LATE CRETACEOUS AND EOCENE PALYNOFLORAS FROM FILDES PENINSULA, KING GEORGE ISLAND (SOUTH SHETLAND ISLANDS), ANTARCTICA

L. CAO

Nanjing Institute of Geology and Palaeontology, Academia Sinica, Nanjing 210008, China

Abstract: Rock samples from the volcanic sedimentary series in the Fildes Peninsula of King George Island, Antarctica, contain two palynofloras, indicating different geological ages. The Half Three Point Formation contains a late Late Cretaceous Palynoflora including about 40 species of fungal spores and 60 species of Pteridophyte spores, gymnosperm and angiosperm pollen grains. The palynomorphs are mainly derived from the latest Mesozoic terrestrial plants, which indicate rain forest vegetation growing on the shores of marshy lakes in mountainous or hilly areas. Because no marine fossils are present, the Half Three Point Formation is probably a terrestrial deposit. The lower part of the Fossil Hill Formation contains fossil leaves and abundant palynomorphs, mainly spores of Cyatheaceae and Lygodiaceae, pollen grains of Araucariaceae, Nothofagidites and Proteaceae. The palyniferous strata is probably of Early and Middle Eocene age. The upper part of the Fossil Hill Formation also contains abundant palynomorphs (ca. 150 species). Of them, Pteridophyte spores, gymnosperm and angiosperm pollen grains occupy 38%, 30% and 32% respectively. Judging from the comparative study, its geological age is the same as, or slightly younger than, the lower part of the formation.

Key words: sporo-pollen, palynomorph, Eocene, Cretaceous, fossil leaf

Introduction

Palynomorph studies on rock samples collected from the volcanic sedimentary rocks of the Eocene, Oligocene and Early Miocene in Admiralty Bay of King George Island and the Fildes Peninsula have been carried out in the past decade by five palynologists in Poland, Brazil, Chile and France (Stuchlik, 1981; Lyra, 1986; Palma-Heldt, 1987; Torres and Meon, 1990). The problem of whether or not there are Mesozoic volcanic rocks in the Fildes Peninsula has been long disputed among geologists. Although Barton (1965) designated the volcanic rocks of the south Fildes Peninsula as the “Jurassic volcanic rock group”, and those in the central and northern parts as the Cretaceous Fildes Peninsula group, there was no paleontological evidence in support of the assumption that this suite of volcanic rocks is of the Jurassic or Cretaceous age.

In order to determine the geologic age of this volcanic rock series and, moreover, enter into stratigraphic classification and correlation, the present author has made sporo-pollen analysis of 20-odd rock samples from the three plant leaf-bearing localities; namely, the Half Three Point Formation (Shen, 1991), the Fossil Hill and the Rock Cover, and has obtained abundant palynomorphs.

Half Three Point Formation

The Half Three Point Formation is located on a small island along the seaside in the Half Three Point area south of the Fildes Peninsula. There, in the volcanic rock series, are sedimentary formations 5.5 m in thickness, containing gray and greenish gray sedimentary tuff and tuffaceous siltstones. Among the eight rock samples under analysis, four contain rich palynomorphs assemblages, totalling 100 species. They include one species of acritarch cyst, Baltisphaeridium sp., which occurs occasionally and individually and accounts for less than 0.5% of the total. Present too are 40 species of fungal spores: Brachysporisporites spp., Dicellasporesites popovi Ellisk, D. spp., Diporicellasporesites spp., Dyadosporites sp., Fractisporites spp., Inapertisporites sp., cf. L. obpyriformis Sheffy and Dilcher, I. sp., Involutisporites sp., Lacrimasporites spp., Multicellasporesites sp., cf. M. ovatus Sheffy and Dilcher, M. sp., cf. M. ellipticus Sheffy and Dilcher, M. spp., Pluricellasporesites sp., Reduviaporites spp. and Staphylosporites sp., accounting for 1–12% of the total sporo-pollen content, up to 20% in individual samples (Fig. 1). Bryophyte spores including Sphagnumporesites sp. and Foraminosporesites dailyi (Cookson et Dettmann) Dettmann, are of lower frequency, accounting for less than 1%. Forty species of fern spores, composed mainly of Deltoideospora hallii Miner, D. microlepoides (Krutzh) Wang, D. spp., Alsophilidites kerguelensis Cookson, A. spp., Cyathidites minor Couper, C. sp., cf. C. minor Couper, C. sp., Clavifera triplexis Bolchovitina, C. jachromensis Bolchovitina, C. spp., Gleicheniidites sensonicus Ross, G. sp., cf. G. delcourtii Döring, G. sp., Plicifera decora (Chlon.) Bolchovitina, P. delicata (Bolchovitina) Bolchovitina, P. spp., Cibotiumspora sp., Appendicosporesites sp., Klukisporites sp., Osmundacidites sp., Echinospores sp., Polypondisporites faves (Potonié) Potonié, P. sp., Extrupunctatorisporites sp., Aequitriradites spinulosus (Cookson and Dettmann) Cookson et Dettmann, Astersporites sp., Biretisporites sp., Foveotriletes scrobiculatus (Ross) Potonié, Leiotritiles sp., Neoralistrockia truncatus (Cookson) Potonié, Undulatisporites sp. and Furrucosporites sp., account overwhelmingly for 81.5%, among which are Gleicheniaceae (28%), Cyatheaceae (20.5%), Adiantaceae (10.5%), Polypodiaceae (3%), Dicksoniaceae, Lygodaceae. Osmundaceae and Selaginellaceae (1%) respectively; indeterminate spores (15.5%).

It may be clearly seen that Gleicheniaceae, Cyatheaceae and Adiantaceae are dominant in the plant communities.

Gymnosperm pollen are rather poor, consisting of eight species, namely Araucariacites australis Cookson, A. sp., Abietinae pollenites microaustus (Potonié) Dilcort et Sprumont, Microcachrydites sp., Phyllocladidites sp., Podocarpidites ellipticus Cookson et Couper, Gnetaceae-pollenites sp. and Dacrydium sp., occupying only 2% of the total content. Angiosperm pollen are low in abundance, including 10 main species such as Nothofagidites senectus Dettmann et Playford, N. spp., Cranwellia sp., Gothanipollis bassensis Stover, Trilcorpollenites spp. and Triporopollonites sp., accounting for 3% (Fig. 2).

This sporo-pollen assemblage differs somewhat from that of the Cretaceous in James Ross Island of the Antarctic Peninsula, which contains 62 species of Cryptogam spores, 54 species of pollen and 80 species of dinoflagellate cysts (Dettmann and Thomson, 1987). It differs also from that of the upper Campanian-Maastrichtian in Seymour Island of the Antarctic Peninsula, where there are plentiful gymno- sperm and angiosperm pollen, with cryptogam spores amounting to only 6–15% of the total sporo-pollen content (Askin, 1990a, b), a fact which may have had something to do with the sedimentary environment and the conditions for preservation.

According to Askin (1989a, b, 1990b), the palynofloras during the period ranging from Late Cretaceous to Paleogene in the Antarctic Peninsula exhibit five levels of provincialism: i.e. the endemic species in the James Ross Island basin and Seymour Island of the Antarctic Peninsula; Antarctic species; and those taxa of Weddellian (i.e. the biogeographic Realm of southern South America - West Antarctica - New Zealand - southeastern Australia region), in which Nothofagidites is the typically diagnostic element; Austral elements refer to some of the taxa existing in such regions as Antarctica, southern South America, south Africa, Australia as well as India, Malay Archipelago; and cosmopolitan taxa. At present, the Half’ Three Point palynological assemblage, though different more or less from those of James Ross Island and Seymour Island, is on the whole comparatively similar in vegetation aspects to share basic characteristics with five different geographical provinces and maybe correlated with those Cretaceous palynofloras of James Ross Island and Seymour Island. Judged by the general aspects of palynofloras, it belongs to the Weddellian biogeographical province and is rather close to the Late Cretaceous palynofloras in southern South America, West Antarctica, New Zealand and southeast Australia.

In the Half’ Three Point palynoflora, Foraminisporis dailiyi, Cyathidites, Deltoisadpora, Klukispores, Appendicispores and Aeguirroradites spinullosus were all taxa widespread in Late Mesozoic and can be found here and there in the Cretaceous beds of the Antarctic Peninsula, whereas Gleicheniidites and Clavifera, despite occurring in Paleogene, were primarily evolving in Cretaceous and are distributed in both the Early and Late Cretaceous strata in the Antarctic Peninsula. It has been shown from known stratigraphic distributions that Asterispores made its appearance centrally in Cretaceous but not in Paleogene so far (e.g. Venkataramula and Rawat, 1970). Hence, the possibility of the palynoflora-bearing rock series of the Half Three Point Formation being referable to the Early Paleogene should be ruled out. The gymnosperm pollen show Araucariaceae and Podocarpaceae to be dominant, and these are distributed in strata ranging from Cretaceous to Tertiary in the Antarctic Peninsula. They are known to be elements common in rainforest communities. In the palynoflora under study, there are angiosperm pollen like Nothofagidites, Cranwellia, Gothanipollis, Triporopollonites and Tricorpollonites, which had not emerged until the later stage of Late Cretaceous; therefore the geological age must be considered as post Early Cretaceous. According to available data, the ancestral pollen type of Nothofagidites was N. senectus, which was first reported in the early Campanian of the Late Cretaceous. Since the palynoflora under study contains Nothofagidites senectus and four other species of Nothofagus, the geological age of the Half Three Point Formation might be either Campanian or Campanian - Maastrichtian.

Among the leading elements of the palynoflora in the Half Three Point Formation are those terrigenous plant communities in south Gondwana during the Late Mesozoic that reflect a vegetation type with ferns as major elements in an environment of low hills and lake shores. On the nearby hillslopes Gleicheniaceae, Cyatheaceae, Adiantaceae, Dicksoniaceae, Lygodiaceae, Osmundaceae and Polypodiaceae, etc. were growing, along with certain taxa of Cyatheaceae, Adiantaceae and Dicksoniaceae. In this kind of vegetation, in addition to the sparse broad-coniferous mixed forests composed of Araucariaceae-Podocarpaceae-Nothofagus, other rain forest communities composed of Araucariaceae-Podocarpaceae-Nothofagus may have existed in hilly areas. Extant ferns like Gleicheniaceae, Cyatheaceae, Dicksoniaceae and Lygodiaceae are currently to be found primarily in the tropics and secondarily in the subtropic and cool subtropics. Thus, it is possible that then vegetation landscape reflected by the sporo-pollen assemblages was like this: luxuriant hygrophilous and thermophilous ferns on the lake shore and the hillslope, in addition to sparsely living in mixed forests composed of coniferous broad-leaved plants. In the distant mountainous area were rain forest communities, where there was climbing liana Loranthaceae, for example, Cranwellia, of which the parent plant is a typical climber. On the lake shore, there were Anthocerotaceae and Sphagnaceae, and in the lake there were also algae-acritarchs. All these indicate that the then climate was warm-cool and humid. What supports this deduction is that the present assemblage also contains many species of fugal spores because the present parent plants have a preference for humid and probably frost-free environments.

In the palynomorph-bearing rock series of the Half Three Point Formation, no marine or littoral animal fossils have been found. Based on sedimentary features, the strata of the Half Three Point Formation may have been deposited in a freshwater limnic environment resulting from damming by basaltic lava flows. Its limited distribution suggests that this formation was a small-sized lacustrine deposit, probably representing an interstitial phase in volcanic eruptions. However, the presence of individual Baltisphaeridium may possibly imply that this lake was occasionally subjected to submergence by the sea. Moreover, in the land plant fossils, palynomorphs are in the overwhelming majority, especially fern spores, which seem to be deposited in situ, not being
Fig. 1. Photomicrographs of palynomorphs collected from the upper Cretaceous Half Three Point Formation. Magnification ×1200. Sample and slide number stored in Nanjing Institute of Geology and Palaeontology is provided for each specimen. 1) Pluricellalesporites sp., GWP5(12); 2) Dicellalesporites popovi Elsik, GWP5(10); 3) Lacrimasporonies sp., GWP7(5); 4) Brachysporisporites sp., GWP5(3); 5) Multicellalesporites sp. 1, GWP5(2); 6) Inapertisporites sp., GWP5(3); 7) Staphylasporonies sp., GWP7(5); 8) Redevisporonies sp., GWP7(8); 9) Multicellalesporites sp. 2, GWP5(8); 10) and 11) Fractisporonies spp., GWP5(6,10).
Fig. 2. Photomicrographs of palynomorphs collected from the upper Cretaceous Half Three Point Formation. Magnification ×1200. Sample and slide number stored in Nanjing Institute of Geology and Palaeontology is provided for each specimen. 1) Cyathidites minor Couper, GWP6(14); 2) Alsophilioidites sp., cf. A. kerguelensis Cookson, GWP6(11); 3) Plicifera sp., GWP4(9); 4) Cyathidites sp., cf. C. minor Couper, GWP6(9); 5) and 7) Giechenioidites sp., GWP6(12); 6) Extrapunctatosporis sp., GWP6(14); 8) Nothofagidites sp., GWP6(12); 9) and 10) Asterisporites sp., GWP7(3,12).
Fig. 4. Photomicrographs of palynomorphs collected from the upper part of Eocene Fossil Hill Formation. Magnification ×1200. Sample and slide number stored in Nanjing Institute of Geology and Palaeontology is provided for each specimen. 1) Multicellularasporites sp., GWP49(15); 2) Gleicheniidites sp., GWP49(3); 3) Lycopodiumsporites agathoecus (R. Potonie) Thiergart, GWP49(14); 4) Liotritelles sp., GWP49(1); 5) Peninsulapoliss truswelliae Dettmann et Jarzen, GWP49(15); 6) Peninsulapoliss gillii (Cookson) Dettmann et Jarzen, GWP49(14); 7) Triorites sp., GWP49(1); 8) Podocarpidites ellipticus Cookson, GWP49(15); 9) Tricolporopollenites sp., GWP49(14); 10) Nothofagidites sp., cf. N. emarginatus (Cookson) Harris, GWP49(15); 11) Nothofagidites sp., cf. N. flemingii (Couper) Potonie, GWP49(14); 12) Proteacidites sp., GWP49(15).
transported a long distance. Hence, the sporo-pollen-bearing horizon in question is clearly of continental facies.

**Fossil Hill Formation**

**Lower part**

In the lower part of the Fossil Hill Formation, which bears megaplant leaf fossils, sporo-pollen analysis of the fern plant fossil specimens has revealed a rich content of palkynomorphs, including such dominant elements as **Lygodioisporites** spp., **Concavisperites** sp., **Cysthidites** sp., **Trisaccites** sp., **Phyllocladidites** sp., **Podocarpites** sp., **Araucariacites** sp., **Nothofagidites cranwelliae** (Couper) Mildenhall et Pocknall, **Nothofagidites** sp., cf. **N. fuesgensis** Menendez and Caccavari, **Proteacidites** sp., cf. **P. stipitatus** Partridge and **Proteacidites** sp., etc. (Fig. 3). This palkynoflora represents a forest vegetation composed mostly of **Podocarpaceae-Araucaria-Nothofagus**, having an undergrowth of luxuriant hygrophilous and thermophilous fern plants and shrubs such as **Pteridaceae**. Judged by the distribution of these palkynoflora taxa extending up to the present, this flora was growing under the climatic conditions of warm and cool as well as rainy, corresponding more or less to those Eocene palkynoflora in South America, New Zealand and Australia. Its geological age is suggested as possibly Early to Middle Eocene, a result which is in accord with what was studied on the plant leaf fossils of those leading elements by Li and Shen (1989, 1990) although it was suggested palynologically to be Early Eocene (Torres and Meon, 1990).

**Upper part**

In the upper part of the Fossil Hill Formation, situated in the Rocky Cover region, the volcanic series contains some 150 species of palkynomorphs, in which are a specific amount of fungal spores and fern plant spores. These include as dominant elements: **Multicellulaesporites** sp., **Laevigatosporites** sp., **Ischyosporites** sp., **Punctatisporites** sp., **Polypodiaceae** sp., **Foveasporis** sp., **Totorisporis** sp., **Cysthidites** sp., **Gleichenidites** sp., **Leiotrilites** sp., **Concavi-sporites** sp. and **Lycopodiumsporites agathocoeus** (R. Potonié) Thiergart, etc., accounting for 38% of the total content of palkynomorphs. Among the dominant gymnospermous pollen are **Dacrycarpites** sp., **Podocarpites ellipticus** Cookson, **Phyllocladidites** sp. and **Araucariaeites** sp., etc. (30%); among the dominant angiosperms are **Nothofagidites** sp. and **N. flemingii** (Couper) Potonié, **Nothofagidites** sp., cf. **N. emarginatus** (Cookson) Harris, **Nothofagidites** sp., **Proteacidites** sp., **Myrtaceidites** sp., **Momipites** sp., **Priorites** sp., **Penisulapolpis gilli** (Cookson) Dettmann et Jarzen, **P. truswelliae** Dettmann et Jarzen, **Triporopollenites** sp. and **Tricloropollenites** sp., etc. (32%) (Fig. 4).

This sporo-pollen assemblage is similar in aspects to Eocene palkynoflora in South America, New Zealand and Australia, especially to those at the Leaves Hill (Lyra, 1986) and Admiralty Bay (Stuchlik, 1981) in King George Island, Antarctica, reflecting a rain forest plant cover composed mainly of **Podocarpaceae-Araucaria-Nothofagus**, with an undergrowth of hygrophilous and thermophilous ferns. For these reasons, this palkynoflora was possibly deposited under paleoclimatic conditions of warm-cool and humid, and its geological age is possibly the same as, or only slightly younger than, the lower part of the formation.

**Acknowledgements**

The author would like to express his gratitude to Dr. Shen Yanbin (Nanjing Institute of Geology and Paleontology, Academia Sinica) for supplying the rock samples upon which this study is based, and to Drs. F. M. Truswell (Bureau of Mineral Resources, Canberra) and Ouyang Shu (NIGP, Academia Sinica) for their critical reading of the manuscript and valuable comments. The project was supported by National Natural Science Foundation of China and State Antarctic Committee, China.

**REFERENCES**


