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Résumé de l'article

On décrit ici le montage et le fonctionnement d'un carottier à percussion conçu pour recueillir des sédiments lacustres. On utilise deux câbles pour faire fonctionner le carottier manoeuvré à partir de la surface de la glace. Le câble principal sert à descendre et à remonter le tube de forage et le câble secondaire sert à manier le marteau que l'on dirige vers la sonde par le câble principal. Un système de poulies ancré dans la glace permet d'obtenir la force mécanique nécessaire à l'extraction de l'échantillon. Une personne seule peut transporter et manoeuvrer l'appareil. En principe, le carottier peut fonctionner quelle que soit la profondeur. L'appareil a d'ailleurs servi à recueillir durant l'hiver des carottes de 7,6 cm de diamètre et jusqu'à 257 cm de longueur.

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Note

AN INEXPENSIVE, LIGHTWEIGHT PERCUSSION CORE SAMPLING SYSTEM*

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ABSTRACT The assembly and operation of lightweight, percussion coring equipment designed for the recovery of lacustrine sediments are described. Two ropes are employed in the operation of the system which is conducted from the surface of the ice pack. The main line is used to raise and lower the core barrel assembly and a secondary line operates the driver. The driver is guided to the core barrel assembly by the main line. The mechanical advantage required for core removal is obtained from a simple pulley system anchored to the surface of the ice pack. The equipment can be transported and operated by one person in the field and is theoretically unrestricted by water depth. The equipment was successfully tested under winter conditions and recovered 7.6 cm diameter core samples up to 257 cm in length.

RÉSUMÉ *Au sujet d'un carottier à percussion léger et peu coûteux.* On décrit ici le montage et le fonctionnement d'un carottier à percussion conçu pour recueillir des sédiments lacustres. On utilise deux câbles pour faire fonctionner le carottier manœuvré à partir de la surface de la glace. Le câble principal sert à descendre et à remonter le tube de forage et le câble secondaire sert à manier le marteau que l'on dirige vers la sonde par le câble principal. Un système de poulies ancré dans la glace permet d'obtenir la force mécanique nécessaire à l'extraction de l'échantillon. Une personne seule peut transporter et manœuvrer l'appareil. En principe, le carottier peut fonctionner quelle que soit la profondeur. L'appareil a d'ailleurs servi à recueillir durant l'hiver des carottes de 7,6 cm de diamètre et jusqu'à 257 cm de longueur.

INTRODUCTION

Core sampling devices which are commonly employed for lacustrine settings are the Livingstone system (LIVINGSTONE, 1955) and its modifications (*e.g.* WRIGHT 1967; PATTERSON *et al.* 1978) or small, gravity impact coring devices (*e.g.*, PHLEGER, 1951). The Livingstone system is expensive, requires two or more people for transportation and operation in remote areas, and is restricted for use in water depths of less than approximately 30 m. Gravity impact coring devices (drop corers), although unrestricted by water depth are limited in terms of penetration and core recovery. This is particularly true in remote locations where the transportation of heavy weights for these systems may be difficult. Furthermore, there is no guarantee that gravity coring systems with long core barrels will remain vertical during "free fall" into bottom sediments. The generally complex, cumbersome and expensive nature of existing coring systems has prompted the development of simple lightweight coring systems that are practical in remote settings, such as the percussion system designed for summer operation from small boats by GILBERT and GLEW (1985) and the system described herein.

The percussion coring system described here is designed for winter operation, is simple and inexpensive, can be transported and operated by one person in the field, and is theoretically unrestricted by water depth. A prototype of the system was tested in March and April of 1985. A total of 30 core samples, 140 to 257 cm in length, were singlehandedly recovered from four subalpine and alpine lakes in Yoho National Park, British Columbia. The identification of accurately dated Bridge River and Mazama tephras in the recovered sediments (REASONER and HEALY, in press), and the recovery of up to 30 cm of "basal" diamicton, suggests that many of the core samples may represent the entire postglacial record. Although the system does not employ a piston, complete core recovery was ensured by the use of an effective core catcher. During testing, the system functioned without difficulties in shallow areas, as well as in water depths of over 40 m, which were the maximum encountered. Slight to moderate core disturbance in the form of downwarped beds along the core edges was observed in split core.

The major advantages of coring under winter conditions are (1) accurate core locations are easily obtained, (2) a boat is not required for a coring platform or for transportation, and (3) the stable platform provided by the ice pack can be utilized for core removal. Transportation of the coring system was carried out entirely on cross-country skis or snowshoes, however, a snowmobile was required to transport the estimated 320 kg of recovered core to the nearest road at the end of the field season.

DESCRIPTION AND ASSEMBLY

The coring system consists of three major components; the core barrel, the core head and the driver (Fig. 1). Core barrels are 3 m lengths of thin-walled 7.6 cm inside diameter PVC pipe. The core barrels are fitted with basket-type core catchers similar to those used in split-tube samplers. The

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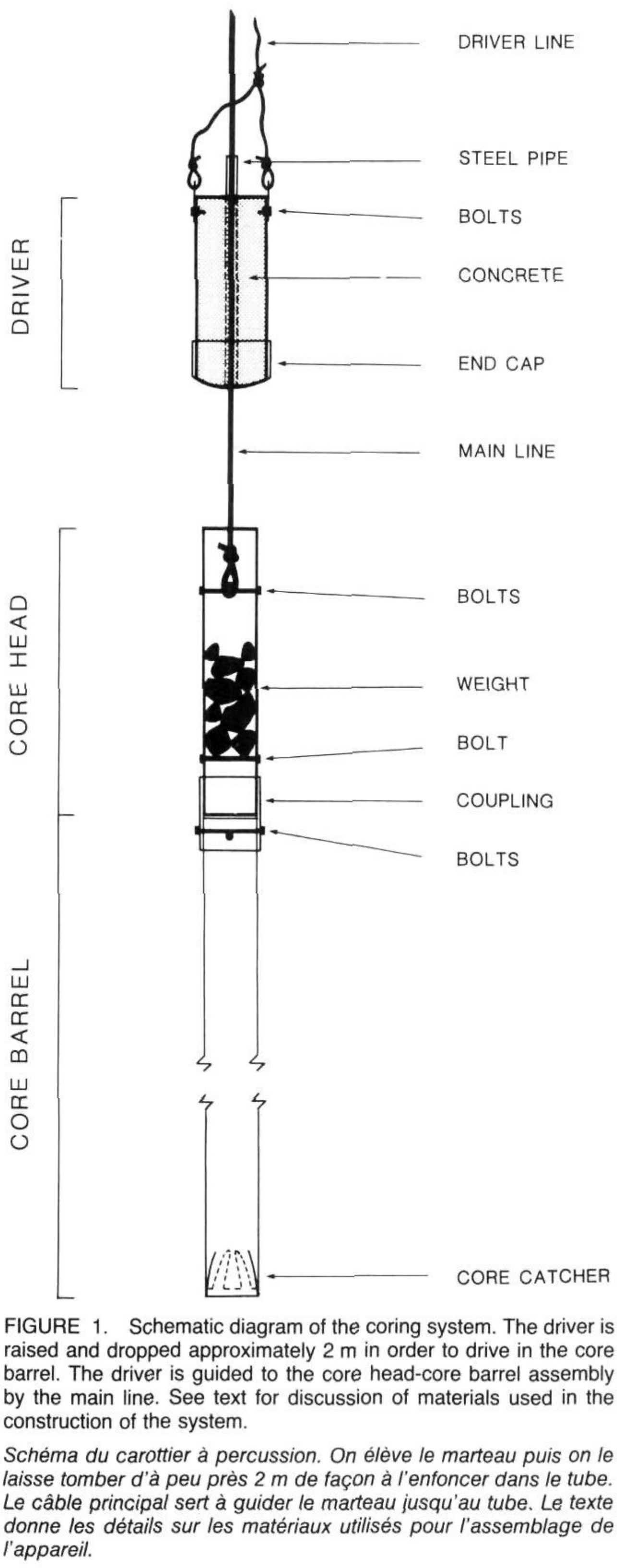

FIGURE 1. Schematic diagram of the coring system. The driver is raised and dropped approximately 2 m in order to drive in the core barrel. The driver is guided to the core head-core barrel assembly by the main line. See text for discussion of materials used in the construction of the system.

Schéma du carottier à percussion. On élève le marteau puis on le laisse tomber d'à peu près 2 m de façon à l'enfoncer dans le tube. Le câble principal sert à guider le marteau jusqu'au tube. Le texte donne les détails sur les matériaux utilisés pour l'assemblage de l'appareil.

core catcher described here consists of a ring of five fingers, each 10 cm long, cut from thin sheet metal. The rings are positioned inside the bottom ends of the core barrels with the finger pointing up and bent in slightly (Fig. 1). The lower 1.5 cm of the core catcher rings are cut into short segments and bent over the outside of the core barrels. The core catchers are held in place by 3.2 mm pop rivets which are flattened with vice grip pliers to reduce core disturbance. A similar, inexpensive core catcher for plastic vibracore tubes is described by REDDERING and PINTER (1985).

The core head is assembled from a 1 m length of ABS pipe (7.6 cm inside diameter) with a standard 7.6 cm coupling attached to the lower end with ABS glue (Fig. 1). This attachment is reinforced with small bolts. The thicker-walled ABS pipe is used for the core head in order to withstand the impact of the driver. Two 1.3 cm bolts inserted at 90° to each other, 12 cm below the top of the core head, provide a rope attachment that centres the main line. Weight may be added to the system as required by inserting cobbles in the core head. The core head and core barrels are joined with 6.4 mm bolts inserted in pre-drilled holes.

A 60 cm length of ABS pipe (10.2 cm inside diameter) fitted with a standard ABS end cap and filled with concrete is used as a driver (Fig. 1). A 2.5 cm diameter steel pipe is set in the centre of the driver, and rope attachments are placed prior to pouring the concrete. By adding scrap iron to the concrete, the weight of the driver may be increased.

To ensure recovery, a high-strength 11 mm diameter perlon climbing rope is used for the main line to lower and raise the core head-core barrel assembly. A 6.4 mm diameter nylon rope is used to raise and drop the driver.

OPERATION

After a hole is made in the ice pack, the core barrel, core head and driver are lowered through the water column and allowed to settle slowly into the surficial bottom sediments. The driver is then raised and dropped approximately 2 m in order to drive in the core barrel. Maintaining tension on the main line is critical during the initial stage of the driving process to keep the system vertical until the core barrel is firmly set into the bottom sediments. As the driver is guided to the core head by the main line, sufficient tension (1-2 kg) is required to keep the main line taut during driving. Downward progress of the core barrel into the sediments during the driving process can be accurately monitored on the surface by attaching paper clips to the main line. Several hundred blows may be required for 3 m penetration. Several carabiners (snap links) are useful for line attachments and minimize the tying and untying of knots under cold and wet conditions.

In the initial stages of system testing, the core head-core barrel assembly was allowed to fall rapidly from a height of approximately 10 m above the lake bottom. This method of starting the core barrel was found to be undesirable as, on several occasions, the core head-core barrel assembly came to rest horizontally on the bottom sediments. On these occasions, downward progress of the main line during driving was not observed and core samples were not recovered, which together could have been interpreted as an indication of hard bottom conditions. However, the appearance of conspicuous dents on the uppermost sidewall of the core head

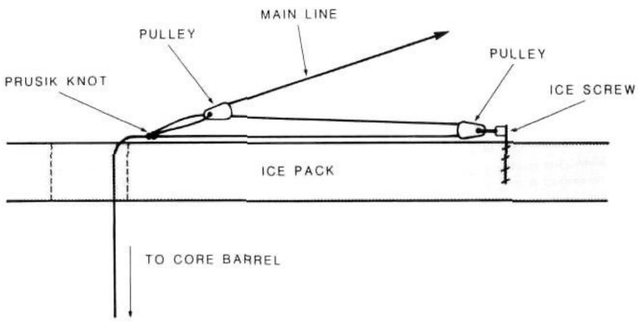

FIGURE 2. Side view of the core removal system. The mechanical advantage required for core removal is obtained from a simple pulley system set up on the surface of the ice pack. A tubular ice screw is used to anchor the pulley system to the ice pack.

Vue latérale du système de poulies. La force mécanique nécessaire à l'extraction de la carotte est obtenue grâce à un système de poulies fort simple ancré à la glace à l'aide d'une vis tubulaire.

clearly demonstrated that the core head-core barrel assembly had been in a horizontal attitude during the driving process. Core samples were subsequently recovered from these locations when the system was slowly lowered into the sediments.

Once the driving process is completed, the driver is raised and removed from the main line. A pulley system is then set up on the ice surface to provide the mechanical advantage required for core removal. A tubular ice screw (a common piece of climbing equipment) is inserted into the ice pack 10 to 15 m from the hole. The main line is then threaded through pulleys attached to the ice screw and to a prusik knot (FERBER, 1974) tied to the main line near the hole (Fig. 2). Utilizing the mechnical advantage of the pulley system, the core head-core barrel assembly is removed from the sediments by hauling on the main line. On several occasions, additional pulleys were required at the prusik knot and ice screw in order to increase the mechanical advantage for removal. Due to the forces involved, recovery on these occasions would have probably been difficult from a small boat. Once the core barrel is clear of the bottom sediments, the system can be raised through the water column by hand.

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