Highlights of U.S. Geological Survey Activities in Photogrammetry and Remote Sensing

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INTRODUCTION

THE U.S. GEOLOGICAL SURVEY is proud to have been a part of the development of photogrammetry and remote sensing in the United States, and I welcome this opportunity to congratulate the American Society of Photogrammetry on its 50th anniversary. We have shared numerous scientific, technical, and program developments and many individuals have been, and continue to be, deeply involved in both organizations.

The professional contributions of the Society to the sciences of photogrammetry and remote sensing are of vital interest to the Geological Survey, and we are honored to be given the opportunity to record our accomplishments over the past five decades.

EARLY HISTORY

The U.S. Geological Survey (USGS) has used photogrammetric methods since 1904 when two of its staff members, C. W. Wright and his brother F. E. Wright, first used a panoramic camera for topographic surveys in Alaska. The first cameras used by the Wrights (1904) were improvised from commercial instruments by the addition of level bubbles and internal scales. In 1907, C. W. Wright had a camera constructed specifically for the purpose of surveying (Figure 1). Another staff member, J. W. Bagley, redesigned and improved this type of camera for reconnaissance mapping in Alaska. Bagley also designed a panoramic photoalidade (Figure 2) to facilitate the use of the panoramic pictures in map-making. Bagley's instrument was the basis for the Wilson photoalidade (Figure 3), built in the 1930's and used extensively by USGS.

In 1916-17, Bagley developed a tri-lens camera for aerial photography (Figure 4), and his colleague, F. H. Moffit, designed a transforming camera for tri-lens camera negatives. The following year, the USGS participated with the Corps of Engineers and the Army Air Service in a program of photographing, with the tri-lens camera, several strips of country between aviation fields for the purpose of making aeronautical charts. In 1918 the Survey cooperated with the Air Service in experiments with a gyroscopically controlled camera; the resulting equipment achieved control of the camera axis within 2°.

In the spring of 1920 the Geological Survey used the tri-lens camera for a systematic aerial survey of parts of Santo Domingo and Haiti. In the same year the Schoolcraft, Michigan, quadrangle was successfully mapped with the aid of single-lens-camera aerial photographs supplied by the Army Air Service. The photographs were used to delineate planimetry on the field sheets; the contours were then added by topographers on the ground. Following the success of this project, the method was applied to other quadrangles.

In 1921 the Section of Photographic Mapping was established in the Topographic Branch of the Geological Survey. In addition to the production of planimetric base maps, this Section soon turned part of its efforts to stereotopography. A semiautomatic stereoscopic plotting instrument, the stereoautograph, was received from Germany in 1921 and tested by the USGS. This instrument used terrestrial photographs only, and while workable, did not prove economical. A second instrument, the Hugershoff Aerocartograph (Figure 5), was imported from Germany in 1927; this was the first optical-mechanical stereoscopic plotting instrument capable of utilizing aerial photographs to be owned by the U.S. Government. Following a number of experimental projects, the Aerocartograph was assigned to a program of complete map compilation in 1930.

GROWTH OF PHOTOGRAMMETRIC MAPPING

The growing importance of photogrammetric methods had been recognized with the inclusion of a 40-page chapter on "Map Compilation from Aerial Photographs," by T. P. Pendleton, in the *Topographic Instructions* of the USGS. The Survey also published, in 1929, a report on the Alaskan Aerial Survey Expedition of 1926, in which it participated with the U.S. Navy and other Federal agencies (Figure 6).

When the Tennessee Valley Authority was established in 1933, one immediate need was map coverage of the entire valley. In cooperation with the TVA, the USGS prepared planimetric maps of this area using five-lens-camera aerial photographs and radial line plotting methods. The planimetric maps filled the immediate need, but there remained a long-range need for complete topographic maps.

Although the Aerocartograph produced satisfactory contour maps, its initial cost was high and it was mechanically complex. The multiplex plotting equipment effectively overcame these disadvantages, and in 1935 the USGS purchased its first multiplex equipment. After some experimentation the value of these German-made instruments was sat-

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PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING,
Vol. 50, No. 9, September 1984, pp. 1323-1331.
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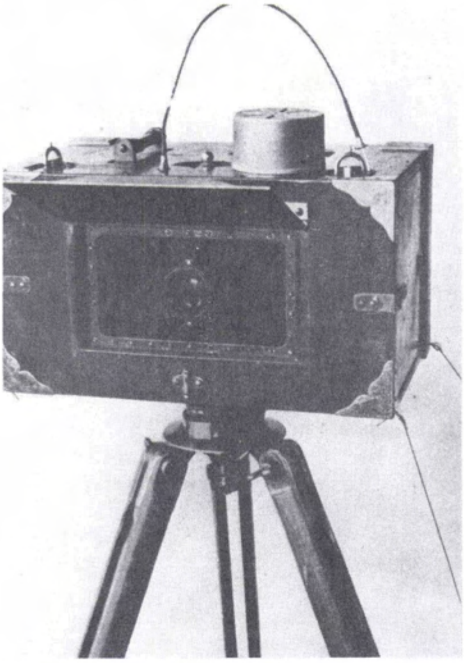


FIG. 1. The first panoramic camera used by the USGS was constructed by C. W. Wright in 1904. The improved 1907 version illustrated here employed a mechanism to insure that all elements of the cylindrical surface of the film were perpendicular to the horizontal level plane and parallel to the axis upon which the lens rotated. Level bubbles were fitted and three leveling screws were used in connection with an adapter plate that fitted a planetable tripod.

FIG. 3. Plotting Alaska map detail with a Wilson photoalidade, designed by R. M. Wilson in 1932. Its precursor was a panoramic photoalidade developed by J. W. Bagley between 1910 and 1916. The illustrated instrument is operated by gerald FitzGerald who later became Chief Topographic Engineer of USGS and 12th President of the American Society of Photogrammetry. This same instrument No. T.1. was the one whose facility for measuring on oblique photographs sparked the idea which grew into the Trimetropor System.

isfactorily demonstrated, and in 1936 a fully equipped USGS-TVA multiplex mapping office (Figure 7) was established in Chattanooga with a program of topographic mapping of the entire Tennessee River Valley. Beginning in 1940 improved multiplex equipment made in the United States was installed in a newly established office in Arlington, Virginia, and a revolutionary transition in basic mapmaking, from field methods to photogrammetric methods, gained full impetus.

During the war years of 1941-1945, the USGS performed numerous strategic mapping assignments of the highest importance, using its well-established photogrammetric plant and personnel. Many staff members were called into service and

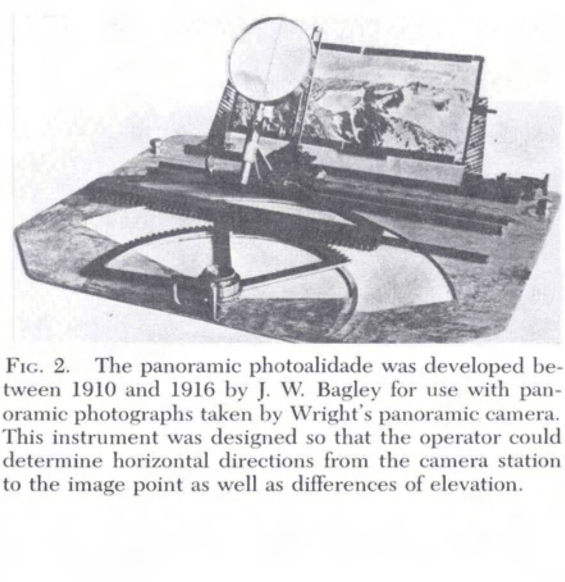


FIG. 2. The panoramic photoalidade was developed between 1910 and 1916 by J. W. Bagley for use with panoramic photographs taken by Wright's panoramic camera. This instrument was designed so that the operator could determine horizontal directions from the camera station to the image point as well as differences of elevation.

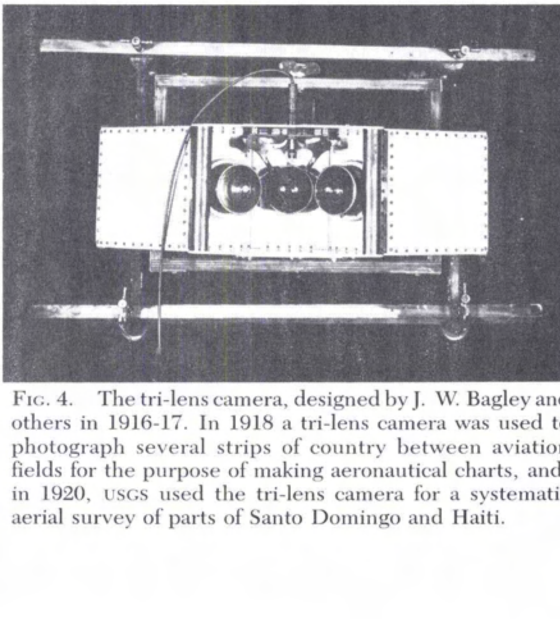


FIG. 4. The tri-lens camera, designed by J. W. Bagley and others in 1916-17. In 1918 a tri-lens camera was used to photograph several strips of country between aviation fields for the purpose of making aeronautical charts, and, in 1920, USGS used the tri-lens camera for a systematic aerial survey of parts of Santo Domingo and Haiti.

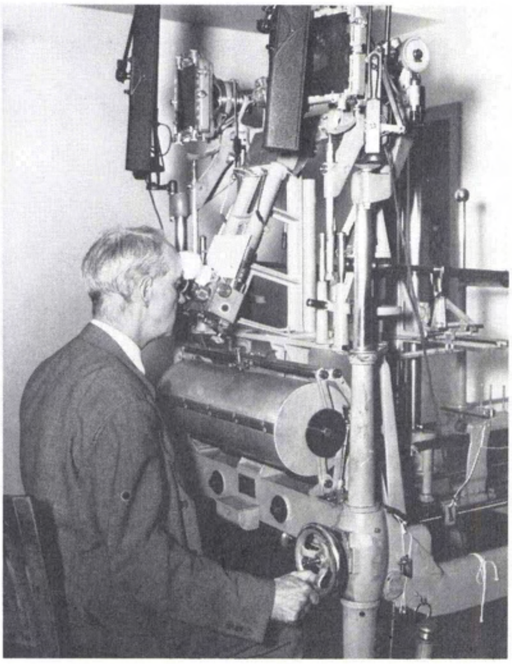


FIG. 5. The Hugershoff Aerocartograph, manufactured by Aerotopograph, GmbH, Germany, was designed to compile from either aerial or terrestrial photographs. It was imported in 1927 and was the first optical-mechanical stereoscopic plotting instrument capable of utilizing aerial photographs to be owned by the U.S. Government. E. A. Shuster, Jr. is shown operating the Aerocartograph.

played important roles in military mapping. Gerald FitzGerald's leadership in the development of trimetrogon mapping procedures was a contribution of the first rank (Figure 8).

New Photogrammetric Hardware

In the early 1950's the photogrammetric equipment at the USGS mapping centers consisted of multiplex plotters with ancillary hardware and a few Zeiss and Wild instruments. There then began a period of research and development that brought forth a succession of new photogrammetric hardware.

The Kelsh plotter was patented by Harry Kelsh of the Department of Agriculture, and redesigned after Kelsh transferred to the USGS in 1949 (Figure 9). In the early 1950's, a team of researchers under R. K. Bean designed the Ellipsoidal Reflector Projector, known in the Survey as the ER-55 and commercially manufactured by Bausch and Lomb as the Balplex (Figure 10). The ER-55 and Kelsh plotters were used to compile thousands of maps in the 1950's and 1960's. Beginning in the mid-1960's, these instruments were gradually replaced by more modern stereoplotting instruments, mostly of foreign manufacture.

Concurrent with the development of the ER-55 plotter was the design and construction of the Twinplex plotter, intended for aerotriangulation with convergent or transverse low-oblique photography.

FIG. 6. Cameras, planes, and some personnel of the Alaskan Aerial Survey Detachment. The USGS and Department of Agriculture funded the Navy Department to complete the aerial survey of the Tongass National Forest in 1929. The Detachment was commanded by Lieutenant Commander A. W. Radford who later became Chairman, Joint Chiefs of Staff, from 1953 to 1957. R. H. Sargent, USGS topographic engineer, was technical advisor. An interesting aspect of this operation was that hatch covers in the hulls of the flying boats needed to be removed in the air to allow camera operation—and replaced *securely* to allow safe landing!

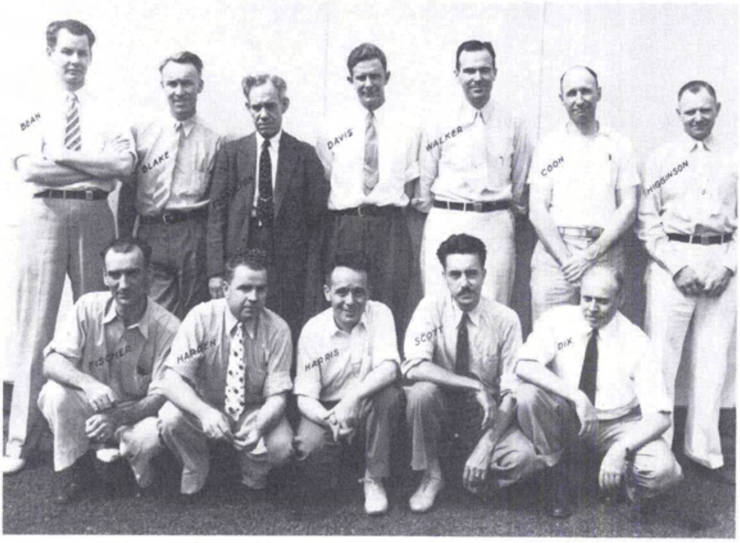


FIG. 7. Early members of the USGS-TVA Multiplex Topographic Unit included Messrs. Bean, Blake, Pendleton, Davis, Walker, Coon, Higginson, Fischer, Harden, Harris, Scott, and Dix. This office was established in Chattanooga in 1936 to map the entire Tennessee River Valley.

The Twinplex never became fully operational and was overtaken by other technology.

The problem of control extension called for an economical solution, something better than "long-bar bridging." The stereotemplet system (Figure 11), devised by M. B. Scher in 1949, provided a practical means of accurate control extension on an area basis. This system served as the Survey's primary aerotriangulation system until replaced by mathematical adjustment by semi and fully-analytical methods introduced in the 1960's. The current USGS analytical aerotriangulation system utilizing the powerful capabilities of modern computers has greatly reduced field-survey control requirements.

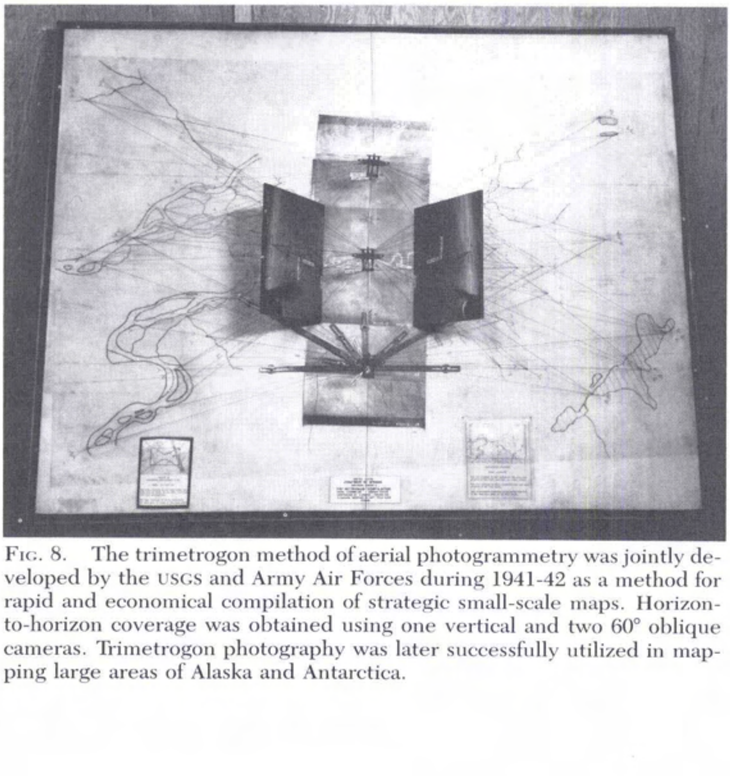


FIG. 8. The trimetrogon method of aerial photogrammetry was jointly developed by the USGS and Army Air Forces during 1941-42 as a method for rapid and economical compilation of strategic small-scale maps. Horizon-to-horizon coverage was obtained using one vertical and two 60° oblique cameras. Trimetrogon photography was later successfully utilized in mapping large areas of Alaska and Antarctica.

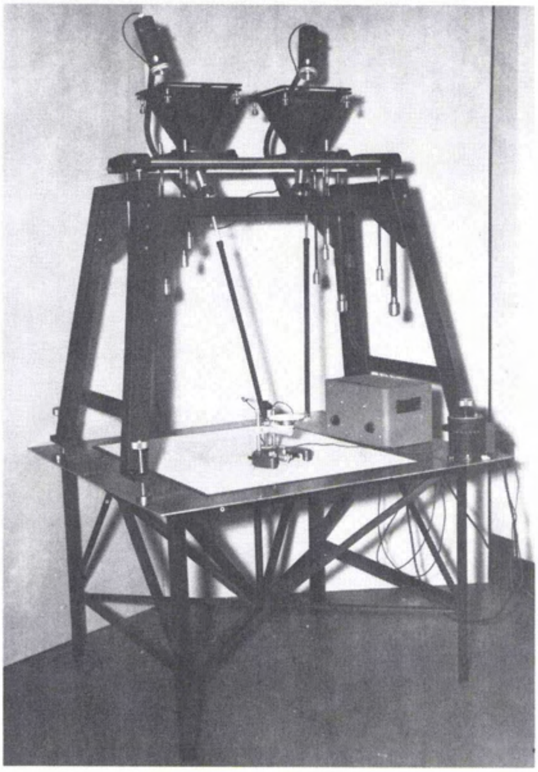


FIG. 9. The basic principles of the Kelsh Plotter were conceived by H. T. Kelsh, 25th president of the ASP, in 1943 while employed at the Department of Agriculture and then developed at the USGS by him and others beginning in 1947. Some improvements of the Kelsh plotter over the multiplex included using full-sized diapositives with a swinging light illuminating only a portion of the diapositive at any one time.

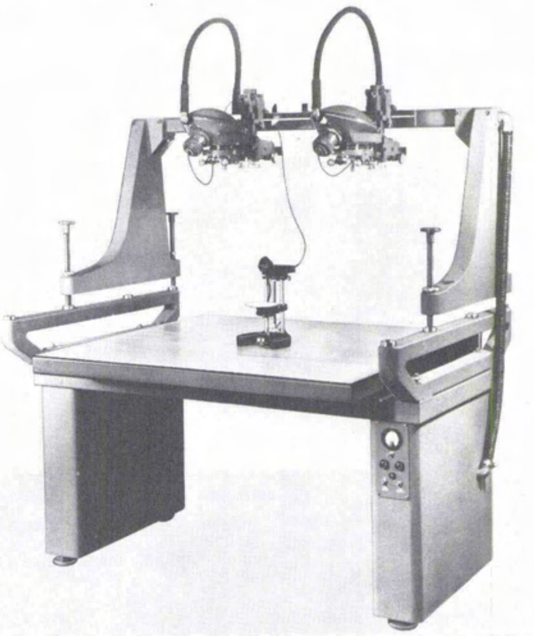


FIG. 10. The ER-55 projector was developed between 1945 and 1952 under the supervision of R. K. Bean. It derived its name from the use of an ellipsoidal reflector which was part of a projection system having a principal distance of 55 millimeters. The distinctive feature of this projector is that the light source is at one focal point of the ellipsoidal mirror while the objective lens is at the other. The ellipsoidal mirror acts as a condenser because any light ray emanating from a light source at one focal point is reflected through the other focal point. Some advantages of this direct double-projection system over multiplex-type systems are larger model scale, increased model resolution, and improved illumination. The commercial version of the ER-55 was manufactured by Bausch and Lomb as the "Balplex." (Photo courtesy of Bausch and Lomb.)

Beginning in the mid-1950's, R. K. Bean's research team designed and built the first orthophotoscope (Figure 12) for producing photographs with no image displacements due to terrain relief and camera tilt. From this beginning came several generations of USGS orthophotoscopes, a number of commercially developed orthophoto devices, and a whole series of new photoimage products, such as orthophotomaps and orthophotoquads.

TRANSITION TO MODERN METHODS

The history of USGS mapping from 1884 to the present indicates that both map scales and map coverage have increased in response to modern needs. The wider use of photogrammetric methods and the need for more information about the land brought about a moderate increase in mapping during the 1930's and early 1940's. In the early 1950's the prevailing scale of USGS topographic maps was changed from 1:62,500 (15-minute quadrangles) to 1:24,000 (7.5-minute quadrangles) with a corresponding adoption of smaller contour intervals in response to a widespread demand for tomographic map detail. The significant increase in 7.5-minute map coverage from 4.8 percent of the conterminous U.S. in 1947 in 77.2 percent by 1982 is due to both expanded activity and improvements in photogrammetric processes-analytical aerotriangulation, stereocompilation, and orthophotography. With the addition of orthophotomaps (full color treatment) and orthophotoquads to the line map coverage, there is some type of 7.5-minute coverage for virtually all of the conterminous U.S.

Increasing demands for current and accurate cartographic and geographic data have required many new technological developments in data acquisition, processing, and display. Active research continues to develop new technology to improve the quality and efficiency of map production. Significant progress has been achieved in color image mapping from multispectral remote sensing data, and research

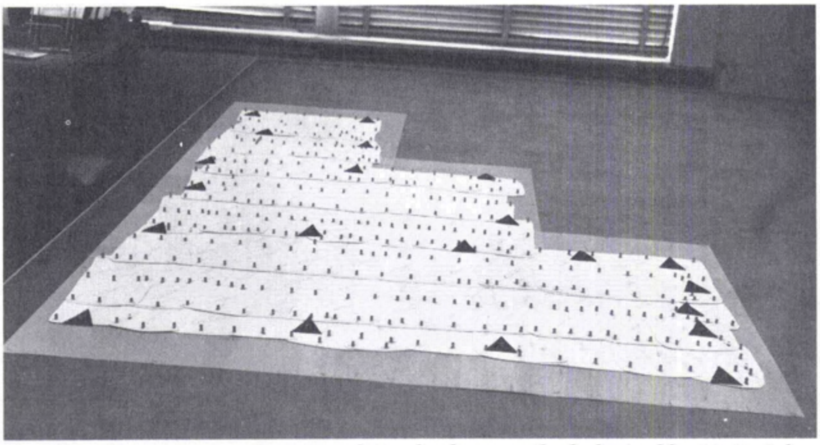


FIG. 11. The stereotemplet triangulation laydown method, devised by M. B. Scher in 1949, provided a practical means of accurate control extension. Stereotemplets, when properly assembled and constrained by given horizontal control, would adjust to a common scale and thereby determine the absolute positions of desired supplemental control.

continues in digital cartography and the related field of spatial data handling.

ERA OF AUTOMATION

During the 1960's, spurred by the potential of the computer and new sensing devices, an era of automation in photogrammetry was born. Using a combination of instruments on hand and commercially available hardware, the USGS introduced automated photogrammetry in three principal directions:

- Interfacing analog stereoplotters with online computers to provide digital storage and readout;
- Operating digital offline orthophoto systems with separately obtained elevation data; and
- Producing contours, profiles, terrain models, and orthophotos by automatic scanning and correlation of images.

These systems are still operational and continue to be improved.

The USGS was involved in many developments in analytical photogrammetry during the 1960's, and numerous computer programs were written or modified for use in mapping operations.

The computer programs include

- Semi-analytical adjustment,
- Simultaneous model adjustment,
- Direct geodetic constraint (DGC) analytical aerotriangulation, and
- General integrated analytical triangulation program (GIANT).

DIGITAL CARTOGRAPHY

The development by the USGS of the National Digital Cartographic Data Base spans all the disciplines of the mapping sciences, with a significant role for photogrammetry and remote sensing. The initial plans were for the data base to consist of boundaries, public land net, streams and water bodies, and transportation features shown on 1:24,000-scale maps; elevation data largely obtained concurrently with the orthophotoquad program; planimetric features from the 1:2,000,000-scale sectional maps of the *National Atlas of the United States of America;* elevation data obtained from the 1:250,000-scale map series; land use and land cover and associated map data; and geographic names. Because of a number of technological and programmatic developments, the scope of the data base has been increased to include digital cartographic data collected from 1:100,000-scale base maps. These

FIG. 12. This breadboard model orthophotoscope being tested by R. B. Southard, Jr. who later became Chief, National Mapping Division, and R. K. Bean. It was developed by R. K. Bean and his research team in the mid-1950's. This USGS orthophotoscope and later models were the first to economically produce orthophotographs that met the horizontal accuracy requirements of the National Map Accuracy Standards.

data include transportation features (roads, railroads, powerlines, pipelines) and hydrographic features (streams, rivers, water bodies). This major new effort will attempt to achieve nationwide coverage by the end of the decade.

Photogrammetry and remote sensing impact the development of the data base both in original data capture and in map revision. Photogrammetric systems such as the Gestalt Photo Mapper II (GPM-2) have been the major collection devices for digital terrain models.

The USGS has also tested the feasibility and cost-effectiveness of capturing digital cartographic data directly from the stereoplotter. New equipment and techniques now permit the use of stereomodel digital-data capture, interactive editing, and cartographic machine-plotting techniques for the automated production of conventional map color-separate guides. The corresponding digital data stored on magnetic tape or disks can be further processed to generate other products and to establish digital topographic data bases for revision.

Desktop computers have been interfaced in recent years to several different types of mapping instruments to eliminate the need for punched cards and allow online error detection. These systems include

- The Online Map Mensuration System,
- The Pass Point Marking System, and
- The Online Aerotriangulation Data Collection and Edit System.

The USGS has adopted voice data entry systems for use in map digitizing work. Their major advantage is to allow photogrammetric instrument operators to make voiced data entries with no interruption to their manual cartographic tasks.

Thematic Mapping

Recent advances in automated systems, remote sensing technology, and space science have been applied by the USGS to the production of special-purpose thematic maps. The object is to bring together specific thematic information requirements of the user community with specialized presentation and treatment of the data in map form. Pursuit of these linkages is illustrated by such environmental problems, and the corresponding thematic maps, as the correlation of land use and the day/night distribution of population in the vicinity of nuclear reactor sites, and the assessment of environment prior to resource assessment in a national wildlife refuge (USGS Map I—1443).

Camera Calibration

The USGS has been calibrating aerial cameras used by contractors on USGS projects since the early 1950's (Figure 13). On 1 April 1973 the calibration services for aerial cameras and lenses provided by the National Bureau of Standards, U.S. Department of Commerce, were transferred to the USGS. Since that date the USGS facility has calibrated an average of 90 aerial cameras each year for both government agencies and private industry.

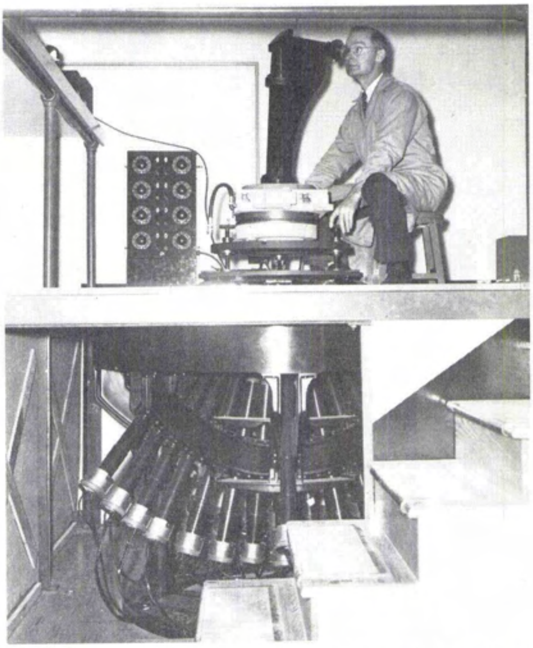


Fig. 13. The USGS Multicollimator Camera Calibrator. An aerial camera is being centered over the bank of 53 collimators by R. E. Ask. After making film exposures, contact diapositives will be made and the positions of the images of the collimators will be measured and analyzed.

Orthophotoquads

The USGS development of the concept of orthophotography and the successful building of a practical orthophotoscope led to the widespread use of a new kind of cartographic product: the orthophotoquad. The USGS has produced approximately 25,000 orthophotoquads from quad-centered 1:80,000-scale black-and-white aerial photographs. In the mid-1970's the USGS experimented with the production of color orthophotoquads by combining and assigning colors to two types of black-and-white film, panchromatic and infrared. This concept was a direct result of the Survey's success in using a similar technique to produce color image maps from Landsat multispectral scanner bands 5 and 7. This approach was used to produce 1:25,000-scale Canada/U.S.-border color image maps in cooperation with the U.S. Customs Service in the late 1970's. The USGS is now using 1:80,000-scale color-infrared film to produce similar maps of the Mexico/U.S. border.

The USGS is also investigating the production of color orthophotoquads from rectified and mosaicked color-infrared photographs being acquired through the National High-Altitude Photography (NHAP) program and currently available for about 70 percent of the country. This technique could lead to preparation of color-infrared or simulated-natural-color orthophotoquads for any area in the United States when NHAP coverage is complete.

The Digital Profile Recording and Ouput System is an automated system developed by the Survey in the 1970's for producing orthophotographs. The system provides instrumentation for producing digital profile information from a stereoscopic model, storing informatiotn on magnetic tape, and offline control of the instruments for exposing orthophotographs.

Land-Use and Land-Cover Mapping

For almost a decade the USGS has applied both remote sensing technology and photogrammetric methods to the classification and inventory of land use and land cover for the entire United States. Most of the maps in this series have been compiled from high-altitude color and black-and-white aerial photographs using conventional interpretation techniques.

Radar Rectification and Image Mapping

Since 1980 the USGS has been evaluating the applications of side-looking airborne radar (SLAR) data. Photogrammetric compilation with stereo radar is not possible with conventional equipment because of the uniqueness of radar geometry. Because high-resolution SLAR is really the only all-weather tool for mapping habitually cloud-covered areas, effective compilation techniques are necessary. A procedure is being developed to remove radar layover using digital image processing techniques so that conventional analytical plotters can be used for map compilation. The USGS has published twelve 1:250,000-scale SLAR image mosaics of the Aleutian Arc in Alaska.

Mapping the Earth in the Space Age

Early in the manned space program, NASA astronauts used hand-held cameras to photograph the Earth. The value of such photos to the mapmaker was quickly evident, and the USGS assumed the lead role in developing the cartographic application of space imagery. Hand-held cameras were soon supplemented with both film and electro-optical systems suitable for cartographic purposes. The first space image map was produced by the USGS in 1970 and by March 1984 over 40 maps had been published and placed on public sale. They vary in scale from 1:1,000,000 to 1:100,000, and most of them meet or approach National Map Accuracy Standards. In size they vary from a 7- by 7-inch format of a single Landsat image to 40- by 60-inch mosaics. Most of these maps are multicolored and are fine complements to standard line maps. To date, the space image maps have all been planimetric; however, satellite stereo image systems with a potential for preparing topographic maps have been defined.

Extraterrestrial Mapping

In 1960 the USGS established an astrogeology program on behalf of NASA to support lunar and planetary exploration. One of the primary activities of the program was the systematic mapping of the stratigraphy and structure of the Moon, Mars, and Mercury. In July 1969 the Lunar Excursion Module *Eagle* landed on the Sea of Tranquility. The site had been selected and mapped photogrammetrically by the USGS during the Lunar Orbiter and Surveyor satellite programs, which produced thousands of photographs for photomosaics and landing-zone charts even though the cameras carried on the Lunar Orbiter and Surveyor missions were not optimized for cartographic purposes. Starting with the Apollo 15 mission, the spacecraft carried an increased payload with better cameras and lunar stay-time capability, thereby providing improved photographs for subsequent lunar mapping.

The Mariner 9 spacecraft was launched in 1971 and placed in orbit around Mars with a primary objective of the mission to map the topography and geology of Mars as a part of the sequence of events leading to the unmanned Viking spacecraft landing on Mars in 1976. The USGS has produced planimetric maps of the entire Martian surface at 1:5,000,000 scale and is completing mapping at 1:2,000,000 scale. Topographic maps at 1:2,000,000 scale with 500- to 1,000-metre contours are also being prepared for approximately 70 percent of the Planet.

EROS Data Center and Development of EROS Program

On 21 September 1966, Stewart L. Udall, Secretary of the Interior, announced the formation of an Earth Resources Observation Satellites (later changed to Systems) (EROS) Program to gather "facts about the natural resources of the Earth from Earth-orbiting satellites carrying sophisticated remote-sensing observation instruments." William T. Pecora, Director of the USGS, was responsible for the new program and he named William A. Fischer to be the first Chief of the EROS Program.

On 3 March 1969, the Apollo 9 spacecraft carried the SO65 multispectral terrain photography experiment into orbit around the Earth as one aspect of a 10-day mission. The four 70-mm cameras used film and filter combinations similar to the spectral bands that would eventually be used on the Landsat series of satellites.

Many USGS scientists served on advisory committees and (or) were active participants in NASA aircraft and space remote-sensing experiments before and during the Landsat era, and several are still actively involved in developing remote sensing instrumentation for the space shuttle.

On 23 July 1972, the first Earth resources technology satellite (ERTS 1, later renamed Landsat 1) was launched by NASA. More than 30 USGS and other Department of the Interior scientists had experiments accepted by NASA to utilize this new imagery. In support of the ERTS project, the USGS in 1971 began the operation of the EROS Data Center in Sioux Falls, South Dakota.

The EROS Data Center was the operational arm of the EROS Program until 1983. It evolved as planned into the major national center for the archiving, processing, and distribution of USGS aerial mapping photographs, NASA high-altitude photographs, satellite photographs (Mercury, Gemini, Apollo, Skylab, and others), and digital satellite imagery (primarily Landsat 1 through 5).

On 30 September 1983, after 18 years of activity and having accomplished its basic mission, the EROS Program and its staff and functions were transferred to other USGS Divisions. The National Mapping Division of USGS became responsible for the continued operation of the EROS Data Center.

Conclusion

Continuing advancements in photogrammetric operations, satellite remote sensing, and automated cartographic techniques have revolutionized the mapping sciences. Over the past five decades the Geological Survey has progressed from conventional topographic mapping and orthophotoquad production to the preparation of multispectral satellite image maps and the development of automated mapping and digital cartographic data bases. The Geological Survey takes much pride in is technological advancements and looks forward to continuing its contributions to the sciences of photogrammetry and remote sensing through research, development, and mapping operations. We welcome the exchange of information with professional societies such as the American Society of Photogrammetry, and with our colleagues abroad through the International Society for Photogrammetry and Remote Sensing.

Acknowledgments

This article is the result of the effort of numerous individuals, and credit is acknowledged to Francis J. Beck, Alden P. Colvocoresses, Clark H. Cramer, Cynthia L. Cunningham, Stephen C. Guptill, Robert H. Lyddan, Sheila E. Martin, Robert B. McEwen, Valerie A. Milazzo, Blyth M. Salamonowica, James W. Schoonmaker, Jr., William P. Tayman, Morris M. Thompson, and Richard S. Williams, Jr. Publication authorized by the Director, U.S. Geological Survey, on 1 May 1984.

References

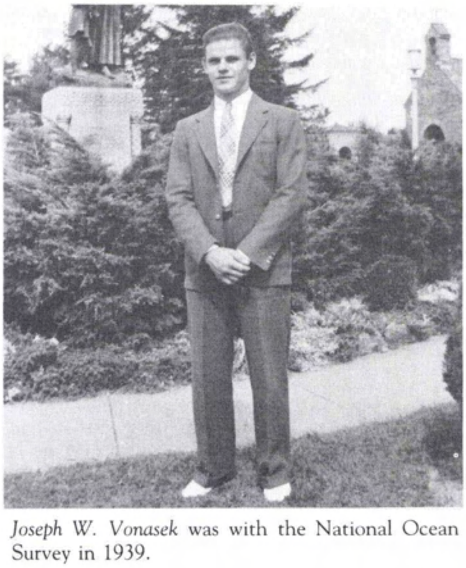
American Society of Photogrammetry, 1979. A century of progress in USGS mapping, *Photogrammetric Engineering and Remote Sensing*, USGS Centennial Edition, vol. 45, no. 12, pp. 1553-1675.

Thompson, M. M., 1952. *Development of photogrammetry in the U.S. Geological Survey:* U.S. Geological Survey Circular 218, 24 p. [Revised 1958].

———, 1981. *Maps for America* (2d ed.): U.S. Geological Survey, 265 p.

U.S. Geological Survey, 1982. *Research, investigations, and technical developments, National Mapping Program 1981:* U.S. Geological Survey Open File Report 82-236, 85 p.

———, 1983. *Research, investigations, and technical developments, National Mapping Program 1982:* U.S. Geological Survey Open File Report 83-568, 79 p.

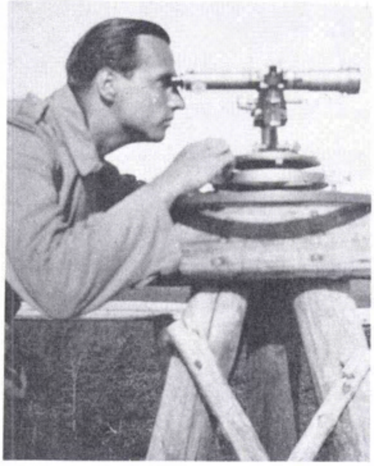


Joseph W. Vonasek was with the National Ocean Survey in 1939.

Eldon C. "Red" Wagner at summer camp in 1938.

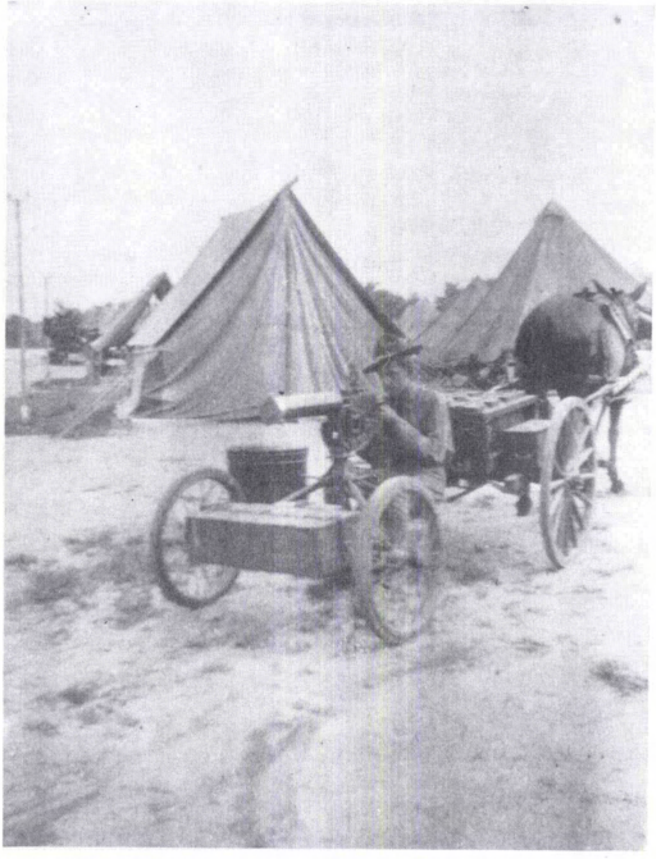
George F. Walker in 1934 with his two sisters, Helen and Mary, and the family dog, Schnozzle.

Francis E. Washer in 1934.



Erick Welander forty years ago, looking into the photogrammetric future.

Robert Zurlinden, a new ASP member in 1936.



John H. Wickham, Jr prepares for action at U.S. Military Training Camp (CMTC) Infantry—White Course, Fort Mead, MD, in July, 1934.