GEOSCIENCE NOTES

The History and Application of Palynology (Pollen and Spores), by C. C. M. Gutjahr *

R. P. Wodehouse described in his excellent book "Pollen Grains" the history of pollen morphology. According to his data, the earliest known recognition of pollen is attributable to the ancient Assyrians, who practiced hand pollination of the date palm. Among the many carvings and examples of glazed brickwork that have been recovered from their ancient civilization are a number which have been interpreted to represent this practice.

Carved slabs of stone representing this theme have been found in the palace of Ashur-nasi-Apal, who was the ruler of the Assyrian empire from 885 to 860 B.C. The gigantic beings have large, widespread wings and the posture is always the same, with the upraised right hand bearing the spathe, the left hand hanging at the side bearing a basket.

Whatever the correct interpretation of the carvings may be, it is recorded that Horodotus, in the middle of the Fifth Century B.C. brought back from his travels in the East the information that the date palm is fertilized by dusting it with branches of the male. This might be one of the first economical applications of pollen.

The detailed study of pollen and spores are, of course, associated with the development of the microscope. On account of the small size of the pollen grains (average 0.025 of a mm) not even the first studies could be made until the microscope had reached a fairly high stage in its development.

In the 17th Century Hook gave the world his compound microscope, which is described and illustrated in the preface to his "Micrographia" dated London 1665. It consists of a brass tube with a single objective at the small end, a large eyepiece at the opposite end. It is hard to estimate its importance in the 17th Century.

GREW (Englishman) and MALPIGHI (Italian) described pollen grains in 1682 and 1687 respectively.

Since the beginning of the 20th Century the study of pollen and spores has increased in importance, mainly based on the experiences

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It is obvious that the petroleum industry is also able to benefit by the new method. For example: in areas with terrestrial or brackish deposits, where correlation by means of other microfossils is generally difficult.

The Standard Oil Company of California and Carter Oil Company (now Jersey Research) have stated that they have taken up palynological research in 1952 and 1953 respectively.

In 1938, on instructions from the Royal Dutch Shell group, R. Potonie in Germany investigated some samples from Mexico. In 1939 one of the members of the Houston Geological Society collected samples in Venezuela for palynological investigations. We like to give the credit to E. H. Rainwater, who realized the real potentialities of the pollen and spore studies 21 years ago. In subsequent years F. Florschütz analysed, at the request of Shell, samples from Malay and the Caribbean.

After the war, in 1947, the first operational laboratory was established by the Royal Dutch Shell group in Maracaibo, Venezuela. Now many palynological laboratories exist throughout the world.

Origin of Pollen and Spores

Spores are borne, for example, on the underside of the leaves of the sporophyt. The brown spots calles sori contain several sporangia. Each sporangium consists of a short stalk and a swollen head containing the spores, usually 64 in number. When the spores are ripe the sporangium wall is ruptured and the spores are ejected and dispersed by the wind and water. In the higher plant groups pollen are formed in the anther and distributed by wind, water or animals.

The pollen grain has three concentric layers. The central part is the living cell which germinates on the stigma and forms a pollen tube that penetrates the style and brings the fertilizing nuclei down to the ovum. The middle layer envelopes the whole of the pollen grain and consists mainly of the same substances that form the bulk of the ordinary cell walls of the plant. The third and outer layer of the pollen grain is made of one of the most extraordinarily resistant materials known in the organic world. The chemistry of the outer wall (exine) is, unfortunately, very poorly understood. Their insolubility in all solvents and their high resistance to most chemical agents makes the study of their chemical nature very difficult. According to ZETZSCHE the material of the outer wall is related to terpenes or similar compounds, for example, rubber. The matter is by no means settled.

There are three factors that serve as the factual basis for pollen analysis:

1. Pollen grains of different taxonomic groups are different.
2. The enormous quantities of pollen grains which are produced and distributed. For example: one shoot of Hemp produces annually 500 million pollen grains, while a ten year old branch of Pine produces annually 350 million pollen grains.
3. The great resistance of the exine (pollen wall) which permits pollen grains to be embedded in sediments and still be recognizable. Excellently preserved and apparently unchanged spore walls are found in Paleozoic rocks where all other material has been carbonized and distorted. According to literature, pollen grains can be heated to almost 300° celsius without destroying them. Pollen and spores can be treated with concentrated acids and bases with very little effect on the exine (wall). They are, however, less resistant to oxidation.

<u>Transportation by Wind</u>

Although exact information concerning the distribution of pollen and spores by wind is difficult to obtain there is considerable evidence showing that they can be transported very great distances.

Hesselman exposed plates to trap pollen on two light ships in the Gulf of Bothnia. On one of the ships, 19 miles off the coast, 103,037 pollen grains were trapped in one month. On the other ship, 34 miles offshore, 56,075 grains were trapped in the same time interval.

Another example shows that certain conifer pollen have been found in Greenland, which have been carried by the wind from the continent of America for a distance of 625 miles or more.

The vertical transportation by winds can be considerable. Investigations have revealed the attack of rust on Canadian crops was caused by windblown infection from the South and rust spores have been found as high as 15,000 feet. Over Kassel and Göttingen (Germany) many pollen have been found as high as 6,000 feet. The greatest concentrations were observed between 1,000 and 2,000 feet.

Transportation by Water

Recent studies in the Orinoco delta have revealed that some pollen and spores are transported by water. Cuticles (plant tissues) can be distributed by rivers and ocean currents over large areas.

Transportation by Animals

Some pollen are carried from the anther of one flower to the stigma of another by some animal such as insect, bird, bat or slug. Pollen grains of this type have small chance of being preserved as fossils. They possess often a heavily armed surface and layer of sticky oil on the surface of the grains, which cause them to stick better to the body of the animal.

Oxidation

Pollen and spores cannot withstand prolonged oxidation. Pollen and spores when subjected to the action of air take up oxygen. This auto-oxidation appears to be a photochemical process involving the addition of oxygen molecules to double linkages in the pollen wall with the formation of peroxides. This will bleach the grains and in the long run the pollen are destroyed.

Fossilization

Since oxygen is the main enemy of the spore and pollen wall it is obvious that strata deposited in reductive environments often contain well preserved pollen and spores.

Application

1. Honey Studies:

In dubious cases a study of the pollen of a honey may help to determine its country of origin. It may also help to reveal dishonest practices: a supposed German honey with an abundance of BOMBACACEAE pollen and other exotic pollen may readily be shown to be a Mexican, etc. (Erdtman)

2. Hayfever Studies:

Besides the grasses and ragweeds many other plants contribute to the production of hayfever. The hayfever specialist will study botanical maps of the region, he will determine the pollen of every wind-pollinated species and from these he selects the extracts of the species which flower during the time the patient has hayfever. Small but gradually increasing amounts of the extracts will be introduced to the patient by the physician to build up a resistance to the toxicity of certain pollen.

3. Criminal Studies:

Some palynologists have cooperated with police departments to analyze fresh mud from the shoes or from the car of a suspect. The assemblage of pollen and spores may reveal the area in which the suspect has travelled.

4. Salt Studies:

Interesting pollen and spore assemblages have been recovered from salt deposits.

5. Correlation:

The late glacial and Holocene (Recent) of Western Europe can be subdivided into 9 to 10 zones which can be traced over large areas. Palynological correlations have been carried out by Shell palynologists around Lake Maracaibo, Venezuela, the results have been published in "The Application of Palynology to Oil Geology with Reference to Western Venezuela" Geologie en Mynbouw nr. 3 New Series, Vol. 17, pp. 49-76, March 1955.