NEW EVIDENCE OF MAJOR FAULTING ON ALEXANDER ISLAND

By C. W. EDWARDS

ABSTRACT. The Mesozoic Fossil Bluff Formation is shown to be unconformable on the metasediments which crop out extensively in central Alexander Island. Usually the two formations are separated by a major north–south trending fault which, it is suggested, may be the western margin of a graben containing the Fossil Bluff Formation and George VI Sound.

THE presence of a major fault, separating the relatively undisturbed fossiliferous Mesozoic sediments of eastern and south-eastern Alexander Island from the largely metasedimentary sequence of the hinterland to the west (Fig. 1), was first suggested by Grikurov (1971), who recognized the marked change in lithology, palaeontology and structure between these successions. He speculated that a fault with a large displacement might exist along the Milky Way and proposed the existence of numerous north–south trending faults south of Uranus Glacier, presumably on the basis of observations from the air of the marked linearity of outcrops in that area.

From an examination of the sedimentary blocks between Uranus and Neptune Glaciers, Horne (1969) proposed a deltaic depositional model for the exposed Cretaceous sediments. He identified the fossiliferous Mesozoic sediments as delta-front platform and pro-delta slope deposits. Thin-bedded black argillites and sandstones were interpreted as having been deposited by turbidity currents and down-slope slumping into an axial trough region. Horne (1969, p. 69) considered that, although the sediments of the Mount Umbriel area had undergone some degree of regional metamorphism, he could recognize certain similarities in mineralogy between them and the unmetamorphosed shallow-water sediments which indicated an identical provenance. In the area he examined, Horne saw no evidence for a major fault and suggested that the metasediments represented the axial facies of a Mesozoic sedimentary environment. However, they are now considered to belong to the (?) late Palaeozoic–early Mesozoic "Trinity Peninsula Series" (Adie, 1957), which crops out extensively on Alexander Island (Bell, 1973, 1974; paper in preparation by C. W. Edwards*).

In an analysis of the physiographical evolution of Alexander Island, King (1964, fig. 2) postulated the existence of a number of faults, seemingly unrelated to each other, to the east and west of the LeMay Range and to the west of Mount Umbriel. However, his misinterpretation of the folded strata of the LeMay Range as being Cretaceous in age suggests that King did not envisage the presence of a major fault intervening between the fossiliferous Mesozoic sediments of the east coast and the folded sediments of the LeMay Range and adjacent areas ((?) late Palaeozoic–early Mesozoic). Further field work by members of the British Antarctic Survey revealed the existence of a major tectonic disturbance approximately 7 km. south of Mount Umbriel, and this was projected northward along the Milky Way and across the head of Grotto Glacier (Bell, 1975, fig. 3). Similarly, Taylor and others (1979) suggested the existence of a fault along the eastern margin of the LeMay Range and through the western end of Nonplus Crag at the head of Jupiter Glacier (Fig. 1).

Recent work by the author has proved the presence of a major normal fault (referred to here as the "LeMay Range fault") at Atoll Nunataks on the northern flank of Uranus Glacier (Fig. 2). Exposed on the eastern side of these nunataks is a narrow outcrop of crush conglomerate, composed largely of sub-angular boulders of the more competent micaceous sandstones of the metasedimentary sequence. Minor amounts of quartz mineralization have occurred within the fault zone which has a maximum width of 3 m. Locally, the rocks on both sides of the

* This paper describes a fauna of bivalves, gastropods, echinoderms and coelenterates recently discovered in the Lully Foothills of central Alexander Island. This fauna is considered to be of early Mesozoic (Triassic–Lower Jurassic) age.

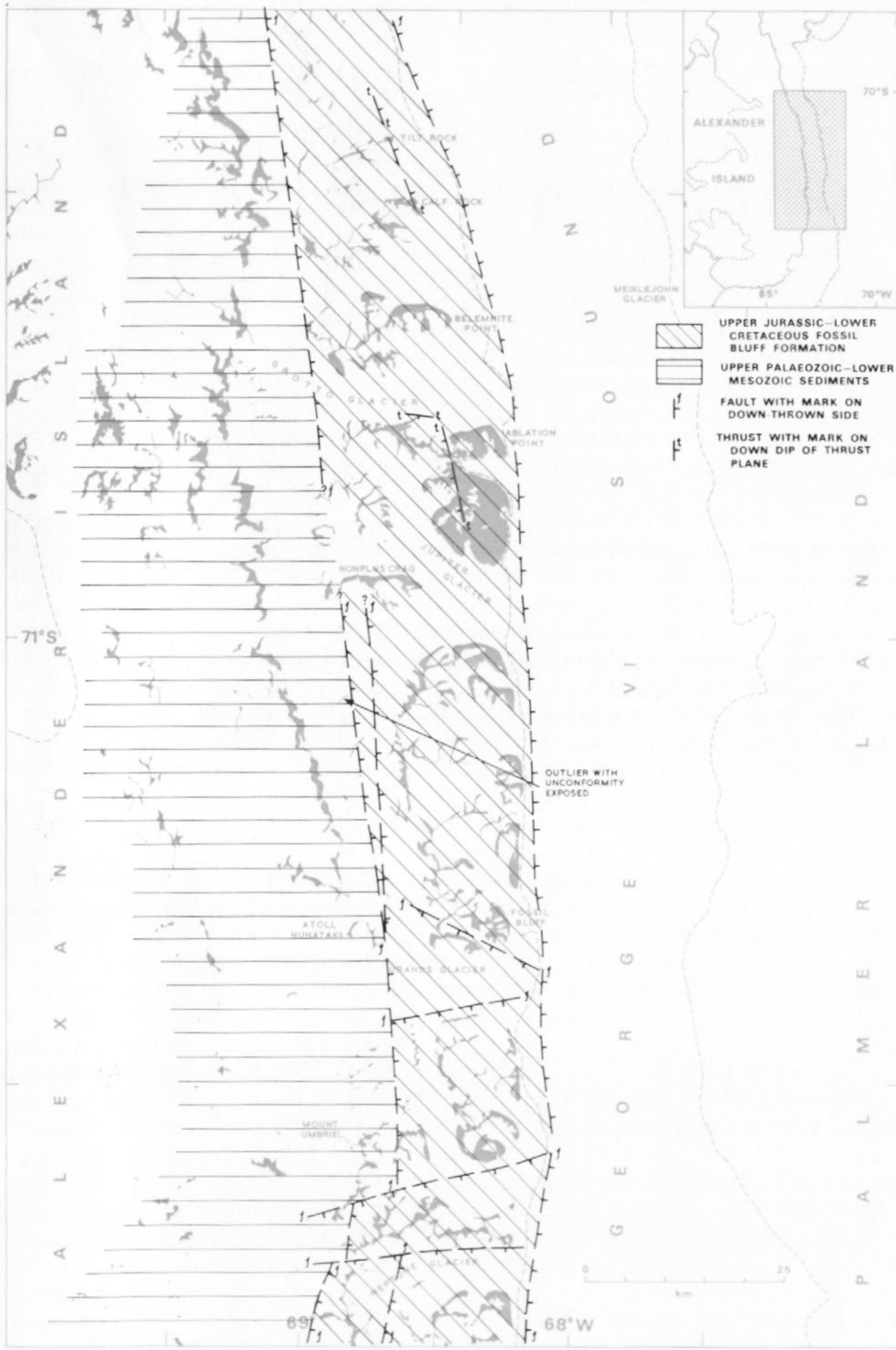

Fig. 1. Sketch map of part of eastern Alexander Island showing the positions of the "LeMay Range fault" and the faulted outlier of basal conglomerate of the Fossil Bluff Formation. Additional information is from Bell (1975).

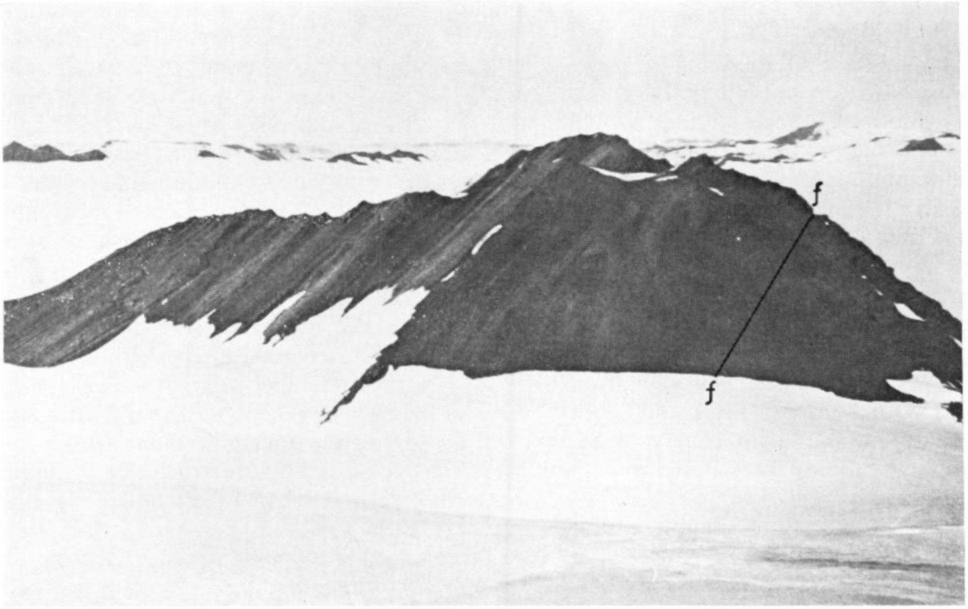

Fig. 2. The "LeMay Range fault" at Atoll Nunataks; looking south.

Fig. 3. The unconformable contact between metasediments and basal conglomerate of the Fossil Bluff Formation at the locality in the Milky Way. The hammer shaft is 40 cm. long.

crush zone are moderately disturbed but much of the deformation in the Fossil Bluff Formation has been taken up by bedding slip and subsidiary minor faulting. The dip of the fossiliferous Mesozoic rocks is 54° to the east, which is identical to that observed south of Mount Umbriel (Taylor and others, 1979), and is probably indicative of the attitude of the fault plane. The cumulative throw of the fault or fault system is estimated to be in excess of 2,000 m. This is the approximate height of the summit of the LeMay Range which, from both air and ground observations appears to be composed almost entirely of metasedimentary rocks of the (?) late Palaeozoic–early Mesozoic "Trinity Peninsula Series". These metasediments comprise a stratigraphical unit which is distinct from the fossiliferous late Mesozoic sediments and they are *not* their metamorphosed equivalents. Confirmatory evidence for this assumption is the presence of an isolated outcrop of sub-horizontal unmetamorphosed conglomerate lying unconformably on deformed, sheared and metamorphosed mudstones (Fig. 3). This outcrop (lat. 71°05′S., long. 68°50′W.) is the only example so far observed of the Mesozoic rocks of the Fossil Bluff Formation (Taylor and others, 1979) in non-faulted contact with the metasediments of the "Trinity Peninsula Series" on Alexander Island. The plane of the unconformity is highly irregular with channels (up to 2 m. deep) cut into the underlying metasediments. The orientation of the channel walls and imbricate pebble structures within the conglomerate suggest a current flow aligned south-south-east to north-north-west, but the absolute current-flow direction is unknown.

The clasts in the conglomerate are generally rounded to well rounded and grade in size from a boulder-conglomerate at the base to a pebbly conglomerate at the top of the 50 m. section exposed. Although pebbly sandstone lenses occur low in the sequence, laterally continuous sandstones appear about 30 m. above the base. Towards the top of the exposed section, carbonaceous plant remains are locally abundant and at one locality bivalve impressions were collected. However, they are too poorly preserved to permit even a tentative identification. The basal part of the conglomerate contains locally derived phyllites and metamorphosed sandstones which have undergone little abrasion and rounding, but the bulk of the material comprising the conglomerate is rounded vein quartz and fine-grained volcanic rocks.

This outlier of the Mesozoic sedimentary rocks is thought to be due to subsidiary faulting which has resulted in narrow down-faulted blocks sub-parallel to the "LeMay Range fault" (Fig. 1). The "LeMay Range fault" itself is sub-parallel to the supposed rift of George VI Sound and is located about 18 km. west of it. Discussion as to whether George VI Sound is a rift valley has been maintained since its discovery (Stephenson and Fleming, 1940) but geophysical and geological investigations in the area have failed to produce unequivocal evidence of rifting along its margins. Evidence of faulting sub-parallel to George VI Sound along the west coast of Palmer Land is slender. However, in the area north of Meiklejohn Glacier, Skinner (1973) recognized that many of the major faults followed this trend. In an adjacent area, Rowe (1973) suggested that block faulting, which showed a marked parallelism with the local trend of the Antarctic Peninsula and by inference George VI Sound, had a considerable influence on the physiography of north-western Palmer Land.

Both the observed and the inferred down-throw on most of these faults on the Antarctic Peninsula is to the west, i.e. towards George VI Sound. This complements the large easterly down-throw of the "LeMay Range fault" on Alexander Island. Nichols (1953) suggested that the relatively straight-sided George VI Sound may have been structurally controlled, presumably by a north-south trending fault or faults. In his geomorphological analysis, King (1964) proposed that a line of faults delimited the eastern coastline of Alexander Island and cited Calf Rock and Tilt Rock as examples of fault drag against one of the proposed faults. The presence of a fault along the eastern margin of Alexander Island was accepted by Bell (1975, fig. 2) in a slightly modified form. He considered the age of the tectonism to be late Cenozoic on the basis of the youthful aspect of the cliffs of eastern Alexander Island adjacent to George VI Sound. The conjectural rift valley of George VI Sound seems probable on the available evidence but, instead of correlating the sides of George VI Sound with the sides of a graben and equating the topographic low with a tectonic low, it is proposed that the western boundary of such a graben may be the "LeMay Range fault". The eastern margin is vaguely defined at present. The rift valley of George VI Sound is the topographical expression of only part of a graben which incorporates the Fossil Bluff Formation of Alexander Island, George VI Sound and perhaps part of western Palmer Land.

In his synopsis of the classical East African Rift System, King (1970) stated that a typical rift generally showed regular widths of between 48 and 80 km. approximately and vertical displacements of 1,525–3,050 m. These dimensions compare favourably with those of the proposed Alexander Island–George VI Sound graben which has a vertical displacement of at least 2,000 m. and a minimum width of about 40 km.

No volcanic rocks have been found on the eastern coastline of Alexander Island which could be contemporaneous with the proposed late Mesozoic–early Cenozoic graben, but rocks of this age have been mapped elsewhere on the island (Grikurov and others, 1967; Bell, 1973). However, volcanic rocks are not necessarily always associated with rifts (King, 1970) and their apparent absence need not invalidate the model suggested here.

Summary and Conclusions

Evidence for a major north–south trending normal fault ("LeMay Range fault") with an easterly down-throw in excess of 2,000 m. on Alexander Island is presented. This confirms the speculations of previous workers in the area who recognized a marked geological discontinuity between the sedimentary rocks of the eastern and central parts of Alexander Island. The exposure of an angular unconformity between fossiliferous Mesozoic sediments and sheared metasediments conclusively proves the distinction between the two formations, and the nature of the contact between these two units provides the first evidence from Alexander Island of the base of the Fossil Bluff Formation. The hypothesis that the metasediments of central Alexander Island constituted a deep-water shelf and "axial" facies of the shallow-water Fossil Bluff Formation of the eastern coastline of the island (Horne, 1969) is clearly no longer tenable. The possibility that the "LeMay Range fault" may represent the western fault margin of a rift system with a graben which includes the Fossil Bluff Formation of eastern Alexander Island, in addition to George VI Sound, is also considered.

Acknowledgements

I should like to thank Dr. M. R. A. Thomson for suggesting the topic and for providing guidance during the preparation of this paper. Laboratory facilities in the Department of Geological Sciences, University of Birmingham, were kindly provided by Professor A. Williams.

MS. received 13 May 1976

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