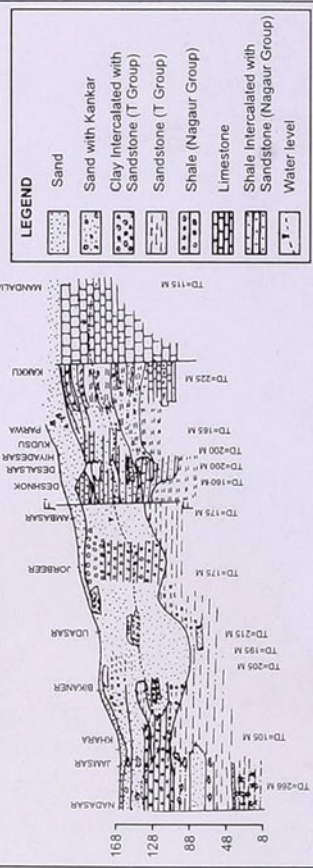
## DISTRICT—BIKANER

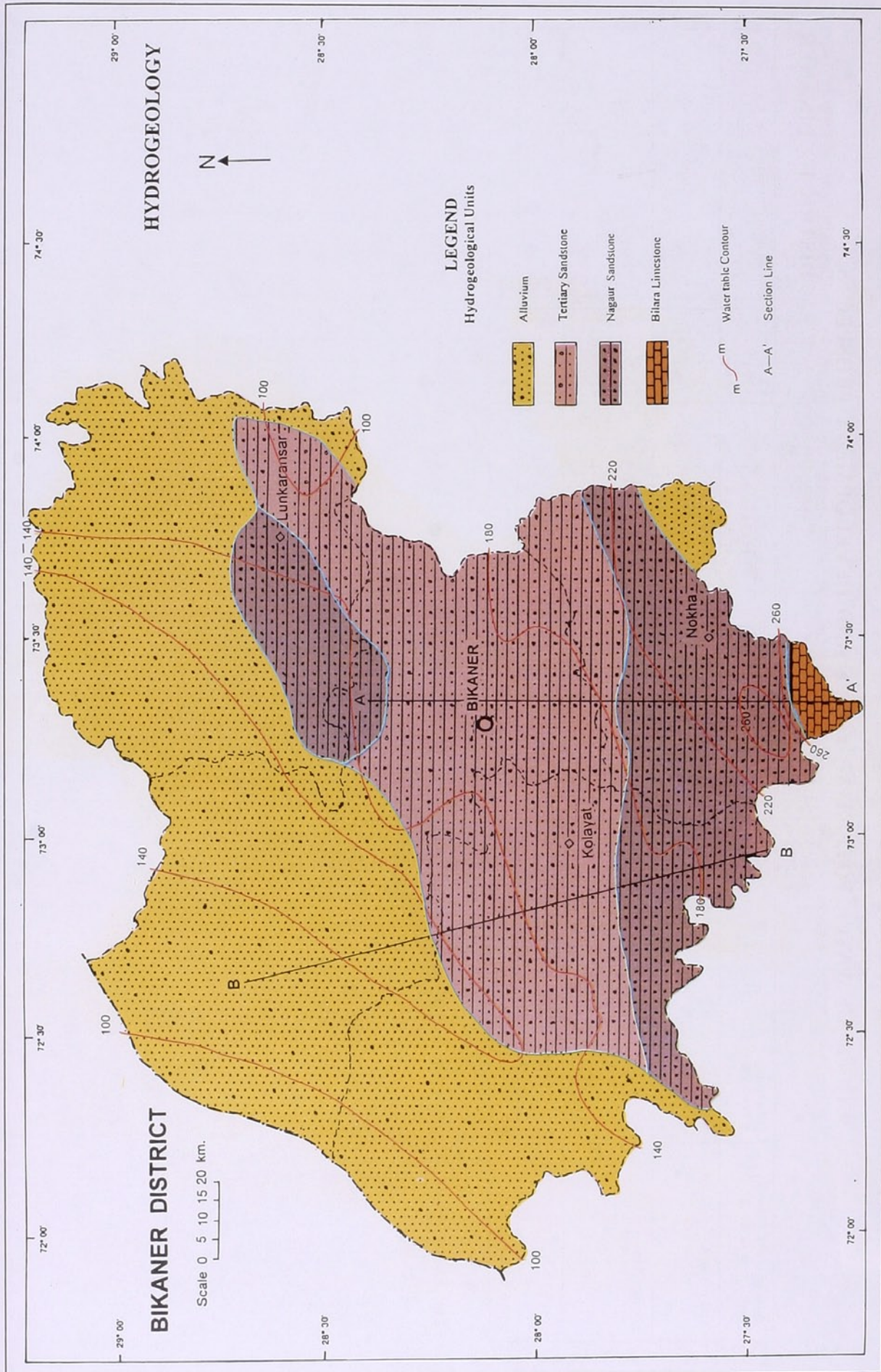
Hydrogeological units	Description of the unit/cross section	Occurrence	Ground Water flow
Alluvium (Quaternary)	It is of greyish yellow to buff colour, unconsolidated to semi-consolidated sediments consist of sand, silt, clay and kankar. Sand is generally medium to coarse grained subrounded to rounded. Cross section between Bikaner to NW boundary reveals that the thickness of alluvium and depth of the basement increases north westward.	The litho unit covers major part of the district, but due to saline ground water and thick clay sequences small area in north eastern and south western part in Lunkaransar and Kolyat blocks have been delineated as ground water potential. Alluvium occupies nearly 14% potential area.	The general direction of ground water flow as inferred from water table contour is south east to north west. Ground water mound and trough structures of localised nature have been noticed in different parts. These structures however, cover more area in north western part. Hydraulic gradient generally varies from 1.1 to 2.5 m/km. In southern part gradient become more steep i.e., between 4.2 to 5.0 m/km.
Tertiary Sandstone (Eocene)	It comprises medium to coarse grained, consolidated to semi consolidated sandstone with gravel silt and variegated clays intercalated with lignite and fullerearth. Thickness of the litho unit varies from 50 to more than 276 m. Cross section trending N-S direction and passing west of Nokha and Kolyat indicate three parallel fault striking E-W. Through these faults interface between Bilara limestone/Nagaur sandstone, Nagaur sandstone/Tertiary sandstone and Tertiary sandstone/Nagaur sandstone have been created and can be located as we move from south to north.	The litho unit occupies south western part of the Bikaner block where it covers extensive area. It also spreads in peripheral part of adjoining block. Tertiary sandstone encompasses nearly 56% potential area.	
Nagaur Sandstone (Marwar super group)	It is buff to reddish brown in colour, fine to medium grained hard and compact sandstone with intercalations of chocolate coloured shale. Thickness of the litho unit varies from 140 to 250 m.	The litho unit covers major part of Nokha block and extends in western direction in part of Kolyat block. It occupies nearly 28% potential area.	
Bilara Limestone (Marwar super group)	It is grey, dark grey or black coloured, cherty and dolomitic limestone with veins of calcite. Thickness of the litho unit varies from 115 to 225 m.	The litho unit occupies small area in southern peripheral part of Nokha block. It covers nearly 2% potential area.	

Hydrogeological Cross Section A-A' District BIKANER



Hydrogeological Cross Section B-B' District BIKANER



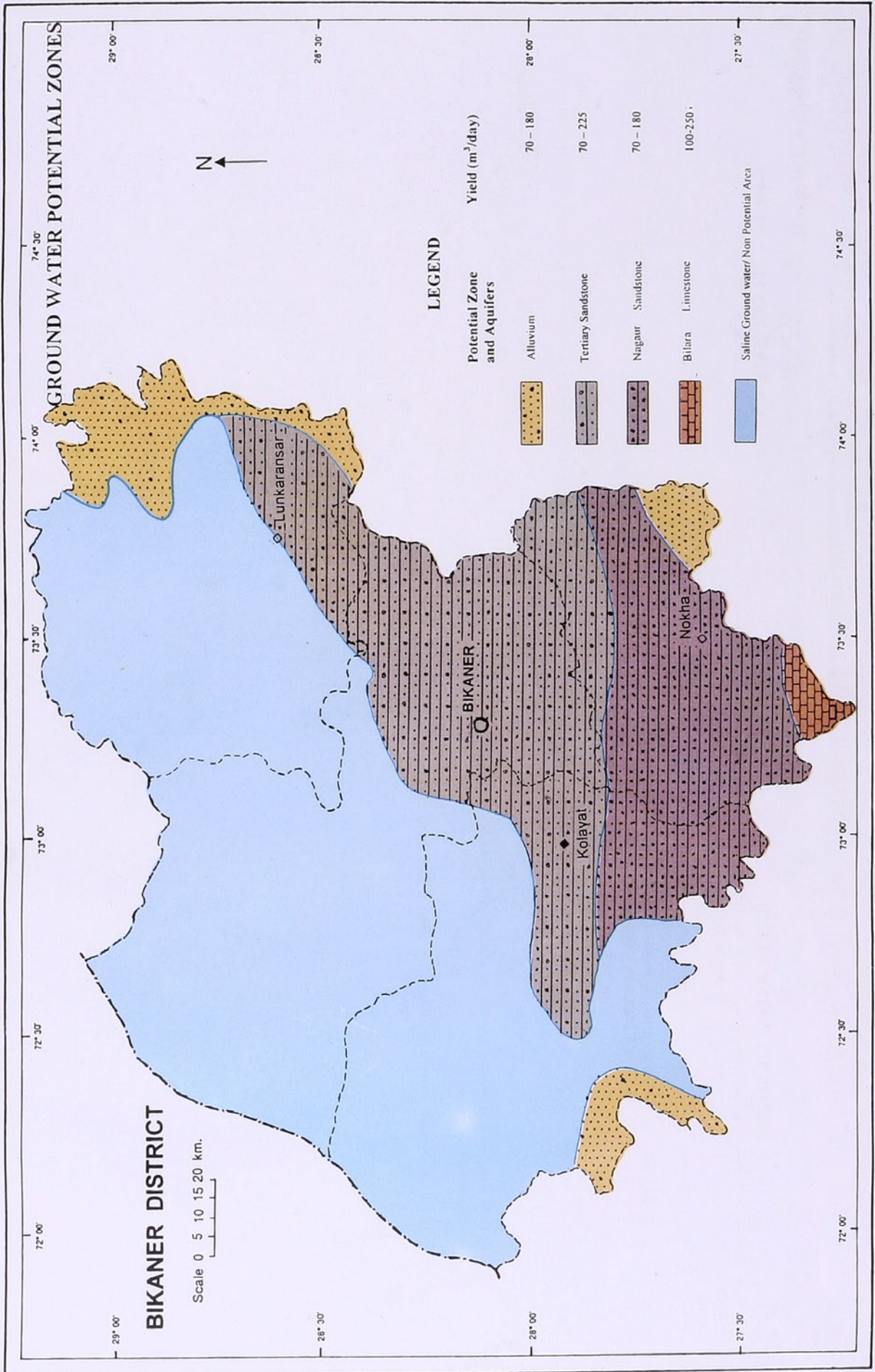


**GROUND WATER POTENTIAL ZONES AND DEVELOPMENT PROSPECTS**

**DISTRICT - BIKANER**

Aquifer in the Potential Zone (Area in Km <sup>2</sup> )	Occurrence * Block (Area in Km <sup>2</sup> )	Water Level (1997) in m.	Well Parameters		E.C. X10 <sup>μ</sup> siem/cm	Development Prospects
			Type	Proposed depth in m		
Older Alluvium (1544.50)	* Kolayat (452.00)	50-60	TW	100-150	<4	Safe
	* Lunkaransar (930.00)	40-60	TW	100-150	<4	Safe
	* Nokha (162.50)	40-60	TW	100-150	<4	Safe
Tertiary Sandstone (6287.00)	* Bikaner (3191.00)	60-100	TW	250-300	4-8	Safe
	* Kolayat (1174.00)	50-120	TW	250-300	4-8	Safe
	* Lunkaransar (1141.00)	40-65	TW	200-250	<4	Safe
	* Nokha (880.00)	90-105	TW	300-250	<4	Safe
Nagaur Sandstone (3248.38)	* Kolayat (750.00)	75-120	TW	200-250	<4	Safe
	* Nokha (2498.38)	50-100	TW	200-250	<4	Safe
Bilaram Limestone (172.13)	* Nokha (172.13)	50-80	TW	125-175	4-8	Safe

TW - Tube wells    Safe - <65% stage of development    Semi Critical - 65-85% development    Critical - 85-100% development    Over exploited - >100% development



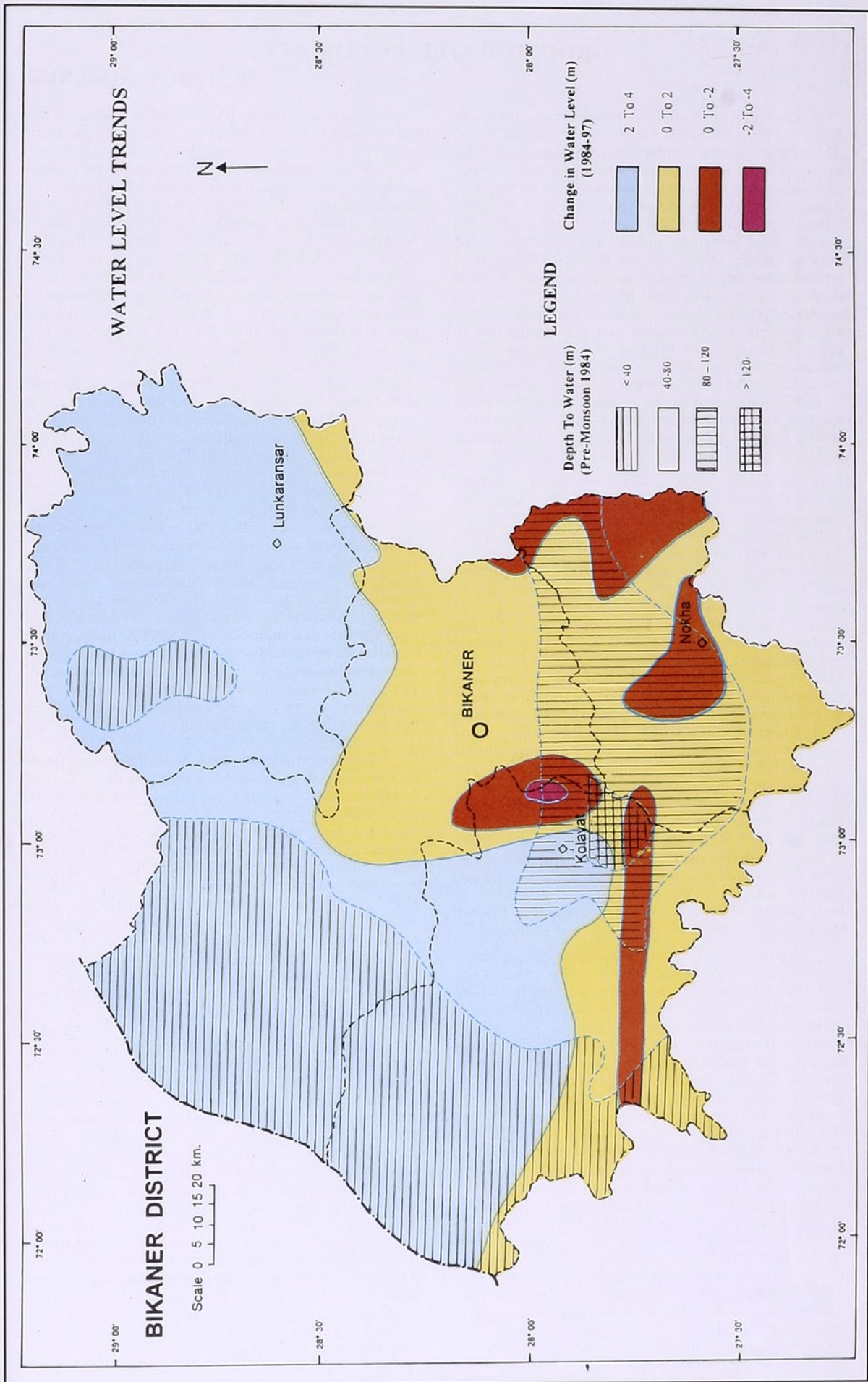
## WATER LEVEL TRENDS

DISTRICT : BIKANER

### CHANGE IN WATER LEVEL (1984-1997)

Range in m	Area	Range in m	Area
2 to 4	Part of Bikaner and Kolayat blocks, west of Indira Gandhi Nahar mainly demarcated in non potential area has shallow water level. A pocket in Lunkaransar block also lies in this range.	2 to 4	Major part of the non potential area traversed by Indira Gandhi Nahar exhibit rise in water level within the range.
0 to 2	Major part of Bikaner and Lunkaransar blocks categorised as non-potential and southern peripheral area of Kolayat and Nokha blocks lie in this range.	0 to 2	Southern part of the district categorised as ground water potential area exhibit marginal depletion in water level less than 2 m.
0 to -2	Part of Kolayat and Nokha blocks located in ground water potential area lie in the depth range.	0 to -2	Localised pockets in different parts of the ground water potential area exhibit marginal depletion in water level less than 2 m.
-2 to -4	A localised pocket south of Kolayat has deep water level ranging more than 120 m.	-2 to -4	A localised pocket south west of Bikaner show steep depletion in water level within the range.

Range in m	Area
< 40	Part of Bikaner and Kolayat blocks, west of Indira Gandhi Nahar mainly demarcated in non potential area has shallow water level. A pocket in Lunkaransar block also lies in this range.
40 to 80	Major part of Bikaner and Lunkaransar blocks categorised as non-potential and southern peripheral area of Kolayat and Nokha blocks lie in this range.
80 to 120	Part of Kolayat and Nokha blocks located in ground water potential area lie in the depth range.
> 120	A localised pocket south of Kolayat has deep water level ranging more than 120 m.





## GROUND WATER POTABILITY

### DISTRICT BIKANER

With the rise in population and steady growth of industries have increased the demand of ground water. Although the Indira Gandhi canal water is utilized for irrigation and drinking, ground water is the sole resource of drinking water for local population in major region of Bikaner district. The native ground water is highly mineralised, a characteristic feature of arid climate. No specific trend in variation of salinity is observed. The map of salinity shows varying degree of mineralised ground water. Fresh to slightly saline water with electrical conductivity less than 2000  $\mu\text{S}/\text{cm}$  occur in east and south east. The moderately saline ground water (2000 to 4000  $\mu\text{S}/\text{cm}$ ) are available in east, west and southern parts of Kolayat and Bikaner blocks. About 3.18% waters occur in the salinity range of 6000 to 8000  $\mu\text{S}/\text{cm}$  and cover the areas of moderate to high salinity. Rest of 14.66% of ground waters in west and north-west of Kolayat, Bikaner and Lunkaransar blocks and south of Nokha block is saline to highly saline with electrical conductivity of more than 8000  $\mu\text{S}/\text{cm}$ .

The salinity varies from as low as 220 to as high as 28000  $\mu\text{S}/\text{cm}$  with an average of 4295  $\mu\text{S}/\text{cm}$ . The water analyses reveal that 10.47%, 70.67% and 78.52% well waters have electrical conductivity less than 1000, 3000 and 5000  $\mu\text{S}/\text{cm}$  respectively. It is observed from the bar chart that the ground water of Kolayat (27.27%) and Lunkaransar (20.57%) have more salinity in comparison to Nokha (3.70%) and Bikaner (11.96%) blocks. The 92.59% well waters of Nokha block has salinity less than 4000  $\mu\text{S}/\text{cm}$ , showing the occurrence of better quality of water. However, the eastern parts of Bikaner and south-eastern parts of Kolayat block have similar ground water quality. Sodium and Chloride are the principal cation and anion in ground waters irrespective of hydrogeological aquifers. More than 47% ground waters covering major region are of sodium-chloride type and fall in high to very high class of salinity. The high average values of chloride in ground waters of Koyalat (1464 mg/L) and Lunkaransar (1385 mg/L) blocks illustrate the ultimate stage of mineralization and waters in most of the aquifers in north and west exists in sluggish conditions. Besides this an arid climate and wind blown sand also adds up to salinity in soils and ground waters. Further salinity is also due to hydrogeological barriers like clayey formation, gypsum hardpans etc. present except in east and south-east.

Nitrate is the significant form of nitrogen present in ground water and its concentration has not shown any relationship with salinity. Low salinity waters in east and south-east of Nokha, north-east of Bikaner, north-west of Kolayat and south-east of Lunkaransar blocks, have high nitrates ranging among 100 to 500 mg/L whereas high salinity waters in west of Lunkaransar block have less than 100 mg/L of nitrate except west of Bikaner. The ground waters have high contents of nitrates in east and south-east and have maximum values in the well waters of Chhatargarh (1160 mg/L) in Bikaner, Mankasar (840 mg/L) in Kolayat, Raipura Hudda (1500 mg/L) in Lunkaransar and Mainsar (1050 mg/L) in Nokha blocks respectively. The percentage of well waters in various ranges of nitrate is shown in bar chart and areal distribution of nitrate is shown in map. Nitrate exceeds 100 mg/L in 51.85% well waters from Nokha block, showing that the quality of ground water is seriously affected by nitrate contamination. While 41.18% and 23.73% waters of Lunkaransar and Bikaner blocks are relatively free from nitrate hazard. Thus, the ground waters of the above regions have a bearing on the potable water supplies due to high contents of nitrate.

Fluoride is an essential ingredient of drinking water but its potable level depends upon the daily intake of water by the consumer and the climatic conditions. Fluoride have not shown any relationship with salinity while the ground water with sodium bicarbonate type character have been found to contain considerable fluoride content. The ground water of the Nokha block is free from fluoride hazard. About 88.68% water have less than 1.5 mg/L of fluoride while 11.32% fall above 1.5 mg/L. The bar chart of fluoride reveals the presence of fluoride in alarming concentration in ground water of Lunkaransar block where 31.25% and 37.50% well water have its concentration above 3.0 mg/L and between 1.5-3.0 mg/L respectively. However, the ground water of Bikaner (43.86%) and Kolayat (41.86%) are also characterized by high fluorides i.e. above 1.50 mg/L above 4 mg/L. It ranges from 0 to 8.68 mg/L in the well water of Hariysar (Lunkaransar block), a highly mineralised water with salinity of 20000  $\mu\text{S}/\text{cm}$  and sodium-chloride character. The chemical analyses reveal that the saline water in Lunkaransar (average EC-5281  $\mu\text{S}/\text{cm}$ ) and Kolayat (average EC-5531  $\mu\text{S}/\text{cm}$ ) blocks are characterized by high fluorides with an average value of 2.66 mg/L and 1.70 mg/L respectively. On the contrary ground waters of Nokha (average EC-2450  $\mu\text{S}/\text{cm}$  & F-0.98 mg/L) and Bikaner (average EC-4493  $\mu\text{S}/\text{cm}$  & F-1.77 mg/L) blocks have comparatively low fluorides as well as salinity. The fluoride map reveals that slightly to moderately saline waters are normally free from fluoride contamination. The high fluorides (above 4 mg/L) are associated with high salinity ground waters and found in north-east and central parts of the district. Few perched water bodies with low and high salinity occurring along the canal region in west and north-west has shown fluoride concentration.

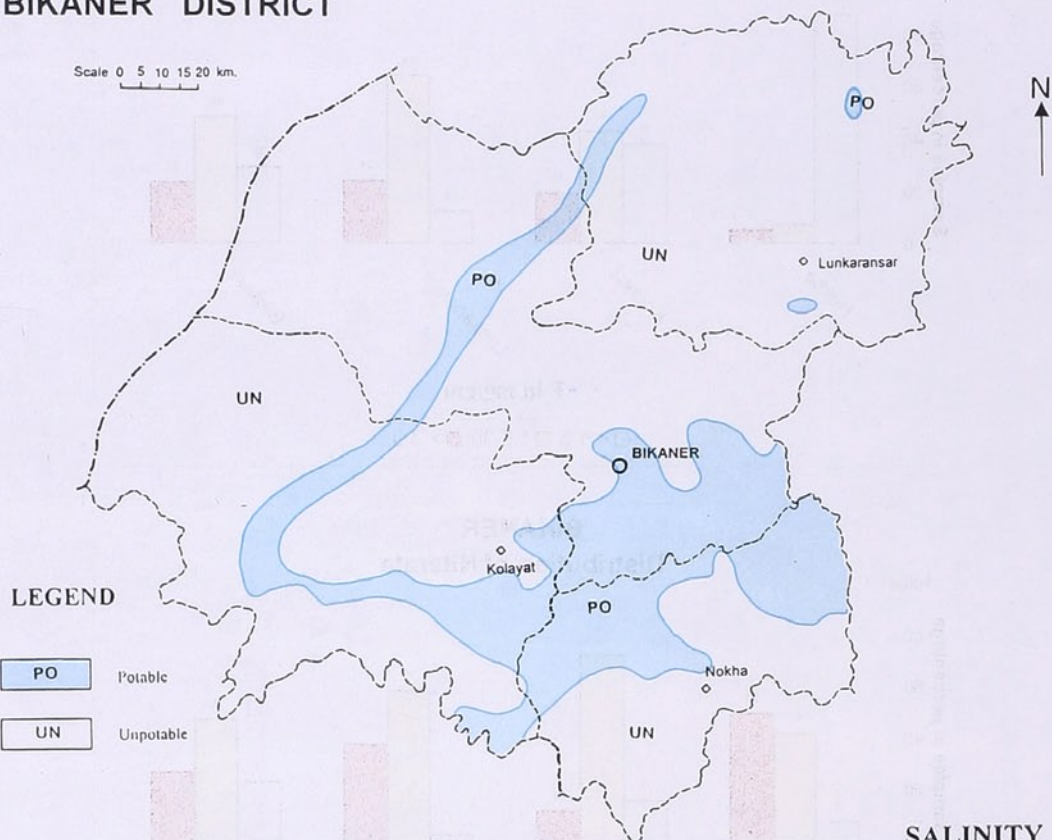
The gypsum appears to be the main contributor of alkaline-earths in ground water besides limestone, Tertiary and Quaternary sediments. Water analyses have shown appreciable concentration of alkaline earth in mineralised ground water. The high average values of hardness in Bikaner (576 mg  $\text{CaCO}_3/\text{L}$ ) Kolayat (841 mg  $\text{CaCO}_3/\text{L}$ ) and Lunkaransar (619 mg  $\text{CaCO}_3/\text{L}$ ) are due to mineralization except in Nokha block where it is 443 mg  $\text{CaCO}_3/\text{L}$ . The hardness varies from 33 to as high as 3810 mg  $\text{CaCO}_3/\text{L}$  in the saline ground water of Ballar in Bikaner block. About 28.8% ground waters have total hardness more than 600 mg  $\text{CaCO}_3/\text{L}$ . Such high hardness have rendered ground water uneconomical for washing purposes while their use in irrigation may help in maintaining the texture of soil.

With respect of ICMR-potability levels about 45% and 78.5% ground water can be consider suitable for drinking under maximum permissible level provided health affecting constituents are well with in recommended limits of potability. The analyses reveal that more than 45% well waters are potable as well as safe for human consumption. The drinking water suitability map clearly illustrates the area where safe ground water is available. Irrigation potential in east and south-east is promising. According to anonymous water rating criteria, more than 85% ground waters having salinity less than 8000  $\mu\text{S}/\text{cm}$  can be used for growing semi-tolerant to salt-tolerant crops with proper drainage for leaching out of salts from root zone. Further the saline ground water can be best utilised by blending with fresh water wherever canal water is available within reach. In general, ground water is suitable for livestock consumption except those with very high salinity or nitrate contents.

# BIKANER DISTRICT

## GROUND WATER POTABILITY

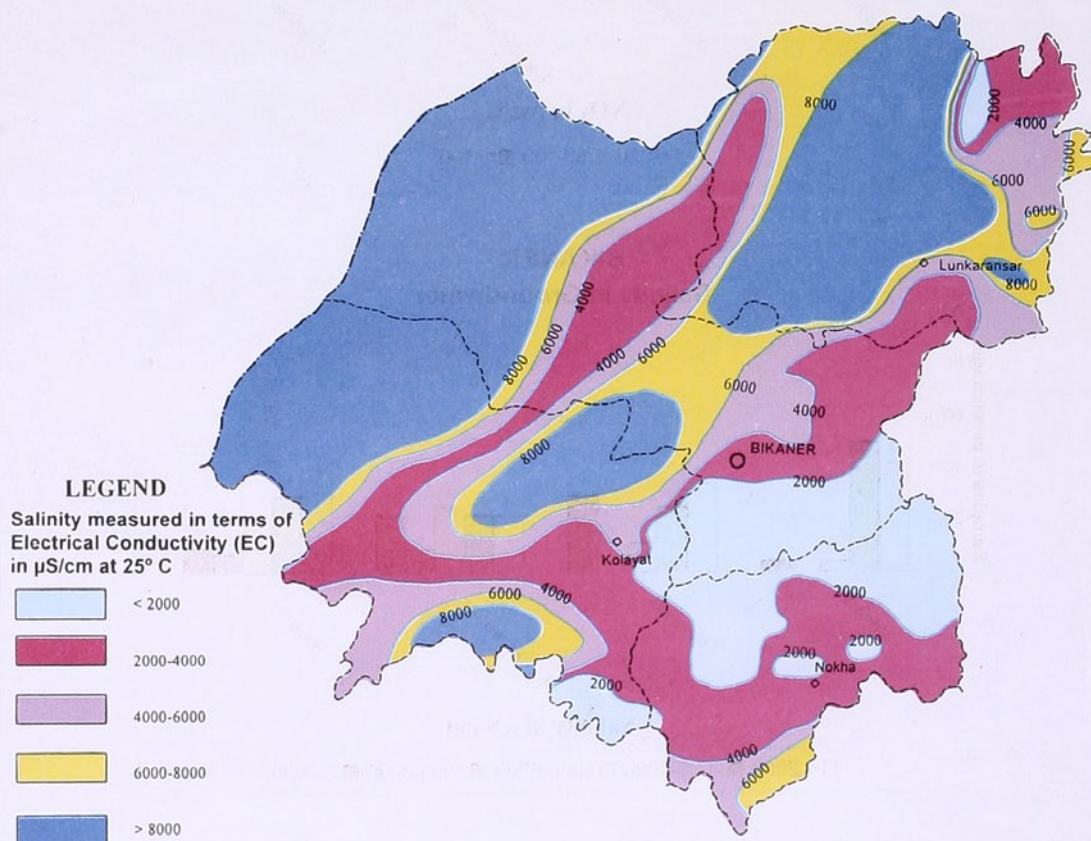
Scale 0 5 10 15 20 km.



### LEGEND

- PO Potable
- UN Unpotable

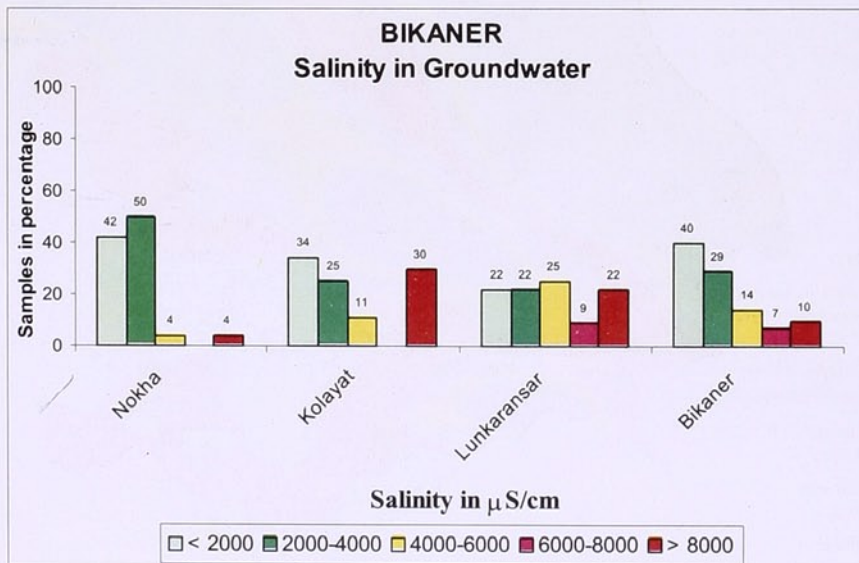
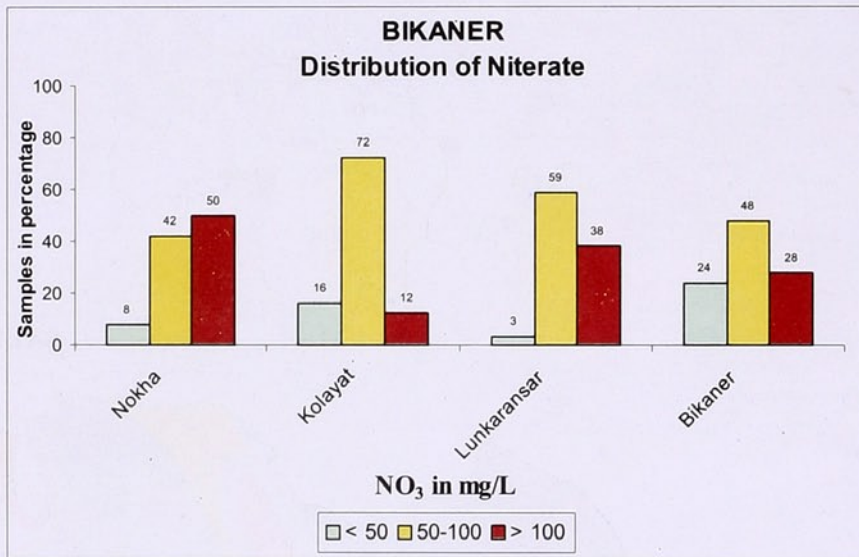
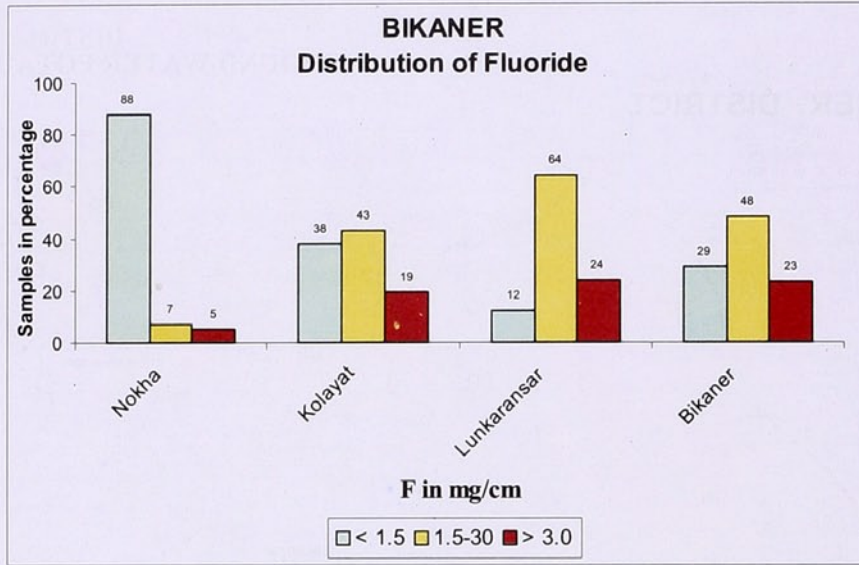
## SALINITY



### LEGEND

Salinity measured in terms of Electrical Conductivity (EC) in  $\mu\text{S}/\text{cm}$  at  $25^\circ\text{C}$

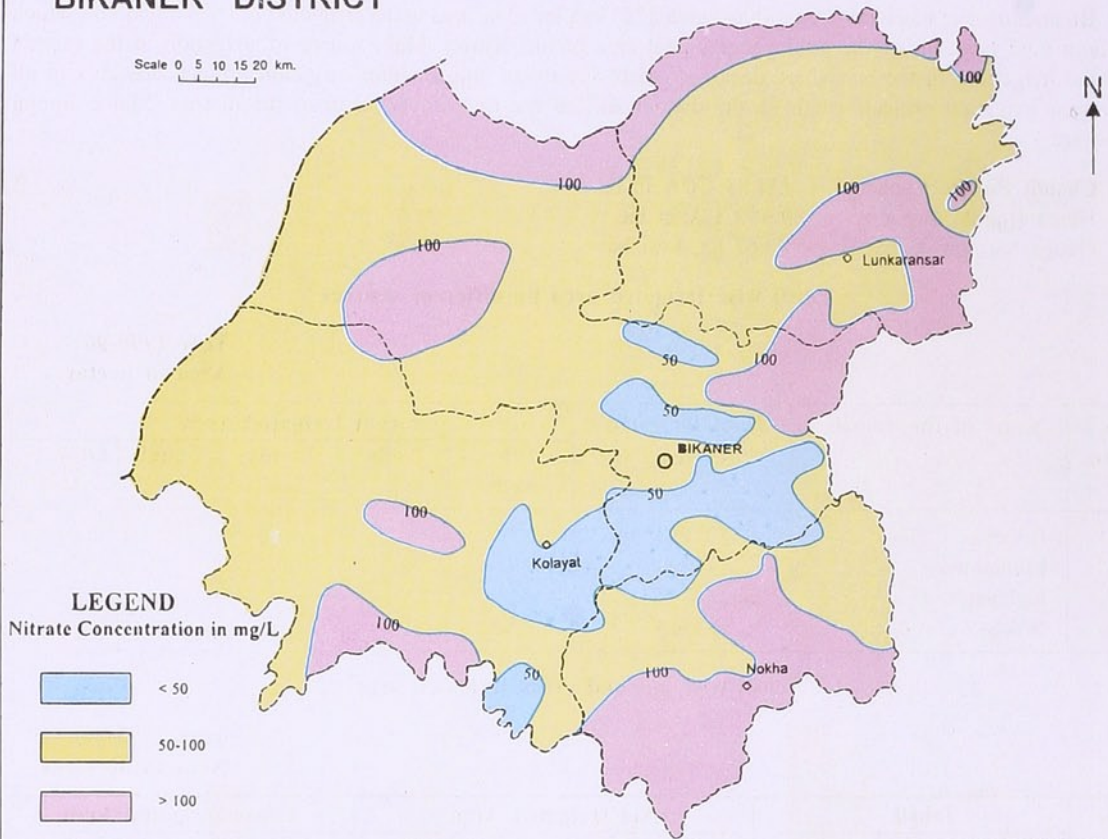
- < 2000
- 2000-4000
- 4000-6000
- 6000-8000
- > 8000



# BIKANER DISTRICT

## NITRATE DISTRIBUTION

Scale 0 5 10 15 20 km.



## FLUORIDE DISTRIBUTION

