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METHOD FOR TAGGING SAND WITH A GASEOUS RADIOACTIVE ISOTOPE

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ABSTRACT OF THE DISCLOSURE

A process for tagging sand with a gaseous radioactive isotope is provided for the purpose of facilitating the tracing and monitoring of natural sand movement in coastal areas. The tagging of the sand is achieved by subjecting sand to an environment containing a gaseous radioisotope selected from ^{133}Xe, ^{82}Kr, ^{131}I, ^{125}I, and ^{37}Ar and the heating of the confined sand to effect sorption of the gaseous isotope into the sand.

The present invention relates generally to the marking of sand for oceanographic studies, and more particularly to the tagging of sand with a gaseous radioisotope without deleteriously altering the natural hydraulic properties of the sand whereby the movement of the sand may be readily monitored when subjected to natural hydraulic forces. This invention was made in the course of, or under, a contract with the United States Atomic Energy Commission.

An aspect of oceanography which is of considerable interest is in the study of sand movement along shore lines bounding oceans and other large bodies of water for the purpose of aiding in the planning of harbors and other coastal constructions and also for the protection and restoration of beaches. Sand is a somewhat hydraulic material and is moved along the shore line by the action of waves breaking against the shore. As the waves break, part of their dissipated energy moves in a direction parallel to the shore line to provide what is commonly referred to as the "littoral current." The sand movement due to the forces of this littoral current effect is referred to as "littoral drift."

The tracing and monitoring of the movement of sand subjected to the above-noted currents and other hydraulic action involves the technique of marking the sand in such a manner that the position of discrete sand grains may be detected at any time by using a suitable monitoring system. The tagging or marking of sand with detectable indicia or signal emitting mechanisms has been accomplished by practicing previously known techniques which offer some degree of satisfaction in the area of tracing sand movement. However, the techniques previously utilized for marking the sand have not been entirely satisfactory in that some shortcomings or drawbacks are present in the marked sand. For example, one of the techniques previously employed for tagging sand involved the application of a resinous or siliceous material containing fluorescent dyes of radioisotopes. The use of these materials provided the individual sand grains with a coating which deleteriously interfered with and altered the natural hydraulic properties of the sand so as to cause the treated sand to behave somewhat differently from the untreated sand. Another of the previously know techniques for tagging sand has been to irradiate batches of sand in a nuclear reactor to induce radioactivity into the impurities contained in the sand, e.g., ^{59}Fe by the neutron irradiation of ^{58}Fe. Sand tagged by this method is somewhat expensive to prepare and the induced activity is

severely limited by the quantity and type of impurities naturally present in the sand.

It is the aim of the present invention to obviate or substantially minimize the above and other shortcomings or drawbacks by providing a method whereby sand is tagged with a radioisotope in such a manner that the activity is retained by the sand grains and the natural hydraulic properties of the sand remain virtually unaltered. This unique tagging method is provided by heating sand indigenous to a test area to a temperature in the range of 860° to 1100° C. in an environment containing a gaseous radioisotope selected from the group of ^{133}Xe, ^{82}Kr, ^{131}I, ^{125}I, and ^{37}Ar. The gaseous radioisotope is sorbed into the sand particles and is retained in such a manner that the activity remains within the sand for a duration sufficient to trace sand movement in the littoral transport area.

An object of the present invention is to provide a new and improved method for tagging sand to facilitate the detection and the monitoring of the movement thereof when such sand is subjected to natural hydraulic forces such as those common to coastal areas.

Another object of the present invention is to provide a method for tagging sand with a gaseous radioisotope whereby the natural hydraulic properties of the sand remain virtually unaltered.

Other and further objects of the invention will be obvious upon an understanding of the illustrative features about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

As briefly pointed out above, the subject method is utilized for tagging sand with a gaseous radioisotope without deleteriously altering the natural hydraulic property of the sand. This feature is highly desirable for the purposes of monitoring the sand movement in that the treated sand must follow the natural hydraulic movement common to the untreated sand for providing accurate data relating to sand movement. Inasmuch as sand taken from one environment and placed in another behaves differently, the sand subjected to the tagging method of the present invention should be indigenous to the area where the sand movement is to be studied. Accordingly, selected batches of sand from the area to be investigated are subjected to radioisotope tagging and thereafter mingled with the untreated sand in the same area for the purpose of monitoring the natural movement of the admixed sand mass.

The tagging of the sand by practicing the present invention is accomplished by heating at batch of sand made up of a plurality of discrete sand grains or particulates in an environment containing a gaseous radioisotope selected from the group consisting of ^{133}Xe, ^{82}Kr, ^{131}I, ^{125}I, and ^{37}Ar. The sand is heated to a temperature in the range of 860° to 1100° C. for effecting the sorption of the radioisotope into the surface of the sand. After exposing the sand to this heated and radioactive gas containing environment for a preselected period of time, the sand grains are cooled with sufficient quantities of the gaseous radioisotope remaining in the sand grains for providing the radioactive tag.

While the mechanism by which the sorption of the gaseous radioisotope into sand takes place is not entirely clear, it is believed that within this temperature range of 860° to 1100° C. a crystalline change takes place in the individual sand grains to make possible the sorption and retention of the radioisotope. The temperature range is somewhate critical in that at a temperature below about 860° C. only temporary surface sorption is obtained which results in the radioactive tag disappearing

at a time somewhat earlier than that required for completing most sand movement studies. On the other hand, temperatures above about 1100° C. have a fusion effect upon the sand grains to somewhat alter the hydraulic properties of the sand and thereby instill an undesirable characteristic in the treated sand. In maintaining the particular temperature range set forth above, the hydraulic properties of the sand remain virtually the same as those of the untreated sand. This similarity between treated and untreated sand indigenous to the same area has been determined by standard settling tube tests which are believed to be accurate.

The stand to be tagged with a gaseous radioisotope is preferably subjected to a cleaning operation to remove the carbonate fragments normally present in beach areas since such fragments may cause outgassing during the heating step and thereby interfere with the sorption of the gaseous radioisotope. Satisfactory results can be achieved by using dilute HCl or any other suitable acid as a sand cleansing solution. Further, the heating step is preferably achieved in an evacuated environment to assure that the sorption is of the gaseous radioisotope rather than of some other material present in the heated environment. Also, the presence of additional gases in the environment may hamper the sorption of the gaseous radioisotope.

In order to provide a better understanding of the present invention, an example of a typical sand tagging operation is described below.

EXAMPLE

Batches of sand collected from a beach area where sand movement in the littoral transport area is to be studied was initially washed with HCl to remove the carbonate fragments and other contaminants. After washing, the sand was dried and then placed in a suitable chamber equipped with a vacuum pump for evacuating the interior of the chambers. The sand was then heated to about 500° C. at a pressure of about 100 microns of Hg. While at this temperature and pressure a quantity of ^{133}Xe equivalent to 4 millicuries of ^{133}Xe per cubic centimeter of said was admitted into the chamber. The chamber was then further heated to provide a sand temperature of 900 C. This temperature was maintained for one hour and then dropped to permit cooling of the sand. The ^{133}Xe remaining in the chamber, i.e., not sorbed by the sand, was then pumped from the chamber for subsequent use. The resulting radioactive sand contained the ^{133}Xe in such a manner that sea water leaching tests did not show any reduction in the retention qualities of the sand.

It will be seen that the present invention provides a unique mechanism for tagging sand whereby valuable knowledge concerning natural sand movement along the shore lines can be readily obtained. Sand tagged with as little as 15 millicuries of ^{133}Xe was readily traced over a large area and the direction and movement of the sand were easily and accurately monitored.

As changes or variations may be made in the sand tagging steps described herein without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In the art of marking sand for facilitating the detection and monitoring of the movement of discrete sand grains is subjected to hydraulic movement, a method for tagging sand with a gaseous radioisotope comprising the steps of subjecting at least one grain of sand to an atmosphere containing a gaseous radioisotope, and heating the grain of sand to a temperature sufficient to effect sorption and retention of the gaseous radioisotope by the grain of sand but below a temperature sufficient to effect the natural hydraulic properties of said grain of sand, wherein the temperature sufficient to effect sorption and retention of the gaseous radioisotope is in a range from about 860° C. to 1100° C.

2. The method for tagging sand with a gaseous radioisotope as claimed in claim **1**, wherein the gaseous radioisotope is selected from the group of gases consisting of ^{133}Xe, ^{82}Kr, ^{131}I, ^{125}I and ^{37}Ar.

3. The method for tagging sand with a gaseous radioisotope as claimed in claim **1**, including the additional step of subjecting said grain of sand to a solution capable of removing contaminants from the sand.

4. The method for tagging sand with a gaseous radioisotope as claimed in claim **1**, including the additional step of placing the sand in a space and thereafter evacuating the space to a pressure corresponding to about 100 millimeters of mercury, and initially heating the sand to a temperature of about 500 C. prior to the introduction of the gaseous radioisotope into the evacuated space.

References Cited

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