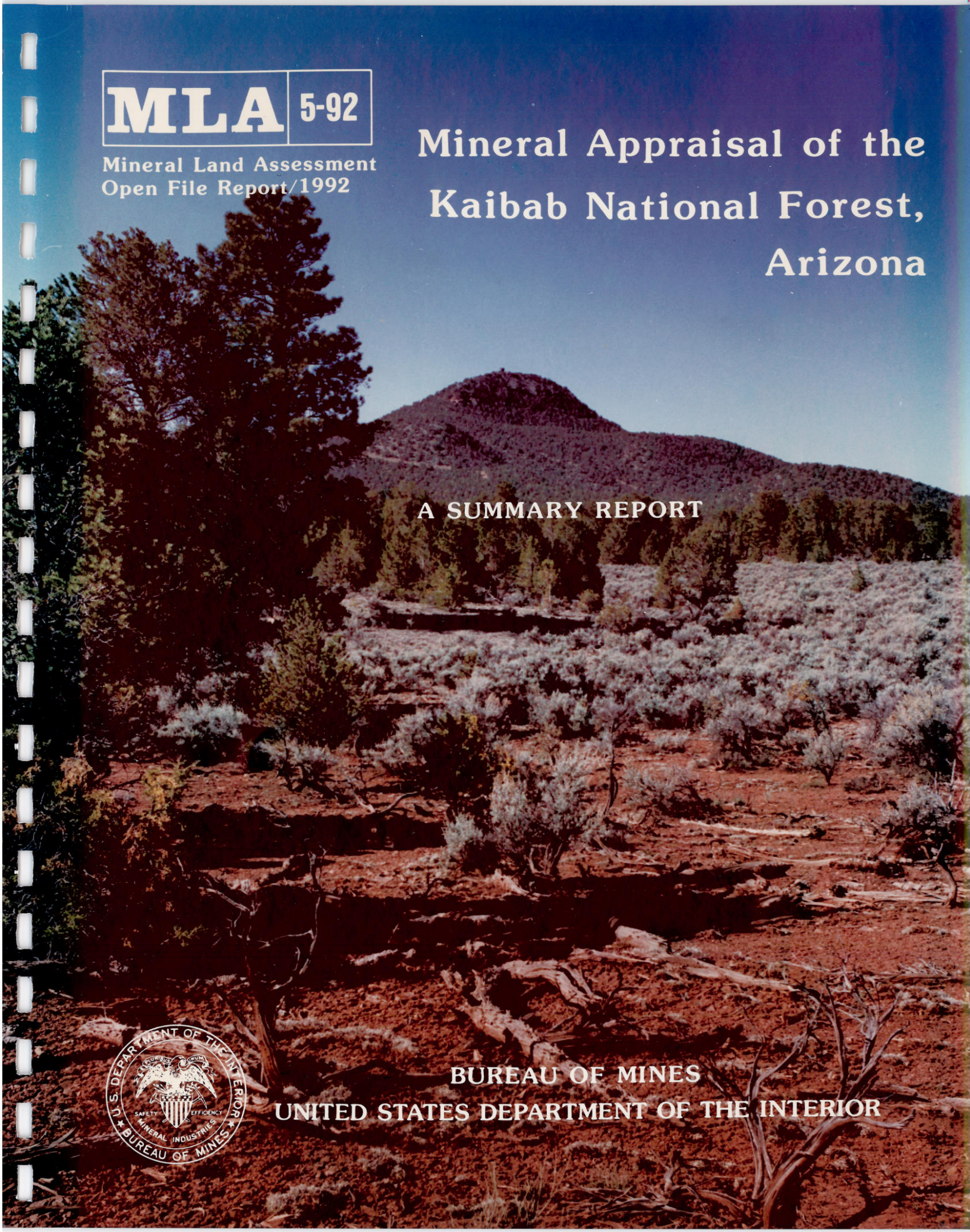

MLA 5-92

Mineral Land Assessment
Open File Report/1992

Mineral Appraisal of the Kaibab National Forest, Arizona

A SUMMARY REPORT

BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR

EXECUTIVE SUMMARY
MINERAL APPRAISAL OF THE KAIBAB NATIONAL FOREST, ARIZONA

by

David C. Scott

MLA 5-92
1992

Intermountain Field Operations Center
Denver, Colorado

UNITED STATES DEPARTMENT OF THE INTERIOR
Manuel Lujan Jr., Secretary

BUREAU OF MINES
T S ARY, Director

PREFACE

A January 1987 Interagency Agreement between the Bureau of Mines, U.S. Geological Survey, and U.S. Forest Service describes the purpose, authority, and program operation for the forest-wide studies. The program is intended to assist the Forest Service in incorporating mineral resource data in forest plans as specified by the National Forest Management Act (1976) and Title 36, Chapter 2, Part 219, Code of Federal Regulations, and to augment the Bureau's mineral resource data base so that it can analyze and make available minerals information as required by the National Materials and Minerals Policy, Research and Development Act (1980). This report is based on available data from literature and limited field investigations.

This open-file report summarizes the results of a Bureau of Mines wilderness study. The report is preliminary and has not been edited or reviewed for conformity with the Bureau of Mines editorial standards. This study was conducted by personnel from the Resource Evaluation Branch, Intermountain Field Operations Center, P.O Box 25086, Denver, CO 80225.

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MINERAL APPRAISAL OF THE KAIBAB NATIONAL FOREST, COCONINO COUNTY, ARIZONA

By David C. Scott

ABSTRACT

Between 1990 and 1991, the Bureau of Mines studied the mineral resources of the Kaibab National Forest to appraise the resources present and to determine the types of deposits, and their location. The study included a comprehensive literature search and a limited amount of field investigation of minerals and mining activity in and near the Forest.

Small amounts of copper with lesser amounts of gold and silver have been produced from limestone-hosted, strata-bound deposits in the North Kaibab and Tusayan Ranger Districts. In addition to these small metallic deposits, volcanic cinders, pumice, flagstone, and sand and gravel have been quarried in the Chalendar and Williams Ranger Districts. At least ten uranium-mineralized breccia pipes have been identified in the Tusayan Ranger District. One of these, the Canyon pipe, contains a high-grade uranium ore body with associated silver, copper, lead, vanadium, and zinc. The mine permit for the Canyon pipe has been approved and the mine shaft head frame erected.

INTRODUCTION

To assist the Forest Service land-use-planning effort, the Bureau of Mines (Bureau) appraised mineral resources in the Kaibab National Forest, Coconino County, northern Arizona (fig. 1). Field investigations by the Bureau of Mines were conducted in 1990 and a report was prepared in 1991. The Forest is administered by the Department of Agriculture, U.S. Forest Service. The Kaibab National Forest encompasses a total of approximately 1.6 million acres in four separate ranger districts.

This report summarizes a more comprehensive minerals report on the Forest prepared by the Bureau of Mines and was written for a general audience without a background in geology or related scientific fields. The summary is intended to stand alone without reference to the backup report. Detailed geologic and technical descriptions of the mineral resources, mining history, production, and mineral resources and related mining economics are discussed in the unabridged version of the report.

A detailed literature search for pertinent geologic and mining information was conducted and is the source of most of the information used in this report. Bureau of Land Management records were examined for location of patented and unpatented mining claims. A field investigation was performed to examine mines, prospects, and mineralized areas. A total of 65 employee-days were spent in the field; 114 rock samples were taken and analyzed for various metals. The Bureau of Mines conducted a study to identify

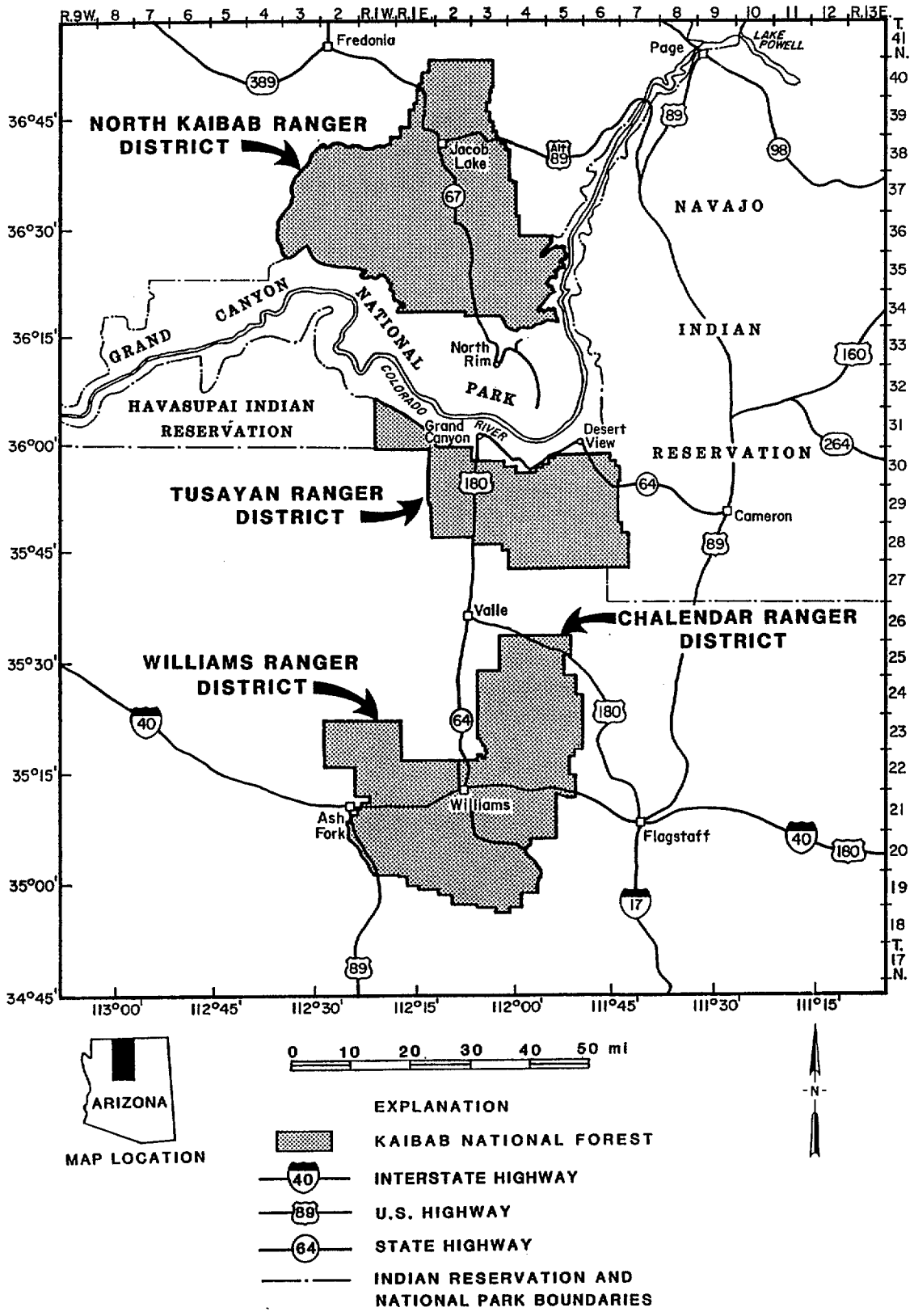


Figure 1. Index map of the Kaibab National Forest, Coconino County, Arizona.

circular features, which may indicate buried breccia pipes containing uranium, in the Tusayan Ranger District.

Mining districts and history

The earliest recorded mining activity in the Kaibab National Forest took place about 1890 when copper was discovered near Tusayan, in the Tusayan Ranger District. The Francis mining district, established in about 1907, is within the Tusayan Ranger District (pl. 1). Complete production figures for all years for the district are not available; however, between 1901 and 1970, 730,000 lbs copper, 500 lbs lead, 100 oz gold, and 4,000 oz silver were reportedly produced (Keith and others, 1983, p. 26-27).

The Warm Springs mining district is in the North Kaibab district (no. 2 on plate 1). Complete production figures are not available for the Warm Springs district; however, between 1903 and 1963, 4,252 lbs copper, 2,000 lbs lead, 200 oz gold, and 17,000 oz silver were produced from 33,000 tons of ore (Keith and others, 1983, p. 52-53).

Although the Grandview mining district is not in the Kaibab National Forest, the proximity of and similar mineral occurrences to the Warm Springs mineral occurrences make it necessary to present a brief discussion. The Grandview district is between the Tusayan and the North Kaibab Ranger Districts (pl. 1). The first assessment work on the claim was performed in 1890 and between 1901 and 1964, 936,000 lbs copper and 14,000 oz silver were produced from 2,200 tons of ore (Keith and others, 1983, p. 28-29).

The Orphan mining district is outside the northwest boundary of the Tusayan Ranger district (pl. 1). This copper deposit was discovered in 1893, a few thousand ft below Maricopa Point in the Grand Canyon. Between 1951 and 1961, 4,534,000 lbs copper, 7,000 lbs lead, 600 lbs zinc, and 80,000 oz silver were produced from 12,000 tons of ore. From 1961 to 1969 4,360,000 lbs of uranium and 509,025 long tons of manganese were produced. (See Keith and others, 1983, p. 40-41.)

Current mining activity

The most recent mining activity in the Kaibab National Forest includes mining of sandstone for building stone, cinder for construction use, and sand and gravel for construction use. Copper has been mined in past years and exploration for uranium is on-going.

Several mining companies currently maintain interests in uranium-mineralized breccia pipes in the Tusayan and North Kaibab Ranger Districts. Energy Fuels Nuclear has been issued a mine permit for the Canyon pipe and has erected a headframe at the site, which is about 7 mi southeast of Tusayan, Arizona, in the Tusayan District.

Copper mining activity in the Warm Springs and Francis mining districts has been nonexistent for many years. As of February, 1991, 1,845 unpatented claims and four patented claims were on file with the BLM.

Cinder is the primary mineral commodity in the Chalendar Ranger District. The Forest Service sells cinder by volume from pits scattered throughout the district.

In the Williams Ranger District, Coconino Sandstone is sold by the Forest Service for use as building stone. Two areas currently have production: north of the town of Ash Fork, and the Drake area, in the southwestern part of the ranger district. This commodity is purchased by weight from the Forest Service and most of it is processed.

There has been recent interest in pumice occurrences in the Williams Ranger District. Among other uses, pumice is frequently utilized as an abrasive by the garment finishing industry to produce stone- and acid-washed denim fabric.

Limestone, which is present throughout both the North Kaibab and Tusayan Ranger Districts, is quarried and crushed as needed for use in road construction. It's value is limited to local use by transportation costs.

Local interest in sand and gravel is long-standing. Although cinder is more commonly used in unimproved road construction, sand and gravel has significant demand in areas where construction projects are underway. Stream beds are the source for this mineral commodity.

APPRAISAL OF COMMODITIES

The presentation of mineral data in this summary is grouped according to commodity. For each commodity, mineral occurrences of that commodity were summarized for the entire forest. Economic

analysis of the copper deposits were determined using the Bureau of Mines PREVAL program.

Base and precious metals

Copper is the predominant base metal of commercial interest in the Kaibab National Forest. Other base minerals are associated with the copper; however, none have been mined exclusively for their own metal content. Gold and silver are also associated with the copper and have been extracted in copper milling. Both the Warm Springs (Jacob Lake) and Francis mining districts had copper, gold, and silver production.

Warm Springs (Jacob Lake) mining district

The Warm Springs mining district, in the North Kaibab Ranger District, is 1-2 mi west of the village of Jacob Lake, Arizona (pl. 1). One large shallow pit, and numerous small, shallow, pits and trenches are found throughout this district. Copper minerals occur stratabound within siliceous intraformational breccia horizons in the limestone at a depth of 5 to 10 ft below the surface.

Although significant concentrations of copper are present, the relatively thin beds containing the copper mineralization constitute too small a tonnage to make the deposit desirable for future development.

Francis mining district

Five small areas of workings comprise the Francis mining district in the Tusayan Ranger District (pl. 1). These areas are found along a generally north-south, 14-mi-long trend, in the Tusayan Ranger District. Copper mineralization is of the same type as in the Warm Springs mining district.

Northern area

Workings in the northern part of the Francis mining district are situated on two patented mining claims, surrounded by the Kaibab National Forest (pl. 1). Copper oxides are concentrated along a narrow horizon that is up to 30 inches thick. Because of the small tonnages, no resources can be identified in this area.

Coconino Wash area

A small group of prospects were found just south of Coconino Wash, about 2 mi south of the northern workings just described (pl. 1). Copper oxides are concentrated along a narrow horizon of the limestone. Because of the small tonnages at this site, no resources can be identified in this area.

Eastern Star Mine (Southern Star)

Ten to twelve prospects and trenches and one 145-ft-long adit are on the Eastern Star patented claim (pl. 1). No evidence of any recent mining activity was found, and the owner indicated that there are no plans to further develop the claim. Copper oxides are confined to a narrow horizon of the limestone. No resources can be identified in this area.

Anita Mine area

The Anita Mine area includes the Emerald Mine, the North Star shaft, and the Tellstar claims (pl. 1). About 40 prospect pits and trenches, one short adit, and one 540-ft-deep shaft comprise the workings. The shaft, known as the North Star mine, is about 100 ft west of a large pit. It is unknown why the shaft is so deep, because no structure is present, and mineralization is only 10 to 12 ft deep in the large pit a few ft to the east. Dump material from the shaft includes gypsum, limestone, and sandstone, but no copper minerals.

Copper oxides exposed in the large pit and other pits at the Anita mine area are the same as previously described. No resources can be identified in this area because of the small tonnages.

Copper Queen Mine (Blue Bonnet)

The Copper Queen Mine is about three mi south of the southern workings at the Anita area (pl. 1). A shallow open pit is the largest working in all the copper areas previously described. The mine is on a patented claim owned by Glover-Hefner-Kennedy Oil Company, of Oklahoma City, Oklahoma. No evidence of recent mining activity was evidenced and a representative from the company stated that there are no plans to further develop the claim. Copper mineralization is the same as previously described.

Although significant concentrations of copper are present, the relatively thin beds containing the copper mineralization constitute too small a tonnage to make the deposit desirable for future development.

Miscellaneous occurrences

Prospect pits were found at two other locations in this general area. One pit is along the northeastern edge of the Tusayan Ranger District. The pit is 30 ft in length, 15 ft wide, and about 8-9 ft deep; no mineralization was apparent. Four small prospect pits were found 5 mi southeast of the southern end of the Anita workings. No resources were identified in any of these areas.

Industrial Minerals

The Kaibab National Forest contains several varieties of industrial minerals, including volcanic cinders, sandstone (flagstone), pumice, sand and gravel, and limestone. Each mineral will be discussed separately, with respect to the entire forest.

Volcanic cinders

Volcanic cinders are present in the Chalendar and Williams Ranger Districts. Annual production since 1970 has been over 22 million st. Production of volcanic cinders from 1982 to the present has fluctuated between 400 and 950 thousand st (U.S. Bureau of Mines Minerals Yearbooks, 1970-1990). The majority, if not all of this production is from the Kaibab and Coconino National Forests. The future market for volcanic cinders will be dependent on population growth in Arizona and neighboring states.

There are more than 200 cinder cones within the Chalendar and Williams Ranger Districts and at least 37 or 18% of the cones have had some mining development on them. Of the total number of cones, roughly 50% of them have an aspect ratio between 0.1 and 0.2. Of

the total number of cinder pits (37), 75% of them had an aspect ratio between 0.1 and 0.2. Thus, the cinder cones with aspect ratios between 0.1 and 0.2 that are near existing roads, and that contain color characteristics needed by the producer will be the most desirable for future mining. The Kaibab National Forest contains virtually inexhaustible resources of cinder.

In recent years, numerous mining claims have been staked for gold, reportedly occurring in the cinder cones in the Chalendar and Williams Ranger Districts. Several companies reported that cinder cones in these areas contained as much as 0.3 oz gold/st (11 ppm).

Low or negligible gold, silver, and other metal concentrations in the cinders in the Kaibab National Forest were confirmed by assay of numerous samples. These concentrations reflect the normal crustal abundance of gold and other metals in this type of rock. It is not anticipated, therefore, that cinder cones in this area will contain economic quantities of gold.

Pumice

Pumice is found in the Williams Ranger District. Pumice fragments were observed in float during Bureau reconnaissance on RS Hill and near Frenchy Hill. On the east flank of Bill Williams Mountain, pumiceous material is exposed in a number of small pits and trenches. Dr. Hoffer, a pumice authority at the University of El Paso, Texas, reports that this pumiceous material has a high density and low porosity, which would limit the usage to local landscaping and road construction.

Flagstone

Dimension flagstone has been produced in northern Arizona since before 1900 and, up to 1966, has amounted to over 350,000 st with a value of over $4 million. (See Keith, 1969, p. 444.)

Flagstone occurs as part of the Coconino Sandstone in the Kaibab National Forest and is found in two separate locations. One area of the forest is north of Ashfork, Arizona, and contains hundreds of pits and small- to medium-size excavations. The Coconino Sandstone is at least 245 ft thick in the Ashfork area. Mining at the present time is at relatively shallow depths, probably not exceeding 20-50 ft below the surface. Several short tons to many hundreds of short tons of flagstone have been removed from each of the pits. Approximately 20 sq mi of the Ashfork area is underlain by the sandstone.

The other area of the forest is known as the "Drake" area and is about 15 mi southwest of the town of Williams, Arizona. Based on geologic maps, the sandstone is probably less than 245 ft thick in this area. Several hundred pits and small- to medium- size excavations have been dug in this area. Approximately 6 sq mi of the Drake is underlain by the sandstone. Several short tons to many hundreds of short tons of flagstone have been removed from each of the pits.

The two flagstone areas in the Kaibab National Forest contain virtually inexhaustible resources of flagstone. Construction, based on the economy, will dictate the usage of flagstone in the future. At the present time, only those resources that are easily

exploited are being mined. In the future, as demand persists, the flagstone could become more expensive as deeper mining will be needed to extract the material.

Limestone

Kaibab Limestone underlies most of the North Kaibab and Tusayan Ranger Districts. There are virtually inexhaustible resources of the limestone in the forest; however, transportation costs are frequently prohibitive and therefore limit interest in the limestone. Limestone could be used for local use as road fill and aggregate.

Sand and gravel

The predominant rocks in the Kaibab National Forest are essentially flat-lying sandstone and limestone and extensive basaltic flows and cinder cones. In general, these rocks produce sand, but little gravel. Because gravel is scarce in the forest, volcanic cinders and scoria are used as a substitute for gravel.

Breccia pipes

The North Kaibab and Tusayan Ranger Districts are within in a geologic environment where uranium-mineralized breccia-collapse pipes have been discovered and mined. Ten uranium-mineralized breccia pipes have been discovered in the Tusayan Ranger District. The purpose of this study was to identify circular topographic expressions in the Tusayan Ranger District to help in identifying collapse breccia structures. Bureau personnel and Petroleum Information Corporation of Denver, Colorado, provided aerial photo

interpretation. Drilling would ultimately be needed to prove mineralization in a particular pipe. The goal of this study, therefore, is to give the Forest Service a tool to predict which areas of the forest may contain breccia collapse features. Forest Service local planners will then be able to predict where exploration and mining activity will occur. The North Kaibab Ranger District was not examined by this method because of the heavily forested terrain. The Williams and Chalendar Ranger Districts were not examined because they are within the San Francisco Volcanic field and any solution-collapse breccia pipes would be buried beneath volcanic rocks.

A total of 504 circular features were identified by Petroleum Information Corporation (pl. 3). These circular features could represent gypsum collapses within the limestone, breccia pipes, or possibly just the topographic expression of normal weathering of the limestone and be totally unrelated to breccia pipes. Some of the circular features were field checked with a helicopter and then ground checked to see what breccia-pipe characteristics were present.

Three areas in the Tusayan Ranger District were identified that exhibit surface characteristics similar to known mineralized breccia pipes (fig. 2). The circular feature investigation has revealed many localities with physical characteristics established by Wenrich and Sutphin (1988). Several of these possess some of the same characteristics of the ten known mineralized breccia pipes in the Tusayan Ranger District.

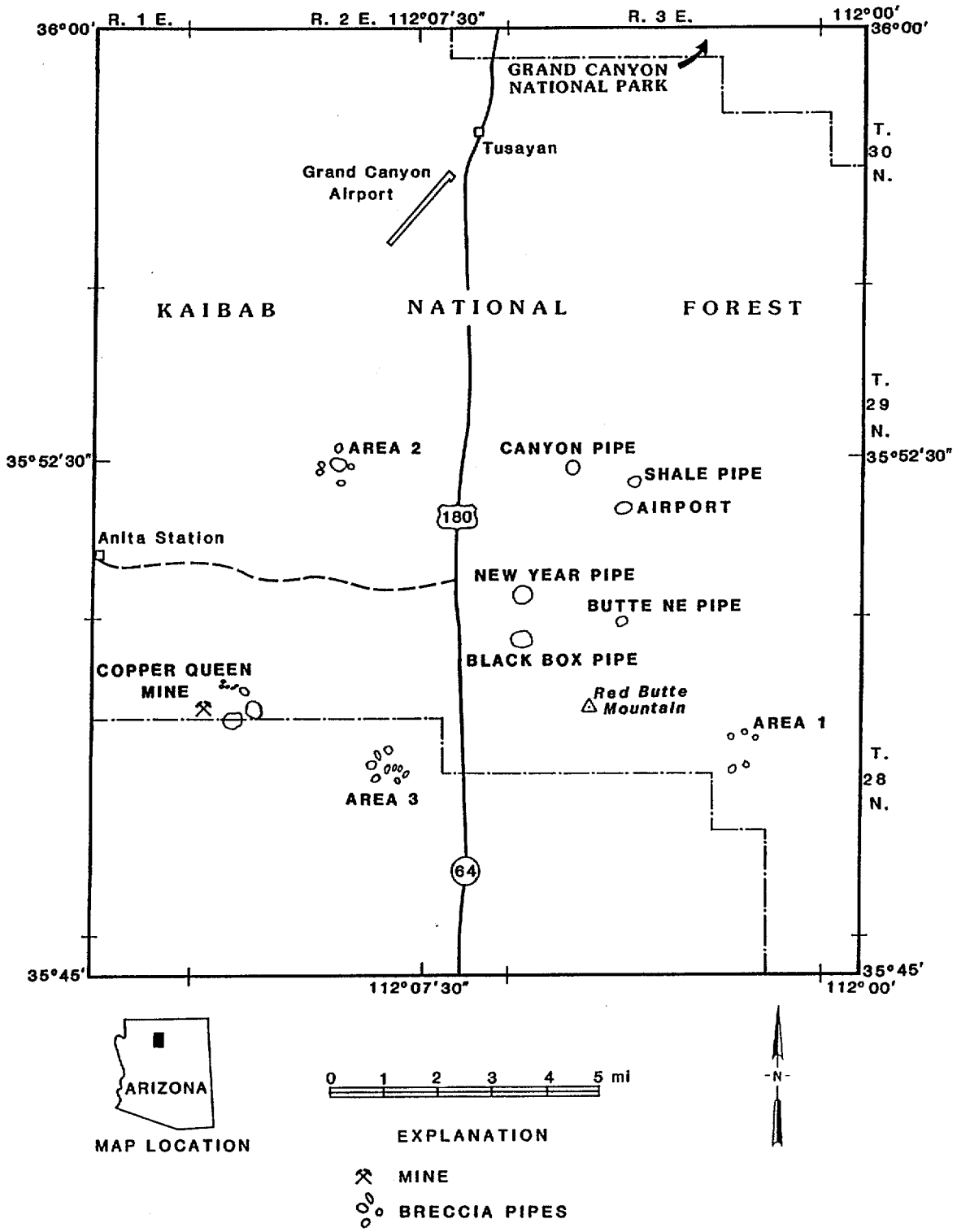


Figure 2. Index map of circular features mapped during the Kaibab National Forest study that exhibit surface features similar to known mineralized breccia pipes.

CONCLUSIONS

Copper is the predominant base metal in the Kaibab National Forest. The mineralization occurs stratabound within narrow horizons of the Kaibab Limestone. The horizons occur approximately five to ten ft below the surface and the average thickness is between four and six ft. Most of the deposits are small, probably not exceeding over 100 short tons each in size.

Volcanic cinder is present throughout the Williams and Chalendar Ranger Districts. There are more than 200 cinder cones in these areas and at least 37 cinder pit excavations known to exist on those cones. Of the total number of cones, roughly 50% of them have a favorable aspect ratio between 0.1 and 0.2. The cinder cones with aspect ratios between 0.1 and 0.2 that are near existing roads, and that contain color characteristics needed by the producer will be most desirable for future mining. The Kaibab National Forest contains virtually inexhaustible resources of cinder.

In recent years, numerous mining claims have been staked for gold, reportedly occurring in cinder cones in the Chalendar and Williams Ranger Districts. Assay data indicates gold and other metal concentrations in the cinders are average for the normal crustal abundance of those elements in scoria and basalt. It is not anticipated, therefore, that cinder cones in these areas will contain economic quantities of gold or other metals.

Pumice is found in the Williams Ranger District. Pumice fragments were observed in float during Bureau reconnaissance of

mapped pyroclastic units east of Sitgreaves Mountain, on RS Hill, and near Frenchy Hill. On the east flank of Bill Williams, pumiceous material is exposed in a number of small pits and trenches. Based on an exhaustive examination of this pumice occurrence by the Forest Service, the material was designated a common variety of stone, salable, but non-locatable. The high density and low porosity of pumiceous material from this location probably limits its uses to local landscaping and road construction. It should be noted however, that the physical properties of pumiceous deposits can vary dramatically over short distances and exposure of this occurrence is fairly limited.

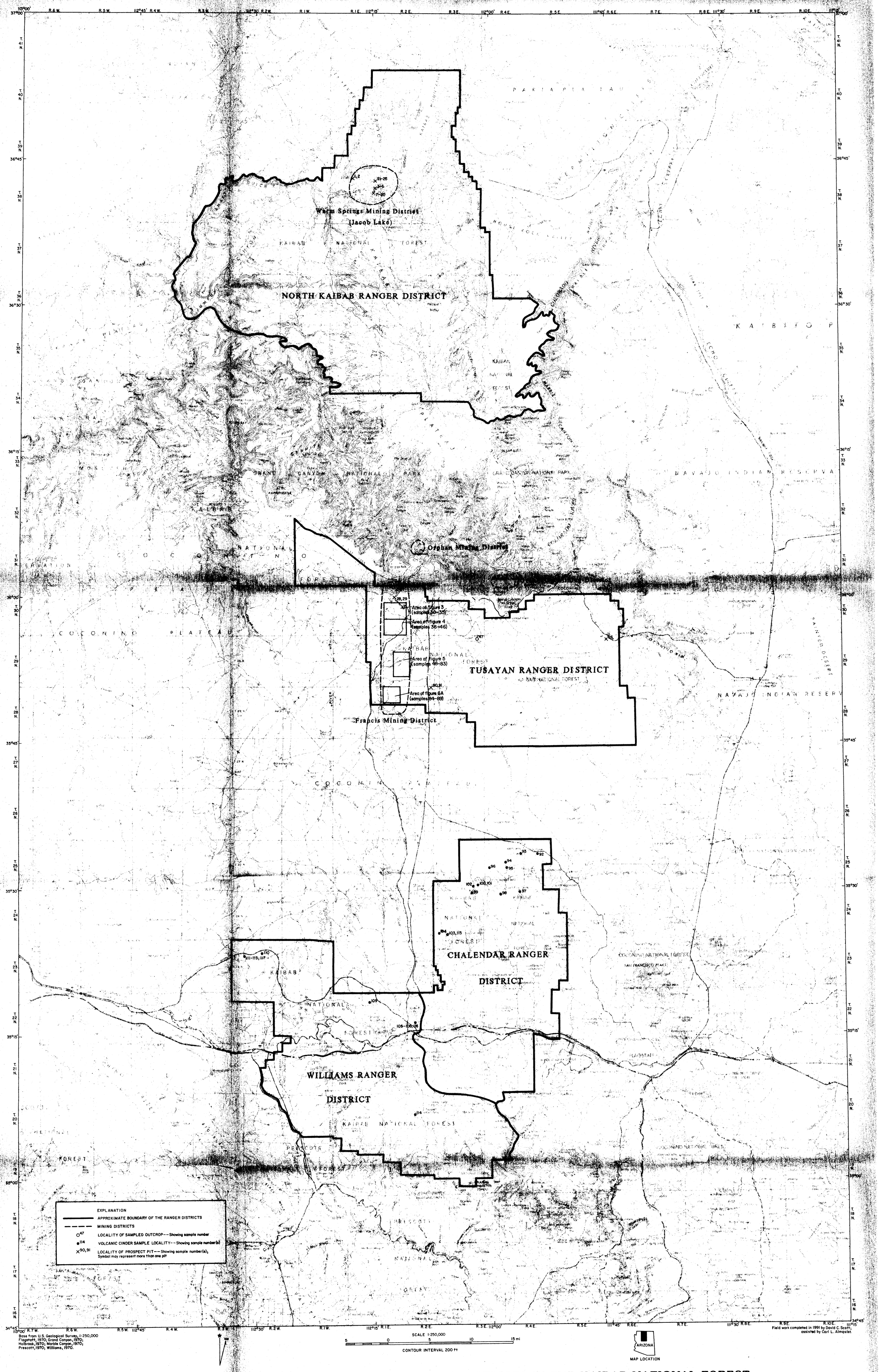
Sandstone mined for flagstone is found in two areas of the Williams Ranger District. Thousands of tons of material have been removed throughout the years. Approximately 20 sq mi of the Ashfork area and 6 sq mi of the Drake area are underlain by thick (up to 245 ft) accumulations of sandstone. These two areas contain virtually inexhaustible resources of flagstone.

Although the Tusayan and North Kaibab Ranger Districts are underlain by limestone, the material is not suitable for general industrial use and is better suited for road fill, etc. Sand and gravel deposits are found in some stream channels; however, volcanic cinders are crushed and substituted for use in construction of roads.

The identification of circular features on the surface is one of the prerequisites to identification of breccia pipes. The Bureau investigation was designed to identify circular features

which may be breccia pipes in the Tusayan Ranger district. Many of these circular features were field-checked and some of them may be uranium-bearing breccia pipes. Not all circular features are surface manifestations of deeply-rooted breccia pipes; some are simply near-surface, unmineralized gypsum collapses. The regional distribution of breccia pipes across the Tusayan Ranger District should be roughly similar to the distribution observed in this study. A total of 504 circular features were identified from aerial photos. Ten pipes are known to occur within these features and at least three other areas that may contain breccia pipes were identified. No matter which surface criteria are used to identify possible pipes, the only way to determine which are mineralized breccia pipes is to drill the site.

OPEN FILE REPORT
MLA 5-92 AND 6-92
PLATE 1



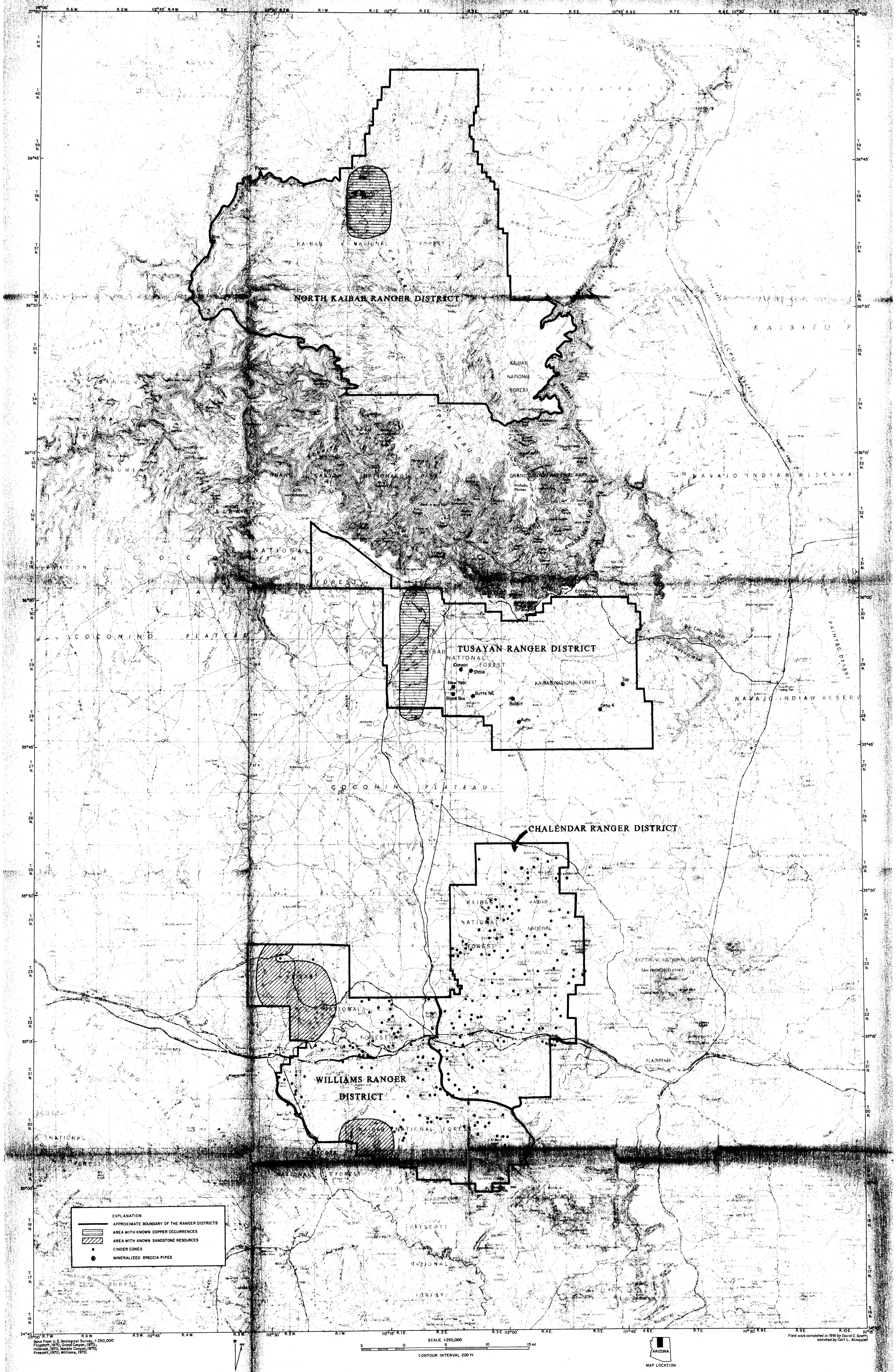
MINES, PROSPECTS, SAMPLE LOCALITIES, AND MINING DISTRICTS IN THE KAIBAB NATIONAL FOREST, COCONINO COUNTY, ARIZONA

BY
DAVID C. SCOTT

1992

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

OPEN FILE REPORT
MLA 5-92 AND 6-92
PLATE 2



MINERAL OCCURRENCES AND RESOURCES, KNOWN BRECCIA PIPE LOCATIONS, AND CINDER CONE LOCATIONS IN THE KAIBAB NATIONAL FOREST, COCONINO COUNTY, ARIZONA

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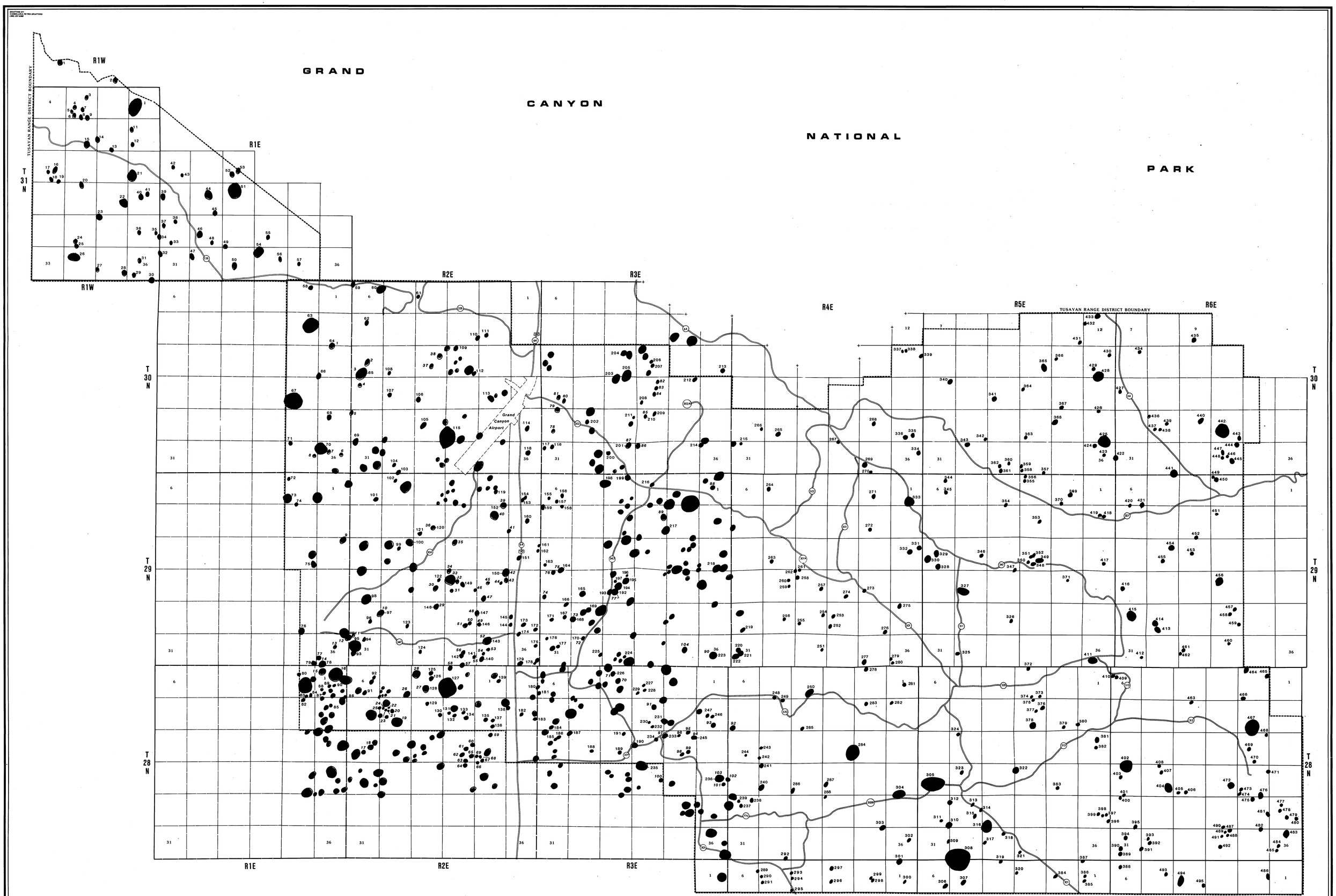

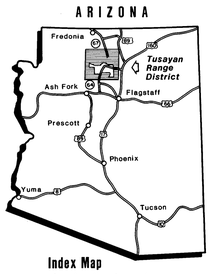

Index Map
... showing location of area mapped.

-Explanation-

- Circular features that have been identified and field-checked by the Bureau of Mines and U.S. Geological Survey (see table 4).
- Circular features that have been identified but not field-checked by the Bureau of Mines and U.S. Geological Survey.
- Circular features identified by Petroleum Information Corporation of Denver, Colorado (see table 5).
- Circular features identified by both Petroleum Information Corporation and Bureau of Mines/U.S.G.S.

CIRCULAR FEATURES OF THE TUSAYAN RANGE DISTRICT

Kaibab National Forest — Coconino County, Arizona

Scale: 1 inch = 1 mile

Plate 3

September, 1992

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Miles