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(71) Applicant (*for all designated States except US*): **STATOIL PETROLEUM AS** [NO/NO]; N-4035 Stavanger (NO).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): **DRÆGE, Anders** [NO/NO]; c/o Statoil Petroleum AS, Stavanger, N-4035 (NO). **DUFFAUT, Kenneth** [NO/NO]; Dyre Halses gt. 14, NO-7042 Trondheim (NO).

(74) Agent: **MITCHELL, Matthew**; Marks & Clerk LLP, Fletcher House , Heatley Road, The Oxford Science Park, Oxford OX4 4GE (GB).

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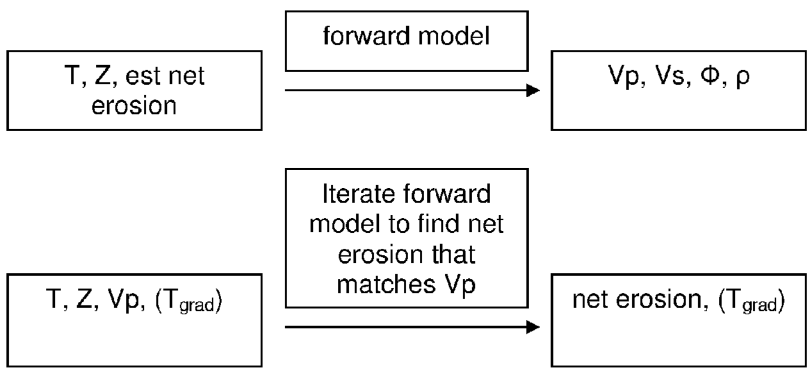

Figure 2

(57) Abstract: A method and apparatus for estimating a rock physics model parameter for a geological formation. The method includes selecting an initial estimate for the parameter, estimating formation porosity using a second parameter, a formation burial depth and the initial estimate for the parameter, estimating formation P-wave velocity using the estimated formation porosity, formation burial depth, the second parameter and estimated parameter in a rock physics model, and comparing the estimated formation P-wave velocity is compared with a measured P-wave velocity. The estimated parameter is amended and the previous steps repeated to obtain an estimated parameter that gives an estimated P-wave velocity that most closely matches the measured P-wave velocity.

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ESTIMATING A ROCK PHYSICS MODEL PARAMETER FOR A GEOLOGICAL FORMATION

TECHNICAL FIELD

The invention relates to the field of estimating a rock physics model parameter for a geological formation.

BACKGROUND

In geological regions that have been subject to uplift and erosion, obtaining accurate measurements for uplift and erosion is essential to predict the location and quality of a hydrocarbon reservoir. Uplift can be considered to be elevation of a geological formation owing to plate tectonics. Uplift and erosion are closely linked and the terms are often combined in an imprecise manner, as described, for example, by Bjørnseth *et al.*, “Uplift and erosion along the coast of Northern Norway—implications for the petroleum potential”, Extended Abstracts, Petroleum Exploration and Production in Environmentally Sensitive Areas, Ålesund, 5–7 May 2003, Norwegian Petroleum Society, Oslo, 29–31.

Referring to Figure 1 herein, there is illustrated schematically a cross section view of a geological formation that is subject to uplift and erosion. Considering Figure 1A, formation 1 is substantially flat prior to uplift, and is subsequently subject to an uplift of 400m with no erosion. The net erosion in this case is zero. Net erosion is defined as the difference between the maximum burial depth and the present day burial depth for a marker horizon or a rock body. Uplift is defined as a vertical movement of a marker horizon or a rock body relative to a given datum. Both terms are defined from geometrical relationships only, and no links to specific geological processes are implied.

In Figure 1B, the geological formation is tilted during uplift. At point 3, the formation has undergone an uplift of 100m, and no net erosion, but at point 4 the geological formation has undergone an uplift of 200m and a net erosion of 150m. A marker horizon at point 3 would therefore be higher than a marker horizon at point 4.

Tilting associated with regional uplift events can cause significant changes to hydrocarbon trapping potential, trap volumes and hydrocarbon migration patterns through time. Estimation of net erosion can be essential for prediction of reservoir quality and source rock maturity, and so estimation of net erosion is often required in order to fully evaluate the potential of a hydrocarbon reservoir in an uplifted area.

Net erosion can be estimated using a variety of methods. Net erosion can be estimated either in metres or, indirectly, in terms of cooling since the maximum burial temperature. Some examples of methods that can be used include:

- Shale compaction (based on either density logs or sonic logs)
- Sandstone diagenesis (determining a chemical or physical change of a sediment after its initial deposition)
- Vitrinite reflectance (for determining the temperature history of sediments)
- Apatite fission track analysis, ATFA (a dating technique)

However, these methods are limited to well locations, where subsurface data is collected and analysed. It is desirable to use methods that are independent of well data, and can make predictions in larger areas.

SUMMARY

It is an object of the present invention to provide a method of estimating rock physics model parameters such as net erosion and maximum historical temperature for a geological formation. According to a first aspect, there is provided a method of estimating a rock physics model parameter for a geological formation. The method includes the following:

a. an initial estimate for the parameter is selected;

b. formation porosity is estimated using a second parameter, a formation burial depth and the initial estimate for the parameter;

c. formation P-wave velocity is estimated using the estimated formation porosity, formation burial depth, the second parameter and estimated parameter in a rock physics model;

d. the estimated formation P-wave velocity is compared with a measured P-wave velocity;

e. the estimated parameter is amended and steps b to d are repeated. This process may be repeated many times to obtain an estimated parameter that gives an estimated P-wave velocity that most closely matches the measured P-wave velocity. This estimated parameter can then be used in a rock physics model.

In an embodiment, the parameter is net erosion and the second parameter is a maximum historical temperature.

In this case, the historical maximum temperature may be obtained using a measured or estimated temperature and an estimate of the historical temperature gradient. In this case, the estimated historical temperature gradient may be amended and steps b to d repeated to obtain an estimated net erosion that gives an estimated P-wave velocity that most closely matches the measured P-wave velocity.

In an alternative embodiment, the parameter is a maximum historical temperature and the second parameter is net erosion.

As an option, the rock physics model is calibrated depending on the lithology of the formation.

The method may further comprise obtaining an estimate for the second parameter by comparing estimated P-wave velocities with measured P-wave velocities at a plurality of burial depths.

According to a second aspect, there is provided an apparatus for estimating a rock physics model parameter for a geological formation. The apparatus is provided with an input device for receiving an initial estimate for the parameter. A processor is provided for estimating formation porosity using a second parameter, a formation burial depth and the initial estimate for the parameter. The processor is further arranged to estimate formation P-wave velocity using the estimated formation porosity, second parameter and estimated parameter in a rock physics model. The processor is further arranged to compare the estimated formation P-wave velocity with a measured P-wave velocity. The processor is further arranged to amend the estimated parameter and produce a new estimated formation P-wave velocity for comparison with the measured

P-wave velocity to obtain an estimated parameter that gives an estimated P-wave velocity that most closely matches the measured P-wave velocity.

As an option, the parameter is net erosion and the second parameter is a maximum historical temperature. In this case, the processor is optionally arranged to estimate the historical maximum temperature using an estimated or measured temperature and an estimate of the historical temperature gradient.

The apparatus may be provided with a computer readable medium in the form of a memory for storing any of the historical maximum temperature value, the formation burial depth value, and the initial estimate of net erosion.

The apparatus may be further provided with a computer readable medium in the form of a memory for storing any of a measured temperature and an estimate of the historical temperature gradient.

As an alternative option, the parameter is a maximum historical temperature and the second parameter is net erosion.

The processor may, in an optional embodiment, be arranged to obtain an estimate for the second parameter by comparing estimated P-wave velocities with measured P-wave velocities at a plurality of burial depths

The apparatus may be provided with a computer readable medium in the form of a memory, in which is stored the rock physics model for use by the processor.

As a further option, the apparatus may be provided with a plurality of rock physics models stored in the memory, each rock physics model being calibrated to a particular formation lithology.

According to a third aspect, there is provided a computer program, comprising computer readable code which, when run on a computer device, causes the computer device to perform the method as described above in the first aspect.

According to a fourth aspect, there is provided a computer program product comprising a computer readable medium and a computer program as described above in the third aspect, wherein the computer program is stored on the computer readable medium.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates schematically a cross section view of a geological formation that is subject to uplift and erosion;

Figure 2 illustrates a procedure for estimating net erosion according to an embodiment of the invention;

Figure 3 shows the steps to estimate net erosion according to an embodiment of the invention;

Figure 4 shows the steps to estimate net erosion according to a further embodiment of the invention;

Figure 5 shows rock physics modelling of burial depth against P-wave velocities according to a further embodiment of the invention;

Figure 6 shows rock physics modelling of burial depth against P-wave velocities obtained from seismic data according to an embodiment of the invention;

Figure 7 shows a net erosion estimate for a seismic 2D- line through a well;

Figure 8 illustrates schematically in a block diagram an apparatus or estimating net erosion according to an embodiment of the invention;

Figure 9 shows a method of estimating a temperature gradient according to an embodiment of the invention; and

Figure 10 is a graph showing the change in P-wave velocity with depth for different historical temperature gradients.

DETAILED DESCRIPTION

One method of estimating net erosion of a geological formation relies on a forward rock physics model that estimates velocities from temperature, porosity, depth, lithology and net erosion. Porosity is estimated with a separate model which requires temperature, net erosion, depth and lithology as input.

In the case of shale formations, these methods assume a linear velocity depth trend with a constant gradient. However, it is known that temperature has a large effect on shale velocities, and that the velocity depth trends will change greatly with large fluctuations in temperature/depth ratio. Some areas, for example the Barents Sea, have experience a high degree of uplift and erosion. This leads to a high variation in the temperatures that a potential reservoir may have been exposed to.

Turning to Figure 2, there is illustrated an embodiment of the invention in which net erosion is estimated.

In a first step, temperature T, burial depth, Z and estimated net erosion are used in a rock physics forward model to obtain an estimate of P-wave velocity, Vp, and any of seismic velocity, Vs, porosity, Φ, and density ρ.

In a further step, temperature, burial depth, Vp and possibly temperature gradient are then used in a forward model. A value of net erosion, when used in the forward model, will give an estimated Vp that best matches the measured Vp. This net erosion value is used as the estimate for net erosion.

In a well, temperature measurements are easily measured and can be extrapolated to different depths. The lithology of the surrounding formation is also easily obtained, for example using a Gamma Ray log. In this case, the only unknown parameter in a rock physics model is net erosion, as Vp can be measured. The rock physics model can therefore be inverted using the temperature, burial depth and Vp to give an estimate of the net erosion that would give an estimate of Vp that best matches a measured Vp.

In most formations, shale is the dominant lithology in determining Vp. Turning now to Figure 3, consider the case where P-wave velocity for shale, burial depth Z and maximum historical temperature (T_{max}) are known, and it is required to estimate net erosion. The following numbering corresponds to the numbering of Figure 3.

S1. An initial estimate of net erosion is made. This is used as a starting point in a forward rock physics model.

S2. The forward rock physics model is used to estimate shale porosity, Φ, using T_{max}, burial depth Z and the estimated net erosion.

S3. P-wave velocity for shale is estimated using the forward rock physics model using the previously obtained estimate of shale porosity, Φ, T_{max} and burial depth Z.

S4. Vp measurements are obtained (this step can happen in any order in the sequence).

S5. A comparison is made between the estimated Vp obtained in step S3 and the measured Vp obtained in step S4.

S6. The forward rock physics model is iterated to find a net erosion value that gives a minimum discrepancy between the measured and the estimated P-wave velocity for shale, for example using a regression function. Further iterations may be necessary to produce a net erosion value that best correlates the estimated and measured velocities.

Using the steps described in Figure 3, an accurate estimate of net erosion can be obtained using Vp, burial depth and historical temperature.

Figure 4 herein illustrates the steps where shale velocity Vp and burial depth Z are known, but historical maximum temperature T_{max} is not known. The following numbering corresponds to the numbering of Figure 4.

S7. An initial estimate of the most likely net erosion and historical temperature gradient (T_{grad_hist}) is made. This is used as a starting point in a forward rock physics model.

S8. The historical maximum temperature T_{max} is calculated using the present temperature, T_{grad_hist} and the estimated net erosion according to equation 1. This is used as a starting point in a forward rock physics model.

$$T_{max} = T_{present} + net\_erosion(km) \times T_{grad\_hist} \quad (1)$$

S9. The forward rock physics model is used to estimate shale porosity, Φ, using estimated T_{max}, burial depth Z and the estimated net erosion.

S10. The P-wave velocity for shale is estimated using the forward rock physics model using the previously obtained estimate of shale porosity, Φ, estimated T_{max} and burial depth Z.

S11. Vp measurements are obtained (this step can happen in any order in the sequence).

S12. A comparison is made between the estimated Vp obtained in step S10 and the measured Vp obtained in step S11.

S13. The forward rock physics model is used to obtain iterated net erosion and historical temperature gradient values to find a net erosion value that gives a minimum discrepancy between the measured and the estimated Vp, for example using a regression function. Further iterations may be necessary to produce a net erosion value that best correlates the estimated and measured velocities.

Figure 5 shows burial depth Z against P-wave velocities. The grey line shows the best-fit estimated P-wave velocity for shale and the black dots show P-wave velocities obtained from a well log. It can be seen that estimated P-wave velocity closely corresponds to the P-wave velocity obtained from the well log. The net erosion that, when use in the forward rock physics model gives this fit, is used as the net erosion estimate.

The embodiments illustrated in Figures 3 and 4 relay on measured P-wave velocities, typically obtained from a well log. However, it should be noted that P-wave velocities obtained from seismic data Vs can also be used. This is an advantage in frontier areas where seismically derived velocities are the only available velocity information and no well logs exist. In this case, regional temperature knowledge is used to estimate a temperature/depth gradient. Seismic velocities have a much lower resolution than well log P-wave velocities, and will normally reflect the velocity of shale, since shale generally is the dominating lithology. It may be that it is known that pure shales only occur in certain intervals, in which case these intervals can be used for net erosion estimation.

Figure 6 shows seismic velocities in at different burial depths (pale grey line), with black dots at the depths where shale formations have been are observed in the well. The dark grey line shows the best fit of the velocity function to the black dots. It can be seen that the best fit of the velocity function closely matches the measured seismic velocities. Again, the net erosion that, when use in the forward rock physics model gives this fit, is used as the net erosion estimate.

As mentioned above, seismic velocities are less accurate and reliable than measured well log velocities. In this case, so a limit (say, ± 200 m/s) can be added to the seismic velocities. Net erosion can therefore be estimated as a value within the upper and lower velocity limits.

Figure 7 shows how net erosion can be estimated for seismic volumes. Net erosion maps can be generated using 3D-cubes of seismic velocities. The estimated net erosion using the present method is shown by the black line. The estimated net erosion closely matches the net erosion using prior art methods until around inline number 1400. After inline number 1400, the estimates deviate. This deviation is because prior art methods do not take account of temperature gradients. The temperature gradient is assumed to be 35°C/km for the whole section. For different gradients, the difference between the net erosion estimate using the present method and the net erosion estimates using previously known methods will be even larger.

Differences arise because existing methods of estimating net erosion are developed for wells with a temperature/depth gradient of around 30°C/km. Existing methods give reasonable predictions of net erosion under these conditions. However, temperature gradients can typically be anywhere from 10 to 60°C/km. When temperature gradients are lower than 30°C/km, temperature dependent diagenetic reactions such as smectite to illite, and kaolinite to illite, will occur at higher depths. These reactions compact the shale and increase the P-wave velocity. For higher temperature gradients, these reactions will occur at shallower depths. Therefore the temperature gradient is a very important parameter when studying shale properties versus depth. The present method uses temperature in the forward rock physics model, and can therefore account for large variations in temperature/depth conditions. The above-described method can be used to estimate net erosion based on temperature dependent non-linear velocity-depth trends.

The present method provides more accurate net erosion estimates than are previously available especially in cases where temperature gradients deviate from around 30°C/km. An advantage of reducing uncertainty in net erosion estimation is that better predictions can be made regarding reservoir quality. Better knowledge of the burial history of the formations improves the predictability of reservoir porosity and permeability. Furthermore, knowledge of the burial history of the formations and hydrocarbons allow better estimates of hydrocarbon maturity to be made.

Note that while the above description concentrates of shale velocities, the same methods can be used with velocities for other lithologies. For example, sandstone velocities can be used to estimate net erosion. However, in that case, the method is most applicable in wells P-wave velocities can be measured, since the resolution of seismic velocities normally is too low to resolve clean sand packages.

Turning now to Figure 8, there is illustrated an apparatus according to an embodiment of the invention. The apparatus takes the form of a computer device 5. The computer device 5 is provided with a processor 6 and a computer readable medium in the form of a memory 7. A user input device 8 is provided to allow a user to interact with the computer device 5 and enter information such as an initial estimate for net erosion. In some embodiments, a display device 9 is provided, although it will be appreciated that the computer device 5 may be a back-end server and process the data for display on a remote computer device. In some embodiments, an in/out device 10 may also be provided to allow the computer device 5 to communicate with other devices, for example to receive or send data.

The processor is arranged to perform the steps described above and shown in Figures 3 and 4. In order to do this, the processor requires data either obtained remotely using the in/out device 10 (for example, measured Vp), entered by a user via the user input device 8 (for example, the initial ‘seed’ estimate for net erosion), or stored in a database 11 in the memory 7. The database may be used to store data 12 such as porosity, burial depth, maximum historical temperature, current temperature, porosity, measured P-wave velocities, and so on. It may also be used to store information about different lithologies and forward rock physics models related to each lithology that can be used by the processor 6.

In some cases a reasonable estimate of net erosion may already be available from other sources such as vitrinite reflectance, apatite fission track analysis (AFTA), and sand and shale diagenesis. This estimate may be made using data obtained from a well. In this case, the method may be adapted to obtain a more accurate estimate of historical temperature gradient.

Turning now to Figure 9, consider the case where P-wave velocity for shale, burial depth Z and net erosion are available, and it is required to estimate maximum historical temperature (T_{max}). The following numbering corresponds to the numbering of Figure 9.

S14. The known value for net erosion is used as a starting point in a forward rock physics model. This value may be estimated or derived from other data sources.

S15. The forward rock physics model is used to estimate shale porosity, Φ, using net erosion, burial depth Z and the estimated T_{max}.

S16. Shale P-wave velocity is estimated using the forward rock physics model using the net erosion, burial depth Z, maximum temperature and the previously obtained estimate of shale porosity, Φ..

S17. Vp measurements are obtained (this step can happen in any order in the sequence).

S18. A comparison is made between the estimated Vp obtained in step S16 and the measured Vp obtained in step S17.

S19. The forward rock physics model is iterated to find a T_{max} value that gives a minimum discrepancy between the measured and the estimated shale velocity Vp, for example using a regression function. Further iterations may be necessary to produce a T_{max} value that best correlates the estimated and measured velocities.

Using the steps described in Figure 3, an accurate estimate of T_{max} can be obtained using Vp, burial depth and net erosion. It will be appreciated that T_{max} can be estimated using a computer device 5 similar to that shown in Figure 8.

In one embodiment of the above description, net erosion is estimated, and in another embodiment, maximum historical temperature is estimated. In a further embodiment, it is possible in some circumstances to estimate both net erosion and maximum historical temperature simultaneously. This can be achieved is there is sufficient depth difference (for example, greater than 500m) between the shallowest and deepest observed values for Vp (typically these will be Vp measurements obtained from seismic data).

By plotting the Vp against the burial depth, an estimate of the historical temperature gradient can be made, as shown in Figure 10. In this case, all predicted information derived from models can be shown to match the shallow Vp observation, but only the one with “correct” historical temperature gradient can match the deep Vp observation. In this way, both net erosion and maximum historical temperature can be simultaneously estimated.

It will be appreciated by the person of skill in the art that various modifications may be made to the above described embodiments without departing from the scope of the present invention as defined in the appended claims. For example, while the above description refers to using P-wave velocities for shale, it will be appreciated that in some circumstances other lithologies may be dominant, or a combination of lithologies may be used. For example, it is in principle possible to use P-wave velocities from both shale and sands to perform the estimates of net erosion or T_{max}.

The following abbreviations have been used in this specification:

ATFA	Apatite fission track analysis
T	temperature
T_{max}	historical maximum temperature
T_{grad_hist}	historical temperature gradient
Vp	P-wave velocity
Vs	P-wave velocity obtained from seismic data
Z	burial depth
ρ	density
Φ	porosity

CLAIMS

1. A method of estimating a rock physics model parameter for a geological formation, the method comprising:

a. selecting an initial estimate for the parameter;

b. estimating formation porosity using a second parameter, a formation burial depth and the initial estimate for the parameter;

c. estimating formation P-wave velocity using the estimated formation porosity, formation burial depth, the second parameter and estimated parameter in a rock physics model;

d. comparing the estimated formation P-wave velocity with a measured P-wave velocity;

e. amending the estimated parameter and repeating steps b to d to obtain an estimated parameter that gives an estimated P-wave velocity that most closely matches the measured P-wave velocity.

2. The method according to claim 1, wherein the parameter is net erosion and the second parameter is a maximum historical temperature.

3. The method according to claim 2, wherein the historical maximum temperature is obtained using a measured or estimated temperature and an estimate of the historical temperature gradient.

4. The method according to claim 3, further comprising amending the estimated historical temperature gradient and repeating steps b to d to obtain an estimated net erosion that gives an estimated P-wave velocity that most closely matches the measured P-wave velocity.

5. The method according to claim 1, wherein the parameter is a maximum historical temperature and the second parameter is net erosion.

6. The method according to any of claims 1 to 5, wherein the rock physics model is calibrated depending on the lithology of the formation.

7. The method according to claim 1, further comprising:

obtaining an estimate for the second parameter by comparing estimated P-wave velocities with measured P-wave velocities at a plurality of burial depths.

8. An apparatus for estimating a rock physics model parameter for a geological formation, the apparatus comprising:

an input device for receiving an initial estimate for the parameter;

a processor for estimating formation porosity using a second parameter, a formation burial depth and the initial estimate for the parameter;

the processor being further arranged to estimate formation P-wave velocity using the estimated formation porosity, second parameter and estimated parameter in a rock physics model;

the processor being further arranged to compare the estimated formation P-wave velocity with a measured P-wave velocity;

the processor being further arranged to amend the estimated parameter and produce a new estimated formation P-wave velocity for comparison with the measured P-wave velocity to obtain an estimated parameter that gives an estimated P-wave velocity that most closely matches the measured P-wave velocity.

9. The apparatus according to claim 8, wherein the parameter is net erosion and the second parameter is a maximum historical temperature.

10. The apparatus according to claim 9, wherein processor is arranged to estimate the historical maximum temperature using an estimated or measured temperature and an estimate of the historical temperature gradient.

11. The apparatus according to claim 9 or 10, further comprising a computer readable medium in the form of a memory for storing any of the historical maximum temperature value, the formation burial depth value, and the initial estimate of net erosion.

12. The apparatus according to claim 10, further comprising a computer readable medium in the form of a memory for storing any of a measured temperature and an estimate of the historical temperature gradient.

13. The apparatus according to claim 8, wherein the parameter is a maximum historical temperature and the second parameter is net erosion.

14. The apparatus according to claim 8, wherein the processor is arranged to obtain an estimate for the second parameter by comparing estimated P-wave velocities with measured P-wave velocities at a plurality of burial depths

15. The apparatus according to any of claims 8 to 14, further comprising a computer readable medium in the form of a memory, in which is stored the rock physics model for use by the processor.

16. The apparatus according claim 15, further comprising a plurality of rock physics models stored in the memory, each rock physics model being calibrated to a particular formation lithology.

17. A computer program, comprising computer readable code which, when run on a computer device, causes the computer device to perform the method as claimed in any of claims 1 to 7.

18. A computer program product comprising a computer readable medium and a computer program according to claim 17, wherein the computer program is stored on the computer readable medium.

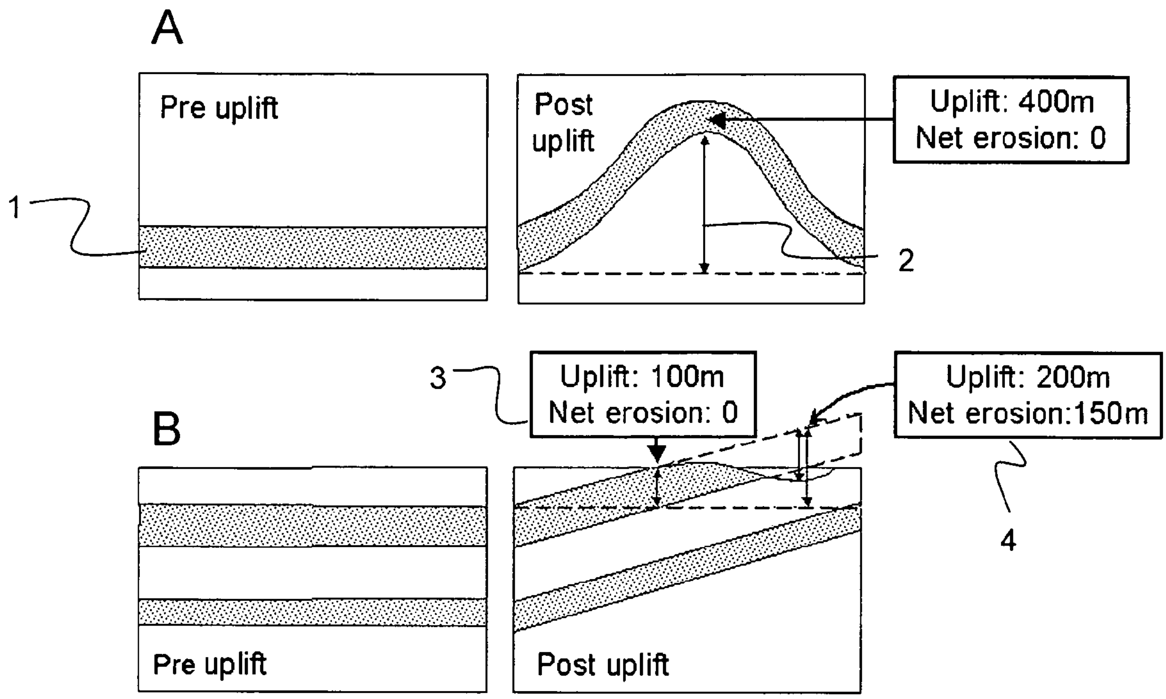

Figure 1

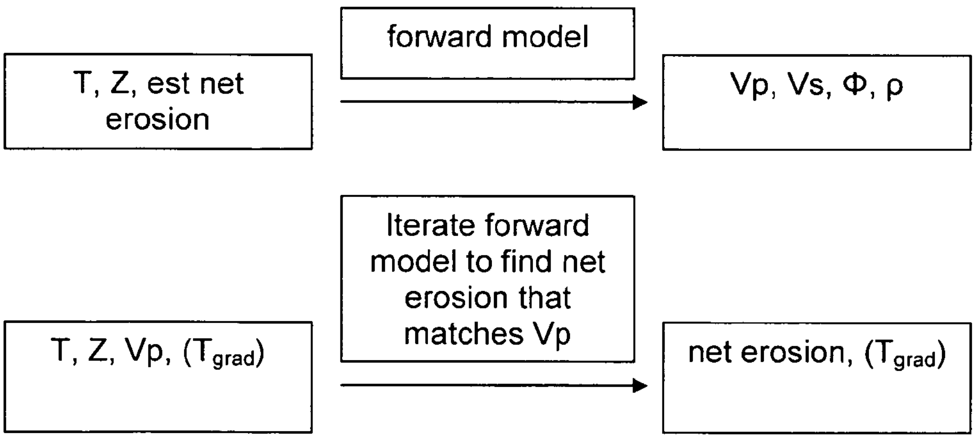

Figure 2

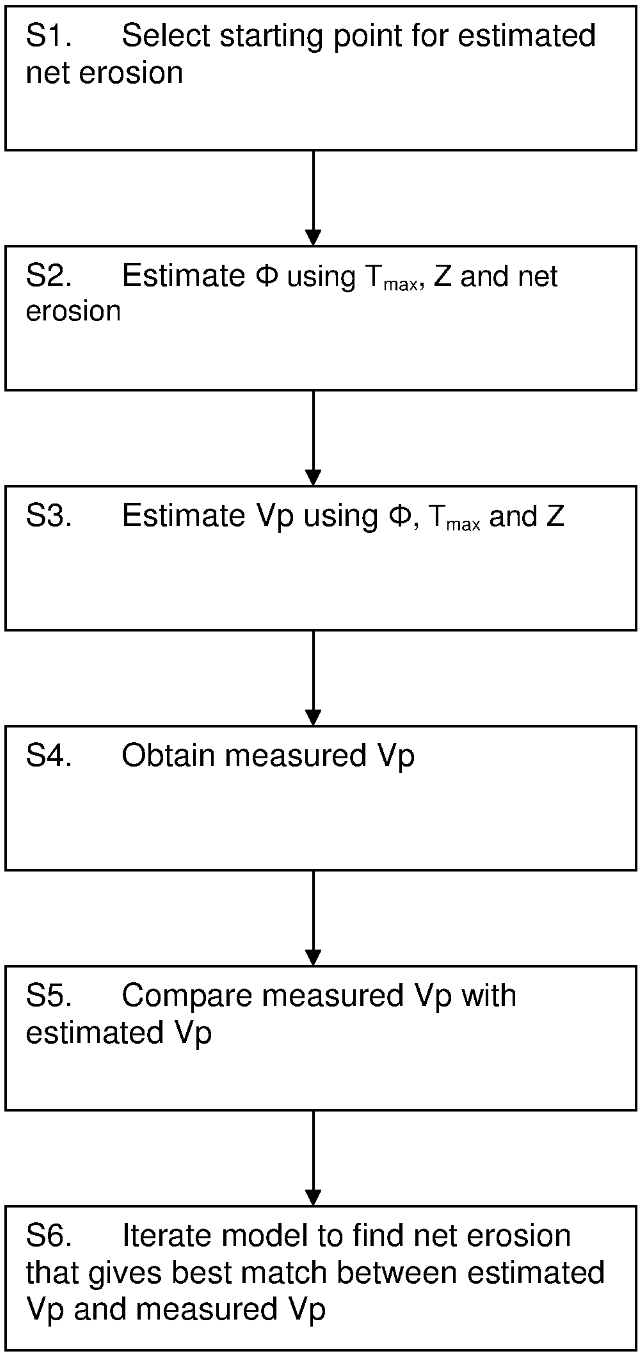
S1. Select starting point for estimated net erosion
S2. Estimate Φ using T_{max}, Z and net erosion
S3. Estimate Vp using Φ, T_{max} and Z
S4. Obtain measured Vp
S5. Compare measured Vp with estimated Vp
S6. Iterate model to find net erosion that gives best match between estimated Vp and measured Vp

Figure 3

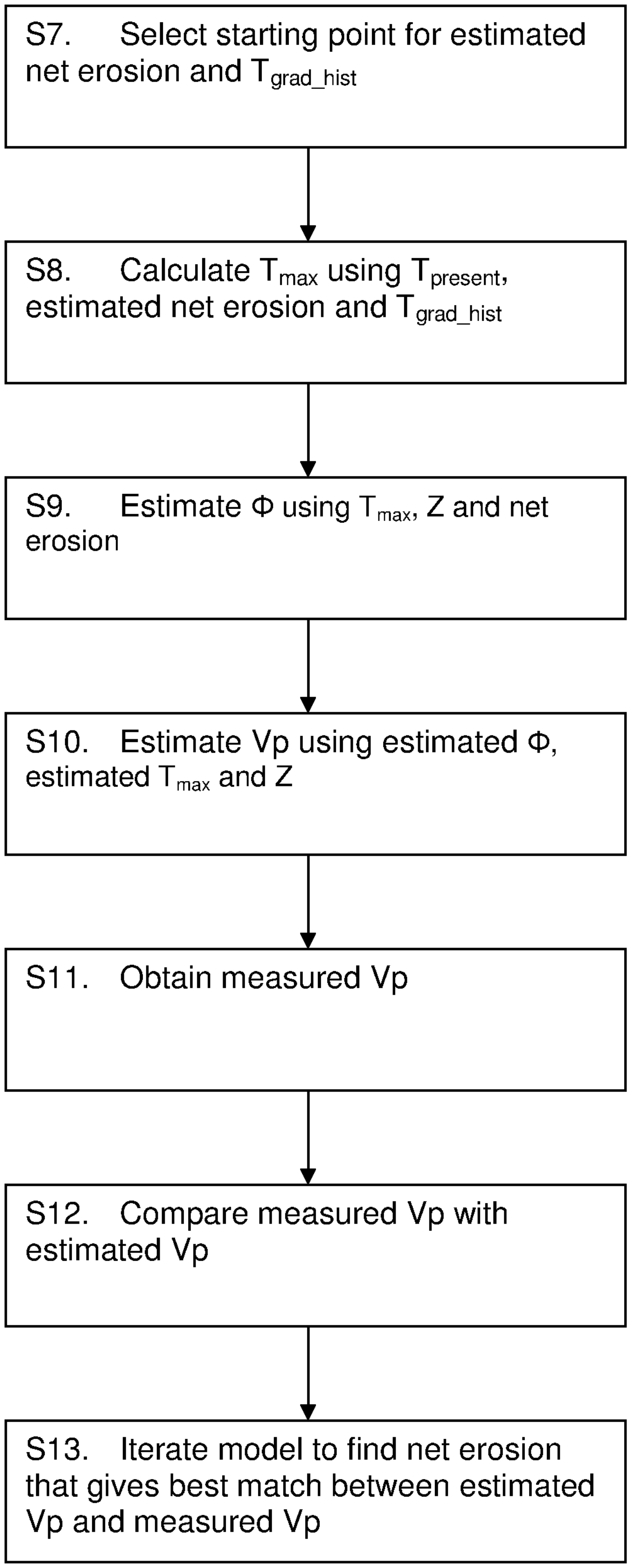
S7. Select starting point for estimated net erosion and T_{grad_hist}
S8. Calculate T_{max} using $T_{present}$, estimated net erosion and T_{grad_hist}
S9. Estimate Φ using T_{max}, Z and net erosion
S10. Estimate Vp using estimated Φ, estimated T_{max} and Z
S11. Obtain measured Vp
S12. Compare measured Vp with estimated Vp
S13. Iterate model to find net erosion that gives best match between estimated Vp and measured Vp

Figure 4

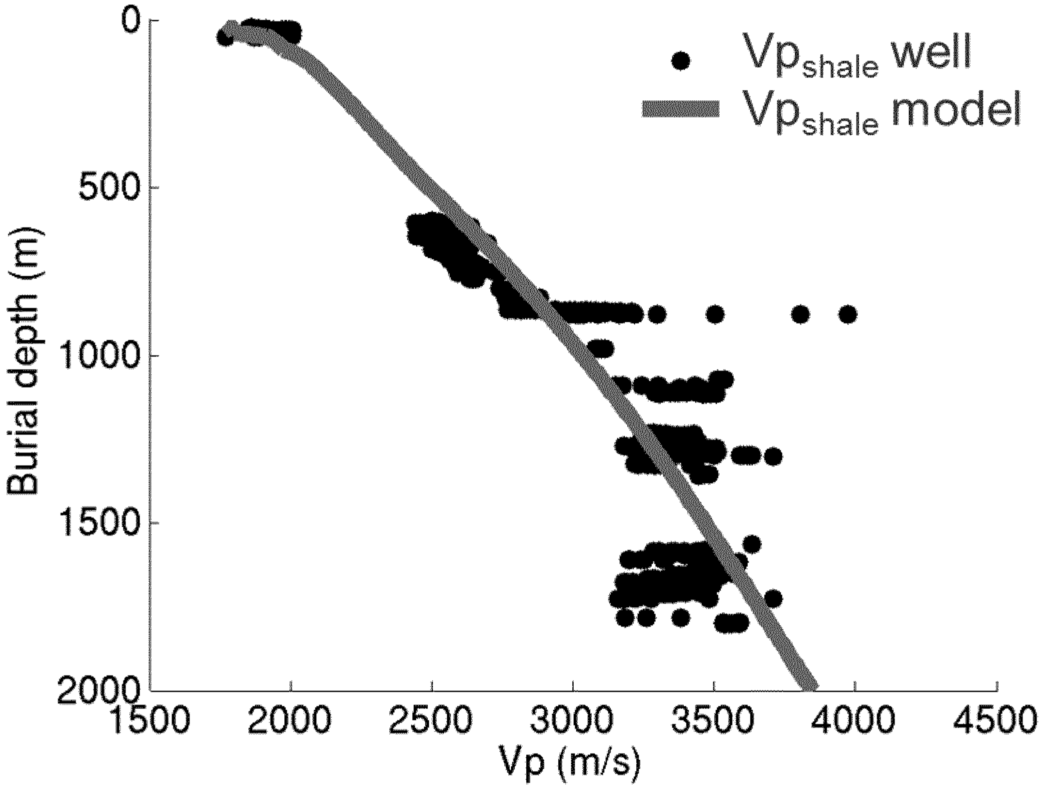

Figure 5

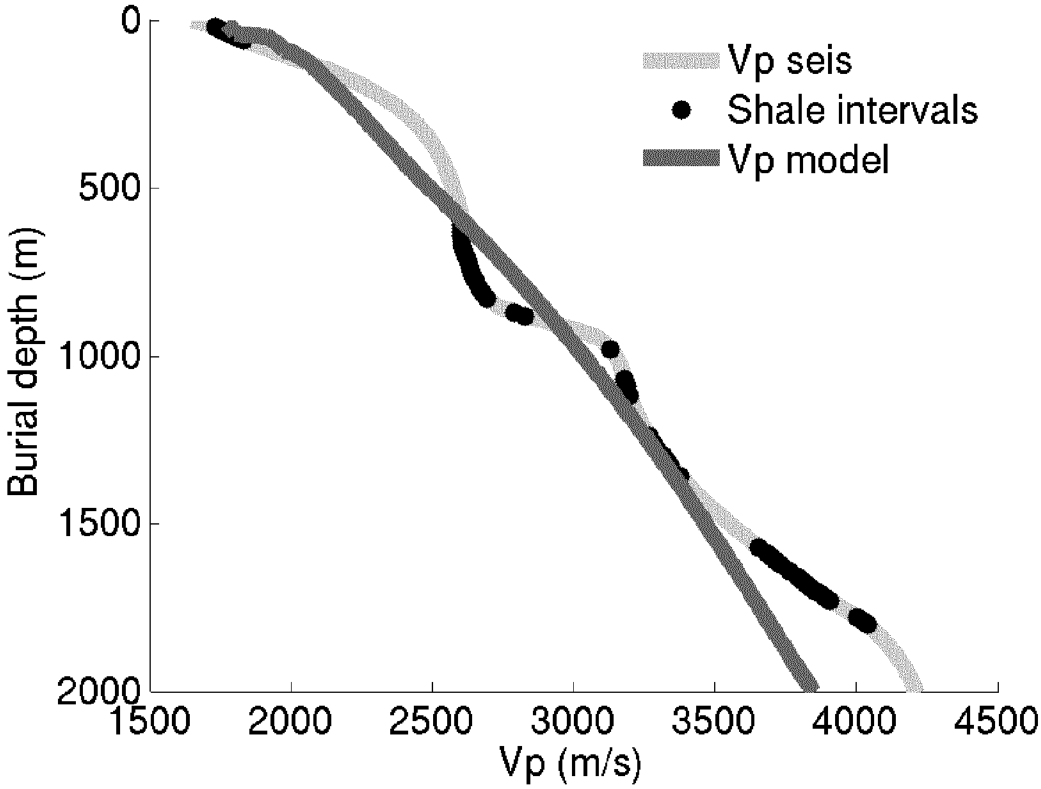

Figure 6

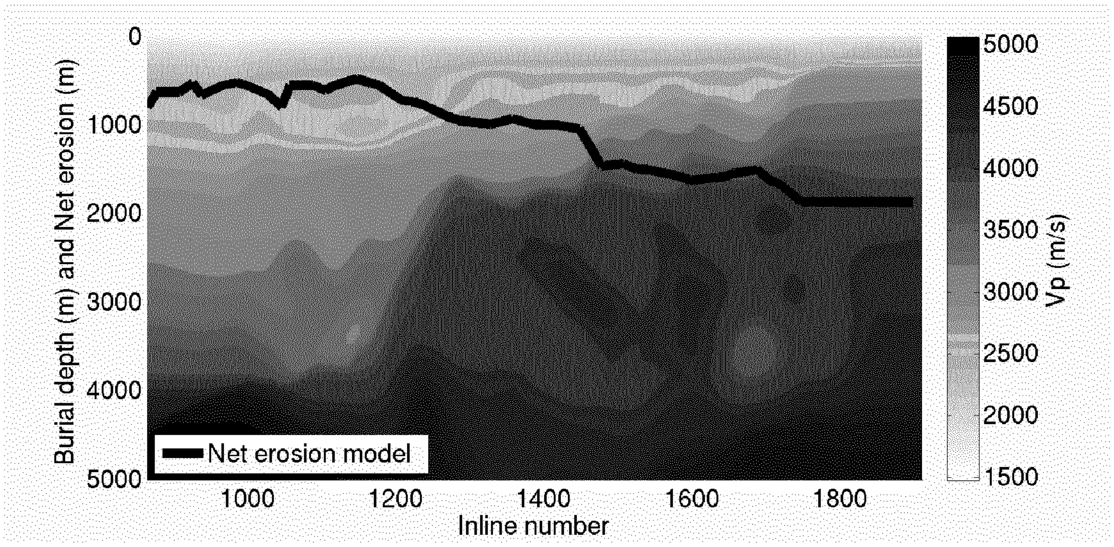

Figure 7

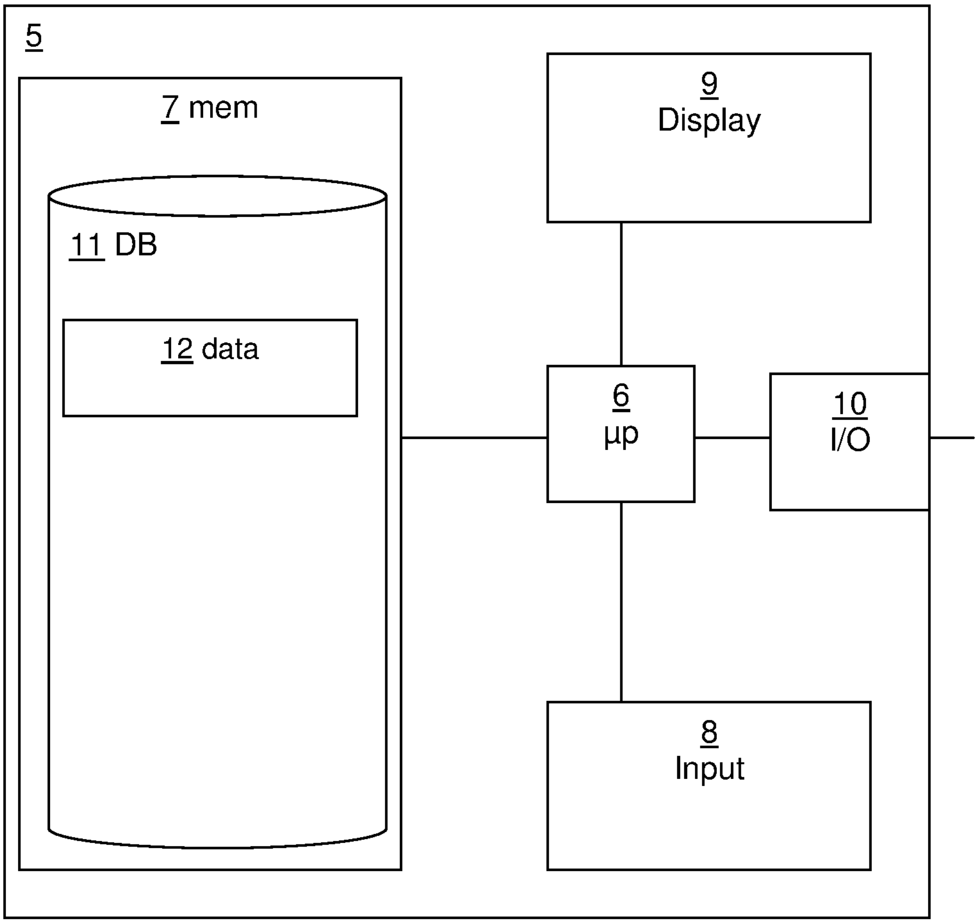

Figure 8

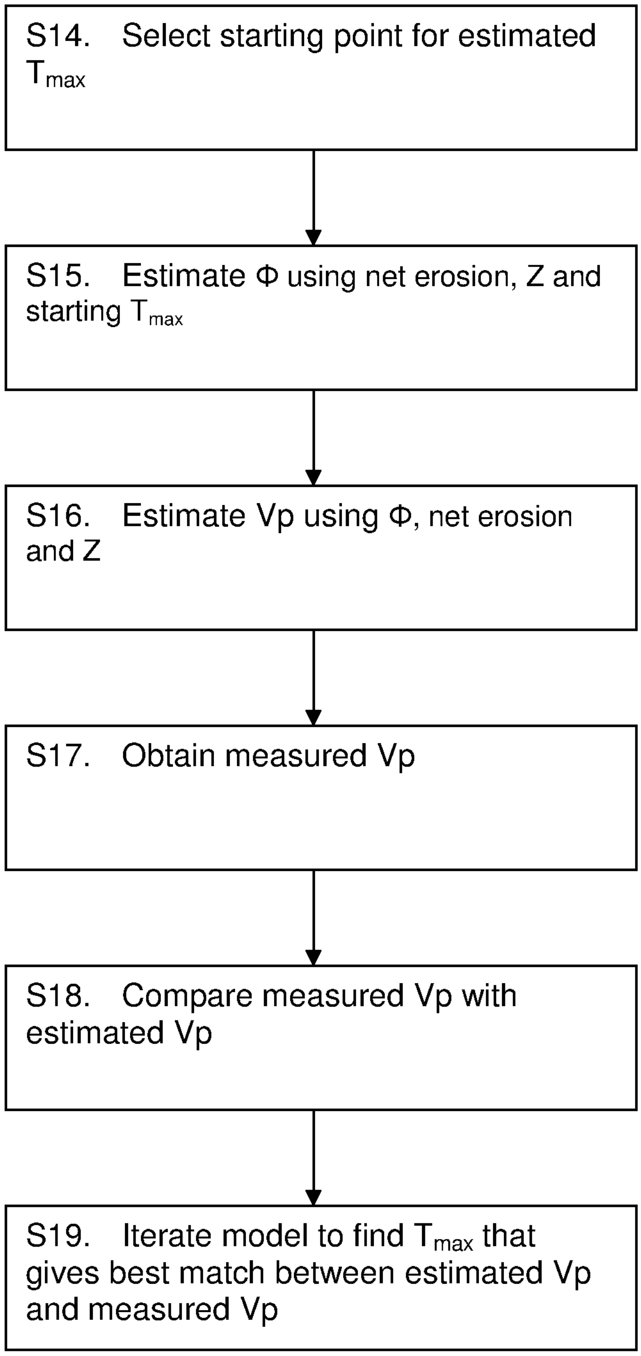
S14. Select starting point for estimated T_{max}
S15. Estimate Φ using net erosion, Z and starting T_{max}
S16. Estimate Vp using Φ, net erosion and Z
S17. Obtain measured Vp
S18. Compare measured Vp with estimated Vp
S19. Iterate model to find T_{max} that gives best match between estimated Vp and measured Vp

Figure 9

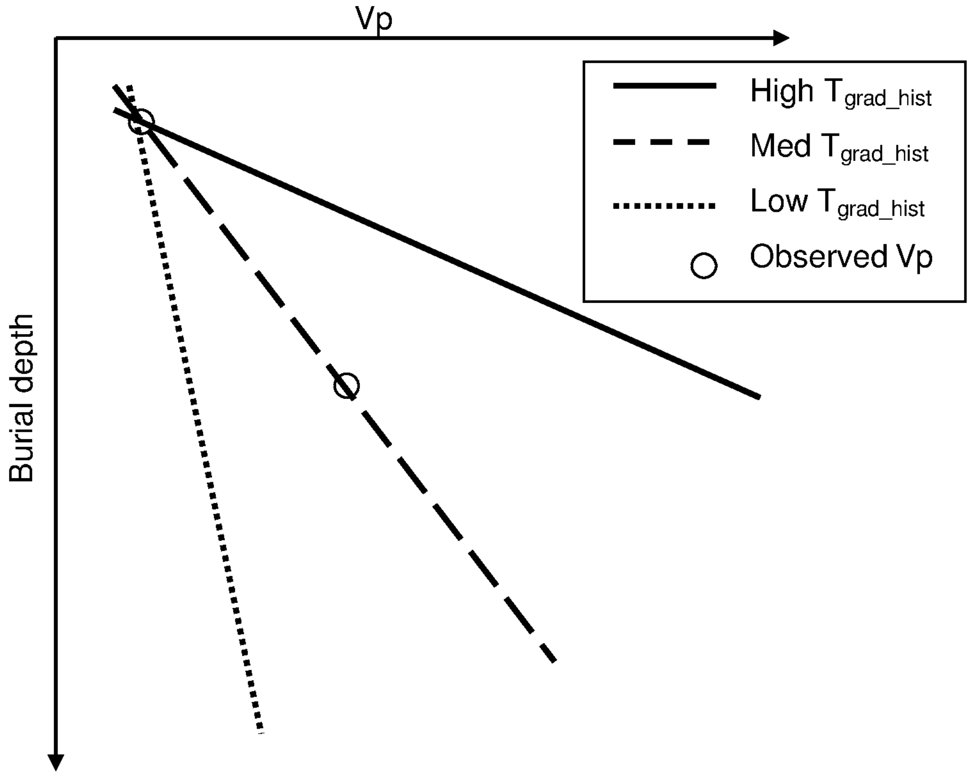
Vp
Burial depth
High T_{grad_hist}
Med T_{grad_hist}
Low T_{grad_hist}
Observed Vp

Figure 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/056136

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01V11/00
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)
G01V

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	ANDERS DRÆGE: "A diagenetic rock physics approach for siliciclastics", THE LEADING EDGE, vol. 30, no. 12, 12 December 2011 (2011-12-12), pages 1368-1375, XP002689268, DOI: 10.1190/1.3672481 the whole document -----	1-18
X	US 7 400 978 B2 (LANGLAIS VALERIE [FR] ET AL) 15 July 2008 (2008-07-15) the whole document -----	1,8
X	WO 01/33481 A1 (EXXONMOBIL UPSTREAM RES CO [US]) 10 May 2001 (2001-05-10) the whole document -----	1,8
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] 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

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 December 2012	04/01/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Marquart, N

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/056136

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 2011/141851 A1 (KACEWICZ MAREK [US] ET AL) 16 June 2011 (2011-06-16) the whole document -----	1,8

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			US	2007156341	A1	05-07-2007
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			US	6480790	B1	12-11-2002
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			EA	201290508	A1	30-11-2012
			EP	2513831	A2	24-10-2012
			US	2011141851	A1	16-06-2011
			WO	2011084236	A2	14-07-2011