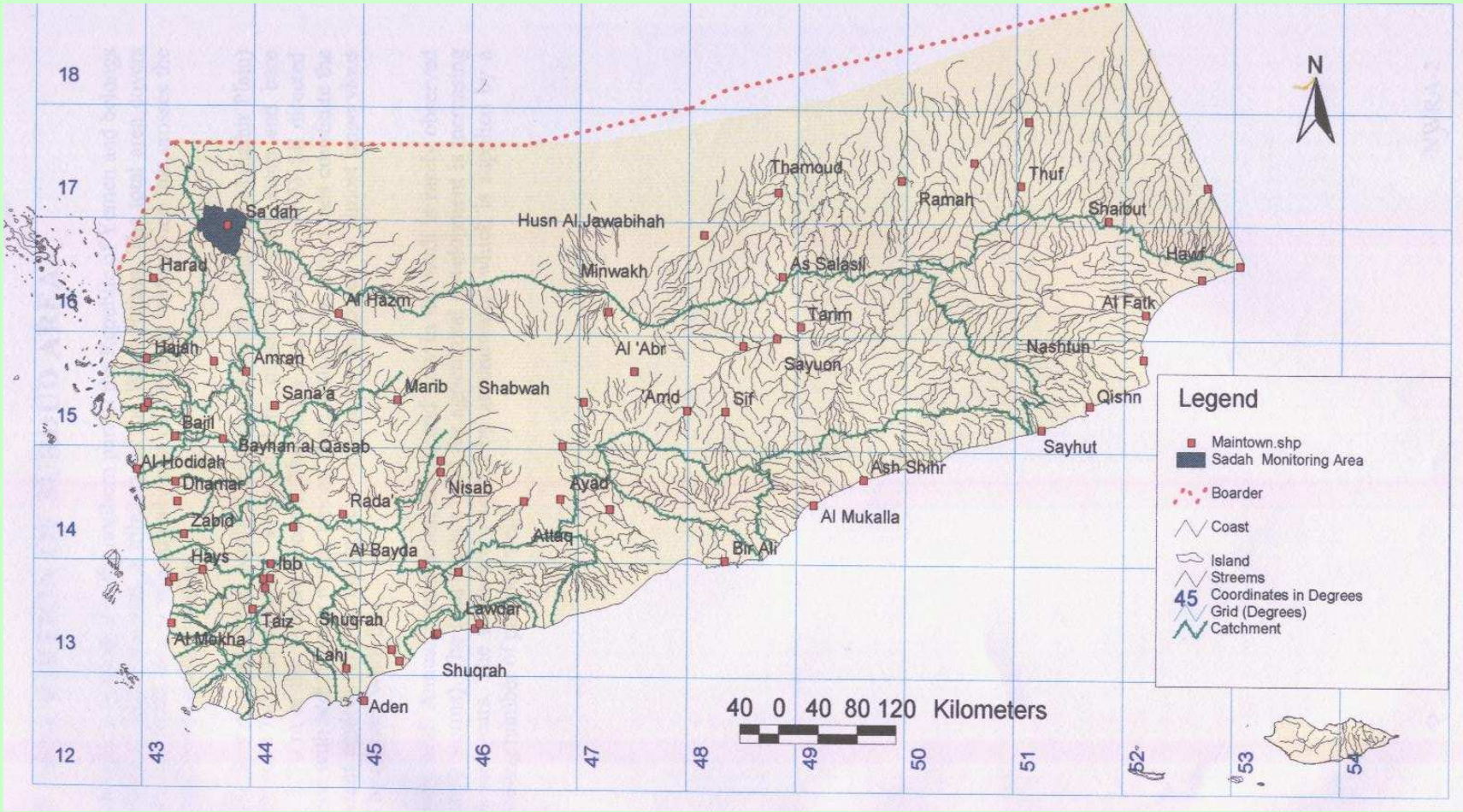
Sadah basin :

- It is located in the northwestern part of Yemen
- It extending over approximately 1147 km2
- It belongs to the catchment of Wadi Marwan, a tributary of the Wadi Najran
- It includes the alluvial Sadah plain and the bordering hilly and mountainous zones draining towards it



Climate:

- **The area is relatively arid**

  Annual precipitation is low

  Flow in the Wadi is rarely observed (only after heavy rain storms)

Hydrological network:

The hydrological network of Sadah contains the following stations:

- **1 meteorological station (Temp., R. Humidity, Radiation, W. Speed, wind direction and Rainfall)**
- **4 rainfall stations and**
- **29 observation wells**

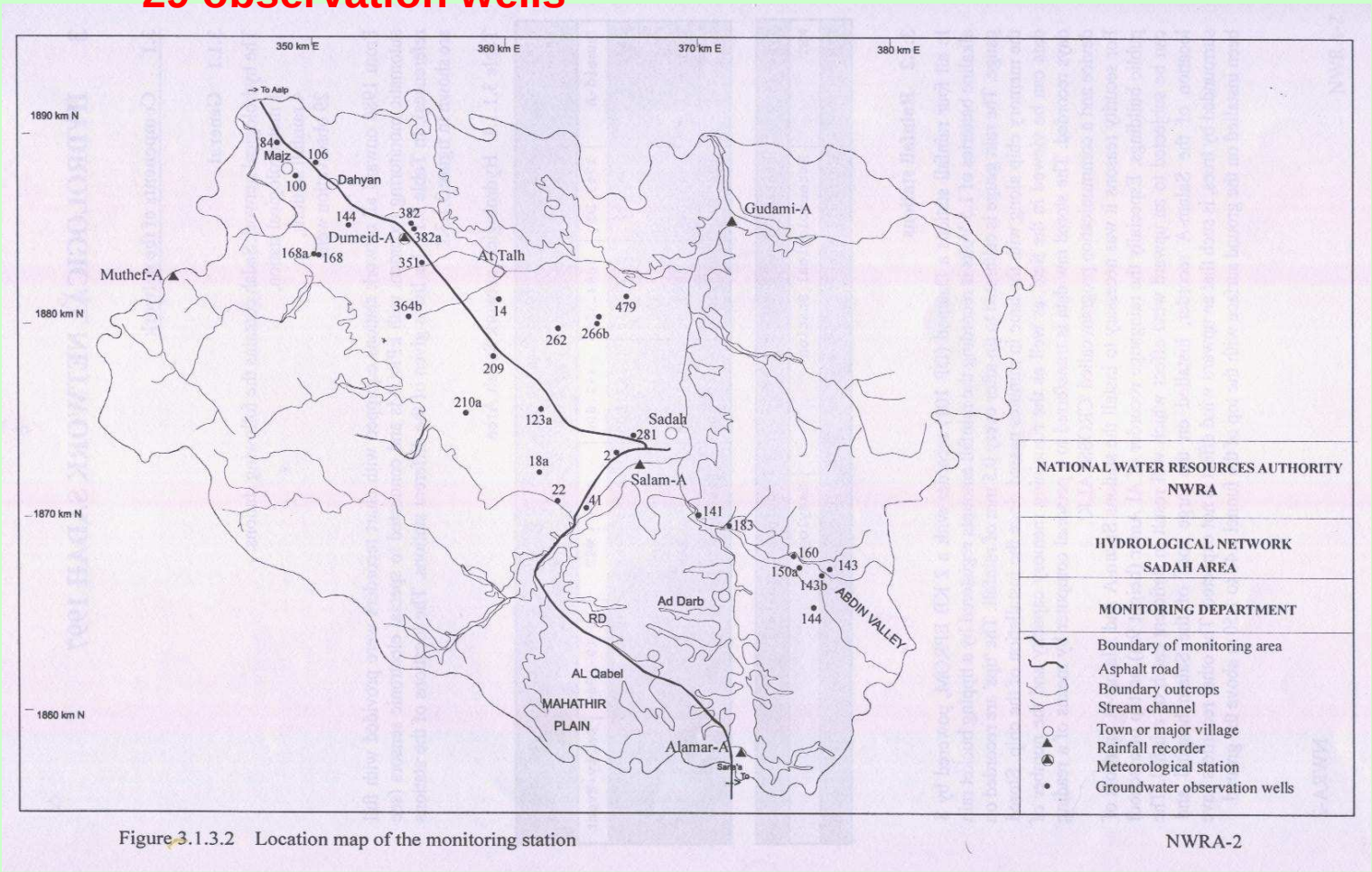


Figure 3.1.3.2 Location map of the monitoring station

NWRA-2

Intensity of rainfall:

Al-Dumaid station represent the Sadah plain

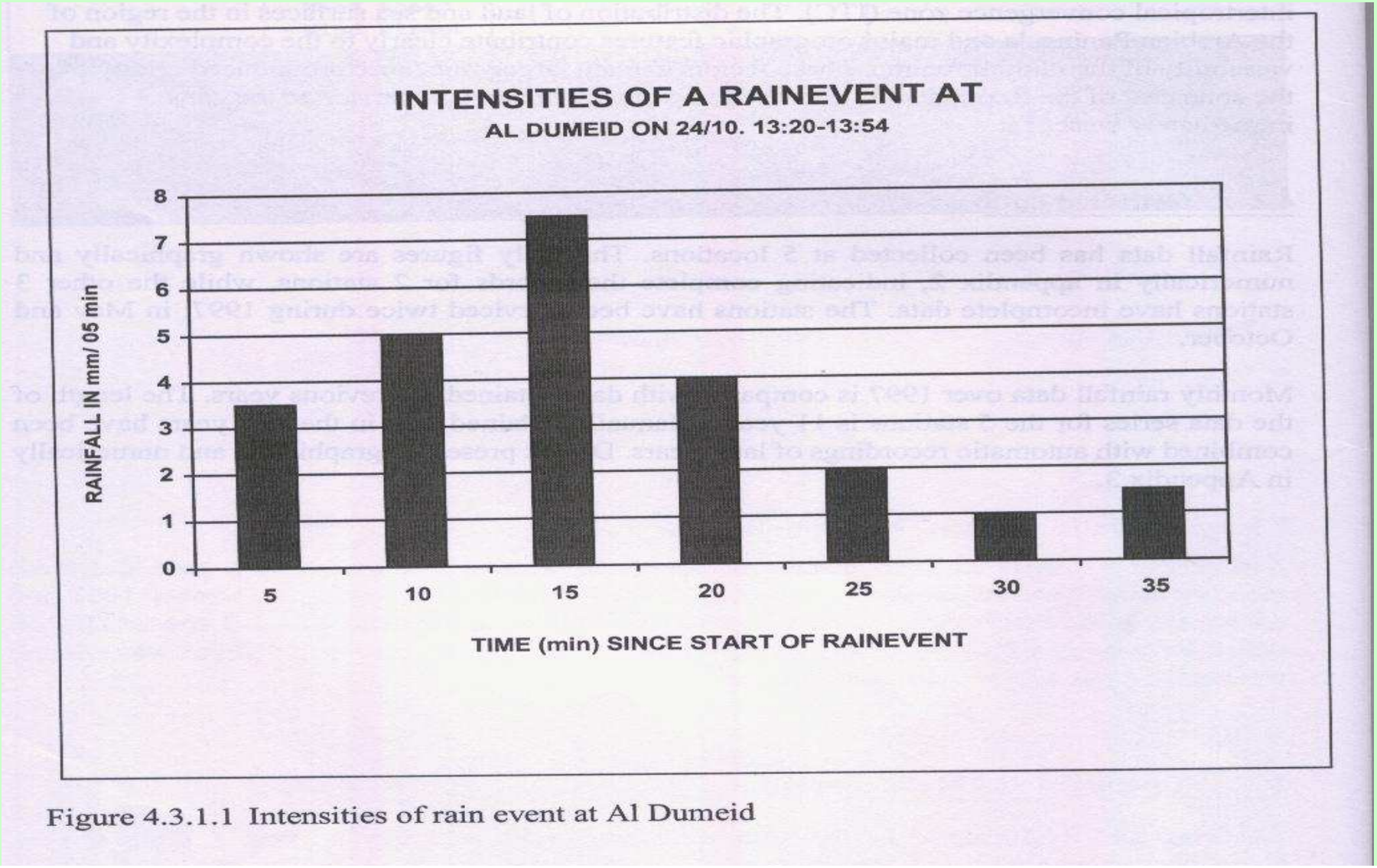
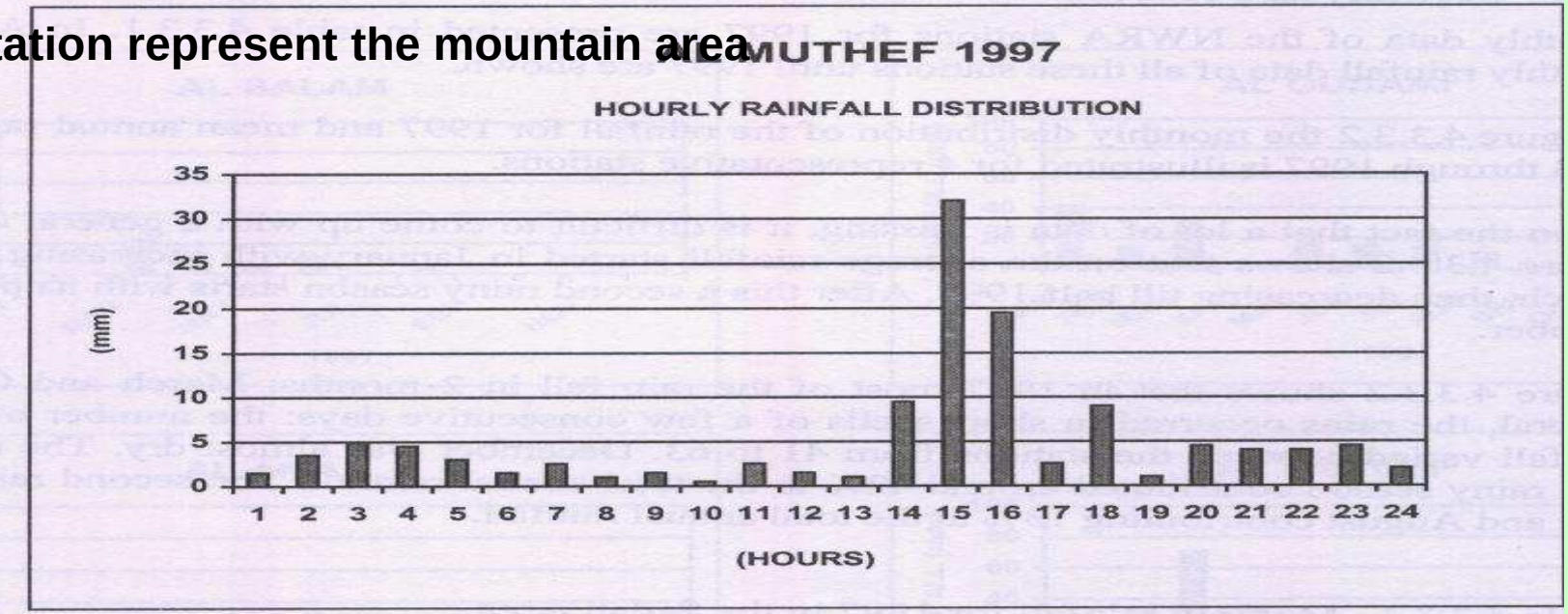


Figure 4.3.1.1 Intensities of rain event at Al Dumeid

Al-Muthef station represent the mountain area



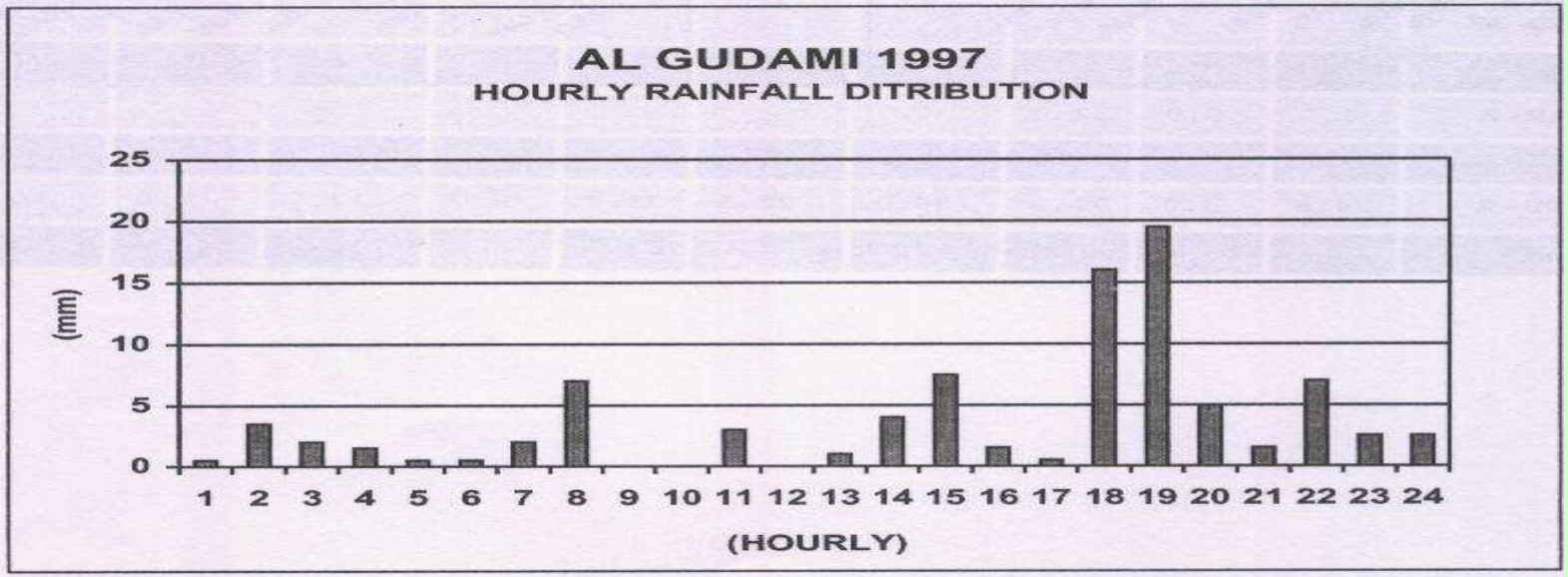


Figure 4.3.1.2 Hourly rainfall distribution for Al Muthef and AL Gudami

Spatial variation of rainfall:

- Rainfall tends to occur during the spring and summer rainy seasons.

- It usually occurs as storm events at the afternoon time

- The isohyets lines show decreasing of precipitation in eastern direction. This due to the fact that the area is located in a transition zone between the relatively humid western highlands and extremely arid desert of the :Empty Quarter" in the east

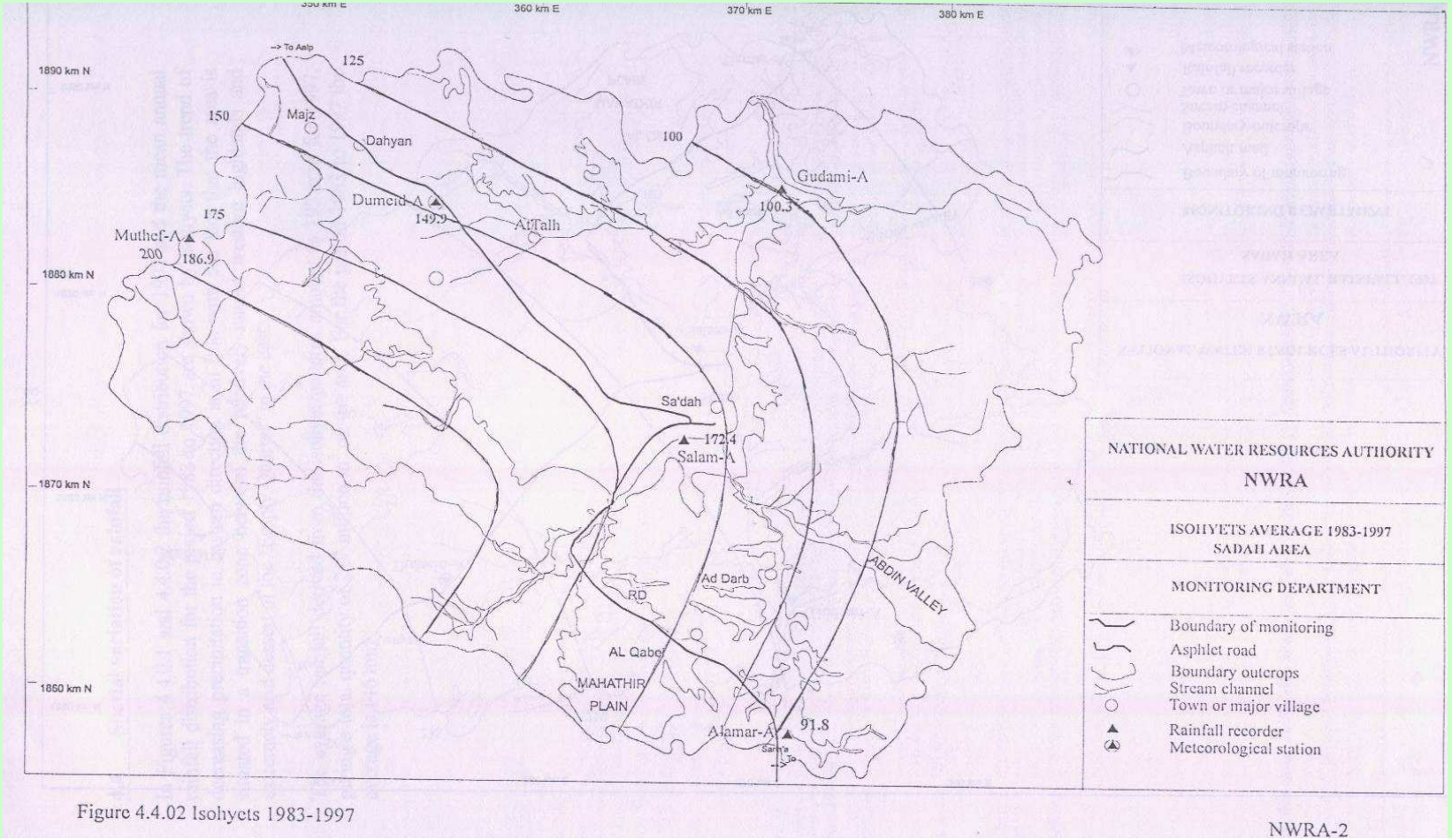


Figure 4.4.02 Isohyets 1983-1997

NWRA-2

Geology:

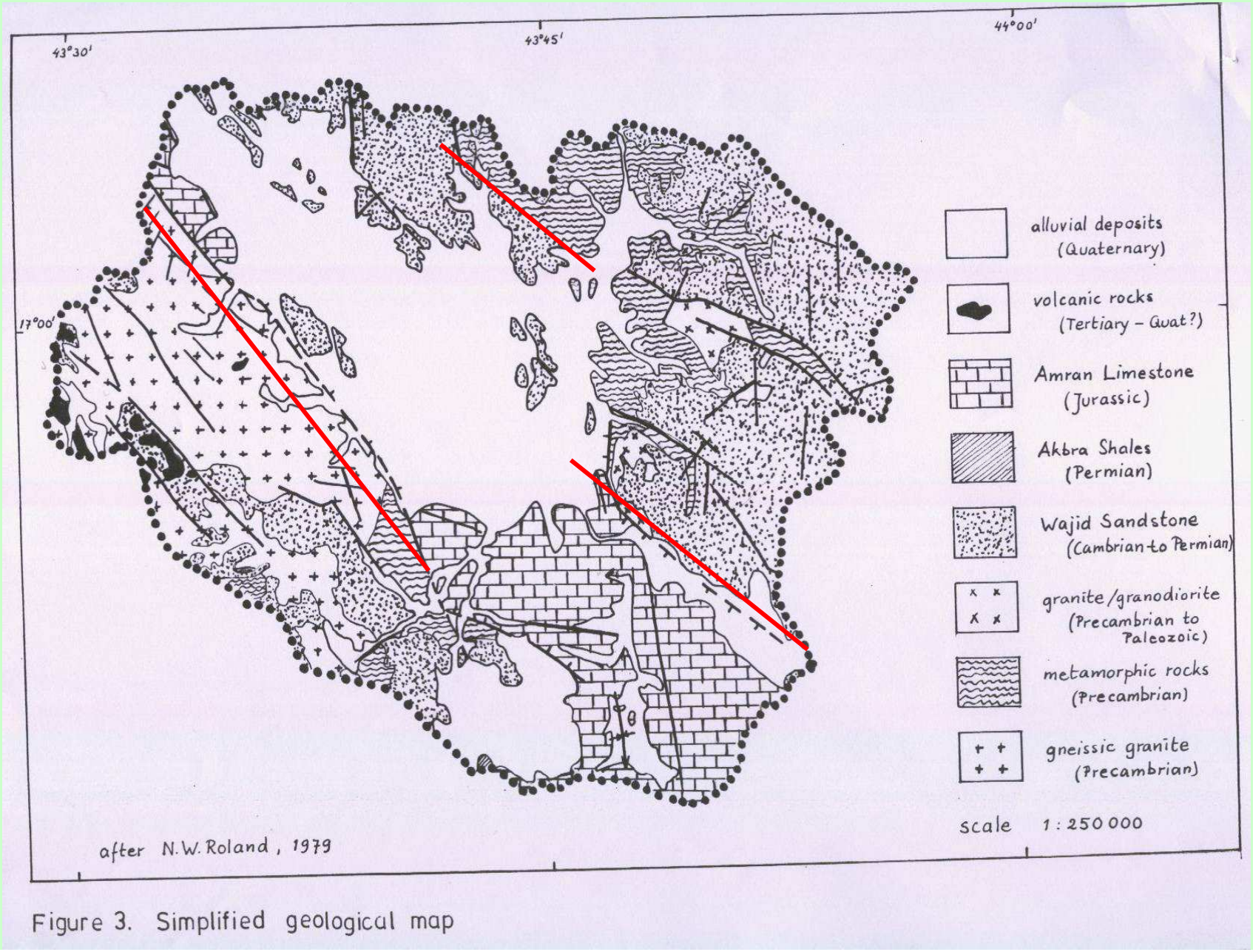


Figure 3. Simplified geological map

	GEOCHRONOLOGY	LITHOSTRATIGRAPHY	LITHOLOGY	HYDROGEOLOGY
Cainozoic	Quaternary	Recent unconsolidated formations	gravels, sands, silts, clays	medium to high permeability; shallow aquifers in/along wadi beds; mostly unsaturated on the Sadah Plain
	Tertiary	Yemen Volcanics (Trap Series)	basalts, andesites, rhyolites, tuffs	low permeability, hydrogeologically insignificant in the Sadah area.
Mesozoic	Jurassic	Amran Limestone	partly dolomitic or ferruginous limestone; alternating with shales and marls	poor aquifer, permeable zones limited to fracture zones
	Triassic	Kohlan Sandstone	fine-grained quartz sands	potential aquifer
Paleozoic	Permian	Akbra shales	glacio-marine laminated shales containing boulders of basement rocks	low permeability
	Carboniferous	(Upper) Wajid sandstone	crossbedded medium-to coarse-grained quartz sands with intercalations of clays and silts	poor to moderate aquifer
	Ordovician	(Lower) Wajid Sandstone	crossbedded medium-to coarse-grained quartz sands; quartzitic ironstones; thin basal conglomerates	
	Cambrian			
Precambrian		Basement complex	granites gneisses schists quartzites	impermeable bedrock; locally some water can be present in cracks and fissures near the surface.

Table 1 : Principal stratigraphic units and their lithological and hydrogeological characteristics

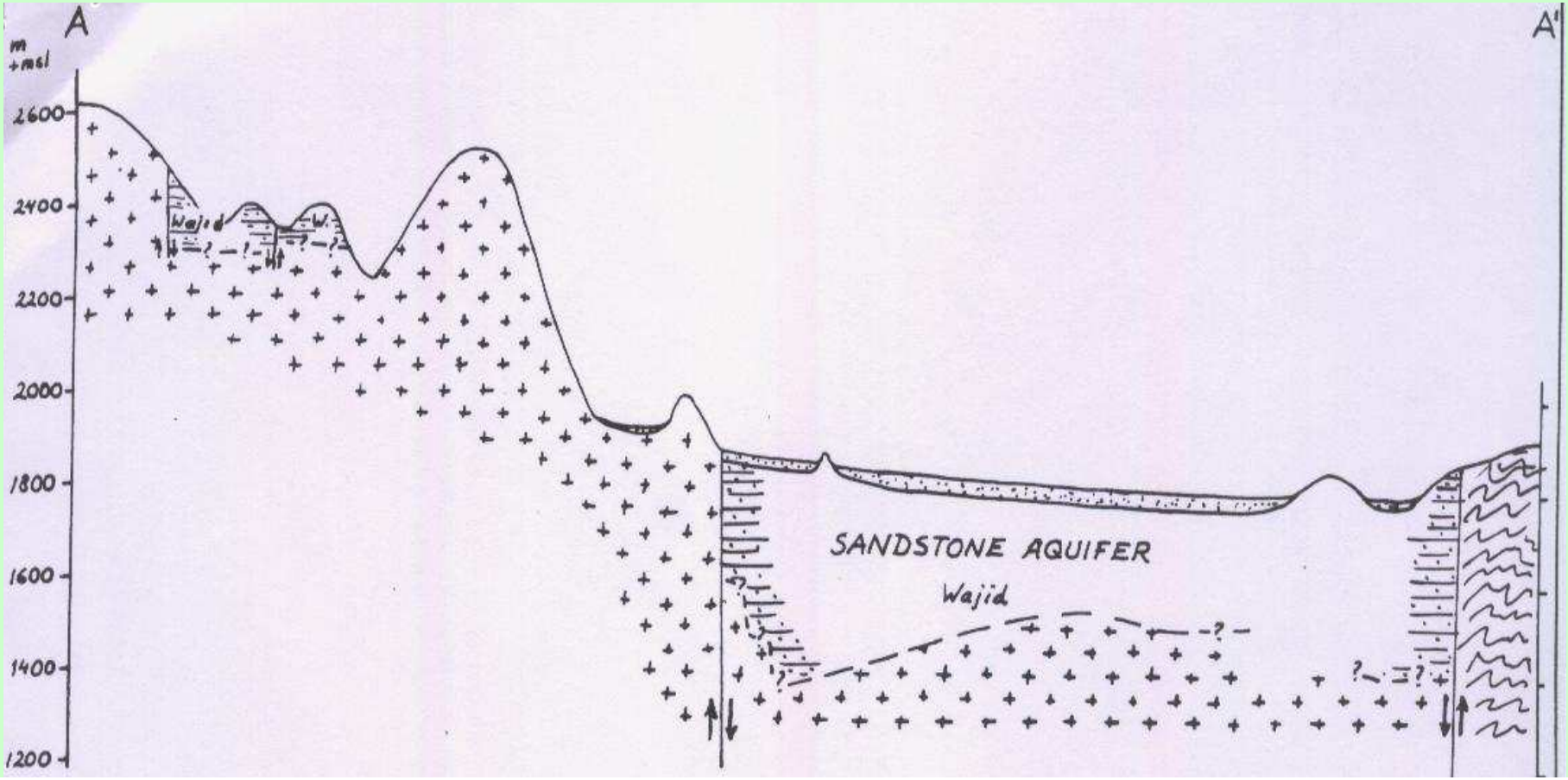
Principal Aquifer System:

Three types of aquifer units are of importance:

1. **Wajid sandstone or perhaps kohlan sandstone**
2. **Limestone aquifer units (Amran limestone)**
3. **alluvium aquifer zone (saturated Quaternary unconsolidated deposits)**

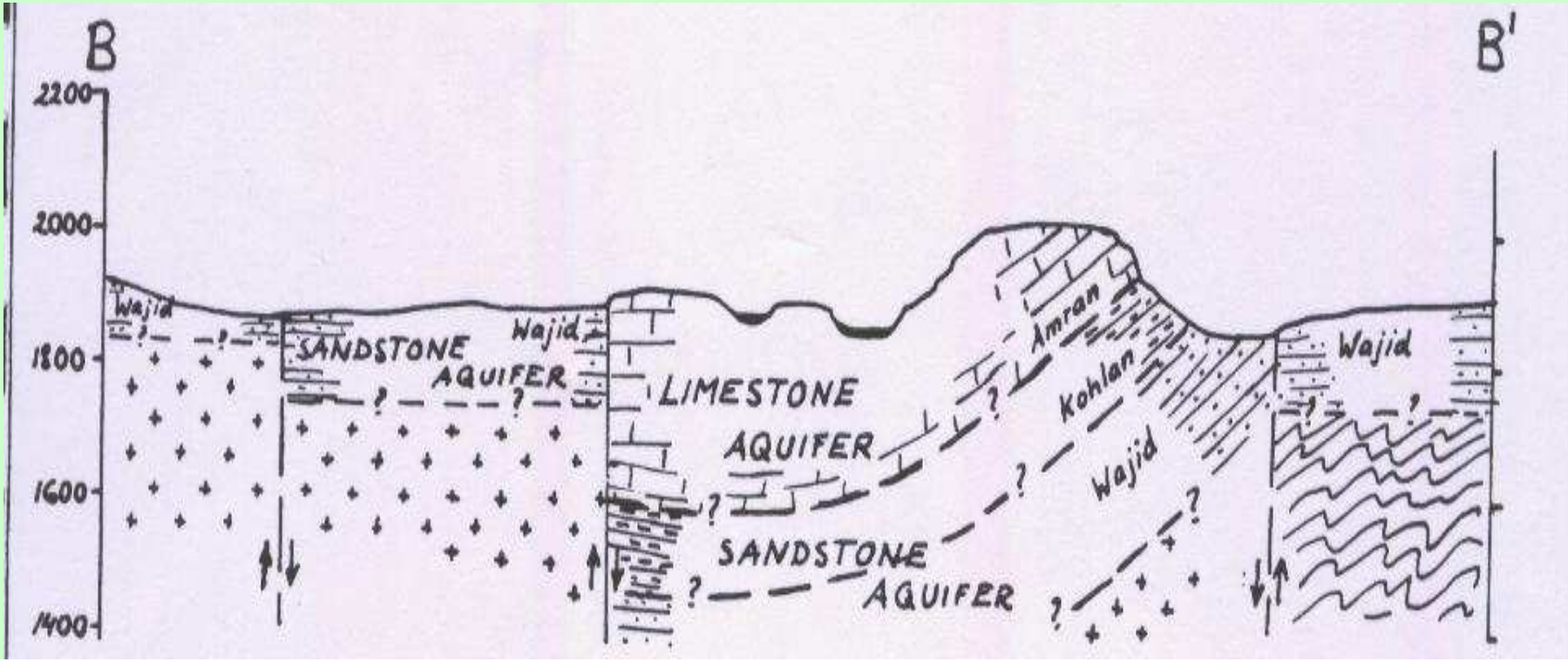
The Wajid Sandstone Aquifer Units:

- **Wajid sandstone aquifer is the most important aquifer in Sadah plain**
- **It lays on top of impermeable basement rocks.**
- **It covered by permeable unconsolidated sediments between 10 and 40 m thick**
- **This aquifer is laterally bounded by the major faults of the graben system**



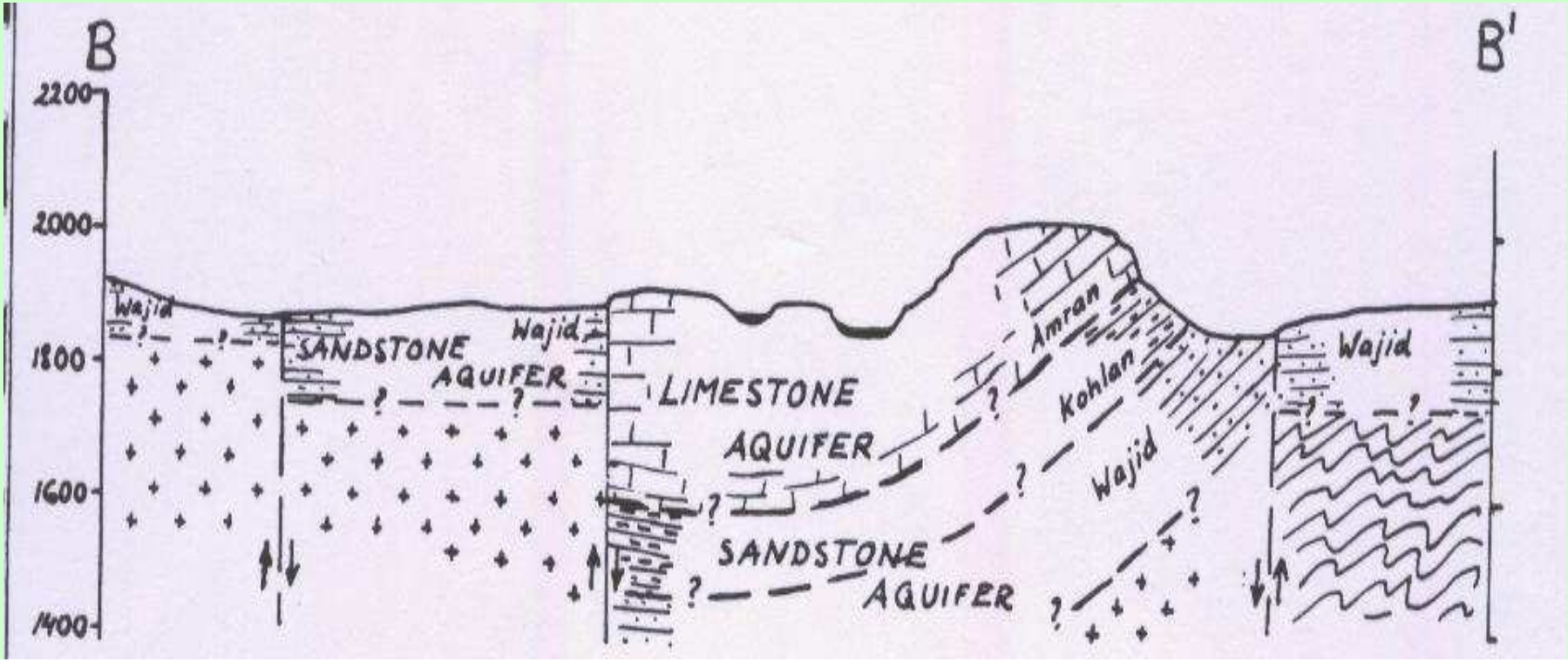
• **The wajid sandstone aquifer is become south of Sadah town confined under thick layers of Kohlan sandstone and Amran limestone.**

• **Only in the valley of Wdi Abdin these layers have been removed by erosion and Wajid sandstone be observed at or near ground surface.**



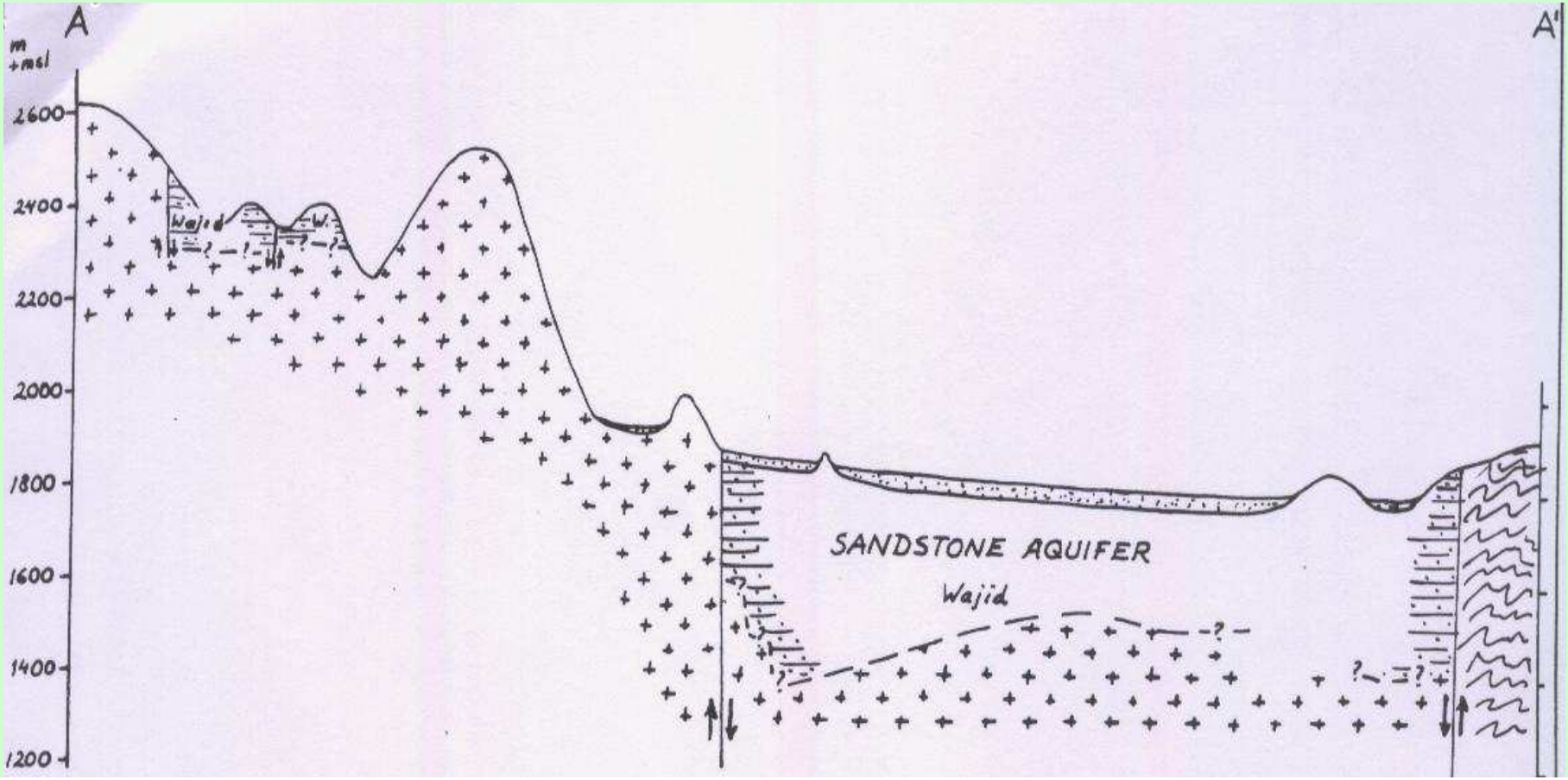
The limestone aquifer Units:

- They constitute poor aquifers
- Groundwater storage and flow seem to be connected to fissures and cracks
- The total thickness of this aquifer may exceed 3oo m.



The alluvium Aquifer zones:

- These zones are linked to the valleys of the major wadis
- They have favorable hydraulic characteristics.



Groundwater level observation wells:

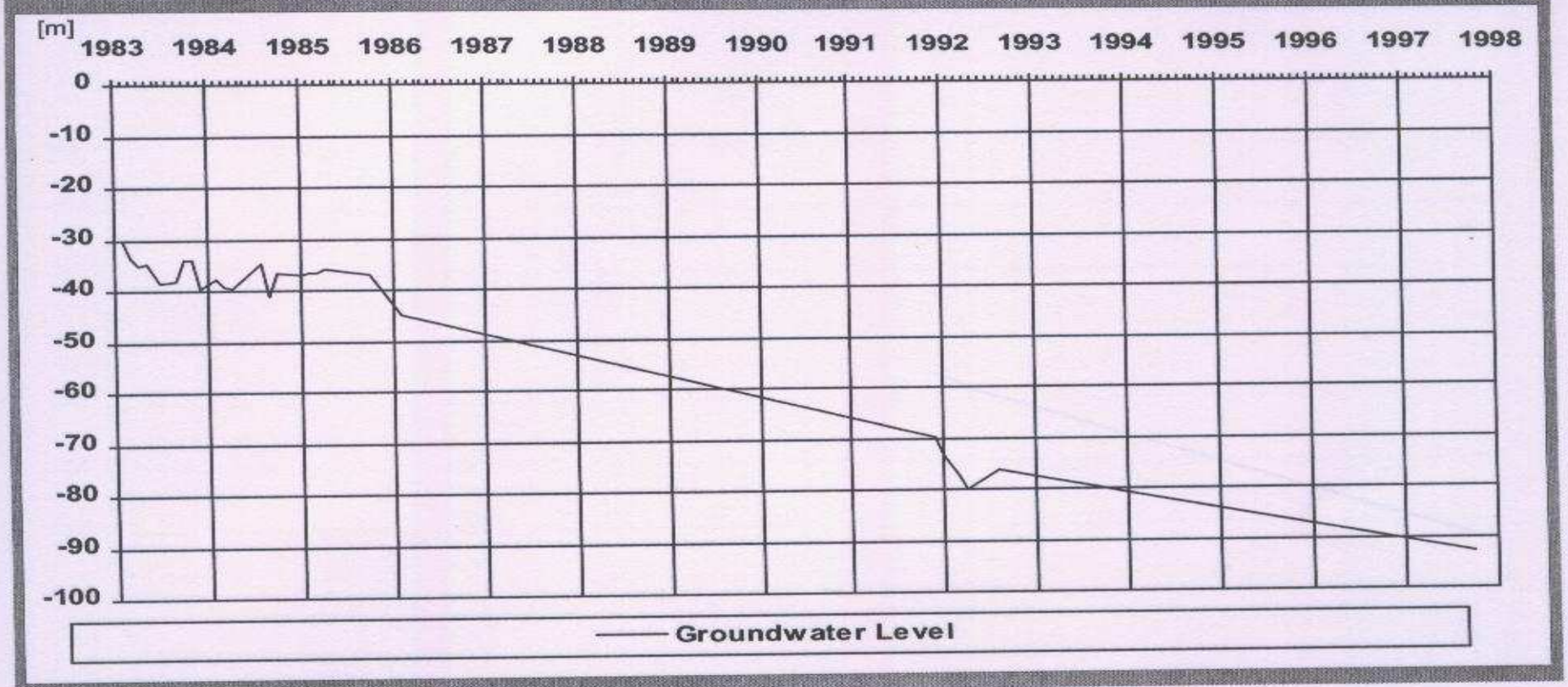
A total of 29 observation wells have started to be monitored 3 times a year. These measurements were supposed to be monthly.

Table: 6.2.0.1 Difference of groundwater levels between Dec.1991 and Oct.1997

Map sheet	Well No.	Av.G.W.L for each well in 91	Av.G.W.L for each well in 92	Av.G.W.L for each well in 97	Difference G.W.L.(m) between 91& 97
1643-B1	281	52.78	56.29	76.24	-23.46
	266b	47.62	-	-	-
	209	51.34	52.07	63.21	-11.87
	18a	57.30	60.11	89.84	-32.54
	2	69.95	76.74	92.90	-22.95
	41	33.40	35.51	38.04	-4.64
	262	56.35	-	-	-
1643-B2	141	31.98	34.83	50.85	-18.87
	160	39.00	34.85	71.00	-32
	143	71.28	73.01	81.25	-9.97
	143b	-	72.26	81.81	-
1743-D3	14	66.92	-	-	-
	382a	64.33	67.00	80.77	-16.44
	106	35.58	-	-	-
	84a	38.50	39.08	44.15	-5.65
	100a	-	56.95	72.26	-
	168	62.53	64.20	94.79	-32.26
	144	48.47	50.91	64.56	-16.09
	382	67.34	68.87	85.26	-17.92
	364b	68.07	76.41	103.71	-35.64
	479	49.32	52.11	-	-
	106	35.58	37.73	48.95	-13.37
Annual average of drawdown					- 3.27

Studies and Information Section (SIS)
National Water Resources Information Center (NWRIC)

Station:	SAB1-2	**UTM North:**	1,872,740 m	**Elevation:**	1,805 m + MSL
Operated by:	NWRA	**UTM East:**	365,310 m	**Installed:**	10 Feb 1983

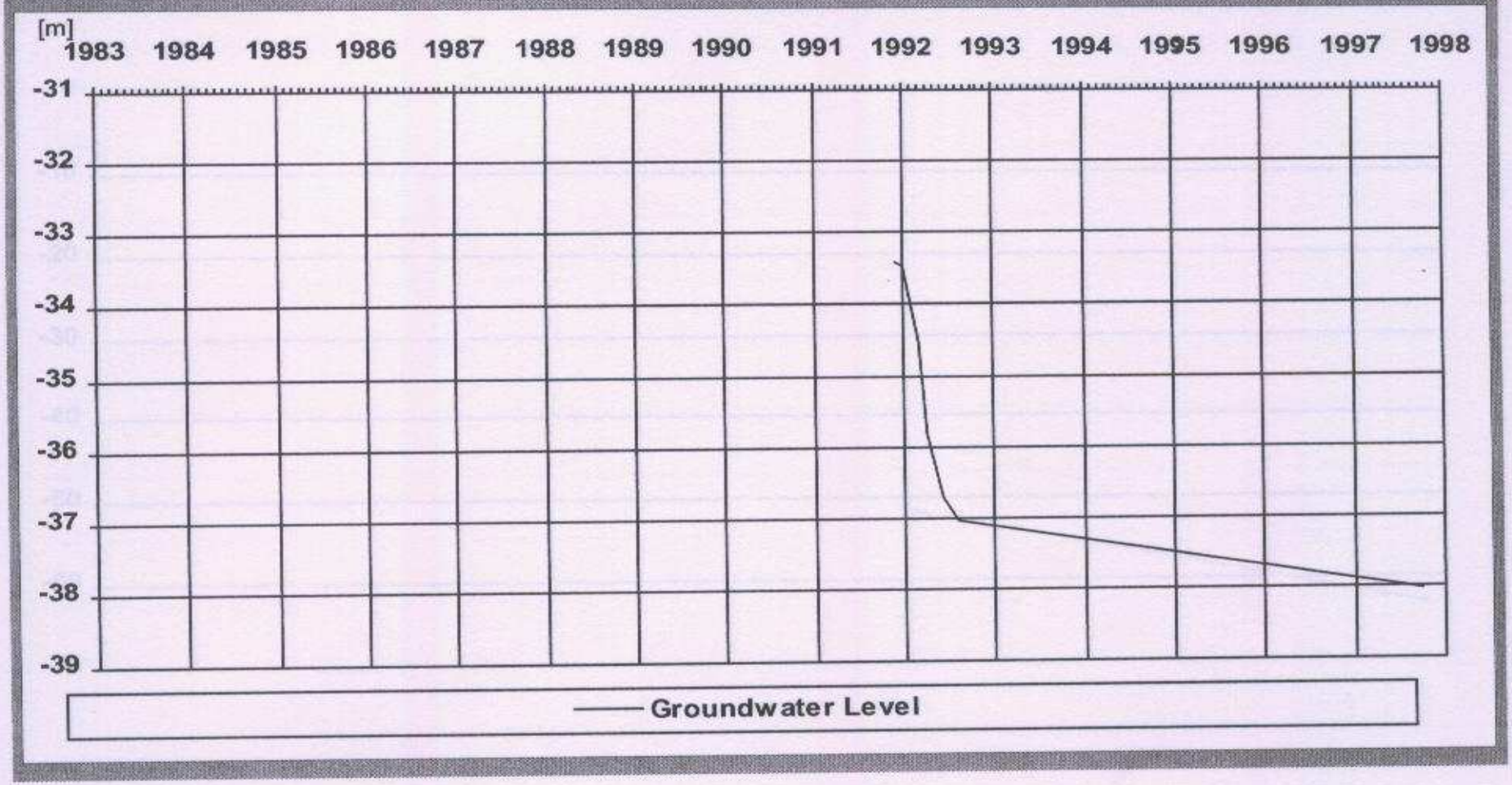


Parameter: ***Groundwater Level in m***

Year	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*Avg*
1983		-30.22	-33.46	-35.00	-34.90		-38.36		-38.22	-33.96	-33.90	-39.79	-35.3
1984		-37.77	-39.11	-39.55				-34.76	-41.22	-36.65			-38.2
1985	-36.84	-36.71	-36.55	-35.92						-37.08			-36.6
1986		-44.89											-44.9
1991												-69.95	-69.9
1992	-73.36		-77.28	-80.06				-76.26					-76.7
1997										-92.90			-92.9
													-44.9

National Water Resources Information Center (NWRIC)

Station:	SAB1-41	UTM North:	1,870,360 m	Elevation:	1,795 m + MSL
Operated by:	NWRA	UTM East:	364,090 m	Installed:	01 Oct 1991

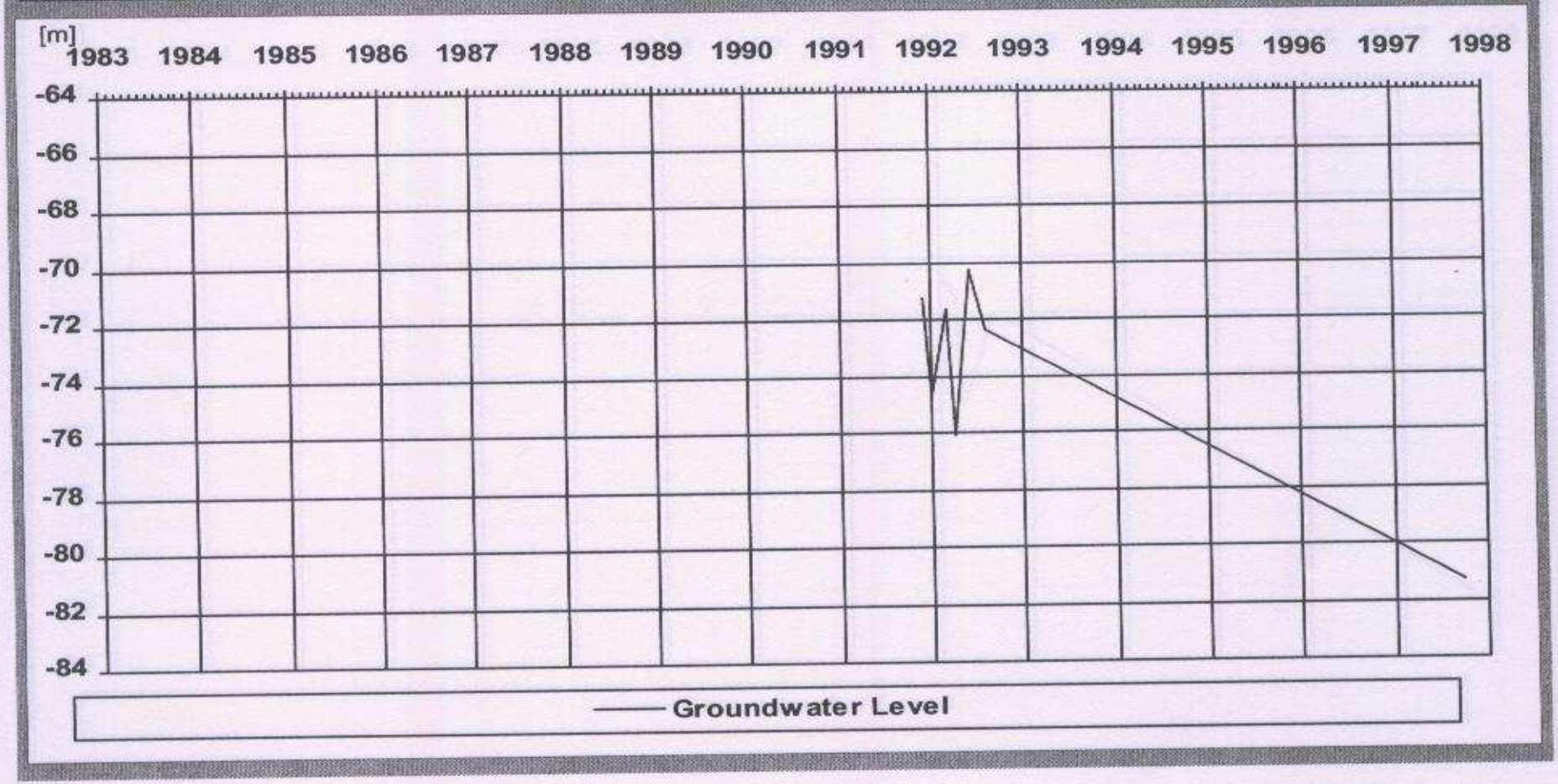


Parameter: ***Groundwater Level in m***

Year	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*Avg*
1991												-33.40	-33.4
1992	-33.47		-34.54	-35.82		-36.70		-37.03					-35.5
1997										-38.04			-38.0
													-35.6

National Water Resources Authority (NWRA)
Studies and Information Sector (SIS)
National Water Resources Information Center (NWRIC)

Station:	SAB2-143	UTM North:	1,866,600 m	Elevation:	1,910 m + MSL
Operated by:	NWRA	UTM East:	376,100 m	Installed:	03 Oct 1991

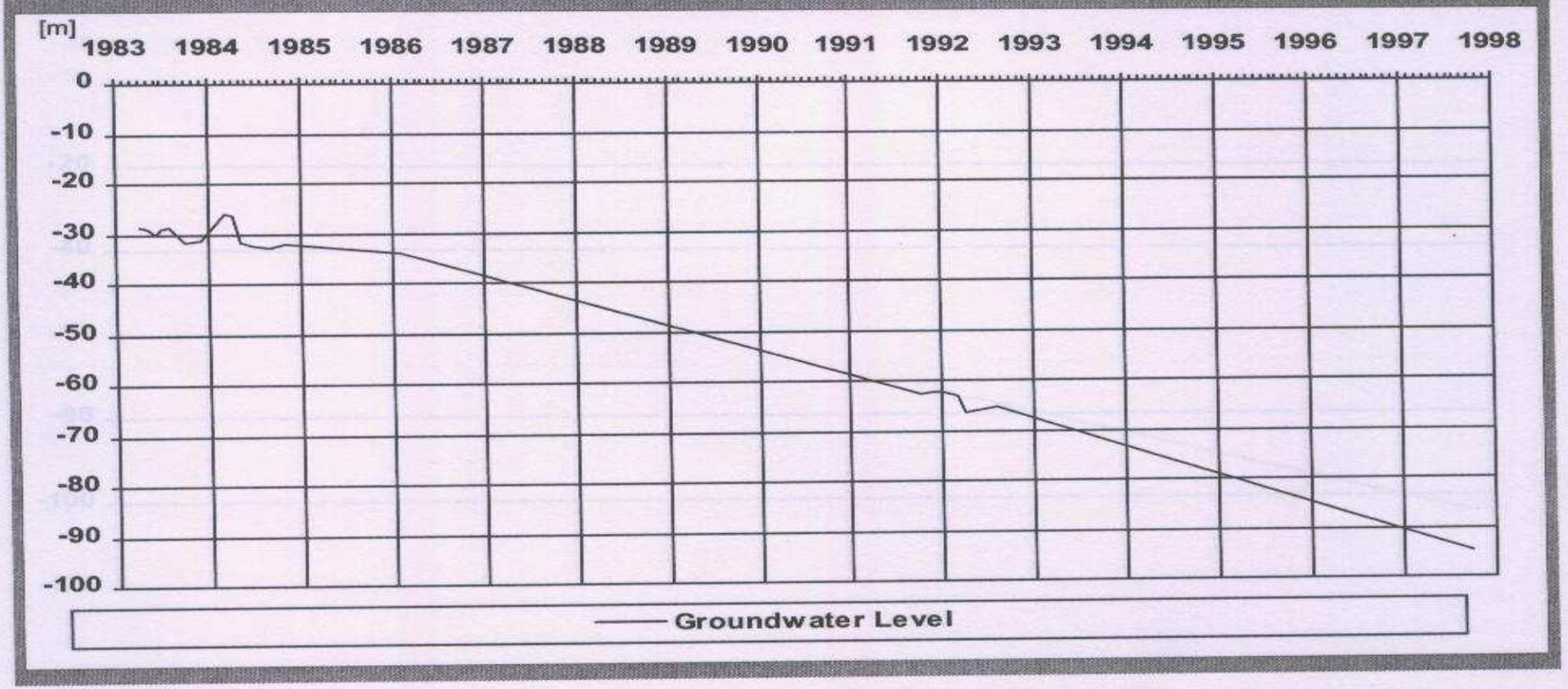


Parameter: *Groundwater Level in m*

Year	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*Avg*
1991												-71.28	-71.3
1992	-74.68		-71.65	-76.05		-70.30		-72.40					-73.0
1997										-81.25			-81.3

National Water Resources Authority (NWRA)
Studies and Information Sector (SIS)
National Water Resources Information Center (NWRIC)

Station:	SAD3-168	UTM North:	1,883,720 m	Elevation:	1,900 m + MSL
Operated by:	NWRA	UTM East:	350,240 m	Installed:	05 Apr 1983



Parameter: *Groundwater Level in m*

Year	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*Avg*
1983				-28.86	-28.93	-30.06	-29.10	-28.56		-31.75		-31.38	-29.8
1984			-25.90	-26.45	-31.87		-32.38		-32.96		-31.96		-30.3
1986		-34.15											-34.2
1991										-62.80		-62.25	-62.5
1992	-62.08		-63.00	-66.33				-65.40					-64.2
1997										-94.79			-94.8
													-41.2