Image analysis in kerogen studies – biostratigraphy and petroleum geochemistry

Stratigraphers (palynologists) and geochemists have a fundamental requirement to study organic residues from rocks.

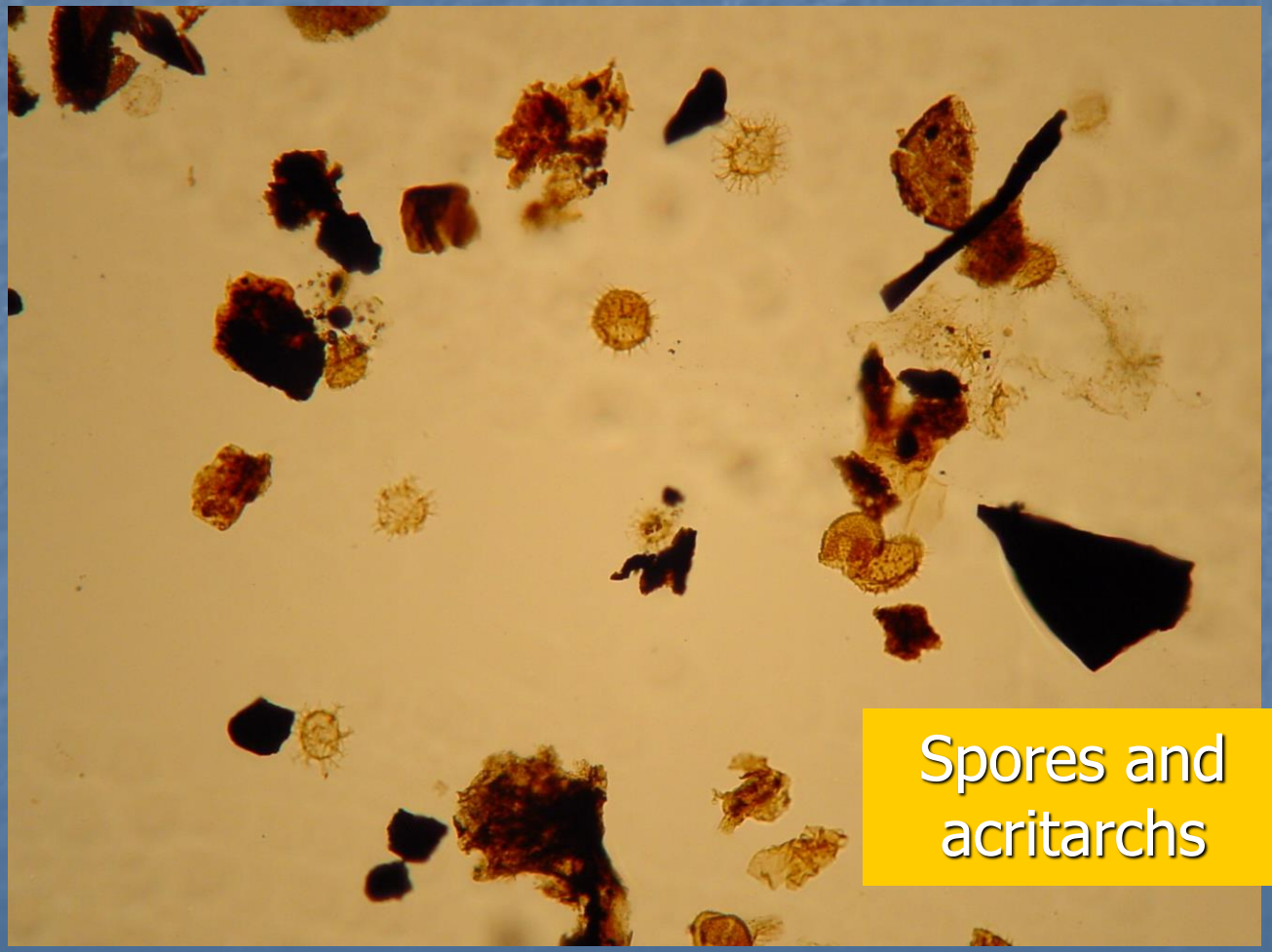
The nature of the materials to be studied and the needs are varied.

Stratigraphic palynology

Stratigraphic palynology aims to identify and classify specific components of kerogen in order to determine the age of the rock from the nature and type of assemblages of palynomorphs present.

Kerogen transmitted light

Example of ?sieved and ?oxidised kerogen of mid maturity with liptinites (spores/ acritarchs and sapropel), vitrinite and fusinite/ semifusinite.



Microscopy in petroleum geochemistry

What does geochemistry try to achieve?

- Assess hydrocarbon generation and production potential in sedimentary basins by analysing:
  - Fluids (oils and gas)
  - Rocks
- Computer modelling of geological processes.

Data generation:

- Chemical – various organic and inorganic chemistry methods;
- Microscopy – whole rock and organic concentrates

Microscopy approaches used

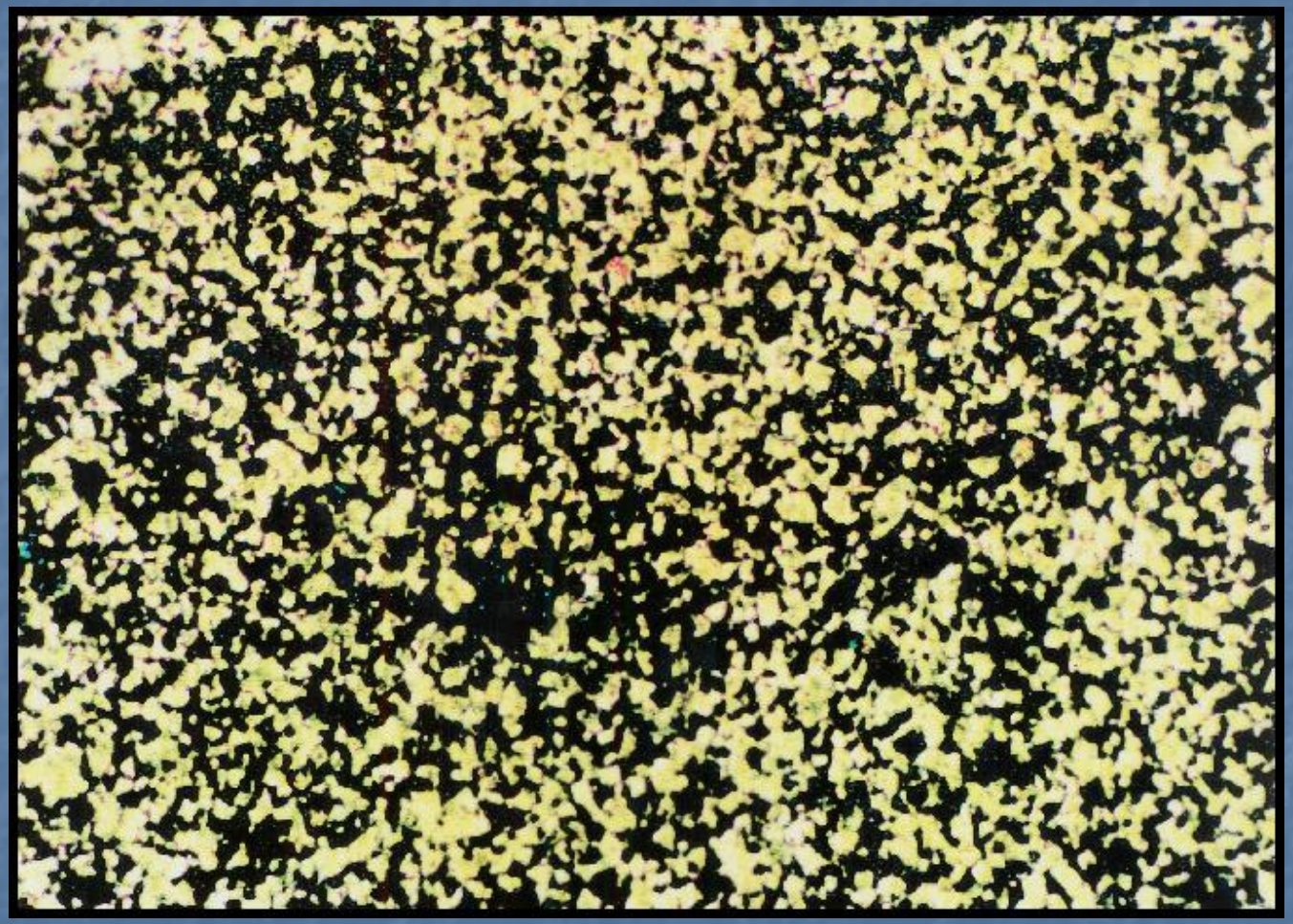
Whole rock:

- Transmitted light – mainly for sedimentary petrography purposes – unable to see any significant detail – black stuff;
- Reflected light – originally by Marie Stopes for coal petrography. Now used to assess organic debris dispersed in rock matrix – humic remnants or replacement hydrocarbon residues.

Kerogen concentrates:

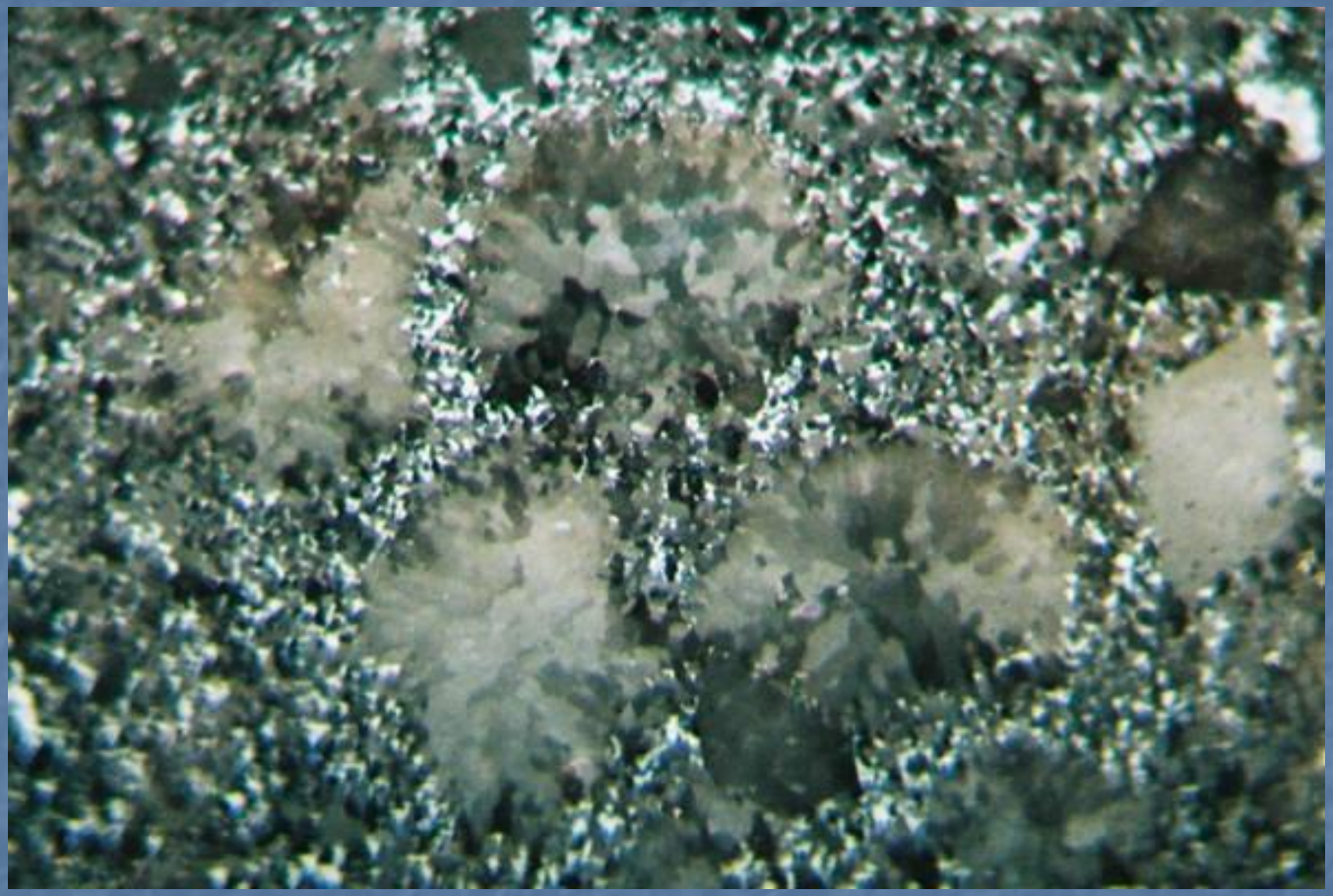
- Transmitted light – off-shoot from stratigraphic palynology;
- Reflected light – mount kerogen usually unoxidised residues, in epoxy resin and give optical grade polish.

Whole rock transmitted light



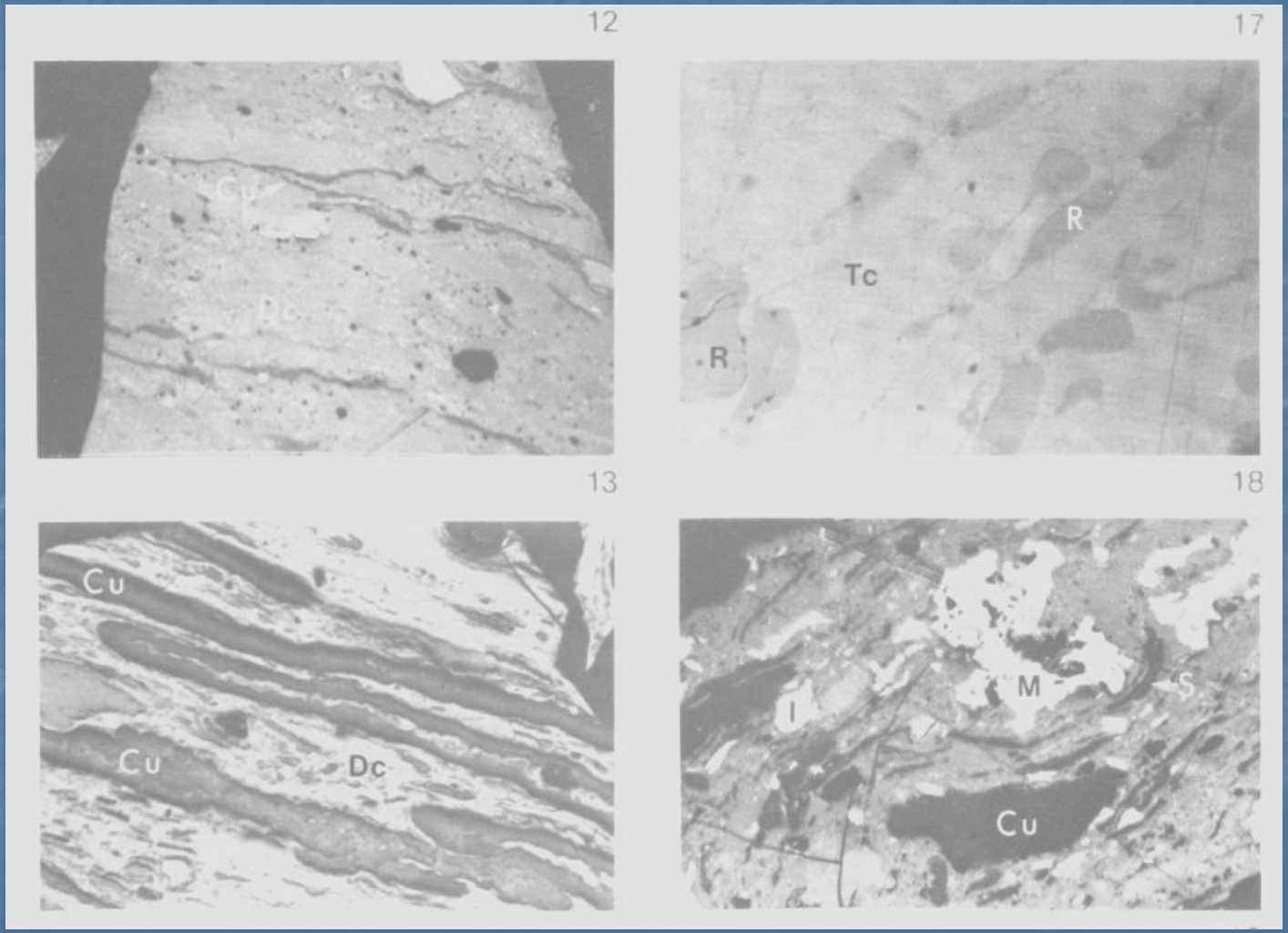
Example of bitumen infilling original porosity in carbonate – not very revealing!

Whole rock reflected light



Example of bitumen infilling original porosity in oolitic limestone with ooliths subsequently replaced by calcite cement

Whole rock reflected light – coal (i)



Bright

inertinites (fusinite, micrinite);

Medium bright

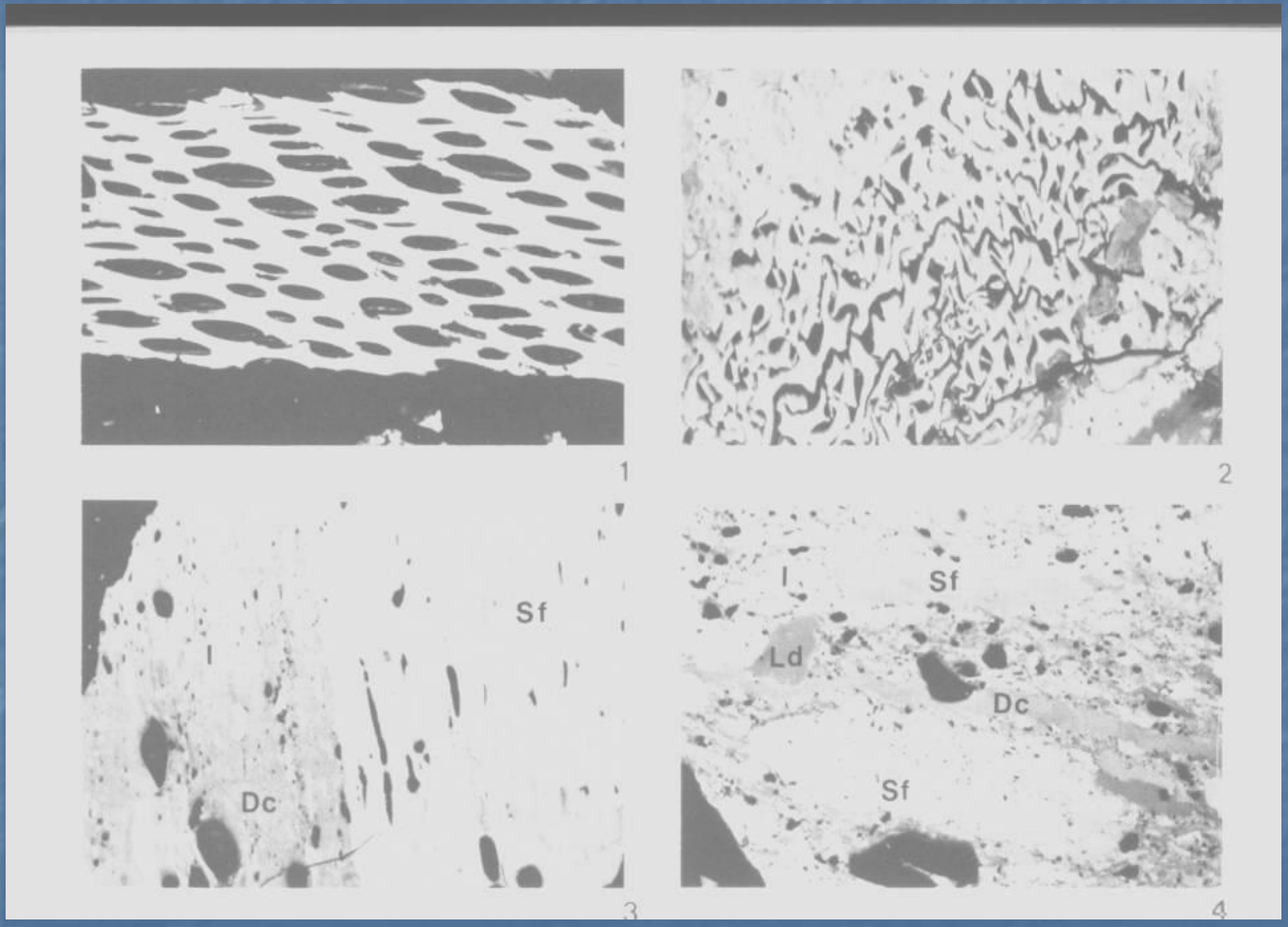
vitrinites (tellinite, colinite);

Dull

liptinites (cutinite, resinite).

Examples of main coal macerals

Whole rock reflected light – coal (ii)



Bright

inertinites (fusinite, micrinite);

Medium bright

vitrinites (tellinite, colinite);

Dull

liptinites (cutinite, resinite).

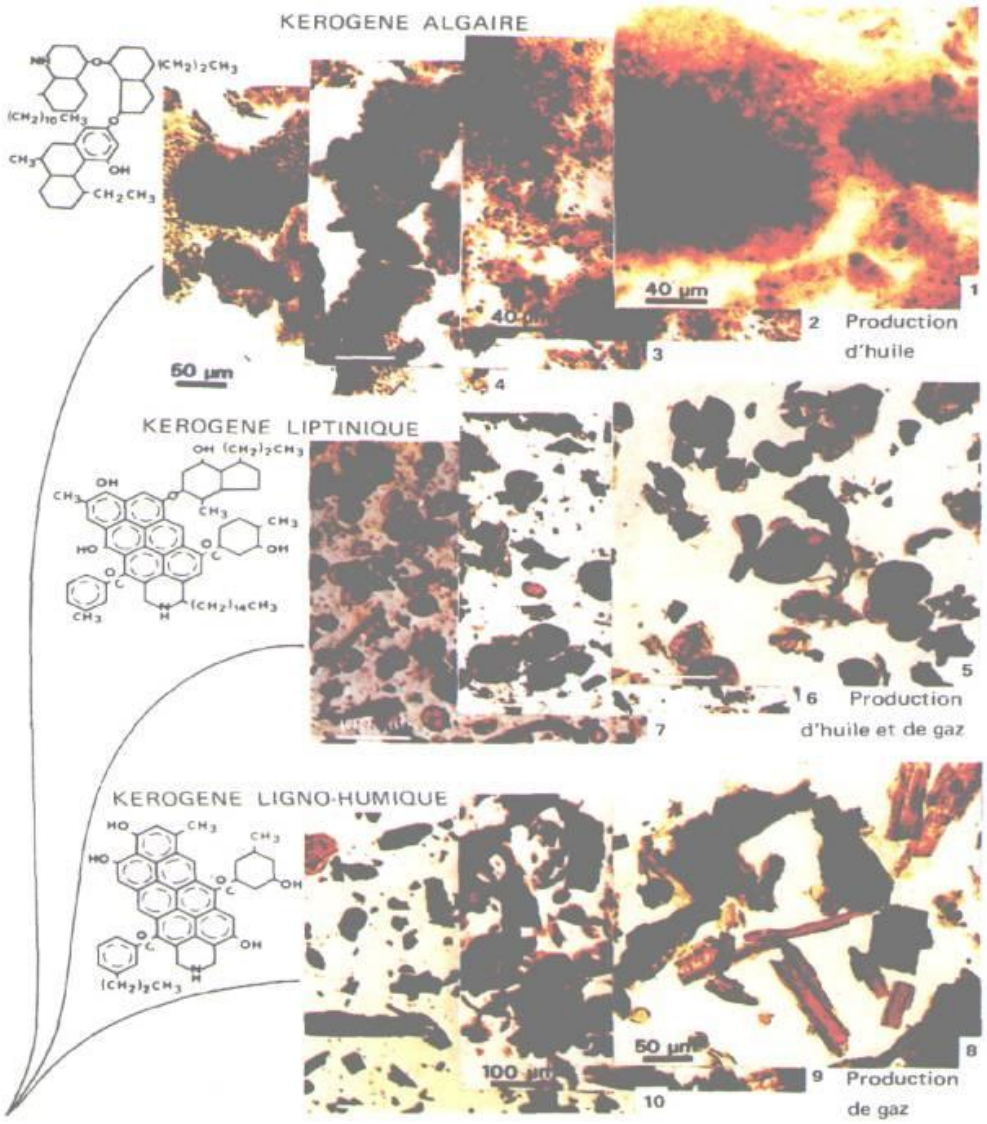
Examples of main coal macerals

Kerogen transmitted light

Examples of different kerogen types at increasing levels of maturity.

Note:

Unoxidised unsieved strew mount slides.



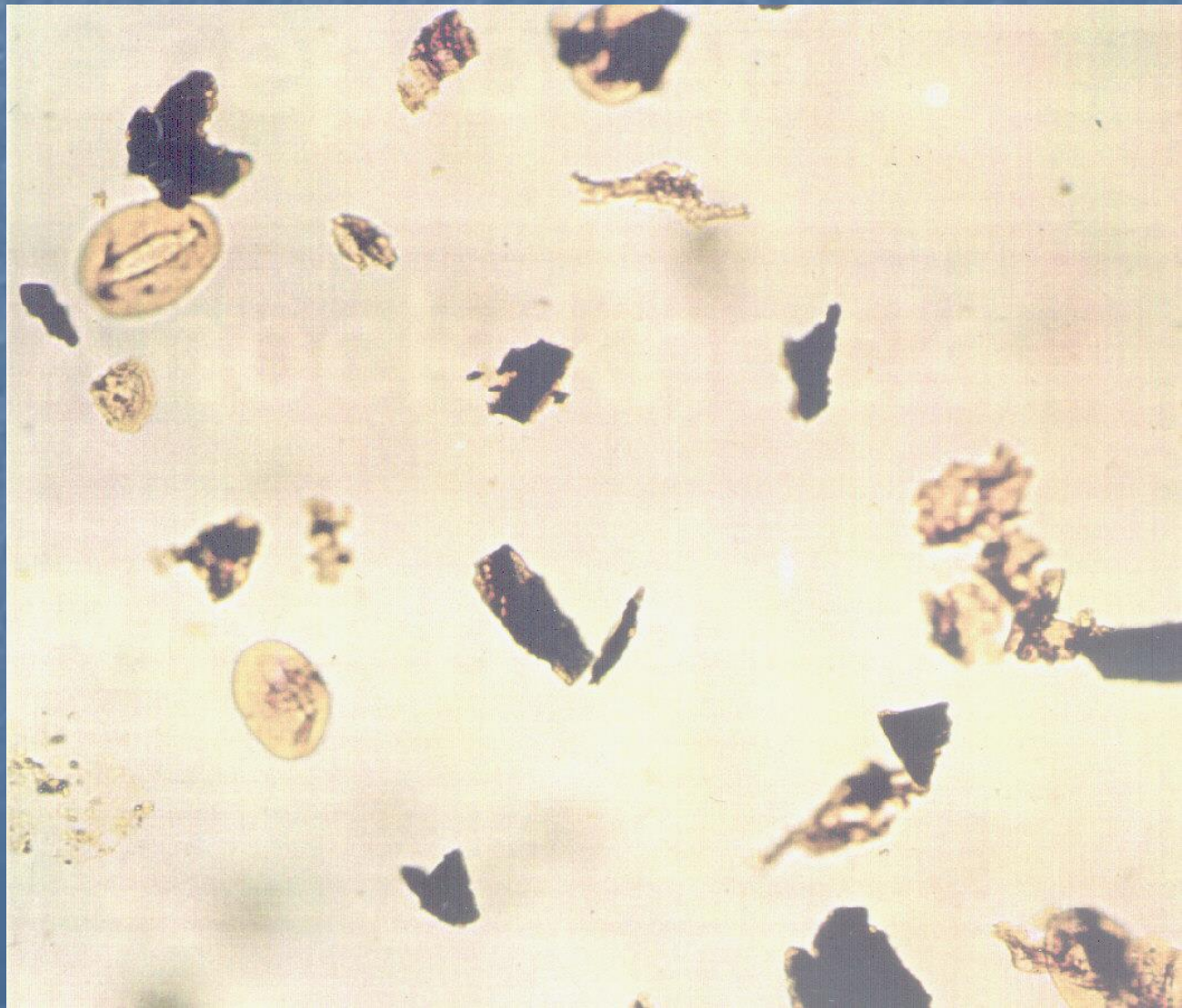
Kerogen transmitted light

Examples of spores attributed with SCI scale value 1.0.

Kerogen transmitted light

Examples of spores attributed with SCI scale value 4.0;

Note other organic debris (vitrinite, semi fusinite, etc.)



Kerogen classification scheme

General type	Liptinitic		Humic		Inertinitic	INDETERMINATE AMORPHOUS
Source potential	Oil-prone		Gas-prone		Inert	
Chemical type	I	II	IIIA		IIIB	
Summary chart code						
Major component classification	LIPTINITE		VITRINITE		INERTINITE	
	AMORPHOUS	EXINITE	AMORPHOUS	STRUCTURED		
Response in UV/ blue light	Fluorescent		Non or weakly fluorescent		Non-fluorescent	
Description and origin	Typical oil-prone, sapropelic kerogen of algal/bacterial origin. Degraded spores, algae	Algae, resin, spores, pollen, cuticle, dinocysts	Amorphous of probable humic origin by gel precipitation or degradation of structured plant tissue	Woody tissues, red-brown becoming black at high maturity	Woody tissues, dark brown to black or opaque	Amorphous kerogen of all types at high maturity
Miscellaneous 'kerogen' components in approximately equivalent categories	Soft bitumens. Grease contamination		Solid bitumen, brown, often with crystal imprints	Microforaminifera tests, chitinozoa, graptolitic fragments, spores etc. at high maturity	Solid bitumen, black or opaque	
NPD guidelines equivalent category	AM - FA	HE,AL	AM - HA	WO	CO	
Mud additives	Additives may fall into all categories					

Image analysis and automation of the geochemists organic petrographic requirements.

The challenge:

- Kerogen classification;

Needs the ability to correctly recognise and ascribe the different components when their apparent colour density is changing as a result of increasing maturation

- Reflectance measurement;

Select the 'right' material to measure and do so with the full measuring area being over the selected organic fragment and without measuring the scratches!

Image analysis and automation of the geochemists organic petrographic requirements.

Competent geochemist/microscopists are almost as rare as hen's teeth!

The data generated are highly subjective so competent microscopists will still be needed to verify the results.

However, automation would remove the grunt work in generating the data in the first place and enable the specialist to concentrate on QC'ing the results and uploading data with confidence.