

- (b) encoding each multi-shot gather with a different encoding function selected from a set of encoding functions that are orthogonal or pseudo-orthogonal with respect to cross-correlation;
- (c) summing the encoded multi-shot gathers by summing all data records in each gather that correspond to a single receiver and repeating for each different receiver, resulting in a simultaneous encoded-source gather;
- (d) assuming a physical properties model of the subsurface region, said model providing values of at least one physical property at locations throughout the subsurface region;
- (e) using the assumed physical properties model, simulating the simultaneous encoded-source gather, encoding source signatures in the simulation using the same encoding functions used to encode corresponding gathers of the measured data, wherein an entire simultaneous encoded-source gather is simulated, using a programmed computer, in a single simulation operation;
- (f) calculating a difference for each receiver between the simultaneous encoded-source gather and the simulated simultaneous encoded-source gather, said difference being referred to as the residual for that receiver;
- (g) applying receiver encoding to each residual, said receiver encoding being selected to attenuate contributions from sources for which the receiver was inactive;
- (h) computing an objective function from the receiver-encoded residuals, and updating the assumed physical properties model based on the objective function computation;
- (i) repeating (b)-(h) at least one more iteration, using the updated physical properties model from the previous iteration as the assumed physical properties model, to produce a further updated physical properties model of the subsurface region; and
- (j) downloading the further updated physical properties model or saving it to computer storage.

~~24. A computer implemented method for inversion of measured data from a geophysical survey to determine a physical properties model for a subsurface region, comprising:~~

(a) simulating, using an assumed physical properties model, all source gathers in the measured geophysical data in a single simulation, using encoding, thereby generating a simulated data set;

5 (b) determining a grouping strategy that helps distinguish between data records corresponding to a receiver and a source where the receiver did not listen to the source during the geophysical survey;

(c) for each group, encoding the sources, each source being encoded with the same encoding used in (a), and performing steps comprising:

10 (i) simulating, using the assumed physical properties model, all source gathers in the group in a single simulation, thereby generating a simulated group data set;

(ii) determining receiver locations in the simulated group data set that were not illuminated by at least one of the sources in the group;

15 (iii) for each of the determined receiver locations, retrieving corresponding data from the simulated group data set and subtracting it from the same receiver location in the simulated data set;

(d) adjusting the measured data to include only data corresponding to that remaining in the simulated data set after (iii), and computing a data residual, being a difference between the adjusted measured data and the simulated data set;

20 (e) adjusting the assumed physical properties model to reduce the data residual; and

(f) repeating (a)-(e) until a predetermined convergence criterion is satisfied or other stopping condition is met.

25 25. The method of claim 24, wherein the encoding in (a) and (c) is encoding each source with a different encoding function wherein the encoding is orthogonal or pseudo-orthogonal with respect to cross-correlation, and simulating some or all groups simultaneously in (c)(i).

26. The method of claim 25, wherein the orthogonal or pseudo-orthogonal encoding comprises a set of bandpass filters, differing from each other in central frequency, phase, or both.
- 5 27. The method of claim 24, wherein both the encoding in (a) and the encoding in (c) are accompanied by a second encoding, making the source gathers in (a) and the sources in (c) doubly encoded.
28. The method of claim 27, wherein the second encoding is $+1/-1$ encoding.
- 10 29. The method of claim 24, wherein the grouping strategy is to group a plurality of individual-source gathers having a common set of illuminated receivers.