U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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U.S. BUREAU OF INDIAN AFFAIRS AND THE
HUALAPAI TRIBE

GEOLOGIC INVESTIGATIONS SERIES
I-2643 (SHEET 1 OF 2)
Pamphlet accompanies map

MAP A. BRECCIA-PIPE AND GEOLOGIC MAP

BRECCIA-PIPE AND GEOLOGIC MAP OF THE SOUTHEASTERN PART OF THE HUALAPAI INDIAN RESERVATION AND VICINITY, ARIZONA

By

George H. Billingsley, Karen J. Wenrich, and Peter W. Huntoon

2000

Base from U.S. Geological Survey, 1:24,000
Diamond Peak, Frazier Wells, Frazier Wells SW, Nelson, Peach Springs NE, 1967;
Dike Tank, Robbers Roost Canyon, Rose Well Camp West, 1980;
Crater Canyon, Grand Canyon Caverns, Supai Camp SE, 1981

SCALE 1:48 000
CONTOUR INTERVALS 10, 20, AND 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped 1983–1986 partly revised from Huntoon and others [19811]
breccia-pipe geology by K.J. Wenrich; stratigraphy by G.H. Billingsley;
structural geology by P.W. Huntoon; Proterozoic geology by M.D. Clark

Edited by Alessandro Donatich
Graphic design by William Sowers
Cartography by Michael Kirtley
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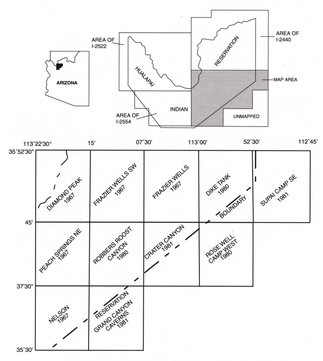

INDEX MAP SHOWING LOCATIONS OF THE MAP AREA AND 7.5-MINUTE QUADRANGLES THAT MAKE UP THE MAP AREA

CLASSIFICATION OF COLLAPSE FEATURES AND BRECCIA PIPES

[Also refer to map B, where characteristics of each feature and pipe are color coded]

C2 276 **Collapse feature or breccia pipe**—Selected features and pipes have one or more of the following alphanumeric symbols. Features and pipes also have identification numbers (identification number range is from 272 to 1208, assigned in order of field discovery). Numbers correspond to those used for geochemical analyses (K.J. Wenrich, unpub. data, 1982–94). Outline of feature or pipe dashed where inferred

B—Brecciated rock (indicating the structure is a breccia pipe)

M—Mineralized rock containing copper minerals or surface radiation greater than 2.5 times background

C1—Radially inward-dipping beds and alteration (bleaching or limonite staining)

C2—Radially inward-dipping beds, no alteration

C3—Visible alteration, no dipping beds

C4—Circular topography or circular vegetation of soil pattern, no alteration or dipping beds

C7—Questionable circular feature. Few recognizable inward-dipping beds, and (or) little alteration, vegetation change, or topographic change. Feature appears vaguely circular

S—Sinkhole

B● Breccia pipe mapped by Huntoon and others (1981) or by authors of this map—Location shown by solid dot, not to scale

C● Collapse feature mapped by Huntoon and others (1981) or by authors of this map—Location shown by solid dot, not to scale

S● Sinkhole mapped by Huntoon and others (1981) or by authors of this map—Location shown by solid dot, not to scale

CONVERSION FACTORS

Multiply	By	To obtain
inches (in)	2.54	centimeters (cm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)

CORRELATION OF MAP UNITS

SURFICIAL AND IGNEOUS DEPOSITS

Qal, Qd, Qc, Qt, Qg, Qb, QTl, Tlp, Tl, Tb, Tg — Holocene, Pleistocene, Pliocene, Miocene, Oligocene, Eocene, Paleocene — QUATERNARY, TERTIARY

SEDIMENTARY ROCKS

Unconformity
Pk
Unconformity
Pt
Unconformity
Pc
Unconformity
Ph
Unconformity
Pep — Supai Group
Unconformity
PMwmw — Upper, Middle, and Lower Pennsylvanian
Unconformity
Mdc — Upper Mississippian
Unconformity
Mr — Lower Mississippian
Unconformity
Dtb — Upper and Middle Devonian(?)
Unconformity
Cm, Cba, Ct — Tonto Group — Middle Cambrian, Lower Cambrian

Pk, Pt, Pc, Ph — Lower Permian — PERMIAN
PMwmw — PENNSYLVANIAN
Mdc, Mr — MISSISSIPPIAN
Dtb — DEVONIAN
Cm, Cba, Ct — CAMBRIAN

Unconformity

METAMORPHIC AND IGNEOUS ROCKS

Xgr, Xvs, Xvb, Xvm — Vishnu Schist (Group) — Early Proterozoic — PROTEROZOIC

LIST OF MAP UNITS

[See accompanying text pamphlet for expanded descriptions of map units]

SURFICIAL AND IGNEOUS DEPOSITS

- **Qal** Alluvial deposits (Holocene)
- **Qd** Dune sand (Holocene and Pleistocene(?))
- **Qc** Colluvium (Holocene and Pleistocene(?))
- **Qt** Travertine deposits (Holocene and Pleistocene)
- **Qg** Older terrace-gravel deposits (Holocene and Pleistocene)
- **Qb** Basalt flows (Pleistocene)
- **QTl** Landslides (Holocene, Pleistocene, and Pliocene(?))
- **Tlp** Long Point basalt flows of McKee and McKee (1972) (Pliocene and Miocene)
- **Ti** Intrusive volcanic rocks (Miocene)
- **Tb** Basalt (Miocene)
- **Tg** Undifferentiated gravel deposits (Pliocene to lower Paleocene(?))
- **Tfw** Frazier Well gravel of Koons (1964) [middle Eocene to upper Paleocene (Young, 1999)]
- **Trr** Robbers Roost gravel of Koons (1948a) [middle Eocene to lower Paleocene (Young, 1999)]

SEDIMENTARY ROCKS

- **Pk** Kaibab Formation (Lower Permian)
- **Pt** Toroweap Formation (Lower Permian)
- **Pc** Coconino Sandstone (Lower Permian)
- **Ph** Hermit Shale (Formation) (Lower Permian)
- **Pep** Supai Group (Lower Permian to Upper Mississippian) Esplanade Sandstone and Pakoon Limestone, undivided (Lower Permian)
- **PMwmw** Wescogame, Manakacha, and Watahomigi Formations, undivided (Upper Pennsylvanian to Upper Mississippian)
- **Mdc** Surprise Canyon Formation (Upper Mississippian)
- **Mr** Redwall Limestone (Upper and Lower Mississippian)
- **Dtb** Temple Butte Formation (Upper and Middle(?) Devonian)
- Tonto Group (Middle and Lower Cambrian)
  - **Cm** Muav Limestone (Middle Cambrian)
  - **Cba** Bright Angel Shale (Middle Cambrian)
  - **Ct** Tapeats Sandstone (Middle and Lower Cambrian)

METAMORPHIC AND IGNEOUS ROCKS

- Vishnu Schist (Group) (Early Proterozoic)
  - **Xgr** Nonfoliated granitic plutons
  - **Xvs** Mica schist
  - **Xvb** Mafic schist and amphibolite
  - **Xvm** Paragneiss

- **Contact**
- **Fault**—Dashed where approximately located; dotted where concealed; bar and ball on downthrown side; R, reverse fault; number indicates estimated displacement in feet. Fault predates alluvium and colluvium where shown bounding these units
- **Thrust fault**—Sawteeth on upper plate; dotted where concealed
- **Folds**—Showing trace of axial plane and direction of plunge where known; dashed where approximately located; dotted where concealed
  - **Monocline**—Axial trace located approximately midway between anticlinal and synclinal hinges of fold. Length of arrows indicates approximate map distance between fold hinges
  - **Syncline**
  - **Anticline**
  - **Dome**
- **Strike and dip of beds**
- **Strike and dip of schistosity**
  - **Inclined**
  - **Vertical**
- **M2 Middle amphibolite faces**
- **Volcanic vent area**

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