subterranean region. The depth of investigation is also typically computationally expensive and ambiguous to determine for any given set of seismic data.

[0009] One method for used in analyzing seismic data is a full-waveform inversion ("FWI"), which outputs a subsurface attribute model to use in calculating the seismic image. Geophysicists also sometimes perform an analysis of the depth of investigation of the velocity model from FWI - a factor in the depth of investigation and overall accuracy of the seismic image. FWI is computationally expensive, however.

[0010] As can be seen from the above discussion, the endeavor is computationally expensive in both time and resources. Significant benefits can therefore accrue in the course of seismic exploration activities by increasing efficiency in operation and usage of computational resources. While there are many techniques suitable for this purpose, the art is always open further advancements. The presently disclosed technique will therefore be well received.

Summary of the invention

[0010a] According to a first aspect of the present invention, there is provided a process for use in seismic exploration, including: obtaining a diving wave illumination image of a subterranean region from a set of seismic data representative of the subterranean region using a selected acquisition geometry; clipping an inverse of the diving wave illumination image to a range of values; performing a weighted full-waveform inversion, including: weighting a full-waveform inversion gradient with the clipped inverse of the diving wave illumination image; and performing the full-waveform inversion using the weighted gradient.

[0010b] According to a second aspect of the present invention, there is provided a process for use in seismic exploration, including: objectively quantifying a depth of investigation in a subterranean region for a selected acquisition geometry; updating a subsurface attribute model for the subterranean region up to the objectively quantified depth of investigation, including: weighting a full-waveform inversion gradient with the objectively quantified depth of investigation; and performing a full-waveform inversion using the weighted full-waveform inversion gradient on the subsurface attribute model using seismic data representative of the subterranean region acquired using the selected acquisition geometry; and iteratively performing subsequent weighted full-waveform inversions using differently weighted full-waveform inversion gradients to update the subsurface attribute model to depths deeper than the depth of investigation.

[0010c] According to a third aspect of the present invention, there is provided a method for use in seismic exploration, including: obtaining a given acquisition geometry; preconditioning a full-waveform inversion on a subsurface attribute model of a subterranean region using the given acquisition geometry; and performing the preconditioned full-waveform inversion on the subsurface model.

[0010d] According to a fourth aspect of the present invention, there is provided a process for use in seismic exploration, including: obtaining a diving wave illumination image of a subterranean region from a set of seismic data representative of the subterranean region using a selected acquisition geometry; clipping an inverse of the diving wave illumination image to a range of values; performing a weighted full-waveform inversion, including: weighting a full-waveform inversion gradient with the clipped inverse of the diving wave illumination image; and performing the full-waveform inversion using the weighted gradient.

[0010e] According to a fifth aspect of the present invention, there is provided a An apparatus, including: a storage; a communication medium; a processor communicating with the storage over the communication medium; a set of seismic data residing on the storage, the seismic data being representative of a subterranean region and obtained using a selected acquisition geometry; a software component residing on the storage that, when executed by the processor, performs a process for use in seismic exploration, including: obtaining a diving wave illumination image of a subterranean region from the set of seismic data; clipping an inverse of the diving wave illumination image to a range of values; performing a weighted full-waveform inversion, including: weighting a full-waveform inversion gradient with the clipped inverse of the diving wave illumination image; and performing the full-waveform inversion using the weighted gradient.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The accompanying drawings, which are incorporated herein and constitute a part of this specification, illustrate embodiments of the invention and together with the description, serve to explain the principles of the invention. In the figures:

[0012] Figure 1 graphically presents the process flow in the method of the technique disclosed herein.

[0013] Figure 2 graphically presents the process flow for obtaining a diving wave illumination image in one particular embodiment of the method of Figure 1.

[0014] Figure 3A-Figure 3B illustrate a computing apparatus that may be used to implement some aspects of the presently disclosed technique.