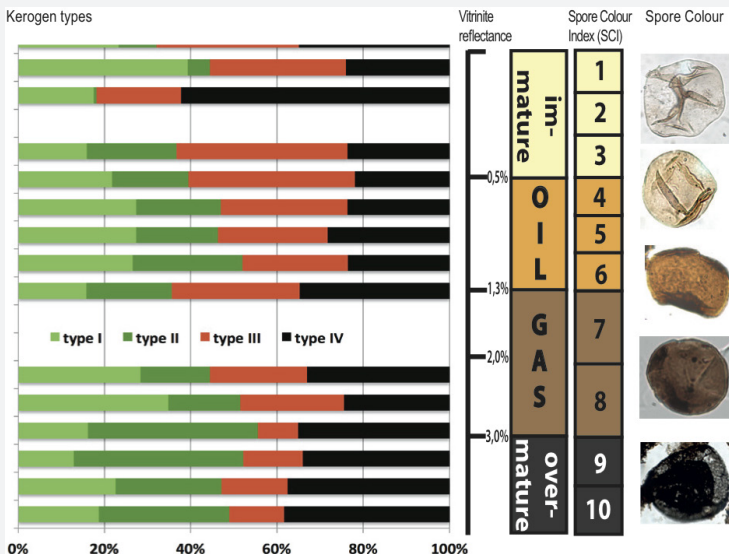


GeoResources

Optical Kerogen Analysis



Preservation

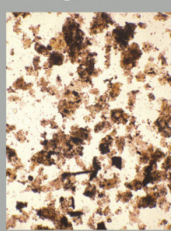
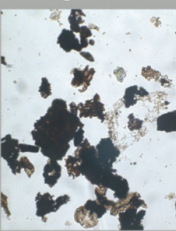
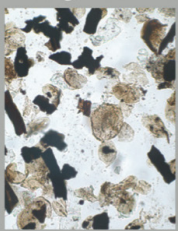
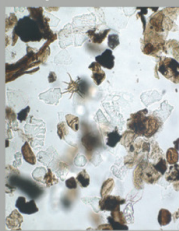
Degradation

1 well preserved

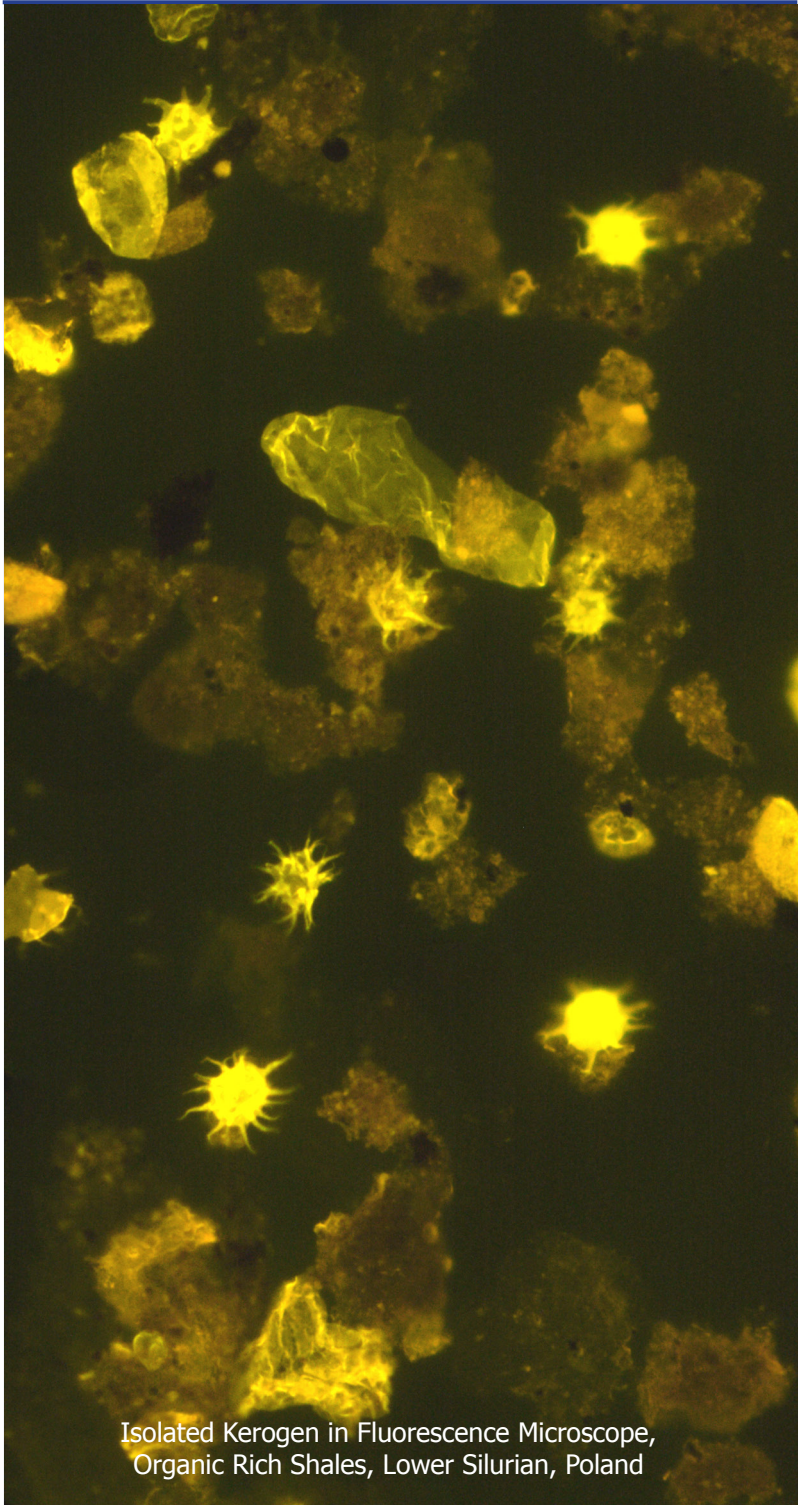
2 slightly degraded

3 hardly degraded

4 totally degraded



Integrated Optical Analysis of
Kerogen Composition & Maturation for
Improved Hydrocarbon System Analysis



Isolated Kerogen in Fluorescence Microscope,
Organic Rich Shales, Lower Silurian, Poland

Benefits for HC Exploration

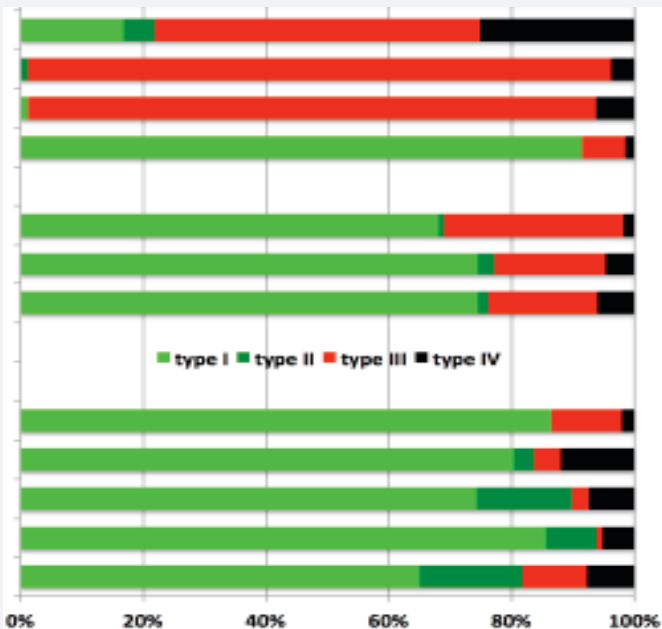
- Detailed quantification of each single kerogen type within the total kerogen of each sample
- Quantification of productive vs. unproductive proportions of the total kerogen => **net-TOC**
- Quantification of oil-prone vs. gas-prone kerogen within the productive kerogen
- Detailed analysis of preservation of each kerogen type => estimation of HC generation from oil-prone and gas-prone parts of kerogen
- High resolution analysis of organic maturation by two independent methods
- Highly reliable in-situ basin maturation vs. maturity of recycled/degraded kerogen
- Identification of different kerogens with different HC potential mixed within the total kerogen
- Identification of productive source rocks = **net-source rock units** (pay zones) within potential source rock formations for significantly improved resource evaluation

Add Ons - for integrated hydrocarbon system analysis

- TOC/CNS analysis - quantification of total organic carbon and information on depositional environment
- Core logging and thin section analysis - analysis of texture and composition of source and reservoir units
- SEM - high-resolution analysis of in-situ microporosity, rock texture and mineral/kerogen distribution
- Petrophysical analysis - information on petromechanical rock properties, porosity and permeability
- Spatial data integration & modelling - distribution of HC system relevant parameters in 1D to 3D models based on integrated lithological and kerogen data sets

Kerogen Composition

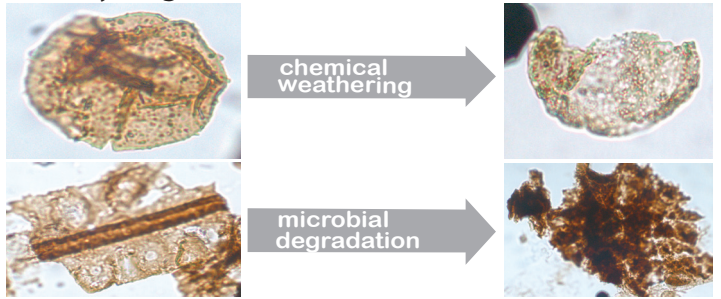
- organic matter (kerogen) is isolated from the rock sample and directly studied under the microscope,
- optical quantification of palynologically defined kerogen groups and transformation to kerogen types
- identification of mixed kerogen, regarding mixed composition, preservation & maturation
- highly sensitive quantification of each kerogen type separately in each sample
- quantification of productive vs. unproductive proportions of the total kerogen
- quantification of oil-prone vs. gas-prone kerogen within the productive kerogen



- data can be implemented directly into organofacies based hydrocarbon system modeling
- optical kerogen analysis is a strong improvement to chemical kerogen analysis (Rock Eval, Biomarker), based on bulk rock analyses, which are unable to identify mixed kerogen and its effect on hydrocarbon potential

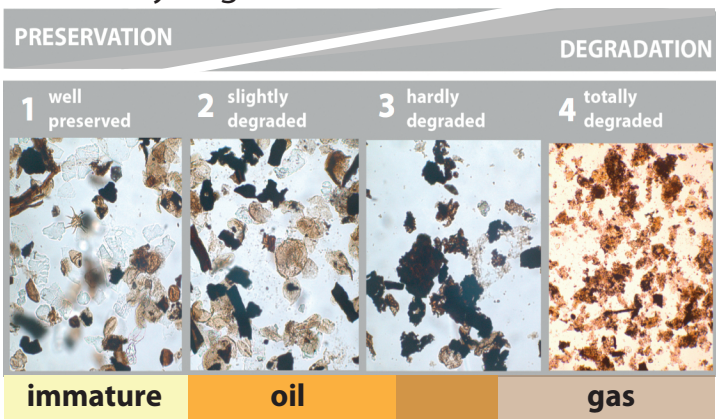
Kerogen Preservation

Primary degradation - Paleoenvironment controlled

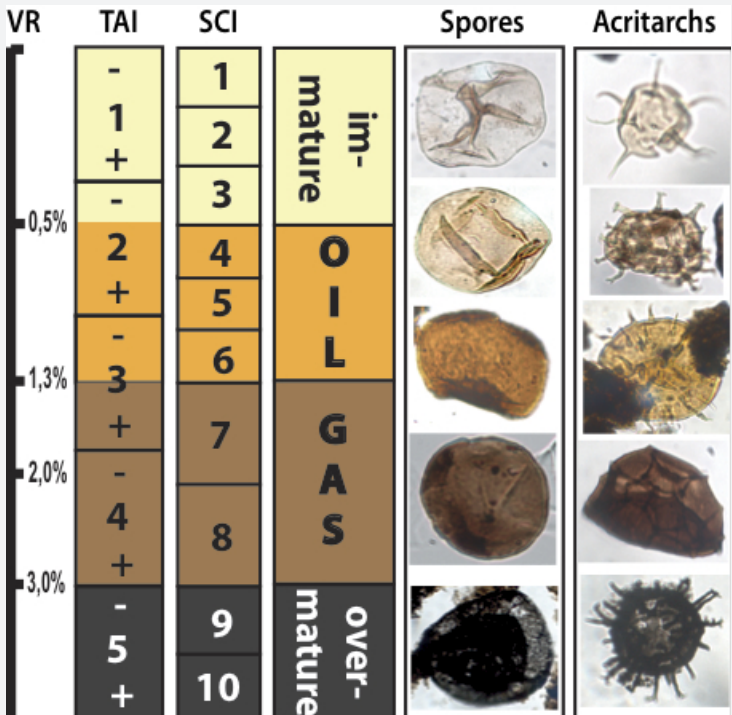


- PRIMARY DEGRADATION = facies controlled microbial and chemical alteration of kerogen during transport, deposition and early diagenesis
- SECONDARY DEGRADATION = maturation controlled alteration during burial heating and other thermal overprint of kerogen and hydrocarbon generation
- maturation controlled degradation indicates levels of hydrocarbon generation from actual kerogen
- kerogen preservation correlates directly to microporosity of kerogen, which is directly linked to storage capacity for unconventional shale gas (and oil) plays
- detailed information on hydrocarbon generation and storage capacity (in unconventional plays)

Secondary degradation - Maturation controlled



Kerogen Maturation



- combination of two independent methods - vitrinite reflectance (VR) and palynomorph colour indices (TAI/SCI/PDI) - for maximum reliability and accessibility of maturation data
- VR as standard method, providing precise and highly reliable palaeo-temperatures and maturation trends
- new high-resolution VR analysis using grey scale analysis of digital vitrinite images, eliminating mixed reflectance values (typical for classical VR analysis).
- additional TAI/SCI/PDI to provide fast-hand first estimates of maturation levels
- TAI/SCI/PDI when vitrinite is missing (by facies, preservation or stratigraphical limitation)
- TAI/SCI/PDI also for independent cross-check of VR data

Projects

including Optical Kerogen Analysis:

- Thermal history and hydrocarbon source rock potential of the Palaeozoic below the Molasse basin, Austria
- Optical and geochemical kerogen and hydrocarbon potential analysis, Palaeozoic to Cenozoic, Peru
- Rift-graben development and hydrocarbon generation, Cenozoic, Southern Germany
- Multidisciplinary studies of unconventional hydrocarbon potential of Silurian Shales, Arabia
- Unconventional HC source rock potential based on Optical Kerogen Analysis, Silurian, Russia
- Source rock potential of organic rich shales, Lower Carboniferous, North German Basin
- Evaluation of unconventional hydrocarbon source rock potential, North German Basin, Germany
- Evaluation of hydrocarbon source rock potential, Mesozoic & Cenozoic, Southern Germany
- Unconventional hydrocarbon source rock potential, Silurian, SE-Poland
- Integrated basin and hydrocarbon system analysis Palaeozoic, Saharian Basins, Algeria
- Source rock and organic maturation analysis, Palaeozoic, Basins, Morocco
- Organic maturation & source rock analysis, Mesozoic to Cenozoic, Upper Rhine Graben, Germany

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