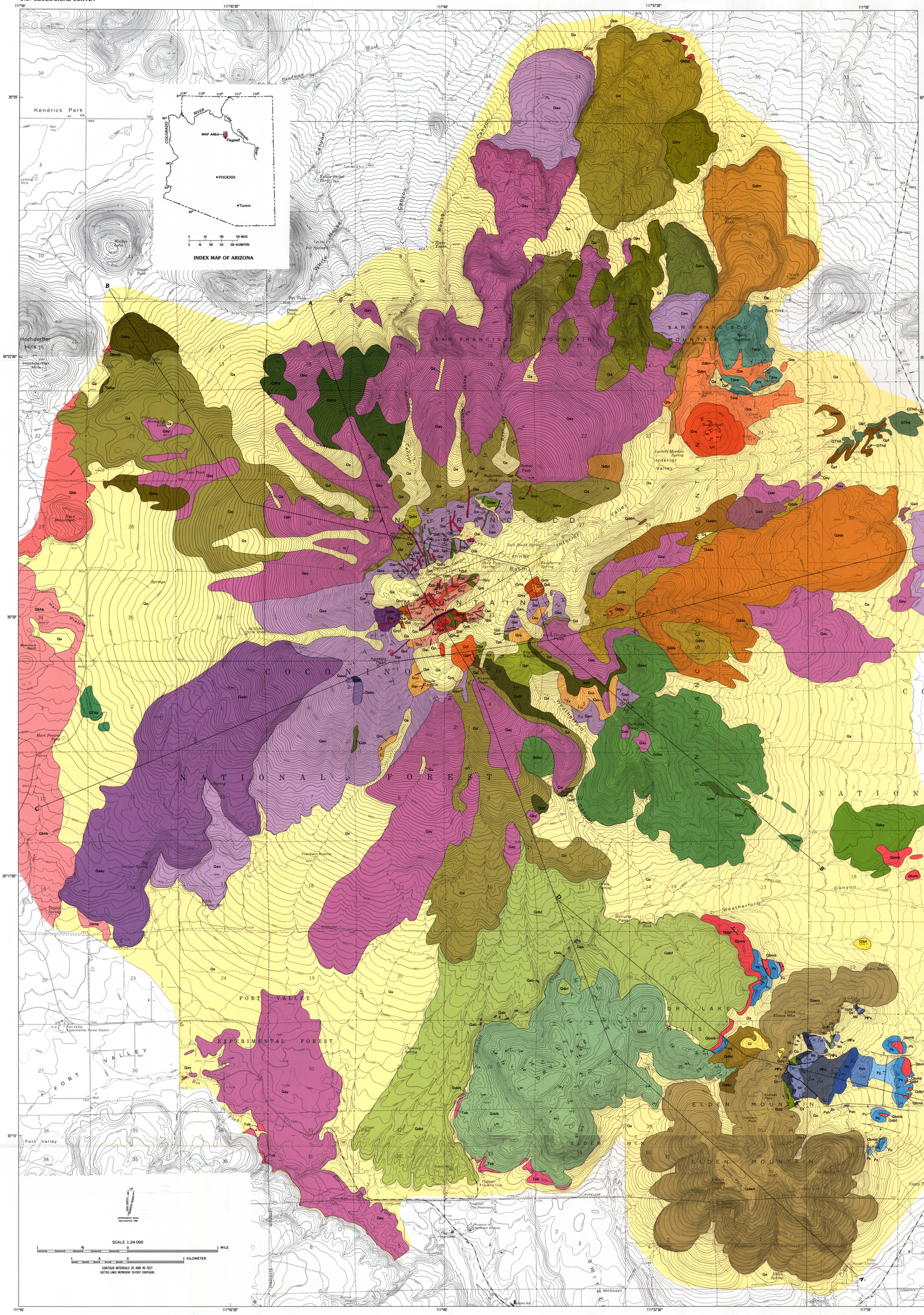
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

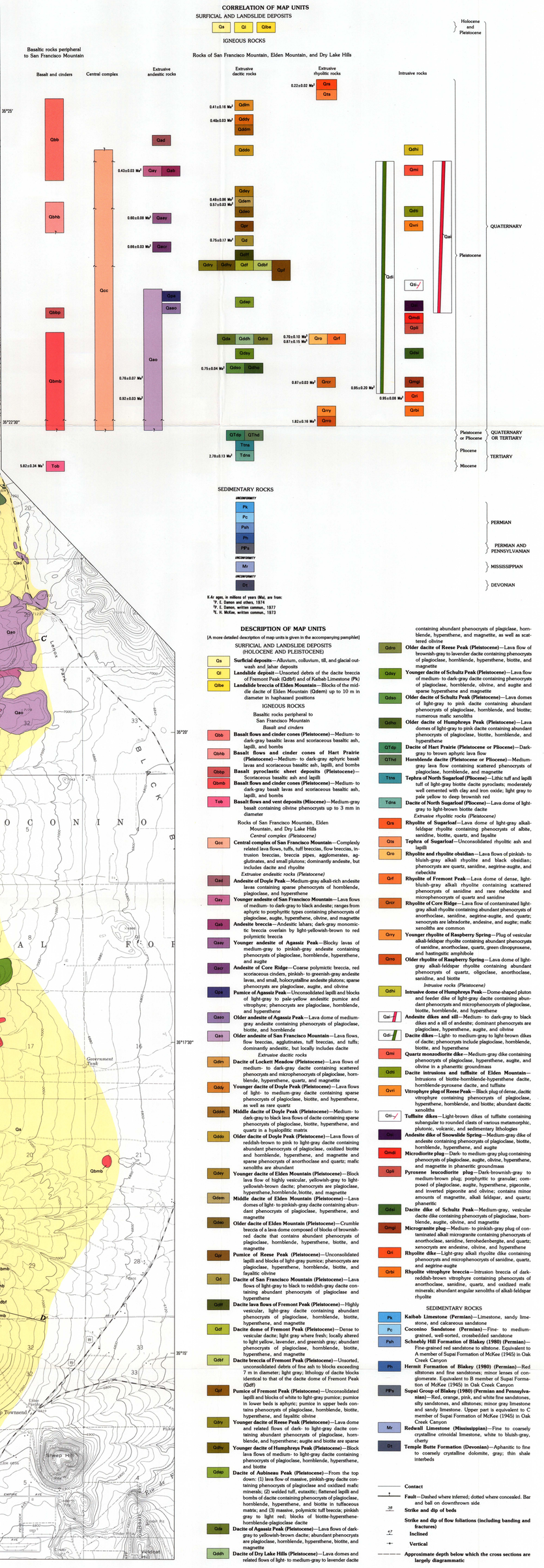
MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1663



Base from U.S. Geological Survey
Flagstaff West and Flagstaff East, 1962;
Humphreys Peak, Sunset Crater West,
White Horse Hills, and O'Leary Peak, 1966

Geology mapped in 1971–73 and 1975–78

CORRELATION OF MAP UNITS



K-Ar ages, in millions of years (Ma), are from:
[1]P. E. Damon and others, 1974
[2]P. E. Damon, written commun., 1977
[3]E. H. McKee, written commun., 1973

DESCRIPTION OF MAP UNITS

[A more detailed description of map units is given in the accompanying pamphlet]

SURFICIAL AND LANDSLIDE DESPOSITS (HOLOCENE AND PLEISTOCENE)

Qs — **Surficial deposits**—Alluvium, colluvium, till, and glacial outwash and lahar deposits

Ql — **Landslide deposit**—Unsorted debris of the dacite breccia of Fremont Peak (Qdbf) and of Kaibab Limestone (Pk)

Qlbe — **Landslide breccia of Elden Mountain**—Blocks of the middle dacite of Elden Mountain (Qdem) up to 10 m in diameter in haphazard positions

IGNEOUS ROCKS

Basaltic rocks peripheral to San Francisco Mountain

Basalt and cinders

Qbb — **Basalt flows and cinder cones (Pleistocene)**—Medium- to dark-gray basaltic lavas and scoriaceous basaltic ash, lapilli, and bombs

Qbhb — **Basalt flows and cinder cones of Hart Prairie (Pleistocene)**—Medium- to dark-gray aphyric basalt lavas and scoriaceous basaltic ash, lapilli, and bombs

Qbbp — **Basalt pyroclastic sheet deposits (Pleistocene)**—Scoriaceous basaltic ash and lapilli

Qbmb — **Basalt flows and cinder cones (Pleistocene)**—Medium- to dark-gray basalt lavas and scoriaceous basaltic ash, lapilli, and bombs

Tob — **Basalt flows and vent deposits (Miocene)**—Medium-gray basalt containing olivine phenocrysts up to 3 mm in diameter

Rocks of San Francisco Mountain, Elden Mountain, and Dry Lake Hills

Central complex (Pleistocene)

Qcc — **Central complex of San Francisco Mountain**—Complexly related lava flows, tuffs, tuff breccias, flow breccias, intrusion breccias, breccia pipes, agglomerates, agglutinates, and small plutons; dominantly andesite, but includes dacite and rhyolite

Extrusive andesitic rocks (Pleistocene)

Qad — **Andesite of Doyle Peak**—Medium-gray alkali-rich andesite lavas containing sparse phenocrysts of hornblende, plagioclase, and hypersthene

Qay — **Younger andesite of San Francisco Mountain**—Lava flows of medium- to dark-gray to black andesite; ranges from aphyric to porphyritic types containing phenocrysts of plagioclase, augite, hypersthene, olivine, and magnetite

Qab — **Andesite breccia**—Andesitic lahars; dark-gray monomictic breccia overlain by light-yellowish-brown to red polymictic breccia

Qaay — **Younger andesite of Agassiz Peak**—Blocky lavas of medium-gray to pinkish-gray andesite containing phenocrysts of plagioclase, hornblende, hypersthene, and augite

Qacr — **Andesite of Core Ridge**—Coarse polymictic breccia, red scoriaceous cinders, pinkish- to greenish-gray andesite lavas, and small, holocrystalline andesite plutons; sparse phenocrysts are plagioclase, augite, and olivine

Qpa — **Pumice dome of Humphreys Peak**—Unconsolidated lapilli and blocks of light-gray to pale-yellow andesitic pumice and vitrophyre; phenocrysts are plagioclase, hornblende, and hypersthene

Qaao — **Older andesite of Agassiz Peak**—Lava dome of medium-gray andesite containing phenocrysts of plagioclase, biotite, and hornblende

Qao — **Older andesite of San Francisco Mountain**—Lava flows, flow breccias, agglutinates, tuff breccias, and tuffs; dominantly andesitic, but locally includes dacite

Extrusive dacitic rocks

Qdm — **Dacite of Lockett Meadow (Pleistocene)**—Lava flows of medium- to dark-gray dacite containing scattered phenocrysts and microphenocrysts of plagioclase, hornblende, hypersthene, quartz, and magnetite

Qdy — **Younger dacite of Doyle Peak (Pleistocene)**—Lava flows of light- to medium-gray dacite containing sparse phenocrysts of plagioclase, biotite, and hypersthene, as well as rare quartz

Qddm — **Middle dacite of Doyle Peak (Pleistocene)**—Medium- to dark-gray to black lava flows of dacite containing sparse phenocrysts of plagioclase, biotite, hypersthene, and quartz in a hyalopilitic matrix

Qdo — **Older dacite of Doyle Peak (Pleistocene)**—Lava flows of reddish-brown to pink to light-gray dacite containing abundant phenocrysts of plagioclase, oxidized biotite and hornblende, hypersthene, and magnetite and sparse phenocrysts of anorthoclase and quartz; mafic xenoliths are abundant

Qdey — **Younger dacite of Elden Mountain (Pleistocene)**—Block lava flow of highly vesicular, yellowish-gray to light-yellowish-brown dacite; phenocrysts are plagioclase, hypersthene, hornblende, biotite, and magnetite

Qdem — **Middle dacite of Elden Mountain (Pleistocene)**—Lava domes of light- to pinkish-gray dacite containing abundant phenocrysts of plagioclase, hypersthene, and magnetite

Qdeo — **Older dacite of Elden Mountain (Pleistocene)**—Crumble breccia of a lava dome composed of blocks of brownish-red dacite that contains abundant phenocrysts of plagioclase, hornblende, hypersthene, biotite, and magnetite

Qpr — **Pumice of Reese Peak (Pleistocene)**—Unconsolidated lapilli and blocks of light-gray pumice; phenocrysts are plagioclase, hypersthene, hornblende, biotite, and fayalitic olivine

Qd — **Dacite of San Francisco Mountain (Pleistocene)**—Lava flows of light-gray to black to reddish-gray dacite containing abundant phenocrysts of plagioclase and hypersthene

Qddf — **Dacite lava flows of Fremont Peak (Pleistocene)**—Highly vesicular, light-gray dacite containing abundant phenocrysts of plagioclase, hornblende, biotite, hypersthene, and magnetite

Qdf — **Dacite dome of Fremont Peak (Pleistocene)**—Dense to vesicular dacite; light gray where fresh; locally altered to light yellow, lavender, and greenish gray; abundant phenocrysts of plagioclase, hornblende, biotite, hypersthene, and magnetite

Qdbf — **Dacite breccia of Fremont Peak (Pleistocene)**—Unsorted, unconsolidated debris of fine ash to blocks exceeding 7 m in diameter; light gray; lithology of dacite blocks identical to that of the dacite dome of Fremont Peak (Qdf)

Qpf — **Pumice of Fremont Peak (Pleistocene)**—Unconsolidated lapilli and blocks of white to light-gray pumice; pumice in lower beds is aphyric; pumice in upper beds contains phenocrysts of plagioclase, hornblende, biotite, hypersthene, and fayalitic olivine

Qdry — **Younger dacite of Reese Peak (Pleistocene)**—Lava dome and related flows of dark- to light-gray dacite containing abundant phenocrysts of plagioclase, hornblende, and hypersthene; augite and biotite are sparse

Qddy — **Younger dacite of Humphreys Peak (Pleistocene)**—Block lava flows of medium- to light-gray dacite containing phenocrysts of plagioclase, hornblende, hypersthene, and biotite

Qdap — **Dacite of Aubineau Peak (Pleistocene)**—From the top down: (1) lava flow of massive, pinkish-gray dacite containing phenocrysts of plagioclase and oxidized mafic minerals; (2) welded tuff, eutaxitic; flattened lapilli and bombs of dacite containing phenocrysts of plagioclase, hornblende, hypersthene, and biotite in tuffaceous matrix; and (3) massive, polymictic tuff breccia; pinkish gray to light red; blocks of biotite-hypersthene-hornblende-plagioclase dacite

Qds — **Dacite of Agassiz Peak (Pleistocene)**—Lava flows of dark-gray to yellowish-brown dacite; abundant phenocrysts are plagioclase, hornblende, hypersthene, biotite, and magnetite

Qddh — **Dacite of Dry Lake Hills (Pleistocene)**—Lava domes and related flows of light- to medium-gray to lavender dacite containing abundant phenocrysts of plagioclase, hornblende, hypersthene, and magnetite, as well as scattered olivine

Qdre — **Older dacite of Reese Peak (Pleistocene)**—Lava flow of brownish-gray to lavender dacite containing phenocrysts of plagioclase, hornblende, hypersthene, biotite, and magnetite

Qdsy — **Younger dacite of Schultz Peak (Pleistocene)**—Lava flow of medium- to dark-gray dacite containing phenocrysts of plagioclase, hornblende, olivine, and augite and sparse hypersthene and magnetite

Qdso — **Older dacite of Schultz Peak (Pleistocene)**—Lava domes of light-gray to pink dacite containing abundant phenocrysts of plagioclase, hornblende, and biotite; numerous mafic xenoliths

Qdhp — **Older dacite of Humphreys Peak (Pleistocene)**—Lava domes of light-gray to pink dacite containing abundant phenocrysts of plagioclase, biotite, hornblende, and hypersthene

QTdp — **Dacite of Hart Prairie (Pleistocene or Pliocene)**—Dark-gray to brown aphyric lava flow

QThd — **Hornblende dacite (Pleistocene or Pliocene)**—Medium-gray lava flow containing scattered phenocrysts of plagioclase, hornblende, and magnetite

Ttns — **Tephra of North Sugarloaf (Pliocene)**—Lithic tuff and lapilli tuff of light-gray biotite dacite pyroclasts; moderately well cemented with clay and iron oxide; light gray to pale yellow to deep brownish red

Tdns — **Dacite of North Sugarloaf (Pliocene)**—Lava dome of light-gray to light-brown biotite dacite

Extrusive rhyolitic rocks (Pleistocene)

Qrs — **Rhyolite of Sugarloaf**—Lava dome of light-gray alkali-feldspar rhyolite containing phenocrysts of albite, sanidine, biotite, quartz, and fayalite

Qts — **Tephra of Sugarloaf**—Unconsolidated rhyolitic ash and lapilli

Qro — **Rhyolite and rhyolite obsidian**—Lava flows of pinkish- to bluish-gray alkali rhyolite and black obsidian; phenocrysts are quartz, sanidine, aegirine-augite, and riebeckite

Qrf — **Rhyolite of Fremont Peak**—Lava dome of dense, light-bluish-gray alkali rhyolite containing scattered phenocrysts of sanidine and rare riebeckite and microphenocrysts of quartz and sanidine

Qrcr — **Rhyolite of Core Ridge**—Lava flow of contaminated light-gray alkali rhyolite containing abundant phenocrysts of anorthoclase, sanidine, aegirine-augite, and quartz; xenocrysts are labradorite, andesine, and augite; mafic xenoliths are common

Qrry — **Younger rhyolite of Raspberry Spring**—Plug of vesicular alkali-feldspar rhyolite containing abundant phenocrysts of sanidine, anorthoclase, quartz, green clinopyroxene, and hastingsitic amphibole

Qrro — **Older rhyolite of Raspberry Spring**—Lava dome of light-gray alkali-feldspar rhyolite containing abundant phenocrysts of quartz, oligoclase, anorthoclase, sanidine, and biotite

Intrusive rocks (Pleistocene)

Qdhi — **Intrusive dome of Humphreys Peak**—Dome-shaped pluton and feeder dike of light-gray dacite containing abundant phenocrysts and microphenocrysts of plagioclase, biotite, hornblende, and hypersthene

Qai — **Andesite dikes and sill**—Medium- to dark-gray to black dikes and a sill of andesite; dominant phenocrysts are plagioclase, hypersthene, augite, and olivine

Qdi — **Dacite dikes**—Light- to medium-gray to light-brown dikes of dacite; phenocrysts include plagioclase, hornblende, biotite, and hypersthene

Qmi — **Quartz monzodiorite dike**—Medium-gray dike containing phenocrysts of plagioclase, hypersthene, augite, and olivine in a phaneritic groundmass

Qdti — **Dacite intrusions and tuffisite of Elden Mountain**—Intrusions of biotite-hornblende-hypersthene dacite, hornblende-pyroxene dacite, and tuffisite

Qvri — **Vitrophyre plug of Reese Peak**—Black plug of dense, dacitic vitrophyre containing phenocrysts of plagioclase, hypersthene, hornblende, and biotite; abundant dacitic xenoliths

Qti — **Tuffisite dikes**—Light-brown dikes of tuffisite containing subangular to rounded clasts of various metamorphic, plutonic, volcanic, and sedimentary lithologies

Qsi — **Andesite dike of Snowslide Spring**—Medium-gray dike of andesite containing phenocrysts of plagioclase, biotite, hornblende, hypersthene, and augite

Qmdi — **Microdiorite plug**—Dark- to medium-gray plug containing phenocrysts of plagioclase, augite, olivine, hypersthene, and magnetite in phaneritic groundmass

Qpli — **Pyroxene leucodiorite plug**—Dark-brownish-gray to medium-brown plug; porphyritic to granular; composed of plagioclase, augite, hypersthene, pigeonite, and inverted pigeonite and olivine; contains minor amounts of magnetite, alkali feldspar, and quartz; phaneritic

Qdsi — **Dacite dike of Schultz Peak**—Medium-gray, vesicular dacite dike containing phenocrysts of plagioclase, hornblende, augite, olivine, and magnetite

Qmgi — **Microgranite plug**—Medium- to pinkish-gray plug of contaminated alkali microgranite containing phenocrysts of anorthoclase, sanidine, ferrohedenbergite, and quartz; xenocrysts are andesine, olivine, and hypersthene

Qri — **Rhyolite dike**—Light-gray alkali rhyolite dike containing phenocrysts and microphenocrysts of sanidine, quartz, and aegirine-augite

Qrbi — **Rhyolite vitrophyre breccia**—Intrusion breccia of dark-reddish-brown vitrophyre containing phenocrysts of anorthoclase, sanidine, quartz, and oxidized mafic minerals; abundant angular xenoliths of alkali-feldspar rhyolite

SEDIMENTARY ROCKS

Pk — **Kaibab Limestone (Permian)**—Limestone, sandy limestone, and calcareous sandstone

Pc — **Coconino Sandstone (Permian)**—Fine- to medium-grained, well-sorted, crossbedded sandstone

Psh — **Schnebly Hill Formation of Blakey (1980) (Permian)**—Fine-grained red sandstone to siltstone; Equivalent to A member of Supai Formation of McKee (1945) in Oak Creek Canyon

Ph — **Hermit Formation of Blakey (1980) (Permian)**—Red siltstones and fine sandstones; minor lenses of conglomerate. Equivalent to B member of Supai Formation of McKee (1945) in Oak Creek Canyon

PIPs — **Supai Group of Blakey (1980) (Permian and Pennsylvanian)**—Red, orange, pink, and white fine sandstones, silty sandstones, and siltstones; minor gray limestone and sandy limestone. Upper part is equivalent to C member of Supai Formation of McKee (1945) in Oak Creek Canyon

Mr — **Redwall Limestone (Mississippian)**—Fine to coarsely crystalline crinoidal limestone, white to bluish-gray, cherty

Dt — **Temple Butte Formation (Devonian)**—Aphanitic to fine to coarsely crystalline dolomite, gray; thin shale interbeds

Contact

Fault—Dashed where inferred; dotted where concealed. Bar and ball on downthrown side

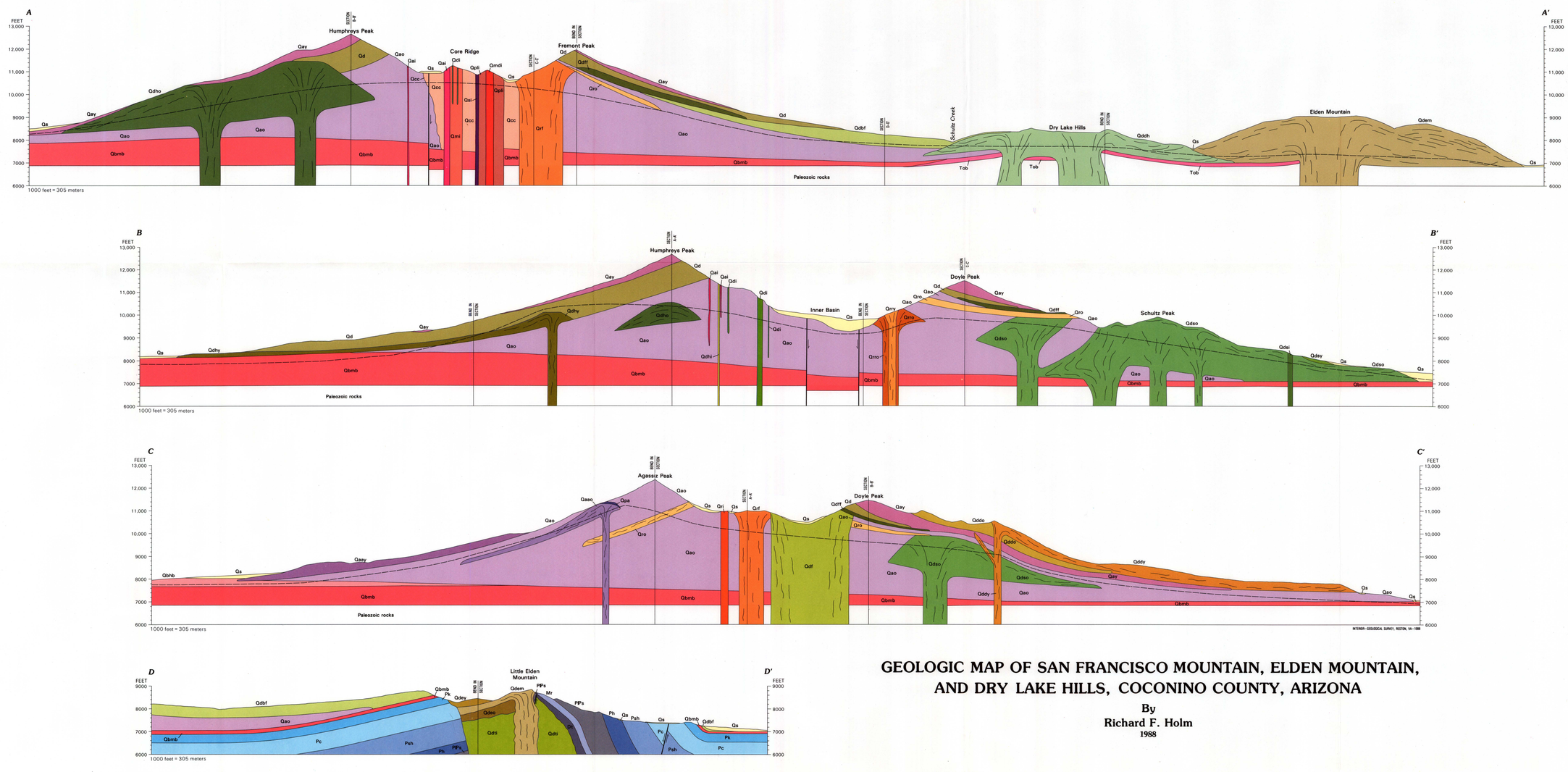
Strike and dip of beds

Strike and dip of flow foliations (including banding and fractures)

Inclined

Vertical

Approximate depth below which the cross sections are largely diagrammatic



GEOLOGIC MAP OF SAN FRANCISCO MOUNTAIN, ELDEN MOUNTAIN, AND DRY LAKE HILLS, COCONINO COUNTY, ARIZONA

By
Richard F. Holm
1988

For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225