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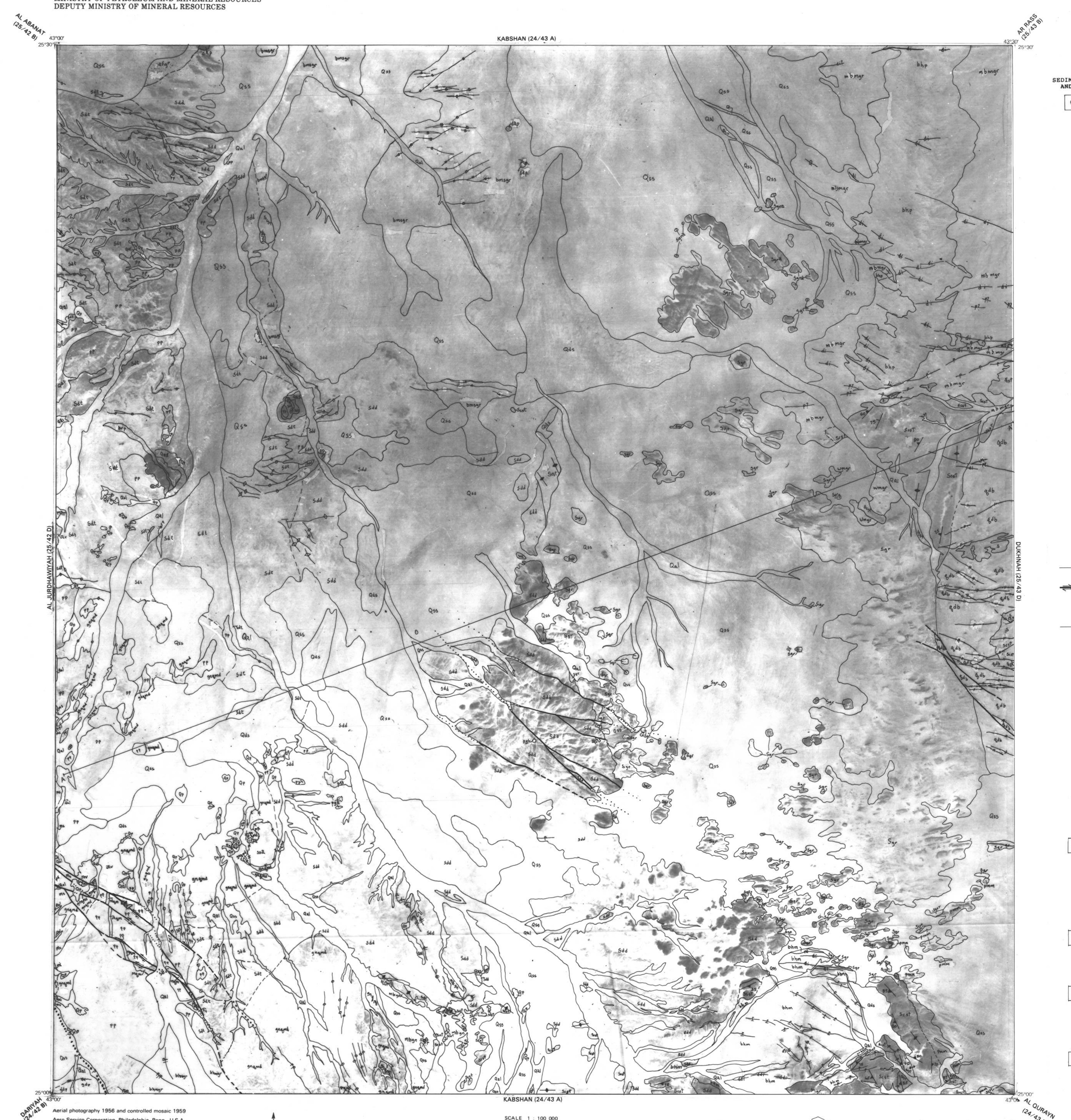
PLATE 1



Aerial photography 1966 and controlled mosaic 1969
Aero Service Corporation, Philadelphia, Penn. U.S.A.

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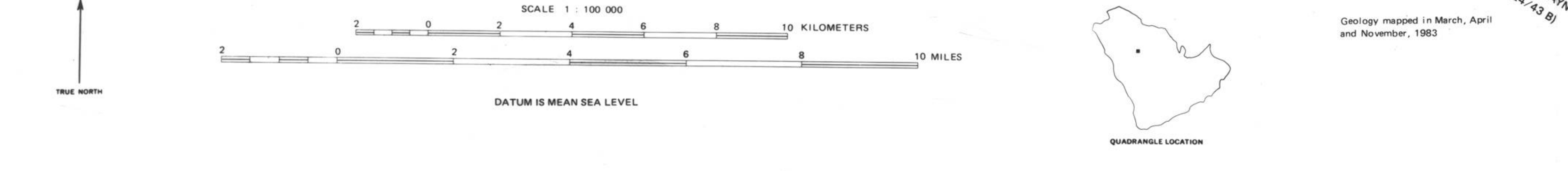
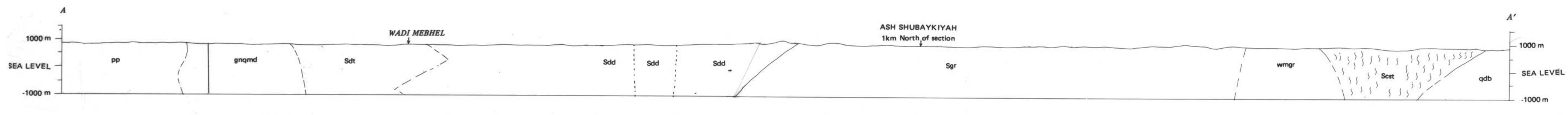


Geology mapped in March, April and November, 1983



ASH SHUBAYKIYAH QUADRANGLE, RECONNAISSANCE GEOLOGIC MAP OF THE SHEET 25/43 C, KINGDOM OF SAUDI ARABIA

by
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1985

EXPLANATION

CORRELATION OF MAP UNITS

SEDIMENTS, SEDIMENTARY ROCKS, AND METASEDIMENTARY ROCKS

Qal | Qss | Qp | Qds — QUATERNARY

UNCONFORMITY

Sgr, wmgr, mgr, —g—, pmm, —p—, afgr

HIATUS?

—di— bhp, dap, —□—

HIATUS?

mbmgr, —Δ— bmsgr, bhm, bhmgr, brp

HIATUS?

—di— —M— —ıı— qdb, —di— mbgn

gdp

HIATUS?

—x— pa

ssa

Jcv

pp, mqm, pp, —o—

UNCONFORMITY

Ms

UNCONFORMITY

pgh

gnqmd

Sdt, Sdd

HIATUS

Scst

PROTEROZOIC

SYMBOLS

CONTACT--Dashed where approximately located. Quaternary units enclosed by continuous contacts

FAULT--Dashed where approximately located; dotted where concealed; arrows indicate relative separation; arrows and U and D symbols are used only where sense of offset is provided by offset reference planes.

ANTIFORM--Showing trace of axial plane

STRIKE AND DIP OF BEDDING
Inclined, showing dip

STRIKE AND DIP OF FOLAIATION
Inclined, showing dip

Vertical

DESCRIPTION OF MAP UNITS

Weakly metamorphosed clastic rocks classified according to the system of Folk (1968); Igneous rocks classified according to the recommendations of the International Union of Geological Sciences (Streckeisen, 1976, 1979). Rock types described within designated units are listed in order of decreasing abundance.

SEDIMENTS, SEDIMENTARY ROCKS, METASEDIMENTARY ROCKS, AND METAVOLCANIC? ROCKS

SURFICIAL DEPOSITS (LATE CENOZOIC)

Differentiated chiefly by unique characteristics on black-and-white vertical air photographs. Slight variances in albedo, vegetation, and geomorphic expression cause individual units to appear different. All contacts are approximate and most are gradational. Units are somewhat simplified owing to the complexity of the surficial deposits. Alluvial deposits probably include several ages and genera of accumulations and sheet sand deposits include a limited amount of colluvial, alluvial, talus, and pediment gravel accumulations.

Qal ALLUVIAL DEPOSITS IN ACTIVE WADIS--Yellow-tan, light- and dark-brown silt, clay, granules, pebbles, and cobbles, with minor amounts of gypsum; unconsolidated, from well sorted to very poorly sorted. In general, poorly sorted only within large hills such as Jabal Suwaj; well to moderately well sorted in most other areas. Contains a large component of reworked wind-blown sand and possibly silt; most other components are locally derived directly upstream. In most cases, components of larger grain sizes limited to vicinity of source outcrop and(or) large hills. Mapped only in channels of largest, most conspicuous wadis; Quaternary sheet sand unit (Qss) includes similar deposits in wadi beds too small to be conveniently differentiated at map scale. 0-10? m thick

Qss SHEET SAND DEPOSITS--Mostly yellow brown sand and silt, also includes granules, pebbles, and cobbles near some hills and on some pediment surfaces; well to moderately well sorted at most places, moderately to poorly sorted locally; unconsolidated. In thin tabular bodies, widespread over much of quadrangle. Primarily wind-blown material, but includes rare, water- and gravity-laid accumulations local to hills. 0-30 m thick

Qp PLAYA LAKE DEPOSITS--Medium-brown, white, and light-brown silt, clay, evaporite minerals, and sand; well sorted; unconsolidated. Small, isolated deposits closely associated with alluvium in active wadis (Qal); well developed in wadi channels where slope is flat and drainage is especially poor or, on upstream side of dune fields where wadis are dammed by fields. Abundant in the vicinity of Abraq al Amala, common throughout western side of quadrangle, uncommon on eastern side. 0-30? m thick

Qds DUNE SAND--Light-brown to light-yellow-brown sand; very well sorted and rounded; entirely eolian transport and deposition; unconsolidated. Occurs in composite dunes and fields of dunes; individual dunes as much as 10 m high. Dunes probably actively migrating and sand probably accumulating, but most dunes stable enough to support limited vegetation. Deposits limited to a band that stretches from the northcentral to southwestern part of the quadrangle. Gradational with sheet sand deposits (Qss) but separated by topographic relief of the dunes. 0-40 m thick

SEDIMENTARY ROCKS (LATE PROTEROZOIC)

The Jurdhawiyah group, originally named the Al Jurdawiyah formation by Muller (1975, p. 13-20) and later redefined by Cole (1981), consists of six mappable units in the adjacent Jurdhawiyah quadrangle. Only one of Cole's (1981) units, the volcanic conglomerate, occurs in Shubaykiyah quadrangle and it is only present in two small outcrops near the central-western and southwestern border. The Murdama group (Letalenet, 1974; Greene, 1983), also originally defined with formational status (Brown and Jackson, 1960), is present only in a few very limited outcrops on the southwestern border of the Shubaykiyah quadrangle. It also is widespread in the adjacent Jurdhawiyah quadrangle (Cole, 1981), only one Murdama unit mapped by Cole (1981); however, the metasiltstone and metasandstone, is present in Shubaykiyah quadrangle. The Jurdhawiyah and Murdama depositionally overlie the Suwaj diorite complex, zircon dated by Cole and Hedge (written commun., 1984) at 683 to 689 m.y. Both of these groups are intruded by granodiorite porphyry (gdp), zircon dated at 620 m.y. (Cole and Hedge, written commun., 1984). The age of tuffaceous sedimentary rocks associated with Abraq al Amala plugs is not constrained except that they rest depositionally on the Suwaj complex. They are included in this interval because Jurdhawiyah volcanism is similar to that of the plugs.

ssa SANDSTONE ASSOCIATED WITH ABRAQ AL AMALA PLUGS--Light-yellow-brown and and pale-brown sandstone; very fine grained. Contains between 10 and 50 percent very fine grained, angular quartz sand grains in a fine-grained plagioclase matrix. Thickness and bedding characteristics not known. Possibly relates to collapse of caldera associated with ring dikes of Abraq al Amala, because unit is spacially confined within dikes. If so, it might be a sedimentary caldron fill of local derivation. Another possibility is that it was once a widespread, pre-caldera deposit that is preserved only in the collapsed area. Neither coarse- grained facies nor tuffaceous materials are present which supports the latter supposition. If it was a widespread pre-caldera deposit, it might correlate with the basal Jurdhawiyah group which Cole (1981) describes as a fine-grained, pre-volcanic sandstone.

Jcv JURDHAWIYAH GROUP, VOLCANIC CONGLOMERATE (Description and thickness after Cole, 1981)--Dark-green to multicolored, weakly bedded, volcanic conglomerate interlayered with andesite flow breccia, coarse- to fine-grained immature andesite arenite, crystal-rich andesite ash, and minor amounts of andesite flow rock. Conglomerate is very poorly sorted, and contains abundant angular to subrounded, boulder to pebble-sized clasts of hornblende-augite-andesite, hornblende dacite, and rare clasts of metasiltstone, rhyolite porphyry and granitoid rock. Raindrop imprints common on upper surfaces of graded fine-grained sandstone, siltstone, and ash beds. Conglomerate and andesite flow breccia make up most of the limited exposures in this quadrangle; conglomerate is best exposed in several hills 5 km northwest of the power station. Unit thickness from 400m to 2,000 m; the entire group thickness exceeds 3,000 m in the Jurdhawiyah quadrangle

Ms MURDAMA GROUP, METASILTSTONE, AND METASANDSTONE (Description after Cole, 1981)--Brownish-green to olive, thinly bedded, highly fractured, contorted, immature feldspathic volcanic arenite and rare pebble-conglomeratic metasandstone; locally phyllitic; very fine grained to medium grained. Conglomeratic metasandstone includes angular to subangular clasts of recrystallized porphyritic rhyolite, coarse granophyric microcline granite, very fine-grained trachytic andesite, monocrystalline quartz and feldspars and minor amounts of siltstone, phyllite and polycrystalline quartz. Metasiltstone, the only rock type present in the Shubaykiyah quadrangle, consists of in poor and limited exposures in southwest corner of the quadrangle. The thickness of the Murdama, although not determinant in this quadrangle, is estimated to be about 2700 m regionally (Letalenet, 1974)

METASEDIMENTARY AND METAVOLCANIC? ROCKS (LATE PROTEROZOIC)

Schist in Shubaykiyah quadrangle is part of a widespread, moderately high-grade metamorphic terrane that includes the Abt schist, Nafi schist, and Dukhnah gneiss. Abt schist is a term that is commonly applied in a collective sense for all of the schistose rocks of the region. However, in the nearby Dukhnah quadrangle (25/43 D), Beurrier and Villey (1982) narrowed their use of the term to schist with interlayered carbonate, clayey silt, graywacke, and volcanic beds. They used the term Nafi schist for similar rocks lacking carbonate beds and the term Dukhnah gneiss apparently for similar rocks with slightly coarser, or more pronounced, compositional layering. Schist of the Shubaykiyah quadrangle seems most closely akin to the Nafi schist of their descriptions. The schist and gneiss are intruded by the oldest dated igneous rocks (the 683-689 m.y. old Suwaj diorite) and are the only rocks with a regional penetrative metamorphic fabric. Thus, they probably are the oldest lithologic terrane in the region.

scst SCHIST--Mostly gray to greenish gray amphibolite grade biotite, hornblende, biotite-hornblende, and muscovite-biotite, pelitic to quartzofeldspathic schist and quartzofeldspathic gneiss with minor amounts of marble and amphibolite; accessory garnet, clinozoisite, diopside, anthophylite and scapolite occur at some locations. Well-developed penetrative fabric ubiquitous; texture mostly lepidoblastic to granoblastic, but poikioblastic and porphyroblastic textures also occur; dips of schistosity and foliation commonly steep to vertical; lineation of elongate minerals, such as hornblende (present at several localities and might be common) observed only in best exposures. Present in southeast corner, east-central part, central to northwest part, and south-central part of the quadrangle. In southeast, prograde diopside and zoisite rarely present in addition to common biotite, hornblende, and muscovite; fine-grained muscovite, biotite, and chlorite form retrograde phase replacing coarser prograde minerals. Protolith in southeast part of the quadrangle mostly well-bedded sandstone, shale, and minor amounts of pebble conglomerate; volcanic flow rocks or pre-metamorphic dikes and sills also suggested by presence of amphibolite and rare relict igneous textures. Original sedimentary structures preserved; bedding parallel and ranges from 1 to 15 cm thick; normally graded bedding and some cross-bedding present locally; schistosity intersects bedding (compositional layering) commonly at a 5-15 degree angle. In east-central part of quadrangle, schist is in large triangular-shaped screen between plutons and in several small roof pendants above a biotite quartz diorite pluton (qdb). Here it is lithologically and structurally similar to southeast, but presence of abundant garnet, diopside, clinozoisite, and scapolite indicate a probable superposed contact metamorphism associated with surrounding plutonism. Prograde chlorite and actinolite present in screen-like bodies of schist in central to northwestern part of quadrangle, indicating a slightly lesser metamorphic grade there; otherwise, fabric, protolith, bedding, and general appearance of schist typical. In south-central part of quadrangle, quartzo-feldspathic gneiss with thicker (10-20 cm), more obvious, and better-defined compositional layering abundant; a greater percentage of course-grained, possibly arkosic sandstone indicated in the protolith. Original sedimentary thickness of schist protolith not known, because base of section not observed

INTRUSIVE ROCKS

YOUNGER COARSE-GRAINED GRANITES (LATE PROTEROZOIC)

These rocks commonly form elliptical plutons or large stocks throughout the northeastern part of the Arabian shield (Stuckless and others, 1982). Where dated, they average about 580 m.y. old (Brown and others, 1978; Stacey and others, 1980) and are thought to represent the last major plutonic event of the Arabian shield

Sgr SHUBAYKIYAH GRANITE--SRG--Pinkish-gray, brown-gray, and light-gray biotite and muscovite-biotite syenogranite and min amounts of monzogranite; texture variable from hypidiomorphic granular to allotriomorphic granular and perthitic, myrmekitic, and(or) graphic textures common; nonfoliated; medium grained and slightly porphyritic to equigranular near southwest margin, medium to coarse grained and equigranular in interior, and coarse grained and porphyritic in center. Common accessory minerals include flourite, apatite, zircon, sphene, and allanite; biotite altered to chlorite locally; plagioclase ubiquitously altered to sericite, saussurite, and muscovite; calcite and epidote occur in veins. Similar rock at Jabal Amrah, is coarse-grained, inequigranular to porphyritic, flourite-bearing syenogranite that could possibly be separate pluton (Sgra). Large, mappable dikes not common, but one of granitic composition occurs in southeast part of pluton (—gr—) and one protoclastically sheared granitic dike occurs along faulted, east-southeast margin of pluton with adjacent quartz diorite (qdb). Figure 1B is plot of percentage quartz, potassium feldspar, and plagioclase (OKP) in Shubaykiyah samples. Forms a peneplain upon which large, isolated, rounded hills crop out

wmgr WHITE MONZOGRANITE--White biotite and muscovite-biotite monzogranite; quartz about 28 percent, potassium feldspar about 33 percent, plagioclase about 33 percent, and mafic minerals about 6 percent of rock; hypidiomorphic equigranular, nonfoliated; perthitic texture common, all grain boundaries intergrown; coarse grained; biotite occurs in elongate grains. Flourite, zircon, and allanite accessories; highly resorbed garnet present, probably incorporated from schist host rock. Differentiated from Shubaykiyah granite mostly on color difference

afgr ALKALI FELDSPAR GRANITE--Pink to pinkish-gray alkali feldspar granite; coarse grained, hypidiomorphic equigranular, nonfoliated; extremely perthitic potassium feldspar 73 percent of rock and quartz over 20 percent; discrete albite rare; graphic texture occurs rarely. Remaining 7 percent of rock subhedral allanite? altered to opaque mineral; common accessories zircon, apatite and flourite. Exposed poorly only in northwest corner of quadrangle,where it is intruded by one biotite-monzogranite porphyry dike (—g—)

mgr MINYA GRANITE--Pinkish-gray, muscovite-biotite syenogranite; coarse grained, hypidiomorphic equigranular, nonfoliated. Quartz about 32 percent, slightly perthitic potassium feldspar about 46 percent, and albite about 22 percent; some chlorite alteration of biotite present; apatite, zircon and flourite common accessory minerals. Exposed at Jabal Minya, in southern part of quadrangle, where it forms a large, rounded, and resistant outcrop. Several coarse-grained porphyritic dikes (p), whose overall composition is similar to that of the Minya granite and may be genetically related to it, cuts other units. Although no large dikes intrude the Minya granite, many east-northeast trending quartz veins (not mapped) common

pmm PORPHYRITIC MUSCOVITE-BEARING MONZOGRANITE--White, very light gray and pale-pinkish-gray muscovite-biotite monzogranite with minor amounts of muscovite-biotite syenogranite; hypidiomorphic granular, porphyritic texture with very coarse grained (2 cm) perthitic potassium feldspar phenocrysts set in a coarse-grained, equigranular groundmass. Quartz between 27 and 35 percent, potassium feldspar between 32 and 43 percent, plagioclase between 22 and 35 percent, and other minerals between 3 and 8 percent of the rock. Zircon and apatite common; slight chlorite alteration of biotite; pleochroic halos common in biotite. Long axes of phenocrysts roughly aligned with pluton margins

GRANITIODS OF THE AD DAWADIMI BATHOLITH (LATE PROTEROZOIC)

This term is used informally (Cole, 1981) to delineate a variety of plutons ranging from alkali feldspar granite to diorite in composition. The conterminuous batholith is confined to the area east of the limits of the Suwaj diorite, both in the quadrangle and regionally, but isolated plutons and stocks of similar rocks are sprinkled here and there within the Suwaj terrane. Age relations of plutons making up the batholith are poorly understood. Circular to elliptical diorite and granodiorite plutons, the "Diban intrusion" of Beurrier and Villey (1982a) in the Dukhnah quadrangle (25/43 D) and another similar pluton that is partially overlapped by the cover rocks in quadrangle 26/43 C, have been dated at 615 and 614 m.y., respectively (Cole and Hedge, written commun, 1984). However, the majority of the rocks in the batholith are more granitic in composition, thus more chemically differentiated, and theoretically are younger. Nonetheless, the shape of the dated plutons argues for their youth relative to many of the surrounding, irregularly shaped granitic plutons. Because observed contact relations between an elliptical diorite pluton (qdb) and granitic rocks to its north (mbmgr) suggest the latter intruded the former, the granitic rocks are shown to postdate the dioritic ones in this quadrangle.

bhp BIOTITE-HORNBLENDE QUARTZ MONZONITE PORPHYRY--Medium- to dark-gray, biotite-hornblende quartz monzonite porphyry; coarse to very coarse grained, unoriented, white plagioclase and rare pinkish potassium feldspar phenocrysts set in a hypidiomorphic unequigranular, nonfoliated, medium- to fine-grained groundmass. Quartz makes up 14 percent, potassium feldspar 40 percent, plagioclase 34 percent, and mafic minerals 12 percent of the rock. Plagioclase phenocrysts commonly include small biotite crystals; plagioclase ubiquitously altered to saussurite, sericite, and muscovite; potassium feldspar phenocrysts contain graphic intergrowths of quartz. Groundmass rich in myrmekitic quartz-plagioclase intergrowths. Hornblende euhedral to anhedral; some grains 1 cm long; allanite, zircon, and apatite common accessories. Demonstrably intrudes the muscovite-biotite monzogranite (mbmgr) and therefore considered to be the youngest of the Ad Dawadimi plutons; intruded by black to dark-gray diabase dikes (—di—)

dap DIORITE AND AMPHIBOLITE PLUGS AND DIKES--Dark-gray, hornblende diorite, quartz diorite, tonalite, and amphibolite; flow banded; medium grained. In small plugs intruding biotite- muscovite syenogranite (bmsgr) in north-central part of quadrangle and the Suwaj diorite in the northwest corner . Associated with quartz diorite, and tonalite dikes (—□—) that also intrude syenogranite

mbmgr MUSCOVITE-BIOTITE MONZOGRANITE--Light gray to medium gray, muscovite-biotite monzogranite, muscovite-biotite syenogranite, and biotite monzogranite; fine to medium grained, hypidiomorphic equigranular to very slightly porphyritic; coarse-grained (0.5) phenocrysts of euhedral potassium feldspar crystals make up less than 1 percent of rock; nonfoliated. Some potassium feldspar crystals are slightly perthitic, rare myrmekitic quartz present. Figure 1b shows composition on QKP (quartz, potassium feldspar, plagioclase) ternary diagram; mafic minerals range from 1.5 to 5.5 percent of rock. Zircon, allanite, sphene, flourite, and apatite common accessories; rare chloritic alteration of biotite. Intruded by group of east-northeast trending porphyry dikes (—p—) in southern part of pluton and by west-northwest trending quartzolite dikes (—Q—) in northern part

bmsgr BIOTITE MONZOGRANITE AND SYENOGRANITE--Light-gray to light-pinkish-gray biotite monzogranite, muscovite-biotite monzogranite, and biotite-muscovite syenogranite; very fine to medium grained, mostly hypidiomorphic equigranular and nonfoliated, slightly porphyritic locally; is allotriomorphic granular and slightly foliated in northern part of pluton . Potassium feldspar very slightly perthitic; rare myrmekite present. Figure 1C depicts composition on QKP ternary diagram; mafic minerals from 1 to 10 percent of rock. Primary biotite ubiquitous, muscovite is not common except at location of foliation in northern part of pluton. Apatite, zircon, flourite and sphene common accessories; rare chloritic alteration of biotite. In southern part of pluton east-trending hornblende- biotite rhyolite porphyry dikes (—Δ—) common

bhm BIOTITE-HORNBLENDE MONZOGRANITE--Medium-gray biotite monzogranite, biotite-hornblende monzogranite, and augite?-biotite-hornblende granodiorite; mostly medium grained, fine grained at intrusive margins; hypidiomorphic inequigranular to slightly porphyritic except at intrusive margins where rock is equigranular; nonfoliated. Composition depicted on QKP ternary diagram of figure 1D; mafic constituents from 2 to 14 percent of rock. Zircon, sphene, apatite, and allanite common accessories; chlorite alteration of biotite and saussuritization of plagioclase cores common. Contains zenoliths of coarse- to medium- grained biotite-hornblende tonalite and quartz diorite. Forms isolated, elliptical pluton intruding schist and Suwaj diorite north of Jabal Minya in southeast part of quadrangle; although not part of conterminuous Ad Dawadimi batholith, grouped with those rocks because of similar composition, morphology, dike geometry, and shape. Associated with a number of intersecting, northwest-, northeast-, and west-trending dikes: rhyodacite dikes (—r—); rhyodacite to monzogranite dikes (—r—); dacite/diabase dikes (ddi); and diabase dikes (—di—)

bhmgr BIOTITE-HORNBLENDE MONZOGRANITE TO SYENOGRANITE--Pinkish-gray biotite-hornblende monzogranite, hornblende-biotite monzogranite, and biotite syenogranite; in interior, pluton coarse- to medium-coarse grained, hypidiomorphic equigranular, and unfoliated; mafic constituents commonly occur in clusters. At margins texture inequigranular to porphyritic with coarse- to medium-grained euhedral plagioclase and medium-grained hornblende and biotite phenocrysts organized in crude layering parallel to contact and set in fine-grained groundmass of allotriomorphic granular quartz, potassium feldspar, and plagioclase. Zircon, sphene and apatite common accessories; chlorite alteration of biotite and saussuritization of plagioclase common. North part of pluton exposed along the southern border of the quadrangle ; not part of conterminuous Ad Dawadimi batholith, but of similar composition, morphology and expression; therefore, grouped with latter rocks. Intruded by rhyolite porphyry (—ryp—) and diabase (—di—) dikes

brp BIOTITE RHYOLITE PORPHYRY--Red to red-brown biotite rhyolite porphyry; fine to medium grained, inequigranular; well-developed flow-banding or foliation. In tabular to lense- shaped, southwest-dipping pluton that intrudes the Suwaj suite at Jabal Ainaya. Age relative to Ad Dawadimi batholith not known; included with latter rocks because of their compositional similarities

qdb BIOTITE QUARTZ DIORITE--Medium-gray and white biotite quartz diorite and biotite-hornblende diorite to tonalite; in interior of pluton, away from dikes, texture medium to coarse grained, hypidiomorphic equigranular, non foliated; near dikes and at margins with older rocks well- to incipiently developed cataclastic to protoclastic foliation present. In latter cases, mafic constituents concentrated in through- going shear zones, are preferentially aligned to varying degrees, and commonly bent to roughly conform to boundaries of larger plagioclase grains; quartz commonly finer grained in the zones of shearing; alteration of biotite and hornblende to chlorite is incipient to nearly complete in these zones. Little alteration present in non-deformed plutonic interior. Grades to medium-grained biotite granodiorite and coarse-grained biotite quartz monzonite near contact with schist. QKP composition depicted on figure 1D; mafic minerals commonly form between 2 and 36 percent of the rock. Apatite, sphene, and allanite common accessories; plagioclase altered to saussurite, sericite, and muscovite. Forms a low-relief pluton with elliptical-shaped western boundary on east-central quadrangle border; part of conterminuous Ad Dawadimi batholith. Not dated, but very similar in pluton morphology and composition to diorite in the Dukhnah quadrangle dated at 615 m.y. by Cole and Hedge (written commun., 1984). Top of pluton exposed; roof pendants of schist abundant; some too small to differentiate on map. Intruded by northwest-trending biotite- and hornblende-bearing monzogranite to monzodiorite dikes (—m—), east to northeast-trending hornblende quartz diorite dikes (—ıı—), and rare diabase dikes (—di—). Granitic and granitoid dikes commonly protoclastically or cataclastically sheared

mbgn MUSCOVITE-BIOTITE GRANODIORITE--Light-gray muscovite-biotite granodiorite with minor amounts of muscovite-biotite monzogranite; medium grained, hypidiomorphic equigranular, non-foliated. QKP composition is depicted on figure 1D; mafic minerals commonly form 3.5 to 5 percent of rock. Apatite and sphene common accessories; prehnite and chlorite replace biotite and plagioclase altered to sericite and saussurite. Forms irregular-shaped, low-relief pluton on south-central border of quadrangle. Isolated from Ad Dawadimi batholith and not dated, but grouped with those rocks because of its similar composition. Apparent source of diabase dikes (—di—) that intrude older rocks

gdp BIOTITE-HORNBLENDE GRANODIORITE PORPHYRY--White and medium-gray biotite-hornblende granodiorite; slightly porphyritic with medium- to coarse-grained feldspar phenocrysts in a medium-grained equigranular, non-foliated groundmass. QKP ratios are quartz 9 percent, potassium feldspar 62 percent, and plagioclase 29 percent; mafic constituents form 15 percent of the rock. Forms large elliptical, low-relief pluton of which only the northeastern part is within southwest corner of quadrangle; isolated from Ad Dawadimi batholith and very poorly exposed in quadrangle. In adjacent Jurdhawiyah quadrangle,zircon dated at 620 m.y. by Cole and Hedge (written communication, 1984). Its age, shape, relief, composition and proximity to Ad Dawadimi batholith warrant its inclusion with those rocks. Associated with, and intruded by, hornblende dacite porphyry dikes (—xx—)

ABRAQ AL AMALA INTRUSIVE CENTER (LATE PROTEROZOIC)

Small group of plugs and dikes defining localized, ring- shaped center. Age not known; intrudes Suwaj suite. Possibly coeval with plagioclase-bearing porphyry (pp) that formed contemporaneously with deposition of Jurdhawiyah group (Cole, 1981); similar in composition to plagioclase porphyry

pa PLUGS--Medium gray-green hornblende dacite to andesite porphyry; medium-grained phenocrysts include plagioclase, hornblende, and quartz; quartz and albite groundmass fine grained. Alteration of plagioclase to calcite or saussurite ubiquitous, and chlorite reaction rims around hornblende common. Associated dikes composed of hornblende dacite porphyry, commonly with pilotaxitic to trachytic texture, that form ring dike complex (—x—)

INTRUSIVE ROCKS ASSOCIATED WITH JURDHAWIYAH SEDIMENTATION

Cole (1981) describes these rocks as being local to the area of Al Jurdhawiyah group sedimentary and volcanic rocks. He also states that they are probably broadly coeval with the development of, and sedimentation in, the Jurdhawiyah basin. In Shubaykiyah quadrangle they form a large intrusion southwest of the power station, several small stocks and plugs along the west border of the map, small plugs in the vicinity of Jabals Aineya and Ainewayea, and many dikes throughout western side of map.

pp PLAGIOCLASE-BEARING ANDESITE PORPHYRY--Medium- to dark-greenish-gray, and light-pinkish-gray hornblende andesite porphyry that commonly contains lesser amounts of biotite, garnet, and(or) augite; also, uncommon dacite porphyry with either or both hornblende and biotite and biotite-hornblende quartz latite porphyry. Ubiquitous, euhedral, white plagioclase phenocrysts are commonly 1-2 mm; groundmass either glass recrystallized to very fine grained, holocrystalline, felted to granofelsic feldspar and quartz or entirely plagioclase laths less than 0.5 mm in length. Phenocryst content varies between 20 and 65 percent of rock. Distinct alteration of plagioclase laths and groundmass to calcite present in many samples, as is saussuritic and sericitic alteration of plagioclase; chlorite alteration of hornblende common. Associated with abundant dikes (—o—) that range in composition and character from porphyry identical to the pluton to fine-grained dark green diabase. One large north- trending, fine-grained, yellow-tan muscovite quartz monzonite dike (mqm) intrudes the large pluton in southwestern corner of quadrangle and presumed to be late stage dike associated with porphyry

GRANITOIDS OF THE SUWAJ SUITE

The Suwaj suite are the oldest intrusive rocks in the region. U-Pb zircon dates by Cole and Hedge (written commun, 1984) indicate these rocks are 683-689 Ma old; sample from north end of Jabal Suwaj dated at 683 Ma and one from tonalite near northwest corner of quadrangle dated at 685 Ma. Extensive throughout western side of quadrangle; eastern limit runs diagonally through quadrangle approximately from northwest to southeast corners. Original eastern limit not certain because younger Ad Dawadimi batholith occurs to east. Both the Suwaj and the rocks of the younger Ad Dawadimi batholith intrude the schist. Although schist is preserved in pendants and septa throughout the Ad Dawadimi batholith, the Suwaj suite is not preserved there. Therefore, it seems likely that the present east limit of the Suwaj terrane was its original east limit. Contacts between units differentiated within the Suwaj suite are approximately located. Intraplutonic lithologic variation is gradational and poor exposures limit accurate delineation of plutonic contacts. Mapped boundaries simply enclose areas typified by a particular lithology; variation within the units is commonly great. It is evident that the more mafic varieties, such as diorite, are concentrated in the Jabal Suwaj and Makhamir areas, the more quartz-rich varieties such as tonalite are common in the northwest, and the more quartz and Kspar rich varieties occur in the southwest.

pgh PERTHITE GRANOPHYRE--Orangish-pink to light tan biotite-hornblende syenogranite; myrmekite and perthite common; protoclastic or comminuted texture commonly overprints primary medium grained, hypidiomorphic inequigranular to porphyritic texture. Occurs in small bodies at west-central quadrangle border and near Wadi Mebhel in central part of quadrangle. Probably a late-stage differentiate of more widespread and more mafic older intrusions

gnqmd GRANODIORITE AND QUARTZ MONZODIORITE--Mostly light-blueish-gray, light-gray, medium-blueish-gray, white, and light- pinkish-gray biotite-hornblende, or hornblende quartz monzodiorite. Lesser amounts of biotite-hornblende, biotite, or hornblende granodiorite also present and rare biotite- hornblende quartz diorite and biotite quartz monzonite. Medium to coarse grained, hypidiomorphic equigranular to slightly inequigranular and nonfoliated at all observed localities except one, 6 km east of the power station, where slight foliation, consisting of alignment of plagioclase and hornblende crystals, occurs; poikilitic enclosure of euhedral plagioclase and hornblende crystals by larger quartz crystals common. QKP compositions of samples shown on figure 1E; mafic constituents form between 6.5 and 15.5 percent of rock. Sphene abundant; zircon, allanite, and apatite common, plus various opaque minerals. Plagioclase ubiquitously altered to saussurite, sericite, and muscovite; replacement of plagioclase by calcite also occurs; chlorite and prehnite alteration of biotite very common. Present in two large plutons within the Suwaj diorite terrane in southwestern part of quadrangle.

Sdt TONALITE--Light-gray, light-blueish-gray, and white, mottled with 10 to 40 percent dark-green, gray to black mafic minerals; hornblende, biotite-hornblende and augite-biotite- hornblende tonalite to quartz diorite. Includes lesser amounts of biotite-hornblende granodiorite, and hornblende diorite, all of about the same general color and appearance. Mostly coarse grained, rarely medium grained, hypidiomorphic equigranular, holocrystalline, and non-foliated except locally where slight foliation present. In some tonalite and granodiorite samples quartz poikilitically surrounds smaller plagioclase phenocrysts; one foliated sample has cataclastic texture with secondary biotite, probably after pyroxene, in shear zones surrounding abraded plagioclase crystals. Sphene and apatite very common accessories; biotite after pyroxene, chlorite after hornblende, chlorite and prehnite after biotite, saussurite and sericite after plagioclase, and calcite after plagioclase are nearly ubiquitous alteration reactions. QKP compositions are plotted on figure 1E; mafic minerals form between 8 and 40 percent of the rock.

Sdd DIORITE AND QUARTZ DIORITE--Mottled black and light blue-gray or white to almost totally black. Includes hornblende, biotite-hornblende, and augite-hornblende diorite; biotite-hornblende and augite-biotite-hornblende quartz diorite; and hornblende, biotite, and augite-biotite- hornblende tonalite. Minor amounts of black amphibolite, light-blue-gray biotite-hornblende monzodiorite, and rare black to dark-gray augite-hypersthene-hornblende norite also present. Medium coarse to coarse grained, hypidiomorphic equigranular, holocrystalline and mostly non-foliated, except in the southeast part of Jabal Makhamir where strong southeast-dipping foliation present adjacent, and parallel to, intrusive contact with schist. Coarse-grained apatite and sphene ubiquitous accessories; monazite and zircon less common accessories. Plagioclase commonly altered to saussurite and sericite; biotite altered in nearly every case to chlorite and prehnite; chlorite also replaces hornblende rarely. QKP compositional plots are shown on figure 1E; mafic minerals form between 12 and 68 percent of most diorites and quartz diorites and as much as 90 percent of amphibolites

EXTENDED EXPLANATION TO ACCOMPANY RECONNAISSANCE GEOLOGIC MAP OF THE ASH SUHBAYKIYAH QUADRANGLE, SHEET 25/43 C, KINGDOM OF SAUDI ARABIA

SUMMARY

The Ash Shubaykiyah quadrangle, sheet 25/43 C, is located between lat 25°00' and 25°30' N. and long 43°00' and 43°30' E., about 350 km west-northwest of Ar Riyad. Principal settlements within the quadrangle include Ash Shubaykiyah in the central part, Dahlah and Shamha in the northeastern part, Al Hamjah in the northwest, and Abu Nakhlah, Urayfijaan, Abu Jilaal and Abu Rukab in the east and southeast. Access to the east part of the quadrangle is provided by a paved road that originates in Ar Rass, a large community north of Shubaykiyah, and terminates, after branching thrice, at Ash Shubaykiyah, Dahlah and Abu Rukab. The west side of the quadrangle is accessible only by a dirt track that runs south from Al Hamjah. Most of the surface area of the quadrangle is a flat to slightly sloped, and in places poorly drained, peneplain around 750 to 850 m in elevation. There is a low-lying, poorly defined, northeast- to north-trending drainage divide that runs through the southeast and east part of the quadrangle. Northwest of the divide, wadis drain northward into Sha'ib Ad Dath and eventually into Wadi Ar Rimah, a major drainage north of the quadrangle. East and southeast of the divide, drainages trend eastward into wadi Al Huyayshah and Wadi Dukhnah, which are east of the quad and which eventually drain into Wadi Ar Rimah. Numerous monadnocks protrude from the peneplain and reach maximum elevations of about 1,100 m. Notable among these are Jabals Suwaj, Amrah, Makhamir and Minya.

The oldest rocks in the quadrangle are metasedimentary. These are composed of pelitic to quartzofeldspathic schist with minor amounts of gneiss that are penetratively deformed and have amphibolite facies mineral assemblages. The metasedimentary rocks are intruded by coarse-grained, hypidiomorphic equigranular diorite to granodiorite called the Suwaj suite herein. U-Pb zircon age determinations from samples of tonalite and diorite collected in the Suwaj suite, within and near the quadrangle, indicate its emplacement between 683 and 689 Ma. A distinct terrane is formed by the Suwaj suite in the west to southcentral part of the quadrangle and by the schist in the north-central to east part of the quadrangle . The vaguely- defined boundary between the two rock types trends northwest and bisects the quadrangle diagonally. Northeast of this boundary, no Suwaj diorite is preserved, and southwest of it, only rare, isolated, small remnants of schist are preserved, that are intruded by the Suwaj.

Sedimentary and volcanic rocks of the Murdama and Al Jurdhawiyah groups depositionally overlie the Suwaj suite. Although widely exposed just west of the quadrangle, these rocks are preserved only in very limited outcrops in the west and southwest parts of Shubaykiyah quadrangle. Small intrusive bodies and abundant dikes of plagioclase-bearing andesite to dacite porphyry, exposed throughout the western side of the quadrangle, may be coeval with the Al Jurdhawiyah group because they are compositionally very similar to volcanic flows of that group. If so, they probably represent the intrusive source for the flow rocks. A small plug and ring-dike complex at Abraq al Amala may be genetically related to the andesites, but its age is poorly known.

In the north and eastern parts of the quadrangle, igneous rocks of the Ad Dawadimi batholith, an extensive batholithic terrane, intrude the schist, preserving the schist in screens and as roof pendants. In Shubaykiyah quadrangle, most of the rocks of the batholith are fine to medium grained, of granitic composition, and have little or no topographic expression. Large, elliptical plutons of diorite to granodiorite are also common in the conterminous batholith. U-Pb zircon age determinations on samples from two such plutons, one to the east and one to the north of the quadrangle, suggest they were emplaced about 615 m.y.ago. Although the conterminous batholith is east of the east limit of the Suwaj suite, isolated plutons of similar composition, morphology, and age intrude the suite and are grouped with the batholithic rocks. One of these plutons, which has been dated by the U-Pb zircon method at 620 m.y., also intrudes the Murdama and Jurdhawiyah in the adjacent quadrangle to the west.

Coarse-grained, equigranular to porphyritic, biotite granite, in large elliptically shaped plutons, is the youngest Proterozoic rocktype in the quadrangle. On a shield-wide basis, rocks similar to these date at around 580 m.y. Most of these young granites erode to form either flat pediment surfaces upon which scattered resistant, spherically weathered hills occur, or to single large resistant, rounded masses.

Quaternary clastic and chemical deposits blanket much of the surface of the quadrangle. These non-marine sediments are eolian, lacustrine and fluvial. They include the deposition of recent alluvium in active wadis, sheet sand deposits, sand dunes, and playa deposits.

There is potential for at least one mineral deposit in the quadrangle. An ancient smelter and possible mine site, located in the southwestern corner of the quadrangle, is surrounded by a large area of phyllic alteration that contains copper minerals. Also, the area around Jabal Minya has some argillic alteration that may be associated with tin.

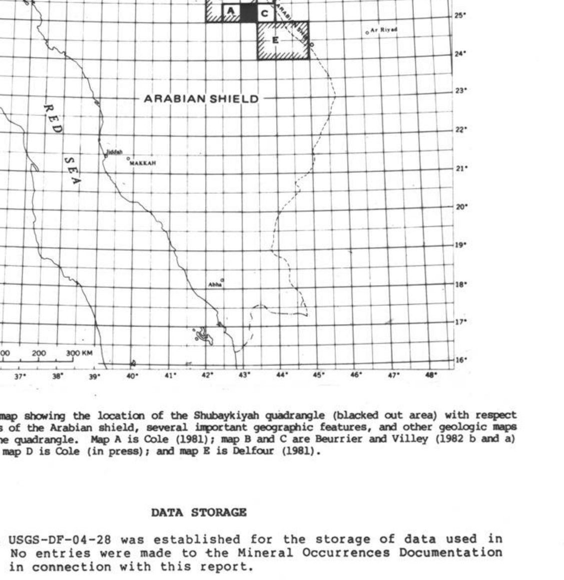

FIGURE 1.—Index map showing the location of the Shubaykiyah quadrangle (blacked out area) with respect to the margins of the Arabian shield, several important geographic features, and other geologic maps adjacent to the quadrangle. Map A is Cole (1981); map B and C are Beurrier and Villey (1982 b and a) respectively; map D is Cole (in press); and map E is Delfour (1981).

DATA STORAGE

Data-file USGS-DF-04-28 was established for the storage of data used in this report. No entries were made to the Mineral Occurrences Documentation System (MODS) in connection with this report.

MINERAL RESOURCE POTENTIAL

An ancient smelter site was identified about 2 km southwest of the power station in the southwestern part of the quadrangle. The site is at the top of a small hill. Some evidence of mine workings is present a few kilometers south of the smelter site. The workings are in an area of phyllic alteration typified by the minerals quartz, sericite, kaolinite, pyrite, epidote, malachite, and chalcopyrite (Gary Raines, written commun., 1984).

Jabal Minya has potential for an associated tin deposit (Bill Moore, written commun., 1983). The Minya granite is highly evolved petrographically and similar granites such as those at Baid Al Jumala and Jabal as Silsilah are associated with such deposits (E.A.du Bray written commun., 1984). Gary Raines (written commun., 1984) indicates that the Jabal Minya area is characterized by argillic alteration associated with quartz, sericite, pyrite, calcite, fluorite, and malachite.

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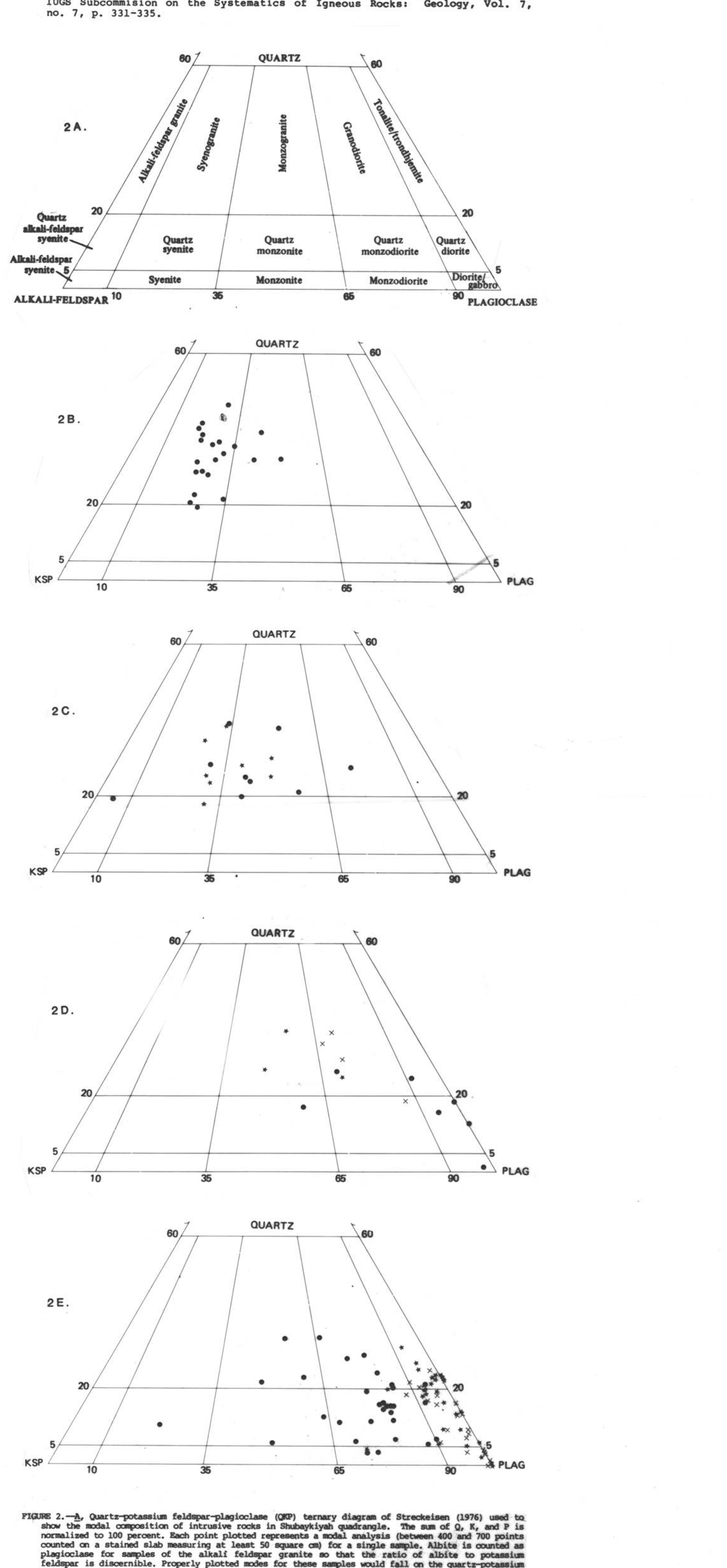

FIGURE 2.—A, Quartz-potassium feldspar-plagioclase (QKP) ternary diagram of Streckeisen (1976) used to show the modal composition of intrusive rocks in Shubaykiyah quadrangle. The sum of Q, K, and P is normalized to 100 percent. Each point plotted represents a modal analysis (between 400 and 700 points counted on a stained slab of at least 50 square cm) for a single sample. Albite is counted as plagioclase for samples of the alkali feldspar granite so that the ratio of albite to potassium feldspar is dis[illegible] modes for these samples would fall on the quartz-potassium feldspar sideline. B, Diagram for Shubaykiyah granite samples. C, Diagram for samples of granitic rocks of [illegible] Ad Dawadimi batholith terrane. Two large plutons, both part of conterminuous batholith; biotite monzogranite and syenogranite (bmsgr) data are shown with dots and muscovite-biotite monzogranite (mbmgr) data are shown with stars. D, Diagram for granitic to intermediate [illegible] Ad Dawadimi batholith. Pluton of biotite-bearing quartz diorite (qdb), [illegible] of conterminuous batholith. Biotite-hornblende monzogranite (bhm), shown with [illegible] biotite granodiorite (mbgn), shown with x's, are both isolated from batholith, [illegible]ally related to it. E, Diagram for samples of Suwaj diorite terrane. Granodiorite and quartz monzodiorite (gnqmd) samples are shown with dots, tonalite (Sdt) [illegible] (Sdd) samples are shown with x's.