

CURRENT STATUS OF GEOLOGIC DIVISION PROJECTS,
U. S. GEOLOGICAL SURVEY, IN ARIZONA

(Data supplied by Chief Geologist, Geologic Division,
U. S. Geological Survey)

State geologic map, J. R. Cooper in charge. Geologic mapping in support of the preparation of County geologic maps has resulted in the following publications; this completes the publications scheduled for this project: MF-231 "Reconnaissance geologic map of the Wellen, Fisher Hills, Cochise and Dos Cabezas quadrangles, Cochise and Graham Counties, Arizona," by Cooper; Bulletin 1121-H "Paleozoic and Cenozoic rocks in the Alpine-Nutriso area, Apache County, Arizona," by C. T. Wrucke; and MF-238 "Reconnaissance geologic map of parts of the San Pedro and Arivaipa Valleys, south-central Arizona," by S. C. Creasey, E. D. Jackson, and R. A. Gulbrandsen.

Porphyry copper studies, S. C. Creasey in charge. Geologic mapping was completed in the Mammoth quadrangle, and has been started in the Benson quadrangle. Manuscript for a report on the geology of the San Manuel area, with a section on the San Manuel ore deposit by J. D. Pelletier and Creasey, is being reviewed. A geologic map of the Mammoth quadrangle is being prepared for publication in the GQ series.

Globe-Miami area, D. W. Peterson in charge. Professional Paper 342 on the geology and ore deposits of the area is in press. GQ-128, "Geology of the Haunted Canyon quadrangle" and MF-81, "A preliminary geologic map of the Pinal Ranch quadrangle," were published. The geologic report on this latter quadrangle is being edited for publication as Bulletin 1141-H. Peterson has begun a detailed study in parts of the Superior and Haunted Canyon quadrangles of a Tertiary dacitic ash-flow sheet and its probable source area in a caldera. A report on "Dacitic ash-flow sheet near Superior and Globe" has been placed on open file.

Dragoon quadrangle, J. R. Cooper in charge. Final report on the geology and ore deposits of this area is being edited for publication as Professional Paper 416.

Pima copper district, J. R. Cooper in charge. Geologic mapping in the Twin Buttes quadrangle is continuing. The report "Some geologic features of the Pima mining district, Pima County, Arizona," was published as Bulletin 112-C. A report on "The turkey-track porphyry—a possible guide for correlation of Miocene rocks in southeastern Arizona" has been approved for publication in the Arizona Geological Society Digest.

Klondyke quadrangle, F. S. Simons in charge. Geologic mapping has been completed, and manuscript for the final report is being reviewed. A preliminary geologic map and cross sections of the quadrangle have been released in open file. A report on "Devitrification dikes and giant spherulites from Klondyke, Arizona" has been prepared for publication in a technical journal.

Patagonia Mountains (Lochiel and Nogales quadrangles), F. S. Simons in charge. The geologic mapping that has been started on this new project is designed to study the geologic setting of the numerous mineral deposits in the area. Work in the southern Canelo Hills indicates they are underlain largely by silicic lava and welded tuff, and there are lenses of Paleozoic sedimentary

rocks in the lavas.

Rare earth mineral deposits, J. W. Adams in charge. Work continues on this study of the occurrence and geochemistry of the rare earths, but most of the work has been in other parts of the western States. We will keep you informed when more work in Arizona is planned.

Geochemical halos, Arizona-New Mexico, L. C. Huff in charge. Studies of halos surrounding ore bodies at Pima have been completed. A report on "A comparison of analytical methods used in geochemical prospecting for copper" has been approved for publication in *Economic Geology*, and the abstract published in *Geol. Soc. America Bull.*, v. 71, no. 12. A summary report is in preparation on the work near Pima. This study indicated that usable techniques can be based on copper and molybdenum analyses of ground water, of phreato-phyte plants, and of carbonate-cemented zone at the base of the alluvium. Detailed work in the Gila Mountains near Safford will be continued. In addition to techniques previously used, the carbon dioxide content of soil gas is under study as a possible guide to ore.

Colorado Plateau botanical prospecting, F. J. Kleinhampl in charge. The report "Development of botanical methods of prospecting for uranium on the Colorado Plateau" by H. L. Cannon was published as Bulletin 1085-A. A report on botanical prospecting methods has been approved for publication in a technical journal.

Devonian of north-central Arizona, C. Teichert in charge. Manuscript for the final report on this project is being reviewed.

Fuels potential of the Navajo Reservation, R. B. O'Sullivan in charge. Geologic mapping is nearing completion and a number of administrative reports have been sent to the Bureau of Indian Affairs. Reports for publication are being prepared on several areas. The geologic map of the Cedar Mesa-Boundary Butte area, San Juan County, Utah, was released in open file.

Devonian system of the middle Rocky Mountain area, V. E. Swanson in charge. This stratigraphic study has been indefinitely postponed because of assignment of Swanson to higher priority work.

Dripping Spring quartzite uranium deposits, H. C. Granger in charge. A summary report on this work is nearing completion, and a report on the stratigraphy of the formation is being reviewed. The report "A geochemical test of diabase as an ore source for the uranium deposits of the Dripping Spring district, Arizona" by G. J. Neuberger and Granger was published in the Ramdohr volume, *Neues Jahrbuch fur Mineralogie*, v. 95.

Reconnaissance for uranium in Arizona, H. C. Granger in charge. The summary report on this study will be published as Bulletin 1147-A. Other work resulting from this study is described in "Some geologic features of Tonto National Monument" by R. B. Raup, which is being reviewed prior to publication.

Distribution of elements, Colorado Plateau, A. T. Miesch in charge. The report "Chemical composition as a guide to the size of sandstone-type uranium deposits in the Morrison formation on the Colorado Plateau" was published as Bulletin 1112-B. Several other reports are in preparation. Some field studies of the igneous rocks of the region will be made.

Geologic maps, Colorado Plateau, D. G. Wyant in charge. Compilation of geologic mapping on the 1:250,000 scale 1⁰ by 2⁰ AMS base maps is continuing. The Shiprock sheet covering northeastern Arizona and northwestern New Mexico has been approved for publication as Map I-345. Work on the Gallup sheet has been started.

Photogeologic mapping, Colorado Plateau, A. B. Olson in charge. Work on this project contributes principally to the compilation of the 1:250,000 scale geologic map compilation described above. Currently, photogeologic studies are in progress for selected parts of the Gallup sheet not covered by previous detailed geologic mapping. The report "Isopach mapping by photogeologic methods as an aid in the location of swales and channels in the Monument Valley area, Arizona," by I. J. Witkind, W. R. Hemphill, C. L. Pillmore, and R. H. Morris was published as Bulletin 1043-D; and the report "The uranium-vanadium ore deposit at Monument No. 1-Mitten No. 2 mine, Monument Valley, Arizona" by Witkind was published as Bulletin 1107-C.

Carrizo Mountains area, J. D. Stobell in charge. A summary report on the geology of the four quadrangles in this area is in preparation.

Regional synthesis, Colorado Plateau, L. S. Hilpert in charge. The report "Uranium deposits of the Moab, Monticello, White Canyon and Monument Valley districts, Utah and Arizona" by H. S. Johnson, Jr., and W. Thordarson is undergoing technical review.

Fossil wood and general paleobotany, R. A. Scott in charge. Studies of the pollen, spores and fossil wood from the Colorado Plateau region are continuing. The report "Pollen of *Ephedra* from the Chinle formation (Upper Triassic) and the genus *Equisetosporifites*" was published in *Micropaleontology*, v. 6, p. 271-276. A number of other reports are in preparation.

Stratigraphic and lithologic studies of the Colorado Plateau, L. C. Craig in charge. A summary report on the stratigraphy and lithology of the Morrison and associated formations is nearing completion. Lithologic studies of Cretaceous and Tertiary formations, including some field reconnaissance and sampling, will be continued.

San Rafael (Entrada) stratigraphic studies, J. C. Wright in charge. Manuscripts are in preparation reporting on these stratigraphic studies.

Triassic stratigraphic studies, Colorado Plateau, J. H. Stewart in charge. Summary reports on the Chinle and Moenkopi formations in this region are in preparation, along with shorter reports on correlation studies and interpretation of lithology and sedimentary structures.

Clay mineral studies, Triassic rocks and the Morrison formation, L. G. Schultz in charge. A report on "Clay minerals of the Morrison formation of the Colorado Plateau" by W. D. Keller will be published as Bulletin 1150, and the report "Clay minerals in the Triassic rocks of the Colorado Plateau" by Schultz will be published as Bulletin 1147, completing the work planned on this project.

Uranium-vanadium deposits of the Colorado Plateau region, R. P. Fischer in charge. Two reports were published: "Distribution and lithologic characteristics of sandstone beds that are hosts to deposits of copper, vanadium and uranium" in Professional Paper 400-B, and "Copper, vanadium and uranium deposits in sandstone—their distribution and geochemical cycles" in Economic

Geology, v. 56, no. 3. Other reports are in preparation on the geology of the uranium-vanadium deposits of the Colorado Plateau. A summary map "Epi-genetic uranium deposits in the United States" was published as Map I-299 in the Miscellaneous Geologic Investigations series.

East Vermillion Cliffs, R. G. Peterson in charge. The following reports were published: "Stratigraphy and structure of the House Rock Valley area, Coconino County, Arizona" by J. D. Wells, as Bulletin 1081-D; "Preliminary geologic map of the Emmett Wash NW quadrangle" by Peterson and Wells, as MF-197; "Preliminary geologic map of the Paria Plateau SE quadrangle, Coconino County, Arizona" by Peterson, as MF-196; and "Detrital appearing uraninite in the Shinarump member of the Chinle formation in northwestern Arizona" by Peterson in Economic Geology, v. 55, no. 1. The report "Geology of the Lees Ferry area, Arizona" by D. A. Phoenix is being edited for publication as Bulletin 1137, and a manuscript report on physical properties of some Permian and Triassic rocks in El Capitan Flat area is being reviewed.

Mineralogic services and research, Washington, D. C., Alice D. Weeks in charge. Descriptive studies of Colorado Plateau uranium, vanadium, mica, clay and chlorite minerals are continuing. An abstract "Mineralogy and geochemistry of vanadium in the Colorado Plateau" was published in Journal of the Electrochemical Society, v. 107, p. 68, and the full report is being prepared for publication. The report "Weeksite, a new uranium silicate from the Thomas Range, Utah," by Outerbridge and others, published in American Mineralogist, v. 45, no. 1-2, describes this new mineral, found at 10 locations, including some in Arizona.

Crystal chemistry, H. T. Evans, Jr., in charge. Studies of crystal chemistry and structure of the uranium and vanadium minerals of the Colorado Plateau are continuing, with several reports in preparation. The report "Crystal chemical studies of some uranyl oxide hydrates" by C. L. Christ and J. R. Clark was published in American Mineralogist, v. 45; "Crystal structure refinement and vanadium bonding in the metavanadates KVO_3 , NH_4VO_3 and $KVO_3 \cdot 2H_2O$ " by Evans was published in Zeitschrift fur Kristallographie, v. 114; and "A crystal chemical study of the vanadium oxide minerals, haggite and doloresite" by Evans and M. E. Mrose was published in American Mineralogist, v. 45.

Colorado Plateau regional geophysical studies, H. R. Joesting in charge. A regional gravity study and magnetic survey has been made in the central part of the Plateau and will be extended to the south. Fieldwork to obtain density data may be needed. The report "Geophysical methods of exploring for buried channels in the Monument Valley area, Arizona and New Mexico" will be published as part of Bulletin 1083. Reports are in preparation on geophysical investigations of several areas.

Great Basin geophysical studies, D. R. Mabey in charge. A gravity survey was made of the Wilcox Basin in support of ground-water investigations, and a geophysical investigation of the Safford Basin is being planned. An abstract "Geophysical studies in support of geologic mapping, Twin Buttes quadrangle, Arizona" was published in Mining Engineering, v. 12, no. 12.

Crustal studies, L. C. Pakiser in charge. As part of the study of major crustal structure, seismic and gravity data have been obtained along the profile from Kingman to the Nevada Test Site. A report on this study "Crustal structure from the Nevada Test Site to Kingman, Arizona, from seismic and gravity observations" by W. H. Diment, S. W. Stewart and J. C. Roller was published in Jour.

Geophysical Research, v. 66, no. 1. Seismic work will continue in the region in connection with activities at the test site.

Asbestos deposits (McFadden Peak and Blue House Mountain quadrangles), A. F. Shride in charge. A comprehensive report on the asbestos deposits is now being revised following review. The report "Some aspects of younger Precambrian geology in southern Arizona" was released in open file. Two manuscripts on regional geology and stratigraphic relationships of the younger Precambrian and Cambrian formations are in preparation. Geologic mapping will be resumed in the McFadden Peak quadrangle.

Christmas quadrangle, C. R. Willden in charge. One horizon in the Martin formation has been identified as containing hematite concentrations, and a potentially economic sedimentary iron ore deposit was discovered in the course of geologic mapping. The iron-bearing horizon locally is 5 to 7 feet thick and contains about 37 percent iron. The report "Sedimentary iron formation in the Devonian Martin formation, Christmas quadrangle, Arizona" was published in Professional Paper 400-B. Geologic mapping was completed, and a manuscript report on the geology of the area is being reviewed for publication.

Holy Joe quadrangle, M. H. Krieger in charge. Mapping will be continued this fall and next spring. Recognition and separation of the Precambrian Troy quartzite from the overlying Cambrian formations of the region, and application of the southern Arizona formational names Bolsa and Abrigo to the Cambrian strata will be discussed in a report in preparation.

Jerome area, M. H. Krieger in charge. The final report on the Prescott and Pauldin quadrangles has been revised following technical review.

Southern Cochise County, P. T. Hayes in charge. Geologic mapping was completed in the eastern part of the Bisbee 15-minute quadrangle, and is continuing in the western part and the adjacent Hereford quadrangle. A report on some of the Paleozoic stratigraphy is in preparation.

Elgin quadrangle, R. B. Raup in charge. Geologic mapping has been completed in the northern and eastern parts of the area, and is progressing to the southwest into an area of volcanic rocks.

Upper Gila River Basin, Arizona-New Mexico, R. B. Morrison in charge. A manuscript report on the geology and geomorphology of the Duncan and Canador Peak quadrangles is nearing completion. Field mapping is continuing in the area to the northwest.

Bradshaw Mountains area, C. A. Anderson in charge. Geologic mapping was continued in the Mount Union NE and SE 7-1/2-minute quadrangles this summer, and will be completed next summer. Older Precambrian rocks are widely exposed in both quadrangles and are yielding important information about the southerly extension of these rocks from the Prescott and Jerome areas.

Stratigraphy of the Redwall limestone, Grand Canyon region, E. D. McKee in charge. Two reports, "Lithologic subdivisions of the Redwall limestone in northern Arizona" and "Spatial relations of fossils and bedded cherts in the Redwall limestone, Arizona" were published in Professional Paper 400-B. A summary report of this work is in preparation.

History of the Supai-Hermit formation, E. D. McKee in charge. Field work will

be concentrated in the western part of the Grand Canyon to round out studies in the type area and at the eastern end of the Canyon. Analysis of the sedimentary structures and lithologic features of these formations is furnishing detailed information on red-bed sedimentation and Permian paleogeography.

Diatremes, Navajo and Hopi Indian Reservations, E. M. Shoemaker in charge. Field work, which had been recessed, will be resumed on this study of the origins of the several hundred diatremes, the mechanics of eruption, and the differences between craters formed by volcanic action and craters formed by impact. The report "Diatremes and Cenozoic geology of the Hopi Buttes region, Arizona" by Shoemaker, F. M. Byers, Jr., and C. H. Roach has been approved for publication in a bulletin of the Geol. Soc. of America. Four additional reports are in preparation.

Terrestrial impact structures, E. M. Shoemaker in charge; and Impact metamorphism, E. C. T. Chao in charge. Investigation of meteorite impact structures has advanced significantly as a result of identification of coesite as an index mineral for strong shock. Several reports detailing this and related work on impact studies have been published: "First natural occurrence of coesite (Meteor Crater, Arizona)" by Chao, Shoemaker, and Madsen published in *Science*, v. 132, no. 3421; "The discovery of coesite from Meteor Crater, Arizona" by Chao in *Footprints*, v. 32, no. 1; "Penetration mechanics of high velocity meteorites illustrated by Meteor Crater, Arizona" by Shoemaker in 21st International Geol. Congress, Copenhagen, v. 18; and "Brecciation and mixing of rock by strong shock (Meteor Crater, Arizona)" by Shoemaker in *Professional Paper 400-B*. Another report "Impact mechanics at Meteor Crater, Arizona" by Shoemaker, has been approved for publication in v. 4 of the *Solar System*, University of Chicago Press.

Paleontologic and stratigraphic studies, C. W. Merriam in charge. The report "Stratigraphy of outcropping Permian rocks, northeastern Arizona and adjacent States" by C. B. Read and A. A. Wanek, is being edited for publication as *Professional Paper 374-H*. The reports "Change in age assignments for the Glen Canyon group (Triassic and Jurassic) on the Colorado Plateau" by G. E. Lewis, J. H. Irwin, and R. F. Wilson; "Some early Cretaceous calcareous algae from Cochise County, Arizona" by Kenji Konishi and R. C. Epis; and "Gastropods from the Redwall limestone (Mississippian) in Arizona" by E. L. Yochelson, have been approved for publication in technical journals.

Other work in Arizona includes:

A report approved for publication "Geology between Lake Mead and Davis Dam, Arizona-Nevada" by C. R. Longwell, will be published as *Professional Paper 374-E*.

The report "Beryl-bearing pegmatites in the Ruby Mountains and other areas in Nevada and northwestern Arizona" by J. C. Olson and E. N. Hinrichs, was published as *Bulletin 1082-D*.

The report "Papagoite, a new copper-bearing mineral from Ajo, Arizona" by C. O. Hutton and A. C. Vlisidis, was published in *American Mineralogist*, v. 45, p. 599.

In addition to the reports cited in the above paragraphs, *Professional Paper 400-A "Geological Survey Research, 1960"* contains a summary of much of our current work. The successor volume "Geological Survey Research, 1961" will be published as *Professional Paper 424-A* in the near future.