CHAPTER 3

RESULTS AND INTERPRETATION

Cross-section balancing has been applied to the seismic interpretation. The restored sections have been compared with the present-day geometry for any changes in bed length. Three composite regional cross-sections were sequentially restored to the geometry at the time of deposition of horizons H3-H6. Because of the incomplete interpretation the Oligocene-middle Early Miocene and Pliocene strata were not restored. These restorations integrated with well data were used to determine the timing of structural development and calculate the amount of extension during deposition of each horizon.

3.1 Cross-section Balancing of Profile AA'

Cross-section AA' (Fig. 3.1) is located in the northern part of the Graben Trend with an original length of 21 kilometers. The seismic interpretation consists of seven markers and 14 fault cuts. Five restored sections (Table 3.1) were constructed. For convenience in restoration, the horizon and fault interpretation were redrawn, leaving out the seismic data (Fig. 3.2).

In terms of layer thickness variation, the profile can be subdivided into two parts. Formations 0, 1 and 2A thicken toward the east. The total thickness of these units is about 1500 meters in west, increasing to about 3000 meters in the eastern part of the profile. The overlying units are relatively uniform in thickness. Fault numbers 1, 6, 7, 8, 10, 11, 12, 13 and 14 are east-dipping and fault numbers 2, 3, 4, 5 and 9 are east-dipping. Large displacement on fault numbers 2 and 8 resulted in thickening of formations 0 and 1. Thickening of Formation 2A relative to fault plane position is subdued.

Horizon H6 is the upper contact of Formation 2D (Fig. 3.3). After restoration or removal of faults slips, bed-length of horizon H6 is 20.76 kilometers. All of the fault cuts are present. Horizon H5 is the upper contact of Formation 2C (Fig. 3.4). After restoration, bed length of horizon H5 is 20.52 kilometers. All of the fault cuts are still present. Horizon H4 is the upper contact of Formation 2B (Fig. 3.5). After restoration, bed length of horizon H4 is 20.16 kilometers and fault numbers 1 and 7 are not present at this stage. Horizon H3 is the upper contact of Formation 2A (Fig. 3.6). After restoration, bed length of horizon H3 is 20.04 kilometers and fault numbers 3, 4, 5, 9 and 13 are not present at this stage. The presence of fault cuts and extension at each stage of restoration are summarized in tables 3.1 and 3.2

It can be seen that movement along normal faults controlled the development of sedimentary depocenters. Normal faults with large offsets in the Oligocene are related to positions of the thick sediment. Four sequential stages can be interpreted from profile restoration. The early extension occurred in the late Early Miocene after the deposition of Formation 2B with 0.60% extension. The second stage was in the early Middle Miocene after the deposition of Formation 2C with 1.79% extension. The third stage was in the late Middle Miocene after the deposition of Formation 2D with 1.17% extension and after the deposition of formations 2E and 3, 0.24% extension occurred. During the middle Early Miocene to the late Middle Miocene the total extension is 0.96 kilometers or 4.71%.

Restored	Bed		Apparent Faults												
Horizon	lengui														
	(km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
H6	20.76	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Н5	20.52	*	*	*	*	*	*	*	*	*	*	*	*	*	*
H4	20.16		*	*	*	3	*		*	*	*	*	*	*	*
H3	20.04		*	Jul I	Ē	JAC 1	*		*		*	*	*		*
224				Z	6	(F	2					Ċ	24		

Table 3.1 The presence of faults and bed length after horizon restorations in section

AA'.

Restored Horizon	Bed length (km)	After Deposition of Formations	Deformed, <i>l</i> ₁ (km)	Undeformed, l_0 (km)	Extension, l ₁ -l ₀ (km)	Extension Ratio (%), $(l_1 - l_0)/l_0 \ge 100$	Cumulative Extension Ratio (%)
H6	20.76	2D	21	20.76	0.24	1.16	1.16
H5	20.52	2C	20.76	20.52	0.24	1.17	2.33
H4	20.16	2B	20.52	20.16	0.36	1.79	4.11
H3	20.04	2A	20.16	20.04	0.12	0.60	4.71
pyri	Tota	al extension	(2A-2D)	iang	0.96	4.71 er	sity

 Table 3.2
 Extension derived from horizon restoration of section AA'.

22



Figure 3.1 Seismic interpretation of faults and horizons in cross-section AA'.

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Figure 3.2 Line drawing of faults and seismic horizons from seismic profile AA'.



Figure 3.3 Restoration of Horizon H6 of cross-section AA'.



Figure 3.5 Restoration of Horizon H4 of cross-section AA'.



Figure 3.6 Restoration of Horizon H3 of cross-section AA'.

3.2 Cross-section Balancing of Profile BB'

Cross-section BB' (Fig. 3.7) is located in the middle part of the Graben Trend with an original length of 25 kilometers. The seismic interpretation consists of seven markers and 11 fault cuts. Five restored sections (Table 3.3) were constructed. For convenience in restoration, the horizon and fault interpretation were redrawn, leaving out the seismic data (Fig. 3.8).

The formations 2A, 2B, 2C and 2D in this profile thicken toward the east. The total thickness of these units is about 1100 meters in the west increasing to about 1300 in the eastern part of the profile. The overlying units are relatively uniform in thickness. Fault numbers 1, 2, 3, 4, 10 and 11 are west-dipping and fault numbers 5, 6, 7, 8 and 9 are east-dipping.

Horizon H6 is the upper contact of Formation 2D (Fig. 3.9). After restoration, bed length of seismic horizon H6 is 24.87 kilometers. Fault number 11 is not present at this stage. Horizon H5 is the upper contact of Formation 2C (Fig. 3.10). After restoration, bed length of seismic horizon H5 is 24.61 kilometers. Fault number 6 is not present at this stage. Horizon H4 is the upper contact of Formation 2B (Fig. 3.11). After restoration, bed length of seismic horizon H5 is 24.48 kilometers. Fault numbers 1 and 9 are not present at this stage. Horizon H3 is the upper contact of Formation 2A (Fig. 3.6). After restoration, bed length of seismic horizon H3 is 24.35 kilometers. Fault number 10 is not present at this stage. The presence of fault cuts and extension at each stage of restoration are summarized in tables 3.3 and 3.4.

Four sequential stages can be interpreted from profile restoration. The early extension occurred in the late Early Miocene after the deposition of Formation 2B with 0.53% extension. The second stage was in the early Middle Miocene after the deposition of Formation 2C with 0.53% extension. The third stage was in the late Middle Miocene after the deposition of Formation 2D with 1.06% extension and after the deposition of formations 2E and 3, 0.52% extension occurrence. During the middle Early Miocene to the late Middle Miocene the total extension is 0.65 kilometers or 2.65%.

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Restored	Apparent Faults												
Horizon													
	1	2	3	4	5	6	7	8	9	10	11		
H6	*	*	*	٠	*	*	*	*	*	*			
H5	*	*	*	*	*		*	*	*	*			
H4		*	*	*	*		*	*		*			
Н3		*	*	*	*		*	*			2		

 Table 3.3
 The presence of faults and bed length after horizon restorations in section BB'.

Restored Horizon	Bed length (km)	After Deposition of Formations	Deformed, <i>l</i> ₁ (km)	Undeformed, l ₀ (km)	Extension, l ₁ -l ₀ (km)	Extension Ratio (%), $(l_1-l_0)/l_0 \ge 100$	Cumulative Extension Ratio (%)
H6	24.87	2D	25.00	24.87	0.13	0.52	0.52
H5	24.61	2C	24.87	24.61	0.26	1.06	1.58
H4	24.48	2B	24.61	24.48	0.13	0.53	2.11
H3	24.35	2A	24.48	24.35	0.13	0.53	2.65
pyrig	Tota	al extension	(2A-2D)	iang	0.65	2.65 en	sity

Table 3.4Extension derived from horizon restoration of section BB'.



Figure 3.7 Seismic interpretation of faults and horizons of cross-section BB'.



Figure 3.8 Line drawing of faults and seismic horizons from seismic profile BB'.



Figure 3.10 Restoration of Horizon H5 of cross-section BB'.



3.1.3 Cross-section Balancing of Profile CC'

Cross-section CC' (Fig. 3.13) is located in the southern part of the Graben Trend with original length of 31 kilometers. The seismic interpretation consists of seven interpreted markers and 16 fault cuts. Five restored sections (Table 3.5) were constructed. For convenience in restoration, the horizon and fault interpretation were redrawn.

The formations 2A, 2B, 2C and 2D in this profile thicken toward the west. The total thickness of these units is about 1000 meters in the east increasing to about 1400 in the western part of the profile. The overlying units are relatively uniform in thickness. Fault numbers 6 and 9 are east-dipping and the other faults are west-dipping. Horizon H6 is the upper contact of Formation 2D (Fig. 3.14). After restoration, bed length of horizon H5 is 30.93 kilometers. Fault numbers 6 is not present at this stage. Horizon H6 is the upper contact of Formation 2C (Fig. 3.15). After restoration, bed length of horizon H5 is 30.60 kilometers. Fault numbers 1 and 3 are not present at this stage. Horizon H4 is the upper contact of Formation 2B (Fig. 3.16). After restoration, bed length of horizon H3 is 29.92 kilometers. Fault numbers 11 and 16 are not present at this stage. Horizon H3 is the upper contact of Formation 2A (Fig. 3.17). After restoration, bed length of horizon H3 is 29.92 kilometers. Fault numbers 7-10 and 12-15 are not present at this stage. The presence of fault cuts and extension at each stage of restoration are summarized in table 3.5 and 3.6.

Four sequential stages can be interpreted from profile restoration. The early extension occurred in the late Early Miocene after the deposition of Formation 2B with 1.80% extension. The second stage was in the early Middle Miocene after the

deposition of Formation 2C with 0.44% extension. The third stage was in the late Middle Miocene after the deposition of Formation 2D with 1.10% extension and after the deposition of formations 2E and 3, 0.22% extension occurred. During the middle Early Miocene to the late Middle Miocene the total extension is 1.08 kilometers or 3.56%.

Restored Horizon			C				A	ppar	ent Fa	aults			05			
252	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
H6	*	*	*	۲	*	-	*	*	*	*	*	*	*	5*	*	*
H5		*		*	٠	K	*	*	*	*	*	*	*	*	*	*
H4		*		*	*		*	*	*	*		*	۲	*	*	
H3		*		*	*			Ñ				C	20			

✤ Fault tip of young cut through the old rock.

Table 3.5	The	presence	of	fault	and	bed	lengths	after	horizon	restoration	in
	secti	on CC'.									

ຄີປ	Restored Horizon	Bed length (km)	After Deposition of	Deformed, l_1 (km)	Undeformed, l ₀ (km)	Extension, l ₁ -l ₀ (km)	Extension Ratio (%), (<i>l</i> ₁ - <i>l</i> ₀)/ <i>l</i> ₀ x 100	Cumulative Extension
Со	H6	30.93	Formations 2D	31.00	30.93	0.07	0.22	Ratio (%)
A	H5	30.6	2C	30.93	30.60	0.34	e ^{1.10} V	1.32
	H4	30.46	2B	30.60	30.46	0.13	0.44	1.76
	H3	29.92	2A	30.46	29.92	0.54	1.80	3.56
		Tota	al extension	1.08	3.56			

Table 3.6Extension derived from horizon restoration of section CC'











