



(51) International Patent Classification:

E21B 44/00 (2006.01)

(21) International Application Number:

PCT/CN2016/084802

(22) International Filing Date:

03 June 2016 (03.06.2016)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

(54) Title: DETECTING EVENTS IN WELL REPORTS

Time Breakdown					
Time (HH:Min)		Measured Depth (ft)		Operations	Comments
Start	End	Start	End		
00:00	13:00	3356	4102	Drilling - Drill-Rotating	DRILLING 8 1/2" SECTION WITH PDC DIRECTIONAL STRING FROM 2205ft TO 4102ft. WITH 510 GPM, 3000 PSI, ROTATING 95 RPM + MUD MOTOR, DIF: 300 PSI
13:00	16:00	4102	4205	Drilling - Drill-Rotating	DRILLING 8 1/2" SECTION WITH PDC DIRECTIONAL STRING FROM 2205ft TO 4102ft. WITH 500 GPM, 2900 PSI, ROTATING 95 RPM + MUD MOTOR, DIF: 300 PSI

FIG. 2

(57) Abstract: Methods, computing systems, and computer-readable media for automatically classifying comments in a well report. As an example, the method includes receiving one or more well reports comprising comments, identifying one or more templates used in composing the comments of the well reports, verifying that the templates are accurate, mapping data from the templates into an engineering data model, and identify offset data of interest for a new well based on the templates.

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

DETECTING EVENTS IN WELL REPORTS

Background

[0001] When constructing a well, many reports are written. Some of these reports are written at the end of well construction, while some are “on demand” and others intermittently, e.g., daily. As well as containing numeric data in a pre-defined template, these reports may also contain a large amount of free text. Among other things, this free text may contain a description of any abnormal events that occur during the drilling process.

Summary

[0002] Embodiments of the disclosure may provide a method of automatically classifying comments in a well report. The method includes receiving one or more well reports comprising comments, identifying one or more templates used in composing the comments of the well reports, verifying that the templates are accurate, mapping data from the templates into an engineering data model, and identifying offset data of interest for a new well based on the templates.

[0003] In some embodiments, the well report comprises an Operations Report from drilling an oil or gas well.

[0004] In some embodiments, the method further includes first taking a large number of reports, and analyzing the comments these reports to detect patterns.

[0005] In some embodiments, the method further includes classifying the templates according to a classification, wherein the classification includes one or more data fields containing numeric data, the method further comprising extracting the numeric data from the report.

[0006] In some embodiments, the numeric data is used when planning drilling operations in other oil or gas wells.

[0007] In some embodiments, the one or more data fields are identified by a technical expert.

[0008] Embodiments of the present disclosure may also include a method of identifying undesired events that occurred when drilling an oil or gas well. The method includes receiving one or more well reports, and searching for comments in the well reports that do not match a particular template.

[0009] In some embodiments, the undesired events include kicks.

[0010] In some embodiments, text in the comments of the well reports that does not match a particular template is analyzed, and words that frequently occur in the same comments are grouped.

[0011] In some embodiments, the method further includes identifying groups of words that correspond to particular event types.

[0012] Embodiments of the present disclosure may also provide a method of assessing risk of drilling an oil or gas well. The method includes identifying a number of similar previously-drilled wells, processing the reports from the previously-drilled wells, and identifying events that occurred in the previously drilled wells as having a risk of occurring in the well.

[0013] It will be appreciated that this summary is intended merely to introduce some aspects of the present methods, systems, and media, which are more fully described and/or claimed below. Accordingly, this summary is not intended to be limiting.

Brief Description of the Drawings

[0014] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present teachings and together with the description, serve to explain the principles of the present teachings. In the figures:

[0015] Figure 1 illustrates an example of a system that includes various management components to manage various aspects of a geologic environment, according to an embodiment.

[0016] Figure 2 illustrates an example of a well report, according to an embodiment.

[0017] Figure 3 illustrates a schematic view of a computing system, according to an embodiment.

Detailed Description

[0018] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings and figures. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be apparent to one of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, circuits, and networks have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

[0019] It will also be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first object or step could be termed a second object or step, and, similarly, a second object or step could be termed a first object or step, without departing from the scope of the present disclosure. The first object or step, and the second object or step, are both, objects or steps, respectively, but they are not to be considered the same object or step.

[0020] The terminology used in the description herein is for the purpose of describing particular embodiments and is not intended to be limiting. As used in this description and the appended claims, the singular forms “a,” “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term “and/or” as used herein refers to and encompasses any possible combinations of one or more of the associated listed items. It will be further understood that the terms “includes,” “including,” “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. Further, as used herein, the term “if” may be construed to mean “when” or “upon” or “in response to determining” or “in response to detecting,” depending on the context.

[0021] Attention is now directed to processing procedures, methods, techniques, and workflows that are in accordance with some embodiments. Some operations in the processing procedures, methods, techniques, and workflows disclosed herein may be combined and/or the order of some operations may be changed.

[0022] Figure 1 illustrates an example of a system 100 that includes various management components 110 to manage various aspects of a geologic environment 150 (e.g., an environment that includes a sedimentary basin, a reservoir 151, one or more faults 153-1, one or more geobodies 153-2, etc.). For example, the management components 110 may allow for direct or indirect management of sensing, drilling, injecting, extracting, etc., with respect to the geologic environment 150. In turn, further information about the geologic environment 150 may become available as feedback 160 (e.g., optionally as input to one or more of the management components 110).

[0023] In the example of Figure 1, the management components 110 include a seismic data component 112, an additional information component 114 (e.g., well/logging data), a processing component 116, a simulation component 120, an attribute component 130, an analysis/visualization component 142 and a workflow component 144. In operation, seismic data and other information provided per the components 112 and 114 may be input to the simulation component 120.

[0024] In an example embodiment, the simulation component 120 may rely on entities 122. Entities 122 may include earth entities or geological objects such as wells, surfaces, bodies, reservoirs, etc. In the system 100, the entities 122 can include virtual representations of actual physical entities that are reconstructed for purposes of simulation. The entities 122 may include entities based on data acquired via sensing, observation, etc. (e.g., the seismic data 112 and other information 114). An entity may be characterized by one or more properties (e.g., a geometrical pillar grid entity of an earth model may be characterized by a porosity property). Such properties may represent one or more measurements (e.g., acquired data), calculations, etc.

[0025] In an example embodiment, the simulation component 120 may operate in conjunction with a software framework such as an object-based framework. In such a framework, entities may include entities based on pre-defined classes to facilitate modeling and simulation. A commercially available example of an object-based framework is the MICROSOFT® .NET® framework (Redmond, Washington), which provides a set of extensible object classes. In the .NET® framework, an object class encapsulates a module of reusable code and associated data structures. Object classes can be used to instantiate object instances for use in by a program, script, etc. For example, borehole classes may define objects for representing boreholes based on well data.

[0026] In the example of Figure 1, the simulation component 120 may process information to conform to one or more attributes specified by the attribute component 130, which may include a library of attributes. Such processing may occur prior to input to the simulation component 120 (e.g., consider the processing component 116). As an example, the simulation component 120 may perform operations on input information based on one or more attributes specified by the attribute component 130. In an example embodiment, the simulation component 120 may construct one or more models of the geologic environment 150, which may be relied on to simulate behavior of the geologic environment 150 (e.g., responsive to one or more acts, whether

natural or artificial). In the example of Figure 1, the analysis/visualization component 142 may allow for interaction with a model or model-based results (e.g., simulation results, etc.). As an example, output from the simulation component 120 may be input to one or more other workflows, as indicated by a workflow component 144.

5 [0027] As an example, the simulation component 120 may include one or more features of a simulator such as the ECLIPSE™ reservoir simulator (Schlumberger Limited, Houston Texas), the INTERSECT™ reservoir simulator (Schlumberger Limited, Houston Texas), etc. As an example, a simulation component, a simulator, etc. may include features to implement one or more meshless techniques (e.g., to solve one or more equations, etc.). As an example, a reservoir
10 or reservoirs may be simulated with respect to one or more enhanced recovery techniques (e.g., consider a thermal process such as SAGD, etc.).

[0028] In an example embodiment, the management components 110 may include features of a commercially available framework such as the PETREL® seismic to simulation software framework (Schlumberger Limited, Houston, Texas). The PETREL® framework provides
15 components that allow for optimization of exploration and development operations. The PETREL® framework includes seismic to simulation software components that can output information for use in increasing reservoir performance, for example, by improving asset team productivity. Through use of such a framework, various professionals (e.g., geophysicists, geologists, and reservoir engineers) can develop collaborative workflows and integrate
20 operations to streamline processes. Such a framework may be considered an application and may be considered a data-driven application (e.g., where data is input for purposes of modeling, simulating, etc.).

[0029] In an example embodiment, various aspects of the management components 110 may include add-ons or plug-ins that operate according to specifications of a framework environment.
25 For example, a commercially available framework environment marketed as the OCEAN® framework environment (Schlumberger Limited, Houston, Texas) allows for integration of add-ons (or plug-ins) into a PETREL® framework workflow. The OCEAN® framework environment leverages .NET® tools (Microsoft Corporation, Redmond, Washington) and offers stable, user-friendly interfaces for efficient development. In an example embodiment, various components
30 may be implemented as add-ons (or plug-ins) that conform to and operate according to

specifications of a framework environment (e.g., according to application programming interface (API) specifications, etc.).

[0030] Figure 1 also shows an example of a framework 170 that includes a model simulation layer 180 along with a framework services layer 190, a framework core layer 195 and a modules layer 175. The framework 170 may include the commercially available OCEAN[®] framework where the model simulation layer 180 is the commercially available PETREL[®] model-centric software package that hosts OCEAN[®] framework applications. In an example embodiment, the PETREL[®] software may be considered a data-driven application. The PETREL[®] software can include a framework for model building and visualization.

[0031] As an example, a framework may include features for implementing one or more mesh generation techniques. For example, a framework may include an input component for receipt of information from interpretation of seismic data, one or more attributes based at least in part on seismic data, log data, image data, etc. Such a framework may include a mesh generation component that processes input information, optionally in conjunction with other information, to generate a mesh.

[0032] In the example of Figure 1, the model simulation layer 180 may provide domain objects 182, act as a data source 184, provide for rendering 186 and provide for various user interfaces 188. Rendering 186 may provide a graphical environment in which applications can display their data while the user interfaces 188 may provide a common look and feel for application user interface components.

[0033] As an example, the domain objects 182 can include entity objects, property objects and optionally other objects. Entity objects may be used to geometrically represent wells, surfaces, bodies, reservoirs, etc., while property objects may be used to provide property values as well as data versions and display parameters. For example, an entity object may represent a well where a property object provides log information as well as version information and display information (e.g., to display the well as part of a model).

[0034] In the example of Figure 1, data may be stored in one or more data sources (or data stores, generally physical data storage devices), which may be at the same or different physical sites and accessible via one or more networks. The model simulation layer 180 may be configured to model projects. As such, a particular project may be stored where stored project information may include inputs, models, results and cases. Thus, upon completion of a modeling

session, a user may store a project. At a later time, the project can be accessed and restored using the model simulation layer 180, which can recreate instances of the relevant domain objects.

[0035] In the example of Figure 1, the geologic environment 150 may include layers (e.g., stratification) that include a reservoir 151 and one or more other features such as the fault 153-1, the geobody 153-2, etc. As an example, the geologic environment 150 may be outfitted with any of a variety of sensors, detectors, actuators, etc. For example, equipment 152 may include communication circuitry to receive and to transmit information with respect to one or more networks 155. Such information may include information associated with downhole equipment 154, which may be equipment to acquire information, to assist with resource recovery, etc. Other equipment 156 may be located remote from a well site and include sensing, detecting, emitting or other circuitry. Such equipment may include storage and communication circuitry to store and to communicate data, instructions, etc. As an example, one or more satellites may be provided for purposes of communications, data acquisition, etc. For example, Figure 1 shows a satellite in communication with the network 155 that may be configured for communications, noting that the satellite may additionally or instead include circuitry for imagery (e.g., spatial, spectral, temporal, radiometric, etc.).

[0036] Figure 1 also shows the geologic environment 150 as optionally including equipment 157 and 158 associated with a well that includes a substantially horizontal portion that may intersect with one or more fractures 159. For example, consider a well in a shale formation that may include natural fractures, artificial fractures (e.g., hydraulic fractures) or a combination of natural and artificial fractures. As an example, a well may be drilled for a reservoir that is laterally extensive. In such an example, lateral variations in properties, stresses, etc. may exist where an assessment of such variations may assist with planning, operations, etc. to develop a laterally extensive reservoir (e.g., via fracturing, injecting, extracting, etc.). As an example, the equipment 157 and/or 158 may include components, a system, systems, etc. for fracturing, seismic sensing, analysis of seismic data, assessment of one or more fractures, etc.

[0037] As mentioned, the system 100 may be used to perform one or more workflows. A workflow may be a process that includes a number of worksteps. A workstep may operate on data, for example, to create new data, to update existing data, etc. As an example, a may operate on one or more inputs and create one or more results, for example, based on one or more

algorithms. As an example, a system may include a workflow editor for creation, editing, executing, etc. of a workflow. In such an example, the workflow editor may provide for selection of one or more pre-defined worksteps, one or more customized worksteps, etc. As an example, a workflow may be a workflow implementable in the PETREL[®] software, for example, that operates on seismic data, seismic attribute(s), etc. As an example, a workflow may be a process implementable in the OCEAN[®] framework. As an example, a workflow may include one or more worksteps that access a module such as a plug-in (e.g., external executable code, etc.).

[0038] In general, the present disclosure may provide systems, methods, and computer-readable media that automatically identify and extract abnormal events or other information from the well reports mentioned above. These events may then form part of the risk evaluation for future well construction activities.

[0039] Identify / use standard structures in offset well data

[0040] As seen in the example shown in Figure 2, even though the comments are entered as free text, there is a repetitive format to this example. In an embodiment, the method of the present disclosure may scan through a database of offset well reports, and identify common “templates” used in the composition of the comments. An expert may then verify that these templates are accurate, and map certain data from the templates into the engineering data model.

[0041] When planning future wells, the software may then use these editing templates to scan through the database, and identify offset data of interest for the new well.

[0042] Identify events in offset well data

[0043] “Unusual” data are those that do not fit in to one of the well templates as described above. Embodiments of the disclosed method may scan through the “unusual” data, and identify “topics” – groups of words that frequently occur together. An expert (e.g., a user having a suitable background) may examine each topic, and flag it depending on whether it represents an undesirable event, and which event type it represents.

[0044] When planning future wells, a number of similar offset wells may be identified (either manually, or automatically). The reports from these similar wells may be scanned, and the events automatically identified, along with the measured depth and parameters describing the well operations when the event occurred. The events in the offset well may be projected to the current well, according to one of a number of projection techniques (e.g. at constant TVD,

following formation boundaries, etc.). The events may then be consolidated into risks for the current well, and taken into account during the well planning process.

[0045] In some embodiments, the methods of the present disclosure may be executed by a computing system. Figure 3 illustrates an example of such a computing system 200, in accordance with some embodiments. The computing system 200 may include a computer or computer system 201A, which may be an individual computer system 201A or an arrangement of distributed computer systems. The computer system 201A includes one or more analysis modules 202 that are configured to perform various tasks according to some embodiments, such as one or more methods disclosed herein. To perform these various tasks, the analysis module 602 executes independently, or in coordination with, one or more processors 204, which is (or are) connected to one or more storage media 206. The processor(s) 204 is (or are) also connected to a network interface 207 to allow the computer system 201A to communicate over a data network 209 with one or more additional computer systems and/or computing systems, such as 201B, 201C, and/or 201D (note that computer systems 201B, 201C and/or 201D may or may not share the same architecture as computer system 201A, and may be located in different physical locations, e.g., computer systems 201A and 201B may be located in a processing facility, while in communication with one or more computer systems such as 201C and/or 201D that are located in one or more data centers, and/or located in varying countries on different continents).

[0046] A processor may include a microprocessor, microcontroller, processor module or subsystem, programmable integrated circuit, programmable gate array, or another control or computing device.

[0047] The storage media 206 may be implemented as one or more computer-readable or machine-readable storage media. Note that while in the example embodiment of Figure 2 storage media 206 is depicted as within computer system 201A, in some embodiments, storage media 206 may be distributed within and/or across multiple internal and/or external enclosures of computing system 201A and/or additional computing systems. Storage media 206 may include one or more different forms of memory including semiconductor memory devices such as dynamic or static random access memories (DRAMs or SRAMs), erasable and programmable read-only memories (EPROMs), electrically erasable and programmable read-only memories (EEPROMs) and flash memories, magnetic disks such as fixed, floppy and removable disks,

other magnetic media including tape, optical media such as compact disks (CDs) or digital video disks (DVDs), BLURAY[®] disks, or other types of optical storage, or other types of storage devices. Note that the instructions discussed above may be provided on one computer-readable or machine-readable storage medium, or may be provided on multiple computer-readable or machine-readable storage media distributed in a large system having possibly plural nodes. Such computer-readable or machine-readable storage medium or media is (are) considered to be part of an article (or article of manufacture). An article or article of manufacture may refer to any manufactured single component or multiple components. The storage medium or media may be located either in the machine running the machine-readable instructions, or located at a remote site from which machine-readable instructions may be downloaded over a network for execution.

[0048] In some embodiments, computing system 200 contains one or more report evaluation module(s) 208. In the example of computing system 200, the computer system 201A includes the report evaluation module 208. In some embodiments, a single report evaluation module may be used to perform some aspects of one or more embodiments of the methods disclosed herein.

In other embodiments, a plurality of report evaluation 208 modules may be used to perform some aspects of methods herein.

[0049] It should be appreciated that computing system 200 is merely one example of a computing system, and that computing system 200 may have more or fewer components than shown, may combine additional components not depicted in the example embodiment of Figure 3, and/or computing system 200 may have a different configuration or arrangement of the components depicted in Figure 3. The various components shown in Figure 3 may be implemented in hardware, software, or a combination of both hardware and software, including one or more signal processing and/or application specific integrated circuits.

[0050] Further, the steps in the processing methods described herein may be implemented by running one or more functional modules in information processing apparatus such as general purpose processors or application specific chips, such as ASICs, FPGAs, PLDs, or other appropriate devices. These modules, combinations of these modules, and/or their combination with general hardware are included within the scope of the present disclosure.

[0051] Geologic interpretations, models, and/or other interpretation aids may be refined in an iterative fashion; this concept is applicable to the methods discussed herein. This may include use of feedback loops executed on an algorithmic basis, such as at a computing device (e.g.,

computing system 200, Figure 3), and/or through manual control by a user who may make determinations regarding whether a given step, action, template, model, or set of curves has become sufficiently accurate for the evaluation of the subsurface three-dimensional geologic formation under consideration.

5 [0052] The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or limiting to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. Moreover, the order in which the elements of the methods described herein are illustrate and described may be re-arranged, and/or two or more
10 elements may occur simultaneously. The embodiments were chosen and described in order to best explain the principals of the disclosure and its practical applications, to thereby enable others skilled in the art to best utilize the disclosed embodiments and various embodiments with various modifications as are suited to the particular use contemplated.

CLAIMS

What is claimed is:

1. A method of automatically classifying comments in a well report, comprising:
5 receiving one or more well reports comprising comments;
identifying one or more templates used in composing the comments of the well reports;
verifying that the templates are accurate;
mapping data from the templates into an engineering data model; and
identify offset data of interest for a new well based on the templates.
10
2. The method of claim 1, wherein the well report comprises an Operations Report from drilling an oil or gas well.
3. The method of claim 2, further comprising of first taking a large number of reports, and
15 analyzing the comments these reports to detect patterns.
4. The method of claim 3, further comprising classifying the templates according to a classification, wherein the classification includes one or more data fields containing numeric data, the method further comprising extracting the numeric data from the report.
20
5. The method of claim 4, wherein the numeric data is used when planning drilling operations in other oil or gas wells.
6. The method of claim 4, wherein the one or more data fields are identified by a technical
25 expert.
7. A method of identifying undesired events that occurred when drilling an oil or gas well, comprising:
receiving one or more well reports; and
30 searching for comments in the well reports that do not match a particular template.

8. The method of claim 7, wherein the undesired events include kicks.

9. The method of claim 7, wherein text in the comments of the well reports that does not match a particular template is analyzed, and words that frequently occur in the same comments
5 are grouped.

10. The method of claim 9, further comprising identifying groups of words that correspond to particular event types.

10 11. A method of assessing risk of drilling an oil or gas well, comprising:
identifying a number of similar previously-drilled wells;
processing the reports from the previously-drilled wells; and
identifying events that occurred in the previously drilled wells as having a risk of
occurring in the well.

15 12. A computing system, comprising:
one or more processors; and
a memory system comprising one or more non-transitory computer-readable media
storing instructions that, when executed by at least one of the one or more processors, cause the
20 computing system to perform operations, the operations comprising any of the methods of claims
1-11.

25 13. A non-transitory computer-readable medium storing instructions that, when executed by
one or more processors of a computing system, cause the computing system to perform
operations, the operations comprising any of the methods of claims 1-11.

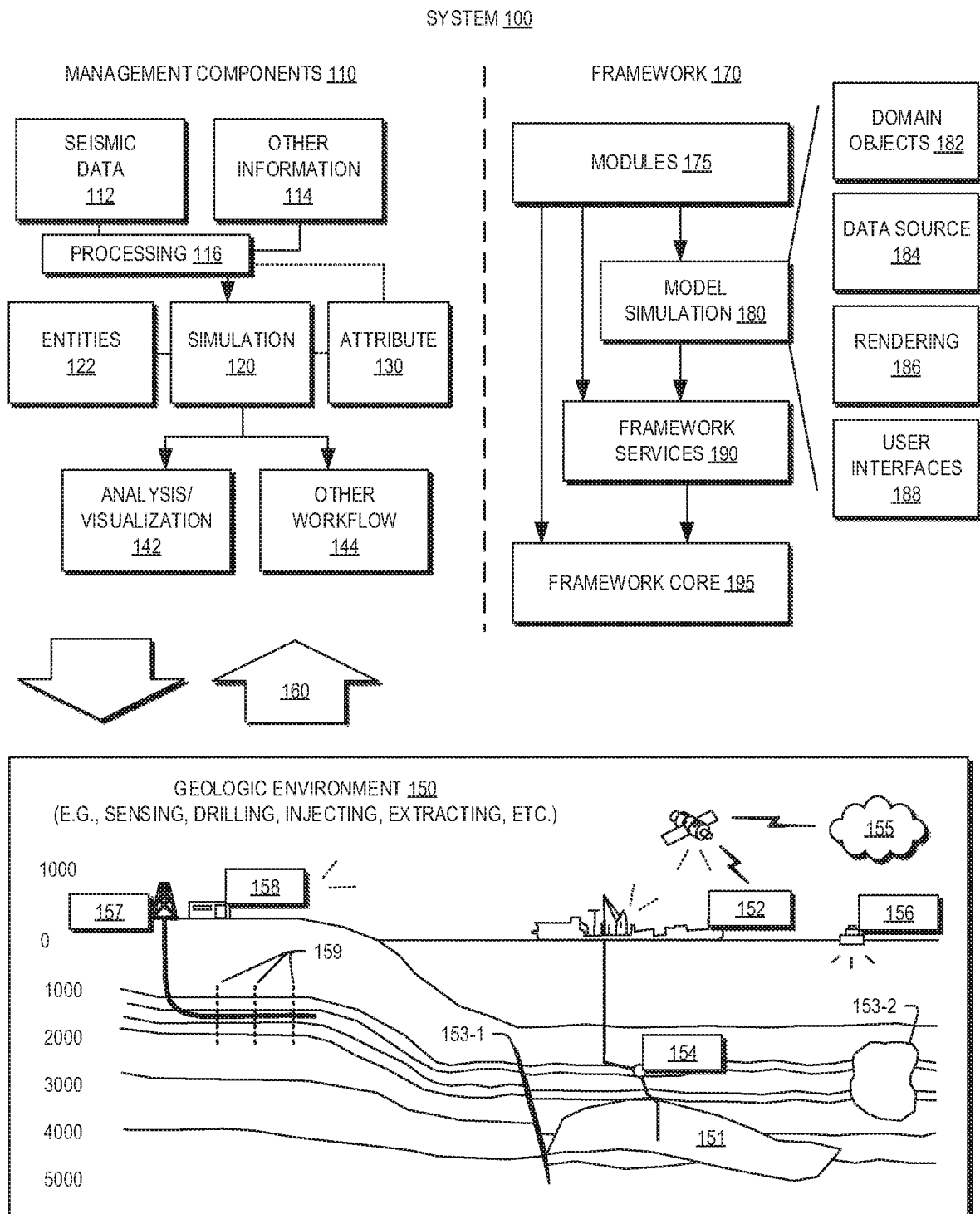
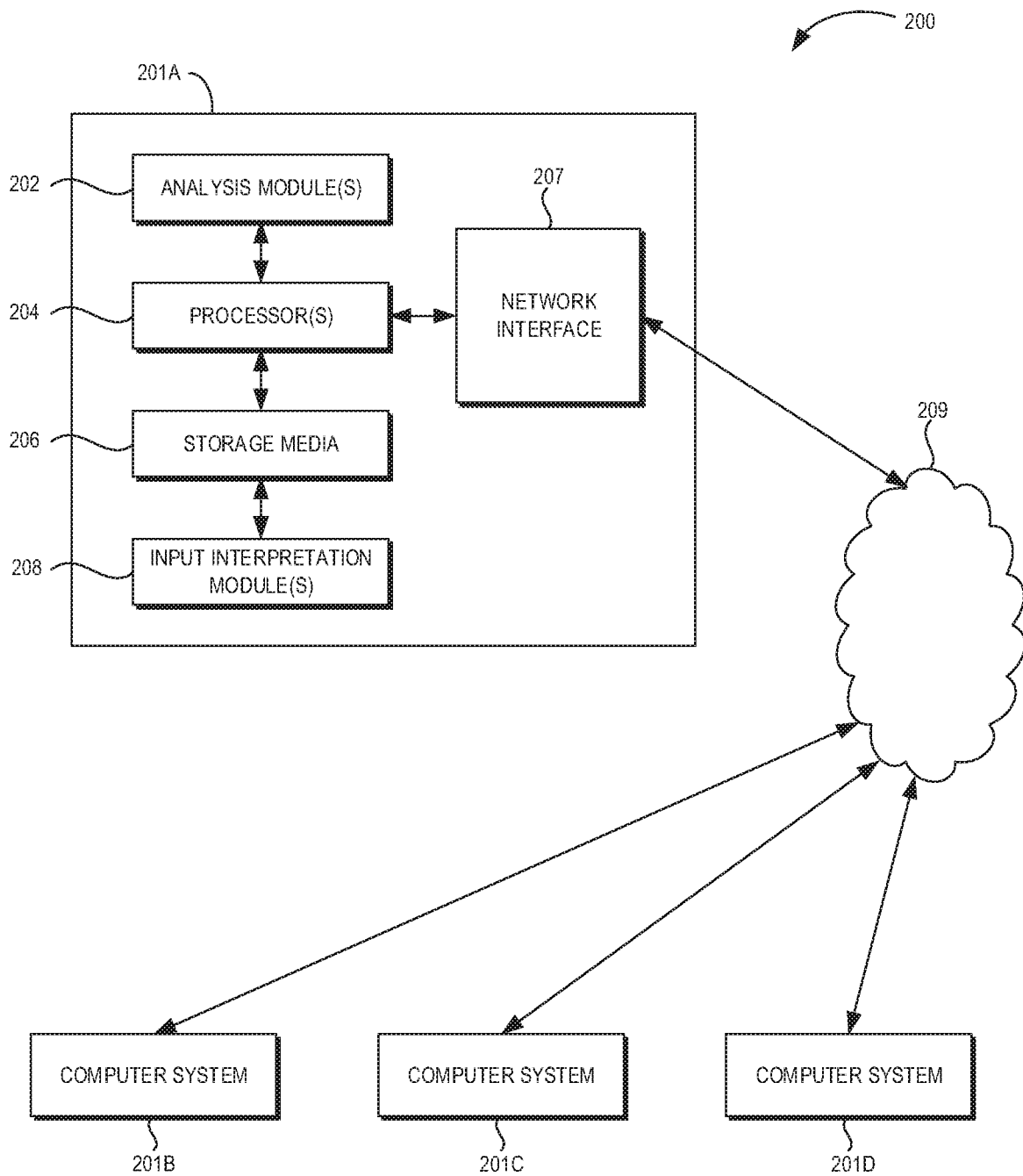


FIG. 1

Time Breakdown					
Time (HH:Min)		Measured Depth (ft)		Operations	Comments
Start	End	Start	End		
00:00	13:00	3356	4102	Drilling - Drill-Rotating	DRILLING 8 1/2" SECTION WITH PDC DIRECTIONAL STRING FROM 2205ft TO 4102ft. WITH 510 GPM, 3000 PSI, ROTATING 95 RPM + MUD MOTOR, DIF: 300 PSI
13:00	16:00	4102	4205	Drilling - Drill-Rotating	DRILLING 8 1/2" SECTION WITH PDC DIRECTIONAL STRING FROM 2205ft TO 4102ft. WITH 500 GPM, 2900 PSI, ROTATING 95 RPM + MUD MOTOR, DIF: 300 PSI

FIG. 2

**FIG. 3**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/084802

A. CLASSIFICATION OF SUBJECT MATTER

E21B 44/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC: well, oil, gas, coal, mine, report, comment, template, model, offset, event, risk, identify, classify, expert, analy?e, group, words

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 104806226 A (BEIJING SILITONG CONTROL TECHNOLOGY CO., LTD.) 29 July 2015 (2015-07-29) description, paragraphs[0139]-[0146]	11-13
Y	CN 104806226 A (BEIJING SILITONG CONTROL TECHNOLOGY CO., LTD.) 29 July 2015 (2015-07-29) description, paragraphs[0139]-[0146]	1-10, 12-13
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14 February 2017

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