Results of Recent Geological and Geophysical Investigations in Moray Firth, Scotland

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Geophysical, shallow drilling and sea-bed sampling investigations have shown that the main sedimentary basin of the Moray Firth is separated by an ENE-trending, horst-like uplift zone from a secondary basin to the south. Mesozoic sequences are broadly conformable and are dissected by a radiate fault pattern; faulting was most active in pre-Mid Jurassic times. Contrary to previous suggestions, the pattern of outcrop precludes any Mesozoic or Tertiary strike-slip movement on the Great Glen Fault.

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The presence of a sedimentary basin in the Moray Firth has long been inferred from the isolated outcrops of New Red Sandstone and Jurassic rocks around its shores (Hallam 1965, Peacock et al. 1968). A shallow seismic and gravity survey carried out by the British Institute of Geological Sciences in 1970, supplemented by shallow drilling with MV Whitethorn, allowed solid geology and gravity maps to be published (Chesher et al. 1972, Sunderland 1972). The geological map showed a basin containing Permian to Lower Cretaceous rocks, delimited in general by the current coastline; the gravity map suggested that the basin was fault-controlled. The Great Glen Fault runs through the mapped area; its nature has been a matter of controversy since Kennedy (1946) suggested a Hercynian sinistral strike-slip displacement of some 105 km. Holgate (1969) has suggested an additional Tertiary dextral movement of about 30 km, and recently Garson & Plant (1972) have proposed a dextral sense for Hercynian movement.

To elucidate the structure of the inner part of this basin, IGS in 1972 commissioned Seiscom–Delta to carry out a deep seismic survey on a 10 by 15 km grid (Fig. 1). Forty-eight-fold coverage obtained during shooting was reduced during processing to an effective 24-fold coverage; the data were processed down to 4 seconds travel time. Several relatively continuous major horizons have been recognised within the area; they have been tentatively identified on the basis of correlation with IGS shallow seismic surveys, IGS sea-bed sampling and shallow drilling results. These horizons range from Lower Cretaceous to ?Permo–Trias in age. Because block 11/30 in the outermost part of the area is currently licensed to a UK operator, this report will concentrate on the inner part of the Firth.

Fig. 2 shows a map of depth to a horizon tentatively identified as base Lower Cretaceous. This is a very strong and continuous event, possibly

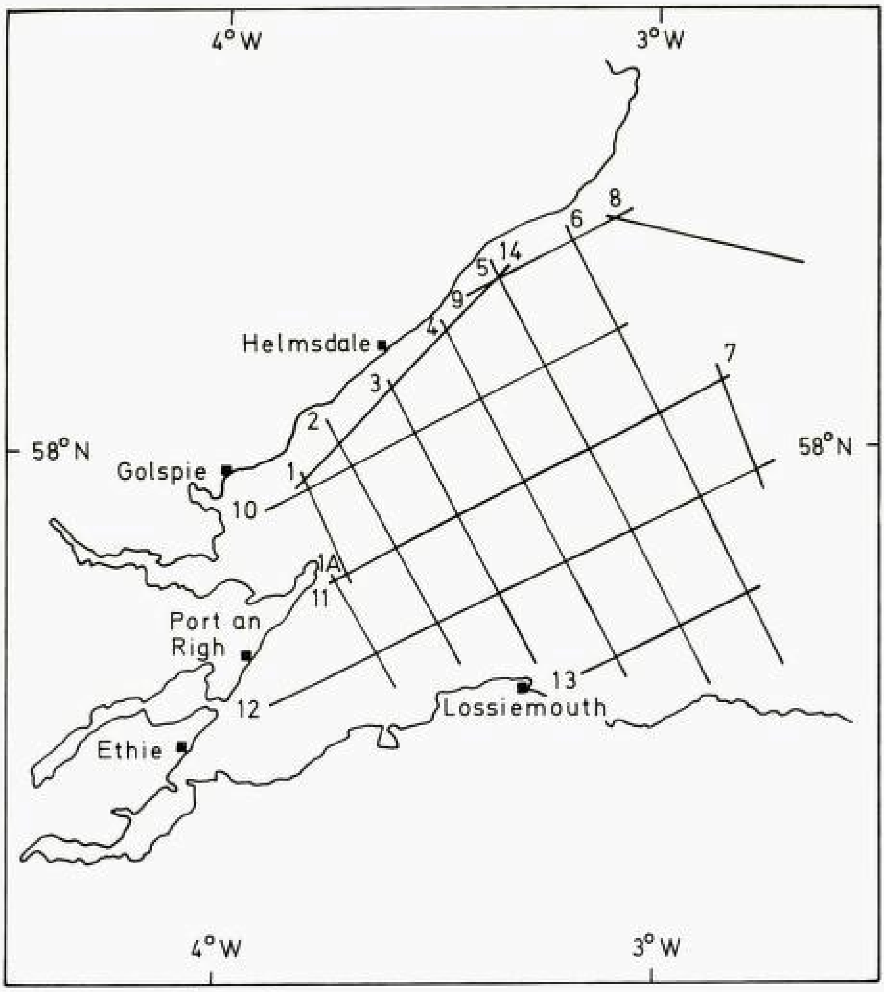

Fig. 1. Location of seismic lines.

representing a widespread unconformity. The horizon follows structural changes in the deeper horizons though it is less affected by faulting. Calculations of RMS velocity to the horizon show high velocities corresponding to regional basin structure and low velocities corresponding to regional highs; thus the apparent topography of the travel-time map is likely to be real.

Fig. 3 shows a map of depth to a horizon thought to be base Jurassic; this is the strongest deep reflector, and can be followed reliably through the central and southern parts of the area, although correlation across the Great Glen Fault is poor. In general the horizon deepens, broken by numerous small and medium faults into the axis of the main basin against the Great Glen Fault zone. In the southern part of the map the most prominent feature is a ridge, fault-bounded on its SE side, to the south of which we see a subsidiary basin.

Fig. 4 summarises the main structural features of the basin. The main basin, the axis of which trends NE–SW, is centred in the NE of the area, and is

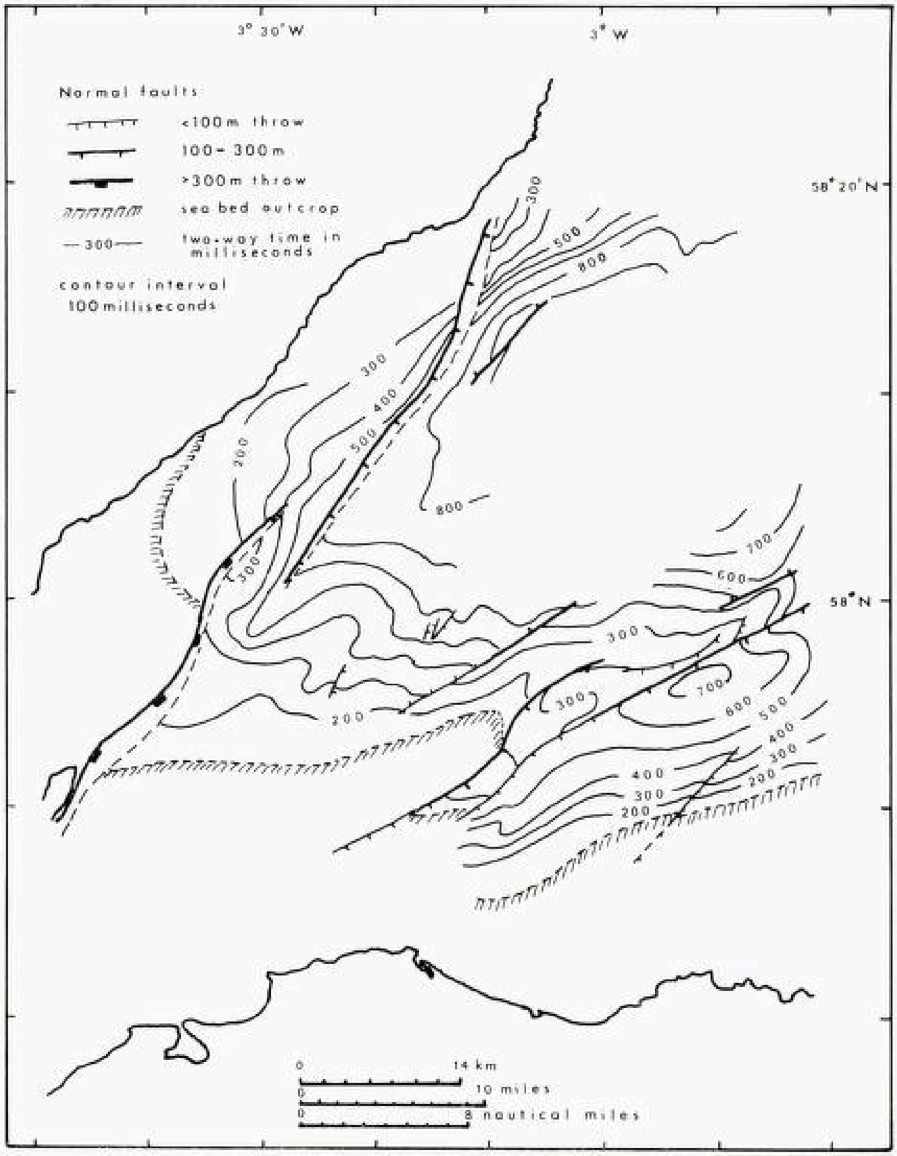

Fig. 2. Map of probable base Lower Cretaceous horizon.

separated by a prominent zone of uplift from a secondary basin to the south. This zone of uplift trends ENE across the centre of the area and seems to be horst-like in structure; the faulting appears to have controlled sedimentation, at least in part. This also appears to be true of the Great Glen Fault.

Horizons within the basin are broadly conformable, though minor discontinuities exist at the base of the Lower Cretaceous and above the base of the Jurassic. There is uniform dip towards the centre of the basin though horizons are broken by normal faulting to form a series of horst and graben structures; they are relatively little affected by folding. The faults vary in

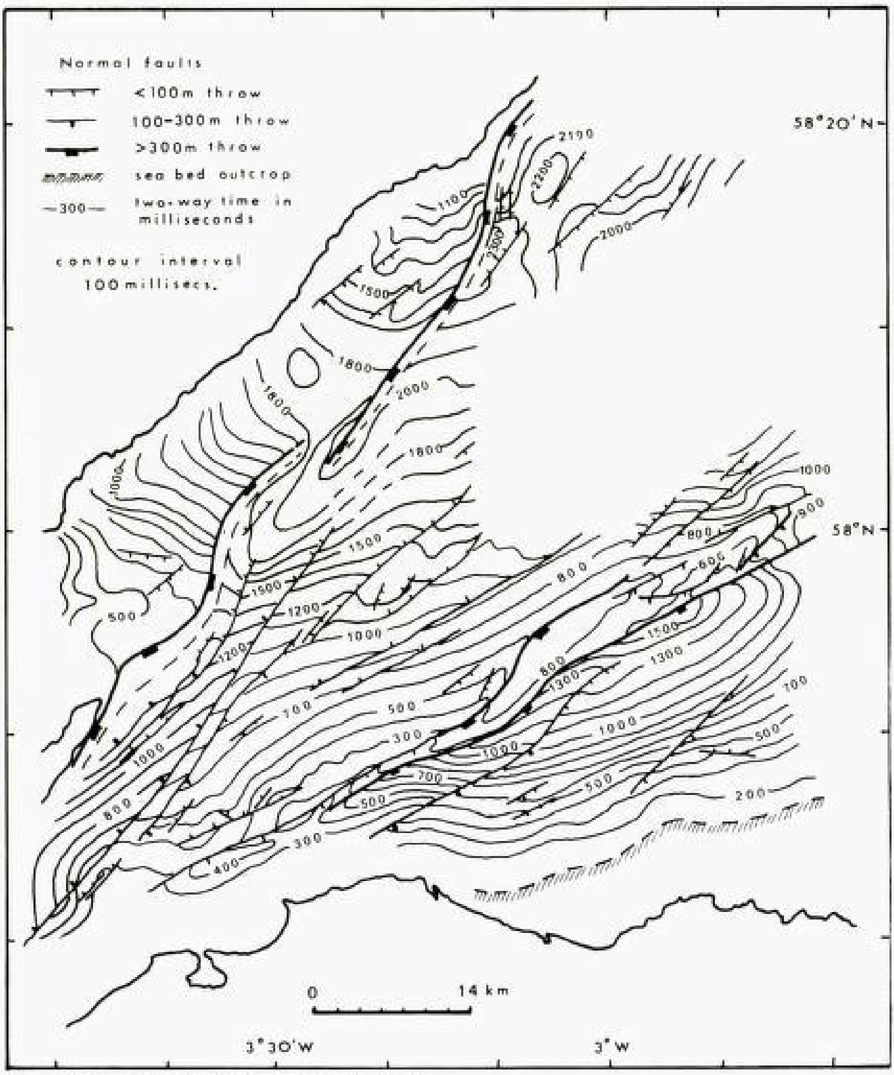

Fig. 3. Map of probable base Jurassic horizon.

trend from NNE in the NW to ENE in the SE of the region, appearing to radiate from a focal point in the SW. Fault activity has been recognised on all the horizons mapped and probably extended throughout the Mesozoic; it was, however, most active pre-Mid Jurassic, and gradually decreased in intensity until during the Lower Cretaceous only the major fault lines remained active.

The Great Glen Fault is undoubtedly the most important fault in the area. The fault zone follows the coastline between Ethie and Tarbat Ness, down-faulting Jurassic against Old Red Sandstone, and continues in a NNE direction with a small northerly kink. Where the zone crosses line 1 it is some 2.5 km wide and has a downthrow to the south of about 800 m/sec for the base–Jurassic horizon. The zone decreases in both width and downthrow to the NE

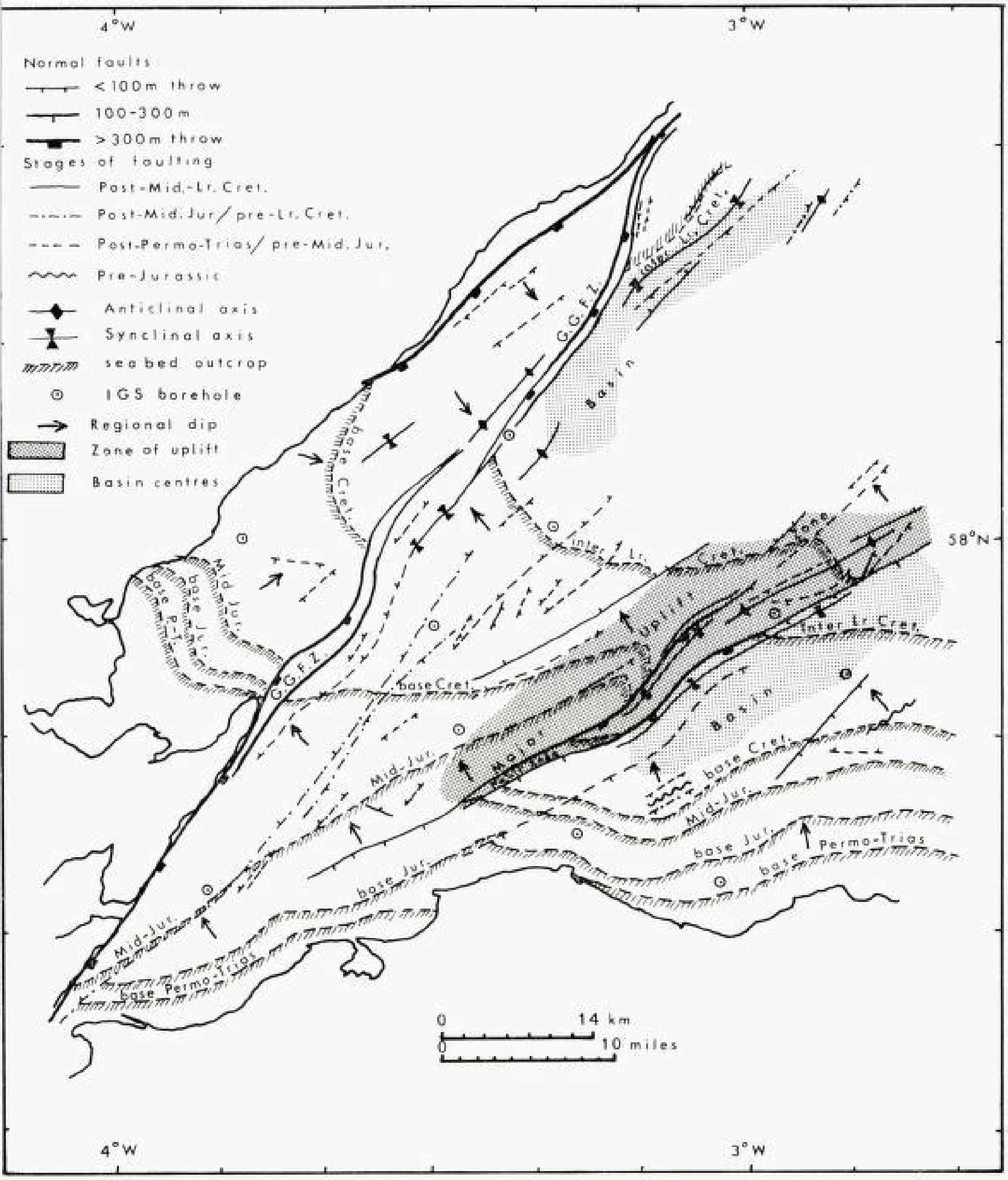

Fig. 4. Structural summary map.

until where it crosses line 3 it is only 8 km wide with a throw of only 500 m/sec on the base Jurassic. Near line 4 the fault line passes into the northern limb of a broad syncline and the fault movement is taken up further south along the axis of the syncline. The fault then continues in a NNE direction with downthrow increasing to 1000 m/sec on the base Jurassic at line 6, where it is 1 km in width. This pattern of outcrop precludes any Mesozoic or Tertiary strike-slip movement on the Great Glen; the fault plexus appears to be entirely normal in character during this period.

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