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Subdivision and Correlation of Eocene Fossil Hill Formation from King George Island, West Antarctica

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ABSTRACT. Based on differences in lithofacies, depositional environment and biota, the Fossil Hill Formation can be subdivided into two members, the lower Great Wall Bay Member and the upper Rocky Cove Member. The Great Wall Bay Member is the main fossil-bearing horizon in the Fildes Peninsula and consists of volcanic breccieas, tuffites, tuffaceous sandstones and siltstones, about 12.5m in thickness, reflecting a proluvial and fluviolacustrine sedimentary environments. The Rocky Cove Member is mainly composed of yellowish green tuffs, interbedded lava, reflecting an intermontane basin accumulation. Fossils of both spore pollen and leaves indicate that the Fossil Hill Formation is probably of Middle Eocene in age.

A stratigraphic correlative studies indicate that the Fossil Hill Formation may be equivalent to Petrified Forest Member of the Arctowski Cove Formation in the Admiralty Bay, the Lower Volcanic Member of Fildes Formation in the Barton Peninsula of King George Island and the lower and middle parts of the La Meseta Formation in Seymour Island of the Antarctic Peninsula.

Key Words: Fossil Hill Formation, Eocene, Subdivision, Correlation, Antarctica

Introduction

Fildes Peninsula located on the southwestern tip of King George Island contains a suite of subalkaline volcanic rocks and richly flora-bearing pyroclastic sedimentary sequence, belonging to the Fildes Peninsula Group (Hawkes 1961). This group is monoclinal dipping 10-15° to northeast and is divided into five formations and an abnormal lithostratigraphic unit based on lithologic, biotic and volcanic characteristics, in ascending order: Half Three Point Formation, Jasper Formation, Agate Beach Formation, Fossil Hill Formation, Block Hill Formation and Suffield Point Volcanic, ranging from Late Cretaceous to Early Miocene in age (Shen 1994) (Fig.1).

Fossil Hill Formation is one of important stratigraphic units for understanding Tertiary continental deposits and paleogeographic and paleoclimatic environments in forearc of the Antarctic Peninsula. In this study the subdivision and correlation of the Fossil Hill Formation are stressed essentially based on the 1994/95 field works in the Fildes Peninsula, the Barton Peninsula and the Admiralty Bay of King George Island and on recent palaeontological results.

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Stratigraphy

Great Wall Bay Member

The Fossil Hill Formation (FHF) was proposed by Chinese Antarctic Expedition (Li and Liu 1987). Fossil Hill e.g. Mount Flora is situated at 62°12′25″S, 58°58′13″W and a height of 106.5m above sea level between the Chinese Great Wall station and the Chile Presidente Frei station in the Fildes Peninsula,

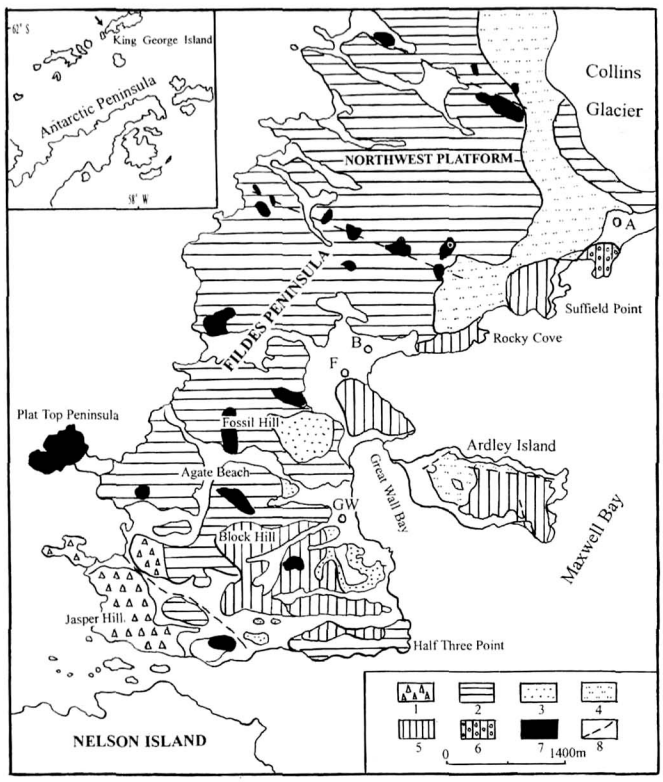

Fig.1. Map showing the stratigraphic units of Fildes Peninsula Group.
1. Jasper Hill Formation; 2. Agate Beach Formation; 3. Great Wall Bay Member of Fossil Hill Formation; 4. Rocky Cove Member of Fossil Hill Formation; 5. Block Hill Formation; 6. Suffield Point Volcanic; 7. subvolcanics; 8. fault; GW: Great Wall station (China); F: Presidente Frei station (Chile); B: Bellingshausen station (Russia); A:Artigas station (Uruguay) (modified after Shen 1994).

King George Island (Fig.1). This is a famous locality with the occurrence of abundant fossil floras and bird footprints (Covacevich and Rich 1982; Li 1992; Lyra 1986). Shen (1994) further subdivided the FHF into lower and upper parts based on lithofacies, depositional environment and biota. The strata outcropping in the type area only represent the lower part of the formation. It mainly consists of volcanic breccieas, pyroclasts, zeolitized tuffites, tuffaceous sandstones and siltstones, interbedded with two coal seams, about 12.5m in thickness. This member rests unconformably on the Paleocene Agate Beach Formation at Fossil Hill. Various structures are developed in the rocks, such as graded rhythmite, small zeolitized "concretions" on the bedding surface, the "lattice window-like" fractures resulted in tectonic pressed stress after diagenesis and remain-mottled structure produced by zeolitization (Xue *et al.* 1996). Abundant trace fossils were also found in the section, which are commonly associated with bird tracks. The tracemakers were considered as thin bilateral symmetrical wormy animal, presumably Oligochaeta (Yang and Shen 1999).

In this study the lower part of the formation, the main fossil-bearing horizon in the Fildes Peninsula, is named Great Wall Bay Member. Both palynomorph and leaf assemblages indicate that the member is probably of Middle Eocene or Early-Middle Eocene in age (Li 1992; Cao 1992), which is just coincident with the isotopic age (52±1 – 43±2Ma) (Li *et al.* 1992).

The Great Wall Bay Member represents a proluvial, fluviolacustrine depositional environments in forearc, approaching to seacoast or bay on the basis of presence of coccolithes in the Fossil Hill (Lyra 1986). Fossil Hill flora is dominated by *Nothofagus, Podocarpus, Araucaria* and *Papuacedrus*, with undergrowth *Thyrsopteris* and a kind of tree fern, the cycad Dion etc. According to "the nearest living relative method and leaf physiognomic analysis," the plants of the Fossil Hill Flora probably grew under a warm temperate-subtropical rainforest. The mean annual temperature was probably 10-14°C and the precipitation was high reaching to 1,000mm/Yr (Li 1992). The area where the plants were growing was at rather low altitude (Shen 1998).

Rocky Cove Member

In the present paper the upper part of the formation is named Rocky Cove Member. The type section of the member is at Rocky Cove (62°11′S; 58°55′W) between the Russian Bellingshausen station and the Uruguay Artigas station, The member is chiefly composed of yellowish green tuffs, interbedded lava, reflecting an intermontane basin accumulation (see Shen 1994, p. 31-32). The member has a visible thickness over 36m, whereas at the western margin of Collins Glacier about 30 m. It is slightly younger than the Great Wall Member in view of stratigraphic relation, although relationships between both members are not directly shown in this area. Its contact with the overlying massive agglomerate of the Eocene Block Hill Formation is unconformable at

the type area. The Rocky Cove Member is more widespread than the Great Wall Bay Member in the Fildes Peninsula, including those of Ardley Island, Rocky Cove, and west of the Artigas station and the Collins Glacier (Fig. 1). Rich fossil woods and spore pollen have been recovered from Rocky Cove Member, but leaves are sporadic to be found (Torres 1984; Cao 1992; Zhang and Wang 1994; Song 1998).

It is worth noting that the stratified tuffs distributed along the western margin of Collins Glacier should be belonged to the Rocky Cove Member instead of the Paleocene Agate Beach Formation (Li *et al.* 1992). In where the greyish green tuffs contain several leaves, such as *Nothofagus* sp., *Podocarpus* sp. and *Araucaria* sp., and palynomorphs that are close similar to those of the Rocky Cove. About 95 taxa of palynomorphs were recovered from these beds, reflecting warm and humid climatic condition and showing the Eocene palynomorph aspects (Cao 1992; Song 1998).

Three kinds of fossil stems, *Podocarpoxylon fildesense, Caldcluvioxylon collinsense* and *Nothofagoxylon antarcticus*, were collected from the Rocky Cove Member (Torres 1984; Zhang and Wang 1994). They are all thick and bulky and are characterized by fairly distinct growth rings. The average breadth value of these rings for *P. fildesense* is 1.232 mm, and 1.05 mm for *C. collinsense*, attaining 2.94 mm at the maximum in the former and 2.4 mm in the latter, reflecting that the then climate along King George Island was much favorable for the existence of various kinds of plants (Zhang and Wang 1994). During the Eocene epoch the terrestrial paleoenvironment was heavily vegetated and humid and warm climatic similar to the present-day southern South America. A paleoisthmus linked the Antarctic Peninsula with southern South America (Shen 1998). The Fossil Hill Formation were probably located on the forearc basin (Elliot 1988; Thomson, *et al.* 1993), based on the volcanic sedimentary characters of this area.

Correlation

Near the Admiralty Bay of King George Island, the

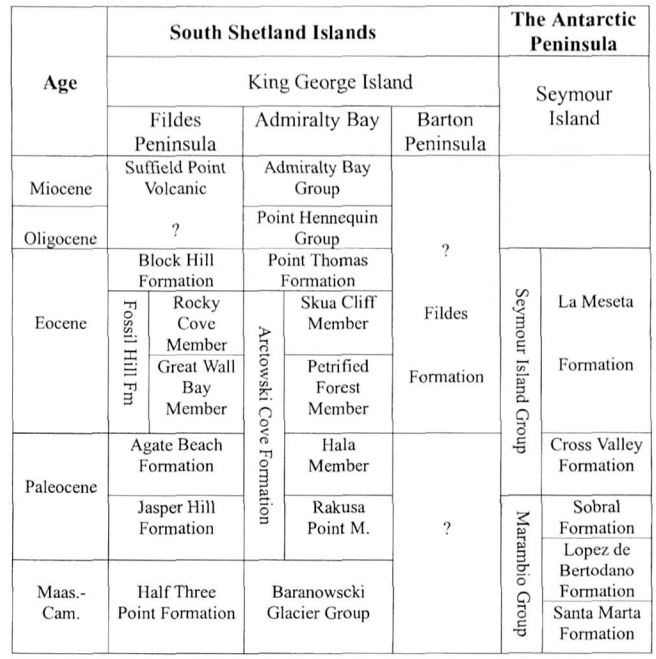

Fig. 2. Stratigraphic subdivision and correlation between the Antarctic Peninsula and King George Island

Petrified Forest Member of the Arctowski Cove Formation consists of shales, mudstones, tuffaceous sandstones and fan conglomerates, containing coal seams, 30-50 m in thickness. This member comprises leaves, stems and over 70 palynomorph taxa (Birkenmajer and Zastawniak 1989; Song 1997). The palynoflora assemblage of Eocene age reflects a warm temperate-subtropical climatic condition. Therefore, it may be correlative to the Great Wall Bay Member. Both members represent fluviolacustrine deposits and include coal seams (Fig. 2).

At Narebski Point of Barton Peninsula of King George Island several fossil leaves and woods occur in the Lower Volcanic Member of Fildes Formation (Chun and Chang 1991; Chun *et al.* 1994) or the Upper Tectonic Unit (Tokarski *et al.* 1987). More leaf specimens from this locality were collected by writer in February 1995. They include 9 species of 8 genera: *Annona* sp., *Liflsea* sp. *Thyrsopteris shenii, Helicia* sp. ?*Weinmannia* sp., *Laurophyllum* sp. *Rhododendron* sp., *Nothofagus* spp. (identified by Gou Shuang-xin of the institute). This assemblage shows Early Tertiary flora aspect rather than Mesozoic and is quite similar to those of Fossil Hill flora (Fig. 2).

In the Antarctic Peninsula, the La Meseta Formation is a deltaic and shallow marine sedimen-

tary sequences which yields various groups of biota, including macro- and microfossils, belonging to Eocene in age (Sadler 1988). Fossil Hill flora from the Great Wall Bay Member consists of more than 40 forms including 16 genera and 14 families, which mostly resemble to the Early Tertiary flora of southern South America and to those of lower and middle parts of the La Meseta Formation. Both of the lower part of the La Meseta Formation and the Great Wall Bay Member contain coal seams and are possibly correlative (Fig. 2). However, the results of geochemical analyses made on the fossil shell material from the La Meseta Formation suggest a considerable climatic cooling event at the time period of deposition of the upper part of the formation (Gazdzicki *et al.* 1992). This cooling event may be related to the final stage of the Gondwanaland breakup in the Antarctic Peninsula sector. The upper part of the La Meseta Formation considered as Late Eocene might be equivalent to Block Hill Formation.

Conclusion

1. The Fossil Hill Formation is further subdivided into two members, the lower Great Wall Bay Member and the upper Rocky Cove Member respectively. They are of Eocene in age.

2. The yellowish green tuffs exposed west of the Collins Glacier should be attributed to the Rocky Cove Member rather than to Paleocene Agate Beach Formation.

3. The Fossil Hill Formation may be correlative with the lower and middle parts of the La Meseta Formation on Seymour Island in the Antarctic Peninsula. Both formations yield similar flora assemblages and contain coal seams, which shows a warm and humid rainforest climatic condition.

4. The flora-bearing beds of the Fildes Formation on the Narebski Point of the Barton Peninsula are possibly equivalent to the Fossil Hill Formation. The fossil floras indicate that the Lower Volcanic Member of Fildes Formation are of Early Tertiary in age rather than of Mesozoic.

5. Both the Great Wall Bay and the Petrified Forest members represent an alluvial and fluviolacustrine sedimentary environment and have a similar megaflora and palynoflora assemblages and coal deposits.

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