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Role of Microfossils Specially Foraminifera in Hydrocarbon Exploration

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Introduction:

Microfossils are perhaps the most important group of all fossils, they are extremely useful in age-dating, correlation and paleoenvironmental reconstruction, all important in the oil, mining, engineering, and environmental industries, as well as in general geology. Billions of dollars have been made on the basis of microfossil studies. Because they usually occur in huge numbers in all kinds of sedimentary rocks, they are the most abundant and most easily accessible fossils.The word fossil has been derived from the Latin word "Fossilium" which literally means anything dugout of the earth. These are recognizable remains of once living plants or animals.

Micropaleontology study of fossil records of micro-organisms for stratigraphical classification and correlation were begun over half a century ago. Micro-organisms, such as, foraminifera, radiolaria, ostrocods, diatoms, pollens and spores, etc. require special diatoms, pollens and spores,etc.require special methods of collection and analysis. Because of these special techniques, micropaleontology is considered as an independent science which has a wide application especially in the exploration of petroleum and natural gas.

The micro-fossils, because of their small sizes, can be collected even from the cores of the bore holes. A large number of microfossils can be collected from a relatively small number of rock samples thus giving a much wider spectrum of data. These microfossils are identified in the laboratory with the help of stereo microscope, petrological microscopes and in special cases electron scan microscopes.

Foraminifera are the most important microfauna for classification and correlation of marine formations. These organisms have a wide geographic distribution and are present in large numbers in many marine rocks. ostrocods (crustacean) are found both in marine and continental formations and they are known to exist since palaeozoic till today.They have been found quite useful for stratigraphic purpose because of their wide distribution and much longer range in geological time.

Spores and pollens are better preserved because of their hard resistant parts. They appear annually in large numbers and they tend to spread over large area on continents, lagoons and marine water due to their agility to flying and floating. How ever, their application in stratigraphy has many limitations. In spite of a large amount of work on the study of pollen and spores from different parts of the world, sometimes it is difficult to identify them even at the generic level. In some cases, the spores and pollens of latter geological periods creep into an already deposited sedimentary rocks through cracks and other opening in rocks.

SYSTEMATICS AND RELATIONSHIPS AMONG MICROFOSSILS:

Micropaleontology continues to be widely used in the exploration and mapping of surface and subsurface stratigraphic units by geological surveys all over the world. The important of using microfossils in age determination and correlation in subsurface water well studies, the microfossils are important as environmental indicators and as biostratigraphic tools. Micropaleontology is generally associated with the petroleum Industry and the application of micropaleontology

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to studies on the geologic history of continental margins and slopes, petroleum and other mineral resources, Micropaleontologists employed by petroleum companies have found the small tests, which commonly can be easily secured from well cuttings and cores, useful for correlating oil-bearing and associated strata.

The practical value of marine microfossils in various fields of historical geology is enhanced by their minute size, abundant occurrence and wide geographic distribution in sediments of all ages and in almost all marine environments. Due to their small size and large numerical abundance relatively small sediment samples can usually yield enough data for the application of more rigorous quantitative methods of analysis. More over most planktonic and many benthic microfossils have wide geographic distributions and comparions and used for paleocenographic reconstructions.

Marine microfossils occur in sediments of Precambrian to Recent ages, and in every part of the stratigraphic column one or more groups can be found useful for biostratigraphic and paleoecological interpretations (Bilal U.Haq and Anne Boersma 1978). Fossil marine organisms lived in almost all the marine environment. ranging from tidal pool to deep sea and can therefore be invaluable in the study of changes in the pale environments.

For instance, Radiolaria, Calcareous Nannoplakton, Petropods, some Foraminifera and Diatoms are planktonic (free floating) and live in abundance from 0-200m. in the open ocean but diminish rapidly near the continents. These forms are useful in monitoring past changes in the oceanic environments, particularly changes in temperature. Other groups such as Ostracodes, Bryozoans and some Foraminifera and Diatoms are Benthic (adopted to living on the bottom of the sea) since these forms exhibit distribution patterns linked to depth, sediment type and various physiochemical variables in seawater, they are useful in delineating changes in bottom environment. Spores and pollen, although derived from land plants are strongly climatic-dependent.

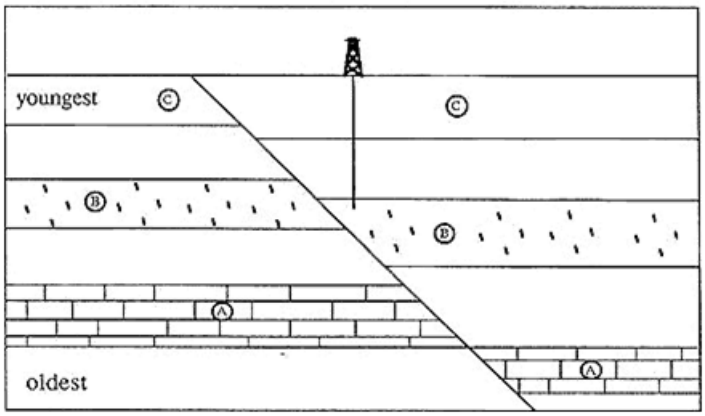
Thus their presence and distribution pattern in nearshore marine sediments allow interpretations on continental climates and their distribution can be used to monitor current movements

Role in Hydrocarbon exploration:

Planktonic foraminfera provide less information concerning the environment of deposition, since they lived floating in the water column; but they have other advantages. Whereas benthic foraminifera are restricted to certain environments, planktonic foraminifera are dispersed over a much broader part of the world oceans and often are found in large numbers. On a geologic time-scale, events such as the first appearance of a given species or its extinction can happen very quickly.

For the paleontologists, these correlate points in time and space across a depositional basin (like the Gulf of Mexico) or even across whole oceans. However, local conditions may exclude a species from one area while it persists somewhere else. This gives a "suppressed" extinction point (i.e. the species disappears locally earlier in geologic time than it does in other parts of its range.)

Figure 6. Schematic cross-section showing rock units from oldest to youngest with LAD of hypothetical fossils A, B, and C noted



Microfossils have many applications in petroleum geology.Two most common uses are Biostratigraphy and Paleoenvironmental analysis. Biostratigraphy is the differentiation of rocks units based on the fossils in which they are present. Paleoenvironmental analysis is the interpretation of the depositional environment of the rock formed, based on the occurrence of the fossils present in that particular rock stratum. Microfossils can also be used to interpret the paleocilmates, paleobiogeography and Thermal maturation etc.

By studying the microfossils in many wells, a geologic model of that area can be builtup.With the recognition of the biostratigraphic utility of Foraminifera in petroleum exploration, Micropaleontology received a new impetus and direction.

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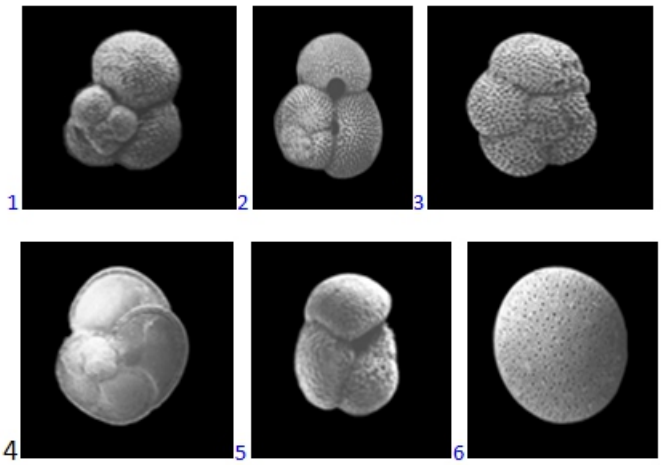
Ecology and paleoecology: The principle behind the role of foraminifera as environmental indicators involves a combination of basic concepts of sedimentology, ecology and oceanography. Hence an interpretation of depositional environment of paleoecology from microfossils depends mainly upon comparison of fossil assemblages to recent foraminifers. Thus foraminifers have been a subject of intensive study in the last few decades and bathymetric distribution is now well established.

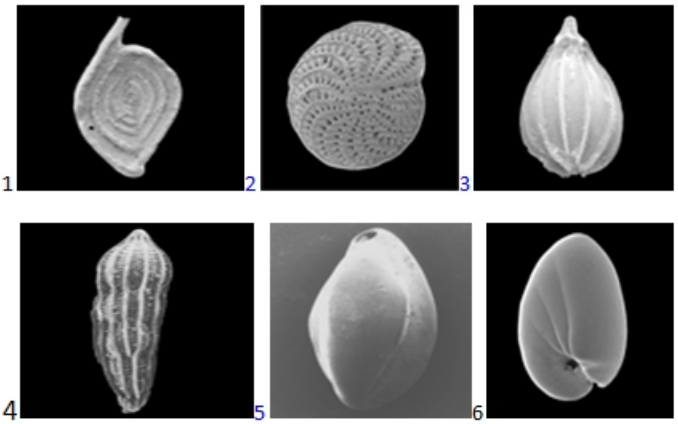
Benthic foraminifers are the chief indicators of temperature, density and bottom conditions whereas planktonic foraminifers overlap a variety of sedimentary environments, indicating broad latitudinal boundaries of temperature and salinity of the overlaying waters. Examples of Benthic Foraminifera are Ammonia, Ammobaculites, Textularia, Quinqueloculina, Elphidium, Bolivina, Cibicides, Uvigerina and Nummalites etc. Example of planktonic foraminifera are Globigerina, Globigerinella, Globigerinoides and Globorotalia etc.

Plankton foraminifera



1.Globigerina bulloides (Pliocene-Recent) 2. Globigerinoides ruber (Miocene-Recent) 3. Neogloboquadrina pachy derma 4.Globorotalia menardii(Pliocene-Recent) 5. Globorotalia inflata (Pliocene-Recent) 6. Orbulina universa (middle Miocene –Recent)

Benthic foraminifera



1.Spiroloculina ornate (recent) 2. Elphidium macellum (recent) 3. Lagena striata (recent) 4. Nodosaria Sp (Jurassic) 5. Quinqueloculina impressa (Ecocene) 6. Nonionella opima (recent)

Biostratigraphy:

Stratigraphy has been succinctly defined as descriptive science of strata. It involves the form, structure, composition, areal distribution, succession and classification of all strata in normal sequence. Recently sequence stratigraphy and Biosequence stratigraphy are emerged and are using in Hydrocarbon Exploration in which planktonic and Benthic Foraminiferal criteria are adopting.

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Biostratigraphy is that aspect of stratigraphy, which involves the direct observation of paleontologic events in superposition. Biozones may generally be grouped to three categories depending on their characteristic features. 1. Assemblage zones 2. Range zones 3. Acme zonesAmong all the above zones Range zone is most important. Range of any taxa can be determined on the FAD (First Appearance of the Datum) and LAD (Last appearance of the datum) of that taxa.

Stratigraphic Correlation:

Stratigraphic correlation can be defined as mutual relation of strata. Rocks of the same age need not contain the same fauna. On the other hand the discovery of two samples with similar faunas is not necessarily an indication that the rocks of the same age.The principal criteria of inter-regional correlation are the stratigraphic limits of species. It is necessary to bear in mind that the same species may have different regions. The correlation of magnetic reversals has provided a framework in which Foraminiferal correlation in deep sea sediments can be accurately placed.

The addition of radiometric dates to this frame work provided even more accuracy. Both oil and gas mostly occurs in Tertiary and Cretaceous (Mesozoic) formations this was also applicable to both onland and offshore sedimentary basins (Specially Deltas) of East and West coasts of India. Now days exploration activities are taken up in the continental margins.To decipher the paleoecology and Biostratigraphy etc. of these areas utility of microfossils are very significant.

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