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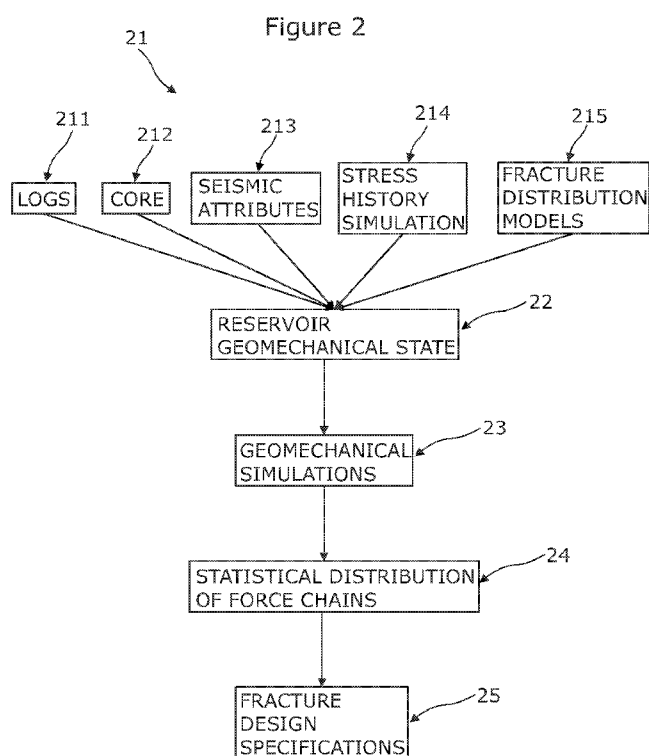
(71) Applicants: **IKON SCIENCE INNOVATION LIMITED** [GB/GB]; Causeway House, The Causeway, Teddington, Middlesex, TW11 0JR (GB). **GEOSPHERE LIMITED OF NETHERTON FARM** [GB/GB]; Sheepwash, Beaworthy, Devon EX21 5PL (GB).(72) Inventor: **HARPER, Timothy Richard**; c/o Ikon Science Limited, Causeway House, The Causeway, Teddington Middlesex TW11 0JR (GB).(74) Agents: **LAWRENCE, Richard** et al.; Keltie LLP, No.1 London Bridge, London, London Greater London SE1 9BA (GB).

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[Continued on next page]

(54) Title: METHOD FOR RESERVOIR ANALYSIS AND FRACTURE DESIGN IN A ROCK LAYER



(57) Abstract: A method of hydraulic fracturing of a hydrocarbon reservoir in a rock layer uses a method of providing a reservoir description. Firstly, a reservoir description is provided for the hydrocarbon reservoir. This reservoir description comprises a distribution of stresses within a rock layer affecting propagation of a hydraulic fracture. This reservoir description can be used to calculate a fracture plan for hydraulic fracture of the hydrocarbon reservoir according to the distribution of stresses in the reservoir description to provide one or more predetermined fracture properties. Hydraulic fracturing of the hydrocarbon reservoir can then follow according to the fracture plan. A method of determining minimum horizontal stress in a rock region is also provided.

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- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2016/051739

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B43/26
ADD.

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/183451 A1 (WENG XIAOWEI [US] ET AL) 31 July 2008 (2008-07-31) paragraph [0019] - paragraph [0026] -----	1-17
X	WO 2012/054139 A2 (EXXONMOBIL UPSTREAM RES CO [US]; EL-RABAA ABDEL WADOOD M [US]; MOORE L) 26 April 2012 (2012-04-26) paragraph [0256]; claim 1 -----	1-17
X	WO 2014/032003 A1 (SCHLUMBERGER CA LTD [CA]; SCHLUMBERGER SERVICES PETROL [FR]; SCHLUMBER) 27 February 2014 (2014-02-27) paragraph [0067] - paragraph [0069] -----	1-17
X	US 2009/125280 A1 (SOLIMAN MOHAMED Y [US] ET AL) 14 May 2009 (2009-05-14) paragraph [0031] - paragraph [0040] ----- -/-	1-17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 October 2016

Date of mailing of the international search report

14/12/2016

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Ott, Stéphane

INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/272407 A1 (LEHMAN LYLE V [US] ET AL) 29 November 2007 (2007-11-29) paragraph [0035] - paragraph [0047] -----	1-17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2016/051739

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-17

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-17

A method of hydraulic fracturing of a hydrocarbon reservoir in a rock layer, the method comprising: providing a reservoir description for the hydrocarbon reservoir, comprising a distribution of stresses within a rock layer affecting propagation of a hydraulic fracture; calculating a fracture plan according to the distribution of stresses; hydraulic fracturing of the hydrocarbon reservoir according to the fracture plan.

2. claim: 18

A method of providing a reservoir description for a hydrocarbon reservoir in a rock layer, the reservoir description comprising a distribution of stresses comprising a distribution of a plurality of stress chains comprising channels of high stress within a rock layer affecting propagation of a hydraulic fracture, comprising determining a geomechanical state for the hydrocarbon reservoir and performing geomechanical simulations to determine a probabilistic distribution of the plurality of stress chains.

3. claims: 19-21

A method of determining minimum horizontal stress in a rock region with depth, comprising: interpreting from in situ measurements an original set of stress values at a plurality of points in the rock region; determining a distribution of stresses in the rock region with depth; and determining a modified set of stress values by applying the determined distribution of stresses in the rock region with depth to the original set of stress values; and calibrating the stress values in the modified set of stress values to determine a minimum horizontal stress in the rock region with depth.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2016/051739

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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