CHAPTER VI

RESULTS

In this chapter, concentration is paid on the magnetic components and results from demagnetization. In addition, paleomagnetism results are described in details.

Magnetic Components

Based primarily upon demagnetization behaviour, magnetic components were determined for all Phu Thok samples. The characteristic features were mainly defined from intensity plots and significantly supported by stereo and zijderveld plots. All data and results are represented in Appendix E.

Thermal demagnetization of all specimens from 140 samples suggests the various patterns of these plots which are inferred not effected by difference in grain-size of sandstone strata. The plots are effected mainly by types of magnetic components (see also McElhinny, 1973, Collinson, 1983, Tarling, 1983 , Cox, 1986, Maranate and Vella, 1986 and Bhongsuwan, 1993). Generally, the overall magnetic components are commonly separated into 2 types (Irving and Opdyke,1965, McElhinny, 1973). One involves the thermally discrete components which are very great stability and remain unchanged up to temperatures near the Curie point, whist the other includes thermally distributed components which are those whose properties are defined by a series of blocking temperatures. The latter are the less stable components which are the more capable of acquiring secondary component of magnetization.

In this study, thermally distributed components are common in the rocks. It is herein referred to remagnetization of secondary magnetization on the original magnetism. The other remagnetization detected involves the laboratory-induced component after heating at the very high temperature (near the Curie point of primary magnetic minerals) which usually created the new magnetic vector (Briden, 1965 , Tarling, 1983).

In this investigation, the magnetic components in the rocks can be divided into 3 types; primary (or C) , secondary (or A & B), and laboratory-induced components.

1. Primary magnetic component

The first component generally varies from 0° to 680°C or sometimes up to 730°C. The typical graph is characterized by the constant intensity of remanence magnetism at demagnetization steps below the Curie point (M/Mo), called as component C (Fig. 6.1) and steeply drops in intensity near zero at Curie temperature. Direction of the primary magnetism in zijderveld plot is constant for each stepwise of demagnetization. The other pattern is the continuously gradual decreasing of remanence magnetization starting from room temperature up to above the Curie point (Bhongsuwan, 1993). Because the primary component is eliminated at high demagnetized temperature. Therefore, it is defined to high temperature components or component C.

The primary component of the Phu Thok rocks is divided into 2 types based on the Curie points at 450° to 550° C (or component C_1) and 600° to 730 °C (or component C_2). The first type, or component C_1, refer to magnetite or titanomagnetite whereas the second type, or component C_2, corresponds to titanohematite or hematite, and both are the primary magnetic carrier (Tarling, 1983). Component C is composed of 40 to 95% NRM. The association of both high temperature components is also encountered in some samples (e.g. no. 38009b).

The widespread occurrence of detrital primary magnetic components, therefore, supports the idea that the primary magnetism in the Phu Thok rocks is assumed to be detrital remanent magnetization (DRM).

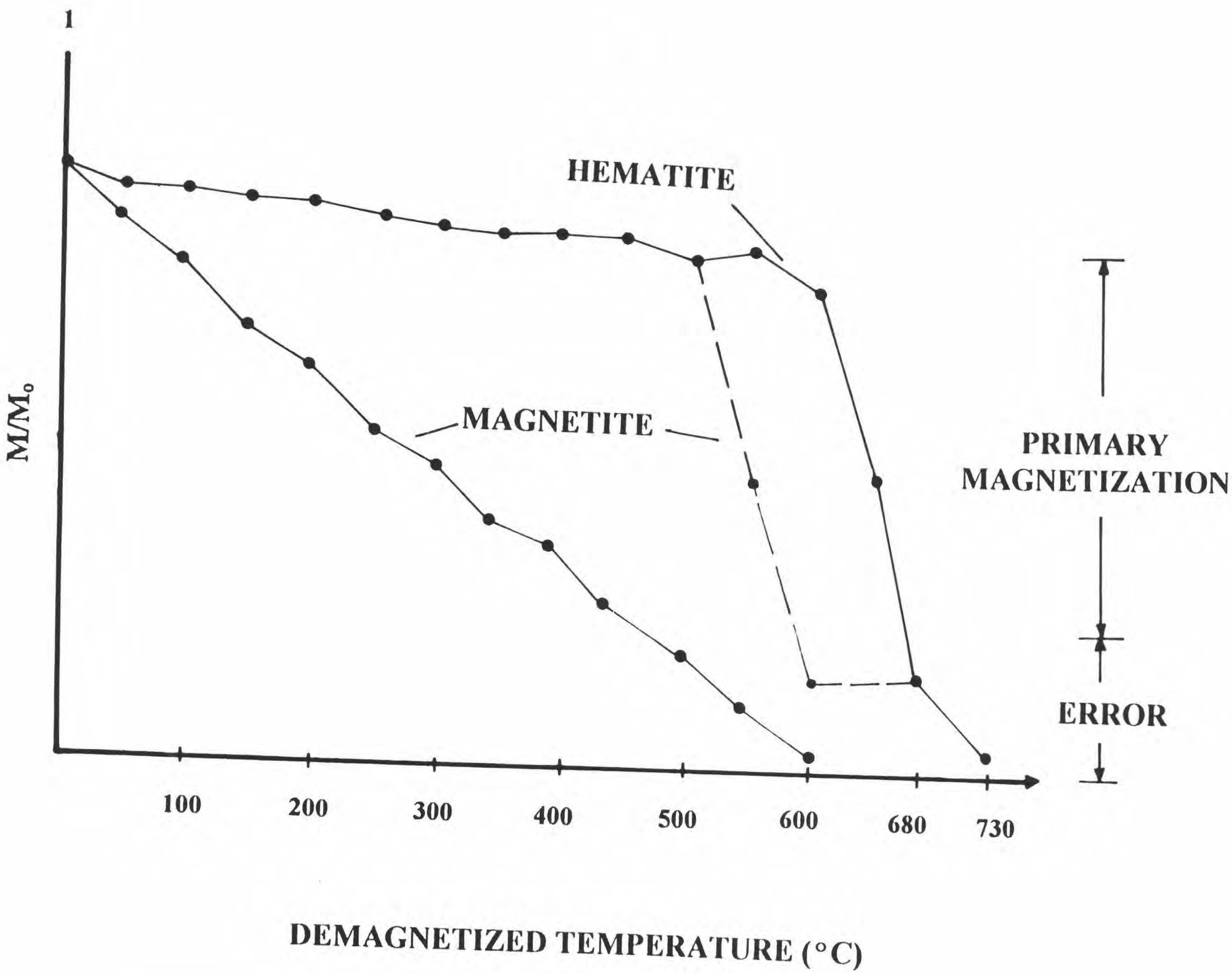


Figure 6.1 Typical feature of primary component (or component C) in intensity plot.

2. Secondary magnetic component

Secondary components is represented by the gradual decrease in intensity at the low- to medium- demagnetized temperature steps. They are suggested by fluctuated slopes of intensity graph. Moreover, the various directions of the combination of several magnetic vectors in zijderveld plot are recognized in individual stepwises of low demagnetized temperature. In the study, secondary magnetism in the rocks ranges from 100° to 400°C or sometimes up to 600 °C. Temperature steps of remagnetization intensity of various secondary components are shown by Figure 6.2. These secondary components are distinguished into 3 types - very low-, low-, and medium- temperature components.

A. Very low temperature component

In the study, this component which is defined herein as component A is formed by ambient magnetic field. It occurs from the reprints of the present geomagnetic field on the rocks samples after collection. The component A comprise 0 to 35%. The value of its mainly depends on the time range after sample collection and may depended upon values of remanent magnetism in the rocks (McElhinny,1973). The ambient magnetic-field component occurs at the room temperature, therefore the demagnetized temperature of this component is limited to 100 °C. The intensity plots of samples with this component illustrate the very rapid increasing or decreasing of NRM values after demagnetization in the step 100 ° C. Direction of the component A is normally E-W and N-S.

B. Low temperature component

This component, or the so-called component B_l, occurs from the remagnetization of goethite, which is found to reprecipitate from iron oxide. The

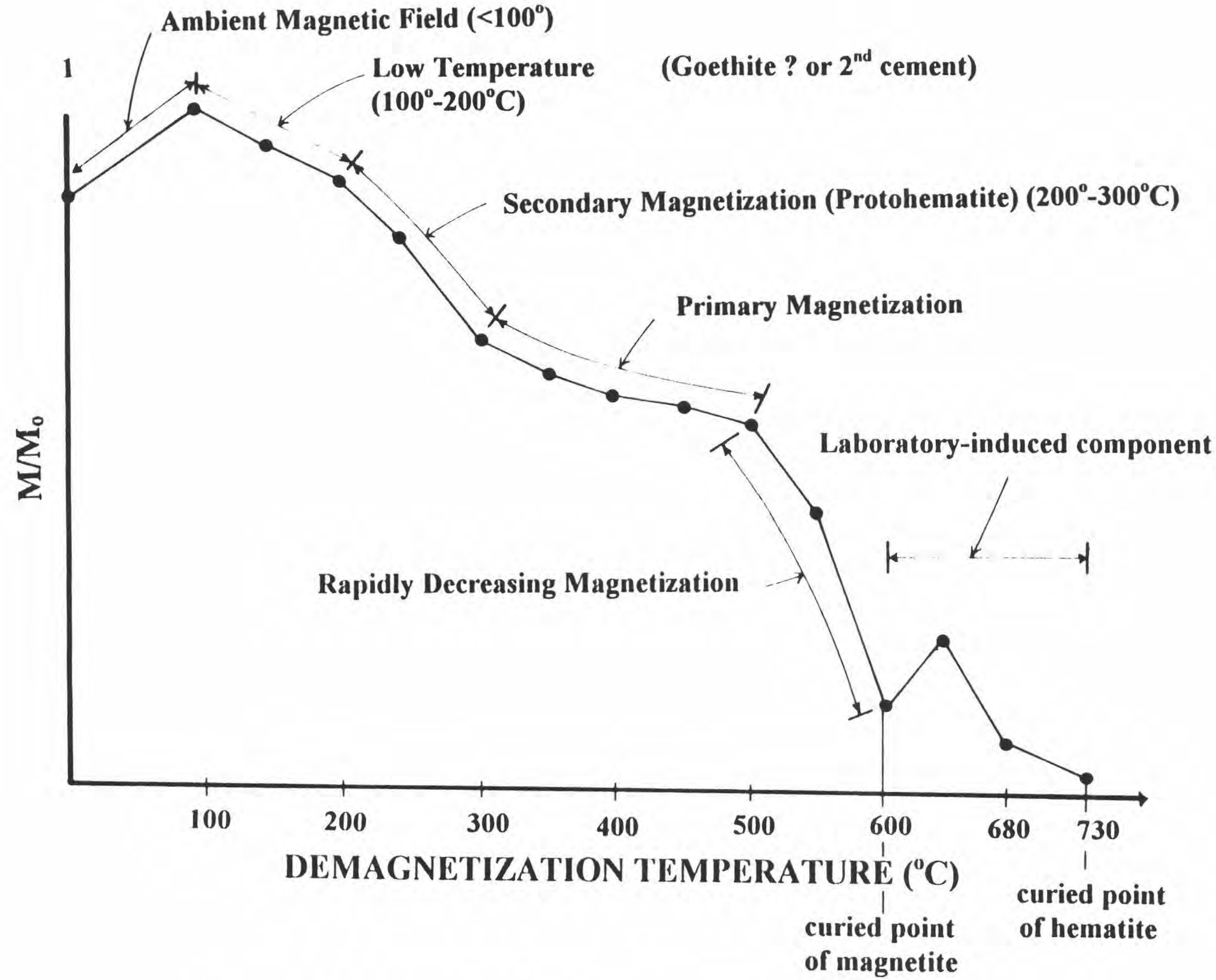


Figure 6.2 Typical feature of secondary component (or component A and B) in intensity plot.

temperature of goethite occurrence as suggested by Tarling (1983), is about 60° to 170° C. Component B_1 is mixed with less than 25% of NRM. The rapidly gradual decrease of intensity with increasing temperature between 100° to 200°C or up to 250 °C in some cases, is assumed to have formed as a result of the contamination of NRM by component B_1. Thus, magnetic vectors of component B_1 differ from the primary magnetization, and are mostly in N-S and E-W directions.

C. Medium temperature component

Tarling (1983) suggested that this component or regarded herein as component B_2, occurs as a result of remagnetization of protohematite or secondary hematite crystals which are dehydrated from goethite or altered from magnetite. The temperature of hematite occurrence varies from 200 to 290 °C or up to 550 °C (Hedley, 1968, Tarling, 1983). In the Phu Thok rocks, composition of the component B_2 ranges from 10 to 80% NRM. The slowly gradual decrease of intensity with increasing temperatures between 250° and 300 °C or to 450 °C or even up to 600°C is regarded to be the mixture of this secondary component with primary (or high temperature) component. Zijderveld plot (Fig no.135-37-45A in Appendix E) is quite essential to identify the component B_2 . In this study, the component B_2 which reprinted the samples is approximately in the N-S direction.

3. Laboratory-induced component

The error of data can be recognized by the overprint of new magnetism. The main cause of the higher appreciated demagnetized temperature on the samples (Briden,1965, Tarling, 1983, and Maranate,1982). The few values of primary magnetism after demagnetized are unstable. Therefore, the magnetism of created magnetic field from the instrument can reprint on the primary magnetism. Laboratory-induced components are presented at demagnetized temperature near the Curie point. After remanence is below 10% NRM so the magnetic vector is then infilled by laboratory magnetic vector. Reverse direction from the remanence magnetism is therefore encountered in the laboratory. However, in the low-magnetic intensity samples, especially those lower than 0.7 mA/m, the induced components may occur at demagnetized temperature in step 450°C or down to 100 °C.

Demagnetization Results

Results of demagnetization of individual specimens suggest that the 10 specimens from total 361 specimens or approximately 2.5% are resigned. It may be caused by the unstability of remanent magnetization. The description of data is concentrated especially on the paleomagnetic data of 89 progressive demagnetized specimens. In this investigation, various features of magnetism in the rocks are discussed. However, the typical features of the primary component types of rock magnetism can be used to classify the data into four magneic carriers.

1. Hematite carrier

This group is characterized by a steep drop in intensity of remanence high temperature component at a temperature of 600° to 730°C. This is probably indicated that the hematite (or titanohematite) is the primary magnetic mineral (or component C_2). The 50 specimens from 89 progressive demagnetized specimens are included in this behaviour. Based on demagnetized behaviour (Figs. 55-37-1A, to 353-W62A, 34-37-13A to 264-37125A, and 142-37-48A to 331-W54A in Appendix E) , the hematite carrier can be further divided into 3 patterns.

A. The first pattern

This demagnetized pattern is detected from 23 specimens (such as 31069d, 31070d, 31072a, 31074d, 31083b, 31085d, 37001a, 37007a, 37009a, 37015b, 37025a, 37035a, 37037a, 37045a, 37046c, 37050a, 37052b, 37056a, 37119a, 37155a, 37159a, 37162a and 38011a). These specimens reveal nearly constant intensity over 80% of remanence at the temperature below 600° to 650°C or 680°C to

730°C (Fig. 6.3a). The slightly fluctuated intensity is revealed at temperatures about 150° to 300 °C. Direction of magnetism is also slightly changed from NNE to NE at temperatures up to 250° to 350°C. It is recognized that few values of secondary magnetization (component B) are often presented at temperature below 350 °C. Then, a steep drop in remained intensity is observed at demagnetized temperature above 650°C (suggesting the hematite component) or drops slowly to 60 to 70% NRM at temperature up to 600 °C and steeply drop to below 10% NRM at temperature about 680° C (suggesting titanohematite-hematite component). It is noted that few specimens (as nos. 37035a and 37052a) display the overprint of component A (50% of NRM), suggesting that three components are acted upon the rock magnetism.

B. The second pattern

This pattern is revealed in 11 specimens (as nos. 31080d, 31081d, 31084d, 37013a, 37014a, 37054a, 37111a, 37125a, 37146a, 37161a, 38007b and 38012b). Generally, the two components usually occur in these specimens. The pattern shows a fluctuated decrease in intensity ranging from 100° to 450 °C, and the remained intensity of less than 50 to 65% NRM drops to below 10% at temperature above 550° to 600° C or 650 °C (see Fig. 6.3b). Some samples establish the component A, suggesting the presence of three components. The component A is always shown by a strong change in intensity at temperature below 100 °C. It is noted that the direction of magnetism is changed dramatically from east to north at demagnetized temperature above 150 °C and shift to NE at above 450 °C.

C. The third pattern

The third characteristic magnetism is shown by the other 11 samples (including nos. 31077d, 37008a, 37020a, 37027a, 37048a, 37058e, 37113a, 37115a, 37130a, 37152a and 37154a). This pattern is usually composed of three components. Component A is presented at about 15 to 25% of NRM intensity, as suggested by a sharp drop of intensity at temperature about 100 °C and the direction of magnetism is

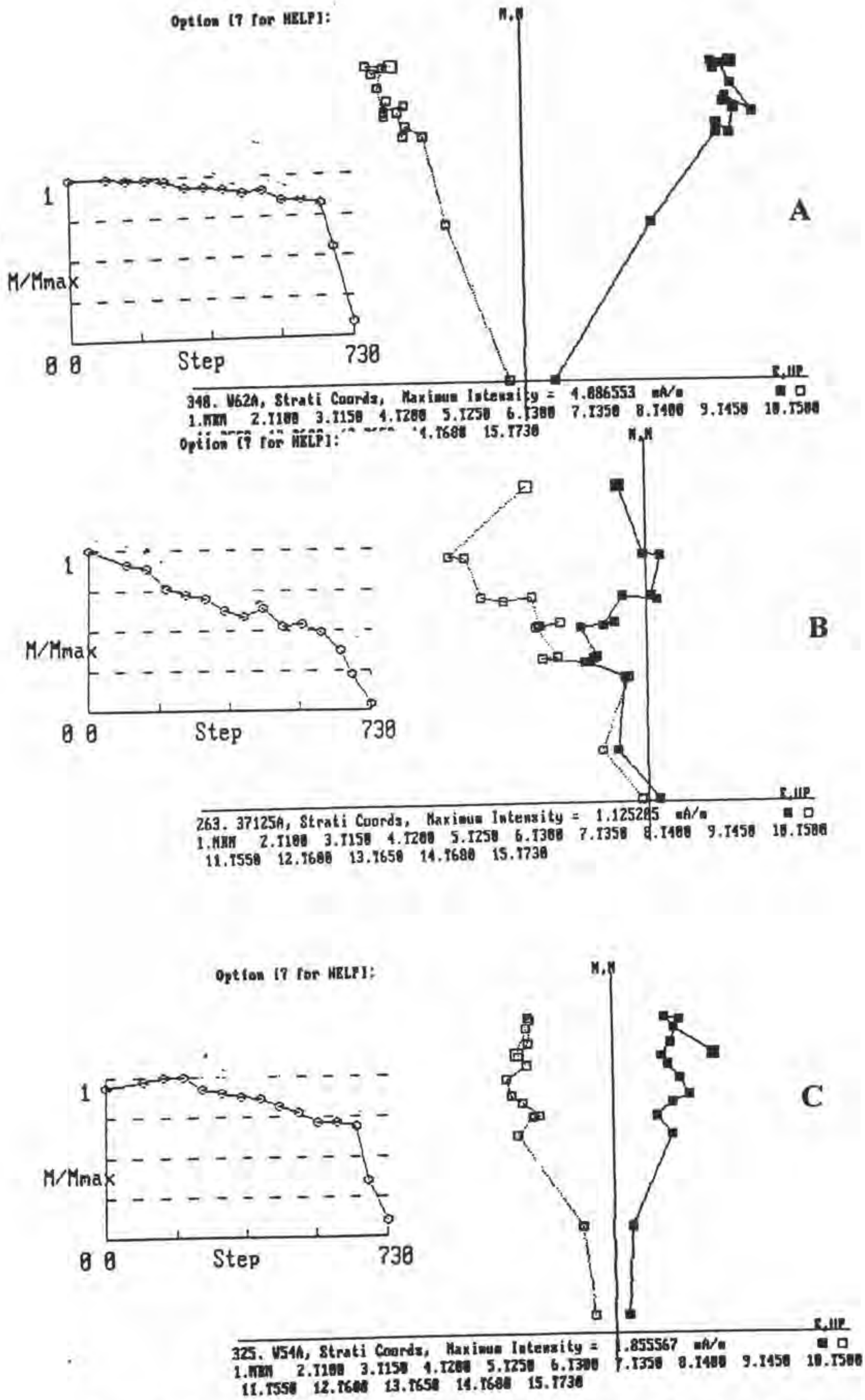


Figure 6.3 Intensity (left) and zijderveld plot (right) of samples in Hematite carrier (A= first pattern, B= second pattern, and C= third pattern).

abruptly changed from ENE to NNE. The remained intensity of 75 to 85% NRM shows the gradual decrease in intensity at the demagnetized temperature ranging from 200° to 550°C or up to 600 °C (see Fig. 6.3c). Magnetic direction is generally N-S and changes to NNE or to NE at the temperatures range from 250° to 400 °C. Some specimens indicate a rapid decrease in magnetic intensity at temperatures about 150° to 250 °C. Therefore, these specimens are assumed to represent the lower and stronger secondary components such as goethite and protohematite (component B_1 and B_2) overprinted on the primary component. Steep drops in remained intensity of 40 to 45% NRM are observed at demagnetized temperatures above 600° to 650°C (titanohematite-hematite) or 680 °C (hematite).

The other feature of the carrier is shown in some specimens (as nos. 37041 a, 37105a, 37123a, 37149a and 38013a). These specimens display high remagnetization of secondary magnetism. Intensity plots reveal the rapidly fluctuated decreasing of magnetic intensity at temperature range from 100° to 450 °C. Over 50% NRM is completely destroyed at the temperature above 400° to 450 °C, implying the demagnetization of component B. Then, a constant remanence of component C is encountered by the rough plateau at temperature range of 500° to 650 °C giving rise to the good direction of magnetism. The unstablity of remanence is detected at the demagnetized temperature above 650 °C.

NRM magnetic intensity of this hematite carrier is relatively low, generally within the range of 1.1-2.5 mA/m. However, these are good representatives on identifying the direction of primary magnetism. The selected data of the behaviour using stereo, intensity and zijderveld plots (see Figs. 7-169D, 8-170D, 28-37-11A and 135-37-45A in Appendix E) suggest the demagnetized temperature ranging from 350° to 550 °C or some 450° to 600 °C. However, the higher demagnetized temperatures, such as 500° to 680 °C, are also recognized in some samples. Remained intensity after demagnetized of each specimen is generally within the range of 0.5 - 1.0 mA/m.

2. Magnetite carrier

This carrier of rock magnetism is defined by a drop in a remanence intensity to below 5 to 10% NRM at temperatures above 500° to 550 °C. This probably indicates that magnetite or titanomagnetite (or component C_1) is of primary origin. The 6 specimens from 89 progressive demagnetized specimens are included in this carrier.

The demagnetized pattern (Figs. 6-168B, 117-37-3A, and 215-37101A in Appendix E) as revealed in 6 specimens (including 31068b, 31075a, 37003a, 37059a, 37101a and 37117a) indicates two or three components. The component A presents in two samples (nos. 31068b and 31075a), is suggested by the sharp drop to 10 to 15% at temperature above 100 °C. Then, the specimens show the steep drop to 90% remanence at 150° to 200 °C. It, therefore, indicates the presence of the low temperature component B_1, such as goethite or iron-oxide minerals. At the demagnetized temperature range of 200° to 450 °C or up to 500 °C, the rapidly gradual decreasing of intensity plots is continuously observed on these steps. Then, the 30 to 35% remanence magnetization are very rapidly decreasing until near zero or less than 5% at temperature between 500° and 550 °C (Fig. 6.4). However, direction of demagnetized step above 200 °C are constantly northeast.

NRM magnetic intensity of the magnetite carrier is relatively high, generally in the range of 6.2 to 16.8 mA/m or up to 55 mA/m. They are very good representatives of primary- magnetism direction. The selected data of the behaviour using stereo, intensity and zijderveld plots (see Figs. 13-175A and 248-37117A in Appendix E) suggest the demagnetized temperature ranging from 250° to 450 °C. Demagnetized temperature at 450° to 550 °C are expected in some specimens which have stronger secondary magnetization. Remained intensity after demagnetized of each specimen is generally within the range of 1.0 - 4.0 mA/m.

3. Hematite & Magnetite carrier

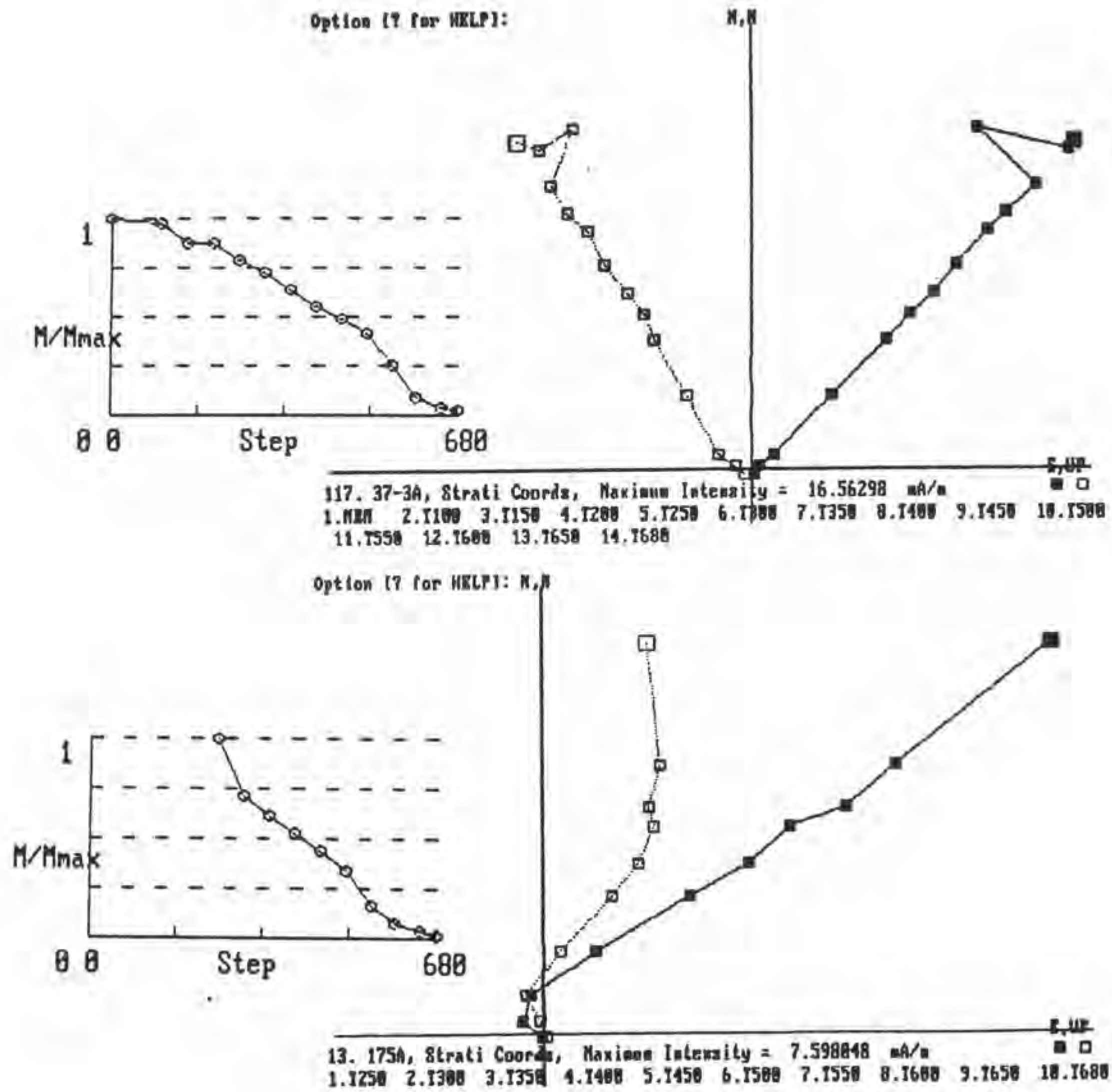


Figure 6.4 Intensity (left) and zijderveld plot (right) of samples in Magnetite carrier.

This carrier of rock magnetism is characterized by two steps of gradual decreasing, or steep drop, in intensity of the remanence high-temperature components (see Figs. 2-111C and 278-38-3A in Appendix E). This feature is required at a demagnetized temperature above 450°C. This is probably indicated that both high-temperature primary magnetic carriers, such as (titano-) magnetite and (titano-) hematite, are encountered as primary magnetic minerals (or component C_1 and C_2). There are 21 specimens included in this behaviour. However, it can be separated, based on demagnetized behaviour, into four patterns below.

A. The first pattern

The demagnetized pattern (Figs. 96-37-33A and 114-37-39A in Appendix E) is shown in 8 specimens (as 31010d, 31011d, 31071b, 31073d, 31079c, 37033a, 37039a and 37145d). Almost specimens show the nearly constant intensity over 90 to 95% remanence at the temperature below 150°C. However, two samples (i.e. nos. 37033a and 37039a) show a sharply fluctuated decreasing of intensity at temperature below 100° or 150°C, suggesting the overprinted magnetism by ambient field magnetism and some goethite or affiliated minerals. Then, the slow gradual or fluctuated decreasing of intensity at demagnetized temperature range from 150° to 250°C or may be up to 400°C are clearly observed in all specimens. It is assumed that the components B_1 and/or B_2 were reprinted in the primary magnetism. The sharp increasing (up to 10%) of magnetization at temperature from remanence about 300° or 450°C is typical feature of this pattern. It is also assumed that only primary components with opposite direction from secondary magnetism are revealed. The rapid gradual decreasing of intensity at demagnetized temperature ranging from 300° to 450°C and 500° to 550°C, suggest the association of titanomagnetite (or magnetite) at about 25-30% NRM. The remained 55-60% remanence formed a plateau until temperature below 600-650°C or so, the steep drop of intensity to below 10% remanence are encountered. It is also remarked that the increase in intensity at temperatures of 500° to 550°C (Fig. 6.5a) are presented. Therefore at least four

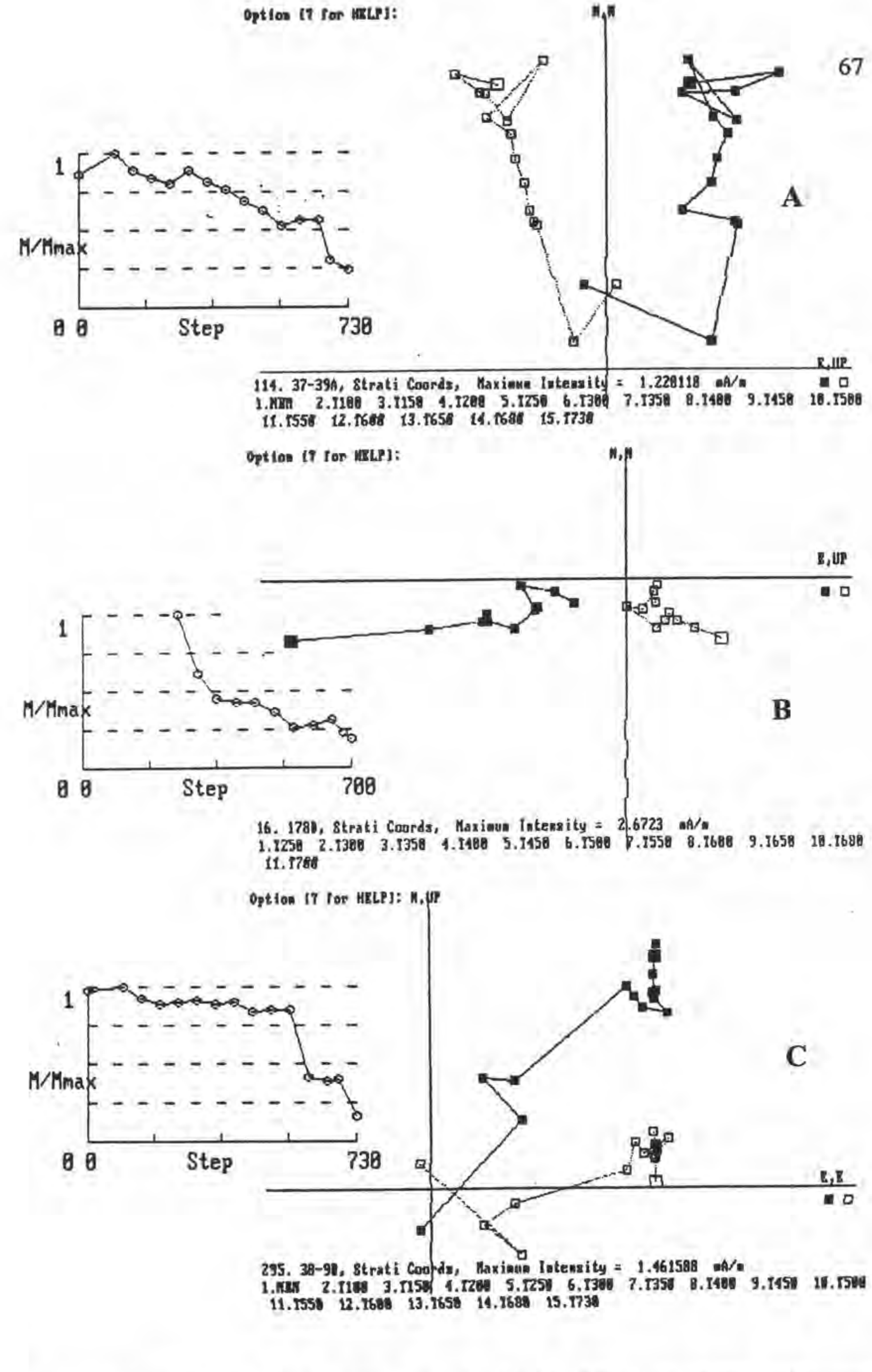


Figure 6.5 Intensity (left) and zijderveld plot (right) of Hematite & Magnetite carrier (A= first pattern, B= second pattern, and C= third pattern).

components as B_1, B_2, C_1 and C_2 were combined to NRM. Generally, zijderveld plots (see Figs. 17-179C and 96-37-33A in Appendix E) show a dramatic modification from ESE to NE direction at demagnetized temperature above 250° to 300°C. It is noted that the similar magnetic vectors are shown in components C_1 and C_2.

The other feature is presented in few specimens including nos. 31086 d, 37016a and 37103a. The 40 to 60% remanence of secondary magnetism is rapidly fluctuate decreasing at temperatures ranging from 100° to 450 °C. The few remained magnetism is similarly characterized to the former. Zijderveld plot (Fig. 43-37-16A in Appendix E) suggests the unstable magnetic vector is happened as the demagnetized temperature below 450 °C. The NE- trending magnetic direction is clear at temperature at about 500° to 600 °C.

B. The second pattern

This pattern as revealed in 2 specimens (nos. 31076a and 31078d), display the strongly drop of intensity at temperature range of 250° to 400°C (see Figs. 14-176A and 16-178D in Appendix E). The 40% remanent magnetism which is almost constant until temperature step of 500 °C , implies the component C_1 (the presence of magnetite). The gradual decreasing of intensity to 20% NRM at demagnetized temperature range from 500° to 600°C, suggest the magnetite component is included at about 15-20% NRM. The remained 20% of remanence formed a fluctuated magnetic intensity until temperature below 700°C (Fig. 6.5b). Direction of magnetism is slightly and susceptibly changed from east to northeast at temperature above 400 °C. It is noted that the unstable in magnetic direction occurred in temperatures up to 650°C. Therefore, at least three component such as components B_1 , C_1 and some C_2 are revealed.

C. The third pattern

This demagnetized pattern is illustrated in 9 specimens (as 31066d, 37018a, 37054a, 38001a, 38003a, 38005a, 38009b, 37121a and 37157b). The typical feature is shown in one specimen (i.e. no. 38009b, Fig. 6.5c). The pattern is characterized by the fluctuated intensity of about less 20% remanence at temperature below 100°-150 °C. It is, therefore, suggested the occurrence of component A. The plateau of constant intensity of over 85 to 90% are determined at demagnetized temperature steps above 500° to 550 °C. It is generally assumed this as a result of the appearance of (titano-) magnetite component (or component C_1). However, almost all of the specimens show small fluctuated and slowly gradual decreasing in intensity at temperature range of 150° to 250 °C. It is therefore suggested the remagnetization of iron-oxide minerals or goethite as supported by zijderveld plot which illustrates the unstability of magnetic vector at temperatures below 250°C. At the temperature above 550 °C, an abruptly steep drop in remanence to 30 to 40% NRM is taken place, and the plateau or slowly gradual decreasing in high constantly remained magnetization are observed at temperature about 600° to 680 °C, and drop immediately to zero at 730 °C. This high-temperature component C_2 (or hematite) are recognized. Therefore, at least two components, such as components C_1 and C_2, are magnetized in the specimens concerned.

NRM magnetic intensity of the hematite & magnetite carrier is relatively high, generally in the range of 1.5-2.7 mA/m, or may be down to 0.8 mA/m. They are rather good representative for the direction of primary magnetism. The selected data of the behaviour using stereo, intensity and zijderveld plots (see Figs. 1-110D, 49-37-18A, 96-37-33A, 278-38-3A and 279-38-5A in Appendix E) suggest the demagnetized temperature ranging from 250° to 400 °C or up to 450 °C. Remained intensity after demagnetized of each specimen is generally within the range of 0.8 - 1.4 mA/m.

4. Unstable carrier

The carrier of magnetism is suggested by unstable remanence intensity at high- temperature experiment. The primary component is unresolved yet. This is probably indicative of weakly low primary magnetism which can be remagnetized by magnetization induced in laboratory. Zijderveld and stereo plots (Figs. 170-37-5A, 64-37-22A, and 227-37107A in Appendix E) shown in some specimens (nos. 37005a, 37029a, 37031a, 37057a and 37107a) depict several directions of magnetism at each step of demagnetization. This suggested the very low value of magnetism that can be strongly destroyed at temperature below 100 °C (Fig. 6.6). Few specimens (including nos. 31067d, 31080d, 37022a, 37109a, 37147a and 37163a) denote the unstable magnetism at temperatures above 400° to 450 °C. They are characterized by a rapid decrease in intensity at temperature range from 100° to 250 °C. The constant low intensity of less than 20 to 30% NRM at temperature range of 300° to 400 °C points to the single direction of magnetism, which may be interpreted to represent the probably primary magnetization. Then, the highly fluctuated values of intensity and direction are observed in most specimens.

NRM magnetic intensity of this unstable carrier is very low, generally less than 0.8 mA/m. It becomes very bad representative for the direction of primary magnetism. The selected data of the behaviour using stereo, intensity and zijderveld plots suggest the demagnetized temperature of some specimens ranging from 300° to 400 °C or NRM-100 °C. However, the result from these data is merely obtained for the polarity of the specimens analyzed . Remained intensity after demagnetized of each specimen is generally within the range of 0.2 - 0.6 mA/m.

Paleomagnetic Result

Cleaned temperatures which can completely demagnetize secondary magnetization are evaluated for the appreciated temperature to select the qualified

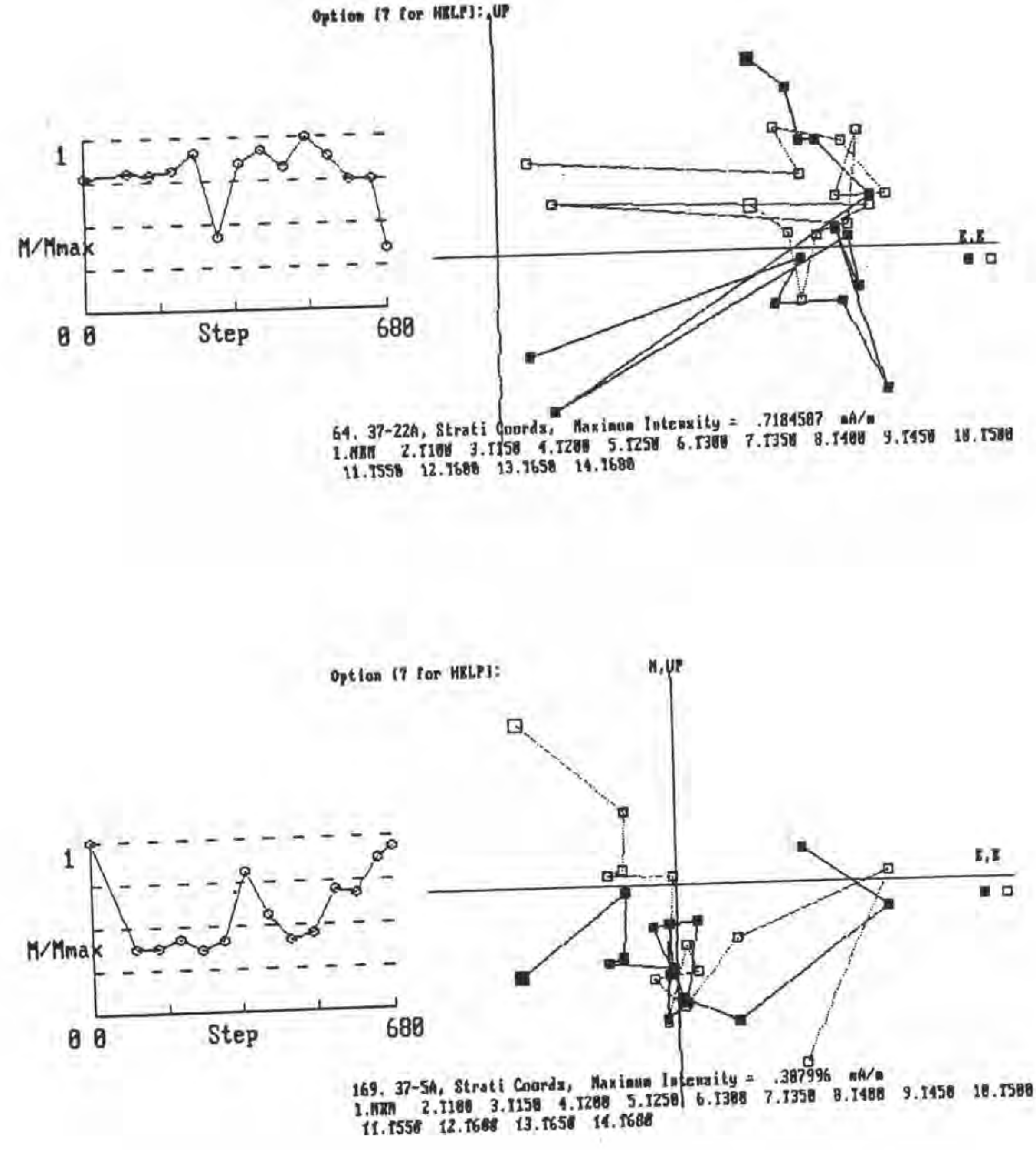


Figure 6.6 Intensity (left) and zijderveld plot (right) of samples in Unstable carrier.

paleomagnetic data. The magnetic vector at these temperatures is reasonably assumed to the primary magnetic vector, and inferred to represent the geomagnetic polarity at depositional time. The 351 appreciated paleomagnetic data are obtained from the result of demagnetization behaviour of the 351 specimens (see Appendix F in detail). Data of one sample are calculated from 2-3 specimens by an on-line computer, and this is called the paleomagnetic data of the sample site. Data of paleomagnetic results of the individual sample sites are then calculated for the pole position (as illustrated in Tables 6.1 to 6.3).

The mean declination (D) of all selected samples excluded the lowest Phu Wua data is about of 29.6° and inclination (I) is approximately 32.7°, with A_{95} = 1.8 and K= 1006.0. The declination also includes the lowest Phu Wua data which is 29.1° and inclination is 31.1° with A_{95}= 3.3 and K= 250.9. Pole position of the rocks (exclude the lowest Phu Wua) is 61.9°N (latitude) and 189.9°E (longitude) and 62.0°N, 192.0 E° if the lowest Phu Wua is included. Paleolatitude of the depositional area is calculated from Phu Thok and Phu Wua samples (excluded the lowest Phu Wua section) of about of 17.8° ± 1.2°N whereas of about 16.7° ± 2.1° N if the lowest Phu Wua data is included.

1. Results of Phu Thok section

Paleomagnetic data of 192 specimens from 72 sample sites show the average inclination and declination of about 30° to 35° and 25° to 31°, respectively. At least 4 sample sites strongly suggested the reverse polarity, whereas at least 50 sample sites certainly reveal the normal polarity.

At the lower member of the Phu Thok section, the 26 samples show the mean I= 30.6° and mean D= 29.9° with A_{95} =4.2 (Table 6.3). Average data of sample sites usually determined for the magnetic declination (D) reveal the direction of NE-SW, ranging from 4.3° to 48.4° and inclination (I) from 13.9° to 48.8° with A_{95} of each site varying from 4.0 to 41.4. Only small data (such as specimen no. 37005a) display

Table 6.1 Paleomagnetic data of all sample sites of the Phu Thok section

				Paleomagnetic data						Accepted parameters						
Samples	**Pole lat.**	**Pole long.**	**Number**	**Mean I**	**Mean D**	**VGP lat.**	**VGP long**	**Paleo-lat**	**R**	**K**	**A95**	**S**	**dP**	**dM**	**Polarit**	**Accept**
37001	18.1	103.9	3	18.1	31.4	58.2	205.8	9.3	2.8	13.2	22.3	22.3	12.0	23.1	N	Yes
37002	18.1	103.9	3	28.0	48.2	43.8	190.4	14.9	3.0	47.9	11.7	11.7	7.0	12.8	N	Yes
37003	18.1	103.9	3	22.6	46.6	44.6	195.1	11.8	3.0	402.3	4.0	4.0	2.3	4.3	N	Yes
37004	18.1	103.9	3	33.3	48.4	44.1	185.9	18.2	2.9	23.1	16.8	16.8	10.8	19.1	N	Yes
37005	18.1	103.9	2	50.7	7.5	75.0	129.5	31.4	2.0	28.2	18.6	15.2	16.9	25.1	N	Yes
37006	18.1	103.9	3	22.2	27.5	62.6	204.0	11.5	2.8	11.8	23.5	23.6	13.2	24.9	N	No
37007	18.1	103.9	3	13.9	27.3	61.2	213.0	7.0	3.0	50.5	11.4	11.4	5.9	11.6	N	Yes
37008	18.1	103.9	3	23.9	4.3	83.0	246.6	12.5	2.8	9.8	25.8	25.9	14.7	27.6	N	No
37009	18.1	103.9	3	33.4	20.0	71.0	190.4	18.2	2.6	5.1	35.6	35.7	23.0	40.5	N	No
37010	18.1	103.9	3	33.2	26.9	64.4	189.6	18.1	3.0	75.8	9.3	9.3	6.0	10.5	N	Yes
37011	18.1	103.9	3	31.7	22.0	69.0	193.0	17.2	2.8	11.2	24.2	24.2	15.3	27.2	N	No
37012	18.1	103.9	3	25.1	16.2	73.6	209.0	13.2	2.8	11.5	23.9	23.9	13.8	25.7	N	No
37013	18.1	103.9	3	30.4	29.3	62.0	193.0	16.3	3.0	510.1	3.6	3.6	2.2	4.0	N	Yes
37014	18.1	103.9	3	51.3	128.2	19.5	148.9	32.0	1.8	1.6	63.1	63.2	58.1	85.6	R?	No
37015	18.1	103.9	3	27.5	49.4	42.6	190.5	14.6	2.9	36.6	13.4	13.4	8.0	14.6	N	Yes
37016	18.1	103.9	3	33.7	187.4	52.7	92.3	18.5	2.4	3.4	44.0	44.1	28.6	50.2	R?	No
37017	18.1	103.9	3	32.7	18.8	72.1	192.0	17.8	2.9	18.7	18.7	18.7	12.0	21.2	N	Yes
37018	18.1	103.9	2	47.0	38.3	53.6	170.6	28.2	2.0	70.4	11.8	9.7	9.9	15.3	N	Yes
37019	18.1	103.9	2	23.8	22.7	67.4	205.1	12.5	1.8	5.8	41.3	33.8	23.5	44.0	N	No
37020	18.1	103.9	3	28.4	46.0	46.0	190.6	15.1	2.8	12.8	22.6	22.7	13.6	24.8	N	Yes
37021	18.1	103.9	3	19.7	23.9	65.6	209.6	10.2	2.8	9.9	25.6	25.7	14.0	26.8	N	No
37022	18.1	103.9	2	21.2	31.1	59.1	202.9	11.0	1.7	4.0	49.7	40.6	27.5	52.3	N	No
37024	18.1	103.9	3	22.6	23.4	66.5	206.3	11.7	2.8	12.5	22.8	22.9	12.8	24.2	N	Yes
37025	18.1	103.9	3	36.0	29.1	62.5	185.3	19.9	2.8	12.7	22.7	22.7	15.3	26.3	N	Yes
37026	18.1	103.9	2	16.4	31.4	58.0	207.5	8.4	2.0	24.1	20.1	16.5	10.7	20.8	N	Yes
37027	18.1	103.9	3	28.7	6.1	83.5	218.6	15.3	2.8	8.5	27.7	27.8	16.7	30.5	N	No
37028	18.1	103.9	3	35.0	42.9	49.5	185.1	19.3	2.9	17.3	19.4	19.4	12.9	22.4	N	Yes
37029	18.1	103.9	1	24.5	356.6	83.8	316.3	12.8	-	-	-	-	-	-	N	No
37030	18.1	103.9	2	44.2	25.5	65.1	171.0	25.9	1.9	9.5	32.1	26.3	25.3	40.3	N	No
37031	18.1	103.9	2	56.9	71.2	25.6	160.3	37.5	2.0	26.2	19.4	15.8	20.4	28.1	N	Yes
37032	18.1	103.9	3	16.5	40.8	49.2	202.1	8.4	3.0	51.4	11.3	11.3	6.0	11.6	N	Yes
37033	18.1	103.9	3	33.5	35.7	56.1	187.9	18.3	3.0	79.3	9.1	9.1	5.9	10.3	N	Yes
37034	18.1	103.9	3	46.5	35.2	56.3	170.7	27.8	3.0	138.8	6.9	6.9	5.7	8.8	N	Yes
37035	18.1	103.9	3	18.2	17.5	70.9	218.8	9.4	2.5	3.7	42.0	42.1	22.7	43.6	N	No
37036	18.1	103.9	2	33.2	36.9	55.0	188.0	18.1	1.9	12.8	27.7	22.7	17.8	31.4	N	No
37037	18.1	103.9	3	21.8	19.3	70.1	211.2	11.3	2.8	12.1	23.2	23.3	12.9	24.5	N	No
37038	18.1	103.9	3	22.1	29.1	61.2	203.1	11.5	2.8	9.5	26.2	26.3	14.7	27.7	N	No
37039	18.1	103.9	3	13.5	33.6	55.4	208.5	6.8	3.0	63.5	10.1	10.2	5.3	10.4	N	Yes

Table 6.1 (continue)

Samples	Pole lat.	Pole long.	Number	Mean I	Mean D	VGP lat.	VGP long	Paleo-lat	R	K	A95	S	dP	dM	Polarit	Accept
			Paleomagnetic data (continue)							Accepted parameters						
37040	18.1	103.9	3	40.6	29.6	61.9	178.4	23.2	2.9	14.0	21.6	21.6	15.8	26.2	N	Yes
37041	18.1	103.9	3	24.8	4.7	83.2	241.9	13.0	2.9	33.8	13.9	13.9	8.0	14.9	N	Yes
37042	18.1	103.9	3	-26.1	14.3	-55.0	79.1	-13.7	2.0	120.6	9.0	7.4	5.3	9.8	R?	No
37043	18.1	103.9	3	29.3	154.6	48.0	142.0	15.7	2.9	15.5	20.5	20.6	12.5	22.7	R?	No
37044	18.1	103.9	3	28.6	32.4	58.9	194.3	15.2	2.8	12.5	22.9	22.9	13.8	25.2	N	Yes
37045	18.1	103.9	3	33.8	26.9	64.5	188.8	18.5	3.0	151.7	6.6	6.6	4.3	7.5	N	Yes
37046	18.1	103.9	1	12.6	179.2	65.5	282.0	6.4	1.0	-	-	-	-	-	R?	No
37047	18.1	103.9	3	42.0	33.0	58.7	176.9	24.2	2.9	35.8	13.5	13.5	10.2	16.6	N	Yes
37048	18.1	103.9	3	34.3	24.1	67.2	188.3	18.8	2.6	5.3	35.1	35.2	23.0	40.2	N	No
37050	18.1	103.9	3.	25.0	40.2	51.0	195.2	13.1	2.9	24.6	16.3	16.3	9.4	17.5	N	Yes
37051	18.1	103.9	3	31.3	24.5	66.6	193.1	16.9	2.9	18.3	18.9	18.9	11.8	21.2	N	Yes
37052	18.1	103.9	3	22.4	56.0	35.7	192.4	11.7	2.9	13.6	22.0	22.0	12.3	23.3	N	Yes
37053	18.1	103.9	3	38.1	25.1	66.2	181.8	21.4	2.8	12.3	23.0	23.1	16.1	27.2	N	Yes
37054	18.1	103.9	3	33.1	346.4	77.0	15.9	18.1	2.0	573.1	4.1	3.4	2.7	4.7	N	Yes
37055	18.1	103.9	3	42.8	14.2	75.2	164.2	24.9	2.8	10.3	25.2	25.2	19.3	31.1	N	No
37056	18.1	103.9	1	11.5	12.4	72.7	237.8	5.8	1.0	-	-	-	-	-	N	Yes
37057	18.1	103.9	1	-21.1	343.8	-56.7	133.9	-10.9	1.0	-	-	-	-	-	N?	No
37058	18.1	103.9	1	25.4	44.0	47.5	193.7	13.4	1.0	-	-	-	-	-	N	Yes
37059	18.1	103.9	3	6.3	47.9	40.8	205.8	3.2	2.5	4.2	39.3	39.4	19.8	39.5	N	Yes
37060	18.1	103.9	3	1.6	47.8	40.0	208.7	0.7	3.0	41.7	12.5	12.5	6.3	12.5	N	Yes
38001	18.1	103.9	3	22.6	31.6	58.8	201.1	11.8	3.0	91.6	8.4	8.5	4.8	9.0	N	Yes
38002	18.1	103.9	3	16.8	29.8	59.5	208.1	8.6	3.0	52.6	11.1	11.2	5.9	11.5	N	Yes
38003	18.1	103.9	3	36.8	42.5	49.9	183.3	20.5	3.0	122.2	7.3	7.3	5.0	8.6	N	Yes
38004	18.1	103.9	3	30.3	13.7	76.8	199.8	16.3	2.7	6.8	31.0	31.1	19.2	34.5	N	No
38005	18.1	103.9	3	29.2	25.2	65.8	196.0	15.6	2.8	10.8	24.6	24.6	15.0	27.1	N	No
38006	18.1	103.9	3	48.8	31.6	59.0	165.8	29.8	3.0	69.7	9.7	9.7	8.4	12.8	N	Yes
38007	18.1	103.9	3	37.1	17.3	73.5	181.9	20.7	2.9	17.5	19.3	19.4	13.3	22.7	N	Yes
38008	18.1	103.9	3	2.5	221.0	45.3	352.6	1.2	2.8	9.8	25.9	25.9	13.0	25.9	R?	No
38009	18.1	103.9	3	27.1	21.2	69.3	201.2	14.3	2.8	8.3	28.1	28.2	16.6	30.6	N	No
38010	18.1	103.9	3	20.9	29.8	60.3	204.0	10.8	2.9	16.7	19.8	19.8	10.9	20.8	N	Yes
38011	18.1	103.9	3	30.6	30.9	60.5	192.2	16.5	2.7	5.9	33.4	33.4	20.7	37.2	N	No
38012	18.1	103.9	3	32.4	16.8	74.0	193.1	17.6	2.9	32.5	14.2	14.2	9.0	16.0	N	Yes
38013	18.1	103.9	3	22.0	19.3	70.2	210.9	11.4	2.5	3.8	41.4	41.5	23.2	43.8	N	No
31010	18.1	103.9	1	16.8	15.4	72.3	224.3	8.6	-	-	-	-	-	-	N	Yes
31011	18.1	103.9	1	0.9	12.7	302.5	68.6	0.5	-	-	-	-	-	-	R?	No

Remark: VGP lat.= calculated latitude of individuals specimen VGP long.= calculated longitude of individual specimen, Paleo-lat = paleolatitude of specimen, R= the sum of direction cosines, K= precision parameter, A_{95}= 95% cone of confidence about mean R, S=angular SD, dP= error in the polelatitude, dM= error in the direction perpendicular to the dP, N Polarity = normal , R Polarity = reverse, Accept = the accepted data to mean pole calculation (<22.5)

Table 6.2 Paleomagnetic data of all samples sites of the Phu Wua section

				Paleomagnetic data						Accepted parameters						
Samples	Pole lat.	Pole long	Number	Mean I	Mean D	VGP lat.	VGP long.	Paleo-lat.	R	K	A95	S	dP	dM	Polarity	Accept
37101	18.1	103.9	3	14.4	87.5	4.6	187.7	7.3	2.7	5.9	33.3	33.4	17.5	34.1	N?	No
37102	18.1	103.9	3	27.9	257.5	6.8	32.0	14.8	2.7	7.9	28.7	28.8	17.2	31.4	R?	No
37103	18.1	103.9	3	37.1	20.7	70.3	182.8	20.7	2.3	3.0	46.3	46.4	31.9	54.3	N	No
37104	18.1	103.9	3	44.6	18.8	70.9	165.5	26.2	2.9	34.6	13.7	13.8	10.9	17.3	N	Yes
37105	18.1	103.9	3	41.0	30.4	61.1	177.9	23.5	1.8	1.7	62.0	62.1	45.8	75.4	N	No
37106	18.1	103.9	3	7.2	336.4	62.7	344.7	3.6	2.8	9.9	25.7	25.8	13.0	25.9	N	No
37107	18.1	103.9	3	9.1	337.6	64.2	345.1	4.6	2.9	15.8	20.3	20.4	10.4	20.5	N	No
37108	18.1	103.9	3	-4.6	28.8	-55.1	46.7	-2.3	1.3	1.4	85.0	69.6	42.7	85.2	N	No
37109	18.1	103.9	3	20.2	315.4	46.1	10.2	10.4	2.1	2.2	54.2	54.4	29.8	56.8	R?	No
37110	18.1	103.9	3	35.4	166.4	50.0	124.0	19.6	2.7	7.2	30.0	30.1	20.1	34.7	R?	No
37111	18.1	103.9	3	36.9	14.0	76.5	181.0	20.6	2.8	8.7	27.4	27.5	18.8	32.1	N	No
37112	18.1	103.9	3	26.1	32.1	58.9	197.2	13.8	2.9	27.6	15.4	15.4	9.0	16.6	N	Yes
37113	18.1	103.9	3	37.0	13.4	77.1	180.4	20.6	2.5	3.9	41.1	41.2	28.2	48.2	N	No
37114	18.1	103.9	3	10.6	47.9	41.6	203.1	5.3	2.7	6.9	30.9	30.9	15.8	31.2	N	No
37115	18.1	103.9	3	34.2	6.7	83.6	187.0	18.7	2.7	8.0	28.6	28.7	18.8	32.8	N	No
37116	18.1	103.9	3	33.8	358.6	88.5	28.9	18.5	2.9	29.3	14.9	15.0	9.7	17.0	N	Yes
37117	18.1	103.9	3	46.3	47.1	45.9	172.6	27.6	2.9	34.8	13.7	13.7	11.3	17.6	N	Yes
37118	18.1	103.9	3	46.0	116.5	13.5	158.0	27.4	3.0	489.6	3.7	3.7	3.0	4.7	N?	No
37119	18.1	103.9	3	17.8	47.1	43.5	198.5	9.1	2.9	28.9	15.0	15.1	8.1	15.6	N	Yes
37120	18.1	103.9	3	25.9	26.6	64.1	199.9	13.6	2.9	27.1	15.5	15.6	9.1	16.8	N	Yes
37121	18.1	103.9	3	25.9	33.0	58.0	197.0	13.7	3.0	43.8	12.2	12.2	7.1	13.2	N	Yes
37122	18.1	103.9	3	28.6	14.1	76.2	203.8	15.2	2.8	12.9	22.5	22.5	13.6	24.7	N	Yes
37123	18.1	103.9	2	46.8	351.4	77.3	66.5	28.0	2.0	27.3	19.0	15.5	15.8	24.4	N	Yes
37124	18.1	103.9	3	51.3	18.6	68.2	150.9	31.9	2.3	3.0	46.5	46.6	42.8	63.1	N	No
37125	18.1	103.9	3	33.3	4.6	85.7	191.8	18.2	2.8	11.4	24.0	24.0	15.5	27.3	N	No
37126	18.1	103.9	3	34.7	19.5	71.5	187.7	19.1	2.9	23.5	16.7	16.7	11.0	19.2	N	Yes
37130	18.1	103.9	3	38.7	342.8	73.3	29.6	21.8	3.0	71.7	9.5	9.6	6.7	11.3	N	Yes
37145	18.1	103.9	1	54.6	39.4	51.2	159.9	35.1	-	-	-	-	-	-	N	Yes
37146	18.1	103.9	3	51.2	253.2	3.9	49.3	31.9	3.0	182.3	6.0	6.0	5.5	8.1	R?	Yes
37147	18.1	103.9	3	30.2	14.1	76.4	199.8	16.2	2.9	19.4	18.4	18.4	11.3	20.4	N	Yes
37148	18.1	103.9	3	18.1	18.2	70.3	218.1	9.3	2.8	11.9	23.4	23.5	12.6	24.3	N	Yes
37149	18.1	103.9	3	42.3	35.9	56.0	176.7	24.5	2.3	3.1	46.1	46.2	34.9	56.7	N	No
37151	18.1	103.9	3	24.6	21.4	68.7	205.0	12.9	2.8	13.2	22.2	22.3	12.8	23.8	N	Yes
37152	18.1	103.9	3	36.2	23.7	67.6	184.9	20.1	2.8	13.1	22.3	22.4	15.1	26.0	N	Yes
37153	18.1	103.9	3	35.4	39.3	52.9	185.1	19.6	3.0	50.7	11.4	11.4	7.6	13.1	N	Yes
37154	18.1	103.9	3	16.8	18.5	69.6	219.3	8.6	3.0	107.1	7.8	7.8	4.2	8.1	N	Yes

Table 6.2 (continue).

Samples	Pole lat.	Pole long	Number	Mean I	Mean D	VGP lat.	VGP long.	Paleo-lat.	R	K	A95	S	dP	dM	Polarity	Accept
				Paleomagnetic data					Accepted parameters							
37155	18.1	103.9	1	-6.2	47.9	-38.2	33.3	-3.1	-	-	-	-	-	-	N	No
37156	18.1	103.9	3	35.5	17.3	73.5	185.8	19.6	2.9	32.5	14.2	14.2	9.5	16.4	N	Yes
37157	18.1	103.9	3	22.7	28.3	62.0	202.9	11.8	2.6	5.4	34.8	34.8	19.6	36.9	N	No
37158	18.1	103.9	3	31.5	26.6	64.6	192.1	17.1	2.9	21.1	17.6	17.6	11.1	19.7	N	Yes
37159	18.1	103.9	3	27.3	28.1	62.8	197.3	14.5	2.9	15.5	20.5	20.6	12.2	22.4	N	Yes
37160	18.1	103.9	3	28.0	19.6	71.0	200.7	14.9	2.9	25.3	16.1	16.1	9.6	17.6	N	Yes
37161	18.1	103.9	3	22.9	40.8	50.2	196.9	11.9	2.7	5.8	33.6	33.6	18.9	35.6	N	No
37162	18.1	103.9	3	23.3	56.3	35.5	191.6	12.2	2.9	24.4	16.3	16.4	9.3	17.4	N	Yes
37163	18.1	103.9	3	22.1	39.5	51.4	198.1	11.5	2.8	13.0	22.5	22.5	12.6	23.7	N	Yes
37164	18.1	103.9	3	36.1	40.1	52.1	184.3	20.0	2.7	6.9	30.8	30.9	20.8	35.9	N	No
31066	18.1	103.9	1	46.3	7.5	78.2	138.5	27.6	-	-	-	-	-	-	N	Yes
37167	18.1	103.9	1	33.5	11.5	79.1	191.0	18.3	-	-	-	-	-	-	N	Yes
31068	18.1	103.9	1	-40.7	155.0	-66.0	30.8	-23.2	-	-	-	-	-	-	R	No
31069	18.1	103.9	1	41.9	53.3	40.2	177.2	24.2	-	-	-	-	-	-	N	Yes
31070	18.1	103.9	1	7.0	30.6	56.7	216.2	3.5	-	-	-	-	-	-	N	Yes
31071	18.1	103.9	1	46.6	1.9	80.1	113.7	27.9	-	-	-	-	-	-	N	Yes
31072	18.1	103.9	1	41.7	67.9	26.9	175.6	24.0	-	-	-	-	-	-	N	Yes
31073	18.1	103.9	1	30.3	30.0	61.3	192.9	16.3	-	-	-	-	-	-	N	Yes
31074	18.1	103.9	1	-18.1	49.4	-34.0	39.1	-9.1	-	-	-	-	-	-	N?	No
31076	18.1	103.9	1	-19.3	186.8	-79.4	143.9	-9.9	-	-	-	-	-	-	R	Yes
31077	18.1	103.9	1	-52.2	211.6	-58.1	160.1	-32.8	-	-	-	-	-	-	R	Yes
31078	18.1	103.9	1	-8.3	249.6	-20.6	191.6	-4.1	-	-	-	-	-	-	R	Yes
31079	18.1	103.9	1	-4.0	175.9	-73.4	89.4	-2.0	-	-	-	-	-	-	R	No
31080	18.1	103.9	1	-16.0	265.8	-6.4	187.4	-8.1	-	-	-	-	-	-	R	No
31081	18.1	103.9	1	-57.2	233.3	-39.6	159.2	-37.8	-	-	-	-	-	-	R	No
31082	18.1	103.9	1	-11.5	198.7	-68.1	162.4	-5.8	-	-	-	-	-	-	R	Yes
31083	18.1	103.9	1	35.0	326.0	57.8	21.6	19.3	-	-	-	-	-	-	N?	No
31084	18.1	103.9	1	7.8	67.7	22.4	197.2	3.9	-	-	-	-	-	-	N	Yes
31085	18.1	103.9	1	13.2	77.9	13.5	191.2	6.7	-	-	-	-	-	-	N	Yes
31086	18.1	103.9	1	66.0	187.6	23.2	98.4	48.3	-	-	-	-	-	-	R?	No

Remark: VGP lat.= calculated latitude of individuals specimen VGP long.= calculated longitude of individual specimen, Paleo-lat = paleolatitude of specimen, R= the sum of direction cosines, K= precision parameter, A_{95}= 95% cone of confidence about mean R, S=angular SD, dP= error in the polelatitude, dM= error in the direction perpendicular to the dP, N Polarity = normal , R Polarity = reverse, Accept = the accepted data to mean pole calculation (<22.5)

Table 6.3 Calculated paleomagnetic data of each member in Phu Thok Formation

Formation	n/N	Lat.	Long.	Mean I	Mean D	Pole lat.	Pole Long.	Paleo-lat.	K	A_{95}	dP	dM
Phu Thok												
member B	66/78	18.1	103.9	30.6	29.9	61.4	192.5	16.5	17.2	4.2	2.6	4.6
member C	32/50	18.1	103.9	32.7	30.2	61.3	189.7	17.8	14.9	6.4	4.1	7.2
member D	35/78	18.1	103.9	32.2	31.2	60.3	190.2	17.5	17.7	4.6	2.9	5.2
Phu Wua												
member A	7/11	18.1	103.9	-21.2	206.1	-63.7	181.9	-11.0	4.7	21.4	11.9	22.6
member B	40/48	18.1	103.9	31.5	31.4	60.1	191.0	17.0	15.4	5.6	3.6	6.3
member C	7/18	18.1	103.9	34.1	24.8	66.5	188.4	18.7	21.1	11.5	7.5	13.2
member D	38/78	18.1	103.9	35.5	30.0	61.6	185.9	19.1	16.4	5.6	3.8	6.5
mean (exclude. member A)				32.7	29.6	61.9	189.9	17.8	1006.0	1.8	1.2	2.0
mean (include. member A)				31.1	29.1	62.2	192.0	16.7	250.9	3.3	2.1	3.7

Remark: N= number of specimens, n= number of accepted specimens, K = precision parameter, A_{95}= cone of confidence, dP = error in pole-latitude and dM- error in direction perpendicular to the dP the erroneous magnetic direction which may have been caused by the very weakly magnetization induced during instrument operation. It is therefore noted that some samples (e.g. nos. 38008 and 38013) showing weakly magnetism is encountered. Since it contains both normal and reverse polarity specimens, therefore it is wisely to be rejected from the calculation.

16 samples taken from the middle part of the Phu Thok section show mean I= 32.7° and mean D= 30.2° with A_{95} =6.4 (see also Table 6.3). Data of a magnetic direction of sample no. 37014 is variable, therefore, it is resigned from interpretation. Almost samples advocate the magnetic declination (D) averagely form the NNE to NE direction, ranging from 16.3° to 46.0° and inclination (I) ranging from 20.3° to 44.7° (A_{95} of each site = 15.5 to 49.7). Some specimens yield the error magnetic direction, for example specimen no. 37018b, showing high angle of inclination (>60°), possibly caused by very weakly magnetization remagnetized by instrument (Maranate,1982). Thus it was also rejected from the calculation. It is marked that a sample (i.e., no. 37022) shows reverse inclination and normal declination.

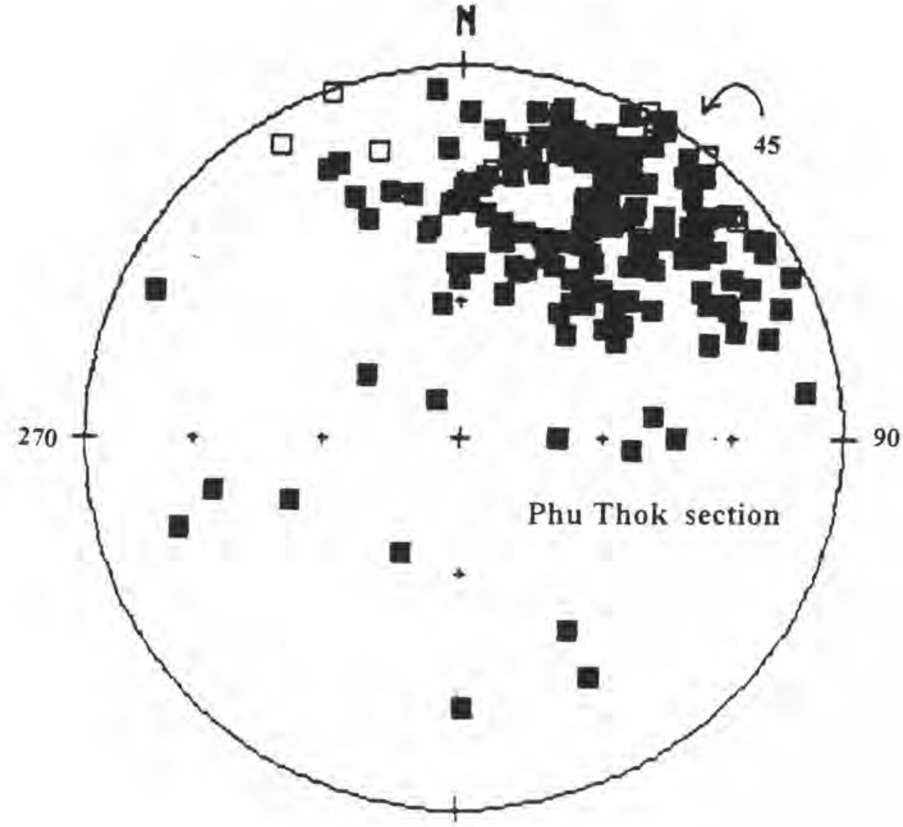
In the upper member of the Phu Thok section, 30 sample data depict mean I = 32.2° and mean D= 31.2° with A_{95} =4.6 (Table 6.3). Average data of the samples data usually reveal the magnetic declination (D) in the NE direction, ranging from 4.7° to 47.9° with inclination (I) from 1.6° to 46.5° with A_{95} of each site from 6.6 to 55.1. The careful notice of this member revealed the 2 reverse polarity and 1 probably short reverse polarity, from the established samples (nos. 37042, 37043 and 37046, respectively). These declination (D) of 14.3°, 154.6° and 179.2° and inclination (I) of -26.1°, 29.3, and 12.6°, respectively, agree with the normal declination and reverse inclination in the first and reverse declination and normal inclination for the others. The unusual data of magnetic direction also reveals in two samples (e.g., nos. 37059 and 37060). They, therefore, contains mixed normal and reverse polarity specimens (see Appendix D). The result represents the secular of polarity intercalated with the long normal polarity of overall samples. Some data (such as specimen no. 37036a) yield the reverse inclination which is believed to be a signal of short reverse polarity. However, the other specimens of the same sample site do not show the similar result, therefore, it is assumed as the erroneous data existing during measurement. The overall data of sample sites of the Phu Thok section is shown in Table 6.1 and Figure 6.7.

2. Results of Phu Wua Section

Paleomagnetic data of 132 specimens from 68 sample sites show the average inclination and declination of about 30° to 35° and 24° to 31°, respectively (see Table 6.2). It is quite similar to the Phu Thok section. At least 10 sample sites probably suggest the reverse polarity, whilst at least 45 sample sites certainly reveal the normal polarity.

In the lowest member of the Phu Wua section, 8 reverse data show the mean I = -21.2° and mean D = 206.1° with A_{95} =21.4 (Table 6.3). The 8 from 12 samples display the reverse polarity. Combined data of two samples (nos. 31076 to 31086) give the magnetic declination (D) ranging from 175.9° to 265.8° and inclination (I) ranging from -4.1° to -57.3° (Table 6.2). Some data (such as sample no. 37184) indicate the normal magnetic declination and low-angle normal inclination (D=67.7°, I=7.8°), probably caused by the short-normal polarity intercalated in the long reverse polarity.

In the lower part of the Phu Wua section, the selected data show the mean I = 31.5° and mean D= 31.4° with A_{95} =5.6. Selected samples frequently yield the magnetic declination (D) ranging from 1.9 to 67.9° and inclination (I) ranging from 7.0° to 46.6° (A_{95} of each site is 7.8°-33.6°). Some sample data point to the abnormal magnetic direction, for example, sample no. 37155a showing the low angle of reverse inclination (I= -6.2°) and normal declination. The other sample (e.g., no. 31074) are rejected from the paleopole calculation because of the unstablity of magnetic direction. Paleomagnetic data from the other sample site (no. 31068) records the reverse polarity (D=155°, I=-40.7°). It is noted also that the normal declination and reverse inclination is presented in some samples (e.g., no. 31075).



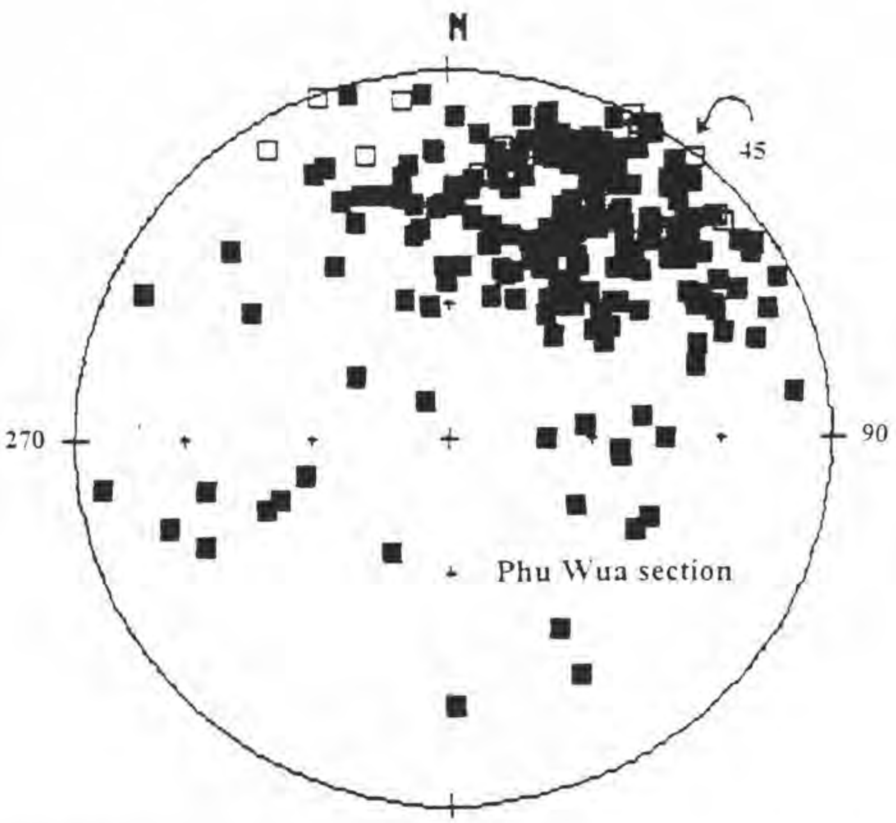


Figure 6.7 Paleomagnetic direction of the Phu Thok (up) and Phu Wua (down) sections showing the mean declination is NW (the fill rectangular referred to the normal pole and blank points represent to the reverse pole

The middle part of Phu Wua section reveals the mean I= 34.1° and mean D = 24.8° with A_{95}=11.5 of 6 samples (see Table 6.3). Sample nos. 37130 and 37145-37149 indicate the magnetic declination (D) is ranging from 343.3° to 39.4° and inclination (I) ranging from 23.7° to 54.6° with A_{95} of each site varying from 6.0 to 46.1 (see Table 6.2). It is noted that sample no. 37146 show high angle of normal inclination (I=51.2°) and reverse declination (D=253.2°). Sample no. 37149a are rejected due to instrumental error.

The Upper member of Phu Wua section, show the mean I= 34.8° and mean D= 30.0° with A_{95} =5.6. The data show the magnetic declination (D) ranging from 347.5° to 56.2° and inclination (I) from 10.6° to 50.0° (A_{95} of each site=12.2 to 46.3). Two sample (nos. 37110 and 37118) yield weakly and very stronger secondary magnetism, respectively. Therefore, they are rejected form the analysis. The probably short reverse polarity is established in one sample (no. 37102) whose declination (D) is 225.1° and inclination (I) is 46.4°. The overall data of the Phu Wua sample sites are shown in Table 6.2 and Figure 6.7.

3. Results of the Paleomagnetic Pole

Any pole position is calculated from the single observation of the direction of the geomagnetic field is called a virtual geomagnetic pole or VGP (Cox, 1986). The VGP paleopole of the rocks are calculated from D and I of all selected samples. It is separated based principally upon lithostratigraphy into 7 values and are illustrated in Table 6.3. The accepted data are recognized by $A_{95} < 20$ for each sample and similar direction with the other samples (declination is ranging from 20° to 40° and inclination from 10° to 40°). Average of VGP is called average pole position or paleomagnetic pole (Cox, 1986).

The calculated paleopole values by paleomagnetic sofeware of 66 specimens for the lower part of Phu Thok section showing the variation of latitude of VGP paleopole ranging from 44.1° to 76.8° N and longitude ranging from 165.8° to 213.0°E (Fig. 6.8). Average position of calculated paleopole or paleomagnetic pole is therefore 61.4°N , 192.5°E with R=62.2, K=17.2, A_{95}= 4.2, S=19.5, dP=2.6 and dM=4.6 (Table 6.3). The 32 specimens of the middle part display the variation of latitude of VGP ranging from 46.0° to 74.5° N and longitude ranging from 172.3° to 206.7°E. Average position of paleopole or paleomagnetic pole is 61.3°N , 189.7°E with R=29.9, K=14.9, A_{95}= 6.4, S=21.0, dP=4.1 and dM=7.2. In the upper part of the section , 53 specimens depict the variation of latitude of VGP ranging from 48.0° to 77.0° N and longitude ranging from 164.2° to 211.2°E. Palemagnetic pole position is 60.3°N , 190.2°E with R= 50.1, K= 17.7, A_{95}= 4.6, S=19.3, dP=2.9 and dM=5.2.

At Phu Wua section, 40 specimens of the lower sequence indicate the variation of latitude of VGP paleopole ranging from 35.5° to 73.9° N and longitude ranging from 184.3° to 219.3°E (Fig. 6.9). Position of paleomagnetic pole is 60.1° N , 191.0° E with R= 37.5 , K= 15.4, A_{95}= 5.6, S=20.7, dP= 3.6 and dM=6.3. The 7 specimens of the middle sequence yield the slight variation of latitude of VGP from 51.2° to 76.4° N and longitude ranging from 159.9° to 212.6° E. Average position of paleomagnetic pole is, therefore, estimated at 66.5°N , 188.4°E with R = 6.7, K = 21.1, A_{95}= 11.5, S= 17.7, dP= 7.5 and dM=13.2). The 38 selected specimens of the upper sequence illustrate the latitude of VGP paleopole ranging from 37.6° to 76.2° N and longitude ranging from 165.5° to 203.8°E. Estimated position of paleomagnetic pole averages approximately 61.5°N , 186.9°E with R=34.8, K= 16.7, A_{95}=5.6, 19.8, dP=3.7 and dM=6.5. The major signal of reverse polarity is shown in 7 samples of the lowest of Phu Wua sequence. They show the typical latitude of VGP paleopole ranging from 6.4° to 79.4° S and longitude ranging from 143.9° to 191.6°E with the average position of paleomagnetic pole is 63.7°S, 181.9°E (Table 6.3) with R= 7.3, K= 4.7, A_{95}=21.4, S=37.2, dP=11.9 and dM=22.6.

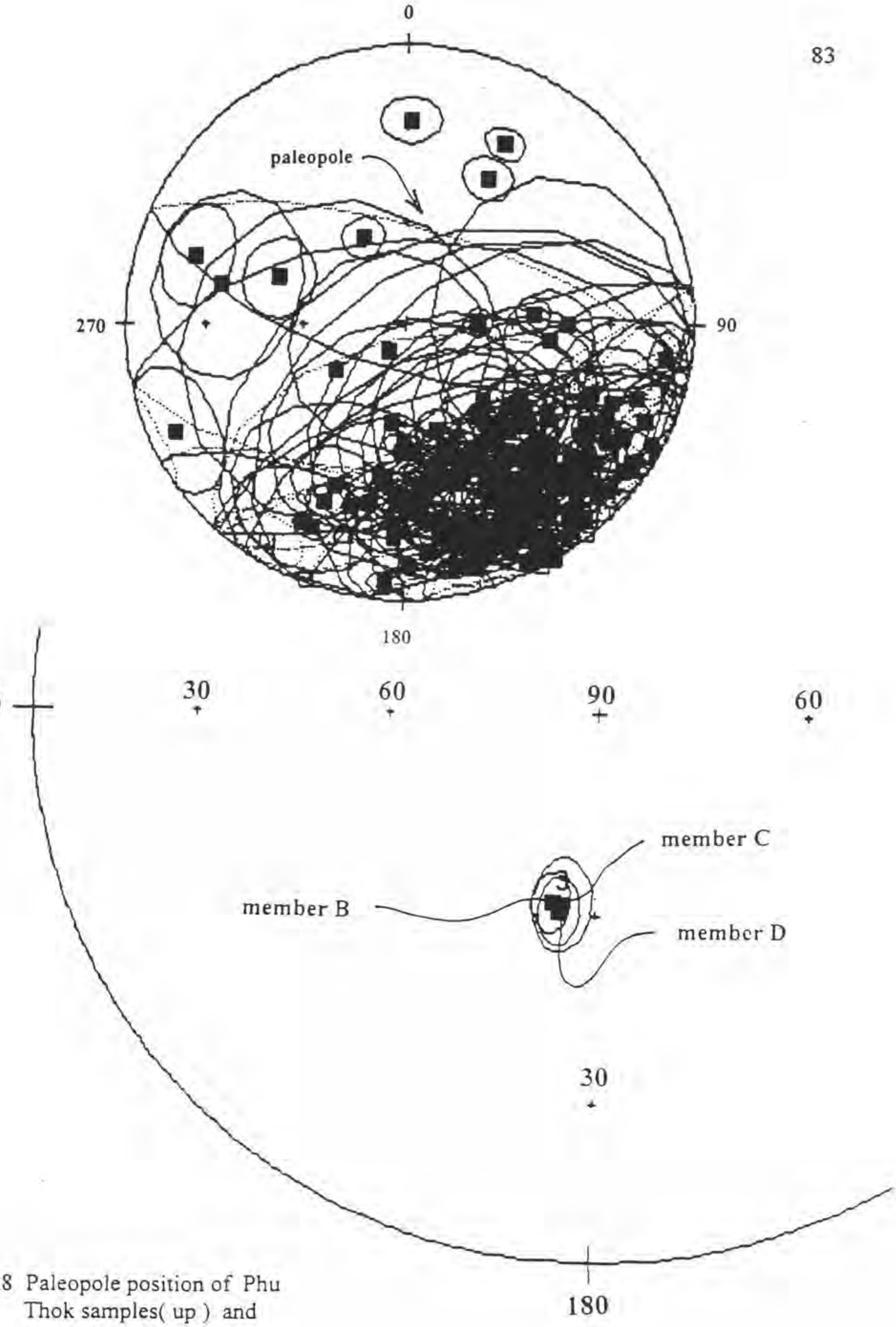


Figure 6.8 Paleopole position of Phu Thok samples(up) and average poles of each member (down)

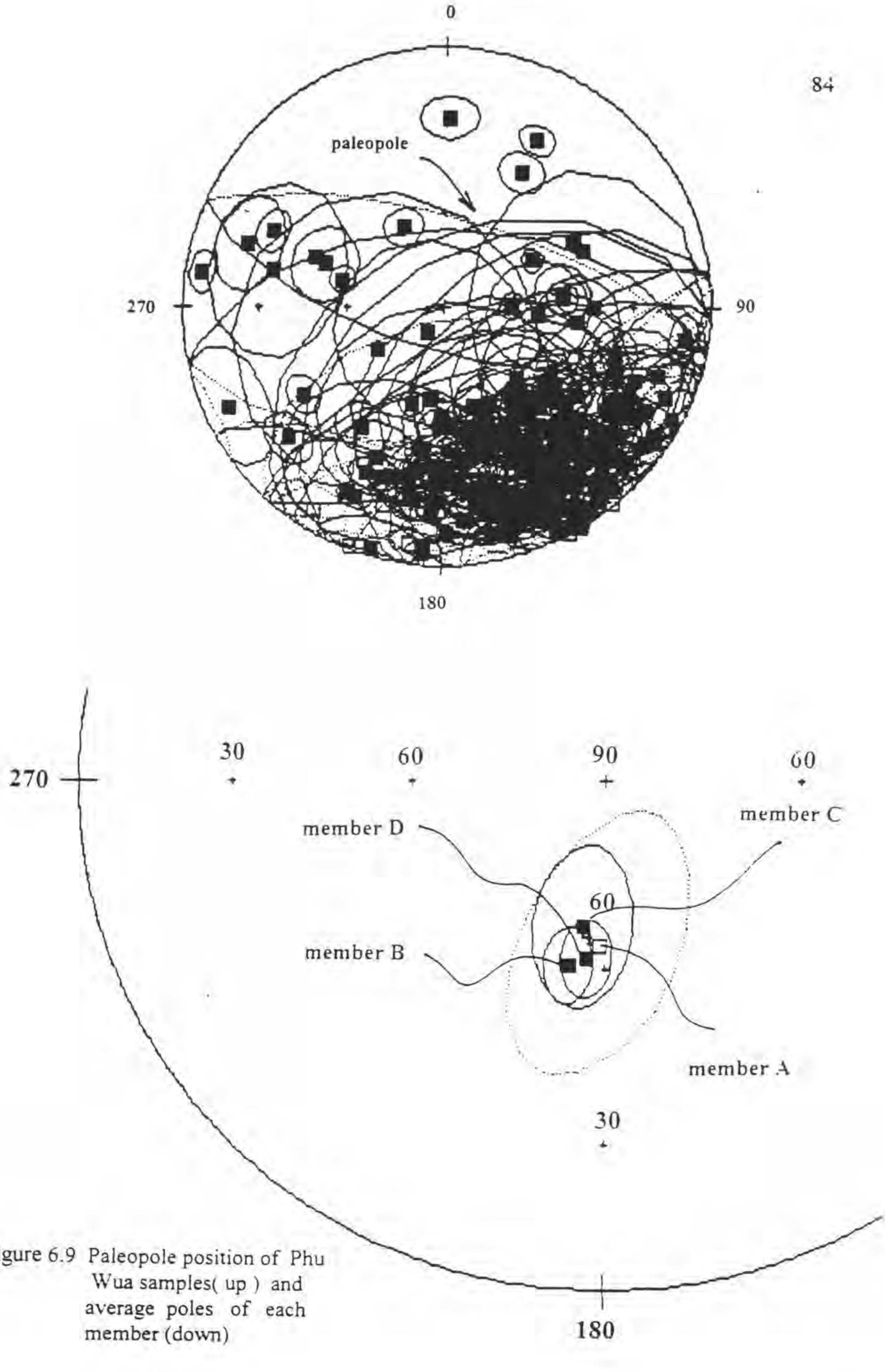


Figure 6.9 Paleopole position of Phu Wua samples(up) and average poles of each member (down)

4. Results of Paleolatitude

The paleolatitude of the area is calculated from inclination of rock samples by function tan I (inclination) = 2 tan λ (latitude). The inclination of sample data are varied about 10-45° and mean is 32.7° (see Tables 6.1 and 6.2). The Paleolatitude of rocks is recognized into 2 categories. One is located at the northern hemisphere, inferred to the normal inclination and the other took place in southern hemisphere, referred to the reverse inclination. The former shows the slightly fluctuation of latitude ranging from 5.3° to 35.1°N with the majority of 16.5°-19.1°N. The latter is ranging from 8° to 37°S, but average is 11.0°-13.7°S. Some specimens, however, show the low latitude, it may be defined the changing about the polarity.

The paleolatitude of the Phu Thok section is very stable. They are located at the latitude about 16.5°±2.6°N, 17.8° ± 4.1°N and 17.5° ±2.9°N (see Table 6.3), ascending from the bottom to top of lithology. Paleolatitude of Phu Wua data is likely higher than the Phu Thok. They are located at about 17.0°±3.6°N, 18.7° ± 7.5°N and 19.1° ±3.7°N. However, the calculated latitude of reverse polarity in the lowest part of Phu Wua section is slightly differed, is about 11.0°±11.9°N. It is not accepted to calculated the paleolatitude of the deposition area of the Phu Thok rocks. Average paleolatitude of the Formation is 17.8° ± 1.2°N (possibly ranging from 16.6°-19°N with A_{95}=1.8).