

Hydrogeochemical Study to Determine Active Hydrodynamic Flow in Hydrocarbon Reservoir: The Case Study of Central Sumatra Basin

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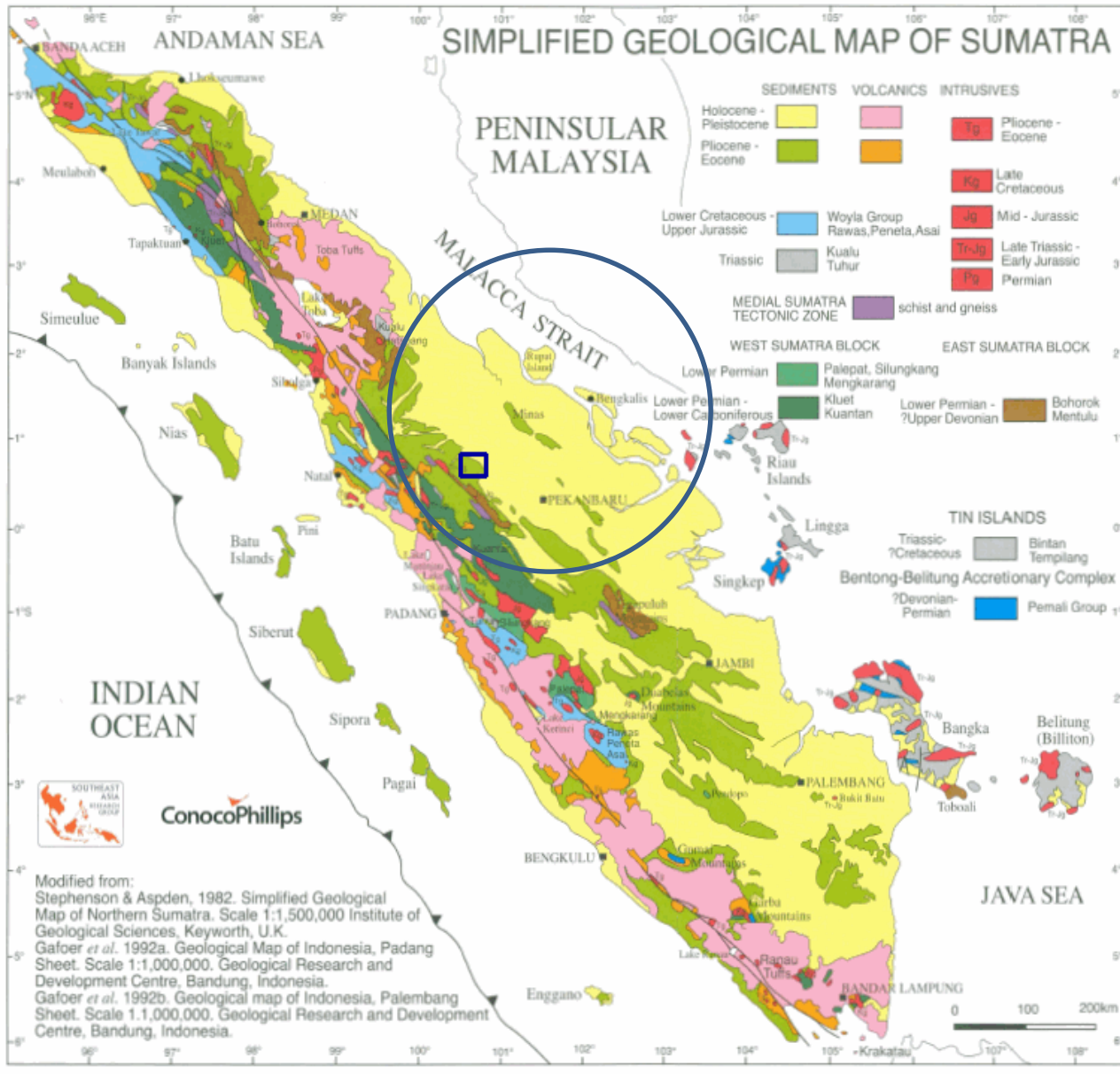
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Background

Research Area

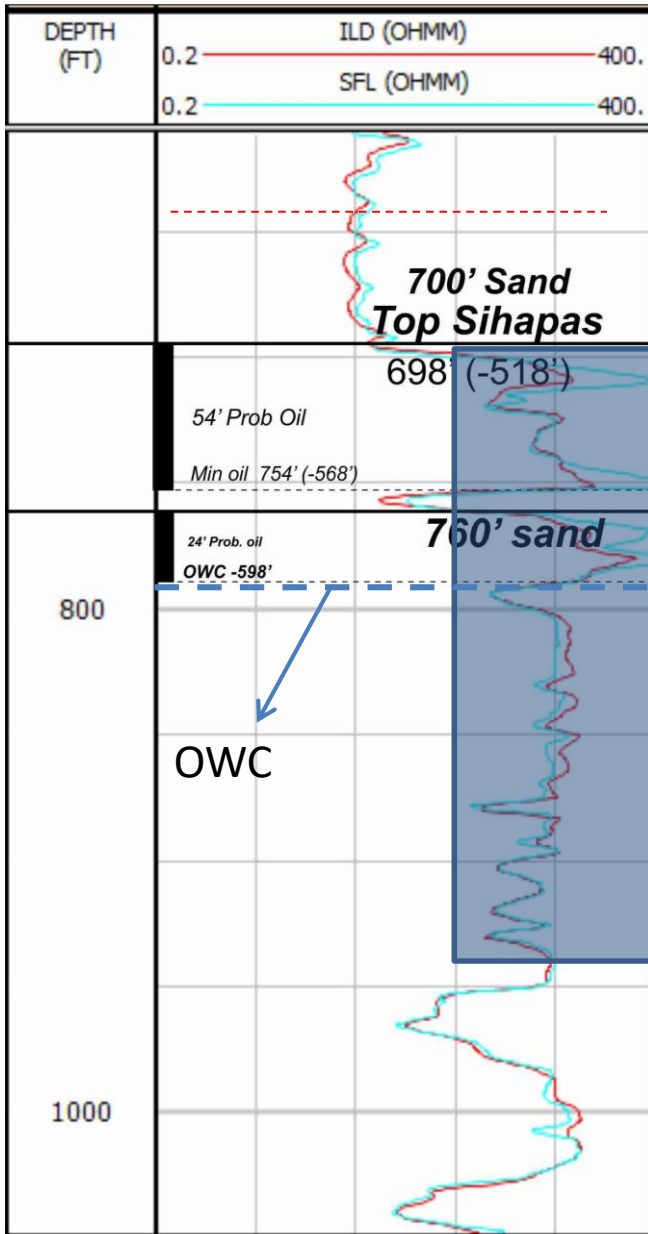


Central Sumatra Basin



Research Area

Resistivity Data



Average resistivity value:
300 – 400 ohmmeter

Serra (2007):

- Igneous rocks
- Metamorphic rocks
- Low porosity sedimentary rocks
- Non-conductive material: oil, gas, fresh water, bitumen, asphalt

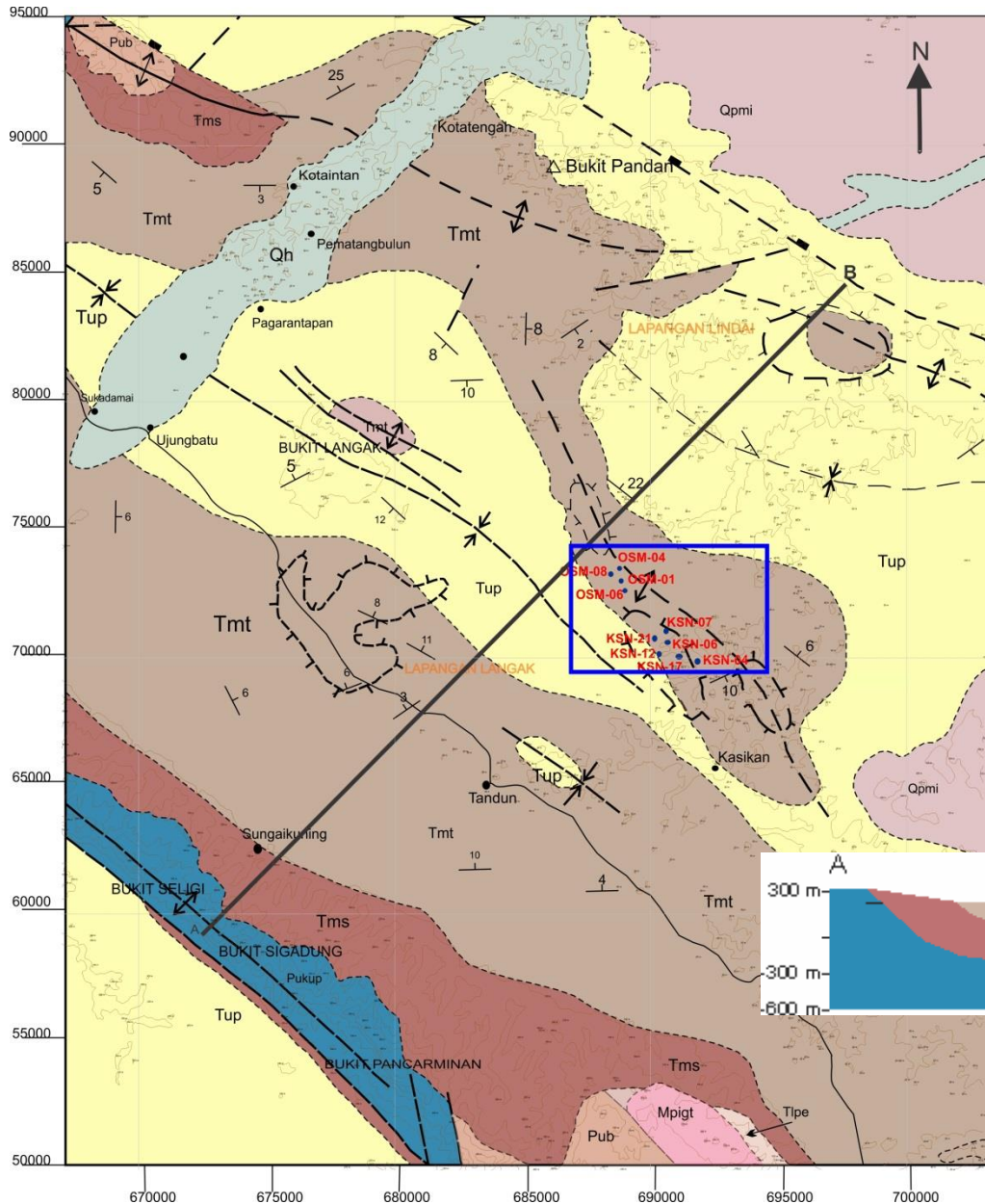
Fresh water (?)

Objectives

1. To determine formation water characteristics
 2. To determine the source of water in reservoir
- To investigate the presence of active hydrodynamic flow

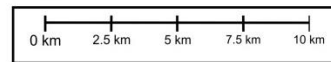
Geological Setting

Geological Map



- Qh Alluvium
- Qpmi Minas Formation
- Tup Petani Formation
- Tmt Telisa Formation
- Tms Sihapas Formation
- Tipe Pematang Formation
- Pukup Pub Basement
- Mpigt Granite Giti
- Formation Boundary
- Interpreted Structure
- Dip
- Interpreted Fold
- Research Area

Scale



(modified after Clarke, et al., 1982)



25-29th
September 2016

43rd
IAH
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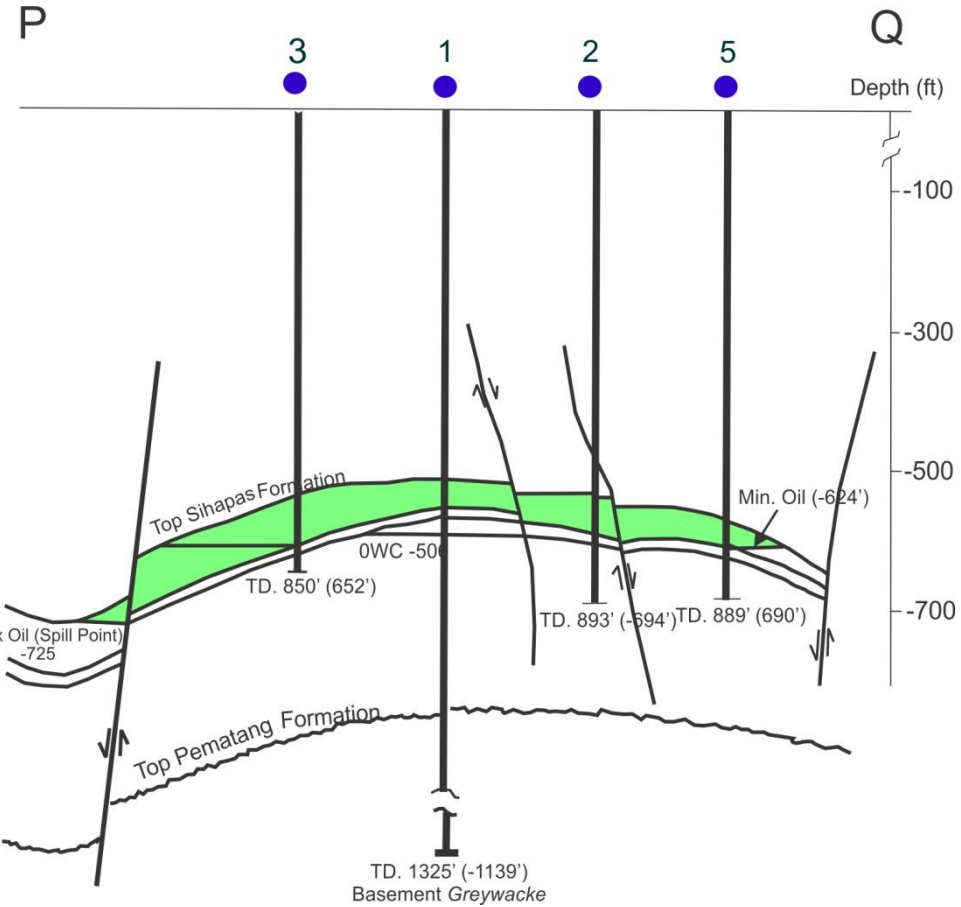
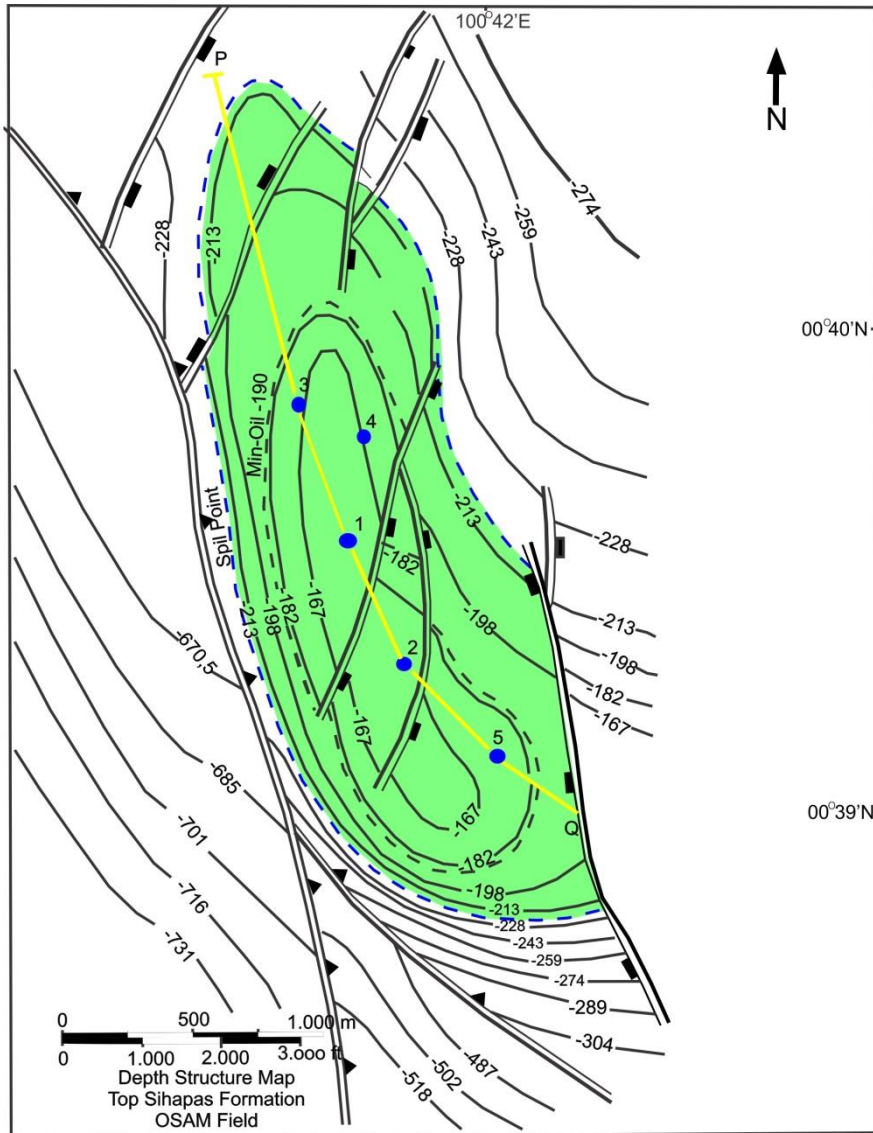
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Stratigraphy

Age		Blow Zonation (1969)	Formation	Depth (ft)	GR Log	Lithology	Description	Depositional Environment					
Miocene	Early Miocene	Lower N7	Telisa Formation	200			Claystone, dark grey, carbonat, calcareous, sandstone, fragment: galuconite, sandstone and limestone as inset	Upper Bathyal					
		N5 - N6						Sublittoral					
		N4							Duri Fm.	Interbedded of sandstone and shale	Sublittoral-Littoral		
Paleocene	Eocene - Oligocene	N?	Sihapas Group	600			<ul style="list-style-type: none"> Interbedded of sandstone with shale and claystone Sandstone, dark grey, coarse-fine grain, well sorted, loose to friable, calcareous Shale, grey, galuconite mineral Shale, greenish grey, sandy, glauconite mineral 	Sublittoral					
			Bekasap Formation/ Sihapas Formation					Bangko Fm	Shale, grey, calcareous				
			Menggala Fm.								800	Sandstone, brownish grey, fine - coarse sand, conglomerate	Fluviatile/ fluviomarine
			Pematang Group								1000	<ul style="list-style-type: none"> Interbedded of claystone and sandstone Claystone, grey, sandy, non calcareous Sandstone, grey, very coarse sand - gravel, rounded - sub rounded, quartz fragment. 	
Pre-Tertiary	-	Basement				Greywacke, light - dark grey, angular, clay matrix, quartz and feldspar mineral							

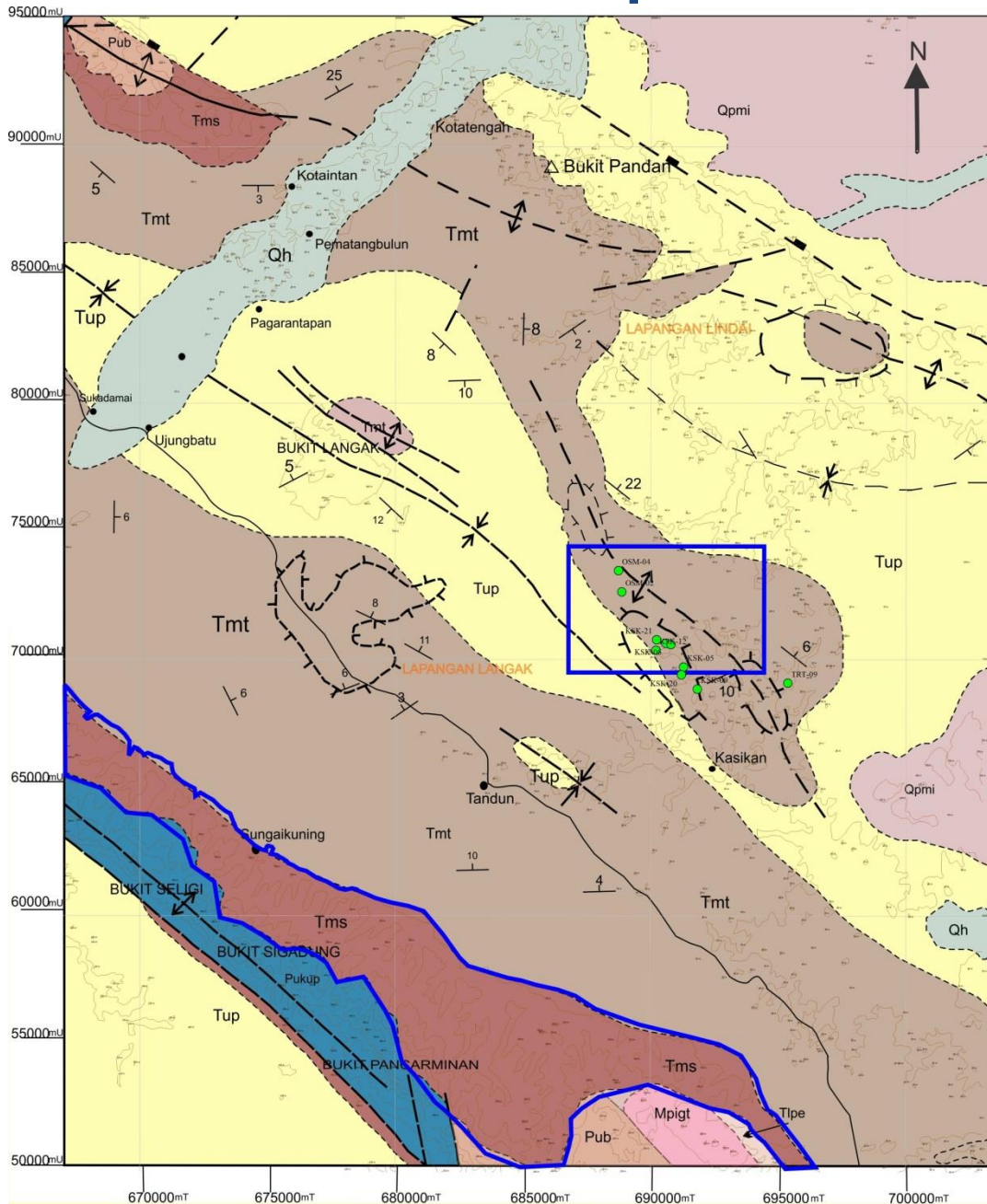
Geological Structure



(Courteney et al., 2006)

Hydrochemistry Study

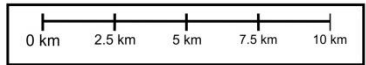
Sample Locations



LEGEND :

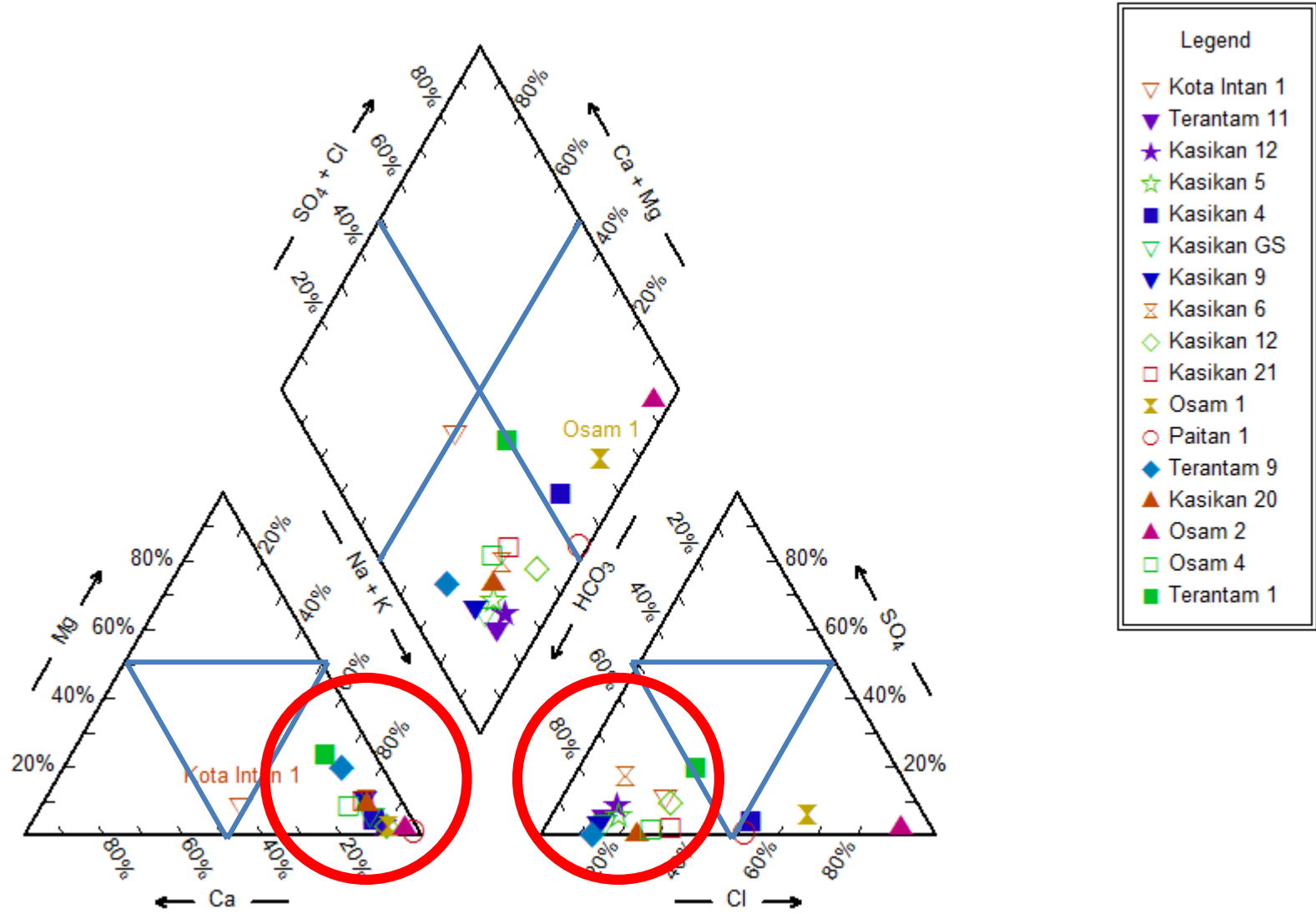
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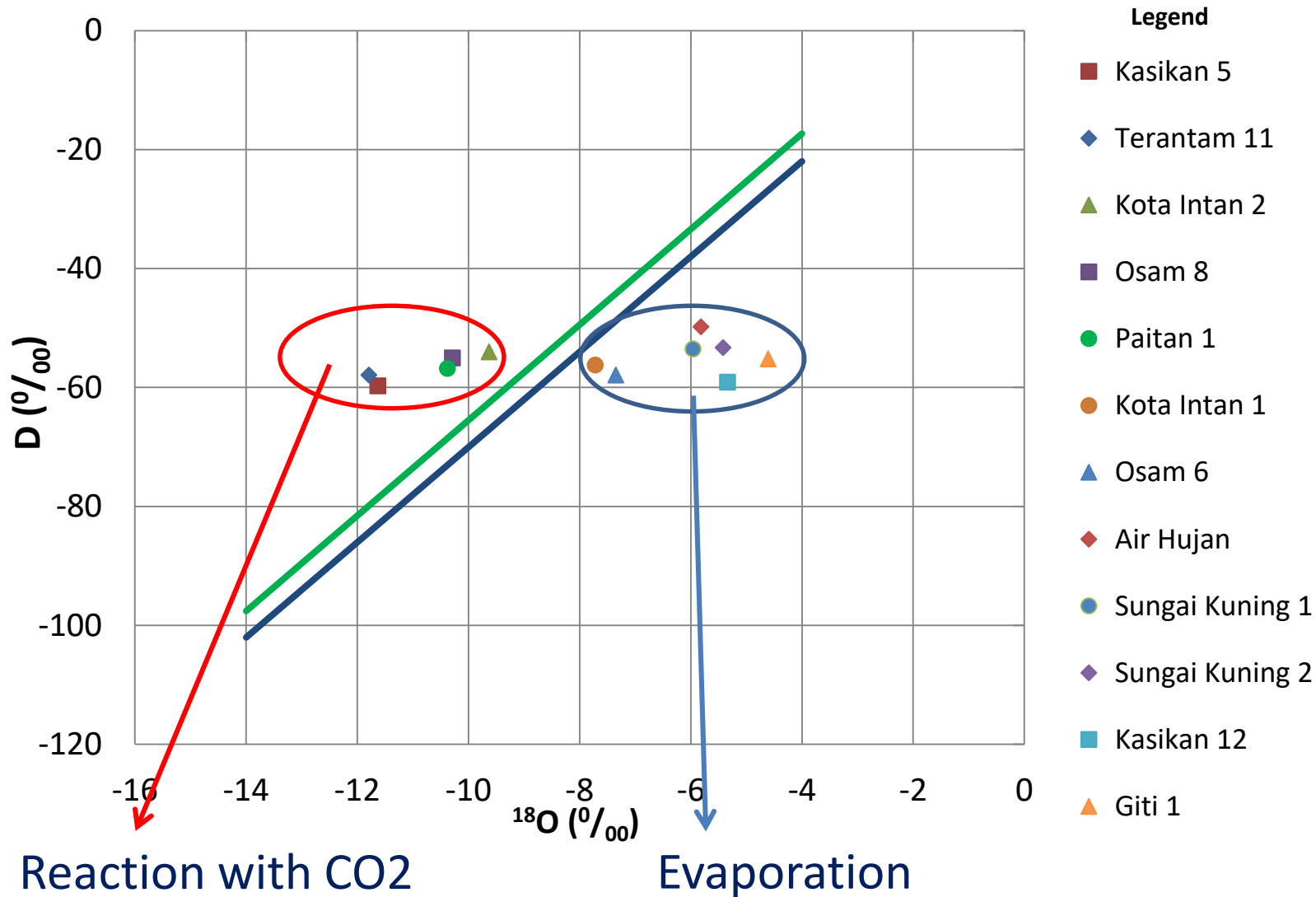
(modified after Clarke, et al., 1982)

Piper Diagram



Na-bicarbonate water characteristics

Stable Isotop Analysis



Hydraulic Conductivity

Samples Name	dl (m)	dh (m)	Water Age (year)	K (m/day)
KTI-2	24247	252	42.6	69.5
OSM-8	21960	265,4	40.8	120
OSM-6	22245	265	67.3	75
KSN-12	22284	264	54	94
GTI-1	28746	265	51.4	164

Unconsolidated sandstone

Discussion

1. Water Characteristics

- High resistivity
- Water chemistry : Na-bicarbonate
- Isotope : Evaporation and reaction with CO₂

→ The water is originated from meteoric water

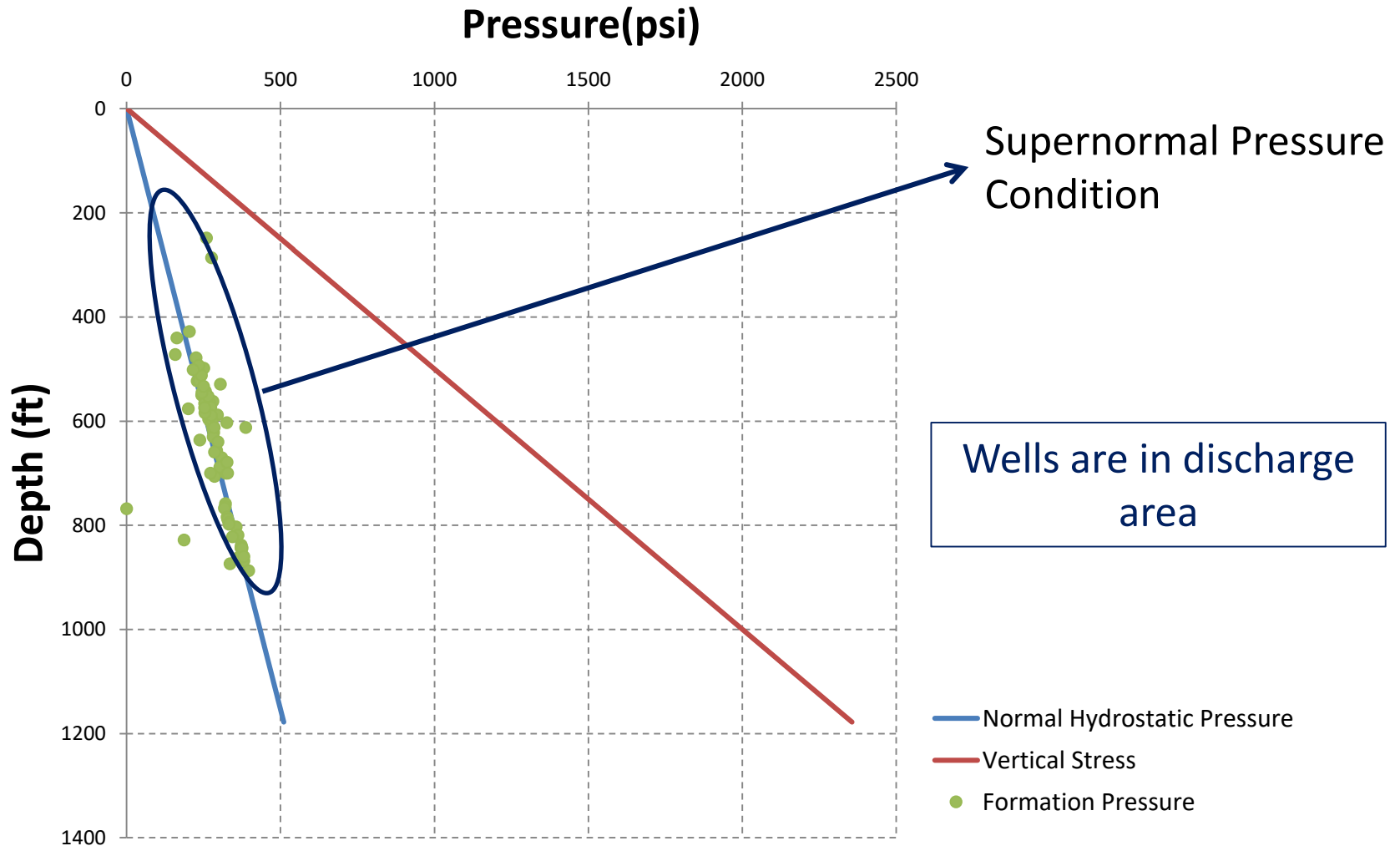
2. Recharge Area

- Equation of the Elevation of recharge area

No	Oxygen-18 Sample	Intercept		Elevation (Deuterium)	Elevation (Oxygen-18)
		Deuterium	Oxygen-18		
1.	SKN-02	-62.2	-7.2	144 m	-26 m
2.	KTI-02	-16.4	-2.1	-166 m	292 m
3.	OSM-06	-50.8	-5.9	67 m	53 m
4.	OSM-08	-11.2	-1.5	-201 m	328 m
5.	KSN-12	-76.2	-8.8	230 m	-123 m
6.	GTI-01	-46.3	-2.8	37 m	247 m

$\text{Elevasi (E)} = -205.77 \cdot \text{Oxygen-18} - 137$ $R^2 = 0.9873$	$\text{Elevasi (E)} = -7.0092 \cdot \text{Deuterium} - 288.88$ $R^2 = 0.9539$
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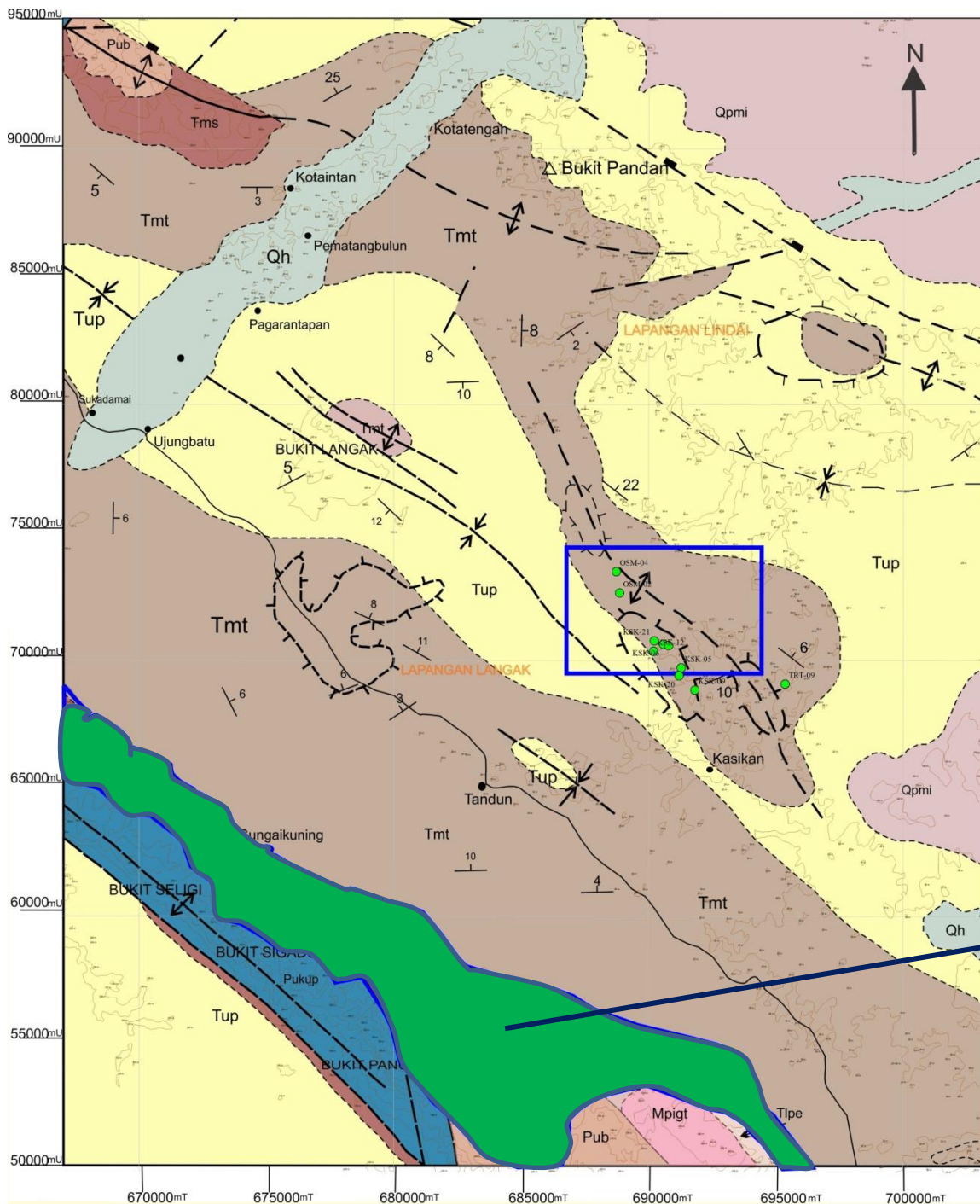
Formation Pressure vs Normal Hydrostatic Pressure



Supernormal Pressure Condition

Wells are in discharge area

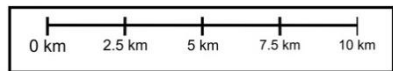
- Normal Hydrostatic Pressure
- Vertical Stress
- Formation Pressure



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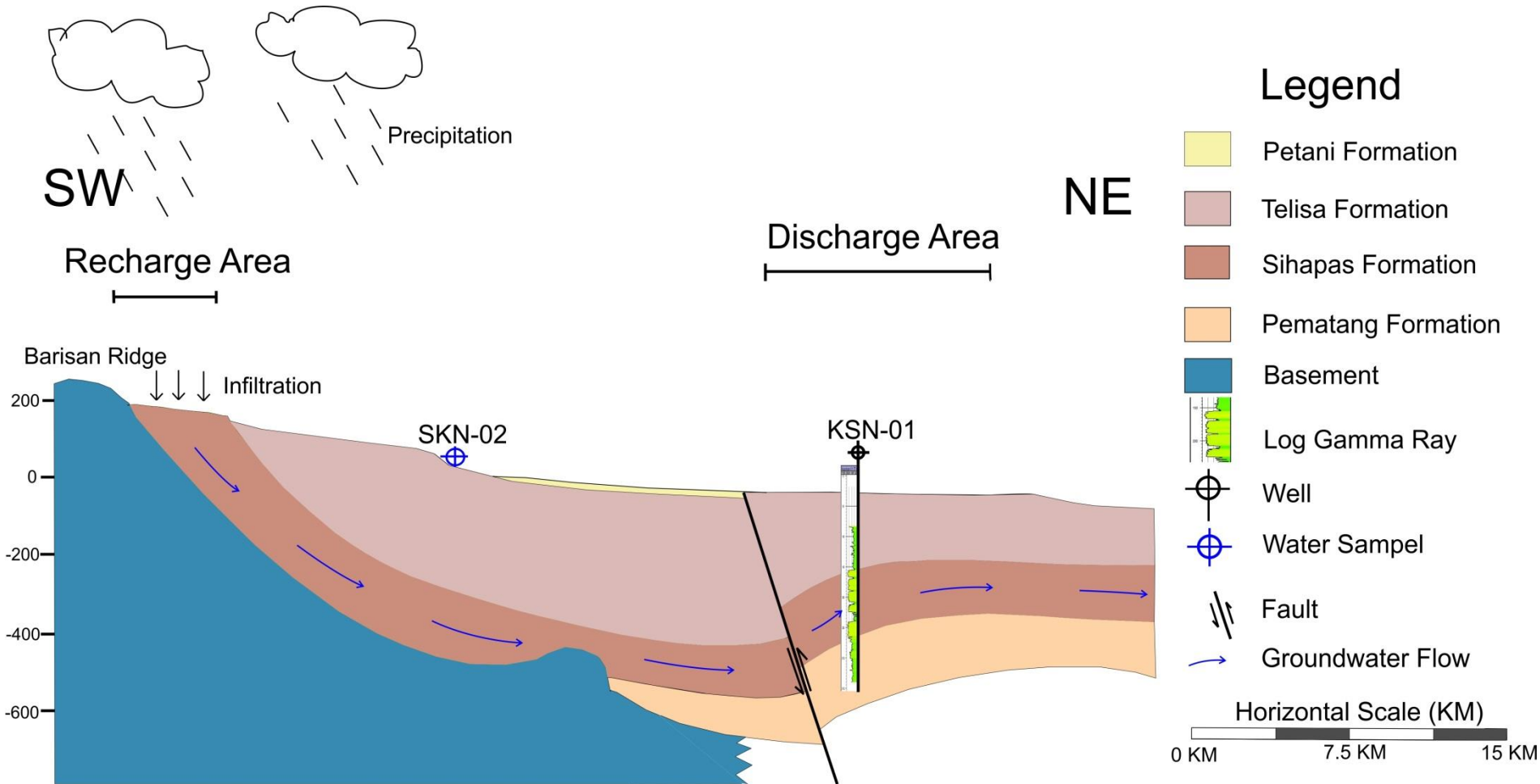
Scale



Recharge Area

(modified after Clarke, et al., 1982)

Groundwater Flow Scheme



Conclusion

Conclusions

1. Formation water is dominated by Na-bicarbonate water type
 2. Source of groundwater → meteoric water that entering the reservoir from the outcrop in recharge area
- Indication of active hydrodynamic flow

Thank You



lembaga pengelola dana pendidikan

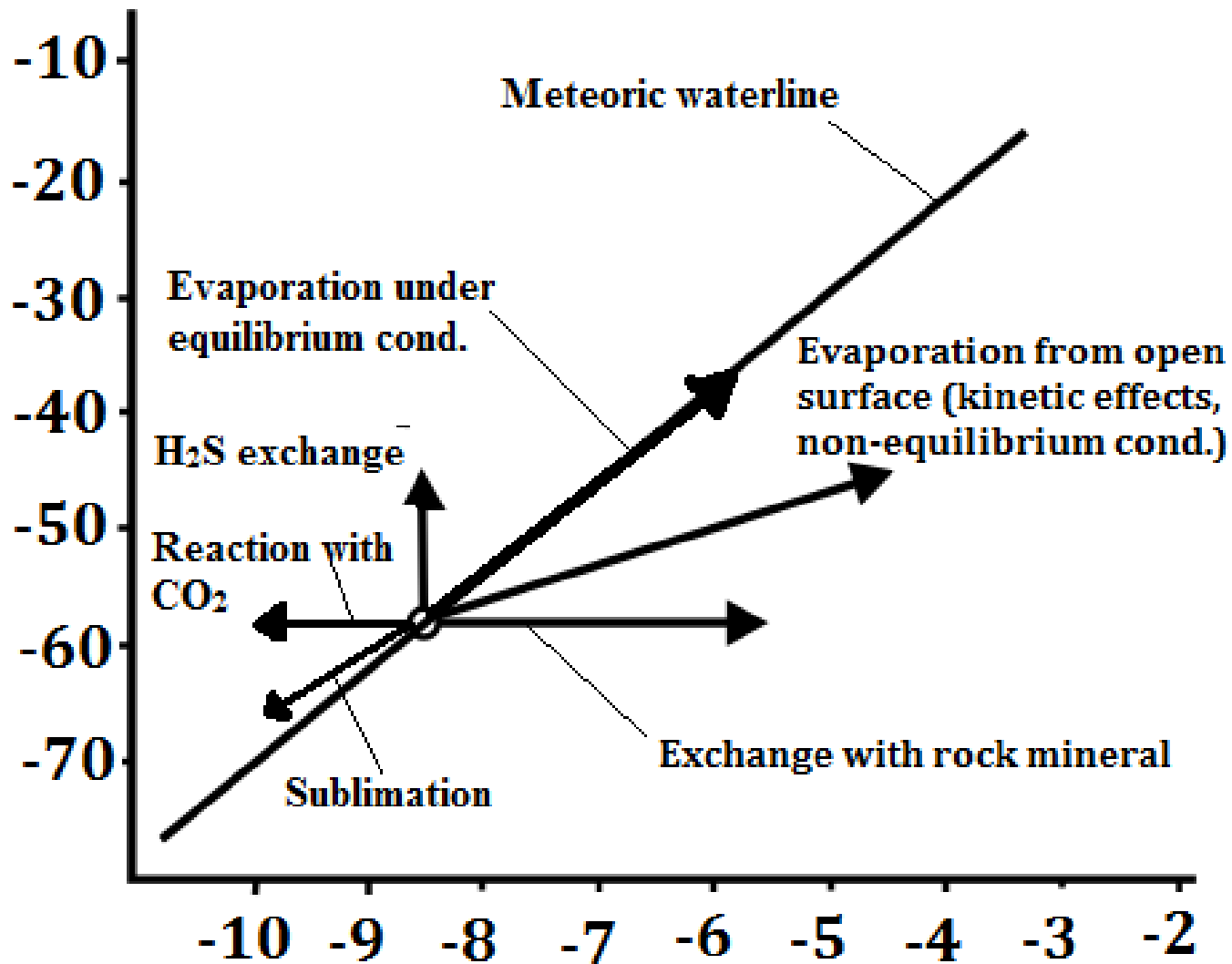


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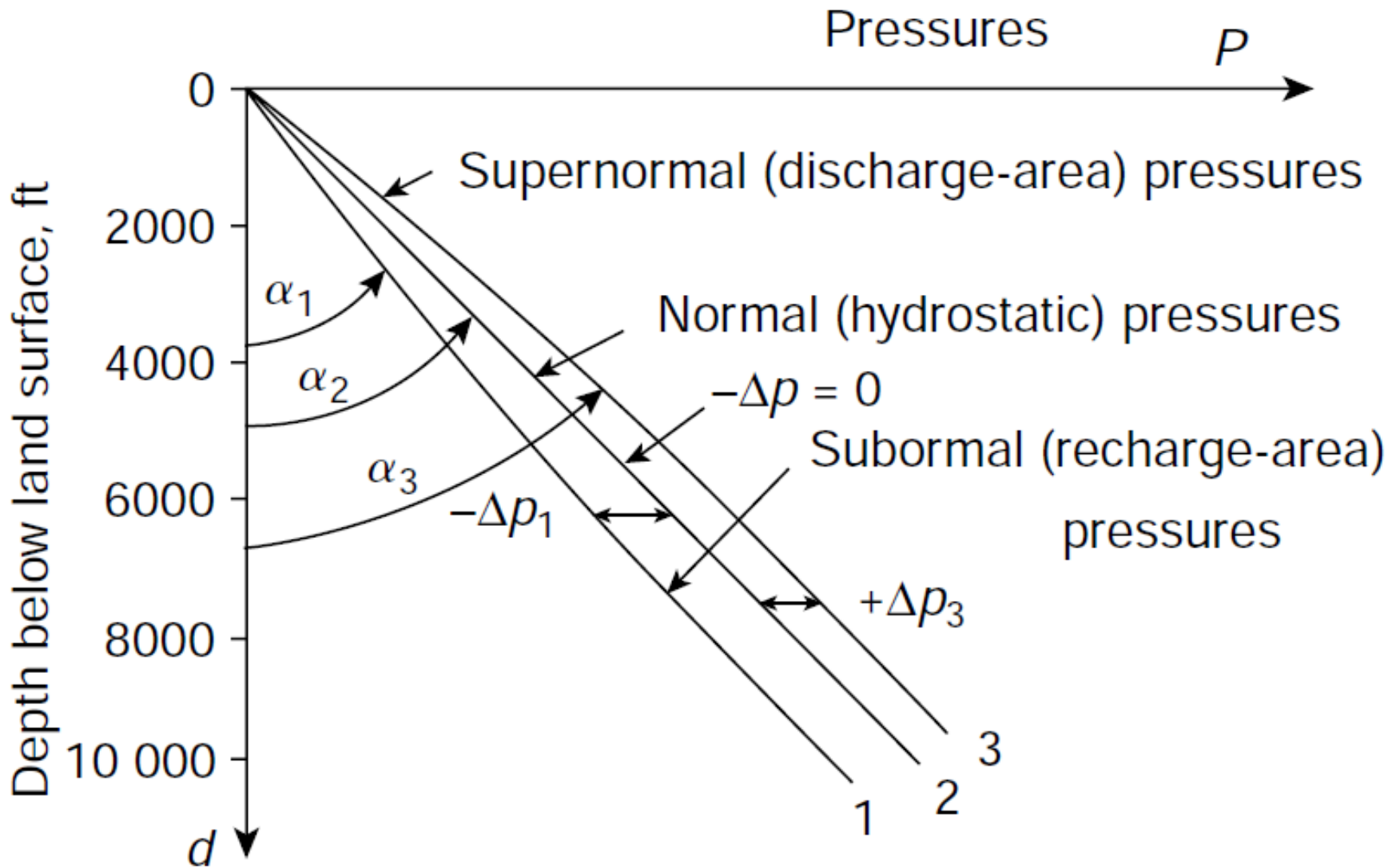
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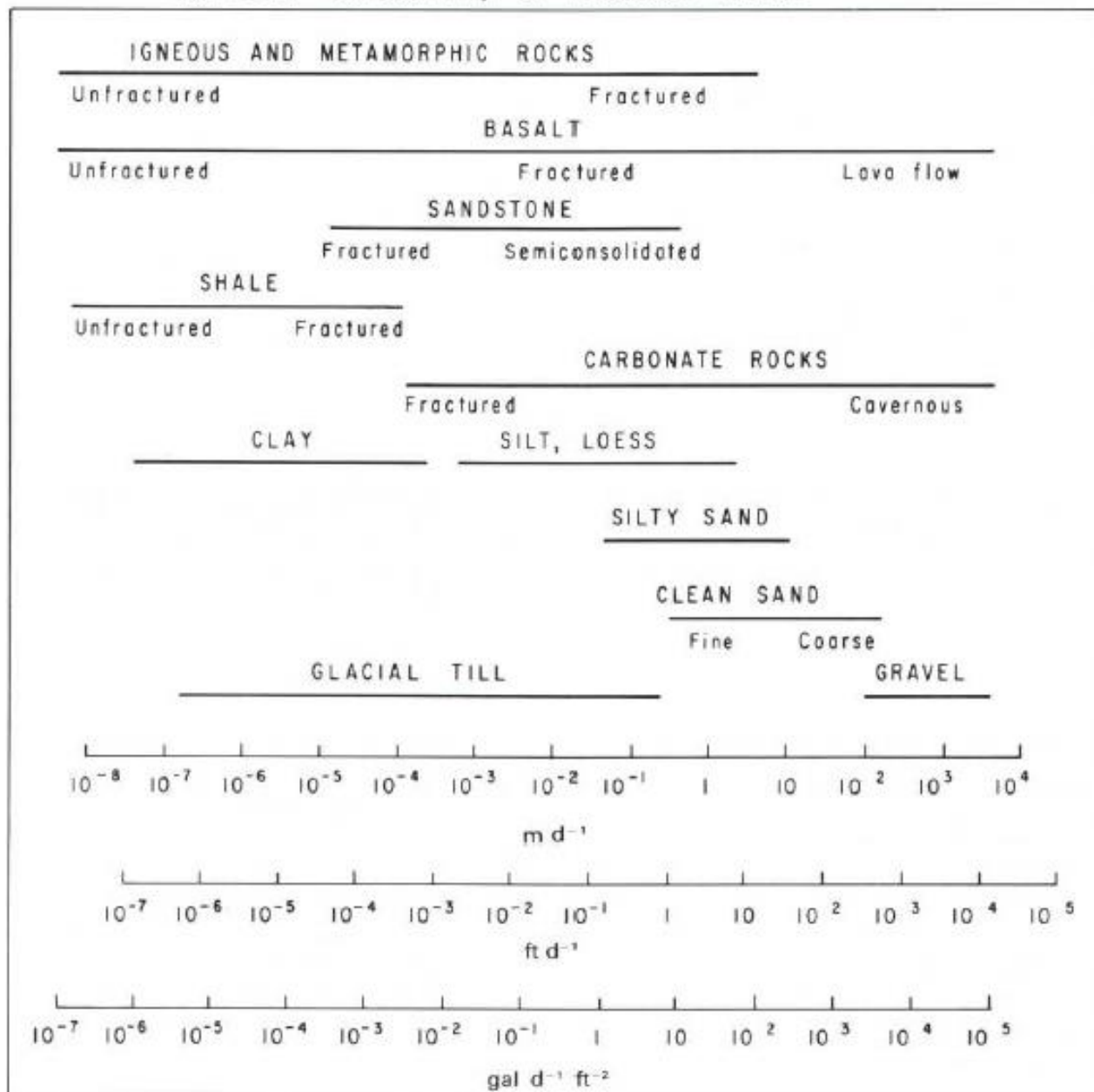


Isotopic variations as a results of evaporation or exchange processes (IAEA, 1983)

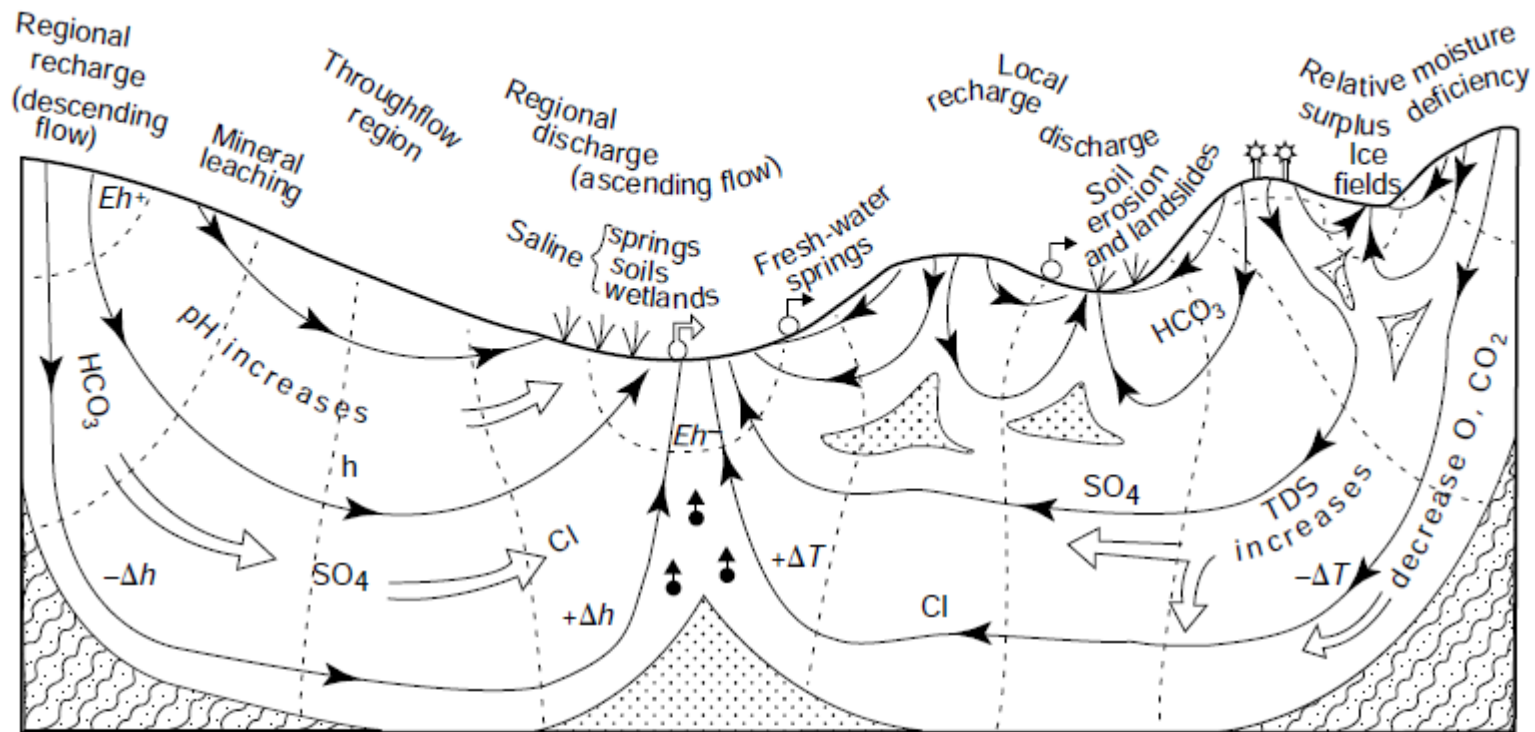


(Toth, 2009)

Hydraulic Conductivity of Selected Rocks



(Heath, 1983)



EXPLANATION

- Line of equal hydraulic head
- Flow line
- Spring: cold, warm
- Phreatophytes
- Xerophytes
- Redox conditions:
 - Eh^+ oxidizing
 - Eh^- reducing
- Mineral (metallic, evaporite, hydrocarbon) traces above accumulations

- Hydraulic heads:
 - $-\Delta h$ subhydrostatic
 - h hydrostatic
 - $+\Delta h$ superhydrostatic
- Hydraulic trap: convergence and accumulation of transported matter and heat
- Quasi-stagnant zone: increased TDS
- Geothermal temperature and gradient anomaly:
 - $+\Delta T, -\Delta T$ positive, negative

(Toth, 2009)