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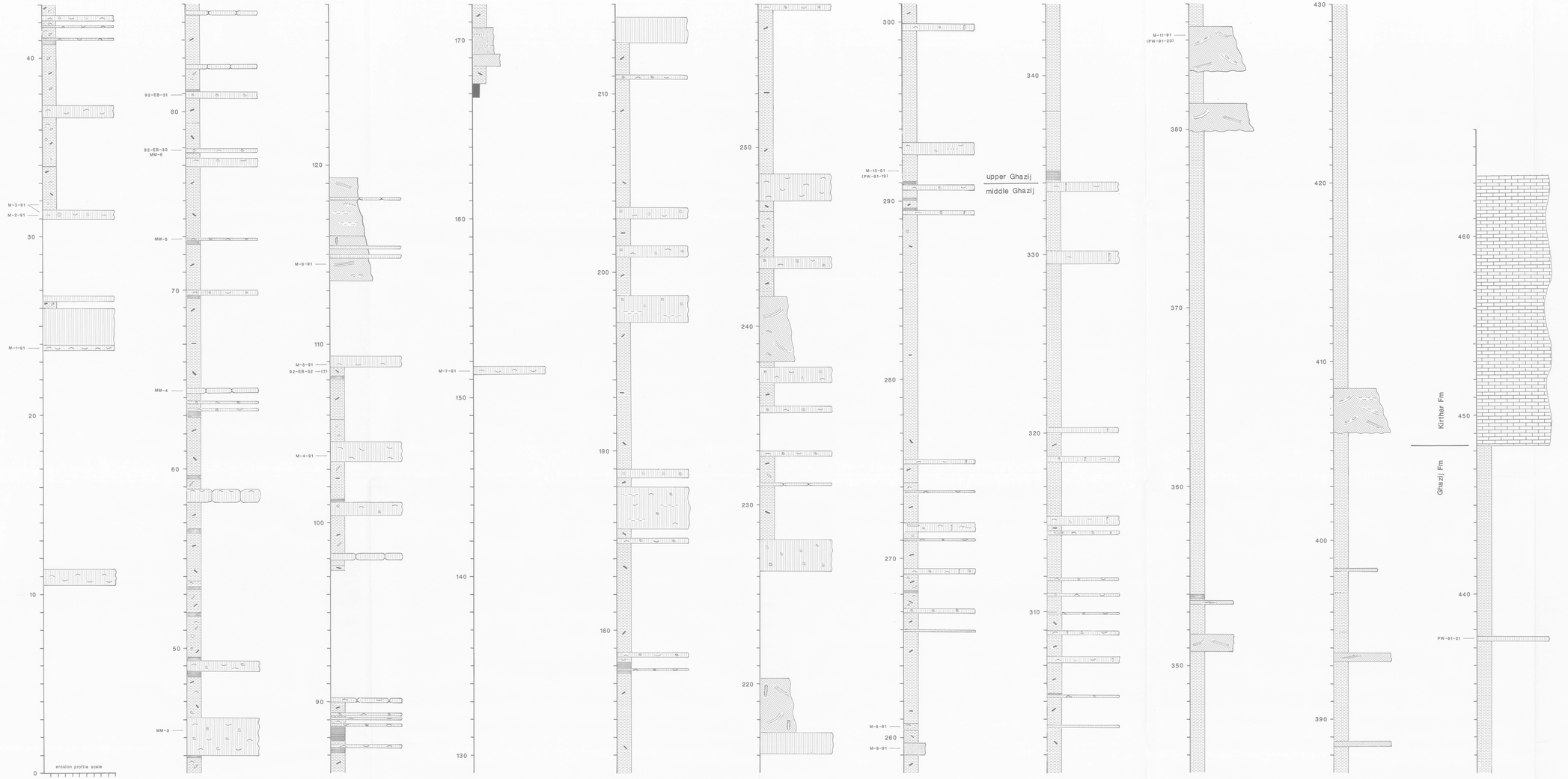
MISCELLANEOUS FIELD STUDIES
MAP MF-2263-D



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PRINCIPAL REFERENCE SECTION FOR PART OF THE EOCENE GHAZIJ FORMATION, MOGHAL MINE AREA, MACH COAL FIELD, BALOCHISTAN, PAKISTAN

By

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INTRODUCTION

The information presented on this sheet was collected as part of a joint U.S. Geological Survey-Geological Survey of Pakistan program sponsored by the U.S. Agency for International Development. As a project within this program, the coal-bearing Ghazij Formation (Eocene) was investigated in the northeastern part of Balochistan east and south of the provincial capital of Quetta. Strata exposed in this area range in age from Permian to Holocene and crop out as a belt of folded and thrusted rocks that form a southeast-facing orocline. In this region of Pakistan, the Ghazij can usually be divided into three parts. The lower part is the thickest (probably more than 1,000 m) and consists of gray-weathering calcareous mudrock (shale, mudstone, and impure claystone) and a few tabular bodies of fine- to medium-grained calcareous sandstone. The middle part (27-300 m) consists of gray-weathering calcareous mudrock and tabular to lenticular bodies of fine- to medium-grained calcareous sandstone; beds of carbonaceous shale and coal are common (in the Mach area, the middle part of the formation also contains numerous individual beds of muddy limestone). The upper part (as thick as 533 m) contains reddish-weathering calcareous mudrock that contains scattered lenticular bodies of fine- to medium-grained calcareous sandstone. Fossil plant debris is common in mudrock of the lower and middle parts of the Ghazij, and bivalves and gastropods are common in the middle part of the formation; the upper part of the Ghazij is usually unfossiliferous. Underlying the Ghazij are the carbonate rocks of the Paleocene Dungan Formation (or its equivalent), and overlying the Ghazij are the mostly carbonate rocks of the Eocene Kirthar Formation (or its equivalent). Both contacts can be conformable or unconformable. All of the pre-Neogene rocks in Balochistan are greatly deformed by the collision of India and Asia. The Ghazij is especially susceptible to regional compressional tectonics because it contains a large amount of shale and is sandwiched between two thick carbonate units. As a result, bedding-plane faults and isoclinal folds are very common.

As part of our study of the Ghazij Formation, five stratigraphic sections were measured: one near Pir Ismail Ziarat, one in the Sor Range, two in the vicinity of Mach, and one near Johan. Each area's section is published separately.

MOGHAL STRATIGRAPHIC SECTION

In the fall of 1991, we measured our stratigraphic section near the Moghal mine, about 2.9 km south of the town of Mach, which is located about 48 km southeast of Quetta. At this location, the Ghazij Formation is well exposed and relatively undeformed. Although the lower part of the Ghazij is exposed in the Mach area, this part of the formation does not crop out in the vicinity of our section. Our section contains some of the middle and upper parts of the Ghazij; the contact between these two subdivisions is located at 354 m; above this level the mudrock commonly has a reddish tinge. Some mudrock between 275.5 and 334 m also weathers reddish, indicating an interfingering of the two subdivisions. Mudrock in the middle part of the formation contains abundant fossil plant debris, weathers brown or gray, and is commonly tinged yellow or green; mudrock in the upper part of the formation lacks plant debris and weathers the same colors as in the middle part of the formation, but it is more commonly tinged red. Sandstone in the Ghazij contains subangular to subrounded grains of quartz, light-colored carbonate rock fragments, and green lithic fragments. Sandstone bodies are uncommon in the middle part of the formation. Most of these bodies weather light gray but two bodies located at 113.5-119.5 m and 217.5 - 220.5 m weather greenish brown, similar to two sandstone bodies in the middle part of the Ghazij in the Pir Ismail Ziarat area about 22 km to the northwest. Sandstone bodies are more common in the upper part of the formation, weather yellowish gray, and are lenticular. Muddy limestone (or in some cases, limy mudrock) is quite common in the middle part of the formation. This lithology is usually present as a single bed and is very fossiliferous. The rock is light gray on fresh surfaces, but weathers yellowish or orangeish gray. At some horizons, muddy limestone takes the form of yellowish-brown ellipsoidal concretions that commonly have recrystalized breciated centers. Muddy limestone is absent in the upper part of the formation, with one exception at 437.5 m. Fossils are very common in the middle part of the formation, with ostracodes, high-spiral gastropods, and large clams being particularly abundant; oysters are less common. No fossils were observed in the upper part of the formation. The carbonaceous shales at 53.5 and 63 m apparently grade into coal along strike, as evidenced by the presence of nearby abandoned mines along these horizons. The coal bed at 167 m is the unit extracted at the Moghal mine. In contrast to the middle part of the Ghazij measured just north of Gishtari Nala, 3.8 km to the northwest, the middle part in the Moghal mine area contains large clams and fewer oysters, and more limestone beds and fewer sandstone bodies. The limestone at the top of the section is part of the Kirthar Formation. However, the structural attitude of these rocks does not match that of the underlying Ghazij Formation, indicating that the two units are not in depositional contact. Most likely the limestone has been faulted into position or is a slide block originating from an extensive exposure of Kirthar that forms a significant cliff farther up the slope.

The scaled horizontal line at the base of the stratigraphic columnar section (grain size generally increasing to the right) is a crude erosional profile. Mudrock (mudrk) includes shale, mudstone, and impure claystone. Sandstone is very fine grained (vfg), fine grained (fg), medium grained (mg), coarse grained (cg), and very coarse grained (vcg). Other abbreviations are "carb sh" for carbonaceous shale, "clayst" for claystone, "silts" for siltstone, "cong" for conglomerate, "lst" for ironstone, and "ls" for limestone. Some of the lithologies shown on the horizontal scale might not be present in the columnar section because they are not present along the line of section. Samples collected along the section for future reference are indicated by letter-number annotations to the left of the column. Contacts between similar lithologies indicate change in grain size, color, or sedimentary or biogenic structures. The parts of the section that lack data represent covered intervals.

INDEX MAP SHOWING LOCATION OF STUDY AREA

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EXPLANATION

- Sandstone
- Siltstone
- Mudrock (shale, mudstone, or impure claystone)
- Carbonaceous shale
- Coal
- Muddy limestone
- Muddy limestone concretions
- Limestone
- Sharp or gradational contact separating lithologic units
- Relief on a sharp contact separating lithologic units
- Internal erosion surfaces
- Mudrock partings
- Sandstone interbeds
- Small- to medium-scale, planar cross-stratification
- Small- to medium-scale, trough cross-stratification
- Ripple laminae
- Limy concretions
- Mudrock clasts
- Secondary gypsum
- Plant fragments as scattered debris or in laminae
- Bivalves
- Gastropods
- Simple vertical or horizontal burrows
- Ophiomorpha-type vertical or horizontal burrows
- M-1-91 Sample number

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