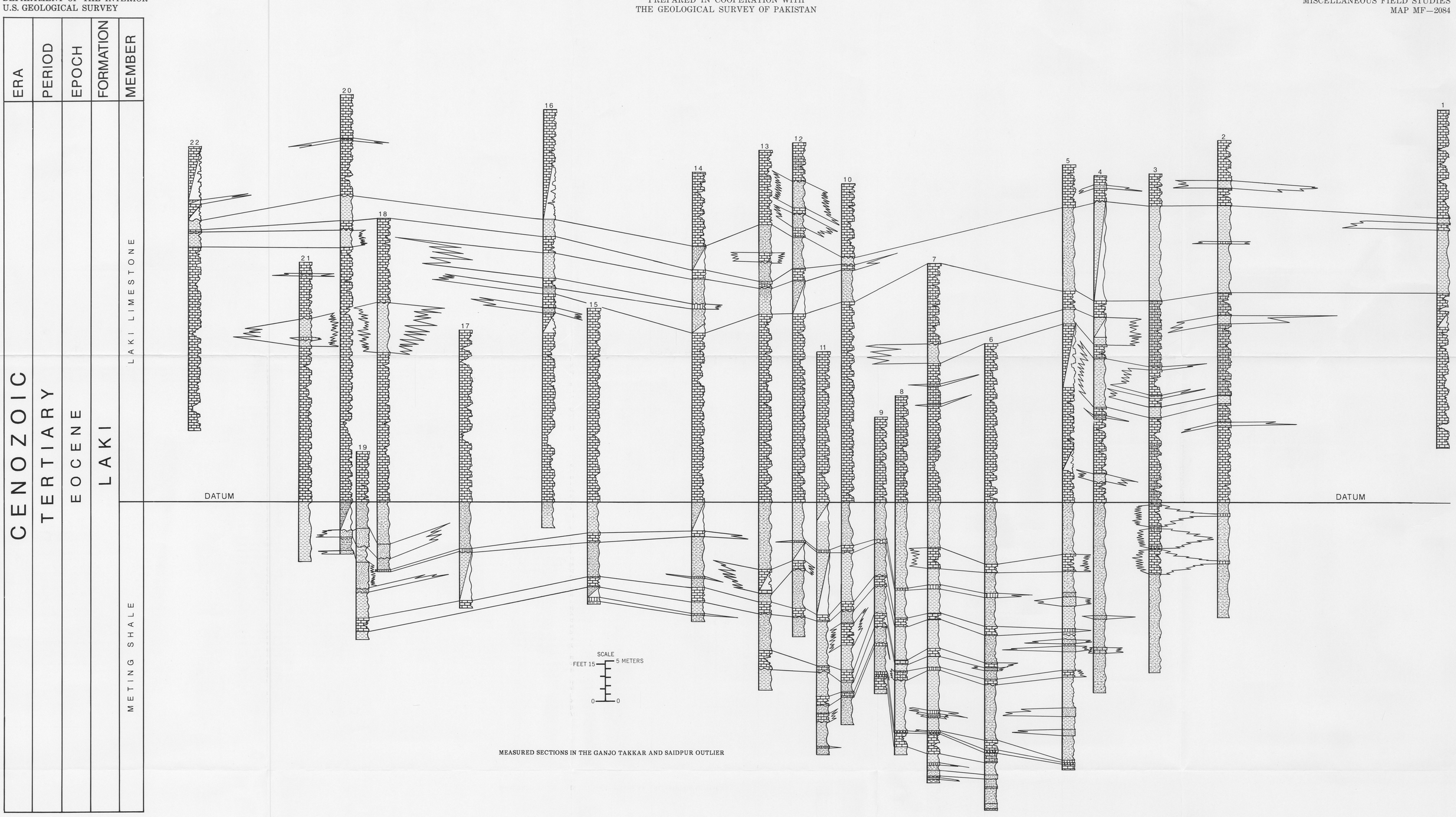
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE GEOLOGICAL SURVEY OF PAKISTAN

MISCELLANEOUS FIELD STUDIES
MAP MF—2084



MEASURED SECTIONS IN THE GANJO TAKKAR AND SAIDPUR OUTLIER

EXPLANATION
General Lithologic Descriptions and Symbols

Claystone--Dark-yellowish-brown (10YR 4/2) to dark-yellowish-orange (10YR 6/6) or light-brown (5Y 5/6), sandy, silty, calcareous, scattered gypsum flakes and crystals, ferruginous grains, glauconitic, manganese surface coatings, dark mineral grains, very fossiliferous, friable, top and base sharp and undulatory, weathered

Partially covered claystone

Sandy claystone

Limestone--Very pale orange (10YR 8/2) to dark-yellowish-orange (10YR 6/6), weathers white (N9), sandy, marly, chalky, silty, clayey, slightly glauconitic, scattered dark mineral grains, ferruginous grains, gypsiferous, manganese surface coatings, cryptocrystalline, vuggy, fossiliferous, burrowed, thick-bedded to massive, few nodules, friable where weathered, saccharoidal, top and base sharp and undulatory, weathered, forms ledges and small cave openings

Partially covered limestone

Sandy limestone

Limestone (coquina)--Dark-yellowish-orange (10YR 6/6) to light-brown (5YR 5/6), sandy, fossil fauna includes gastropods, pelecypods, cephalopods, brachiopods, many broken shell fragments, burrowed, scattered dark mineral grains, some ironstone concretions on surface, well indurated, base sharp and undulatory, weathered

Sandstone--Dark-yellowish-orange (10YR 6/6) to pale-yellowish-orange (10YR 8/6) or grayish-orange (10YR 7/4), very fine to medium-grained, clayey, silty, calcareous, contains 50 to 80 percent quartz, subrounded to subangular quartz grains, scattered dark mineral grains, some glauconite grains, foraminifera, scattered fossil hash, few oxidized zones, gypsum lenses, crossbedded, poorly sorted, thin-bedded to massive, mostly thick-bedded, top and base sharp, friable, weathered

INTRODUCTION

The sections presented were measured in an unstudied area southeast of the city of Hyderabad and 175 km northeast of Karachi, capital of Sind Province in southern Pakistan. These sections are preliminary to more detailed studies, particularly of the fossil fauna and the Paleocene and Eocene stratigraphy in southern Pakistan. The data present a major elucidation of the lateral relationships of individual rock units that collectively form part of the Laki Formation exposed in the Ganjo Takkar and nearby Saidpur outlier.

The field work was performed as part of the Coal Resource Exploration and Assessment Program (COALREAP) that is Component 2a of the Energy Planning and Development Project. Component 2a is financed by the Government of Pakistan and the U.S. Agency for International Development (USAID) with technical assistance from the U.S. Geological Survey and the Geological Survey of Pakistan (GSP).

Acknowledgments

We are grateful for the expertise and skills of the GSP personnel in assisting with this project. Special thanks are given to the USAID drivers for reaching the off-road sites and to the police who performed guard duty while we measured sections. In addition, the services provided by the team of laborers who uncovered rock contacts in the intense heat and dusty conditions are much appreciated. Finally, the graciousness of Mohammad Ali Tariq of the GSP in permitting Mohammed Raiz Kahn to spend time measuring sections is most appreciated.

STRATIGRAPHY

The Laki Formation of Eocene age is a prominent part of the stratigraphic sequence in Sind Provence. The formation is exposed over large areas and crops out in cliffs, ledges, and ridges. This limestone ranges from very soft and chalky to cryptocrystalline and contains a rich fossil microfauna and megafauna. Because of its fossil fauna, the Laki has attracted researchers, beginning with the earliest geologic studies in the western part of the Indian subcontinent. Very little small-scale mapping of the formation has been performed, and there are almost no data available on its physical characteristics. Faunas from a few widely scattered exposures have been studied to determine the biostratigraphy, but minimal attention has been paid to the lithology. All stratigraphic sections have been measured from the Indus River base level (Meting Shale Member) to the top of the Ganjo Takkar hills (Laki Limestone Member).

Laki Formation

The Laki Formation of Early Eocene (Ypresian) age was divided by Nuttall (1925) into four subdivisions (descending): (1) the Laki Limestone Member, (2) the Meting Shale Member, (3) the Meting Limestone Member, and (4) the Sohnari Member (basal Laki laterite). This report concentrates on the upper units, the Laki Limestone and Meting Shale Members. These units are well exposed along the Ganjo Takkar bluffs and form steep slopes, especially in the Laki Limestone Member. Rocks in the Laki Formation are predominantly marly limestone and claystone with thin beds of sandstone and lateritic claystone. Both the claystone and the limestone have abundant megafossils and microfossils, with the foraminifera *Alveolona* sp. being common.

The Laki Limestone Member forms plateaus and weathers to a vuggy and undulatory surface. The contact between the Laki Limestone Member and the underlying Meting Shale Member is sharp and undulatory, indicating an unconformity. The contact of the Meting Shale Member with the underlying Meting Limestone Member is concealed in the area by Holocene colluvium and the Indus River alluvial silt and sand. The Sohnari Member lies on the Ranikot Group or Lakhra Formation and is unconformably overlain by the Meting Limestone Member of the Laki Formation.

Laki Limestone Member

The Laki Limestone Member of the Laki Formation crops out in cliffs and ledges having steeply dipping slopes. It unconformably overlies the Meting Shale Member and they typically have a sharp undulatory contact. The limestone is usually thick-bedded to massive with numerous cavernous to drape-like features. The surface has undergone intensive weathering, producing many vugs and solution cavities. Where it forms ledges, the limestone is typically cryptocrystalline and emits a sharp ring when struck by a hammer. The thick-bedded limestone is generally chalky and crumbles easily. Fossil burrows and pelecypods are common throughout the member. In the sandy and argillaceous parts of the member, fossil invertebrates, such as pelecypods, gastropods, and brachiopods, are abundant. Cephalopods are found scattered on the surface, along with sea urchins and spines. Foraminifera are so abundant in places that entire beds can be recognized from section to section. Scattered dark mineral grains commonly occur where the texture becomes saccharoidal and chalky. Color varies from very pale-orange (10YR 8/2) to dark-yellowish-orange (10YR 6/6) to pale-yellowish-orange (10YR 8/6) (Goddard and others, 1948).

Claystone in the Laki Limestone Member is soft and very friable. Most contacts are sharp and well defined, but some are gradational with thick-bedded, slope-forming limestone. In addition to scattered gypsum crystals and lenses, dark mineral grains are common. Some beds are very fossiliferous with numerous pelecypods, gastropods, and echinoderms, whereas similar beds show no fossil fauna. Due to intense weathering, color varies from moderate-brown (5YR 4/4) to moderate-yellowish-brown (10YR 5/4) to light-brown (5YR 5/6) with moderate-red (5YR 4/6) oxidized zones.

Meting Shale Member

The Meting Shale Member of the Laki Formation is unconformably overlain by the Laki Limestone Member. The Meting Shale Member is predominantly claystone with a few massive to thick-bedded limestone and sandstone beds. Fossil coquina approximately 30 m below the Laki Limestone-Meting Shale contact serves as a marker bed in several sections.

Claystone in this member is soft and loose and forms gentle slopes. Abundant gypsum crystals and lenses are common, and sparse glauconite weathers to moderate-olive-brown (5Y 4/4) colored units. In various sections, the claystone is sandy and ferruginous and grades into limestone or sandstone. Abundant pelecypods, gastropods, and echinoderms comprise the fossil fauna in particular sections, and cephalopods weather out near the limestone contacts. Color varies depending upon the duration of weathering, but it is generally moderate-brown (5YR 4/4) to moderate-yellowish-brown (10YR 5/4).

Sandstone is thick-bedded, fine-grained, and contains less than 50 percent quartz. It commonly has a sharp contact with claystone and may represent channel deposits. The color is dark-yellowish-orange (10YR 8/6) weathering to grayish-orange (10YR 7/4). Fossils include pelecypod and gastropod fragments, scattered foraminifera, and echinoderms. The sandstone is calcareous and clayey in a few sections.

The fossil coquina bed is comprised of broken pelecypods, gastropods, brachiopods, and echinoderms, with few cephalopods. It ranges in thickness from 0.16 to 0.25 m and extends northward 4 km from section 5 to section 9, where it has been eroded by the Indus River. The coquina makes a sharp contact with a pale-yellowish-orange (10YR 8/6) limestone, and together they can be traced through the five sections. The coquina bed typically forms a plateau and ledges out intermittently. Due to the number of broken shells and their disorientation, the coquina bed may represent a storm or marginal marine deposit.

The limestone in the Meting Shale Member is chalky, thick-bedded to massive, and forms gentle slopes. Individual units can be traced from section to section, but others abruptly disappear under thick colluvium. Ironstone concretions are found frequently on the slopes. Exposed contacts are sharp and undulatory. Scattered fossil pelecypods, gastropods, and numerous fossil burrows are present. The limestone color ranges from dark-yellowish-orange (10YR 6/6) to very pale orange (10YR 8/2).

COLLUVIUM

Colluvium is extremely thick on the lower slopes and gradually thins toward the top of each section. The steep upper slopes characteristically are covered with large scree and boulders from the massive ledge-forming limestone above. In addition, the weathering of the soft, chalky upper limestone creates thick, powdery, clayey material with large angular cobbles. The contacts between different rock types is usually located by digging through the cobbles and into the underlying unit. The contacts in the lower slopes are found by digging as much as 2 m. Indus River alluvial silt and sand are extremely thick and are used as a point to begin the description of a section.

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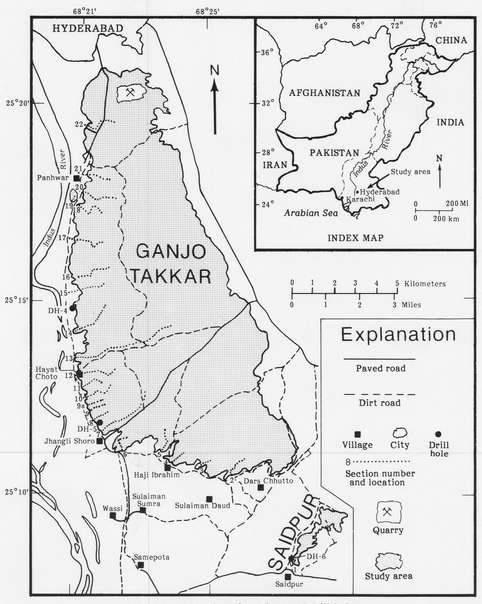
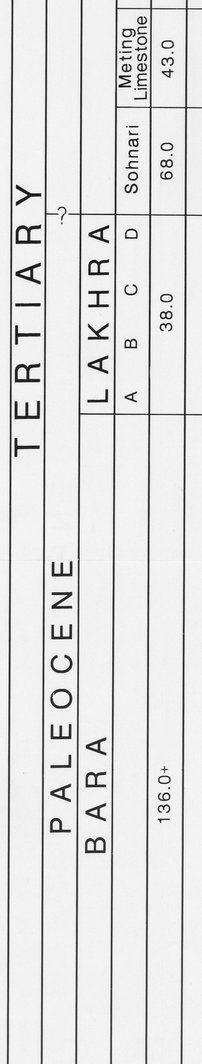


General location of sections and drill holes



MEASURED SECTIONS WITH DRILL HOLES IN THE GANJO TAKKAR AND SAIDPUR OUTLIER SHOWING STRATIGRAPHIC RELATIONSHIP BETWEEN SURFACE AND SUBSURFACE SECTIONS

EXPLANATION
Limestone
Sandstone
Claystone or shale
Siltstone
Coal with underclay
Section
DH-4
Drill hole

LATERAL RELATIONSHIPS IN THE LAKI FORMATION, GANJO TAKKAR AND SAIDPUR OUTLIER, HYDERABAD DISTRICT, SIND PROVINCE, PAKISTAN

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