GEOPHYSICS: THE EXPLORATION BARGAIN

J. R. PULLEN* AND W. C. STROUP*

ABSTRACT

The 1.1 Million acre West Whitecourt Block in Western Alberta has been the site of seismic operations conducted by the same three partners each year since 1952, where the geophysical programs have been an integral part of the successful exploration program. The area is one in which the mineral rights are owned by the Province of Alberta and have been issued to the companies involved as permits and latterly as leases. Bush and muskeg cover the area and accessibility has evolved from initially virtually none to the present system of all weather roads linking oil and gas production facilities. A full spectrum of seismic data acquisition problems have confronted the operators over the years. The overall costs involved in the seismic data acquisition through the 26 years are reviewed, and adjusted for inflation using an indexing system. They are then compared over the same time period with costs of drill bits, and bulldozer services. The environmental costs — line cleanup, erosion control and timber salvage are segregated as well, and a final comparison is made with development well costs over the 26 years. Costs today are determined to be less than in the early 1950's and the much improved data quality obtained is illustrated at several localities. This improvement is judged necessary and needs to be continued in order to identify the remaining reserves in a partly explored area.

INTRODUCTION

There are few geophysicists who have not lately had to endure caustic remarks about the present cost of doing geophysical work, together with complaints that escalation of these costs is entirely out of reason. Described below is a unique chapter in geophysical history and a repudiation of these charges.

People also talk glibly about lies, damn lies & statistics, and comment that one can prove anything by statistics, however they also carry a strong element of objective truth as will be seen.

HISTORY

In the West Whitecourt area of Western Alberta, in May 1951, Canadian Fina acquired 11, maximum sized Petroleum and Natural Gas Reservations from the Province of Alberta, (Fig. 1). In November 1951, Fina put a seismic crew in the field and during that winter, 100 miles of continuous seismic profile were shot. On September 16th, 1952 Fina, now Petrofina Canada Ltd., farmed out to Stanolind, now Amoco Canada Petroleum Company Ltd., and to Hudson's Bay Oil and Gas Company Limited, who was named Operator for all future geophysical work. As Operator for the group, Hudson's Bay has conducted seismic work over the lands every year since 1952. That means in 1977 when 150 miles of new data were recorded, it was the 26th consecutive year that the team had acquired new seismic data on the same block.

The block encompasses some 1.1 million acres in a roughly square area, 45 miles on the side which stretches from Range 14 W.5 in the East to Range 22 W.5 in the West and from Township 55 in the South to Township 62 in the North.

The original Petroleum and Natural Gas Reservations have been duly converted to 21 year leases.

*Hudson's Bay Oil and Gas Company Limited.

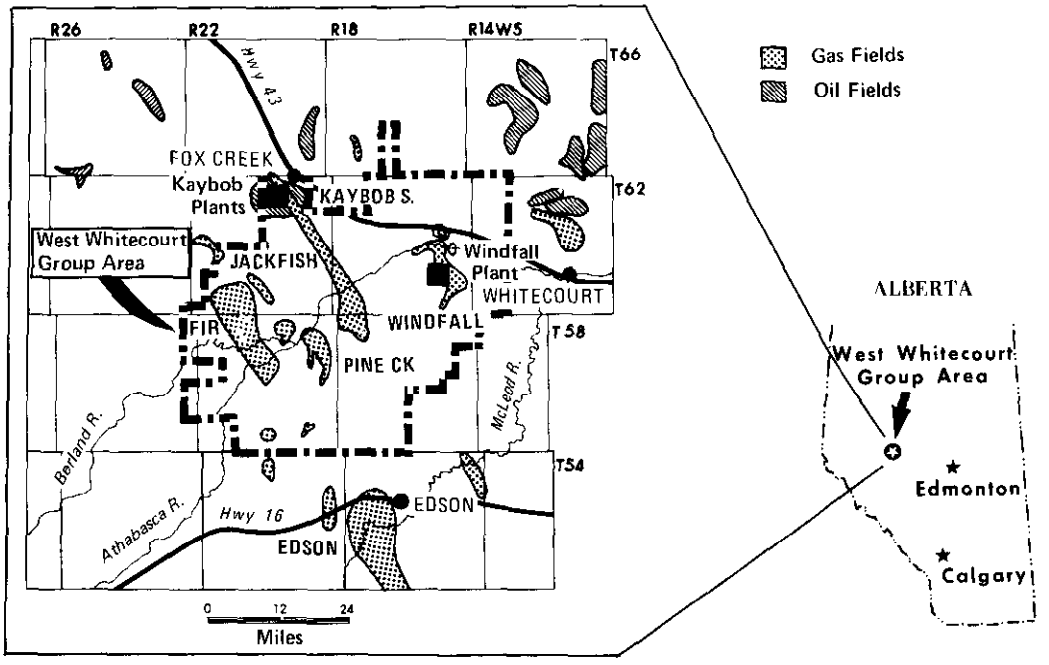

Fig. 1. Location map. West Whitecourt Block, Alberta.

Before we examine the costs, here is a brief geophysical history of the partners' work on the Block. The work done in 1952 was conducted by one National Geophysical, now Teledyne Exploration, and one Seismograph Service Corporation crew. Since then a total of 73 crews have recorded more than 5,500 miles of seismic data at a cost in excess of $13 million. The list of contractors includes practically every company which has worked in the province and the equipment list looks like a quarter century long history of both seismic instrument and seismic source development.

The maximum number of miles recorded was 690 in 1955 which was done by 10 crews, and the minimum was 16 miles recorded in 1961. In 1977, the 150 miles were recorded using one crew. Due to the remoteness of the area, all the seismic work has been conducted from portable camps.

Fig. 1 also shows the reason that the group has continued to shoot over these lands over 25 years — success in finding hydrocarbons. The major pools discovered include Windfall in 1955, Pine Creek D1 in 1956 and Pine Creek D3 in 1957. Kaybob South was found in 1961 and N.W. Pine in 1963. Little of significance was found from then to 1973 when the Fir Field was discovered and in 1974 the Jackfish Field was first drilled. In addition many other smaller finds have been made. Reserves discovered as of 1976 according to the Energy Conservation Board of the Province of Alberta, total approximately 4.6 Trillion Cubic Feet of recoverable gas equivalent.

Topography & Accessibility

Over the years three centres have been used for access and supply depots. As the name would suggest, the town of Whitecourt is one such centre, the others are Edson and more recently Fox Creek.

Since the Athabasca River splits the Block into two almost equal halves, it has been necessary to use Whitecourt and Fox Creek for access to that portion of the Block which lies north of the Athabasca. Provincial Highway No. 43 between Whitecourt and Fox Creek crosses a large portion of this north Block. A number of all-weather roads provide access from Highway 43 into most areas where seismic has been conducted.

It should be noted that three bridges have been built across the Athabasca River within the past twenty years which allow easier access from north to south on the Block. These have opened up the country to hunters, fishermen and tourists as well as providing access to production facilities.

Edson has been the centre of activity for crews working the entire south half of the Block. The dominant topographic feature in the southern part of the block is a height of land trending from southwest to northeast.

It is in this portion of the Block that crews have encountered the extremes in topography. From the Athabasca River Valley to the Crests of Crown and Mayberne Hills the elevations change from an approximate 2,500 feet A.S.L. to something over 4,500 feet A.S.L.

Anyone who has worked on the West Whitecourt Project during the past twenty-five years will attest to the fact that it is indeed a very difficult and challenging area to work.

Seismic Costs

Fig. 2 shows the cost per mile (top line of graph) for new seismic data over 26 years. No smoothing or averaging was done. These costs include all expenses involved except for interpretation and therefore reflect processing, dozing, drilling and line clean-up costs as well as actual recording expenses.

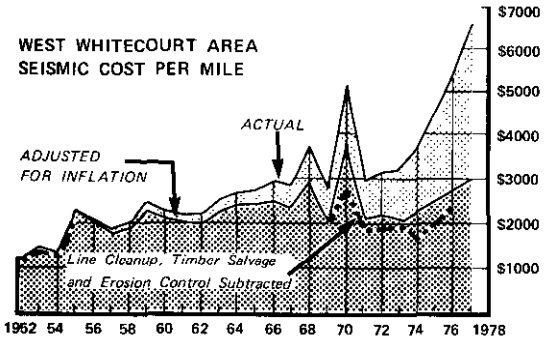

Fig. 2. Cost per mile for seismic acquired in the West Whitecourt Block.

An obvious weakness of the data displayed is that special circumstances involved in each year's shooting, and there are always special circumstances, are not shown. Annual variables such as amount of program, difficulty of the drilling or terrain, depth of holes or trace spacing, and more recently percentage sub-surface coverage are all simply lumped together. This means that while detailed comparisons should not be made general ones are fully valid. Data for 1977 are based on May 1 actual and accrued expenditures.

It is clear from the graph that the first three years of relatively low costs were replaced with much higher ones as the work moved from where access and drilling was easy, to the much more difficult data acquisition areas. Three high points are worthy of comment.

In 1955 costs nearly doubled as year round work was attempted with Bombardiers and similar tracked units, and year round operations continued for two years with only brief interruptions. In recent years, however, the better quality of data acquired in the winter over that acquired in the summer, together with the increased costs of summer oprations has virtually eliminated summer work.

In 1968 large mobilization costs were incurred and a short program was recorded.

In 1970, what turned out to be one of the wettest summers in recent history was chosen for another attempt at year round operation in a difficult area. The effect on the costs per mile is clear.

The vigorous and sustained upturn in costs since 1973 is really what caused this paper to be written. An increase of 50% is conservatively calculated.

A price index has been derived for the 25 years using the Canadian Price Index published by Statistics Canada and converted to a 1952 base. (See appendix 1) The middle of the three curves in Figure 2 shows the effect of its application to the gross costs. It is clear that from 1955 to 1976 seismic costs rose very little if at all in terms of 1952 dollars. 1975 through 1976 are high inflation years but costs in terms of 1952 dollars are up only slightly. A low frequency filter applied to these data would give a near horizontal line at about $2,000 per mile.

Another rapidly growing component of the overall costs is the line clean-up, erosion control and since 1973, timber salvage. This has been done to Forestry specifications for the last ten years and incur costs which are both significant and which vary with the amount and size of timber, the steepness of the terrain and of course, the mix of old and new cut lines in any program.

The lowest curve shows costs per mile corrected for inflation less costs involved in timber damage,

line cleanup, erosion control and timber salvage. The attitude at the end of the curve has been turned downwards.

In an area where the bush is so heavy and the topography so extreme, bulldozing costs are a major component of the overall costs, so the hourly rate for a D-7 Bulldozer over the 25 years was examined. (Fig. 3) Here again the upper curve is the actual dollars and the lower is that adjusted to constant 1952 dollars. In this case the hourly rates are distinctly higher in the last few years even net of inflation. I am advised by operators that a modern D-7 provides many more horsepower than a vintage one, however the net cost increase is about 65%.

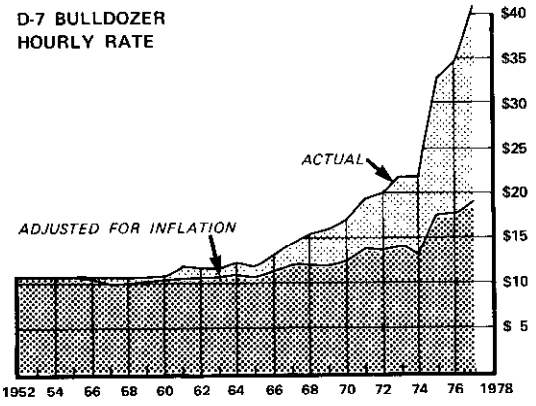

Fig. 3. Hourly Bulldozer costs in the West Whitecourt Block.

The final component of geophysical costs for which hard data is available, is that of prices of 4½" rock bits. (Fig. 4) Again the upper curve is the unadjusted dollar costs and the lower one that for constant 1952 dollars.

Apparently both the competitive marketplace and improved and automated production facilities also affect this component, with the 25 year trend being definitely downwards — another bargain.

Other components of overall costs were also examined, with two of them in particular being of interest. Data Processing has cost almost the same per mile since 1968; and camp costs have also remained remarkably constant.

In order to view these costs from a perspective different from that already present in the cost of living index corrections being used, another component of oil industry costs was selected. We tried to choose an item which has a few variables

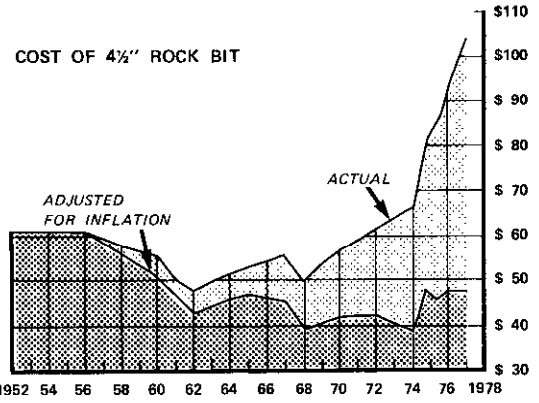

Fig. 4. Rock Bit Costs in the West Whitecourt Block.

over the years as possible and settled on the cost of a development well in the Windfall Field, which was discovered in 1955 and is still being extended.

Fig. 5 shows these costs, with a high 1955 cost halved by 1960, a ten year level period and then the escalator effect of the 70's.

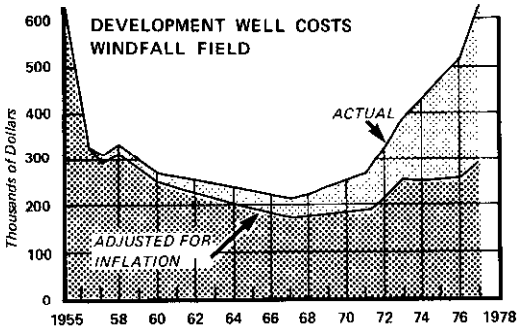

Fig. 5. Well costs in the Windfall Field.

In this case, however, some of the components, particularly tubular goods rose at a much higher rate than average Canadian costs, so that the adjusted costs in the 70's show a net rise compared with the flat or downward trend of the seismic costs.

Data Quality

It is all very well to prove, as these statistics do, that seismic costs have been approximately constant for twenty-five years. That still doesn't make it a bargain. Seismic data is obtained in order to resolve the geological section and to identify

potential hydrocarbon traps. To permit comparison of quality of data obtained, sections from two areas were selected. No significant anomalies are present.

The only horizons identified are the Lower Cretaceous marker and the Cambrian zone.

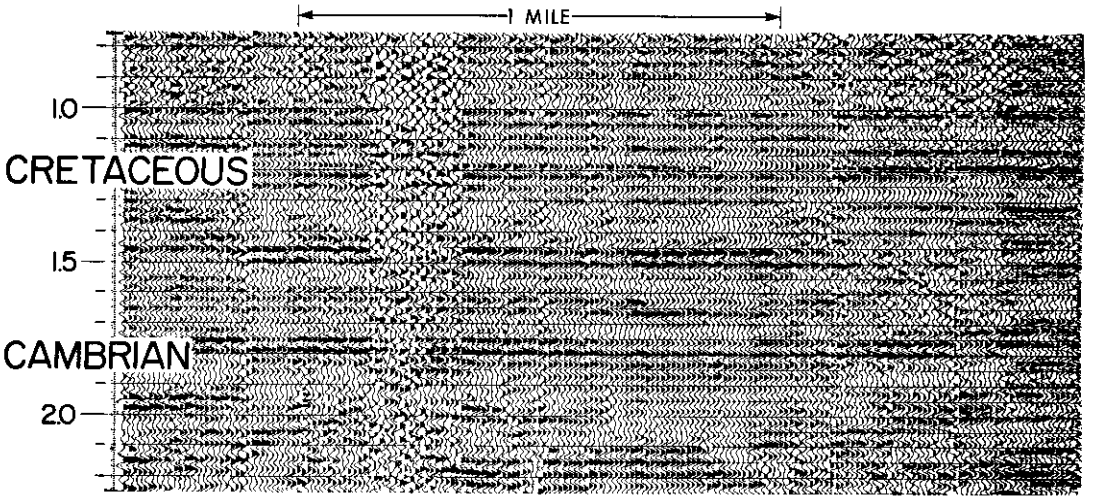

Fig. 6. Seismic data — Heavysound Area (1962).

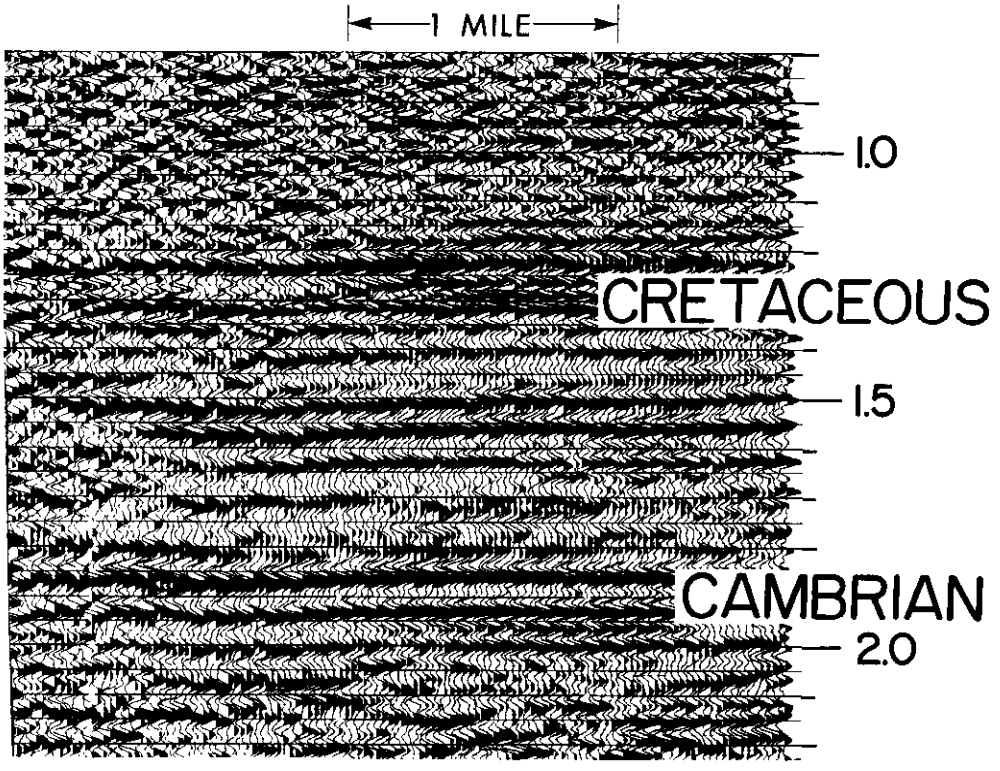

Fig. 7. Seismic data — Heavysound Area (1971).

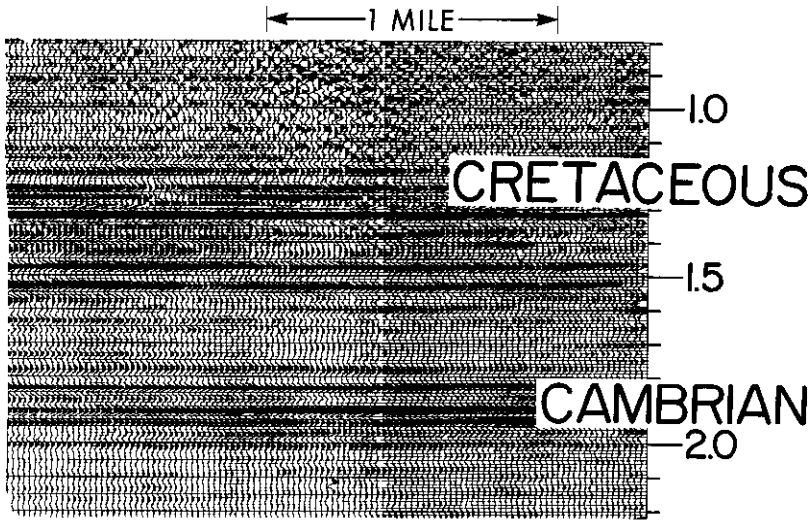

Fig. 8. Seismic data — Heavysound Area (1976).

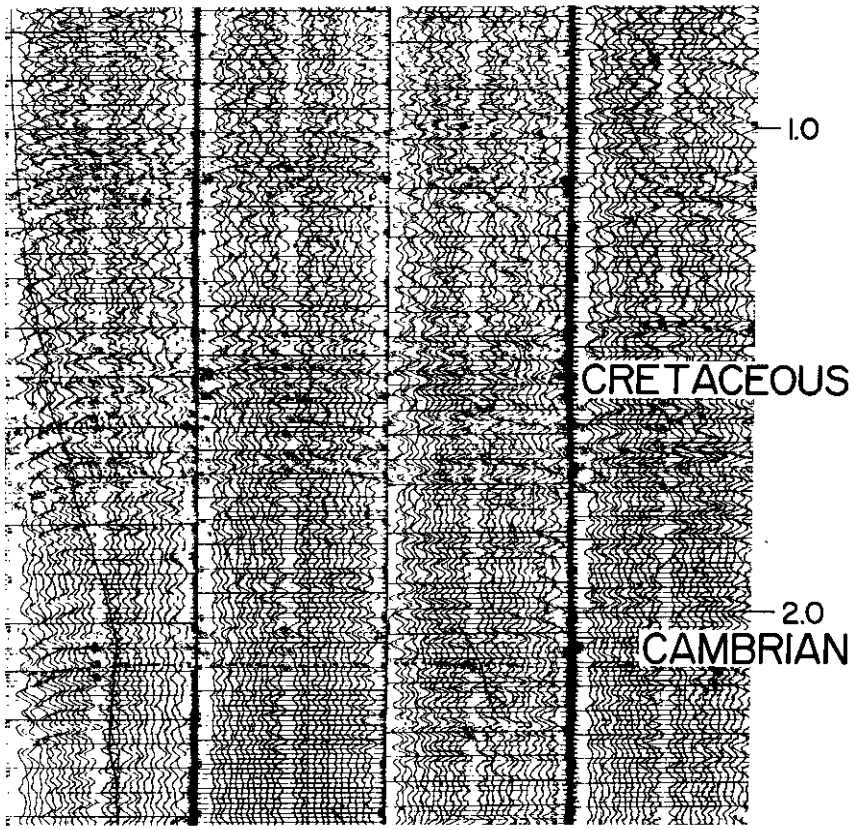

Fig. 9. Seismic data — Mayberne Area (1953).

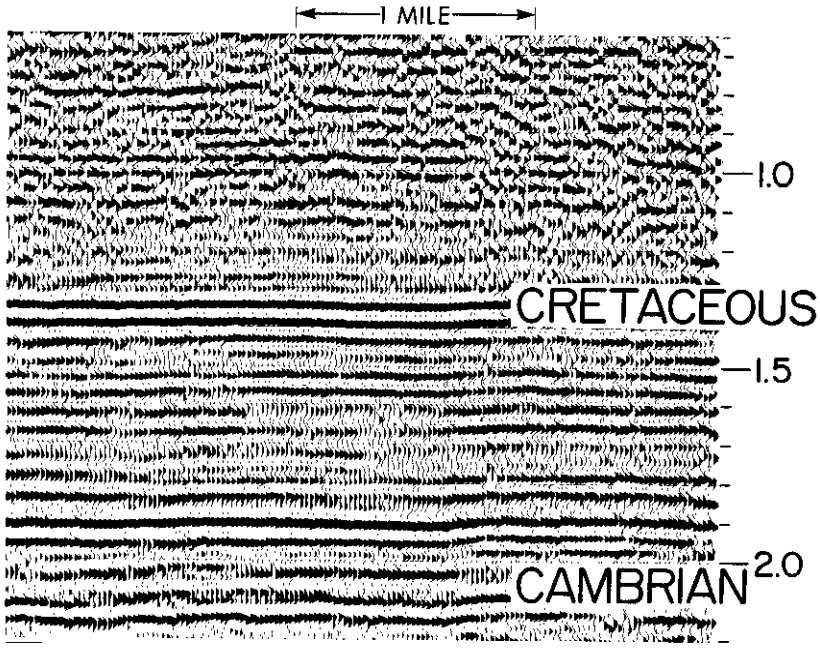

Fig. 10. Seismic data — Mayberne Area (1976).

In the Heavysound (Windfall) Area, Fig. 6 is a 100% sub-surface coverage line shot in 1962 and reprocessed in 1970. Fig. 7 is 600% CDP shot data recorded in 1971. Fig. 8 is shot data recorded in 1976.

In the Mayberne (Pine Creek) Area some of the very earliest shooting may be compared with some of the very latest. Fig. 9 is a section prepared from 1953 shooting. Fig. 10 is a portion of a 1200% CDP line of data recorded in March 1976.

Conclusion

The foregoing proves conclusively that in the West Whitecourt Area of Alberta, over the last 25 years, better and better seismic data has been obtained with no increase in costs. There are many interesting corollary deductions which can be made from a study of the data above as well. The first is that improved technology and continuing exploration effort will indeed result in more reserves being discovered. The second is that while the costs and quality of data acquired are something of which geophysicists can be justifiably proud, now is no time to be resting on our laurels. Even better data at even lower prices are mandatory if we are to discover the increasingly elusive remaining hydrocarbon reserves.

Acknowledgements

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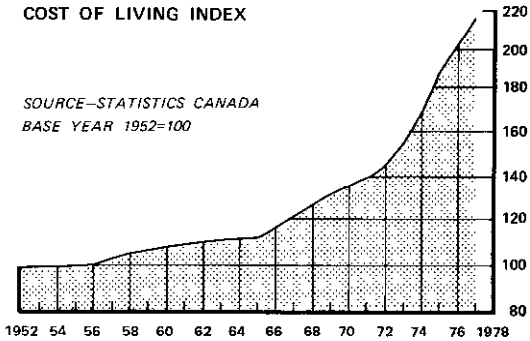

APPENDIX 1. Canadian Price Index