Coal Exploratory Drilling:

A cost percentage comparison

of three methods

by

Robert G. Hobbs

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Introduction

Coal exploratory drilling constitutes a desirable and sometimes necessary part of coal resource assessments. Rotary drilling and preparation of a sample log, accompanied by applicable forms of geophysical logging, can yield information about coal quantity; but core drilling is generally required to obtain samples for coal quality determinations. Three different methods have been used to obtain the required coal and associated rock samples at the least cost. Any one of the methods may be economically applicable in a particular circumstance, depending on the relative relationship of several variables.

General

When planning a coal exploratory drilling program, the question frequently arises as to how to reduce the costs without reducing the cored footage that is necessary for the individual project or drill hole.

This report outlines three methods of coal-core drilling: (1) coring of the entire coal-bearing interval, (2) combination rotary drilling and coring within the same hole, and (3) twin-hole drilling, which is a rotary-drill pilot hole offset by a second hole of selected cored intervals.

Each method has its advantages and disadvantages. The selection of the method used will depend on the project requirements and the cost.

Drilling and coring methods

Method 1. Coring of entire coal-bearing interval:

The full section to be evaluated is cored from the surface to total depth. This method is likely to be used when little is known of the coal bearing section or undisturbed samples are needed in both the coal and non-coal intervals. This method was generally used prior to the advent of easily portable, accurate geophysical-logging units.

Method 2. Combination rotary and coring within the same hole:

This method is commonly used where the intervals between coal beds are approximately known and samples are required only of the coal or other selected beds. A coring program can thus be planned with a reasonable certainty of coring all the coal beds and other beds of interest that are present.

Method 3. Twin-hole:

A rotary-drill pilot holes, in which beds to be sampled are identified, and an offset hole, in which selected intervals are cored, are drilled.

This method is commonly used in coal fields in the Western United States in which only selected intervals are to be cored and the depth to coals or other beds of interest is unknown. It is especially useful where geophysical logs give sufficient data for non-cored intervals and only selected coals are to be cored for analysis or other studies.

The initial pilot hole is rotary drilled to the depth required and geophysically logged from the total depth of the hole to the surface. Coal beds and rock intervals to be cored are selected from the logs.

Cost comparison of the three methods

Two equations were developed which show a cost ratio or comparative cost percentage of the three methods:

1. Method 1 compared to Method 3

$$\frac{(R_3) + K(C_3)}{K(C_1)}$$ = Cost percentage of Method 3 compared to Method 1: If it is less than 1.0, Method 3 is less costly.

R_3 = Total rotary footage of a pilot hole and a second combination

rotary and core hole (Method 3)

K = Coring cost factor - This factor is derived by dividing the coring costs per foot by the rotary drilling costs per foot. The factor for recent coal drilling programs in the Western United States was about 5.0; that is, core-drilling costs per foot were about 5.0 times the cost of rotary drilling per foot.

C_3 = Total core footage of the second combination core and rotary hole (Method 3)

C_1 = Total core footage of single core hole (Method 1)

Figure 1 is based on this equation and illustrates the comparison of Method 3 to Method 1. To use this graph, read the cored footage of Method 3, expressed as a percentage of the pilot-hole footage of Method 3, on the vertical scale; proceed horizontally to the appropriate K factor (diagonal); then downward to the cost percentage scale.

2. Method 2 compared to Method 3

$\frac{(R_3) + K(C_3)}{(R_2) + K(C_2)}$ = Cost percentage of Method 3 compared to Method 2: If it is less than 1.0, Method 3 is the less costly

R_2 = Total rotary footage (Method 2)

C_2 = Total core footage (Method 2)

Other factors are as above.

Conclusions

The equations contained herein have been presented as an aid in estimating relative costs when planning a coal exploratory drilling project. The costs of the well-site geologist, supervision, and ancillary costs should be estimated separately for each method.

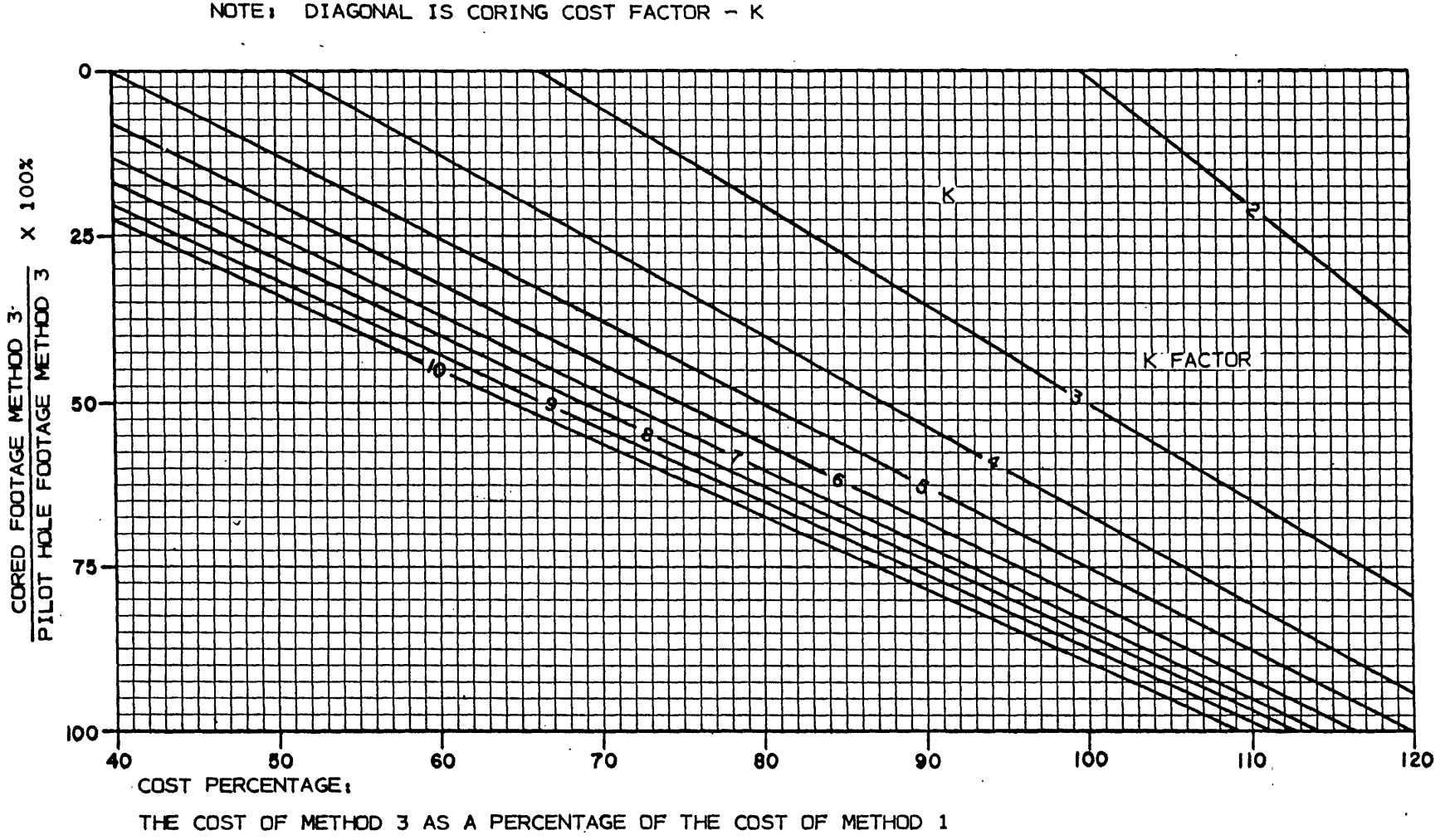

FIGURE 1.--COST RELATIONSHIP OF METHOD 3 TO METHOD 1

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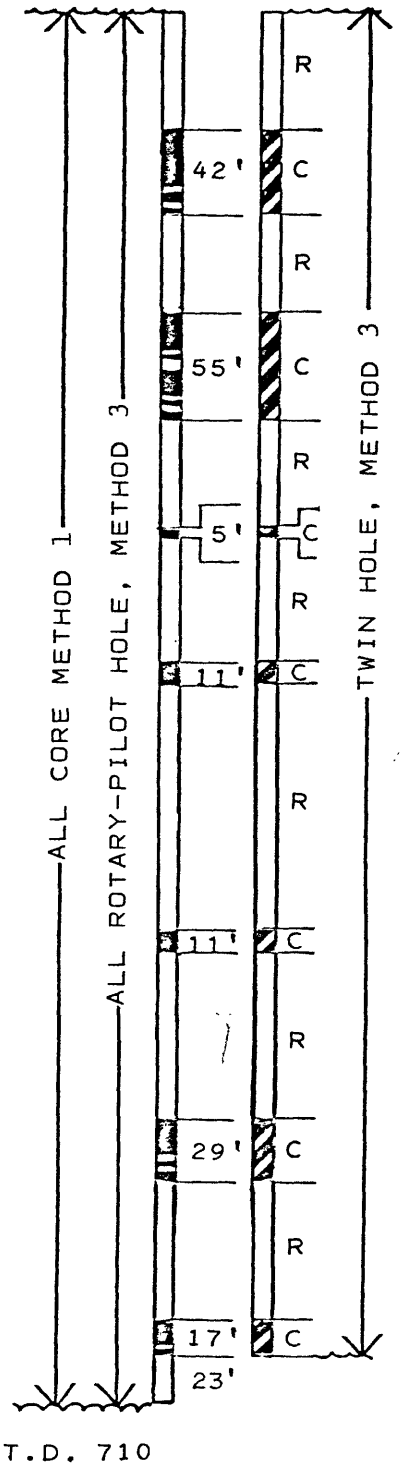
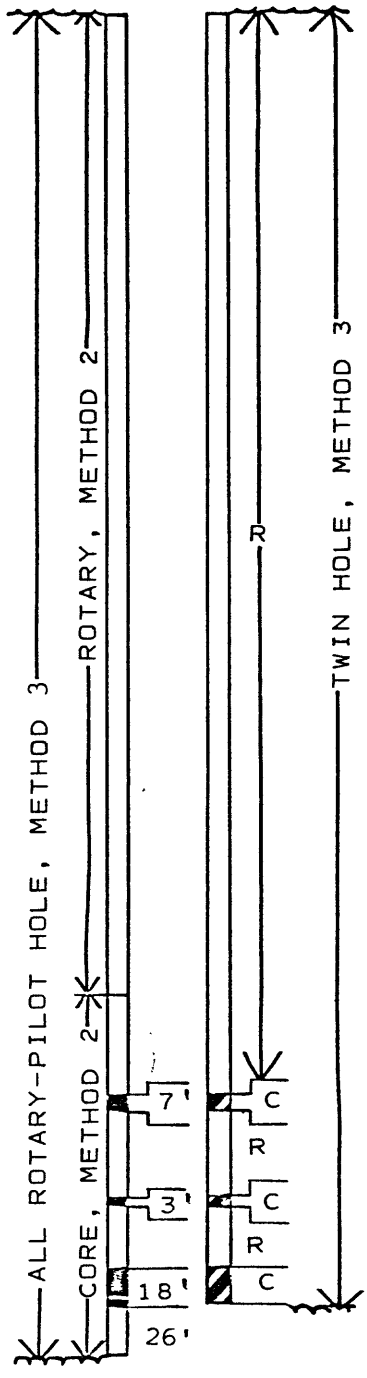


R = ROTARY DRILLED
C = CORE DRILLED

SCALE: 1" = 100'

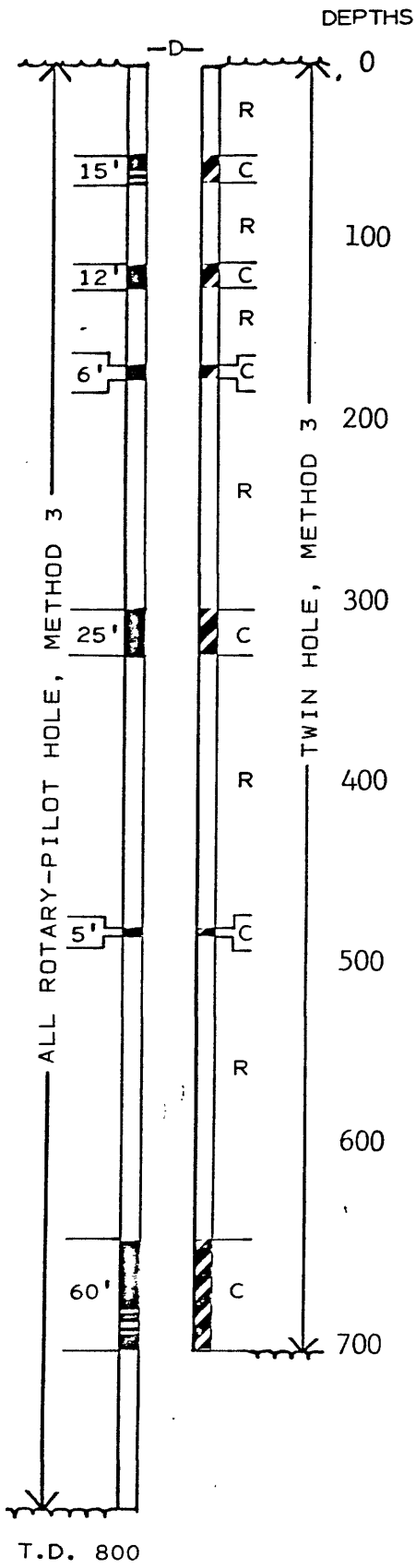
FIGURE 2.--HOLE A - COMPARING METHODS 1 & 3



R = ROTARY DRILLED
C = CORE DRILLED

SCALE: 1" = 100'

FIGURE 3.--HOLE B - COMPARING METHODS 2 & 3



D = DISTANCE TWIN HOLE OFFSET FROM PILOT HOLE, USUALLY 15' TO 25'.

FIGURE 4.--TYPICAL METHOD-3 DRILLING

Discussion and examples

Figures 2 and 3 illustrate examples of each type of method. The pertinent data for each example are:

Hole A - Method 1 to Method 3 comparison. (Figure 2)

Total depth: 710 feet

Coal intervals: 170 feet total

Partings: to be cored with coal. A parting is defined as a rock interval within the coal interval equal to or less than either enclosing bed.

K factor = 5

Drilling method:

Method 1

Core = 710 feet (C_1)

Rotary = 0

Method 3:

Core = 170 feet including rock partings (C_3)

Rotary:

Pilot hole = 710 feet

Twin = 517 feet (710 - 170 feet core - basal 23 feet of pilot hole = 517 feet.)

R_3 = 710 + 517 = 1227

$$\frac{R_3 + K(C_3)}{K(C_1)}$$

$$\frac{(710 + 517) + 5\ (170)}{5(710)} = \frac{1227 + 850}{3550} = \frac{2077}{3550} = .585 \times 100\% = 59\%$$

Using Figure 1

Read cored footage as percentage of pilot hole footage =

$$\frac{170}{710} = .239 \times 100\% = 24\%$$ on vertical scale, read horizontally

to K factor of 5, and then downward to cost percentage = 59%.

The relative cost of drilling Method 3 is about 59% that of Method 1.

Hole B - Method 2 to Method 3 comparison (Figure 3)

Total depth: 685 feet

Coal intervals: 28 feet total lower portion of hole

Parting: In lower coal, to be cored see fig. 3 Hole B.

K factor = 5

Drilling method:

Method 2:

Core: lower 185 feet (C_2)

Rotary: top 500 feet (R_2)

Method 3:

Core: 28 feet total (C_3)

Rotary: Pilot hole = 685 feet

Twin = 631 feet (685 feet - 28 feet core - basal 26 feet of pilot hole = 631 ft)

$R_3 = 685 + 631 = 1316$

$$\frac{R_3 + K(C_3)}{R_2 + K(C_2)}$$

$$\frac{(685 + 631) + 5(28)}{500 + K(185)} = \frac{1316 + 140}{500 + 925} = \frac{1456}{1425} = 1.02 \times 100\% = 102\%$$

The relative cost of Method 3 is about 2 percent more than that of Method

2. This example shows that if the cored intervals remained the same for both methods and the rock cover or non-coal bearing interval was:

(a) less, Method 3 would be the less costly method

(b) greater, Method 2 would be the less costly method

Hole C (Figure 4)

This illustrates the pilot-twin hole method without comparisons to other methods. It shows all coal intervals cored however different criteria for cored intervals may be used.