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Scotia Arc Tectonics Project, 1977-78

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During the austral winter of 1977 and the austral summer of 1977-78, Scotia Arc Tectonics Project (Dalziel, 1975) fieldwork was conducted by scientists from Lamont-Doherty Geological Observatory at the South Shetland Islands, Antarctica; at Cordillera Darwin, Tierra del Fuego, Chile; in the Andean foothills, Magallanes Province, Chile; and the Patagonian coastal cordillera, Chile. The fieldwork involved the history of the Scotia Arc region from the late Paleozoic to present day.

In his work in the Patagonian coastal cordillera, Randall Forsythe (1978) mapped detailed pre-Middle Jurassic basement rocks of southern South America to tie in with work in the South Orkney and South Shetland Islands (Dalziel, in press). Margaret Winslow and Terry Wilson undertook field studies of the tectonic evolution of the well-developed Andean foreland fold and thrust belt. The first detailed study of the structural geology and tectonic history of Cordillera Darwin in Tierra del Fuego, a highly deformed region on the continental side of the Early Cretaceous marginal basin in the southern Andes (Dalziel *et al.*, 1974), was initiated by Eric Nelson (Nelson *et al.*, 1977). Finally, Margaret Winslow undertook a detailed study of the late Mesozoic and Tertiary rocks on Byers Peninsula of Livingston Island.

Laboratory work on all these individual projects, as well as my study of the basement rocks of the South Orkney and South Shetland Islands, continued at Lamont-Doherty.

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Geologic reconnaissance of the Pre-Late Jurassic Basement: Patagonian Andes

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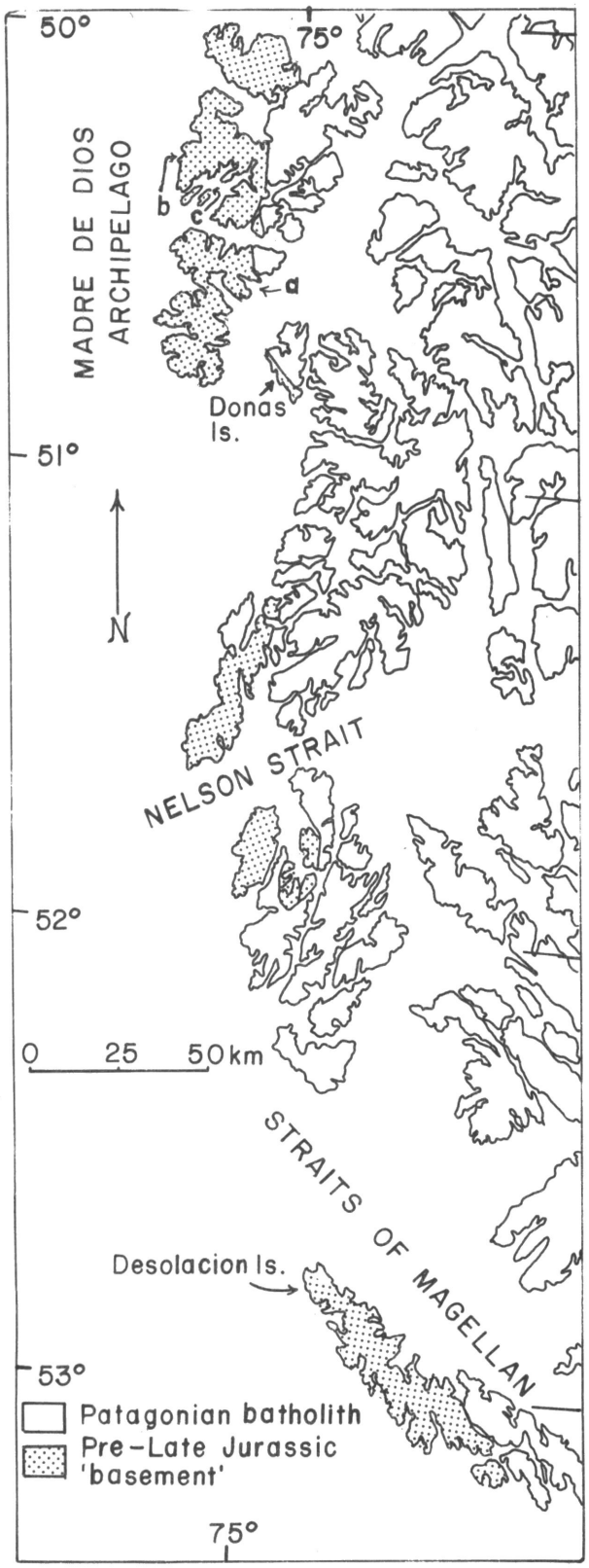
Over 3 months of field work have been done to define the regional geologic framework of the Pre-Late Jurassic basement exposed along the outer perimeter of southernmost Chile. This work has been carried out through the R/V *Hero* cruise 76-5, and more recently through the logistical support of the limestone quarry operated by the Compania de Acero del Pacifico within the region of concern. These investigations were part of the continuing study of the structural and tectonic history of the Scotia Arc supported by the National Science Foundation. (See, for example, Dalziel *et al.*, 1975; Dalziel, 1975.)

The Pre-Late Jurassic basement forms an almost continuous belt of exposure from 47°S. to 54°S. along the outer belt of islands that comprise the southern Chilean archipelago (see figure). The islands containing basement exposures that have thus far been investigated are Desolacion, Donas, Madre de Dios, and Duque de York.

Desolacion Island. Over 90 percent of the basement within this region is composed of a monotonous sequence of alternating conglomerate, sandstone, and shale, all generally immature and containing many graded units of turbidite character. Tectonically emplaced into these clastic sediments are lenticular bodies of red and green rhythmically bedded chert.

Structurally the flyschoid and chert units exhibit an extreme parallelism between bedding and cleavage, usually striking northwest and dipping variably to the southwest. The discontinuous nature of the chert and clastic units together with the cleavage-bedding relationships suggest massive imbrication and thrusting on a inter- and intraformational scale.

Madre de Dios, Duque de York, and Donas Islands. As a result of detailed investigations carried out in this region, a geologic



Pacific perimeter of southern Chile between latitudes 50° and 53°. Islands investigated were Duque de York ("a" on map), Desolacion, Doñas, and Madre de Dios ("b" on map). Limestone quarry located at "c."

map for these three islands at a scale of 1:100,000 is close to completion. Many new discoveries have been made to add to the previous work in this region (Oppinger, 1883; Biese, 1945; Mordojovich, 1953; Cecioni, 1956; Douglass and Nestill, 1976; Dalziel, 1975). Probably the most important discovery is the occurrence of over 20 bodies of a basalt/chert/shale/limestone association that are for the most part in thrust contact with the other two dominant lithologies in the region, these two being (1) a massive fusulinid-bearing limestone of Carboniferous to Permian age (Mordojovich, 1953; Douglass and Nestill, 1976) and (2) a monotonous sequence of conglomerate, sandstone, and shale similar to those on Desolacion Island. In 3 of the 20 localities stratigraphic relationships among the basalt/chert/shale/limestone association have been preserved. Massive pillow basalt with interstitial red and purple manganiferous chert is overlain by a sequence of red ribbon chert. The red chert consistently passes upward into a sequence of green ribbon chert. Within both red and green cherts, radiolaria and fine turbiditic structures occasionally are visible. The green chert can be seen in transitional contact with thinly bedded limestones in at least three localities. In one of the three localities, the limestone contains a fusulinid-bearing zone. This suggests a late Paleozoic age for the basalt/sediment association. The sequences of conglomerate, sandstone, and shale commonly contain zones of soft sediment deformation, olistostromes, and cleavage-bedding relationships similar to those observed in Desolacion Island. Conglomeratic horizons contain many clasts of silicic volcanics, occasional clasts of limestone, and many angular sandstone and shale clasts.

Structurally the region is more complicated than the Desolacion area and cannot be adequately synthesized here. Structural domains of both consistent fabric characteristics and consistent orientation are generally relatively small, perhaps less than 25 square kilometers on the average.

Regional Synthesis. The presence of (1) pillow basalts overlain in sequence by red chert, green chert, and limestone, (2) immature clastic sequences containing clasts of felsic/silicic volcanics, turbidite intervals, and soft sediment deformation features, (3) tectonic melanges, and (4) zones of small- and large-scale crustal imbrication as well as complicated discontinuous folds, corroborate the hypothesis suggested earlier that this region represents a fore-arc, arc-trench-gap assemblage of late Paleozoic to early Mesozoic age (Barker *et al.*, 1976; Dalziel, 1975; Dalziel, in press; de Wit, 1977; Suárez, 1976).

This work could not have been accomplished without the cooperation and excellent seamanship of Captain Pieter Lenie and the entire crew of the R/V *Hero*. Further thanks is due the Compañia de Acero del Pacifico and the kind people at the Guarello Quarry for their assistance in the Madre de Dios area. This research was supported by National Science Foundation grant DPP 74-21415.

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Geologic studies in the northern Antarctic Peninsula, R/V *Hero* cruise 78-1B, February 1978

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Geologic investigations were carried out between 2 and 18 February on eastern Joinville Island and surrounding offshore islands and at Hope Bay (figure 1). Studies originally planned for the South Shetland Islands were not carried out because the cruise was terminated early.

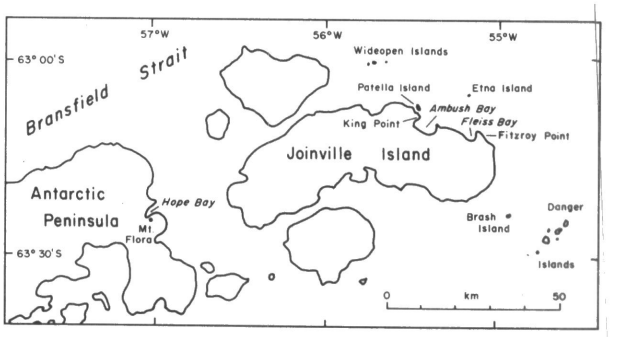

Figure 1. Location map of northern Antarctic Peninsula.

The objectives of the studies were:

1. To investigate the Mesozoic conglomerates and associated rocks cropping out on Joinville Island and at Hope Bay, as part of the program initiated in 1974-75 to study the late Mesozoic and Cenozoic evolution of the Antarctic Cordillera through the sedimentary rocks of that age (Dalziel *et al.*, 1977; Elliot *et al.*, 1975; Elliot and Trautman, in press; Elliot and Wells, in press); and

2. To collect samples for paleomagnetic study to establish the position of the northern Antarctic Peninsula relative to South America and the east antarctic craton during the late Mesozoic and early Cenozoic (see Watts, in press).

Mesozoic sedimentary and volcanic rocks. The principal objective of this part of the program was to establish the relationship between the Mesozoic sedimentary and volcanic rocks (see Bibby, 1966; Elliot, 1967) that crop out on Joinville Island and at Hope Bay and the evolution of the Antarctic Cordillera. The sedimentology of the conglomerates suggests that all are alluvial fan deposits. Four sedimentary facies have been recognized, and at Hope Bay an evolution in the depositional environment is suggested by the vertical change from debris flows, through sheetwash conglomerate, to fluvial or lacustrine plant-bearing beds at the top of the section. All the conglomerates reflect erosion of the late Paleozoic-early Mesozoic Trinity Peninsula Formation. The alluvial fan deposits are probably related to fault block tectonism. The finer grained, plant-bearing sandstones at Hope Bay represent a sedimentary facies not preserved elsewhere, except possibly at inaccessible outcrops west of Fleiss Bay (see Bibby in Elliot, 1967); the plant beds are known to be either fluvial or lacustrine deltaic deposits, but a precise distinction must await further detailed fieldwork. Siliceous volcanic rocks occur at intervals through the sedimentary sequence at Hope Bay and form a thick pile of rocks conformably overlying the plant beds.

The unconformity between the conglomerate beds and the Trinity Peninsula Formation was observed at three places around Ambush Bay, and what appear to be Trinity Peninsula Formation outcrops were located very close to the conglomerates at Hope Bay.

Dating of these rocks has regional significance and, therefore, samples were collected for palynological study. It is hoped that such studies will help define the age of the conglomerates and refine the age of the plant beds.

Hope Bay is particularly important in the Mesozoic history of the northern Antarctic Peninsula (figure 2). Here the Trinity Peninsula Formation, which was deformed during