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On the age of fossil flora from Barton Peninsula, King George Island, West Antarctica

ABSTRACT: Three tectonic units occur in folded stratified volcanic sequence on Barton Peninsula. Fossil flora (Del Valle *et al.* 1984) occurs in the basal part of the upper unit which age is not younger than Paleocene. The rocks of the middle and lower units are older, possibly Mesozoie.

Key words: Antarctica, paleobotany, stratigraphy.

Introduction

Fossil flora has been recently reported (Del Valle *et al.* 1984) from Barton Peninsula, King George Island. The site has been re-examined in 1986, in the course of structural research undertaken on the peninsula (Tokarski *in press*). A small collection of fragmentary deciduous leaf impressions have been collected. This collection, designated as collection no. 173/739—752, is housed at the Department of Paleobotany, W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków, Poland.

Regional setting

King George Island (Fig. 1) consists largely of stratified volcanic rocks. This volcanic sequence, except for its uppermost part, is calc-alkaline and belongs to volcanic arc related to Mesozoic-Cenozoic eastward subduction

of ancient Pacific ocean crust, which ceased about 4 Ma ago (Barker 1982). According to Birkenmajer (1983), the backbone of the island is formed by the Barton Horst (Fig. 2). Inside, the horst, volcanic rocks, divided by Birkenmajer (1982a) into the Martel Inlet and Cardozo Cove groups,

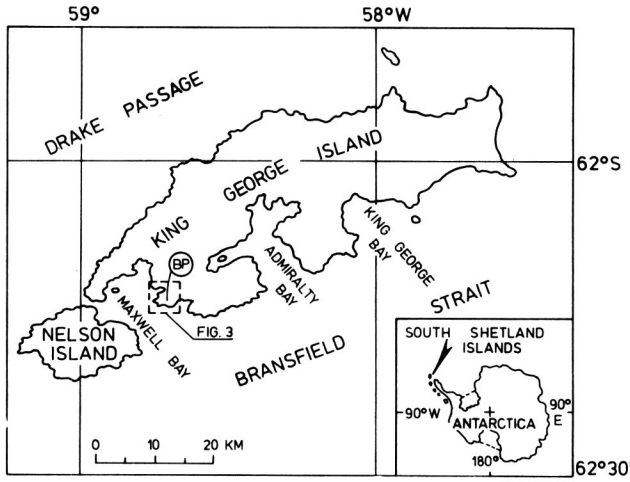

Fig. 1. Key map to show location of Fig. 3 (boxed) in King George Island (South Shetland Islands). BP — Barton Peninsula

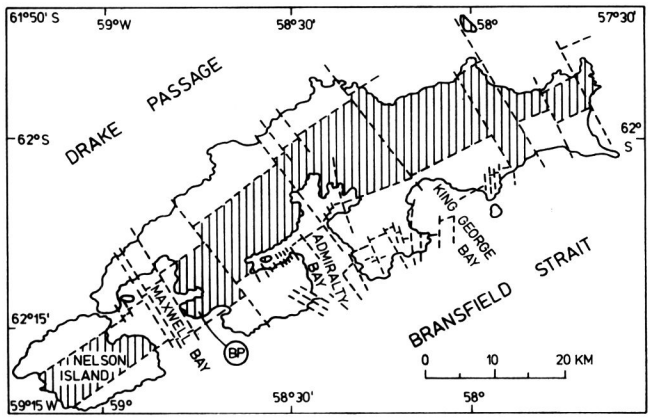

Fig. 2. Structural sketch of King George Island (*after* Birkenmajer 1983; simplified). Barton Horst vertically shaded; BP — Barton Peninsula

are commonly altered (carbonatised, chloritised), whereas those outside the horst are mostly fresh. The horst is pierced by numerous, calc-alkaline intrusions ranging in composition from quartz-gabbro to granodiorite. These intrusions were distinguished by Birkenmajer (1982a) as the Wegger Peak Group.

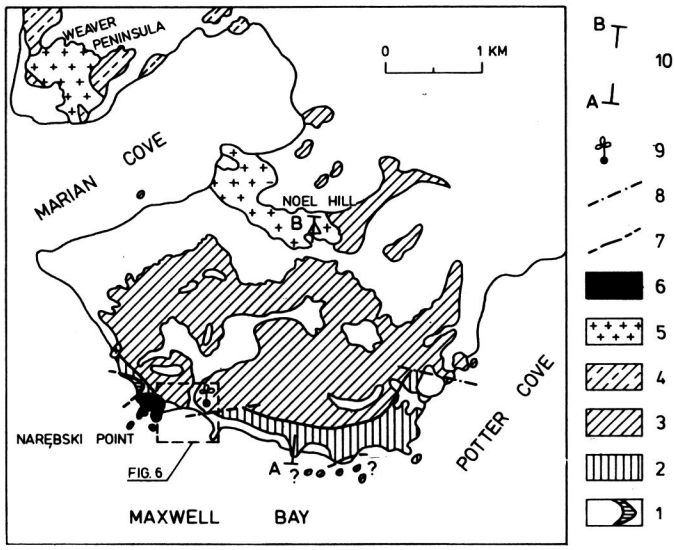

Fig. 3. Structural sketch of Barton Peninsula (*after* unpublished map by Birkenmajer 1981, with new tectonic elements introduced by Tokarski *in press*). Stratified sequence of Barton Horst: 1 — lower tectonic unit; 2 — middle tectonic unit; 3 — upper tectonic unit: 4 — undivided; 5 — Wegger Peak Group intrusions; 6 — basaltic plug; 7 — decollements; 8 — faults; 9 — fossil flora site; 10 — line of cross-section of Fig. 4; position of Fig. 6 marked by box

Barton Peninsula is situated at the south-western termination of the Barton Horst on King George Island (Figs. 2—3). According to Birkenmajer *et al.* (1983), stratified volcanics occurring there belong to the Cardozo Cove Group.

Outline of geological structure of Barton Horst

Barton Peninsula was mapped successively by Barton (1961, 1965), Davies (1982), Birkenmajer (1982b). According to Barton (*op. cit.*), and Davies (*op. cit.*), the stratified rocks on the peninsula are flatly dipping. This view was opposed by Birkenmajer (1982b) who ascertained that "there occur strongly folded, often vertical lavas, tuffs and agglomerates". This observation was however ignored by Smellie *et al.* (1984), according to whom the lower part of the stratified sequence dips at about 20° to the south, whereas the upper part is sub-horizontal.

The whole stratified sequence is pierced by two Wegger Peak Group intrusions and a volcanic plug (Fig. 3). The largest of them, the Noel Hill intrusion, is a composite intrusion ranging from quartz-gabbro through diorite, to granodiorite (Birkenmajer 1982b, Davies 1982, Birkenmajer *et al.* 1983, Smellie *et al.* 1984). These different lithologies have yielded different

K-Ar ages (for review *see* Birkenmajer *et al.* 1983, Smellie *et al.* 1984) down to about 60 Ma (quartz-gabbro). This date is a minimum age for the stratified sequence.

Tectonics of stratified sequence

Three tectonic units separated by subhorizontal decollements occur in the stratified volcanic sequence on Barton Peninsula (Tokarski *in press*) (Figs. 3—4).

1. The lower unit, exposed only in a restricted area immediately west from the basaltic plug at Narębski Point, comprises gently dipping rocks. Incomplete thickness of the unit is about 10 m.

2. The middle unit crops out in the coastal part of the peninsula,

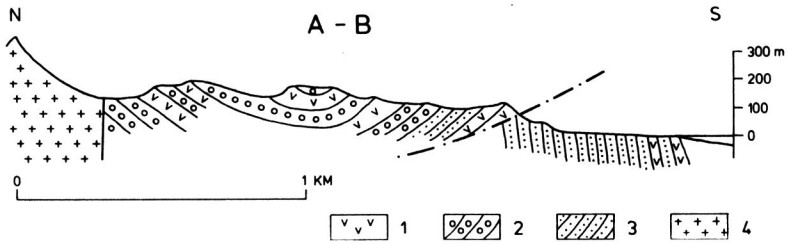

Fig. 4. Geological cross-section of Barton Peninsula (*after* Tokarski *in press*); 1 — lavas; 2 – agglomerates; 3 — lapillistones; 4 — plutonic rocks

from Potter Cove westward as far as a small Wegger Peak Group intrusion north-west from Narębski Point. It comprises steeply dipping rocks. The thickness of the unit is not known.

3. The upper unit, which occupies most of the peninsula, is gently folded. The thickness of the unit in the area between Maxwell Bay and Noel Hill is about 500 m.

The stratified rocks of the units II and III are folded around a NW—SE oriented axis, except close to the two smaller intrusions where strikes of folded rocks conform with the shapes of the intrusions (Tokarski *in press*). It appears that the whole stratified sequence represents a normal stratigraphic succession (Tokarski *in press*).

Fossil flora site

The discussed fossil flora site (Fig. 5) is situated in a cliff 45 m high, about 500 m east from the basaltic plug at Narębski Point (Figs. 3, 6), in the basal part of the upper tectonic unit (Fig. 4). The plant remains

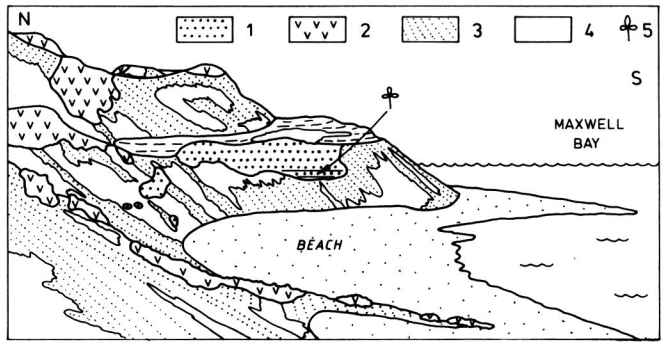

Fig. 5. Fossil flora site, view from Narębski Point (drawn from a photograph, February 1986); 1 — volcanoclastics; 2 — lavas; 3 — talus; 4 — snow; 5 — fossil flora site. Cliff on the first plan is about 50 m high

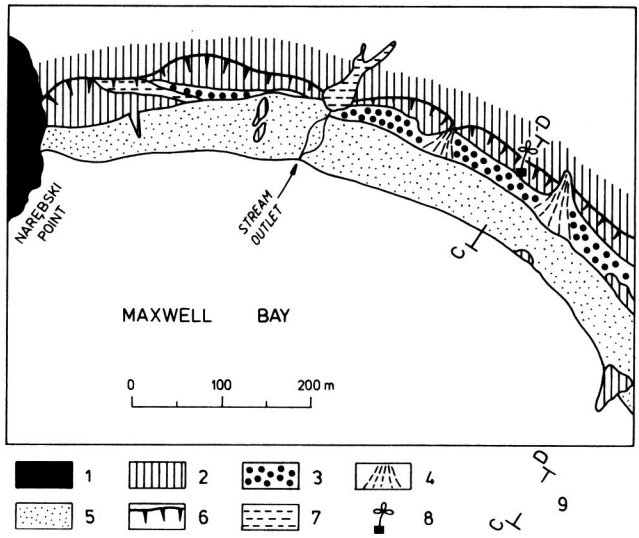

Fig. 6. Location of fossil flora site (*in* February 1986); 1 — basaltic plug; 2 — other bedrocks; 3—4 — talus; 5 — beach; 6 — cliff; 7 — snow; 8 — fossil flora site; 9 — cross-section line of Fig. 7

occur in the middle part of the cliff, at the base of a well exposed volcanoclastic sequence about 30 m thick (Figs. 5, 7; *cf.* Del Valle *et al.* 1984, Fig. 2). Ten fragmentary leaf impressions have been found (Fig. 8) in a layer of red pelitic tuff, 45 cm thick (Fig. 7), 22 m a.s.l.

Plant remains

Description. — The studied material comprises ten small fragmentary leaf impressions (Fig. 8). The shapes, sizes and margins of the leaves are not

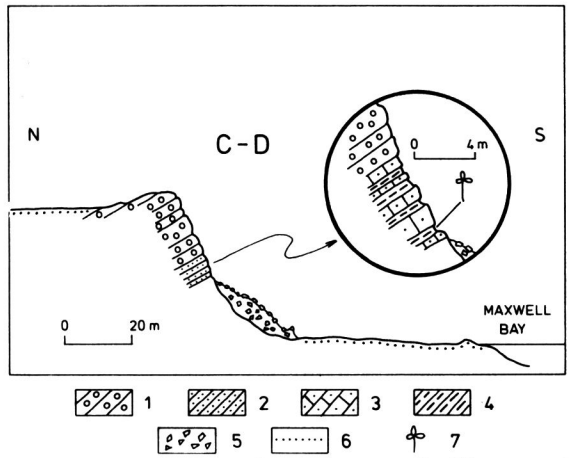

Fig. 7. Geological cross-section of fossil flora site; 1 — lapillistones; 2—4 — fine-grained tuffs; 2 — undivided; 3 — psammitic; 4 — pelitic; 5 — talus; 6 — other recent deposits; 7 — fossil flora site

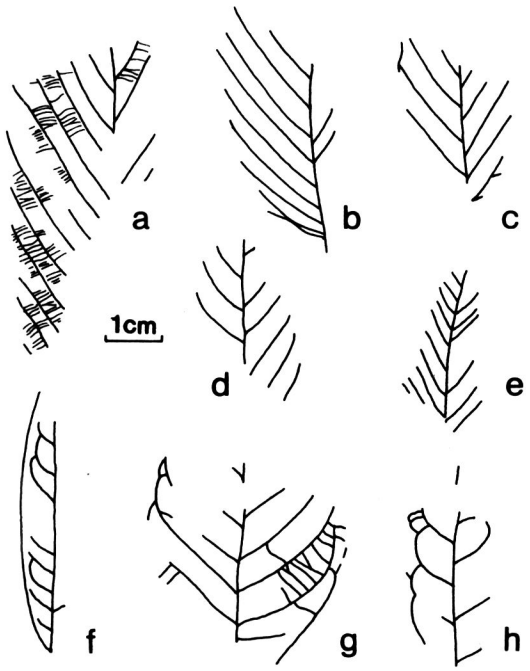

Fig. 8. Leaf impressions from Barton Peninsula: a, d — ?*Nothofagus*; b—c — ?*Nothofagus subferruginea* (Dusén) Tanai; e — ?*Nothofagus densi-nervosa* Dusén; f—h — dicotyledonous leaves of uncertain affinity

visible in these specimens, but fragments of venation are preserved, and these are characteristic of dicotyledonous angiosperms. Some specimens of craspedodromous type of venation (a—e) resemble *Nothofagus* leaves in their type

of venation. Venation in two of them (b—c) is similar to that in the leaves of a fossil species *N. subferruginea* (Dusén) Tanai, in one (e) to the leaves of another fossil species, *Nothofagus densi-nervosa* Dusén. The other leaf fragments (f—h), of camptodromous venation, represent undeterminable dicotyledons.

Discussion. — Leaf impressions described by Del Valle *et al.* (1984) were collected at the same place. Their material comprised eleven specimens. Seven of them, all fragmentary impressions of leaves, have been attributed to five fossil taxa: *Laurelia guinazui* Berry, *Nectandra prolifica* Berry, *Nothofagus densi-nervosa* Dusén, *Ocotea menendezi* Hunicken, and *Sterculia washburni* Berry. The distinguished taxa served base for dating the flora at Early Eocene — Early Oligocene, by reference to the fossil flora from Ardley Island (Peninsula) — Fildes Peninsula, King George Island (Orlando 1963, 1964) dated as Late Paleocene — Middle Eocene (Romero 1978), and to two localities from the Eocene of Argentina (Berry 1925, 1938).

The material described here, shown in Fig. 8, cannot be compared to the taxa distinguished by the mentioned authors, because of the small number of specimens, lack of complete leaf impressions, and because their material has not been illustrated.

It is difficult to decide what age the plant remains from Barton Peninsula represent, even when compared to the Tertiary and Late Cretaceous localities of West Antarctica where Angiospermae leaf impressions have been found (Dusén 1908, Orlando 1963, 1964, Barton 1964, Thomson and Burn 1970, Jefferson 1980, Zastawniak 1981, Zastawniak *et al.* 1985, Birkenmajer and Zastawniak 1986, Zastawniak *unpubl.*). Leaf impressions of craspedodromous type of venation, similar to that of *Nothofagus*, occur in all hitherto known plant-bearing strata on King George Island, from the Upper Cretaceous Zamek Formation (Birkenmajer 1985, Zastawniak *unpubl.*) through the Upper Oligocene Mount Wawel Formation, Point Hennequin Group (Zastawniak *et al.* 1985). The fossil leaves of this type are then without stratigraphic significance. The leaf impressions with other type of venation, which occur in the same plant—bearing strata in varying proportions, could belong to various taxa of dicotyledonous plants. Those which are oblong or elliptic and have comptodromous venation (so called laurophyllous type), as at the taxa *Laurelia, Nectandra* and *Ocotea,* listed by Del Valle *et al.* (1984), are difficult to exact identification, and for this reason may be used only with reservation for comparison purposes. This type of leaves is however much more numerous in older floras, *e.g.* from the Dufayel Island Group (Birkenmajer and Zastawniak 1986). Some of the leaf forms are more characteristic, *e.g.* lobed leaves determined as *Sterculia* or *Cochlosperum.* The remains of *Sterculia* leaves, reported in the material from Barton Peninsula by Del Valle *et al.* (1984) are abundantly represented in the fossil flora of the Fildes Peninsula (Orlando 1963, 1964, Zastawniak

unpubl.). They probably occur also in the Paleocene of Seymour Island (Dusén 1908, Sub Phyllites sp. (9), tabl. 2, fig. 17) and in the rocks of the Dufayel Island Group, dated at Late Cretaceous or Early Tertiary (Birkenmajer and Zastawniak 1986). On the other hand, *Sterculia* leaves are absent in the Late Oligocene flora from Mount Wawel Formation (Point Hennequin Group) (Zastawniak *et al.* 1985) and in other plant-bearing horizons from Point Hennequin Group (Zastawniak 1981). If we accept the presence of the *Sterculia* type of leaves in the deposits from the Barton Peninsula and assume that they are accompanied mainly by laurophyllous forms, then the paleobotanical data permit only to consider these deposits as older than the Point Hennequin Group.

Stratigraphic remarks

The age of stratified volcanic sequence on Barton Peninsula is open to discussion. Davies (1982) believes that the sequence is of Paleocene age, while Birkenmajer *et al.* (1983) prefer a Mesozoic age for the whole Cardozo Cove Group.

According to Del Valle *et al.* (1984) the discussed flora indicates an Early Eocene to Early Oligocene age. This disagrees with the aforementioned opinions on the age of the Barton Peninsula stratified sequence. Moreover, an Early Eocene to Early Oligocene age is also at variance with about 60 Ma K-Ar age obtained from the quart-gabbro part of the Noel Hill intrusion (Birkenmajer *et al.* 1983) which cuts the stratified sequence. Thus the age of the flora-bearing volcaniclastic rocks may be either Paleocene or Cretaceous.

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Streszczenie

Sfałdowana sekwencja wulkaniczno-wulkanoklastyczna na Półwyspie Bartona (Wyspa Króla Jerzego), Antarktyka Zachodnia (fig. 1—2) jest ujęta w trzy jednostki tektoniczne (fig. 3—4). Flora kopalna (Del Valle *et al.* 1984) występuje w spągowej części najwyższej jednostki (fig. 5—8). Wiek skał tej jednostki jest paleoceński lub kredowy. Skały jednostek środkowej i dolnej są mezozoiczne.

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