UNMANNED UNATTENDED MINERAL EXPLORATION DRILLING AND SAMPLE RETURN SYSTEM

ABSTRACT

The invention is a system and methods for conducting automated, unmanned and unattended drilling operations. The system comprises an unmanned and unattended landing and launch vehicle capable of navigating to a location and reversibly coupled to an automated drilling platform. The automated drilling platform can autonomously conduct drilling operations, such as, collecting core samples. Automated drilling operations may comprise deploying a core drilling rigid mast that autonomously feeds pipe sections onto the rigid mast proportional to depths drilled, then extracting the pipe sections containing core samples sequentially from the mast head, securing the core samples in the launch and landing vehicle, retracting the mast head from the bore line and securing it in the launch and landing vehicle. Once drilling is complete, the automated drilling platform may be decoupled from the landing and launch vehicle before re-launching the vehicle and returning the samples to an accessible terrain or location.
Table 1: General exploration sequence of activities

- Area selection and review of existing data
- Application for permit
  - Airborne survey
  - Geochemical survey
  - Geophysical survey on surface
  - Trenching
  - Drilling
  - Environmental impact study
  - Application for mining permit
  - Feasibility study
Fig. 2

START

VERTICAL LANDING FROM DESIRED ELEVATION TO GPS LOCATION INSERTION INTO INACCESSIBLE AND UNNAVIGABLE ENVIRONMENT

VERTICAL LANDING CORRECTION CAPABILITY CORRECT STRUCTURE'S ORIENTATION UP-RIGHT UPON LANDING

QC BOTTOM SURFACE FLAT & LEVEL TO TERRAIN DESIRED FOR DRILLING

YES

NO

TRANSFORMATION INTO A DRILLING PLATFORM FULLY AUTOMATED DRILLING PLATFORM DEPLOYS DRILL

DRILLING MAST & FEED ASSEMBLY SECTIONS ADDITION ON BOARD PIPE RACK SECTIONS ADDED SEQUENTIALLY AS BORING PROCEEDS

DRILLING MAST & FEED ASSEMBLY SECTIONS RECOVERY PIPE SECTIONS WITH CORE SAMPLES EXTRACTED SEQUENTIALLY, LAST-IN-FIRST-OUT

DRILLING PLATFORM TRANSFORMATION FOR VERTICAL LAUNCH QC TRANSFORMS AFTER CORE SAMPLE RECOVERY INTO VERTICAL LAUNCH STRUCTURE

VERTICAL LAUNCH & RECOVERY LAUNCH OF CORE SAMPLES TO PREDETERMINED ELEVATION/DESTINATION FOR RECOVERY

END
UNMANNED UNATTENDED MINERAL EXPLORATION DRILLING AND SAMPLE RETURN SYSTEM

FIELD OF THE INVENTION

[0001] The invention of the present disclosure relates generally to the field of mining and drilling operations and particularly for unmanned and unattended mineral exploration in inaccessible locations.

BACKGROUND

[0002] Prospecting is the endeavor of searching areas for mineral deposits with the intention of mining those mineral deposits for a profit. The term used for systematic examination of deposits is exploration. In order to ascertain whether mineral deposits are present, core samples may be taken along a given bore line. Core sampling refers to the process of bringing up samples of mineral deposits at core densities as they occur at specific depths along the bore line. The term “bore” refers to the internal diameter of the drill’s hollow cylindrical shaft. If there is any mineralization at given points along the bore line, core samples can yield definitive results regarding the properties of the mineralization at varied depths. The most expensive part of the exploration sequence is the drilling process. Two of the leading types of drilling are core drilling and percussion drilling.

[0003] Core drilling involves drilling into material using a hollow shaft, such that, as the shaft penetrates the material, a cross section of the material is collected within the shaft. Core drilling yields a solid cylindrical sample of the ground that can be correlated to an exact depth. The core sample is an intact sample of the underground geology. Through laboratory analysis of the core samples, the nature and extent of mineralization can be determined. Core drilling can define the size and boundaries of mineralization. The information gathered in the core sampling process is important and represents a substantial investment of time and money. To obtain fast geological information at less cost, methods known as reverse circulation may be used. Compared with core drilling equipment, which are readily disassembled, the rigs are truck mounted and restricted to accessible terrain and improved road conditions. Core drilling in areas inaccessible by road requires insertion and extraction of personnel and equipment by helicopter.

[0004] One way to identify areas which may prove to be rich sources of desired mineral deposits is to utilize hyperspectral remote sensing imagery, acquired from satellite mapping. This technology, along with geophysical surveys and air-borne surveys is available to prospectors and may give them important data regarding probable locations for drilling operations. This data can be collected without the need for on-site visits. A geologist can use this data to ascertain and identify certain locations where there is a strong potential for ore deposits. Unfortunately, many areas which show promise as mining locations, are located in very remote and inaccessible terrain. Mining these areas by conventional means may be cost prohibitive.

[0005] To quantify the mineralization and to define the shape, size and content of the deposit, the stepwise procedure depicted in FIG. 1 has long been believed to be required. Common core samples have diameters of 4.5 inches, however, naturally occurring ore densities (as they occur at specific depths along a bore line) are proportionally equivalent at specific depths at smaller diameters, such as 0.25 inches. A core sample of 0.25 inches, processed with laboratory analysis, may yield the same information as the standard 4.5 inch core samples.

[0006] Therefore, there is a need in the field for a solution that will allow access to, and sample extraction from these inaccessible areas in an economically reasonable manner.

SUMMARY

[0007] To address the needs in the field, a system and method is disclosed that allows for the unmanned and unattended conducting of drilling operations in remote and inaccessible terrain. The system comprises an unmanned and unattended landing and launch vehicle capable of navigating to a predetermined location and reversibly coupled to an automated drilling platform. The landing and launch vehicle should be capable of identifying a landing area with appropriate surface topology for conducting drilling operations, and landing on the appropriate landing area. The automated drilling platform has the capability of autonomously conducting drilling operations, such as, collecting at least one core sample. The automated drilling platform may further comprise a rigid mast further comprised of hollow pipe sections, a mast head coupled to the rigid mast, and a bit coupled to the mast head. Automated drilling operations may comprise deploying a core drilling rigid mast that autonomously feeds additional pipe sections onto the rigid mast proportional to depths drilled, then extracting the pipe sections containing core samples sequentially from the mast head, securing the core samples in the launch and landing vehicle, retraction the mast head from the bore line and securing it in the launch and landing vehicle. Once the drilling operations are complete, the automated drilling platform may be de-coupled from the landing and launch vehicle before re-launching the vehicle and returning the samples to an accessible terrain or location.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1: Shows the standard procedure typically followed during drilling operations.

[0009] FIG. 2: Shows a flow diagram of an embodiment of the method for conducting drilling operations.

[0010] FIG. 3: Shows an example of a rocket landing at a desired location using a parachute.

[0011] FIG. 4: Shows an example of the landing vehicle conducting operations on an uneven surface.

[0012] FIG. 5: Illustrates the operation of the rocket stabilizers.

[0013] FIG. 6: Illustrates the deployment of the drilling mechanism.

[0014] FIG. 7: Illustrates the collection and storage of core samples.

[0015] FIG. 8: Illustrates the collection and storage of core samples and the operation of the automated drilling platform.

[0016] FIG. 9: Shows a bottom view of the rocket illustrating an exemplary placement of rocket stabilizers and stabilizing fins.

[0017] FIG. 10: Illustrates an exemplary embodiment of the system.

[0018] FIG. 11: Illustrates the launch of the landing vehicle using a dirigible.

[0019] FIG. 12: Illustrates an exemplary embodiment of the rocket storing core samples.
FIG. 13: Illustrates the rocket being launched while storing core samples.

DETAILED DESCRIPTION

The following detailed description is of the best currently contemplated modes of practicing the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention since the scope of the invention is best defined by the appended claims.

The invention of the present disclosure is a system and collection of methods comprising automated systems that will land a drilling platform, extract core samples at various depths and return the core samples to an accessible location for further testing and processing. The purpose of the invention is to make it economically feasible for an individual prospector to acquire sample cores taken from designated GPS locations, at definitive depths, and make those core samples available for laboratory analysis. The analysis would be used to quantify the mineralization content of the samples and, define the shape, size and mineral content of the deposit, without the need for or expense of manned, on-site exploration and/or transportation.

Based on the data collected, a geologist would be able to recommend whether or not to continue exploration efforts and/or development of a given site. The objective would be to ascertain whether a given deposit is economically viable. Economic viability may be determined based on a quantification of the desired mineral (ore) concentration as compared to the surrounding material. The process is described as a quickly derived sample core or Quick Core ("QC"). and data from one or more QCs may be necessary to derive full knowledge about the mineralization of a deposit and label a mineral deposit as an ore body. Conceivably, based on careful study, environmental impact and confidence in profitability, the prospector, or owner can apply for permission to conduct mining operations in the area. All instruments required to proceed with planning on how to mine the deposit could be available without access to terrain or roads, nor having required insertions and extractions of personnel and equipment, until after determining that such deployments were deemed economical.

As such, the invention of the present disclosure will alter the standard procedure depicted in FIG. 1. The application for permit, airborne survey, and geophysical survey on surface, can be accomplished without an on-site visit from field geologists. The geophysical survey, trenching, and drilling steps currently require on-site visits from field geologists and additional mining personnel and equipment. The automated system of the present disclosure, may replace the current and costly processes of the geophysical survey, trenching and drilling steps. Later, after determination is made following laboratory analysis from the sample cores, an informed decision can be made whether to proceed with further efforts or abandon the site at no further cost.

In an embodiment, the invention is a system for conducting unmanned and unattended drilling operations. The system comprises a launch and landing vehicle (5) such as a rocket (95) capable of navigating to a terrestrial or extraterrestrial location and an automated drilling platform (10) capable of conducting drilling operations such as collecting at least one core sample (20). The system may drill using pipe sections 12 inches long, with a bore hole diameter as small as 0.25 inches. The automated drilling platform (10) may further comprise a rigid mast (30) which may be further comprised of interconnected, hollow, cylindrical pipe sections (31), a mast head (35) coupled to the mast and a bit (6-85) coupled to the mast head. The automated drilling platform may be reversibly coupled to the launch and landing vehicle such that it can decouple from the vehicle. The decoupling may be useful for reducing weight for a return flight. The launch vehicle may be a rocket (95) coupled to any stabilizer known to those skilled in the art, as in, for example retractable and deforming stabilizers or fins (55). The rocket may further comprise a top portion (75) and a bottom portion (80) and a circumferential aspect (100). The rocket may further comprise a storage means (105) for storing core samples collected by the automated drilling platform. The system may further comprise a dirigible (115) coupled to the rocket and capable of being deployed and lifting and carrying (120) the rocket, loaded with core samples, back to an accessible location.

In another embodiment the invention is a method for unmanned and unattended drilling in inaccessible locations. The method may be further directed to collecting core samples. The method may comprise the steps of deploying an unmanned and unattended launch vehicle capable of navigating to a predetermined location, allowing the launch vehicle to land at the predetermined location, and allowing the unmanned and unattended vehicle to conduct drilling operations. The drilling operations may further comprise collecting and storing core samples from a predetermined area. The invention may further comprise the step of allowing the unmanned and unattended vehicle to correct its orientation in order to land on a substantially flat surface that is suitable for conducting drilling operations. A surface that is suitable for conducting drilling operations is one that is substantially parallel to the base of the unmanned and unattended vehicle.

In the method as described, the step of conducting automated drilling operations may further comprise, deploying the automated drilling platform (10) in such a manner so that the automated drilling platform is capable of deploying a drilling mast head (35), further comprising a bit (85), at a desired angle (165) relative to the surface suitable for conducting drilling operations. The automated drilling process may further comprise sequentially and automatically adding and connecting pipe sections to the rigid mast thereby extending its length to allow deeper drilling. The automated drilling process may further comprise automatically and sequentially retracting the pipe sections, now containing core samples, and coupling them to the landing and launch vehicle. In order to transport the core samples to a location appropriate for subsequent testing and analysis, the automated process may further comprise the step of launching (185) the unmanned and unattended vehicle from the predetermined location and returning to an accessible location. The launch and travel to an accessible location may be accomplished by deploying a lighter-than-air vehicle such as a dirigible (115) or balloon, capable of lifting the landing and launch vehicle loaded with core samples. Once lifted, the lighter-than-air vehicle will transport the landing and launch vehicle to an accessible location. In order to maximize efficiency, it may be desirable to jetison extra weight before transport to the accessible location. This can be accomplished by decoupling the automated drilling platform from the rocket or other selected landing and launch vehicle.

A system for implementing the process described above is shown in FIG. 4. FIG. 4 shows a rocket coupled to common stabilizers (50) such as airfoils sufficient to keep a
flying vehicle aligned with the direction of flight. Coupled to both the rocket and the airfoils are retractable weight stabilizers (55), that can adjust the rocket’s orientation and aid in maintaining the rocket’s upright position and keep it normal to a planar surface. For uneven surfaces (60), one or more of the retractable stabilizers may require some deformation (45) in order to allow drilling to proceed and facilitate launch. In addition to the weight stabilizers, rocket engines (65) may also be present in order to facilitate accurate and level landing.

[0029] FIG. 3 illustrates an embodiment of the system and automated process. A rocket (95), coupled to common stabilizers and retractable weight stabilizers is shown attached to a top parachute (70). For uneven or non-upright landings, retractable weight stabilizers (55) can adjust the rocket’s orientation in order to aid in maintaining the rocket’s upright position and keep it normal to a planar surface prior to drilling.

[0030] FIG. 10 illustrates an embodiment of the system and process described above. The pictured bottom portion (80) of the rocket may follow any of the processes described herein. The automated drilling platform (10) may be coupled to the bottom portion of the rocket. Common stabilizers (50) may be coupled to both the drilling platform and the rocket. Coupled to, and deployed from the automated drilling platform, is the mast head (35). In order to maintain a parallel aspect relative to the ground, reorientation of the rocket, the bottom portion of the rocket, or the rocket’s bottom surface may be desirable. Following any reorientation of the drilling platform to maintain a parallel aspect relative to the ground, the mast head can be deployed (141). Coupled to the mast head is a bit (85), which may further comprise a diamond drill bit. A diamond impregnated cutting bit produces a solid cylinder of rock.

[0031] FIGS. 7, 8 and 9 illustrate examples of mast head assemblies. Embodiments and placements are shown that would feed sections of pipe sequentially to the mast head (35), connect them together to the depth drilled, then retract them. When retracted the pipe sections (90) will contain core samples (20). The pipes containing the core samples may then be placed around an inner circumference (106), as in, for example around the rocket’s bottom or middle portion. As the last section of the pipe is disconnected from the mast head, the end that is connected to the drill bit is retracted within the base of the rocket and secured for launch.

[0032] FIG. 11 illustrates an embodiment of the system and process. Once the core samples are collected the launch vehicle will return the collected samples to an accessible location for further processing. For example, following retraction of the pipe sections and storage of all of the core samples around the circumference of the bottom or top or middle portion of the rocket, the rocket further comprising retractable and deforming stabilizers is launched (185) and returned to an accessible location. In order to conserve fuel, and increase efficiency by reducing launch weight, the components of the automated drilling platform may be decoupled or separated from the rocket prior to launch. The launch and return may be accomplished by any appropriate methods known to those skilled in the art. The inventor specifically contemplates the use of a lighter-than-air craft, such as a dirigible (115) to lift and carry the landing and launch vehicle containing the core samples back to an accessible location. For example, a rocket (95), coupled to retractable and deforming stabilizers, common stabilizers, a mast head, an automated drilling platform, drill bit, and mast head assembly are launched by deploying a dirigible (115) or helium filled balloon. Once launched the payload is carried to an accessible location for retrieval.

[0033] With respect to the above, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangement of the components listed or the steps set forth in the description or illustrated in the drawings. The various apparatus and methods of the disclosed invention are capable of other embodiments, and of being practiced and carried out in various ways that would be readily known to those skilled in the art, given the present disclosure. Further, the terms and phrases used herein are for descriptive purposes and should not be construed as in any way limiting.

[0034] As such, those skilled in the art will appreciate that the conception upon which this disclosure is based by be utilized as a basis for designing other inventions with similar properties. It is important therefore that the embodiments, objects, and claims herein, be regarded as including such equivalent construction and methodology insofar as they do not depart from the spirit and scope of the present invention.

[0035] It should be noted that the components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention. Moreover, in the figures, like reference numerals designate corresponding parts throughout the different views. However, like parts do not always have like reference numerals. Moreover, all illustrations are intended to convey concepts, where relative sizes, shapes and other detailed attributes may be illustrated schematically rather than literally or precisely.

1-6. (canceled)

7. A system for conducting unmanned and unattended drilling operations comprising:

An unmanned and unattended launch and landing vehicle capable of navigating to a predetermined location; and

An automated drilling platform capable of conducting automated drilling operations, the automated drilling platform detachably coupled to the launch and landing vehicle.

8. The system of claim 1 where the drilling operations further comprise collecting core samples.

9. The system of claim 1 where the automated drilling platform further comprises a rigid mast, a mast head coupled to the rigid mast, and a bit coupled to the mast head.

10. The system of claim 3 where the rigid mast is further comprised of pipe sections capable of collecting core samples during drilling.

11. The system of claim 1 where the landing and launch vehicle is a rocket further comprising a circumferential aspect.

12. The system of claim 1 where the landing and launch vehicle further comprises storage capable of holding collected core samples.

13. The system of claim 5 wherein the storage is a rack around the circumferential aspect of the rocket.

14. The system of claim 1 where system further comprises a dirigible coupled to the launch and landing vehicle, the dirigible capable of lifting the launch and landing vehicle, while the vehicle is loaded with core samples and carrying the vehicle to an accessible location.

15. A method of drilling comprising the steps of deploying an unmanned and unattended launch vehicle capable of navigating to a predetermined location, allowing the launch
vehicle to land at the predetermined location, and allowing the unmanned and unattended vehicle to conduct drilling operations.

16. The method of claim 9 further comprising the step of allowing the unmanned and unattended vehicle to correct its orientation to land on a substantially flat surface substantially parallel to the base of the unmanned and unattended vehicle.

17. The method of claim 10 wherein the step of conducting drilling operations further comprises the steps of, deploying an automated drilling platform which is in turn capable of deploying a drilling mast head further comprising a bit, at a desired angle relative to the flat surface.

18. The method of claim 9 wherein the step of conducting drilling operations further comprises the step of sequentially and automatically adding and connecting pipe sections to a rigid mast thereby extending the length of the rigid mast to allow deeper drilling.

19. The method of claim 12 wherein the step of conducting drilling operations further comprises the step of automatically and sequentially retracting the pipe sections, now containing core samples, and coupling them to the landing and launch vehicle.

20. The method of claim 12 further comprising the step of launching the unmanned and unattended landing and launch vehicle from the predetermined location and transporting it to an accessible location.

21. The method of claim 14 further comprising the step of decoupling the automated drilling platform from the unmanned and unattended vehicle in order to reduce launch weight and improve fuel economy.

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