

Observations on USGS-State Cooperative Mapping

THE DICTIONARY defines the word cooperate to mean: to work together willingly for a common purpose. Thus, when The United States Geological Survey and a state agency enter into a cooperative agreement, they have definite objectives which involve both state and federal agencies. The signed agreements are quite simple and indicate the nature of the funding, who performs the operations, who owns the original materials, the mutual considerations, and the publication of the results.

There are several types of cooperative programs:

- The usgs furnishes the personnel, supervises personnel and operations, in field and office, reviews, approves, does cartography, and publishes. Plans and priorities are formulated mutually, and funds are matched.
- This is the same, except by agreement the state furnishes some of the personnel and pays them from state funds. State funds and services are matched by the usgs.
- The usgs has a mission in a given state with which the state is in agreement, so the usgs grants money to it to perform supervision, operations, and cartography with state personnel. Close control is exerted by both parties. Periodic progress reports are required, as are maintenance of given standards.

There are cooperative agreements in several types of mapping, for example, topographic, areal geologic, aeromagnetic, gravity, seismic, radiometric, orthophotographic; water, coal, and mineral resources, slope maps, engineering geologic, and geologic hazards.

The first cooperative agreement in topographic mapping was entered into in 1885 by the usgs with Massachusetts. Since then all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands have contributed over \$95 million to cooperative topographic mapping programs with the usgs through FY 1978.

One of the usgs missions is to map the topography of all 50 states, and since it cannot map all at the same time, it is necessarily

selective based on immediate needs of our country. A state may attract the usgs to map in it, or accelerate mapping in progress, by entrance into a cooperative program. This also reduces the cost to the federal government, and produces a base map sooner, and consequently enhances economic development in the State.

Fourteen states now have complete 7.5 minute topographic map coverage on a 1:24,000 scale, most of which was done in cooperative programs. Last year in FY 1978, 38 states and Puerto Rico contributed \$3.5 million toward the National Mapping Program, primarily for new 7.5 minute topographic mapping. Some states' cooperative mapping agreements included:

- High-altitude aerial photography, photo-inspection, and photorevision of published 7.5 minute maps in the states of Indiana, Kansas, Pennsylvania, Ohio, and Virginia.
- Standard revision of published 7.5 minute maps in the state of Kentucky.
- Revision and series conversion in the states of Louisiana and Wyoming.
- Preparation of 7.5 minute orthophotoquads in the states of Massachusetts and North Carolina.
- Preparation of county topographic maps for the states of Colorado, Connecticut, Kentucky, and Pennsylvania.
- Pilot projects to generate and use digital cartographic data in the states of Kansas and Texas.
- Preparation of 1:100,000 scale topographic/bathymetric maps in the state of Georgia.

In the past, usgs-state cooperative mapping agreements generally meant matching dollars or 50 percent each party. Today they are beginning to include other types of state assistance such as utilizing state facilities and capacity to compile new map manuscripts and map finishing; revising and updating older published maps; researching and data gathering to revise and update map content; and similar activities.

Today's discussion will briefly cover two cooperative mapping programs in which Kentucky has participated with the usgs.

Cooperative topographic mapping started in Kentucky in 1903 and continued until 1929, and from then until 1948 there was no cooperative mapping in Kentucky. In 1947, the Kentucky Chamber of Commerce appointed a sub-committee of their Natural Resources Committee to investigate the possibility of a statewide topographic mapping program in cooperation with usgs. It consisted of a cross-section of representatives from state and local governments, mineral industries, oil and gas industry, professional engineers, agriculturalists, and foresters. As a result of their conclusions and support, Governor Clements made it possible to enter into a five-year program on a matching fund basis to map the 767 7.5 minute quadrangles on a scale of 1:24,000. State funds came from the Kentucky Department of Highways and from Legislature appropriations. The Kentucky Agricultural and Industrial Development Board at Frankfort, Kentucky provided the necessary coordination, administration, and technical direction through Phil M. Miles to formulate concrete plans with the usgs for a complete five-year mapping program.

The first step to devise a plan of action was to review the status of mapping in Kentucky. About 35 percent of the State's 40,395 square miles had never been mapped topographically. About 20 percent of the area of the state was covered by topographic maps made from 1882 to 1910, many of which were at a scale of 1:125,000. About 30 percent of the state was covered by 1:62,500 scale maps made from 1910 to 1929. About 55 percent of the state required remapping, so it was decided to map the entire state on a scale of 1:24,000 on 7.5 minute quadrangles.

Cost and time estimates were prepared. The cost for the 36,000 square miles, excluding 1:24,000 mapping already done by TVA and AMS, was estimated at \$7 million and five years. The program commenced in 1949 and was completed in 1956 at a cost of \$6,360,000 or \$0.28 per acre or \$0.14 per acre for the state. At that time, in 1956, Kentucky became the best modern-mapped state in the United States, which was to prove economically most beneficial to it.

In 1958 the Kentucky State Legislature transferred a modest cooperative topographic mapping revision program to the Kentucky Geological Survey (KGS) for planning and administration for the state. The program was gradually accelerated until about 28 to 30 maps are revised each year. There are never enough funds to revise all those maps which need it each year. The usgs placed a topographic engineer into

Kentucky to check the quadrangles for cultural and topographic changes. He and the state geologist would meet annually with representatives of the Kentucky Departments of Highways and Commerce, look over the changes, and select quadrangles for revision, assign priorities, and send the recommendations to the Atlantic Region office for implementation.

Robert Lyddan, then Chief of the usgs Topographic Division, recommended to the states in 1976 that, in order to incorporate statewide requirements for 7.5 minute quadrangle and other map products into the preparation of the annual national mapping plan, each should establish a State Mapping Advisory Committee. The state requirements then submitted annually by each committee would receive equal consideration with those of a federal agency that usgs receives through the annual OMB A-16 procedure. This would not guarantee that all of a state's requirements will materialize in the following year's program, but it will help insure that the topographic program is geared toward meeting the greatest needs. Kentucky has essentially implemented such a procedure through the KGS, although it has not formalized it. Our present program is only adequate to revise urban areas about once every five years, and other quadrangles about once every 20 to 30 years. I believe the procedure recommended by Robert Lyddan would take care of many of the cooperative problems which arise in the course of a program, and would place the emphasis on the areas of greatest need in the United States.

In the 1960's the OMB requested the usgs to cut the cost of preparation of topographic map revision by use of photorevision and overprint of cultural changes in color, but not a revision of contours. Kentucky was against this because it would downgrade the quality of the maps on which so much had been spent. We felt the standard revision, which includes cultural and topographic changes, would maintain the quality of the maps. We finally compromised and agreed for an interim or photorevision only in areas of low relief with many cultural changes, to be followed by a standard revision. We believe that in areas of high relief the color overprint would be very misleading or even dangerous to the map users where deep excavations or roadcuts had been made.

Items such as the representation of rock cliffs and strip mines have posed specific problems difficult of representation. The new strip mine laws make it more imperative to represent the stripped areas as realistically as possible, and to show the spoil

banks. Slope maps are important in these areas.

The practice of changing a quadrangle name when the original populated place for which it was named ceases to exist poses problems of significance for the consumer in selection of the proper name of a quadrangle when he places an order, particularly if he deals with two types of maps for the same quadrangle. We don't believe it is necessary to change quadrangle names.

The byproducts of the topographic cooperatives such as planimetric maps, aerial photographs, orthophotographs, composites and advance sheets, and bench marks are all very valuable. One of the unresolved problems is the destruction of bench marks by construction, new highways, or vandalism. There is a great need to replace them and mark the elevation on each of them.

Conversion of maps to the metric system is imminent, and it poses distinct problems in a state such as ours where the 7.5 minute maps under the present system are in use as bases for the new geologic maps. We advised the usgs in our case to wait until we had completed the areal geologic mapping program before our maps were changed to the metric system. At present usgs is in the process of preparing 1:50,000 metric county topographic maps in the Cincinnati, Louisville, and Paducah areas as bases for future environmental studies.

There are many uses of topographic maps which you well know and no attempt will be made to enumerate them here, but they run from mineral resource and industrial development to hunting, fishing, environmental protection, and genealogy.

Because Kentucky was completely mapped with 767 7.5 minute topographic quadrangles, it had the bases upon which to build new areal geologic or bedrock maps. In 1959, the Kentucky Society of Professional Engineers passed a resolution which they submitted to the Governor, Happy Chandler, to the kgs, and to other agencies, in which they resolved that the areal or bedrock geology of the entire state needed to be mapped. The State Geologist and Assistant State Geologist, with consent of Dr. Frank Dickey, President of the University of Kentucky, enlisted support from the Kentucky Chamber of Commerce, Kentucky Oil and Gas Association, Kentucky Coal Association, Kentucky Farm Bureau, Kentucky Departments of Highways, Commerce, and Natural Resources, and the administration of the state government, as well as professional societies, industry, agriculture, education,

and individuals. The usgs agreed to enter the program if we could arrange for funds. A ten-to-12-year program to cost about \$12,000,000 was outlined to the usgs as a cooperative program on a 50/50 matching basis. We worked through our U.S. Senators and Representatives, in particular Senator John Sherman Cooper and Representative William Natcher, and the Secretary of Interior. The program and funding were approved in 1960 and funded. It started in July 1960, and the usgs put the first parties in the field in September. The first completed map of the Austin quadrangle was printed and released in 1961. The 767 maps were completed and printed by the end of October 1978.

This was the first attempt by the usgs to map the geology of a state this large on 7.5 minute quadrangles at a scale of 1:24,000. The Directors and staffs of both Surveys formulated plans, agreements, map formats, areas of responsibility, location of field offices, review process, and approval process by both Directors before final cartography and printing. "Members of the usgs assigned to the program were organized as the Branch of Kentucky Geology. Branch headquarters, including an editorial staff, were at Lexington, Kentucky, but actual mapping was conducted from 18 field offices distributed throughout the State. The Publications Division of the usgs established a cartographic office at Lexington to prepare the maps for publication." Final printing and printing costs were done by the usgs at their main offices.

About 260 persons, including more than 200 professionals, were assigned to the program by usgs at one time or another. The most geologists assigned in any one year was 61. A total of 661 professional man years were required by usgs to complete the mapping and ancillary studies, compared with an original estimate of 600 man years.

kgs furnished 18 persons to the program to provide coordination, review, field conferences, stratigraphic information and nomenclature, core hole supervision, reports on oil and gas test holes, and review of maps; they filmed geologists' field notes, acquired mylar copies of field work, and provided economic data to the field map authors. kgs geologists made subsurface structural interpretations, constructed bedrock topography overlay maps, and mapped several quadrangles.

Many problems were encountered but were solved by mutual agreement by field and office conferences in Kentucky and at the usgs main offices in Washington, D.C.

and Reston, Virginia. Since this large program covered 40,395 square miles in a given period of time, it was a real shakedown cruise, but one which I believe will prove beneficial to all state-usgs cooperative programs in the future. Our program was cooperative in the truest sense of the word, with the missions and interests of both state and federal governments represented. Professional geologists came from a great variety of backgrounds and experience; therefore, individual maps vary somewhat in quality, though continuous quality control was run on all work. It would be best before entering into such a large program to have a period of training of all professional geologists who would participate, and to familiarize them thoroughly with the regional geology and the work of prior geologists.

The following slides show:

1. Photorevised topographic map.
2. State topographic map, 1:500,000.
3. Distribution of topographic map revision, and number of quadrangles in process in one year.
4. Status of Areal Geologic mapping in Kentucky in 1960 prior to commencement of the 7.5 minute mapping program.
5. Status of the 7.5 minute program in 1965.
6. Status of the 7.5 minute mapping program in 1973.
7. Status of the 7.5 minute areal geologic mapping program in January 1978.
8. Status of the 7.5 minute program on October 30, 1978.
9. A typical 7.5 minute areal geologic map, the Salem quadrangle, from the Kentucky program.
10. Cost of the program, and unit costs.

The program cost a total of \$20,927,500 or, in terms of constant 1960 dollars, it cost \$16,035,000. This compares with an original estimate of \$12 million. The added eight years over the original estimate of ten years was the primary cause of the added cost due to inflation, higher salaries, and expenses. Each map, covering about 59 square miles, cost \$29,500 on the average, or about 80 cents per acre. The kgs cost was about 37 cents per acre, and the usgs 43 cents per acre.

Kentucky sales of over 100,000 of the maps indicates they are being used. Demand for the maps is greatest in the eastern Kentucky coal field, next in the western Kentucky coal field, and finally in the western Kentucky fluorspar district.

The main impetus behind the mapping program was the stimulus the maps would provide to economic development of Ken-

tucky. The discovery of 500,000 tons of a 4-foot seam of coal in an area of western Kentucky will more than pay back the cost of the program for Kentucky. A strippable coal seam 5 feet thick under 200 acres would at \$20 per ton be worth more than the entire cost of the program. The returns on investment are estimated at 50 to 1. The maps have been and are being used in the exploration for coal, oil and gas, fluorspar, limestone, and clay. They are also used in planning highways and location of dams, in evaluation of foundation and excavation conditions, in preparation of environmental impact statements, for geologic hazard studies, for preparation of water availability and soils maps, by tourists to collect minerals and fossils, by educators in their classes, and by students.

Kentucky is now in a good position to make many special studies by the utilization of these maps by their professional geologists.

Some very useful byproducts have come from this cooperative areal geologic mapping program: 154 technical reports, field notes and location maps of field data, core hole tests, seven county economic geology reports by kgs, engineering geology maps, and 20 bedrock topography overlay maps in western Kentucky.

It has been shown that the topographic and areal geologic cooperative mapping programs are economically very valuable to Kentucky. Common missions of kgs and usgs, cooperation in mutual problem solution, the savings in costs to both parties, utilization of the facilities of the professional expertise and facilities of both parties, particularly of the support technical personnel, and the greater laboratories, instrumentation, printing plants, modern methods, and standardization of the usgs makes cooperative programs very valuable to those who participate. This is particularly true for a state which has a small staff and lacks adequate facilities. The usgs also has the advantage that they can move large numbers of personnel into an area to do a program and move them out when it is done, whereas a state hiring a large number of persons would have to let them go at the end of the program. However, the local knowledge and support by state personnel is of utmost value in a cooperative program.

As brothers we work together toward common goals, achieve together, and reap economic benefits for all the people of our states and nation. Let us continue to work together in the future and profit by our experiences in past programs.