Journal of Seismic Exploration
Volume 26, Issue 2, April 2017, Pages 183-198

Least-squares reverse-time migration toward "true" reflectivity

Zhang, H., Liu, Q., Hao, J.

Key Laboratory of Petroleum Resources Research, Institute of Geology and Geophysics, Beijing, China

King Abdullah University of Science and Technology, Thuwal, Saudi Arabia

Research Institute of Petroleum Exploration and Development, PetroChina, Qinghai, China

Abstract

Conventional least-squares reverse time migration (LSRTM) usually aims to improve the quality of seismic image, by removing the acquisition footprint, suppressing migration artifacts, and enhancing resolution. We find that the conventional reflectivity defined in the LSRTM is related to the normal-incidence reflection coefficient and the background velocity. Compared with the defined reflectivity, our inverted result is approximate. With reflected data, LSRTM is mainly sensitive to impedance perturbations. According to an approximate relationship between them, we reformulate the perturbation-related system into a pseudo reflection-coefficient related one. Then, we seek the inverted image through linearized iteration. With the assumption that the density varies gradually compared to the migration velocity, only the knowledge of the velocity is required, although the reflected waves are produced at impedance discontinuities. We validate our scheme using the 2D Marmousi synthetic dataset. © 2017 Geophysical Press Ltd.

Author keywords

Linear Inversion LSRTM Normal-incidence reflection coefficient

References

1) Beylkin, G., Oristaglio, M., Miller, D.
SPATIAL RESOLUTION OF MIGRATION ALGORITHMS.
(1985) Acoustical Imaging: Proceedings of the International Symposium, 14, pp. 155-168. Cited 38 times.

2) Claerbout, J.F.
Earth soundings analysis
(1992) Processing Versus Inversion. Cited 1 time.

3) Clapp, M.L., Clapp, R.G., Biondi, B.L.
Regularized least-squares inversion for 3-D subsalt imaging
(2005) 75th Annual International Meeting, pp. 1814-1817. Cited 15 times.

4) Dai, W., Schuster, G.T.
Plane-wave least-squares reverse-time migration
(2013) Geophysics, 78 (4), pp. S165-S177. Cited 57 times.
DOI: 10.1190/GEO2012-0377.1

5) Dutta, G., Schuster, G.T.
Attenuation compensation for least-squares reverse time migration using the viscoacoustic-wave equation
(2014) Geophysics, 79 (6), pp. S251-S262. Cited 39 times.
DOI: 10.1190/GEO2013-0414.1

ELSEVIER
Terms and conditions Privacy policy
Copyright © 2017 Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.
RELX Group™

6) Guitton, A., Valenciano, A., Bevc, D., Claerbout, J.
Smoothing imaging condition for shot-profile migration
(2007) Geophysics, 72 (3), pp. S149-S154. Cited 44 times.
DOI: 10.1190/1.2712113

7) Huang, Y., Schuster, G.T.
Multisource least-squares migration of marine streamer and land data with frequency-division encoding
(2012) Geophysical Prospecting, 60 (4), pp. 663-680. Cited 29 times.
DOI: 10.1111/j.1365-2478.2012.01086.x

8) Kaplan, S.T., Routh, P.S., Sacchi, M.D.
Derivation of forward and adjoint operators for least-squares shot-profile split-step migration
(2010) Geophysics, 75 (6), pp. S225-S235. Cited 31 times.
DOI: 10.1190/1.3506146

9) Kuehl, H., Sacchi, M.
Robust AVP estimation using least-squares wave-equation migration
(2002) SEG Technical Program Expanded Abstracts, 21 (1), pp. 281-284. Cited 7 times.
DOI: 10.1190/1.1817231

10) Mora, Peter
NONLINEAR TWO-DIMENSIONAL ELASTIC INVERSION OF MULTIOFFSET SEISMIC DATA.
(1987) Geophysics, 52 (9), pp. 1211-1228. Cited 444 times.

ELSEVIER
Terms and conditions Privacy policy
Copyright © 2017 Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.
RELX Group™

11) Mora, P.
Inversion = migration + tomography
(1989) Geophysics, 54 (12), pp. 1575-1586. Cited 137 times.

12) Lailly, P.
The seismic inverse problem as a sequence of before stack migrations
(1983) Conference on Inverse Scattering: Theory and Application, pp. 206-220. Cited 374 times.

13) Nemeth, T., Wu, C., Schuster, G.T.
Least-squares migration of incomplete reflection data
(1999) Geophysics, 64 (1), pp. 208-221. Cited 330 times.

14) Plessix, R.-E.
A review of the adjoint-state method for computing the gradient of a functional with geophysical applications
(2006) Geophysical Journal International, 167 (2), pp. 495-503. Cited 445 times.
DOI: 10.1111/j.1365-246X.2006.02978.x

15) Plessix, R.-E., Li, Y.
Waveform acoustic impedance inversion with spectral shaping
(2013) Geophysical Journal International, 195 (1), pp. 301-314. Cited 6 times.
DOI: 10.1093/gji/ggt233

16) Schuster, G.T.
Least-squares cross-well migration
(1993) 63rd Annual International Meeting, SEG, Expanded Abstracts, pp. 110-113. Cited 44 times.

ELSEVIER
Terms and conditions Privacy policy
Copyright © 2017 Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.
RELX Group™

17) Tan, S., Huang, L.
Least-squares reverse-time migration with a wavefield-separation imaging condition and updated source wavefields
(2014) Geophysics, 79 (5), pp. S195-S205. Cited 13 times.
DOI: 10.1190/GEO2014-0020.1

18) Tang, Y.
Wave-equation Hessian by phase encoding
(2008) SEG Technical Program Expanded Abstracts, 27 (1), pp. 2201-2205. Cited 15 times.
DOI: 10.1190/1.3059323

19) Kroode, F.T.
A wave-equation-based Kirchhoff operator
(2012) Inverse Problems, 28 (11), art. no. 115013, . Cited 18 times.
DOI: 10.1088/0266-5611/28/11/115013

20) Virieux, J.
P- SV wave propagation in heterogeneous media: velocity- stress finite-difference method.
(1986) Geophysics, 51 (4), pp. 889-901. Cited 1404 times.

21) Virieux, J., Operto, S.
An overview of full-waveform inversion in exploration geophysics
(2009) Geophysics, 74 (6), pp. WCC1-WCC26. Cited 839 times.
DOI: 10.1190/1.3238367

22) Wang, J., Kuehl, H., Sacchi, M.D.

Terms and conditions Privacy policy
Copyright © 2017 Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.
RELX Group™

High-resolution wave-equation AVA imaging: Algorithm and tests with a data set from the Western Canadian Sedimentary Basin

(2005) Geophysics, 70 (5), pp. S91-S99. Cited 15 times.

DOI: 10.1190/1.2076748

23) Wang, J., Sacchi, M.D.

High-resolution wave-equation amplitude-variation-with-ray-parameter (AVP) imaging with sparseness constraints

(2007) Geophysics, 72 (1), pp. S11-S18. Cited 26 times.

DOI: 10.1190/1.2387139

24) Zhang, Y., Ratcliffe, A., Roberts, G., Duan, L.

Amplitude-preserving reverse time migration: From reflectivity to velocity and impedance inversion

(2014) Geophysics, 79 (6), pp. S271-S283. Cited 17 times.

DOI: 10.1190/GEO2013-0460.1

25) Zhang, Y., Duan, L., Xie, Y.

A stable and practical implementation of least-squares reverse time migration

(2014) Geophysics, 80 (1), pp. V23-V31. Cited 28 times.

DOI: 10.1190/GEO2013-0461.1

ELSEVIER

Terms and conditions Privacy policy

Copyright © 2017 Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.

RELX Group™