Eocene – Late Miocene Tectonostratigraphy of Bima Field in Northwest Java Basin

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Abstract

This study aim to understand the tectonostratigraphy of Bima Field from Basement forming in Eocene to Late Miocene Interval based on seismic observation. Regional structural analysis of the Bima Field and surrounding area was conducted using integration 2D seismic lines and existing wells. The main purpose of the analysis is to describe structural pattern and style in the study area in relation to regional tectonic of the North-West Java Basinal area. The results of structural mapping using regional 2D seismic data controlled by numbers of wells indicates study area is mostly located along NNE-NSW trending basement high structures (Figure 3). Structural development of the study area is dominated by series of normal faults system with some locally observed folds. In many seismic sections, faults geometry characterized by high to moderate dips. This specific geometry often interpreted as half graben and horst structures resulting from Eocene rifting. The structural geology of Bima field can be observed clearly at the WNW-ESE seismic line. It was dominated by N-S trending Normal fault that was probably related to the Eocene rifting which occurred predominantly at the west part of the study area. The main fault, occurred toward to the west, formed the half graben system which cut from basement to Parigi formation. However, others that placed at central part only cut the basement. The pre-Baturaja Sediment can be divided into two packages, which are syn-rift package and quiescence package while the post-Baturaja interval is the late post rift (sag) package.

Keywords: Tectonostratigraphy, Bima Field.

Regional Geology

Tectonic Setting

The West Java region currently marks the transition between frontal subduction beneath Sumatra, to the west. However, the region has been continuously active tectonically since rifting in the Eocene. The Eocene rifting, as throughout SE Asia, was probably related to the collision between India and Asia (e.g. Tapponier et al. 1986) and involved a significant influx of coarse clastic sediments. The Oligocene-Recent history is more dominated by subduction-related volcanism and limestone deposition.

In general, West Java may be subdivided into the following tectonic provinces: (see Figure 1; modified after Martodjojo, 1975; Lemigas, 1975, and Keetley et al, 1997) Northern basinal area: A relatively stable platform area, part of the Sundaland Continent, with N-S trending rift basins offshore and adjacent onshore, filled with Eocene-Oligocene non-marine clastics, overlain by Miocene and younger shallow shelf deposits. Bogor Trough foreland basins composed of Miocene and younger sediments mostly deeper water sediment gravity flow facies. Young E-W trending anticlines formed during a recent episode of north-directed compressive structuring; Modern Volcanic Arc: Active andesitic volcanism related to subduction of Indian Oceanic Plate below Sundaland Continent (Gede-Panggrango, Salak, Halimun, etc., volcanoes). Southern slope regional uplift: mainly Eocene-Miocene sediments, including volcanic rocks belonging to the Old Andesite Formation. Structurally complex, N-S trending block faults, E-W trending thrust faults and anticlines and possible wrench tectonism. South-West Java contains a number of sedimentary basins that formed within the axial ridge and in the area between the volcanic arc and submerged accretionary prism associated with the northward subduction of the Indian Oceanic Plate. Banten Block: The most western part of Java Island which

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may be subdivided into Seribu Carbonate Platform in the north, Rangkas Bitung sedimentary sub-basin, and Bayah High in the south. In the west there are minor low and highs so called Ujung Kulon and Honje High, and Ujung Kulon and West Malingping Low (Lemigas, 1975; Keetley et al, 1997).

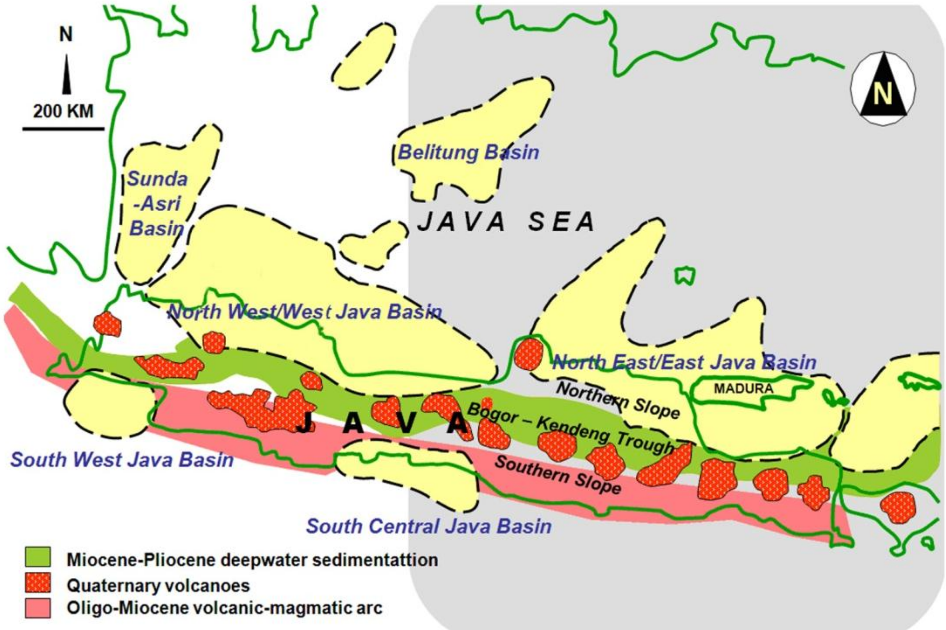

Figure 1 Regional Tectonic and Structure

Stratigraphy

The Northwest Java Basin (Figure 1) lies both on and offshore and comprises two main half graben-defined depocentres: the rich offshore Ardjuna Basin towards the west and the onshore Jatibarang Basin in the southeast (Noble et., 1997). The onshore and nearshore areas contain clastic wedges derived from the Java hinterland in the postrift, while the more distal offshore areas remained dominated by carbonates.

- Early synrift (late Eocene – early Oligocene): this comprises tuffs and minor interbedded lacustrine shales of the Jatibarang Formation. Volcaniclastics provide the reservoir facies for some onshore Java fields, whereas the source rocks appears to have a significant deltaic component, indicative of major contributions from the overlying Talang Akar Formation.
- Late synrift (late Oligocene – early Miocene): As in South Sumatra, this sequence comprises a transgressive sequence of fluvio-deltaic, coastal and shallow marine sands, shales and coals (Talang Akar Formation), followed by platform and reefoid carbonates (Baturaja Formation), both of which are productive.
- Early postrift (early - middle Miocene): In constrast to the basins further to the west, parts of the Java basins remained in an open to distal marine carbonate environment longer. This makes it difficult to distinguish early from late postrift phases. While a number of regressive clastic deltaic phases are recognized onshore and nearshore in the Cibulakan Formation, much of the area is characterized by shelfal marine sands (Massive, Main) that are important reservoirs in offshore northwest Java.
- Late postrift (late Miocene – Quaternary): Platform carbonates and regressive clastics of the Parigi and Cisubuh Formations reflect a

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reduction in subsidence and the onset of inversion movements.

The tectonic history of the area (Gresko et al., 1995) can be traced back to the earliest Tertiary, when cooling followed metamorphism of the basement rocks. Rifting related to dextral wrenching followed in the Eocene (50-40 Ma), while a series of middle to late Miocene collisions (17 – 5 Ma) led to repeated local inversions along the onshore trend. Offshore, the massive nature of the carbonate sequence inhibited tectonic reactivations.

The summary of regional stratigraphy for the North-West Java by Martojoyo et al. (2005) is summarized in Figure 2.

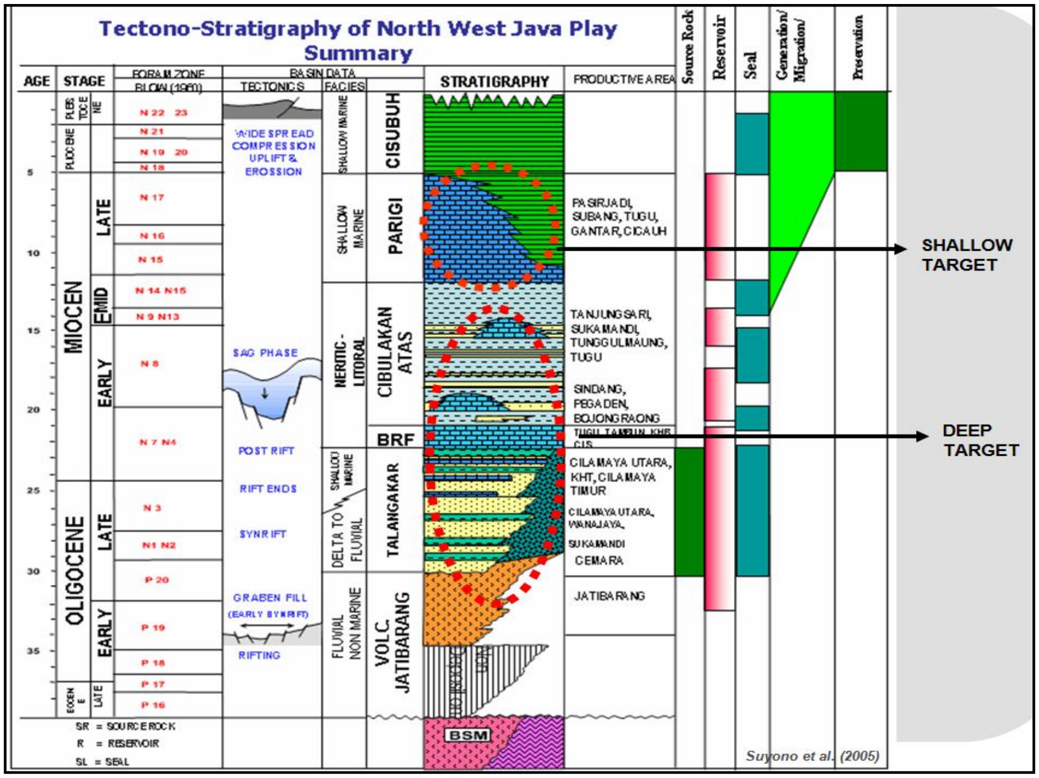

Figure 2. Regional Tectonostratigraphy of North-West Java (Martojoyo et al., 2005)

Tectonostratigraphy of Zulu Field (Seismic Observation)

Regional structural analysis of the Bima Field and surrounding area was conducted using integration 2D seismic lines and existing wells. The main purpose of the analysis is to describe structural pattern and style in the study area in relation to regional tectonic of the North-West Java Basinal area.

The results of structural mapping using regional 2D seismic data controlled by numbers of wells indicates study area is mostly located along NNE-NSW trending basement high structures (Figure 3). Structural development of the study area is dominated by series of normal faults system with some locally observed folds. In many seismic sections, faults geometry characterized by high to moderate dips. This specific geometry often interpreted as half graben and horst structures resulting from Eocene rifting. The structural geology of Bima field can be observed clearly at the WNW-ESE seismic line. It was dominated by N-S trending Normal fault that was probably related to the Eocene rifting which occurred predominantly at the west part of the study area. The main fault, occurred toward to the west, formed the half graben system which cut from basement

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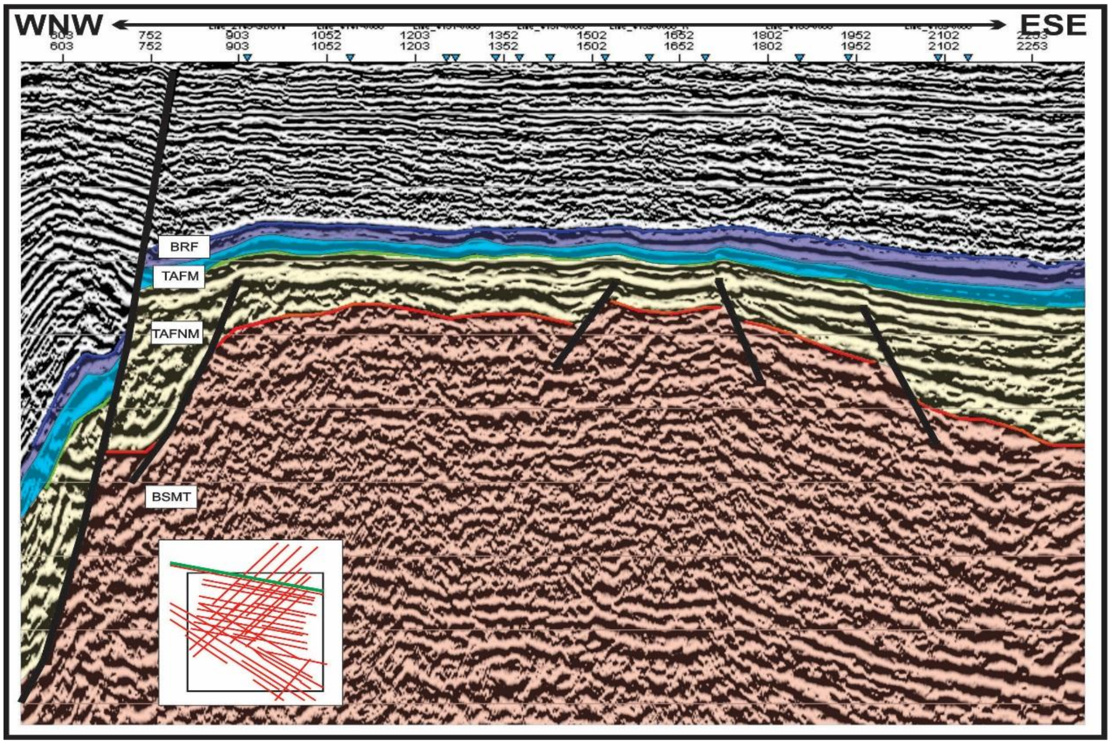

Figure 3. Example of 2D interpretation of WNW – ESE Seismic Line

3.1.1 Rifting Phase.

The Eocene rifting, as throughout SE Asia, was probably related to the collision between India and Asia (e.g. Tapponier et al. 1986). The main fault that involved directly with this rifting event can be observed clearly in the seismic line. Non-marine Talang Akar (TAFNM) interval can be interpreted as syn-rift deposit characterized by several reflectors onlap to the basement high and thickening toward fault plane (Figure 4).

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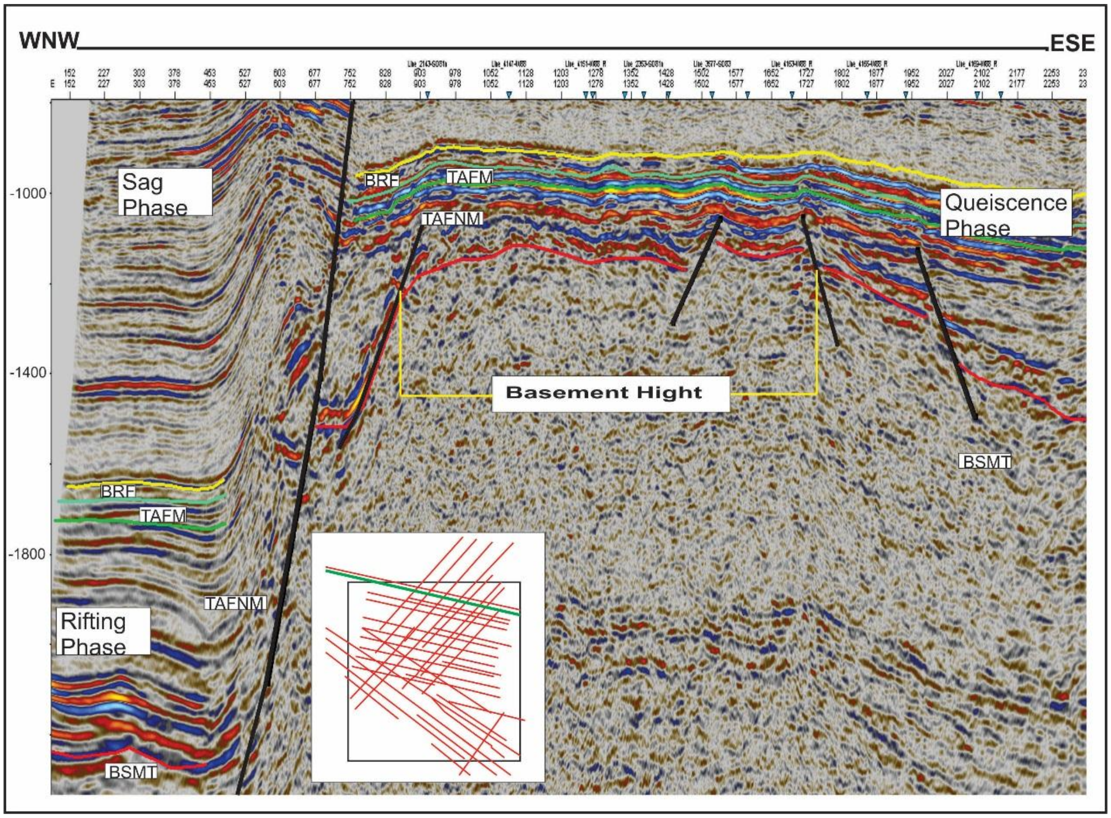

Figure 4. WNW-ESE Seismic Section Showing a rift package at WNW

Tectonic Quiescence Phase

Tectonic quiescence phase was started with the development of TAFM Interval characterized by several carbonate mounded reflection and relative similar thickness of sediments form TAFM to BRF interval (Figure 5). It is interpret that the basin was deepening toward NNW. This interpretation was conducted by observation of the internal and external seismic configuration that implies the directions. These configurations are observed clearly in the NNW-SSW seismic line while the WNW-ESE lines shows the parallel configuration only. The sedimentation direction at this phase is from SSW to NNE direction (Figure 6). The downlapping configuration at TAFM interval that observed toward NNE implied the direction.

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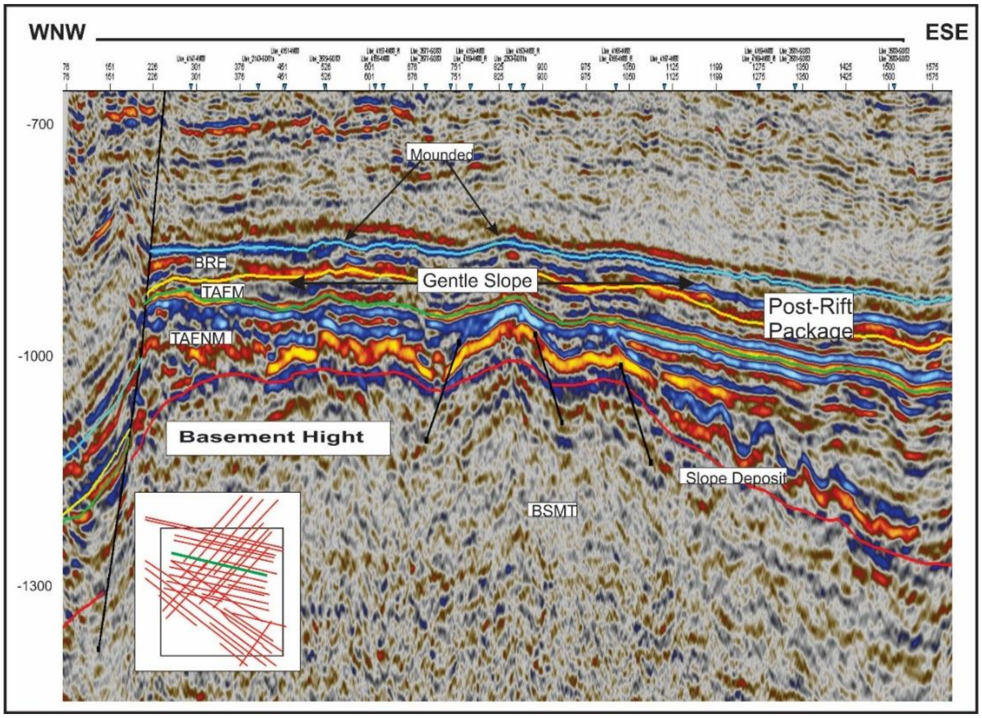

Figure 5. WNW – ESE Seismic Section show Quiescence and Post rift package

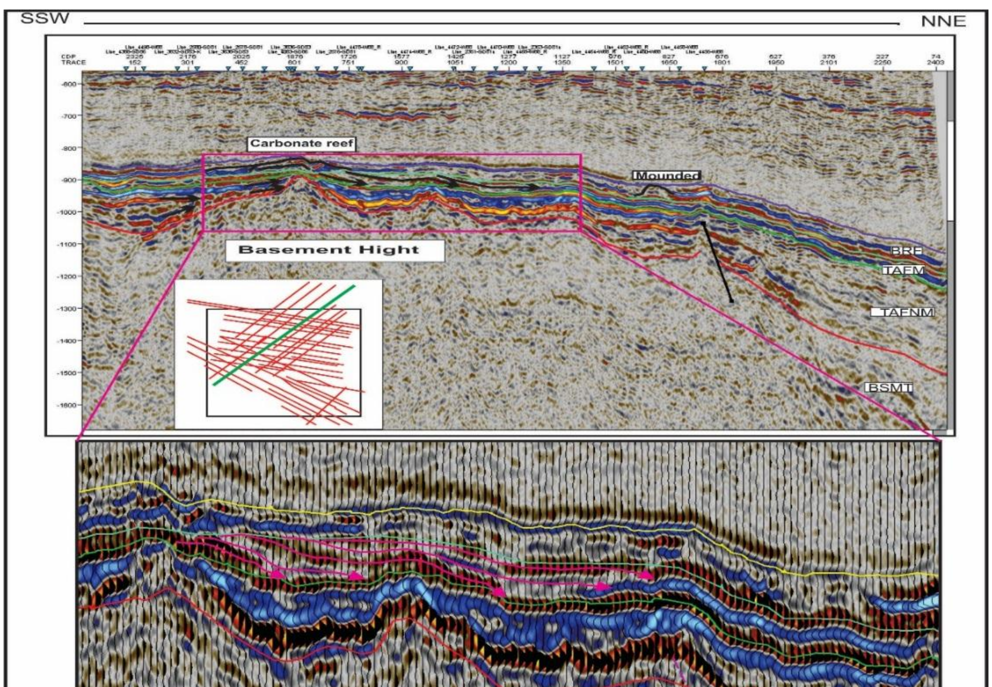

Figure 6. SSW-NNE Seismic section shows detailed carbonate development in the area

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Sag Phase

It is quite difficult to estimate when this phase start, because there is no clear boundaries that can determine the onset of this phase. But it can be said that this phase occurs after the formation of Parigi carbonate, as this formation is still separated by normal faults formed in the Eocene rifting (Figure 4).

Time structure map shows the similarity structure configuration from TAFM to BRF, indicating that no structural configuration changes that occurred during the deposition of TAFM and BRF. These configurations are the high structure at SW with SE-NW trending and deep structure toward the NE.

The deposition of TAFNM interval was strongly influenced by tectonic activity that occurred at the time, so that there are significant differences of sediment thickness in the area affected by the fault structure. During the deposition of the TAFM there was a sea level rise which caused the deposition environment change from deltaic into marine. There are several carbonate mounded and platform that can be observed from several seismic sections that characterized this formation.

The formation of Baturaja Carbonate takes place after the TAFM formation. Several forms of carbonate in this formation can be observed on seismic sections clearly, they are mounded form, carbonate platforms and isolated platforms. During the depositional phase of TAFM and BRF interval, there is no significant tectonic activity. Isochron map of the BRF shows the relative similar thickness of this formation, so there is a bit difficult to analyze the distribution of the carbonate. This may occur due to the shale deposition that interfingered with this formation. Some previous researchers call this shale deposits Baturaja Onlap.

Conclusion

Figure 7 and Figure 8 below illustrating the tectonostratigraphy development of Zulu Field.

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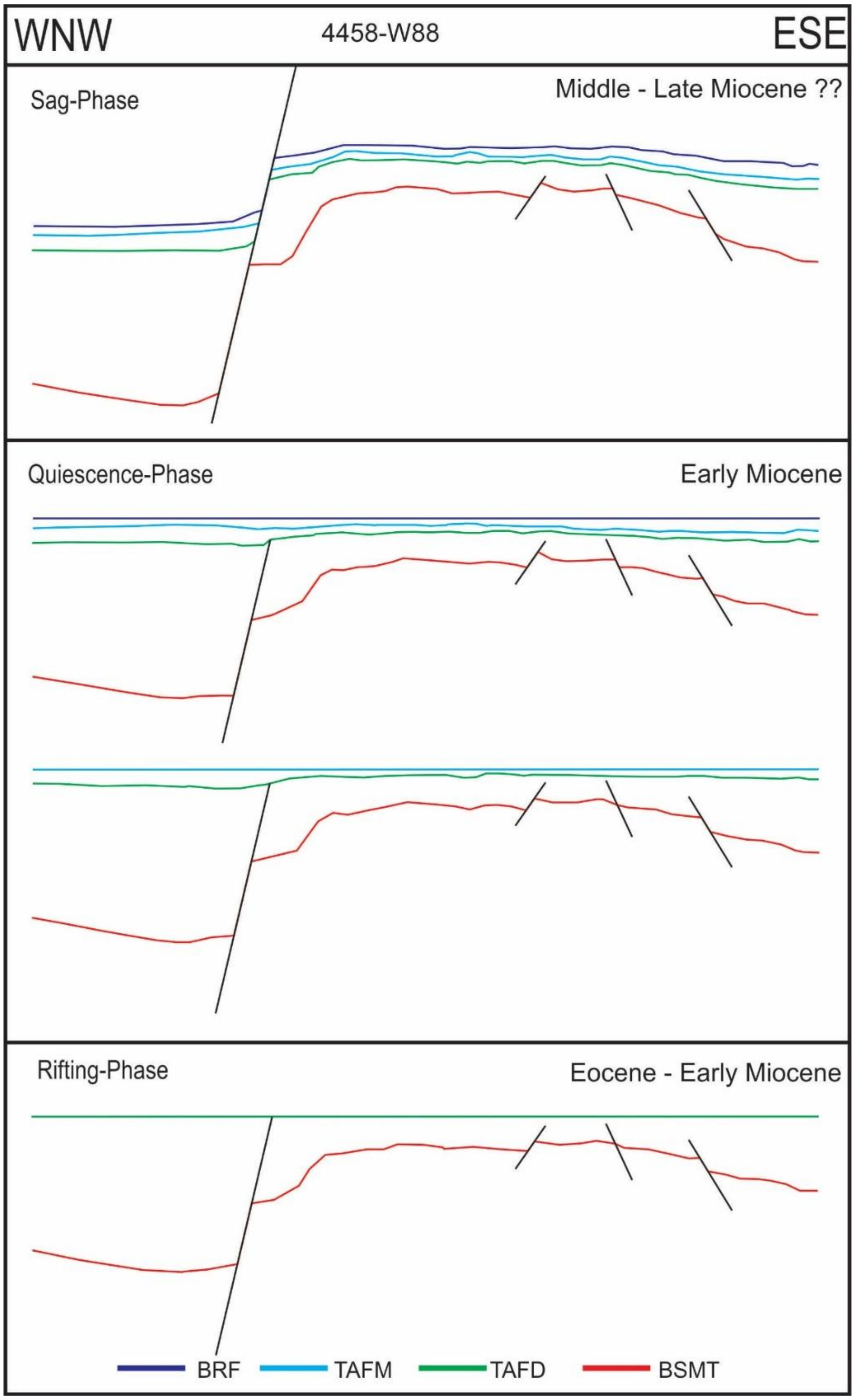

Figure 7. Tectonics Evolution (WNW-WSW Section)

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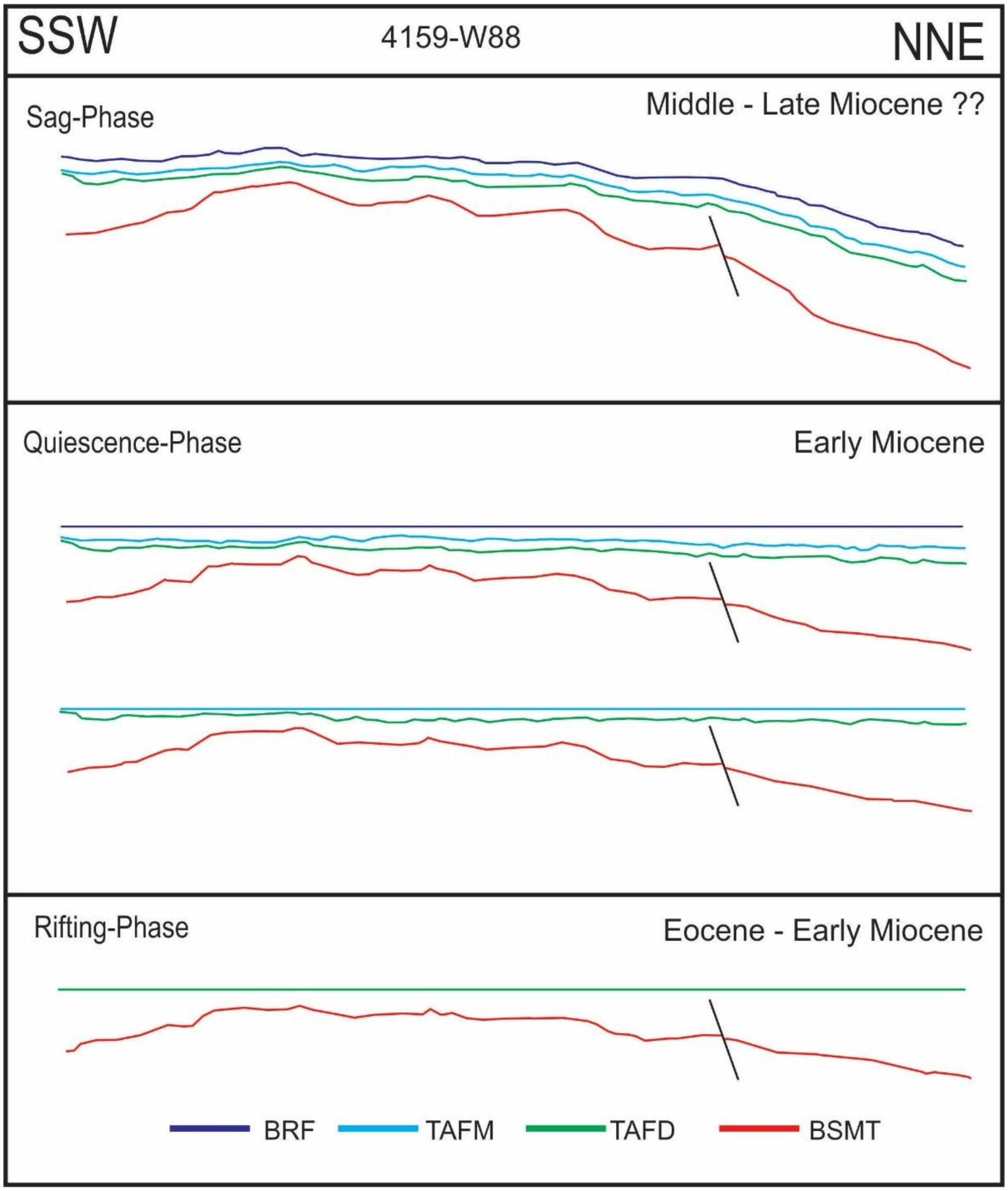

Figure 8. Tectonics Evolution (SSW-NNE Section)

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