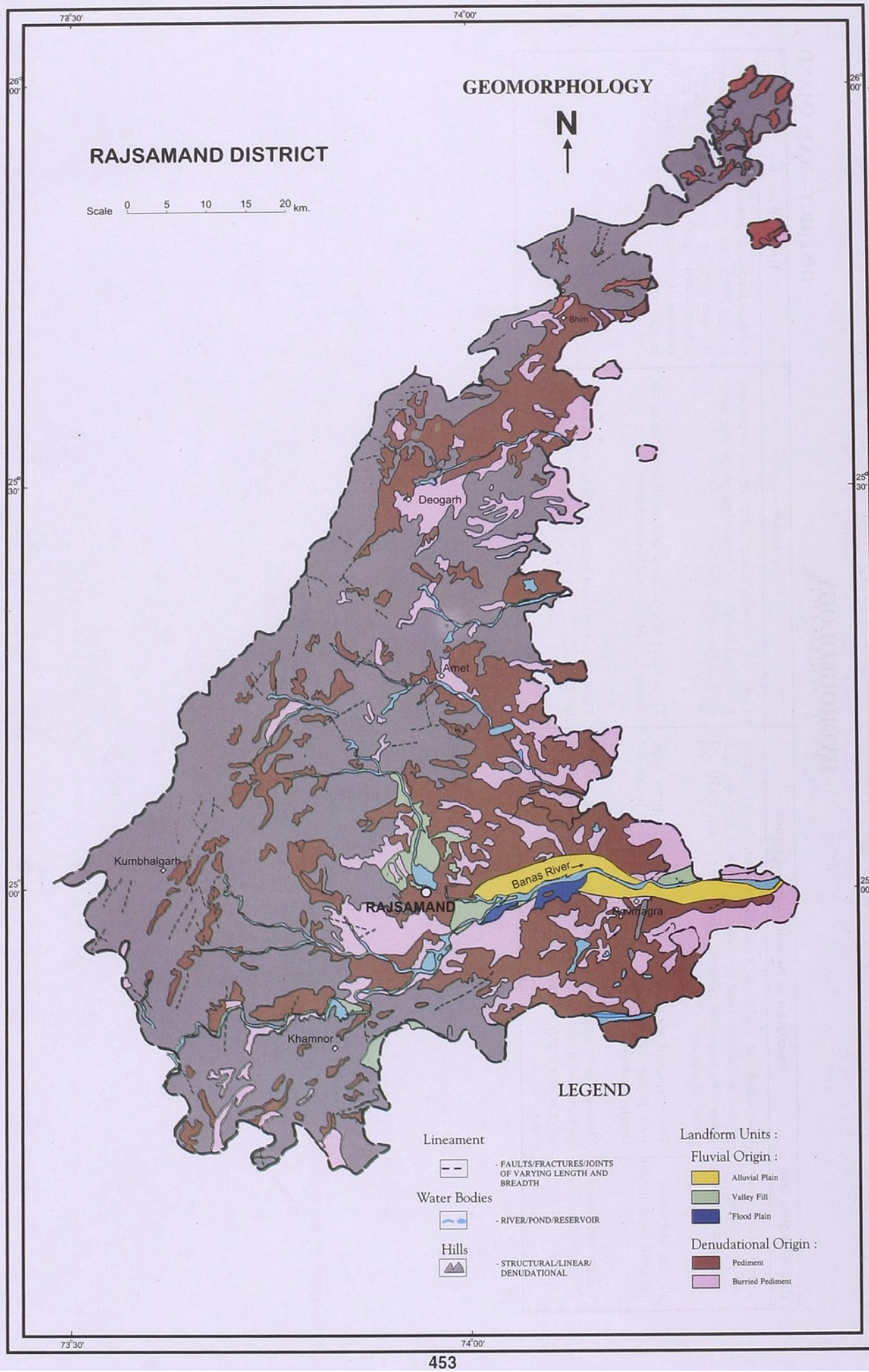
GEOMORPHOLOGY

DISTRICT—RAJSAMAND

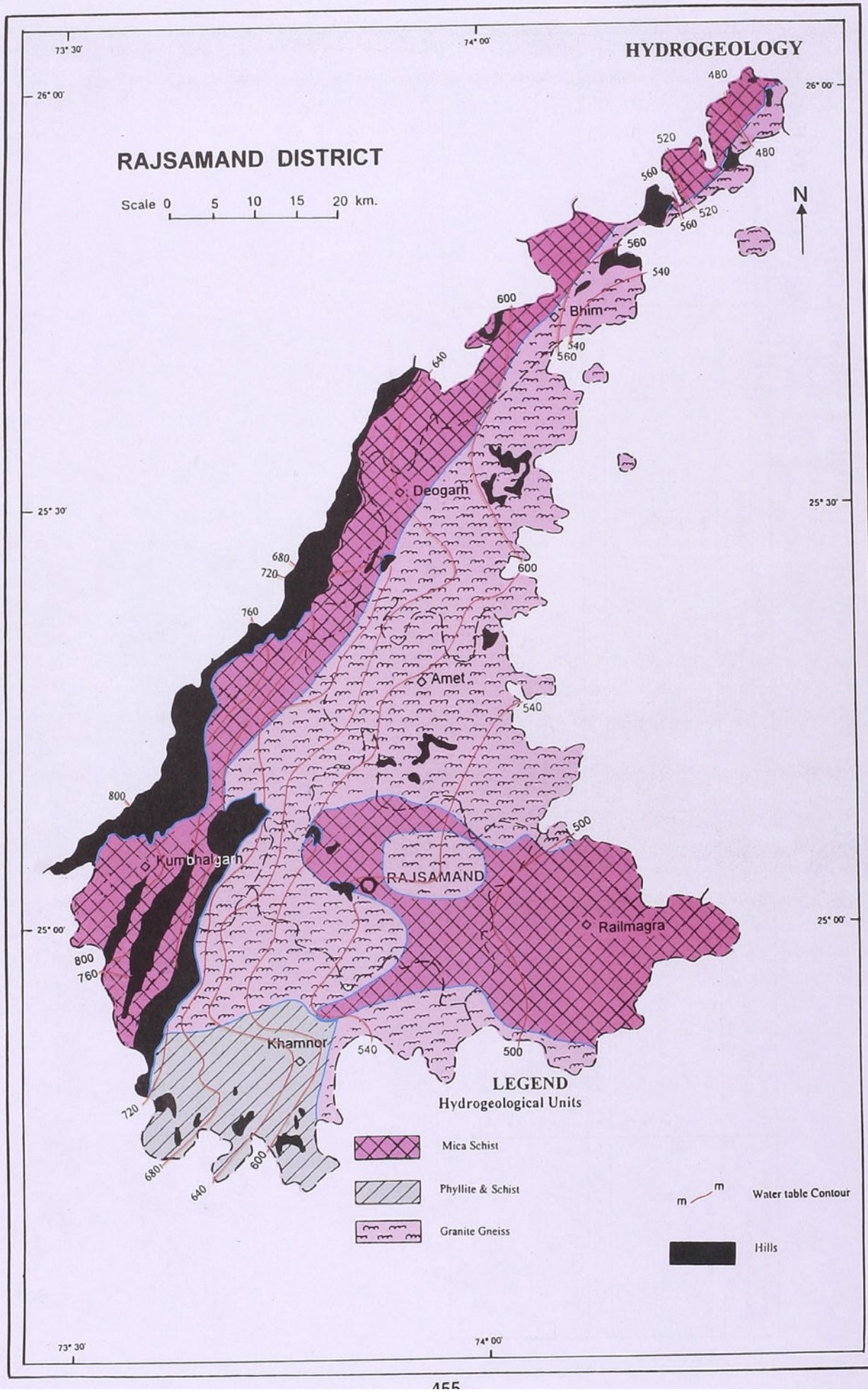
Landform Units	Symbol	Lithology / Material / Description	Occurrence in district	Land use/Land cover
Fluvial Origin				
Alluvial Plain	AP	Mainly undulating land scape formed due to fluvial activity, consists of gravels, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium by river system.	Along river Banas in eastern part of district.	Double crop, single crop (Rabi / Kharif), fallow.
Valley Fill	VF	Formed by fluvial activity, usually at lower topographic locations, comprising of boulders, cobbles, pebbles gravels, sand, silt and clay. The unit has consolidated sediment deposits.	In central part of the districts, north of Rajsamand town.	Marginal double crop, single crop (Rabi).
Flood Plain	FP	The surface or strip of relatively smooth land adjacent to a river channel formed by river and covered with water when river over flows its bank. Normally subject to periodic flooding.	Along river Banas.	Marginal double crop, single crop (Kharif), fallow, open scrub.
Denudational Origin				
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.	Scattered in entire district. More concentration in east & south east.	Single crop (Kharif), fallow, open scrub.
Burried Pediment	BP	Pediment covered essentially with relatively thicker alluvial, colluvial or weathered materials.	Negligible along river Banas.	Marginal double crop, single crop (Rabi / Kharif), fallow.
Hill				
Structural Hill	SH	Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc.	South and south west to north.	Forest, open scrub.


GEOMORPHOLOGY
N
RAJSAMAND DISTRICT
Scale 0 5 10 15 20 km.
73°30'
74°00'
26°00'
25°30'
25°00'
Bhim
Deogarh
Amet
Kumbhalgarh
Banas River
RAJSAMAND
Railmagra
Khamnor
LEGEND
Lineament
- FAULTS/FRACTURES/JOINTS OF VARYING LENGTH AND BREADTH
Water Bodies
- RIVER/POND/RESERVOIR
Hills
- STRUCTURAL/LINEAR/ DENUDATIONAL
Landform Units :
Fluvial Origin :
Alluvial Plain
Valley Fill
Flood Plain
Denudational Origin :
Pediment
Burried Pediment

HYDROGEOLOGY

DISTRICT—RAJSAMAND

Hydrogeological units	Description of the unit/Geological section	Occurrence	Ground Water flow
Calc Schist, Gneiss and Mica schist (Delhi super group)	Calc schist and gneiss are hard and compact, fine to medium grained and characterised by alternating bands of light and dark colour ferromagnesian minerals. Mica schist is soft friable and closely cleavaged.	These cover south eastern area in Railmagra and Rajsamand blocks, and western peripheral area along the boundary of the district.	General direction of ground water flow has been inferred NW to SE or W to E. Hydraulic gradient is more steep in western and south western peripheral area. It gradually becomes gentle south eastward. Hydraulic gradient varies between 1.60 to 4.57 m/km.
Phyllite and Schist (Aravalli super group)	These represent argillaceous sediments and grades from shale, slate, phyllite to mica schist. The litho units are soft, friable and closely cleavaged.	These occur in a localised area in southern part of the district & confined to Khamnor block.	
Granite and Gneiss (Pre Aravalli)	These comprise porphyritic and non-porphyritic, gneissic complex associated with aplite amphibolite, schist and augen gneiss. Schist and gneiss are grey to dark coloured, medium to coarse grained rocks.	These litho units cover extensive area in central part of the district.	

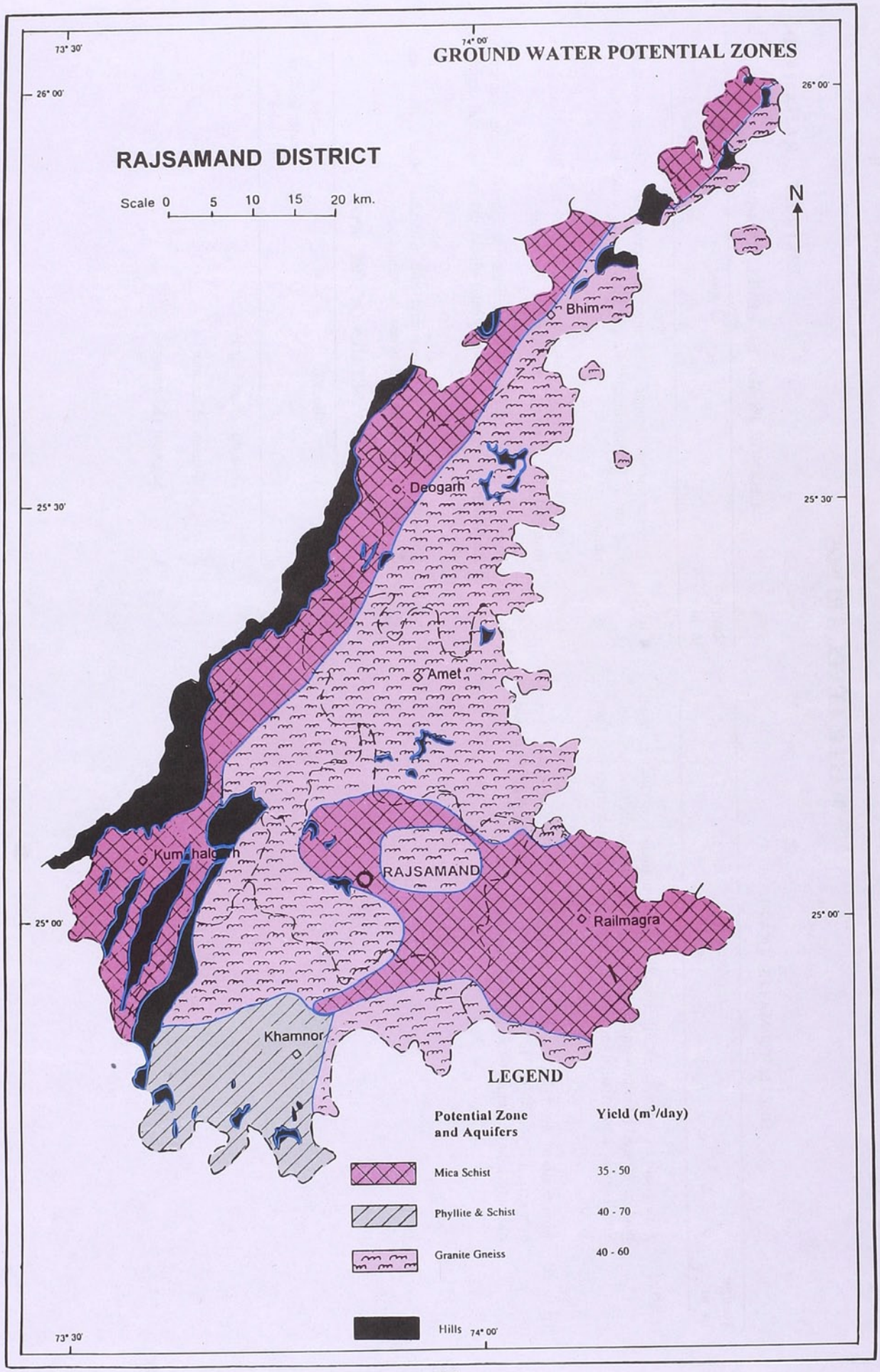

HYDROGEOLOGY
RAJSAMAND DISTRICT
Scale 0 5 10 15 20 km.
N
73° 30'
74° 00'
26° 00'
25° 30'
25° 00'
Bhim
Deogarh
Amet
RAJSAMAND
Railmagra
Kumbhalgarh
Khamnor
480
520
560
540
600
640
680
720
760
800
500
LEGEND
Hydrogeological Units
Mica Schist
Phyllite & Schist
Granite Gneiss
Water table Contour
Hills

GROUND WATER POTENTIAL ZONES AND DEVELOPMENT PROSPECTS

DISTRICT - RAJSAMAND

Aquifer in the Potential Zone (Area in Km²)	Occurrence * Block (Area in Km²)	Water Level (1997) in m.	Well Parameters			E.C. X10³µ siem/cm	Development Prospects
			Type	Proposed depth in m	Discharge in m³/day		
Mica Schist (1552.95)	* Bhim (232.78)	<15	DW	20-25	40-60	<2	Safe
	* Deogarh (123.75)	<10	DW	20-25	40-60	<2	Safe
	* Kumbhalgarh (372.49)	<20	DW	20-25	40-60	<2	Safe
	* Railmagra (600.18)	<25	DW	20-25	40-60	<2	Safe
	* Rajsamand (223.75)	<20	DW	20-25	40-60	<2	Safe
Phyllite & Schist (251.23)	* Khamnor (251.23)	<20	TW/DW	80-90/20-25	80-100/50-70	<2	Safe
Granite Gneiss (1735.91)	* Amet (465.19)	<20	DW	20-25	45-60	<2	Safe
	* Bhim (104.38)	<15	DW	20-25	45-60	<2	Safe
	* Deogarh (267.01)	<20	DW	20-25	45-60	<2	Safe
	* Khamnor (424.63)	<25	DW	20-25	45-60	<2	Safe
	* Kumbhalgarh (164.07)	<20	DW	20-25	45-60	<2	Safe
	* Rajsamand (310.63)	<20	DW	20-25	45-60	<2	Safe

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


GROUND WATER POTENTIAL ZONES
RAJSAMAND DISTRICT
Scale 0 5 10 15 20 km.
N
73° 30'
74° 00'
26° 00'
25° 30'
25° 00'
Bhim
Deogarh
Amet
Kumbhalgarh
RAJSAMAND
Railmagra
Khamnor
LEGEND
Potential Zone and Aquifers
Yield (m³/day)
Mica Schist
35 - 50
Phyllite & Schist
40 - 70
Granite Gneiss
40 - 60
Hills

WATER LEVEL TRENDS

DISTRICT : RAJSAMAND

DEPTH TO WATER LEVEL

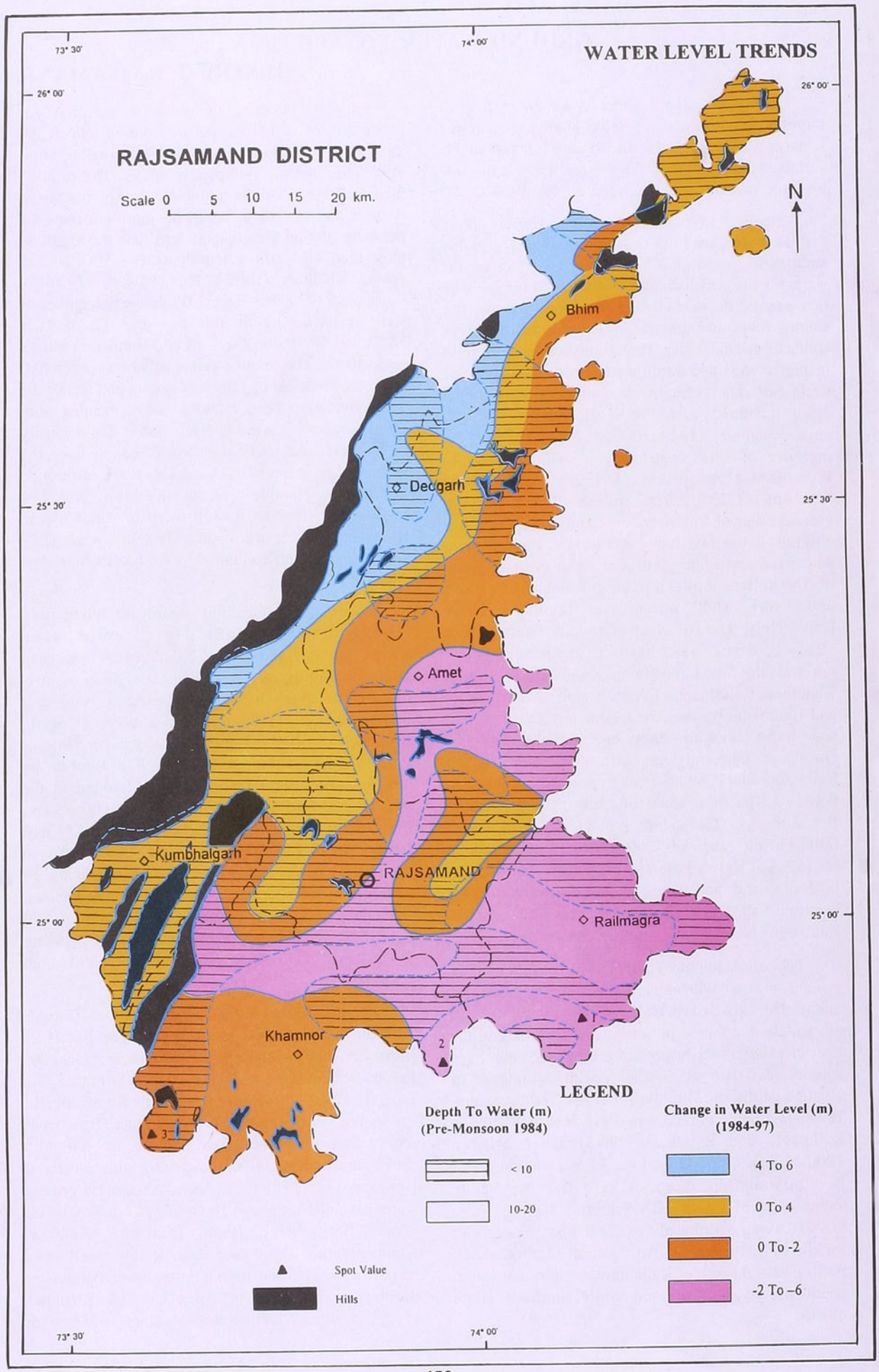
Range in m	Area
< 10	Area south of Amet extending upto the district boundary, excluding some pockets around Khamnor and Railmagra blocks, have shallow water level. Small pockets distributed in northern part also have water level less than 10 m.
10 to 20	Area north of Amet, leaving aside some pockets, has depth to water level between 10 to 20 m. In southern part, area around Khamnor and Railmagra have depth to water level within the range.

CHANGE IN WATER LEVEL (1984-1997)

Range in m	Area
4 to 6	Western part of Deogarh streching northward upto Bhim and southward in parts of Kumbhalgarh block exhibit rise in water level between the range.
0 to 4	Kumbhalgarh block and part of Amet, Deogarh and Bhim blocks show marginal rise in water level between the range.
0 to -2	Part of Khamnor block and northeastern peripheral region comprising Bhim, Amet, Deogarh and Rajsamand blocks exhibit marginal depletion in water level less than 2 m.
-2 to -6	Railmagra and part of Rajsamand and Khamnor blocks show steep depletion in water level between the range.

DETAILS OF THE SPOT

Spot code	Village (Block)	Change in water level in m (1984-97)
1.	Gawardi (Railmagra)	(-) 11.35
2.	Mogana (Khamnor)	(-) 12.70
3.	Sagroon (Khamnor)	(-) 10.00


WATER LEVEL TRENDS
RAJSAMAND DISTRICT
Scale 0 5 10 15 20 km.
N
73° 30'
74° 00'
26° 00'
25° 30'
25° 00'
Bhim
Deogarh
Amet
Kumbhalgarh
RAJSAMAND
Railmagra
Khamnor
1
2
3
LEGEND
Depth To Water (m)
(Pre-Monsoon 1984)
< 10
10-20
Change in Water Level (m)
(1984-97)
4 To 6
0 To 4
0 To -2
-2 To -6
Spot Value
Hills

GROUND WATER POTABILITY
DISTRICT RAJSAMAND

Quality of ground water is assuming a great importance with the degradation of environment and surface water resources. In absence of sustainable surface water resources, the ground water is the sole resource of safe drinking water in the district.

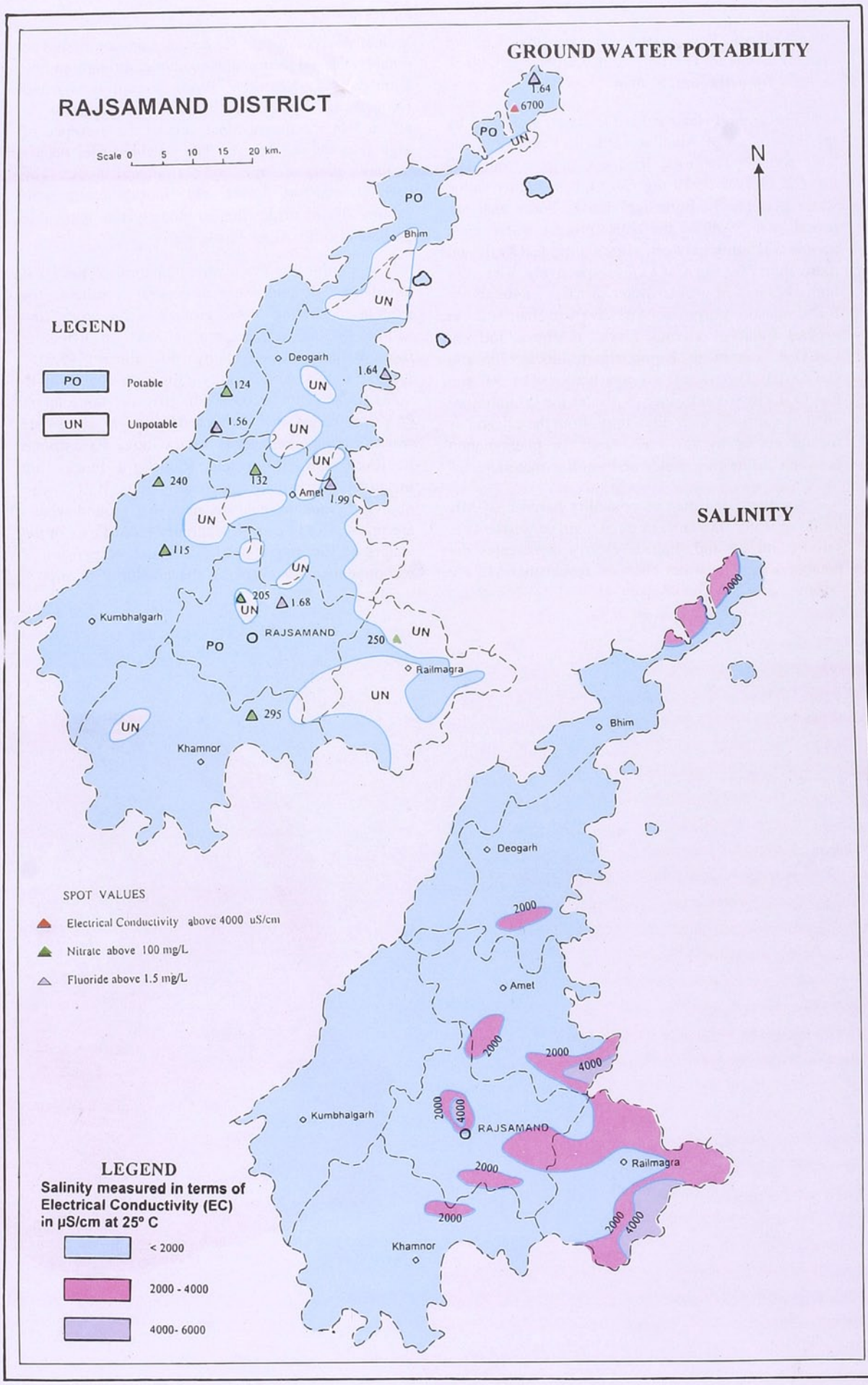
Chemical investigation of ground water shows that the waters are fresh to slightly saline. The highly undulating topography has a marked effect on the water quality which changes from fresh to saline with increase in depth to water at many places. The salinity map illustrates the variation in the dissolved solids of ground water. The salinity varies from fresh in north, west and south-west to saline in east and south-east. The average values of salinity of ground water in Kumbhalgarh (906 µS/cm), Bhim (1282 µS/cm), Khamnor (1449 µS/cm) blocks reveal the presence of fresh water while slightly saline in Rajsamand (1583 µS/cm), Deogarh (1633 µS/cm) and Amet (1739 µS/cm) blocks. The salinity in ground water of Railmagra block (Avg. EC 2434 µS/cm) falls in the moderately saline class. The minimum and maximum salinity are noticed in the well water of Aret ki Bhagal (400 µS/cm) in Kumbhalgarh block and Kotri (8600 µS/cm) in Railmagra block respectively. The bar chart of salinity indicates that 79.8% of ground water have EC less than 2000 µS/cm and are found mostly in Kumbhalgarh, Bhim, Khamnor, Rajsamand, Deogarh and parts of Amet and Railmagra blocks. The moderately saline ground water (15.61%) with salinity between 2000-4000 µS/cm occur frequently in north and south east of Railmagra block, small areas in north small patch in north of Khamnor, south of Deogarh and north of Bhim blocks. The saline ground water (12.89%) falling in the range of 4000-6000 µS/cm and above are found at Kelwa-Pasoond and Galwa-Jhar sections in Rajsamand and Amet block respectively. Few localised saline ground water pockets also exists in Railmagra block.

The mix cationic character is predominant in ground waters with bicarbonate as the principal anion. The mix-bicarbonate type of water (50.79%) are widely distributed in north, west and south of the district. These mix-bicarbonate type of water have salinity less than 1000 µS/cm with dominance of alkaline earths showing the water are fresh in nature. However, salinity of such waters in Deogarh, Khamnor, Railmagra and Rajsamand blocks range between 1000-1500 µS/cm. More than 31.5% ground water have mix-mix type character and fall in the slightly saline class of salinity. The chloride type of water (18%) having salinity above 2000 µS/cm occurs in middle & south east of Amet, north of Rajsamand, north-east and south of Railmagra, north of Khamnor, south-east of Deogarh and entire north of Bhim blocks.

Fluoride in drinking water is essential for prevention of dental carries in children and at the same time if it is excess from the permissible limit, may cause chronic fluorosis in adults. The fluoride map indicates that the ground water is free from fluoride hazard. The bar chart of fluoride reveals the presence of fluoride contents less than 1.5 mg/L in more than 75% well waters of Amet (75%), Bheem (76%), Khamnor (100%), Kumbhalgarh (79.16%), Rajsamand (77.78%) blocks. While the percentage of well waters having fluoride less than 1.5 mg/L is 58.33 and 40.91% in Deogarh and Railmagra blocks respectively. The fluoride contents between 1.5 to 3.0 mg/L are observed in 22% well waters and rest of the 4% water have been found to be associated with fluorides above 3.0 mg/L. Such waters occur mostly in Deogarh and Railmagra blocks which have the high average values of 1.45 and 1.81 mg/L of fluoride respectively. Fluoride contents varies from 0 to 5.94 mg/L with maximum in well water of Amaratiya in Kumbhalgarh block, a moderately saline water (EC-2300 µS/cm) with sodium-chloride bicarbonate type character.

Water analyses exhibit significant relationship between fluoride and alkalinity of ground water. Higher fluorides (above 1.5 to 3.0 mg/L) are associated with low salinity waters with either sodium or mix-biocarbonate type character and occur in south-east and north-east of Bhim block; parts of Deogarh, Kumbhalgarh, Amet, Rajsamand and major parts of Railmagra blocks. More than 3.0 mg/L of fluoride are also associated with low salinity and found in the phyllite-schist aquifers of Meriya (EC-1600 µS/cm, F-3.31 mg/L), Railmagra (EC-920 µS/cm, F-4.91 mg/L and Sadri (EC-1690 µS/cm, F-4.00 mg/L) in Railmagra block, Nathoowas (EC-1870 µS/cm, F-4.90 mg/L) in Rajsamand block. The granite-gneises/calegneiss aquifers at Teeker (EC-670 µS/cm, F-4.90 mg/L in Amet block and Amartiya (EC-2300 µS/cm, F-4.94 mg/L) in Kumbhalgarh also yield high fluorides.

The nitrate content ranges from 0 to 370 mg/L with an average value of 48 mg/L. The bar chart illustrates that its concentration in more than 89% ground waters have been less than 100 mg/L. The ground waters in Bhim, Khamnor, Kumbhalgarh, Railmagra and Rajsamand blocks are free from nitrate contamination. High nitrates are normally found in moderately saline water with electrical conductivity of 2000-4000 µS/cm. About 11% ground water have nitrates above 100 mg/L and includes well waters from Amet, Bhim, Deogarh, Khamnor, Kumbhalgarh, Rajsamand and Railmagra blocks respectively. The contamination of ground water by nitrates is significant in Amet (35%)& Khamnor (16.67%) blocks and to some extent in Deogarh

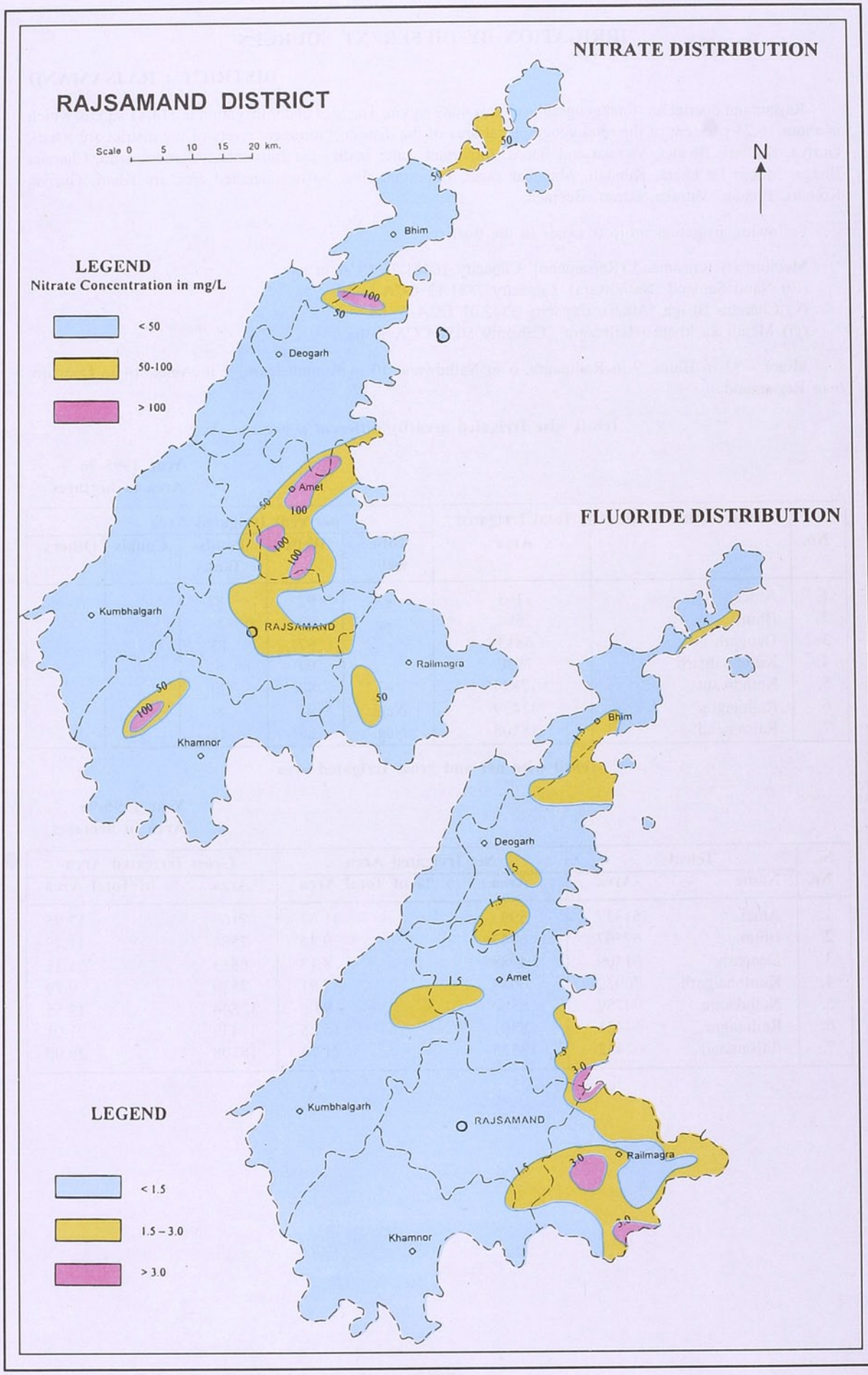

GROUND WATER POTABILITY
RAJSAMAND DISTRICT
Scale 0 5 10 15 20 km.
N
LEGEND
PO Potable
UN Unpotable
SPOT VALUES
Electrical Conductivity above 4000 uS/cm
Nitrate above 100 mg/L
Fluoride above 1.5 mg/L
Deogarh
Bhim
Amet
Kumbhalgarh
RAJSAMAND
Railmagra
Khamnor
1.64
6700
124
1.56
240
132
1.99
115
205
1.68
250
295
SALINITY
LEGEND
Salinity measured in terms of Electrical Conductivity (EC) in µS/cm at 25° C
< 2000
2000 - 4000
4000- 6000

(9.66%) block. Few ground water pockets of nitrate contamination are also noticed in Kumbhalgarh block as seen from the nitrate map.

The ground water is hard in nature as shown by the dominance of Alkaline earths in majority of the well waters. The total hardness ranges from 100 mg $CaCO_3$/L to 1950 mg $CaCO_3$/L, a highly saline water of Kotri in Railmagra block. Water analyses reveal that 39.89% and 13% ground water have hardness ranging between 300-600 mg $CaCO_3$/L and more than 600 mg $CaCO_3$/L respectively. The very high hardness in ground water restricts its suitability for domestic purposes. The average hardness in ground water of various blocks is above 360 mg $CaCO_3$/L except in Kumbhalgarh block (295 mg $CaCO_3$/L). The overall average hardness of 391 mg $CaCO_3$/L) in ground water illustrates the saturation of alkaline earths by their dissolution from the calcareous formations or by the base exchange phenomenon between infiltrating water and aquifer material.

An integrated map of potability based in ICMR drinking water standards of three main parameters i.e. salinity, nitrate and fluoride clearly demarcates the potable area. The water analyses reveal that 64.74% ground waters are safe for human consumption. The potable ground water are available throughout the Kumbhalgarh, Khamnor, Bhim (except north) and Deogarh (except south) blocks. The potability is affected in Railmagra block due to the presence of high fluoride and salinity. The potable water occurs in major parts of Amet and Rajsamand blocks. The high contents of nitrate and flouride along with salinity have made the ground water unpotable particularly in Amet block.

Agriculture is the main occupation of the local population. Ground water in general is suitable for irrigation. Around 80% ground water with low salinity (<2000 µS/cm) are suitable for irrigating most of the crops on loamy soils. Further 15.61% ground waters with salinity ranging from 2000 to 4000 µS/cm can be used for growing salt-tolerant crops on loamy soils with good drainage. The saline waters having conductivity values above 4000 µS/cm in Rajsamand, Bhim and Railmagra blocks are unsuitable for irrigation on loamy soils. It is also observed from the analysis data that ground waters are practically free from alkalinity hazard except the waters of Railmagra block.. The use of gypsum is recommended for checking the alkalinity hazard.


NITRATE DISTRICT
RAJSAMAND DISTRICT
Scale 0 5 10 15 20 km.
N
LEGEND
Nitrate Concentration in mg/L
< 50
50-100
> 100
Bhim
Deogarh
Amet
Kumbhalgarh
RAJSAMAND
Railmagra
Khamnor
50
100
FLUORIDE DISTRICT
LEGEND
< 1.5
1.5 – 3.0
> 3.0
1.5
3.0