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SUCTION LYSIMETER AND A GEOPHYSICAL ACCESS PORT

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DISCLAIMER

CONTRACTUAL ORIGIN OF THE INVENTION

The United States Government has rights in this invention pursuant to Contract No. DE-AC07-76ID01570 between the U. S. Department of Energy and EG&G Idaho, Inc.

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for monitoring fluids within soil, sediment and rock throughout the vadose zones and more particularly to such an apparatus which is operable as an access port for geophysical logging and collecting fluid samples in sediment, to permit analysis of such fluid samples for the presence of toxic, or otherwise undesirable substances, more accurately, conveniently and less intrusively than has heretofore been possible.

With the advent of public concern, as well as legislation, with respect to the control, use and disposal of waste and the preservation of ground waters from contamination, there is an increasing need for monitoring fluids in sediment. Although various methods have been employed in the past for monitoring such fluids, with the increasingly stringent regulations for protecting the sediment and ground waters from contamination, the inadequacy of such prior art methods has become evident.

These inadequacies result both from the difficulties inherent in the practice of the monitoring fluids in sediment as well as from the inability of the methods to accurately gauge both the quantity and content of fluids in vadose zones. As a consequence, prior art methods for geophysical logging and sampling are incapable of providing the information required to alleviate public concern and apply the regulations now in effect.

In order for such monitoring to accomplish the desired objectives, monitoring must take place in the unsaturated zone of sediment, known as the "vadose zone", within and below the biologically active root zone and above the ground water within the saturated zone of sediment. Prior art technology commonly calls for the use of three instruments which must be placed in the vadose zone for operation: a suction lysimeter, for taking liquid samples; a gas sampling port, for taking gas samples; and a geophysical access tube, for geophysical logging.

A suction lysimeter is a hydrologic sampling instrument used to sample liquid in sediment or like substrates. The lysimeter accomplishes this function by

application of vacuum principles causing the liquid to be drawn toward the lysimeter, as depicted in U.S. Patent No. 4,759,227 to Timmons, incorporated herein by reference. Removal of collected liquid from the lysimeter may be accomplished by any one of a number of methods.

A gas sampling port is a sampling instrument, similar to the lysimeter, used to collect samples of gas in sediment or like substrates. The gas sampling port accomplishes this function by the application of vacuum principles causing gas to be drawn into the sampling port. Removal of the gas sampling may be accomplished by any one of a number of methods.

The geophysical access tubing is a device used to allow access at a depth being monitored or measured, i.e., the vadose zone. The geophysical access port accomplishes this function by providing an artery through which geophysical testing devices may be lowered and measurements taken. Measurements may be taken by a number of methods, including neutron, spectral, gamma-gamma and other geophysical tools.

The installation and maintenance of such lysimeters, gas sampling ports and geophysical access ports, particularly where a substantial number are required, is extremely expensive and intrusive, and is therefore quite unsatisfactory.

Therefore, it is known that it would be desirable to have a dependable method and apparatus for collecting fluids in sediment and allowing geophysical logging, without requiring a vast number of installations, without requiring expensive procedures for achieving such installations and without requiring maintenance of the

installations once established. This invention is novel in that it describes a single apparatus that collects gas, liquid and other fluid samples and allows for geophysical logging, without the use of the three of or more monitoring devices heretofore required.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide a single improved apparatus for collecting fluid samples.

An additional object is to provide an improved apparatus to allow neutron, spectral, gamma-gamma and other geophysical logging.

Another object is to provide such an apparatus, which is dependable, to collect fluid samples in such a manner that the fluid samples so collected bear a direct and precise relationship to the actual fluids in the formation sampled.

Another object is to provide such an apparatus which permits such installation to be made at minimal expense and intrusion and requiring little or no maintenance over a long period of operation.

Another object is to provide such an apparatus which is particularly well suited to widely divergent usages without modification.

Additional objects, advantages and novel features of this invention will become apparent to those skilled in the art upon examination of the following and by practice of the invention.

One embodiment of the invention comprises a sampling apparatus implanted in sediment for monitoring vadose zones, geologic media or buried waste in said

sediment by collecting fluid samples and acting as an access port for geophysical logging. The sampling apparatus has a pipe-like, stainless steel, longitudinally extending, access tube with two ends, the first end extends above the surface of the sediment and has a removable air tight seal. The sampling apparatus further has a backing in fluid communication with the access tube and a fluid permeable plate contiguous with the backing, wherein the fluid permeable plate is made up of porous stainless steel. In addition, a lip extends above, and runs circumferentially around the fluid permeable plate. Finally, a reservoir is integrated into the second closed end of the access tube for containing the collected liquid. A vacuum pump with a vacuum gauge/transducer is connected to the removable air tight seal for applying a vacuum to the access tube, such that fluid samples may be drawn through the fluid permeable plate. Moreover, a fluid sample connector is also coupled to the removable air tight seal, in addition to the vacuum pump with a vacuum gauge/transducer, for withdrawing a fluid sample from the access tube. Finally, the subject invention has a bailer, or other suitable liquid sampler, wherein the bailer may be lowered down the access tube by means of the removable air tight seal and withdraw a sample of the liquid contained in the reservoir.

DESCRIPTION OF THE DRAWINGS

The present invention is illustrated in the accompanying drawing wherein:

FIG.1 is an elevation view of the sampling apparatus showing the access shell and porous plate attached thereto in cross section.

FIG. 2 is a plan view of sampling apparatus showing access tube and porous plate attached thereto.

DETAILED DESCRIPTION OF THE INVENTION

As used herein, "liquid" is defined as a fundamental phase of matter characterized by free movement of the constituent molecules among themselves, including, but not limited to, slurries, supercritical phases, etc. "Fluid" is defined as any flowable phase including, but not limited to gas, smoke, fog, mist and liquid as defined above. "Sediment" is defined solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site or origin by air, water, or ice, and has come to rest on the earth's surface, either above or below sea level.

FIG. 1 illustrates sampling/monitoring apparatus 10 with longitudinally extending access tube 12 having first end 20 extending above sediment surface 32 and second, closed end 22. Access tube 12 may be made from a number of non-permeable materials, including stainless steel, polyethylene, low carbon steel, thermoplastic, fiberglass-reinforced plastic, fluorocarbon resins and polyvinylchloride (PVC), depending on the sediment and type logging to be undertaken. Access tube 12 may be formed of any geometric shape, again depending on the sediment and type logging to be undertaken. Air tight seal 14 is connected to first end 20. Such seal may be accomplished by a number of methods, including a threaded cap with an o-ring seal, neoprene gasket, rubber stopper, rubber gasket, cork stopper or other suitable sealing method. First end 20 has vacuum gauge/transducer

16 and fluid sample connector 18 connected to air tight seal 14. Opposite first end 20, reservoir 24 is integrated into, and is part of, second, closed end 22.

A plurality of porous plates 30 are attached to, and are contiguous with, a plurality of backings 28, which, in turn are in fluid communication with access tube 12 by means of a plurality of conduits 26. Porous plates 30 may be made of a number of materials having a low air entry value (in a range of from about 0.2 to.75 bars), including ceramic, fritted glass, porous stainless steel, porous PVC or some combination thereof, while backings 28 is usually made of the same material as access tube 12. Porous plates 30 are attached to backings 28 by means of a plurality of connections 38, said connections 38 may be accomplished by a number of methods, including welding, a gasket, a compression fitting or epoxy, depending on the material chosen for plates 30 and backings 28. Lips 39 protrude above, and run circumferentially around, porous plates 30 assisting in the collection of fluid.

In the preferred embodiment, sampling apparatus 10 has one porous plate 30 attached to, and contiguous with, one backing 28, which in turn is in fluid communication with access shell 12. While sampling apparatus 10 may be constructed from a number of materials, as set forth above, in the preferred embodiment access tube 12 and backing 28 are constructed of stainless steel, while porous plate 30 is constructed of porous stainless steel. Moreover, access tube 12 is pipe-like in shape. Connection 28 is accomplished by a weld attaching porous plate 30 to backing 28, wherein stainless steel lip 39 protrudes above, and runs circumferentially around, porous plate 30 and attached thereto. Air tight seal 14 is

established by a cap with an o-ring seal inserted into first end 20 with vacuum gauge/transducer 16 and fluid sample connector 18 inserted through holes in the cap (air tight seal 14). Finally, in the preferred embodiment, the fluid communication between backing plate 28 and access tube 12 is accomplished by one stainless steel conduit 26 welded to backing 28 and access tube 12.

Sampling apparatus 10 is installed in sediment 34, with porous plate 30 situated below waste 36 (or, depending on the sampling to be undertaken, the disturbed or undisturbed sediment), which is to be monitored. Sampling apparatus 10 is installed such that first end 20, having vacuum gauge/transducer 16 and fluid sampling connector 18 in communication with it, extends above surface 32. Sampling tube 10 need not be installed vertically, but may be installed at an angle to sediment surface 32, depending on the type of sampling to be undertaken. In operation, a partial vacuum (exceeding the air entry value of porous plate 30) is applied to access tube 12 by means of vacuum pump 17 attached to vacuum gauge/transducer 16. This allows fluid to move through porous plate 30 and into access tube 12. Said fluid sample is withdrawn from access tube 12 by means of fluid sample connector 18. Liquid samples are withdrawn from sediment 34 when such sediment is wetted. Again, a partial pressure (less than the air entry value of porous plate 30) is applied to access tube 12 by means of vacuum pump 17 attached to vacuum gauge/transducer 16. This permits the liquid to move, by surface tension, from sediment 34 into porous plate 30 and backing 28. If locally saturated conditions forms at porous plate 30, i.e., perched water, liquid may move into porous

plate 30 by the force of gravity and vacuum pump 17 need not be used. As backing 28 is in communication with access tube 12, the liquid flows down, and is collected in reservoir 24. Air tight seal 14 is opened and said liquid sample is collected by means of a sampler (not shown), wherein said sampler may include a suction tube, a bailer or other suitable device, lowered down access tube 12. Finally, when sampling device 10 is to be used as a geophysical access port to monitor sediment 34, air tight seal 14 is opened and one of a number of geophysical tools (not shown), such as neutron, spectral, gamma-gamma monitoring devices, are lowered down access tube 12 and geophysical logging is conducted.

The foregoing description and drawings merely explains and illustrate the invention, and the invention is not limited thereto except insofar as those who have the disclosure before them are able to make modification and variations therein without departing from the scope of the invention.

ABSTRACT

A sampling apparatus for monitoring vadose zones, geologic media or buried waste in sediment and more particularly to such an apparatus which is operable as an access port for geophysical logging and collecting fluid samples to permit analysis of such fluid samples, having a pipe-like, stainless steel, longitudinally extending, access tube with two ends, where the first end extends above the surface of the sediment and has a removable air tight seal. The subject invention further has a backing in fluid communication with the access tube and a fluid permeable plate contiguous with the backing, wherein the fluid permeable plate is made up of porous stainless steel. A reservoir is integrated into the second closed end of the access tube for containing the collected fluid. A vacuum pump, having a vacuum gauge/transducer attached thereto, is connected to the removable air tight seal for applying a vacuum to the access tube, such that gas and fluid samples may be drawn through the fluid permeable plate. A fluid sample connector coupled to the removable air tight seal, in addition to the vacuum pump with vacuum gauge/transducer, for withdrawing a fluid sample from the access tube.

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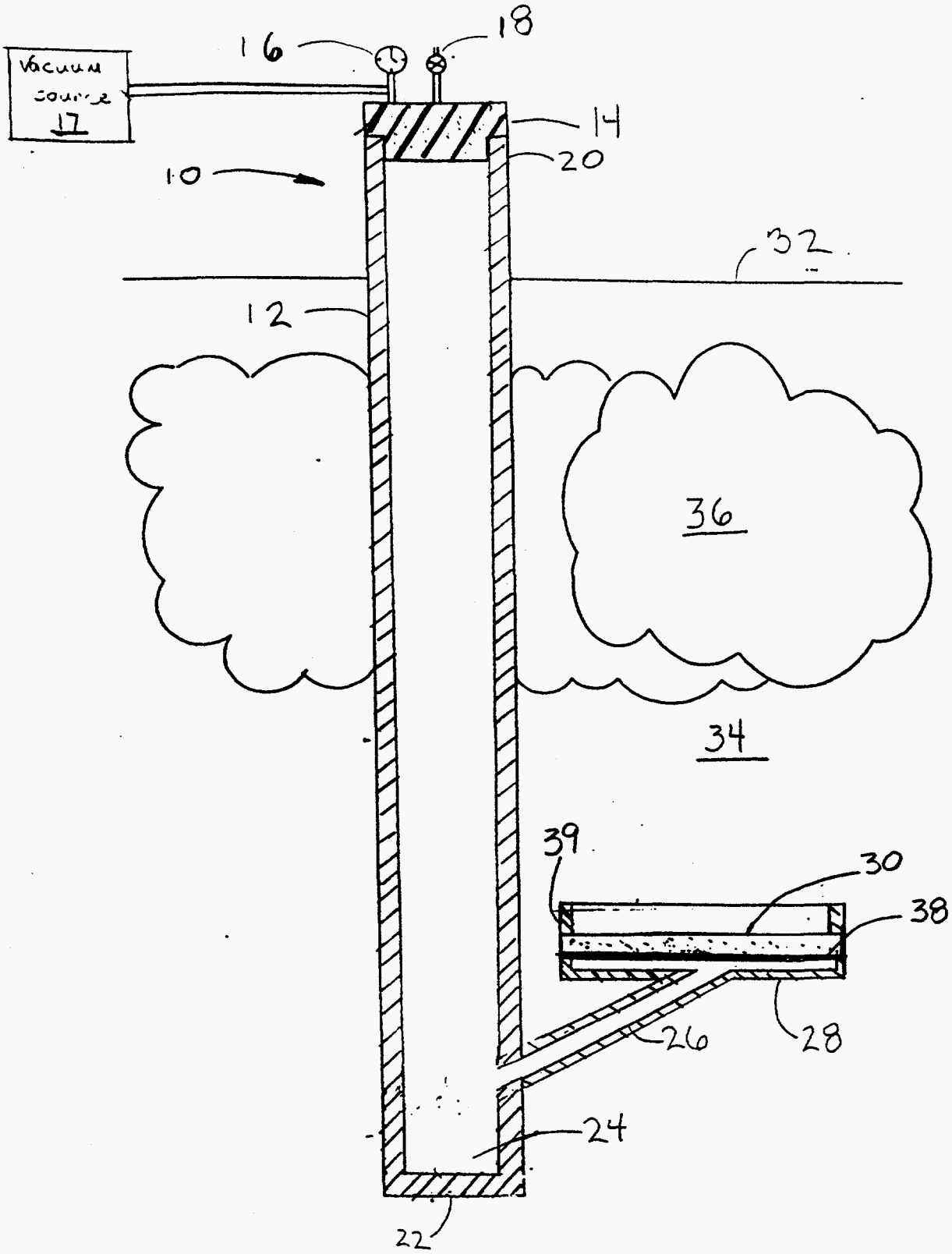

FIG. 1

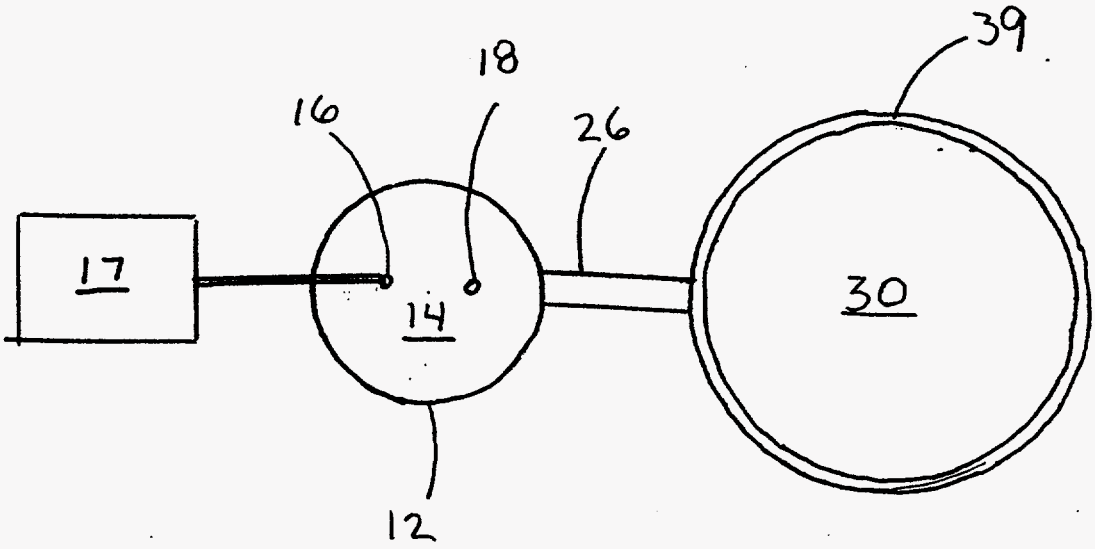

FIG 2