

"The History and Activities of Your State Geological Survey"

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As the decade of the 1970s draws to a close, the Colorado Geological Survey nears the completion of 11 years of growth and accomplishment. Actually our agency has had a long and interesting history of development, from meager beginnings in 1872 through a prolific period early in the century and into a troubled but productive era that ended with the creation of the present agency. Our predecessors were concerned primarily with the metallic mineral resources and metal mining industries, but now, as a result of changing needs, the Survey has expanded into the fields of engineering and environmental geology, geohydrology, mineral fuels, and nonmetallics. Often confused with the "other" geological survey, your state geological survey has become one of the most active divisions in the Department of Natural Resources. In this article I would like to trace the history of the Survey, its accomplishments and shortcomings, and outline our present duties and recent work, with emphasis on mineral resources.

The Territorial and Early State Geologists

The discovery of gold at Idaho Springs in 1859 marked the beginning of what for Colorado has become a billion-dollar industry. Rich strikes in the 1860s hailed an era of boom towns, prosperity, and great personal triumphs and failures. Even before official Colorado statehood, the territorial legislature certainly realized the importance and potential of this emerging industry. An official government representative was needed to assist and advise the fledgling industry and to begin the monumental task of identifying and evaluating the territory's mineral wealth. On February 9, 1872, the legislature empowered the Governor to appoint a Territorial Geologist who was to reside in the territory and serve a two-year term. Because neither a salary nor expenses were budgeted, the early Territorial Geologists made

their livings essentially by consulting for the mining industry. In 1874 J. Alden Smith was appointed as Colorado's first Territorial Geologist and served until 1883 and again from 1885 to 1887. Smith was born in Maine in 1830, and after completing his formal education at age 14, worked in such areas as printing, wool manufacturing, stone cutting, and finally back to newspaper printing. His early fascination with rocks and minerals led to tutored studies in geology and mineralogy. By 1864 his expertise brought him to Gilpin County where his reputation as a consultant and assayer grew quickly. Smith's most notable work was the first detailed list of Colorado's minerals and gem stones. After its publication in Black Hawk in 1865, it appeared in Ovando Hollister's 1867 classic, Mines of Colorado, and republished again in 1870 and 1880. He is also recognized for several telluride gold discoveries and the donation of his valuable mineral collection to the University of Colorado. Six competent and highly regarded men succeeded Smith--Ernest Le Neve Foster (1833-1885), F. G. Buckley (1887-1889), George E. Kedzie (1889-1895), Thomas A. Rickard, a prominent mining editor and prolific author (1895-1901), John Wellington Finch, who later became director of the U.S. Bureau of Mines (1901-1905), and B. A. Langridge (1906-1907).

The First Survey

So that more formal investigations of the state's resources could be made, the legislature created the Colorado Geological Survey on April 24, 1907. Among the eight objectives, one dealt specifically with mineral resources:

"A study of the geological formations of the state with special reference to its economic mineral resources, namely: the gold, silver, lead, copper, iron and other metallic ores; the clays, coals, oil, gas, building materials, cement materials, artesian and mineral waters and other mineral substances."

Although Colorado's mining industry was oriented essentially toward metals, specific mention was made for the nonmetallics, mineral fuels, and water resources. Provisions were also made for a comprehensive bibliography of geology and resources, the publication and distribution of maps and reports, the collection and distribution

of mineral specimens, and most importantly--a budget. The act appropriated the State Geologist's salary (\$500), an \$8 per diem, and an operating fund of \$5,000 for fiscal years 1907 and 1908. By virtue of his chairmanship at the University of Colorado Department of Geology, Russell D. George became the new State Geologist and first director of the Survey. Born in 1866, George was raised and educated in Ontario, Canada. Following graduation from McMaster University (Toronto) in 1897, he served as an instructor at the University of Chicago, where he earned his Ph.D., and then at the University of Iowa. In 1903 he came to the University of Colorado where he built up the young and ill-equipped geology department. His affinity for the mining industry's problems soon established his notoriety in the consulting field. For 20 years George and his limited but highly proficient staff produced a series of comprehensive bulletins on the geology and ore deposits of a number of mining districts, along with the first complete bibliography and inventories of such resources as molybdenum, clay, manganese, fluorspar, oil shales, and mineral waters. Horace B. Patton, P. G. Worcester, R. D. Crawford, Harry Aurand, and Junius Henderson were among the Survey's other noted authors. R. C. Coffin's 1921 report on uranium and radium is still an often cited reference. Another important accomplishment was a revision of the then 30-year-old state geologic map compiled during the Hayden Survey (1876-1881). Besides the emphasis on resources and pure scientific contribution, the legislature intended the Survey to contribute directly to education:

"The Survey shall.../prepare/...bulletins on the geology, geography and natural resources of Colorado suitable for use in the Schools of the State."

The Survey was also empowered to borrow freely upon the geology faculty at the state's colleges, and indeed, many of the Survey's permanent staff also taught at the University of Colorado and at Colorado School of Mines.

People-related problems were first hinted at in the second legislated objective:

"An examination of the topography and physical features of the State with reference to their practical bearing upon the occupations of the people."

The Interim Agencies

Reasons for the cessation of the Survey's activities in the late 1920s are not known exactly, but political and financial problems undoubtedly had their effects. In an act passed in May 1929, the Survey was placed under the control of a Geological Survey Board, which was authorized to enter cooperative agreements with the USGS and U.S. Bureau of Mines to fulfill the Survey's objectives. Most of the cooperative projects done in the next 40 years, though, seemed to have been supervised by one of three other interim boards.

The nine-member Colorado Metal Mining Fund Board (CMMFB) was created in March 1921 to collect, administer, and disburse tax monies collected from the state's metal mining properties. Specifically the CMMFB was to "...make such investigations regarding the prospecting for, mining, production, transportation, buying, selling, treatment or reduction of metalliferous ores..." Later on, in 1927, another act gave the CMMFB the authority to contract with USGS for the completion of geologic and topographic mapping. Through this cooperative program the USGS published many excellent geologic reports and maps, including the 1935 edition of the state geologic map. The CMMFB itself contracted locally for two studies on Colorado tungsten mines and vanadium.

To aid the deteriorating mining industry in the Depression era of the 1930s, the state created the Colorado Mineral Resources Board (CMRB) in June 1937. The intent of the act was to develop and utilize the state's mineral resources through the construction of such public works as drainage tunnels, tailings disposal dams, and mills. The Board could issue "mining development revenue bonds" or seek federal aid to finance its projects. Its major achievements included construction of the Alma-Fairplay tailings dam and a geophysical study of the Leadville drainage tunnel. The most well-known publications to emerge were John Vanderwilt's classic volume, Mineral Resource of Colorado (1947), and Sam Del Rio's equally informative 1961 sequel, both of which are still standard references.

At several times in the late 1940s and 1950s, proposals were made to place both boards' duties into one state agency and reestablish the office of the State Geologist, but the boards and the mining industry preferred to maintain the cooperative federal programs. Eventually, because of mounting political and ever-present financial problems, the CMMFB and CMRB were consolidated into the Colorado Mining Industrial Development Board (CMIDB) in April 1963. Besides restatement of previous board duties, the new 12-member CMIDB received a primary charge to "...assist, encourage, and benefit the mining and mineral industries, and...to bring about the proper development and encouragement of mining activity within the state..." While continuing its cooperative USGS mapping studies, the CMIDB also sponsored two important economic studies of Colorado's metal mining and smelting industries, and the second mineral resources sequel, compiled by the USGS at the request of Senator Gordon Allott. By the late 1960s a move had begun to repeal the metals tax and transfer the CMIDB's duties into the Department of Natural Resources, thus relegating the CMIDB to an advisory status. After a relatively short but productive term, the Board was quietly abolished by SB 20 on July 1, 1974.

This marked the end of a 40-year era of effort to directly benefit Colorado's mining industry. Through the interim boards, however, Colorado gained a number of excellent locally contracted studies and a wealth of classical USGS literature.

The Second Survey

Records show that the interim boards were beset with perennial financial problems, outside political pressures, and internal conflicts that in the 1960s led to their dissolution. Perhaps as crucial as these problems was a failure to recognize changing attitudes and needs. During that decade the local geological community saw once again the need for a formal state agency to deal not only with mineral resources in general but also with "people" problems and the geological and engineering aspects of construction, development, and land use. In 1965 Representative George Fentress began working toward the reestablishment of the Colorado Geological Survey by collecting background information and support from other state surveys and from the Association

of American State Geologists. The first reorganization attempts outside the legislature came in 1966 when the Rocky Mountain Association of Geologists and American Institute of Professional Geologists formed a joint committee with representation from Colorado Scientific Society and the local chapters of the Association of Engineering Geologists and Society of Exploration Geophysicists. Through the efforts of the RMAG-AIPG committee and Representative Fentress, state statutes were amended by HB 1282, and on June 9, 1967, the Colorado Geological Survey was recreated. The enabling act set forth the following general purpose:

"...to coordinate and encourage...the full development of the state's natural resources, as /they/ are related to the geological processes that affect realistic development of human and mineral utilization and conservation practices and needs in the state of Colorado, all of which are designed to result in an ultimate benefit to the citizens of the state."

The bill also provided for at least four operational specialties in mineral deposits, hydrology, mineral fuels, and engineering geology. More importantly, nine specific objectives were cited:

- (1) "assist, consult with, and advise existing state and local governmental agencies on geologic problems;
- (2) promote economic development of mineral resources;
- (3) conduct studies to develop geologic information;
- (4) inventory and analyze the state's mineral resources as to quantity, chemical composition, physical properties, location, and possible use;
- (5) collect and preserve geologic information;
- (6) advise the state and act as liaison agency on transactions dealing with natural resources between state agencies and with other states and the federal government on common problems and studies;
- (7) evaluate the physical features of Colorado with reference to present and potential human and animal use;
- (8) prepare, publish, and distribute reports, maps and bulletins when necessary to achieve these purposes;
- (9) determine areas of natural geologic hazards that could affect the safety of or economic loss to the citizens of Colorado."

Funding was appropriated in 1968, and the agency began official operations in February, 1969, with the hiring of the new State Geologist, John W. Rold, and one secretary. Born in 1927 in Kirkman, Iowa, John Rold was raised and educated in Salida, Colorado. After active service in the U.S. Naval Reserves, he attended the University of Colorado from which he received geology degrees in 1948 and 1950. His 18 years of experience with Chevron Oil Company earned him the positions of Area Geologist and finally District Geologist. As an active member and officer of a number of local and national geological associations, John has also served on many panels and commissions in his position as State Geologist and has published numerous papers on geological and land-use problems in Colorado.

In the last ten years the agency has grown to a permanent staff level of ten geologists with five administrative and technical persons. As of October 1979, current federal grants contribute another 19 geologists and 2 administrative persons. To contrast the first biennial budget appropriations of \$5,000 (1907-08) and \$10,000 (1909-10), the Survey's budget for FY 1979-80 now totals \$1,154,245, of which approximately \$700,000 is authorized federal funds. The organization and general duties of the sections are outlined on the following chart.

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Most of the permanent employees' work is generated by three recent laws:

- SB 35 (1972)--review of geologic reports for subdivisions
- HB 1529 (1973)--Front Range aggregate inventory and review
of master plans and mining proposals
- HB 1041 (1974)--identification of mineral resource and
geologic hazard areas

As current staffing levels clearly show, much of the Survey's work is funded by federal agencies; for example, the USGS, DOE, U.S. Bureau of Mines, and EPA. Although many of the projects involve basic data-gathering and inventory, some have proceeded further into resource evaluation, economic potential, and other applied aspects. Let us now briefly review some of the work and current research in the four sections.

In addition to on-going subdivision and EIS review, the Engineering Section's completed and in-progress work encompasses a variety of geologic-hazard and land-use investigations:

- environmental geology of the Windsor Study Area
- geologic hazards in the Big Thompson Canyon, Crested Butte-Gunnison, Upper Blue River, North Fork Gunnison, Upper Crystal River, and Douglas County areas
- geology for land planning in the Craig (Moffat County) and Redlands (Mesa County) areas
- debris flow and avalanche mechanics and hazards
- earthquake potential and seismicity
- layman publications on problem soils and geologic aspects of home construction
- sponsoring the Governor's Conferences on Environmental Geology

As a result of its studies in some hazardous areas, the Survey has been intimately involved in rather controversial issues at the local level.

Research by the other three sections in the field of energy resources has been detailed in an earlier article (see May 1979 issue of Mines Magazine, "Government and Energy"). Briefly, the Ground Water Section has supervised geothermal investigations since 1972 and now has completed an inventory and intensive sampling of Colorado's thermal springs, a preliminary evaluation of resources, and a study of the availability and potential of the state's resources for various uses, including the drilling of a geothermal test well at Pagosa Springs. A short-term project begun this fall in cooperation with the State Health Department will examine hydrogeologic conditions of all the state's aquifers.

Mineral Fuels Section has contributed immensely to the state's coal data base through detailed statewide mine and resource inventories, coal bibliographies, on-going coal sampling, and an industrial directory and source book. The section has completed other important federally funded evaluations of coking coals, methane potential, and coal reserve depletion. On the regional scale the section has investigated lignite resources and energy development impact in the Denver Basin.

Early this year Mineral Resources Section published the first comprehensive bibliography and descriptions of Colorado's radioactive occurrences. A DOE-funded outgrowth of that project now in progress is a closer study of similar occurrences in the Leadville 1⁰ x 2⁰ quadrangle, an area of about 7,600 sq mi.

Also this last spring we released the results of a two-year inventory of Mesa County mineral resources--the end product of three years of researching, advising, and formulating concepts for the HB 1041 land-use program. Under that law the Survey was directed to assist county governments in the identification of mineral resource and geologic hazard areas. After initial identification guidelines and other aids had been assembled, we saw the need and opportunity to prepare a finished product ourselves which would demonstrate the concepts that we had formulated and that we felt were necessary for success of the program at the local level. So, at Mesa County's request, the Survey began the work. In addition to their use as a model or format, the report and maps represent a condensation of available geologic and mineral resources information (a) essential to county government for planning and management purposes, and (b) useful to the mining and mineral industries located or operating in the county. The effort was experimental from the standpoint of testing proposed standardized mineral resource map symbols.

Current project work in the section is a statewide inventory of nonmetallic mining and processing operations that will cover sand and gravel, crushed, dimension and decorative stones, clay, cement materials, pegmatites, and a variety of industrial minerals, along with manufacturing and processing plants (concrete and concrete products, asphalt, brick and clay products, insulation, cement, lightweight aggregates, and others). This project will complement our other recent inventories for oil and gas fields and pipelines, energy resources and coal mines, and uranium-vanadium mines.

A substantial part of the section's work since the passage of HB 1529 is concerned with aggregate resources along the Front Range. Most of the Survey's involvement is, by law, advisory:

- assisting county and city governments in the formulation of mineral extraction plans and policies

- reviewing proposals for new gravel pits and rock quarries
- special review of proposed development on and near aggregate (and other resource) lands
- advising landowners, real estate developers, mining companies and others on particular sites and problems

Regarding the last item, we have established a number of new contacts with the aggregate industry in the last two or three years as a result of the increasingly critical supply problem in the Denver metro area. Since our initial inventory in 1973, we have gained a keen appreciation of the industry's situation and of the effects of the law and local policies on current and future availability of commercial aggregate deposits. We have now fairly well documented the history of the problem and the actual success and failure of HB 1529. Our contacts with industry have given us more insight on the problems among industry, local governments, and the citizenry. Consequently, we can better advise all these groups as we analyze two drastic shifts underway in industry's search for future aggregate reviews:

- seeking lower-grade gravels along the South Platte River north of Denver (Adams County)
- proposing crushed-rock quarries along the edge of the Front Range (Boulder, Jefferson, and Douglas Counties)

Besides the standard reviews, we have presented oral and written testimony at local hearings, made field inspections and even several court appearances. In a very recent and particularly gratifying example, we helped a Boulder gravel company locate a potential quarry aggregate deposit near its market area. After a contracted geological investigation, the company has just submitted its proposal to open a quarry, complete with mining and reclamation plans and thorough environmental reviews.

A number of recent local and out-of-state inquiries focus on two other important mineral commodities--limestone and silica sand. Currently limestone in Colorado is used for blast-furnace fluxstone, sugar-beet refining, aggregate, cement manufacture, and coal mine dusting. Most of the interest we detect centers on high-calcium limestones for metallurgical use, and we anticipate more interest in the use of these limited resources in the field of emissions control. What little silica sand is

produced in Colorado goes into glass manufacture. Although the physical and chemical limitations of western glass sands have been studied, inquiries still tell us of some future development potential. Other nonmetallics that hint at future development include nahcolite and dawsonite, bentonite, barite, diamonds, alunite, gypsum, volcanic ash, gem stones, and rare earths (actually metals). Selection of our future projects and investigations could well be determined by those inquiries, which range from basic geology and occurrences to economics and market conditions.

The role of your state geological survey is becoming increasingly prominent in the field of mineral resources development, both as technical advisor to industry and local government and as general public information outlet. To strengthen our credibility and technical proficiency, the agency is establishing a working rapport with many of the state's mineral industries. Largely because of our nonregulatory status, we have valued industry's cooperation in many of our efforts and have been able to distribute informative products equally useful to industry and to local governments and others engaged in mineral resource development, research, planning, and education. In contemplating the Survey's role in the future of Colorado's mineral heritage, Russel George perhaps said it best 70 years ago--"The Survey can render the state no greater service than the preparation of bulletins which shall give the youth of the state an accurate and complete knowledge of her vast mineral resources."