CHAPTER IV

CHERT AT KHAO CHAN AND CHERTIFICATION

Chert is a sedimentary rock made up of chemically precipitated silica, composed largely or entirely of fibrous microcrystals of chalcedonic quartz and microcrystalline or cryptocrystalline quartz which mostly formed during diagenesis (Berner, 1971).

In the sedimentary succession of Thailand , bedded cherts and nodular cherts are recognised in carbonate sequences throughout the geological times. In the Paleozoic era, the distribution of cherts in broad area of western province are as follows:

In the Lower Paleozoic era, there are abundant chert nodules in Tha Manao limestone of Chao Nen Group of Ordovician period, and the nodular cherts in bedded limestone in Doi Musur Group of Silurian-Devonian periods (Bunopas, 1981).

In the Upper Paleozoic era, the distribution of cherts are in Phra Woh limestone (Bunopas, 1981), and Khao Plukmu Limestone (Bunopas , 1976) in the western province. The more abundant of both nodular and bedded cherts are associated with carbonate sequences of the Saraburi Group (Bunopas, 1981) in central Thailand particularly in the Phu Phe, Khao Khwang, Nong Pong, Khao Khad, and Sab Bon Formations (Hinthong et al., 1985).

Moreover, the Tak Fa Formation (Nakornsri, 1977) in the vicinity of Changwat Nakorn Sawan contains nodular cherts in very thick bedded limestone succession. In the area of Loei fold-belt, the Nam Mahoran Formation (Charoenprawat et al., 1984, Assavapatchara, 1998) and Pha Nok Khao Formation (Chonglakmani and Satayarak, 1984) also contain nodular and bedded cherts in limestone sequences. In the central north, the Pha Huat Formation (Piyasin, 1972) of Ngao Group (Bunopas, 1981) is characterised by the very thick-bedded limestone succession with nodular and bedded cherts.

In the Sukhothai fold-belt, the Phrae Group (Bunopas, 1981) of Middle Permian to early Upper Permian age is characterised by a thick flysh with thin limestone assemblages following up to radiolarian chert, thin limestone and ultramafic rocks with pillow lava basalt. In the eastern part of Thailand, the Sra Kaew Formation of Chanthanburi Group (Bunopas, 1981) is also represented by the radiolarian chert, limestone and composite melange assemblages.

In the Mesozoic era, the Mae Sarieng Group (Bunopas, 1981) of Triassic-Jurassic age in the western north consists of shale, sandstone, and intercalations of thin chert beds and limestones.

4.1 Chert in sedimentary sequences at Khao Chan area

The Cherts in carbonate sequences examined in this study, Khao Khad Formation at Khao Chan area, are totally 595 to 865 metres thick consisting of largely calcilutite to fine calcirudite with subordinate cherts. The chert-bearing carbonate sequences are altogether five separate lithofacies out of totally nine lithofacies of Khao Khad Formation at Khao Chan area.

They are: Lithofacies I consists exclusively of dark grey to black nodular cherts in dark grey calcilutite; Lithofacies III consists exclusively of dark grey nodular cherts in grey to dark grey coarse calcarenite and fine calcirudite; Lithofacie V consists dominantly of dark grey banded cherts in grey to light grey normal graded bedding of calcarenite to calcilutite; Lithofacies VII consists mostly of dark grey nodular cherts in dark grey calcarenite to fine calcirudite; and Lithofacies VIII consists some of high impurity cherts, porcelanite, in limestone interbedded with silt-shale. In addition to darkcoloured cherts in these five lithofacies, the light grey, translucent and structureless cherts commonly occur within chert layers in lithofacies V.

For the lowermost lithofacies, lithofacies I, these cherts are characterised by dark grey to black nodular cherts with the size varies from a few centimetres to several decimetres. In the lower part of the lithofacies, the cherts display ellipsoidal shape with longitudinal axis lies parallel or sub-parallel to the bedding plane with the size ranging form 5 to 10 centimetres along short axis and 10 to 40 centimetres along long axis (Figure 4.1). Occasionally, the geometry of the nodular cherts is deformed within the carbonate host rock.

In the middle part of the lithofacies, the nodular cherts in limestone usually display irregular shape of different sizes ranging from a few centimetres to several decimetres (Figure 4.2, 4.3). They are scattered in medium-bedded limestone beds. In the uppermost of the lithofacies, the cherts are characterised as elongated nodules flattened in the plane of the bedding similar to those in the lowermost part of the lithofacies (Figure 3.15). On the weathered surface of cherts, small irregular cavities and moulds of fossils particularly foraminifera are most common. These cavities and moulds represent by dissolution of pre-existing carbonate grain components in the chart. The average quantity of cherts in this lithofacies is approximately 5 to 10 per cent.

Petrographically, the nodular cherts in the lithofacies I is consisting of microcrystalline quartz and chalcedonic quartz. The microcrystalline quartz forms the bulk of most chert nodules. The individual grains of microcrystalline quartz possess undulatory extinction and are less than ten microns in size with the average of 3 to 5 microns in diameter which interlocking in random orientation. The aggregate has "pinpoint" birefringence, but, in some parts, the grains are so small as to make the aggregate appear nearly isotopic. The chalcedonic quartz appears to be composed of

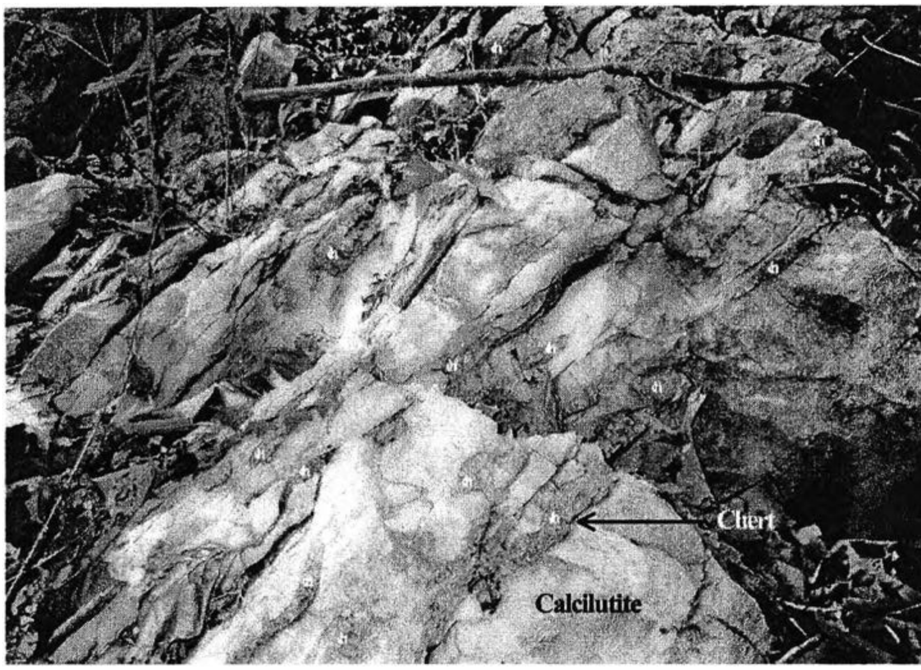

Figure 4.1 The flattened elongate nodular cherts in the lower part of lithofacies I scatter in thin- to medium-bedded, dark grey calcilutite.

Figure 4.2 The irregular shape nodular cherts in the middle part of lithofacies I scatter in medium-bedded, dark grey calcilutite.

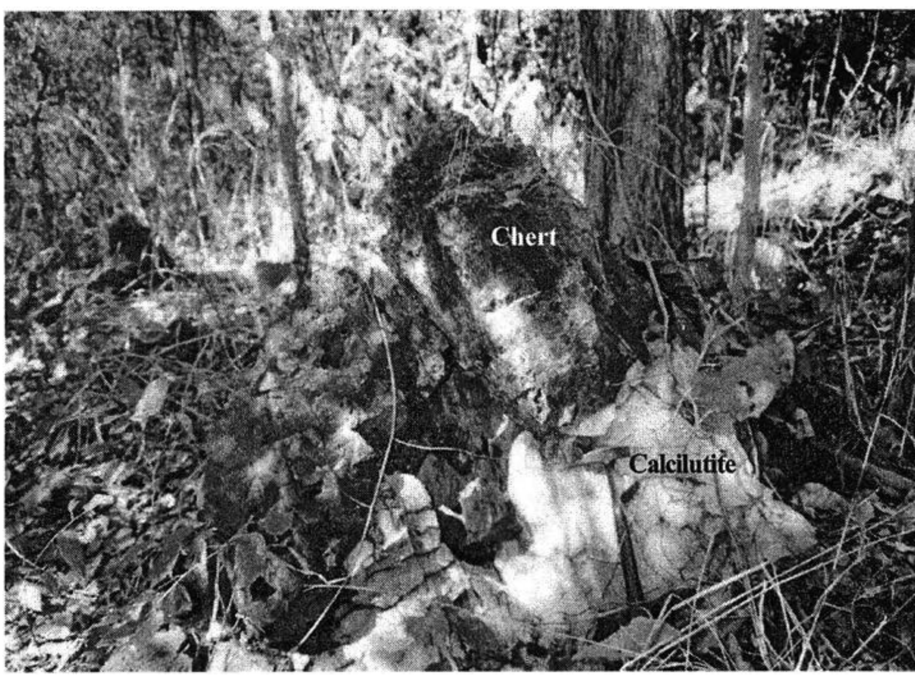

Figure 4.3 The big nodular cherts with the size larger than a metre associate with medium-bedded dark grey calcilutite of the lithofacies I.

radiating or sheaflike bundles of fibres with few microns in diameter and ranging up to 200 microns or more in length. The brownish colour of impurity are disseminated throughout the body of chert and isolated small rhomb of dolomite scattered in some parts of chert (Figure 4.4, and 4.5).

In the lithofacies III, nodular cherts of difference sizes and shapes are evenly distributed in the carbonate sequence of calcarenite to fine calcirudite of totally 57 to 117 metres thick. The chert is characterised by lens and elongated nodular shape of dark grey colour with the average size of a ten centimetres along the short axis and 60 centimetres along the long axis (Figure 4.6). It is noted that there are some original carbonate allochemical components of granule-size remain embedded in chert nodules (Figure 4.7). Besides, the fossil of crinoid stems are represented by both original carbonate composition and completely to partially chertified forms. The amount of chert in lithofacies III is approximately 5 to 10 per cent.

Petrographically, the nodular cherts in the lithofacies III is consisting of microcrystalline quartz and chalcedonic quartz with abundant carbonate remnants and isolated dolomite rhombs. The microcrystalline quartz forms as the matrix of chert nodules characterised by fine-grained microcrystalline aggregate. Individual grains of microcrystalline quartz, under the high magnifications, commonly shows an undulatory extinction with less than ten microns size. They are interlocking together as described in the lithofacies I.

Some of fine-grained microcrystalline cherts appear nearly isotropic due to the packed of very minute grains of cherts. The chalcedonic quartz consists of fibrous silica usually fill in fractures and cavities of fossils. The fibers typically create oscillatory extinction textures in cross-polarised light. The calcareous patches of both sparry calcite and micrite are scattered in fine-grained chert matrix with tiny isolated dolomite rhombs. Besides, some parts of the chert show the ghost structure of former

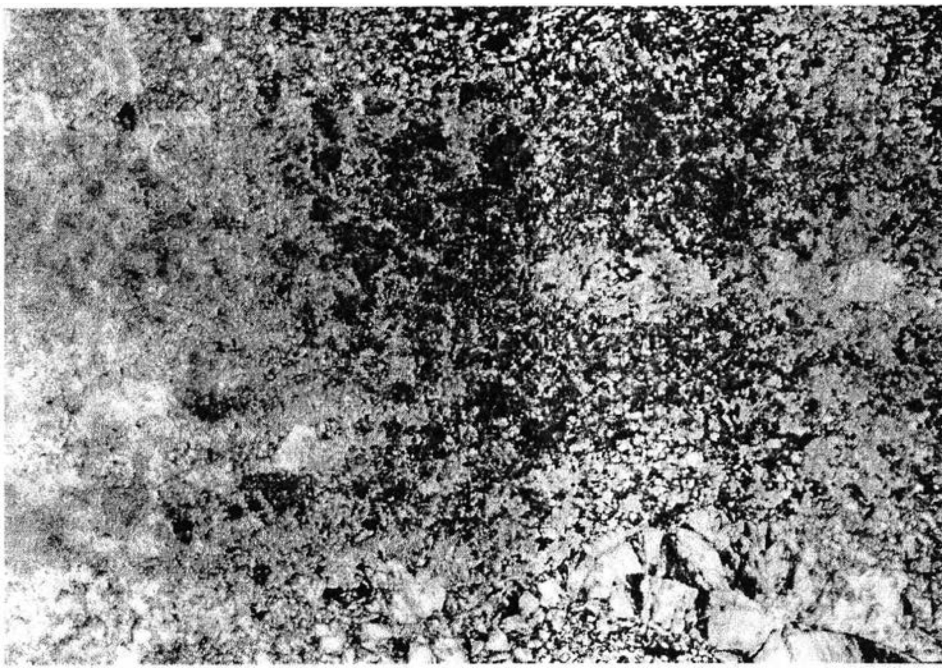

Figure 4.4 The photomicrograph of nodular chert of the lithofacied I showing the microcrystalline chert with spherulitic texture of chalcedonic chert enclose the fine-grained calcareous patches. (Crossed nicols, x44)

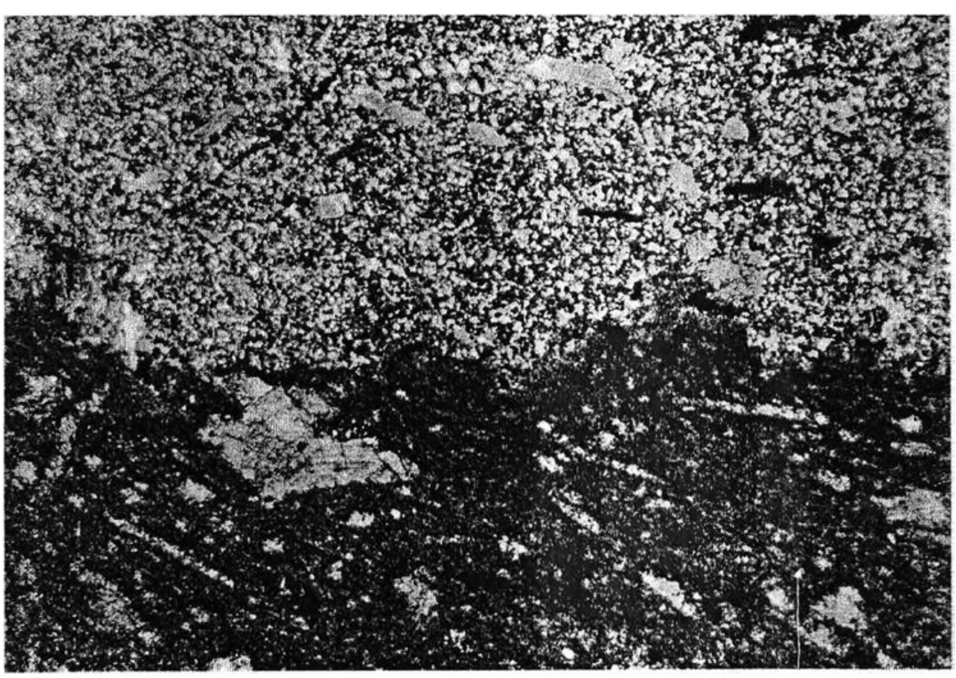

Figure 4.5 The photomicrograph of nodular chert of the lithofacies I showing the microcrystalline chert with small individual dolomite rhombs scatter in the chert (upper half part) and the fine-grained carbonate (lower half part). (Crossed nicols, x44)

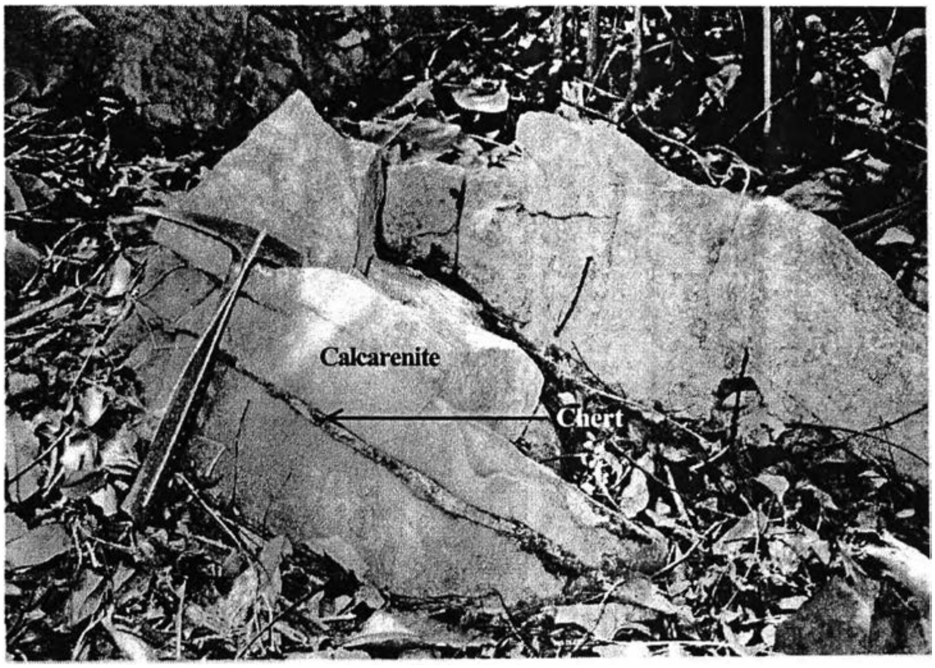

Figure 4.6 The outcrop of dark grey elongate nodular chert in grey calcarenite of the lithofacies III.

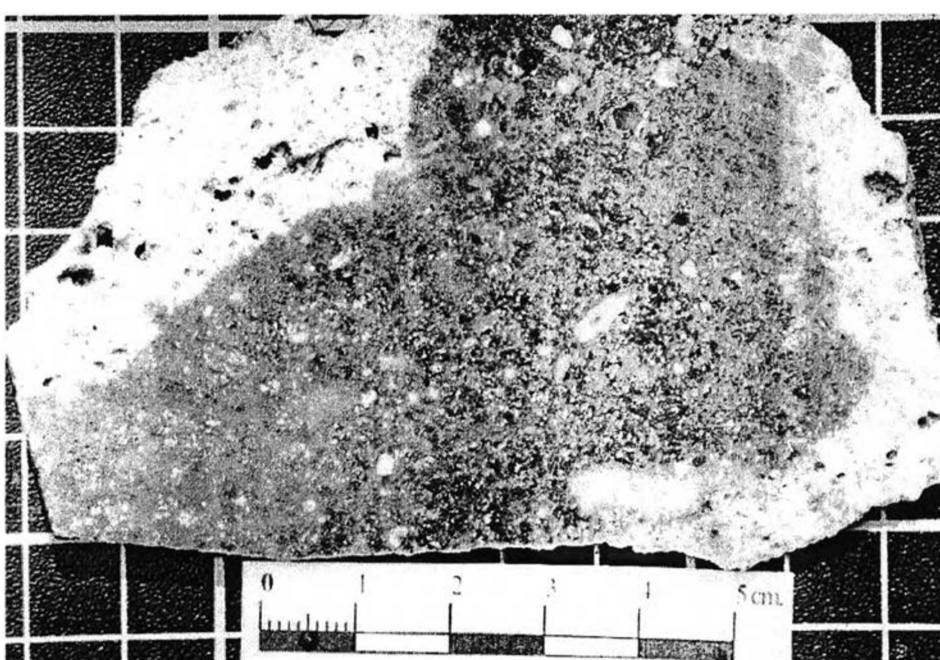

Figure 4.7 The rock slab of nodular chert of the lithofacies III showing the abundant calcareous skeletons embedded in chert with pores of dissolved carbonate parts in weathered chert, outer rim.

calcareous skeletons which completely replaced by chert. The remnant of calcareous skeletons partially replaced by chert are also recognised (Figures 4.8, and 4.9).

In the middle part of the sequence of the Khao Khad Formation, lithofacies V, the cherts are distributed in thin-bedded calcarenite/calcilutite interbedding as dark grey banded and nodular cherts. The banded cherts appear as alternating layers in light grey to grey, thin-bedded, limestone beds, that usually differ in colour (Figure 4.10). The thickness of banded cherts vary from 1 centimetre to 10 centimetres, with more than a metre in length conformably embedded in limestone beds. The nodular cherts are mostly elongated nodular shape of dark grey colour with varying sizes from 2 to 10 centimetres along the short axis and 10 centimetres to a metres along the long axis (Figure 4.11). There are some skeletal remains embedded in cherts especially those associated in the calcarenite. It is noted that the light-coloured cherts implanted in the calcilutite are translucent, structureless, and lack of skeletal remain. The amount of cherts in the carbonats sequence of lithofacies V is approximately 10 to 20 per cent.

Petrographically, the banded and nodular cherts of the lithofacies V is consisting of microcrystalline quartz, megaquartz (Folk, 1950), and chalcedonic quartz. The microcrystalline quartz is similar to those in nodular cherts of the lithofacies I and III. The megaquartz is a well-defined crystal of authegenic α-quartz of any size and absent of crystallographic complexities of any microquartz or fibious silica. The megaquartz occures as drusy quartz crystal or as intergrown crystal in cavities of fossils. The chalcedonic quartz of the lithofacies V is quite similar to those in the lithofacies I and III, but there are some more features which can be distinguished that the chalcedonic quartz forms the spherulitic texture and concentric ring texture with fibers regulary oriented at right angles around the rim. Some of chalcedonic quartz forms parallel two banded texture. It is suggested that some of chalcedonic quartz features are casts of former sponge spicules. The mass of chert usually contains some of calcareous remnants especially, more abundant, in the rim of chert bodies.

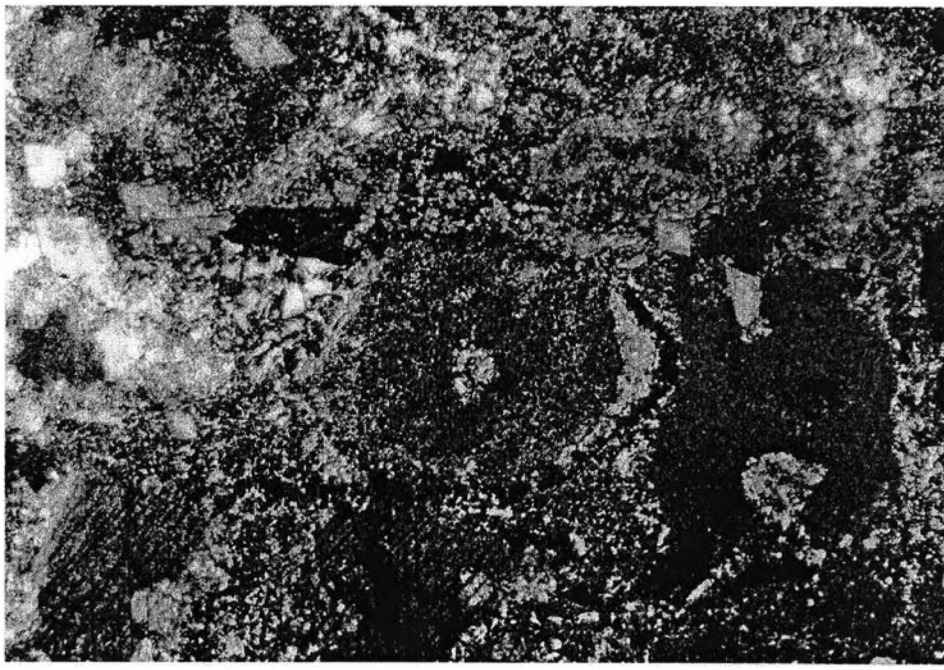

Figure 4.8 The photomicrograph of nodular chert of the lithofacies III showing carbonate patches remain in microcrystalline chert with some chalcedonic cherts and dolomite rhombs. (Crossed nicols, x44)

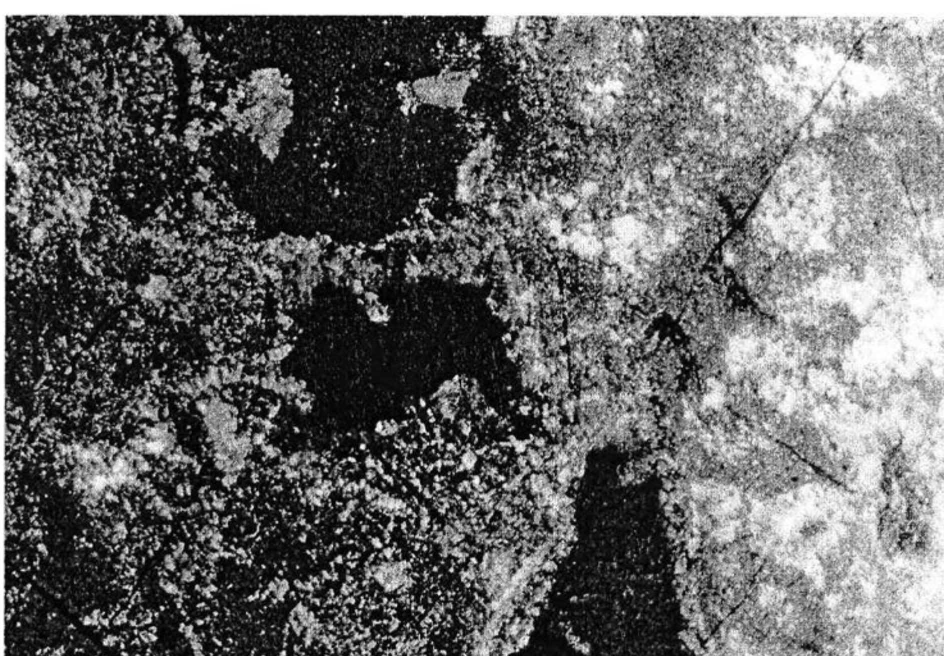

Figure 4.9 The photomicrograph of nodular chert of the lithofacies III showing partially silicified carbonate parts remain in microcrystalline chert matrix. (Crossed nicols, x44)

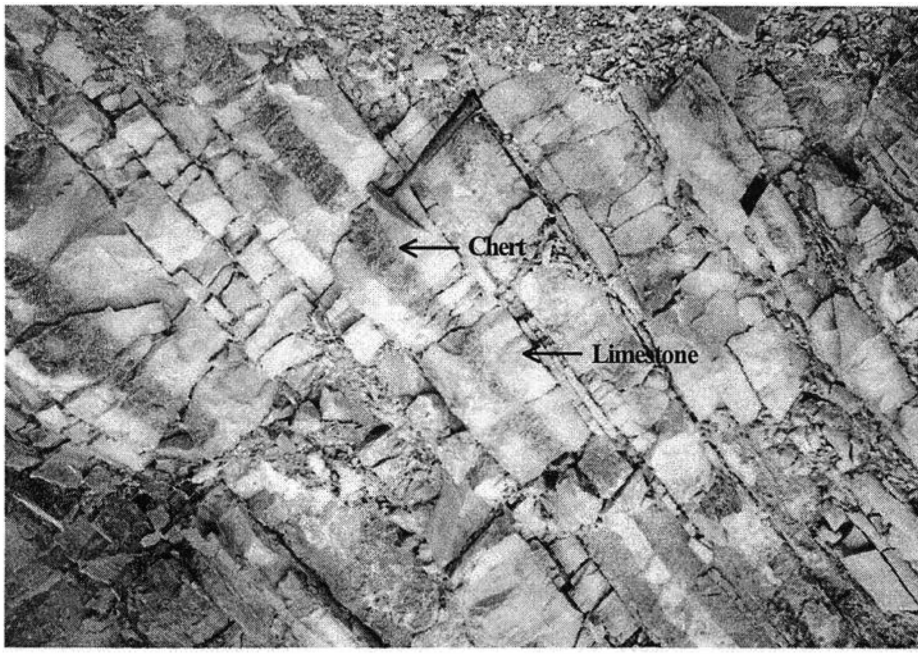

Figure 4.10 The exposure of grey to dark grey banded cherts in thin- to medium-bedded graded bedding calcarenite to calcilutite of the lithofacies V.

Figure 4.11 The exposure of black elongate nodular cherts in medium-bedded calcarenite of the lithofacies V.

In the lower part of the lithofacies, the isolated dolomite rhombs scatter in the fine-grained chert matrix (Figures 4.12, and 4.13).

In the lithofacies VII, the cherts occur chiefly as elongated nodules with their long axis essentially parallel to the bedding plane (Figure 4.14). The size of nodular cherts are 2 to 20 centimetres along the short axis, and 10 to 70 centimetres along the long axis. It is noted that there are some chert lenses located closely to spotted dolomitic limestones. The quantity of cherts in the lithofacies VII is approximately 3 to 5 per cent.

Petrographically, the elongate chert nodule is consisting of, mostly, microcrystalline quartz with abundant small calcareous patches of micrite, sparry calcite, and calcareous skeletons. Some parts along the rim of the elongate nodular chert, there is alignment of detrital quartz with size varies from 10 to 50 microns. The microcrystalline quartz usually shows the ghost structure of original calcareous skeletons and forms as the matrix in the chert body (Figures 4.15, and 4.16)

The upper part of the carbonate sequence of Khao Khad Formation in the study area, lithofacies VIII, is represented by a sequence of limestone interbedded with silt-shale which subordinate of "impure chert", or "porcelanite" (Bramlette, 1946). The impure chert is characterised by thin-bedded, dull colour of white to light grey resembling that of unglazed porcelain, brittle, with high porosity. The porcelaneous rocks are locally present interbedded with silt-shale which can not be estimated quantitatively because of the few exposures, and soil covered in most part.

Petrographically, the porcelanite consists essentially of a mixture of clay or silt clay with a large proportion of siliceous skeletons like sponge spicules and less abundant calcareous matter. The spherulitic and concentric ring textures of chalcedonic quartz which the fibres are regularly oriented at right angles around the cast of the

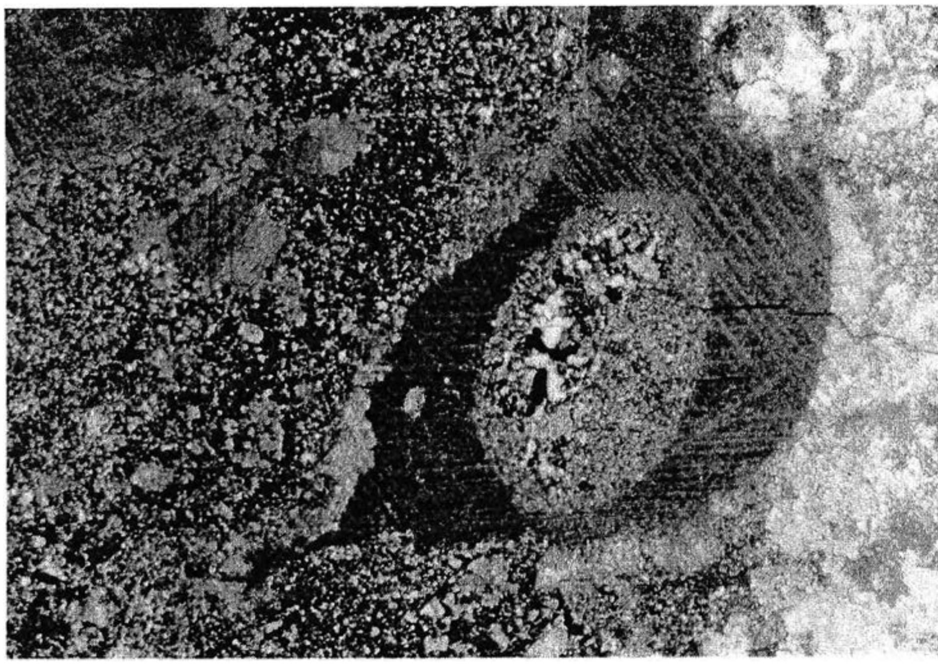

Figure 4.12 The photomicrograph of nodular chert of the lithofacies V showing microcrystalline quartz, chalcedonic quartz, and megaquartz with calcareous remnants. (Crossed nicols, x44)

Figure 4.13 The photomicrograph of banded chert of the lithofacies V showing some sponge spicules in microcrystalline quartz (in the centre of picture). (Crossed nicols, x44)

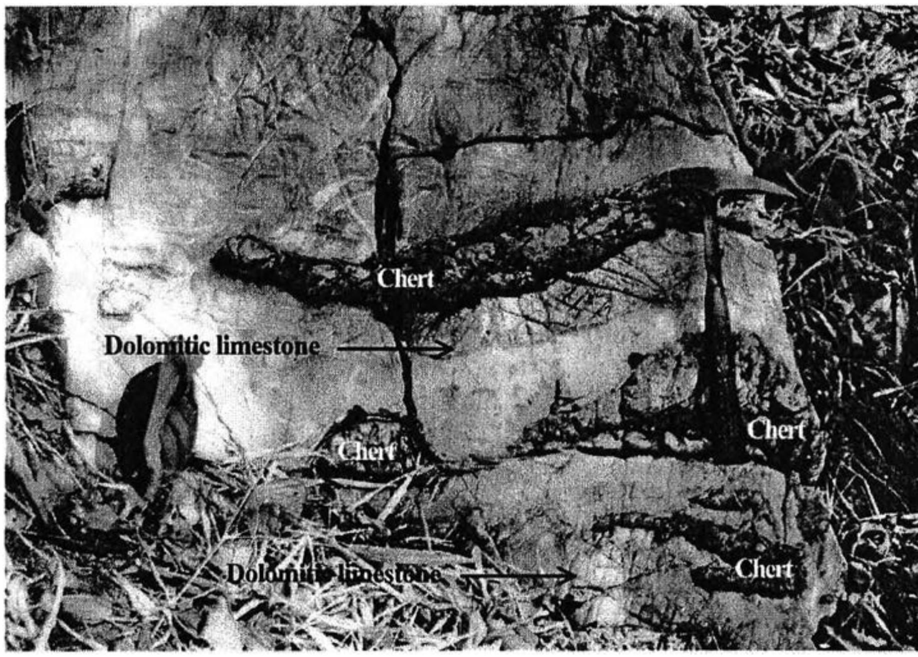

Figure 4.14 The outcrop of dark grey calcarenite of the lithofacies VII showing the elongate chert nodules and elongate dolomitic limestone patches in close contact oriented conformably to the bedding plane.

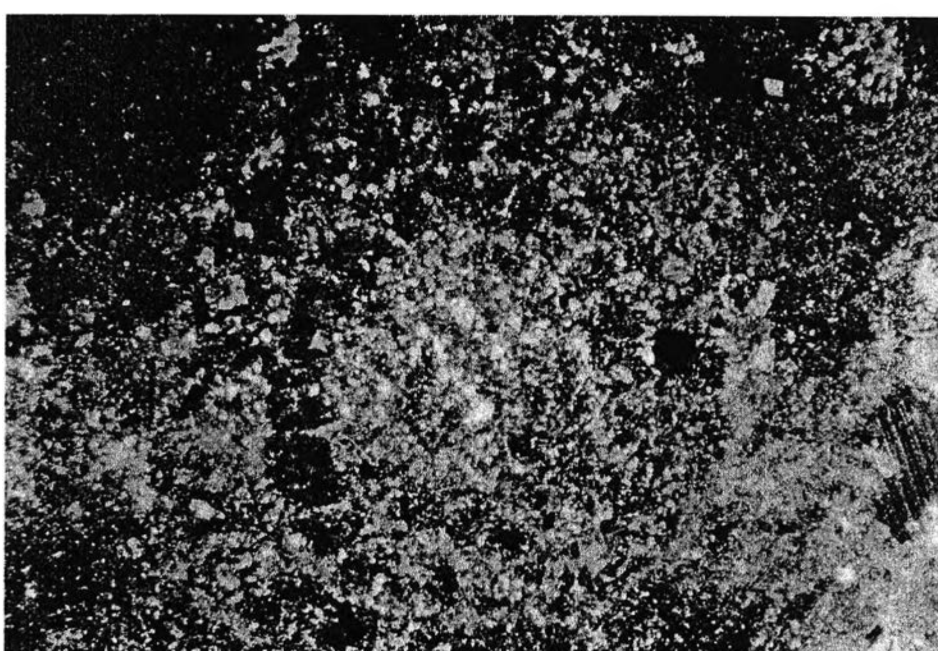

Figure 4.15 The photomicrograph of nodular chert of the lithofacies VII showing the ghost structure of pre-existing fossil replaced by microcrystalline chert with small patches the fine-grained carbonate and calcareous allochems. (Crossed nicols, x44)

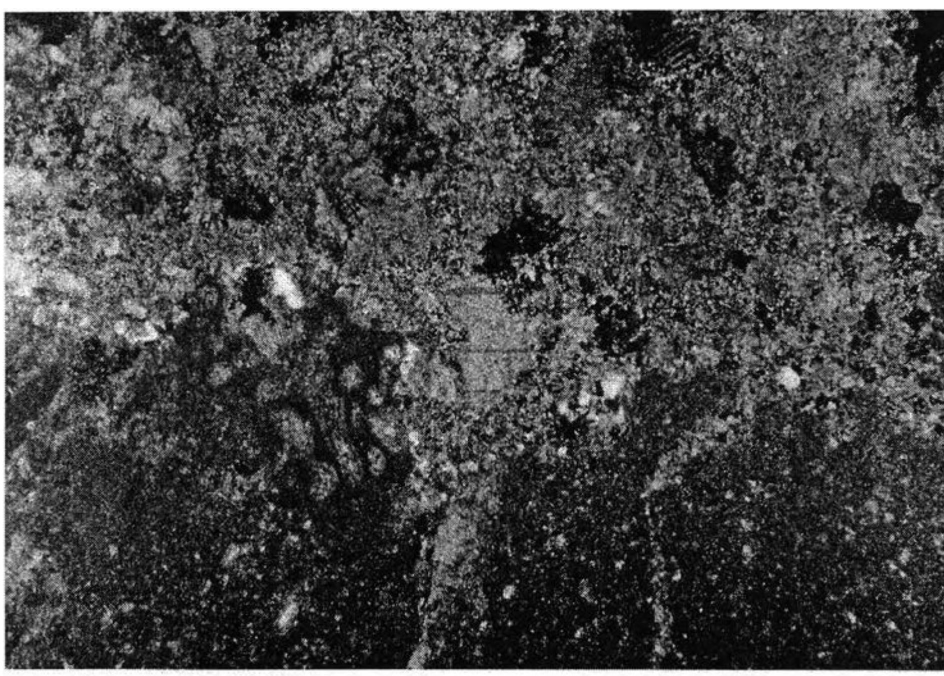

Figure 4.16 The photomicrograph of nodular chert of the lithofacies VII showing the alignment of detrital quartz with size varies from 10 to 50 microns along the rim of the elongate nodular chert. (Crossed nicols, x44)

original siliceous skeletons, approximately 20 to 120 microns size, sparsely distributed throughout the matrix of brownish colour of cryptocrystalline quartz (Figures 4.17).

4.2 Detailed characteristics of cherts

The data presented in this part are from a detailed petrographic study of cherts in the four lithofacies of the chert-bearing carbonate sequence of the Khao Khad Formation at Khao Chan area. Petrographic conclusion is based on examinations of rock-slab samples, and thin-sections collected from five measured rock-sections. Besides, additional attempt has been made to examine 6 samples under the scanning electron microscope. The various lithology as well as texture of cherts recognised under the polarising microscope can be categorised into three types, namely, cavity-fills, fossil replacements, and matrix cherts. They are present in all of the five lithofacies and they are also commonly associated in the same chert masses.

The cavity-filled type is abundant in nodular and banded cherts associated with coarse carbonate allochems. This type of cherts can be further subdivided into two kinds; notably, intergranular void-filling and intragranular void-filling. The texture of intergranular void-filling chert can be recognised into three from, namely, fibrous rim cement of chalcedony, approximately 30 to 50 microns long (Figures 4.8, and 4.9) the microcrystalline chalcedony in elongate crystals idomorphic toward the center of the pore space, approximately 100 to 200 microns long, and granoblastic quartz, approximately 20 to 100 microns. The texture of intragranular-void filling chert generally develops within the foraminifera chamber with spherulitic, microcrystalline, and granoblastic habits (Figure 4.18).

For the fossil replacement chert, original carbonate fossil of foraminifera, crinoid stems and other skeletal materials have been partially or completely replaced by microcrystalline chalcedony (Figure 4.19). It is noted that the original skeletal outlines

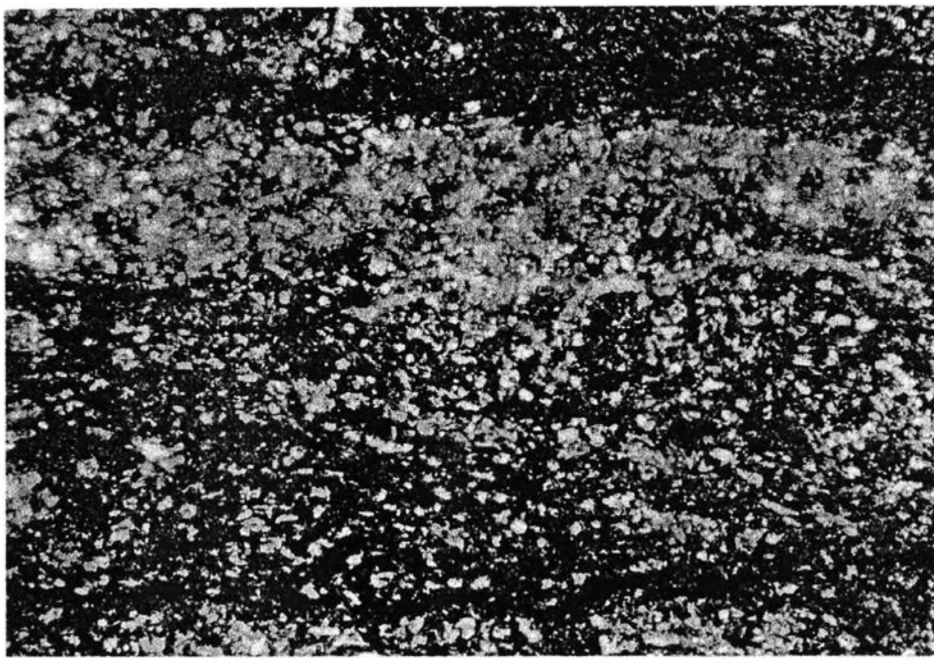

Figure 4.17 The photomicrograph of porcelaneous rocks of the lithofacies VIII showing abundant sponge spicules (white spot) sparsely distributed in the fine-grained matrix. (Crossed nicols, x44)

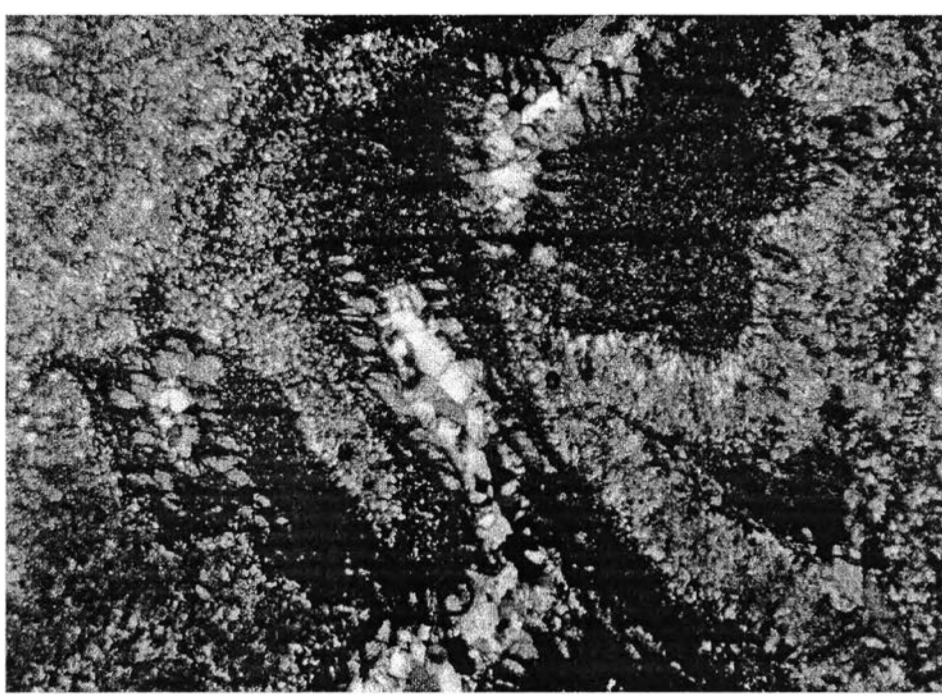

Figure 4.18 The photomicrograph of banded chert of the lithofacies V showing microcrystalline, chalcedonic, and mega quartz of cavity-filling type. (Crossed nicols, x44)

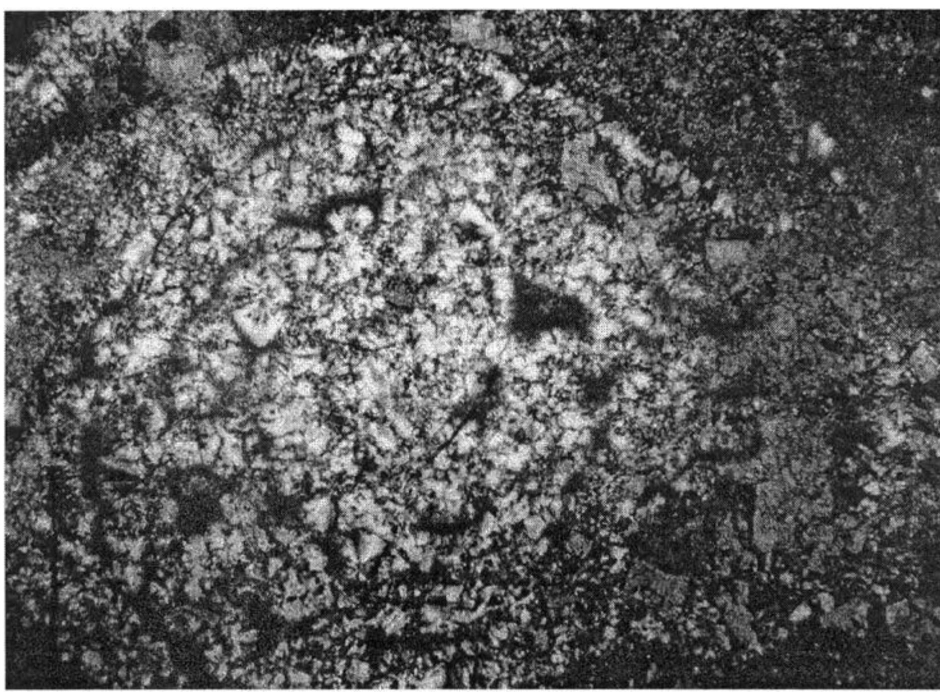

Figure 4.19 The photomicrograph of the fossil replacement chert, original carbonate fossil of foraminifera have been completely replaced by microcrystalline chalcedony showing the ghost structure. (Crossed nicols, x44)

and some internal skeletal structures are, in most cases, preserved as "relic structures or ghost structures".

The last type of chert is characterised mostly as cryptocrystalline chalcedony. However, there are some calcareous residues as a result of local or incomplete chertification as shown by varies irregular and large patches of limestone containing their normal organic and detrital constituents and isolated calcareous fossils (Figures 4.4, and 4.5). In addition isolate dolomite rhombs of difference size are also commonly embedded in the micro mosaic texture of chalcedonic chert (Figure 4.20). Beside, there are some hazy parallel outline rodlike forms of 80 micron width and 300 microns long, and some circular outline of 20 to 60 microns that may be the relic of former sponge spicules distributed on microcrystalline silica, especially in the chert of lithofacies V and VIII (Figure 4.13).

The scanning electron micrographs of etched chert samples show that the cherts are chiefly composed of granular texture, generally 1 to 5 microns (Figure 4.21). Some of the cherts show acicular texture with 1 micron width and 4 to 5 microns long (Figure 4.22). The mould of former rhombohedron of dolomite dissolved from acid etching show that the equigranular of 1 to 2 microns fine-grained chert packing around the mould and throughout the matrix (Figure 4.23). The siliceous and/or chertified skeletal materials can be microscopically distinguished from the arrangement of fine-grained chert in banded chert of lithofacies V.

4.3 Chertification

Based on data acquired from the present study, an attempt has been made to propose the origins of cherts at Khao Chan area according to their field characteristics. There are two types of chert, namely, nodular chert, and banded chert. The nodular cherts are present in lithofacies I, III, V, and VII, whereas the banded cherts are

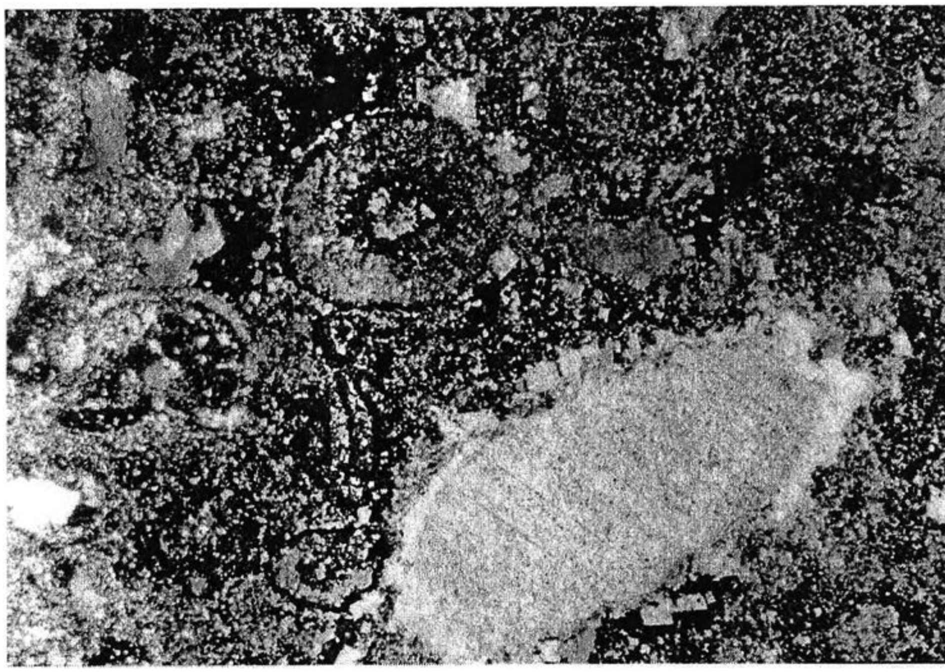

Figure 4.20 The photomicrograph of nodular chert showing the isolate dolomite rhombs and calcareous allochems of difference size are commonly embedded in the micro mosaic texture of chalcedonic chert. (Crossed nicols, x44)

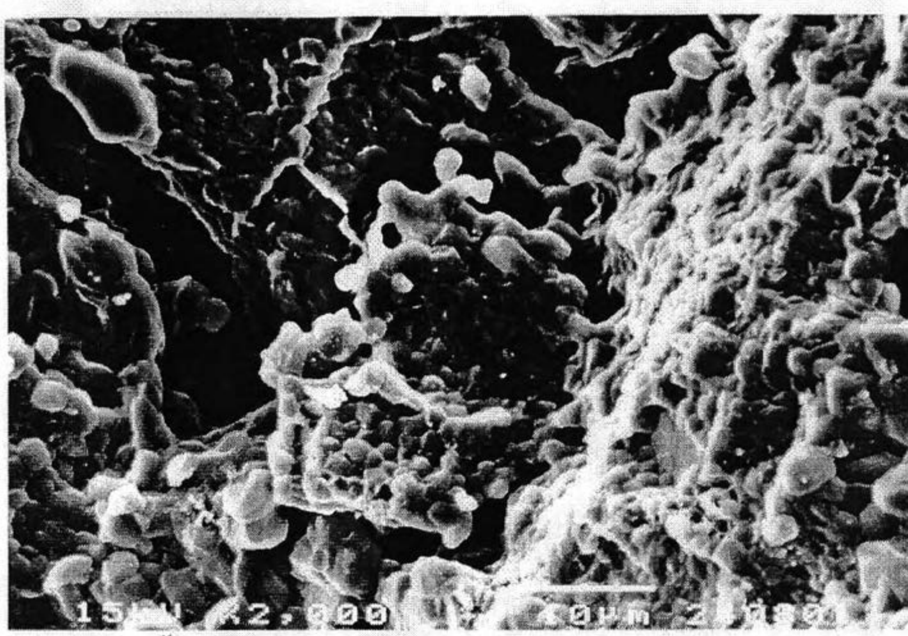

Figure 4.21 The scanning electron micrographs of etched chert samples showing the cherts are chiefly composed of granular texture, generally 1 to 5 microns size.

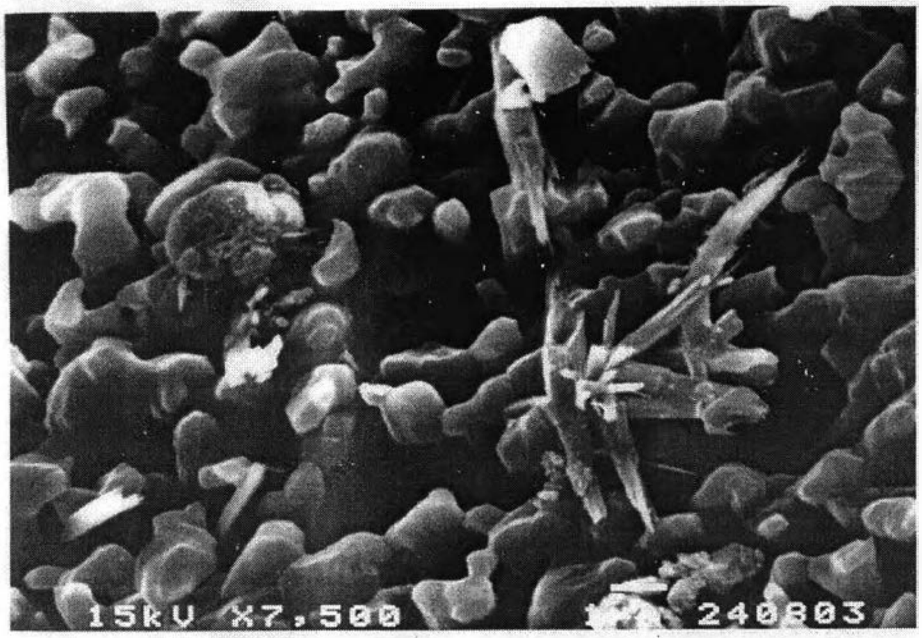

Figure 4.22 The scanning electron micrographs of etched chert samples showing the acicular texture with 1 micron width and 4 to 5 microns long in the granular texture.

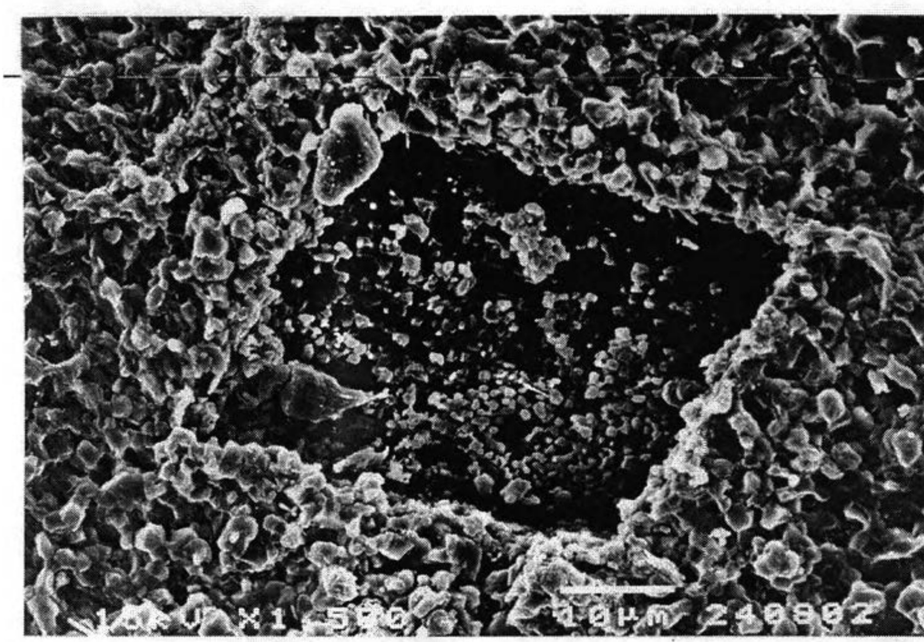

Figure 4.23 The scanning electron micrographs of etched chert samples showing the mould of former rhombohedron of dolomite dissolved from acid etching with the equigranular of 1 to 2 microns fine-grained chert packing around the mould and throughout the matrix in the granular texture.

distributed in lithofacies V, and VIII. The most difficult problems to determine the chertification are the source of silica, mode of silica precipitation, and diagenesis of silica.

Theoretically, chert is a sedimentary rock made up of chemically precipitated silica, composed largely or entirely of fibrous microcrystals of chalcedonic quartz and microcrystalline or cryptocrystalline quartz which mostly formed during diagenesis (Berner, 1971). Many authors, (Berner, 1971), suggest that the direct chemical precipitation of chert or any other forms of quartz are impossible because of the less amount of silica content in sea water. In fact, quartz does precipitate directly from solution in the laboratory that Mackenzie and Gee (1971) grew 10 microns sized subhedral quartz crystals in sea water at 20 degree celsius in 2 year.

The silica is believed to be mainly supplied by the dissolution of siliceous skeletals. During their life processes, the siliceous-secreting organisms are able to remove molecules of silica from undersaturated sea water. The silica is used to construct opaline skeletals (Kling, 1978). After death of the organisms and during diagenesis, the opal dissolved to produce aqueous solution with content of dissolved silica 6 to 120 ppm. (Blatt, 1982).

Besides, the silica content of natural water has an approximate range from 0.1 parts per million, ppm., in melted snow to 4,000 ppm. in mineral spring. However, it is less variable than any other major dissolved constituent of natural water

Originally, bedded cherts must have been laid down as some forms of silica which two possibilities as exist as to the source of silica. One is that it was precipitated inorganically from supersaturated solution, and the other is that it was supplied as the skeletal remains of silica-secreting organisms.

Table 4.1 Average silica concentration in some natural water

Type of water	Approx. SiO_2 range (ppm.)
Groundwater	5-60
Oil field brine	5-60
Rivers and lakes	5-25
Hot spring and geyser	100-600
Sea water	0.01-7

(Source: Fairbridge, 1972.)

For normal sea water, inorganic precipitation is impossible since it is undersaturated with amorphous silica. But the most favourable for possible volcanic-inorganic chert formation can be predicted. Silica released to solution from the volcanic glass in restricted basin where submarine volcanism takes place. This enables a build-up of dissolved silica to saturation in the deep water because a lack of circulation and lack of oxygen. Thus, the deep water, besides being high in silica, should be anaerobic and most likely sulphidic as in the Black Sea. The common occurrence of bedded cherts in association with black shales and submarine volcanics is a predicted result of the conditions necessary for the formation of inorganic cherts (Berner, 1971).

In certain areas of the ocean, opaline silica skeletal debris is presently accumulating in sufficiently high concentration that it would form chert if recrystallised. The modern oceans contain large number of silica-secreting organisms, about 70% of which are diatoms (Lisitzin, 1972). Second in importance are the radiolaria, followed by the silica sponges. Silicoflagellates and higher organisms also precipitate silica, but on a much smaller scale. Most ancient bedded cherts provide direct evidence of a biogenic origin in the form of fossil diatoms or radiolaria (Berner, 1971). The possible fossil evidences may be destroyed by diagenetic alterations that may cause confuse to inorganic cherts.

The nodular chert also occurs abundantly in sedimentary rocks as fossil replacement. The source of silica for such secondary chert is not as obvious as in the case of bedded cherts. The source of silica is probably the remains of siliceous skeletals in fossiliferous carbonate rocks. Dissolution of the siliceous skeletals, local migration, and precipitation of silica would be involved in the silicification or chertification of carbonate skeletals or nodular formation (Berner, 1971). The nodular cherts can be expected to form along zones of greatest groundwater flux where transport of dissolve silica is most active (Knauth, 1994)

4.3.1 Origin of nodular chert

The nodular cherts in Khao Chan area is believed to be a product of diagenesis, where the source of silica is suggested to be from the dissolution of siliceous skeletals and siliceous minerals associated with the carbonate sediments or the migration of silica-rich waters from adjacent strata. The siliceous skeletal content in limestone-bearing chert nodules strata, notably, lithofacies I, III, and VII, are relatively less abundant, but they are quite abundant and can be observed in the lithofacies V, and VIII. Besides, the silt-shale laminations containing siliceous minerals, such as quartz, muscovite, and chlorite, are usually recognised between limestone bearing nodular chert beds.

The dissolution of siliceous matter, siliceous skeletals, and siliceous minerals, can be caused by corrosion at high pH values of greater than 9 (Kastner, 1981) because of active photosynthesis by indigenous algae (Blatt et al., 1972), that as high as 10.2 in the Coorong Lagoon of South Australia (Perterson and Von Der Borch, 1965). The decrease in pH and/or decrease in volume of solvent (water) will cause the silica in solution to precipitate, thus forming an amorphous gel containing cristobalite crystallites or opal-CT (Blatt et al., 1972). The decaying organic matter just beneath the surface reduces pH to as low as 6.5 (Peterson and Von Der Borch, 1965).

Therefore, during the early diagenesis, the dissolved carbonate skeletals under the decreasing pH condition can be replaced with the precipitation of mobilised silica that probably occurred in the shallow marine environments during the conversion of metastable biogenic carbonates into calcite and dolomite. The microquartz probably precipitates as nodular chert in zones of highest permeability (Knauth, 1994). The high permeability may be caused by the dissolution of carbonates in response to solubility changes at groundwater interfaces and/or initial intergranular cavities that chertified by affected with silica-rich groundwater.

The mechanism illustrating the dissolution/precipitation of silica and calcite under the influence of pH is shown in Figure 4.24.

4.3.2 Origin of banded chert

The banded chert in Khao Chan area is believed to be organic chert where the sources of silica are derived from siliceous skeletals of sponge spicules in the form of cryptocrystalline quartz or chalcedony. The petrographic examination of banded chert samples obtained from the lithofacies V and lithofacies VIII reveal the presence of some sponge spicules which common in shallow platform, and deep oceans (Knauth, 1994) (Figures 4.13, 4.17). Their siliceous skeletals are accumulated as siliceous oozes, mostly abundant in deep ocean in the form of amorphous opal, opal-A (Knauth, 1994).

During the diagenetic transformation, two reaction paths are possible for siliceous oozes. It may crystallise directly to microcrystalline quartz, probably through a dissolution - precipitation reaction (Stein and Kirkpatrick, 1976), or it may first past through a phase of disordered cristobalite (opal-CT) before crystallising as chert (Mizutani, 1977).

4.3.3 Conclusion

In conclusion, it is suggested that the opaline skeletons of sponge spicules, and probably silicoflagellates are the major sources of silica, whereas the argillaceous and siliceous rocks are the minor source of silica. These siliceous skeletons as well as argillaceous and sediments are contemporaneously deposited with carbonate sediments under the shallow marine environment.

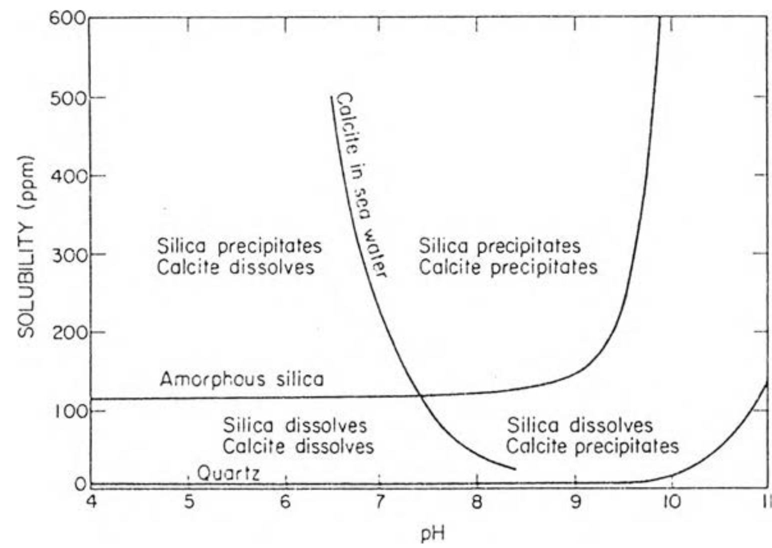

Figure 4.24 Relationship between pH and the solubilities of calcite, quartz, and amoephous silica. (afert Blatt et al., 1972)

During diagenetic alteration, the nodular cherts were formed from the dissolution of pre-existing siliceous skeletons and argillaceous as well as siliceous sediments and migrated to replace carbonate allochems and matrix in neighbouring area. The silica-rich pore fluid generally percolates along the interstitial pore space conformable with the bedding plane in most cases. The irregularity of interstitial pore space within the carbonate sediment horizons are believed to be responsible for the irregular body of chert formed by both cavity filling and replacement processes. The irregular bodies of chert within the carbonate sediment horizon further develop into the pinch-and-swell structures. Subsequent stage of chertification by dissolution and cavity filling/replacement of pre-existing carbonate sediment combined with differential compacting may cause some disruptions of the pinch and swell structures to form nodular structure.

For the banded chert and porcelanite, they are suggested that the partial dissolution of the abundant siliceous skeletons originally embedded in the carbonate sediment are believed to be the main source of the silica. The subsequent chertification by cavity filling/replacement of pre-existing carbonate sediment mainly occur in situ. However, some of the silica-rich interstitial solution may be migrated further along the carbonate horizon to cause chertification else where.

The origin of both nodular and banded cherts (including some bedded chert?) under the present study can be summarised and shown in Figure 4.25.

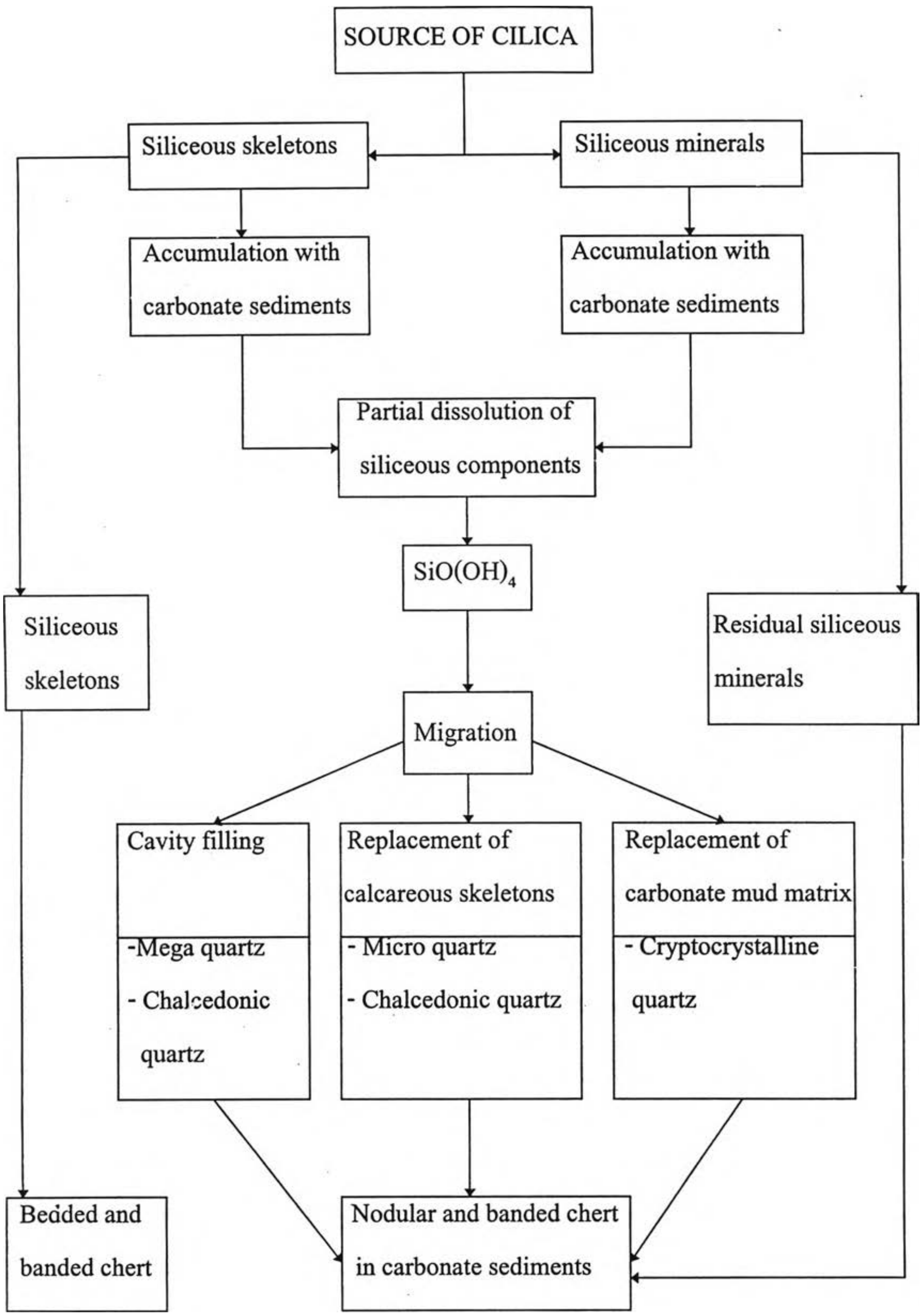

Figure 4.25 Schematic diagram illustrating the formation of nodular and banded (or partly bedded?) cherts in carbonate sediment under the present study.