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A guide to Tertiary geochronology of King George Island, West Antarctica

ABSTRACT: The paper presents an overview of lithostratigraphy and radiochronological and biochronological data for the Tertiary volcanic and sedimentary successions of King George Island, South Shetland Islands (West Antarctica). Special stress was laid on dating fossiliferous terrestrial and marine strata and glacial and glacio-marine deposits of Tertiary age, for which King George Island offers the most complete and so-far best documented standard in the Antarctic Peninsula sector of West Antarctica.

Key words: Antarctica, Tertiary geochronology.

Introduction

The present Guide to Tertiary Geochronology of King George Island is part of the *Antarctic Cenozoic Geochronology Project* of the SCAR Group of Specialists on the Evolution of Cenozoic Palaeoenvironments of the Southern High Latitudes chaired by Professor Dr Peter N. Webb (Ohio State University, Byrd Polar Center). The guide is intended to serve the purpose of an overview of the present (1989) state of knowledge of geochronology, mainly lithostratigraphy and radiochronology, partly also biochronology, of King George Island, the largest member of the South Shetland Islands (Fig. 1), where Cenozoic rock-sequences are known in considerable detail. The time-scale used is that published by Haq *et al.* (1987).

Tectonic framework

King George Island is situated in the middle of the South Shetland Island arc, at the southern termination of the South Scotia Ridge. To the

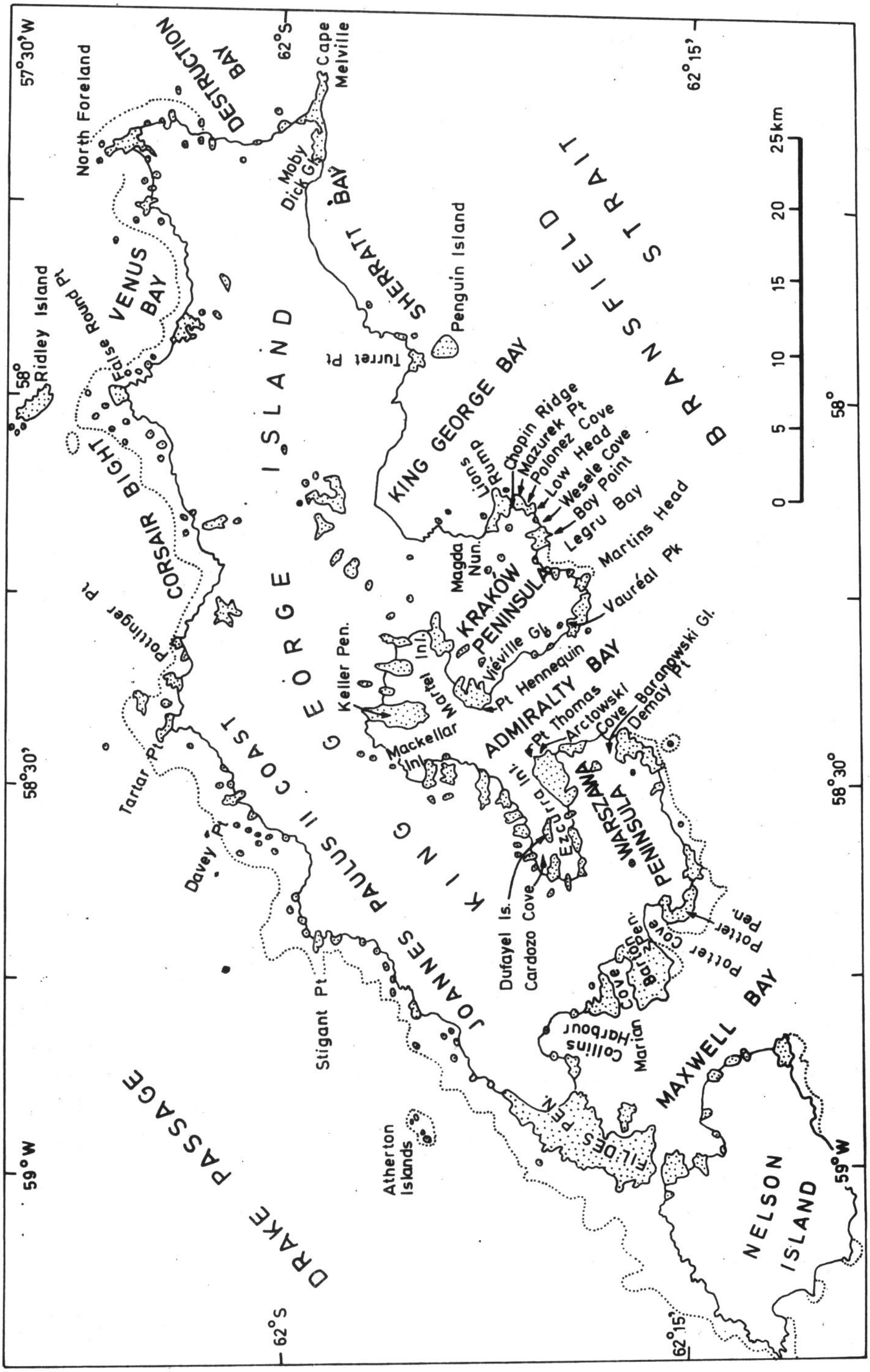


Fig. 1. King George Island — location map

north, it borders on the South Shetland subduction trench, part of the Drake Passage, to the south it is separated from the Antarctic Peninsula crustal block by young rift-like structure of the Bransfield Strait.

King George Island, and the neighbouring Nelson Island, consist of several tectonic terrains bounded by longitudinal faults: the downthrown Fildes Block (northern) is separated from the Barton Horst (axial) by the Collins Fault, probably strike-slip; the upthrown axial Barton Horst is bounded on the south by right-lateral strike-slip Ezcurra Fault which separates it from the downthrown Warszawa Block on the south; the dip-slip southernmost Kraków Block system separates the Warszawa Block from the Kraków Block (Figs 2, 3). Considerable differences in stratigraphic succession, ages and character of rocks occur between particular tectonic blocks (Tab. 1) that may suggest large-scale lateral displacement along strike-slip Ezcurra and Collins faults of the three terrains: the Fildes Block, the Barton Horst and the Warszawa Block.

The age of longitudinal strike-slip faults is Tertiary. Based on K-Ar dating of a system of plugs and dykes related to the strike-slip motion along the Ezcurra Fault (Birkenmajer *et al.* 1986a), it is assumed that the motion began at about 54 Ma (Paleocene-Eocene boundary) and continued for a period of at least 33 Ma to die-out at about 21 Ma BP (Early Miocene) when a new system of transversal faults was formed followed by fault-parallel dyke intrusion (Admiralty Fault system — *see* Birkenmajer 1983, 1989).

Lithostratigraphy

The stratigraphic sequence of King George Island includes mainly Upper Cretaceous through Oligocene and Lower Miocene island-arc, predominantly calc-alkaline, extrusive and intrusive sequences separated into several lithostratigraphic groups. These are mainly terrestrial lavas, pyroclastics and volcaniclastic sediments often with terrestrial plant fossils, intruded by small hypabyssal dykes and plugs, more seldom sills, sometimess also moderate-scale plutons. Fossiliferous marine and glacio-marine sediments represent a subordinate element in pre-Oligocene sequence, but grow in importance during the Oligocene and Lower Miocene time span.

Moderate-size plutons which cut through altered, predominantly terrestrial volcanic piles of Paleocene and pre-Paleocene (probably Cretaceous) ages, are exposed only in the axial upthrown Barton Horst but do not crop out at the surface in the downthrown Fildes, Warszawa and Kraków blocks.

Informal lithostratigraphic units of "group" and "formation" ranks have been proposed for particular rock-sequences on King George Island already by Hawkes (1961) and Barton (1964, 1965). They were revised, and new

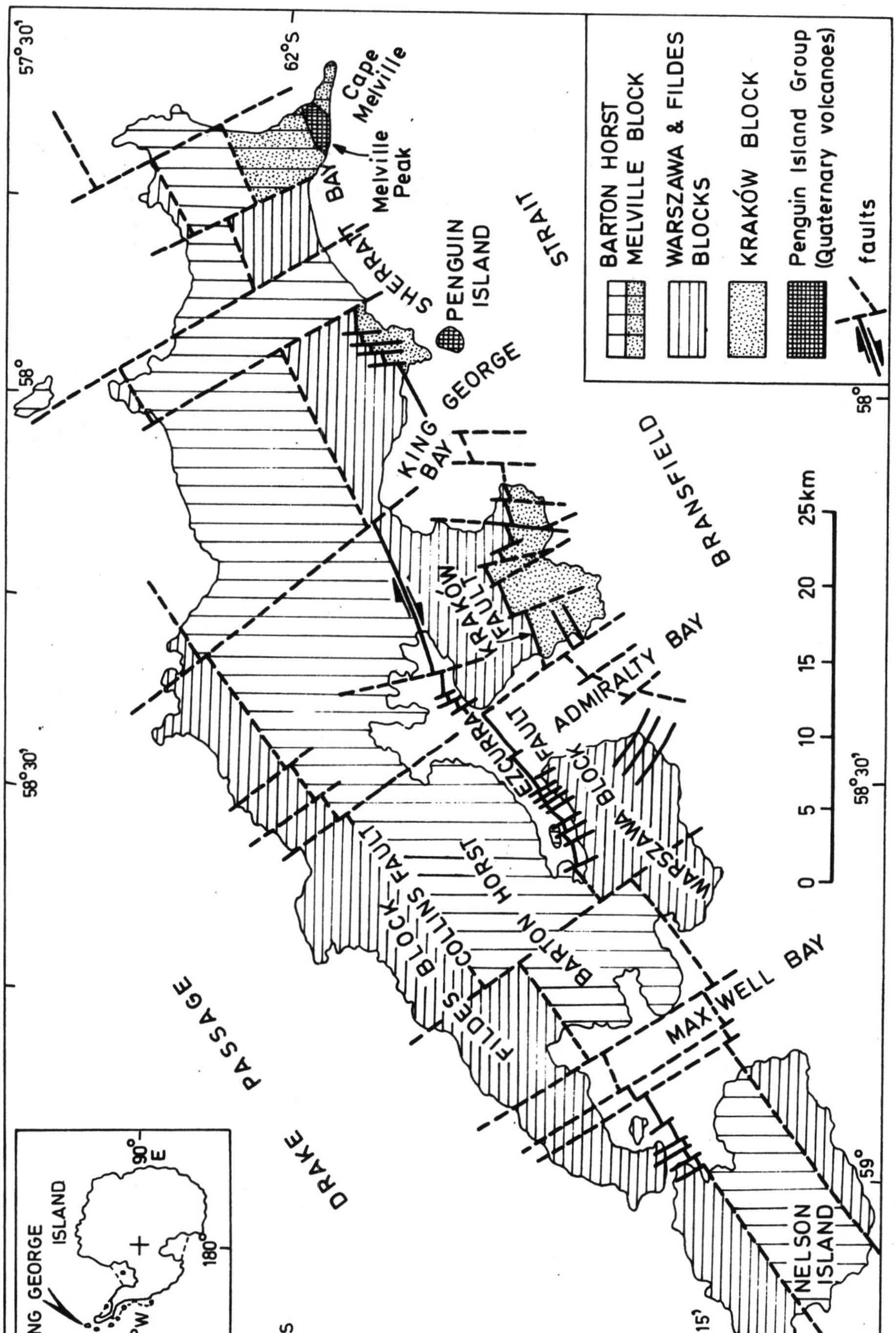


Fig. 2. Structural elements of King George Island and Nelson Island (*after* Birkenmajer 1983)

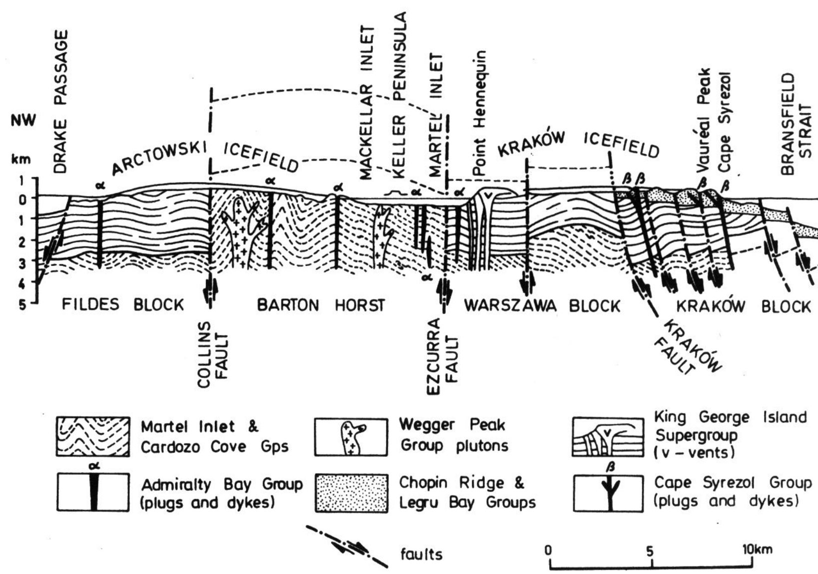


Fig. 3. Geological cross-section along Admiralty Bay, between Bransfield Strait and Drake Passage (*after* Birkenmajer 1983)

formal units of supergroup, group, formation, member and bed(s) ranks were introduced by Birkenmajer (1980a, b; 1981a, b, 1982a–d, 1984) Fenster-seifer *et al.* (1988).

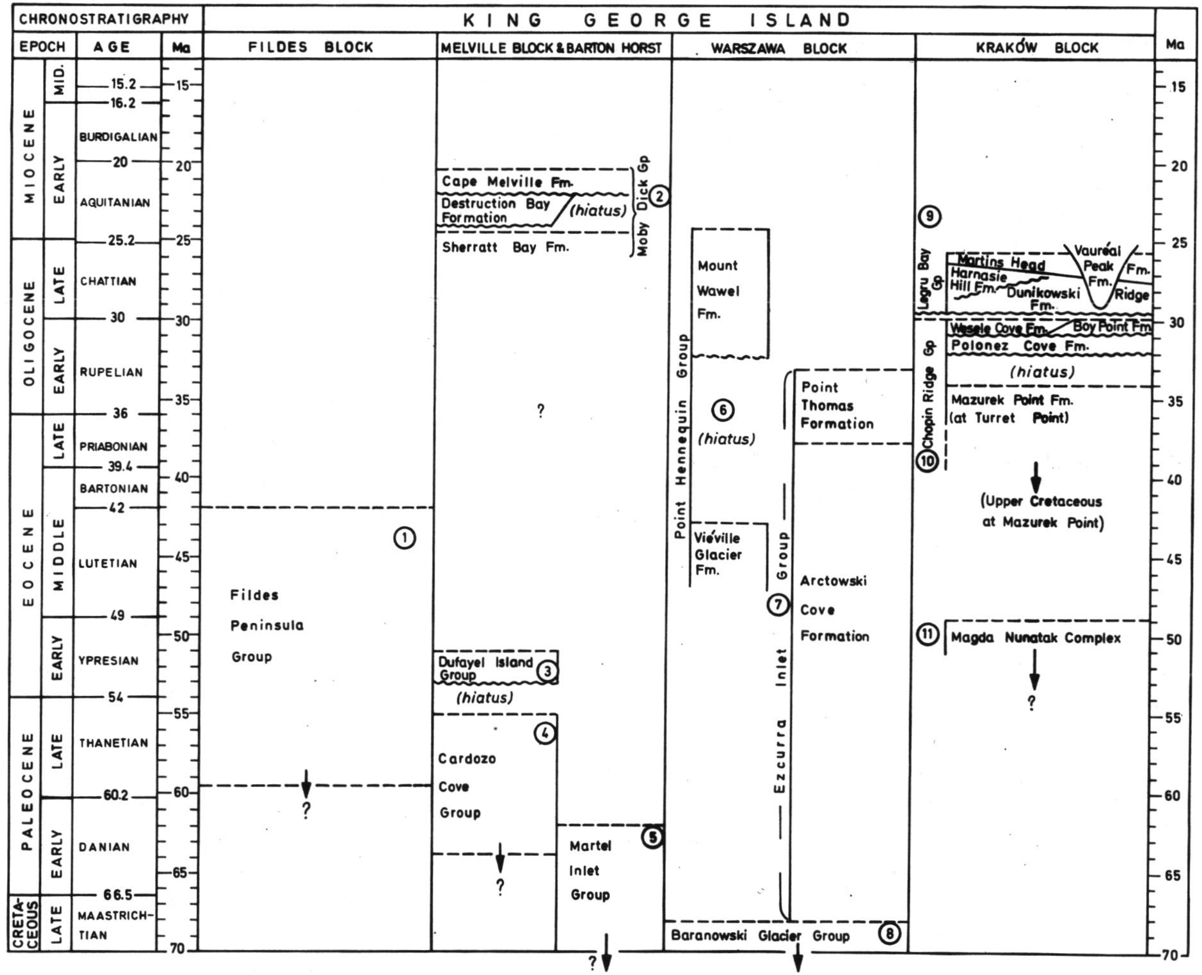
The present guide deals with Tertiary geochronology of King George Island and its immediate vicinity. The dating of stratiform lithostratigraphic units (Tab. 1) is based mainly on K-Ar, more seldom Rb-Sr, and $^{87}Sr/^{86}Sr$, dating of their lavas and pyroclastics, moreover on radiometric dating of hypabyssal intrusions (Admiralty Bay Group and Cape Syrezol Group) and plutons (Wegger Peak Group) which cut through the stratiform units (Tab. 2). It was only the case with marine and glacio-marine sediments of Tertiary age that biochronologic criteria for dating the sediments were found applicable. The dating of terrestrial sediments based on plant assemblages (leaves, pollen-spore spectra) was possible only in a few cases (Tab. 3).

(1) Fides Peninsula Group

Unit introduced by Hawkes (1961) on Fildes Peninsula, SW King George Island (Fig. 1). Despite numerous papers pertaining to the geology of this peninsula (e.g., Barton 1965; Grikurov and Polyakov 1968; Grikurov *et al.* 1970; Smellie *et al.* 1984), the group continued to be poorly defined from formal lithostratigraphic viewpoint until recently (*cf.* Li Zhaonai and Liu

Table 1

Lithostratigraphy of King George Island Tertiary, Numbers refer to groups described in the text



Xiaohan 1987; Fensterseifer *et al.* 1988). This was mainly due to strong faulting of the area and the lack of suitable continuous sections.

The group consists mainly of andesitic lavas and pyroclastics in the lower part (in the south), and basaltic, andesitic and dacitic lavas and pyroclastics in the upper part (in the north), with a distinct fossiliferous terrestrial sediment horizon approximately in the middle of the succession.

Five lithostratigraphic units ("members") have recently been proposed (as yet without formal description) for the south-central part of Fildes Peninsula by Li Zhaonai and Liu Xiaohan (1987); these units are believed to span the time from 58 to 42 Ma. The fossil-bearing unit (Fossil Hill "member") is the third one in the succession.

Two formations have been distinguished in the north-central part of Fildes Peninsula by Fensterseifer *et al.* (1988): the lower Schneider Bay Formation (basalts, basaltic andesites, andesites and dacites, with debris-flow breccias, altogether more than 250 m thick); and the upper Winkel Point Formation, subdivided into three "facies" (Pareira Bay "facies" — basaltic and basaltic andesite lavas and pyroclastics, with lahar-type breccias, altogether more than 160 m thick; Rick Hill "facies" — basalts and basaltic andesite lavas and pyroclastics, lahar-type breccias etc., more than 120 m thick; Leinz Point "facies" — basaltic lavas and volcanoclastics, stratocone type, more than 230 m thick).

The base of the Fildes Peninsula Group is unknown.

Radiometric age: The Fildes Peninsula Group is contained between Late Paleocene (59 Ma) and Middle Eocene (43—42 Ma), as indicated by K-Ar dating of the lavas from the southern and northern parts of Fildes Peninsula, respectively, and of hypabyssal intrusions which cut through the lavas (*see* dates in Pankhurst and Smellie 1983; Smellie *et al.* 1984; Soliani *et al.* 1988; Fensterseifer *et al.* 1988), *See*: R 1.1—1.6 (Tab. 2).

Biostratigraphic age: Numerous impressions of fossil plants (mainly leaves) described by Orlando (1964), Czajkowski and Rösler (1986), Troncoso (1986) and Birkenmajer and Zastawniak (*in press* 1, 2) from "Mount Flora" (resp. "Leaves Hill", resp. "Fossil Hill") on Fildes Peninsula belong to a palaeoassemblage with *Monimiophyllum antarcticum* and *Sterculia*-type leaves, poor in *Nothofagus*-type leaves, with an admixture of gymnosperms. It corresponds to broad-leaved evergreen forests with conifers as subordinate element (Birkenmajer and Zastawniak, *in press* 1, 2). This flora was initially accepted as Miocene (Orlando 1964), but later corrected to Paleocene — Middle Eocene (Romero 1978), and ?Late Paleocene — Early Eocene (Troncoso 1986); the latter biostratigraphic age determination is in agreement with radiometric age-ranges for the Fildes Peninsula Group volcanics (*see* above and Tab. 2).

Palynological spectra from the plant-bearing beds at "Leaves Hill", and from sediments at Suffield Point, by Lyra (1986), characterized by the presence of pteridophytes, gymnosperms and angiosperms (including *Nothofagus*) support early Palaeogene age as based on leaf remains. *See*: B 1.1—1.2 (Tab. 3).

Bird footprints described from terrestrial sediments associated with plant-bearing strata (Covacevich and Lamperein 1972; Covacevich and Rich 1982), attributed to large non-volant ground birds, probably ratite or phororhacoid, and to anatid birds, give no closer age determination. *See*: B 1.3 (Tab. 3).

(2) Moby Dick Group

Unit introduced by Birkenmajer (1982b) at Cape Melville — Melville Peninsula, NE King George Island (Fig. 1), Melville Block — Barton Horst terrain (Fig. 2). Subdivided into: Sherratt Bay Formation (terrestrial basaltic lavas, more than 60 m thick), at the bottom; Destruction Bay Formation (marine fossiliferous, partly volcaniclastic, non-glacial deposits, 40—110 m thick); Cape Melville Formation (glacio-marine fossiliferous, fine-grained clastics, 200 m thick, with iceberg-rafted dropstones: evidence for the Melville Glaciation). Closer descriptions in Birkenmajer (1982b, 1984, 1987).

Radiometric age: Between 23.6 Ma (near the base) and about 20 Ma (near the top) — Lower Miocene (Aquitanian) — Birkenmajer *et al.* (1985a, 1988a); Birkenmajer (1988, *in press* 1, 2). *See*: R 2.1—2.3 (Tab. 2).

Biostratigraphic age: Early Miocene as based on brachiopods (Biernat *et al.*, 1985) and foraminifera (Birkenmajer and uczkowska, 1987a, b). *See*: B 2.1—2.2 (Tab. 3).

(3) Dufayel Island Group

Name introduced by Barton (1964, 1965). Unit redefined and subdivided by Birkenmajer (1980a, b) into the lower Gdynia Point Formation (andesite agglomerate, conglomerate, sandstone, 60 m thick), and the upper Dalmor Bank Formation (plant-bearing tuffs, conglomerates, agglomerates and basaltic to andesitic lavas, 47—150 m thick). The Dufayel Island Group is separated by erosional unconformity from folded and altered andesite lavas of the Cardozo Cove Group (Barton Horst terrain).

Radiometric age: K-Ar date of 51.9 ± 1.5 Ma from basaltic lava capping plant-bearing beds of the Dalmor Bank Formation at Dufayel Island (Birkenmajer *et al.*, 1983a, b) indicates Lower Eocene age of this formation. *See*: R 3.1 (Tab. 2).

Biostratigraphic age: The *Nothofagus* and laurophyllous broad-leaved forest assemblage from the Dalmor Bank Formation is indicative of temperate climate, and resembles that of the Fildes Peninsula (north-west King George Island) dated at Paleocene-Eocene (Birkenmajer and Zastawniak, 1986, in press 1, 2). *See*: B 3.1 (Tab. 3).

(4) Cardozo Cove Group

Name (Cardozo Cove complex) introduced by Birkenmajer (1980a, b), later formalized to Cardozo Cove Group (Birkenmajer, 1982c). The group consists predominantly of basic andesite lavas alternating with tuff and agglomerate, altogether more than 540 m thick (base unknown). Metasomatism, in the form of wide-spread chloritization, carbonatization and other alteration processes, is marked mainly in the lower and middle parts of the group, especially close to the Wegger Peak Group plutons. The rocks are often strongly folded, particularly near strike-slip faults of the Ezcurra Fault system. Petrified wood fragments occur throughout the group, and there is evidence of shallow-marine environment in the uppermost part of the succession. Two formations have been distinguished: the Znosko Glacier Formation (lower) and the Admiralen Peak Formation (upper) — *see* Birkenmajer (1982c; Birkenmajer *et al.*, 1985c). The Cardozo Cove Group occurs in the Barton Horst west of the Mackellar Inlet transversal fault.

Radiometric age: K-Ar date 56.8 ± 1.2 Ma from Dufayel Island (Birkenmajer *et al.*, 1983a, b), and Rb-Sr isochron age of 60.4 ± 5.3 Ma (Kawashita and Soliani, 1988) indicate Paleocene age of the Znosko Glacier Formation. K-Ar date of 43.7 ± 4.8 Ma (apparently Middle Eocene) from the Admiralen Peak Formation has been treated as possible effect of reheating by the Wegger Peak Group pluton and partial argon loss (Birkenmajer *et al.*, 1986b). *See*: R 4.1–4.4.

Biostratigraphic age: Plant remains determined as *Araucaria* sp. by Barton (1964) but revised as *Pagiophyllum* sp. by Zastawniak (1981) which occur in the Admiralen Peak Formation, give no closer age indication; the latter genus is known from plant-bearing Jurassic strata of Hope Bay, Antarctic Peninsula, but is unknown from Tertiary and Upper Cretaceous strata of King George Island (*see* Birkenmajer and Zastawniak 1986, *in press* 1, 2). *See*: B 4.1.

(5) Martel Inlet Group

Unit distinguished by Birkenmajer (1980d) later subdivided into five formations (Birkenmajer 1982c): the Keller Peninsula Formation (235 to more than 270 m thick) at the base (substratum unknown); the Visca Anchorage Formation (140—145 m thick); the Domeyko Glacier Formation (320 m + thick); the Ullman Spur Formation (320 m); and the Goetel Glacier Formation (110 m + thick). The group, altogether more than 1100 m thick, is represented by several terrestrial stratocone complexes issued from separate centres, partly overlapping one another. It consists of basaltic andesite, moderately high-Al basalt, andesite, subordinately also dacite and rhyolite lavas, pyroclastics and volcaniclastic sediments with petrified wood fragments (Birkenmajer 1982c; Birkenmajer *et al.*, 1985c). The group occurs in the Barton Horst east of the Mackellar Inlet transversal fault.

Radiometric age: Widely scattered K-Ar dates, between 66.7 and 26 Ma, showing no positive correlation with relative stratigraphic ages of five formations distinguished (Birkenmajer *et al.*, 1986b; Soliani and Kawashita 1986) are considered to be a result of reheating by Tertiary volcanic-plutonic activity and partial argon loss. This could correlate mainly with the 41—44 Ma BP thermal event well evidenced by K-Ar ages of hypabyssal intrusions (see Pankhurst and Smellie, 1983) of the Admiralty Bay Group which cut through the stratiform complex of the Martel Inlet Group. The oldest K-Ar date of 66.7 ± 4 Ma (Birkenmajer *et al.*, 1983a; see also Birkenmajer *et al.*, 1986b) indicates a Cretaceous-Palaeogene boundary age for the lower part of the Martel Inlet Group (Visca Anchorage Formation, Barton Buttress Member). *See*: R 5.1 (Tab. 2).

(6) Point Hennequin Group

Name introduced by Hawkes (1961). Unit redefined by Barton (1965) and Birkenmajer (1980b, 1981a). Closer described and subdivided by Birkenmajer (1980b, 1981a) into: Viéville Glacier Formation (andesite lavas, more than 200 m thick, subordinate plugs), at the bottom (substratum unknown); Mount Wawel Formation (andesite lavas and agglomerates, more than 300 m thick, with plant-bearing tuff intercalations near the top; associated andesite plugs).

Radiometric age: The K-Ar dates are between 44 Ma at the base of the section and 24.5 Ma near the top (Birkenmajer *et al.*, 1983b; 1986a), indicating a Middle Eocene through Upper Oligocene-lowest Miocene time span. Older still, 46—47 Ma dates (Middle Eocene), have also been reported from the section at Point Hennequin, however without closer location in the stratigraphic succession (Pankhurst and Smellie, 1983; Smellie *et al.*, 1984; *see* comments by Birkenmajer *et al.*, 1986a). *See*: R 6.1—6.4.

Biostratigraphic age: Comparatively well preserved Tertiary *Nothofagus*-podocarp plant assemblages from the top part of the Mount Wawel Formation (Barton, 1964; Zastawniak, 1981; Zastawniak *et al.*, 1985; Birkenmajer and Zastawniak *in press* 1, 2) are indicative of temperate climate forest communities but give little information as to exact biostratigraphic age of the deposits. *See*: B 6.1 (Tab. 3).

(7) Ezcurra Inlet Group

Name introduced by Barton (1965). Unit redefined and subdivided by Birkenmajer (1980a, b) into: Arctowski Cove Formation (basic andesite lavas at the bottom — Rakusa Point Member; followed by andesite and basalt lavas with pyroclastics, with fresh-water shale and pebble-lag intercalations, with fossilized wood fragments — Hala Member; separated by erosional unconformity from overlying fresh-water sediments — plant-bearing shales, clays, tuff-sandstones and conglomerates — Petrified Forest Member; capped by lahar-type agglomerate with high-Al basaltic lava intercalations — Skua Cliff Member), altogether 200 m thick; Point Thomas Formation (low-K high-Al tholeiitic basalt lavas and pyroclastics with plant-bearing horizon; 300 to more than 430 m thick). *See also* Birkenmajer *et al.* (1981).

Radiometric age: The Arctowski Cove Formation spans the time from about 67 Ma (latest Cretaceous) to about 37 Ma (Upper Eocene). The Point Thomas Formation is about 37 Ma (Upper Eocene) old at the base but may range upward into Lower Oligocene (Birkenmajer *et al.*, 1983b, 1986a). *See*: R 7.1—7.2 (Tab. 2).

Biostratigraphic age: *Nothofagus*-pteridophyte spore-pollen assemblages from the top part of the Arctowski Cove Formation (Petrified Forest Member) are indicative of Eocene-Oligocene boundary age of the Petrified Forest Member (Stuchlik 1981; Birkenmajer and Zastawniak *in press* 1, 2). *See*: B 7.1 (Tab. 3).

(8) Baranowski Glacier Group

Unit introduced by Birkenmajer (1980a, b), subdivided into: Llano Point Formation (basaltic andesite lavas and pyroclastics, more than 1100 m thick), at the bottom; Zamek Formation (basaltic andesite lavas with plant-bearing horizon; more than 40 m thick). *See also* Birkenmajer *et al.* (1981).

Radiometric age: K-Ar dates, 77± 4 Ma from the base of the Baranowski Glacier Group (base of the Llano Point Formation), and 66.7± 1.5 Ma from the base of the succeeding Ezcurra Inlet Group (base of Arctowski Cove Formation, Rakusa Point Member), determine Upper Cretaceous (Santonian — Maastrichtian) age of the Baranowski Glacier Group (Birkenmajer *et al.*, 1983b). *See*: R 8.1 and R 7.2 (Tab. 2).

Biostratigraphic age: *Nothofagus* and laurophyllous broad-leaved forest assemblage from the Zamek Formation suggests subhumid mesothermal climate but gives no closer age indication of the plant-bearing strata (Birkenmajer and Zastawniak *in press* 1, 2). *See*: B 8.1 (Tab. 3).

(9) Legru Bay Group

Unit introduced by Birkenmajer (1980a) between Admiralty Bay and King George Bay, King George Island. Subdivided into: Dunikowski Ridge Formation (terrestrial andesite lavas, pyroclastics, agglomerates, lahars, 65—80 m thick), at the bottom; Harnasie Hill Formation (basaltic cinder cone, with agglomerate and lava flows, up to 215 m thick); Martins Head Formation (andesite lavas, pyroclastics and lahar-type agglomerates, 125 m thick); Vauréal Peak Formation (terrestrial glacial tillite, fill of buried valleys, cutting through older formations, maximum 80—100 m thick). The lahars and tillite are evidences for the Legru Glaciation. Closer descriptions in Birkenmajer (1982a, 1987).

Radiometric age: From about 30 Ma (at the bottom) to about 26 Ma (at the top): Upper Oligocene (Chattian) — Birkenmajer *et al.* (1986a, in press 2, 3); Birkenmajer (1988, *in press* 1, 2). *See* R 9.1—9.6 (Tab. 2).

(10) Chopin Ridge Group

Unit introduced by Birkenmajer (1980a, c) between King George Bay and Admiralty Bay, King George Island, mainly at Chopin Ridge and in Polonez Cove. Subdivided into: Mazurek Point Formation (terrestrial basaltic lavas, more than 100 m thick) at the base; Polonez Cove Formation (glacial tillites followed by glacio-marine clastics with iceberg-rafted dropstones — evidences for the Polonez Glaciation, moreover basaltic lavas and hyaloclastites, altogether 5—65 m thick), subdivided into Krakowiak Glacier Member (lodgement till and related glacially-controlled deposits, maximum 5—15 m thick), Low Head Member (fossiliferous glacio-marine basaltic conglomerates and hyaloclastites, 5—20 m thick), Siklawa Member (fossiliferous glacio-marine fine clastics, 2—10 m thick), Oberek Cliff Member (fossiliferous glacio-marine clastics, hyaloclastites and basaltic lavas, 10—40 m thick); Boy Point Formation (acidic lavas, 20—130 m thick); Wesele Cove Formation (fresh-water coarse clastics, maximum 75 to more than 110 m thick, filling buried valleys). Closer descriptions given by Birkenmajer (1982a, 1987) and Porębski and Gradziński (1987).

Radiometric age: Basal basaltic to andesitic lavas of the Mazurek Point Formation yielded K-Ar ages between 74 Ma (Upper Cretaceous) and about 34 Ma (Lower Oligocene) — Birkenmajer and Gaździcki (1986), Birkenmajer *et al.* (*in press* 2, 3). *See*: R 10.3—10.4 (Tab. 2).

K-Ar dates from the Polonez Cove Formation (Low Head Member, basaltic hyaloclastite), and from the overlying Boy Point Formation (acidic lavas) are treated as apparent (Birkenmajer *et al.*, 1986a, *in press* 1, 3). *See*: R 10.1—10.2 (Tab. 2).

The Chopin Ridge Group pre-dates the 30-Ma old basal andesite lavas of the Legru Bay Group, Dunikowski Ridge Formation (*see above*); it may represent a 30—32 Ma (Lower Oligocene, upper part) time span.

Biostratigraphic age: Invertebrate faunas recorded mainly from high--energy Low Head Member deposits of the Polonez Cove Formation (*see* Gaździcki and Pugaczewska 1984; Gaździcki ed., *et al.*, 1987) are at least partly recycled and give no clear indication of the age of the Polonez Cove Formation (Birkenmajer 1987). Calcareous nannofossils from the Low Head Member are partly recycled from older strata (mainly Paleocene — Eocene taxa), partly they are probably *in situ*: the youngest taxa indicate Oligocene (Early Oligocene, upper part to Late Oligocene) — *see* Gaździcka and Gaździcki (1985); Birkenmajer (1987, 1988, *in press* 1, 2); Birkenmajer *et al.* (1988). *See*: B 10.1 (Tab. 3).

(11) Magda Nunatak complex

Unit (informal) recognized by Tokarski *et al.* (1981) at Magda Nunatak, King George Bay. The complex consists of fossiliferous glacio-marine deposits (minimum 4 m thick) at the base (bottom not exposed), passing upward into fossiliferous basaltic hyaloclastite alternating with basaltic lavas (15—20 m thick), capped by basaltic lava sheet (about 20 m thick). Closer descriptions given by Birkenmajer (1982a) and Birkenmajer *et al.* (1985b). The glacio-marine strata (with iceberg-rafted dropstones) are considered evidence for the Kraków Glaciation, the oldest Tertiary glaciation recognized on King George Island (Birkenmajer *in press* 1, 1988).

Radiometric age: A single K-Ar date of 49.4± 5 Ma obtained from basaltic lava at the top of the complex (Birkenmajer *et al.* 1986a) is suggestive of a Lower-Middle Eocene age. *See*: R 11.1 (Tab. 2).

Biostratigraphic age: Bivalves and scaphopods recovered from glacio-marine strata are certainly Tertiary, but give no closer age determination (Pugaczewska 1984). Calcareous nannoplankton (coccoliths) recovered from the matrix of hyaloclastite (Birkenmajer *in press*, 1988), ranges in age from the uppermost Paleocene through lower Early Eocene. The same age may be accepted for the underlying glacio-marine strata which interfinger with the hyaloclastite (Birkenmajer *et al.* 1985b; Birkenmajer 1988, in press 1, 2). *See*: B 11.1 (Tab. 3).

Radiochronology (selected dates)

(1) Fildes Peninsula Group (Tab. 2)

R 1.1 — K-Ar dates from andesite lavas, southern Fildes Peninsula (Smellie *et al.* 1984), closer location not given: 59± 2; 58± 1; 51± 1 Ma.

R 1.2 — K-Ar dates from lavas and plug, northern Fildes Peninsula, closer location not given (Smellie *et al.* 1984): 58± 4 (andesite plug); 57± 3 (basalt lava); 52± 1 (basalt lava); 48± 1 (basalt lava); 46± 1 (dacite lava); 43± 1 (basaltic andesite lava); 42± 1 Ma (dacite lava).

R 1.3 — $^{87}Sr/^{86}Sr$: between 58 and 42 Ma (14 dates), Fildes Peninsula without closer location (Smellie *et al.* 1984).

R 1.4 — K-Ar dates 51.9± 4.9 Ma (basaltic andesite), and 57.7± 1.2 Ma (basalt), from Winkel Point Formation, Pareira Bay "facies" (Soliani *et al.* 1988; Fensterseifer *et al.* 1988).

R 1.5 — K-Ar dates 57.1± 1.1 Ma and 58.5± 1.4 Ma, lavas of the Winkel Point Formation, Rick Hill "facies" (Soliani *et al.* 1988; Fensterseifer *et al.* 1988).

R 1.6 — K-Ar date 42.9± 1.3 Ma, lavas of the Winkel Point Formation, Leinz Point "facies" (Fensterseifer *et al.* 1988).

(2) Moby Dick Group (Tab. 2)

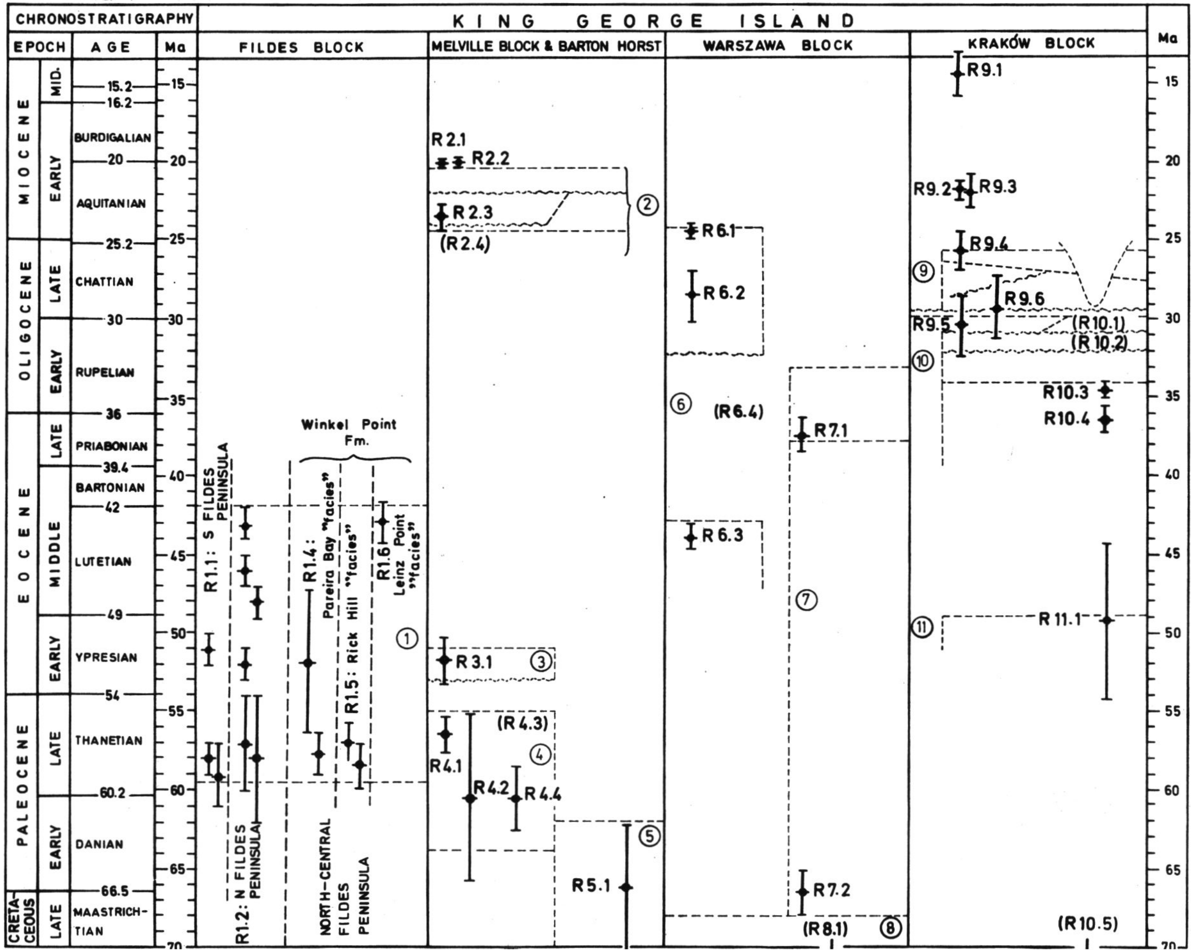
R 2.1 — K-Ar date 20.1± 0.2 Ma: andesite dyke of the Admiralty Bay Group cutting through the whole Moby Dick Group (Birkenmajer *et al.* 1985a).

R 2.2 — K-Ar date > 19.9± 0.3 Ma: andesite dyke of the Admiralty Bay Group cutting through the whole Moby Dick Group (Birkenmajer *et al.* 1985a).

R 2.3 — K-Ar date 23.6± 0.7 Ma: basaltic tuff of the Destruction Bay Formation (Birkenmajer *et al.* 1988a).

Table 2

Radiochronology of Tertiary rocks of King George Island. Numbers explained in the text



R 2.4 — K-Ar date > 18 Ma: basalt lava flow, Sherratt Bay Formation — considered apparent due to zeolitization of the basalt (Birkenmajer *et al.* 1985a).

(3) Dufayel Island Group (Tab. 2)

R 3.1 — K-Ar date 51.9± 1.5 Ma: basaltic lava at the top of plant-bearing beds, Dufayel Island Group, Dalmor Bank Formation (Birkenmajer *et al.* 1983a, b).

(4) Cardozo Cove Group (Tab. 2)

R 4.1 — K-Ar date 56.8± 1.2 Ma: folded andesite lavas just below unconformity separating the Cardozo Cove Group from the overlying Dufayel Island Group (Birkenmajer *et al.* 1983a, b).

R 4.2 — Rb-Sr isochron age 60.4± 5.3 Ma: based on 6 Rb-Sr dates obtained from 4 localities of the Cardozo Cove Group, andesite lavas, inner Admiralty Bay (Kawashita and Soliani 1988).

R 4.3 — K-Ar date 43.7± 4.8 Ma: basaltic andesite lava at the top of the Admiralen Peak Formation, Cardozo Cove Group (Birkenmajer *et al.* 1986b); considered apparent due to reheating by the Wegger Peak Group pluton (at Wegger Peak) and partial argon loss.

R 4.4 — K-Ar date 60.7± 2 Ma: gabbroic part of pluton (Wegger Peak Group) at Noel Hill, Maxwell Bay (Birkenmajer *et al.* 1983a). The pluton cuts through folded and altered volcanics and volcaniclastics of the Cardozo Cove Group.

(5) Martel Inlet Group (Tab. 2)

R 5.1 — K-Ar date 66.7± 4 Ma: basal andesite lava flow of the Barton Buttress Member, Visca Anchorage Formation (Birkenmajer *et al.* 1983a; *see also* Birkenmajer *et al.* 1986b).

(6) Point Hennequin Group (Tab. 2)

R 6.1 — K-Ar date 24.5± 0.5 Ma: 7th andesite lava flow, Mount Wawel Formation (Birkenmajer *et al.* 1983b).

R 6.2 K-Ar date 28.3± 1.7 Ma: andesite plug cutting through the Viéville Glacier Formation, possibly feeder vein for the Mount Wawel Formation lavas (Birkenmajer *et al.* 1986a).

R 6.3 — K-Ar date 43.9± 0.9 Ma: bottom part of the Viéville Glacier Formation, 1st andesite lava flow (Birkenmajer *et al.* 1986a).

R 6.4 — K-Ar dates: 27± 1; 32± 1; 45± 1; 46± 1; 47± 1 Ma; Point Hennequin Group, without closer location in the section (Pankhurst and Smellie 1983; Smellie *et al.* 1984), corresponding partly to the Mount Wawel Formation, partly to the Viéville Glacier Formation lavas and plugs (*see* Birkenmajer *et al.* 1986a).

(7) Ezcurra Inlet Group (Tab. 2)

R 7.1 — K-Ar date 37.4± 1.1 Ma: high-Al basalt lava, bottom part of the Point Thomas Formation (Birkenmajer *et al.* 1986a).

R 7.2 — K-Ar date 66.7± 1.5 Ma: basaltic andesite lava flow at the bottom of the Arctowski Cove Formation, Rakusa Point Member (Birkenmajer *et al.* 1983b).

(8) Baranowski Glacier Group (Tab. 2)

R 8.1 — K-Ar date 77± 4 Ma: basaltic andesite lava flow, bottom of the Baranowski Glacier Group, Llano Point Formation (Birkenmajer *et al.* 1983b).

(9) Legru Bay Group and (10) Chopin Ridge Group (Tab. 2)

R 9.1 — K-Ar date 14.4± 1.4 Ma: olivine-basalt plug, Cape Syrezol Group, cutting through the Chopin Ridge Group at Low Head (Birkenmajer *et al.* 1986a).

R 9.2 — K-Ar date > 21.8± 0.6 Ma: basaltic dyke, Cape Syrezol Group, cutting through the whole Chopin Ridge Group at Polonez Cove (Birkenmajer and Gaździcki 1986).

R 9.3 — K-Ar date 21.9± 1.1 Ma: basaltic dyke, Cape Syrezol Group, cutting through the Legru Bay Group at Cinder Spur (Birkenmajer *et al.*, in press 2).

R 9.4 — K-Ar date 25.7± 1.3: top andesite lava flow of the Legru Bay Group, Martins Head Formation (Birkenmajer *et al.* 1986a).

R 9.5 — K-Ar date 30.8± 2.0 Ma: bottom andesite lava flow of the Legru Bay Group, Dunikowski Ridge Formation (Birkenmajer *et al.*, *in press* 2).

R 9.6 — K-Ar date 29.5± 2.1 Ma: andesite lava flow close to the bottom of the Legru Bay Group, Dunikowski Ridge Formation (Birkenmajer *et al.* 1986a).

R 10.1 — K-Ar dates > 22.4 and > 23.6 Ma: andesite-dacite lavas of the Boy Point Formation, Chopin Ridge Group, at type localities (Birkenmajer and Gaździcki, 1986). Unreliable (apparent) in the light of dating of the Legru Bay Group lavas (*see* Birkenmajer *et al.*, 1986a, *in press* 2, 3; Birkenmajer 1988) — probable effect of reheating by younger intrusions and partial argon loss.

R 10.2 — K-Ar date 22.3± 0.8 Ma: hyaloclastite from the Polonez Cove Formation (Chopin Ridge Group), Low Head Member (Birkenmajer *et al.*, *in press* 1). Date unreliable — probable effect of reheating by younger intrusions and partial argon loss — as R 10.1 (*see* Birkenmajer 1988, *in press* 2; Birkenmajer *et al.*, *in press* 2, 3).

R 10.3 — K-Ar date 34.4± 0.5 Ma: basaltic andesite lava, Mazurek Point Formation (Chopin Ridge Group) at Turrett Point, King George Bay (Birkenmajer *et al.*, *in press* 2, 3).

R 10.4 — K-Ar date 37.6± 0.9 Ma: andesite plug cutting through the Mazurek Point Formation lavas at Turrett Point, King George Bay (Birkenmajer *et al.*, *in press* 2, 3).

R 10.5 — K-Ar date 74^{+1}_{-7} Ma: basaltic lava of the Mazurek Point Formation, Chopin Ridge Group, at Polonez Cove (Birkenmajer and Gaździcki 1986).

(11) Magda Nunatak complex (Tab. 2)

R 11.1 — K-Ar date 49.4± 5 Ma: top basaltic lava flow overlying hyaloclastite and glacio-marine deposits (Birkenmajer *et al.* 1986a).

Biochronology

(1) Fildes Peninsula Group (Tab. 3)

B 1.1 — Fossil Hill "member" (*sensu* Li Zhaonai and Liu Xiaohan 1987): Rich leaf flora from "Mount Flora" or "Leaves Hill" (Orlando 1964; Czajkowski and Rösler 1986; Birkenmajer and Zastawniak *in press* 1, 2), representing palaeoassemblage with *Monimiophyllum antarcticum* and *Sterculia*-type leaves, associated with *Dicotylophyllum duseni*, etc., poor in *Nothofagus*-type leaves, with gymnosperms (Araucariaceae, Cupressaceae, Podocarpaceae). It is suggestive either of Paleocene — Middle Eocene (Romero 1978) or ?Late Paleocene — Early Eocene (Troncoso 1986) age.

B 1.2 — Fossil Hill "member" (*sensu* Li Zhaonai and Liu Xiaohan 1987), at "Leaves Hill", and sediments at Suffield Point: pollen-spore assemblage with pteridophytes (5 taxa), gymnosperms (podocarps: 5 taxa), angiosperms

(8 taxa), including *Nothofagus* (3 taxa), described by Lyra (1986), indicative of early Palaeogene age.

B 1.3 — Fossil Hill "member" (*sensu* Li Zhaonai and Liu Xiaohan 1987) at "Ichnites Hill": bird footprints (ichnites) of little stratigraphic value (Covacevich and Lamperein 1972; Covacevich and Rich 1982).

(2) Moby Dick Group (Tab. 3)

B 2.1 — Cape Melville Formation: foraminiferal *Cibicides-Cibicidoides* Assemblage Zone (lower) and *Cribrostomoides-Cyclammina-Globobulimina* Assemblage Zone (upper), Early Miocene (Birkenmajer and Łuczkowska 1987a, b).

Rich invertebrate fauna described (*see* Gaździcki (ed.), *et al.* 1987), so-far of little stratigraphic value.

B 2.2 — Destruction Bay Formation: foraminiferal *Cibides-Cibicidoides* Assemblage Zone (Birkenmajer and Łuczkowska 1987a, b), Early Miocene.

Brachiopod species of the genera *Discinisca, Pachymagas, Neothyris, Rhizothyris, Magellania* and ?*Magella*, comparable with Early Miocene brachiopod assemblages of New Zealand (Biernat *et al.* 1985).

(3) Dufayel Island Group (Tab. 3)

B 3.1 — Dalmor Bank Formation at Dufayel Island: *Nothofagus* and laurophyllous leaf assemblage comparable with Paleocene-Eocene floras of Fildes Peninsula, King George Island (Birkenmajer and Zastawniak *in press* 1, 2).

(4) Cardozo Cove Group (Tab. 3)

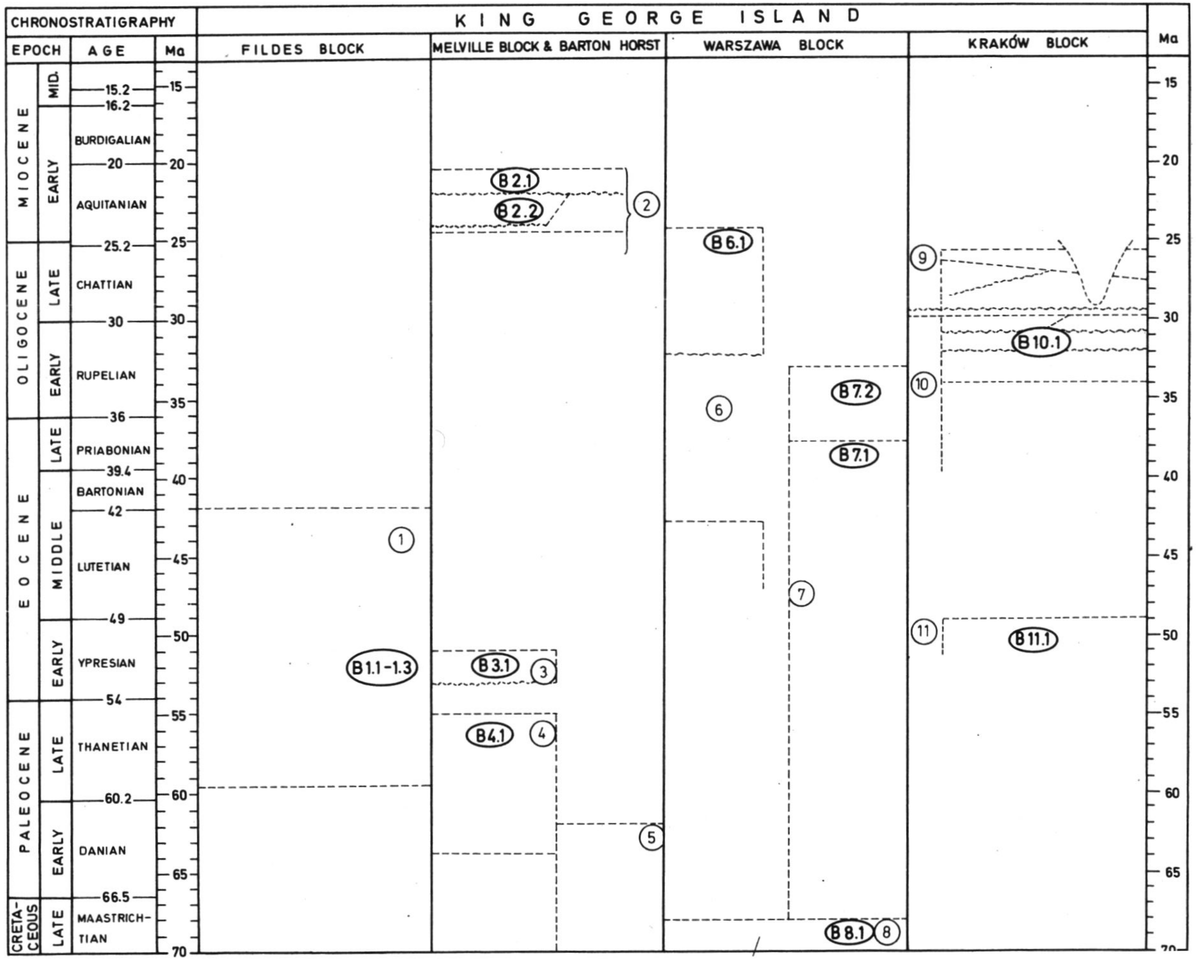
B 4.1 — Admiralen Peak Formation, Admiralen Peak: impressions of shoots determined as *Araucaria* sp. by Barton (1964), corrected to *Pagiophyllum* sp. by Zastawniak (1981). So-far without stratigraphic value (however, the genus *Pagiophyllum* has been reported from Jurassic plant-beds of Hope Bay, Antarctic Peninsula).

(6) Point Hennequin Group (Tab. 3)

B 6.1 — Mount Wawel Formation, Dragon Glacier plant beds and Mount Wawel plant beds. Tertiary *Nothofagus*-podocarp assemblages believed to represent Oligocene-Miocene boundary (Zastawniak 1981, Zastawniak *et al.* 1985, Birkenmajer and Zastawniak *in press* 1, 2).

Table 3

Biochronology of Tertiary sediments of King George Island. Numbers explained in the text



(7) Ezcurra Inlet Group (Tab. 3)

B 7.1 — Petrified Forest Member, Arctowski Cove Formation: *Nothofagus*-pteridophyte pollen-spore assemblage, indicative of Eocene-Oligocene boundary age (Stuchlik 1981).

B 7.2 — Point Thomas Formation at Cytadela: *Nothofagus*-pteridophyte (and ?podocarp) leaf assemblage, transitive between B 7.1 and B 6.1 plant assemblages, in Lower Oligocene part of the formation (Birkenmajer and Zastawniak *in press* 1, 2).

(8) Baranowski Glacier Group (Tab. 3)

B 8.1 — Zamek Formation, *Nothofagus* and laurophyllous leaf assemblage, considered to represent Late Cretaceous, as based on radiometric dating of the succession (Birkenmajer and Zastawniak *in press*, 1, 2).

(10) Chopin Ridge Group (Tab. 3)

B 10.1 — Polonez Cove Formation, Low Head Member: calcareous nannofossils (coccoliths) recorded from *Chlamys*-coquina (Gaździcka and Gaździcki 1985), and from neptunian dyke (Birkenmajer *et al.* 1988b), are partly recycled from older (Paleocene—Eocene) strata, but partly probably *in situ* (Oligocene forms). The youngest taxa indicate Oligocene, resp. upper Early Oligocene — Late Oligocene (Birkenmajer 1987, 1988, *in press* 1, 2; Birkenmajer *et al.* 1988b).

Rich Tertiary invertebrate fauna (*see* Gaździcki and Pugaczewska 1984; Gaździcki (ed.), *et al.* 1987), partly recycled (*see* Birkenmajer 1987), is at present of little stratigraphic value.

(11) Magda Nunatak complex (Tab. 3)

B 11.1 — Poor calcareous nannoplankton (coccoliths) assemblage from basaltic hyaloclastite ranges in age from uppermost Paleocene through lower Early Eocene (Birkenmajer *in press* 1, 2, 1988).

Poor assemblage of Tertiary bivalves and scaphopods of little stratigraphic value (Pugaczewska 1984).

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Streszczenie

W artykule przedstawiono przegląd jednostek litostratygraficznych, datowań radiometrycznych skał i dane biostratygraficzne odnoszące się do trzeciorzędowej sekwencji wulkaniczno-osadowej Wyspy Króla Jerzego w Szetlandach Południowych, Antarktyka Zachodnia (fig. 1—3, tab. 1—3). Zwrócono szczególną uwagę na osady lądowe i morskie zawierające szczątki fauny i flory kopalnej, jak też na osady glacjalne i glacjalno-morskie wieku trzeciorzędowego, które są rzadkością w Antarktyce Zachodniej, a dla których Wyspa Króla Jerzego dostarcza standardu chronostratygraficznego o znaczeniu światowym.