GE-P-1

TECTONIC EVENT TRAILING BASED ON FAULT GENERATED FRAGMENTS OF WATURANDA FORMATION, WADASMALANG, KARANGSAMBUNG, CENTRAL JAVA

Satrio Esti Hapsoro [1], Hanif Ibadurrahman [1], Muhammad Gazali Rachman [1], R.Imam Rahmadi Pratama [2], Alfathony Krisnabudhi [2], Bayu Rahmanto [2]

[1] GeoPangea Research Group (GPRG) Indonesia , website : gprgindonesia.wordpress.com
[2]Dept. Geology of University Pembangunan Nasional ”Veteran” Yogyakarta Indonesia

Abstract

Waturanda Formation, a member of Old Andesite Formation-first breccias, consists of Oligo-Miocene volcanic clastic rock. It can be found in the South Serayu zone, part of the Karangsambung complex, Central Java. It formed by a Neogene Compressional Wrenching tectonic phase which caused a volcanic belt in southern Java. This formation consists of foreign fragments. The provenance of these fragments is approximately pre-tertiary age which equivalent to tectonic mélange rocks Karangsambung.

Petrology and tectonic studies were based on paleogeographical investigations from structure analysis and petrographic thin section. There are 2 faults cut both pre-tertiary and tertiary rocks. It indicated as the main factor for the variety fragments in Waturanda formation. The deposition of Waturanda Formation occurred when the Tertiary orogenesis, whereas maximum uplift of Mélange Luk-Ulo and deposition of Waturanda Formation in South Serayu Zone occurred constantly at the same time.

Based on petrographic analysis of 20 samples, northern part of Waturanda Fm consists of crystalline rock fragments such as phyllite, quartz, slate, and deep marine sedimentary rock-chert associated with red limestone which controlled by fluxoturbidite deposition in the fore arc. Foreign fragments associated with mud > 55% showed that this formation hypothetically related with depth changes which caused by west-east structure pattern, Oligo-Miocene tectonic phase and reactivation of northeast-southwest structure pattern known as Meratus pattern. Supported XRD analysis (Shimadzu MAXima_X XRD-7000), trace minerals such as Tantalum Oxide (TaO2) and Tin Dioxide (SnO2) in breccia sample. They formed in high temperature and indicating the tectonic environment origin from post-collisional and post-orogenic or associated with extensional regime of the main tectonic.

Waturanda Fm assumed to be affected by basin subsidence caused by normal fault contact. It triggered a change of morphology between tectonic mélange and olistostrom mélange to fore-arc basin. Sediment from both mélange products deposited in the local basin or sub-basin.

Keywords: Normal fault contact, Paleogeography, Provenance, Petrography analysis, Waturanda Fm

Introduction

Karangsambung area is one of the most geologically unique area where the cretaceous basement of Java Island to the most recent rocks exposed to the surface (Asikin et al, 1991 in Prasetyadi 2007). Waturanda Formation with many variety of fragments will be the focus of this study. Physiography of Waturanda Formation is located in South Serayu depression zone (Van Bemmelen, 1949). This formation consist of Early Miocene volcanic rocks (Asikin, 1992) which is well known as Old Andesite Formation (OAF) in South of Java Island. The fragments of this formation are varied, such as andesite-basaltic igneous rock, pelagic sedimentary rock, and metamorphic rocks which the provenance in the fore arc area dominantly controlled by fluxoturbidite. In tectonic point of view, Waturanda Formation is controlled by Neogene Compressional Wrenching which caused by subduction south of Java Island. South Serayu depression zone also affected by maximum uplift from strong isostatic effect in Miocene-Pliocene (Satyana and Purwaningsih, 2002). In central Java,it is affected by imbrication structure which could be seen by the narrowing in north and south area of South Serayu depression zone. The relation of Waturanda formation fragments and the tectonic event will be the main focus of this study.

Methods

Literature studies of Karangsambung and specifically Waturanda formation combined with detail geological mapping of 4 x 5 km^2 in Wadasmalang area had been done. It supported by structural geology analysis, petrography of selected outcrop samples to find out the mineral content and XRD analysis (Shimadzu MAXima_X XRD-7000) to identified the provenance, geochemistry and also tectonic setting based on fragments of Waturanda formation. The analysis had been done in Geotechnology LIPI Bandung. The result of the analysis will be combined to have a better understanding of tectonic event in South Serayu depression zone, specifically in Waturanda Formation.

Stratigraphy of Wadasmalang Area

Based on micropaleontology analysis of Blow classification (1969), Wadasmalang is a contact zone between early Miocene Waturanda formation (Asikin, 1992) and middle-late Ponosogan. Lower part of Waturanda formation consist of breccia with varied fragments and gradually change into masif sandstone to shale (Figure 1). Based on profile analysis, the depositional environment of Waturanda Formation is a fluvial-marine which controlled by turbidity current showed by suspension, loading and erosional sedimentary structures from the turbiditic process (Figure 1).

Petrography Analysis and Geochemistry

Petrography analysis from 20 selected samples of Waturada Formation were used to figure out fragment distribution and tectonic setting. In petrography analysis, some variety of fragments could be distinguished. Fragments from volcanic process with extrusive igneous rocks and andesite-basaltic characteristic can be identified by amigdaloid secondary minerals. In some samples, foreign fragments could be found from metamorphic rock and pelagic sedimentary rock such as polycrystalline quartz which also deposited in Waturanda formation (Figure 2). Samples were taken from study area have mud-supported clast with >55% mud content which indicate this formation deposited in high density current. Geochemistry of Waturanda indicating the chemical of typical igneous rock from continental crust (Table 1). The chemical composition could be interpreted clearly from 3 samples. Based on XRD analysis, trace mineral such as Tantalum Oxide (TaO^2) and Tin Dioxide (SnO^2) in breccia sample from sample observation location 6. These mineral formed in a high temperature and indicating the post-collisional and post-orogenic or associated with extensional regime of the main tectonic (Kuster., 2009 dalam Pollard. 1989).

Provenance Analysis of Waturanda Formation

Provenance analysis was conducted to find out the tectonic environment where the provenance was deposited, some parameters were used to support this study, such as (1). Feldspar Quartz, Lithic (2). Monocrystalline Quartz, Feldspar, Lithic (Dickinson and Suzcek., 1979) in 15 petrography samples of Waturanda formation. By using parameter number 1, the provenance originated from recycled orogen-magmatic arc. Provenance derived from recycled orogeny dominated by slate, phyllite, quartzite, chert which grouped into metamorphic rock and pelagic sediment, whereas the provenance derived from magmatic arc (dissected-transitional arc) dominated by fragments from basalt-andesite igneous rock (Figure 3a). By using parameter number 2, the provenance originated from recycled orogen (transitional-lithic recycled) with slate, phyllite, quartzite, chert fragment and magmatic arc (dissected-transitional arc) with basalt-andesite (Figure 3b). Based on the provenance analysis, the provenance of tectonic environment recycled orogeny originated from Mélange Luk-Ulo Karangsambung, northern part of Waturanda formation, whereas the provenance of magmatic arc group originated from volcanism.

Identification of Tectonic and Structure Analysis

The lineaments from DEM (Digital Elevation Model) map used to make structural geology interpretation of South Serayu Zone to be specifically in Wadasmalang area. There are 3 main structural trends could be distinguished in this study area, NE-SW (Meratus Trend), SE-NW (Sumatra Trend) and N-S (Sunda Trend) (Figure 4). All of the structural trends are related to the indentation in southern Central Java where 2 major faults which are dextral strike slip fault Pamanukan-Cilacap (PCFZ) and sinistral strike slip fault Progo-Muria (PMFZ). These 2 major faults caused maximum isostatic uplift in Luk-Ulo complex and Karangbolong high (Satyana and Purwaningsih., 2002). This Tertiary orogenesis still occur in Miocene-Pliocene which at the same time Mélange Luk-Ulo complex was uplifted to 2000 meters high (Untung and Sato, 1978 in Satyana and Purwaningsih, 2002) in late Miocene with constant tertiary volcanism. Tectonic process generated E-W trend fold and thrust, reactivation of old structures in Kebumen Low and N-S new trend from the extensional force. South Serayu depression zone (Figure 5) which interpreted as oblique normal and normal fault. These faults cut both pre-tertiary and tertiary rocks (Asikin dkk, 1992 in Prasetyadi, 2007) and interpreted as the main factor for the variety fragments in Waturanda formation. The deposition of Waturanda occurred when the Tertiary orogenesis, maximum uplift of Mélange Luk-Ulo and sub-basin subsidence from Waturanda formation in South Serayu depression zone occurred constantly at the same time.

Discussion and Results

Based on fieldwork and studio analysis, 2 groups of fragment were classified as alochton and autochthon. Alochton group consist of metamorphic rocks, such as phyllite, slate, quartzite which origin from northern high, Mélange Luk-Ulo. There are also pelagic sediment, such as polycrystalline quartz and chert, also supported by provenance analysis from Dickinson and Suzcek (1979) which stated that alochton fragment originated from recycled orogen (Figure 3). Autochthon fragment consist of basalt-andesite igneous rock which are typical products of Old Andesite Formation volcanism from magmatic arc tectonic environment (Figure 3). All of the petrography analysis were conducted from 20 samples (Figure 2). Based on XRD analysis, typical feldspar from igneous rock is dominant and trace mineral could be found in the samples, which conclude that the fragment is older than the Waturanda formation. Waturanda formation was deposited in a high density current, indicated by >55% mud content in petrography analysis (Figure 2) and based on profile analysis, this formation is a turbidity deposit affected by slope morphology of volcano which can be proved by sedimentary structures on outcrop, such as suspension, loading and erosional sedimentary structures from the turbidity current (Figure 1).

As for structural geology, the main role is indentation structure where Mélange Luk-Ulo was uplifted 2000 meters in late Miocene by tertiary orogenesis (Untung and Sato, 1978 in Satyana and Margaretha, 2002) and causing chain reaction of old structures reactivation and formed N-S new structures from extensional force that cut through old structures of South Serayu depression zone (Figure 6) in Neogen Compressional Wrenching tectonic phase.

Conclusions

Waturanda formation has 2 groups of fragment, (1). Alochton, originated from Karangsambung basement with recycled orogeny tectonic environment. (2). Autochthon, originated from Old Andesite Formation volcanism with magmatic arc tectonic environment and deposited at the same time in fluvial-marine environment by a turbidity current. The fragment variety caused by indentation in Southern Central Java. The indentation reactivated old structures and formed N-S new structures as the result of extensional force. This N-S new structures interpreted as oblique normal and normal fault. Both faults are the main factor behind the variety of fragments in Waturanda formation. The moment Waturanda formation was deposited, Mélange Luk-Ulo was maximum uplifted in tertiary orogenesis and sub-basin subsidence from Waturanda formation in Southern Serayu depression zone occurred at the same time as constant Compressional Wrenching in Neogene tectonic.

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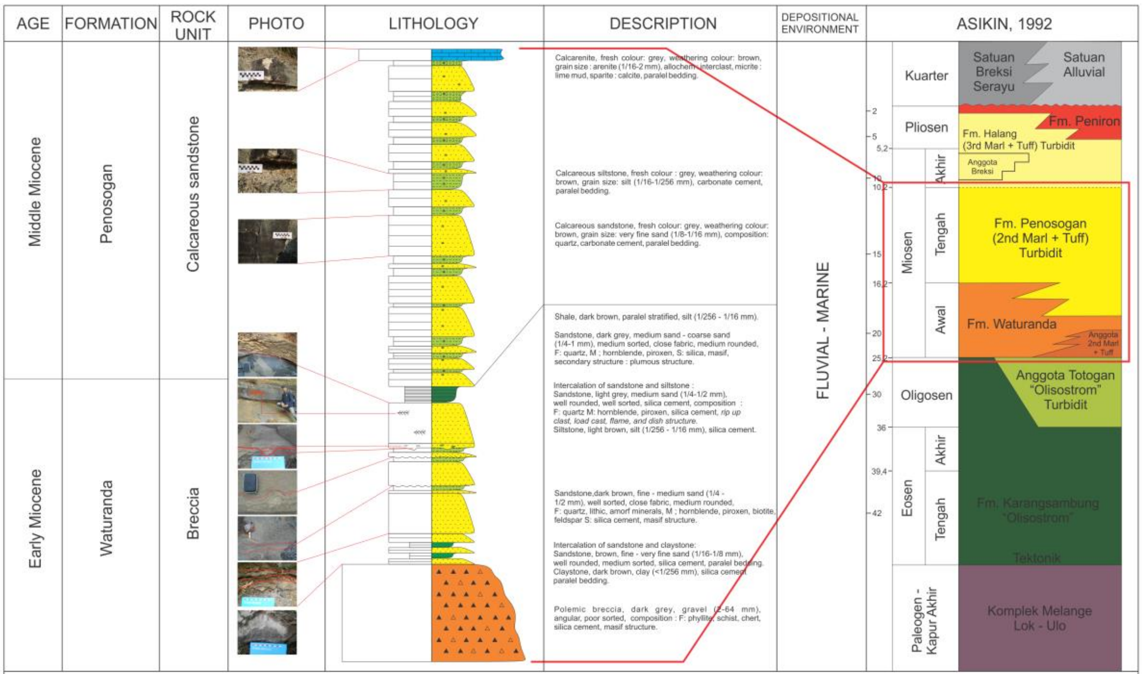

Figure 1. Stratigraphic propotionality column from analysis result with stratigraphy of Karangsambung complex according Asikin, 1992.

Table 1. The result analysis of the chemical contetns of mineral with XRD of the 3 sample : (a) Stopsite 4C Shale, (b) Stopsite 6 Polemic Breccia, (c) Stopsite 13 Polemic Brreccia.

Sample Rock Type		Lp 4C Shale	Lp 6 Polymic Breccia	Lp 13 Polymic Breccia
Mineral Group (wt %)	Chemical Formula			
Feldspar Group	Na(Si3Al)O8 albite, disorde	0.756	0.871	0.868
	Na(Si3Al)O8	0	0.767	0
	Ca3(Fe,Ti)2[(Si,Ti)O4]3	0	0.643	0
	Ca0.1Fe2(Si,Al)4O10(OH)2.4H2O	0	0.468	0
	Na0.3(Al,Mg)2Si4O10(OH)2.xH2O	0.587	0	0.754
	Na(Si3Al)O8	0	0	0
HFSE Group	ZrO2	0	0.693	0
	Zr	0	0	0.459
LILE Group	PbS	0	0.493	0
	BaZrO3	0	0.515	0
MRFE Group	FeO	0.713	0	0
	CuZn	0.597	0	0
	SiC	0	0.755	0
	AlB2	0	0.682	0
	NiFe2O4	0	0.761	0
	Si	0	0	0.651
	Fe3O4	0	0	0.61
	Fe3N	0	0	0.781
Rutil Group	SnO2	0	0.653	0
Niobium Group	TaO2	0	0.759	0
(yellow)	Trace Minerals			

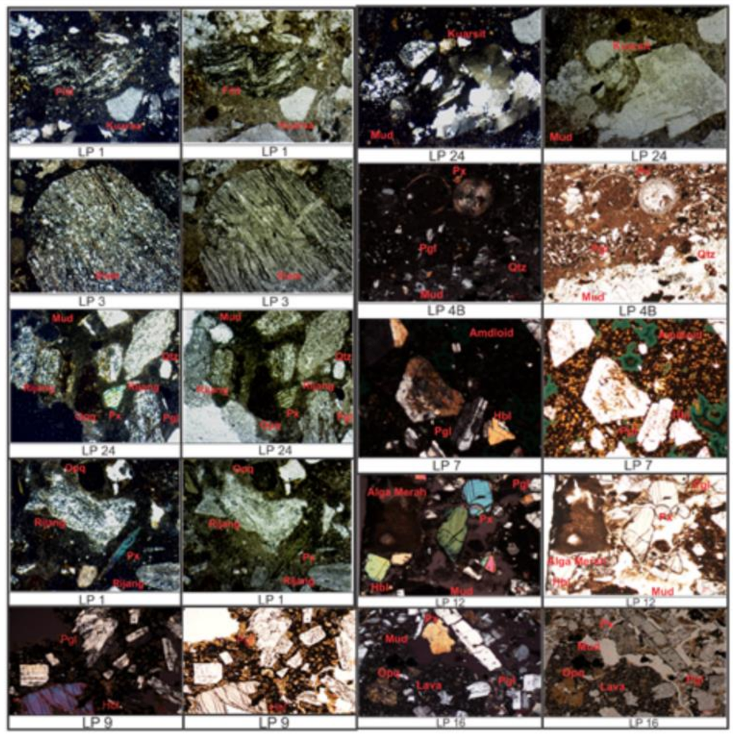

Figure 2. Thin section of Waturanda Fm. with the fragment consisting of metamorphic rock, igneous rock, and sedimentary rock (the right side is parallel nikol and the left side is cross nikol).

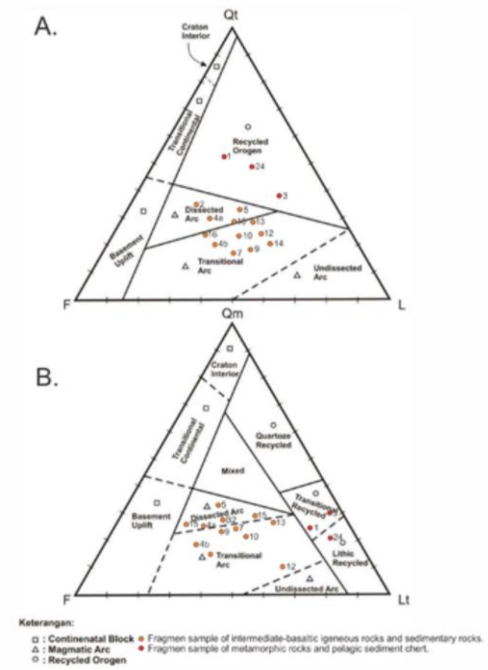

Figure 3. Provenance analysis of Waturanda Fm. using 15 sample with parameter : (1) Quartz, (2) Feldspar, (3) Lithic (Dickinson and Suzcek 1979).

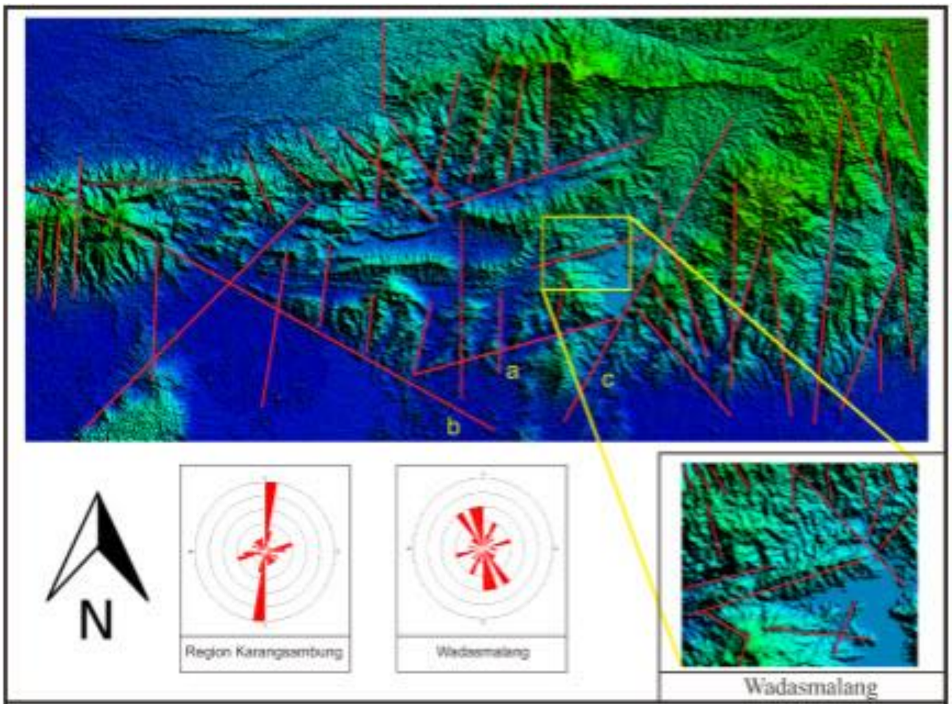

Figure 4. Geological structure lineament analysis map with 3 main structure pattern, (a) North - South, (b) Southeast - Northwest, (c) Northeast - Southwest Wadasmalang area, Karangsambung

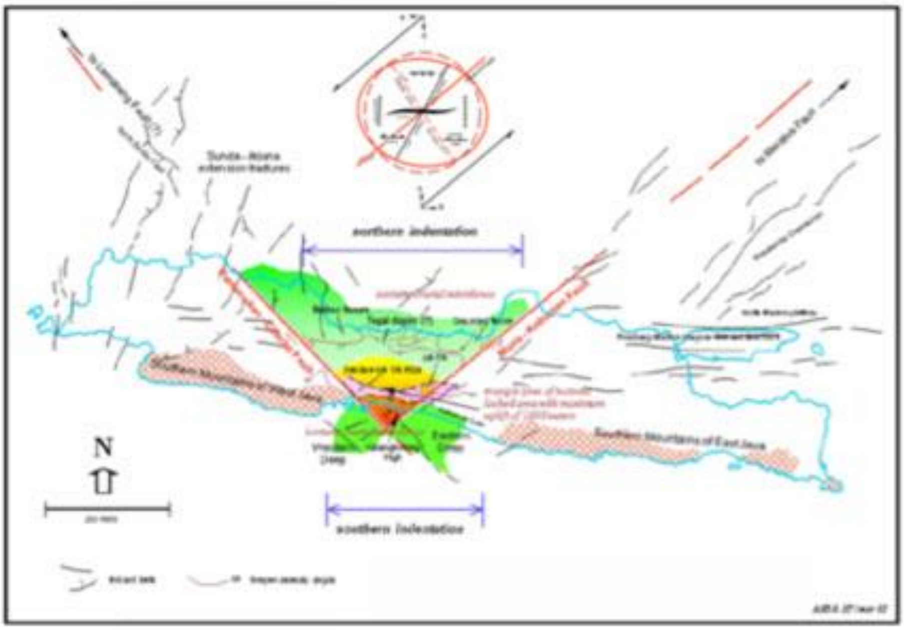

Figure 5. Structural map of Java Island and strain elipsoid which showing chain effect from the structure indents at Central Java specially Lok-Ulo basement and South Serayu depresion zone (figure by Satyana and Purwaningsih, 2002).

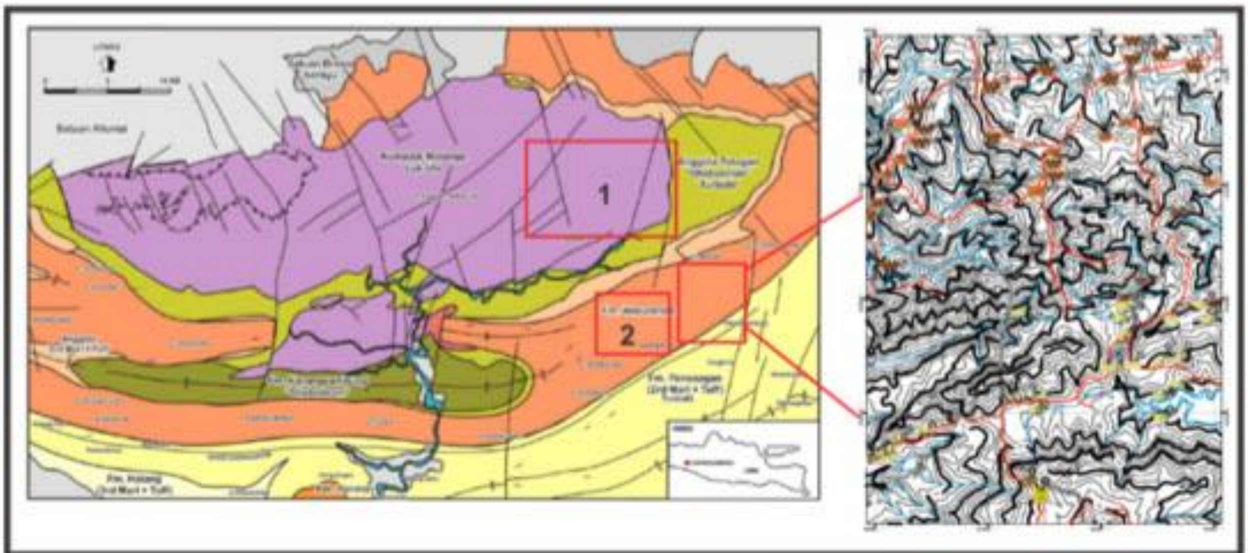

Figure 6. The left side : geological map of Lok-Ulo area (Modification from Asikin, 1992 and Condon, 1996).
(1) Alocton fragment from Melange Lok-Ulo with tectonic environment recycled orogen.
(2) Autocon fragment from Old Andesite Formation with tectonic environment magmatic arc.
The right side : observation map Wadasmalang area, Karangsambung.