## **An assignment on Micropaleontology and Paleoecology.**

## **(GEY406).**

## **By**

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## **Matric no-16/Sci14/015**

## **Submitted to**

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## **In fulfilment of the Assignment given on the Course.**

25th May, 2020.

**Question 1**

Discuss the morphological classification of pollens and spores.

**Solution;**

Definition; Spores are reproductive haploid structures that is adapted for dispersal and surviving for extended periods of time in unfavorable conditions. Spores are part of the life cycle of many plant, algae, fungi and some protozoans. Spores are found in the ovule.

Pollens are produced from the microspore mother cells, but female spores are produced by the megaspore mother cells. Pollen have two outer coats extine and intine which spores do not possess. Pollens are found in the pollen sac. In other words, pollens are spores but not all spores are pollen.

One of the major ways of classification of pollens and spores is NPC classification. This is an articicial system of classification of pollen and spore based on the three features of aperture only, i.e. number, position and character. According to NPC system each pollen grain has an arithmetic cardinal number consisting of three digits

The first digit reveals the absence or presence of aperture, and when present it mentions the total number of aperture(s) present in a pollen grain which is denoted by the ‘**N**’ in the **N**PC system. These aperture pollens are divided into seven groups mentioned as **N1** to **N7**, which are also referred to respectively as monotreme, ditreme, tritreme, tetratreme, pentatreme, hexatreme, and polytreme (greek trema means hole, opening; pl. tremata). Each group has characteristic number of aperture, with **N7** group having seven or more apertures. Pollens grains with apertures absent are termed inaperture or atreme and they are placed in N0 group. Another special group N8 termed anomotreme is created where the pollen grains and spores have one or several irregular or irregularly spaced aperture.

The second digit illustrates the position of aperture(s) in full clarity which is represented by the ‘**P**’ in the N**P**C system. The position may be proximal, distal and equatorial. There are seven groups of aperture based on position namely – **P0** to **P6**. Pollen grains having **P0** group have uncertain or unknown position of aperture. **P1** groups of pollen and spores are catatreme, these pollen grains have one aperture that occurs on the proximal part of a grain which faces inward/nearest or toward the center of tetrad. **P2** group of pollens and spores are anacatatreme which have two apertures, one with its center at the proximal pole and the other with its center occurring on the distal pole (faces outward). **P3** groups pf pollen and spores are anatreme, i.e. the aperture is distal in position. **P4** groups of pollens and spores are zonotreme characterized by having apertures on equator or sub-equator. **P5** groups of pollen and spore are dizonotreme which are arranged in two or more zones that occur parallel to the equator. **P6** groups of pollen and spore are pantotreme which are scattered over the while surface uniformly. As a rule pantotreme pollen grains are spheroidal.



**Fig 1; Systematic representation of position of aperture(s) only in pollens**

The third digit explains the character of an aperture, i.e. circular/oval or elongated, simple or compound etc. It is denoted by ‘**C**’ in the NP**C** system. There are seven character groups of aperture that are mentioned as **C0** to **C6**. **C0** groups have apertures whose character cannot be established with certainty. **C1** groups of pollen and spore have leptoma (Greek leptoma means thin place). Pollen grain having one leptoma are termed as monlept. The leptoma may occur on either proximal- or distal face of a pollen grain and spore and accordingly termed as catalept and analept. **C2** groups are trichomocolpate which is a three branched aperture, the branches of which are more than two times longer than breadth. The group **C3** has colpate grains, group **C4** comprises porate pollen grains, group **C5** comprises colporate pollen. The group **C6** comprises pororate pollen.

**Question 2**

Explain and highlight the various applications of pollens and spores in geosciences.

Explain the stratigraphical and paleoenvironmental applications and significance of pollens and spores in sedimentary and petroleum geology.

**Solution;**

There are multiple aspects that pollens and spores are applied to in both petroleum and sedimentary geology. They are involded in the following ways

* **Biostratigraphy**

Biostratigraphy zonation can be based on any kind of fossil fauna or flora. The relative values of different kinds of taxa, however, vary with geological age, depositional environment of the section under study and the kind of samples available for investigation. In subsurface stratigraphy, microfossils are invariably used for biozonation because of their small size, which is useful in the limited size of the samples recovered in drilling. One of the reasons why micropaleontology has reached its present level of specialization is because of the ability of microfossils to provide finer time slices of the stratigraphic column. The stimulus for this came from the oil industries, who initiated major research into foraminiferal biostratigraphy at the beginning of the 1940s. Another important phase in the development of microfossil-based biostratigraphy came in the 1960s through the initiative of oceanographic institutions engaged in the study of deep-sea sediments. Microfossils other than foraminifera also gained importance due to the Deep Sea Drilling Project (DSDP). The precision that the modern biochronology provides is due to the use of multiple groups of microfossils, including foraminifera, radiolarian, calcareous nanoplankton, silicoflagellates and diatoms. This chapter introduces some basic aspects of biostratigraphy and discusses the applications of microfossils in providing standard zonal schemes.

* **Paleoenvironment and Paleoclimate**

Microfossils occur in sediments of all ages and under practically all environmental conditions. Their abundance in a sample in comparison to mega-fossils makes them a true representative of the biological community of an environment. A host of physical, chemical and biological factors of the environment control the distribution of microfauna. As a result, there are characteristic assemblages of microfauna corresponding to specific environments of deposition. Furthermore, the oxygen and carbon isotopes and trace elements in shells of several microfossils have enabled quantitative estimation of environmental parameters. The key points in the micropaleontologic approach to interpretation of paleoenvironment and paleoclimate are as follows:

1. The basis of interpretation is environmental controls on the present-day distribution of microfauna (uniformitarian approach).
2. The more specific and limited the criteria derived from the present-day fauna, the lower the probability of finding analogous criteria in ancient assemblages.
3. The older the faunal assemblage, the less likely that its environmental distribution will be similar to the present-day fauna.
4. The environmental conditions limiting the distribution of microfauna vary. The environmental tolerance may be large for a group, but the specific requirements of species within the group may be very limited.
5. The pre-requisite for paleoenvironmental interpretation is a carefully carried out taphonomic evaluation of fossil assemblages. Preferential preservation in certain settings, such as marshes and deep sea, may have a marked effect on the original assemblages.

* **Basin Analysis and Hydrocarbon Exploration**

Sedimentary basins are host to mineral and fuel resources, the exploration of which requires a sound knowledge of the evolution of the sedimentary basin that hosts them. Basin analysis traces the evolution of the sedimentary basin and includes the origin, stratigraphic architecture, paleogeography and subsidence history of the basin. Micropaleontology is applied at various stages of basin analysis. The stratigraphic framework of the basin is primarily based on micropaleontology and key data in reconstruction of paleogeography and subsidence history are provided by microfossils. Furthermore, two modern techniques in basin analysis, the seismic stratigraphy and sequence stratigraphy, need micropaleontology support in a major way. It was a revolutionary concept that seismic reflections are essentially timelines (Vail et al. 1977 ), but the reflections are required to be biostratigraphically calibrated. In sequence stratigraphy, microfossils contribute significantly to the recognition of sequence boundaries, transgressive surface, maximum flooding surface and systems tracts. Micropaleontology is indispensable wherever information on age and environment of the sedimentary fill of the basin is required in basin analysis. Historically, the petroleum industry nurtured micropaleontology for its outstanding contributions in subsurface exploration. Microfossils, due to their small size, abundance and occurrence in sediments of all environments, proved useful in the limited size of the core and drill cuttings. They have been found useful in all three phases of hydrocarbon exploration, including exploration for prospects, appraisal of discoveries and development of fields. The role of micropaleontology has expanded beyond its traditional use in determining the age of strata and correlation of wells. Biostratigraphy is being used successfully in the monitoring and guiding of horizontal or deviated drilling through reservoirs, known as “bio steering”. This chapter discusses the application of micropaleontology in basin analysis and hydrocarbon exploration.

* **Paleoceanography**

Paleoceanography is the study of the evolutionary development of ocean systems through geologic time. It is an interdisciplinary field, integrating stratigraphy, sedimentology, marine micropaleontology, geochemistry and geophysics, and relating them to physical, chemical and biological oceanography. Paleoceanography is one of the youngest branches of earth system science, largely born of the Deep Sea Drilling Project (DSDP), and continues to be nourished by deep-sea exploration. Oceans cover 70.8 % of the earth’s surface. The four oceans include the Pacific, Atlantic, Indian, and Southern Ocean. In addition, there is a large number of smaller water bodies connected to these oceans, often referred to as seas, for example, the Arabian Sea, Red Sea, and Persian Gulf, all connected to the Indian Ocean. The depth of the ocean floors is variable, the maximum reaching 10,924 m in the Pacific. Ocean water properties vary aerially and through the depths. High salinity waters are found in enclosed seas and tropical–subtropical regions where evaporation exceeds precipitation and generally decrease poleward. Similarly, the warmest temperatures are found in the tropical regions of the Indian and Pacific Oceans and decrease poleward. Salinity, density and temperature also change vertically and, based on trends in variation, three depth zones are recognized. The upper ~100 m is a mixed layer or surface zone, characterized by water with higher temperature, lower density and lower salinity. There is a rapid change in temperature, density and salinity of water below the mixed zone, continuing for ~1000 m, called the thermocline, pycnocline and halocline, respectively (Fig. 13.1). The lower layer, called the deep zone, contains most of the ocean water column, and properties of the water change slowly in this zone. Thus, the mixed layer and the deep zone are relatively uniform in temperature, salinity and density, while the thermocline and the corresponding pycnocline and halocline are transitional layers between the two.