AN INVESTIGATION OF THE PALYNOLOGY OF THE PEACE RIVER COALFIELD, NORTHEASTERN BRITISH COLUMBIA

By Jane Broatch
Department of Geological Sciences
University of British Columbia

INTRODUCTION

Attention has been focussed on the Peace River Coalfield of northeastern British Columbia (Figure 1) as a result of an agreement to sell 115 million tonnes of thermal and coking coal to Japan over the next 15 years. Mining and exploration activities have been accelerated but are hampered by the complex structure and poorly understood stratigraphy of the foothills region.

The 1981 field season was spent sampling Upper Jurassic-Lower Cretaceous coal-bearing strata in the southern half of the coalfield to determine whether fossil pollen, spores, and dinocysts can be used to generate a type-section of microfossils to aid in solving structural and stratigraphic problems and assist in seam correlations.

Rapid evolution of both flora and fauna during the Cretaceous, as well as the appearance of flowering plants (angiosperms) toward the end of the Lower Cretaceous, resulted in diverse species with restricted stratigraphic ranges. Pollen and spores produced by land plants and cysts produced by marine dinoflagellates are extremely durable and their relative abundance in finer grained sediments creates the potential for a fairly complete microfossil record. Marine-influenced coal measures are particularly suited to studies in palynology because of their high plant content, their relatively high proportion of muds and clays, and because marine and continentally derived microfossils overlap as a result of wind transport of pollen and spores. This overlap allows direct correlation between non-marine facies and laterally equivalent marine facies.

PREVIOUS WORK

Studies of Upper Jurassic and Lower Cretaceous macroflora and microflora of the Peace River district have been carried out by Zeigler and Pocock (1960) in the Minnes Group, by Singh (1971), and by McGregor for the Gething Formation as reported by Hughes (1964) and Stott (1968). Studies of the adjacent Plains region have been published by Pocock (1962), Singh (1964), and Norris (1967). Much of this previous work has been concerned with establishing age and regional correlation of strata, not stratigraphy.

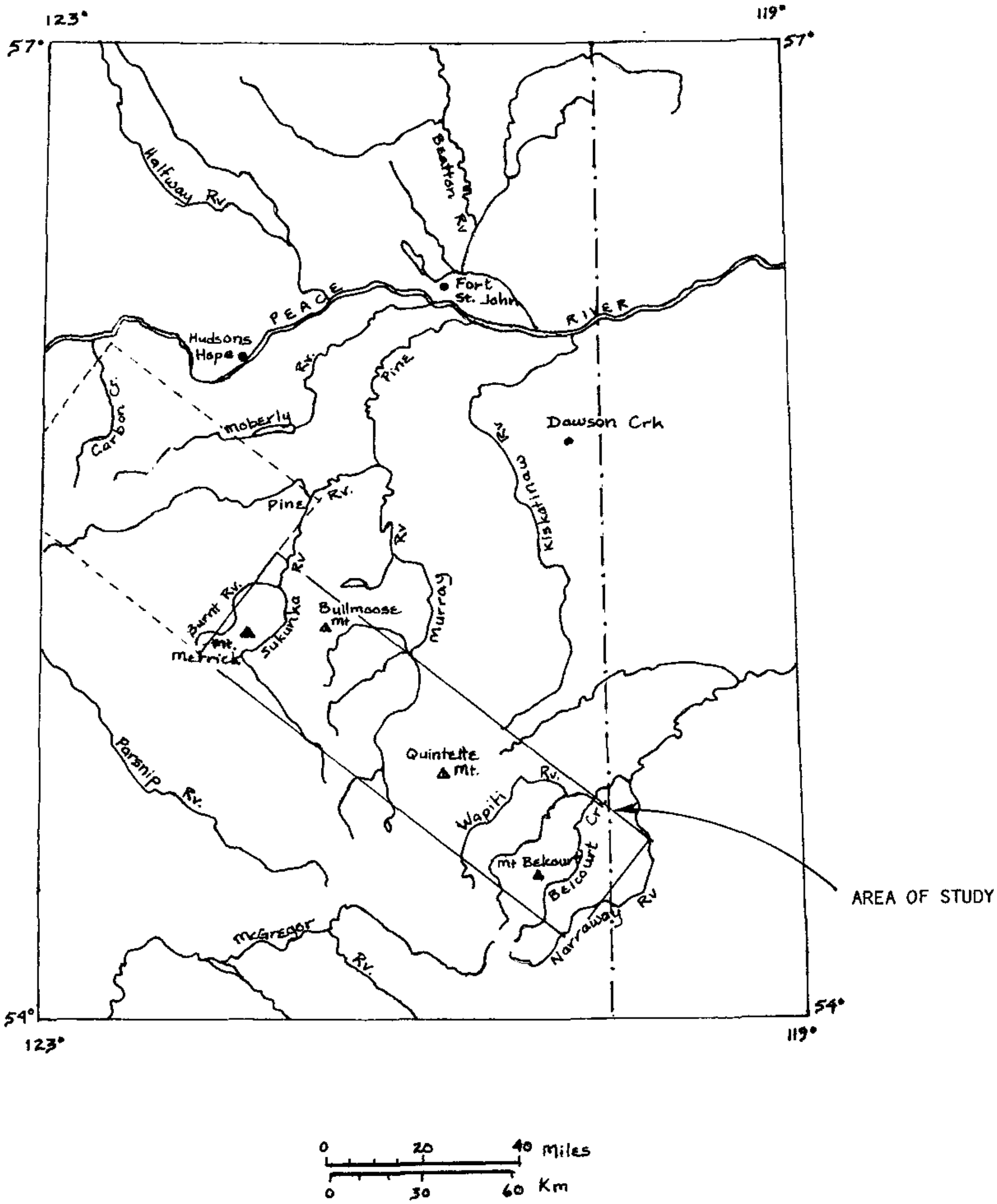

Figure 1. Peace River coal district.

STRATIGRAPHY

The general stratigraphy of the Peace River Coalfield is outlined on Figure 2. In the southeast, coal occurs in economic amounts in the non-marine Gates Member, in the central part in the Gething Formation, and in the northwest in Hughes' Brenot Formation. Non-marine strata have been identified on a gross scale and there are a number of marine incursions which may in part be responsible for the disappearance of coal in some areas (R.D. Gilchrist, pers. comm.). Detailed descriptions of the lithologies and structure may be found in Hughes (1964, 1967) and Stott (1968, 1973). They will only be discussed here in relation to specific stratigraphic problems.

Two sets of terminology (Figure 2) are currently in use in exploration as a result of a number of unresolved problems which include:

(1) A lack of identifiable stratigraphic horizons both locally and regionally. The one exception is the Bluesky Formation. It occurs as a thin (less than 0.5 metre) glauconitic sandstone horizon at the top of the Gething Formation in the eastern part of the coalfield. The Cadomin conglomerate is used as a stratigraphic horizon but varied thickness, rapid fining to the northwest, and close resemblence to the Gething conglomerates, both on surface and in drill holes, make it extremely difficult to identify in many cases. Only its log character appears consistent (R.D. Gilchrist, pers. comm.).

(2) Certain members and formations are difficult to distinguish, for example, the Hulcross Member and Moosebar Formation, the Gates Member and Gething Formation, the Gething and Cadomin conglomerates.

(3) Lateral variations in certain units over the length of the coalfield, specifically the Cadomin/Dresser Formations and the formations that comprise the Minnes Group.

(4) The difficulty of recognizing marine incursions in non-marine sequences because marine macrofossils are scarce.

(5) Determination of the paleoshorelines. Studies in progress reveal that many are not oriented along the strike of the coalfield as was previously believed.

(6) Determination of the nature and significance of the 'unconformity' at the base of the Cadomin Formation (see Stott, 1968).

Until recently workers in the Peace River Coalfield, with the exception of Stott and Hughes, have concentrated on locating economic coal deposits. Attention is now being focussed on stratigraphic problems. New information should eliminate the need for a dual terminology and facilitate future exploration, mine planning, and reserve estimates.

Age	after Stott (1968): Group	Formation	Member	Lithology	after Hughes (1967): Group	Formation	Member	Lithology
U. Cret	Fort St John Gp	Dunvegan Fm		marine & non-marine sst, shl		Dunvegan Fm		non-marine sst, sltst, shl; con
Lower Cretaceous	Fort St John Gp	Cruiser Fm		marine shl & sst	Fort St John Gp	Cruiser Fm		marine shl & md
Lower Cretaceous	Fort St John Gp	Goodrich Fm		sst,shl & mdst	Fort St John Gp	Goodrich Fm		marine sst,minor congl & shl
Lower Cretaceous	Fort St John Gp	Hasler Fm		marine shl with sltst,sst,cong	Fort St John Gp	Hasler Fm		marine shl, minor sltst & sst
Lower Cretaceous	Fort St John Gp	Commotion Fm	Boulder Ck Mb	sst,congl; non-marine sst,mdst	Fort St John Gp	Commotion Fm	Boulder Ck Mb	marine sst,shl & congl some non-marine beds with coal
Lower Cretaceous	Fort St John Gp	Commotion Fm	Hulcross Mb	marine shl	Fort St John Gp	Commotion Fm	Hulcross Mb	
Lower Cretaceous	Fort St John Gp	Commotion Fm	Gates Mb	marine & non-marine sst; coal	Fort St John Gp	Commotion Fm	Gates Mb	
Lower Cretaceous	Fort St John Gp	Moosebar Fm		marine shl	Fort St John Gp	Moosebar Fm		marine mdst & shl
Lower Cretaceous	Bullhead Gp	Gething Fm		glauconitic sst; sst,coal,congl	Crassier Gp	Gething Fm		coal measures
Lower Cretaceous	Bullhead Gp	Cadomin Fm		mass. congl	Crassier Gp	Dresser Fm		coal meas, sst grits & congl
Lower Cretaceous	? - - - - ? - - - -				Crassier Gp	Brenot Fm		coal measures
Jurassic	Minnes Gp	unnamed		qtzose sst; f.g. sst,mdst & carb seds (Stott, 1973)	Beaudette Gp			
Jurassic	Minnes Gp	Monach Fm			Beaudette Gp	Monach Fm		sst & qtzites marine
Jurassic	Minnes Gp	Beattie Peaks Fm			Beaudette Gp	Beattie Peaks Fm		marine shl, sst & sltst
Jurassic	Minnes Gp	Montieth Fm			Beaudette Gp	Montieth Fm		marine sst,qtzites & shl
		Fernie Fm				Fernie Fm		

Figure 2. General stratigraphy, Peace River area.

FIELD AND LABORATORY WORK

A sampling program was carried out in the coal-bearing Upper Minnes through Gates section between the Narraway River in the southeast and Burnt River in the northwest. Very fine clastic rocks in seven surface sections and thirteen drill holes were sampled (Figure 3).

Complete, undisturbed surface sections were difficult to find. Extensive thrust faulting and poor outcrop exposure resulted in gaps in surface coverage. Where relatively complete sections are available, steep dips and the recessive nature of the mudstones and shales frequently made it difficult to obtain fresh samples at the desired 30-metre intervals.

Drill holes were selected to compliment the surface sections and were 'pieced together' to obtain a complete sequence of strata. Core samples were obtained from core storage facilities of the British Columbia Ministry of Energy, Mines and Petroleum Resources at Charlie Lake, British Columbia. It is expected that the core samples, which were taken at 15-metre intervals, will provide more complete and reliable results than surface samples. A total of 238 core samples and 89 surface samples was taken.

Processing of the samples is currently underway in a laboratory at the University of British Columbia. The rock must be completely dissolved in acid to release the palynomorphs which are then treated as necessary to concentrate and bleach them for mounting and identification. The general procedures employed are described in the Appendix. To date one complete section of core from the Mount Belcourt area has been processed and mounted.

PRELIMINARY RESULTS

Of the 60 samples processed to date, approximately 85 per cent contain palynormorphs. Twenty samples were examined by Dr. Glenn Rouse: half of the Minnes and Gething samples contain diagnostic spores and/or dinocysts; fewer Moosebar and Gates samples appear to contain diagnostic palynomorphs but exact statistics are not yet available. However, Gates samples apparently contain angiosperm pollen. There has not been time yet to attempt to identify them.

The Minnes samples contain: the diagnostic fern spores Cicatricosisporites dorogensis and C. mohrioides; the conifer pollen Podocarpidites multesimus; and one sample contains the dinocysts Gonyaulacysta cf. exilicristata, G. cf. cretacea and Cyclonephelium distinctum. Correlation with assemblages found in the Quartz Sand-Upper Develle Members of the Mannville Group (Pocock, 1962; Zeigler and Pocock, 1960) suggests a Valanginian to Early Barremian age for the upper 340 metres of the Minnes Group.

The Gething samples contain the diagnostic fern spores Appendicisporites tricornitatus, A. cf. problematicus, Cicatricosisporites australis, and

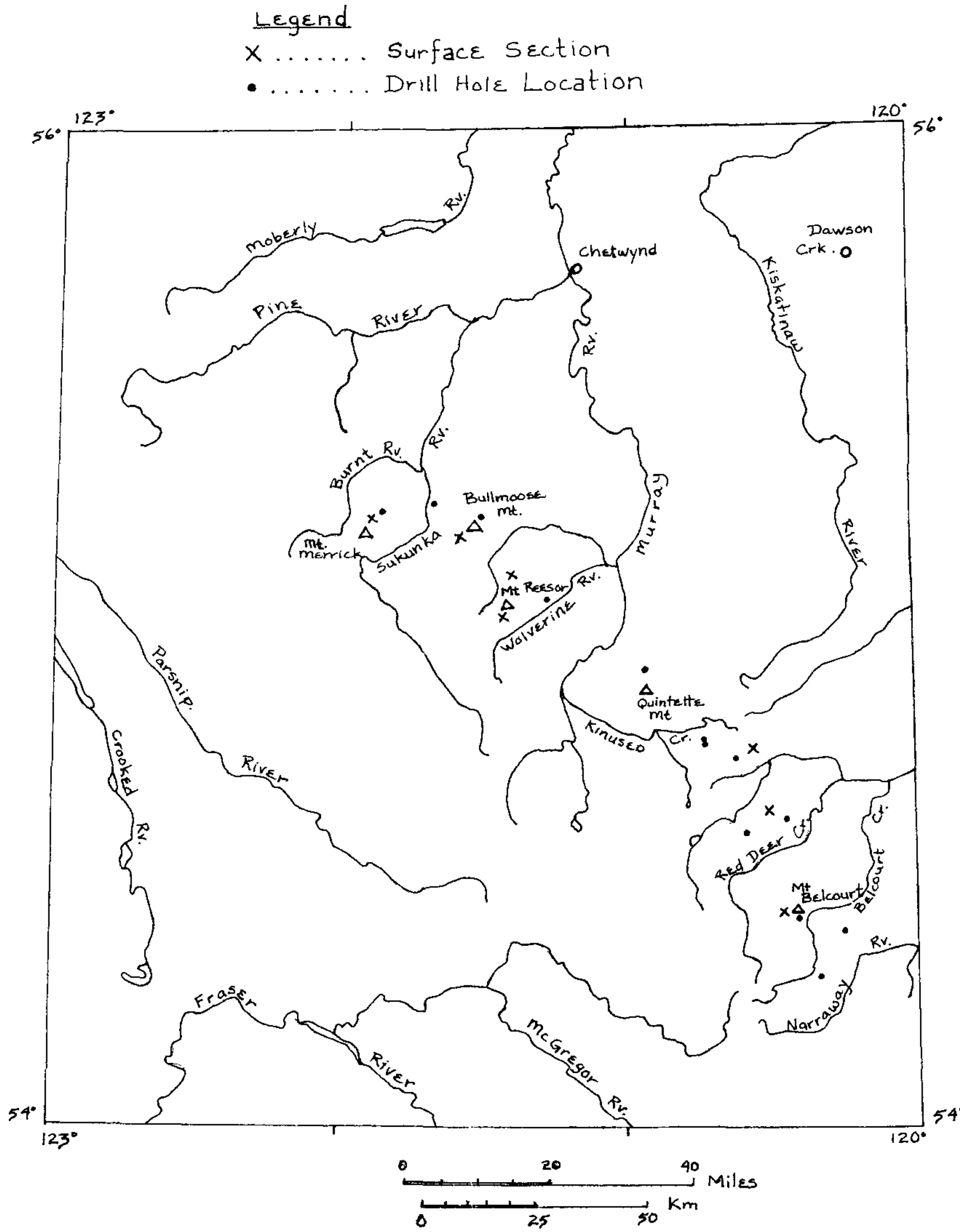

Figure 3. Surface sections and drill hole locations, Narraway River-Burnt River.

Trilobosporites apicerructus. Although the assemblage appears to be dominantly terrestrial the presence of dinocysts in one sample suggests occasional marine incursions. This assemblage correlates with the Calcareous Member of the Lower Mannville Group (Pocock, 1962) and in the Gething and Calcareous Member (Zeigler and Pocock, 1960) suggesting a Late Barremian age.

The presence of dinocysts in several of the Gates samples and one of the Gething samples supports the proposal by Gilchrist that marine incursions have occurred in the non-marine sequences. Macrofossils found in core by P. McL. D. Duff should provide a useful check of the relative ages of the palynomorph assemblages described above.

These preliminary results suggest that the unconformity at the base of the Cadomin Formation does not represent a significant time gap in deposition. Mudstone samples from a coal-bearing lens in the Cadomin to the north may provide a better indication of the temporal relationship of this unit to those above and below.

Only one section has been processed to date and it is not yet possible to recognize palynological or stratigraphic horizons. However, the presence of marine beds in non-marine sequences, and the abrupt appearance of species or assemblages holds much promise for the existence of such horizons.

SUMMARY

Until recently work in the northeast coal block has been concerned primarily with locating economic coal deposits. Complex structure and a poor understanding of the stratigraphy have hampered the search and attention is now being turned to solving these problems. Initial results of a study of the palynology indicate a potential for determining age relationships, locating stratigraphic horizons and laterally correlating strata. Distinct assemblages in the Upper Minnes Group and Gething Formation, and marine units in non-marine sequences have been identified. It is hoped that as processing of samples continues a microfossil type-section will be generated which will serve as a useful tool in its own right and add support to other stratigraphic studies currently in progress.

ACKNOWLEDGMENTS

I would like to thank Dr. G.E. Rouse for his assistance in identifying the assemblages noted in the preliminary results and for his ongoing support, R.D. Gilchrist for providing stratigraphic information based on studies carried out in conjunction with P. McL. D. Duff, and the companies that generously offered information on surface section locations and their time to discuss and examine the geology and stratigraphy of their respective properties, most notably PetroCanada, Denison Mines, BP Exploration, and Gulf Canada Ltd. I am especially grateful to the British Columbia Ministry of Energy, Mines and Petroleum Resources for their support of this project.

REFERENCES

Hughes, J.E. (1964): Jurassic and Cretaceous Strata of the Bullhead Succession in the Peace and Pine River Foothills, B.C. Ministry of Energy, Mines & Pet. Res., Bull. 51, 73 pp.

.... (1967): Geology of the Pine Valley, B.C. Ministry of Energy, Mines & Pet. Res., Bull. 52, 137 pp.

Norris, G. (1967): Spores and Pollen from the Lower Colorado Group (Albian?-Cenomanian) of Central Alberta, Palaeontographica, Series B, Vol. 120, pp. 71-115.

Pocock, S.A.J. (1962): Microflora Analysis and Age Determination of Strata of the Jurassic-Cretaceous Boundary in the Western Canada Plains, Palaeontographics, Series B, Vol. 111, pp. 1-95.

Singh, C. (1964): Microflora of the Lower Cretaceous Mannville Group, East-Central Alberta, Research Council of Alta., Bull. 15, 238 pp.

.... (1971): Lower Cretaceous Microfloras of the Peace River Area, Northwestern Alberta, Research Council of Alta., Bull. 28, Vol. 1, 299 pp.

Stott, D.F. (1968): Lower Cretaceous Bullhead and Fort St. John Groups, Between Smoky and Peace Rivers, Rocky Mountain Foothills, Alberta and British Columbia, Geol. Surv., Canada, Bull. 152, 279 pp.

.... (1973): Lower Cretaceous Bullhead Group Between Bullmoose Mountain and Tetsa River, Rocky Mountain Foothills, Northeastern British Columbia, Geol. Surv., Canada, Bull. 219, 228 pp.

Zeigler, W.H. and Pocock, S.A.J. (1960): The Minnes Formation, Field Meeting Guide, Edmonton Geol. Soc., June 1960, pp. 43-71.

APPENDIX

Extracting Palynomorphs

(1) Wash approximately 50 grams of sample, crush to pea size, and place in plastic beaker; rinse twice to remove clay and damaged palynomorphs.

(2) Test for carbonates using a 10-per-cent solution of HCl; when no more fizzing is evident rinse sample three times with water.

(3) Place beaker with sample in a water bath in a fumehood and add full strength HF acid in small increments (to prevent 'boiling over') until the volume of acid is approximately 10 times that of sample; place on magnetic stirrer, add spin bar, and leave 24 to 48 hours (inside the fumehood).

(4) Remove from stirrer and allow to settle until acid is almost clear; pour spent acid into waste bottle; rinse sample three times in water allowing to settle between each wash so that very fine clay remaining in suspension may be siphoned off.

(5) Rinse through 210 µm sieve to remove coarse fragments retaining the liquid fraction; pour through 20 µm sieve retaining sediment trapped in sieve; rinse into centrifuge tube.

(6) Examine by placing a drop of sample on a glass slide to determine degree of carbonization of palynomorphs (if present) and amount of mineral matter still present.

(7) Bleach black and dark brown palynomorphs to reduce their specific gravity (before carrying out heavy liquid separation) or to lighten to pale to golden yellow for easier identification; rinse three times to remove bleach.

Concentration of bleach and length of bleaching vary for each sample - start with low concentrations (5-10 per cent) for short periods of time (2-5 minutes) and increase as necessary.

(8) Remove unwanted mineral matter by neutralizing in 10 per cent HCl acid and centrifuging in $ZnBr_2$ with a specific gravity of 3.4; pipette organics ('float' material) into a clean test tube, neutralize again with 10 per cent HCl and rinse three times with water.

(9) Bleaching may break down unwanted organics permitting their removal by a second 20 µm sieving.

(10) Stain sample with Safrinin (red); make fine, medium and coarse mount by placing a drop of elvanol on a coverslip with 1 or 2 drops of sample; stir to distribute evenly and dry slowly on hotplate or in dessicator; place a blob of gelva on a glass slide and invert the coverslip with sample onto it; press to spread gelva; label.