

STATE GEOLOGICAL SURVEY

EVALUATION REPORT

FIRST EDITION
OCTOBER 1992



COLORADO GEOLOGICAL SURVEY COMMITTEE
COLORADO SECTION
AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS



AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS

F.W. (Rick) Obernolte, President
Colorado Section,
American Institute of Professional Geologists

October, 1992

Committee & Board Members,
Legislators, Governor, and
Other Interested Parties

re: Colorado Geological Survey

Ladies & Gentlemen:

This cover letter is attached to the first edition of a report, "State Geological Survey Evaluation Report," prepared by the Colorado Geological Survey Committee of the Colorado Section of the American Institute of Professional Geologists (Colo Sect-AIPG).

The report has been in preparation since March, 1991, when the Colo Sect-AIPG started an in-depth review of the Colorado Geological Survey and twelve other state geological surveys around the United States. The targeted audience for this report is the State Legislature, the Governor and other elected representatives, as well as state bureaucrats, local government officials, Colorado's geological community and interested citizens.

The report, which has summarized the results of a survey conducted by Colo Sect-AIPG on some of the critical aspects of State Geological Surveys around the country, is not yet complete. During the investigation period, several other geological surveys were selected for inclusion in a second round of investigations. Those results will be included in the second edition, due to be completed during 1993.

Because of the demands placed on the newly appointed members of the Department of Natural Resources' Minerals, Energy and Geology Advisory Board, the Colo Sect-AIPG felt it expedient to release the results of our survey to that Board at this time. It is not anticipated that the results and recommendations of this report will change significantly from this first edition to the second edition.

We urge your careful and deliberate review of this document. The Colorado Geological Survey should have a key role in the future of the State, as well as the health and welfare of Colorado's citizens. The Colo Sect-AIPG looks forward to the opportunity to meet with you and discuss our recommendations, the means of implementation, and to answer any questions you may have about the role and economic potential of an effective geological survey.

Respectfully submitted

F.W. Obernolte
Colorado Section,

American Institute of Professional Geologists
Rick Obernolte, President

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NOTE: Although the state geological survey evaluation project started in April, 1991, the database for the report originally planned is still incomplete. A limited amount of data remain to be collected on the Nebraska, New Mexico and Oklahoma surveys, and little has been received on Arizona and West Virginia, which were added to the project only a few months ago. With the approach of the legislative session and formation of the new Minerals, Energy and Geology Policy Advisory Board, it was decided to prepare a first edition utilizing the data in hand, which are considerable. A second, more complete edition will be published during 1993.

Thomas G. Fails
Chairman
CGS Committee
Colorado Section, AIPO

"In the early 1800's as our fledgling nation expanded its borders and its appetite for raw materials, there arose a growing awareness that geological conditions and mineral resources play a major role in the development of our lands and the feedstock for our industries.

Thus it was that State Geological Surveys came into being. By 1860 some 30 State Geological Surveys had been established. Today...there are 50 functioning State Geological Surveys. While they are diverse in size, in name, and in detailed functions, each has the basic responsibility to delineate the geologic resources and conditions as they impact upon the economic and environmental well-being of the respective state."

Arthur A. Socolow, Editor
"The State Geological Surveys: A History" (1988)

INTRODUCTION

State Geological Surveys appear to be useful things for a state to have. Large or small, rich or poor, resource-endowed or not, all 50 states have one. A few states have shut down their geological surveys from time-to-time, but as they are useful and inexpensive, they always seem to be revived.

Usually, the principal roles of state geological surveys are:

- identification and mitigation of geologic hazards;
- assistance to government in geologic matters and in land-use management and planning;
- geologic mapping and evaluation of the earth's surface, including soils;
- water resource and/or environmental monitoring, control and remediation are additional survey responsibilities in many states;
- and in states with commercially exploitable natural resources:
 - identification, mapping and description of mineral and/or energy resources;
 - publication of detailed studies describing these resources;
 - basic applied research designed to aid industry in exploration for new sources of mineral and/or energy resources, which sometimes includes geologic mapping, and geophysical and/or geochemical surveys;
 - active promotion of exploration activities and responsible development as a means of increasing natural resource wealth of the state, as a source of employment, revenues and taxes;
 - maintain inventories of geologic materials and data useful in mineral and/or energy resource studies; and

- education of the public and governmental officials concerning resource occurrence, availability, and development and the economic and environmental consequences of resource development.

(See also the Krason abstract: "Geological Surveys and Bureaus of Mines: Managing for Profit" in the Appendix.)

A number of events, mainly economic, have adversely affected the Colorado Geological Survey (CGS) during the past decade. Most have been beyond the ability of the CGS to control, and many beyond the ability of Colorado to control or alleviate as well. The Colorado Geological Survey Committee of the Colorado Section American Institute of Professional Geologists was established during 1990. The purpose of the CGS Committee has been and is to help the CGS become more effective and of greater value to Colorado. Our original aim was to build constituencies supportive of the CGS and its improvement among the public, industries, local communities, educational and environmental groups and at the state government level. We found that outside of Colorado's geologic community, the CGS is little known or appreciated. The potential of the survey to provide expanded services of economic and social value is totally unrecognized. We found that many legislators and state bureaucrats are in these categories and that legislators familiar with, and sometimes sympathetic to, the CGS were sometimes unaware of its potential, especially in the economic development area. In general, few Coloradans:

- know what a state geological survey does.
- realize that the CGS provides vitally important services in recognition, control and mitigation of Colorado's many geologic hazards.
- are aware of the role the CGS plays in environmental monitoring and remediation.
- know that most of Colorado's surface is unmapped or inadequately mapped, despite past productivity of, and future prospectivity for, mineral and energy resources.
- realize that many state geological surveys are highly competitive with other state surveys in promotion of increased mineral/energy exploration, development and the resultant increased employment.
- are aware of the educational outreach programs of some state geological surveys to the public in their states.

It became obvious that a broadly focused educational program would be necessary before effective persuasion and constituency building could be undertaken. This report and its conclusions represent a first step.

What constitutes a useful, valuable, effective state geological survey? Because of the problems affecting the CGS, our committee found it necessary to go to other states and to examine and evaluate

their geological surveys. That is what the CGS Committee has done in preparation of this evaluation report. We have collected, evaluated and compared relevant information on the geological surveys of all seven states contiguous to Colorado, as well as seven additional state surveys--Alabama, California, Illinois, Nevada, North Dakota, Texas and West Virginia--all of which are considered to be among the best and most successful in the United States. A copy of the data compilation form used for each state survey is included in the Appendix. Complete data were not available on Arizona, New Mexico, Nebraska and West Virginia at the time this first edition was prepared; a more complete second edition is planned that will incorporate these states and possibly others. The state geological surveys reviewed and compared herein were evaluated for:

- organization
- staffing
- funding, including cash funding
- ongoing programs and specialties
- communications and publications
- relationships and accountability
- outstanding special activities or services
- strengths and weaknesses

The committee members believe we have learned a great deal of interest and potential value. We certainly have gained considerable insight into state geological surveys and the reasons why some are healthy, effective and efficient and some are not. We have recognized a pattern of state geological survey evolution, whereby they are removed from the universities or Bureaus of Mines where they originated and reorganized as semi-autonomous scientific research and service agencies. We have discovered several innovative funding approaches. The Committee has provided a short list of recommendations at the end of this report. Further, we believe that readers interested in the subject and who treat the report objectively may arrive at conclusions and recommendations of their own of great value in reorienting and improving Colorado's geological survey. We hope that these conclusions and recommendations will be conveyed to our Committee, as they will enhance the effectiveness and value of this report. Everyone wants to "help" the CGS, but the ways of doing so cover a broad spectrum. Our hope is that the "cure" eventually chosen will bring the patent back to health rather than "kill" it.

HISTORICAL DEVELOPMENT

State geological surveys came into being with the convergence of two early 19th Century expansions--that of geologic knowledge and the westerly expansion of the young United States beyond the Appalachians. Most of the original "state geologic surveys" involved preparation of a geologic map of a state during a three or four year period by a temporarily- employed individual or a small group familiar with the new science of geology. Rudimentary geological maps of most states east of the Mississippi were made by this method during the period 1824-1850. Many states were mapped again in greater detail, during or immediately after the Civil War. Only New York's geological survey has been in continuous existence since it's beginning in 1836.

Resource-rich and resource-poor states alike behaved similarly, as the haves and have-nots to be engaged in a discovery-of-self process. Some were disappointed and some were made enthusiastic by their potential riches. The earliest geological mapping by states west of the Mississippi occurred in the mid-1850s in Missouri, Iowa and Texas. In the far west, Nevada's Bureau of Mines, of which the state geological survey is a part, was founded in 1866. As the immensity of the potential mineral wealth of some areas was gradually recognized during the 1870s and '80s, many states (excluding a few in the northeast) set up permanent, continuing geological survey organizations during the 1880-1910 period (Table 1). Mining operations required regulation and the revenues generated could be taxed! It thus became very important that a state have at least some knowledge of the resources within its boundaries. Awareness of the roles played by state geological surveys in dealing with geologic hazards and water supply problems gradually developed as well. As a result, all 50 states have some kind of "geological survey" today, including the resource-poor ones.

TABLE 1

<u>STATE</u>	<u>DATES OF ACTIVE STATE SURVEY OPERATION</u>
Alabama	1847-57, 1873-present
Alaska	1959-present
Arizona	1888-present
Arkansas	1857-60, 1871-75, 1887-93, 1923-present
California	1880-present
Colorado	1907-27, 1967-present
Connecticut	1903-present
Delaware	1837-41, 1951-present
Florida	1852-55, 1886-87, 1907-present
Georgia	1836-40, 1876-79, 1890-present
Hawaii	1953-present
Idaho	1919-present
Illinois	1851-75, 1905-present
Indiana	1837-39, 1859-61, 1869-present
Iowa	1855-58, 1866-69, 1892-present
Kansas	1864-65, 1889-present
Kentucky	1838, 1854-57, 1873-92, 1904-present
Louisiana	1869-72, 1892-1909, 1914-19, 1931-present
Maine	1836-38, 1861-62, 1899-1911, 1914-present
Maryland	1834-42, 1896-present
Massachusetts	1830-39, 1921-present
Michigan	1837-45, 1859-62, 1869-present
Minnesota	1864-62, 1872-present
Mississippi	1850-72, 1903-present
Missouri	1853-61, 1870-78, 1889-present
Montana	1919-present
Nebraska	1871-present
Nevada	1866-78, 1895-present
New Hampshire	1839-78, 1942-present
New Jersey	1835-40, 1854-56, 1864-present
New Mexico	1927-present
New York	1836-present
North Carolina	1824-27, 1851-85, 1891-present

TABLE 1

<u>STATE</u>	<u>DATES OF ACTIVE STATE SURVEY OPERATION</u>
North Dakota	1895-present
Ohio	1837-38, 1869-74, 1882-present
Oklahoma	1908-present
Oregon	1911-present
Pennsylvania	1836-42, 1851-58, 1874-95, 1899-1914, 1919-present
Rhode Island	1839-40, 1909-13, 1975-present
South Carolina	1825-26, 1843-60, 1901-present
South Dakota	1893-present
Tennessee	1831-50, 1854-99, 1909-present
Texas	1858-61, 1866-67, 1873-75, 1888-94, 1901-05, 1909-present
Utah	1931-present
Vermont	1844-48, 1853-present
Virginia	1835-43, 1908-present
Washington	1890-present
West Virginia	1897-present
Wisconsin	1853-62, 1870-82, 1897-present
Wyoming	1877-present

STATE GEOLOGICAL SURVEY DEVELOPMENT IN RESOURCE-RICH STATES

Among the 25 resource-rich states in the lower forty-eight, 12 had formed permanent state geological survey organizations before 1900. Ten more were organized between 1900 and 1930. Oil and gas discoveries in many states, sometimes on state-owned lands, hastened the process. Only Colorado, Louisiana, New Mexico and Utah fell outside of this pattern. The New Mexico Bureau of Mines and Mineral Resources evolved formally out of the School of Mines in 1927. Similarly, in Utah, the state university and the USGS provided "state survey" services prior to the 1931 founding of the Utah Geological and Mineralogical Survey. Louisiana organized a series of short-lived geological surveys between 1869 and 1919, reflecting the disorganization and governmental inefficiency of the period. The present Louisiana Geological Survey developed out of the Department of Conservation organized in 1931, as the state's vast petroleum potential was recognized via the drill bit, seismograph and gravity meter. Colorado had employed a series of Territorial or State Geologists in a one person operation between 1874 and 1907. The first Colorado Geological Survey was founded in the latter year, but activities ceased in 1927 as competition with the rival Metal Mining Fund increased. The second (and existing) Colorado Geological Survey was organized in 1967.

TABLE 2

<u>STATE</u>	<u>CHANGES IN STATE GEOLOGICAL SURVEY ORGANIZATION</u>
Alabama	- O&G Board split-off and established in 1945. - State Geologist is also O&G Board Supervisor.
Alaska	- Prior to 1966, part of Division of Mines; Geological Survey separated from Division of Mines and Geology in 1970.
Arizona	- Part of Bureau of Mines, 1893-1977. - Branched into Geological Survey and Mineral Technology Division, 1977-1988. - GS separated from University of Arizona and became free-standing agency in 1988.
Arkansas	- Has included Land Survey Division since 1977.

TABLE 2

<u>STATE</u>	<u>CHANGES IN STATE GEOLOGICAL SURVEY ORGANIZATION</u>
Connecticut	- Geological and Natural History Survey.
Georgia	- Forestry and Geology, 1932-37. - Mines and Geology, 1937-72. - Geological Section or Geological Survey since 1972.
Hawaii	- Irrigation Authority till 1957; Water Authority, 1957-60; Division of Water and Land Development, 1960-present.
Idaho	- Bureau of Mines and Geology 1919-84. - Idaho Geological Survey reorganized as a special program at Univ. of Idaho, 1984.
Kentucky	- Department of Geology and Forestry, 1918-20. - Part of Department of Mines and Minerals, 1934-48. - Kentucky Geological Survey transferred to University of Kentucky, 1948.
Louisiana	- Part of Department of Conservation, 1931-34. - Established as Louisiana Geological Survey, 1934.
Maryland	- Had regulatory authority over petroleum and water, and was linked to Bureau of Mines until 1976. - Separated from petroleum functions and Bureau of Mines in 1976 as Maryland Geological Survey.
Missouri	- Geological Survey separated from Bureau of Geology and Mines in 1933, as Geological Survey and Water Resources.
Montana	- Called Bureau of Mines and Geology, but is a research and service agency only with no regulatory duties or authority.
Nebraska	- Originally Conservation and Soil Survey, 1909-21. Conservation and Survey Division, 1921-present. Oil and Gas Commission separated from Survey Division in 1959.
Nevada	- Bureau of Mines, 1895-1971. Since 1971, Bureau of Mines and Geology.
New Mexico	- Bureau of Mines and Mineral Resources separated from N.M. School of Mines in 1927.
New York	- Geological Survey is a bureau of the State Museum.
North Dakota	- Oil & Gas regulatory function removed from Survey, 1981. - Geological Survey removed from University of North Dakota and transferred to Industrial Commission, and physically moved from Grand Forks to Bismark.
Oregon	- Part of Bureau of Mines, 1911-37. - An independent state agency since 1937, the Department of Geology and Mineral Industries.
Virginia	- Geological Survey became part of Department of Conservation and Development in 1948, later named Dept. of Conservation and Economic Development, including a Division of Geology in 1958, and had some regulatory responsibilities. Further reorganized as a part of Dept. of Mines, Minerals and Energy in 1984.
Washington	- Removed from Washington State University in 1945, Div. of Geology was merged into new Div. of Mines and Geology in 1945; reorganized in 1973 as Div. of Geology and Earth Resources.
Wyoming	- In 1933, regulatory functions for oil & gas and mining were transferred from the geological survey, which became a "collector and disseminator of geological knowledge." - In 1969, geological survey was separated from Department of Geology, University of Wyoming.

Most resource-rich states have long recognized the value of their geological surveys in promotion of exploration and exploitation of the state's natural resources. The prosperity of Arizona, California, Colorado, Oklahoma, Texas and Wyoming in particular was built upon mineral- and/or energy-based wealth. More recent entries in this group include Alabama, Kansas, New Mexico and Utah. A geological survey is one of the few state agencies that can indirectly return more funds to the state than have been invested in it. It is similar to fish and wildlife departments and tourism offices in this regard. Most resource-rich states have been aware of this for some time. They view their state geological surveys, which usually enjoy excellent instate reputations, as developmental assets and try to fund them adequately to the extent possible.

THE COLORADO GEOLOGICAL SURVEY: UNREALIZED POTENTIAL
OF A TROUBLED ORGANIZATION

This is no longer true in Colorado. The CGS was modestly successful in economic development promotion work between 1967 and 1982. Important early research in the coalbed methane potential of much of the Western Slope laid a foundation for the extensive activity occurring there during the past 7 years. The Colorado economy was badly damaged in the early 1980s by the "energy bust." Tax revenues declined drastically and many state agencies, including the CGS, were put on a cash funded basis, totally or in part. Fees are now charged for geologic services previously provided gratis to state and local governmental agencies. As the CGS struggled to survive in this difficult environment, many services, including those in the economic development promotion and educational/tourism areas, were severely curtailed or eliminated. Only geologic hazard work (landslide, avalanche, swelling soil, surface subsidence) and provision of geologic service to state and local governmental agencies have been maintained on a continuing basis. The CGS enjoys an excellent reputation world-wide for its landslide and avalanche expertise, which is largely neither recognized nor appreciated in Colorado.

As promotion of responsible development of a state's natural resources is the first priority of many geological surveys in resource-rich states, competition for increasingly scarce exploration dollars in their particular state has become increasingly intense. And economically stimulative when successful. Applied geologic research and data compilation, often cash funded, are the basic tools used in this competition. Colorado is largely on the sidelines and is suffering the economic consequences. Why go into an essentially business-hostile Colorado and make major expenditures for data obtainable in other states at low cost, states where explorers are welcome and encouraged? It's part of the "Colorado Conundrum" that affects us all.

This is nothing new. Colorado developed in response to our outstanding scenic and natural-resource assets. In the mining days, "gold nuggets the size of robin's eggs lying around on the ground" apparently were found. As the railroads were built, the first tourists thronged in to enjoy Colorado's scenic splendor. State support and encouragement of such activities was not necessary. Colorado had it best of all, and "things would take care of themselves." The lack of a geological survey between 1927 and 1967 was symptomatic of this attitude. Only water was a problem, a problem which government has solved to the degree possible. But those easy days are over. Arizona, New Mexico, Utah and Wyoming, with much less to offer, are major competitors for tourist dollars. Colorado woke up to this a few years ago, and now has an effective state tourism effort, which could be enhanced by CGS educational activities. Kids love dinosaurs, which we have in abundance, and their parents have tourist dollars to spend on such things. Why not in Colorado? Mineral and energy exploration dollars are going to other resource-rich states. Why not to Colorado? The potential for change exists in Colorado, which could include expanded CGS activities, but does the will to obtain such change exist as well?

ORGANIZATION AND STAFFING

Twelve successful state surveys were examined to compare to the Colorado Geological Survey (Table 3). These surveys were founded from 1848 to 1933 whereas the Colorado Survey originally active between 1907 and 1927, was reorganized in 1967, and is the next-to-youngest survey in the United States. Six of the 13 surveys reviewed are a part of their state university system; most have been so since they were founded. The North Dakota Geological Survey was removed from the Board of Higher Education in 1989 and made a part of the North Dakota Industrial Commission. Several other state geological surveys (Arizona, New Mexico, Washington and Wyoming) have been removed from state university systems over the years. Only two, Idaho and Kentucky, have been administratively combined with university systems from earlier Bureau of Mines-type organizations (Table 2). An additional ten states (see Table 2) have removed their geological surveys from the Bureau of Mines/Department of Conservation-type of organization where they originated and reorganized them as semi-autonomous organizations providing scientific research and services. This parallels a general trend in resource-rich states starting in the 1930s to remove regulatory responsibilities and activities from state geological surveys. An additional three of the 13 state geological surveys are physically located on state university campuses, but are administratively independent of the universities. State surveys independent of universities are usually divisions within state departments of natural resources, conservation or industry (Table 3).

Among the university-affiliated surveys reviewed, some have excellent reputations as do some non-university surveys. Some in both categories are less-renowned, but are still effective and efficient in meeting their responsibilities. Being organizationally a part of a university system does not appear to be an important organizational factor, over-all. It should be noted, however, that successful state surveys which are parts of state university systems (Kansas, Texas) are positioned at high levels, as research institutes within their university hierarchies and have their own separate budget lines. University-system state surveys farther down the university table of organization, often as affiliates of Geology Departments, must compete with academic departments for funds and are often underfinanced. High university overhead factors often price them out of competitive research contracts.

Eleven of the 13 surveys are totally non-regulatory in nature. The California Survey is responsible for mined land reclamation activities. North Dakota has some regulatory functions, dealing with subsurface minerals, underground injection control and coal exploration. A number had some regulatory functions in the past (Table 2) as noted above. None of the non-regulatory geological surveys are subsidiary-to, nor a part-of, a regulatory agency, as has been proposed for the Colorado Survey.

TABLE 3
STATE GEOLOGICAL SURVEY ORGANIZATIONAL AFFILIATIONS

YEAR FOUNDED	STATE	UNIVERSITY LOCATION	PART OF	
			UNIVERSITY SYSTEM	ADMINISTRATIVELY NON-UNIVERSITY NON-REGULATORY
1847	Alabama	X		X
1880	California			X
1907	Colorado			X
1851	Illinois	X		X
1894	Kansas	X	X	X
1841	Nebraska	X	X	X
1866	Nevada	X	X	X
1927	New Mexico	X	X	X
1895	North Dakota			X
1908	Oklahoma	X	X	X
1858	Texas	X	X	X
1931	Utah			X
1817	Wyoming	X		X

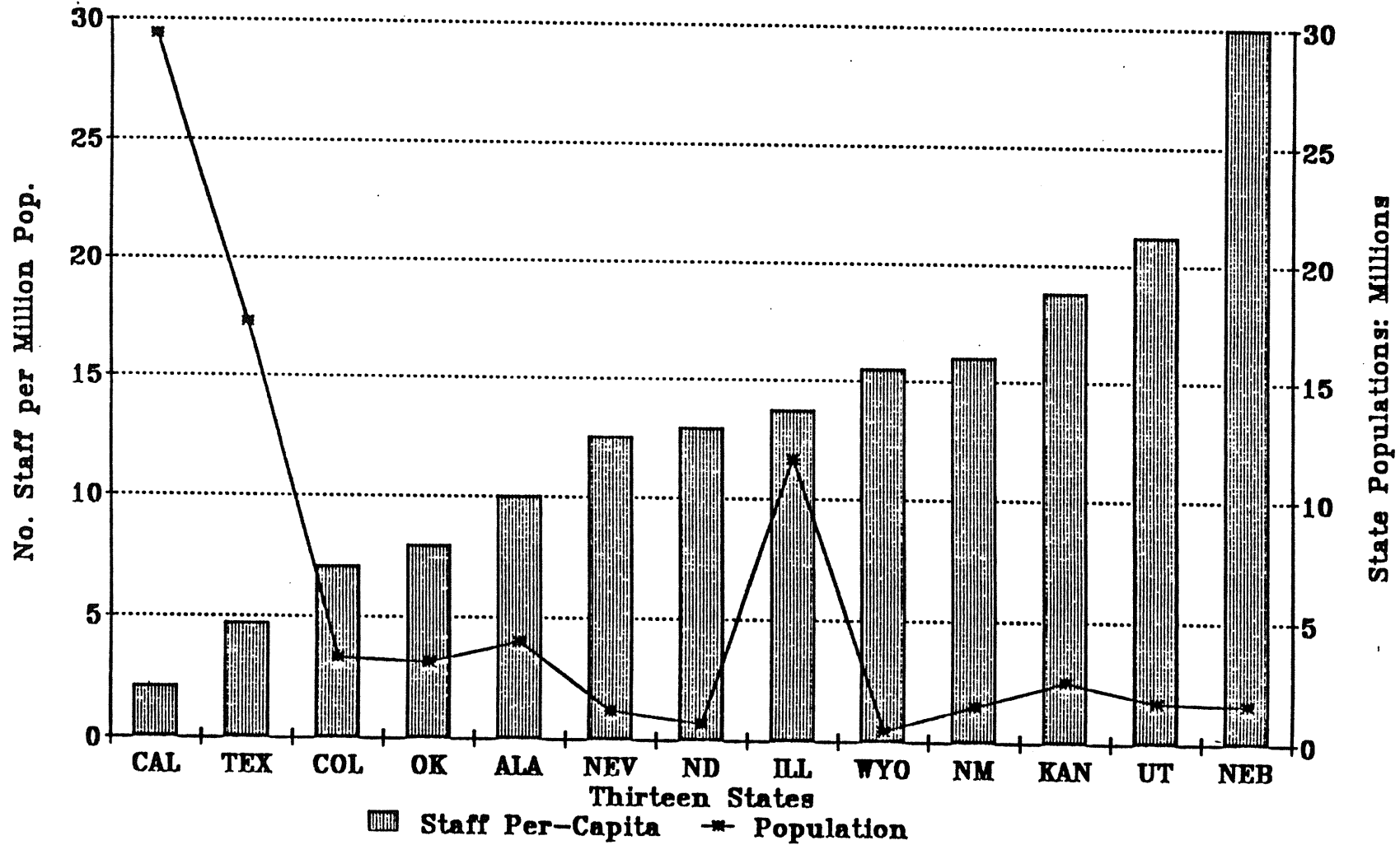
Full-time staff sizes, professional and support, are tabulated on Table 4. Part-time staffing among these surveys is very irregular. In some cases, part-timers are mainly in support roles, but with others (Wyoming for instance), they are mostly professionals. University-based surveys sometimes have large, part-time support staffs of students. Full-time professional staffs are also tabulated on a per capita basis (number of professional staff per million) in Table 4 and in Figure 1.

TABLE 4
STATE GEOLOGICAL SURVEY STAFFING

STATE	POPULATION MM	FULL-TIME PROFESSIONAL STAFF	FULL-TIME SUPPORT STAFF	% FULL-TIME PROFESSIONAL STAFF	PART-TIME STAFF	FULL-TIME PROFESSIONAL
						STAFF PER CAPITA (per MM.)
ALABAMA	4.00	40	19	67.8%	2	10
CALIFORNIA	29.40	62	83	42.7%	1	2.1
COLORADO	3.30	23	6	79.3%	3	7.0
ILLINOIS	11.66	160 [†]	90 [†]	64.0%	38	13.7
KANSAS	2.50	47	30	61.0%	0	18.8
NEBRASKA	1.60		--48--	ND	16	ND
NEVADA	1.20	15	8	65.2%	14	12.5
NEW MEXICO	1.50	24	29	45.3%	23	16.0
NORTH DAKOTA	0.70	9	2	81.8%	9	12.9
OKLAHOMA	3.15	25	25	50.0%	0	7.9
TEXAS	17.30	81	190	29.8%	6	4.7
UTAH	1.70	36	16	69.2%	0	21.2
WYOMING	0.45	7	6	53.8%	9	15.5
MEDIAN		44		59.2%		12.7
MEAN		30.5		62.5%		11.9

FIGURE 1

GEO. SURVEYS: FULL-TIME PROF. STAFF
PER CAPITA (per million population)



The high professional to support percentages of Colorado and North Dakota at first glance suggest a "mean and lean" survey. Professional to support percentages of most scientific organizations are usually close to the two professional to one support staff ratio, 66.6%. If support staff is inadequate, professionals spend more time than is desirable on support-type functions. With the exception of Illinois, large population states have smaller professional staffs per capita, even though the number of professionals employed is high. Medium-population states (2.5+ to 10.0-mm.) are all in the 7.0 to 10.0 professional per MM range. Small population states (2.5 or less) have proportionally-larger professional staffs per capita.

There is some reason for alarm here. Colorado's neighbors--New Mexico and Utah--have geologic hazard problems similar to Colorado's, which probably require similar amounts of professional staff time for this vital function. But with their larger staffs, New Mexico and Utah are more able to provide economic development promotion services as well. And, as will be seen later in this report (Table 9), they are far more effective than the CGS in this area, as is Wyoming with an even smaller staff than Colorado.

FUNDING

The 13 state geological surveys reviewed for this first edition report are funded in four basic ways:

- direct appropriation from the state budget
- federal funding (federal 50% of jointly-funded projects)
- "cash-funding"
- "other-funding" (or "special-funding")

The terms "cash-funding" and "other-funding" are somewhat ambiguous and overlapping. Funding as reported under these terms by the individual state surveys is clarified by footnotes where appropriate in Tables 5, 6 and 7. In four states--California, Illinois, Texas and Utah--financially significant "other-funding" amounts represent special geological survey projects funded by other state agencies and, in California and Utah, by funds derived from federal mineral leases and royalties as well. North Dakota is entirely funded by two special revenue funds. As these "other" funds can be considered a form of appropriated funds, they also have been shown as "special state funds" supplements to the direct appropriation funding for these states.

Table 5 lists annual state geological survey budgets (in \$1000s) for recent fiscal years for the 13 states reviewed. The budgets have been subdivided into the four categories discussed above where relevant. Total geological survey budgets are graphically compared in Figure 2.

FIGURE 2

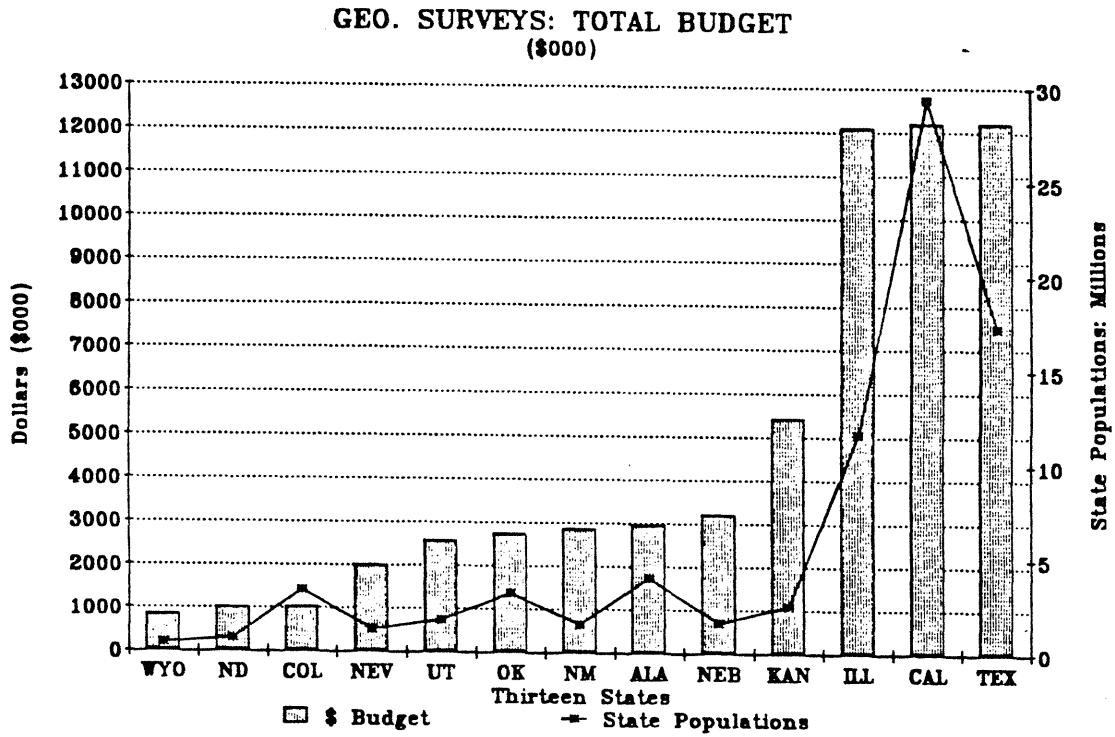


FIGURE 3

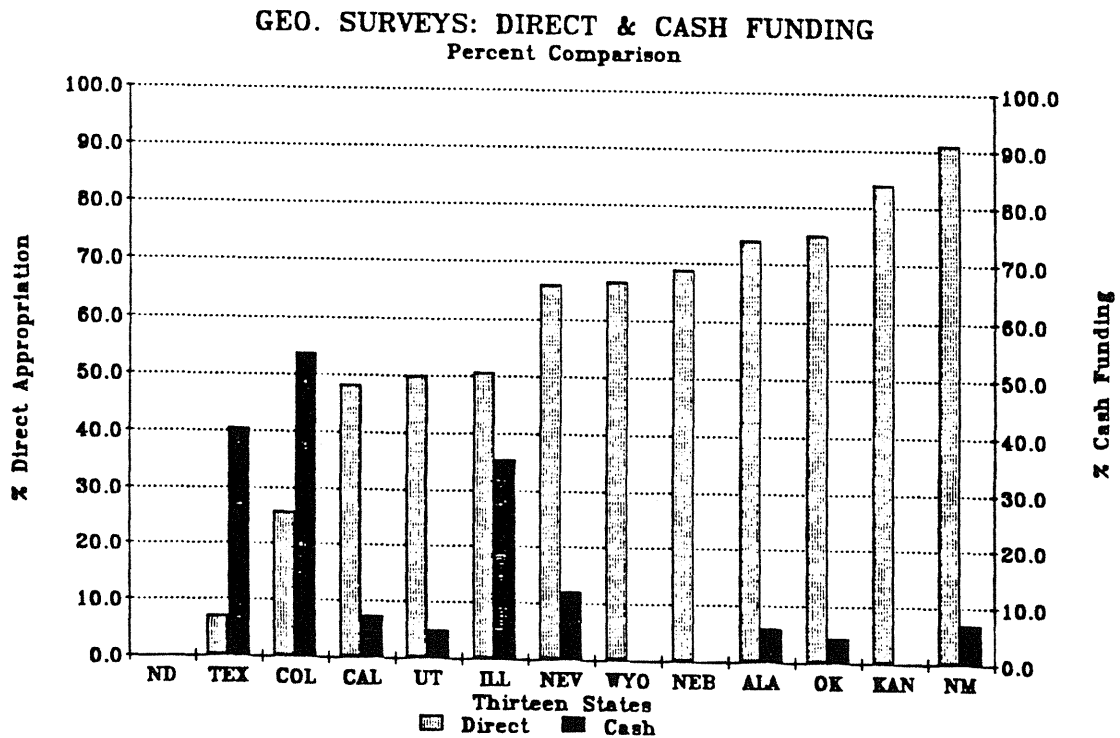


TABLE 5
STATE GEOLOGICAL SURVEY BUDGETS, SUBDIVIDED BY FUNDING CATEGORY
(\$000)

STATE	FISCAL YEAR	TOTAL			FEDERAL FUNDING	CASH FUNDING	OTHER FUNDING
		GS BUDGET	DIRECT APPROPRIATION	SPECIAL STATE FUNDS			
ALABAMA	89/90	2,950	2,183 +	0	590*	177	0
CALIFORNIA	91	12,196	5,878 +	3,293	2,134*	890	3,293 (1)
COLORADO	90/91	1,030	265 +	365	213	553 (2)	0
ILLINOIS	91	12,094	6,118 +	4,427 (3,3A)	1,094*	4,295 (3)	588 (3A)
KANSAS	90/91	5,424	4,563 +	0	354*	0	508 (4)
NEBRASKA	91	3,200	2,200 +	0	345*	0	655 (4)
NEVADA	91	1,990	1,313 +	72	438*	239 (2)	0
NEW MEXICO	92	2,860	2,603 +	0	22	ND	ND
NORTH DAKOTA	91/92	1,009 (5)	0 +	929 (5)	80*	0	929 (5)
OKLAHOMA	91	2,730	1,925 +	0	678*	120	7 (4)
TEXAS	90	12,196	854 +	4,269	2,171*	4,939 (6)	4,269 (7)
UTAH	90/91	2,570	1,259 +	1,028	129*	129 (8)	1,028 (9)
WYOMING	90/91	849	735 +	0	53	0	61 (10)

(*) COGEMAP program with USGS.

(1) Special projects funded by other state agencies--major portion from mined land reclamation and other environmental accounts.

(2) Colorado: revenue from geologic services provided to state (66%) and local (18%) governmental agencies (84% total) and to Gas Research Institute (16%).

Nevada: revenues from geologic services provided to state (30%) and local (56%) governmental agencies (86% total) and industry (14%).

(3) All but 7.2% (\$309) represents contracts and grants, other state agencies.

(3A) Mainly from publication sales and miscellaneous state sources.

(4) Grants and contracts.

(5) One-half of two-year budget appropriation. NDGS funding totally derived from Land & Minerals Trust Fund (93%) and Solid Waste Fund (7%).

(6) Research funded by industry and private foundations (mainly Gas Research Institute).

(7) Special projects funded by other state agencies--most are energy, environmental or water related.

(8) Special projects funded by other state agencies.

(9) From Federal Mineral Lease Revenues allocation (UGS recovers 2.25% of Utah's share of royalties and severance taxes on Federal leases).

(10) Mainly industrial support.

The percentage distributions of the funds listed in Table 5 are presented in Table 6. Figure 3 graphically compares some of the significant percentage distributions.

TABLE 6
PERCENTAGE DISTRIBUTION
STATE GEOLOGICAL SURVEY BUDGETS, SUBDIVIDED BY FUNDING CATEGORY

<u>STATE</u>	<u>FISCAL</u> <u>YEAR</u>	<u>TOTAL</u>						
		<u>GS</u> <u>BUDGET</u> (\$000)	<u>% DIRECT</u> <u>APPROPRIATION</u>	<u>% SPECIAL</u> <u>STATE FUNDS</u>	<u>% FEDERAL</u> <u>FUNDED</u>	<u>% CASH</u> <u>FUNDED</u>	<u>% OTHER</u> <u>FUNDED</u>	
ALABAMA	89/90	2,950	74.0%	+	.0%	20.0%	6.0%	.0%
CALIFORNIA	91	12,196	48.2%	+	27.0%	17.5%	7.3%	27.0% (1)
COLORADO	90/91	1,030	25.7%	+	35.4%	20.7%	53.7%	.0%
ILLINOIS	91	12,097	50.6%	+	36.6%	9.0%	35.5%	4.9%
KANSAS	90/91	5,424	84.0%	+	.0%	6.5%	.0%	9.5%
NEBRASKA	91	3,200	68.8%	+	.0%	11.6%	.0%	19.6%
NEVADA	91	1,990	66.0%	+	.0%	22.0%	12.0%	.0%
NEW MEXICO	92	2,860	91.0%	+	.0%	.8%	?%	?%
NORTH DAKOTA	91/92	1,009	0.0%	+	92.0% (2)	8.0%	0.0%	92.0% (2)
OKLAHOMA	91	2,730	75.0%	+	.0%	24.8%	4.4%	.3%
TEXAS	90	12,196	7.0%	+	42.0% (3)	17.8%	40.5% (3)	35.0% (3)
UTAH	90/91	2,570	49.8%	+	40.0% (4)	5.0%	5.0% (4)	40.0% (4)
WYOMING	90/91	849	66.6%	+	.0%	6.2%	.0%	7.2% (5)

- (1) State funded.
- (2) See footnote 5, Table 5.
- (3) See footnotes 6 and 7, Table 5.
- (4) See footnotes 8 and 9, Table 5.
- (5) See footnote 10, Table 5.

As the states reviewed vary widely in population, the figures shown in Table 5 are also presented on a per-capita basis in Table 7. State populations (1990 census) are listed by millions following the state name. Significant per capita funding figures are also compared graphically in Figure 4.

TABLE 7

PER-CAPITA ALLOCATIONS (\$/CITIZEN) TO STATE GEOLOGICAL SURVEY BUDGETS, SUBDIVIDED BY FUNDING CATEGORY

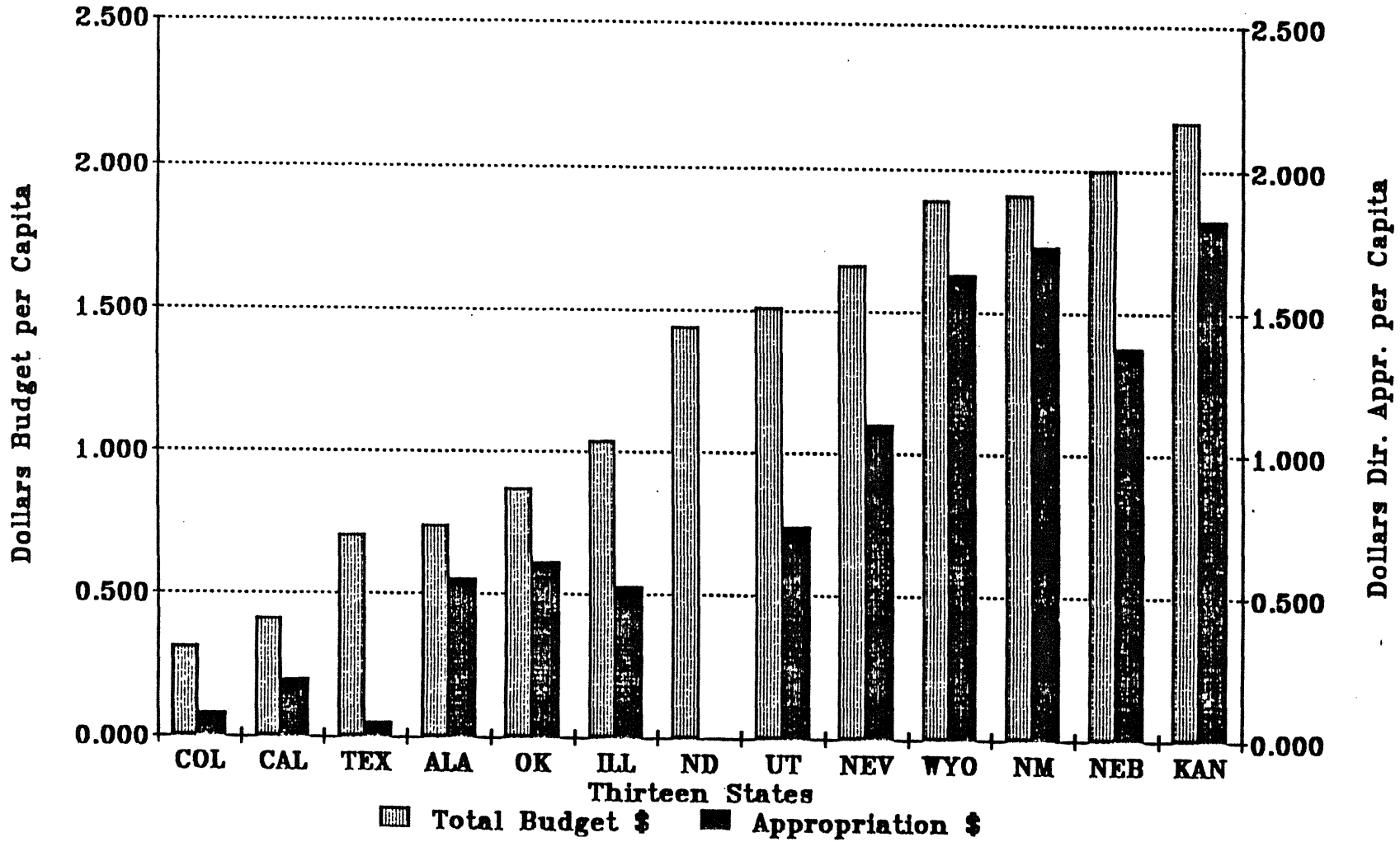
STATE	POPULATION MM	PC GS BUDGET	PC DIRECT APPROPRIATION	PC SPECIAL STATE FUNDS	PC FEDERAL FUNDING	PC CASH FUNDING	PC OTHER FUNDING	
ALABAMA	4.00	\$.74	\$.55	+	.00	\$.15 *	\$.044	\$.00
CALIFORNIA	29.40	.41	.197	+	.11	.072 *	.03	.11
COLORADO	3.30	.312	.08	+	.00	.065	.168	.00
ILLINOIS	11.66	1.037	.525	+	.40 (4)	.094 *	.368 (4)	.05 (4)
KANSAS	2.50	2.17	1.825	+	.00	.14 *	.00	.20
NEBRASKA	1.60	2.00	1.375	+	.00	.22 *	.00	.41
NEVADA	1.20	1.66	1.10	+	.00	.37 *	.20	.00
NEW MEXICO	1.50	1.91	1.73	+	.00	.077		
NORTH DAKOTA	.70	1.44	.00	+	1.33 (1)	.11 *	.00	1.33 (1)
OKLAHOMA	3.15	.87	.61	+	.00	.215 *	.038	.002
TEXAS	17.30	.705	.05	+	.247 (2)	.125 *	.285 (2)	.247 (2)
UTAH	1.70	1.51	.74	+	.670 (3)	.076 *	.076 (3)(5)	.605 (3)
WYOMING	.45	1.89	1.63	+	.00	.12	.00	.14
		PC	PC		PC	PC	PC	PC
					[totals]			
MEDIAN		1.44	.74	+	.247	[.992]	.12	.1365
MEAN		1.281	.801	+	.20	[.821]	.1375	.095
HIGHEST	KANSAS	2.17	KAN 1.825		N/A	NEVADA .37	ILL .368	
LOWEST	COLORADO	.312	TEX .05		N/A	COLO .065	CALIF .03	

- (1) See footnote 5, Table 5.
- (2) See footnotes 6 and 7, Table 5.
- (3) See footnotes 8 and 9, Table 5.
- (4) See footnotes 3 and 3A, Table 5.
- (5) 85% state funds.

States with COGEOGAP Programs (*) usually receive greater per-capita federal funding. Per-capita income figures (1989) for the subject states are shown and ranked in Table 8 below, as are geological survey budget amounts per capita.

FIGURE 4

GEO. SURVEYS: DOLLARS PER CAPITA
Total Budget and Direct Appropriation



4 - 14

Table 8

<u>STATE PER-CAPITA INCOME (1989)</u> <u>RANKED BY AMOUNT</u>		<u>STATE GEOLOGICAL SURVEY BUDGET PER-CAPITA</u> <u>RANKED BY AMOUNT</u>	
<u>STATE</u>	<u>PER-CAPITA INCOME</u>	<u>STATE</u>	<u>GS BUDGET PER-CAPITA</u>
CALIFORNIA	\$ 19,929	KANSAS	\$ 2.17
NEVADA	19,269	NEBRASKA	2.00
ILLINOIS	18,824	NEW MEXICO	1.91
COLORADO	17,553	WYOMING	1.89
KANSAS	16,498	NEVADA	1.66
TEXAS	15,702	UTAH	1.51
NEBRASKA	15,446	NORTH DAKOTA	1.44
WYOMING	14,508	ILLINOIS	1.037
OKLAHOMA	14,154	OKLAHOMA	.87
ALABAMA	13,625	ALABAMA	.74
NORTH DAKOTA	13,563	TEXAS	.705
NEW MEXICO	13,140	CALIFORNIA	.41
UTAH	13,079	COLORADO	.312
		MEDIAN	1.33
		MEAN	1.262

Source: US Bureau of Economic Analysis
"Survey of Current Business"

There is obviously no direct relationship of state geological survey budget to income on a per-capita basis. Unsurprisingly, per capita budgets tend to be lower (below \$1.05 per capita) in the larger-populated states.

Cash-Funding

Four of the states reviewed report a substantial portion of their revenue as being "cash-funded":

	<u>% of Revenues</u> <u>Cash-Funded</u>	<u>Cash-Funded</u> <u>Amount</u>
Colorado	53.7%	\$ 553,128
Illinois	35.5%	4,295,000
Nevada	12.0%	234,000
Texas	40.5%	4,939,000

Cash-funded activity clients are similar in Colorado and Nevada (basis of 100%):

	<u>Government Agencies *</u>		<u>Industry</u>	<u>Private</u> <u>Foundations</u>
	<u>State</u>	<u>Local</u>		
Colorado	66%	18%	0%	16% +
Nevada	30%	56%	14%	0%

* Services provided gratis in most states.

+ Gas Research Institute (GRI).

"Cash-funded" revenues of the Illinois Geological Survey (\$4.295 MM in 1991) are almost entirely received from other state agencies in the form of grants or contract revenues: Energy and Natural Resources (34.5%), Commerce and Community Affairs (15.6%), Transportation (14.1%), Coal Research and Development (20.7%), Conservation (2.1%), Hazardous Waste (0.9%) and Misc. State and Local Government Sponsors (4.9%). Only 7.2% comes from miscellaneous non-governmental sponsors, presumably industry and private foundations. Further, much of the IGS "other-funding" is state-derived as well.

Texas reports its 40.5% "cash-funded" revenue distribution as 12.8% from industry and 27.7% from private foundations, mainly GRI and the Institute of Gas Technology. However, an additional \$4,269,000, 35% of the budget shown as "Other-Funding," actually represents funds paid to the Texas Bureau of Economic Geology (i.e., the Texas Geological Survey) by other state agencies for research, mainly in the areas of energy resources on state lands, water resources and environment.

Therefore, if the Illinois and Texas "cash-funded and other-funded" activities are considered on the same basis as those of Colorado and Nevada, the upper summary changes to:

	<u>% of Revenues Cash-Funded</u>	<u>Cash-Funded Amount</u>
Colorado	53.7%	\$ 553,128
Illinois	39.2%	4,736,000
Nevada	12.0%	234,000
Texas	75.5%	9,208,000

And the lower summary of cash-funded activity clients becomes (basis of 100%):

	<u>Government Agencies</u>		<u>Industry</u>	<u>Private Foundations</u>
	<u>State</u>	<u>Local</u>		
Colorado	66%	18%	0%	16%
Illinois	--97.45%--	*	--2.55%--	
Nevada	30%	56%	14%	0%
Texas	46%	0%	17%	37%

* Overwhelmingly state agencies.

Two conclusions can be drawn from the above:

- 1) The "Texas model" of a largely cash-funded state geological survey can be successful. It depends for success, however, on:
 - a long-term, widely-recognized reputation for excellence in basic and applied geologic research.
 - high quality leadership.

- strong financial support by other state agencies.

- 2) The Colorado survey's strong reliance on provision of cash-funded services to other state agencies is not particularly "out of line." Based on the above, however, the CGS should attempt to increase provision of cash-funded services and research to industry and private foundations. Provision of "seed money" by small, specifically-designated direct appropriation increases to initiate programs in these areas might prove to be an excellent investment of state funds.

Resource Revenues-based Funding.

Three of the 13 state geological surveys reviewed herein are partially funded from mineral and energy production revenues received by their states. This may be viewed as a type of performance-based cash-funding which will increase or decrease in response to the survey's success or failure in promoting economic development of the states' natural resources.

CALIFORNIA - The Division of Mines and Geology receives \$2.2 million from state lease and royalty income revenues in years when the gross revenues from these sources exceed \$20 million.

NORTH DAKOTA - The Geological Survey is totally funded by the Land and Minerals Trust Fund (93%) and the Solid Waste Fund (7%). The former is based upon severance tax revenues, and the latter receives income from fees charged to solid waste haulers and city garbage collectors.

UTAH - The Geological Survey is partially funded (about 25-30%) through "Federal Mineral Leasing Revenues," which represent 2-1/4% of the State of Utah's share of royalties and severance taxes received on federal mineral/energy rights production in the state.

COLORADO - Colorado's share of Federal mineral/energy rights royalty revenues was \$53,720,000 in 1991. Colorado severance tax revenues in 1991 amounted to \$22,100,000, and State Land Board revenues were \$12,900,000 in the same year. If CGS economic development promotion activities were resumed and proved to be successful in generating increased mineral and energy revenues, a case could be made for allocation of a small percentage of Federal royalty revenues, and perhaps State Land Board revenues, to CGS direct funding, as an indirect form of results-related "cash-funding."

PROGRAM EMPHASIS

Each of the 13 state surveys reviewed were asked to estimate the percentage of total survey effort during the past two or three years that was expended on specific programs. These programs are among those usually listed as the primary responsibilities of state geological surveys:

- economic development research and promotion
- water resources

- environment, including geologic hazards
- education
- provision of geologic services to state and local governmental agencies

Their answers are compiled in Table 9 below, and are compared in Figures 5 and 6.

TABLE 9
PERCENTAGE OF TOTAL EFFORT, SPECIFIC STATE GEOLOGICAL SURVEY RESPONSIBILITIES

	<u>ECONOMIC DEVELOPMENT PROMOTION</u>	<u>ENVIRONMENTAL CONCERNS (INC. GEOL. HAZARDS)</u>	<u>WATER RESOURCES</u>	<u>EDUCATION</u>	<u>PROVIDE GEOL. SERVICES TO GOV'T. AGENCIES</u>
ALABAMA +	45%	15%	15.0%	ND	ND
CALIFORNIA	18%	51%	*	17.0%	14.0%
COLORADO	9%	65%	1.0% *	3.0%	22.0%
ILLINOIS	38%	24%	14.0%	8.0%	6.0%
KANSAS	40%	ND	10.0%	50.0%	ND
NEBRASKA	NO PERCENTAGE OF EFFORT DATA PROVIDED				
NEVADA	48%	24%	18.0%	5.0%	5.0%
NEW MEXICO	"Primary"	ND	ND	ND	ND
NORTH DAKOTA	27%	13%	13.0%	7.0%	40.0%
OKLAHOMA	ND	ND	12.5%	"Small"	ND
TEXAS	59%	8%	8.0	2.5%	21.5%
UTAH	45%	30%	*	10.0%	15.0%
WYOMING +	65%	21%	*	0.0%	14.0%
MEDIAN	42.5%	24%	12.5%	7.0%	14.5%
MEAN	39.4%	27.9%	9.1%	10.9%	17.2%
HIGHEST	WYO 65.0%	COLO 65.0%	NEV 18.0%	KAN 50.0%	ND 40.0%
LOWEST	COLO 9.0%	TEX 8.0%	COLO 1.0% *	WYO 0.0%	NEV 5.0%

* Not a survey responsibility.

+ No percentage of effort supplied: figures based upon publication subjects.

ND No data provided.

Note: A number of percentage reports totaled more-than 100%. They have been proportionately reduced to total 100%.

It is obvious from the above that heavy emphasis by the CGS on environmental concerns and on supply of geologic services to other governmental agencies has seriously compromised the survey's economic development promotion responsibilities, given the limited staff and funding available. Colorado's ability to compete with other resource-rich states in attracting explorers and developers is thus limited. Increased CGS efforts in this area, supported by increased direct funding if necessary, should be given higher priority by the State than has been the case since 1983.

FIGURE 5

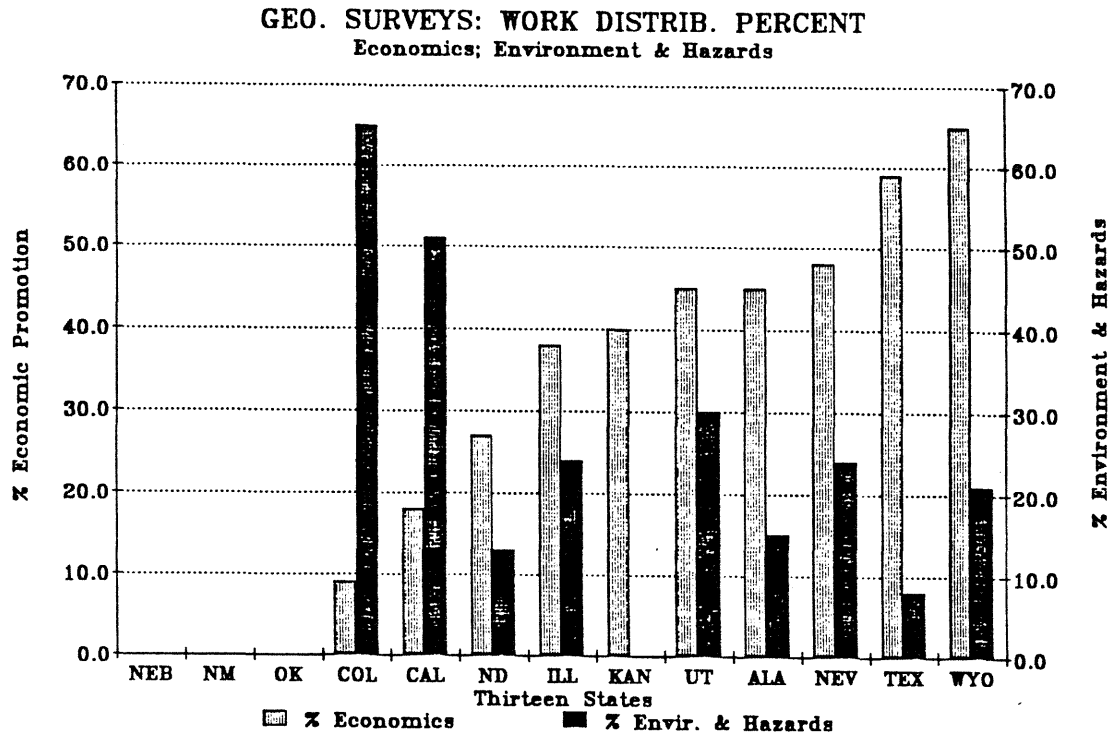
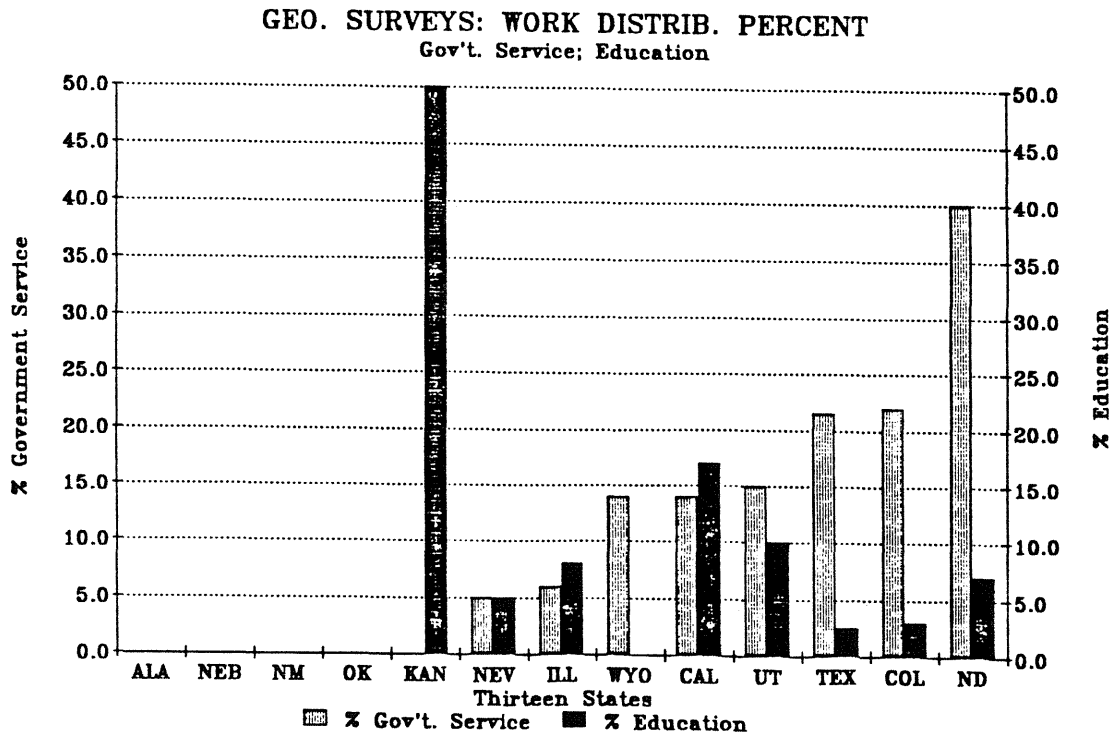


FIGURE 6



COMMUNICATIONS AND PUBLICATIONS

Successful human activities depend upon effective communication. This is as true for state geological surveys as for any other public service organization, whether or not scientific. The production of maps, research reports, data compilations, public information circulars and general geologic information is useless if they are not readily available to the widest possible audience, as printed material or verbal reports on items of interest.

State geological surveys communicate with their widely-varied audience in two ways.

- 1) Survey publications - maps, bulletins, reports, data and circulars--some highly specialized, some of general interest--are sold directly to the public, usually for nominal amounts. Open-file reports, too specialized or bulky for publication, are made available for review.
- 2) State geological survey outreach activities are very important as well, as they provide "fast-path" distribution of specialized materials, usually research reports, to widespread specialist audiences. Outreach activities are usually of three types:
 - State survey-generated papers are published in non-survey specialist publications. This is a fast, economical way to distribute research to targeted consumers. Subjects are usually in the environmental and resource areas.
 - State survey-generated talks, lectures and papers are presented in formal settings--scientific symposia, industrial conventions, short courses, etc.--to specialist audiences. This is another fast, economical means of supplying data and/or research results to audiences seeking such information. Environmental and resource exploration subjects are usually the most common for state geological surveys.
 - Public enquiry services. Geological surveys receive a wide variety of usually unsophisticated requests for geological information and advice from the general public. Provision of courteous, accurate, informative answers is as important a state survey function as are those listed previously. Use of geologic survey libraries falls in this area as well. No data on this important function were collected in this review and report.

Regardless of distribution, whether through over-the-counter sales or by giving an illustrated talk to a group of petroleum geologists, the information provided is of two general types:

- Geologic maps of the earth's surface, which have many specialized purposes. In Colorado, they address environmental concerns--water, geologic hazards, toxic waste disposal sites, etc.--and

provide data useful in exploration for sources of aggregate, energy, minerals and/or water.

- Basic geologic research reports, data compilations, applied research assessments, lectures, papers, talks, etc.. They are usually concerned with environmental and water subjects affecting public benefit, health and safety, or with responsible economic development of the state's natural resources affecting the public's economic well-being.

Tables 9, 10-A and 10-B and Figures 7, 8 and 9 summarize the public communication activities of the 13 state geological surveys reviewed, both in direct production of maps and publications and indirect outreach activities.

TABLE 10-A
STATE GEOLOGICAL SURVEY, COMMUNICATION ACTIVITIES
DIRECT, SURVEY-PUBLISHED

STATE	PERIOD	MAPS/PUBLICATIONS ANNUAL BASIS	% ENVIRONMENTAL	% ECONOMIC DEVELOPMENT	P/SFR
	YEARS AVERAGED				
ALABAMA	2	27.0 Average	15%	46%	.01237
CALIFORNIA	1	48.0 †	55%	19%	.00523
COLORADO	2	6.0 Average	80%	20%	.00952
ILLINOIS	1	120.0 †	31%	39%	.01232
KANSAS	1	45.0	+	+	.00986
NEBRASKA	?	25-40.0 Annually 33.0 Average	+	+	.01500
NEVADA	1	17.0	30%	40%	.01227
NEW MEXICO		+	+	+	+
NORTH DAKOTA	2	5.5 Average	30%	70%	.00592
OKLAHOMA	2	12.0 Average	+	+	.00623
TEXAS	1	19.0	0%	42%	.00371
UTAH	2	50.0 Average	35%	65%	.02186
WYOMING	1	142.0	77%	8%	.19320
MEDIAN		30.0	31%	40%	.01106
MEAN		43.7	39.2%	38.8%	.02562

P/SFR = publication (or lecture) per \$1000 of direct or indirect state funding (Table 5). A high number indicates relatively more effective use of available funds for publication and/or lecture purposes. This is especially true with Outreach Activities where the out-of-pocket cost to the geological survey (beyond salary and support) is low, as publication-related costs are avoided.

+ = Data incomplete.

ND = No data.

FIGURE 7

GEO. SURVEYS: DIRECT COMMUNICATIONS
 No. Pubs.; % Env. & % Econ.

F 20

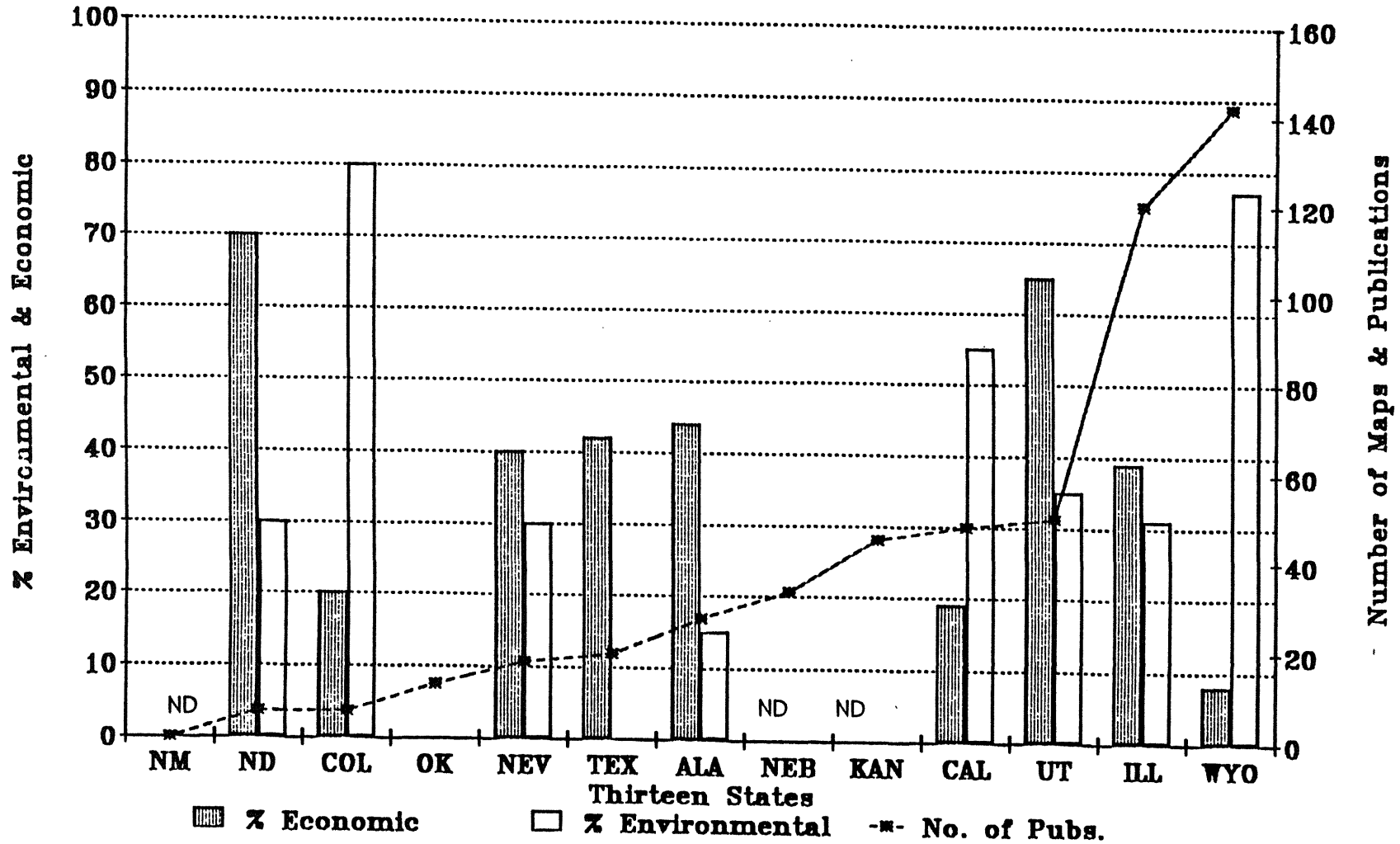


TABLE 10-B
STATE GEOLOGICAL SURVEY, COMMUNICATION ACTIVITIES
 (Excluding public enquiries and library use)
 INDIRECT, OUTREACH ACTIVITIES

	SURVEY-GENERATED PAPERS PUBLISHED IN NON-SURVEY PUBLICATIONS				SURVEY-GENERATED LECTURES/TALKS PRESENTED IN FORMAL SETTINGS			
	ANNUAL BASIS	% ENVIRONMENTAL	% ECONOMIC DEVELOPMENT	P/SFR	ANNUAL BASIS	% ENVIRONMENTAL	% ECONOMIC DEVELOPMENT	P/SFR
ALABAMA	NO STAT. DATA BUT VERY ACTIVE, ECON. DEV. AREA			ND	NO STAT. DATA BUT VERY ACTIVE, ECON. DEV. AREA			ND
CALIFORNIA	ND	-	-	ND	ND	-	-	ND
COLORADO	4 Average	50%	50%	.00635	10 Average	70%	30%	.01587
ILLINOIS	129 †	31%	39%	.01223	727	28%	34%	.06894
KANSAS	72	ND	ND	.01578	76	ND	ND	.01666
NEBRASKA	ND	-	-	ND	ND	-	-	ND
NEVADA	38	30%	40%	.02744	67	40%	40%	.04838
NEW MEXICO	ND	-	-	ND	ND	-	-	ND
NORTH DAKOTA	7 Average	15%	85%	.00753	11 Average	10%	90%	.01184
OKLAHOMA	ND	-	-	ND	ND	-	-	ND
TEXAS	117	7.7%	68%	.02284	160	6.2%	41%	.03123
UTAH	10	ND	ND	.00437	15 Average	ND	ND	.00655
WYOMING	44	10%	90%	.05986	40	40%	60%	.05442
MEDIAN	41	22.5%	59%	.01400	58.5	34%	40.5%	.023945
MEAN	52.6	24%	62%	.01955	138	32%	49%	.03174

P/SFR = publication (or lecture) per \$1000 of direct or indirect state funding (Table 5). A high number indicates relatively more effective use of available funds for publication and/or lecture purposes. This is especially true with Outreach Activities where the out-of-pocket cost to the geological survey (beyond salary and support) is low, as publication-related costs are avoided.

+ = Data incomplete.

ND = No data.

The CGS is producing a reasonable number of publications annually with respect to the limited available funding. However, exploitation of "low-cost" outreach opportunities, especially in the economic development promotion area, is at a disappointingly low level, as shown in Figs. 8 & 9. The incoming State Geologist may wish to encourage improved participation in outreach activities by CGS geologists.

FIGURE 8

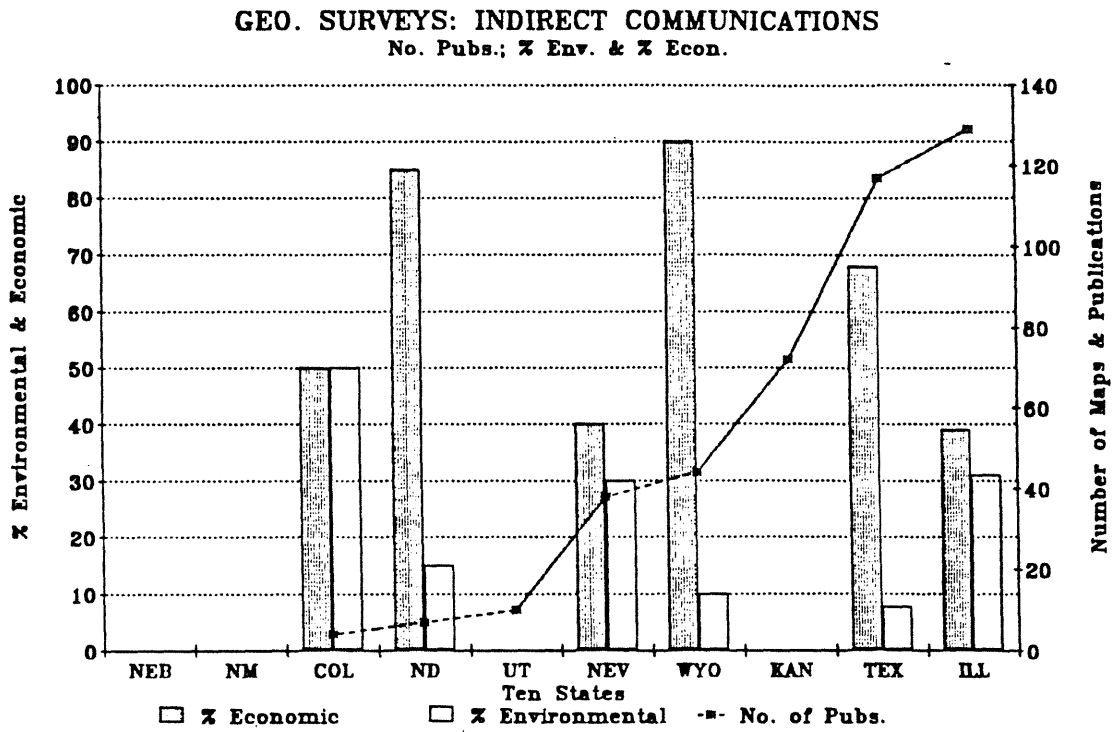


FIGURE 9

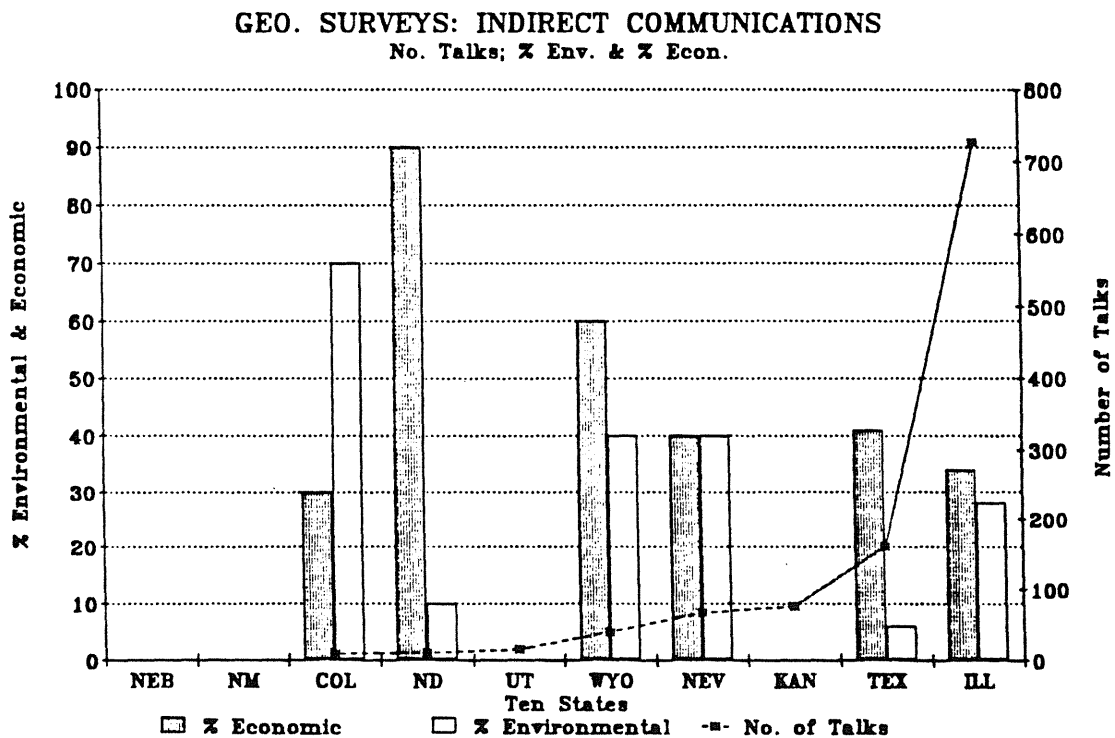


TABLE 11
STATE GEOLOGICAL SURVEY COMMUNICATIONS ON A PER CAPITA BASIS

STATE	POPULATION MM	DIRECT PUBLICATIONS PER MM, ANNUAL	OUTREACH ACTIVITIES PER MM, ANNUAL	
			PUBLISHED	LECTURES/TALKS
ALABAMA	4.00	6.75	ND, BUT ACTIVE	ND, BUT ACTIVE
CALIFORNIA	29.40	1.63	NO DATA	NO DATA
COLORADO	3.30	1.82	1.21	3.03
ILLINOIS	11.66	10.29 [†]	11.06	62.35
KANSAS	2.50	18.00	28.80	30.40
NEBRASKA	1.60	NO DATA	NO DATA	NO DATA
NEVADA	1.20	14.17	31.67	55.83
NEW MEXICO	1.50	DATA INCOMPLETE		
NORTH DAKOTA	.70	7.86	10.00	15.71
OKLAHOMA	3.15	3.81	NO DATA	NO DATA
TEXAS	17.30	1.10	6.76	9.25
UTAH	1.70	29.41	5.88	8.82
WYOMING	.45	315.56	97.78	88.89
MEDIAN		7.0	10.5	22.5
MEAN		37.3	14.1	34.3

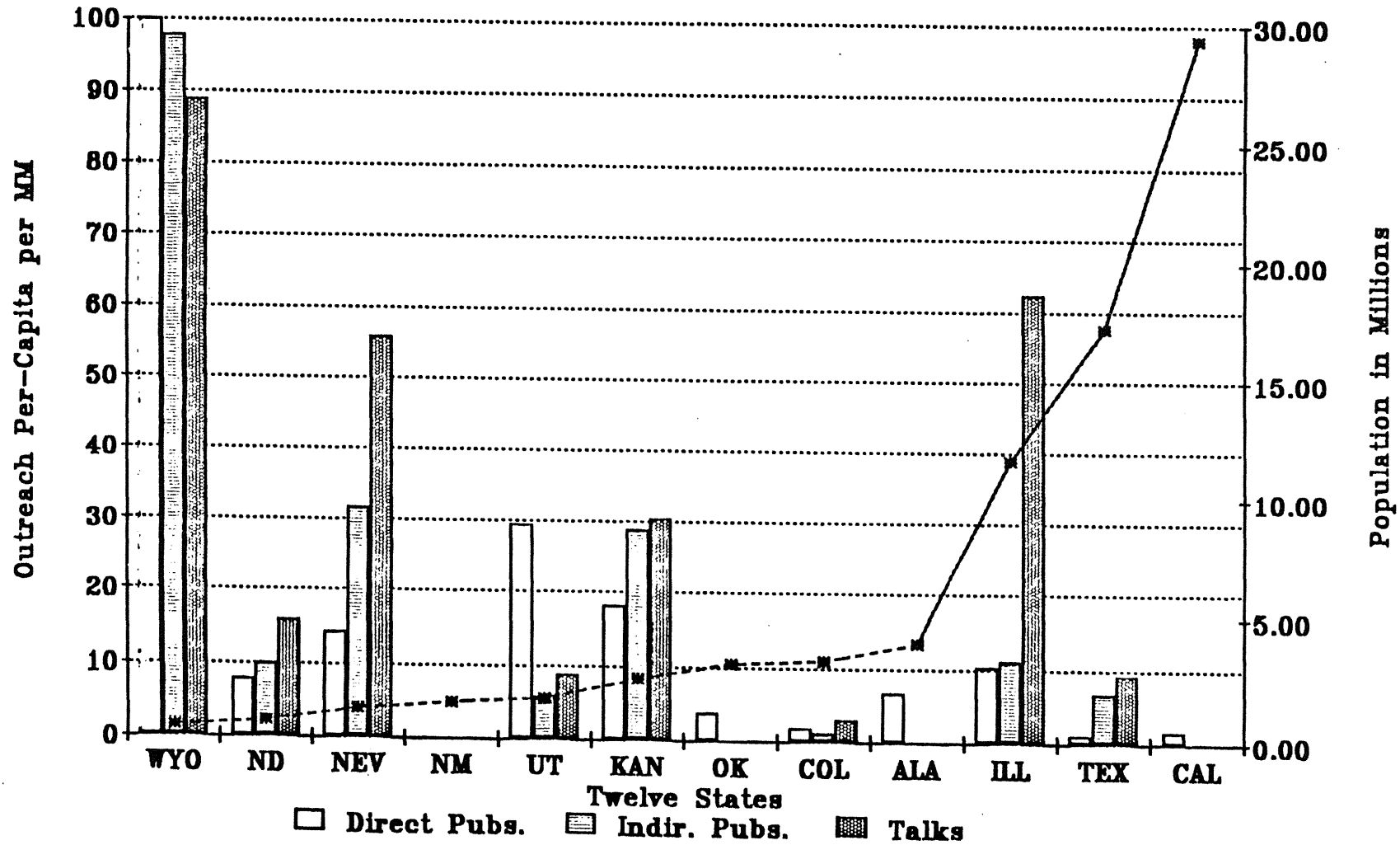
As noted at the beginning of this section, effective communication is an important function of state geological surveys. How well is the CGS doing in this area? Not very well, particularly in the number of publications and lectures generated by the Colorado Survey. Even in an area where they are fairly effective, publications/lectures generated per \$1,000 of state funding (P/SFR), the CGS is still at about one-half the average P/SFR for the state surveys reviewed. In particular, CGS participation in Outreach Activities Communications, the most cost-effective means of publicizing research and services in the economic development and environmental areas in a timely inexpensive manner, runs last among those reviewed. Given the economic situation in the state at present, this represents a tragic loss of present opportunities, which lead to losses of potential revenues and employment in the future. Why has this been allowed to happen? As much as anything, it reflects the distractions and diversions inflicted on the CGS since 1984 by heavy dependence on cash-funding. Much of our survey's personnel, time and activities are so focussed on non-research, non-economic development, engineering-oriented activities undertaken for cash-funding purposes that most of the applied research work, especially in resources, that is a major CGS responsibility is no longer being done on a consistent basis. Lack of communication by the CGS is not the fault of the CGS alone--rather, it is a symptom of much that ails our geological survey.

ENVIRONMENTAL ACTIVITIES

All state geological surveys have strengths and weaknesses. The Colorado Geological Survey possibly has the best reputation and

FIGURE 10

GEO. SURVEYS: ALL COMMUNICATIONS
Per-Capita Publications & Talks



highest levels of achievement in the environmental activities area of all of the 13 state surveys reviewed. Most of these environmental activities involve the numerous, potentially dangerous and expensive geologic hazards so common in Colorado. Landslide, avalanche, rock-fall, swelling soils and surface subsidence problems abound. And they often present themselves at very inconvenient times, requiring immediate attention on an emergency basis. Many land-use decisions depend on CGS input as well-- subdivision and school-site reviews, riparian investigations and hazardous-waste site work. All are major CGS responsibilities that are being served on an effective, efficient basis.

Approximately 65% of the Colorado Survey's annual effort is in the environmental area. This is highest among the thirteen state surveys reviewed. Only the California Survey, heavily involved in earthquake work, comes close at 51%. Wyoming's production of environmentally-oriented reports and lectures is high (57.5%) compared to Colorado's 70% of all publications/ lectures. This is ample evidence of the CGS's ability to excel in a specific, important role despite funding shortfalls. And is further evidenced by the Colorado Survey's world-wide reputation for excellence in landslide and rock research and alleviation. Colorado's citizens would be justifiably proud of their geological survey's outstanding performance on limited financial support in the environmental area--if they were only aware of it.

ECONOMIC DEVELOPMENT PROMOTIONAL ACTIVITIES

Among the 13 state geological surveys reviewed herein, the Colorado Geological Survey ranks well below average in the area of promotion of economic development of the state's natural resources. This comparison is applicable to all of the major mineral sectors: petroleum, hard-rock minerals, soft-rock minerals, and sand, gravel and aggregate. Several suggestions from other surveys' activities are presented.

Compilation of Resource Production Data: State geological surveys can provide useful information to industry in a timely fashion on the volume and value of particular commodities extracted from the state. Often, individual firms in a particular resource sector need data to determine their overall ranking among their business peers. This may be modified by individual firms, or by the authors, to look at assumed efficiencies of operation.

Synthesis and Analysis of Production Data: With certain input parameters, state surveys can provide more detailed analyses of basic production data. Production data, coupled with basic geologic maps of the producing area, can provide industry, government and the general public with estimates of the future life of a particular deposit or a producing trend.

These types of analyses can be extremely useful in determining potential land-use conflicts, impact on governmental infrastructure, present and predicted governmental tax basis, as well as useful tools

to industry, who pay taxes on each type of commodity production. (They pay taxes and provide the data, but may not have the necessary resources to compile the basic data to do these analyses themselves.)

Geologic Analysis (Play Analysis, Resource Appraisal and Reserve Estimates): Some aggressive geological surveys provide the above mentioned reports, but actually go a significant step farther. By using all available geologic data, coupled with industry-provided production data, geological surveys have generated maps that show the producing trends of the commodities, and, by using well-established geologic and engineering principles (those commonly used by exploration-oriented private-industry firms), can actually define the most likely spots for future exploration work, often leading to the extension and/or discovery of additional minerals of economic importance. In such cases, the information available to the public (i.e., private enterprise, as well as governmental agencies) is produced to "level the playing field." Such activities can provide the incentive for capitalists to invest in the exploration stage of resource development. By securing this investment risk-capital, geological surveys can promote further resource development in their states.

Several state geological surveys have been doing exactly this. Some states just provide basic production data: tons produced, barrels and thousands of cubic feet produced, and so on. Others go a step further, by providing the locations of the particular site (a mine, oil and gas well, a quarry, or a common marketing center). Other states have made a significant investment in computer hardware and software in order to provide the general public with a host of data on demand, all shown in real-world coordinates, for further interpretation and refinement. And a handful of geological surveys actually provide the public with resource appraisal maps of a specific producing commodity, define the geologic criteria controlling the deposits, and the projection of these criteria into areas that have not yet been found to be productive, but that could be considered prospective, based on a variety of the controlling criteria. For example, if the controlling criterion for the development of coal resources is the depth of overburden (noncommercial rock) above major coal deposits, by use of geologic and engineering data commonly provided to the state agencies, geological surveys have outlined three different areas for future development: probable development (assuming cost factors involved with the mining operations do not change significantly), possible development, and speculative development. If the state owns coal in areas designated in the possible or speculative development categories, it may choose to lease the coals to private sector firms on a sliding scale royalty, thereby providing incentives to the private sector to risk additional exploratory dollars to prove and confirm additional coal resources for potential development.

HOW DOES COLORADO STACK-UP WITH OTHER STATES IN PROMOTING ITS GEOLOGICAL ECONOMIC DEVELOPMENT?

Oil and Gas Development: Moderate to poor. The CGS publishes regional maps periodically on the location of the major oil and gas

fields in the state, but a concerted effort to summarize publicly available data with the known geologic habitat of these deposits is poor. Significant efforts could be made to synthesize data presented by the oil and gas operators to the State Oil and Gas Conservation Commission to provide significant improvement in the data utilized by private enterprise. In addition, basic geologic research of the potential petroleum system (source rock, reservoir rock and seal) of the state could be a significant contribution to the private-enterprise sector for additional exploratory drilling. A significant start could be a basic penetration map of the major (and inferred) petroleum basins of the state.

Metalliferous Ores: Moderate to Poor. Only recently has the Geological Survey provided maps and detailed cross-sections of sufficient detail to show diagrammatically the relationship of the rock-types to the ore bodies, and this is only for some gold deposits of the state. Additional basic surface mapping, and the coordination of the mine maps provided by the individual mines should be provided for each mining district. In addition, ore analysis and host rock petrographic- and chemical-analyses are needed to determine the alteration halos and age of mineralization for each district.

Non-metallic Mineral Deposits: Poor. See above.

Coal Resources: Moderate, but getting poor quickly. The basic coal resource data of the state have not been updated since the early 1980s. The results of underground and strip mining activity should be updated, and the details of specific, representative mines included as analogs for future development. In addition, the relationship between methane from coal and the petroleum geology of tight formation gas should be further refined and evaluated to provide technology transfer from one industry to the other. In this manner, new gas "plays" might be identified.

Sand, Gravel and Aggregate: Poor. With the development of construction projects using significant quantities of concrete (Denver International Airport) and the improvement in the residential housing market, it appears that the Front Range area is at a crisis-stage for the development of new deposits of sand, gravel and aggregate. Because of the price-sensitivity of transportation on the total price of the commodity, a major effort should be undertaken to identify and define the deposits closest to the metropolitan areas most in need of this resource. In addition, given the volatile nature of public involvement in the approval process of an aggregate development plan, land-use issues are critical in locating and developing the best locations of the deposits, with minimal impact on the existing population centers and infrastructure.

SUMMARY-ECONOMIC DEVELOPMENT PROMOTION

The other states studied for this report range from those that use their geological surveys to assist private industry in the economic development of the states resources to those which do little in this area. Colorado, which falls in the latter group, has lost its

initiative to provide data already within its domain to the general public. An investment in human resources to process and present this data in a form most easily accessible to the public-at-large provides the best opportunity for interpretation of the data by the largest segment of the public. This, in turn, provides the optimum opportunity for the data to be turned into prospects for risk-capital investment, and, consequently, additional production of resources which will benefit the citizens of Colorado, and the governmental entities with increased tax revenues. Efforts and activities of this type are not commonly found in organizations with primary responsibilities for regulation and not scientific research. Regulation and research differ philosophically, use different methodologies and have much different goals. One is creative, one not. Regulators are interested in closing mines while scientists are concerned with finding new ones.

CONCLUSIONS

Much of interest and value has been learned concerning the 13 state geological surveys reviewed and evaluated, especially in comparison with the Colorado Geological Survey:

- 1) A definite movement toward reorganization of state geological surveys as semi-autonomous scientific research and service organizations developed during the 1930s and continues today. State surveys have been systematically removed from the universities and Bureaus of Mines where they originated and given greater autonomy and assigned scientific responsibilities. Regulatory responsibilities have been omitted as well, emphasizing the scientific nature of geological surveys.
- 2) Innovative state survey funding techniques utilizing severance tax or Federal lease royalty revenues are used in several resource-rich states. As noted in our recommendations, serious consideration should be given to finding alternate, supplemental ways of increasing CGS funding. On a nominal basis, the CGS budget is third from the bottom among the surveys reviewed. On a per-capita basis, the CGS is lowest. The problems resulting are compounded by heavy reliance on cash-funding. It seems incredible that small, relatively poor states like Kansas, Nebraska, New Mexico, and Utah allocate much greater funds to their geological surveys.
- 3) The CGS is understaffed by most measures. This is especially true with professional/support staff ratios.
- 4) Heavy CGS dependence on cash-funding is not unique. Illinois and Texas have high-quality geological surveys heavily dependent on cash-funding. With both, as with Colorado, most "cash-funds" come from other state agencies. Texas obtains significant "cash-funds" from industrial and foundation sources as well. With proper leadership and planning, it can be done.
- 5) Heavy, effective emphasis by the CGS on environmental and geologic hazards work is commendable; it greatly exceeds that of other state geological surveys.
- 6) Unfortunately, CGS efforts to promote responsible economic development of Colorado's natural resources are undesirably limited. Most state geological surveys have made economic development their most important activity, even in states with geological hazard problems comparable to Colorado's.

- 7) Communication with the public and industry is an important state geological survey function, through the publication of research reports, maps and data compilations, especially in the economic development area. Due to limited funding, at present the CGS is not remotely competitive with most of the state surveys reviewed in "getting the word out." This is especially disappointing in the low-cost outreach activity area of scientific organization publications, conventions and meetings.
- 8) Heavy CGS reliance on cash-funding since 1983 has diverted Colorado's survey from fulfillment of many of its statutory responsibilities. While doing an excellent job in the environmental area, the CGS is no longer competitive with other state surveys in economic development promotions. Wide availability of the basic research reports data compilations and collections, maps and applied research studies produced and distributed in volume by other states place Colorado at a disadvantage in attracting resource exploration and development dollars. Employment and tax revenues are inevitably reduced as a result. Relatively small increases in direct funding (seed money), intelligently applied, could help revitalize the CGS in this vital area.
- 9) Although this first edition does not deal with geological survey leadership per se, this is one of the most important issues affecting state survey excellence. All of the state surveys with excellent reputations that were evaluated for this report--Alabama, Illinois, Kansas, Texas--had or have one or more outstanding State Geologists. They all possessed the necessary combination of charismatic personality, solid scientific credentials and political skills. They were just as effective in convincing a major oil or mining company to finance survey applied research projects as they were in dealing with legislators, gubernatorial staffs, the press and the public. To the degree possible, Colorado's new State Geologist should have these skills as well.

RECOMMENDATIONS

A healthy, effective, efficient, properly-led Colorado Geological survey would be of benefit to Colorado in meeting the environmental, economic and educational needs of the state. We must ensure we have the very best geological survey we can afford. The following recommendations are made to the General Assembly, the Department of Natural Resources, the Minerals, Energy and Geology Policy Advisory Board, the CGS Advisory Committee, Colorado's geological community and interested citizens in the hope that members of these groups working together will provide Colorado with the geological survey it needs and deserves.

ORGANIZATION/STAFFING

- 1) The importance of leadership in creation of an outstanding state geological survey is difficult to quantify - in practice it has been extremely important. DNR and the CGS Advisory Committee should seek a new State Geologist possessing outstanding proven technical competence, an aggressive, people-oriented personality and good political sense. While a PhD does not guarantee competence, a PhD may be necessary to establish credibility of the research capabilities of the CGS. Salary is important, but the challenge involved in rejuvenating the CGS will be more important to suitable candidates.
- 2) The CGS must continue as an independent Division, with the State Geologist reporting to the Executive Director, DNR, if the Legislative Declaration directing the CGS to reemphasize economic development of Colorado's resources is to be properly fulfilled. Although a few successful state surveys are organized as university research institutes, they have been so since their founding. As the general trend of state survey reorganization in recent years has been OUT of universities to semi-autonomous organizations, as university over-head markups are much higher than that of CGS and as reorganization within a university would be time-consuming, expensive and difficult, this option is not recommended.
- 3) The CGS staff should be increased when affordable. In the medium term, professional FTE's should be increased to about 6 to 7 positions and further increased later. The professional/support staff ratio should be reduced by a proportionate increase in support personnel.

Funding - Given Colorado's current financial difficulties, constructive commentary on funding is difficult. Nevertheless, a geological survey is one of the few state agencies that will return indirectly more than the amount invested in it (though increased resource exploitation). PLEASE consider the following:

- 1) Take another look at how the CGS is funded. Reliance on cash-funding has been overdone - the CGS is hurting as a result. Budget and direct appropriations for the CGS are deplorable on a per-capita basis. They are the lowest among the states with which Colorado must compete. California and Utah allocate a small percentage of the Federal resource royalty payments received by the state to support their geological surveys. These Federal royalty payments exceeded \$50 million in Colorado in 1991. As these revenues fluctuate in response to geological survey economic development promotion to some degree, they can be viewed as sort of performance-related cash-funding. One percent for the CGS - why not?
- 2) Overemphasis on cash-funding has diverted CGS efforts into activities lacking long-term economic potential. More time needs to be spent on state resource exploitation. Intelligently conceived policies could change this situation at modest cost.
- 3) Basic and applied state survey research in economic development oriented areas can be substantially cash-funded, as is consistently proven by the Texas Bureau of Economic Geology. This could be done in Colorado on a smaller scale, if properly conceived and lead. Relatively small amounts of directly appropriated "seed money" will be necessary to design and sell programs of this type to industry or GRI. Returns on this type of investment in terms of employment, royalties and revenues could be great.
- 4) Employment of one FTE for basic resource data compilation and publication, difficult to cash fund due to lack of "sex appeal" but still very important, should be considered for a direct appropriation basis when possible.

Ongoing Programs

- 1) An increase in economic development promotion activity is mandatory if we are to compete with neighboring states to bring exploratory spending to Colorado instead of to Wyoming, Utah, Nevada or New Mexico.
- 2) Only a small percentage (20% at most) of Colorado is adequately mapped geologically. Federal funds are available for half of the cost of mapping programs. Our competitors have such programs, why not Colorado? The economic "fall-out" could eventually be great, for both geologic hazard and resource exploration work.
- 3) The potential educational role of state geological surveys is rarely realized - in just about any state. This is especially tragic in Colorado, given our spectacular geologic heritage. An eventual goal for the CGS, when staff, finances and circumstances allow, should be to become effective in those areas, especially with respect to tourism.

Communications - As a consequence of cash-funding-related diversions, the CGS publication rate is one of the lowest among the state surveys reviewed on both nominal and per capita basis. This is particularly pronounced in the low cost, outreach activities area. One of the first "problem areas" to be dealt with by the new State Geologist should be CGS communications, or the relative lack there of.

APPENDIX

KRASOVS, J., *Geoscientists International*, 1984, 1, 1, 1-10

Geological Surveys and Bureaus of Mines: Managing for Profit

Mineral resources developed into an active industry can play a vital role in the economy of a country by providing raw materials for consumers, employment, revenue, and sources of foreign exchange. In free market economies, governments have an obligation to facilitate development of a country's mineral resources by assisting the industry. In centrally planned economies, government, through its geoscientific and mining institutions and state owned enterprises, carries out exploration, development, and exploitation of mineral deposits.

National geological and/or mining institutions have been established early in the history of many countries because of the importance of mineral resources to national welfare. These institutions operate as government agencies. They are known as geological surveys, research bureaus, geological services, geological institutes, administrations of mineral resources, and by many other names. Geological surveys and bureaus of mines or their equivalents are usually a part of a larger administrative unit, although in some countries they operate autonomously as a separate ministry.

Effective and efficient geological surveys and bureaus of mines or mining authorities are fundamental prerequisites for maximizing the beneficial and orderly use of land and offshore areas, and the contribution of mineral, energy and water resources to the national and local economy. However, the importance of the geoscientific and mining engineering services and information provided by geological surveys and bureaus of mines are not always appropriately appreciated. Therefore, in this presentation an attempt is made to review and redefine the generally applicable functions and duties of geological surveys and responsibilities and authorities of bureaus of mines. In this context, functions are understood as major categories of an institution's work performance, while duties define the approach necessary to accomplish the functions.

Generally the principal role of the geological surveys of all countries encompasses the following functions:

1. Assistance to government in land use planning and management with objectives of beneficial and orderly use of land.
2. Research into and exploration for mineral resources, aiming for advancement of relevant knowledge.
3. Promotion of mineral wealth for its optimal use.
4. Identification and mitigation of geologic hazards.

The functions of the geological surveys are similar in principle in all countries. However, the precise objectives of a particular national geological survey depend on many factors, among them: the size and level of development of the country, extent of previous geological work, the natural environments and geology of the country, requirements for environmental protection, and short- and long-term priorities.

Principal duties of a geological survey permit the functions to be fulfilled and the primary objectives to be achieved. In modern geological surveys, duties are multidisciplinary. While the priority order varies from country to country, duties typically include:

1. Geologic mapping, and geochemical and geophysical surveys
2. Geoscientific services, and assistance in exploration, development, mining, and other geology-related projects.
3. Geochemical and mineralogical laboratory services.
4. Generating, compiling, publishing, and providing information on a country's geology, mineral resources, exploration and mining
5. Continuous education and professional training.

The bureau of mines is often directly connected and jointly managed with the geological survey. However, the bureau of mines and the geological survey work in totally different capacities. In many countries, especially in those with an advanced mining industry, the bureau of mines or mining authority forms a separate government agency, or a mining-research and safety-oriented institution. The role, responsibilities, authority, and size of a national bureau of mines or mining authority differ greatly between countries. They depend not only on the size of the country and mining industry but also on the type of prevailing mineral resources and mining operations, mining technology, mineral rights/ownership, and government policies toward mineral resource development, mining and environmental control.

Since "there is no challenge in finding mineral deposits if the cost of discovery is considered irrelevant" and since budgets are always limited, it is highly recommended that geological surveys and bureaus of mines manage research programs and services for direct and indirect tangible benefits, or in short, manage for profit.

This would require considerable reorientation of many geoscientific research programs and individual projects to focus on direct, practical application of the research results. When managed for profit the geological surveys and bureaus of mines should be funded mainly from proceeds (proportionally to profits) generated from most beneficial and orderly use of land and associated mineral resources. Therefore, special encouragement is made to involve geological surveys and bureaus of mines not only into challenging research programs, but also to extend their deeply committed professional assistance into highly reliable mineral resources assessment exploration, development and profitable exploitation. While this approach holds promise for all countries, it is especially applicable in developing countries where national budgets are insufficient to adequately support a research-oriented geological survey and bureau of mines.

REFERENCES

- Woodall, R., 1984, Success in mineral exploration, a matter of confidence, *Geoscience Canada*, v. 11, n. 1, p. 41-46.