GERALD FITZGERALD*
Chief Topographic Engineer
U.S. Geological Survey (Ret.)

USGS Mapping: A Historical Review

Gerald FitzGerald.

I WOULD LIKE to thank Rupe Southard for asking me to take part in this program to commemorate the Survey in its first 100 years of mapping.

Let's take a brief look at the 12 years preceding the founding of the Geological Survey and some of the problems that led to its organization. Following the Civil War, interest increased in exploratory surveys of the West and several organizations were created. These included the United States Geological and Geographical Survey of the Territories, directed by Professor Hayden under the Department of the Interior; the Geographical Survey West of the 100th Meridian, directed by George M. Wheeler, Corps of Engineers, under the War Department; the U.S. Geographical and Geological Survey of the Rocky Mountain Region, directed by Major J. W. Powell under the Smithsonian Institution, which was in part supported by the federal government; and the U.S. Geological Expedition of the 40th Parallel, directed by Clarence King under the War Department.

These four Surveys are commonly referred to by the names of their respective Directors as the Hayden, Wheeler, Powell, and King Surveys. All were exploratory and were competing for federal appropriations without having any well-defined boundaries between their fields of operation. They did, however, produce the first comprehensive maps covering large areas of the western United States. Astronomic observations were made, base lines were measured, and a system of triangulation extended over the area mapped. Contour lines were used in representing physiographic forms on maps of quadrangle areas, usually on a scale of 4 miles to the inch. Although the equipment then available did not permit a high degree of accuracy, the resulting maps were a great improvement over any that had been produced up to that time. The four Surveys have been described in detail by Richard A. Bartlett in a book called *Great Surveys of the American West*, which was published in 1962.

I have not attempted to describe the square miles covered by the four surveys of the west because they included such vast areas and overlap so much. Instead, I am using a sketch prepared by Dwight Rutledge of the Geological Survey several years ago in Menlo Park, which not only portrays graphically the areas covered, but also some of the problems that resulted (Figure 1).

During the period from 1867 to 1879, more progress was made in geographic research than in any other period of equal length thus far in American history. In 1878, Congress, in an effort to consolidate the individual Surveys of the West, requested the National Academy of Sciences to make an investigation of the methods and costs of such Surveys and to submit to the Congress a plan for effecting the necessary coordination and consolidation. As a result of the National Academy's recommendation, Congress, on March 3, 1879, created the United States Geological Survey (USGS). Clarence King was appointed first Director of the USGS and served for one year. He was followed by Major J. W. Powell, who was appointed Director in March of 1881, and served until 1894. Henry Gannett was in charge of mapping for the USGS and the men who followed him were dedicated and in most cases had gained wide experience in topographic mapping and related problems.

* This paper was tape recorded at Mr. FitzGerald's home for presentation at the Plenary Session.

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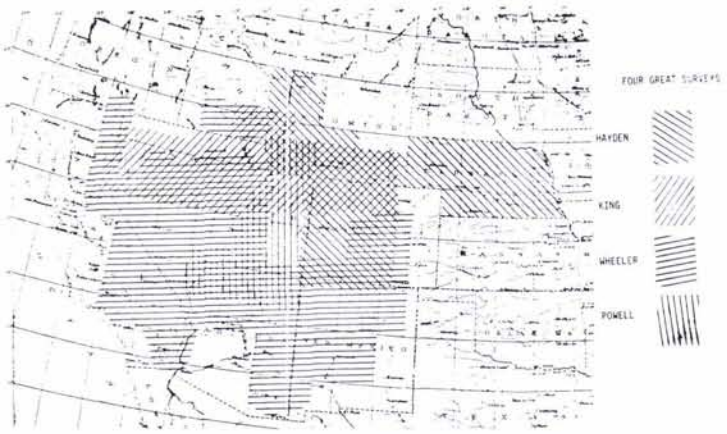

FIG. 1. Surveys of the American West, 1867–1879.

In the early years of the USGS, topographic mapping was carried on with the same type of equipment that had been used for the exploratory surveys. Following a study of mapping scales employed in Europe, multiples of the 1:1,000,000-scale were adopted. These included 1:250,000 for the 1° quadrangles, 1:125,000 for the 30-minute quadrangles, and 1:62,500 for the 15-minute quadrangles. The plan was worked out and adopted by Gannett and members of his organization to cover the entire country in a systematic manner by needed quadrangle mapping. Small scales were used initially but have been gradually increased for more detailed surveys of important areas.

Instruments used on these earlier surveys were a crudely improvised plane-table board with a tripod, an 8-inch open-sight alidade, and a light mountain transit having a striding level and a 3-inch horizontal and vertical circle. A portable mercurial barometer was used to determine the elevation of each instrument station and an aneroid barometer was used for secondary points along the line of traverse between stations. Distances were measured by counting the paces of mules or the revolutions of a cartwheel (Figure 2). In 1886, members of the USGS designed the telescopic alidade and the Johnson tripod. After this, the old barometer was discarded and elevations were determined by vertical angles with the aid of the newly perfected Beaman stadia arc. Graphic triangulation by the planetable method increased the accuracy of these early reconnaissance maps (Figure 3).

Immediately following World War II there

FIG. 2. Redick H. McKee, topographer, 1898–99, showing equipment for a mounted topographer.

FIG. 3. Topographer illustrating the use of a planetable, ca. 1905.

was an increasing demand for considerably more topographic map coverage, especially for maps on larger scales and with a higher degree of accuracy (Figure 4). The Geological Survey undertook a thorough reorganization of its Topographic Branch to meet these urgent post-war requirements. In the Washington office, two special staff divisions were set up: a Plans and Coordination Division to work out a comprehensive plan in considerable detail for expediting a National Mapping Program, and a Research and Technical Control Division with the responsibility of modernizing mapping methods and specifications to meet current needs and to conduct much-needed research in the development of new techniques. These two staff divisions were composed of men who had many years of experience and who, for the most part, were recognized authorities in their special fields.

Operations were carried on by three principal field divisions: the Atlantic Division located in Arlington, Virginia; the Central Division located in Rolla, Missouri; and the Pacific Division located originally in Sacramento but later transferred to Menlo Park, California. Immediately following the initial phases of the new organization, it was found advisable to re-establish a fourth office, the Rocky Mountain Mapping Division, which was located in Denver, Colorado. This Division, in addition to its work in the western States, was also headquarters for the Alaskan mapping program. The operating personnel of the Topographic Branch increased from approximately 700 skilled employees in 1945 to more than 2,500 in 1948.

The Temple Act, enacted by Congress in 1925, called for a 20-year National Mapping Program. Although this program was actively supported by professional and engineering organizations throughout the country, funds were not provided in the succeeding years to implement it. Consequently, the Survey's mapping operations were dependent entirely on relatively small Congressional appropriations, transfers from other agencies, and State cooperative offerings. It is interesting to note that in the 60-year period from 1888 to 1948 funds directly appropriated to the Survey for topographic mapping amounted to approximately $33,000,000. This amount was increased through transfers and State cooperative mapping programs by about $37,000,000, making a total of $70,000,000 for the entire 60 years.

I joined the Geological Survey on August 5, 1917 as a rodman. After they had fed me for a few weeks, they couldn't get rid of me. I became a Survey camp follower: Washington, Oregon, California, and way stations. Following a brief hitch in the West Indies and Texas, I was sent to Alaska in 1921. From then on for the next 20 years I became a sourdough doing small-scale exploratory mapping of remote areas—and loved it. Much of our early field season mapping was north of the Arctic Circle where we used dog teams and snow shoes for winter transportation and canoes for summer work. There was a brief interlude in 1942 when I was commissioned in the Army Air Corps and assigned to the Aeronautical Chart Service. I served in this organization until 1946 when I was relieved from active duty to re-

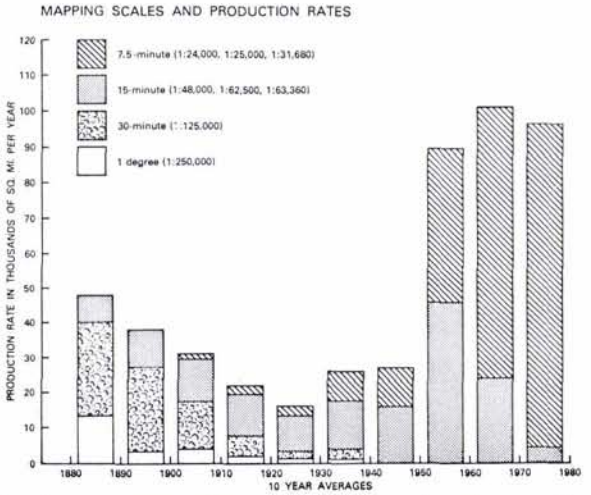

FIG. 4. USGS map scales and production rates shown as ten-year averages, 1884–1890.

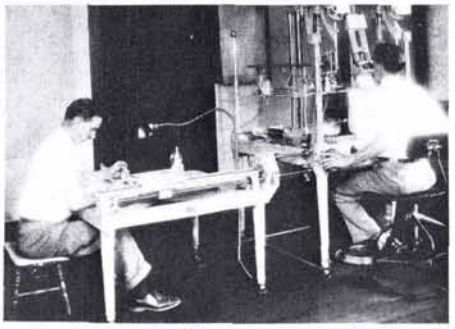

FIG. 5. Hugershoff Aerocartograph, the first photogrammetric plotter used by USGS, was introduced in 1928.

FIG. 7. C. R. Lloyd, topographer, and R. Chassion, pilot, members of a USGS field party on toadstool formation in Orange Cliffs area, Utah.

turn to the Survey as a staff topographic engineer. As a result of Tom Pendleton's illness, I was appointed Chief Topographic Engineer by William Wrather, the Director on May 22, 1947.

Due largely to the ravages of World War II, the Survey as a whole and the Topographic Branch in particular suffered from lack of personnel and shortage of funds. Thanks to the effort of our Directors, both situations were steadily improved and much new modern equipment was obtained. Two of my immediate predecessors, Col. Birdseye and T. P. Pendleton, had introduced photogrammetric equipment and techniques into our mapping system (Figures 5 and 6). Since the late 1930's, as a matter of fact, most mapping projects of the Federal Government and private agencies have used aerial photographs in some form to assist in their work.

One of our post-war problems was the standardization of the National Mapping Program. This involved scales, contour intervals, and many other accepted specifications. And, of course, this required full cooperation between the Washington staff and the four regional offices across the country. As I remember, this coordination was not always easy to achieve. It was a major hassle to bring the regions into a realization that we had a national program and, if we were to survive, we had to accept the fact.

At the same time, we were asked to provide personnel and equipment to some of our foreign friends who needed help. We did set up an inter-departmental committee which formulated the first comprehensive plan to map the Antarctic continent. During

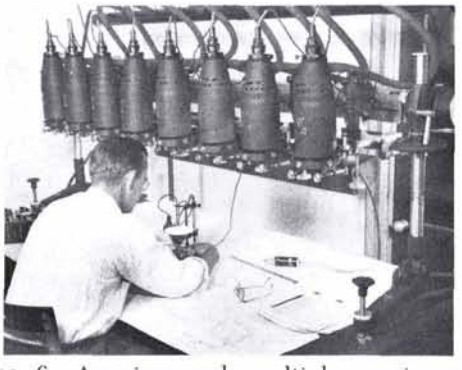

FIG. 6. American-made multiplex equipment used by USGS in the 1940's.

FIG. 8. Directors of the U.S. Geological Survey.

this period the Topographic Branch began to use helicopters to aid topographic control surveys in the field, which permitted more efficient use of key personnel (Figure 7). This, combined with the use of airplanes to transport fieldmen and equipment, speeded up our work in remote areas and especially in Alaska. State advisory groups were fostered and encouraged to assist in planning their own State programs and also our National Mapping Program.

During this post-war period, two national organizations were destined to play an important part in mapping problems and research. They were the American Society of Photogrammetry, which was originated by Scott Reading of the Coast and Geodetic Survey and was supported by many others in and out of Federal service, and also the American Congress on Surveying and Mapping, a brain child of Robert Randall, then of the Bureau of the Budget. This organization also won widespread support throughout the mapping world.

I retired on September 30, 1957 after serving 40 years under four of the outstanding Directors of the United States Geological Survey: George Otis Smith, Walter C. Mendenhall, William E. Wrather, and Thomas B. Nolan (Figure 8).

I regret very much that I couldn't be here today, especially to greet Al Quinn and other old friends of long ago. However, I realize that taping this review has some advantages. No one can ask me questions, at least not in person.

Notice to Contributors

1. Manuscripts should be typed, double-spaced on 8½ × 11 or 8 × 10½ white bond, on *one* side only. References, footnotes, captions—everything should be double-spaced. Margins should be 1½ inches.
2. Ordinarily *two* copies of the manuscript and two sets of illustrations should be submitted where the second set of illustrations need not be prime quality; EXCEPT that *five* copies of papers on Remote Sensing and Photointerpretation are needed, all with prime quality illustrations to facilitate the review process.
3. Each article should include an abstract, which is a *digest* of the article. An abstract should be 100 to 150 words in length.
4. Tables should be designed to fit into a width no more than five inches.
5. Illustrations should not be more than twice the final size: *glossy* prints of photos should be submitted. Lettering should be neat, and designed for the reduction anticipated. Please include a separate list of captions.
6. Formulas should be expressed as simply as possible, keeping in mind the difficulties and limitations encountered in setting type.

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