Open File Report No. 80-4

APPLICATION OF PALYNOLOGICAL TECHNIQUES FOR CORRELATION OF COAL SEAMS IN THE LOWER LIGNITE CREEK AREA, NENANA COAL FIELD

by

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1980

Final Report

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Submitted to

Mining and Mineral Resources Research Institute
Office of Surface Mining
U.S. Department of Interior
Washington, D.C. 70740

Grant No. G5184001

March 1980

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Introduction

The fossil plant associations that contribute to coal swamp formation are recorded by the pollen and spores trapped in the coal. Every coal seam is formed under unique environmental conditions which in turn give rise to characteristic plant assemblages that are reflected in the pollen record. These characteristic plant assemblages allow stratigraphic correlation of coal seams which is of great value in coal mining. The areal extent of an important seam may be elusive due to pinching out, replacement or division of the seam. Knowledge of coal basin stratigraphy enables the coal miner to more accurately calculate reserves and evaluate mining strategy. Palynology is a simple, economical and environmentally sound method of correlation. These advantages become very obvious in comparison to conventional methods of extensive drilling and sampling.

Palynology is a valuable technique not only in coal seam correlation but for paleo-ecologic studies, paleo-climatic studies, plant migration studies, and coal formation and deposition studies. Investigating the application of palynological techniques for correlation of coal seams in the Nenana Coal Field will be of great value in characterizing Alaskan Tertiary coals. Very little palynological work has been done on Alaskan coals and more work is needed to fill this gap of knowledge. Indeed, expansion of knowledge on all aspects of coal is important in today's fuel-conscious society.

This study concerns spores and pollen in the coals of the lower Lignite Creek area in the Nenana Coal Field, which is operated by Usibelli Mining Company. The seams studied are part of the Suntrana Formation which contains a large portion of the coal reserves of Nenana coal. These coals are mid-Miocene in age and are separated from each other by cyclic sandstone, clay and silt deposits, which reflect alternating periods of coal forming swamps and depositing streams. A preliminary study of the mega and micro botanical fossils of this area was made in 1969 by Wolfe and Leopold (Wahrhaftig et al, 1969). Palynological investigation was done on 26 samples of the Suntrana Formation and evidence from this and fossil leaves indicate that the formation should be placed in the Seldovian stage.

Sampling

Three seams have been sampled for palynological investigation. Seam #4 is 24 ft. thick; #5 is 2 1/2 ft. thick (and is assumed to be pinched out in the area) and #6 is 25 ft. thick. The coal seams and intervening sediments were sampled by channel sampling on freshly exposed surfaces. A total of 61 samples were collected; a total of 35 samples from seam #4; 5 samples from seam #5 and 21 samples from seam #6. A sample of clay was collected under the seam, a sample was collected from the bottom 6 inches of the seam

and then for 12 inch intervals. Samples were crushed to 1/4 inch and 10 gms of sample was processed. Multiple slides of these samples are being made and studied. The pollen is being described in as much detail as possible, and botanic affinities identical, if possible. Complete information will be available in the thesis of a graduate student working on the project.

Maceration Procedures

Maceration techniques are numerous and vary with rank and "chemical" composition of the coal. For example, presence of minerals such as pyrite will greatly affect chemical reactions. Thus, knowledge of the absence of pyrite in Alaskan coals was taken into consideration in developing these techniques. Developing laboratory techniques and maceration procedures suitable for these coals was an important part of this research. Developing a technique involved consideration of speed, simplicity, safety, corrosion potential and economy. In addition to information from literature, the USGS palynology labs at Reston, Virginia and Denver, Colorado were of great help in developing these techniques and procedures. Special thanks go to Mr. Orrin Oftendahl of the Reston palynology lab and to Robert Kosanki of the Denver lab, for the time spent in explaining and demonstrating techniques. The establishment of the MIRL coal palynology lab will make it possible to use this research technique on coals from all over Alaska.

In summary, there are three main steps in maceration techniques: disaggregation, dispersal, chemical extraction and density separation. After the coal is crushed and cleaned it is oxidized by the addition of Schultz solution (a mixture of potasium chlorate and nitric acid). Treatment with KOH is utilized in order to solubilize and disperse humic compounds of the oxidized organic residues. Heavy liquid separation is done with $ZnCl_2$ at specific quanity of 1.3 to 1.5 and samples made into slides using a glycerine jelly mounting media. A step by step account of procedures is listed in the appendix.

Interpretation

By mid-Miocene, flora in the Alaska Range area was slowly becoming more modern in representation of current plant species. The physiography of early Tertiary plant leaves reflect a tropical climate, but by mid-Tertiary, the percentage of now-exotic genera decreased to about 49% (estimate) (Leopold, 1969). Alnus (Alder) and Betula (Birch) type pollen are dominant in the slides examined to date. Figure 1 lists the different varieties of plants tentatively identified from seam #6.

FIGURE 1 - Preliminary List of Pollen and Spore Types, Seam #6, Nenana Coal Field.

Taxodium	Picea	Tricolporate types	Drosera
Tsuga	Abies	Monoporate types	Lycopodium
Juglans	Quercus	Sphagnum types	Onagraccae
Carya	Alnus	Fungal spores	Nyssa
Betula types	Tilia	Ovoididites cysts	Polygonum
Pinus	Salix	Ericales	

To give a more complete botanical characterization of the coal, additional techniques will be used including SEM, IR spectrography, x-ray diffraction, fluorescence microscopy and coal petrography. It is important to note that these techniques compliment each other and will be of great aid in seam characterization. The environment of coal deposition and adjacent uplands in general determines spore content and petrography of seams at any one stratigraphic horizon. Fluorescence can aid coal petrographic investigation and identification of different types of resins in addition to problems of pollen contamination. Detailed examination of plant remains by SEM will aid petrographic work and routine microscope work of the pollen. Study of resins by IR spectroscopy and x-ray diffraction will aid pollen work by indicating their botanic origins. All these techniques have the potential for increasing the botanical knowledge of the coal. Comparison of results of these techniques will also be of interest. Some of the results of these techniques will be more valuable in piecing together seam correlation information and this work will identify which ones will be of most use.

The maceration technique that separates the pollen grain and spores from the coal also separates out plant tissues, woody debris, bark, small plant organs, and cellular material. Of particular interest is the tracheid pitting of woody debris. Tracheid pitting may be opposite, alternate, scaliform or aucarioid type, transitional or abietoid. This information may be characteristic to genera. SEM will help identify the type of tree that produced this material. This material is generally autochthonous which is also important in understanding the local swamp flora whereas pollen gives information from both local and regional flora. The tracheid pitting investigation will be of most use in identification of conifers since angiosperms decay more readily in coal forming environments.

The resolution provided by SEM will also allow more accurate identification of species. Different plants may have pollen that is difficult to distinguish morphologically. Betula type pollen is common in these samples and SEM will help distinguish between Betula, Corylus and Myrica.

Resins are resistant to coalification in low rank coals and retain the composition of the parent resin. For this reason IR spectrophotometric studies can be of value. Spectra of recent and fossil resins are often similar in that certain absorption peaks can be matched. The intensity of the peaks is usually much weaker in the fossil resins than recent ones but the technique has still been useful in some studies for identifying the plant source for fossil resin. Some resins have crystalline components which enable x-ray diffraction studies. In a few cases, sharp patterns of the crystalline constituents of resins may be identical to those of modern resins. Of most importance is the identification of certain triterpenoid alcohols which are characteristic of certain angiosperms.

Fluorescence is a type of luminescence in which the emission of light ceases when the external stimulus ceases. This technique is useful in coal petrography work for identification of the microstructural components of the coal. It is also an aid in palynological investigation. The primary fluorescence colors are characteristic of fresh constituents but have only a limited value for fossil material. Samples showing contaminated or recycled pollen and spores will be identifiable with fluorescence. Certain fluorescence techniques can be used to state the degree of corrosion of pollen and spores. If this technique can be applied to Nenana coals, reworked, contaminant, and autochthonous sporomorphs may be differentiated.

References

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Wahrhaftig, Clyde, Wolfe, J.A., Leopold, E.B., and Lanphere, M.A., 1969. The coal-bearing group in the Nenana coal field, Alaska: U.S. Geol. Survey Bull. 1274D, p. D1-D30.

APPENDIX

Procedures

1. Weigh 10-50 gm of coal sample.
2. Rinse sample with deionized water and place in 1000 ml beaker.
3. Cover the sample with cold Schultz solution, approximately 100 ml and let react for 30 minutes. (Keep Schultzes solution refrigerated to slow down initial reaction and prevent bubbling over and loss of sample).
4. Flood the sample with deionized water and let stand overnight.
5. Decant and flood sample with deionized water repeatedly until water loses black color. Allow 1 inch per hour settling time between decantations.
6. Decant sample and add scant KOH 5% to cover, stir and let react for 5 minutes, then flood with deionized water.
7. Let sample stand overnight then decant and seive through window screen, discarding coarse filtered product.
8. Put liquid sample in centrifuge tubes and centrifuge for 15 minutes until liquid is clear (centrifuge/decant/flood repeatedly).
9. When liquid is clear, decant water and set up heavy liquid separation procedure. Place sample in tygon tubes filled with $ZnCl_2$. Centrifuge at 1500 for 30 minutes (this rate is only applicable if the centrifuge used has arms of the same radius).
10. When good separation is achieved place pinch clamps on tubes just below float material. Transfer to centrifuge tube, washing tygon tube with deionized water.
11. Place contaminated $ZnCl_2$ in recycle bottle (can be filtered and reused).
12. Add distilled water to test tube containing sample, mix well and centrifuge and decant repeatedly until heavy liquid is completely diluted.
13. Flood sample with deionized water and add 2.3 drops NH_4OH 1% solution (basic solution takes dye better.)
14. Add 2-3 drops safrarin dye to sample and let set overnight.
15. Decant sample and flood with ETOH solution and centrifuge repeatedly until liquid is clear.
16. Set up sieving procedure. Cut membrane of Nalgene member filter out. Cut out top of filter unit cover, use this ring to hold the 10μ screen in place. Place the seiving cloth on top of the filter and seive with a 25% ETOH solution using a small portion of the sample handle with a pipette.
17. To use swirl technique, take a small sample and place on water glass, add ETOH and swirl as in micro-gold panning until "sinks" and "float" develop. Place drop of each on slide, cover and check under microscope to check which is more representative of spores present in sample.

18. Place 1 or 2 drops glycerin jelly on cover slip that has been heated for a few minutes on hot plate. Drop sample material on cover slip also and spread in thin layer. Let glycerin congeal partially and place slide on top of cover slip by gently pressing. Seal edges with clear nail polish.