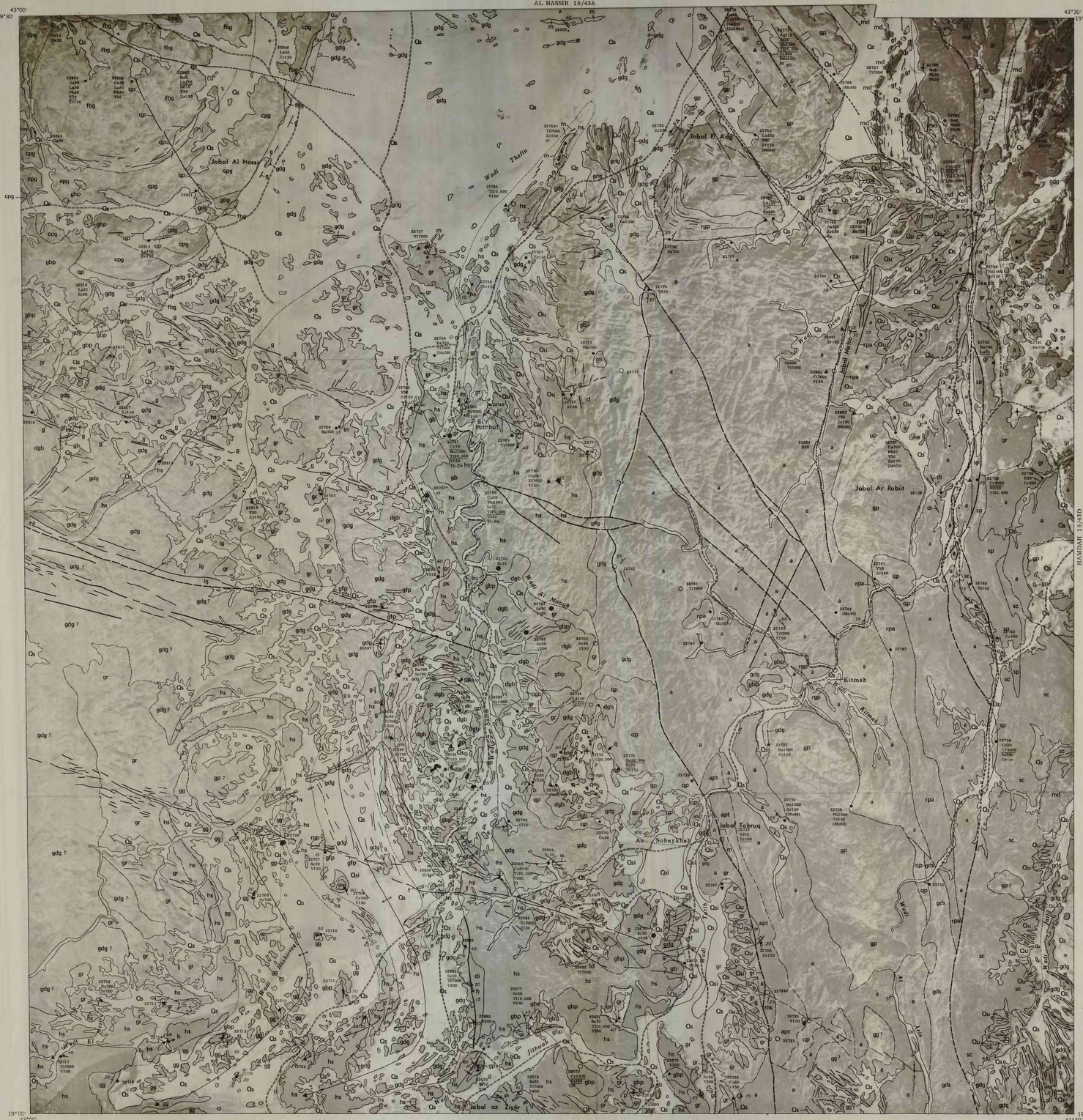
U.S. GEOLOGICAL SURVEY
SAUDI ARABIAN PROJECT

KINGDOM OF SAUDI ARABIA
MINISTRY OF PETROLEUM AND MINERAL RESOURCES



SCALE 1:100 000
2 0 2 4 6 8 10 KILOMETERS
2 0 2 4 6 8 10 MILES

Aerial photography and controlled mosaic, 1951, for southeast half, and aerial photography, 1955, and controlled mosaic, 1956, for northwest half. The two mosaics were controlled to different datums and are not reconcilable, but have been combined to give the best possible fit of detail. West meridian and most of north parallel from 1956 mosaic; south parallel, east meridian, and east part of north parallel from 1951 mosaic

Geology mapped during 1965

RECONNAISSANCE GEOLOGY OF THE DUTHUR AS SALAM QUADRANGLE, SHEET 19/43C, KINGDOM OF SAUDI ARABIA

By
William C. Overstreet
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EXPLANATION

PLUTONIC AND HYPABYSSAL INTRUSIVE ROCKS
NONLAYERED METAMORPHIC ROCKS

LAYERED SEDIMENTARY, PYROCLASTIC, AND METAMORPHIC ROCKS

QUATERNARY

Qs — Alluvial and aeolian sand
Poorly sorted alluvial sand along wadi floors, includes small areas of mobile aeolian sand

Qsi — Silt
Silt and associated fine sediments generally deposited by floods above restrictions in wadis; locally in poorly drained depressions

Qu — Alluvial fan and terrace deposits
Gravel and coarse sand deposited in coalescing alluvial fans or preserved in terrace deposits; also includes lag gravels on pediments

UNCONFORMITY

TERTIARY(?)

Tb — Basalt dike
Fine-grained, dark-gray to nearly black dikes of nonmetamorphosed basalt

UNCONFORMITY

PRECAMBRIAN AND CAMBRIAN(?)

Peralkalic Magma Series

qp | qp — Quartz porphyry
Red, massive to brecciated, medium- to coarse-grained quartz porphyry and biotite-quartz porphyry; where intrudes diorite or gabbro, epidote is common in the mafic rocks near contact, and epidote or unakite fills fractures in the mafic rock

ld — Lamprophyre and other dark dikes
Lamprophyre, andesite, or dacite dikes characterized by fine grain and dark color, intrude felsite and the younger granitic dikes

g | f | gf | gfl | gfp | p | q — Granite, felsite, and pegmatite dikes, quartz veins
White, pink, or red granite dikes (g) in swarms generally associated with or grading into felsite dikes (f); granite and felsite dikes undivided (gf); locally felsite intruded by lamprophyre (gfl); granite, felsite, and pegmatite undivided (gfp); simple granitic pegmatite dikes generally lacking mica (p); quartz veins and masses of several ages (q)

rgp | rgp — Red granite porphyry
Massive, flow-banded, or brecciated, medium- to coarse-grained, strongly inequigranular red granite porphyry and red biotite-hornblende granite porphyry; generally forms small stocks, may form marginal selvages on plutons of peralkalic granite, also forms long dikes where it is light-gray to pink and grades along strike into granite or felsite dikes

bpg | fbg | cpg — Biotite-pyroxene granite and biotite granite
Massive to locally flow-banded, peralkalic granitic rocks generally in composite subcircular plutons; including pink to red, coarse-grained locally porphyritic biotite-pyroxene granite (cpg); fine-grained biotite-pyroxene granite (bpg); and fine-grained biotite granite (fbg)

gp — Biotite granite
Massive to locally flow-banded, gray and pink to red peralkalic biotite granite and biotite-pyroxene granite, generally in homogeneous subcircular plutons

gb | di | d — Gabbro, diorite, and diabase dikes
Fine- to coarse-grained dark-gray, dark-green, dark-brown, and nearly black dikes of gabbro (gb), diorite and diorite porphyry (di) and diabase (d)

di | gb | dgb | gbp | gba — Diorite, gabbro, pyroxenite, and anorthosite
Commonly fine- to medium-grained, locally coarse-grained, light- to dark-gray diorite and biotite-diorite (di), massive to gneissic and locally epidotized; dark-gray, greenish-gray, and brownish-black, massive to layered, fine- to coarse-grained gabbro (gb) and composite masses of diorite and gabbro (dgb), gabbro and pyroxenite (gbp), and gabbro and anorthosite (gba)

gr — Granite
Light-gray to pink or red calc-alkalic biotite granite, medium-grained, inequigranular to porphyritic, generally contains bluish quartz; may include some biotite granite of the peralkalic magma series

gg | gdg | gds — Biotite granite gneiss and biotite-hornblende granodiorite gneiss
Light-gray to gray, fine- to medium-grained, massive to strongly foliated biotite granite gneiss (gg), biotite-hornblende granodiorite gneiss (gdg), and strongly sheared and chloritized biotite-hornblende granodiorite gneiss (gds); common inclusions and septa of meta-andesite, hornblende schist, and marble

sp — Serpentinite
Dark green to brownish green serpentinite associated with marble and gabbro; may be part of an ophiolite sequence

md | ad — Diorite and microdiorite
Dark microdiorite, diorite, and gabbro; mainly biotite diorite, biotite-hornblende diorite, and quartz diorite; locally metamorphosed to dark gray, nonlayered, biotite-rich, quartz-poor porphyroblastic gneiss (md); dioritic rocks complexly mixed with meta-andesite (ad)

sc | rpa | apt | a | hs | lg — Andesite, graywacke, sericite-chlorite schist, meta-andesite pyritized andesite, rhyolite, hornblende schist, interlayered biotite schist and hornblende schist, marble
Interlayered andesite and graywacke metamorphosed to sericite-chlorite schist (sc); meta-andesite (a) consists dominantly of massive epidotized or chloritized andesite, andesite lithic tuff, andesite porphyry, and andesite agglomerate, includes interbedded graywacke conglomerate and argillite; locally pyrite replaces minerals in meta-andesite forming pyritized andesite (apt); brown, black, or red rhyolite (rpa) containing up to 0.1 percent of pyrite, forms layers, plugs, sills and dikes in meta-andesite but is itself nonmetamorphosed; hornblende schist (hs) formed by metamorphism of andesite; interlayered biotite gneiss, biotite schist, and hornblende schist (lg) formed by metamorphism of interlayered graywacke and andesite; marble (m)

PRECAMBRIAN

SELECTED ELEMENTS IN RECONNAISSANCE SAMPLES

Showing sample numbers and results of spectrographic analyses of wadi sand

COPPER, ZINC, AND MOLYBDENUM

Location of sample with 20 ppm (parts per million) or less copper; also, less than 100 ppm zinc and 2 ppm or less molybdenum, unless otherwise indicated

Location of sample with 30 to 50 ppm copper; also less than 100 ppm zinc and 2 ppm or less molybdenum unless otherwise indicated

Location of sample with 70-100 ppm copper; also less than 100 ppm zinc and 2 ppm or less molybdenum unless otherwise indicated; Cu = threshold

ZINC

Threshold 100 ppm zinc; located by adjacent copper symbol

Anomalous 150-300 ppm zinc; located by adjacent copper symbol

MOLYBDENUM

Threshold molybdenum, 3-5 ppm; located by adjacent copper symbol

OTHER ELEMENTS

Ag, silver; Ba, barium; Be, beryllium; Bi, bismuth; Cr, chromium; Co, cobalt; Ga, gallium; La, lanthanum; Mn, manganese; Nb, niobium; Ni, nickel; Pb, lead; Sc, scandium; Sr, strontium; Ti, titanium; V, vanadium; Y, yttrium; Zr, zirconium; located by adjacent copper symbol. In ppm, parts per million

Cr1100 — Other anomalous elements and values

Ti7000 — Other threshold elements and values

(Mo1 08) — Threshold element in detrital magnetite by chemical analysis: 30-50 Mo; anomalous elements: 70, 100 Mo; 1,000 Zn

Scheelite and/or powellite
Present in wadi sand (superimposed on symbol for copper)

MINERAL RESOURCES

INDUSTRIAL MINERALS AND ROCKS

q — Quartz

Building and ornamental stone

m — Limestone and marble

Chemical analysis given in table 14 for sample number with asterisk

MINERALS OF LITTLE OR NO ECONOMIC IMPORTANCE

Chromite

Detrital scheelite or powellite

Garnet

Gossan

Pyrite

ms — Siderite

Siderite beds interlayered with marble

CONTACT - Dashed where approximately located or inferred; dotted where concealed

U / D — FAULT - Dashed where approximately located or inferred; dotted where concealed; queried where probable

PROBABLE ANTICLINE - Showing crestline and plunge

PROBABLE SYNCLINE - Showing troughline and plunge

FA 40 — MINOR FOLD AXIS - Showing plunge

STRIKE AND DIP OF BEDS

25 — Inclined

Vertical

55 — Overturned

STRIKE AND DIP OF FOLIATION

40 — Inclined

Vertical

h 25 — With horizontal lineation marked by oriented hornblende

28 25 bi — With plunge of lineation marked by oriented biotite (b), hornblende (h), striations (st), or slickensides (sl)

h — Horizontal, with horizontal lineation marked by oriented biotite

ps 60 — Vertical, with plunge of lineation marked by pencil structure (ps) or striations (st)

20 — Generalized; crumpled

STRIKE AND DIP OF PRIMARY FLOW BANDING

70 — Inclined

Vertical

60 — With plunge of lineation marked by oriented biotite (b), hornblende (h), or inclusions (in)

STRIKE AND DIP OF CATACLASTIC FOLIATION

60 — Inclined

b 60 — With plunge of lineation marked by biotite (b), or hornblende (h)

35 in — STRIKE AND PLUNGE OF PRIMARY LINEATION Marked by oriented inclusions; flow banding absent

DIKE - Lithology not determined

m — ISOLATED OUTCROP OF MARBLE

LINEAMENT FROM AERIAL PHOTOGRAPHS - Not checked on ground; may be dikes, foliation, joints, beds, or faults