Characterisation of the groundwater environment

for resource assessment, development, management and protection

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Outline

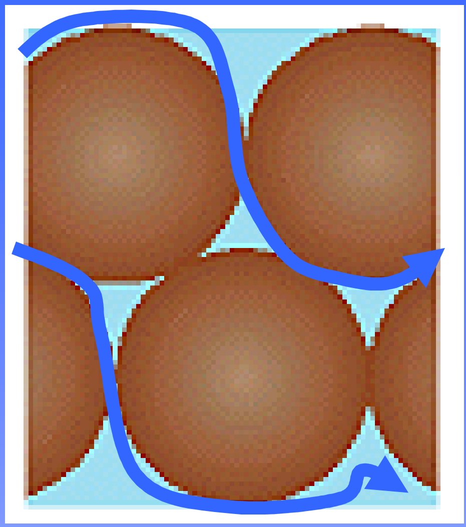
- Irish groundwater systems
- Aquifer classification
- National ‘groundwater’ datasets
- Characterisation of the groundwater environment for resource evaluation, development, protection and management
- Areas requiring further research
- Conclusions and the future…

Groundwater occurrence in Ireland

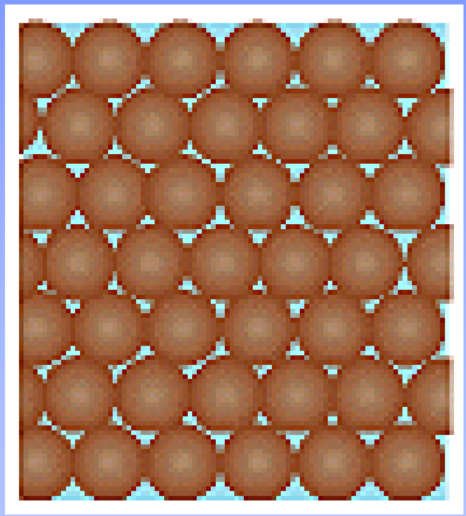
- Groundwater occurs in useful amounts in:
  - – Sand and Gravel deposits
  - – Bedrock

Sand and Gravel aquifers

- Groundwater flows around the grains of gravel/sand



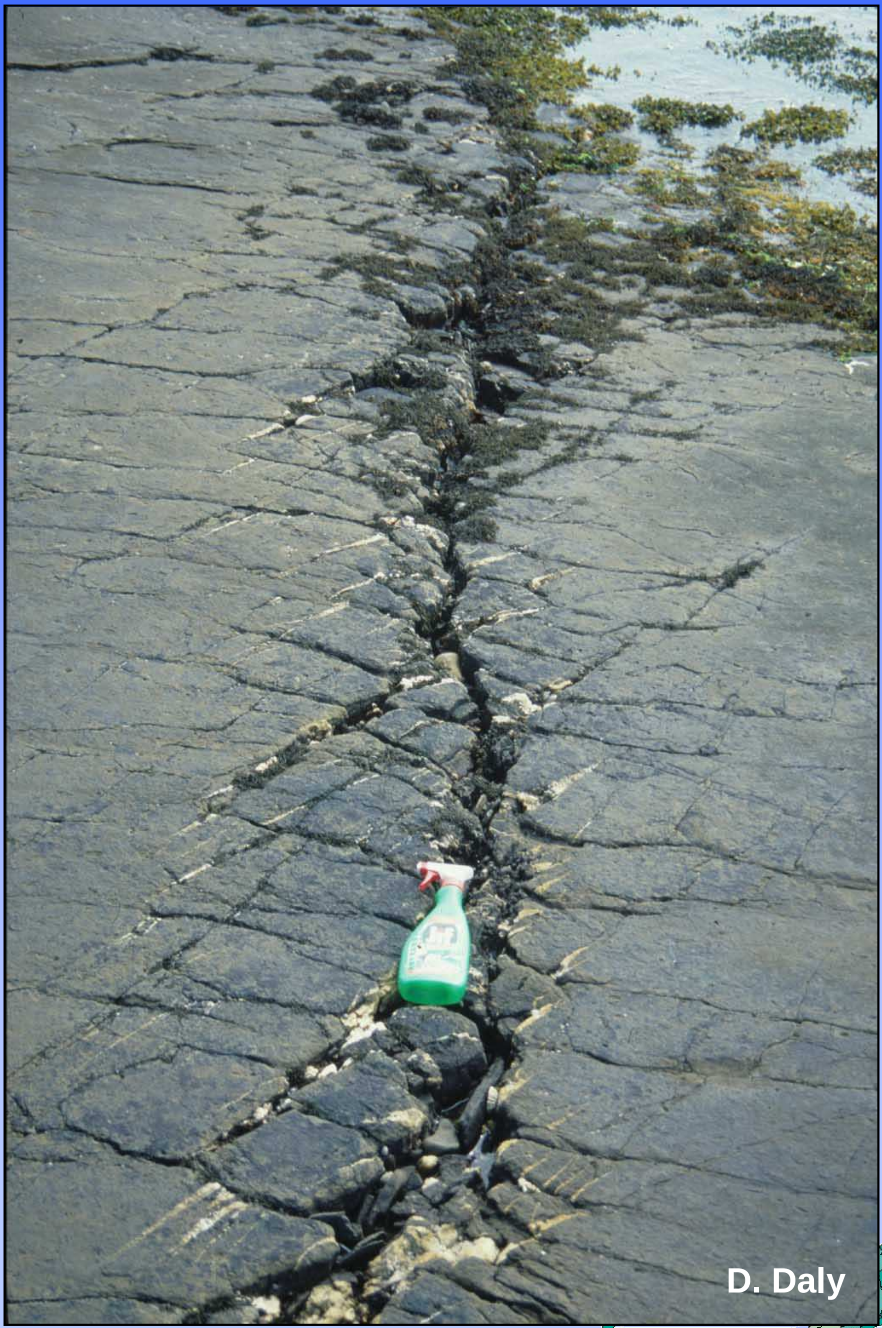
- More groundwater through gravel



- Less (but significant) volumes through sand

- Size and saturated thickness criteria

Bedrock aquifers

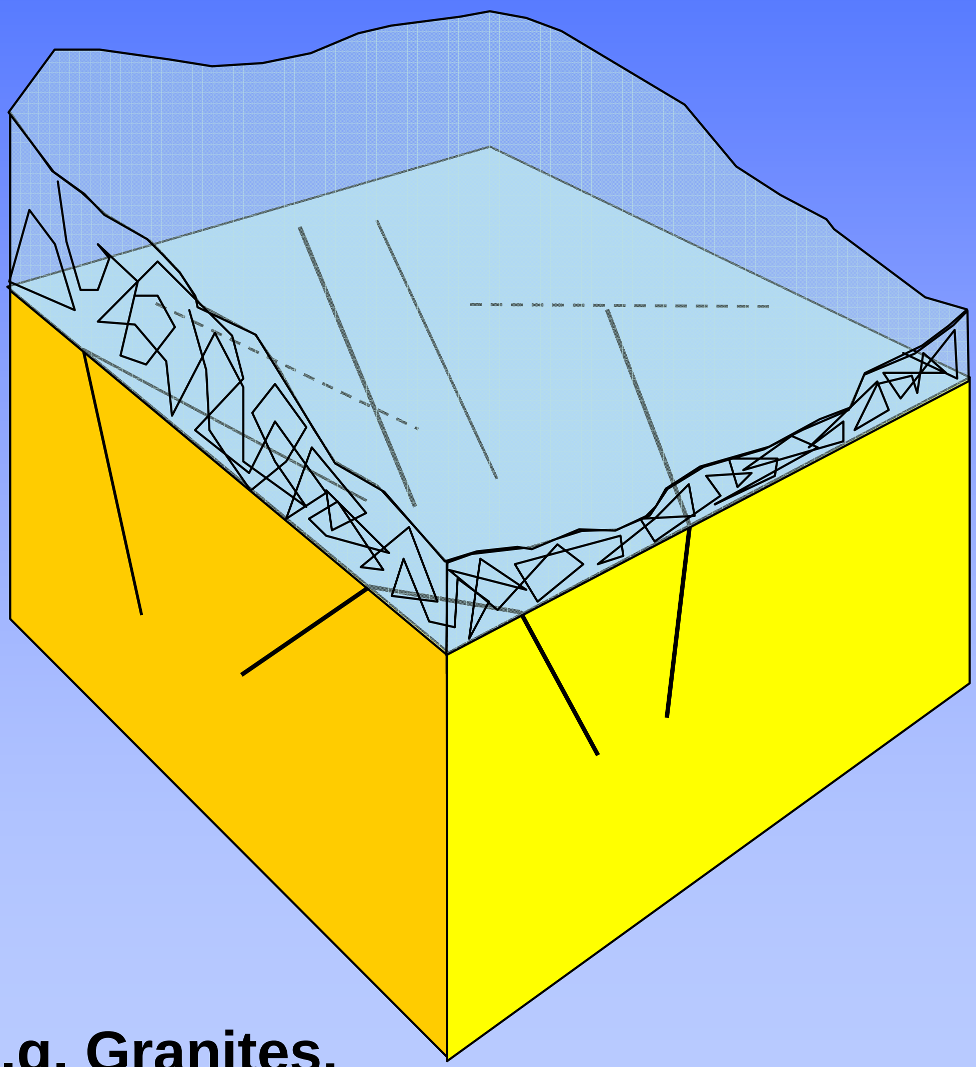


Bedrock aquifers

- Permeability development depends
  - mainly on faulting and fracturing
    - width
    - density
    - connectivity

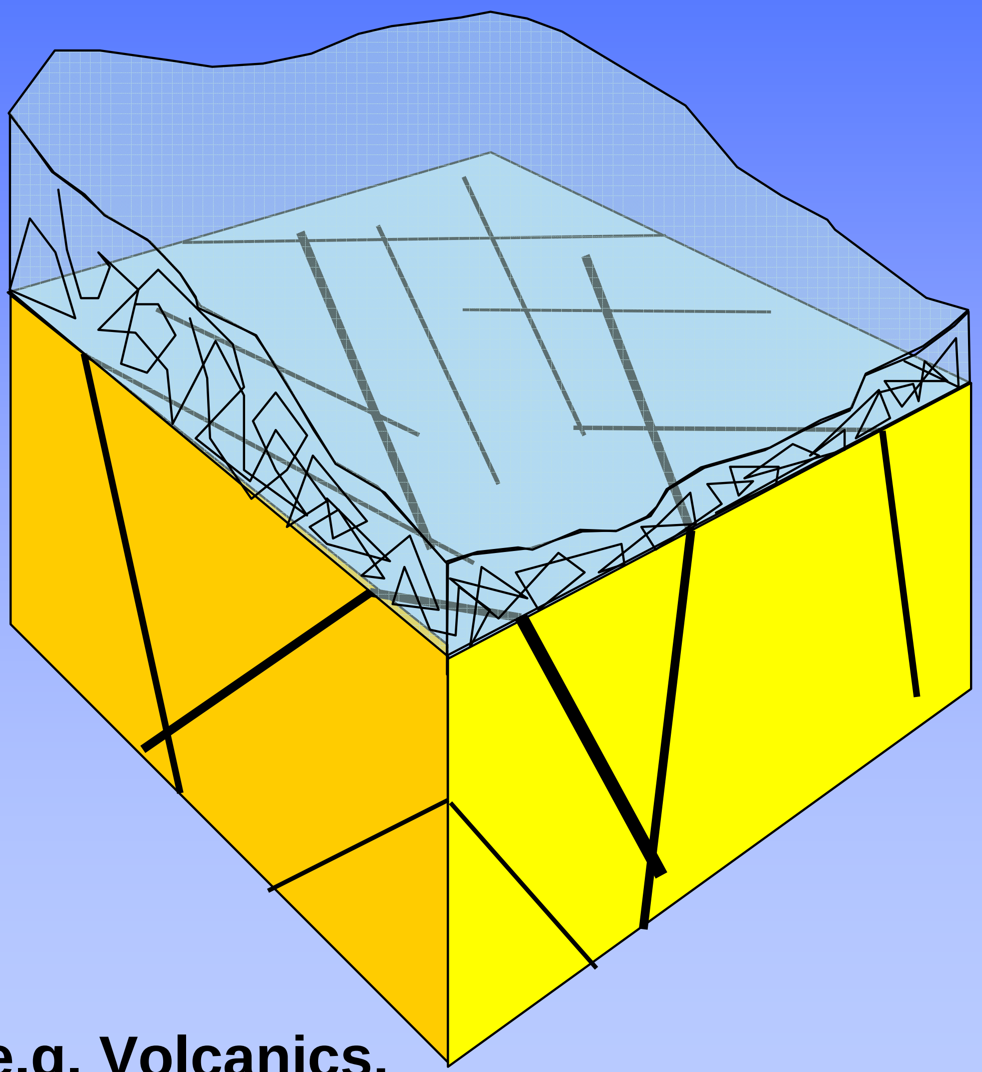
Fissures as fluid pathways

Fissures generally localised, small and poorly connected



e.g. Granites, Old Red Sandstones, rocks of NW

Larger faults, wider and better connected fissures



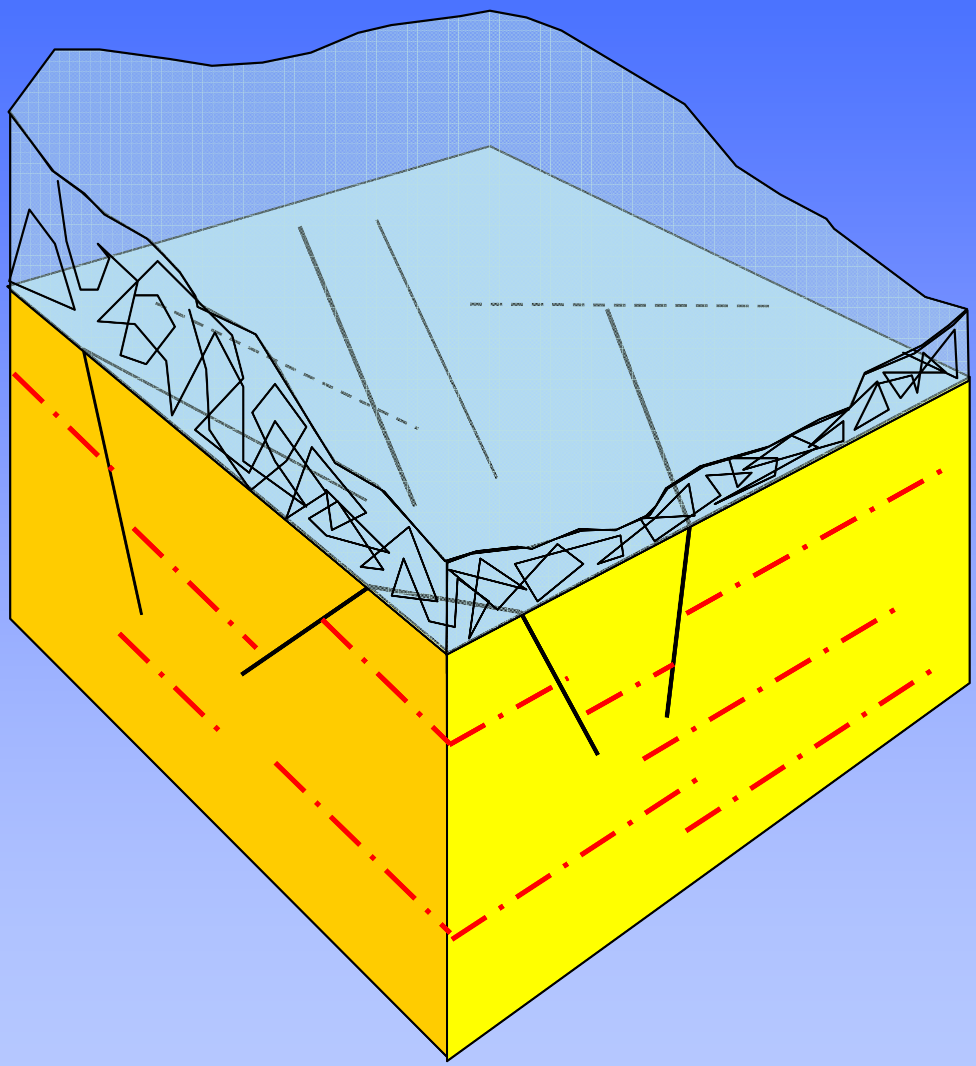
e.g. Volcanics, Impure limestones at Clones

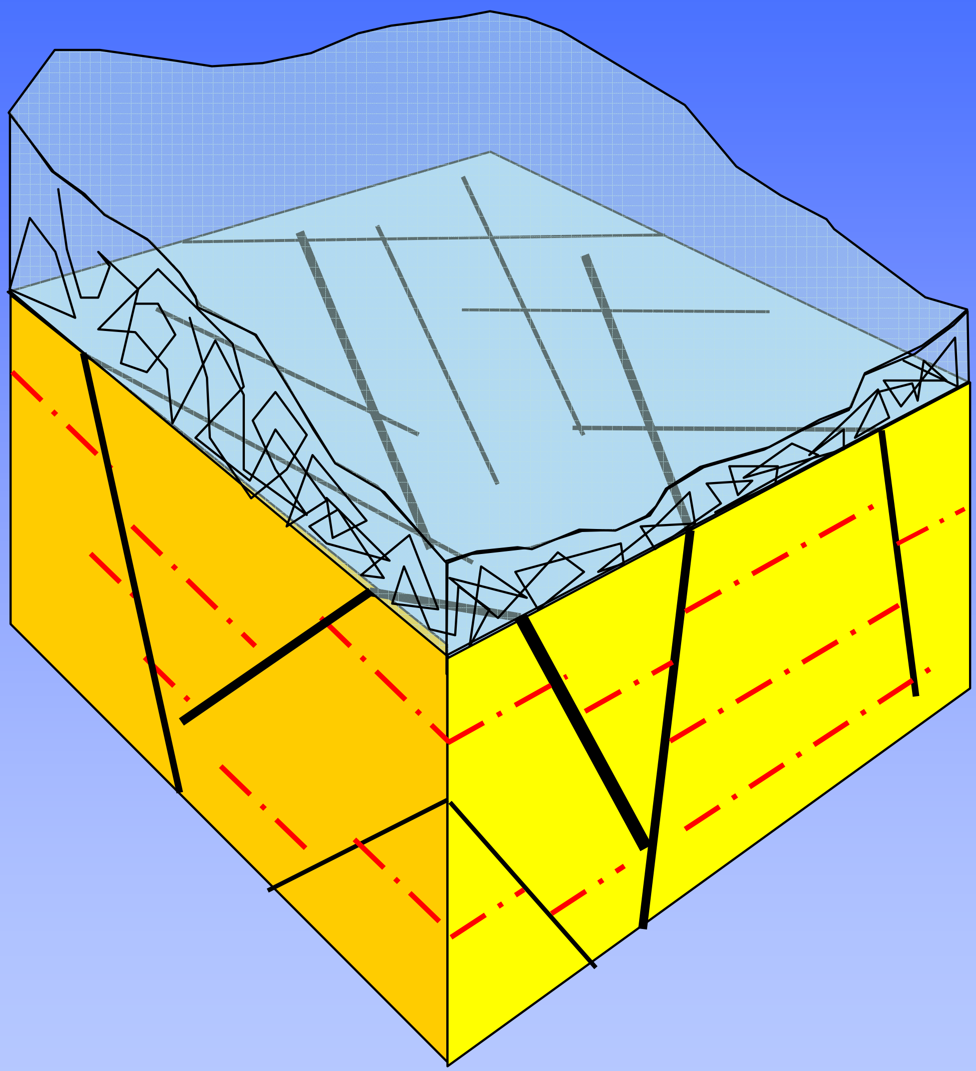
Fissured rock aquifers

- Flow between sand/silt grains unusual
- Permeability development depends:
  - mainly on faulting and fracturing
  - also on flow along bedding planes and joint surfaces

Joints & bedding planes as fluid pathways

Bedding planes and fissures as fluid pathways

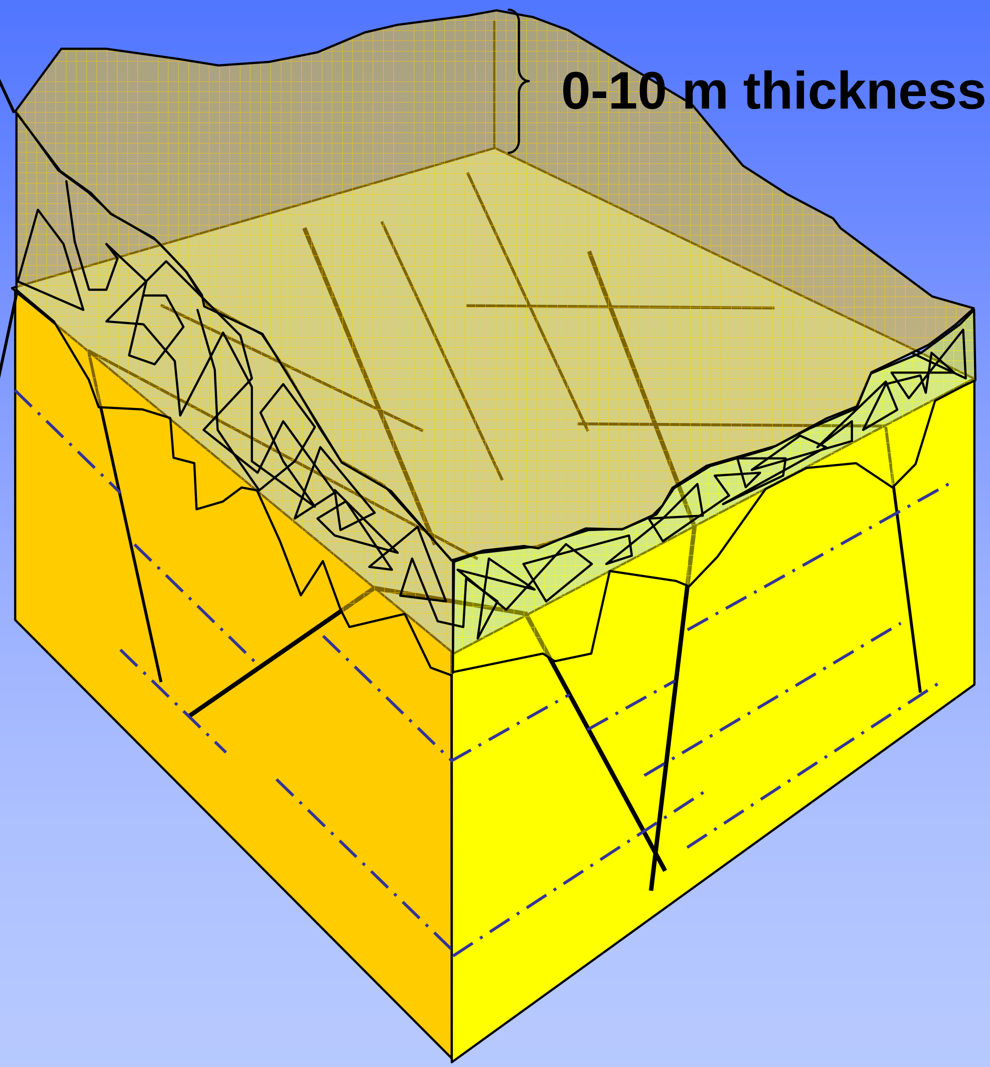




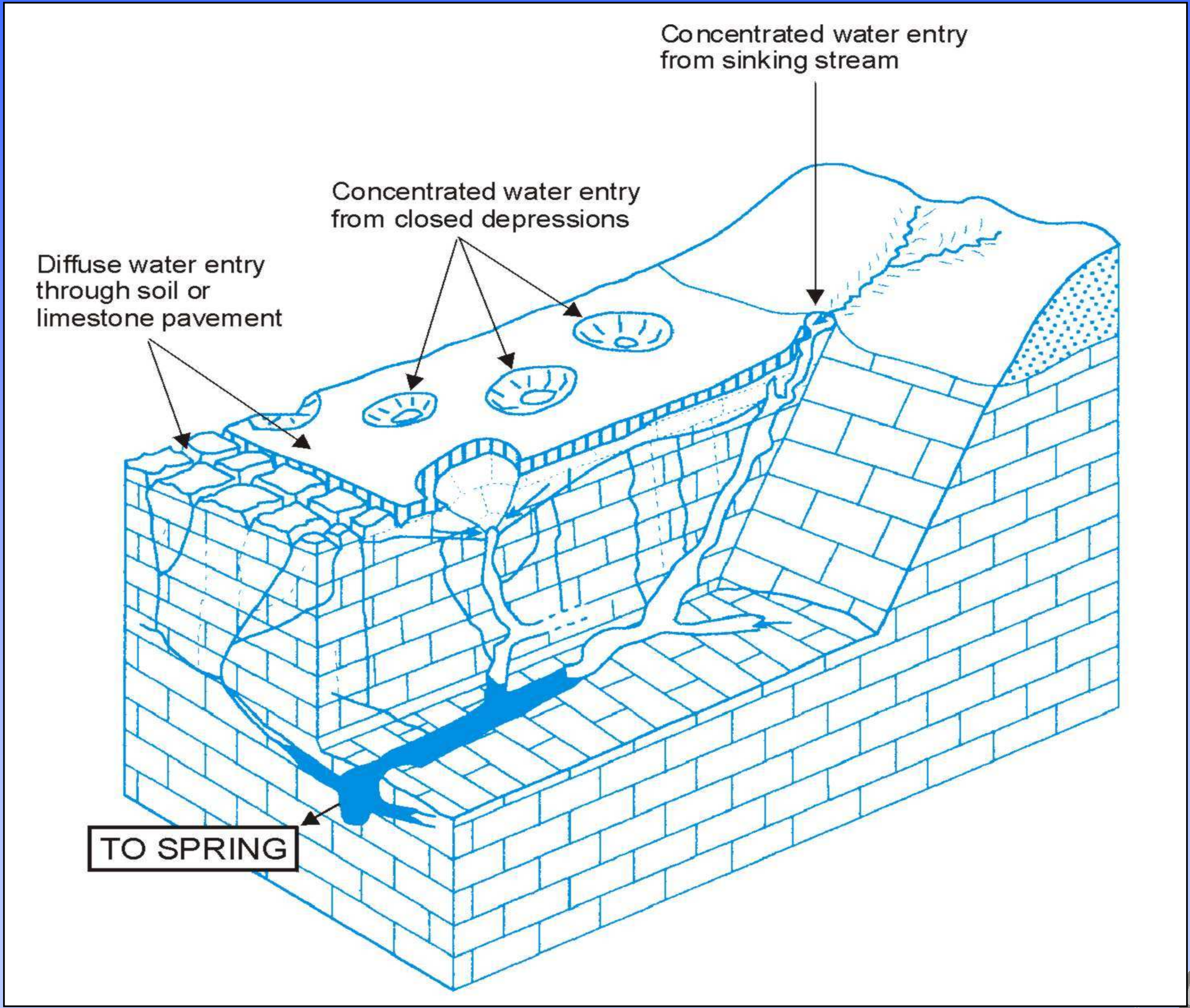
Fissured rock aquifers

- Flow between sand/silt grains unusual
- Permeability development depends:
  - mainly on faulting and fracturing
  - also on flow along bedding planes and joint surfaces
  - and on weathered zone at top of the rock

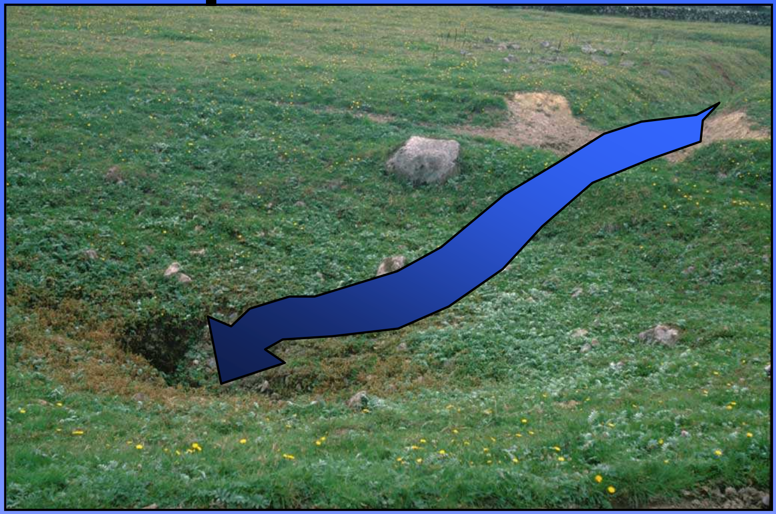
Weathered zone as fluid pathway

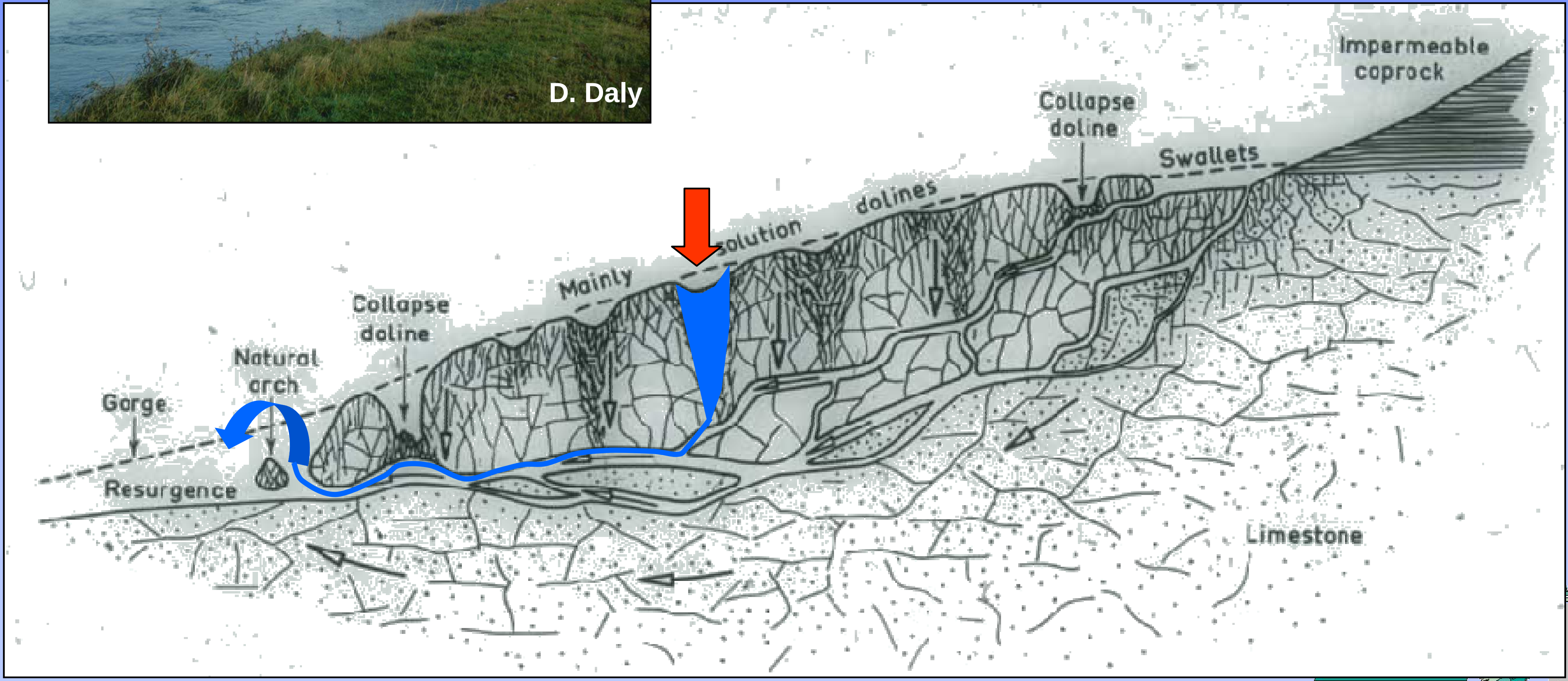


Karstified limestone aquifers



Karstified limestone aquifers





Karstified limestone aquifers

Aquifers

- Different groundwater transmitting capabilities
- Heterogeneous & complex

$\Rightarrow$**How do we make sense of natural variability?**

Aquifer characterisation

- Hydrological indications of groundwater storage & movement, e.g.
  - presence of large springs (-> good aquifer)
  - high groundwater flows to rivers (-> good aquifer)
  - high % of high yielding boreholes (-> good aquifer)
  - high % of high productivity boreholes (-> good aquifer)
  - absence of surface drainage (~> high permeability)
  - high surface drainage density (~> low permeability usually)

- Correlate with bedrock type and/or geological structures (e.g. faults, bedding)

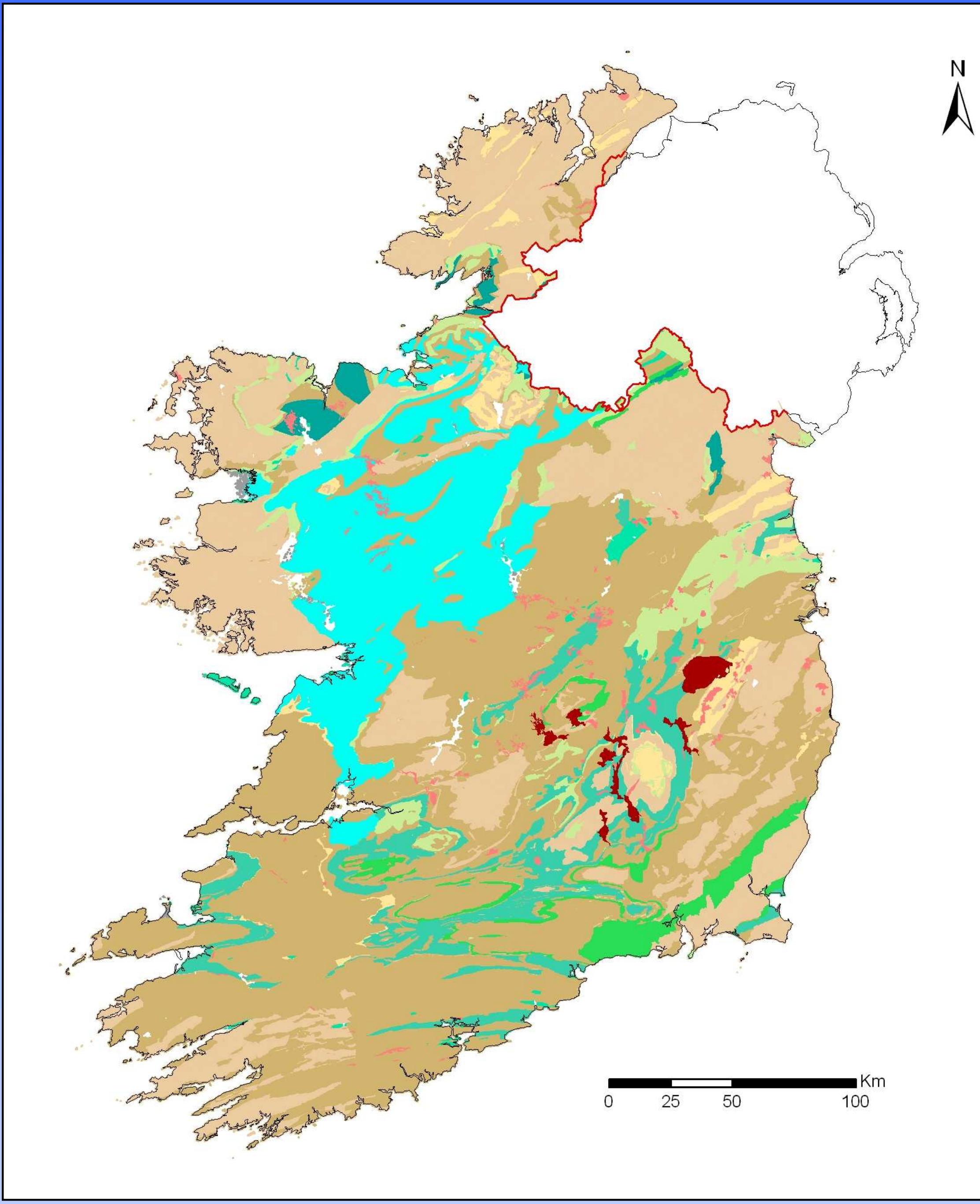
- Extrapolate correlation to data-poor areas

Aquifer classification

- Aquifer type
  - Gravel
  - Fissure
  - Karst
- Aquifer resource value
  - Regional
  - Local
  - Poor

Scale of aquifer classification

National Aquifer Map



Bedrock aquifers

Regionally Important

Rk Karstified

Rf Fissured bedrock

Locally Important

Lm Generally moderately productive

Ll Moderately productive only in local zones

Lk Locally important karstified aquifer

Poor

Pl Generally unproductive except for local zones

Pu Generally unproductive

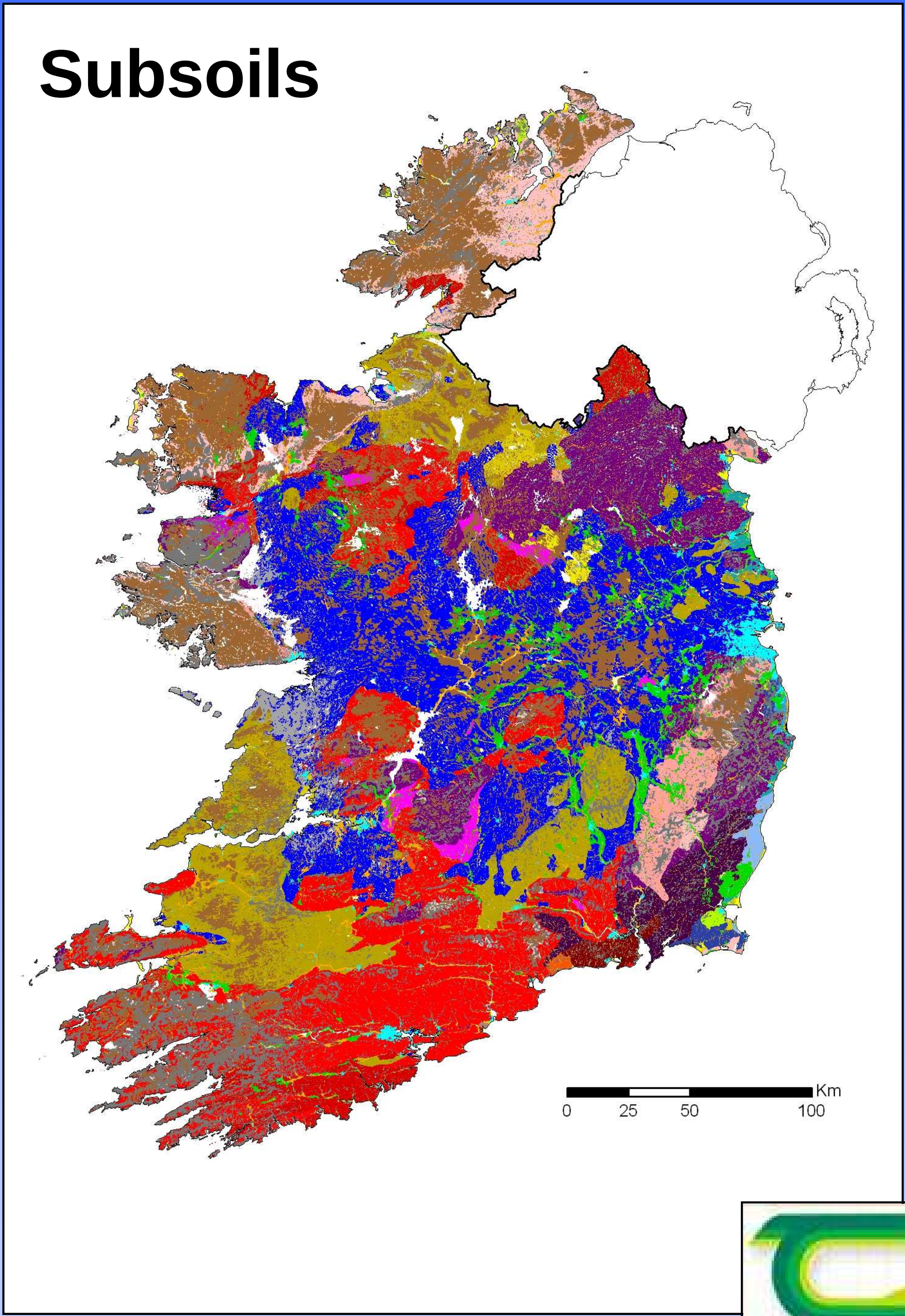
Gravel aquifers

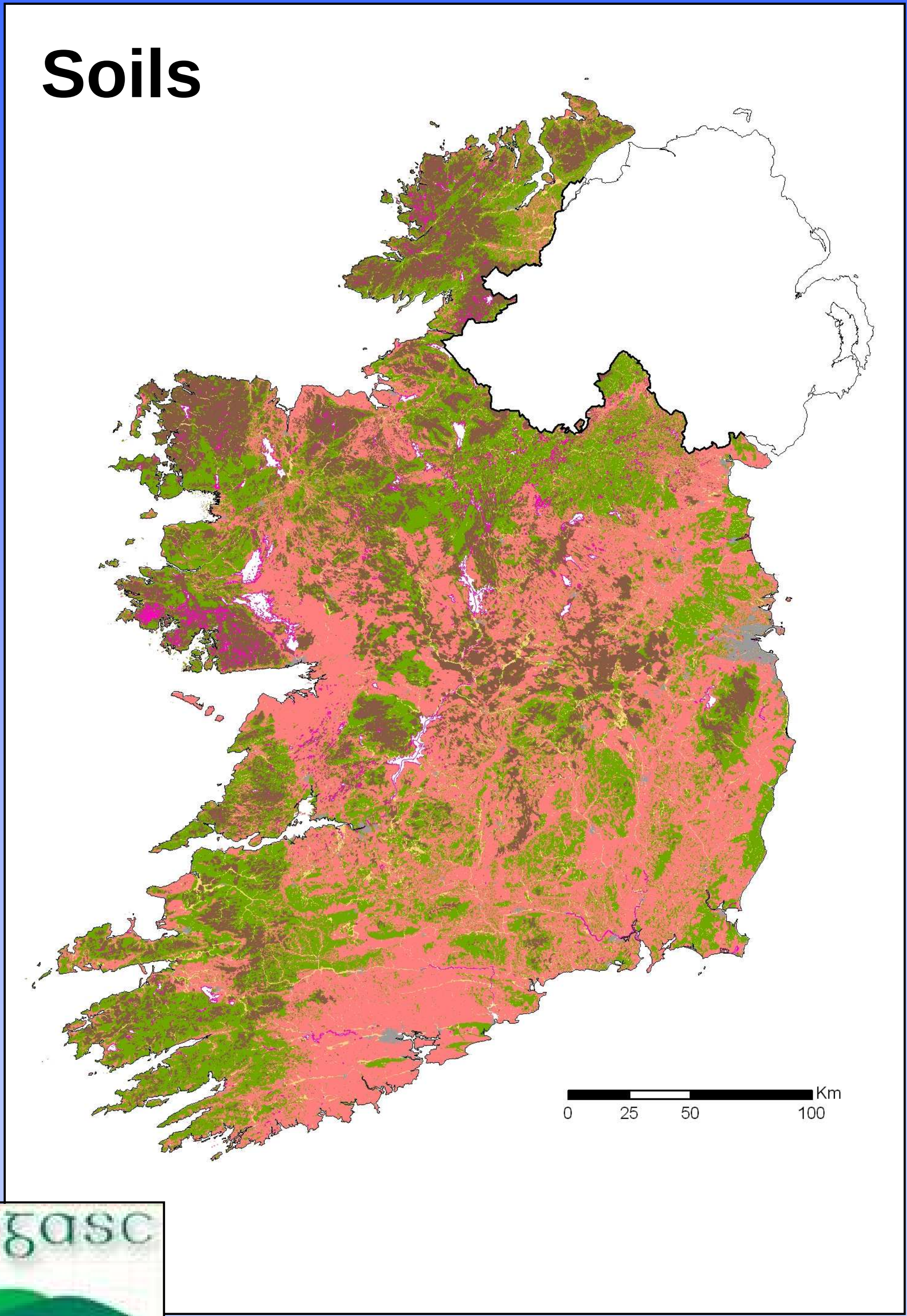
Regionally Important **Rg**

Locally Important **Lg**

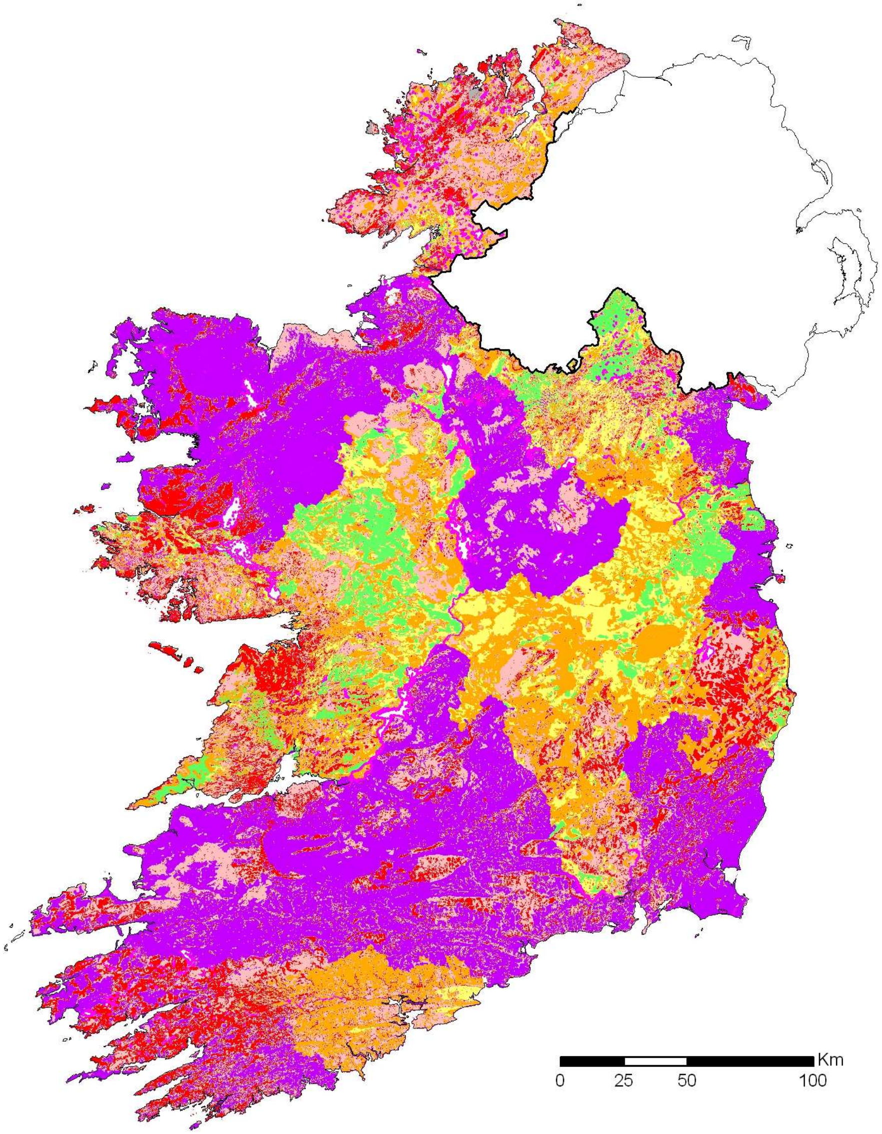
GSI

National Soils and Subsoils Maps





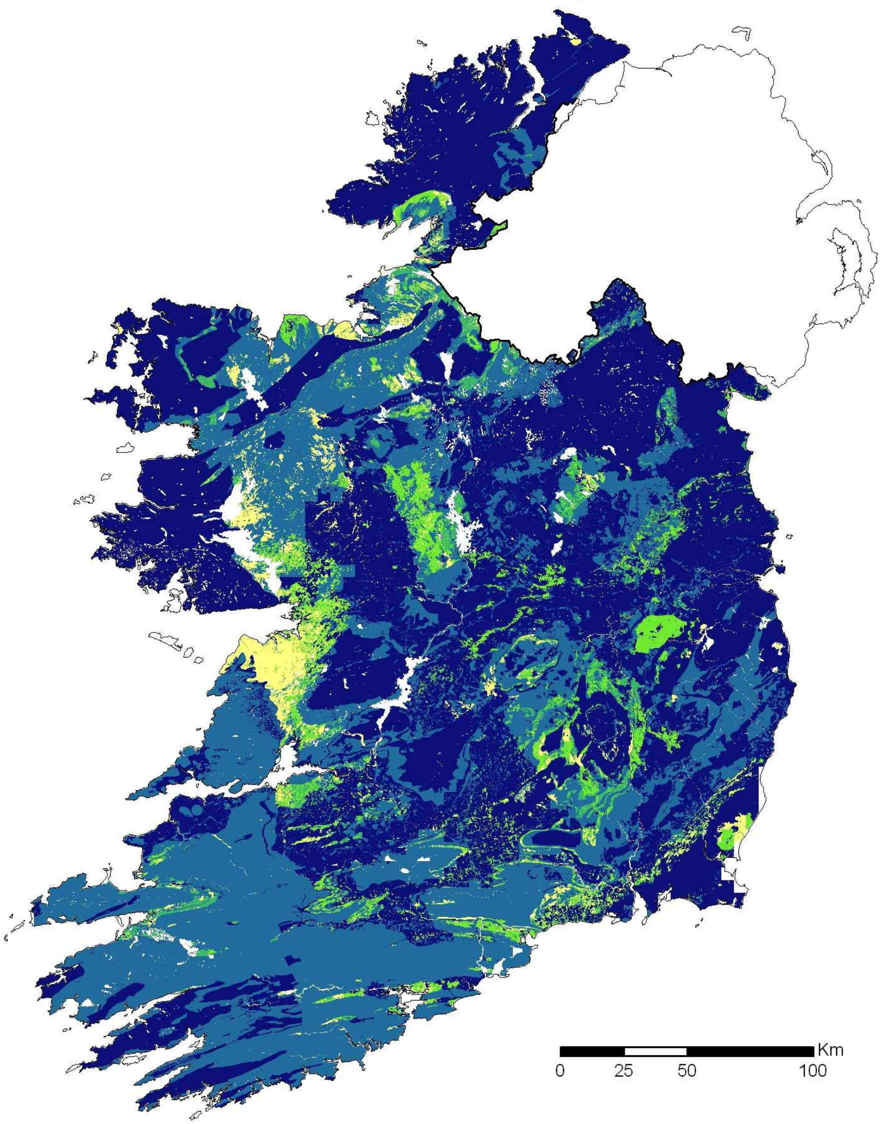
National Interim Vulnerability Map



Groundwater Vulnerability

- Extreme (rock close/karst)
- Extreme
- High
- Moderate
- High to Low
- Low
- No data
- Water

National Interim Recharge Map



Groundwater Recharge

mm/yr

- 0 - 150
- 151 - 250
- 251 - 350
- 351 - 500
- 501 +

GWWG

compass informatics

Where we're at

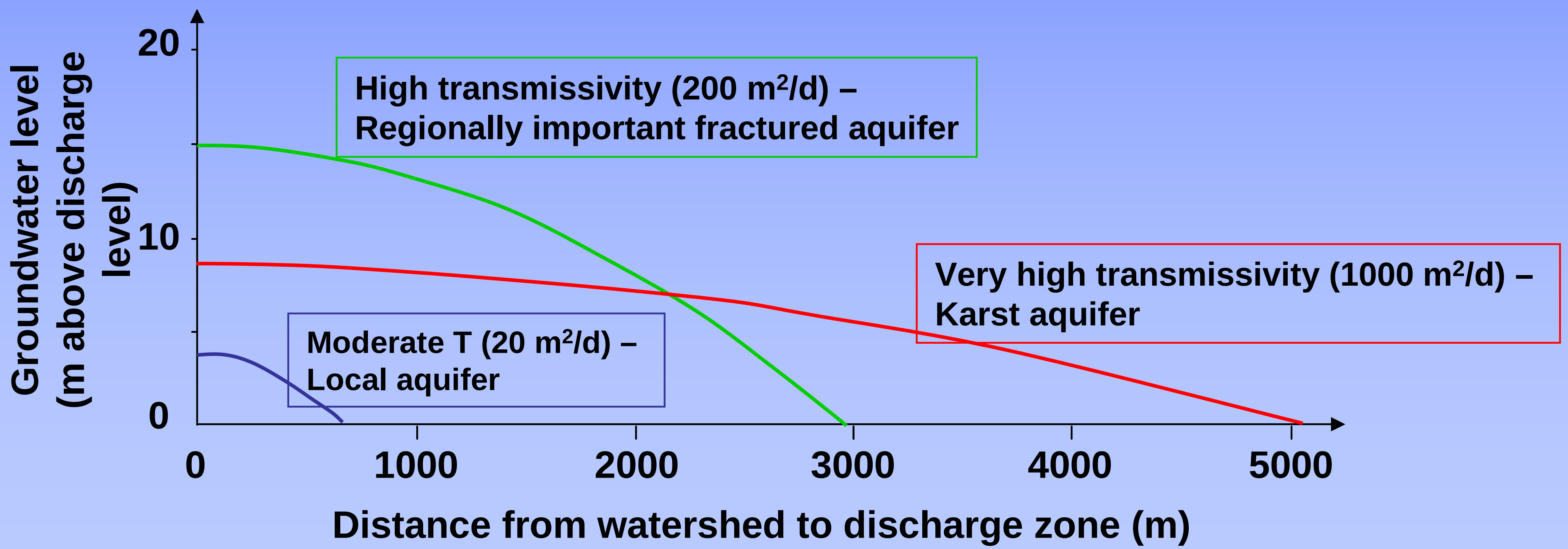
- Resource potential =>
  - Aquifer category map
- Resource evaluation =>
  - Aquifer map + Recharge map

- Groundwater protection =>
  - Vulnerability + Aquifer + Groundwater Protection Responses
- Groundwater pollution risk maps =>
  - Soils + Vulnerability + Aquifer + Pressure

- Runoff risk maps =>
- Hydrological catchment modelling =>
  - Aquifer + Vulnerability + Subsoil perm + Soils + ….

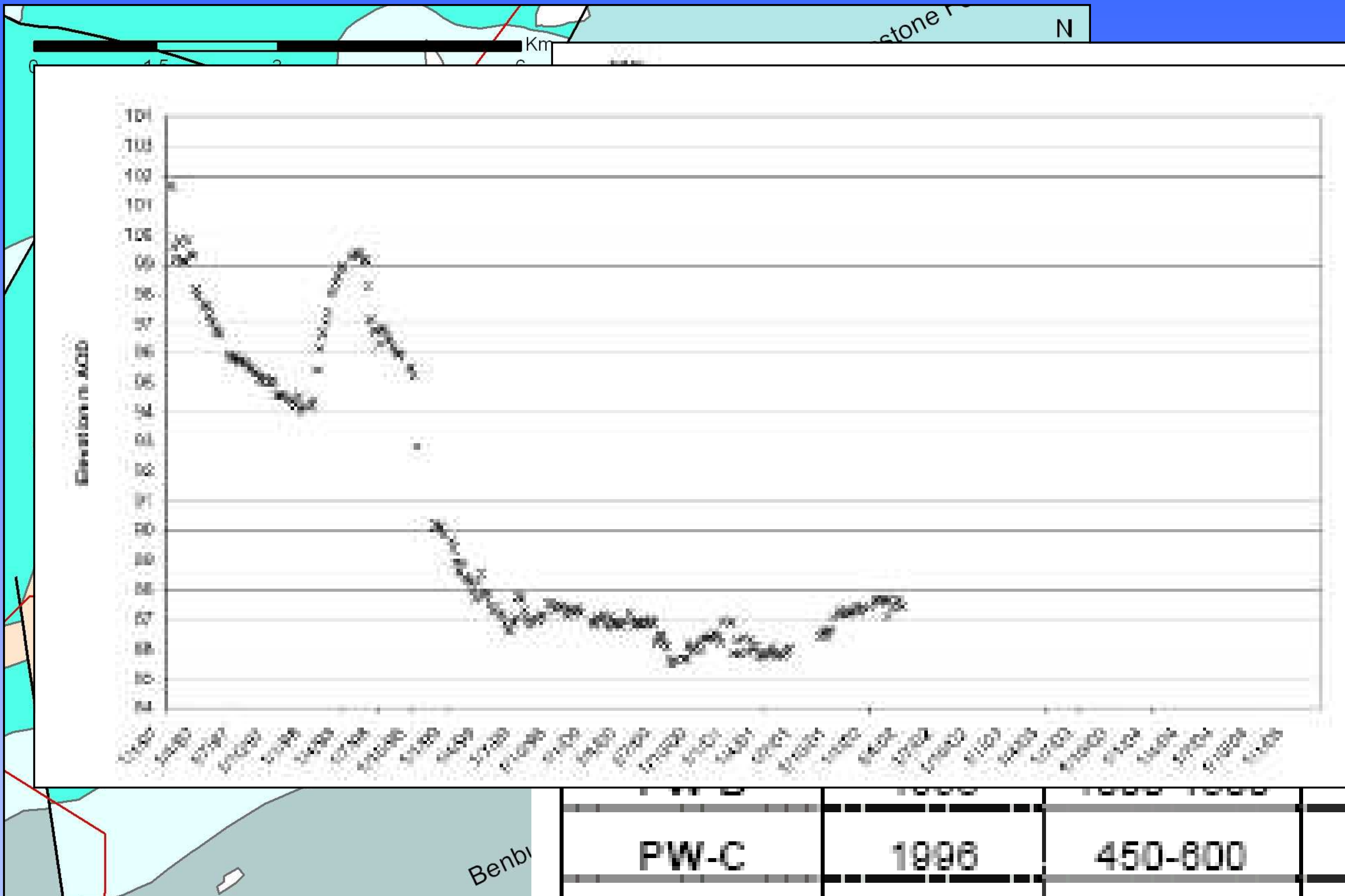
Resource potential

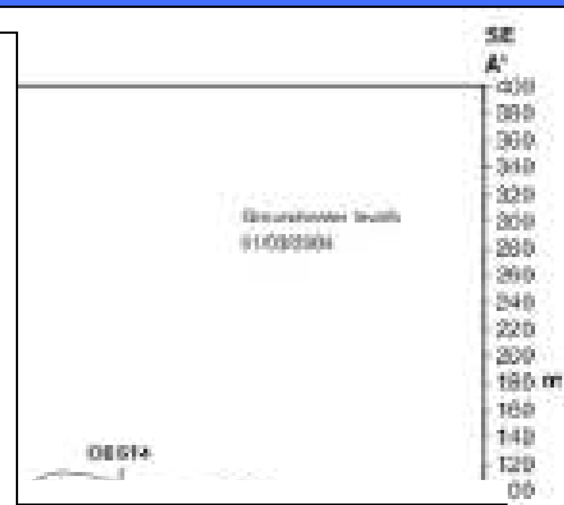
- Aquifer category indicates:
  - *Range* in likely yields, drawdowns
    (capacity for pollution attenuation)
  - Groundwater flow system size
    (pollution transport distance)



Fitzsimons *et al.*, 2005

Resource evaluation





			...ater pumping rates (examples) m³/day	
			1988	500 (av)
PW-B			1995	250-600
PW-C	1996	450-600	1998	300-400
PW-D	1997	350-750	1998	300-400
PW-E	2000	160-330	No Change	
MCC	1985	912	Well abandoned 1988	
TGWS-Burns	1992	300-600	Well abandoned 1993	

Kelly, 2001; Misstear et a...

Resource evaluation

- Sustainable groundwater resource
  - related to long-term recharge
- Function of subsoil and aquifer properties
- Individual source development
  - local aquifer characteristics influence sustainable yield
- Can begin to assess groundwater resource more ‘holistically’
- BUT – not all long-term recharge is there to be abstracted!

Knowledge gaps

- Testing of aquifer conceptual models
  - particularly less productive fractured bedrock aquifers
- Groundwater flow system characterisation
  - effective aquifer thickness, transmissivity, storativity
- Groundwater recharge
  - amount, timing, location
- Prediction of abstraction impacts
  - distances from receptors
- How to reconcile aquifer scale conceptual models and parameters with site scale

Addressing knowledge gaps

Funded research projects

- Griffiths
  - QUB – groundwater flow in poorly productive bedrock at local and larger scales, GW-SW interactions
  - NUIG – karst aquifer linkages with coastal surface and transitional waters
- STRIVE
  - GW-SW interactions and contaminant migration pathways
  - Groundwater-dependent ecosystems
- Completion of subsoil permeability mapping
  - National Development Plan

Some future directions & challenges

- Shorter term
  - Characterising geothermal potential
  - Making preliminary assessment of climate change impacts
- Longer term
  - Improving conceptual model
  - Enhancing maps and databases
    - Subsoil permeability
    - Aquifer parameters
    - Fracture zonations

Finally

- Highlighted achievements in national mapping and data applications
- Indicated areas that need improved understanding
- Outlined some areas for future work
  - shorter and longer term

- Very interested to hear opinions from the floor
  – priorities?

Acknowledgements

- GSI hydrogeologists – past and present
  - Donal Daly, Vincent Fitzsimons, Geoff Wright, Coran Kelly
- Irish Working Group on Groundwater (GWWG) and RBD consultants
- Hydrogeologists and Engineers working on groundwater issues in the academic, public and private sectors