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Abstract

Three classes of portable breaker/driver/drill, which can be used either for sampling and pitting permafrost or for driving and emplacing shallow benchmarks, are evaluated. Field tests were conducted on Victoria Island, Northwest Territories.

Introduction

Geomorpologists are often required to collect samples of frozen soil or to install a temporary benchmark network to facilitate process studies in remote areas. Because of logistical constraints, often only two-man portable equipment can be used. We have used several types of machine that break, drill, or drive. They can be used for digging soil pits and for collecting frozen sediment samples in permafrost or for the installation of semi-permanent benchmarks. This report results from a number of requests to the authors for comments on, or an evaluation of, these types of machines.?

It is beyond the scope of our collective experience to comment on all the various machines that are currently available in the market place. However the 'Cobra, 'Pico', and 'Kango' machines that we have used extensively are representative of the range of back-pack portable machines currently available (Fig. 1).

The Cobra is representative of a relatively heavy machine powered by a two-cycle gasoline engine, while the Pico is typical of a lighter class. The Kango is a light weight electric machine which requires an external power source for its operation (Table 1).

It must be stressed that larger electric and gas powered machines are available, but they were excluded from our evaluation because of the emphasis on portability. The following comments are admittedly subjective but they are tempered by our experience.

Pitting

In breaker mode, the Cobra, Pico, and Kango can be used with a cutter (wide chisel) or spade to break frozen or unfrozen ground and/or to dig pits to several metres. Rates of penetration in frozen ground are dependent upon the grain size of the material, its ice content, and temperature, and are therefore variable (Veillette and Nixon, 1980, p.3-4). For comparision, rates of both horizontal and vertical pentration in both a frozen and thawed marine diamicton were recorded at Cambridge Bay, Northwest Territories (Table 2). In frozen ground the greater weight and power of the Cobra gave it four times faster vertical penetration than the Pico or twice that of the Kango. When the spade was driven horizontally, rates of penetration by the Cobra and Kango were similar. In unfrozen ground there was little difference in the rates of pentration amongst the machines.

Pitting is a laborious task and a single pit 1.5 to 2.0 m deep may take one or two days to dig depending on the nature of the sediments (Fig. 2). Although the Cobra penetrates frozen ground more rapidly than the other units tested, its greater weight makes it more tiring to use over long periods than either the Pico or Kango.

An electric unit like the Kango (Fig. 3) offers two distinct advantages over the gasoline-powered machines tested: 1) The power source, a generator of 1 kilowatt or greater, can be located some distance from the hole so that the gas fumes do not fill the hole and so that noise is reduced. 2) Penetration can be halted by releasing the trigger. On the gasoline powered units the tool must be held off the surface or the engine stopped to halt driving. This can be awkward when clearing rubble or resting. The familiar four-cycle generator engines running at constant speed are easily adjusted for effective power output and readily maintained in the field. For pitting we prefer a compact, electric machine like the Kango, although in wet holes caution must be used.

In our experience it is not possible to expose a clean, continuous face within a pit dug in permafrost. The cutting process obliterates sedimentary structure. If one wishes to see structure, the sides of the pit must be carefully broken exposing sediment not touched by the tool. This can make it difficult to orient or locate the sample relative to the pit wall.

Drilling

All three machines tested can be used in a rotary mode. The Pico and Cobra will take motordrill steels of various lengths while the Kango is only capable of drilling short vertical holes in soft rock. In practice these drills are of limited use in drilling frozen sediments although they may be used to install thermistor or thermocouple strings at shallow depth or to drill through boulders before driving small-diameter benchmarks . The gasoline drills are useful for drilling to short depths into competent bedrock. Rates of pentetration are variable depending on the

rock type (Table 1). The Cobra gives the best rate and depth of penetration; if the main use for this type of equipment is drilling, a heavier machine like the Cobra is preferred.

Driving

With suitable attachments these machines can be used for driving small diameter rods or 'T' section posts into permafrost. In frozen silts and clays we have used the Cobra to drive rods to depths of 7 m over a period of two to three hours; however, these machines are more efficient at shallower depths. Their relative performance for driving is the same as that for pitting through frozen ground (Table 2). In a frozen silty sand above -5°C driving rates are of the order of 30 cm/minute. Penetration is slowed if stones are encountered, but if the clasts are small the driven rod will crack them or will snake around them.?

If a substantial number of rods are to be driven or if the rods are to be driven to some depth, a heavier machine like the Cobra has a definite advantage. However, it is extremely difficult to keep a heavy, hand-held driver, like the Cobra, balanced on top of a long rod being driven into the ground.?

Discussion

In our opinion an electric breaker like the Kango is the best choice for pitting frozen ground. Its light weight and power switch make it easy to use for extended periods, but it does require a generator with at least 1 kilowatt output. The generator may, of course, be useful for other work besides powering the electric hammer. In our experience the four-cycle generator engine requires less adjustment and is more dependable than the two cycle engines found on most breaker/driver/drills.?

If extreme portability is required, then a light weight machine like the Pico is a clear choice. It will perform most tasks but will take somewhat longer than the heavier gas powered machines like the Cobra. The lighter weight makes the Pico easier to use over extended periods and it is completely self-contained.

If the machine is to be used primarilly for driving rods or for drilling small diameter holes in bedrock and if only an occasional pit is required, then a heavier machine like the Cobra may be preferred.?

References

Veillette, J.J. and Nixon, F.M.

1980: Portable drilling equipment for shallow permafrost sampling; Geological Survey of Canada, Paper 79-21, 35 p.

Figure 1: Kango, Pico, and Cobra (from left to right) with spades attached. Note the generator used to power the Kango.?

Figure 2: Pitting in frozen ground with the Cobra.?

Figure 3: Pitting in frozen ground with the Kango.?

Figure 1:

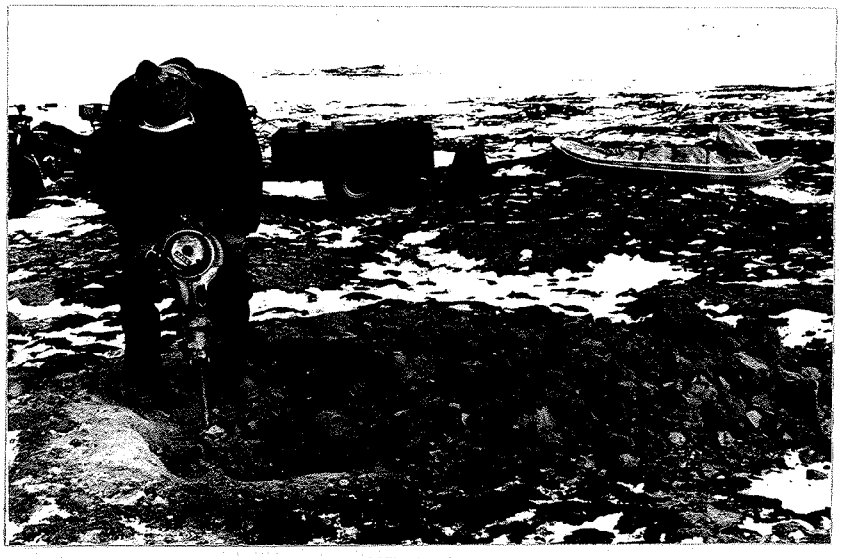

Figure 2:

Figure 3:

Table 1: Specifications of machines tested

Machine	Weight (kg))	Self Contained	Fuel	Relative Impact Index	Recommended Drilling Depth (rock)	Drilling Rate (granite) (cm/min.)
Cobra	25	YES	gas/oil	100	4 m	20
Pico	10	YES	gas/oil	~50	1 m	10
Kango	10 (+ 30 generator)	NO (electric)	gasoline	~50	NA	NA

Table 2: Performance in a stony marine sediment, Cambridge Bay, NWT
(Time, in seconds, required to drive the spade to a depth of 10 cm is given. The average value of three observations is used.)

Machines	Vertical Penetration rate		Horizontal Penetration rate	
	Frozen	Thawed	Frozen	Thawed
Cobra	4	2	4	2
Pico	17	3	11	2
Kango	9	2	5	2