CHAPTER VI

THE MAJOR STRUCTURES OF THE STUDY AREA

To construct and understand the larger macroscopic structures, the collected data of the smaller-scale structures, in this case the minor folds geometry, bedding plane orientation and the nature of the cleavage (the axial plane foliation, ?), must be analyzed. The knowledge then leads to the theory of the deformation processes.

6.1 Overturned Major Syncline

From the field examination (Figure 60), the distribution of asymmetric z-type (looking west) minor folds were recognized in X2.2 member at Khao On, Khao Mai Nuan, Khao Phu Phe, Khao Tham, Khao Lom Phat and Khao Nam Tok. Most of these folds are gently plunging, tight to isoclinal, overturned, with subrounded to subangular hinge area. Elswhere, the same type of minor folds are mostly claracterized by a series of horizontal to gently plunging, close and open, upright to inclined with a subrounded to subangular hinge area, symmetry and asymmetry folds. These folds were common in X1.2, X2.2, X4.3, X5.3 and X6.2 members at Khao Yai, Khao Chan, Khao Makok, Khao Ta Paen and Khao Hua Lon.

The interpretation and analysis of the structural development based on the above findings are shown in Figures 60 and 61. When this

rock region has continuously undergone a flattening process, the major overturned syncline and anticline developed as shown in Figure 60 (a) and Figure 61, stage 3. The overturned syncline was not clearly seen since its overturned part was partially buried underneath the northward thrusting overturned anticline. At the present, the rock units at Khao On, Khao Mai Nuan, Khao Phu Phe, Khao Tham, Khao Lom Phat and Khao Nam Tok are a part of the normal limb of the overturned anticline and those at Khao Yai, Khao Chan, Khao Makok, Hhao Ta Paen and Khao Hua Lon a part of the normal limb of the adjacent overturned syncline.

The axial plane foliation (S1), or the cleavage, was observed only in the normal limb of the overturned anticline, and was used to indicate the normal (top side-up) nature of that fold limb (Figures 60, 70 and 71).

The geologic structures in the rock unit X3 and its vicinities were especially discussed. The description, analysis and interpretation of the mesoscopic structures are for a description of the major overturned syncline and anticline. It was first found that the lithologic succession were repeated across the southwest-northeast section. The geologic cross section A - A′ (Figure 47) illustrated that the successive units were, from top to bottom and from northeast to southwest, X2.2, X3 and X4.3 members. Further southwestwardly, the succession is reverse from what just mentioned. Besides, X4.2 member also has a repeated lithological succession and underlied X3 member. The bedding planes of this rock region generally incline to the south and southwest directions. The others structures

were very hard to be recognized. However, the M-type folds though not extremely clear, were observed in X4.2 member. In fact, other minor structures should also be observed here, but they are lacking because of several reasons. One of which could be that the beds are rather thick to form the smaller-scale structures. The above findings, i.e. the occurrence of a southward-dipping normal fold limb to the north, the less-obvious M-type minor folds and the reverse succession further to the south, and another southward-dipping normal limb to the extreme south across the peculiar break in the stratigraphic sequence, all point to a suggestion of an overturned synclinal structure here.

6.2 Nong Chan Overturned Anticline

Nong Chan overturned anticline is discussed in according to the distibution of the rock types and some characteristic structural features. The anticline locates in Subarea 1.1 with a part exposed near Ban Nong Chan and is formed by the folded rock units X5.1 and X6.1 members. Though the outcrops in the area are generally poor, an attempt to describe the structure was successfully done. Based on the field study, the attitude of bedding planes mostly incline to the southeast and southwest, and strike approximately in the east-west direction. The smaller-scale lower-order folds developed in the thin-bedded chert of X5.1 member in a gravel pit about 1 kilometer east of Ban Phu Khae are seemed to be complicate. The folds (Figures 52 and 53) are close to tight, inclined to upright, and gently plunging to horizontal, asymmetric Z-type (when looking west) with a subangular and subrounded hinge area. Elsewhere, the thin-bedded chert and limestones,

Figure 52 S-type overturned fold (looking east) in the thin-bedded chert at grid reference 05202156, Ban Phu Khae.

Figure 53 Close fold in bedded-chert at grid reference 05202156, Ban Phu Khae.

and shale of X5.1 member at the Highway 21 around Kilometers 6 to 7 are complexly folded. Unfortunately, their characteristic description could not be determined. Moreover, when the outline of the rock types are considered, X6.1 member is complexly underlied and overlied by X5.1 member (Figure 54). In addition, Subarea 1.1 was subdivided into two structurally homogenous subareas, subareas 1.1.1 and 1.1.2 (Figure 54), along a proposed line. The stereonet plots of the poles of bedding planes were performed for each rock unit within these 2 subareas.

Based on the above findings, a major overturned anticline is suggested here. The anticline has its 2 limbs corresponding to Subareas 1.1.1 and 1.1.2 and the axial trace along the proposed line separating the two subareas from each other. The geologic cross section line B - B′ is revealed in Figure 54 to indicate this fold. According to the stereonet plots of bedding planes, minor fold axes and axial surfaces, the results suggest that the bedding planes are characteristically uniform and correspond to those in the outcrops. The stereonet plots of the fold axes in Figure 55 (a) indicates a gently-plunging fold system to the west to southwest, and of the fold axial surfaces (Figure 55 b) striking northeast and dipping mostly to southeast. The fold axis and axial surface orientation which are seemed to be diversified may only show the irregularity in the fold geometry normally occurred in an incompetent rock unit.

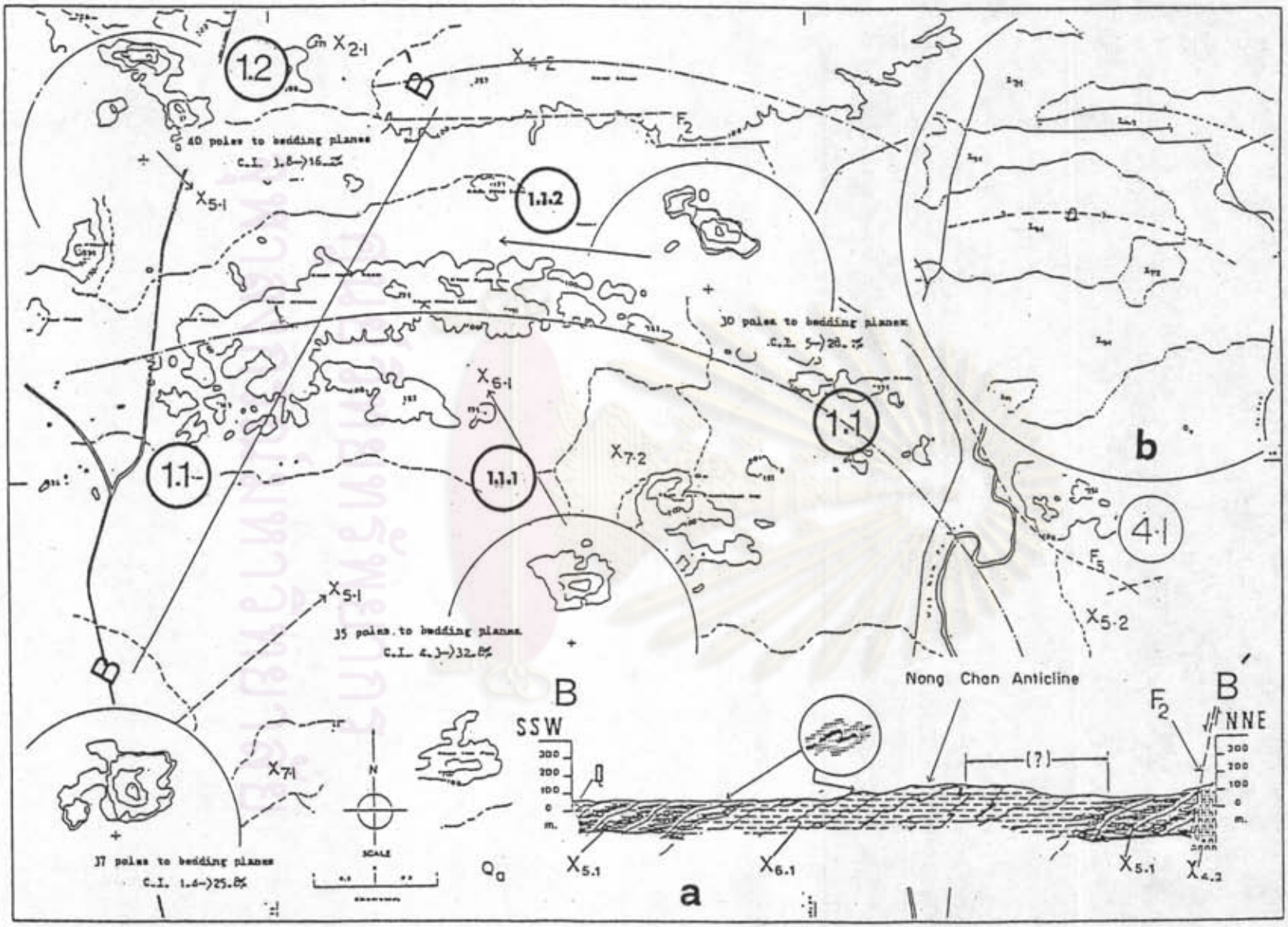

Figure 54 Nong Chan Overturned Anticline with the stereonet plots of the bedding planes.

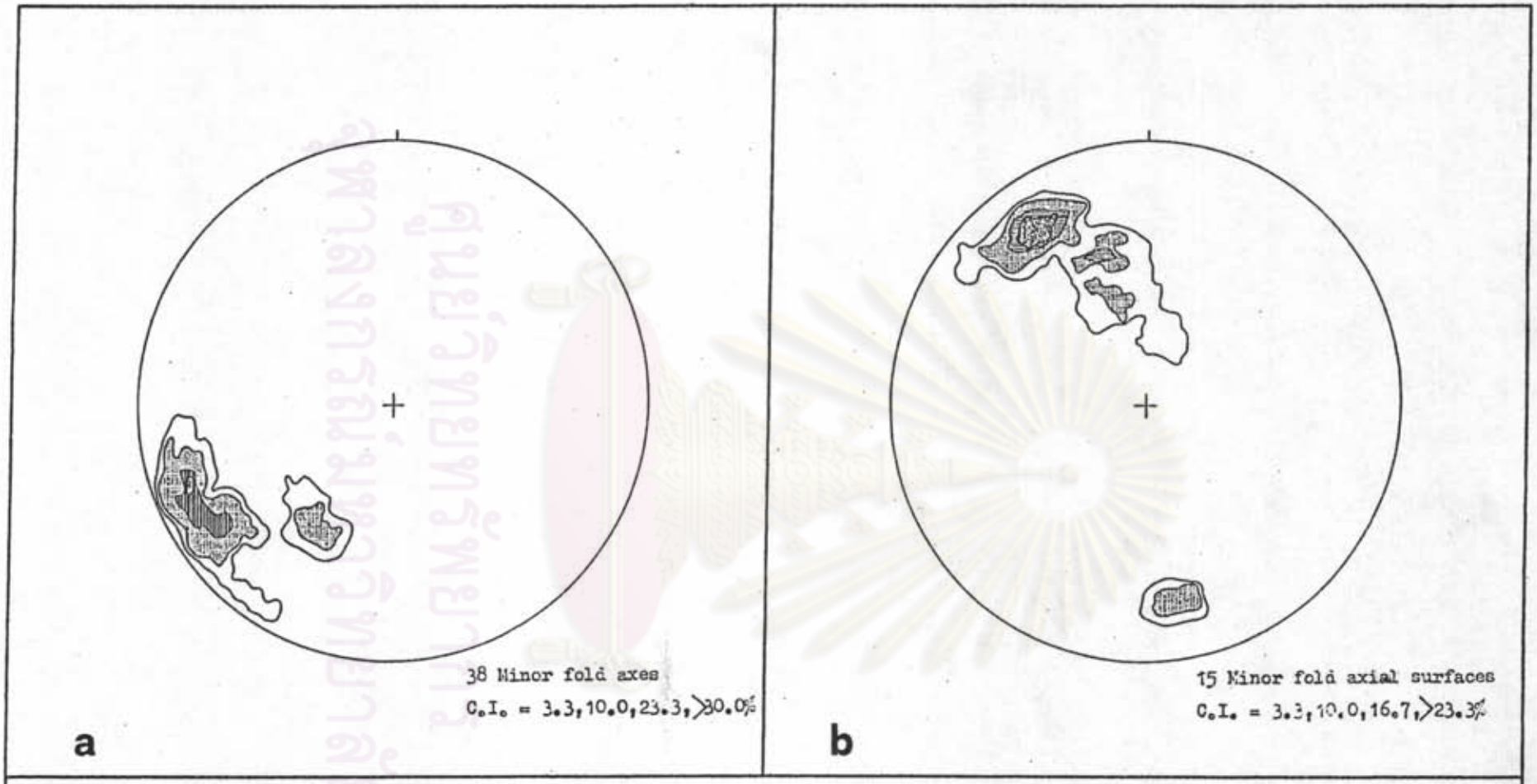

Figure 55 Stereonet plots of (a) minor fold axes (shaded), and (b) minor fold axial surfaces (shaded) in Nong Chan Overturned anticline.

6.3 Thap Kwang Thrust

The unusual boundary of the stratigraphic succession in the Kaeng Khoi-Muak Lek area was first reported by Abele and Beeser (1963). The structure was recognized as a thrust fault by Borax and Stewart (1966) and confirmed by the later workers (e.g. Campbell et al., 1972, Hinthong, 1981).

In the present study, the thrust was observed along the boundary of many rock members. For example, the lithological succession of X1.2, X2.2, X4.3, X5.3 or X6.2 members end abruptly to lie underneath X2.2 member (Figure 56). The abrupt boundary is also characterized by some faulting evidences such as the shear zones, cleaved rocks, slip planes, fault drags and slickensides, hence suggests a fault (Figure 57 - 59).

It has been found that the Z-type (looking west) minor folds were only recognized in X2.2 member at Khao On, Khao Mai Nuan, Khao Phu Phe, Khao Tham, Khao Lom Phat and Khao Nam Tok. Meanwhile, a series of horizontal to gently plunging, close and open upright to inclined asymmetry and symmetry folds were noted in X1.2, X2.2, X4.3, X5.3 and X6.2 members on Khao Yai, Khao Chan, Khao Makok, Khao Ta Paen and Khao Hua Lon, to the north of the former fold group. Both S- and Z-type minor folds were observed in the lower-lying rock members. This latter fold group was interpreted as the drag folds formed by the fault movement.

The interpretation and analysis of the structural development based on the above findings are shown in Figures 60 (a) and 61. In Figure 61, stage 1, the sedimentary succession was originated by the

Figure 56 Topographic expression of Khao Phu Phe, X2.2 member, X5.3 member and Thap Kwang Thrust Fault (Facing Southeast).

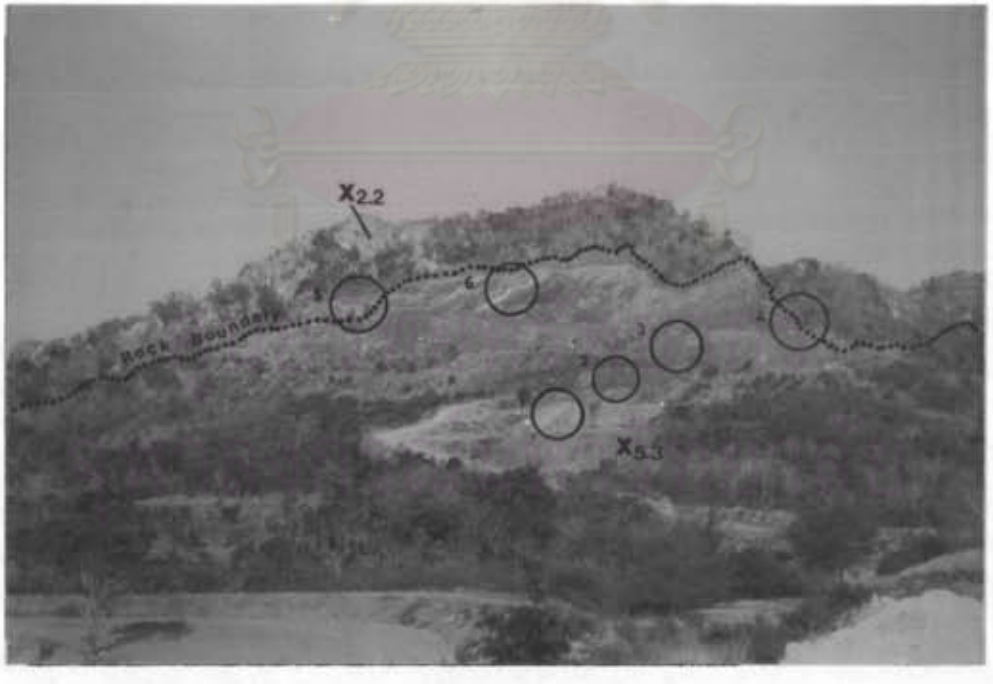

Figure 57 Veiw of thrust front, showing the associating structures
(Notations : 1,2,3 = shear zone
4,5 = slip plane, step by step and slickenside
6 = igneous sill).

Figure 58 Photograph showing the fault drag at grid reference 25301870, Siam Cement Co. Ltd. Quarry.

Figure 59 Photograph showing the crush rock of X2.2 member at grid reference 27201712, Khao Phu Phe.

law of superposition. Later, the buckling process, perhaps resulted from the horizontal principal stress, σ_1, in the north/south and northeast/southwest directions, followed and gave rise to the folds in stage 2. The flattening continuously developed (Ramsay, 1967), as in stage 3. At this stage the overturned syncline and anticline were progressively developed.

The overturned major folds were proposed from the minor folds which could be used to disclose the hidden structures, e.g., a change from the Z-type to S-type minor folds along the section of the simple-looking uniformly dipping strata may signal the presence of an otherwise-hidden fold structure (Davis, 1984). As the strata here generally dip to the south (southeast to southwest), the Z-type (looking west) minor folds hence indicate a normal limb of the overturned fold, in this case the normal limb of the overturned anticline while other Z-type (looking west) minor folds locate on the normal limb of the adjoining overturned syncline to the north.

As the folding prolonges, the folding gives way to the faulting at the common overturned limb (Figures 60 b, c, and 61, stage 4) in a ductile-to-brittle fasion, and resulted in a low-angle reverse fault or thrust.

It must be noted that the sheared-off overturned limb was not obviously observable. This perhaps is caused by the gliding of the thrust block further northward as illustrated in Figure 61, stage 4. Perhaps the erosion and dense vegetation with thick weathering zones also mar the evidences of the structures from their best quality.

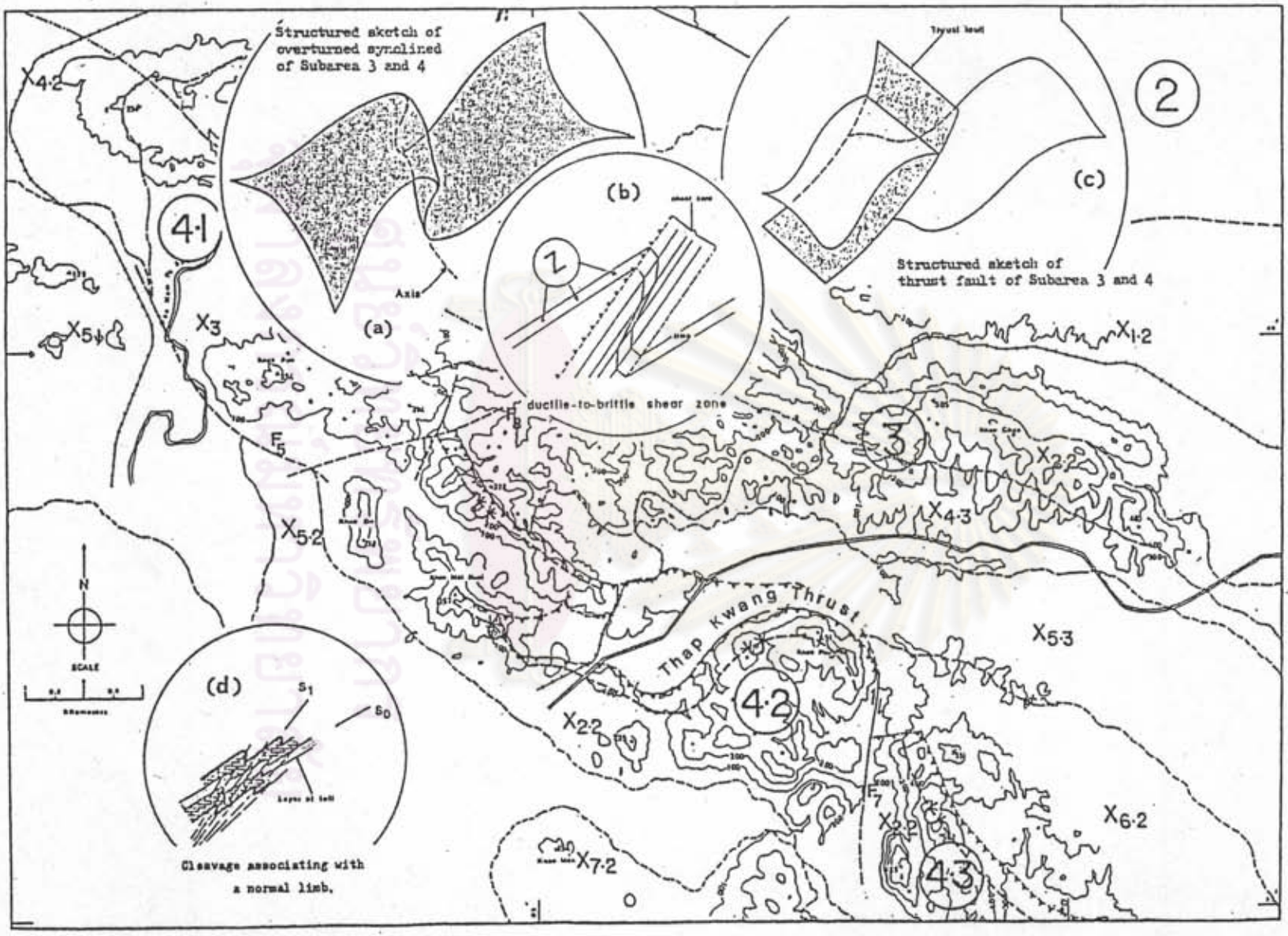

Figure 60 The fold styles in the vicinities of Khao Phu Phe and Khao Chan.

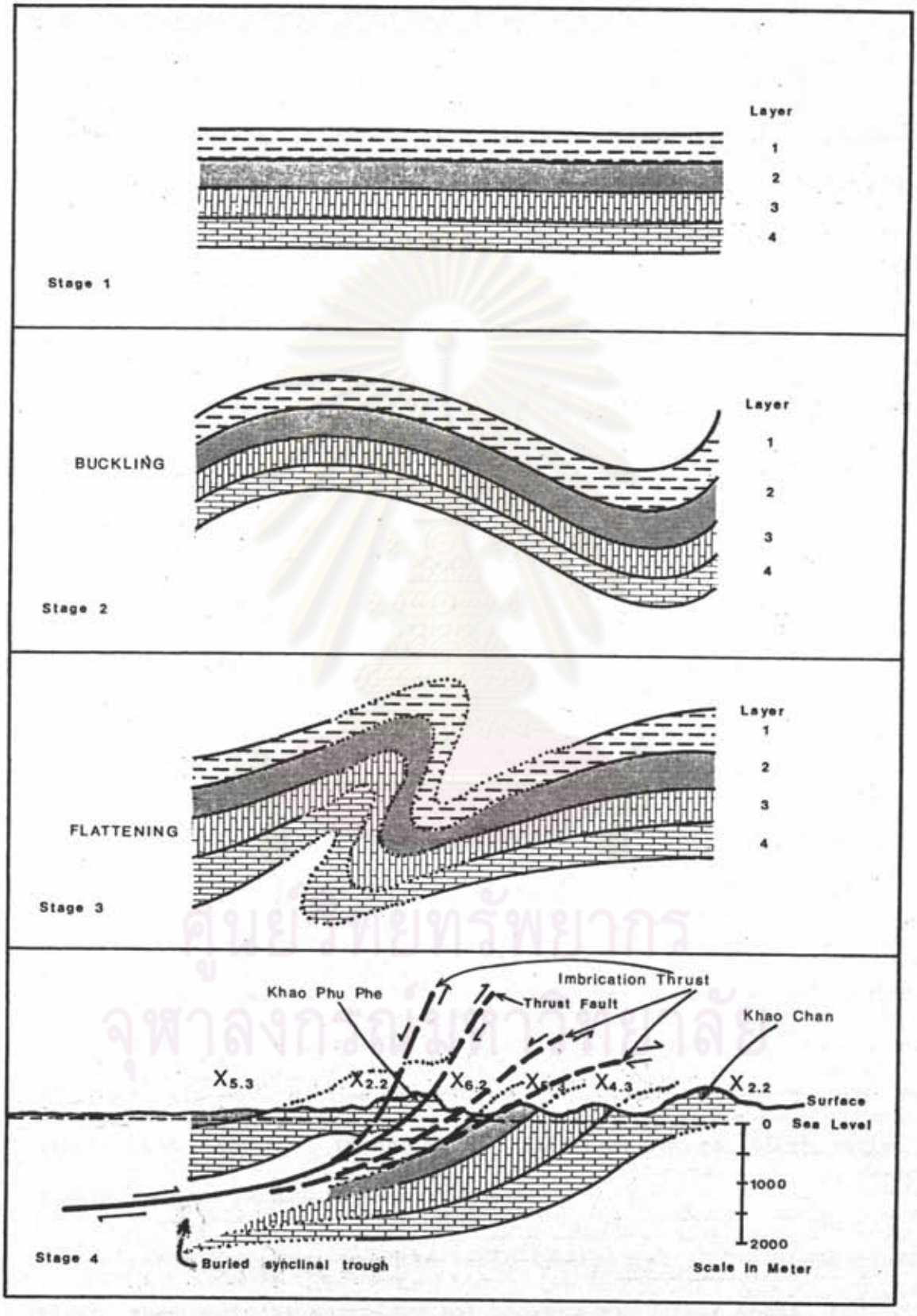

Figure 61 Ideal development of Thap Kwang Thrust.

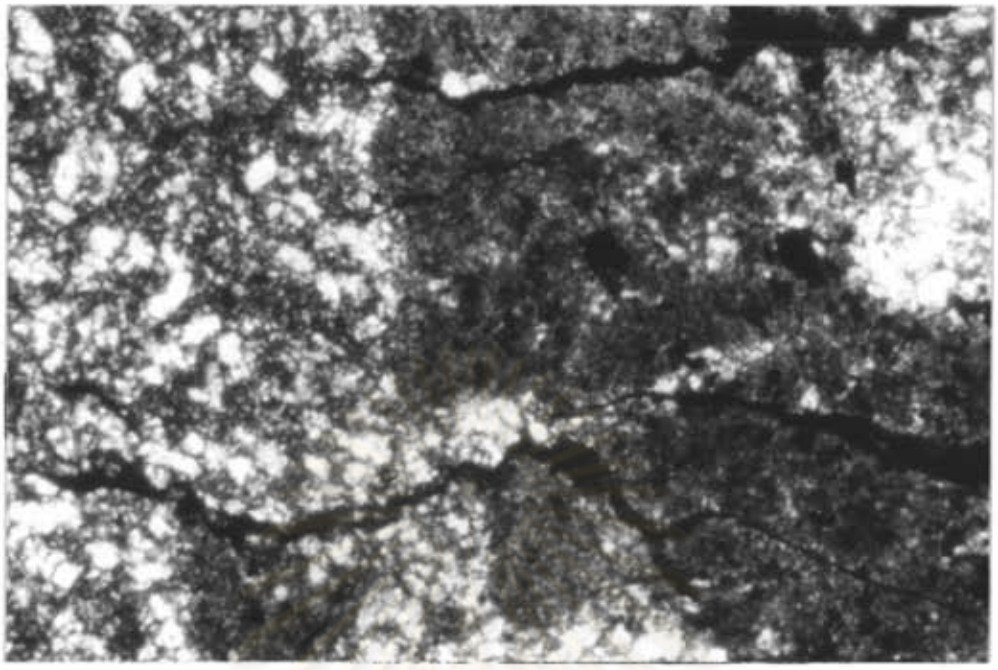

Figure 62 Photomicrograph showing brecciated rock of F4-fault at grid reference 30142528. (45X, crossed nicols)

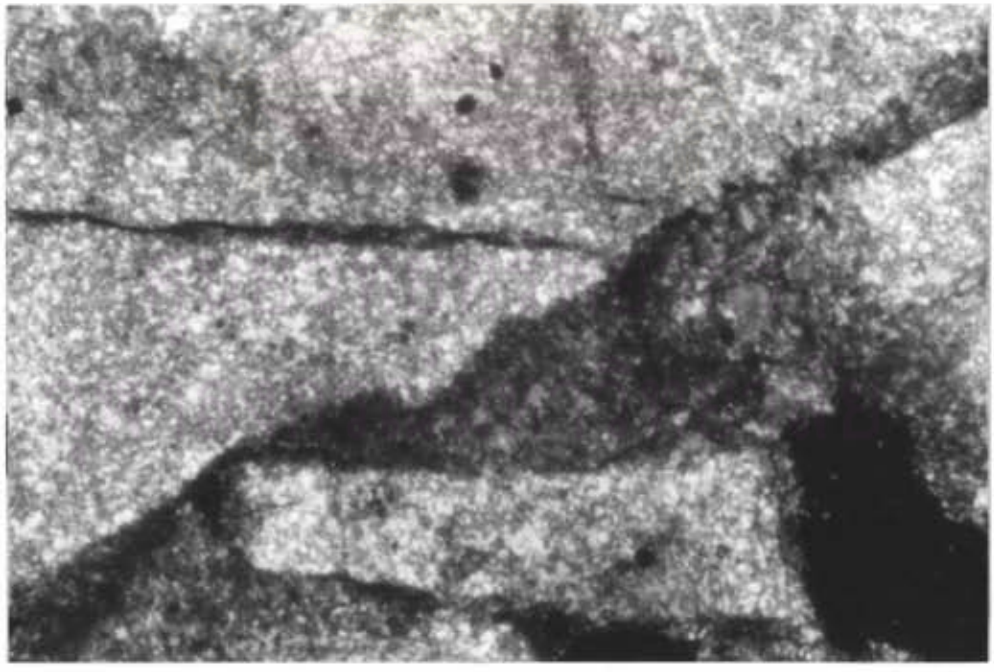

Figure 63 Photomicrograph showing brecciated rock of F7-fault at grid reference 29901524. (45X, crossed nicols)