



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 thrust rocks that form a southeast-facing escarpment. 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, or impure claystone) and a few tabular bodies of fine- to medium-grained calcareous sandstone. The middle part (21-300 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. 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; the upper part of the Ghazij is usually unfossiliferous. This three-fold division of the Ghazij is less distinct in the Johan area. Here, the upper part of the formation is clearly identifiable, but rocks below it are poorly exposed and assigning a stratigraphic level that separates the middle and lower parts of the formation is problematic. Below the upper part of the formation is a thick sequence of greenish-gray calcareous mudrock that contains locally abundant plant debris and isolated bodies of brown-weathering sandstone. Rare carbonaceous shale and even rare coal are present in the upper part of this sequence, and this interval of the formation might correspond to the middle part of the Ghazij exposed in areas to the north. We propose that, in the Johan area, these rocks below the upper part of the formation be referred to as the main body of the Ghazij (for example, main-body Ghazij). 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 Karhar 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 common. As part of our study of the Ghazij Formation, five stratigraphic sections were measured: one near Pir Ismaili Ziarat, one in the Sor Range, two in the vicinity of Mach, and one near Johan. Each area's section is published separately.

SARAWAN RIVER STRATIGRAPHIC SECTION

In the fall of 1991, we measured our stratigraphic section on the south side of the Sarawan River several kilometers west of the village of Johan, which is located about 95 km south of Quetta. At this location, the Ghazij Formation is well exposed and relatively undeformed. The contact between the upper part of the Ghazij and the main body of the formation is located at the top of a sandstone unit at about 413 m. Although a thick covered interval overlies this sandstone along the line of section, reddish mudrock interpreted to be the upper part of the Ghazij is exposed laterally. Mudrock in the main body of the Ghazij weathers light gray or light greenish gray and contains abundant fossil plant debris; fossil oysters are common below 115 m. Limestone-sized limy concretions that weather light tan, have chocolate-brown fresh surfaces, and usually contain yellow calcite crystals in their centers are present locally. The color of the mudrock in the upper part of the formation is similar to that of the main body, but reddish tinges are very common; fossil plant debris and shell fragments are absent. Sandstone in both parts of the Ghazij contains subangular to subrounded grains of quartz, light-colored carbonate rock fragments, and green lithic fragments. The rocks are light gray and weather light brownish gray. Individual sandstone bodies are broad and lenticular. The two units of muddy limestone (or possibly limy mudrock) in the main body of the Ghazij (at 81 and 179 m) weather light brown and contain abundant fossil high-spiral gastropods, oysters, and ostracodes. Although the presence of coal in the Johan area has been known for more than 80 years, mining has never been successful. The only attempt known to the authors is a small entry on a 26-cm-thick seam located several kilometers northeast of our measured stratigraphic section.

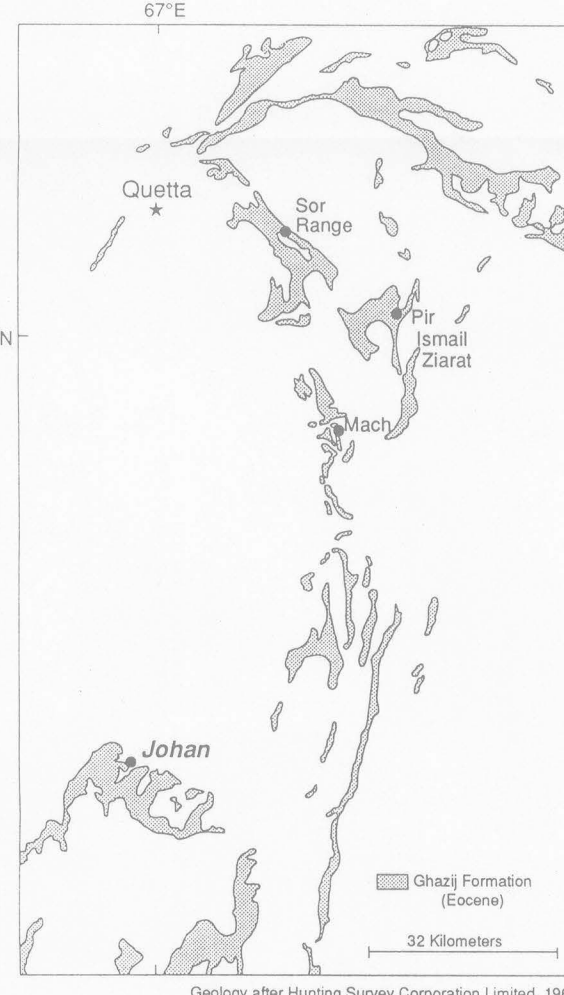
The scaled horizontal line at the base of the stratigraphic columnar section (grain size generally increasing to the right) is a crude erosional profile. Mudrock (mudry) includes shale, mudstone, and impure claystone. Sandstone is very fine grained (vfg), fine grained (fg), medium grained (mg), coarse grained (cg), and very coarse grained (vcg). Other abbreviations are "carb" for carbonaceous shale, "clayst" for claystone, "siltst" for siltstone, "cong" for conglomerate, "fsst" 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. Those parts of the section that lack data represent covered intervals.

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EXPLANATION

- Sandstone
Mudrock (shale, mudstone, or impure claystone)
Carbonaceous shale
Muddy limestone
Limestone
Sharp or gradational contact separating lithologic units
Relief on a sharp contact separating lithologic units
Mudrock partings
Sandstone interbeds
Small- to medium-scale, planar cross-stratification
Small- to medium-scale, trough cross-stratification
Ripple laminae
Limy concretions
Mudrock clasts
Leaves
Plant fragments as scattered debris or in laminae
Rooting
Bivalves
Gastropods
Simple vertical or horizontal burrows
Ophiomorpha-type vertical or horizontal burrows
Feeding structures or grazing trails on bedding surfaces
SR-1-91 Sample number



INDEX MAP SHOWING LOCATION
OF STUDY AREA

PRINCIPAL REFERENCE SECTION FOR PART OF THE EOCENE GHAZIJ FORMATION, SARAWAN RIVER AREA, JOHAN COAL FIELD, BALOCHISTAN, PAKISTAN

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Manuscript approved for publication February 1, 1994