[0005] Seismic survey designs provide locations for the energy sources and receivers (otherwise known as acquisition geometry). The survey designs are generated with a goal of ensuring that seismic acquisition will have adequate illumination of targets of interest to allow for imaging or mapping of the subsurface region. As such, it may be useful to develop survey designs that result in improvements of the imaging or mapping of the subsurface region, such that the operations related to extracting the hydrocarbons may be modified to more efficiently extract the hydrocarbons from the subsurface region of the Earth.

SUMMARY

[0006] A summary of certain embodiments disclosed herein is set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of these certain embodiments and that these aspects are not intended to limit the scope of this disclosure. Indeed, this disclosure may encompass a variety of aspects that may not be set forth below.

[0006a] According to first aspect, there is provided a method, including: selecting a plurality of sets of source and receiver locations over a survey area; modeling on a subsurface attribute model of a subterranean region each source and receiver pair of the plurality of sets of source and receiver locations to generate low frequency seismic data; performing a reverse time migration on the low frequency seismic data to reposition refraction wave and/or diving wave energy of each source and receiver pair of the plurality of sets of source and receiver locations to generate a diving wave illumination image; extracting seismic amplitudes from the diving wave illumination image around a region of interest; and computing a contribution of a respective diving wave from each source and receiver pair of the plurality of sets of source and receiver locations to diving waves passing through the region of interest.

[0006b] According to a second aspect, there is provided a tangible, non-transitory, machine-readable media, including instructions configured to cause a processor to: select a plurality of sets of source and receiver locations over a survey area; model on a velocity model of a subterranean region each source and receiver pair of the plurality of sets of source and receiver locations to generate low frequency seismic data; performing a reverse time migration on the low frequency seismic data to reposition diving wave energy of each source

and receiver pair of the plurality of sets of source and receiver locations to generate a diving wave illumination image; extract seismic amplitudes from the diving wave illumination image at a region of interest; compute a contribution of a respective diving wave from each source and receiver pair of the plurality of sets of source and receiver locations to diving waves passing through the region of interest; and calculate results indicative of the contribution of the respective diving wave from each source and receiver pair of the plurality of sets of source and receiver locations to the diving waves passing through the region of interest.

[0006c] According to a third aspect, there is provided a device including: a processor configured to: select a plurality of sets of source and receiver locations over a survey area; model on a subsurface attribute model of a subterranean region each source and receiver pair of the plurality of sets of source and receiver locations to generate low frequency seismic data; perform a reverse time migration on the low frequency seismic data to reposition diving wave energy of each source and receiver pair of the plurality of sets of source and receiver locations to generate a diving wave illumination image; extract seismic amplitudes from the diving wave illumination image at a region of interest; and compute a contribution of a respective diving wave from each source and receiver pair of the plurality of sets of source and receiver locations to diving waves passing through the region of interest.

[0007] Seismic acquisition utilizing sources and receivers may be useful in the generation of, for example, seismic images or velocity models. Seismic images may be used, for example, in the determination of hydrocarbon deposits (e.g., areas within a subsurface that contain hydrocarbons) and/or subsurface drilling hazards. Seismic images are generally produced using seismic waveforms produced by a source, reflected off regions within a subsurface, and received by one or more receivers. The seismic images that are generated depend greatly on the locations of the sources and receivers, also known as the acquisition geometry, of a seismic survey design. Trial and error may be used to determine the acquisition geometry of a seismic survey design. However, seismic surveying is too costly to be performed using trial and error to find a suitable acquisition geometry. So computational modeling and analysis can be used to evaluate prospective acquisition geometries to determine which might yield the most desirable survey results.