STRUCTURAL CHARACTERISTICS IN AYUTTHAYA BASIN

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ลักษณะเฉพาะทางโครงสร้างในแอ่งอยุธยา

นางสาวสุวดี จิระราชวโร

โครงงานนี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรวิทยาศาสตรบัณฑิต

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Field of Study	Geology
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(Dr. Sukonmeth Jitmahantakul)

สุวดี จิระราชวโร : ลักษณะเฉพาะทางโครงสร้างในแอ่งอยุธยา (STRUCTURAL CHARACTERISTICS IN AYUTTHAYA BASIN) อาจารย์ที่ปรึกษาโครงงานหลัก : อาจารย์ ดร.สุคนเมธ จิตรมหันตกุล, 56 หน้า

แอ่งอยุธยาเป็นแอ่งตะกอนวางตัวในแนวเหนือ-ใต้ในมหายุคซีโนโซอิก ตั้งอยู่ในบริเวณที่ราบลุ่มภาคกลางตอนล่าง โดยแอ่งอยุธยาวางตัวอยู่บนรอยเลื่อนแม่ปิงซึ่งอยู่ในแนวตะวันตกเฉียงเหนือ-ตะวันออกเฉียงใต้ ในการศึกษาโครงงานนี้มีการนำข้อมูลคลื่นไหวสะเทือน 2 มิติ และข้อมูลหลุมเจาะมาช่วยในการจำแนกลักษณะชั้นหินและโครงสร้างภายในแอ่ง อีกทั้งมีการจัดทำแผนที่พื้นผิว แผนที่ความหนาของชั้นตะกอน ลำดับชั้นหินจากข้อมูลคลื่นไหวสะเทือน 2 มิติ และแบบจำลองวิวัฒนาการของแอ่งสะสมตะกอน โดยพบว่าแอ่งอยุธยามีลักษณะเด่นคือเป็นแอ่งตะกอนแบบกึ่งกราเบนที่เอียงไปทางด้านตะวันออก พบรอยเลื่อนปกติที่มีการเอียงเทไปทางทิศตะวันตกเป็นจำนวนมาก

การศึกษานี้ได้แบ่งวิวัฒนาการได้เป็น 4 ช่วงอายุ โดยในช่วงแรกคือเหตุการณ์แอ่งขยายในสมัยโอลิโกซีนตอนปลายส่งผลให้แอ่งอยุธยาเกิดการยืดออกในแนวเหนือ-ใต้ ต่อมาแรงที่มากระทำได้หยุดลงและเข้าสู่เหตุการณ์แอ่งทรุด หลังจากนั้นในสมัยไมโอซีนตอนปลาย แอ่งอยุธยาได้รับอิทธิพลจากแรงบีบอัดในแนวตะวันตกเฉียงเหนือ-ตะวันตกเฉียงใต้ ส่งผลให้เกิดเหตุการณ์โครงสร้างผกผันขึ้นในพื้นที่ ท้ายที่สุดแอ่งอยุธยาได้เข้าสู่เหตุการณ์แอ่งทรุดในสมัยไพลโอซีน โดยรูปร่างของแอ่งอยุธยาถูกควบคุมด้วยลักษณะโครงสร้างเก่าที่อยู่ในแนวตะวันตกเฉียงเหนือ-ตะวันออกเฉียงใต้

ภาควิชา............ธรณีวิทยา............ลายมือชื่อนิสิต..

สาขาวิชา...........ธรณีวิทยา.......... ลายมือชื่อ อ.ที่ปรึกษาหลัก..................................

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SUWADEE JIRARACHWARO : STRUCTURAL CHARACTERISTICS IN AYUTTHAYA BASIN. ADVISOR : SUKONMETH JITMAHANTAKUL, Ph.D., 56 pp.

The Ayutthaya Basin is a N-S trending Cenozoic basin located in Lower Central Plain Thailand. The basin overlies on Mae Ping fault zone in NNW-SSE trend. 2D seismic sections and well data are included to illustrate a structural and stratigraphic variation in the basin. Surface map, isopach map, tectono-stratigraphy and structural evolutionary model are presented in this study. Ayutthaya basin is characterized by half-graben geometry which is eastward tilted. The major faults are west dipping normal fault with N-S oriented. The evolution of Ayutthaya basin can be divided into 4 phases. The first phase commences with extensional rifting in which the basin was developed during the Late Oligocene to Middle Miocene period. Subsequently, the extensional stress ended and subsidence phase had increased. After that, the stress regime had changed to the NNW compression which episodically resulted in strike-slip reactivation and basin inversion phase. Finally, the overall stress has been stopped in Pliocene. Basins were subsided without significant tilting or rotating.

Department : …..…Geology….....	Student's Signature……………..………..…
Field of Study : …...Geology….…	Advisor's Signature……………………..………
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I am very grateful to my classmates for their help and friendship. It has been a special experience knowing all of you.

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Chapter 1

Introduction

The Ayutthaya Basin is an elongate, N-S trending Cenozoic basin located in Lower Central Plain Thailand and trending in N-S (Fig 1.1). The basin is considered as low petroleum potential basin due to well data and seismic survey (O'Leary,1987). This leaves the basin with no more exploration activity since 1956.

Ayutthaya basin is an eastward tilted half-graben basin with total area of about 2,790 km^2 (with a width of about 30 km and a length of about 90 km) (Fig 1.2) The basin is 3 km deep which composed of conglomerate, sandstone, siltstone, and mudstone (O'Leary,1987). The evolution of Ayutthaya basin is similar to the other basins; that is, the basins have developed during Late Oligocene and rifting stopped in Pliocene (Morley et al., 2011). Ayutthaya Basin is believed to be a rift structure that is relate to the interaction of Indo-Australian and Eurasian Plates since the Late Eocene period. As India penetrate to the north, Southeast Asia block was gradually push out southeastwards with progressively clockwise rotation and the faults extended result in Cenozoic basins (Charusiri & Pum-Im, 2009).

Since the previous studied about was limited by seismic data, the structural characteristic in Ayutthaya Basin is still ambiguous. This report discusses a new tectono-stratigraphy and structural evolutionary model based on 2D seismic data. Information about the basin has come from Department of Mineral Fuels, Thailand.

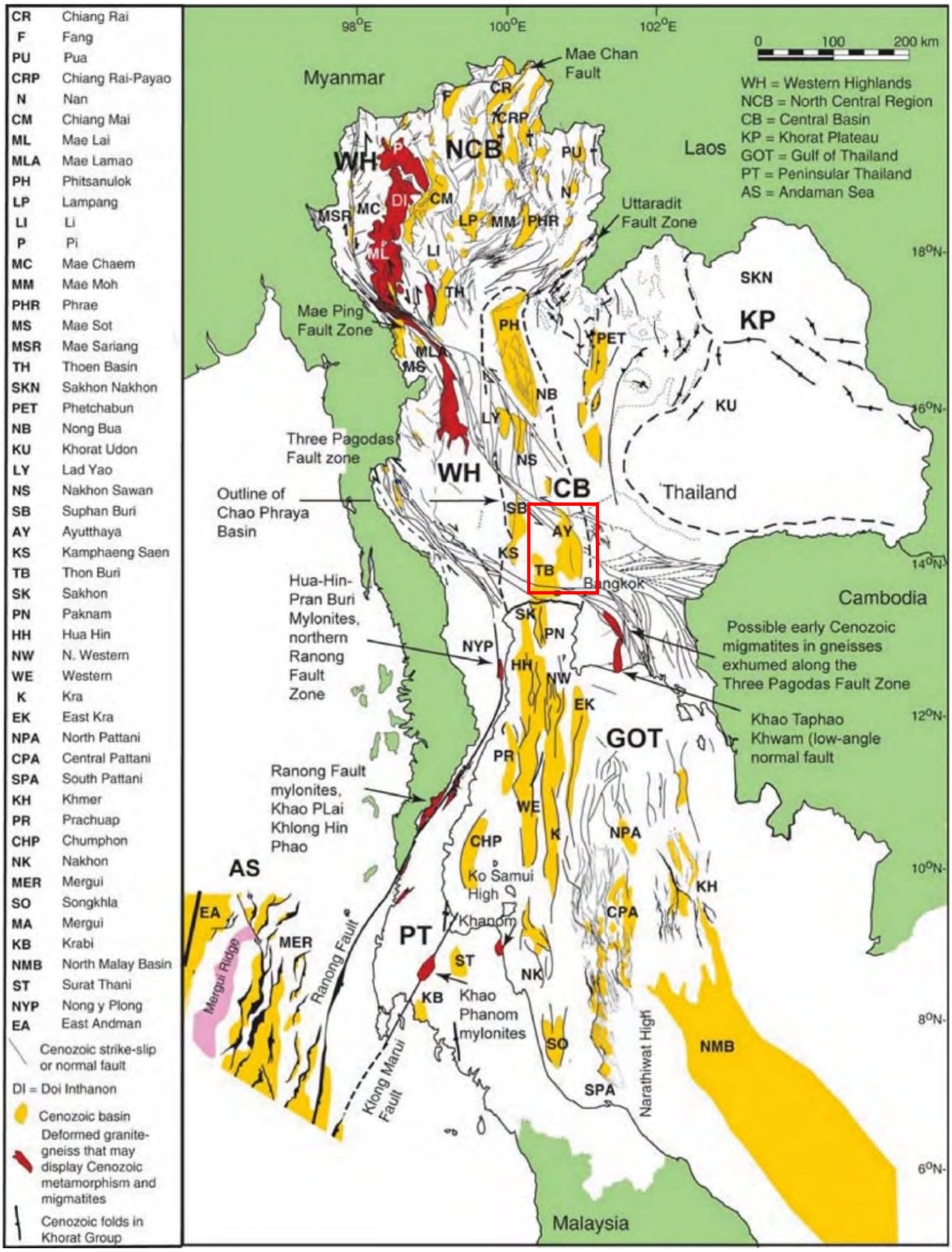

Figure 1.1 Location of major Cenozoic basins and structural features in Thailand (modified from Morley et al., 2011).

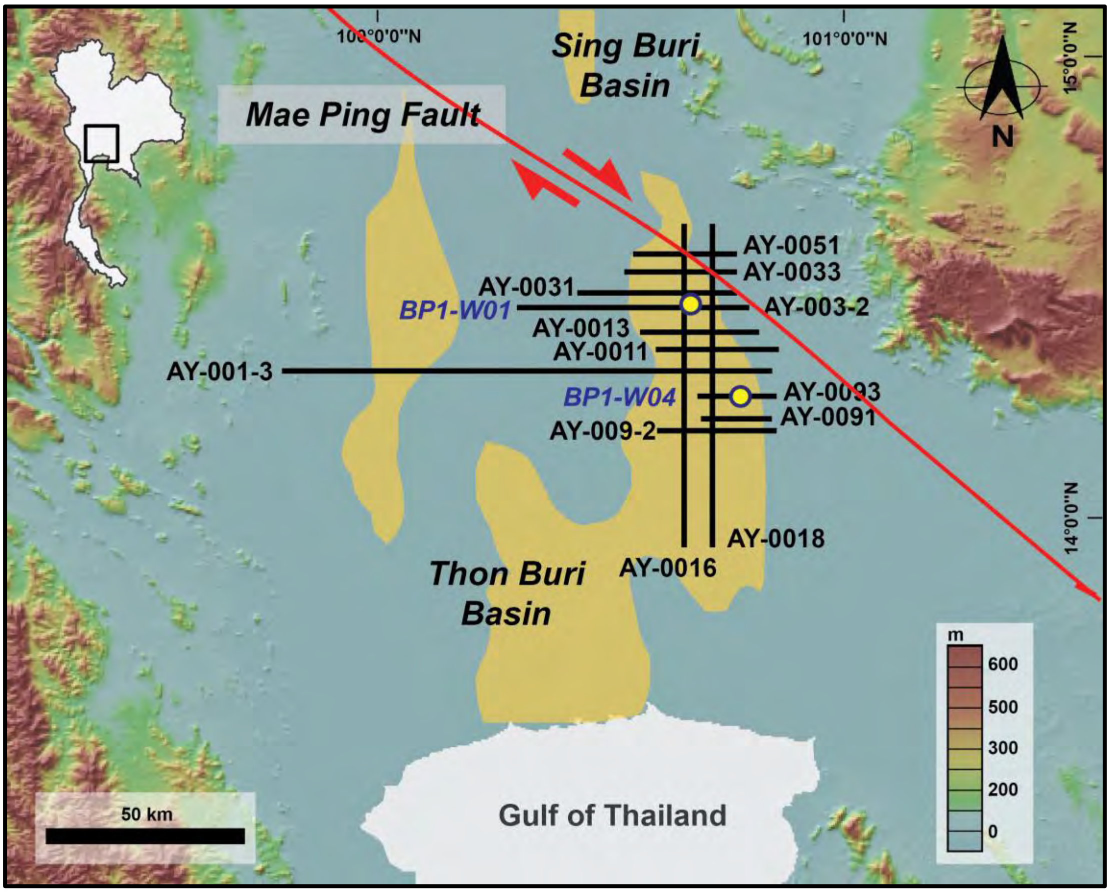

Figure 1.2 Digital elevation model of Lower Central Plain Thailand showing outlines of Sing Buri, Suphan Buri, Thon Buri and Ayutthaya basins (ASTER Global Digital Elevation Map). The Ayutthaya Basin is bound to the north by the NW-SE-striking Mae Ping Fault. Black lines are seismic sections used in this study. Yellow circles are locations of BP1-W01 and BP1-W04 wells.

Chapter 2

General Geology

2.1 Evolution of Cenozoic basins

Major Cenozoic basins in Thailand are occurred by the interaction of India and Asia subduction and continental collision (Tapponnier et al., 1986). In summary, the basin development can be divided into 4 phases;

2.1.1 Pull-apart and Syn-rifting phase

The first episode of basin formation commences with the onset of transtensional rifting in which predominantly N-NNW trending extensional troughs were formed. After the interaction between India and Asia in Early Miocene, tectonic style has changed from passive continental margin to subduction continental margin. The crustal pure extension with oceanic rifting in Andaman Sea and continental rifting in Gulf of Thailand may result in extensive crustal thinning and might increase the heat flow, cause the mild regional uplift. Resulting from this tectonic episode, the basins formed as graben and half graben type basins in Late Eocene to Late Oligocene.

2.1.2 Thermal subsidence phase

This episode start in Late Oligocene when pure extension in the basin dropped and transtensional tectonic significant increased. It can be inferred that thermal contraction from mantle plume triggered the basin extension. The lithosphere strengthening from cooling may cause the tectonic strain, forming the widening basin by strike-slip motion. The continental crust thinning due to high heat flow results in rapid basin subsidence. According to rapid extension and deepening, graben to half-graben developed.

2.1.3 Transpressional wrenching (Inversion) phase

The continuing dextral shear subsequent caused a change of tectonic style, becoming transpressional in late Middle Miocene, resulting in folding and inversion of Thailand basin in very late Neogene. The time fairly correlate with the commence of Burma plate to part of Southeast Asia block and the development of Andaman sea floor spreading.

2.1.4 Post-rifting phase

After the transpressional event, the overall region is being stable. In the Gulf and Central Thailand, basins were subsided without significant tilting or rotating and the subsidence rate in the basin decrease with time (Charusiri and Pum-Im, 2009).

2.2 Geology of the Lower Central Plain Thailand

With the major faults movement, e.g. Mae Ping fault, Three Pagoda fault, and Uttaradit fault, during Late Cretaceous to Late Oligocene, Gulf of Thailand opened in south direction and the Cenozoic basins are developed in the northern and western part of Thailand. After that, the north-south trending fault zone and the Central Plain are occurred, respectively (Bunopas, 1981). The Central Plain deposited as alluvial fan, floodplain, channel, lake, and delta.

2.2.1 Geological structures and evolution in Central Plain

The Central Plain development during Eocene is controlled by the 2 major structural trends.

A north-south trending structure in Pre-Triassic section

The north-south fabric is resulting from Indosinian Orogeny; that is, interaction between western Shan-Thai and eastern Indochina continental blocks in which occurred Early to Mid-Triassic. Closing of the Paleo-Tethys Ocean commenced in Late Permian is now represented by Nan-Uttaradit suture zone. Subsequent to Indosinian Orogeny and the closing of Paleo-Tethys, the continental plate suffered rapid tectonic relaxation and resultant basin extension with north-south structural trend.

A series of northwest-southeast strike-slip fault zones

Evidence from satellite photos and geologic map indicates that the northeast-southwest trending fault zones were active during Mesozoic. Strike-slip Mae Ping and Three Pagoda fault zones show the sinistral movement from basement structure in Mesozoic (Fig 2.1).

Both of fault zones have the dextral strike-slip movement in Tertiary. The changing of fault movement from sinistral to dextral during the Neogene is relate to the interaction between Indo-Australian and Eurasian Plates. This could be result in Indochina’s western margin rotation and continued collision between India and Asia blocks.

All major Cenozoic basins in Central Plain are north-south trending extension, which develop in Late Oligocene. The geological structures are controlled by 2 major northwest-southeast trending strike-slip fault zones; Mae Ping and Three Pagoda fault zones. For Ayutthaya basin, one of the major basins in Lower Central Plain, is half-graben basin in north-south direction. The basin developed various period of time and related to the rifting and inversion. With the study from geological structures and stratigraphy, it may be inferred to tectonic evolution in the Central Plain.

2.2.2 Stratigraphy in Central Plain

The stratigraphy in Central Plain can be categorized into 7 units from outcrops in eastern and western part of study area., which are 5 rock units and 2 sediment units. (Fig 2.2)

Rock units

- Lower Paleozoic Silurian-Devonian rocks compose of tuffaceous rocks, limestone, marble and chert in Sukhothai fold belt.
- Upper Paleozoic Carboniferous rocks mainly consist of red sandstone with shale and red siltstone interbedded which found in Nakhon Sawan and Chainat provinces
- Upper Paleozoic Permian rocks compose of limestone, shale, and sandstone which located in western part of Chao Phraya river and Nakhon Sawan-Lopburi trend, respectively.
- Upper Mesozoic rocks is limestone interbedded with volcaniclastic rocks which were overlaid by the red rocks of Khorat Group. These rocks deposited as north-south trend in the eastern Central Plain.
- Cenozoic Paleogene rocks in Central Plain is all covered by Quaternary sediments. Geological data from seismic survey and well logging shows the 3 majors basins; Phitsanulok basin, Suphanburi basin, and Thonburi basin, which can be divided into subgroups.

Sediment units

Quaternary Pleistocene sediments are mostly found in Chao Phraya floodplain. The sediment thickness is about 650 -1,830 meters which continued depositing in slowly subsidence fault block. The sediments are divided into 2 units.

- Chao Phraya sediment mainly composed of gravel, various sizes of sand, and clay which deposited in forms of layers, and lenses.
- Bangkok clay, is also known as the marine clay, this sedimentary unit overlies the Pleistocene stiff clay mainly composed of the intercalation between clay and sand or silt together with the peat and mollusk shells.

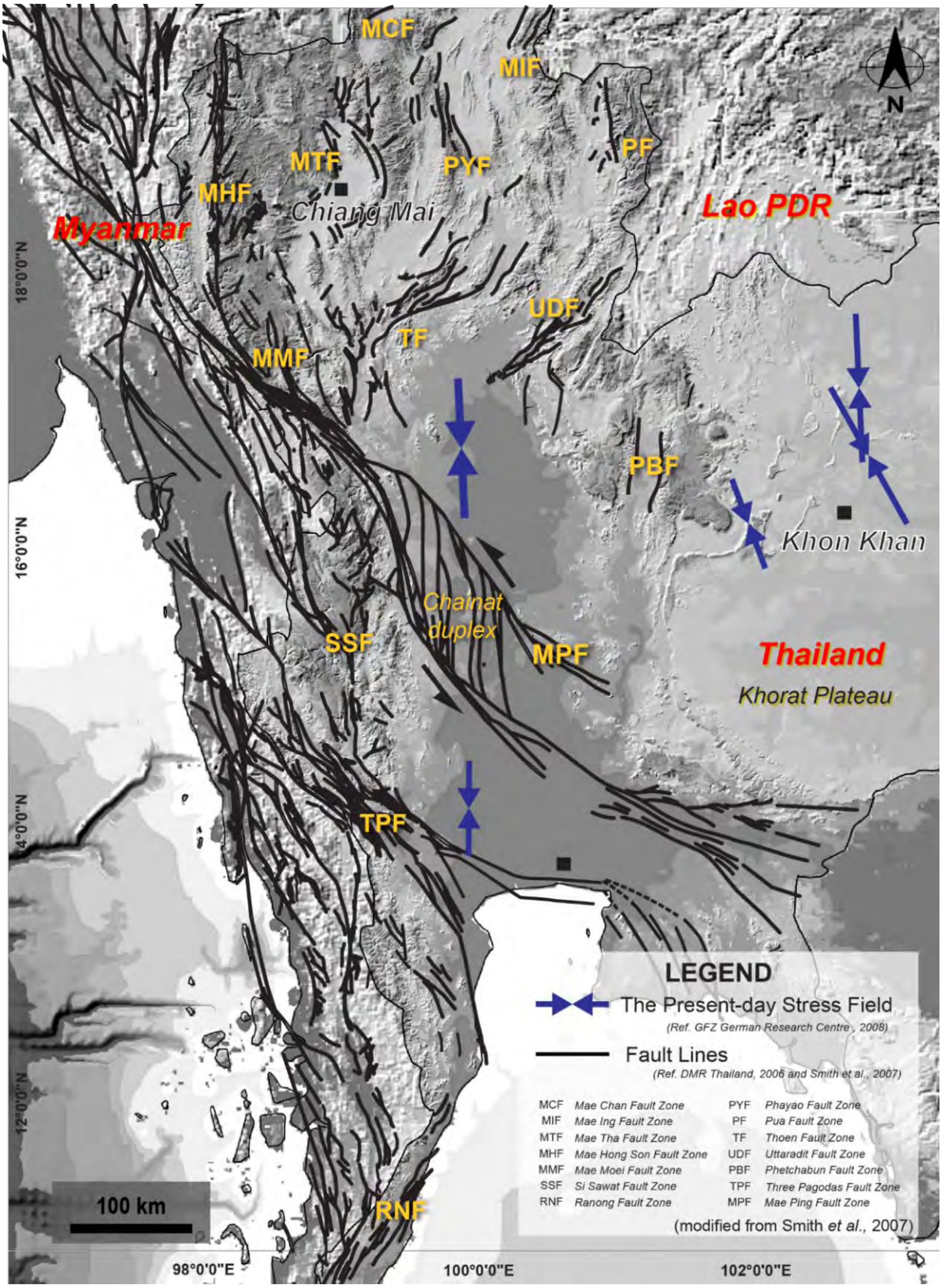

Figure 2.1 Structural map along Mae Ping fault zone, Chainat duplex, and active fault zones in northern and central part of Thailand (modified from Smith et al, 2007)

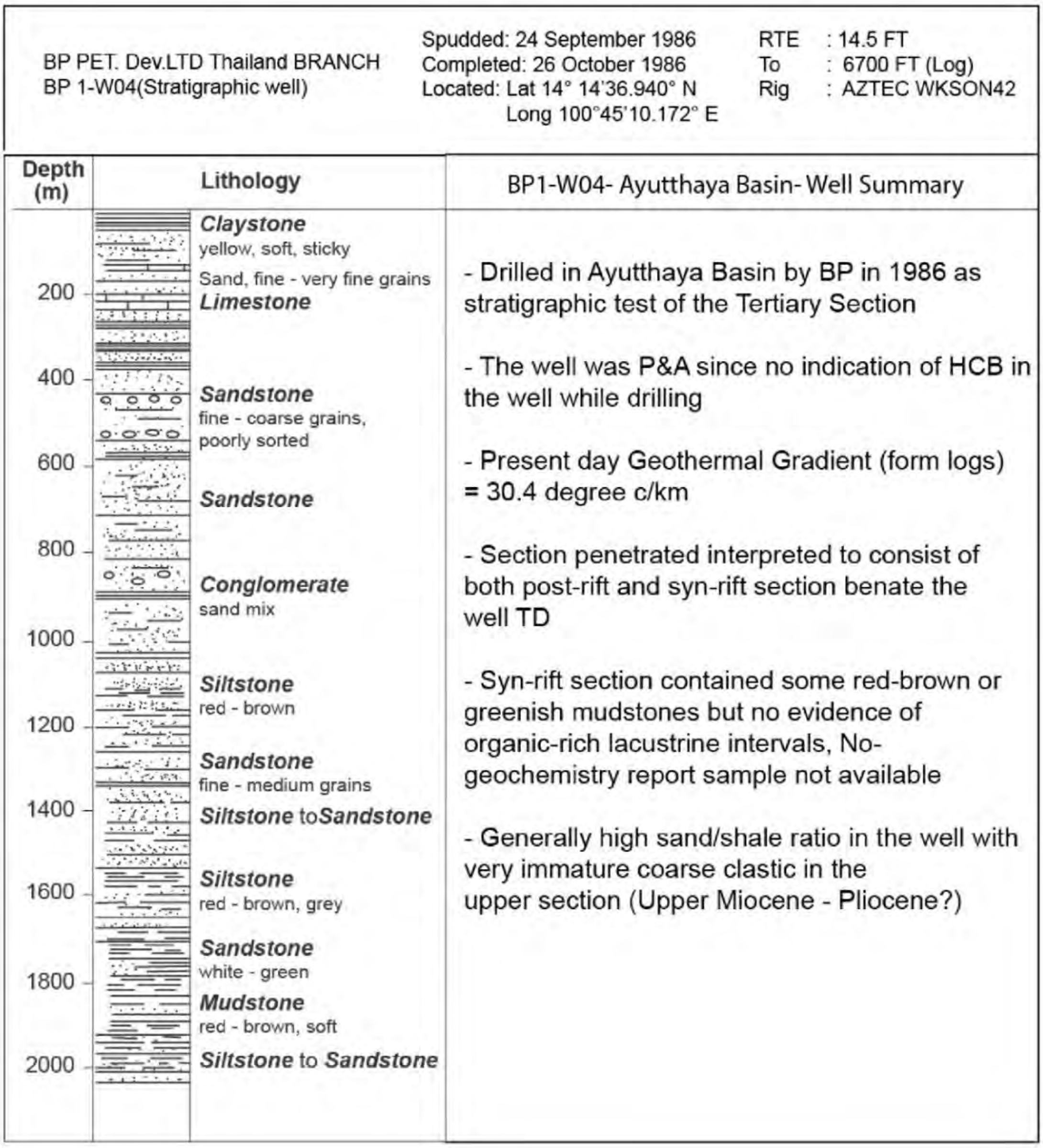

Figure 2.2 Well data from BP1-W04 with 2,000 m depth in Ayutthaya area (Modified from O'Leary,1987)

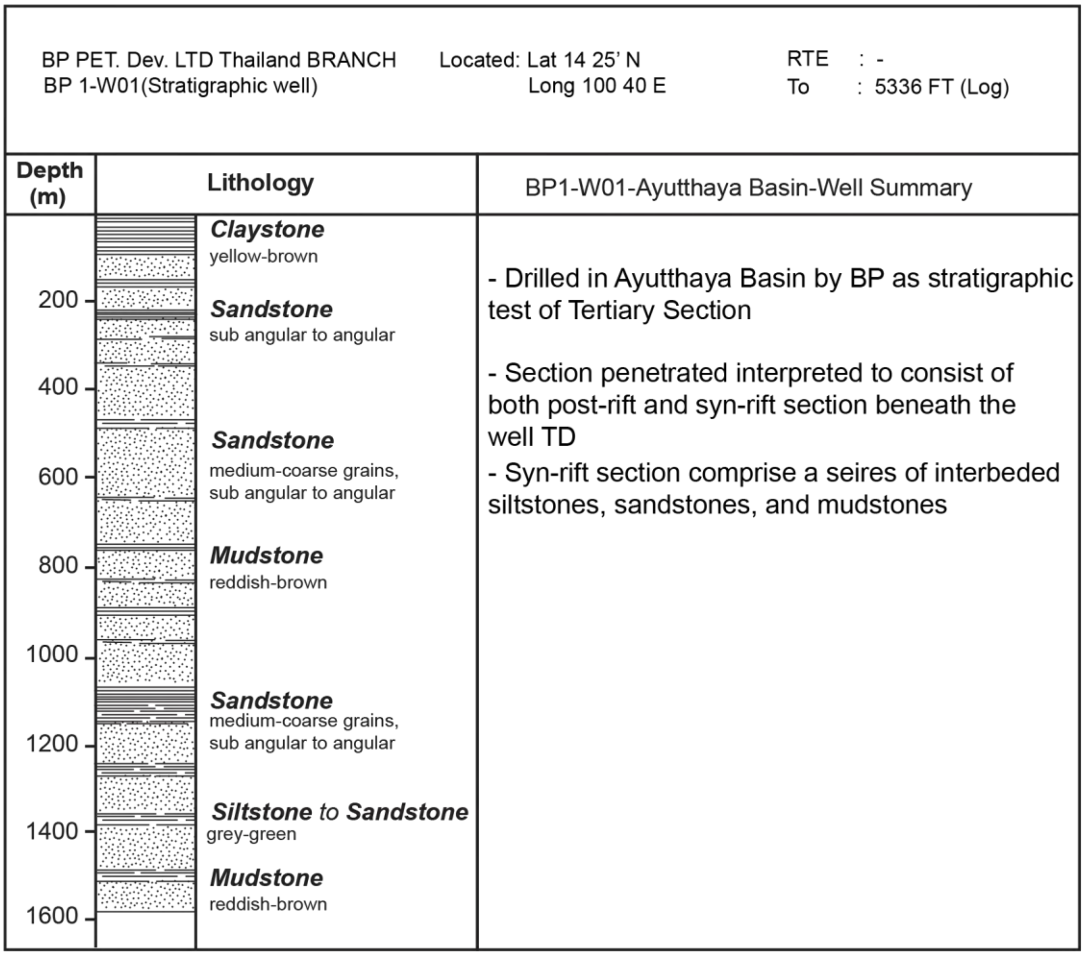

Figure 2.3 Well data from BP1-W01 with 1600 m depth in Ayutthaya area (Modified from O'Leary,1986)

Chapter 3

Methodology

3.1 Data and Programs

The seismic database used in the present study is 2D reflection seismic survey sections from Department of Mineral Fuels. Most surveys consist of strike line oriented E-W which are AY-051, AY-033, AY-031, AY-003-2, AY-013, AY-011, AY-001-3, AY-093, AY-091 and AY-009-2. The other surveys are AY-016 and AY-018 oriented N-S trend (Fig. 1.2). Seismic sections have a vertical scale of 0.2 millisecond/centimeters while horizontal scale is 1:25000. The wells data, BP1-W01 and BP1-W04, are used. The 2D seismic data and well data are acquired in 1986 by BP Petroleum Development.

The RadExPro Seismic Program and Schlumberger Petrel 2012 program are used in this study for seismic interpretation.

3.2 Methods

The processes of this study can be subdividing into 4 parts as literature review, improving 2D seismic data quality, 2D seismic interpretation, proposing Tectono-stratigraphy and evolutionary model of the basin.

3.2.1 Literature review

Studying from the previous works about structural geology of Thailand during Cenozoic (Morley et al.,2011), Cenozoic tectonic evolution in Central Thailand (Charusiri & Pum-Im, 2009), evolution of rift basin (Morley, 2001), analogue model of rift system (McClay, 2004), transtensional pull-apart basin (Corti,2013; Yassin,2017).

3.2.2 Improving 2D seismic data quality

Since Ayutthaya basin hasn’t done seismic survey for 30 years, the data in the basin was limited and had a poor quality. Therefore, improving the data quality may help interpretation to be more accurate and effective.

- **Define georeferenced of seismic data**

The seismic data doesn't have grid reference in the sections so the raw data is used for linear interpolation with Excel program, leading to define the grid references of the data. The grid references and 2D seismic survey sections were matched by RadExPro seismic program and output the file in .segy format.

- **Seismic data attribute**

The seismic sections in .segy format are input in the Schlumberger Petrel 2012, which are 10 inline and 2 crossline in east-west and north-south trending, respectively. The attributes of seismic data improve the seismic data quality and reduce some noises. For this study, Frequency filter, Structural smooth and Trace Gain AGC are used as the attributes. These attributes help for decrease some noise and stack the comparable amplitudes result in more accurate structural interpretation.

3.2.3 2D seismic interpretation

This step commences with create horizons and structures e.g. fault, unconformity and harpoon structure by using geological knowledge. The interpreted segments output into .IESX format for creating the model.

- **Well data correlation**

BP1-W01 and BP1-W04 well data are used by correlating with 2D seismic sections. For the first step, the vertical scale of seismic sections should be converted from second to meter. Then, correlate the seismic and well data by depth for create seismic stratigraphy.

BP-W01 and BP-W04 are drilled by BP Development Ltd. in 1986 and 1987, respectively. BP-W01 is located in the seismic survey section named AY003-2 and BP-W04 is in AY-093.

- **Seismic restoration**

After seismic interpretation, the Flatten Horizon function is used for seismic restoration. It generates the cross-section of the each event which indicate the evolution of the basin reasonably.

3.2.4 Proposing Tectono-stratigraphy and evolutionary model of the basin

From the results, it can propose a new tectono-stratigraphy and evolutionary model of Ayutthaya basin based on 2D seismic and well data.

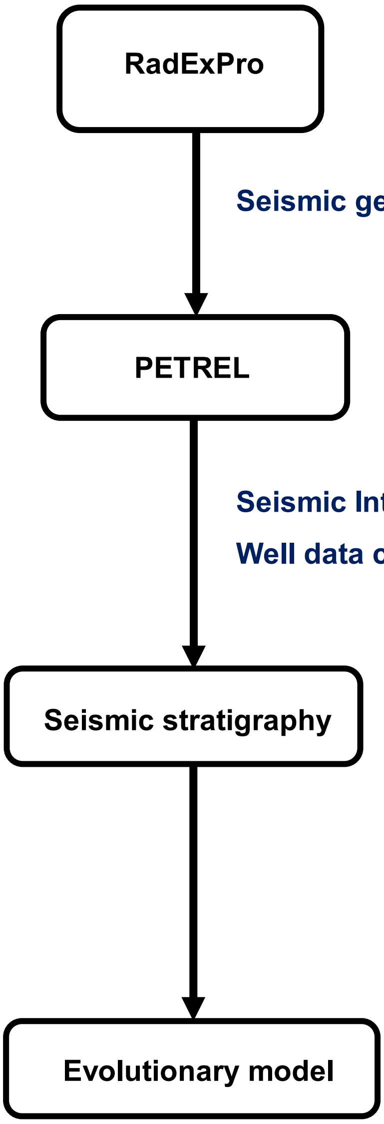

Figure 3.1 Workflow for methodology

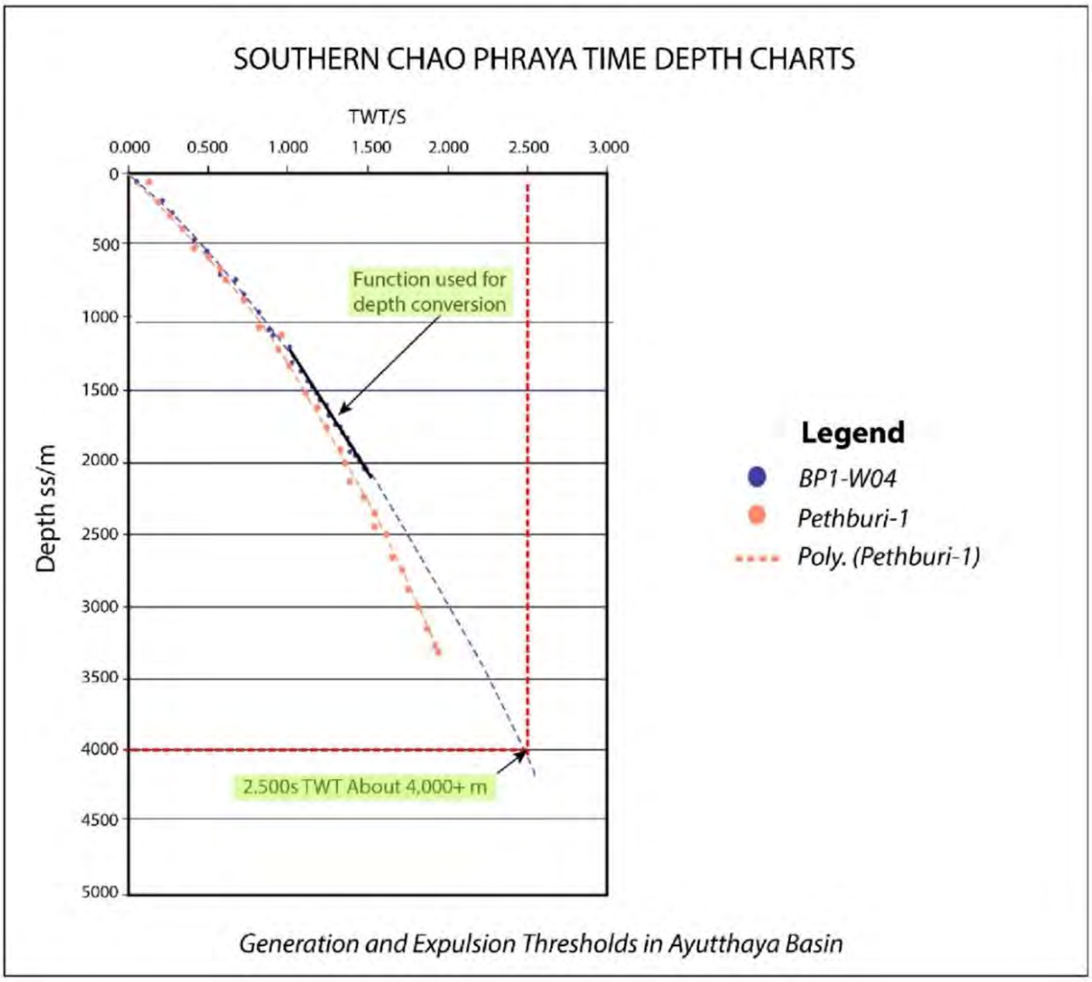

Figure 3.2 Southern Chao Phraya time-depth conversion chart in seismic survey sections from second to meter (Mitra Energy Limited, 2009)

Chapter 4

Results

4.1 Seismic interpretation

Seven horizons were interpreted, Land floor, Top syn-inversion II, Base syn-inversion II, Base syn-inversion I, Base post-rift 1, Base syn-rift II, and Base syn-rift I. seismic stratigraphy is generated by using seismic section named AY-093 and BP1-W04 well data. The first step commences with time-depth conversion in seismic section by plotting graph. The slope of graph converts time (millisecond) to depth (meters). When correlate the seismic and the well data by depth, stratigraphic units will be categorized. The events from the 2D seismic data can be divided into six units, older to the younger (Fig.4.1).

4.1.1 Pre-rift unit

It shows strong amplitude and medium continuity which is moderate identified and traced. It found the anticline topography which the westward is in higher elevation than the eastward. This unit could be the basement of Ayutthaya basin.

4.1.2 Syn-rift unit

It shows strong amplitude and fair continuity in seismic sections. This unit is an eastward tilted wedge-shape to the normal fault. It comprises of siltstone, shale, mudstone, sandstone and conglomerate.

4.1.3 Post-rift I unit

It shows strong amplitude and good continuity which is easily traced in the seismic section. The onlap structure is presented on the syn-rift unit. This unit consists of siltstone, shale, mudstone, and fine-coarse grain sandstone.

4.1.4 Syn-Inversion I unit

It shows strong amplitude and fair continuity. It is separated from the Post-rift I unit by unconformity and onlap structure. Also, it has harpoon structure with invert normal fault in the seismic section. This unit comprises of siltstone, shale, mudstone, and sandstone.

4.1.5 Syn-inversion II unit

It shows fair amplitude and fair continuity. The unit is like the Syn-inversion I unit but the sediments are less thickening. It composes of siltstone, shale, sandstone, and thin bedded of limestone.

4.1.6 Post-rift II unit

It shows strong amplitude and very good continuity in the seismic section. It can be separated from the earlier unit by unconformity and deposited in the uppermost of sequence. It comprises of siltstone, claystone, and very fine-fine grain sandstone.

4.2 Structural interpretation

4.2.1 Major normal fault

The major faults are west dipping normal fault founded in central to the eastern part of Ayutthaya basin. Some small faults are rotated as domino style faults in west dipping trend (Fig. 4.5). The mostly strike trend of normal fault in the basin are N-S oriented. Some fault segmented are linked with left stepping en echelon style faults.

4.2.2 Harpoon structure

Harpoon structure mostly occurred in the southern and eastern part of the basin. It is a dome shape structure associated with the invert normal fault.

4.2.3 Basin characters

Ayutthaya basin is an elongate shaped basin lied in N-S trend. It is about 35 km in width. In the middle part of the basin lied in NNW-SSE trend which is probably controlled by pre-existing structure (Fig. 4.3). The angle of basin lying is approximately 60 degree. Ayutthaya basin has 2 depocenters. Due to limit of seismic data, this study only focus on the upper sub-basin. The sediment thickness in Syn-rift unit is thickening in northward more than the south of the basin (Fig. 4.4A). It can assume that an initial rifting phase is occurred in the northern part of the basin and it gradually developed to the southern part.

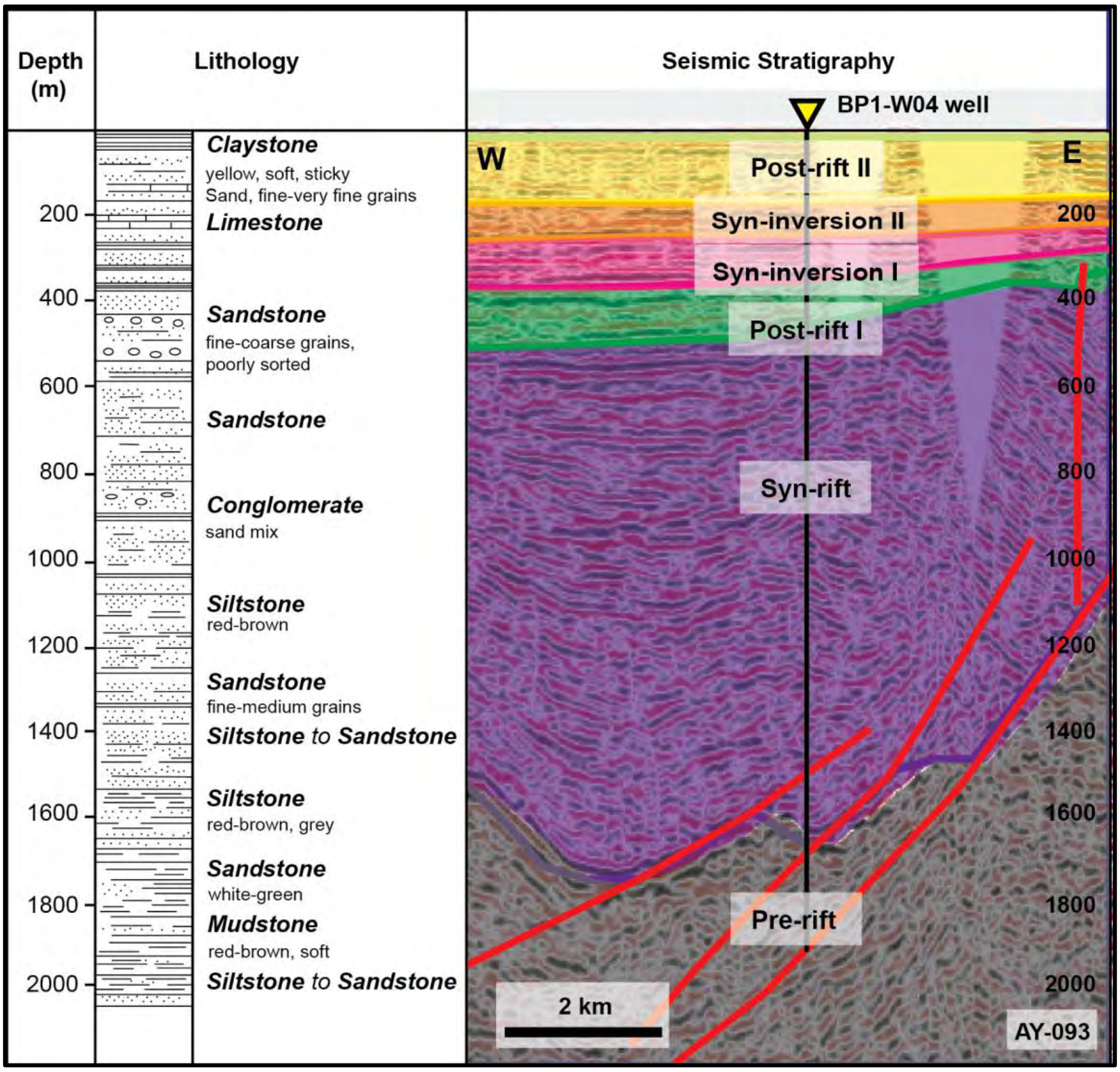

Figure 4.1 Seismic stratigraphy in Ayutthaya basin with AY-093 seismic section and BP1-W04 well data

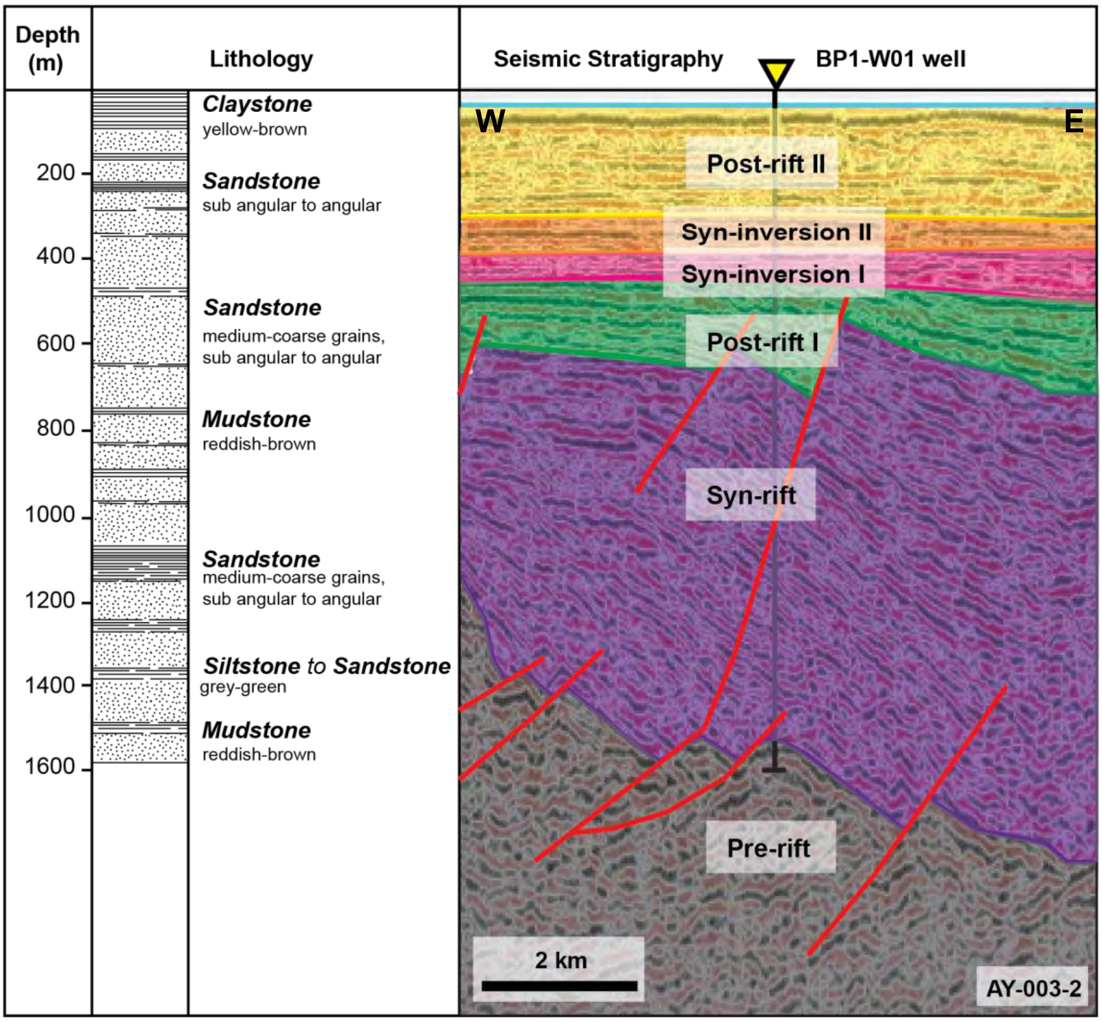

Figure 4.2 Seismic stratigraphy in Ayutthaya basin with AY-003-2 seismic section and BP1-W01 well data

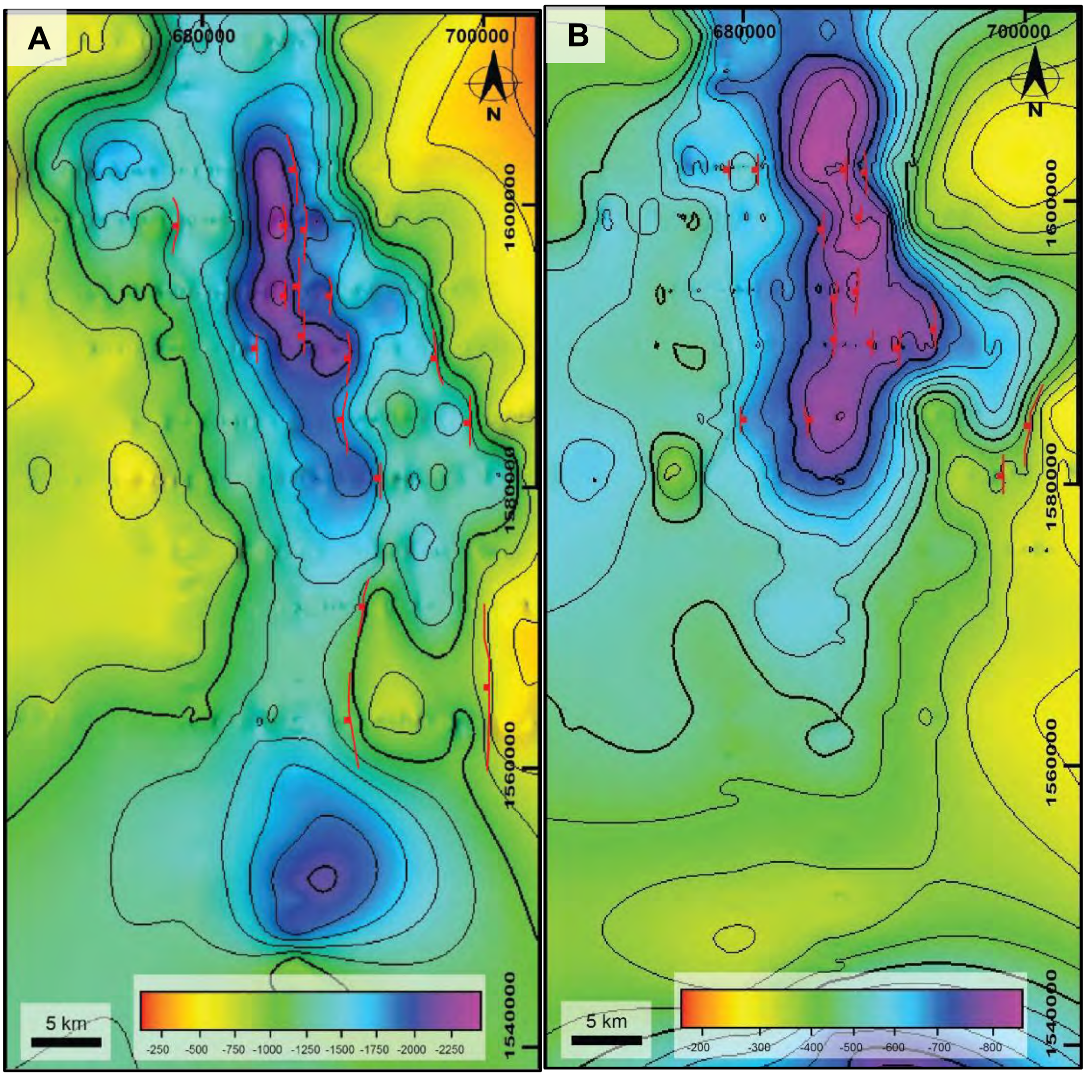

Figure 4.3 A) Surface map of Syn-rift horizon B) Surface map of Base post-rift I horizon

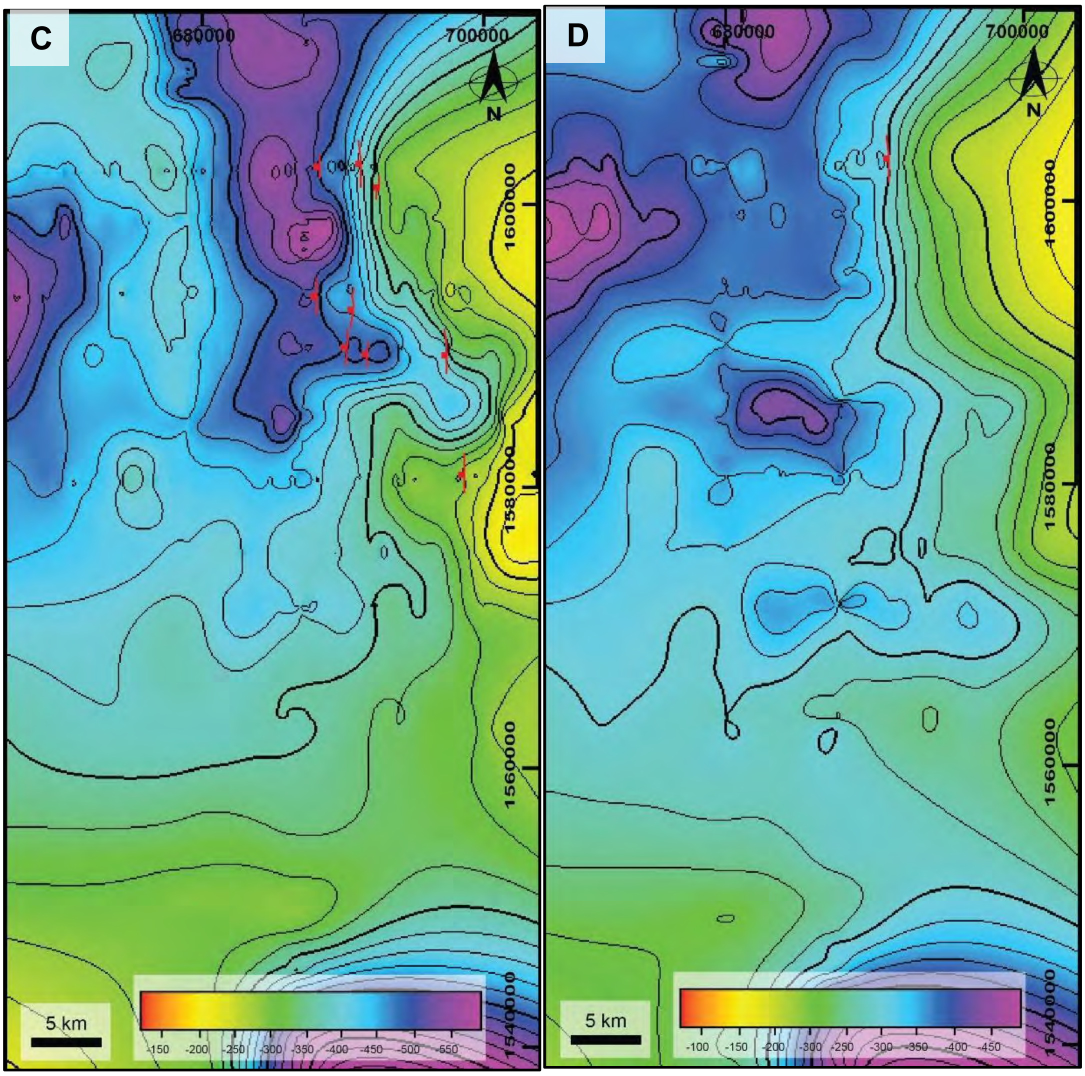

Figure 4.3 C) Surface map of Base syn-inversion I horizon D) Surface map of Base syn-inversion II horizon

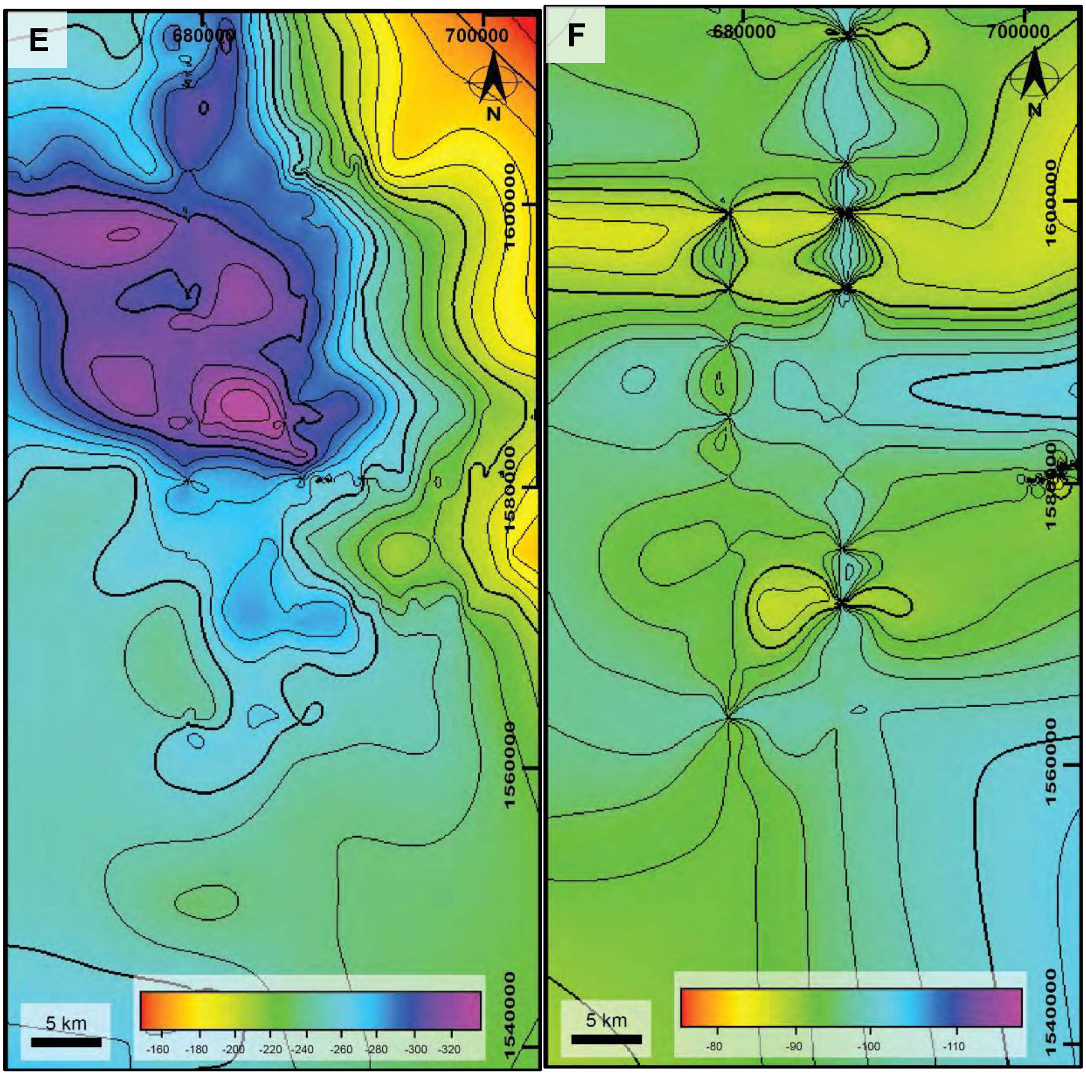

Figure 4.3 E) Surface map of Top syn-inversion II horizon F) Surface map of Land floor horizon

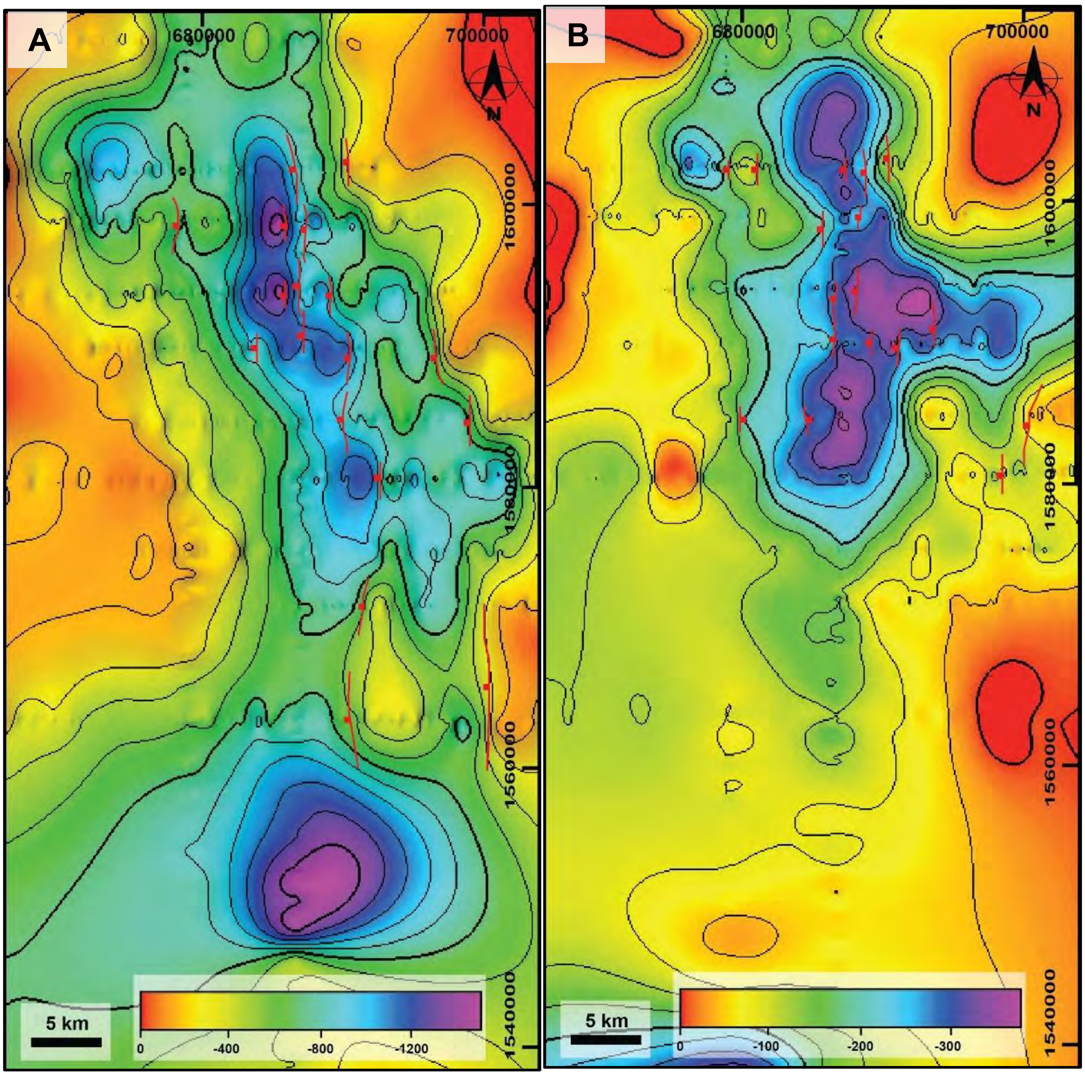

Figure 4.4 A) Isopach map of Syn-rift unit B) Isopach map of Post-rift I unit

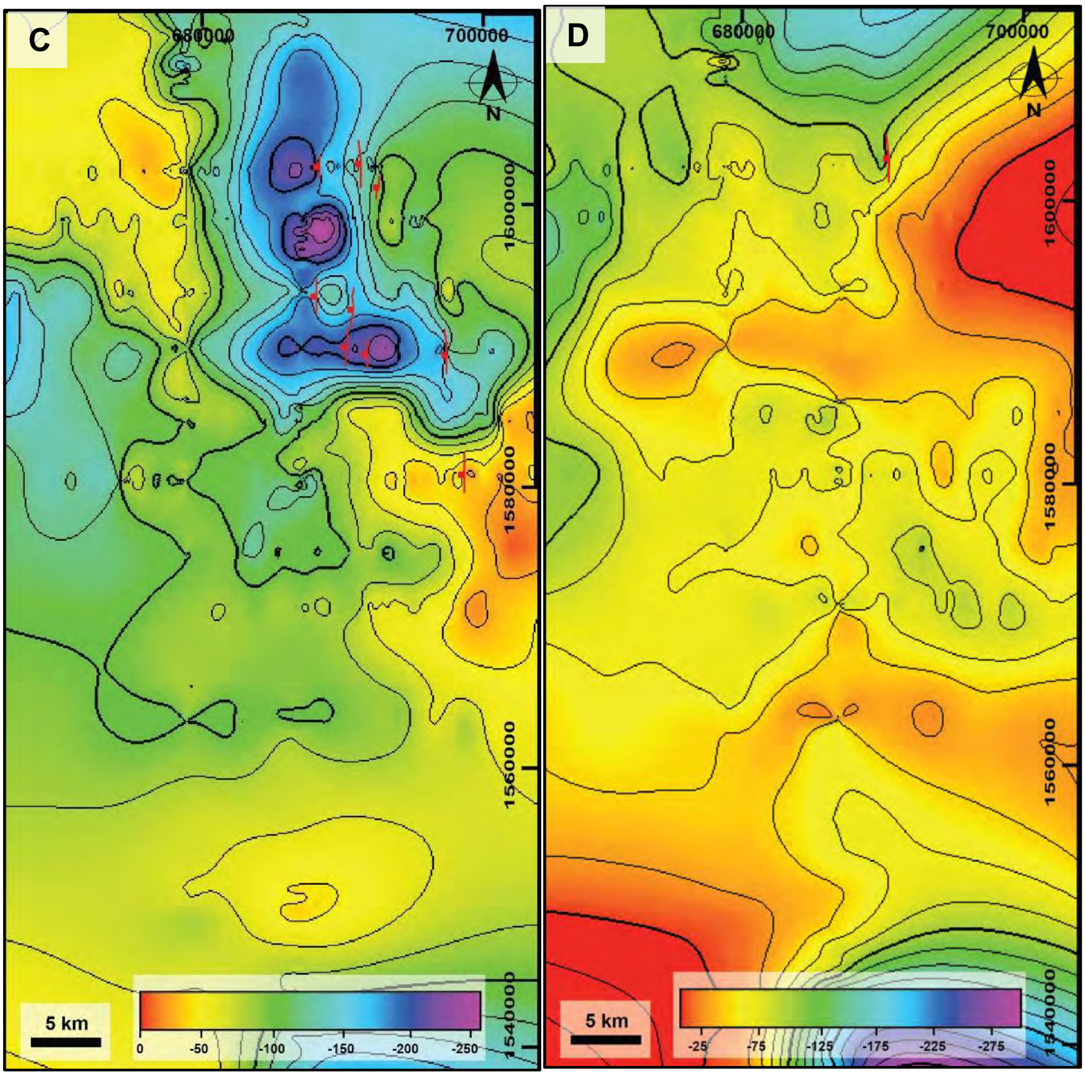

Figure 4.4 C) Isopach map of Syn-inversion I unit D) Isopach map of Syn-inversion II unit

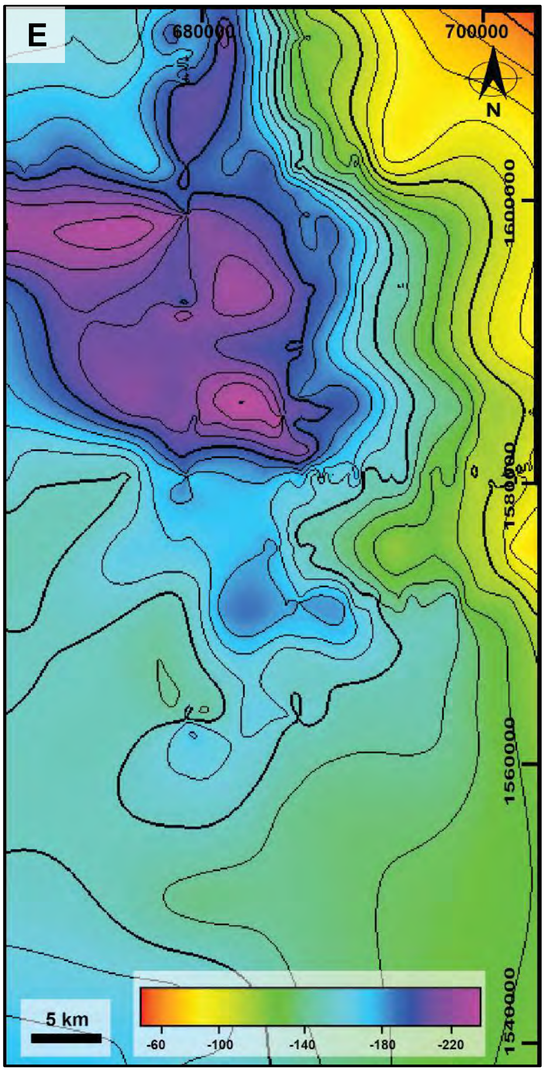

Figure 4.4 E) Isopach map of Post-rift II unit

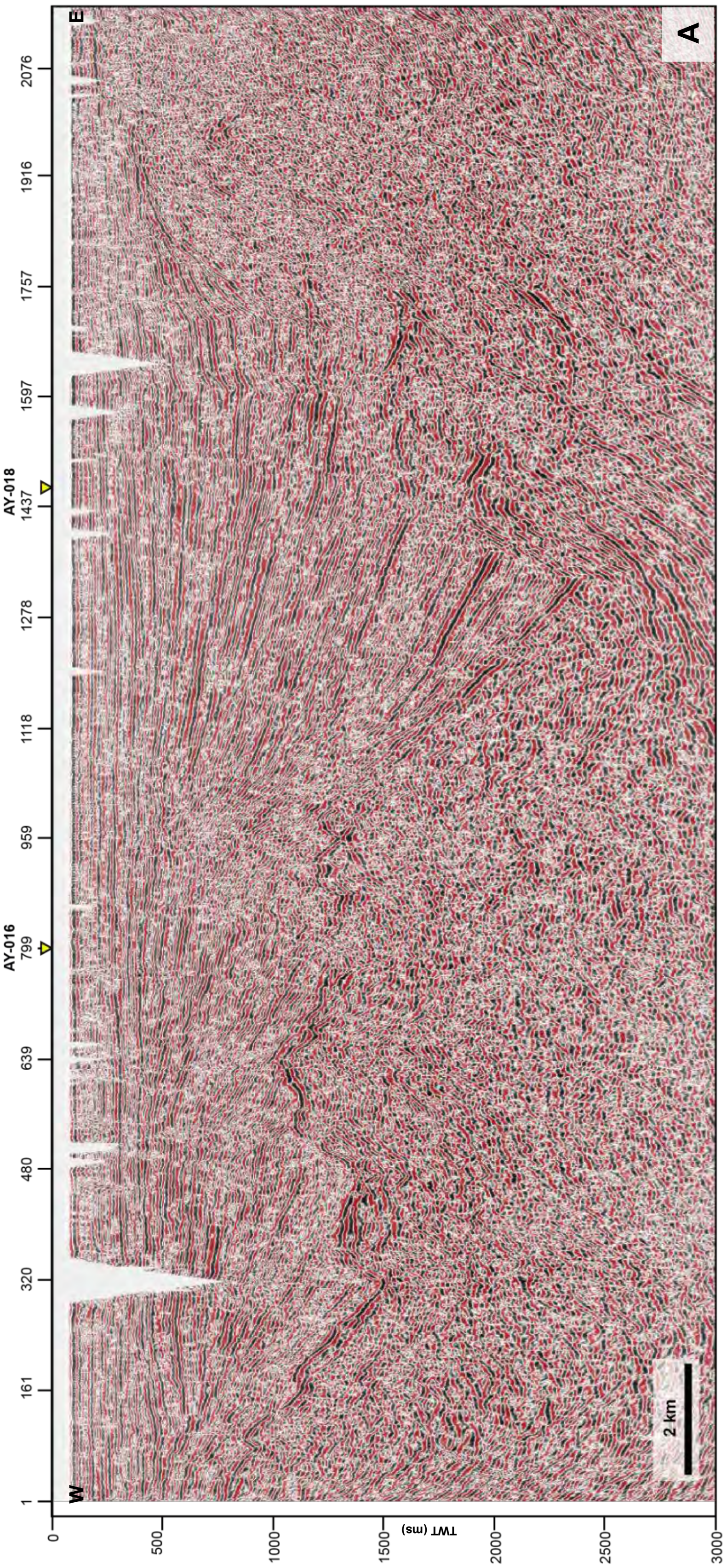

Figure 4.5 A) Uninterpreted and seismic lines, AY-031, showing structural events and characteristics in Ayutthaya Basin.

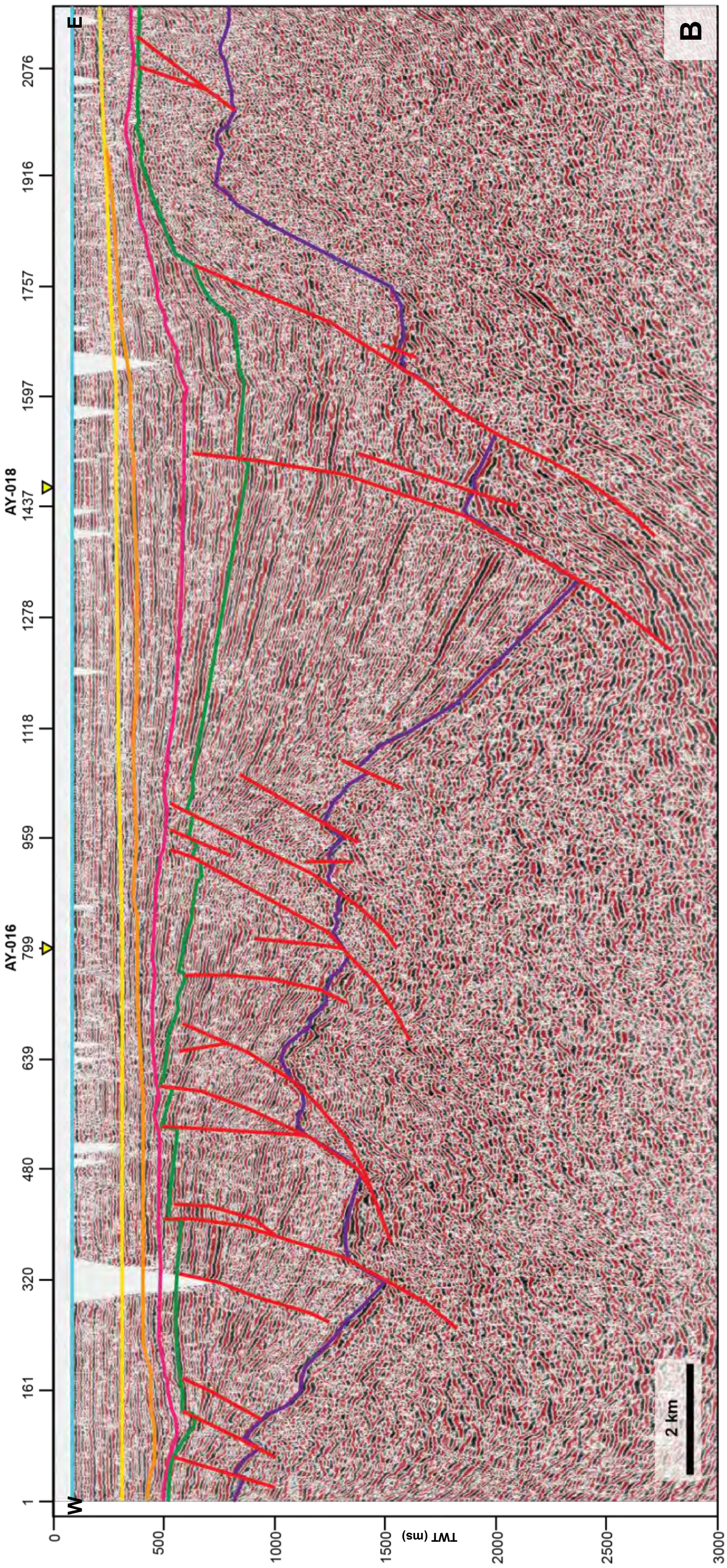

Figure 4.5 B) interpreted seismic lines, AY-031, showing structural events and characteristics in Ayutthaya Basin.

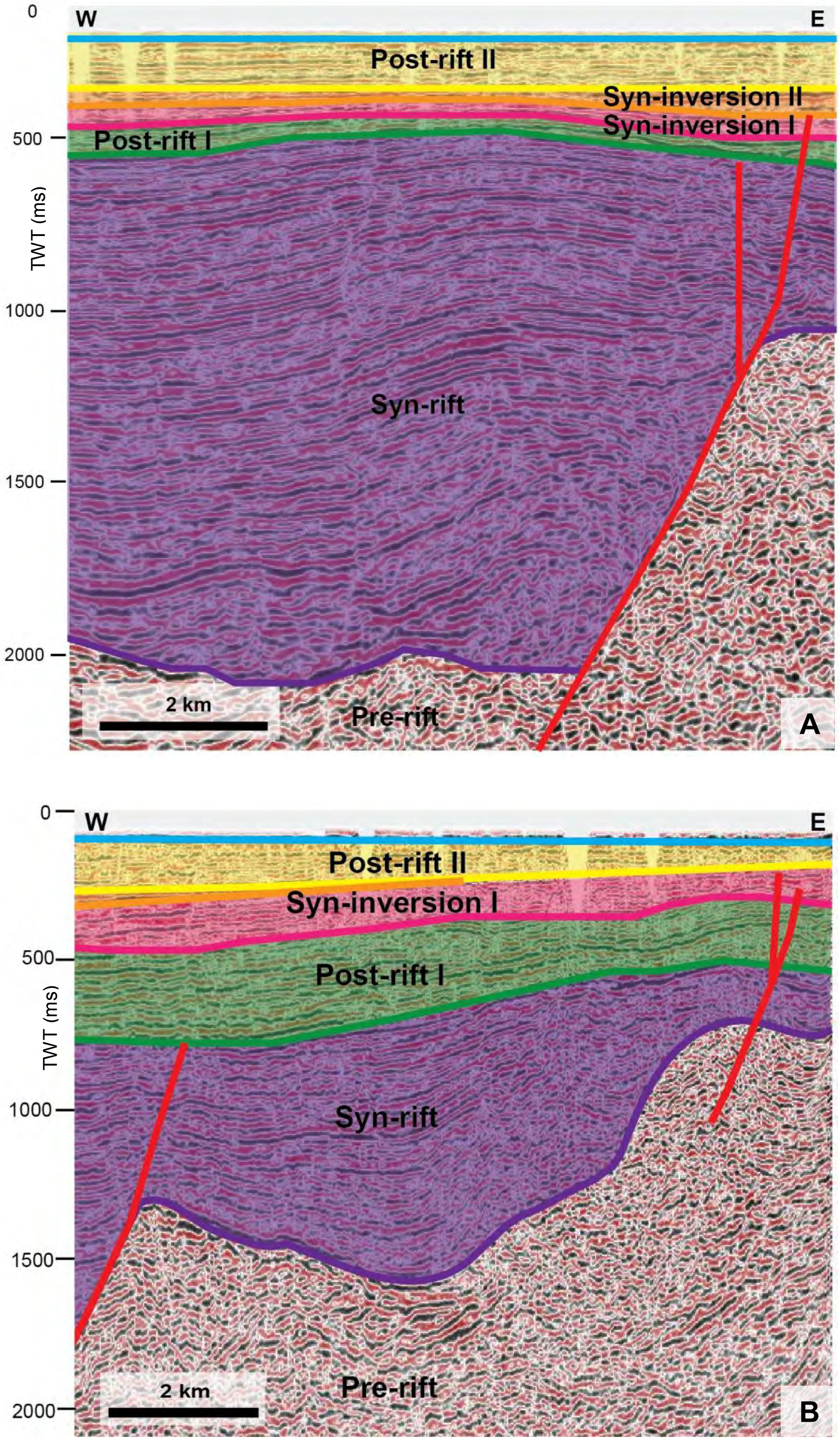

Figure 4.6 Example of inversion structure in Ayutthaya Basin A) Harpoon structure in AY-018, N-S seismic section B) Harpoon structure in 003-2, E-W seismic section. (Line location are shown in **Figure 1.2**)

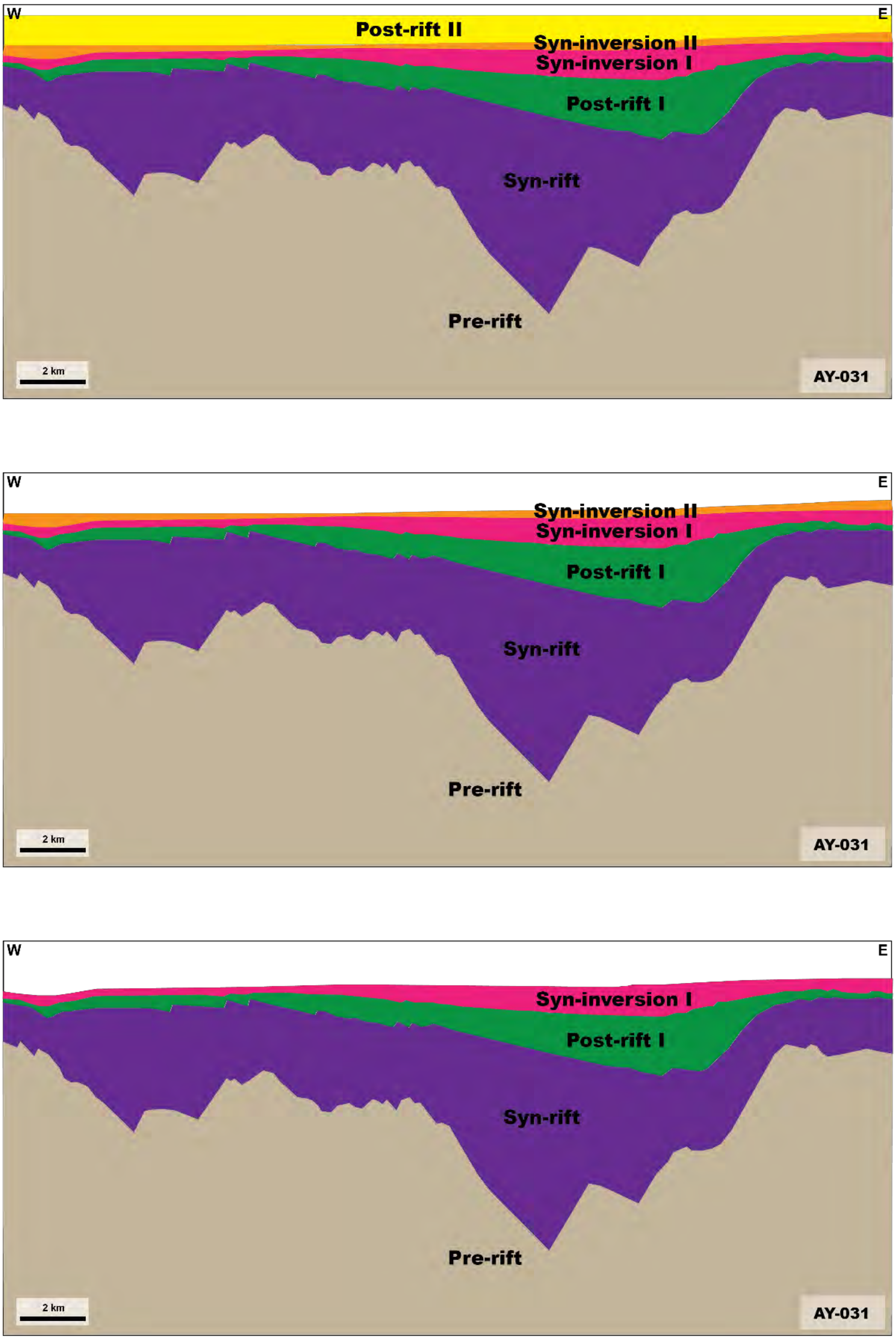

Figure 4.7 A) Cross section of AY-031 section in present day B) Cross section of AY-031 section with Syn-inversion II restoration C) Cross section of AY-031 section with Syn-inversion I restoration

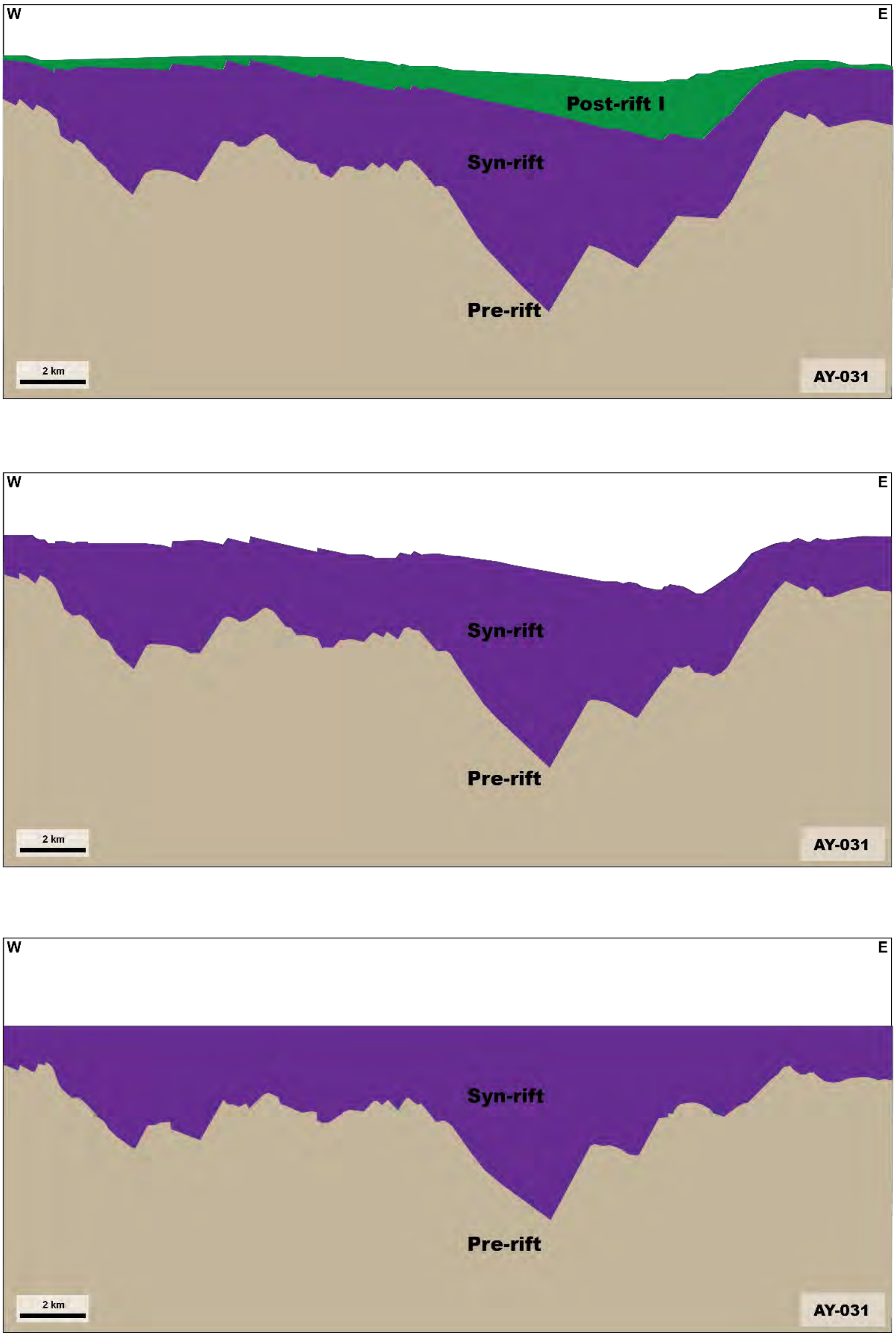

Figure 4.7 D) Cross section of AY-031 section with Post-rift I restoration E) Cross section of AY-031 section with Syn-rift restoration F) Cross section of AY-031 section with Pre-rift restoration

Chapter 5

Discussion

5.1 Structural Evolution of Ayutthaya Basin

5.1.1 Extensional phase

During the Late Oligocene to Middle Miocene period the Syn-rift unit was developed. The basin is eastward tilted wedge-shape to the normal fault. The basin shape is influenced by pre-existing structure in NW-SE oriented caused oblique rift (McClay, 2004). The mostly major faults in the basin are west dipping normal faults lie in N-S direction. The fault segments are connected with left stepping en echelon style faults. The deposition environment in this phase can be inferred as alluvial fan having sediment source area from the western margin (Fig 5.1B).

5.1.2 Subsidence phase

During Middle Miocene, the extensional stress ended and subsidence had increased and fresh water lake environment developed in the basin. Sediments in Post rift I unit is deposited onlap to the Syn-rift unit

5.1.3 Inversion phase

During Late Miocene-Pliocene the stress regime had changed to the NNW compression which episodically resulted in strike-slip reactivation and basin inversion period. Inversion can be defined by harpoon structure associated with invert normal fault. The deposition environment in this phase changing from fresh water lake to the river system due to the uplift and erosion process (Fig .5.1C).

5.1.4 Regional subsidence phase

The overall stress has been stopped in Pliocene. Basins were subsided without significant tilting or rotating. The depositional environment is dominated by river system. The sediments in Post-rift II unit is westward thickening. It can be inferred that the western part of the basin has more subsidence rate than the eastward.

5.2 Effects of Mae Ping fault zone in Ayutthaya Basin

Ayutthaya Basin is a rift basin which composed of east-thickening half grabens. It overlies on Mae Ping fault zone in NW-SE oriented which can see in seismic reflection data, magnetic data (Fig.5.3) and gravity survey (Fig.5.2). According to analogue model experiments, the pre-existing structure oriented at 60° to the extension direction caused the oblique rift. It characterized by stepping en echelon fault segments. Moreover, A curve boundary fault changing from N-S to NW-SE orientation in the northern termination of the basin. There appears to be no displacement of NW-SE fault segments towards the northwest or linkage between Ayutthaya boundary fault with any strike-slip fault. Therefore, a normal fault characteristic is controlled by a pre-existing structure. An extensional stress developed a normal fault in N-S trend and leading to the opening of Cenozoic basins. Since the pre-existing fabric area is a weak zone, the normal faults in the northern part of the basin are rotated from N-S to NW-SE orientation. However, the reactivation of Mae Ping fault zone may be resulting in a local inversion in the basin.

5.3 Comparison of basin structure to Suphan Buri Basin

Suphan Buri Basin located in western part of Lower Central Plain. It lies in N-S oriented as well as Ayutthaya Basin and about 70 km far. Suphan Buri Basin is a rift basin with a westward thickening half graben geometry (O' Leary & Hill,1989; Seusuthya & Morley, 2004). The major normal faults are east dipping. On the contrary, Ayutthaya Basin is the eastward thickening half graben with west dipping normal fault. Ayutthaya and Suphan Buri Basins are about 3 km in depth. Any large inversion anticlines do not show in Suphan Buri Basin. The basin does not appear to link with Mae Ping fault zone same as Ayutthaya basin. Moreover, Suphan Buri Basin has a potential for petroleum production while Ayutthaya Basin is considered as low petroleum potential basin. It is believed that granite intrusion in limestone basement leading to hydrocarbon maturation. Since Ayutthaya Basin does not have any igneous intrusion, organic matters could not mature and changing to petroleum.

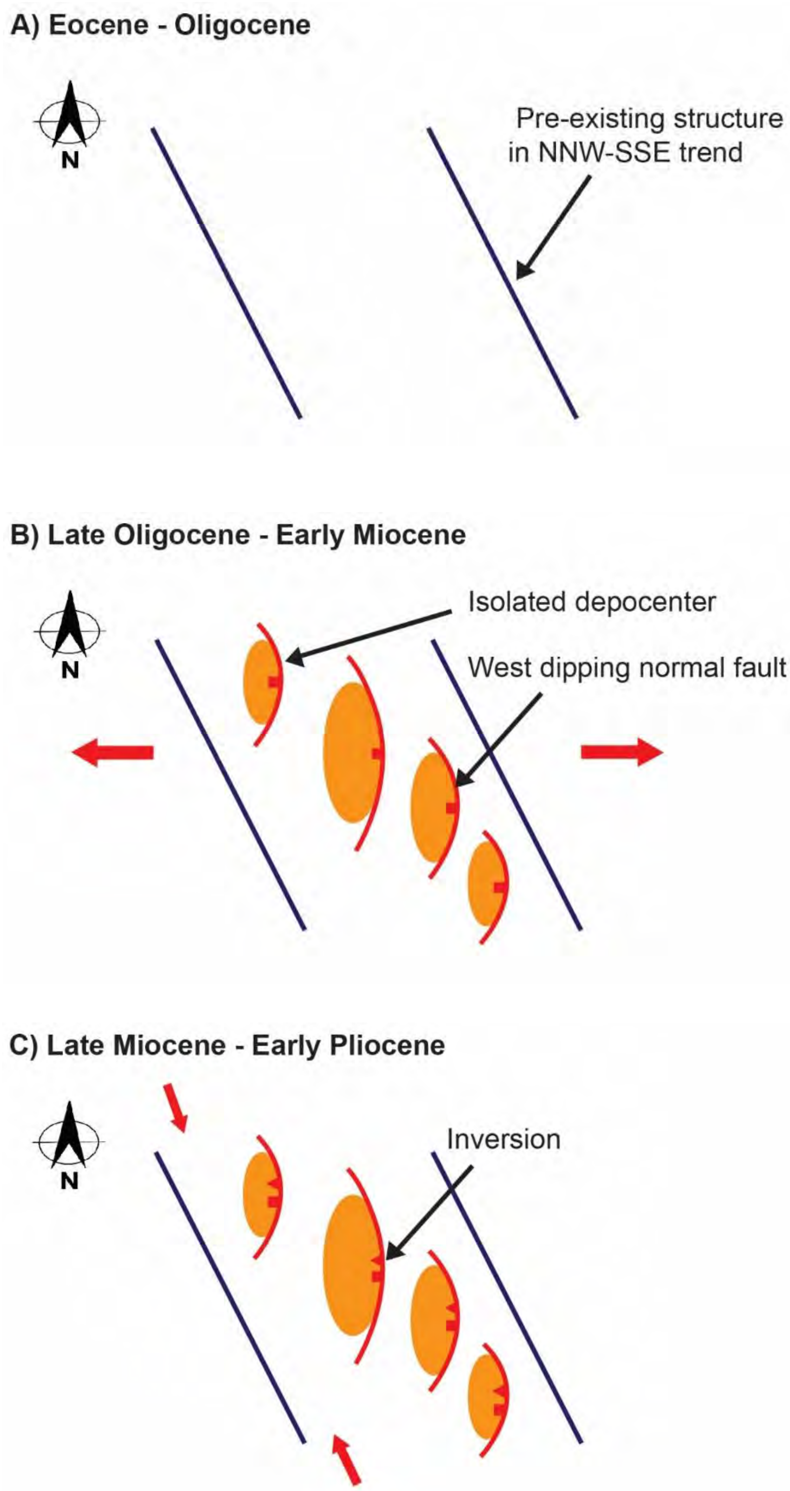

Figure 5.1 A) Structural evolution of Ayutthaya basin Before Ayutthaya basin has developed B) Ayutthaya basin has developed from E-W Extension C) Structural evolution of Ayutthaya basin NNW-SSE compression leading to the inversion in Ayutthaya basin

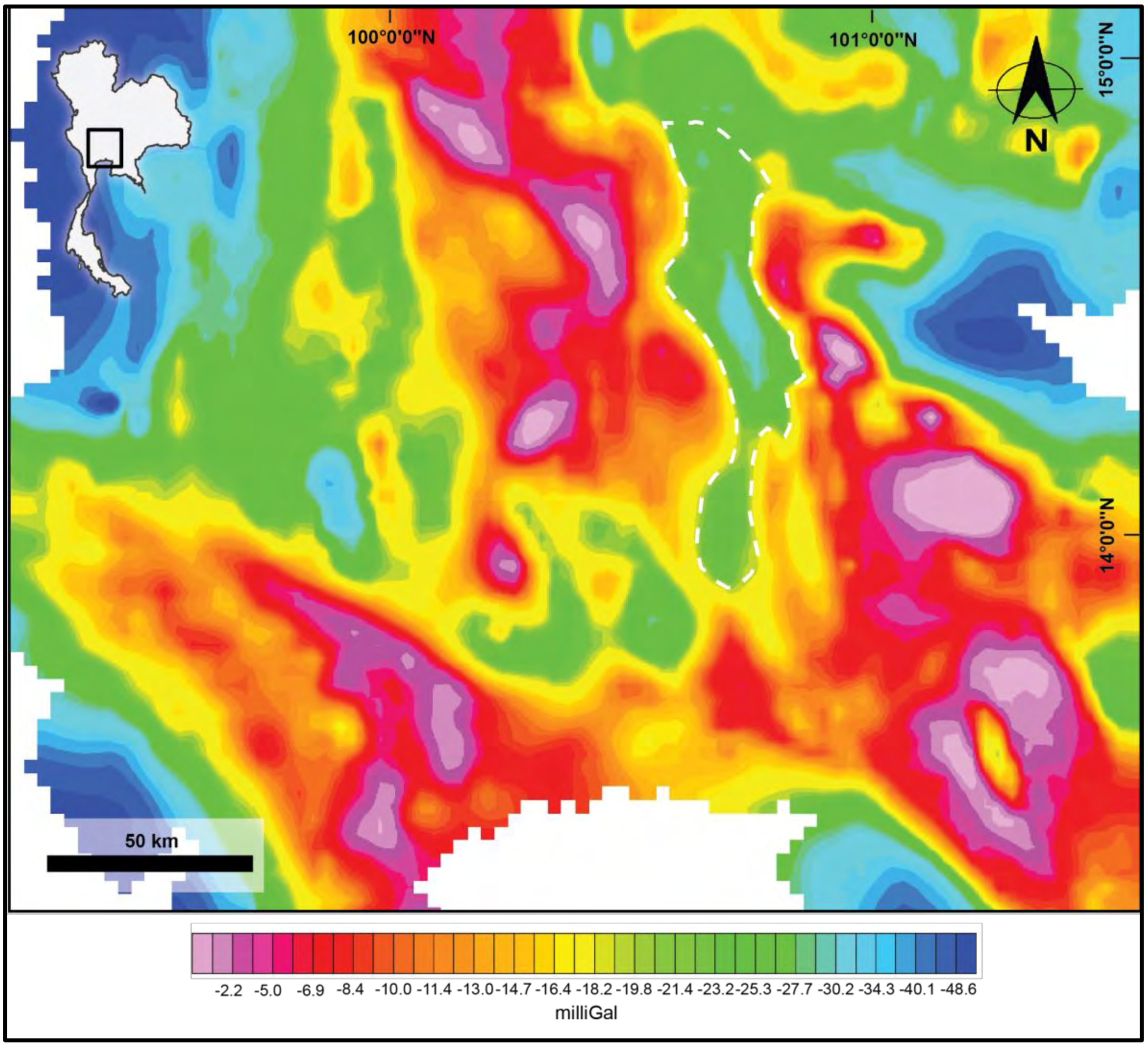

Figure 5.2 Bouguer Gravity map in Lower Central Plain, Thailand showing negative anomalies of the Ayutthaya Basin (white-dashed line). The middle part of the basin is in NNW-SSE trend which is probably controlled by NNW-SSE trend pre-existing structure. (Gravity map courtesy of Department of Mineral Resources)

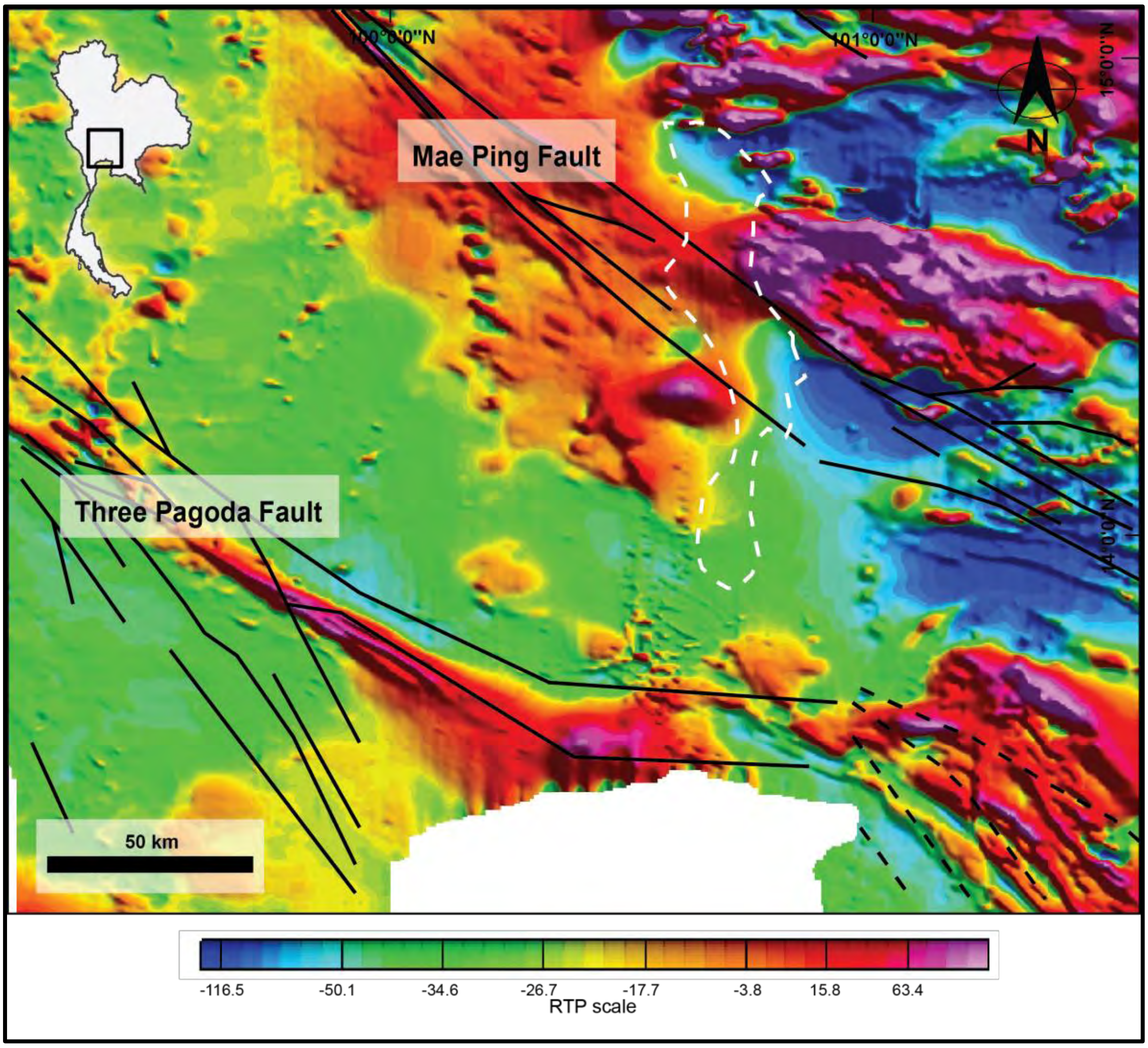

Figure 5.3 Magnetic map in the Lower Central Plain, Thailand showing in places strong linear magnetic features associated with strike-slip faults. The black and white-dashed line are represented fault zone and Ayutthaya basin, respectively. (Map courtesy of Department of Mineral Resources)

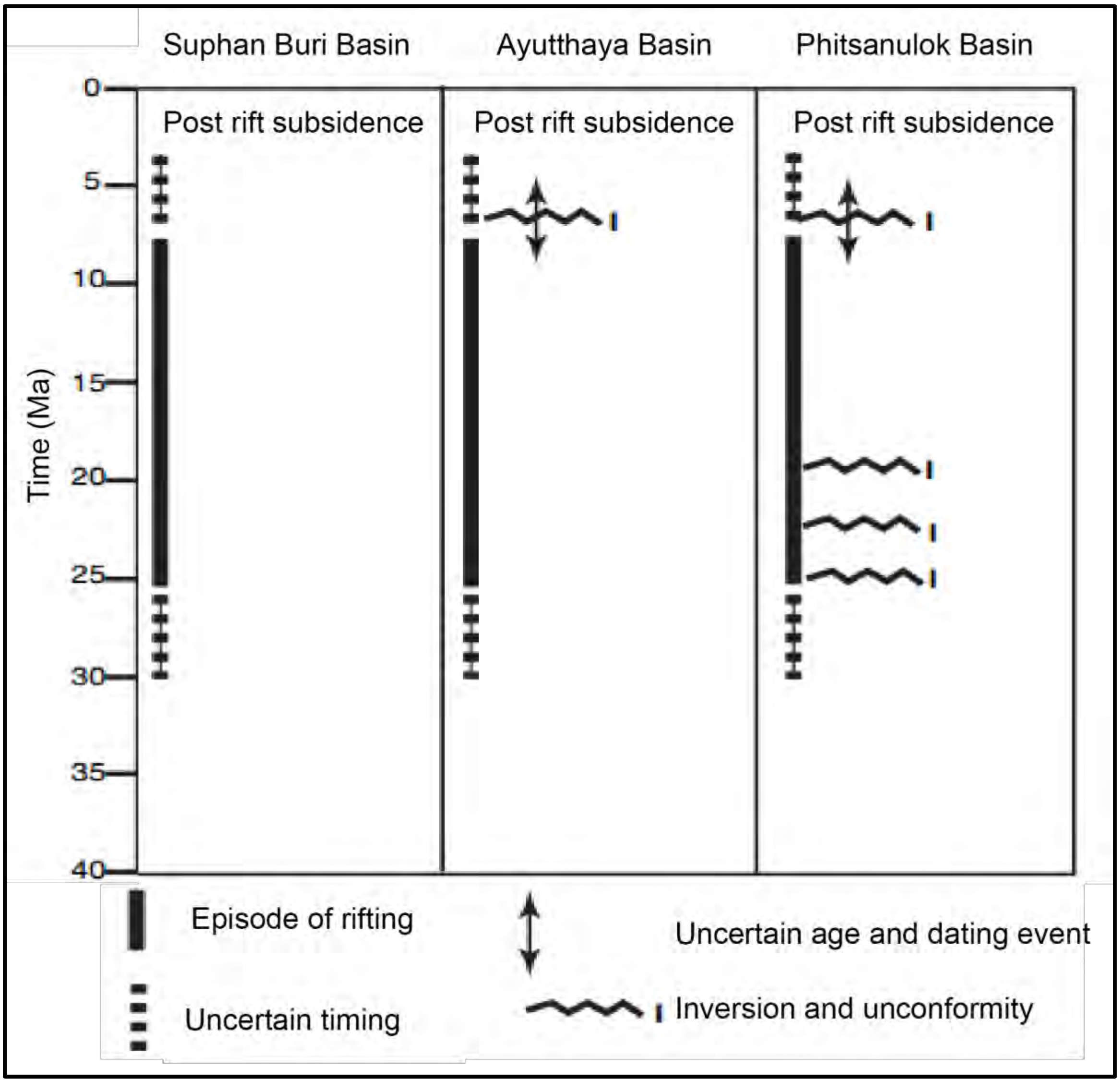

Figure 5.4 Summary of tectonic events in Cenozoic sedimentary basin around Lower Central Plain (Modified from Smith et al., 2007)

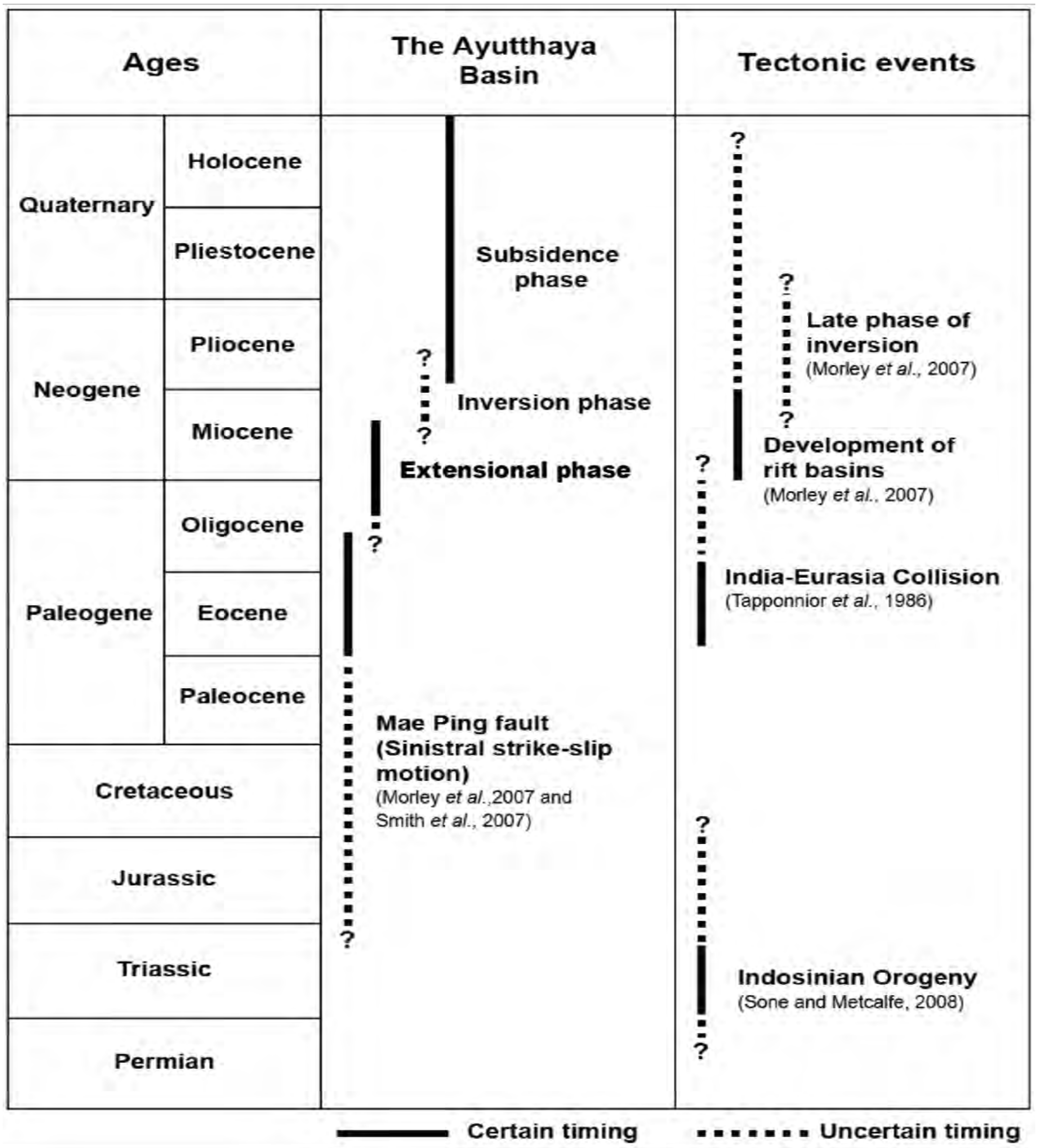

Figure 5.5 Summary of evolution in Ayutthaya Basin compared with tectonic events in Thailand (compiled from Morley et al., 2007; Smith et al., 2007; Tapponnior et al., 1986)

Chapter 6

Conclusion

The Ayutthaya Basin is a N-S trending Cenozoic basin located in Lower Central Plain Thailand. In the middle part of the basin lied in NNW-SSE trend which is probably controlled by pre-existing structure. The angle of basin lying is approximately 60 degree to extension direction. Ayutthaya basin has half-graben geometry which is eastward tilted. The major faults are west dipping normal fault with N-S oriented. Some small faults are rotated as domino style faults in west dipping trend and fault segmented are linked with left stepping en echelon style faults. The evolution of Ayutthaya basin can be divided into 4 phases. The first phase commences with extensional rifting in which the basin was developed during the Late Oligocene to Middle Miocene period. Subsequently, the extensional stress ended and subsidence phase had increased. After that, the stress regime had changed to the NNW compression which episodically resulted in strike-slip reactivation and basin inversion phase. Finally, the overall stress has been stopped in Pliocene. Basins were subsided without significant tilting or rotating. Accordingly, Ayutthaya Basin is oblique rift, the basin does not appear to link with Mae Ping fault zone.

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Appendix

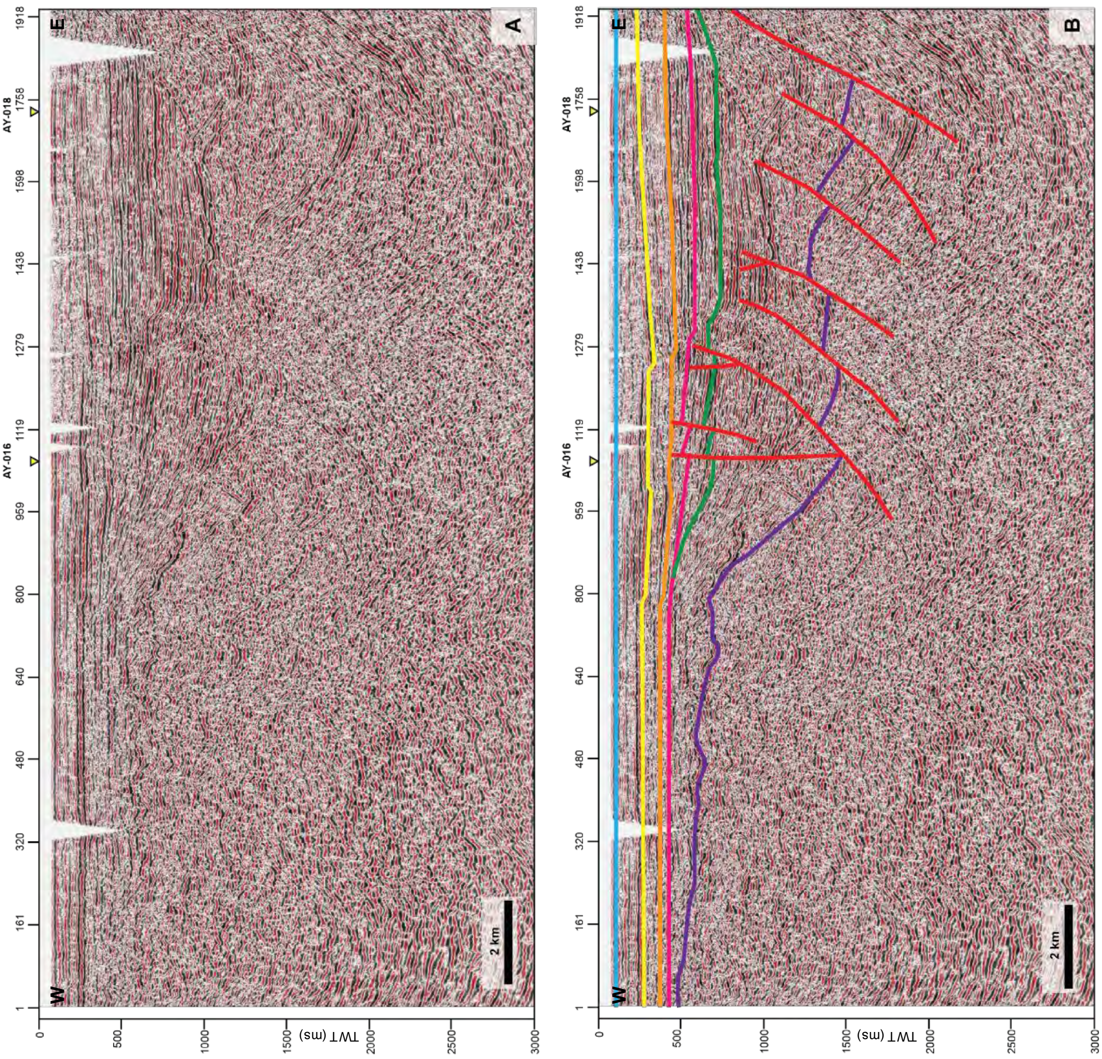

Figure A.1 A) Uninterpreted and B) interpreted seismic lines, AY-051, showing structural events and characteristics in Ayutthaya Basin.

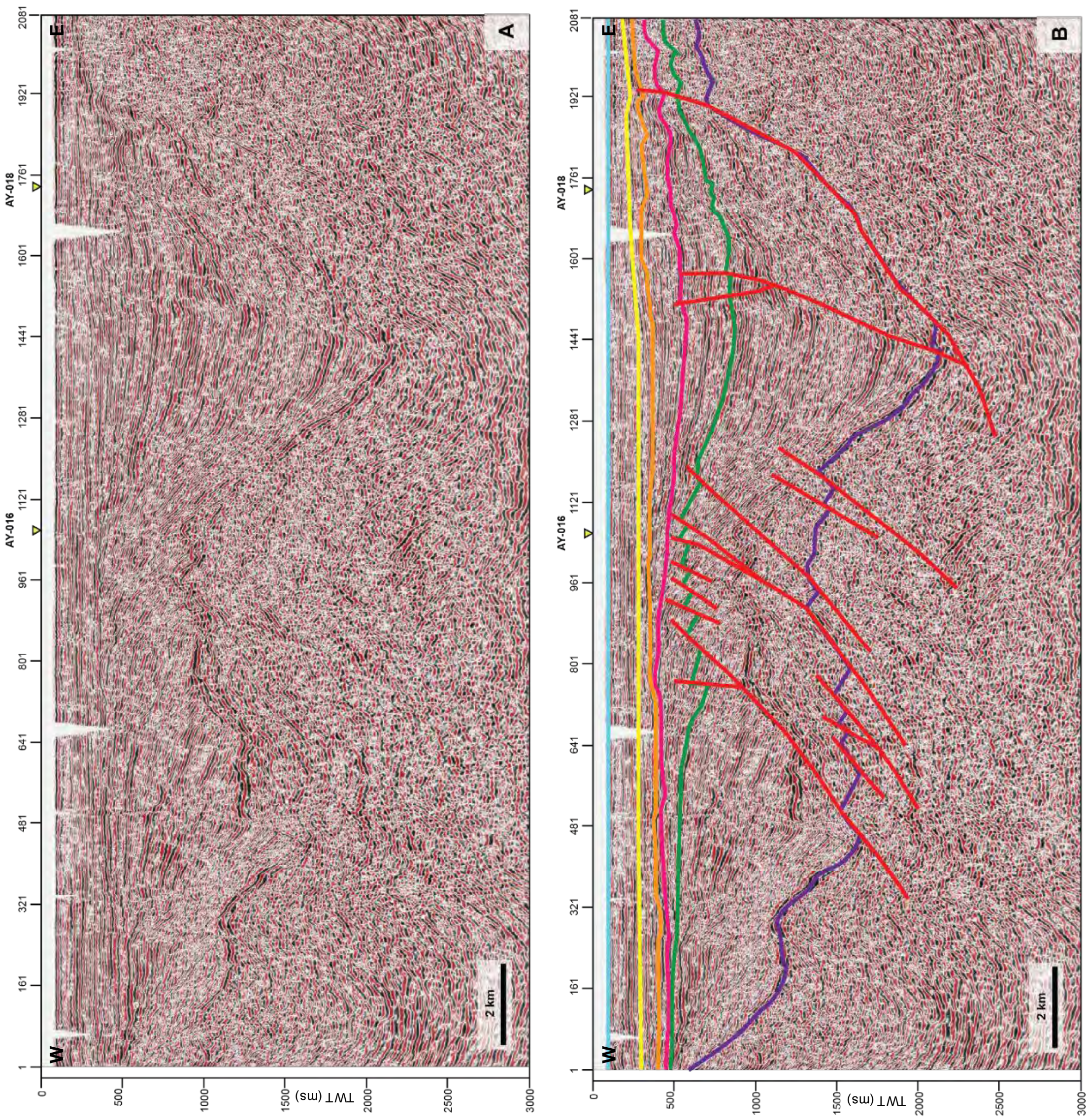

Figure A.2 A) Uninterpreted and B) interpreted seismic lines, AY-033, showing structural events and characteristics in Ayutthaya Basin.

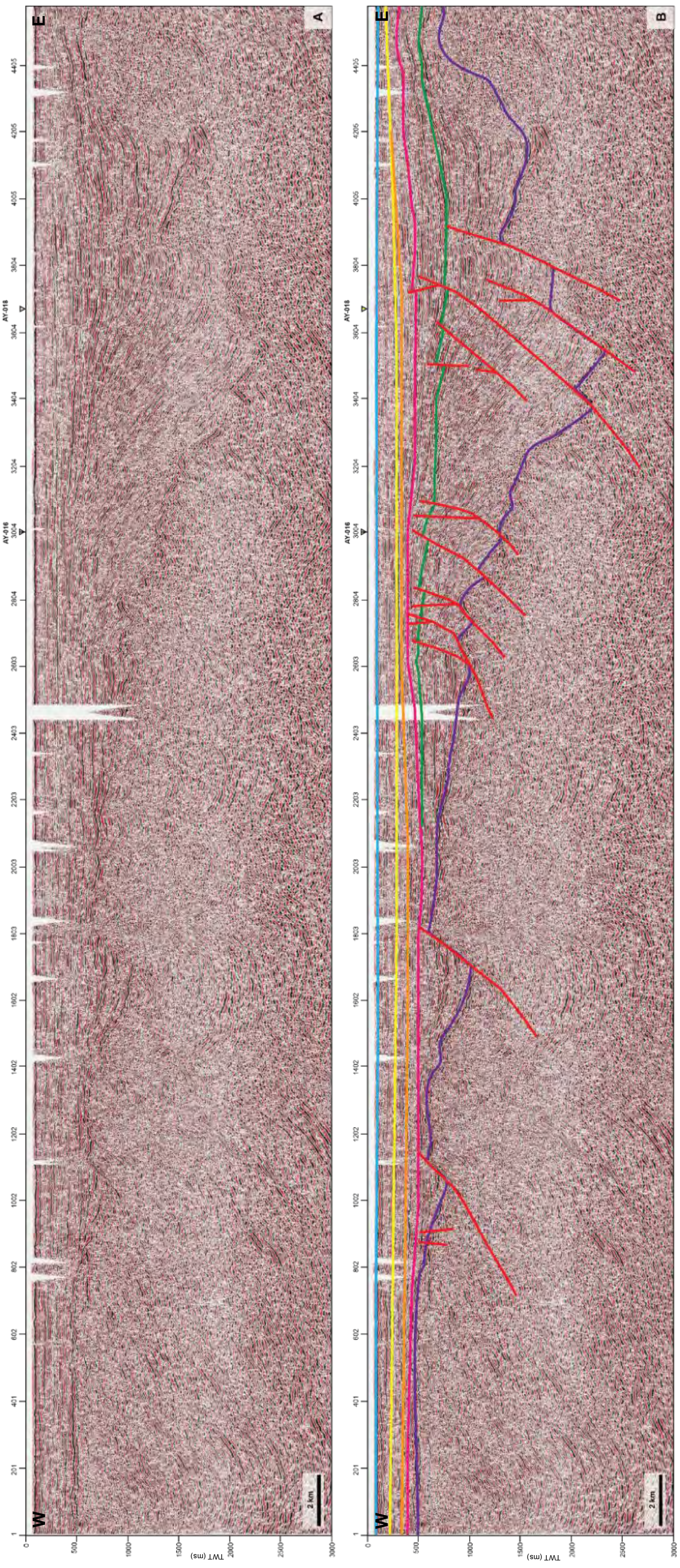

Figure A.3 A) Uninterpreted and B) interpreted seismic lines, AY-003-2, showing structural events and characteristics in Ayutthaya Basin.

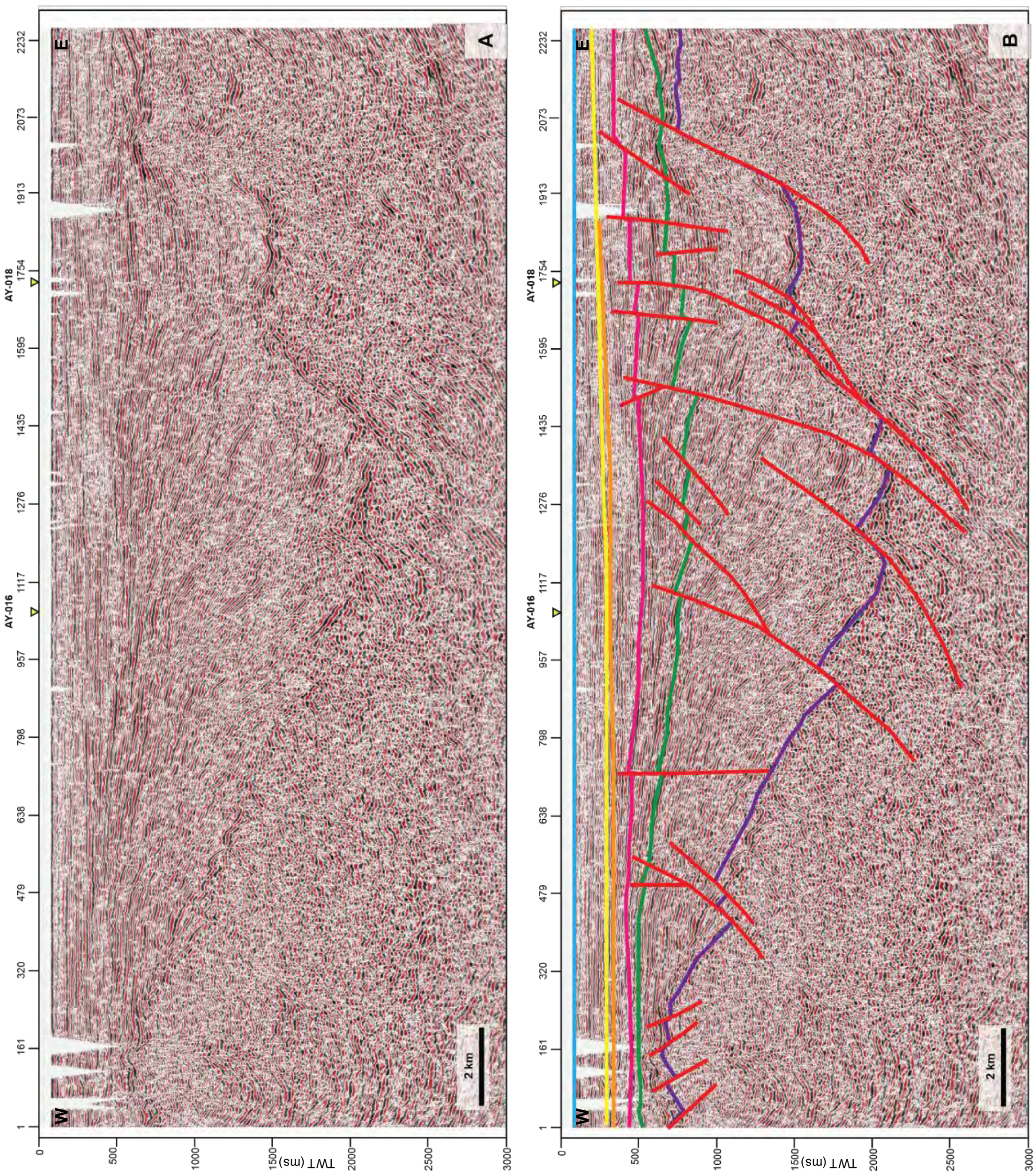

Figure A.4 A) Uninterpreted and B) interpreted seismic lines, AY-013, showing structural events and characteristics in Ayutthaya Basin.

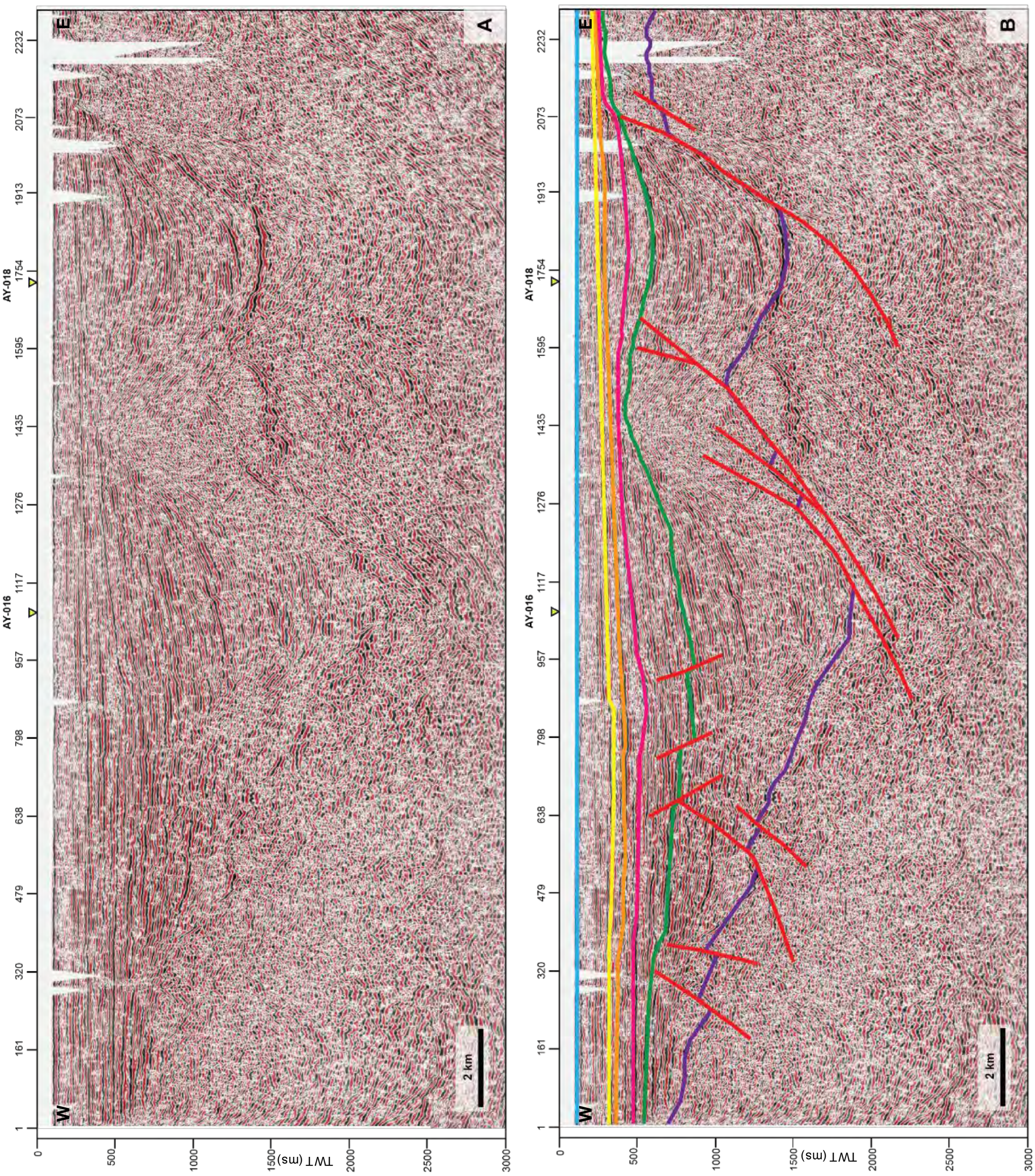

Figure A.5 A) Uninterpreted and B) interpreted seismic lines, AY-011, showing structural events and characteristics in Ayutthaya Basin.

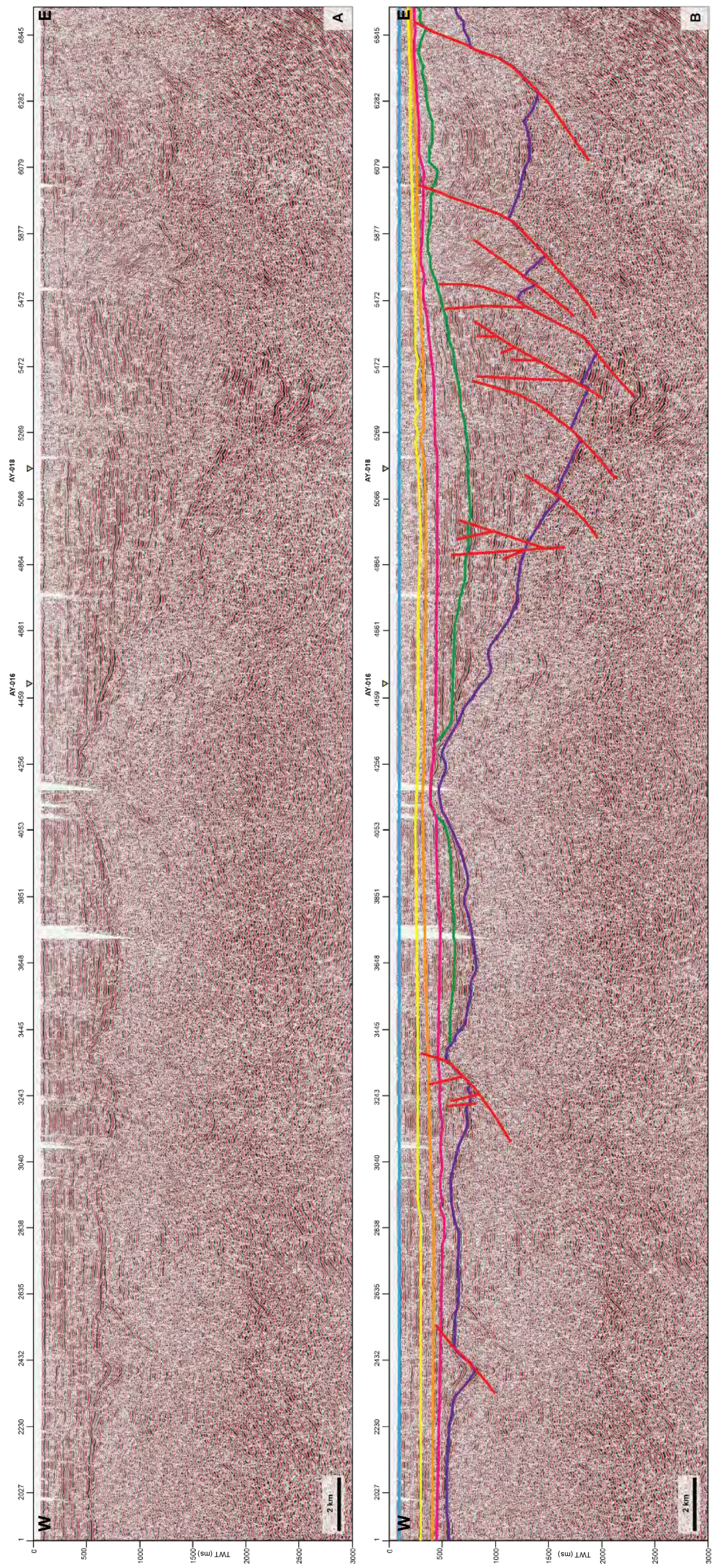

Figure A.6 A) Uninterpreted and B) interpreted seismic lines, AY-001-3, showing structural events and characteristics in Ayutthaya Basin.

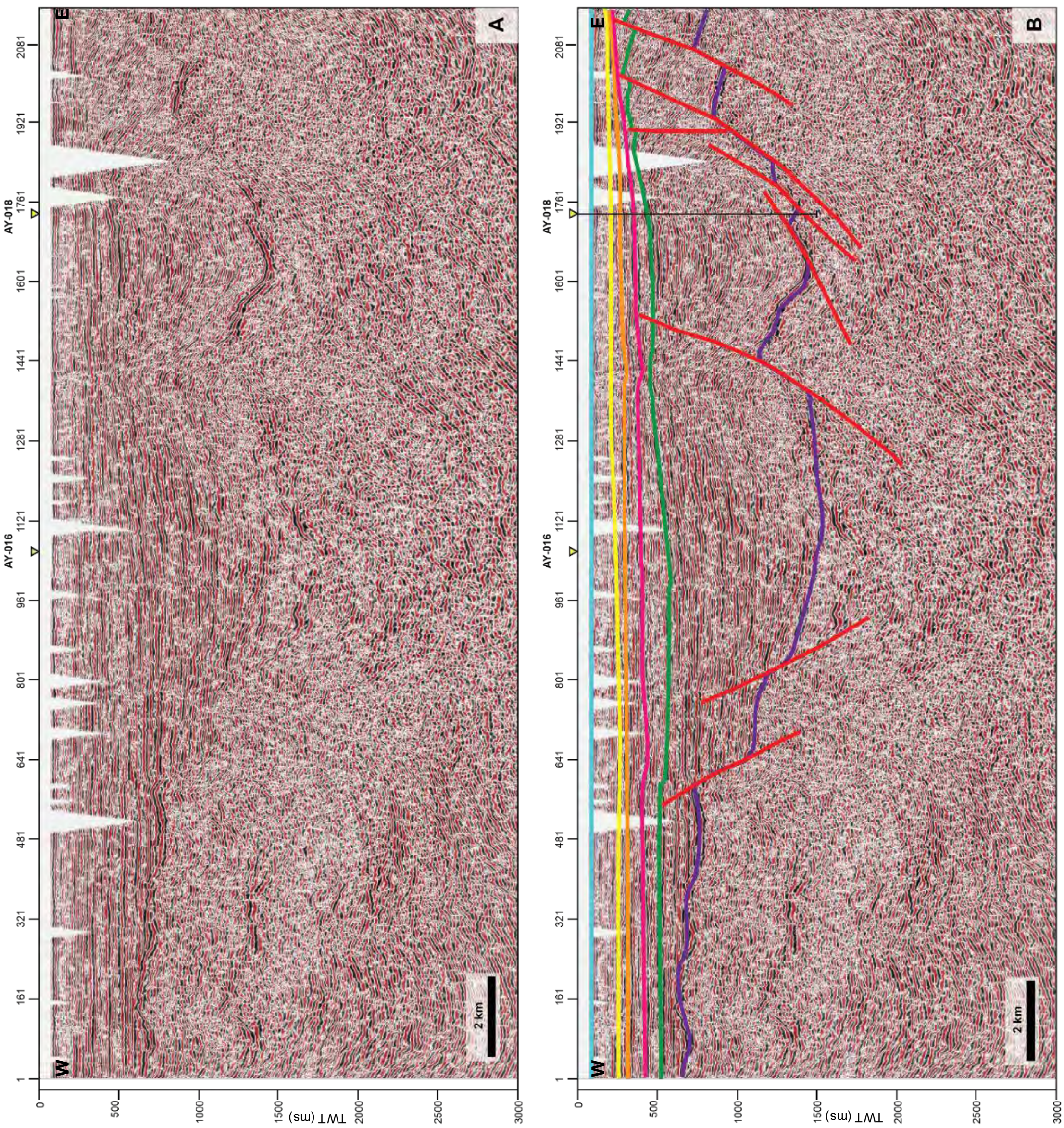

Figure A.7 A) Uninterpreted and B) interpreted seismic lines, AY-093, showing structural events and characteristics in Ayutthaya Basin.

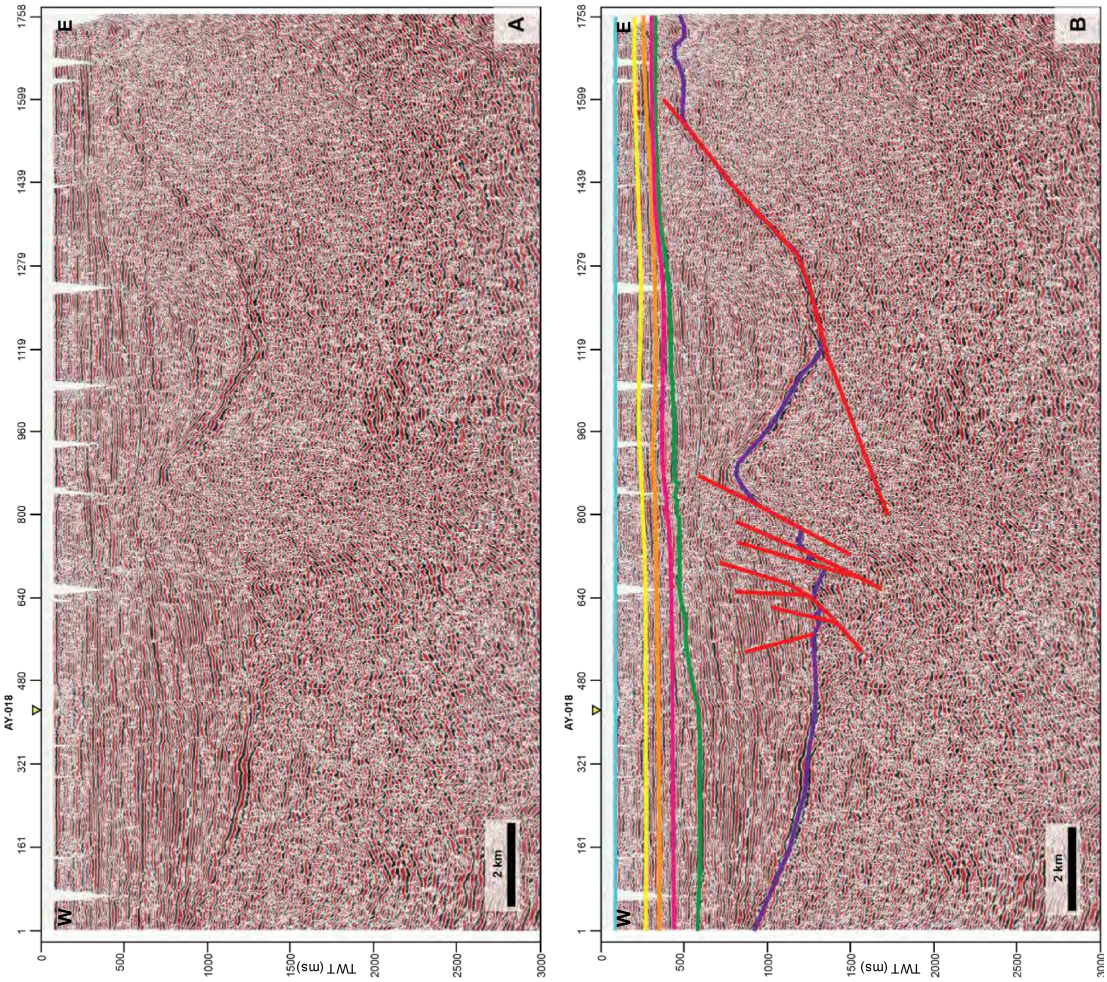

Figure A.8 A) Uninterpreted and B) interpreted seismic lines, AY-091, showing structural events and characteristics in Ayutthaya Basin.

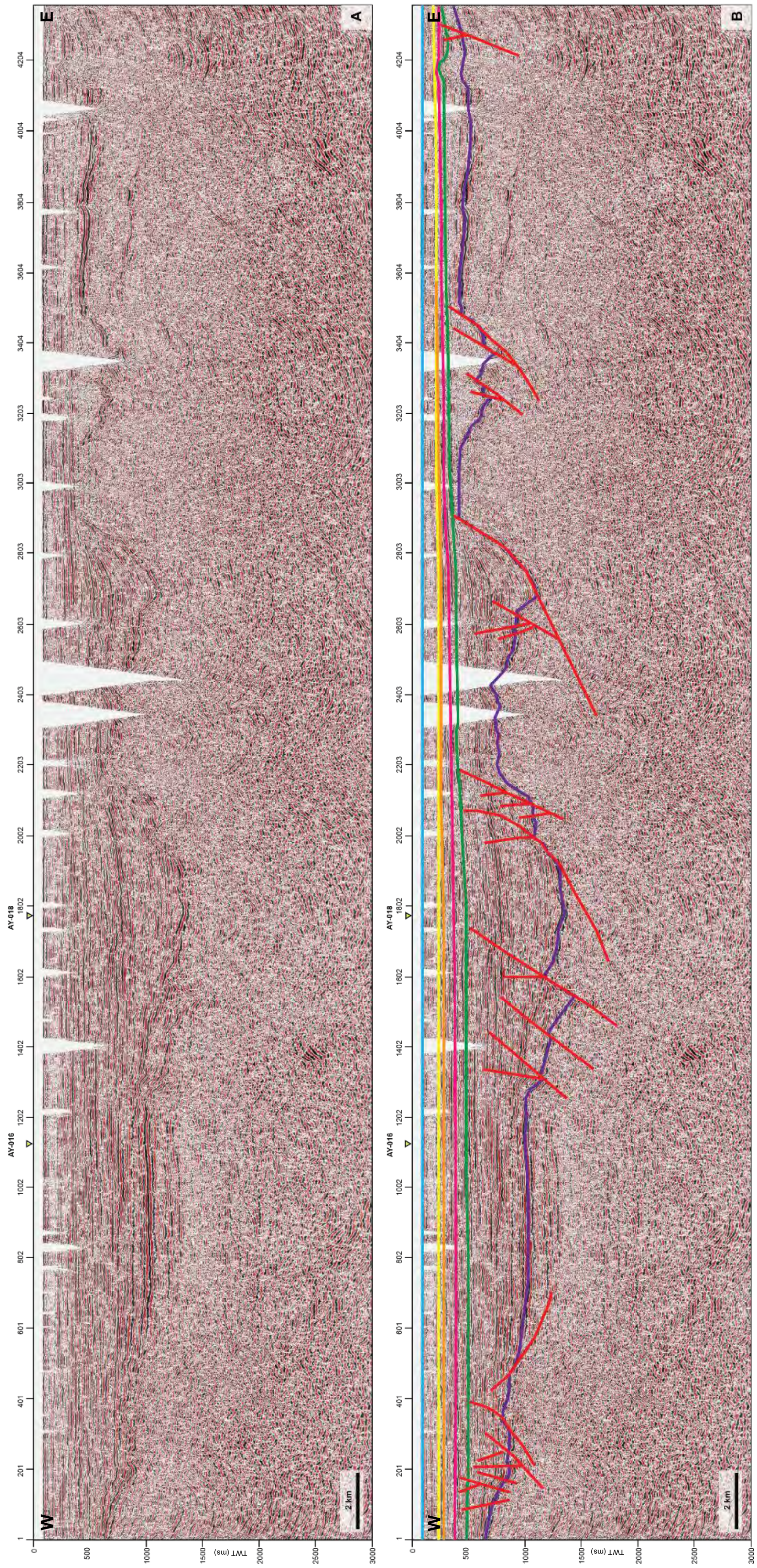

Figure A.9 A) Uninterpreted and B) interpreted seismic lines, AY-009-2, showing structural events and characteristics in Ayutthaya Basin.

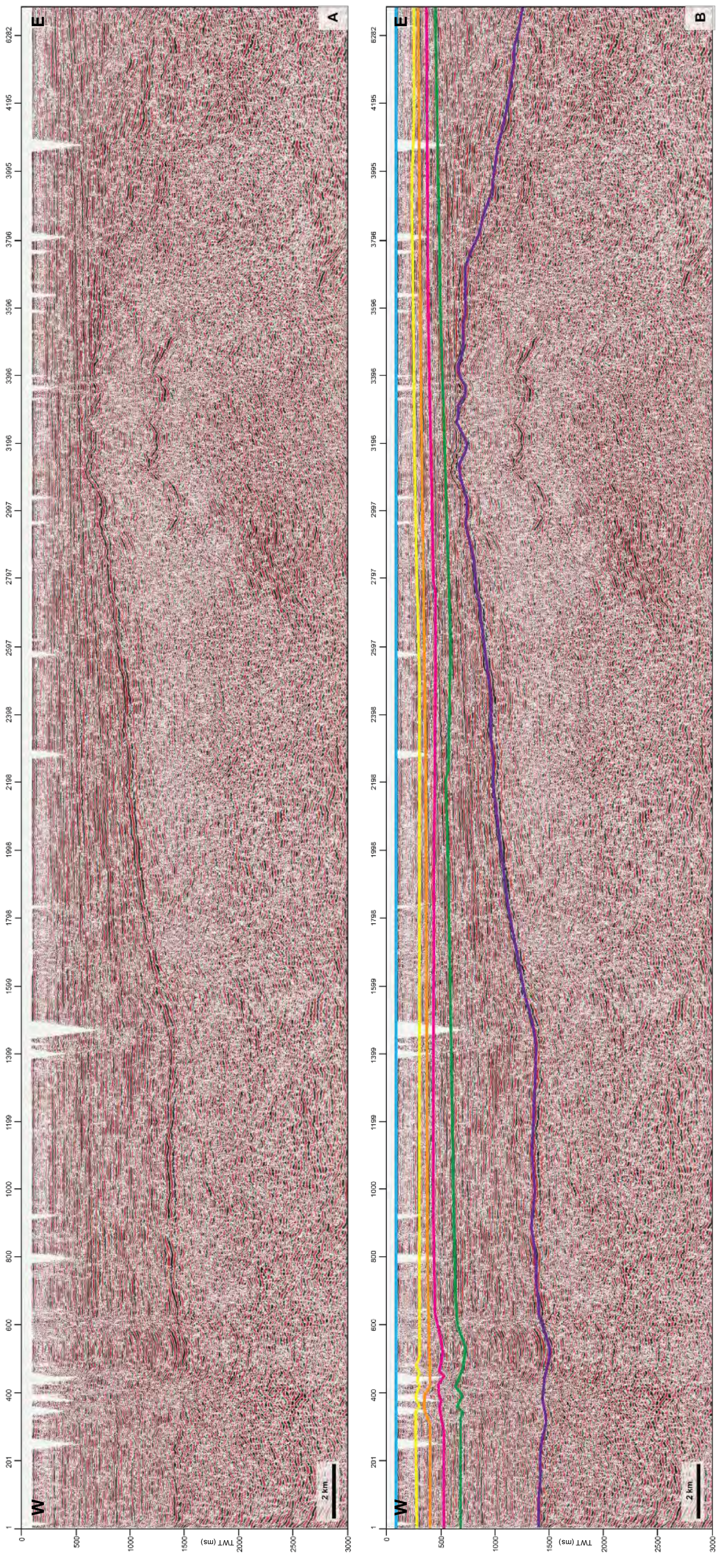

Figure A.10 A) Uninterpreted and B) interpreted seismic lines, AY-016, showing structural events and characteristics in Ayutthaya Basin.

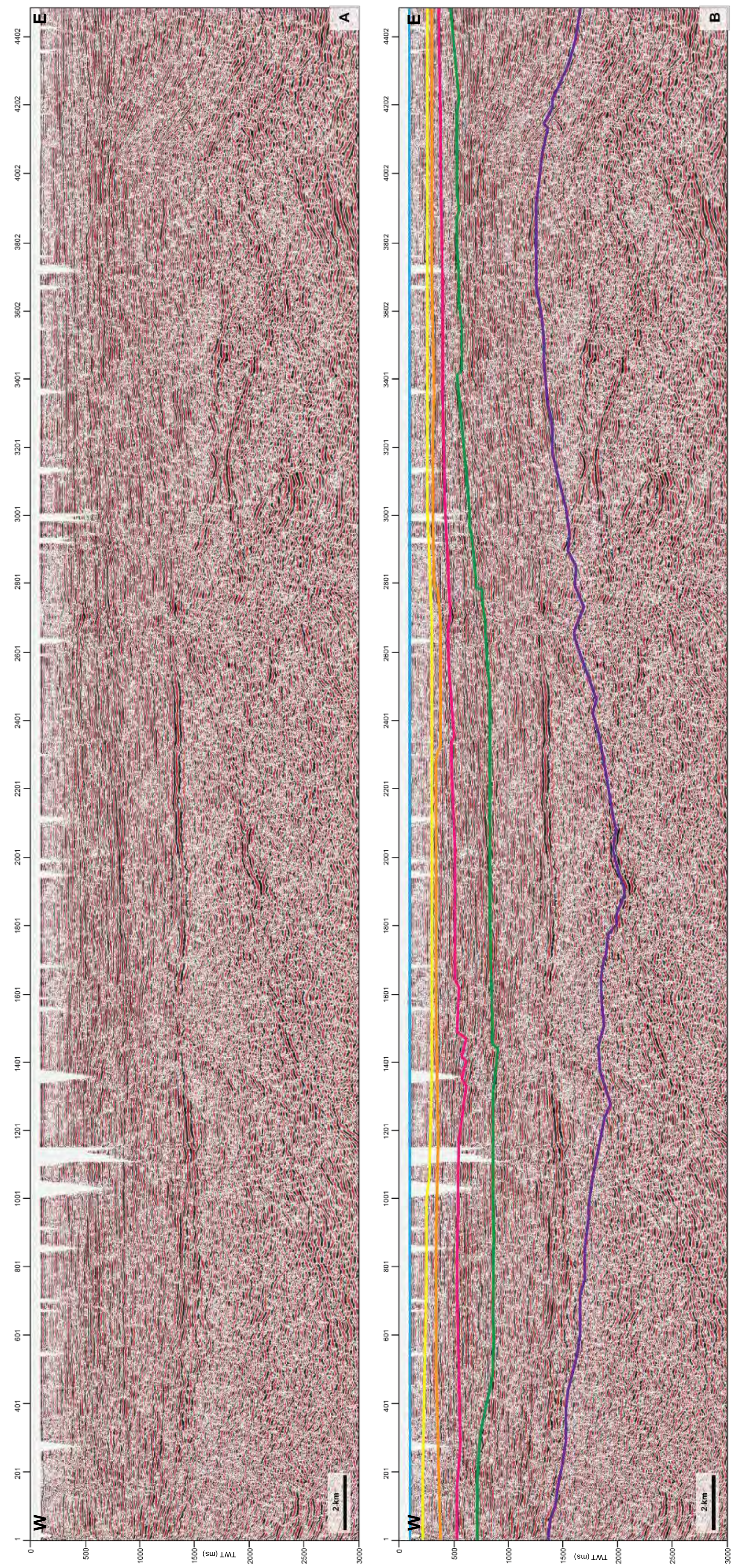

Figure A.11 A) Uninterpreted and B) interpreted seismic lines, AY-018, showing structural events and characteristics in Ayutthaya Basin.

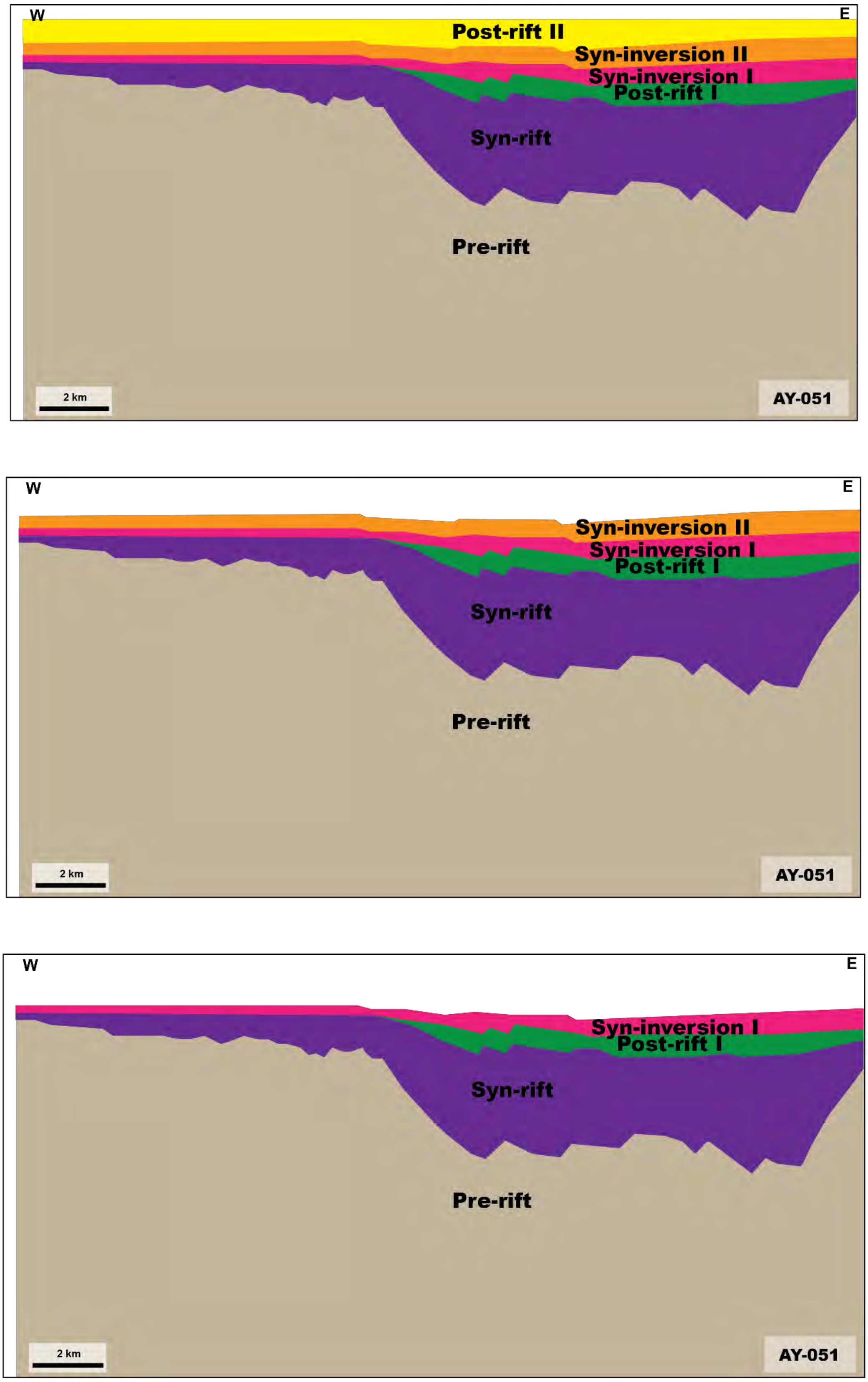

Figure A.12 A) Cross section of AY-051 section in present day B) Cross section of AY-051 section with Syn-inversion II restoration C) Cross section of AY-051 section with Syn-inversion I restoration

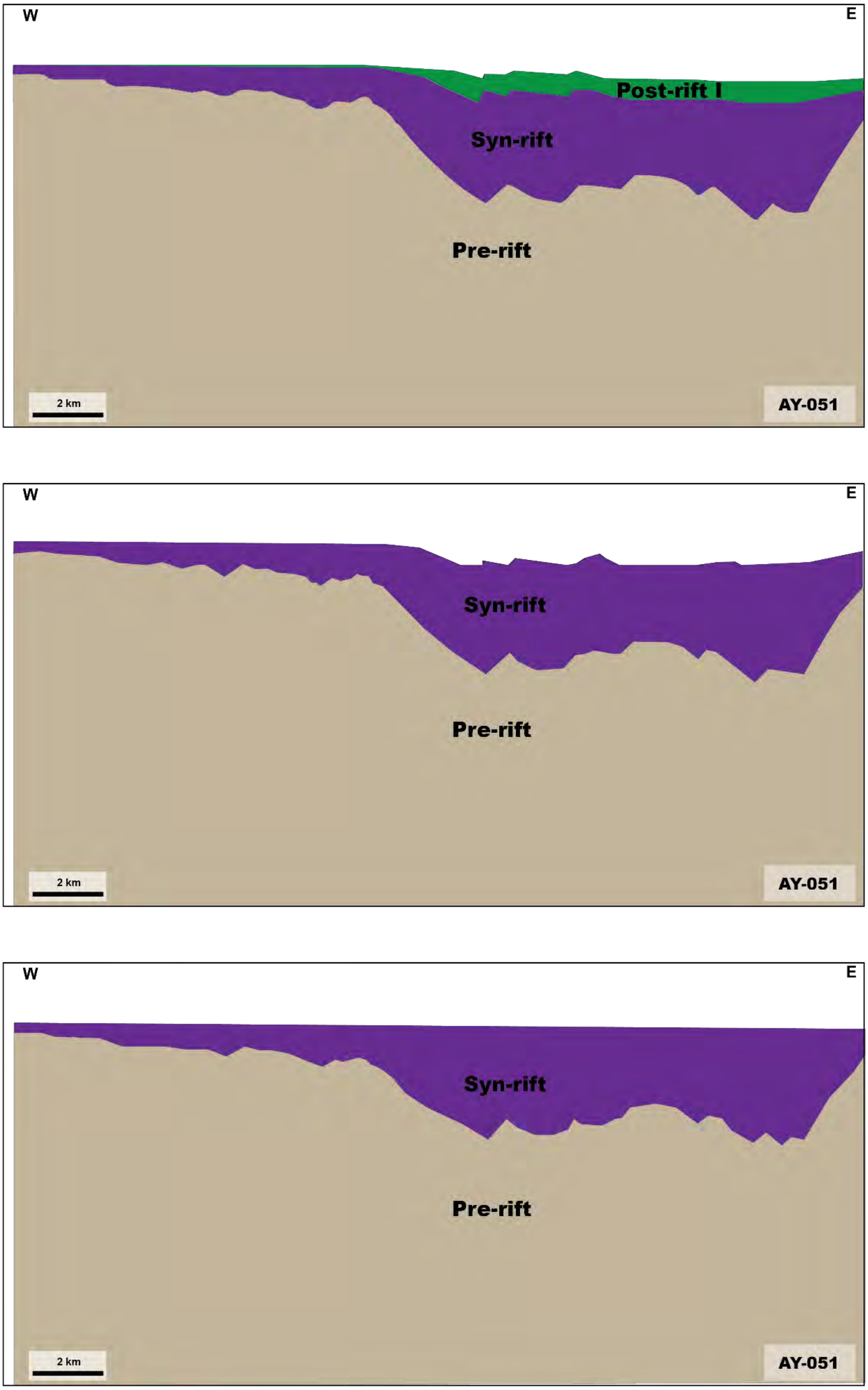

Figure A.12 D) Cross section of AY-051 section with Post-rift I restoration E) Cross section of AY-051 section with Syn-rift restoration F) Cross section of AY-051 section with Pre-rift restoration

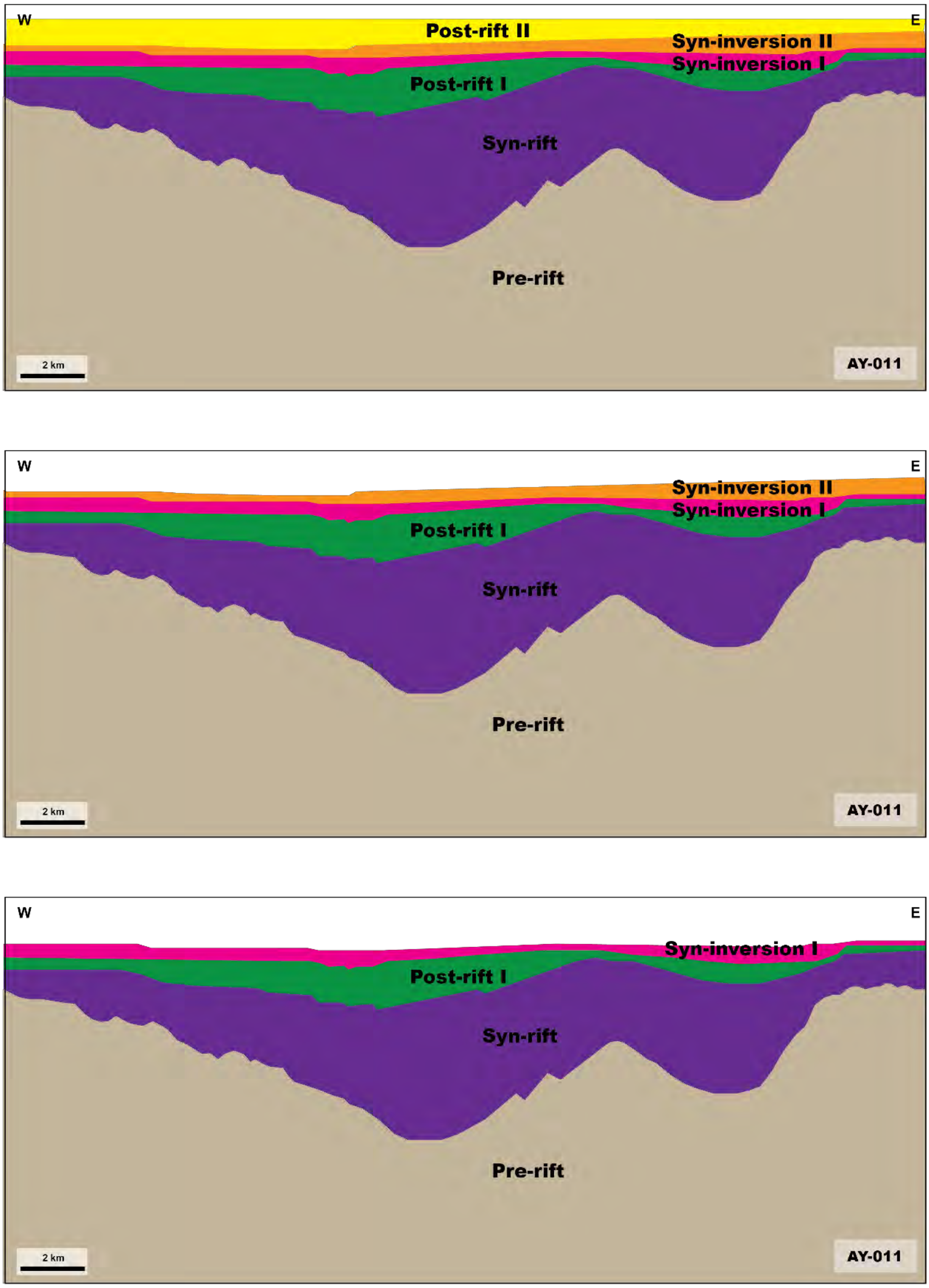

Figure A.13 A) Cross section of AY-011 section in present day B) Cross section of AY-011 section with Syn-inversion II restoration C) Cross section of AY-011 section with Syn-inversion I restoration

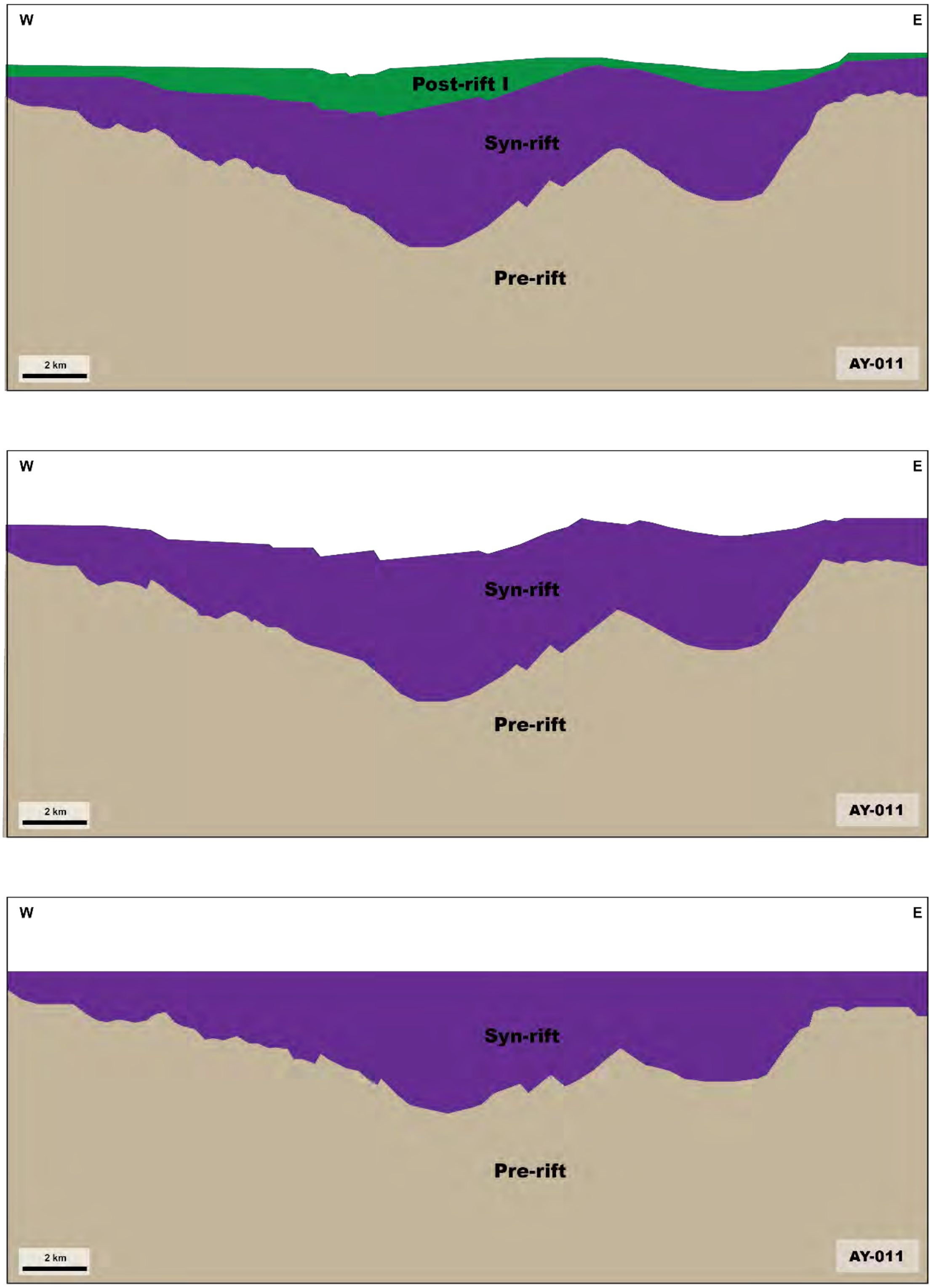

Figure A.13 D) Cross section of AY-011 section with Post-rift I restoration E) Cross section of AY-011 section with Syn-rift restoration F) Cross section of AY-011 section with Pre-rift restoration

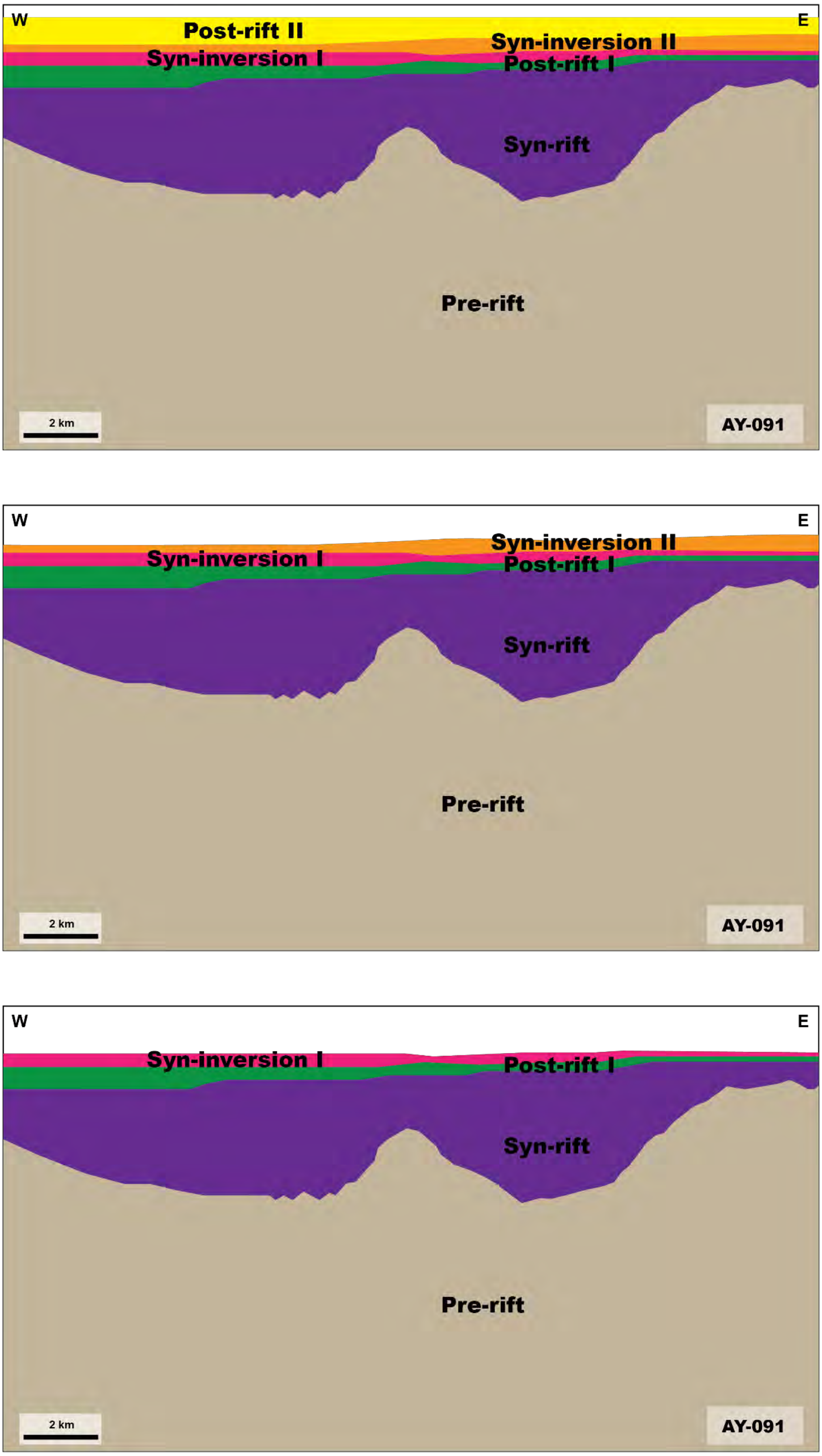

Figure A.14 A) Cross section of AY-091 section in present day B) Cross section of AY-091 section with Syn-inversion II restoration C) Cross section of AY-091 section with Syn-inversion I restoration

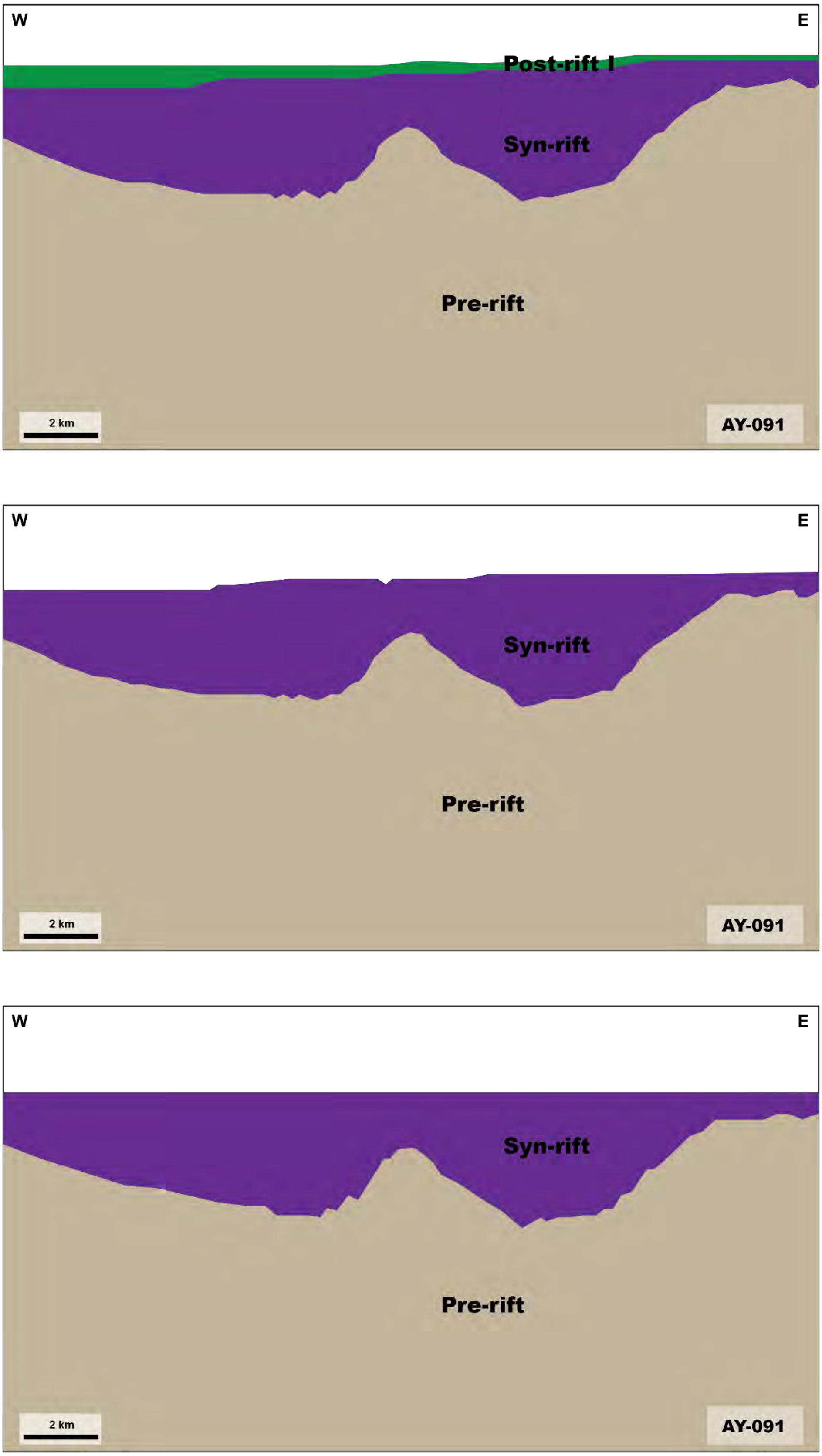

Figure A.14 D) Cross section of AY-091 section with Post-rift I restoration E) Cross section of AY-091 section with Syn-rift restoration F) Cross section of AY-091 section with Pre-rift restoration