Studies in Antarctic Paleobotany*

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Devonian floras. Devonian plant fossils are known from three widely separated localities along the Transantarctic Mountains: (1) at West Beacon, Victoria Land, where an erratic specimen was collected by Speden and identified as the axis of *Haplostigma* by Plumstead (1962); (2) on Discovery Ridge, Ohio Range, in central Antarctica, where plant material has been found intercalated with fossiliferous marine beach sands (Long, 1964), and where the plant fossils include numerous spores and small axis fragments of psilophytes; and (3) at "Okanogan" nunatak (Loc. "C," Schmidt *et al.*, 1964) in the southwestern part of the Patuxent Mountains, where Dwight Schmidt found an erratic axis fragment of *Haplostigma* preserved as a mold in quartzitic sandstone, and where shaly carbonaceous pods *in situ* in the sandstone include numerous spores and compressions of *"Cyclostigma"*-type stems.

Locality 3 is apparently Middle Devonian; locality 2 is Early Devonian, as proved by association with Emsian-age marine fossils (Doumani *et al.*, 1965), the age being further confirmed by the plant assemblage. The age and source horizon of locality 1 is uncertain. Additional searching should provide more material. Bony fish plates that David Matz has found in place near the top of the Victoria Land Devonian section (presumably above the plants) suggest that the age is perhaps Frasnian or older, according to a preliminary estimate by Dr. R. H. Denison, who is now studying this material.

The Devonian plant fossils are significant. They indicate the presence of a cosmopolitan flora that can be compared with assemblages in both Northern and Southern Hemispheres. Occurrences of land plants also define the extent of the antarctic landmass during the Devonian. They are in near-shore marine deposits, which in the Ohio Range were closest to the strand. They are also found in quartzitic sandstones that probably represent offshore bars.

Permian and Triassic floras. Most of the fossil plant collections from the Antarctic are Permian. The Permian floras, characterized by *Glossopteris, Gangamopteris, Noeggerathiopsis,* and *Paracalamites,* apparently represent mostly Late Permian floras (Rigby *and* Schopf, 1968). One occurrence of *Buriadia* at the bottom of the Mount Gran section in Victoria Land apparently is an indication that Early Permian floras also may be present. "Northern" plant types are lacking, and there are few novelties. Most species represent familiar forms widely reported from other parts of Gondwanaland.

A comparable Late Permian plant assemblage has been collected in the Ellsworth and Pensacola Mountains. Similar material is present in the Theron Mountains and the Whichaway Nunataks (Plumstead, 1962), the Horlick Mountains, the Queen Maud Mountains, the Queen Alexandra and Queen Elizabeth Ranges, and central and northern Victoria Land. All told, about 300 horizon localities are represented, according to a count by J. F. Rigby, who has been associated with these studies. The antarctic Permian flora is most similar to that of the Lower Beaufort of South Africa, the Damuda of India, the Newcastle of Australia, and possibly to the Passa Dois series in Brazil. Most of the antarctic glossopterid floras probably are of Guadalupian and Ochoan age in terms of the American section and of Kazanian and Tatarian in terms of the Ural sequence.

The Triassic is sharply distinguished from the Permian in the Antarctic by the occurrence of *Dicroidium* and megaspores of *Nathorstisporites.* At Allan Nunatak, Lower Triassic may be present, as indicated by sparse admixture of *Glossopteris* and *Taeniopteris. Czekanowskia* occurs with *Dicroidium* in collections obtained by David Matz at Robison Peak. Elsewhere, *Dicroidium* and the form that Townrow (1967) has compared with *Diplasiophyllum* may represent a somewhat younger Triassic assemblage. According to Barrett *et al.* (1968), this plant assemblage is associated most closely with the one known antarctic example of an ancient terrestrial vertebrate.

Permian and Triassic fossil wood, some of it almost certainly glossopterid and none of it wholly characteristic of *Rhexoxylon,* provides the surest index to rate of plant growth in a seasonal temperate climate. Some of the wood is rotted by fungi, which provides an indication of degradation processes. Clamp connections of the fungus suggest the Triassic occurrence of Basidiomycetes of a type that can be matched in temperate humid forests of the present day.

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Aerial Color Photography for Antarctic Photogeology

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This paper is intended as a progress report on the evaluation of successive trial color-photography runs that began in 1962. It is part of a more general study of the applicability of photo interpretation to antarctic terrain (Smith, 1967). The earlier trials with color, although showing promise, were beset by various mechanical and optical problems, and were less than satisfactory. The photography considered here was taken in January 1967 by means of a T–11 camera with a 6-inch Metrogon wide-angle lens set at f/6.3; the shutter speed was 1/300 second. The film was Ektachrome Aero. The photos were overlapping verticals taken at heights of 1,800 to 3,000 m above the terrain. Flights were made by the U.S. Navy in cooperation with the U.S. Geological Survey. Photographs were taken along eight short flight lines, three over Ross Island and five over the dry-valley area.

Of the Ross Island flights, one was over Cape Crozier and two were over the coast on the west side of Mount Bird. Resolution of detail was very good, and color contrasts within the volcanic rocks were conspicuous. Particularly noteworthy was the contrast of areas of reddish-brown coloration with the generally prevalent blue-black coloration, suggesting lithologic differences, which, however, have not as yet been correlated with field observations. Comparisons made with black-and-white photography of volcanic terrain of other parts of Ross Island appear to indicate that color photography is definitely advantageous for the study of volcanic rocks.

Flights over the dry-valley area were spread out over a distance of some 35 miles, from the Finger Mountain-Maya Mountain locality to Lake Vida. All except four exposures were over sedimentary rocks of the Beacon group and intercalated dolerite sills. Despite the general monotony of coloration, details of bedding and of variations in tone and hue from one bed to another were well displayed. In particular, minor differences between Devonian and Permian beds, which are separated by a major unconformity (Matz *and* Hayes, 1966), were much more easily recognized on color than on black-and-white photography. However, comparisons between dicontinuous exposures were handicapped by vignetting. An outcrop near the border of one frame appears much darker than the same outcrop positioned more centrally in the overlapping frame; in other words, there was increasing underexposure from center to edge. Only within a circular central area roughly four inches in diameter was color rendition more or less uniform. This restriction, which applied also to previous experiments with color photography, reflects a deficiency of the optical system used. It probably constitutes the main technical barrier to effective and more widespread use of color. Undoubtedly, further experimentation with different lenses and/or filters will provide a solution. When this difficulty is removed, color photography should become a much more important tool for the antarctic geologist.

What is said above applies also to the study of the basement rocks. Although only four photographs taken along the flight lines considered here covered exposures of those rocks, some of the photography from an earlier date gave better coverage, but was similarly plagued by vignetting. It did suggest, however, that if this difficulty were overcome, the use of color could be particularly valuable in distinguishing the various igneous and metamorphic rocks.

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Origin of the Salts in Taylor Valley

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The isotopic composition of strontium is being used as a natural tracer to identify the source of strontium in the salts of lakes and soils in southern Victoria Land. If the source of the strontium can be deter-