Palynofacies Analysis for Beginners: A Simplified Guide

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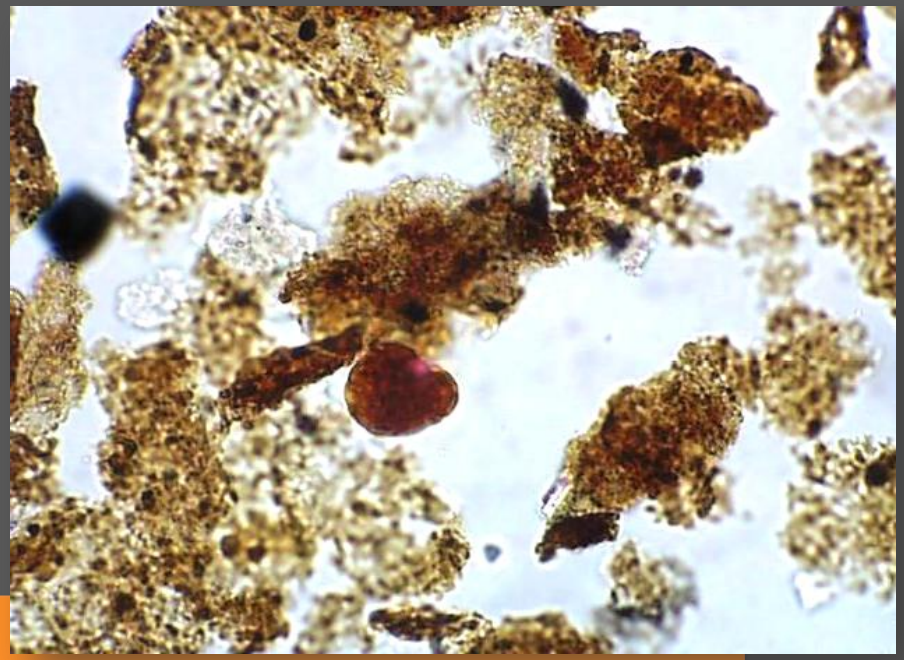
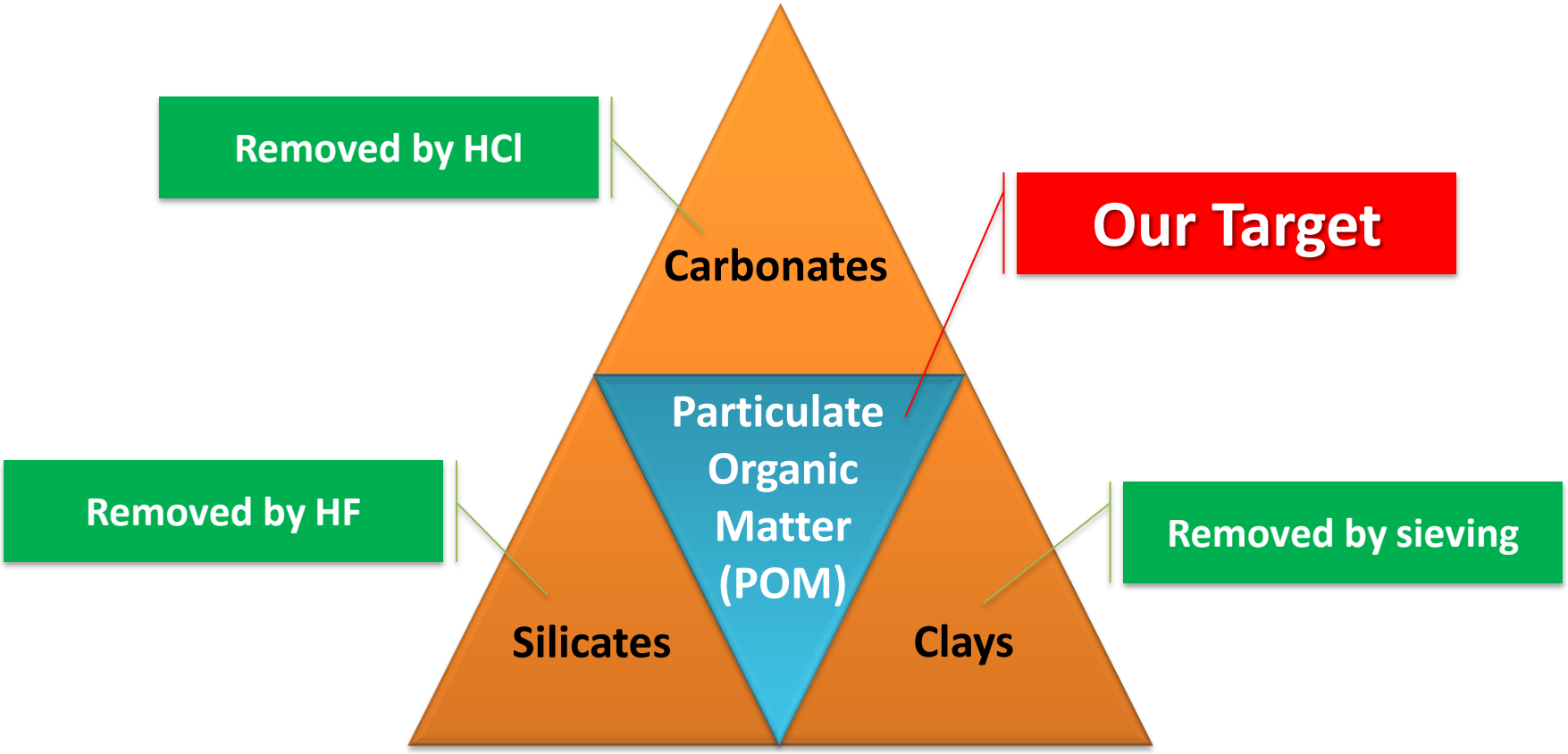
Fossil Organic Matter



Kerogen is a term commonly used to refer to the preserved *Fossil Organic Matter* in sedimentary rocks. In a palynological sense, kerogen refers to the dispersed particulate organic matter (POM) contained in sedimentary rocks that are resistant to the palynological extraction techniques (including treatment with the inorganic acids HCl and HF)

Sample preparation for palynological analysis



Major components of a sediment/sedimentary rock sample

Steps of work…

1- Crushing the sample in a mortar to the powder size

2- Transferring the crushed powder into a Nalgene plastic beaker that is resistant to high temperature

3- Conc. HCl treatment

4- Washing and neutralization

5- Conc. HF treatment

6- Washing and neutralization

Agate mortar and pestle

Porcelain mortar and pestle

Nalgene beakers

7- Conc. HCl treatment

8- Washing and neutralization

9- Sieving the sample in a 125 µm brass sieve and collecting the residue in a 5-15 µm nylon sieve

10- Making permanent kerogen slides
(containing all POM present in the sample)

11- Oxidation if necessary

12- Making permanent oxidized slides
(containing only the palynomorph fraction of the POM)

Brass sieve

Palynological analysis includes two major branches:

1) Palynofacies (kerogen) analysis, studying all the existing POM in the sedimentary rocks (including palynomorphs)

2) Palynomorph analysis, studying only the palynomorph portion out of the whole POM present in the sedimentary rocks

Major Kerogen Categories

1- Palynomorphs (all discrete HCl- and HF-resistant organic-walled microfossils. E.g., spores, pollen, dinoflagellates, etc.)

2- Phytoclasts (all structured, yellow to brown, dispersed silt- to fine sand-sized particles of plant-derived kerogen other than palynomorphs)

3- Opaques (all structured brownish-black to black oxidized or carbonized particles of plant-derived kerogen)

4- Amorphous organic matter (AOM) (all structureless dispersed silt- to fine sand- sized particles of kerogen, whether of marine or non-marine origin)

CATEGORY		SOURCE	CONSTITUENT	MACERAL GROUP	MACERAL	
STRUCTURED	Zooclasts	Zooplankton and Zoobenthos	Graptolite debris Arthropod debris	Faunal relics		
	Palynomorphs	Zoomorphs	Scolecodonts Tectin foraminiferal linings Chitinozoa			
		Organic-walled Phytoplankton (including meroplankton)	Prasinophyte phycomata	Liptinite or Exinite	Telalginite	
			Chroococcale cyanobacteria			
			Chlorococcales: Botryococcales Hydrodictyales			
			Dinocysts Acritarchs Rhodophyte spores		Lamalginite (pars)	
		Sporomorphs	Miospores: microspores pollen Megaspores		*Sporinite:* tenui crassi	
	Phytoclasts	Macrophyte plant debris	Cuticle/epidermal tissue		Cutinite	
			Cortex tissues	Vitrinite or Huminite	Telinite	
			Secondary xylem (wood)			
			Charcoal Biochemically oxidized wood	Inertinite	Pyrofusinite Degradofusinite	
		Fungal debris	Hyphae		Sclerotinite	
STRUCTURELESS	Amorphous ('AOM')	Higher plant secretions	Intra-/exta-cellular resins	Liptinite or Exinite	Resinite	
		Flocs	Organic aggregates and Faecal pellets		Bituminite Fluoramorphinite Liptodetrinite	
		Phytoplankton				
		Bacteria	Cyanobacteria/Thiobacteria		Lamalginite	
		Higher plant decomposition products	Humic cell-filling precipitates Humic extracellular precipitates	Vitrinite or Huminite	Collinite Hebamorphinite	?

Figure 20.1 Correlation of published kerogen terminology, also indicating biological so

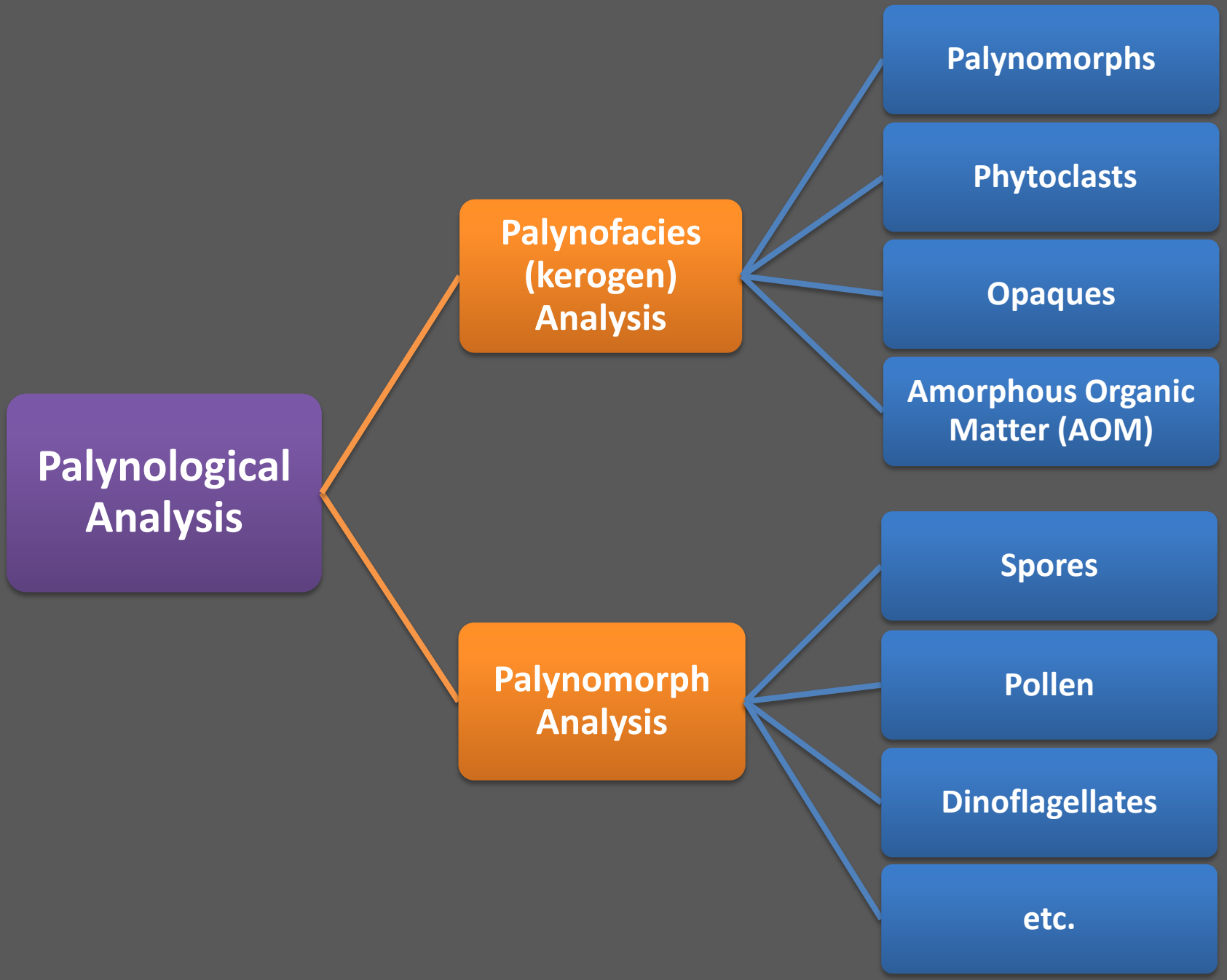
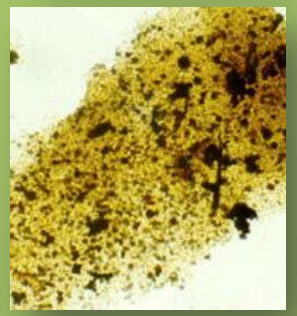
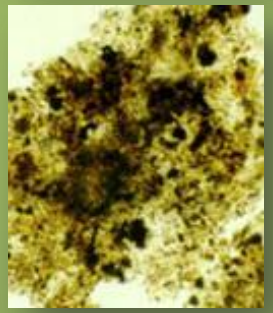
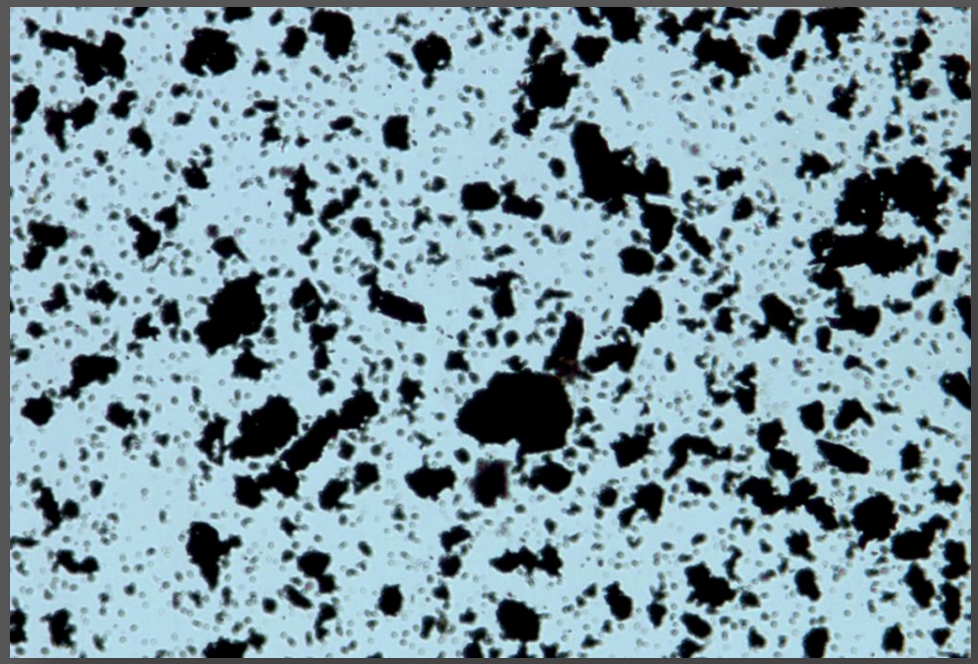

Palynological Analysis
Palynofacies (kerogen) Analysis
Palynomorphs
Phytoclasts
Opaques
Amorphous Organic Matter (AOM)
Palynomorph Analysis
Spores
Pollen
Dinoflagellates
etc.

Image Examples of Kerogen Particles

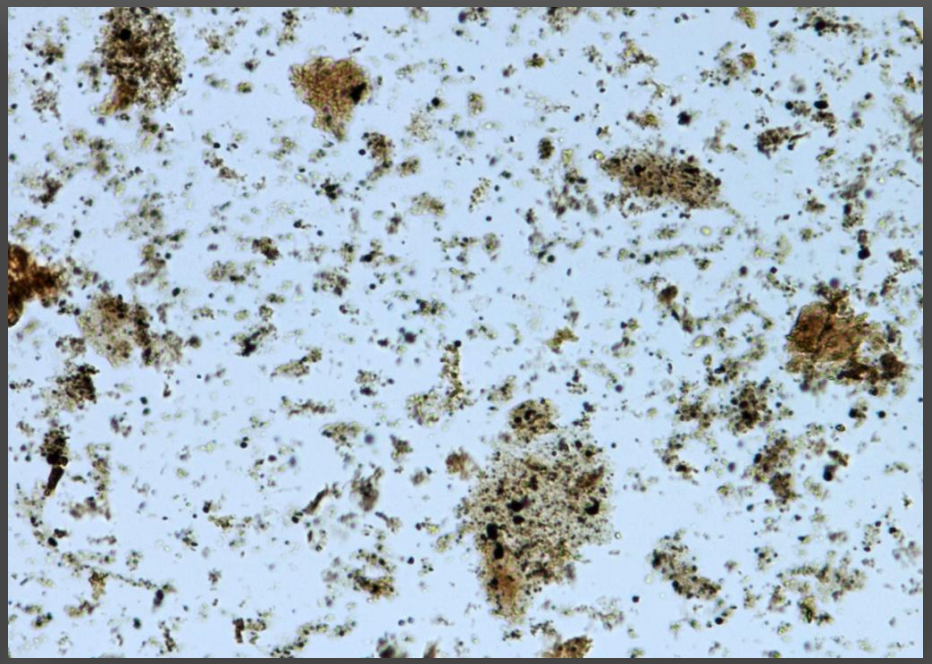
Palynomorphs	Phytoclasts	Opaques	AOM
			
			
			

Kerogen Types and Source Rock Determination

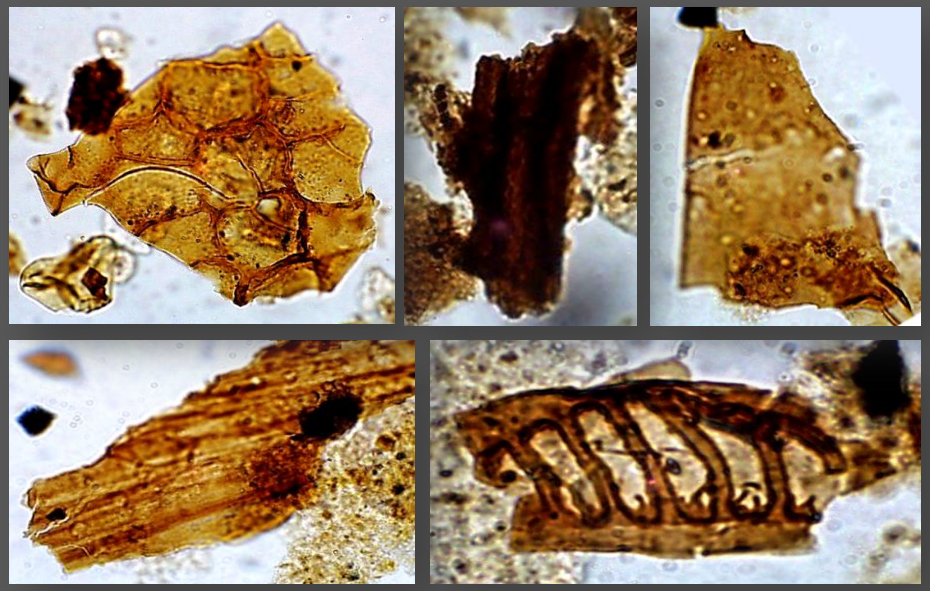
Kerogen Type	Characteristics	Source Rock Indication
I	Almost entirely AOM	Highly oil-prone
II	Mainly AOM; minor other kerogen particles present	Oil-prone
III	Mainly phytoclasts; minor other kerogen particles present	Gas-prone
IV	Mainly opaques; minor other kerogen particles present	Inert material



Kerogen type IV: Inert material



Kerogen type I: Highly oil-prone



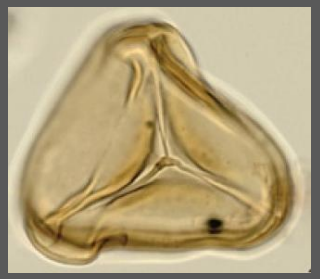
Kerogen type III: Gas-prone

Organic Thermal Maturation

Palynomorphs exine (wall) colors can be used to determine the thermal maturation level of their enclosing source rocks

Certain palynomorphs (e.g., bisaccate pollen and psilate spores) tend to become darker with increasing thermal maturation

Pearson's (1984) pollen/spore color "standard" provides an easy way for routine source rock thermal history evaluations



ORGANIC THERMAL MATURITY	COLOR OF FOSSIL SPORES/ POLLEN	MUNSELL PROD. NO.	APPROXIMATE CORRELATION TO OTHER SCALES	
			TAI = 1-5	VITRINITE REFLECT-ANCE
IMMATURE		17,391	1	0.2%
		20,520	1+	
		19,688	2-	0.3%
		14,253	2	
MATURE MAIN PHASE OF LIQUID PETROLEUM GENERATION		13,800	2+	0.5%
		12,424	3-	.9%
		15,816	3	
		17,209	3+	1.3%
DRY GAS OR BARREN		15,814A	4-	2.0%
		19,365	4	2.5%
			(5)	
	BLACK & DEFORMED			

Pearson's (1984) pollen/spore color "standard" correlated with other thermal maturation scales (After Traverse, 1988)

References

Pearson, D.L., 1984. Pollen/Spore Colour ‘‘Standard’’, Version 2. Phillips Petroleum Company, Privately Distributed.

Traverse, A., 1988. Paleopalynology. Unwin Hyman, Boston, 600 p.