UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Saudi Arabia Investigation Report
(IR) SA-65

SECTION OF THE FATIMA FORMATION
NEAR BAHRAH, SAUDI ARABIA

by

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1968

PREFACE

In 1963, in response to a request from the Ministry of Petroleum and Mineral Resources, the Saudi Arabian Government and the U. S. Geological Survey, U. S. Department of the Interior, with the approval of the U. S. Department of State, undertook a joint and cooperative effort to map and evaluate the mineral potential of central and western Saudi Arabia. The results of this program are being released in USGS open files in the United States and are also available in the Library of the Ministry of Petroleum and Mineral Resources. Also on open file in that office is a large amount of material, in the form of unpublished manuscripts, maps, field notes, drill logs, annotated aerial photographs, etc., that has resulted from other previous geologic work by Saudi Arabian government agencies. The Government of Saudi Arabia makes this information available to interested persons, and has set up a liberal mining code which is included in "Mineral Resources of Saudi Arabia, a Guide for Investment and Development," published in 1965 as Bulletin 1 of the Ministry of Petroleum and Mineral Resources, Directorate General of Mineral Resources, Jiddah, Saudi Arabia.

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Saudi Arabian Mineral Exploration 65

SECTION OF THE FATIMA FORMATION NEAR BAHRAN, SAUDI ARABIA

by

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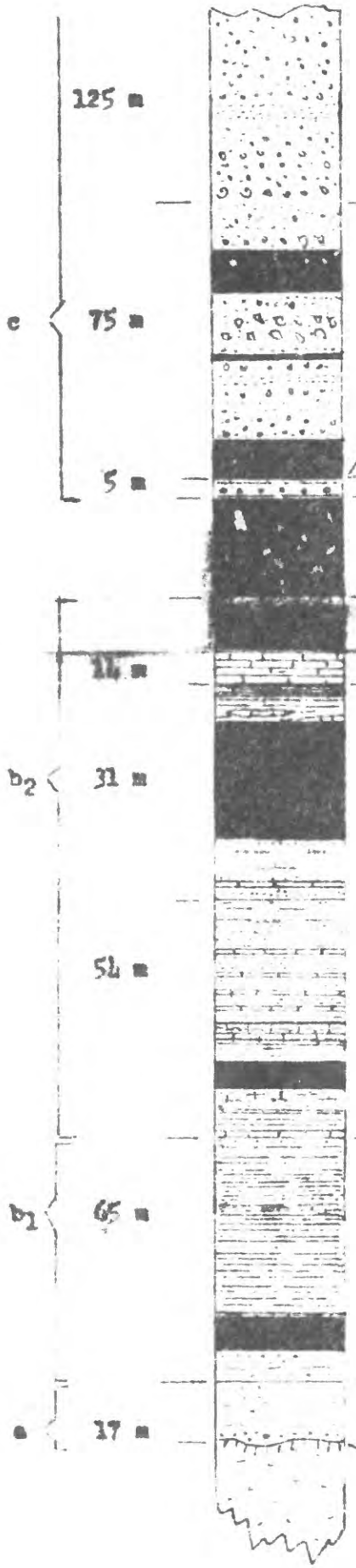
The Fatima Formation in the area east of Jiddah, Saudi Arabia, lies in a series of faulted ranges on the northwest side of lower Wadi Fatima. The measured section is in the most westerly range on the north side of the Jiddah-Makkah highway northwest of Bahrah located at 21°24'N. Lat. 39°29'E. Long. The traverse was made starting in a basin on the northwest side of the range about 6.5 kilometers from Bahrah and ending at the summit. The location is my station 699, SAG photo 1-7-28, mosaic 21-E Fatima - Rabigh Area.

The traverse started in quartz monzonite of the unit labeled gg on the 1:500,000-scale geologic map of Brown and others, (1962), which lies unconformably below the Fatima Formation. The traverse continued eastward up the mountain across the uptilted eastward-dipping beds of the formation (table 1). About four hours were spent in traversing the section. Measurement consisted of pacing, with later correction for dip of beds, or visual estimation of thicknesses where key beds were thin or where the slope was steep. The resulting section represents only a crude approximation of the true thickness of the units, but it may be useful as a description of gross lithologic aspect of the Fatima Formation in the general type area. More time was spent in the lower part of the section (a, b in fig 1) than in the upper part (c in fig. 1) above the limestone beds, for as time was getting short these beds were very rapidly traversed, and no attempt was made to estimate thicknesses of individual rock types or of natural groupings of rock types.

North and north-northwesterly-trending faults cut the lower part of the section but these appear to be of little displacement and allowance is made for them where



125 m — gray conglomerate passing upwards into red and gray conglomerate and sandstone; agglomerate

mostly red conglomerate, sandstone, and siltstone; tan and gray tuffaceous layers, agglomerate; andesite and daci-andesite sills or flows

c — 75 m

baked red shale and siltstone passing upwards into red conglomerate with much cryptocrystalline quartz, jasper, and limestone fragments; overlain by red-orange hornfelsed shale and siltstone

5 m

buff colored, thick bedded limestone with red shale partings

14 m

b_2 — 31 m

red sandstone, siltstone and shale with a few buff to tan limestone beds

54 m

greenish grey sandstone, siltstone and shale, with thin orange-brown weathering carbonate beds, some containing stromatolitic structures

b_1 — 65 m

green to purplish black, thin bedded siltstone, shale, with subordinate sand lenses; a few carbonate cemented sand and grit layers; at bottom pink and green, platy carbonate cemented grit passing upwards into greenish gritty arkose and pebble conglomerate; green mudstone lenses and layers

a — 17 m

red conglomerate, grit, arkosic sandstone with red shale partings; at bottom green arkose, grit and mudstone with pink concretions

quartz monzonite

Note: sills not included in description or thicknesses in units a and b

Fig. 1 Schematic columnar section of Fatima Formation near Baharah, Saudi Arabia

observed in the measured section. A larger fault truncates the beds on the west side of the mountain but lies west and south of the location of the traverse and thus is not involved.

The lower part of the section contains sporadic sills, locally dikes of andesite, basalt (?), and porphyritic daci-andesite (?). The thicknesses of these rocks are not included in the measured thickness of the section. The changes from red to green beds and the development of hornfels is ascribed in part at least to the intrusion of the sills. At the top of the largest sill at about 155 meters is a thin white schistose and talcose marble interlayered with talc schist, silicious layers and red shale. The presence of talc and the schistosity in these beds suggests that the alteration and deformation occured at the time of emplacement of the sill. They could however have occurred during later faulting and local hydrothermal activity.

Unit (a) is the basal unit of the formation and the basal beds at least are obviously derived from the underlying quartz monzonite. Unit (b) consists of two parts. A lower unit (b_1) consists predominantly of thin bedded siltstone and shale, but with sandstone, grit, and conglomerate prevailing in the lower part. The rocks are predominantly of green color. An upper unit (b_2) is also typically thin bedded, at least in the lower part, but contains intercalated white, gray, or pink limestone beds. These typically weather orange and are thin in the lower part of the section, but in the upper part of the unit weather buff to tan and are thick. Possible stromatalitic structures occur in the thinner beds in the lower part of (b_2).

The difference in aspect between the lower and upper parts of the section is striking. The lower part (a and b) contains deposits indicative primarily of quiet water deposition: fine-grained siltstone, shale, and limestone, with no obvious pyroclastic deposits. The upper part (c) contains little fine-grained material or chemical deposits, but it has much conglomerate, pyroclastic material, and agglomerate, as well as possible flows of andesite and daci-andesite(?). The break between the two parts occurs above the thin quartz and jasper-bearing conglomerate bed above the limestone section. This conglomerate and associated siltstone is taken as the base of the upper Wadi Fatima section (c). This upper part appears to continue

with similar lithology eastward beyond the end of the traverse to the wadi extending north of Bahrah which appears to be occupied by a fault which cuts off the top of the Fatima section. If no folding or repetition by faulting has occured, and the dip remains constant, the additional thickness of the section beyond the end of the traverse would be about 650 meters.

The upper part of the section (c) greatly resembles the upper sequence of the Mahd adh Dhahab Series at Mahd adh Dhahab. The lower part (a and b) could be, but is not recognizably equivalent to the lower sequence of the Mahd adh Dhahab Series. Two sills or flows were recognized as similar to those in the Mahd adh Dhahab area. One of these is a dacit-andesite(?) containing egg-shaped amygdules of chalcedonic quartz. The other is a gray andesite with large tabular light-gray plagioclase phenocrysts. This kind of andesite is widespread in rocks mapped as Halaban andesite elsewhere in the quadrangle it cuts across the upper sequence at one place in the Mahd adh Dhahab area of the Mahd adh Dhahab Series.

Units (a) and (b) together deserve consideration for rank as lower member of the Fatima Formation, and the upper unit (c) deserves consideration for rank as upper member of the Formation. However, the upper unit needs more detailed study to determine its full characteristics. And too, other sections of the Fatima formation should be studied in order to see if the twofold division of the Fatima Formation seen is everywhere valid. I have seen a superposition of conglomerates and pyroclastic rocks on predominantly fine-grained and non-volcanic sediments similar to those in the lower part of the Fatima Formation at several places in the Southern Hijaz quadrangle, but the break may not everywhere represent the same interval.

Karpoff (1957, p.672-673) has summarily described sections of the Fatima Formation which he calls the Wadi Fatima Series, in the Wadi Fatima area and divides the unit into a lower red conglomerate and arkose; a limestone-argillite ("schist") section containing stromatolitic beds; and on top lavas, red tuffs, and green and violet breccias, conglomerate and pyroclastic beds. He estimates the section to be 500 m thick at one locality. Comparison of my measured section near Bahrah with Karpoff's description of the Fatima indicates that my section is a representative one.

Table 1. Section of Fatima Formation near Bahrah, Saudi Arabia (measured from base of section upwards).

		Grussy-weathering, altered, quartz monzonite containing quartz, greenish-white plagioclase, pink potassium feldspar, altered mafic minerals; alteration most intense in zone 2 m wide at contact; 7 m exposed epidote in fractures
a	0 - 2.3 m	green arkose, arkosic grit and gritty mudstone with 10 cm layer of mudstone with green and pink concretions, particles in grit include quartz and fedlspar derived from underlying quartz monzonite.
a	2.3-17 m	red conglomerate, grit, arkosic sandstone with red shale partings, cross-bedded, tops to east, dip 30° east
b_1	17 - 27 m	pink and green, platy, carbonate-cemented grit, passing upwards into greenish gritty arkose and conglomerate, red aphanitic fragments as well as quartz and feldspar; gray green mudstone lenses and layers
b_1		amygdaloidal basalt - 10 m
b_1	27 - 28 m	same as below basalt
b_1	28 - 48 m	greenish to purplish-black thin-bedded to laminated siltstone, shale and sandstone; some concretionary spots in shale
b_1	48 - 80 m	green thin-bedded shale and siltstone with subordinate lenses of sandstone; rare carbonate-cemented tan to green grit beds 1 cm thick, clusters of epidote in some beds.
b_1	80 - 82 m	green sandstone
	82 - 82.2 m	coarse-grained greenish-gray limestone, brown-weathering, brecciated appearing
	82.2 - 88	greenish-gray shale with minor greenish gray sandstone
	88 - 95 m	10 cm schistose pink and white limestone, thin-bedded gray, subordinate pink sandstone above and below, cross-bedded on fine scale

Table 1. Section of Fatima Formation near Bahrah, Saudi Arabia (cont'd.)

	andesite or basalt sill
95 - 99 m	green gray ripple-marked sandstone with subordinate shale
99 - 101 m	schistose light gray carbonate beds and shale
101 - 107 m	brownish-orange weathering limestone, swirled and knotted siliceous internal planar structures, possibly stromatolites
	Fault - offset in section
101 - 123 m	interbedded green-gray sandstone and siltstone with interlayers of brown to orange-weathering carbonate 10-20 cm thick
123 - 129 m	sandstone beds more abundant
129 - 136 m	siltstone and orange-weathering calcareous shale and siltstone with minor sandstone
	shift section to north at base of red beds
136 - 155 m	red siltstone, sandstone, ripple marked, a few orange-weathering limestone layers near bottom, rare at top: platy red shale
	prominent orange-weathering sill, about 35 m thick
155 - 161 m	interbedded white schistose talcose marble, talc schist, siliceous layers and red shale
161 - 167.5 m	red gritty sandstone and siltstone with a few buff or tan-weathering white to pink limestone layers 10 to 20 cm thick
167.5 - 178 m	buff weathering thick-bedded white limestone, beds 0.7 to 1 m thick
	andesite sill 14 m thick
178 - 181 m	orange-weathering limestone, with red very thin limey-shale top and bottom; some veins of silica in center of thickest beds
	"trachytic" amygdaloidal dacit-andesite (?), glomerporphyritic, calcite amygdules, possible pillow structure at one place along strike to north, about 30 m thick

Table 1. Section of Fatima Formation near Bharah, Saudi Arabia (contd.)

C	181 - 186 m	baked red shale and siltstone passing upwards into red conglomerate containing much cryptocrystalline quartz, tuff (?) or marble (?) fragments, and subordinate jasper; conglomerate overlain by red-orange hornfelsed shale and siltstone
		green andesite
	186 - 261 m	mostly red conglomerate, sandstone, siltstone; some tan to gray fine-grained tuffaceous (?) layers; gray to brownish black andesite with egg-shaped amygdules of chalcedonic quartz; greenish gray agglomerate
	261 - 386 m	conglomerate, gray at bottom, red at top, subordinate sandstone. Summit of mountain. No noticeable dikes or sills
	386 - 1030 m(+)	not traversed. Section probably continues to wadi to east.

References cited

Brown, G. F., Jackson, R. O., Bogue, R. G., and MacLean, W. H., 1962, Geologic map of the southern Hijaz quadrangle, Kingdom of Saudi Arabia: U. S. Geol. Survey Misc. Geol. Inv. Map I-210A.

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