PREMACERAL CONTENTS OF PEATS CORRELATED WITH "PROXIMATE AND ULTIMATE ANALYSES"

A. D. Cohen* and M. J. Andrejko

Department of Geology
University of South Carolina, Columbia, South Carolina 29208
*(presently at Los Alamos National Laboratory
Earth and Space Sciences Division, MS K586
Los Alamos, New Mexico 87545)

I. Introduction

In a number of publications, peat types have been defined petrographically by their botanical and "premaceral" compositions (1, 2, 3, 4). "Premacerals" are the organic components in the peats which, due to their color, opacity, shape, and fluorescence, can be projected as the probable progenitors of particular corresponding macerals in coals. Although the petrographic characterization of peats constitutes an important "first step" in understanding the origin and in predicting the general composition of the resultant coals, it is important that premaceral types and amounts in peats be correlated with various coal-quality tests (such as "proximate" and "ultimate" analyses). With these results it then becomes possible to develop a series of models with which to predict more precisely the chemical and physical composition of the resulting theoretical coals. These predictive characterizations can be applied not only to the projected seam-wide variability in coal quality for coals produced in similar depositional settings as that of the studied peats, but also to the prediction of the variations in industrial properties of the peats themselves, such as for gasification, liquifaction, soil conditioning, organic chemical production and so forth.

It is for these reasons that we have initiated this correlative study of peat petrography and peat industrial-chemical (coal quality) properties. Note that the information reported herein represents preliminary results based on a limited number of different types of peats that were analyzed for only a few "coal quality tests" (i.e., proximate analysis, ultimate analysis, and BTU content). Future studies will involve measurement of other petrographic parameters and include other industrial analyses (such as, gas and liquid yields, physical properties, organic chemical yields, and so forth).

II. Objectives

The objectives of this study are to:

A. Determine the variations in premaceral types and proportions within a wide variety of peat types.
B. Correlate premaceral contents with corresponding proximate (fixed carbon, moisture, ash, volatile matter), ultimate (C, H, O, N, S) and heating value (BTU) analyses.
C. Predict the probable variations in the proximate and ultimate makeup and BTU levels for coals which formed in similar vegetational and depositional settings to those of the peats studied in this project.

III. Methods

Carefully extracted samples of peat were slowly dehydrated in a series of alcohol solutions and then embedded in paraffin. After embedding, thin-sections (15 microns in thickness) were cut from these samples with a sliding microtome and mounted in Canada Balsam. Details of the procedure for the embedding and sect'oning of peats have previously been described by Cohen.(2,3).

Premaceral identification was made in transmitted white light, in polarized light (birefringence) and fluorescent light. Premaceral proportions were determined by area point-counting at 200 X. Proximate and ultimate analyses and BTU were obtained from commercial testing laboratories and also from the Department of Energy's Energy Technology Center at Grand Forks, North Dakota.

IV. Results and Discussion

A. Botanical Composition

Figure 1a shows the relative abundances of plant groups observed in microtome sections of the peats. Note that these peats varied considerably in their botanical compositions. The Minnesota peat consisted predominantly of Sphagnum (peat moss) debris with some grasses and conifers. The Maine peat was composed mostly of algal material with some Sphagnum and Nymphaea (water lily) debris. The North Carolina peat was dominated by bay tree (Magnolia, Persea, Gordonia) and gum tree (Nyssa) debris; while the Georgia Nymphaea peat consisted predominantly of Nymphaea debris.

Figure 1b shows the abundance of plant organs comprising the peat. Again the differences between peat types are pronounced. The Minnesota peat is dominated by roots but with lesser but equal amounts of stem and leaf debris. On the other hand, the Maine peat has the highest concentration of leaves; the North Carolina peat has the highest wood content (stems) and lowest leaf content, while the Georgia (Nymphaea) peat has the highest proportion of roots.

B. Premaceral Types and Proportions

One simplified but useful means of displaying petrographic composition of peats in thin section is by graphing the area percentages of ingredients of different colors. Figure 2 shows such a point-count for four representative types of peat from this study. Note that the Minnesota Sphagnum and Georgia Nymphaea peats have approximately the same range of colors (peaking between light-yellow and light-brown) but that the Maine peat peaked in the clear to light-yellow range while that of the North Carolina peat had peaks in the light-yellow to red-brown range and also in the dark-brown and black categories.

The Georgia Nymphaea and Minnesota Sphagnum peats tended to have the highest previtrinites while the North Carolina and Georgia Taxodium peat (not shown) had the highest prephlobaphenites (and precorpocollinites) and also the highest preinertinites (premicrinites, prefusinites, and presclerotinites).

Figures 3 and 4 give the area percentages of birefringent premacerals found in the samples studied. Since birefringence has been equated with cellulose content, it might therefore be expected that birefringence would decrease with depth in a deposit as a result of cellulose decomposition. However, as can be seen in Figure 3 (representing two cores from the Okefenokee Swamp of Georgia), birefringence may increase or decrease with depth depending on successions of peat types and moisture conditions during initial deposition. Figure 4 shows that Georgia Nymphaea and Minnesota Sphagnum peats have the highest proportions of birefringent constituents.

The concentration of fluorescent premacerals tended to correlate slightly with the proportion of birefringent premacerals. However, different plant types were found to produce different fluorescent colors and intensities. Furthermore, natural "staining" (i.e., darkening or coloring by natural impregnation or chemical alteration) of cell walls tended to effect birefringence and fluorescence in very different ways. Natural staining tended to correlate strongly with birefringence (i.e., the darker the staining the less the birefringence), but did not correlate well with overall fluorescence properties. For example, some tissues that were highly stained tended to have higher fluorescence intensities than those that were unstained.

C. Proximate and Ultimate Analyses and BTU

Figure 5 shows the results of proximate and ultimate analyses and BTU measurement. Note that the peat from North Carolina (a lower-coastal-plain, woody, dark, more inertinite-rich sample) had the highest fixed carbon, elemental carbon and sulfur content. Woody Taxodium peats from Georgia (not shown) and South Carolina (not shown) were similar in character to the North Carolina samples. The Georgia *Nymphaea* peats, which had the highest previtrinites, can be seen to have the highest oxygen, hydrogen, and volatile matter contents. Note that BTU values tended to correlate more strongly with ash contents than with maceral contents.

V. Summary and Conclusions

Preliminary correlations of petrographic characteristics of peats (i.e., peat types, premaceral proportions, and premaceral types) with proximate and ultimate analyses suggest the following trends:

A. Peats with the highest proportions of birefringent macerals tend to have the highest volatile matter (and H and O contents).
B. Fluorescence of macerals, on the other hand, seems to correlate only slightly with proximate and ultimate analyses.
C. Higher previtrinite contents tend to correlate with higher volatile matter contents.
D. Peats with higher preinertinites, prephlobaphenites (and pre-corpocollinites), and presclerotinites have the highest fixed carbon.
E. BTU correlates strongly with ash content and only slightly with maceral content.

VI. Acknowledgments

This work was funded in part by Grant #EAR-79-26382 from the National Science Foundation and in part by funding from the Office of Basic Energy Sciences of the Department of Energy.

References

1. Cohen, A. D. (1968). The Petrology of Some Peats of Southern Florida (with Special Reference to the Origin of Coal), Ph.D. Thesis: Penn. State Univ., 352 p.
2. Cohen, A. D., and Spackman, W. (1972). Methods in Peat Petrology and Their Application to Reconstruction of paleoenvironments: Geol. Soc. Amer. Bull,, v. 83, 129-142.
3. Cohen, A. D. (in press). Obtaining More Precise Descriptions of Peats by Use of Oriented Microtome Sections, In Proceedings of ASTM Symposium for Testing of Peats and Organic Soils. Toronto, Canada. ASTM, Philadelphia, PA.
4. Corvinus, D. A., and Cohen, A. D. (in press). Petrographic Characteristics of Carbonaceous Sediments from the Snuggedy Swamp of South Carolina. Compt. Rendu. IX Inter. Carb. Cong.

ABUNDANCE OF PLANT TYPES

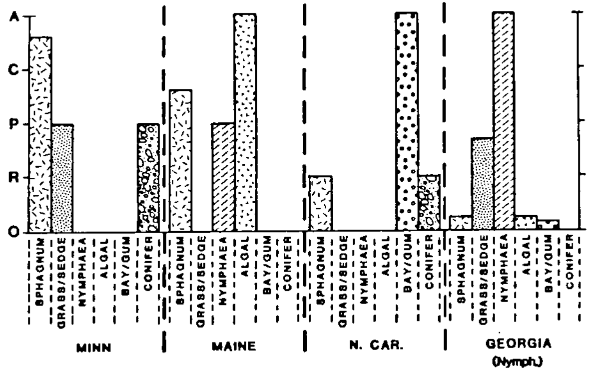

FIGURE 1a

ABUNDANCE OF PLANT ORGANS

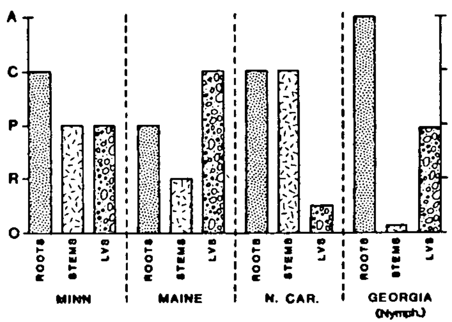

FIGURE 1b

COLOR OF ALL INGREDIENTS

(AVE. OF 3 SAMPLES FROM EACH AREA)

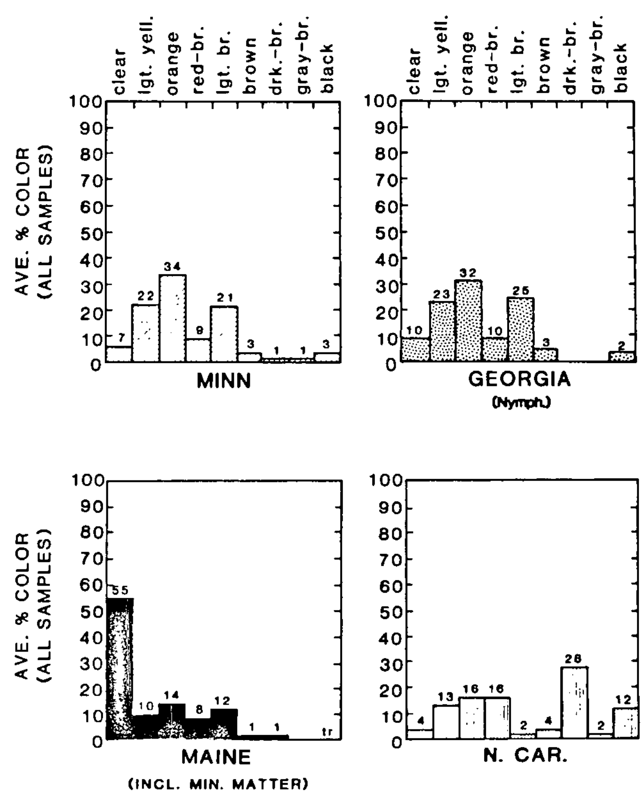

FIGURE 2

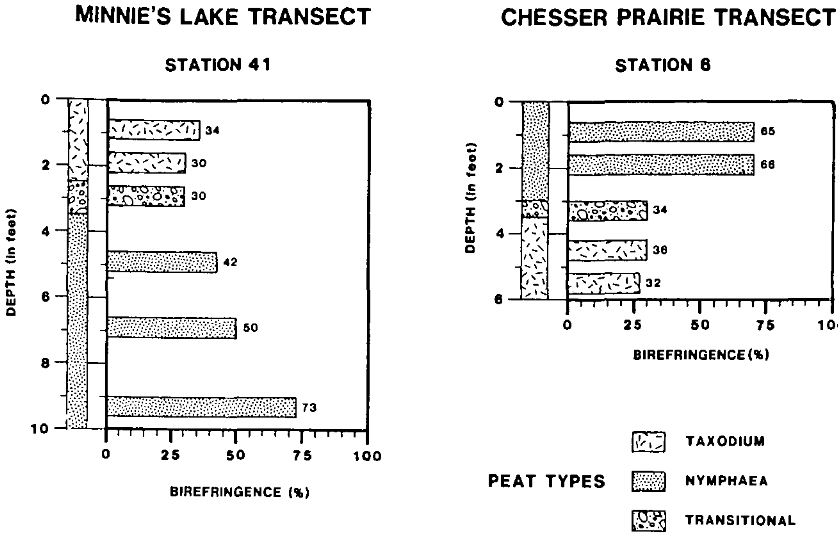

FIGURE 3

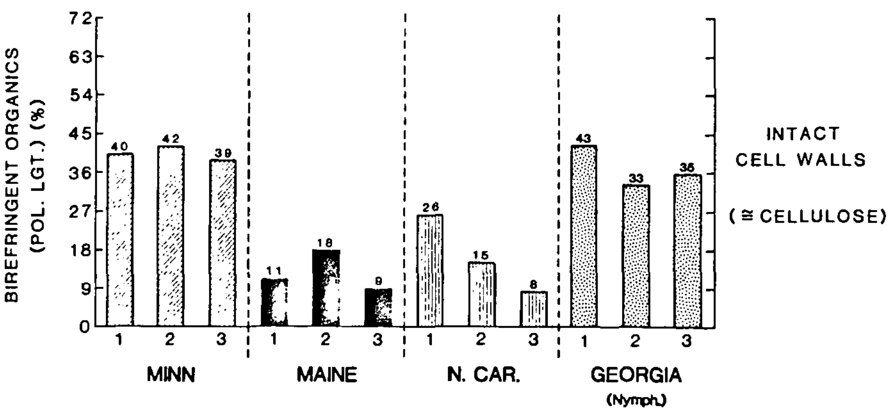

FIGURE 4

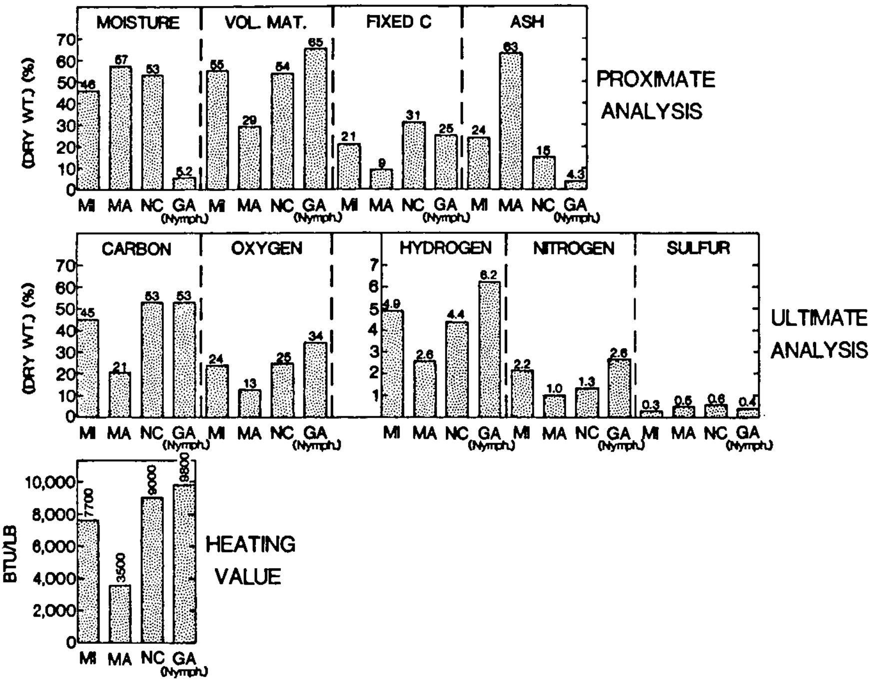
MOISTURE
VOL. MAT.
FIXED C
ASH
PROXIMATE ANALYSIS
(DRY WT.) (%)
46
57
53
5.2
55
29
54
65
21
9
31
25
24
63
15
4.3
MI MA NC GA (Nymph.)
CARBON
OXYGEN
HYDROGEN
NITROGEN
SULFUR
ULTIMATE ANALYSIS
45
21
53
53
24
13
25
34
4.9
2.6
4.4
6.2
2.2
1.0
1.3
2.6
0.3
0.5
0.6
0.4
BTU/LB
7700
3500
9000
9800
HEATING VALUE

FIGURE 5