TOTAL-INTENSITY AEROMAGNETIC MAP OF THE SOUTHERN HIJAZ QUADRANGLE, KINGDOM OF SAUDI ARABIA

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Total-intensity aeromagnetic data have been obtained for nearly all of the precambrian Shield of Saudi Arabia. These data were recorded in two major surveys, one during 1965-66 in which more than 300,000 sq km were flown, and the other in 1966-67 when nearly 250,000 sq km were flown (Millon, 1969). The surveys were made by a consortium of companies that included Lockwood Survey Corp., Ltd.; Aero Service Corp.; Hunting Geology and Surveying Company; and the Arabian Geophysical and Surveying Company. In addition to the two main surveys, several smaller airborne surveys covering a total area of about 41,000 sq km were flown in 1962. Total-intensity contour maps were compiled at scales of 1:50,000 and 1:100,000 and the French Bureau de Recherches Géologiques et Minières also compiled all available contour data on nine maps at a scale of 1:500,000. The present color compilation is based on one of these maps covering the southern Hijaz quadrangle (Brown and others, 1963). (fig. 1).

The eastern part of the mapped area was flown at an altitude of 150 m above the terrain along northeast-trending flight lines spaced 800 m apart, and the western part was flown in the same direction and with the same flight-line spacing, but at an altitude of 300 m (fig. 2). The higher flight altitudes were required because of the

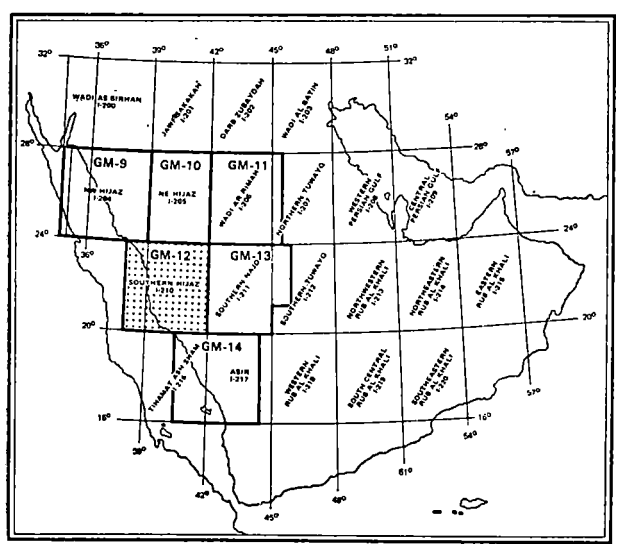

FIGURE 1.—Index map showing geologic and geographic maps (U.S. Geological Survey Miscellaneous Geologic Investigations Maps I-200—I-220, scale 1:500,000) and geophysical maps (Saudi Arabian Dir. Gen. Mineral Resources Geologic Maps GM-9 — GM-14, scale 1:500,000). Area of this report shaded.

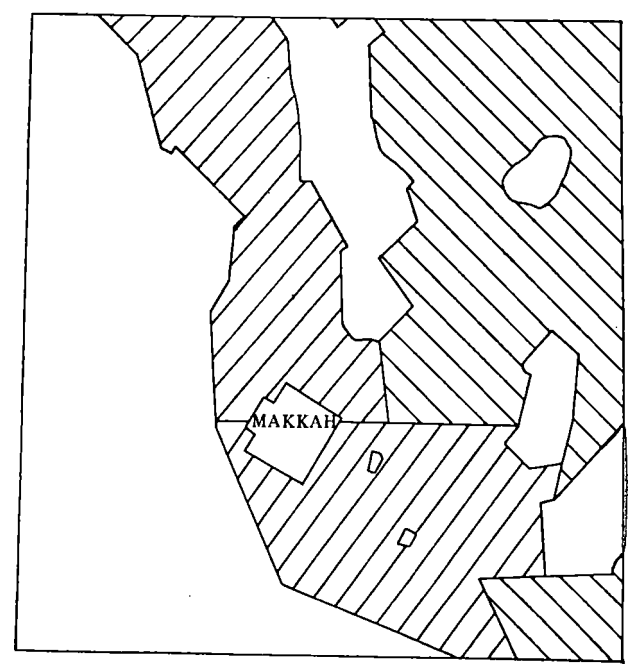

FIGURE 2.—Index map showing areas flown at 300 m and 150 m altitude.

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rugged topographic relief of the escarpment. The smaller area adjoining the northern boundary of the map (fig. 2) was flown in earlier surveys of 1962.

An elongate, north-trending blank area in the northern half of the map separates the surveys of different flight altitudes. This blank area approximately defines a Cenozoic basalt field. Flight lines were terminated at the edges of this basalt field as well as at the edges of three smaller fields shown as blank areas in the eastern part of the map. The blank rectangular area in the southwestern part of the map is the area of Mecca, over which aerial surveys were not made.

Magnetic intensity is shown by contours at intervals of 100 gammas. The areas between contours are colored according to the color code shown on the map and represent magnetic intensity relative to an arbitrary datum. The colors green and yellow, for example represent an average intensity, whereas dark red and deep blue represent the highest and lowest intensities, respectively.

The changes in magnetic level resulting from the 150- and 300-m flight altitudes are not so apparent in the northern half of the map where the flight areas are, for the most part, separated by the blank area of the Cenozoic lava field (fig. 2). Magnetic contours of the 300-m- and the 150-m-altitude surveys do not join, especially in areas of steep-gradient, high-amplitude anomalies. As would be expected, observed anomalies of the 150-m-altitude surveys possess greater amplitudes and steeper gradients than those observed from higher altitudes, which are farther removed from the anomaly source. To compensate in part for the discrepancy, contours of the 300-m survey, south of an east-west line through Mecca (fig. 2), were adjusted to agree with those of the 150-m survey. The resulting color shift may be thought of as a quasi-downward continuation of the field, though of course the gradients remain unchanged.

The accompanying map is a residual map of the total-intensity field. Prior to contouring, a linear gradient was removed from the observed profile data along the flight path. This gradient is, principally, the gradient of the earth's main field, but it also includes diurnal variations and instrument drift. The value of the gradient differs for each compilation and, in some cases, differs within the individual compilation. Hence, it is possible only to estimate an average gradient for the Shield. For the magnetic north component, the average gradient is estimated to be 3.9 gammas/km and for magnetic east, 1.2 gammas/km. In this map the viewer can observe a grading of colors representing the higher magnetic intensities in the south to the lower intensities in the north.

Review of the map indicates that either the residual field is tilted as a result of removing too steep a regional gradient, or that the rocks are inherently more magnetic in the south. The gradient actually removed from the observed data, shown in solid lines in figure 3, is 3.9 gammas/km as compared with 3.7 gammas/km taken from the International Geomagnetic Reference Field (IGRF), computed for 1967.330 (year) at an altitude of 1 km. Hence, the north component removed is 0.2 gamma/km greater than the IGRF (or about three color intervals), so that if the IGRF had been removed, the apparent tilting would have been much less. The question of whether the southern part of the Shield is more magnetic cannot be resolved from the data on hand. However, whether the tilt of the residual field is real or not does not detract from the usefulness of the map for purposes of geologic interpretation.

A detailed interpretation of the map is not within the scope of this report; however, the reader's attention is directed to some of the significant magnetic features of the map. Examples are the long narrow lineaments that trend north-northwest near the western edge of the map and traverse the entire length of the area, except for a relatively short distance south of Mecca. These lineaments, produced by reversely magnetized Tertiary dikes, parallel the axial trough of the Red Sea and may be related to the development of the Red Sea rift (Brown, 1972).

The northwest-trending anomalies in the northeast part of the map correlate with the Najd fault system (Brown and Jackson, 1960; Delfour, 1970), a principal fault system of the Arabian Shield. This fault system is sharply reflected in the magnetic data for the adjoining geophysical map (GM-13 Andreasen and Petty, 1973) to the east, and may be clearly followed across parts of maps GM-9 and GM-10 (Andreasen and Petty, 1974 a and b) to the north.

Several anomaly pairs may be seen throughout the map area. These anomalies, usually indicated by red or pink on the south and blue or green on the north, are produced by intrusive bodies. In this magnetic latitude, magnetization in the direction of the earth's present field produces a magnetic high along the south edge of a body and a low of newly the same magnitude along the north side. A particularly notable anomaly of this type is in the northwest part of the map near the west-central edge of the blank area.

East-northeast-trending anomaly patterns are present in the map area, especially along the western half. A study of the Red Sea magnetic data suggests that these trends may be continuations of similar trends found in the center of the rift zone where they are believed to reflect transform faults.

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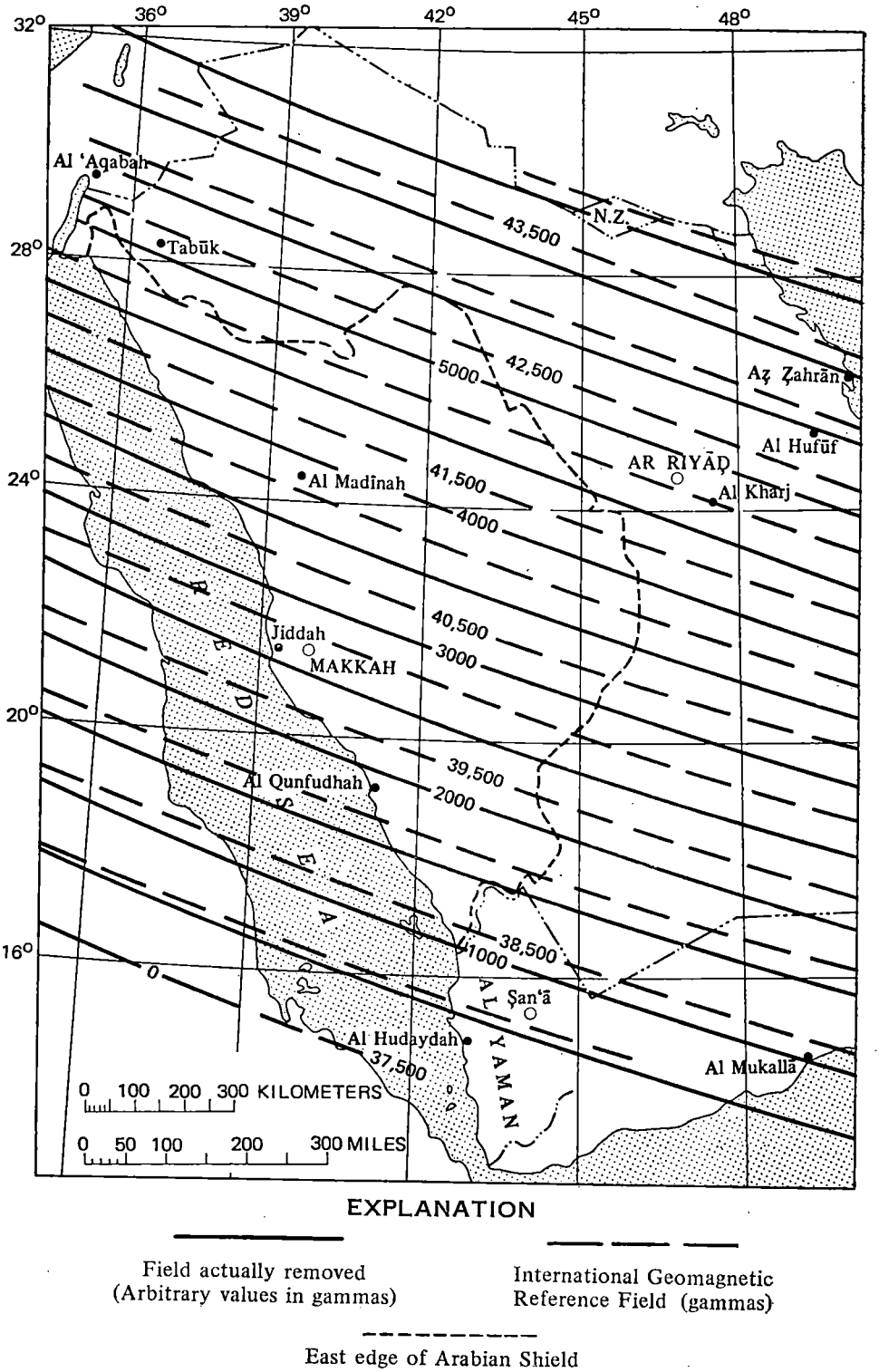

EXPLANATION

Field actually removed (Arbitrary values in gammas)

International Geomagnetic Reference Field (gammas)

East edge of Arabian Shield

FIGURE 3.—Map showing comparison of average field removed and computed field (IGRF).

sources Geologic Map GM-9.

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