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WATER SAMPLING FROM UNPUMPED WELLS WITH STATIC WATER LEVELS DEEPER THAN 10 METRES

(NOTE)

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INTRODUCTION

One of the problems encountered in groundwater quality surveys is that of obtaining samples from wells not equipped with pumps and where the static water level is at a depth greater than that which permits sampling by simple suction techniques. This problem is particularly acute when special sampling and observation bores are drilled for investigation purposes alone.

In a recent investigation of groundwater quality in the aquifers of New Zealand's Canterbury Plains this sampling problem was encountered. Owing to the nature of the investigations, the following requirements had to be met by the sampling apparatus:

(a) Maximum diameter less than 65 mm.
(b) Hand or battery operated.
(c) Portable.
(d) Fully autoclavable (for sampling for bacteriological purposes).
(e) Free of metal (for sampling for trace amounts of metals).
(f) Capable of operating to depths of at least 30 m.
(g) Simple to operate and of low cost.

These criteria were satisfactorily met by the final pump design.

PUMP DESIGN

The pump design selected is a modification of a device described by Wood (1973) for use in collecting water samples from unsaturated soils at any depth.

The apparatus used is shown diagrammatically in Fig. 1. The major components are:

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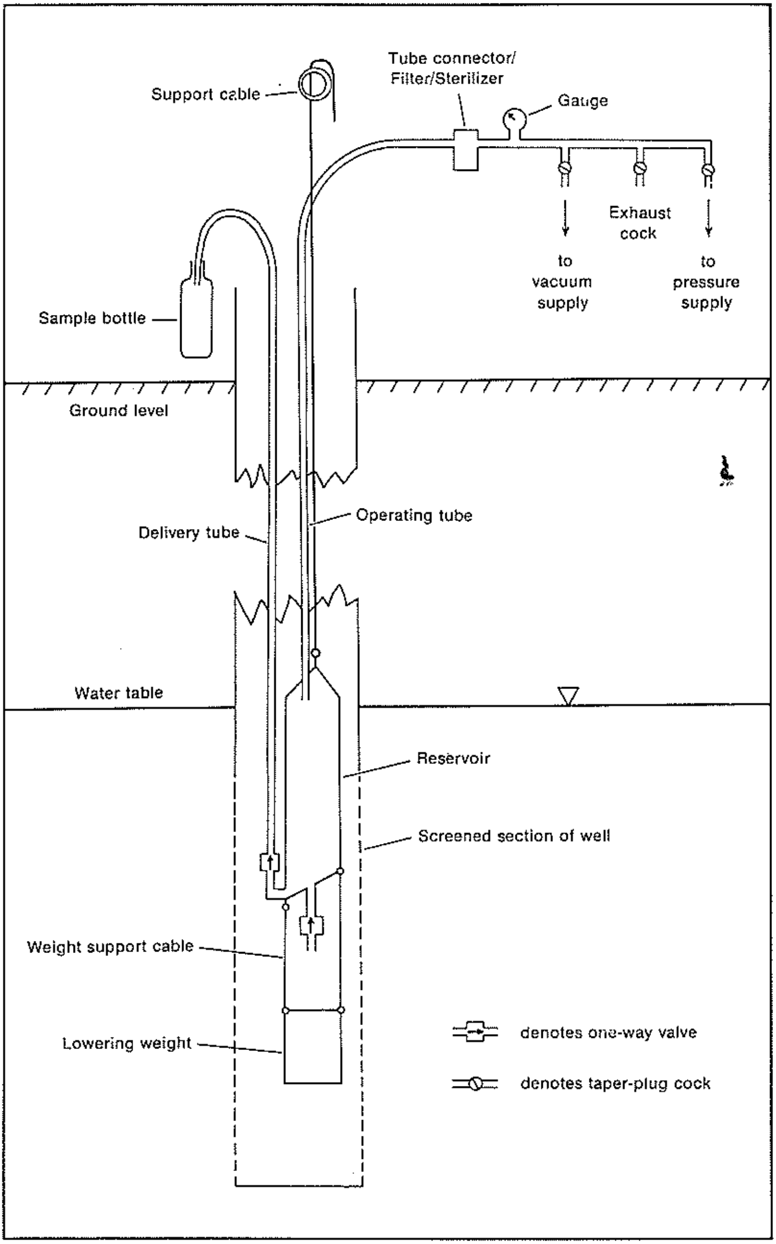

FIG. 1 — Sampling apparatus.

(a) Control gear, including combined vacuum/pressure gauge and control taps.
(b) Reservoir assembly, including support cable and delivery and operating tubes.
(c) Vacuum and pressure pumps (or supplies).

These three major components may be made to suit individual investigation requirements. For example, the reservoir could be made to any size from some satisfactory sheet metal or other material, according to needs.

The control gear consists of a combined vacuum/pressure gauge, three taper-plug cocks and three tube connectors. The gauge should operate over a gauge pressure range of -100 kPa to $+400$ kPa (more if pumping from depths greater than 40 metres). The three taper-plug cocks are positioned as shown in Fig. 1, but could be replaced by a four-port taper-plug cock of suitable port configuration if a satisfactory design of such were available. (A multiport cock has some operating advantage.) The tube connectors to the vacuum and pressure pumps may be of any convenient design, but the connector to the operating tube should be able to incorporate an air sterilizer or filter if required.

The reservoir assembly consists of the reservoir, the operating and delivery tubes, two one-way valves, the support cable and the weight. The reservoir may be constructed from any suitable material to whatever size is desired. The greater the volume of the reservoir the easier it is to pump large samples. However, the reservoir size is limited by the maximum diameter that can be passed down the bores to be sampled and by the weight of the unit which has to be supported by a cable. Two litres is a reasonably convenient size. The weight is to assist lowering of the reservoir assembly down the bore and should be of minimum size. The one-way valves are assembled as shown in Fig. 1. These valves should operate with a very small pressure differential in order to keep operating pressures low and to increase overall efficiency. The operating and delivery tubes are preferably thick-walled rubber tubing attached to the support cable.

For microbiological sampling, the entire reservoir assembly must be autoclavable. This generally means that all components should be metal, rubber, or a suitable plastic such as polypropylene. If care is taken during autoclaving, the reservoir body may be constructed from heavy-duty rigid pvc tubing and fittings.

The vacuum and pressure supplies may be of any suitable type. Hand-operated car tyre pumps are satisfactory for both pressure and vacuum. In the latter case, the leather washer must be reversed, and so must the one-way valve in the pump base – this is best achieved by removing the valve and installing a new one in the connecting tube.

OPERATING PROCEDURE

(1) The exhaust and pressure cocks are closed and the vacuum cock opened. A vacuum is applied to the system until the gauge shows that a steady vacuum of the desired gauge pressure is being held within the system. (This process fills the reservoir and some of the control tube with an aliquot of water.)

(2) The vacuum cock is then closed. The exhaust cock is opened and after 'venting' has ceased, it is closed again. The pressure cock is opened and pressure is gradually applied until the appropriate aliquot of water is delivered into the sample flask. (This process drives the water from the reservoir through the delivery tube to the sample flask. As noted below, care should be taken to avoid forcing air into the delivery tube.)

(3) As soon as the required aliquot is delivered into the sample flask, the pressure cock is closed and the exhaust cock opened.

Steps (1) through to (3) are repeated as many times as required to deliver the sample.

During operation, the following points should be noted:

(a) The vacuum used need only be great enough to fill the reservoir, although the greater the vacuum the more rapid the filling.

(b) The applied pressure to deliver the sample should be kept to a minimum to avoid undue stress on the tubing and connections. Approximately 100 kPa is required for each 10 metres of lift.

(c) On the first cycle of operation, the amount of water delivered to the sample flask should be the volume of the reservoir less the volume of the delivery tube. On subsequent cycles, the volume of the reservoir can safely be delivered. During each cycle, as soon as the aliquot has been delivered to the sample flask the pressure cock should be closed and the exhaust cock opened to prevent further delivery.

If the reservoir is not properly filled or if too great a sample is delivered to the flask, aeration of the sample may occur as air is forced up the delivery tube.

COMMENT

The pumping system outlined here is a simple and low-cost one that can be satisfactorily used in field locations remote from mains power. The design is sufficiently flexible to enable sterile sampling for bacterial analysis whilst retaining virtues of simple operation. For bacterial sampling, all down-hole equipment and all water-contacting surfaces are autoclaved, to prevent introduction of contaminants to the well.

It should be noted that the system is not a high-capacity one and cannot satisfactorily be used for pumping stagnant water from a well to enable fresh water entry into the well for sampling.

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REFERENCE

Wood, W. W. 1973: A technique using porous cups for water sampling at any depth in the unsaturated zone. *Water Resources Research* *9*(2) : 486–488.