

Biennial Report
of the State Geologist
for 1963-1965



THE GEOLOGICAL SURVEY OF WYOMING

Laramie, Wyoming

January, 1965

THE GEOLOGICAL SURVEY OF WYOMING
UNIVERSITY OF WYOMING
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LARAMIE, WYOMING 82071

January 1, 1965

The Honorable Clifford P. Hansen
Governor of the State of Wyoming
Cheyenne, Wyoming.

Sir:

I have the honor to submit herewith the Biennial Report of the State Geologist covering the period, July 1, 1963 to June 30, 1965, in accordance with the requirements of Article 11, Section 9-252, Wyoming Compiled Statutes, 1957.

Respectfully yours,

Horace D. Thomas

Horace D. Thomas
State Geologist

HDT:sa

CONTENTS

	Page
Introduction	1
Organization of the Geological Survey	1
Comparison with other states.	2
Agricultural research vs. geological research	2
Depletable mineral deposits and the future.	4
Need for a continuing program of geological investigations	4
Activities of the Geological Survey	6
Technical investigations	6
Absaroka Mountains project.	6
Hartville project.	8
Precambrian project	8
Regional mapping and commodity studies.	13
Engineering geology.	15
Mineral inventory	15
Ground water geology	16
Mineral identification service.	16
Cooperation with the U.S. Geological Survey	16
Fund-matching projects.	17
Cooperation with Northern Rocky Mountains Branch.	18
Cooperation with other Federal agencies	19
U.S. Bureau of Mines.	19
U.S. Coast and Geodetic Survey	19
Other agencies	19
Cooperation with University agencies	20
Department of Geology	20
Natural Resources Research Institute	20
Cooperation with State departments	20
Natural Resource Board.	20
Commissioner of Public Lands	20
State Highway Department.	20
State Game and Fish Commission.	20
Oil and Gas Conservation Commission	21
Oil well sample repository.	21
Public education	22
Wyoming industrial rock and mineral sets	22
Tourist information	22
Public services.	23
Office callers	23
Correspondence	23
Topographic sheets	23
Air photos	23
Publications, maps and reports	23
Miscellaneous publications	23
Lectures and addresses	24
National committees	24
Epilogue.	25

TABLE

Table 1. Appropriations to state geological surveys for geological research, service, and administration for 1963. The figure in parentheses following each state name indicates the rank of that state in the valuation of mineral production for 1963	3
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Cover: Francs Peak, elevation 13,140 feet. This is the highest prominence in the Absaroka Mountains, northwestern Wyoming.

BIENNIAL REPORT OF THE STATE GEOLOGIST

OF THE

STATE OF WYOMING

for

1963 - 1965

by

HORACE D. THOMAS

INTRODUCTION

This report covers the activities and accomplishments of the Geological Survey of Wyoming during the two-year period 1963-65. The geological projects undertaken are briefly described, the various activities of the Survey are discussed, and the resulting publications are listed.

ORGANIZATION OF THE GEOLOGICAL SURVEY

The Geological Survey of Wyoming was created in 1933 and has been located at the University of Wyoming since that time. Of the 47 state geological surveys, over two-thirds are located at state universities or colleges, which suggests that most states recognize the advantages in affiliating the state geological survey with the department of geology at a state institution of higher learning.

Because of its university affiliation, it is possible for the Geological Survey of Wyoming to obtain the advice and part-time assistance of the nine geological specialists on the staff of the University Geology Department. The office of the Northern Rocky Mountains Branch of the U.S. Geological Survey is also located in Geology Hall and provides valuable assistance. Close collaboration is maintained with the University of Wyoming Natural Resources Research Institute, whose research is in part on the utilization of Wyoming mineral resources. The U.S. Bureau of Mines Laramie Petroleum Research Center is located nearby on the campus. The advice, suggestions, and assistance of engineers, chemists, physicists and other scientists on the campus are readily available.

In September, 1955, quarters in the new Geology Building on the campus were occupied. The Survey has four offices and a map and publication distribution room. In addition, a large part of the basement is devoted to storage space for oil well samples and cores. Most important, the Survey benefits from the availability of the modern technical equipment installed by the Department of Geology, such as X-ray diffraction equipment, differential thermal analysis equipment, magnetic separators, ultrasonic devices, and other equipment used in rock and mineral identifications.

Dr. S.H. Knight, Professor of Geology, served as State Geologist and Director of the Geological Survey of Wyoming from 1933 to 1940. The incumbent, Dr. H.D. Thomas, has served since March, 1941. By virtue of action by the University Administration, the State Geologist has a reduced teaching load so that a share of his time may be devoted to the direction of the Geological Survey.

In 1951, for the first time, a full-time Assistant State Geologist was employed. Dr. William H. Wilson resigned from the U.S. Geological Survey to accept the appointment. Dr. Wilson is the holder of five university degrees in geology and engineering and is a specialist in economic geology, engineering geology, and ground water geology. The addition of Dr. Wilson to the staff aided immeasurably

in broadening the program and services of the State Geological Survey.

In September, 1963, Mr. Marvin L. Millgate was employed as a full-time geologist. He holds Bachelor's and Master's degrees in geology and left the Natural Resources Division of the Union Pacific Railroad to accept employment with the State.

A full-time secretary, Mrs. Stephanie Aker, is also employed. Her duties involve the maintenance of office records, the distribution of publications and maps, and administration of non-technical office matters.

Students majoring in geology or taking post-graduate work constitute a valuable store of geological talent and are employed on a part-time basis as summer field geologists, to serve as geological draftsmen, to maintain collections of samples from wells drilled for oil or water, and in many other ways.

COMPARISON WITH OTHER STATES

The Geological Survey of Wyoming does not receive as large an appropriation as those received by most other state geological surveys. At present, 47 states have geological surveys. During 1962-63, the latest fiscal year for which figures are available, the 47 surveys had funds totaling \$9,030,185 for geological research, services, and administration, or an average of about \$190,000 per survey. This contrasts with the \$34,063 appropriated to the Geological Survey of Wyoming for that year. Total funds available to the 47 geological surveys for all purposes (regulatory duties, federal matching monies, etc.) exceeded \$13.5 million.

Although Wyoming ranks 10th among the states in valuation of mineral products (\$509,500,000 in 1964), the State ranks 44th among those appropriating funds for state geological surveys. Table 1 shows the funds available for geological research, services, and administration available to the various state geological surveys in 1962-63 and the valuation of mineral production for each state in 1963, the latest year for which complete figures are available. The Illinois Geological Survey has over \$1¼ million per year; 28 other surveys have between \$900,000 and \$100,000 per year, and 11 receive between \$100,000 and \$50,000 per year. Only the Connecticut, Vermont, and New Hampshire surveys had less money than the Wyoming Geological Survey had. These states rank low as mineral producers.

Many states having much smaller mineral production valuations than Wyoming appropriate a great deal more money for geological research than does our State (Table 1). Furthermore, most of these do not have the potential for future mineral developments that Wyoming does.

The average number of full-time permanent technical personnel employed by each of the 47 geological surveys was 12. This compares with the 2.5 on the staff of the Geological Survey of Wyoming. Some of the geological staffs are surprisingly large: Illinois, 71; California, 37; Indiana, 31; Michigan, 33; Missouri, 18; and Pennsylvania, 16. Some of the geological surveys of other western states have fair-sized staffs: New Mexico, 16, North Dakota, 15; Nebraska, 10; and South Dakota and Montana, 6 each.

AGRICULTURAL RESEARCH vs. GEOLOGICAL RESEARCH

Just as agricultural research may increase the valuation of Wyoming's annual agricultural products, so can geological research increase the valuation of our mineral production. It is of interest to note that our agricultural products during 1963 were valued at \$172,100,000*, whereas our mineral products were valued at \$504,633,000, or about three times as much. Vast sums of public money are spent

* The Farm Income Situation; Economic Research Service, U. S. Department of Agriculture, February, 1964.

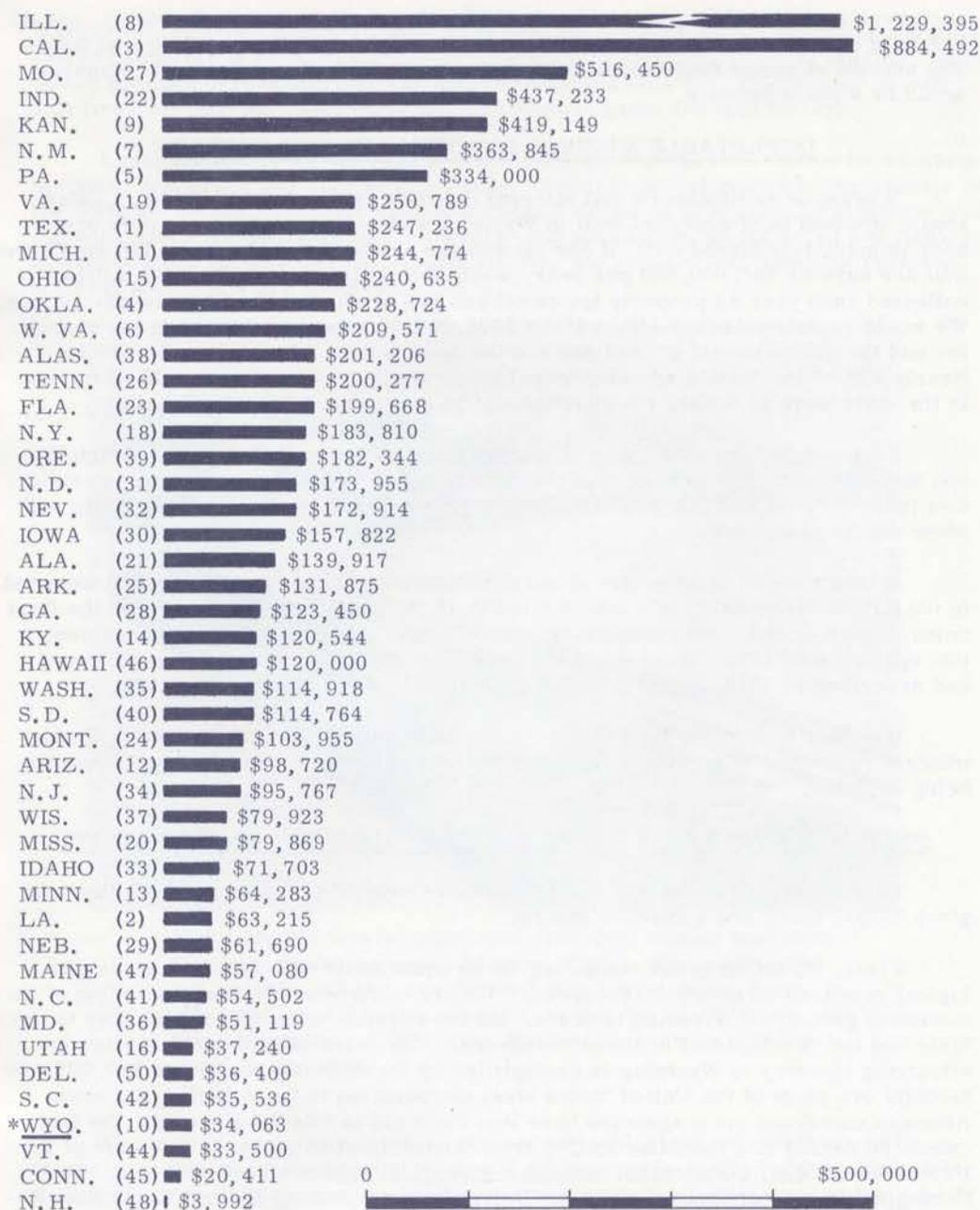


Table 1. - Appropriations to state geological surveys for geological research, service, and administration for 1963 (1). The figure in parentheses following each state name indicates the rank of that state in the valuation of mineral production for 1963 (2).

1. Report of the Statistician, 1963, Association American State Geologists.
 2. U.S. Bureau of Mines, Mineral Yearbook for 1963.

each year in research in plant and animal pathology, agricultural chemistry, cereal and field crops, forage and range, bee culture, wool, and other agricultural fields. The amount of public funds spent in Wyoming on geological research, if compared, would be a mere pittance.

DEPLETABLE MINERAL DEPOSITS AND THE FUTURE

It must be remembered that mineral deposits are depletable. What a catastrophe it would be if every oil well in Wyoming suddenly went dry and every ore body immediately played out! If our oil and gas production ceased, 11,100 employees, who are earning \$61,000,000 per year, would move elsewhere. The \$12 million collected each year as property tax on oil and gas production would no longer accrue. We would greatly miss the effect of the \$200,000,000 spent each year in the search for and the production of oil and gas and the manufacture of petroleum products. Nearly 37% of the State's ad valorem valuation would no longer exist. If all mining in the state were to cease, the result would be a similar economic disaster.

Fortunately, the exhaustion of our reserves of mineral fuels and nonmetallic and metallic minerals will not take place over night, but it is an absolutely certain fact that every oil and gas well and every mine presently producing in the State will some day be abandoned.

It takes time to develop new mineral industries. Although trona was discovered in the Green River Basin in a well drilled in 1937, it was not until 1948 that the first trona was produced. Fourteen years passed before a second mine and plant went into operation in 1962. Even though the Atlantic City taconite deposit was mapped and described in 1949, it was not until 1962 that the first ore was shipped.

We must look to the future, therefore, and continue to study and evaluate our mineral resources if we are to find new deposits which may replace those presently being depleted.

NEED FOR A CONTINUING PROGRAM OF GEOLOGICAL INVESTIGATIONS

Four fundamental reasons for an intensive program of geological studies are given below; there are numerous others.

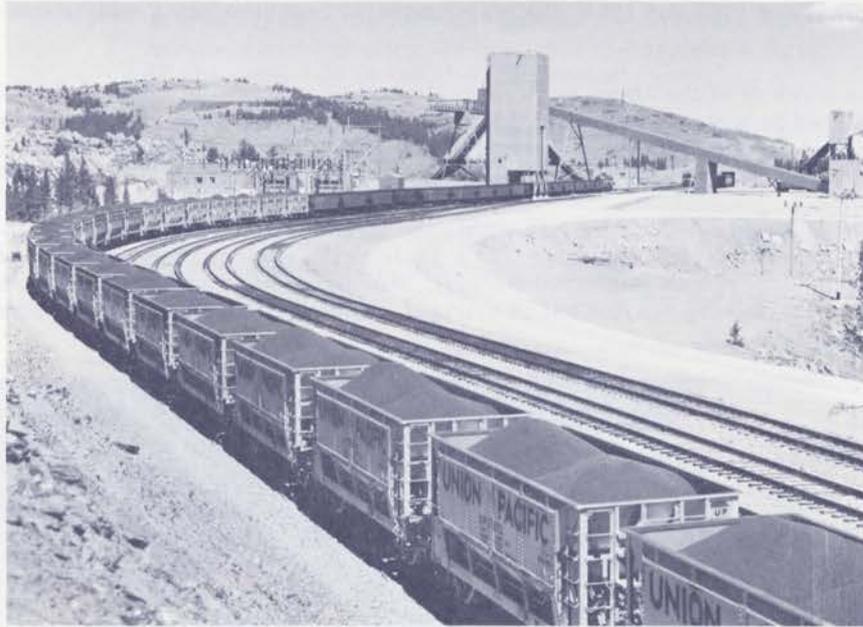
First, Wyoming is not competing on an equal basis with other states in geological research on mineral resources. A more comprehensive understanding of the economic geology of Wyoming is needed for the possible attraction of industry to the State and the development of these resources. The value of geological studies in attracting industry to Wyoming is exemplified by the recently completed \$60,000,000 taconite ore plant of the United States Steel Corporation in the Atlantic City area. Although numerous state agencies have lent their aid to this development, the fact cannot be denied that the Atlantic City iron deposit first came to the attention of the United States Steel Corporation through a geological report issued jointly by the Geological Survey of Wyoming and the University of Wyoming Natural Resources Research Institute in 1949. Numerous other developments could be cited as having originated through previous geological studies.

Secondly, geological data are basic to the solution of Wyoming's water needs and usage. For instance, the development of ground water supplies cannot be attained without a proper understanding of the geology of the rocks in which the ground water occurs. Nor is it wise to construct a dam, large or small, unless geological studies indicate that the rocks at the dam site afford an adequate foundation for the structure and that geological conditions do not allow for subterranean leakage of water from the reservoir area. Geological studies provide knowledge regarding sources of construction materials: sand, gravel, and riprap for dams, bentonite for canal linings, and similar materials.

Thirdly, other State and municipal agencies are finding needs for more geo-

logical information and are seeking more and more data from us to help in the solution of problems in mineral availability, land classification, mineral leasing, foundation adequacy, road and highway construction and location, availability of water supplies, radioactive waste disposal, and even in game and fish culture.

Lastly, there is an increasing demand for geological information by rockhounds, tourists, and grade and high school pupils. Semi-technical guides to the geology of the State parks and the major mountain ranges should be prepared. Pamphlets dealing with localities where rocks, minerals, and fossils can be collected are needed. Requests from schools and individuals all over the country for Wyoming rock and mineral specimens are increasing daily.



U.S. Steel's newly completed iron ore mining and beneficiating facilities near Atlantic City. The economic possibilities of the ore deposit were first pointed out in a report issued by the Geological Survey of Wyoming and the University of Wyoming Natural Resources Research Institute in 1949.

There is only one way in which the needed geological information can be obtained, and that is through technical investigations made in the field by competent geologists, and the only way geologists can operate effectively is under the supervision of experienced geologists -- not under the aegis of nontechnical agencies -- and with available laboratory and library facilities which are so necessary in modern geological studies.

In summary, an expanded program of geological investigations by the Geological Survey of Wyoming seems necessary and desirable. To achieve this would involve an increased appropriation for the employment of an additional full-time geologist and the maintenance of the appropriation for part-time summer field geologists.

ACTIVITIES OF THE GEOLOGICAL SURVEY

TECHNICAL INVESTIGATIONS

Absaroka Mountains Project

The geologic mapping of the southern Absaroka Mountains was begun by Dr. W. H. Wilson in 1951. The total area mapped now approximates 800 square miles and has given detailed information on a region of essentially virgin geology. Nearly all the mapping, in country so rough that it can be covered adequately only on foot, has been done by Dr. Wilson, although an area of 30 square miles with an average relief exceeding 5,000 feet was mapped by Fred S. Fisher, graduate student, during the summers of 1963 and 1964, the major mineral resource being molybdenum deposits.

As a result of the above work an exploration program for mineral deposits was initiated by a major mining company in one part of the area in 1961 and in another part in 1963. The same company conducted diamond drilling in the Kirwin area for copper, molybdenum, and silver during the summers of 1963 and 1964.

The mapped area lies mainly within the Shoshone National Forest and in 1962 the U. S. Forest Service suggested that a guide to the geology of the area be prepared. The report was completed by W. H. Wilson in 1963 and has proved useful not only to the Forest Service but to tourists, hunters, fishermen, and backpackers visiting the area.



The southern Absaroka Mountains, in Park County, are a massive accumulation of volcanic debris. Geologic mapping in this high, rough country can be done only on foot.

During the summer of 1964, Alan McGrew, a graduate student, carried on a petrologic and stratigraphic study of the Carter Mountain tuff bed, a unit which has extensive areal distribution. Laboratory studies currently in progress suggest that

it may be suitable for use in making structural clay products, pottery, or stoneware, or for use as a lightweight aggregate, as a bonding material in foundaries, or as an ingredient of drilling mud.

The following formal reports have resulted from this project:

Dunrud, C.R., 1962, Volcanic rocks of the Jack Creek area, southeastern Absaroka Range, Park County, Wyoming: 92 ms. pages, 12 figs., 2 pls. (Graduate thesis).

Love, J.D., Wilson, W.H., Houston, R.S., and Simons, E.L., Dating of Eocene and Oligocene pyroclastic rocks near source areas in the southern part of the Absaroka Range, northwestern Wyoming: 23 ms. pages, 2 tables, 6 figs. (To be published by the U.S. Geological Survey).

Wilson, W.H., 1960, Petrology of the Wood River area, southern Absaroka Mountains, Park County, Wyoming: 122 ms. pages, 1 table, 16 figs., 2 pls.

_____, 1963, Correlation of volcanic units in the southern Absaroka Mountains, Wyoming: Contribs. to Geol., Univ. Wyo., Vol. 2, No. 1, pp. 13-20, 1 table, 3 pls.

_____, 1963, A guide to the geology of the Shoshone National Forest, Wyoming: 43 ms. pages, 1 table, 16 figs., 1 pl.

_____, 1964, The Kirwin mineralized area, Park County, Wyoming: Geol. Surv. Wyo. Prelim. Rept. No. 2, 12 pp., 1 table, 1 fig., 2 pls.

_____, 1964, Geological reconnaissance of the southern Absaroka Mountains, northwest Wyoming, Part I - The Wood River - Greybull River area: Contribs. to Geol., Univ. Wyo., Vol. 3, No. 2, pp. 60-77, 1 table, 12 pls.

The following manuscripts are in preparation:

Fisher, F.S., The Needle Creek mineralized area, Park County, Wyoming. (To be published as a Geological Survey of Wyoming Preliminary Report).

McGrew, Alan, Petrology and stratigraphy of the Carter Mountain tuff, Park County, Wyoming. (Graduate thesis).

Wilson, W.H., Geologic reconnaissance of the southern Absaroka Mountains, northwest Wyoming: Part II - Structure of volcanic sediments in the Wood River area. (To be published in Contributions to Geology).

Wilson, W.H., and Dunrud, C.R., Geology of the Irish Rock quadrangle, Park County, Wyoming. (To be published as a Geological Survey of Wyoming Bulletin).



Diamond drilling for copper and molybdenum in the Kirwin mineralized area, Absaroka Mountains, northwestern Wyoming.

Hartville Project

The geology of parts of the Hartville uplift of east-central Wyoming is being studied by Marvin L. Millgate.

Haystack Range. - The Precambrian rocks of the Haystack Range have been studied over an area of 52 square miles and their distribution and attitude have been delineated on a map with a scale of 1:24,000. Two published reports will result from this project, one being completed at this time and titled as follows:

Millgate, Marvin L., 1965, The Haystack Range, Goshen and Platte Counties, Wyoming: Geol. Survey Wyo. Prelim. Rept. No. 5, 12 pp. 1 pl.

Rawhide Buttes area. - During the 1964 field season Mr. Millgate completely mapped the geology of the Rawhide Buttes area on a scale of 1:12,000. The area is principally one of Precambrian rocks, although Paleozoic rocks occupy part of it. The final map is now being drafted. *

Precambrian Project

The Precambrian project, which involves the mapping of the crystalline cores of the mountain ranges, was initiated in July, 1957.

Medicine Bow Mountains. - The first phase of the program, the mapping of the Medicine Bow Mountains, has been completed. This work was done by 12 graduate students at the University of Wyoming and by Dr. R.S. Houston, Professor of Geology, who also directed the program. Mapping covered approximately 41 townships, or about 1,500 square miles. The scale of the mapping ranged from 600 feet to the inch to 2,200 feet to the inch, depending on structure, rock type, and exposures. A number of areas of economic interest were studied, including pegmatites in the southern part of the mountains, vermiculite on the western slope, copper-gold

deposits in the Keystone and Gold Hill districts, magnetite deposits in the Lake Owen area, sulfide-facies iron formation in the central part of the mountains and scattered nonmetallic deposits of possible economic interest.

In addition to the regional mapping and the study of mineral deposits, the geologic study of the Medicine Bow Mountains has been especially valuable in demonstrating the relationship between structural features of Precambrian age and those of younger age that are of interest to the petroleum geologist. A complex Precambrian geologic history has been worked out and the region is well suited for correlation of field and geochronologic studies. Drs. Alan Hill and Paul Gast, of the University of Minnesota, have cooperated in the project by dating the Precambrian rocks in years, using primarily whole-rock strontium-rubidium methods. They have shown that rocks older than 2.5 billion years are present in the northwestern part of the mountains, and preliminary results indicate that the great line of crustal weakness that divides the mountains into two distinct geological parts, which Houston and McCallum have named the Mullen Creek - Nash Fork shear zone, may be a major structural feature of this part of the Rocky Mountains, since no rocks 2.5 billion years or older are found south of this shear zone.

The results of the study of the Medicine Bow Mountains are to be published by the Geological Survey of Wyoming but some phases will appear as papers in technical periodicals. A number of manuscripts and maps are presently being prepared for future publication. Eleven papers and abstracts published to date are as follows:

- Currey, Donald R., 1965, The Keystone gold-copper prospect area, Albany County, Wyoming: Geol. Survey Wyo. Prelim. Rept. No. 2, 12 pp., 1 table, 2 figs, 2 pls.
- Hills, Alan, Gast, P.W., and Houston, R.S., 1964, Chronology of some Precambrian igneous and metamorphic events of the Medicine Bow Mountains, Wyoming (Abst.): Geol. Soc. America Program, 1964 Ann. Meeting.
- Houston, R.S., 1961, Geology of the Big Creek pegmatite area, Carbon County, Wyoming: Geol. Survey Wyo. Prelim. Rept. No. 1, 11 pp., 1 fig., 2 pls.
- _____, 1963, Structure of Precambrian rocks of the Medicine Bow Mountains and its relationship to post-Precambrian structural patterns (Abst.): Am. Assoc. Petrol. Geol., Rocky Mt. Sec. Program, pp.18-19.
- Houston, R.S., and McCallum, M.E., 1961, The Mullen Creek-Nash Fork shear zone, Medicine Bow Mountains, southeastern Wyoming (Abst.): Geol. Soc. America Special Paper 68, p. 91.
- Houston, R.S., and Parker, R.B., 1963, Structural analysis of a folded quartzite, Medicine Bow Mountains, Wyoming: Bull. Geol. Soc. America, Vol. 74, pp.197-202.
- King, John S., 1964, Cooper Hill - a gravity slide in the north-eastern Medicine Bow Mountains, Wyoming: Contribs. to Geol., Univ. Wyo., Vol. 3, No. 1, pp.33-37
- McCallum, M.E., 1962, Glaciation of Libby Creek Canyon, east flank of Medicine Bow Mountains, southeastern Wyoming: Contribs. to Geol., Univ. Wyo., Vol. 1, No. 1, pp.21-30.

McCallum, M.E., 1964, Cataclastic migmatites of the Medicine Bow Mountains, Wyoming: Contribs. to Geol., Univ. Wyo., Vol. 3, No. 2, pp. 78-89.

_____, 1964, Dedolomitized marble lenses in shear-zone tectonites, Medicine Bow Mountains, Wyoming (Abst.), Geol. Soc. America Program, 1964 Ann. Meeting.

Swetnam, Monte, 1962, The origin of Precambrian crystalline rocks in the Pelton Creek area, Medicine Bow Mountains, Wyoming: Contribs. to Geol., Univ. Wyo., Vol. 1, No. 1, pp. 41-48.

Eleven formal reports (graduate theses) have been completed for the Medicine Bow Mountains. These may be consulted at, or copies may be borrowed from, the Geology Library or the Geological Survey of Wyoming. Separate maps are available to the public. The reports are as follows:

Childers, M.O., 1957, Geology of the French Creek area, Albany and Carbon Counties, Wyoming. (Covers 49 sq. mi., 58 ms. pp.)

Currey, D.R., 1959, Geology of the Keystone area, Albany County, Wyoming. (Covers 45 sq. mi., 64 ms. pp.)

King, James, R., 1962, Geology of the Boswell Creek area, Albany County, Wyoming. (Covers 30 sq. mi., 83 ms. pp.)

King, John S., 1963, Petrology and structure of the Precambrian and post-Mississippian rocks of the northeastern Medicine Bow Mountains, Carbon County, Wyoming. (Covers 65 sq. mi., 125 ms. pp.)

Matus, Irwin, 1958, Geology of the lower French Creek area, Carbon County, Wyoming. (Covers 28 sq. mi., 38 ms. pp.)

McCallum, M.E., 1964, Petrology and structure of the Precambrian and post-Mississippian rocks of the east-central portion of the Medicine Bow Mountains, Albany and Carbon Counties, Wyoming. (Covers 110 sq. mi., 164 ms. pp.)

Myers, W.G., 1958, Geology of the Sixmile Gap area, Albany and Carbon Counties, Wyoming. (Covers 18 sq. mi., 74 ms. pp.)

Orback, C.J., 1960, Geology of the Fox Creek area, Albany County, Wyoming. (Covers 19 sq. mi., 100 ms. pp.)

Ruehr, Ben, 1961, Geology of the Devils Gap area, Albany and Carbon Counties, Wyoming. (Covers 26 sq. mi., 48 ms. pp.)

Stensrud, Howard L., 1963, Geology of the Lake Owens mafic complex, Albany County, Wyoming. (Covers 26 sq. mi., 46 ms. pp.)

Swetnam, Monte, 1961, Geology of the Pelton Creek area, Carbon and Albany counties, Wyoming. (Covers 23 sq. mi., 78 ms. pp.)

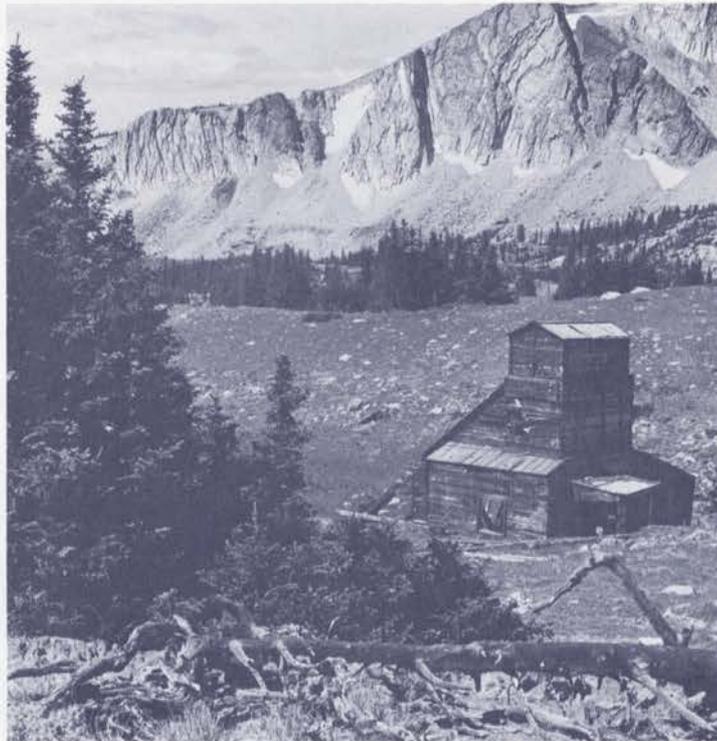
Manuscripts in preparation are listed below, the last two being extracts from more comprehensive reports and are to be published as Preliminary Reports:

Houston, R. S., Geology and structure of the Medicine Bow Mountains.
(This will be a summary report emphasizing descriptive geology and structure. A colored map on a scale of 1 inch to 1 mile and detailed maps of certain key areas will be included. The drafting of the maps has been completed; the manuscript is in preparation.)

McCallum, Malcolm, Mineral deposits of the Centennial Ridge district, Albany County, Wyoming. (Manuscript in preparation.)

Stensrud, H., Magnetite occurrences in the Lake Owens mafic complex, Albany County, Wyoming. (Manuscript in preparation.)

A series of geologic quadrangle maps has been compiled by Dr. Houston made up of the 28 quadrangles which cover the Medicine Bow Mountains. These maps are on a scale of $2\frac{1}{2}$ inches to 1 mile. The drafting is largely completed and the maps will be printed in black and white.



Abandoned mine in the Medicine Bow Mountains. The quartzite cliff of the Snowy Range forms the background.

Other Precambrian studies. - The mapping of the Precambrian rocks of mountain ranges other than the Medicine Bows is continuing. Approximately one half of the Sierra Madre, a range in southern Carbon County, has been mapped in recent years. The following reports (graduate theses) have been completed and are available to the public:

Ferris, C.S., Jr., 1964, Petrology and structure of the Precambrian rocks southeast of Encampment, Wyoming. (Covers 29 sq. mi., 74 ms. pp.)

Merry, Raymond J., 1963, Precambrian geology, shear zones, and associated mineral deposits of the Hog Park area, Carbon County, Wyoming. (Covers 30 sq. mi., 73 ms. pp.)

Short, B.L., 1958, A geologic and petrographic study of the Ferris-Haggerty mining area, Carbon County, Wyoming. (Covers 10 sq. mi., 138 ms. pp.)

Wied, O.J., 1960, Geology of the Encampment area, Carbon County, Wyoming. (Covers 36 sq. mi., 52 ms. pp.)

Field work has been completed on the following projects in the Sierra Madre:

Ebbett, Ballard, Metasedimentary rocks and copper deposits of the northern Sierra Madre, Carbon County, Wyoming. (Covers 25 sq. mi.)

Lackey, L.L., Geology of the Huston Park area, Sierra Madre, Carbon County, Wyoming. (Covers 23 sq. mi.)

Geologic work in the Wind River Mountains is under the supervision of Dr. Ronald B. Parker in his position as Associate Professor of Geology. Two formal reports (graduate theses) have been completed, as follows:

Hodge, Dennis, 1963, Polymetamorphism of Precambrian rocks in the southwestern Wind River Mountains, Fremont County, Wyoming. (Covers 16 sq. mi., 49 ms. pp.)

Worl, R.G., 1963, Superimposed deformations in Precambrian rocks near South Pass, Wyoming. (Covers 16 sq. mi., 53 ms. pp.) A condensation of this report was published in Contributions to Geology, Vol. 2, No. 2, 1963, pp. 109-116.

Worl continued field work in 1964 in the northern Wind River Mountains during which time a taconite deposit similar to that being mined by the U.S. Steel Company at South Pass was discovered. The iron-bearing body has been studied and sampled and the geology of a 60-square mile area has been mapped. A formal report (Ph.D. thesis) is being prepared which is tentatively titled, "The Precambrian geology of the Union Pass area, Wyoming".

Geologic work in the Laramie Mountains is under the supervision of Dr. Parker. One formal report has been completed as a graduate thesis on an area in the central part of the mountains and another one is in progress, as follows:

Fields, E.D., 1963, Precambrian rocks of the Halleck Canyon area, Albany County, Wyoming. (Covers 18 sq. mi., 91 ms. pp.)

Hodge, Dennis S., Petrology and structural geometry of the Precambrian rocks of the Bluegrass Creek area, Albany County, Wyoming. (Covers 45 sq. mi.)

A project in the Seminoe Mountains has been completed and the final report compiled, titled as follows:

Bishop, D. T., 1964, Retrogressive metamorphism in the Seminoe Mountains, Carbon County, Wyoming. (Covers 27 sq. mi., 49 ms. pp.)

All field work has been completed on a project in northern Fremont County supervised by Dr. Parker and the final report is in preparation, titled as follows:

Giozzi, James, Petrology and structure of the Precambrian rocks of the Copper Mountain area, Fremont County, Wyoming.

Regional mapping and commodity studies

In 1961 an increased appropriation was made for wages for temporary summer geologists, and the program of regional mapping and commodity studies was initiated. Additional graduate students were employed to undertake mapping of areas in which the geology was poorly known, but which might contain nonmetallic mineral deposits or mineral fuels. The resulting maps are also useful in ground water studies and petroleum exploration. Other investigations were made of specific commodities. Since the program was started, 23 projects have been initiated, final reports have been completed on 15, and 8 are still in progress.



Geologic mapping with plane table and alidade. Most of the mapping done during the past two summers involved the plotting of geological data directly on vertical air photographs.

A number of published papers have resulted from this program, as follows:

Blackstone, D. L., Jr., 1965, Gravity thrusting in the Bradley Peak - Seminoe Dam quadrangles, Carbon County, Wyoming, and the relationship to the Seminoe iron deposits: Geol. Survey Wyo. Prelim. Rept. No. 6, 13 pp., 1 table, 5 figs., 1 pl. Dr. Blackstone, Professor of Geology and Head of the Geology Department at the University of Wyoming, carried his own field expenses on this project, and the State Geological Survey was grateful to have the opportunity to publish his results.

Davis, John C., 1965, Bentonite deposits of the Clay Spur District, Crook and Weston Counties, Wyoming: Geol. Survey Wyo. Prelim. Rept. No. 4, 17 pp., 3 tables, 6 figs., 1 pl.

_____, 1963, Origin of the Mowry shale: Contribs. to Geol., Univ. Wyo., Vol. 2, No. 2, pp. 135-146, 1 table.

Ten formal reports were completed in this program during the biennium and are listed below. Copies of the graduate theses have been placed in the Geology Library and the files of the Geological Survey where they are available to the public. Maps accompanying the reports are available for purchase.

Bullock, James M., 1964, Gypsum deposits in the northeastern part of the Bighorn Basin, Park County, Wyoming. (25 stratigraphic sections, 91 ms. pp.)

Davis, James R., 1963, The Mesaverde formation of the Kindt Basin, Carbon County, Wyoming. (Covers 90 sq. mi., 134 ms. pp.)

Davis, John C., 1963, Clay Spur bentonite district, Crook and Weston Counties, Wyoming. (79 ms. pp.)

Gries, John P., 1964, Structure and Cenozoic stratigraphy of the Pass Creek Basin, Carbon County, Wyoming. (Covers 144 sq. mi., 69 ms. pp.)

Hauf, Charles B., 1963, Overthrusting in the Upper Fontenelle - LaBarge Creeks area, Lincoln and Sublette Counties, Wyoming. (Covers 23 sq. mi., 75 ms. pp.)

Nicoll, Gerald, 1963, Geology of the Hutton Lake anticline, Albany County, Wyoming. (Covers 100 sq. mi., 80 ms. pp.)

Stuart, William, 1963, Stratigraphy of the Green River formation west of the Rock Springs uplift, Sweetwater County, Wyoming. (8 stratigraphic sections, 48 ms. pp.)

Suydam, Robert, 1963, Overthrusting in the South LaBarge Creek area, Lincoln and Sublette Counties, Wyoming. (Covers 29 sq. mi., 86 ms. pp.)

Tebbutt, Gordon, 1964, Lithogenesis of a distinctive Permian carbonate reservoir, Big Horn and Washakie Counties, Wyoming. (81 ms. pp.)

Voorhees, G. E., 1963, Upper Cretaceous stratigraphy and overthrusting in the Deadman, Blind Bull, and Horse Creek area, Lincoln County, Wyoming. (Covers 35 sq. mi., 88 ms. pp.)

Field work was carried on during the summer of 1964 on the projects listed below. In most cases, field work has been completed and formal reports are being prepared; on some projects a few weeks of additional time will need to be spent during the 1965 field season. Completed field projects are starred, and final reports should be available on these by the end of the biennium.

*Bragdon, F.F., Geology of Poison Meadows and adjacent areas, Lincoln and Sublette Counties, Wyoming. (Covers 36 sq. mi.)

Davis, James R., Stratigraphy and depositional environments of the upper Mesaverde formation (Upper Cretaceous) of southeastern Wyoming. (17 stratigraphic sections and collection of specimens for petrographic and paleontologic study)

*Davis, John C., Petrology of the Mowry shale. (33 stratigraphic sections and collection of samples for petrographic study)

Graveson, David, Uranium-bearing granite of the Shirley Mountains as a possible source of the uranium deposits of the Shirley Basin, Carbon County, Wyoming. (Sampling for petrographic and geochemical work)

Davidson, Peter, Stratigraphy of the Lewis shale of the Laramie and Carbon basins, southeastern Wyoming. (6 stratigraphic sections; collection of specimens for petrographic and paleontologic studies)

*Litchford, Robert, Jr., Overthrust faulting in the Wyoming Peak area, Lincoln and Sublette Counties, Wyoming. (Covers 40 sq. mi.)

*Spanski, G. T., Geology of the Grizzly Creek kyanite deposit, Laramie Mountains, Albany County, Wyoming. (Very detailed map of the deposit)

*Wilband, J. T., Geochemistry of the Collins sericite deposit, Platte County, Wyoming. (Deposit sampled and major and minor elements will be determined)

Miscellaneous Activities

Engineering geology. - During recent years 35 damsites in 14 counties were examined for the Natural Resource Board. Such studies were made to determine whether or not the foundation is adequate for the dam and whether or not there might be water leakage around or under the dam. In 1964 Dr. Wilson made a geological examination of a radioactive waste disposal site for the University of Wyoming.

Mineral inventory. - As a long range project, the Geological Survey has been compiling reliable and factual information on the known mineral deposits of the State. Our Bulletin 50, "Mineral Resources of Wyoming", which was published in 1959, is currently being revised and brought up to date for publication during the next biennium.

During the 1963-65 biennium a great deal of new information was obtained on a variety of mineral deposits or prospects; coal, copper, gold, kyanite, and magnetite (iron) in Albany County; asbestos, barite, coal, copper, gold, iron, jade, kyanite, peat, and vermiculite in Carbon County; graphite and iron in Goshen County;

coal and phosphate rock in Lincoln County, beryl in Niobrara County, gold, gypsum, lead, molybdenum, and silver in Park County; talc in Platte County; and phosphate rock and taconite (iron) in Sublette County. Information on bentonite was obtained over the State, and construction materials were mapped at many places.



The Colorado Fuel and Iron Corporation's newly completed beneficiation plant at Sunrise which will upgrade Sunrise iron ore. The mine's No. 3 headframe is in the background.

Ground water geology. - Helpful advice was given to individuals, principally ranchmen, seeking ground water supplies in the Laramie and Saratoga areas. Good geologic maps are prerequisites in ground water studies, hence those resulting from our general mapping programs are useful for that purpose.

Mineral identification service. - The Geological Survey maintains a free mineral identification service designed to be of value to prospectors, amateur rock collectors, and the general public. If the submitted specimens appear to have possible economic importance they are turned over to the Natural Resources Research Institute for assay or analysis. Several potentially important mineral deposits in the State have been brought to light through this service in the past.

Since the University of Wyoming Natural Resources Research Institute does not have a mineralogist on its staff, all mineral specimens received by that agency are turned over to the Geological Survey.

COOPERATION WITH THE U. S. GEOLOGICAL SURVEY

Informal cooperation is carried on with all branches of the U. S. Geological Survey. The State Geologist has brought to the attention of the U. S. Geological Survey certain geological problems needing attention, and the Federal Survey has taken action on them. Conversely, the Federal Survey keeps us informed on the independent projects it is carrying on in Wyoming. This complete cooperation lends

effectiveness and efficiency to the geological work carried on by both agencies in the State and prevents overlap or duplication of effort.

In August, 1964, the Geologic Division of the U.S. Geological Survey was independently carrying on 57 specific geological projects in Wyoming, according to Chief Geologist Charles A. Anderson. These include regional geology (17 projects), mineral deposits (12 projects), stratigraphy and paleontology (15 projects), geochemistry (6 projects), geophysical studies (6 projects), and oil shale (1 project).

As of August, 1964, these projects had resulted in 52 published papers, and at that time 80 papers were being written, being processed, or were in press. Eight maps had been published and 16 were being prepared.

At the same time the Conservation Division of the U.S.G.S. was engaged in 15 projects involving the geological mapping of 52 quadrangles. This is part of a program leading toward the classification of 2,000,000 acres of withdrawn federal coal lands and 1,000,000 acres of withdrawn phosphate land.

Fund-matching projects. - Formal cooperation involving the matching of funds with the U.S. Geological Survey for specific projects in Wyoming has been carried on since 1941. In the past, projects have been undertaken on phosphate rock, titaniferous magnetite, anorthosite, cordierite, and regional geology.

A part of the fund-matching project on the stratigraphy of the Wind River Basin has been completed and two reports have been published during the biennium, as follows:

Keefer, W.R., 1963, Karst topography in the Gros Ventre Mountains, northwestern Wyoming: U.S. Geol. Survey Pro. Paper 475-B, pp. B129-B130.

Keefer, W.R., and Love, J.D., 1963, Laramide vertical movements in central Wyoming: Contribs. to Geol., Univ. Wyo., Vol. 2, No. 1, pp. 47-54.

Love, J.D., and Keefer, W.R., 1963, Contrasting tectonics of basin margins in central and northwestern Wyoming (Abst.): Program, Rocky Mt. Sec. American Assoc. Petrol. Geols.

A number of other reports are nearing completion, as follows:

Keefer, W.R., and Van Lieu, J.A., Paleozoic formations in the Wind River Basin, Wyoming, U.S. Geol. Survey Pro. Paper 495-B. (Being reviewed in Washington, D.C.)

Keefer, W.R., Stratigraphy and geologic history of the uppermost Cretaceous, Paleocene and lower Eocene rocks of the Wind River Basin, Wyoming: U.S. Geol. Survey Pro. Paper 495-A. (Being processed for publication)

_____, Geologic history of the Wind River Basin. To be published in a special volume issued by the American Association of Petroleum Geologists.

_____, Structure of the south flank of the Gros Ventre Mountains: U.S. Geol. Survey Pro. Paper. (In press; should appear before the end of the biennium)

_____, Structural geology of the Wind River basin. (Map with text in preparation)

Keefer, W.R., and Case, James, Gravity survey of the Wind River basin. (Work completed, report in preparation)

Love, J.D., Geology of the Granite Mountains, central Wyoming: U.S. Geol. Survey Pro. Paper 495-C. (Manuscript being completed)

Love, J.D., Van Lieu, J.A., and Keefer, W.R., Stratigraphy of pre-Meeteetse Mesozoic rocks in the Wind River basin, Wyoming: U.S. Geol. Survey Pro. Paper 495-D. (In preparation)

Love, J.D., Wilson, W.H., Houston, R.S., and Simons, E.L., Dating of Eocene and Oligocene pyroclastic rocks near source areas in the Absaroka Range: U.S. Geol. Survey Pro. Paper. (Being edited)

In order to properly complete a project on the Tertiary rocks of southeastern Wyoming, and since neither the State nor Federal geological surveys had funds available for this use, financial assistance was solicited from the Natural Resource Board. A grant was given by the Board, and Dr. P.O. McGrew was engaged as the State Survey's representative to work on the project in cooperation with Dr. Norman Denson, the Federal Survey's representative. Work on the project is nearing completion and its value has already been proved, since we were able to furnish the U.S. Army Corps of Engineers with a geological map covering most of the area in which Minuteman missile sites have been constructed, thereby saving hundreds of man-hours of work by their own geologists. The project will also prove invaluable in ground water studies, since these rocks occupy the surface over most of southeastern Wyoming.

Cooperation with Northern Rocky Mountains Branch. - In 1942 a branch office of the U.S. Geological Survey was established in Laramie and located in the Geology Building at the University. No fund matching is involved in this cooperative program. Dr. J.D. Love is research geologist and supervising geologist, and Mrs. Laura McGrew and Mr. J.A. Van Lieu are geologists. A secretary completes the staff. Since the establishment of the office, 41 maps, charts and bulletins pertaining to Wyoming geology have been issued as Federal documents prepared in cooperation with the Geological Survey of Wyoming and the Department of Geology of the University of Wyoming. Seven publications by the Geological Survey of Wyoming have resulted.

Reports which were issued during the biennium are as follows:

Keefer, W.R., and Troyer, M.L., 1964, Geology of the Shotgun Butte area, Fremont County, Wyoming: U.S. Geol. Survey Bull. 1157, 123 pp., 4 tables, 16 figs., 3 pls.

Love, J.D., 1964, Uraniferous phosphatic lake beds of Eocene age in intermontane basins of Wyoming and Utah: U.S. Geol. Survey Pro. Paper 474-E, 66 pp., 17 tables, 22 figs., 5 pls.

McGrew, Laura, 1963, Geology of the Fort Laramie Area, Platte and Goshen Counties, Wyoming: U.S. Geol. Survey Bull. 1141-F, 39 pp., 4 tables, 5 figs., 3 pls.

Privasky, Norman, 1963, Geology of the Big Piney area, Sublette County, Wyoming: U.S. Geol. Survey Oil Map 205.

Work in progress includes geological maps of 10 quadrangles in Platte and Goshen Counties prepared by Laura McGrew which are now being processed in Washington, D.C. The Four Corners quadrangle in Crook and Weston Counties is being mapped by J.A. Van Lieu.

COOPERATION WITH OTHER FEDERAL AGENCIES

U.S. Bureau of Mines. - In 1953, the State Geological Survey entered into a formal agreement with the U.S. Bureau of Mines for the annual collection of basic data on Wyoming mineral production. A new 5-year agreement for the continuation of this work was consummated in March, 1962. Each year a pamphlet is issued by the Bureau of Mines, in which it is indicated that the work was prepared in cooperation with the Geological Survey of Wyoming, containing data on mineral production and valuation, as well as discussions of new developments in the State. Briefer preliminary reports are also issued. Those which have appeared during the biennium are:

Everett, F.D., Jan. 2, 1963, Mineral production in Wyoming in 1962, Preliminary annual figures: U.S. Bureau of Mines Preliminary Area Report, 5 pp., 1 table.

_____, 1963, The mineral industry of Wyoming: pre-print from Bureau of Mines Yearbook for 1962, 26 pp., 12 tables.

_____, Jan. 2, 1964, Mineral production in Wyoming in 1963, Preliminary annual figures: U.S. Bureau of Mines Preliminary Area Report, 7 pp., 1 table.

_____, 1964, The mineral industry of Wyoming: pre-print from Bureau of Mines Mineral Yearbook for 1963, 29 pp., 13 tables.

Meeves, H.C., Jan. 4, 1965, Mineral production in Wyoming in 1964, Preliminary annual figures: U.S. Bureau of Mines Preliminary Area Report, 5 pp., 1 table.

Close, but informal, cooperation is carried on in other ways. Deposits of certain minerals which need core drilling, or other subsurface development, have been brought to the attention of the Bureau of Mines and, if warranted, that agency has carried on subsurface exploratory work. There has been a free interchange of information between the Bureau of Mines and the State Geological Survey.

The Petroleum Research Center, located on the campus, has been especially helpful to the State Geological Survey in many ways. A large number of oil shale samples have been assayed for us by the Center without cost.

U.S. Coast and Geodetic Survey. - Since 1941 the State Geologist has served as Collaborator in Seismology and has collected reports on earthquakes felt in Wyoming. A fine seismograph has now been installed in the Geology Building by the Geology Department, and reports on the earthquakes registered are forwarded daily to the Coast and Geodetic Survey. Average frequency of quakes recorded is two per day. Few of these have their epicenters in Wyoming; other parts of the world are much more active seismically. A knowledge of earthquake frequencies in Wyoming is of value in the establishment of equitable insurance rates involving earthquake coverage. The station here has also participated in the study and detection of waves created by atomic blasts.

Other agencies. - The State Geological Survey is called upon occasionally to supply geological information to many other Federal agencies, such as the Soil Conservation Service, the Grazing Service, the Reclamation Bureau, the Department of Commerce, the U.S. Army Corps of Engineers, and others. Data have been supplied to Congressional Committees and to other Federal groups or committees.

COOPERATION WITH UNIVERSITY AGENCIES

Department of Geology. - The intimate interrelationship of the Geological Survey and the Department of Geology has been pointed out earlier in this report. It should be pointed out further, however, that the field research undertaken by graduate students is of great value to the Geological Survey. These results are made available to us early. Many of the resulting theses have been published by the Geological Survey. In turn, the Geological Survey has assisted students in defraying field expenses on projects in which the Survey is interested, or by supplying thin sections or polished surfaces.

The graduate students constitute a valuable store of part-time assistance for the Survey. They have been employed to catalog oil well samples, plot oil well logs, draft geological maps and illustrations, and to undertake other assignments. The students, in turn, receive useful experience in applied geology. If it were not for the high-quality part-time help available through the employment of graduate students, the full-time staff would have to be considerably larger.

Although the State Geological Survey underwrote the thesis work of a good many graduate students during the biennium, dozens of other graduate students undertook research on the geology of Wyoming at their own expense, the investigations serving as part of the requirements for advanced degrees. The results of all these investigations are immediately available to the Survey.

Natural Resources Research Institute. - The Natural Resources Research Institute was established to carry on scientific research on the utilization of the natural resources of the State. The Geological Survey and the Natural Resources Research Institute work in close cooperation on mineral resources, and the State Geologist is a member of the Advisory Committee of the Institute. The Geological Survey may bring to the attention of the Institute any mineral deposits whose quality or uses might be determined through laboratory investigations. In turn, the Institute supplies the State Geological Survey with needed analytical information on mineral specimens submitted as an aid in determining the potentialities of certain deposits.

COOPERATION WITH STATE DEPARTMENTS

Natural Resource Board. - The State Geological Survey stands ready to cooperate with the Natural Resource Board in any possible manner on the mineral resources of the State or in engineering or ground water problems on which geology has a bearing. The Geological Survey has supplied data on mineral deposits, made examinations of potential dam sites, conferred on ground water problems, and participated in public conferences held over the State on natural resources. In turn, the Natural Resource Board paid most of the cost of compiling and printing Geological Survey of Wyoming Bulletin 50, "Mineral Resources of Wyoming". In addition they have given financial aid to help complete the study of the Tertiary rocks of southeastern Wyoming.

Commissioner of Public Lands. - Prior to the issuance of permits for the collection of fossils in Wyoming, which are obtained from the State Commissioner of Public Lands, the endorsement of the State Geologist is necessary. The Geological Survey also has been called upon to offer opinions on mineral associations in respect to State mineral leases, or on the mineral or nonmineral character of certain lands. These are strictly geological matters, and each one appears to constitute an individual problem.

State Highway Department. - From time to time the Geological Survey is asked to collaborate on problems in engineering geology which confront the Highway Department.

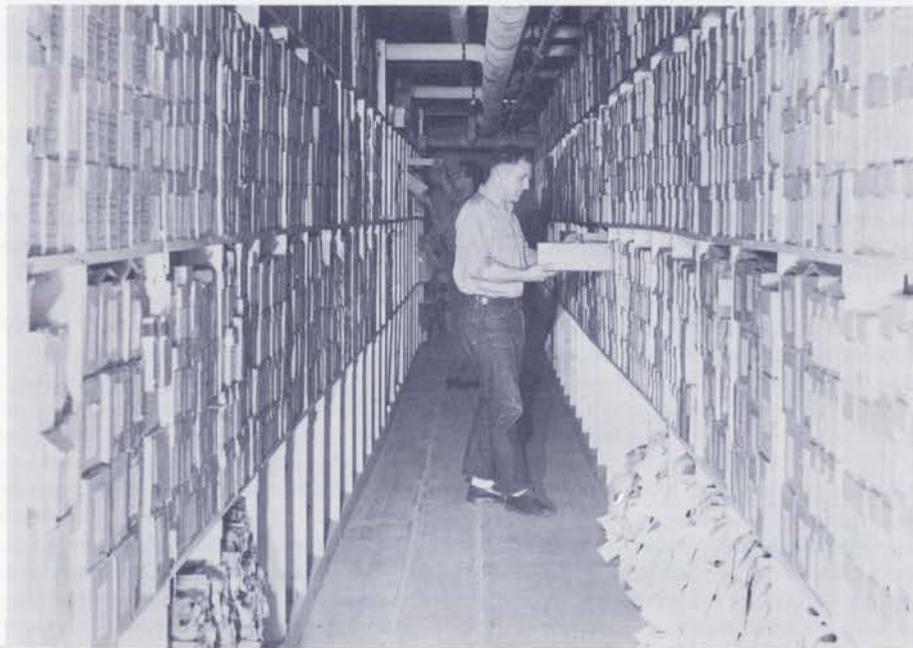
State Game and Fish Commission. - Through the years the Geological Survey has assisted the Game and Fish Commission, principally on problems of water supply for hatchery use or in dam site investigations.

Oil and Gas Conservation Commission. - The State Geologist, by law, is a member of the Oil and Gas Conservation Commission.

OIL WELL SAMPLE REPOSITORY

The Geological Survey's oil well sample repository contains a very important collection of cuttings and cores from deep wells drilled over the State. The collection has been accumulated through the cooperation of oil companies operating in Wyoming who have donated samples and cores in the belief that they will be properly catalogued, stored, and preserved for the future at the University.

The repository contains catalogued sets of samples from over 937 wells drilled in Wyoming representing 6,103,680 feet, or 1,156 miles, of drilled hole. The collection also contains samples from 310 wells drilled in neighboring states, representing 332 miles of drilled hole. The cost of drilling the wells from which the samples came was probably somewhere between \$75 and \$100 million. Samples are commonly the only tangible result of large sums of money spent in drilling deep dry holes.



Partial view of oil well storage bins. There are five rows of bins, each row 70 feet long. Additional samples are stored in a steel building adjacent to the Geology Building.

The samples are useful in the further search for oil, particularly now that subsurface data are being used in Wyoming as the main tool in exploring for stratigraphic type fields. Many petroleum geologists visit the repository to examine sets of samples, or the Geological Survey will send sets elsewhere for examination. The samples also give valuable information on the depth, thickness, and character of water-bearing sands.

The University Board of Trustees has recognized the importance of the repository by allowing 2,000 square feet of space in the basement of the Geology Building in which storage bins were built by the University. Subsequently the Board of Trustees assigned a Butler Hut near the Geology Building to the Geological Survey, and again paid for the erection of storage bins, since space in the basement is already

filled. Storage space is now nearly exhausted.

A number of important acquisitions have been made recently. All the cores from 13 holes drilled for trona exploration in the Green River Basin, at a cost exceeding a million dollars, were donated by the Diamond Alkali Company and the Olin Mathieson Chemical Company. Through a special grant made by the Board of Trustees to the Geology Department, it was possible to transport the 20,278 feet of cores from Green River to Laramie for storage in the Survey's repository. The cores have already served as basic data for one graduate thesis, and in the future will serve in many more research investigations.

The Mountain Fuel Supply Company donated cores from their North Baxter Basin deep test and paid all trucking charges to transport the cores from Rock Springs to Laramie. The well was cored continuously with diamond bits from a depth of 6,404 feet to the total depth of 9,290 feet. The cores exhibit the rock section from near the top of the Weber sandstone almost to the base of the Cambrian rocks. The value of the cores can be appreciated when it is realized that the nearest surface exposures of these rocks are in the Uinta Mountains, about 50 miles south of the well; in the Wind River Range, about 65 miles north of the well; in LaBarge Ridge, about 75 miles northwest of the well; and in the Rawlins uplift, about 95 miles east of the well. The cores constitute the only record of the formations penetrated within an area of about 6,000 square miles.

A 10,000-foot well was completed in January, 1965, which was drilled in the crystalline Precambrian rocks of the Wind River Mountains near Pinedale by the United States Air Force. No well in Wyoming has ever penetrated Precambrian rocks to such a depth. The cuttings and cores from this well have been donated to the State Geological Survey and research on them will provide a great deal of previously unknown information.

The cuttings from 40 important wells scattered over the State were recently donated by The California Oil Company and constitute a valuable addition to the collection.

PUBLIC EDUCATION

Wyoming industrial rock and mineral sets. - Sets of 16 important Wyoming rocks and minerals have been prepared in special compartmented boxes. Composition, properties, uses, and occurrences are given inside the lid. These sets are available to Wyoming secondary schools for instructional purposes. A simplified brochure on Wyoming mineral resources has been prepared for use in conjunction with the sets of specimens. In order to fill the many requests received from out-of-state teachers, school children, and other interested persons for specimens of Wyoming rocks or minerals, special sets of two specimens have been prepared, and hundreds of these have been distributed during the biennium.

Tourist information. - The hobby of "rock hounding" has become a very popular one in recent years and there are literally millions of persons who are amateur mineralogists or paleontologists and lapidarists. Many of these persons come to Wyoming as tourists and prior to their visits ask for information on the occurrences of rocks, minerals, and fossils in the State. A mimeographed pamphlet has been used to fill such requests, but the need for a better, more comprehensive one is apparent. Dr. Wilson has now completed the manuscript for what will be an illustrated publication titled, "A field guide to Wyoming rocks and minerals". It will be useful not only to rock hounds, but to students as well.

There is a need, also, for a companion guide to Wyoming fossils, but this can be done only when a qualified person can be found to prepare such a publication. As future projects, we have planned on the compilation of popular guides to the geology of State parks, mountain ranges, and other areas of geological interest.

PUBLIC SERVICES

Office callers. - Almost every day representatives of oil and mining companies or other individuals interested in mineral resources call at the Geological Survey offices. One of the most effective points in handling these callers is that here in one building such persons may take advantage of advice and information available from the staffs of the State Geological Survey, the U.S. Geological Survey and the Department of Geology of the University. In addition, it is possible for such persons to confer also with other agencies located on the campus, such as the Bureau of Mines Petroleum Research Center, the Natural Resources Research Institute, the Engineering College, or other departments.

Correspondence. - A large volume of inquiries seeking information on Wyoming mineral resources, petroleum geology, and geology in general is received daily by the office. Properly answering this mail constitutes an imposing chore which becomes more burdensome each year.

Topographic sheets. - The Geological Survey carries a supply of the topographic maps covering Wyoming. These are useful to hunters, fishermen, campers, prospectors, ranchmen, tourists, and others, and many hundreds of copies are distributed each year.

Air Photos. - The entire State has aerial photographic coverage, but because of the cost of such photos it has been impossible to purchase more than a fraction of all the available ones. It is hoped that by adding to the air-photo library from time to time, it will eventually be possible to obtain complete coverage. These photographs are very useful to anyone seeking information on surface features, or the geology, of specific areas.

PUBLICATIONS, MAPS AND REPORTS

Geological examinations have little value unless the accumulated information is made available to the public. Every effort has been made, within limited resources, to publish printed reports on the results of projects of major magnitude. About 300 copies of each publication are deposited in libraries in the United States and foreign countries. Other copies are distributed to individuals, corporations, agencies, and others on request.

Unpublished reports are placed on open file for public examination and photocopies are available to interested parties. Copies of more comprehensive unpublished reports are placed in the Geology Library where they may be consulted or borrowed.

Copies of unpublished regional geological maps made by more than 200 graduate students at the University as part of the requirements for advanced degrees are available to the public through the Geological Survey. Over the years thousands of these maps have been distributed, principally to oil companies.

Along with increased activity in petroleum and uranium exploration in Wyoming, there has been increased demand for our publications. Many of the earlier ones are now out of print and no longer available for distribution.

Miscellaneous publications. - In addition to the publications listed earlier in this report, a number of other publications have arisen in, or been distributed, by the State Geological Survey during the biennium, and these are listed below.

Houston, R.S., 1963, Non-paleontological methods of correlation of rocks of Tertiary age in Wyoming; Part II - Glass shards: Contribs. to Geol., Univ. Wyo., Vol. 2, No. 1, pp. 81-86.

_____, 1964, Non-paleontologic correlation of rocks of Tertiary age in Wyoming; Part III - The petrographic calendar: Contribs. to Geol., Univ. Wyo., Vol. 3, No. 1, pp. 15-26.

Lawrence, John C., 1963, Origin of the Wasatch formation, Cumberland Gap area, Wyoming: Contribs. to Geol., Univ. Wyo., Vol. 2, No. 2, pp. 151-158.

Love, J. D., McGrew, Paul, O., and Thomas, Horace D., 1963, Relationship of latest Cretaceous and Tertiary deposition and deformation to oil and gas occurrences in Wyoming: Geol. Survey Wyo. Reprint No. 21 (Reprinted from Backbone of the Americas, American Association of Petroleum Geologists, Tulsa, Okla.)

Thomas, Horace D., 1963, Samuel Howell Knight: Contribs. to Geol., Univ. Wyo., Vol. 2, No. 1, pp. 1-6. (This number was dedicated to Dr. S. H. Knight in commemoration of his service as Professor of Geology at the University of Wyoming, 1916-1963)

LECTURES AND ADDRESSES

Houston, R. S.

Structure of Precambrian rocks of the Medicine Bow Mountains and its relationship to post-Precambrian structural patterns: American Association of Petroleum Geologists, Rocky Mountain Section, Casper, 1963.

Thomas, Horace D.

Geologic history and petroleum resources of the Wind River Basin, Wyoming: American Institute Mining Engineers, Wyoming Mining and Metals Section 8th Annual Uranium and Minerals Symposium, Riverton, 1963.

Geologic history of southeastern Wyoming: Rocky Mountain Association of Geologists Field Conference, Cheyenne, 1963.

Geological Survey work in the further development of our ground water resources: Wyoming Water Development Association, Annual meeting, Casper, 1963.

Wilson, William H.

Lecture series on the Absaroka volcanic rocks: Conference on structures and origin of volcanic rocks of Montana, Wyoming, and Idaho, sponsored by National Science Foundation, Red Lodge, Montana; August, 1963, July, 1964.

Geology and mineral exploration in the Absaroka Range, northwestern Wyoming: Wyoming Mining Association, Sheridan, 1964.

NATIONAL COMMITTEES

During the biennium the State Geologist served on a number of committees of national organizations, as follows:

American Association of Petroleum Geologists
Committee on Professional Standards (1963-65)
Research Committee (1963-65)

Interstate Oil Compact Commission
Research Committee (1963-65)
Committee on Secondary Recovery and Pressure
Maintenance (1963-65)

Geological Society of America
Associate Editor for Rocky Mountain Region (1963-65)

American Institute of Professional Geologists
Committee on Arrangements, 1965 Meeting
Coordinator for State of Wyoming, 1964 -

EPILOGUE

The State Geologist will complete his 24th year of office on March 1, 1965. During the 24 years, the writer has served under nine Governors -- Smith, Hunt, Crane, Barrett, Rogers, Simpson, Hickey, Gage and Hansen. The years of service to the State have been pleasant ones. Although there have been times when it appeared that little progress was being made, it is apparent today that our comprehension of Wyoming geology is immeasurably better than it was in 1941. This increased knowledge is the result of the combined efforts of the many geologists who have worked in the State -- State and Federal geologists, staff members and students from this and many other universities, and petroleum and mining geologists. There remains much to be learned, however.

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