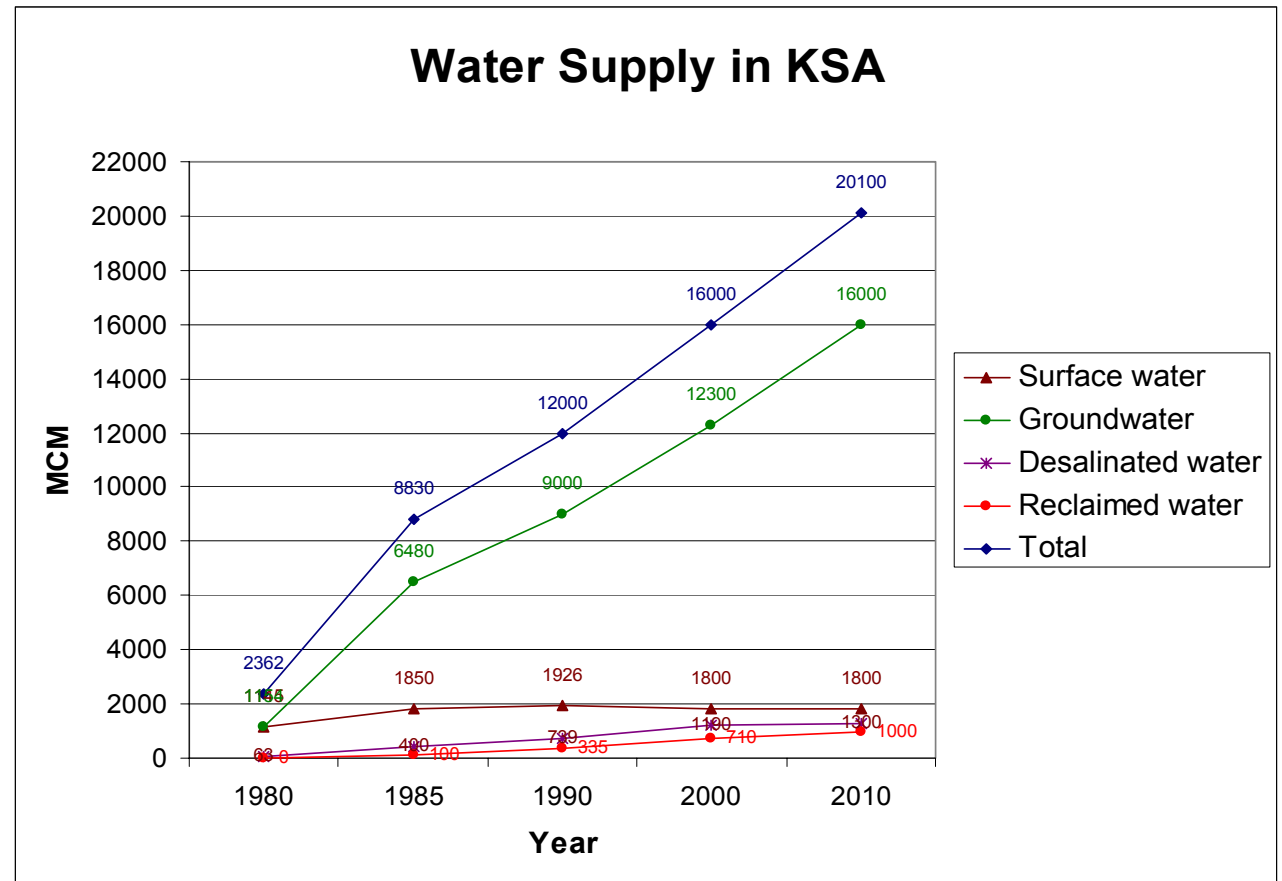




Water Resources of Saudi Arabia

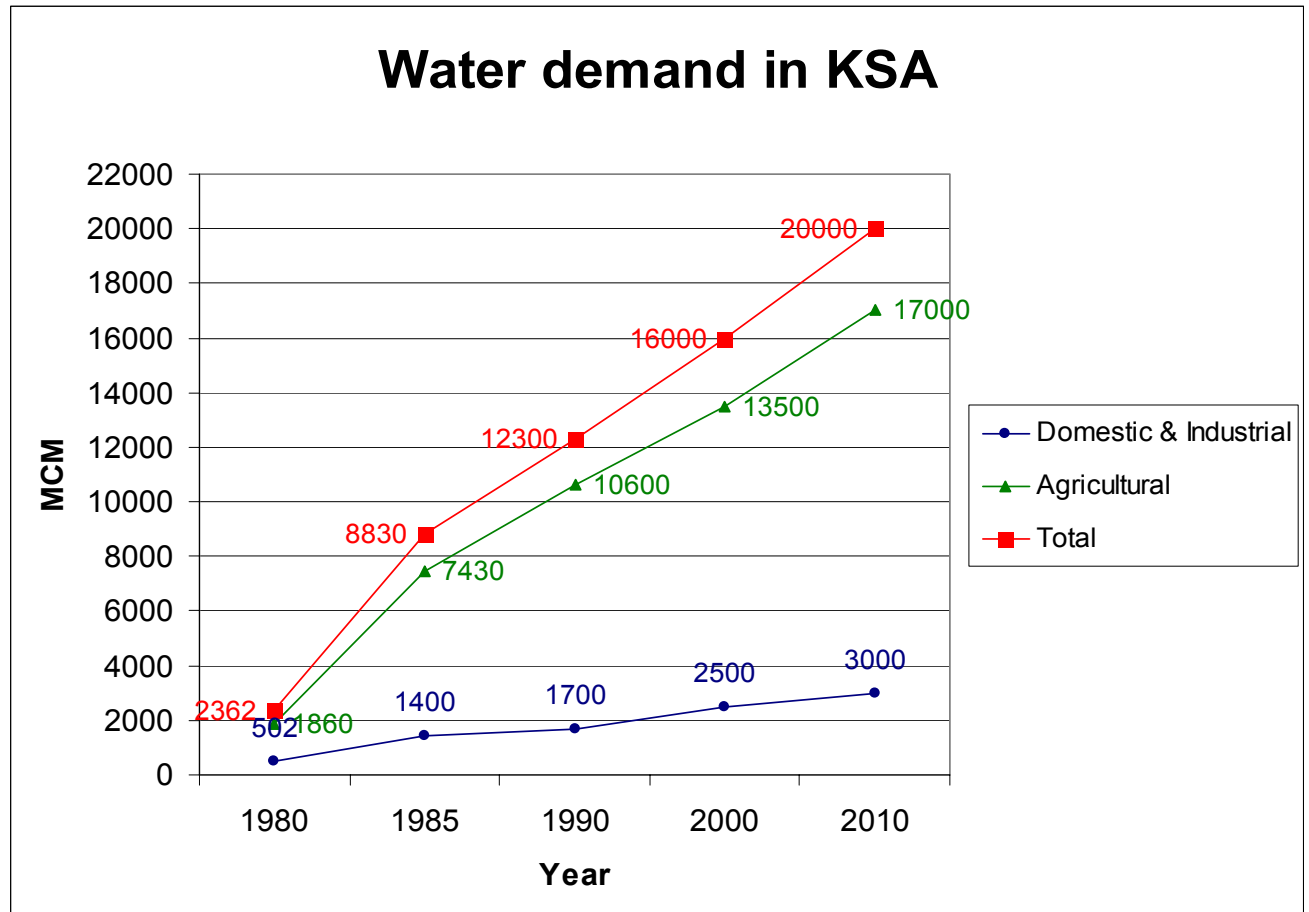
Water Resources of Saudi Arabia

- Surface water
(48-10%)
- Groundwater
(49-80% @ 70m-1000m depth)
- Desalinated water
(3-6%)
- Reclaimed water
(0-5%)



Water Demands in Saudi Arabia

- Domestic and industrial uses
(15-21%)
- Agricultural uses
(79-85%)



Problems Associated with Water Demands

- Increasing number of private & farming wells
(26,000 in 1982 – 85,000 in 1997 ???)
- Uncontrolled pumping (sharp drop in water levels)
(Sea water intrusion in eastern province and dryness of natural springs in the eastern, central and western provinces)
- Water quality deterioration (high TDS levels)
- Uncontrolled agricultural practices
(Around 88% of water resources are used by agriculture out of which only 30% is really needed !! This means that about 62% of the total water resources are lost!!!)
- Over-irrigation increases soil salinity (sabkhanization)
- Leakage from water supply systems
(About 20% of water leaks from domestic water supply systems)

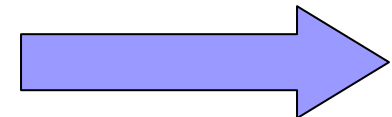
Surface Water

- Average annual precipitation 90-500(SW)mm
- 20-80% of precipitated water evaporates to the atmosphere
- 200 dams were constructed allover KSA
- Largest dams in KSA
 - Jazan dam sores 51 mcm of water
 - Najran dam stores 86 mcm of water
- Dams:
 - Prevent flush floods
 - Recharge alluvial (unconfined) aquifers
 - Agricultural uses

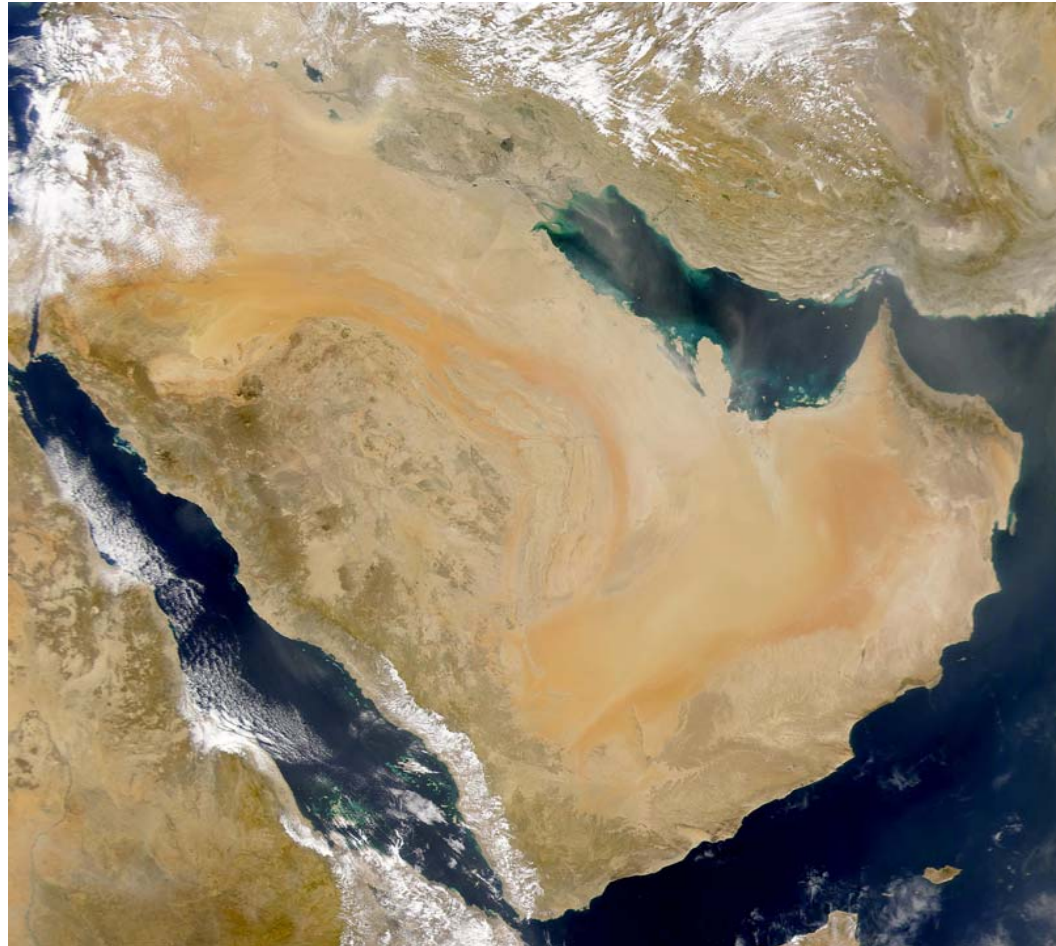


Desalinated Water

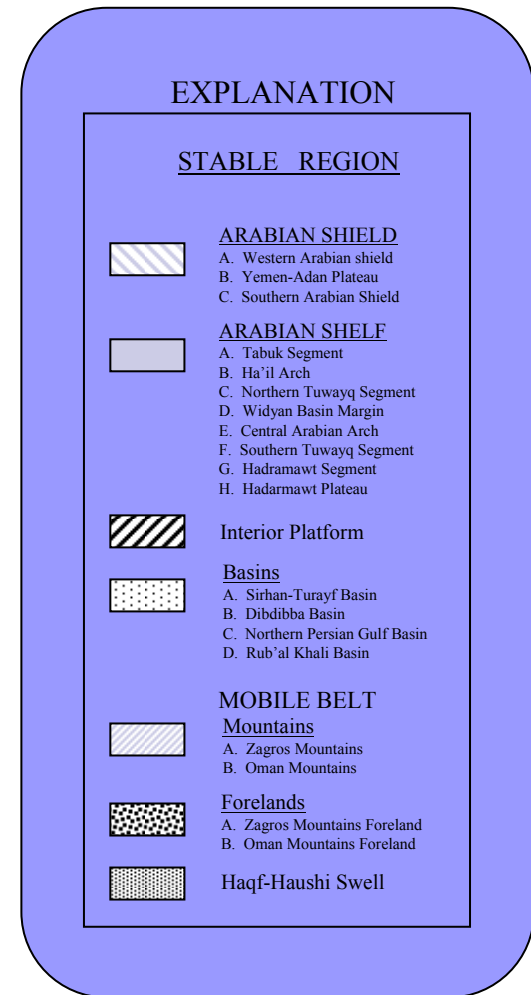
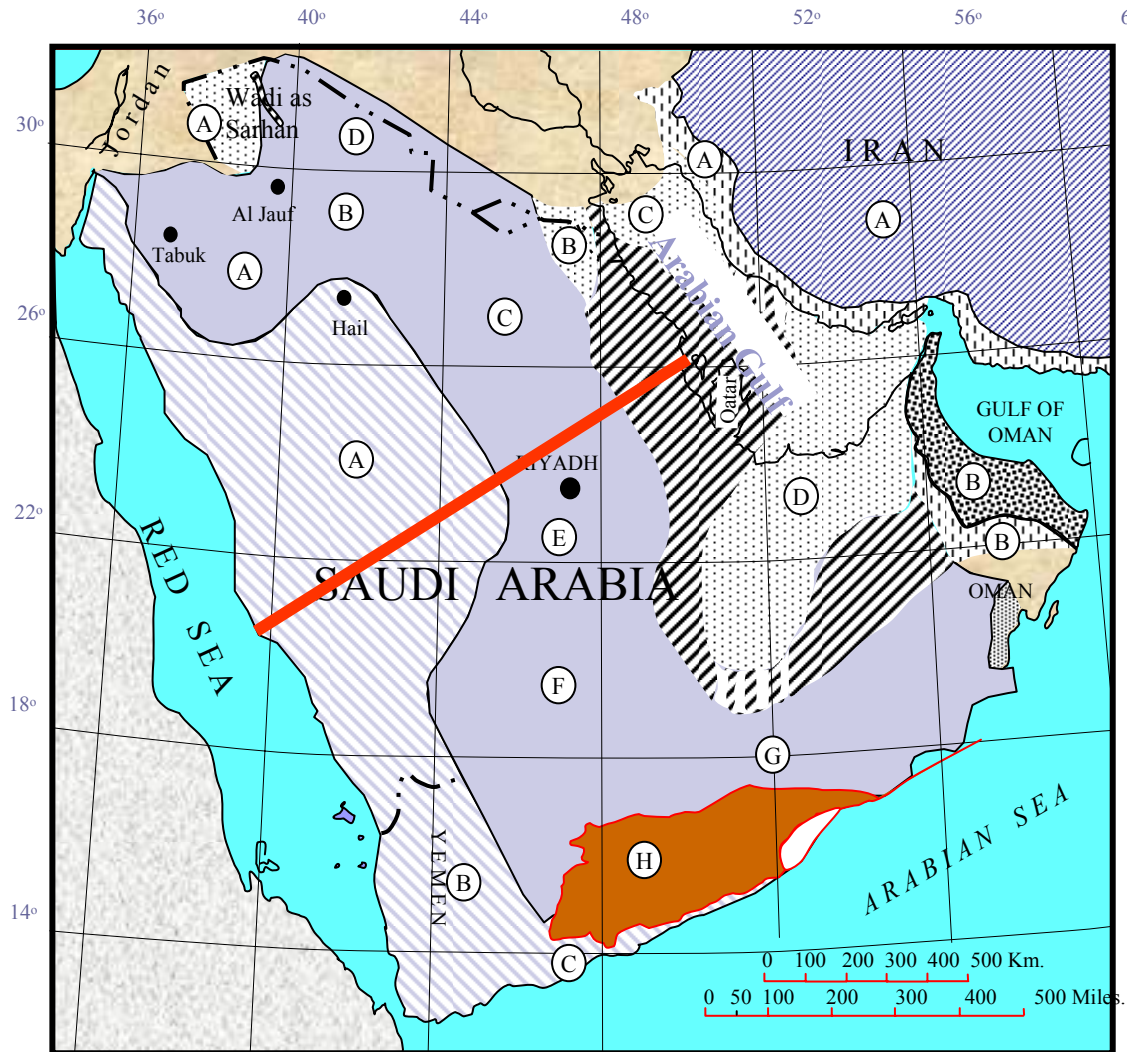
- Started in 1970
- Average desalination cost is SR 4.00 per cubic meter
- 21 plants in the western province
- 6 plants in the eastern province
- Operation modes
 - 76% of plants are operated by multistage flash systems
 - 24% of plants are operated by reverse osmosis technology



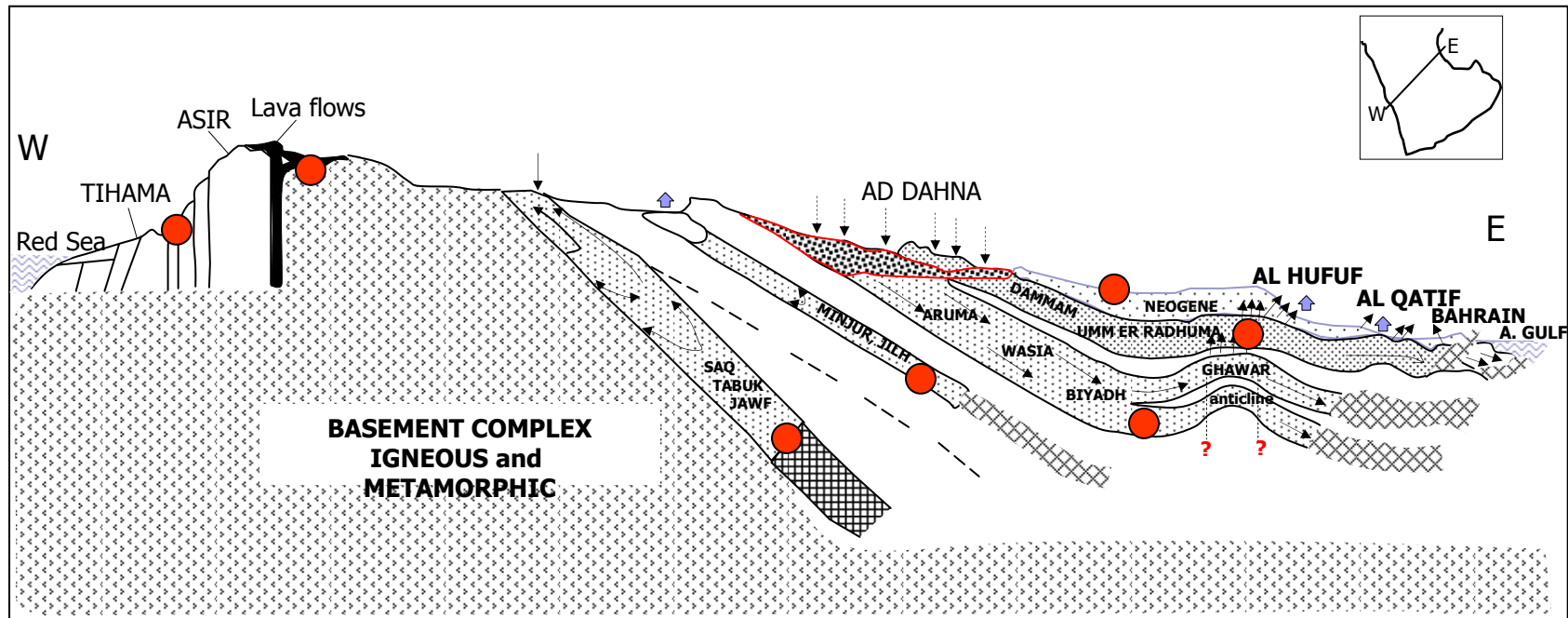
Groundwater & Regional Geology of KSA



Regional Geology of KSA



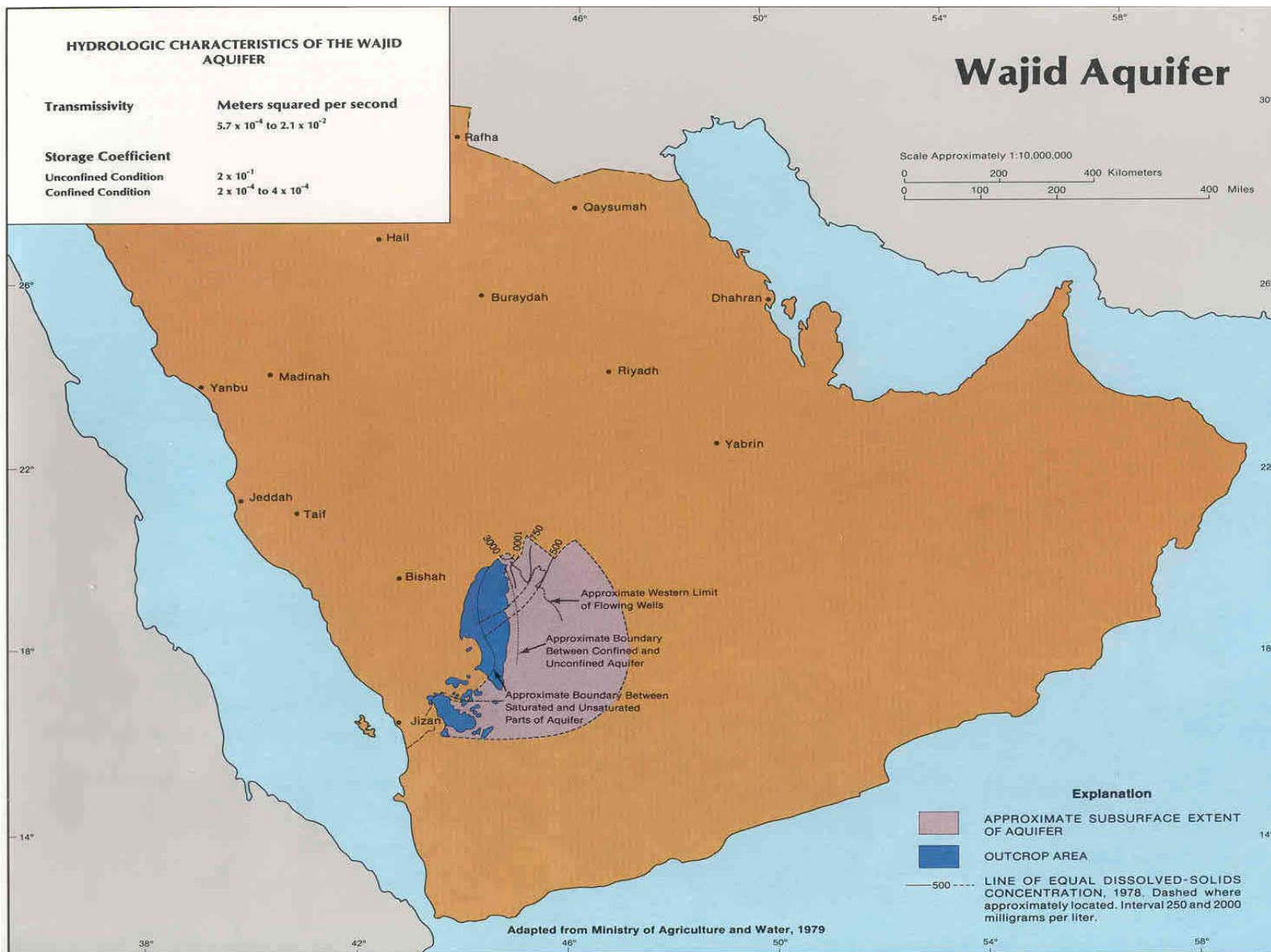
SW-NE Cross-section of KSA

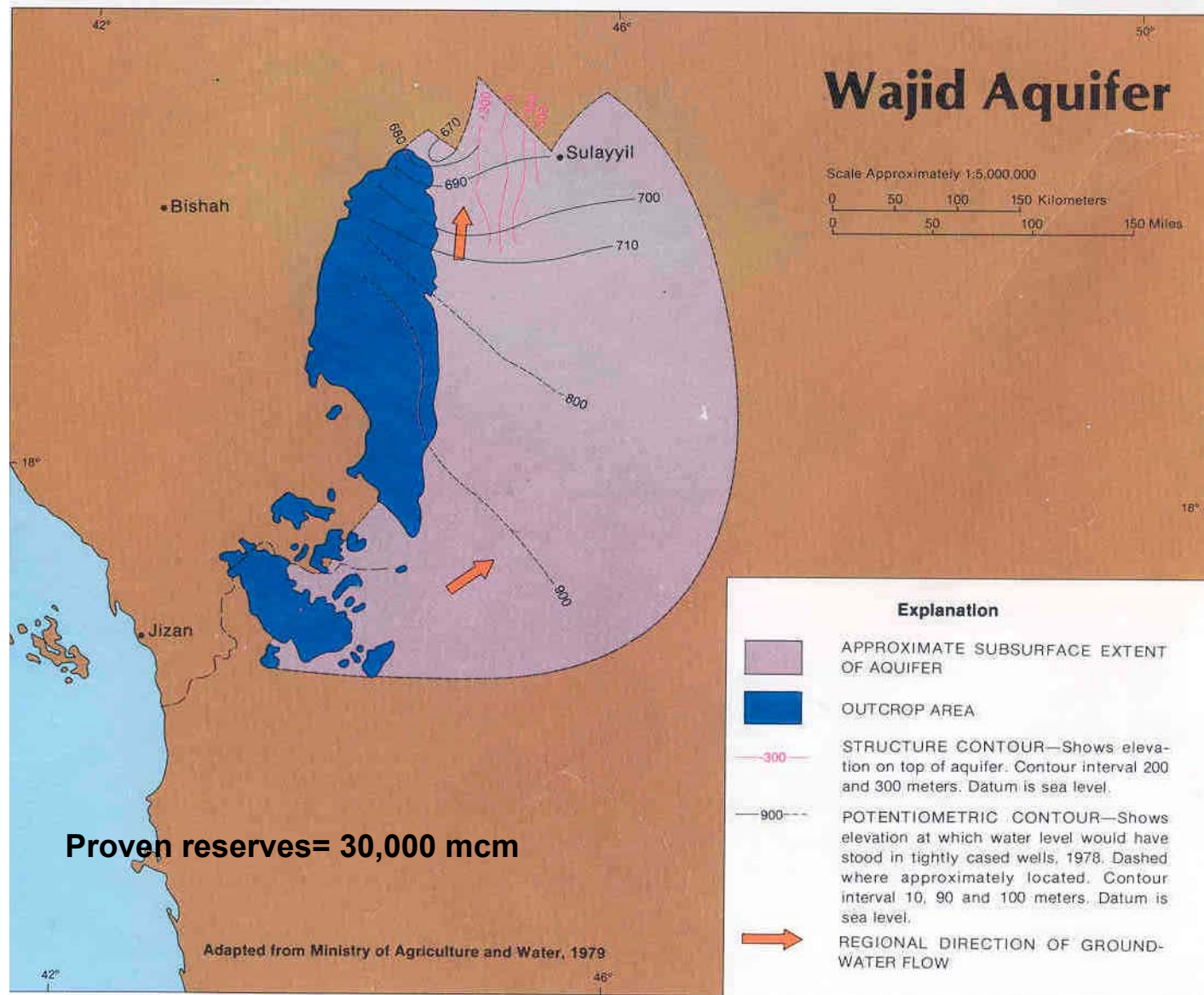


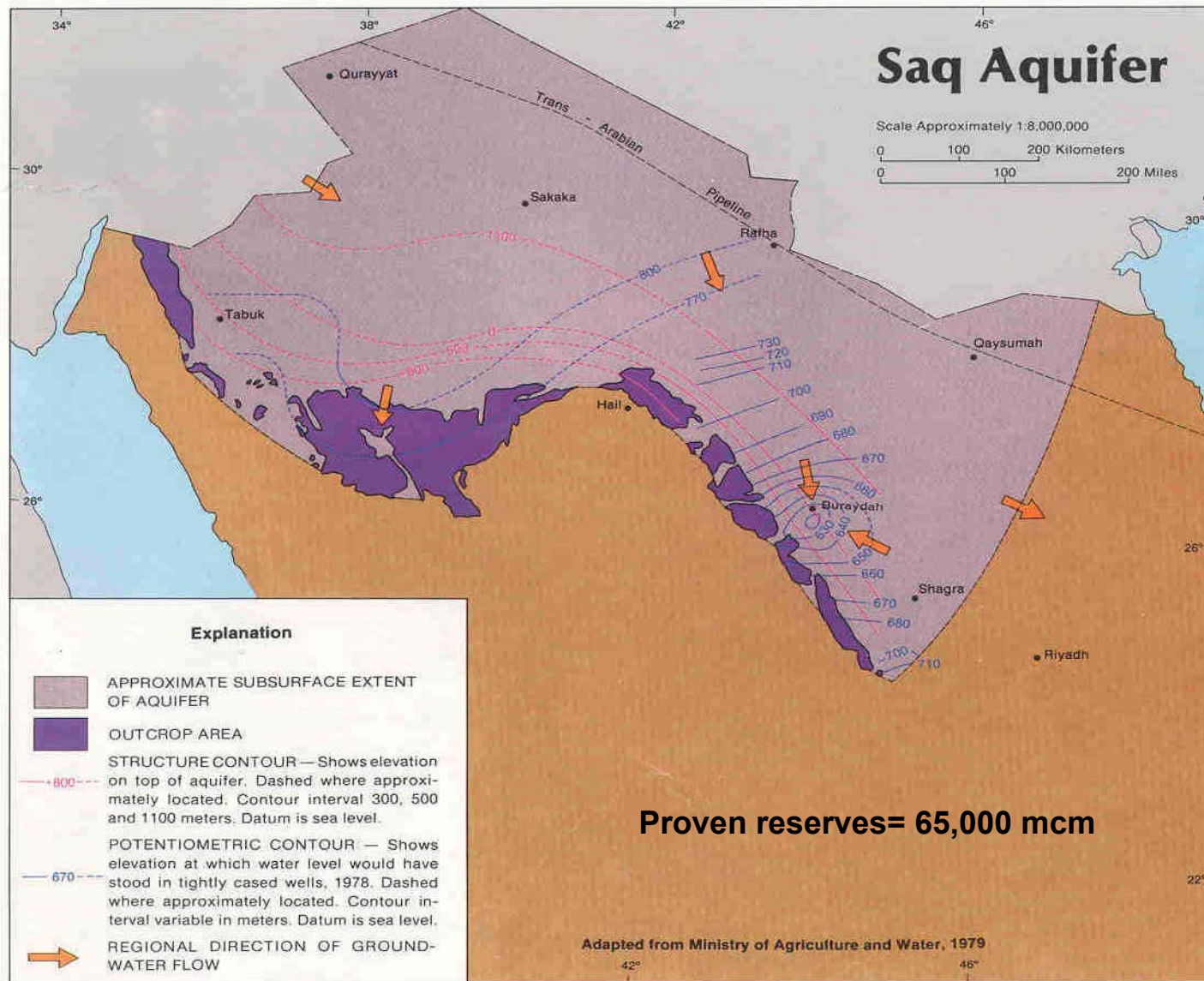
- Probable fault
- Groundwater discharge to surface
- Sabkha (groundwater evaporation)
- Infiltration / Recharge
- Flow lines
- Depleted aquifers
- Fresh groundwater
- Saline groundwater

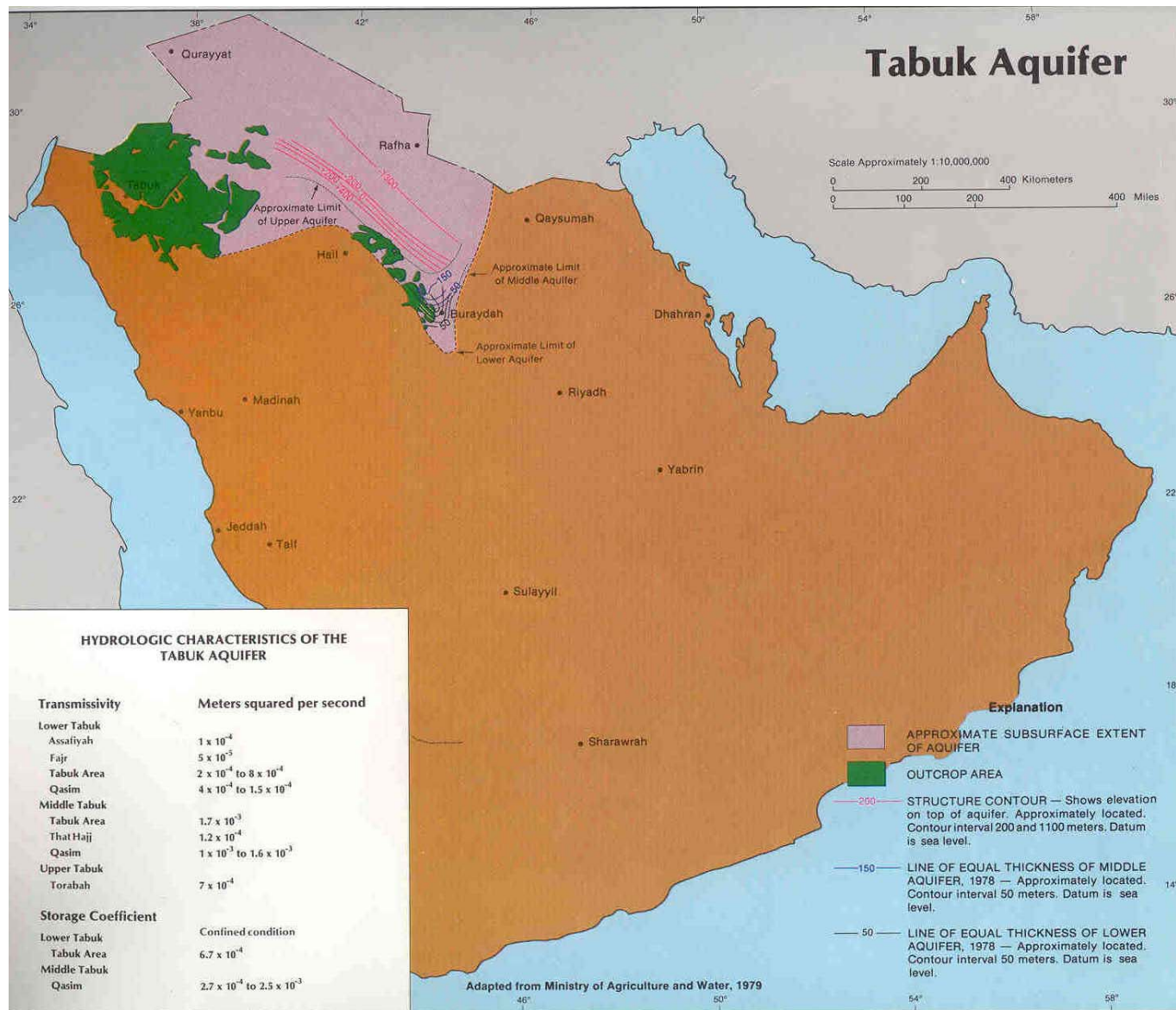


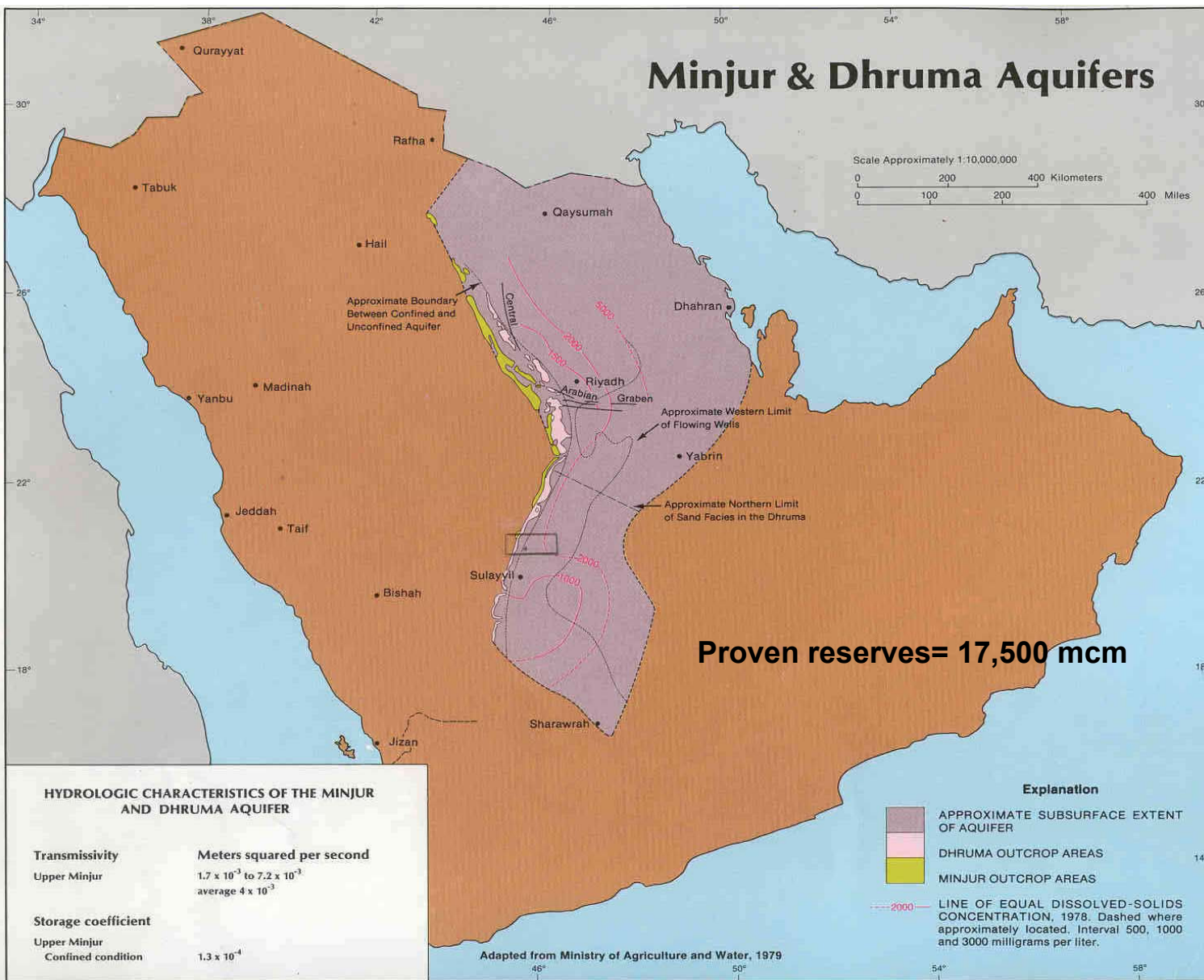
PRINCIPAL AQUIFERS in KSA

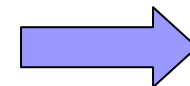
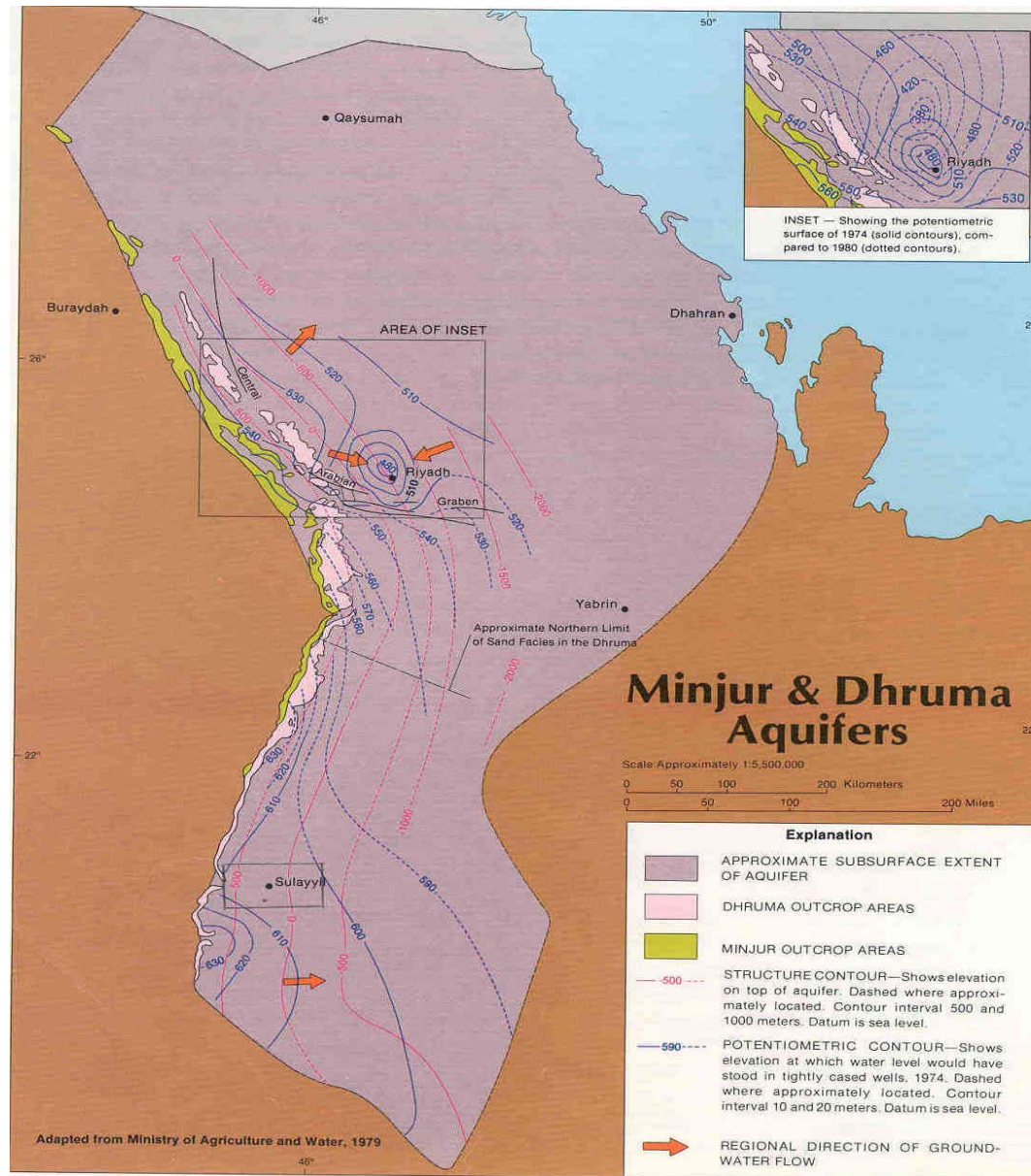


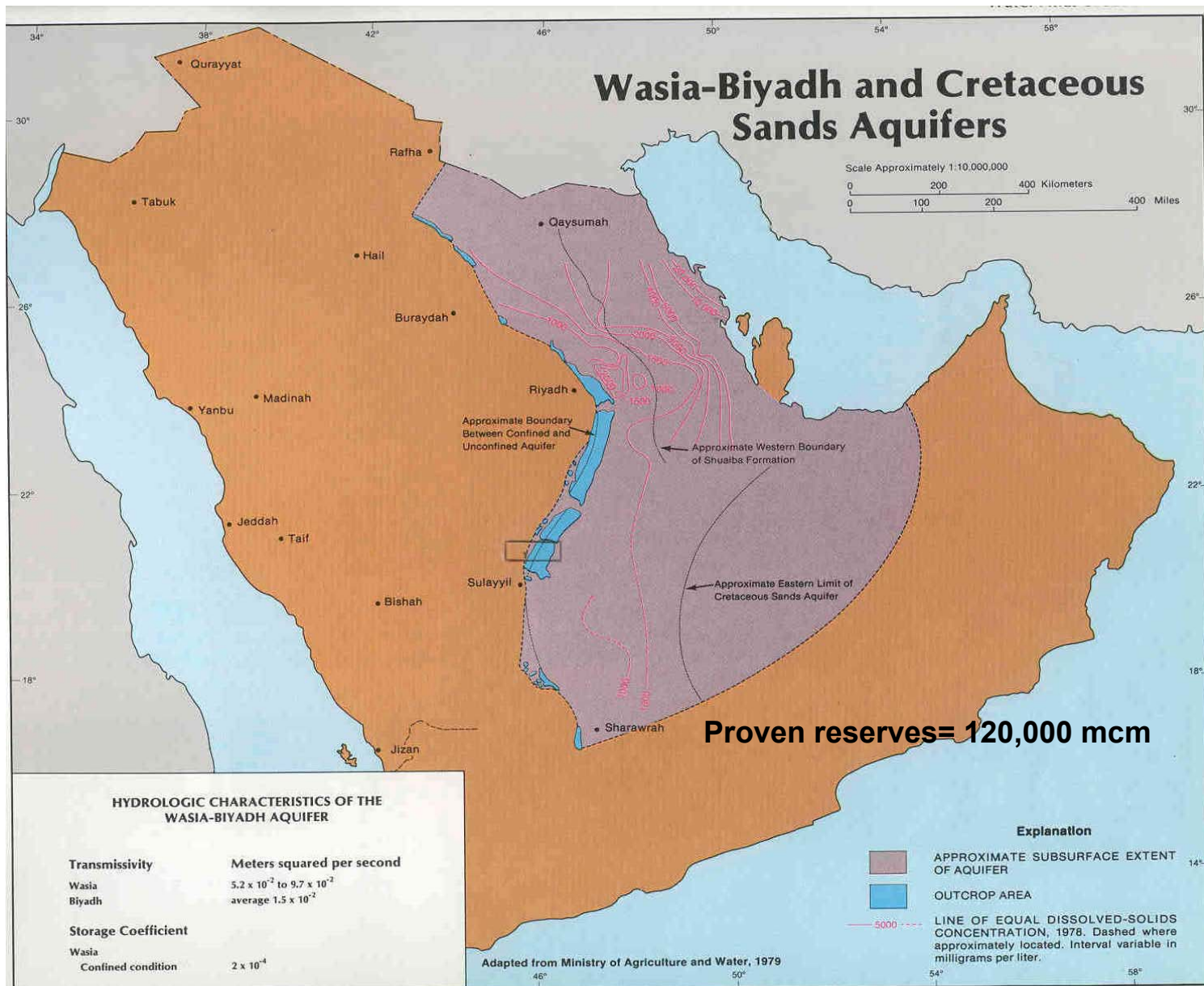


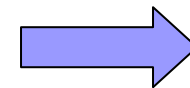
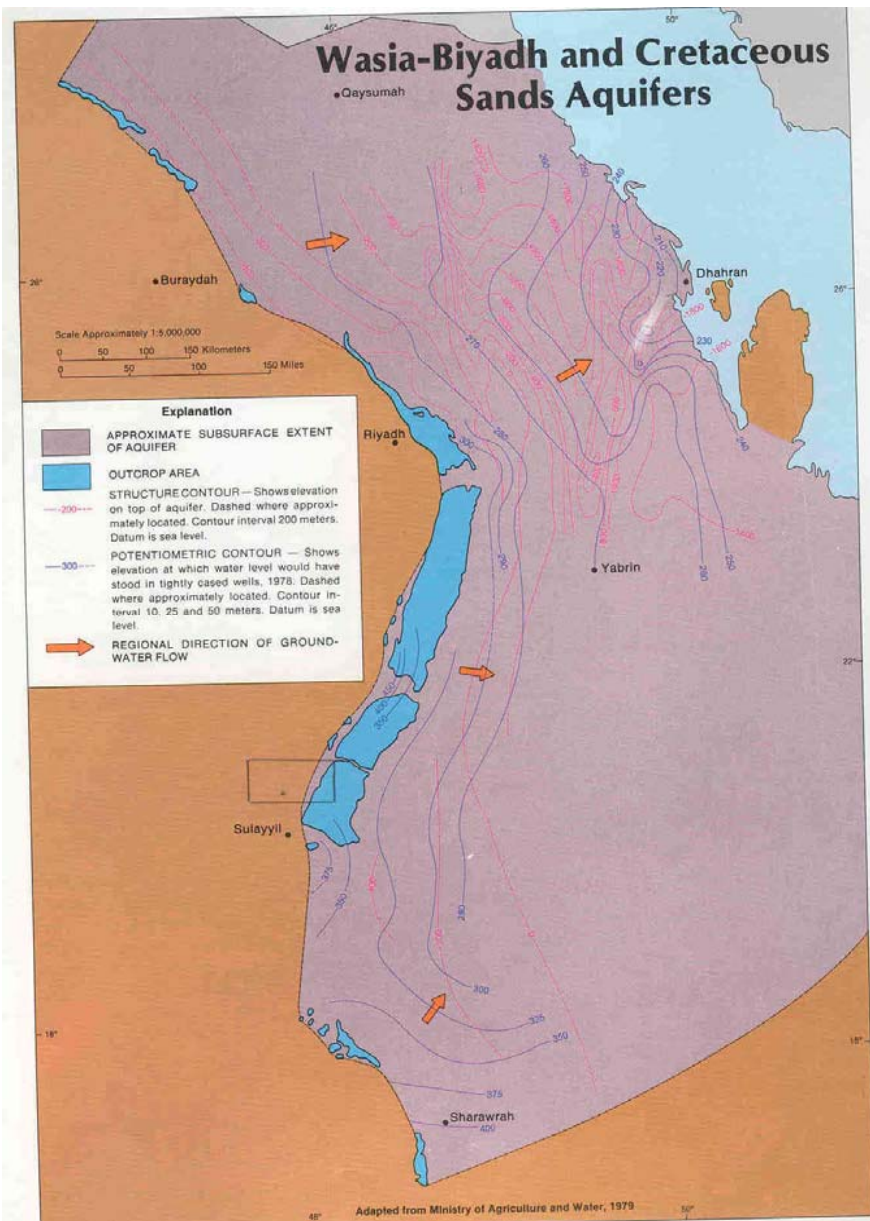


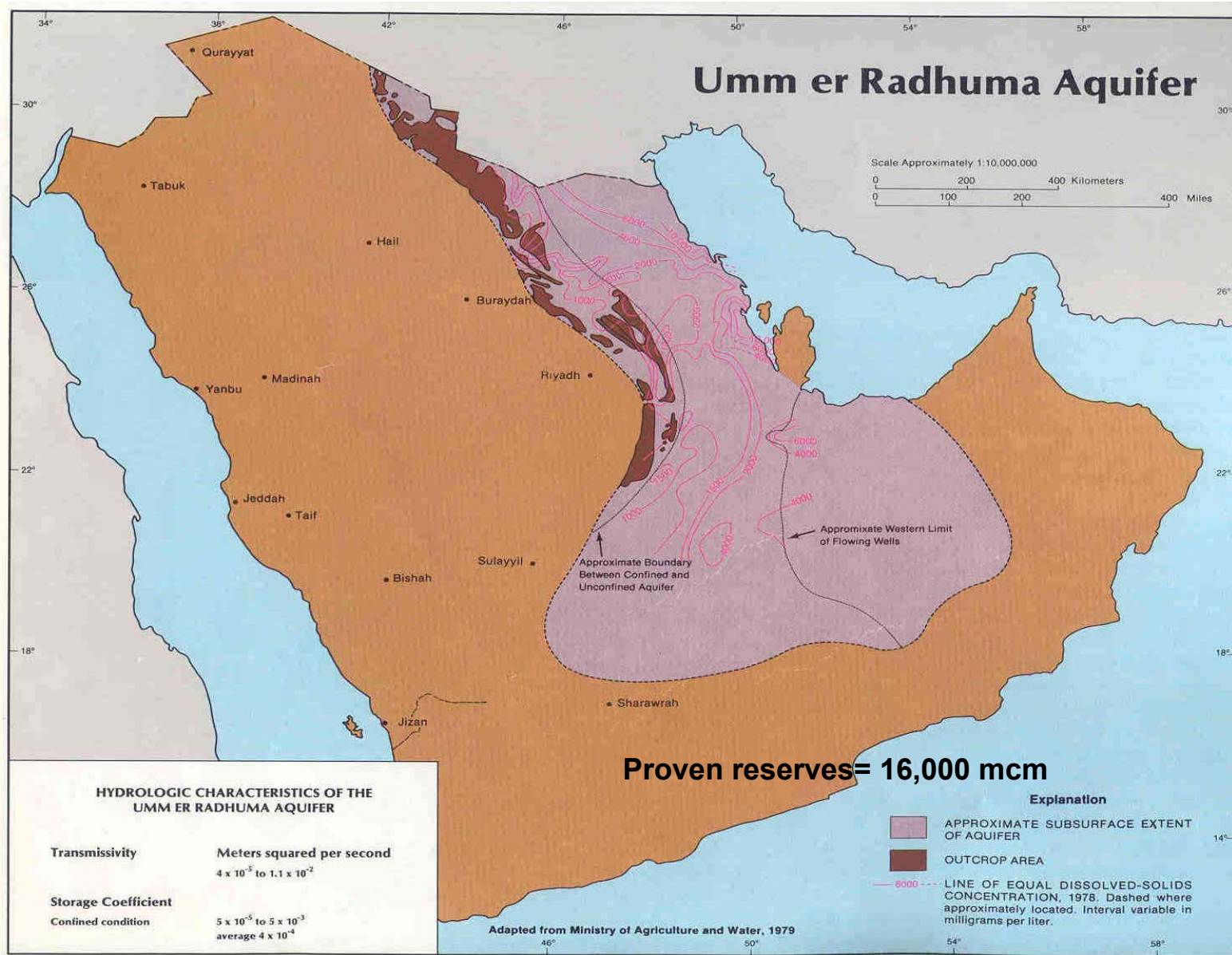




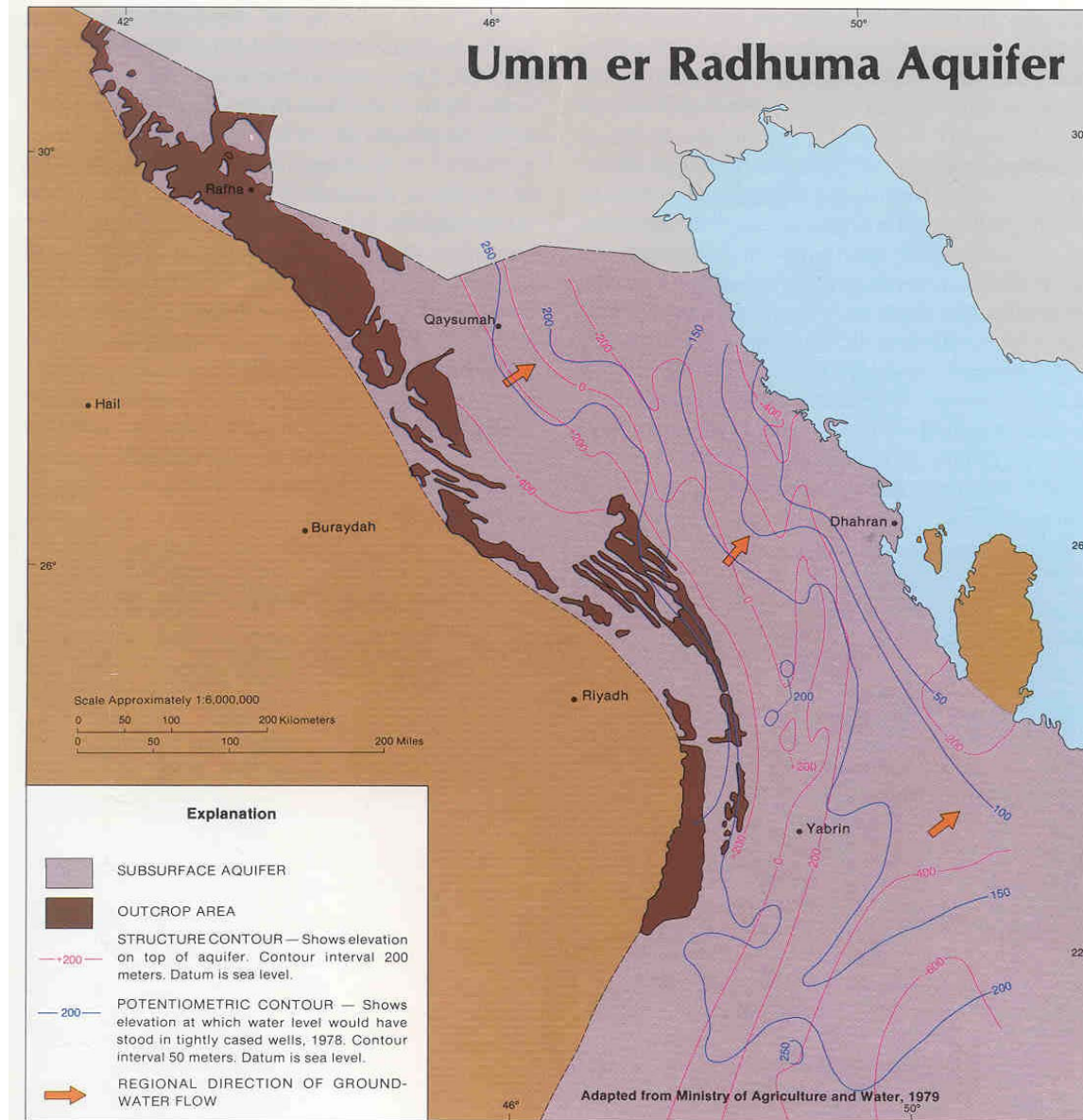


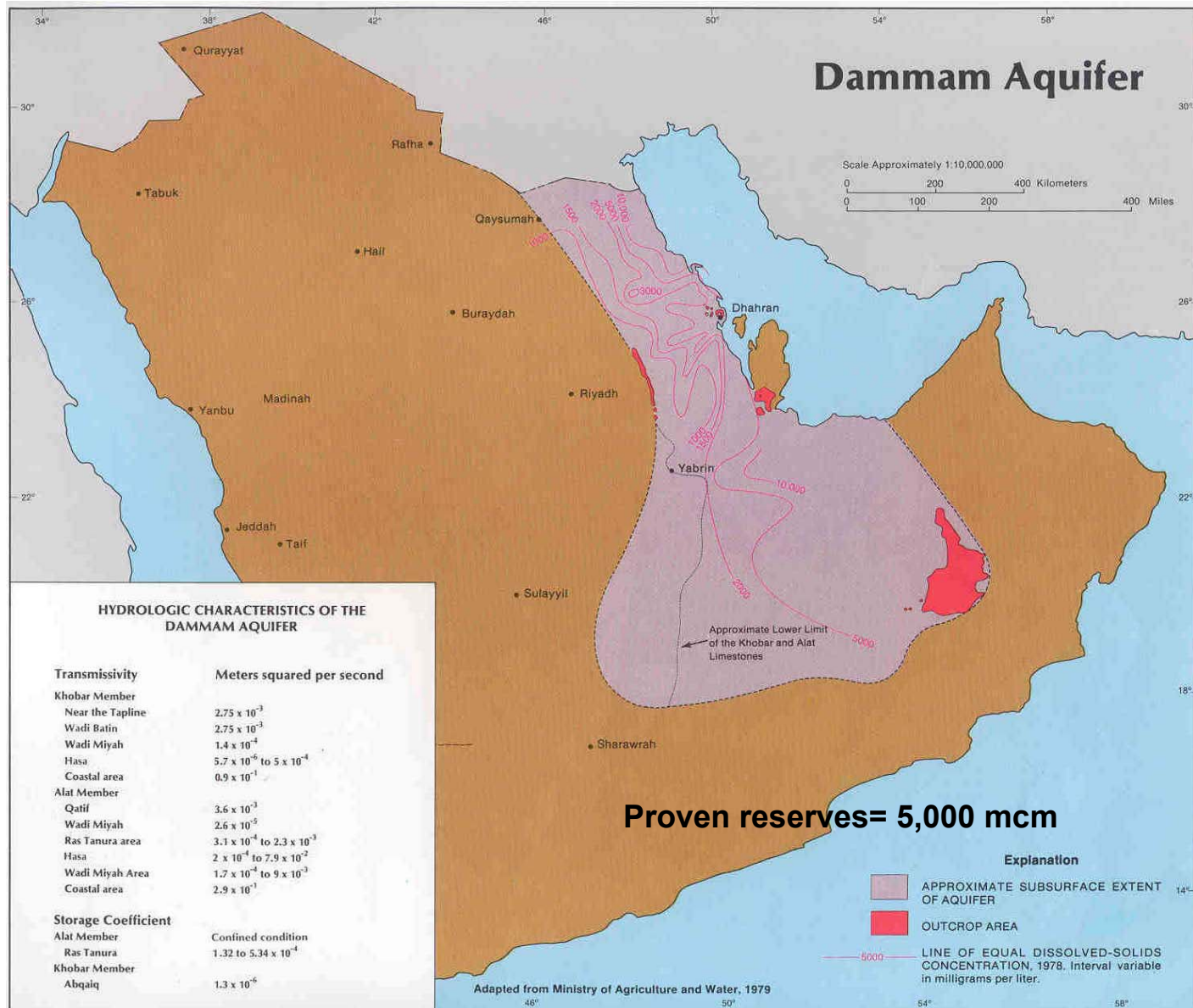


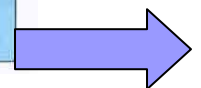
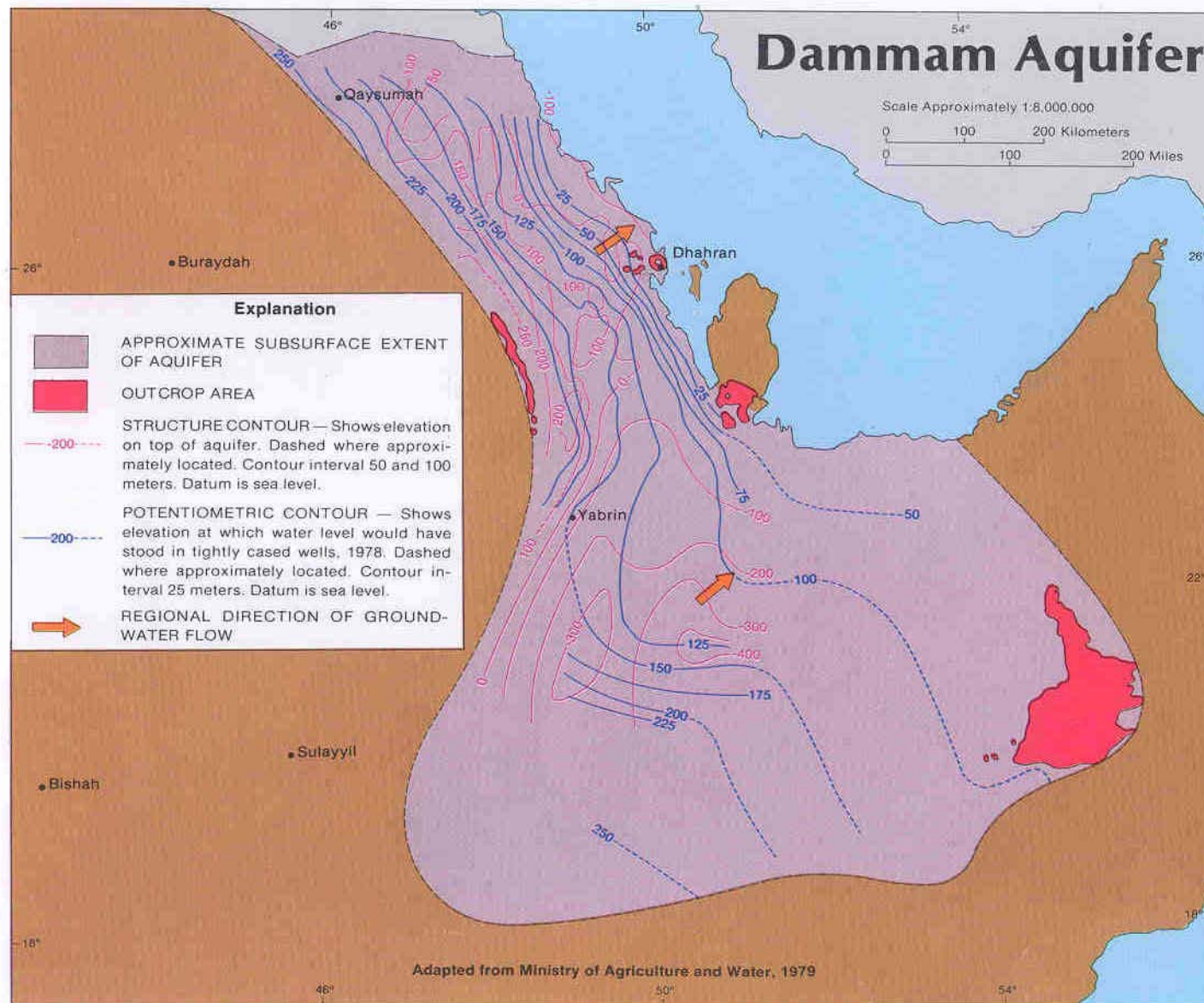


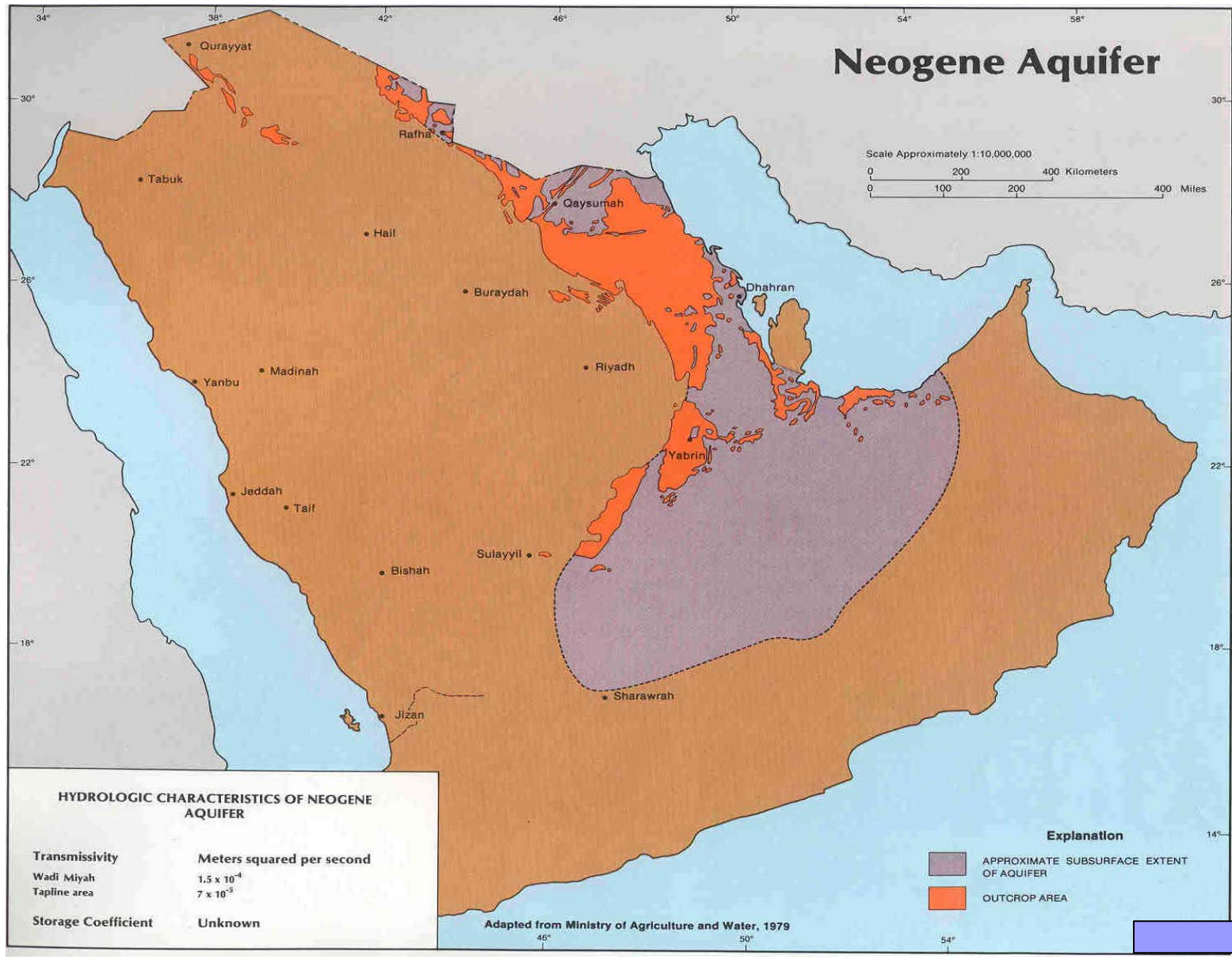


Umm er Radhuma Aquifer





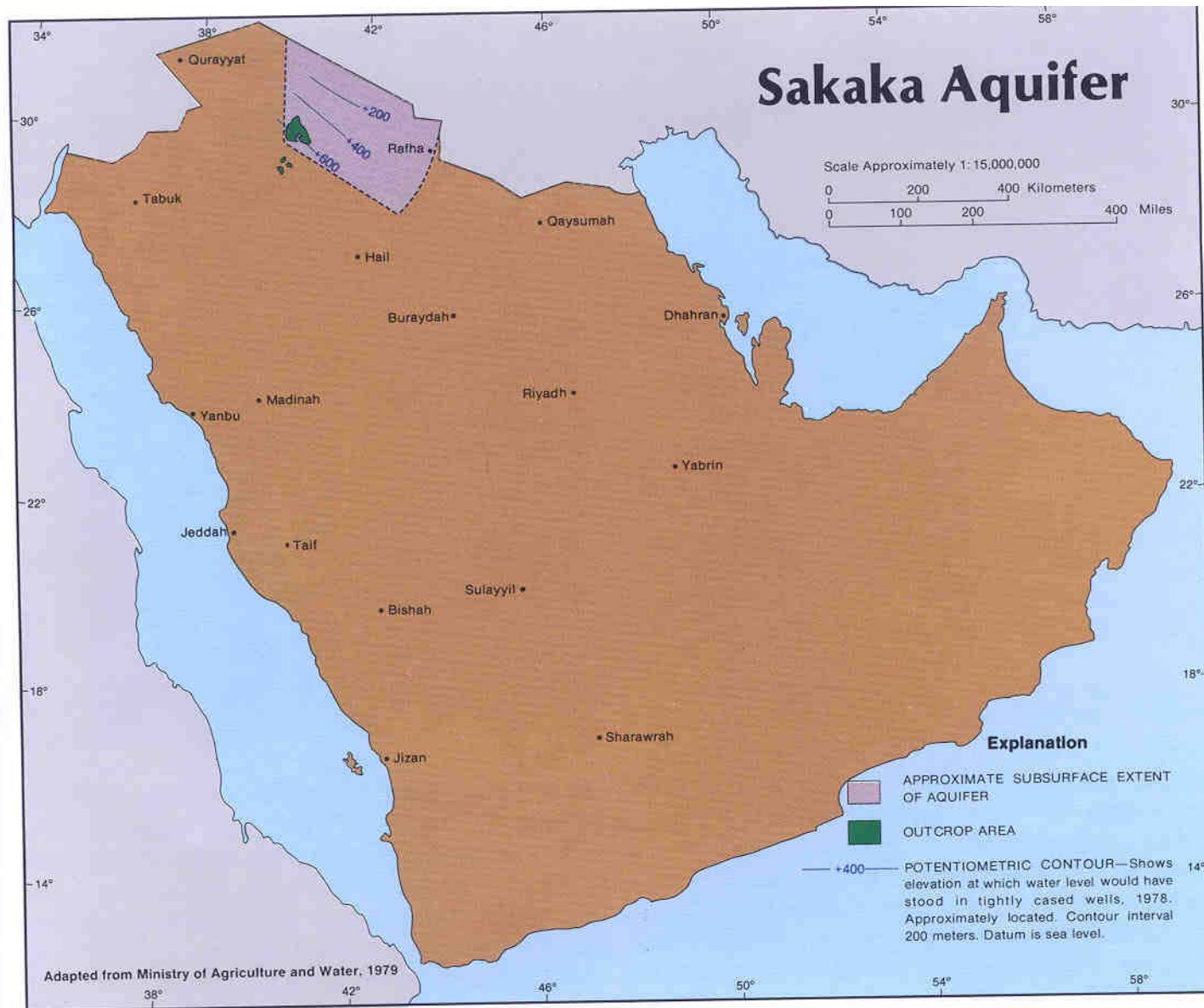


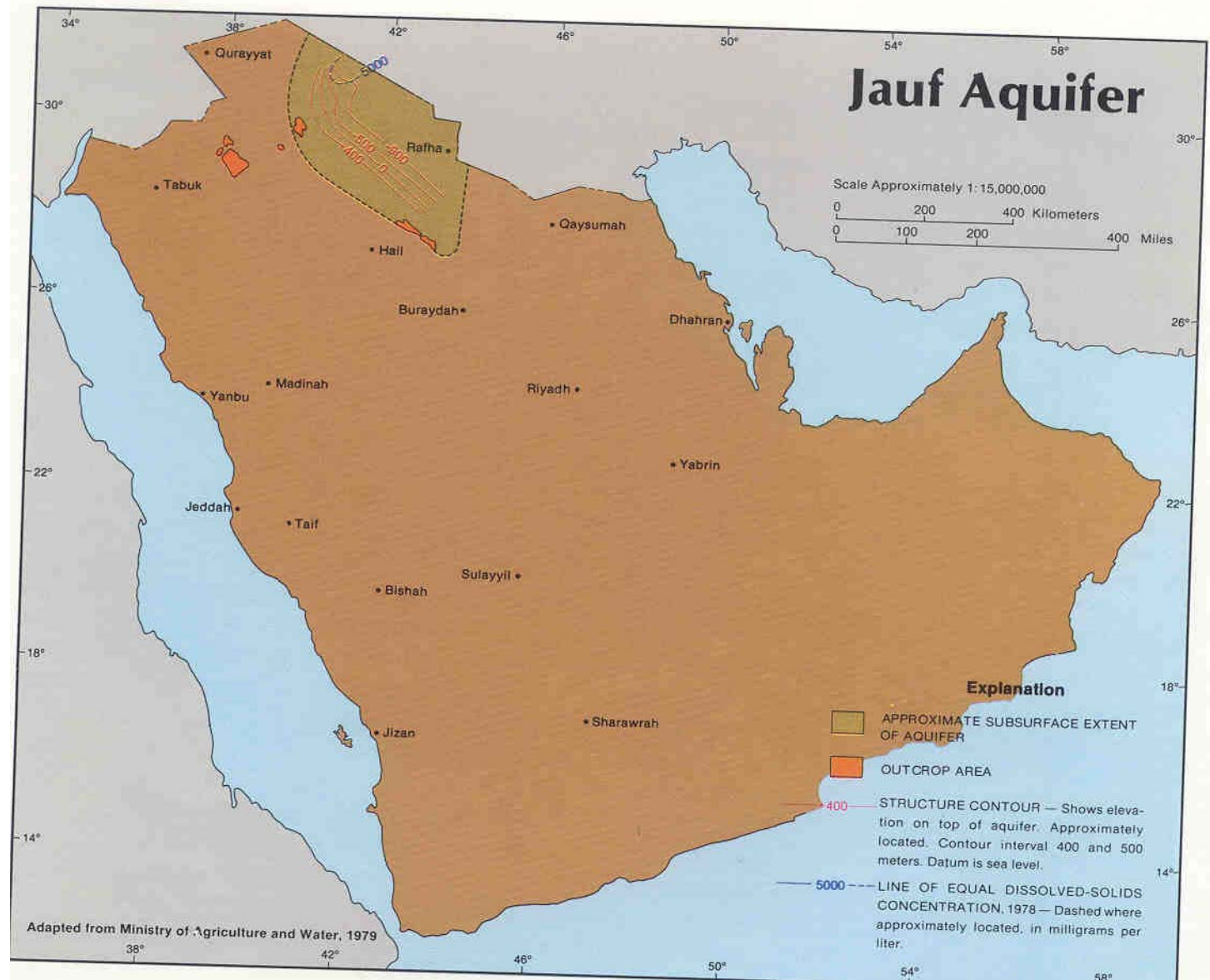


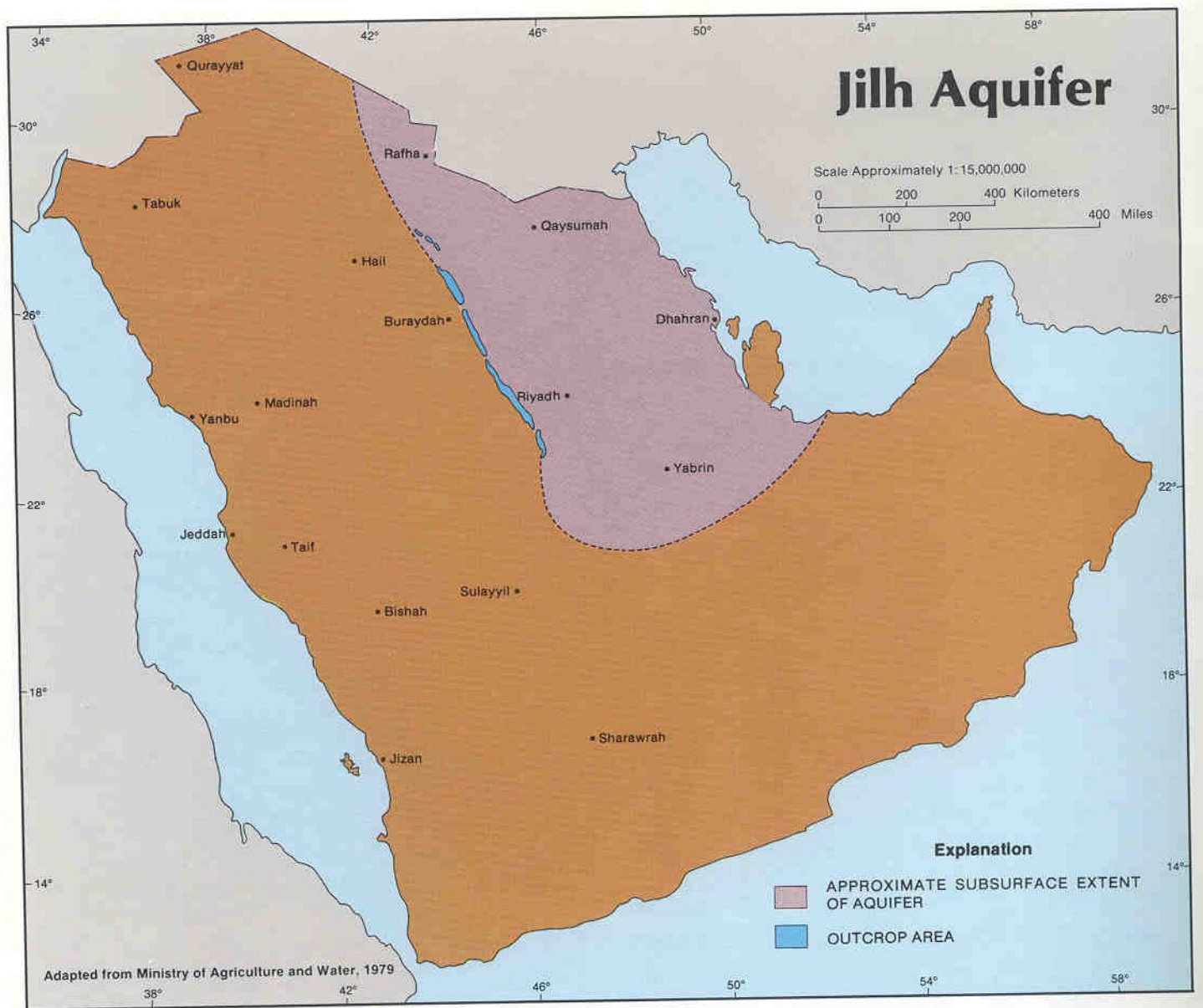


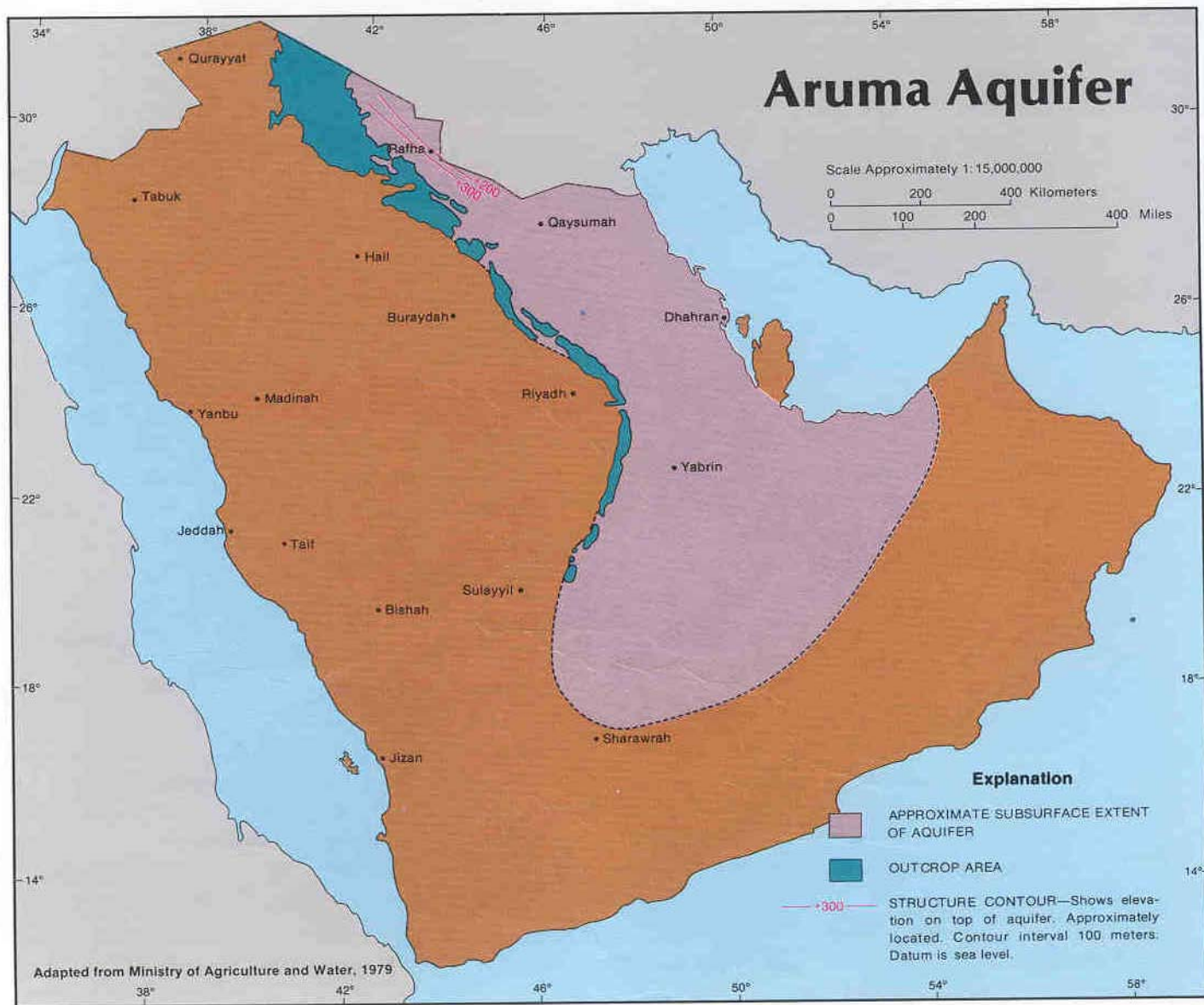
SECONDARY AQUIFERS in KSA

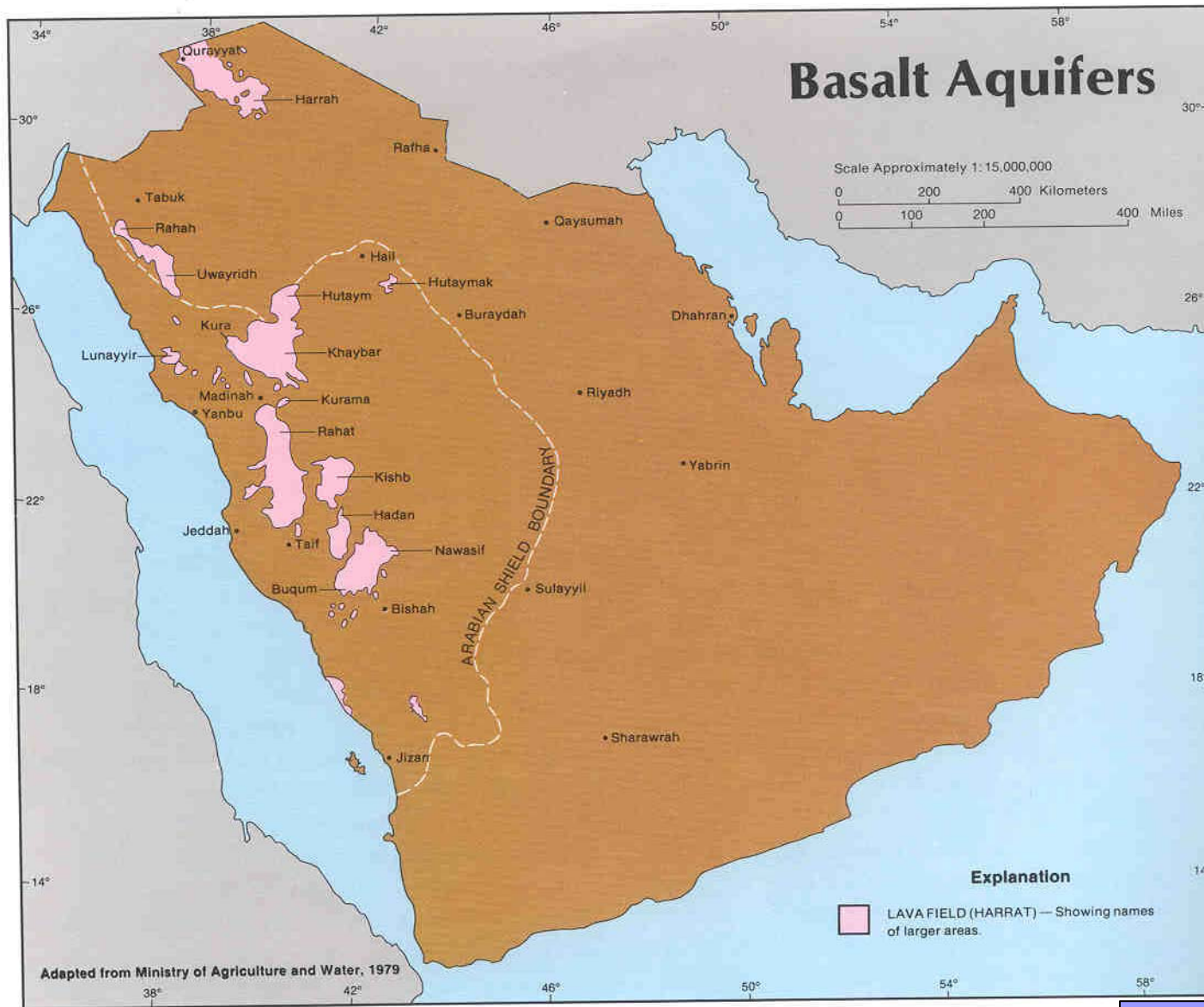


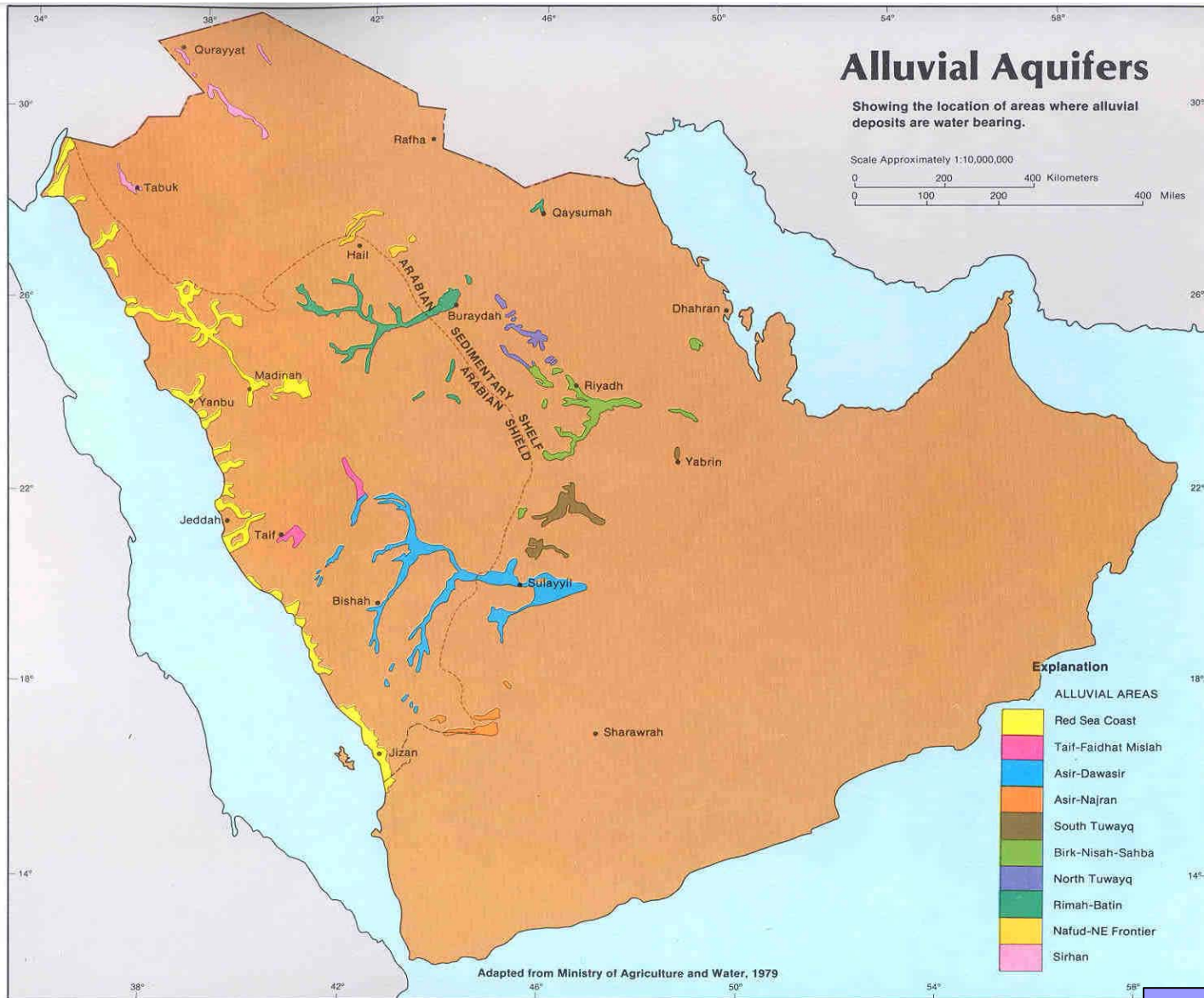












Age	Formation	Member	Lithology	Hydrogeologic Unit
Quaternary and Recent	Surficial Deposits		Gravel, Sand and Silt	Aquifer with variable productivity
MIOCENE and PLEISTOCENE	Kharij		Limestone, gypsum and gravel	Aquifer
	Hofuf		Sandy marl and Sandy limestone	Aquifer
	Dam		Marl and Shale	Aquitard
	Hadhruk		Silty Sandstone	Aquifer
EOCENE	Dammam	Alat	Limestone	Aquifer
		Marl	Marl	Aquitard
		Khobar	Limestone	Aquifer
		Alveolina Limestone	Limestone	Aquitard
		Saila Shale	Shale	
		Midra Shale	Shale	
		RUS	Marl, chalky limestone, gypsum	
PALEOCENE	Umm Er Radhuma		Limestone, Dolomitic limestone	Aquifer
CRETACEOUS	Aruma		Shales, Limestone	Aquifer (poor)
	Wasia		Sandstone	Aquifer
	Sakaka (in North - Western region)			
	Bivadh		Sandstone	Aquifer
	Buwaib		Biogenic calcarenite, limestone	Aquitard
	Yamam		Biogenic-pellet calcarenite	
JURASSIC	Sulay		Chalky aphanitic limestone	Aquifer (Local)
	Hith		Anhydrite	Aquitard to poor Aquifer (locally)
	Arab		Calcarenite, Aphanitic limestone	
	Jubaila		Aphanitic Limestone, calcarenite	
	Hanifa		Aphanitic Limestone, calcarenite	Aquifer (locally)
	Tuwaiq Mountain		Aphanitic Limestone	Aquitard
	Dhurma		Aphanitic limestone and sandstone	Aquifer
	Marrat		Shales and aphanitic limestone	Aquitard
	TRIASSIC	Miniur		Sandstone
	Jilh		Sandstone, aphanitic limestone	Poor Aquifer
	Sudair		Shales (red and green)	Aquitard
PERMIAN	Khuf		Limestone, dolomites	Aquifer
CARBONIFEROUS	Unyza (FAW)		Sandstone	Poor Aquifer
	Berwath		Argillaceous Sandstone	Aquifer
DEVONIAN	Jauf	Upper	Limestone	Aquifer
		Shaibah	Shale and sandstone	Aquitard
SILURIAN	Tabuk	Tawil	Sandstone	Aquifer
		Qusaibah	Shale	Aquitard
		Middle Tabuk	Sandstone	Aquifer
		Ra'an	Shale	Aquitard
ORDOVICIAN		Lower Tabuk	Sandstone	Aquifer
		Hanadir	Shale	Aquitard
	Saq - Wajid		Sandstone	Aquifer
CAMBRIAN				
PRE-CAMBRIAN	Basement Complex			

Figure 1 Lithostratigraphic Succession and Hydrogeologic Units in Saudi Arabia (Modified after Powers et. al 1966; MAW, 1984; and Edgell, 1997)

Figure 1 Lithostratigraphic Succession and Hydrogeologic Units in Saudi Arabia (Modified after Powers et. al 1966; MAW, 1984; and Edgell, 1997)

Age	Formation	Member	Lithology	Hydrogeologic Unit
Quaternary and Recent	Surficial Deposits		Gravel, Sand and Silt	Aquifer with variable productivity
MIOCENE and PLIOCENE	Kharij		Limestone, gypsum and grannels	Aquifer
	Hofuf		Sandy marl and Sandy limestone	Aquifer
	Dam		Marl and Shale	Aquitard
	Hadhrukh		Silty Sandstone	Aquifer
EOCENE	Dammam	Alat	Limestone	Aquifer
			Marl	Aquitard
		Khobar	Limestone	Aquifer
		Alveolina Limestone	Limestone	Aquitard
		Saila Shale	Shale	
		Midra Shale	Shale	
	RUS		Marl, chalky limestone, gypsum	
PALEOCENE	Umm Er Radhuma		Limestone, Dolomitic limestone	Aquifer

Lithostratigraphic succession and hydrogeologic units in Saudi Arabia (modified after Powers et al. 1966, MAW 1984, Edgell 1997),

Contd.

CRETACEOUS	Aruma		Shales, Limestone	Aquifer (poor)
	Wasia Sakaka (in North - Western region)		Sandstone	Aquifer
	Biyadh		Sandstone	Aquifer
	Buwaib		Biogenic calcarenite, limestone	Aquitard
	Yamama		Biogenic-pellet calcarenite	
	Sulay		Chalky aphanitic limestone	Aquifer (Local)
JURASSIC	Hith		Anhydrite	Aquitard to poor Aquifer (locally)
	Arab		Calcarenite, Aphanitic limestone	
	Jubaila		Aphanitic Limestone, calcarenite	
	Hanifa		Aphanitic Limestone, calcarenite	Aquifer (locally)
	Tuwaiq Mountain		Aphanitic Limestone	Aquitard
	Dhurma		Aphanitic limestone and sandstone	Aquifer
	Marrat		Shales and aphanitic limestone	Aquitard

Lithostratigraphic succession and hydrogeologic units in Saudi Arabia (modified after Powers et. al 1966,
MAW 1984, Edgell 1997)

Contd.

TRIASSIC	Minjur		Sandstone	Aquifer
	Jilh		Sandstone, aphanitic limestone	Poor Aquifer
	Sudair		Shales (red and green)	Aquitard
PERMIAN	Khuf		Limestone, dolomites	Aquifer
CARBONIFEROUS	Unyzah (FAW)		Sandstone	Poor Aquifer
	Berwath		Argillaceous Sandstone	Aquifer
DEVONIAN	Jauf	Upper	Limestone	Aquifer
		Shaibah	Shale and sandstone	Aquitard
SILURIAN	Tabuk	Tawil	Sandstone	Aquifer
		Qusaibah	Shale	Aquitard
		Middle Tabuk	Sandstone	Aquifer
ORDOVICIAN		Ra'an	Shale	Aquitard
		Lower Tabuk	Sandstone	Aquifer
		Hanadir	Shale	Aquitard
	Saq - Wajid		Sandstone	Aquifer
CAMBRIAN				
PRE-CAMBRIAN	Basement Complex			

Lithostratigraphic succession and hydrogeologic units in Saudi Arabia (modified after Powers et. al 1966, MAW 1984, Edgell 1997)

Water in Empty Quarter!!!



Water in Empty Quarter!!!



Water in Empty Quarter!!!



Water in Empty Quarter!!!



Water in Empty Quarter!!!



Water in Empty Quarter!!!



Water in Empty Quarter!!!



Water in Empty Quarter!!!



Water in Empty Quarter!!!

