

# CONTENTS

	Page
Acknowledgement	<b>Error! Bookmark not defined.</b>
Abstract in Thai	<b>Error! Bookmark not defined.</b>
Abstract in English	f
List of Tables	j
List of Figures	k
Chapter 1 Introduction	<b>Error! Bookmark not defined.</b>
1.1 The objective of study	<b>Error! Bookmark not defined.</b>
1.2 Literature review	<b>Error! Bookmark not defined.</b>
Chapter 2 Theory and Methodology	<b>Error! Bookmark not defined.</b>
2.1 General Theory	<b>Error! Bookmark not defined.</b>
2.1.1 Zero-offset and Exploding reflector	<b>Error! Bookmark not defined.</b>
2.1.2 Downward continuation	<b>Error! Bookmark not defined.</b>
2.1.3 Lateral Resolution	<b>Error! Bookmark not defined.</b>
2.1.4 Time and Depth Migration	<b>Error! Bookmark not defined.</b>
2.1.5 Wave Equation Migration	<b>Error! Bookmark not defined.</b>
2.1.6 Wavefield Extrapolation	<b>Error! Bookmark not defined.</b>
2.1.7 Gazdag Migration	<b>Error! Bookmark not defined.</b>
2.1.8 Finite-difference Migration	<b>Error! Bookmark not defined.</b>
2.2 Methodology	<b>Error! Bookmark not defined.</b>
2.2.1 Wavefield Extrapolation in log-polar Coordinates	<b>Error! Bookmark not defined.</b>
2.2.2 Migration in log-polar Coordinate System	<b>Error! Bookmark not defined.</b>
2.2.3 Database	<b>Error! Bookmark not defined.</b>
2.2.4 Data Checking	<b>Error! Bookmark not defined.</b>

2.2.5 Preparing velocity	<b>Error! Bookmark not defined.</b>
2.2.6 Changing coordinate system to log-polar coordinate system	<b>Error!</b>
<b>Bookmark not defined.</b>	
Chapter 3 Results	<b>Error! Bookmark not defined.</b>
3.1 The migration impulse response	<b>Error! Bookmark not defined.</b>
3.2 The synthetic data set	<b>Error! Bookmark not defined.</b>
3.3 Post-stack unmigrated section	<b>Error! Bookmark not defined.</b>
3.4 Post-stack migration result of WSS140-Shelikof, Alaska	<b>Error! Bookmark not defined.</b>
3.5 Post-stack migration result of WSS160-Shelikof, Alaska	<b>Error! Bookmark not defined.</b>
3.6 Post-stack migration result of WNS324-Norton Sound, Alaska	<b>Error!</b>
3.7 Post-stack migration result of WNS325-Norton Sound, Alaska	<b>Error!</b>
Chapter 4 Discussion and Conclusion	<b>Error! Bookmark not defined.</b>
4.1 Discussion	<b>Error! Bookmark not defined.</b>
4.1.1 The additional area from coastal of California	<b>Error! Bookmark not defined.</b>
4.1.2 The migration results of the additional area from coastal of California	<b>Error! Bookmark not defined.</b>
4.2 Conclusion	<b>Error! Bookmark not defined.</b>
References	<b>Error! Bookmark not defined.</b>
Appendix	<b>Error! Bookmark not defined.</b>
Curriculum Vitae	<b>Error! Bookmark not defined.</b>

## LIST OF TABLES

Page

Table 2.1 The data from Alaska **Error! Bookmark not defined.**

Table 4.1 The addition area from coastal of California **Error! Bookmark not defined.**



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่  
Copyright© by Chiang Mai University  
All rights reserved

## LIST OF FIGURES

		Page
Figure 2.1	a) Unmigrated section and b) Migrated section (After Yilmaz, 1987).	Error! Bookmark not defined.
Figure 2.2	Zero-offset (Claerbout, 1985).	Error! Bookmark not defined.
Figure 2.3	Exploding reflectors (Claerbout, 1985).	Error! Bookmark not defined.
Figure 2.4	Storm barrier for understanding downward continuation (After Claerbout, 1985).	Error! Bookmark not defined.
Figure 2.5	Fresnel zone.	Error! Bookmark not defined.
Figure 2.6	The geometry of Fresnel zone (After Sheriff, 1980).	Error! Bookmark not defined.
Figure 2.7	Migrated seismic section a) time migration and b) depth migration (Gray et al., 2001).	Error! Bookmark

Figure 2.8 Step of Gazdag migration method (After Yilmaz, 1987).

**Error!**

## Bookmark

Figure 2.9 Dispersion relation (Claerbout, 2010).

**Error!**

## Bookmark

Figure Workflow

**Error!**

## Bookmark

Figure Proposed steps.

**Error!**

## Bookmark

Figure 2.12 The study areas a) The data from Alaska and b) coastal of California (USGS, 2015).

**Error!**

## Bookmark

Figure Post-stack data with the problem.

**Error!**

## Bookmark

Figure Post-stack data without the problem.

**Error!**

## Bookmark

Figure The velocity data a) Before preparing and b) After AWK

**Error!**

2.15	software (USGS, 2015).	<b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 2.16	AKW code for preparing velocity data (Hutawarakorn, 2015).	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 2.17	The example of velocity before interpolating.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 2.18	After interpolating velocity.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 2.19	The velocity model before interpolated from Cartesian to log-polar coordinate.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 2.20	The effective slowness model in log-polar coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่  
Copyright© by Chiang Mai University  
All rights reserved

Figure 2.21	After interpolated back from Cartesian to log-polar coordinate systems.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 2.22	The difference value between the data before interpolated the data and interpolated back to Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.1	Wavelet	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.2	Gazdag migration impulse response in Cartesian coordinate system with constant velocity 2000m/s.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.3	Gazdag migration impulse response in log-polar coordinate system with constant velocity 2000m/s.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.4	15-degree Finite-difference migration impulse response in Cartesian coordinate system with constant velocity 2000m/s.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.5	15-degree Finite-difference migration impulse response in log-polar coordinate systems with constant velocity 2000m/s.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.6	Marmousi velocity.	<b>Error!</b> <b>Bookmark not defined.</b>

Figure 3.7	Gazdag migration impulse response in Cartesian coordinate system with Marmousi velocity.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.8	Gazdag migration impulse response in log-polar coordinate system with Marmousi velocity.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.9	15-degree Finite-difference migration impulse response in Cartesian coordinate system with Marmousi velocity.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.10	15-degree Finite-difference migration impulse response in log-polar coordinate systems with Marmousi velocity.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.11	The synthetic velocity data.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.12	Unmigrated synthetic data.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.13	After interpolated to log-polar coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.14	The data in log-polar coordinate system after migration with Gazdag migration method.	<b>Error!</b> <b>Bookmark not defined.</b>



Figure 3.15	The data in log-polar coordinate system after migration with 15-degree Finite-difference migration method.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.16	Gazdag migration result in Cartesian coordinate system of syncline synthetic data.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.17	Gazdag migration result in log-polar coordinate system of syncline synthetic data.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.18	15-degree Finite-difference migration result in Cartesian coordinate system of syncline synthetic data.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.19	15-degree Finite-difference migration result in log-polar coordinate system of syncline synthetic data.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.20	Post-stack unmigrated section of WSS140-Shelikof Strait, Alaska.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.21	Post-stack unmigrated section of WSS160-Shelikof Strait, Alaska.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.22.	Post-stack unmigrated section of WNS324-Norton Sound, Alaska.	<b>Error!</b> <b>Bookmark not defined.</b>

		<b>defined.</b>
Figure 3.23	Post-stack unmigrated section of WNS325-Norton Sound, Alaska.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.24	WSS140-Shelikof Strait, Gazdag migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.25	WSS140-Shelikof Strait, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.26	WSS140-Shelikof Strait, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.27	Shallow part of WSS140-Shelikof Strait: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.28	Instantaneous frequency of WSS140-Shelikof Strait: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.29	WSS160-Shelikof Strait, Gazdag migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 3.30	WSS160-Shelikof Strait, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not</b>

			<b>defined.</b>
Figure 3.31	WSS160-Shelikof Strait, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>	
Figure 3.32	Shallow part of WSS160-Shelikof Strait: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate systems.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>	
Figure 3.33	Instantaneous frequency of WSS160-Shelikof Strait: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>	
Figure 3.34	WNS324-Norton Sound, Gazdag migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>	
Figure 3.35	WNS324-Norton Sound, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>	
Figure 3.36	WNS324-Norton Sound, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>	
Figure 3.37	Deeper part of WNS324-Norton Sound: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate systems.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>	
Figure	Instantaneous frequency of WNS324-Norton Sound: a)	<b>Error!</b>	

3.38	Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Bookmark not defined.</b>
Figure 3.39	WNS325-Norton Sound, Gazdag migrated section in Cartesian coordinate system.	<b>Error! Bookmark not defined.</b>
Figure 3.40	WNS324-Norton Sound, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error! Bookmark not defined.</b>
Figure 3.41	WNS325-Norton Sound, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error! Bookmark not defined.</b>
Figure 3.42	Shallow part of WNS325-Norton Sound: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate systems.	<b>Error! Bookmark not defined.</b>
Figure 3.43	Instantaneous frequency of WNS325-Norton Sound: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error! Bookmark not defined.</b>
Figure 4.1	Migration section of Marmousi data set in log-polar coordinate system: a) migration in Cartesian coordinate and b) migration in log-polar coordinate (Naghadeh and Riahi, 2013a).	<b>Error! Bookmark not defined.</b>
Figure 4.2	15-degree Finite-difference migration testing velocity error a) a zero-offset section that contains a diffraction hyperbola with 2500m/s velocity b) desired migration c) the medium velocity of 2500m/s d) velocity 5 percent lower e) velocity 10 percent lower f) velocity 5 percent higher g) velocity 10	<b>Error! Bookmark not defined.</b>

	percent higher (After Yilmaz, 1987).	
Figure 4.3	The stacked section and migration results including Gazdag and 15-degree Finite-difference migration methods (Yilmaz, 1987).	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.4	Finite-difference migration method for 15, 45 and 65 degree approximation (After Yilmaz, 1987).	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.5	Migrated section of WNS324, 15-degree Finite-difference migrated section a) in Cartesian coordinate system b) in log-polar coordinate system after doubling the number of step size during interpolation.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.6	Amplitude Spectrum after doubling the number of step size during interpolation.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.7	Comparison of amplitude spectrum in log-polar after doubling the number of step size during interpolation of data set from Cartesian to log-polar.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.8	The additional area from coastal of California (USGS, 2015).	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.9	Post-stack unmigrated section of WNC82025, coastal of California.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.10	Post-stack unmigrated section of WNC82014, coastal of California.	<b>Error!</b> <b>Bookmark</b> <b>not</b>

		defined.
Figure 4.11	Post-stack unmigrated section of WNC82012, coastal of California.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.12	Post-stack unmigrated section of W75520, coastal of California.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.13	Post-stack unmigrated section of W532A, coastal of California.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.14	WNC82025-coastal of California, Gazdag migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.15	WNC82025-coastal of California, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.16	WNC82025-coastal of California, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.17	WNC82025-coastal of California: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate systems.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.18	Instantaneous frequency of WNC82025-coastal of California: a) Gazdag migrated section in Cartesian b) 15-	<b>Error!</b> <b>Bookmark</b>

	degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>not defined.</b>
Figure 4.19	WNC82014-coastal of California, Gazdag migrated section in Cartesian coordinate system	<b>Error! Bookmark not defined.</b>
Figure 4.20	WNC82014-coastal of California, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error! Bookmark not defined.</b>
Figure 4.21	WNC82014-coastal of California, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error! Bookmark not defined.</b>
Figure 4.22	Deeper part of WNC82014-coastal of California: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate systems.	<b>Error! Bookmark not defined.</b>
Figure 4.23	Instantaneous frequency of WNC82014-coastal of California: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error! Bookmark not defined.</b>
Figure 4.24	WNC82012-coastal of California, Gazdag migrated section in Cartesian coordinate system.	<b>Error! Bookmark not defined.</b>
Figure 4.25	WNC82012-coastal of California, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error! Bookmark not defined.</b>

Figure 4.26	WNC82012-coastal of California, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.27	Deeper part of WNC82012-coastal of California: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate systems.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.28	Instantaneous frequency of WNC82012-coastal of California: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.29	W75520-coastal of California, Gazdag migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.30	W75520-coastal of California, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.31	W75520-coastal of California, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.32	Shallow part of W75520-coastal of California: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-difference migrated section in log-polar coordinate systems.	<b>Error!</b> <b>Bookmark not defined.</b>
Figure 4.33	Instantaneous frequency of W75520-coastal of California: a) Gazdag migrated section in Cartesian b) 15-degree Finite-difference migrated section in Cartesian c) 15-degree Finite-	<b>Error!</b> <b>Bookmark not</b>



	difference migrated section in log-polar coordinate system.	<b>defined.</b>
Figure 4.34	W532A-coastal of California, Gazdag migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.35	W532A-coastal of California, 15-degree Finite-difference migrated section in Cartesian coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>
Figure 4.36	W532A-coastal of California, 15-degree Finite-difference migrated section in log-polar coordinate system.	<b>Error!</b> <b>Bookmark</b> <b>not</b> <b>defined.</b>

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่  
 Copyright© by Chiang Mai University  
 All rights reserved