

WELLSITE GEOLOGY

SPEAKER: MEDET JUNUSSOV

# Topic:

# Wellsite Biostratigraphy and Wellsite Geochemistry

Photo by author from the well of Tasbulat 324 in Aktau, Kazakhstan



# Biostratigraphy

Content

1. Introduction
2. Aspect and Principle
3. Application
4. Practical experiment
5. Discussion

Photo by author from the well of Tasbulat 324 in Aktau, Kazakhstan

# INTRODUCTION

**Biostratigraphy**

**is the branch of STRATIGRAPHY which**

**- detects relative ages to sediments using the FOSSILs contained within them.**

**- Information from fossils can also be used to infer environments of deposition.**

# Geological time

- **Relative time** determination is based on the vertical position of fossils within the stratigraphic column.
- **Absolute time** is obtained by radiometric dating methods, and is expressed in years.

# INTRODUCTION

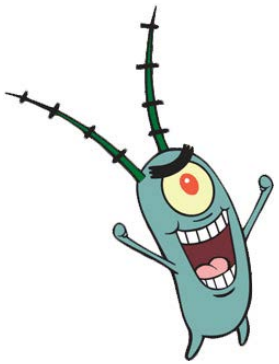
**Biostratigraphy is a sub-discipline of paleontology that relies on:**

1. **The physical zonation of biota in time and space,**

2. **The order to establish the relative stratigraphic position (i.e. older, younger, same age) of sedimentary rocks in different geographic localities.**

# INTRODUCTION

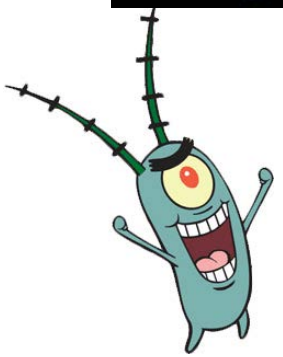


Plankton
(copepod/crustacean)

# INTRODUCTION



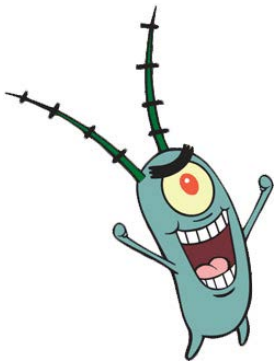


ZooPlankton

# INTRODUCTION



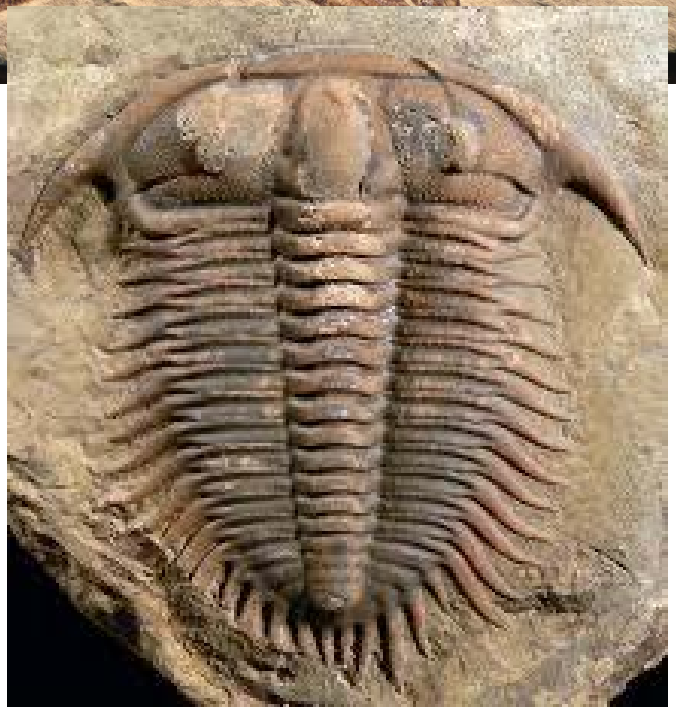
Ammonites
(nectonic)

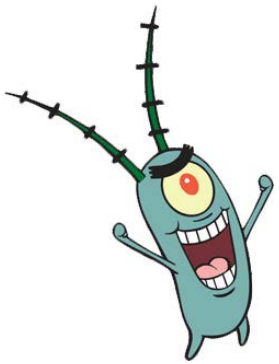


# INTRODUCTION







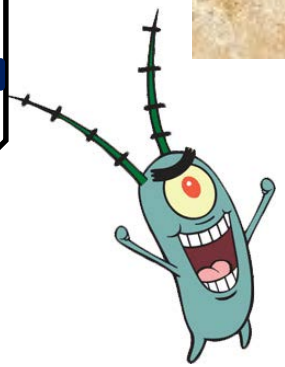


FOSSILS

# INTRODUCTION



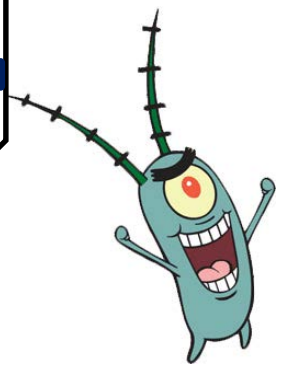
FISH



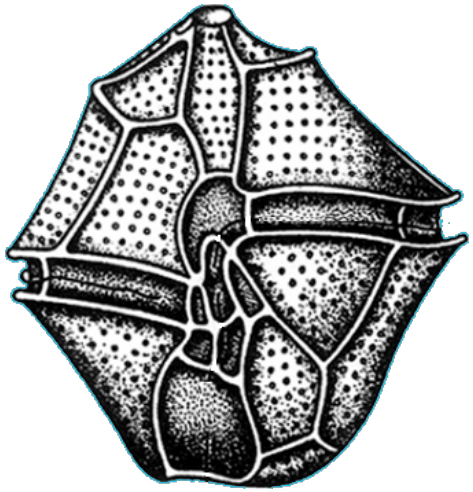
# Aspect and Principle

## Useful scientific disciplines in biostratigraphy

1. Micropaleontology
2. Nannopalaeontology
3. Palynology



# Aspect and Principle



**Dinoflagellate (algae)**

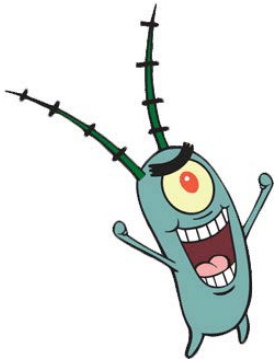


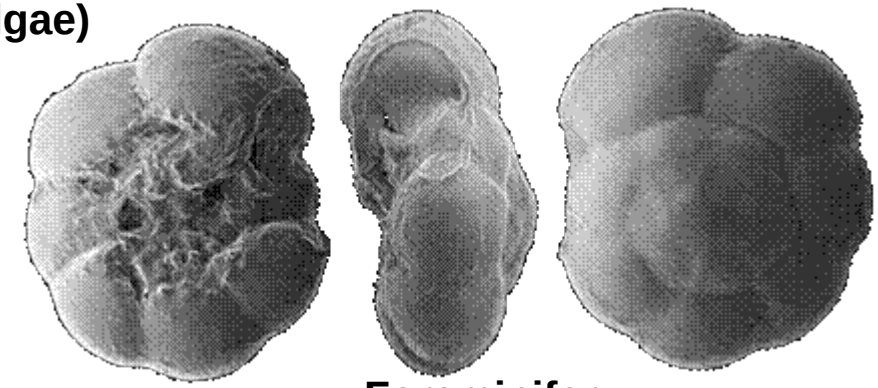
**Diatom**

( **algae, the house is made of glass**



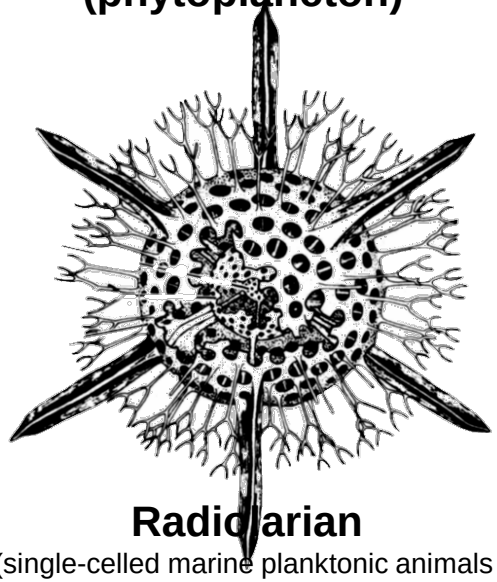
**Coccosphere (phytoplancton)**





**Foraminifer**

**(single-celled organisms with calcareous shell)**

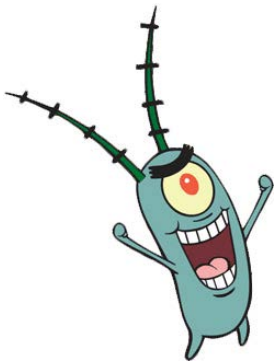


**Radiolarian**

(single-celled marine planktonic animals that secrete an opal skeleton)

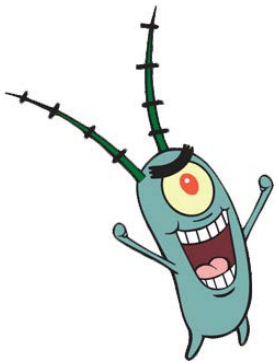
# Aspect and Principle

**Micropaleontology is the branch of palaeontology that studies microfossils, or fossils that require the use of a microscope to see the organism, its morphology and its characteristics details.**



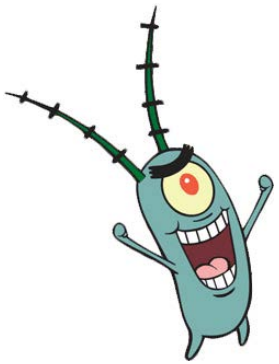
# Aspect and Principle

**Microfossils are fossils that are generally between 0.001 mm and 1 mm in size, the study of which requires the use of light or electron microscope. Fossils which can be studied with the naked eye or low-powered magnification, such as a hand lens, are referred to as macrofossils.**



# Aspect and Principle

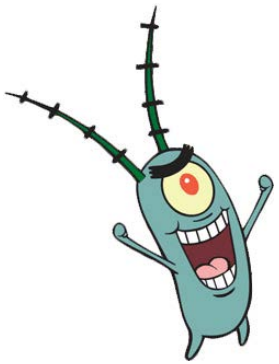
**Microfossils are a common feature of the geological record, from the Precambrian to the Holocene. They are most common in deposits of marine environments, but also occur in brackish water, fresh water and terrestrial sedimentary deposits.**



# Aspect and Principle

**Based on the mineral composition of the fossils used in micropaleontology four areas an be distinguished:**

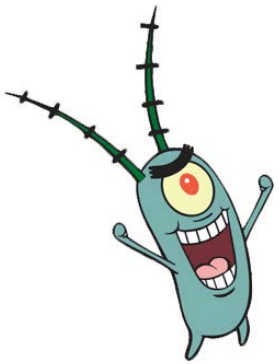
1. **Calcareous microfossils**
2. **Phosphatic microfossils**
3. **Siliceous microfossils**
4. **Organic microfossils**



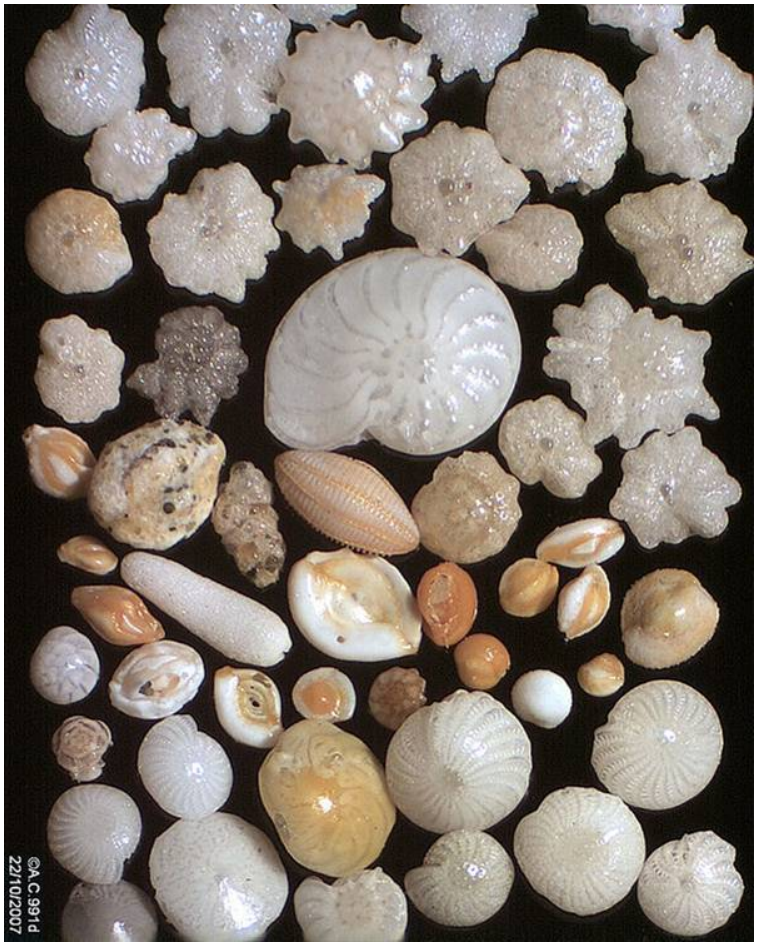
# Aspect and Principle

**Micropaleontology can be roughly divided into four areas of study on the basis of microfossil composition:**

**1. Calcareous ($CaCO_3$) microfossils include foraminifers, and ostracods (seed shrimp).**



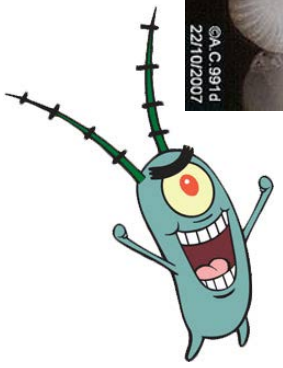
# Aspect and Principle




## 1.2 Foraminifera

typically produce a shell, which is commonly made of calcium carbonate.

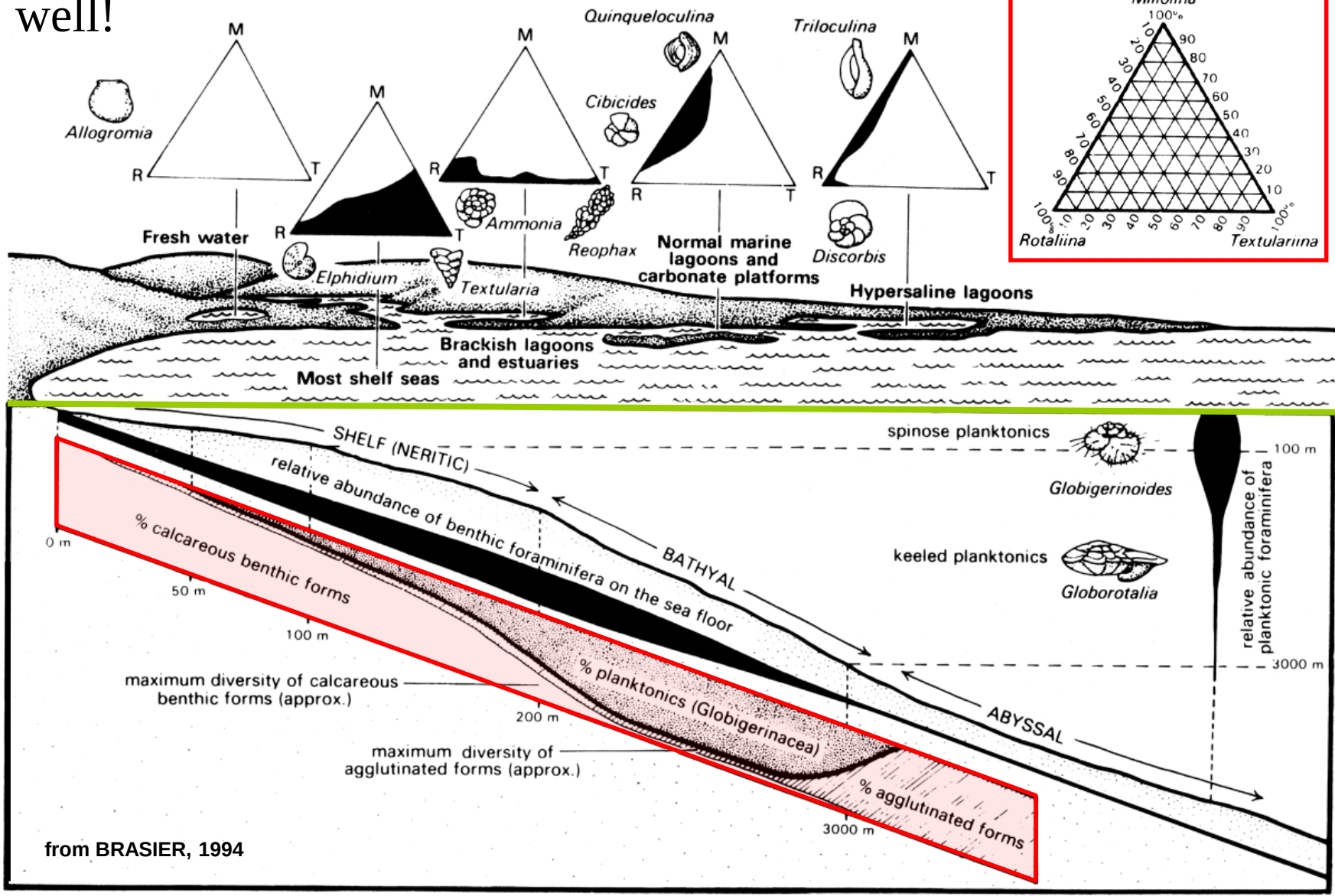
Over 50,000 species are recognized, both living (10,000) and fossil (40,000). They are usually less than 1 mm in size, but some are much larger, the largest species reaching up to 20 cm.





# Aspect and Principle

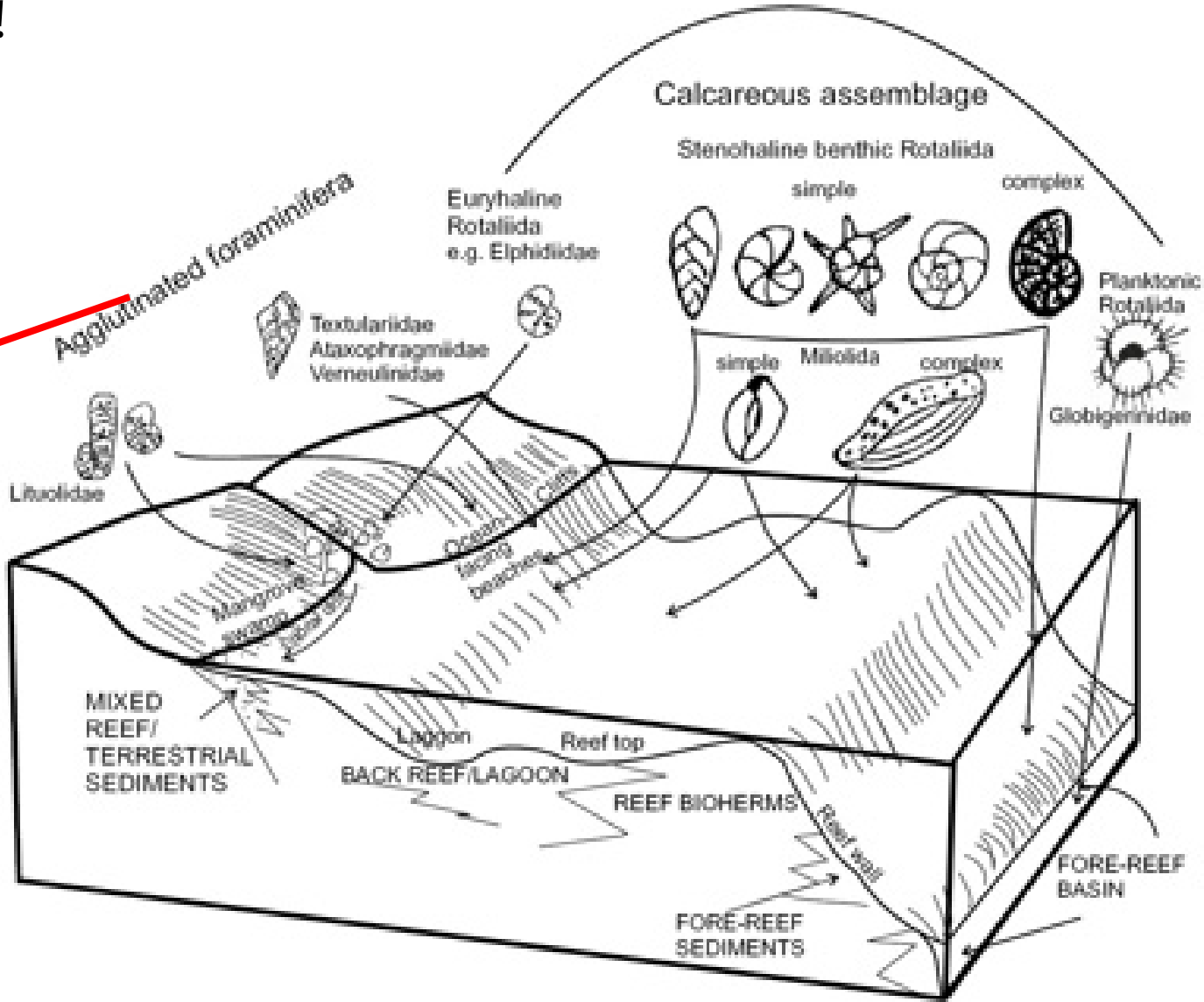
**1.2 Foraminifera** are environment-indicators as well!



# Aspect and Principle

**1.2 Foraminifera** are environment-indicators as well!



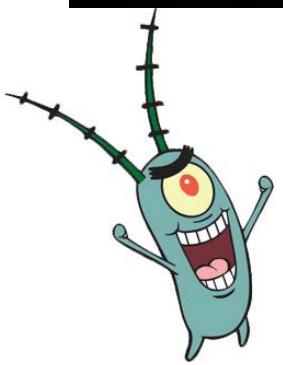


# Aspect and Principle

**1.3 Ostracods are** sometimes known as **seed shrimp**. Some 70,000 species have been identified.



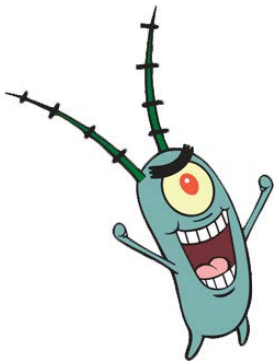




# Aspect and Principle

## 2. Phosphatic microfossils

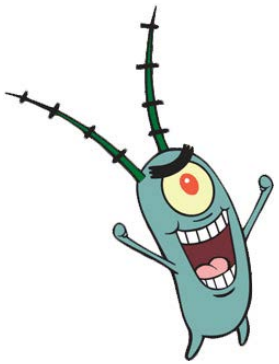
**Phosphatic microfossils include conodonts (tiny teeth like fossils of an extinct chordate group), some scolecodonts ("worm" jaws), Shark spines and teeth, and other Fish remains (collectively called "ichthyoliths").**

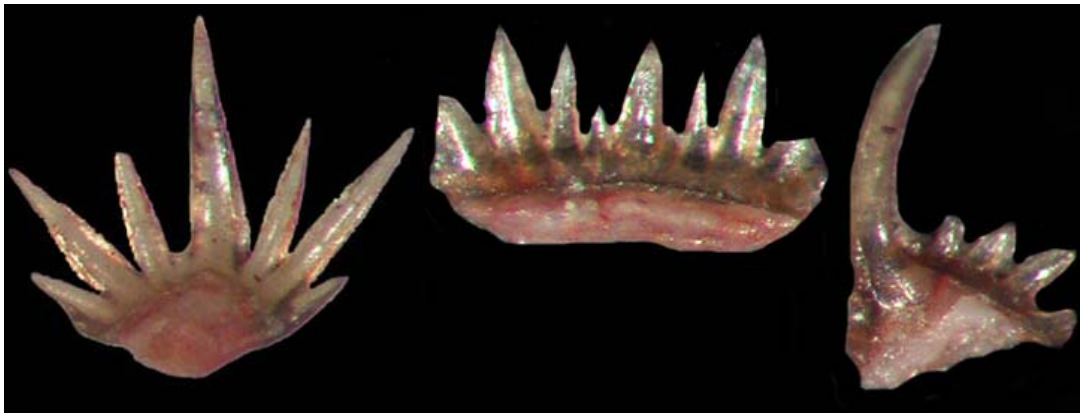


# Aspect and Principle



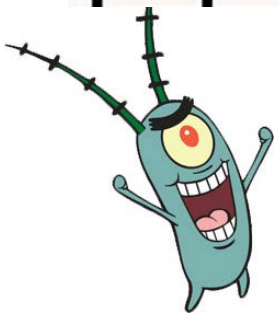
**2.1 Conodonts** (Greek *kōnos*, "cone", + *odont*, "tooth") . The conodonts first appeared during the Cambrian Stage. The organisms range from one centimeter up to 40 cm in length.





# Aspect and Principle



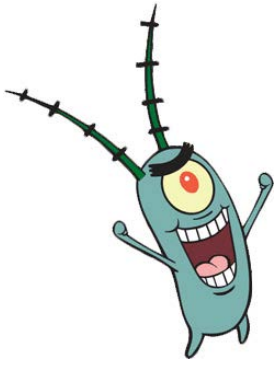
**Shark teeth**

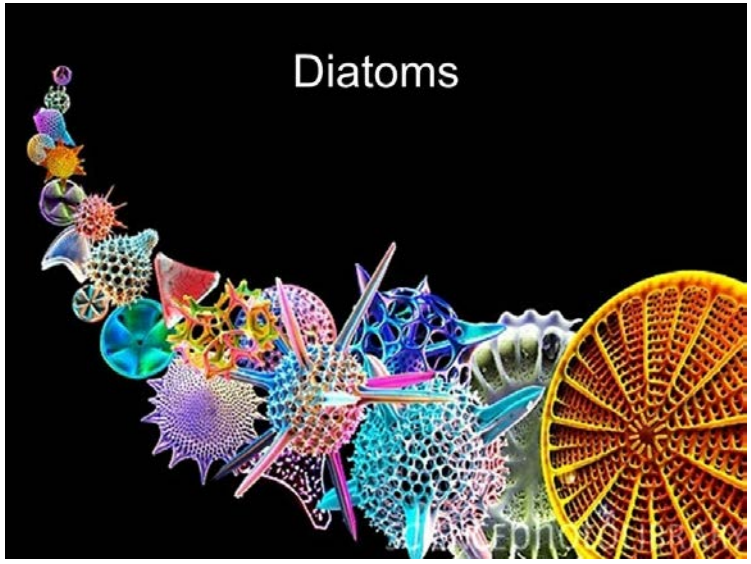
# Aspect and Principle

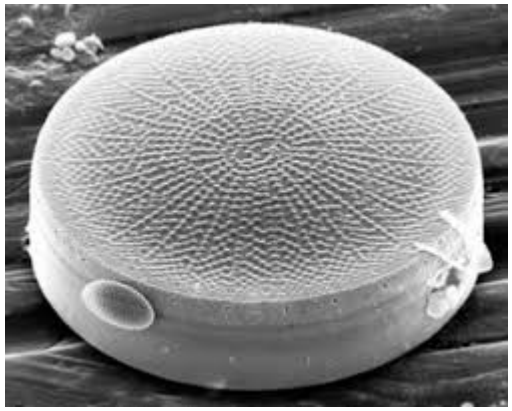
## 3. Siliceous microfossils

**Siliceous microfossils include diatoms and radiolarians.**

**Diatoms** are a major group of microalgae, and are among the most common types of phytoplankton. Though most are microscopic, some species of diatoms can reach up to 2 mm in length.



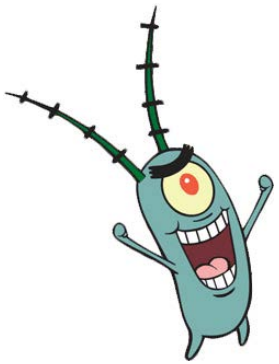


# Aspect and Principle

**Palynology** is the study of organic-walled fossils including pollen, spores and marine microplankton.

**Study size:** they are usually between 5 and 100 µm in size and in most cases consists of sporopollenin, a compound very resistant to decay.

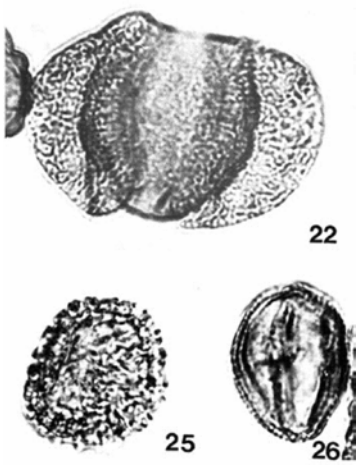


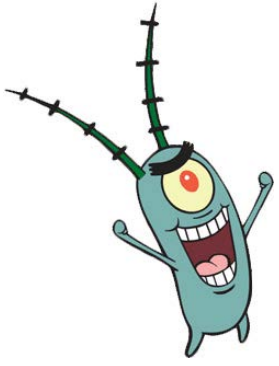
# Aspect and Principle

## 4. Organic microfossils (Palynology)

include pollen, spores.

**Pollen** grains are produced by seed plants and are very small in size.





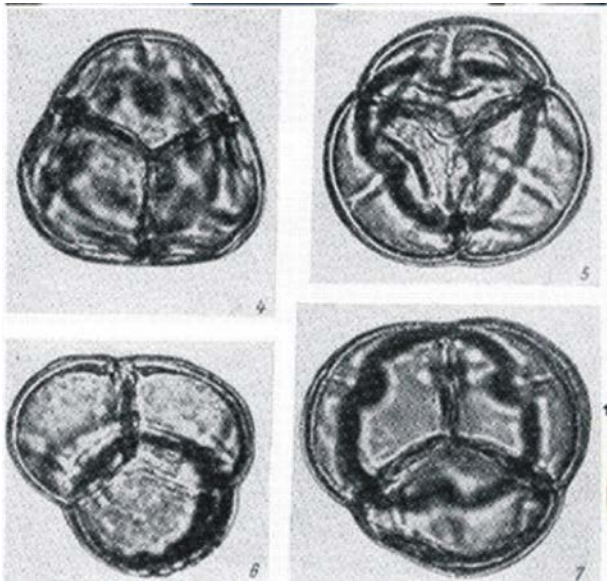


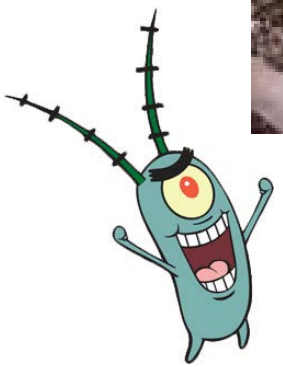
# Aspect and Principle

**Spores** form part of the life cycles of many plants, algae and fungi.



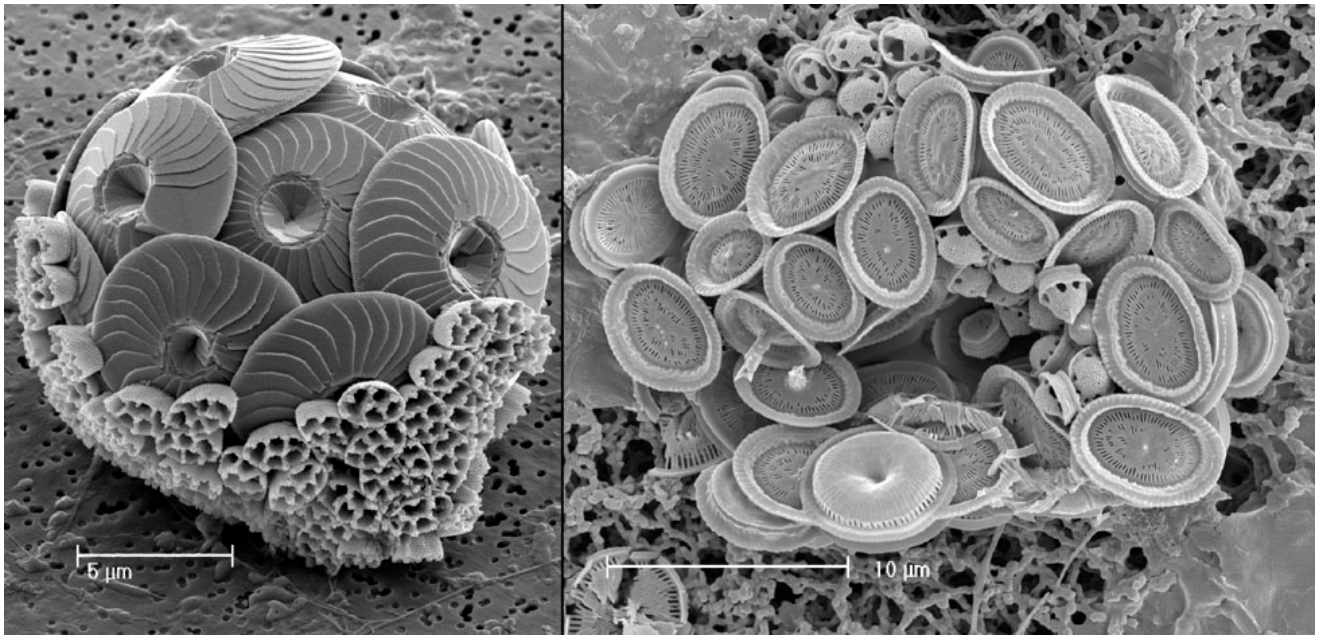


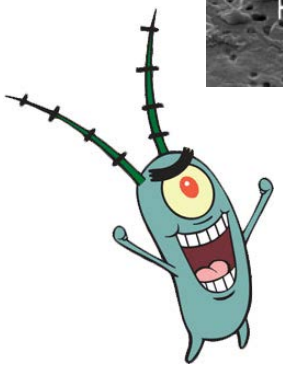


# Aspect and Principle

## 2. Nannopalaeontology




Coccospheres

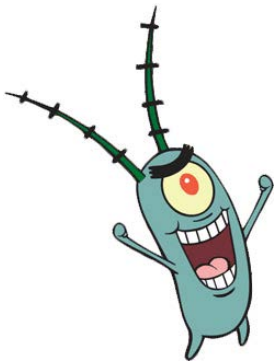


# Aspect and Principle

**Nannopalaeontology** is the study of the calcite skeletons of single-celled marine planktonic algae.

**Size:** less than 30 µm in diameter, single coccoliths are usually between 5 and 10 µm.

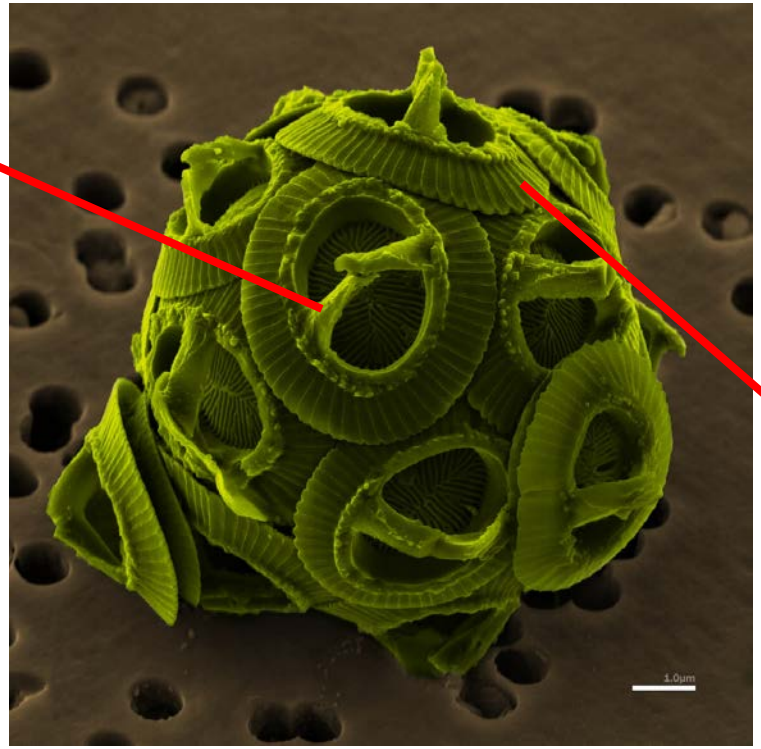
**Study use:** They are very easily extracted from sediments and are very abundant in calcareous marine sediments.



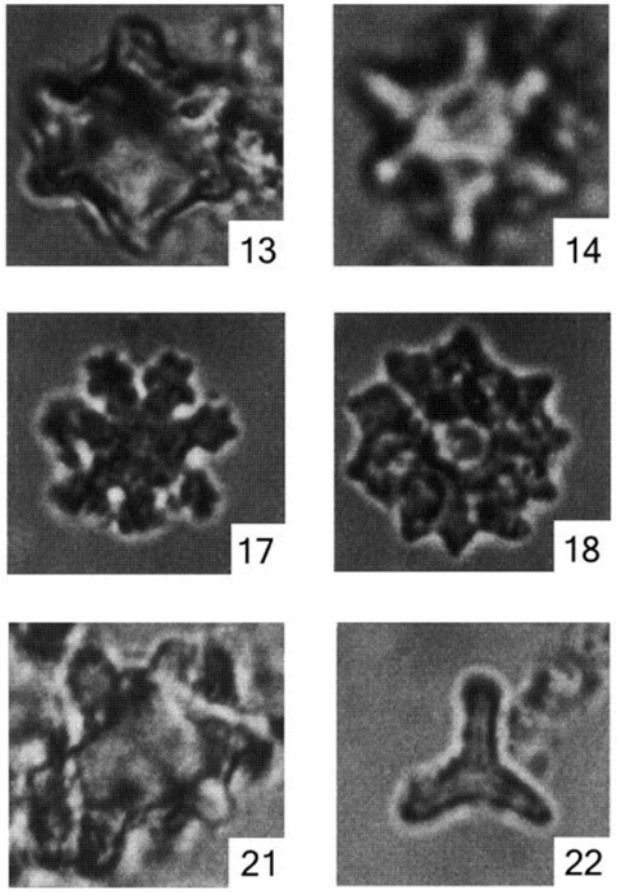
# Aspect and Principle

**1.1 Coccoliths** are individual plates of a coccosphere and consist of calcium carbonate.

coccolith



**nannoplakton**

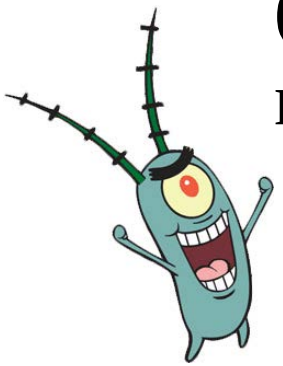


# Aspect and Principle

In the oil industry, biostratigraphy is usually based on micropalaeontology.

Which is the recovery and identification of microfossils which are sufficiently small to survive the drilling process.

The most important microfossil groups are both organic (spores and pollen) and inorganic (foraminifera, ostracods, conodonts, calcareous nannoplankton).

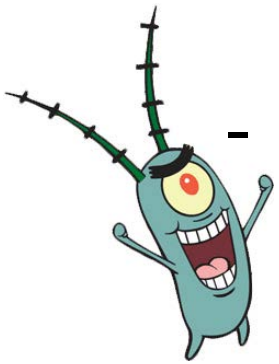


# Aspect and Principle

Microfossil extraction requires laboratory processing and identification of the recovered specimens by microscopic examination.

Microfossils

- often occur in high abundance, even in small well samples (cuttings),
- can occur in palaeoenvironments ranging from freshwater to deep marine,
- occur in sediments ranging in age from Palaeozoic to present day.

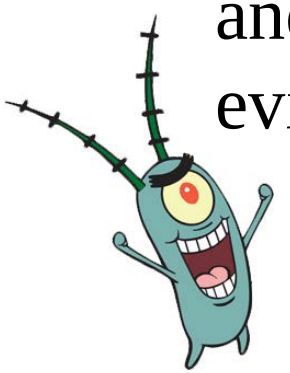


# Aspect and Principle

## Eye for Detail (study experince):

1. A micropalaeontologist needs good observational skills with a keen eye for accurate identification of often less than ideally preserved fossils

2. The ability to recognise an **evolutionary succession** of species. This is the basis of biozonation schemes that are used to subdivide and correlate rock successions and provide evidence of age.



# Aspect and Principle

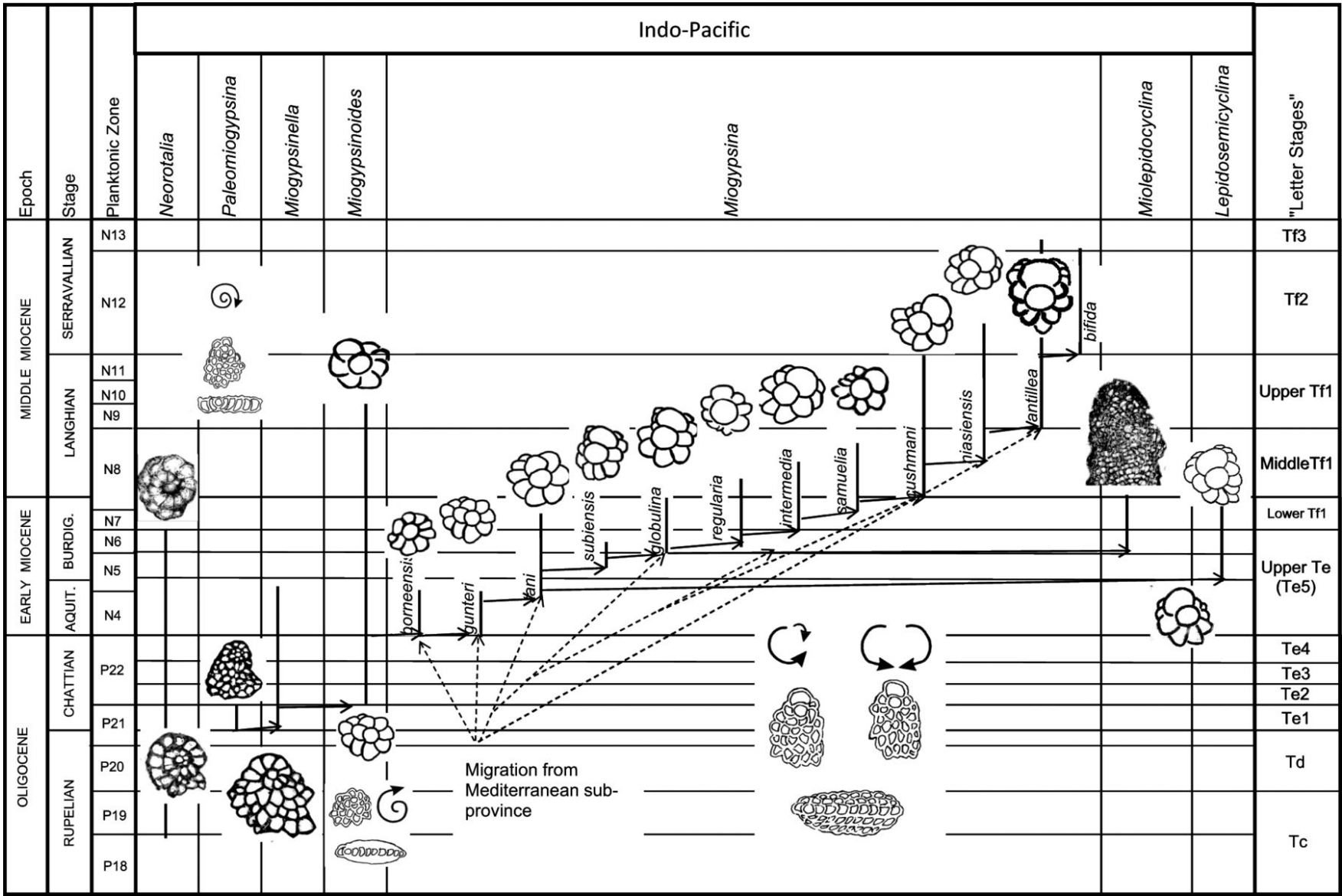
## Index fossils

**Indexfossils must be**

- easily recognisable,
- geographically widespred
- and short lived.

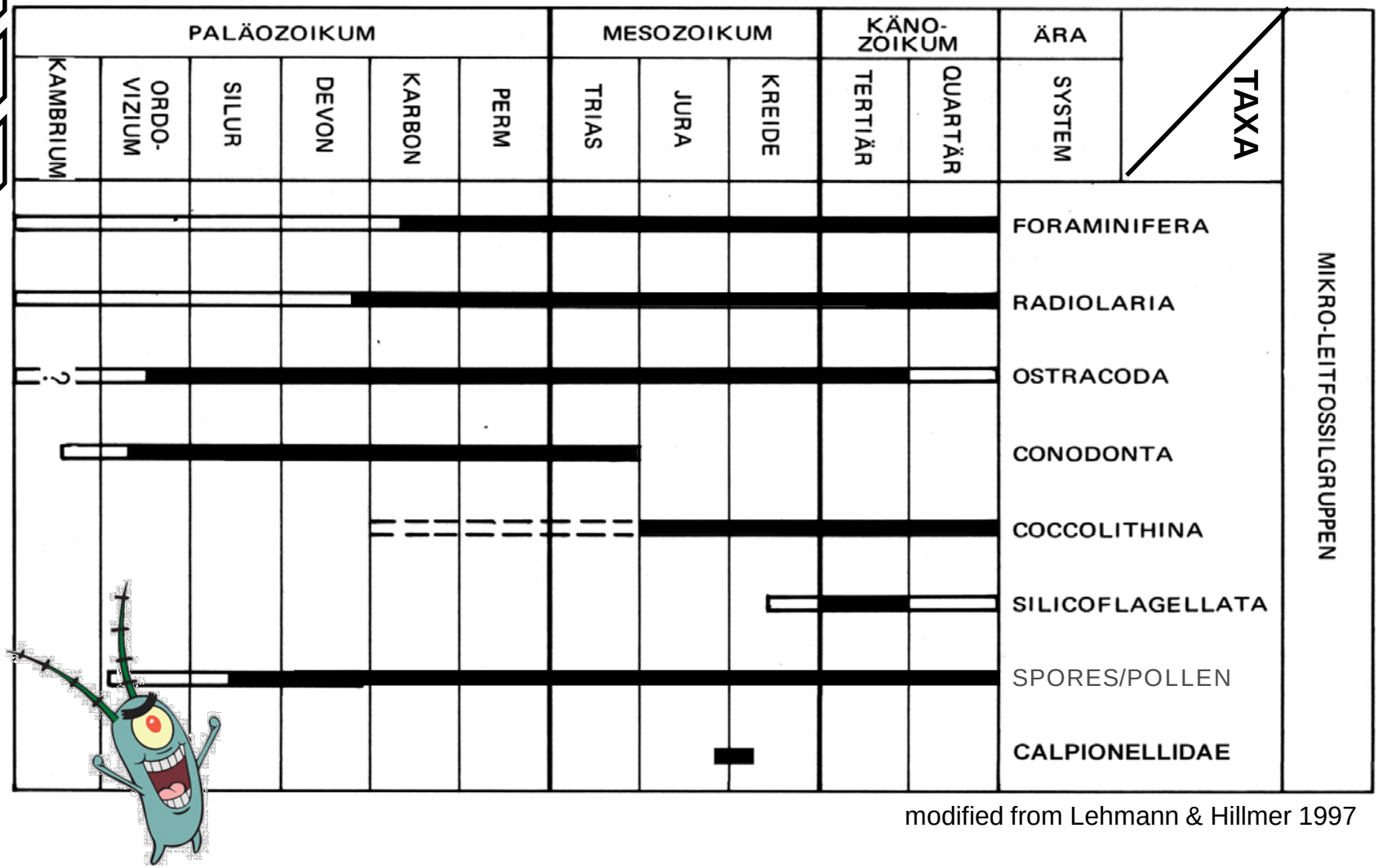
# Aspect and Principle

## Index fossils



# Aspect and Principle

## index fossil groups

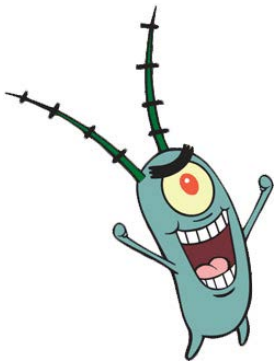



modified from Lehmann & Hillmer 1997

# Application for well site

Biostratigraphers are often asked to work at the well site to support operational decisions while drilling:

- by **monitoring the biostratigraphic succession** while drilling,
- with a prior knowledge of the successions in nearby offset wells,
- it is possible **to predict what will be encountered ahead of the drill bit**;
- this can **aid the setting of casing points** (e.g. above high pressure formations)

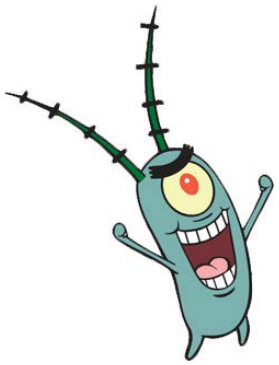


# Application for well site

Well site biostratigraphy can also guide horizontal drilling (“biosteering”),

- whereby knowledge of the expected microfossil assemblages within, above, and below a reservoir can help **steer the drill bit within a thin reservoir layer,**
- find faults not visible on seismic.

It can therefore be cost-effective to have a biostratigrapher at the well site as these techniques can save considerable drilling time and costs.

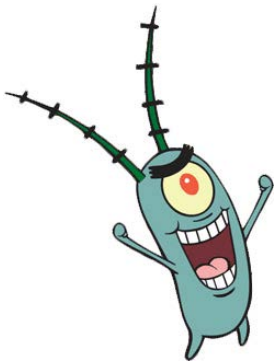


A horizontal well **allows successful development of smaller discoveries** with one well, which has all together higher production than numerous traditional vertical wells.

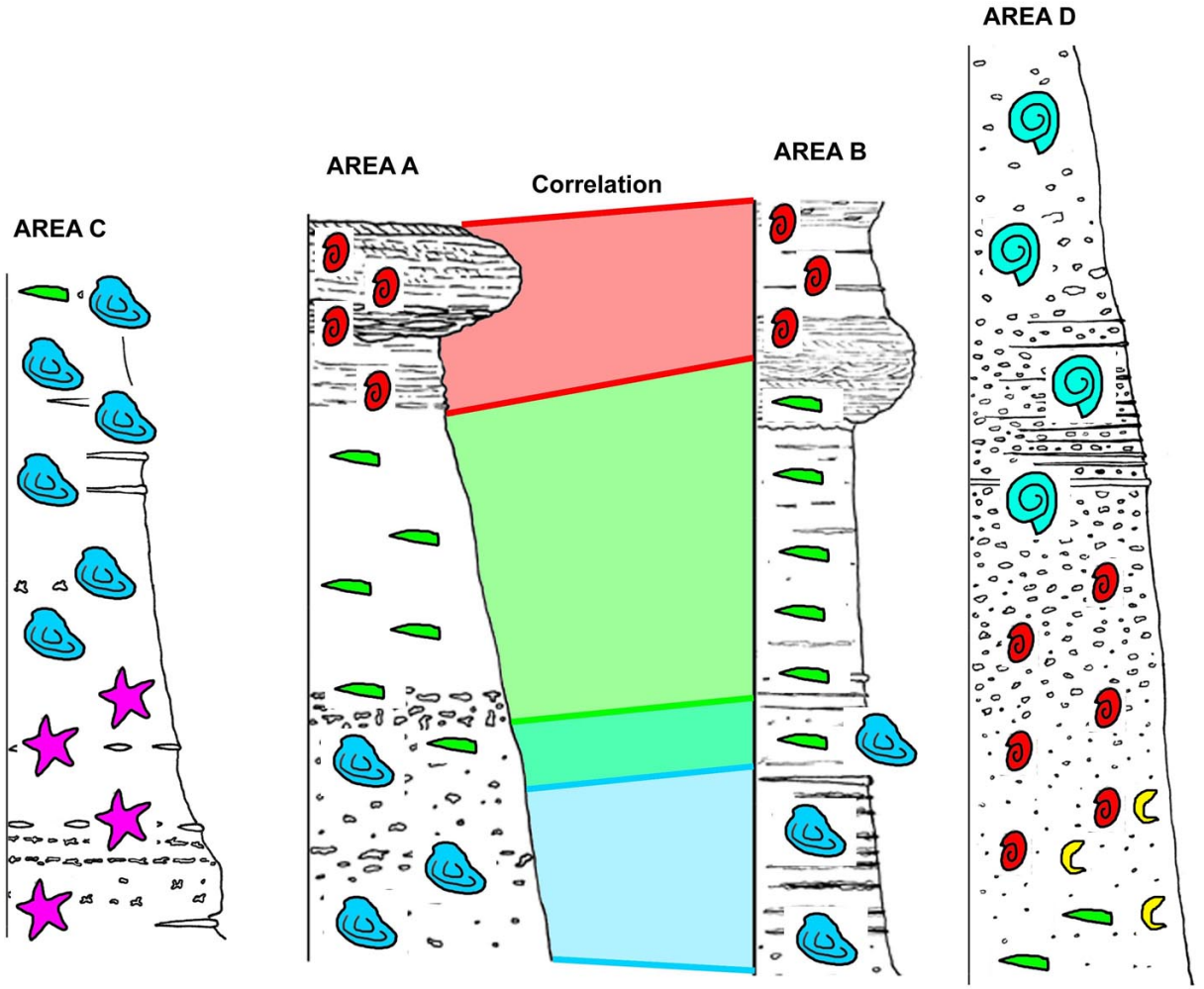
# Application for well site

**Well Correlations & Legacy Data Sets**

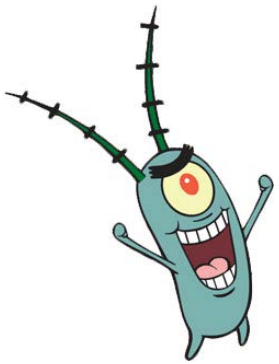
Much of a stratigrapher's work, however, is undertaken in the office, where one of the key tasks is **correlating 'tops'**, **the upper boundaries of formations** and key biostratigraphic markers between wells.



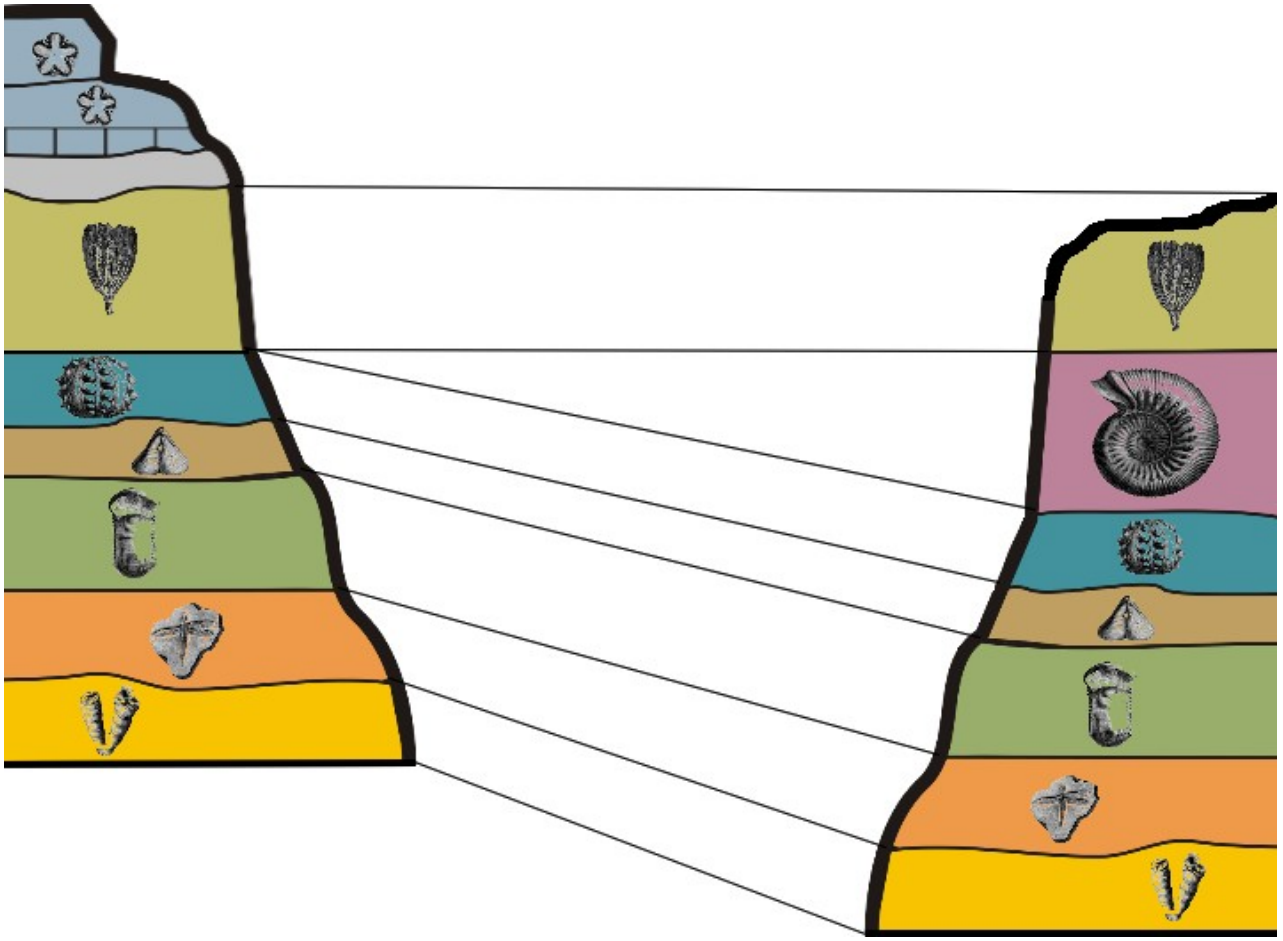
# Application for well site

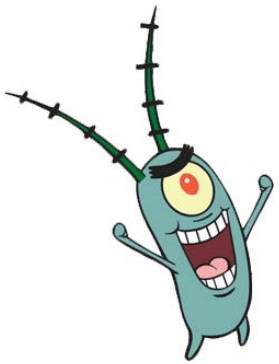



**Biostratigraphy correlation**



# Application for well site



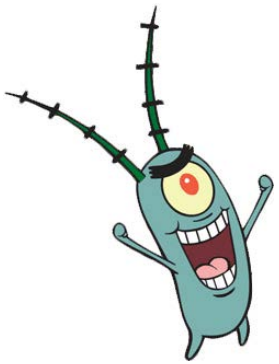


**Biostratigraphy correlation**

# Application for well site

One of the prime aims of defining the tops of different formations is to **identify the key seismic horizons.** It is important for any block or regional evaluation that **the stratigraphic control is consistent across the whole interpreted data set.**

- A further key role of stratigraphy is in **basin modelling**, a knowledge of the geological **history, geological time scale, the breaks in deposition, and timing of major tectonic events, such as burial and uplift**.

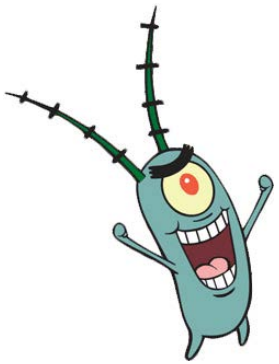


# Discussion

Integration of the results of biostratigraphy with other aspects of hydrocarbon exploitation:

- **- Stratigraphic interpretations can be extrapolated away from wells via seismic interpretation**
- - Providing **age control for geochemical basin modelling**,
- **- Detailed reservoir zonation** and correlation help field development.

Stratigraphy is a fundamental tool in the explorationist's toolkit.



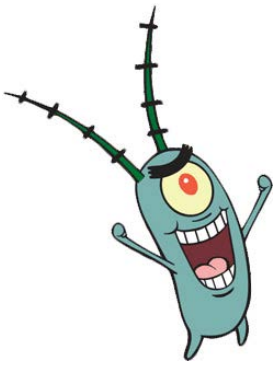
# Discussion

Real time well site biostratigraphy monitors the stratigraphic compositon of the drilled wells,

- advising if **the well is conforming to or deviating from predicted stratigraphy**,
- including **determining if Total Depth** criteria have been met.
- It is **the only technology that can provide age information at the wellsite**.

**New technology** now makes it possible **to do well site biostratigraphy remotely.**

An **automatic microscope** has been developed that can scan and photograph nannofossil and palynology slides at a quality almost indistinguishable from conventional microscopy. A technician present on the wellsite produces slides from cuttings and places them under the microscope, software takes over and scans the slide at several focus levels, compresses the files and transfers the images to the office.



1.1
1.2
1.3
1.4
1.5

# Application for well site

The technology has been used on several wells and provided adequate stratigraphic support.

Remote well site biostratigraphy creates a controlable record.

Development in progress of **automated image recognition** will further speed up analysis and improve accuracy.

1. The software **identifies possible fossil candidates** and cuts them out from the background.
2. Directed shape sorting allows the paleontologist **quickly focus on marker species.**
3. **Statistical counts of abundances and size sorting** of large data sets can be done in seconds.

