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To Henryk Arctowski
– the Father of Antarctic Geology

Geological research of the Polish Geodynamic Expeditions to West Antarctica, 1984–1991: Antarctic Peninsula and adjacent islands

ABSTRACT: During the Polish Geodynamic Expeditions to West Antarctica, 1984–1991, led by A. Guterch, the scientific research of the geological group (leader K. Birkenmajer) included stratigraphic, sedimentological, petrological, tectonic, volcanological and Quaternary geology studies. They were caried out mainly in the area of Antarctic Peninsula, Palmer Archipelago and South Shetland Islands (the results from King George Island have been reviewed separately, in 1996). The major scientific archievements are: (1) introduction of formal lithostratigraphical standards, recognition of tectonic structure, and sedimentological characteristics of the Trinity Peninsula Group (?Upper Permian–Triassic) metasediments (Antarctic Peninsula: Hope Bay and Paradise Harbour; Livingston Island: Hurd Peninsula); (2) elaboration of Late Mesozoic–?Tertiary magmatic successions (Antarctic Peninsula Volcanic Group and Andean Intrusive Suite) on northern Antarctic Peninsula (Hope Bay; Arctowski Peninsula; Paradise Harbour – Gerlache Strait); (3) together with geophysical group: elaboration of lithospheric transect from South Shetland Islands to Antarctic Peninsula; (4) elaboration of Late Cenozoic evolution stages of the Bransfield Basin and Rift, as based on geological and palaeontological record; (5) introduction of a revised volcanostratigraphic standard, and reconstruction of evolution stages, of the Deception Island volcano (South Shetland Islands); (6) reconstruction of the Holocene history in some areas of Antarctic Peninsula (Hope Bay) and South Shetland Islands (King George Island). The results of palaeontological and sedimentological research on Seymour and Cockburn islands (NE Antarctic Peninsula) were presented separately.

Key words: West Antarctica, metasediments, magmatic arcs, rifting, volcanism.

Introduction

The Polish geological research on Antarctic Peninsula and adjacent islands during the Austral Summer seasons of 1984/5, 1987/8 and 1990/91 (leader Prof. K. Birkenmajer) was carried out within the programme of the Polish West Antarctic Geodynamic Expeditions organized and led by Prof. A. Guterch (see Birkenmajer 1987, 1988a, 1991a). The field studies were carried out mainly in the following areas (Fig. 1):

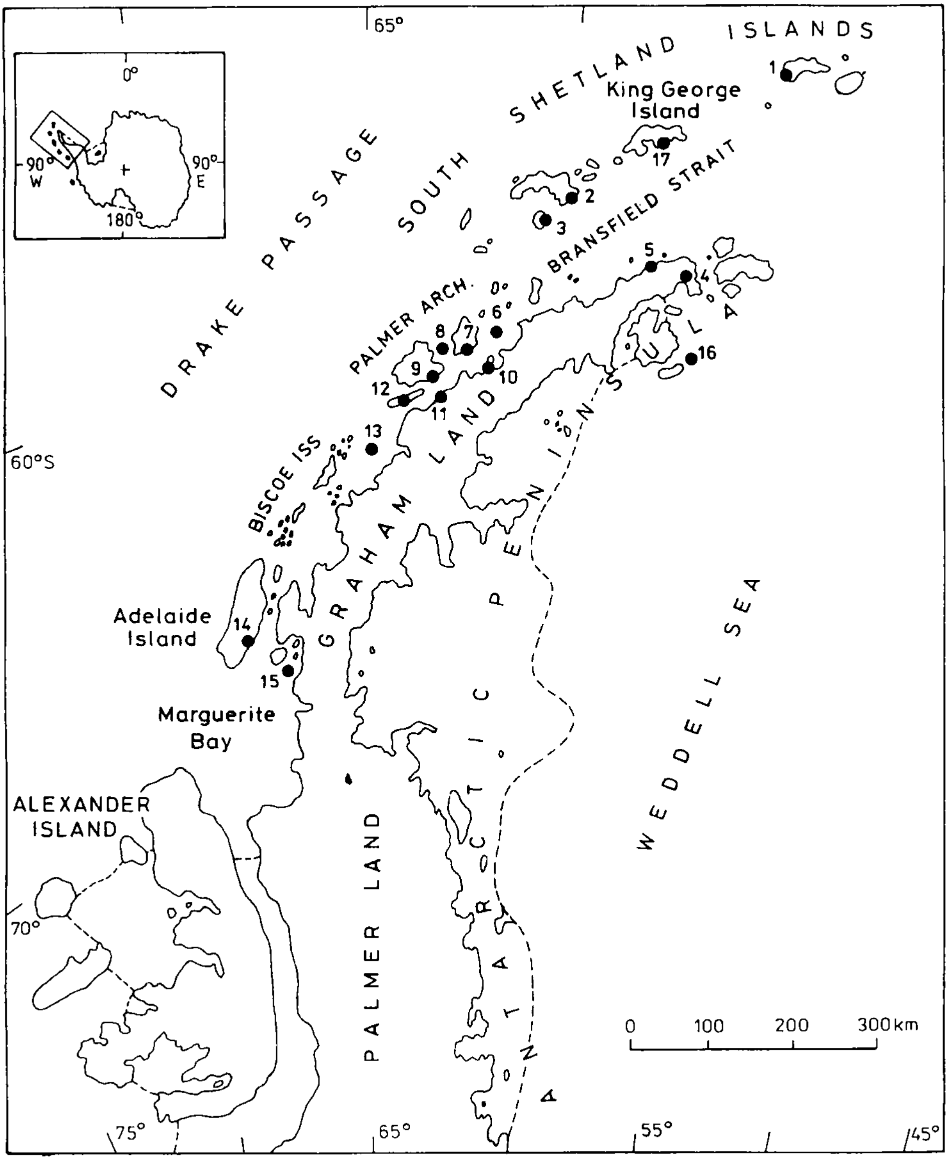

Fig. 1. Main areas geologically investigated during the Polish Geodynamic Expeditions, 1984–1991. 1 – Elephant Island; 2 – Hurd Peninsula (Livingston Island); 3 – Deception Island; 4 – Hope Bay (Trinity Peninsula); 5 – Cape Legoupil (Trinity Peninsula); 6 – Gerlache Strait; 7 – Brabant Island; 8 – Melchior Archipelago; 9 – Anvers Island/Neumayer Channel; 10 – Arctowski Pennisula-Andvord Bay (Danco Coast); 11 – Paradise Harbour (Danco Coast) and adjacent islands; 12 – Wiencke Island; 13 – Lemaire Channel-Penola Strait; 14 – Adelaide Island (Reptile Ridge, Rothera); 15 – Horseshoe Island; 16 – Seymour Island-Cockburn Island (see Gaździcki 1996); 17 – King George Bay to Low Head (see Birkenmajer 1996a).

South Shetland Islands: Elephant Island (western part); King George Island (King George Bay to Low Head); Livingston Island (Hurd Peninsula); a part of Half Moon Island; the Deception Island volcano;

Antarctic Peninsula and Palmer Archipelago: Trinity Peninsula (Hope Bay; Cape Legoupil); Danco Coast (Cape Herschel; Arctowski Peninsula and offshore islands; Andvord Bay; Paradise Harbour and adjacent islands); Gerlache Strait – Neumayer Channel; Brabant, Anvers and Wiencke islands; Melchior Islands; Lemaire Channel-Penola Strait;

Marguerite Bay: Adelaide Island, south-eastern part (Reptile Ridge near U.K. Rothera Station); Horseshoe Island.

The field investigations included stratigraphic, sedimentological, tectonic and volcanologic studies of the whole stratigraphic succession: from ?Upper Permian–Triassic through Quaternary, exposed within the inner (Antarctic Peninsula; Marguerite Bay) and the outer (South Shetland Islands; Palmer Archipelago) Mesozoic–Cenozoic magmatic arcs of West Antarctica (cf. Birkenmajer 1993f, 1994b, 1995d)[1].

The present paper has been prepared on the occasion of the Centennial of Participation of the Polish scientists, H. Arctowski and A. B. Dobrowolski, in the famous Belgian Antarctic Expedition on *Belgica* (1897–1899) under command of Adrien de Gerlache de Gomery. It is dedicated to Henryk Arctowski – the first scientist who carried out systematic geological field studies in Antarctica (see Andersson 1906, Pelikan 1909, Kosiba 1960, Adie 1964, Machowski 1998), and is regarded the Father of Antarctic Geology. Among his numerous scientific discoveries, the large past extension of Antarctic glaciers, the great depth of Antarctic shelf margin, and the analogy in geological structure between Tierra del Fuego and West Antarctica – his theory of Antarctandes (Arctowski 1900a, b; 1908), were among the most stimulating finds in Antarctic Earth sciences for the years to come.

Trinity Peninsula Group: stratigraphy, sedimentology, petrology and tectonics

The Trinity Peninsula Group (TPG: ?Upper Permian–Triassic) represents the oldest metasediments exposed at the surface in the northern part of Antarctic

[1] The results of geological and palaeontological research on King George Island carried out during the Polish Geodynamic Expeditions (1984–1991) were reviewed separately (Birkenmajer 1996a) and will not be repeated here. For reviews of sedimentological and palaeontological studies carried out on Seymour and Cockburn islands (NE Antarctic Peninsula) within the programme of the Polish Geodynamic Expeditions, in co-operation with Argentinian geologists, the reader is referred to papers by Doktor *et al.* (1988), Porębski (1995) and Gaździcki (1996). For the Polish Antarctic Earth sciences bibliography up to 1990, the reader is referred to paper by Birkenmajer and Gaździcki (1991b).

Peninsula, and on Livingston Island in the South Shetland Islands. This is a turbidite sequence of strata laid down in a marginal basin adjacent to palaeo-Pacific margin of the Gondwanaland supercontinent.

The Polish investigations included geological mapping, tectonics, lithostratigraphy, sedimentological and petrological studies in the most representative exposures of the Trinity Peninsula Group: along the north-west (Pacific) coast of Antarctic Peninsula (Hope Bay; Cape Legoupil; Cape Herschel; Andvord Bay; Paradise Harbour) and in the South Shetland Islands (Hurd Peninsula on Livingston Island).

Hope Bay

This is the classical area of occurrence of the Trinity Peninsula Group which is here represented by the Hope Bay Formation (Hyden and Tanner 1981). The formation, more than 1200 m thick, was mapped in detail and subdivided into three members (Birkenmajer 1988a, 1992c): the Hut Cove Member (oldest) more than 500 m thick (base unknown); the Seal Point Member, 170–200 m thick; and the Scar Hills Member, more than 550 m thick (top unknown). The Hope Bay Formation was folded prior to deposition of the Middle Jurassic terrestrial plant-bearing beds (Mount Flora Formation), from which it is separated by angular unconformity. The formation is displaced by two systems of faults, an older longitudinal, and a younger transversal, of Late Cretaceous or Tertiary ages.

Cape Legoupil

Geological studies were carried out in the Legoupil Formation (Trinity Peninsula Group, TPG) exposed in the vicinity of the Chilean station General Bernardo O'Higgins at Cape Legoupil and offshore islets. This is the only area of the TPG rocks where Triassic marine bivalves were found (Thomson 1975). The metasediments of the Legoupil Formation were folded about a N70E oriented axis and affected only by brittle deformation which occurred in four stages: (1) jointing, set I; (2) dyke intrusion; (3) faulting; (4) jointing, set II (Tokarski 1989, 1991).

Andvord Bay and Cape Herschel

At Andvord Bay (Graham Land: Danco Coast), the metasediments of the Trinity Peninsula Group (TPG) are strongly folded, thermally altered by Andean intrusions (AIS-1), and crossed by quartz veins and by two generations of thin melanocratic and leucocratic dykes (AIS-2).

At Cape Herschel (Trinity Peninsula/Graham Land: northern Danco Coast), the TPG metasediments are folded and faulted, the faults were used by melanocratic dykes (Birkenmajer 1995a).

Paradise Harbour

The Trinity Peninsula Group metasediments at Paradise Harbour, Danco Coast (Birkenmajer 1987, 1988b), more than 1000 m thick, were distinguished as the Paradise Harbour Formation (PHF – Birkenmajer 1992a). It was subdivided into three members: the Almirante Brown Member (lowest), more than 500 m thick (base unknown); the Skontorp Cove Member, about 200 m thick; and the Mount Inverleith Member, 100–300 m thick. This is a turbidite rhythmic succession of sandstones, siltstones and shales, representing mainly distal portion of a deep submarine fan (Birkenmajer and Doktor 1988, Birkenmajer *et al.* 1997). Clastic components of the turbiditic sandstones were derived from an uplifted basement of palaeo-Pacific margin of Gondwanaland.

The metasediments are strongly tectonically deformed – folded and thrust (Birkenmajer 1987, 1997) – Fig. 2. The deformation occurred during two major phases. The first phase (Trinity phase of the Gondwanian orogeny: probably Triassic/Jurassic boundary: Birkenmajer 1994c, 1997) caused strong folding and south-eastward thrusting of the PHF rocks (retroarc with respect to the Mesozoic magmatic arc of Antarctic Peninsula). The Trinity orogen was deeply eroded and levelled during the Jurassic, then covered (angular unconformity) by Lower Cretaceous basaltic-andesitic lava-agglomerate pile (Antarctic Peninsula Volcanic Group, APVG) some 2000 m thick. The second phase of deformation post-dated the APVG rocks, the mid-Cretaceous plutons and the ?Late Cretaceous hypabyssal dykes of the Andean Intrusive Suite (AIS). During this phase, a large asymmetric anticline was formed, its core consisting of the PHF, and the limbs of the APVG rocks. The anticline is cut in its south-eastern limb by a reverse fault along which the PHF rocks are thrust retroarc over the APVG lavas (see Birkenmajer 1987, 1992a, 1997).

Livingston Island

Detailed lithostratigraphic, sedimentological, petrological and mesostructural studies were carried out in the Miers Bluff Formation (MBF) of the Trinity Peninsula Group at Hurd Peninsula, Livingston Island (Doktor *et al.* 1994, 1996; Tokarski and Doktor 1996). The redefined MBF, more than 1600 m thick, was subdivided into three members: the South Bay Mbr, more than 850 m thick (base unknown); the Johnsons Dock Mbr, about 150 m thick; and the Glaciar Rocoso Mbr, about 600 m thick.

This is a marine clastic turbidite sequence corresponding to the proximal (lower and middle members) and distal (upper member) submarine fan. The source area of clastics was possibly a dissected continental margin.

A large majority of the MBF strata occur in tectonically inverted position (see Dalziel 1972). Three stages of tectonic deformations were recognized: (1) regional folding around a N25-oriented axis; (2) and (3) brittle deformation in strike-slip tectonic regime with the maximum stress axis horizontal, oriented N90 (2) and N0 (3), respectively. During stages (2) and (3), two systems of joints, minor faults and quartz veins were formed, and magmatic dykes were intruded (Doktor *et al.* 1994).

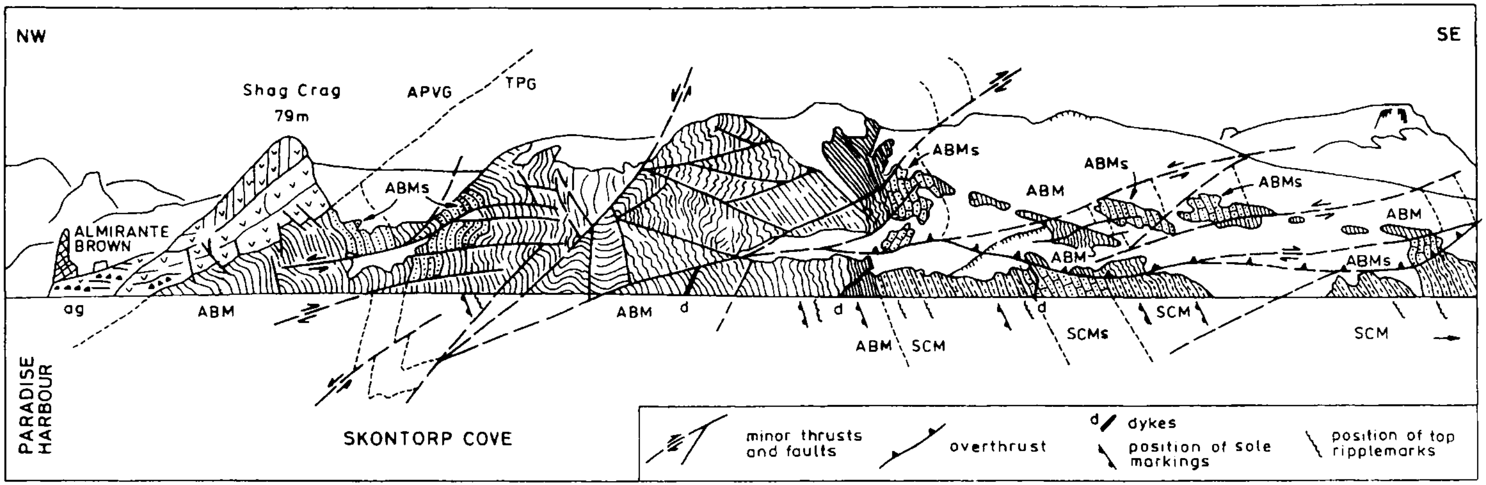

Fig. 2. Strongly folded and thrust Trinity Peninsula Group metasediments (TPG: Paradise Harbour Formation) at Skontorp Cove, Paradise Harbour (after Birkenmajer 1987, 1997). They are unconformably overlain by Lower Cretaceous basaltic-andesitic lavas (APVG: Antarctic Peninsula Volcanic Group). ABM – Almirante Brown Member (ABMs – thicker sandstone horizons); SCM – Skontorp Cove Member (SCMs – thicker sandstone horizons); ag – lava-agglomerate.

Antarctic Peninsula Volcanic Group and Andean Intrusions

Hope Bay

The succession of Mesozoic magmatic rocks at Hope Bay includes (Birkenmajer 1988a, b, 1993b, c): (1) Acidic, stratocone-type, terrestrial effusive complex of the Kenney Glacier Formation (rhyolite-dacite lavas, ignimbrites, tuffs and agglomerates: Upper Jurassic–lowest Cretaceous) which represents the basal unit of the Antarctic Peninsula Volcanic Group (APVG). The volcanics rest with a low-angle unconformity upon tilted and eroded plant-bearing terrestrial clastics of the Mount Flora Formation (MFF: Middle–Upper Jurassic); (2) Leucocratic dykes and sills which intrude the Trinity Peninsula Group metasediments (Hope Bay Formation, HBF: ?Upper Permian–Triassic) and the MFF terrestrial plant-bearing clastics (Middle–Upper Jurassic). They were probably feeder veins for (1); (3) Gabbro and diorite plutons of the Andean Intrusive Suite (AIS-1: ?Early Cretaceous); (4) Melanocratic (basic to intermediate) dykes (AIS-2: ?Late Cretaceous), post-dating the Kenney Glacier Formation and the Andean plutons.

Three systems of faults displace the Kenney Glacier volcanics and its sedimentary basement (MFF and HBF), the youngest of them possibly also the ?Early Cretaceous Andean plutons (Birkenmajer 1988b, 1993b, c; Birkenmajer *et al.* 1995b).

Danco Coast: Arctowski Peninsula

Magmatic rocks exposed along the west coast of Arctowski Peninsula, and on offshore islands (see West 1974), were mapped in 1987/8. The following magmatic complexes were distinguished (Birkenmajer 1988a, 1995a; Birkenmajer *et al.* 1995a): (1) Antarctic Peninsula Volcanic Group (APVG): basalt, andesite, rhyolite lavas, agglomerates and tuffs (Lower Cretaceous); (2) Andean Intrusive Suite (AIS-1): adamellite, granite, granodiorite, diorite, tonalite and gabbro plutons (mid-Cretaceous); (3) Basic and acid hypabyssal dykes (?Upper Cretaceous).

Paradise Harbour

Geological mapping in 1984/5 allowed to establish the succession of magmatic rocks at Paradise Harbour (Danco Coast) and adjacent islands in considerable detail (Birkenmajer 1987, 1993a, 1994a): (1) Early Cretaceous basaltic lava-agglomerate pile (Antarctic Peninsula Volcanic Group, APVG) some 2000 m thick, with subordinate rhyodacite lava intercalations; (2) Mid-Cretaceous Andean plutons (Andean Intrusive Suite, AIS-1): granite, granodiorite, diorite and gabbro; (3) ?Late Cretaceous acidic, intermediate and basic hypabyssal dykes (AIS-2).

The APVG effusives rest unconformably upon sedimentary basement formed by strongly folded Trinity Peninsula Group metasediments (Paradise Harbour Formation – see Fig. 2). The APVG rocks, together with its TPG basement, probably also a part of the Andean plutons (AIS-1) and younger dykes (AIS-2), are involved in SE-vergent, retro-arc thrusts. The thrust-folding could be an expression of the oceanic Aluk Ridge/Antarctic Peninsula Magmatic Arc collision

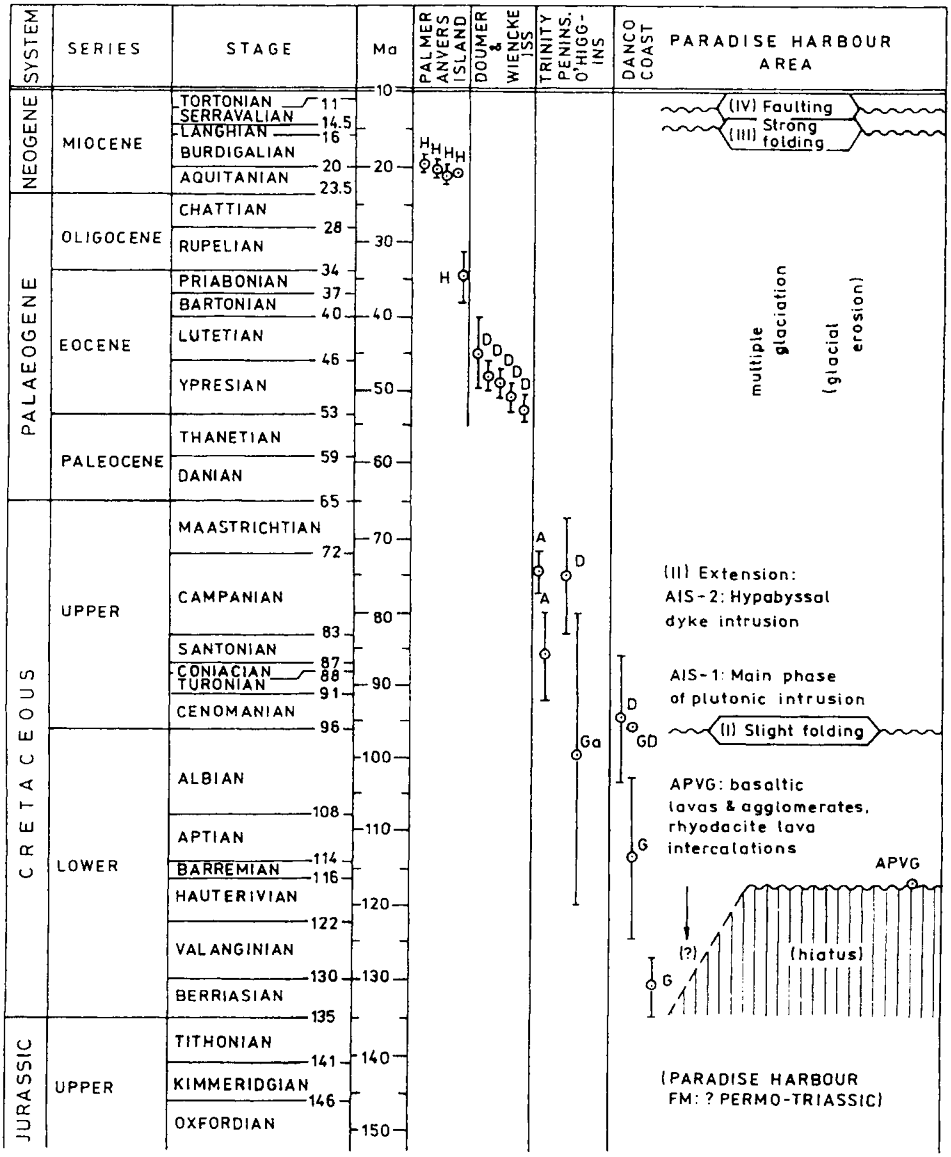

Fig. 3. Succession of magmatic and tectonic events at the Antarctic Peninsula (Danco Coast and southern Trinity Peninsula) – Gerlache Strait – Anvers Island (Palmer Archipelago) transect, and radiometric ages (Birkenmajer 1993a, 1994a). APVG – Antarctic Peninsula Volcanic Group (lava-agglomerate pile); AIS – Andean Intrusive Suite (AIS-1 plutons: D – diorite; G – granite; Ga – gabbro; H – hybrid rocks); AIS-2 – hypabyssal dykes (A – andesite). For location and sources of radiometric dating – see Birkenmajer (*op. cit.*).

(between the Tula and Anvers fracture zones of the adjacent SE Pacific area) during the Tertiary (Fig. 3).

Gerlache Strait-Neumayer Channel

Rock-sampling and geological mapping of the Lower Cretaceous APVG complex were carried out on Wiencke and Brabant islands. Tertiary plutons, hybabyssal dyke systems that post-date the plutons, and their ?Late Tertiary volcanic cover, were studied at SE Anvers Island (Gerlache Strait/Neumayer Channel) and on Melchior Islands (Birkenmajer 1987).

Adelaide Island and Horseshoe Island

In the SE part of Adelaide Island (Marguerite Bay), pyrite-chalcopyrite mineralisation of the APVG rocks and the adamellite intrusions (AIS) were studied at Reptile Ridge (north of the U.K. Base *Rothera*). It was found that this mineralisation used a sub-meridional fault system post-dating the APVG and AIS. Traces of Cu-mineralisation were also observed at intrusive contact of diorite (AIS) with altered lava complex (APVG) at Horseshoe Island, close to the U.K. hut at Sally Cove (Birkenmajer 1987).

Lithospheric transect: South Shetland Islands – Antarctic Peninsula

A lithospheric transect (see Fig. 5C): from South Shetland Islands (SSI) across Bransfield Strait (BS) to Antarctic Peninsula (AP), was constructed (Birkenmajer *et al.* 1989, 1990; Birkenmajer and Guterch 1991). It was based on deep-seismic refraction and multichannel reflection soundings made during three Polish Geodynamic Expeditions, 1979/80, 1984/85 and 1987/88 (Guterch *et al.* 1985, 1990, 1991)[2], and on available geological data, including those obtained during the Polish expeditions.

The transect traverses (see Fig. 5C): the South Shetland Trench (subductional) and the adjacent portion of the SE Pacific oceanic crust; the South Shetland Microplate (younger magmatic arc superimposed on continental crust); the Bransfield Rift and Platform (younger back-arc basin); the Trinity Horst (older magmatic arc superimposed on continental crust); the Gustav Rift (Late Cenozoic) and the James Ross Platform (older back-arc basin).

Tertiary glaciation and sea-level changes

The Tertiary strata of King George Island provide evidence for four cold (glacial) and three warm (interglacial) epochs: (1) the Kraków Glaciation

[2] Deep seismic sounding established the depths of the Moho discontinuity at about 30 km under the South Shetland Islands, and at 38–42 km in the northern part of Antarctic Peninsula.

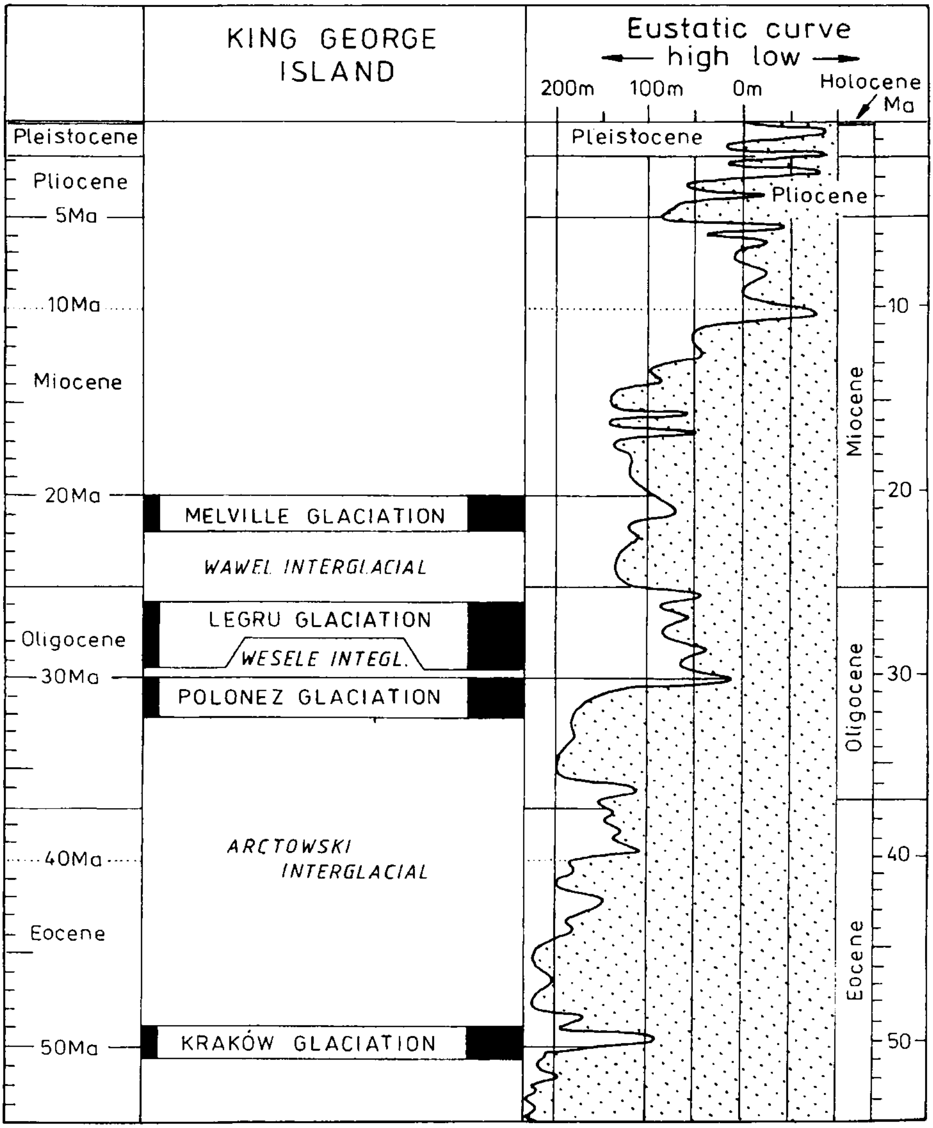

Fig. 4. Tertiary glaciations and interglacials of King George Island against eustatic curve of Haq *et al.* (1987). From Birkenmajer (1996b, c).

(Early/Middle Eocene, about 50 Ma); (2) the Arctowski Interglacial (Middle Eocene–Early Oligocene, 50–32 Ma); (3) the Polonez Glaciation (late Early Oligocene, 32–30 Ma); (4) the Wesele Interglacial (mid-Oligocene, ca 30 Ma); (5) the Legru Glaciation (Late Oligocene, 30–26 Ma); (6) the Wawel Interglacial (Oligocene/Miocene transition, 26–22 Ma); (7) the Melville Glaciation (Early Miocene, 22–20 Ma).

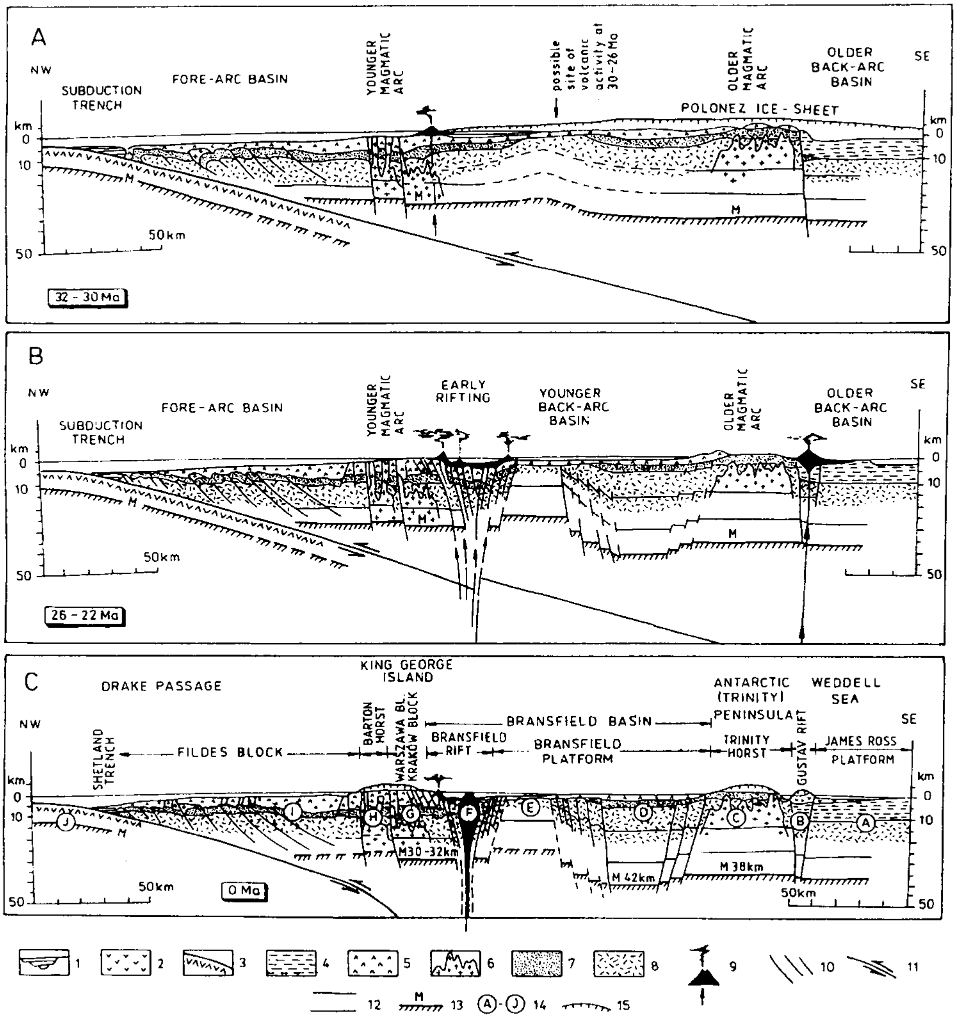

Fig. 5. Stages of evolution of the Bransfield Rift and Basin (Birkenmajer 1992e). A – pre-rifting stage; B – initiation of rifting; C – present stage (from Birkenmajer *et al.* 1990). 1 – marine tuffogenic sediments (Pliocene–Quaternary in Fig. C; Paleocene–Eocene in Fig. A); 2 – volcanics of the Weddell province (Pliocene–Quaternary); 3 – oceanic crust and sediment cover (Tertiary–Quaternary); 4 – Mesozoic marine deposits (Weddell province); 5 – stratiform volcanics (Mesozoic in Antarctic Peninsula; Upper Cretaceous and Tertiary between Bransfield Strait and Shetland Trench); 6 – Andean plutons (Cretaceous and ?Tertiary in Antarctic Peninsula; Paleocene–Oligocene in King George Island); 7 – Trinity Peninsula metaturbidites (?Upper Permian–Triassic); 8 – metamorphic substratum (?lower Palaeozoic and ?Precambrian); 9 – active volcanoes and feeder veins; 10 – major faults; 11 – subduction zone; 12 – crustal boundaries (from seismic modelling – see Birkenmajer *et al.* 1990; Guterch *et al.* 1985, 1990, 1991); 13 – Moho discontinuity; 14 – crustal structural elements; 15 – ice-sheet.

GROUP	FORMATION	PHASE	FORM	PRINC. PROD.	PETR. TYPE	DATE	VOLC. CYCLE	STAGE
HAWKES	TELEFON	GONZÁLEZ	MAARS	(t)	A	1970	II	POST - CALDERA
		POND	FISSURE ERUPTIONS	(t) (l)	A	1969		
		YELCHO	CONES	(t)	A	1967		
	KIRKWOOD	KRONER	MAAR	(t)	B*	1912 - -1829		
		KIRKWOOD	FISSURE ERUPTIONS	(l) (t)	B*	1842		
	CASCO	EMERALD	CONE WITH CRATER	(t) (l)	?BA	pre-1829		
		CASCO	CONES WITH CRATERS	(l)	BA	–"–		
	CHACAO	KENDALL	MAARS	(t)	(MIX)	–"–		
		CHACAO	CONES WITH CRATERS	(t)	BA	–"–		
	COLLINS		CONES WITH CRATERS	(t)	(MIX)	–"–	I	
			LAVA FLOWS	(l)	TD	–"–		
	RONALD		PLUG	(l)	TD	–"–		
			LAVA FLOW	(l)	TD	–"–		
	radial faulting – caldera collapse							SYN-CALDERA
	MURATURE		DESTROYED RING CONES	(t)	A	–"–		
ring faulting – caldera collapse								
FOSTER	WINDOW		DYKES	(l)	TB	LATE PLEISTO-CENE?-HOLOCENE		PRE-CALDERA
	STONETHROW		STRATO-CONE	(l)	BA			
	CATHEDRAL			(t)	(MIX)			
	ENTRANCE			(l)	B, BA			

BASEMENT: EOCENE MARINE SEDIMENTS UPON LATE MESOZOIC TO EARLY TERTIARY VOLCANICS AND INTRUSIVES

Fig. 6. New volcanostratigraphic standard for the Deception Island volcano (Birkenmajer 1991a, 1992b, 1995b). A – andesite; B – basalt (* after Hawkes 1961); BA – basaltic andesite; TB – trachybasalt; TD – trachydacite: MIX – mixed petrology; l – lava; t – tuff.

There is a good correlation between the Eocene (Kraków) and Early Oligocene (Polonez) glaciations and low stands of world ocean level (Fig. 4). There is no good correlation between low stands of world ocean level and the Late Oligocene (Legru), and the Early Miocene (Melville), glaciations. The Oligocene/Miocene transition was the time of opening of the back-arc Bransfield Rift, and of up– and downwarping of tectonic blocks in the area of Antarctic Peninsula-South Shetland Islands. As a result, eustatic signal in sedimentary record was obliterated (Birkenmajer 1992d, 1996b, c).

Evolution of the Bransfield Basin and Rift

Based on geophysical and geological investigations in the area of the lithospheric transect: South Shetland Islands-Antarctic Peninsula (see above), a model of evolution of the Bransfield Rift and Basin was proposed (Birkenmajer 1991c, d, 1992a). Simultaneous changes in Antarctic Cenozoic palaeoenvironments and biota (Webb *et al.* 1989; Birkenmajer and Gaździcki 1991a; Birkenmajer 1996b, c), and the Late Tertiary/Quaternary transition from arc to back-arc volcanism (Keller *et al.* 1989, 1992) were taken into account.

Fig. 5 presents three characteristic stages of the structural evolution of the area in question:

(A) At 32–30 Ma (Early Oligocene), a continental ice-sheet of the Polonez Glaciation transgressed over shallow-marine Bransfield Basin. It reached as far NW as King George Island, where local basaltic volcanic activity accompanied slow subduction of the SE Pacific oceanic slab under continental crust wedge of the South Shetland Islands-Antarctic Peninsula. An up-doming lithospheric block within the continental crust wedge indicates a possible site of strong volcanic activity at the end of Oligocene (30–26 Ma), during the Legru Glaciation;

(B) At 26–20 Ma (Late Oligocene/Early Miocene), the subducted oceanic slab was broken, and a back-arc tensional Bransfield Rift was initiated with intense basaltic-andesitic (calc-alkaline) volcanism. The sea encroached upon the ever deepening Bransfield Rift and adjoining Bransfield Platform. At the beginning of the Miocene, King George Island was drowned down to 500 m below the sea. Alkaline volcanoes were active in back-arc position with respect to the older magmatic arc of Antarctic Peninsula;

(C) Tensional regime reigns to-day in the area between the Shetland Trench and Antarctic Peninsula. Tholeiitic submarine volcanic activity is confined to the Bransfield Rift axis, while calc-alkaline volcanoes are located at inner edge of the South Shetland Microplate. The subduction of oceanic crust under the South Shetland Microplate probably still continues at a slow rate.

Evolution of the Deception Island volcano

Detailed geological mapping of the Deception Island volcano (South Shetland Islands) during three Austral Summer seasons (1984/5, 1987/8 and 1990/91)

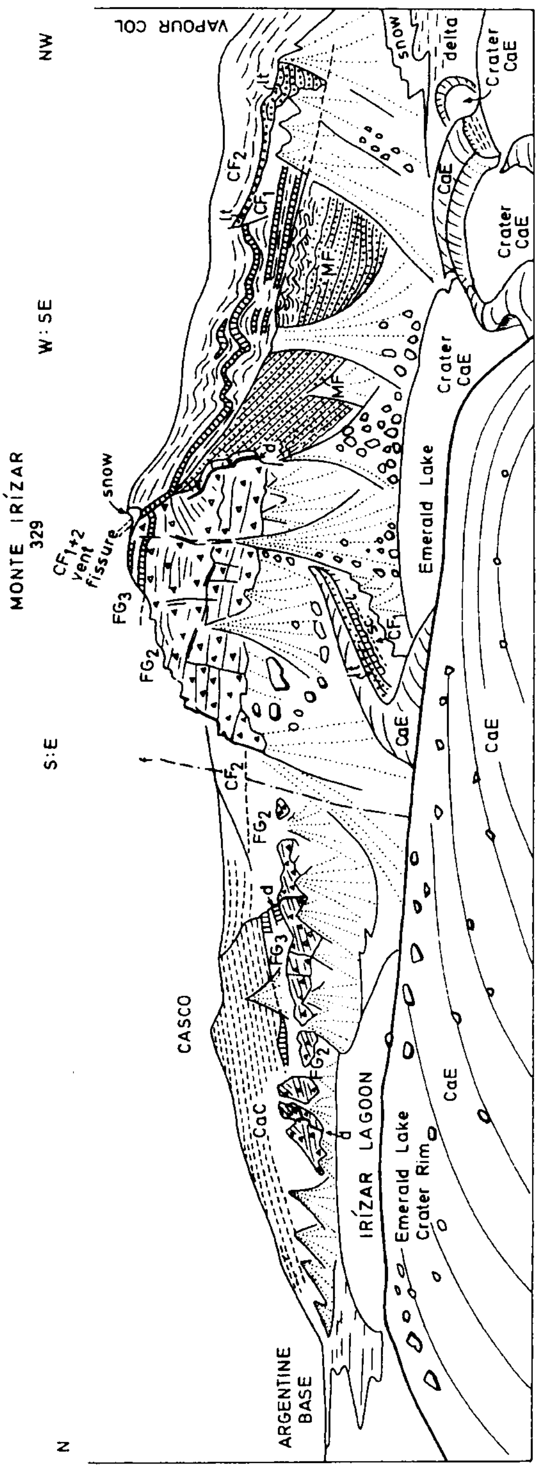

Fig. 7. Geological panorama of Monte Irízar and vicinity, Deception Island volcano (Birkenmajer 1991a, 1992b). FG_2 – Cathedral Fm. (agglomerates); FG_3 – Stonethrow Fm. (basaltic lavas and tuffs, subordinately agglomerates); MF – Murature Fm. (lapilli tuffs); CF – Collins Fm. (CF_1 – trachydacite lavas; CF_2 – tuffs); CaC – Casco Fm., Casco phase (tuffs); CaE – Casco Fm., Emerald phase (lavas and tuffs); d – Window Fm. (?trachybasalt dyke); f – ring fault; lt – lithified tuff.

allowed to revise the succession of volcanic events and to introduce a new, formal volcanostratigraphic standard (Birkenmajer 1987, 1988, 1991b, 1992b, 1995b, c; Birkenmajer and Dudziak 1991). Two volcanostratigraphic groups, the pre-caldera Foster Group, and the post-caldera Hawkes Group, were distinguished. They were subdivided into 4 and 6 formations, respectively (Figs 6, 7).

Structural evolution of the Deception Island volcano includes the following events: (1) formation of a large central stratovolcano; (2) caldera collapse along ring faults; intrusion of dykes (syn-caldera); violent Krakatoan-type eruption and flooding of the caldera by the sea; (3) parasitic phreatic eruptions along ring faults, and radial faulting (syn-caldera); (4) further sectorial subsidence of the caldera, resulting in a succession of parasitic cones and craters (post-caldera) along rejuvenated ring faults.

A new tectonic pattern of historical parasitic eruptions inside the caldera, is possibly a result of plate readjustments along the Hero Fracture Zone system constrained by slow spreading at the Bransfield Rift (Birkenmajer 1995b).

Quaternary geology

Quaternary geological studies were carried out along with mapping of the bedrock on King George Island (King George Bay: see Birkenmajer 1996a) and at Hope Bay (Trinity Peninsula: Antarctic Peninsula).

At Hope Bay, two generations of Holocene raised marine terraces/beaches were distinguished: at 40–60 m, and up to 10 m a.s.l. Moreover, six generations of moraines, dated at: late Pleistocene or early Holocene (Ist); 350 BPL (IInd); about 300 BPL (IIIrd); 250 BPL (IVth); and the 20th century (Vth and VIth) were recognized (Birkenmajer 1993d)[3].

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[3] BPL = years before 1988 A.D., lichenometric dating.

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