MINUTES OF THE MEETING
EDUCATION SUBCOMMITTEE
50TH LEGISLATURE

February 5, 1987

The meeting of the Education Subcommittee was called to order by Chairman Dennis Nathe at 8:08 a.m. on Thursday, February 5, 1987 in the Scott Hart Auditorium.

ROLL CALL: All members were present. Also present were Dori Nielson and Jane Hamman of the Legislative Fiscal Analyst office, Sib Clack of the Office of Budget and Program Planning, and Deb Thompson, Secretary.

BUREAU OF MINES AND GEOLOGY

Sib Clack reviewed the Bureau of Mines program description and discussed the budget issues (Exhibit 1).

Jane Hamman referred to page F-53 of the analysis. She discussed the reductions in the formula (Exhibit 2).

Dr. Lindsay Norman, president of Montana College of Mineral Science and Technology (MCMST), discussed the Bureau of Mines and the economic activities involvment in the state. He pointed out that the bureau is known worldwide for work in mapping.

Dr. Edward T. Ruppel, director, presented the budget report on the Bureau of Mines and Geology. The state is dependent on mineral and groundwater resources. He stated that Montana's greatest resources are to be found among the skilled scientists in the Bureau of Mines and Geology. The bureau is the only state agency responsible for gathering and disseminating to the public information on geology, mineralogy resources, groundwater, and hydrology. He cited examples of studies and uses of groundwater. (Exhibit 3) He said this state is viewed by many mining geologists as having a potential for bulk mineable precious metal deposits. More gold mining and exploration is anticipated in Montana. (220)

Dr. Ruppel discussed the bureau's budget. He said that grants and replacement contracts, and cooperative agreements were difficult to find because of restricted budgets in federal and state agencies and because of reduced matching capabilities within the bureau. The principle federal cooperative agreement pending of the geo-map proposal is reasonably sure of funding but at an initial low level. The loss of state appropriated general fund affects every part

of bureau operations. This has been made more serious by parallel Gramm Rudman losses in federal funding. The result has been reductions in staff, travel funds, no replacement of equipment, the discontinuation of hiring part-time research students, and the request for information hampered by the reduction in staff (see page 11 of Exhibit 3). Because of 50:50 match required for most grants, the general fund cutbacks are doubling up reductions.

Representative Peck asked for an explanation of the administrative charges. Vic Burt, fiscal vice president at Montana Tech, (373) replied that the bureau transfer was an inflated figure which just increased over the years. He pointed out that the bureau does not have a separate building.

MONTANA COLLEGE OF MINERAL SCIENCE AND TECHNOLOGY

Dr. Lindsay Norman, president of MCMST, discussed the campus and the 20 percent increase in first-time engineering enrollment (Exhibit 4). He mentioned the aggressive recruiting program. Solid growth is projected for the campus but he made a plea to the committee to use accurate real numbers for enrollment figures. The Board of Regents had announced that Montana Tech would no longer offer a business administration degree by the year 1990; however, the business degree was the fastest growing and highest demand degree turnover. Dr. Norman pointed out the international reputation of Tech and that 26 Chinese scholars would be attending the school because MCMST has been selected to help estblish a mineral science graduate program in China. He said there would be a shortage of mineral engineers in the next few years and that Montana Tech was the principle supplier. The program is unique to Montana and is not duplicated. (1-B)

Dr. Norman discussed the overall budget reductions. The estimated fixed operating costs were 99.7 percent of the current budget. He said that any further cuts will affect the core of the academic programs. Both the LFA and OBPP budgets severely punish Tech because of erroneous enrollment figures. He pointed out that Tech had a double cut compared to other schools (118). Further budget reductions threaten programs (Exhibit 5) and would be a financial dilemma in considering faculty contractual obligations. He pointed out that formula funding does not work well for any campus especially Tech. Specialization costs more than the generic variety and Tech is special. He compared the state support per student with other units. The business administration program had subsidized the engineering program. He recommends full funding and to use realistic enrollment figures (Exhibit 6). (373) He stated that if the committee would appropriate additional funds that no new positions will be

filled but instead would repair academic areas with quality and reputation. Flexibility to apply financial help where needed was requested. He told the committee that the future choices are self evident and to not have a reactionary response to a short-term problem but rather to give Tech full support.

Proponents - MCMST: Representative Joe Quilici (480) testified in support of Montana Tech. He said he had appeared before the Board of Regents concerning the phaseout of the business school. He pointed out that Tech was a premier engineering college and the state support for funding was lower at Tech than at peer institutions. He said that economic development will be created by students out of Montana Tech and that adequate funding was needed.

Representative Fritz Daily said that if the Board of Regents made Tech a premier college then they needed adequate funding. He pointed out that the business program was important for students to become leaders. People in Butte support adequate funding in order to grow. Education is the solution to the problem.

Senator Larry Stimatz testified in support of Montana Tech. He said it was a temporary phase of economic difficulty. He recommended to stand fast and properly fund the universities.

(2-A) Representative Dan Harrington spoke in favor of adequate funding for education.

Representative Red Menehan spoke about the importance of education and the result of spinoff to jobs. He said that kids make a better living than they would have after attending college.

Representative Bob Pavlovich said it takes money to make money. He said the 80 million dollars of coal tax money was set aside for education. He recommended taking the money for higher education to balance that budget. (060)

Mr. Dennis Lind, Chairman of the Board of Regents (077) said he had intentionally stayed away but felt compelled to speak in respect to Montana Tech. He said the regents had conducted a thorough study and had considered outright closure, merger, elimination of programs, or two year programs. The Board of Regents believe that Montana Tech is a viable, important unit and should be funded at HB500 levels. The dependence on mineral resources will make Montana Tech a solution to economic recovery. He said the regents made a difficult decision in terms of cost efficiency and program duplication and the decision to eliminate the business

program at Montana Tech. He said Tech should have proper base budget funding in order to survive. He pointed out Tech's ability to attract national and international students and he urged the committee to fund Montana Tech and higher education at requested levels.

Mrs. Bea McCarthy, member of the Board of Regents, (164) said the actions of the board was to strengthen and return the classrooms at Montana Tech to the high technical quality that students deserve. She pointed out that is was far more costly to equip and maintain a classroom and lab for geology, physics, or chemistry, than it is no maintain a classroom for English or history.

Mr. William Robinson, Vice President of Western Energy testified in support of funding for Montana Tech.(Exhibit 5) He pointed out that Tech was a resource for hiring professional staff. Otherwise companies would hire students from other states.

Mr. Don Peoples, Butte Silver-Bow chief executive, (258) supports Montana Tech. He said to consider the highly technical nature of Montana Tech and evaluate the institution on its own merits and needs. For the good of the state he asked to support programmatic funding at Tech. He said that flexibility should be given to Tech to work within a reasonable budget and to be able to raise additional revenues as they see fit and to reinstate the level of funding to provide unique programs. The turnaround in Butte in mining has been the result of Tech graduates.

Mr. Ray Hillman, human resources manager for Montana Resources, spoke for Mr. Frank Gardner the president of Montana Resources. He discussed the copper industry and the worldwide involvement. He said that Montana Tech was a needed resource to the state of Montana. He pointed out that Tech graduates held key responsible positions.

Mr. Tom White, manager of Pegasus Gold Corporation, testified in support of Montana Tech. He said their company employed 130 people and would be increasing. Montana Tech graduates had been key building blocks. He mentioned that the president and the vice president were both Tech graduates. He recommended no further funding cuts.

Mr. John Crowley, property division manager of Washington Corporation in Missoula, discussed the budget impacts that will harm private industry. He pointed out that Montana Tech has attracted mining ventures in the state and can be attributed to Tech graduates.

Mr. Gary Langley, executive director of Montana Mining Association, represents users of minerals (709). He said there has been a slow steady growth of mining that has represented millions of dollars of outside money coming into the state. He urged the committee to restore funding.

(2-B) Mr. Evan Barrett, executive director of Butte Local Development Corporation, questioned the economic development and his concern that the core of curriculum should not be cut.

Robert Vanderver (014) testified in support of funding for Montana Tech.

Robert A. Poore, president of Montana Tech foundation, suggested the committee search for adequate funding. He pointed out that future success of the mining industry was at risk. He suggested support for adequate funding.

Jim Malmo (205), president of the student body, spoke in support of funding for Montana Tech.

Elisa Sutty, student in the business program, spoke about the need for the program to the community of Butte and for non-traditional and re-entry students. She said the Butte people deserve the opportunity to go to school.

Joe Mikoletti, a senior at Tech in minerals processing, discussed the value of higher education. He pointed out that Montana had a large abundance of natural resources. Tech is important for the development of mineral reserves in Montana.

Susi Jensen, a student in business administration, spoke about her concern for funding at Montana Tech. She said that the students were the primary natural resource.

Mark Dufour, engineer scientist, spoke about the students who would not come to school because they were scared of the cuts. He related a bridge story (338).

Kelly Holmes, Montana College Coalition lobbyist, testified in favor of maintaining quality in Montana Tech.

Homer Stout, professor emeritus, supports funding at Tech. He said they produced a useful product and provided a complete service to industry.

Ladene Bowen, executive director of the Butte Chamber of Commerce, said maintaining qulity at Tech was vital in economic development of the state.

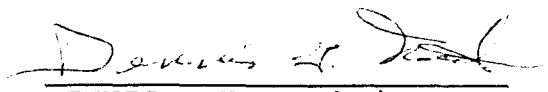
Thomas A. Dale, mining engineer and past president of the Montana Mining Association, said that the Bureau of Mines was being penalized for being cost effective. He said that Tech had indepth information available to help regulate natural resources and to the benefit of basic industry. He showed booklets that were developed at the Bureau of Mines that showed historical literature on mining districts and data needed for exploration (Exhibit 6).

Mr. Ron Long, director of the Highwood Alkali Association, said there was a need for help to control saline seep in groundwater. This is consuming 100,000 acres of prime state farmland. The Bureau of Mines is the only agency able to provide information in the hydrology area.

Dr. Ruppel summarized that Montana Tech was fundamental to the financial economy of the state.

Representative Peck asked for clarification on the enrollment figures because some of the graduate programs at Tech are extremely small. Chairman Nathe mentioned that the Board of Regents looked for duplication when restructuring and it is ironical that dropping business may now increase costs. Dr. Norman replied that Tech matches graduate productivity tothe marketplace with a goal of placing 100 percent of the graduates. Dr. Norman reported that the business students were subsidizing engineering students by about $600 per year. Tech will continue to offer the first two years of business and may offer the last two years through the U of M on the Butte campus. Commissioner Carroll Krause mentioned that Montana Tech was asking for fair treatment - not special treatment. The formula was developed based on multi-purpose institutions and Tech is specialized institution. He reported that the cost is over $8,200 per student at two similar institutions in New Mexico and Nevada. The alternatives are to provide enough funding to maintain Tech or to make it a multi-purpose institution which the state does not need. Commissioner Krause noted the same problem will impact Northern to some degree because the institution is losing education which has subsidized the technical programs. He suggested the formula could be adjusted for these decisions.

ADJOURNMENT: The meeting was adjourned at 11:45 a.m. The next meeting was announced for 8:00 a.m., February 6, in the SRS Auditorium.



DENNIS NATHE, Chairman

DAILY ROLL CALL

EDUCATION SUB COMMITTEE

50th LEGISLATIVE SESSION -- 1987

Date 2-5-87

| NAME | PRESENT | ABSENT | EXCUSED |
|---|---|---|---|
| Rep. Dennis Nathe, Chairman | ✓ | | |
| Sen. Judy Jacobsen, Vice Ch. | ✓ | | |
| Sen. Swede Hammond | ✓ | | |
| Rep. Dennis Iverson | ✓ | | |
| Sen. Greg Jergeson | ✓ | | |
| Rep. Ray Peck | ✓ | | |
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LEGISLATIVE ACTION

AGENCY: BUREAU OF MINES AND GEOLOGY

| BUDGET ITEM | FY 1986 Actual | Fiscal 1988 Executive | Fiscal 1988 Current Level | Fiscal 1988 Difference | Fiscal 1989 Executive | Fiscal 1989 Current Level | Fiscal 1989 Difference | FY 86-88 % Change |
|---|---|---|---|---|---|---|---|---|
| FTE | 32.41 | 26.43 | 26.43 | 0.00 | 26.43 | 26.43 | 0.00 | -18.45% |
| Personal Services | $957,620 | $868,378 | $868,378 | $0 | $868,378 | $868,378 | $0 | -9.32% |
| Operating Expenses | $549,685 | $526,623 | $369,151 | $157,472 | $527,013 | $368,024 | $158,989 | -32.84% |
| Equipment | $16,868 | $20,000 | $22,075 | ($2,075) | $20,000 | $23,875 | ($3,875) | 17.00% |
| TOTAL EXPENSES | $1,524,173 | $1,415,001 | $1,259,604 | $155,397 | $1,415,391 | $1,260,277 | $155,114 | -17.47% |
| FUNDING | | | | | | | | |
| General Fund | $1,173,871 | $1,362,001 | $1,206,604 | $155,397 | $1,362,391 | $1,207,277 | $155,114 | 2.79% |
| State Special | $52,302 | $53,000 | $53,000 | $0 | $53,000 | $53,000 | $0 | 1.33% |
| Resource Indemnity Trust | $300,000 | $0 | $0 | $0 | $0 | $0 | $0 | -100.00% |
| TOTAL FUNDING | $1,526,173 | $1,415,001 | $1,259,604 | $155,397 | $1,415,391 | $1,260,277 | $155,114 | -17.47% |

| ISSUES | Add to (Subtract From) LFA Current Level Fiscal 1988 | Add to (Subtract From) LFA Current Level Fiscal 1989 | COMMITTEE ACTION Fiscal 1988 | COMMITTEE ACTION Fiscal 1989 |
|---|---|---|---|---|
| 1. Administrative Charge (Executive higher by $324,854 for the biennium. LFA reduced to 5 percent of total expenditures each year.) | $162,135 | $162,719 | _____ | _____ |
| 2. Operating Expenses (Executive higher in shop items but lower in contracted services, supplies and materials, and communications for a net decrease.) | ($4,663) | ($3,730) | _____ | _____ |
| 3. Equipment (Executive lower) | ($2,075) | ($3,875) | _____ | _____ |

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galleries, audio/visual services, academic administration and personnel development, and course and curriculum development.

Student services - These activities include admissions, registrar activities, counseling and career guidance, helping students obtain financial aid, student admissions and records, and supplementary educational services.

Administrative services - These activities include the operational support for the day-to-day functioning of the institution and include executive and fiscal management, general administrative services, logistical services, and community relations.

**Budget Issues**

This program expenditure level reflects 94% of the Support formula using Fall 1986 FYFTE enrollment of 1,527 for both years of the biennium. FTE data for FY88 and FY89 are derived by dividing the formula-generated personal services amount by the average compensation for this composite program as shown on the agency's revised operational plans for FY87 following the 5% cut.

Biennial appropriation of audit costs of $54,000 are included in FY88.

| Agency Summary<br>Budget Detail Summary | Actual<br>FY 1986 | Budgeted<br>FY 1987 | Recommendation<br>FY 1988 | <br>FY 1989 |
|---|---|---|---|---|
| Full Time Equivalent Employees | 374.53 | 358.46 | 323.21 | 323.21 |
| Personal Services | 9,735,025.10 | 10,017,823 | 8,930,610 | 8,930,610 |
| Operating Expenses | 3,770,599.61 | 3,472,423 | 3,626,149 | 3,592,510 |
| Equipment | 274,202.27 | 245,000 | 190,032 | 190,032 |
| **Total Agency Costs** | **$13,779,826.98** | **$13,735,246** | **$12,746,791** | **$12,713,152** |
| Current Unrestricted Fund | 13,779,826.98 | 13,735,246 | 12,746,791 | 12,713,152 |
| **Total Funding Costs** | **$13,779,826.98** | **$13,735,246** | **$12,746,791** | **$12,713,152** |
| Current Level Services | 13,779,826.98 | 13,735,246 | 12,746,791 | 12,713,152 |
| **Total Service Costs** | **$13,779,826.98** | **$13,735,246** | **$12,746,791** | **$12,713,152** |

**Agency Description**

Eastern Montana College was established in 1927 with an initial authorization to prepare teachers for the elementary schools. The establishment of the college was in response to needs expressed by citizens in the eastern part of the state, because all the existing institutions of higher education were in the western half. Eastern Montana College is a comprehensive state college with programs in the liberal arts, teacher training, business and human services. Graduate programs through the master's level are offered in teacher training, special education and related areas. The programs in special education and rehabilitation are unique in the University System. The Continuing Education Program gives the student an opportunity to learn the newest developments in his field of study and to explore newly emerging areas of interest and concern.

| INSTRUCTION<br>Budget Detail Summary | Actual<br>FY 1986 | Budgeted<br>FY 1987 | Recommendation<br>FY 1988 | <br>FY 1989 |
|---|---|---|---|---|
| Full Time Equivalent Employees | 218.22 | 204.73 | 170.54 | 170.54 |
| Personal Services | 5,916,160.36 | 6,023,073 | 5,412,627 | 5,412,627 |
| Operating Expenses | 693,861.62 | 550,000 | 672,858 | 672,858 |
| Equipment | 66,300.51 | 30,000 | 66,546 | 66,546 |
| **Total Program Costs** | **$6,676,322.49** | **$6,603,073** | **$6,152,031** | **$6,152,031** |
| Current Unrestricted Fund | 6,676,322.49 | 6,603,073 | 6,152,031 | 6,152,031 |
| **Total Funding Costs** | **$6,676,322.49** | **$6,603,073** | **$6,152,031** | **$6,152,031** |
| Current Level Services | 6,676,322.49 | 6,603,073 | 6,152,031 | 6,152,031 |
| **Total Service Costs** | **$6,676,322.49** | **$6,603,073** | **$6,152,031** | **$6,152,031** |

**Program Description**

The objective of the Instruction Program is to provide educational activities directed primarily at the production of credits which satisfy the various curricula requirements leading toward a post-secondary degree. The category also includes expenditures for academic administration where the primary assignment is administration (academic deans).

**Budget Issues**

Instruction is funded at 95% of the formula using Fall 1986 FYFTE enrollments of 3,276 for the entire 1989 biennium. The FTE listed in the 1989 biennium are only the budgeted faculty derived from the Instruction formula. Instructional support staff are not estimated because actual program FTE are a matter of discretion at each unit and may vary depending on how staff reductions have been made. Vacancy savings were not applied.

(Ex 1)

| SCHOLARSHIPS & FELLOWSHIPS PGM Budget Detail Summary | Actual FY 1986 | Budgeted FY 1987 | Recommendation FY 1988 | Recommendation FY 1989 |
|---|---|---|---|---|
| Full Time Equivalent Employees | .00 | .00 | .00 | .00 |
| Operating Expenses | 294,067.50 | 273,073 | 289,193 | 289,193 |
| **Total Program Costs** | **$294,067.50** | **$273,073** | **$289,193** | **$289,193** |
| Current Unrestricted Fund | 294,067.50 | 273,073 | 289,193 | 289,193 |
| **Total Funding Costs** | **$294,067.50** | **$273,073** | **$289,193** | **$289,193** |
| Current Level Services | 294,067.50 | 273,073 | 289,193 | 289,193 |
| **Total Service Costs** | **$294,067.50** | **$273,073** | **$289,193** | **$289,193** |

**Program Description**

This program applies only to funds given in the form of outright grants and trainee stipends to individuals enrolled in formal course work. Scholarships include: outright grants-in-aid; trainee stipends; tuition and fee waivers; and prizes to undergraduate students. Fellowships include outright grants-in aid and trainee stipends to graduate students, but not funds for which services to the institution must be rendered (e.g., payments for teaching).

| INDEPENDENT OPERATIONS Budget Detail Summary | Actual FY 1986 | Budgeted FY 1987 | Recommendation FY 1988 | Recommendation FY 1989 |
|---|---|---|---|---|
| Full Time Equivalent Employees | 31.91 | 26.43 | 26.43 | 26.43 |
| Personal Services | 957,620.02 | 916,923 | 868,378 | 868,378 |
| Operating Expenses | 549,684.86 | 542,326 | 526,623 | 527,013 |
| Equipment | 18,868.16 | 20,830 | 20,000 | 20,000 |
| **Total Program Costs** | **$1,526,173.04** | **$1,480,079** | **$1,415,001** | **$1,415,391** |
| Current Unrestricted Fund | 1,526,173.04 | 1,480,079 | 1,415,001 | 1,415,391 |
| **Total Funding Costs** | **$1,526,173.04** | **$1,480,079** | **$1,415,001** | **$1,415,391** |
| Current Level Services | 1,526,173.04 | 1,480,079 | 1,415,001 | 1,415,391 |
| **Total Service Costs** | **$1,526,173.04** | **$1,480,079** | **$1,415,001** | **$1,415,391** |

**Program Description**

This program consists of the Bureau of Mines and Geology, which conducts the only Montana agency work in the geological, mineral, mineral-fact, geothermal, and groundwater resource fields. The research involves data collection and interpretation, and dissemination of research results to the public, and to state and federal agencies.

**Budget Issues**

The amount of the unfunded pay plan to be cut from the personal services base is $32,649. The agency reduced program FTE from 31.91 in FY86 to 26.43 in FY87. This represents a compensation cut of $53,060. The 60% of the FY87 5% cut amount is $44,581. The operational base was cut by $24,170 to achieve the total program reduction required. Approximately $4,600 of contracted services authority was added as a positive adjustment. Equipment acquisitions totalling $20,000 per year is recommended.

| SUPPORT Budget Detail Summary | Actual FY 1986 | Budgeted FY 1987 | Recommendation FY 1988 | Recommendation FY 1989 |
|---|---|---|---|---|
| Full Time Equivalent Employees | 71.43 | 60.90 | 69.30 | 69.30 |
| Personal Services | 1,888,300.34 | 1,999,294 | 1,526,205 | 1,526,205 |
| Operating Expenses | 776,146.95 | 527,638 | 639,954 | 585,954 |
| Equipment | 131,081.42 | 376,617 | 95,388 | 95,388 |
| **Total Program Costs** | **$2,795,528.71** | **$2,903,549** | **$2,261,547** | **$2,207,547** |
| Current Unrestricted Fund | 2,795,528.71 | 2,903,549 | 2,261,547 | 2,207,547 |
| **Total Funding Costs** | **$2,795,528.71** | **$2,903,549** | **$2,261,547** | **$2,207,547** |
| Current Level Services | 2,795,528.71 | 2,903,549 | 2,261,547 | 2,207,547 |
| **Total Service Costs** | **$2,795,528.71** | **$2,903,549** | **$2,261,547** | **$2,207,547** |

**Program Description**

The Support Program includes funds for activities designed to support three functions of the institution: academic programs, student services and administrative services.

Academic support - These activities include the retention, preservation and display of materials and the provision of services that directly assist the academic functions of the institution. This category includes libraries, museums and

| ORGANIZED RESEARCH<br>Budget Detail Summary | Actual<br>FY 1986 | Budgeted<br>FY 1987 | Recommendation<br>FY 1988 | <br>FY 1989 |
|---|---|---|---|---|
| Full Time Equivalent Employees | .82 | 1.30 | 1.26 | 1.26 |
| Personal Services | 44,758.65 | 23,060 | 30,703 | 30,703 |
| Operating Expenses | 5,019.76 | 16,801 | 5,223 | 5,352 |
| Equipment | 106.28 | 1,103 | 1,500 | 1,500 |
| **Total Program Costs** | **$49,884.69** | **$40,964** | **$37,426** | **$37,555** |
| Current Unrestricted Fund | 49,884.69 | 40,964 | 37,426 | 37,555 |
| **Total Funding Costs** | **$49,884.69** | **$40,964** | **$37,426** | **$37,555** |
| Current Level Services | 49,884.69 | 40,964 | 37,426 | 37,555 |
| **Total Service Costs** | **$49,884.69** | **$40,964** | **$37,426** | **$37,555** |

**Program Description**

This program includes all funds expended for activities specifically organized for research purposes and commissioned either by an agency outside of the institution or separately budgeted by an organizational unit within the institution.

**Budget Issues**

The amount of the unfunded pay plan to be cut was zero because the agency did not allocate any pay plan to this program in FY87. The 60% of the 5% FY87 cut amounts to $826. This was cut from travel and registration fees. The program budget request changed the personal services costs for this program by planning to staff at lower compensation. This results in a personal services cut of $12,778. $15,000 of laboratory equipment acquisition is recommended for each year.

| OPERATION & MAINT OF PLANT<br>Budget Detail Summary | Actual<br>FY 1986 | Budgeted<br>FY 1987 | Recommendation<br>FY 1988 | <br>FY 1989 |
|---|---|---|---|---|
| Full Time Equivalent Employees | 37.27 | 35.00 | 34.43 | 34.43 |
| Personal Services | 749,111.92 | 753,620 | 766,144 | 766,144 |
| Operating Expenses | 553,764.13 | 557,903 | 576,738 | 609,834 |
| Equipment | 8,175.73 | 15,762 | 10,000 | 10,000 |
| Capital Outlay | 8,500.00 | 0 | 0 | 0 |
| **Total Program Costs** | **$1,319,551.78** | **$1,327,285** | **$1,352,882** | **$1,385,978** |
| Current Unrestricted Fund | 1,319,551.78 | 1,327,285 | 1,352,882 | 1,385,978 |
| **Total Funding Costs** | **$1,319,551.78** | **$1,327,285** | **$1,352,882** | **$1,385,978** |
| Current Level Services | 1,319,551.78 | 1,327,285 | 1,352,882 | 1,385,978 |
| **Total Service Costs** | **$1,319,551.78** | **$1,327,285** | **$1,352,882** | **$1,385,978** |

**Program Description**

This program includes all expenditures of current funds for the operation and maintenance of the physical plant, except for amounts charged to auxiliary enterprises and hospitals. It does not include expenditures made from the institutional plant fund accounts. It includes all expenditures for operations established to provide services and maintenance related to campus grounds and facilities, utilities, property insurance, fire protection, and similar items.

**Budget Issues**

The amount of the unfunded pay plan to be cut from the personal services base is $27,517. $10,000 of this cut was achieved by reducing part-time staff by .57 FTE. The full amount was not taken because the staffing level for this program is too low. The severe and rapid decline in revenues for TECH has resulted in personal services cuts in areas with less stringent contractual obligations than those that are associated with faculty employees. Three FTE were to be added in FY87 to cover the maintenance of the new Engineering Laboratory/Classroom building. These FTE have not been hired due to the cutbacks.

The operating base was reduced by $44,000 before positive adjustments were made for utilities and insurance and bonds. Equipment acquisition of $10,000 per year is recommended.

A modification request for current unrestricted fund support for new space added to the Health and Physical Education complex and for office space created by remodeling the old gym building were not included in the Executive Budget. Since 1979, current unrestricted funds have been appropriated for ongoing maintenance of buildings constructed, remodeled or reconstructed for academic use with other funding sources. The Executive Budget recommends that no current unrestricted funding be budgeted for maintenance of facilities built or renovated with other funding sources. The intent is that units accept funding responsibility for the ongoing maintenance of buildings constructed or renovated with funds other than those approved through the Long Range Building program.

BUREAU OF MINES AND GEOLOGY
COMPARISON OF EXECUTIVE BUDGET AND LFA CURRENT LEVEL

| | FTE | Biennium | |
|---|---|---|---|
| | FY '89 | General Fund | Total Funds |
| Executive Budget | 26.43 | $2,724,392 | $2,830,392 |
| LFA Current Level | 26.43 | 2,413,881 | 2,519,881 |
| Executive Over (Under) LFA | 0.00 | $ 310,511 | $ 310,511 |

The executive budget is $310,511 over the LFA current level primarily due to differences in the administrative charge paid to Montana College of Mineral Science and Technology. The differences are summarized in the three issues presented below.

ISSUE 1: ADMINISTRATIVE CHARGE

The executive budget administrative charges paid to Montana Tech are $324,854 higher than the LFA current level. This issue is presented in the LFA current level.

ISSUE 2: OPERATING EXPENSE DIFFERENCE

The executive budget has $8,393 less in professional services, supplies, and communications than the LFA current level for the 1989 biennium.

ISSUE 3: EQUIPMENT

The executive budget includes $5,950 less for equipment during the 1989 biennium than the LFA current level.

## BUREAU OF MINES AND GEOLOGY

| Budget Item | Actual Fiscal 1986 | Appropriated Fiscal 1987 | - - Current Level - - Fiscal 1988 | Fiscal 1989 | % Change 1987-89 Biennium |
|---|---|---|---|---|---|
| F.T.E. | 28.84 | 32.41 | 26.43 | 26.43 | (5.98) |
| Personal Service | $ 957,620 | $ 910,560 | $ 868,378 | $ 868,378 | (7.0) |
| Operating Expense | 549,685 | 545,489 | 369,151 | 368,024 | (32.7) |
| Equipment | 18,868 | 24,030 | 22,075 | 23,875 | 7.1 |
| Total Expenditures | $1,526,173 | $1,480,079 | $1,259,604 | $1,260,277 | (16.2) |
| Fund Sources | | | | | |
| General Fund | $1,173,871 | $1,427,079 | $1,206,604 | $1,207,277 | (7.2) |
| State Special | 52,302 | 53,000 | 53,000 | 53,000 | 0.7 |
| Resource Indemnity Trust | 300,000 | -0- | -0- | -0- | --- |
| Total Funds | $1,526,173 | $1,480,079 | $1,259,604 | $1,260,277 | (16.2) |

The Bureau of Mines and Geology, a public service agency and research entity of the Montana College of Mineral Science and Technology in Butte, is responsible for assisting in development of the state's mineral resources. The agency gathers, field tests, analyzes, catalogs, and disseminates information on ground water, metals, oil, gas, coal, and other non-metallic minerals.

Bureau employees decrease by 5.98 FTE as requested by the agency to reflect the cutbacks caused by 1987 biennium funding reductions. Operating expense declines 32.7 percent from the 1987 to the 1989 biennium, primarily due to a reduction in the administrative charge as described under current level adjustments. Equipment increases 7.2 percent because the agency eliminated appropriated purchases during the 1987 biennium. General fund, which provides most of the agency's unrestricted budget, decreases 7.2 percent. The bureau generates $53,000 of state special revenue, primarily from the sale of maps and publications.

The bureau receives restricted federal and state grants and contracts not included in the table above. Restricted grants of about $700,000 in fiscal 1986 included $100,000 for the bureau's Statewide Ground Water Information Center funded through the Department of Natural Resources and Conservation under House Bill 947, as well as $75,000 for ground-water programs and $91,870 for the Williston Basin Reclamation Project funded under House Bill 922. The balance of the $433,000 in restricted funds includes $237,00 matching funds from the United States Geological Survey, plus grants from other state and federal agencies and private sources.

### Fiscal 1986: Comparison of Actual Expenses to the Appropriation

The following table compares fiscal 1986 actual expenditures and funding to appropriations as anticipated by the 1985 legislature.

Table 1
Comparison of the Appropriation to Actual Expenses - Fiscal 1986

| Budget Item | Legislature | Actual | Difference |
|---|---|---|---|
| F.T.E. | 32.41 | 28.84 | 3.57 |
| Personal Service | $ 916,572 | $ 957,620 | $(41,048) |
| Operating Expense | 584,637 | 549,685 | 34,952 |
| Equipment | 25,833 | 18,868 | 6,965 |
| Total Expenditures | $1,527,042 | $1,526,173 | $ 869 |
| Funding | | | |
| General Fund | $1,174,042 | $1,173,871 | $ 171 |
| State Special | 53,000 | 52,302 | 698 |
| Resource Indemnity Trust | 300,000 | 300,000 | -0- |
| Total Funds | $1,527,042 | $1,526,173 | $ 869 |

The bureau's personnel were 3.57 FTE below the level authorized by the 1985 legislature, with reductions of 0.64 FTE professional, 1.67 FTE classified, and 1.26 FTE faculty. In addition to decreasing the number of FTE, the bureau also transferred $41,048 from operating expenses and equipment in order to pay higher salaries. Operating expenses were $34,952 less than budgeted with major reductions of $8,891 in communications, $25,478 in travel, and $6,583 in professional services and major increases in equipment repair of $6,000.

Equipment was $6,965 less than anticipated and purchases included $11,010 for computers and software, $6,890 for geology and hydrology field items, $427 for office furnishings, $330 for books, and $211 for photographic equipment.

## Current Level Adjustments

Current level personnel are reduced from the fiscal 1986 appropriated level of 32.41 FTE to 26.43 FTE. Table 2 shows the FTE and average salary by FTE category.

As shown in the following table, the average professional salary requested is 20 percent above that anticipated by the legislature. The other average salaries are lower than anticipated by the legislature. The average salary for the 1989 biennium is as requested by the agency. Vacancy savings of 4 percent is taken in the amount of $36,182 in fiscal 1988 and 1989.

Table 2
Comparison of Appropriated 1986 FTE and Average Salaries to the 1989 Biennium

| | FTE | | | Average Salary | | | |
|---|---|---|---|---|---|---|---|
| Category | FY 86 | 89 Bien. | Diff. | FY 86 | 89 Bien. | Diff. | % Change |
| Professional | 18.74 | 17.06 | (1.68) | $29,070 | $34,850 | $ 5,780 | 20.0 |
| Classified | 11.91 | 8.65 | (3.26) | 18,174 | 16,683 | (1,491) | (8.2) |
| Part-time | 1.76 | 0.72 | (1.04) | 17,060 | 16,666 | (394) | (2.3) |
| Total | 32.41 | 26.43 | (5.98) | | | | |

Operating expense decreases 32.7 percent for the biennium, with fiscal 1988 summarized in Table 3.

Table 3
Operating Expense Adjustments in Current Level

| Category | Actual FY 1986 | (Decrease) Increase | Current Level FY 1988 |
|---|---|---|---|
| Professional Services | $105,939 | $ 2,561 | $108,500 |
| Legal Fees | 653 | (653) | -0- |
| Laboratory Supplies | 3,188 | 452 | 3,640 |
| Research Supplies | 3,200 | 251 | 3,451 |
| Rent | 10,438 | 662 | 11,100 |
| Earthquake Batteries | 1,500 | (750) | 750 |
| Relocation/Recruiting | 1,444 | (1,144) | 300 |
| Theft Loss | 943 | (943) | -0- |
| Administrative Charge | 238,520 | (178,061) | 60,459 |
| All Other | 183,860 | (2,909) | 180,951 |
| Total Adjustments | $549,685 | $(180,534) | $369,151 |

Professional services increase by $2,561 to pay for the scientific analysis of rock and water samples that is purchased by the geology and hydrology divisions from the Butte Analytical Laboratory at a total cost of $28,500 each year of the biennium. The $80,000 balance of this item is for the cooperative ground-water funding agreement with the United States Geological Survey continued at the fiscal 1986 level and matched with about $237,000 of federal restricted funds.

One-time legal fees are deleted. Laboratory and research supplies increase $703 as a result of inflation. Rent, for the Billings office and for the core storage laboratory in Butte, increases $662 due to a change in the Billings facilities which will

enable staff and equipment to be shared with the geological survey. Because current level equipment includes a photovoltaic system to permanently replace batteries for remote earthquake study stations, the $1,500 annual cost of batteries is reduced by half in fiscal 1988 and by $1,500 in fiscal 1989.

One-time recruiting and relocation expenses of $1,144 for the new bureau director are deleted and this expenditure is reduced to the level of $300 per annum. Likewise, the one-time theft loss of $943 is removed from current level.

The largest adjustment is a $178,061 reduction in the administrative charge paid by the bureau to Montana Tech. Campus officials advise there is no methodology for determining this charge and that it usually increases based on projected inflation. When analyzed with comparable administrative charges based on actual cost factors at the University of Montana and Montana State University, however, it becomes clear that this particular fee has over the years become unique in the university system. Table 4 presents a comparison of the administrative charges for the last four years at the bureau of mines, the forest experiment station, the agricultural experiment station, and the cooperative extension service.

Table 4 shows that the fiscal 1987 administrative charge the bureau is paying to Montana Tech is $242,153, representing 16.36 percent of its total agency expenditures and an increase of $3,633 over the fee paid in fiscal 1986. This increase occurs in a year when the personal service, operating expense, and equipment expenses of the agency have been cut $46,094 and when the administrative charges for the other three university-related agencies have all decreased. The only operating expense increase in the Bureau of Mines' fiscal 1987 budget is this administrative charge.

Table 4
Comparison of Administrative Charges Within the University System

| University Unit | Fiscal 1984 | Fiscal 1985 | Fiscal 1986 | Fiscal 1987 |
|---|---|---|---|---|
| Bureau of Mines | | | | |
| Montana Tech Fee | $222,172 | $233,586 | $238,520 | $242,153 |
| Percent Rate of Budget | 14.97 | 15.57 | 15.63 | 16.36 |
| Forest Station | | | | |
| U of M Fee | $ 17,006 | $ 24,657 | $ 26,784 | $ 26,124 |
| Percent Rate of Budget | 2.59 | 3.81 | 4.15 | 4.22 |
| Agriculture Exp. Sta. | | | | |
| MSU Fee | $450,888 | $472,636 | $505,212 | $485,004 |
| Percent Rate of Budget | 5.23 | 5.33 | 6.28 | 5.63 |
| Extension Service | | | | |
| MSU Fee | $154,542 | $159,664 | $175,248 | $168,238 |
| Percent Rate of Budget | 4.13 | 3.99 | 4.52 | 4.14 |

The percentage rates of the fees paid by the forest station, agricultural experiment station, and cooperative extension service averaged 5 percent of the three

agencies' other expenditures for fiscal 1986. Utilizing the 5 percent rate generated by the specific cost factors of the other two universities for the bureau of mines results in a fiscal 1988 administrative charge of $60,459 and a fiscal 1989 administrative charge of $59,875.

The fiscal 1989 operating expense is $368,024. Supplies increase by $504 and telephone by $48, for total increases of $552. Because of the fiscal 1988 purchase of earthquake studies equipment, travel is cut $345 and the cost of batteries by an additional $750. In addition, the administrative charge is reduced $584, for total reductions of $1,679.

Equipment is $45,950 for the biennium compared with the appropriated level of $46,663 for the 1987 biennium. The agency requested $185,240 in its priority equipment list for the 1989 biennium and the top-ranked items presented in Table 5 are included in current level.

Table 5
Biennium Equipment in Current Level

| Department/Division | Equipment Items | FY 88 | FY 89 |
|---|---|---|---|
| Information and Publications | Compugraphic MS 8400 Editwriter | $12,000 | $ -0- |
| General | Library Books | 275 | 275 |
| | PC Computer with laser graphics | -0- | 6,000 |
| Hydrology | Multiparameter water quality probe, winch | -0- | 14,000 |
| Geology and Mineral Resources | Zoom Stereoscope (replace 30 yrs old) | 1,200 | -0- |
| | Flux-gate magnetometer | 800 | -0- |
| | Steel map case | -0- | 1,800 |
| Earthquake Studies | Photovoltaic systems/seismograph station | 7,800 | -0- |
| Analytical Division | Platinum-Gold Crucibles (2) | -0- | 1,800 |
| Total | | $22,075 | $23,875 |

Equipment for the Information and Publications Division, as well as for total agency use, is a $12,000 editwriter to produce the bureau's publications, library books continued at the 1986 level of $275, and a computer with laser graphics for the analysis, interpretation, and publication of maps, cross-sections, charts, and diagrams.

Hydrology Department equipment totals $14,000 for the biennium and Geology and Mineral Resources Department equipment totals $3,800.

Earthquake studies equipment includes a $7,800 photovoltaic system of solar panels and rechargeable batteries at remote seismograph stations. Batteries for these stations currently cost $1,500 per year and cannot be recharged or reused, plus there are the costs of time and travel to the sites. Conversion to the new system will pay for itself within five years.

The Analytical Division's laboratory equipment totals $1,800 for two platinum-gold crucibles which are needed because present equipment limits the number of fusions for analysis to five each day, thereby creating losses through instability of the materials and through delays.

The following table presents a comparison of the actual fiscal 1986 expenditures to the projected distribution of fiscal 1988 and 1989 current level funds among agency divisions and the cooperative groundwater research program with the geological survey.

Table 6
Bureau of Mines Expenditures by Division
Fiscal 1986-1989

| Budget Item | Actual Fiscal 1986 | Projected Fiscal 1988 | Projected Fiscal 1989 | FY 86-89 % Change |
|---|---|---|---|---|
| Administration and Benefits | $ 370,667 | $ 337,742 | $ 336,668 | (9.2) |
| Geology | 278,986 | 260,818 | 261,718 | (6.2) |
| Earthquake Studies | 27,000 | 27,000 | 26,631 | (1.4) |
| Hydrology | 303,679 | 283,768 | 284,668 | (6.3) |
| Information | 228,708 | 209,817 | 210,717 | (7.9) |
| USGS Cooperative Water Research | 78,613 | 80,000 | 80,000 | 1.8 |
| Subtotal w/o Recharge | $1,287,653 | $1,199,145 | $1,200,402 | (6.8) |
| University Charges | 238,520 | 60,459 | 59,875 | (74.9) |
| Total | $1,526,173 | $1,259,604 | $1,260,277 | (17.4) |

Except for the geological survey water research contract, which is continued at $80,000, table 7 shows that there are reductions in all bureau divisions. The smallest projected cut is 1.4 percent in the earthquake studies section because there is only one professional and limited supplies in that program. The fiscal 1989 reduction in earthquake studies is due to one less working day that year and to cuts in required travel after the replacement batteries are no longer needed at remote stations.

Administration is projected to decrease 9.2 percent for the biennium due to employee reductions.

Because geology and hydrology are sharing faculty, professional, and classified FTE reductions about equally, both divisions are anticipated to be reduced approximately 6 percent. The information division is reduced 7.9 percent because the fiscal 1987 agency plan made more personnel cuts in publications than in geology or hydrology. The overall agency reduction from fiscal 1986 to fiscal 1989 is 17.4 percent. Without the 74.9 percent reduction in university administrative charges, the fiscal 1989 budget decreases 6.8 percent from fiscal 1986.

## MONTANA COOPERATIVE EXTENSION SERVICE
## COMPARISON OF EXECUTIVE BUDGET AND LFA CURRENT LEVEL

| | FTE | Biennium | |
|---|---|---|---|
| | FY '89 | General Fund | Total Funds |
| Executive Budget | 116.19 | $3,784,946 | $7,443,482 |
| LFA Current Level | 121.02 | 4,077,346 | 7,735,882 |
| Executive Over (Under) LFA | (4.83) | $ (292,400) | $ (292,400) |

The executive budget is under LFA current level by 4.83 FTE and by $292,400 in both general fund and total funds. The major issues are summarized below.

### ISSUE 1: NUMBER OF FTE

The executive budget has 4.83 fewer FTE than LFA current level and personal service costs, excluding vacancy savings, are $202,780 less for the biennium. This would equal average personal service costs of $20,992 per annum for 4.83 FTE.

### ISSUE 2: VACANCY SAVINGS

The executive budget has $61,660 more in vacancy savings for the biennium than LFA current level.

### ISSUE 3: OPERATING EXPENSE

The executive budget has $32,302 less operating expense for the biennium than LFA current level. The major differences include $15,285 in publications and $10,876 for in-state travel each year.

### ISSUE 4: EQUIPMENT

The executive budget has $4,342 more for equipment during the biennium than LFA current level.

# MONTANA BUREAU OF MINES AND GEOLOGY

MBMG

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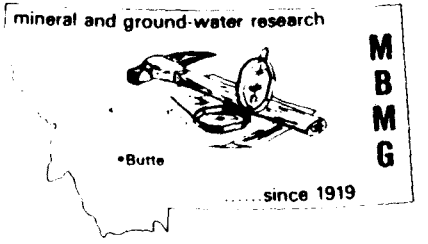
# PUBLICATIONS CATALOG

## 1987




**Montana Bureau of Mines and Geology**
**A Department of**
**Montana College of Mineral Science and Technology**

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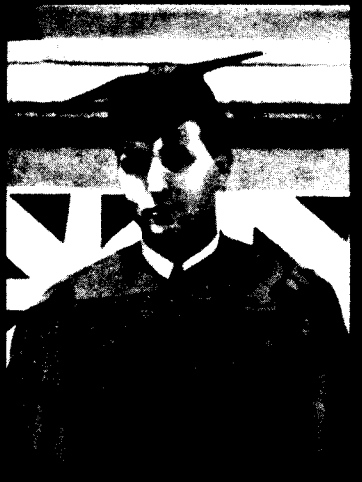


# ANNUAL REPORT

## 1985-1986

**Montana Bureau of Mines and Geology**

TESTIMONY TO THE
EDUCATION SUBCOMMITTEE
ON THE

BUREAU OF MINES AND GEOLOGY

BY

EDWARD T. RUPPEL, DIRECTOR AND STATE GEOLOGIST

Mr. Chairman, Ladies and Gentlemen:

I appreciate this opportunity to report on the Bureau of Mines and Geology and on what we have accomplished in the last two years, what we are doing now, and on new directions we believe our geologic and hydrologic research should take in the future to better serve the State of Montana.

In a State so dependent on its mineral, energy, and water resources, I would suggest that some of Montana's greatest resources are to be found in the talents of the capable scientists in the Montana Bureau of Mines and Geology. We are by our original charter a public service agency, and the only State agency specifically charged with the responsibility for gathering and disseminating to the public information on geology, mineral and energy resources, and hydrology. We take that responsibility very seriously, and so any work we undertake must first meet a critical test--will it benefit the Montana taxpayer.

Bureau studies cover a wide range of problems in Montana geology, mineral and energy resources, and groundwater hydrology in projects widely distributed across the State. The Bureau is divided into two operating divisions: the Geology and Mineral Resources Division and the Hydrology Division, which are supported by other Bureau staff in information services, analytical laboratories, and administration. The Bureau divisions are all relatively small, but the organizational structure works efficiently. And because the Bureau itself is small, there is constant beneficial interchange of information and ideas between Bureau scientists regardless of internal boundaries.

Bureau Accomplishments in the Last Two Years:

In the past two years, the Bureau has published or made available to the public about 55 reports on investigations of Montana geology and hydrology. These include two major book reports--one on the Stillwater Complex and its platinum deposits, a book that has been widely acclaimed in professional journals and that now is going to a second printing; and one, most recently published, on the Belt Supergroup of western Montana, the rocks that, near Troy, contain the most productive silver deposits in the northwest in 1986. A complete listing of reports published or released in 1985 and 1986 is attached.

In addition, Bureau scientists respond to more than 2,000 requests per year for information on geology and hydrology by telephone or letter. These requests come from individuals, other State agencies, Federal agencies, and many corporations. They range from requests for information on individual water wells or specific small mines, to requests for discussions of the geologic or hydrologic framework of large regions. For example, a recent request from a major corporation asks that Bureau scientists discuss the thrust Belt and associated mineral deposits in southwest Montana with several members of their exploration staff, to help guide their search for new mineral deposits.

Bureau scientists also discuss the results of their research in reports published in professional journals and in talks at public and professional meetings. Lists of these outside reports and talks in Fiscal Year 1986, are given in the attached Annual Report.

Current and Recently Completed Work of the Geology & Mineral Resources Division:

Current studies in the Geology & Mineral Resources Division (GMR) include the following projects; project locations are shown on the accompanying map. Complete project descriptions are attached.

Published Investigations:

1) Geology and Oil Shale Resources of the Heath Formation, Fergus County, Montana - 1985.

2) Geology of the Baker and Wibaux 30 x 60-minute quadrangles, eastern Montana and adjacent North Dakota - 1986.

Completed Investigations in Press:

1) Coal resources of the Baker and Wibaux 30 x 60-minute quadrangles.

2) Geology of the Glendive 30 x 60-minute quadrangle.

3) Coal resources of the Glendive 30 x 60-minute quadrangle.

4) Coal resources of the Sidney 30 x 60-minute quadrangle.

5) Subsurface coal geology of the Lame Deer 30 x 60-minute quadrangle.

6) Seismicity and late Quaternary faulting of the Northern Basin and Range Province, Montana and Idaho

7) Geologic map of the Helena Valley

Completed Investigations Now Being Prepared for Publication:

1) 1:500,000 map and bibliography of deep-seated landslides in Montana.

2) Barite in Montana.

3) Geologic maps of the following 7 1/2-minute quadrangles: Ramsay, Deer Lodge, Baggs Creek, Dempsey, SE Great Falls, Stockett, Sugarloaf Mountain and Scratchgravel Hills.

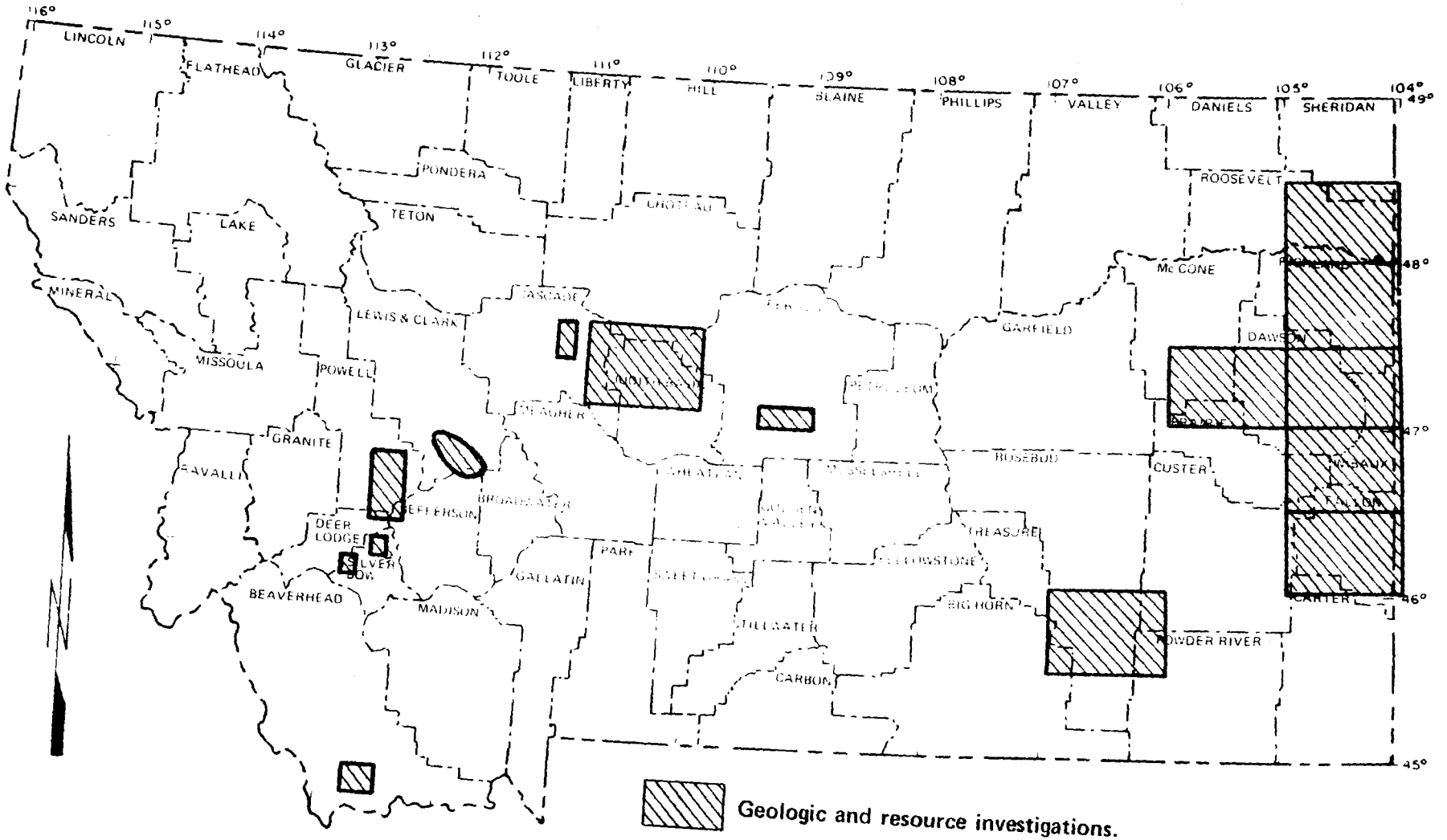
4) Trench logs across the Red Rock, Blacktail, Lima Reservoir, Georgia Gulch, Vendome and Divide faults.

5) Subsurface coal geology of the Culbertson and Circle 30 x 60-minute quadrangles.

Major Investigations in Progress:

1) 1:1,000,000 map of active faults in Montana.

2) 1:1,000,000 map of earthquake epicenters in Montana.




SITE-SPECIFIC PROJECTS

3) Geology of the Belt 30 x 60-minute quadrangle.

4) Geologic maps of the following 7 1/2-minute quadrangles: Dixon Mountain, Dell, Dickie Peak, Avon, Luke Mountain and Austin.

In addition, the GMRD annually puts out a seismicity catalog, mining directory, and a list of current studies. Open-file county reports on mines and mineral occurrences are being compiled and will be made available over the next four years.

Current and Recently Completed Work of the Hydrology Division:

Current Studies

Most of the projects undertaken by the Hydrology Division have originated from discussions with citizen groups, local organizations and/or state agencies which have expressed a desire to evaluate specific problems or opportunities relating to Montana's water resources. Generally, the questions and concern can be answered by existing information contained in reports, maps, and from water-well and water-quality data mandated at the Ground-Water Information Center (GWIC).

Frequently, however, additional information must be gathered and evaluated to provide adequate answers. In order to accomplish this, a proposal is developed to address the local concerns. Virtually every proposal is evaluated carefully by the interested parties (irrigation districts, county planning boards, commissioners, or conservation districts) and is further reviewed and ranked by appointed citizen and agency advisory boards (Water Resources Center, Coal Board, DNR&C-Conservation District's Board; DNR&C-Water Development Bureau and its advisory board). The final ranking and funding of most of the larger projects is determined by the legislature through the Long Range Planning Subcommittee.

The following is a list of 23 active projects currently being conducted by the Hydrology Division showing title, cooperating organization (in parentheses) and agencies, and project investigators:

1. Montana Map Atlas Project - geology and hydrogeological derivative sheets - $1^{\circ}$ x $2^{\circ}$ sheets (MBMG plus selected data obtained from all investigations are entered into GWIC) Bergantino, Schofield, and entire division staff.

2. Expanded Statewide Ground-Water Information Center (DNR&C-Water Development and RIT) Patton, Schofield, Bergantino, Miller.

3. Hydrologic Monitoring of the Upper Poplar River Basin (Daniels Co. Cons. Dist., Geol. Survey, DNR&C-Water Development) Schmidt, Sholes, Sonderegger, Miller.

4. Coal Lands-Hydrologic Monitoring, Southeast Montana (Rosebud and Big Horn Co. Cons. Dist., Coal Board) Van Voast, Reiten, Lalley.

5. Coal-mine Spoils Salinity (Bureau of Land Management) Van Voast, Reiten, Lalley.

6. Irrigation from Abandoned Coal Mines near Roundup - Preliminary investigation (Water Resources Center, Irrigation Districts) Reiten, Van Voast, Lalley.

7. Northeast Montana Groundwater Investigation (Sheridan Co. Cons. Dist., DNR&C-Water Development & 223 Program, Geol. Survey) Donovan, Bergantino.

8. Groundwater Resources of the Fort Peck Reservation (Bureau of Indian Affairs) Donovan, Bergantino.

9. Investigation of Ice-marginal and Buried Preglacial Channels, North Central Montana (Bureau of Land Management, Geol. Survey) Patton.

10. Hydrogeology of the Turner-Hogeland Area, Northern Blaine Co. (Blaine Co. Cons. Dist., DNR&C - 223 funds) Patton.

11. Proposed Sage Creek Coal (North Fork of Flathead) Project - Mine Development Committee (International Joint Commission, Governor's Office) Sonderegger.

12. Characterization of Suspended Sediment and Baseline Conditions - North Fork of Flathead River (Flathead Co. Commissioners, Coal Board, University of Montana) Noble, Sonderegger.

13. Hydrogeological Evaluation of Stockett Sand Coulee Area (Department of State Lands, Montana Salinity Control Association) Zaluski, Van Voast, Moore, Osborne.

14. Hydrogeology of Colorado Tailings - Silver Bow County (Department of State Lands) Duaime, Sholes, Moore.

15. Berkeley Pit Mine Flooding - Hydrological Monitoring and Evaluation (Butte-Silver Bow, Geol. Survey) Duaime, Sonderegger.

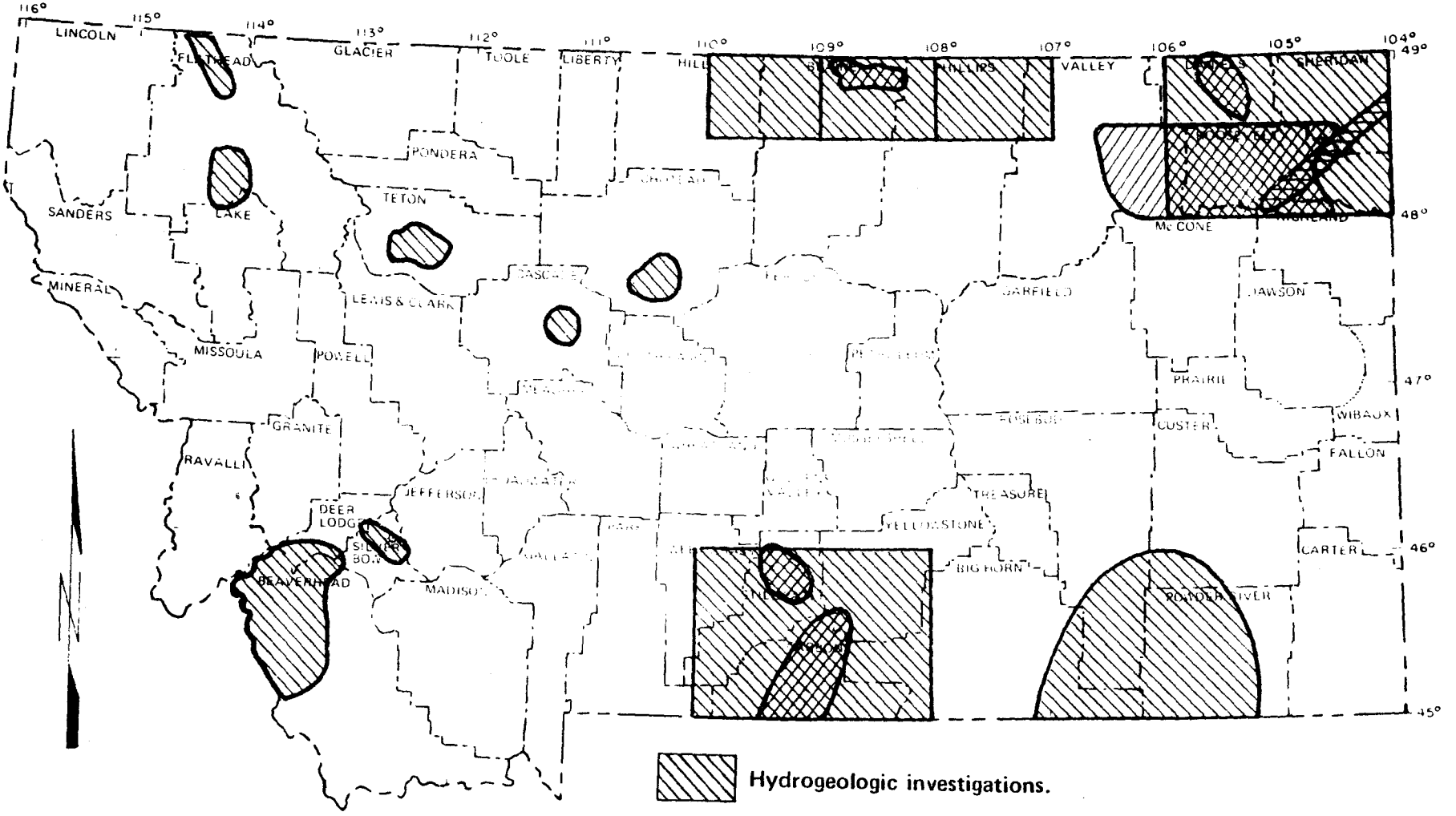
16. Enhanced Flooding of the Berkeley Pit - Solution or Asking for Touble? (Montana Tech) Zaluski,

17. Toxic-metal Contamination in Upper Deer Lodge Valley (Headwaters RC &D, Powell and Deer Lodge Co. Cons. Dist., Soil Conservation Service, DNR&C-Resource Indemnity Trust) Sonderegger, Duaime.

18. Heavy-metal Contamination in the Butte Area (Environmental Protection Agency, Butte-Silver Bow, Department of State Lands) Duaime, Schmidt, Sholes, Moore.

19. Mineralogy and Phosphorus Absorption Properties of Clay Sediments in the Flathead River Drainage (Water Resources Center, University of Montana) Noble, Sonderegger.

20. Iron and Iron Bacteria in Montana Groundwater (Water Resources Center) Donovan.




Hydrogeologic investigations.

SITE-SPECIFIC PROJECTS

21. Effects of Plowout on Shallow Groundwater Systems (Stillwater Co. Cons. Dist. DNR&C-Water Development and 223 Program) Duaime, Moore, Miller.

22. Upper Teton Aquifer Study (Teton Co. Cons. Dist., Ditch companies, City of Choteau, DNR&C-Water Development)Patton, Noble, Schmidt.

23. Montana Hydrogeology Field Program - Development of Aquifer Test Facility (Western Energy, Montana Tech) Zaluski, Schmidt.

## Recently Completed Projects And Reports - Current Biennium

Information and knowledge obtained from the investigations conducted by the Hydrology Division is disseminated to the public in several ways:

a. Local involvement - During the study, status reports are presented to the cooperators and sponsors to encourage local participation and involvement. In some cases this involvement has been the key to get citizens and organizations together to initiate some of the recommendations and findings of the project.
b. Published products - In addition to the published reports, plates, maps and appendices, the results of the study are usually presented to all interested citizens at one or more public meetings.
c. Data entry to Ground-Water Information Center (GWIC) - During the project, available hydrogeological data are inventoried, corrected and updated; and new information is entered into GWIC eventually to build a comprehensive, statewide groundwater database.

Recently completed projects of the Hydrology Division are as follows:

1. Little Bitterroot Valley Groundwater Investigation (Dept. of Energy); Donovan.

   Products: Hydrogeology and Geothermal Resources of the Little Bitterroot Valley, Northwestern Montana: MBMG Memoir 58, 60p.

2. Montana Map Atlas Project - Geology and Hydrogeological Derivative Maps $1^{o} \times 2^{o}$ (MBMG); Bergantino.

   Products:
   1) Preliminary Geologic Map of the Jordan $1^{o} \times 2^{o}$ Quadrangle, Northeastern Montana: MBMG OFR-170.
   2) Prequaternary Geology of Wolf Point $1^{o} \times 2^{o}$ Quadrangle, Northeastern Montana: MBMG OFR-171 (part of the NE Montana Groundwater Study).
   3) Quaternary Geology of Wolf Point $1^{o} \times 2^{o}$ Quadrangle, Northeastern Montana: MBMG OFR-172 (part of the NE Montana Groundwater Study).
   4) Quaternary Geology of the Eastern Half of Glasgow $1^{o} \times 2^{o}$ quadrangle, northeastern Montana: MBMG OFR-179 (part of the Fort Peck Reservation Groundwater Project).

5) Prequaternary Geology of the Eastern Half of Glasgow $1^{o} \times 2^{o}$ Quadrangle, Northeastern Montana: MBMG OFR-180 (part of the Fort Peck Reservation Groundwater Project).

3. Northeastern Montana Groundwater Study (Sheridan Co. Cons. Dist., DNR&C-Water Development and 223 Program, Geol. Survey); Donovan, Bergantino.

Products: 1) Preliminary Report: Northeast Montana Groundwater Study: DNR&C, 30p.; Donovan.
2) Altitude of the Top of the Bearpaw Shale, Judith River Formation, Basal Colorado Sandstone, and Kootenai Formation; Wolf Point $1^{o} \times 2^{o}$ Quadrangle; MBMG OFR-173,-174,-175,-176; 4 sheets; Bergantino.

4. Fort Peck Reservation Groundwater Project (Bur. of Indian Affairs); Donovan, Bergantino.

Products: 1) Groundwater Resources of the Fort Peck Indian Reservation, with Emphasis on Aquifers of the Preglacial Missouri River Valley: MBMG OFR-178; 3 maps, 68p; Donovan, Bergantino.
2) Altitude of the Top of the Judith River Formation, Claggett Shale, Basal Colorado Sandstone, and Kootenai Formation; Glasgow $1^{o} \times 2^{o}$ Quadrangle; MBMG OFR-181,-182,-183,-184; 4 sheets; Bergantino.

5. Groundwater Information Center and Regional Aquifer Map Project (EPA).

Products: 1) Quality of Groundwater in Montana; 1:1,000,000; MBMG OFR-154; 6 sheets; Bergantino, Sholes, Schofield.
2) Expected Yield (gpm) for Wells in Montana; 1:1,000,000; MBMG OFR-155; 6 sheets; Bergantino, Sholes, Schofield.
3) Structure Contour Map of the Top of Precambrian Crystalline Rocks, Montana; 1:1,000,000; MBMG OFR-158; Bergantino, Clark.
4) Structure Contour Map of the Top of Madison Group, Montana; 1,500,000; MBMG OFR-159, 2 sheets; Bergantino.

6. Groundwater Quality and Soluble Salt Loads in Overburden and Spoils (Bur. of Land Management); Van Voast, Reiten.

Products: 1) Groundwater Reaction to Surface Coal Mining in Semiarid Lands; in Proc. Second Int. Congress of International Mine Water Assoc., Granada, Spain, p. 861-873; Van Voast.
2) Groundwater Changes Associated with Surface Coal Mining in Northern Powder River Basin; in Innovative approaches to reclamation, Southern Illinois Press, Carbondale; Van Voast and Reiten.

7. Develop Data Adequacy Standards for Powder River Basin (Bur. of Land Management, Powder River Regional Coal Team Task Force).

   Products: 1) Hydrologic Data Standards: In Proposed Data Adequacy Standards for the Powder River Coal Region; Powder River Regional Coal Team Task Force, Cheyenne, Wy.; Van Voast.

8. Potential Hydrologic Effects of Proposed Coal Mining - North Fork Flathead River (Water Resources Center).

   Products: 1) Some Hydrologic Aspects of Proposed Coal Mining - North Fork Flathead River, NW Montana and SE British Columbia, 35p. MBMG OFR-152; Noble, Van Voast, Sonderegger.

9. Groundwater Resources - North of Flathead Lake (DNR&C-RIT, U. of Montana).

   Products: 1) Groundwater Resources and Water Quality of the Unconfined Aquifers in the Kalispell Valley, 112p. MBMG OFR-177; Noble, Stanford.

10. Groundwater Seepage - Whitefish Lake Area (Whitefish Water & Sewer Dist., Univ. of Montana).

    Products: 1) Investigation of Septic Contaminated Groundwater Seepage as a Nutrient Source to Whitefish Lake, Montana; Flathead Lake Biological Station, 40p: Open-File Report; Jourdonnais and Noble.

11. Upper Poplar River Basin Monitoring Program (Daniels Co. Cons. Dist., U. S. Geol. Survey, Coal Board).

    Products: 1) Montana Monitoring Results North of Scobey, Montana, Related to Coronach, Saskatchewan Coal-fired Generating Facility, in Int. Joint Comm. 1985 Annual Report; Schmidt, Sholes, Sonderegger, Miller.

12. Reconnaissance Evaluation of Preglacial Aquifers in North Central Montana (Water Resources Center, Bur. Land Management).

    Products: 1) Identification of Glaciofluvial and Buried Preglacial Aquifers as a Source of Water - North Central Montana: Montana Water Resources Center Report No. 151, 67p.; Patton, Colton.

13. Reconnaissance Investigation of Alluvial Aquifers along Sage Creek for Rural Water Supply (Sage Creek Rural Water Assoc.).

    Product: 1) Sage Creek Alluvial Aquifer Test, Liberty Co., Montana: MBMG OFR-157, 42p.; Osborne, Zaluski.

14. Dryland Salinity Investigations in the Geraldine Area (Choteau Co. Cons. Dist, DNR&C-RIT and 223, Dept. of State Lands, City of Geraldine, Montana Salinity Control Assoc.).

Products: 1) Saline-seep Assessment of Geraldine, Montana and Surrounding Area: MBMG OFR-169, 127p.; Duaime, Moore, Holzer, Hockett.
2) Hydrogeologic Controls on Saline-seep Development, Geraldine, Montana: in Third Canadian Hydrogeological Conference, Saskatoon, April, 1986; Duaime, Moore, Harrison, Holzer).

15. Reclamation Techniques for Heavy Metal Contaminated Pastures in Deer Lodge Valley - Preliminary Evaluation (Deer Lodge & Powell Co. Cons. Dist., Coop. Ext. Service, DNR&C-223).

Products: 1) Metal and Arsenic Distribution in Soils and Soil Water of Contaminated Pasture Land Adjacent to Silver Bow Creek: MBMG OFR-166, 35p.; Osborne, Duaime, Moore.

16. Hydrogeology of Colorado Tailings, Silver Bow County, Montana (Dept. of State Lands).

Products: 1) Hydrogeology of Colorado Tailings; in Proceeding - Clark Fork River Symposium, 1986 Mont. Academy of Sciences, p. 4-20; Duaime, Sonderegger, Zaluski.

17. Arsenic contamination in the Vicinity of Three Forks, Montana (City of Three Forks).

Products: 1) Irrigation Related Arsenic Contamination of a Thin Alluvial Aquifer, Madison Valley Montana; Environmental Geology and Water Sciences Journal: in press; Sonderegger

1987 Biennium Budget:

The initial unrestricted budget appropriated for the Bureau of Mines and Geology for Fiscal Year 1986 was $1,541,331, and for Fiscal Year 1987, $1,587,030. The actual budget for Fiscal Year 1986 was $1,526,344, and the current budget for Fiscal Year 1987 is $1,443,651. These figures include $53,000 per year State Special Revenue, which is anticipated agency generated revenue mainly from sales of maps and publications. Total budget reductions affecting the Fiscal Year 1987 budget are $143,379.

Impact of Budget Cuts on the Bureau:

The loss of State appropriated General Fund dollars has affected every part of Bureau operations, and has been made more serious by parallel Graham-Rudman losses in Federal funding for cooperative programs, grants, and contracts. As a result, the position of Chief Chemist and one hydrologist position, left empty by a death and a resignation, cannot be filled. Similarly, a geologist position and a half-time hydrologist position to be left empty on June 30, 1987, by reassignment outside the Bureau will not be filled. Termination notices effective June 30, 1987, have been issued to two other staff members, an Economic Geologist and

the Associate Editor. In addition, two geologists supported by grants and contracts have been let go as those agreements for outside funds were ended. At least one geologist and two hydrologist positions supported by grants and contracts may be similarly left vacant by September 30, 1987. As a result, the FTE level in the Bureau has been reduced from the earlier level approved by the legislature of 32.41 to an anticipated level in Fiscal Year 1988 of 26.4.

The personnel losses directly affect the Bureau's ability to seek Federal cooperative funds, contracts or grants, either because these programs commonly require matching salary and operational funds on a 50/50 basis or because the Bureau no longer has earth scientists trained in disciplines required for new programs.

The reductions in the scientific staff have been accompanied by reductions in program, and by reductions in travel funds for all but essential field work. Almost no replacement of ageing scientific, laboratory, and publications equipment is possible. The long-time practice of hiring part-time student assistants to enhance their academic training as well as to contribute to Bureau research has been discontinued. And the Bureau capability of quickly responding to taxpayer requests for information has been impaired by reductions in staff and by limited funds for communications. Construction of the computerized mineral resource, coal resource, and groundwater data bases continues on a reduced basis; but all of these may have to be indefinitely recessed in Fiscal Year 1988 because of losses in Federal, State, and other funding that now supports them.

1989 Biennium Budget
Comparison of Executive Budget and LFA Current Level Budget:

| | Executive | | LFA Current Level | |
|---|---|---|---|---|
| | FY'88 | FY'89 | FY'88 | FY'89 |
| Personal Services | 868,378[1] | 868,378[2] | 868,378[3][5] | 868,378[4][5] |
| Operations | 526,623 | 527,013 | 369,151 | 368,024 |
| Equipment | 20,000 | 20,000 | 22,075 | 23,875 |
| Total | $1,415,001 | $1,415,391 | $1,259,604 | $1,260,277 |
| Biennium | $2,830,392 | | $2,519,881 | |
| Executive Over LFA | $310,511 | | | |

[1] includes $237,923 College transfer
[2] includes $226,028 College transfer
[3] includes $ 60,459 College transfer
[4] includes $ 59,875 College transfer
[5] includes 4 percent vacancy savings

As noted by the Legislative Fiscal Analyst, the difference between the Executive Budget and the LFA Current Level Budget is primarily due to differences in the administrative charge paid by the Bureau to Montana Tech.

Fund Sources (LFA Current Level)

| | Fiscal Year 1988 | Fiscal Year 1989 |
|---|---|---|
| General Fund | $1,206,604[1] | $1,207,277 |
| State Special | 53,000[1] | 53,000 |
| Total | $1,259,604 | $1,260,277 |

[1] Mainly from Bureau sales of reports and maps.

The Bureau also receives restricted Federal and State grants and contracts not included above. Restricted grants in Fiscal 1986 included $100,000 for the Groundwater Information Center funded through the Department of Natural Resources and Conservation (House Bill 947) and $75,000 for groundwater programs and $91,870 for the Williston Basin Reclamation project funded under House Bill 922. The remaining $433,000 in restricted funds includes $237,000 in matching funds from the U.S. Geological Survey and grants from other Federal and State agencies and other sources. Few of these restricted grants, contracts, and cooperative programs continue into Fiscal Year 1988. Replacement grants, contracts, and cooperative agreements are increasingly difficult to find because of restricted budgets in Federal and State agencies, and because of reduced matching capabilities within the Bureau due to reductions in personnel. The principal Federal cooperative agreement pending at the present time is the Montana State Geologic Map COGEOMAP proposal, which is reasonably certain of funding in Fiscal Year 1989, but at an initial low level.

The major differences between the Executive Budget and the LFA Current Level Budget other than the College transfer are small increases in the Current Level Budget to pay analytical costs for water and rock samples; for various operational costs; and to purchase equipment, particularly in Fiscal Year 1988 to purchase a replacement Editwriter and to purchase photovoltaic systems for remote seismograph stations. The photovoltaic systems are expected to pay for themselves in battery savings and other battery replacement costs within five years.

Summary Comparison of MBMG Budgets FY'86 (actual), FY'87 (actual 1-87)
Executive FY'88-89, LFA Current Level FY'88-89

| | | | Executive | | LFA Current Level | |
|---|---|---|---|---|---|---|
| | FY86, actual | FY87, present | FY88 | FY89 | FY88 | FY89 |
| ersonal services | 957,620 | 915,528 | 868,378 | 868,378 | 868,378 | 868,378 |
| perations | 311,165 | 275,647 | 288,700 | 300,985 | 308,692 | 308,149 |
| quipment | 18,868 | 2,030 | 20,000 | 20,000 | 22,075 | 23,875 |
| ubtotal | $1,287,653 | $1,193,205 | $1,177,078 | $1,189,363 | $1,199,145 | $1,200,402 |
| ollege ransfer | 238,520 | 250,446 | 237,923 | 226,028 | 60,459 | 59,875 |
| otal | $1,526,173 | $1,443,651 | $1,415,001 | $1,415,391 | $1,259,604 | $1,260,277 |
| TE | 32.41 (appr.) 28.84 (actual) | 32.41 (appr.) 27.19 (actual) | 26.43 | 26.43 | 26.43 | 26.43 |

The LFA Current Level Budget provides the Bureau with somewhat greater operational flexibility and the opportunity to start replacing specific equipment; it is the recommended alternative.

The Impact of Reduced Budgets in FY'88 and FY'89:

The Bureau of Mines and Geology has moved aggressively to resolve the problems of reduced General Fund support in FY'87 and in anticipation of the further reductions in FY'88 and FY'89. As a result of current and planned reductions in staff, we expect to be able to regain some operational flexibility under the proposed FY'88 and FY'89 budgets but at a minimal level. The funds available for travel, communications, and other operations will be at about half of the optimum level, and in general will support the most essential field studies, but little more. Database programs in mineral resources, coal, and groundwater will be recessed in FY'88 unless additional outside restricted funding can be found to support them. The existing network of seismic recorders will be maintained and converted as far as possible to photovoltaic systems rather than batteries, but the long-term Bureau effort to expand and strengthen the network will be recessed. Landslide studies will be similarly recessed or greatly reduced--an especially difficult reduction because Federal programs for landslide hazards are being set aside on the grounds that landslides are a State problem. Bureau programs on coal distribution, quality and hydrogeology will be recessed because Federal support for coal studies has virtually disappeared and no State funds are available. Other field studies in geology and geologic hazards, mineral and energy resources and hydrology will be continued but severely constrained by limited funds for travel costs.

Search for other Federal and State restricted funding to support continuing or new research on Montana geologic and hydrologic problems will be limited by the lack of available matching funds. The Bureau has a very high success rate on obtaining such restricted funds, but current and proposed outside funded projects have already required almost complete matching of the diminished Bureau staff and leave no flexibility for seeking new funds.

Budget reductions beyond those proposed in the Executive Budget for FY'88 and FY'89 would require further reductions in staff with parallel reductions in program. Some programs on restricted funds would have to be recessed or terminated because of reduced matching capability.

Bureau Long-Range Planning:

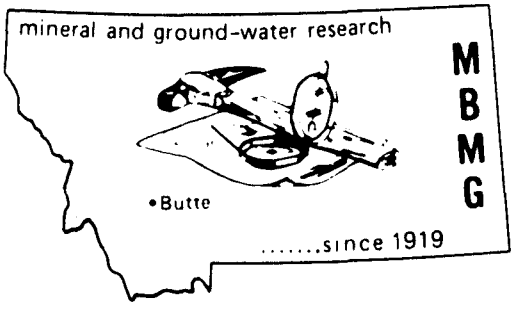
The Montana Bureau of Mines and Geology has participated in Montana's economic development for many years by being a principal source of information on mineral and energy resources and groundwater. To be able to respond appropriately to the increasing numbers and complexity of requests for information, the Bureau has developed a Long-Range Plan that anticipates geologic and hydrologic research needed to benefit Montana's economy in the next 5-10 years. Most of the current field research in the Bureau is already integrated into the Long-Range Plan; our intent is to continue that work on whatever scale is possible during the present time of more restrictive budgets, and to gradually expand the work as the Montana economy improves and as more grants, contracts, and cooperative programs become available from Federal and other State agencies. Clearly the successful completion of the major elements of the Long-Range Plan will eventually require modest growth of the Bureau professional staff, but, equally clearly, not until economic conditions improve.

The Long-Range Plan is not a rigid document, but rather is one designed for change. Its probable useful life is about five years, after which project completions, changed needs, and staff changes will require a new look at the Bureau plans. A copy of the Long-Range Plan is included with the attached material for your inspection, and if you wish, for comment.

MBMG 168

# MINING AND MINERAL DEVELOPMENTS IN MONTANA—1986

by
Edward T. Ruppel




MONTANA BUREAU OF MINES AND GEOLOGY

1986

## INTRODUCTION

This summary of mining and mineral developments in Montana in 1986 is principally the work of two of my colleagues in the Montana Bureau of Mines and Geology, Don C. Lawson and Richard B. Berg, who have drawn extensively, too, on the knowledge of other members of the Bureau. The information comes from many sources. We are particularly indebted to the many mining companies that have freely contributed information on their properties and current mining in the State. The Montana Department of Revenue provided tax information (**Table 1**). The U.S. Bureau of Mines, U. S. Forest Service, and U. S. Bureau of Land Management all provided much information on mining that significantly improves our perspective on the mineral industry in Montana. And finally, much information has come from the Montana Oil Journal and the Montana Coal Council.

Small base-metal mines in Montana are still largely dormant, but nonetheless the mining industry has made some major gains in the State in the last year. One of the most notable new developments was resumption of mining at Butte by Montana Resources, Inc., a development closely followed in importance by the construction of mills by Montana Tunnels in the Corbin-Wickes area and by Stillwater Mining Company in the Stillwater Complex. Exploration for precious metals was widespread in central and western Montana, and some new discoveries appear to be promising. Exploration for new talc resources continued in southwestern Montana, and the talc industry in the State was strengthened by the opening of a new talc mill at Sappington, by the opening of a new talc mine by Montana Talc and reopening of the Willow Creek mine by Willow Creek Talc.

There are indications that exploration activity in Montana has increased over that of the last year. As of mid-October 1986, 385 plans of operation had been filed with the Forest Service for Montana, compared with a total of 380 plans of operation for all of 1985. The 385 plans of operation exceed by 101 the number filed in 1981, a year of substantial exploration for silver and molybdenum. However, not all work proposed under plans of operation filed with the Forest Service is actually carried out. The distribution of these plans of operation by National Forest in Montana follows:

| | |
|---|---|
| Deer Lodge | 87 |
| Beaverhead | 79 |
| Lolo | 74 |
| Helena | 65 |
| Kootenai | 29 |
| Gallatin | 25 |
| Bitterroot | 20 |
| Custer | 5 |
| Lewis and Clark | 1 |
| Total | 385 |

The Bureau of Land Management reported that on January 1, 1986 there were 66,471 mining claims in Montana for which the assessment work had been done. This figure does not include work on patented claims or leases on state land. In the period from January 1, 1986 through October 1, 1986, 6,044 new claims were recorded with the Bureau of Land Management, suggesting that the number of new claims filed in Montana in 1986 will be slightly above that of 1985 (Figure 1).

Taxes collected in Montana from the extraction of natural resources decreased slightly for fiscal year 1986 compared with 1985 (Table 1). In fiscal year 1985 taxes from natural resources were 25.2 percent of the total taxes collected, as compared with 23.3 percent in fiscal year 1986. The greatest decline was in the oil producers' severance tax, which decreased almost $10 million from 1985 to 1986. With the start up of mining at Butte, a new gold mine and a new palladium-platinum mine, revenue from the metalliferous mines license tax will increase for the next calendar year. This compilation was

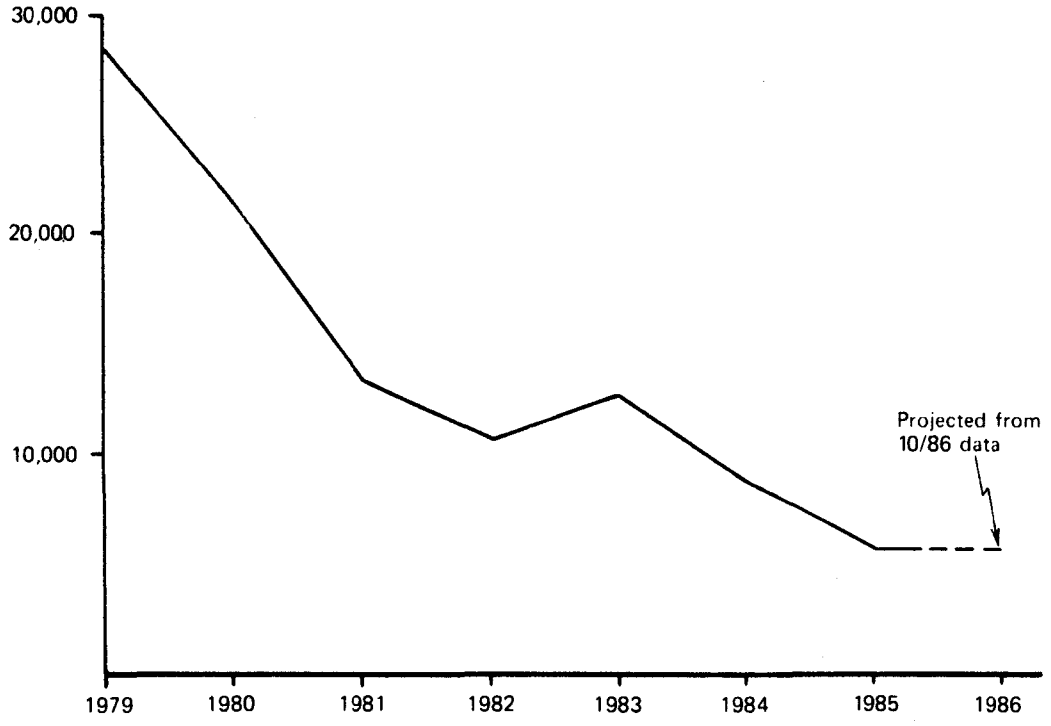



**Figure 1—New mining claims filed in Montana, 1986 (*from* Bureau of Land Management).**

**Table 1--FIVE-YEAR SUMMARY OF STATE MINERAL TAX STATISTICS (From Natural Resource and Corporation Tax Division of the Montana Department of Revenue).**

| Type of Tax | FY'82* | FY'83* | FY'84* | FY'85* | FY'86* |
|---|---|---|---|---|---|
| Cement and gypsum tax and license fee | 136,942 | 88,811 | 117,213 | 103,536 | 115,057 |
| Coal license and severance tax | 86,186,886 | 80,045,016 | 82,823,447 | 91,748,856 | 84,217,223 |
| Metalliferous mines license tax | 1,961,208 | 1,711,247 | 2,497,382 | 2,455,769 | 1,479,993 |
| Micaceous mineral license tax | 10,432 | 9,824 | 8,941 | 8,492 | 8,001 |
| Natural gas severance tax | 2,659,811 | 2,525,325 | 3,011,496 | 2,939,948 | 2,890,666 |
| Oil producers severance tax | 51,073,425 | 43,777,965 | 48,660,324 | 44,034,348 | 34,728,749 |
| Resource indemnity trust | 7,159,153 | 7,901,819 | 6,703,325 | 4,458,184 | 5,978,304 |
| Total mineral taxes | 149,087,857 | 136,060,007 | 143,822,128 | 145,749,133 | 129,417,993 |
| Total Dept. of Revenue collection | 414,035,930 | 457,386,501 | 520,443,409 | 577,829,483 | 554,444,355 |
| % of total from minerals | 36.0% | 29.8% | 27.6% | 25.2% | 23.3% |

* The Montana Fiscal Year ends on June 30 of the year indicated.

prepared by the staff of the Montana Bureau of Mines from information gathered before November 1, 1986.

## METALS

One of the most significant developments in the Montana mining industry was the resumption of copper and molybdenum mining at Butte by Montana Resources, Inc. Exploration and development activity in Montana was centered around precious metals. The Montana Tunnels gold, silver, lead and zinc mine and mill south of Helena are in the construction stage and a palladium-platinum mill is under construction by the Stillwater Mining Co. Gold exploration is widespread over much of the western half of the State.

In 1986 ASARCO's silver-copper Troy mine (Figure 2) will produce more silver than any other mine in the United States. ASARCO is on schedule with the required environmental studies for their nearby Rock Creek ore body, which is significantly larger than the ore body now being mined at the Troy mine. U.S. Borax continued extensive diamond drilling on the Rock Lake deposit which, like the Troy and Rock Creek ore bodies, is a stratabound silver-copper deposit in metasedimentary rocks of the Belt Supergroup.

Santa Fe Mining Co., Inc. began gold exploration in the Sweet Grass Hills in north central Montana. Southeast in the Little Rockies, Pegasus Gold Mining, Inc. became the owner of both the Zortman and Landusky heap leach operations from which they expect to recover a production record of 85,000 ounces of gold, in addition to silver, in 1986. During an 18-hour period on September 26, the mine received 9.5 inches of rain, more than half of the average annual rainfall of 18 inches for this area. Although torrential rain caused dilution of the leach solutions, it is a credit to the design of their leach system and their management that there was no loss of cyanide solutions from the containment ponds.

Limited development and mining activity continued at the Kendall gold mine in the North Moccasin Mountains. To the east in the Judith Mountains, Cimarron Exploration of Denver has been mining gold ore at the Spotted Horse mine, with 20 tons per day production expected.

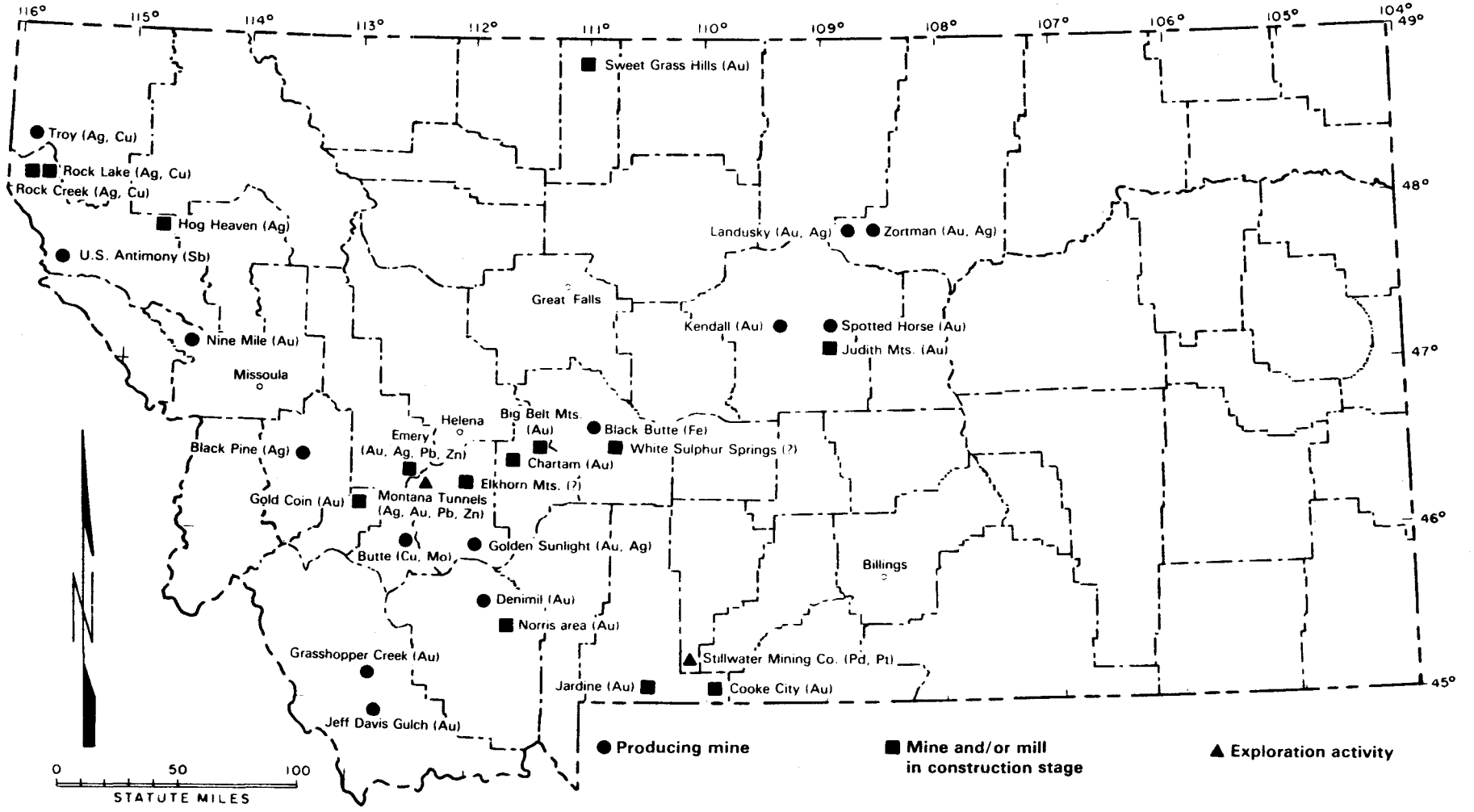



**Figure 2—Metal producers, mines and mills in the construction stage and areas of exploration activity in Montana, 1986.**

Other companies continued exploration for gold in the Judith Mountains.

The Utah International, Inc.-Cominco American joint venture continued exploration work in the White Sulphur Springs area. This area has seen considerable exploration interest for sediment-hosted massive sulfide mineralization by major mining companies over the past 13 years. Hallet Minerals Co. continues to mine iron from their Black Butte deposit northwest of White Sulphur Springs. The iron from this deposit is used by a Montana cement producer in the manufacture of Portland cement. Southwest in the Big Belt Mountains, there is considerable exploration activity for gold, particularly in the vicinity of Miller Mountain.

Stillwater Mining Company (a joint venture of Chevron Resources Co., Lac Minerals Ltd. and Manville Corp.) received approval on all of their permits and have been stockpiling palladium-platinum ore from their underground mine in the Stillwater Complex. Construction of a 500 ton-per-day mill and tailings ponds is underway, with a planned start up date of mid-August 1987. Cost of this construction will be $52 million.

A joint venture of American Copper and Nickel and Homestake Mining Co. continued surface and underground drilling for "Homestake type" gold mineralization at Jardine. Only minor activity is reported at Cooke City in the New World mining district.

West of Norris on the eastern flank of the Tobacco Root Mountains, there is some exploration interest. To the north near Pony, Denimil Resources (U.S.), Inc. received their permit to begin the operation of the Boss Tweed gold mine. Although the mill at this property was put in operation last spring, production has been temporarily suspended.

Two new gold placer mines southwest of Dillon were operating last summer. Channel Mining Co. ran a 800-1000 yard-per-day washing plant on their deposit in Jeff Davis Gulch near Grant, and another miner recovered gold from placer deposits on Grasshopper Creek near Bannack.

On July 16 Montana Resources, Inc., who had purchased the Anaconda Minerals Co. Butte property, began mining ore from the

Continental Pit on the east side of the district. Three hundred workers are employed and 40,000 tons of ore per day are being processed in the Butte concentrator. Copper concentrates are being shipped to smelters in Pacific Rim countries and molybdenum concentrates to smelters in Europe, Chile and North America.

Several different properties underwent extensive trenching and drilling in the Emery (Zosell) mining district east of Deer Lodge.

Gold and silver exploration and development activity in the Silver Lake-Southern Cross area did not materialize to the extent that was anticipated. Exploratory work was conducted at the Gold Coin mine in this area.

In April, mining of sulfide ore at the Black Pine mine was discontinued, but mining of near-surface oxidized silver ore continues. The silver ore was concentrated in the only heavy-media plant in Montana and shipped to ASARCO's East Helena smelter.

The Golden Sunlight mine will again be Montana's largest gold producer. In late 1986 a sand tailings retreatment plant was put into production at a cost of $5 million. This plant will decrease costs and improve gold recovery. On-site exploration continued in an effort to develop mineable reserves at depth on the known mineralization in the breccia pipe.

Western Energy Company continued their exploratory work on the Chartam gold property. Results of this work look favorable for the construction of a mill in 1988. One of the most active areas for precious metals exploration in the State is around the old town of Elkhorn (Jefferson County) where several major mining companies are involved.

Pegasus is well into the construction phase of their Montana Tunnels pit and mill complex, which is planned to begin production in the spring of 1987. A cyanide leach will be used for gold and silver recovery. Ore will be milled to produce a lead-zinc concentrate. The operators expect to move 40,000 tons of rock per day and to mill 12,000 tons at this mine.

In the Lincoln area, Western Energy continues exploration of their Keep Cool gold property.

U.S. Antimony Corp. continued mining gold from their placer deposit on Nine Mile Creek. They also accomplished considerable reclamation on this property. U.S. Antimony Corp. operated their antimony mill and refinery west of Thompson Falls using foreign antimony concentrates.

Co Ca Mines, Inc. kept development of their silver properties in the Hog Heaven district on hold, awaiting improvement in silver prices. This company has recently merged with Minerals Engineering Co., which has mined tungsten ore in southwestern Montana.

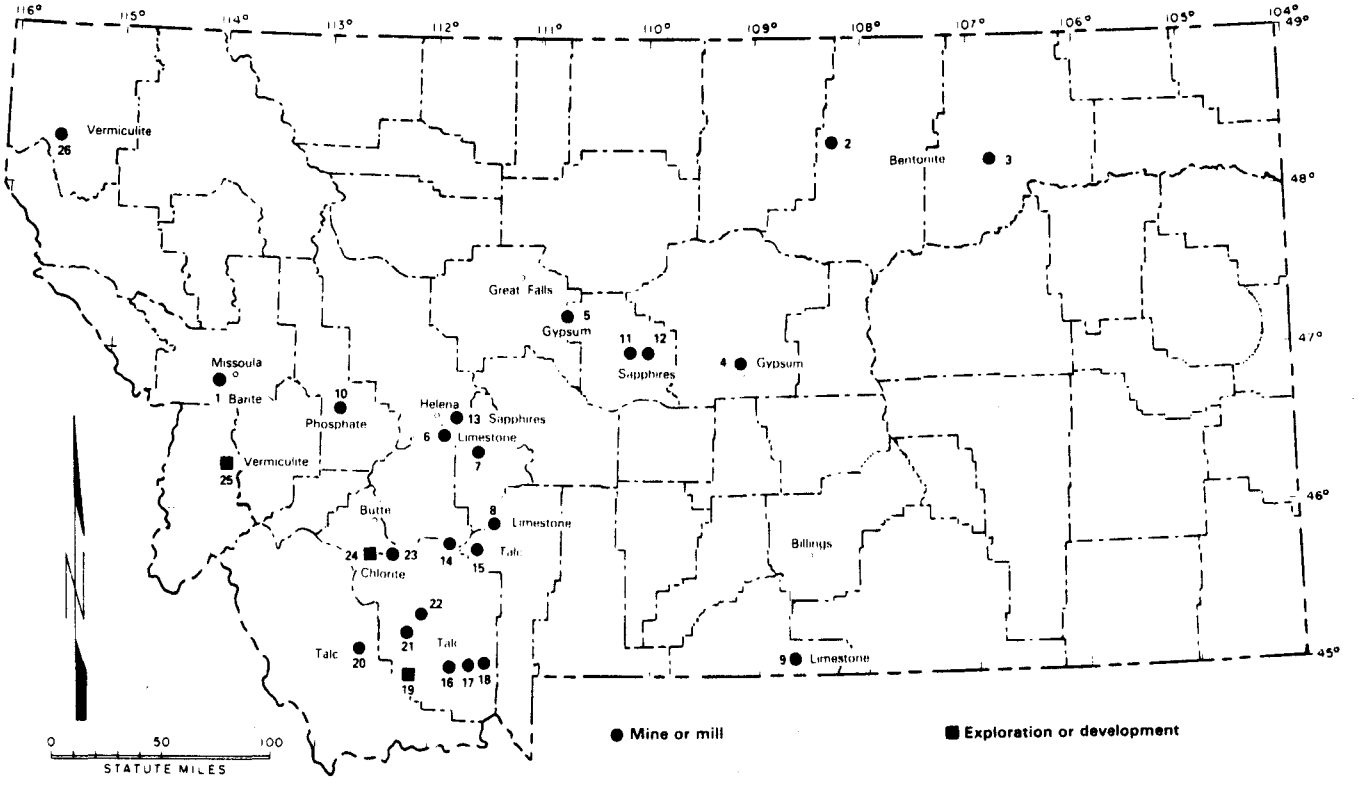
## INDUSTRIAL MINERALS

Montana continues to produce a large variety of industrial mineral commodities (Figure 3). Talc again continued to receive much attention in southwestern Montana, with completion of a new talc mill this spring and the opening of a new mine by Montana Talc as well as the reopening of the inactive Willow Creek mine by Willow Creek Talc, Inc.

Both barite and bentonite markets have been severely limited because of the low level of oil and gas drilling activity. Montana Barite is selling milled ore from their Missoula plant, but is not mining barite at this time. American Colloid produced some bentonite in early 1986, but are now dismantling their Malta mill. Federal Bentonite did not produce bentonite from their Brazil Creek deposit near Glasgow in 1986.

U.S. Gypsum has been mining gypsum from their underground Shoemaker mine for the manufacture of wallboard in their adjacent plant. The wallboard market has been at about the same level as in 1985. Maronick Construction, Inc. has begun mining gypsum at a new site in the Raynesford area for use by the cement industry. The two Montana cement producers, Ideal Basic Industries and Kaiser Cement, report that demand for cement in the Montana area has remained flat. Continental Lime, Inc. has continued to increase production at their lime plant west of Townsend. Cominco American continued to mine phosphate from their underground mine near Garrison.

The Yogo sapphire deposit is now owned and operated by Roncor,




1 - Barite mill (Montana Barite Co.)
2 - Bentonite mill (American Colloid Co.)
3 - Bentonite mine (Federal Bentonite)
4 - Gypsum mine and plant (U.S. Gypsum Company)
5 - Gypsum mine (Maronick Construction)
6 - Cement plant (Kaiser Cement Corp.)
7 - Lime plant (Continental Lime Inc.)
8 - Cement plant (Ideal Basic Industries)
9 - Limestone quarry (Big Horn Calcium Co.)
10 - Warm Springs phosphate mine (Cominco American, Inc.)
11 - Yogo sapphire deposit (Vortex Mining)
12 - Yogo sapphire mine (Roncor Inc.)
13 - French Bar Underwater section (Montana Gold and Sapphire, Inc.)
14 - Talc mill (Montana Talc Co.)
15 - Talc mill (Cyprus Industrial Minerals Co.)
16 - Willow Creek talc mine (Willow Creek Talc, Inc.)
17 - Johnny Gulch talc mine (Montana Talc Co.)
18 - Yellowstone talc mine (Cyprus Industrial Minerals Co.)
19 - Talc exploration (Dillon Exploration, Inc.)
20 - Talc mill (Pfizer, Inc.)
21 - Treasure talc mine (Pfizer, Inc.)
22 - Beaverhead talc mine (Cyprus Industrial Minerals Co.)
23 - Golden Antler chlorite mine (Cyprus Industrials Minerals Co.)
24 - Newly discovered chlorite deposit
25 - Vermiculite deposit (Western Vermiculite Co.)
26 - Zonolite vermiculite mine (Construction Products Division, W. R. Grace and Co.)

Figure 3—Industrial minerals production and exploration in Montana, 1986.

Inc. Vortex Mining has built a washing plant and is now recovering sapphires from a western extension of the Yogo dike. Vortex Mining is marketing the cut stones. Montana Gold and Sapphires, Inc. has recently completed construction of a new dredge and is now recovering gold and sapphires from the Missouri River below the Canyon Ferry dam.

Montana Talc Co. completed construction of a new talc mill at Sappington in the spring of 1986 and has been processing talc from their new Johnny Gulch mine south of Ennis. Willow Creek Talc, Inc. started doing stripping and clean up at the Willow Creek talc mine in May before mining talc from this mine, which had been inactive since 1979. Woodward and Dickerson, Inc. is the majority owner of Willow Creek Talc, Inc.

Cyprus Industrial Minerals Co. continues to mine talc from their Yellowstone mine and in December 1986 will begin to mine talc underground at their Beaverhead mine. Cyprus will have a new loading facility in operation at the talc mill at Three Forks by early 1987.

Pfizer, Inc. is well into a major stripping program at their Treasure mine. By the end of 1986 they will have stripped 5.8 million tons of rock and in 1987 they will strip 4.7 million tons. Talc from the Treasure mine is processed at Pfizer's mill south of Dillon.

During the past year Dillon Exploration, Inc. continued talc exploration in the southern Ruby Range.

Cyprus Industrial Minerals Co. mined chlorite at the Golden Antler mine, and in the summer of 1986 an individual staked claims on a newly discovered chlorite deposit in the southern Highland Mountains.

Western Vermiculite Co. drilled 90 holes for a total of 10,000 feet on the vermiculite deposit near Hamilton. They report that the results of this drilling are encouraging. Western Vermiculite Co. is owned by Stansbury Mining Co. W. R. Grace and Co. continued mining vermiculite from their large deposit at Libby.

## COAL DEVELOPMENTS

Coal continues to be a significant factor in Montana's economy, with a production of 33 million tons during 1985 in spite of the weak

coal market. The principal production is from the East and West Decker mines, 11,351,688 tons; Western Energy's Rosebud mine at Colstrip, 12,275,351 tons; Peabody's Big Sky mine, 3,332,907 tons; Westmoreland's Absaloka mine, 3,112,595 tons; NERCO's Spring Creek mine, 2,837,037 tons; and Montana-Dakota Utilities' Savage mine, 212,654 tons. Inasmuch as about 90% of Montana's coal is shipped out of state, new production above existing contracts is very sensitive to economic conditions. Production figures for 1986 suggest that total production will be similar to or slightly less than that for 1985. Locations of active mines is given in Figure 4 and production is given in Figure 5.

## OIL AND GAS DEVELOPMENTS

Through October 17, 1986, there were 269 oil and gas wells completed in Montana, as compared with 640 for 1985. Forty-seven percent of these wells were successful, with 73 completed as oil wells at an average total depth of 5520 feet and 54 completed as gas wells at an average total depth of 1682 feet. The major drilling activity for oil was in the Williston basin in eastern Montana and along the Sweetgrass arch in north central Montana. Gas wells were mainly drilled in the Tiger Ridge and Bowdoin areas in northern Montana. The decrease in drilling activity in recent years is shown by the following tabulation of total completions for Montana: 1981, 1149 completions; 1982, 905 completions; 1983, 533 completions; 1984, 801 completions; 1985, 640 completions.

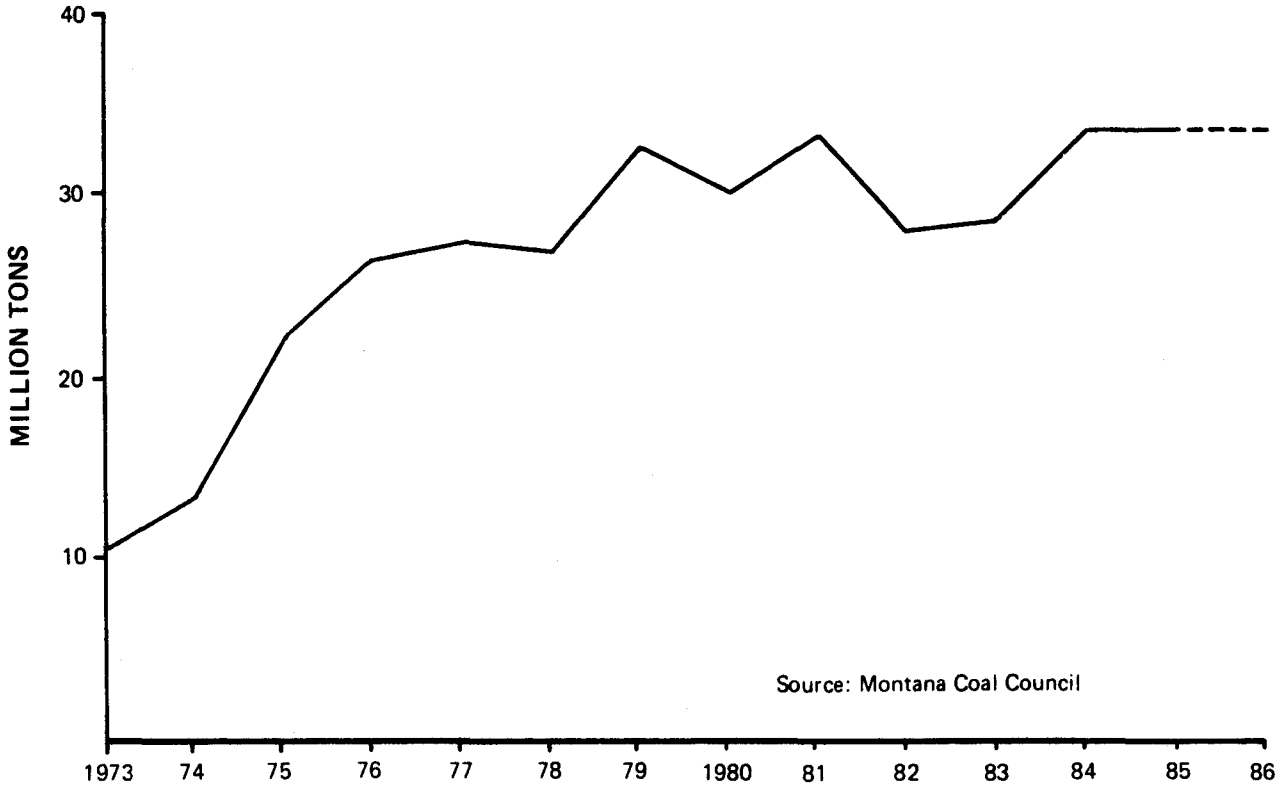



**Figure 4—Montana coal production, 1973-1986.**

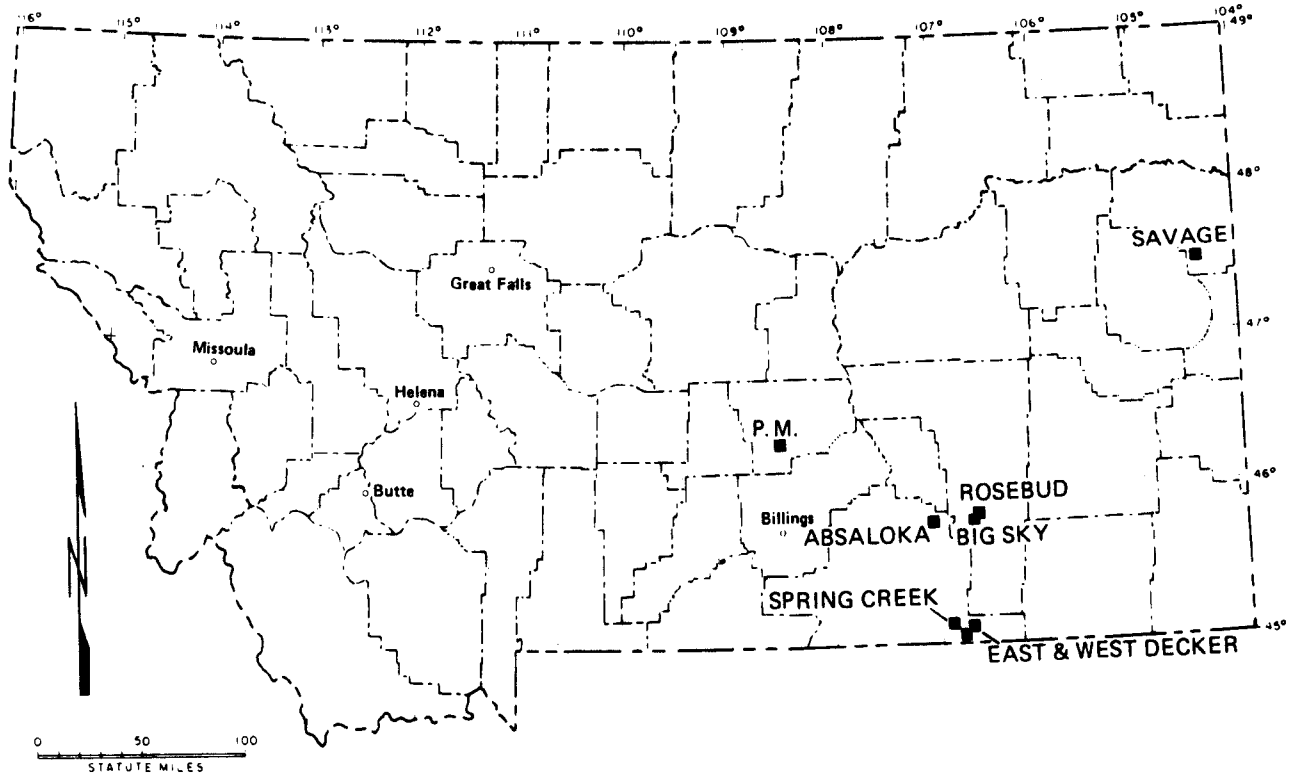



**Figure 5—Active coal mines in Montana, 1986.**

# LONG-RANGE PLAN FOR THE MONTANA BUREAU OF MINES AND GEOLOGY JANUARY 21, 1987

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## 1.0 INTRODUCTION

The Long-Range Program Committee of the Montana Bureau of Mines and Geology was established by the Director on November 20, 1986, for the purposes of identifying program segments and targets, establishing priorities for the targets, and recommending long-term balance of staffing, funding, and activities. The Committee of five, representing a cross section of personnel in terms of scientific discipline and geographic area of work pursued its commission by interviewing all available Bureau members, administrators at Division, Branch, and Office levels. In addition, inquiry was made of representatives of companies in the mineral and fossil-fuel, and nuclear-fuel industries, and of representatives of mineral- and water-oriented State and Federal agencies to determine what research and services are of highest value to their work.

The recommended program segments that follow are thus a collective product of Bureau thought and suggestion, as supplemented, modified, and evaluated by the Bureau Program Committee.

### 1.1 Enabling Legislation And Legislative Mandates

The Bureau of Mines and Geology was established by the Montana Legislature (MCA 20-25-212) in 1919 as a Department in the Montana School of Mines with the following specific duties:

1. Compile and publish statistics relative to Montana geology, mining, milling, metallurgy;
2. Collect:
   a) typical geological and mineral specimens;
   b) samples of products;
   c) photographs, models, and drawings of appliances used in the mines, mills, and smelters of Montana; and
   d) a library and bibliography of literature relative to progress of geology, mining, milling, and smelting in Montana;
3. Study the geological formations of Montana, with special reference to their economic mineral resources and groundwater;
4. Examine the topography and physical features of Montana relative to their bearing upon the occupation of the people;
5. Study the mining, milling, and smelting in Montana relative to their improvement;
6. Publish bulletins and reports of a general and detailed description of the natural resources, geology, mines, mills, and reduction plants of Montana;
7. Make qualitative examinations of rocks and mineral samples;
8. Consider scientific and economic problems the Regents consider valuable to the people of Montana;
9. Communicate special information of Montana geology, mining, and metallurgy;

10. Cooperate with:
    a) departments of the system;
    b) the state mine inspector;
    c) departments of the State;
    d) the United States Geological Survey; and
    e) the United States Bureau of Mines;
11. Make examinations of state land regarding its geology and mineral value at the request of the Department of State Lands .....;
12. Deposit all material collected in the state museums or in the Montana College of Mineral Science and Technology after completed use by the Bureau of Mines and Geology
13. Distribute duplicates of representative material to the units of the University System to their best educational advantage; and
14. Print the regular and special reports with illustrations and maps and distribute them on direction of the Regents.

In a subsequent action (MCA 20-25-301), the legislature specified the minimum qualifications of the Director of the Bureau saying in part:

> "The Board of Regents . . . shall . . . appoint a certified professional geologist or registered mining engineer as the director . . ., who shall be designated the state geologist . . ."

A later session of the legislature added the duty (MCA 15-35-106) to test coal production subject to provisions of the Coal Severance Tax and make rules governing the collection of test data.

The scientific and technical nature of the Bureau was addressed again in MCA 2-15-1862 and 82-11-126. These statutes state, respectively, that the Board of Water Well Contractors shall include "one technical adviser hydrogeologist appointed by the Montana Bureau of Mines and Geology" and the Board of Oil and Gas Conservation shall make available to the Bureau "such facilities, equipment, records, cores and cuttings, or samples ... as are or may be required by the Bureau in the furtherance of its oil and gas research and studies. Bottom-hole temperatures of oil and gas wells shall be made available ... in order to facilitate the determination of possible geothermal energy sources."

Changes in state appropriated general fund support for the Montana Bureau of Mines and Geology is shown in Figure 1.1.

## 1.2 Current Management Structure

Chief administrator of the Bureau is the Director, who is responsible to the President of Montana Tech and to the Board of Regents for operation of the overall Bureau program. Reporting to the Director are Chiefs of the Administrative,

Geology and Mineral Resources, Hydrology, Analytical and Information Services Divisions. The Division Chiefs are responsible for administering Bureau programs and budgets within their Divisions, for establishing priorities of effort and direction on these programs, and for suggesting new program directions, a responsibility that is shared by the entire professional staff. Chiefs of the research divisions (Geology and Mineral Resources, Hydrology, and Analytical) also conduct their own scientific research as their time allows. Below the division level is a loose structure of principal investigators, other professionals, technicians, and clerical staff all answering directly to the Chiefs of their respective divisions.

The Bureau's divisions have the following roles:

1) The Geologic and Mineral Resources Division primarily produces new geologic data in maps and reports, particularly on subjects related to the States's mineral and energy resources and geologic hazards, and assists the mining industry.
2) The Hydrology Division conducts practical research related to the State's water resources, especially underground water and provides public service related to water resources.
3) The Analytical Division provides chemical analyses of rock and water samples plus coal characterization analyses.
4) The Information Division publishes and distributes reports about the mineral and water resources, and the geology of the State.
5) The Administrative Division provides financial oversight and direction for the Bureau's activities.

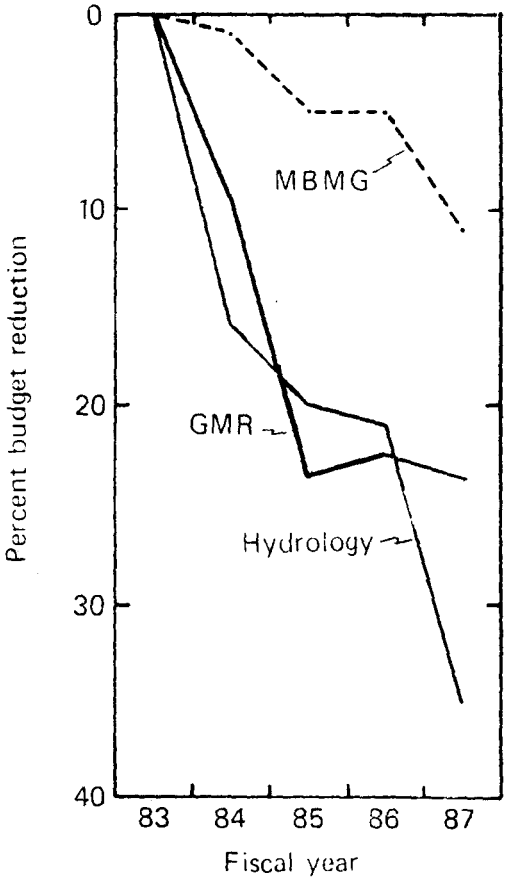


Figure 1.1: Graph showing the percent reduction in general fund support of the total Bureau and the GMR and Hydrology Division in constant (1982 base) dollars.

## 2.0 GEOLOGY AND MINERAL RESOURCES DIVISION

### 2.1 History Of Geology And Mineral Resources Division

In the fifties and early sixties, the Geology Division consisted of Metals and Non-metals Branches which emphasized economic geology. The Metals Branch was largely devoted to preparation of reports on mines and mineral resources of individual counties in a systematic program to cover the entire State and to extensive geochemical programs in western Montana. The Non-metals Branch prepared reports on non-metallic mineral commodities on a statewide basis. Montana School of Mines faculty members were employed by MBMG during summers and investigated the clay and shale resources of Montana and individual mining districts. Because of minimal staff, most geochemical sampling, mapping and studying the geology of specific areas was generally accomplished by college or university faculty and graduate students temporarily employed by MBMG. In 1958, a major six-year cooperative project began between the Montana Bureau of Mines and Geology, the Pacific Power and Light Company and the Great Northern Railway. It consisted of mapping the geology and geochemical sampling in Lincoln and Flathead Counties and providing information on mineral resources of this large area. A field office was maintained in Kalispell by the Montana Bureau of Mines and Geology during this project.

Interest in Montana's large deposits of strippable coal increased in the mid-1960's and in August, 1965, the Montana Bureau of Mines and Geology hired a geologist to begin the study of coal resources in eastern Montana. In July, 1967, the Mineral Fuels Branch was further strengthed by the opening of an office in Billings and a geologist to provide information on oil and gas and do stratigraphic studies useful to the petroleum industry. This program ended in 1973 when that geologist resigned. Investigations of coal resources were expanded in the 1970's and into the early 1980's with the addition of funding from the Department of Energy and then the U.S. Geological Survey. This funding enabled the MBMG to conduct an extensive drilling and mapping program in an effort to evaluate some of Montana's coal resources. Stratigraphic and petrologic information obtained from drill holes was entered into the USGS National Coal Resource Data System (NCRDS) for use in assessing the resource potential of Montana's coal.

In the late 1970's, the Montana Atlas project was initiated. The purpose of this project was to provide geologic maps at a scale of 1:250,000 for all 26 of the 1 by 2 degree quadrangles in the State. In addition to geologic maps, hydrologic maps and mineral resource maps are prepared.

During the 1970's, the Montana Bureau of Mines and Geology acquired drill core donated by mining companies. In 1979, the MBMG repository for this core was on the Montana Tech campus. With the addition of more core the repository was moved to a larger building at the Butte Industrial Park.

The Earthquake Studies Office was established in July, 1980, to monitor seismic activity in Montana and to conduct research into the seismicity of this area. This program has grown to the present operation of nine permanent seismograph stations in western Montana. The Energy Division and Economic Geology Division were combined in 1981 to form the Geology and Mineral Resources Division which now also includes the Earthquake Studies Office. During the early 1980's, the Geology and Mineral Resources Division continued a major program in coal resource mapping and evaluation which included studies of coal petrology, sedimentology, stratigraphy, and the continual addition of information into the National Coal Resource Data System. With a decrease in the availability of USGS funding for coal research, this program was reduced significantly in the mid-1980's.

With the establishment of the Geology and Mineral Resources Division, greater emphasis was placed on geologic mapping. In 1986, geologic mapping was underway in eastern and central Montana, as well as in the vicinity of the Boulder batholith near Butte and in southwestern Montana.

Activities of the Geology and Mineral Resources Division are divided into three major programs: 1) the Geologic Framework program; 2) the Mineral Resource Program; and 3) the Educational Program. Programs are further divided into specific projects which may consist of several smaller investigations.

## 2.2 Geologic Framework Program

This program is designed for maximum utilization of the limited staff and financial resources of the GMR Division by targeting specific regions or types of studies which will provide the kind of geologic data applicable to useful and extensive extrapolation throughout the State. The two specific elements of this program are geologic mapping related to completion of an updated State geologic map and topical investigations related to identification and susceptibility evaluations of geologic hazards.

### 2.2.1 State Map Project

The ultimate aim of this project is to complete a modern, updated geologic map of the State of Montana. The existing map was published in 1955, and must be replaced by a new map that shows the major changes and new understanding of Montana geology gained since then. Preparation of the new State geologic map is to be a cooperative venture between the MBMG and the USGS; field studies and compilation are planned for completion in five to seven years depending on funding, and publication by the USGS should follow within three years. Under the cooperative project, MBMG efforts will be concentrated in three areas: 1) overall compilation of the geology of the Great Plains portion of Montana; 2) completion of 1:100,000 scale transects within the Great Plains to provide the regional

stratigraphic-structural framework; and 3) completion of 1:24,000 scale transects within the Rocky Mountain portion of the State also to provide a detailed structural-stratigraphic framework. As an integral part of the framework program, subsurface data from oil and gas wells and coal drillholes will be utilized whenever available. The first three transects will provide stratigraphic and structural information on a series of 1:100,000 scale maps. This contiguous information on sedimentation and tectonic history is essential for understanding hydrocarbon accumulation within the many sedimentary rocks of Montana. Such framework investigations then provide the basis for developing the depositional and tectonic models needed to locate and recover new hydrocarbon resources. The transects will also provide new geologic mapping in many of the growing urban areas of the State thus providing geologic information pertinent to land use planning and development. Moreover, these transects will supply additional information on geologic hazards throughout the State.

#### 2.2.1.1 Great Plains Transects

Glendive--Great Falls transect - The foundation for providing a stratigraphic-structural framework for the Great Plains is an east-west transect which will allow correlation of stratigraphic units from the state border with the Dakotas to the Rocky Mountains west of Great Falls. This transect between latitudes 47° and 47°30'N consists of eight 1:100,000 maps (in order of planned publication: Glendive, Belt, Great Falls South, Lewistown, Winnett, Sand Springs, Jordan, Circle). The anticipated schedule for their publication is shown on Figure 2.1.

Havre-Billings transect - This North-South transect will provide the framework for the central portion of Montana from the Canadian border to the Wyoming border. Its initiation will be coordinated with completion of the Lewistown and Winnett maps. One portion of this transect, between longitudes 109° and 110°W consists of three 1:100,000 maps (in order of publication: Winifred, Rocky Boy, Havre) and will extend from the Lewistown map northward and the other portion, between longitudes 108° and 109°W, will consist of four 1:100,000 maps (in order of publication: Musselshell, Roundup, Billings, Bridger) and extend from Winnett southward. The anticipated schedule for publication is shown on Figure 2.1.

Alzada-Plentywood transect - This north-south transect, between longitudes 104° and 105°W, consists of eight 1:100,000 maps (in order of publication: Baker, Wibaux, Glendive, Sidney, Culbertson, Plentywood, Ekalaka, Alzada). It will provide the framework for the eastern portion of Montana. Half of this transect has already been completed with the maps and accompanying coal resource assessments either published or in press. The anticipated schedule for publication is shown on Figure 2.1.

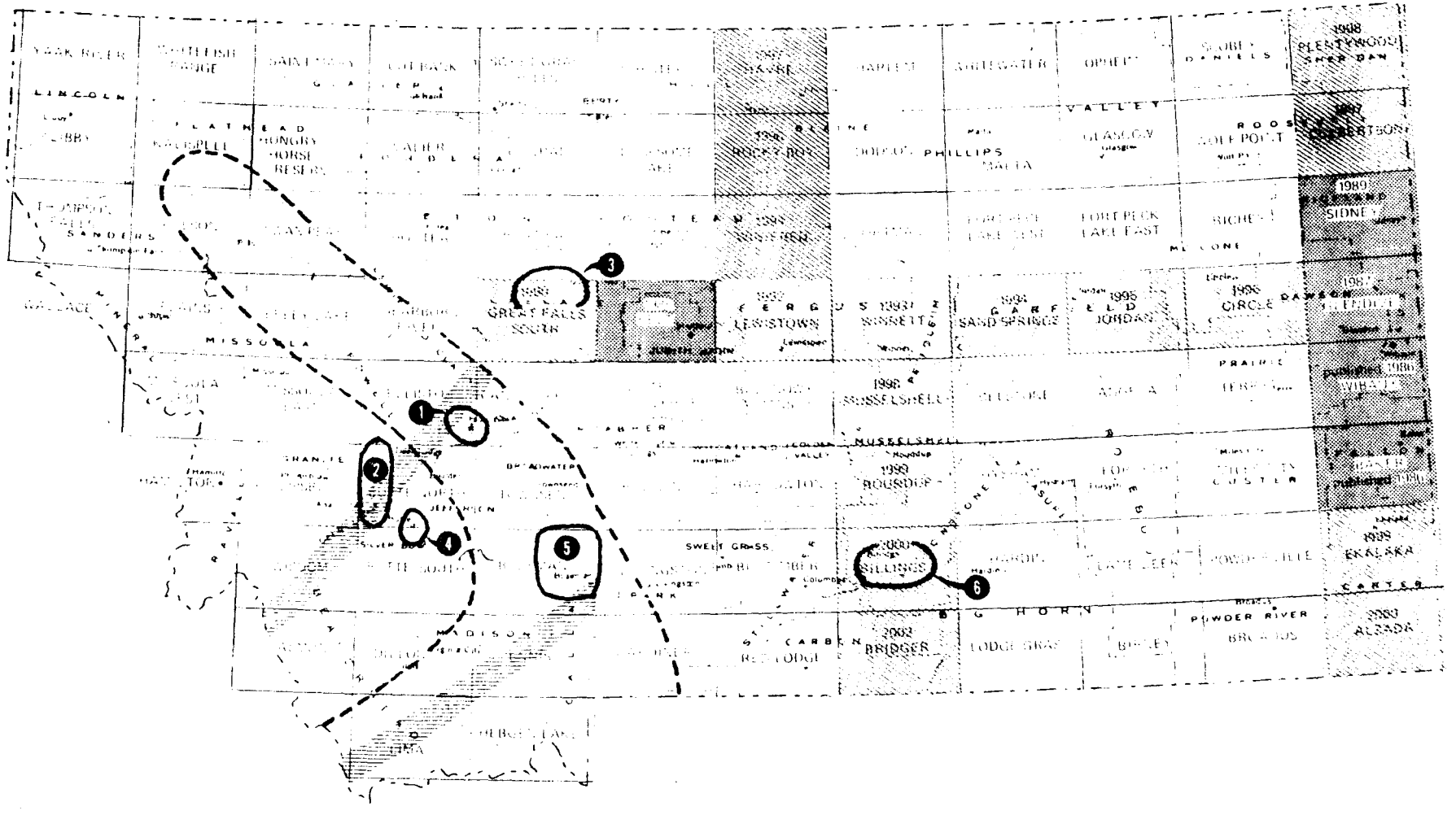


Figure 2.1: General Index to work being done by the Geology and Mineral Resources Division; 1:100,000 maps of the Great Plains Transects have estimated date of publication shown above name for both work in progress (dark shading) and planned work (diagonal strips); horizontal strips show locations of Rocky Mountain Transects (shown on Figure 2.2 and 2.3) numbered solid heavy lines indicate urbanized basins in sequence to be completed; heavy dashed line encloses the seismically active portion of the State containing active faults.

Minimum staff requirements: 2.0 FTE professional staff plus 0.2 technical support staff.

### 2.2.1.2 Rocky Mountain Transects

Because of the complex geology in western Montana it is not feasible to use 1:100,000-scale maps as the principal base for the Rocky Mountain area, thus 1:24,000 scale 7 1/2-minute quadrangles will be mapped along two transects crossing western Montana. These transects are located in central and southwestern Montana and will complement extensive work by the U.S.G.S. in northwestern Montana. The Lima-Bozeman transect (Figure 2.2) is expected to be one of GMR's major efforts under the anticipated USGS/MBMG cooperative COGEOMAP project. This transect lies within the most seismically active part of the State and the western end is currently a site of extensive petroleum exploration. The Wisdom-Wolf Creek transect (Figure 2.3) crosses the northern end of the seismically active belt near where it ties in with the Glendive-Great Falls 1:100,000 transect thus providing an east-west corridor of geologic mapping entirely across the State. This transect also crosses a large part of the mineralized volcanic/-plutonic rocks which contain many known metallic mineral reserves and have a high potential for new precious metals discoveries.

Each of the Rocky Mountain transects contains about 35 7 1/2-minute quadrangles and about 1/4 of each transect is currently being mapped by MBMG and USGS geologists. Priorities for mapping will be integrated with both GMR's Mineral Resources Program and the Geologic Hazard Project of the Geologic Framework Program.

Current investigations to be completed during the next five years are listed below with anticipated dates of publication:

1) Deer Lodge 7 1/2' quadrangle (1987)
2) Baggs Creek 7 1/2' quadrangle (1987)
3) Ramsay 7 1/2 quadrangle (1987)
4) Scratchgravel Hills 7 1/2' (1988)
5) Dixon Mountain 7 1/2' quadrangle (1988)
6) Dell 7 1/2' quadrangle (1988)
7) Dempsey 7 1/2' quadrangle (1988)
8) Austin 7 1/2' quadrangle (1989)
9) Sugarloaf Mountain 7 1/2' quadrangle (1989)
10) Dickie Peak 7 1/2' quadrangle (1989)
11) Avon 7 1/2' quadrangle (1989)
12) Luke Mountain 7 1/2' quadrangle (1989

Minimum staff requirements: 2.0 FTE professional staff plus 0.2 FTE technical support staff.

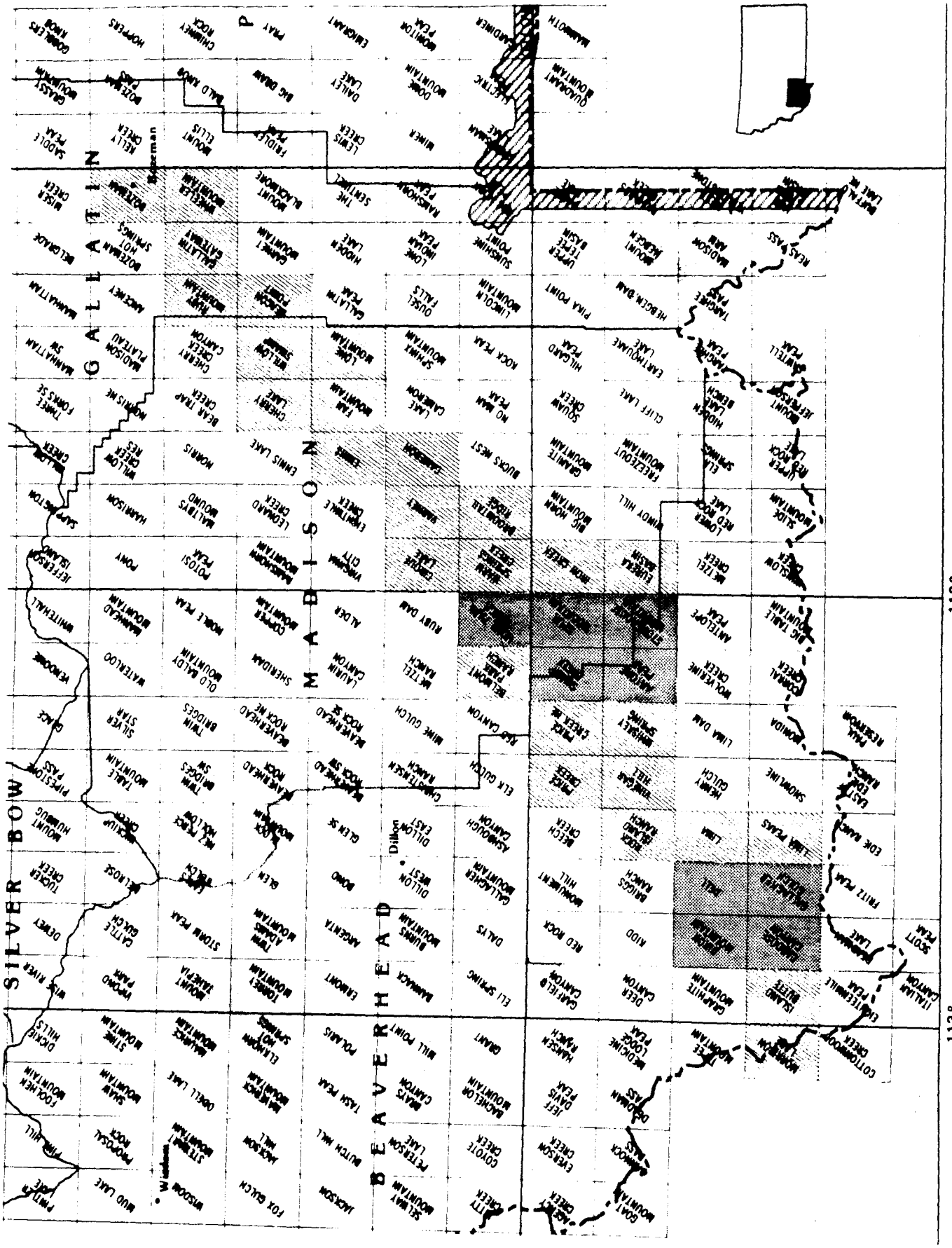


Figure 2.2: Index to current (heavy shading) and planned (diagonal strips) work along the southern Rocky Mountain transect.

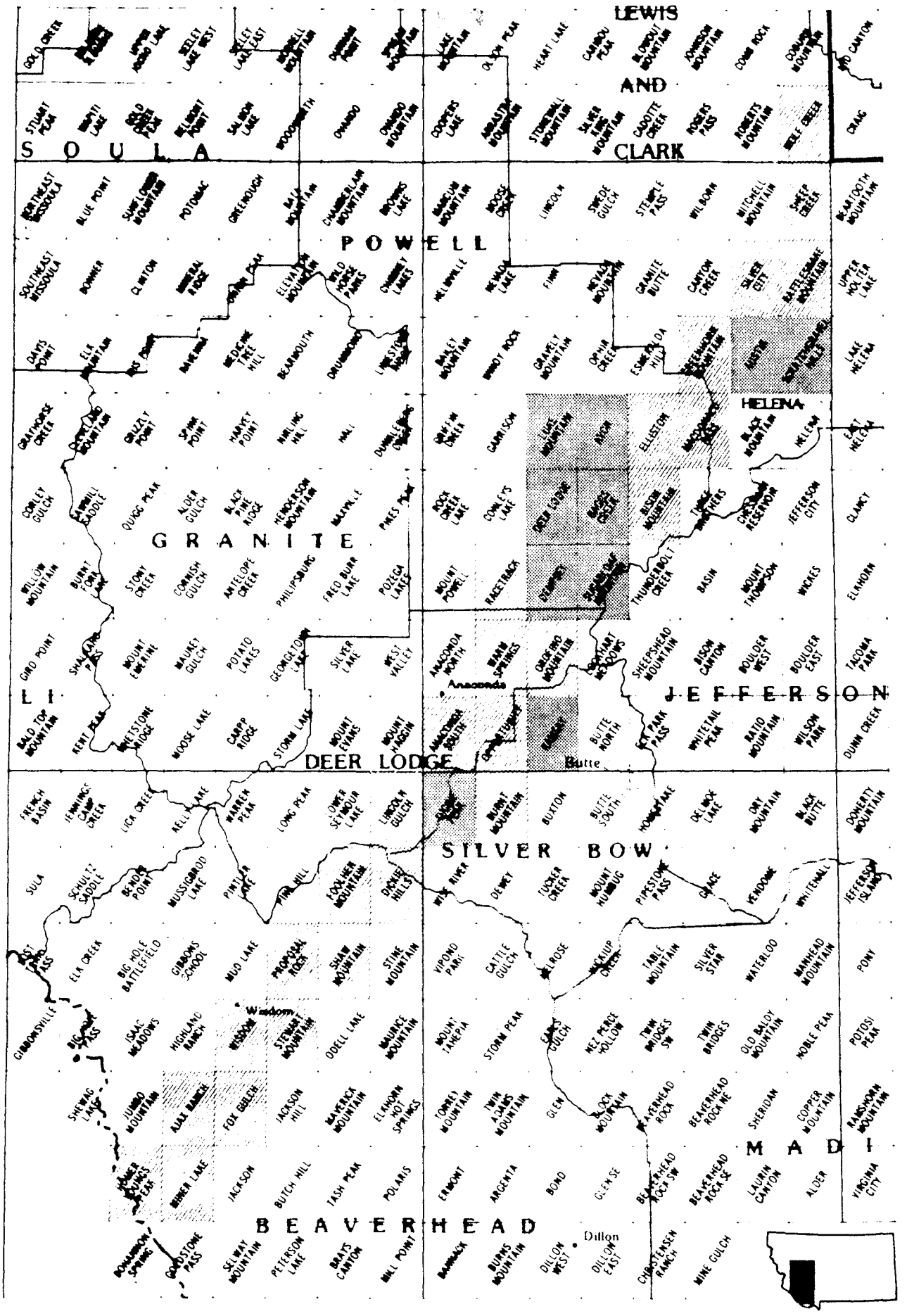


Figure 2.3: Index to current (heavy shading) and planned (diagonal strips) work along the northern Rocky Mountain transect.

### 2.2.2 Geologic Hazard Assessment Project

Within the conterminous lower 48 states, Montana ranks second (after California) in terms of earthquake-related deaths and third in terms of total seismicity. Over 20 active faults have been identified within Montana and the largest historic earthquake recorded in the Rocky Mountains was the Hebgen Lake (magnitude 7.5) which caused both surface rupture on several active faults and triggered a major landslide that killed 32 people. The Geologic Hazard Assessment Project is aimed at first identifying geologic hazards, and second, at assessing the impact such hazards may have on the citizens and visitors of Montana. Because major earthquakes can cause severe groundshaking hundreds of miles from their epicenters, hazard assessment must be concerned with many of the population centers of the State even though such population centers may not lie adjacent to active faults. Additionally, landslide hazard assessment is by no means solely related to those slides triggered by earthquakes. Landslide susceptibility is a function of many factors including rock type, slope, groundwater conditions, precipitation, and construction. The project currently consists of four types of hazard investigations: 1) Earthquakes; 2) Active Faults; 3) Landslides; and 4) Mine Waste Disposal.

During the next five years, geologic maps of sensitive urbanized areas are to be completed and are listed below with the anticipated dates of publication:

1) Helena Valley 1:50,000 map (1987)
2) Deer Lodge Valley 1:50,000 map (1989)
3) Great Falls area 1:50,000 map (1991)

#### 2.2.2.1 Earthquake Hazard Investigations

MBMG's Earthquake Studies Office (ESO) is charged with the responsibility of monitoring, analyzing, and reporting on seismicity throughout the State through the use of both permanent and portable seismographs. Presently, ESO has nine permanent stations and five portable stations. In order to do meaningful analysis of earthquake data, the permanent stations need to be systematically increased to 40 in 20 years, at the suggested rate of two per year. Initial acquisitions will be installed around the seismically active western part of the State where earthquake hazard is greatest. Portable networks are set up for limited periods over selected areas to monitor and record periodic earthquake swarms. Ten additional portable stations are needed to obtain useful data; these ten portables will be acquired at the rate of two per year so that a fully functional portable network will then be available for stratigic deployment during episodes of intense seismicity. Additionally, a fully automated computerized recording and analyzing system will be developed concomitantly with upgrading the network. This seismograph network will provide Montana with a state-of-the-art seismic monitoring system comparable to that in nearby states which experience much lower seismicity. Assessment of earthquake hazard in Montana will be updated as the full network becomes functional.

Reports on earthquake hazards investigations to be published within the next five years include:

1) Seismicity catalog of current investigations.
2) 1:1,000,000-scale-map of earthquake epicenters in Montana (1989)
3) Refine crustal velocity models to enable more accurate epicenter locations (1988)
4) Detailed investigations of the source areas of major historic Montana earthquakes (1991)

Minimum staff requirements: 1.0 FTE professional staff plus 1.0 FTE technical support staff plus 1 student assistant.

### 2.2.2.2 Active Fault Hazard Investigations

These investigations are aimed at identifying all active faults in Montana. Active faults are considered to be those which have either (1) moved once during the last 10,000 years or (2) have moved two or more times during the last 500,000 years and (3) are likely to experience surface rupture associated with major earthquakes in Montana. Presently 21 active faults have been identified in western Montana and several possible active faults have been located in eastern Montana.

Once identified, these faults and the adjacent geology will be mapped. Concurrent with mapping, several trenches will be excavated across each fault and logged. As an integral part of the trenching, geochronological techniques (uranium-series; thermal luminescence; Carbon 14) will be used to determine the ages of individual fault displacements. Knowing the ages and amounts of individual offsets along each fault, MBMG can establish the frequency and magnitude of fault displacements in Montana. This data when combined with data from ESO will provide accurate modern data for Hazard Susceptibility Assessment related to active faults and earthquakes in Montana.

Current investigations to be completed during the next five years are listed below with anticipated dates of publication:

1) Seismicity and late Quaternary faulting of the Northern Basin and Range Province, Montana and Idaho (1987)
2) 1:1,000,000-scale map showing late Quaternary faults in Montana (1988)
3) Radiometric age determinations of Quaternary deposits (1988)
4) Trench logs for Red Rock, Lima Reservoir, Blacktail, Georgia Gulch, Vendome and Divide faults (1989)

Minimum staff requirements: 0.5 FTE professional staff plus 0.1 FTE technical support staff.

### 2.2.2.3 Landslide Hazard Investigations

Landslides are the most costly hazard in much of the United States in terms of both deaths and property damage. The Montana Highway Department, Bureau of Land Management, and U.S. Forest Service each have high annual maintenance costs because of landslides associated with road construction and maintenance. Additionally, landslide potential affects design and construction of buildings, mines, and irrigation canals. Also urban expansion with extensive use of individual wells and septic systems may promote landsliding in areas already prone to it.

These investigations are aimed at identifying all landslides and landslide-prone areas in Montana. The GMR Division has recently completed a preliminary map (1:500,000 scale) of deep-seated (involves bedrock) landslides in the State, in cooperation with the USGS. This map, which is now in the stage of being checked for accuracy and completeness, is the first step in developing a landslide-susceptibility map for eventual use by planners, the Highway Department and others interested in landslide reduction and mitigation.

Following completion of a deep-seated landslide-susceptibility map for the state, GMR will undertake work on the shallow-seated (involves only upper few meters of soil vegetation and loose rock) landslide map and landslide-susceptibility map.

Current investigations to be completed within the next five years are listed below with anticipated dates of publication:

1) 1:500,000-scale map of deep-seated landslides in Montana (1988)
2) 1:1,000,000-scale map of landslide-prone lithologies in Montana (1989)
3) 1:1,000,000-scale map showing deep-seated landslide-susceptibility in Montana (1991)

Minimum staff requirements: 0.5 FTE professional staff plus 0.1 FTE technical support staff.

### 2.2.2.4 Mine-Waste Disposal Investigations

These investigations are aimed at identifying mine-waste deposits and removal of toxic chemical and metals from mine-waste. The one current investigation to be completed is listed below with the anticipated date of publication:

1) Identification of rare earths and precious metals in tailings near Anaconda, Butte, Whitehall, Troy and Zortman-Landusky (1988)

Minimum staff requirements: 0.5 FTE professional staff plus 0.1 FTE technical support staff.

## 2.3 Mineral Resource Program

### 2.3.1 Information And Assistance Projects

#### 2.3.1.1 Montana Mine And Mineral Occurrence Database (MONT MODS)

This continuing cooperative program with the USGS, which is now in its second year, was funded by the USGS at $24,000 (FY86) and currently $20,000 (FY87). Federal financial support may continue for several more years, but State maintenence of this program will be necessary eventually.

The purpose of this project is to assemble all of the available information on Montana's mineral resources (exclusive of energy resources) in a comprehensive data base. This project includes both metallic and non-metallic mineral resources and includes information in the MBMG's files as well as published information.

Within five years, GMR will have the information on counties in southwestern Montana entered into this computerized system, and within seven years will have data for the entire state included in this data base. An integral part on MONT MODS is to provide access to this system for the public by use of a desk top computer. With this system in operation, an individual could come into the MBMG's offices, request the district, mine, or mineral occurrence by name or location, and receive a printout of synoptic information on the occurrence and a list of references. Minimum staff requirements: 1.0 FTE professional staff plus student assistant. Current projects to be completed within the next five years are listed below with anticipated dates of open-filing:

1) Silver Bow County (exclusive of the Butte District) (1987)
2) Butte District (1987)
3) Deer Lodge County (1987)
4) Beaverhead County (1987)
5) Madison County (1988)

#### 2.3.1.2 National Coal Resources Data System (NCRDS)

NCRDS is a cooperative effort between the USGS and MBMG. NCRDS is totally a Federally funded investigation now in its sixth year. The purpose of NCRDS is to assemble all of the available information on Montana's coal resources into an easily accessible computer format. During these first six years, NCRDS has concentrated on subsurface data from drill holes and petroleum wells and consists of about 50,000 entries (representing about 3200 drill holes and wells) are included to date. Combining this data with coal outcrop information, GMR can use the computer to generate various types of maps (such as structure contours, coal and/or overburden thickness) and cross sections for use in Coal Resources Inves-

tigations. NCRDS also enables GMR to quickly respond to public inquiries on coal with the most complete information that is publicly available. Federal funding of NCRDS has progressively been reduced -- $100,000 (FY82), $90,000 (FY83), $90,000 (FY84), $72,500 (FY85), $49,000 (FY86), $20,000 (FY87) -- and can be expected to be discontinued soon. To maintain this vital database, 1.0 FTE needs to be supported from State appropriation upon cessation or further reduction of Federal support.

Current projects to be completed within the next five years are listed below with anticipated dates of publication:

1) Subsurface coal geology of the Lame Deer 1:100,000 map (1987)
2) Coal resource calculations of the Sidney 1:100,000 map (1987)
3) Subsurface coal geology of the Culbertson 1:100,000-scale map (1988)
4) Coal resource calculations of the Glendive 1:100,000 map (1988)
5) Subsurface coal geology of the Circle 1:100,000-scale map (1989)
6) Coal resource calculations of the Baker and Wibaux 1:100,000 maps (1990)

Minimum staff requirements: 1.0 FTE technical support staff.

### 2.3.1.3 Economic Core Repository

The long-range goal is to maintain a catalogued collection of drill core that is available both to exploration geologists and researchers. Core is donated by companies involved in mineral exploration. This repository contains core representing over 120,000 feet of drilling which has an estimated cost greater than $3,000,000. This is an ongoing project. Mininimum staff requirements: 0.2 FTE technical support staff and one student assistant; five-year goal - to obtain larger facility. The present facility is filled to capacity.

### 2.3.1.4 Assistance To Small Mine Operators And Source Of Information On The Mineral Industry In Montana

Continuation of present program to offer information and services to the mining industry and general public.

This program was first staffed as a full-time position in January, 1967, and has continued at this level since then. Until January, 1967, geologists with the Montana Bureau of Mines and Geology had offered assistance to mine operators in addition to their other duties. During the last 1 1/2 years, with the assistance of an $83,000 grant from MSHA, this project has been expanded to provide information on safety and health to Montana miners. Specific elements completed under the MSHA grant include:

1) Slide collection of mining hazards
2) Modern slide/talk on cyanide safety in mining
3) Extensive audiovisual and library collections on mining/-health/safety
4) Equipment to develop an audiovisual program for MBMG

With the allocation of one individual to this program, the MBMG has been able to increase the level of assistance substantially and the result has been a very successful program. This assistance program will be maintained at its present level to accomplish the following:

1. Field examination of mines and prospects and giving helpful advice to the operator or prospector.
2. Providing information to prospectors or operators on services, supplies, markets, etc.
3. Providing a rock and mineral identification service for specimens from Montana. This free service does not include assays for metals, but the people who submit specimens that should be assayed for metals are so informed.
4. Maintaining close contact with the mineral industry so that the individual in this position is the main source of information on new developments in this important industry.

Annual reports published under the Assistance project are listed below:

1) Montana Mining Directory
2) Mining and Mineral Developments in Montana
3) The Mineral Industry of Montana (published in the U.S. Bureau of Mines Mineral Yearbook)

Minimum staff requirements: 1.0 FTE professional staff plus 0.1 FTE technical support staff.

### 2.3.2 Resource Assessment Projects

#### 2.3.2.1 Metallic Resources Investigations

The project in metallic mineral resources is made up of the following three investigations. All of these investigations are ongoing.

First, to provide a source of information on occurrences of deposits of metallic minerals and the geologic setting in which these deposits occur. As part of this effort, information will be added to MONTS MODS. Staff requirements remain constant.

Second, is research on occurrences of metals or geologic environments showing potential for metallic mineral resources that are encountered during mapping in the Geologic Transect Project or Montana State Geologic Map Project. This research might involve such work as detailed mapping of host rocks and alteration assemblages in areas of mineralization or of trace element geochemistry of a suspected host rock, or geochemical reconnaissance survey of suspected deposits. Staff requirements fluctuate depending on specific work.

The third is specific topical research in the area of metallic mineral deposits. Studies include areas of new mineral deposits or areas of potential resources in anticipation of demand for new commodities. Detailed studies may involve stable isotope and trace element geochemical studies and physiochemical studies to determine conditions at the time the ore deposit formed. The goal is to develop methods for recognition of extension of present or new deposits. An example of such research might be a study of a specific district or a study of a particular geologic association such as rare earth elements in carbonatites. See also description under geologic hazards of investigation of tailings from metallic mining operations. Staff requirements fluctuate depending on specific work.

Current investigations to be completed within the next five years are listed below with anticipated dates of publication:

1) Survey of gold placers of Montana (1988).
2) Geologic conditions that influenced the formation of ore deposits in the Elkhorn Mountains Volcanics (1988).
3) Solvent extractants applied to mixed metals systems (1988).
4) Physiochemical conditions during formation of selected ore bodies in western Montana (1990).

Minimum staff requirements: 1.5 FTE professional staff plus 0.2 FTE technical support staff.

### 2.3.2.2 Non-Metallic Resources Investigations

The project in industrial mineral commodities is made up of the following three investigations:

First, to provide a source of information on industrial minerals resources in Montana and current trends in industrial minerals commodities that influence the development of Montana's industrial mineral resources. In conjunction with this effort, information will be provided to MONT MODS. Staff requirements remain constant.

Second, is research on occurrences of industrial minerals encountered during geologic mapping in either the Geologic Transect Project or Montana Geologic Map Project. This research would

normally result in a publication dealing only with this commodity giving the extent of the occurrences and characterizing the commodity in terms of mineralogy and chemical composition as well as suggestions for other areas in which it may occur. Detailed physical testing for a specific end use will not generally be conducted by the MBMG because such testing can be very time consuming and, in many cases, can only be adequately performed in the consumers laboratories. Staff requirements fluctuate depending on the level of geological mapping effort. In many instances a brief, but informative report could be completed in one year at this level of support. This project would be initiated at the beginning of the State Geologic Map project. More in-depth studies of an industrial mineral commodities encountered in geologic mapping will be made if there appears to be exceptional economic potential.

The third area is research on a specific mineral commodity. This would be a detailed study including descriptions of all known occurrences of the commodity, study of its origin, and in some instances, mapping the geology of areas with a high potential for the discovery of new deposits. Commodity studies in this detail are the mainstay of many state geological survey research programs in industrial minerals and very useful to industry because essentially all known information on a given commodity is available under one cover. Staff requirements fluctuate depending on specific work. Addition of a staff position will be required for these studies or after completion of the new state geologic map more effort can be shifted to the area of economic geology and at that time commodity studies can be resumed.

Current investigations to be completed within the next five years are listed below with anticipated dates of publication:

1) Montana Barite Deposits (1987)
2) Clay Resources of the Belt 1:100,000 quadrangle (1989)

Minimum staff requirements: 1.0 FTE professional staff plus 0.2 FTE technical support staff.

### 2.3.2.3 Coal Resources Investigations

Montana has very large coal resources easily minable by surface mining techniques which probably constitute the most valuable mineral resource in Montana. The general distribution of the principal economic resources is known largely because of MBMG studies, but little is yet known about the geographic variation in coal quality. Furthermore, coal is extremely variable in thickness and quality laterally, and we are only beginning to understand the sedimentologic controls on this variation.

The purpose of these investigations is to identify, map and evaluate the economic potential of coal beds throughout the State and to characterize the coals in selected areas physically and chemically. This program has been largely supported by Federal funds for most of the last 16 years but such funding has declined dramatically ($98,000 FY82; $98,000 FY83; $75,000 FY84; $40,000 FY85 and extended through FY86; zero FY87) and is likely to be unavailable during the next five years. At least 1.5 FTE needs to be supported by State appropriations to even maintain GMR's capability of assessing Montana's coal resources.

Coal resource and coal petrography investigations have been conducted as part of the USGS funded Coal Lands Mapping Project in conjunction with NCRDS (2.3.1.2), Great Plains transects (2.2.1.1) and some hydrological investigations. Coal resource assessments have been made for each of the four 1:100,000-scale maps completed as part of the Great Plains transects. Assessment of coal resources will be done for each map of the transects after the geologic mapping is completed. Additionally selected areas of abundant subsurface coal data are also being investigated. As part of this investigation, GMR is in the initial stages of preparing a synthesis volume on coal geology of eastern Montana due to be published in about three years. Extensive geochemical data obtained during the MBMG's coal drilling program is currently being prepared for publication in useable map form. Montana coal generally is low in sulfur but locally contains deleterious amounts of sodium. Adequate assessment of coal resources requires knowledge not only of thickness and location, but also of chemical and petrographic characteristics. These are controlled largely by the environment in which the precursor peat formed, therefore, in addition to surface and subsurface mapping, we are conducting integrated studies of the chemical and petrographic characteristics in conjunction with sedimentologic studies of the coal-bearing rocks.

Current investigations to be completed during the next five years are listed below with the anticipated dates of publication:

1) Coal Resources of the Baker and Wibaux 1:100,000-Scale Maps (1987)
2) Coal Resources of the Glendive 1:100,000-scale map (1987)
3) Coal Resources of the Sidney 1:100,000-scale map (1988)
4) Characteristics of the Knobloch Coal, southeastern Montana (1988)
5) Geology and Coal Resources of the SE Great Falls and Stockett quadrangles (1988)
6) Diagenetic features of the Fox Hills Formation (1989)

Minimum staff requirements: 1.5 FTE professional staff plus 0.2 technical support staff plus one student assistant.

### 2.3.2.4 Oil And Gas Resources Investigations

MBMG currently has no staff involved in assessment of oil and gas resources in Montana. MCS82-11-126 provides for a cooperative working arrangement between MBMG and the State Oil and Gas Commission; however, it did not address the staffing needs for MBMG to conduct modern petroleum resources assessment. 1.0 to 2.0 state-fund FTEs are needed to initiate an aggressive program aimed at identifying new petroleum and natural gas resources within the state. These investigations will not focus on petroleum exploration because extensive data is available to petroleum companies which is not routinely available to MBMG. Instead, GMR's petroleum assessment investigations will initially be aimed at preparing exhaustive reviews of existing fields. Such reviews lead to revision of the subsurface structure and stratigraphy and commonly show the location of potential reserves not currently under production. Approximately one major petroleum field can be reviewed per year. In addition to revision of the structural-stratigraphic framework, each review will also involve evaluation of other parameters such as porosity, permeability, gravity of crude, production records, etc., in order to locate potential new reserves. The results of each review will be published by MBMG as a synthesis of the geology of each field.

## 2.4 Educational Program

In addition to conducting research and providing information, the Geology and Mineral Resources Division is involved in educational activities which, although outside the area of classroom teaching, reach a large number of people. The following are the main educational activities. Because, with the exception of the curatorship of the Mineral Museum, they are part of the general activities of the MBMG staff, it is not practical to assign fractional positions to them. It is proposed that they be continued at approximately the same level.

### 2.4.1 Short Courses And Lectures

Three short courses relating to the mineral industry are offered annually and will be continued depending on changing needs. A two-day placer mining short course is designed mainly for those not familiar with placer mining. A two-day prospecting course is also offered at the introductory level. A three-day course on practical development, mining and milling is offered at a more advanced level.

Lectures given to school classes, mining groups, and mineral collectors deal with some aspect of geology or the mineral industry.

### 2.4.2 Mineral Museum

The Mineral Museum is under the supervision of the Montana Bureau of Mines and Geology. In recent years, the main efforts have been directed at improving the collection of mineral specimens from Idaho and Montana, improving displays, and conducting tours for groups through the Museum. The collection contains many very fine specimens and is considered a good collection for a regional museum.

Displays can be improved by adding more interpretative material and by displaying specimens more attractively. This requires a higher level of funding than is now available and it is most likely that this would have to be obtained from outside sources. To date the Mineral Museum has been unsuccessful in obtaining grants, mainly because its activities are too limited and in many ways it is too small; it has not yet reached a critical size. To reach this critical size and level of activity a full-time director is needed. The cost of this position should be shared between the Montana Bureau of Mines and Geology and other departments of Montana Tech. The Montana Bureau of Mines and Geology should not be solely responsible for this College Mineral Museum which more than 16,000 people visit each year.

The greatest need in the Mineral Museum is to display the fine mineral specimens in this collection more attractively and to add more educational material to these displays thus making them more informative to the public. Thus a continuing program of building new, well-illuminated display cases is needed. Funding at the level of $5000/year and increased for inflation would provide for the addition of at least one new display each year.

### 2.4.3 Mineral Museum And Economic Geology Research Collection

The Mineral Museum is housed in a facility originally designed to be an auditorium, hardly the ideal facility for a public museum. Because of the position of this building on the Montana Tech campus, public access to this building is not very good. A somewhat related activity of the Montana Bureau of Mines and Geology is the curatorship of an extensive collection of approximately 15,000 specimens from the Butte district donated to Montana Tech by the Anaconda Co. Unlike the collection displayed in the Mineral Museum this collection is mainly a research collection. This collection is now housed in a rented building in the business district of Butte. The MBMG has in recent years established a repository of drill core donated by mining companies from mineral exploration projects in Montana. This core is stored in a modern but overcrowded facility at the Butte Industrial Park south of the city of Butte. Because all three of these collections have similar curatorial needs and should be in an accessible location, it is proposed that the Mineral Museum, Butte research collection be housed in one facility situated on the Montana Tech campus and under the direction of one individual. Obviously this would require a major expenditure to build this facility. Advantages of building this facility and staffing it with a director at (0.8 FTE) are:

1. Improved display space for the Mineral Museum and a building specifically designed for storage of core and research specimens.
2. Improved public access.
3. Providing for adequate curatorial activities by having these three collections under the responsibility of one director.

### 2.4.4 Research Laboratory

In 1985, the Anaconda Company donated essentially all of the equipment from their research lab to Montana Tech. The replacement value of this laboratory equipment is estimated to be in excess of $250,000. This equipment is now in storage in the Mill Building on the Montana Tech campus awaiting the establishment of a research lab. This lab would be administered by the GMRD Montana Bureau of Mines and Geology and would be used primarily for sample preparation, mineralogical analysis and other procedures. The cost of establishing a research laboratory from existing space on the Montana Tech campus is estimated to be $85,000. This figure includes the necessary remodelling, wiring, plumbing and construction of fume hoods.
Staff requirements: 1.0 FTE.

**Total staff requirements:**

| | Professional Staff | Technical Support | Nontechnical Support | |
|---|---|---|---|---|
| Existing staff requirements | | | | |
| 2.2 Geologic Framework Program | 6.5 | 1.7 | - | |
| 2.3 Mineral Resources Program | 6.0 | 1.9 | - | |
| Division nontechnical support | - | - | 1.0 | |
| Subtotal | 12.5 | 3.6 | 1.0 | = 17.1 |
| New project needs | | | | |
| 2.3.2.4 Oil and Gas Res. Invest. | 1.0 | | | |
| 2.4.3 Mineral Museum | 0.8 | | | |
| 2.4.4 Research Lab | | 1.0 | | |
| Total | 14.3 | 4.6 | 1.0 | = 19.9 |

The average budgets and staffing of GMRD for the last three biennial budgets are shown in Figure 2.4 and 2.5. During this period of time, the legislature first added 1.5 FTE to GMRD for study of strategic and critical minerals for the FY82/83 biennial and then 0.5 FTE to GMRD for the Earthquake Studies Office for the FY86/87. Due to these additions, average State appropriations have only shown a net six percent decline over the last three bienniums. State-supported staffing had a net 0.4 FTE gain during these three bienniums but the budget cuts already made during FY87 will result in a net loss of 0.86 FTE as of the end of FY87. Total GMRD staffing has been reduced 44% from 16 to 9 at the end of FY87.

Much of the modern program development of GMRD has taken place during the period FY82-FY87 because of the availability of research contracts and grants received by GMRD staff. Most of this research money comes from federal agencies and as their budgets have become more constrained federal research dollars have declined also. This decline has averaged $40,000/yr for the last six years. GMRD's state appropriations have declined at an average rate of $4000/yr for the same period, thus reducing the overall available budget by $264,000 by the end of FY87.

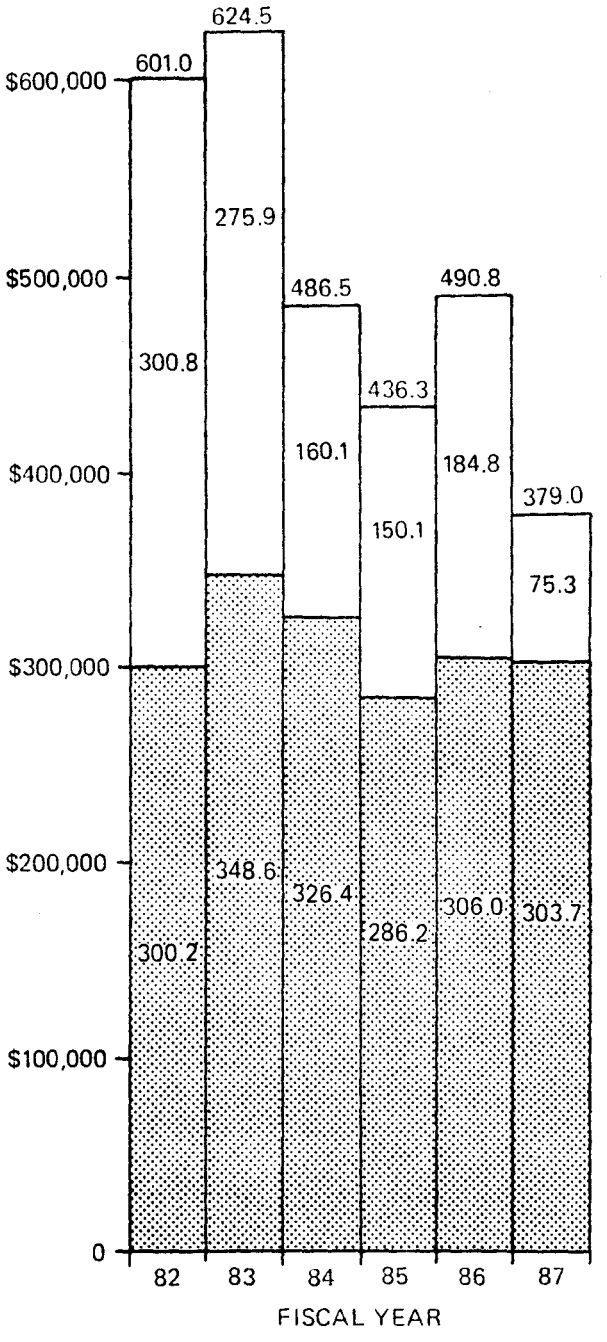


Figure 2.4: Graph showing General Funds (shaded) and Research Grants used to support the Geology and Mineral Resources Division for the last three biennium.

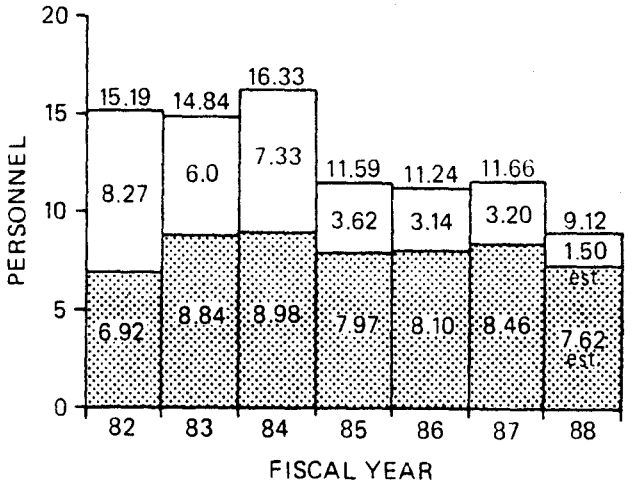


Figure 2.5: Graph showing FTE supported by General Funds (shaded) and Research Grants Funds (shaded) and Research Grants in the Geology and Mineral Resources Division for the last three biennium.

To maintain our existing program as outlined in the long-range plan for the next five years requires 17.1 FTE (both state and research) and to implement new work on Oil and Gas Resources, install and maintain the $250,000 research laboratory and to develop the mineral collection requires an additional 2.8 FTEs for a projected total of 19.9 FTE.

## 3.0 HYDROGEOLOGICAL SERVICE AND RESEARCH

The Bureau has been providing groundwater information to residents and municipalities since 1931, when Eugene Perry became Chief Geologist for the Bureau. The Hydrology Division provides information to the public and provides assistance to local, state and federal agencies. Topics addressed in the research program frequently reflect results needed to answer public inquiries, to define the magnitude and areal extent of a groundwater resource or problem, or to gather the information needed to propose solutions to groundwater problems.

To provide the service and research needed to permit wise development and protection of Montana's groundwater resources (over half of Montana's citizens depend upon groundwater as their sole source of drinking water) the Hydrology Division's efforts are divided into three main areas:

1) Service programs;
2) Data-base development; and
3) Research programs

The Division's 7.12 FTEs (FY 87) supported by general fund appropriations to the Bureau work at public service (2.4 FTEs), research (1.64 FTEs), clerical (1.25 FTEs), data-base (1.0 FTE) and administrative (0.83 FTE) activities. The data base is the major linkage between the service and research programs.

### 3.1 Service Programs

Assistance ranges from answering simple requests like providing a copy of a citizen's well log to a complex evaluation of groundwater resources in specific areas for units of the state or federal governments. Unlike most projects that produce a specific product at the end of a specified period of time, public assistance is ongoing as long as a need exists for hydrogeologic information.

#### 3.1.1 Direct Assistance

The goal of this program is to provide hydrologic information currently available in Montana Bureau of Mines and Geology (MBMG) files, and to provide new and better information more quickly and efficiently. In a normal year, about 1000 written and phone call requests for groundwater information are received at the Hydrology Division offices. Approximately 55% of these requests are to locate and copy well logs either for private citizens or for consultants. Another 45% of the requests are for detailed information on groundwater availability or quality, usually at a specific site such as at a well that is proposed or being drilled. Additionally, several hundred questions are answered by staff members at various meetings throughout the State.

The ability of the Hydrology Division to respond to these numerous requests has been enhanced greatly by the electronic data bases developed within the division. By using electronic retrieval capabilities, routine requests can be

answered easily for information in electronic format. Additionally, computer-driven plotters and printers can produce hard-copy graphic materials such as maps, hydrographs, and plots or tables of hydrologic information, greatly enhancing information dissemination. Despite the assistance provided by electronic data bases, two basic problems in providing public assistance still exist: 1) not all of MBMG's hydrologic data files are in electronic format and 2) requests for ever-more-specialized assistance continue to increase. Problem 1 can be solved eventually by continued support for the development of electronic data bases. Problem 2 can be solved only by having hydrogeologists in the MBMG become more skilled in their particular fields of expertise and by using the information contained in the electronic data bases to generate derivative hydrogeological information through geographic and statistical analysis of those data. Thus, providing improved public assistance in hydrogeology requires making use of the MBMG's own hydrogeologic data as a research tool to improve the general knowledge of aquifers and aquifer systems, groundwater quality distribution (both areally and vertically) and how various aquifers interact. Expertise needs to be improved continually also in such fields as well hydraulics, well construction and water-quality amelioration techniques.

### 3.1.2 Special Assistance and Service

The Hydrology Division continually provides technical expertise to various panels, advisory and regulatory boards, and commissions, as well as providing advice and technical reviews for various State agencies. The Division provides technical support to the Highway, Fish, Wildlife and Parks, State Lands, and Natural Resources and Conservation Departments of State government.

By statute, the MBMG must provide a member of the Water Well Contractors Board which licenses water-well drillers in Montana, hears and resolves complaints concerning the performance of water-well drillers, and establishes rules and regulations on proper well construction. The Bureau provides a hydrogeologist for the Interaction Joint Commission's working committees to evaluate each of the potential Canadian-U.S. boundary waters problems in which Montana groundwater could be involved. The Bureau also provides specific staff members requested (because of their area of expertise), as well as an advisory hydrogeologist, because the protection of Montana's water resources is important to the citizens of the State.

The Division normally provides members to several permanent and ad hoc committees dealing with specific groundwater problems or conditions within the State. This need is expected to grow in the future.

Additionally, MBMG hydrogeologists informally interact with various federal agencies concerning their programs and Montana's groundwater resources.

### 3.1.3 Assistance Projections for Future

We currently have 2.4 FTE's split amongst six professionals assigned to service functions, with the workload roughly split between special and direct assistance. The approach has been to utilize the areas of expertise and geographical experience of every professional, supported by direct appropriations, within this program. Recent budget cuts have reduced our staff size and expertise in the areas of agricultural and metallic-mining (and contaminant) hydrogeology.

Recent trends in assistance requests suggest that the time needed to respond adequately to an individual's information request will double within five years. Better coordination and communication with Federal agencies is needed to obtain the maximum amount of hydrogeologic information from their research work. Public awareness of the environmental impacts of mining, urbanization and industrial development, and agricultural practices (pesticides and herbicides) is leading to increased requests for systematic assistance at the municipal and county level. We need 0.6 FTE immediately (0.3 for our Kalispell office and 0.3 in Butte for mining impacts) and project the need for another 0.5 professional FTE in five years due to an increased workload. The projected staffing needs in 20 years is a total of 5.0 professional FTEs, assuming that these trends continue.

The Office Program (Figure 3.1) provides basic data, library and interpretive services pertaining to Montana's groundwater. More than 80,000 water well logs, 9,000 chemical analyses of water from wells and springs, about 30,000 spring appropriations, 25,000 deep aquifer records and Montana Department of Highways drill logs and groundwater level records comprise the data resource of the Ground-Water Information Center. Of these basic data files, the water well log file and the water quality file have been computerized for rapid access and retrieval; use with computer graphics and statistics for map and report preparation; and tabulation of data or extracting specific information (such as the number or location of flowing wells or locations of wells or springs containing elevated levels of nitrate or arsenic or some other chemical constituent).

### 3.1.4 University System Educational And Service Program

The hydrogeological specialization for the graduate and undergraduate students of the Geological Engineering Department of Montana Tech was initiated and developed by the Hydrology Division of Montana Bureau of Mines and Geology in early 1983. Prior to that time, one course (on yearly basis) had been taught by the staff of the Hydrology Division as a service course for the Department. Since then, seven new hydrogeologically oriented courses have been added to the list of offerings of the department. At present, Montana Tech has a strong hydrogeological specialization with large diversity of courses, and provides a quality education to eight graduate and about twenty undergraduate students.

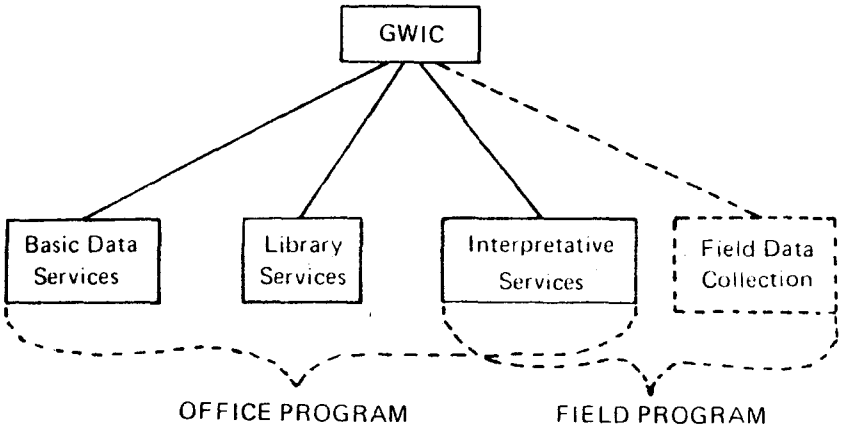


Figure 3.1 GROUNDWATER INFORMATION CENTER PROGRAMATIC AND SERVICE AREAS. Field data collection services are planned but not presently funded.

As of December 10, 1986, the College has 0.38 FTE assigned to the specialization; this covers about three courses a year. The remaining courses are taught by the MBMG staff on a reimbursement basis. Equipment of the Hydrology Division is available to students for educational purposes and for the research conducted by graduate students. Additionally, several research projects provide the graduate students with the necessary funds and research opportunities. In return, the results of master theses would be incorporated in the final reports presented by MBMG.

The future involvement of the Hydrology Division in teaching duties shall depend on the mutual needs and possibilities at a given time, and shall be run to the benefit of both the MBMG and the College. We do not expect to increase the FTE commitment in this area.

## 3.2 DATA BASE PROGRAM

This program connects the research program results with the public service efforts. Information obtained from research conducted by the Division and by Federal agencies such as the Geological Survey, Bureau of Indian Affairs, Bureau of Land Management, Environmental Protection Agency, and Soil Conservation Service under cooperative programs is entered into the various data bases to assist the Division's staff in responding to inquiries. Additionally, the stored data is retrieved to produce research products, mainly in map format. Goals for the next five years are to transfer deep-aquifer data, static water-level data, and aquifer-test data from non-computerized files into electronic format in addition entering newly obtained information.

In 1984-85, the Division moved to begin truly integrating its hydrologic data bases and constructing a comprehensive groundwater data management program which would collect, manage and distribute groundwater data. The Ground-Water Information Center (GWIC) is a program that has been evolving within the Division's activities for over 15 years and is an outgrowth of the Bureau's mandate to "compile statistics", "study", and "communicate" information about geologic and groundwater characteristics of Montana. GWIC contains two main program and four service areas. Relationships between the service and program areas are shown on Figure 3.1. The proposed Field Program (dashed lines on Figure 3.1) would collect new hydrogeologic data in areas of Montana where it was needed to address specific problems on a short term basis. The Field Program has not been implemented due to lack of specific funding. Most of GWIC's effort goes towards maintenance of Basic Data Services activities.

Figure 3.2 illustrates existing (solid line) and proposed (dashed line) data bases maintained or planned by the Division within the Basic Data Services area. Water well log and water quality data bases are the traditional data bases of the GWIC and are those presently available in electronic format. A microfische-based data base is utilized which contains about 25,000 records relative to strati-

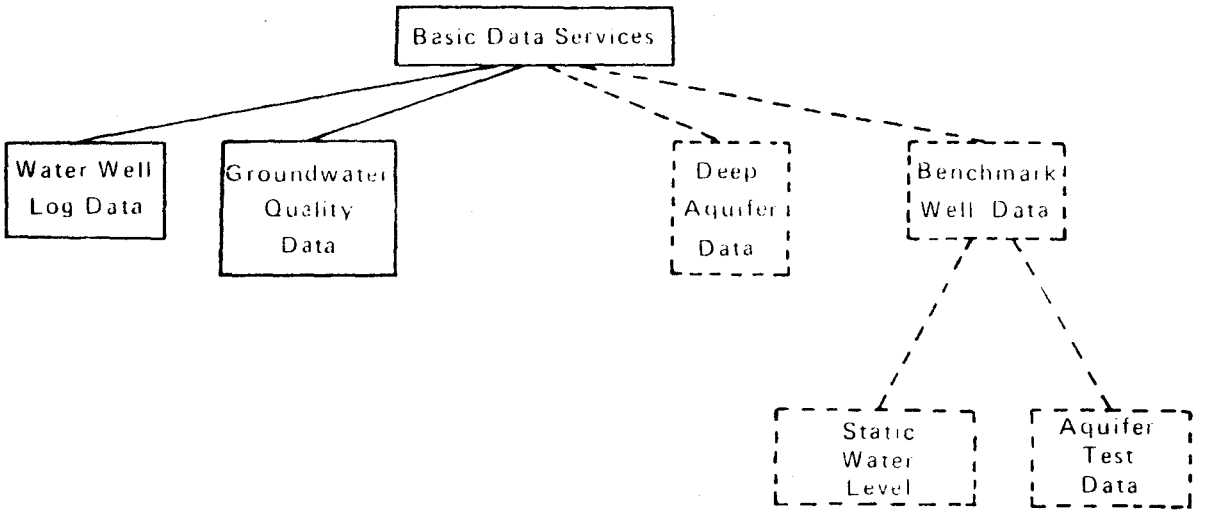


Figure 3.2 EXISTING AND PLANNED (DASHED LINE) GROUNDWATER INFORMATION CENTER DATA BASES.

graphic information about deeper, water-bearing formations in eastern Montana. The planned Benchmark well data base will be similar in function to the U. S. Geological Survey's groundwater site inventory data system representing the best, most reliable groundwater data available at the GWIC. It will contain two smaller adjunct data bases addressing static water level and aquifer test data.

Implementing the planned data management functions shown in Figure 3.2 will depend on the level of effort that can be placed towards these goals. Presently 1.0 FTE from Bureau funding and 0.83 FTE from outside grants are committed to GWIC operations. At this support level, we are keeping current with new water-quality data analyzed by the MBMG lab, but not adding previously published data from other laboratories. We are reducing the backlog of new water-well-log data, but we are only able to keep up with well-inventory, aquifer-test, and static-water-level data from Bureau research; data from cooperator's research is not being entered. If additional FTE support can be augmented to the 3.0 FTE level over the next five years, implementation of all planned GWIC programs will be possible.

## 3.3 RESEARCH PROGRAMS

The Hydrology Division's research efforts are directed toward resource assessment and the solution of groundwater problems. Past emphasis has been related to groundwater availibility and quality, agricultural and mining impacts, and resource protection (prevention of overdevelopment or contamination). The research goals have been practical in their orientation and are intended to support the present and future needs of the service programs. These goals will not change, but an increased concentration on resource protection from contaminant impacts is projected.

### 3.3.1 Aquifer Exploration In Areas Having Limited Ground And Surface Water Resources

Knowledge of stratigraphy in Montana is adequate to locate major aquifer systems, but is inadequate to locate and define local aquifers that may have potential to yield large quantities of good quality groundwater. Tertiary gravel beds, for example, are present in most intermontane basins, but their depths, locations, and potential productivities are poorly known. In northern Montana, gravels ranging in age from Tertiary through Quaternary are buried beneath and within Pleistocene glacial drift. Objectives of this program are to locate and evaluate the poorly known aquifers, giving priorities to areas where other water supplies are limited by quantity or quality.

The first element of this program is currently in place. A study of the ancestral (pre-glacial) channel of the Missouri River in Roosevelt and Sheridan Counties is in process and is scheduled for completion in October, 1987. Future program elements will be implemented according to availability of hard and soft dollars.

This program will require 1.5 FTEs. At a minimum, one-half FTE should be assigned in finding preliminary indications of the aquifers and in obtaining outside funding for detailed evaluations. Currently we have 0.4 FTE assigned to this role. A full FTE will be needed for drilling, testing, mapping, and modeling.

### 3.3.2 1:250,000 Hydrogeologic Map Series

Data accumulated in a file system serves little purpose until it is used, and geographic data are best used in conjunction with maps. In order for MBMG hydrogeologists to be able to respond to most requests for information on groundwater resources, a fundamental question put to the requestor is, "What is your location?". The location, coupled with the basic groundwater request provides the key to a correct response to the requestor. The location is essential because of the variety of aquifers and aquifer conditions within the State - all of which vary with location. Because an aquifer is a geologic entity as well as an economic one, good geologic maps are essential.

Equally important as good, detailed geologic maps are maps showing various hydrogeologic parameters. This is true because, unlike geologic maps that provide virtually continuous "ground truth-information" across the area of the map, hydrogeologic information is generally derived from point sources, often some distance apart. It is essential, therefore, to use not only good, detailed geologic maps, but also smaller-scale geologic maps as a base to show hydrogeologic information.

The series of maps that has proved most effective overall in displaying these hydrogeologic data is the 1:250,000 ($1^{o}$ x $2^{o}$) series. If the density of hydrogeologic data were greater across the State, the 1:100,000 (30' x 60') series would be the preferred choice. At present (and probably for many years to come) the density of hydrogeologic data for the State does not warrant the larger scale, and the 1:250,000 scale maps should continue to be developed.

The first step needed is to produce a geologic map at 1:250,000 scale for a given quadrangle. This map is generally compiled from existing maps, but photogeologic interpretation from high-altitude aerial photographs or satellite imagery is sometimes used in areas where existing maps are poor. Once the geologic base map has been prepared, the next step is to delimit the geologic formations on that quadrangle that are known to be aquifers. Next, verified hydrogeologic data such as information on water quality or data from inventoried wells is added to the map. Then, non-verified hydrogeologic data which is consistent with the verified data is added, and, lastly, a description of the aquifer units and a discussion of their potential yield and water quality is added.

The completed map thus shows a number of essential hydrogeologic parameters and their geographic interrelationship to enable the hydrogeologist - whether at the MBMG or elsewhere - to make correct evaluations of various aspects of the groundwater situation in a given area. The maps are thus useful to reply to requests for groundwater information as well as to assist State or Federal agenices in the planning or management of groundwater resources.

The map, as described above, is only one type of map that can be completed at the 1:250,000 scale. Other maps would be: 1) altitude of the top of an aquifer, 2) thickness of the aquifer, 3) water-quality variations within that aquifer, 4) concentrations of specific chemicals within the groundwater (iron, selenium, nitrate, arsenic). The maps thus generated can thus show a great number of parameters which affect the quality and quantity of water within a given aquifer.

At present, only one staff member in the MBMG is involved in preparing these maps, and only on a quarter time basis. The rate of progress in completing these maps - as important as they are - has been slow. Although support exists for this series of maps, one full FTE plus student and drafting support is needed. This would permit the production of one basic 1:250,000 hydrogeologic map, and the relevent derivative maps, annually, and would provide this type of coverage for all of eastern Montana in 12 to 14 years. At that time, this program would be revised to a 1:100,000 mapping effort for Quaternary aquifers, and would require 2 FTEs.

### 3.3.3 Enhanced Field Data Collection

The Bureau interacts with many State and Federal agencies. Frequently we provide drilling or hydrogeologic support for the U. S. Bureau of Indian Affairs, Bureau of Land Management, Soil Conservation Service, Geological Survey, and Environmental Protection Agency as well as the Montana Department of Highways, Governor's Office, Department of Fish, Wildlife and Parks, and Department of State Lands. Assistance to Federal agencies is normally on a cost recovery basis or as part of a cooperative program. In many cases, wells are drilled for these agencies but hydrologic testing of the wells is not part of their program, despite the fact that such tests are usually considerably less expensive than the cost of the well.

This inneraction provides a favorable situation to develop an in-house testing program that utilizes wells drilled by or for other agencies. These wells-of-opportunity would be tested to provide specific hydrogeologic information about the aquifer(s) from which the well produces water. Values would be determined for well yield and specific capacity, aquifer hydraulic conductivity, static water level, saturated thickness, and water quality. These data would be entered into the Ground Water Information Center computerized data base.

Obviously, not all wells that become available would be tested and the results analyzed. However, if 10 to 12 wells per year from areas where there is little or no good aquifer data, could be tested properly, we should have representative values for the major aquifers of the State within a period of 15 to 20 years. A proper test would generally require the efforts of two FTE's for a week per site to complete. It would consist of pump installation and recorder set up, a 24-hour pumping period, a 24- to 48-hour recovery period (which is also monitored), and equipment breakdown and clean up. This new program would require 1.0 FTE (6-man months field time, 3-man months data analysis in the office, and 3-man months coordinating with the other agencies, obtaining discharge permits and other necessary approvals, etc.).

Additionally, a groundwater sampling program to provide water-quality data is needed to fill in many large gaps within the MBMG data base. A five-year project to collect 30 to 40 samples per year should be adequate to meet most inquiry needs concerning the groundwater quality for stock and domestic wells when well yield is not a critical factor. To implement this project, 0.25 FTE is needed. We have 0.10 FTE currently available for this project, but funding for travel and analytical costs is not presently available.

### 3.3.4 Coal Hydrogeology

Mining of subbituminous coal in southeastern Montana has accelerated since 1968 to a current annual production of 30 million tons. Climate of the area is semiarid, so agricultural enterprises there are reliant upon wells and springs for stock and household water supplies. Many of the coal beds destined for mining are also aquifers that supply vital groundwater.

Groundwater levels near mines along aquifer outcrops do not change substantially during mining. In contrast, mines that penetrate a more central part of an aquifer near Decker have caused declines of the potentiometric surface of 5 to 180 feet over an area 12 miles long and 6 miles wide. The area of drawdown is strongly controlled by faults that act as barriers to groundwater flow.

As backfilling follows coal removal, groundwater re-enters spoils at the mines. The greatest resaturation has thus far occurred through recharge by lateral flow from undisturbed aquifers. Where vertical gradients are favorable, upward flow through pre-mining test holes can be significant. Much groundwater flow in spoils occurs along "mine-floor" aquifers where a variable thickness of wasted coal and course rubble have been covered by finer-grained materials. Future research should address the viability of intentional creation of mine-floor aquifers during mining in order to create post-mining water supplies, and to mitigate adverse water-quality conditions created during mining.

The quality of mined-land groundwater is very diverse. Cations (calcium, magnesium, sodium) and anions (sulfate and bicarbonate) occur over a wide range of concentrations and ratios. In all cases, however, mined-land groundwaters are substantially more highly mineralized than groundwaters from undisturbed aquifers. Two- to three-fold increases in dissolved solids seem to be most common. Where mine-floor aquifers are present, water quality improves. Where they are absent, water quality degradation thus far appears to be permanent.

The Coal Hydrology Program consists of two concurrent elements: monitoring and research. Monitoring of changes in water levels and quality has produced more than ten years of record at Rosebud, Big Sky, West Decker, and East Decker mines. The continuing hydrologic changes provide irreplaceable information on consequences of opening future mines. The research element applies scientific analysis to the monitoring element by integrating field data with laboratory column-leach experiments. The ultimate goals of the research are the development of techniques for predicting post-mining water quality before mining is begun, and for predicting off-site effects of migration of spoils water. One FTE of technician grade, and 0.5 FTE professional are required to maintain the monitoring element. One and one-half FTE, both professional will be required to conduct the research element. We currently have 0.4 FTE assigned to these tasks.

### 3.3.5 Metallic Mining Hydrogeology

The mining of non-metallic minerals may produce suspended sediment, increases in both surface-water and groundwater dissolved solids and nutrient concentrations as the major impacts. Mining of precious and base metals normally releases heavy metal contaminents associated with ores. Past Bureau research has investigated reclamation feasibility, neutralization of acid mine drainage within the waste materials using fly ash, and characterization of existing conditions.

Future work should include: (1) developing better methods of determining the source and age of cyanide detected in groundwater and streams; (2) further investigations to test extraction of dissolved metals from contaminated waters using zeolites; (3) additional investigations on arsenic mobility; and (4) studies that may develop knowledge or methods which will assist Montana's mining industry in reducing the environmental impact of their operations.

We currently have 0.25 FTE assigned to this area, but believe that at least 1.25 FTE is needed to do the job adequately.

### 3.3.6 Conjunctive Use Studies

Conjunctive use of surface water and groundwater resources in a basin can help to satisfy a given level of water demand in a cost-effective manner. In reaching this objective, a variety of factors is often taken into account; some of these factors include the timing of water demand, the timing of surface water

and groundwater availability, and the cost of securing each type of water supply. If carried out properly, conjuctive use can potentially alleviate water shortages, use resources that are normally wasted or remain untapped, and aid in water conservation.

The most familiar form of conjunctive use is the artifical recharge of an aquifer through seepage ponds or injection wells. This technique has been used successfully in Fresno, California; Minot, North Dakota; and other locations throughout the country. Artifical recharge may be benefical if (1) groundwater levels on an annual or seasonal basis are declining at an unacceptable rate, and an increased rate of aquifer recharge is desirable; (2) use of the storage capacities of an aquifer are preferable to construction of a surface water storage facility; (3) use of the transmissive capabilities of an aquifer are preferable to construction of surface distribution systems.

The withdrawal of groundwater to supplement surface water flow is also a form of conjunctive use. Such a strategy can be utilized in a situation where groundwater resurces have not yet been developed and surface water during low-flow periods is insufficient to satisfy appropriators. Again, extensive site-specific data must be available. Questions must be answered regarding whether groundwater withdrawals will deplete the surface-water flow to be supplemented and whether groundwater diverted into the stream will remain in the stream or be lost to seepage into the groundwater system before it serves its supplemental purpose.

Conjunctive use is employed to a limited extent in Montana. The city of Missoula, for example, has long relied on both groundwater and surface water sources to supply its municipal water needs. In other areas of the state, conjunctive use is being inadvertently practiced. There are many areas where groundwater systems are being artifically recharged by leaking ditches and inefficient use of water for irrigation. The resulting increase in local groundwater supplies is then tapped through the use of wells to supply water for other purposes, often domestic or agricultural. The developing dependency on this artifically recharged water can cause problems if water-distribution/water-use efficiencies are suddenly increased; the associated artifical recharge is reduced and groundwater well levels fall. This potential problem is of concern in the Bitterroot Valley, Gallatin River Valley, and the Dillon area and many other valleys that now support flood-irrigated agriculture.

The first element in the Bureau's conjunctive use program will begin April, 1987, with experimental pumping of water from abandoned underground coal mines at Roundup. Objectives will be to determine viability of using mine waters to augment low flows in the Musselshell River to meet downstream irrigation demands, historically not met in eight out of ten years.

A second program element is planned for implementation in approximately September, 1988, when an artifical-recharge project will begin on the Turner-Hogeland Bench in northern Montana. In this element, artifical recharge of the

Flaxville Formation will be tested. Snow-retainment measures will be attempted in order to increase recharge to the Flaxville where irrigation demands are depleting the amount of aquifer storage.

Each of these program elements require a duration of three or more years, and two to three FTEs will be needed depending upon activities. The current staff assigned to conjunctive use studies is 0.1 FTE of Bureau's cooperative program with the U.S. Geological Survey-WRD, and will be strengthened in 1990 to obtain streamflow modeling support on the Musselshell River.

### 3.3.7 Groundwater Contamination Evaluation

The evaluation of whether groundwater sources have been contaminated and an initial assessment of what options are available to individuals and communities when contamination has occurred is rapidly becoming a serious problem in Montana. In the past, the MBMG has not had any formal mechanism for responding to requests for assistance. Consequently, the level of assistance has varied widely, and has ranged from: 1) a site visit and recommendations on relocating a domestic/stock water well after a fuel tank leak has contaminated a ranch well, 2) through emergency response actions (overseeing an emergency artificial recharge program to prevent the spread of a gasoline spill in Billings), 3) to municipal assistance studies to determine the extent of the existing contamination and the available options to replace contaminated wells (example, Three Forks, where the shallow alluvial aquifer water in the Madison Valley is contaminated with arsenic).

It is expected that requests for this type of assistance will continue to increase, particularly because the Bureau has no regulatory functions. It will be necessary to expand our expertise through the research program and to make that additional knowledge and experience available through some form of a public assistance program. The minimum state funding that can accomplish this would be 0.5 FTE, split between research and service. If the perceived need for assistance grows as expected, this will need to be increased to 1.0 FTE in about five years. About $10,000 would be needed to purchase field equipment needed to determine and test the leakage extent of gasoline, and diesel and other volatile organic compounds leakage.

### 3.3.8 U. S. Geological Survey Cooperative Program

The U. S. Geological Survey Water Resources Division is a key Federal agency that works with surface-water and groundwater resources. The Water Resources Division coordinates its operation with the MBMG and we exchange information. Money and services provided from the budget of the Montana Bureau of Mines and Geology are consigned to the U. S. Geological Survey, which then uses that money and matches it with equal additional federal funds. The topics for research or investigation to be conducted by the U. S. Geological Survey within this program are determined by both agencies, and the information and data ultimately made

available help us to understand and solve specific problems related to Montana's groundwater. The research done through this program is usually published by the Montana Bureau of Mines and Geology.

This program has provided valuable contributions, and it is hoped that it can be expanded from predominently resource evaluation to include other types of work such as urban hydrology utilizing a team approach.

### 3.3.8.1 Basin Studies

Groundwater and surface-water systems consist of multiple components of the hydrologic budget. Availability of water, hydrologic disruptions caused by climate or man, and other hydrologic considerations are dependent upon a balance of the hydrologic budget that can be determinable through studies of hydrologic basins. Inherent in the basin-study approach are determinations and balance of the components of the hydrologic budget: precipitation runoff, evapotranspiration , groundwater flow, and changes in storage. Other results are knowledge of groundwater flow patterns, groundwater availability and quality, and groundwater/surface-water relationships. Studies of several Montana basins, e.g. the Flathead, Missoula, Helena, and Gallatin Valleys, have been conducted in the past, and the reports produced now provide frameworks for solutions of local problems in those areas. Other valleys of the State have been experiencing increased population growth and development, but still have poorly known hydrologic conditions (e.g. Paradise Valley south of Livingston). Future elements of the basin studies program will address these valleys according to priorities to be established by the Bureau in agreements with the U. S. Geological Survey (WRD).

Studies will be conducted by WRD staff under funding by the long-term Bureau/Geological Survey cooperative matching program. Bureau staff, when needed and available, will participate in the studies. About one-half of a Bureau FTE will be required to administer and coordinate the program.

### 3.3.8.2 Urban Hydrology

Urbanization creates changes in groundwater levels and quality. Paving, lawn watering, storm sewers and other urban aspects greatly alter distributions of aquifer recharge. Water quality is adversely effected by a myriad of urban factors including spills of petroleum and industrial wastes, leakage of gasoline and diesel fuel from underground storage tanks, broken sewer lines, and road-salt runoff and infiltration. Conversely, groundwater often creates problems for urban development where high water tables and/or capillary zones create unstable slopes and footing conditions. All of these problems are aggrevated because most of Montana's urban centers are located on valley-fill deposits containing highly transmissive aquifers. The Federal Government recognizes the hydrologic problems of urbanization. The Federal Safe Drinking Water Act, expected to be passed in early 1987, includes a theme of well-head protection and protection of sole-source aquifers. Opportunities for groundwater investigations are sure to arise under this Act.

The Bureau's Urban Hydrology Program contains elements of public service as well as research. Long-term commitments are made to the service element where information is provided upon request for individuals, companies, municipal organizations, and State agencies. Research elements are a series of hydrologic studies of urban areas, conducted as time, staffing, and funding allow.

The first program research element will begin in April, 1989, with a study of Yellowstone County. The study is intended to provide information for:

(a) Land-use planning: For the entire county, one or more maps will be produced that show best and worst areas for solid-waste disposal sites. Geologic and hydrologic conditions, and field checking will be utilized as the ranking criteria.
(b) Groundwater development and protection: All available groundwater data for the county will be compiled into one standard format and file. Data sources will include the Water Quality Bureau, the Bureau of Mines and Geology, the Department of Natural Resources and Conservation, the U. S. Geological Survey, local consultants, and local well drillers. The file and other results will be disseminated to the users listed above and to the City-County Planning and Resource Departments.

Staff needed for the service element of the Urban Hydrology Program are included in the long-range plan for Bureau service programs. For research elements, 1.4 FTE for a professional hydrogeologist and 0.5 FTE for a hydrologic technician will be required.

### 3.3.9 Topical Studies

Occasionally an opportunity becomes available to do research dealing with a significant groundwater problem which the Bureau has not addressed, or cannot afford to address under the existing budgetary limitations. Often the seed from which a research project grows results from an inquiry or request for assistance that could not be addressed adequately. In other cases, public concern over a potential problem causes the Bureau to look beyond its normal scope of activities (as an example of this, we are currently investigating the environmental impact that a proposed coal mine in Canada could have on the North Fork of the Flathead River and upon Flathead Lake).

If the expected research results or experience acquired is relevent to problems in Montana, a research proposal is developed with the intent of obtaining the data and/or equipment and experience needed to respond to Montana's groundwater problems. We currently have 0.1 FTE committed to this area to this area but need one-half FTE just to meet grant matching requirements.

## 3.4 PRIORITIES AND FUNDING

The Division's general priorities for assigning additional FTEs should be: (1) Data Base; (2) Public Service; and (3) Research. The funding picture in recent years has made it very difficult to meet the objectives of the three major programs. The funding reductions that the Division has undergone are shown in Figure 1.1. We cannot continue to provide the expected service to the State and its citizens if this trend is not reversed.

## 4.0 ANALYTICAL DIVISION

### 4.1 Introduction

The Analytical Division, which currently receives no State funding, is a research quality, production-oriented inorganic laboratory. At present it is staffed by two chemists, one administrative aide and student help. With the help of stable key personnel and modern instrumentation, it has earned a national reputation for excellence.

The primary future objective of the Analytical Division is to continue to provide high quality technical support to the Bureau, Montana Tech, and the State of Montana. This technical support is critical to the meeting of the proposed goals of the Bureau.

The Lab should concentrate its efforts in those areas in which it now excels and anticipate other service needs as they arise. It is recognized that there may be selected types of analysis which the Lab should not try to perform. This could be due to the lack of specialized equipment, very high costs, hazards to personnel and/or inadequate expertise.

### 4.2 Current Status

In 1979, laboratory capabilities were dramatically expanded through the purchase of an ARL Induction Coupled Argon Plasma Emission Spectrometer (ICAP) and a Dionex Anion chromatograph. These two automated instruments are able to analyze 80 percent of the samples (for previously requested parameters) more rapidly and with greater accuracy and precision than prior techniques, while providing additional test results that were not available in the past. The Analytical Division is able to analyze almost any sample matrix for 71 to 79 stable elements.

The ICAP is now more than ten years old. It has been upgraded by adding on an external spectrometer salvaged from an even older emission instrument. This allows the measurement of one additional element of choice. Since its installation, it has been part of the long-range plan to add 12 channels (elements) to the original spectrometer. If resources allow, a more advanced scanning ICAP should be added while retaining the present ICAP. This would permit an even wider range of analytical services to be added to the high output of routine services.

The Lab's Perkin Elmer 604 Atomic Absorption spectrometer is also ten years old. Its design (slow response) does not allow its use with graphite furnace technology. This technology would enable the reduction of detection limits to one-tenth or one-hundredth of what they are now. Because of the importance of low levels of the toxic metals (cadium, chromium, selemium, arsenic, etc.), more information is being requested at or below the laboratory's present detection limits.

The Anion Chromotograph is over five years old. it also has been upgraded (twice) by the use of developing technology. However, this area of technology is advancing so rapidly that the unit is again approaching obsolescence. This instrument needs to be replaced with one of newer design to improve efficiency, accuracy and versatility.

## 4.3 The Future

To meet the Division's goals, it must retain key personnel, provide analyses at reasonable costs, and improve instrumentation capabilities.

The concensus within the Bureau is almost unanimous that the Lab must return to the historic "hard money" support from the Bureau in the form of FTEs. There needs to be 1 FTE added soon and another .5 to 1 FTE added in five years (as the opportunity arises). This is less than the 2.3 FTEs recommended some years ago by the four Division Chiefs and about the same as has been repeatedly recommended by the Policy and Planning Committee.

The Lab should aggressively seek outside work, as long as it doesn't adversely affect service to the Bureau. This would include continuation of Montana State Certification, the U.S.G.S. Standard Reference Water Sample Program, application for the EPA Contract Lab Program and for the other organization laboratory certification programs. The increase in outside money would help stabilize the laboratory, decrease the cost per analysis and justify addition of new instrumentation.

A healthy responsive Analytical Division is essential to Bureau programs: it should be retained as a part of the Bureau and not become part of a campus-wide lab.

## 5.0 INFORMATION SERVICES DIVISION (ISD)

### 5.1 Publica[redacted]

Results of research accomplished by the staff of the Montana Bureau of Mines and Geology is made available to users by publication either by the Montana Bureau of Mines and Geology or by publication in appropriate professional journals and by presentations at technical meetings. Additionally, information is released to the public in the form of open-file reports and maps. News releases, an annual catalog of publications, and mailings of individual announcements inform users of the availability of new publications. Copies of MBMG publications are routinely sent to approximately 400 libraries and geological organizations in other states to help in the widespread dissemination of the results of MBMG research.

The first priority of the MBMG publications program is to publish the results of investigations conducted either by the Montana Bureau of Mines and Geology or by other organizations in cooperation with the Montana Bureau of Mines and Geology. Occasionally as funds permit the Montana Bureau of Mines and Geology may accept individual manuscripts for publication submitted by authors outside of the organization. Normally the MBMG will not enter into contracts with other agencies for either the publication of their work or the preparation of their work for publication unless MBMG personnel are involved in the research.

Results of research by MBMG staff can be divided into two categories of technical publications: Geologic and Mineral Resources Investigations and Hydrologic Investigations. The content of these professional manuscripts is the responsibility of the Geology and Mineral Resources Division and Hydrology Division, respectively. The Information Services Division is responsible for editing and publication of these technical manuscrips. In addition, ISD has the primary responsibility for preparation of all miscellaneous publications.

#### 5.1.1 Geologic And Mineral Resources Investigations

The results of investigations of the geology of specific areas would be published in this series in map format accompanied by explanatory text, and in book reports. Reports on mineral deposits as well as those on geologic hazards would also be included in this series. The sequential numbers of those publications that are maps with only brief explanatory text will be followed by M for map, whereas those publications that are mainly text will be designated B for bulletin.

#### 5.1.2 Hydro[redacted]gic Investigations

Results of investigations in hydrogeology will be published in this series and will also be designated M and B for those that are essentially maps and those that are mainly written text respectively. Hydrogeologic maps published at a scale of 1:250,000 and covering 1 by 2 degree quadrangles will be included in

this series of publications as will topical hydrogeologic studies. Also, the results of investigations completed under the Cooperative Program between the Montana Bureau of Mines and Geology and the Water Resources Division of the USGS will be included.

### 5.1.3 Miscellaneous Publications

This category includes a variety of publications not generally presenting the results of research activities of the Montana Bureau of Mines and Geology. Examples of Miscellaneous Publications follow.

Circular - On some aspect of the geology, groundwater or mineral resources of Montana written for the nongeologist

Annual report of the Montana Bureau of Mines and Geology

Directory of Mining Enterprises - annual publication

List of Current Geological and Geophysical Studies - annual publication

Index of Theses on Montana Geology - revised every five years

Catalog of MBMG publications - revised every several years with annual inserts

Reprints - From time to time it may be desirable for the MBMG to reprint significant articles or even entire publications from a variety of sources when these publications are out of print and there is the need to make them more generally available. This would be a relatively minor effort.

### 5.1.5 Open-File Reports

Open-file reports are clearly not a substitute for publication of the results of MBMG research. They do, however, have their place in the dissemination of information, specifically serving the following three functions:

1. To release data that are too extensive or intended for too limited a readership to be formally published. An example might be extensive chemical data that are summarized in a publication and would be useful only to someone continuing with that research.

2. To release critical information in advance of a comprehensive publication that will not be available for a year or more. The prompt release of newly acquired information can be particularly important in the areas of hazards evaluation, hydrogeology or economic geology where this information may have social or economic consequences. These open-file reports would be superceded by the formal publications.

3. To release indexed file data normally filed on computers and intended for frequent periodic updating as new material is obtained and added to the [redacted] (MONT MODS, NCRDS); thus, the open-file report undergoes periodic revision which is not possible with a formal publication.

## 5.2 Publication Sales And Public Assistance

A major responsibility of the Information Services Division is the sale of publications including topographic maps. Members of this division are the first contact that many individuals have when they visit the Montana Bureau of Mines and Geology in search of information. Assistance to the public is a very important part of the MBMG's operation and although it doesn't produce a tangible product such as a publication it requires a commitment of time and resources. The informational activities of the Information Services Division must be coordinated with other sources of information in the MBMG both individuals and computer-stored data. An inquiry received by the Information Services Division will in many instances be answered directly by a member of the division, sometimes by simply referring the individual to a publication. More complex inquiries will be referred to the most knowledgeable individual available. This requires that Information Services Division staff have a good idea of who knows what. In the case of certain types of information, for instance information on coal resources, there is a computer database available within the MBMG. There are similar data storage systems for groundwater information and for information on mines and prospects.

## 5.3 Summary Of Present Staffing And Future Needs

The following summarizes the staff requirements for the Information Services Division at the anticipated level of publication activity and information services for the next 5 years.

Publications

| | |
|---|---|
| Drafters | 2.5 FTE |
| Editwriter operator | 1.0 FTE |
| Editor | 0.5 FTE |
| Overseeing publications process | 0.2 FTE |
| Preparation of miscellaneous publications | 0.4 FTE |
| Information Activities | |
| Publication sales and technical inquiries | 1.5 FTE |
| Experienced geologist or geologist/editor to assist in answering inquiries | 0.1 FTE |
| Total | 6.2 FTE |

The staffing level of this division would increase in response to greater needs in the publications area as a result of a greater research effort by the Montana Bureau of Mines and Geology. If the expansion in research effort of the MBMG is from outside contracts and grants expansion of the publications staff would in part be funded from these contracts and grants.

The estimated rate of submission of manuscripts over the next five years is summarized below.

| | Maps/Yr | Text Manuscripts/Yr |
|---|---|---|
| GMR Division | 5 | 2 |
| Hydrology Division | 2 | 2 |
| Information Services Division | 0 | 2 |
| Total/Yr | 7 | 6 |

ISD's budget has remained relatively constant at about $210,000 +10% during the last three biennial periods (FY82 to FY87). Most of ISD's budget is used for personal services with only about $40,000 ± 15% available for publication costs. In FY87 $35,000 was budgeted for publication cost. In 82 dollarS this is effectively reduced to $29,500 purchasing power; thus creating a backlog in publication of MBMG research.

A printing budget of approximately $50,000 per year (in '82 dollars) adjusted for increases in printing costs will be required to establish and maintain the estimated rate of publications.

MONTANA BUREAU OF MINES AND GEOLOGY

# LONG-RANGE PLAN
# FISCAL YEAR 1987 - FISCAL YEAR 1992

LONG-RANGE PLAN COMMITTEE:

JERRY BARTHOLOMEW
DICK BERG
WAYNE VAN VOAST
JOHN SONDEREGGER
WAYNE OLMSTEAD

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR-S-1

**Project Name:** MINERAL MUSEUM

**Principal Investigator:** Richard B. Berg, Curator

**Other Personnel:** Lester Zeihen, Adjunct Curator; student assistant

**Project Description:** Consists of the following:

1. Curate mineral collection
2. Prepare new displays.
3. Conduct tours for groups.
4. Generally improve the Mineral Museum

**Project Status:** Continuing service project

**Completion Date (mo./yr):** --

**Final Product:** --

**Funding Source:** 56

Richard B. Berg 1/27/87
**Principal Investigator** Date

1/27/87
**Division Chief**

**Director** Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR-S-2

**Project Name:** CORE REPOSITORY

**Principal Investigator:** Robert Derkey

**Other Personnel:** Student assistant

**Project Description:** Cataloging and storing of mainly diamond drill-hole core from Montana donated to the MBMG by mining companies. There is over 120,000 feet of drilling represented by core stored in the core repository at the Industrial Park in Butte. This core is available for research and examination at the repository.

**Project Status:** Continuing service project

**Completion Date (mo./yr):** --

**Final Product:** --

**Funding Source:** 56

Robert E. Derkey 1-27-87
**Principal Investigator** **Date**

**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR-S-3

**Project Name:** OPERATION OF EARTHQUAKE STUDIES OFFICE

**Principal Investigator:** Michael Stickney

**Other Personnel:** 2 part-time student lab assistants

**Project Description:** The nine-station seismograph network is operative. Seismographic data is routinely collected from regional stations operated by other agencies.

**Project Status:** 1984 catalog open-filed; 1985 catalog should be completed by March, 1987

**Completion Date (mo./yr):** 1986 catalog to be completed by July, 1987

**Final Product:** Annual catalog of seismicity put on open-file with the Montana Bureau of Mines and Geology.

**Funding Source:** 56 and 62

Michael Stickney 1-27-87
**Principal Investigator** **Date**

**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR-S-4

**Project Name:** SMALL MINERS PROGRAM

**Principal Investigator:** D. C. Lawson

**Other Personnel:** Nontechnical student help; other Division staff

**Project Description:** Liaison with small miners; information and verbal advice on exploration, mining, milling, equipment and problems; on-site visits all over Montana gathering data for publication of annual Directory of Montana Mining Enterprises. General answer man on Montana mines and mineral deposits. Building and maintaining most complete reference library in the state of catalogs and fliers pertaining to any item used in mineral identification service. Informal Bureau public relations person; mineral talks to school and civic groups. Chairman and Instructor on 3 short courses in 1986 and Chairman and Instructor for two 2-day short courses and 1 advanced 3-day course in 1987.

**Project Status:** Continuing service project

**Completion Date (mo./yr):** Ongoing programs: Directory in April each year; short courses annually (March, April and May 1987)

**Final Product:** Annual Directory; coauthor of USBM chapter on the Mineral Industry of Montana; data for Montana Mineral Data Bank files, Bureau Annual Report; Element Data reference file, mineral equipment files.

**Funding Source:** 56 and MSHA

Dick C. Lawson 1/27/87
**Principal Investigator** **Date**

**Division Chief** **Date**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR-S-5

**Project Name:** INDEX OF THESES AND CURRENT STUDIES

**Principal Investigator:** Richard B. Berg

**Other Personnel:** geological assistant

**Project Description:** Index of graduate thesis on Montana geology is compiled every 5 years. Compilation of next index should begin in 1987. Most of the work will be done by a geological assistant.

List of current geological and geophysical studies. This list of several hundred studies is compiled annually.

**Project Status:** Continuing service project: Next Index of Theses to be published in 1988. Next List of Current Geological and Geophysical Studies to be published May or June, 1987.

**Completion Date (mo./yr):** With completion of the 1987 Current Studies these projects will be turned over to H. L. James for completion as per responsibilities outlined in long-range plan.

**Final Product:** Publications by MBMG

**Funding Source:** 56

Richard B. Berg 1/27/87
**Principal Investigator** **Date**

1/27/87
**Division Chief** **Date**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR80-1

**Project Name:** BARITE DEPOSITS OF MONTANA

**Principal Investigator:** Richard B. Berg

**Other Personnel:** student assistants

**Project Description:** Comprehensive study of all known barite occurrences in Montana with geologic mapping of the area surrounding the Elk Creek-Coloma district. The report includes detailed descriptions of 68 barite occurrences.

**Project Status:** Manuscript completed March, 1986, now being revised based on 3 reviews.

**Completion Date (mo./yr):** Reviewed and revised manuscript will be submitted for publication March, 1987.

**Final Product:** Montana Bureau of Mines and Geology Memoir

**Funding Source:** 56

Richard B. Berg 1/27/87
**Principal Investigator** **Date**

1/27/87
**Division Chief** **Date**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR82-1

**Project Name:** COAL LAND MAPPING

**Principal Investigator:** Mark Sholes, Susan Foster

**Other Personnel:** Jan Downey, Edith Wilde, Pam Derkey, Bob Bergantino, Michael Stickney, Jane Mathews

**Project Description:** Preparation of geologic maps, coal outcrop maps, coal correlation charts, coal isopach overburden, interburden and structure contour maps, coal resource evaluation and reports on the geology and coal resources of the Baker, Wibaux, Glendive and Sidney 30X60-minute quadrangles.

Coal Lands Mapping is a cooperative project with the United States Geological Survey. The main purpose of the project is to produce new geologic maps and assess the coal resource potential for a 6,580 square mile area of eastern Montana.

**Project Status:** The Baker-Wibaux map was published in 1986; the coal reports for Baker-Wibaux, Glendive and Sidney are in press; Glendive geologic map in review.

**Completion Date (mo./yr):** December 1988

**Final Product:** All of the maps and reports listed above

**Funding Source:** 56 and USGS Coop #14-08-0001-A087

Mark A. Sholes 1/27/87
Principal Investigator Date

1/27/87
Division Chief Date

Director Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR82-2

**Project Name:** NATIONAL COAL RESOURCES DATA SYSTEM (NCRDS)

**Principal Investigator:** Jannette L. Downey

**Other Personnel:** Edith M. Wilde, Pamela D. Derkey

**Project Description:** Montana has vast coal resources. To be most valuable in planning our energy future, information on these resources must be gathered, compiled, and studied to provide more accurate evaluation of the resources. Data on Montana coal, including stratigraphic, analytical, petrographic, and coal outcrop data is collected, and this information is compiled, interpreted, and entered into the NCRDS computer files. Having all of this information gathered in one database allows cross sections, coal bed thickness isopach maps, coal resource maps, overburden isopachs, coal resource tables, coal quality tables, etc., to be produced.

**Project Status:** The project is presently in the last half-year of a six year program. A great deal of data remains available to be entered if the project were continued.

**Completion Date (mo./yr):**

| | | | |
|---|---|---|---|
| Coal resource assessment of | Sidney | 1:100,000 sheet | - June 1987 |
| " " " | Glendive | " | - Dec 1987 |
| " " " | Baker-Wibaux | " | - June 1988 |

**Final Product:** A substantial database of Montana coal data with the ability to generate coal resource evaluations of various areas of Montana

**Funding Source:** USGS #14-08-0001-A0107

1/27/87
**Principal Investigator** **Date**

1/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR83-1

**Project Name:** STOCKETT AND SE GREAT FALLS QUADRANGLES

**Principal Investigator:** Mervin J. Bartholmew and Susan Foster

**Other Personnel:** John Daniel, Nancy Williams, Robert Murray

**Project Description:** Detailed geologic maps of the Stockett and Great Falls SE 7 1/2 quadrangles as well as coal petrologic data. A concurrent hydrology project dovetails with this one.

**Project Status:** Compilation of data on maps completed

**Completion Date (mo./yr):** Geologic map and text to be ready for review by March, 1987; coal article ready for review by July 1987

**Final Product:** A combined geologic map of SE Great Falls and Stockett quadrangles; coal article for inclusion in coal volume (GMR87-1).

**Funding Source:** Hydrology project 1983/84; 56 thereafter

M J Bartholmew 1/20/87
**Principal Investigator** **Date**

M J Bartholmew 1/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR83-2

**Project Name:** DEER LODGE - AVON AREA MAPPING

**Principal Investigator:** Robert Derkey

**Other Personnel:** Graduate students, Mervin J. Bartholomew

**Project Description:** Detailed petrographic and chemical study of volcanic rocks in the Deer Lodge - Avon area is a major part of this project of mapping the geology of this area.

**Project Status:** Deer Lodge and Baggs Creek submitted for publication, December, 1986; Dempsey, Sugarloaf Mtn, Avon completed and preparing for review.

**Completion Date (mo./yr):** Dempsey, Sugarloaf Mtn and Avon will be prepared for review by April 1987.

**Final Product:** Five 7 1/2-minute quadrangle geologic maps.

**Funding Source:** 56

Robert L. Derkey 1-27-87
**Principal Investigator** **Date**

1/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR84-1

**Project Name:** BUTTE NORTH MAPPING PROJECT

**Principal Investigator:** Pamela D. Derkey

**Other Personnel:** M. J. Bartholomew

**Project Description:** This is a detailed (1:24,000) geologic mapping project, primarily concerned with identifying the various volcanic units of the Lowland Creek volcanic field (in the Butte North 15-minute quadrangle) with the aid of petrographic and geochemical data.

**Project Status:** Mapping of the southwest quarter of the Butte North quadrangle (Ramsay) completed June, 1986; this quadrangle map is being revised based on reviews and will be submitted for publication in February, 1987.

**Completion Date (mo./yr):** February 1987 for the Ramsay quadrangle. Completion of mapping for remainder of Butte North quadrangle unknown due to withdrawal of state funding.

**Final Product:** Geologic map and text

**Funding Source:** 56

Pamela D. Derkey 1-28-87
Principal Investigator Date

1/28/1987
Division Chief

Director Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR84-2

**Project Name:** STRUCTURAL STUDY OF THE OVERTHRUST BELT IN SOUTHWESTERN MONTANA

**Principal Investigator:** Mervin J. Bartholomew

**Other Personnel:**

**Project Description:** Detailed mapping of two structurally complex 7 1/2-minute quadrangles. The purpose is to understand the formation of the Overthrust Belt in this area. If funding can be obtained, project will expand to cover a larger area.

**Project Status:** A portion of the Dixon Mountain and Dell 7 1/2-minute quadrangles has been mapped. Mapping will be completed in 1987.

**Completion Date (mo./yr):** Maps and text will be ready for review by Dec 1987

**Final Product:** Geologic maps and texts of Dixon Mountain and Dell 7 1/2-minute quadrangles.

**Funding Source:** 56

M J Bartholomew 1/27/87
**Principal Investigator** **Date**

M J Bartholomew 1/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR85-1

**Project Name:** COAL LANDS MAPPING; COAL PETROGRAPHY

**Principal Investigator:** Mark Sholes

**Other Personnel:**

**Project Description:** Coal petrographic studies of Montana Coals and correlation of petrographic data with chemical and sedimentologic data.

Current work deals with collation of available data and will result in publication of maps and reports on petrographic and chemical characteristics of Montana coals.

**Project Status:** in progress

**Completion Date (mo./yr):** June 30, 1987

**Final Product:** Report on the petrography of the Knobloch coal

**Funding Source:** 56 and USGS coop agreement 14-08-0001-A087

Mark Sholes 1/27/87
Principal Investigator Date

1/27/87
Division Chief

Director Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR85-2

**Project Name:** LANDSLIDE MAP OF MONTANA

**Principal Investigator:** Mervin J. Bartholomew

**Other Personnel:** E. M. Wilde, P. D. Derkey, M. C. Stickney, F. Daniel, H. W. Dresser, R. B. Colton, and E. E. Brabb

**Project Description:** Identification of landslides in Montana. Also comprehensive bibliographic search for information on landslide. Preliminary compilations will be done at 1:100,000 and at 1:250,000.

**Project Status:** Map to be ready for review by March 1987.

**Completion Date (mo./yr):** Map will be submitted in spring 1988 for publication release at 1988 GSA meeting.

**Final Product:** 1:500,000 map of landslides in Montana to be published by MBMG.

**Funding Source:** MBMG-USGS Coop #14-08-0001-A0222 during 1985/86; 56 thereafter.

M J Bartholomew 1/27/87
**Principal Investigator** **Date**

M J Bartholomew 1/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR85-3

**Project Name:** MINERAL OCCURRENCE DATA BASE FOR MONTANA

**Principal Investigator:** Robert E. Derkey and Pamela Dunlap Derkey

**Other Personnel:** Jannette L. Downey

**Project Description:** The purpose of this project is to make information on mines and mineral deposits available to the public. This will be accomplished by storing and cataloging this information in a computer file accessible in the Bureau of Mines and Geology.

**Project Status:** Silver Bow County open-file submitted December, 1987;

**Completion Date (mo./yr):** Silver Bow County open-filed February, 1987

**Final Product:** Open files of inventory information on a county by county basis; publications will consist of 3 regional summaries.

**Funding Source:** MBMG-USGS cooperative agreement
14-0800001-A0222-A-311

Principal Investigator Date

Division Chief 1/27/87

Director Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR85-4

**Project Name:** CHLORITIC ALTERATION OF ARCHEAN GNEISSES IN THE HIGHLAND MOUNTAINS

**Principal Investigator:** Richard B. Berg

**Other Personnel:** none

**Project Description:** The purpose of this research is to understand the formation of chlorite veins in Archean gneisses. One of these veins is now being mined.

**Project Status:** Approximately 2 weeks have been devoted to project.

**Completion Date (mo./yr):** Uncertain -- a low priority project.

**Final Product:** MBMG Bulletin and/or journal article.

**Funding Source:** 56

Richard B. Berg 1/28/87
**Principal Investigator** **Date**

1/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR86-1

**Project Name:** GEOLOGY OF THE BELT 1/2° X 1° QUADRANGLE, CENTRAL MONTANA

**Principal Investigator:** Richard B. Berg

**Other Personnel:** Susan Foster, MBMG; Roger Colton, USGS; Hugh O'Brien, University of Washington, student assistants

**Project Description:** Reconnaissance geologic mapping of this quadrangle.

**Project Status:** Field work completed in 1987; 12 maps of individual 7 1/2 maps are on open-file with the MBMG; map to be prepared for review by the end of 1987.

**Completion Date (mo./yr):** Map to be submitted for publication late in 1988.

**Final Product:** Geologic map at scale of 1:100,000; possibly derivative maps and text.

**Funding Source:** 56 supplemented by USGS-MBMG cooperative project #14-08-0001-A047.

Richard B. Berg 1/27/87
**Principal Investigator** **Date**

1/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR86-2

**Project Name:** GEOLOGICAL INVESTIGATIONS OF DICKIE PEAK 7 1/2-MINUTE QUADRANGLE

**Principal Investigator:** Sharon Lewis

**Other Personnel:**

**Project Description:** Detailed geologic mapping of a geologically complex area that includes part of the German Gulch gold deposit. Special emphasis on structure, mineral deposits, and both Paleozoic and post-Kootenai stratigraphy.

**Project Status:** Field work to be completed in 1987; manuscript and map to be prepared for review by February, 1988.

**Completion Date (mo./yr):** December 1988

**Final Product:** Geologic map of the Dickie Peak 7 1/2-minute quadrangle and text.

**Funding Source:** 56

Sharon E Lewis 1/27/87
**Principal Investigator** **Date**

1/27/87
**Division Chief**
Richard B. Berg

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR86-3

**Project Name:** INVESTIGATION OF DISPLACEMENT HISTORIES ON NEOGENE FAULTS IN THE NORTHERN BASIN AND RANGE PROVINCE

**Principal Investigator:** Michael Stickney

**Other Personnel:** Mervin J. Bartholomew

**Project Description:** Trenches across six faults to record features indicative of movement. Will attempt to date movement.

**Project Status:** Field work completed in 1986; trench log to be ready for review by December, 1987.

**Completion Date (mo./yr):** December 1988

**Final Product:** Trench logs to be published by MBMG.

**Funding Source:** Grant 1986; 56 thereafter

Michael Stickney 11/27/87
**Principal Investigator** **Date**

11/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR86-4

**Project Name:** RADIOMETRIC AGE OF QUATERNARY DEPOSITS

**Principal Investigator:** Sharon Lewis

**Other Personnel:** Gail Russell

**Project Description:** Dating of Quaternary deposits less than 300,000 years of age using U/Th techniques (done in conjunction with Dr. Gail Russell of the University of Southern Mississippi) using an alpha spectrometer.

**Project Status:** Field work completed in 1986; initial ages determined by January, 1987.

**Completion Date (mo./yr):** Final analyses to be completed by July 1987; manuscript ready for review by December, 1987.

**Final Product:** Article for journal publication.

**Funding Source:** Montana Tech Research Grant 1986; 56 thereafter.

Sharon E. Lewis 1/27/87
**Principal Investigator** **Date**

1/27/87
**Division Chief**
Richard B. Berg

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR86-5

**Project Name:** DETERMINATION OF DIAGENETIC FEATURES USING SCANNING ELECTRON MICROSCOPE ANALYSIS

**Principal Investigator:** Edith Wilde

Other Personnel: Jannette L. Downey (co-investigator)

Project Description: Will examine samples from the Fox Hills Formation of eastern Montana that are at different diagenetic grades.

Project Status: Project completed June, 1986; results presented at AAPG meeting in Sept 1986; manuscript in preparation.

Completion Date (mo./yr): Manuscript ready for review by June, 1987.

Final Product: An article for a professional journal.

Funding Source: Montana Tech Research Grant.

Jannette L. Downey 1/27/87
Principal Investigator Date

1/27/87
Division Chief

Director Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR86-6

**Project Name:** NATURE OF ORE DEPOSITS OF THE BOULDER BATHOLITH REGION, SOUTHWESTERN MONTANA

**Principal Investigator:** Robert Derkey

**Other Personnel:** Hiroharu Matsueda

**Project Description:** Investigation of geology of Boulder batholith related mineralization. Distinguishing Boulder batholith mineralization from Tertiary mineralization. Physiochemical conditions during formation of Boulder batholith related mineralization. Economic potential of the Boulder batholith region.

**Project Status:** First year field investigations completed. Additional field studies planned. Microproble and fluid inclusion data from Dr. Matsueda will control date of first formal publication. Talk planned for summer 1987.

**Completion Date (mo./yr):** On-hold pending results.

**Final Product:** Dependent on analytical data.

**Funding Source:** MBMG

Robert E. Derkey 1-27-87
**Principal Investigator** **Date**

1/27/87
**Division Chief**

**Director** **Date**

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. GMR87-1

**Project Name:** STRATIGRAPHY AND SEDIMENTOLOGY OF COAL-BEARING STRATA IN MONTANA: A SYNTHESIS.

**Principal Investigator:** Mark Sholes

**Other Personnel:** Susan Foster

**Project Description:** This project is aimed at bringing together a number of current studies of geology related to coal in eastern Montana and to provide a basic reference on the coal-bearing rocks. Data presentation will be emphasized so that the publication will retain its usefulness. Volume will include a major paper by Sholes.

**Project Status:** Abstracts due 2/28/87; papers due 5/31/87; reviews completed 8/31/87; revisions completed 11/31/87.

**Completion Date (mo./yr):** Anticipated submittal date 2/28/88

**Final Product:** Coal synthesis volume

**Funding Source:** 56

Mark Sholes 1/27/87
**Principal Investigator** **Date**

**Division Chief**

**Director** **Date**

Fiscal Year 1986-1987

# MBMG - Hydrology Division Activities Summary

Personnel:

Butte - Miller, Sonderegger, Bergantino, Patton, Schmidt, Zaluski, Schofield, Duaime, Moore, Middelstadt, Sholes and McManus (12), plus 2 to 5 students.

Billings - Van Voast, Donovan, Reiten, Lalley, and Donato (5), plus 1 to 2 students.

Kalispell - Noble, plus 1 part-time student.

Programs: (5)

A. PUBLIC SERVICE AND SPECIAL ASSISTANCE PROGRAM (Shared by entire Division staff).

1. Technical services to local, county, state and federal organizations.

2. Membership and technical assistance to Boards, Councils, Commissions, Task Forces and Advisory Committees.

3. Special investigations which typically requires some field and/or office work with data evaluation and interpretation.

4. Support and cooperate with other divisions and departments of the Bureau and College.

B. GROUND-WATER INFORMATION CENTER (Patton, Schofield, Sholes, Bergantino - with input from entire staff).

1. Office Program

a. Basic data services.

b. Library services - repository for State's water resource information, particularly relating to groundwater.

c. Compilation services (requests for selected maps, tables, and other retrievals)

d. Maintain and improve existing data bases and gradually develop other specific data bases in the future.

2. Field Program
At the present time there is no funded data collection program, however, all pertinent data collected from ongoing MBMG and USGS investigations are entered into the Center.

C. HYDROGEOLOGICAL INVESTIGATIONS PROGRAM

1. Current Projects (23)

a. Montana map atlas project - geology and hydrogeological derivative sheets - 1 x $2^{o}$ sheets (MBMG plus selected data obtained from all investigations are entered into GWIC) Bergantino, Schofield, and entire division staff.

b. Expanded statewide Groundwater Information Center (DNR&C-Water Development and RIT) Patton, Schofield, Bergantino, Miller.

c. Hydrologic monitoring Upper Poplar River Basin (Daniels Co. Cons. Dist., Geol. Survey, DNR&C-Water Development) Schmidt, Sholes, Sonderegger, Miller.

d. Coal lands-hydrologic monitoring, Southeast Montana (Rosebud and Big Horn Co. Cons. Dist., Coal Board) Van Voast, Reiten, Lalley.

e. Coal-mine spoils salinity (Bureau of Land Management) Van Voast, Reiten, Lalley.

f. Irrigation from abandoned coal mines near Roundup - Preliminary investigation (Water Resources Center, Irrigation Districts) Reiten, Van Voast, Lalley.

g. Northeast Montana groundwater investigation (Sheridan Co. Cons. Dist., DNR&C-Water Development & 223 Program, Geol. Survey) Donovan, Bergantino.

h. Groundwater Resources of the Fort Peck Reservation (Bureau of Indian Affairs) Donovan, Bergantino.

i. Investigation of ice marginal and buried preglacial channels, north central Montana (Bureau of Land Management, Geol. Survey) Patton.

j. Hydrogeology of the Turner-Hogeland area, northern Blaine Co. (Blaine Co. Cons. Dist., DNR&C – 223 funds) Patton.

k. Proposed Sage Creek coal (North Fork of Flathead) project - Mine Development Committee (International Joint Commission, Governor's Office) Sonderegger.

l. Characterization of suspended sediment and baseline conditions - North Fork of Flathead River (Flathead Co. Commissioners, Coal Board, University of Montana) Noble, Sonderegger.

m. Hydrogeological evaluation of Stockett Sand Coulee Area (Department of State Lands, Montana Salinity Control Association) Zaluski, Van Voast, Moore, Osborne.

n. Hydrogeology of Colorado tailings - Silver Bow County (Department of State Lands) Duaime, Sholes, Moore.

o. Berkeley Pit mine flooding - hydrological monitoring and evaluation (Butte-Silver Bow, Geol. Survey) Duaime, Sonderegger.

p. Enhanced flooding of the Berkeley Pit - solution or asking for touble? (Montana Tech) Zaluski,

q. Toxic-metal contamination in Upper Deer Lodge Valley (Headwaters RC &D, Powell and Deer Lodge Co. Cons. Dist., Soil Conservation Service, DNR&C-Resource Indemnity Trust) Sonderegger, Duaime.

r. Heavy-metal contamination in the Butte area (Environmental Protection Agency, Butte-Silver Bow, Department of State Lands) Duaime, Schmidt, Sholes, Moore.

s. Mineralogy and phosphorus absorption properties of clay sediments in the Flathead River drainage (Water Resources Center, University of Montana) Noble, Sonderegger.

t. Iron and iron bacteria in Montana groundwater (Water Resources Center) Donovan.

u. Effects of plowout on shallow groundwater systems (Stillwater Co. Cons. Dist. DNR&C-Water Development and 223 Program) Duaime, Moore, Miller.

v. Upper Teton aquifer study (Teton Co. Cons. Dist., Ditch companies, City of Choteau, DNR&C-Water Development)Patton, Noble, Schmidt.

w. Montana hydrogeology field program - development of aquifer test facility (Western Energy, Montana Tech) Zaluski, Schmidt.

2. Projects and Reports Recently Completed (17) - Current Biennium

a. Little Bitterroot Valley groundwater investigation (Dept. of Energy) Donovan

Products: Hydrogeology and geothermal resources of the Little Bitterroot Valley, northwestern Montana: MBMG Memoir 58,60p.

b. Montana Map Atlas project - geology and hydrogeological derivative sheets 1 x $2^{o}$ (MBMG) Bergantino.

Products: 1) Preliminary geologic map of the Jordan 1 x $2^{o}$ quadrangle, northeastern Montana: MBMG OFR 170.

2) Prequaternary geology of Wolf Point 1 x $2^{o}$ quadrangle northeastern Montana: MBMG OFR 171 (Part of the NE Montana groundwater study).

3) Quaternary geology of Wolf Point 1 x $2^{o}$ quadrangle, northeastern Montana: MBMG OFR 172 (Part of the NE Montana groundwater study).

4) Quaternary geology of the eastern half of Glasgow 1 x $2^{o}$ quadrangle, northeastern Montana: MBMG OFR 179 (Part of the Fort Peck Reservation groundwater project).

5) Prequaternary geology of the eastern half of Glasgow 1 x $2^{o}$ quadrangle,northeastern Montana: MBMG OFR 180 (Part of the Fort Peck Reservation groundwater project.

c. Northeastern Montana groundwater study (Sheridan Co. Cons. Dist., DNR&C-Water Development and 223 Program, Geol. Survey) Donovan, Bergantino.

Products: 1) Preliminary report: Northeast Montana groundwater study: DNR&C, 30p. (Donovan).

2) Altitude of the top of the Bearpaw Shale, Judith River Formation, Basal Colorado sandstone, and Kootenai Formation; Wolf Point 1 x $2^{o}$ quadrangle; MBMG OFR 173, 174, 175, 176; 4 sheets (Bergantino).

d. Fort Peck Reservation ground-water project (Bur. of Indian Affairs) Donovan, Bergantino.

Products: 1) Groundwater resources of the Fort Peck Indian Reservation, with emphasis on aquifers of the preglacial Missouri River Valley: MBMG OFR 178; 3 maps, 68p. (Donovan, Bergantino).

2) Altitude of the top of the Judith River Formation, Claggett Shale, Basal Colorado sandstone, and Kootenai Formation; Glasgow 1 x $2^{o}$ quadrangle; MBMG OFR 181, 182, 183, 184; 4 sheets (Bergantino).

e. Groundwater Information Center and Regional Aquifer Map Project (EPA).

**Products:** 1) Quality of groundwater in Montana; 1:1,000,000; MBMG OFR 154; 6 sheets (Bergantino, Sholes, Schofield).

2) Expected yield (gpm) for wells in Montana; 1:1,000,000; MBMG OFR 155; 6 sheets (Bergantino, Sholes, Schofield).

3) Structure contour map of the top of Precambrian crystalline rocks, Montana; 1:1,000,000; MBMG OFR 158 (Bergantino, Clark).

4) Structure contour map of the top of Madison Group, Montana; 1,500,000; MBMG OFR 159, 2 sheets (Bergantino).

f. Groundwater quality and soluble salt-loads in overburden and spoils (Bur. of Land Management) Van Voast, Reiten.

Products: 1) Groundwater reaction to surface coal mining in semiarid lands; in"Proc. Second Int. Congress of International Mine Wtaer Assoc., Granada, Spain, p. 861-873 (Van Voast).

2) Groundwater changes associated with surface-coal mining in northern Powder River Basin; in Innovative approaches to reclamation, Southern Illinois Press, Carbondale (Van Voast and Reiten).

g. Develop data adequacy standards for Powder River Basin (Bur. of Land Management, Powder River Regional Coal Team Task Force).

Products: 1) Hydrologic data standards: in proposed data adequacy standards for the Powder River Coal Region; Powder River Regional Coal Team Task Force, Cheyenne, Wy. (Van Voast).

h. Potential hydrologic effects of proposed coal mining - North Fork Flathead River (Water Resources Center).

**Products:** 1) Some hydrologic aspects of proposed coal mining - North Fork Flathead River, NW Montana and SE British Columbia, 35p. MBMG OFR 152 (Noble, Van Voast, Sonderegger).

i. Groundwater resources - north of Flathead Lake (DNR&C-RIT, U. of Montana).

Products: 1) Groundwater resources and water quality of the unconfined aquifers in the Kalispell Valley, 112p. MBMG OFR 177 (Noble and Stanford).

j. Groundwater seepage - Whitefish Lake area (Whitefish Water & Sewer Dist., Univ. of Montana).

Products: 1) Investigation of septic contaminated groundwater seepage as a nutrient source to Whitefish Lake, Montana; 40p.; Flathead Lake Biological Station, Open-File Report (Jourdonnais and Noble).

k. Upper Poplar River Basin Monitoring Program (Daniels Co. Cons. Dist., Geol. Survey, Coal Board).

Products: 1) Montana monitoring results north of Scobey, related to Coronach, Saskatchewan coal-fired generating facility, in Int. Joint Comm. 1985 Annual Report (Schmidt, Sholes, Sonderegger, Miller).

l. Reconnaissance evaluation of preglacial aquifer in north central Montana (Water Resources Center, Bur. Land Management).

Products: 1) Identification of glaciofluvial and buried preglacial aquifers as a source of water - north central Montana: 67p.; Montana Water Resources Center Report No. 151 (Patton and Colton).

m. Reconnaissance investigation of alluvial aquifers along Sage Creek for rural water supply (Sage Creek Rural Water Assoc.).

Product: 1) Sage Creek Alluvial aquifer test, Liberty Co. Montana; 42p.; MBMG OFR 157 (Osborne and Zaluski).

n. Dryland salinity investigations in the Geraldine area (Choteau Co. Cons. Dist, DNR&C-RIT and 223, Dept. of State Lands, City of Geraldine, Montana Salinity Control Assoc.).

Products: 1) Saline-seep assessment of Geraldine, Montana and surrounding area; 127p.; MBMG OFR 169 (Duaime, Moore, Holzer and Hockett).

2) Hydrogeologic controls on saline-seep development, Geraldine, Montana; in Third Canadian Hydrogeological Conference, Saskatoon, April, 1986 (Duaime, Moore, Harrison, Holzer).

o. Reclamation techniques for heavy metal contaminated pastures in Deer Lodge Valley - preliminary evaluation (Deer Lodge & Powell Co. Cons. Dist., Coop. Ext. Service, DNR&C-223).

Products: 1) Metal and arsenic distribution in soils and soil water of contaminated pasture land adjacent to Silver Bow Creek; 35p.; MBMG OFR 166 (Osborne, Duaime, Moore).

p. Hydrogeology of Colorado tailings, Silver Bow County, Montana (Dept. of State Lands).

Products: 1) Hydrogeology of Colorado Tailings; in Proceeding - Clark Fork River Symposium: 1986 Mont. Academy of Sciences, p 4-20 (Duaime, Sonderegger, Zaluski).

q. Arsenic contamination in the vicinity of Three Forks, Montana (City of Three Forks).

Products: 1) Irrigation related arsenic contamination of a thin alluvial aquifer, Madison Valley Montana; Environmental Geology and Water Sciences Journal: in press (Sonderegger).

3. Potential Projects (10)

a. Mobility of agricultural chemicals in soils and shallow groundwater aquifers. (MSU, Geol. Survey, DNR&C-Water Dev.).

b. Turner-Hogeland irrigation and aquifer study (Blaine Co. Cons. Dist., Soil Cons. Service, Turner-Hogeland Water Users, DNR&C-Water Devevelopment).

c. Yellowstone County groundwater study (Yellowstone Co. Cons. Dist., Yellowstone Co. Commissioners, DNR&C-Water Development).

d. Coal land groundwater monitoring (Rosebud and Big Horn Co. Cons. Dist., DNR&C-Water Development).

e. Little Bitterroot Valley recharge enhancement and conservation (Sanders Co. Cons. Dist., Irrigation Dists., DNR&C-Water Development).

f. Satellite groundwater data network (Toole, Sheridan, Lake Co. Cons. Dist., DNR&C-Water Development).

g. Reserve pit and oilfield brine disposal assessment (Sheridan Co. Cons. Dist., Soil Conservation Service, DNR&C-RIT).

h. Berkeley Pit reindustrialization and mineral recovery (Headwaters RC&D, Headwater Research Institute, Geol. Survey, DNR&C-RIT).

i. Groundwater from abandoned mine workings for irrigation and instream flows, (Lower Musselshell Co. Cons. Dist., Water Resources Center, Geol. Survey, Soil Cons. Service, Deadman's Basin Water Users Assoc., DNR&C-RIT).

j. Deep aquifer data base-groundwater information center.

D. MBMG-USGS GROUNDWATER COOP PROGRAM

1. Current Projects

a. Berkeley Pit water flooding - surface-water aspects.

b. Geohydrologic mapping on 1 x $2^{o}$ quadrangles (to supplement the Montana Map Atlas project).

c. Deer Lodge Valley groundwater investigation.

d. North Fork of Flathead River - stream gaging and sediment monitoring.

e. Statewide observation well network (Continuous).

f. Special investigations (Continuous).

2. Projects Recently Completed (5) - Current Biennium

a. Water resources of the Clark Fork Yellowstone River Valley, Montana: MBMG-HM 8 (Levings).

b. Water resources of the Big Hole Basin, southeastern Montana: MBMG-M59; 72p. (Levings).

c. Groundwater-surface water relationship in the Flathead Valley near the proposed Cabin Creek coal mine, British Columbia: USGS OFR 87-28, 20p. in review (Moreland, Liebscher, Van Voast, Feltis).

d. Appraisal of water resources of the Boulder and Stillwater River basins, including the stillwater Complex, south-central Montana: MBMG Memoir _____ in review. (Feltis, Litke).

e. Records of wells and water-level fluctuations from the statewide observation-well network in Montana through 1985: USGS OFR 86-528, 221p., (Johnston and Dodge).

E. UNIVERSITY SYSTEM EDUCATIONAL AND SERVICE PROGRAM

1. Formulation and development of a hydrogeological program at Montana Tech.

a. Teaching - classroom, laboratory and field courses.

b. Assistance and support to graduate and undergraduate students.

2. Assistance to other units of Montana University System - particularly University of Montana and Montana State University.

   a. Special lectures, field trips, workshops and graduate student support.

   b. Data exchange.

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY E
No. BMG-14

Project Name: EDUCATIONAL ASSISTANCE TO MONTANA UNIVERSITY SYSTEM

Principal Investigator: Marek Zaluski

Other Personnel: Hydrology Division staff as needed.

Project Description: The Hydrogeological Specialization has been developed for the Geological Engineering Department of Montana Tech by the staff of the Hydrology Division of the MBMG. One hydrogeological course has been taught prior to 1983. At present, eight courses in hydrogeology at both undergraduate and graduate levels, are taught by the combined staff of the Department and the Hydrology Division. Equipment of MBMG, including a drilling rig and geophysical logger are available for students. They use it mainly during a summer Field Hydrogeology Course which is taught in cooperation with the University of Montana. The Hydrogeological program is one of the fastest growing at Montana Tech. At present, 9 graduate students are enrolled in the program and more than 10 additional students take courses at the undergraduate level. This is the only comprehensive Hydrogeological Specialization offered within the Montana University System. The growing trend of this specialization reflects increasing needs of the State of Montana for hydrogeologists, and needless to say, also an extremely absorbing job market nationwide.

Project Status: Ongoing

Completion Date (mo./yr.): N.A.

Final Product: N.A.

Funding Source: Montana Tech Geological Engineering Department and Montana Bureau of Mines and Geology

Marek Zaluski 1/27/17
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY D
No. BMG-22, (Joint Funding Agrmt.)

Project Name: MBMG-USGS GROUNDWATER COOPERATIVE PROGRAM

Principal Investigator: Marvin R. Miller - MBMG; Joe Moreland - USGS

Other Personnel: Staff primarily comes from USGS, Water Resources Division, Montana District

Project Description: the major tasks accomplished or being accomplished under this program are investigating groundwater resources in poorly studied or unstudied areas and assisting in the development and maintenance of a Statewide basic water-data collection network. Studies initiated through this cooperative program include:

1) Inventory of wells, springs, and groundwater withdrawals to provide data on the groundwater resources of the state.

2) Publication of reports, maps, tables, and diagrams showing aquifers, water-level changes, changes in water quality and areal extent, and average water yield of aquifers.

3) Specific projects such as the Deer Lodge Valley Groundwater Study; hydrogeologic mapping on 1o x $2^{o}$ quadrangles; the statewide observation well network; stream gaging on Silver Bow Creek and the North Fork of the Flathead River; and groundwater assessments for particular communities.

Project Status: Ongoing - projects are usually one to three years in duration and are generally published by MBMG.

Completion Date (mo./yr.): Variable, depending on project.

Final Product: Published reports; Open File information; entry of data in state and national data bases; and technical letters.

Funding Source: Primarily from MBMG and USGS with other state and federal support depending on project.

Marvin R. Miller 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-a
NO. BMG-19

Project Name: MONTANA ATLAS SERIES

Principal Investigator: R. N. Bergantino

Other Personnel: B. Sholes, J. Schofield, students, other professionals.

Project Description: The Montana Atlas Series is a means to show the geology, groundwater resources, and mineral resources of the State of Montana at a uniform scale of 1:250,000 on 1 degree by 2 degree quadrangles. The quadrangles when completed will serve as the base for new State maps (1:500,000 scale) of these topics. The maps are compiled primarily from existing information, making especial use of the latest information and ideas in these disciplines. Some field mapping is done where necessary to fill data gaps.

Project Status: Continuing

Completion Date (mo./yr.): N.A.

Final Product: Geologic, groundwater, and mineral resource maps of Montana at 1:250,000 scale (1 degree by 2 degree)

Funding Source: MBMG funds.

Robert N Bergantino 26 January 1987
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-b
NO. R/C - 81 BMG-12

Project Name: STATEWIDE GROUND WATER INFORMATION CENTER

Principal Investigator: Thomas W. Patton/Marvin Miller

Other Personnel: Brenda Sholes--Data Base Technician, Jan Downey--Data Base Technician, and Judeykay Schofield--Programmer.

Project Description: This is an effort to organize and disseminate information about Montana's groundwater resources. The MBMG has been struggling to automate its groundwater data base for 10 years, but has always been hampered by lack of both computer facilities and personnel to tackle the job. The Water Development portion of this project will alleviate the lack of data processing equipment and the Resource Indemnity Trust funding will temporarily support personnel to do a portion of the work. The tasks of the project are to : purchase and install computer and data base management systems; design and structure the datas bases; design public views to the data; organize a data set task force; design procedures to feed data to the Ground Water Information Center; hire personnel to complete the work; and produce basic data and other reports for the DNRC.

Project Status: Ongoing--computer system installed and data base conversion is in progress.

Completion Date (mo./yr.): July, 1988

Final Product: Operational Data Management System for handling Montana's groundwater data. Basic data reports for selected counties.

Funding Source: Water Development and Resource Indemnity Trust Grant Programs. MBMG matching commitment.

Thomas W. Patton 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-c
NO. R/C - 163 BMG-25

**Project Name:** POPLAR RIVER MONITORING

**Principal Investigator:** Fred Schmidt

**Other Personnel:** John Sonderegger, Herman Moore, Brenda Sholes

**Project Description:** In 1974, Saskatchewan Power Corporation announced plans for a coal fired power plant about 5 miles north of the International Boundary. During construction phase of the facilities, an International Water Quality Board was established to deal with potential water-quality problems. Recommendations were made by the board, and a Bilateral Monitoring Committee was later established to direct and coordinate monitoring activities.

This project is to conduct the groundwater and surface-water monitoring for the Montana portion of this program.

**Project Status:** This is a continuous program since 1978, dependent upon a source of funding.

**Completion Date (mo./yr.):** June, 1988 for current funding

**Final Product:** Report on potential impacts.

**Funding source:** DNRC Water Development Grant Program

Principal Investigator 1-30-86 Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. HY C-1-d
R/C - 164

Project Name: COAL LANDS HYDROLOGIC MONITORING

Principal Investigator: Wayne Van Voast

Other Personnel: Jon Reiten and Joe Lalley

Project Description: Over a period of 15 years of hydrologic research into the effects of surface coal mining on groundwater in southeastern Montana, a hydrologic monitoring program evolved. The program, utilizing more than 200 observation wells in and near the active mines, consists of monthly water-level measurements at all wells and semiannual water-quality analyses at selected wells. Water levels are being seen to change strongly in response to mining of coal-bed aquifers; water-quality changes consist of 2- to 4-fold increases in dissolved solids, rendering most mine water unusable for stock, irrigation, or domestic purposes. A major objective of the monitoring program is to learn how creation of "mine-floor aquifers" can enhance the improvement of water quality, making mine waters useable.

Project Status: Ongoing; final report to be submitted by May 30, 1987.

Completion Date (mo./yr.): May 30, 1987; New funding applied for.

Final Product: Text, maps, hydrographs of findings

Funding Source: Montana Coal Board

Wayne Van Voast 1-27-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. HY C-1-e
R/C - 159

Project Name: MINE SPOILS SALINITY

Principal Investigator: Wayne Van Voast

Other Personnel: Jon Reiten, Joe Lalley

Project Description: Ground-water-quality changes caused by surface coal mining in southeastern Montana can be predicted during mine planning stages if adequate data on overburden salinity and other hydrologic conditions are available. During mine planning, analyses of overburden salinities are required to be submitted with mine-permit applications. These data are required for revegetative predictions, but can also be useful for predicting post-mining ground-water quality. Under this project, column leach experiments are conducted to improve ways of interpreting the overburden salinity data for hydrologic uses. Also, regional and stratigraphic distributions of soluble salts in overburden are being examined.

Project Status: Ongoing; final report due by July 1, 1987.

Completion Date (mo./yr.): June 1, 1987.

Final Product: Maps, graphs, tables, text of data and interpretations.

Funding Source: U.S. Bureau of Land Management

Wayne Van Voast 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. HY C-1-f

Project Name: IRRIGATION WATER FROM ABANDONED COAL MINES NEAR ROUNDUP

Principal Investigator: Jon Reiten

Other Personnel: Wayne Van Voast, Joe Lalley

Project Description: Underground coal mines near Roundup were abandoned in the 1950's and 60's, leaving potentially large- volume underground reservoirs of water. Most of the mines likely have good hydrologic connection with alluvium along the Musselshell River, and depending on degree of mine interconnection may contain as much as 11,000 acre-ft of groundwater that has an apparent satisfactory quality for irrigation. In 8 out of 10 years the Musselshell River downstream from Roundup cannot satisfy irrigation demands after the month of June, so this possible new development is considered important. Project objectives are to participate with the Lower Musselshell Conservation District in experimental pumping to determine, effects on the river and on other ground-water supplies, and recharge rates to the mines.

Project Status: Begun August, 1986; instrumentation installed and preliminary pumping in progress.

Completion Date (mo./yr.): April, 1988

Final Product: Graphs, tables, data, interpretations.

Funding Source: Montana Bureau of Mines and Geology, and Montana Water Resources Center

Jon Reiten 1/26/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-g
No. R/C - 169

Project Name: NORTHEAST MONTANA GROUNDWATER STUDY

Principal Investigator: Joseph J. Donovan

Other Personnel: Bureau of Mines and Geology Field Support

Project Description: This is a comprehensive groundwater resource evaluation of the Northeast Montana region. The study area is the Wolf Point $1^{o}$ x $2^{o}$ 1:250,000 quadrangle, including all of Montana north and east of the vicinity of Oswego. The reconnaissance phase of the investigation involves compilation of existing water well and water quality data, with verification and sampling of groundwater sources in areas of limited data. The detailed phase of the investigation involves test drilling, aquifer test evaluation, and groundwater monitoring within glacial outwash and alluvial (pre-glacial Missouri River) gravel aquifers of potentially high capacity for agricultural and industrial development. One of these aquifers, the Westby-Dagmar aquifer, is the source of approximately 5,000 acre-feet/year of new irrigation development over the past 7 years. The project has been coordinated by five conservation districts (Daniels, Dawson, McCone, Roosevelt, and Sheridan) under management of the Sheridan County Conservation District.

Project Status: Second and final phase, began September 1, 1986.

Completion Date (mo./yr.) June, 1988

Final Product: Quaternary geologic, and pre-Quaternary geologic maps of the Wolf Point $1^{o}$ x $2^{o}$ Quadrangle. Maps showing altitudes of tops of several important aquifers and aquicludes such as the Bearpaw Shale, Judith River Formation, Basal Colorado Sandstone, and the Kootenai (Fuson) Formation. An interpretive MBMG report.

Funding Source: DNRC Water Development Grant Program, U.S. Geological Survey, and Montana Bureau of Mines and Geology.

Joe Donovan 7/27/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

No. HY C-1-h

Project Name: GRCUNDWATER RESOURCES OF THE FORT PECK INDIAN RESERVATION

Principal Investigator: Joseph J. Donovan/Robert N. Bergantino

Other Personnel: None

Project Description: This project focuses on the shallow- and intermediate-depth groundwater resources of the Fort Peck Indian Reservation. Special emphasis is given to the groundwater potential of deposits in the pre-glacial channel of the Missouri River between Poplar and Muddy Creek. Aquifers are evaluated with respect to both water availability and water quality. Information on the deeper aquifers which do not contain potable water is summarized. Basic data on wells and water quality collected during the study were compiled and tabled to provide specific detailed information on groundwater resources of the reservation.

Project Status: Completed except for some drafting and revision.

Completion Date (mo./yr.) January, 1987

Final Product: MBMG Open File Report 178, a report on the geology and groundwater resources of the reservation with three maps showing water quality, geologic formation, and selected well data for the reservation at a scale of 1:126,720.

Funding Source: Bureau of Indian Affairs - MBMG matching funds.

Robert N Bergantino 26 Jan 87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-i
NO. R/C-92 BMG-18
CO-OP AGRMT.
950-CA5-03

**Project Name:** IDENTIFICATION OF GLACIOFLUVIAL AND BURIED PREGLACIAL AQUIFERS

**Principal Investigator:** Thomas W. Patton

**Other Personnel:** Roger B. Colton - U.S.G.S., Denver, Colorado

**Project Description:** This project continues the exploration of the Havre and Harlem 30' x 60' quadrangles started with the Water Resources Center R/C-131 Buried Channel project. The Bureau of land Management controls a large percentage of the land in the study area and manages grazing on these lands. The possibility of developing groundwater supplies in the many glaciofluvial and buried preglacial drainage features of the study area caused them to provide funds to drill exploratory holes in selected drainage features. To date approximately 18 drill holes constructed during the project have encountered water of usable quality.

The users of the information will be the BLM who is funding the work. The MBMG is participating in the project under its mandate to collect and disseminate information about Montana's groundwater. Local citizens will find the information provided by this project useful in attempting to develop their own groundwater supplies within the study area.

**Project Status:** Ongoing - drilling of additional selected drainages will be completed summer of 1987.

**Completion Date (mo./yr):** September, 1988

**Final Product:** Report and maps to BLM - MBMG publication

**Funding source:** BLM/MBMG Cooperative Agreement 950-CA5-03

Thomas W. Patton 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-j
No. BMG-17 R/C - 90

Project Name: HYDROGEOLOGY OF THE TURNER-HOGELAND AREA NORTHERN BLAINE COUNTY, MONTANA

Principal Investigator: Thomas W. Patton

Other Personnel: Student assistants and technicians as needed.

Project Description: This project developed as a response to a need by the Department of Natural Resources and Conservation to monitor groundwater level response to expanding irrigation development supported by the Turner-Hogeland aquifer. About 7,800 acres of irrigation are supported by the aquifer making it one of largest acreages of groundwater supported irrigation in Montana. Very serious limitations to recharge to the aquifer make the monitoring necessary and require detailed water table, bedrock surface, saturated thickness, and hydrogeologic parameter definition for the aquifer. Falling water levels in 1984-85, prompted a preliminary report to the citizenry of the study area in February, 1986. Heeding the warning, the irrigators of the Turner-Hogeland area formed the Big Flat Water Users Association to plan reductions in water taken from the aquifer during the 1986 and later growing seasons. Preliminary information from this study is available to the local management group upon request.

Project Status: Ongoing - data collection 50% complete. Need additional funding to define aquifer parameters to construct groundwater model. Preliminary presentation of water level and precipitation data given at public meeting in February, 1986.

Completion Date (mo./yr.): December, 1987 for present phase.

Final Product: Maps and report detailing groundwater conditions in the Turner-Hogeland aquifer.

Funding Source: Conservation District 223 funds - MBMG matching funds.

Thomas W. Patton 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. HY C-1-k

Project Name: PROPOSED SAGE CREEK COAL PROJECT - NORTH FORK OF THE FLATHEAD RIVER - I.J.C. MINE DEVELOPMENT COMMITTEE

Principal Investigator: John Sonderegger

Other Personnel: Mel Grangerg (OSM), Neil Harrington (DSL); Jake McDonald (B.C. Ministry of Energy, Mines and Petroleum Res.), Mark Strosher (B.C. Ministry of Environment and Parks), Hugh Liebscher (Environment Canada)

Project Description: The committee was requested to provide the Flathead River International Study Board with mine site and design information for proposed coal mine. Sonderegger was assigned the off-site flux evaluation of water, dissolved constituents and elemental particulate loadings. Sonderegger and Liebscher co-authored the section on hydrogeology; Sonderegger wrote all of Chapter 5, Parameters, Concentrations, Loadings and Fluxes, except the subsection on suspended solids. The manuscript underwent several substantial revisions to meet the needs of other committees established by the Board. Additionally, the report had to have full and complete endorsement, by all committee members, of the entire report content.

Project Status: Essentially Complete - report still in review by the Board.

Completion Date (mo./yr.): March, 1987

Final Product: A 172-page report (plus references and technical appendices) which will be released to the public in 1987.

Funding Source: Travel and per diem were provided by the Governor's Office. My time was donated by the Bureau to the Governor's Office.

John Sonderegger 1/30/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-1
No. R/C - 124

Project Name: CHARACTERIZATION OF SUSPENDED SEDIMENT AND BASELINE CONDITIONS RELATED TO THE PROPOSED CABIN CREEK COAL MINE IN THE HEADWATERS OF THE NORTH FORK OF THE FLATHEAD RIVER

Principal Investigator: Roger A. Noble

Other Personnel: John L. Sonderegger and Jack Stanford

Project Description: This assessment is intended to provide a pre-mining interpretation of water quality dynamics and suspended sediment composition related to the proposed Cabin Creek Coal mine in the North Fork of the Flathead River. The assessment will also determine the mine-spoil geochemistry which will likely result as mining activities issue. A sampling network has been designed so that the results will show the influence of mining areas upon the present water quality and stream-sediment composition. In general, the objective of this assessment is to provide information that would be needed to prevent unnecessary degradation of water resources as a result of mining. The data from the assessment will be compatible with goals of the Flathead Basin-wide Master Plan for long-term monitoring of water quality. The Montana Bureau o f Mines and Geology is serving as the lead agency and is responsible for the overall direction of the impact assessment. The assessment is a cooperative effort with the Flathead Lake Biological Station and the U.S. Geological Survey, blending hydrogeological, limnological, and hydrological expertise. It is expected that the output will provide answers to solve and/or mitigate many of the water quality problems that could result from mining operations.

Project Status: The project is 50% complete and is entering its second year.

Completion Date (mo./yr.): December, 1987

Final Product: MBMG publication

Funding Source: Montana Coal Board

Roger A. Noble 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-m
NO. R/C 79

**Project Name:** ACID MINE DRAINAGE CONTROL IN THE SAND COULEE CREEK AND BELT CREEK WATERSHEDS, CASCADE COUNTY, MONTANA

**Principal Investigator:** Marek H. Zaluski, Thomas J. Osborne

**Other Personnel:** Wayne A. Van Voast, Herman Moore

**Project Description:** The Jurasic age bituminous and sub-bituminous coal deposits found in the Great Falls-Lewistown coal field were extensively mined by underground methods rom the 1880's to the 1950's. The abandoned mines have discharged highly acidic and metal-rich water for decades. The research conducted for the project should determine the impact of hydrogeological conditions on the quality and volumne of water discharged from the abandoned mines. The MBMG has made an attempt to control the discharge of the abandoned mines by experimenting with evapotranspirational control methods using intensive farming. The experiment is in its third year and has yielded certain promising results.

**Project Status:** Ongoing - Field program on schedule, Interim Report overdue

**Completion Date (mo./yr.):** December, 1987

**Final Product:** Bureau publication, interim report to Dept. of State Lands, Journal articles.

**Funding Source:** Montana Department of State Lands

Marek H. Zaluski 1/27/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-n
No. BMG-27 see also
R/C - 101

**Project Name:** HYDROGEOLOGY OF THE COLORADO TAILINGS

**Principal Investigator:** Terence E. Duaime

**Other Personnel:** John L. Sonderegger and Herman R. Moore

**Project Description:** The current project is an extension of the 1982 Monitoring and Reclamation Alternatives presented to DSL. The previously established groundwater monitoring network has been maintained with minor additions made. Monthly water levels, specific conductance, and temperature readings continue to be collected as well as limited water quality sampling. All of the collected data have been used to establish existing or background conditions in the tailings area.

Collected data has been used for reclamation design and by state and federal investigators participating in the Clark Fork River Super Fund study and the Montana Pole Plant cleanup.

**Project Status:** Active - 95% complete. Reclamation plans on hold pending completion of Silver Bow Creek Super Fund study.

**Completion Date (mo./yr.):** March, 1987

**Final Product:** Report with data presentation of pre-reclamation water quality conditions.

**Funding Source:** Department of State Lands

Terence E. Duaime 11/30/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-0
No. BMG-29 see also
R/C - 184

Project Name: BERKELEY PIT - MINE FLOODING MONITORING

Principal Investigator: Terence E. Duaime

Other Personnel: John L. Sonderegger and Marek Zaluski

Project Description: With the cessation of the underground water pumping in the spring of 1982, local and state concern arose centering on the potential affect on local groundwater and surface-water. Initial funding was used to establish a comprehensive monitoring network of groundwater wells and surface-water sites, in addition to participation in state and company agreed to sampling. The MBMG through its cooperative agreement with the USGS established 3 surface-water gaging locations, which have also been used by state and federal investigators participating in the Clark Fork River Super Fund study.

Currently the MBMG and USGS are maintaining the 3 gaging sites, with the MBMG collecting monthly data from its groundwater wells, and periodically collecting depth (multi-level) samples at selected mine shafts.

All the data will be used to help establish background conditions, and help make predictive assumptions on overall water quality as flooding continues.

Project Status: Active - 85% complete

Completion Date (mo./yr.): July, 1987

Final Product: Written report

Funding Source: 1983-85 H.B. 819; 1985-87 Butte-Silver Bow Government

Terence E. Duaime 11/30/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. HY C-1-p

**Project Name:** ENHANCED FLOODING OF BERKELEY PIT: SOLUTION OR ASKING FOR TROUBLE?

**Principal Investigator:** Marek H. Zaluski

**Other Personnel:**

**Project Description:** In 1982 the Anaconda Minrerals Company suspended pumping of its mining operation in Butte and the eventual result of this action will be a huge reservoir of very acidic water (ph 4?).

The environmental consequences of having this huge pool of acidic water near the city of Butte are not very pleasant, and the impact of this pool may not be predictable. There is no question, however, that the less acidic the water in the pit is the smaller the environmental impact will be.

In this proposal, I want to investigate what would happen if we enhance the flooding of the Berkeley Pit by recharging it using good quality water.

Both problems, quality of water in the pit and its filling time will be addressed by this research; it will use computer modeling as an investigtive tool. This may provide an answer to how the acidity of pit water would change depending on the quality and volume of the water recharging the pit--in adition to the present natural recharge.

**Project Status:** Will be started in the Spring of 1987.

**Completion Date (mo./yr.):** June 30, 1987

**Final Product:** Report

**Funding Source:** Montana Tech

Marek H. Zaluski 11/27/87
Principal Investigator Date

BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-q
NO. R/C - 87

Project Name: RECLAMATION TECHNIQUES FOR HEAVY METAL CONTAMINATED AGRICULTURAL LANDS

Principal Investigator: John Sonderegger

Other Personnel: Terence E. Duaime

Project Description: The Bureau is analyzing the impact of agricultural amendments being tested to re-establish vegetation upon tailings-damaged Deer Lodge Valley soils. The goal of our investigation is to quantify the release and/or retention of toxic constituents from these damaged soils as a result of these different amendment applications and compare them to untreated conditions at the research site. Laboratory studies will be utilized to accelerate the weathering processes. Laboratory results will be compared with field values to predict long-term effects of the agricultural reclamation processes upon the flux of toxic constituents from the damaged soils.

Project Status: Active - detailed study phase initiated October 10, 1986.

Completion Date: September, 1988

Final Product: MBMG report

Funding source: Resource Indemnity Trust Grant program and MBMG matching funds.

John Sonderegger 1/30/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

No. HY C-1-r
R/C - 76 and
R/C - 77

**Project Name:** HEAVY METAL CONTAMINATION IN BUTTE-SILVER BOW

**Principal Investigator:** Terence E. Duaime

**Other Personnel:** Herman R. Moore, Fred A. Schmidt, and Brenda Sholes

**Project Description:** The purpose of this project is to verify the existence and severity of heavy metal contamination at selected locations in Silver Bow County. This is to be accomplished via the collection of soil samples at selected depths within the profile and analyzed for heavy metals (mercury, lead, cadmium, etc.). Soil collection and analysis will also be done at sites from which topsoil will be potentially used for reclamation activities.

Information gleaned will be used in completion of SuperFund studies and local governmental attempts to reclaim recreational facilities.

**Project Status:** Active - 50% complete

**Completion Date (mo./yr.):** July, 1988

**Final Product:** Report with data summary and sampling locations described.

**Funding Source:** Butte-Silver Bow government, Department of State Lands, Department of Health and Environmental Sciences, and U.S. Environmental Protection Agency.

Terence E Duaime 11/30/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-s
No. R/C - 185

Project Name: MINERALOGY AND PHOSPHORUS ADSORPTION PROPERTIES OF CLAY SEDIMENTS IN THE FLATHEAD RIVER DRAINAGE, MONTANA

Principal Investigator: Roger A. Noble

Other Personnel: John L. Sonderegger

Project Description: Many lakes in the United States and elsewhere are undergoing accelerated rates of eutrophication. Reasons for this deteriorating condition can be related to both point and non-point pollution. In some cases, the major non-point source is riverine suspended sediment derived from streambank erosion. This work is directed at evaluating phosphorus transport associated with clay minerals of suspended sediments in the Flathead River Basin. In addition, it will be determined if there exists a difference in total and inorganic phosphorus between riverine and lacustrine sediments. There is a clear need for clay mineral speciation of the streambank sediments in order to understand the type and kinetics of sorption processes involving phosphorus and sediments. The kinetics of phosphate adsorption will also be determined by uptake experiments. This will permit evaluation of the clay mineralogy in relation to phosphorus sorption-desorption capacity. These data will be related to ongoing analyses of the biological availability of sediment phosphorus and will better illuminate inferences about the availability of sediment phosphorus to microbial communities in the rivers and Flathead Lake.

Project Status: Beginning with 1987 spring runoff.

Completion Date (mo./yr.): December, 1987

Final Product: Montana Water Rsources Center report and MBMG Open-File Report.

Funding Source: Montana Water Resources Center

Roger A. Noble 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

NO. HY C-1-t
R/C - 80; WRC 837

Project Name: IRON AND IRON BACTERIA IN MONTANA GROUNDWATER

Principal Investigator: Joseph J. Donovan

Other Personnel:

Project Description: This is an information dissemination project dealing with a problem that is extremely widespread among groundwater users across the state. Iron and iron bacteria act over time to reduce the usability of well water, and in extreme cases cause well failure due to plugging and bacterial fouling. The project has compiled research results and practical remedial techniques from the scientific community, and applied them to the types of iron problems seen in Montana. Major Montana iron-prone aquifers are identified, and the regional distribution of high-iron water is outlined. Both well treatment (to prevent plugging) and water treatment (to remove iron) techniques are identified in practical detail.

Project Status: Completed. Publications in review.

Completion Date (mo./yr.): October 1, 1986.

Final Product: Extension Guide, published as part of Cooperative Extension Service MONTGUIDE series. Comprehensive final project report, to be published by Montana Water Resources Center in pamphlet form.

Funding Source: Montana Water Research Center

Joe Donovan 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-u
No. R/C 125

**Project Name:** IMPACTS ON WATER QUALITY FROM PLOWOUT AND SALINE-SEEP RECLAMATION PRACTICES, STILLWATER COUNTY, MONTANA

**Principal Investigator:** Terence E. Duaime

**Other Personnel:** Herman R. Moore and Marvin R. Miller

**Project Description:** The project is located in northern Stillwater county mainly within the Hailstone and Wheat Basins.

The investigation has two main objectives: 1) Documenting whether saline-seep impacted surface and groundwaters improve, stay constant, or degrade over time once surface reclamation practices are undertaken; and 2) document whether the application of saline-seep control (reclamation) measures applied to newly broken lands (sod busting), prevents or lessens the quality degradation of surface and groundwaters.

**Project Status:** 45% complete

**Completion Date (mo./yr.):** January, 1988

**Final Product:** Written report.

**Funding Source:** Stillwater Conservation District, Beartooth RC&D, Department of Natural Resources and Conservation, Soil Conservation Service, and Department of Health and Environmental Sciences.

Terence E Duaime 11/30/87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-v
No. R/C - 117

Project Name: UPPER TETON AQUIFER STUDY

Principal Investigator: Thomas W. Patton/Roger N. Noble

Other Personnel: Thomas Osborne - Central Wisconsin Groundwater Center

Project Description: Contention between local property owners over surface- and ground- water rights in the vicinity of Choteau, Montana has been common for many years. The Teton County Conservation District and the Montana Bureau of Mines and Geology are working together to build an information base about aquifers in the Upper Teton area to help local citizens and the Department of Natural Resources effectively manage groundwater resources of the area. Newly drilled observation wells, water level records, aquifer tests, precipitation records, and water quality data will all be used to develop a picture of how aquifers in the study area perform. The information provided by the project will help local citizens understand how the resource can be used and what any particular use will do to other water users in the vicinity.

Project Status: 75% complete - a small amount of drilling and aquifer testing remains.

Completion Date (mo./yr.): June, 1987

Final Product: Written report with interpretive maps to Conservation District - MBMG publication.

Funding Source: DNRC Water Development Grant Program - MBMG matching funds.

Thomas W. Patton 1-26-87
Principal Investigator Date

MONTANA BUREAU OF MINES AND GEOLOGY
PROJECT STATUS FORM

HY C-1-w
NO. R/C 44

**Project Name:** MONTANA HYDROGEOLOGY FIELD PROGRAM, DEVELOPMENT OF AQUIFER TEST FACILITIES

**Principal Investigator:** Marek H. Zaluski

**Other Personnel:** John L. Sonderegger, Fred A. Schmidt

**Project Description:** The prime goal of the project is to develop the "Field Laboratory" where the eductional and research project on the aquifer testing could be conducted. The project is in its initial stage with the site carefully selected (5 miles west of [illegible]) where your shallow observation wells were drilled prior to the project. Two new production wells were drilled in the summer of 1986 and one more well will be added each summer. This well be drilled by students who participate in the Field Hydrogeology Summer Course.

The project is funded by private sources, (Western Energy) and by Montana Tech (Field Course tuitions).

**Project Status:** Active

**Completion Date (mo./yr.):** Ongoing

**Final Product:** Installation of Aquifer Test Facilities and graduate theses.

**Funding Source:** MBMG, Montana Tech and Western Energy

Marek H. Zaluski 11/27/87
Principal Investigator Date

# LIST OF FORMALLY PUBLISHED TITLES

by

## THE MONTANA BUREAU OF MINES AND GEOLOGY

1965 - 1986

### ANNUAL REPORT

AR 6 Fiscal Year: July 1, 1984 to June 30, 1985 (1985), 52 p., 17 Figs., 11 tables.

AR 7 Fiscal Year: July 1, 1985 to June 30, 1986 (1986), 60 p.,

### MEMOIRS

M 57 Geology and oil shale resources of the Heath Formation, Fergus County, Montana, Pamela Dunlap Berkey, Frank R. Abercrombie, Susan M. Vuke and John A. Daniel, 1985, 100., 19 figs., 9 tables, 11 appendicies, 2 sheets.

M 58 Hydrogeology and geothermal resources of the Little Bitterroot Valley, northwestern Montana, Joseph J. Donovan, 1985, 60 p., 22 figs., 5 tables 5 appendicies, 2 sheets.

M 59 Water resources of the Big Hole Basin, southwestern Montana, Julieanne F. Levings, 1986, with a section on Mean flows at selected stream sites, R. E. Thompson Jr., 72 p., 20 figs., 6 tables, 9 appendicies, 3 sheets. Prepared in cooperation with the U. S. Geological Survey.

### BULLETINS

B 122 Directory of Montana mining enterprises for 1984, compiled by D. C. Lawson, with a section on the Elk Creek-Colona mining district, Richard B. Berg, 1985, 60 p., 3 figs., 1 table, 1 appendix, 1 sheet.

B 123 Current geological and geophysical studies in Montana, compiled by Richard B. Berg, 1985, 35 p., 2 sheets.

B 124 Directory of Montana mining enterprises for 1985, compiled by D. C. Lawson with a section on the Emery mining district by Robert E. Berkey, 1986, 59 p., 7 figs., 1 table, 1 appendix, 2 sheets.

B 125 Current geological and geophysical studies in Montana, compiled by Richard B. Berg, 1986, 33 p., 2 sheets.

### SPECIAL PUBLICATIONS

SP 92 The Stillwater Complex, Montana: geology and guide, Gerald K. Czamanske and Michael L. Zientek (eds.), 1985, 496 p., 361 figs., 28 tables, 4 sheets Prepared in cooperation with the U. S. Geological Survey.

SP 93 Proceedings: Montana coal forum, compiled by Janie Ryan, 1985, 249 p., 77 figs. Prepared in cooperation with the Montana Mining and Mineral Resources Research Institute.

SP 94 Belt Supergroup: A Guide to Proterozoic Rocks of Western Montana and Adjacent Areas, Sheila M. Roberts (ed.), 1986, viii p., 175 figs., 11 tables, 10 color plates, 4 sheets

GEOLOGIC MAP SERIES

GM 38 **Bozeman 1° x 2° quadrangle, southwestern Montana: Structure contour (configuration) map of the top of the Bozeman Group, R. D. Feltis, 1985. Prepared in cooperation with the U. S. Geological Survey, Scale 1:25,000.**

GM 39 White Sulphur Springs 1° x 2° quadrangle, West-central Montana. Structure contour (configuration) map of the top of the Madison Group, R. D. Feltis, 1985. Prepared in cooperation with the U. S. Geological Survey, Scale 1:250,000.

GM 40 Belt Supergroup Stratigraphic Correlation Sections, Western Montana and Adjacent Areas, Don Winston, 1986, 1 sheet (full color) w/16-page pamphlet text.

GM 41 Geology of the Baker and Wibaux 30 x 60-minute Quadrangles, Eastern Montana and Adjacent North Dakota, Susan M. Vuke-Foster, Roger B. Colton, Michael C. Stickney, Edith M. Wilde, J. Elise Robocker and Kim C. Christensen, 1986, 1 sheet (full color). Prepared in cooperation with the U. S. Geological Survey. Scale 1:100,000.

GM 42 Coal Development Potential of the Northwest Scobey Area, Daniels and Valley Counties, Montana, James R. Gruber, Jr., 1986. Prepared in cooperation with the Bureau of Land Management. Scale 1:47,520.

GM 43 Coal Stratigraph of the Lame Deer Quadrangle, Southeastern Montana, Pamela Dunlap Berkey, 1986, 4 sheets. Prepared in cooperation with the U. S. Geological Survey. Scale 1:100,000.

GM 44 Coal Resources of the Cedar Coulee Quadrangle, Richard and Roosevelt Counties, Montana, Mary Alice Spencer, 1986. Prepared in cooperation with the Bureau of Land Management. Scale 1:24,000.

HYDROGEOLOGIC MAP SERIES

HM 8 Water Resources of the Clarks Fork Yellowstone River Valley, Montana, Julianne F. Levings, 1986, 5 tables, 3 sheets. Prepared in cooperation with the U. S. Geological Survey.

MONTANA ATLAS SERIES

MA 4-A **Geologic and Structure Maps of the Wallace 1° x 2° Quadrangle, Montana and Idaho, Jack E. Harrison, Allan B. Griggs and John D. Wells, 1986, 2 sheets (full color). Prepared in cooperation with the U. S. Geological Survey (I 1509-A, 1986). Scale 1:250,000.**

MA 4-B Geochemical Map Showing Distribution of Samples of Nonmagnetic Heavy-mineral Concentrates that Contain Anomalous Concentrations of Antimony, Arsenic, Copper, Lead, Silver and Zinc in the Wallace 1° x 2° Quadrangle, Montana and Idaho, David L. Leach and James A. Domenico, 1986. Prepared in cooperation with the U. S. Geological Survey (I 1509-B, 1986). Scale 1:250,000.

MA 4-C Geochemical Map Showing Distribution of Stream-Sediment Samples That Contain Anomalous Concentrations of Antimony, Bismuth, Cadmium, Copper, Lead, Silver and Zinc in the Wallace 1° x 2° Quadrangle, Montana and Idaho, David L. Leach and D. M. Hopkins, 1986. Prepared in cooperation with the U. S. Geological Survey (I 1509-C, 1986). Scale 1:250,000.

MA 4-D Geochemical Map Showing Distribution of Stream-Sediment Samples That Contain Anomalous Concentrations of Partially Extractable Antimony, Bismuth, Copper, Lead, Silver and Zinc in the Wallace 1° x 2° Quadrangle, Montana and Idaho, David L. Leach and D. M. Hopkins, 1986. Prepared in cooperation with the U. S. Geological Survey (I 1509-D, 1986). Scale 1:250,000.

MA 4-E Resource Appraisal Map for Placer Gold in the Wallace 1° x 2° Quadrangle, Montana and Idaho, Jack E. Harrison, James A. Domenico and David L. Leach, 1986, 1 sheet with 4-page pamphlet text. Prepared in cooperation with the U. S. Geological Survey (I 1509-E, 1986). Scale 1:250,000.

MA 4-F Resource Appraisal Map for Stratabound Copper-silver Deposits in the Wallace 1° x 2° Quadrangle, Montana and Idaho, Jack E. Harrison, James A. Domenico and David L. Leach, 1986, 1 sheet with 4-page pamphlet text. Prepared in cooperation with the U. S. Geological Survey (I 1509-F, 1986). Scale 1:250,000.

MA 4-G Resource Appraisal Map for Sullivan-Type Stratabound Lead-zinc-silver Deposits in the Wallace 1° x 2° Quadrangle, Montana and Idaho, Jack E. Harrison, Earle R. Cressman, Carl L. Long, David L. Leach and James A. Domenico, 1986, 1 sheet with 4-page pamphlet text. Prepared in cooperation with the U. S. Geological Survey (I 1509-G, 1986). Scale 1:250,000.

MA 4-H Resource Appraisal Map for Porphyry Molybdenum-tungsten, Platinum-group Metals and Epithermal Silver Deposits in the Wallace 1° x 2° Quadrangle, Montana and Idaho, Jack E. Harrison, David L. Leach, M. Dean Kleinkopf and Carl L. Long, 1986, 1 sheet with 4-page pamphlet text. Prepared in cooperation with the U. S. Geological Survey (I 1509-H, 1986). Scale 1:250,000.

MA 4-I Resource Appraisal Map for Mesothermal Base and Precious-metal Veins in the Wallace 1° x 2° Quadrangle, Montana and Idaho, Jack E. Harrison, David L. Leach and M. Dean Kleinkopf, 1986. 2 sheets with 4-page pamphlet text. Prepared in cooperation with the U. S. Geological Survey (I 1509-I, 1986). Scale 1:250,000.

MA 4-J Summary Map of Resource Potential for Metallic Minerals in the Wallace 1° x 2° Quadrangle, Montana and Idaho, Jack E. Harrison, David L. Leach, M. Dean Kleinkopf, Earle R. Cressman, Carl L. Long and James A. Domenico, 1986. Prepared in cooperation with the U. S. Geological Survey (I 1509-J, 1986). Scale 1:250,000.

## REPRINT SERIES

R 5 Montana in the Geologic Past (2nd ed., 1986), E. S. Perry, 1962, 78 p., 38 figs., 5 tables, 2 plates.

LIST OF OPEN-FILE REPORTS

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THE MONTANA BUREAU OF MINES AND GEOLOGY

MBMG 153 Lithofacies of the Middle-Upper Cambrian sequence, Libby syncline, Montana, Rolf K. Aadland, 1985, 30 p., 17 figs.

MBMG 154 Quality of ground water in Montana, Robert N. Bergantino, Brenda C. Sholes and Judeykay Schofield, 1985, 6 sheets. Scale 1:1,000,000.

MBMG 155 Expected yield (gpm) for wells in Montana, Robert N. Bergantino, Brenda C. Sholes and Judeykay Schofield, 1985, 6 sheets. Scale 1:1,000,000.

MBMG 156 Preliminary geologic map of the McCartney Mountain salient, Beaverhead and Madison counties, Montana, William C. Brandon, 1985, 4 sheets. Scale 1:62,500.

MBMG 157 Sage Creek alluvial aquifer test, Liberty County, Montana, Thomas J. Osborne and Marek H. Zaluski, 1985, 42 p., 9 figs., 3 tables, 3 appendices.

MBMG 158 Structure contour map on the top of Precambrian crystalline rocks, Montana, Robert N. Bergantino and Mike Clark, 1985. Scale 1:1,000,000.

MBMG 159 Structure contour maps on the top of the Madison Group, Montana, Robert N. Bergantino, 1985, 2 sheets. Scale 1:500,000.

MBMG 160 Montana seismicity report for 1983, Michael C. Stickney, 1985, 30 p., 3 figs., 4 tables.

MBMG 161 Sulfide and associated platinoid mineralization in the Stillwater reef and underlying graphite-pyroxenite pegmatoids, Alex Volborth, 1985, 105 p., 36 figs.

MBMG 162 Hydrogeologic test data for the Lonepine aquifer, Little Bitterroot valley, northwestern Montana, Joseph J. Donovan, 1985, 10 p.,

MBMG 163 Mining and mineral developments in Montana, Henry G. McClernan, 1985, 9 p., 4 figs., 1 table.

MBMG 164 Montana seismicity report for 1984, Michael C. Stickney, 1986, 42 p., 5 figs., 5 tables.

MBMG 165 Analysis to the T. 6S., R 7W., magnetic anomaly, southwestern Montana: Final report of 1985 University of Arkansas summer geophysical field exercise, Robert W. Langston and Marian M. Bankston, 1986, 30 p., 1 appendix.

MBMG 166 Metal and arsenic distribution in soils and soil water of contaminated agricultural land adjacent to Silver Bow Creek, Deer Lodge and Silver Bow counties, Montana, Thomas J. Osborne, Terence E. Duaime and Herman R. Moore, 1986, 35 p., 3 figs., 5 tables.

MBMG 167 Overburden soil paste: A revision of a procedure, Wayne G. Olmstead, 1986, 20 p., 7 tables.

MBMG 168 Mining and mineral developments in Montana - 1986, Edward T. Ruppel, 10 p., 5 figs.

MBMG 169 Saline-seep assessment of Hertzdine, Montana and surrounding area, Terence E. Duaime, Herman R. Moore, Jane M. Bolzer and Glenn A. Hockett, 1986, 127 p., 20 figs., 1 table, 5 appendices.

MBMG 170 Preliminary geologic map of the Jordan $1^{\circ}$ x $2^{\circ}$ quadrangle, northeastern Montana, compiled by Robert N. Bergantino, 1986. Scale 1:250,000.

MBMG 171 Geology of the Wolf Point quadrangle, northeastern Montana, 1986, Robert N. Bergantino, 1 sheet. Scale 1:250,000.

MBMG 172 Quaternary Geology of the Wolf Point $1^{\circ}$ x $2^{\circ}$ quadrangle, northeastern Montana Robert N. Bergantino, 1 sheet. Scale 1:250,000. 1986.

MBMG 173 Altitude of the top of the Bearpaw shale Wolf Point $1^{\circ}$ x $2^{\circ}$ quadrangle, 1986, Robert N. Bergantino, 1 sheet. Scale 1:250,000.

MBMG 174 Altitude of the top of the Judith River Formation Wolf Point $1^{\circ}$ x $2^{\circ}$ quadrangle, 1986, Robert N. Bergantino, 1 sheet. Scale 1:250,000.

MBMG 175 Altitude of the top of the Basal Colorado sandstone Wolf Point $1^{\circ}$ x $2^{\circ}$ quadrangle, 1986, Robert N. Bergantino, 1 sheet. Scale 1:250,000.

MBMG 176 Altitude of the top of the Pool Coal Formation Wolf Point $1^{\circ}$ x $2^{\circ}$ quadrangle, 1986, Robert N. Bergantino, 1 sheet. Scale 1:250,000.

MBMG 177 Ground-water resources and water quality of the unconfined aquifers in the Kalispell Valley, 1986, Peter A. Dodds, 112 p., 23 figs., 4 tables, 5 appendices.

Exh. 6.7 B4

MONTANA TECH BUDGET PRESENTATION
1988-89 Biennium

- **Appreciation**
- **1986-87 Academic Year in Review**

1986 was both the best of years and the worst of years for Montana Tech. Focusing first on the positive events in 1986, I am delighted to report to you that Tech this year was able to stem its three year slide in enrollment and that we firmly project solid growth over the next few years, contrary to what is happening at many other institutions, both public and private.

Exhibit 1:

(Enrollment curve) **Fall 1986** - Freshman +6%
- 1st time engrs. +20%
) 1,850 students (1,540 FTE)

**Fall 1987** - Freshman +4% (est.)
- 1,880 students, 1,560 FTE

**1988-90** - steady growth to 2,000 students

These estimates assume all current Tech programs remain in tact. However, a significant challenge to Montana Tech will be insuring that all potential students who may be adversely impacted by the recent Regents' decision to eliminate business administration at Tech, are suitably accommodated within our remaining programs. Because business administration was our highest demand, most rapidly growing program, we are aggressively marketing our other programs to minimize the potential loss of enrollment. We also hope that many students will take advantage of the two year transfer opportunities at Tech.

Recognition of Tech's international reputation was outstanding in 1986. For example,

- China - 26 Chinese scholars to study for one year at Tech - World Bank funded
- invitation to establish a graduate program in China

- SME - largest, most successful mining engineering program in America
- LSU - 200 vs. 2; Tech only positive growth institution w/+20% in petroleum engineers
  - falling enrollments elsewhere will create a desperate lack of graduates 3 to 4 years from now.

Private financial support for Tech is setting all time records for the institution (about 20% increase in permanent endowment in just last 6 months of 1986) due in part, I believe, to industry recognition of Montana Tech's pivotal role in rejuvenating Montana's and the nation's mineral and energy economies. You may wonder how our little college could be so important?

Exhibit 2: (matrix)
- special session--I said 4 or 5 comprehensive institutions remained
- now there is only one--Montana Tech--CSM (2nd); Rolla & NMT (3rd)
- unlike Montana, most eastern states have written off mining
- Tech the benefactor--U. Wisc. mining--mining visits
- accreditation visit--outstanding reviews--all program accredited

Exhibit 3: (1 of chart)
- clear demonstration that Tech is "keeping the faith" with our economic and defense needs for minerals and fuels--industry has responded by keeping faith w/Tech.

Montana Tech is truly a national resource and, even more important, a unique and desperately needed resource to Montana. I say unique because Tech's technical programs are nowhere duplicated on any other Montana campus, public or private, and they are becoming increasingly unique in America.

I say Montana Tech is desperately needed by Montana because each of you have some mineral or agricultural-related venture in your district--whether oil, gas, coal, base metals, gold, or nonmetallics. These activities in 1985 paid 25.2% of all Department of Revenue collections clearly demonstrating their worth to the state. Perhaps more important, mining, minerals, and energy along with Montana's other natural resources are viewed as our only sure hope for improving our economy in the short to mid-term. (Note: Governor's Economic Task Force). Mining is not dead in Montana nor is Tech's support to the many new mining ventures in the state.

You may be surprised that I mentioned agriculture a moment ago. Are you aware that Montana Tech has pioneered most hydrogeology efforts in our state and that Tech is the institution that helps our farmers and ranchers in areas where there are groundwater concerns. Needless to say, water may well be Montana's most important natural resource--Montana Tech and its Bureau of Mines are Montana's water experts.

As an aside, I was a bit taken back during the Special Session in June when it was suggested to me that Montana Tech merely trained our young people to leave the state. This comment prompted me to check our alumni statistics with the result that I found that about one-half of Tech's living, working alumni are right here in Montana. I believe many more would be here were there jobs for them. Nonetheless, I think Tech's record of serving Montana is amply demonstrated because our programs help solve the out-migration problems of educated Montana citizens.

Unfortunately, I think Montana's track record of keeping her best and her brightest talent at home is in for a very rude shock in the next few years.

Over the years Montana Tech has been very successful in recruiting some of our high schools' best students. Now because of the many grave uncertainties surrounding Montana's University System, and the perceived and real lack of state support for our public colleges and universities, my recruiting people tell me that more and more of the top high school students are applying out-of-state. I would suggest to you that once gone, most of these people are gone for good. A Montana "brain drain" is real and it is happening now!

Finally, I maintained earlier that Tech is an irreplaceable resource to Montana. It has taken 90 years for Tech to earn its reputation--a reputation for excellence in engineering that could not be transferred overnight to another or built anew some time in the future. Montana students would simply go to another proven institution in another state were there no Montana Tech. Here too, I see the fall-out from Montana's treatment of higher education, where I am having to exercise all of my persuasive skills to keep some of my current students from leaving for less well recognized minerals schools in Colorado, Nevada, South Dakota and Idaho where, in the past two years, support for higher education has risen 10 to 25% or more. Unfortunately, I have not always been successful.

- 1986-87 Budget Year in Review

In this academic year, the dark side of Montana Tech's performance was all related to our budgetary situation. We experienced an overall reduction in operating funds of about 8% in calendar year 1986 contributing to a total reduction of 14% in the past 18 months.

At this point in my testimony, I want to again express my appreciation to this committee which last June recognized the dangers of cutting Montana Tech too much because of minimum accreditation requirements. To review, you may recall that I spoke of the minimum number of faculty and instructional support dollars needed regardless of enrollment to maintain ABET accreditation of our engineering programs. That accreditation is firmly in place, in part due to this committee's conviction that Tech engineers are critical to Montana's economic future.

Because of my continuing conviction that academic quality must be preserved at all costs, I have consciously sought to avoid cutting instructional efforts in my attempts to meet the 14% budget reduction--a cut I might add that would cripple many companies if, like Tech, they were unable to refinance the business.

As a result, in 1985 and 1986, employment at Tech was reduced by about 16%; all capital equipment expenditures were halted; only critical maintenance was performed; program offerings, courses, and options are much more limited; campus security has been halved as has library acquisitions; and community services have been drastically reduced; to name only a few of the many areas of campus operations impacted by the repeated budgetary reductions.

Currently, I estimate my fixed operating costs--that is, those costs that go to faculty salaries, plant operations, and the like--to be about 99.7% of my available funds this year. Clearly, any further attacks on Tech's budget must

now affect the very core of the academic fiber of the College. I view this prospect with considerable concern for the economic future of our state--that is, if Montana hopes to enjoy any part of an economic resurgence in our domestic mining and energy industries.

- **The Executive/LFA Budgets**

And now I come to the next biennium. Whether considering the Executive or LFA budget recommendations, which treat Tech roughly the same at the bottom line, either budget must be viewed as posing dire consequences for Montana's quality minerals engineering school.

As can be seen in Exhibit 4, Tech is proposed for the largest cut of any campus unit or more than 15%. This proposed cut translates to a budgetary reduction of over 25% in an 18 month period.

**Exhibit 4:**

(budget numbers)

Even though enrollment is stabilizing and the industry need for Tech graduates is on the rise in Montana, the budgetary proposals for Tech can no longer be met by scaling back operations or administrative expenses--fixed costs would grossly exceed operating revenue.

The only way for Tech to lower fixed costs is to fire people because almost 80% of those costs are made up of salaries and personnel benefits. Here's the "catch 22"—in our efforts to maintain academic quality, we have already terminated virtually every administrative and staff position conceivable just to reach the 14% cuts already mandated.

What's left to cut? Should the proposed Executive Budget be enacted by Montana's legislature, Montana Tech would have to cut spending by an additional $1.2 million. Lacking any further management flexibility in allocating operating expenditures, the College would in 1987 have to begin the painful and, for the most part, irreversible process of eliminating major degree and service programs that have been an integral part of Tech's heritage for many decades. These same programs are unique within Montana's University System and are increasingly becoming unique in America. As a result, Tech has recently experienced an increased demand for these programs. However, if the legislature cannot adequately fund the campus in the next biennium, important instructional activities that support future mining, oil, gas and groundwater development in Montana will be abandoned leading to a fundamental change in the historic role and scope of Montana Tech.

Although specific program and personnel reductions will be contingent upon the wisdom and decisions of the legislature, the overall impact of any budgetary reduction that approaches that proposed in the Executive budget will lead to similar net losses in Montana Tech programs, personnel and service to the state and to the nation. For example,

**Possible Degree Program Eliminations**

Over one-third of Montana Tech's undergraduate degree offerings would be abolished should the Executive budget be adopted. These programs include in part our mineral processing engineering, technical communications, occupational safety and health, all associate degrees, and perhaps our geophysical or environmental engineering programs.

**Exhibit 5:** (*)identifies programs for possible elimination

You will note that most of the threatened programs are unique in Montana. Coupled with the loss of the business administration program at Tech, 200 to 400 or 25% of my students could be adversely affected by these curtailments; however, the major population group that will be hurt by the potential change will be nearby residents who cannot relocate to another campus to achieve their pursuit of a first level college degree. The mineral processing degree is one of only four offered in America and would be lost; geophysical engineering is one of two remaining accredited programs in the United States. Because most of the impacted degrees are not offered elsewhere in Montana, the affected students who continue with their education would likely leave the state.

One-half of Montana Tech's graduate degrees would be lost under the Executive budget seriously compromising Tech's ability to serve current and future economic development needs in Montana. Affected programs include: metallurgy, mineral processing engineering, geological engineering, geochemistry, geophysical engineering and geology. Loss of programs will also adversely impact research contract and grant opportunities to the economic disadvantage of the campus, the community, and the state. More than 20% of Tech's graduate

students would be affected; these students would also be inclined to leave Montana for lack of similar programs in the state.

At this point in my presentation, I must give you my solemn oath that what I project as the dire impact on Tech of the budget proposal that you have before you is not one worried college president posturing before you or a matter of my trying to hold the legislature at ransom. The consequences are real and so is the impact of adopting the Executive budget.

Let me also share another important fact with you. Should the legislature adopt the Executive budget for Tech, there is absolutely no legally conceivable way for Tech to meet those severe budgetary restrictions in the first year of the biennium because of existing contractural obligations with my people. Twenty or more currently employed faculty, staff, and administrative personnel would be terminated under the Executive budget. These reductions would amount to 10% or more of remaining college staff for an overall personnel reduction of 26% over the past two years. More than half of these positions are faculty in the degree areas that would be dropped by Tech should the Executive recommendation be followed. Even if I had given these faculty notices of termination on the day the Executive budget was printed, I could not eliminate them from the Tech payroll until July 1988. So we have a real financial, and maybe legal, dilemma should any budget approaching either the LFA or Executive numbers be adopted. The equivalent dilemma in the business world is Chapter 11 bankruptcy—a situation that none of us wish to advertise to the world is happening to Montana's higher education business.

- **Possible Administrative Changes**

The graduate school organization at Montana Tech could be dismantled by the

Executive budget. This action would seriously affect Tech's growing ability to attract high-level scientists and engineers at the national and international levels. The type of interaction that I mean is seen in the arrival this summer of the 26 Chinese scholars for one year's study at Tech that I noted earlier to you. Although China, Canada, and many other countries can select from other institutions, they have chosen Tech because of our reputation for quality. I now fear that reputation and that quality are at risk.

Other equally distressing consequences of accepting such a huge cut in Tech's budget are slashing library acquisitions to the point of elimination. Faculty participation in scientific meetings would be virtually nonexistent in the next biennium as would any form of sabbatical--each important to the continued updating of instructional and academic knowledge. Physical plant operations would be further curtailed as would campus security. Finally, intercollegiate athletic programs at Montana Tech would be substantially reduced even though major negative enrollment impacts would be experienced that could exceed 100 students.

I noted earlier that the Executive budget would pose dire problems to Montana Tech--now I say to you it would create irreversible damage to the institution. Why is this so? To meet the recommended budget, we must eliminate 50% of our degree offerings; this action would in turn disenfranchise 200 to 400 of our students or 13 to 25% of the entire student body. Reapplying the formula with these lower enrollments, now or in the next biennium, would once again call for a major reduction in operating funds and once again demand further program eliminations. An irreversible and endless downward spiral results.

Various Montana leaders, including legislators, have asked me why Tech seems to always be worse off under formula funding than any other campus. In truth, formula funding does not work well for any campus, especially when actual funding is well below the peer averages used in the formula. Formula funding works even less well for Tech. Why is this so?

For one, education is no different than medicine, agriculture, or any other profession. Specialization usually costs more money than the generic variety. And that is what Tech is--a very specialized, very unique educational institution. Are our costs per student too high? Not really. Although our state support per student at $3,853 is roughly $500 more than the average for the other five units, such questions compare apples and oranges. Let's compare Tech's engineering programs with similar professional programs on Montana's other campuses--you will find that Tech's state support per FTE student is very much in line with the others.

The advantage the other campuses enjoy is their ability to lower their <u>average</u> cost per student FTE with many diverse, lower cost programs such as business, vocational, liberal arts, and teacher education. Even Tech has partially enjoyed this benefit in the past few years. Our business administration program was our largest, fastest growing degree area. On average it has subsidized the higher cost of our engineering programs to the tune of about $500 to $700 per student FTE per year. With the announced termination of Tech's business administration degree, I want no surprises with this committee; thus, you should be aware that Tech's average per student cost will rise once the full enrollment impact of not having a business program is felt. As obvious as this seems, so very few seem to understand it.

Concurrent with the Regents' decision to terminate the business program at Montana Tech, perhaps a more important decision was reached by that governing board. The Regents have forcefully stated their belief that Montana needs a high quality educational institution to serve important current and future economic developments within the minerals and energy sectors of our state. Moreover, they have affirmed their conviction that Montana Tech must be that institution, must be independent, and must be adequately funded to fully meet the economic and human needs of Montana. I view the Regents' decision as an affirmation of faith in Montana Tech and recognition of Tech's long history of outstanding professional contributions.

On the funding issue, you have before you a recommendation from the Regents to programmatically fund Montana Tech in the next biennium. I hope that you will give serious consideration to this request so that Tech can continue its long history of service to the state, but also so that we may begin rehabilitating and repairing those areas where our academic programs, their quality and their reputation have suffered.

The programmatic funding requirements needed to restore new vigor to Tech's engineering programs are modest. (See Exhibit 6)

**Exhibit 6:** (Program Budget) - H.B. 500

In most expenditure areas, we propose only to maintain 1986/87 levels. The modest changes we seek would allow Tech to replace essential instructional equipment and provide library, computer and research support, that is now severely restricted or nonexistent because of budgetary pressures, to levels needed to help strengthen academic programs and quality, and to renew the

process of firmly establishing Tech's academic credentials among similar institutions.

I noted earlier to you the no. 2 and 3 mineral schools--Colorado School of Mines and New Mexico Tech. Preliminary research indicates state support for these institutions exceeds $8,000 per student FTE. These schools are also Montana Tech's only true peers. The program or base budget idea before you would require far fewer state funds than these peer institutions or roughly $5,000 per FTE. I believe this cost is quite a bargain considering the broader scope of Tech's activities, the quality of those activities, and the great importance of Tech's programs to Montana's economic development.

- **Summary**

I believe it is fair to say that today Montana Tech has arrived at what is perhaps the most significant and perilous crossroad in its illustrious history. Faced with extremely difficult fiscal problems, the State of Montana must now decide how important it is to support a strong, high quality minerals and energy engineering school in our state.

Superbly trained engineers cannot be educated on a shoestring. Although Tech has achieved unique status nationwide, it cannot maintain that enviable position unless adequately funded--at funding levels I might add that are far lower than comparable peer schools.

Before you seek to apply your wisdom and your vision to deciding Montana Tech's future, please give serious thought to the future of mining, oil, gas, and groundwater development in our state and to Montana's economic recovery that we all so desperately seek.

In the final analysis, I think the future choices for Montana Tech are self evident. I also believe the future must not be jeopardized by a reactionary response to short-term and hopefully temporary problems. Montana needs a vision of a successful future. We must seek the courage and the commitment to act on that view of a better world. I hope this committee will seek that vision and, in the end, recommend full support for Montana's most unique institution of higher learning.

LDN:jm

14/B:4

1/23/87

# Montana Tech

## Fall Enrollment 1901–1986

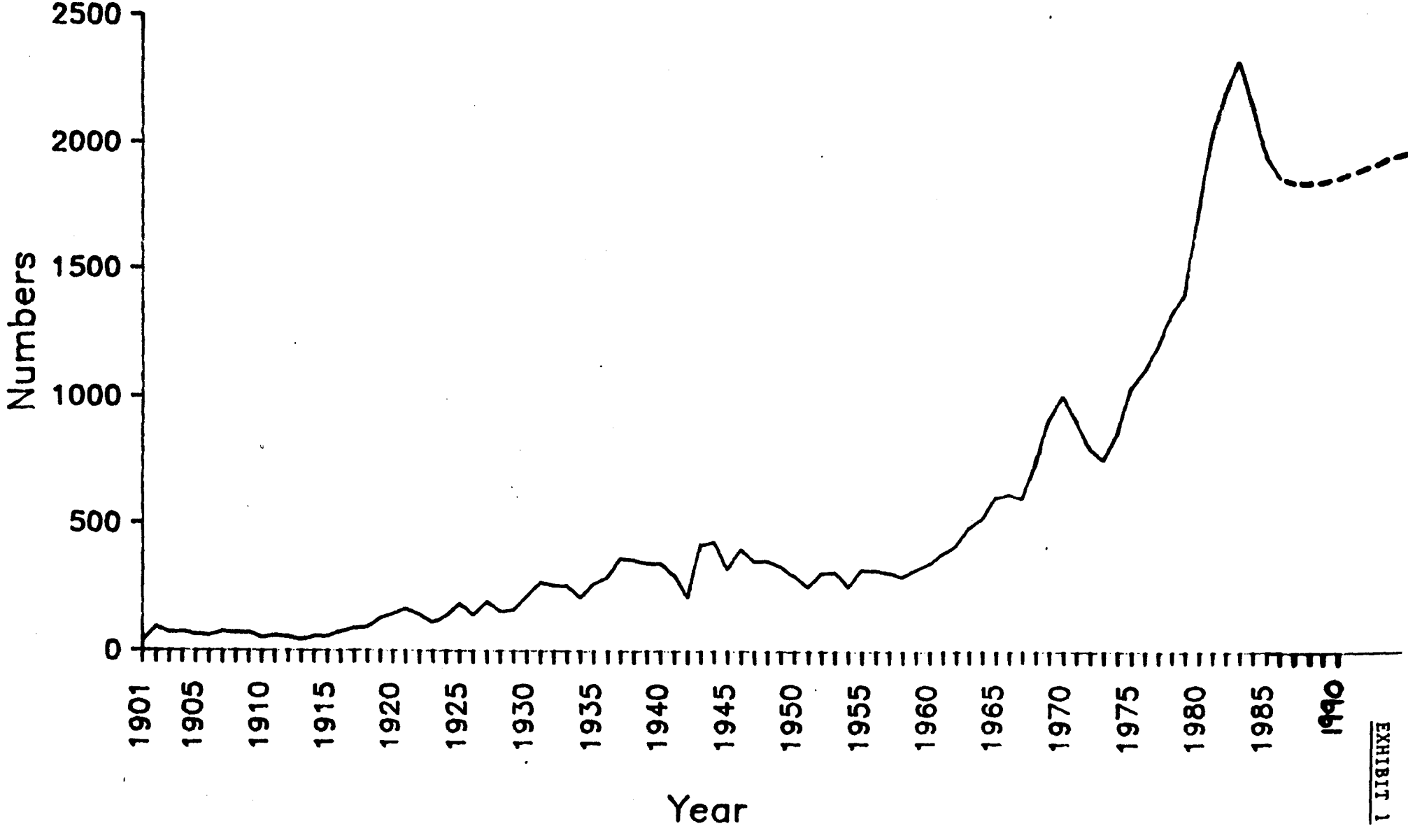
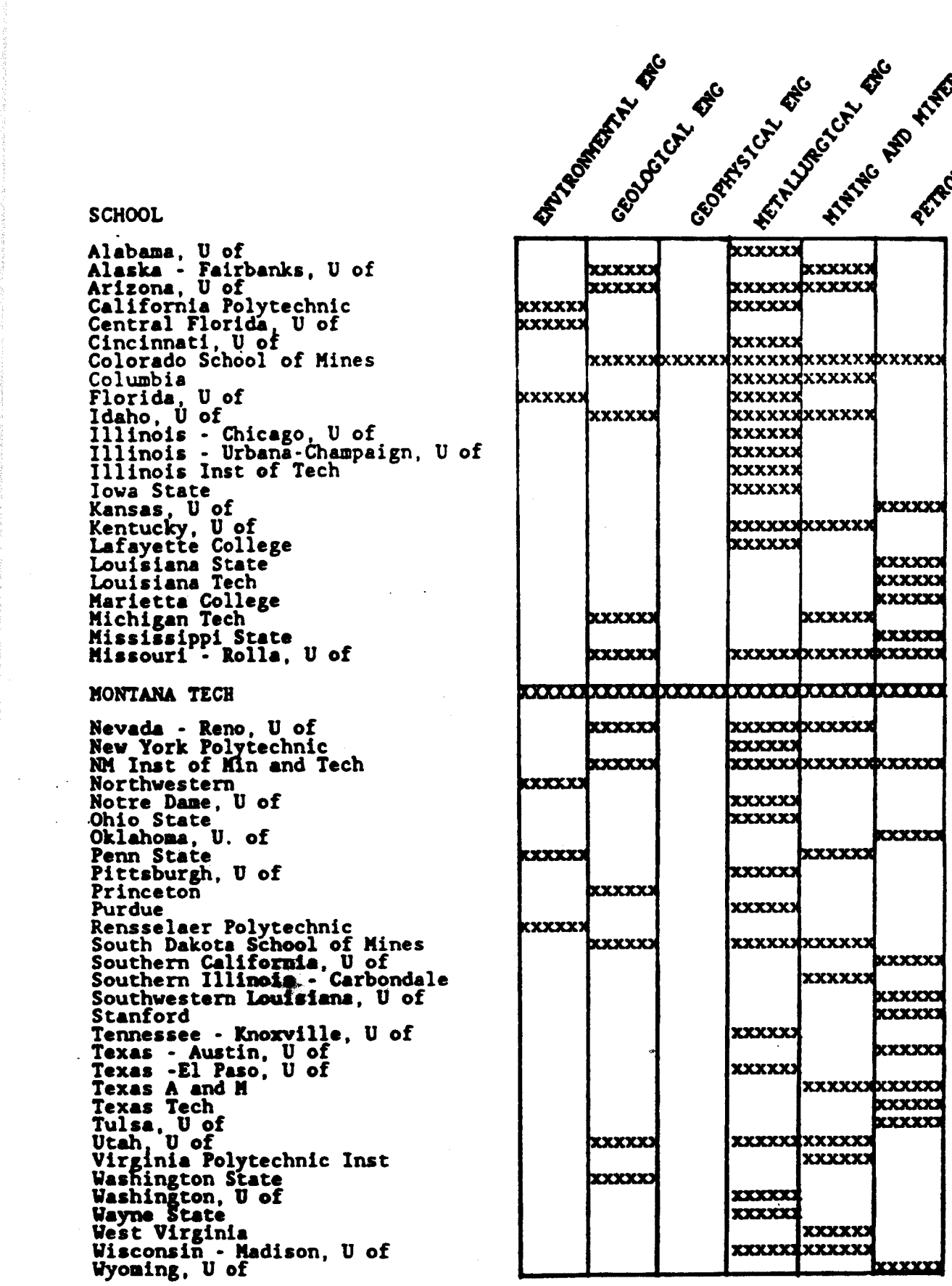



EXHIBIT 1

# ABET ACCREDITED UNDERGRADUATE DEGREE PROGRAMS IN MINERALS AND ENERGY ENGINEERING




Reference:- Annual Report, Accreditation Board, Engineering and Technology, 1985.

## Montana Tech: Minerals and Energy Engineering in the 80's

- Every Montana Tech Engineering program is accredited by ABET (Accreditation Board for Engineering and Technology).

**In the United States today:**

- 1 of every 300 citizens is a Montanan, however:
- 1 of every 10 graduating Petroleum engineers receives his or her degree from Montana Tech.
- 1 of every 12 graduating Geophysical engineers receives his or her degree from Montana Tech.
- 1 of every 14 graduating Mineral Processing and Mining engineers receives his or her degree from Montana Tech.
- 1 of every 25 graduating Geological engineers receives his or her degree from Montana Tech.
- 1 of every 26 graduating Environmental engineers receives his or her degree from Montana Tech.

**MONTANA TECH, A NATIONAL RESOURCE**

EXHIBIT 4

# EXECUTIVE BUDGET RECOMMENDATIONS

## Total Budget

| | Actual 1985-86 | Current Level 11/11/86 | Executive Budget 1988 | Executive Budget 1989 | 11/11/86 To 1989 |
|---|---|---|---|---|---|
| EMC | $ 13,779,827 | $ 13,758,296 | $ 12,758,791 | $ 12,713,152 | $ (1,045,144) (-7.6%) |
| TECH | 8,736,398 | 8,667,305 | 7,353,919 | 7,333,144 | (1,334,161) (-15.4%) |
| MSU | 45,110,613 | 43,950,548 | 41,731,554 | 41,849,038 | (2,101,510) (-4.8%) |
| NMC | 7,586,260 | 7,575,192 | 7,490,039 | 7,472,178 | (103,014) (-1.4%) |
| UM | 35,951,843 | 35,465,769 | 34,332,329 | 34,082,600 | (1,383,169) (-3.9%) |
| WMC | 3,936,631 | 3,972,081 | 4,194,525 | 4,161,871 | 189,790 (+4.8%) |
| SIX CAMPUS TOTAL | $115,101,572 | $113,389,191 | $107,861,157 | $107,611,983 | $ (5,777,208) (5.1%) |
| Amount Needed to Stay "Current" | | | $ 5,528,034 | $ 5,777,208 | $ 11,305,242 |

## MONTANA TECH'S FISCAL SUPPORT

| YEAR | PROPOSED BUDGET | ACTUAL BUDGET | ANNUAL % CHANGE | FTE'S | FACULTY & STAFF | EMPLOYMENT % CHANGE |
|---|---|---|---|---|---|---|
| 1984/5 | $10.2MM | $ 9.80MM | - | 1,880 | 248 | - |
| 1985/6 | 8.96 | 8.76 | (-10.6%) | 1,659 | 221 | (-11%) |
| 1986/7 | 9.10 | 8.51 | (- 2.8%) | 1,540 | 210 | (- 5%) |
| 1987/8* | 7.35 | ( ? ) | (-15.1%) | 1,560** | 185** | (-12%) |
| 1988/9* | 7.33 | ( ? ) | (- 0.3%) | 1,600** | 180** | (- 3%) |
| TOTAL CHANGE | (-$2.9MM) | ($2.47MM) | (-25.2%) | (-280) | (-68) | (-28%) |

*Proposed in Executive Budget **Estimated

EXHIBIT 5

# MONTANA COLLEGE OF MINERAL SCIENCE AND TECHNOLOGY
## Academic Programs/Graduates
## 1982-86

| PROGRAM | UNIQUE | GRADUATES 1982 | 1983 | 1984 | 1985 | 1986 | Five Year Total |
|---|---|---|---|---|---|---|---|
| * Assoc. Arts | | 27 2 | 17 1 | 18 0 | 30 7 | 29 3 | 121 |
| * Assoc. Science | | 9 | 29 4 | 21 4 | 19 8 | 13 3 | 91 |
| * Assoc. Engineering | X | 24 1 | 33 10 | 38 9 | 30 4 | 13 4 | 138 |
| (Assoc degree students also rec B.S. degrees) = | | 3 | 15 | 13 | 19 | 10 | (60) |
| * B.S. Business Administration | | 0 | 0 | 14 | 33 | 59 | 106 |
| B.S. Chemistry | | 3 | 2 | 3 | 4 | 4 | 16 |
| B.S. Computer Science | | 0 | 6 | 11 | 19 | 17 | 53 |
| B.S. Engineering Science | | 11 | 14 | 17 | 36 | 22 | 100 |
| B.S. Environmental Engineering | X | 9 | 16 | 14 | 7 | 7 | 53 |
| B.S. Geological Engineering | X | 10 | 15 | 22 | 18 | 21 | 86 |
| * B.S. Geophysical Engineering | X | 9 | 9 | 5 | 8 | 9 | 40 |
| B.S. Math | | 6 | 4 | 5 | 5 | 4 | 24 |
| B.S. Metallurgical Engineering | X | 7 | 11 | 15 | 8 | 13 | 54 |
| B.S. Mineral Processing Engr. | X | 6 | 7 | 5 | 2 | 5 | 25 |
| B.S. Mining Engineering | X | 24 | 25 | 23 | 27 | 20 | 119 |
| B.S. Occupational Safety & Health | X | 19 | 14 | 14 | 3 | 2 | 52 |
| B.S. Petroleum Engineering | X | 72 | 69 | 85 | 101 | 103 | 430 |
| * B.A. Society & Technology | X | 2 | 4 | 2 | 1 | 1 | 10 |
| B.S. Society & Technology | X | 13 | 17 | 14 | 18 | 9 | 71 |
| M.S. Engineering Science | X | 0 | 1 | 2 | 2 | 3 | 8 |
| M.S. Geochemistry | X | 1 | 3 | 1 | 2 | 2 | 9 |
| * M.S. Geological Engineering | X | 1 | 0 | 1 | 1 | 2 | 5 |
| * M.S. Geology | | 0 | 2 | 1 | 3 | 0 | 6 |
| M.S. Geophysical Engineering | X | 0 | 2 | 2 | 2 | 1 | 7 |
| M.S. Industrial Hygiene | X | 0 | 0 | 0 | 3 | 1 | 4 |
| * M.S. Metallurgy | X | 1 | 0 | 0 | 0 | 0 | 1 |
| M.S. Metallurgical Engineering | X | 3 | 2 | 4 | 5 | 4 | 18 |
| M.S. Mineral Processing | X | 0 | 0 | 0 | 0 | 0 | 0 |
| * M.S. Mineral Processing Engr. | X | 4 | 2 | 4 | 4 | 2 | 16 |
| M.S. Mining Engineering | X | 2 | 3 | 6 | 2 | 6 | 19 |
| M.S. Petroleum Engineering | X | 2 | 0 | 3 | 7 | 5 | 17 |
| | | 265 | 307 | 350 | 400 | 377 | 1699 |

MONTANA TECH

Program (Base) Budgeting Considerations ($000)

| | H.B. 500 & H.B. 375 | FY 87 Actual Budget | FY 88 Executive Budget | FY 88 Minimum Program Budget |
|---|---|---|---|---|
| • **Instruction:** maintain minerals, energy, and academic support levels for essential accreditation--87 FTE faculty + 5.5 FTE (summer) | $4,380 | $4,228 | $3,413 | $4,228 |
| • **Organized Research:** fund at same proportionate level as the other research units in University System (1.4% of budget). | 42 | 42 | 37 | 120 |
| • **Institutional Support:** maintain 1986/87 level; add 1 FTE technical library position, plus library acquisitions (+60K), partially restore computer engineering support (+100K), and reestablish small (+200K) capital equipment fund for critical academic programs. | 3,010 | 2,544 | 2, 262 | 2,904 |
| • **Physical Plant:** maintain 1986/87 level. | 1,399 | 1,352 | 1,353 | 1,352 |
| • **Scholarships/Fellowships:** maintain 1986/87 level. | 273 | 313 | 289 | 313 |
| | $9,104 | $8,479 | $7,354 | $8,917 |

12/B:24
1/22/87

EXHIBIT 6

2-7-5

TESTIMONY ON BEHALF OF MONTANA TECH

February 5, 1987

My name is Bill Robinson. I live at 11 North Lake in Butte, Montana and work for Western Energy Company. I am here today representing the Montana Tech Alumni Association of which I am past President, Montana Tech Booster Club, Montana Tech Foundation, Miners and Citizens of the Butte/Anaconda/Deer Lodge area. I am presently active in all of those organizations and have had an opportunity to discuss Montana Tech's future with a broad cross-section of people in the surrounding areas. The testimony I bring to you today is representative of those conversations and a consensus of the feelings of all those involved.

Montana Tech is an important part of our community. It represents a major part of our economic base, but more so, an institution of higher education that is available to people in our area that can't afford to send their children to more costly institutions. It provides unique degrees in the mineral industry that cannot be matched anywhere in the world. There is a blend of mining, geology, geophysics, environmental and safety, and strong basic engineering programs.

Over a third of Montana Tech Alumni work in Montana and many work for the same company I do. The majority of the professional people in the mining and mineral areas throughout Montana are Montana Tech graduates and work in Butte, Helena, Billings, Missoula, Lincoln, Winston, Troy, Kalispell, Dillon, Ennis, Jardine, Silver Star and Colstrip, Montana as well as many other locations in the state. Not only has Tech been a resource for professionals to staff mining companies but also it has been a resource for academic staff professionals to provide assistance for specific project support and various research projects. Should this great institution of world-wide recognition be dismantled for political or financial reasons, it would force companies to support and hire students from Colorado, Utah, or Nevada mineral schools. This would not be done out of desire, but out of necessity. Montana can ill afford any more dollars leaving the state.

Many mining companies are presently trying to develop some precious metals mines as well as additional coal reserves in the state and it seems imprudent to pull out the necessary higher education support for these companies at a time when it is so badly needed. I sincerely hope you would consider the highly technical nature of Montana Tech and evaluate this institution on its own merits and needs. For the good of this State and the good of all mining companies, I am asking that you support the

programmatic funding at Montana Tech. Allow the president of that institution, who is a very capable administrator, the flexibility to work within a reasonable budget and raise additional revenues as he sees fit. Reinstate the level of budget needed to provide these unique programs. The past budget cuts, not to mention any further cuts or restructuring, can only harm an institution with nearly 100 years of superb reputation and performance.

Thank you for your consideration.

we:15:0007

# TESTIMONY TO THE EDUCATION SUBCOMMITTEE

# ON THE

# BUREAU OF MINES AND GEOLOGY

By

Thomas A. Dale

Mining Engineer, P.E.

February 5, 1987

Mr. Chairman, Members of the Subcommittee, Ladies and Gentlemen:

My name is Thomas A. Dale and I appear here today as a practicing Mining Engineer and also as a representative of Montana's Mining Industry. I urge you to fully fund the Bureau of Mines and Geology's 1988-89 biennium budget. I would also point out that this budget has already been drastically reduced from even that of the last biennium. A streamlined agency like the Bureau is actually penalized for being cost-effective when percentage cuts are introduced, as has been the case this past year.

The importance of the Bureau to the Mineral and Energy industries cannot be over-emphasized. Because they are basic industries and contribute so heavily to the tax base, what fosters their growth also benefits the taxpayers. It seems only common sense to put some of this tax money back into the areas that generated it. Also, it eludes the sense of fair play to regulate the natural resource industries so heavily without also providing some background assistance and information on the very things Montana wants to protect.

An example of this would be hydrology information on groundwater in an area where cyanide heap leaching was to take place. The flooding of the Berkeley Pit is another example of gaining in-depth information that can be used to plan and prevent problems in future abandoned open pit mines.

Another important assist from the Bureau is the historical literature they have on file about the mining districts and areas of mineral occurrences in our state. From the small miner to the large mining company, this mineral data is usually the first step toward exploration. One mineral occurrence -- identified by the Bureau in their on-going geologic mapping and brought into production -- returns untold dividends to the taxpayers of this state.

In a few short words I hope I have convinced you of the importance of the Bureau of Mines and Geology to our natural resource industries and to our Treasure State. The Bureau is critical to the long term financial health of Montana. It is said that it takes money to make money, so I urge you to fund this budget and cash in on Montana's future.

Thank you.

TESTIMONY PRESENTED TO THE JOINT EDUCATION SUB-COMMITTEE
FEBRUARY 5, 1987

Mr. Chairman, and Members of the Committee, for the record, I am Kelly Holmes, lobbyist for the Montana College Coalition.

This has happened before. First, Butte's elementary and now Montana Tech. Both had cuts they had to make. A miscalculation of over $1 million and now, Montana Tech is calculated for over $1 million worth of cuts.

Board of Regents exclaimed, "we have to maintain quality." Sacrifices have to be made. Who and what is expendable? At times, we are our own worst enemies. Currently, Montana's educational system is at its worst time. Fewer dollars and no flexibility.

Contingency plans were requested. The Boards' initiatives for the future of Montana, to you lawmakers were: admission standards, combining Western with University of Montana, cut business administration at Tech, sports and faculty cuts were made. The list continues.

This is an emotional, controversial and heartbreaking situation. But, to stop now and start it up again lateron, is not the alternative, and it would not work that way.

The biggest and hardest hit are Montana's current and future students. Through all this, "how can we rate our quality education and its future standards?" How do you achieve the greatest good for the greatest number? That is an impossible question to ask, since you

are comparing a quantity to a quality. You know what happens. If you have to make a choice, you reduce the quality, never the quantity. Is this the price we have to pay? Things will never be the same again. Thank you.

VISITOR'S REGISTER

SUBCOMMITTEE _____

AGENCY(S) MT. Tech DATE 2-5-87

DEPARTMENT _____

| NAME | REPRESENTING | SUPPORT | OPPOSE |
|---|---|---|---|
| Vic Burt | MT. Tech. | ✓ | |
| Joe Michelethi | MT. Tech | ✓ | |
| L.O. Norman | " " | | |
| Kelly Holmes | Montana College Coalition | ✓ | |
| BILL ROBINSON | MT TECH ALUMNI BR | ✓ | |
| Ed Kappel | Mt. Bur. Mines & Geol. | ✓ | |
| Mavrin Miller | Mt. Bur. Mines & Geol. | ✓ | |
| Tom Weetz | Pegasus Gold Corp | ✓ | |
| JOHN HEYWOOD | MT. TECH | ✓ | |
| ROBT JOHN DERVEKIS | SELF | ✓ | |
| Bea McCarthy | Bd of Regents | ✓ | |
| Carrol Krause | Comm of Ed | ✓ | |
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IF YOU CARE TO WRITE COMMENTS, ASK SECRETARY FOR WITNESS STATEMENT.
IF YOU HAVE WRITTEN COMMENTS, PLEASE GIVE A COPY TO THE SECRETARY.

FORM CS-33A
Rev. 1985