

water or moisture was available for plant survival during these episodes. The apparently low number of surviving species probably represents the last vestiges of land-plant vegetation in Antarctica before the Pleistocene to present-day essentially nonvegetated scenario.

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## Structural geological investigations in the Nimrod Glacier area

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A folded unconformity crops out in the Nimrod Glacier area of the Transantarctic Mountains (Laird, Mansergh, and Chappell 1971). Lower Cambrian Shackleton Limestone overlies an erosion surface on late Precambrian Goldie Formation, which is truncated at a high angle, demonstrating a Precambrian episode of folding. The Shackleton Limestone and, presumably, the Goldie Formation beneath it, were folded during the Cambro-Ordovician Ross Orogeny. However, previous descriptions of Goldie Formation deformation identified only one episode of folding (Gunn and Walcott 1962; Grindley 1963; Laird, Mansergh, and Chappell 1971). Our objective was to identify and characterize the two episodes of deformation in the Nimrod Glacier area that seemed required by reported field relations.

During the 1985–1986 field season, our party occupied three base camps placed by helicopter out of the Beardmore South camp (figure). The campsite at Mount Markham was reached by snowmobile from a helicopter put-in at 3,000 meters in the saddle of the Markham Plateau. We had 1 day of helicopter reconnaissance in the Miller Range examining Nimrod Group metamorphics, and Edgerton spent 2 additional weeks in the Miller Range with the party of Borg et al. (*Antarctic Journal*, this issue).

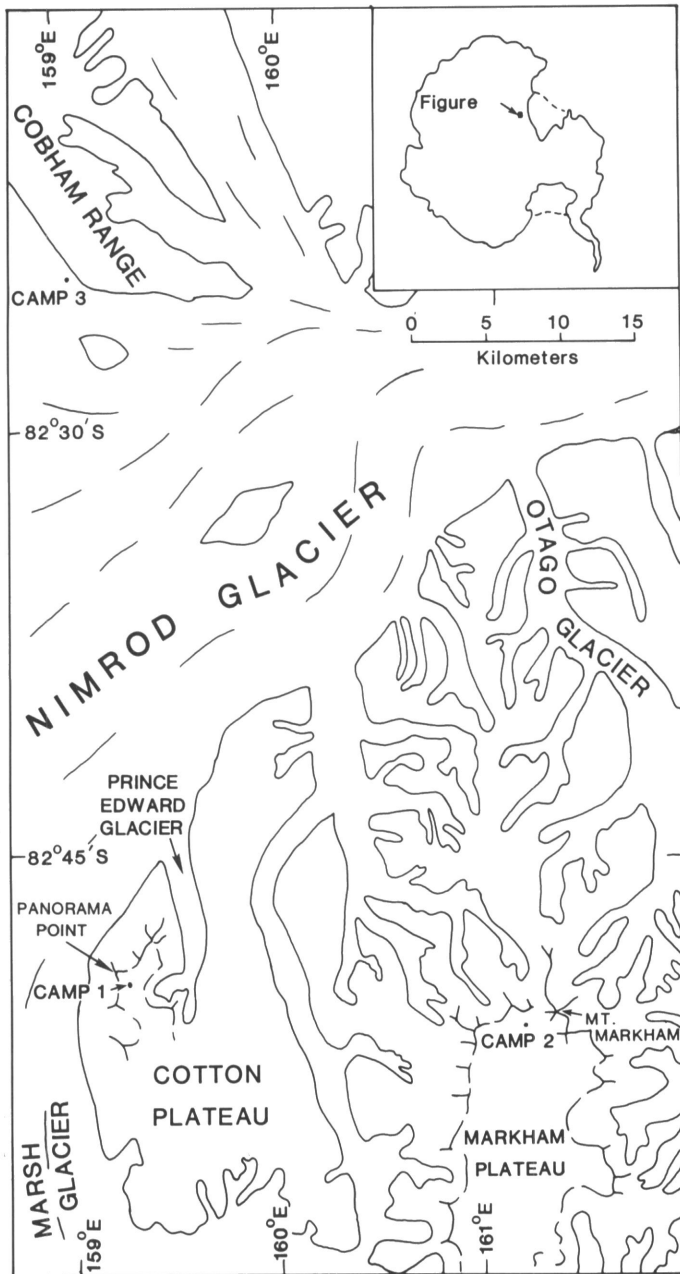
Our first camp was on Cotton Plateau where a syncline of Shackleton Limestone overlying Goldie Formation associated with the younger cleavage verge to the west (east over west folding). The older cleavage in Goldie Formation is clearly exposed at Panorama Point. We found that throughout the northern end of Cotton Plateau, Goldie Formation contains two sets of intersecting cleavage and two sets of mesoscopic folds with opposite vergences (directions of overturning). The younger cleavage has a northwesterly strike corresponding to the axial-planar orientation of the syncline of Shackleton Limestone. The folds in Goldie Formation associated with the younger cleavage verge to the west (east over west folding). The older cleavage in Goldie Formation is oriented north to northeast; folds associated with it verge eastward.

We systematically collected all formations visited during the season. In addition to the typical graywacke-shale association previously reported for Goldie Formation, we found within it a thick sequence of mafic pillow lavas containing portions of coarse-grained gabbro. This crops out at Panorama Point and at the head of Prince Edward Glacier. In addition, we found four units of diamictite (pebbly mudstone) within the Goldie Formation. The possibility exists that these units are of glacial origin. If this proves to be true, it will be the first known locality in Antarctica of an episode of late Precambrian glaciation that is recorded on all of the other continents.

Beneath the summit peaks that are composed of Beacon Supergroup and Ferrar Dolerite, the northern end of the Markham Plateau is underlain entirely by steeply dipping Shackleton Limestone. Rocks that appear on air photos to resemble Goldie Formation are in fact a dark portion of Shackleton Limestone.

From our third camp we examined the sole locality of the Cobham Formation, a metamorphic assemblage containing calc-schists and marbles, which Laird, Mansergh, and Chappell (1971) reported is conformably overlain by Goldie Formation. We affirmed this relationship and found two generations of structures within both Cobham and Goldie formations, similar to those at Cotton Plateau.

Based upon field observations of both lithology and structure, it may be suggested that the Cobham Formation is correlative



Field locations, Nimrod Glacier area.

with portions of the Nimrod Group, exposed in the Miller and Geologists Ranges to the southwest and west. Metamorphism is of a higher grade and deformation is more intense in the Nimrod Group than in the Cobham Formation. However, the pelitic and calc-schists, the quartzites, and the marbles of the Cobham Formation, all find equivalent lithologies in the Nimrod Group. Grindley (1972) reported five phases of deformation in the Nimrod Group. His  $F_4$  phase, with broad, open flexures was associated with the Ross Orogeny. All three of the earlier phases of deformation ( $F_1$ ,  $F_2$ ,  $F_3$ ) have eastward vergences, similar to the older deformation recorded in the Cobham and Goldie formations.

The suggestion that Cobham Formation and portions of the Nimrod Group are correlative has important implications for regional tectonics. At present, rocks of the Nimrod Group are

thought to have been the cratonic margin along which rocks of the Ross Supergroup, including Cobham and Goldie formations, were deposited (e.g., Elliot 1975; Grindley 1981; Stump 1981). Nimrod Orogeny is the name given to the principal deformation and metamorphism of the Nimrod group (Grindley and McDougall 1969). Uncertainties exist in the dating of this event; however, it probably occurred sometime before approximately 1,000 million year ago (Grindley and McDougall 1969; Gunner and Faure 1972; Adams, Gabites, and Grindley 1982). The folding of Cobham and Goldie formations prior to deposition of Shackleton Limestone has been termed the "Beardmore Orogeny" and is thought to have postdated the Nimrod Orogeny (Grindley and McDougall 1969). The Beardmore Orogeny has been dated at approximately 620–680 million years based on the ages of certain silicic magmatic rocks 500 kilometers to the southeast. However, Stump, Smit, and Self (1986) have shown that the silicic magmatism postdates the folding event. Therefore, the age of deformation assigned to the Beardmore Orogeny remains in doubt. If the Cobham Formation and portions of the Nimrod Group are correlative, and if the Precambrian, east-vergent deformation of each is equivalent, then the Nimrod and Beardmore orogenies were one in the same. Petrographic, geochemical, and isotopic studies on returned samples will test this hypothesis.

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