GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF ENERGY AND MINERAL RESOURCES
GEOLOGICAL SURVEY OF BANGLADESH

PREPARED UNDER THE DIRECTION OF
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AEROMAGNETIC ANOMALY MAP OF BANGLADESH

বাংলাদেশের বিমান চুম্বকীয় মানচিত্র

Compiled By
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Geological Survey of Bangladesh

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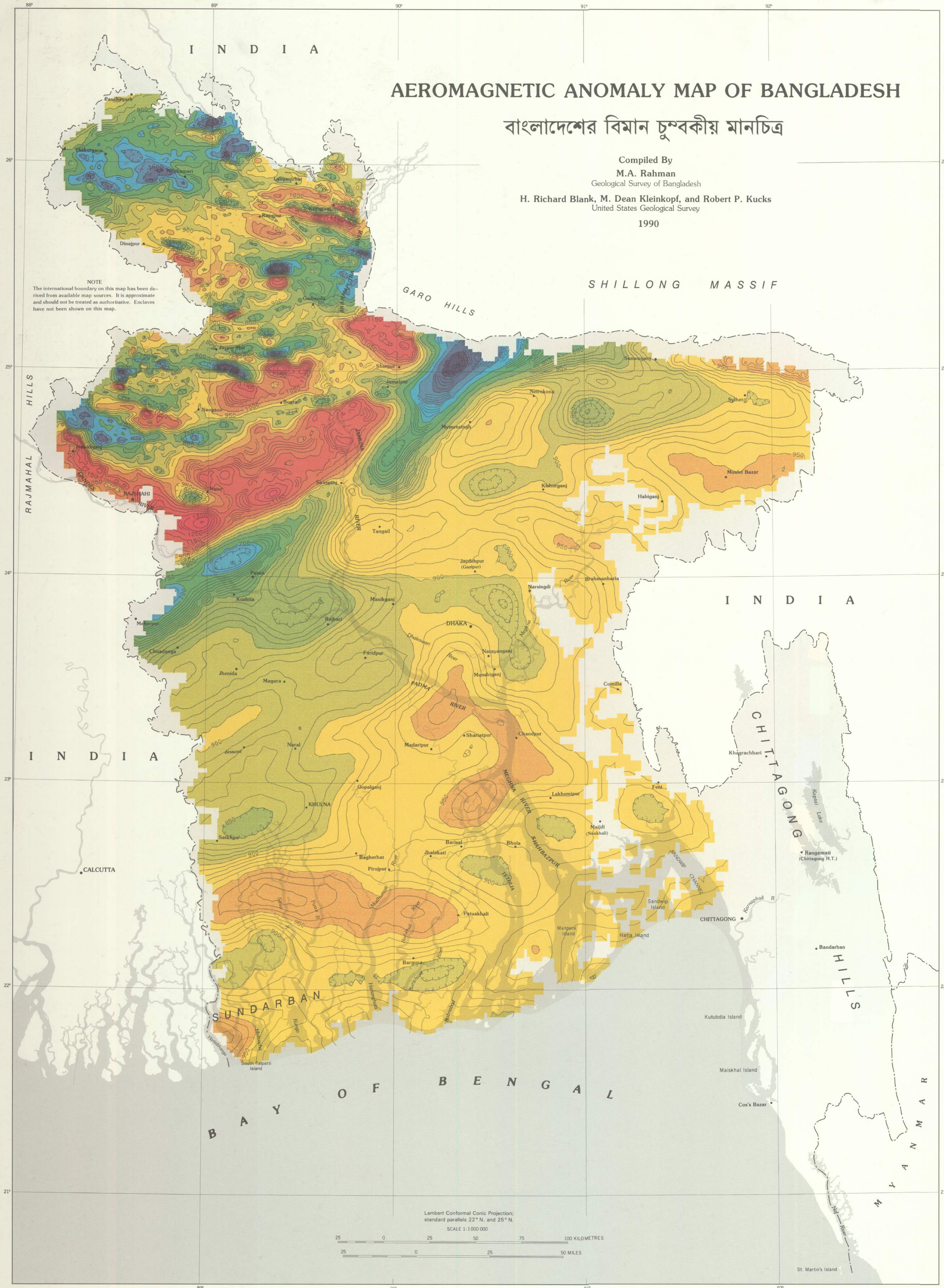
United States Geological Survey

1990



NOTE
The international boundary on this map has been derived from available map sources. It is approximate and should not be treated as authoritative. Enclaves have not been shown on this map.

Lambert Conformal Conic Projection;
standard parallels 22° N. and 25° N.
SCALE 1:1 000 000
25 0 25 50 75 100 KILOMETRES
25 0 25 50 MILES

Base compiled from LANDSAT Satellite Digital Mosaic, 1984, with permission of Space Research and Remote Sensing Organization (SPARRSO), Bangladesh, and other available topographic maps.

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AEROMAGNETIC SURVEY PARTICULARS

The aeromagnetic survey was flown in 1979-80 by Hunting Geology and Geophysics Ltd. for the Government of the People's Republic of Bangladesh, sponsored by the Geological Survey of Bangladesh and Petrobangla. The survey specifications were as follows:

Survey instrument	— Proton magnetometer, Geometrics G-803
Flight lines	— N. 45° W. at 3- and 1-km spacing
Tie lines	— N. 45° E. at 5-km spacing
Flight altitude	— 500 ft (152 m) above ground level
Sampling interval	— 2 seconds, resolution ±0.05 nT
Geomagnetic field	— Inclination 28° 30′-38° 30′ Declination 13′ W.-37′ W. Total intensity 44,848 nT-47,086 nT

An area east of long. 90° 30′ E. and south of lat. 23° 40′ N. was flown at 6-km flight-line and 40-km tie-line spacings. Total coverage was 61,916 line-km. Survey data were recorded in both digital and analog form. Intensity datum was arbitrarily raised by 900 nT in order to make all value positive.

PREPARATION OF MAPS

The aeromagnetic maps were produced by digitizing a residual total-intensity aeromagnetic map compiled by Hunting Geology and Geophysics Ltd. (1981) at a scale of 1:500,000. Digital data were gridded on 1-km grid and plotted on Hewlett-Packard and Applicon computer plotters prior to publication. Digital processing was done by Robert P. Kucks and Esther Sandoval, at the facilities of the Branch of Geophysics, U.S. Geological Survey, Denver, Colorado, U.S.A.

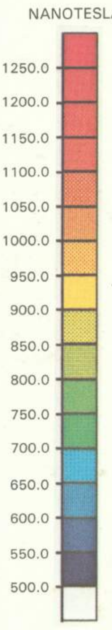
DISCUSSION

This aeromagnetic anomaly map is one in the map series of Bangladesh prepared and published by the Geological Survey of Bangladesh (GSB) at a scale of 1:1,000,000, in support of geologic framework investigations, mineral and energy resources evaluation, and natural hazards mitigation. The other maps are the Geological Map of Bangladesh (Alam and others, 1990) and the Bouguer Gravity Anomaly Map of Bangladesh (Rahman and others, 1990).

Also shown on this sheet are an aeromagnetic map overprinted with supplementary information (fig. 1) and a generalized tectonic map of Bangladesh and surroundings (fig. 2). Both of these maps are at a scale of 1:4,000,000.

Most of Bangladesh is covered by unconsolidated alluvium and deltaic deposits of Quaternary age. Tertiary sedimentary formations crop out in limited areas in the northeast along the Dauki fault zone and in the east and southeast in the Tripura-Chittagong Fold Belt. Pre-Tertiary strata and Precambrian crystalline basement rocks are nowhere exposed. Knowledge of the subsurface geology depends primarily upon geophysical and deep borehole data acquired during a vigorous program of mineral and energy resource prospection.

Reconnaissance aeromagnetic surveys in the territory of Bangladesh were carried out in 1952 and 1963-64 in conjunction with seismic and gravity surveys and exploratory drilling. The 1979-80 survey, by Hunting Geology and Geophysics Ltd. (hereafter referred to as "Hunting") under the sponsorship of GSB and Petrobangla, provides a modern, tightly controlled, digital aeromagnetic data base for the entire country except in the extreme southeast (Chittagong area and Chittagong Hills) and a 10-km strip along the international border.



Total-intensity magnetic anomaly field in 50-nT (nanotesla) intervals

—— 900 ——

Contour showing total-intensity magnetic anomaly—Intervals 10 and 50 nT. International Geomagnetic Reference Field (IGRF) removed.

A preliminary interpretation of the 1979-80 aeromagnetic anomaly data made by Hunting (1981) includes estimates of depth to magnetic basement obtained by a variety of standard two-dimensional methods, and forward models of selected prominent anomalies. Four magneto-tectonic provinces are delineated in the Hunting report: 1) a "geosynclinal" area of very deep basement, 2) an eastern shelf area of moderately deep basement, 3) a western shelf area of moderately shallow basement, and 4) a platform area characterized by very shallow basement. The Hunting results are discussed below in reference to major tectonic domains and structural elements depicted on figure 1. In addition to contours of estimated depth to basement as computed by Hunting, figure 1 shows anomaly axes and structural trends interpreted from anomaly gradients by the present authors. Note that the aeromagnetic anomaly map of figure 1 employs the same color-coded intensity scheme as that of the 1:1,000,000-scale map but lacks black-line isointensity contours.

Magneto-tectonic province 1 of Hunting occupies approximately the southeastern three-fifths of the area surveyed and is characterized by subdued, long-wavelength aeromagnetic anomalies and great depths to magnetic basement. This province corresponds to the "Bengal Basin" or "Bengal Foredeep" tectonic province of some authors, or to the eastern part of the "Bengal Basin" of others. Magneto-tectonic provinces 2, 3, and 4 comprise the northwestern two-fifths of the area, and are characterized by relatively intense, short-wavelength anomalies and much shallower depths to magnetic basement. These three provinces are mostly or entirely underlain by Archaean crystalline rocks of the Indian Shield, whereas the age and composition of crust beneath magneto-tectonic province 1 are unknown. The boundary between the northwestern provinces and province 1 is the so-called Calcutta-Mymensingh "Hinge Zone", or "Hinge Line", hereafter referred to as the "Hinge". The Hinge is defined as a monoclinal flexure of regional strike extent on a specific seismic reflector, the Eocene Sylhet Limestone. It is shown on figure 1 as an unbroken shaded band between crossings by two seismic reflection profiles that we examined, and as a broken shaded band elsewhere. Although the Hinge has no surface expression, it separates shelf facies from geosynclinal facies in the Tertiary rocks and is a zone of pronounced differential thickening and subsidence (Evans, 1964). The Hinge apparently extends offshore from Calcutta and merges with a southwest-trending structural zone interpreted as a Mesozoic continental margin of peninsular India (Raman and others, 1986; Salt and others, 1986).

Contours of depth to magnetic basement at 1-km intervals in magneto-tectonic province 1 (fig. 1) delineate a broad, but prominent, arcuate trough or synform that transects the province from north to south immediately west of the Tripura-Chittagong Fold Belt, whose outer margin has been located from gravity data (Rahman and others, 1990). This trough may represent a tectonic depression produced by the same forces that produced the fold belt, that is, it may be a result of east-west plate convergence. The trough plunges in a southerly direction and attains maximum axial depths exceeding 10 km. To the north, it becomes progressively more confined between the Fold Belt and the Hinge, and apparently terminates in the vicinity of the western flank of the Sylhet Trough (an adjunct of the Bengal Basin also known as the Sylhet Basin, Surma Trough, or Surma Basin). A weak basement rise in the northern part of the aeromagnetic-basement trough is indicated by closure of the 8-km depth contour.

The relation of Hunting's interpreted aeromagnetic-basement depths to the principal gravity anomalies of province 1 can be observed by comparing the data of figure 1 with regional gravity features of the Bengal Basin as depicted by Alam and others (1990) and shown on figure 2. The "Bengal Basin" of figure 2 includes a portion of the region known to be floored by Archaean rock to the northwest of the Hinge, and "continental crust" is shown as extending southeast of the indicated "Hinge". "Faridpur Trough" and "Hatia Trough" of figure 2 are Bouguer gravity anomaly lows flanking the "Barisal gravity high", while "Sylhet Trough" is a deep gravity low as pointed out above. The location of these features is depicted somewhat differently on the 1:1,000,000-scale gravity anomaly map of Rahman and others (1990).

A weak aeromagnetic-basement depression coincides with much of the Faridpur gravity trough (fig. 2), but the axis of the prominent aeromagnetic-basement trough crosses the Barisal gravity high nearly at right angles, and a domal basement high in the southwest corner of the province (attributed by Hunting to a northern continuation of the Ninety-East Ridge off the Indian Ocean) has no corresponding gravity expression. The aeromagnetic depth contours give no indication of a basement depression beneath the Sylhet Trough. This is an unexpected result, since the Trough is associated with a deep Bouguer gravity anomaly low (Rahman and others, 1990), and contains sedimentary deposits estimated from seismic data to be more than 15 km thick (more than 7.5-sec. two-way travel time; see Hiller and Elahi, 1984). Thus in general the interpreted configuration of the aeromagnetic basement in province 1 is poorly reflected in the anomaly pattern of the Bouguer gravity field. Somewhat better agreement is obtained when comparing aeromagnetic-source depths with basement depths interpeted from the gravity field (Mirkhamidov and Mannan, 1981; see also Rahman and others, 1990). However, the aeromagnetic-depth estimates for province 1 are much shallower than estimates derived from either gravity or seismic-reflection data. If the depth estimates are accepted, then we are led to conclude that aeromagnetic basement generally represents a different lithology from that of the density basement and is located within the geosynclinal section.

Axes of most aeromagnetic anomalies in magneto-tectonic province 1 trend mainly easterly (fig. 1). However, almost all the areas of anomaly level above 950 nT (fig. 1) are aligned northeasterly; collectively these areas may comprise a long-wavelength positive anomaly slightly offset from the position of the Barisal gravity high and roughly parallel to the Hinge. The significance of the easterly and northeasterly trends is uncertain. They probably in part reflect deformation of the magnetic substrate, but if the province is floored by mafic crust of Mesozoic or younger age, they could in addition reflect the orientation of seafloor "stripes" of alternating crustal polarity. Crust formed during Mesozoic rifting or continental separation might have a net magnetization dominated by southern hemisphere remanence.

The northwest margin of province 1 (the Hinge) is marked by a nearly continuous anomaly low at about the 6- to 7-km depth contour (fig. 1). The axis of this low is everywhere either at the upper lip of the Hinge or immediately northwest of it, and generally coincides with the crest of a prominent Bouguer gravity anomaly, the Calcutta-Mymensingh gravity high (Rahman and others, 1990). Seismic-reflection data indicate that the aeromagnetic low and gravity high correspond to an area of relatively uplifted basement. The nature of this basement is undetermined; it has not been penetrated by drilling. The anomalies could be due to a mafic intrusion of reversed polarity. An alternative and perhaps preferable explanation is that the negative aeromagnetic anomaly is an edge effect (polarization low) associated with juxtaposition of thick mafic "transitional" crust of magneto-tectonic province 1 and less magnetic Archaean continental crust of provinces 2 and 3. Either model would be compatible with interpretation of the Hinge as the locus of a Mesozoic rifted continental margin.

Agreement in depth estimates derived from the various geophysical data sets is reasonably good for the northwestern magneto-tectonic provinces. The aeromagnetic depth contours (fig. 1) delineate a broad, east-northeast-trending arch on magnetic basement with a crest passing approximately through lat 25°30′ N. This arch is the subsurface connection between exposed Indian Shield rocks in the Rajmahal Hills and Shillong Massif in India and is known as the Rangpur Platform or Rangpur Saddle (magneto-tectonic province 4). The sedimentary cover on the crest of the arch is known to be as thin as 130 m (Zaher and Rahman, 1980). Aeromagnetic basement consists of Archaean crystalline rock or, locally, rift-related mafic lavas of the upper Mesozoic trap series. The predominant aeromagnetic anomaly grain again appears to be easterly. Some aeromagnetic trends correspond to faults that produce structural relief on the Archaean basement surface and are also expressed in gravity and seismic reflection data. Other trends probably arise from intrabasement magnetization contrasts.

North of the Rangpur Platform, aeromagnetic basement depths increase toward the Himalayan Foredeep. This northernmost area is dominated by a broad anomaly low. South of the platform, depths increase across the Bogra Shelf toward the Hinge. Much of the Bogra Shelf, particularly the southern part, consists of rift basins having substantial structural relief (as much as 4-5 km) and pronounced geophysical signatures. In places where the basins preserve trap lavas as well as Permian sedimentary rocks (Gondwana Group), the basins are characterized by aeromagnetic anomaly highs that correspond to gravity depressions.

The magnetic anomaly fields in the northwestern magneto-tectonic provinces do not provide definitive evidence relating to the Dauki fault zone north of the Sylhet Trough, as the area was not covered by aeromagnetic traverses. The Dauki Fault (fig. 2) forms the tectonic boundary between the Sylhet Trough and the Shillong Massif of adjacent Meghalaya, India, and is associated with as much as 19 km of vertical relief between Archaean crystalline basement of the massif (2 km above sea level) and basement flooring the trough (more than 15 km below sea level, according to Hiller and Elahi (1984), although aeromagnetic and gravity depth estimates yield lower values). Recent work indicates that the Dauki Fault is a high-angle reverse fault having a lateral component, and is the southern limit of a possible thrust beneath the Shillong Massif (Herd, 1989; Johnson and Alam, 1990; Molnar, 1987). We find no indication of a westerly continuation of this structure across northwestern Bangladesh in either the isopleths of depth to basement or the anomaly pattern.

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Figure 1: AEROMAGNETIC ANOMALY MAP OF BANGLADESH
Showing trends of anomalies, isopleths of estimated depth to magnetic basement, and major tectonic elements. Map reduced from 1:1,000,000-scale map.

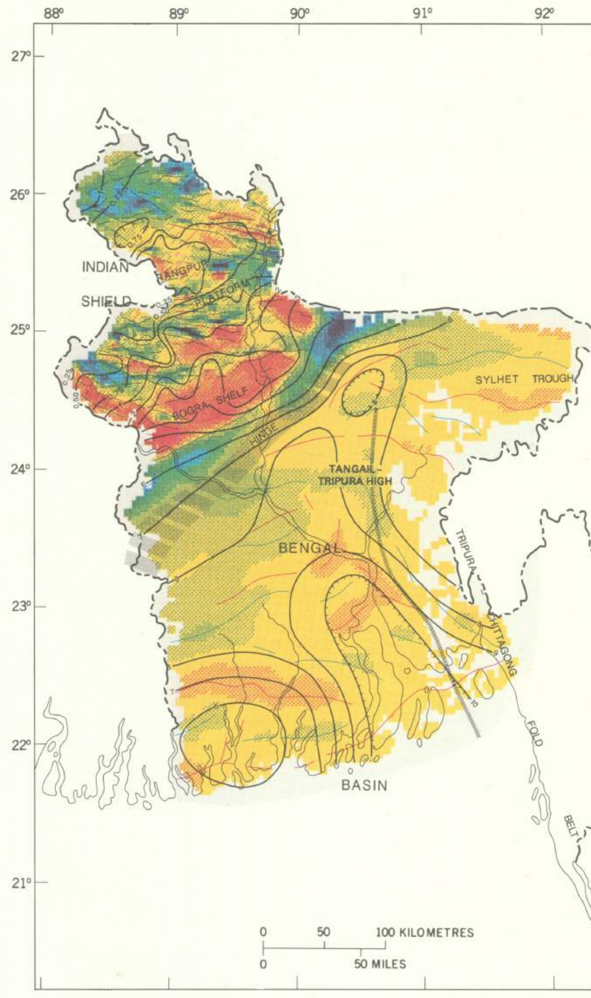
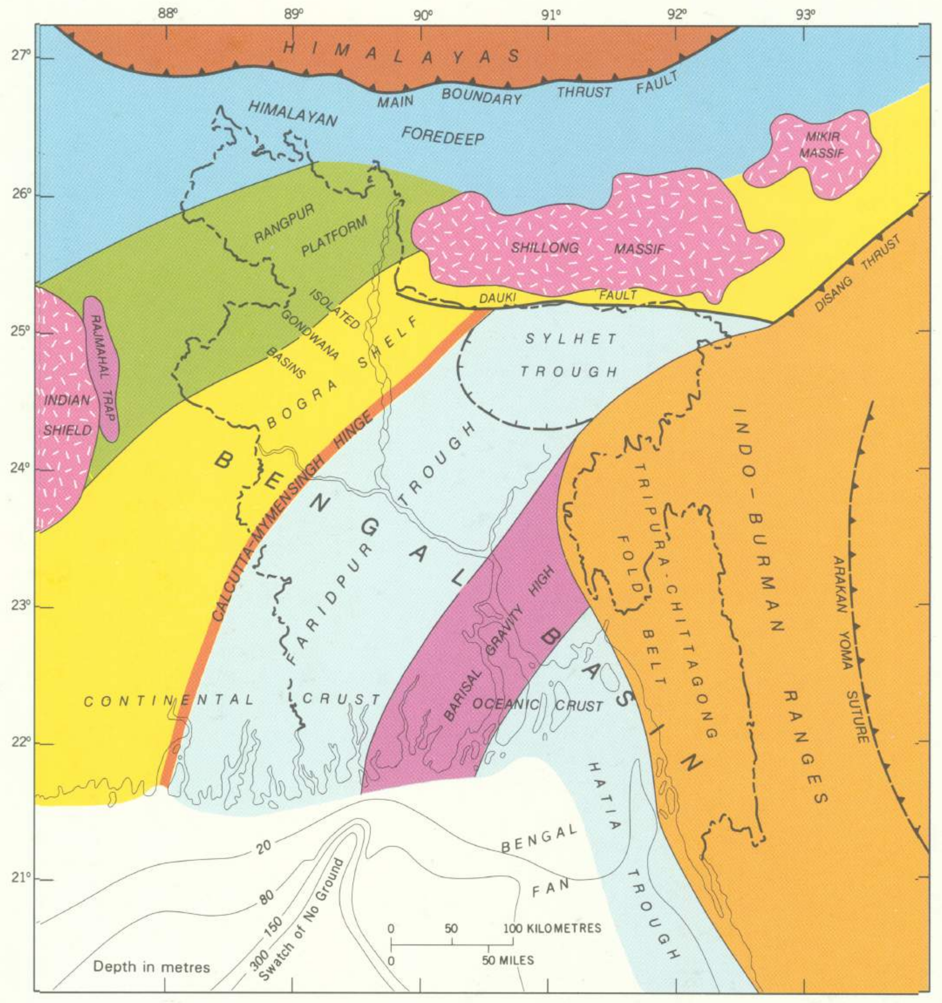


Figure 2: GENERALIZED TECTONIC MAP OF BANGLADESH AND ADJOINING AREAS
Modified from Alam and others (1990).



EXPLANATION

- **Trend delineated by anomaly gradients**
- **Axis of positive magnetic anomaly**
- **Axis of negative magnetic anomaly**
- **Depth to magnetic basement in km**—Hachures indicate depression. After Hunting Geology and Geophysics Ltd.(1981)
- **Western boundary of Tripura-Chittagong Fold Belt**

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