

Ar-Ar age of metamorphic and mylonitic rocks in northern part of the Kon Tum massif: evidence for the Indosinian movement along shear zones between Kon Tum massif and Truong Son belt

Vu Van Tich^{1,*}, Henri Maluski², Nguyen Van Vuong¹

¹College of Science, VNU

²ISTEM, University of Montpellier II, France

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Abstract. The studied area is situated in the easternmost of Indochina (south of Central Vietnam), covers the boundary between Kon Tum massif and Truong Son belt, where exposed a lot of intensively deformed ductile shear zones. The study result shows that those shear zones have undergone strong deformation with mylonites in high temperature metamorphism accompanied. The kinematic criteria observed in field indicate that they are suffered from a dextral strike-slip shear with sub-vertical foliation and sub-horizontal stretching lineation. Mineral assemblages of metamorphism associated with the deformation show that metamorphism of the shearing attain amphibolitic facies. Age of this deformation took place at c.a 240 Ma for metamorphism of the shear zone and of 230 Ma for mylonite related to ending of ductile deformation. The obtained results evidence that both Truong Son belt and Kon Tum massif had been affected by Indosinian movement.

Keywords: Ar-Ar age; Metamorphism; Kon Tum; Truong Son; Indosini.

1. Introduction

South East Asian geology was considered as an assemblage of different gondwanaphile fragments (Sibumasu, Indochina, South-China blocks) (Fig. 1) during the Permo-Triassic time [11, 6]. This tectonic event is nowadays well defined by metamorphic and magmatic activities in plural places [2, 7-10, 17, 20]. The central part of Vietnam, Truong Son belt, which

was characterized by a folded Paleozoic sedimentary strata covered place to place by Uper-Triassic red bed [3]. Numerous ductile shear zones such as the Song Ma, Song Ca, Dai Loc - Khe Sanh shear zone exist in the belt with NW-SE gradually changes to E-W trend (Fig. 1). The rocks of different protoliths exposed along these shear zones are strongly deformed into mylonite, even ultramylonites. Strike-slip shears took place at around of 245 Ma corresponding to Indosinian movement [5, 10], some of them reactivate in younger stages. The South of Central Vietnam is occupied by a high

* Corresponding author. Tel.: 84-4-5587060.
E-mail: tichvv@vnu.edu.vn

metamorphic massif (Kon Tum massif) which consists mainly of high metamorphic and magmatic rock (amphibolite, granulite and charnockite) [13-15, 20]. It was regarded as an oldest basement of Indochina and originated from Gondwanian super-continent [4, 18]. In contrast with Truong Son belt, the major structure in this massif is other while N-S direction (Fig. 1). The studied area is situated between high metamorphic Kon Tum massif and very low grade metamorphism Truong Son belt, is a zone of intense deformation represented by mylonitic and ultramylonitic rocks derived from various protoliths. With the presence of serpentinized ultra-mafic and ophiolitic affinity bodies, the studied area was considered as the main boundary between two Gondwanaphile micro-fragments (Kon Tum massif and Truong Son belt) [6]. In this paper, we present the study of the metamorphism associated with ductile deformation and results of Ar-Ar dating in this area in order to constrain in detail the spatial metamorphic evolution and interpretation of geodynamic setting of the Indochina.

2. Geological background and characteristics of deformation

The studied area is documented as a transition zone between the high grade metamorphic basement of Kon Tum massif and very low grade metamorphism Truong Son belt (Fig. 1). This area consists of mainly metasedimentary and meta-igneous rocks forming Kham Duc metamorphic basement. The metasedimentary rocks are mainly of pelitic-semipelitic micaschist, gneiss, quartzite and some intercalated bands of calc-schist. The meta-igneous rocks compose of three orthogneissic W-E elongated massifs, corresponding respectively to Dai Loc, Que Son and Chu Lai (Fig. 1). Place to place, intercalated

in parallel with these metamorphic rocks is low metamorphic series as philitic rock. The whole basement is intruded in some places by undeformed granite of Hai Van complex and covered place to place by Late Mesozoic redbed and volcanogenic sediments [15]. This region is sliced by a series of ductile shear zones called from North to South as Dai Loc - Khe Sanh, Tam Ky, Tra Mi and Tra Bong shear zones (Fig. 1). One of the main deformation zone, Tra Bong shear zone including two ductile faults (Tra Bong and Tra Tan), located at southern-most of studied area. Geomorphologically, it coincides with the W-E valley of Tra Bong River. This shear zone marks important structural characteristics between high grade metamorphic anatectic series of Ngoc Linh Formation characterized by low angle foliation and Kham Duc Formation characterized by nearly vertical foliation. Orthogneiss and metasediments exposed along this valley recorded a strong deformation. The field observation shows a right lateral-strike slip of movement with the foliation of 80° dips to the south. Northward, another ductile shear zone (Tra Mi shear zone) also exists. Its deformation characteristics can be observed from Chu Lai through Dak Mi to Kham Duc Townlet. This shear zone bounds the northern rim of Chu Lai granitogneiss massif. Further to the North, another shear zone, called Tam Ky shear zone, possessing the same direction with previous one, extending from Tam Ky Town to Hiep Duc Village and continue to Giang Village. Here, their direction inflects to NW, the same way of Tra Bong shear zone. Along this shear zone, the rock composing ophiolitic ultramafic, micaschist and orthogneiss are strongly deformed into mylonites. More away from this Tam Ky shear zone to the N and limited by Que Son elongated intrusive massif and Upper Mesozoic ribbed and volcanic synclinal of Nong Son is Dai Loc - Khe Sanh shear zone.

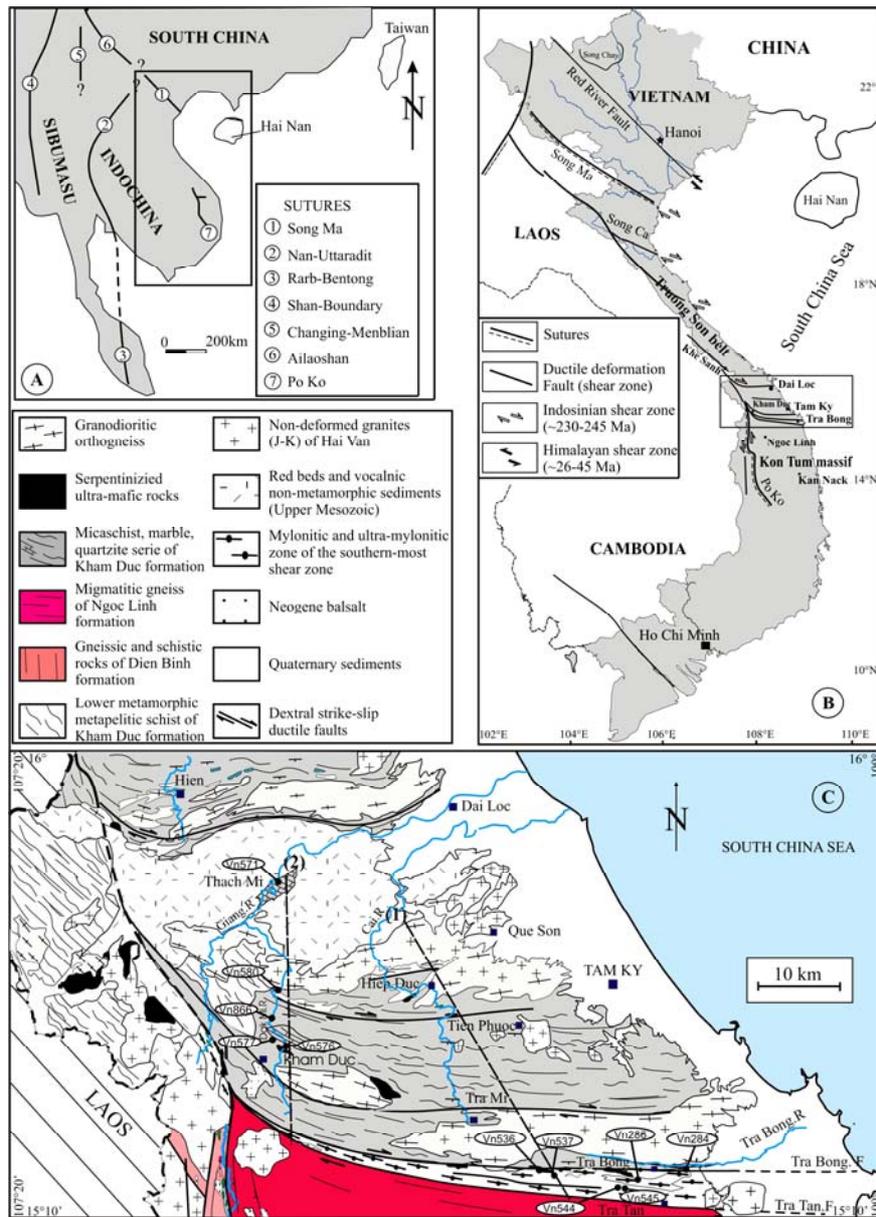


Fig. 1. The study area and its location in regional geological setting: A. Position of studied area and main boundaries involved in the Indosinian Orogenic period between Gondwanian crustal blocks (adapted from [6, 11]); B. Sketch map of the major Indosinian strike-slip shear zones in Vietnam (adapted from [5, 6]). C. Structural map of studied area and location of dated samples represented by numbers in ellipses.

This shear zone is northern limit of studied area, because, immediately in the North is non-metamorphism materials of Truong Son belt. This shear zone has affected and dismembered the Dai Loc intrusive massif. Some previous

data show that the Dai Loc intrusive massif, emplaced at around of 400 Ma, has undergone a ductile deformation into orthogneiss at 245 Ma relating to right-lateral strike slip movement [5].

In summary, in these shear zones, the

ductile deformation affected granodiorites, quartzite, micaschist and amphibolites, giving the forming of mylonite and ultramylonite. Whole of foliation is subvertical around of 80° , dips to the south. This foliation has sub-horizontal lineation in E-W direction (Fig. 1, 2). In the western part of this series of shear zones, the direction of whole shear zones and regional foliation of metasediment basement changes from E-W to NW and joins to Po Ko shear zone. In the East of Tra Bong Town (Tra Bong shear zone), the diorite forming principal of outcrop is intensively deformed and exposed very nice fabric of L-type tectonites. At Tra Mi Village (Tra Mi shear zone), the deformation evidences by ultra-mylonite from an elongated dioritic orthogneiss. The band of shearing observed in multi-points indicates one regime of dextral strike-slip movement (Fig. 2). These W-E mylonitic shear zones also present metamorphic characteristics accompanying deformation. We will present this characteristic in the following section.

3. Ductile deformation and accompanying metamorphism

The interpretation of isotopic ages depends on the attribution of the parageneses to particular metamorphic and deformation conditions. We present here the main data relating to mineral parageneses observed in the metamorphic rocks and ductile deformation rocks. Then, ages of both rock types are discussed in conjunction with their metamorphic assemblages and degree of deformation.

3.1. Metamorphic characteristics in Kham Duc Formation

Mineral assemblage study showed that the protolith forming the Kham Duc basement

consists of mainly argillite, sandstone and some bands of limestone and this material are metamorphosed and now found in the form of gneiss, micaschist, quartzite and marbles. The representative mineral assemblages observed in this formation are the following: Quartz-plagioclase-garnet-biotite-fibrous sillimanite-staurolite \pm ilmenite; Quartz-plagioclase-chlorite-garnet-staurolite; Quartz-kyanite-garnet-biotite; Quartz-fibrous sillimanite-biotite-garnet.

From point of metamorphic view, in general, these rocks are naturally belonged to model KFMASH system. The diagram of compatibility AFM (+quartz, +muscovite, +H₂O) has modeled indicated that the degree of metamorphism varies quickly, according to observed sectors. To the east, immediately at the South of Que Son massif, it exposes one isodegree of metamorphism of garnet-chlorite (VN559), the staurolite is already appeared in this zone in assemblage of staurolite-chlorite-garnet (VN703, VN704). More toward the west (VN566), the same latitude of previous sample, we observe one zone isodegree of metamorphism of staurolite-biotite which representative for degree of medium metamorphism in amphibolite facies. Finally, more toward the west, at around of Kham Duc Townlet, the degree of metamorphism is still increased more important because we are here in the zone of kyanite-biotite (VN574 and VN576), event in zone of fibrous sillimanite-biotite (VN577). It could be referred by the phase relation in AFM diagram in which at least four univariant reactions have crossed as following:

- (a) Garnet + chlorite \rightarrow staurolite + biotite,
- (b) Staurolite + chlorite \rightarrow kyanite + biotite,
- (c) Kyanite \rightarrow sillimanite fibrolite, or
- (d) Quartz + staurolite + muscovite \rightarrow garnet + sillimanite + biotite.

From viewpoint of metamorphism, in this region, the gradient of metamorphism is medium pressure, typically for collisional

metamorphism. But, here, take into account: the direction and slope of regional foliation; small number of sample and their location; the proximity of dextral movement of the numerous shear zones, so it is very difficult to say this metamorphism is prograde normal or inverse from the east to the west or from the north to the south and the metamorphism is syn-or-post regional deformation. But with this observation, there is two possibilities, if: (1) the isogrades are subparallel to the regional foliation and global foliation direction is W-E, and with slope dip to S, so the metamorphism is inverse and syntectonic; (2) the isogrades are crossing the regional foliation and dip to the east and the degree of metamorphism increase from the east to the west, this metamorphism is post-foliation and normal prograde. However, take into account of slope and foliation direction of Kham Duc complex, the hypotheses (1) seem to be more reasonable, specially if we accept that high degree metamorphism (sillimanite-biotite zone) which we observed inside Tra Bong shear zone belong to the same metamorphism in Indosinian time, so the Kham Duc Formation is really inverse prograde.

3.2. Condition of deformation in the shear zone

Inside of Tra Bong valley is occupied by dioritic orthogneiss, amphibolites and quartzites, also by micaschists containing muscovite, biotite, sillimanite and locally relic andalusite (VN530), in which, fibrous sillimanite forming from andalusite. In these rocks, C/S bands are well developed, with dextral shear movement. This series is intruded by non-deformed granite. From point of view of metamorphism, all these rocks seem to be metamorphosed at regional low pressure and high temperature metamorphism relating to intense ductile deformation. Because the presence of andalusite is unknown in non-deformation zone. It is probable formed concerning to the increasing of temperature

relating to shearing (shear heating) which are responsible for this blast of low pressure and high temperature, differentiated to the more high pressure which is affected to Ngoc Linh complex to give anatectic metapelite, immediately to the south, in Kon Tum massif.

This zone, present not only the different mineralogical assemblage but also a superposition of deformation while the ductile regime could be confirmed by radiometric analysis in order to show out their evolution in the time and space.

4. ^{40}Ar - ^{39}Ar dating of metamorphism and deformation

^{40}Ar - ^{39}Ar radiometric method was applied, using single grain dating, by a LEXEL 3500 continuous argon-ion laser for stepwise heating in Montpellier II University (France). Analytical conditions are in detail described in [10]. Correction interference used for $^{36}\text{Ar}/^{37}\text{Ar}$ Ca is 2.93×10^{-4} . Mass discrimination correction factor is calculated for a $^{40}\text{Ar}/^{36}\text{Ar}$ ratio of 291. In order to reduce the vertical irradiation gradient effect, the $^{40}\text{Ar}/^{39}\text{Ar}$ ratio measured on each monitor was also used for age calculation. Two kind of sample selected for dating are relation to metamorphism and their deformation. The representative sample location is presented in Fig. 1. Results are presented in Fig. 2.

4.1. Sample in western part of Kham Duc Formation, relating to Tra Mi and Tam Ky fault

Four samples represent for metamorphism relating ductile deformation including staurolite bearing schist, micaschist and intercalated marble have been selected for dating.

+ VN580 ($15^{\circ}33'39''$; $107^{\circ}49'19''$): is granodioritic mylonitic orthogneiss contains quartz, brown biotite, green-blue hornblende, perthitic K-feldspar, acid-intermediate plagioclase, apatite,

zircon, allanite. Age spectra of hornblende do not present, in fact, a real plateau because 90% of ^{39}Ar is degazed seen the second step, this

case is frequent with hornblende. However, age of second step, 238.5 ± 1.3 Ma is close to total age calculated on three steps, of 239.5 Ma (Fig. 3).

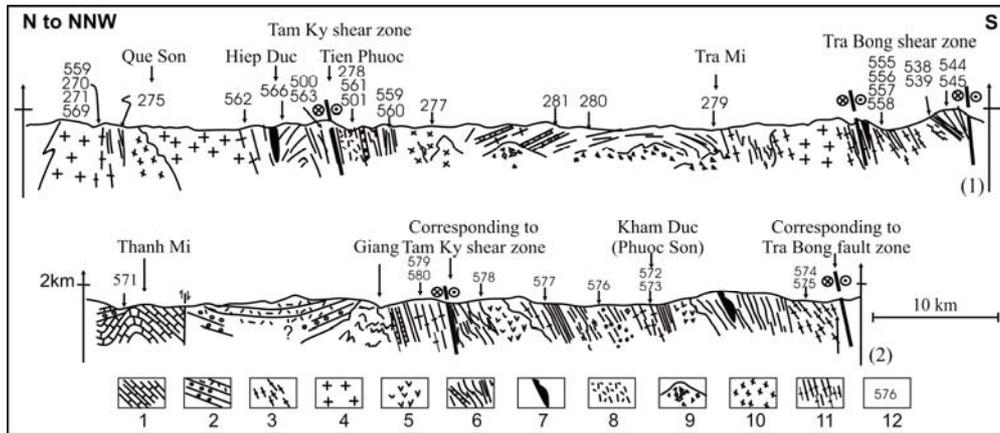


Fig. 2. Cross sections and the location of samples across the studied area in N-S direction. 1. Marbles, 2. Upper Mesozoic sediments (red bed and volcanics), 3. Gneiss, 4. Granite, 5. Rhyolite, 6. Quartzite-micaschist (metasediments), 7. Serpentinized ultramafic body, 8. Metavolcanics, 9. Amphibolite-gneiss migmatites, 10. Gabbro syenite, 11. Mylonitic orthogneiss, 12. The numbers is represented for samples (275 = VN275).

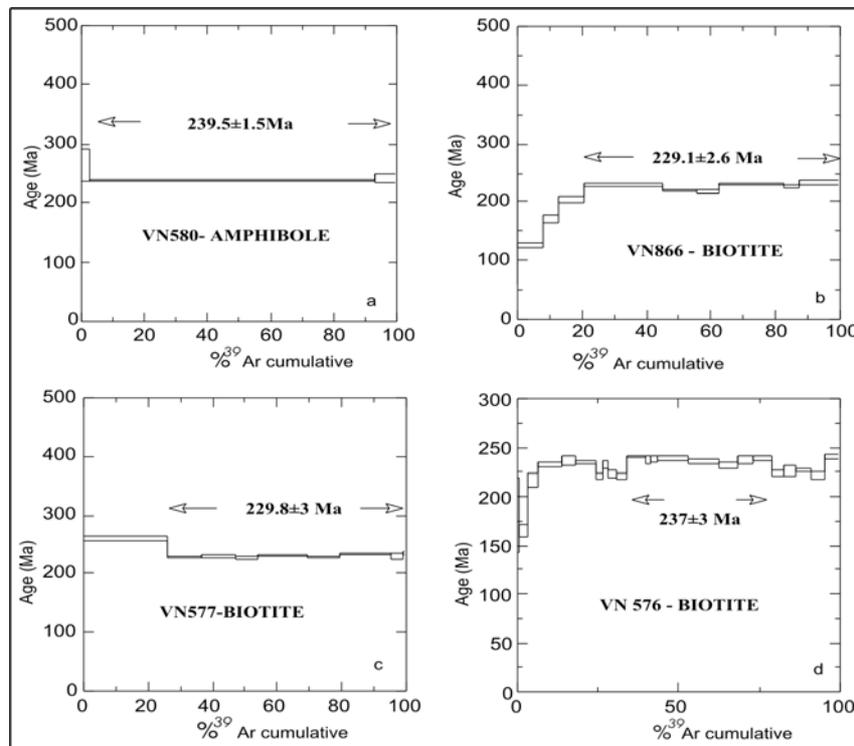


Fig. 3. Age spectra of metamorphic and deformed rocks affected by shear zones in Kham Duc complex.

+ VN866 (15°32'09"; 107°49'16"): a micaschist contains quartz, kyanite, garnet, biotite, acid plagioclase and secondary muscovite, iron ore, tourmaline and secondary chlorite. Age spectra of biotite is complex and present a regular increasing of age corresponding to steps of low temperature, between 125 Ma and the plateau at 229 Ma. This disposition indicate a argon loss from the sites release in lower temperature relating to partial reopening of these sites at around of 125 Ma, after the closing of the site the most retentive around of 230 Ma (Fig. 3).

+ VN577 (15°29'14"; 107°50'01"): a micaschist consist of quartz, green-brown biotite, sillimanite, almadin garnet, acid plagioclase, muscovite, iron ores, zircon and apatite. The fibrous sillimanite development depends on biotites. Rutile and Fe-Ti oxide are expelled locally from biotites. This sample (VN577) located near the VN866, is representative for isodegree zone of sillimanite-biotite of medium pressure metamorphism of Kham Duc complex. In contrast to the previous sample, the C/S kinematic criteria on biotites are very frequent and clear. It indicates that this sample is undergone to deformation of shear zone. The age spectra obtained on biotite presents a first step corresponding to an age of 260 Ma. The next steps formed a plateau corresponding to 80% released argon. This plateau gives an age of 229.8 ± 3 Ma (Fig. 3). Age of primary step corresponds clearly to the fraction of argon in excess. Plateau age could reflect the time of biotite forming.

+ VN576 (15°28'34"; 107°50'27") is a micaschist including quartz, biotite, kyanite, garnet, and some muscovites. The foliation is underlined by biotite and kyanite. The albitic feldspar blast presents an internal foliation composing of quartz, muscovite, biotite and tourmaline, graphite. Garnet presents the growing rim in cross form with radial fibres formed by quartz and opaques. This sample represents typically an isodegree zone of

metamorphism of kyanite-biotite. The age spectra of biotite (Fig. 3) obtained from this sample presents a plateau of 237 ± 3 Ma which corresponds to intermediate temperature steps. The primary steps give the dispersal age between 164 Ma and 236 Ma. The final step of spectra corresponds to ages at 226-223 Ma. For this sample, the plateau age is not well defined as the previous one. It could be related to the complex mineralogy of this micaschist indicating for the important exchange, which formed the style of the spectra. Total age calculated on whole step is equal 230.6 ± 3 Ma.

4.2. Sample in eastern part of Kham Duc Formation relating to Tra Bong shear zone

- Sample in Tra Bong and Tra Tan faults

+ VN536 (15°15'08"; 108°28'21"): on the field, we observed the alternance of different mylonite bands of amphibolite and micaschist. The amphibolite contains biotite, hornblend plagioclase and rarely diopsidic clinopyroxene and apatite. The deformation is well underlined in microband of micaschist where syn-tectonic biotites are numerous which indicate a dextral C/S structure. The age spectra of biotite show a homogeneous plateau of 70 % liberated ^{39}Ar , at 248.1 ± 35 Ma (Fig. 4a).

+ VN537 (15°15'08"; 108°28'21"): mylonitic albitic gneiss composing quartz, biotite, albitite, tourmaline, zircon, apatite. The deformation giving the structures C/S with dynamic recrystallization of quartz, biotite gives a homogeneous spectra allowing to calculate a plateau age of 237.7 ± 3 Ma on 60% of liberated ^{39}Ar (Fig. 4b).

+ VN544 (15°13'24"; 108°25'55"): micaschist contains muscovite, fibrous sillimanite, biotite. In this deep amphibolite facies metapelite sample, quartz, muscovite and fibrous sillimanite underline the foliation. In plan C, sillimanite and muscovite define a shear deformation at high temperature and isolate the

nodules of sillimanite sigmoid. The biotites and muscovites are also in fish form. The biotite defines a homogeneous plateau age with more than 95% ^{39}Ar released, from the low temperature until fusion. The determined age is of 245.5 ± 3 Ma (Fig. 4c).

+ VN545 ($15^{\circ}13'24''$; $108^{\circ}25'55''$): quartzite contains muscovite, albite-oligoclase, garnet and rare zircon. The syn-tectonic muscovite underlines foliation. Age spectra obtained from muscovite present a pseudo-plateau, because of almost of ^{39}Ar radiogenic argon has been released since the second increase of temperature during heating. The nearly perfect transparency of this mineral explains this phenomenon. The integrated age is of 250 ± 4 Ma (Fig. 4d).

- Sample in Tra Bong fault

+ VN284 ($15^{\circ}15'08''$; $108^{\circ}34'34''$) is mylonitic granodioritic orthogneiss. It contains quartz, K-

feldspar, antiperthitic plagioclase, hornblende, biotite, epidote, sphene, and zircon. The biotites are syntectonic and underline foliation. One of these biotites gives an irregular spectrum, showing age increasing at low temperature, from 100 Ma to 226 Ma (Fig. 5b). The next step, which releases more than 50% of radiogenic argon giving age of 229 Ma, follows just after by a "plateau" formed by four steps of 223 Ma. The final step, corresponding to only 2% of ^{39}Ar , corresponds to an age of 234 Ma - the maximal value given by this sample.

+ VN286 ($15^{\circ}14'14''$; $108^{\circ}26'53''$): dioritic orthogneiss with mylonitic structure of high temperature showing quartz ribbon, acid plagioclase, biotite, apatite and zircon. The biotites are titaniferous and can expulse their Ti in the form of aiguillete of rutile. The age spectrum of this biotite (Fig. 5a) is composite

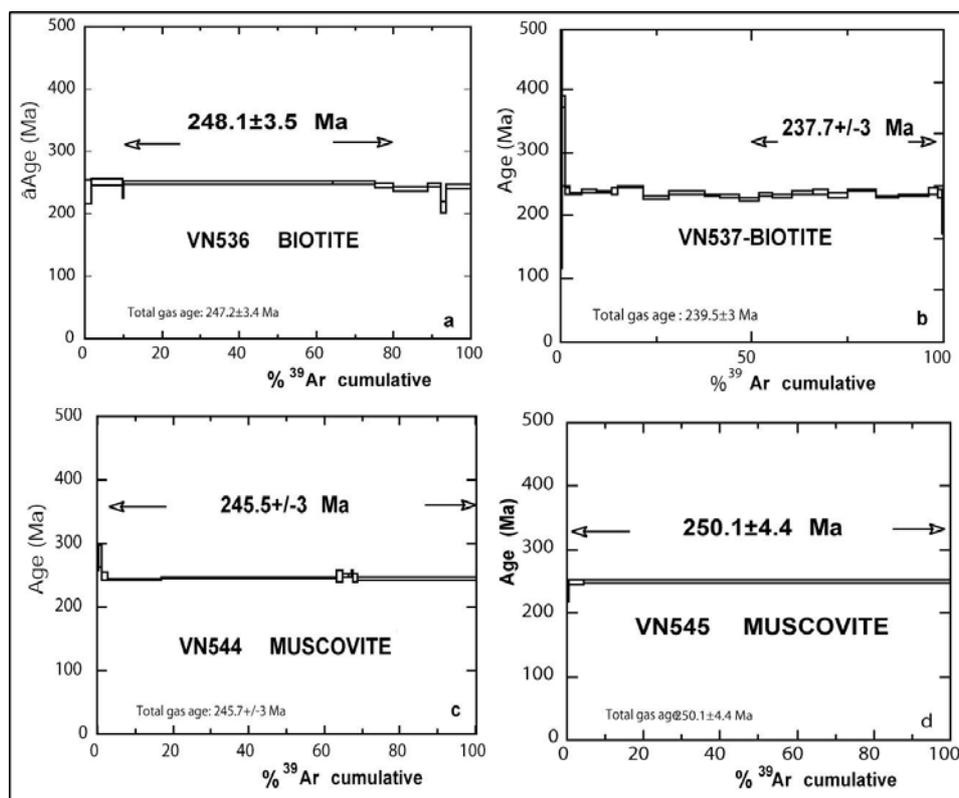


Fig. 4. Age spectra of metamorphic rocks inside two ductile faults of Tra Bong shear zone.

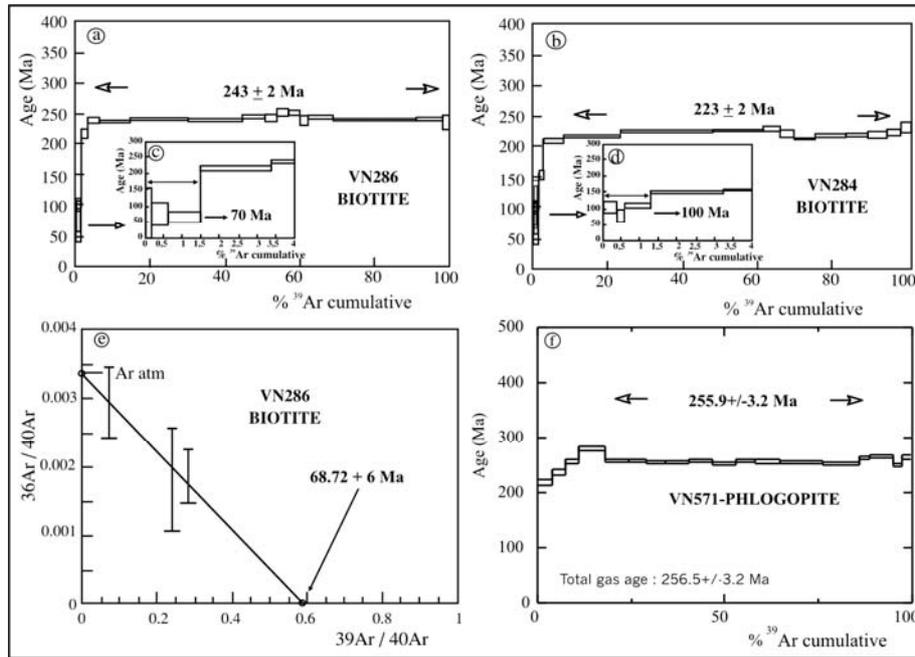


Fig. 5. Age spectra of deformed rocks at Tra Bong fault and metamorphic event in northern part of Kham Duc Formation.

and presents a plateau of 243 Ma, calculated for 95 % of ^{39}Ar released from the low temperatures. The beginning of the spectra is particularly informative: the three primary steps (enlarged in Fig. 5c) give homogeneous ages in which we can calculate one value integrated of 70 Ma. The isotopic rapports present in inverse isochrone, which gives for these steps an intercept corresponding to an age of 68.7 ± 6 Ma (Fig. 5e), with ratio $^{36}\text{Ar}/^{40}\text{Ar}$ initially corresponding to ratio of normal atmospheric argon (295.5).

4.3. Sample in northern part of Kham Duc Formation

One sample located in northern part of Kham Duc Formation (Fig. 1c) and far from zone of shear, is selected to analyse for obtaining the metamorphic age.

+ VN571 ($15^{\circ}46'10''$; $107^{\circ}50'03''$) is a marble without of ductile deformation showing calcite, phlogopite, muscovite, plagioclase and quart. The phlogopite is analysed by step heating

technique and gives a spectrum with a plateau age of 255.9 ± 3.2 Ma (Fig. 5f) corresponding to 70% of released ^{39}Ar . This spectrum shows a loss of argon for 4 steps at the beginning of released gas, corresponding to 20 % ^{39}Ar . These steps could be related to later event of ductile deformation of shear zone in the southern part.

5. Discussion and conclusion

5.1. Timing and thermal evolution

Relating to age of metamorphism in western part of Kham Duc Formation and two faults (Tra Mi and Tam Ky), four samples have been analysed. All four ages are fallen on the interval of Indosinian event: hornblende (VN580) and biotite (VN576) reflect activity of indosinian metamorphism accompanied shear deformation, evidenced for western zone of Kham Duc Formation. The biotite VN577 and

VN866, typical syn-kinematic minerals, reflect the ultimate movement of two faults at 229 Ma, it means western part of Tra Mi and Tam Ky shear zone.

Concerning to eastern part of Kham Duc Formation and Tra Bong shear zone, 6 samples have been analysed. The samples VN536, VN544, and VN545 correspond respectively to amphibolites, micaschists and quartzites situated in the south of Tra Bong fault. They show plateau age between 245 and 250 Ma. This group of age is similar to value found on ensemble of minerals of syn-tectonic metamorphism analysed in the north of Tra Bong shear zone, i.e. in Dai Loc - Khe Sanh shear zone and Tra Mi, Tam Ky one. This age corresponds to age of metamorphism associated to Indosinian orogeny. We noted that these three samples are less deformed than samples located exactly at Tra Bong fault. The sample VN537 showing C/S structures underlined by biotites, which have given a plateau age of 237 ± 3 Ma. This age is younger than the previous one and is clearly related to crystallization or recrystallization of biotites during mylonitic deformation, which is developed locally in this sector. One sample (VN571) in the northern part of the studied area, far from zone of shear, has been investigated. Age of this sample corresponds to age of metamorphism of Kham Duc Formation at 255.9 Ma. The samples which are selected in the main mylonitic zone of Tra Bong shear zone (VN284 and VN286) show a considerable difference of their age spectrum shapes in comparison with the samples in the zone that less deformed: the biotite VN284 does not present a plateau corresponding to a mineral while the totality of the sites are affected by a loss of argon after its primary closing. If the final steps present the homogeneous ages, they give only an integrated age clearly younger than the previous one, being 223 ± 2 Ma. Moreover, the steps correspond to releasing of ^{39}Ar at low temperature show the ages of about 100 Ma. It

is clearly that this mineral is underwent a reopening of its matrix after the primary crystallization, at about 245-250 Ma. The thermo-tectonic event related to this reopening is sufficiently intense to open the sites of low temperature, and causes a loss of argon to form the intermediate ages on the more retentive sites (sites of high temperature). However, it is not possible to fix accurately the age of this event because the gas released of low temperature steps is enough to obtain a precise value. The biotite of mylonite VN286 has the same type of information as the biotite VN284, but with more detail: here, this mineral gave a plateau well defined, in which, age falls in Indosinian event, with value of 243 ± 2 Ma. The primary steps at low temperature gave an accordant age in which integration allows to calculate a value of 70 ± 10 Ma. If take into account the range of error, we have here a good precision on age of thermo-tectonic event which reworked the system and gave an age around 70 Ma. We have confirmed the isotopic data by using inverse isochrone diagram, which allows to propose an age of 68.7 ± 6 Ma (Fig. 5e).

In summary, we can propose the evolution scenario of metamorphism and ductile deformation of the studied areas as follows: this zone is affected by metamorphism and deformations in Indosinian time between 245 and 250 Ma. The mylonitic ductile deformations happened in around 237-238 Ma. A low temperature event affected this zone between 150 and 50 Ma, clearly in around 70 Ma.

5.2. Age, metamorphic evolution and possible tectonic signification

Indosinian tectonic event relating to collision of different Gondwanaphile fragments during Permo-Triassic has been firstly recorded by regional stratigraphic discordance in Vietnamese-Laotian-Cambodian geological basement [3] and well defined by radiometric data relating to the ductile deformation in Truong Son belt and

metamorphism in Kon Tum massif [9,10, 19, 12, 20]. The ages obtained in this research also mark an Indosinian event in different places. However, the presence of an intense deformation accompanying metamorphism in amphibolite facies and the occurrence of some ophiolitic ultra-mafic serpentinitic body inside this zone, so this W-E metamorphic shear zone could be representative for the main tectonic boundary between Kon Tum metamorphic massif and non-metamorphic Truong Son belt during Indosinian movement.

Ensemble of structural measurements showing the southern dip regional foliation and the mineral assemblage observation showing different metamorphic isodegrees from the south to the north (sillimanite-biotite/kyanite-biotite/chlorite-garnet), so the Kham Duc Formation could be explained by a regional inverse prograde metamorphism relating to collision between two micro-continents Kon Tum and Truong Son belt corresponding to the metamorphic age of 240-260 Ma presented above. The W-E sub-vertical foliation and sub-horizontal lineation movement of shear zones in this area could be a final stage of collision corresponding to the age of 220-230 Ma (obtained by sample in the fault). This characteristic structure could be explained by changing of stress field related to oblique subduction as proposed for Po Ko paleo-suture in W of Kon Tum massif [6]. The Kham Duc Formation could be represented for transition zone (main boundary) between two Gondwanian micro-fragments Truong Son and Kon Tum massif.

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