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APPENDIX A

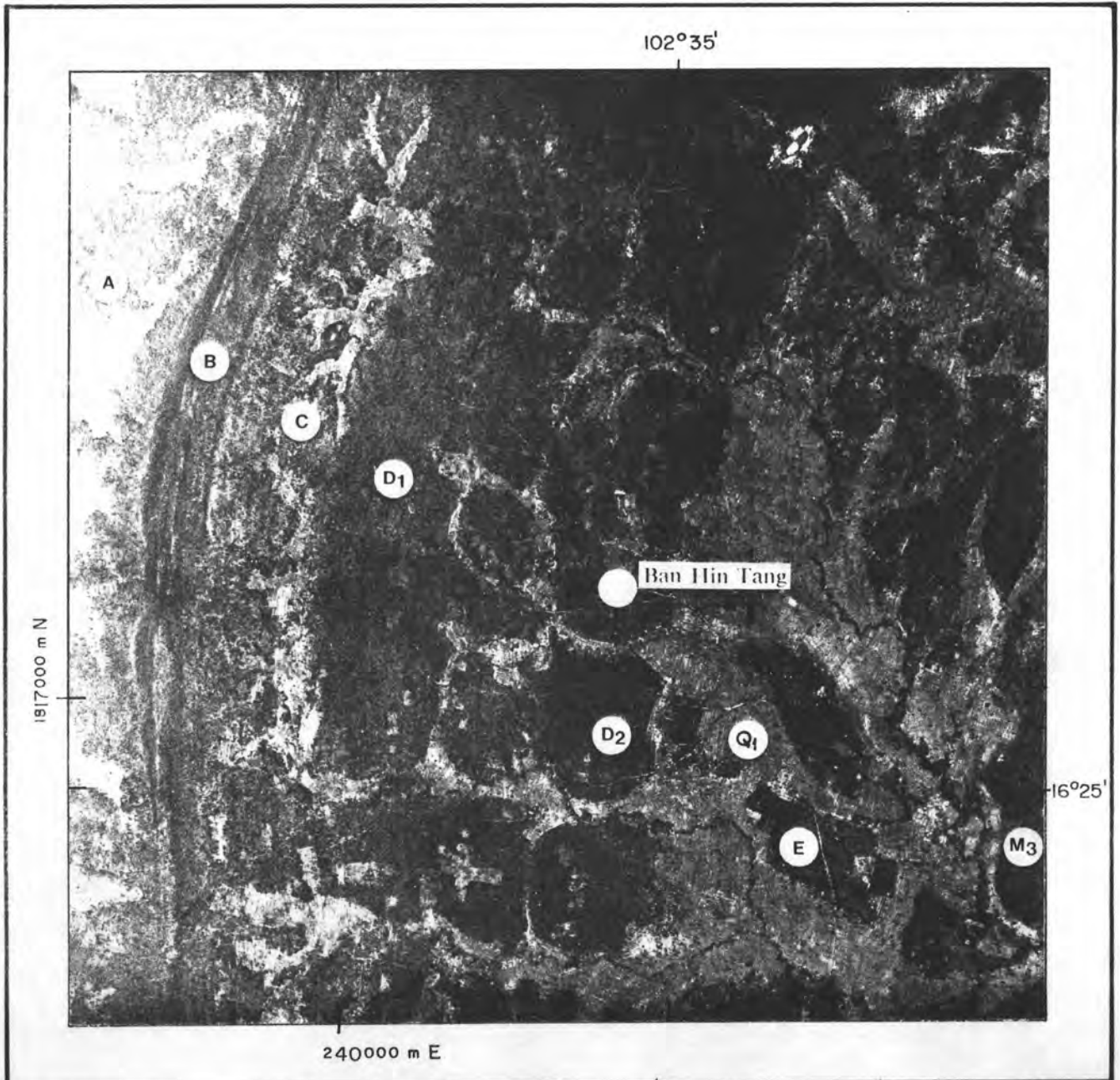


Photo No. 20195 Area 4 Sheet 6 Strip 18	Photo Scale km.
Map Reference: Sheet 5541 IV (Figure A-1-2)	Photo Date 07 April 1954 (09.07 a.m.)

Figure A-1-1. Aerial photograph of Ban Hin Tang area, shows the best arrangement of rock units sequence of the study area. It is composed of A, B, C, D1, D2, E, M3 and Q1 Units from the west to the east respectively. All of the rock units are N-S trending and gently sloping eastward. Bedding can be clearly observed in Unit B and can be traced along regional pattern of Unit D2 and D1. This structure is vague in other units but should be comparatively the same attitude as the former units. Fracture traces are developed in nearly perpendicular to the bedding trend. The Q1 Unit appears along the erosional patterns of each parent rock unit.

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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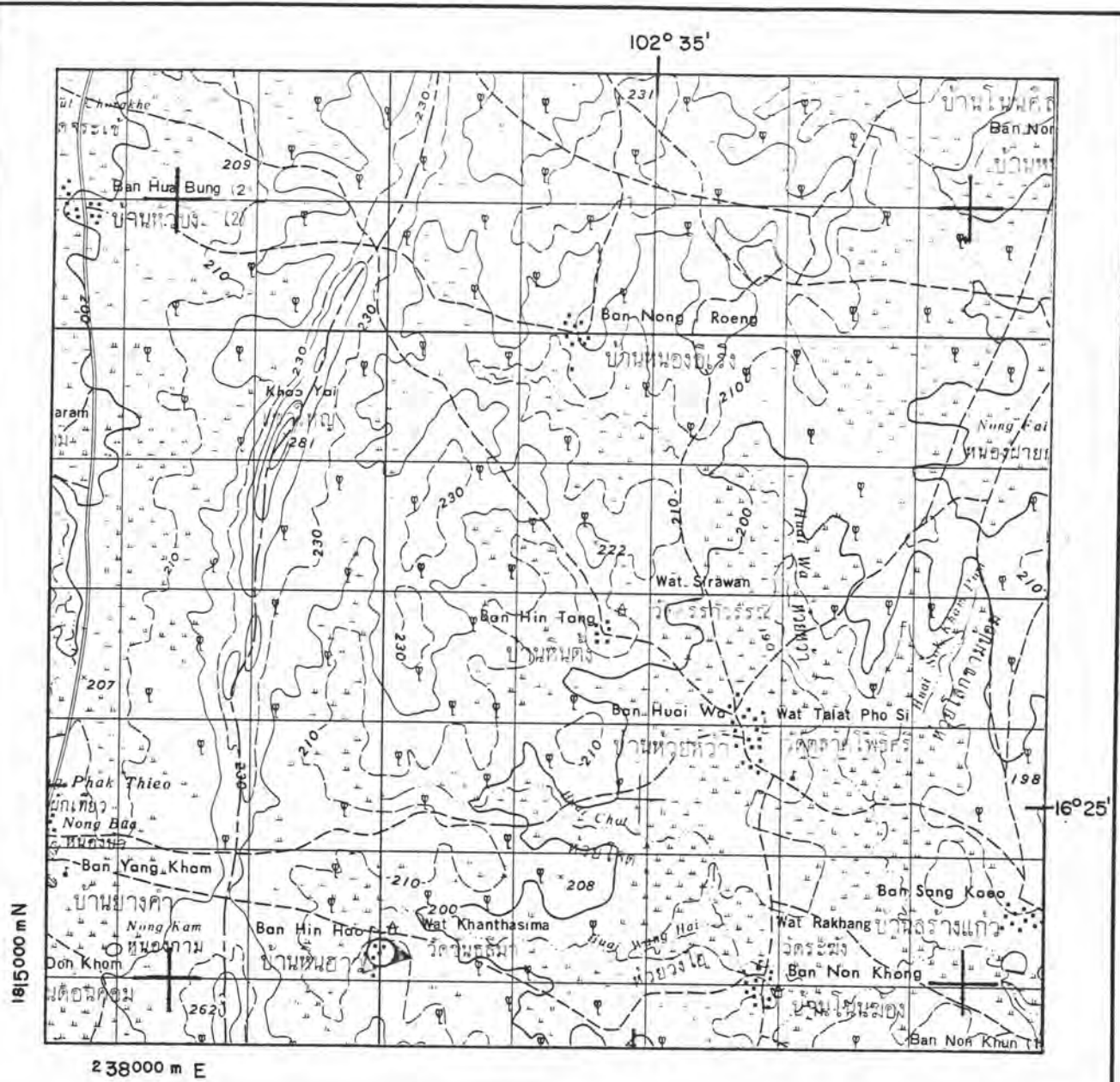


Figure A-1-2 [A) = Above ; B) = Left]

A) Topographic Map (1:50,000) Sheet 5541 IV
 [+ + = map area as shown on the aerial]
 [+ + = photograph of Figure A-1-1]

B) Terrestrial photograph at UTM Grid Ref.
 2400 18153 to N 105 ° E direction.

**Photo-interpretation for Geological Mapping
 of Changwat Khon Kaen and Adjacent Areas.**

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

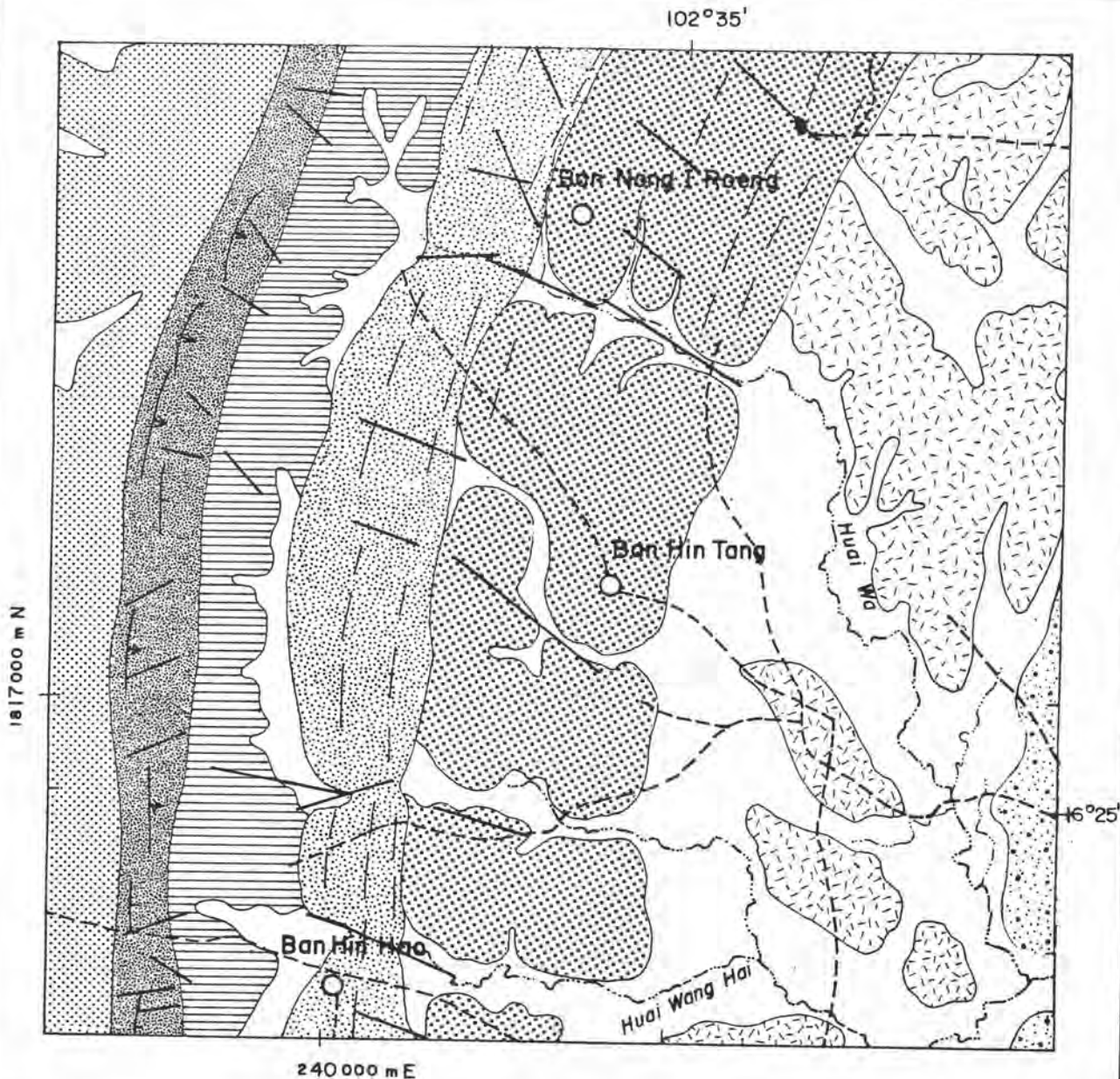


Figure A-1-3 Photogeological Map.

Scale km.

Photo Ref. : Photo No. 20195 (Figure A-1-1)

Map Ref. : Sheet 5541 IV (Figure A-1-2)

Explanations for Photogeological Map

- SYMBOLS**
- Amphoe (district)
 - Ban (village)
 - Primary road & Route no.
 - Secondary road
 - Railroad
 - River, Stream
 - Water body

- Geological unit boundary
- Bedding (sub-horizontal)
- Bedding trace
- Fracture trace
- Syncline, Anticline - with plunging direction
- meander scar

PHOTOGEOLOGICAL UNITS

- | | | | |
|--|----|--|----|
| | Q4 | | E |
| | Q3 | | D2 |
| | Q2 | | D1 |
| | Q1 | | C |
| | M3 | | B |
| | M2 | | A |
| | M1 | | |

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

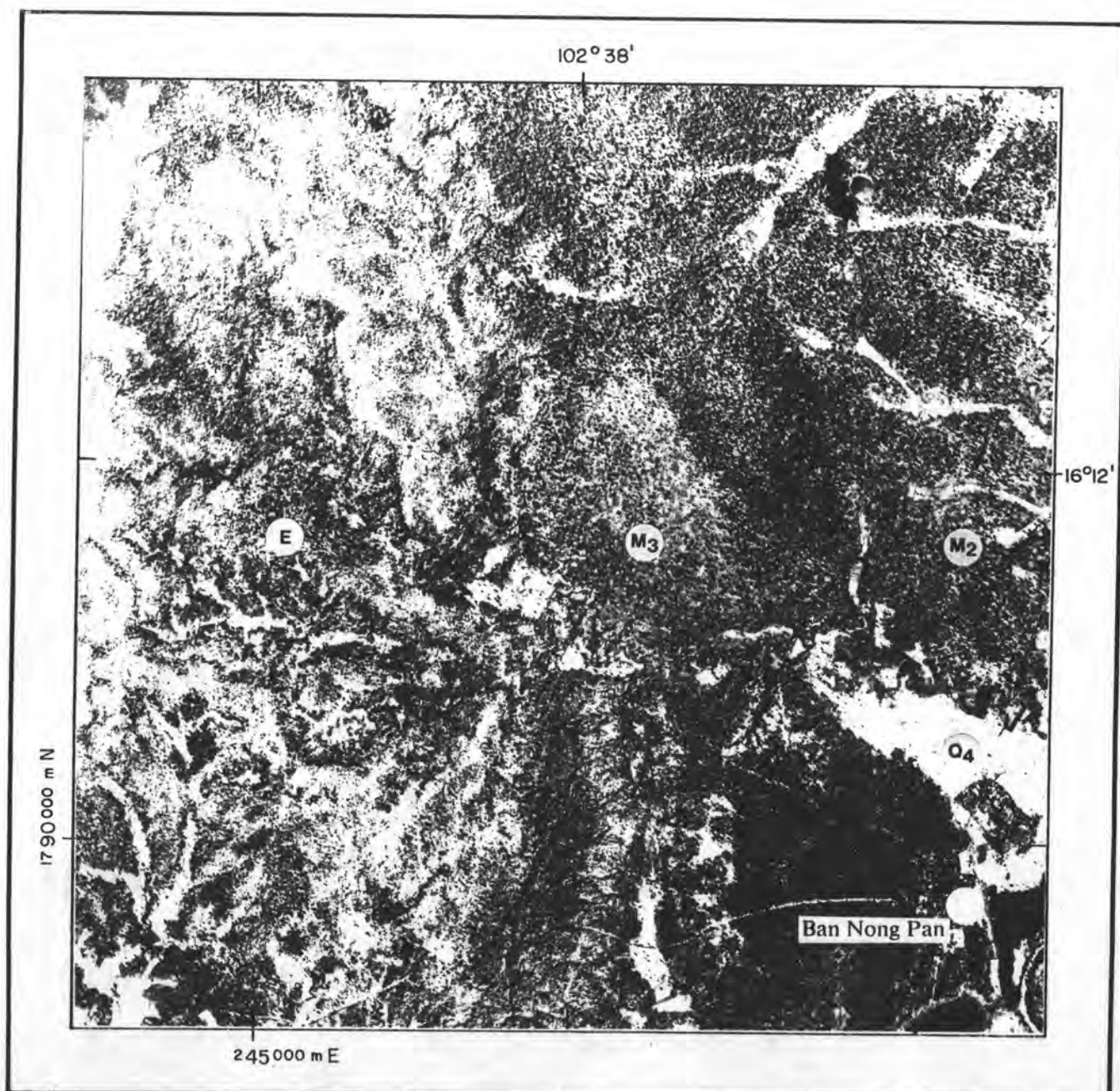


Photo No. 08786 Area 4 Sheet 6 Strip 19

Photo Scale $\frac{1.0}{0.5} \frac{0}{1.0}$ km.

Map Reference: Sheet 554I III (Figure A-2-2)

Photo Date 31 December 1953 (09.10 a.m.)

Figure A-2-1. Aerial photograph of Ban Nong Pan area, illustrates mainly of the anticlinal structure of Unit E. The east flank is covered by Unit M3 and M2. The anticlinal axis is nearly north-south trending and plunging to the south. Bedding can be clearly observed from the tone contrast and erosional features in Unit E. Fracture traces are much developed in E-W direction.

**Photo-interpretation for Geological Mapping
of Changwat Khon Kaen and Adjacent Areas.**

Somyot Hokjaroen
Dept. of Geology, Graduate School,
Chulalongkorn University, 1986.

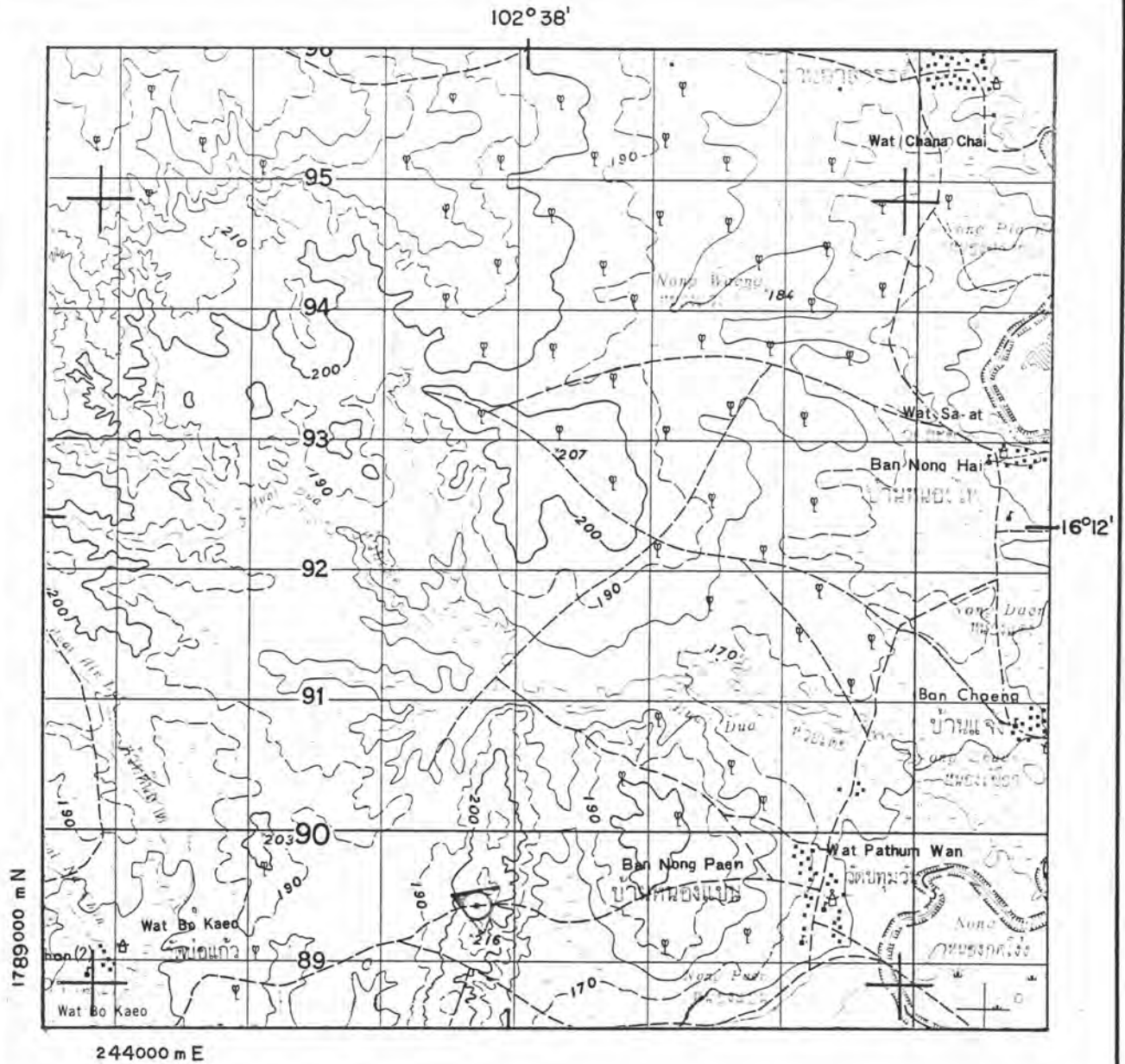


Figure A-2-2 [A) = Above ; B) = Left]

A) Topographic Map (1:50,000) Sheet 554I III
 [+ + = map area as shown on the aerial
 [+ + = photograph of Figure A-2-1]

B) Terrestrial photograph at UTM Grid Ref.
 2467 17894 to N 295 ° E direction.

**Photo-interpretation for Geological Mapping
 of Changwat Khon Kaen and Adjacent Areas.**

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

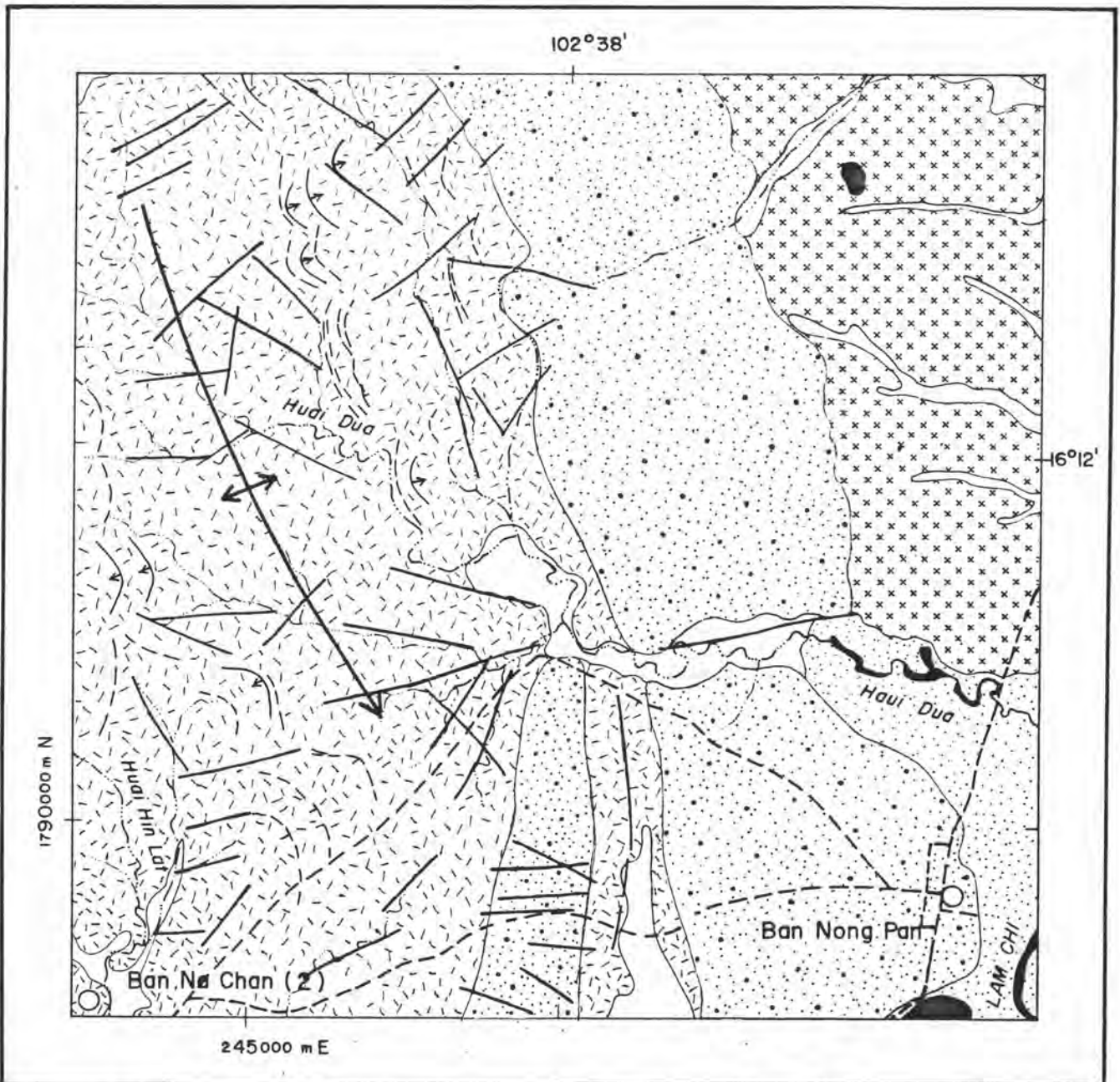


Figure A-2-3 Photogeological Map. Scale 1.0 0.5 0 1.0 km.
 Photo Ref. : Photo No. 08786 (Figure A-2-1) Map Ref. : Sheet 5541 III (Figure A-2-2)

Explanations for Photogeological Map

<p>SYMBOLS</p> <ul style="list-style-type: none"> Amphoe (district) Ban (village) Primary road & Route no. Secondary road Railroad River, Stream Water body 	<p>SYMBOLS</p> <ul style="list-style-type: none"> Geological unit boundary Bedding (sub-horizontal) Bedding trace Fracture trace Syncline, Anticline - with plunging direction meander scar 	<p>PHOTOGEOLOGICAL UNITS</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <ul style="list-style-type: none"> Q4 Q3 Q2 Q1 M3 M2 M1 </td> <td style="width: 50%; vertical-align: top;"> <ul style="list-style-type: none"> E D2 D1 C B A </td> </tr> </table>	<ul style="list-style-type: none"> Q4 Q3 Q2 Q1 M3 M2 M1 	<ul style="list-style-type: none"> E D2 D1 C B A
<ul style="list-style-type: none"> Q4 Q3 Q2 Q1 M3 M2 M1 	<ul style="list-style-type: none"> E D2 D1 C B A 			

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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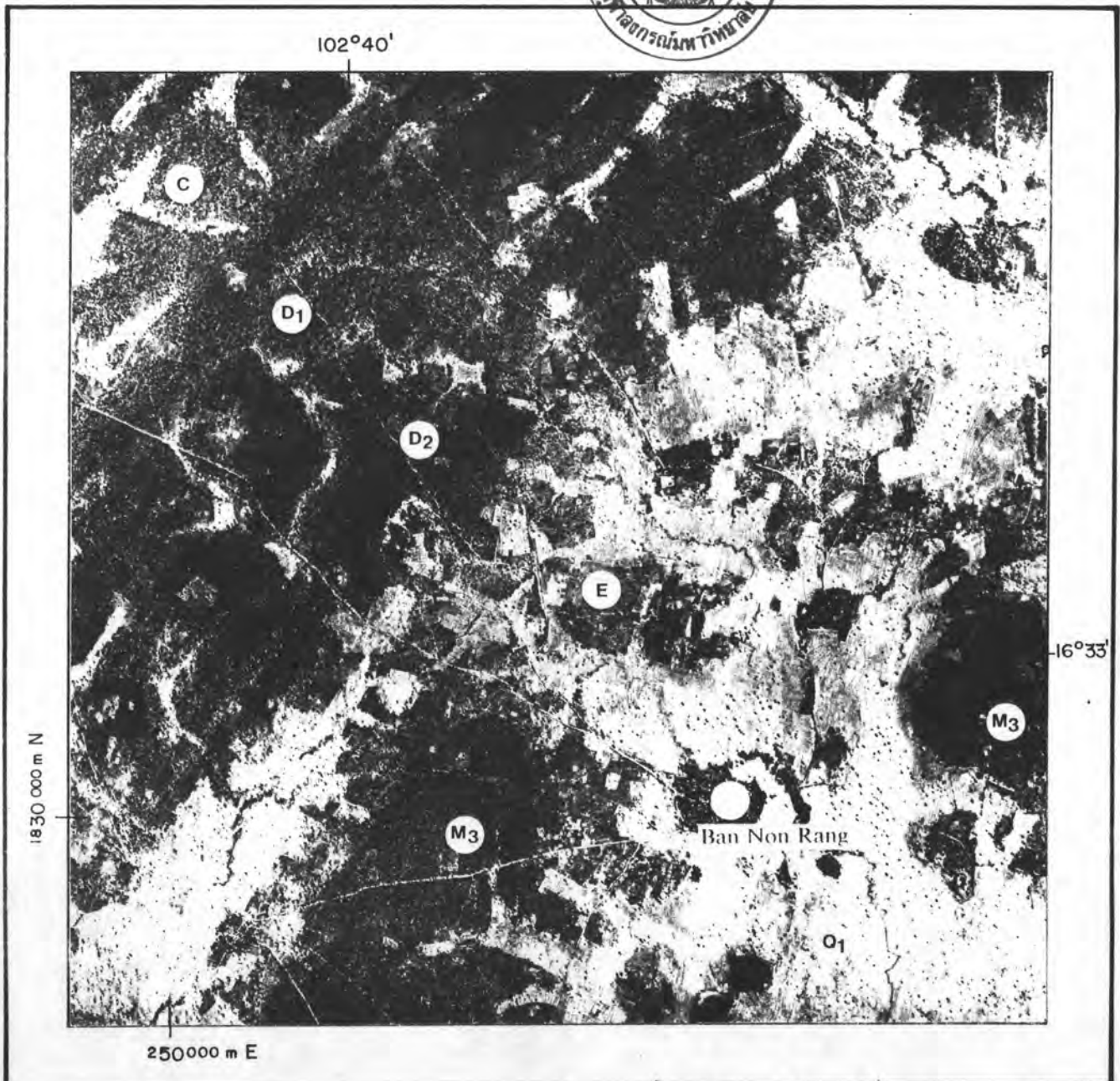


Photo No. 08890 Area 4 Sheet 6 Strip 20	Photo Scale km.
Map Reference: Sheet 5542 III (Figure A-3-2)	Photo Date 31 December 1953 (10.17 a.m.)

Figure A-3-1. Aerial photograph of Ban Non Rang area, shows the sequence of C, D1, D2, E, M3 and Q1 Units from the northwest-southeast corner. The M3 Unit unconformably overlies the E Unit as found at Ban Non Rang and adjacent areas. Bedding of each unit is not clearly observed but can be traced according to their erosional features along the ridge and valley which can be seen in NE-SW direction, and gently sloping to S-E direction.

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.	Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.
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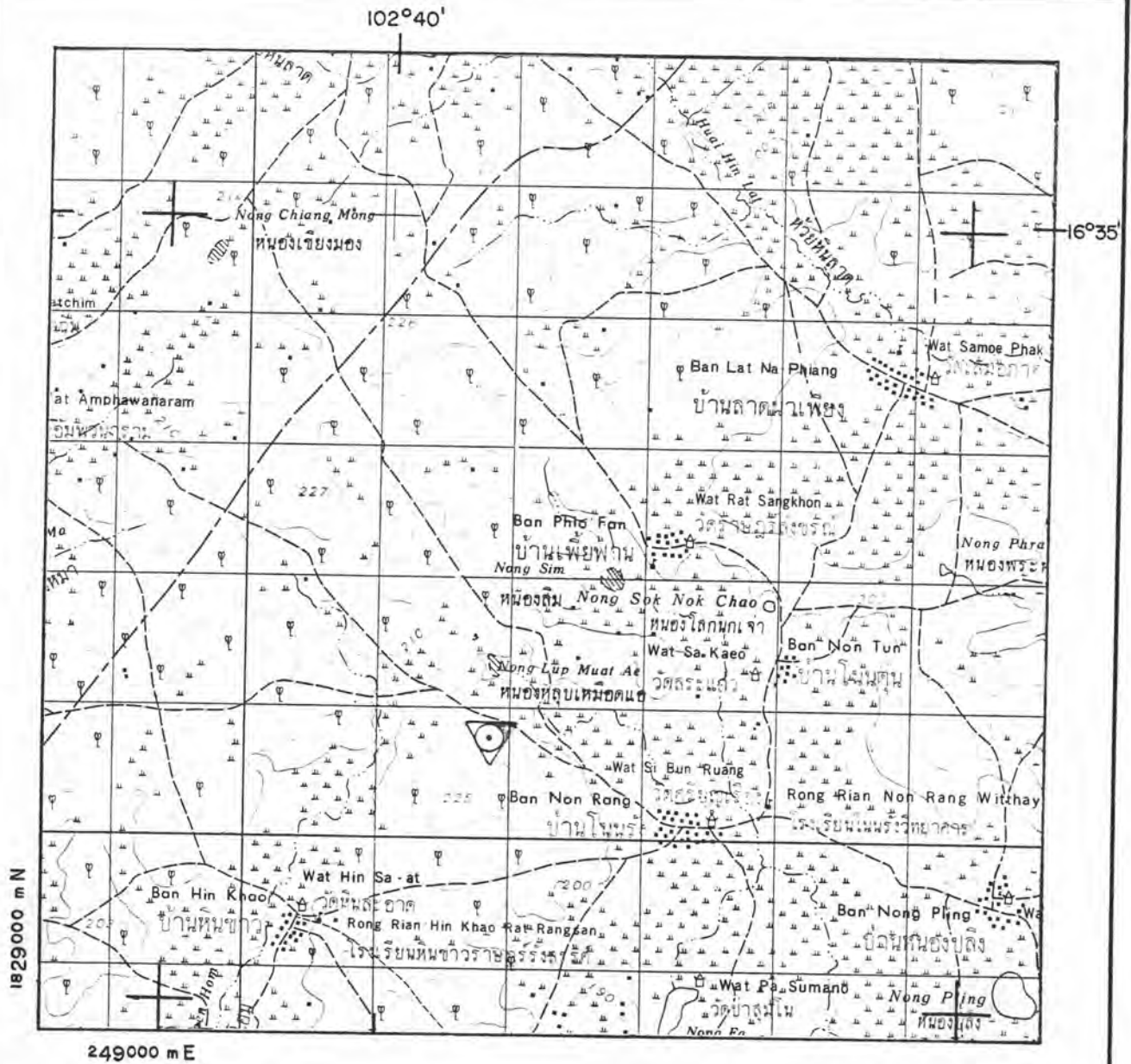


Figure A-3-2 [A) = Above ; B) = Left]

A) Topographic Map (1:50,000) Sheet 5542 III
 [+ + = map area as shown on the aerial
 + + = photograph of Figure A-3-1]

B) Terrestrial photograph at UTM Grid Ref.
 2518 18307 to N 060 ° E direction.

Photo-interpretation for Geological Mapping
of Changwat Khon Kaen and Adjacent Areas.

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 Chulalongkorn University, 1986.



Figure A-3-3 Photogeological Map. Scale 1.0 0.5 0 1.0 km.
 Photo Ref. : Photo No. 08890 (Figure A-3-1) Map Ref. : Sheet 5542 III (Figure A-3-2)

Explanations for Photogeological Map

<p>SYMBOLS</p> <ul style="list-style-type: none"> Amphoe (district) Ban (village) Primary road & Route no. Secondary road Railroad River, Stream Water body 	<ul style="list-style-type: none"> Geological unit boundary Bedding (sub-horizontal) Bedding trace Fracture trace Syncline, Anticline - with plunging direction meander scar 	<p>PHOTOGEOLOGICAL UNITS</p> <table border="0" style="width: 100%;"> <tr> <td></td> <td>Q4</td> <td></td> <td>E</td> </tr> <tr> <td></td> <td>Q3</td> <td></td> <td>D2</td> </tr> <tr> <td></td> <td>Q2</td> <td></td> <td>D1</td> </tr> <tr> <td></td> <td>Q1</td> <td></td> <td>C</td> </tr> <tr> <td></td> <td>M3</td> <td></td> <td>B</td> </tr> <tr> <td></td> <td>M2</td> <td></td> <td>A</td> </tr> <tr> <td></td> <td>M1</td> <td></td> <td></td> </tr> </table>		Q4		E		Q3		D2		Q2		D1		Q1		C		M3		B		M2		A		M1		
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	Q3		D2																											
	Q2		D1																											
	Q1		C																											
	M3		B																											
	M2		A																											
	M1																													

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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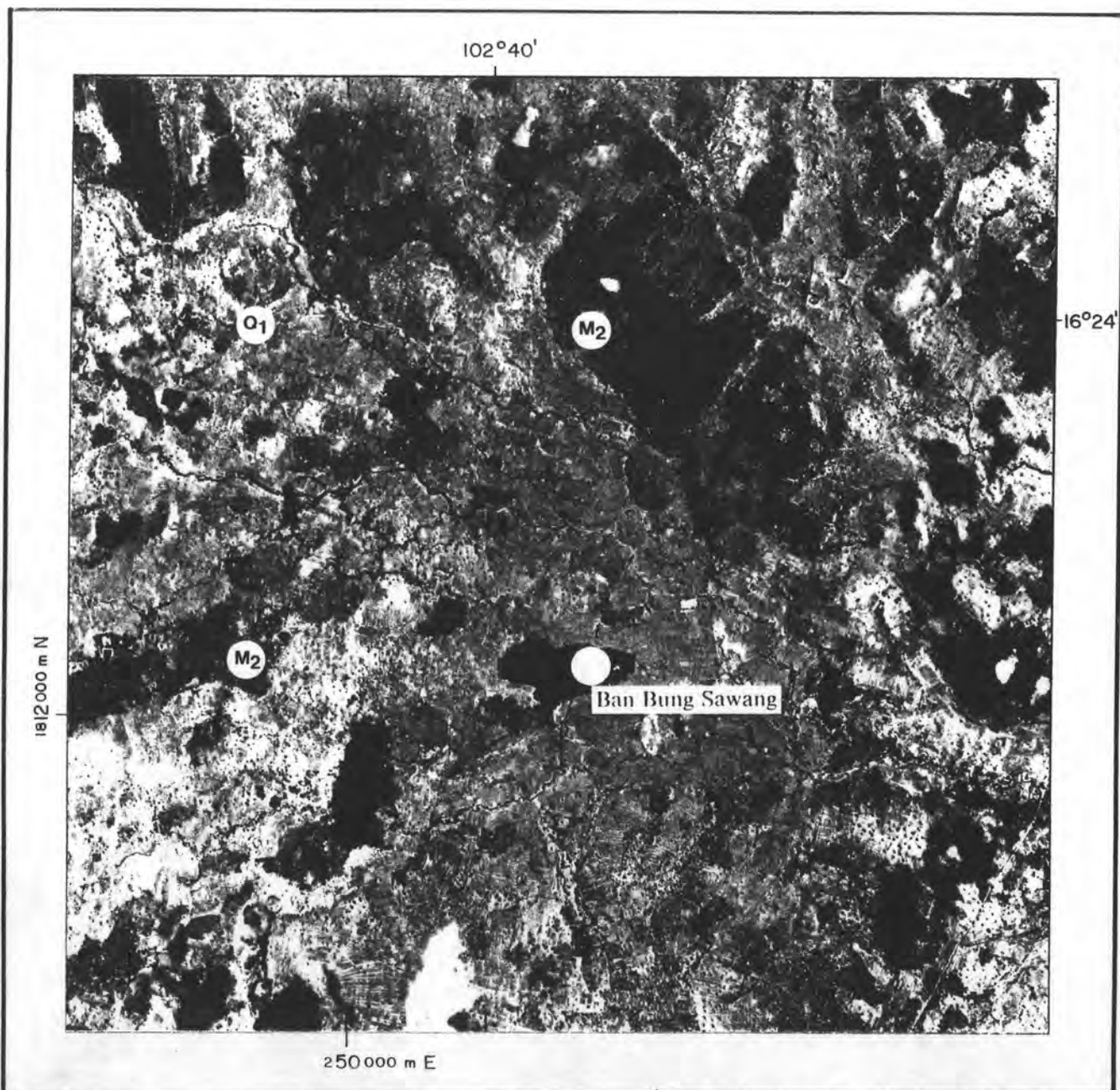


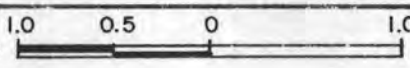
Photo No. 08895 Area 4 Sheet 6 Strip 20	Photo Scale  km.
Map Reference: Sheet 5541 IV (Figure A-4-2)	Photo Date 31 December 1953 (10.20 a.m.)

Figure A-4-1. Aerial photograph of Ban Bung Sawang area, shows the typical characteristics of Q1 and M2 Unit. Erosional remnants of M2 Unit are well observed. The Q1 features expose where M2 Unit had been completely eroded. Some areas in the south are dark tone and smooth feature caused by the cloud shadow. A numerous depression features are observed and most of them are belived to cause by dissolution of the soluble layers underlying bed rock.

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.	Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.
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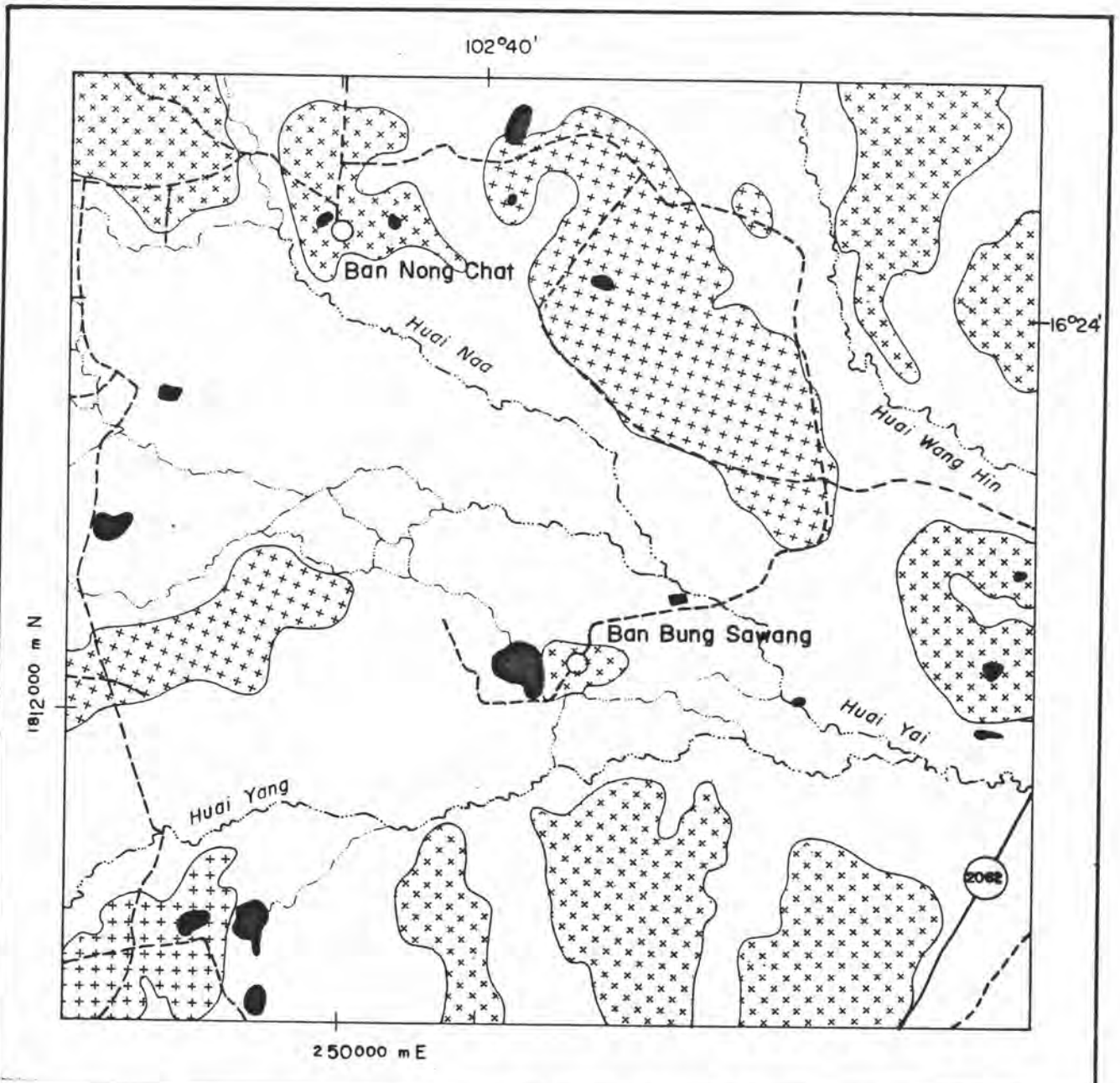


Figure A-4-3 Photogeological Map. Scale 1.0 0.5 0 1.0 km.
 Photo Ref. : Photo No.08895 (Figure A-4-1) Map Ref. : Sheet 5541 IV (Figure A-4-2)

Explanations for Photogeological Map

<p>SYMBOLS</p> <ul style="list-style-type: none"> Amphoe (district) Ban (village) Primary road & Route no. Secondary road Railroad River, Stream Water body 	<ul style="list-style-type: none"> Geological unit boundary Bedding (sub-horizontal) Bedding trace Fracture trace Syncline, Anticline - with plunging direction meander scar 	<p>PHOTOGEOLOGICAL UNITS</p> <table border="0"> <tr> <td></td> <td>Q4</td> <td></td> <td>E</td> </tr> <tr> <td></td> <td>Q3</td> <td></td> <td>D2</td> </tr> <tr> <td></td> <td>Q2</td> <td></td> <td>D1</td> </tr> <tr> <td></td> <td>Q1</td> <td></td> <td>C</td> </tr> <tr> <td></td> <td>M3</td> <td></td> <td>B</td> </tr> <tr> <td></td> <td>M2</td> <td></td> <td>A</td> </tr> <tr> <td></td> <td>M1</td> <td></td> <td></td> </tr> </table>		Q4		E		Q3		D2		Q2		D1		Q1		C		M3		B		M2		A		M1		
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	Q3		D2																											
	Q2		D1																											
	Q1		C																											
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<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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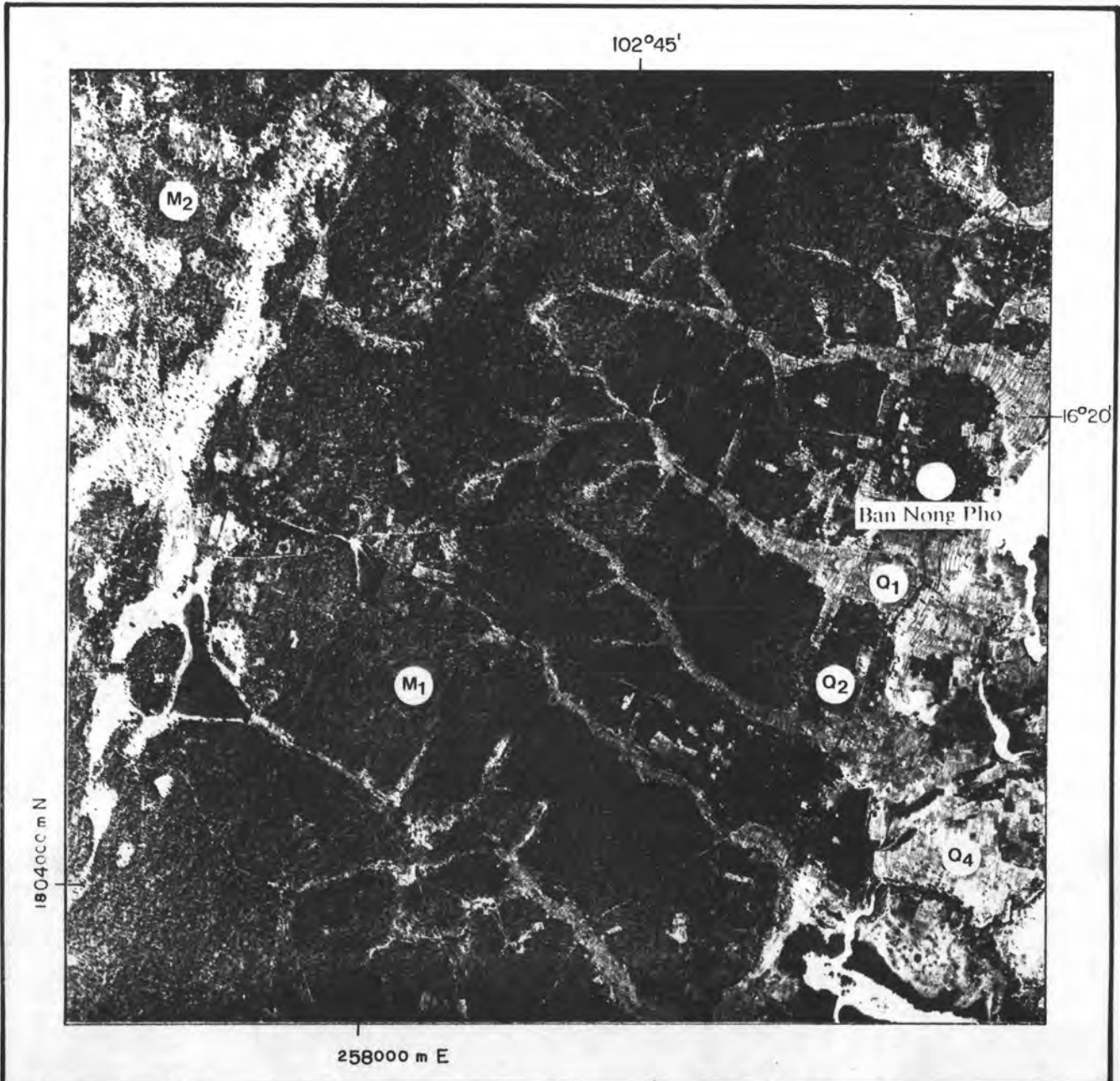



Photo No. 12277 Area 4 Sheet 6 Strip 21	Photo Scale  km.
Map Reference: Sheet 5541 I, IV (Figure A-5-2)	Photo Date 15 January 1953 (09.13 a.m.)

Figure A-5-1. Aerial photograph of Ban Nong Pho area, shows the typical characteristics of M₁ Unit. Drainage lines in N-NE-S-SW direction represent the bedding trace of the M₁ Unit in contrast with the NW-SE direction which represent the joint system. Depression features developed along NE-SW direction can be noticed at the south of the area.

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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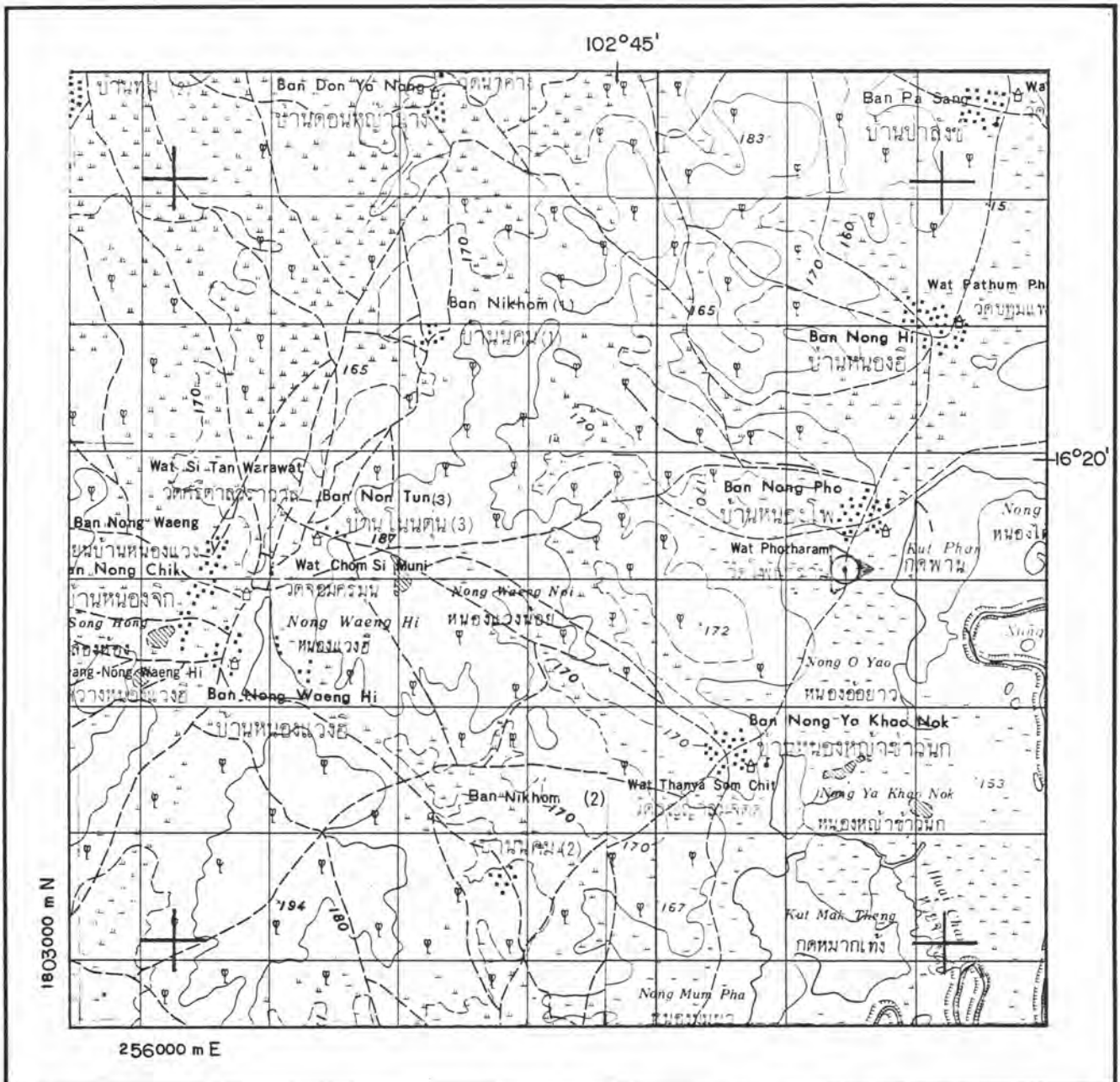


Figure A-5-2 [A) = Above ; B) = Left]

A) Topographic Map (1:50,000) Sheet 5541 I, IV
 [+ + = map area as shown on the aerial]
 [+ + = photograph of Figure A-5-1]

B) Terrestrial photograph at UTM Grid Ref.
 2614 18061 to N 085 ° E direction.

**Photo-interpretation for Geological Mapping
 of Changwat Khon Kaen and Adjacent Areas.**

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 Chulalongkorn University, 1986.



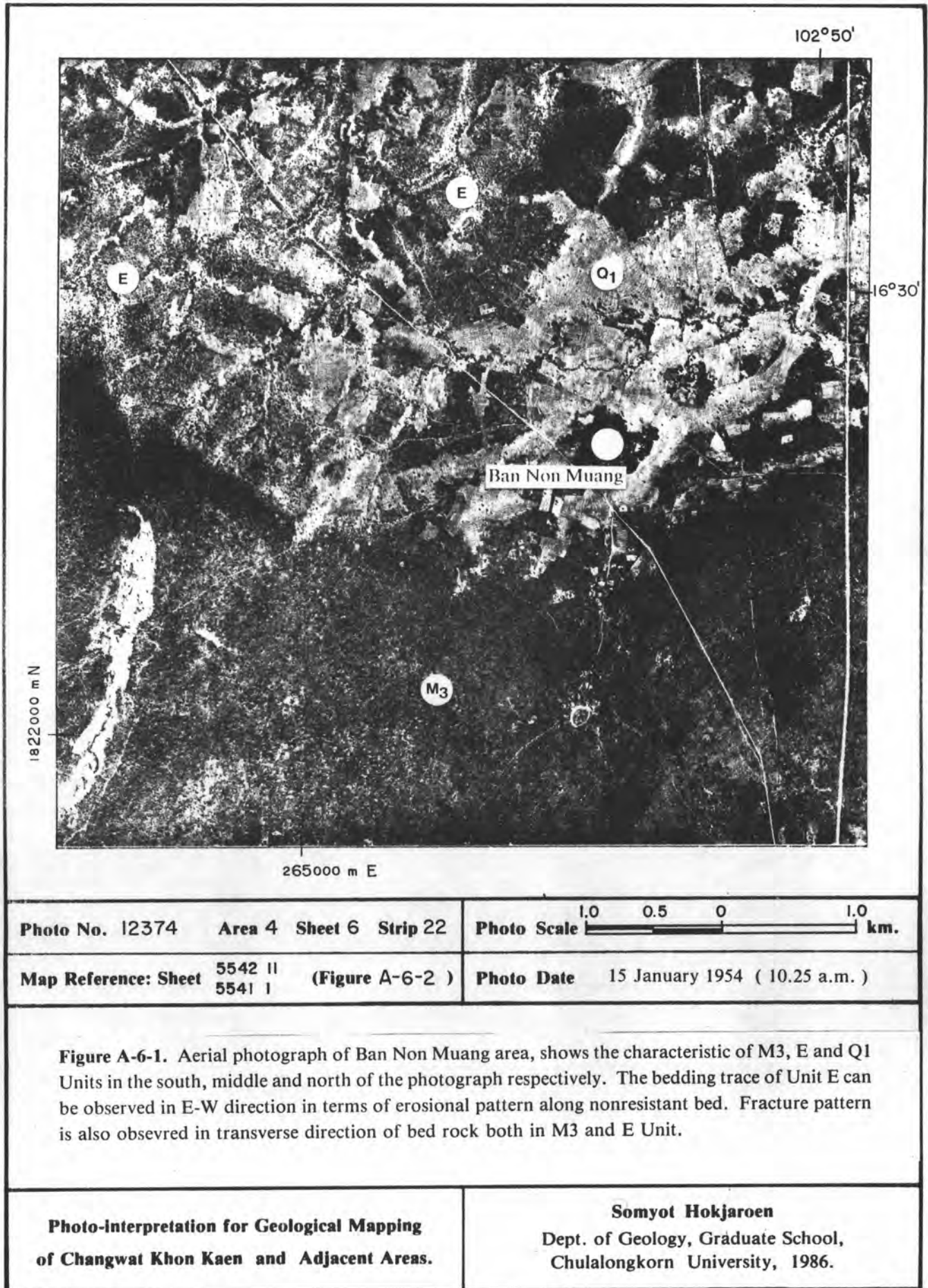
Figure A-5-3 Photogeological Map. Scale 1.0 0.5 0 1.0 km.

Photo Ref. : Photo No. 12277 (Figure A-5-1) **Map Ref. : Sheet 5541 I, IV (Figure A-5-2)**

Explanations for Photogeological Map

<p>SYMBOLS</p> <ul style="list-style-type: none"> Amphoe (district) Ban (village) Primary road & Route no. Secondary road Railroad River, Stream Water body 	<ul style="list-style-type: none"> Geological unit boundary Bedding (sub-horizontal) Bedding trace Fracture trace Syncline, Anticline - with plunging direction meander scar 	<p>PHOTOGEOLOGICAL UNITS</p> <table border="0" style="width: 100%;"> <tr> <td> Q4</td> <td> E</td> </tr> <tr> <td> Q3</td> <td> D2</td> </tr> <tr> <td> Q2</td> <td> D1</td> </tr> <tr> <td> Q1</td> <td> C</td> </tr> <tr> <td> M3</td> <td> B</td> </tr> <tr> <td> M2</td> <td> A</td> </tr> <tr> <td> M1</td> <td></td> </tr> </table>	Q4	E	Q3	D2	Q2	D1	Q1	C	M3	B	M2	A	M1	
Q4	E															
Q3	D2															
Q2	D1															
Q1	C															
M3	B															
M2	A															
M1																

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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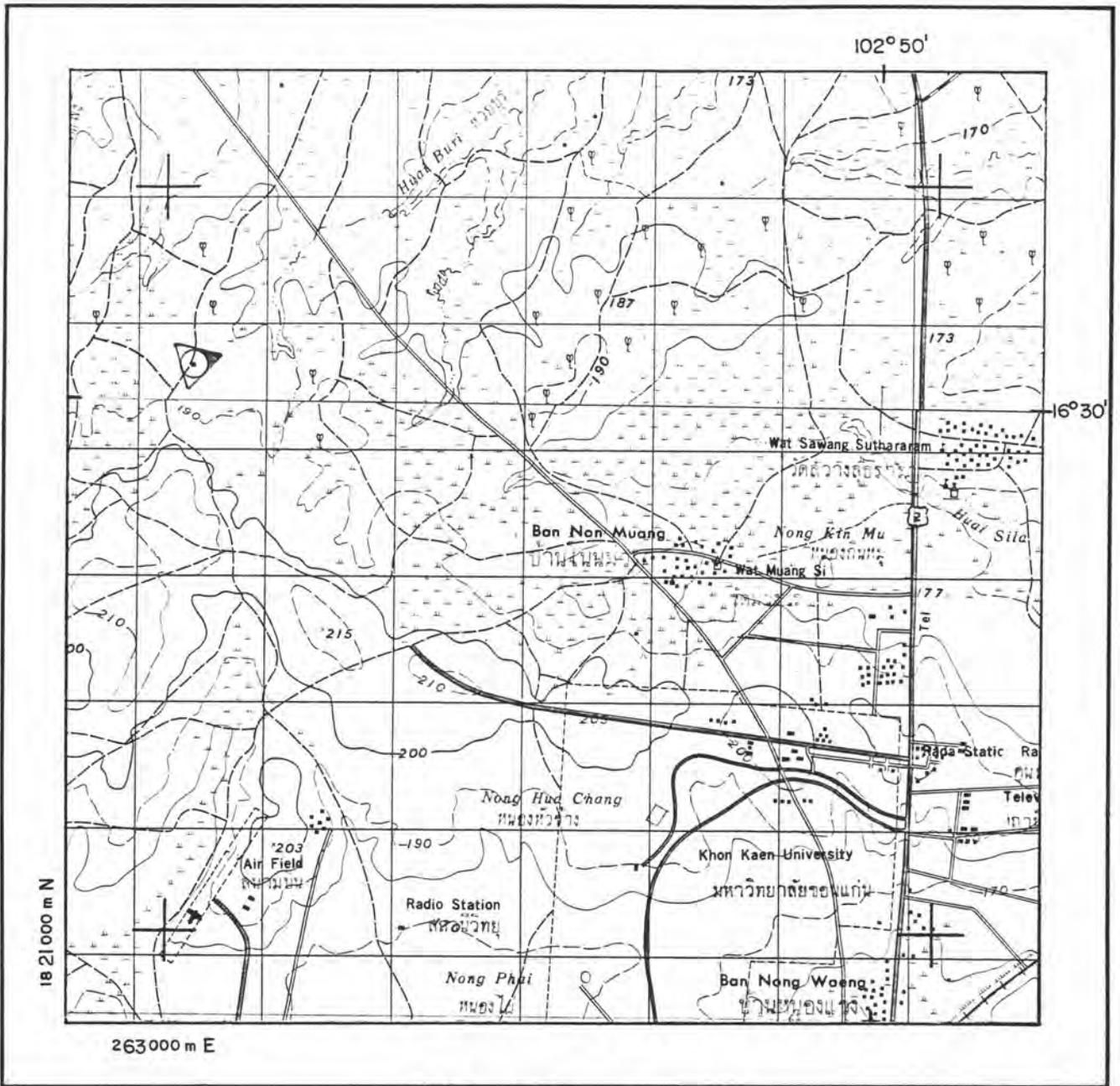


Figure A-6-2 [A) = Above ; B) = Left]

A) Topographic Map (1:50,000) Sheet 5541 I
 5542 II
 [+ + = map area as shown on the aerial
 + + = photograph of Figure A-6-1]

B) Terrestrial photograph at UTM Grid Ref.
 2634 18256 to N 075 ° E direction.

**Photo-interpretation for Geological Mapping
 of Changwat Khon Kaen and Adjacent Areas.**

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

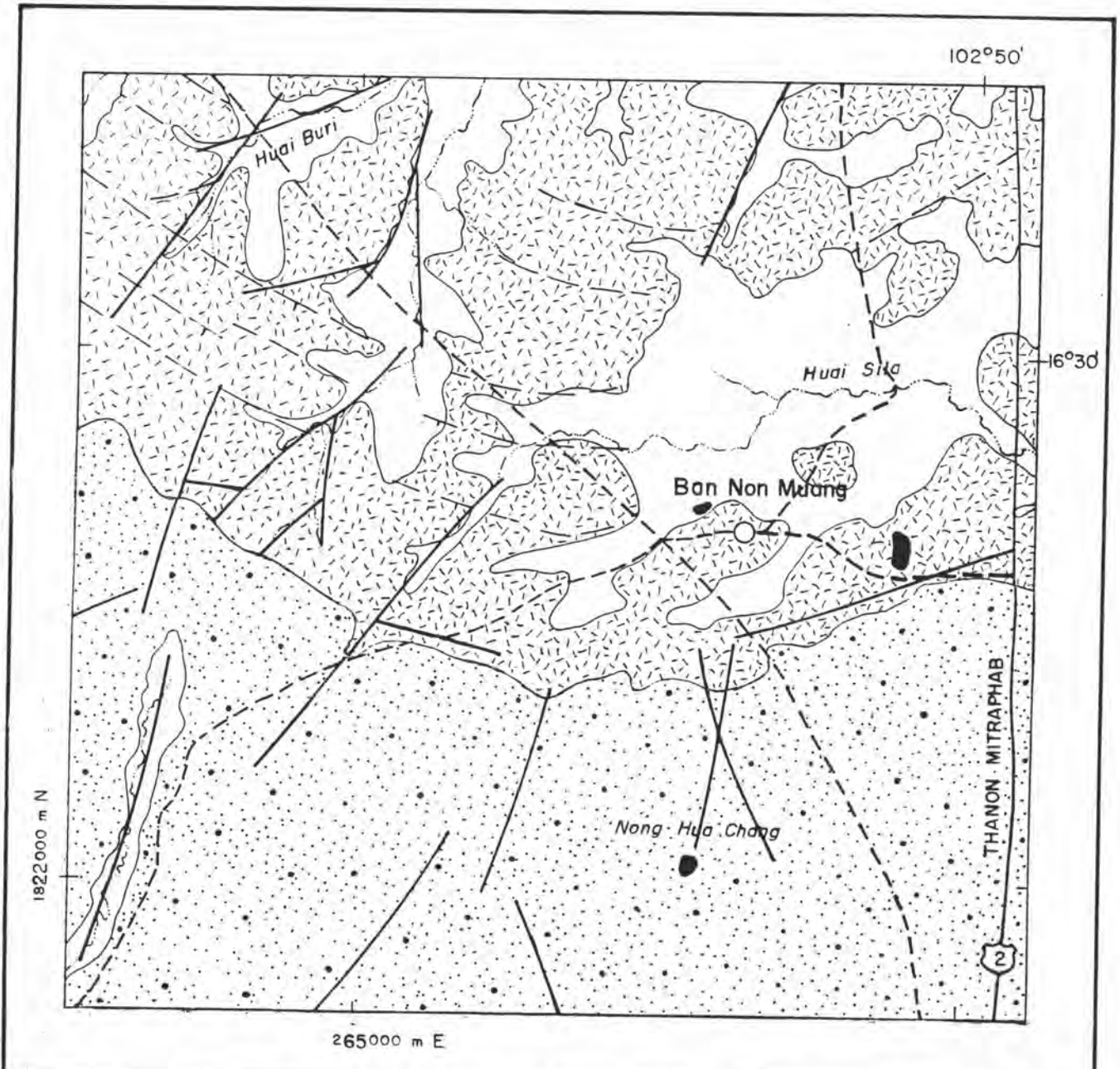


Figure A-6-3 Photogeological Map.

Scale 1.0 0.5 0 1.0 km.

Photo Ref. : Photo No. 12374 (Figure A-6-1) Map Ref. : Sheet 5542 II (Figure A-6-2)
 5541 I

Explanations for Photogeological Map

<p>SYMBOLS</p> <ul style="list-style-type: none"> Amphoe (district) Ban (village) Primary road & Route no. Secondary road Railroad River, Stream Water body 	<ul style="list-style-type: none"> Geological unit boundary Bedding (sub-horizontal) Bedding trace Fracture trace Syncline, Anticline - with plunging direction meander scar 	<p>PHOTOGEOLOGICAL UNITS</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;"> Q4</td> <td style="width: 50%;"> E</td> </tr> <tr> <td> Q3</td> <td> D2</td> </tr> <tr> <td> Q2</td> <td> D1</td> </tr> <tr> <td> Q1</td> <td> C</td> </tr> <tr> <td> M3</td> <td> B</td> </tr> <tr> <td> M2</td> <td> A</td> </tr> <tr> <td> M1</td> <td></td> </tr> </table>	Q4	E	Q3	D2	Q2	D1	Q1	C	M3	B	M2	A	M1	
Q4	E															
Q3	D2															
Q2	D1															
Q1	C															
M3	B															
M2	A															
M1																

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p style="text-align: center;">Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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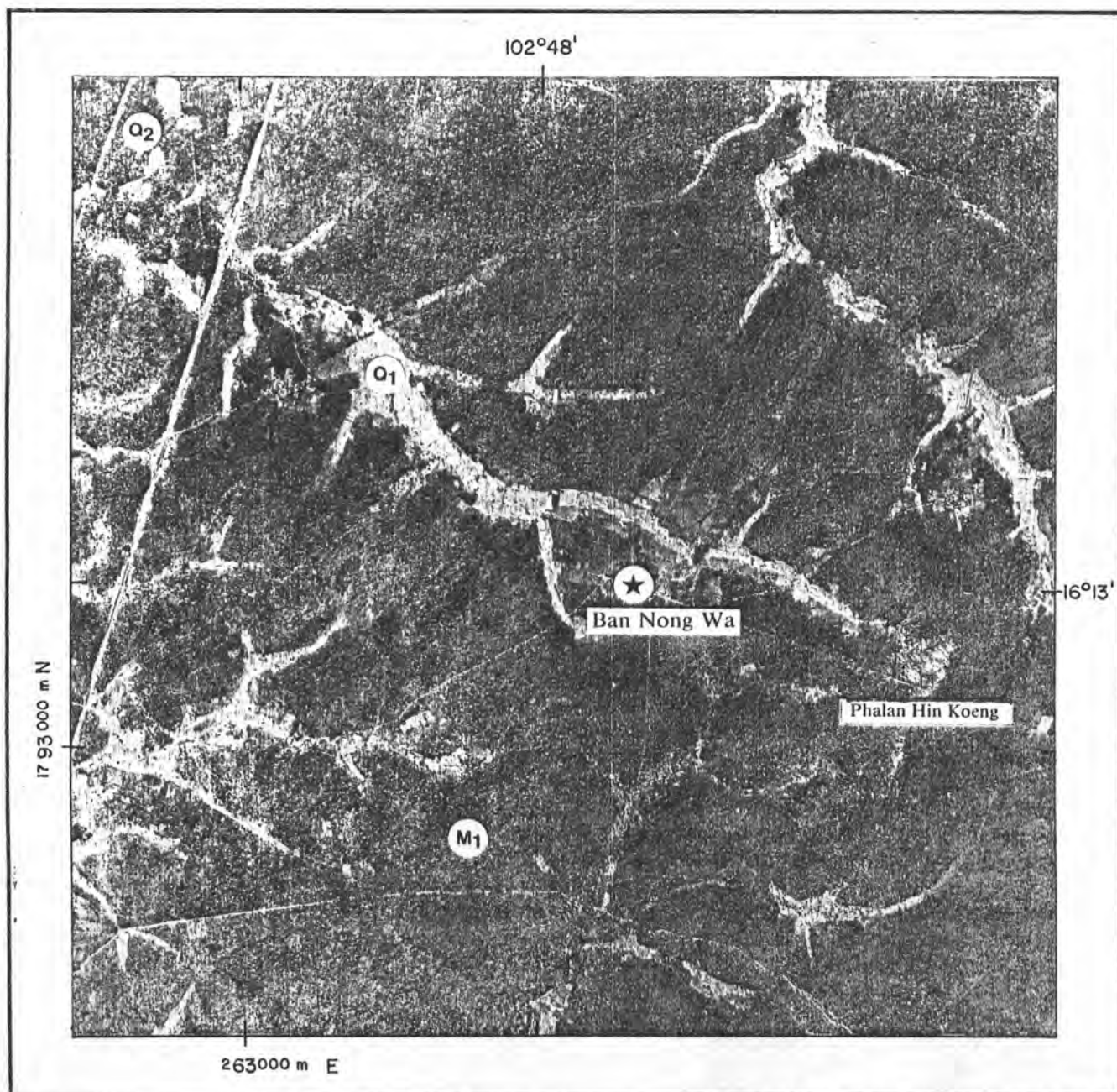
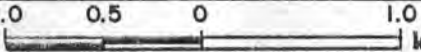


Photo No. 12382 Area 4 Sheet 6 Strip 22

Photo Scale  km.

Map Reference: Sheet 5541 I, II (Figure A-7-2)

Photo Date 15 January 1954 (10.30 a.m.)

Figure A-7-1. Aerial photograph of Ban Nong Wa area, shows the typical characteristic of the M3 Unit. The photo shows rolling topography of the M3 Unit and depicts joint patterns in NW-SE and N-NE-S-SW sets, particularly at Phalan Hin Koeng, NW-SE joint patterns can be clearly observed. Drainage patterns in this area mostly follow the joint traces.

**Photo-interpretation for Geological Mapping
of Changwat Khon Kaen and Adjacent Areas.**

Somyot Hokjaroen
Dept. of Geology, Graduate School,
Chulalongkorn University, 1986.

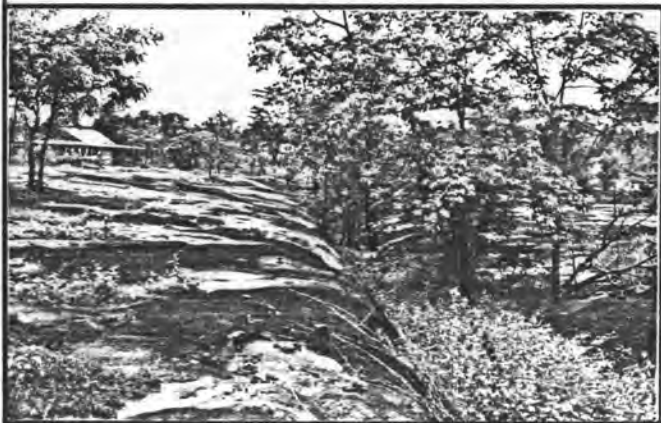
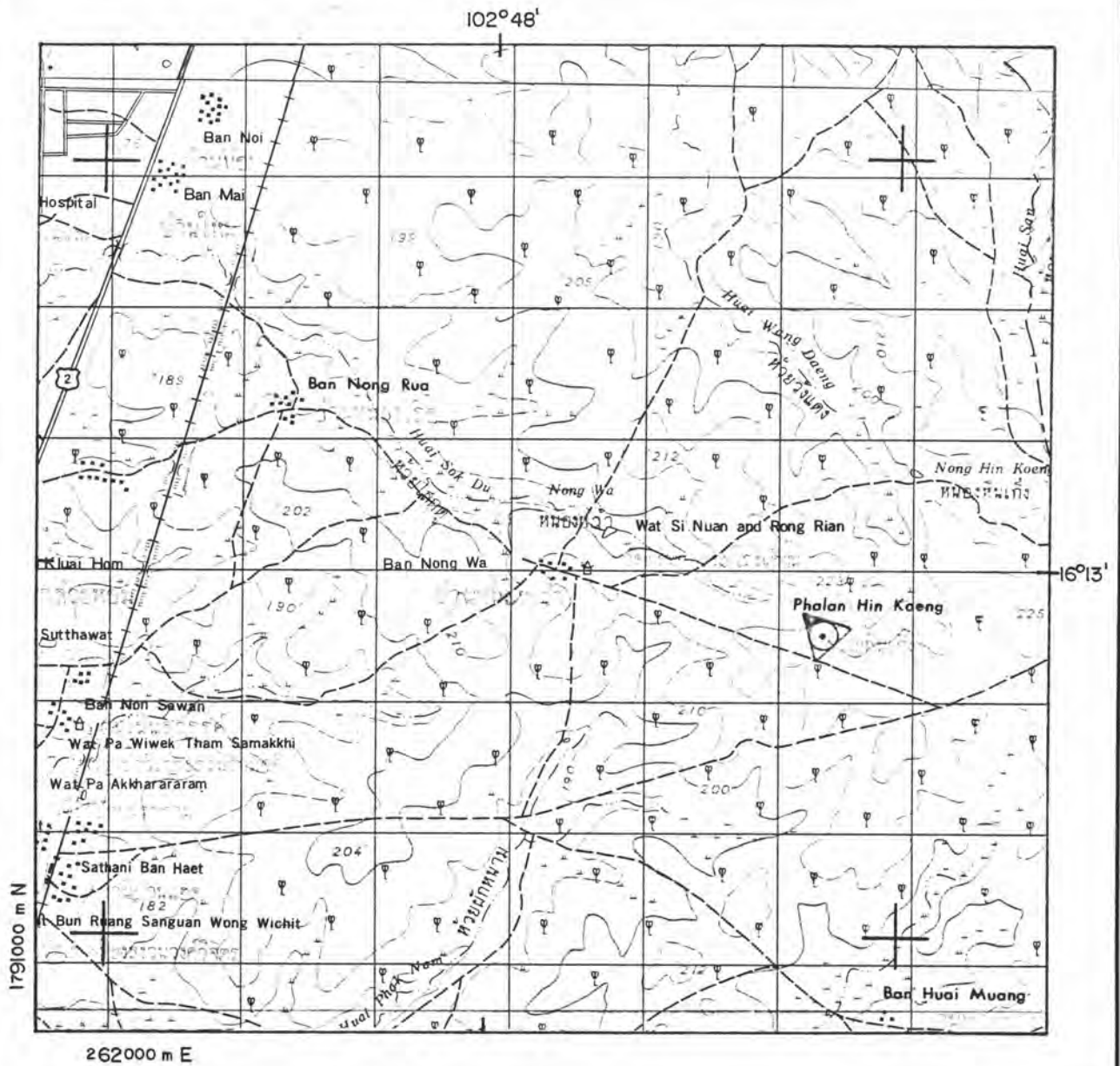


Figure A-7-2 [A) = Above ; B) = Left]

A) Topographic Map (1:50,000) Sheet 5541 1,11
 [+ + = map area as shown on the aerial]
 [+ + = photograph of Figure A-7-1]

B) Terrestrial photograph at UTM Grid Ref.
 2673 17935 to N 320° E direction.

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 of Changwat Khon Kaen and Adjacent Areas.**

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 Chulalongkorn University, 1986.

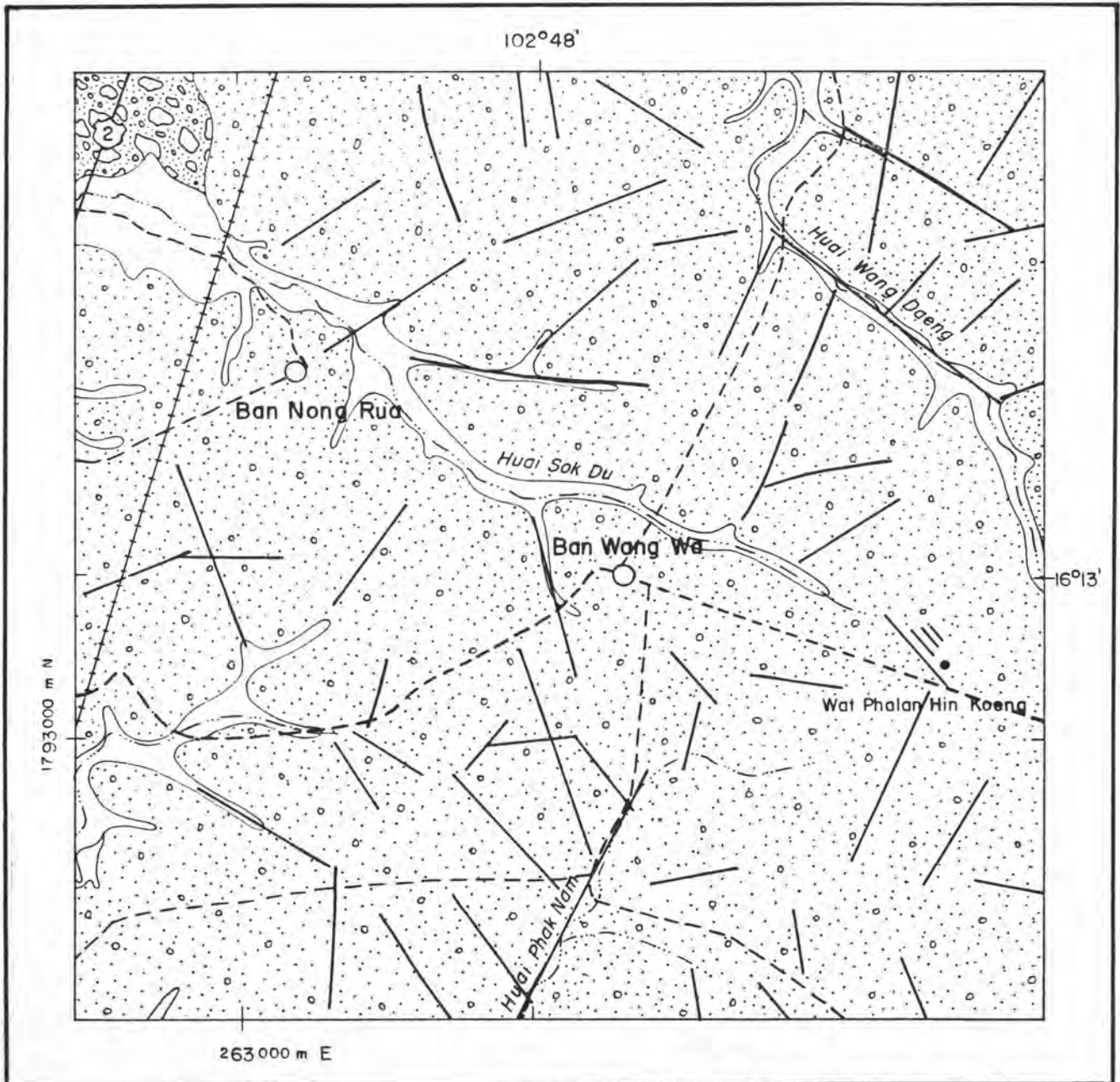


Figure A-7-3 Photogeological Map.

Scale km.

Photo Ref. : Photo No. 12382 (Figure A-7-1)

Map Ref. : Sheet 5541 I, II (Figure A-7-2)

Explanations for Photogeological Map

- SYMBOLS**
- Amphoe (district)
 - Ban (village)
 - Primary road & Route no.
 - Secondary road
 - Railroad
 - River, Stream
 - Water body

- Geological unit boundary
- Bedding (sub-horizontal)
- Bedding trace
- Fracture trace
- Syncline, Anticline - with plunging direction
- meander scar

PHOTOGEOLOGICAL UNITS

- | | | | |
|--|----|--|----|
| | Q4 | | E |
| | Q3 | | D2 |
| | Q2 | | D1 |
| | Q1 | | C |
| | M3 | | B |
| | M2 | | A |
| | M1 | | |

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of Changwat Khon Kaen and Adjacent Areas.**

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Chulalongkorn University, 1986.

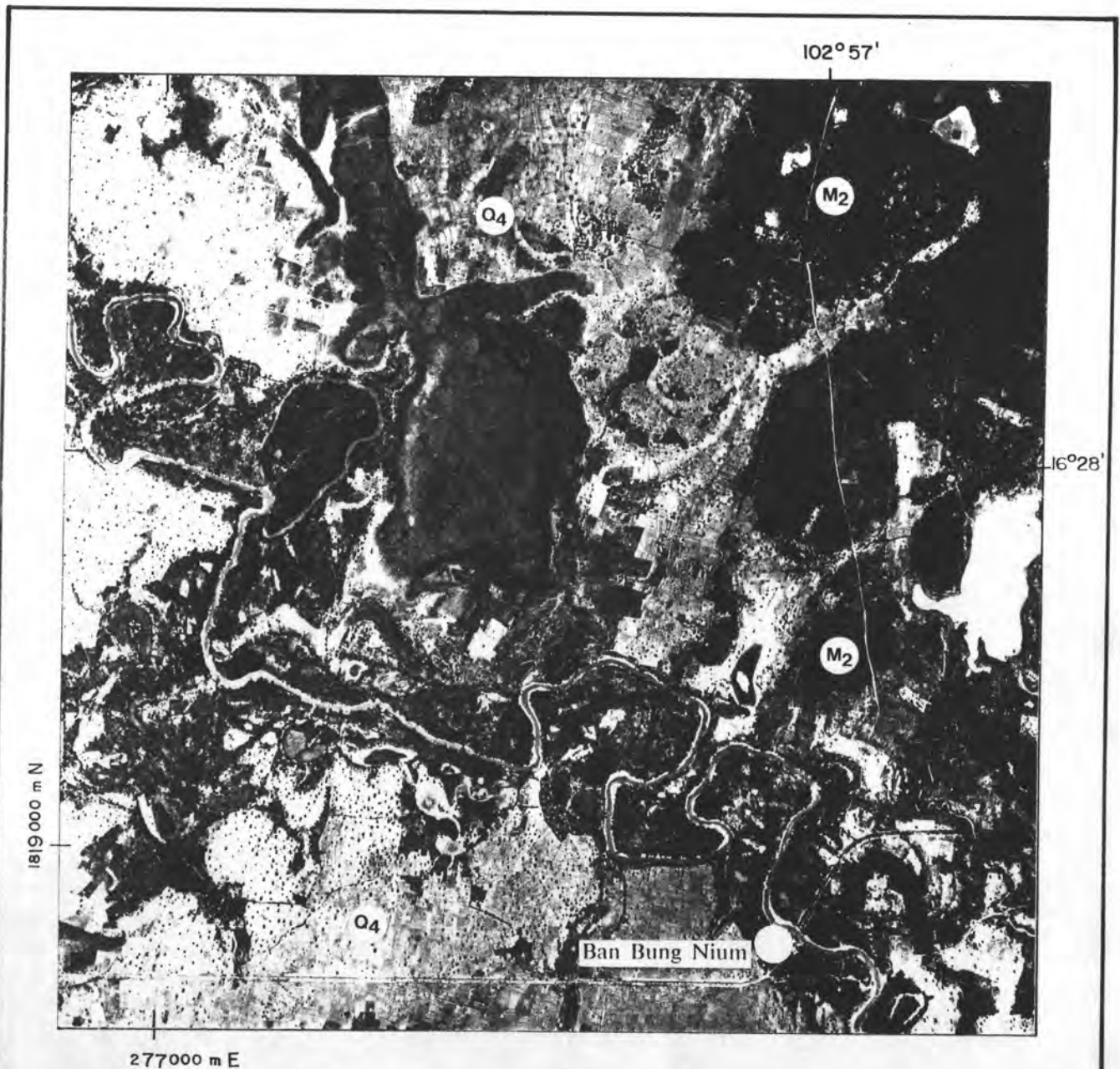


Photo No. 12506 Area 4 Sheet 6 Strip 24

Photo Scale $\frac{1.0}{0.5} \frac{0}{1.0}$ km.

Map Reference: Sheet 5541 II (Figure A-8-2)

Photo Date 15 January 1954 (00.01 p.m.)

Figure A-8-1. Aerial photograph of Ban Bung Nium area, shows the features of Q4 Unit which represents mainly of fluvial morphology, i.e., natural levees, point bar deposits, oxbow lakes, back swamp, meander scars and flood plain. Nong Saeng, the large depression feature can be observed at the center of the area in N-S direction. The M2 and Q1 Units present at the northeast of the photograph.

**Photo-interpretation for Geological Mapping
of Changwat Khon Kaen and Adjacent Areas.**

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Dept. of Geology, Graduate School,
Chulalongkorn University, 1986.

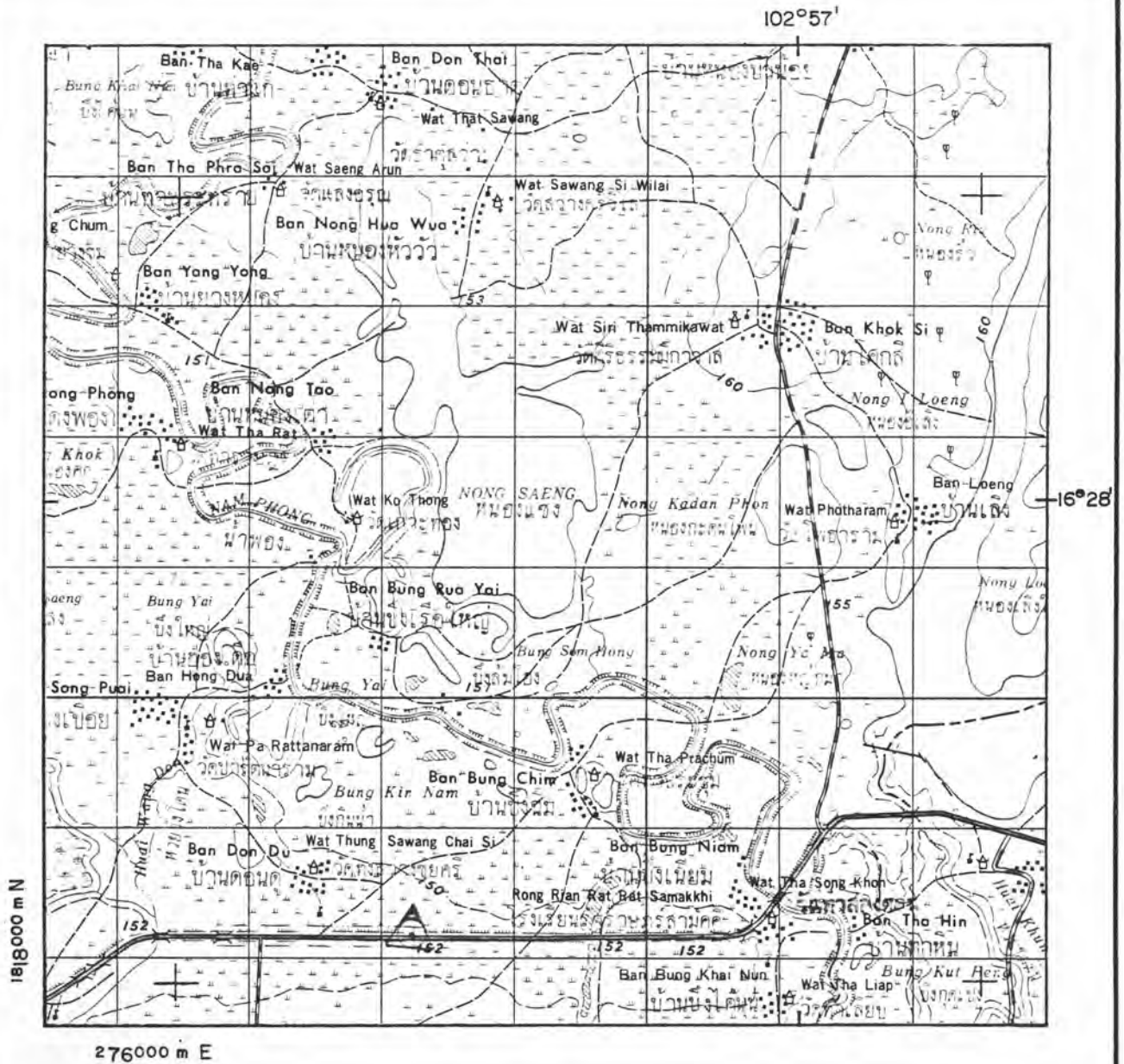


Figure A-8-2 [A) = Above ; B) = Left]

A) Topographic Map (1:50,000) Sheet 5541 II
 [+ + = map area as shown on the aerial]
 [+ + = photograph of Figure A-8-1]

B) Terrestrial photograph at UTM Grid Ref.
 2783 18182 to N 005 ° E direction.

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

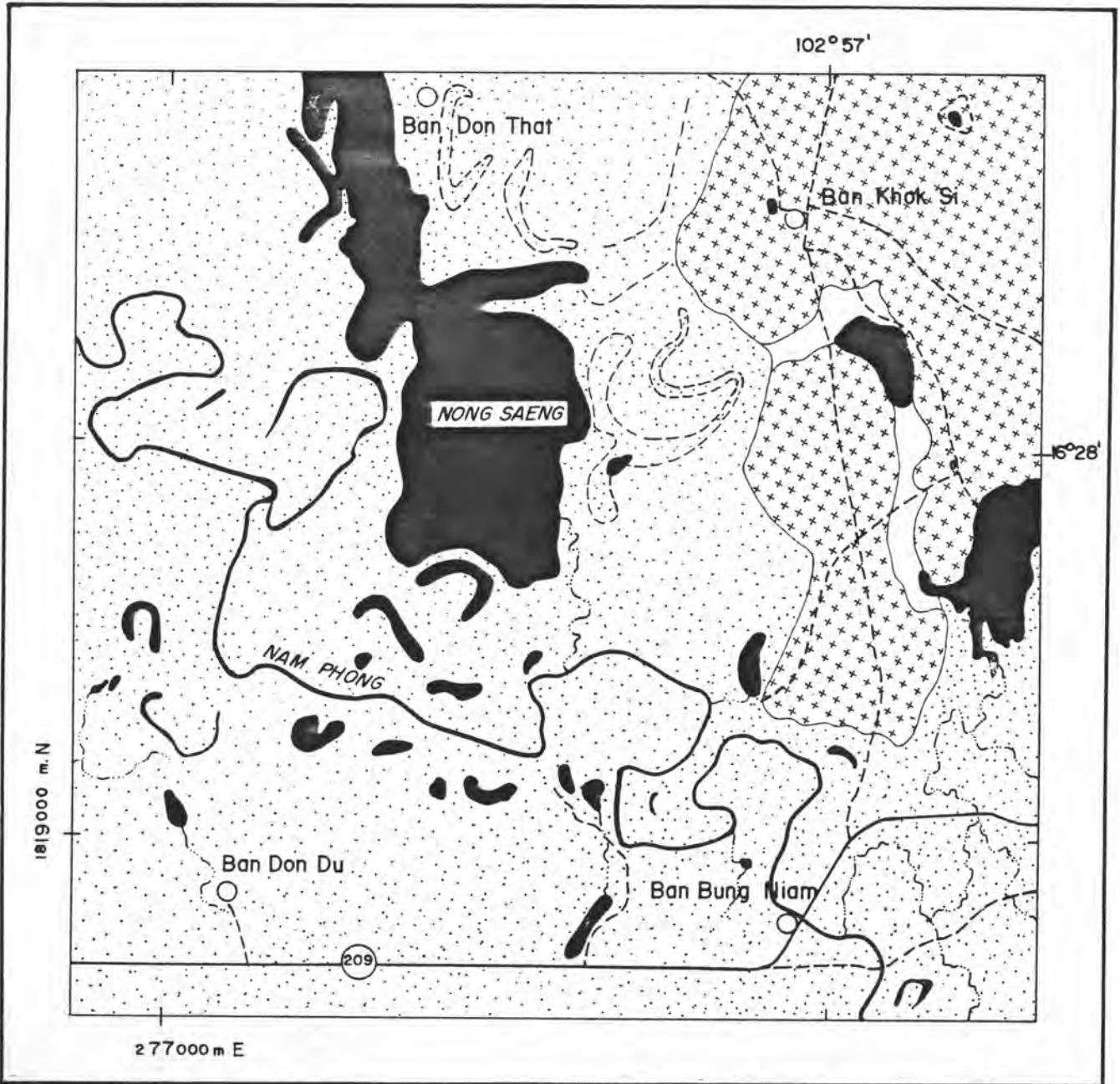


Figure A-8-3 Photogeological Map.

Scale km.

Photo Ref. : Photo No. 12506 (Figure A-8-1)

Map Ref. : Sheet 5541 II (Figure A-8-2)

Explanations for Photogeological Map

- SYMBOLS**
- Amphoe (district)
 - Ban (village)
 - Primary road & Route no.
 - Secondary road
 - Railroad
 - River, Stream
 - Water body

- Geological unit boundary
- Bedding (sub-horizontal)
- Bedding trace
- Fracture trace
- Syncline, Anticline - with plunging direction
- meander scar

PHOTOGEOLOGICAL UNITS

- | | | | |
|--|----|--|----|
| | Q4 | | E |
| | Q3 | | D2 |
| | Q2 | | D1 |
| | Q1 | | C |
| | M3 | | B |
| | M2 | | A |
| | M1 | | |

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

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 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

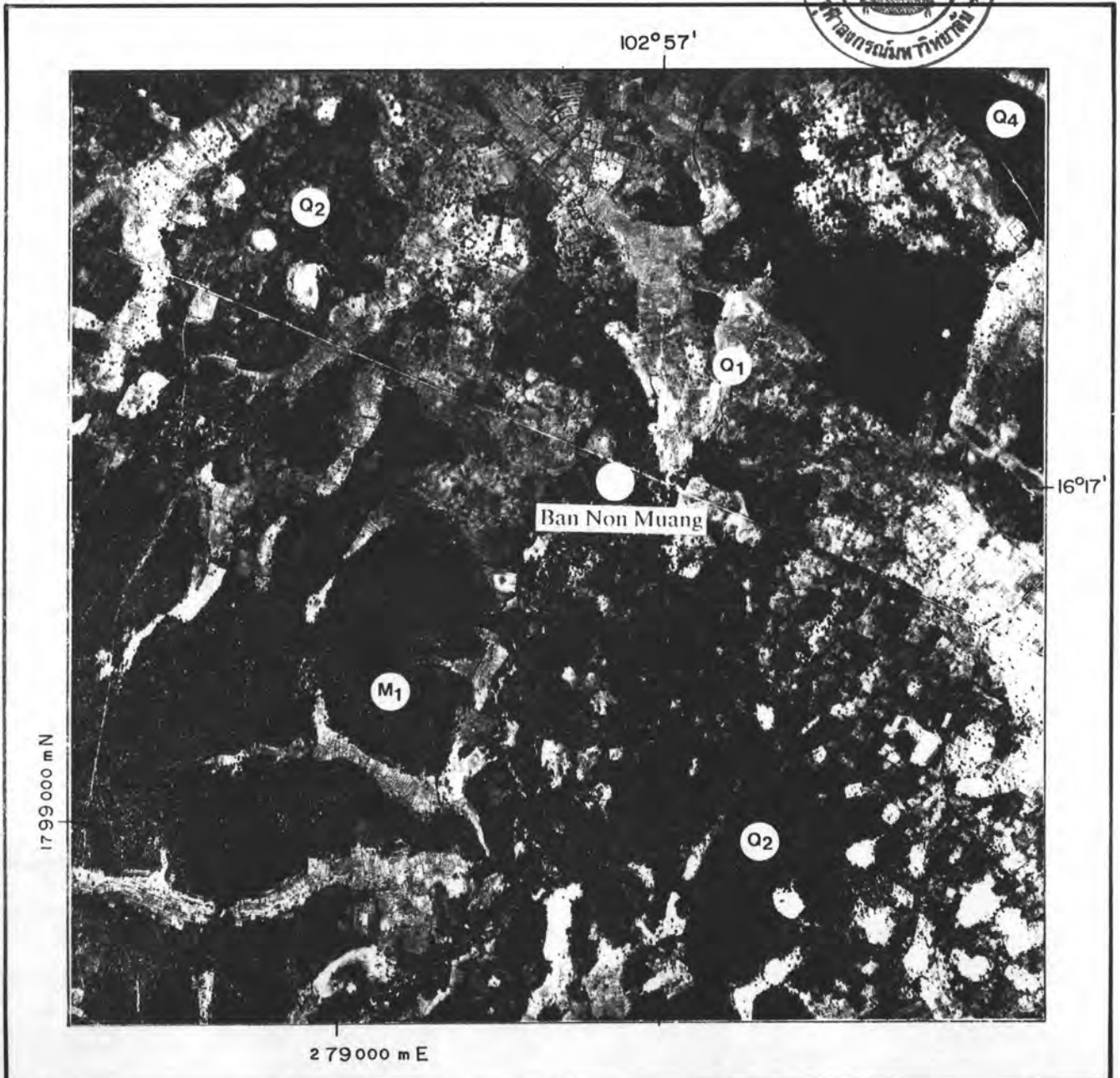


Photo No. 12513 Area 4 Sheet 6 Strip 24	Photo Scale km.
Map Reference: Sheet 5541 I (Figure A-9-2)	Photo Date 15 January 1954 (00.07 p.m.)

Figure A-9-1. Aerial photograph of Ban Non Muang area, shows the characteristics of Unit M1, Q1, Q2 and Q4. The M1 Unit occurs at the south-west of the area. The Q2 Unit represents nearly flat terrain in the middle of the area. A number of small depression features occur in the Q2 Unit in NW-SE direction and show as water body or paddy field area. The Q1 Unit represents in light-grey tone and appears as narrow flat terrain along the erosional valley.

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.	Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.
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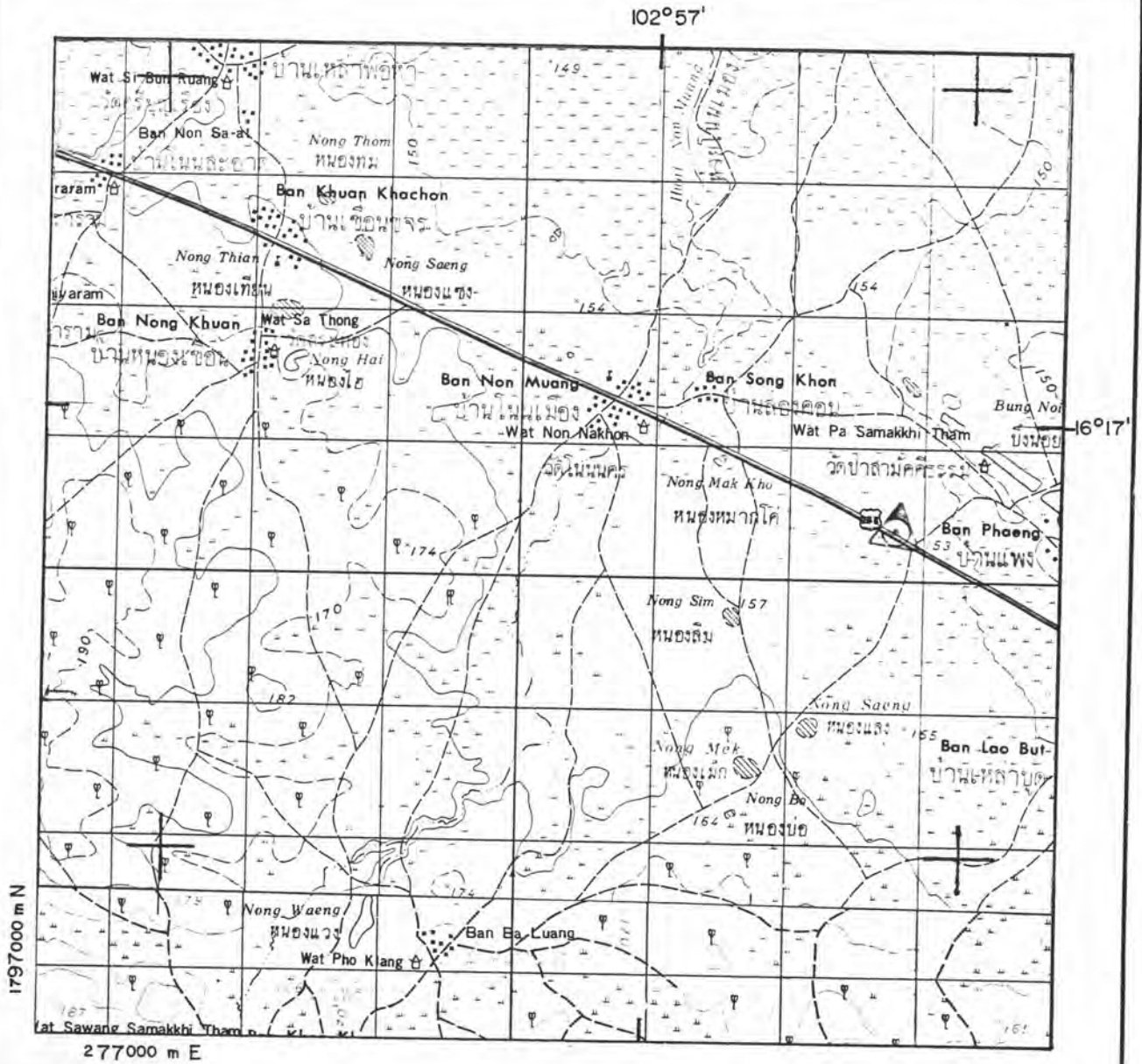


Figure A-9-2 [A) = Above ; B) = Left]

- A) Topographic Map (1:50,000) Sheet 5541 I**
+ + = map area as shown on the aerial
+ + = photograph of Figure A-9-1
- B) Terrestrial photograph at UTM Grid Ref. 2828 18003 to N 010 ° E direction.**

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

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 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

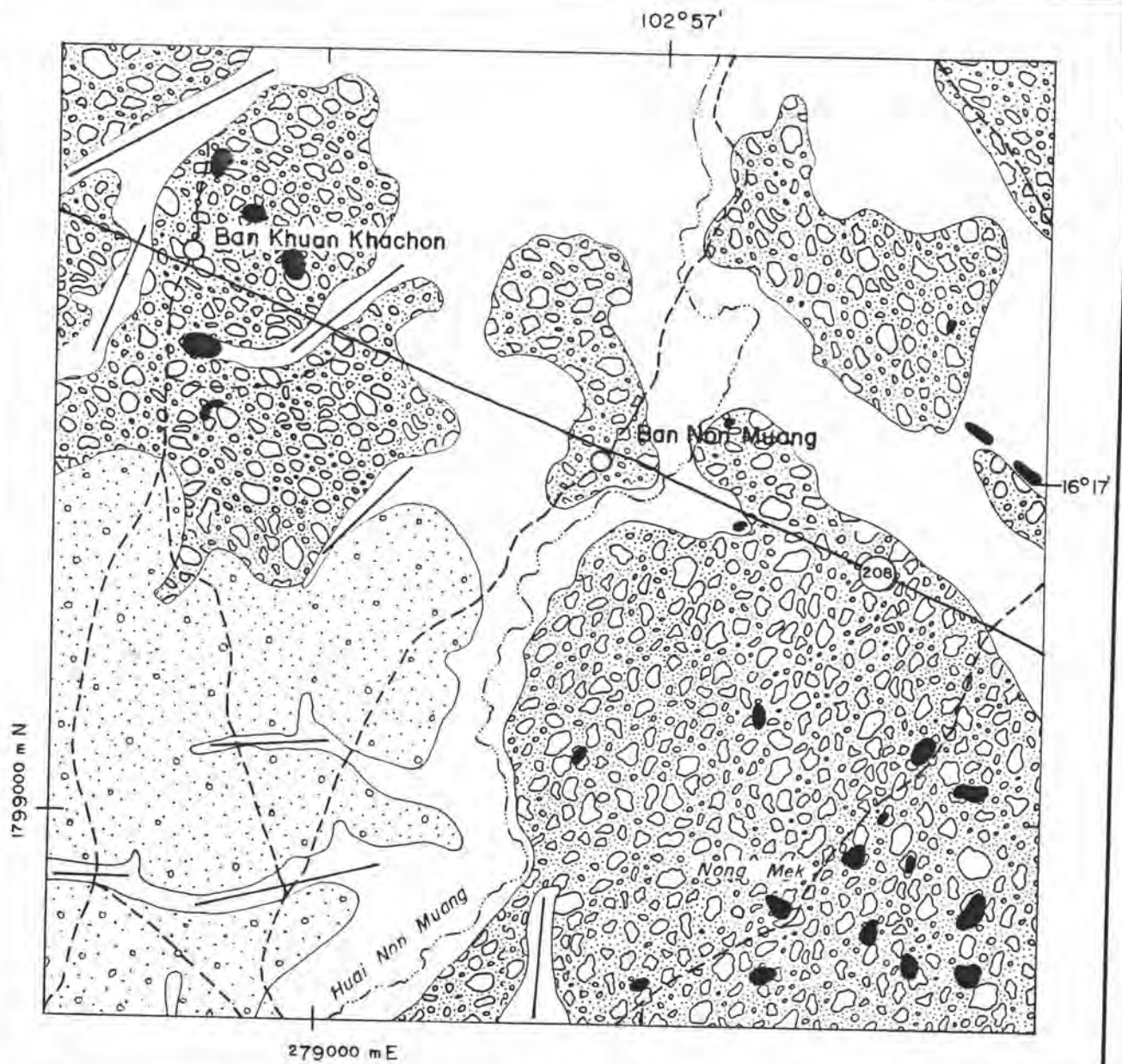


Figure A-9-3 Photogeological Map.

Scale 1.0 0.5 0 1.0 km.

Photo Ref. : Photo No. 12513 (Figure A-9-1)

Map Ref. : Sheet 5541 I (Figure A-9-2)

Explanations for Photogeological Map

<p>SYMBOLS</p> <ul style="list-style-type: none"> Amphoe (district) Ban (village) Primary road & Route no. Secondary road Railroad River, Stream Water body 	<ul style="list-style-type: none"> Geological unit boundary Bedding (sub-horizontal) Bedding trace Fracture trace Syncline, Anticline - with plunging direction meander scar 	<p>PHOTOGEOLOGICAL UNITS</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;"> Q4</td> <td style="width: 50%;"> E</td> </tr> <tr> <td> Q3</td> <td> D2</td> </tr> <tr> <td> Q2</td> <td> D1</td> </tr> <tr> <td> Q1</td> <td> C</td> </tr> <tr> <td> M3</td> <td> B</td> </tr> <tr> <td> M2</td> <td> A</td> </tr> <tr> <td> M1</td> <td></td> </tr> </table>	Q4	E	Q3	D2	Q2	D1	Q1	C	M3	B	M2	A	M1	
Q4	E															
Q3	D2															
Q2	D1															
Q1	C															
M3	B															
M2	A															
M1																

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p style="text-align: center;">Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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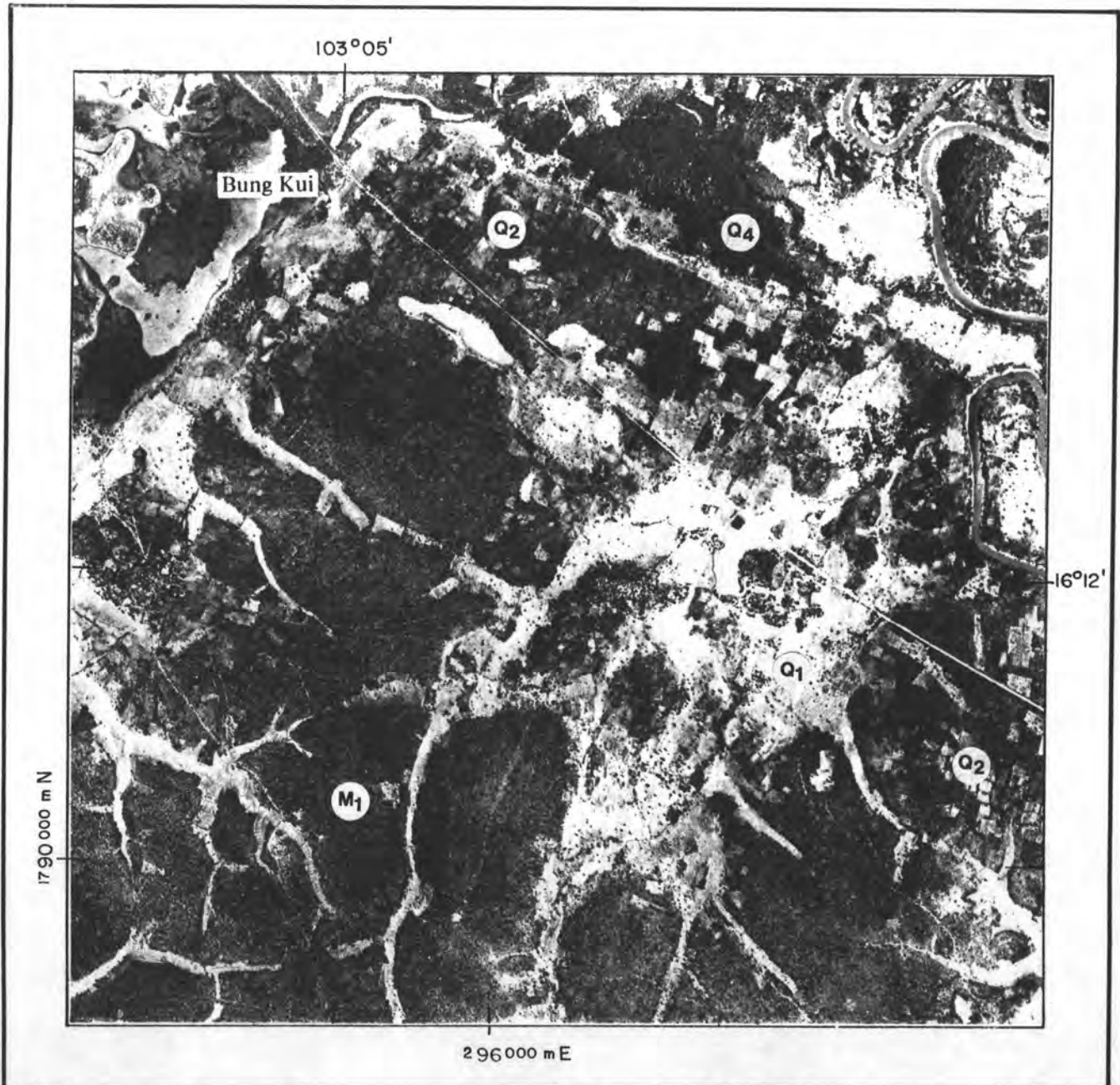


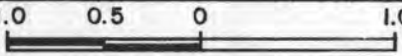
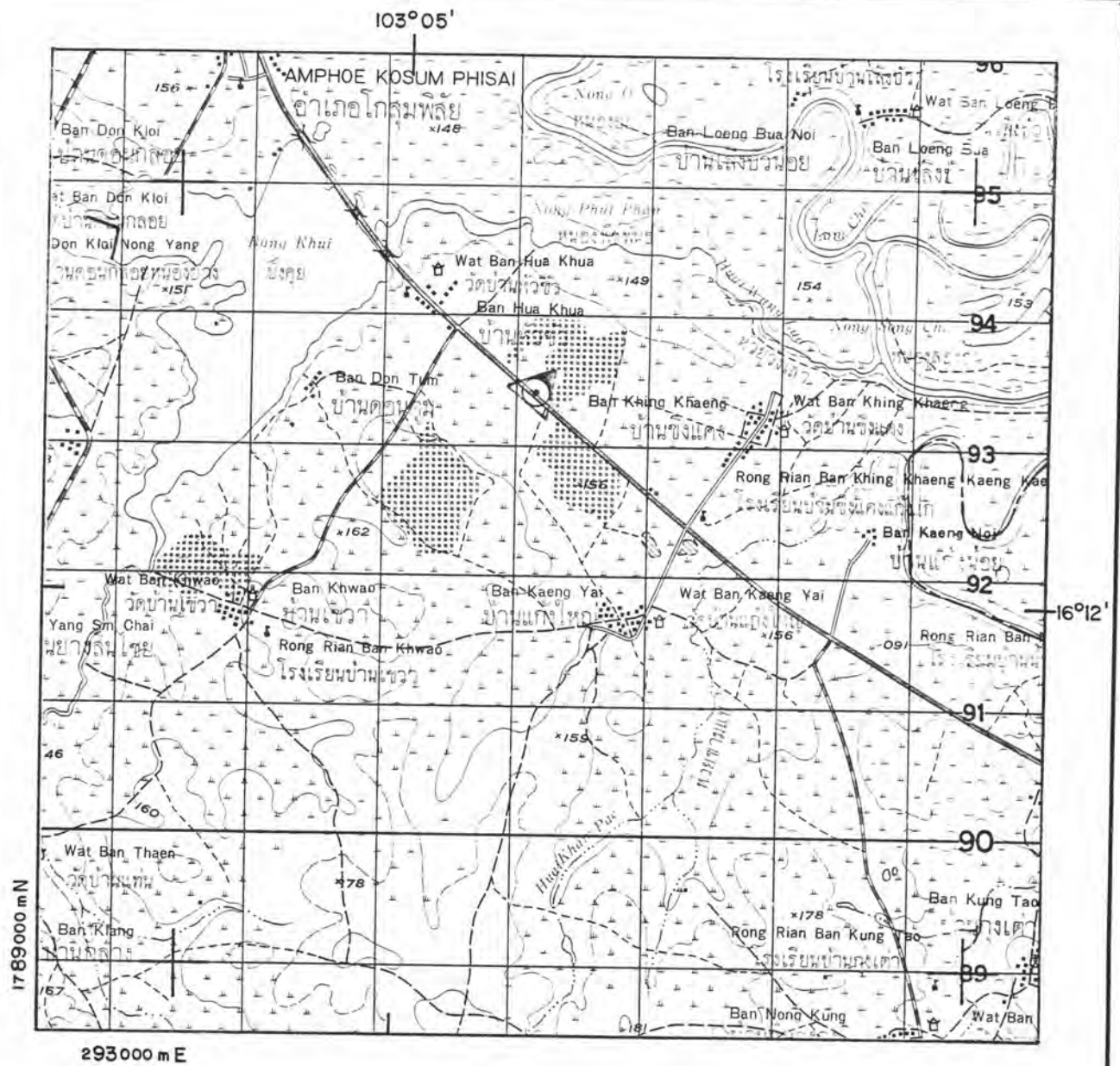
Photo No. 14596 Area 4 Sheet 7 Strip 26	Photo Scale  km.
Map Reference: Sheet 5541 III (Figure A-10-2)	Photo Date 01 February 1954 (11.01 a.m.)

Figure A-10-1. Aerial photograph of Bung Kui area, shows the features of M1, Q2, Q1 and Q4 Unit. The M3 Unit occurs at the south of the area and much developed joint system in NW-SE directions. The Q2 Unit occurs in the middle portion of the area, nearly flat terrain and some parts of the unit developed some of small depression features as shown in light-grey tone and low relief pattern. The Q1 Unit appears around the previous units and clearly observed in forms of the small valleys of the erosional features.

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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1789000 m N

293000 m E



Figure A-10-2 [A) = Above ; B) = Left]

A) Topographic Map (1:50,000) Sheet 5541 III
 [+ + = map area as shown on the aerial]
 [+ + = photograph of Figure A-10-1]

B) Terrestrial photograph at UTM Grid Ref.
 2962 17934 to N 045 ° E direction.

**Photo-interpretation for Geological Mapping
 of Changwat Khon Kaen and Adjacent Areas.**

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

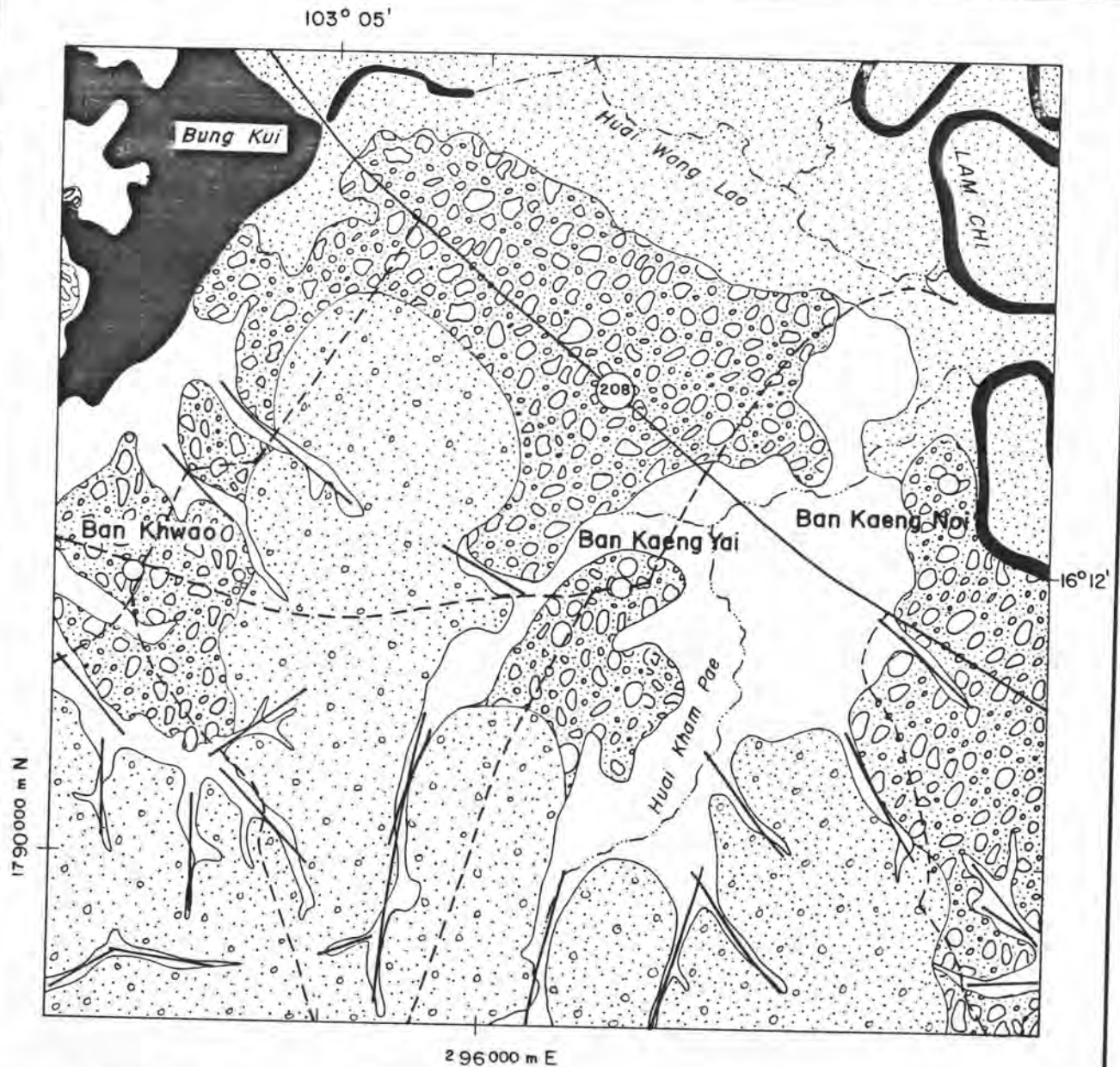


Figure A-10-3 Photogeological Map.

Scale 1.0 0.5 0 1.0 km.

Photo Ref. : Photo No. 14596 (Figure A-10-1)

Map Ref. : Sheet 5541 III (Figure A-10-2)

Explanations for Photogeological Map

- Amphoe (district)
- Ban (village)
- Primary road & Route no.
- Secondary road
- Railroad
- River, Stream
- Water body

SYMBOLS

- Geological unit boundary
- Bedding (sub-horizontal)
- Bedding trace
- Fracture trace
- Syncline, Anticline - with plunging direction
- meander scar

PHOTOGEOLOGICAL UNITS

- | | | | |
|--|----|--|----|
| | Q4 | | E |
| | Q3 | | D2 |
| | Q2 | | D1 |
| | Q1 | | C |
| | M3 | | B |
| | M2 | | A |
| | M1 | | |

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

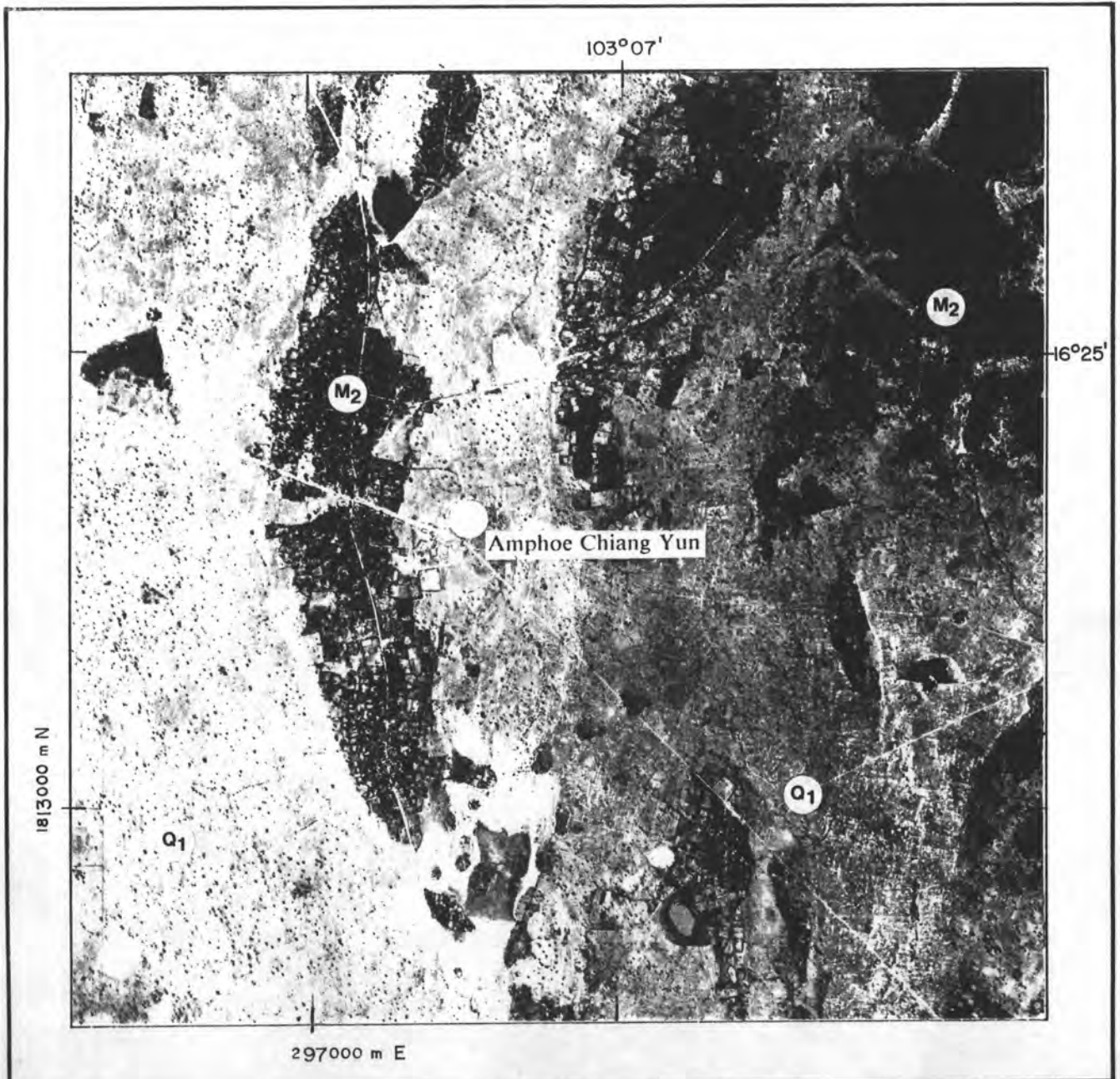


Photo No. 14866	Area 4 Sheet 7 Strip 27	Photo Scale	1.0 0.5 0 1.0 km.
Map Reference: Sheet 5641 IV (Figure A-11-2)		Photo Date	02 February 1954 (09.41 a.m.)

Figure A-11-1. Aerial photograph of Amphoe Chiang Yun area, shows the feature of only Q1 and M2 Units. Unit M2 represents in higher relief and develops in N-S trending, some part are still show the erosional pattern and gradually change to Q1 Unit. Many of small depression areas developed within the Q1 Unit nearly in N-S trending. The light tone along the edge of M2 Unit represents the salt patch which is the typical feature of this unit.

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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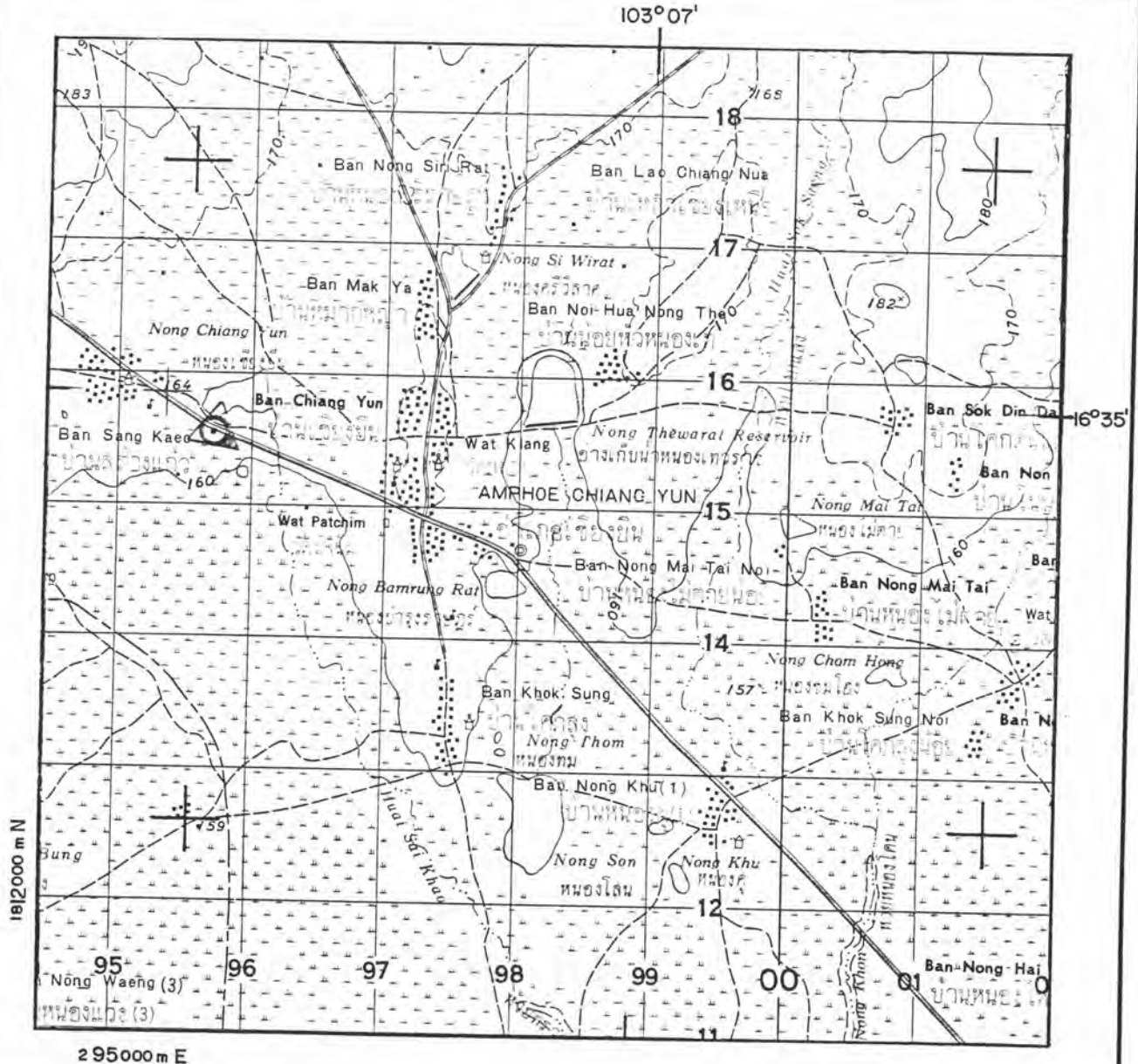


Figure A-II-2 [A] = Above ; [B] = Left]

- A) Topographic Map (1:50,000) Sheet 564I IV**
 [+ + = map area as shown on the aerial]
 [+ + = photograph of Figure A-II-1]
- B) Terrestrial photograph at UTM Grid Ref.**
 2957 18158 to N 120° E direction.

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

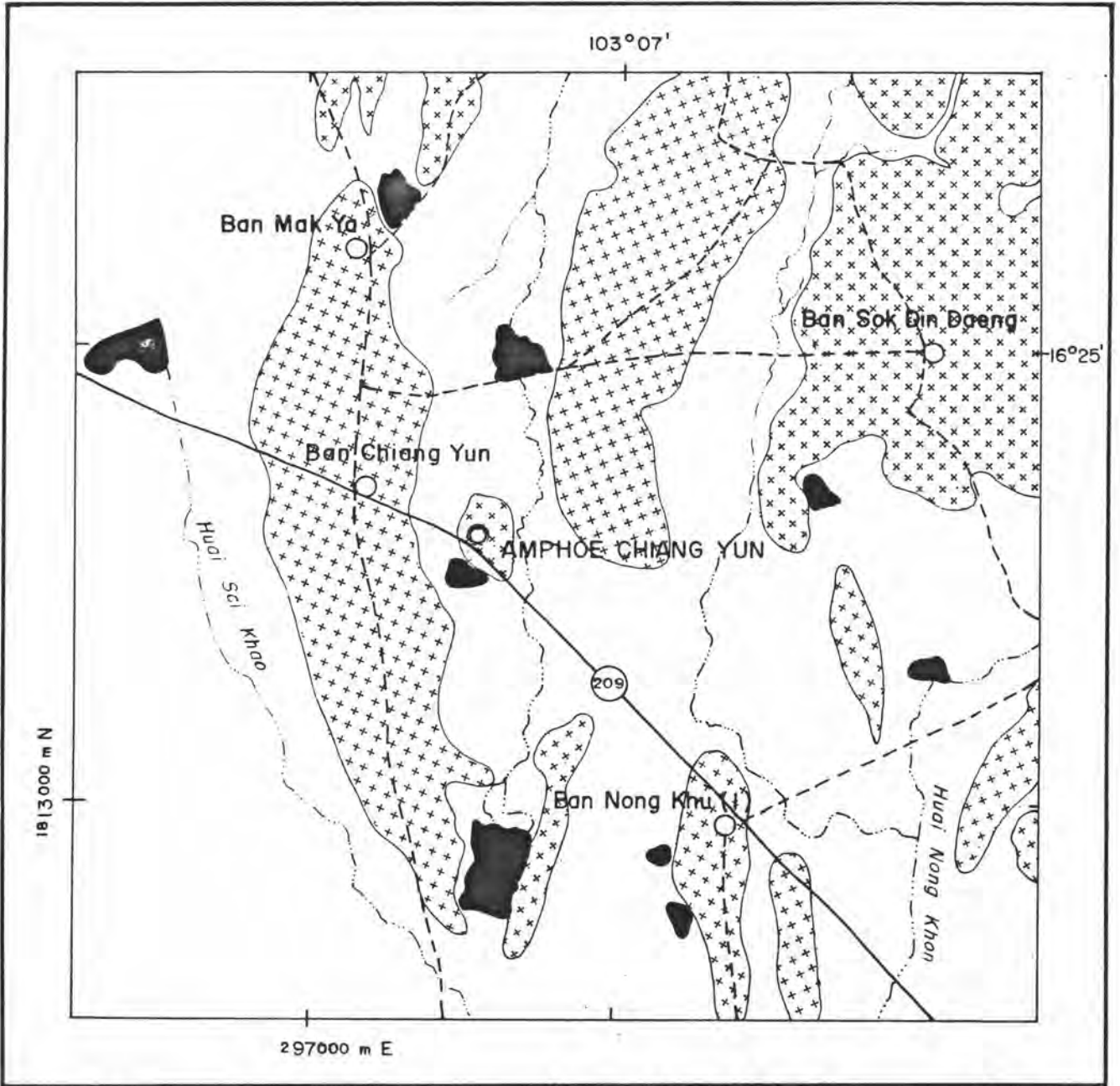


Figure A-11-3 Photogeological Map.

Scale km.

Photo Ref. : Photo No. 14866 (Figure A-11-1)

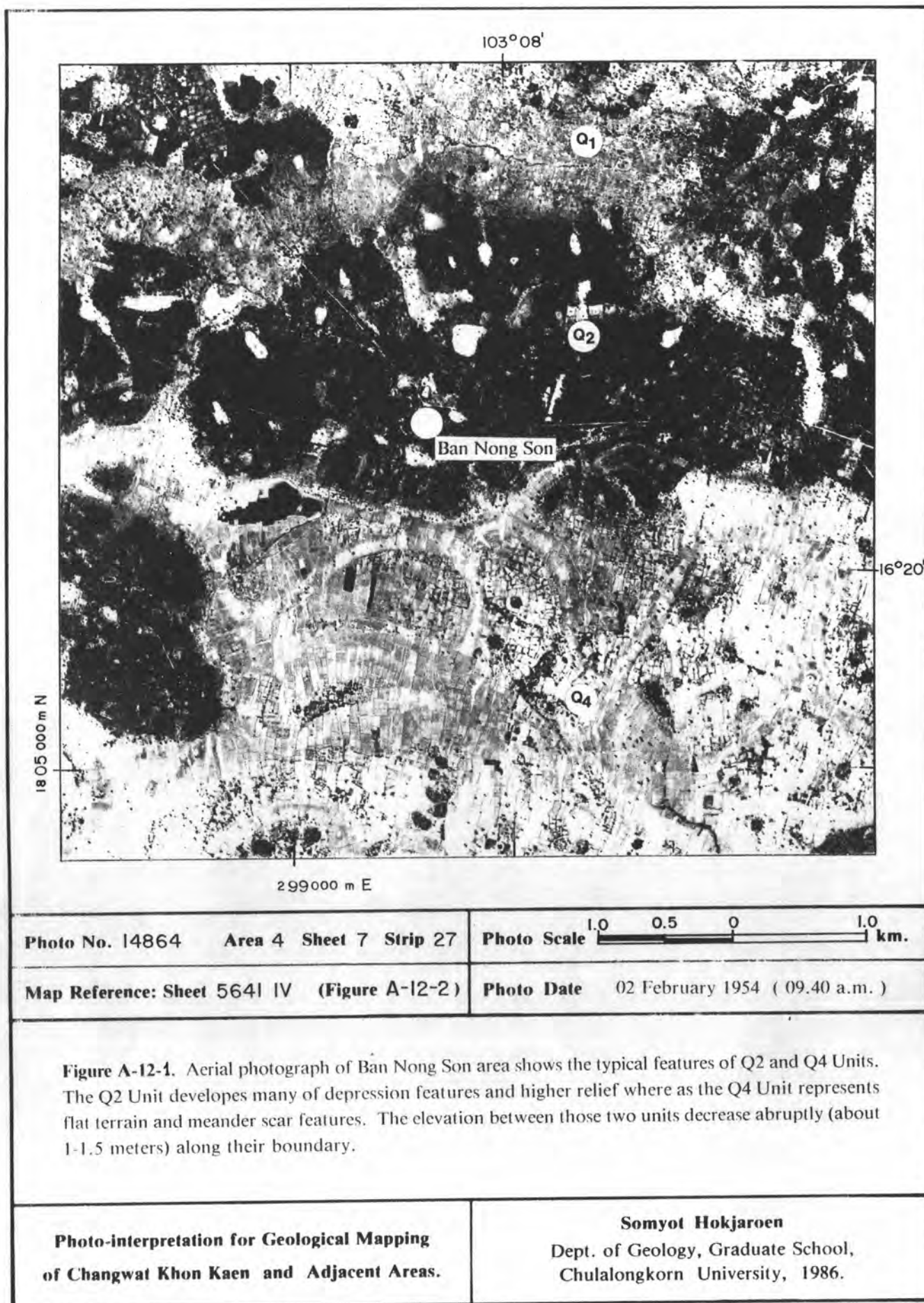
Map Ref. : Sheet 5641 IV (Figure A-11-2)

Explanations for Photogeological Map

SYMBOLS		PHOTOGEOLOGICAL UNITS	
<ul style="list-style-type: none"> Amphoe (district) Ban (village) Primary road & Route no. Secondary road Railroad River, Stream Water body 	<ul style="list-style-type: none"> Geological unit boundary Bedding (sub-horizontal) Bedding trace Fracture trace Syncline, Anticline - with plunging direction meander scar 	<ul style="list-style-type: none"> Q4 Q3 Q2 Q1 M3 M2 M1 	<ul style="list-style-type: none"> E D2 D1 C B A

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.



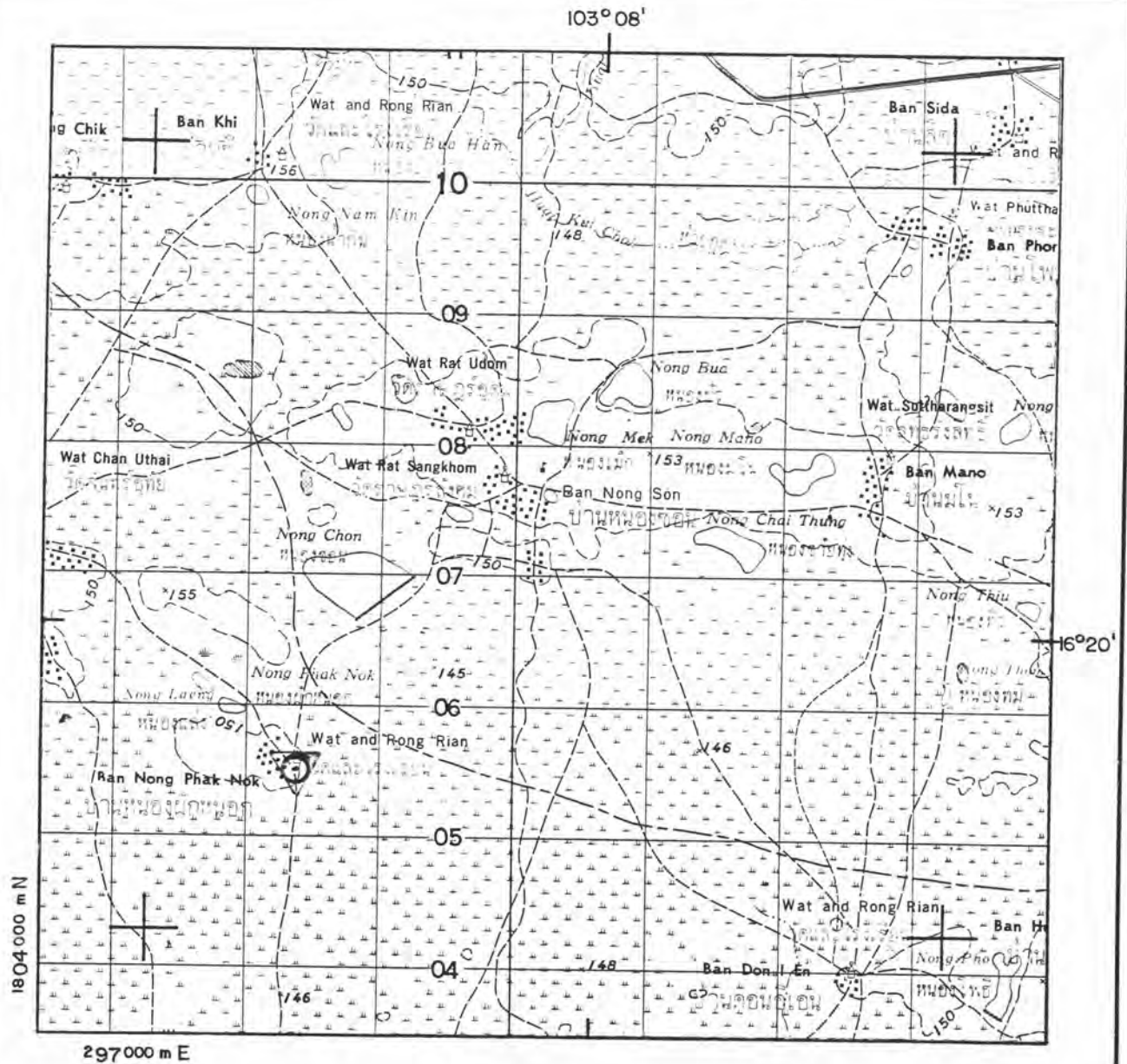


Figure A-12-2 [A] = Above ; B] = Left]

A) Topographic Map (1:50,000) Sheet 564I IV
 [+ + = map area as shown on the aerial]
 [+ + = photograph of Figure A-12-1]

B) Terrestrial photograph at UTM Grid Ref.
 2984 18055 to N 065 ° E direction.

**Photo-interpretation for Geological Mapping
 of Changwat Khon Kaen and Adjacent Areas.**

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

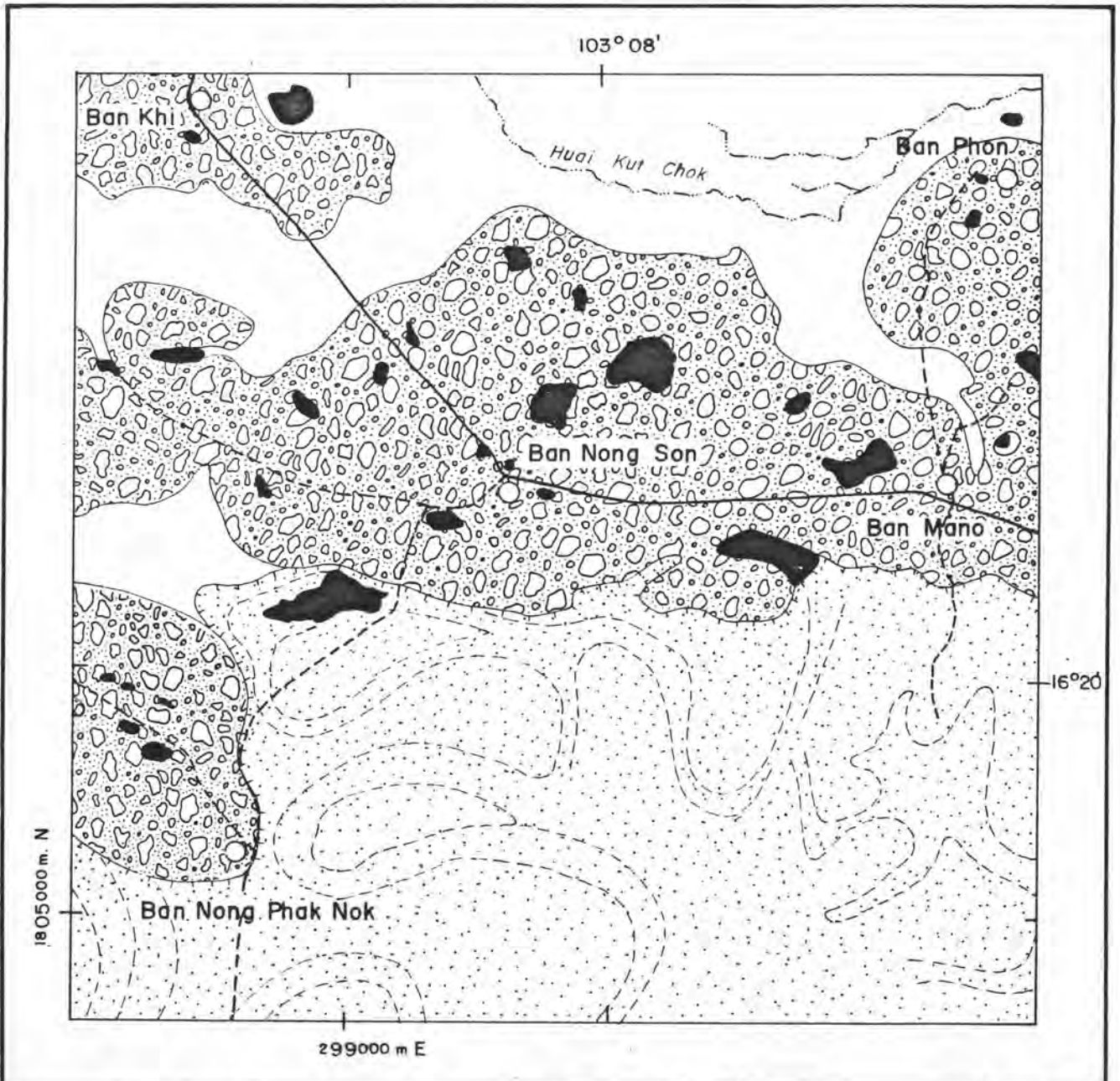


Figure A-12-3 Photogeological Map. Scale 1.0 0.5 0 1.0 km.

Photo Ref. : Photo No. 14864 (Figure A-12-1) Map Ref. : Sheet 5641 IV (Figure A-12-2)

Explanations for Photogeological Map

<p>SYMBOLS</p> <ul style="list-style-type: none"> Amphoe (district) Ban (village) Primary road & Route no. Secondary road Railroad River, Stream Water body 	<ul style="list-style-type: none"> Geological unit boundary Bedding (sub-horizontal) Bedding trace Fracture trace Syncline, Anticline - with plunging direction meander scar 	<p>PHOTOGEOLOGICAL UNITS</p> <table border="0" style="width: 100%;"> <tr> <td> Q4</td> <td> E</td> </tr> <tr> <td> Q3</td> <td> D2</td> </tr> <tr> <td> Q2</td> <td> D1</td> </tr> <tr> <td> Q1</td> <td> C</td> </tr> <tr> <td> M3</td> <td> B</td> </tr> <tr> <td> M2</td> <td> A</td> </tr> <tr> <td> M1</td> <td></td> </tr> </table>	Q4	E	Q3	D2	Q2	D1	Q1	C	M3	B	M2	A	M1	
Q4	E															
Q3	D2															
Q2	D1															
Q1	C															
M3	B															
M2	A															
M1																

Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

Somyot Hokjaroen
Dept. of Geology, Graduate School,
Chulalongkorn University, 1986.

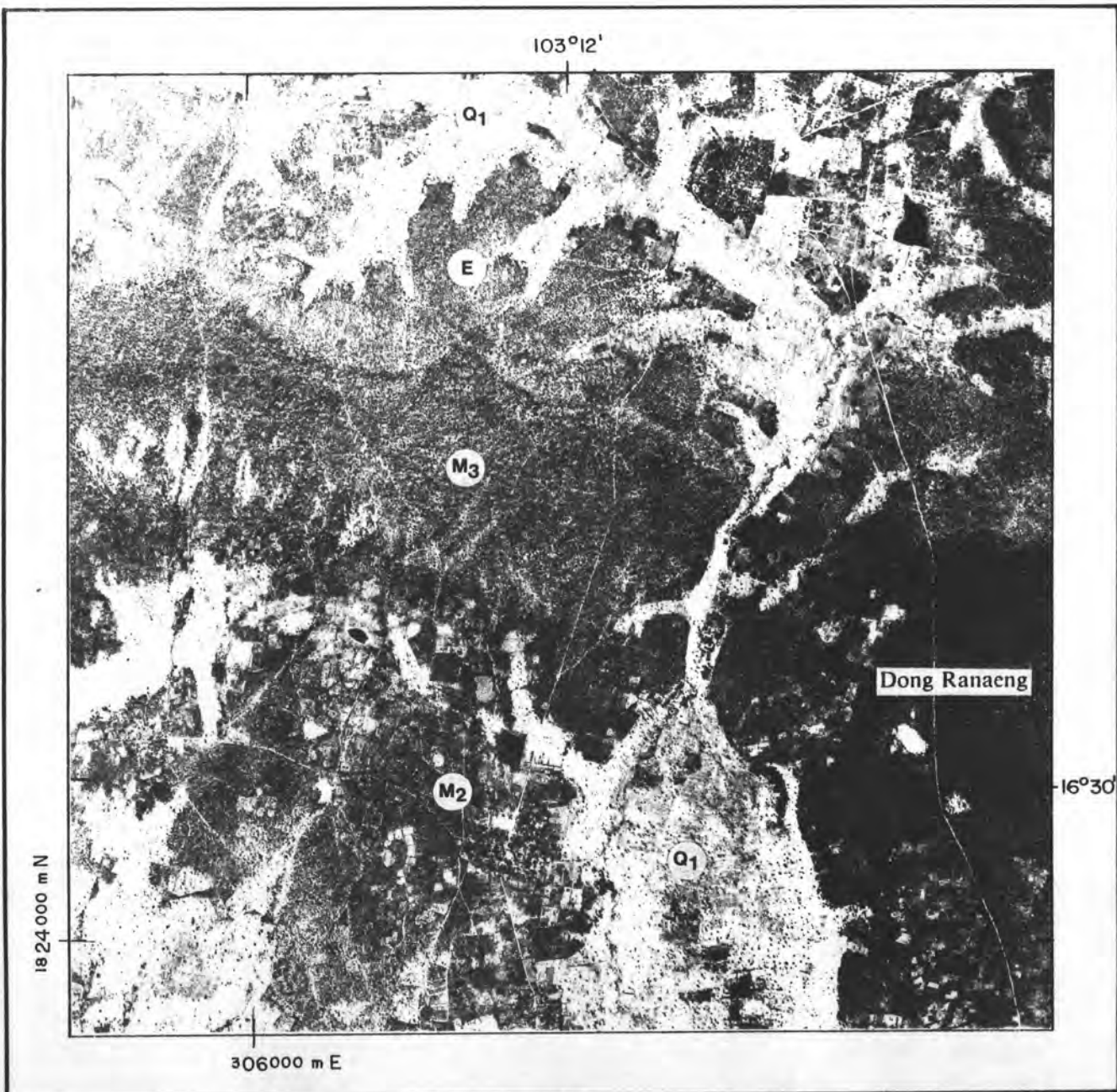


Photo No. 14971	Area 4 Sheet 7 Strip 28	Photo Scale	1.0 0.5 0 1.0 km.
Map Reference: Sheet	5642 III 5641 IV (Figure A-13-2)	Photo Date	02 February 1954 (11.02 a.m.)

Figure A-13-1. Aerial photograph of Dong Ranaeng area, shows the relationships and sequence of Unit E, M3, M2 and Q1. Generally, the rocks are lying in E-W direction and dipping southward. Many of fracture traces are observed on M3 Unit in N-S direction. The geological boundary between Unit M3 and M2 are quite clear by means of photo characteristics and their morphology in this area.

<p>Photo-interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.</p>	<p>Somyot Hokjaroen Dept. of Geology, Graduate School, Chulalongkorn University, 1986.</p>
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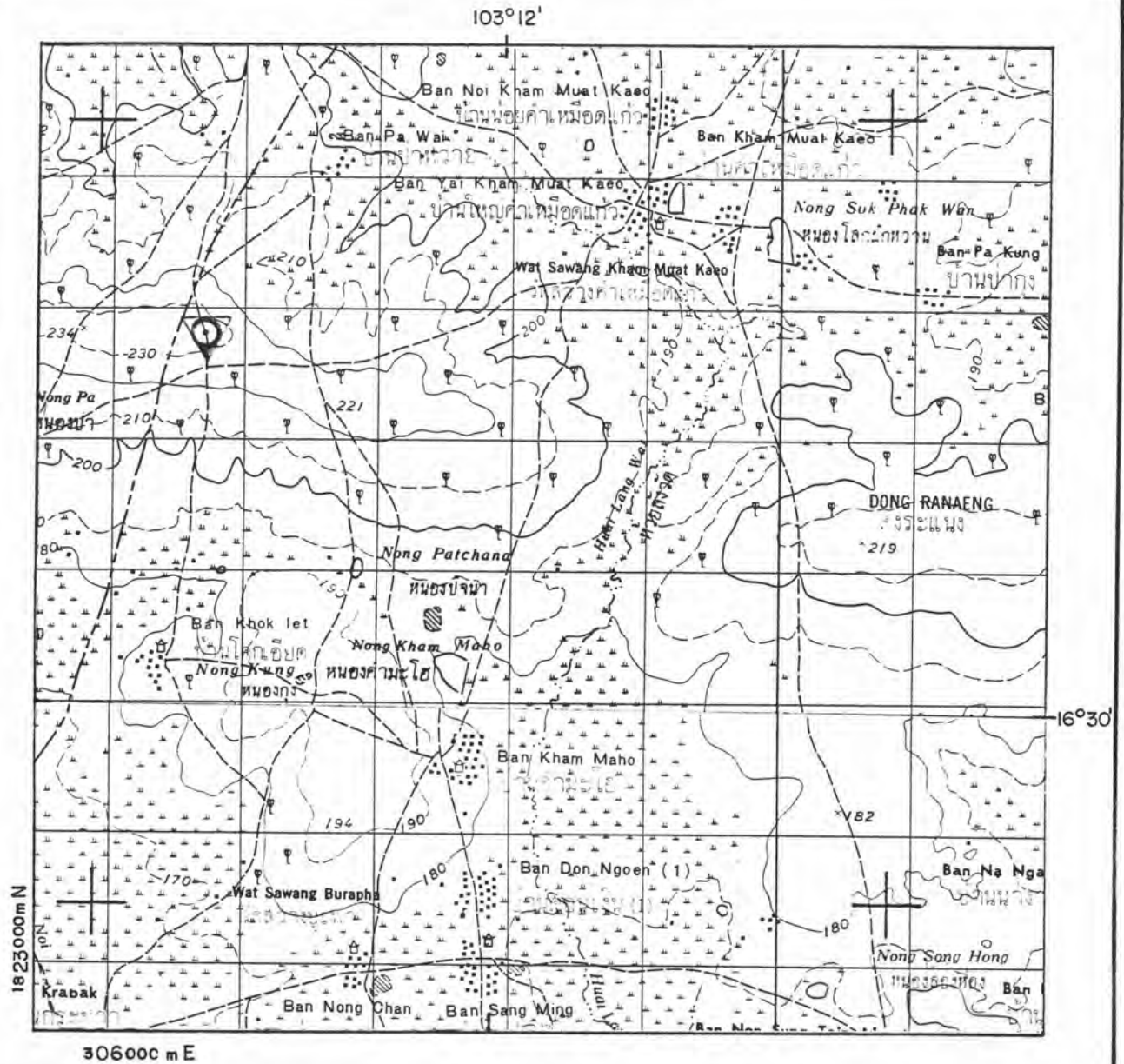


Figure A-13-2 [A] = Above ; B] = Left]

5642 III
 A) Topographic Map (1:50,000) Sheet 5641 IV
 [+ + = map area as shown on the aerial
 [+ + = photograph of Figure A-13-1]

B) Terrestrial photograph at UTM Grid Ref.
 3067 18278 to N 090° E direction.

Photo-interpretation for Geological Mapping
 of Changwat Khon Kaen and Adjacent Areas.

Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1986.

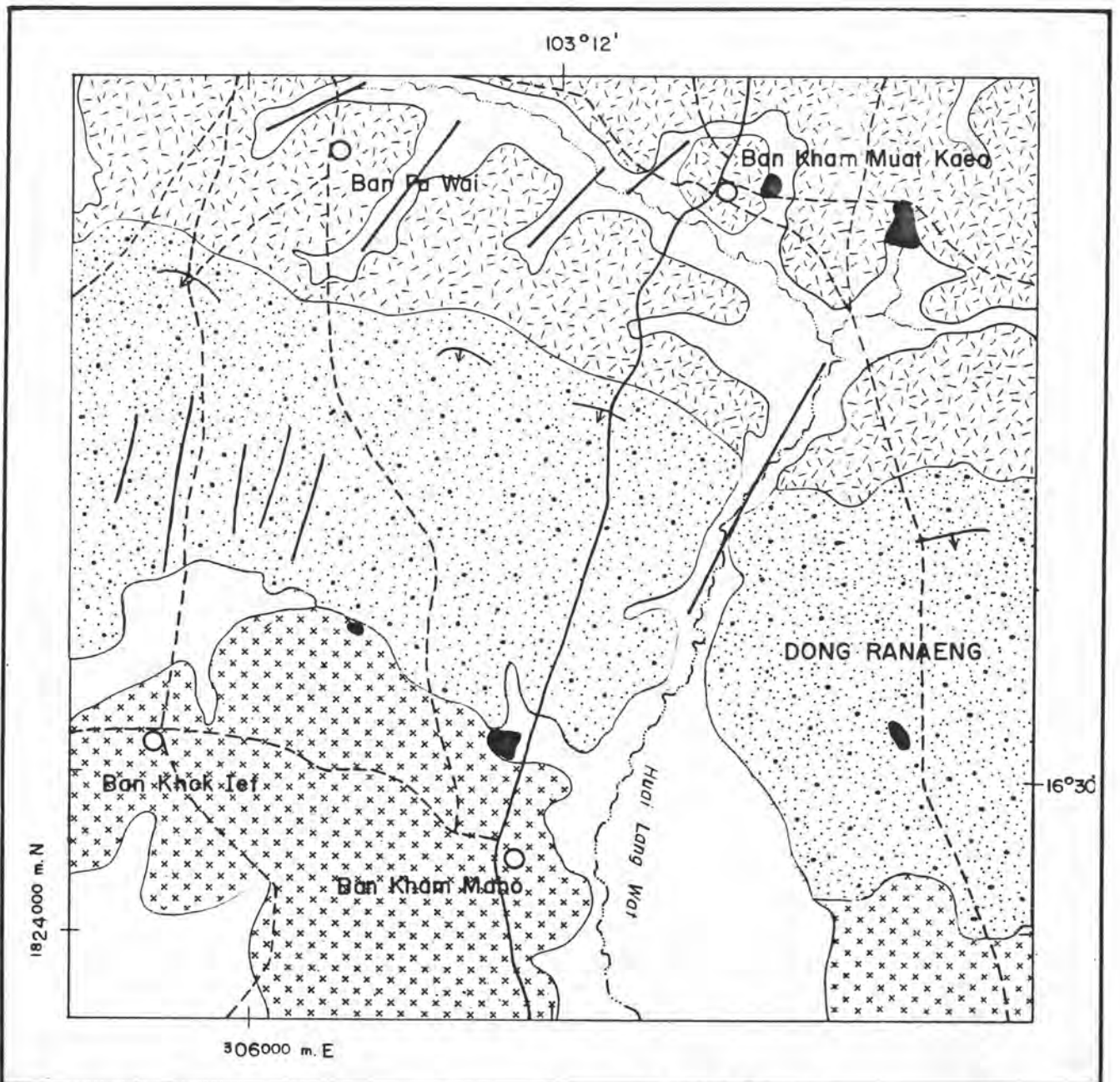


Figure A-13-3 Photogeological Map.

Scale km.

Photo Ref. : Photo No. 14971 (Figure A-13-1)

Map Ref. : Sheet 5642 III (Figure A-13-2)
5641 IV

Explanations for Photogeological Map

- SYMBOLS**
- Amphoe (district)
 - Ban (village)
 - Primary road & Route no.
 - Secondary road
 - Railroad
 - River, Stream
 - Water body

- Geological unit boundary
- Bedding (sub-horizontal)
- Bedding trace
- Fracture trace
- Syncline, Anticline - with plunging direction
- meander scar

PHOTOGEOLOGICAL UNITS

- | | | | |
|--|----|--|----|
| | Q4 | | E |
| | Q3 | | D2 |
| | Q2 | | D1 |
| | Q1 | | C |
| | M3 | | B |
| | M2 | | A |
| | M1 | | |

Photo-Interpretation for Geological Mapping of Changwat Khon Kaen and Adjacent Areas.

Somyot Hokjaroen
Dept. of Geology, Graduate School,
Chulalongkorn University, 1986.

APPENDIX B

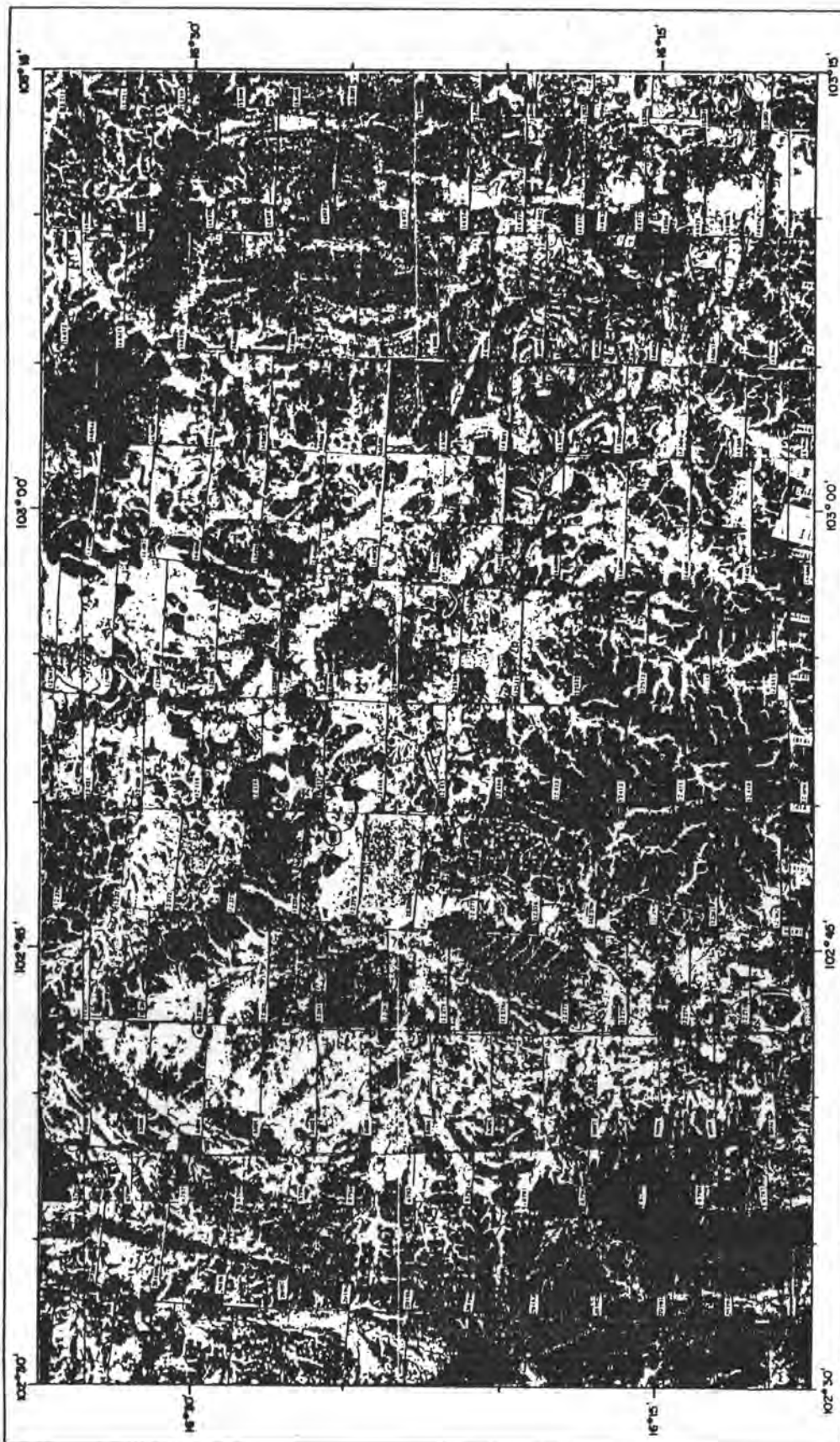


Figure B-1 Photo index of the study area, approximate scale of 1 : 407,000. The figure shows the arrangement of the aerial photographs used in the study area which consists of 13 flight lines with 169 frames of total photographs. Regional geology of the area and selected illustration sites are delineated and shown in Figure 2.5 and Figure 2.6.

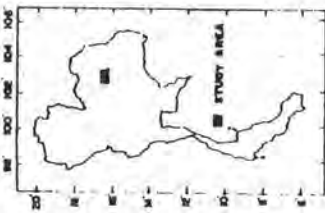


PHOTO-INTERPRETATION FOR
GEOLOGICAL MAPPING OF CHANGWAT
KHON KAEN AND ADJACENT AREAS.

Somyot Hokjaroen

Dept. of Geology, Graduate School,
Chulalongkorn University, 1986.

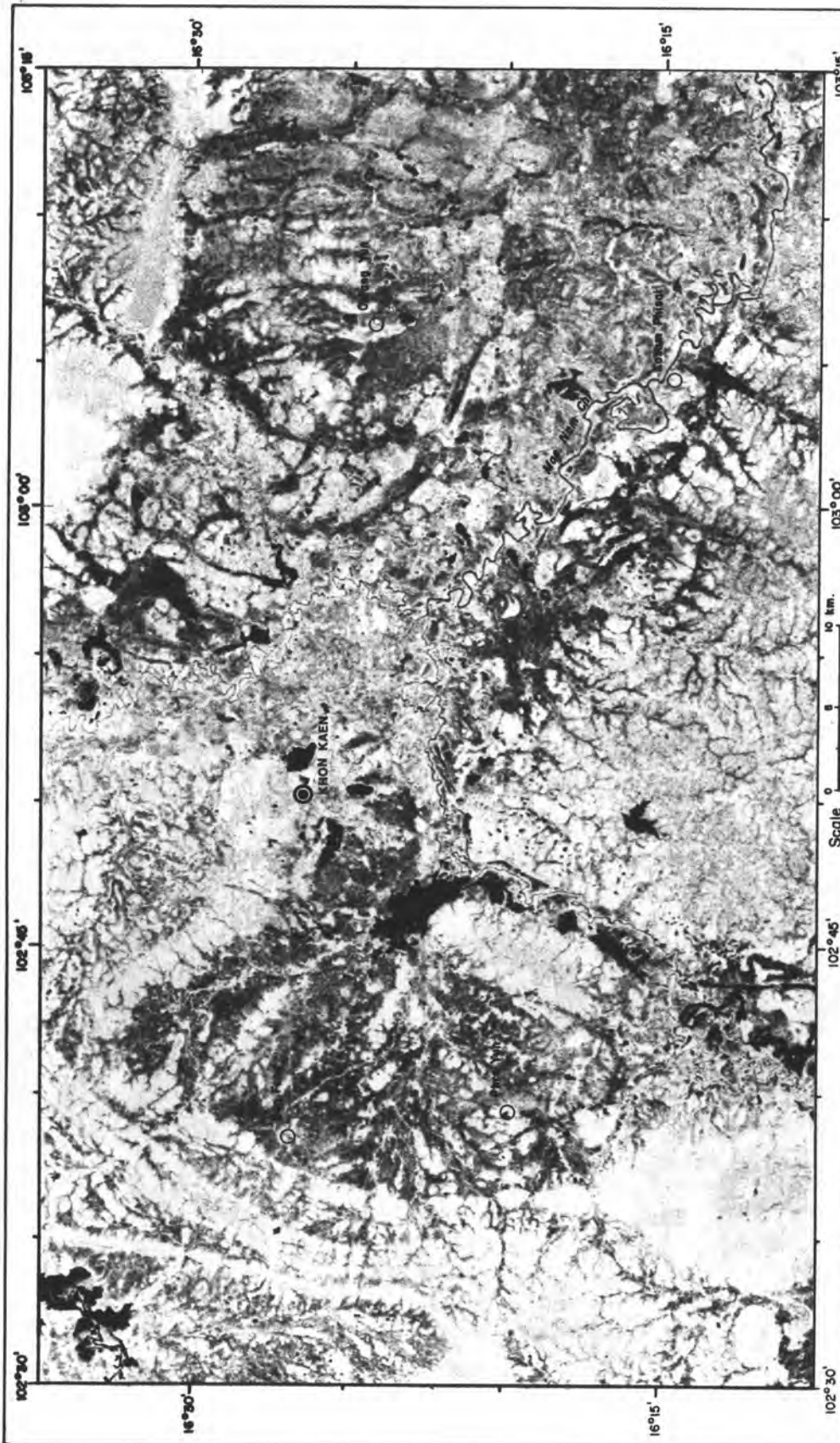


Figure B-2 Landsat - 3 imagery (MSS, Band 7) of the study area, scene: Thailand I.D. 791007-3-5; Path 137, Row 049. Drainage system, structures and regional geology are simultaneously studied with the imagery of MSS, Band 5, FCC, and RBV. of the area by means of visual interpretation techniques. Results are illustrated in Figure 2.2, 2.3 and 2.4.

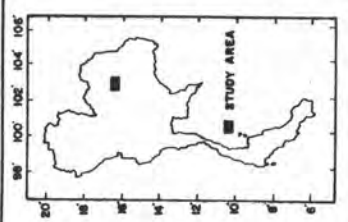


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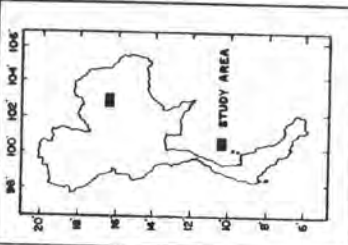
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Figure B-3 Landsat-3 imagery (RBV) of the study area, scene :
 Thailand I.D.791007-3-5-A, Path 137, Row 049. The image well
 depicts main transportation networks and drainage system,
 especially irrigational canal. This image is of good quality
 for fracture and drainage pattern analysis of the region.



APPENDIX C

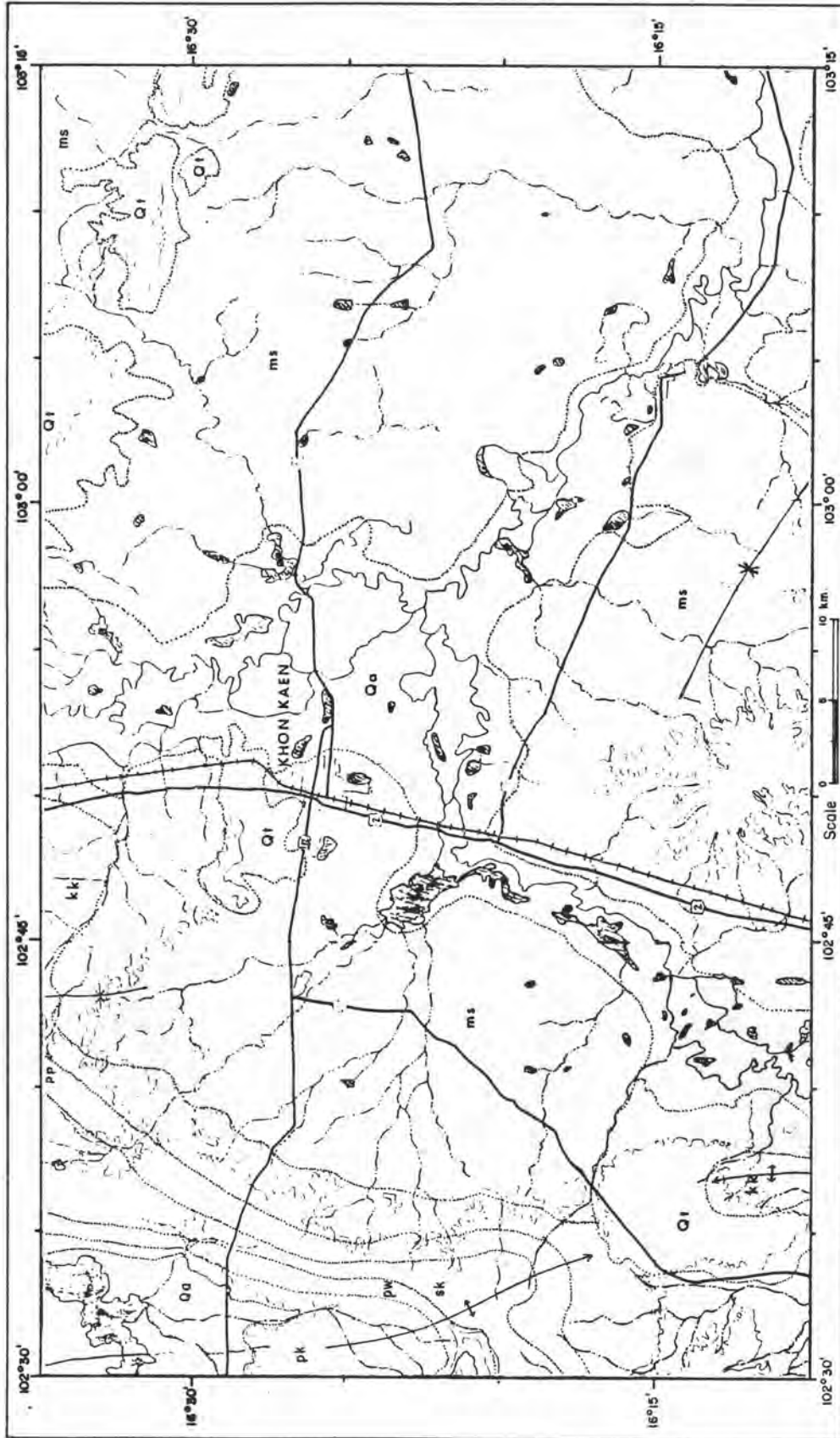


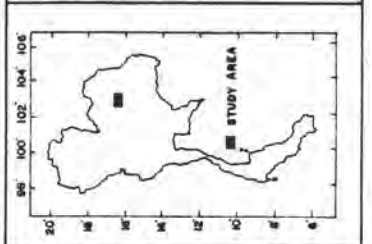
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Figure C-1 Geological map of the study area (after Chonglakmani et al., 1979).

EXPLANATION

Qa = Alluvial deposits	pp = Phu Phan Formation
Qt = Terrace gravel	sk = Soa Khoa Formation
ms = Maha Sarakham Formation	pw = Phra Wihan Formation
kk = Khok Kruat Formation	pk = Phu Krading Formation



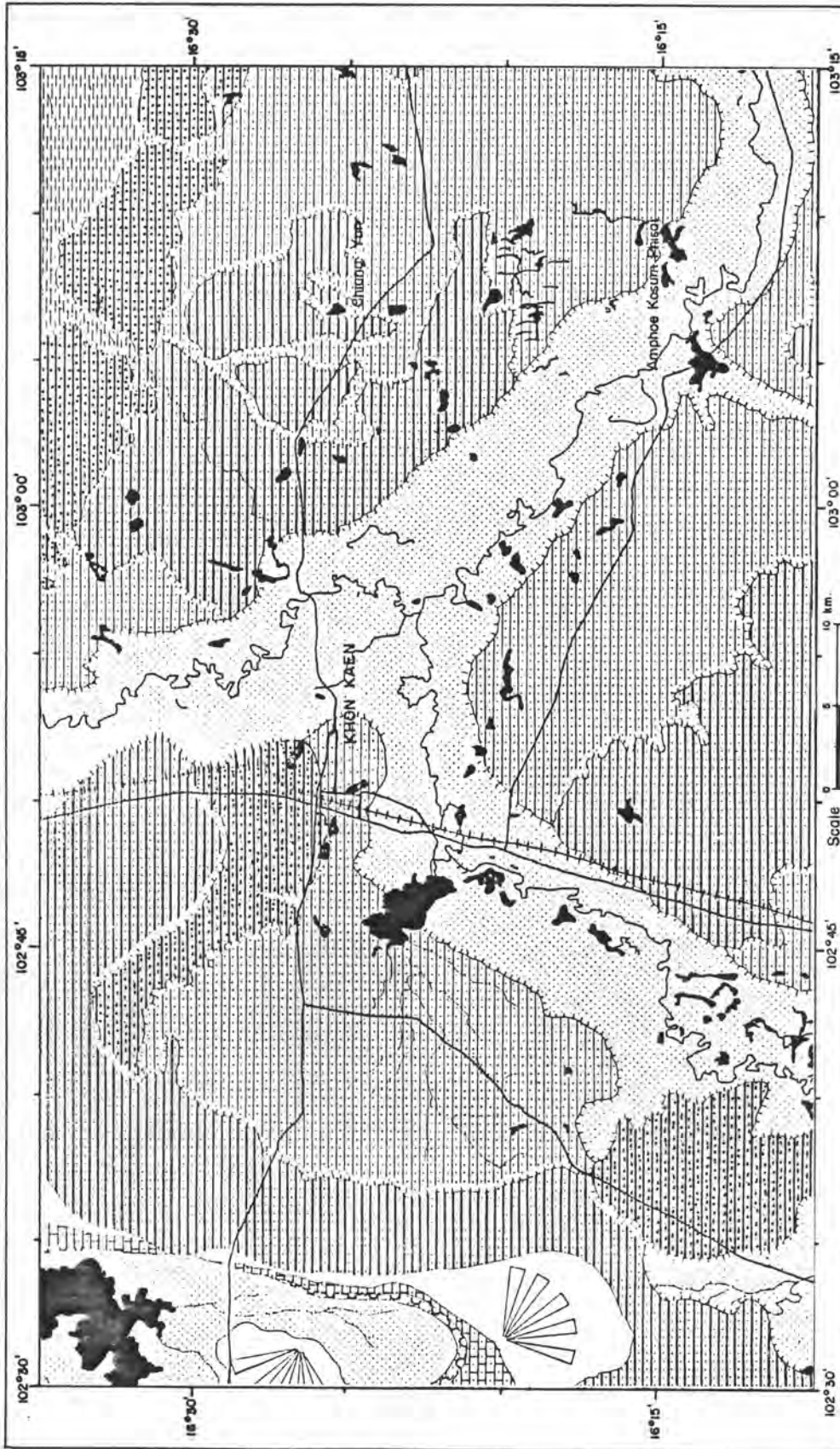


Figure C-2 Geomorphological map of the study area
(after Eiumnoh and Kheowruenrom, 1981).

EXPLANATION


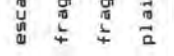
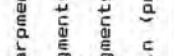
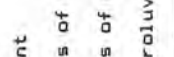
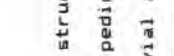

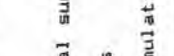
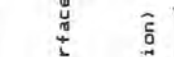
-  escarpment
-  fragments of structural surfaces
-  fragments of pediments
-  plain (proluvial accumulation)
-  high river terrace
-  middle river terrace
-  low river terrace
-  river built plain

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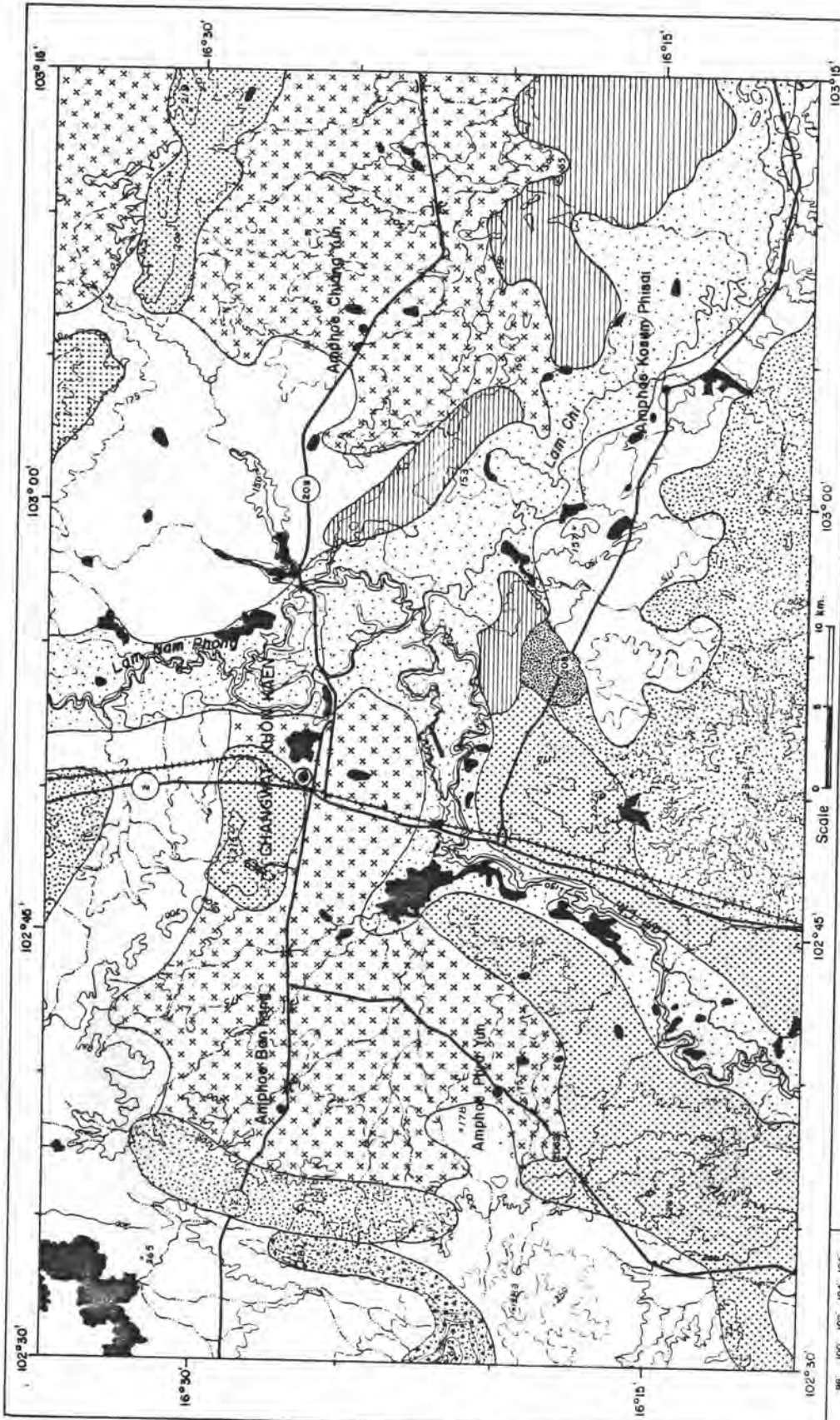
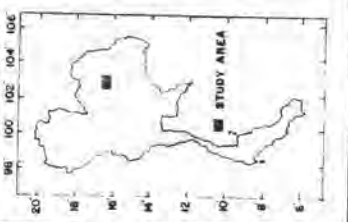


Figure C-3 General soil map of the study area (after Vijarnsorn, 1982).

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 GEOLOGICAL MAPPING OF CHANGWAT
 I-HON TAEN AND ADJACENT AREAS.
 Somyot Hokjaroen
 Dept. of Geology, Graduate School,
 Chulalongkorn University, 1982.

EXPLANATION

Soil mapping unit number / Phase of Great Groups	Symbol
55 Sandy Quartzipsamments	[Pattern: Dotted]
18L Loamy Dystrupepts	[Pattern: Horizontal lines]
30L Loamy Paleaquults	[Pattern: Vertical lines]
33L/30L Loamy Paleaquults / Loamy Paleaquults	[Pattern: Diagonal lines]
14C Clayey Tropeaquests	[Pattern: Stippled]
30C Clayey Paleaquults	[Pattern: Cross-hatched]
33L Loamy Paleaquults	[Pattern: Dotted]
42 Slope complex	[Pattern: Checkered]



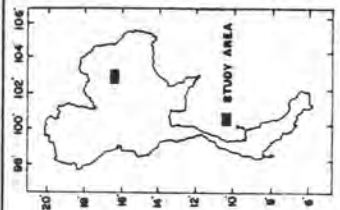
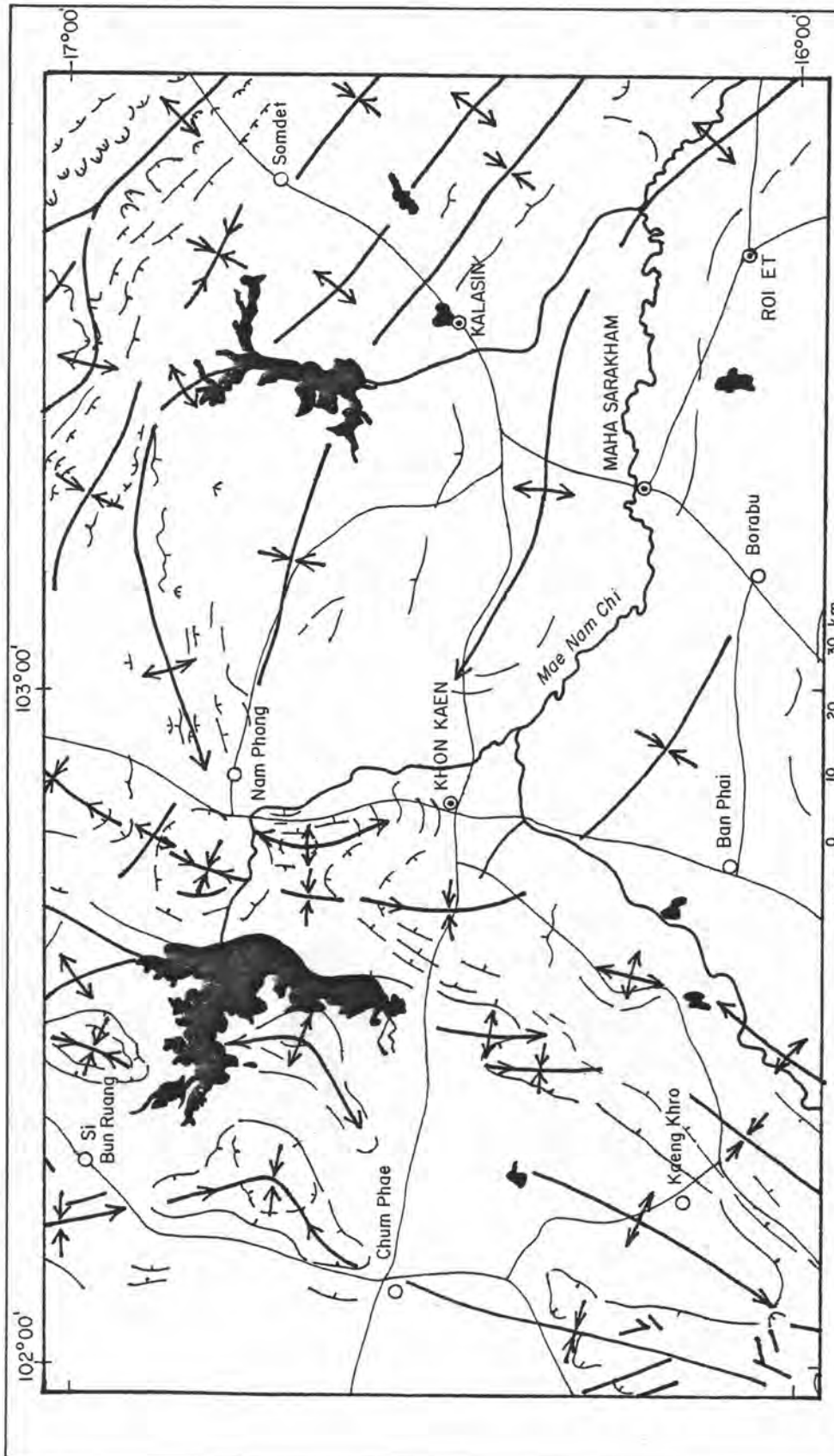


Figure C-4 Photolineament and folding map of the neighbourhood of the study area (after Aramprayoon, 1981).

- SYMBOL**
- Changwat
 - Amphoe
 - Road
 - River
 - Reservoir

LEGEND

- Bedding trace with low angle dip (5 - 30)
- Bedding trace with unspectacular dip direction
- Photolineament (faults and fractures)
- Anticline
- Syncline
- Plunging anticline
- Structural basin
- Domal structure

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Chulalongkorn University, 1986.

APPENDIX D



SUMMARY OF

REVIEW OF THE CONTINENTAL MESOZOIC STRATIGRAPHY OF THAILAND

(after Sattayarak, 1983)

The continental Mesozoic rocks in Thailand can be divided provincially into the Khorat-Phayao basin and other small separated basins (Bunopas, 1978, Pitakpaivan and Chonglakmani, 1978). The Khorat-Phayao basin is part of the huge basin, so-called "Indochina basin". It is believed that this basin covered the areas of the eastern part of northern Thailand, the eastern Thailand, the northern part of Campuchea, the northeastern Thailand and can be traced across the border to Laos and probably to southern China. The basin is roughly NW-SE trending. Thus, the source rocks in the central plain, the Chon Buri massif, the Pailin massif in Campuchea, the Kontum, Rao Co and Song Ma massif in Viet Nam. The basin is probably connected to the Lampang sea by the NW end and/or probably to another sea in Campuchea. The thickness variation of the Nam Phong and Phu Kradung Formation shows that the basin center is more or less parallel to the line between Khon Kaen and Maha Sarakham.

Lower to Middle Triassic Sediments

The Indosinian orogeny uplifted the Permian basin.

Compressional forces caused the Permian series to be folded and faulted. The continental Mesozoic sediments started to accumulate since the Scythian in some area in the north, contemporaneously with the beginning of the Marine Triassic Lampang Group (Hahn and Sieberhuner, 1982).

From the fields observation in the northeastern and north central Thailand, e.g. at Phu Hin Kong, Chum Phae, just west of the Huai Hin Lat type locality, the redbeds start with basal conglomerate containing pebbles of limestone. Overlying the redbeds in the interbedded sequence of reddish brown conglomerate and sandstone with an intercalation of volcanic rocks at the upper part. Subsequently, conglomerate beds with pebbles of volcanic rocks are encountered again. The sequence is followed by the black shale of the Huai Hin Lat Formation.

The section along the Pitsanulok-Lom Sak Highway and its vicinity starts with the basal conglomerate that rests unconformably on the Permian limestone. The sequence is followed by predominant gray beds, but redbeds were observed locally. After that the pyroclastic rocks appear. Redbeds are found again in the upper part showing an intercalation with the volcanic rocks. The true redbeds belonging to the Khorat Group overlies this sequence with an inferred contact. The correlation between these two strata above both conglomerate beds are inferred, but, possibly they are equivalent.

The difference in natures of folding was found in these two sequences, together with the presence of igneous dikes in the lower unit, and, in addition, the Permian limestone was found as a thrust sheet above the volcanic rocks. The latter two criteria are not seen in the nearby Khorat Group. The data suggest possibly an unconformity. The environment of deposition is considered to be a fluvio-lacustrine type. Unidentified bone fragments and fossil plants are found. The age of the unit is Middle Triassic (Maranate, in print) and probably a continuation from the Lower Triassic. These continental sediments occurred in the north-central and northeastern part of the country while in the western and northern part marine deposits were found. By the reasons already mentioned, the new rock unit is suggested.

The Huai Hin Lat Formation

After the late stage of the Indosinian orogeny, probably in Carnian, the Huai Hin Lat sediments were deposited in the separated paleo-basins. The contacts with the older Triassic rocks were more or less unconformable. The depositional environment was considered to be a fluvio-lacustrine type. Restricted basins were typical, and the limestone is believed to be a lacustrine deposit (Broin, et al. 1982). According to the paleogeography it can be noted that, in some areas, the Huai Hin Lat Formation comprises only redbeds, while in other areas it may contain a minor gray beds. Since the positions of the

Norian beds are located in the middle part of the sequence, the base of the Huai Hin Lat Formation are considered to be Carnian (Chonglakmani and Sattayarak, 1978).

The Nam Phong Formation

Just before or when all small-separated basins were filled with the Huai Hin Lat sediments, the Nam Phong Formation started its accumulation. The deposits were transitionally changed into redbeds from the gray beds below. As the matter of fact, the Nam Phong Formation is the lowest formation of the Khorat Group where the Huai Hin Lat is absent, e.g. in the high lands and the basin flanks. It is predominantly reddish brown and resistant sandstone, siltstone and conglomerate. No fossil was found but the age is considered to be between those of the Huai Hin Lat and of the Phu Kradung Formation, i.e., Rhaetian. The fluvio-lacustrine environment was its depositional environment.

The Phu Kradung Formation

Deposition of the Phu Kradung Formation took place when the Indochina basin was a huge basin. This unit rests unconformably on the Pre-Khorat rocks at the basin flanks. Ward and Bunnag (1964) noted the contact between the Nam Phong and Phu Kradung Formation at the limestone alternating zone. The formation is characterized by pre-

dominantly claystone in the lower part, and with some massive sandstone intercalation in the middle part, while the upper part consists of massive sandstone interbedded with claystone. The interpreted marine ingression based on the presence of a Plesiosaur tooth at Nong Bua Lam Phu (Ward and Bunnag, 1964) was doubtful due to a recent discovery of the fresh water crocodile bones (Buffetaut and Ingavat, 1980) probably at the same locality. The fluvio-lacustrine depositional environment is again assigned to the Phu Krabung sediments (Hahn, 1982 a). The claystone represented the flood plain deposits, while sandstone was the channel sand of the meandering streams. The upper sequence characterized a gradually change to the Phra Wihan rocks's environment. The age of this formation is Lower Jurassic (Hayami, 1968, Hahn, 1982 a).

The Phra Wihan Formation

The formation comprises massive, resistant, light-coloured sandstone with some interbedded siltstone and conglomerate. Pebbly sandstone usually are encountered in the upper part of the section. The sequence reveals a deposition of braided streams. In some areas, it resembles the fluvio-lacustrine deposits (Hahn, 1982 a). The fossils indicated the Upper Triassic to Lower Jurassic age. The age of the formation is considered to be the Middle Jurassic.

The Sao Khua Formation

This formation is known as the less-resistant, reddish brown-coloured siltstone lying in between the more resistant sandstone. Aside from the marine pelecypods (Ward and Bunnag, 1964, Huhn, 1982 a), Plesiosaur tooth (Hahn, 1982 a) and Ichthyosaur tooth (Takai, 1963), other types of fossils and the rock characteristics suggest the continental depositional environment. The age of the Sao Khua Formation is Upper Jurassic.

The Phu Phan Formation

This formation is characterized by massive beds of light-coloured, pebbly sandstone and conglomerate. The average thickness is about 80 meters, but at Nam Phung Dam site, it is about 400 meters thick. The middle part of the Nam Phung section comprises the redbeds containing Lower Cretaceous pelecypods (Kobayashi, 1968). Paleocurrent measurements in the northern part of the Khorat Plateau was studied by the author. The result suggests the S-SW and/or W current direction which is similar to that of the Phra Wihan Formation. Hahn (1982 a) considered the Phu Phan Formation as a typical fluvial sediments.

The Khok Kruat Formation

The redbeds overlying the Phu Phan Formation represent the Khok Kruat Formation. It consists predominantly of sandstone with some siltstone and claystone.

The fluviatile environment is suggested and the deposition took place in an arid climate. Gypsum nodules and lenses were observed. The fossil found in its equivalent beds, the Ban Na Yo Formation, points to the Upper Cretaceous age (Kobayashi, 1968).

The Maha Sarakham Formation

This formation is thought to rest unconformably on the underlying Khorat strata (Japakasetr and Workman, in print) thus, raising the problem about its status. This rock unit consists of the Lower, Middle and Upper Rock Salt with 2 units of claystone in between. The unconformity does not show a strong discordance, thus a disconformity is suggested (Japakasetr and Workman, in print). The depositional basin, is quite similar in shape to that of the older Khorat sediments. The Khorat and Sakon Nakorn basins were the same basin at that time. The age of this formation is inferred as the upper most Cretaceous.

The Phu Tok Formation

This informal formation was mapped by Sattayarak and Sutheetorn (1979). It consists of two sandstone types, one with very large-scaled crossbedding and the other with small wavy structures. The sandstone was described as a red-coloured, fine-grained, well sorted and friable rock. The gross characteristics of this formation resembled an eolian deposits. The strata are found above

the Khok Kruat Formation, but, correlation with the Maha Sarakham Formation is not conclusive. It was probably deposited contemporaneously, but in different environment, with the rock salt. This formation, on the other hand, is possibly younger than the Maha Sarakham Formation as it lies unconformably on the latter.

The Upper Claystone

The sequence consists typically of brick red-coloured claystone, siltstone and sandstone with gypsum and anhydrite lenses and/or nodules. This unit rests unconformably on the Maha Sarakham Formation (Japakasetr and Workman, in print). Its age is likely to be Tertiary more than Mesozoic. Furthermore, the sandstone resembled that of the Phu Tok Formation. If this is true, the two units would be of the same age but with a slightly different environment of deposition. This unit cropped out in the central part of the Plateau. It was probably accumulated in two separated basins, the Khorat and Sakon Nakhon basins, after the Himalayan orogeny built up the Phu Phan Anticlinorium.

BIOGRAPHY

Mr. Somyot Hokjaroen was born in Ratchaburi Province on January 3, 1955. He graduated with a B.Sc. degree in Geology from Chulalongkorn University in 1979. He worked as an instructor at the Department of geology, Faculty of Science, Khon Kaen University from 1979-1981. He then was on leave for higher degree study at Chulalongkorn University from 1981-1984.

During his study at graduate school, he was a research assistant involving a study of Ancient settlement from aerial photograph. He was also awarded certificates on ERTS. Remote Sensing Training and Landsat Digital Data Processing Training from NRCT. Moreover, he was appointed as the secretary and an editorial staff of the GEMRDNET Conference which was held at Khon Kaen University, 1985.

At the present moment, he is working as an instructor in the Department of Geotechnology, Faculty of Technology, Khon Kaen Universtiy.