E-ISSN : 2541-5794
P-ISSN : 2503-216X

Journal of Geoscience,
Engineering, Environment, and Technology
Vol 02 No 01 2017

Geological Structure Analysis to Determine the Direction of the Main Stress at Western Part of Kolok Mudik, Barangin District, Sawahlunto, West Sumatera

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Received: Jan 1, 2017. Revised : 15 Feb 2017, Accepted: Feb 20, 2017, Published: 1 March 2017
DOI: 10.24273/jgeet.2017.2.1.20

Abstract

On the study area there are three types of structure, those are fault, fold and joint. Types of fault were found in the study area, reverse fault with the strike/dip is N215°E/75°, normal fault has a fault directions N22°E and N200°E with pitch 35°, and dextral fault with pitch 10° and strike N219°E. Fold and joint structures used to determine the direction of the main stress on the study area. Further, an analysis used stereonet for data folds and joints. So that from the data got three directions of main stress, those are Northeast – Southwest (T1), North – South (T2) and Southeast – Northwest (T3). On the Northeast – Southwest (T1) stress there are four geological structures, anticline fold at ST.3 , syncline folds at ST. 13a, ST. 13b, ST. 13c and ST. 33, chevron fold at ST. 44 and joint at ST. 2. On the North – South (T2) stress there are three geological structures, those are syncline fold at ST. 35, anticline fold at ST. 54 and joints at ST. 41, ST. 46 and ST. 47. On the Southeast – Northwest (T3) stress were also three geological structures, those are chevron fold at ST 42a, overturned fold at ST. 42b, syncline fold at ST. 42c and joints at ST. 5 and ST. 34.

Keyword: *fault, fold, joint, stress.*

1. Introduction

The study area is located at Western part of Kolok Mudik, Kecamatan Barangin, Kotamadya Sawahlunto, Sumatera Barat. Study area is bounded by longitude 100°41' 52,9737" N – 100°43' 30,3465" N and latitude 0° 37' 56,7542" E – 0° 38' 55,8050" E (Figure 1). The topography of Sawahlunto is hilly areas with elevation about 250 – 650 meters above sea level (Pebri aldi, 2015). The topography grown could be interpreted that on the study area be affected by tectonic activity such as fold or fault (Koesoemadinata and Matasak, 1981). Its can be seen from shape of river that nudge, indicated that river formed due to crack or fracture is relatively weak zone and then eroded along fracture (Fig 2). Hilly area would be described that this area has occured uplift and then formed a fold (Koesomadinata and Matasak, 1981).

The study area is within ombilin basin. Overall the strucuture of the basin ombilin showed transtensional duplex or pull apart duplex systems. Woodcock and Fischer (1986) said in Situmorang, et.,al (1991). subduction of geometry from duplex faults would be meet in sub basin became single shear zone.

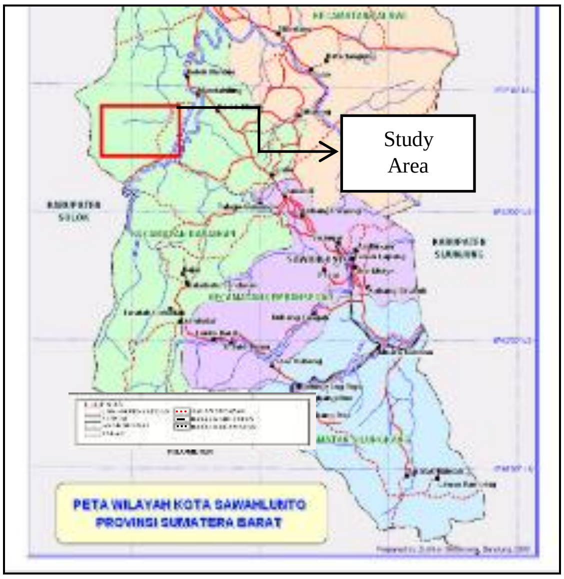

Fig 1. Map of the Sawahlunto city (Basmoera, 2008)

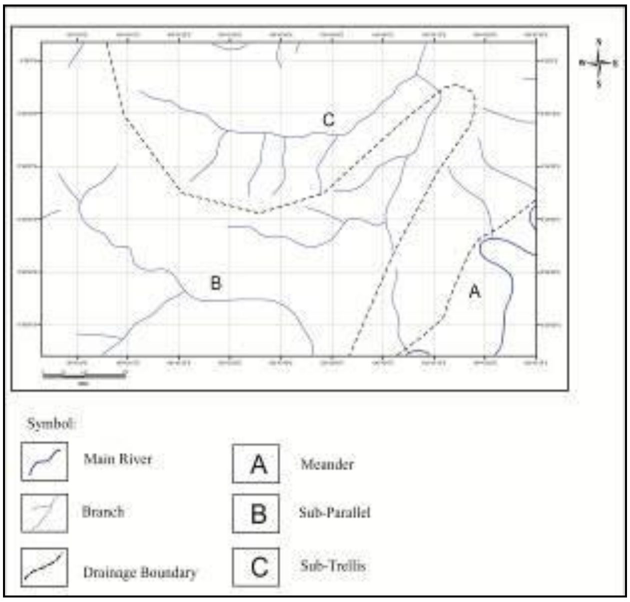

Figure. 2. Map of drainage in the study area; (A) Meander; (B) Subparallel; (C) Subtrellis

This condition is so different with the geological structure of the northern part of Central Sumatra Basin that was developing at the time of Neogen and asymmetrical shape that led northwest-southeast (NW-SE) which is a pattern of young structure (Kausarian, 2017).

2. General Geology and Stratigraphy

Based on Peta Geologi Lembar Solok (1995), the study area has two formation and one deposition, that are Silungkang Formation, Brani Formation and Porphyry Deposition. The Silungkang Formation there are andesit hornblende, andesit argit, meta-andesit with thin interbedded tuff, limestone, shale and clay shale (PH. Silitonga and Kastowo, 1995). There is also a Fusulinida fossil (Koesomadinata and Matasak, 1981). The Brani Formation there is conglomerate interbedded with sand. The Porphyry Deposition consist of porphyry quartz with quartz phenocrysts and feldspar (PH. Silitonga and Kastowo, 1995). Furthermore, wolud be found fractures on the body of rocks and alteration that happened on wall rocks (Berger, et.al,2008).

After observation on the study area, we found three formation, that are Silungkang Formation, Brani Formation and Sangkarewang Formation. Silungkang Formation consists of limestone with mudstone type, sandstone and conglomerate. On the Brani Formation there are conglomerate, sandstone and shale. Meanwhile Sangkarewang Formation consists shale, sandstone, slump and crossbedding.

3. Methodology

The methodology used in this research were literature review, field survey and stereonet analysis. The first literature review to known structure types on the study area. The study area in the field showed by plotting points to generate the geological mapping (Kausarian, 2016). After that field survey was done to get the data that needed to determine the direction of main stress from geological structure. The last analysis used streonet from the data. All of data has plotted on stereonet to get the direction of main stress at the study area (Adi Suryadi, 2016).

4. Geological Structure on the Study Area

4.1 Faults

Geological structures on the study area are faults, folds and joints (Fig 3). Indication of fault is difficult to found in the field, because the rocks on the study area have been a heavily weathering (Rizky prata, 2011; (Putra and Choanji, 2016). On the study area, there are three types of fault, these are reverse fault, normal fault and dextral fault. Reverse fault located in southwest the study area with value fault plane is N215oE/75oon station 2. Normal fault located at central of study area, these are in station 10 with direction N200oE and pitch 35o, station 56 and station 57 has same direction is N22oE. Dextral fault located in north of study area with pitch 10o. Fault would be known if we found indications in the field, like waterfall, displacement of bedding and slickenside etc.

4.2 Folds

On the study area were found four types of folds, there are anticline fold, syncline fold, chevron fold and overturned fold. The all of data would be plotted in stereonet to known the direction of main stress (Fig 5). Based on stereonet analysis result, there are three direction of main stress, those are Northeast – Southwest, North – South and Southeast – Northwest (Table 1).

4.3 Joints

On the study area, joints data took at southwest – north of the study area. Based on joints data that has been obtained and analysis used stereonet (Figure 6), there are three direction of main stress, Northeast – Southwest, North – South and Southeast – Northwest (Table2).

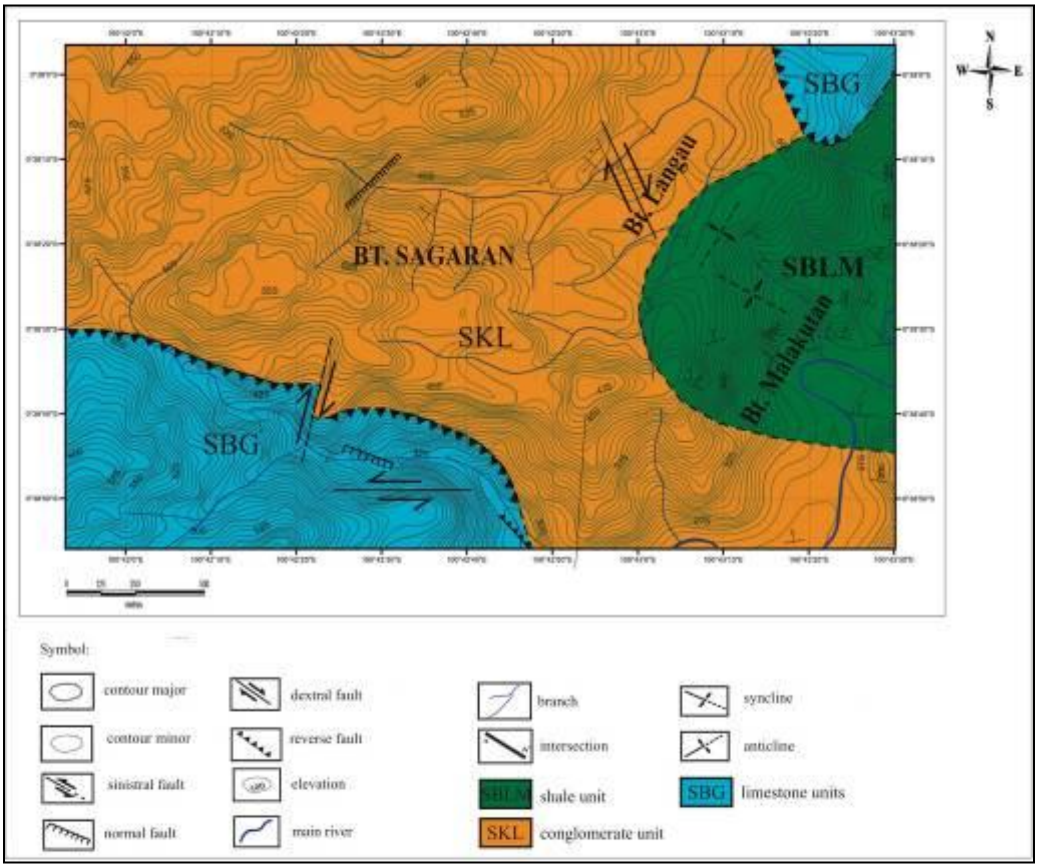

Fig 3. Geology map on the study area

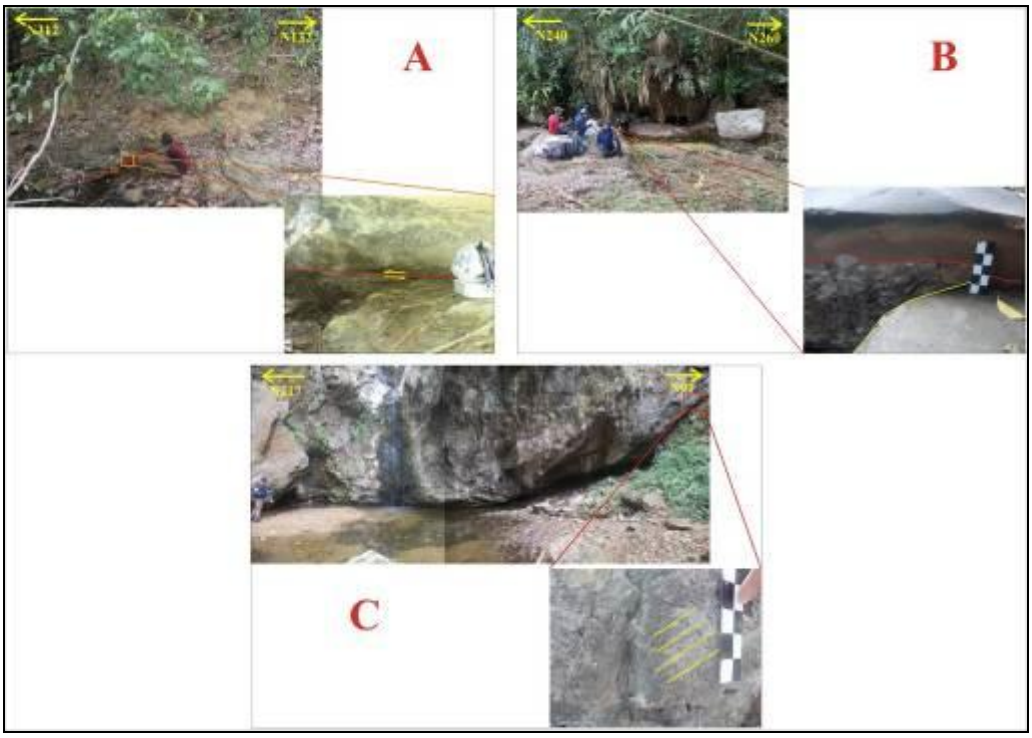

Fig. 4. (A) dextral fault; (B) reverse fault; (C) normal fault

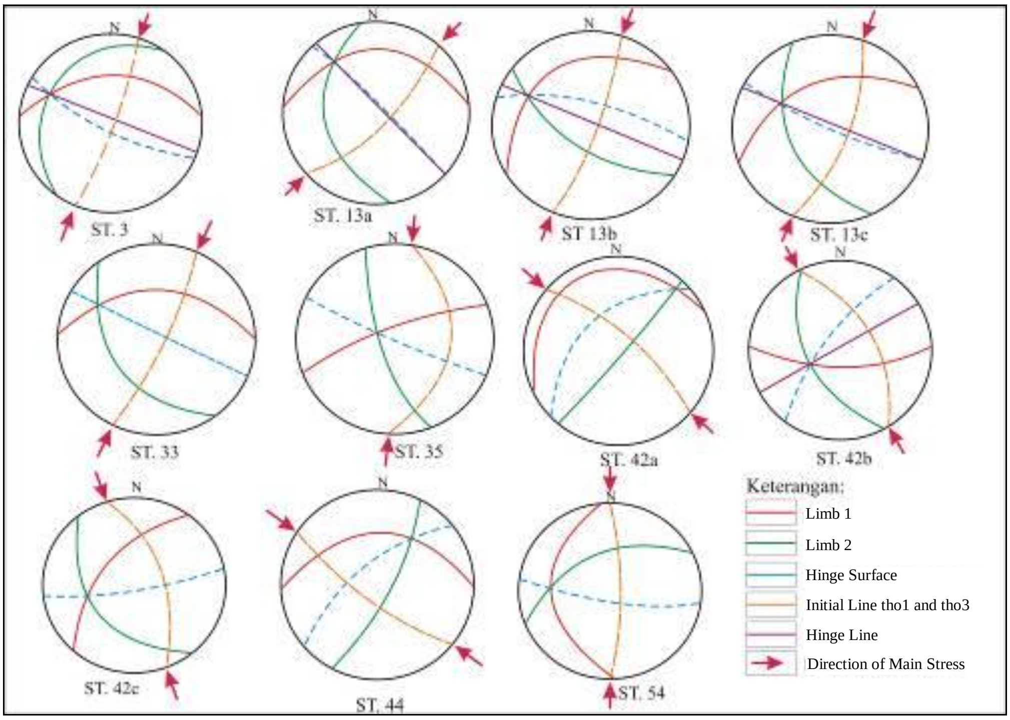

Fig. 5. Stereonet analysis of folds on the study area

Table. 1. Stress analysis result of folds

Station	σ_1	σ_2	σ_3	Hinge Line	Hinge Surface	Axis Surface	Plunge Axis Line	Directions of Major Stress
ST. 3	25°, N24°E	18°, N251°E	72°, N178°E	18°, N251°E	72°, N116°E	Steeply inclined fold	Gently plunging fold	Northeast – Southwest
ST. 13a	18°, N219°E	26°, N315°E	72°, N131°E	26°, N315°E	44°, N87°E	Moderately inclined fold	Gently plunging fold	Northeast – Southwest
ST. 13b	28°, N196°E	21°, N232°E	66°, N45°E	21°, N232°E	80°, N21°E	Steeply inclined fold	Gently plunging fold	Northeast – Southwest
ST. 13c	5°, N23°E	35°, N251°E	65°, N137°E	82°, N20°E	35°, N251°E	Moderately inclined fold	Vertical fold	Northeast – Southwest
ST. 33	3°, N204°E	21°, N256°E	80°, N126°E	21°, N256°E	80°, N114°E	Steeply inclined fold	Gently plunging fold	Northeast – Southwest
ST. 35	9°, N23°E	70°, N279°E	30°, N118°E	70°, N279°E	84°, N188°E	Upright fold	Steeply inclined fold	North – South
ST. 42a	51°, N140°E	5°, N225°E	44°, N329°E	5°, N225°E	46°, N186°E	Moderately inclined fold	Horizontal fold	Northwest - Southeast
ST. 42b	25°, N130°E	52°, N241°E	44°, N21°E	52°, N241°E	70°, N330°E	Steeply inclined fold	Moderately plunging fold	Northwest - Southeast
ST. 42c	12°, N349E	32°, N249°E	54°, N91°E	32°, N249°E	54°, N80°E	Moderately inclined fold	Moderately plunging fold	Northwest – Southeast
ST. 44	8°, N307°E	38°, N38°E	72°, N212°E	38°, N38°E	62°, N130°E	Steeply inclined fold	Moderately plunging fold	Northeast – Southwest
ST. 54	20°, N5°E	24°, N270°E	64°, N156°E	24°, 270°E	68°, N181°E	Steeply inclined fold	Gently plunging fold	North – South

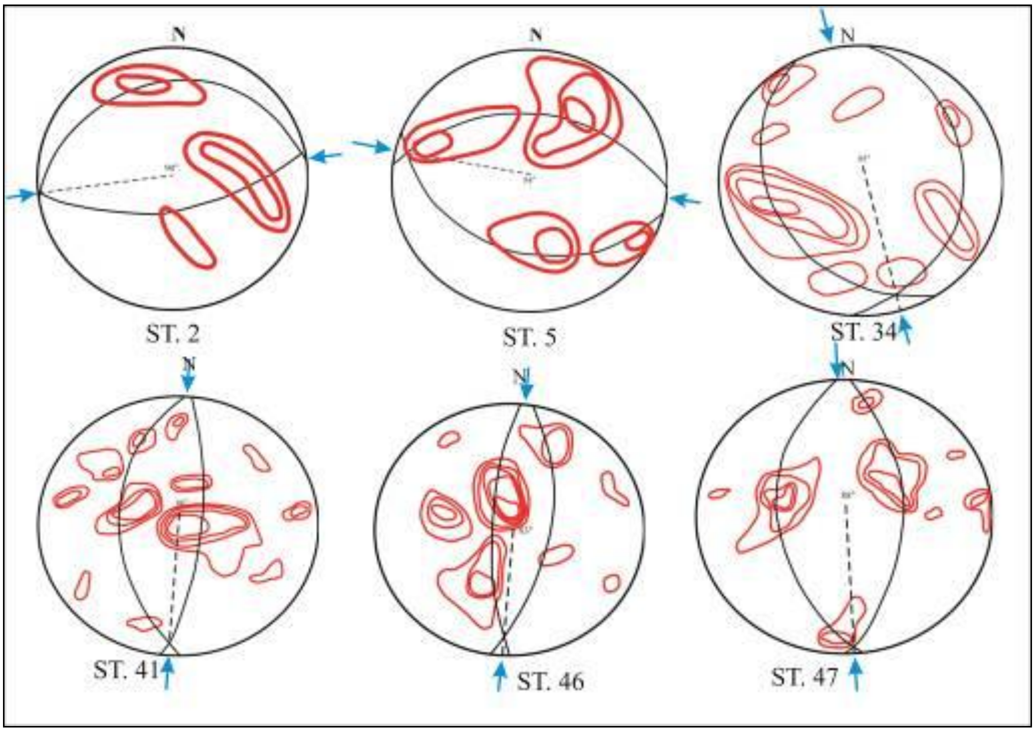

Fig. 6. Joints analysis used stereonet

Table.2.Stress analysis result of joints

Station	Direction of Main Stress
ST. 2	Northeast – Southwest
ST. 5	Southeast - Northwest
ST. 34	Northwest - Southeast
ST. 41	North – South
ST. 46	North – South
ST. 47	North – South

5. Discussion

Analysis result for folds and joints used stereonet, were met three main stress with direction, Northeast – Southwest (T1), North – South (T2) and Southeast – Northwest (T3). Northeast – Southwest (T1) main stress formed some structures, there are syncline folds, anticline folds, chevron fold and joint. North – South (T2) main stress generated some structures, there are syncline folds, anticline folds and joints. Southeast – Northwest (T3) main stress resulted three structures, there are chevron fold, overturned fold, syncline fold and joints.

Table.3.Stress analysis on the study areas

Stress	Direction of Main Stress	Station	Geological Structure
T1	Northeast – Southwest	ST. 3, ST. 13a, ST. 13b, ST. 13c, ST. 33, ST. 44 and ST. 2	anticline fold, syncline folds, chevron fold and joint.
T2	North – South	ST. 35, ST. 54, ST. 41, ST. 46 and ST. 47	anticline fold, syncline fold and joints
T3	Southeast – Northwest	ST. 42a, ST. 42b, ST. 42c, ST. 5 and ST.34	overturned fold, chevron fold, syncline fold and joints

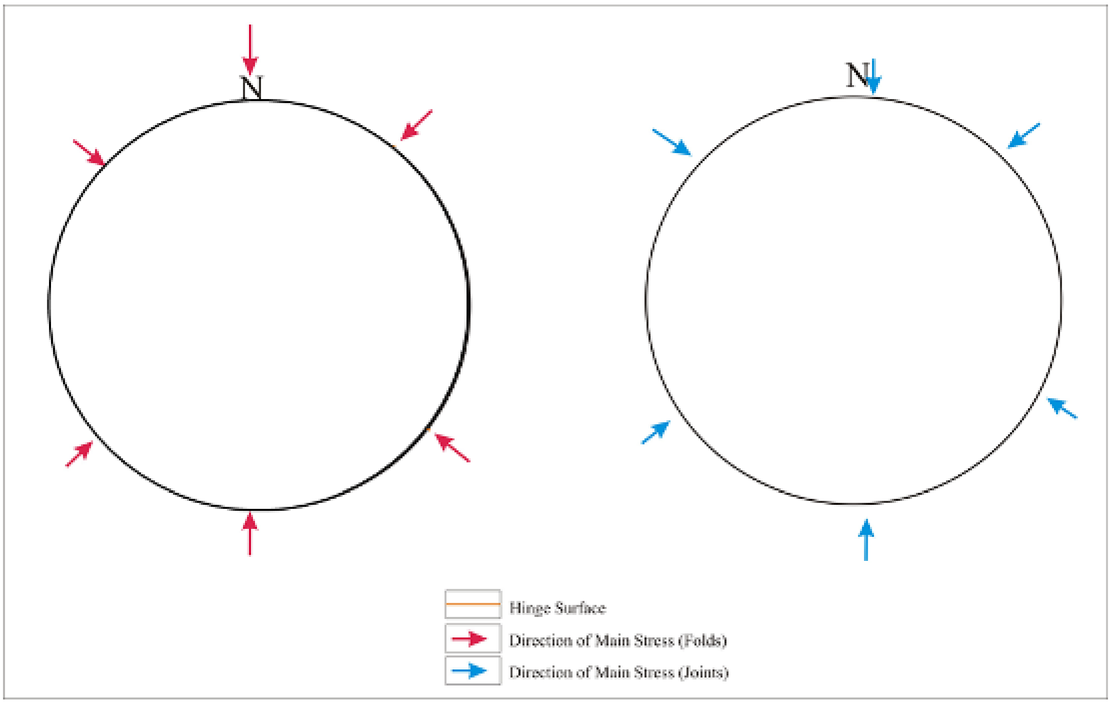

Figure. 7. Direction of main stress at study area

6. Conclusion

Based on analysis of geological structure were found three main stress that deform the geological condition of study area. The first stress is Northeast – Southwest (T1) this stress generated some structures, these are syncline folds, anticline folds, chevron fold and joint. Another stress is from North – South (T2) that resulted syncline folds, anticline folds and joints. The last main stress with direction Southeast – Northwest (T3) was form chevron fold, overturned fold, syncline fold and joints.

7. Acknowledgements

We would like to say thanks for our parents that always prayed us. For our advisor is Mr. Adi Suryadi, B.Sc(Hons)., M.Sc that has been faithful guided us until this paper finished. Don't forget for our instructures, are Adlan Rahmat, Arsyad and Yogi Aditya that always have companied us when we are collected data in the field.

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