COST OF EXPLORATION FOR METALLIC MINERALS IN ALASKA

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ABSTRACT

The high cost of exploration for metallic minerals in Alaska not only reflects a 20-50% increase in the cost of supplies, food and salaries over those "outside" but also some additional costs that are characteristic of most Alaskan exploration efforts. Transportation in particular often represents half of the exploration budget and is a major cost of almost all programs. Helicopters commonly are used as the basic mode of field transportation; their cost is high (about $125 to $300 per hour) and increasing, and their availability is becoming less certain with the accelerating demand for them. Salaries for field personnal are also considerably higher than those paid to personnel "outside". And the demand, both from within and without the mining industry, for those with Alaskan experience is so great as to drive those salaries even higher.

Fuel and communication costs not only show the usual Alaskan mark-up but are also subject to local scarcity and almost unavoidable problems. Fuel will probably continue to be available in the major population centers but there have always been difficulties in providing or obtaining fuel in the bush; these will undoubtedly be magnified with the booming development of Alaska's petroleum resources and national scarcity. Communications with the field will undoubtedly continue to be uncertain at times and will frequently present major problems that money along cannot solve and result in much frustration and delay.

Contract services such as drilling, geophysical work, and geochemical analyses are available within the state in varying degree or can be obtained "outside" at rates that do not seem to be unduly expensive. However, the cost of transportation, mobilization, and demobilization of the personnel

and equipment used in performing these services may result in unusually high costs for projects of short duration.

Early logistical planning has always been considered wise in Alaskan field work and it will undoubtedly continue to be important, if not essential. The lack of it may be alleviated in some cases with copious applications of money but with Alaska's present booming development, the lack of planning may lead to an uncertain ability to work in the field at all.

The cost of Alaskan exploration programs vary greatly. Many of the reconnaissance geologic and geochemical programs are strikingly expensive chiefly because of the need for helicopter support. Other types of programs such as prospect evaluations are not nearly so expensive and Alaskan costs for projects of limited area or duration are not necessarily prohibitive. In almost all cases, experience, imagination, and prior planning can reduce costs significantly.

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INTRODUCTION

Barring more unforseen complications, Alaska will undoubtedly become one of the frontiers of metal exploration in North America in the near future. The development of metal exploration in Alaska has flucuated somewhat in recent years chiefly because of the complexities and uncertainties associated with the Alaska Native Land Claims Settlement. However, not only is the land situation becoming more of a known factor, other developments such as the worldwide mineral shortage, increasing metal prices, and Alaska's favorable political environment indicate that a rapid expansion in metal exploration may be expected shortly. In fact, indications such as the demand for personnel and helicopters and the number of companies that have already announced their plans clearly indicate a record amount of exploration this (1974) summer - if not an explosive expansion of exploration.

Purpose and Scope of the Project

Commonly, the first thought associated with Alaska by those unfamiliar with the state is the high, if not exorbitant, prices. In this case, reality often coincides with that first impression. Costs are high in Alaska - and they will probably be getting higher in the immediate future as the boom associated with the construction of the Alaska oil pipeline develops.

This study is an attempt to try to first, give some examples of the cost of typical metal exploration projects in Alaska, and second, attempt to analyze those costs in terms of specific items. As such, it is not meant primarily for those that have previous experience in Alaska although they may find it informative. Neither, is it an attempt to cover the cost of exploration in general. Rather, it attempts to illustrate how Alaskan exploration differs in cost from other areas and particularly from that in the "lower 48".

The data comes from three main sources, a comprehensive questionaire that was sent to a number of mining and exploration companies that were known to have been active in Alaska within the recent past, from the literature, and from personal interviews with experienced explorationists. Although not stated explicitly (to achieve some degree of anonymity), the data in the tables relates to work that has been completed within the last five years and the material from the literature attempts to use as current as costs as possible.

It must be emphasized that costs are escalating rapidly in Alaska and that many of the costs cited in the various projects would now be increased substantially - and will probably continue to increase in the near future. This is not only due to the inflation but what is developing into a boom economy fueled by oil development in Alaska. And perhaps, it would not be out of place in indicate that locally some types of equipment and personnel will not be available at any practical price in the immediate future.

Characteristics of Alaskan Metal Exploration

Perhaps the very size of Alaska is the factor that most influences the metal exploration that form the bulk of the programs at the present time. While it is quite easy to cite numbers, the reality of the distances and size of the area in the state are not always easy to grasp. This is particularly true when one must come to grips with the lack of roads and a transportation network. Much of the state lacks even minimal geologic mapping; it will be some time in the distant future before all the state is mapped at a scale of 1:250,000 and little is mapped at a scale of inch to the mile or larger. The geologic mapping that has been done is often explicitly labeled as reconassissance geologic mapping and much that is not so labeled is understood to be such.

Although Alaska has a long and colorful history as a mining state, the metal mining industry is presently almost non-existent except for some gold and platinum produced from placers. There is not a single, large underground mine now operating in the state and at best, only a few small underground mines. There are persistent rumors that one or more of the prospects that have been found in recent years are well on their way to becoming major mines, but as yet, there has been no formal announcement of new operations.

Much (most?) of the metal and geologic exploration done in Alaska has been accomplished by groups that come into the state only for the field season. For example, the U.S. Geological Survey which has done the great majority of the geologic mapping in the state is based in Menlo Park, California, and has only a limited geologic staff based permanently in Alaska. Many of the private companies do likewise but within the past two years a number of companies have opened offices in Anchorage and Fairbanks and more have expressed an interest in doing so.

The helicopter has revolutionized geologic field work in Alaska. The days of the epic journeys by backpacking, by boat along the rivers, or by horse are largely gone. Most of the work is now done from substantial, semi-permanent base camps using helicopters either as the main means of transportation or in conjunction with foot traverses limited to a single day's work. This is basically an outgrowth of the need or desire to cover large amounts of ground as rapidly as possible and is thus related to the goal of finding the relatively obvious ore deposits in the wide expanse of unexplored terrain.

There are, of course, other types of programs. Increasingly, prospect evaluation and development work is being done and drilling in particular is increasing. Programs involving mainly foot traversing, while overshadowed in dollar value by the helicopter programs, continue to be important. Indeed, we may well see a return to foot traverses and detailed mapping as reconaissance work becomes less productive and the mineralized areas are outlined.

By far, the bulk of the geochemical work involves stream sediment sampling and in many programs is the only type of geochemical sampling. The geophysical work has been dominated by regional aeromagnetic coverage, especially the work by the Alaska Division of Geological and Geophysical Surveys and the U.S. Geological Survey.

One could argue the point in relating to specific areas, but in general, the traverseability of the state is poor when compared to most of the western United States; much of it is covered by tundra, by heavy rain forest, or consists of extremely mountainous terrain. Perhaps as a consolation to the explorationist, it is still possible to find surface outcroppings of mineralization, and at least for the immediate future, one has the chance to explore country that has not been picked over and examined by legions of geologists.

Kaufman (1972) presents an excellent review of metal exploration in Alaska, he stresses the geologic possibilities and also discusses the general characteristics and flavor of recent work. Bailly (1964) cites costs for base metal exploration in a series of excellent tables, however his figures are more in terms of the (wide) range of costs rather than specific costs and case histories. His paper also delves into the organization and philosophy necessary for successful metal exploration in some detail but his work is applicable to Alaska only generally. Hawley's paper (1974) serves as the most recent summary of the potential of Alaskan ore deposits and in particular discusses the land situation as it applies to mineral exploration. Wolff (1969) presents an excellent summary of the history of Alaskan mining as well as the methods and philosophy that characterized Alaskan mining and exploration prior to the present "helicopter" era.

It is not at all difficult to be pessimistic about the chances of finding enough ore in Alaska to make a mine. Not only do the chances of finding ore probably decrease with the need for high grades to match the higher cost of operation but some would even suggest that Alaska is metal poor. Costs will probably remain high and perhaps the pessimism concerning the distribution of metals in understandable in view of the relative paucity of mines and prospects. It is however, contradicted by the major new discoveries within the last 15 years, many in areas previously thought to be devoid of mineralization but which now are known to have been under-explored. Examples include the porphyry coppers of the Forty Mile area and the Wrangell Mountains, the copper belt in the southern Brooks Range, the Pb-Zn-Ag mineralization in the eastern Seward Peninsula, and many more. The more optimistic, if not realistic, way of looking at the possibilities for ore in Alaska is directly related to the frontier aspects of the state - the lack of certainty and scarcity of data are not absolutes but opportunities. While one can perhaps be too optimistic, the development of the petroleum industry in Alaska might be used as an encouraging example. After decades of exploration facing all of Alaska's problems with only marignal results, the Prudhoe field transcends all of those problems and will probably repay all the previous work handsomely.

One could also perhaps question whether Alaskan exploration is really much different from exploration in other areas of the United States or the world in other than superficial details and in cost. That of course depends on the philosophy and experience of the individual. However, one comment to a question in this study about the unique problems of Alaskan metal exploration might be of interest. The answer was "All problems are unique in Alaska!"

[Comments added Spring 1975: Since this report was written in the late Spring of 1974, there have already been many changes in the costs and the availability of personnel and equipment. In particular, the "fuel crisis" proved to be illusionary. Fuel costs have obviously risen but fuel availability does not appear to be any more of a problem than in the recent past. Most other costs are increasing as well and some are skyrocketing although much of these increased prices can be attributed to the general inflation in the country.

The pipeline boom is in progress and it is accelerating toward a maximum effort in the next year or two. Alaska still has a high unemployment rate but skilled workers and in particular construction workers are exceedingly difficult to find and hold. Skilled workers commonly draw $1000 per week on the piepline projects and the demand for them is increasing. It remains to be seen if a great influx of unskilled workers arrives in Alaska this summer in response to these wages; if as expected they do, they will certainly add to the boom atmosphere and the unemployment rate. Housing in particular is extremely short all along the pipeline route.

Fixed-wing and helicopter companies have expanded to meet the increasing demand for air transport. The number of aircraft can probably be expanded without difficulty. However, there is the feeling in many quarters that the supply of pilots skilled in the type of flying necessary in mineral exploration cannot be so quickly expanded.

There does not appear to be any lessening of the mineral exploration effort in Alaska this coming summer. Most of the traditional sources for personnel and services seem to have been relatively unaffected by the pipeline boom. Whether this will continue into the immediate future is uncertain because of the great demand for geologists and technical personnel from the pipeline projects, petroleum exploration, and government projects.]

CHAPTER 2

COSTS

Summary of Project Costs

Table 1 (in pocket) summarizes the costs of 29 metal exploration projects completed within the last 5 years in Alaska. Some general comments are in order to fully interpret these costs. There was obviously no uniformity in the subdivision of the budgets as found in the company records. There was an attempt to reduce the costs to clearly defined categories by means of the questionaires used in this study. However, even with the use of the questionaires, there is undoubtedly still some lack of uniformity. To what degree this is truly significant is impossible to say but aside from a few costs which appear anomalous the costs assigned to any particular subdivision seem to be roughly comparable. Probably the main problem in assigning the costs to any particular item lies in lumping costs under a superior heading, e.g. not breaking out the different types of transportation due to the bookkeeping procedures of the various companies.

There was also no attempt to "audit" the numbers in the sense of making all the various categories of costs add up to the total budget. It is assumed that the total budget figures are correct and that the costs for any particular item of the total costs are correct but these numbers were presented as the respondent best saw fit. Note that the same project numbers are used in all the tables where costs are discussed.

One comparison that the reader may find conspicuously absent, the cost of exploration per square mile, is purposely not calculated. Probably the main reason is that the sample population is simply not large enough to make comparisons. The cost of the various projects varies from more than $400,000 per square mile to less than $11 per square mile. These figures are obviously tied to the type of program and the programs listed in Table 1 vary from detailed prospect evaluation with drilling and geophysical exploration to reconnaissance geologic or geochemical programs. Not only is there a wide variety of programs but there is also the lack of a common base of definition. Thus, one project's "detailed" mapping may well be another project's "reconnaissance" mapping (and this is known to be true in at least one comparison). One is somewhat hesitant to rank a geologist's work as "detailed" or "reconnaissance" in other than his terms.

Another striking thing about the data in Table 1 is the great variability in the costs between projects of roughly similar type and area. This variation could probably best be explained with reference to the quality or effectiveness of the work. That such an evaluation would be valuable is obvious but the scope of such an evaluation is rather more than can be handled in this project.

Transportation

Transportation is probably the main factor that differentiates Alaskan exploration from that in most other areas of the United States. It is basically expensive and lack of attention to the possibilities and limitations of Alaskan transportation can make it even more expensive. Most exploration programs in Alaska depend heavily on air transport; many rely on it almost entirely and few do not use it. To a lesser extent, boat, tracked vehicles and wheeled vehicles may prove useful. Table 2 (next page) summarizes the various components of the total cost of transportation in the case histories of this study.

Fixed-wing aircraft

Fixed-wing aircraft are probably the most important method of transportation to the "bush" areas of Alaska and the remoteness of many parts of the state often make air transportation the only practical method of transportation available.

Small fixed-wing aircraft are in common use throughout the state, and are readily available for charter services from a great number of air taxi operators. A listing of all registered air taxi operators in Alaska is maintained by the Federal Aviation Administration. The list can be obtained from them on request and includes both fixed-wing and helicopter operators. Table 3 (page 13) is a compilation of specifications and charter costs of the various light, fixed-wing aircraft that are in general use in Alaska. The most commonly used types are the Piper PA-18 "Super Cub", the Cessna 180 and 185, the Cessna 206, and the DeHavilland Beaver.

Table 2

Transportation Expenditures

Project	Freight to Alaska	Freight within Alaska	Personnel to Alaska	Personnel within Alaska	Fixed Wing Aircraft: Total Cost	Fixed Wing Aircraft: Type	Fixed Wing Aircraft: Cost per Hour	Helicopter: Total Cost	Helicopter: Type	Helicopter: Cost per Hour	Boat: Total Cost	Boat: Size	Vehicle Cost	Other: Total Cost	Other: Specify	Fuel Transportation Costs	Total Transportation Costs	Total Project Budget
1	*	*	*	*	*			*			0		0	0		0	*	$425,000
2	*	*	*	*	0			0			0		$4,000	0		0	$6,948	$103,614
3	*	*	*	*	$1,460			0			0		$445	0		*	$2,157	$40,000
4	*	*	*	*	*			*			0		0	0		0	*	$205,000
5	*	*	*	*	*			*			0		0	0		0	*	$95,000
6	*	$35,386	$12,013	*	$22,685			0			0		0	0		0	$70,057	$531,996
7	$26,043	$8,112	$12,306	*	$10,545			0			0		0	0		0	$57,006	$251,425
8	$200	*	$1,000	*	$700	Beaver Cessna 185	$90 $80	$23,000	Bell 206 UH12E	$225 $140	0		$800	0		$250	$25,850	$48,000
9	*	$1,000	*	*	$2,000	Piper PA-18		$20,000			0		0	0		0	$22,000	$60,000
10	$32,000	$5,000	$27,000	$5,000	$15,000	Cessna 185 Cessna 206	$75 $80	$81,000	UH12E	$135	$12,000	30 feet	0	0		$4,500	$177,000	$685,520
11	*	$800	*	*	$1,000	Cessna 185	$60	$2,500	Hughes 300 UH123	$85 $135	0		0	0		0	$5,400	$24,000
12	*	*	*	*	0			$2,200	Bell 206	$210	0		0	0		$80	$2,222	$6,925
13	*	*	$900	*	$500			$15,000	UH12E Alouette II	$150 $240	0		$650	0		0	$17,400	$30,000
14	$1,000	$6,000	$4,000	$2,000	$4,000	Beaver Cessna 185	$130 $75	$70,000	Bell 206 UH12E		0		$1,500	0		$600	$88,500	$250,000
15	$100	$350	$380	*	0			$3,900	Bell G3B	$114	0		0	0		$2,000	$5,080	$8,700
16	$100	$250	$2,750	*	$750	Cessna 185	$60	$75,000	Hughes 500	$200	$27,000	107 feet	$100	0		0	$106,450	$164,375
17	*	*	*	*	*			*			0		0	0		$.40/gal	*	$105,000
18	*	$50	$500	$50	$330	Piper PA-18		$10,280	Bell G3B	$114	0		$650	0		0	$11,850	$27,765
19	*	*	*	*	$2,500	Piper PA-18	$50	$40,500	FH-1100	$180	0		0	0		$2,000	$47,000	$64,000
20	*	*	*	*	$4,089	Cessna 185 Cessna 180 Turbo Beaver		$13,588	UH12E		$21,561	35 feet	$243	0		0	$44,388	$150,000
21	*	$200	*	$200	$1,000	Cessna 185	$70	$22,875	UH12E	$125	0		0	0		0	$24,275	-
22	*	*	0	$2,002	$8,320	C-46 DC-3 Cessna 180 Cessna 185 Cessna 206		$21,232	Bell G4	$55	0		0	0		$1.00/gal	$31,552	$65,000
23	$300	$150	$350	$100	$10,000	Piper PA-18	$25	0			0		0	0		0	$11,900	$57,800
24	*	*	*	*	$2,000			$17,000	Alouette II	$255	0		$1,500	$2,000	Tracked vehicle	0	$28,500	$170,000
25	*	*	$1,600	$2,629	$15,106			$49,627	Bell G3B-1		0		$188	0		*	$69,150	-
26	$3,000	$500	$300	*	$9,600	Piper PA-18		$18,000		$90	0		$2,000	$2,000		0	$35,000	$87,000
27	$514	$612	$1,454	*	0			$25,523	FH-1100	$190	0		0	0		0	$28,112	$41,208
28	*	*	*	*	*	Otter Beaver C-47		*			0		0	0		0	*	$449,000

* = Under another heading.

Table 3

Specifications and Charter Costs of Small, Fixed Wing-Aircraft

Manufacturer	Model	Seating Capacity	Useful Load[1]		Airspeed[2]		Range[3]		Fuel Type	Average Charter Cost[4]
			Wheels	Floats	Wheels	Floats	Wheels	Floats		
Bellanca	Champ	2	500 lbs.		125 mph		480 mi.		100-130	$54 per hour
Cessna	150	2	600 lbs.	400 lbs.	117 mph	98 mph	412 mi.	330 mi.	100-130	$29 per hour
Piper	PA-18 "Super Cub"	2	800 lbs.	500 lbs.	115 mph	103 mph	460 mi.	412 mi.	100-130	$45 per hour
Aero Commander	Shrike	4	2115 lbs.		203 mph		750 mi.		100-130	$186 per hour
Cessna	172	4	1000 lbs.	800 lbs.	114 mph	92 mph	615 mi.	500 mi.	100-130	$45 per hour
Piper	140	4	1100 lbs.		135 mph		725 mi.		100-130	$50 per hour
Piper	180	4	1160 lbs.		143 mph		725 mi.		100-130	$55 per hour
Cessna	310	4	2100 lbs.		213 mph		1000 mi.		100-130	$117 per hour
Cessna	180	6	1300 lbs.	1100 lbs.	162 mph	147 mph	695 mi.	630 mi.	100-130	$65 per hour
Cessna	185	6	1800 lbs.	1400 lbs.	169 mph	155 mph	1075 mi.	970 mi.	100-130	$77 per hour
Cessna	206	6	1900 lbs.	1400 lbs.	164 mph	151 mph	650 mi.	600 mi.	100-130	$77 per hour
Helio	H295	6	1400 lbs.		165 mph		660 mi.		100-130	$75 per hour
Piper	Cherokee 6	6	1260 lbs.		147 mph		455 mi.		100-130	$82 per hour
Piper	Navajo B	9	2500 lbs.		213 mph		1110 mi.		100-130	$180 per hour
Aero Commander	681B	11	3853 lbs.		278 mph		1062 mi.		100-130	$300 per hour

1) Useful Load is Maximum take-off weight less empty weight.
2) Airspeed is at 75% power.
3) Range with standard tanks.
4) Approximate charter cost in Fairbanks, Alaska in April, 1974.

Data from Jane's All the World Aircraft (Taylor, 1973) with minor additions and cost information

Cessna 185's and 206's are probably the most frequently encountered light aircraft in the "bush"; they combine the ability to operate from minimal airstrips with good cargo and passenger capacity.

The DeHavilland Beaver offers greatly increased cargo and passenger capacity with the ruggedness to operate off "bush" airstrips. However, they are not nearly so widely available as the smaller aircraft. The Piper PA-18 "Super Cub: is exceptionally well suited for some uses. In particular, their very short take-off and landing characteristics enable a skilled pilot to land on river bars and bare ridges unsuitable for other aircraft. They are, however, limited to a capacity of two persons and their cargo volume is somewhat limited.

It should be noted that the addition of floats to the aircraft reduces both the useful load and airspeed of the aircraft (see Table 3). Float equipped aircraft are almost universally used in Southeastern Alaska where few landing strips are available.

Sainsbury (1972) has strongly advocated the use of light aircraft in the mapping and geochemical phases of metal exploration. He utilizes a 135 horsepower Piper PA-18 "Super Cub" aircraft that has been slightly modified so that it has better flying characteristics at lower speeds. His mapping technique involves flying along areas of geologic interest, and mapping such things as contacts, joints, and faults. The mapping is done directly upon topographic maps, where they are available, or upon aerial photographs where maps are unavailable. The initial mapping is done about 3000 feet above the ground; this enables the mapper to distinguish major geologic features. The aircraft is then flown closer to the ground in order to identify rock units and minor features such as jointing.

This type of airborne geological investigation is believed by Sainsbury to be more economical and the rate of coverage per unit cost is increased markedly over conventional techniques. Using this technique, Sainsbury has mapped 20,000 square miles on the Seward Peninsula in five field sessions. In a test of this technique, Sainsbury mapped six 1:63,360 quadrangles in six days. The maps produced were later used by ground parties in the area and were found to be quite accurate. He also points out that while these methods would seem to be inherently dangerous, they are probably less so than working with the helicopters and boats that are routinely used and which have a demonstrated high accident rate.

Large fixed-wing, multi-engine aircraft are often utilized in support of mineral exploration programs. Table 4 (page 16) is a compilation of specifications and charter costs of most of the large fixed wing aircraft available in Alaska.

Fuel in particular is conveniently transported to the field with large aircraft. The cost per unit obviously drops markedly with the size of the aircraft limited only by the ability to fully utilize its capacity. It is also a great convenience to be able to transport all the equipment and supplies necessary in a program in one or two trips as opposed to a scheme which relies on many flights by smaller aircraft or other transportation methods which extend the process over a long period of time. The ability of multi-engine aircraft to transport equipment and supplies quickly is often the overriding consideration for their use.

Tremendous tonnages of materials are now being flown out of Fairbanks and Anchorage, most of it in support of pipeline construction on the North

Table 4

Specifications and Charter Costs of Large, Fixed-Wing Aircraft

Manufacturer	Model	No. of Pass.	Maximum Payload	Cruise Speed [1]	Range [2]	Take-off Distance [3]	Landing Distance [4]	Charter Cost [5]
Boeing	737	*	*35,000 lbs.	576 mph	2,370 mi.			$4.20/mi. Min. $2,400
Boeing	727	*131-169	*41,000 lbs.	600 mph	*2,000 mi.	*8,500 ft.	*4,900 ft.	$3.00/mi. $330/hr. Min. $2,000
Boeing	747	*300	*257,850 lbs.	608 mph	*6,620 mi	10,900 ft.	7,270 ft.	
DeHavilland	Twin Otter	*20	4,420 lbs.	210 mph	794 mi.	*1,500 ft.	*1,940 ft.	$2.50/mi. $350/hr. Min. $250
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.			$1.80/mi. $295/hr.
Curtis Wright	C-46		11,000 lbs.	190 mph	1,500 mi.			$2.20/mi. $425/hr.
Fairchild	F-27	40	15,200 lbs.	306 mph	1,570 mi.	4,100 ft.	3,580 ft.	$3.00/mi. $700/hr.
Fairchild	F-227	*44-52	11,200 lbs.	294 mph	1,656 mi.			$3.75/mi. $900/hr. Min. $1,000
Lockheed	HC-130		45,000 lbs.	368 mph	2,400 mi.	5,580 ft.	3,750 ft.	$5.16/mi.
Short	Sky Van	*2-19	5,000 lbs.	195 mph	240 mi.	2,000 ft.	2,040 ft.	$2.50/mi. $350/hr. Min. $250

*) 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.
5) Approximate charter cost in Fairbanks, Alaska in April, 1974.

Data from _Jane's All The World Aircraft_ (Taylor, 1973) with minor additions and cost information.

Slope. Large tonnages of equipment and supplies have been moved by large fixed-wing aircraft (chiefly Lockheed Hercules) to the Prudhoe Bay area at a cost of between $.23 and $.27 per ton mile; this was actually less expensive than truck transportation over a winter haul road (Wolff et al, 1973).

The military has developed the technology to deliver supplies and equipment from multi-engine aircraft in flight with near pinpoint accuracy and with little damage - most of the time. As an example, the Air Force dropped a capacity load of almost 100 barrels of diesel fuel on top of a glacier on Mr. Wrangell (about 14,000 feet in elevation) as part of a supply operation in 1963. The load was dropped from a Lockheed Hercules and landed within 200 feet of a target. The fuel was palleted and attached to a streamer chute that did little more than to produce a stabilized free-fall. Only one barrel of the fuel had a minor leak. This type of service is apparently not available commercially or at least, it has not been utilized commercially in Alaska to any extent. It would seem to have potential under certain circumstances, but most people would rather land the aircraft and off-load.

The utilization of large fixed-wing aircraft in support of mineral exploration programs may reduce transportation expenditures greatly. In exploration programs where large amounts of fuel or other materials must be moved long distances, the use of large fixed wing aircraft deserves serious consideration.

Helicopters

Helicopters are the main-stay of mineral exploration in Alaska.

Their versatility and applicability to mineral exploration has revolutionized field work in the last decade. Frequently, the cost of helicopter support in a mineral exploration program accounts for the majority of the transportation expenditures.

Tables 5a and 5b are a compilation of specifications and charter costs, and limitations and strong points for the helicopters generally used in mineral exploration and available in Alaska. These tables were taken from the Helicopter Safety and Operations Manual of the Alberta Society of Petroleum Geologists (1972). It also contains an excellent treatment of the use of helicopters, and helicopter safety, and an extended discussion of contracting helicopters with an example of a typical contract.

Commonly, individuals utilizing helicopters in support of mineral exploration programs have misconceptions about the range limitations of helicopters. Most helicopters have a maximum flight time of about two and one half hours. This means that the maximum radius of the area that can be worked from a central base without refueling is 100 to 150 miles. This radius of action would not appear to be a serious limitation - and is not when the helicopter is used primarily to place people for day-long traverses. However, when it is used as a basic mode of movement between geologic or geochemical sample stations at some distance from a fuel source, much of the day can be spent in refueling trips. The obvious answer to this situation is to establish a multitude of fuel caches throughout the field area. Establishing fuel caches with the helicopter itself is expensive: it is also flexible and convenient, and is frequently done.

Good helicopter management can significantly reduce the cost of transportation as well as aid in producing the maximum amount of work. However,

Table 5a

Specifications and Charter Costs of Helicopters

Manufacturer	Model	Seating Capacity[1]	Load Capacity Body Load[a]	Sling Load[b]	Flight time (hrs.)	Airspeed (mph)	Fuel Consumption per hour	Fuel Type	Ceiling (feet)[2]	Charter Cost[3]
Alouette II	318C	4	960 lbs.	1,200 lbs.	4/5	100	30 gal.	JP-4	12,000	$240 per hour
Alouette II	318	4	520 lbs.	930 lbs.	3	90	45 gal.	JP-4	6,000	$240 per hour
Bell	47G-2	2	360 lbs.	450 lbs.	2 1/4	65	14 gal.	80/87	4,000	$125 per hour
Bell	47G-2	2	360 lbs.	450 lbs.	2 1/4	65	12 gal.	100/130	10,000	
Bell	Super 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	$135 per hour
Bell	47G-3B1	2	450 lbs.	600 lbs.	2 3/4	65	15 gal.	100/130	10,000	$145 per hour
Bell	47G-3B2	2	450 lbs.	600 lbs.	2 3/4	65	15 gal.	100/130	10,000	
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 1/2	125	22 gal.	JP-4	8,000	$250 per hour
Bell	204 B	10	2,150 lbs.	3,700 lbs.	2 3/4	115	65 gal.	JP-4	6,000	$700 per hour
Bell	205 A	14	2,550 lbs.	4,150 lbs.	2 1/2	120	80 gal.	JP-4	8,000	$700 per hour
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	$135 per hour
Hiller	FH-1100	4	850 lbs.	1,050 lbs.	2 1/2	125	22 ga;.	JP-4	8,000	$250 per hour
Hughes	500	4-6	920 lbs.	1,150 lbs.	2 1/2	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	$400 per hour

1) Seating capacity plus pilot.
2) Recommended maximum ceiling.
3) Approximate charter cost in Fairbanks, Alaska in April, 1974.
a) Body load with 2 hours fuel.
b) Sling load with 1 hour fuel.

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

Table 5b

Helicopter Limitations and Strong Points

Manufacturer	Model	Strong Points	Limitations
Alouette	II	Very reliable turbine and airframe. Ruggedly constructed. Excellent cabin and cargo rack capacity.	Not as fast as other turbine helicopters. Higher fuel consumption than other turbine helicopters in its class.
Bell	47G-2	Reliability, simplicity.	Relatively restricted to low elevations.
Bell	47G-2 Super	Supercharged increased performance over G-2 and a good machine with light sling loads.	Narrow cabin
Bell	47G-3B	Good visibility, stability and greater speed than G-2 models, good altitude.	Narrow cabin
Bell	47G-3B1	As G-3B with wider cabin seating.	Some loss of speed with wide cabin.
Bell	47G-3B2	Wide cabin: low consol gives improved visibility: better transmission and hydraulics.	Some loss of speed with wide cabin
Bell	47AJ-2	Large cabin space. Improved air speed over G-2 and G-3 types.	Passenger visibility poor with arranged seating behind pilot.
Bell	206A	Good cruising speed, increased range and comfort for year round operations.	Has suffered in past with engine development problems. Does not have cargo rack. Poor visibility for 3 passengers in rear seat.
Bell	204B	Good speed with inside loads, very reliable.	
Hiller	SL-4	Good performance with load at high altitude.	Visibility of passengers is restricted due to passenger seats located behind pilot.
Hiller	UH12E	Excellent capacity at low altitude.	Noise level above average, cold weather operation should be restricted to above 20 degrees below.
Hiller	FH1100	Excellent sling loads due to good pilot visibility.	Engine has given trouble in past. Poor visibility in rear seats.
Hughes	500	High speed; seat and cabin construction advertised as giving better protection in hard landings. Licensed to carry 6 passengers by removing aft seats.	Limited luggage space; more floor space but limited head room in aft cabin. Same engine as Bell 206 and Hiller FH1100.
Sikorsky	S55B	Large cabin for freight and passengers. Tail and main rotors high for brushy clearings. Can stop rotor and have engine running. Strong construction.	Large for small clearings. High noise level in cabin. Wheels poor in soft ground.

From Helicopter Safety and Operations Manual, Alberta Society of Petroleum Geologists (1972) one cannot usually change the temperament or the rate of which helicopter pilots (or geologists) work and individual pilots may vary markedly in their ability to get from one point to another. Indecision in picking landing spots may be particularly time consuming.

The type of helicopter to be used is quite important in producing optimum results. The most obvious criteria in choosing a specific type of helicopter are the load capacity, the airspeed, and the ceiling. However, these criteria are to some extent dependent on the local weather and to a great extent by the condition of the aircraft. The ceiling limitations in particular are often overlooked in Alaska where so much of the terrain is so high or the relief is so great; one can use great amounts of time fighting for altitude with a full load as one approaches the ceiling limit of the aircraft. In general, it is wise to have ample reserves in load capacity and ceiling; the work will not only progress faster but also more safely.

Piston helicopters are usually sufficient for 1-2 man (or in some cases 3-4 man) field parties. Turbine (or jet) helicopters are, however, becoming increasingly prominent in Alaskan metal exploration. For larger parties they are often less expensive than piston helicopters in that they have markedly greater load capacity and speed. They also generally have good high altitude capabilities and being of more recent development, turbine helicopters require less maintenance than piston types.

Several helicopter-supported field operations were conducted from 1952 to 1955 in remote areas of northern Canada; these are discussed in detail in a paper by the Canadian Geological Survey (1959). Although the surveys were conducted almost two decades ago, many of the methods used and the conclusions reached concerning helicopter support of reconnaissance geologic operations are still applicable today. This paper should be read in detail by those contemplating helicopter work in Alaska. The helicopter used for most of these Canadian projects, was the Bell 47G1 (the range and load capacities of this helicopter are quite low when compared with some newer models.) The Canadians devised fairly well defined procedures to fully utilize their helicopters. One method employed the establishment of fuel caches throughout the study area with the aid of a DeHavillan Beaver or a Norseman before the field season began. Another method made use of what the Canadians called a traverse net. The net consisted of triangular helicopter traverses, set in a spoke-like arrangement radiating from a central base camp. The traverses consisted of round trips of about 100 miles which proved to be the optimum operating distance for the helicopter. The main problem with this design was the concentration of data at the center of the grid. The triangular net was later replaced with a rectangular net to alleviate the probelm of data concentration.

The Canadians concluded that the use of helicopters in reconnaissance geologic surveys was a vast improvement over the foot and canoe methods previously used. The geologist could now concentrate most of his efforts on geology and not on the problems encountered in traversing. They also concluded that total utilization of helicopters for geologic application is essential and that good planning and early action are necessary to sustain effective operations.

Flying in helicopters is hazardous. It pays to know the company that one intends to charter from and the pilot who will be flying for you. Strict requirements for both pilots and machines are used by many agencies such as the United States Geological Survey to promote the safety of their field parties in Alaska. The U.S.G.S. and many companies also require that a resident mechanic be present to maintain the helicopter in the field at all time. Not infrequently there is also a legal agreement or understanding that a helicopter pilot can be released at will by the chartering group without any lengthly documentation or presentation of an undisputed case of incompetence. A replacement pilot is then furnished within some stated, reasonable length of time.

Most helicopters used in mineral exploration are contracted for periods of 60-120 days with a 3-4 hour a day minimum flying time averaged over the length of the contract. Chartering for shorter periods may be more expensive than the rate quoted on Table 5a. and helicopters may not be available locally on short notice or for short periods of work.

One of the major problems in operating aircraft in Alaska is the local availability of fuel. The problems of fuel in Alaska are discussed in more detail in another section of this study (p. 29).

It should again be emphasized that if fixed-wing aircraft or helicopters are to be utilized in field work in Alaska, early action and reservation is strongly recommended.

Commercial Air Service

Daily commercial passenger and freight service to Alaska is provided by the major airlines. Within Alaska, air service between the major population centers is also provided on an almost daily basis. Reference should be made to the current airline schedules as they frequently change. Figure 1 shows the location of the major airports in Alaska on the basis of Federal Aviation Administration manned, flight centers. These airports usually also serve as the hubs for air service into the surrounding country. The scheduled air service to the villages and towns surrounding these centers of air transport is usually on a more limited basis, often twice a week, with light aircraft. These major airports usually also have one or more resident air taxi operators who can provide chartered aircraft. It is often more convenient and less expensive to utilize chartered aircraft than to wait for the intermittant, local scheduled flights.

Boats

Boats have long been effectively used in mineral exploration in Alaska and particularly in the protected marine waters of Southeastern Alaska and Prince William Sound. There they offer a reliable method of movement in the rainy weather that characterizes the climate and inhibits transportation by air. The type of boat used there varies widely from large boats or barges that serve as heliports and floating camps to outboard-powered small boats. The latter are extremely useful in much of Southeastern Alaska in that the high tidal-range keeps a belt of almost continual-outcropping rock beautifully exposed along the coastline. This extensive outcropping almost compensates for the heavy rain forest that borders the coast. It would appear that boats would similarly be quite appropriate for work on the Alaska Peninsula and along the Aleutians but few parties have used them there for metal exploration.

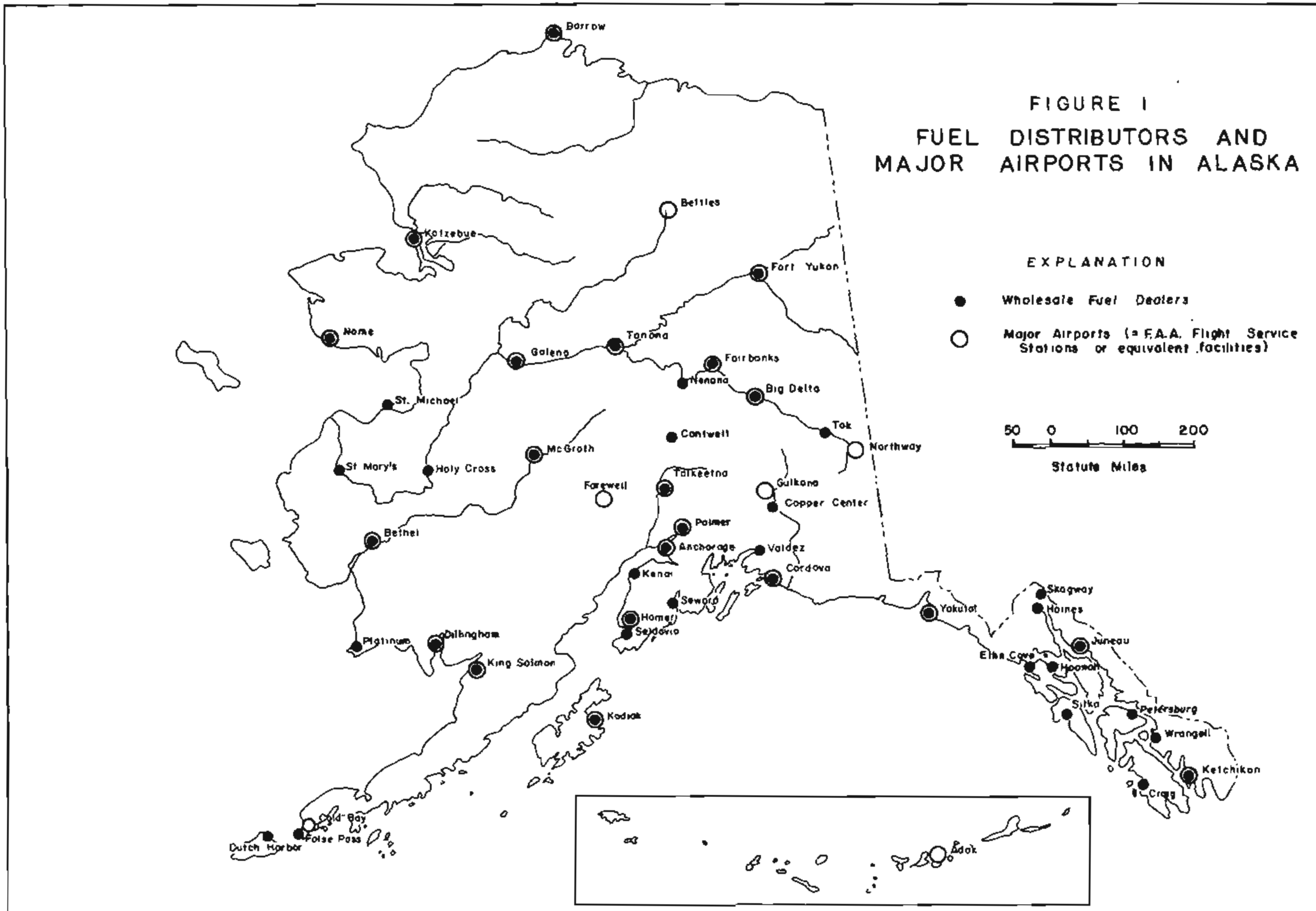

FIGURE I
FUEL DISTRIBUTORS AND MAJOR AIRPORTS IN ALASKA

The U.S. Geological Survey has utilized a 107 foot vessel, the MV Don Miller II in Alaska for a number of years. It has operated mainly in Southeastern Alaska but has had periods of operation in Prince William Sound and as far as St. Matthew Island in the middle of the Bering Sea. Operations from it in Southeastern Alaska usually involve a helicopter that works the high country above the timber line supplemented by small boats with outboard motors that work along the coast. These methods complement each other nicely in that geologic work can be done from the small boats in the bad weather that so frequently stops helicopter operations. This particular ship, as would others of similar capability, provides an extremely flexible operation and allows for movement of the base of operation at will from one area to another within hours.

Vessels of sufficient size to serve as floating camps on salt water are expensive. It is difficult to cite any specific costs because of the variability of the size of the vessels involved, their equipment and their crews, but $200 per day would probably not be unreasonable as a <u>minimum</u> charter rate. Acceptable boats are widely available in Southeastern Alaska and the coast bordering the Pacific Ocean but must be obtained on an individual basis.

Boats have also been used on the rivers of Interior Alaska since the earliest days of geologic exploration. There is still a great deal of traffic along the rivers by small boats with outboard motors both as a means of movement between villages and for pleasure and several geologic parties have utilized them in recent years. None of the projects cited in this paper utilized river transportation and it probably will not be generally of importance to metal exploration; however, it may prove convenient in some cases.

Tracked vehicles

Light tracked vehicles would seem to be ideal for transportation in Alaskan mineral exploration projects and they do have a long history of use here. They were first used on a large scale in the exploration of Naval Petroleum Reserve No. 4 on the North Slope in the period 1944-1953. The topography is flat or subdued and Reed (1958) indicates: "The M29C, a light tracked vehicle proved to be a very useful personnal carrier and light land vehicle on the reserve. In fact, it is believed that parts of the exploration would have been impossible without the weasel or an equivalent vehicle. Careful driving is required to avoid damaging the carrier's two weak spots, the differential and the tracks."

Modern light tracked-vehicles are undoubtedly more reliable than the old weasels used in the Naval Reserve exploration and are available in a great variety of types. They are clearly useful in drilling programs and prospect evaluation where good roads are not available (which is almost all of Alaska). However, their use in reconnaissance programs seems doubtful in many cases. They are basically slow, they cannot traverse really rough terrain, and their maintenance requirements are high. They have been used in recent years for detailed (1:63,360) mapping mortheast of the Wrangell Mountains and on St. Lawrence Island by the U.S. Geological Survey where they proved quite successful.

Although none of the projects commented upon it in detail, winter haulage by heavy tractor-sled combination has a long history in Alaskan mining and exploration (especially see Reed, 1958, p. 179). It may be quite useful in winter drilling programs or in freighting large tonnages of material. Tractor haulage has been generally supplanted by other means of transportation because it is expensive ($1.00 to more than $2.00 per ton mile) and slow; it is however, exceedingly flexible and does not demand an airstrip (Wolff, et. al., 1973).

Wheeled Vehicles

Trucks and automobiles have limited applicability to most Alaskan exploration programs at present due primarily to the lack of an extensive road network in the state. Where roads are convenient to the area of interest vehicles are of course effective. Four-wheel drive vehicles may be necessary even on some "roads", particularly in the Spring but it is questionable if they can cope with the terrain (particularly tundra) very far off the roads in most areas of Alaska. Most large cities have the usual car rental agencies but there is often a scarcity of light utility trucks.

Fuel

One of the most frequently overlooked or poorly planned areas in Alaskan exploration logistics lies in the area of fuel. The fuel costs listed in Table 1 would indicate that fuel is not a major cost item in most budgets but the frequent reference to paying as much as $1.00 per gallon for transportation of the fuel suggests there is a problem.

Most major towns have wholesale or bulk fuel distributors; Figure 1 (page 25) indicates the location of these distributors in Alaska. However, their ability to provide petroleum products may vary seasonally and with location. In general, aviation fuels, diesel fuel, and gasoline can be obtained easily year-round in Southeastern Alaska, in Anchorage and Fairbanks or at distributors located along major highways. On the otherhand, distributors subject to intermittent, bulk transport such as Nome, which is ice-bound much of the year, may not be able to fulfill demands for certain products at times, and certain of the smaller dealers may not always have aviation fuel. It has always been considered good practice to order fuel from distributors as soon as possible.

In addition to these distributors, almost any village and town has some fuel of most types - sometimes. It would be extremely naive to expect to be able to locate fuel in quantity for say a jet helicopter at the nearest village without prior planning. However, fuel may be available in small amounts in rather unexpected places and most explorationists will sooner or later be helped out of an uncomfortable situation by the foresight or helpfulness of a local businessman, company, or air taxi operator.

Establishment of fuel caches within the field area is a commonly used technique to ensure convenient fuel supplies. Such work should be done as soon as possible. Usually the cheapest way of placing such caches is by means of the largest fixed-wing aircraft that can be handled within the landing limitations of the airstrips in the field areas. Ski and float planes greatly expand the potential for location of fuel caches. The former obviously demands that fuel be set out in winter or late spring and the latter is limited by the cargo capacity of float planes. A number of cargo and fuel supply operators have been quite successful in using large wheeled aircraft on frozen lakes in the winter. As noted previously, helicopters are the most expensive way of distributing fuel caches in the field but are frequently used because of their availability and convenience. There has been some theft from fuel caches and some imagination should be used in placing them to alleviate this problem.

Predictions of fuel availability in 1974 for Alaskan air taxi operators indicated that severe shortages may exist in aviation fuel. The allocated fuel supplies are based on the 1972 fuel consumption by air taxi operations in Alaska. That year was an "off" year for many air taxi operations in Alaska, and as a result, the 1974 allocation is low (Alaska Industry, 1974).

The present energy situation has placed the distribution of petroleum products by wholesale fuel distributors under the jurisdiction of the Federal Energy Office and the Mandatory Petroleum Products Allocation Program. Fuel in amounts over 8,488 gallons must be allocated on a priority basis established by the Federal Energy Office. Currently, exploration for petroleum and minerals have a very high priority. Mineral exploration companies are routinely allocated an amount of fuel equal to the total amount of fuel consumed during 1972. If a company did not conduct a mineral exploration program in 1972, application for allocation of fuel must be made to the Federal Energy Office.

In Alaska, the Federal Energy Office is located at:

Deputy Regional Administrator
Federal Energy Office
Room 127, Post Office Building
605 4th Avenue
Anchorage, Alaska 99501

There does not appear to be a formalized scheme for distribution of smaller amounts of fuel. Some foresight can probably insure that it will be available through distributors. But requests for immediate delivery, especially in the "bush", without prior planning will probably be even more uncertain than in the past.

Salaries and Personnel

Salaries are a major portion of most exploration budgets and work in Alaska is hardly an exception. As with most other exploration costs, salaries are also higher in Alaska than in the "lower 48". Coxey (1967) in discussing Alaskan construction costs, states: "Considering the cost of labor in Alaska, the actual differential is 30-35% above Seattle depending primarily on the employer and amount of overtime worked."

Table 6 is a compilation of salaries paid to the personnel involved in the programs tabulated in this study. The salaries vary from $850 to $2000 per month for geologist and $625 to $1500 per month for field assistants. This wide variance may be due to several factors:

1. Personnel residing in Alaska are usually paid higher salaries because of the higher cost of living in Alaska (conversely, some of the low salaries represent persons that were hired "outside" and were in Alaska only for the summer.) In particular, federal government employees receive a 25% tax-free cost-of-living allowance if they are stationed in Alaska.
2. Persons with Alaskan field experience may demand higher salaries.
3. Persons working as field assistants and geologist in Alaska have an unusually wide variation in geologic experience and education.

The high cost of living in Alaska shown by Table 7 is adapted from Massell, et. al. (1971). The data compares the cost of living in the major Alaskan cities to the cost of living in Seattle during 1969.

Table 6

Monthly Salaries

Program Number	Type of Organization	Senior or Project Geologist	Geologist	Field Assistant or Junior Geologist	Other
2	Private Industry	$1400—Project Geologist		3 at $1000 ea.	$1000--Cook
3	Private Industry		$1667	$1500	$2000--Bulldozer Operator $1200--Cook
8	Private Industry			$870 $800	
10	Private Industry		6 at $1300(ave.)	18 at $1000(ave.)	3 at $1200--Mechanic, Cook, etc.
11	State Government		$2000	2 at $1300 ea.	
12	State Government	$1760--Petroleum Geologist		$876	
13	Private Industry	$3000--Senior Consulting Geologist	$1100 $1500		
14	Private Industry	$3000—Project Chief $1250--Senior Geologist	2 at $1000 ea.		$1000--Claim Staking Chief
15	Federal Government		$1200 $1250	$700	$850--Cook
16	Federal Government		2 at $1750 ea. $1500 $1200	5 at $650 ea.	$1750--Mining Engineer $1500--Mining Engineer $1500--Ship Captain $1200--Cook/Seaman
17	Private Industry	$75/day--Party Chief	2 at $850 ea.	3 at $625 ea.	$750--Cook
19	State Government		$2000	$1000	
20	Private Industry	$2200--Project Geologist	$1667 $1250		
21	Private Industry	$1750--Party Chief	2 at $850 ea.	3 at $625 ea.	$650--Cook
22	Private Industry		2 at $1500 ea.		
23	Private Industry	$1800--Senior Geologist		$850	
25	Private Industry	$1667--Project Geologist	$1500	$1000	$1200-Cook
26	Private Industry		$1000		
27	Private Industry		$1220		

Table 7

Intercity Differences in the Cost of Goods and Services in Alaska

City	All Items	Food	Housing Total	Housing Rental
Anchorage	120	119	129	142
Fairbanks	132	137	142	182
Juneau	126	131	134	146
Ketchikan	119	122	123	129

As compared to costs in Seattle (=100) in 1969

From Massell, et. al., (1971)

It should be noted that one of the major factors contributing to the higher cost of living is the cost of housing. This should be kept in mind by mineral exploration companies considering moving personnel permanently to Alaska.

Geologic field work in Alaska is markedly seasonal. The short field season coupled with a high demand for geologic personnel results in high base salaries. Massell, et. al., (1971) discussing construction costs in Alaska states that: "Labor must be paid a premium during the summer months to compensate for the absence of employment in the winter." They cite the seasonal nature of the work as the major factor contributing to the high Alaska labor costs.

In recent years, competition has been keen for personnel with Alaskan field experience. There are, for instance, more summer field positions offered by mineral exploration companies than can be filled by the student enrollment at the University of Alaska. Finding summer employment has not been a problem in recent years for geology or mining students. In addition, exploration companies seeking Alaskan field personnel, experienced or not, often find a shortage of such personnel if they offer wages on a scale similar to that used "outside". A poll of the geology students at the University of Alaska in the Spring of 1974 indicated summer salaries for field assistants (no experience necessary) ranged between $625 and $1000 per month and averaged $778 per month. Salaries for those students hired as geologists ranged between $800 and $1400 per month with an average salary of $1000 per month. With the growing interest in Alaska's mineral resources in the past few years, these salaries will probably continue to rise at an increasingly rapid rate.

Many companies involved in mineral exploration in Alaska try to make a substantial effort to hire persons with Alaskan field experience. There are several reasons for such a policy. The most important is probably that personnal with Alaskan field experience have proved their abilities under the peculiar field conditions here - conditions which might be considerably different from what many geologist and assistants are familiar with. Experienced personnel usually also have a general knowledge of the geology and geography of the state and their familiarity with the climate can be invaluable in many parts of Alaska. These persons will know what field equipment and personal items are essential and can make certain they are included in the field gear.

The wages for field personnel other than geologists are also variable and high. The last column in Table 6 lists salaries of personnel frequently utilized in mineral exploration programs. While many such personnel used in mineral exploration programs do not necessarily belong to a union, union scale wages will provide strong support for wages in general. The current union rates, by Laborer's International Union of North America, Local No. 942 and Operating Engineers, Local No. 302, for a few pertinent positions are:

Common Laborers	$ 8.33 per hour
Miners	$ 9.39 per hour
Diamond Drillers	$11.23 per hour
Driller Helper	$ 9.32 per hour
Bulldozer Operator, D-6 through D-9	$10.40 per hour

It should be noted that some wage scales listed above are currently being renegotiated and are expected to rise. As a comparison to show the rate of inflation, Hershberger (1970) quotes a wage for common laborers of $6.38 per hour from contract agreements which became effective August 1, 1969. The wages quoted above also do not reflect the added cost of overtime. Massell, et. al. (1971) feels that the premium price to Alaskan construction workers is only partially reflected in the hourly wage. The balance of the higher pay is usually in the form of overtime, with 60-hour work weeks being commonplace in the Alaskan construction industry.

Although Alaska's unemployment rate is exceedingly high, it has been found in the past that it is often difficult to find skilled workers. Such a situation exists for diamond drillers in particular. Most diamond drilling in Alaska is seasonal and there is a lack of large footage, drilling projects. An interview in Alaska Construction and Oil with Dave McCrillis, a mining engineer and diamond drill contractor based in Ketchikan, spoke of the hardships his crews had to contend with: "...crews must be willing to camp out on a mountain top or in a deep canyon, often for several weeks without a break. It is sometimes necessary for them to do their own cooking, to repair and maintain machinery, to build drill set-ups in heavy timber, in muskeg, or hanging by a rope from a cliff. They might be required to walk several miles a day on snowshoes, or with crompons and ice ax on a steep glacial face." These conditions and the seasonal employment strongly discourage drillers from staying in the state.

Alaskan miners and prospectors are scarce to the point of being almost extinct as well. The lack of experienced miners is easily understood considering the very small number of operating mines within the state. The reasons for the virtual nonexistence of prospectors in Alaska are more complex. Most of those prospectors that are found today in Alaska are "old timers" from earlier mining days. In recent years there has been no incentive from mineral exploration companies for trained prospectors in Alaska. Jobs for prospectors in Alaska, as in most of the rest of the U.S., are next to impossible to find. Perhaps U.S. exploration companies have overlooked a valuable tool for Alaskan exploration by ignorning the prospector. Canada is similar to Alaska in many ways - climate, population density, mineral potential, and lack of mineral development. However, trained prospectors have been successfully used in Canada for many years. Kaufman (1972) stresses that for reconnaissance-type exploration now under way in Alaska, the prospector might be utilized with considerable success.

In summary, even though Alaska has a high unemployment rate, certain types of qualified workers are difficult to find within the state. Mineral exploration companies planning to work in Alaska can expect to pay high wages for qualified, experienced personnel. Alaskan field experience costs more but it is generally considered that it is worth the cost. Due to recent increases in the amount of Alaskan mineral and petroleum exploration and the limited number of experienced field personnel, it is expected that Alaskan salaries will continue to remain well above those in the rest of the United States.

Communications

Although direct communication costs show up only intermittantly in the project budgets (Table 1), there are also undoubtedly hidden communication costs in other budget categories. The dollar cost of communications is probably not high, but the cost in time and confusion can be significant indeed. Depending on the individual needs of the project, one method or a combination of methods of communication can go far toward insuring adequate interchange of information.

The most convenient method of long-range communications is the High-Frequency, Single-Side-Band radio (SSB). It is not restricted to line-of-sight operation and under good conditions is capable of transmission across the state and is quite reliable as well. SSB radio equipment may be leased or purchased from Alaskan companies that specialize in communications; the cost of leasing an adequate unit is approximately $300 per month (in Fairbanks). Leasing or renting equipment is convenient when planning radio communications support for an exploration program. By working through a service company, one can take advantage of their maintenance facilities and phone patching.

Very High Frequency (VHF) radios operate on a line-of-sight basis with a maximum range of 100 miles. If relay stations are available, longer range communications are possible. Most aircraft are equipped with VHF radios and such equipment will be necessary on the ground if communications are to be maintained with fixed-wing aircraft or helicopters.

Radio-telephone communication is in general use in Southeastern Alaska. It is convenient and usually works well but is not infrequently affected by weather and has a limited range. Access to the system is through marine operators listed in the telephone directories in that area. As used there, relatively small, licensed, marine transmitters are used to tie into the telephone network at the major towns.

Many small towns and villages in the rest of Alaska are connected to the RCA Alaska network of radio-telephone communications. This network has expanded greatly in recent years and usually works well but the lines are often fully utilized and are not completely reliable. These units are large permanent transmitters that are usually sited at some central location in the village. All the radio-telephone systems have the very important advantage of tying into the worldwide telephone network once a line has been secured.

With almost any type of long range radio or radio-telephone unit, some provision must be made for generating power. Even units that work on batteries usually must be recharged periodically.

Citizens-band radios, especially in the form of small "walkie-talkie" units are handy for short range communications but rarely are useable for more than ten miles or within line of sight. Small, SSB transreceivers are now becoming available that offer convenient hand-carried communications over much longer distances.

In summary, there is no single method of radio communication from remote areas of Alaska that is completely reliable. Magnetic storms, aurora borealis and bad weather in particular frequently cause problems that cannot be completely forecast. The case studies examined in this project reveal a general problem of poor radio communications. These problems either must be solved or at least recognized for an effective field program in Alaska.

Camp Costs and Living Expenses

Camp costs and living expenses while not insignificant, did not appear to be a major item in most budgets (Table 1). In several, their cost was less than items lumped under "miscellaneous".

Costs for field camps were quoted as from about $5.00 to $20.00 per man day and most figures were in the lower portion of this range (Table 1). It is almost an act of faith in Alaskan field work that the personnel should be adequately, if not sumptuously fed, and generally, it would appear that this can be done easily for less than $10.00 per man day. However, it is also probable that at least part of the costs of camps and living expenses is covered under various other headings of the budgets, such as salaries (e.g. the cook's salary), field equipment, and transportation. In general, camp costs and living expenses in the field appear quite predictable after allowing for a food mark-up of about 50% over "outside" prices, transportation and increased salaries.

However, living costs in settled areas of Alaska are considered higher than might be expected or desired - spectacularly so to the uninitiated. The per diem rates used by the U.S. Department of the Interior (which are based on Department of Defense rates) may give some idea of the costs of first-class accommodations and food at various locations in Alaska. As of March 28, 1974, the maximum per diem rate for Alaska (U.S. Department of Interior, 1974) generally was $38.00 per day, but a number of localities have higher rates, some of the more prominent of which are:

Anchorage:	$43.00	Juneau:	$41.00
Bethel:	$42.00	Kodiak:	$43.00
Fairbanks:	$49.00	Kotzebue:	$52.00
Galena:	$52.00	Nome:	$52.00
		Prudhoe Bay:	$82.00

Not infrequently, cheaper accommodations can be found especially when one can make arrangements outside the usual tourist channels. Most often however, these government per diem rates are quite in line with the commercial rates for food and lodging.

It is perhaps significant that none of the questionaires for the various projects made any particular comments on the problems of camps and the costs associated with food and shelter. And even more striking was the lack of any comments on cooks in view of the almost legendary problems and idiosyncrasies associated with some of them.

Costs of Geochemistry

Cost of Collecting Samples

The cost of collecting geochemical samples is usually difficult to assign exactly. Programs dealing strictly with geochemical sampling are infrequent. The sampling is normally done in conjunction with the other exploration work and cannot easily be broken out as a separate cost. The use of the helicopter for regional geochemical sampling is almost a necessity in most parts of Alaska as sampling from roads or from a base camp on foot have obvious limitations. However, using a helicopter for sample collecting produces a very high cost per sample.

A geochemical feasibility study done by the Geological Survey of Canada (Allen, et. al., 1972) in the Coppermine River region, Northwest Territories gives an excellent breakdown of costs for a regional helicopter-supported geochemical program. The cost per sample for this program was figured to be approximately $20. This cost was based on a helicopter cost of $120 per hour and a sample collecting rate of six samples per hour (note that 1974 helicopter rates in Alaska, Table 5a, are substantially higher). At each sample site, one water and one sediment sample were collected; this required approximately five minutes. The time for take-off, landing, and flying between sites was also estimated to be about five minutes. Because the time spent flying between sites was nominal compared to the time spent in landing, taking off, and on the ground at the site, it was felt that the rate of sampling estimated did not vary appreciably for sample densities between one site per square mile and one site per twenty-five square miles. The optimum sample density for the Coppermine area was found to be about one site per ten square miles. At this sample density, the cost of collecting the samples for an area of 1,000 square miles would be $2,000 or $2 per square mile. The costs quoted in the study did not include salaries of field crews, field support costs, or of commercial analytical costs. It should be noted that for all helicopter flight times quoted, it was assumed that base camp was approximately in the center of the survey area. If parts of the survey area are excessively far from the base camp or fuel supply, the added cost of returning to camp or fuel must be considered. Also, although not particularly stated in the report, it is assumed that the availability of helicopter landing sites for the Coppermine area study was no particular problem. This, of course, is not the case in many areas of Alaska. Often considerable walking between the landing site and the sampling location is necessary. Lack of landing sites can add to the cost per sample greatly, depending upon the amount of helicopter time used in moving the field crews and the density of sampling.

A new approach to geochemical sampling, and geologic mapping being used by C. L. Sainsbury (1972) involves sampling from a helicopter or light fixed-wing aircraft while the aircraft is in flight. Samples are retrieved using special devices designed specifically for such work. The devices are either dropped from the aircraft onto the desired sample site and retrieved by an attached line or are affixed to the aircraft and the sample is scopped up while the aircraft is flown within a few feet of the ground. Sainsbury (1972) states; "As can be surmised, their use requires a skilled pilot-geologist capable of recognizing suitability of the material to be sampled and of operating the aircraft safely within a few feet of the ground." When sampling by light aircraft on a reconnaissance geochemical program the rate of sample collection (and, likewise, the cost per sample) would depend upon topography, availability of sample sites, and tree and bush cover. Because of these variabilities, no exact cost figures for sampling could be given; however, it can be seen that sampling by light aircraft could significantly reduce the cost of many sampling programs.

Cost of Geochemical Analyses

In general, the cost of geochemical analyses in Alaska is comparable to the cost in the "lower 48". However, exact costs of analyses are difficult to compare because of variabilities in pricing systems, methods of sample preparation and quality of work. It should be noted that analytical laboratories which provide mineralogical and geochemical services are available both in Anchorage and Fairbanks. The local availability of services can become important to exploration programs when it is necessary that geochemical or assay results be obtained in a relatively short period of time.

In addition to the commercial analytical firms available, the State of Alaska Division of Geological and Geophysical Surveys provides a free public assaying service. In the Surveys' "Public Assay Policy Statement," it is stated that "It is not the intent of this function to support exploration, drilling, or production operations." The service is provided to "support and encourage prospecting." The policy statement also contains the procedure for submitting samples for assay. The samples are processed in the same chronological order as received. Depending upon the backlog of samples, the time needed to complete the assays is approximately four to six weeks.

Contract Services

Drilling and Construction Costs

The data in Table 8 (page 48) is a summary of the drilling information accumulated for this study. This data, meager as it is, gives an idea of diamond drilling costs in the state. In most instances it appears that the cost per foot figures were computed by merely dividing the total cost of the drilling program by the number of feet drilled. In other words, the cost per foot data probably are not only direct drilling costs, but incorporate other costs as well (such as mobilization, demobilization, transportation, etc.). The average cost per foot computed from the values in Table 8 for "A"-size core was $9.38. For "B"-size core the cost per foot was $22.33. Drilling costs will vary widely, depending upon remoteness of area, accessability, size of drilling project, and many other factors. The data in Table 8 are probably not sufficient to compute accurate averages for Alaskan drilling costs. Hawley (1974) suggests an average cost of from $10 to $11 per foot of contracted NX or BX drilling. However, he also indicates that logistics may more than double this cost so that total costs of from $25 to $40 per foot for a 1-2 hole program as mobilization costs are generally in excess of $10,000.

The major reason for the lack of information on diamond drilling is due to a general scarcity of diamond drilling programs within the State. Most exploration programs in Alaska are of a general reconnaissance nature and have not yet progressed to the final states in which detailed diamond drill core information is needed. One of the main reasons for the higher drilling costs in Alaska is high labor costs. As mentioned elsewhere in this study, union wages for diamond drillers is $11.23 per hour. For driller's helper the wage is $9.32 per hour. These figures do not include overtime and fringe benefits which can often increase costs considerably.

Concerning construction costs, Coxes (1968) states, "The higher cost in a remote area is also reflected by the equipment rental rates and the estimating rates used for heavy equipment". Coxey used the Rental Rate Blue Book for Construction Equipment by the Equipment Guide-Book Company because it "has an area adjustment map with percentages shown on each area to adjust the rental rates for the locality." In the Rental Rate Blue Book for Construction Equipment (1972) Alaska is divided into two sections. The southern section includes Southeastern Alaska and the area around Anchorage. The northern section covers the remainder of the state. The rental rates given below are percentages above the national average. The percentages for western Washington are given for comparison.

Area	Tractors & Earthmoving Equipment	Drilling Equipment
Western Washington	0	0
Southern Section of Alaska	+32	+9
Northern Section of Alaska	+47	+60

It should be emphasized that these rental rates do not include wages to the operator or operating expenses such as insurance, fuel, or lubricants.

A major portion of the cost of any construction project is cost of materials. In Alaska costs of materials in perhaps the main factor contributing to high construction costs. Coxey (1968) states, "Alaska's three main construction materials - cement, steel, and lumber presently must be imported from at least as far as Seattle with a shipping expense that occasionally is greater than the material cost." According to Coxey's table, "Survey of Lumber Costs per M.B.F. or M.S.F.", the cost of lumber in Anchorage ranges between 19% and 168% above the prices for the same sized lots of lumber in Seattle. Exploration companies planning to work in Alaska may have a need for such materials and should be aware of the exceedingly high prices for heavy, imported material.

In conclusion, it should be pointed out that one of the most important reasons for high drilling, trenching, or construction costs in Alaska is the high mobilization-demobilization expenses. Exploration drilling programs in Alaska need to be planned with extreme care and must be of adequate size so that a second drilling program, with additional mobilization-demobilization costs, will not be necessary. As in all other phases of Alaskan mineral exploration, planning and forethought are the keys to saving money.

Table 8

Drilling Costs

Program Number	Footage	Size	Total Cost	Cost/foot
1	9863'	BX	N.A.	$17/ft
2	3605'	4½"*	N.A.	$ 7/ft
3	5000'	6"**	$23,409	$4.68/ft
6	7500'	AX	N.A.	$8.78/ft
7	3737'	AX	$38,674	$10.35/ft
10	10,000'	NX-BX	$200,000	$20/ft
24	800'	BQ	$24,000	$30/ft
28	N.A.	EX	N.A.	$50/ft
	N.A.	AX	N.A.	$20/ft

*Down-the-hole percussion drill - no core recovery.

**Rotary drill - no core recovery

Geophysical Work

In recent years, geophysical prospecting in Alaska centers around the cooperative aeromagnetic program of the U.S. Geological Survey and the Alaska State Division of Geological and Geophysical Surveys. This program which began in 1970 was planned to add to basic knowledge and to encourage orderly planned development of Alaska's resources. The actual surveys are based on U.S. Geological Survey inch-to-the-mile topographic maps; flight lines were flown at 3/4 mile spacing at an altitude of 1,000 feet above the ground.

The cost to the state for their aeromagnetic surveys were:

Year	Total Area (Square Miles)	Total Cost	Cost per Square Mile	Location
1971	42,000	$398,000	$9.48	Seward Peninsula Goodnews Bay East Central Alaska
1972	23,337	$193,000	$8.27	East Central Alaska Central Alaska
1973	15,317	$ 92,287	$6.07	Central Alaska

Heiner and Wolff (1964) thoroughly discuss the cost of airborne geophysical prospecting methods in Alaska. They quote expenditures from various companies working with airborne geophysics at that time. To some extent their estimated figures are superseded by the actual costs of the Alaska-U.S. Geological Survey contacts but this source should be consulted if airborne geophysical work is contemplated.

The data collected in this study, Table 9, concerning the cost of different types of geophysical surveys is inconclusive, due to insufficient data on specific geophysical methods.

Table 9

Cost of Geophysical Surveys

Project No.	Type of Geophysical Work	Area Covered	Total Cost
1	Induced Polarization	10 line miles	$ 7,000
1	Ground Magnetics	50 line miles	$10,000
2	Airborne E-M		$23,900
11	Induced Polarization		$400/day
20	Induced Polarization	26 line miles	$15,000
21	Aero Magnetics	1,500 sq. mi.	$10,600

Miscellaneous Services

None of the projects cited costs related to vertical aerial photography. In 1971, the Federal Field Committee for Development Planning in Alaska estimated a cost of about $25 per flight line mile to inventory timber. However, this cost is probably somewhat high and is subject to wide variations related to the size and location of the area to be photographed and the weather conditions. More recently, extensive work has been done for about $6 per flight line mile and film and processing furnished (written communication, A. B. Follett, Northern Pacific Aerial Survey Inc.) and a general estimate of about $12 pr flight line mile for black and white imagery at a scale of 1:24,000 was given by Air Photo Tech. Inc. Almost any large Alaskan city can also furnish photographers who will undertake oblique aerial photography. There is not enough factual data available from actual metal exploration projects to do more than generalize and the prices are subject to so many variables that the contractors should be contacted personally for consultation about a specific project.

There are a number of engineering and geological consultants available in Alaska. The Alaska Division of Geological and Geophysical Surveys distributes a circular (1973) listing all such consultants available for work in the state. The Alaska Petroleum and Industrial Directory (Roguszka, 1974) also provides a listing of consultants available for work in Alaska as well as a comprehensive summary of services available in the state.

The cost of mining in Alaska is even more difficult to quantify than the cost of exploration mainly because of the scarcity of mining operations. Wolff and Johansen (1973) present a short summary of mining costs in Alaska which indicate that the costs may be at least double those in the western U.S. In addition, there is currently a project being undertaken by the Mineral Industry Research Laboratory to examine Alaskan mining costs in detail.

Many programs have found it exceedingly convenient to use some sort of expeditor based at the nearest large city to purchase and relay supplies and equipment to the field camps. Most governmental agencies normally have one permanent staff member based in Alaska to handle this operation but a number of companies have also found it convenient to hire someone at least part-time to handle these tasks. If the program is of significant size and complexity to require continual logistical support from within Alaska, it will be a time-consuming and often frustrating task for the expeditor to complete his work. To do them from the field without an expeditor and with the usual communication problems can often be frustrating.

CHAPTER 3

MISCELLANEOUS CONSIDERATIONS

Lost Time and Weather

Due to short summers and adverse winter conditions in Alaska, field time is precious. Maximum use should be made of what little time is available for field work. Table 10 lists the amount of time lost due to weather and to other causes as taken from case histories used in this project. For the convenience of the reader, the data are presented in terms of percent rather than in the days lost; many of the figures were estimated as percentages by those with the project.

The average time lost due to weather was 11.5%. Averages computed for various sections of Alaska, such as Southeastern Alaska or interior Alaska showed that the regional averages did not significantly deviate from the overall average - or at least the sample population was not large enough to define the differences. It was felt that sufficient data was not available to determine an average for time lost due to causes other than weather.

The greatest loss of time was due to bad weather. But as can be seen, the data for time lost due to weather vary widely from program to program. The variation is a result of several considerations, luck being one. However, the variation also depends greatly on the type of program. For example, if the program depends heavily on helicopter support for the work at some distance from the base camp or for ferrying personnel to and

Table 10

Lost Time

Program Number	Length of Program (days)	% Lost Due to Weather	% Lost Due to Other	Location
1	180	10%	---	Southeast Alaska
2	88	23%	11%	Central Alaska
3	90	11%	6%	East Central Alaska
7	128	0%	0%	Clearwater Mtns
10	120	18%	8%	Southeast Alaska
11	90	1%	---	Southeast Alaska
12	27	15%	---	Talkeetna Mtns
13	60	5%	---	Alaska Range
14	110	33%	---	Brooks Range
15	13	12%	25%	S. Central Brooks Range
16	90	11%	---	Southeast Alaska
17	90	2%	---	South Central Alaska
18	105	10%	5%	Eagle Quadrangle
19	90	8%	---	South Central Alaska
20	27	30%	---	Talkeetna Mtns
21	60	1%	---	Wrangell Mtns
22	80	23%	6%	Kuskokwim
23	65	8%	2%	Northwest Alaska
24	90	11%	6%	South Central Alaska
25	120	10%	5%	Alaska Range
26	70	6%	---	South Central Alaska
27	90	11%	6%	East Central Alaska
28	240	5%	---	Southern Alaska Range

from the working area, bad weather can cause unavoidable delays. Conversely, on programs where the working area is within walking distance of the base camp, it becomes a matter of personal preference whether work will be accomplished during days of bad weather. Most geologists, of course, prefer not to work in the rain, wind and cold. In many parts of Alaska, however, the days of poor weather can easily outnumber the days with good weather and a refusal of personnel to work under poor weather conditions can endanger the success of a program.

The program planner should be aware of the weather conditions in the work area before arriving on location. A general source for this data is the Environmental Atlas of Alaska by Johnson and Hartman (1969). Once the climate of the work area is understood, the planner should use this information to make certain adequate field equipment accompanies the field party into the field. This is especially important in remote areas where such equipment may not be available locally.

The weather conditions also play an important role in the starting and finishing dates for most Alaskan field program. Snow cover in many localities prevents field work in the early parts of summer and may limit the summer field season to two months. And specific localities such as gulleys or trenches may have snow in them well into July or even later. In mountainous and high latitude areas, the field season may also be interrupted by occasional snowfalls of several inches. Johnson and Hartman (1969) state that "A good definitive description of the Alaska climate is not possible at this time." Weather stations are generally widely scattered, particularly in southwestern Alaska and the Arctic where few stations provide data that is only a sampling of the area. In addition, most data is collected from coastal and river valley stations and very little is known regarding weather in the hills and mountains." For these reasons and because the amount of snow cover from year to year can be so highly variable, specific dates are not given. For most mountainous areas, data are simply not available. It is recommended that persons who have had recent contact with the area (e.g. bush pilots, guides, local inhabitants, etc.) should be contacted for specific answers about snow cover and weather conditions. The presence or absence of snow cover in particular can easily be taken too lightly by persons unfamiliar with Alaskan field work.

Table 10 indicates that in most programs, lost time due to reasons other than weather did not make up a significant percentage of the program time. The reasons for such delays vary widely with the program. Mechanical failure, particular of helicopters, is frequently noted but poor planning and lack of communications often contribute to the problem.

Comments

The questionnaires that were sent out included a request for particular or unusual problems that were encountered or written comments that respondents thought important in planning metal exploration in Alaska. This material was used extensively in preparing the text of this report. It was also some of the most interesting data received and a selection of it follows. It must be emphasized that the comments represent only the respondent's views and not that of the authors, the Mineral Industry

Research Laboratory or the U.S. Bureau of Mines. The main criteria for selection of comments was repetition and conflicting or widely divergent views are purposely used.

Occasionally more colorful comments were censored. Note that all comments in brackets were added for information by the authors.

Although it is difficult to categorize some of the comments, there was a strong emphasis on the problems that were encountered. These chiefly centered around helicopters, personnel, logistics and weather.

"Our major problem was difficulties with the helicopter. Each summer of helicopter work on this project had one or more of the following:

a. Pilot unable to cope with terrane and(or) weather
b. Significant amounts of bad weather
c. Many 'down days' because of mechanical problems"

[Alaska Range] "Need B-1 [Bell, Model 37G3B-1] or turbine engine helicopter. Avoid Vietnam helicopter drivers. Plant fuel in winter on skis to avoid excessive helicopter ferry time from camp."

"Poor helicopter contractor, excessive snow; lack of good bush plane charter service."

"Three or four day spells of bad weather or helicopter downtime are not uncommon. So it is always possible that short-term projects (1-2 weeks) may be a 50% washout and a four day project a complete loss."

"Jet helicopter is probably more economical than setting up remote camps without access to an airfield."

"Helicopter support must be carefully pre-planned."

[Southeastern Alaska] "Local labor force inadequate for claim staking."

"Top quality field personnel are essential otherwise you are wasting time."

"Field personnel must be equipped properly for and be willing to work in inclement weather conditions."

Other problem areas cover a great variety of subjects:

"No major problems, once fuel problem was solved."

"Plan 1 year ahead, no fuel available in region."

"Weather. Lack of availability of some equipment and material in Alaska, getting replacement parts within a few days, handling of equipment and supplies by carriers."

"Much heavier than normal snow cover throughout study area [Southeastern Alaska] during 1972 and 1973 field seasons."

[Eastcentral Alaska] "Communications 'outside' difficult. Supply situation with regards to hardware and groceries generally poor. Predictability of weather very poor so that flying is often difficult or impossible to plan."

"Patience! Mail is slow. Need good SSB radio in addition ot local HF."

"Getting decent, reliable radio communications in Southeastern Alaska is a ...."

"Published U.S.G.S. maps were pretty bad - we had to remap much of the area to do the job we planned to do."

"Current laws make use of radios by Canadian companies a matter of considerable difficulty."

"Streams still frozen in June [southern Brooks Range] are probably unique to Alaska."

"Frozen and thawed tundra present major summer problems with heavy equipment."

"Companies should realize that the major part of a dilling program is mobilization and demobilization. Should plan to drill more while there; then the cost per foot goes down. If it's worth drilling it's worth a good effort with adequate budget. Mobilization should be done in the winter; winter rotary drilling also best."

"A capable, experienced (in Alaska) and cooperative pilot is essential. Condition of aircraft is critical and quick availability of parts is necessary. Company furnishing helicopter must be prepared to keep ship operating with minimum of field time (and without continual prodding from the Party Chief)."

There were a number of comments on personnel. A number that are not quoted commented on personalities in rather strong terms; in general these represented helicopter pilots, drillers, and geologists. However, it should be understood that at least to some degree, the comments on these particular types of personnel represent their degree of indispensibility to the program. For instance, there was not a single comment on poor adaptability or incompetence of field assistants; it is rather naive to think that they as a group are more competent than say helicopter pilots. However, one can usually work around a poor field assistant while a good helicopter pilot is almost an absolute necessity. There is no doubt that Alaska has many highly capable helicopter pilots, drillers and geologists and it is only unfortunate that this study is not the medium for recognizing their work. Some comments on personnel of more general significance are:

> "Capable miners are nonexistent in Alaska."

> "Don't be responsible for 'outside' consultants unfamiliar with Alaska. Had to hand-feed two...consultants - real cheechakoes, and lost an aircraft because of them."

> "Use Alaska-based consultants to set up program. Plan months ahead."

> "Border crossing problems for technical people [from Canada] , i.e. highly trained competent prospectors. My experience based on many years in Alaska has shown an almost complete lack of competent prospectors available south of Fairbanks. However, the U.S. authorities feel that any unemployed Texan can be used as a prospector. Obviously our definitions need clarification."

A number of comments were of a general nature:

> "It is possible to make satisfactory mineral resource appraisals of large areas (at reconnaissance scale) using multidisciplinary geology-geochemistry-geophysics approach.
> a. Good basic understanding of geology is essential.
> b. Reconnaissance geochemistry and geophysics is also necessary.
> c. Follow-up, in depth or detailed geological, geochemical and geophysical studies may be necessary."

> "Proper geochemical techniques work. Avoid cheap dilute acid techniques."

" [Two-man crew with helicopter pilot and mechanic doing spot reconnaissance of pre-selected targets] ...program of this size good only for getting feel of the country. Poor way to do reconnaissance."

And many discussed the general philosophy of exploration and making mines in Alaska.

" Alaska metal exploration is not all that different from Northern or Central B.C.; reconnaissance costs are much the same for this type of program because helicopter charter is substantially cheaper [this may not now be true] although supplies may cost somewhat more."

"Natives were very cooperative; wanted exploration to find mines and create jobs."

"Keep good relations by hiring local bush pilots."

"More consideration needs to be given to preserving the environment during exploration such as:

a. Hauling out old gas cans and not leaving them sprinkled over the countryside.
b. Leaving clean camp sites; hauling out all leftover gear and debris.
c. Not leaving debris at remote sites where helicopters land.

Crews need to respect the property of local miners, prospectors, residents, etc. They should not disturb cabins and equipment around them, even if they appear abandoned."

"Work long enough in one region to understand what the prospectors and geologists that preceeded you understood. Use a careful balance of helicopter, boat and foot traversing."

"Do not plan for programs of short duration - one year or less. It generally takes five years or more to complete a meaningful program-reconnaissance to detailed mapping to examination by drilling."

" [Southeastern Alaska] Look at the area; talk to local residents before making budgets. Rain gear and rubber foot gear a must. Poor light in brush makes geologic observations difficult. Geochemistry more difficult than in Interior. Poorly mapped."

"The land situation vis a vis Federal Withdrawals, etc. is much more complicated than in Canada. Claim status, location, and ownership is inadequately documented."

"Dealing with food, radio, etc. in town thru bush pilot is a great advantage. An experienced, built-in expeditor so that one doesn't have to go to town."

"The best thing Alaska has had going for it for decades was the U.S.G.S. Heavy Metals Program, an offshoot from which some of the better geologists carried out extremely useful geologic mapping programs... However, these extremely useful programs have more or less been cancelled in favor of moss-collection. When the government itself insists on this negative attitude, more exploration companies follow suit since the costs of operating there, despite some well-intentioned comments to the contrary, are double what it is in the next highest cost area - Canada. The complete land muddle on top of this makes a joke of serious exploration attempts north of the Panhandle at the present time."

"Logistical planning is the key to budget control...."

"Techniques do not differ substantially from elsewhere in northern latitudes although climatic conditions are more limiting in regards to work season. The legal aspect of claim staking, ownership, etc. is sufficiently complicated to act as a strong deterrent."

CHAPTER 4

CONCLUSIONS

Alaskan exploration costs are not only high but the high costs are often tied to specific items in the exploration budget in which the costs are often extraordinarily high. The following seems to represent the most significant factors in the costs of Alaskan metal exploration (arranged roughly in order of importance):

1. Transportation is often the largest single item in the exploration budget. It not infrequently makes up more than half of the total budget and is almost invariably an important cost item. In the past (under relatively favorable conditions), it was very important that the logistics of an exploration program be worked out in detail as early as possible. The transportation situation will undoubtedly become even more difficult with the construction of the Alaska pipeline and prior planning will become even more critical.
2. Experienced exploration personnel are available in Alaska and it is generally assumed that they are to be preferred because of Alaska's unusual conditions. However, they are relatively scarce and can demand a premium salary. Many, if not most, of the stronger comments on the problems of operating in Alaska were related to the unsuitability of personnel and the difficulty in replacing them.
3. In the past, fuel was often critically short in the "bush" in

early Spring and not always obtainable at times in some localities during the rest of the field season. The current petroleum shortages and regulations have greatly exacerbated the problem. Because it is so obviously necessary for most programs, it is critically essential that provisions for fuel be made as soon as possible. Transportation costs alone may add $0.50 to $1.00 to the basic cost of fuel in many areas of the state.

4. Cost of communications are not significant in the sense of comprising a large item in the exploration budget. Communications are, however, frequently slow and uncertain and there is no foolproof method of assuring quick, completely reliable communications in many areas of the state.

5. Contract services such as drilling, geophysical work, and geochemical analyses, and consultants, are available within the state in varying degree. The price per unit of work may be directly competitive with that from "outside" but more frequently is somewhat higher. However, the additional cost of mobilization and demobilization, transportation, and camp costs (especially in drilling and geophysical work) are often a major cost item that is not usually included in the quoted price from the contractor. These additional costs can be very high for projects of short duration.

6. There does not seem to be a particular problem with camp costs or living expenses. While Alaskan costs in this area are high, and often spectacularly high, the total costs in this category are generally only a small percentage of the budget. There may

be inconvenience at times but lack of accommodations or food is rarely a real problem.

Probably the most important conclusions were commented up in various forms by a great number of people: "Bring money", begin your logistical planning as soon as possible and stay loose.

REFERENCES CITED

Alaska Division of Geological and Geophysical Surveys, 1972, Consultants available for work in Alaska: Inform. Cir. 8, 7 p.

_____________, 1973, Annual Report, 1972: 57 p.

Alaska Industry, 1974, Small carriers face fuel woes in '74: Jan., p. 33 and 69.

Alberta Soc. of Petroleum Geologists, 1972, Helicopter safety and operations manual, 2nd ed.: 16 p.

Allan , R. J., Lynch, J. J., and Lund, N. G., 1972, Regional geochemical exploration in the Coppermine River area, District of MacKenzie; a feasibility study in permafrost terrain: Geol. Survey of Canada Paper 71-33, 52 p.

Alaska Construction and Oil, 1972, The rugged business of diamond drilling: v. 13, no. 6, p. 24.

Bailly, P. A., 1964, Methods, costs land requirements and organization in regional exploration for base metals: American Inst. of Mining Metallurgical and Petroleum Engrs. Meeting, Fairbanks, Alaska, March 18-21, 31 p.

Coxey, J. G., 1968, Cost factors of Alaskan construction: Unpubl. M.S. thesis, University of Alaska, 59 p.

Hawley, C. C., 1974, There's gold and other minerals in them Alaskan hills: Western Miner, April, p. 89-91.

Geological Survey of Canada, 1959, Helicopter operations of the Geological Survey of Canada: Bull. 54, 60 p.

Heiner, L. E., and Wolff, E. N., 1969, Mineral Resources of Northern Alaska: Mineral Industry Research Laboratory, University of Alaska, Report 16, 229 p.

Hershberger, H. M., 1970, Alaska's pay rates: $5.63-$9.27: Alaskan Construction and Oil, v. 11, no. 1, p. 49-50.

Johnson, P. R., and Hartman, C. W., 1969, Environmental Atlas of Alaska: Institute of Arctic Environmental Engineering, University of Alaska, 111 p.

Kaufman, M. A., 1972, Non-ferrous metal exploration in Alaska: Soc. of Mng. Engineers, American Inst. of Mining, Metallurgical and Petroleum Engrs., Preprint 72-I-53, 25 p.

Massell, B. F., Massell, A. P., and Fryer, Mark, 1971, Construction costs and Alaska regional inflation analysis and policy: Institute of Social, Economic and Government Research, Univ. of Alaska, 27 p.

Preston, L. E., 1960, Exploration for non-ferrous metals: Resources for the Future Inc., Washington, D.C., 198 p.

Reed, J. C., 1958, Exploration of Naval Petroleum Reserve No. 4 and adjacent areas, Northern Alaska, 1944-53; Part I, History of the Exploration: U.S. Geol. Survey Prof. Paper 301, 192 p.

Roguszka, E. G., (ed.), 1974, Alaska Petroleum and Industrial Directory: Petroleum Publ. Inc., Anchorage, 364 p.

Sainsbury, C. L., 1972, Geologic mapping and geochemical sampling by use of light aricraft in Jones, M. J., (ed.), Geochemical Exploration 1972: Institute of Mining and Metallurgy (London), p. 337-346.

Taylor, J. W. R., (ed.), 1973, Jane's all the world's aircraft 1972/1973: Jane's Yearbooks, London, 798 p.

U.S. Department of the Interior, 1974, Table of maximum per diem rates in lieu of subsistence for United States government civilian officers and employees for official travel in Alaska, Hawaii, the Commonwealth of Puerto Rico, the Canal Zone, and possessions of the United States: Civilian Personnel Per Diem Bull. 42, 2 p.

U.S. Federal Field Committee for Development in Alaska, 1971, Economic outlook for Alaska: in cooperation with the Office of the Governor of Alaska, Anchorage, 392 p.

Wolff, E. N., 1969, Handbook for the Alaskan prospector, 2nd ed.: Mineral Industry Research Laboratory, Univ. of Alaska, 460 p.

Wolff, E. N., and others, 1973, Optimum transportation systems to serve the mineral industry north of the Yukon basin in Alaska: Mineral Industry Research Laboratory, Univ. of Alaska, Report 29, 70 p.

Wolff, E. N., and Johansen, N. I., 1973, Problems of mining in the Arctic in Given, I. A. (ed.), Mining Engineering Handbook: American Institute of Mining, Metallurgical and Petroleum Engineers, Inc., p. 17-172 to 17-175.