COST OF EXPLORATION FOR METALLIC MINERALS IN ALASKA-1982

M.I.R.L. Report No. 56

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by the

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Forward

This report prepared by the professional staff of the Mineral Industry Research Laboratory (M.I.R.L.), is a contemporary and detailed source of information relating to the costs of conducting mineral exploration for metallics in Alaska with commentary on the availability of essential services. As such it will serve the needs of established mining companies engaged in exploration ventures as well as newcomers to the Alaskan scene.

In its mission to serve and promote the emergence of a healthy mining industry in Alaska, the Office of Mineral Development identifies a need to generate a relaiable and accurate base for statistical reporting. Much of the substance of this report stems from information supplied by industry in response to questionnaires. I am confident that there will be a strong demand from the private sector for this report. Looking ahead to the next edition for update I would like to make a firm request. Please be forthcoming with constructive criticism and ideas as well as reliable information in response to questionnaires. The quality, reliability and usefulness of this report depends on your cooperation and involvement.

The report is intended as a tool of the mining industry - something that is functionally useful. There will be other projects initiated by the office of Mineral Development designed to inform the public at large about the mining industry and the vital role that it plays in our everyday lives. It is going to be that much easier to do this if some sound hard facts documenting the contribution of mining to the economy of the State of Alaska can be reserved. Your help will be needed in compiling those data to further the goal of having an important and healthy mining component to our economy.

John Simms, Director
Office of Mineral Development

Acknowledgements

Funding for this report was provided by the Office of Minerals Development, Department of Commerce and Economic Development, State of Alaska. The project would not have been possible without the many mineral exploration firms, support businesses, and individuals who took the time and effort to supply the cost data. It is hoped that none of the cost data was taken out of context and that this information will provide a realistic basis for additional mineral exploration and investment in Alaska.

CONTENTS

	Page
Introduction	1
Purpose and scope	1
History of metallic mineral exploration in Alaska	6
Cost data	7
Salaries and personnel	8
Transportation	10
Fixed-wing aircraft	11
Helicopters	11
Commerical air service	13
Boats	13
Tracked and wheeled vehicles	14
Surface and air freight	14
Fuel	15
Camp costs and living expenses	17
Communications	17
Costs of geochemistry	18
Sample costs	18
Sample analysis	19
Contractual services	19
Geophysical surveys	19
Drilling	20
Heavy equipment	20
Miscellaneous	20
Administrative and legal	21

Contingencies 22

Sample of 1981 exploration programs 22

Summary and Conclusions 24

References Cited 26

Appendices

Appendix A - Alaskan 401 certificated air carriers 69

Appendix B - Alaskan air taxi operators registered under part 298 . . . 70

Appendix C - Cost of exploration for metallic minerals - questionnaire for 1982 80

LIST OF ILLUSTRATIONS

Figure

1. Location cost indices for Alaska 5
2. Major airports and fuel distribution centers in Alaska 16

Table

1. Important dates in the history of Alaska mineral exploration and mining 28
2. Moderate budget for family of four by major metropolitan area 34
3. Summary of wages paid to geoscientists who live and work in Alaska 35
4. Adjusted results of wage studies of geoscientists in U.S., including Alaska 37
5. Estimate of professional exploration personnel costs for Alaska during 1982 38
6. Estimating guide for exploration costs adjusted for Alaska, 1982 39

7a. Specifications for small fixed-wing aircraft 44
7b. Specifications for multi-engine fixed-wing aircraft 46
8. Comparison of fixed-wing aircraft cost per hour or per mile between 1973 and 1982 47
9. Specifications for helicopters 48
10. Comparison of helicopter cost per hour between 1973 and 1982 50
11. Cost of round trip business class ticket between major cities in Alaska and various cities in the contiguous states 51
12. Cost of round trip business class airline ticket between various cities and villages in Alaska 52
13. Cost of automobile and light truck rentals for the Fairbanks area, 1982 53
14. Surface and air freight rates between Seattle and various cities in Alaska 54
15. Fuel prices for various distribution centers in Alaska, 1982 55
16. Estimated camp costs for various sizes of field operations . . 56
17. Communication subscription and rental costs in Alaska, 1982 57
18. Comparison of geochemical analytical costs between 1976 and 1982 58
19. Comparison of assay analytical costs between 1976 and 1982 . . 59
20. Comparison of contracted ground and airborne geophysical line traverse costs between 1973 and 1982 61

21. Comparison of contract down hole logging cost between 1976 and 1982 62

22. Comparison of control drilling costs between 1976 and 1982 . . 63

23. Comparison of heavy equipment costs between 1976 and 1982. . . 64

24. Summary of cost, sample of metal exploration programs in Alaska, 1981 65

25. Transportation costs by item from sample of metal exploration programs in Alaska, 1981 67

Introduction

Purpose and Scope

The objective of this study is to provide data on the costs of non-petroleum mineral exploration in Alaska during 1981/1982, based on samples of actual exploration programs as well as published or quoted prices for equipment, supplies, services etc. which are essential to exploration programs. Actual exploration costs were sampled via a questionnaire which was sent to 135 companies active in Alaska. Thirteen replies were received and the total expenditure of those firms on 24 exploration projects was $9 million. An independent sample of only total expenditures (Bundtzen et al., 1982) indicates that approximately $75 million was spent during 1981, thus the cost data sample only represents 12 percent of the total exploration expenditure. Because of the wide variation in the types of programs, the cost data sample may not be representative of entire 1981 cost distribution.

Two important factors must be considered in the analyses of historical exploration cost data. First, each mining firm defines and accrues exploration cost data according to the needs of its management. Second, exploration objectives, methods and geographic areas vary from year to year and thus costs vary with time, technique, and location.

Hilton (1979) reviewed the five specific terms used in the mining industry to describe the different phases of operations. These terms are used to establish accounting standards for the accrual of cost data and are summarized as follows:

1. "Exploration means the search for a mineral deposit ... which appears capable of commercial exploitation by an extractive operation. It includes topographical, geological, geochemical and geophysical studies and exploratory drilling.

2. Evaluation means the determination of the technical feasibility and commercial viability of a particular prospect. It includes determination of the volume and grade of the deposit or field, examination and testing of extraction methods and metallurgical or treatment processes, surveys of transportation and infrastructure requirements, and market and finance studies.

3. Development means the establishment of access to the deposit ... and other preparation for commercial production. It includes shafts, underground drives and permanent excavations, roads and tunnels, advance removal of overburden and waste rock.

4. Construction means the establishment and commissioning of facilities for the extraction, treatment and transportation of product from the deposit. Such facilities include infrastructure, buildings, machinery and equipment.

5. Production means the day-to-day activities directed to obtaining saleable product from the deposit ... on a commercial scale. It includes extraction and any processing prior to sale."

In practice these phases frequently overlap, and in addition costs for a given phase may be accrued in more than one cost center. Cost accounting is further complicated by the carry forward or written-off decision (Hilton, 1979). Within the exploration and evaluation phases, the inconsistencies with respect to the carry forward or write-off decision can be demonstrated by the following cases:

1. Costs incurred before establishing the existence of economically recoverable ore reserves.

2. Costs or acquiring property rights where there are no known deposits or even where deposits do exist.

3. Costs incidental to the acquisition of properties.

4. Costs of development resulting in access, or additional access, to deposits.

5. Costs incidental to a development program (e.g., drilling to establish the limits of a mineral deposit, either within or outside the mine area).

Exploration objectives in the aggregate vary with time due to changes in world-wide supply and demand of minerals. Exploration objectives of individual firms are additionally affected by corporate profits or losses and by changes in financial, production, marketing and management structure.

Mineral deposit models and exploration methods are constantly changing, thus cost comparisons with time must account for the differences in the types of expenditures. During the 1960's and early 1970's a large portion of exploration budgets in Alaska was dedicated to porphyry copper deposits. By the mid 1970's companies in base metal exploration shifted their assets to the search for massive sulfide type deposits. From the late 1970's to present, exploration targets have shifted to strategic and precious metal deposits.

The geographic distribution of exploration expenditures world-wide and within Alaska has affected the cost of exploration in the State. Total mineral exploration expenditures in Alaska rose from less than $10 million per year for the period 1959 to 1973, to over $50 million per year average for the period 1974 to 1982. The rapid rise of expenditures in Alaska during 1974 was the result of a deteriorating mineral investment climate in western Canada. During the initial escalation in expenditures, firms were competing for limited local resources, however during 1981 and 1982 there is adequate personnel and service capacity in the Alaskan mineral industry.

Within Alaska, exploration activity has shifted dramatically over the last 10 years. Prior to 1970 very little activity occurred north of the

Brooks Range. Since 1975 major lead-zinc-silver reserves have been blocked out in that region. During that same time period, most of the historic gold mining districts that were essentially dormant since the 1940's have been re-examined. Unit costs of operations in these diverse areas varied considerably.

Figure 1 shows the location distribution of construction cost factors in Alaska. These factors are based on the cost of construction on the east coast of the U.S. The range of cost factors is primarily a function of distance from supply points and major transportation networks. The data in Figure 1 does not indicate that mineral exploration costs in Alaska will be 1.7 to 4.0 times the cost of exploration on the east coast of the U.S. but it does indicate relative costs in Alaska due to geographic location.

Analysis of costs must be weighed against the benefits to be accrued. Although the assessment of the mineral potential of Alaska is beyond the scope of this report, such an assessment must be made at the same time that an exploration program budget is completed. The necessity for a proper perspective on costs and benefits can be demonstrated by the following case:

> In 1968, with the discovery of 10 billion barrels of oil in the Prudhoe Bay area, the mineral potential of Alaska became very apparent. With the completion of the Trans-Alaska Pipeline System (TAPS) this potential began to be realized, however, at a cost in excess of $10 billion, the pipeline represented an investment equal to 10 percent of the gross value of the oil in the ground. The marketability of such high cost oil placed serious doubts on the viability of the project. By 1980, with world oil prices escalating to $35 per barrel, the cost of TAPS was only 3 percent of the gross value of the oil field and with that perspective the

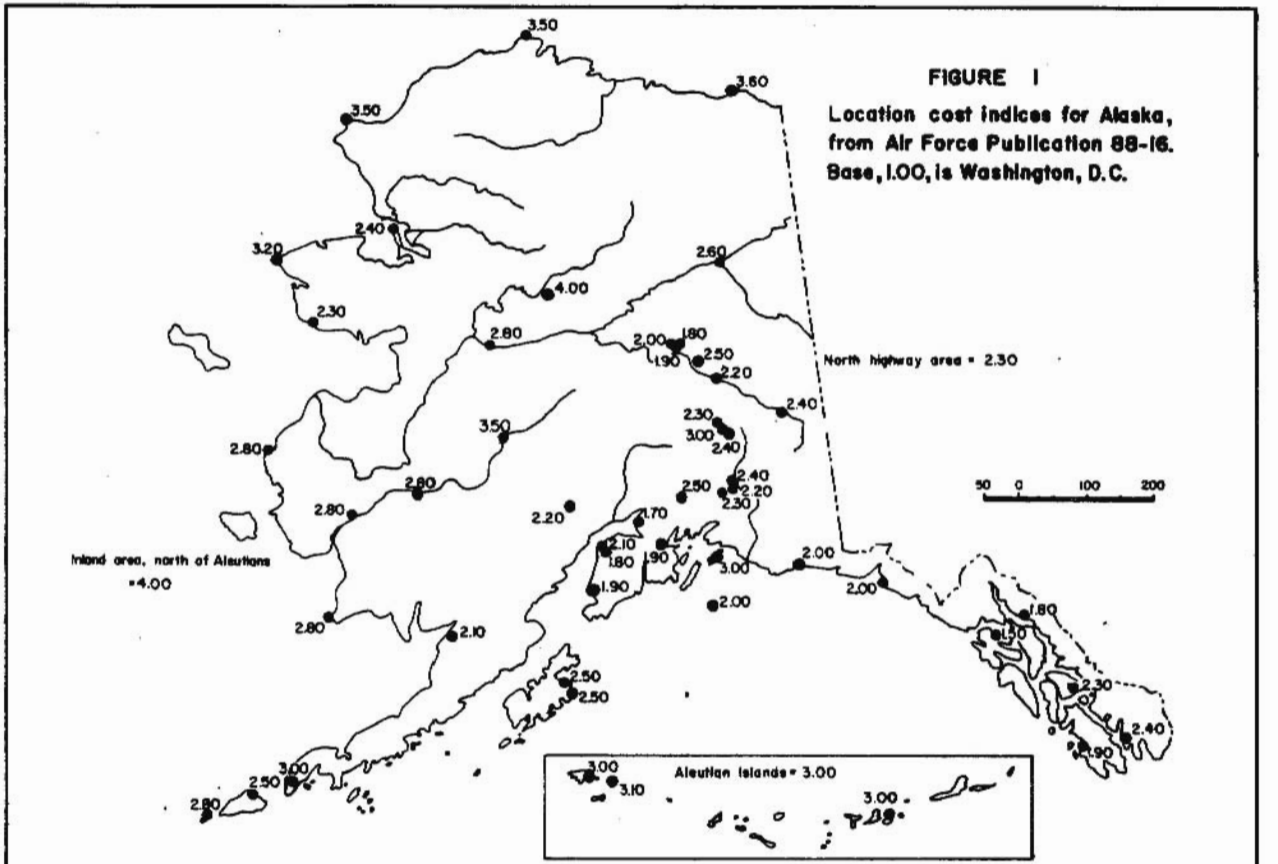

FIGURE 1

Location cost indices for Alaska, from Air Force Publication 88-16. Base, 1.00, is Washington, D.C.

investment decision appeared very good. The gross value of the oil in the ground at world market prices is 35 times the cost of the construction of the pipeline system.

History of Metallic Mineral Exploration in Alaska

Table 1 lists the important dates in the history of mineral exploration and mining in Alaska. The discovery of gold in 1849 by Peter Doroshin, a Russian mining engineer, marked the beginning of mineral exploration in the State, and the development of coal in the Cook Inlet Basin at the same time initiated the mining industry in Alaska. From 1849 to 1958, mineral exploration and discoveries were made primarily by the individual prospector. From 1959 to present, major mineral discoveries have been made generally by either large mining firms or by government geologists. From data by Eakin and Daniels (1980a, 1980b) and Bundtzen et al. (1982, in press), the estimated cumulative mineral exploration expenditure from 1959 to 1981 is approximately $465 million. Bundtzen et al. (1982) estimated that at 1980 price levels the cumulative mineral production of Alaska, exclusive of oil and natural gas for the period 1880-1980, is valued at $20 billion. Since most of the mineral production was prior to 1959 and it is difficult to estimate exploration costs before that date, it is not possible to relate mineral production to exploration costs and success. The cost effectiveness of mineral exploration in Alaska can be measured by a review of the published reserves of the major discoveries since 1959. At current metal prices, the gross metal value of the Brady Glacier, Bond Creek, Arctic, Red Dog, Quartz Hill, Admiralty Island and Lik deposits is in excess of $68 billion. The value of these reserves is three times the current value of the past mineral production of the State and 150 times the cost of all exploration in the State since 1959.

COST DATA

Project Planning and Budgeting

The prime objective of a mineral exploration program is to find mineral reserves and develop the maximum mineral data base at a minimum cost. Program planning is necessary to select from a large number of possible geologic models, methods, and expertise the optimum mixture to achieve this objective. In addition a project manager is confronted with logistic, personnel, environmental, and legal requirements that compete for his time and financial resources. Without sufficient project planning these activities may monopolize the manager's time while critical technical activities are left unattended.

Project budgeting is essential in maintaining cost control and benefit maximization, however it is also an essential part of providing a data base for future project planning. Historic cost data however should be used with caution and must be adjusted with both inflation and geographic location.

A program budget should include the following major cost centers:

1. Salaries and personnel
2. Transportation
3. Fuel
4. Camp costs and living expenses
5. Communications
6. Costs of geochemistry
7. Contractual services

The major cost centers should include sub-accounts to meet individual project and company needs.

In a past report on the "Cost of Exploration for Metallic Minerals in Alaska", Grybeck et al. (1976) concentrated on historic cost data from a

sample of 28 exploration programs in Alaska sampled over a five year period. In this report a balance will be sought between a sample of past exploration activities and a review of individual cost items sampled from suppliers and updated to 1982. Cost indexes have been calculated where possible to show the trends in costs over the periods 1973-1980 and 1973-1982.

Salaries and Personnel

Historically costs of living and wages in Alaska have been higher than in the contiguous states. Table 2 is a comparison of costs of living for a family of four in various major metropolitan areas including Anchorage. Since many mineral industry firms operating in Alaska have major regional offices in Seattle, Denver, or Dallas, a comparison of costs for these areas and Anchorage was also made. The cost of living in Anchorage is 1.23, 1.28 and 1.41 times higher than each of these metropolitan areas respectively.

Since World War II, the largest single employer in Alaska has been the federal government. Even after major oil development in the 1970's, as recently as 1979 the federal government accounted for 22 percent of the jobs in Alaska (Goldsmith and Rowe, 1982). Federal employees have traditionally received a 25 percent non-taxable cost of living allowance thus for a person in the 30 percent tax bracket the effective income is 33 percent over that in the contiguous states. This factor has and will continue to support salaries and costs above those in the contiguous states.

Dillon (1981) compiled data on the wages paid to geoscientists in Alaska and the contiguous states (see Tables 3 and 4). Dillon concluded that "lead geologists and above in the employ of the State of Alaska are paid significantly less than their colleagues working in industry" (Table 3). Beginning and experienced field assistants as well as beginning and working geoscien-

tists in the employ of the state are paid more or the same as their counterparts in industry.

Table 4 (after Dillon, 1981) lists the average wages paid to geoscientists in the U.S. including Alaska during 1980. The wages "adjusted for Alaska for 1981" are 1.43 to 1.48 times the U.S. average for 1980. The wages "adjusted for Alaska for 1981" are also 1.07 to 1.36 times the overall average of wages paid as presented in Table 3.

Table 5 is an estimate of professional personnel costs for Alaska for 1982 based on the overall average of wages paid in 1981 (Dillon 1981) and indexed for a 7 percent pay increase.

Although salaries are not the highest single cost in an exploration budget, personnel expenditures are the most important item in an exploration program. People find ore deposits and experienced personnel greatly increase a firms probable success rate. Exploration firms operating in Alaska generally find that they must compete vigorously for the limited number of professional personnel with experience in Alaska. The University of Alaska has been a prime source of senior personnel as well as beginning geoscientists, engineers, and field assistants. University earth scientists and mineral engineers are usually available for up to 3 months of non-university consulting work. Generally there are between 50 to 75 graduate and post graduate students available for summer employment. During the field seasons between 1975 and 1981, University of Alaska undergraduates in geology, geophysics, geological engineering, and mining engineering, each had on the average two to three summer job offers.

Persons with Alaska field experience have a significant competitive advantage for the following reasons:

1. Exposure to unpublished Alaskan mineral exploration information.
2. Direct knowledge of complex and poorly documented geology.
3. Familiarity with the extremes of field conditions.
4. First hand knowledge of personal equipment essential to safe and efficient field operations.
5. Familiarity with the geography of Alaska.

Table 6 is an estimating guide for exploration personnel costs indexed for Alaska for 1982. The guide can provide a basis for the design of a mineral exploration program budget.

In addition to professional personnel, several categories of labor are usually essential to an exploration program. Union wages for a few pertinent positions are as follows:

1.	Chief cook	$ 19.68
2.	Assistant cook	19.25
3.	Common laborer	18.82
4.	Miner	20.24
5.	Miner helper	19.73
6.	Diamond driller	19.97
7.	Driller helper	19.49
8.	Tractor operator D-6 thru D-9	22.45

Additional employer costs average approximately $5.50 per hour. On the average wages have increased to about twice the 1973 level.

Transportation

Transportation costs are usually the single largest item in an exploration budget in Alaska and have ranged from 25 to 30 percent of total budget

over the last 10 years. Because there is only a limited road network in Alaska most exploration programs are dependent on air transport. Long flying distances, limited landing facilities and high fuel costs contribute to high air transport costs. In addition to aircraft the exploration industry has utilized wheeled and tracked vehicles and boats. Boat transport has been most significant in southeastern Alaska and to a lesser extent in the Gulf of Alaska, the Aleutian Islands, and the Yukon River system.

Fixed-wing aircraft Fixed-wing aircraft are the most important source of transport to the majority of villages in Alaska. Access is provided by both scheduled flights as well as charter services from a large number of air taxi operators. Appendix A is a list of Alaskan 401 Certificated Air Carriers and Appendix B contains a list of Alaska Air Taxi Operators registered under part 298.

Table 7 gives the specifications for most of the fixed-wing aircraft available in Alaska. Table 8 is a comparison of fixed-wing aircraft costs between 1973 and 1982. For that ten year period cost increased from 1.5 to 2.75 times depending on the type of aircraft.

Since individual aircraft often undergo modifications to meet the specifications of individual operators caution is recommended in comparing Table 7 to individual aircraft. Similarly there is often a range of operating costs to account for specific aircraft capabilities (see Table 8).

Helicopters While small and large fixed-wing aircraft are used primarily to transport personnel and supplies respectively to the remote exploration camp, helicopters are essential component of most daily operations of the field program. Helicopters generally account for 70 percent of the transportation costs and average about 85 percent of the total aircraft support budget.

Helicopters are used primarily for:

1. Transporting geologists and geophysists to and from traverse points.
2. Transport of geochemical sampling crews.
3. Transport of drilling equipment and crews.

Table 9 lists the specifications of helicopters and Table 10 is a comparison of costs of helicopter operations between 1973 and 1982. Two important trends can be inferred from the data. First, of the ten major types of helicopters in use in 1982 only four were in use in 1973. Second, the cost of these four aircraft types increased from 1.29 to 2.06 times over the period 1973 to 1982. This data suggests increasing efficiencies with new equipment developments. These efficiencies are considerably greater than those achieved for fixed-wing aircraft.

Due to high hourly operating costs and fuel consumption rates, helicopter costs can be significantly lessened by careful planning. Lost time for refueling and excessive fuel costs can be reduced by the establishment of strategic fuel caches. Operational efficiencies can also be achieved by providing all ground personnel with hand held VHF transceivers with aircraft frequencies. Personnel pick up time to also greatly reduced significantly by providing personnel with brightly colored signal cloth or clothing.

In addition to selecting the proper aircraft for the job, it is essential to insure that the helicopter pilot is experienced in field operations and the climatic conditions (mountain flying, southeast fog and rain, severe wind areas, etc.) in which a project will be operated. Similarly all personnel must be briefed in helicopter safety as well as intelligent use of the equipment. A single disregard for safety can endanger several lives or cripple a field operation, while a few minute delay for each landing and take off can add up

to many extra hours of flying time over the duration of a major project.

Commercial Air Service Commercial air service to and from Alaska is available on a daily basis to major cities in the contiguous states as well as London and Tokyo. The cost of a round trip business class air ticket to major cities in the contiguous states is given in Table 11.

Commerical air service is also available to many villages and towns in Alaska from the major population centers of Anchorage, Fairbanks, Juneau, and Ketchikan. Costs of intrastate commercial air service tickets are given in Table 12. Figure 2 gives the location of major airports and fuel distributors centers in Alaska. These major airports usually have several air taxi operators who can provide chartered aircraft.

Boats Boats continue to be an important means of transportation in the coastal areas of Alaska, particularly in southeastern Alaska. Since boats can operate in rainy and overcast conditions they are a more reliable means of transport than aircraft. Because coastal areas are generally subject to heavy rainfall, and are usually covered by thick vegetation, outcrops are usually limited to tidal areas and to a lesser extent small stream drainages and ridge tops. Tidal outcrops are readily accessed by boat while stream and ridge traverses require helicopter support.

Boat supported operations are highly variable and equipment ranges from large vessels that provide living, office, and helicopter base support to small outboard powered craft. Due to the custom nature of each operation, unit costs are not available as they are for other forms of transport.

River boat transport has been a traditional means of access in interior Alaska. Small craft with a capacity of 4-6 passengers are usually available in the larger villages along the Yukon, Tanana, and Kuskokwim rivers. Rates range from $250-350 per day.

Tracked and Wheeled Vehicles Light tracked vehicles were first used on a large scale during the exploration of the Naval Petroleum Reserve No. 4 during the period 1944-1953. These vehicles were indispensable in the transport of personnel and equipment over the tundra covered north slope of Alaska.

Modern tracked vehicles are more reliable than the vehicles used in the 1940's and 1950's and logistic support and drilling rig transport are the main uses of tracked vehicles today. The cost of a new machine suitable for a medium size rotary or diamond drill rig is approximately $140,000. Generally such equipment is not readily available on a rental basis.

Heavy tractors without dozer blades are utilized for winter transport of bulk freight including fuel and for the transport of sled mounted drill rigs. The method is slow but cost effective in cases in which bulk freight must be transported to areas lacking airstrips to accommodate large multi-engine aircraft. The cost of tractor rental is covered in the section on contractual services.

The primary and secondary road network in Alaska is very limited. Most of the secondary roads and trails are in poor condition during the winter and spring thaw periods. Four-wheel drive vehicles are useful during these periods; however, wheeled vehicles have limited utility on many tractor trails, particularly on trails over tundra.

Cost of automobile and light truck rentals are given in Table 13. The data is an average cost for the Fairbanks area. Rental vehicles are available in all the major cities at slightly different rates.

Surface and Air Freight Table 14 lists the surface and air freight rates between Seattle and various cities in Alaska. These are "average" rates based on a mix of the various type of freight that may be included in an exploration

program. Since rates vary with the types of material or equipment transported, actual rates will vary from the rates in the above table.

Fuel

Fuel costs F.O.B. the distributor are usually a small percentage of the total cost of transportation however a major portion of the transportation budget is usually allocated to the transport of fuel to the field operation. The location of major fuel distribution centers is given in Figure 2 and the price of fuel at these centers is listed in Table 15.

The availability of fuel in Alaska is a function of the season. Fuel orders should be made well in advance of the field program. Since resupply to distribution centers is a lengthy process, adequate amounts of fuel for an entire program must be secured in advance. The cost of down time of equipment and loss of personnel efficiency due to inadequate fuel supply is many times the cost of excess fuel inventories.

Fuel caching within the field operational area is an important techinique for decreasing transportation and lost time costs. Fuel caches should be established with the largest cargo aircraft possible or by tracked vehicles. The caches should be supplied during the late winter to take advantage of the flexibility of operating with ski equiped aircraft or over frozen tundra. Completing the caching operation before the field work begins also decreases the chance of lost field time due to inadequate supplies.

Tables 7a, 7b and 9 list the specifications and fuel consumption of fixed-wing aircraft and helicopters respectively. Care must be exercised in estimating fuel consumption since individual aircraft modifications can affect consumption rates.

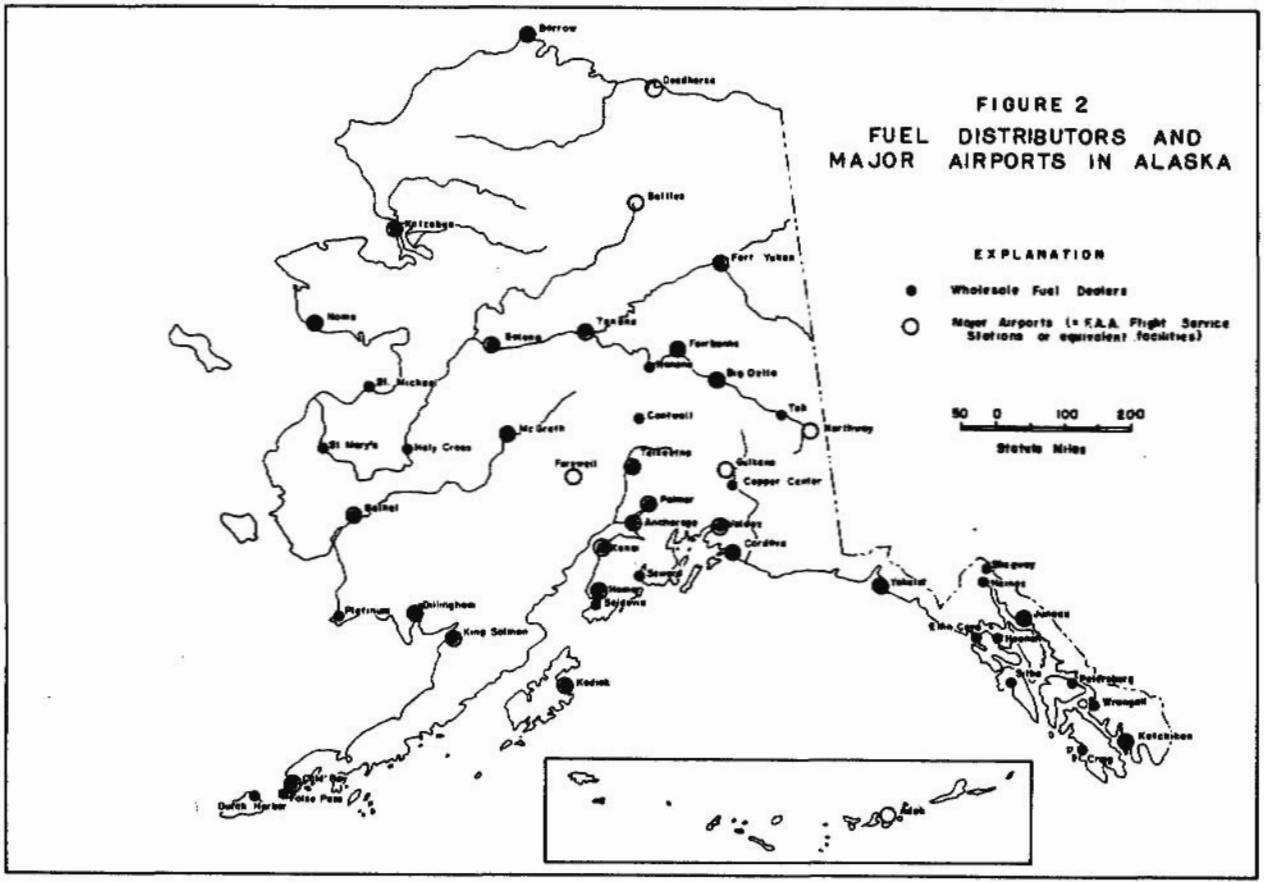
FIGURE 2
FUEL DISTRIBUTORS AND
MAJOR AIRPORTS IN ALASKA
EXPLANATION
Wholesale Fuel Dealers
Major Airports (= F.A.A. Flight Service Stations or equivalent facilities)
50 0 100 200
Statute Miles
Barrow
Deadhorse
Bettles
Kotzebue
Fort Yukon
Nome
Emmonak
Tanana
Fairbanks
Big Delta
St. Michael
Tok
Northway
Cantwell
McGrath
St. Mary's
Holy Cross
Talkeetna
Gulkana
Copper Center
Farewell
Palmer
Bethel
Anchorage
Cordova
Kenai
Seward
Homer
Soldotna
Yakutat
Sitka
Petersburg
Wrangell
Ketchikan
Dillingham
King Salmon
Kodiak
Dutch Harbor
Cold Bay
Adak

Camp Costs and Living Expenses

Camp costs and living expenses account from 5 to 15 percent of the total exploration budget. Costs vary not only due to location but also with the particular personnel policy of the exploration firm. Some firms emphasize abundant camp facilities and variety of menu as a means of enhancing personnel recruitment. The small marginal cost of comfortable living conditions and good food is usually offset by increased productivity and ease of personnel recruitment.

Table 16 lists estimated camp rental cost and cost of food. These costs do not include transport of the camp facilites or food to the field location or the cost of food preparation. Transportation cost can be estimated from the data presented in Tables 7, 8, 9, 10, and 14 and preparation costs from the data provided in the above section on wages.

Living expenses in the major cities can exceed those in the field camp. Accommodations in the better hotels range from $45 to $70 per day and food costs may average $30 per day. Food and lodging at roadhouses along the highway systems will total approximately $50 to $70 per day.

Communications

Communications may seldom exceed 3 percent of the exploration budget but are essential in project planning. Communications are necessary from both a safety and morale standpoint but also can be a major factor in decreasing transportation, and resupply cost.

Long range communications can be supplied by high frequency singe-side-band radios (SSB). Radio communications can be linked to telephone systems for a minimal cost.

Air to air and air to ground communication can be achieved thru very high frequency (VHF) transceivers. Communications are generally limited to line of sight and a maximum of 100 miles. VHF transceivers are essential to all ground personnel that must depend on fixed-wing or helicopter support. Pickup times can be cut to a minimum and in the case of an emergency a VHF transceiver may become a life saving device.

Communications rental costs are given in Table 17. VHF transceivers are generally available on a limited basis and provisions for rental should be made far in advance of the field program. VHF transceiver purchase prices range from $350 to $800 thus for extended programs purchasing is a cost effective option to rental.

Costs of Geochemistry

Sample Costs The cost of geochemical sampling are difficult to delineate since these costs are usually grouped with other field expenses. Geochemical sampling in Alaska whether it be stream sediment, pan concentrate, soil, or rock is usually supported by a helicopter. This activity normally accounts for a majority of the helicopter time and cost, thus sampling is a major cost item.

Flying time to the sample site is nominal compared to the landing, sampling, and take off times. Unit costs of geochemical sampling can be minimized by:

1. Selection of an appropriate helicopter.
2. Selection of a pilot experienced in geological sampling.
3. Strategic location of fuel resupply sites.
4. Adequate air to ground communications.
5. Planning of sample density and sites.

6. Training of sampling personnel in sampling technique as well as methods of navigation and communication.

There are several factors that the project manager has little control over yet these may greatly affect the cost of geochemical sampling. First, geologic variability will affect the sample density thus the number of required samples. Second, topography and vegetation will determine the availability of landing sites which in turn will affect transport costs. Recent experience indicates that unit costs can range from $40 to $150 per sample for stream and pan concentrate sampling.

Sample Analysis Tables 18 and 19 list the cost of geochemical and assay analytical costs respectively. From 1976 and 1982 analytical costs have only increased by a very small amount. This has been the result of increased productivity due to new technology. In some cases levels of detection have improved while productivity rates of sample analysis have increased thus making geochemistry a very attractive technique from a cost basis.

Contractual Services

Geophysical surveys The U.S. Geological Survey and the Alaska Division of Geological and Geophysical Surveys began a program of aeromagnetic surveys in Alaska in 1970. This work is based on inch-to-the-mile topographic maps with flight lines at 0.75 mile spacing and an elevation of 1000 feet above ground.

Regional aeromagnetic and gravity surveys have been compiled at 1:1,000,000 scale. Although the data bases are far from complete they do provide a framework for more detailed geophysical surveys.

Table 20 is a comparison of contracted ground and airborne geophysical surveys for the period 1973 to 1982. Labor intensive ground surveys increased

the most during this time period and this can probably be attributed to increased labor costs without increases in productivity.

Table 21 is a comparison of down hole logging cost between 1976 and 1982. These services are not readily available in Alaska and the cost data is primarily from Hoskins and Green (1977) and Hoskins (1982).

Drilling Drilling costs may range from 0 to 25 percent of the exploration budget. Unit costs of drilling have increased from 1.32 to 2.80 times the 1976 levels of Hoskins and Green (1976). Grybeck et al. (1976) reported a limited amount of drilling cost data however this data is not easily compared with Table 22.

In 1973 there were very few drilling programs in the state but in 1982 there are over 50 diamond drilling rigs available for contract. This fact reflects a change in mineral exploration programs in Alaska from those concentrating on geologic and geochemical reconnaissance to programs of property assessment and evaluation.

Heavy Equipment Table 23 is a comparison of heavy equipment costs between 1976 and 1982. The 1982 cost data is an average for the Fairbanks area and includes operator plus fuel but neither mobilization nor room and board costs for the operator. As more projects progress to the evaluation stage heavy equipment rental costs will form a larger portion of the total exploration expenditures in Alaska.

Miscellaneous Engineering and geological consultants are available and are listed in the phone directories of the major cities. Consulting fees range from $250 - $450 per day. These rates do not include transportation or room and board charges.

Contract aerial photography services are available to supplement existing 1:63,360 and 1:40,000 scale photography available from the U.S. Geological

Survey. Due to the great variability in cost of photography with respect to project location and size, costs per line mile are not available. There are several firms in Alaska providing services and are listed in the major phone directories.

For any medium or large scale field operation, expediting services are essential. Expediting can be accomplished by a person assigned or hired for that purpose or may be accomplished through contractual services. Expediting services are available in the larger cities or may be secured through an air carrier as part of the logistic support. For a 15-20 man camp or larger, a full time equivalent position should be budgeted at $200 to $250 per day.

Sources of supply and services can be found in the Alaska Petroleum and Industrial Directory (1980) and the Alaska Miners Association Service Directory 1981-1982. Basic data on Alaska may be found in The Alaska Statistical Review 1982.

A major new contractual cost item not included in Grybeck et al. (1976) is the cost of base-line ecological studies. These investigations are becoming a significant item in the exploration phase as well as in the development phase. Actual costs are highly variable and will depend on the environmental sensitivity of the area. Firms in Alaska conducting ecological surveys can be found in the above directories.

Administrative and Legal

Administrative and legal costs are often overlooked in preparing an exploration budget. Administrative costs may appear more significant to top level management than to the project geologist or engineer however such items as V.I.P. visits to the field area may make the project manager more cognizant

of their existence. Project planning changes can result in major administrative costs and these should be related to the exploration budget.

Administrative costs have increased in all sectors of the economy due to the increased requirements for businesses to comply with government regulations. The State of Alaska Directory of Permits provides a listing of all state and federal permits as well as the description, requirement, authority, and contact for each permit.

Legal fees may become a significant budget item with respect to property acquisition, access and environmental problems. These costs are also highly variable thus a unit cost per project is not a meaningful number at this time.

Contingencies

A contingency factor should be added as a percentage of total budget. Companies new to Alaska should use larger factors while those with many years experience have a data base for the projection of costs. Hoskins (1982) suggests 10-20 percent of the budget as a contingency factor. If all of the above items have been included in the project planning then an average of 15 percent is a reasonable percentage for firms with a history of operations in Alaska.

Sample of 1981 Exploration Program

Of the 135 cost of exploration questionnaires sent out for 1981, 13 replies were received and these included expenditures for 24 individual exploration programs. An independent sample of only total exploration expenditures was made by Bundtzen et al. (1982) and it was concluded that the total mineral exploration expenditure in Alaska for 1981 was $75 million. The individual cost data sample represents only 12 percent of the total estimated

expenditures. Reasons for the low response rate on the cost data questionnaire may include a perception that this was simply another government interference in the affairs of private industry and an aversion for completing a lengthy and difficult to interpret form that provided no immediate reward to the firm providing the data.

A summary of the sample expenditure data for metal exploration programs in Alaska during 1981 is given in Table 24. The total of the 24 programs reported for 1981 was more than twice the total of the 28 programs reported for 1973 by Grybeck et al. (1976),

During 1981, transportation continued to be the largest item at 25 percent of total expenditures. In 1973 transportation accounted for 30 percent of total expenditures. Table 25 lists the transportation costs by item for 1981. Seventy percent of the total transportation expenditure reported in 1981 was allocated for helicopter support. This was comparable to the transportation cost distribution for 1973.

Salary expenditures increased from less than 20 percent of total budget in 1973 to 23 percent in 1981. Similarly drilling expenditures increased from 13 percent of budget in 1973 to 15 percent in 1981. The other major item reported in 1981 was miscellaneous expenditures. This may represent an inadequacy in the design of the questionnaire, limited accounting methods used by the reporting firms or a combination of both.

There was a shift in the types of programs from a majority concentrating on reconnaissance geology in 1973 to a predominance of assessment and evaluation in 1981. Although total mineral exploration in Alaska in 1981 was near the 1979 and 1980 levels, low metal prices will probably cause a notable decline in 1982. Precious metals were the main target for 1981 and some of the medium to large size firms were active in placer as well as hard rock

exploration. Even though many firms expect lower budgets for 1982 none of the firms replying to the 1981 questionnaire indicated plans to terminate their Alaskan operations.

Mechanical failures and weather accounted for most of the lost time during 1981. Total lost days accounted for 20 percent of the 1981 field season. Weather conditions for 1981 were more severe than the previous 8 years thus the lost time for 1981 is probably not representative for the period 1973 to 1981.

Appendix C is a questionnaire for the cost of exploration for metallic minerals for the 1982 field season. It is intended that the enclosed questionnaire be easily and quickly completed by each project manager, utilizing his records. It is not intended that a significant amount of time be spent unearthing precise receipts, approximate answers are sufficient, particularily where the in-house accounting methods are incompatible with the questionnaire.

Please add additional or incidental cost information which you feel may benefit another project manager about to plan an Alaskan project, or is distinctive of the region of Alaska in which you operate.

Summary and Conclusions

Mineral exploration activity in Alaska has increased considerably over the period 1973 to 1981. Costs have generally increased however not all cost items increased equally. Low metal prices and decreased revenues make it imperative that mineral exploration firms maintain effective cost control. The principal of management by exception dictates that major cost items receive the attention of exploration managers.

Over the above 9 year period transportation, salary and drilling costs have dominated exploration budgets. Helicopter costs account for 70 percent of transportation costs thus cost savings may be realized by careful planning of field logistic operations. Wages and salaries are the second largest cost item and probably account for 25 percent of the average exploration budget. Personnel cost control can be exercised by care in recruitment and by insuring productivity through intrinsic as well as extrinsic rewards. Support of work study programs and graduate research as part of the employment opportunity can be effective means of securing quality personnel at minimum costs. Drilling expenditures will continue to increase as a percentage of total budget as mineral exploration programs shift from the reconnaissance to the assessment stage. Increased availability of equipment, new technology, and competition will help to decrease the rate of drilling cost increases. Detailed mapping of prospects before drilling will also mitigate excessive drilling expenditures.

Costs for mineral exploration in Alaska have not risen at a rate greater than the general price levels of other economic activites. Exploration success rates have increased markedly over the last 9 years. The ratio of the value of in-place metal reserves to total exploration investment is much greater than the ratio of the value of in-place oil to total petroleum investment in Alaska.

There are many factors that have and will to continue to affect mineral development in Alaska, but on a cost basis the state continues to be an attractive place to invest exploration dollars.

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TABLE 1. Important dates in the history of Alaskan mineral exploration and mining (after Wolff 1964 and Hawley and Whitney, 1977).

Year	Event
1849	Peter Doroshin, Russian mining engineer working for the Russian American Company, mined coal on Cook Inlet and prospected for gold on Russian River, Kenai Peninsula. Otherwise, Russian American Company was indifferent or hostile to mineral development.
1862	Buck Choquette found placer gold in small amounts on the bars of the Stikine River.
1867	Copper discovered on Kasaan Peninsula.
1870	Placer gold found around Sumdum Bay, southeastern Alaska.
1871	Placer gold found in the Cassiar district, northern British Columbia, bringing many prospectors to the Alaskan Coast.
	Placer gold found near Wrangell, southeastern Alaska.
1872	Gold quartz found near Sitka; named "Stewart Mine."
1873	Two parties, headed by Arthur Harper and Jack McQuesten, reached the Yukon Basin via the MacKenzie River.
1875 (approx.)	Placer gold found on Shuck River, Windham Bay, southeastern Alaska, reportedly by Max Silva.
1875	Upper Yukon reached by Chilkoot Pass for first time.
1877	5 Stamp mill erected at Stewart Mine.
1879	John Muir and S. Hall Young explore southeastern Alaska Coast south of Glacier Bay, reported geology favorable for gold lodes.
1880	Joseph Juneau and Richard T. Harris, grubstaked by George E. Pilz of Sitka and Hull Brothers of San Francisco, discover placer and lode gold at present site of Juneau (>6,500,000 oz Au).
1882	First stamp mill at Treadwell Mine, Douglas Island.
	First stamp mill on the mainland, at Ebner Mine, Juneau.
1884	Lode gold found at Unga Island in southwestern Alaska (>100,000 oz Au).

TABLE 1. (continued)

1886	Lode gold discovered at Berners Bay, southeastern Alaska.
1886	Howard Franklin finds gold on Fortymile River and on Franklin Creek (>400,000 oz Au).
1887	Beach placer gold mined at Yakutat Bay and Lituya Bay (>18,000 oz Au).
1888	Placer gold found on Resurrection Creek, Kenai Peninsula (>125,000 oz Au).
1893	Pitka and Sorresco discover placer gold on Birch Creek (Circle District >700,000 oz Au).
	John Mynook discovers placer gold in Rampart district (>80,000).
	Placer gold found on Tramway Bar, upper Koyukuk.
1896	Placer gold discovered in Klondike district, Y.T., independently by Robert Henderson and George W. Carmack.
1897	Placer gold found on Ophir Creek, Seward Peninsula (>700,000 oz Au).
1898	Klondike stampede. Placer gold found in Porcupine district near Haines (>53,000 oz Au).
1898	Placer gold found at Nome, Seward Peninsula by Jafet Lindeberg, Jon Brynteson, and Eric O. Lindblom (>6,000,000 oz Au).
	Kobuk stampede (>20,000 oz Au).
1899	Upper Koyukuk placers discovered.
	Nome beach gold discovered.
	Copper discovered at Kennicott.
1889–1900	First shipments of copper from Prince William Sound.
1900	Placer tin found on Seward Peninsula.
1902	Placer gold discovered in Tanana (Fairbanks) district by Felix Pedro (>7,500,000 oz Au).
1903	Placer gold discovered in Bonnifield district (>45,000 oz Au).

TABLE 1. (continued)

1903	Placer gold found at Denali (Valdez Creek) on upper Susitna River (>40,000 oz Au).
	Lode tin discovered at Lost River, Seward Peninsula.
1905	Placer gold found in Kantishna district (>55,000 oz Au).
	Copper mining on Prince of Wales Island begins.
	Copper smelter begins three years of operation at Hadley.
1906	Placer gold found in Tenderfoot district (>97,000 oz Au).
	Placer and quartz gold found in Chandalar district by Frank Yasuda and Thomas G. Carter, partners (30,000 oz Au).
	Gold in quartz found in Willow Creek district (>650,000 oz Au).
1906-07	Placer gold found on Ganes Creek, Innoko district (>350,000 oz Au).
	Placer gold found about this time in Talkeetna (Yentna) district (>115,000 oz Au).
1907	Placer gold found in Ruby district, although little activity until 1910 when gold discovered on Long Creek (>389,000 oz Au).
	Gold discovered on Nolan Creek, Upper Koyukuk district (295,000 oz Au).
1909	Placer gold discovered in Iditarod district by John Beaton and W.A. Dikeman (>1,300,000 oz Au).
	Placer gold discovered on Klery Creek, Kiana, Kobuk district.
1910	Placer gold discovered near Hughes, middle Koyukuk (209,000 oz Au).
	Gold bearing quartz found at Valdez.
1900-1914	Lower Kuskokwim, Arolik River and Wattamus Creek stampeded several times (>240,000 oz Au).
1910-1920	Several mercury deposits found in Kuskokwim region.
1911	Placer gold found on Hammond River, Upper Koyukuk.
	First copper shipped from Kennicott.

TABLE 1. (continued)

1912	Placer gold discovered at Chisana (Shushana), (>45,000 oz Au).
1913	Placer gold discovered at Nelchina.
	Placer gold discovered at Marshall, lower Yukon.
1914	Placer gold discovered in Tolvana district (Livengood), (>380,000 oz Au).
1915	Large scale gold quartz mining started at Juneau.
1915	Copper-nickel found on west Chichagof and Yakobi Islands.
	Stepovich tungsten deposits found by Albert Johnson.
	Stampede antimony deposit.
1915-1916	Steele Creek tungsten area discovered.
1916	Chromite shipped from Red Mountain and Claim Point, Kenai Peninsula; these were discovered before 1909.
1918	Premier Mine in British Columbia, across border from Hyder district discovered, accelerated prospecting in Hyder district.
1921	Barometer and DeCourcy mercury deposits discovered in Kuskokwim province.
1922	Bluff mercury deposit, Seward Peninsula.
1924	Alaska Railroad completed, bringing rail tranportation to the Interior; coal mining in Interior made possible.
1924	Large scale dredging program at Fairbanks planned.
1926	Placer platinum discovered at Goodnews Bay: small scale mining until 1934 when mining with mechanical equipment began, (>575,000 oz Pt).
1927	Katagi Lake mercury deposit, Kuskokwim Province.
1930	Gold in quartz discovered at Nabesna.
	Copper mining in Prince William Sound ended.
1933	Red Devil mercury deposit, Sleetmute area.
1933-34	Price of gold increased from $20.67 to $35.00 per ounce.

TABLE 1. (continued)

1941	Cinnabar Creek group located, Kuskokwim Province.
1941-45	Intensive investigation by Federal and Territorial agencies of known strategic mineral deposits.
1942	Gold mining prohibited by law because of war.
	Yellow Pup tungsten deposit, Fairbanks district.
1943	Oil exploration started in Arctic; private oil exploration prohibited.
1945	Gold mining again allowed by law.
1945	War ended, inflation adversely affected resumption of gold mining. Private oil exploration allowed.
1952-1955	Rhinehart Berg delineates major copper mineralization in Kobuk (Ruby Creek) district.
1955	Don Ross and Kelly Adams discover uranium thorium mineralization at Bokan Mountain, southeast Alaska, (120,000 tons ore > 1.0% U_3O_8.
1957	Rhyolite mercury deposit, Kuskokwim Province.
1958	Jack Egnaty discovers White Mountain mercury deposit, southwest Alaska.
	Brady Glacier copper-nickel deposit discovered by major mining syndicate (100 million tons of 0.5% Ni, 0.3% Cu, plus Pt and Co).
	Bond Creek copper-molybdenum deposit in northern Wrangell Mountains located by major mining company, (320 million tons of 0.35% Cu and 0.03% M_0S_2).
1962	Beryllium discovered in Lost River area, Seward Peninsula during reexamination of the tin deposits by U.S.G.S.
1965	Arctic copper deposit is located and reserves delineated by major mining company (30-35 million tons of 4% Cu, 5.5% Zn, 1% Pb, and 1.5 oz/ton Ag).
1965-1968	Denali copper deposit, Alaska Range located by major syndicate.
1970	Red Dog Zn-Pb-Ag deposit discovered by U.S.G.S., (85 million tons of 17% Zn, 5% Pb, and 2.4 oz/ton Ag).

TABLE 1. (continued)

1970	Haines Ba-Pb-Zn deposit located by prospector Merrill Palmer
1974	Sun deposit, Brooks Range Copper Belt located by major syndicates.
1975	Quartz Hill molybdenum deposit, Southeast Alaska, located by major mining company, (1.5 billion tons of 0.2 to 0.35% MoS_2).
	Zn-Cu-Au-Ag massive sulfide deposits located on Admiralty Island by major mining company near earlier prospector discoveries. (>3.1 million tons of 10% combined Pu-Pb-Zn, 12 oz/ton Ag and 0.12 oz/ton Au).
1976	Dall trend, southwest of McKinley area discovered by U.S.G.S. and U.S.B.M. contrator.
1977	First ore-grade drill intercept in the Red Dog area, northwestern Brooks Range by major mining company, (Lik deposit 18 million tons of 10% combined Pb-Zn and 3 oz/ton Ag).

Table 2. Moderate budget for family of four by major metropolitan area (after U.S. News and World Report, 1982)

Area	Budget	Budget Index Dallas = 100	Budget Index Denver = 100	Budget Index Seattle = 100
Anchorage	$31,890	1.41	1.28	1.23
Atlanta	23,273	1.03	0.94	0.90
Baltimore	25,114	1.11	1.01	0.97
Boston	29,213	1.29	1.18	1.13
Buffalo	26,473	1.17	1.07	1.02
Chicago	25,358	1.12	1.02	0.98
Cincinnati	25,475	1.12	1.03	0.98
Cleveland	25,598	1.13	1.03	0.99
Dallas	22,678	1.00	0.91	0.88
Denver	24,820	1.09	1.00	0.96
Detroit	25,208	1.11	1.02	0.97
Honolulu	31,893	1.41	1.28	1.23
Houston	23,601	1.04	0.95	0.91
Kansas City	24,528	1.08	0.99	0.95
Los Angeles	25,025	1.10	1.01	0.97
Milwaukee	26,875	1.12	1.08	1.04
Minneapolis-St. Paul	25,799	1.14	1.04	1.00
New York City	29,540	1.30	1.19	1.14
Philadelphia	26,567	1.17	1.07	1.03
Pittsburgh	24,717	1.09	1.00	0.96
St. Louis	24,498	1.08	0.99	0.95
San Diego	24,776	1.09	1.00	0.96
San Francisco	27,082	1.19	1.09	1.05
Seattle	25,881	1.08	1.04	1.00
Washington, D.C.	27,352	1.21	1.10	1.06

Table 3. Summary of wages paid to geoscientists who live and work in Alaska
(after Dillon 1981)

Position	Qualifications and responsibilities	Geologist Respondents	Geologist Avg. mo. wage	Geologist Benefits[1]	Geophysicist Respondents	Geophysicist Avg. mo. wage	Geophysicist Benefits
Beginning field assistant	Beginning, seasonal, field geoscientist with some training in geosciences (no degree required); duties mainly involve camp operations.	10	Range	1000-1600	105-600		
		10	Overall avg	1370	321		
		7	Industry	1350	341		
		3	Govt.[3]	1419	257		
		1	State[4]	1660	448		
Experienced field assistant	Seasonal field geoscientist with 2 or more seasons field experience[2] and college training[2]; duties mainly geologic.	10	Range	1300-1900	145-644		
		10	Overall avg	1672	374		
		7	Industry	1657	398		
		3	Govt.[3]	1706	316		
		1	State[4]	1870	505		
Beginning geoscientist	Permanent, nonsupervisory, entry-level geoscientist with BS or BA; works on geologic projects of various types, usually under direction of lead geoscientist.	10	Range	1700-2538	50-829	4	1900-3135	399-900
		10	Overall avg	2004	462	4	2296	668
		8	Industry	2018	460	2	2645	865
		2	Govt.[3]	1948	470	2	1948	470
		1	State[4]	1995	539	1	1995	539
Working geoscientist	Permanent geoscientist with MS (or Bachelors plus 2 yr experience); may be assigned supervisory and project management responsibility.	13	Range	1889-3325	100-1000	6	1889-3350	464-990
		13	Overall avg	2494	614	6	2562	707
		8	Industry	2558	584	3	2974	881
		3	Govt.[3]	2151	521	3	2151	521
		1	State[4]	2455	663	1	2455	663
Lead geoscientist	Permanent research geoscientist with PhD (or MS plus 2 yr experience or Bachelors degree plus 5 yr experience); usually assigned supervisory and project management responsibility for his projects.	12	Range	2200-3742	150-3000	6	2300-3726	608-1734
		12	Overall avg	3101	864	6	3261	879
		9	Industry	3128	992	3	3500	1055
		3	Govt.[3]	3021	680	3	3022	736
		1	State[4]	3039	820	1	3039	820

1. Approximate dollar value. 2. Experience, training, and education requirements assumed to be in field of geosciences related to position. 3. Federal and State Geological Surveys and University of Alaska. 4. Anchorage base for DNR, does not include UA.

Table 3 (continued)

Position	Qualifications and responsibilities	Respondents	Geologist	Avg. ann. wage	Benefits[1]	Geophysicist	Respondents	Avg. ann. wage	Benefits
Senior geoscientist	Permanent senior research geoscientist with Masters or PhD plus 7 yr experience, including either well-established reputation as a research expert or 3 or more yr supervisory and management experience; may assume specialized scientific duties or supervisory responsibility for 4 or more lead and working geologists and coordinate their projects.	14	Range	2740-6234	150-3000		8	2740-5988	685-1734
		14	Overall avg	3956	1126		8	4093	1151
		11	Industry	4056	1195		5	4613	1212
		3	Govt.[3]	3595	876		3	3561	1050
		1	State[4]	3494	943		1	3494	943
Chief geoscientist	Qualifications same as senior geoscientist; employee may be a "superstar" research geoscientist (regional exploration geologist, consulting specialist, or may have overall management responsibilities for a region).	13	Range	3500-8200	150-3000		6	4022-7669	804-2700
		13	Overall avg	5101	1512		6	5667	1614
		10	Industry	5086	1477		3	6712	2122
		3	Govt.[3]	4623	1129		3	4623	1105
		1	State[4]	4022	1086		1	4022	1086
Executive vice-president	Vice-president of geoscience firm.	4	Range	4022-6033	804-1500				
		4	Overall avg	5264	1335				
		1	Industry	6000	1500				
		3	Govt.[3]	5018	1279				
		1	State[4]	4022	1086				

1. Approximate dollar value. 2. Experience, training, and education requirements assumed to be in field of geosciences related to position. 3. Federal and State Geological Surveys and University of Alaska. 4. Anchorage base for DNR, does not include UA.

Table 4. Adjusted results of wage studies of geoscientists in U.S., including Alaska. (After Dillon 1981)

Position	Qualifications and responsibilites	Source[2]	Geologist Wages	Geologist Benefits[1]	Source[2]	Geophysicist Wages	Geophysicist Benefits
Beginning field assistant	See table 3.	B	1128	67.65			
		D	1613	97			
Experienced field assistant	See table 3.	B	1312	79			
		D	1876	113			
Beginning geoscientist	Permanent nonsupervisor beginning geoscientist with BS or BA.	A	1700 ± 400	170			
		B	1355	87	B	1355	
		C	1685	- -	C	1685	- -
		D	2340	180	D	2294	116
Working geoscientist	Permanent geoscientist with a MS (or with Bachelors plus 2 yr. experience; may be assigned a supervisory responsibility in rare instances.	A	2174	400	A	2333 ± 600	250
		B	1554	93	B	1554	93
		C	- -	- -			
		D	2666	352	D	2779	245
Lead geoscientist	Permanent research geoscientist with a PhD (or MS plus 2 yr. experience or Bachelors plus 5 yr experience; employee may be assigned supervisory and project management responsibility.	A	3000 ± 800	450			
		B	1787	107	B	2031	127
		C	2484	- -			
		D	3584	398	D	2904	182
Senior geoscientist	See table 3.	A	3800 ± 800	500	A	4400 ± 700	900
		B	2852	171	B	3170	630
		C	2690	- -			
		D	4581	480	D	5413	1094
Chief geoscientist	See table 3.	A	4750 ± 1400	1200			
		B	3280	750	B	3780	750
		C	3624	- -			
		D	5728	1394	D	5405	1073
Executive	Vice president of a geoscience firm.	A	6250 ± 2000	2500			
		B	3750	602			
		D	7157	2218			

[1]Approximate dollar value. [2]Source studies: A-Oil and Gas Journal, Dec. 1980; B-Dietrich and Associates, 1980; C-Scientific Manpower Commission, 1979; D-Average this table adjusted to Alaska 1981.

Table 5. Estimate of professional exploration personnel costs for Alaska during 1982.

	Geologist	Geophysicist
Beginning field assistant	$ 1466	$ —
Experienced field assistant	1789	—
Beginning geoscientist	2144	2457
Working geoscientist	2669	2741
Lead geoscientist	3318	3489
Senior geoscientist	4233	4380
Chief geoscientist	5458	6064
Executive vice-president	5632	

Table 6. Estimating guide for exploration costs (after Clement et al. 1978) adjusted for Alaska, 1982

Description	Manpower	Man-hours Per Unit	Unit Cost	Remarks
Geological Methods				
surface geological mapping	2-4 man	3-12 / sq. km.	$68-270 / sq. km.	Rate of production and cost is dependent on terrain, ground cover, complexity of geology, detail required and scale of mapping.
geological inference			180-450 / day	A qualified geologist interprets data shown on maps, photographs or field investigations.
Geophysical Methods				
gravitational survey	1 geophysicist 2-3 man survey crew	12-50 / profile km.	300-900 / profile km.	Production varies from a few to 50 readings per day depending on type of equipment. Production is also dependent on station spacing and terrain. Surveying is the costly phase of the survey.
magnetic survey				
airborne	1-3 men		15-45 profile km.	Magnetic, electromagnetic and radioactivity surveys, etc., are usually taken concurrently from one aircraft at 400 to 800 line km. per day. Production and cost dependent on the type of aircraft equipment etc.
ground	2-3 men	4-6 / profile km.	$100-150 / profile km.	production is dependent on precision and spacing of readings, type of equipment, weather, terrain and mode of travel.

Table 6 (continued)

Description	Manpower	Man-hours Per Unit	Unit Cost	Remarks
seismic survey				
0-150 meters depth	2- 7 men	1-4 / depth det.	25-100 / depth det.	portable equipment with 5 to 15 depth determinations per day.
over 150 meter depth	15-20 men	5-10 / depth det.	125-250 / depth det.	vibroseis equipment with 3 to 15 depth determinations per day.
radioactivity survey				
airborne			15-45 / line km.	usually taken concurrently with magnetic and electromagnetic surveys from one aircraft at 400-800 line km. per day. Production and cost are dependent on the type of aircraft and equipment, etc.
resistivity survey	1 geophysicist			
	1-4 assistants	2-3 / depth det.	50-75 / depth det.	
electromagnetic survey				
airborne			15-45 / line km.	Usually taken concurrently with magnetic and radioactivity surveys from one aircraft at 400 line km. or 80 square km. per day.
ground	1-4 men	106 / line km.	75-150 / line km.	Readings are taken at 25 to 50 meter intervals covering 5 to 10 km. per day and are dependent on type of equipment, terrain and mode of travel.

Table 6. (continued)

Description	Manpower	Man-hours Per Unit	Unit Cost	Remarks
induced polarization survey			$30-60 / sq. km.	
Aerial Photography				
black and white photography			30-60 / sq. km.	photographs cover 40 square km. each at 1:6000. Many areas are already photographed. Flying accounts for 15-30% and ground work for 70-85% of survey cost.
photogeologic interpretation			1,500-2,500 / print	
color photography			60-90 / sq. km.	photographs cover 40 square km. each at 1:6000. Flying accounts for 15-30% and ground work for 70-85% of survey cost.
photogeologic interpretation infrared			1,500 - 2,500 / print	
color or black and white			60-90 / sq. km.	photographs cover 40 square km. each.
thermal infrared imagery			150-450 / sq. km.	image covers 40 square km. area.
aerial radar imagery:				
side looking radar (slar)			$3-6 / sq. km.	used for 13,000 or more square km.
satellite survey			30-75 / print	23 x 23 cm. prints at 26,060 square km. each are available for U.S.G.S.

Table 6 (continued)

Description	Manpower	Man-hours Per Unit	Unit Cost	Remarks
other remote sensing methods				remote sensing data acquisition can cover several hundred square km. per day. Cost of interpretation reduction or interpretation equal to or greater than cost of acquisition.
Geochemical Methods				
stream sediment sampling	1 man		$25-50 / sq. km.	dependent on sampling interval, terrain, access and mode of travel.
reconnaissance soil sampling	1 man	0.05-0.20 / sample	600-3,000 / sq. km.	50 to 200 samples per day dependent on access, terrain, ground cover and geologic complexity.
detailed soil sampling	2 men	1-2 / sample	25-50 / sample	
humus sampling			25-50 / sample	
biological sampling			25-50 / sample	
water samples			30-60 / sample	
Drilling Methods				
core drilling				
earth		0.8-3.3 / meter	20-85 / meter	varies as to access, quantity and depth of holes.
soft rock nx 3" hole	2 men	1.6-3.3 / meter	40-85 / meter	varies as to access, quantity and depth of holes.
hard rock nx 3" hole	2 men	3.3-6.6 / meter	85-165 / meter	
churn drill 6" hole			25-120 / meter	

Table 6 (continued)

Description	Manpower	Man-hours Per Unit	Unit Cost	Remarks
percussion drilling	1-3 men	0.1 / meter	$5-15 / meter	
auger			0.65 / dia. cm. / meter	
rotary drilling				
soft rock 5" hole	2 men	0.8-2.0 / meter	20-40 / meter	varies as to access, quantity and depth of hole.
hard rock 5" hole	2 men	2.0-3.3 / meter	45-85 / meter	
ground	1 man	1-2 / line km.	25-50 / line km.	dependent on terrain and ground to be covered. Survey is run as fast as terrain can be covered.
other drilling methods				
borehole logging			4-8 / meter	
field testing			5 / test	
laboratory testing			10-100 / test	
Test Pit				
trenching				
earth	1-3 men	0.1-2.8 / cu. meter	3-50 / cu. meter	depends on whether excavation is by hand or with equipment.
rock	3 men	0.2-3.5 / cu. meter	10-90 / cu. meter	
Claim Staking	1-2 men		75-150 / claim	depends on topography, ground cover, and type of claim i.e. Federal or State.

Table 7a. Specifications for small, fixed wing-aircraft

Manufacturer	Model	Seating Capacity	Useful load[1] Wheels	Useful load[1] Floats	Airspeed[2] Wheels	Airspeed[2] Floats	Range[3] Wheels	Range[3] Floats	Fuel Type
Bellanca	Champ	2	500 lbs.		125 mph		480 mi.		100-130
Cessna	150	2	600 lbs.	400 lbs.	117 mph	98 mph	412 mi.	330 mi.	100-130
Piper	PA-18 "Super Cub"	2	800 lbs.	500 lbs.	115 mph	103 mph	460 mi.	412 mi.	100-130
Aero Commander	Shrike	4	2115 lbs.		203 mph		750 mi.		100-130
Cessna	172	4	1000 lbs.	800 lbs.	114 mph	92 mph	615 mi.	500 mi.	100-130
Piper	140	4	1100 lbs.		135 mph		725 mi.		100-130
Piper	180	4	1160 lbs.		143 mph		725 mi.		100-130
Cessna	310	4	2100 lbs.		213 mph		1000 mi.		100-130
Cessna	180	6	1300 lbs.	1100 lbs.	162 mph	147 mph	695 mi.	630 mi.	100-130
Cessna	185	6	1800 lbs.	1400 lbs.	169 mph	155 mph	1075 mi.	970 mi.	100-130
Cessna	206	6	1632 lbs.	1400 lbs.	164 mph	151 mph	650 mi.	600 mi.	100-130
Cessna	207	7	1736 lbs.		164 mph	151 mph	690 mi.	635 mi.	100-130
Cessna	402	7	2800 lbs.		245 mph		818 mi.		100-130
Helio	H295	6	1400 lbs.		165 mph		660 mi.		100-130
Piper	Cherokee 6	6	1260 lbs.		147 mph		455 mi.		100-130

Table 7a (continued)

Manufacturer	Model	Seating Capacity	Useful load[1] Wheels	Useful load[1] Floats	Airspeed[2] Wheels	Airspeed[2] Floats	Range[3] Wheels	Range[3] Floats	Fuel Type
Piper	Navajo B	9	2500 lbs.		213 mph		1110 mi.		100-130
Pilatus	Islander	9	2988 lbs.		160 mph		717 mi.		100-130
Pilatus	Trislander	17	4157 lbs.		166 mph		1000 mi.		100-130
Aero Commander	681B	11	3853 lbs.		278 mph		1062 mi.		100-130

1) Useful Load is Maximum take-off weight less empty weight.

2) Airspeed is at 75% power.

3) Range with standard tanks.

Data from Jane's All the World Aircraft (Taylor, 1980) with minor additions and cost information.

Table 7b. Specifications for multi-engine fixed-wing aircraft

Manufacturer	Model	No. of Pass.	Maximum Payload	Cruise Speed[1]	Range[2]	Take-off Distance[3]	Landing Distance[4]
Boeing	737	*	*35,000 lbs.	576 mph	2,370 mi.		
Boeing	727	*131-169	*41,000 lbs.	600 mph	*2,000 mi.	*8,500 ft.	*4,900 ft.
Boeing	747	*300	*257,850 lbs.	608 mph	*6,620 mi.	10,900 ft.	7,270 ft.
Beechcraft	E18	10	4,800 lbs.	280 mph	2,170 mi.	2,380 ft.	2,107 ft.
DeHavilland	Twin Otter	*20	4,420 lbs.	210 mph	794 mi.	*1,500 ft.	*1,940 ft.
DeHavilland	Otter	*10	*4,000 lbs.	138 mph	836 mi.	1,310 ft.	980 ft.
DeHavilland	Beaver	*2-10	2,100 lbs.	143 mph	405 mi.	1,300 ft.	1,210 ft.
Douglass	DC-3		4,500 lbs.	150 mph	1,200 mi.		
Casa	212-100	19	5,592 lbs.	212 mph	**850 mi.	1,755 ft.	1,310 ft.
Casa	212-200	19	7,285 lbs.	228 mph	**940 mi.	1,855 ft.	1,410 ft.
Curtis Wright	C-46		11,000 lbs.	190 mph	1.500 mi.		
Fairchild	F-27	40	15,200 lbs.	306 mph	1,570 mi.	4,100 ft.	3,580 ft.
Fairchild	F-227	*44-52	11,200 lbs.	294 mph	1,656 mi.		
Lockheed	HC-130		45,000 lbs.	368 mph	2,400 mi.	5,580 ft.	3,750 ft.
Short	Sky Van	*2-19	5,000 lbs.	195 mph	240 mi.	2,000 ft.	2,040 ft.

*) Specification depending upon model.
1) Maximum cruise speed with maximum payload.
2) Maximum range with maximum payload.
3) Take-off distance to 50 ft. with maximum payload.
4) Landing distance from 50 ft. with maximum landing weight.
**) Range with approximately half the maximum payload.

Data from Jane's All The World Aircraft (1980) with minor additions.

Table 8. Comparison of fixed-wing aircraft cost per hour or per mile between 1973 and 1982.

Manufacturer/Model	1973 $/hr ($/mi)	1982 $/hr ($/mi)	INDEX 1973=100
Piper PA-18	45	100-150	2.22-3.33
Cessna 180	65	150	2.30
185	77	150-175	1.94-2.27
206	77	125-190	1.62-2.47
207	—	175-195	—
402	—	350-375 (2.10)	—
Piper Navajo	180	275-375 (2.10)	1.52-2.08
Beechcraft E18	—	330	—
Islander	—	378 (2.80)	—
Trilander	—	475 (3.30)	—
Twin Otter	350 (2.50)	535	1.52
Casa 212-100	—	610	—
212-200	—	780	—
DC-3	295 (1.80)	810 (5.40)	2.74 (3.00)
C-46	425 (2.20)	1,152 (6.40)	2.71 (2.91)
Lockheed HC 130	(5.16)	4,500 (14.54)	(2.82)

Table 9. Specifications for helicopters

Manufacturer	Model	Seating Capacity[1]	Load Capacity Body Load[a]	Load Capacity Sling Load[b]	Flight time (hrs.)	Airspeed (mph)	Fuel Consumption per hour	Fuel Type	Ceiling[2] (feet)
Alouette II	318C	4	960 lbs.	1,200 lbs.	.80	100	30 gal.	JP-4	12,000
Alouette II	318	4	520 lbs.	930 lbs.	3	90	45 gal.	JP-4	6,000
Bell	47G-2	2	360 lbs.	450 lbs.	2.25	65	14 gal.	80/87	4,000
Bell	47G-2 Super	2	360 lbs.	450 lbs.	2.25	65	12 gal.	100/130	10,000
Bell	47G-3	2	660 lbs.	770 lbs.	2	70	13 gal.	100/130	10,000
Bell	47G-3B	2	600 lbs.	720 lbs.	2	70	15 gal.	100/130	10,000
Bell	47G-3B1	2	450 lbs.	600 lbs.	2.75	65	15 gal.	100/130	10,000
Bell	47G-3B2	2	450 lbs.	600 lbs.	2.75	65	15 gal.	100/130	10,000
Hughes	300C	2	875 lbs.	900 lbs.	3	77	12 gal.	100/130	10,200
Bell	47 AJ-2	3	500 lbs.	600 lbs.	2	85	15 gal.	100/130	10,000
Bell	47 J	3	500 lbs.	600 lbs.	2	85	15 gal.	80/87	6,000
Bell	206 A	4	850 lbs.	1,050 lbs.	2.50	125	22 gal.	JP-4	8,000
Bell	206 B	5	1,600 lbs.	3,200 lbs.	2.80	134	34 gal.	JP-4	13,500
Bell	206 L	5	2,000 lbs.	4,150 lbs.	2.90	134	34 gal.	JP-4	13,200

Table 9. (continued)

Manufacturer	Model	Seating Capacity[1]	Load Capacity Body Load[a]	Load Capacity Sling Load[b]	Flight time (hrs.)	Airspeed (mph)	Fuel Consumption per hour	Fuel Type	Ceiling[2] (feet)
Bell	212	14	5,000 lbs.	5000 lbs.	1.80	142	119 gal.	JP-4	14,200
Bell	204 B	10	2,150 lbs.	3,700 lbs.	2.75	115	65 gal.	JP-4	6,000
Bell	205 A	14	2,550 lbs.	4,150 lbs.	2.5	120	80 gal.	JP-4	8,000
Hiller	SL-4	4	450 lbs.	950 lbs.	2	70	18 gal.	100/130	12,000
Hiller	UH12-E	2	825 lbs.	950 lbs.	2	80	16 gal.	100/130	6,000
Hiller	FH-1100	4	850 lbs.	1,050 lbs.	2.50	125	22 gal.	JP-4	8,000
Hughes	500	4-6	920 lbs.	1,150 lbs.	2.50	150	19 gal.	JP-4	8,000
Sikorsky	S55B	8-10	1,500 lbs.	1,700 lbs.	4	90	30 gal.	100/130	8,000

1) Seating capacity plus pilot.
2) Recommended maximum ceiling.
a) Body load with 2 hours fuel.
b) Sling load with 1 hour fuel.

From Helicopter Safety and Operations Manual. Alberta Society of Petroleum Geologist (1972) with minor additions and modifications

Table 10. Comparison of helicopter cost per hour between 1973 and 1982 (after Grybeck et al., 1976, Hoskins and Green, 1977 and Hoskins 1982).

Manufacturer	Model	Mean 1973 Cost/hr. ($)	Mean 1976 Cost/hr. ($)	1976 Cost Index 1973=100 ($)	Mean 1980 Cost/hr. ($)	1980 Cost Index 1973=100 ($)	Mean 1982 Cost/hr. ($)	1982 Cost Index 1973=100 ($)
Bell	47G2	125	$ 100.00	0.80	$ 175.00	1.40	n.a.	n.a.
Hiller	12-D	n.a.	100.00	n.a.	n.a.	n.a.	n.a.	n.a.
Hughes	300	n.a.	n.a.	n.a.	n.a.	n.a.	250	n.a.
Bell	47G-3B2	145	165.00	1.14	190.00	1.31	n.a.	n.a.
Hiller	12-E	135	170.00	1.26	200.00	1.40	250	1.85
Hiller	SL3	n.a.	175.00	n.a.	n.a.	n.a.	n.a.	n.a.
Hiller	SL4	n.a.	225.00	n.a.	n.a.	n.a.	n.a.	n.a.
Hiller/Saloy	12-E	n.a.	210.00	n.a.	290.00	n.a.	n.a.	n.a.
Hiller	FH-1100	250	240.00	0.96	n.a.	n.a.	n.a.	n.a.
Bell	206 A	250	250.00	1.00	n.a.	n.a.	n.a.	n.a.
Bell	206 B	n.a.	275.00	n.a.	375.00	n.a.	430	n.a.
Bell	206 L	n.a.	n.a.	n.a.	n.a.	n.a.	535	n.a.
Hughes	500 C	n.a.	275.00	n.a.	350.00	n.a.	365	n.a.
Hughes	500 D	n.a.	n.a.	n.a.	400.00	n.a.	430	n.a.
SUD Allouette	II	240	300.00	1.25	440.00	1.83	495	2.06
SUD Allouette	Gazelle	n.a.	375.00	n.a.	n.a.	n.a.	n.a.	n.a.
SUD Allouette	III	n.a.	460.00	n.a.	575.00	n.a.	n.a.	n.a.
SUD Allouette	Lama	n.a.	375.00	n.a.	560.00	n.a.	n.a.	n.a.
Bell	204 B	700	n.a.	n.a.	n.a.	n.a.	900	1.29
Bell	205 B1	700	800.00	1.14	1,010.00	1.44	1,095	1.56
Bell	212	n.a.	n.a.	n.a.	n.a.	n.a.	1,395	n.a.
Bell	214	n.a.	1,500.00	n.a.	1,800.00	n.a.	n.a.	n.a.
Boeing	107	n.a.	1,500.00	n.a.	1,995.00	n.a.	n.a.	n.a.
Sikorsky	S-64	n.a.	3,800.00	n.a.	7,000.00	n.a.	n.a.	n.a.

*1973 and 1982 data for Alaska only.
n.a. data not available.

Table 11. Cost of round trip business class airline ticket between major cities in Alaska and various cities in the contiguous states

	ANCHORAGE	FAIRBANKS	JUNEAU	KETCHIKAN
Dallas	$ 928.00	$1,078.00	$920.00	$746.00
Denver	830.00	942.00	646.00	582.00
Houston	976.00	1,024.00	896.00	832.00
Los Angeles	738.00	880.00	629.42	549.42
San Francisco	630.00	810.00	580.00	520.00
Seattle	490.00	630.00	378.00	318.00

Table 12. Cost of round trip business class airline ticket between various cities and villages in Alaska

	ANCHORAGE	FAIRBANKS	JUNEAU	KETCHIKAN
Anchorage	$ —	$170	$296	$380
Barrow	464	294	760	912
Deadhorse	412	242	708	860
Fairbanks	170	—	466	618
Galena	160	156	456	608
Juneau	296	466	—	152
Ketchikan	380	618	152	—
King Salmon	312	482	608	760
Kotzebue	365	354	661	813
Nome	365	354	661	813

TABLE 13. Cost of automobile and light truck rentals for the Fairbanks area, 1982.

	MEAN DAILY ($)	MEAN WEEKLY ($)	MEAN MONTHLY ($)
Automobile			
Full size			
Period	31	132	395
Mileage	0.34	0.21	0.11
Compact			
Period	26	126	375
Mileage	0.29	0.20	0.10
Four Wheel Drive Pickup			
Period	35	180	660
Mileage	0.35	0.30	0.20

Table 14. Cost of surface and air freight between Seattle, Anchorage, and Fairbanks.

Mode	Seattle-Anchorage ($/100 lbs.)	Anchorage Fairbanks ($/100 lbs.)	Seattle Fairbanks ($/100 lbs.)
Ocean/truck			
0-2000 lbs.	24.18	—	30.89
2000-5000 lbs.	21.95	—	27.51
5000-10,000 lbs.	21.53	—	26.74
Car load	15.82	—	22.49
Truck			
< car load	21.00-26.00	4.00	25.00-30.00
car load	12.00-21.00	3.00	15.00-24.00
Rail	—	11.87	—
Air	47.68	36.48	56.63

Note: Rates are highly dependent on type of material transported.

TABLE 15. Fuel prices for various distribution centers in Alaska, 1982

Item:*	Anchorage	Dutch Harbor	Fairbanks	Delta Junction	Ketchikan	Nome	Kotzebue	Galena
Reg. Gasoline	$1.249	1.285	1.332	1.339	1.179	1.434	1.50	1.585
Unleaded Gas	1.289	1.325		1.379	1.219	1.474		1.625
AV Gas 80-87	1.414	Avail.	1.524	1.531	1.773**	1.628	1.70	1.897
100-130	1.464				1.823**	1.678	1.75	1.947
Diesel #1	1.194	Marine: 1.173	1.284	1.341	1.177	1.421	1.44	—
#2	1.144		1.284	1.271	1.177	1.381		—
Heating Fuel #1	1.114	1.183	1.204	1.251	1.097	1.361	1.42	1.679
#2	1.054	1.123	1.204	1.191	1.027	1.301		1.619
Jet A	1.225	Avail.				1.466	1.466	1.737
B	1.225		—		N/A	N/A		N/A
in sealed drum	1.545		1.545	1.875	1.545			
Kerosine 5g	3.16	Avail.	3.16	3.16	3.16	3.32	3.71	3.16
over 50g	2.91		2.83	2.91	2.91	3.07		
in 55g drum	2.46			2.47	2.46	2.62	3.156	2.62
Blazo 5g	3.17	Avail.	3.17	3.17	3.17	3.33	3.54	3.33
over 50g	2.91		2.92	2.92	2.92	3.08		
in 55g drum					2.47	2.62	3.015	2.63

* Prices are for bulk quantities, except where noted, and do not include drum fees.

** In sealed Drum

TABLE 16. Estimated camp costs for various sizes of field operations

Crew size	Camp Rental ($/mo.)* Low	Camp Rental ($/mo.)* High	Food and Expendable ($/mo.)* Low	Food and Expendable ($/mo.)* High	Mobil/Demobil $
4	2,100.	3,200.	1,800.	3,600.	1,400.
6	2,300.	3,400.	2,700.	5,400.	1,800.
8	3,100.	4,600.	3,600.	7,200.	2,000.
12	4,100.	6,200.	5,400.	10,800.	2,600.
20	5,900.	8,800.	9,000.	18,000.	3,600.

* Does Not Include Transportation Cost

TABLE 17 Communication subscription and rental costs, 1982

	MEAN MONTHLY ($)
Radio Phone (1)	
Subscription	95
0-10 calls	+0.00/call
11-20 calls	+9.00/call
21-30 calls	+8.50/call
Non-Subsription	11.35/call
Single Side Band	
Radio	
0-1 month	295
1-6 months	245
6+ months	195
VHF Transceivers with Aircraft frequencies	85

(1) Plus cost of long distance call

Table 18. Comparison of geochemical analytical costs between 1976 and 1982 (after Hoskins and Green 1977, and Hoskins, 1982)

Element	1976 Mean ($)	1980 Mean ($)	Index 1976 = 100	1982 Mean ($)	Index 1976 = 100
Antimony	2.38	3.12	1.31	5.00	2.10
Arsenic	2.53	3.27	1.29	5.00	1.98
Barium	2.50	3.62	1.45	5.00	2.00
Bismuth	1.75	2.65	1.51	5.00	2.86
Cadmium	1.23	1.86	1.51	5.00	4.07
Calcium	2.13	3.35	1.57	n.a.	n.a.
Chromium	2.00	3.24	1.62	5.00	2.50
Cobalt	1.23	1.63	1.33	2.30	1.87
Copper	1.19	1.63	1.37	1.80	1.53
Fluorine	3.60	4.34	1.21	n.a.	n.a.
Gold	3.00	3.90	1.30	4.05	1.35
Iron	1.25	2.20	1.76	n.a.	n.a.
Lead	1.23	1.63	1.33	1.80	1.46
Magnesium	2.13	2.50	1.17	n.a.	n.a.
Manganese	1.25	2.36	1.89	n.a.	n.a.
Mercury	3.00	3.20	1.07	5.00	1.67
Molybdenum	1.25	1.84	1.47	2.30	1.84
Nickel	1.23	1.63	1.33	2.30	1.87
Palladium	5.67	n.a.	n.a.	n.a.	n.a.
Platinum	8.50	n.a.	n.a.	n.a.	n.a.
Rubidium	3.00	2.50	0.83	n.a.	n.a.
Strontium	3.00	2.17	0.72	n.a.	n.a.
Silver	1.23	2.13	1.73	1.95	1.59
Tin	n.a.	n.a.	n.a.	4.50	n.a.
Tungsten	2.94	4.33	1.47	4.75	1.62
Uranium	3.00	4.03	1.34	6.00	2.00
Zinc	1.19	1.63	1.37	1.80	1.51
Semi-quant Spec 30-40 Elements	16.25	17.67	1.09	36.00	2.22
Sample prep	n.a.	.87	n.a.	1.60	n.a.

1982 data from laboratories in Alaska

Table 19. Comparison of assay analytical costs between 1976-1982 (after Hoskins and Green 1977, and Hoskins, 1982)

Element	1976 Mean ($)	1980 Mean ($)	Index 1976 = 100	1982 Mean ($)	Index 1976 = 100
Aluminum	8.95	6.62	0.74	7.50	0.84
Antimony	8.25	6.80	0.82	7.50	0.91
Arsenic	8.75	7.85	0.90	12.00	1.37
Barium	8.85	7.65	0.86	9.50	1.07
Berylium	14.75	9.17	0.62	5.00	0.34
Bismuth	8.45	5.75	0.68	6.75	0.80
Cadmium	7.95	3.82	0.48	6.75	0.85
Calcium	7.55	5.65	0.75	7.00	0.93
Carbon	9.08	11.30	1.24	12.00	1.32
Chlorine	9.75	8.55	0.88	9.00	0.92
Chromium	8.95	5.87	0.66	9.00	1.01
Cobalt	5.95	4.14	0.70	5.75	0.95
Columbium	14.13	15.75	1.11	n.a.	n.a.
Copper	5.05	3.76	0.74	5.50	1.05
Gold	5.50	6.10	1.11	10.00	1.82
Indium	15.06	21.50	1.43	n.a.	n.a.
Iron	6.05	4.50	0.74	6.00	0.99
Lead	5.45	3.76	0.69	5.75	1.06
Lithium	13.83	5.62	0.41	n.a.	n.a.
Magnesium	8.05	6.90	0.86	7.00	0.87
Manganese	7.25	5.00	0.69	7.50	1.03
Mercury	8.25	7.39	0.90	12.00	1.45
Molybdenum	6.25	4.53	0.72	7.50	1.20
Nickel	5.55	3.76	0.68	5.75	1.04
Niobium	13.33	8.00	0.60	n.a.	n.a.
Palladium	19.31	20.00	1.04	35.00	1.81
Phosphorus	8.65	7.17	0.83	13.00	1.50
Platinum	19.68	21.00	1.07	35.00	1.78
Potassium	7.90	6.37	0.81	7.00	0.98
Silica	8.35	7.85	0.94	10.50	1.26
Strontium	10.56	7.00	0.66	8.50	0.80
Silver	5.25	6.40	1.22	10.00	1.90
Sodium	8.95	6.37	0.71	7.00	0.78

Table 19. Comparison of assay analytical costs between 1976-1982 (after Hoskins and Green 1977, and Hoskins, 1982)

Element	1976 Mean ($)	1980 Mean ($)	Index 1976 = 100	1982 Mean ($)	Index 1976 = 100
Sulfur	7.20	7.45	1.02	8.00	1.11
Tin	n.a.	n.a.	n.a.	8.50	n.a.
Tungsten	10.25	8.35	0.81	13.00	1.27
Uranium	11.45	6.25	0.55	8.00	0.70
Zinc	5.45	3.45	0.63	6.50	1.19
Sample prep	*	1.40	n.a.	2.25	n.a.

* Sample prep included in above price

1982 data from laboratories in Alaska

Table 20. Comparison of contracted ground and airborne line traverse costs between 1973 and 1982 (Grybeck et al. 1976, after Hoskins and Green, 1977, and Hoskins, 1982).

SURVEY	1973 MEAN cost/line mile ($)	1976 MEAN cost/line mile ($)	INDEX 1973 = 100	1980 MEAN cost/line mile ($)	INDEX 1973 = 100	1982 MEAN* cost/line mile ($)
IP	577	566.66	0.98	1,633.00	2.83	1,960
Helicopter mag.	n.a.	27.50	n.a.	42.50	n.a.	50
Fixed-wing mag.	5.30	10.00	1.89	19.50	3.68	25
Ground mag.	200.00	225.00	1.13	270.83	1.35	325
Helicopter EM	n.a.	45.83	n.a.	67.50	n.a.	80
Fixed-wing EM	n.a.	22.50	n.a.	61.75	n.a.	75
Ground EM	n.a.	325.00	n.a.	400.00	n.a.	475
Helicopter mag., EM, and radiometrics	n.a.	n.a.	n.a.	68.75	n.a.	85
Fixed-wing, mag., EM, and radiometrics	n.a.	n.a.	n.a.	37.50	n.a.	45
Helicopter radiometrics	n.a.	n.a.	n.a.	37.50	n.a.	45

* Estimated cost based on data from contiguous states and indexed for 1982. Does not include mobilization cost to Alaska.

Table 21. Comparison of contract down hole logging cost between 1976-1982 (after Hoskins and Grun, 1977, and Hoskins, 1982)

	Portable equipment rental gamma ray only	Truck-mounted equipment gamma ray S.P./Res. daily	Truck-mounted equipment gamma ray S.P./Res. weekly	Truck-mounted equipment gamma ray S.P./Res. monthly	Directional survey	Loss of equipment charge	Mobilization-demobilization
1976 MEAN	$125/Hole + $.10/ft	32.50/hr + $.07/ft + $.50/mi mobilization	$1,375/wk + $.07/ft Includes 50 hrs and 375 mi mobilization	$4,075/mo. + $.07/ft Includes 216 hrs and 2000 mi mobilization	$40/hr. + $.50/mi + mobilization 750/mo. + $.11/ft	$2,500/probe $.39/ft/cable	$15/day/man + Lodging + $.47/mi
1980 MEAN	$2,500/mo (1 mo. min) $1,800/mo 6 mo. min	$400/day + $.16/ft + $.65/mi	$1,513/wk + $.10/ft + $.65/mi	$4,425/mo + $.10/ft	7,700/mo + $.15/ft	$3,000/probe $0.65/ft/cable	$35/day/mon + $0.75/mi
1980 COST INDEX 1976=100	n.a.	1.54 (day) + 2.29 (ft) 1.30 (mi)	1.10 (wk) 1.43 (ft) n.a. (mi)	1.09 (mo) 1.43 (ft)	0.93 (mo) 1.36 (ft)	1.20 (probe) 1.67 (cable)	2.33 (mon) 1.60 (mi)
1982 MEAN	$3,000/mo. (1 mo. min) $2,150/mo. (6 mo. min)	$480/day + $.20/ft $.80/mi	$1,800/wk + $.12/ft + $80/mi	$5,300/mo. + $.12/ft	$840/mo. + $.18/ft	$3,600/probe $.80/ft/cable	$42/day/mon + $.90/mi

NOTE 1982 estimates from 1980 data adjusted by cost index = 1.20. Data for contiguous states.

Table 22. Comparison of control drilling costs between 1976 and 1982 (after Hoskins, 1982 and Hoskins and Green, 1977).

TYPE OF DRILLING	1976 MEAN ($)	1980 MEAN ($)	INDEX 1976=100	1982 MEAN ($)	INDEX 1976=100
Diamond drilling cost/ft (0-500 ft)	13.00 BX 14.50 NX	25.50 BX 27.00 NX	1.96 1.86	30.00 32.00	2.31 2.21
Diamond drilling cost/ft (500-1000 ft)	14.12 BX 15.63 NX	28.50 BX 29.50 NX	2.02 1.83	32.00 34.00	2.27 2.18
Diamond drilling cost/ft (1000-1500 ft)	14.75 BX 17.00 NX	30.00 BX 32.00 NX	2.03 1.88	34.00 36.00	2.31 2.12
Diamond drilling cost/ft (1500-2000 ft)	16.38 BX 18.13 NX	32.25 BX 32.50 NX	1.97 1.79	36.00 38.00	2.20 2.10
Portable diamond drilling cost/ft (0-250 ft)	15.50 IEX 17.50 IAX	23.00 IEX 24.00 IAX	1.48 1.87	25.00 26.00	1.61 1.49
Portable diamond drilling cost/ft (250-500 ft)	16.50 IEX 18.50 IAX	25.00 IEX 26.00 IAX	1.52 1.41	27.00 28.00	1.64 1.51
Portable diamond drilling cost/ft (500-800 ft)	n.a. n.a.	27.00 IEX 28.00 IAX	n.a. n.a.	29.00 30.00	n.a. n.a.
Conventional rotary drilling cost/ft	6.88	12.00	1.74	15.00	2.18
Conventional rotary drilling cost/hr	122.50	144.00	1.18	180.00	1.47
Percussion-down hole hammer drilling cost/ft	9.00	12.00	1.33	15.00	1.67
Rotary-reverse ciurculation system cost/ft	9.50	9.75	1.03	12.50	1.32
Rotary ancillary hourly charges cost/crew/hr	62.50	87.50	1.40	110.00	1.76
Resonant drilling cost/ft	n.a.	n.a.	n.a.	34.00	n.a.
Churn drilling (1) cost/ft	n.a.	n.a.	n.a.	35.00	n.a.
Diamond drilling ancillary charges cost/crew/hr	40.00	66.25	1.66	82.50	2.06
Mobilization-demobilization cost/mi	1.25	3.38	2.70	3.50	2.80

(1) Note: based on single quote of $200/day rental plus cost of two drillers and production rates of 20 feet per day.

Table 23. Comparison of heavy equipment costs for the period 1976-1982 (after Hoskins and Green, 1977 and Hoskins, 1982)

Equipment	1976 Mean Cost/hr. ($)	1980 Mean Cost/hr. ($)	1980 Index 1976 = 100	1982 Mean* Cost/hr. ($)	1982 Index 1976 = 100
Dozer w/ripper					
D-8	$59.40	88.00	1.48	120-140	1.48
D-6	46.00	59.00	1.28	84-100	2.00
D-4	29.90	45.00	1.51	65-75	2.33
Dozer wo/ripper					
D-8	60.00	71.25	1.19	130-150	2.33
D-6	30.10	55.00	1.83	90-110	3.33
D-4	22.60	40.00	1.77	65-75	3.04
Backhoe	29.63	46.00	1.55	75-110	3.13
Grader	28.63	42.57	1.49	85	2.93
Lowboy	33.40	44.57	1.33	85	2.58

* 1982 data for Fairbanks area

TABLE 24. Summary of Cost, Sample of Metal Exploration Programs in Alaska, 1981

Proj. No.	Location	Type of Program	Salary Cost ($)	Trans-portation ($)	Fuel ($)	Camp & Living Expense ($)	Assaying & Geochemical ($)	Drilling ($)	Geophysics ($)	Field Equip. ($)	Misc. ($)	Total ($)
1.	South Central	Reconnaissance	400	2,000	—	300	500	—	—	—	—	3,200
2.	Southeast	Reconnaissance	400	2,500	—	—	500	—	—	—	—	3,400
3.	Interior	Reconnaissance	800	2,900	—	400	500	—	—	—	—	4,600
4.	South Central	Reconn, claim staking & assess.	8,600	10,000	—	4,000	450	—	—	1,300	1,650	26,000
5.	Southeast		16,000	13,000	—	4,500	1,000	—	—	550	4,950	40,000
6.	Interior	Assessment	24,000	7,500	—	3,000	3,100	—	—	200	22,200	60,000
7.	South Central	Reconn., staking	38,700	54,200	7,000	3,000	1,600	—	—	300	20,200	125,000
8.	Interior	Reconnaissance	53,200	32,000	—	3,300	3,300	—	—	700	33,500	126,000
9.	Southeast	Reconnaissance	20,000	115,650	—	2,500	27,400	—	5,000	500	49,100	220,150
10.	Southeast	Reconn., staking assess. & drilling	24,000	72,200	—	6,500	10,000	14,000	—	9,000	94,300	230,000
11.	Western	Reconn., staking assess. & drilling	88,000	31,000	—	11,000	300	—	—	2,000	117,700	250,000
12.	Southeast	Assessment & drilling	200,000	51,500	5,000	5,000	13,000	80,000	—	300	25,000	380,000
13.	Interior	Assessment & drilling	110,000	148,000	—	13,500	27,000	10,000	30,000	6,500	55,000	400,000
14.	Statewide	Reconnaissance	—	—	—	—	55,000	—	—	—	345,000	400,000
15.	Alaska Range	Reconnaissance	200,000	141,000	—	—	3,000	—	—	—	66,000	410,000

TABLE 24. Summary of Cost, Sample of Metal Exploration Programs in Alaska, 1981, (continued)

Proj. No.	Location	Type of Program	Salary Cost ($)	Transportation ($)	Fuel ($)	Camp & Living Expense ($)	Assaying & Geochemical ($)	Drilling ($)	Geophysics ($)	Field Equip. ($)	Misc. ($)	Total ($)
16.	Brooks Range	Reconn., claim staking, assess. & drilling	172,000	15,000	—	—	70,000	100,000	50,000	—	93,000	500,000
17.	Alaska Range	Assessment & drilling	131,000	132,000	—	34,000	31,000	175,000	—	5,500	41,500	550,000
18.	Southeast	Reconn., claim staking & drilling	232,000	188,500	18,000	22,000	52,800	90,000	69,000	5,000	—	677,300
19.	Alaska Range	Drilling	55,000	146,800	20,000	65,000	19,000	320,000	—	1,600	—	627,400
20.	Interior	Reconn. & claim staking	140,500	181,000	—	20,000	40,000	—	15,000	8,800	244,700	650,000
21.	Alaska Range	Assessment & drilling	125,000	35,000	90,000	—	20,000	120,000	10,000	8,000	257,000	665,000
22.	Seward Penn.	Drilling	166,000	276,500	—	35,000	60	250,000	6,500	5,500	60,440	800,000
23.	Brooks Range	Reconn., assess. and drilling	203,000	313,000	3,900	42,000	20,100	170,000	—	11,300	196,700	960,000
24.	Interior	Reconnaissance	82,000	268,300	10,000	80,000	72,000	—	9,000	3,300	475,400	1,000,000
TOTAL			2,090,600	2,239,550	153,900	355,000	471,610	1,329,000	194,500	70,350	2,203,540	9,108,050

TABLE 25 - Transportation costs, 1981 by item

Proj. No.	Project Area	Fixed Wing ($)	Helicopter ($)	Commercial Airline ($)	Truck ($)	Boat/ Barge ($)	Freight/ Postage ($)	Fuel ($)	Trans. Total ($)	Project Budget ($)
1.	South Central		2,000						2,000	3,200
2.	Southeast		1,300	1,200					2,500	3,400
3.	Interior	500	2,400						2,900	4,600
4.	South Central		10,000						10,000	26,000
5.	Southeast		4,000	5,000	1,000		3,000		13,000	40,000
6.	Interior		5,000	2,500					7,500	60,000
7.	South Central		45,000		2,200			7,000	54,200	125,000
8.	Interior	3,000	25,000		4,000				32,000	126,000
9.	Southeast		110,000	4,500	500		650		115,650	220,000
10.	Southeast		34,000	1,500	1,200	34,000	1,500		72,200	230,000
11.	Western	7,500		2,500			21,000		31,000	250,000
12.	Southeast	10,000	35,000	2,000	500	2,000	2,000		51,500	380,000
13.	Interior	15,000	120,000	7,000	500		5,500		148,000	400,000
14.	Alaska Statewide									400,000
15.	Alaska Range	10,000	120,000	5,000	2,500	3,500			141,000	410,000

TABLE 25 (continued)

Proj. No.	Project Area	Fixed Wing ($)	Helicopter ($)	Commercial Airline ($)	Truck ($)	Boat/ Barge ($)	Freight/ Postage ($)	Fuel ($)	Trans. Total ($)	Project Budget ($)
16.	Brooks Range		10,000		5,000				15,000	500,000
17.	Alaska Range		110,000	12,000	5,000		5,000		132,000	550,000
18.	Southeast	18,000	120,000	10,000	2,500	15,000	5,000	18,000	188,500	677,300
19.	Alaska Range	36,000	82,000	8,000			800	20,000	146,800	627,400
20.	Interior	33,000	133,000	15,000					181,000	650,000
21.	Alaska Range		10,000				25,000		35,000	665,000
22.	Seward Peninsula	75,000	175,000	25,000	1,000		500		276,500	800,000
23.	Brooks Range		180,000	98,000			35,000		313,000	960,000
24.	Interior	32,000	210,000	14,000	7,000		5,300		268,300	1,000,000
TOTALS		240,000	1,543,700	213,200	32,9000	54,500	110,250	45,000	2,239,650	9,023,200

Appendix A

ALASKAN 401 CERTIFICATE AIR CARRIERS

Mr. Tom Olson
Air North (Yukon Air Service d/b/a)
P.O. Box 60054
Fairbanks, Alaska 99706
456-5555

Alaska Airlines, Inc.
4750 W. International Airport Rd.
Anchorage, Alaska 99502

Mr. Gary E. White
Alaska International Air, Inc.
Box 6769
Anchorage, Alaska 99502
243-1414

Mr. Grant Thompson
Cape Smythe Air Service, Inc.
P.O. Box 549
Barrow, Alaska 99723
852-8333

Mr. Ken Loken
Channel Flying, Inc.
2601 Channel Drive
Juneau, Alaska 99801
586-3331

Mr. James Porter
Evergreen Helicopters of Alaska, Inc.
P.O. Box 587
Anchorage, Alaska 99510
276-2454

Mr. Harold Esmailka
Harold's Air Service, Inc.
P.O. Box 168
Galena, Alaska 99741
656-1251

Mr. Stanley G. Hermens
Hermens Air, Inc.
P.O. Box 114
St. Mary's, Alaska 99658
438-2112

Mr. Layton A. Bennett
L.A.B. Flying Service, Inc.
P.O. Box 272
Haines, Alaska 99827
766-2222

Mr. Richard Galleher
Munz Northern Airlines, Inc.
P.O. Box 790
Nome, Alaska 99762
443-2215

Mr. Orin D. Seybert
Peninsula Airways, Inc.
6231 Collins Way
Anchorage, Alaska 99502
243-7701

Mr. Richard D. Reeve
Reeve Aleutian Airways, Inc.
P.O. Box 559
Anchorage, Alaska 99510
243-1112

Mr. Lance Wells
Sea Airmotive, Inc.
P.O. Box 6003
Anchorage, Alaska 99502
243-1115

Mr. Paul Breed
Southeast Alaska Airlines, Inc.
1515 Tongass Avenue
Ketchikan, Alaska 99901

Mr. Kirk Thomas
Tyee Airlines, Inc.
P.O. Box 8331
Ketchikan, Alaska 99901

Mr. Larry L. Ledlow
Western Yukon Air (Delta Development Corp. d/b/a)
P.O. Box 131
St. Mary's, Alaska 99658
438-2616

Mr. Howard Fowler
Kodiak Western Alaska Airlines, Inc.
2015 Merrill Drive
Anchorage, Alaska 99501
276-4404

Wien Air Alaska, Inc.
4100 W. International Airport Rd.
Anchorage, Alaska 99502
243-2400

Appendix B

ALASKA AIR TAXI OPERATORS REGISTERED UNDER PART 298

Mr. Richard Ardaiz
Aero Tech Flight Service, Inc.
1100 Merrill Field Drive
Anchorage, Alaska 99501
279-6558

Mr. Leslie W. Bays
Air Logistics of Alaska, Inc.
6400 South Air Park Drive
Anchorage, Alaska 99502
243-5289

Mr. Josefina B. Seller
Air Martel, Inc.
P.O. Box 97
King Salmon, Alaska 99613

Mr. Tom Olson
Yukon Air Service, Inc. d/b/a
Air North
P.O. Box 60054
Fairbanks, Alaska 99706
456-5555

Mr. Larry Gillespie
Mr. Lawrence E. Campbell d/b/a
Air Valley
P.O. Box 157
Palmer, Alaska 99645
745-2171

Mr. James D. Rood d/b/a
Aircraft Services
Box 741
Kotzebue, Alaska 99752
442-3525

Mr. Thomas J. Classen d/b/a
Alaska Air Charter
P.O. Box 80507
Fairbanks, Alaska 99708
479-2303

Mr. Donald Cogger
Alaska Air Guides, Inc.
327 E. Fireweed Lane
Anchorage, Alaska 99503
243-3969

Mr. Lynwood Marshall
Alaska Air Service, Inc.
P.O. Box 6-167
Anchorage, Alaska 99509
243-3348

Mr. David A. Klosterman
Alaska Bush Carrier, Inc.
4801 Aircraft Drive
Anchorage, Alaska 99502
243-3127

Mr. Pete Haggland
Alaska Central Airways, Inc.
3606 University Avenue
Fairbanks, Alaska 99707
(WCA/Schedule)
456-4411

Mr. Lynwood Marshall
Alaska Floatplane Service, Inc.
3338 Strawberry Road
Anchorage, Alaska 99502
243-5346

Mr. Dennis K. Brown d/b/a
Akland Helicopters
P.O. Box 302
Talkeetna, Alaska 99676
733-2222

Mr. Houston D. Haynes
Alaska Aeronautical Industries, Inc.
P.O. Box 6067 Airport Annex
Anchorage, Alaska 99502
(ASA/Mail/Schedule)
243-1583

Mr. Lloyd Roundtree
Alaska Island Air, Inc.
P.O. Box 508
Petersburg, Alaska 99833
(ASA)
772-3130 or 772-4222

Mr. Millard Aregood d/b/a
Alaska North Flying Service
P.O. Box 6323
Anchorage, Alaska 99502
243-2686

Mr. David E. Hoffenkamp
Mr. Ronald W. Kaylor
Alaska Skyways, Inc.
P.O. Box 10-1032
Anchorage, Alaska 99511

Mr. Kenneth D. Triplett
Alyeska Air Service, Inc.
1000 Merrill Field Drive
Anchorage, Alaska 99501
(Mail)
276-8141 or 277-5002

Mr. George . Kitchen d/b/a
Anchorage Air Service
3806 Carolina Drive
Anchorage, Alaska 99503
243-2624 or 243-3726

Mr. F.D. Hurlbut, Jr.
Anchorage Airways, Inc.
4950 Aircraft Drive
Anchorage, Alaska 99502
243-4600

Mr. Rex Bishop
Alaska Helicopters, Inc.
P.O. Box 6238 Airport Annex
Anchorage, Alaska 99502
243-3404

Mr. John W. Stoehner
Arctic Aviation, Inc.
P.O. Box 550
Kenai, Alaska 99611
283-7158

Mr. Douglas A. Butler
Arctic Circle Air Service, Inc.
P.O. Box 60049
Fort Yukon, Alaska 99706
456-6075 (WCA)

Mr. Harmon R. Helmericks d/b/a
Arctic Tern Fish Freight Co.
930 9th Avenue
Fairbanks, Alaska 99701

Mrs. JoAnn Armstrong
Armstrong Air Service, Inc.
P.O. Box 204
Dillingham, Alaska 99576
842-5940

Mr. Ray Atkins d/b/a
Ray Atkins Registered Guide
P.O. Box 22
Cantwell, Alaska 99729

Mr. Walt Audi d/b/a
Audi Air, Inc.
P.O. Box 40
Kaktovik, Alaska 99747

Mr. Dennis Parrish
Aurora Air Service, Inc.
P.O. Box 1640
Fairbanks, Alaska 99707
452-5422

Ms. Marjorie Baker
Baker Aviation, Inc.
P.O. Box 116
Kotzebue, Alaska 99752
442-3108 (WCA)

Mr. Glenn W. Wheeler
Arctic Air Service, Inc.
P.O. Box 6227
Anchorage, Alaska 99502
272-1834

Mr. Jack Ronald Smith
Big Country Flying Service
Medfra, Alaska 99629

Mr. Gary L. Anderson
Big Red's Flying Service, Inc.
P.O. Box 6281
Anchorge, Alaska 99502
243-4376

Mr. Michael J. Osolnik d/b/a
Birchwood Air Service
Box B
Chugiak, Alaska 99567
(Schedule)
688-2824

Mr. Jim Bishop
Bishop Bros., Inc.
P.O. Box 2989
Kenai, Alaska 99611
262-9650

Mr. E.G. Branham d/b/a
Branair
P.O. Box 6184
Anchorage, Alaska 99502

Mr. Ronald E. Costello
Brooks Range Aviation, Inc.
Bettles Field, Alaska 99726

Mr. Ronald Peltola
Bush-Air, Inc.
P.O. Box 100
Bethel, Alaska 99559

543-2424 or 543-2628

Mr. Grant Thompson
Cape Smythe Air Service, Inc.
P.O. Box 549
Barrow, Alaska 99723
(WCA/Mail)
852-8333

Mr. Kenneth Bellows
Bellair, Inc.
Box 371
Sitka, Alaska 99835
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747-8636

Mr. Ken Loken
Channel Flying, Inc.
2601 Channel Drive
Juneau, Alaska 99801
(ASA)
586-3331

Mr. G.C. (Jack) Chisum
Chisum Flying Serv. of Ak., Inc.
P.O. Box 1288
Cordova, Alaska 99574
424-7671

Mr. James M. Foode d/b/a
Chitina Air Service
Box 731
Cordova, Alaska 99574
(ASA/Mail)
424-3534

Mr. Ralph Doyle d/b/a
Chugiak Aviation
P.O. Box 249
Chugiak, Alaska 99567
688-2752

Mrs. Joanne Yager
Bethel Ventures, Inc. d/b/a
Coastal Aviation
P.O. Box 888
Bethel, Alaska 99559
543-3900 (WCA)

Mr. Robert Gruber
Cook Inlet Aviation, Inc.
P.O. Box 175
Homer, Alaska 99603
(Mail)
235-8163

Mr. Mark Heikel
Delta Air Service, Inc.
Emmonak, Alaska 99581

949-1715

Mr. David Goocey
Central Airways, Inc.
1842 Merrill Field Drive
Anchorage, Alaska 99501
279-1616

Mr. Lee Daniels d/b/a
Delta Aviation
P.O. Box 924
Delta Junction, Alaska 99737
895-4382 Delta Junction
479-2588 Fairbanks

Mr. Lynn M. Castle
L & S Outfitters, Inc. d/b/a
Denali Flying Service
Box 82
McKinley Park, Alaska 99755
Fairbanks mailing address:
683-2261 Mt. McKinley
344-7361

Mr. Kenneth D. Owsichek d/b/a
Fishing Unlimited
Box 6301
Anchorage, Alaska 99502
Port Alsworth 781-8001

Mr. W.T. Ellis
Ellis Air Taxi, Inc.
P.O. Box 106
Glennallen, Alaska 99588
(ASA)

Ms. Marilyn Buker
Flirite, Inc.
P.O. Box 297
Kodiak, Alaska 99615

Mr. David Baumeister
ERA Helicopters, Inc.
Jet Alaska
6160 South Air Park Drive
Anchorage, Alaska 99502

272-4422 or 278-4651
243-3316 Jet Alaska

Arthur Warbelow
40-Mile Air, LTD
Box 443
Tok, Alask 99780
(Mail)
883-4821 or 883-2686

Mr. James Porter
Evergreen Helicopters of Alaska, Inc.
P.O. Box 578
Anchorage, Alaska 99510
276-2454

Mr. Neal W. Foster
Foster Aviation, Inc.
P.O. Box 1028
Nome, Alaska 99762
(Mail)
443-5292

Mr. Jack Hansen
Mr. Richard H. Matthews d/b/a
Evergreen Lodge Flying Service
SRC Box 264
Palmer, Alaska 99645
344-9811

Mr. John Hajdukovich
Frontier Flying Service, Inc.
3820 University Avenue
Fairbanks, Alaska 99701
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456-4670, 452-1014, 452-7923

Mr. Thomas D. Ratledge
Nelson Island Air Service, Inc. d/b/a
Executive Charter Service
P.O. Box 486
Bethel, Alaska 99559
453-2670

Mr. A.E. Gay
Gay Airways, Inc.
P.O. Box 6003
Anchorage, Alaska 99502
243-1135

Mr. Gary Pogany
Fire Lake Flying Service
P.O. Box 323
Eagle River, Alaska 99577
688-2390

Mr. Arthur D. Hayes
Glacier Bay Airways, Inc.
P.O. Box 1
Gustavus, Alaska 99826
697-3331

Mr. Aleck V. Griechen d/b/a
Griechen Air Taxi
P.O. Box 161
Naknek, Alaska 99633
268-4268

Mr. H. Michael Ivers
Gulf Air Taxi, Inc.
P.O. Box 37
Yakutat, Alaska 99689
784-3240

Mr. Stanley G. Hermens d/b/a
Hermens Air
P.O. Box 114
St. Mary's Alaska 99658
438-2112 (WCA)

Mr. Larry T. Thompson
C and L, Inc. d/b/a
Homer Air
P.O. Box 302
Homer, Alaska 99603
235-8591

Mr. Cyril D. Hetherington d/b/a
Hot Springs Aviation
Manley Hot Springs, Alaska 99756
672-3141

Mr. Daniel L. Smith
Hub Air Service, Inc.
P.O. Box 2
McGrath, Alaska 99627
(WCA/Mail)
524-3266

Mr. John D. Gifford
Gifford Aviation, Inc.
2015 Merrill Drive
Anchorage, Alaska 99501
276-4404

Mr. Tim LaPorte
Iliamna Air Taxi, Inc.
P.O. Box 109
Iliamna, Alaska 99606
(Mail)
571-1248

Mr. Ted Gerken d/b/a
Iliaska Lodge
P.O. Box 28
Iliamna, Alaska 99606
571-1221

Mr. James Sink
International Air Taxi, Inc. d/b/a
International Air Transport
2404 Merrill Field Drive
Anchorage, Alaska 99501
242-5425 or 272-5426

Mr. Robert G. Stanford
Island Air Service, Inc.
P.O. Box 125
Kodiak, Alaska 99615
486-3285

Mr. William de Creeft
Kachemak Air Service, Inc.
P.O. Bo 1769
Homer, Alaska 99603
235-8924

Mr. Raymond F. Peterson
Katmai, Inc.
519 Lynnwood Drive
Anchorage, Alaska 99502
349-2973

Mr. Vernon L. Lofstedt, Jr.
Kenai Air Alaska, Inc.
P.O. Box 3921
Kenai, Alaska 99611
283-7561

Mr. Robert T. Bielefeld d/b/a
Kenai Aviation
P.O. Box 46
Kenai, Alaska 99611
283-4124

Mr. Warren E. Johnson
Kenai Float Plane Service, Inc.
P.O. Box 152
Kenai, Alaska 99611

Mr. Roy Musgrove
North Pacific Airlines, Inc.
P.O. Box 6689, International Airport
Anchorage, Alaska 99502
248-2003

Mr. Terry M. Kennedy
Kennedy Air Service
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Valdez, Alaska 99686
835-4304

Mr. Michael B. Salazar
Ketchikan Air Service, Inc.
P.O. Box 6900
Ketchikan, Alaska 99901
225-6608

Mr. L.H. Ketchum
Ketchum Air Service, Inc.
2708 Aspen Drive
Anchorage, Alaska 99503
243-5525

Mr. Edward M. King d/b/a
King Flying Service
P.O. Box 26
Naknek, Alaska 99633

Mr. Herbert L. Downing d/b/a
Kodiak Air Taxi
P.O. Box 933
Kodiak, Alaska 99615
486-4242

Mr. Layton A. Bennett
L.A.B. Flying Service, Inc.
P.O. Box 272
Haines, Alaska 99827
(ASA/Mail/Schedule)
766-2222

Mr. Larry Chenaille d/b/a
Larry's Flying Service
Box 2348
Fairbanks, Alaska 99707
452-5169

Mr. Clarence L. Larson, Jr.
Larson's Northway Airport
Enterprises
P.O. Box 410
Northway, Alaska 99764
778-6677

Mr. John J. Lee
Lee's Air Service, Inc.
P.O. Box 4-2495
Anchorage, Alaska 99509
243-6500

Mr. Jim Wilson
Livingston Copters, Inc.
P.O. Box 1468
Juneau, Alaska 99802
586-2030

Mr. Donald M. Fell
Maritime Helicopters, Inc.
P.O. Box 357
Homer, Alaska 99603
235-8966

Mr. Stephen L. Hamilton d/b/a
Mountain Aviation
P.O. Box 875
Sitka, Alaska 99835
747-8032

Mr. Richard Galleher
Munz Northern Airlines, Inc.
P.O. Box 790
Nome, Alaska 99762
443-2215

Mr. Tom Olson
Nenana Air Service, Inc.
P.O. Box 296
Nenana, Alaska 99760

832-5574

David Olson
Olson Air Service
Golovin, Alaska 99762
775-8001

Mr. Rod Thompson
Pacific Alaska Airlines, Inc.
P.O. Box 60047
Fairbanks, Alaska 99706
452-1946
206-743-6262 Everett, WA.

Mr. Orin D. Seybert
Peninsula Airways, Inc.
P.O. Box 36
King Salmon, Alaska 99613
246-3373
6231 Collins Way
Anchorage, Alaska 99502
243-7701
(RAA/Mail)

Mr. Arthur J. Hack
Pro Mech, Inc.
Yes Bay, Alaska 99950

Mr. Lawrence Thompson d/b/a
Quality Aircraft Maintenance & Repair
P.O. Box 4-1583
Anchorage, Alaska 99509
892-6451

Mr. Thomas J. Freeburg
Raven Copters, Inc.
P.O. Box 2242
Sitka, Alaska 99835
747-5316

Mr. Dale D. Clark d/b/a
Revilla Flying Service, Inc.
1427 Tongass Avenue
Ketchikan, Alaska 99901
225-4379

Mr. Gene Franks
Rocky Mountain Helicopters, Inc.
P.O. Box 1896
Palmer, Alaska 99645
745-2115
(Registered with Board in D. C.
Palmer is additional base of
operations).

Mr. Charles A. Roat d/b/a
Royal Alaska Aviation
P.O. Box 60242
Fairbanks, Alaska 99707
832-5620

Mr. Henry B. Rust
Rust's Flying Service, Inc.
P.O. Box 6325
Anchorage, Alaska 99502
243-1595

John Eckels
Ryan Air Service, Inc.
P.O. Box 127
Unalakleet, Alaska 99684
624-3200 (WCA)

Mr. George W. Kimball
Sand Point Air Service, Inc.
P.O. Box 4
Sand Point, Alaska 99661
383-3242

Mr. Larry F. Kammerer
Sea Airmotive, Inc.
P.O. Box 6003
Anchorage, Alaska 99502
243-1115

Mr. Homer Hoogendorn
Seward Penn. Flying Service, Inc.
P.O. Box 142
Nome, Alaska 99762
443-2229

Leon Shellabarger d/b/a
Shellabarger Flying Service
Box 11
Kotzebue, Alaska 99752
442-3281

Dr. Gary W. Archer d/b/a
Silvertip Lodges/Bush Pilots
P.O. Box 6389
Anchorage, Alaska 99502
243-1416 or 243-2603

Mr. Benny L. Lingle
Skagway Air Service, Inc.
P.O. Box 357
Skayway, Alaska 99840
983-2218

Mr. Arthur H. Johnson
Roy Smith Flying Service, Inc.
P.O. Box 56
Naknek, Alaska 99633
268-4467

Mrs. Norma C. Hodges
Soldotna Air Service, Inc.
P.O. Box 470
Soldotna, Alaska 99669
262-4397, 262-4554 or 262-4545

Mr. Paul H. Breed
South East Alaska Airlines, Inc.
1515 Tongass Avenue
Ketchikan, Alaska 99901
225-6691 (Schedule/Mail)

Mr. David L. Diamond
SouthCentral Air, Inc.
Box 4324
Kenai, Alaska 99611
283-7676 (Schedule)

Mr. David Wunsch
Southeast Skyways, Inc.
1873 Shell Simmons Drive, Rm 129-A
Juneau, Alaska 99801
(Schedule)
789-0790 or 789-9860

Mr. George Spernak
Spernak Airways, Inc.
P.O. Box 2255
Anchorage, Alaska 99510
272-9475

Mr. Kenneth H. Bunch d/b/a
Sportsman Flying Service
and/or Gulkana Air Service
P.O. Box 31
Glennallen, Alaska 99588
822-3221 (ASA)

Mr. Redmond K. Schunke
Camps, Inc. d/b/a
Stikine Air Service
P.O. Box 631
Le Conte Airlines
P.O. Box 1681
Wrangell, Alaska 99929
874-3327

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Circle, Alaska 99733
773-1219

Mr. Lowell Thomas Jr.
Talkeetna Air Taxi
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Talkeetna, Alaska 99676
733-2218

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Tanana Air Service
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Tanana, Alaska 99777
366-7108

Mr. Jerry A. Scudero
Taquan Air Service, Inc.
P.O. Box 376
Metlakatla, Alaska 99926
886-6868

Mr. Kenneth C. Eichner
Temsco Helicopters, Inc.
P.O. Box 5057
Ketchikan, Alaska 99901

Kathy Wills, Secretary
Wills Corporation d/b/a
Todd's Air Service
Mile 1 1/4 So. Tongass Hwy.
Ketchikan, Alaska 99901
225-4267

Mr. Fred Bismark, Sr.
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583-2711

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Trans-Alaska Helicopters, Inc.
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274-7762

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243-4303

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452-5429 or 456-7394

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(ASA/Schedule)
225-6118

Mr. Jerry D. Haddock
Mr. Ronald A. Watson d/b/a
Valdez Airlines
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243-4307 (Schedule)

Mrs. Ruth Jefford
Valley Air Transport, Inc.
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376-5743

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Wrangell, Alaska 99929
874-3971

Mr. Robert I. Vanderpool d/b/a
Vanderpool Flying Service
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Red Devil, Alaska 99656

Mr. Bryon R. Walton
Walton Company, Inc. d/b/a
Walt's Air Service
General Delivery
Anvik, Alaska 99558
462-8001

Mr. Kenneth R. Ward d/b/a
War Air
1873 Shell Simmons Dr., Suite 5118
Juneau, Alaska 99801
789-9150

Mr. Harley Tessier d/b/a
Wasilla Air Service
P.O. Box 2140
Wasilla, Alaska 99687
376-2353

Mr. Larry L. Ledlow d/b/a
Western Yukon Air
P.O. Box 131
St. Mary's, Alaska 99658
438-2616 or 438-2617

Mr. Charles Slagle
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P.O. Box 6440
Ketchikan, Alaska 99901
225-9693

Mr. Joseph Wilbur
Wilburs, Inc. d/b/a
Wilbur's Flight Operations
1740 E. 5th Avenue
Anchorage, Alaska 99501
277-0511

Ron M. Warbelow d/b/a
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Tok, Alaska 99780
883-2685

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456-5502

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842-5333

Charles J. Sassara
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Anchorage, Alaska 99508
277-4561

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Willow, Alaska 99688
276-3939

Richard Maloney
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581-1531

Jon M. Berryman d/b/a
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Homer, Alaska 99603
235-8256

ASA = Part 293 subcontract with Alaska Airlines, Inc.

RAA = Part 293 subcontract with Reeve Aleutian Airways, Inc.

WCA = Part 293 subcontract with Wien Air Alaska, Inc.

AIA = Part 293 subcontract with Alaska International Air, Inc.

Mail = Operator has a direct contract with the U.S. Postal Service

Schedule = Operates a round-trip schedule of five frequencies per week between two (2) or more points. (Not under a Part 293 contract)

Appendix C

COST OF EXPLORATION FOR METALLIC MINERALS QUESTIONNAIRE
1982 Field Season

Part I

General

1) What commodities and types of deposits is your exploration program directed towards?

2) How many years of additional exploration in Alaska are anticipated or planned? (0, 1-2, 2-10, more than 10)

3) What size deposit is required to meet your corporated goals? ($0.5 million; $0.5-2 million; $2-10 million; $10-100 million; $100 million-1 billion; $10-100 billion)

4) What was your total Alaskan Budget for the:

   fiscal year?_____ total field expenses?_____
   total office expense_____.

5) Total number of personnel in 1981 (office)_____(Field)_____.

6) Past number of years of operation within Alaska?_____

7) Number of permanent personnel within Alaska?_____

8) Permanent office in (Anchorage, Fairbanks, Juneau,_____).

9) Maximum possible field days for 19___:_____

10) Total area covered by your field projects_____sq. (mi., km.)

11) Number of separate project field areas_____

12) In what areas of Alaska were you involved in metallic mineral exploration: (Arctic, Seward Penn., Interior, Aleutian, Southern, Southeast, Other_____.

13) Did your exploration include placer gold deposits?_____.

14) Legal costs_____.

15) Have you secured a land position on native-selected lands? (Yes, No)_____.

16) Comments or suggestions for someone considering an Alaskan mineral exploration program:

Part 2

Individual Project Summary. General Location:_____.

1) Objectives of project:

____ Reconnaissance Mapping
____ Detailed claim mapping
____ Claim assessment
____ Drilling
____ other_____
____ geochemical sampling
____ geophysics, ground
____ geophysics, airborne
____ mineral beneficiation testing

2) Length of field program_____days.

3) Number of days lost due to weather_____; due to equipment failure_____.

4) Size of project area_____(sq. mi., km.)

5) Total number of field personnel involved_____; total personnel cost $_____

6) Number of professional personnel

	Number	Cost/day	Man-days
Geologists	_____	$_____	_____
Engineers	_____	_____	_____
Surveyors	_____	_____	_____
Others_____	_____	_____	_____
_____			

7) Number of support personnel

Pilots *	_____	$_____	_____
Mechanics	_____	_____	_____
Equipment Operators	_____	_____	_____
Cooks	_____	_____	_____
Labor	_____	_____	_____
Expeditors	_____	_____	_____
Other _____	_____	_____	_____
_____			

* Do not include if listed below in charter costs.

8) Total transportation costs $_____.

a) Fuel costs $_____, types of fuel used:

b) Freight to Alaska $_____. (Air, truck or boat?)

c) Freight within Alaska $_____. (Air, truck or boat?)

d) Personnel to Alaska $_____, $_____.

e) Personnel within Alaska $_____.

f) Total cost of fixed wing aircraft $_____, type used_____, cost per hour_____, recommendations:

g) Total cost of helicopters $_____, type used_____, cost per hour_____, recommendations:

h) Boat expenditures $_____, cost per hour_____.

i) Vehicle cost $_____.

j) Other transportation: $_____.

k) Total cost of tranporting fuel $_____, $/gal._____.

9) Communication cost: Phone $_____, Radio $_____, type of radio used_____.

10) Living or camp costs:

a) Food, total $_____; $/man_____.
b) Camp costs $_____.
c) Lodging, meals not at camp $_____.
d) Other costs (specify):

11) Field equipment purchases (new) $_____.

a) Maps, photos $_____.
b) Maintenance $_____.
c) Other $_____.

12) Contractual Services cost, total $_____.

a) Claim, Staking $_____, $/claim_____.

b) Surveying $_____.
c) Ground geophysics $_____, line miles_____approx.
d) Geological Consultants $_____, $/man-day_____.
e) Airborne geophysics $_____, line miles_____approx.
f) Geochemistry $_____.
g) Drilling $_____, footage_____approx.
type of drills used:

h) Heavy Equipment $_____, type_____

i) Other, specify $_____.

13) Laboratory analyses $_____, $_____approx.

14) Administrative costs, personnel $_____, other_____.

15) Legal costs $_____.

16) Miscellaneous $_____

17) Project total $_____ approx.

18) Comments M.I.R.L. Report No. 56 "Cost of exploration for metallic minerals in Alaska-1982"

a. _____ Useful

b. _____ Useful but recommend the following changes_____

_____

_____

c. _____ not useful-discontinue publication.

19) Comments on Questionnaire

a. _____ adequate

b. _____ not adequate and requires the following changes_____

_____

_____

20) Return to: Mining Geology Unit, Attn: Metz/Campbell
Mineral Industry Research Laboratory
O'Neil Building
University of Alaska, Fairbanks
Fairbanks, Alaska 99701