Diagenesis

of

Rotliegend Reservoirs

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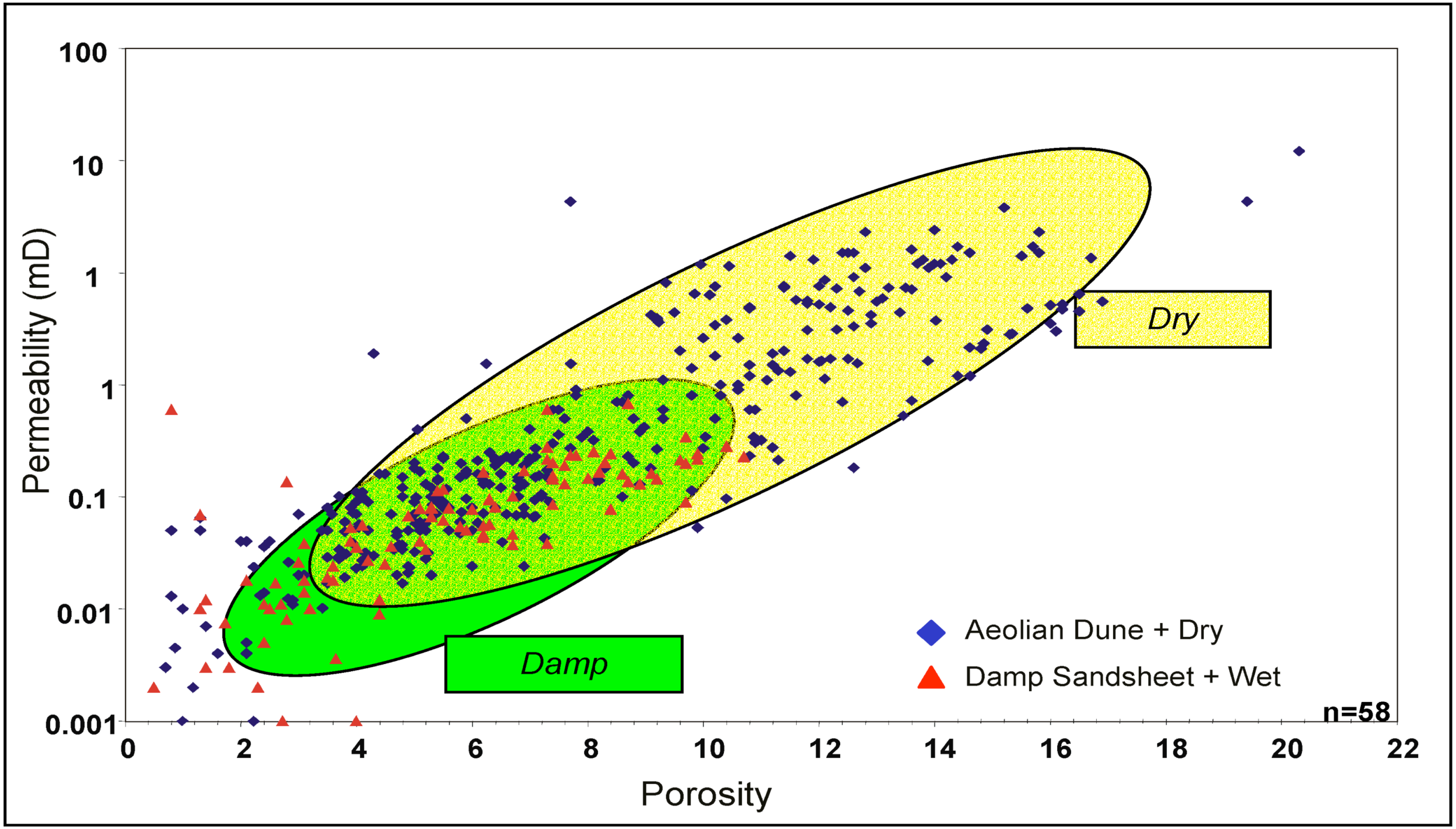
“Fifty years of petroleum exploration in the Netherlands after the Groningen discovery” Utrecht 2009

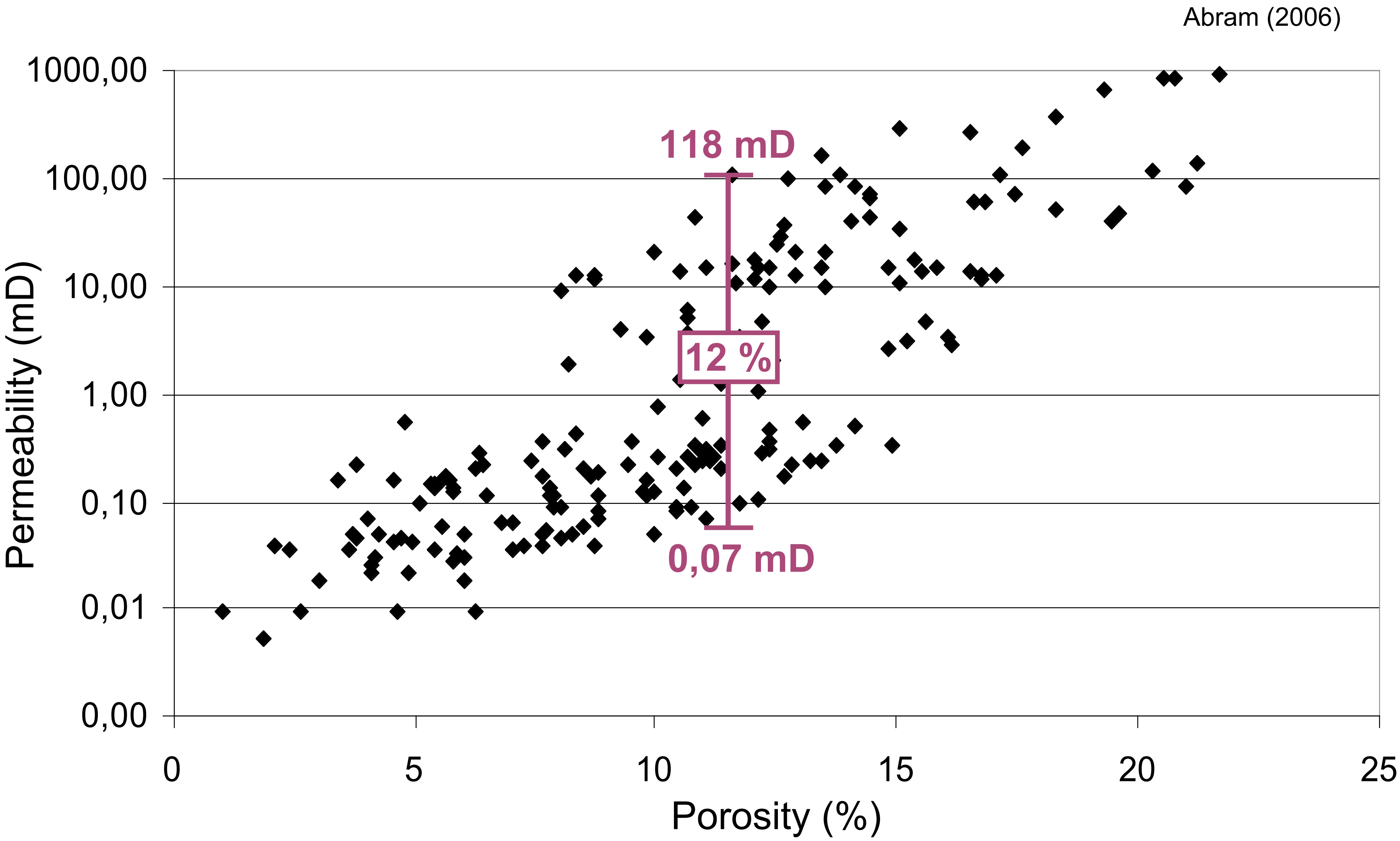
Depositional controls on Reservoir Quality



Gaupp et al 2004

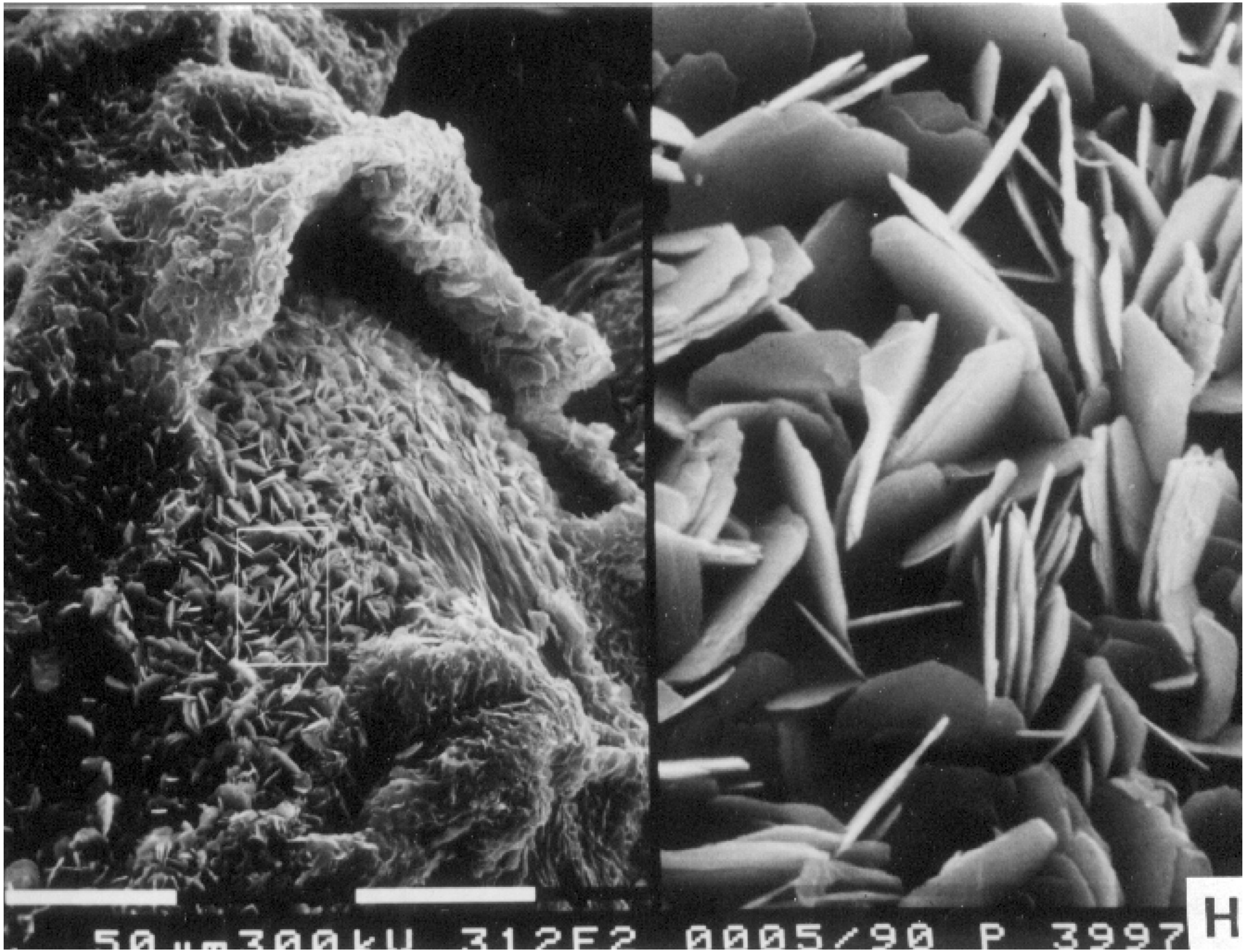
“Fifty years of petroleum exploration in the Netherlands after the Groningen discovery” Utrecht 2009

Porosity and permeability of dry-aeolian sandstones



Similar lithology, similar porosity ←→ large scatter of permeability

Fe-Chlorite radially / subtangentially to grain surface



Major Factors Controlling Rotliegend Diagenesis

1. **Environment is predominant control of reservoir quality in <3500m depth** **(dry aeolian facies with best RQ)**

2. **Mineral composition with moderate influence** **(e.g. lithic vs. quartzose)**

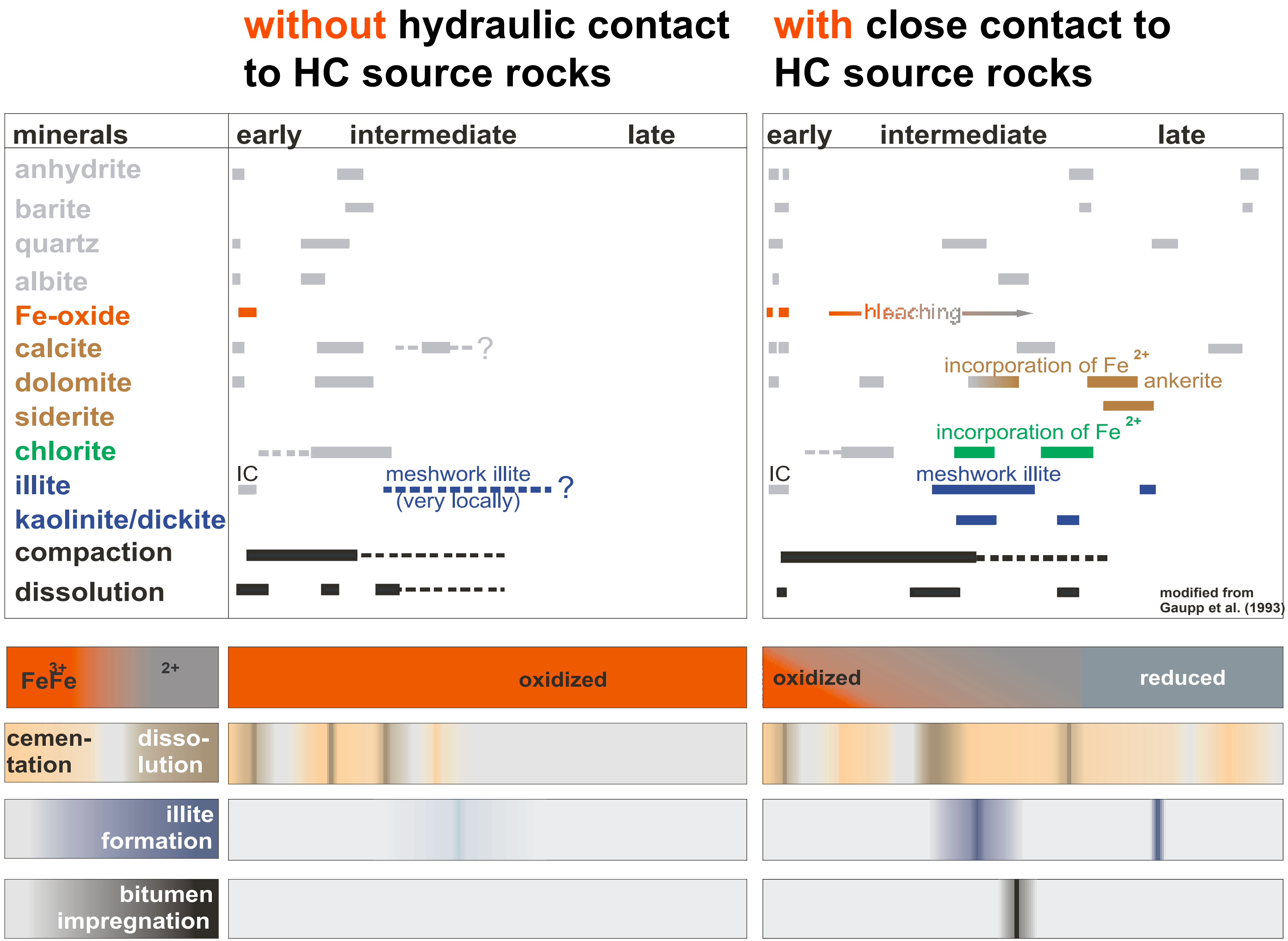
3. **Burial history: residence time in high temperature and maximum burial depth** **(mainly affects mechanical compaction)**

4. **Fluid flow history: e.g. accessability to illitising fluids** **(Carboniferous sources, Zechstein brines)**

5. **Influence of organic maturation products** **(organic acids, early oil in later gas reservoirs, bitumen, bleaching)**

Rotliegend Reservoir sandstones

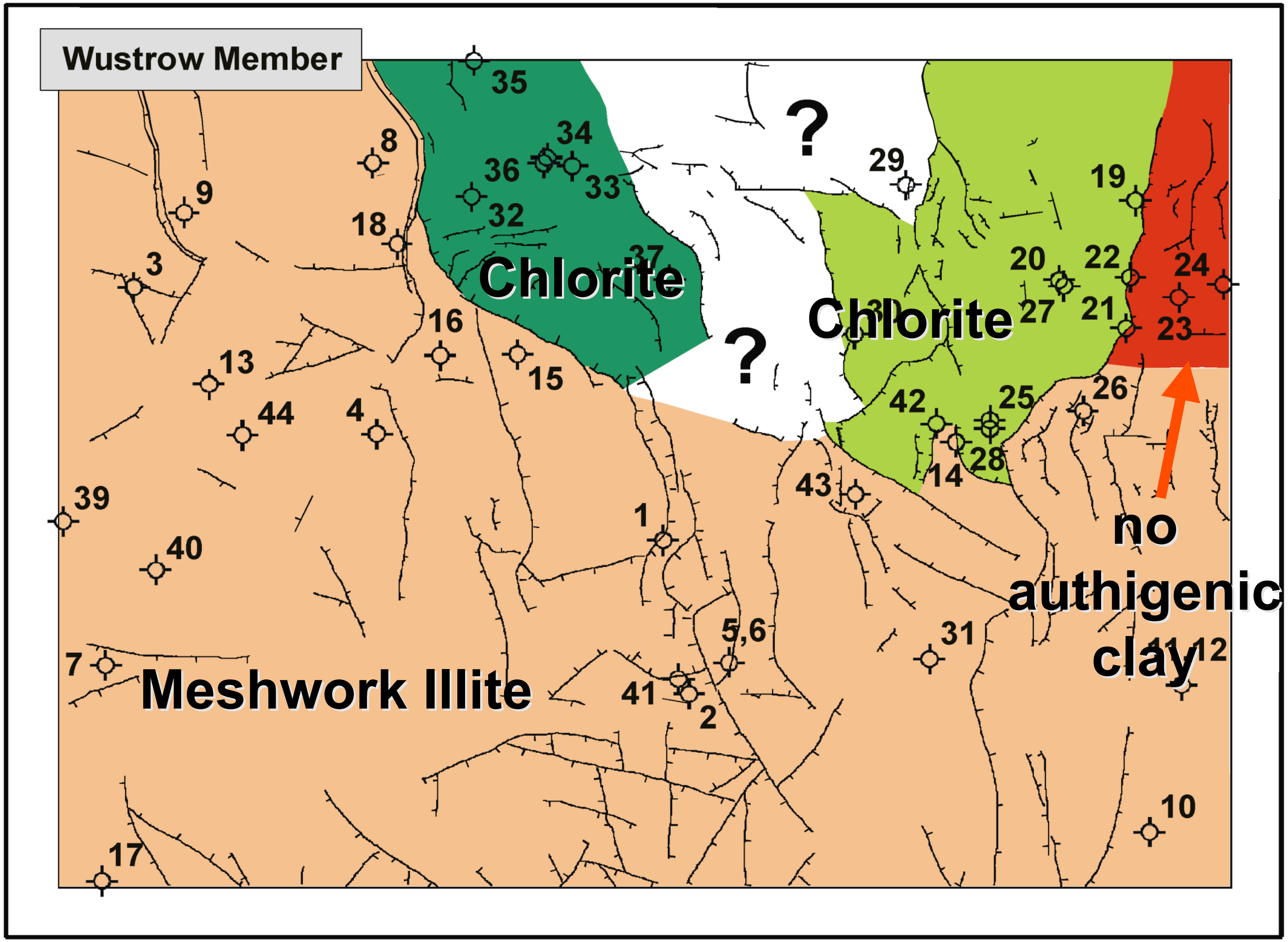
Schöner & Gaupp (2005)



"Fifty years of petroleum exploration in the Netherlands after the Groningen discovery" Utrecht 2009

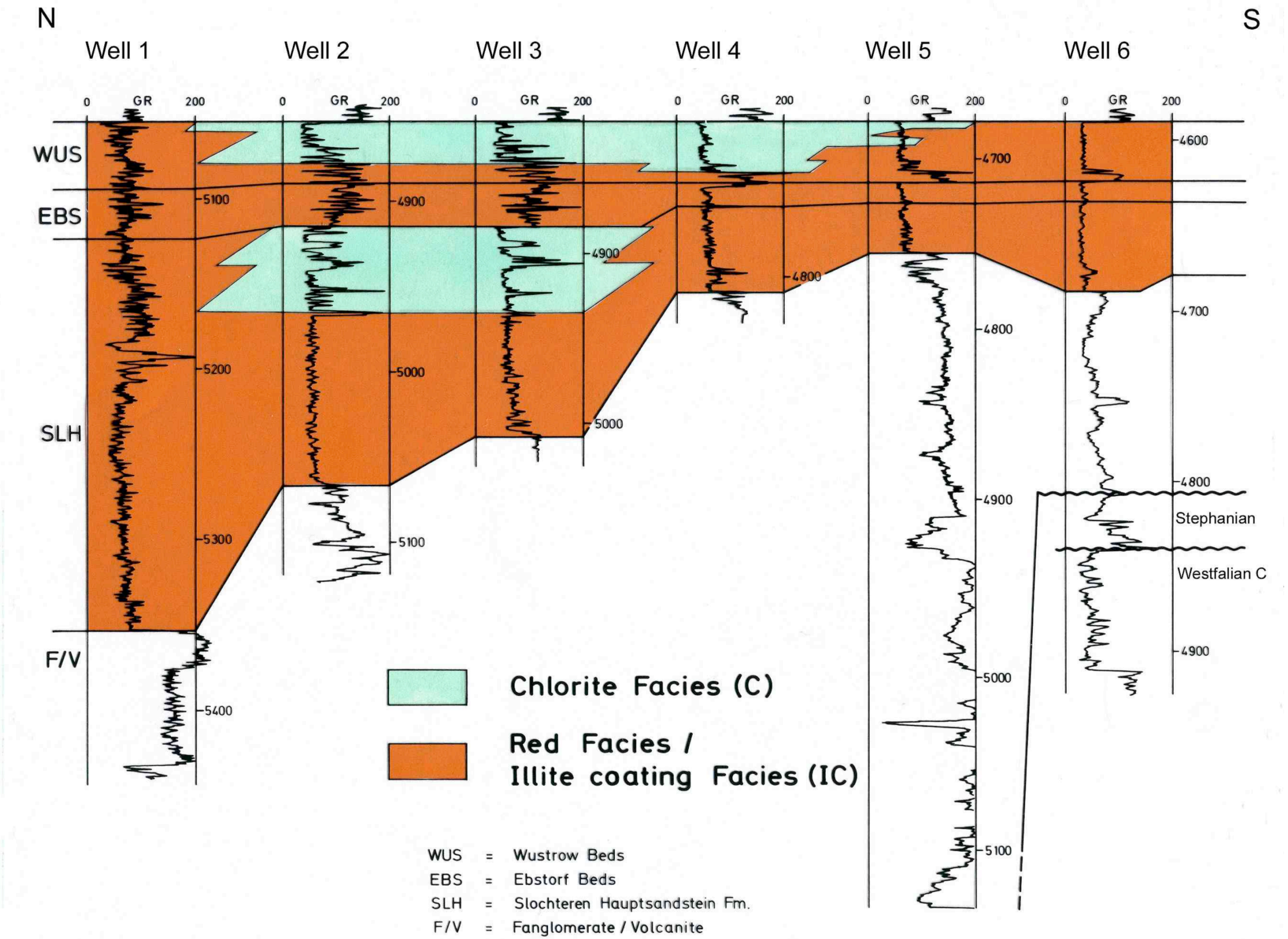
Clay Provinces in a Rotliegend reservoir unit, N. Germany

22 x 10 km²

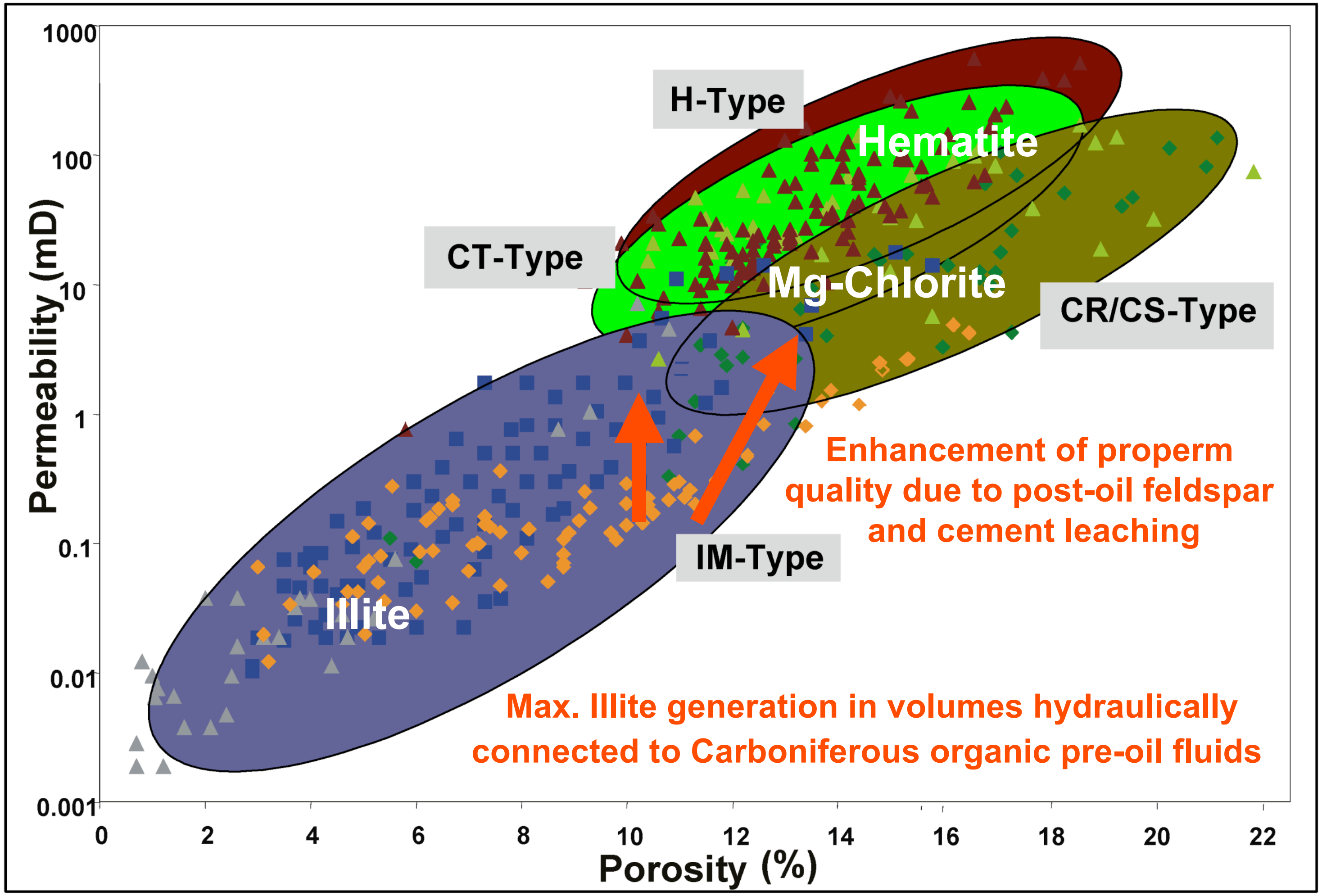


Gaupp et al 2004

Bleached sandstones with chlorite diagenesis

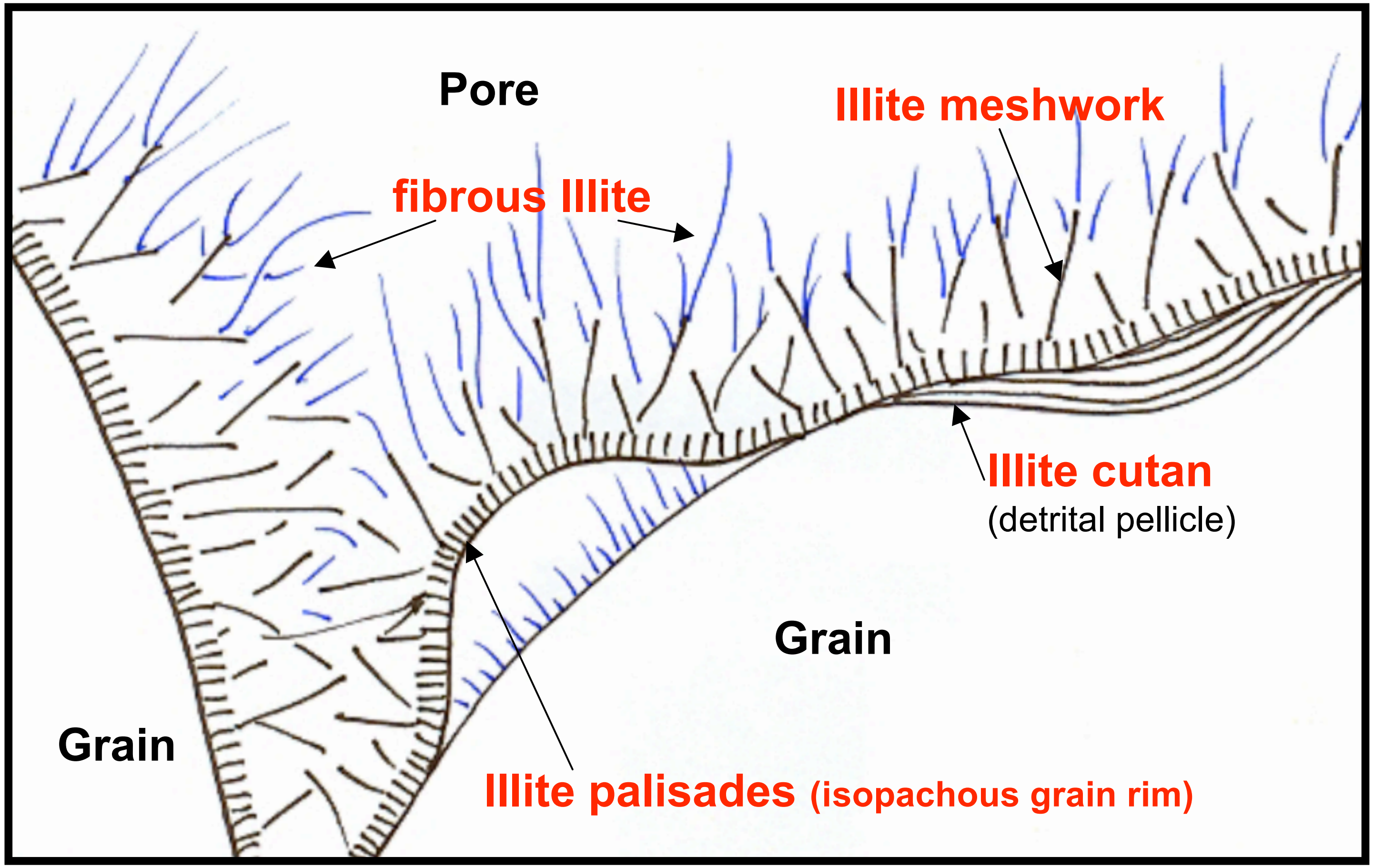


Diagenesis types (diagenetic facies) depend on fluid compositions and strongly control RQ in deep basinal settings



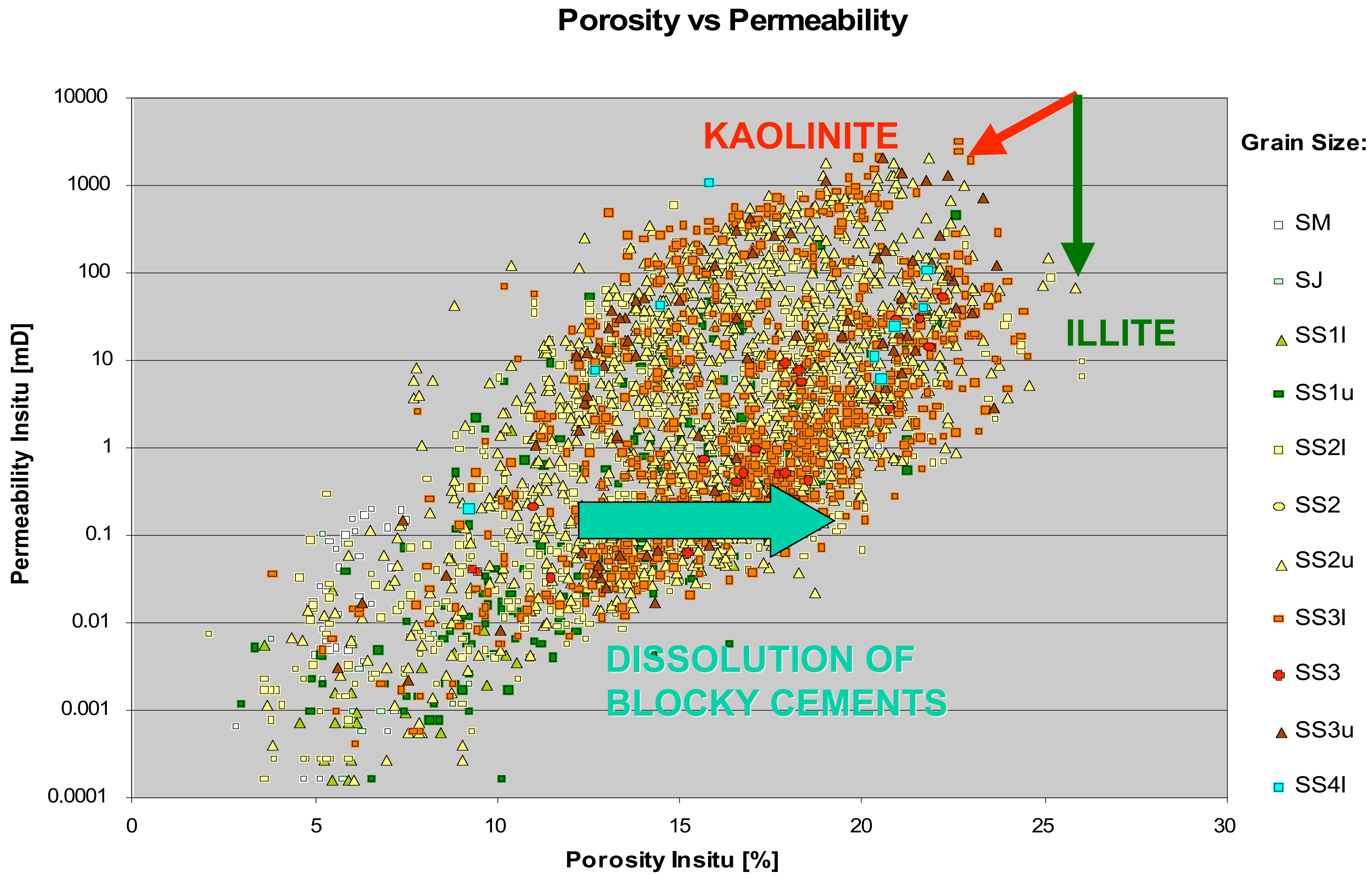
Gaupp et al 2004

Illite morphotypes and textural positions



Diagenetic effects on porosity & permeability

n = 3310

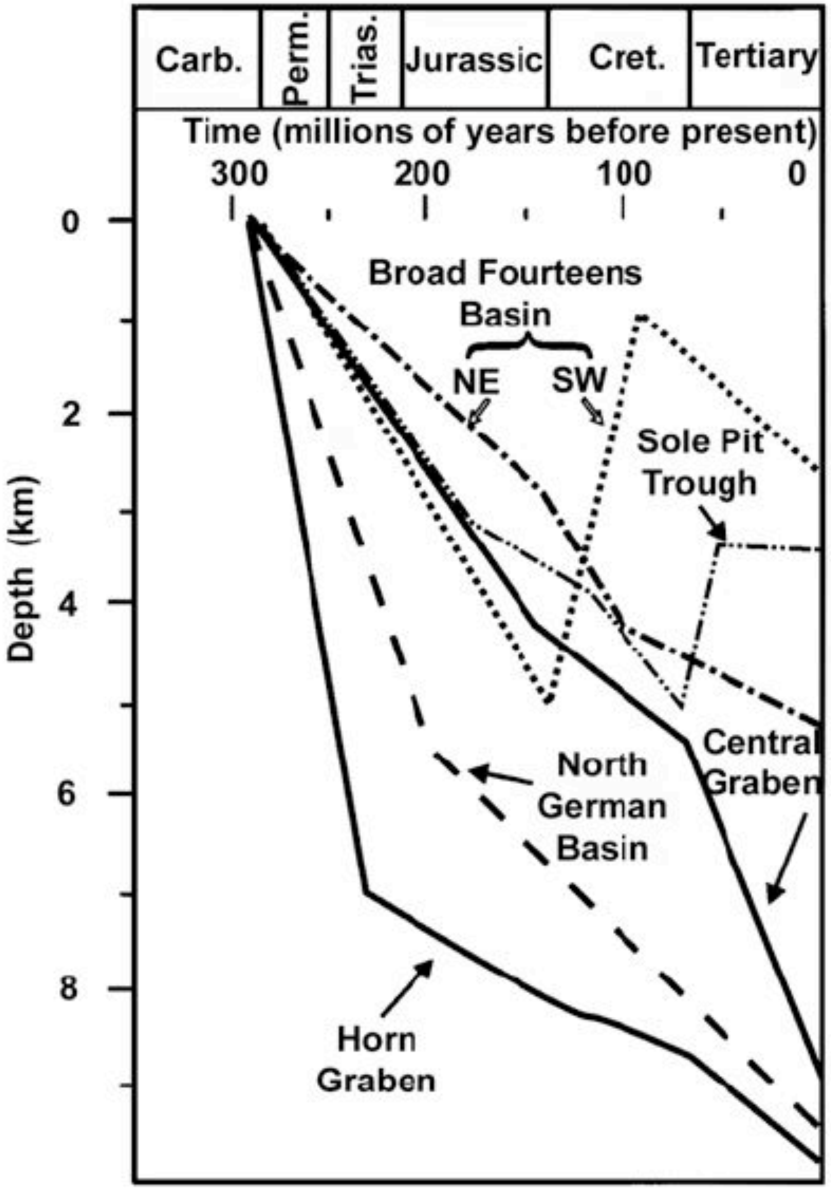


Clay Minerals and their influence on RQ

In a compacted sandstone (intergranular volume <25%):

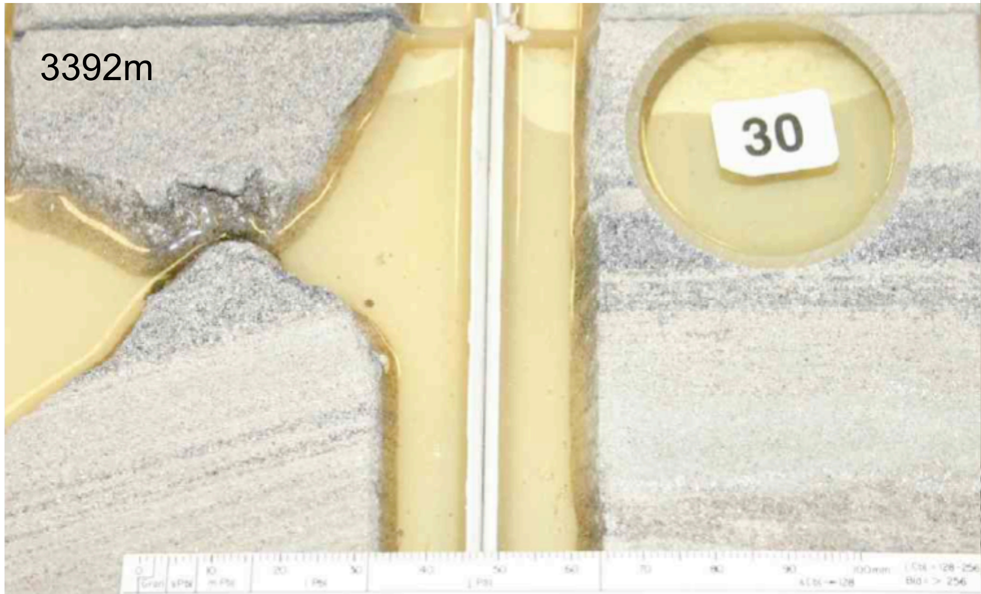
- ⇨ **Illite reduces permeabilities (standardized to equal facies) by 1 - 2 orders of magnitude**
- ⇨ **Kaolinite reduces porosity by <6% (max 15%)**

Effect of Burial Histories (subsidence and heat flow evolution)



Ziegler (2006)

Bleaching in red beds:



Possible effects of HCs in reservoirs:

Occlusion of pores by solid bitumen

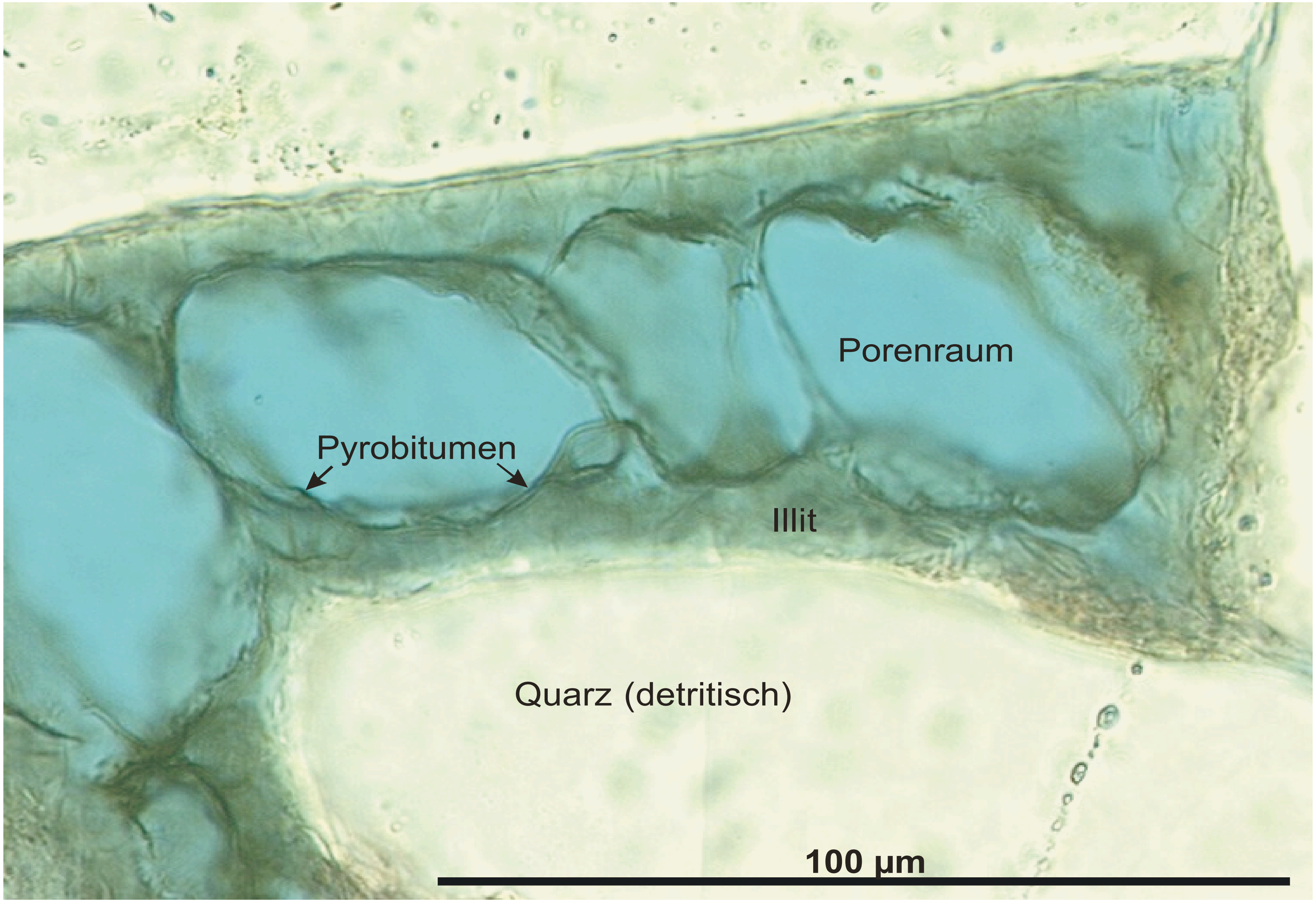
Hydrophobisation of reactive surfaces
(inhibition of cementation?)

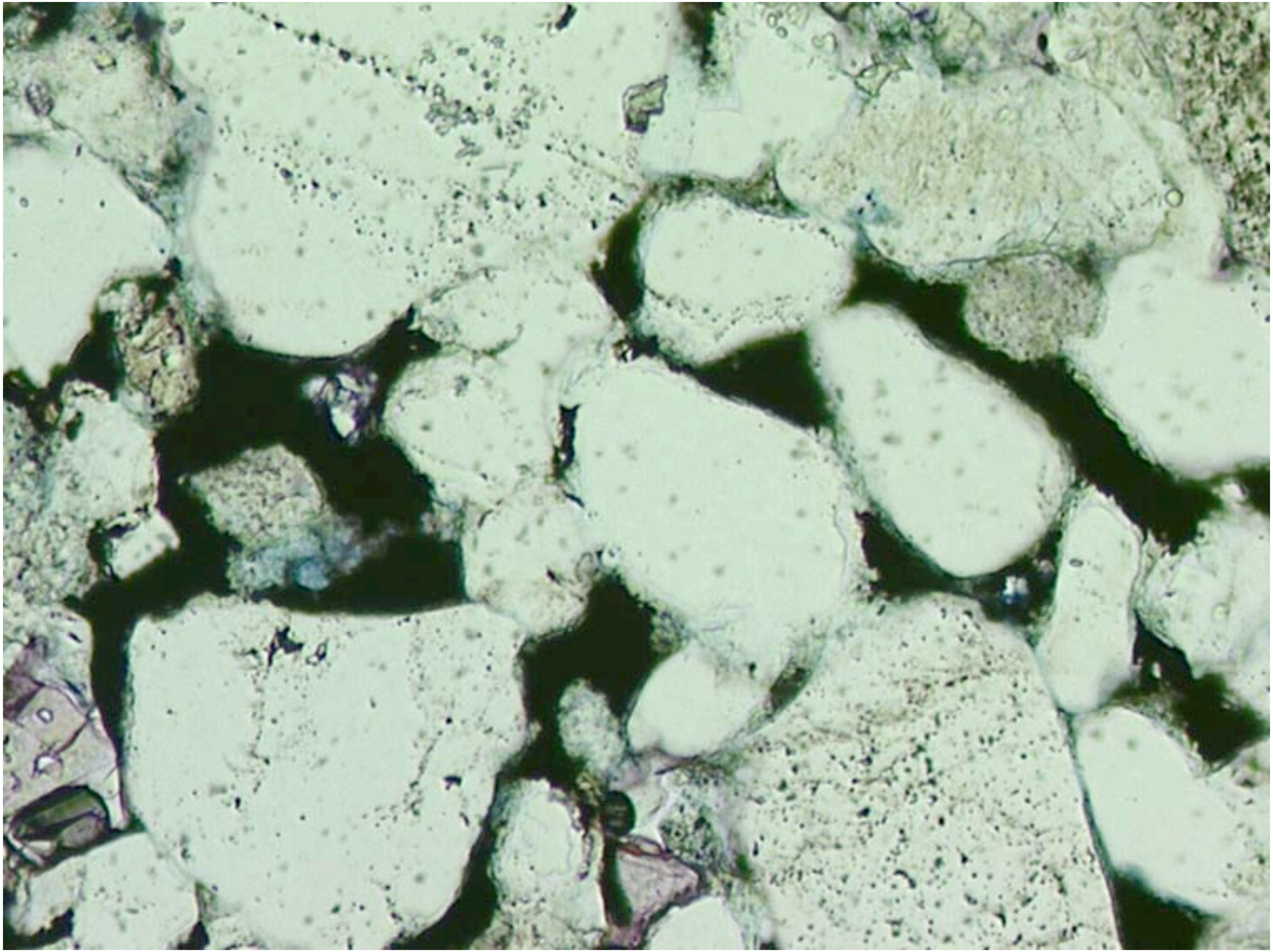
Minimizing internal surfaces

Oil/Gas fills retard cementation

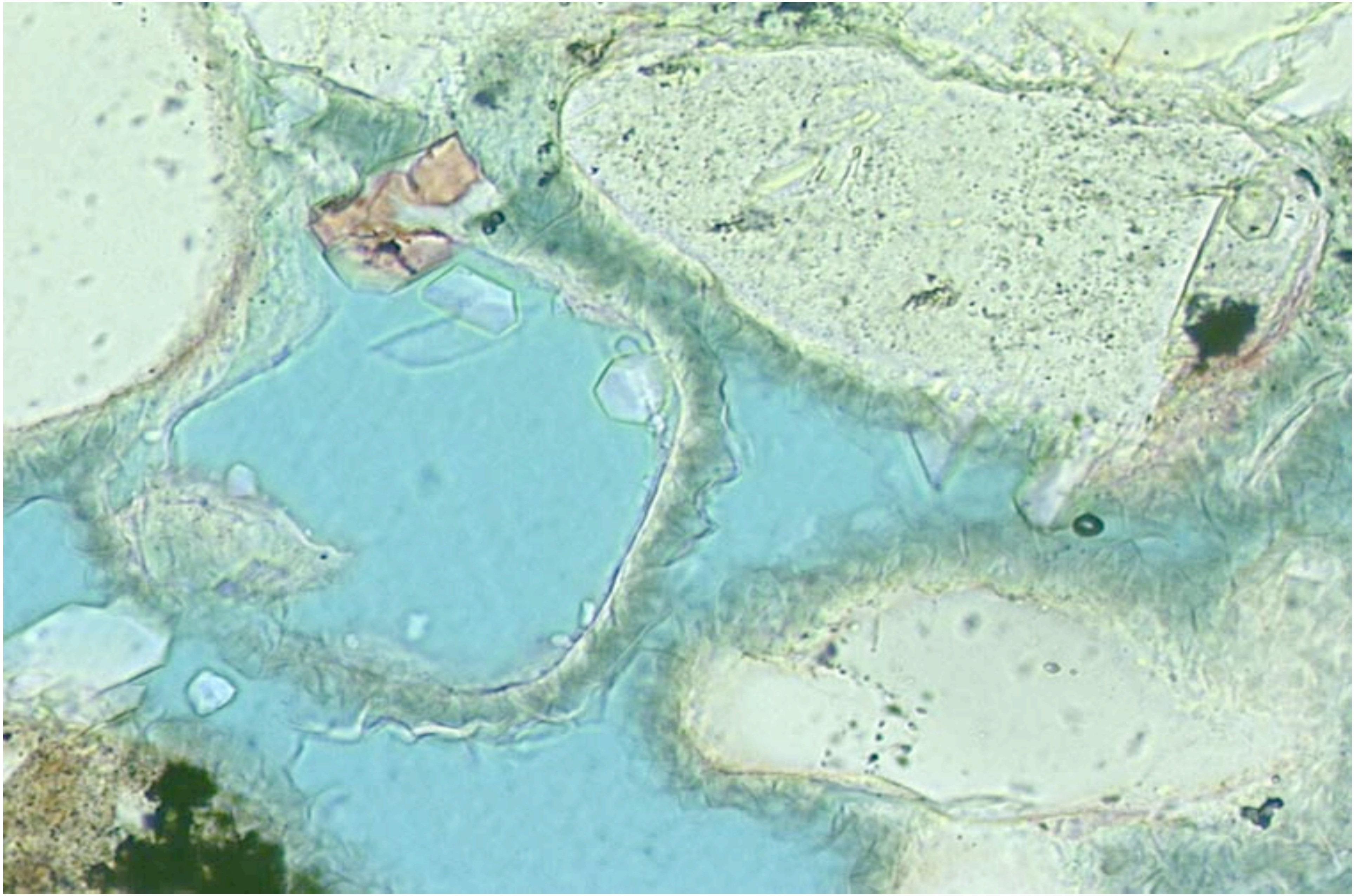
Early Bitumina have an important role
in successive diagenesis!

Bleaching, Illitisation and Bitumenimpregnation



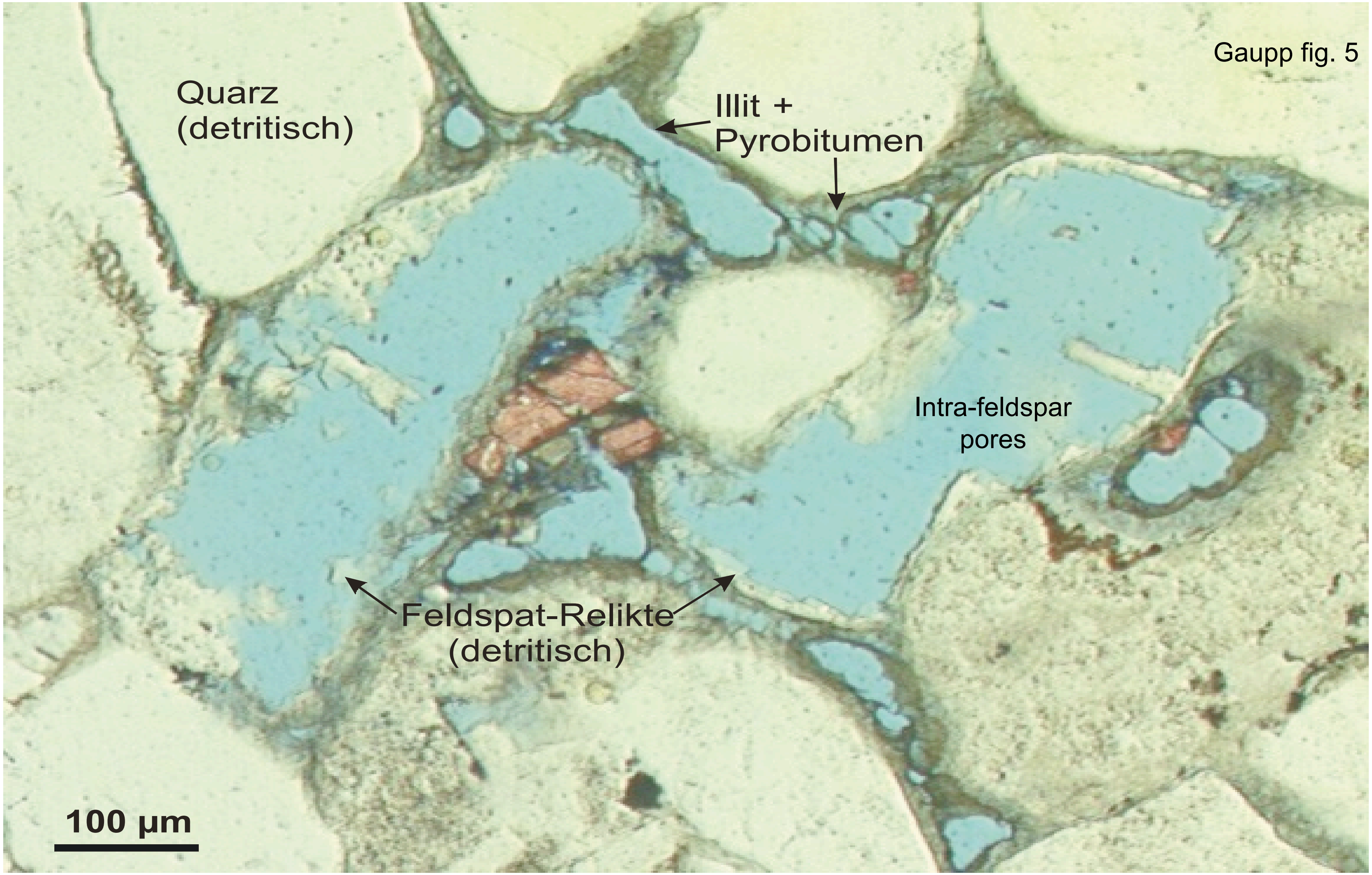


„Secondary late“ porosity is relevant!



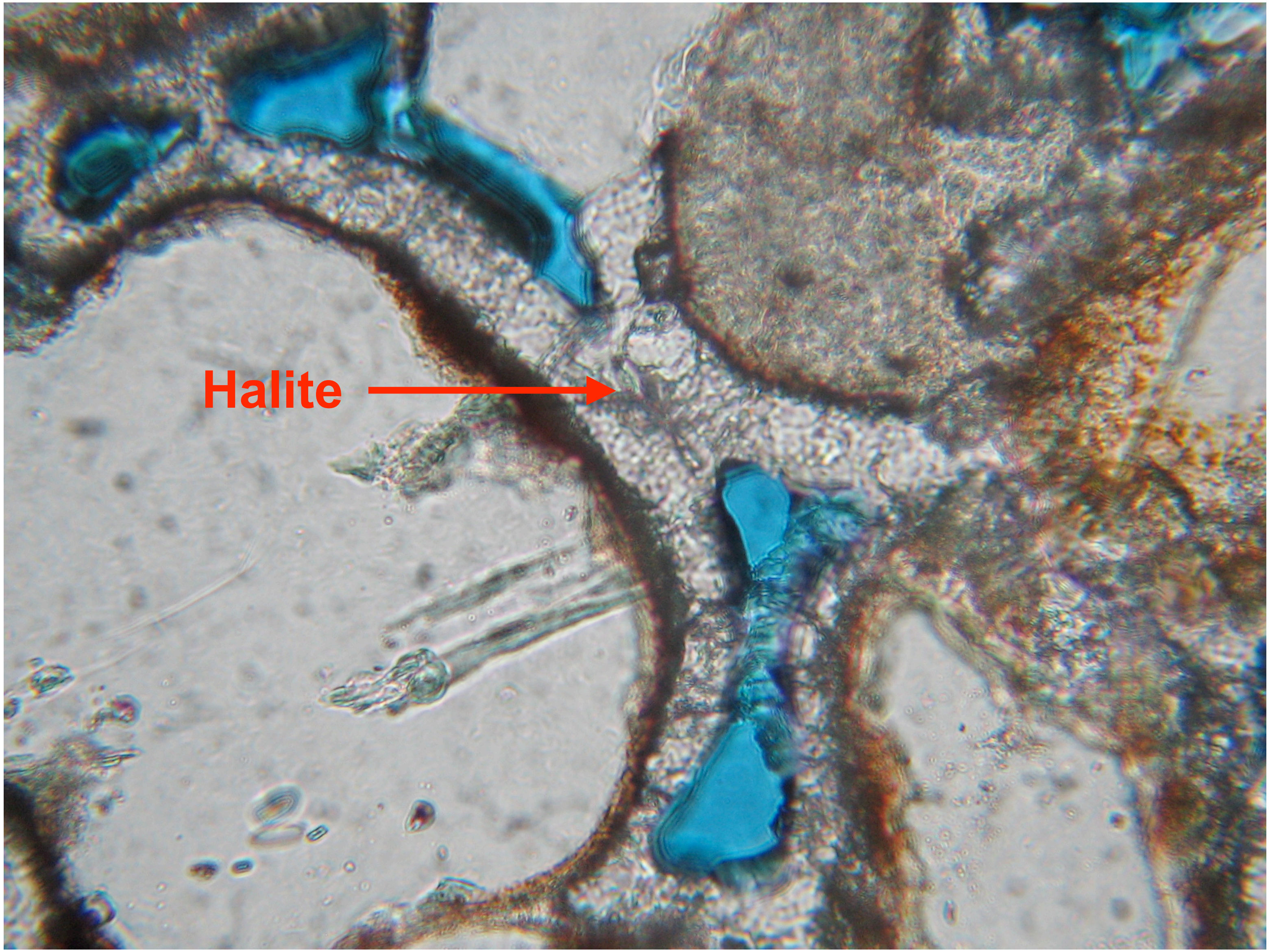
Late porosity enhancement after illite & paleobitumen

Cement and feldspar leaching after illite-bitumen (+ 2-5% porosity)



Effect of Early Cements (framework stabilisation, flow barrier)

Rotliegend NENED depth 3479,49 m 23,7 % 120,6 mD



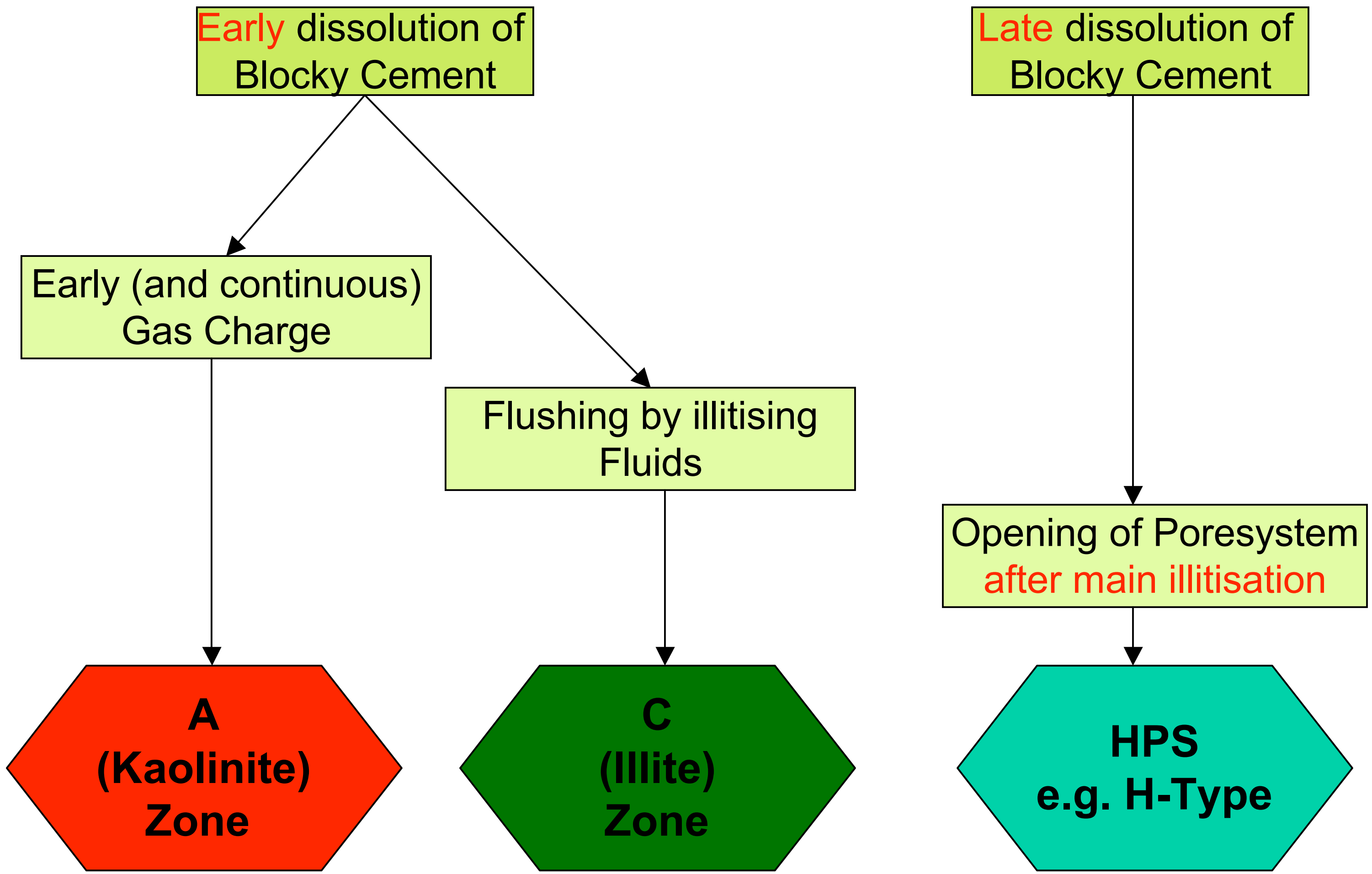
Salt cement (halite) formed early, prior to illite rims. Isopachous halite stabilized framework, but was partly dissolved late during mesodiagenesis.

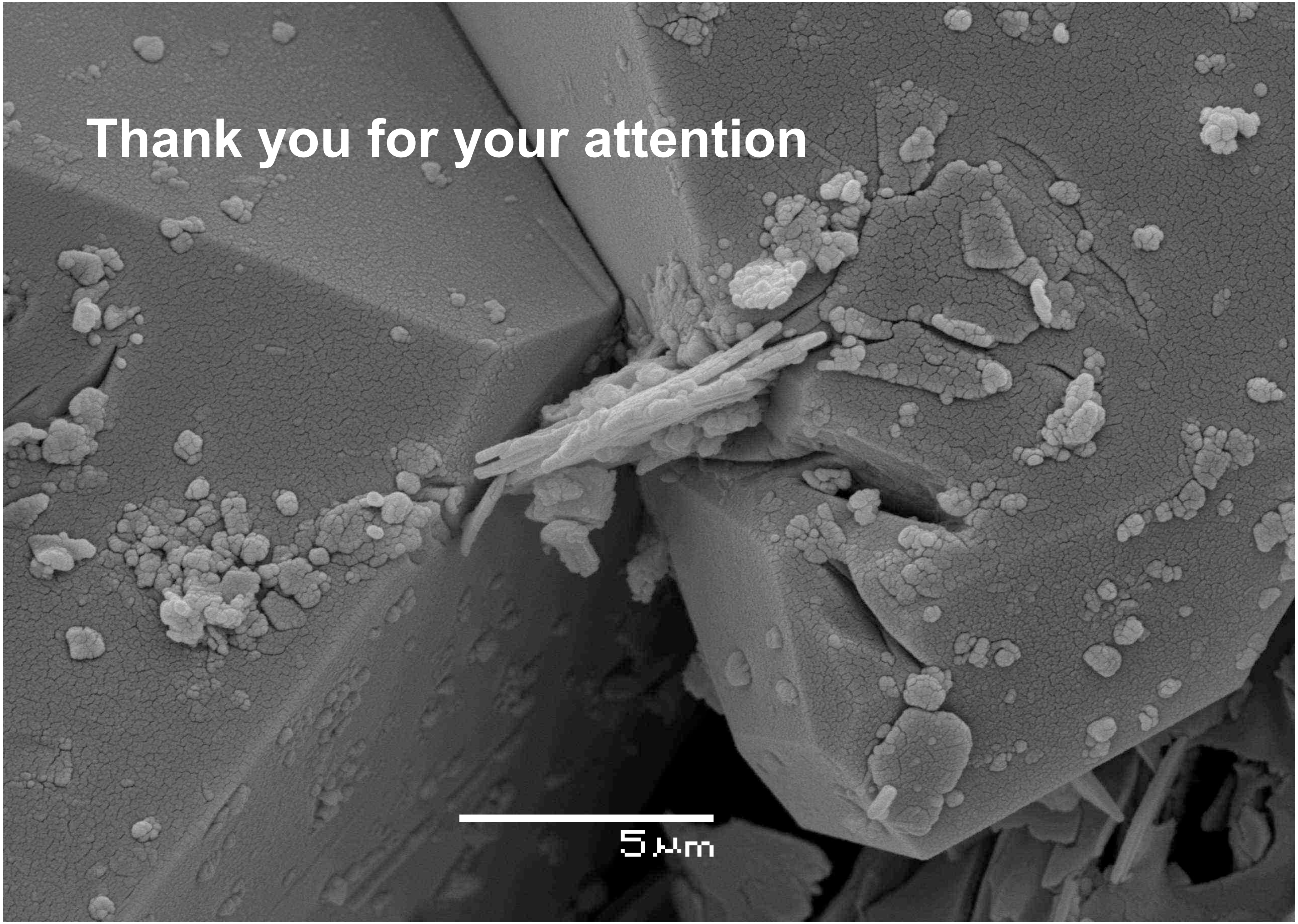
H-Type reservoir without authigenic clay.

No detectable bitumen staining

50 µm

The Importance of Early Cements (Blocky Cements) and their Late Leaching




Thank you for your attention
5 µm

Rotliegend Diagenesis General Aspects

1. Clay effects on RQ vary with type (Chlorite, Illite meshwork, Kaolinite)

2. Clay provinces exist (?fault controlled, stratigraphic?)

3. Clay locally varies with depth (C >3500m, K <3200m, IM in between ?)

4. Vertical clay variations in wells are obvious, but no simple storey/layer model

5. Bleaching is relevant for reservoir properties, does not occur during all HC charging events, frequently associated with clay growth

Rotliegend Diagenesis General Aspects