CHAPTER 2

ESSENTIAL THEORIES AND METHODS

Balanced cross-section technique is a quantifying tool for structural analysis in petroleum exploration. The technique was originated in the 1950’s. Dahlstrom (1969) defined a “balanced” section concept in two rules: 1). There is a simple test of the geometric validity of cross-section, where bed lengths in deformed and undeformed states must be consistent unless a discontinuity intervenes. 2) In a specific geological environment, there is only a limited suit of structures which can exist. The technique can be applied in evaluating the result of seismic interpretation with implications for tectonic evolution of basin. In this study balanced cross-sections have been constructed based on seismic data from the Arthit project of PTTEP. The data was analysed and interpreted in Schlumberger Charisma® program. The method of study is as follows:

1. cross-section construction
2. seismic interpretation
3. cross-section balancing, and

4 basin development model construction.

2.1 Cross-section construction

Generating structurally significant cross-section requires identification of major structural geometries and orientation. The Graben trend in the study area consists of N-S and NE-SW trending normal faults with bedding dip into the west.

Three E-W cross-sections AA', BB' and CC' were constructed across the area (Fig 2.1) in order to optimally display the dominant N-S structural trend. Seismic horizons were interpreted in the Charisma® program. The interpretations were adjusted where needed to better represent the interaction between horizons and faults.

2.2 Seismic interpretation

The interpretations were digitized over seismic data by using Charisma® program. Illustration of the various patterns of fault geometries is based on the relationship between faults, sedimentary rock layers and the pre-rift basement. Seismic section and time slice displays provide information for the most reliable interpretation. The seismic horizons were correlated with well log data. They consist of 8 horizons: basement, H1, H2, H3, H4, H5, H6 and H7, successively upward (Fig. 2.2).

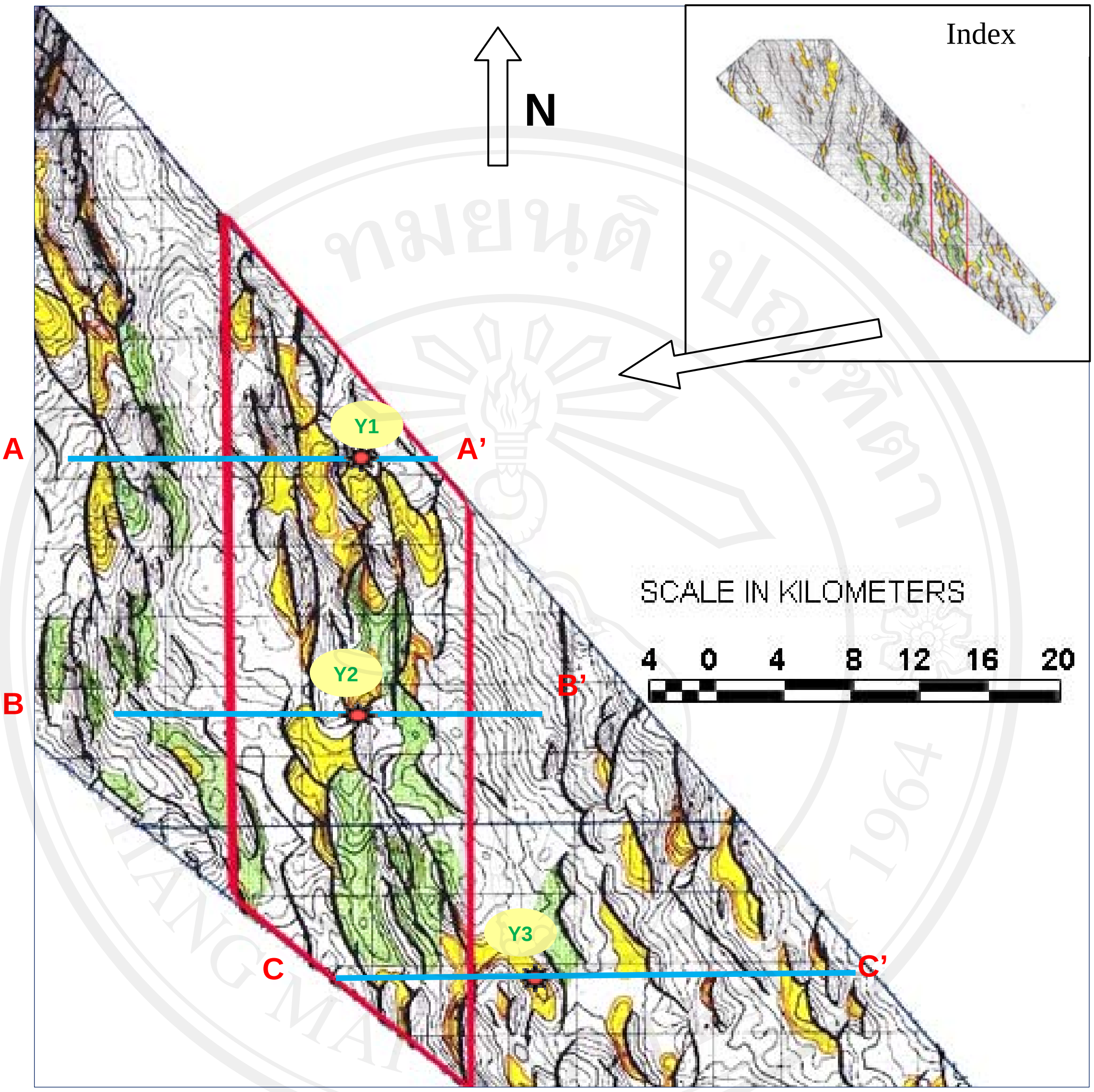

Figure 2.1 Three cross-sections AA', BB', and CC' following northern, middle and southern part of The Graben fault trend.

The horizon near the top of basement and horizon H1 are identified as markers in the syn-rift succession while horizons H2, H3, H4, H5, H6 and H7 are in the post-rift succession. Horizon H1 is a marker near the top of formation 0 which is the top of the Oligocene internal. Horizon H2 is a marker near the top of formation 1 which is members Early Miocene. Horizons H3, H4, H5, H6 and H7 are markers near the top of 2A, 2B, 2C, 2D and 2E respectively in the Formation 2.

The interpretation of seismic horizons and faults was made in a grid of every 10 in-line and 20 cross-line. In interested areas arbitrary lines and time slices were checked to improve the existing interpretation. A number of time slices was generated at 0-4500 millisecond Early to Middle Miocene interval (Fig. 2.3).

2.3 Cross-section balancing

2.3.1 Balancing cross-section concept

The concept of balancing cross-section was first discussed in detail by Dahlstrom (1969). Balanced cross-sections can be restored so that the beds are placed back into their depositional, pre-deformational position. It also links the deformed and undeformed states. Furthermore, a balanced structural model validates the geophysical interpretation and promotes a better understanding of the geological history of the area of interest. There are three principle facts that we may use in the construction of cross sections of layered rocks:

1) The orientation of bedding, cleavage and fold axes at specific places.
2) The distribution and thickness of stratigraphic unit.
3) The originally undeformed nature of the rock.

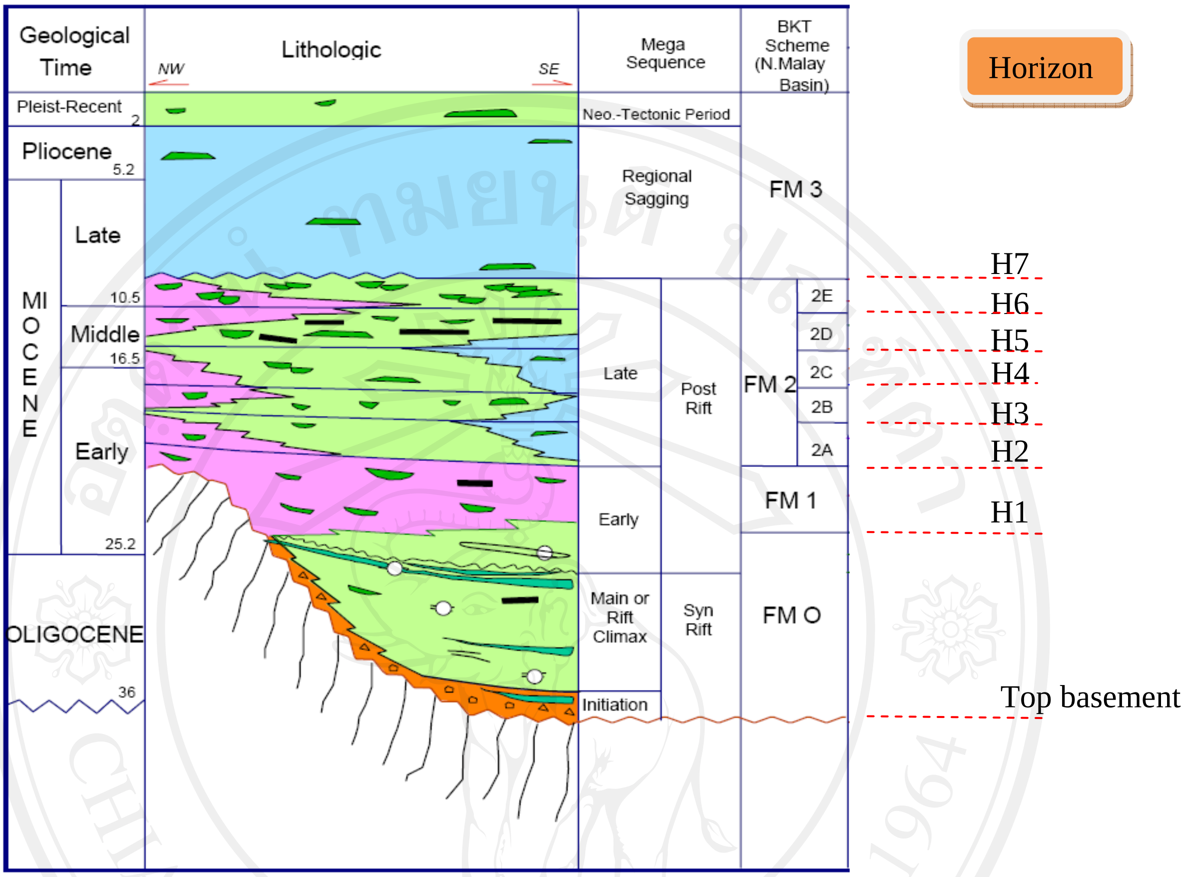

Figure 2.2 Seismic horizons that were re-interpreted in the interested area (modified form Intrawijitr, 1998)

2.3.2 Balancing cross-section method

Three techniques of balancing sections have been developed (Ramsay and Huber, 1987).

1. Line-length balancing-assumes that rock layers maintained constant thickness and length during deformation. (Fig. 2.4)
2. Area balancing–assumes that the original cross sectional area before and after must be equal.
3. Strain balancing–uses the known finite strains in a structure to correct layer lengths and bed thicknesses.

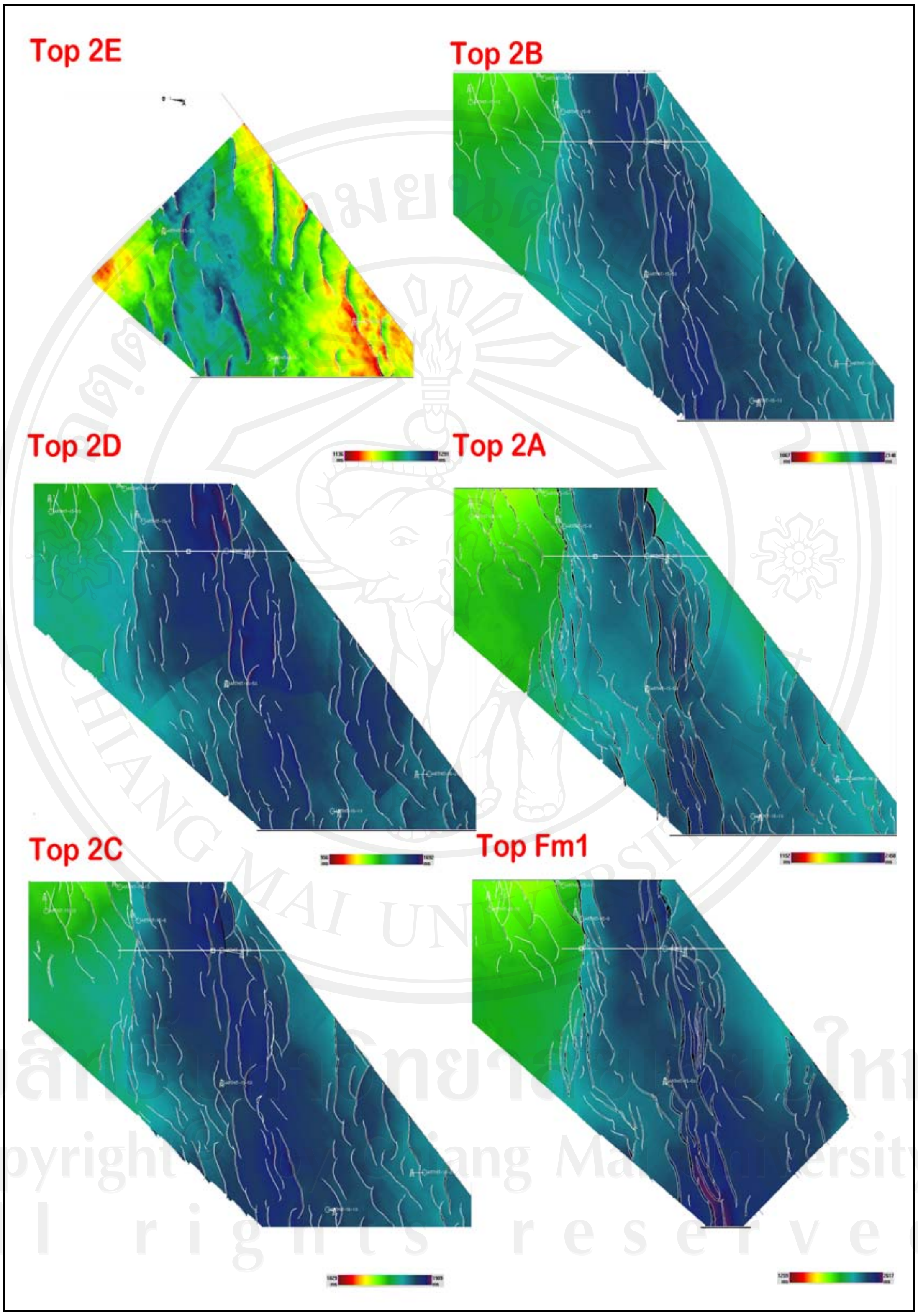

Figure 2.3 Time structure maps of seismic horizons of near the top of member 1, 2A, 2B, 2C, 2D.

Undergoing deformation, rock formations in the area still maintain their thickness and bed length. Thus the line-length balancing technique was adopt in this study.

2.3.3Balancing cross-section of study area

Cross-sections in the study area were selected so that they are oriented perpendicular to the regional trend of the structures and these are shown in Figures 2.5-2.7. The balancing cross-section procedure in this study is described as follows.

1. Select the seismic section lines that are perpendicular to the regional fault trend.
2. Interpret seismic horizons and faults
3. Construct a sequence model for the structural evolution of each seismic section.
4. Calculate the amount of extension at the time of deposition of each seismic horizon. The extention determined by the equation.

$$[(l_1-l_0)/l_0]\text{x } 100\%$$

Where l_0 is the bed length in the undeformed state,

l_1 is the bed length in the deformed state.

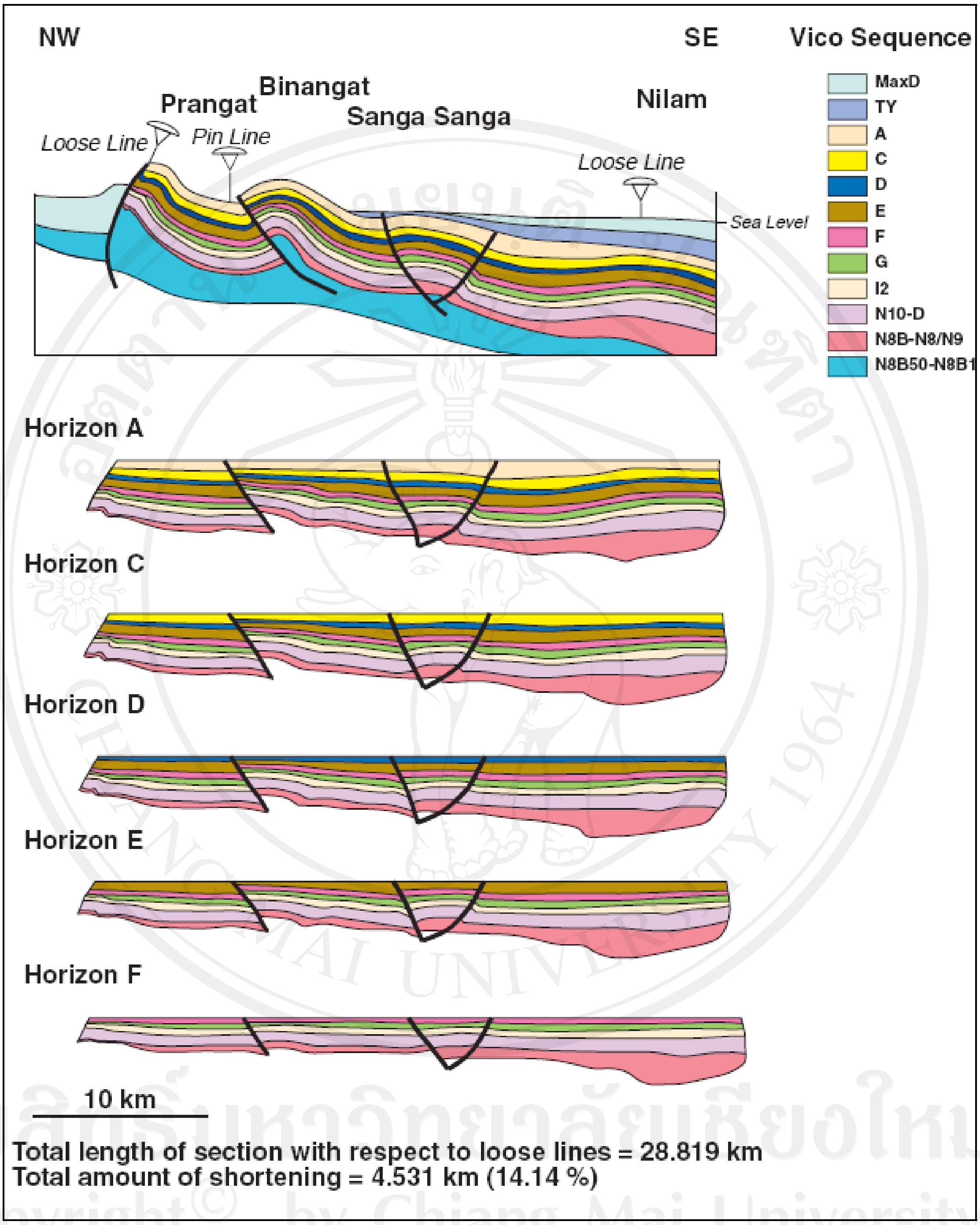

Figure 2.4 Line length balancing cross-section cross Mutiara field, Mahakam delta, Kalimantan, Indonesia (McClay *et al*., 2000).

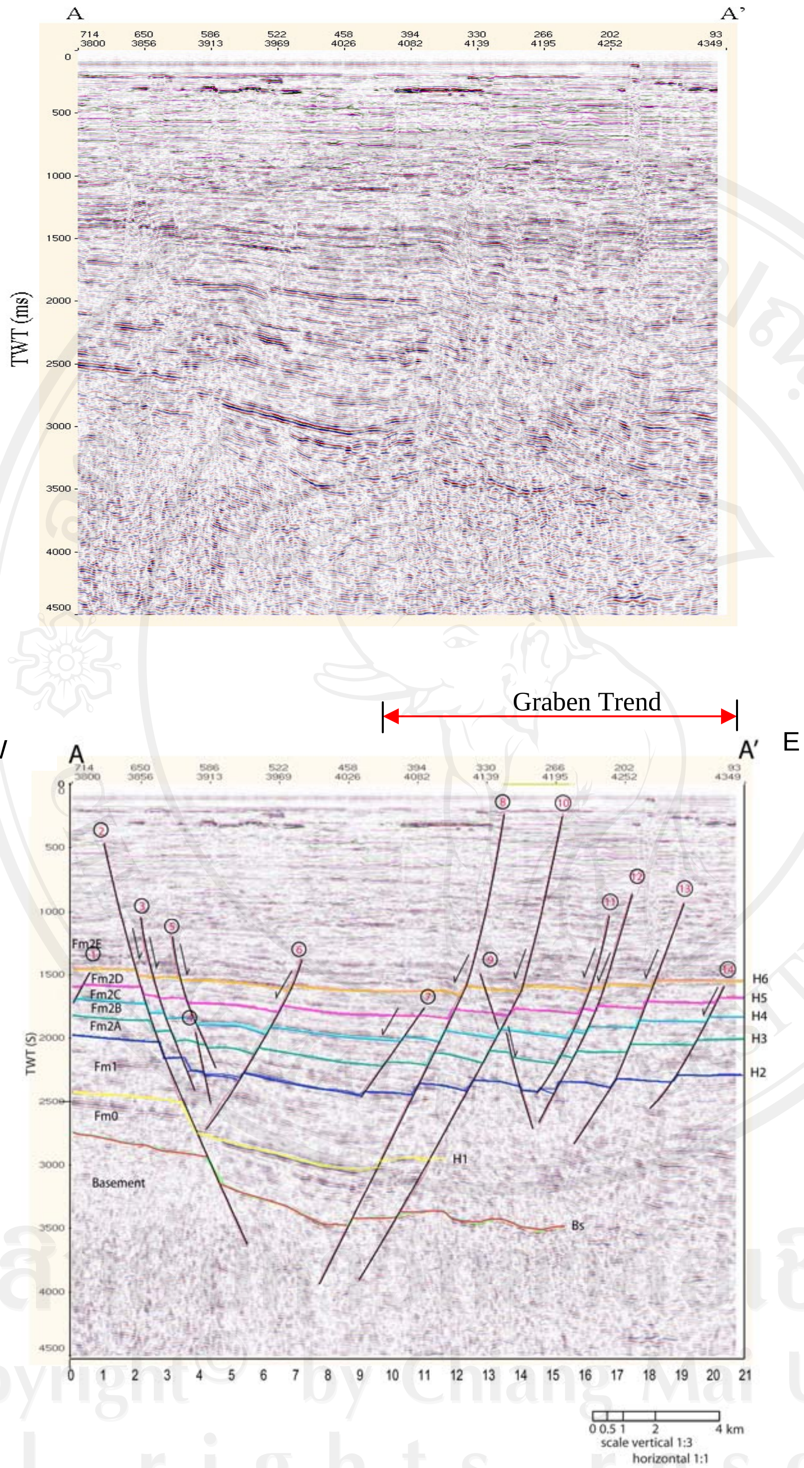

Figure 2.5 The seismic interpretation of cross-section AA'.

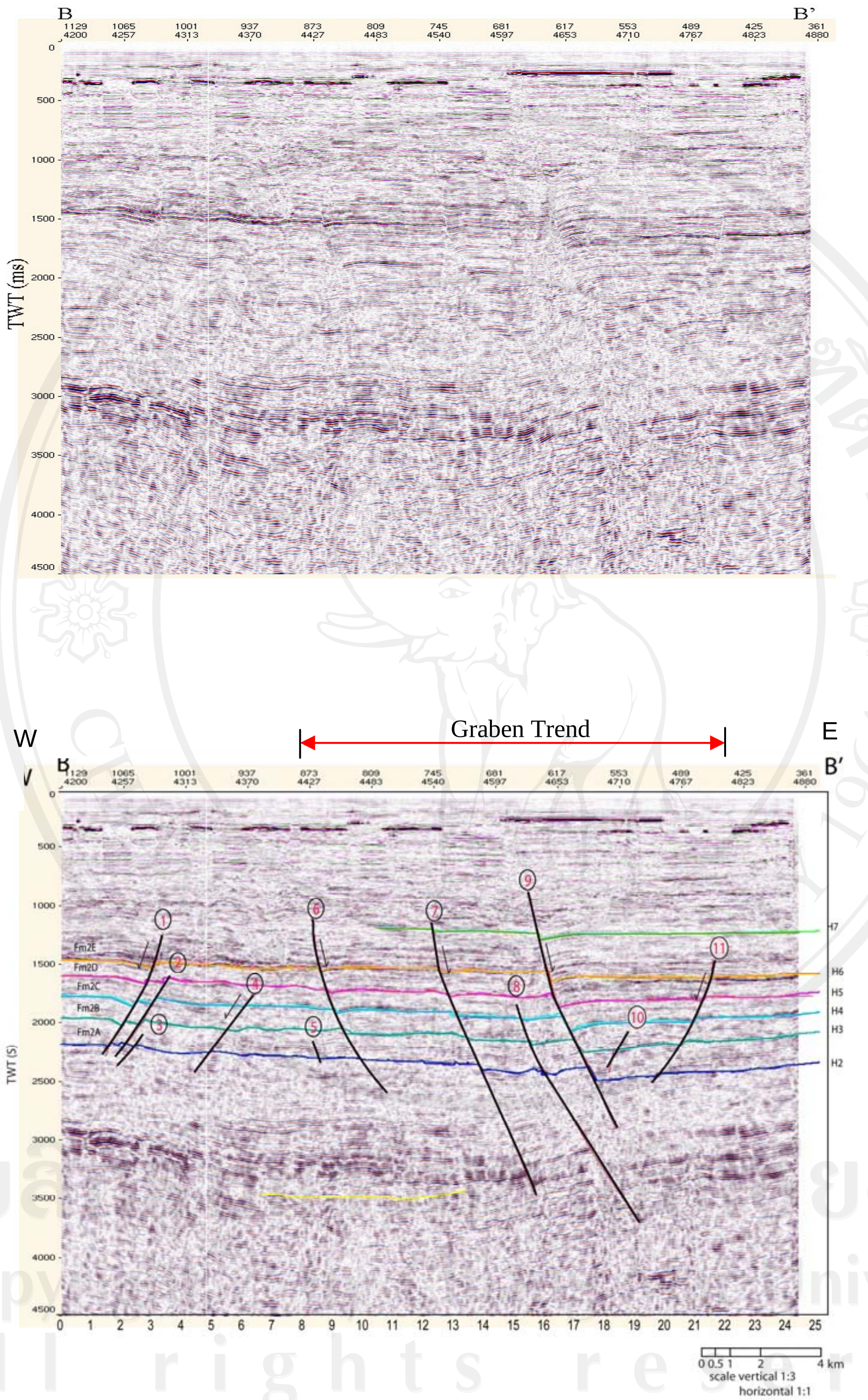

Figure 2.6 The seismic interpretation of cross-section BB’

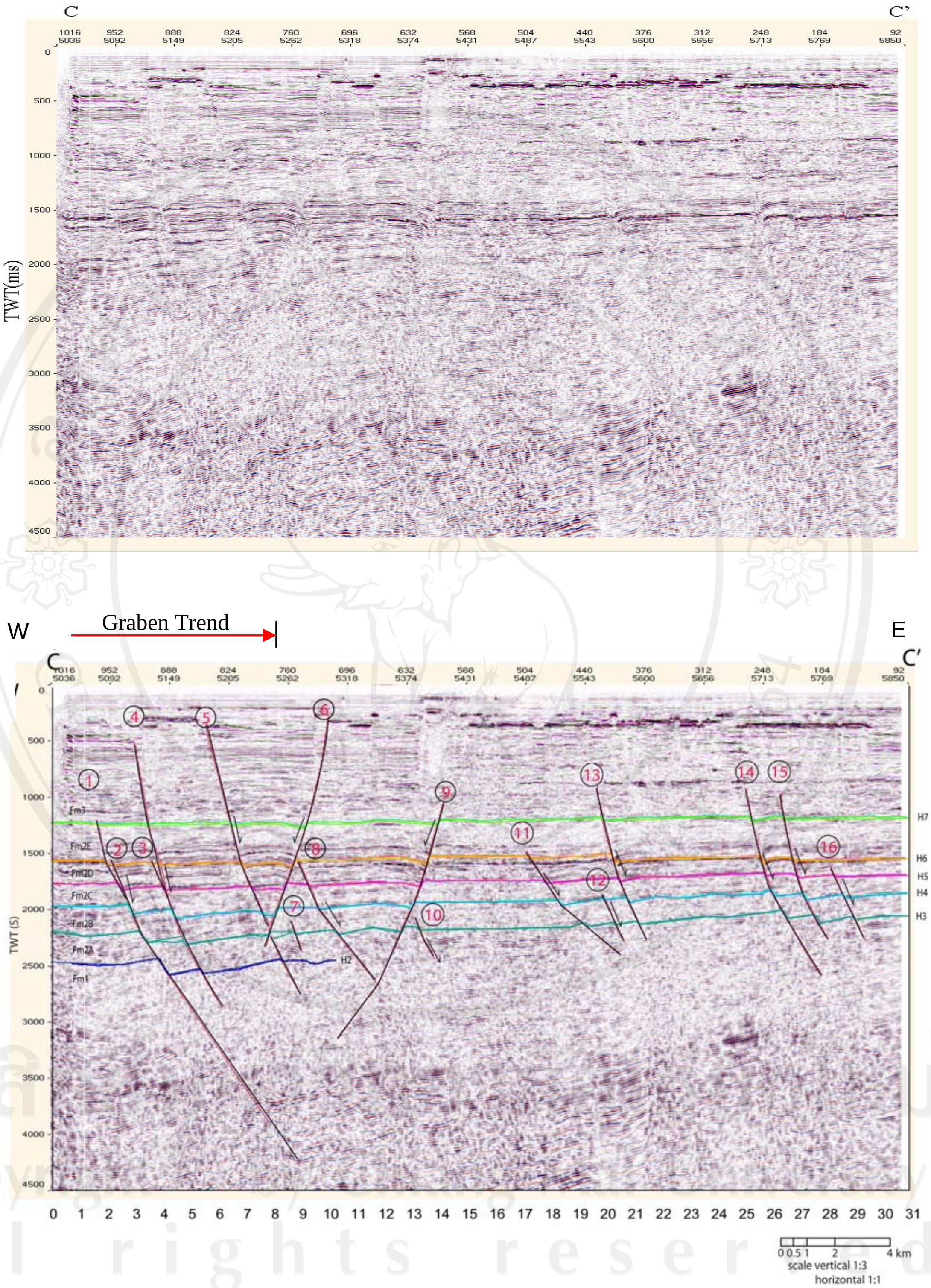

Figure 2.7 The seismic interpretation of cross-section CC’