

## CURRENT STATUS OF

## GEOLOGIC DIVISION PROJECTS

## U. S. GEOLOGIC SURVEY, IN ARIZONA

(Data supplied by chief Geologist, U. S. Geological Survey)

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## PROJECT COMPLETED SINCE SUMMARY OF OCTOBER 1958

1. Arizona State Geologic Map. Geologic Division contributions to the State geologic map compilation during the past year have been A. F. Shride's reconnaissance map of an area northeast of Globe, submitted in October 1958, and his generalized maps of parts of Blue Horse Mountain, Rockinstraw Mountain and McFadden Peak quadrangles, submitted in September 1959. Also, Medora Kreiger is preparing two mineral investigations (MF) maps covering most of Yavapai County. See reports 2, 30, and 32.

## NEW WORK STARTED AND PLANNED

2. Rare earth mineral deposits, J. W. Adams in charge. This is part of a nation-wide topical study to develop more definitive information on (1) the geologic occurrence and resources of rare earth minerals; and (2) the geochemistry of the rare earths in different geologic environments. The first-stage objective will be an investigation of rare earth deposits in Arizona, New Mexico, and Colorado. The project began in November 1958. Most of the time to date has been spent assembling general information on rare earth deposits. A few rare earthbearing deposits in Arizona were investigated in May of this year.

3. Elgin 15-minute quadrangle, Santa Cruz County, R. B. Raup in charge. Geologic mapping was started in October in the Elgin quadrangle to 1) study and delineate structural features and establish their relation to regional structural trends in south-central Arizona; 2) study mineral deposits in the area to determine their regional geologic setting, origin and economic potential; and 3) study the stratigraphy in the project area, especially the Permian and Cretaceous rocks.

4. Southern Cochise County, P. T. Hayes in charge. This project has been approved, but, due to lack of funds, mapping will not be started this fiscal year. Detailed geologic mapping will be undertaken in the Mustang Mountains, Ft. Huachuca SW, Huachuca Peak, Miller Peak, Highsville, Hereford, Bisbee NW and Bisbee NE 7 1/2 minute quadrangles, and in the north half of the Sunnyside SW, Sunnyside SE, Hereford SW, Stark, Bisbee SW, and Bisbee SE 7 1/2 minute quadrangles, in the southern part of Cochise County. Emphasis will be placed on the geologic history and stratigraphic relationships, especially Cretaceous and early Tertiary tectonic and depositional history. Source areas of Cretaceous sediments and facies relationships between clastic and carbonate strata will be studied in detail, and the relation between Comanche and Upper Cretaceous rocks will be evaluated.

5. Devonian system of the middle Rocky Mountain area, Arizona, New Mexico, Colorado, Utah, and Wyoming, V. E. Swanson in charge. The sedimentary and tectonic history of the middle Rocky Mountain area during the Devonian time will be investigated by making regional stratigraphic studies. The determination of age and facies relationships of Devonian strata that formed in shoreline, marine basin, and geosynclinal environments will establish a more uniform nomenclature and effect more accurate correlations. The mineral fuels potential of the Devonian rocks will be appraised as related to regional and local stratigraphic factors that govern the localization of mineral fuels within these rocks. Work on this project is already underway in Colorado but has not yet been extended into Arizona.

## CONTINUING PROJECTS

6. Fuels potential of the Navajo Indian Reservation, Arizona and Utah, R. B. O'Sullivan in charge. This project has been curtailed because of lack of funds. The first draft of an administrative report for the Bureau of Indian Affairs on Agathla Peak 3 and 4 quadrangles has been completed for technical review; a report covering Shato Springs quadrangle may be added to this report. All administrative reports will later be consolidated into a bulletin report for USGS publication. An administrative report, "Geology and Uranium Deposits of the Rough Rock-Red Point-Chilchinbito Area, Navajo and Apache Counties, Arizona," has been approved and submitted to the Bureau of Indian Affairs.
7. Arizona asbestos, A. F. Shride in charge. The study of metamorphic phenomena related to diabase intrusions and the geologic mapping of the McFadden Peak 15-minute quadrangle, Gila County, are being continued. A manuscript on the geology of Arizona asbestos deposits is nearing completion. A paper on the Younger Precambrian geology in southeastern Arizona was presented at the November 1958 GSA meeting in St. Louis. See report 23.
8. Globe-Miami area, Gila County, N. P. Peterson in charge. A report on the geology and mineral deposits of the Pinal Ranch quadrangle will be completed for technical review later this year. Four months of this fiscal year will be spent in completing geologic mapping in the Superior quadrangle, with the remaining time spent in laboratory work and in preparing a report on the Superior quadrangle. A paper on the origin of dacite welded tuff near Superior and Globe, by D. W. Peterson, was presented at the Cordilleran Section of GSA at Tucson in April 1959. See reports 35, 36, and 44.
9. Geologic studies in the Carrizo Mountains, Arizona-New Mexico, J. D. Strobell in charge. Preparation of the final report on the Toh-Atin Mesa, Pastora Peak, Redrock Valley, and Los Gigantes 15-minute quadrangles is continuing, and the manuscript is expected to be completed this fiscal year. See report 26.
10. Dripping Spring quartzite, Gila County, H. C. Granger in charge. Field work has been completed. Two reports are being revised by the author following technical review and one report is nearing completion. See reports 5 and 42.
11. Distribution of elements, Colorado Plateau, A. T. Miesch in charge. Field work has been completed and reports are in preparation. A paper on chemical composition as a guide to the size of sandstone-type uranium deposits in the Morrison formation of the Colorado Plateau, was presented at the November 1958 GSA meetings in St. Louis. See reports 19, 33, and 34.
12. Triassic stratigraphic studies, Colorado Plateau, J. H. Stewart in charge. A report on the Triassic stratigraphy of the Colorado Plateau region is nearing completion. Three weeks were spent in August field checking the Triassic in the Arizona and New Mexico portions of the region. Papers on stratigraphy and origin of major lithologic units of the Upper Triassic series of the Colorado Plateau, and sedimentary facies of the Moenkopi formation of Triassic age on the Colorado Plateau, were presented at the November 1958 meetings of GSA in St. Louis. See reports 4, 24, 25, and 28.
13. General stratigraphic study of the Colorado Plateau, L. C. Craig in charge. A detailed report on the Morrison formation will be completed for review this fiscal year, and the compilation of stratigraphic data on the Cretaceous and Tertiary strata of the Colorado Plateau and adjacent areas will be resumed. Brief field inspection trips will be made with some sample collection at selected localities. See report 15.
14. Entrada stratigraphic studies, Colorado Plateau, J. C. Wright in charge. Most of this year will be spent in the preparation of reports, two of which are "Stratigraphy of the San Rafael Group in Northern Arizona and New Mexico," and "Regional Synthesis and Interpretation of the San Rafael Group." A paper on Upper Jurassic strata of the Colorado Plateau as a record of tectonic history in

the eastern Great Basin was presented at the November 1958 meetings of GSA in St. Louis. See report 29.

15. Twin Buttes 15-minute quadrangle, Pima County, J. R. Cooper in charge. Geologic mapping is being continued. The scope of the project has been increased by integration with new geophysical and geochemical work. See report 31.

16. Klondyke 15-minute quadrangle, Pinal County, F. S. Simons in charge. Geologic mapping has been completed except for a one-month field check planned for the spring of 1960. Preparation of reports will continue past the end of the fiscal year, but probably will be completed in draft form by September 1960.

17. Holy Joe Peak 15-minute quadrangle, Pinal County, Medora H. Krieger in charge. Field work will be continued during four months of this fiscal year. Map compilation and some petrographic work will be done in time available from other commitments. A paper on the Cambrian age of some of the basal Paleozoic sandstone in central Arizona was presented at the Cordilleran Section meeting of GSA at Tucson. See report 41.

18. Geologic map, Colorado Plateau, D. G. Wyant in charge. Compilation of the Shiprock, Arizona-New Mexico, 2-degree sheet is being revised after editing and will be submitted for approval and publication later this year. Compilation is in progress in the Gallup, Arizona-New Mexico, sheet and in three sheets in surrounding states.

19. Bradshaw Mountains area, Mayer and Mt. Union 15-minute quadrangles, Yavapai County, C. A. Anderson in charge. Mapping has been done in both quadrangles during the current fiscal year, but completion of the mapping and resultant reports will be delayed because of an administrative assignment of the project chief. See report 1.

20. Porphyry copper studies, S. C. Creasey in charge. This project has been revised to include detailed studies in the San Manuel area. About three months will be spent on geologic mapping in the Mammoth 15-minute quadrangle. Six months or longer will be spent in a general review of the geology of porphyry copper deposits and in selecting the most promising techniques or types of investigations necessary to understand them. A report on the geology of the San Manuel area, Pinal County, is nearing completion. See report 16.

21. Christmas 15-minute quadrangle, Gila and Pinal Counties, C. R. Willden in charge. Geologic mapping is being continued in the part of the quadrangle lying south of Mescal Mountains and east of Gila River, and the unmapped area northwest of the Gila River.

22. Geochemical halos in valley-fill in the Basin and Range Province, Arizona, Nevada, Utah, Oregon, California, and New Mexico, L. C. Huff in charge. Geologic investigations aimed at developing and appraising the applicability of geochemical techniques to the search for concealed ore bodies in the intermountain basins of the Basin and Range Provinces are being continued. In the definitive study of geochemical dispersal patterns around the concealed ore bodies now known, the geochemical prospecting investigations will be continued in the Pima mining district south of Tucson, where important copper ore bodies have been discovered beneath 200 feet of basin alluvium.

23. History of Supai-Hermit formations, Grand Canyon area, E. D. McKee in charge. Field trips of one month each are planned for the fall and spring of fiscal year 1960 in connection with this study. Considerable data already accumulated over a period of years from measuring sections, analyzing cross-bedding and other special studies are being fitted into the general program.

24. Stratigraphy of the Redwall limestone, Grand Canyon area, E. D. McKee in charge. Field work is essentially complete although some details are still to be checked. It is anticipated that this can be done in connection with field work on the Hermit-Supai problem. Study of thin sections will be continued as time permits throughout the year.

25. Stratigraphy and paleoecology of Devonian of Central Arizona, C. Teichert in charge. Reports are in preparation on description of a new type of "Calcspheres" and on the stratigraphy and paleoecology of Devonian rocks of central Arizona. These reports are nearing completion and may be transmitted for technical review in early 1960.

26. Eastern Mogollon Rim area, Navajo and Apache Counties, E. J. McKay and T. L. Finnell in charge. Geologic mapping is being continued in the Shumway No. 3 and No. 4 15-minute quadrangles. Study is being made of fault zones and lithologic properties and distribution of sedimentary rocks and surficial materials in the area with special reference to their water-bearing properties, potential engineering use, and resource value. Mapping has been completed in the Ellison No. 1 quadrangle.

27. Upper Gila River basins (Safford-Duncan areas), Arizona-New Mexico, R. B. Morrison in charge. Geologic mapping will be completed in the Arizona part of the Duncan SE 15-minute quadrangle (and in the Steeple Rock SW quadrangle in New Mexico) and a report will be prepared before field work is completed in the rest of the project area.

28. Great Basin geophysical studies. G. V. Keller is in charge of the work in Arizona and New Mexico. An investigation is now in progress, using applicable geophysical methods, to study the geologic structure of pediments and other alluvium-covered areas in the Great Basin region. Included in this general project is a gravity survey of the Twin Buttes quadrangle which will be extended to cover adjacent quadrangles (San Xavier, Mission, Tucson, Helvetia, Tubac, and Agua Caliente). Interpretation of the data should help in deciphering the structural relationship between the Sierrita Mountains and the other mountain ranges in the area. Geophysical logs have been run in drill holes and laboratory measurements of the physical properties of core samples are being made. Surface resistivity studies are in progress to assist in mapping shear zones in the Sierrita Mountains and to measure the thickness of alluvial fill around the mountains. An aeromagnetic survey was made in the Twin Buttes area during the summer of 1959 and the data are now being compiled.

29. Geophysical studies in uranium geology, R. M. Hazlewood in charge. A report, "Geophysical Methods of Exploring for Buried Channels in the Monument Valley area, Arizona and New Mexico," by R. A. Black, F. C. Frischknecht, R. M. Hazlewood, and W. H. Jackson, has been prepared and submitted for technical review. A manuscript by the same authors on geophysical investigations in the El Capitan Flat area is in preparation. This report is expected to be completed in 1960.

30. Fossil wood and general paleobotany studies, R. A. Scott in charge. A study is in progress of the Mesozoic pollen and spores from the Colorado Plateau area. Reports are in preparation on pollen and spores from the Chinle formation (Triassic) and on fossil woods associated with uranium on the Colorado Plateau.

31. American Tritylodontoidea, G. E. Lewis in charge. A report on these fossils is being prepared for presentation at the 1960 International Geological Congress.

32. Crystallography of uranium and associated minerals, H. T. Evans, Jr., in charge. Studies related to the Colorado Plateau uranium investigations in 1960 will include: 1) continuation of crystal structure studies of the autunite group of minerals, now well advanced; 2) conclusion of crystal chemical studies of other uranyl complexes with hydroxyl, carbonate, vanadate, sulfate, etc.; and 3) conclusion of several studies involving vanadium compounds and minerals. See reports 17 and 22.

## REPORTS PUBLISHED AND WORK IN PROGRESS

## U. S. GEOLOGICAL SURVEY, GROUND WATER BRANCH

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## REPORTS PUBLISHED

Moenkopi and Chinle formations of Black Mesa and adjacent areas, in Guidebook of the Black Mesa basin, northeastern Arizona, by J. P. Akers, M. E. Cooley, and C. A. Repenning. New Mexico Geol. Soc. Field Conf., 9th, 1958. p. 88-94, 4 figs.

The stratigraphic relationships and lithology of the Moenkopi formation of Lower and Middle (?) Triassic age and of the Chinle formation of Upper Triassic age in the Navajo Indian Reservation of northern Arizona are discussed. One new unit, the Sonsela sandstone bed, is introduced. The Sonsela sandstone bed divides the Petrified Forest member of the Chinle formation into an upper and lower part. A fence diagram of both formations and an isopach map of the Chinle formation are presented.

Ground water in Black Mesa basin and adjacent areas, in Guidebook of the Black Mesa basin, northeastern Arizona, by J. P. Akers and J. W. Harshbarger. New Mexico Geol. Soc. Field Conf., 9th, 1958. p. 173-183, 8 figs.

Describes briefly the ground-water conditions of the eight physiographic subdivisions of the Black Mesa area of northern Arizona. Also describes the individual aquifers with a brief statement on quality of water. Four small-scale maps show the areal distribution, the direction of ground-water movement, and the depth to water in 4 principle aquifers.

The occurrence of ground water in diatremes of the Hopi Buttes area, Arizona, by J. T. Callahan, William Kam, and J. P. Akers. Plateau, v. 32, no. 1, 1959. p. 1-12, 2 figs., 2 tables.

Ground water occurs in diatremes in Hopi Buttes area where potable water is scarce. The diatremes are of volcanic origin, apparently caused by explosions and collapse and contain inward-dipping beds of tuff, agglomerate, and fragments of sedimentary rocks. They are potential reservoirs for small ground-water supplies because of their inward-dipping strata, the porosity and permeability of the fractured rocks, and the relative impermeability of the surrounding rocks.

Annual report on ground water in Arizona--spring 1957 to spring 1958, by W. F. Hardt, J. M. Cahill, and M. B. Booher. Arizona State Land Department Water Resources Report No. 5, Phoenix, Arizona. 1958. 60 p., 19 figs., 1 table.

This annual report is a summary of the basic hydrologic data collected during the spring of 1957 to spring 1958. It broadly describes the ground-water pumpage in the State and water-level fluctuations in the counties, and principal basins. Approximately 4.5 million acre-feet of ground water was pumped in 1957 and the trend of water levels in the heavily pumped areas continued downward. The quality of water is generally satisfactory for irrigation and public supplies. However, in a few areas the dissolved solids concentration, particularly the salt content, is increasing or is too high for most uses. Illustrations include 10-year hydrographs showing water-level fluctuations in selected wells, maps showing change in water levels for the 5-year period 1953-58 for the Salt River Valley, lower Santa Cruz Willcox, and Douglas areas, selected well logs, and a map showing location of the annual watersampling program.

Use of ground-water in Arizona, in Climate and man in the Southwest, by J. W. Harshbarger. University of Arizona Bull., v. 28, no. 4, 1958. p. 51-68, 5 figs., 1 table.

This paper presents a resume of the ground-water conditions in the State of Arizona and includes discussion of the major geologic features that control the occurrence of ground water, the effect of geologic conditions on the recharge, movement, storage, and discharge of ground-water from the various reservoirs.

The various uses of ground-water in the State are discussed and the effect that this use has on the ground-water reservoirs is described by means of a comparison of the early status of the water table with current conditions.

Geology of the San Xavier Indian Reservation, Arizona, in Southern Arizona Guidebook, by L. A. Heindl. Ariz. Geol. Soc., 1959. p. 152-159, 1 fig.

Test holes in southern Arizona valleys, in Southern Arizona Guidebook II, by P. W. Johnson. Ariz. Geol. Soc., 1959. p. 62-65, 1 table.

Precambrian and Paleozoic sedimentary rocks on the Papago Indian Reservation, Arizona, in Southern Arizona Guidebook, by N. E. McClymonds. Ariz. Geol. Soc., 1959. p. 77-84, 1 fig.

Paleozoic stratigraphy of the Waterman Mountains, Pima County, Arizona, in Southern Arizona Guidebook II, by N. E. McClymonds. Ariz. Geol. Soc., 1959. p. 66-76, 2 figs.

REPORTS RELEASED TO THE OPEN FILE  
(AVAILABLE FOR PUBLIC INSPECTION)

Preliminary report on the availability of water in the Red Lake area, Navajo Indian Reservation, Arizona and New Mexico, by J. P. Akers, N. E. McClymonds, and J. W. Harshbarger. 1959. 22p., 2 maps, 4 tables.

The stratigraphy, structure, and ground-water conditions of the Red Lake area are discussed. Test wells drilled in alluvium, bedrock, and lapilli tuff in a diatreme indicate that more than 1 million gallons per day of good water is available from the area.

Availability of water along the south rim, Grand Canyon National Park, Arizona, by D. G. Metzger. 1959. 81 p., 6 figs., 2 tables. (Released to the open file and approved for publication as a water-supply paper.)

The geology and hydrology of springs along the south rim, Grand Canyon National Park, Ariz., are discussed. Most of the springs issue from rocks of the Tonto group of Cambrian age, principally the lower part of the Muav limestone. Ground water occurs in the Paleozoic rocks as a series of perched water bodies, which are upheld by relatively impermeable rocks and are governed by the geologic structure. The report describes briefly the stratigraphy and geologic structure of the south-rim area as they are related to the occurrence, movement, quantity, and quality of ground water.

Geology and promising areas for ground-water development in the Hualapai Indian Reservation, Arizona, by F. R. Twenter. 1959. 94 p., 10 figs., 1 table. (Released to the open file and approved for publication as a water-supply paper.)

The report contains brief descriptions of the Pre-cambrian, Paleozoic, Mesozoic, and Cenozoic stratigraphy, and major geologic structure. A brief discussion of the occurrence, movement, recharge, discharge, and quality of the ground water is also given. Included in the report is a geologic map and cross sections of the area. Geologic and hydrologic data indicate that the Muav limestone of Cambrian age offers the best possibilities for the development of ground-water supplies in the Hualapai Indian Reservation because of the large springs that issue from the Muav. The tertiary and Quaternary deposits offer additional possibilities for ground-water development.

Physical phenomena in arid-zone hydrology, by H. E. Skibitzke and N. D. White. 1959. 19 p., 5 figs.

A study in arid-zone hydrology must entail an analysis of the processes of water movement in all its forms: liquid, vapor, and solid. Arid regions are characterized by low precipitation rates and high evaporation potential. The

development of water by man in arid regions is largely one of converting liquid water to water vapor--mostly by the cultivation of crops--or in capturing, for other economic uses, some of the water that is converted to vapor by relatively nonbeneficial natural processes. In most arid regions man soon finds that his water demands, present and potential, far exceed the water that is available perennially. This additional water must come from water reserves that have been stored in the basin prior to development. Such water is found in the pore spaces of the rocks of the earth's mantle. The hydrologist must eventually become interested in and concerned about the storage characteristics of this mantle. A study in arid-zone hydrology will then be primarily concerned with a geologic analysis of the ground-water reservoir and a study of water utilization in the region.

#### REPORTS IN PRESS

Geohydrology of arid lands (Arizona--a case study), by J. W. Harshbarger.

The report presents a discussion on the relationships of the basic problem in arid lands--the scarcity of surface water to meet the demands and how ground-water development has depleted storage reserves. The problem also includes the determination of the ultimate amount of water that can be withdrawn and still maintain a sound and healthy economy in the arid zone environment. The occurrence and the amount of water yield are discussed for the major aquifers in the State. The State has been subdivided into three major water provinces--Plateau Uplands, Central Highlands, and Basin and Range Lowlands. A block diagram for each of these provinces shows the geologic framework and the controls of ground-water yield and production. A discussion is given on how Arizona uses its water resources; the current trend indicates that the amount of water being consumed by industry and municipalities is increasing very rapidly, owing to the population increase. The paper states that one of the most practical ways of intercepting additional water supplies is by storing flood water underground via recharge wells. If additional water is not captured from perennial supplies, it may be necessary to transport water into Arizona at some time in the future to sustain the established economy.

#### REPORTS IN REVIEW

Geology of the Cameron quadrangle, by J. P. Akers.

The geology, geomorphology, and geologic history, ground water, uranium deposits, and construction materials in the Cameron quadrangle in northern Arizona are discussed. The report and accompanying geologic map is to be published by the U. S. Geological Survey as part of the new geologic quadrangle series.

Geology of the Leupp quadrangle, by J. P. Akers.

This report and accompanying geologic map is to be published as part of the geologic quadrangle series by the U. S. Geological Survey. The text describes the geology, physiography, and ground water of the Leupp quadrangle.

Geology and ground-water resources of McMullen Valley, Maricopa, Yavapai, and Yuma Counties, Arizona by William Kam.

Describes briefly the bedrock geology and discusses in greater detail the thick deposits of valley-fill sediments. These sediments constitute a large ground-water reservoir and have been divided into 4 units as follows: (1) conglomerate; (2) alluvial fan deposits; (3) lakebed deposits; and (4) alluvium. A fence diagram shows the distribution of these units and their relationships. Water-table contour maps show the effect of a subsurface dam on the movement of ground water at the lower end of the valley and also the general effect of pumping in local areas.

Water regimen of the San Pedro River near Mammoth, Pinal County, Arizona

(preliminary report on a pilot study), by H. G. Page.

A small area along the San Pedro River near Mammoth, Pinal County, Ariz., is the site of a preliminary investigation of the water regimen of an inner valley of an intermittent stream in a semiarid basin. Three principal alluvial units are exposed and the study evaluates the feasibility of determining quantitatively their relationships to ground-water recharge and discharge and streamflow. Qualitatively, the regimen in the reach studied involves loss in streamflow, fluctuation in ground-water storage, discharge by pumping and evapotranspiration, and movement of ground water between two of the alluvial units. The general annual cycle of events can be described by water-table fluctuations and is largely controlled by the seasonal streamflow, irrigation, and evapotranspiration. Long-term water-table fluctuations show essentially no decline in the area. Quantitative evaluation of the regimen will involve measurement of the hydrologic factors to an accuracy within the magnitude of the amount of annual recharge. The hydrologic factors to be measured include those listed above and, in addition, recharge from irrigation and precipitation.

#### REPORTS IN PROGRESS

Investigation of the ground-water resources of Apache County, Arizona, by J. P. Akers.

This report will describe the geology and ground-water resources of the central part of Apache County, Ariz. The report will include a geologic map, fence diagram of geologic sections, well records, tables showing chemical analyses, and selected drillers' logs.

Water supply for Luke Air Force Base, Arizona, by J. M. Cahill.

The report describes the ground-water conditions in the valley-fill deposits in the vicinity of Luke Air Force Base. Much emphasis is placed on the quality of water as this is the major problem, and on the decline of the water table. Two well sites, based on the study, are recommended for drilling.

Woody Mountain Well Field--city of Flagstaff, by J. W. Harshbarger.

Owing to the municipal and industrial expansion in the Flagstaff area, it became necessary for the city to develop ground-water supplies to augment their surfacewater supplies, collected in nearby lakes. With the aid of a geologic study and the application of theoretical hydrologic principles a site was selected for drilling an exploration well near Woody Mountain. A yield of 200 gpm (gallons per minute) from this well indicated that it was possible to develop an adequate well field to supply the city with ample water. Three additional wells were drilled and they yield 400, 500, and 700 gpm, respectively. The wells penetrate through several hundred feet of basaltic volcanic rocks, and the Moenkopi formation, Kaibab limestone, Coconino sandstone, and uppermost part of the Supai formation. Most of the water is from the lower part of the Coconino sandstone which has been faulted and fractured. The Coconino sandstone has a much higher permeability and allows the water to move along the fault zone readily. The occurrence of natural recharge into the field has been established; thus the present field is capable of producing 3 mgd (million gallons per day) on a sustained basis without excessive drawdown.

Availability of ground water on the Papago Indian Reservation, by L. A. Heindl.

The geology and ground-water resources of the Papago Indian Reservation have been investigated during the past few years by the Geological Survey in cooperation with the Bureau of Indian Affairs. Fieldwork is now completed. The final report will include a geologic map of the reservation on a scale of 1:125,000 and maps summarizing the hydrologic information on scales from 1:62,500 to 1:250,000. The report will include discussions of igneous, sedimentary, and metamorphic rocks, structure, physiography, hydrology, occurrence and quality

of ground water, and pertinent corollary material including charts and tables.

Ground-water resources and geology of the Verde Valley area, by D. G. Metzger and F. R. Twenter.

This report describes a reconnaissance investigation of the geology and ground water of the Verde Valley--the area is the drainage of the Verde River from the junction with Fossil Creek upstream to Perkinsville. Particular emphasis is to be placed on the water-bearing characteristics of the Verde formation and the Paleozoic formations. Also, the importance of the post-Paleozoic structure to the occurrence of ground water will be discussed.

Sedimentation, stratigraphy, and post-depositional history of the Verde formation, Verde Valley, Arizona, by F. R. Twenter.

Features of the Verde formation that are described in this report are: the type of deposits, the depositional environments, post-depositional changes, and a general summary of the fossils and fossil localities. Also discussed are the Verde basin prior to deposition of the Verde formation, the events relating to the blocking of the pre-Verde formation drainage, and volcanic activity. Stratigraphic sections and a fence diagram of the Verde formation are included in the report.

Special report. Analysis and evaluation of available hydrologic data for San Simon basin, by N. D. White.

The purpose of this study is to evaluate the data available on the San Simon basin to determine what additional data would be necessary to produce quantitative values for the hydrologic characteristics. Several methods will be used to analyze and interpret the existing data in an effort to determine these hydrologic characteristics. The study is scheduled to be completed in June 1960.