GEOLOGICAL FEATURES OBSERVATIONS IN EASTERN INDONESIA BASED ON SELECTED P3GL SEISMIC DATA

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*Based on presentation materials provided by Naibaho *), Nainggolan **), and Wijaya et al. ***) from P3GL*

On January 31st, 2018, FOSI (Indonesian Sedimentologists Forum) organized a one day seminar in Cirebon (West Java), hosted by the Marine Geological Institute of Indonesia (or P3GL: Pusat Penelitian dan Pengembangan Geologi Kelautan). P3GL is a government institution which operates research vessels called Geomarin III. Their surveys typically include seismic acquisition, magnetic data acquisition and seafloor sediment sampling in Indonesian water. The seminar was aimed to provide an overview of their data to the geoscience community, especially those in the petroleum industry as the data may help petroleum exploration activities in Eastern Indonesia. This article focuses on selected seismic data which were presented during the seminar.

From 2013 to 2016, P3GL had acquired more than 100 seismic lines and a significant number of drop cores in the vicinity of north Banda Arc from SE Halmahera to the north of Aru Island. Most of those data were acquired by using their modern seismic vessel, named Geomarin III. The seismic data were acquired in different survey projects named Barat Waigeo, Kepulauan Aru, Laut Seram, Seram-Semai, West Misool, Wokam Kaimana (Figure 1).

These seismic data cover a number of basins in the area. Figure 2 shows the distribution of the seismic lines over the sedimentary basins. The structures are displayed on the map to give a regional geological understanding of the region.

BARAT WAIGEO SURVEY

Several sparse 2D seismic lines were acquired in Barat Waigeo or the West Waigeo area. These seismic lines cover East Halmahera Basin (6 lines) and Weda Basin, SE of Halmahera (8 lines). Figure 4a represents the seismic lines which cover the East Halmahera Basin. The line shows that water depth goes deeper from SE to the NW and it is probably part of the same geological unit as the Waigeo Island. This area is considered frontier and receives minimum interest from petroleum industry.

Figures 4b, 4c and 4d were acquired In the south of Weda Basin. Figure 4b is oriented in NW-SE and it goes across the great Sorong Fault, which is WSW-ENE in orientation. There are some acquisition problems, so there are gaps in the section. The thick sediment section in the middle of the section fills up a depression that was most likely created by the Great Sorong Fault movements. There are a number of petroleum concessions in this area (Figure 3), unfortunately no wells have been drilled in the area.

BWL-26 (Figure 4c) and BWL-10 (Figure 4d) lines cover the main part of the Weda Basin. In general the water depth is deeper northward in this area. A local depression was recorded in BWL-26, probably caused by a structure which is no longer active as it doesn't give a significant expression at the sea bottom. The BWL-10, however, recorded sea bottom expression which may indicate active faults in the area. Naibaho (2018) interpreted several normal faults across BWL-10. After seismic multiple removal processes, probably more geological features could be seen.

WEST MISOOL SURVEY

The West Misool Survey covers the north, west and south of Misool areas (Figure 1). The two lines selected are PMSL-42 and PMSL-48, located in the north of Misool Island (Figures 6a and 6b). The basin which is in the middle of PMSL-42, is probably filled with young clastic sediments. The depression was formed by the great Sorong Fault. An unconformity surface is indicated as dash lines, underlying the depression as interpreted by Naibaho (2018). Units 2, 3 and 4 in PMSL-42 are thickening to the east. The section is overlapping on top of Unit 1 above the unconformity on the east side. An intensive normal faults occur in the west of the depocenter, cut through Unit 2. Both Units 2 and 3 are cut by larger normal faults in the centre of the depression.

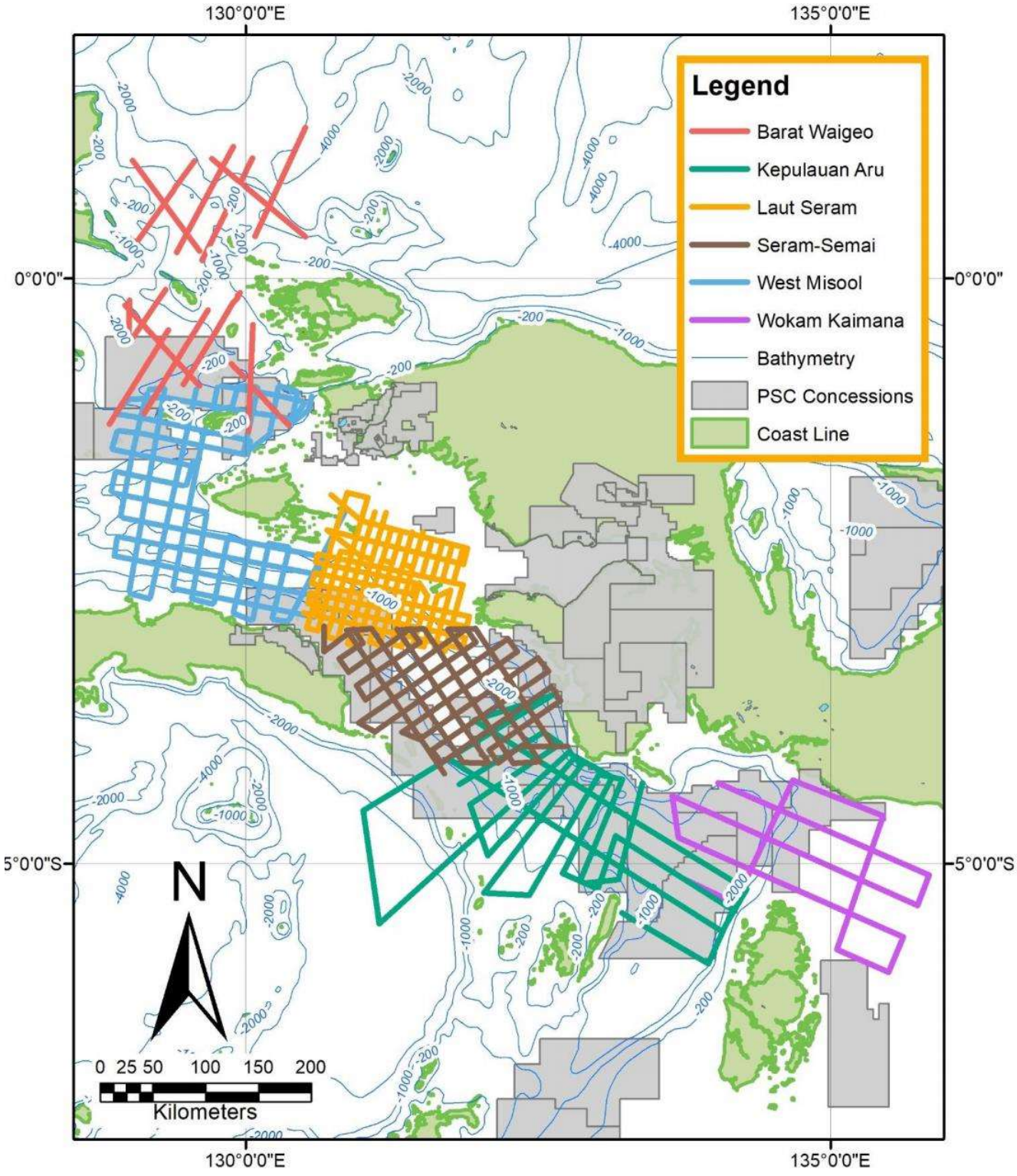


Figure 1: *Distribution of seismic lines of P3GL surveys in Eastern Indonesia*

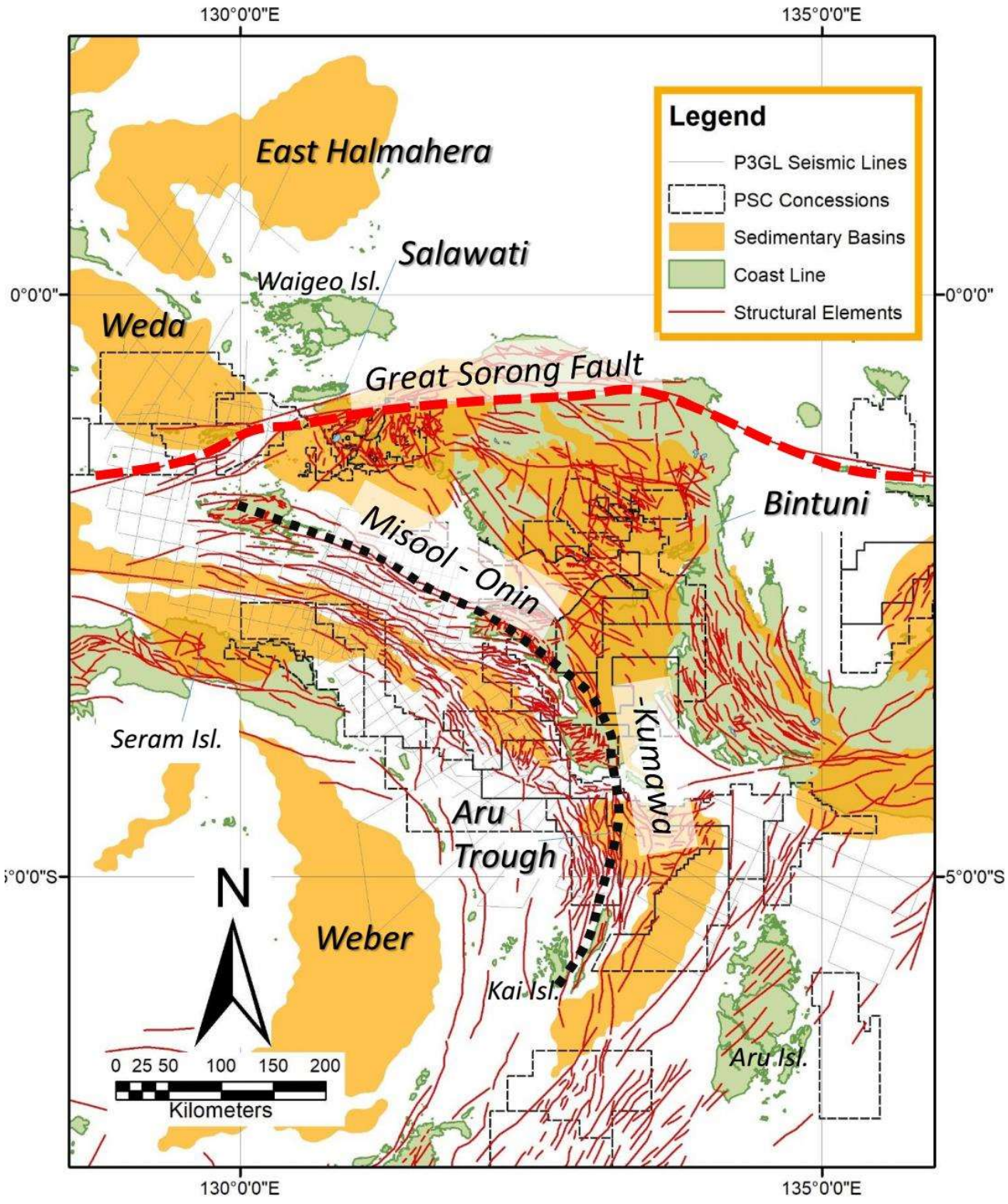


Figure 2: *Location of P3GL seismic lines relative to the sedimentary basins and structural features in the North Banda Arc region.*

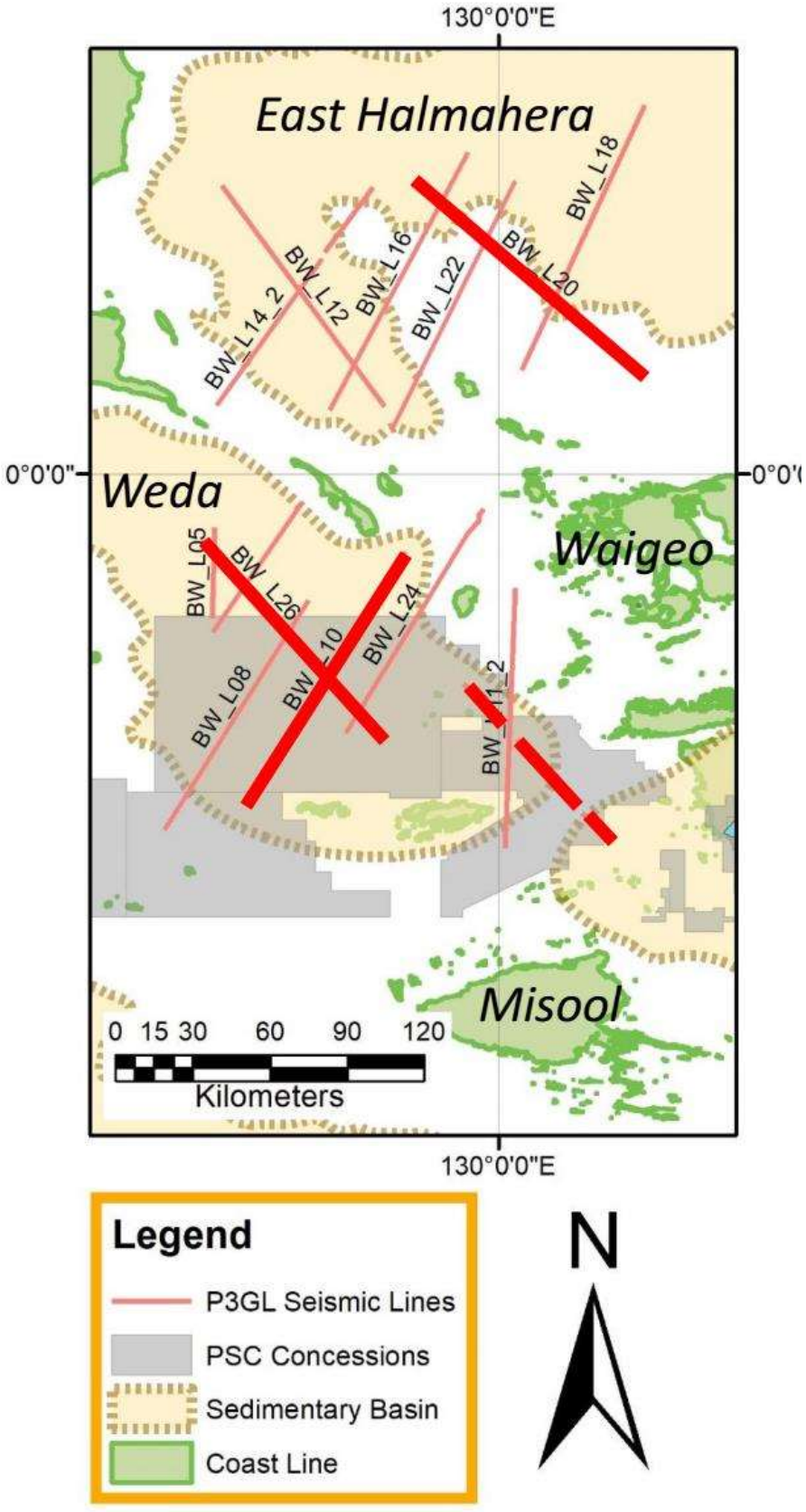


Figure 3: *Location of P3GL seismic lines in East of Halmahera and Weda Basin. The southeast part of the Weda Basin is an exploration target of some operators.*

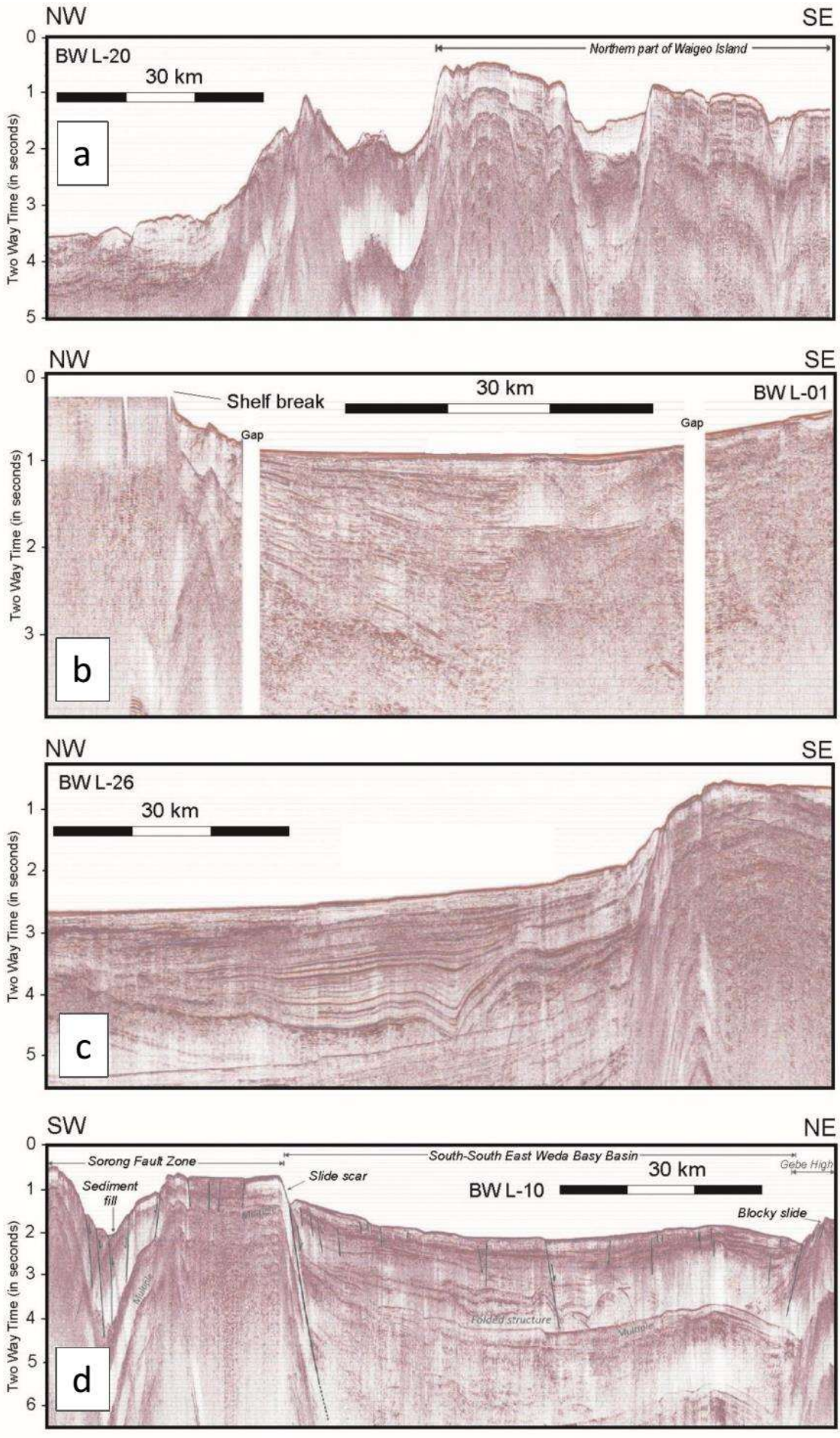


Figure 4: *P3GL seismic data from East Halmahera basin (a) and Weda Basin (b, c and d) after Naibaho, (2018).*

Line PMSL-48 is located in the southwest of PMSL-42. This line also goes across the Great Sorong Fault. Similar to PMSL-42, intensive normal faults occur in the west part of the section. The dash line separate the re-extensional sediment unit (Unit 1) from the syn-extension sediment (Unit 2). A positive feature occur in the centre of the section which can be interpreted as a shale intrusion or a horst block. Another unconformity surface underlain Unit 4. Both Unit 2 and Unit 3 are truncated by this unconformity at the centre of the section (Naibaho, 2018).

LAUT SERAM SURVEY

Several seismic lines of Laut Seram Survey cover the Misool-Onin Ridge and its southern flank (Figure 1). Three lines in this article represent the data set. PLS-30, PLS-22 and PLS-16 (Figures 7a, 7b and 7c after Naibaho, 2018) are NNE-SSW orientation lines which cover the southern flank of the Misool-Onin Ridge. The area is covered by water depth down to 2.5 second TWT.

PLS-30 recorded some reliefs in the trough which are generated by thrust faults. PLS-22 shows a relatively flat beds at the deepest section. These are young sediment accumulations which are not disturbed by faults. A local high appears at the centre of the trough which is caused by a thrust fault. PLS-16 is the east most section with flat sediment fill in the deepest section, bounded to the north by the Misool-Onin ridge and to the south by a topographical high generated by thrust faults.

SERAM-SEMAI SURVEY

In 2013, P3GL completed a survey called Seram-Semai. SS-14 (Figure 8) is a sample of the Seram-Semai Survey lines. It is a regional line which connect the eastern part of Seram to the sothern flank of Onin Ridge. The rugged sea bottom is an indication of active faulting in the region, which is part of the north Seram thrust belt. The seismic section provided is only down to 2 second TWT with a 1.8 second TWT water depth in part. It is necessary to get deeper seismic signal to understand the regional geology of the area.

Nainggolan (2018) has interpreted several sequences on this section. Sequence 1 is the Plio-Pleistocene interval and Sequence 2 is the Miocene-Oligocene interval. This area is dominated by thrust faults which are dipping to the SW.

KEPULAUAN ARU SURVEY

Several long seismic lines connecting Seram Island, Onin Ridge, Kai Islands and Aru Island were acquired as part of Kepulauan Aru Survey (Figure 1). The southern extension of the Onin High, which also known as Onin-Kumawa Ridge, is called Kuenen Ridge in P3GL reports (Figure 9, Naibaho, 2018). South of Adi Trough separate the Kuenen Ridge from East Kai Ridge. The East Kai Ridge is the northern extension of Kai Island highs. Thick sediment layers filled the Aru Trough. A diapiric feature is recorded in the southeast of Aru Trough and it is interpreted as a shale diapir. The survey area is located between Misool Island and Onin Peninsula, covers a well known Misool-Onin Ridge, which is also the west boundary of Bintuni Basin. P3GL utilized Geomarin III research vessel to acquire seismic, magnetic data and drop cores.

WOKAM KAIMANA SURVEY

Two lines were selected in this article to represent Wokam-Kaimana seismic survey, based on Wijaya et al. (2018). The SE part of the sections are the Aru shelf, which is part of the Sahul Shelf. It is a stable area attached to the Australian continent. The NW part of these sections are the Aru Trough with rugged sea bottom as they are cut by significant number of faults (Figure 10a). To the south, the sea bottom of Aru Trough has less relief but still have significant indication of faults.

CONCLUSION

These seismic samples from P3GL survey provide an overview of the data acquired by the institute. The data acquired by Geomarin III research vessel could be improved by applying more modern seismic processing methods. It is important to integrate P3GL data with other data such as those seismic acquired by the industry and also the surface geology. The data integration will provide a better geological overview of the region, which is important for petroleum exploration.

SOURCES

*) Geological and Geophysical Sistematic Mapping LP 2713 and LP 2714 of West Papua by Tommy Naibaho (P3GL)

**) Hasil Litbang 2014: Geological and Geophysical Sistematic Mapping LP 2812 AND LP 2912 of Seram Sea, West Papua by Tumpal Bernhard Nainggolan (P3GL)

***) Result of Geological and Geophysical Research Offshore Wokam –Semai, West Papua : Data of RV. Geomarin III 2013 , 2014 and2015; by P. Hadi Wijaya, I Wayan Lugra, Nyoman Astawa, GM. Hermansyah, Deny Setiady, Ediar Usman, Maman Surachman, Nur Adi Kristanto, Abdul Wahib, P. Raharjo, D. Ilahude, KresnaTri Dewi, Bambang Tri Hardjanto, M. Akrom Mustafa, T.P. Nainggolan, H.C. Widiatmoko, H. Kurnio, A. Wisnu Pertala, Ai Yuningsih, B. Rachmat, A.W. Djaja, Andrian Ibrahim, Edi Rohendi, Andrianto Wibowo (P3GL)

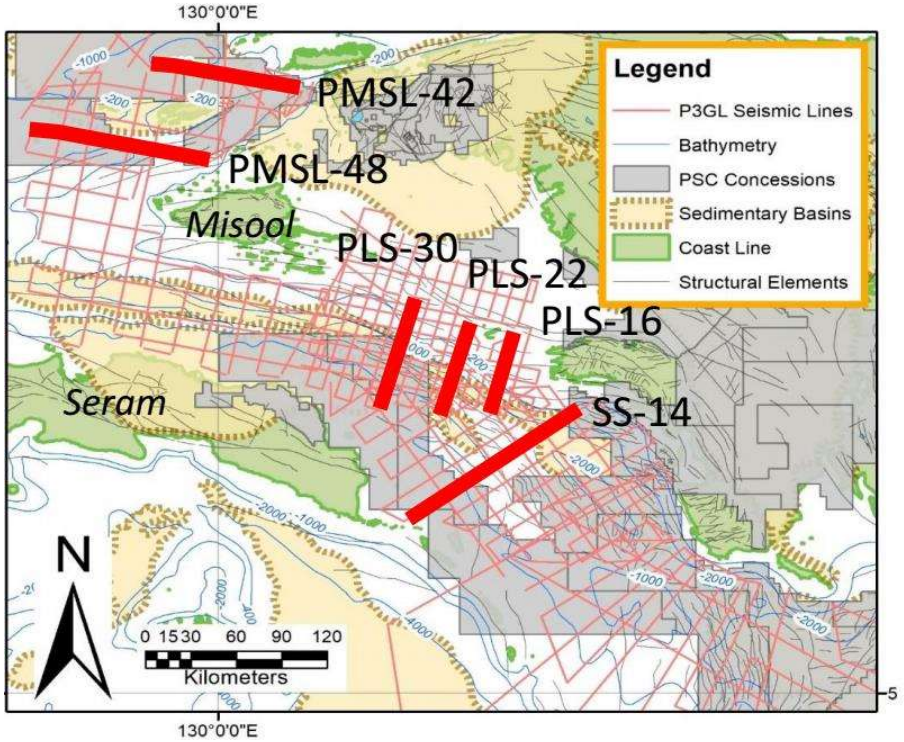


Figure 5: *Location map of several seismic lines in NW Misool Island and the south of Misool Onin ridge. The bold lines indicating seismic lines which are discussed in this article.*

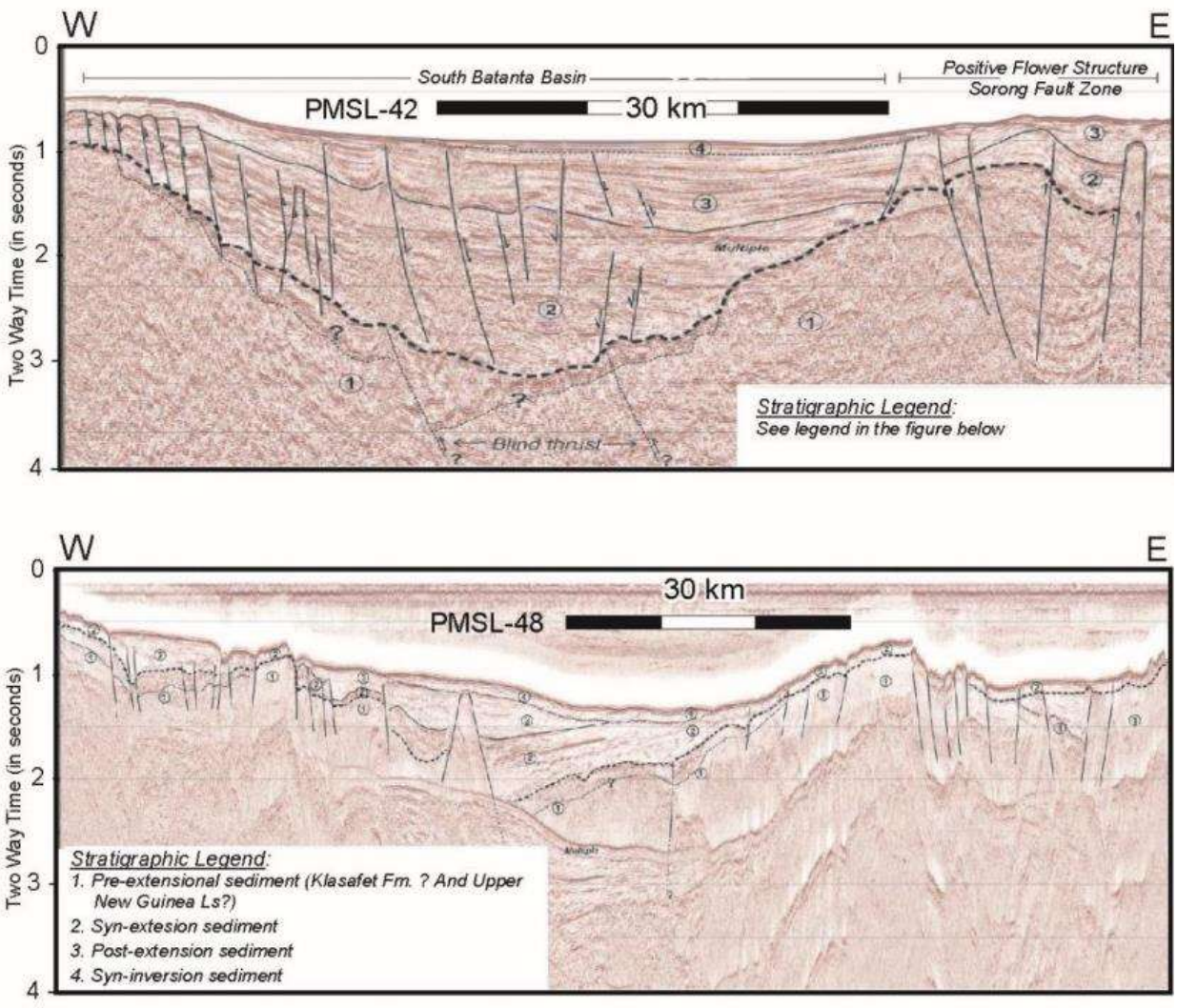


Figure 6: *Seismic in the north of Misool Island (Naibaho, 2018).*

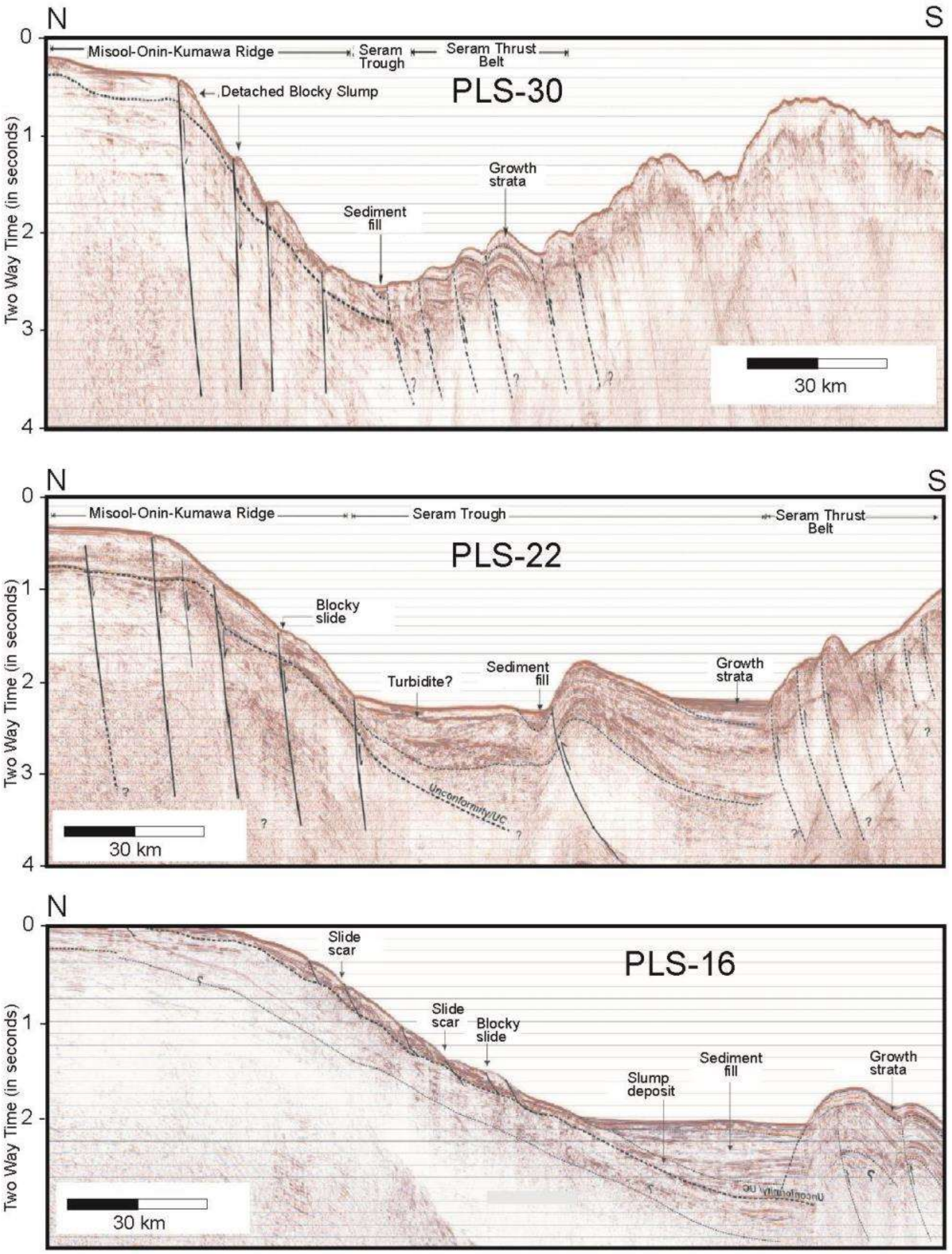


Figure 7: *Seismic sections of Semai Seram Survey (Naibaho, 2018).*

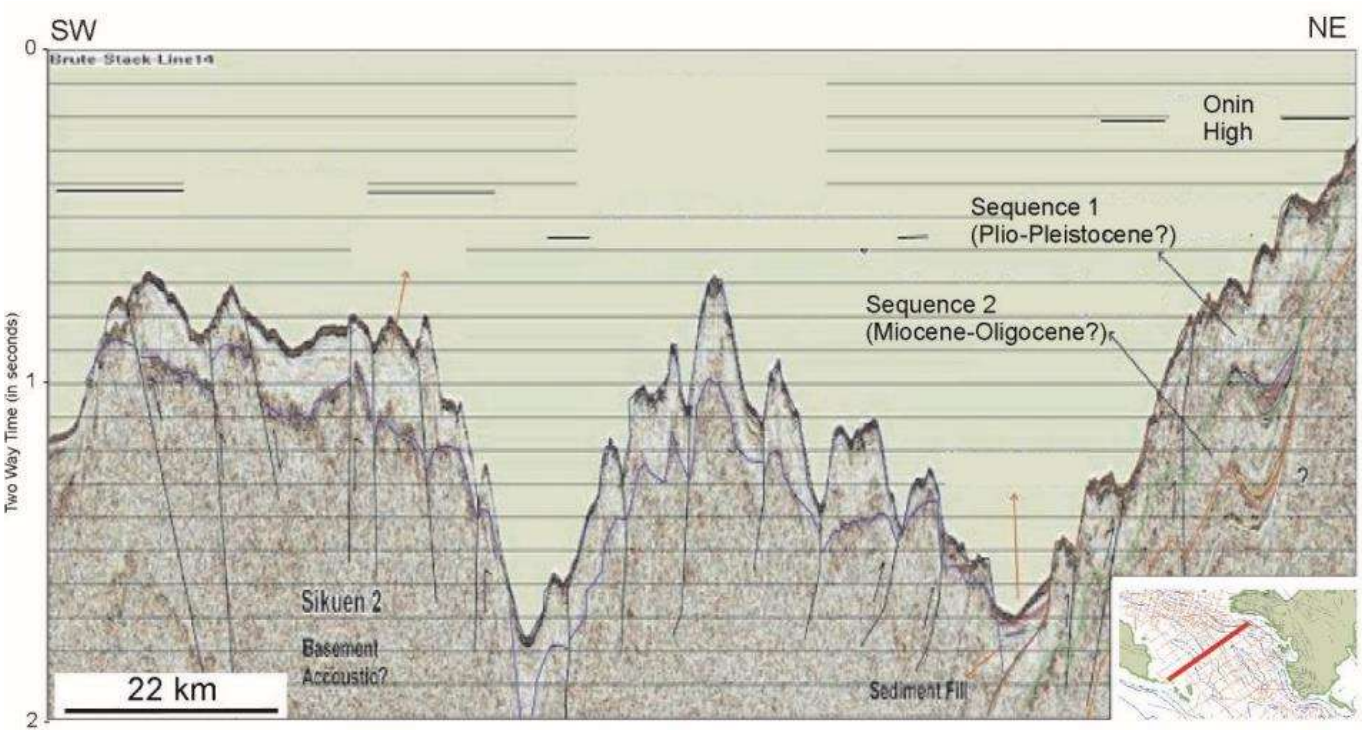


Figure 8: *NE-SW oriented seismic section which connect Seram Fault Belt to Onin Ridge (Nainggolan, 2018).*

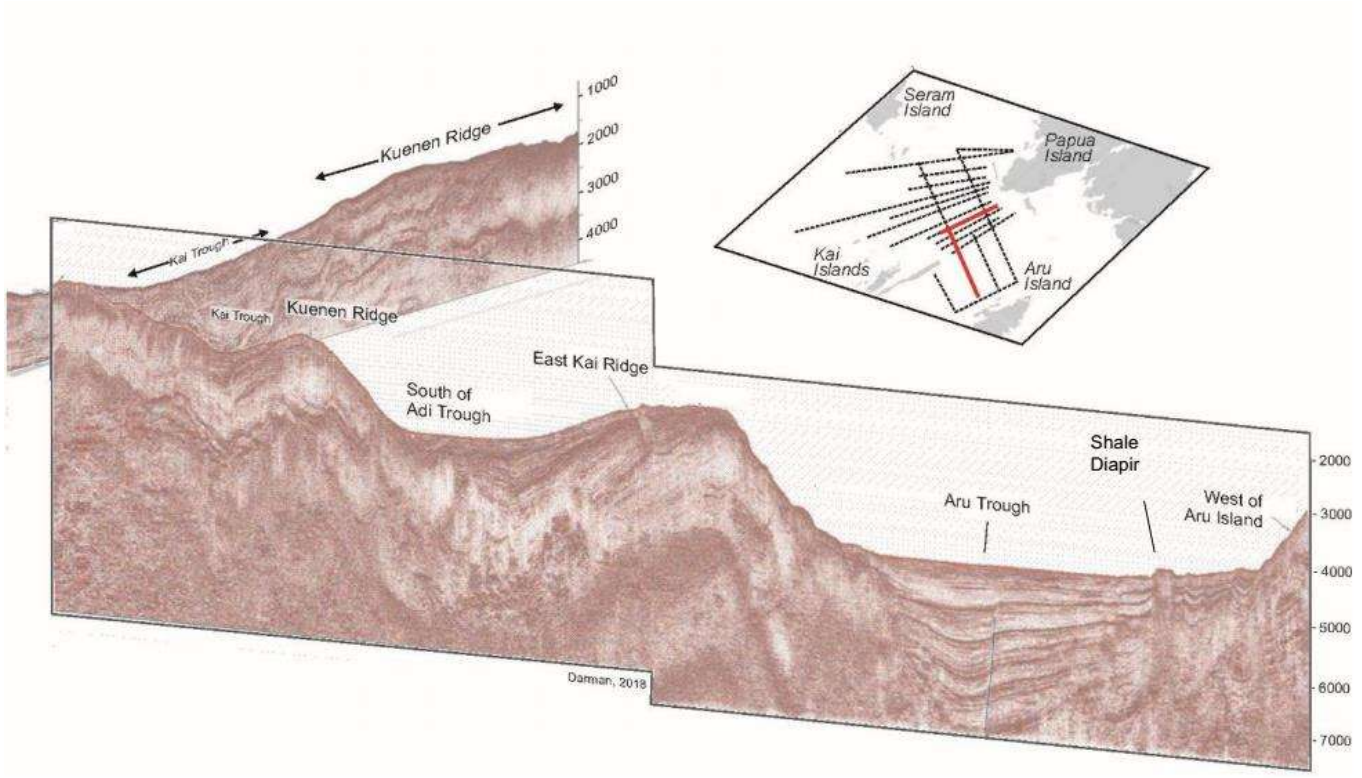


Figure 9: *A 3D view of 2 seismic sections from Kepulauan Aru Survey (Naibaho, 2018), showing geological features in the area. The Kuenen ridge is also know as part of the Misool-Onin-Kumawa Ridge.*

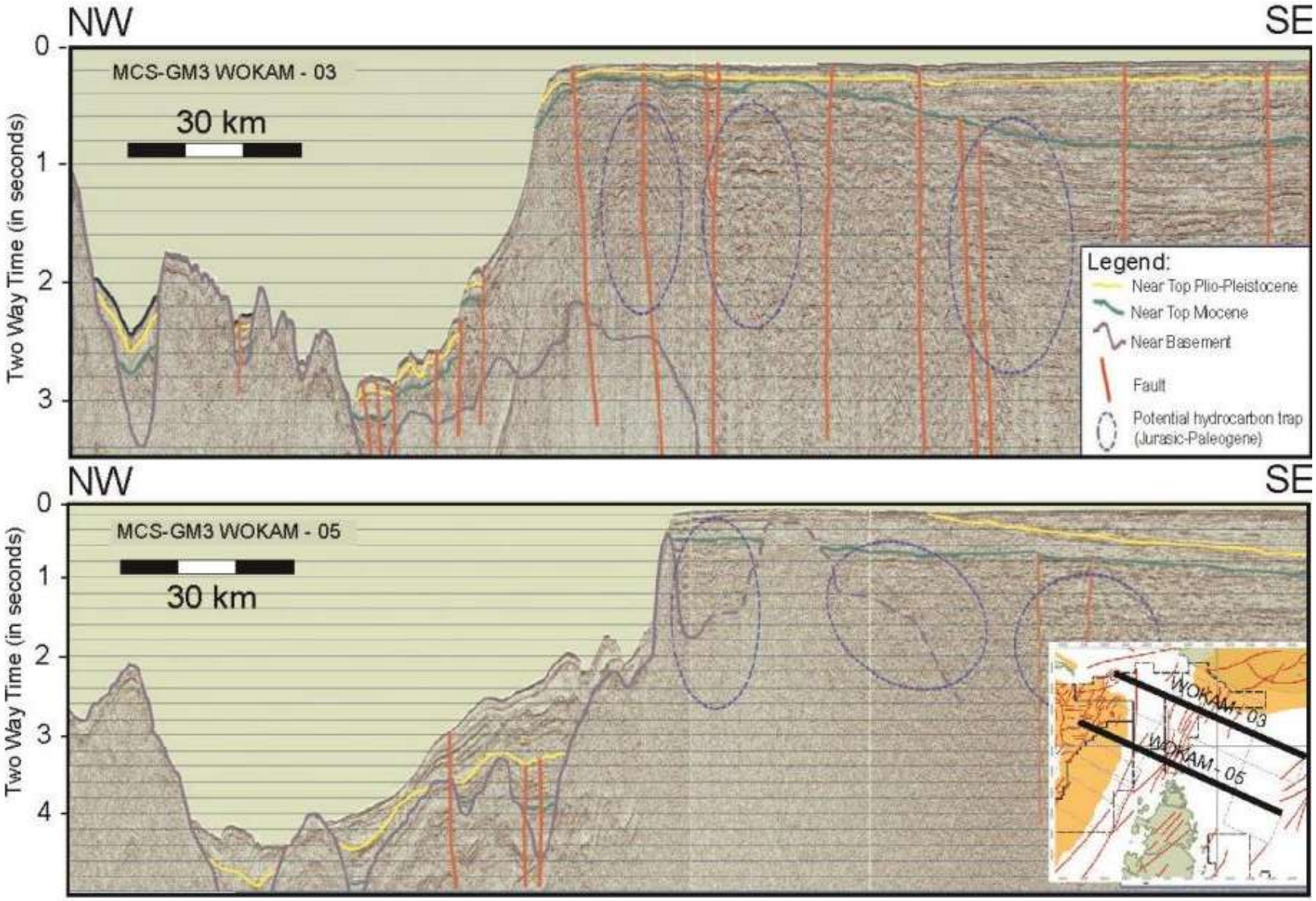


Figure 10 : *Two NW-SE oriented seismic sections which show the transition from Aru Sea Shelf to the Aru Trough. Potential hydrocarbon plays are indicated in blue circles (Wijaya et al, 2018).*