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Springs

Nainital district = 3860 sq kms
= 21,616 Springs

Uttarakhand = 53483 sq kms
=3,05,617 springs

Himalayas = ~500000 sq kms
= 2800000

Western Ghats, Eastern Ghats!!!!!!!?????

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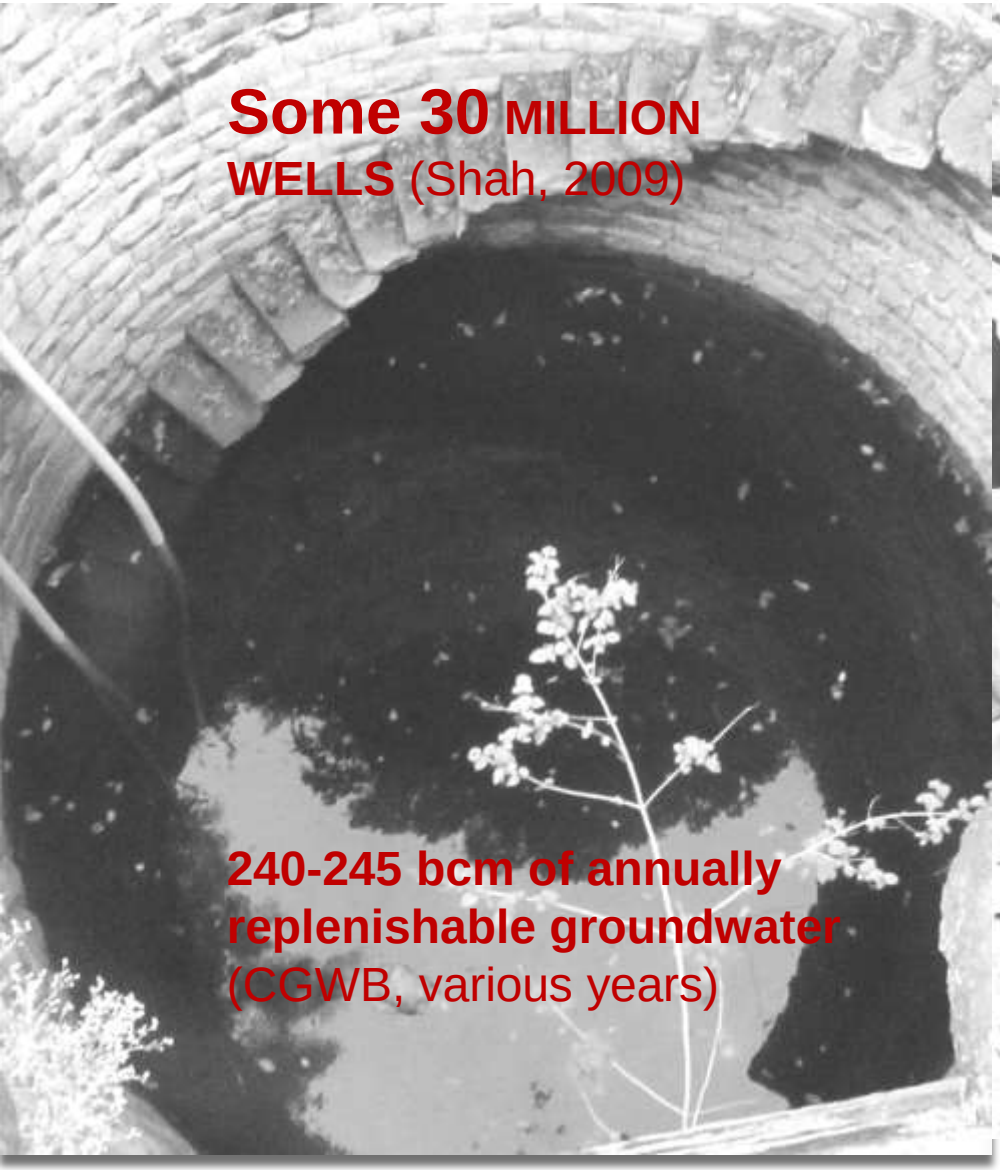
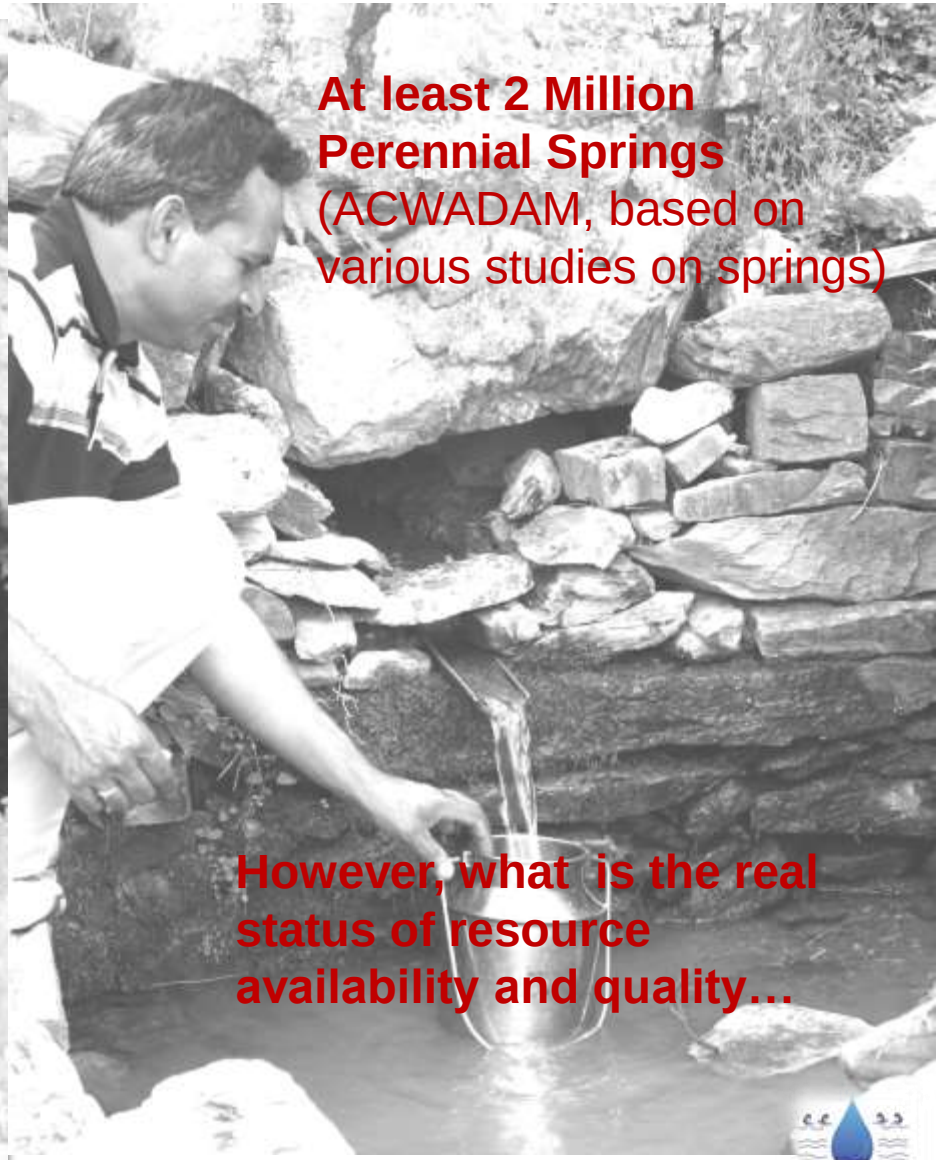
Supply: wells, springs…



Some 30 MILLION WELLS (Shah, 2009)

240-245 bcm of annually replenishable groundwater (CGWB, various years)



At least 2 Million Perennial Springs (ACWADAM, based on various studies on springs)

However, what is the real status of resource availability and quality…

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What are springs ?????

Springs are indicated by locations or points on the ground surface, where water from beneath the ground emerges onto the surface.

A spring may be considered as an ‘overflowing aquifer’

Springs represent ‘natural groundwater discharge’ that feeds streams and rivers, often making such streams and rivers perennial…

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Springs: wide-ranging usage

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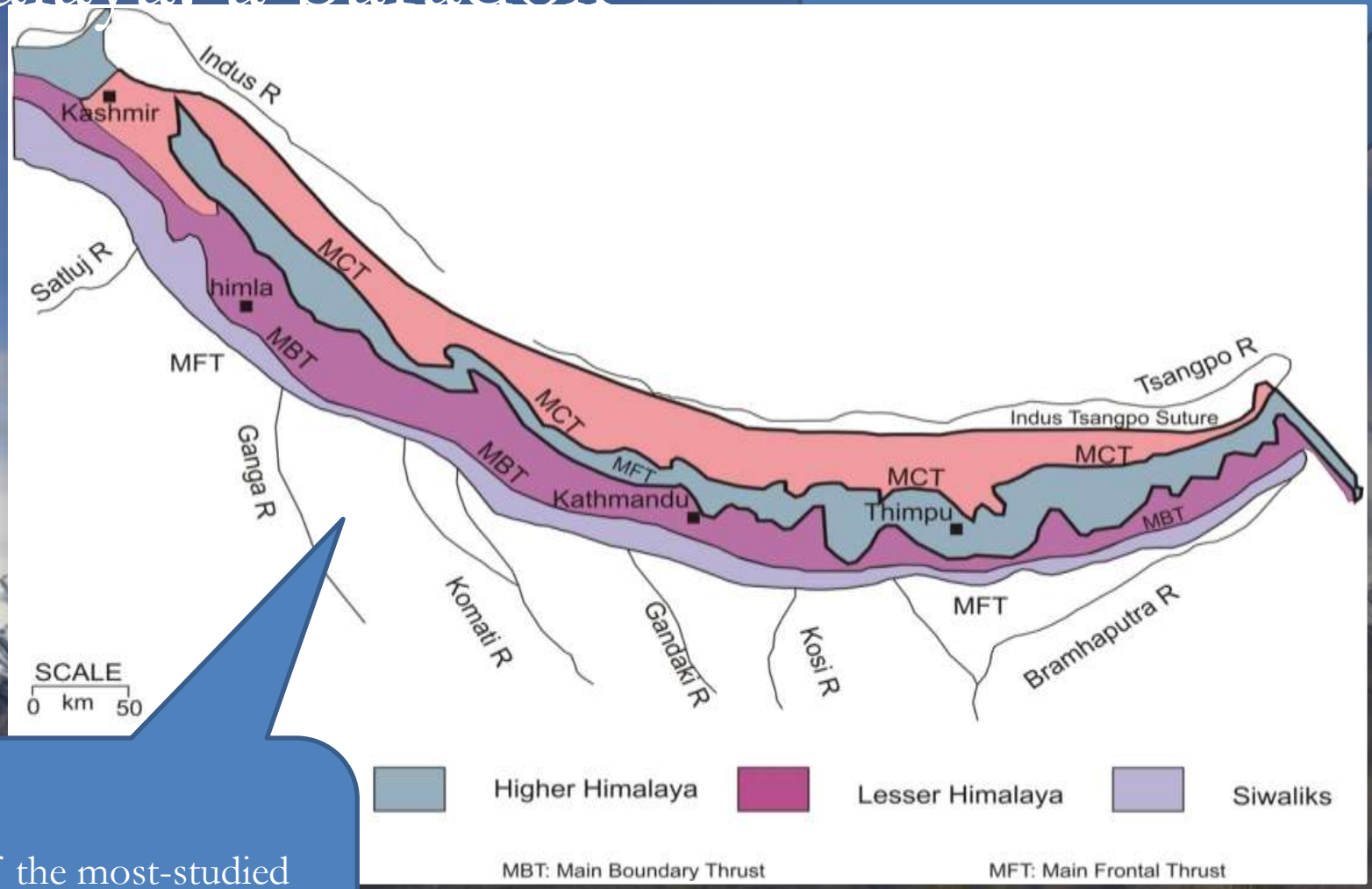
Himalaya: a paradox

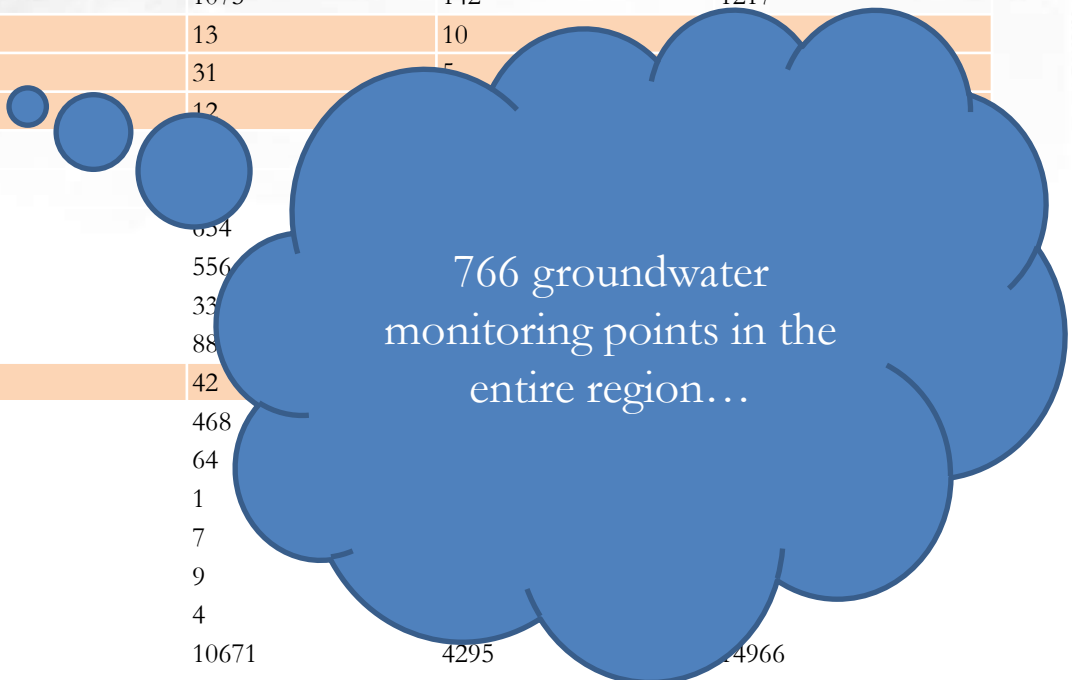
Groundwater – blind

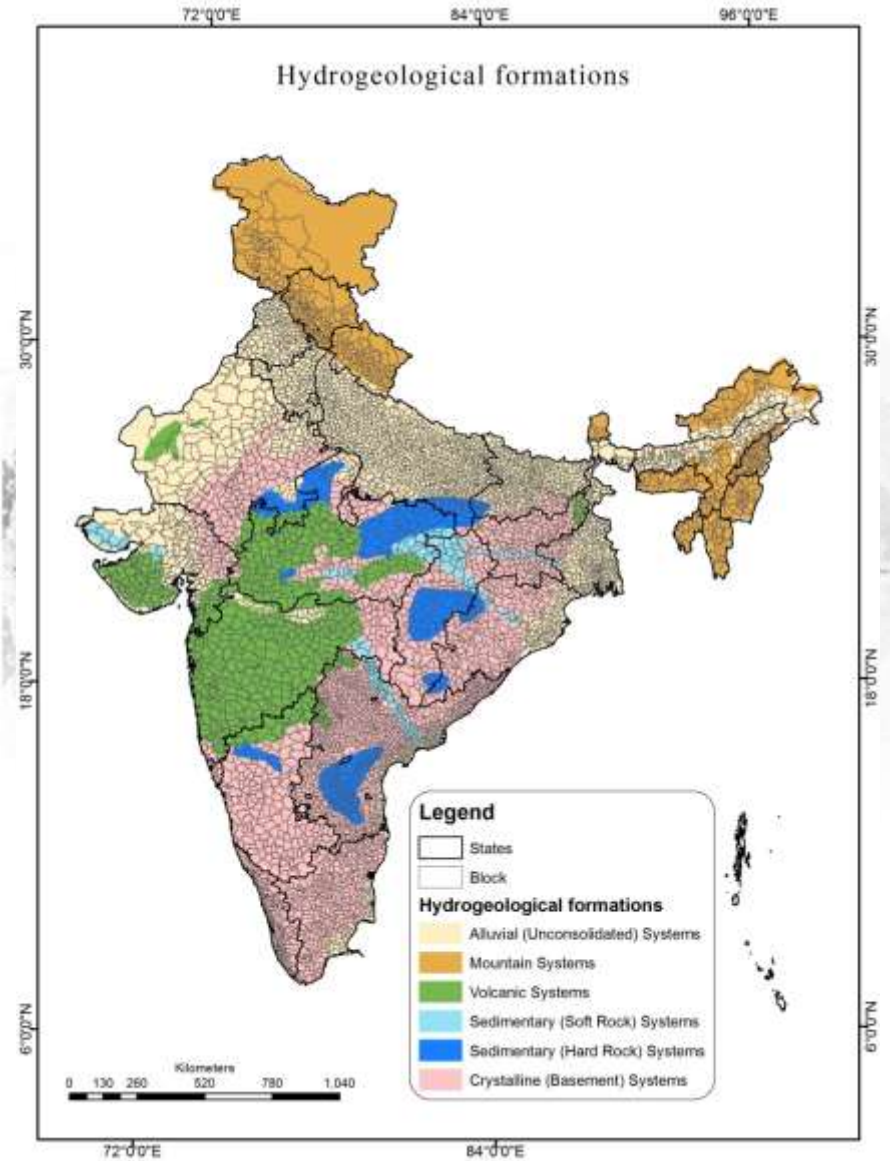


One of the most-studied geological regions in the world…

STATE-WISE STATUS OF GROUND WATER MONITORING WELLS IN INDIA AS ON 31.03.2011

S. No.	Name of the State	Total No. of Ground Water Monitoring Wells (as on 31.03.2011)		
	States	DW	PZ	Total
1	Andhra Pradesh	591	311	902
2	Arunachal Pradesh	12	1	13
3	Assam	297	9	306
4	Bihar	314	12	326
5	Chhattisgarh	461	117	578
6	Delhi	25	137	162
7	Goa	43	10	53
8	Gujarat	635	376	1011
9	Haryana	205	186	391
10	Himachal Pradesh	86	0	86
11	Jammu & Kashmir	168	19	187
12	Jharkhand	212	14	226
13	Karnataka	1132	373	1505
14	Kerala	665	273	938
15	Madhya Pradesh	870	298	1168
16	Maharashtra	1075	142	1217
17	Manipur	13	10	
18	Meghalaya	31		
19	Nagaland	12		
20	Orissa			
21	Punjab			
22	Rajasthan	654		
23	Tamil Nadu	556		
24	Tripura	33		
25	Uttar Pradesh	88		
26	Uttaranchal	42		
27	West Bengal	468		
1	Andaman & Nicobar	64		
2	Chandigarh	1		
3	Dadra & Nagar Haveli	7		
4	Daman & Diu	9		
5	Pondicherry	4		
	Total	10671	4295	4966





After: COMMAN 2005; GSI (various years), ACWADAM (various publ.), CGWB (2012)

Wide ranging scale of aquifers

- The Himalayas feed the vast alluvial plains of the Indus, Ganga and Brahmaputra basins
- Many hydrogeological settings leading to a diversity in aquifer conditions
- Groundwater conditions vary in space and time
- Contexts of droughts and floods

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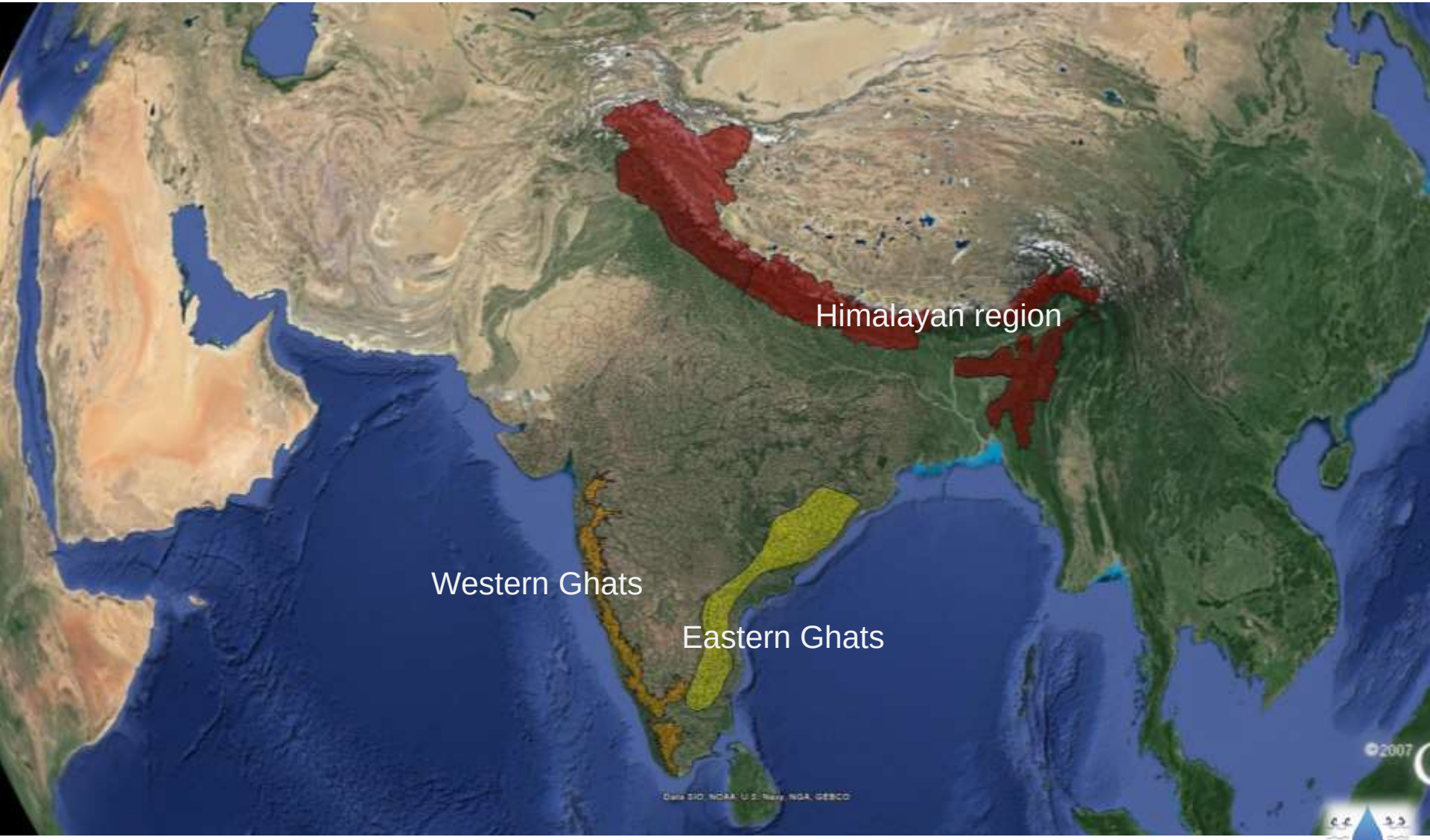
Spring-scapes of India

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Springs: not just water emerging from the ground…

…but a wide variety of ‘systems’

Springs: the lifeline of mountain water supply


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Springs: a few characteristics

Difficulty in access

Water quality

Varying discharge

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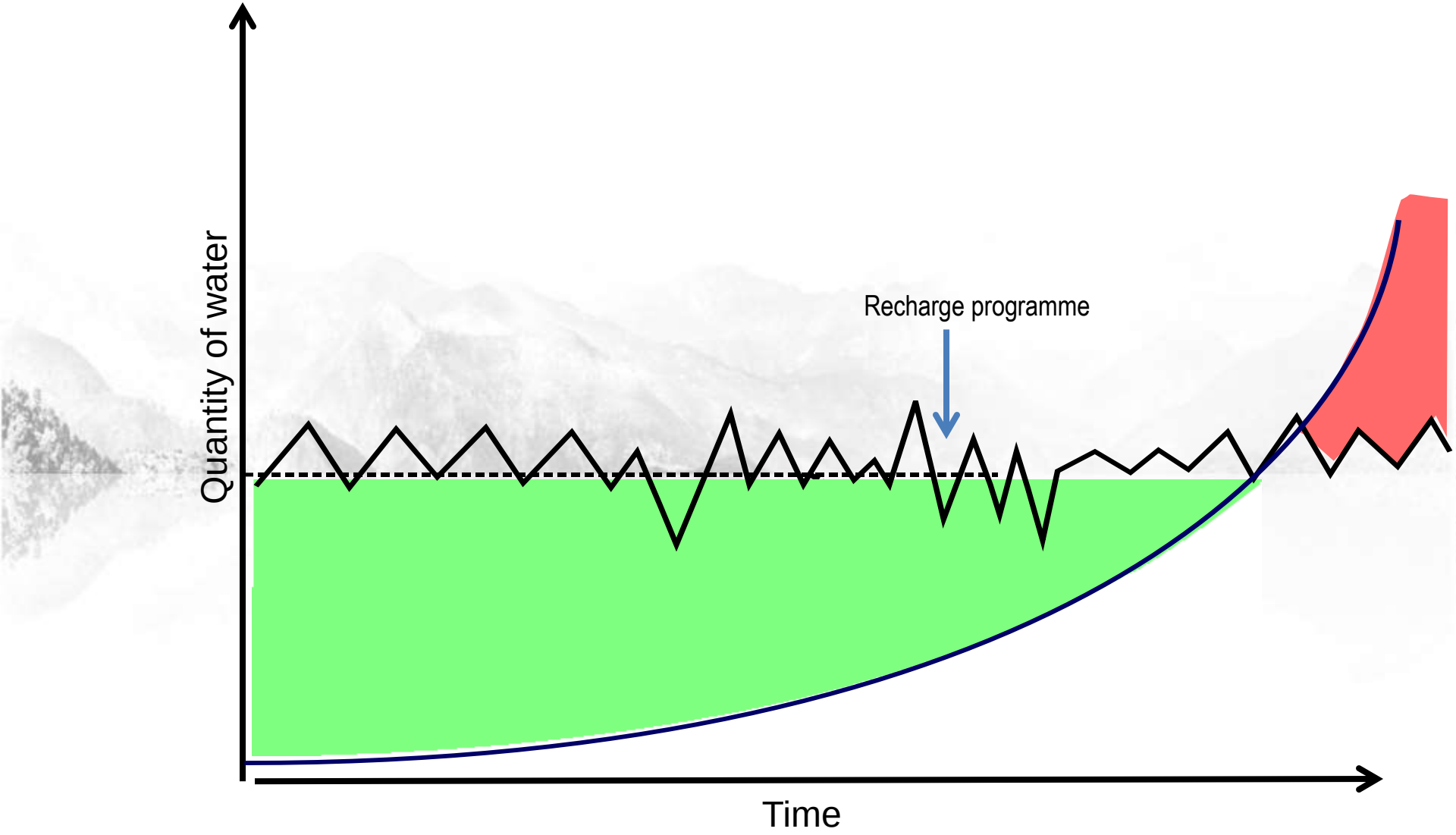
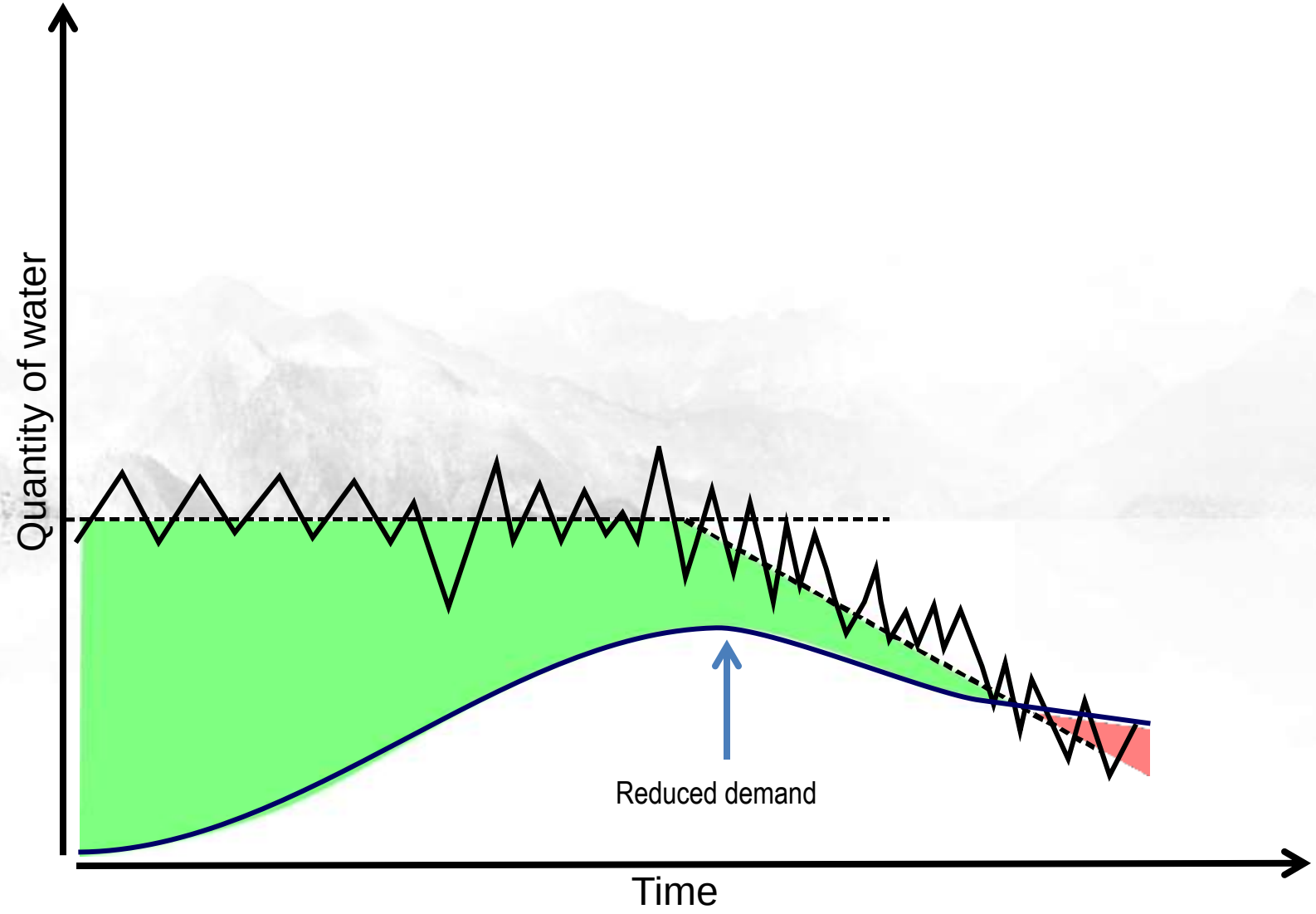
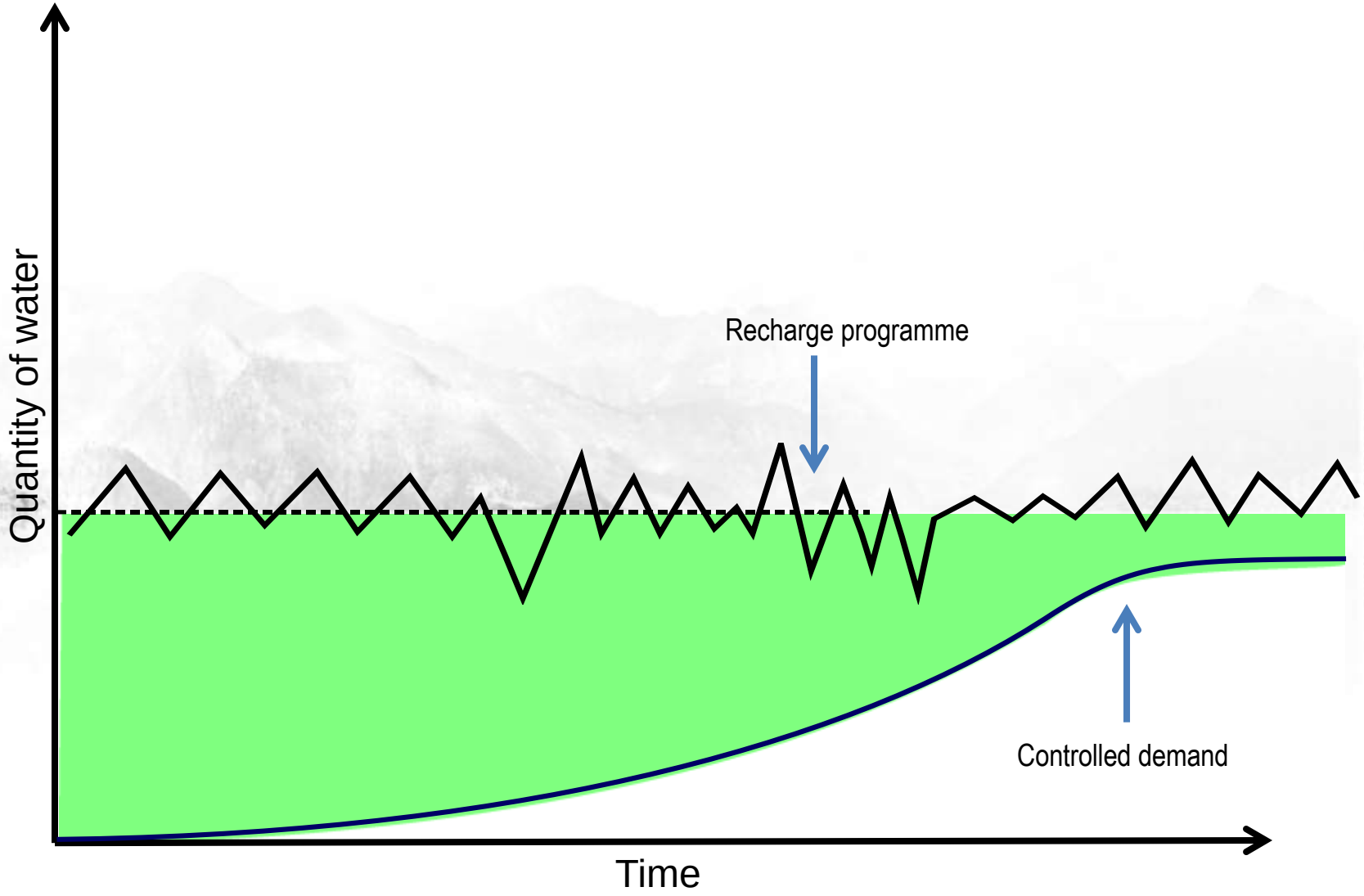
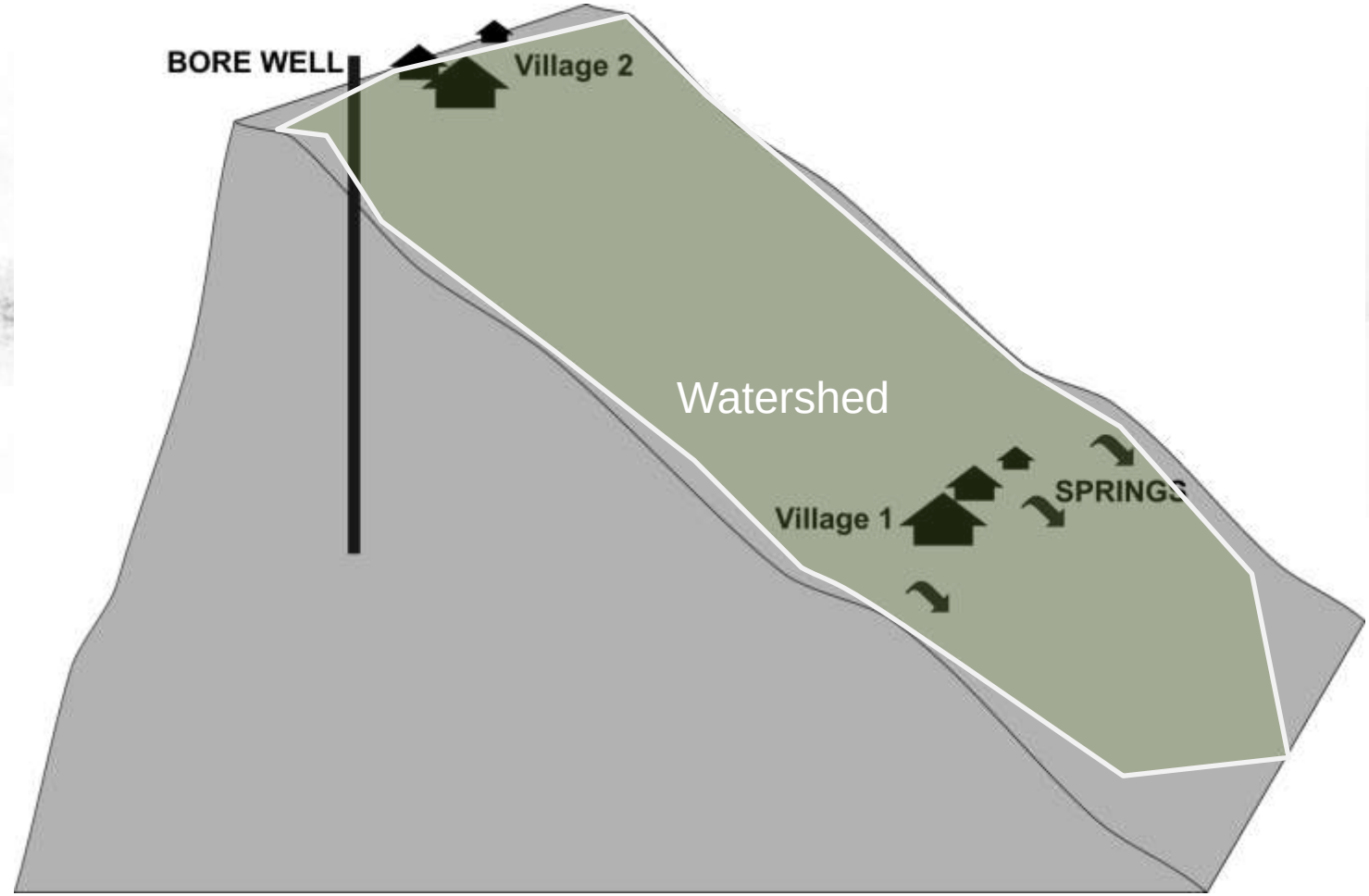

Quantity of water
Recharge programme
Time

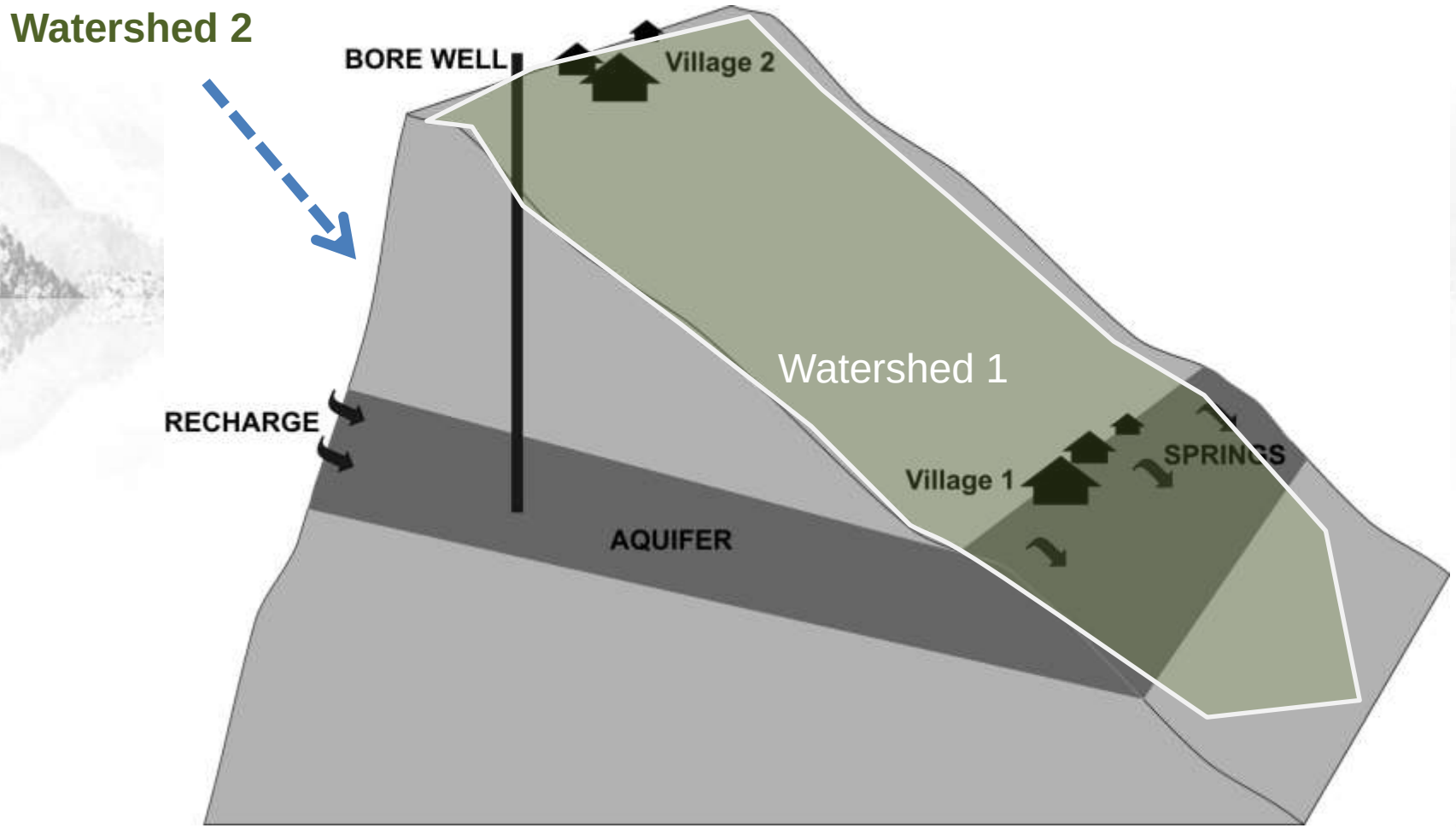

Quantity of water
Reduced demand
Time


Quantity of water
Recharge programme
Controlled demand
Time

Groundwater: shift in focus needed – from *sources*...



...to a 'resource', i.e. aquifers



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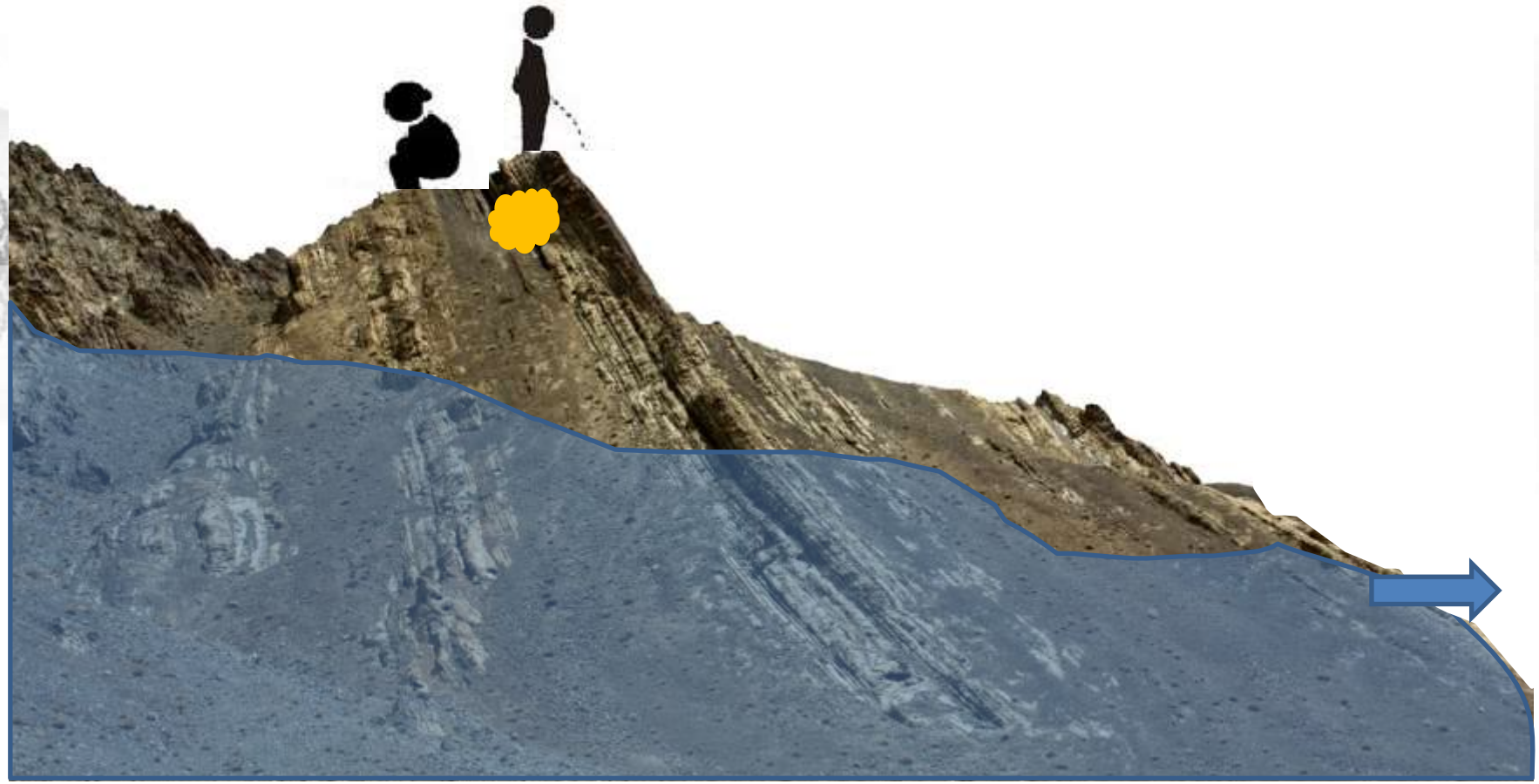
Meghalaya: a schema of spring systems

Springs – sanitation nexus



Types of springs

It is necessary to identify the type of spring in order to understand how they behave over time and space

-Depression spring

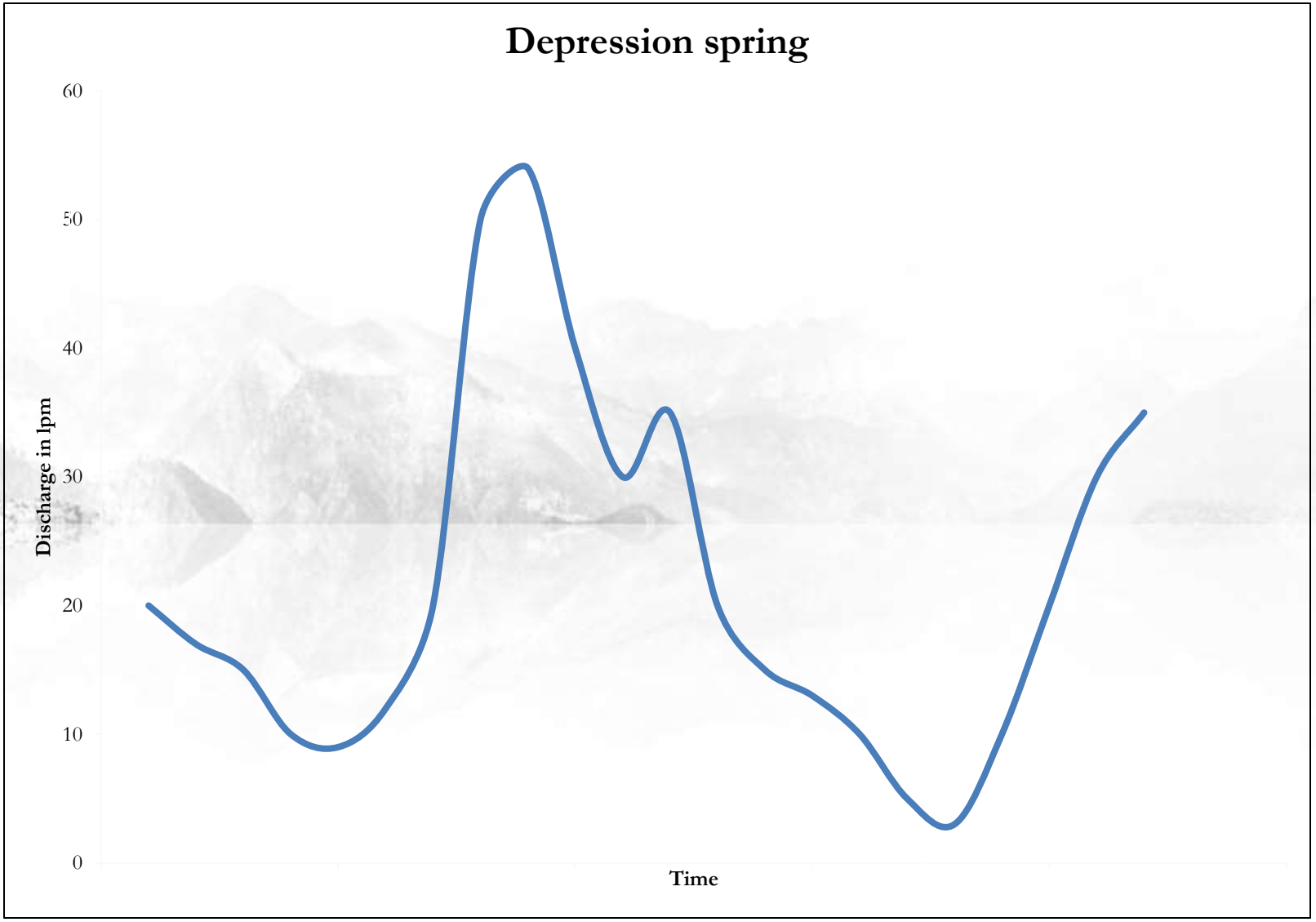
- Contact spring

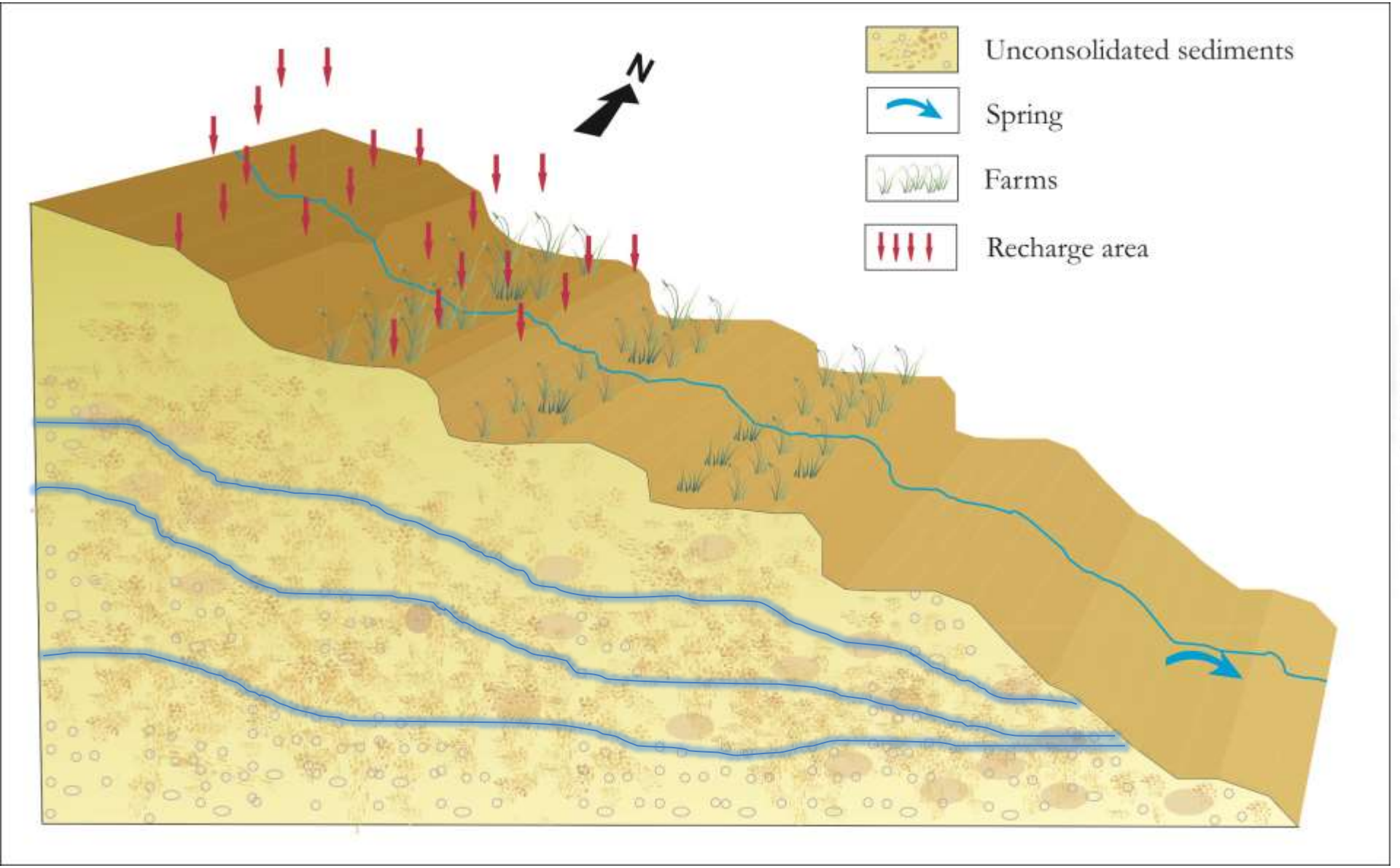
- Fracture spring

- Fault spring

- Karst spring

Modified after Tolman, 1937


Depression spring
60
50
40
30
20
10
0
Discharge in lpm
Time



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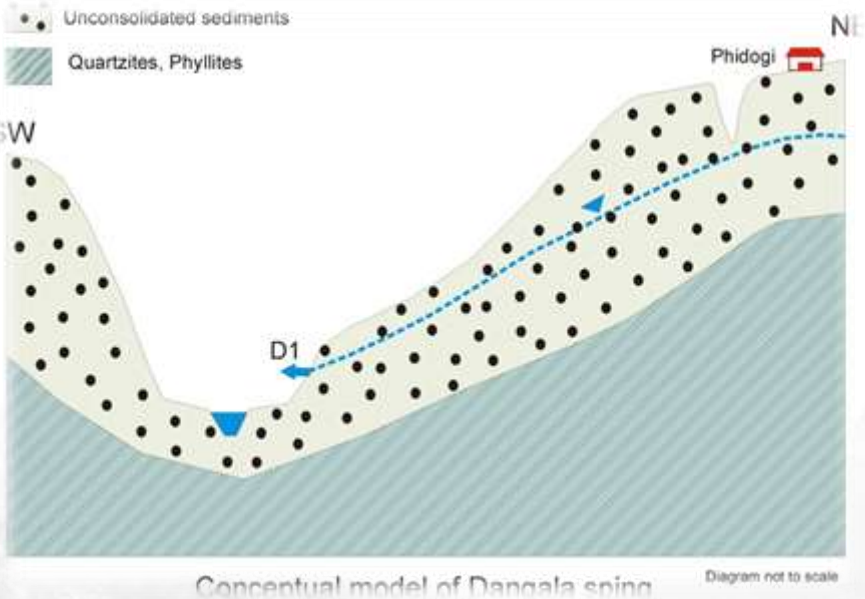
Depression spring

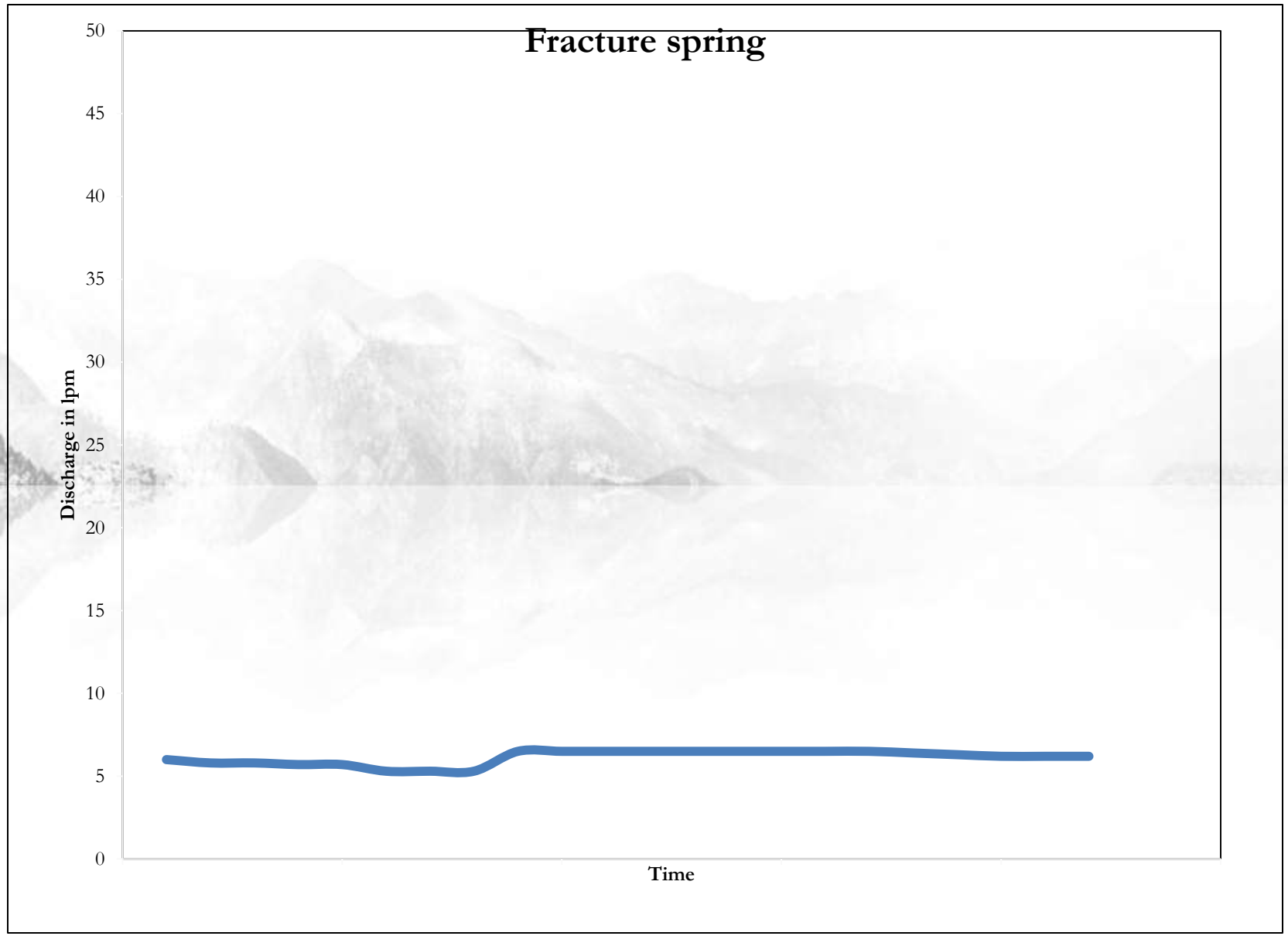
Formed at topographic lows.

Formed when water table reaches the surface due to topographic undulations.

A local flow system is created and a spring is formed at the local Discharge zone.



Conceptual model of Dangala spring


Fracture spring
50
45
40
35
30
25
20
15
10
5
0
Discharge in lpm
Time

Fracture spring

Occur due to existence of jointed or permeable fracture zones in low permeability rocks.

Movement of groundwater is mainly through fractures that may tap shallow as well as deep aquifers.

Springs are formed where these fractures intersect the land surface.

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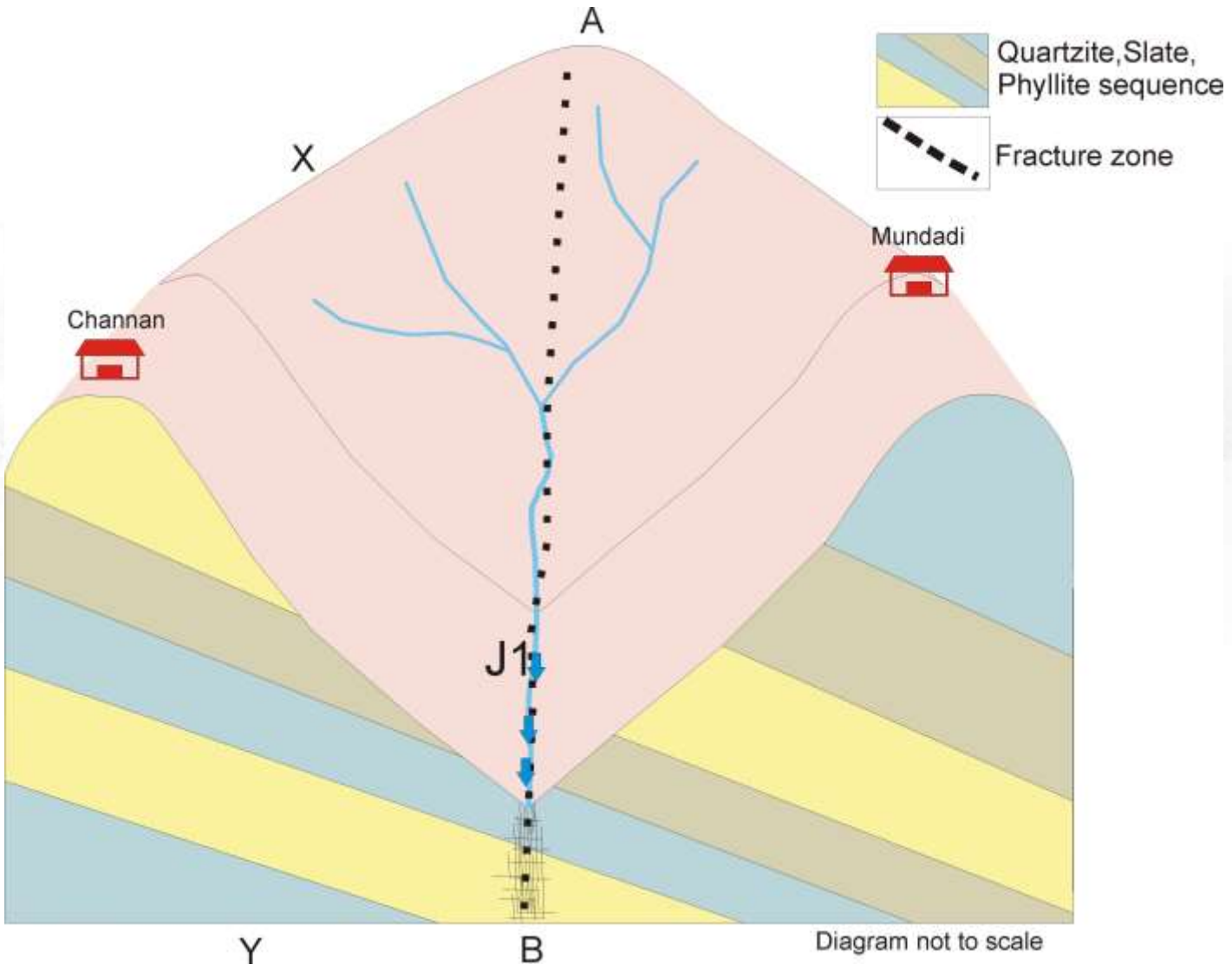
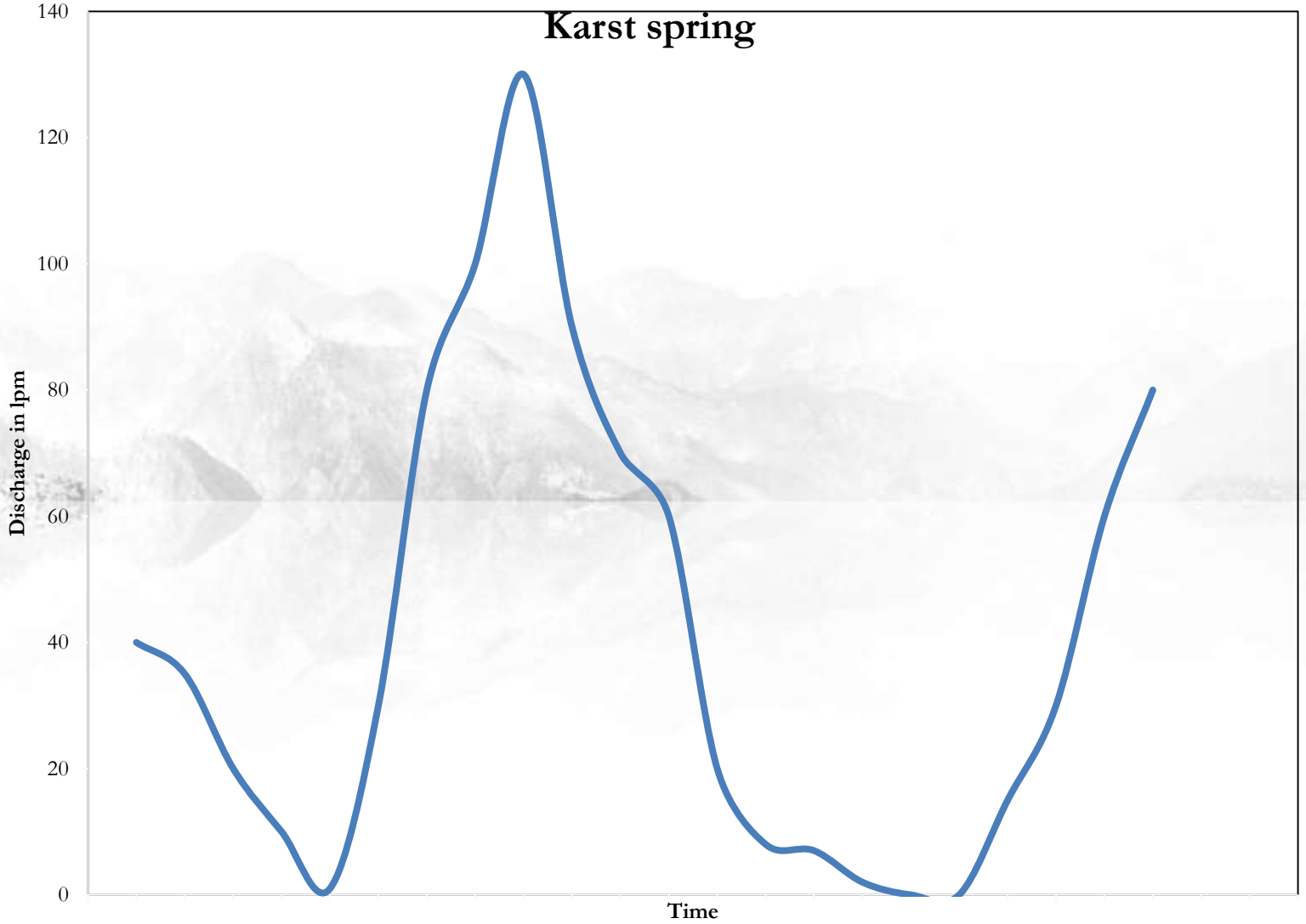
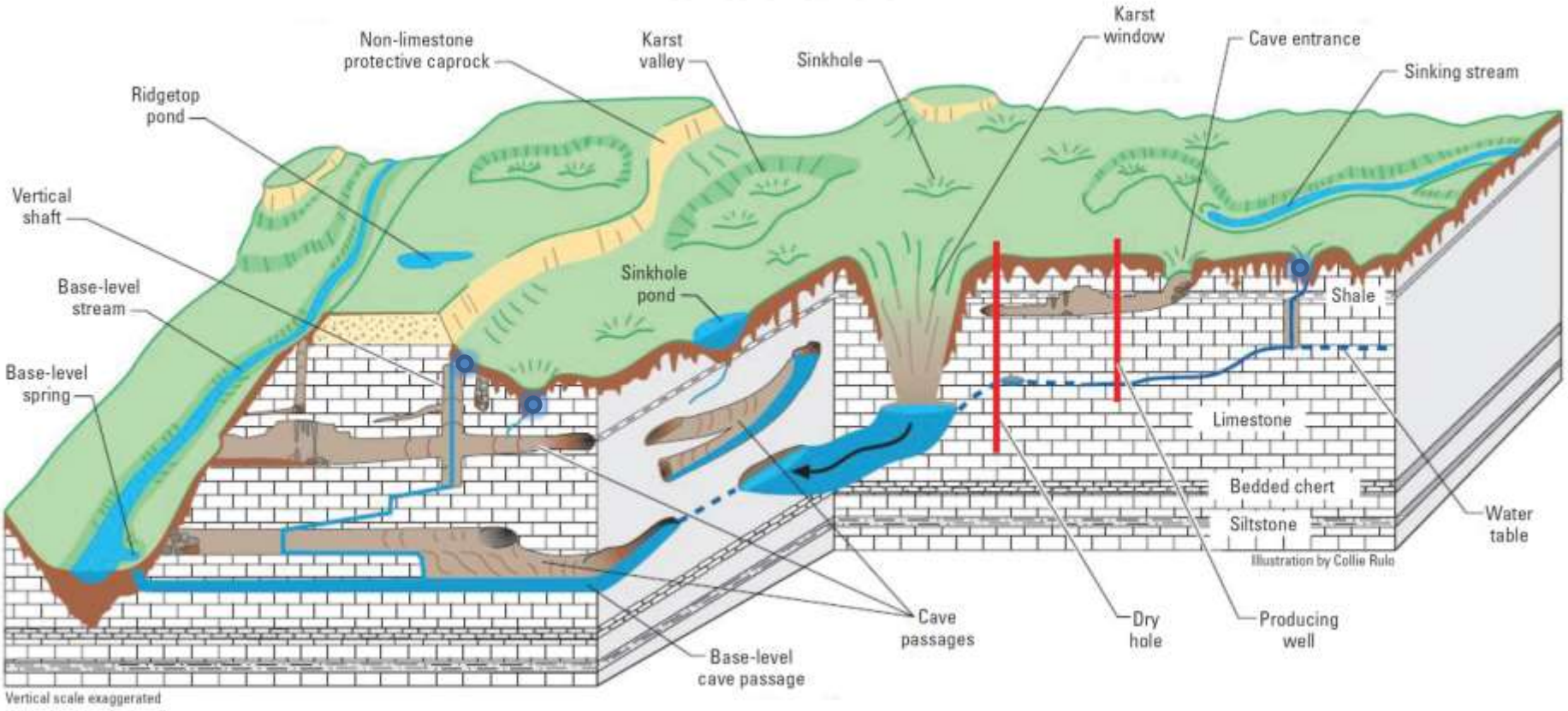
Fracture spring




Karst spring
140
120
100
80
60
40
20
0
Discharge in lpm
Time



Modified from Currens, 2001, Kentucky Geological Survey,

Karst spring

Limestones host many springs.

Springs in limestone terrains can be interconnected to topographic depressions caused by sinkholes – depressions in the ground surface cause due to the dissolving of limestones below.

Large quantities of water move through the cavities, channels, conduits and other openings developed in limestones.

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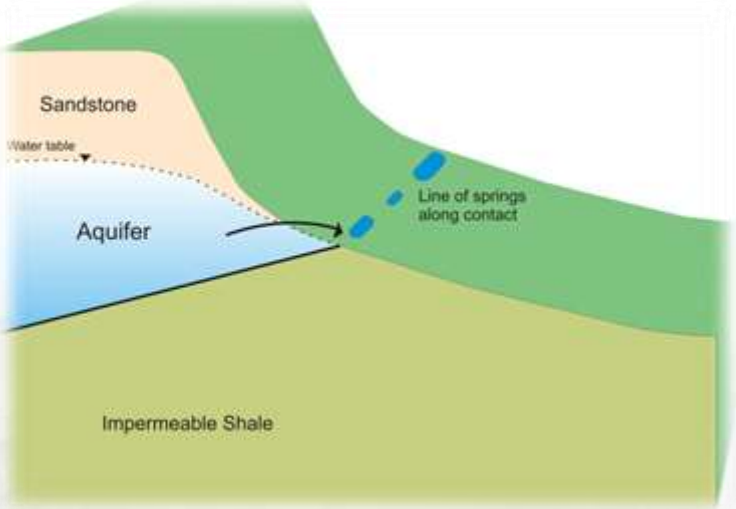
Contact spring

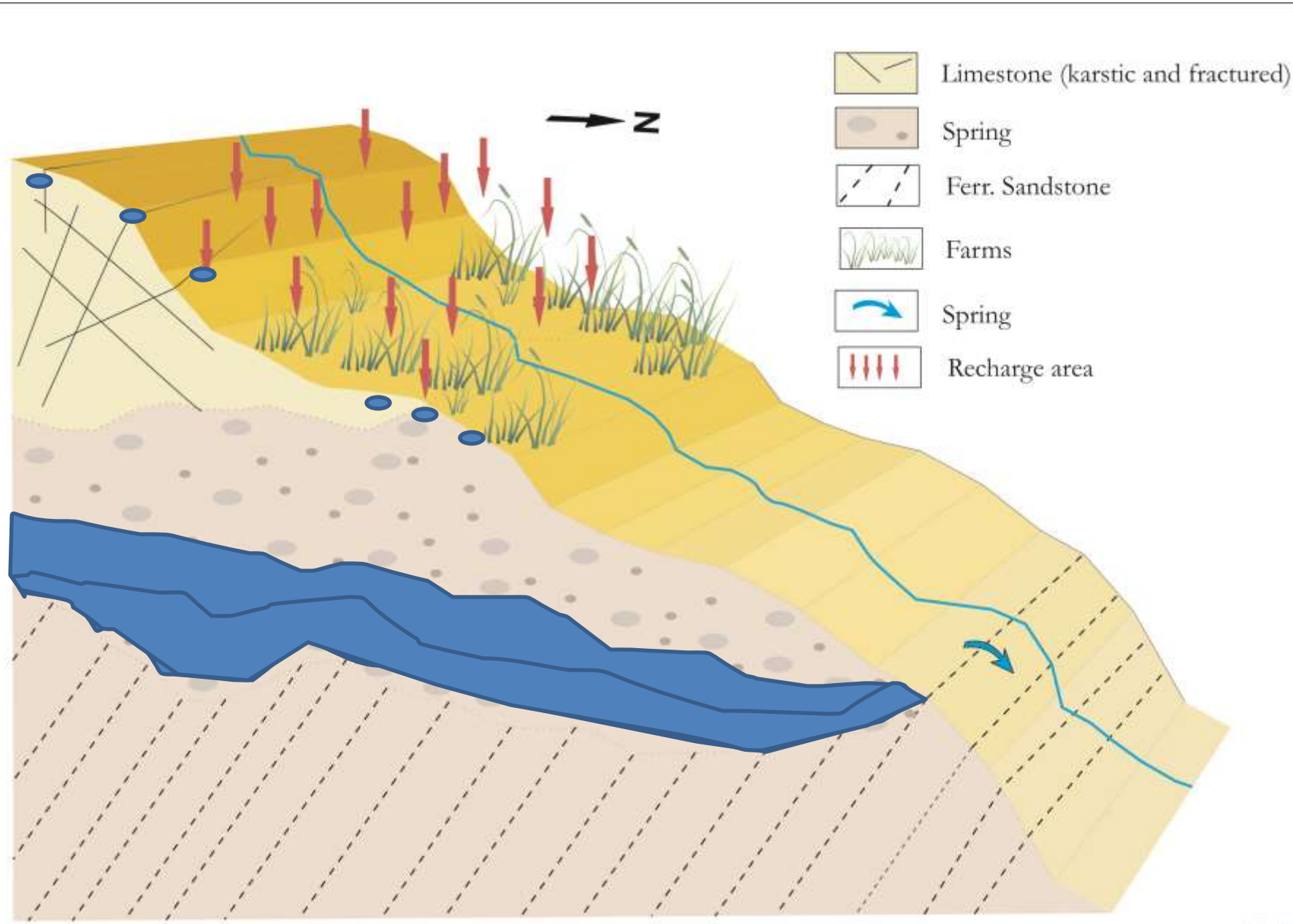
Formed at places where relatively permeable rocks overlie rocks of low permeability.



A lithological contact is usually marked by a line of springs.

Such springs are usually associated with perched aquifers in mountains.

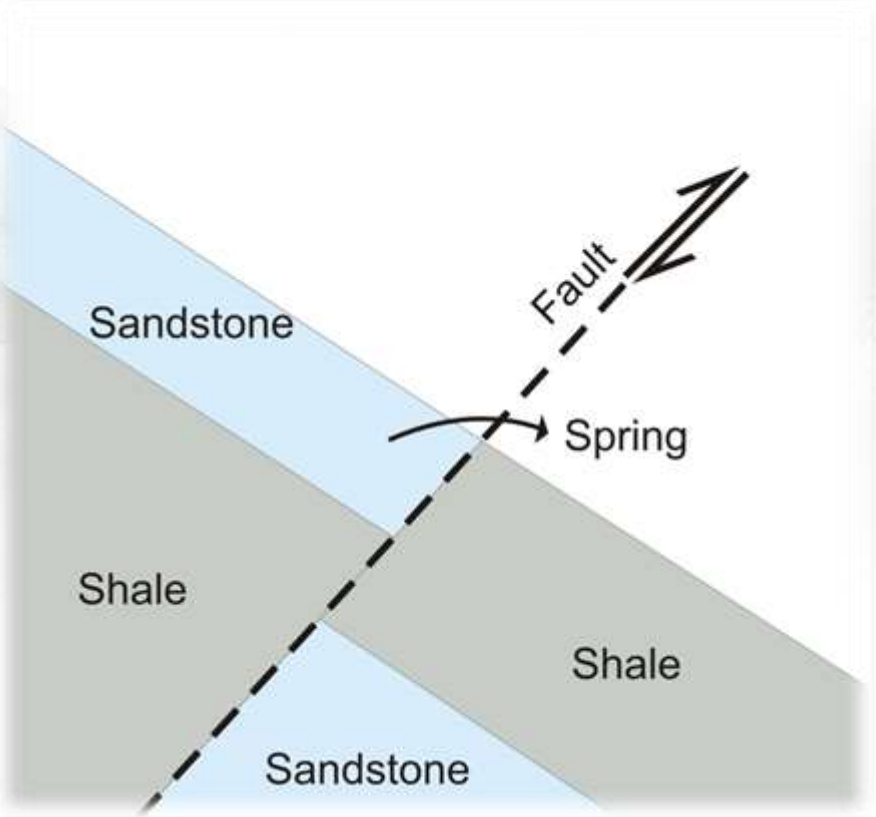
ACWADAM


N
Limestone (karstic and fractured)
Spring
Ferr. Sandstone
Farms
Spring
Recharge area

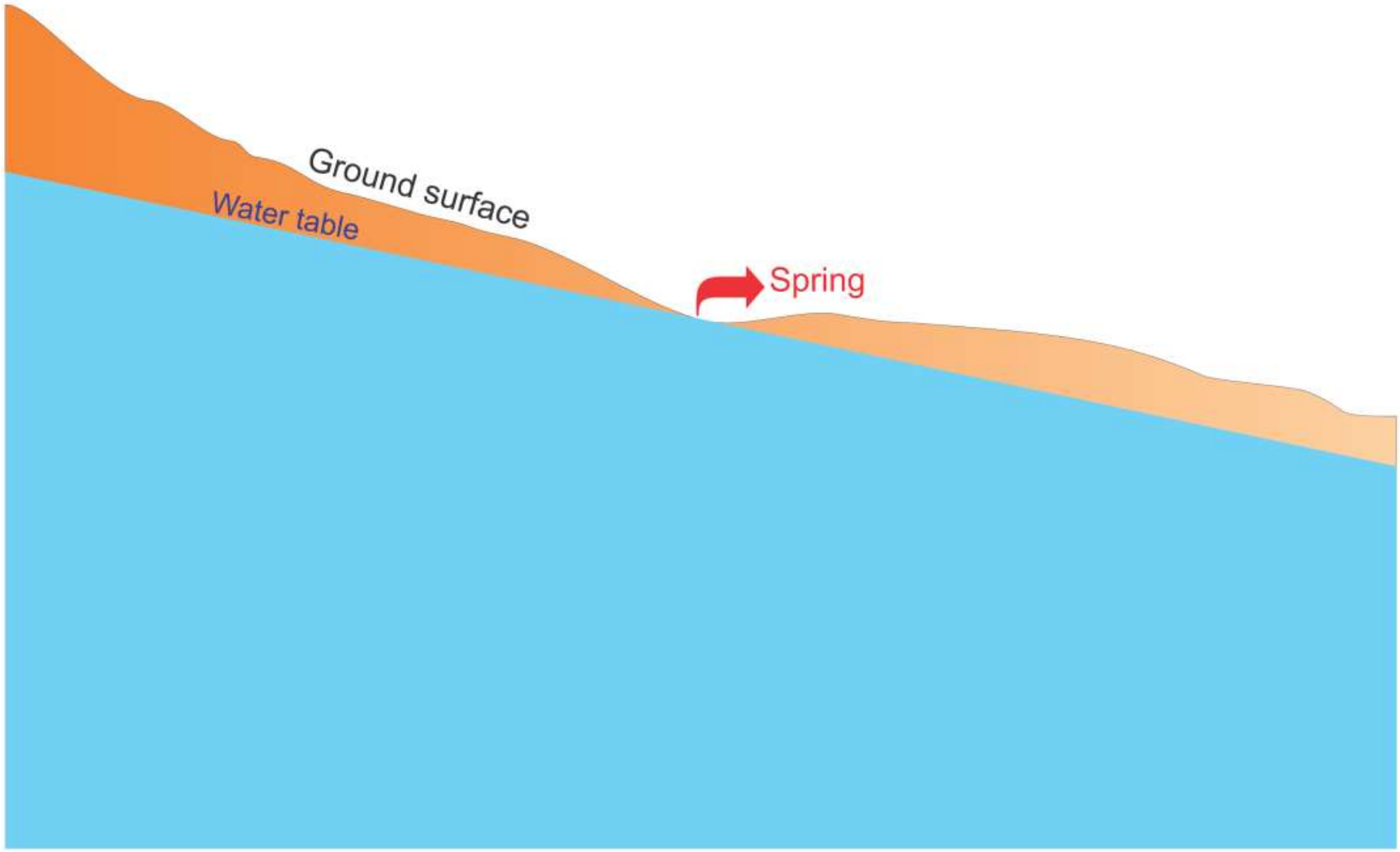
Fault spring

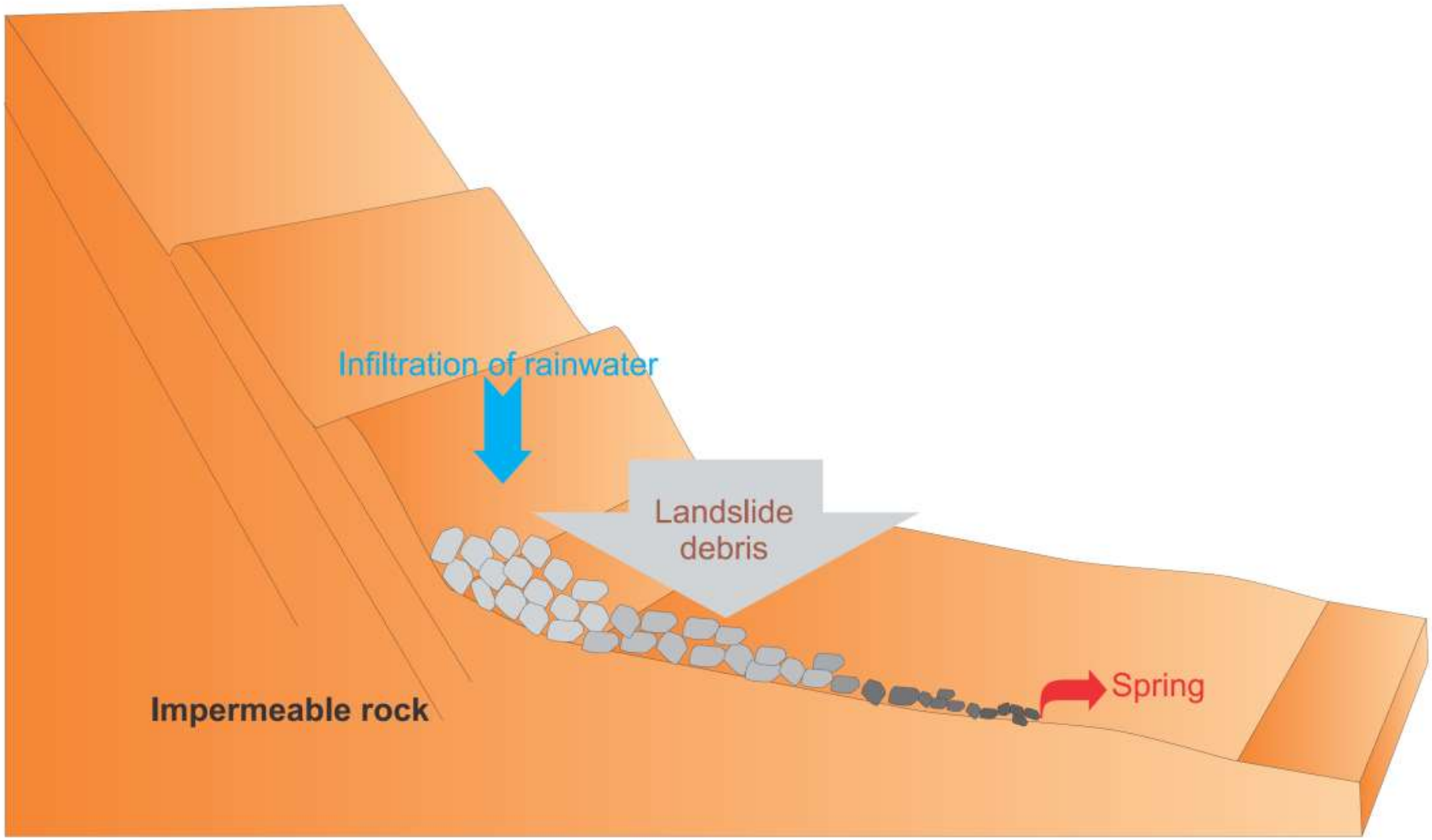
Faulting may also give rise to conditions favorable for spring formation as groundwater (at depth) under hydrostatic pressure (such as in confined aquifers) can move up along such faults.

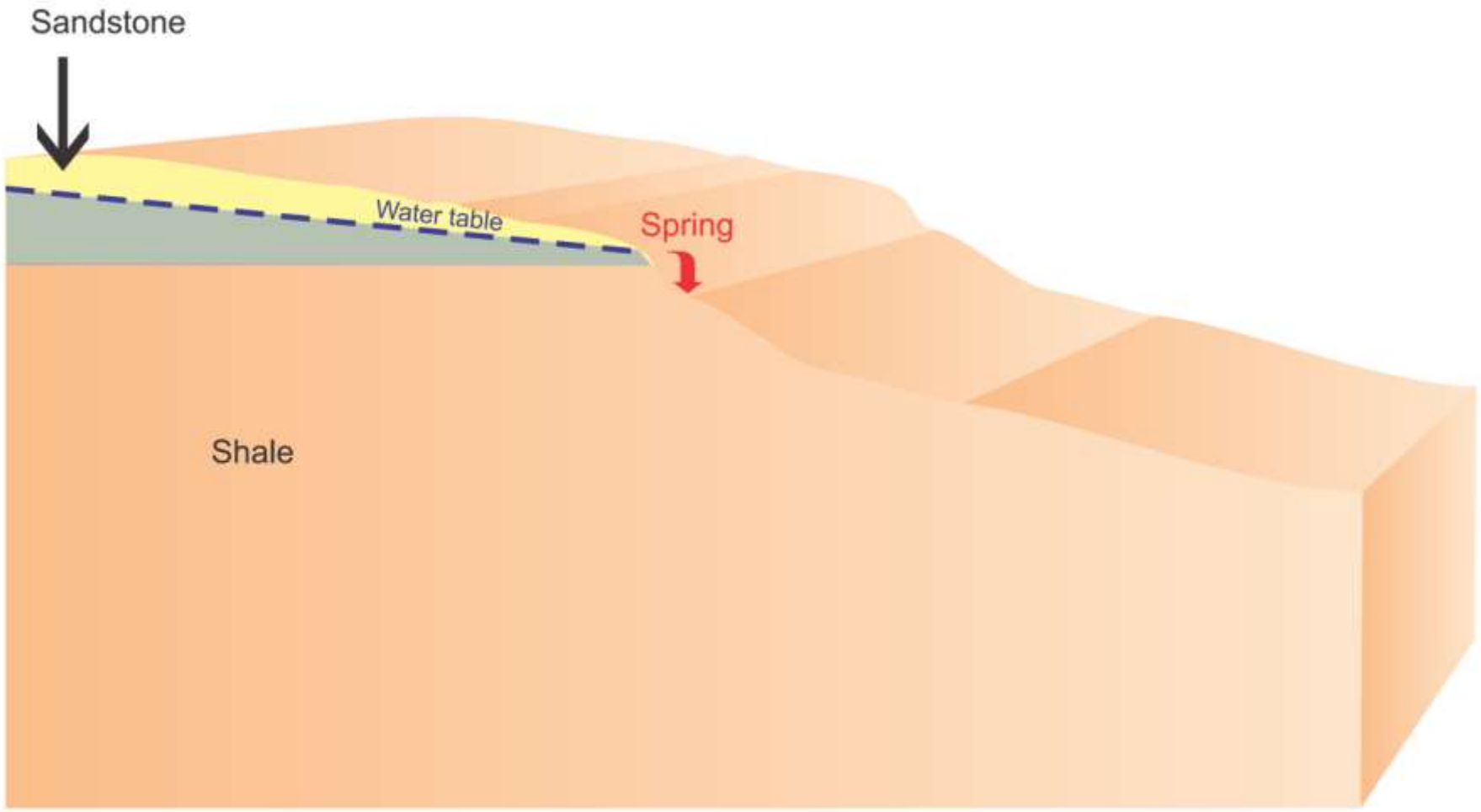
An impermeable rock unit may be brought in contact with an unconfined aquifer due to faulting.

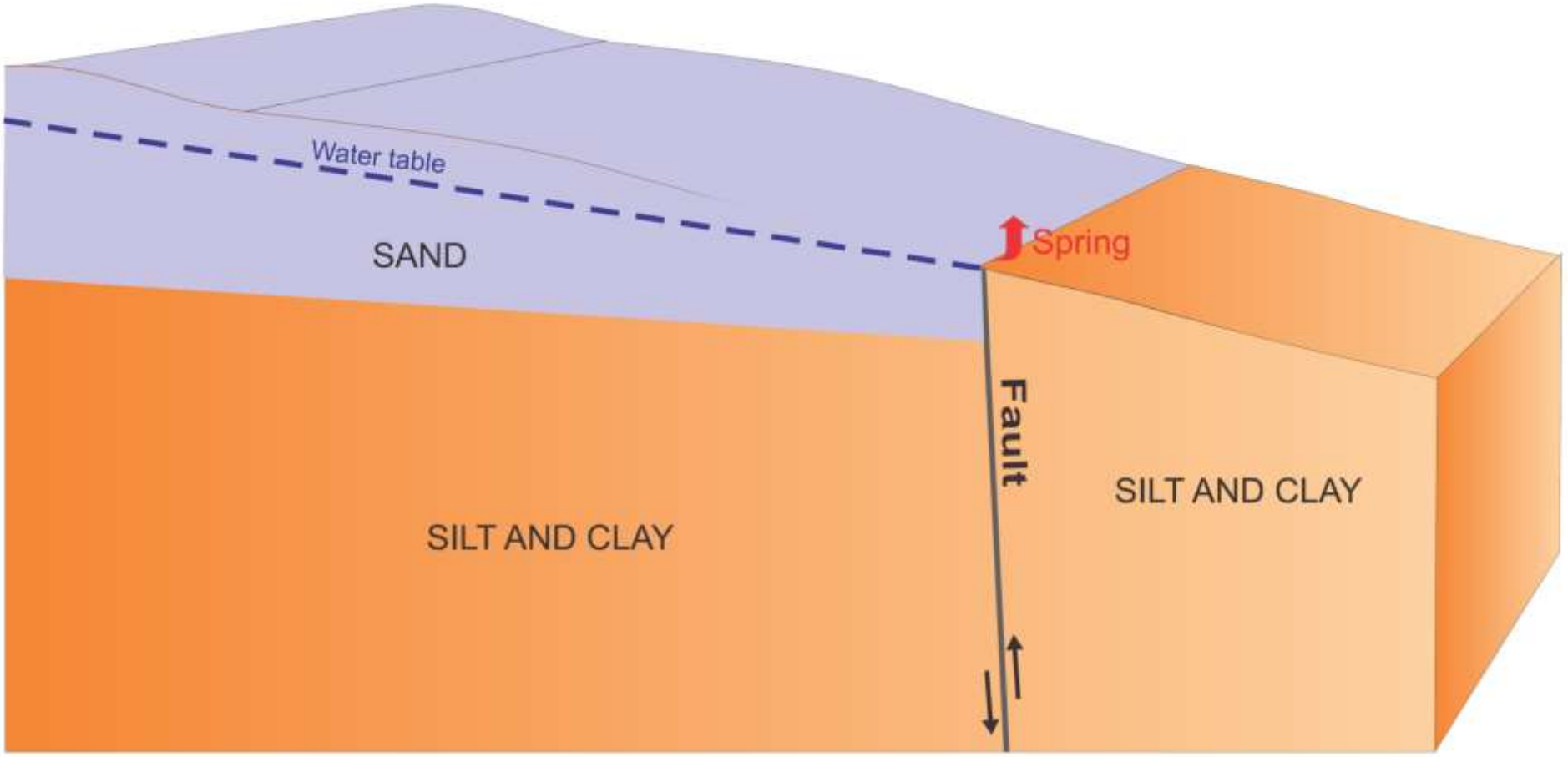


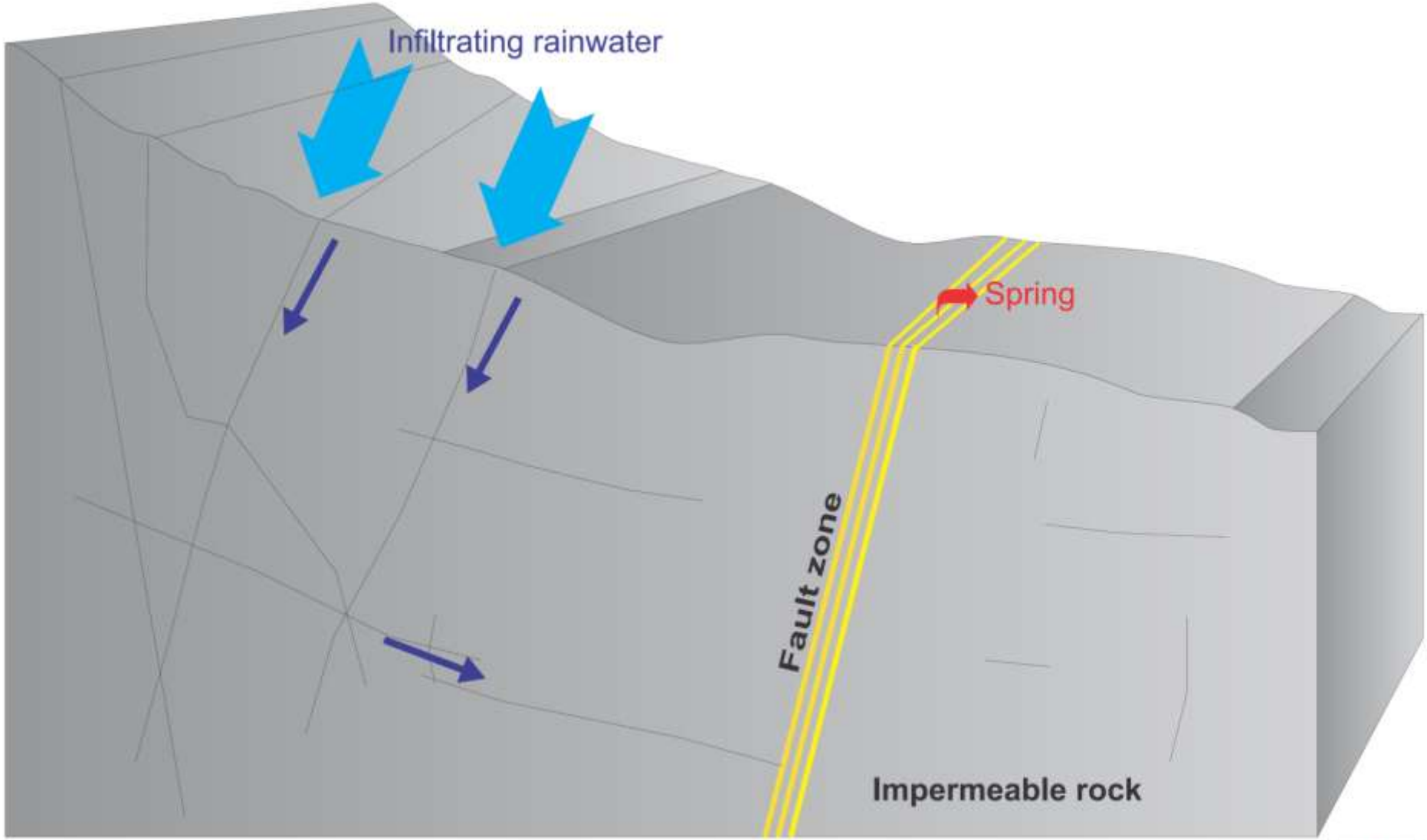
A short exercise in identification…




Infiltration of rainwater
Landslide debris
Spring
Impermeable rock


Sandstone
Water table
Spring
Shale


Water table
SAND
Spring
Fault
SILT AND CLAY
SILT AND CLAY


Infiltrating rainwater
Spring
Fault zone
Impermeable rock

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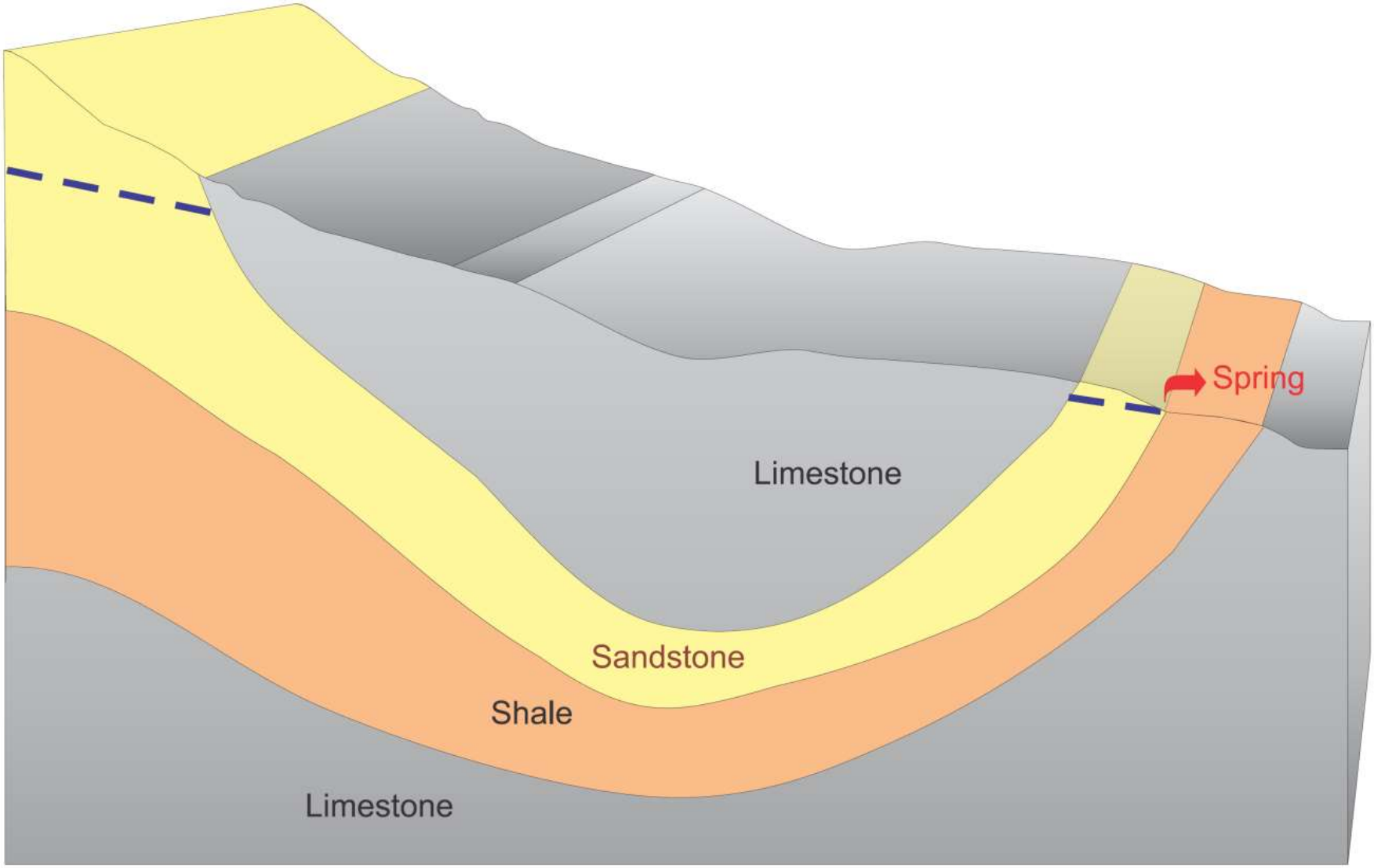

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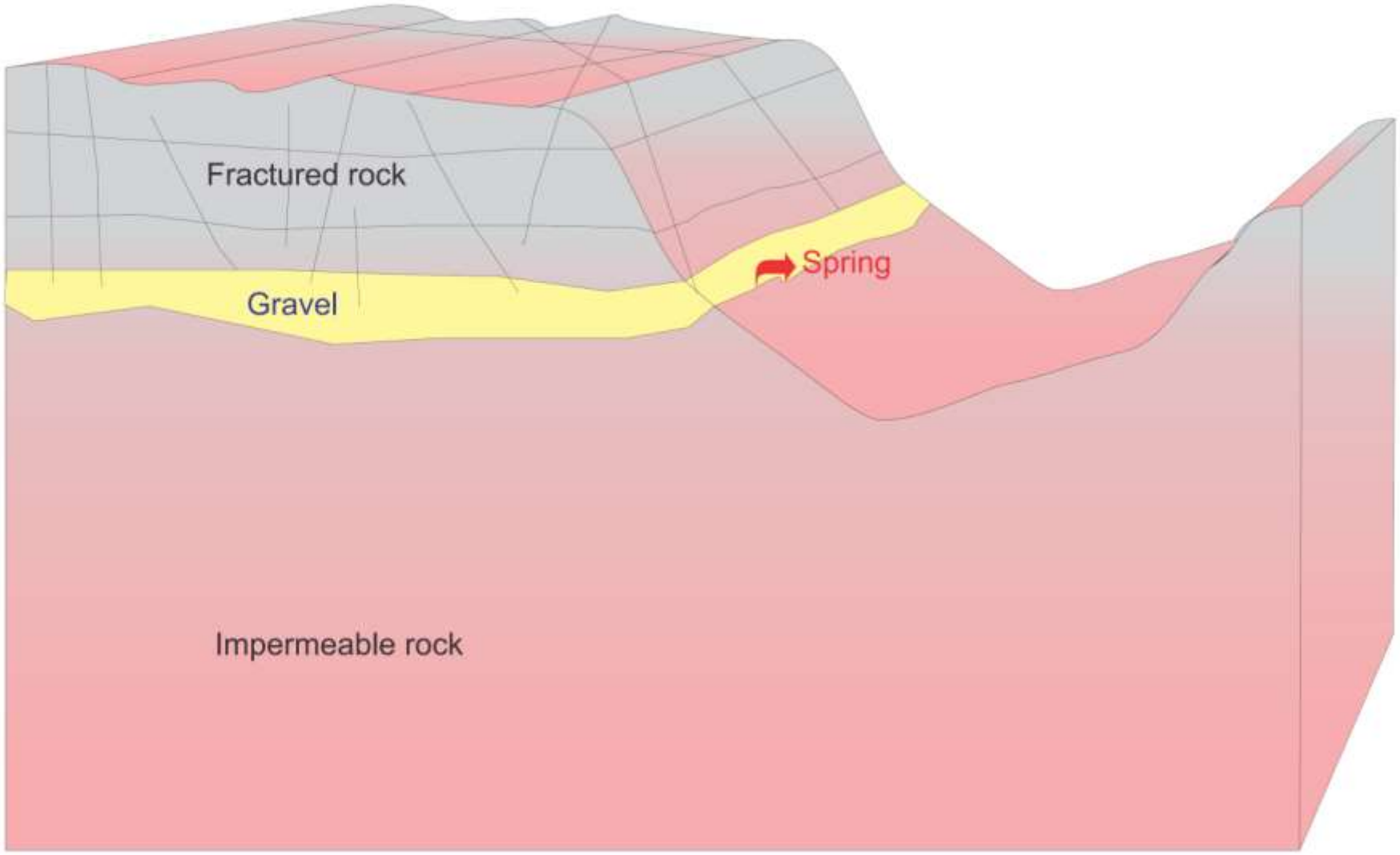

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Springs and aquifers as commons

Spring is a natural discharge point and its location is irrespective of type of land

Similarly aquifer boundaries also are irrespective to land type but governed by local hydrogeology

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Spring and a well : what is common ?????

AQUIFER

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