

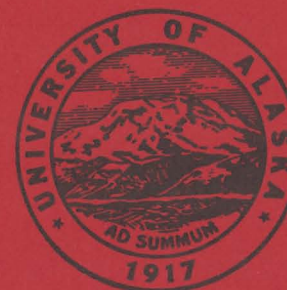
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M.I.R.L.
Report No. 14-A

ANNUAL REPORT OF RESEARCH PROGRESS

1967



Mineral Industry Research Laboratory
University of Alaska
College, Alaska 99701

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MINERAL INDUSTRY
RESEARCH LABORATORY

"The industrial strength and the security of the United States require an adequate, dependable, and continuing supply of raw materials of which minerals constitute an indispensable segment. With an expanding population, a rising standard of living, and the instability inherent in a constantly changing international situation, the mineral supply outlook is a major national concern.

In bringing mineral resources into man's service, aggressive research--from basic science through applied technology, including economic investigations--must characterize all stages, first in determining where and how best to explore and then on through actual exploration, development, production, processing, refining, utilization, marketing and reclamation for reuse."

A quotation of Philosophy
from a Federal Agency.

Annual Report
of
Research Progress
1967

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FORWARD

The need for continued research is amply stated on the inside cover. Work in the future will continue to be along these lines.

This year the Mineral Industry Research Laboratory has concentrated its efforts on projects relating to the more complete utilization of Alaska's mineral resources. This report briefly describes the projects that have been undertaken. These are broad in scope including topics such as mineral economics, exploration, mining, mineral beneficiation, beach and ocean mining, use of coal resources, resource evaluation, and market research analysis. Studies have been undertaken which investigate problems or topics in nearly all areas of the state, including Southeastern Alaska, Anchorage area, Northern Alaska and the Fairbanks area.

In the future the MIRL Annual Report will be presented on a fiscal basis. To bridge the gap this year, an addendum to this report will be prepared in the Spring.

Staff of the
MIRL
University of Alaska

MINERAL INDUSTRY RESEARCH LABORATORY STAFF

Earl H. Beistline, Dean, College of Earth Sciences and Mineral Industry
and Professor of Mining Engineering

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Bruce I. Thomas, Mining Engineer, representing the Bureau of Mines, U. S.
Department of Interior, in a Cooperative Agreement in the Study of
Factors Affecting Lode Mining in the Fairbanks District, Central
Alaska

Ernest N. Wolff, Associate Professor of Geology (Now at Colorado State
University)

Douglas W. Huber, Assistant Professor of Mineral Engineering (through May 1967)

Norman S. Smith, Assistant Professor Mining Engineering (through May 1967)

Stephen Stoney, Graduate Assistant, Mineral Engineering (through May 1967)

Paul S. Glavinovich, Graduate Assistant, Geology (through May 1967)

*Full time basis. All other part time basis.

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INTRODUCTION

The importance of State economy on the exploitation and utilization of its mineral resources led the 1963 State Legislature to establish the Mineral Industry Research Laboratory at the University of Alaska. The Laboratory is an integral part of the College of Earth Science and Mineral Industry. The objective of the Laboratory is the expansion and diversification of the mineral economy of the State through a program of applied and basic research in the mineral industries.

Since its inception, the Laboratory has continued to develop a strong research program. Studies have been undertaken in many mineral related fields. Several sponsored research programs have been undertaken in an effort to more fully serve pertinent governmental agencies and private interests within the State. The annual funding supplied by the State has been more than matched during this year making the States dollar doubly productive.

Research projects are approved by an advisory committee composed of members of the MIRL staff. Projects are reviewed by this committee to insure conformance to the limits of authorizing legislation. The direction and scope of individual studies are coordinated with government agencies and other institutes where possible overlap may occur.

ORGANIZATION AND FUNCTIONS

MIRL is staffed by members of the Department of Mineral Engineering on a time-share basis. Department members assume a research responsibility for the Laboratory when his academic duties permit it. There are only two full time members presently on the MIRL staff. These members also teach courses in their specialty when the occasion warrants it.

The Laboratory gains additional talent by assisting selected graduate students who are working on projects of interest to the State. This results in the publication of valuable information at slight cost to the Laboratory.

Cooperative work with specialists in allied fields, i.e., Electrical Engineering, Math, Economics, Physics, and Geology enhances the scope of research conducted by the Laboratory. This academic environment greatly stimulates progressive research aimed toward advancement of the mineral industry of Alaska.

FACILITIES

Major progress has been made in obtaining the most advanced instrumentation possible to more efficiently conduct research programs. This instrumentation is also necessary to provide the basis for obtaining research grants from federal and private sources. While some equipment has been purchased from MIRL funds, other equipment was obtained through National Science Foundation grants, pooling of University departmental funds, construction by research personnel, private donations and placement of related equipment in the Laboratory by other research institutes. The following lists some of the major equipment which is available to the Laboratory for research work:

- (1) Spectrograph - Analytical equipment which provided for qualitative, semi-quantitative and quantitative determinations of approximately 70 elements. Since it is most efficient in trace to minor amounts on a quantitative basis, it is ideal for geochemical work. For qualitative purposes it works well in all concentration ranges and gives a permanent photographic record for all types of analysis.
- (2) Recording Comparator Microphotometer - An auxiliary unit to the emission spectrograph which will allow more rapid and a recorded interpretation of analytical results.
- (3) X-Ray Diffractometer and Spectrometer - Complements the spectrograph in that it provides qualitative and quantitative analysis of elements most efficiently in concentration ranges in excess of one percent. When used as a diffractometer the identification of basic information concerning the crystal structure of minerals and compounds is possible.
- (4) Electron Microscope (Geophysical Institute equipment installed in Laboratory) - A research tool which allows visible examination and photographing of minute particles and cell structures not detectable with a conventional microscope.
- (5) Low-Intensity Magnetic Separator - A permanent magnet capable of separating highly magnetic minerals from weakly or non-magnetic minerals.
- (6) Hi-Intensity Magnetic Separator - A variable electromagnetic separator capable of separating minerals of varying magnetic properties from each other and from non-magnetic minerals.
- (7) Franz Isodynamic Separator - A variable field electromagnetic separator capable of separating minerals of

small variances in magnetic characteristics on small scale Laboratory basis.

- (8) Gouy Balance (National Science Foundation Funds) - A sensitively controlled electromagnet and balance system for the determination of magnetic characteristics of minerals.
- (9) High-temperature Kiln - A four cubic foot kiln for the study of the bloating characteristics of expanding shales and the firing characteristics of clays.
- (10) Centrifuge - High speed separatory apparatus to aid in the sink-float analysis of coal and other mineral products.
- (11) Superpanner - A small scale mechanical panning device that allows selective concentration of minerals due to minor variations in their specific gravities.
- (12) Heat Conductivity Apparatus - Apparatus fabricated in the Laboratory to determine the thermal conductivity of light-weight aggregate concrete block.
- (13) Apparatus for Determination of Dielectric Constants - Electronic equipment obtained on a loan basis from the Geophysical Institute to make determinations of dielectric constants of minerals.
- (14) Hardgrave Grindability Apparatus - An ASTM test apparatus for determination of the relative grindability or ease of pulverization of coal.
- (15) Free Swelling Index Apparatus - An ASTM test apparatus which measures the free swelling properties of coal indicative of coking characteristics.
- (16) IBM 1620 and 360 Model 40 Computers - Although not equipment of the Mineral Industry Research Laboratory, The University owned computers have been used to aid in basic research, placer valuation, mapping, statistical analysis and data plotting.
- (17) Versa Tester - An electrically operated press, capable of 60,000 lbs. pressure, utilized for rock mechanics studies, concrete testing and pelletizing of analytical samples.
- (18) Geophysical Prospecting Units -
Electromagnetic - Portable electromagnetic induction unit for detection of subsurface conductors. Principal conductors applicable are metallic sulfides.

Self Potential - Detects electric current generated by subsurface ore zones by the phenomenon of spontaneous polarization exhibited under proper structural and chemical conditions.

Resistivity - Indicates conducting properties of subsurface materials by enabling the calculation of the apparent resistivity of the ground.

- (19) Experimental Air Flow Equipment - For the study and testing of controlled air flow in round and rectangular ducts. Apparatus can be arranged to simulate air flow problems in mines, beneficiation plants and industrial applications.
- (20) Leitz ortholux reflected and transmilled light research microscope with photometer attachment for measurement of reflectivity of coal constituents and ore minerals.
- (21) Polishing machine with automatic arrangements for polishing six coal samples or ore minerals simultaneously.

EDUCATIONAL ASPECTS

The total benefit of the Mineral Industry Research Laboratory is not limited to development of the mineral industry since it exerts a continuing influence in stimulating and improving the graduate and undergraduate Mineral Engineering curricula at the University. The equipment additions and specialized studies attributable to the Laboratory have served as the nucleus for development of many new educational areas within the mineral industry discipline. Such curricula development not only allows better guidance of the ambitious student through a challenging and comprehensive educational program but stimulates the teaching and research effort of faculty members.

II RESEARCH ACTIVITIES

RESEARCH IN PROGRESS

This section briefly describes research currently being conducted by MIRC staff. Two of these projects are funded by the Laboratory and one by the North Commission.

Mineral Potential of the North

The Mineral Industry Research Laboratory has undertaken a contract with the North Commission of the State of Alaska to delineate potentially favorable areas for mineral exploration in Northern Alaska. Northern Alaska includes most of the land mass north of Fairbanks, including the Seward Peninsula. A preliminary Report, MIRC Number 13, has been presented to the North Commission. Work on the final report, scheduled for July 1968, is currently in progress.

Coal Research

Although coal is the largest known natural resource of Alaska, it has not yet contributed its full share to the development of the State. Currently available data indicate the coal reserves of Alaska are of the order of 130 billion tons (USGS Bul. 1242-B). Further detailed subsurface studies on areas where sufficient data is not available could increase this figure substantially. Most of the coal produced today is mined in Nenana and Matanuska coal fields. Increased competition from natural gas has not only leveled off production, but also threatened closure of mines in the Matanuska coal field. The Mineral Industry Research Laboratory is engaged in a continuous study to determine alternate methods of utilization of Alaskan coals and marketing to enable coal to play an increasing role in developing the economy of the State.

As a part of the overall research program, seventy-five samples of coal were selected for a study of the distribution of certain minor elements. These coal samples were previously collected from coal fields of Northern Alaska (Kukpowruk), Nenana, Jarvis Creek, Matanuska, and Kenai. Some of the samples were reported at 1.6 Sp.G. The float and sink fractions and the unfloated samples were ashed and the ash was analyzed by a quantitative spectrographic procedure. The elements analyzed were: lead, gallium, copper, silver, barium, nickel, beryllium, titanium, vanadium, zirconium, cobalt, chromium, germanium and tin. Some selected samples were analyzed for gold. The primary objective in analyzing for minor elements was three fold: (a) to determine if any of the elements are present in appreciable concentrations

PICTURES DEPICTING MINING
@ USIBELLI COAL MINE



Usibelli Coal Corporation established the Emil Usibelli Coal Preparation Laboratory in 1965 in memorium of Emil Usibelli. The Laboratory is dedicated to pioneering research for the more complete utilization of Alaska's Coal Resources. Equipment has been purchased and placed in the Laboratory as a result of this memorium.



for commercial exploitation (since the raw material for extraction would be ash, a waste product from a power plant, it will not involve any mining, transportation and primary crushing costs), (b) to develop additional criteria for correlation of seams, and (c) to determine the distribution of these elements between organic and inorganic phases of the coal seam. The analytical work on the project is complete. A report containing results is under preparation and will be published in the immediate future.

Certain coal seams from the Nenana coal field were found to contain concentrations of gold; up to 5 ppm in coal ash. These preliminary results certainly warrant analysis of all samples for gold. It is planned to study the distribution of gold in Alaskan coals to enable further insight into the nature of association of gold in coal. A proposal has been submitted to the Office of Coal Research for funding this phase of the research program.

Looking into the future the prospects of increased utilization of Alaskan coals lie in the petro-chemical field for subbituminous coals and as a raw material for metallurgical coke for bituminous coals. It would certainly be necessary to investigate the economic potential of various petro-chemicals that can be produced from coal in the State and for the export market. A proposal to cover this study has been submitted to the Matanuska-Susitna Borough. Oil, coal and natural gas industries could play complimentary roles to each other in fossil fuel energy utilization and development of petro-chemical industries. Coal based petro-chemical plants could supply hydrogen to Alaskan refineries for hydrocracking processes and buy benzene from refineries for production of cyclohexane (raw material for nylon 6 and nylon 66) and styrene monomer (raw material for styrofoam). These are only a few of several possibilities but specific recommendations can only be made through a thorough study of economics involved and market potentials.

Another project could be the preparation of a comprehensive report on coal resources of Alaska based on various U.S.G.S. publications and the analytical data available with MRL. This would be of immense use as a comprehensive source of information for possible investors in Alaskan coal industry and foreign buyers.

Heavy Mineral Investigations

Natural concentrations of heavy minerals or black sands along present and past marine beaches have been investigated in many areas of the continental United States and foreign countries. Some of these deposits represent potential sources of titanium, zirconium, chromium, tin, tungsten, gold, platinum, uranium, thorium, and rare earths. In areas such as the East Coast of Florida, Australia and India, deposits of this nature have been mined successfully for many years.

Knowledge of the location, origin, distribution and grade of mineral constituents in deposits of this type is important to their evaluation, as well as providing information as to possible extensions into the continental shelves. Because nature has provided such basic processes, such as liberation and sizing with an accompanied degree of concentration, these deposits can be attractive from a mining standpoint.

There are a number of areas along Alaska's coastline that offer promise of potential sources of tin, tungsten, gold, platinum, rare earths and other associated heavy minerals. The Mineral Industry Research Laboratory has conducted investigations for individuals on samples obtained from on-shore deposits from Yakataga, Lituya Bay, Cook Inlet, Sitkinak Island, Dillingham, Nome, Yakutat and Tyonek areas. Reports have been sent to the individuals submitting the samples, and a composite report of these investigations is in process of publication.

The Mineral Industry Research Laboratory has collaborated with the Institute of Marine Science of the University in their investigation of the Marine mineral resources of the Alaska continental shelf. Information obtained from on-shore deposits of the Yakutat and Yakataga areas has been useful in an off-shore reconnaissance survey of the Gulf of Alaska continental shelf from Dry Bay west to Cape Yakataga.

Information concerning gold size distribution, especially in the sub-sieve ranges, is important to the evaluation as well as exploitation aspects of beach and off-shore alluvial deposits. A proposal has been submitted to the United States Bureau of Mines to gain further knowledge from this standpoint.

COMPLETED RESEARCH

The Laboratory has been extremely productive this year, as evidenced by the following abstracts of completed research. The available reports are given on page 13.

Factors Affecting Lode Mining in the Fairbanks District

The Cleary Summit, Pedro Dome and Ester Dome Lode Mining areas form a gold Lode Mining complex that comprises the core of the Fairbank's Lode Mining district. An analysis of the factors affecting Lode Mining in the district, including an analysis of minimum grade for an economic venture was undertaken under a contract with the U. S. Bureau of Mines. The Laboratory portion of this study has been completed and submitted to the U. S. Bureau of Mines.

Study of Distribution of Copper Mineralization in Part of the Denali Copper Belt, Alaska Range

A graduate student in Geology, partially supported by MIRL funds, sampled and mapped an area of the Alaska Range. The results of this investigation are contained in a thesis entitled, "Trace Element Copper Distribution and Areal Geology in a Portion of the Clearwater Mountains, Alaska." The study shows that all rock types in the area are abnormally high in trace copper content, an average background being 1000 ppm. Publication has been delayed by the interior flood.

Fairbanks North Star Borough Comprehensive Planning Program

This study was accomplished in cooperation with the Institute of Social, Economic and Government Research. The result of this effort is a synthesis of the economic development potential of natural resources in the greater Fairbanks region. A Report containing the results of this study has been published as MIRL Report Number 8, "Natural Resource Base of the Fairbanks North Star Borough." Funding came from the North Star Borough to the SEG and MIRL.

Development of a Light-Weight Self Potential Unit

A light-weight, low-cost self potential unit has been developed using solid state components. The basic unit, excluding copper sulfate pots, costs approximately \$40, contains batteries which have a shelf life of 10 years and an estimated operation life (based on continuous use for 10 hours per day) of 65 days, and weighs approximately 3 pounds. The unit was developed specifically for the Alaskan prospector who is cost conscious and wants a light-weight instrument to pack in the field. A report is being prepared for publication.

State Technical Services Act of 1965

The Mineral Industry Research Laboratory participated in a study for the Alaska State Department of Economic Development to outline the technological and economic conditions of Alaska, taking into consideration its region, business, commerce and its industrial potential including the identification of the major regional and industrial problems along with the general approaches and methods to be used in the solution to these problems. MIRL participated on an advisory board to establish guidelines for conduct of the project. This project has been completed and published as SEG Report Number 13.

Application of Statistics and Computer Techniques to Ore Deposits

The Mineral Industry Research Laboratory has investigated the application of computers and statistics to mineral deposits in Alaska. Existing programs have been adapted and new ones written for the computers available at the University.

The methods tested are trend surface analysis and geologic model making. An existing coefficient of association program was converted to Fortran IV, but was not applied to an Alaskan problem. A trend surface is a mathematical function that most closely approximates a three dimensional map representing observed data. In geologic model making, regression analysis is used to determine what geologic features are significant as ore controls. Coefficient of association compares samples to each other on the basis of a variable being present or absent.

Trend surfaces were computed for dips and strikes of geologic features (veins, faults, bedrock) for Southeastern Alaska, the Chichagof district, and the Hyder district. Trend surfaces and residual maps were prepared for geochemical data from the Slana district, Alaska. A mineral occurrence model was made for a portion of the Craig Quadrangle, and potential values were computed for cells in the area. Appraisals of potential values by five geologists are compared with those of the model. MIRL Report Number 11 describes this research.

Trend Surface Program for the IBM 360 Model 40 Computer

A Fortan IV trend surface program with polynomial contouring and residual plotting has been adapted to the University of Alaska IBM 360 model 40 computer. The program will compute equations of polynomials of the first through sixth degree, measures of the "goodness of fit" of the surfaces, tabulate original data, x y coordinates and corresponding residuals for each surface; contour each polynomial, and plot original values and residuals for each surface computed.

This program is a useful tool for the study and reduction of geophysical and geochemical data. It has been published as MIRL Report Number 9.

Geochemical Geophysical Investigations, Fairbanks District, Alaska

A final report on a cooperative project in which the Bureau of Mines, U. S. Department of the Interior, provided work in kind for a series of geochemical-geophysical investigations conducted in the vicinity of Cleary Hill, Alaska, has been sent to the publisher.

III FINANCES AND CONTRIBUTIONS

The Mineral Industry Research Laboratory funding for the year may be seen in the following breakdown:

Support provided by the 1967 State Legislature for continued research	\$ 45,000
Usibelli Coal Mine Inc. final payment on a grant of \$25,000 for the establishment of a Coal Research Laboratory	11,500
Grant by the University of Alaska Computer Center for computer time on MIRL projects	1,200
Research project funded by the State of Alaska North Commission for study of the mineral potential of the North	34,500
Contract with the U. S. Department of Interior for a study entitled "Factors Affecting Underground Lode Mining in the Fairbanks District, Central Alaska"	7,908
Cooperative research with the Institute of Social, Economic, and Government Research on a study entitled, "Natural Resource Base of the Fairbanks North Star Borough." Study funded by the North Star Borough	3,600
Cooperative research with Institute of Marine Science on "Sedimentology and Geochemistry of Marine Mineral Resources of the Alaska Continental Shelf"	4,515
TOTAL	\$108,223

The Alaska Division of Mines and Minerals has assisted MIRL projects in various ways. Conversely, a cooperative arrangement permits the use of certain laboratory equipment at operational cost by the Division for Assaying and Mineral Identification.

Assistance from many individuals ranges from financial, statistical and informative data, to properly access. Space does not permit a complete listing of all contributions, but the MIRL staff wishes to acknowledge and extend appreciation for the help received.

IV PUBLICATIONS

Published Reports available from MIRL, College of Earth Sciences and Mineral Industry, University of Alaska, College, Alaska, 99701.

- *ANNUAL REPORT OF RESEARCH PROGRESS, MIRL Report No. 1.
- *THE MARKET POTENTIAL FOR ALASKAN CLAY PRODUCTS, MIRL Report No. 2.
- *ALASKA CEMENT MARKETS AND OPPORTUNITIES FOR REGIONAL PRODUCTION, published as research Monograph No. 4 by the Institute of Business, Economics and Government Research of the University of Alaska in cooperation with MIRL, February 1965.
- PETROGRAPHIC EVALUATION OF COKING POTENTIAL OF SELECTED ALASKAN COALS AND BLENDS, MIRL Report No. 3, July 1965.
- MARKET FOR INSULATION IN ALASKA AND FEASIBILITY OF REGIONAL MANUFACTURE, MIRL Report No. 4, July 1965.
- *ANNUAL REPORT OF RESEARCH PROGRESS 1965, MIRL Report No. 5, January 1966.
- INVESTIGATIONS OF LIGHT-WEIGHT AGGREGATES IN ALASKA, MIRL Report No. 6, December 1966.
- ANNUAL REPORT OF RESEARCH PROGRESS 1966, MIRL Report No. 7, January 1967.
- NATURAL RESOURCE BASE OF THE FAIRBANKS NORTH STAR BOROUGH, MIRL Report No. 8, March 1967.
- FORTRAN IV TREND-SURFACE PROGRAM FOR THE IBM 360 MODEL 40 COMPUTER, MIRL Report No. 9.
- TRACE ELEMENT COPPER DISTRIBUTION AND AREAL GEOLOGY IN A PORTION OF THE CLEARWATER MOUNTAINS, ALASKA, MIRL Report No. 10, May 1967, in print.
- APPLICATIONS OF TREND SURFACE ANALYSIS AND GEOLOGIC MODEL BUILDING TO MINERALIZED DISTRICTS IN ALASKA, MIRL Report No. 11, June 1967.
- GEOCHEMICAL-GEOPHYSICAL INVESTIGATIONS FAIRBANKS DISTRICT, ALASKA, MIRL Report No. 12, in print.
- PRELIMINARY REPORT-MINERAL RESOURCES OF NORTHERN ALASKA, MIRL Report No. 13, November 1967.
- ANNUAL REPORT OF RESEARCH PROGRESS 1967, MIRL Report No. 14, January 1968.
- *Out of print - available at the University of Alaska Library or possibly on loan from the College of Earth Sciences and Mineral Industry.