Structural complexity in the boundary of forearc basin – accretionary wedge in the northwesternmost Sunda active margin

Kompleksitas struktur di batas cekungan busur muka – prisma akresi di bagian ujung baratlaut tepian aktif Sunda

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ABSTRACT: The area from Andaman to northern Sumatran margin is a region where major faults collided that complicates the structural configuration. The origin of structures in the boundary between the accretionary wedge and forearc basin in the northwesternmost segment of the Sunda margin has been a subject of debates. This article reviews several published works on the Andaman – north Sumatran margin to characterize the boundary between forearc basin and accretionary wedge. Complex strain partitioning in this margin is characterized by sliver faults that crossing boundaries between the backarc basin, volcanic arc, forearc basin, and accretionary wedge. The fault zone can be divided into two segments: The West Andaman Fault (WAF) in the north and Simeulue Fault (SiF) in the southern part. A restraining step-over formed in between WAF and SiF. The SiF may extent onshore Simeulue to a strike-slip fault onshore. Strain-partitioning in such an oblique convergent margin appears to have formed a new deformation zone rather than reactivated the major rheological boundary in between the accretionary wedge and forearc basin. The eastern margin of the Andaman-north Sumatra accretionary wedge appears to have form as landward-vergent backthrusts of Diligent Fault (DF) and Nicobar Aceh Fault (NAF) rather than strike-slip faults. This characteristic appears to have formed in the similar way with the compressional structures dominated the eastern margin accretionary wedge of the central and south Sumatra forearc.

Keywords: Andaman, North Sumatra, forearc, structure, accretionary wedge, strain partitioning

ABSTRAK: *Daerah Andaman - Sumatera bagian utara adalah wilayah di mana patahan-patahan besar saling bertemu dan membuat konfigurasi struktur menjadi rumit. Asal-usul struktur di batas antara prisma akresi dan cekungan busur muka di bagian paling baratlaut dari tepian Sunda telah menjadi topik perdebatan. Artikel ini mengulas beberapa studi yang telah diterbitkan sebelumnya mengenai tepian Andaman - Sumatra bagian utara untuk mengkarakterisasikan batas antara cekungan muka dan prisma akresi. Pemisahan regangan yang kompleks di tepian ini dicirikan oleh sliver fault yang melintasi batas antara cekungan busur belakang, busur vulkanik, cekungan busur muka, dan prisma akresi. Zona sesar tersebut dapat dibagi menjadi dua segmen, yaitu Sesar Andaman Barat (WAF) di utara dan Simeulue Fault (SiF) di bagian selatan. Sebuah restraining step-over terbentuk di antara WAF dan SiF. SiF kemungkinan menerus sampai ke Pulau Simeulue dan menyatu dengan sesar geser. Pemisahan regangan di tepian konvergen yang miring seperti itu tampaknya telah membentuk zona deformasi baru daripada mengaktifkan kembali batas reologi utama di antara prisma akresi dan cekungan busur muka. Batas bagian timur dari prisma akresi di Andaman – Sumatera bagian utara memiliki bentuk sebagai backthrusts berarah darat yaitu Sesar Diligent (DF) dan Sesar Nicobar Aceh (NAF) dan bukan merupakan sesar geser. Karakteristik ini tampaknya terbentuk dengan proses yang mirip dengan struktur-struktur kompresional yang mendominasi bagian timur prisma akresi di daerah Sumatra bagian tengah dan selatan.*

Kata kunci: Andaman, Sumatera bagian, busur muka, struktur, prisma akresi, pemisahan regangan

INTRODUCTION

The origin of the boundary between forearc basin and forearc slope in the convergent margin has been the subject of debates by geologists. Convergent margins can be simply divide into two classes based on mass balances in the subduction zones: accretionary and erosive types (Clift and Vannucchi, 2004; von Huene and Scholl, 1991). Accretionary margins are characterized by accumulation of thrusted and deformed trench and oceanic sediments in the forearc slope, whilst the erosive type is marked by steep trench slopes, dominated by mixtures of volcanic, plutonic, and mantle rocks, with limited sedimentary rocks (Clift and Vannucchi, 2004). In the subduction accretion zone, where trench sedimentations occur rapidly (von Huene and Scholl, 1991), the accretionary complex is buttressed by a backstop that developed as trenchward-dipping or arcward-dipping geometry (Byrne *et al.*, 1988; 1993). In both types of backstop geometry, boundary of accretionary wedge and forearc basin is marked by development of compressional structures (Hoth *et al.*, 2007; McClay *et al.*, 2004; Noda, 2016; Storti *et al.*, 2000. In oblique active margins, the boundary between forearc basin and accretionary prism is characterized by strike-slip faults (Berglar *et al.*, 2010; Malod and Kemal, 1996; Martin *et al.*, 2014), where the slope of the backstop tends to be vertical.

The area from Andaman to northern Sumatran margin is a region where major structures collided. The region is composed of the northern extension of the Sumatran Fault (SF), the southern extension of the Sagaing Fault (SaF) and Andaman Sea Spreading Center. Another fault zone developed in this area, the West Andaman Fault (WAF) that stretches for more than 1200 km along a north-south trending from the Andaman Sea to the Sumatran forearc (Figure 1). The origin of this structure has been interpreted as a strike-slip fault that developed in the boundary between the forearc high and forearc basin (Berglar *et al.*, 2010; Curray, 2005; Izart *et al.*, 1994; Malod and Kemal, 1996; Martin *et al.*, 2014). However, recent works with better resolution of seismic reflection data revealed the occurrence of landward-vergence backthrusts in the trenchward margin of the forearc basins (Chauhan et al., 2009; Hananto e*t al.*, 2012; Moeremans and Singh, 2015; Singh *et al.*, 2011, 2013). Detailed structural observation on seismic reflection data crossing the northern Sumatran forearc suggested that the border between the forearc basin and accretionary complex is complicated by multiple structures with strike-slip faults appears to be active (Martin *et al.*, 2014). Further southeast in the central and southern Sumatran forearc, the margin of the forearc basin is marked by thrusting and folding (Deighton *et al.*, 2014; Mukti *et al.*, 2011; 2012a; 2012b; Samuel *et al.*, 1995). Several published works on the Andaman – north Sumatran margin were reevaluated in this study to characterize the structural styles developed in the boundary between forearc basin and accretionary wedge.

Geological setting

In the Andaman-Nicobar subduction system, the Indo-Australian plate subducts beneath the Eurasian plate in a nearly arc-parallel direction (McCaffrey, 1992; 2009) (Figure 1). This area stretches from the Gulf of Martaban in the north to the Aceh Basin in the south and can be divided into the western part dominated by compressional and strike-slip deformation, the central area that comprised the spreading center and Alcock and Sewell rises, the eastern region dominated by extensional, oblique-slip and strike-slip sedimentary basin, and the northern region that include several sedimentary basinal lows and highs (Curray, 2005; Moeremans and Singh, 2015; Morley, 2015). The western region covers the Andaman-Nicobar accretionary complex and the forearc basins. The forearc high islands are composed of remnant Cretaceous ophiolites (Pedersen *et al.*, 2010) that covered by younger sedimentary successions (Allen *et al.*, 2007; Roy and Banerjee, 2016). Trench-parallel structures formed in the accretionary complex as strike-slip and extensional faults of the Diligent (DF) and East Margin fault (EMF) zones (Curray, 2005; Curray *et al.*, 1978). However, recent seismic reflection data show anticlines and thrust faults in the DF (Cochran, 2010). To the east, WAF appears to have crossed the spreading center and continues farther south to the north Sumatra forearc as a major strike-slip fault zone (Curray, 2005; Curray *et al.*, 1978; Izart *et al.*, 1994; Malod and Kemal, 1996). Several authors named this fault zone as the Andaman-Nicobar Fault that stretches from offshore Nicobar to the axis of the Andaman Spreading Center (ASC) (Jourdain *et al.*, 2016; Moeremans and Singh, 2015; Singh *et al.*, 2013). The ASC separates the Alcock and Sewell rises due to the birth of ~130 km wide of oceanic crust (Curray, 2005). The main valley of this spreading is characterized by a flat seafloor along 190 km long in ENE trend that divided into 4 segments (Raju *et al.*, 2004).

In the northern Sumatran forearc, the Aceh forearc basin is bordered by Sumatra Island to the east and WAF to the west (Figure 1). Further west, the accretionary wedge marked the trenchward margin of northern Sumatra forearc. To the southeast, a prominent bathymetric rise bordered the basin and referred to as Tuba Ridge (TR) (Berglar *et al.*, 2010; Izart *et al.*, 1994; Malod and Kemal, 1996). Simeulue basin occupied the area to the southeast of TR that filled by more than 5 seconds two-way traveltime (twt) of sediments

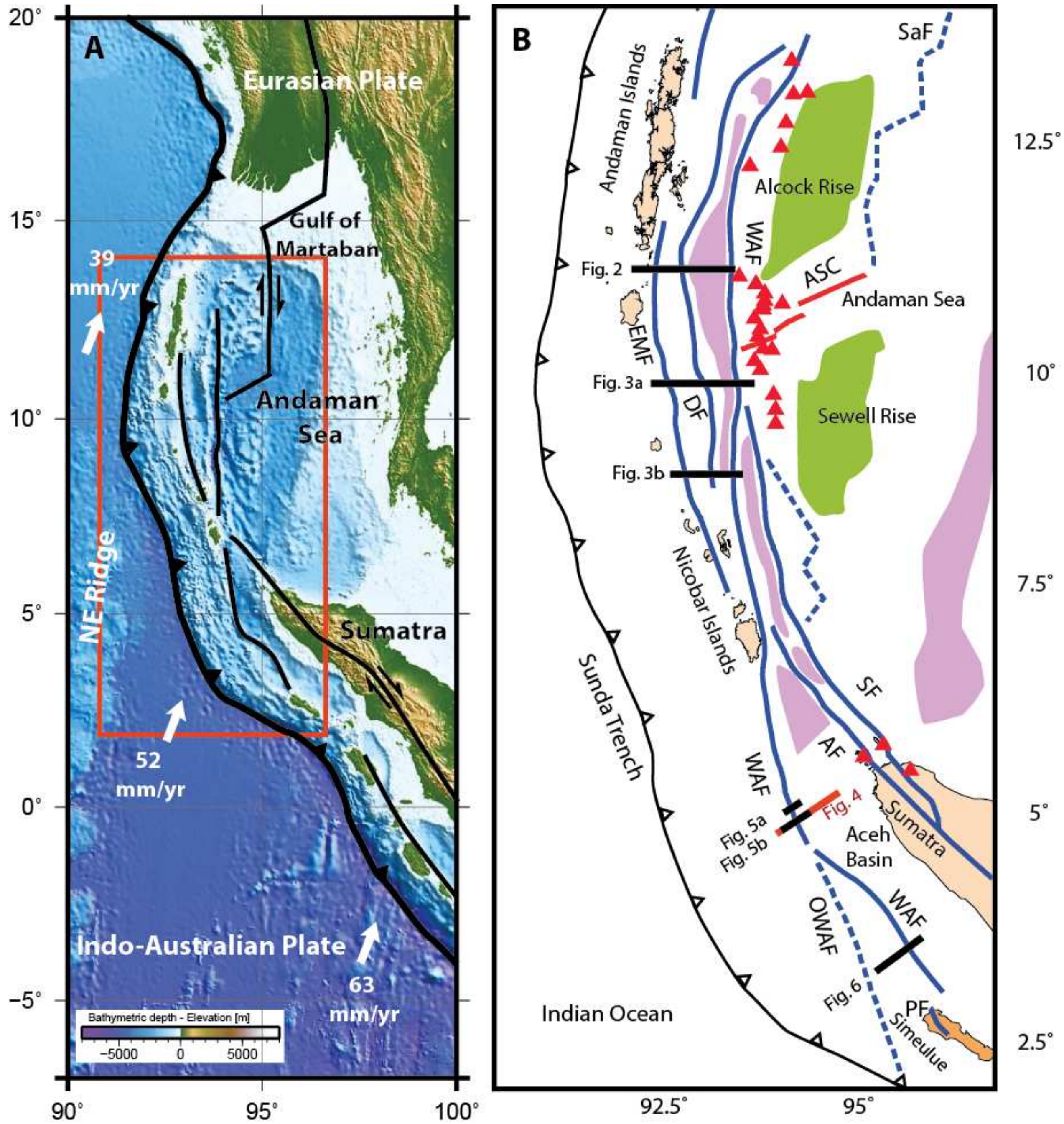

Figure 1. A. Stuctural configuration of the Andaman-north Sumatra forearc. Vectors and rate of convergence bertween the Indo-Australian Plate and Eurasian Plate is from Moeremans and Singh (2015). B. Major structures based on Cochran (2010) and Curray (2005). Shaded area is topographic high in the bathymetry. SaF = Sagaing Fault, WAF = West Andaman Fault, ASC = Andaman Spreading Center, DF = Diligent Fault, EMF = East Margin Fault, SF = Sumatra Fault, AF = Aceh Fault, OWAF = Old West Andaman Fault, PF = Pagaja Fault.

consisted of pre-Neogene sequence and 3 sequences of Neogene basin fills (Berglar *et al.*, 2008). Similar equivalent sedimentary units had been identified in the Aceh Basin and their deposition is related to the development of major strike-slip faults, such as SF and the WAF (Izart *et al.*, 1994). Several works support the hypothesis of strike-slip related basins in the northern Sumatra forearc (Berglar *et al.,* 2008; 2010; 2017; Martin *et al.*, 2014; Seeber *et al.*, 2007) that also applied to their extension in the southern Sumatran forearc (Diament *et al.*, 1992; Hall *et al.*, 1993; Sapiie *et al.*, 2015). However, detail geological field work in the central Sumatra forearc island argued that the western margin of the forearc basin is characterized by compressional structures that is likely to have developed during inversion tectonic (Samuel and Harbury, 1996). Recent works with higher quality of seismic reflection imaging reveal the existence of landward-vergence backthrusts in the boundary between the forearc basins and forearc highs (Chauhan *et al.*, 2009; Deighton *et al.*, 2014; Mukti *et al.*, 2012a; Singh *et al.*, 2008; 2010) and reveal the role of fold-thrust orogeny in the formation of forearc high and accretionary wedge complex that influence the development of forearc basin (Mukti *et al.*, 2012a).

METHODS

The available published geologic-geophysical data in the northwesternmost Sunda forearc were reviewed in this paper (Berglar *et al.*, 2010; Cochran, 2010; Curray, 2005; Deighton *et al.*, 2014; Hananto *et al.*, 2012; Martin *et al.*, 2014; Moeremans and Singh, 2015; Pesicek *et al.*, 2010; Singh *et al.*, 2013). Furthermore, several onshore field works (Aribowo *et al.*, 2014; Endharto and Sukido, 1994; Roy and Banerjee, 2016; Samuel and Harbury, 1996) were highlighted in this paper.

RESULTS

WAF – ANF – MFZ

To the north of the ASC, a cuesta morphology is observed to form shallow bathymetry along 300 km in a relatively north-south direction from the Martaban Gulf to the offshore Nicobar Island (Figure 1). The top of the cuesta is called the Invisible Bank and its eastern steep slope is interpreted to have formed by the West Andaman Fault (Curray, 2005; Curray *et al.*, 1978). In the western slope of Invisible Bank (IB), tilted strata of possibly Cretaceous – Paleogene age are observed that thickened toward the basin to the west (Figure 2). The overlying Neogene strata exhibit similar pattern with deformed sequence in the area of DF-EMF. Recently acquired seismic reflection data in between Curray's line in Figure 2 and the ASC shows similar tilted strata in the western flank of IB (Moeremans and Singh, 2015). However, they argued that WAF is actually formed in the depression to the east of IB, as evidence by offset of reflectors beneath the seafloor. Furthermore, faulted blocks are observed to the east of the IB and had been interpreted as part of an active right-lateral strike-slip fault (Goli and Pandey, 2014).

To the south of the spreading center, trace of the WAF still can be observed in bathymetry, gravity and

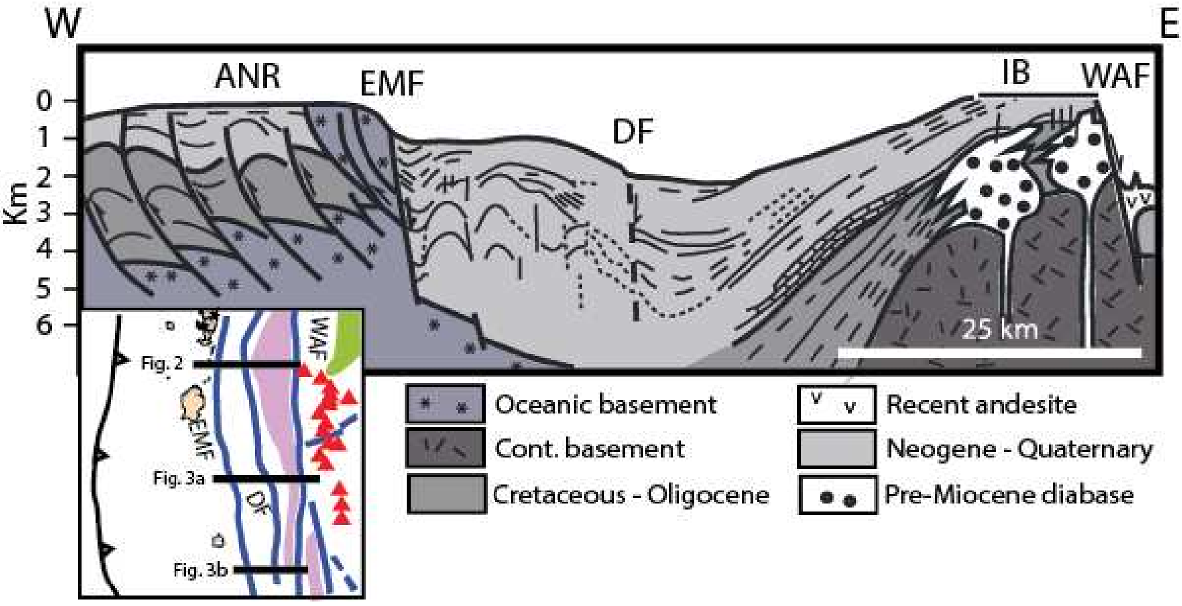

Figure 2. Interpretation of seismic section in the Andaman showing EMF (Eastern Margin Fault), DF (Diligent Fault) and WAF (West Andaman Fault). Modified after Curray (2005), Moeremans and Singh (2015). Invisible Bank (IB) is tilted strata that formed a cuesta morphology with steep slope of WAF in the eastern part. ANR = Andaman Nicobar Ridge.

seismic reflection data (Cochran, 2010; Curray, 2005). A gravity high over the WAF appears to have formed the eastern boundary of the deep gravity low over the forearc basin (Cochran, 2010). The WAF ridge to the south of ASC had been suggested to have formed by a component of compression and uplift across the fault that related with spreading in the ASC (Curray, 2005). This uplift is evidenced by fossil of benthic foraminifera normally found deeper than 1000m discovered in a dredge sample from a depth of 490 m (Frerichs, 1971). Seismic reflection data in the southern part of the WAF imaged similar cuesta that formed IB but named as Andaman-Nicobar Fault (Moeremans and Singh, 2015) (Figure 3). They argued that the steep fault of ANF (WAF of Curray) in the southern ASC could have been the sliver fault prior to that observed in the northern part of ASC.

The WAF is traceable on the bathymetry as a linear feature extent farther south to offshore Nicobar and even to northern Sumatra (Figure 1). A surface fault break had been proposed in the area around Nicobar Island by some author (Pandey *et al.*, 2017) although there is no high resolution bathymetry to support that. However, relocation of the hypocenters of events between the 2004 and 2005 Sumatran earthquakes show activity only in the segment of WAF from the spreading center to the Nicobar Island (Cochran, 2010). Furthermore, a cluster of seismicity is observed in the area of juxtaposition of the WAF and the northern extension of the Sumatran Fault (Cochran, 2010). Acquired swath bathymetry around the WAF (Cochran, 2010) showing a decrease of slope angle and throw of the WAF offshore Nicobar Island.

In the northern Sumatra forearc, the WAF is consistently showing vertical offsets of reflectors in several recent seismic reflection data that interpreted as a strike-slip faults in the western margin of the Aceh Forearc Basin (Berglar *et al.*, 2010; Martin *et al.*, 2014) (Figures 4,5). On the seafloor, this fault zone appears to have crossed the area of accretionary wedge and developed farther west (Hananto *et al.*, 2012; Martin *et al.*, 2014), even though WAF had been suggested to have formed a rheological boundary between the forearc basin and accretionary wedge (Izart *et al.*, 1994; Martin *et al.*, 2014). The WAF appears to have continued to a complex of anticlinal structures that interpreted as Tuba Ridge (Berglar *et al.*, 2010; 2017; Izart *et al.*, 1994; Malod and Kemal, 1996), which was bounded the east by another strike-slip fault developed within the forearc basin. This strike-slip fault has been interpreted to have formed the southern extension of the WAF or MFZ (Berglar *et al.*, 2010; Hananto *et al.*, 2012; Izart *et al.*, 1994; Malod and Kemal, 1996; Martin *et a*l., 2014) (Figures 6,7). Farther south, this strike-slip fault has been suggested to have extent either to the Simeulue Island or offshore Simeulue Basin (Berglar *et al.*, 2010; Hananto *et al.*, 2012; Martin *et al.*, 2014).

Re-examination of high resolution bathymetry data (Hananto *et al.*, 2012; Martin *et al.*, 2014) showing indeed the strike-slip fault of WAF is developed in the eastern side of the landward-margin of accretionary wedge in the northern part of Aceh Basin and extend farther southwest in the southern part (Figure 7). Farther up north in the Andaman, the WAF had been interpreted to have developed from the backarc and forearc basin (Cochran, 2010; Curray, 2005; Moeremans and Singh, 2015; Singh *et al.*, 2013). Therefore, this study support the hypothesis that WAF/ANF is indeed a major sliver fault developed in the Andaman-northern Sumatra (Singh *et al.*, 2013).

Tuba Ridge had been interpreted as an anticlinal structure within WAF (Malod *et al.*, 1995) that marked a change in the bathymetry of Aceh and Simeulue basins (Berglar *et al.*, 2010). This ridge has also been proposed to have formed as a transpressional stepover between the WAF and MFZ (Berglar *et al.*, 2010). However, here the MFZ is marked as a strike-slip fault in the forearc basin, whereas is in its type locality the MFZ has been interpreted as landward-vergence backthrusts in the arcward margin of accretionary wedge (Deighton *et al.*, 2014; Mukti *et al.*, 2011; 2012a; 2012b; Singh *et al.*, 2011; 2010). Furthermore, the strike-slip faults in the Simeulue forearc basin appear to have extent farther south the Simeulue Island (Hananto *et al.*, 2012) (Figure 7). A relatively north-south trending fault is observed in the northern part of Simuelue Island and extent father southeast along the axis of the island (Aribowo *et al.*, 2014; Endharto and Sukido, 1994). Hence, here we proposed to name this strike-slip fault as the Simuelue Fault (SiF), to avoid confusion with the previous interpretation.

DF – EMF – backthrusts in the northern Sumatra accretionary wedge

Diligent Fault (DF) has been interpreted to have formed as a strike-slip fault that dissected the Paleogene-Neogene strata in the Andaman forearc basin (Curray, 2005). However, the vertical offset of reflectors in this fault zone is not prominent. (Figure 2 and all figures in Curray (2005). On recently acquired seismic reflection data, the area of DFZ exhibit compressional faults that may related with deformation zone in the East Margin Fault (EMF); hence the structural style could not be formed due east-west extension in the crust (Cochran, 2010). Furthermore, recently acquired seismic data in the Andaman Sea show that DFZ is actually landward-vergent thrusts rather than strike-slip faults (Moeremans and Singh, 2015; Singh *et al.*, 2013) (Figure 3). Moreover, seismic reflection images acquired in 2002-2003 showing

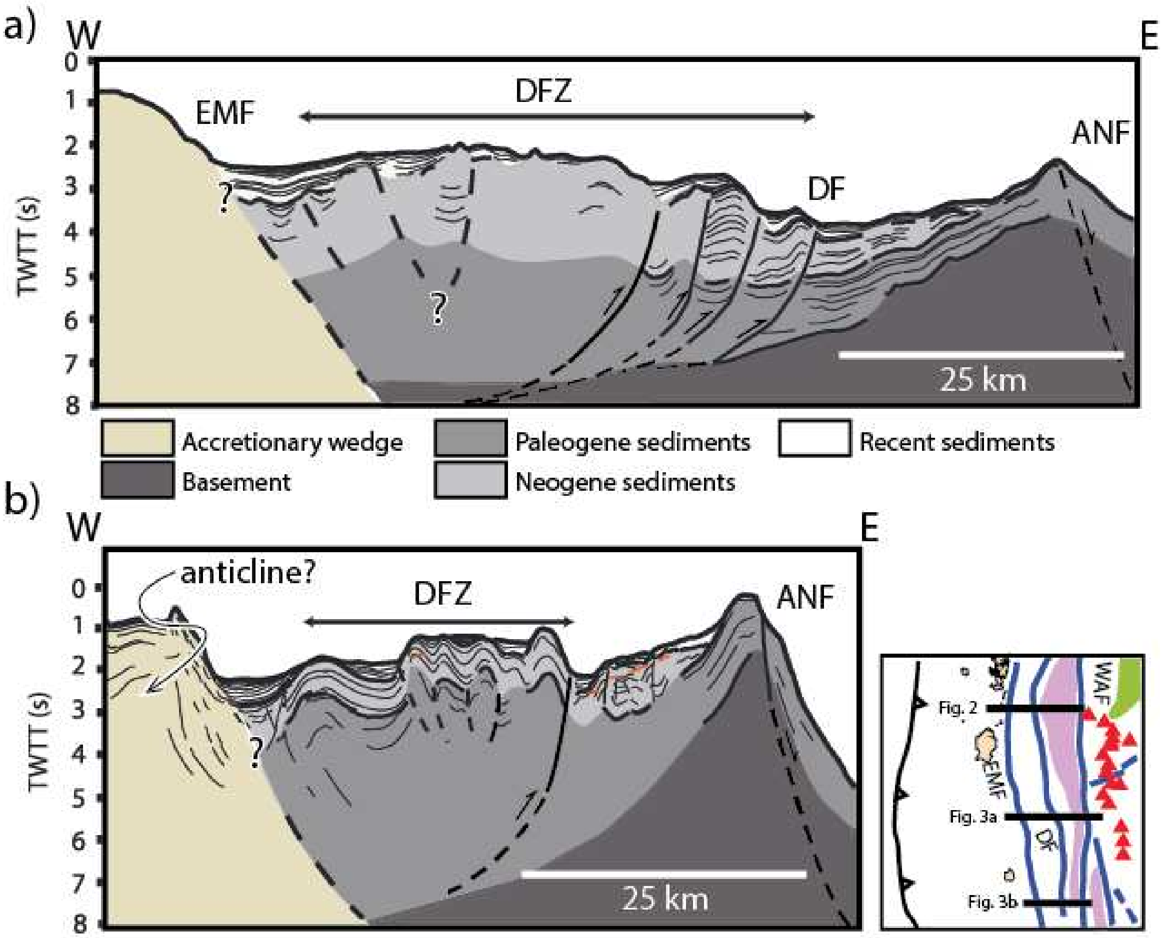

Figure 3. Structural interpretation of seismic sections in the Andaman showing backthrusting in the DF (Diligent Fault), anticline in the EMF (Eastern Margin Fault), and ANF (Andaman Nicobar Fault) to the south of Andaman Spreading Center (ASC). Modified after Moeremans and Singh (2015). ANF is equivalent to WAF (West Andaman Fault) of Curray (2005). DFZ (Diligent Fault Zone) is dominated by thrust faults and folded sediments.

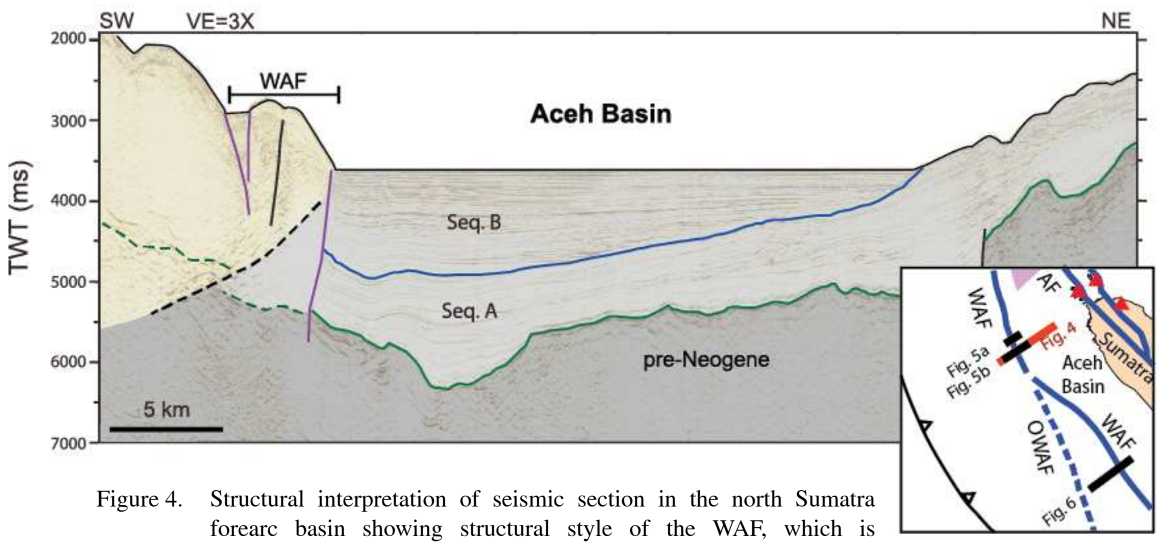

Figure 4. Structural interpretation of seismic section in the north Sumatra forearc basin showing structural style of the WAF, which is characterized by nearly vertical faults, modified after Berglar *et al.* (2010), Martin *et al.* (2014). However, a west-dipping reflector (black dash line) is also observed beneath the WAF that is likely to represent a landward-vergence thrust.

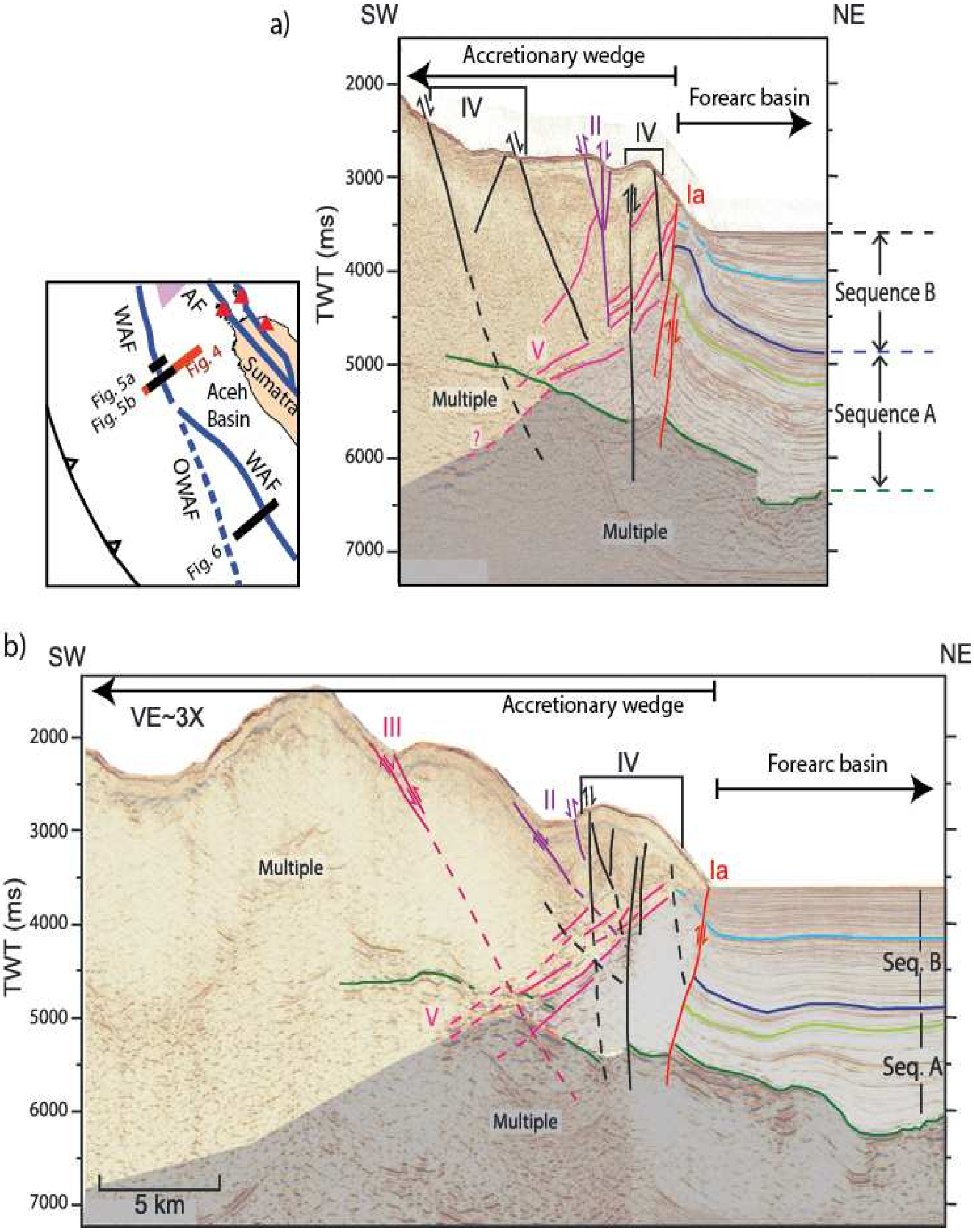

Figure 5. Detail structural identification of WAF in the northern Sumatra forearc showing different possible type and geometry (Martin *et al.*, 2014). See Figure 1 for the location of lines. Faults of type I to IV is characterized by thrust and normal offset on the seafloor and belong to the WAF strike-slip fault zone. Type V is thrust with no surface offset.

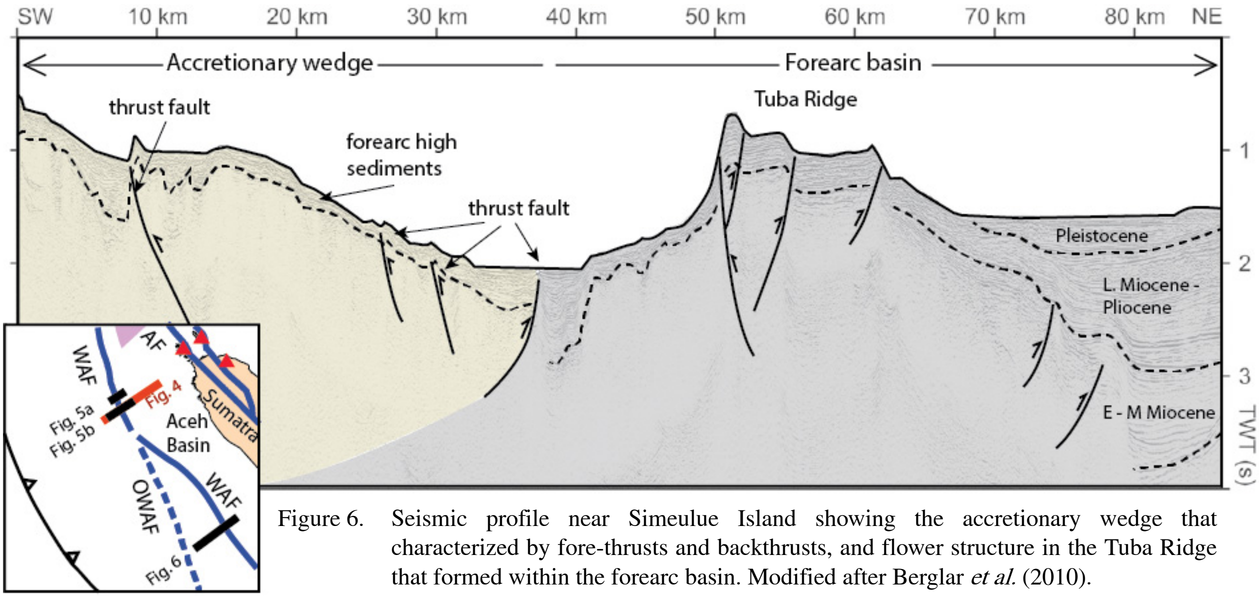

Figure 6. Seismic profile near Simeulue Island showing the accretionary wedge that characterized by fore-thrusts and backthrusts, and flower structure in the Tuba Ridge that formed within the forearc basin. Modified after Berglar *et al.* (2010).

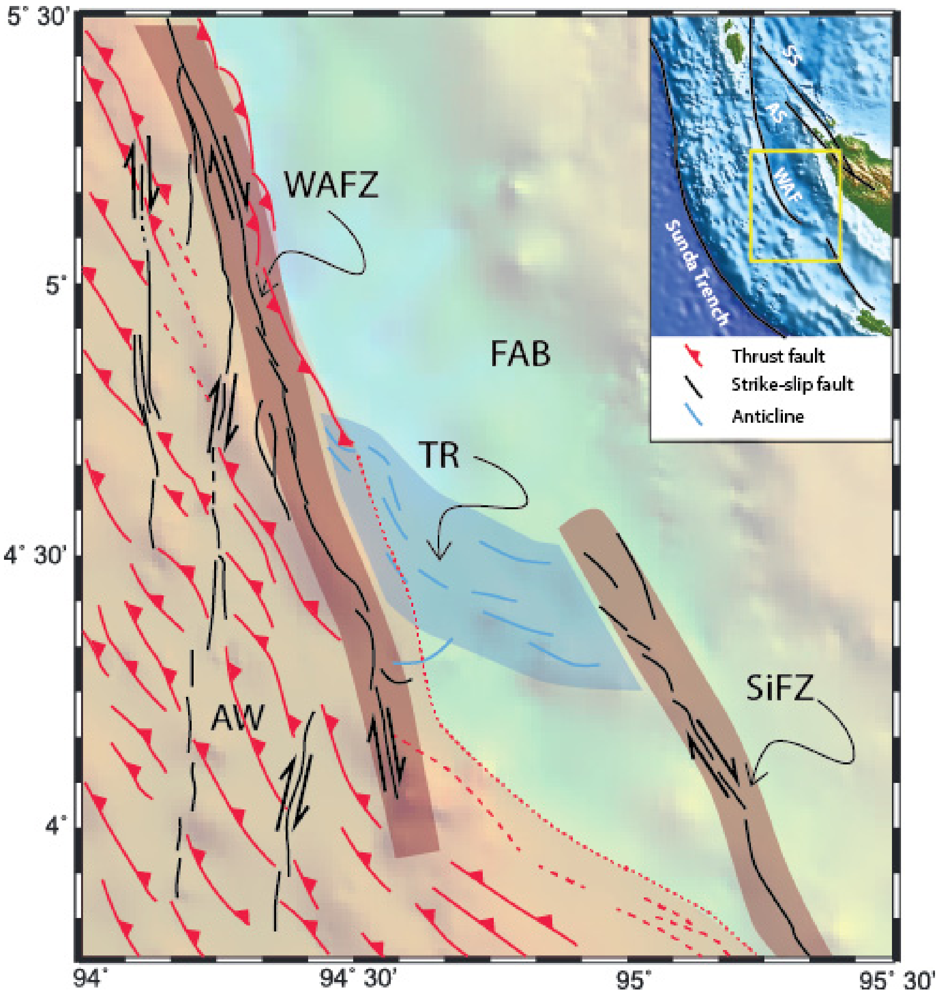

Figure 7. Compilation of possible interpretation for structures in the accretionary wedge (AW) that is bounded by landward- and seaward-vergence thrusts. The West Andaman Fault zone (WAFZ) is a strike-slip fault zone that crossed the accretionary wedge, whilst Simeulue Fault zone (SiFZ) is a strike-slip fault zone developed in the forearc basin that over stepped and formed the Tuba Ridge (TR). Possible splays of the WAF developed further west in the accretionary wedge. FAB = Forearc basin.

anticlinal structures and landward-vergence thrusts are prominent in the DFZ (Goli and Pandey, 2014; Pandey *et al.*, 2017). However, the width of DFZ decreased toward south with the occurrence of steeper thrust with the deformed strata.

To the west, EMF has been interpreted as a strike-slip fault with some vertical offset of reflectors in the subsurface (Cochran, 2010; Curray, 2005; Raju *et al.*, 2004) (Figure 2). Recently acquired seismic reflection data in the Andaman Sea also support this mechanism for the EMF by showing a large subsiding basin to the east of the EMF (Moeremans and Singh, 2015). However, re-observation on the data set reveal that anticlinal structures are prominence in the area of the EMF (Goli and Pandey, 2014; Moeremans and Singh, 2015; Pandey *et al.,* 2017), suggesting that vertical fault in the slope of the EMF seems to be unlikely. These folded sediments in the EMF zone may coeval to the younger sedimentary successions observed in Andaman Island (Allen *et al.*, 2007; Roy and Banerjee, 2016). A vertical fault plane may have developed within the axis of the anticlines, as normally observed in the strike-slip fault zone (Berglar *et al.*, 2010). However, this study could not conclude it based on the available data set. A second scenario for the anticlinal structures is it represent a blind-thrust in the subsurface as have been proposed in the fold thrust belt development (Hubbard and Shaw, 2009; Shaw *et al.*, 1999). Moreover, farther south in the Sumatran forearc, structures within the forearc high are dominated by folding and thrusting in the accretionary wedge (Deighton *et al.*, 2014; Hananto *et al.*, 2012; Mukti *et al.*, 2011,;2012a; 2012b). Uplift of the forearc high island induced development of subaerial unconformity that followed by the growth of carbonate that normally hindered seismic wave propagation to the subsurface, hence seismic reflection imaging beneath these carbonates becomes difficult.

DISCUSSION

The WAF remains a prominent morphologic feature to the north of the ASC and probably was one of the primary active structures prior to the initiation of spreading in the Andaman Sea (Cochran, 2010). The northern segment of this fault zone may extent from the Gulf of Martaban in the north (Cochran, 2010; Curray, 2005; Goli and Pandey, 2014; Pandey *et al.*, 2017) to offshore Nicobar Island (Pandey *et al.*, 2017). However, the southern boundary of this northern segment should be observed in high resolution bathymetry data. The segment formed crossing boundary from backarc basin, volcanic arc, and forearc basin. Here the fault zone is named as the northern segment of WAF, agreeing the results of previous workers in this area (e.g. Curray, 2005).

The southern segment of the WAF stretches from the south of Nicobar Island to the accretionary wedge complex of northern Sumatra in the Aceh forearc (Figure 8). Several splays of this fault zone developed farther southwest in the accretionary wedge. Farther south the southern segment of WAF appears to step over

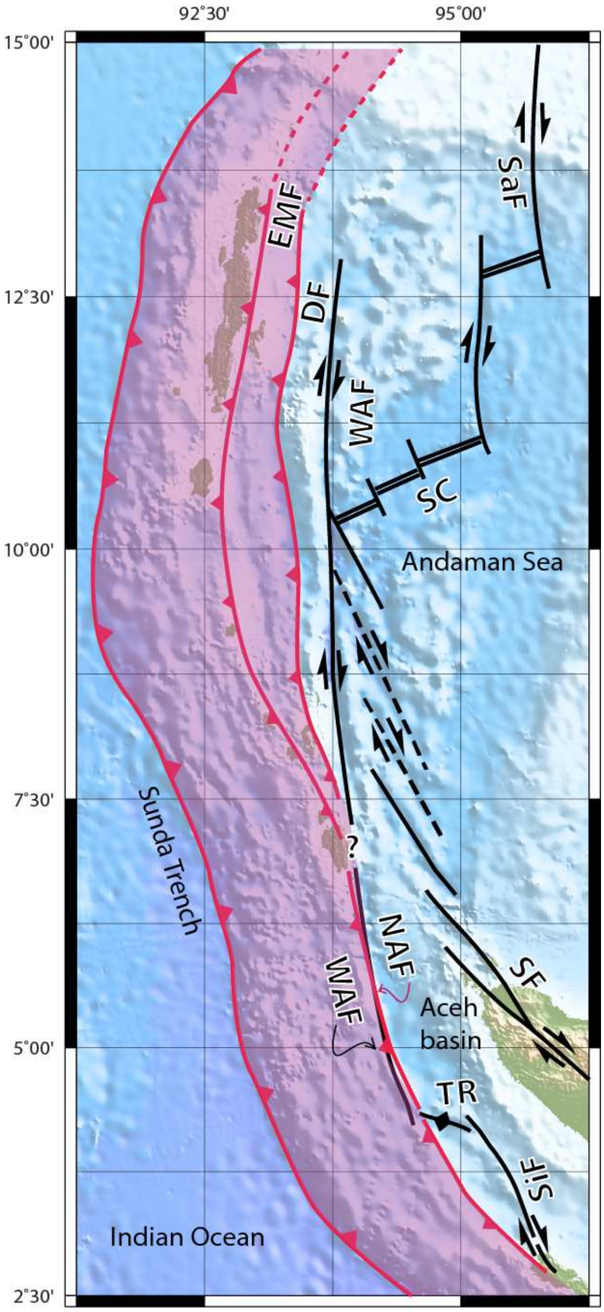

Figure 8. Proposed structural configuration in the northwesternmost Sunda margin based on this review. See text for detail. Shaded area is the accretionary wedge complex. EMF = Eastern Margin Fault, DF = Diligent Fault, WAF = West Andaman Fault, SaF = Sagaing Fault, ASC = Andaman Spreading Center, NAF = Nicobar Aceh Fault, SiF = Simeulue Fault, TR = Tuba Ridge, SF = Sumatra Fault.

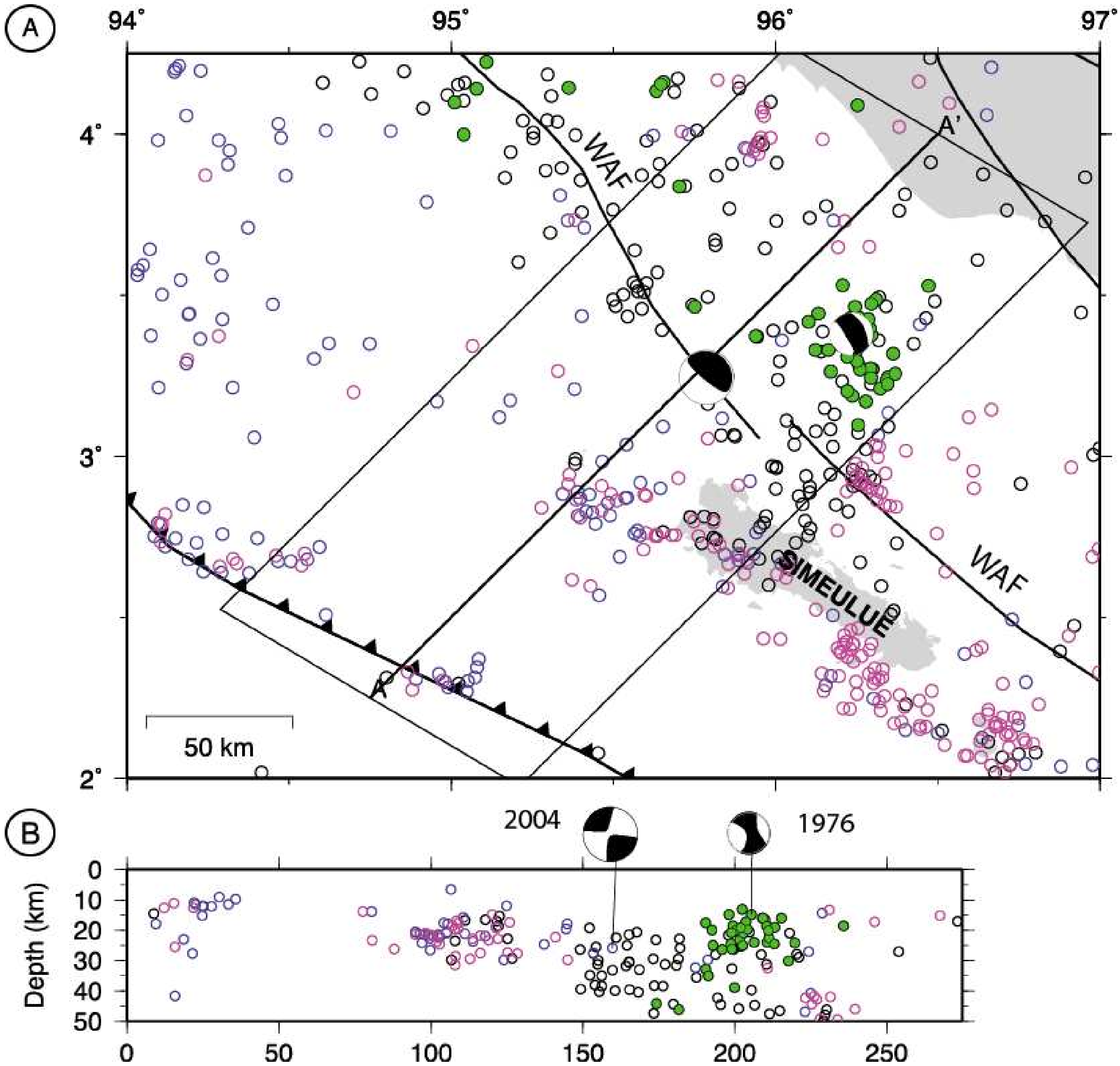

Figure 9. Map (A) and projection (B) of relocated hypocenters of events before the 2004 great earthquake (black), after the 2004 event but before the 2005 event (purple) and after the 2005 event (blue) (Pesicek *et al.*, 2010). Green is aftershocks of the 1976 events that possibly initiated in the forearc basement as backthrust or reactivated basement structures. CMT solutions for the 2004 and the 1976 events shown at their relocated positions. The location of WAF is from Curray (2005).

with SiF and formed the transpressional anticline, TR (Figure 8). The SiF itself developed farther south to the Simeulue Island and may have continued with the Pagaja Fault onshore (Aribowo *et al.*, 2014; Endharto and Sukido, 1994) (Figure 1). These observations suggest that slip-partitioning in such an oblique convergent margin tends to initiate a new deformation zone rather than reactivated the major rheological boundary. Similar scenario occurred in the Southern Burma where the active Sagaing Fault indeed developed crossing several tectonic provinces (Sloan *et al.*, 2017).

Based on the compilation of new data acquired in 2008 (Moeremans and Singh, 2015), the arcward margin of the Andaman-north Sumatra accretionary wedge is marked by landward-vergent thrusts of the Diligent Fault in the north and Nicobar Aceh Fault in the south (Figure 2). Similar seismic images and geologic cross section in this boundary zone have been observed in the central and southern Sumatran forearc (Deighton *et al.*, 2014; Mukti *et al.*, 2011; 2012a; 2012b; Samuel and Harbury, 1996; Singh *et al.*, 2011), suggesting that compressional structures dominated structural style in the inner part of accretionary wedge. Focal mechanisms of earthquakes in the region show no evidence of active strike-slip in the eastern margin of Andaman-north Sumatra accretionary wedge (Hananto *et al.*, 2012; Singh *et a*l., 2010; 2013). Projection of relocated hypocenters of the 2004 and 1976 events in the northern Sumatran forearc suggesting that the 1976 event may have initiated in the forearc basement as backthrust or reactivated basement (Pesicek *et al.*, 2010) (Figure 9).

Despite the obliquity of the present-day convergence in the northernmost Sunda margin, our regional observation shows similar development of a major zone of backthrusting observed in the case of orthogonal convergence as have been proposed by previous works (Chauhan *et al.*, 2009; Moeremans and Singh, 2015; Singh *et al.*, 2008; 2013). Experiments performed with oblique convergence indeed exhibit landward-vergence thrusting in the rear margin of accretionary wedge (McClay *et al.*, 2004). Based on the undeformed strata in the area between DF and ANF-WAF, it is clear that this area does not belong to the accretionary complex as had been suggested by several authors (Berglar *et al.*, 2017; Izart e*t al.*, 1994; Martin *et al.*, 2014; Seeber *et al.*, 2007). The accretionary complex in the oblique Andaman-northern Sumatra subduction zone is bounded by fold-thrust belts in the landward and seaward margins.

CONCLUSIONS

In the Andaman-north Sumatra forearc, the complex strain partitioning is characterized by sliver faults that crossing boundaries between the backarc basin, volcanic arc, forearc basin, and accretionary wedge. The fault zone can be divided into two segments of WAF in the north and SiF in the southern part. A restraining step-over formed in between WAF and SiF. The SiF may extent onshore Simeulue to a strike-slip fault onshore. Slip-partitioning in such an oblique convergent margin appears to have formed a new deformation zone rather than reactivated the major rheological boundary in between the accretionary wedge and forearc basin. The eastern margin of the Andaman-north Sumatra accretionary wedge appears to have form as landward-vergent backthrusts rather than strike-slip faults, differed from the previous reconstruction. This characteristic appears to have formed in the similar way with the compressional structures dominated the eastern margin accretionary wedge of the central and south Sumatra forearc.

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