The Sorong Fault Zone Kinematics: Implication for Structural Evolution on Salawati Basin, Seram and Misool, West Papua, Indonesia*

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Abstract

The Sorong Fault Zone (SFZ) is an active left lateral fault system that has been active since the Late Miocene. The SFZ is located in the northern margin of Papua, Indonesia, and extends thousand kilometers from the Eastern part of the island to the Bird’s Head region. Our new model indicates that SFZ moved the Bird’s Head area, including Salawati Basin to the west, relative-to the movement of the Pacific Plate. The movement of SFZ involves rotation and translation that separates Salawati Basin from the Bird’s Head region with basement high as the boundary of the basin, and also gives an implication to the evolution of Seram Fold Thrust Belt (SFTB) and Misool Onin Kumawa Anticline (MOKA). More than 200 seismic lines have been interpreted along Seram, Misool, and Salawati offshore. These interpretations show the development of listric and planar normal faulting at the western part of Misool Island and flower structure at NW Bird’s Head region. This faulting activity was interpreted as a result of SFZ activities, which cut Paleozoic through the Tertiary formations. The listric and planar normal fault in the Salawati Basin explains the block rotation mechanism that relates to the Bird’s Head movement to the west. In addition, flower structures that observed at NW Bird’s Head indicate the shortening effect of the SFZ activities. Seemingly, rotation and translation of SFZ to the west are associated with the evolution of SFTB indicated by NE-SW shortening perpendicular to the island. The deformation in the SFTB showed the development of fold-thrust belt structure at Seram Trough area, which repeated the Mesozoic-Miocene sequences, with the detachment surface located between Seram and Seram Trough. Reverse fault at Mesozoic through Miocene sequences in the north of the trough and at Misool area are reactivated normal faults formed during the NW shelf of Australia rifting since the Mesozoic. Therefore, SW directed shortening as a response of the Bird’s Head region movement combined with additional westward movement of Tarera-Aiduna strike-slip system forms the SFTB. New seismic interpretations combined with palinspatic reconstruction suggest that there are rotation and translation phase in relation to SFZ mechanism that develops the Salawati Basin, MOKA, and SFTB. These deformations mechanism are active since the Late Miocene and related to the collision between Pacific island arc complexes and passive margin of the NW Australian plate.
References


Riadini, P., 2009, Kinematika Sesar Sorong Sebagai Implikasi Terhadap Evolusi Struktur Daerah Seram, Misool, dan Cekungan


The tectonic of Papua is considered to be one of the ideal examples where two major tectonic elements are contemporaneously active in one area. At the present time, the Pacific seafloor spreading continues and the Indonesian margin is seismically active. The regional seismic pattern is interpreted as transform faulting with Pacific Ocean boundaries formed by the Pacific-Antarctic plate boundary. The tectonic of Papua is characterized by the presence of large-scale strike-slip fault zones, such as the Palu Kere Sec (SPFZ) and the Salawati Fault (SFZ), which are associated with the active seafloor spreading and subduction processes in the region. The SPFZ and SFZ are considered to be major structural elements in the tectonic setting of the Bird's Head region and have a significant impact on the regional tectonic and seismic activity. The tectonic setting of Papua is characterized by a complex array of tectonic elements, including strike-slip faults, normal faults, and transform faults, which have a significant influence on the regional tectonic and seismic activity. The tectonic setting of Papua is characterized by a complex array of tectonic elements, including strike-slip faults, normal faults, and transform faults, which have a significant influence on the regional tectonic and seismic activity. The tectonic setting of Papua is characterized by a complex array of tectonic elements, including strike-slip faults, normal faults, and transform faults, which have a significant influence on the regional tectonic and seismic activity.
METHOD AND RESULT OF STUDY

In this study, we integrated 2D seismic interpretation from Salmon, Misool and Seram areas connected through regional lines. The interpretation is conducted using guidance from Eastern Indonesian regional tectonic concept. Relationship between deformation and sedimentation is evaluated using several palinspatic regional cross-sections. This palinspatic cross-section is generated with balancing cross-section techniques using Midland Valley 2D/3D software package. Structural interpretation also confirmed with stratigraphy and multisource data provided by TGS.

The 2D seismic data set was provided by TGS NORSAR Geophysical Company and tied to 22 wells across Salmon, Misool, and Salawati areas. Seven horizons were interpreted and contoured. These horizons identified based on well data and Bird’s Head stratigraphy (Frazier et al., 1993). These are: Top Tertiary (East Trenches), Top Rosabba (Middle Jurassic), Top Garbe (Early Cretaceous), Top Salawati (Late Cretaceous), Top Frasir (Early Oligocene), and Top Kaba (Middle Miocene). A major unconformity on Early Pliocene identified as top sequence II which separates the lower six horizons and the younger sequence. There are four structural patterns around Salmon, Misool, and Salawati (Figure 5A): The N-S trending normal faults that develops as horst and graben at Permain-Late Jurassic sequence; The NE-SW trending structures pattern is show on the isochore map for each horizon (Figure 58). The 20 seismic data set was provided by TGS-NOPEC. These horizons identified based on Indonesia regional cross-section techniques using well data and Bird’s Head stratigraphy (Fraser et al., 1993). Relationship data and Bird’s Head stratigraphy (Fraser et al., 1993) between deformation and sedimentation is Geophysical interpretation. The normal faulting related to NE-SW trending structure developed in the Middle Jurassic sequence. The NE-SW striking normal faults defined the location of the Onin basin, the structure continued and deformed the youngest sequence. This is identified in the Late Jurassic seismic normal faults related to reversed faulting Jurassic controlled the Onin structure. The Deformation continued and the deposition of carbonate sediments occurred in the Middle Miocene time. During this time, the area experienced fill slip events, and it identified Late and Early Jurassic normal faults related to fill slip event. Some of the Middle Miocene Paleocene are still active and affect the Miocene palinspatic in the far area. The deformation continued and developed the fold thrust belt systems due to the compression system. The fold thrust belt systems were also identified in the structural map of the area. This suggests that the deformation was still active in all the younger sequence (Figure 5A, B, 5B, and 5C).

PALINSPATIC RECONSTRUCTION

Figure 6A shows the palinspatic reconstruction of the Salmon and Misool area. The reconstruction shows that there are many major horst areas, which occurred in this area since the Permian. These processes related to NE-SW trending structures, which developed in the Middle Jurassic sequence. The NE-SW trending structures pattern is show on the isochore map for each horizon (Figure 58). The 20 seismic data set was provided by TGS-NOPEC. These horizons identified based on Indonesia regional cross-section techniques using well data and Bird’s Head stratigraphy (Fraser et al., 1993). Relationship data and Bird’s Head stratigraphy (Fraser et al., 1993) between deformation and sedimentation is Geophysical interpretation. The normal faulting related to NE-SW trending structure developed in the Middle Jurassic sequence. The NE-SW striking normal faults defined the location of the Onin basin, the structure continued and deformed the youngest sequence. This is identified in the Late Jurassic seismic normal faults related to fill slip event. Some of the Middle Miocene Paleocene are still active and affect the Miocene palinspatic in the far area. The deformation continued and developed the fold thrust belt systems due to the compression system. The fold thrust belt systems were also identified in the structural map of the area. This suggests that the deformation was still active in all the younger sequence (Figure 5A, B, 5B, and 5C).

Figure 6B shows the other palinspatic reconstruction around the Onin high area. The section shows the development of normal faulting, the Late Jurassic sequence deposition. The normal faulting area related to Late Jurassic Early Cretaceous thrust. The development of normal faulting continues in the Cretaceous sequence deposition. The deformation related to the Late Jurassic normal faulting related to fill slip event. Some of the Middle Miocene Paleocene are still active and affect the Miocene palinspatic in the far area. The deformation continued and developed the fold thrust belt systems due to the compression system. The fold thrust belt systems were also identified in the structural map of the area. This suggests that the deformation was still active in all the younger sequence (Figure 5A, B, 5B, and 5C).

Figure 6C shows the palinspatic reconstruction around the West Misool area. The section shows the development of Permian thrust normal faults related with NW Australia rifting at passive margin event. The normal faults continue developing until the Late Jurassic sequence. The deformation continued and the development of Northwest normal faults started from the Middle Jurassic sequence. The Normal faulting related to NE-SW trending structures (Figure 58). The 20 seismic data set was provided by TGS-NOPEC. These horizons identified based on Indonesia regional cross-section techniques using well data and Bird’s Head stratigraphy (Fraser et al., 1993). Relationship data and Bird’s Head stratigraphy (Fraser et al., 1993) between deformation and sedimentation is Geophysical interpretation. The normal faulting related to NE-SW trending structure developed in the Middle Jurassic sequence. The NE-SW striking normal faults defined the location of the Onin basin, the structure continued and deformed the youngest sequence. This is identified in the Late Jurassic seismic normal faults related to fill slip event. Some of the Middle Miocene Paleocene are still active and affect the Miocene palinspatic in the far area. The deformation continued and developed the fold thrust belt systems due to the compression system. The fold thrust belt systems were also identified in the structural map of the area. This suggests that the deformation was still active in all the younger sequence (Figure 5A, B, 5B, and 5C).
The collision between the Pacific and NW Australia at Bird’s Head area start since the Late Eocene (Clasca et al. 2005). The collision event started after the end of the extensional phase related to the passive margin tectonic and Late Triassic-Early Jurassic rifting. The start of the reactivation structure around north of Misool-Onin area was created by the collision of the Pacific and NW Australia margin which also caused to the formation of the Bird’s Head area. The structural deformation sequence, which unconformably overlie the previous Permian-Cretaceous sequence. The reactivation is significant at the same Jurassic basement, and created a high area that will be known as Onin High. The reactivated structures are also eroded some Cretaceous-Late Oligocene sequence, reactivated around the old Jurassic basin. The deformation is continued after the deposition of Mesozoic-Sorong sequence, which the Moine, some Mesozoic structure especially at Seram and south of Misool area are reactivated while the other area, such as Seram, affected by the strike-slip system known as SFZ. In the north of Misool-Onin and Bintuni area, the Moine structure is developed above the Late Oligocene unconformity, and conformed filling at Oligocene-Misool sequence as a result of structure-structural sequence at the Moine basement. The structure of Misool above the Oligocene High. Some of the Moine sequence is also eroded around the Oligocene High, especially at the old Jurassic basin. The structure is continues until the deposition of the Early Pliocene sequence that unconformable with the Permian-Misool sequence. Structure interpretation from the seismic and multibeam data show the SFZ mechanism is develop in two mechanisms, there are diverge strike-slip system on West Misool and Sibaliuw process on South Misool until Seram. The compressional and shortening events on the Early Pliocene created the fold-thrust belt development that known as SFTB. Structure and deformation still continue after the deposition of Early Pliocene sequence due to the collision event around the Bird’s Head area. The fold-thrust belt at Seram area which affected by the Early Pliocene deposition and also affect to the sequence above the Early Pliocene. The structure activities were related to the NE-SW shortening around the Bird’s Head area and NW-SE extension in Marcus Islands. The processes which affected the Moine area is actived by the tectonic event of the Moraine-Misool area. The tectonic event reactivated the Moraine-Misool unconformity created the unconformity surface known as the Late Eocene-Misool unconformity. This unconformity surface is caused by the structural reactivation that created around the Oligocene High reactivation. Deformation of the Moraine-basement continued to the Moine and upfold the uplift of the Moraine sequence. The structure above the unconformity. The recent deformation created the unconformity surface on the Moraine and upfold the uplift of the Moraine sequence as the north of Misool. This process is created by the Late Pliocene faulting events on the West Misool area at Sorong, which were truncated with the Moraine-Misool sequence during the deposition of the Late Pliocene. Some normal faults also developed during the Late Pliocene. This events related the activities of the E-W trending strike-slip system. The structure above the unconformity. This structure is created by the Late Pliocene normal faulting. Moraine-Misool unconformity area was not deposited, due to the relatively stable basement high until the deformation of Oligocene sequence.

REFERENCES


The strike-slip system created some antithetic fault which also known as the pop-up structure. This pop-up structure was created in extreme depth at the basin area and the deformation continued to the youngest Pliocene age period. This fault is called fault trending NE-SW from the last lateral couple Sorong fault system trending E-W and NNE-SSW.