APPENDIX

APPENDIX A

GEOGRAPHICAL DATA FOR THE FLUORITE DEPOSITS.

Table A-1 Location of deposits. Asterisk (*) denotes the deposit studied.

Chiang Mai Province

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
1	Fang	Mae Sun	Ban Huai Krai, Doi Pha Mad.	47Q/DD18 275/885	99°15'45"E 19°47'37"N
2	Fang	Mon Pin	Huai San, Ban Huai Phung.	47Q/DD21 164/064	99°09'22"E* 19°57'19"N*
3	Fang	Na Wang	Ban Pa Daeng, Mae Na Wang.	47Q/DD22 329/975	99°18'47"E 19°52'31"N
4	Chiang Dao	Muang Ngai	Ban Muang Ngai.	47Q/CD16 929/565	98°55'56"E* 19°30'16"N*
5	Samoeng	Samoeng	Ban Umlong, Huai Nam Bua.	47Q/CC23 540/912	98°33'45"E 18°54'48"N
6	Samoeng	Yung Mern	Doi Pha Som.	47Q/CC23 585/935	98°36'20"E 18°56'05"N
7	Samoeng	Samoeng	Ban Mae Sap.	47Q/CC23 661/837	98°40'43"E 18°50'47"N
8	Mae Cham	Mae Suk	Huai Nam-mae-okhoo Ban Mae Pan.	47Q/CC14 360/502	98°23'38"E 18°32'35"N
9	Mae Cham	Mae Suk	Doi San Tham, Ban Mae Pan.	47Q/CC14 375/490	98°24'27"E 18°31'53"N
10	Mae Cham	Tha Pha	Ban Kong Khak.	47Q/CC10 347/387	98°22'53"E* 18°26'18"N*
11	Mae Cham	Tha Pha	Doi Santong, Ban Omkhut.	47Q/CC10 278/280	98°18'57"E 18°20'31"N
12	Mae Cham	Tha Pha	Huai Pong Chugkak, Ban Omkhut.	47Q/CC6 262/245	98°18'05"E 18°18'38"N

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/grid	Longitude/ Latitude
13	Mae Cham	Tha Pha	Doi Pong Daeng, Ban Omkhut.	47Q/CC6 267/224	98°18'22"E 18°17'28"N
14	Mae Cham	Mae Na Jon	Doi Ku, Nam Mae Nai.	4646 II 216/674	98°15'22"E 18°41'39"N
15	Hod	Hang Dong	Doi Kai Kia, Ban Mon Hin.	47Q/CC7 595/170	98°37'01"E 18°14'36"N
16	Omkoi	Yang Piang	Huai Nog Huk, Ban Yang Piang.	47Q/CB10 386/302	98°25'22"E 17°27'30"N
17	Omkoi	Yang Piang	Ban Sop Lan.	4644 II 372/444	98°24'32"E * 17°35'13"N *
18	Omkoi	Yang Piang	Huai Pu Poei.	4644 II	98°23'04"E 17°41'36"N
19	Omkoi	Mae Tun	Huai Haeng, Ban Pada.	47Q/CB10 365/333	98°24'08"E 17°29'13"N
20	Omkoi	Mae Tun	Huai Mae Thoei.	47Q/CB10 359/288	98°23'47"E 17°26'42"N
21	Omkoi	Mae Tun	Doi Chang, Ban Huai Nam Khao.	47Q/CB10 469/173	98°30'00"E 17°20'30"N
22	Hod	Doi Tao	Khao Hin Taek.	47Q/CB24 740/790	98°45'16"E 17°54'00"N
23	Hod	Doi Tao	Doi Tao.	47Q/CB24 750/792	98°45'51"E 17°54' 5"N
24	Hod	Doi Tao	Khao Sila Thip.	47Q/CB24 765/770	98°46'42"E 17°52'54"N
25	Hod	Doi Tao	Huai Kong Kang.	47Q/CB24 757/810	98°46'15"E 17°55'06"N

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
26	Hod	Doi Tao	Doi Pae Po Mak (MC-1 Mine).	47Q/CB24 737/765	98°45'10"E 17°52'38"N
27	Hod	Doi Tao	Doi Pae Po Mak Linking Mine.	47Q/CB24 751/770	98°45'53"E 17°52'55"N
28	Hod	Doi Tao	Doi Pae Po Mak (Toho Mine).	47Q/CB24 756/767	98°46'09"E 17°52'45"N
29	Hod	Doi Tao	Doi Pae Po Mak (Suwat Mine).	47Q/CB24 770/748	98°47'00"E 17°51'42"N
30	Hod	Doi Tao	Ban Doi Tao (Boon Fluorite Mine).	47Q/CB24 737/782	98°45'06"E 17°53'35"N
31	Hod	Doi Tao	Doi Yao.	47Q/CB24 782/787	98°47'39"E 17°53'50"N
32	Hod	Doi Tao	Doi Lao (Khao Kiu Kung).	47Q/CB24 818/755	98°49'45"E 17°52'05"N
33	Hod	Doi Tao	Between Huai Mae-Buan and Huai Mae Tup.	47Q/CB24 775/782	98°47'16"E 17°53'35"N
34	Hod	Doi Tao	Sop Huai In - Huai Hok.	47Q/CB24 787/745	98°47'56"E 17°51'32"N
35	Hod	Doi Tao	South of Huai In deposit (NO.34).	47Q/CB24 795/722	98°48'23"E 17°50'19"N
36	Hod	Doi Tao	SW of Muang Lib Mine.	47Q/CB20 792/695	98°48'13"E 17°48'51"N
37	Hod	Doi Tao	Doi Sam Liam.	47Q/CB24 787/772	98°47'55"E 17°53'01"N
38	Hod	Doi Tao	South of A - Anan Mine.	47Q/CB20 805/689	98°48'59"E 17°48'51"N

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
39	Hod	Doi Tao	Nong Daeng – Ban Kong-wa Tai.	47Q/CB20 792/679	98°48'14"E 17°47'58"N
40	Hod	Mud Ga	Huai Jowo.	47Q/CB23 687/750	98°42'17"E 17°51'48"N
41	Hod	Mud Ga	Doi Prae Pa Mak (Muang Thong Mine).	47Q/CB23 691/742	98°42'32"E 17°51'22"N
42	Hod	Mud Ga	Doi Prae Pa Mak (Doi Luang Mine).	47Q/CB23 676/735	98°42'33"E 17°51'00"N
43	Hod	Mud Ga	Doi Prae Pa Mak (Noparat Mine).	47Q/CB23 671/746	98°41'23"E 17°51'36"N
44	Hod	Mud Ga	Doi Prae Pa Mak (Jowo Mine).	47Q/CB23 681/752	98°41'56"E 17°51'55"N
45	Hod	Mud Ga	Huai Mae Yiap Luang.	47Q/CB 23 682/881	98°41'59"E 17°59'17"N
46	Hod	Doi Tao	Doi Pha Pherng.	47Q/CB24 795/840	98°48'21"E 17°56'40"N
47	Hod	Mud Ga	Huai Mae Yiap.	47Q/CB23 705/871	98°43'17"E 17°58'25"N
48	Hod	Mud Ga	Huai Kongda.	47Q/CB20 762/675	98°46'32"E 17°47'47"N
49	Hod	Mud Ga	Huai Mo.	47Q/CB20 738/692	98°45'12"N 17°48'42"N
50	Hod	Tha Dua	Huai Poi, Doi Kerng.	47Q/CB23 592/865	98°36'49"E 17°58'05"N
51	Hod	Tha Dua	Huai Mae Had.	47Q/CB23 622/732	98°38'35"E 17°50'50"N

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
52	Hod	Tha Pha	Doi Had Yuak.	47Q/CB19 677/598	98°41'45"E 17°43'38"N
53	Hod	Tha Dua	Doi Pha-om.	49Q/CB19 635/695	98°39'21"E 17°48'50"N
			Mae Hong Son Province		
54	Mae Sariang	Mae Sariang	Doi Chang, Ban Chom Chaeng.	47Q/BC8 896/089	97°57'24"E 18°10'02"N
55	Mae Sariang	Mae Umlong	Pha Kwang.	47Q/BC8 320/280	97°59'26"E 18°12'13"N
56	Mae Sariang	Mae Katuan	Doi Tham, Nam Mae Rid.	47Q/BB24 910/810	97°58'15"E 17°54'55"N
57	Mae Sariang	Mae La Noi	Mae La Noi.	47Q/BC12 920/331	97°58'36"E * 18°23'10"N *
58	Khun Yuam	Mae La Luang	Doi Pha Daeng.	47Q/CC13 975/492	98°01'45"E 18°31'55"N
59	Muang	Pang Mu	Huai Plu.	47Q/CD9 954/398	98°05'25"E 19°21'04"N
60	Muang	Pha Bong	Pha Bong.	47Q/BD8 928/246	97°58'46"E 19°12'50"N
61	Pai	Thung Yao	Ban Sop Sa.	47Q/CD6 426/267	98°27'12"E * 19°14'02"N *
62	Pai	Thung Yao	Ban Sop Pam.	47Q/CD6 420/270	98°26'52"E 19°14'13"N
63	Pai	Thung Yao	Huai Chakpan.	47Q/CD6 445/256	98°28'17"E 19°13'28"N

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
64	Pai	Thung Yao Tai	Ban Sop Sa.	47Q/CD6 361/262	98°23'28"E 19°13'48"N
65	Pai	Thung Yao Tai	South of Ban Sop Sa.	47Q/CD6 393/241	98°25'22"E 19°12'40"N
66	Pai	Thung Yao Tai	Huai Hung.	47Q/CD6 313/249	98°20'48"E 19°13'02"N
67	Pai	Thung Yao Tai	Huai Mae Yan Noi.	47Q/CD6 290/340	98°19'26"E 19°18'00"N
68	Pai	Thung Yao Tai	Huai Mae Yan Noi.	47Q/CD6 292/345	98°19'30"E 19°18'17"N
69	Pai	Thung Yao Tai	Huai Pong Kang.	47Q/CD5 205/305	98°14'39"E 19°16'06"N
70	Pai	Thung Yao Tai	Huai Kang Hom.	47Q/CD5 210/266	98°14'55"E 19°14'00"N
71	Pai	Wiang Nua	Huai Phra Baht.	47Q/CD10 457/476	98°28'54"E 19°25'25"N
72	Pai	Wiang Nua	Huai Pong Pa.	47Q/CD10 435/490	98°27'42"E 19°26'11"N
73	Pai	Wiang Nua	Huai Pong Jo.	47Q/CD10 427/478	98°27'15"E 19°25'31"N
74	Pai	Wiang Nua	North of Huai Pong Pa.	47Q/CD10 431/482	98°27'28"E 19°25'45"N
75	Pai	Wiang Nua	Huai Pong Sak.	47Q/CD10 448/481	98°28'26"E 19°25'42"N
76	Pai	Wiang Nua	Huai Nam Un.	47Q/CD10 340/500	98°22'15"E 19°26'40"N

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
77	Pai	Mae Hi	Huai Sai.	47Q/CD6 466/339	98°29'33"E 19°21'15"N
78	Pai	Mae Hi	Huai Kaew.	47Q/CD6 465/310	98°29'27"E 19°16'23"N
79	Khun- Yuam	Nong Haeng	Nong Haeng, Mae La Ka.	47Q/BC20 922/648	97°58'45"E 19°12'50"N
			Lamphun Province		
80	Ban Hong.	Pa Phlu	Phu Kaew, at 53 km of the road NO.106.	47Q/CC8 834/134	98°50'38"E * 18°12'39"N *
81	Ban Hong.	Pa Phlu	Doi Tone, 48 km of the road NO. 106.	47Q/CC8 843/107	98°51'06"E 18°11'12"N
82	Ban Hong.	Ban Hong	Doi Kan.	47Q/CC8 778/215	98°47'24"E 18°17'05"N
83	Mae Tha	Tha Kad	Ban Mae Kha-nad 1. Thepnithi Mine.	47Q/CC12 995/323	98°59'45"E * 18°22'56"N *
			2. Universal Mine.	47Q/CC12 992/324	98°59'35"E * 18°22'57"N *
			3. Ban Tha Mine.	47Q/DC12 988/320	98°59'20"E 18°22'51"N
84	Mae Tha.	Tha Pla Duk.	Ban Tha Pla Duk.	47Q/DC9 237/433	99°13'24"E 18°28'52"N
85	Pa Sang	Makok	Mae Ao.	47Q/CC12 889/325	98°53'42"E 18°23'02"N
86	Li	Ban Pang	Ban Pang.	47Q/CC4 900/015	98°54'22"E 18°06'12"N

Lampang Province

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
87	Thoen	Mae Thod	Ban Mae Tia.	47Q/DB17 226/665	99°12'48"E 17°47'15"N
88	Thoen	Mae Thod	Ban Mae Kaeng.	47Q/DB17 180/567	99°10'12"E 17°41'57"N
89	Thoen	Mae Thod	Ban Mae Tern.	47Q/DB17 220/610	99°12'28"E 17°44'15"N
90	Thoen	Mae Thod	Ban Mae Thod.	47Q/DB17 250/645	99°14'10"E 17°46'08"N
91	Thoen	Mae Thod	Ban Don Chai.	47Q/DB13 263/504	99°14'55"E 17°38'33"N
92.	Thoen	Wiang Nok	Ban Pang A.	47Q/DB10 410/270	99°23'10"E 17°25'47"N
93	Thoen	Mae Prik	Ban Manao.	47Q/DB9 160/220	99°09'09"E 17°23'05"N
94	Thoen	Wiang Nok	Ban Mae Phu.	4843 I 452/172	99°25'30"E * 17°20'28"N *

Chiang Rai Province

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
95	Mae Suai	San Puloei	Huai Mun Thep.	47Q/DD19 641/818	99°36'40"E 19°43'58"N
96	Mae suai	San Puloei	Huai Sak.	47Q/DD19 638/807	99°36'32"E 19°43'20"N
97	Mae Suai	San Puloei	Huai Ngok-ngaek.	47Q/DD19 631/812	99°36'07"E 19°43'43"N

Uttaradit Province

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
98	Tha Pla	Had La.	Ban Nam Ri.	47Q/EB 22 485/865	100°24'10"E 17°57'37"N
99	Tha Pla	Had La	Ban Nam Phra.	47Q/EB22 525/785	100°26'23"E 17°53'27"N
100	Tron	Pa Khai	Ban Pa Khai.	47Q/EB14 390/350	100°18'35"E 17°29'55"N

Sukhothai Province

101	Si Satchanalai	Ban Kaeng	Ban Pak-kha.	47Q/DB14 515/428	99°29'10"E 17°34'23"N

Kamphaeng Phet Province

102	Muang	Na Bo Kam	Nong Ping Kai.	47Q/DA10 285/150	99°16'01"E 16°25'10"N
103	Muang	Pong Nam Ron	Ban Pong Nam Ron.	47Q/DA6 302/041	99°16'59"E* 16°19'10"N*
104	Muang	Pong Nam Ron	Ban Pang Khanun.	4841 I 286/186	99°16'02"E 16°27'00"N

Tak Province

105	Mae Ramat	Mae Tun	Huai Nok Nuek.	47Q/CB3 580/962	98°36'17"E 17°09'06"N
106	Mae Ramat	Mae Tun.	Huai Pa La Door.	47Q/CB7 544/007	98°34'20"E* 17°11'31"N*
107	Sam Ngao	Phu Tang	Huai Mae Sa.	47Q/CB15 551/396	98°34'38"E 17°32'37"N

NO.	Amphoe	Tumbol	Location	Map1:50,000 Sheet/Grid	Longitude/ Latitude
108	Tha Song Yang	Mae Tan	Nam Mae Usu, Ban Mae Usu.	4643 IV 142/178	98°11'34"E * 17°20'47"N *
109	Sam Ngao	Bhumiphol Dam.	Ban Samong.	47Q/CB12 842/202	98°51'03"E 17°21'41"N

Table A-2.1 Climatic data : Mean rain fall (mm) in northern Thailand during 1951-1975. (After the Northern Region Weather Forecast Center, Chiang Mai Province)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1. Chiang Rai	17.8	7.1	29.5	76.2	217.1	250.0	299.7	442.5	263.5	129.4	41.2	21.1	1795.1
2. Mae Hong Son	13.2	1.9	9.3	45.7	178.1	183.0	204.1	262.8	219.9	96.3	30.4	9.0	1253.7
3. Chiang Mai	10.8	7.2	20.2	51.1	162.0	152.3	172.4	248.9	262.3	128.1	40.0	15.6	1270.9
4. Mae Sariang	10.9	4.9	8.1	36.7	170.2	185.8	197.4	258.9	196.5	118.9	24.6	10.5	1223.4
5. Lampang	6.4	6.2	28.9	63.2	152.6	137.6	131.3	215.7	210.8	122.0	26.6	5.7	1107.0
6. Nan	10.9	14.0	38.1	94.9	172.4	157.0	195.5	238.1	219.7	88.7	14.1	4.8	1298.2
7. Phrae	8.9	7.0	29.2	61.7	161.5	126.4	137.8	271.6	203.4	89.8	14.7	9.8	1114.8
8. Uttaradit	12.0	12.8	34.9	73.7	192.6	211.4	198.3	265.2	298.5	127.8	20.0	5.0	1452.2
9. Tak	7.3	3.2	25.9	48.1	182.3	105.5	89.5	106.2	251.2	187.5	41.2	6.2	1054.1
10. Phitsanulok	9.2	12.9	39.2	56.6	202.4	170.7	192.9	246.1	256.3	140.1	26.9	4.8	1358.1
11. Mae Sod	6.8	5.7	9.1	28.5	166.6	250.9	326.0	408.9	207.1	99.6	13.1	2.8	1525.1
12. Phetchabun	13.1	31.8	48.3	70.9	150.2	149.1	171.2	201.1	230.9	94.5	14.1	2.1	1177.3
13. Bhumiphol Dam	10.6	1.8	19.4	30.6	227.3	66.8	91.2	107.2	274.9	226.0	49.7	11.1	1116.6

Table A-2.2 Climatic data : Mean temperature (°c) in northern Thailand during 1951-1975.
(After the Northern Region Weather Forecast Center, Chiang Mai Province)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1. Chiang Rai	19.6	21.8	24.7	27.5	27.6	27.1	26.7	26.2	26.2	25.1	22.7	19.6	24.6
2. Mae Hong Son	20.6	22.2	26.1	29.7	28.7	27.1	26.6	26.2	26.5	26.2	24.3	21.4	25.4
3. Chiang Mai	20.0	22.2	25.6	28.3	28.0	27.1	26.7	26.2	26.2	25.5	23.4	20.6	25.0
4. Mae Sariang	21.9	23.7	27.6	30.8	29.4	27.2	26.5	26.3	27.0	27.0	25.3	22.5	26.2
5. Lampang	21.5	24.1	27.5	29.8	28.9	28.0	27.6	27.1	26.6	25.9	24.1	21.5	26.0
6. Nan	21.2	23.8	26.9	29.4	29.2	28.4	27.6	27.2	27.2	26.6	24.5	21.4	26.1
7. Phrae	22.9	25.5	28.8	30.9	29.8	28.7	28.0	27.6	27.5	27.1	25.5	22.9	27.1
8. Uttaradit	24.1	26.3	29.3	31.3	30.3	28.8	28.3	27.9	27.9	27.7	26.1	24.1	27.7
9. Tak	23.6	27.3	30.7	31.9	29.8	28.2	28.1	27.8	27.5	26.6	25.2	23.3	27.5
10. Phitsanulok	23.8	26.1	28.5	30.3	29.3	28.3	27.8	27.5	27.6	27.4	26.0	23.8	27.2
11. Mae Sod	23.5	25.8	28.7	30.4	28.8	26.7	25.9	25.9	26.4	26.7	25.5	23.4	26.5
12. Phetchabun	24.7	27.3	28.2	30.9	29.8	28.7	28.0	27.5	27.4	27.4	26.1	24.5	27.6
13. Bhumiphol Dam	24.2	27.5	30.6	32.3	30.0	28.7	28.3	28.1	27.6	27.0	25.8	23.9	27.8

Table A-2.3 Climatic data : Mean relative humidity (%) in northern Thailand during 1951-1975.
(After the Northern Region Weather Forecast Center, Chiang Mai Province)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1. Chiang Rai	77.0	69.0	64.0	64.0	74.0	80.0	82.0	85.0	83.0	81.0	80.0	80.0	76.0
2. Mae Hong Son	74.0	66.0	55.0	55.0	71.0	81.0	83.0	85.0	85.0	82.0	79.0	77.0	74.0
3. Chiang Mai	74.0	65.0	58.0	60.0	72.0	79.0	80.0	84.0	84.0	82.0	80.0	77.0	75.0
4. Mae Sariang	73.0	64.0	55.0	55.0	70.0	82.0	83.0	85.0	83.0	80.0	77.0	75.0	73.0
5. Lampang	68.0	61.0	55.0	56.0	69.0	75.0	75.0	79.0	81.0	80.0	77.0	73.0	71.0
6. Nan	75.0	68.0	65.0	65.0	74.0	79.0	81.0	85.0	84.0	81.0	79.0	77.0	76.0
7. Phrae	68.0	62.0	57.0	58.0	69.0	75.0	77.0	80.0	81.0	79.0	75.0	71.0	71.0
8. Uttaradit	67.0	63.0	60.0	61.0	72.0	79.0	80.0	83.0	83.0	79.0	75.0	70.0	73.0
9. Tak	63.0	51.0	46.0	51.0	68.0	73.0	71.0	73.0	78.0	81.0	77.0	71.0	67.0
10. Phitsanulok	69.0	67.0	65.0	65.0	73.0	80.0	81.0	83.0	83.0	80.0	75.0	71.0	74.0
11. Mae Sod	66.0	60.0	56.0	58.0	73.0	83.0	84.0	85.0	83.0	79.0	74.0	70.0	73.0
12. Phetchabun	62.0	60.0	60.0	62.0	72.0	78.0	81.0	83.0	84.0	78.0	71.0	64.0	71.0
13. Bhumiphol Dam	63.0	51.0	46.0	49.0	67.0	71.0	72.0	73.0	78.0	79.0	74.0	71.0	66.0

Table A-3. Comparison of elevation of fluorite deposits with the nearest stream, mountain and basin elevations. Datum used is mean sea level (MSL).

Deposit	Elevation (m)	Elevation of nearest stream and distance from deposit	Elevation of nearest hill and distance from deposit	Elevation of basin and distance from deposit
Fang, Thepnithi Mine	480-520	Nam Mae Chai = 500-510 m, 300 m E.	869 m., 2.2 km NE	470-500 m, at NW edge of Fang Basin
Amphoe Pai, Mahalanna Mine	460-700	Nam Mae Pai = 450 m, 50 m N.	931 m, 1.5 km NW 1042 m, 1.5 km SE	500-510 m, at 5 km N.
Mae La Noi, S.P. Mine	400-500	Nam Mae Hu = 350-360 m, 20 m N.	800 m, 0.5 km E 900 m, 2.0 km N	Elevation of the deposit decreases to Nam Mae Yuam from 350 to 250 in 6 km distance W.
Mae Tha, Thepnithi Mine & Universal Mine.	380-400	Unnamed intermittent stream = 360-380 m, 200 m S; Nam Mae Moei = 335 m, 2.2 km W.	500 m, 0.5 km N 680 m, 1.3 km S 545 m, 1.5 km SE 600 m, 1.5 km SSE	330-380 m (Basin 1 inN-S trend) close to E basin edge. 350-380 m (Basin 2 in E-W trend) 1.5 km N.

Deposit	Elevation (m)	Elevation of nearest stream and distance from deposit	Elevation of nearest hill and distance from deposit	Elevation of basin and distance from deposit
Ban Hong, Thai Fluorspar Mine & Universal Mine	360-400	Nam Mae Li = 345 m , 1.2 km E.	853 m , 3.5 km NW 1090 m , 5.0 km W 1228 m , 5.5 km SW 1020 m , 6.0 km E	310-340 m, at S edge of Ban Hong Basin.

APPENDIX B

PRODUCTION DATA FOR FLUORITE IN THAILAND

Table B-2. Production and export of fluorite (in metric tonnages) during 1972-1978.

Period	Production		Export	
	Met. grade	Low grade	Met. grade	Acid grade
1972	374,590.0	20,480.0	257,707.6	3,500.0
1973	342,081.2	55,924.0	268,401.4	-
1974	340,759.9	87,931.0	278,921.1	35,370.0
1975	174,918.0	111,231.2	174,160.0	36,336.0
1976	128,529.1	71,835.0	187,776.0	104,432.0
1977	193,315.0	46,490.0	184,792.0	56,908.0
1978	175,531.0	84,255.0	172,602.0	35,307.0

Table B -2. Production (in metric tonnes) of Mae Tha Mine of Universal Mining Co., Mae Tha, Lamphun Province, 1967-1977.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1967	2330	2550	2580	2289	3700	2900	3100	3351	2652	2888	3625	3791
1968	3060	2104	3061	2601	3247	3592	3021	4105	4824	4780	3645	3451
1969	3932	3425	3635	2550	3228	3418	2967	2538	2180	3756	2955	3700
1970	6490	5064	4823	4355	4624	4753	3190	3756	4416	5408	3875	3544
1971	6369	6004	5967	3459	4149	4769	4354	4451	4213	3342	4248	5063
1972	4011	4270	3990	2307	3847	2711	4113	2937	4819	4420	4191	2603
1973	4002	3024	3161	2847	5199	4176	3846	3393	3762	4465	3013	3787
1974	4929	4221	4083	2347	3411	3192	3889	3063	2652	2888	1825	3791
1975	1618	3024	4008	2289	2449	2711	1846	1352	1645	1844	1525	1400
1976	1334	1509	1867	1647	2059	2020	2987	2371	2219	1701	2040	1787
1977	2149	3087	2331	1606	1445	1810						

Total = 419093 Tons.

APPENDIX C

HEATING STAGE, CALIBRATION AND SAMPLE PREPARATION.

C.1 History and evolution of heating stage

The heating stage is the most important equipment in the study of the homogenization temperature of fluid inclusions in the mineral sample on the microscope. The general model consists of a heating chamber made of various kinds of non-conductive materials, placed on the microscope stage under the objective lens. This room allows the transmitted light from the microscope illuminator to pass through the mineral sample refractively, and the behaviour of the fluid inclusion can be observed during heating. Heating was accomplished by nichrome wire and the temperature measured with a chromel-alumel thermocouple.

There are many types of microscope hot stage. It was originally designed by Dr. Sawkins (University of Illinois), then modified by Dr. M. Zentilli (Dalhousie University). Phillips (1875) used a simple paraffin bath as the heater. Yermakov (1944, 1950) used an electrically heated microscope stage, using air as the heat exchange medium, that operated to 650°c. Kalyuzhnyi (1958) described an improved chamber using heating-conducting plates to move heat from the winding to the sample instead of air-heated thermochambers. A heating stage under external hydrostatic pressure has been designed by Ypma (1965). Temperature is up to 250°c, with external pressure up to 500 kg/cm^2. The most important design feature is that the sample can be crushed while under observation, and the behaviour of the gas bubble can be noted, followed by evaluation of vapour pressures of the fluid, and the identification of certain gas constituents. Roedder (1962) designed a heating stage in which the sample is immersed in rapidly circulating thermostated-silicone oil as the heat exchange medium. But the procedure is relatively slow, and is limited by the nature of the fluids to approximately 250°c. Recently, several heating stages for use at high temperatures (1100-1600°c) have been designed.

However, the development of the microscope heating stage is still a major hurdle for the progress of the inclusion research, and a generally optimum design for such work has not yet been found.

C.2 Problems

The major problems are :

1. Minimizing thermal gradients within the sample chamber. The small distance between the small hot chamber and the cold microscope stage, objective and condenser, at most only ten of millimeters away, make significant temperature gradients inevitable in the chamber. The gradient changes with the sample size, shape, and placement, and is a function of thermal conductivities of the metal, glass, and sample, and of the effectiveness of hot air convection in the chamber. Heat flow along thermocouple wire can be a serious source of error, particular if the wire is thick.

2. Calibration. Tiny crystals of an organic compound of known melting point are used as the standard (see section on calibration). This is the most difficult problem.

3. The working distance need for the objective lens on the microscope. The long-working-distance lens must be used in order to keep the objective lens out of heat. Most commonly these are

objectives designed for use with the universal stage. (It is frequently better optically to use an ordinary objective of lower magnification, with higher magnification oculars, than the universal stage objective.)

4. Inclusion leakages cause erroneously high homogenization temperature. To solve this, we must do a second run.

5. The dynamic method of heating yields very large errors. It is far preferable to effectively level off the temperature of the stage after each temperature increment, as the thermal gradients are high under dynamic conditions.

6. Daughter minerals not exsolved, even at higher temerature. This is one problem of homogenization.

C.3 The first heating stage in Thailand.

In Thailand, no heating stage had ever built, probably there is nobody who was really interested in fluid inclusions, until Dr. Alan McDonald, CUSO volunteer at the Department of Geological Science, Chiang Mai University during 1975-1977, studied and planned to build the equipment. Finally, the first heating stage was built by Praphon Vibulsukh (Department of Physics, Chaing Mai University) as his 4th year special project under the supervision of Dr. D. Breen, his supervisor. Labelled diagrams with explanation will be given as follows.

The heating stage of microscope consists of the following major parts (Fig. C.1) :

1. Heating stage chamber
2. Heating equipment

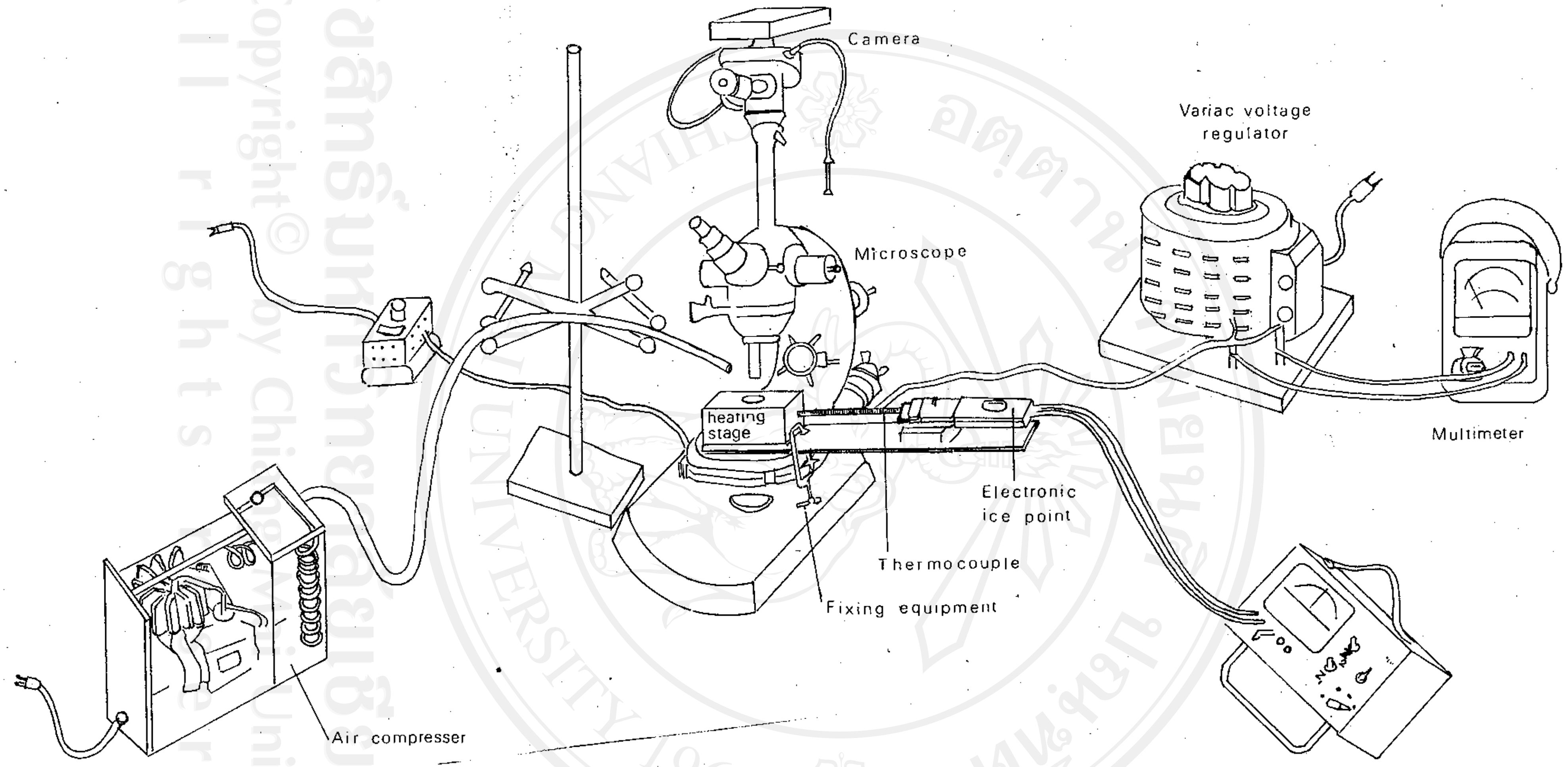


Fig. C.1 Heating stage equipments

3. Temperature-measuring equipment

C.3.1. Heating stage chamber. The important parts of heating stage (Fig. C.2) built by Vibulsukh (1977) can be described as :

C.3.1.1 Thermal brick (8.7 x 7.7 x 2.8 cm) made of fire clay by ceramic process. Its chemical composition is :- Al_2O_3 25-45 %, SiO_2 70-50 %, MgO 0-1 %, Fe_2O_3 0-1 %, CaO 0-1 %, TiO_2 1-2 %. Apparent porosity 10-25 % by volume.

C.3.1.2 Asbestos plate covering top and bottom of the bricks. At the bottom the plate is longer so as to be a bridge for other equipment. The plate is about 5 mm. thick. The asbestos is the heat insulator and very little heat conductively passes through.

C.3.1.3 Aluminium cylinder is used to wall the vertical hollow cylinder in the middle of the stage. Aluminium is used because of its resistance to heat and chemical reaction. Its smooth surface is also convenient during the operation in the heating hallow.

C.3.1.4 Fused quartz disc. Four fused quartz discs are used in the cylindrical hollow space.

The basal disc is 2 inches diameter, 1/8 inch thick, imbedded in the bottom section of the brick over the aluminium cylinder. This disc protects the cylinder from unwanted material and loss of heat.

The mineral samples are laid on the second fused disc 1 inch diameter and 1/16 inch thick. Its rim is fixed in parts of the aluminium cylinder. An aluminium ring (3mm thick) is placed on this plate.

The third disc lay on the aluminium ring. Hence, these

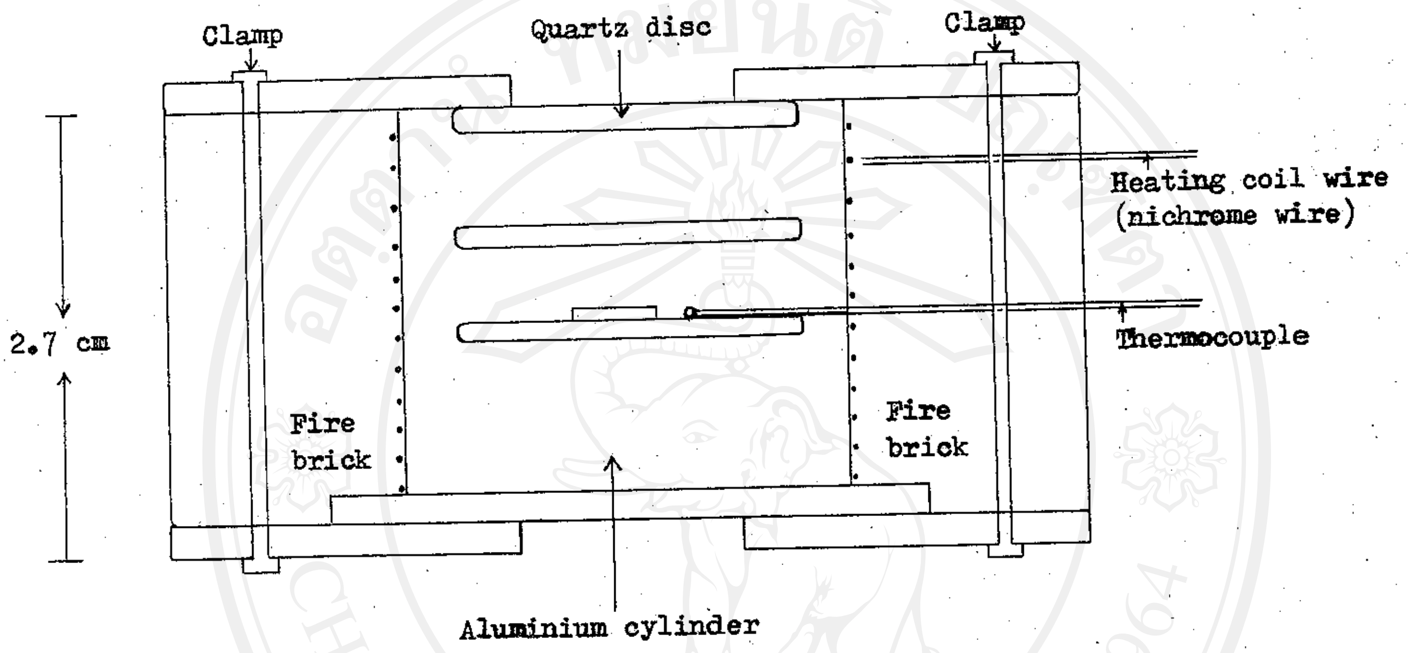


Fig. C.2 Side view of the heating stage.

two discs constitute the heating room. The fourth disc is laid on another aluminium ring over the third disc. The first and the fourth discs are the second layer protection of heat. The quartz discs have a low thermal expansion coefficient ($5.4 \times 10^{-7}/ ^{\circ}c$), resistance to heat mp = 1650 $^{\circ}$c, low heat conduction, normal refractive index (1.4585) and no interference colour. There is a space at the edge of the disc, for its expansion.

C.3.1.5 Clamps are used to fix the whole stage by fixing a screw through the whole section of the stage from brick to asbestos plate.

C.3.2 Heating equipment. consists of ;

nichrome wire

"variac" voltage regulator

multimeter

air compresser

To heat the heating room, Vibulsukh (1977) designed the heating equipment by inserting the nichrome wire in the hole through the brick into the heating room. This nichrome wire is connected to the "variac" voltage regulator. When the variac volage regulator gives the voltage potential, the nichrome coil transforms this electrical current into heat because of its high resistance ($108.3-110 \times 10^{-8}$ m). The total resistance of the length used is 80 Ohms, and was wired around a piece of aluminium cylinder with asbestos cloth as insulator. A higher voltage gives rise to increasing heat. The amount of voltage increase is checked by the connection with the multimeter. By using the the multimeter, we can control the most effective voltages of the variac

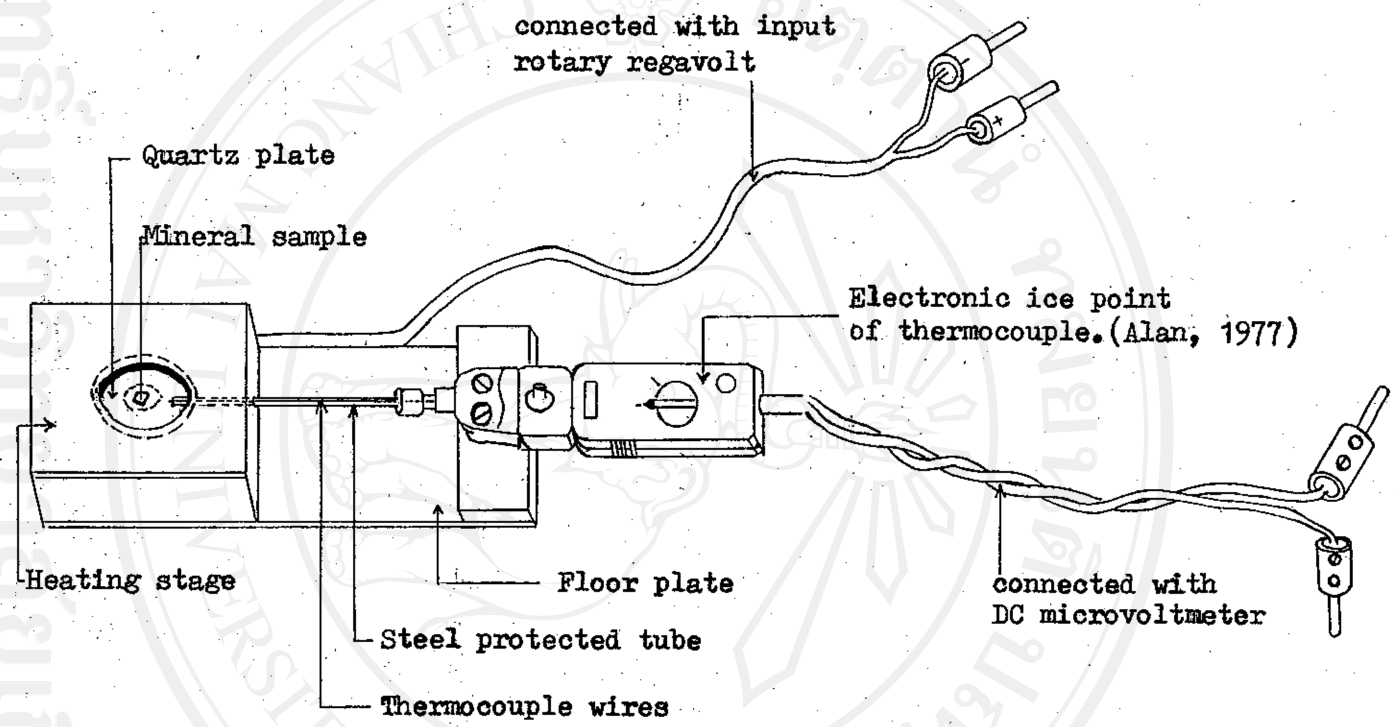


Fig. C.3 Heating stage and thermocouple.

voltage inputs.

C.3.3 Temperature-measuring equipment.

The temperature of the heating room ranges from room temperature to $450-500^{\circ}c$. This range of temperature can not measured by using a normal thermometer (mercury in glass), we need thermocouples.

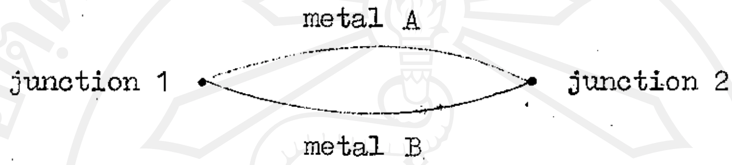


Figure C.4 The thermocouples.

The thermocouples are electric circuits consisting of the connection of two wires of different metals. When the two junctions are at different temperatures, a thermo-electric current exists in that complete circuit. The electromotive force depends on the difference in temperature between the junctions.

C.3.3.1 Thermocouples reference junctions. The e.m.f. can be measured if we maintain one junction at the ice point ($0^{\circ}c$) by using ice or electeonic ice point equipment (Fig. C.3). The thermocouple wires selected are the chromel-alumel type.

Chromel (Chromium-Nickel) contains 90 % Ni, 10 % Cr, melting at $1430^{\circ}c$, nonmagnetic.

Alumel (Aluminium-Nickel) contains 95 % Ni, 2 % Mn, 3 % Al, melting at $1400^{\circ}c$, magnetic.

One junction is inserted in the heating room inside the thermocouple probes, another junction is related to the ice point by using an ice bath (Vibulsukh, 1977). The electronic ice point manufactured by Omega Engineering Inc., U.S.A. was suggested by Dr. Alan Mcdonald and used during the present work. The electronic ice point is controlled by using a small dry battery. The thermo-electric current after being related to the standard temperature (Ice point) is measured by a DC microvoltmeter from which the current is read in millivolts.

C.3.3.2 Microvoltmeter. The microvoltmeter uses a 9 volts battery; by selecting a suitable scale, we can read the output voltage from the thermocouple during heating of the st ge.

C.4 Testing of the heating stage.

After Praphon Vibulsukh had built the heating stage, it was tested by C. Premgamone, using Amphoe Pai fluorite samples, and later by Suraphol Panupaisal on the fluorite samples from Mae Lama. It proved satisfactory, but still there were some problems about the naked thin thermocouple wires which were usually tied to each other. There was also protection for the ceramic insulator which is very fragile. We initially used the ice bath for the thermocouple standard temperature $(0^{\circ}c)$.

C.5 Improvements

Dr. Alan McDonald improved this heating stage. He ordered the heavier gauge thermocouple from Omega Engineering Inc. It is in a small box about 1 x 6 x 3.5 cm. This solves the tieing up problem of the chromel-alumel wires. He also ordered the steel protection tube for the ceramic insulator, to be connected with the new thermocouple. This make it more convenient to move because the steel tube protects the inner delicate part. The electronic ice point using a dry battery was applied instead of the ice bath. This is more easily operated, and quicker, as the ice in the bath usually melts, and ice needs to be added periodically. This application provides a dry operation and solve the problem that ice has to be added periodically.

C.6 Optical limitations

The Carl Zeiss Universal microscope with the magnification 12.5 x 1.25 x 16 is applied. The fluid inclusion size that is suitable for study ranges from C.01 mm to 1 mm. Those inclusions which are less than 0.01 mm are to small to be studied. Fluid inclusions greater than 1 mm are too large to be studied under the microscope. We can increase the magnification by using Olympus 20 x oculars and/or the 2 x Zeiss "Optivar".

The heating stage temperature should be $< 450^\circ$c because of limiting temperature of the 16 x objective lens monitored by a separate thermocouple taped to the lens barrel. During blowing cool air at the lens by the air compresser, the lens was at 41°c when the heating room was 425°c. The absolute limit for the cement used in the optical lens is 50°c.

C.7 Calibration

To calibrate the temperature in the heating stage and the millivolts output recorded by the DC microvoltmeter, standards of known melting point are needed : the tempisticks. These are tiny crystals of organic compounds of known melting point. These standards may be individually sealed into short segments of the thin walled capillary glass tubing and placed on the stage. The calibration must be made with the same stage and the same sample geometry and the same heating schedule as that used with the unknown samples. In this experiment, we used three tempisticks of known melting points.

Table C-1. Calibration between temperatures in heating stage recorded by melting point standards versus millivolts output recorded from DC microvoltmeter.

MP. standards "tempisticks" (accuracy ± 1 %)		66 °c	177 °c	288 °c
Millivolts Output	Vibulsukh 1977	2.64	7.15	11.6
		2.62	7.10	11.5
		2.68	7.16	11.65
	April 1977	2.61	7.05	11.35
	May 1977	2.68	6.9	11.0
	June 1977	2.64	6.75	11.5
	Mean ± SD.	2.65 ± 0.03	7.02 ± 0.15	11.43 ± 0.22

Several repetitions on experiments are needed because the organic compounds have impurities. Most impurities lower the melting point and cause it to occur over a range of temperature ; the melting point of the last crystal should be used.

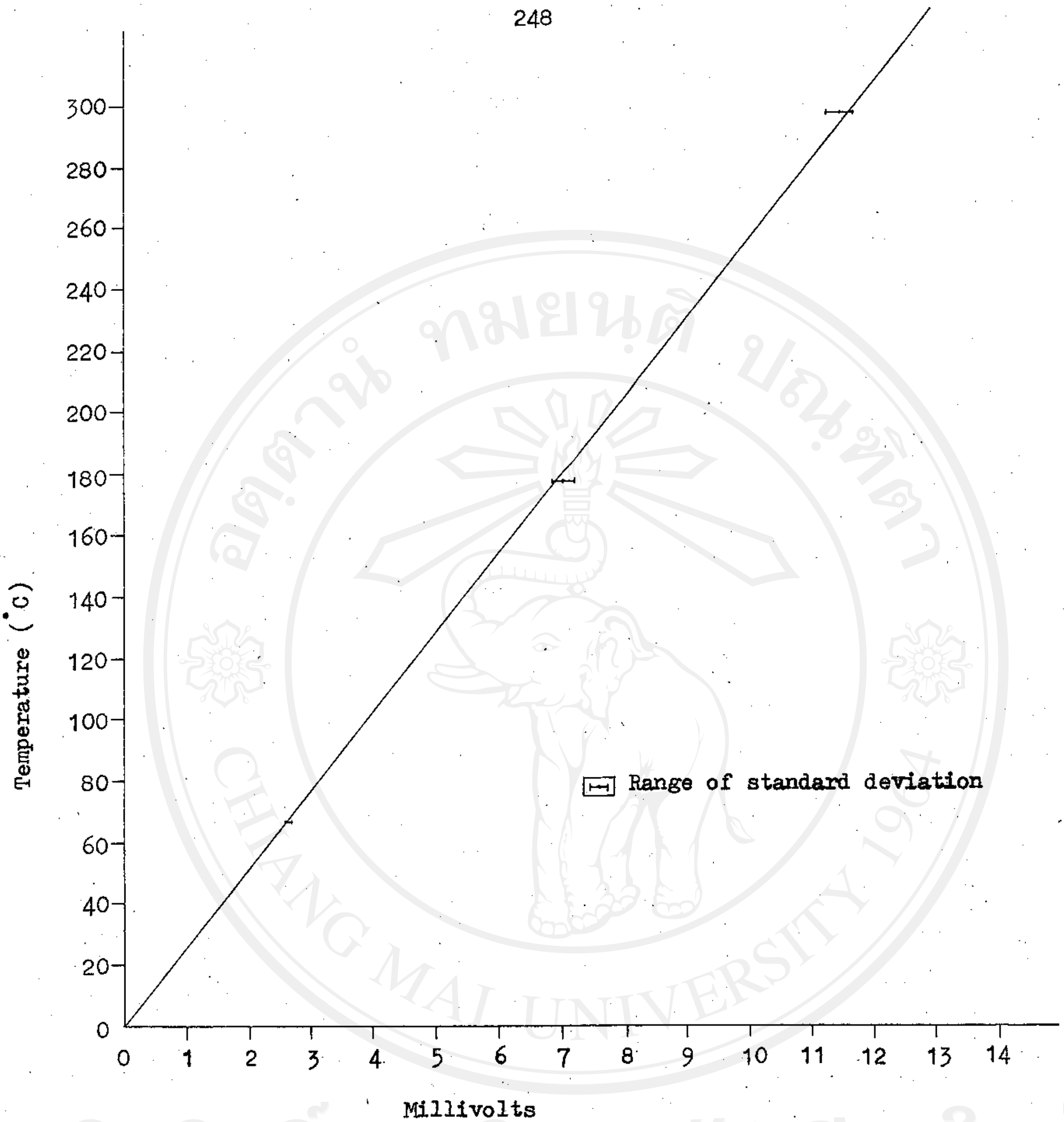


Fig. C.5 Calibration between millivolts output from DC micro-voltmeter versus temperature of heating stage by using MP. standard.

From the data on the Table of Calibration between millivolts output from DC microvoltmeter and temperature of heating stage by using MP. standard "tempistick" accuracy ± 1 %, we found that the higher the temperature of the experiment, the greater the standard deviation of millivolts output calculated. This relationship, when illustrated as a graph, tells us that the accuracy of the voltage read out from DC microvoltmeter varies inversely with increasing temperature. This error is the weak point of such heating stage equipment.

C.8 <u>Sample preparation.</u>

C.8.1 Suitable materials.

To find the fluid inclusions in the minerals, the best material would be large clear euhedral zoned crystals of the ore mineral. If all the ore minerals are opaque, the transparent gangue minerals growing "contemporaneously" with the ore minerals can be used, but obviously the significance of the data obtained is a direct function of the validity of this determination of contemporancity (Roedder, 1976). Large crystal size increases the probability of finding adequate criteria for establishing fluid inclusion origin. Some samples have much better inclusions than others, and it is simply not possible to predict what material will be good (Roedder, 1976). Cleavage plates are particular useful. Roedder (1976) favoured the (111) cleavage plane of fluorite to search for the fluid inclusions.

To find those areas or individual crystals that are most likely to be candidates for further study, it is convenient to use the low power binocular microscope. A cover glass stuck on with an index liquid that matches the mineral helps in looking into imperfect crystal faces or cleavage surfaces. The large inclusions in clear crystals can readily seen with a hand lens. Less transparent minerals can be crushed and examined in a matching index liquid. For example :

Table C-2.

Mineral Sample	Index Liquid
Fluorite	Kerosene n = 1.45
Quartz	Kerosene + HB-40 Oil n = 1.55
Sphalerite	Methylene iodide saturated with sulfur n = 1.788

C.8.2 Polished thin sections

The best method of preparation is the "doubly polished thin section". The advantage of this is that, after finding, we can apply both non-destructive methods and destructive methods to that section. The lazer probe analysis, electron microscope, heating, and freezing methods need the well polished thin section. To look through the sample section and heat or freeze the fluid inclusions, good polishing is needed on both sides. The suitable thickness of the polished sections ranges from 1 to 5 mm. depending on the degree of transparency, illumination, and physical properties of the individual mineral samples. Very dark sphalerite may require a doubly polished section of less than 0.03 mm.

Doubly polished sections that are too thick prevent adequate illumination, and usually result also in degraded images from birefringence of from superposition of other inclusions, cracks, etc. upon the image being examined.

Doubly polished sections that are too thin present less actual volume of mineral for examination for a given amount of sample preparation, and the inclusions may leak out during heating.

If the samples were much fractured, granularised, or cavernous, they need to be filled by epoxy before polishing on each side. This type of sample must be polished on one side, and after that, we can cut another side of the sample and polish again because we can not fill with epoxy on both sides at the same time as the sample is brittle. There are also some problems after cementing. Some curing procedures with epoxy formed thousands of tiny spherical immiscible liquid inclusions in the cure rasin, occurring as nearly invisible films of epoxy within cracks in the plates ; they can appear to be indigenous to the sample. Bubbles in the cementing material generally spoil the plate for photomicrography, and if numerous, they can confuse the eye in searching for suitable inclusions. It is better to use the well crystalline/dense samples instead of the porous or cavernous ones.

C.8.3 Technique for preparing doubly polished thin sections

Doubly-polished thin sections of fluorite samples were made by a hand polishing method in the thin and polished section laboratory, Department of Geological Science, Chiang Mai University (based on Ore Microscopy Laboratory directions for making polished sections, Department of Geological Sciences, Chiang Mai University, 1975). A total of 348 doubly-polished thin sections were prepared by this method, summarized below :

1) Cutting by the rock-cutting blade into sections with uniform thickness between 2.5 mm and 3 mm thick.

2) Grinding with 400 grade carborundum on an iron wheel, for about 3 minutes on each side.

3) Grinding with 600 grade carborundum on an iron wheel, for about 3 minutes on each side.

4) Grinding with 1,000 grade carborundum on a glass plate ; for about 3 minutes on each side.

5) Fine grinding with a 5 micron Al_2O_3 on a copper wheel ; 7 minutes on each side.

6) Rough polishing with a 6 micron diamond on "Texmet" or cloth lap cover ; 7 minutes on each side.

7) Fine polishing with 1 micron diamond on "Texmet" or nylon lap cover ; 5-7 minutes on each side.

8) Polishing with 0.3 micron Al_2O_3 on "Green billiard" cloth lap cover ; 3 minutes on each side.

9) Final polishing with 0.05 micron Al_2O_3 on "Green billiard" cloth lap cover ; 3 minute on each side.

Between each face and each stage from 2 to 9, the sample must be thoroughly cleaned, and dried.

APPENDIX D

HOMOGENIZATION DATA FOR FLUID INCLUSIONS IN FLUORITE FROM NORTHERN THAILAND

Table D-1. Homogenization temperature & phase of gaseous inclusions

Deposit	Homogenization temperature (°c)	
	in liquid phase	in gas phase
Fang	251.3, 269.2, 296.9, 306.4, 329.8 347.2, 357.2	254.1, 299.4, 295.8
Mae Tha	269.2, 271.7, 279.3, 291.8, 337.1 352.2, 374.8, 377.4, 378.6, 397.5	314.5, 322.0, 354.7, 369.8, 390.0 402.5, 410.0
Ban Hong	301.9, 319.5	281.8, 289.3

Table D-2 Homogenization temperature for gas-liquid inclusions.
Asterisk (*) denotes gaseous inclusions listed in Table D-1.

Sample	Location	Colour	Characteristic of Fluid inclusions	Temperature of Vapour-bubble Disappearance(°c)
F TDH-9 at 7.2 m th	Fang, Thepnithi Mine.	grey & colorless	Zone of primary inclusions.	60.4, 60.4, 62.8, 66.6, 95.6 108.2, 110.7, 113.2, 118.2, 119.8 120.8, 124.5, 125.8, 125.8, 125.8 125.8, 125.8, 127.0, 129.0, 130.8 130.8, 130.8, 132.0, 132.6, 132.6 133.3, 137.1, 138.1, 138.4, 139.4 140.8, 140.8, 141.6, 141.6, 143.4 143.4, 143.9, 144.6, 145.4, 145.9 147.2, 148.4, 148.6, 149.6, 149.6 152.2, 153.4, 156.0, 156.0, 156.0 156.0, 156.0, 156.4, 157.7, 158.0 158.4, 161.0, 162.8, 168.0, 170.6 170.6, 179.8, 180.4, 181.1, 187.6 194.2, 201.2, 203.5, 251.6, 299.4*

Sample	Location	Colour	Characteristic of fluid inclusions	Temperature of Vapour-bubble Disappearance(°c)
F TDH-9 at 7.1 th m	Fang, Thepnithi Mine.	grey & colorless	Zone of primary inclusions.	108.2, 118.2, 120.8, 124.5, 125.5 130.8, 132.0, 133.3, 134.6, 137.6 140.6, 140.8, 142.9, 143.9, 144.2 145.9, 148.4, 150.7, 153.4, 183.6 192.4, 269.2*, 306.4*
F 0/1	Fang,	grey & colorless		95.6, 96.0, 108.2, 118.2, 129.3 130.8, 138.4, 147.2, 148.4, 150.9 150.9, 152.2, 228.9 254.1*
F 0/4	Fang, Thepnithi Mine.	grey & colorless	radiated-prismatic.	80.5, 85.5, 100.8, 111.9, 113.2 114.4, 120.8, 123.2, 125.5, 137.8
F Outcrop/2	Fang, Thepnithi Mine.	grey & colorless		113.2, 113.2, 119.8, 125.8, 128.3 130.8, 135.9, 138.4
F 0/5	Fang, Thepnithi Mine.	grey & colorless		135.9
F TDH-15, at 9.5 th m	Fang, Thepnithi Mine.	grey & colorless		182.4, 296.8*

Sample	Location	Colorless	Characteristic of fluid inclusions	Temperature of Vapour-bubble Disappearance(°c)
F Outcrop/1	Fang, Thepnithi Mine	grey & colorless	primary inclusion	120.8, 151.0, 251.3
F/L	Fang, Thepnithi Mine	grey & colorless	inclusions in open-space filling near replacement fluorite.	95.6, 101.8, 110.7, 113.2, 120.8 123.2, 133.3, 140.6, 142.1, 143.4 144.6, 147.4, 153.4, 157.2, 175.6 181.1, 296.8*, 347.1*, 357.2*
F 0/6	Fang, Thepnithi Mine	grey & colorless	primary inclusion	110.7, 113.2, 117.7, 118.2, 118.2 118.2, 118.8, 119.2, 120.8, 127.0 326.8*
F 0/2	Fang, Thepnithi Mine	grey & colorless	primary inclusion	131.6, 132.0
F TDH-9 at 10.45^{th}m	Fang, Thepnithi Mine	grey & colorless	primary inclusion	75.4
AP 3/1	Amphoe Pai, Mahalanna Mine, Vein NO.3	deep green	primary inclusion	120.8, 123.2, 124.5, 125.2, 125.5 125.8, 125.8, 125.8, 126.0, 127.0 127.0, 127.0, 128.3, 128.3, 129.6 129.6, 130.8, 131.0, 131.3, 131.8

Sample	Location	Colour	Characteristic of fluid inclusions	Temperature of Vapour-bubble Disappearance (°c)
				132.0, 132.0, 132.3, 132.8, 133.3 133.3, 133.3, 134.6, 134.6, 135.8 153.0, 156.7, 182.4, 183.2, 188.6 193.7
AP 3/2	Amphoe Pai, Mahalanna Mine Vein NO.3	pale green	primary inclusion	120.8, 123.2, 125.8, 125.8, 125.8 128.3, 128.3, 128.3, 128.3, 128.3 128.3, 129.6, 130.8, 132.0, 137.1 145.9, 147.2, 147.2, 147.2, 148.4 149.6, 149.6, 149.6, 149.9, 150.4 150.7, 150.7, 150.9, 150.9, 150.9 150.9, 152.2, 152.2, 152.2, 152.2 153.4, 153.4, 153.4, 154.7, 156.0 156.0
AP 3/3	Amphoe Pai, Mahalanna Mine, Vein NO.3	colorless	primary inclusion	125.8, 125.8, 128.3, 133.3, 133.3 137.1, 140.8, 147.2, 147.2, 150.9 154.7, 156.0, 156.0, 156.0, 156.0 156.2, 156.2, 156.4, 156.4, 156.7 157.2, 157.2, 157.2, 157.7, 158.4 158.4, 158.4, 159.8 159.8, 159.8

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance (°c)
			primary inclusion	160.5, 161.0, 161.0, 161.0, 161.0 161.0, 164.8, 166.0, 166.0, 166.0 166.0, 166.0, 166.0, 166.0, 166.0 168.6, 168.6, 168.6, 168.6, 168.6 168.6, 168.6, 168.6, 168.6, 168.6 168.6, 168.6, 168.6, 168.8, 169.0 169.0, 169.3, 169.8, 169.8, 169.8 169.8, 169.8, 169.8, 169.8, 170.0 170.6, 171.0, 171.0, 171.0, 171.0 171.0, 172.3, 173.6, 173.6, 175.1 183.6, 183.6, 183.6, 184.9, 201.0 203.8, 208.8
AP 3/4	Amphoe Pai, Mahalanna Mine Vein NO.3	colorless (transparent and sub-transparent)	primary inclusion	123.2, 130.8, 130.8, 131.3, 131.8 132.0, 132.3, 135.8, 137.1, 140.8 140.8, 141.4, 141.8, 142.1, 144.6 145.4, 145.6, 145.9, 148.4, 150.7 150.9, 150.9, 150.9, 151.7, 151.7 153.0, 153.4, 153.4, 153.4, 153.4 154.0, 154.7, 154.7, 155.2, 156.0 156.0, 156.0, 156.0, 156.0, 156.0

Sample	Location	colour	Characteristic of fluid inclusions	Temperature of Vapour-bubble Disappearance(°c)
				156.0, 156.0, 156.2, 156.2, 156.4 157.2, 157.2, 157.2, 158.4, 158.4 158.4, 161.0, 161.0
AP 3/5	Amphoe Pai, Mahalanna Mine, Vein NO.3	colorless (fluorite with quartz interlayering)	**primary inclusion**	125.8, 130.8, 132.0, 132.3, 138.8 140.8, 144.6, 145.2, 145.4, 150.9 150.9, 152.0, 152.2, 152.4, 153.2 153.4, 153.4, 156.0, 156.2, 157.2 158.4, 158.4, 158.4, 159.8, 161.0 162.2, 163.5, 163.5, 163.5, 164.2 166.0, 166.0, 166.0, 166.0, 168.6 169.8, 171.0, 172.3, 274.2
AP 4/1	Amphoe Pai,	pale green		133.3, 135.9, 135.9, 140.9, 142.4 143.4, 151.2, 151.7
		pale violet		130.8, 131.8, 132.1, 132.1, 135.9 143.4, 157.7, 158.5, 158.5, 163.0 163.5, 164.8, 166.0, 171.1
		pale brown		140.9, 142.1, 153.4, 154.7, 155.2 155.2, 155.4, 155.9, 155.9

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
AP 4/2	Amphoe Pai, Mahalanna Mine, Vein NO.4	colorless	primary inclusion	143.4, 145.7, 145.9, 145.9, 146.4 147.2, 147.9, 147.9, 148.2, 148.4 149.7, 163.5, 188.7
AP 4/4	Amphoe Pai, Mahalanna Mine, Vein NO.4	pale brown pale green	primary inclusion	138.4, 140.1, 145.9, 147.2, 148.4 149.7, 150.9, 152.2, 152.9, 156.0 125.8, 145.9, 148.4, 150.7, 150.8 150.9, 151.2, 151.2, 151.5, 151.5 152.2, 153.5, 156.0
AP 4/5	Amphoe Pai, Mahalanna Mine, Vein NO.4	pale green	primary inclusion	140.9, 143.4, 145.9, 148.4, 149.7 150.9, 150.9, 150.9, 153.0, 153.5 153.5, 153.5, 153.5, 154.0, 154.7 156.0, 157.2, 157.7, 157.7, 158.0 158.5, 159.8, 160.0, 160.0, 163.5
AP 5/2	Amphoe Pai, Mahalanna Mine, Vein NO.5	pale violet (with color-less).	primary inclusion	156.0, 157.2, 158.0, 158.5, 159.0 159.3, 161.0
AP 5/3	Amphoe Pai, Mahalanna Mine, Vein NO. 5	pale violet (with color-less).	primary inclusion	120.8, 128.8, 150.9, 157.2, 157.2 159.8, 161.0, 163.3, 163.5, 164.8

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
				165.5, 165.8, 165.8, 166.0
AP 5/4	Amphoe Pai, Mahalanna Mine, Vein NO.5	colorless	primary inclusion	156.0, 158.5, 162.3, 163.5, 163.5 163.5, 163.5, 163.5, 163.5, 164.8 164.8, 165.3, 165.8, 166.0, 166.0 167.3, 167.3, 168.6, 168.6, 169.6 169.8, 169.8, 169.8, 169.8, 169.8 171.1, 171.1, 171.1, 172.3, 172.3 172.3, 173.3, 173.6, 174.9, 176.1 176.1, 181.1, 191.2
AP 5/5	Amphoe Pai, Mahalanna Mine, Vein NO.5	colorless	primary inclusion	123.3, 128.3, 138.4, 150.9, 154.7 156.5, 157.2, 157.2, 158.5, 161.0 161.0, 163.5, 163.5, 173.6
AP 5/6	Amphoe Pai, Mahalanna Mine, Vein NO.5	bluish green	primary inclusion	128.3, 130.8, 130.8, 133.3, 145.9 148.4, 154.7, 154.7, 155.0, 156.0 157.2, 158.0, 158.5, 160.0, 161.0 161.0, 161.0, 162.8, 163.3, 163.5 163.5, 163.5, 163.5, 163.5, 163.5 164.8, 165.5, 168.6, 181.1, 196.2 251.6

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
AP A/1	Amphoe Pai, Mahalanna Mine, Vein NO.1	very pale brown. deep purple deep green	primary inclusion	130.8, 133.3, 154.7, 161.5, 163.5 164.8, 165.5, 165.5, 166.0, 169.8 169.8, 309.4* 156.0, 166.0, 169.8 161.0, 161.0, 163.5, 163.5, 164.0 164.5, 164.8, 164.8, 168.6, 168.6 169.8
AP 2/3	Amphoe Pai, Mahalanna Mine, Vein NO.2	pale purple (associated with color-less)	primary inclusion	120.8, 123.3, 134.6, 148.4, 157.2 177.4, 178.6
AP 2/1	Amphoe Pai, Mahalanna Mine, Vein NO. 2	deep purple (associated with pale purple	primary inclusion	129.6, 129.8, 130.8, 133.3, 168.6
AP "Old vein"/3	Amphoe Pai, Mahalanna Mine, "Old vein"	colorless with white quartz interlayer.	primary inclusion	259.1, 264.2

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
Dark brown/1	Mae La Noi, S.P. Mine.	dark brown	usually rectangular primary inclusions.	77.4, 80.5, 80.5, 80.5, 80.5 84.2, 85.5, 87.6, 88.0, 88.3 88.8, 90.6, 90.6, 90.6, 90.6 90.6, 91.8, 93.0, 93.6, 95.6 95.6, 95.6, 96.8, 100.6, 100.6 113.2, 118.2, 157.4, 158.0, 206.3 210.0, 210.8, 329.6*
MLN 0/4	Mae La Noi, S.P. Mine.	very pale purple.	outer zone of primary fluid inclusions.	113.2, 113.2, 113.2, 115.7, 120.8 125.8, 127.0, 128.3, 129.6, 129.6 138.1, 145.2, 145.2
			inner zone of primary fluid inclusions.	93.6, 100.6, 101.8, 105.6, 105.6 105.6, 108.2, 110.7, 112.0, 113.2 113.2, 115.7, 120.8, 122.0, 123.2 124.0, 125.8, 125.8, 128.3, 138.4 148.4, 148.4, 156.0, 181.1
MLN C_1F	Mae La Noi, S.P. Mine.	colorless	ε zone of primary fluid inclusions.	57.4, 75.4, 80.5, 88.0, 90.6 94.6, 95.6, 95.6, 96.8, 101.8 106.9, 106.9, 110.7, 113.2, 113.2 118.8, 120.5, 120.8, 123.2, 125.2

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
				130.0, 130.8, 132.3, 151.0, 158.4 170.0
MLN 0/12	Mae La Noi, S.P. Mine	colorless	a zone of primary fluid inclusions.	75.4, 100.6, 100.6, 103.2, 110.7 114.0, 115.7, 118.2, 119.0, 129.6 129.6, 132.0, 143.4, 145.9
MT,(TP) East end outcrop	Mae Tha, Thepnithi Mine	grey & colorless	primary inclusions	123.2, 125.2, 125.8, 128.3, 130.3 130.8, 130.8, 130.8, 130.8, 130.8 135.8, 137.1, 145.9, 402.5*, 410.0*
MT (TNT) Core NO.18, 128-157thm.	Mae Tha, Thepnithi Mine.	grey & colorless	primary fluid inclusions.	88.0, 88.0, 95.6, 98.1, 99.4 100.4, 100.6, 100.6, 100.6, 100.6 100.6, 100.6, 101.8, 105.6, 105.6 106.9, 106.9, 108.2, 108.2, 110.7 112.0, 112.4, 112.4, 113.2, 113.2 113.2, 113.4, 114.2, 115.0, 115.4 118.2, 118.2, 118.8, 120.8, 120.8 123.2, 125.5, 125.8, 134.6, 144.6 145.9, 150.7, 160.0, 163.5, 176.1 183.6, 188.6, 188.6, 208.8, 239.0 314.5*

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
MT(TP)O/1	Mae Tha, Thepnithi Mine	grey & colorless	primary fluid inclusions	98.0, 108.4, 110.2, 117.0, 120.8 135.8, 138.4, 138.4, 139.6, 206.2
MT(TP)O/2	Mae Tha, Thepnithi Mine	grey & colorless	primary fluid inclusions	88.0, 88.0, 88.0, 90.6, 90.6 90.6, 93.0, 105.6, 105.6, 105.6 107.2, 107.6, 107.6, 108.2, 108.2 110.7, 110.7, 112.0, 112.4, 113.2 113.2, 113.2, 113.2, 113.2, 114.4 114.4, 115.7, 115.7, 115.7, 117.0 118.2, 119.5, 125.8, 125.8, 125.8 125.8, 128.3, 128.8, 133.3, 140.8 140.8, 145.9, 143.4, 150.9, 159.8 163.5, 164.8, 181.1, 193.7, 193.7 196.2, 249.0, 251.6, 269.2, 279.2 369.8*
MT(U)O/X_3	Mae Tha, Universal Mine	grey & colorless	primary fluid inclusions	163.5
MT(U)4102, at 24^{th}m	Mae Tha, Universal Mine	grey & colorless	primary fluid inclusions	100.6, 103.2, 103.4, 108.2, 110.7 114.4

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
MT(U) 2105, at 72^{th}m	Mae Tha, Universal Mine	grey & colorless	primary fluid inclusions	91.8, 102.6, 113.2
MT(U) 2105, at 73^{th}m	Mae Tha, Universal Mine	grey & colorless	primary fluid inclusions	128.3, 354.7*, 378.6*, 390.0*, 390.0*
MT(U) 2105, at 74^{th}m	Mae Tha, Universal Mine	grey & colorless	primary fluid inclusions	125.8
MT(U) 2105, at $83\text{-}85^{th}$m	Mae Tha, Universal Mine	grey & colorless	primary fluid inclusions	75.4, 78.0, 80.5, 80.5, 85.5 88.0, 88.0, 88.0, 90.6, 90.6 93.0, 93.0, 95.6, 98.1, 101.8 106.2, 106.4, 106.9, 113.2, 134.6 138.4, 153.4, 291.8*, 337.1*, 352.2* 374.8*, 377.4*
BH(TFM) DDH 3, 74'	Ban Hong, Thai Fluorspar Mine.	pale yellow	primary fluid inclusions	113.2, 143.4, 155.4, 168.0, 168.6 176.1, 281.8*, 301.9*, 319.5*
BH(U) 0/1	Ban Hong, Univerdal Mine	grey & colorless	inner zone of primary fluid inclusions.	85.5, 90.6, 94.3, 94.3, 98.1 98.1, 98.1, 100.6, 100.6, 100.6 100.6, 103.1, 103.1, 103.1, 103.1

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
				105.6, 105.6, 113.0, 113.2, 120.0 120.8, 120.8, 125.8, 125.8, 127.0 128.3, 128.3, 129.6, 130.3, 132.0 133.3, 135.8, 142.1, 148.4
			outer zone of primary fluid inclusions.	83.0, 85.5, 88.0, 88.0, 89.3 90.6, 90.6, 95.6, 98.1, 108.2 113.2, 115.7, 120.2, 129.0, 133.3 183.6
BH(U) 0/2	Ban Hong Universal Mine	grey & colorless	inner zone of primary fluid inclusions ; 6.5 mm from rock nucleus.	108.2, 113.2, 114.4, 114.4, 116.0 118.2, 119.2
			outer zone of primary fluid inclusions ; 11.5 mm from rock nucleus.	105.6, 106.2, 110.5, 110.7, 113.2 113.2, 119.2, 120.2, 123.2, 129.6 129.8, 130.8, 132.0, 138.4, 289.3*

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
BH(U) 0/3	Ban Hong, Universal Mine.	grey & colorless	primary fluid inclusions.in replacement & vug-filling	80.5, 85.5, 88.0, 94.3, 94.3 95.0, 95.6, 104.4, 105.6, 106.9 107.6, 107.9, 110.7, 110.7, 115.7 115.7, 118.2, 125.8, 125.8, 125.8 125.8, 126.2, 127.8, 132.0, 135.6 136.4, 143.2, 143.4, 158.8, 166.0 193.7
BH(U) 0/7	Ban Hong Universal Mine	grey & colorless	primary fluid inclusions.	110.7, 143.4
BH(U) 0/8	Ban Hong Universal Mine	grey & colorless	primary fluid inclusions.	108.2, 113.2, 113.2, 118.2, 123.2
BH(U) 0/10	Ban Hong Universal Mine	colorless	primary fluid inclusions.	90.6, 105.6, 113.2, 113.7, 115.7 123.3, 128.3, 152.2, 163.5
BH(U) 0/11	Ban Hong Universal Mine	colorless	primary fluid inclusions.	71.7, 206.3
BH(U) 0/14	Ban Hong Universal Mine	grey & colorless	primary fluid inclusion (low grade ore)	69.4, 74.2, 81.8, 110.7, 155.7 208.8

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
BH(TFM) 0/2	Ban Hong, Thai Fluorspar Mine.	brown	primary inclusions in botryoidal fluorite, 4 mm from rock nucleus.	173.6
			2 cm from rock nucleus.	100.6
BH(TFM) 0/4	Ban Hong, Thai Fluorspar Mine.	brown	primary inclusions in botryoidal fluorite; 6 mm from rock nucleus.	103.2
			16.5 mm from rock nucleus.	90.6
BH(TFM) 0/5	Ban Hong, Thai Fluorspar Mine.	brown	primary inclusion in botryoidal fluorite close to rock nucleus.	208.8
BH(TFM) DDH 13, at 15'	Ban Hong, Thai Fluorspar Mine.	colorless	primary fluid inclusions	83.0, 95.4, 105.6, 108.2

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
BH(TFM) DDH 13, at 15'	Ban Hong, Thai Fluorspar Mine.	colorless	secondary fluid inclusions.	93.0, 105.4, 110.7, 118.2, 118.2 119.2
TSY-1	Tha Song Yang, South Pacific Mine.	pale green	secondary fluid inclusions.	125.8, 125.8, 125.8
TSY-2	Tha Song Yang, South Pacific Mine.	purple	primary fluid inclusions.	124.5, 135.8, 135.8, 138.1
TSY-3	Tha Song Yang, South Pacific Mine.	pale green	primary fluid inclusions.	125.3, 128.3, 129.5, 132.0, 132.0 132.3, 133.3, 133.3, 133.3, 134.6 135.8, 137.1, 137.1, 137.1, 137.1 137.4, 137.4, 137.6, 138.4, 138.4 138.4, 138.4, 138.6, 138.6, 138.6 138.6, 139.4, 139.6, 139.6, 139.6, 139.8, 139.8, 143.4, 143.4, 143.4 143.4, 143.6, 143.6, 143.6, 143.6 143.9, 147.2, 148.4

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
T-1	Omkoi, Ban Sop Lan	sky blue	secondary fluid inclusions.	125.8, 133.3, 135.4, 137.1, 138.4 138.4, 138.4, 138.4, 138.4, 138.4 138.4, 138.4, 138.4, 138.4, 138.5 138.5, 138.5, 138.5, 138.8, 139.4 142.1
T-2	Omkoi, Ban Sop Lan	sky blue	primary fluid inclusions.	135.8, 138.5, 140.6, 145.6, 163.5 164.8, 167.3
T-3	Omkoi, Ban Sop Lan	very pale yellow	pseudo-secondary inclusions.	156.0, 165.0, 168.6, 168.6, 168.6 168.6, 168.6, 168.6, 169.3, 169.8 169.8, 169.8, 169.8, 170.0, 170.0 170.0, 170.6, 170.8, 172.3, 175.4, 176.1, 176.1, 176.1, 176.1, 176.1 178.4, 178.6, 178.6, 178.6, 178.6 178.6, 178.6, 179.1, 181.1, 181.1 181.1, 181.4, 181.8, 182.1, 182.4 182.4, 193.7
T-4	Omkoi, Ban Sop Lan.	deep green	pseudo-secondary inclusions.	182.4, 183.2, 183.6, 184.9, 185.4 185.6, 185.9, 186.2, 186.2, 186.2 186.4, 187.4, 187.4, 188.6, 188.6

Sample	Location	Colour	Characteristic of fluid inclusion	Temperature of Vapour-bubble Disappearance(°c)
				189.2, 190.7, 191.2, 191.2, 191.4 192.4, 192.4, 192.4, 192.4, 192.4 193.0, 193.2, 193.2, 193.2, 193.4 193.7, 193.7, 194.0, 194.2, 194.7 195.0, 195.0, 197.4
CHD-1	Chaing Dao, Ban Muang Ngai	colorless & white	primary fluid inclusions	75.4, 106.9, 106.9, 110.7, 110.7 110.7, 113.2, 113.2, 113.2, 113.2 115.7, 115.7, 115.7, 116.0, 118.2 119.8, 120.8, 120.8, 120.8, 120.8 122.0, 123.2, 123.2, 123.2, 123.2 123.8, 125.0, 125.5, 125.8, 125.8 125.8, 125.8, 125.8, 125.8, 125.8 125.8, 125.8, 125.8, 126.2, 126.5 127.0, 127.0, 127.0, 127.0, 127.0 127.3, 127.6, 127.8, 127.8, 128.3 128.3, 128.3, 128.3, 128.3, 128.3 128.3, 128.3, 128.8, 129.6, 132.0 138.4, 138.4, 161.0, 163.5, 164.0 206.2, 276.7*, 281.8*, 289.3*

Table D-3. Decreptitation temperature of gaseous inclusions

Sample	Location	Decrepitation temperature (°c)	Mean	SD
F/L	Fang, Thepnithi Mine	347.2	347.2	-
MT(U) 2105, at 73^{th}m MT(U) 2105, at 74^{th}m	Mae Tha, Universal Mine Mae Tha, Universal Mine	374.9 397.5	386.2	11.3
BH(U) O/1 BH(TFM) DDH- 3, at 74' BH(TFM) DDH-12 DH-7	Ban Hong, Universal Mine Ban Hong, Thai Fluorspar Mine Ban Hong, Thai Fluorspar Mine	327.0 304.4, 332.0, 332.0 379.8	335.0	27.5

D-4. Statistics for inclusions in separate veins, colours and zones of fluorite.

Table D-4.1 Statistics for primary fluid inclusions in separate veins in Mahalanna Mine, Amphoe Pai.

Sample location	Fluid inclusions studied		Homogenization studied		
	Number	Type	Range	Mean	SD
Vein NO.3	256	L_p	120.8-274.2	152.8	18.3
Vein NO.4	111	L_p	113.2-188.6	148.1	16.2
Vein NO.5	104	L_p	120.8-251.6	160.5	21.1
Vein NO.1	26	L_p	139.8-169.8	162.0	9.6
	1	G_p	309.4	309.4	-
Vein NO.2	12	L_p	120.8-178.6	144.4	21.0
"Old Vein"	2	L_p	259.1-264.1	261.6	2.5

L_p = primary gas-liquid inclusions (Type 2, or Type 3)

G_p = primary gaseous inclusions (Type 4)

Table D-4.2 Statistic for primary fluid inclusions in separate colours in Mahalanna Mine, Amphoe Pai ; South Pacific Mine, Tha Song Yang ; and Ban Sop Lan deposit, Omkoi.

Sample location	Colour	Fluid inclusions studied		Homogenization studied		
		Number	Type	Range	Mean	SD
			1. Mahalanna Mine, Amphoe Pai.			
Vein NO.3	deep green.	36	L_p	120.8-193.7	137.1	19.0
	pale green.	41	L_p	120.8-156.0	142.6	11.5
	colorless.	179	L_p	123.2-208.8	158.3	16.4
Vein NO.4	deep green.	19	L_p	113.2-152.2	143.1	8.9
	pale green.	46	L_p	125.8-163.5	150.4	7.5
	pale violet.	14	L_p	130.8-171.0	150.6	14.8
	pale brown.	19	L_p	138.4-156.0	150.0	5.8
Vein NO.5	colorless.	52	L_p	123.2-191.2	164.5	11.2
	pale violet, colorless.	14	L_p	120.8-166.0	156.5	13.7
	pale violet, pale green, colorless.	7	L_p	156.0-161.0	158.4	1.5

Sample location	Colour	Fluid inclusions studied		Homogenization studied		
		Number	Type	Range	Mean	SD
Vein NO.1	very pale brown.	11	L_p	13C.8-169.8	158.7	13.1
	deep purple.	3	L_p	156.0-169.8	163.9	5.8
	deep green.	11	L_p	161.0-169.8	164.9	2.8
2. South Pacific Mine, Tha Song Yang.						
Deposit 1: TSY-2	purple.	4	L_p	124.5-138.1	133.6	5.3
-3	green.	43	L_p	125.8- 148.4	138.2	4.8
-1	green.	3	L_s	125.8	125.8	0.0
3. Ban Sop Lan deposit, Omkoi.						
T-1	sky blue.	21	L_s	125.8-142.1	137.6	3.1
T-2	sky blue.	7	L_p	135.8-167.3	150.9	13.8
T-3	pale yellow	42	L_{ps}	156.0-193.7	174.6	6.6
T-4	green & deep. green	38	L_{ps}	182.4-197.4	190.2	3.9

Table D-4.3 Statistic for primary fluid inclusions in separate zones in deposits.

Sample location and character of fluorite	Fluid inclusion studied		Homogenization studied		
	Number	Type	Range	Mean	SD
1. Thepnithi Mine, Fang.					
F TDH-9, at 7.1thm ; the inclusions in zone	21	L_p	108.2-192.4	140.6	19.0
F TDH-9, at 7.2thm ; the inclusions in zone	69	L_p	60.4-251.6	142.4	31.6
F 0/4 ; radiated prismatic F.I.	10	L_p	80.5-137.8	111.4	17.0
F 0/1	13	L_p	95.6-228.9	138.0	32.8
F Outcrop/2	8	L_p	113.2-138.4	125.7	9.0
F 0/L in replacement type of fluorite.	16	L_p	95.6-181.1	136.5	23.8
F 0/6	10	L_p	110.7-127.0	118.2	4.3
2. S.P. Mine, Mae La Noi.					
Dark brown/1 ; layering fluorite. rectangular shaped fluid inclusion.	32	L_p	77.4-210.8	106.6	38.2
MLN 0/4 ; the inclusions in the outer zone.	13	L_p	113.2-145.2	126.5	10.9

Sample location and characteristic of fluorite	Fluid inclusion studied		Homogenization studied		
	Number	Type	Range	Mean	SD
MLN O/4. inclusions in the outer zone in very pale purple fluorite surrounded rock breccia	13	L_p	113.2-145.2	126.5	10.9
MLN O/4. inclusions in the inner zone in very pale purple fluorite surrounded rock breccia	24	L_p	93.6-181.1	122.0	19.9
MLN C_1F inclusions in zone.	26	L_p	57.4-170.0	111.9	25.0
MLN O/12 inclusions in zone.	11	L_p	75.4-129.6	110.6	14.7
3. Universal Mine and Thepnithi Mine, Mae Tha.					
MT(U) 2105, at 83-85thm	22	L_p	75.4-153.4	99.4	19.8
MT(U) 4102, at 24thm	11	L_p	91.8-128.3	109.3	10.3
MT(TP) East end outcrop	13	L_p	123.2-145.9	131.2	5.6
MT(TNT) Core NO.18, 128-157thm	50	L_p	88.0-239.0	124.3	31.2
MT(TP) O/1	10	L_p	98.0-206.2	131.3	28.6
MT(TP) O/2	55	L_p	88.0-279.2	133.6	44.6
4. Universal Mine and Thai Fluorspar Mine, Ban Hong.					
BH(TFM) DDH 3, 74'	6	L_p	113.2-176.1	154.1	21.1

Sample location and character of fluorite	Fluid inclusion		Homogenization studied		
	Number	Type	Range	Mean	SD
BH(U) O/1 inclusions in the inner zone near rock nucleus	34	L_p	85.5-148.4	113.5	16.1
BH(U) O/1 inclusions in the outer zone.	16	L_p	83.0-183.6	107.0	25.2
BH(U) O/2 inclusions in the inner zone near rock nucleus.	7	L_p	108.2-166.0	121.9	18.3
BH(U) O/2 inclusions in the outer zone.	14	L_p	105.6-138.4	120.2	10.2
BH(TFM) O/2, O/4, and O/5 in brown botryoidal fluorite.	5	L_p	208.8-90.6	135.4	47.1
BH(U) O/3 replacement and vug-filling fluorite.	31	L_p	80.5-193.7	119.4	24.4
BH(TFM) DDH 13, at 15'	6	L_p	93.0-119.2	110.8	9.4

Table D-5. Summary of data of homogenization temperatures for each deposit

Sample location	Fluid inclusions studied		Homogenization studied			Ratio of mean H.T. of gaseous inclusions/ mean H.T. of gas-liquid inclusions
	Number	Type	Range	Mean	SD	
Fang, Thepnithi Mine	154 10	L_p G_p	60.4-251.6 251.3-357.2	136.3 300.5	28.2 34.2	2.2
Amphoe Pai, Mahalanna Mine	510 1	L_p G_p	113.2-274.2 309.0	154.9 309.0	19.0 -	2.0
Mae La Noi, S.P. Mine	119 1	L_p G_p	57.4-210.8 329.6	115.0 329.6	27.5 -	2.86
Mae Tha, Universal Mine and Thepnithi Mine.	162 15	L_p G_p	75.4-279.2 271.7-410.0	124.3 355.8	35.4 39.5	2.86
Ban Hong, Universal Mine and Thai Fluorspar Mine	142 10	L_p G_p	69.4-208.8 281.8-379.8	118.6 324.5	26.5 31.6	2.74

Sample location	Fluid inclusions studied		Homogenization studied			Ratio of mean H.T. of gaseous inclusions/ mean H.T. of gas-liquid inclusions
	Number	Type	Range	Mean	SD	
Tha Song Yang, South Pacific Mine.	47	L_p	125.4-148.4	137.8	5.0	-
Omkoi, Ban Sop Lan Deposit.	87	L_p	135.8-197.4	179.6	12.9	-
Chiang Dao, Ban Muang Ngai deposit.	66 3	L_p G_p	75.4-206.2 276.7-289.3	125.6 282.6	15.7 5.2	2.25

APPENDIX E

HOMOGENIZATION DATA FOR FLUID INCLUSIONS

IN FLUORITE FROM OTHER COUNTRIES.

Table E-1. Homogenization temperatures for fluid inclusions in fluorite from other countries. (From

Country	Deposit	Associated minerals	Homogenization temperature (°c)
Central Kazakhstan	Kara-oba	Molybdenite-feldspar-quartz	260
		Wolframite-quartz	318-260
		Wolframite-quartz	246-143
		Bismuth-siderite	252,232
		Siderite	150- 98
		Quartz	78- 55
	Akehatau	Quartz-molybdenite-wolframite	375-350
Transbakalia	Bom-Gorkhan	Quartz-calcite	190-107
	Dzhida	Rhodochrosite-huebnerite	145-100
England	Cornwall	Quartz-sulfide (chalcopyrite)	270-256
		(galena)	146-115
			146-115
	Derbyshire	Barite-calcite-galena-sphalerite	80-184

Country	Deposit	Associated minerals	Homogenization temperature (°c)
Spain	La Cabana	Calcite-quartz	50-160
Bolivia	Chakattaya Colquiri	Cassiterite-wolframite-bismuth Cassiterite (early) (late)	283-211 287-213 175- 92
United States	Upper New York State, Central Kentucky, Central Tennessee.		132- 72
	Sweet Water District. (East Tennessee)		196-109

APPENDIX F

DATA FOR HOT SPRINGS IN NORTHERN THAILAND

Table F-1. General descriptions of hot springs in northern Thailand.

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c) T(NK)	T(NKC)	$T(SiO_2)$	General descriptions and remarks
1	Fang Hot spring, Ban Pong Nam Ron, Fang, Chiang Mai	NE 47-3 NC 2004	100	134	160	183	More than 50 hot springs occur in a partly dissected terrace, approximately 10-12 m above river level, with large boulders and pebbles of foliated biotite granite and quartz veins. Most of the springs are hot-pool type, bubbling out at regular intervals. Some are shooting 15-30 cm above surface at intervals of 15-45 seconds. The thermal area is situated in the fault controlled Nam Mae Chai valley. Ordovician limestone exposed in a fluorite mine south of the area.
2	Pa Pae Hot Spring, Ban Mae Sae, Mae Taeng, Chiang Mai.	NE 47-2 MB 6728	100	154	169	200	Seven hot springs, of which 4 are of geyser-type, occur in a small intermontane valley. The hot spring pools lie on a line trending 130°. The two largest pools are of diameter 3 and 4.5 m respectively. The hot springs are geysering about 2m high at 30 seconds intervals, with moderate eruptions every 12-15 seconds. Siliceous cinter coating occurs at edges of the pools, and along the hot stream flowing into the main stream. Outcrops of biotite gneiss, possibly of Pre-Cambrian age. Fractures and foliation are principally N 15 E and N 15 W.

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c) T(NK)	T(NKC)	$T(SiO_2)$	General descriptions and remarks
3	Pong Hom and Pong Nog Hot springs, Ban On Luay, A. San Kamphaeng Chiang Mai.	NE 47-7 NA 2380	99	217	191	178	More than 20 hot springs are found with a distance of 1 km along small stream in a gravel filled derression. Country rocks are quartzo-feldspathic sandstone inter bedded with slaty shales and chert beds. Highly weathered andesitic tuffs and agglomerates also found along the stream. Quartz vein are numerous. Highly jointed with attitude of N 17 W
4	Ban Pong, A. Phrao, Chiang Mai	NE 47-3 NB 1842	72	-	150	142	Located on the flood plain of Mae Ngud River in the Phrao Basin, about 2 km east of its western edge. One spring occurs in the river, two occur in adjacent field. Alluvium has concealed the bed rock. Each hot spring are consisted of 3 to 10 small pools of discharge less than 1 l/s. The springs are bubbling under the water surface at intervals of less than 10 seconds. Thermal water in the pools are much contaminated by river and pond water. No siliceous sinter deposit occurs.
5	Ban Nong Krok, A. Phrao, Chiang Mai	NE 47-3	72	-	-	-	Five hot springs occur in alluvial plain near the edge of Phrao Basin.
6	Pong Kum Hot Spring, Ban Pong Din, A. Doi Saket, Chiang Mai.	NE 47-7	85	176	156	159	The thermal area is located in a rice paddy paddy in an intermontane valley. Five springs of hot-pool type occur in two main areas about 250 m apart. Orthoquartzite

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c)			General descriptions and remarks
				T(NK)	T(NKC)	T(SiO_2)	
							with some quartz veins crop out in the area. The rock is well jointed with attitude N 70 W, 70 SW.
7	Tepanom Hot spring, Ban Omkhut, A. Mae Cham, Chiang Mai.	NE 47-6 MA 3819	98	117	148	171	Located on the dissected terrace of Nam Mae Cham River. More than 15 hot springs of hot-pool type occur, with deposits of siliceous sinter. Boulder of quartzo-feldspathic biotite gneiss and quartz veins are seen in the area.
8	Ban Ping Kong, A. A. Chiang Dao, Chiang Mai.	NE 47-2 MB 9951	70	-	-	-	Located on flood plain and sandy stream floor of a stream. Only one hot pool but with numerous seeps occur along the stream floor within a distance of 50 m. Discharge is small.
9	Ban Pong Mai, A. Pai. Mae Hong Son.	NE 47-2 MB 4535	-	-	-	146	Vinyarat (1974)
10	Ban Pong Dued, A. Mae Taeng, Chiang Mai.	NE 47-2	20	-	-	-	Mineralized water seeps out along fractures in foliated granite adjacent to a small stream. Give out fainted small of H_2S and appearance of white residues which are commonly observed in other thermal area.

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c) T(NK)	T(NKC)	$T(SiO_2)$	General descriptions and remarks
11	Pong Muen Hot spring Ban Om Mueng, Mae Cham, Chiang Mai.	NE 47-6 NA 3336	75	158	-	160	One large hot pool occurs along fracture of limestone exposed along Nam Mae Cham River. Fracture attitude is N 50 W, 80 NE The hot spring is bubbling out at 1 minute regular interval. Strong smell of H_2S. A few number of seeps along the river bank and river floor.
12	Hot spring near Mae Chok Luang Stream, A. Mae Taeng, Chiang Mai	NE 47-2 MB 6732	-	-	-	179	Vinyarat (1974). Geology is probably the same as NO.22
13	Thepnithi Fluorite Mine, Ban Tha Kad, A. Mae Tha, Lamphun.	NE 47-7 NA 0038	42	-	-	-	One small spring issues out from andesitic rocks which is faulted contact with limestone. The spring was discovered when the mine face (fluorite,stibnite) was opened several ten of meters below the original ground surface. Fainted smell of H_2S.
14	Universal Fluorite Mine, Ban Tha Kad, A. Mae Tha, Lamphun	NE 47-7 NA 0038	27	-	-	-	Mineralized water with white residue appearance similar to NO.10. No smell of H_2S. Water seeps out in the mine face several tens of meters below the original ground surface. Geology is similar to NO.13.

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c) T(NK)	T(NKC)	$T(SiO_2)$	General descriptions and remarks
15	Hot spring near Nam Mae Mon, Ban Chae Son, A. Chae Hom, Lampang.	NE 47-7 NA 4983	82	210	-	164	Located on a small valley filled with terrace deposits of Nam Mae Mon. Only two large hot-pool type springs with numerous seeps. Country rock is granite porphyry (Triassic). The thermal water is discharg discharged to Nam Mae Mon.
16	Pong Sak Hot spring Ban Tan Ched Ton, A. Pai, Mae Hong Son.	NE 47-2 MB 4737	85	138	-	155	Located partly on terrace and partly on flood plain in a small valley of Mae Nam Pai. Country rocks are quartzo-feldspathic sandstone interbedded with slaty shale and chert. Two hot-pool type springs occur on the left bank about 150 m from the stream, with numerous seeps occur along along the river floor. Mae Nam Pai at this section is certainly fault controlled, trending N-S.
17	Pong Pa Hot spring Ban Tan Ched Ton, A. Pai, Mae Hong Son.	NE 47-2 MB 4347	90	144	-	160	Located on the foot of a small hill, about 3 m above Mae Nam Pai. Five hot pool type springs occur in area of 30 x 30 m^2. Some seeps also occur along the river bank. Country rocks are chert and quartzo-feldspathic sandstone, highly jointed. Small outcrop of rhyolite porphyry is exposed on the bank of the river but its relationship with the country rocks is not known.

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c) T(NK)	T(NKC)	$T(SiO_2)$	General descriptions and remarks
18	Hot spring near Huai Paeng, Ban Muang Paeng, A. Pai Mae Hong Son.	NE 47-2 MB 3522	-	-	-	142	Vinyarat (1974), Country rock is granite.
19	Hot spring along E-W striking Mae Nam Pai, A. Pai Mae Hong Son.	NE 47-2	-	-	-	-	Data from unpublished 1:50,000 geological map, by Economic Geology Division, D.M.R. At least three hot springs are known to exist. Country rock, as mapped is limestone.
20	Ban Pong, near Mae Sariang, A. Mae Sa-riang, Mae Hong Son.	NE 47-6 LA 8709	-	-	-	115	Vinyarat (1974), Country rock is probably limestone.
21	S.P. Fluorite Mine, near Nam Mae Hu, Mae La Noi, Mae Hong Son	NE 47-6 LA 9433	80	-	-	152	Two hot springs occur near Nam Mae Hu. Country rock is highly sheared fine grained limestone of Lower Paleozoic age

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c) T(NK)	T(NKC)	$T(SiO_2)$	General descriptions and remarks
22	Ban Huai Pong, A.Muang Mae Hong Son.	NE 47-6 LB 9405	80	-	-	-	Located on the rice paddy.
23	Ban Pong Pu Fueng, A. Mae Suay, Chiang Rai	NE 47-3 NB 6382	72	120	-	128	Three hot-pool type springs occur in a small intermontane valley with relatively flat terrain. A few seeps are also noted. At the foot of the hill, the area is mainly swamp and is probably the ground water natural discharge point. No outcrops are seen but there are few boulders of quartz veins with inclusions of black slaty shale.
24	Ban Huai Sai Khao, A. Phan, Chiang Rai.	NE 47-3	55	-	-	120	Country rock is sandstone. The thermal water has pH 8.3, TDS 209 mg/1 and SiO_2 72.3 mg/1, (EGAT,1977)
25	Ban Sop Pong, Mae Chedi A.Wiang Pa Pao, Chiang Rai.	NE 47-3 NB 4914	99	277	-	135	Located on river flood plain and river floor of E-W trending Nam Mae Lao River. The springs are mainly of hot-pool type and occur in three different areas. On the river floor, there are two big pools with numerous seeps within a distance of 40 m. Three pools occur at a distance of 150 m south of the river near the foot of the andesite hill. One pool and few seeps occur in the rice

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c) T(NK)	T(NKC)	T(SiO_2)	General descriptions and remarks
							paddy, across the road on the north side of the river, at a distance of about 100m. The area is covered with alluviums and boulders of granite por-porphyry, up to 2-3 m diameter, however andesite hills border the area.
26	Ban Pong Na Khum, A. Muang, Chiang Rai.	NE 47-3 NC 7605	60	114	-	149	Two springs of hot-pool type occur in swampy area in the rice field. There are about 4-5 separate swampy areas which thermal water are though to seep out. The swampy area is found to be about 75 cm higher than the normal rice field level, Outcrops of reddish brown sandstones and shales occur on the adjacent hill.
27	Ban Pong Nam Ron, A. Mae Chan, Chiang Rai.	NE 47-15 NC 8525	100	160	165	173	Located in the Nam Mae Chan Valley. Hot springs occur in two different areas. The first and the main dis-charging area is situated on the north side of Mae Chan tribury, where more than 10 hot springs and numerous seeps occur. Country rock is granite porphyry (Triassic), highly jointed with attitude of N 5° W, 80° NE and N 30° E , 80° NW. The second discharge area is along Nam Mae Chan River, about 300 m SE of the first area. Here, four hot springs occur on the river bank. Numerous seeps are observed

NO.	Locality and name	Grid Reference	Surface Temp. (°c)	Subsurface temp. (°c) T(NK)	T(NKC)	$T(SiO_2)$	General descriptions and remarks
							along the river floor and within a distance of 300m. Along this section Nam Mae Chan River is fault-controlled, trending approximately E-W.
28	Ban Pong Yang Pa Kiew, A. Muang, Chiang Rai.	NE 47-3 NC 7208	85	138	-	150	Located on the headwaters of small tributary of Nam Mae Kok, about 60 m away but at higher altitude. There are three large pools. One is about 2 x 2 m, the other two are of smaller size. Country rocks is granite porphyry.
29	Ban Sop Pong Nam Ron, A. Muang, Chiang Rai.	NE 47-3	76	138	-	165	Located on the headwaters of a small tributary, Huai Pong Nam Ron, of Nam Mae Kok River. One large pool occur on the stream bank and numerous seeps occur along the stream floor. The position of the large pool is known to have a shifted about 6 m away from its former position with a drop of 0.5 m in elevation. No outcrops are seen but certainly is underlained by granite porphyry.
30	Wat Hong Tai, A. Muang Phrae.	NE 47-3	-	-	-	120(94)	Analysis by Vinyarat (1974) gave 120°c. Analysis by EGAT (1977) gave 94°c, it with pH 8.00, TDS 296 mg/1 and SiO_2 42.1 mg/1.

NO.	Locality and name	Grid Reference	Surface Temp.(°c)	Subsurface temp.(°c) T(NK)	T(NKC)	$T(SiO_2)$	General descriptions and remarks
31	Mae Chok, A. Wang Chin Phrae	NE 47-3	85	-	-	139	EGAT (1977) pH 8.8, TDS 604 mg/l and SiO_2 103.5 mg/l.
32	Between A. Rong Kwang and A. Song, Phrae.	NE 47-3	50	-	-	65	EGAT (1977) pH 7.6, TDS 42 mg/l, and SiO_2 20.8 mg/l. Country rock is reported as sandstone.
33	Ban Huai Bong, A. Mae Sod, Tak.	-	80	-	-	-	Limestone
34	Ban Mae Sin, A, Sisat-Chanalai, Sukhothai.	-	55	-	-	94	EGAT (1977) pH 8.5, TDS 584 mg/l, and SiO_2 42.1 mg/l.
35	Ban Luang, A. Hang Chat, Lampang.	NE 47-7	-	-	-	-	-
36	Ban Pha Bong, A. Muang Mae Hong Son.	NE 47-6	-	-	-	-	-
37	Ban Nong Haeng, A. Khun Yuam, Mae Hong Son.	NE 47-2	-	-	-	-	-

T(NK)= Na,K geothermometer ; T(NKC) = Na,K,Ca geothermometer ; $T(SiO_2)$ = SiO_2 geothermoter.

Table F-2. Chemical analysis of thermal waters in northern Thailand

NO.	Appearance	Temp. °c	pH	TDS mg/1	Alkalinity mg/1. $CaCO_3$	Acidity mg/1 $CaCO_3$	S mg/1 H_2S	Cl mg/1	F mg/1	Na mg/1	K mg/1	Si mg/1
	Fang Hot Spring, Ban Pong Nam Ron, Fang, Chiang Mai											
1	Pool-clear	97	7.95	1200	320	nd	9.91	114	47	133	8	89
2	Pool-clear	99.5	8.85	750	326	nd	10.34	102	48	150	8	87
3	Geyser type	100	9.00	1000	366	nd	10.45	116	50	188	9.1	91
4	Geyser type	100	8.6	1800	376	nd	10.91	124	45	217	10.1	91
5	Geyser type	98.2	9.1	1350	424	nd	11.31	100	52	194	10.2	83
6	Pool	98.5	9.1	400	424	nd	10.83	146	48	198	9.7	94
7	Spring	99	9.0	400	416	nd	12.16	144	47	172	9.7	91.5
8	Pool	97.5	9.8	2100	338	nd	10.06	98	46	140	9.8	91.5
9	Geyser	100	9.0	600	372	nd	11.20	80	48	151	10.2	98.5
10	Pool	97.5	9.1	2000	388	nd	5.09	92	47	136	10.0	94
	Tapanom Hot Spring, Ban Omkhut, Mae Cham, Chiang Mai											
1	Spring	97	8.2	1150	304	nd	5.56	136	40	163	7.1	85
2	Spring	97	8.2	1000	152	nd	5.36	56	45	164	7.3	82
3	Spring	97	8.2	900	416	nd	3.64	56	43	177	7.5	85
4	Pool deep,clear	95	8.4	5650	280	nd	5.16	48	40	178	7.15	85

NO.	Appearance	Temp. °c	pH	TDS mg/1	Alkalinity mg/1.$CaCO_3$	Acidity mg/1 $CaCO_3$	S mg/1 H_2S	Cl mg/1	F mg/1	Na mg/1	K mg/1	Si mg/1
5	Pool	95	8.5	1200	312	nd	3.84	60	39	160	7.4	78
6	Pool	97	8.4	700	240	nd	4.02	72	7[illegible]	194	7.3	83
7	Pool	95	8.4	500	280	nd	3.83	30	30	165	7.4	81
8	Pool	95	8.4	500	140	nd	3.49	72	35	156	7.0	82
	Pong Maen, Ban Om Mueng, Mae Cham, Chiang Mai											
1	Pool	70	7.5	900	248	nd	4.80	297	33	122	9.0	78
	Pa Pae Hot Spring, Ban Mae Sae, Mae Taeng, Chiang Mai											
1.	Geyser-clear	100	nd	550	266	nd	nd	35	70	88	7.1	124
2.	Geyser-clear	100	nd	900	240	nd	nd	30	64	102	6.7	124
3.	Geyser-clear	100	nd	1050	212	nd	nd	28	54	101	7.25	124
4.	Geyser-clear	100	nd	500	274	nd	nd	39	54	112	7.55	130
5.	Geyser-clear	102	nd	600	214	nd	nd	37	56	114	7.55	124
	Pong Kum Hot Spring, Ban Pong Din, Doi Saket, Chiang Mai											
1.	Pool-spring	82	7.7	3975	320	112	10.74	38	50	142	12.5	67.5
2.	Pool-spring	96.5	8.2	4075	322	88	10.51	207	38	144	13	75
3.	Pool	81.0	8.2	1675	380	40	5.96	40	45	160	20	63
4.	Pool	79.5	6.5	1400	280	40	6.95	46	40	122	11.5	66

NO.	Appearance	Temp. °c	pH	TDS mg/l	Alkalinity mg/l.$CaCO_3$	Acidity mg/l Ca CO_3	S mg/l H_2S	Cl mg/l	F mg/l	Na mg/l	K mg/l	Si mg/l
	Pong Hom Hot Spring, Ban On Luay, San Kampaeng, Chiang Mai											
1	Shooting at 3-7 minutes	85	8.5	300	366	nd	20.56	50	85	194	25	93
2	Pool-clear	93	8.95	800	410	nd	15.25	42.4	78	164	24.5	109
3	Pool-clear	93	9.0	1500	252	nd	12.13	45.4	84	165	11.5	86
4	Bubbling-clear	100	9.4	1100	324	nd	20.96	37.4	97	140	21	93
5	Mixed with stream water	100	8.5	750	286	nd	7.97	41.0	80	135	11.5	74
6	Pool-clear	99.5	8.5	700	428	nd	11.27	78	85	182	22	87
7	Seeps in stream	99.5	8.45	700	370	nd	20.03	77	167	167	23	87
8	Pool-clear	80	8.0	450	392	nd	20.09	65	78	180	22	89
9	Mixed with stream water	97	8.3	400	366	nd	6.19	34	78	151	13.5	78
10	Pool-cloudy	95	8.3	400	432	nd	19.54	62	85	134	17	106
	Ban Sop Pong, Mae Chedi, Wiang Pa Poa, Chiang Rai											
1	Spring	99	nd	450	-	18	-	165	76	18	5.75	25
2	Spring	98	7.0	650	386	22	14.53	215	11	41	5.2	37
3	Spring	83	8.2	1150	-	-	-	-	22.5	43	8.75	87

NO.	Appearance	Temp. °c	pH	TDS mg/l	Alkalinity mg/l.$CaCO_3$	Acidity mg/l $CaCO_3$	S mg/l H_2S	Cl mg/l	F mg/l	Na mg/l	K mg/l	Si mg/l
				Ban Pong Pu Fueng, Mae Suay, Chiang Rai								
1	Spring	71	8.9	510	148	32	19.4	134	27	93	4	40
				Ban Pong Nam Ron, Mae Chan, Chiang Rai								
1	Spring	99.5	8.2	950	300	nd	19.72	193	48	192	10.4	85
2	Spring	99.5	8.2	1050	254	nd	21.39	158	50	150	10.4	85
3	Spring	99.5	8.2	800	248	nd	19.03	149	51	120	10.45	86
4	Spring	99.5	8.2	750	254	nd	18.32	166	52	138	10.25	85
				Ban Pong Na Khum, Amphoe Muang, Chiang Rai								
1	Pool	60.0	8.4	1850	164	12	15.62	321	37	113	4.45	85
				Ban Sop Pong Nam Ron, Amphoe Muang, Chiang Rai								
1	Pool	76.0	8.4	750	180	nd	19.72	109	37.5	118	5.3	57
				Ban Pong Yang Pa Kiew, Amphoe Muang, Chiang Rai								
1	Pool	85.0	8.4	500	208	nd	17.18	185	39	105	5.85	58.5
2	Pool	82.0	7.2	nd	nd	nd	11.78	nd	21.5	10.3	12.2	73
3	Pool	82.0	7.2	nd	nd	nd	10.08	nd	18.5	100	13.7	75

NO.	Appearance	Temp. °c	pH	TDS mg/1	Alkalinity mg/1 $CaCO_3$	Acidity mg/1 $CaCO_3$	S mg/1 H_2S	Cl mg/1	F mg/1	Na mg/1	K mg/1	Si mg/1
		Pong Sak Hot Spring, along Nam Mae Pai, Ban Tan Ched Ton, Amphoe Pai, Mae Hong Son										
1	Pool	85.0	8.1	5[illegible]0	254	nd	11.19	32	43	109	5.9	63
2	Spring	85.0	8.1	600	256	nd	10.54	31	41	114	6.25	65.5
		Pong Pa Hot Spring, along Nam Mae Pai, Ban Tan Ched Ton, Amphoe Pai, Mae Hong Son.										
1	Spring	90.0	8.1	nd	288	nd	14.45	36	43	100	6.2	69

Table F-3. Subsurface temperature of hot springs.

Location number*	Sample Number**	SiO_2 mg/1	Temp. (°c)	Na mg/1	K mg/1	Na/K atomic ratio	Temp. (.c)
1	2	186.2	175	150	8.0	32.5	136
	3	194.7	178	188	9.1	35.9	130
	4	194.7	178	217	10.1	37.4	124
	5	177.6	172	194	10.2	33.2	132
	6	201.2	180	198	9.6	35.2	128
	7	195.8	178	172	9.7	30.8	138
	8	195.8	178	140	9.8	24.8	154
	9	210.8	183	151	10.2	25.8	130
2	1	265.4	200	88	7.1	21.5	168
	2	265.4	200	102	6.7	26.5	150
	3	265.4	200	101	7.3	24.2	156
	4	278.0	204	112	7.5	25.8	150
	5	265.4	200	114	7.5	26.3	148
3	1	199.0	180	194	25.0	13.5	211
	4	199.0	180	140	21.0	11.6	231
	7	186.0	177	167	23.0	12.6	219
	8	190.4	176	180	22.0	14.2	205
6	1	144.5	157	142	12.5	19.8	176
	2	160.5	166	144	13.0	19.3	176

Location number*	Sample Number**	SiO_2 mg/l	Temp. (°c)	Na mg/l	K mg/l	Na/K atomic ratio	Temp. (°c)
7	1	181.9	173	163	7.1	39.9	120
	2	175.5	172	164	7.3	39.1	122
	4	131.9	173	178	7.2	43.3	114
	6	177.6	172	194	7.3	46.2	110
11	1	166.9	168	122	9.0	23.6	158
15	1	156.2	164	103	12.2	14.7	202
	2	160.5	165	100	13.7	12.7	218
16	2	140.2	157	114	6.3	31.7	138
17	1	147.7	160	100	6.2	28.1	144
23	1	85.6	128	93	4.0	40.4	120
25	3	186.2	175	43	8.8	8.6	277
26	1	120.9	148	113	4.5	44.2	114
27	1	181.9	173	162	10.4	28.5	144
	2	181.9	173	150	10.2	24.8	154
	3	184.0	175	120	10.5	19.9	180
	4	181.9	173	138	10.3	23.4	160
28	2	125.1	150	105	5.8	31.2	138
29	2	125.1	150	105	5.8	31.2	138

*Location number as referred in Table F-1.

**Sample number as referred in Table 3.

APPENDIX G

SOLUBILITY DATA FOR FLUORITE

(From Strubel, 1965)

Table G-1. Solubility (L) of fluorite from 20°c to 350°c (After Strubel, 1965)

Temperature (°c)	Pressure (Bar)	L (mg CaF_2/kg H_2O)
23.0		8.76 ± 0.14
25.0		9.13 ± 0.16
26.5		9.24 ± 0.09
39.0		11.43 ± 0.10
50.0		13.70 ± 0.10
61.0		15.43 ± 0.16
76.5		16.70 ± 0.12
86.5		16.82 ± 0.11
98.5		16.78 ± 0.06
150.0	4.8	15.20
200.0	15.6	13.20
250.0	39.8	11.30
255.0	43.3	13.00 ± 9.00
300.0	85.9	7.85 ± 0.20
310.0	98.7	14.50 ± 4.50
350.0	165.4	6.50

Table G-2. Solubility (L) of CaF_2 in the ternary system CaF_2-$NaCl$-H_2O (After Strubel, 1965)

Temperature (°c)	Density ($g.cm^{-3}$)	L (mg CaF_2/kg H_2O) 0.1 n NaCl	0.5 n NaCl	1.0 n NaCl	2.0 n NaCl
20.0	0.9982	19.35 ± 0.08	23.88 ± 0.11	24.58 ± 0.10	25.19 ± 0.11
30.0	0.9956	23.96 ± 0.06	28.84 ± 0.05	29.64 ± 0.06	29.88 ± 0.11
40.0	0.9922	27.13 ± 0.14	33.35 ± 0.08	33.81 ± 0.08	34.67 ± 0.32
50.0	0.9881	29.51 ± 0.11	36.08 ± 0.16	37.17 ± 0.00	38.66 ± 0.08
60.0	0.9832	31.78 ± 0.23	38.03 ± 0.08	40.22 ± 0.08	41.54 ± 0.15
70.0	0.9778	32.64 ± 0.15	40.15 ± 0.15	42.40 ± 0.24	44.20 ± 0.00
80.0	0.9718	33.27 ± 0.15	41.31 ± 0.08	44.04 ± 0.16	46.31 ± 0.23
90.0	0.9654	33.34 ± 0.08	41.86 ± 0.16	45.29 ± 0.32	48.03 ± 0.24
		33.58 ± 0.15	42.48 ± 0.15	46.31 ± 0.71	49.93 ± 0.11
		(100.5°c)	(99.5°c)	(100.1°c)	(101.5°c)

Ts* : Boiling temperature of the mixed phase.

PLATE 1

Photomicrographs of fluid inclusions in fluorite from Ban Sop Lan (Omkoi) deposit. Photographed at room temperature (26.6°c). Symbols : F - fluorite ; liq - liquid part of inclusion ; v - vapour bubble ; a,b,c - separate inclusions.

1. Primary fluid inclusion in sky blue fluorite. The sample section was cut along plane {100} . The inclusion is aligned parallel to {100} , as the negative shape of the crystal and is caused by imperfection of crystal during growth.

2. Pseudo-secondary inclusions with uniform phase ratio in very pale yellowish fluorite. The irregular shapes are the result of fracturing in crystal during crystalization.

3. Pseudo-secondary inclusions in deep green fluorite. The inclusion shape of a is half irregular and half negative of the crystal. The irregular side is older, formed after fracturing, and show parallel alignment.

4. Box-shaped primary fluid inclusion in sky blue fluorite. The shape is the negative of the crystal with the right edge parallel to plane of crystal growth. Note small secondary inclusions are also present in cleavage planes.

5. Uniformity of phase ratio of secondary fluid inclusions in cleavage plane of sky blue fluorite. Most of the inclusions are arranged in the same direction in the cleavage plane.

PLATE 1

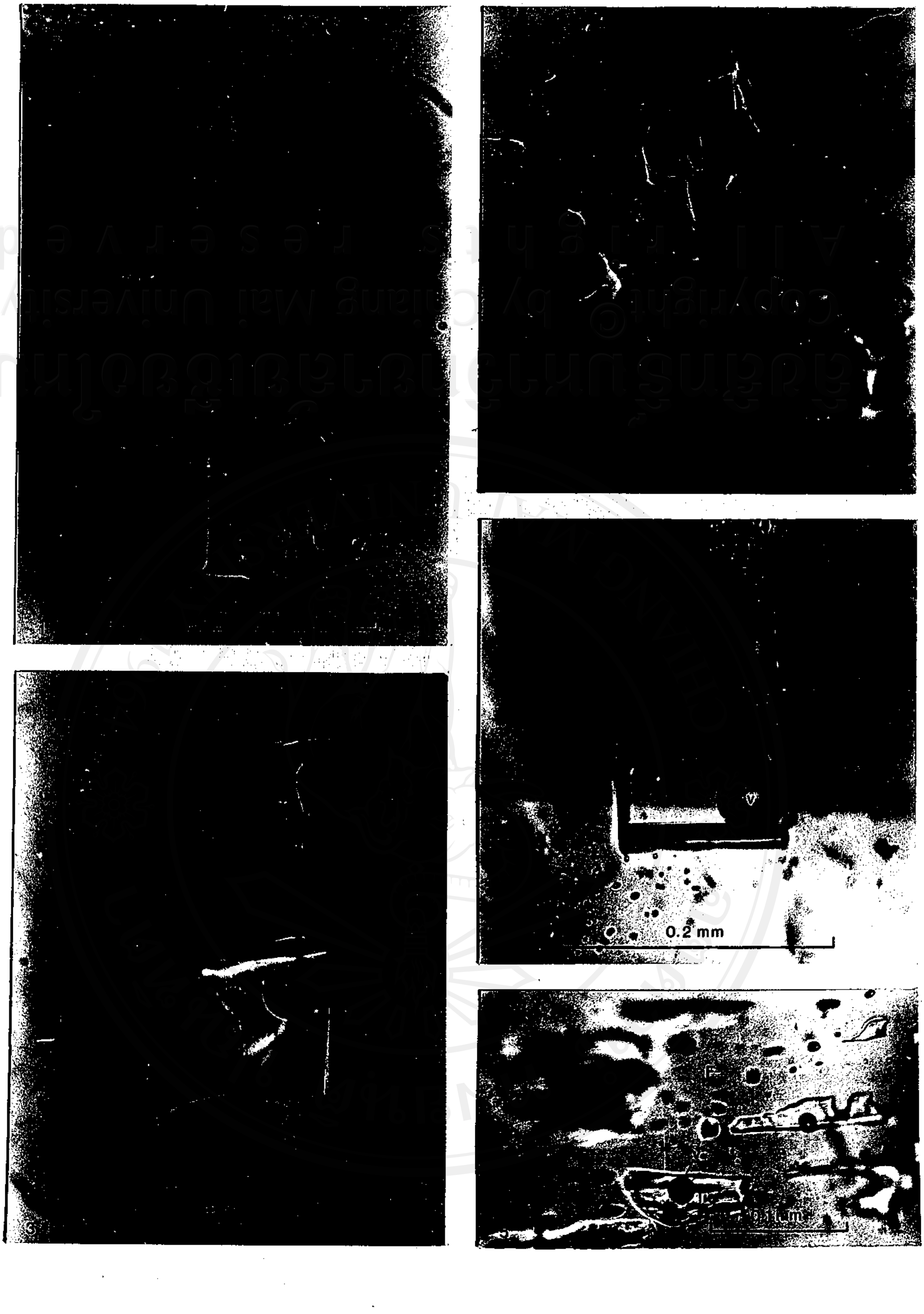


PLATE 2

Photomicrographs of primary fluid inclusions in fluorite. Symbols as for Plate 1.

1. Cone-shaped primary fluid inclusion. Inclusion is negative shape of crystals which are prismatic-radiated aggregate type. Sample MLN 0/5, SP. Mine, Mae La Noi.

2. Primary fluid inclusion (Type 3). Shape is typically negative of crystals. Core sample DDH 3, 74 m depth, Thai Fluorspar Mine, Ban Hong.

3. Primary fluid inclusion. Vapour bubble is ellipsoidal. The shape is rather flat-triangular. Found in transparent part of replacement type fluorite, Thepnithi Mine, Fang.

4. Box-shaped isolated primary fluid inclusion in white layer fluorite. Numerous fractures perpendicular to this layer. Deposit no.2, Chiang Dao.

5. Ruler-shaped primary fluid inclusion (Type 3), in well crystalline green fluorite. The vapour bubble is about 5 % of inclusion volume. Tha Song Yang deposit.

6. Primary angular-shaped fluid inclusion of gaseous type (Type 4) with about 60 % of gas volume. This indicates low-density ore fluid during this stage of fluorite mineralization. The inclusion is trapped in between negative of coarse grains of fluorite. Core sample DDH-12 DH 7, Thai Fluorspar Mine, Ban Hong.

7. primary liquid inclusion (Type 1) . Consists entirely of liquid. Flucrite is brown and zoned, interlayered with blue quartz-fluorite bands. This is typical of inclusions in Pa La Door deposit indicating that this deposit precipitated from aqueous solution. Pa La Door deposit, Tak Province.

PLATE 2

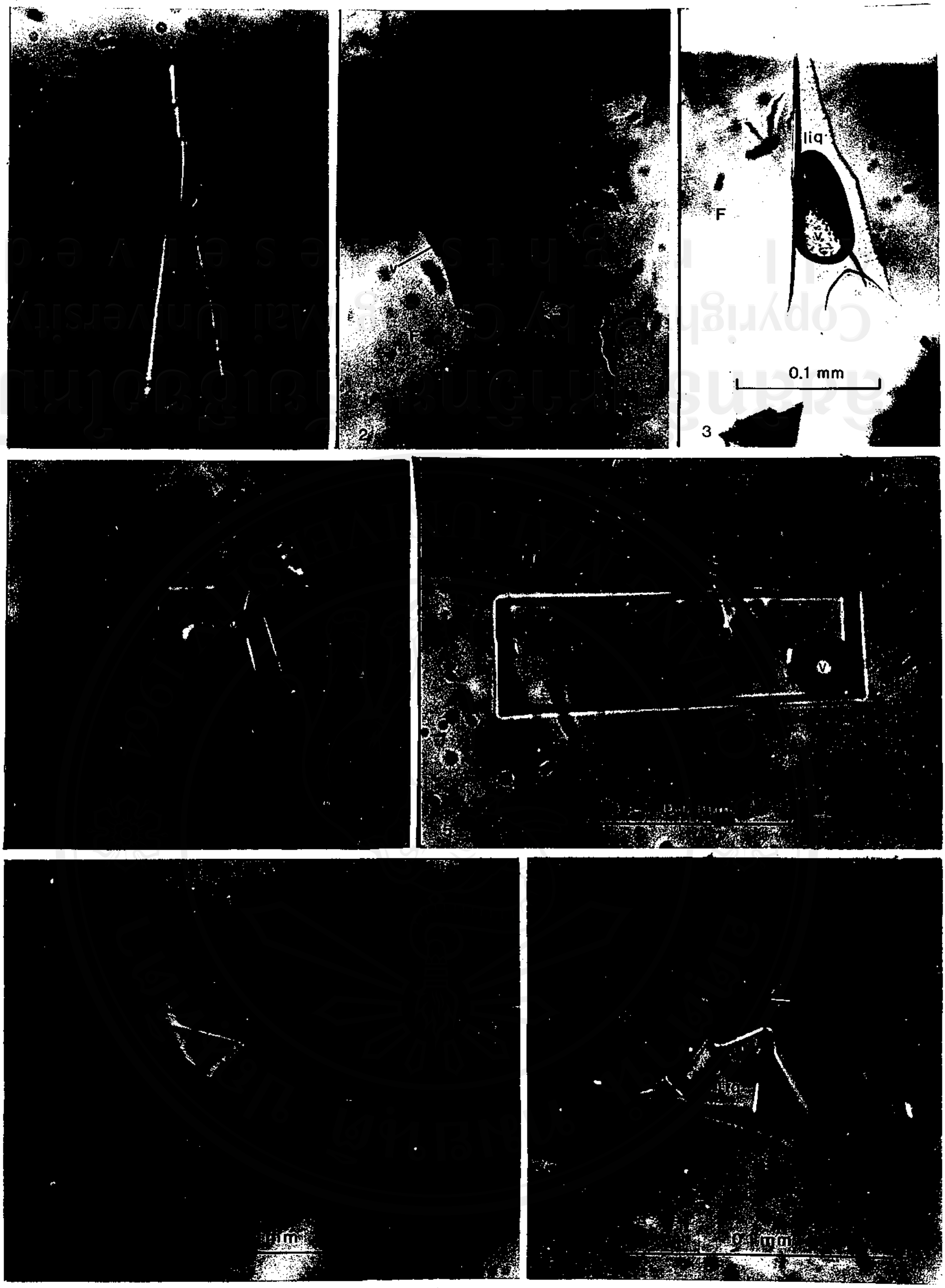


PLATE 3

Photomicrographs of primary and pseudo-secondary **fluid inclusions** in fluorite from Mahalanna Mine, Amphoe Pai. Symbols as for Plate 1 ; and QTZ - quartz ; sFI - secondary fluid inclusions.

1. Large pseudo-secondary fluid inclusion. The inclusion is pseudo-secondary because its shape follows fracture direction and later developed as the negative of the crystal. Note many small blebs of secondary inclusions in the fracture zone. Vein no. AP 5/3.

2. Primary inclusion. Solid inclusion of crystalline quartz was accidentally trapped in the liquid during the stage of mutual fluorite - quartz crystallization. Inclusion contains only liquid. Sample AP 4/3, Vein no. 4.

3. Large primary fluid inclusion of gaseous type (type 4) containing about 80 % gas by volume in crystalline colorless fluorite. The abnormally high gas content of this fluid inclusion is rather unusual in fluorite in Mahalanna Mine.

4. Primary fluid inclusion in pale green fluorite intergrown with quartz. The inclusion is contorted-spherical shaped, with ellipsoidal vapour bubble. This inclusion type is found only in pale green fluorite from Vein no. 3, and might be of organic origin. The shape of this type of inclusion is normally spherical. This inclusion shape was changed during recrystallization of the crystals. Sample AP 3/2, Vein no. 3.

5. Primary fluid inclusions in pale green fluorite. The inclusions are pen-shaped arranged parallel to the clear-transparent pale-colour zoned fluorite interlayered with green fluorite. The phase ratio of a and b are similar.

PLATE 3

PLATE 4

Photomicrographs of primary fluid inclusions of Type 4 (gaseous inclusion) in fluorite from Universal Mine, Mae Tha. Symbols as for Plate 1.

1. Primary gaseous inclusion with about 60 % gas. The irregular shaped inclusion trapped between the granules of fluorite crystals. Core sample DH 2105 at 73 m depth.

2. Primary gaseous inclusion. Inclusion show extremely large gas volume (90 %). This type of fluorite was deposited from very low-density ore solution. Core sample DH 2105 at 73 m depth.

3. Primary gaseous inclusion contains about 50 % gas by volume. The irregular shape is the result of trapping between grains of granular fluorite. Core sample DH 2105 at 83-85 m depth.

4. Primary gaseous inclusion (Type 4) and primary liquid inclusion (Type 1). The strong contrast of phase ratio between two adjacent inclusions indicates a mixing process between two liquids. Core sample DH 2105, 74 m depth.

5. Primary gaseous inclusion. The gas volume is about 30 % of inclusion volume. Sample 'outcrop' O/Y_1.

PLATE 4

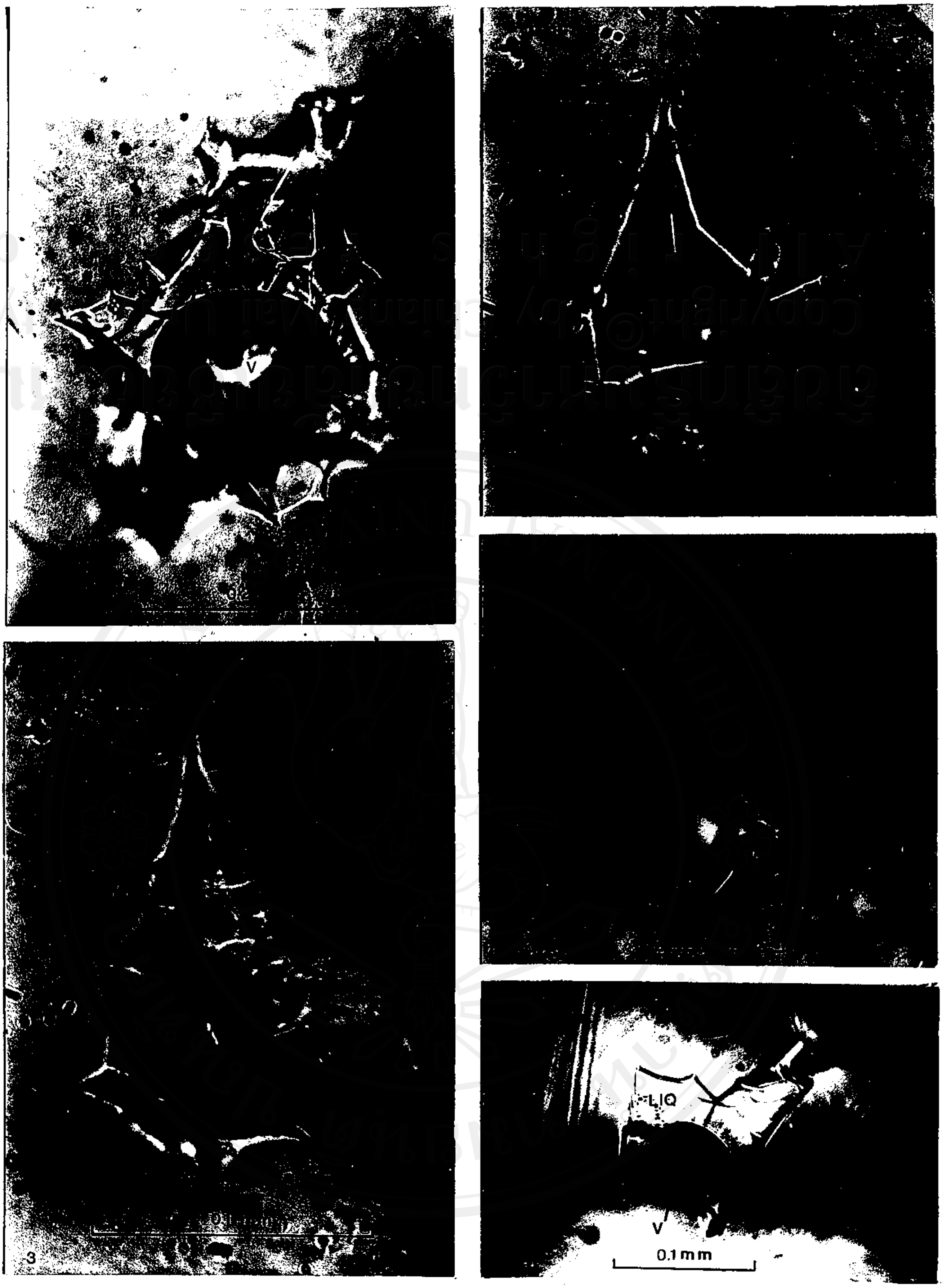


PLATE 5

Photomicrographs of solid and fluid inclusions in fluorite. Symbols as for Plate 1.

1. Solid inclusions (SS). The solid inclusions are grains of decomposed sandstone, the main country rock of the area. The solid inclusions are abundant only in purple inner zones of fluorite cubes. South Pacific Mine, Tha Song Yang.

2. Euhedral prismatic crystal aggregates of stibnite (SB). Sample ' outcrop ' $0/Y_2$, Thepnithi Mine, Mae Tha.

3,4. Calcite solid inclusions (cc) at 83-85 m depth. Core sample DH 2105, and outcrop sample $0/x_1$ respectively, Universal Mine, Mae Tha.

5. Primary fluid inclusions (Type 3). The phase ratio of b is higher than a. Thepnithi Mine, Fang.

6. Prismatic primary fluid inclusion (Type 3). The gas bubble is 16 % of total inclusion volume. The inclusion is aligned parallel to the growing zone of the crystal and is caused by the imperfection during crystallization. In green fluorite in the outer zone of cubic fluorite. South Pacific Mine, Tha Song Yang.

7. Primary fluid inclusion. Rhombohedral-box shape, in well-crystalline pale purple layered fluorite. Ban Muang Ngai deposit, Chiang Dao.

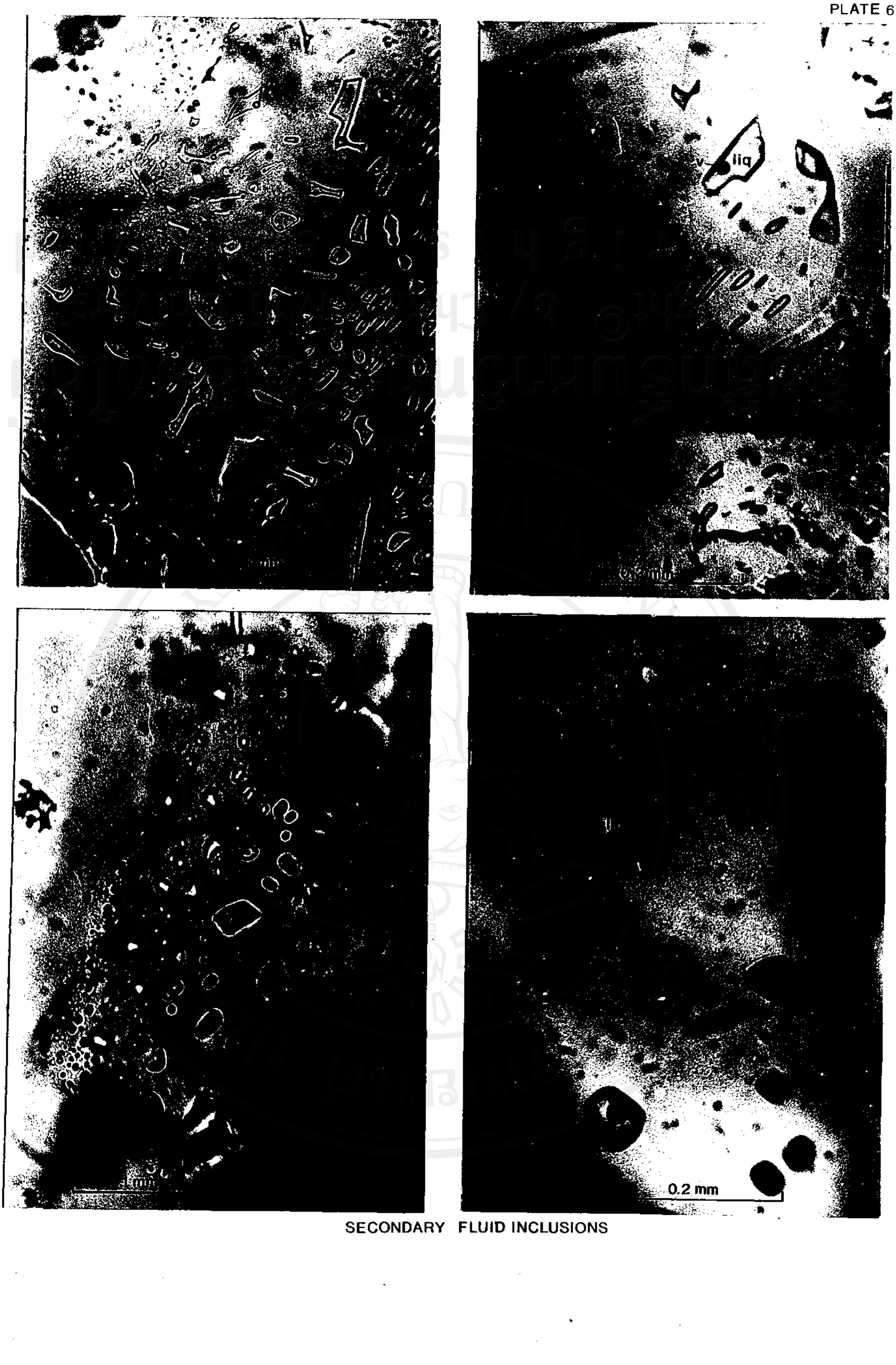
PLATE 5

PLATE 6

Photomicrographs of secondary fluid inclusions in fluorite. Symbols as for Plate 1.

1,2. Uniform phase ratio of secondary inclusions. They homogenized at nearly the same temperature. These inclusions are found in a cleavage plane of green fluorite. The phase ratio of these inclusions is the lowest in this deposit. Shape of inclusions are mainly irregular elongate. South Pacific Mine, Tha Song Yang.

3,4. Uniform phase ratio of secondary inclusions. Found in cleavage planes of sky-blue fluorite. Most inclusions are sub-rounded. The size of inclusions in the group is nearly the same, and differs from that in other cleavage planes, but the phase ratio is constant. This indicates that the necking down process of fluid inclusions occurred before the separation of gas and liquid phases at lower temperature. Ban Sop Lan deposit, Omkoi.



SECONDARY FLUID INCLUSIONS

PLATE 7

Photomicrographs of fluid inclusions in fluorite. Symbols as for Plate 1.

1. Secondary fluid inclusions along cleavage plane of crystalline colorless fluorite. The inclusion shape is very irregular. The inclusions are roughly aligned in the same direction. Vein no. 5. Mahalanna Mine, Amphoe Pai.

2. Pseudo-secondary fluid inclusions along the colour-zoning of deep green fluorite. Note the uniform phase ratio of the inclusions. Inclusions are irregular-elongate, roughly parallel. Ban Sop Lan deposit, Omkoi.

3. Primary fluid inclusions in sky blue fluorite. The section is cut perpendicular to face $\{100\}$. The inclusions are oriented parallel to the crystal faces. Phase ratios of the inclusion (a, and b) are nearly the same. Ban Sop Lan deposit, Omkoi.

4. Fluid inclusions along cleavage plane of sky blue fluorite. The p..ase ratio of inclusions are nearly the same. Ban Sop Lan deposit, Omkoi.

PLATE 7

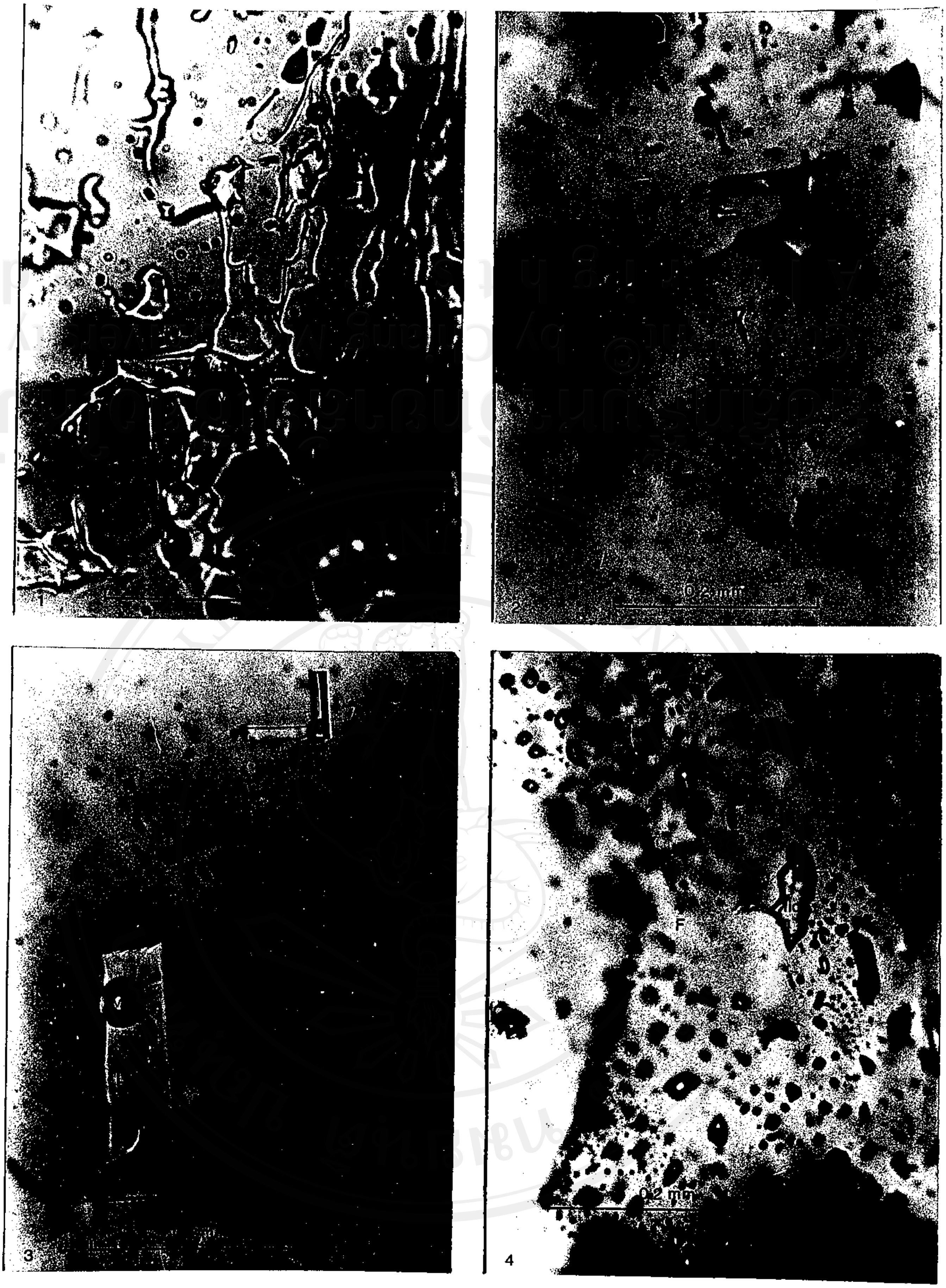


PLATE 8

Photomicrographs of primary fluid inclusions in fluorite. Symbols as in Plate 1.

1. Spherical fluid inclusions. The spherical vapour bubble is in liquid containing hair-like particles. This inclusion might be of organic origin, found typically in pale green fluorite sample AP 3/2 Vein no. 3, Mahalanna Mine.

2,3. Primary fluid inclusions of the same generation as in 1., but different in shape. The spherical shape changing to ellipsoidal in 2. and irregular shaped in 3. is caused by recrystallization.

4. Umbrella-shaped primary fluid inclusion (Type 3). This kind of inclusion is rare, and usually found in open space-filling near rock breccia. Sample 0/9, Universal Mine, Ban Hong.

5. Primary fluid inclusions found in clear-transparent green fluorite. The phase ratios of a and b are nearly the same. The pyramid shape of b is the negative of the crystal. Sample 3/2 Vein no. 3, Mahalanna Mine, Amphoe Pai.

6. Prismatic primary fluid inclusion in colorless fluorite. Sample AP 3/3 Vein no. 3, Mahalanna Mine, Amphoe Pai.

7. Prismatic primary fluid inclusion. This inclusion is aligned parallel to colour layering. Sample AP 5/3, Vein no. 5, Mahalanna Mine.

8. Triangular primary fluid inclusion of Type 4 (gaseous inclusion). The gas phase is about 60 % of total volume. This inclusion homogenized in gas phase in heating experiment. Sample AP 5/3, Vein no. 5, Mahalanna Mine , Amphoe Pai.

9. Necking down of single primary inclusion. The inclusion is nearly separated at the middle. The right hand part contains vapour bubble in liquid while the left hand part contains only liquid. This necking down is evidence of recrystallization of fluorite after cooling. The phase change occur before necking down. Clear-transparent green fluorite from Vein no.3 sample 3/2, Mahalanna Mine, Amphoe Pai.

10. Primary fluid inclusions contain nearly the same phase ratio. The long axis of the pyramidas are aligned in the same direction. Colorless fluorite sample AP 3/2 Vein no. 3, Mahalanna Mine, Amphoe Pai.

PLATE 8

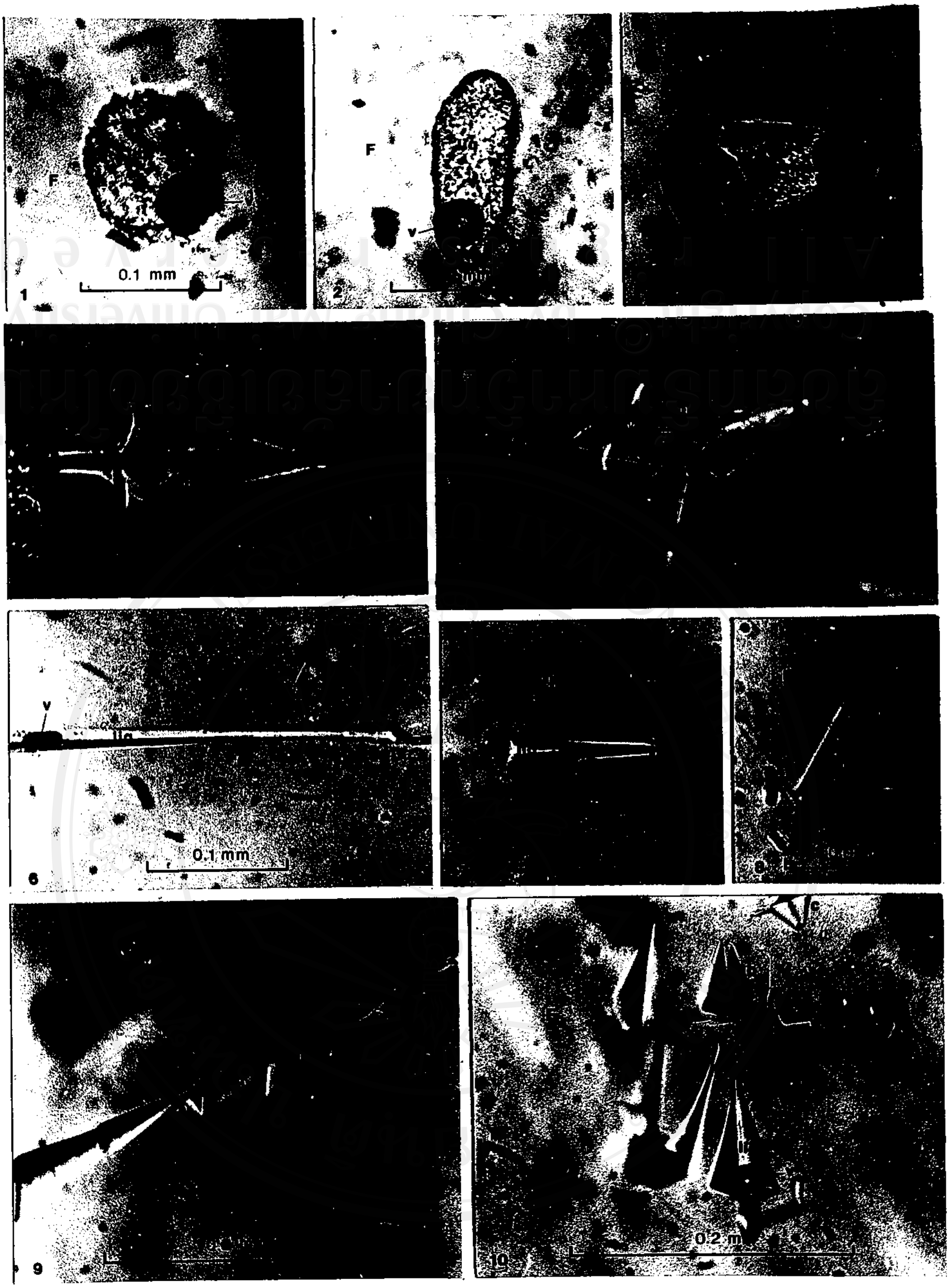


PLATE 9

Photomicrographs of primary fluid inclusions in fluorite. Symbols as in Plate 1.

1. Primary fluid inclusion (Type 3). Found in coarse-grained crystalline fluorite near the replacement fluorite. The inclusion shape is the negative of the crystal. Sample O/10, Thepnithi Mine, Fang.

2. Primary fluid inclusion. Wedge shaped inclusion in fluorite near replaced-rock breccia. The shape is negative of the crystals. Sample TDH 15 at 9.5 m depth, Thepnithi Mine, Fang.

3. Rectangular-shaped primary fluid inclusion in dark brown layered fluorite, SR Mine, Mae La Noi.

4,5,6. Primary fluid inclusions of Type 4 (more than 50 % gas by volume). Inclusion in (4) contains about 80 % gas ; inclusion in (6) contain about 90 % gas ; and inclusions in (5) contains extremely high phase ratio about 95 % gas. The inclusion shapes are irregular, as a result of trapping between grains of granular fluorite. These inclusions are usually found near rock breccia. Core sample DDH 2105 at 73 m depth, Universal Mine, Mae Tha.

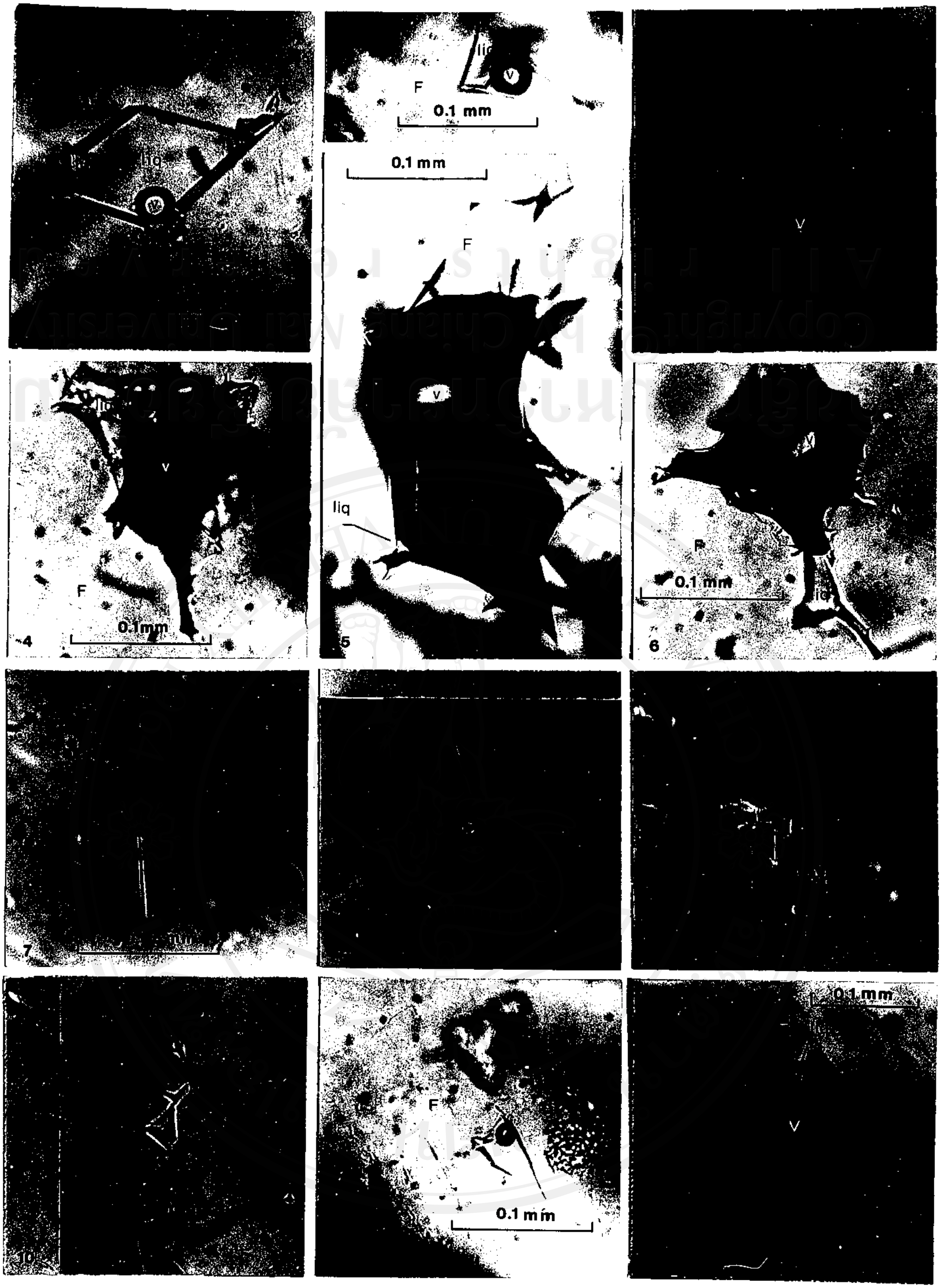
7. Prismatic primary inclusions (Type 2) oriented parallel to the the length of radiated-prismatic aggregate crystals. Sample F 0/4, Thepnithi Mine, Mae Tha.

8,9. Primary fluid inclusions in botryoidal fluorite, The inclusions are irregular shaped, very small and isolated. The gas bubble is very small in (8), and can not be seen in (9). Sample BH (TFM) 0/1, 0/5 respectively, Thai Fluorspar Mine.

10. Primary fluid inclusion found in fine grained crystalline fluorite. This type of inclusion is the most common. Sample F 0/3, Thepnithi Mine, Fang.

11. Primary fluid inclusion of Type 3. The vapour bubble is rather large, compared with other of Type 3. This type of inclusion is usually found near rock nuclei. Sample BH (U) 0/8, Universal Mine, Ban Hong.

12. Primary gaseous inclusion found in open-space filling close to rock breccia. Drill core DDH 3, 74 m depth. Thai Fluorspar Mine, Ban Hong.



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F
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PLATE 10

Photomicrographs of primary fluid inclusions in fluorite. Symbols as in Plate 1.

1. Zone of primary fluid inclusions. The zone is about 0.5 mm wide, parallel to the concentric layering of fluorite around rock breccia. Out of the layer, inclusions are very rare. The zone of inclusions is in the part with better degree of crystallization. Most are gas-liquid inclusions of low phase ratio. Sample TDH 9, 7.2 m depth, Thepnithi Mine, Fang.

2. Abnormally gas-rich inclusion. This type of inclusion is irregular in shape and concentrated in certain parts of the deposit. Sample DDH 12 - DH 7, Thai Fluorspar Mine, Ban Hong.

3. Zone of primary fluid inclusions. The zone is 0.32 mm wide, parallel to concentric layers of fluorite around rock nuclei. Inclusions are mostly gas-liquid (Types 1,2,3). The inclusions are primary in origin as they are related to the original layered structure of deposition. Sample BH (U) 0/1, Universal Mine, Ban Hong.

4. Primary gaseous inclusions (Type 4). Inclusions a and b are found near rock breccia (lower left). They are typical of fluid inclusions in fluorite near rock breccia. Sample TDH 15, 9.5 m depth, Thepnithi Mine, Fang.

PLATE 10

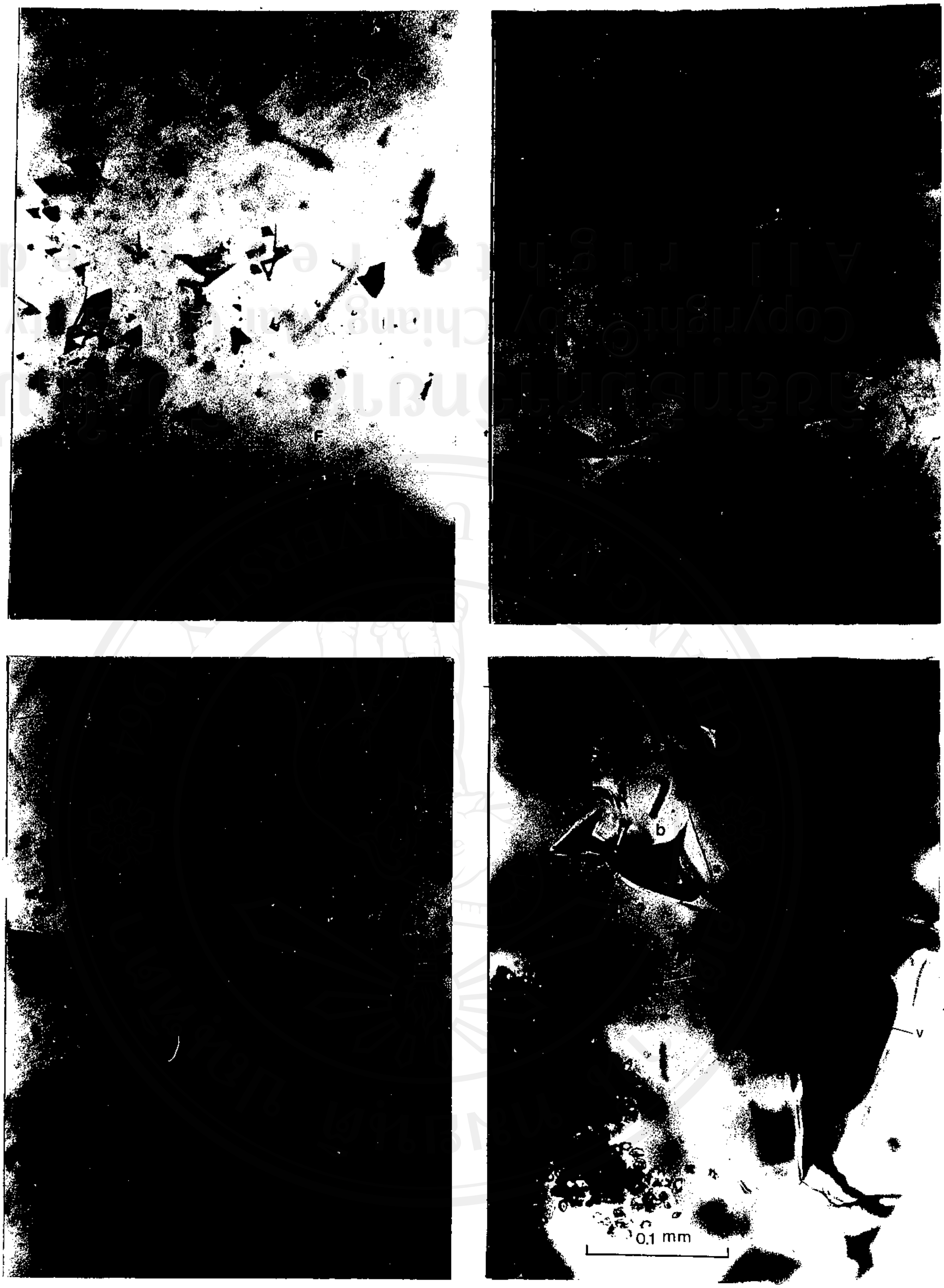


PLATE 11

Photomicrographs of primary fluid inclusions in fluorite. Symbols as in Plate 1.

1. Type 3 inclusion. Found in zone of purple fluorite near zone of green fluorite. Sample AP 4/1, Vein no. 4, Amphoe Pai. This inclusion is believed to be pseudo-secondary, related to fracture parallel to the zone of colour.

2. Type 3 inclusion, prismatic in shape. South Pacific Mine Tha Song Yang.

3. Type 3 inclusion. Sample AP 5/4, Vein no. 5, Mahalanna Mine.

4. Type 3 inclusion in pale-purple layered fluorite. The rectangular-box shape of the inclusion is the negative of crystalline fluorite. Universal Mining Co.'s property near Amphoe Pai.

5. Type 4 gaseous inclusion in fluorite interlayered with quartz. The shape of inclusion is the result of trapping between crystal grains. This type of inclusion is typical of fluorite intergrown with quartz in Mahalanna Mine.

6. Type 3 inclusion found in colorless layer interlayered with green fluorite. The inclusions is more abundant in colorless than in green fluorite.

7. Type 3 inclusion near the fracture zone in clear transparent green fluorite. Vein no. 3, Mahalanna Mine, Amphoe Pai.

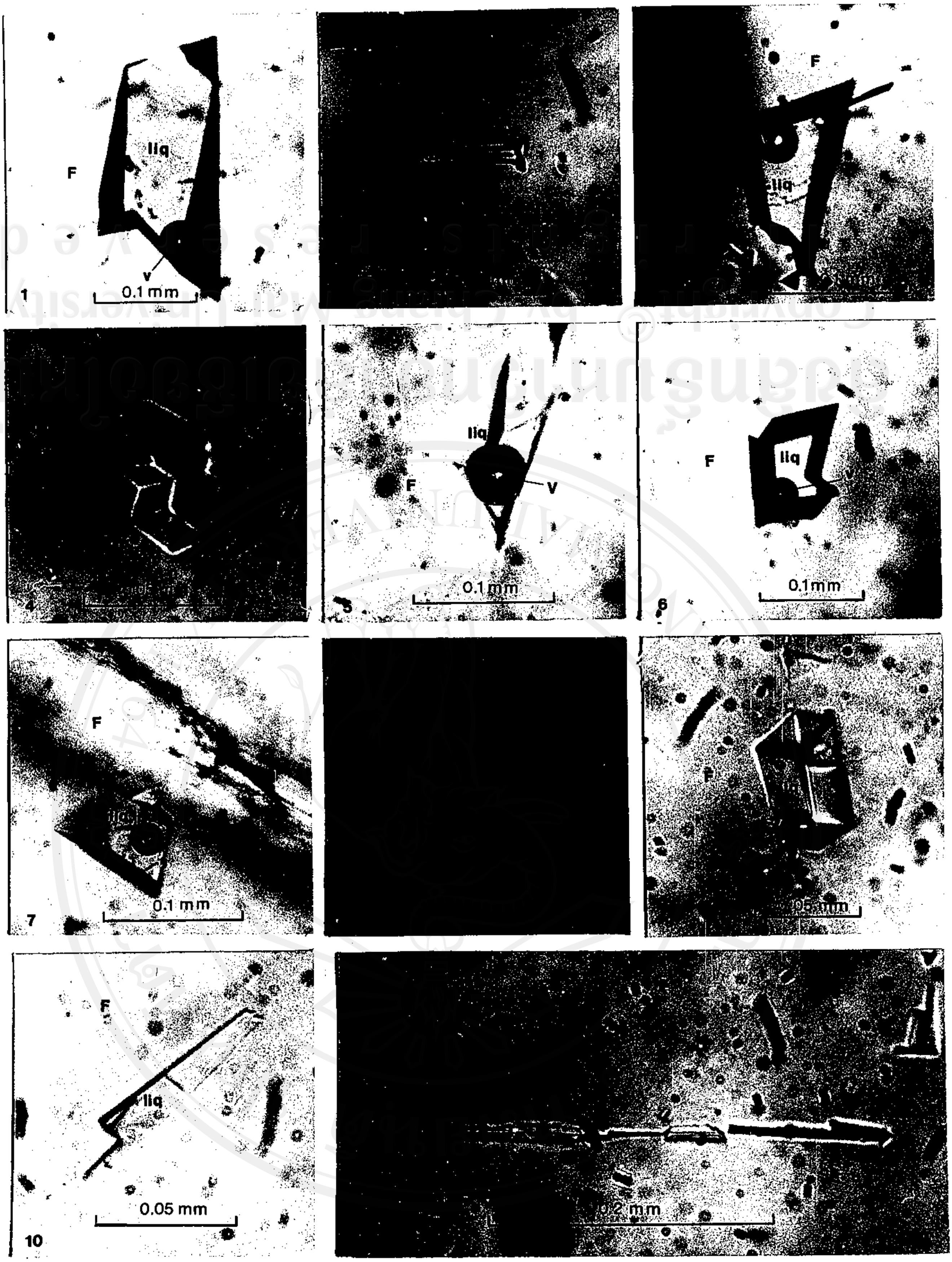
8. Type 3 inclusion in colorless fluorite near brown and black rock breccia. Thepnithi Mine, Fang.

9. Type 3 inclusion, rectangular - box shaped. From zone of inclusions parallel to layers in fluorite. Universal Mining Co.'s property, Amphoe Pai.

10. Type 1 liquid inclusion, prismatic knife-shape. The inclusion contains only the liquid phase, the only type found at the center of concentric-globular aggregate of very deep purple fluorite. Typical of Chom Thong fluorite.

11. Type 2 prismatic inclusion. It shows tendency to be necked down into separate parts. Sample AP 5/5, Vein no. 5 Mahalanna Mine, Amphoe Pai.

PLATE 11



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F
liq
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10
0.2 mm

PLATE 12

Photomicrographs of fluid inclusions in fluorite. Symbols as in Plate 1.

1. Primary fluid inclusions (Type 3) in pale green fluorite. Aligned parallel to colour layers. Sample AP 3/2, Vein no. 3, Mahalanna Mine, Amphoe Pai.
2. Pseudo-secondary fluid inclusion. The inclusion is near and parallel to a fracture zone. Sample AP 4/2, Vein no. 4, Mahalanna Mine, Amphoe Pai.
3. Primary liquid inclusion (Type 1). Core sample DDH 13, at 15 m depth, Thai Fluorspar Mine, Ban Hong.
4. Uniformity of phase ratio between Type 3 inclusions. Sample AP 3/5, Vein no. 3, Mahalanna Mine.
5. Primary fluid inclusions (Type 3) in colorless fluorite. Sample AP 3/3, Vein no. 3, Mahalanna Mine, Amphoe Pai.
6. Fluid inclusions of different phase ratios. Inclusion a is of Type 3, while inclusion b is of Type 1. Both a and b lie perpendicular to the fracture. Mahalanna Mine, Amphoe Pai.
7. Primary gaseous inclusion (Type 4) contains about 60 % gas by volume. This type of inclusion is rare in Mahalanna Mine. Fluorite associated with cryptocrystalline quartz. Sample 2 " Old Vein " near the river.

8. Primary fluid inclusions (Type 3) in green zone in fluorite. Inclusions a, b, and c have similar shape and uniform phase ratio, and are aligned perpendicular to the green zone. Sample AP 4/1, Vein no. 4, Mahalanna Mine, Amphoe Pai.

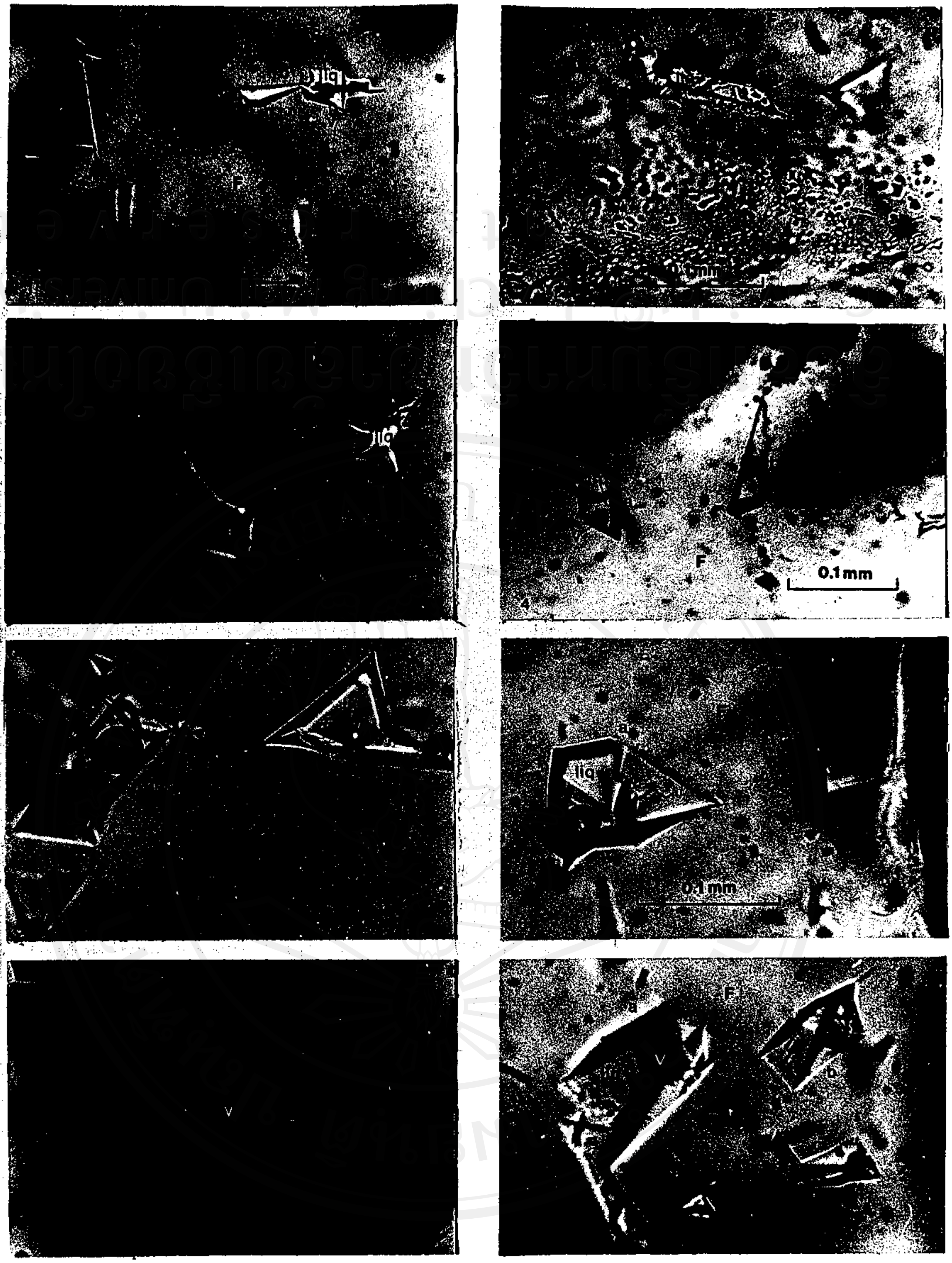
0.1 mm
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PLATE 13

Serial photomicrographs of inclusions in fluorite to show homogenization with increasing temperature. Taken on heating stage. symbols as for Plate 1.

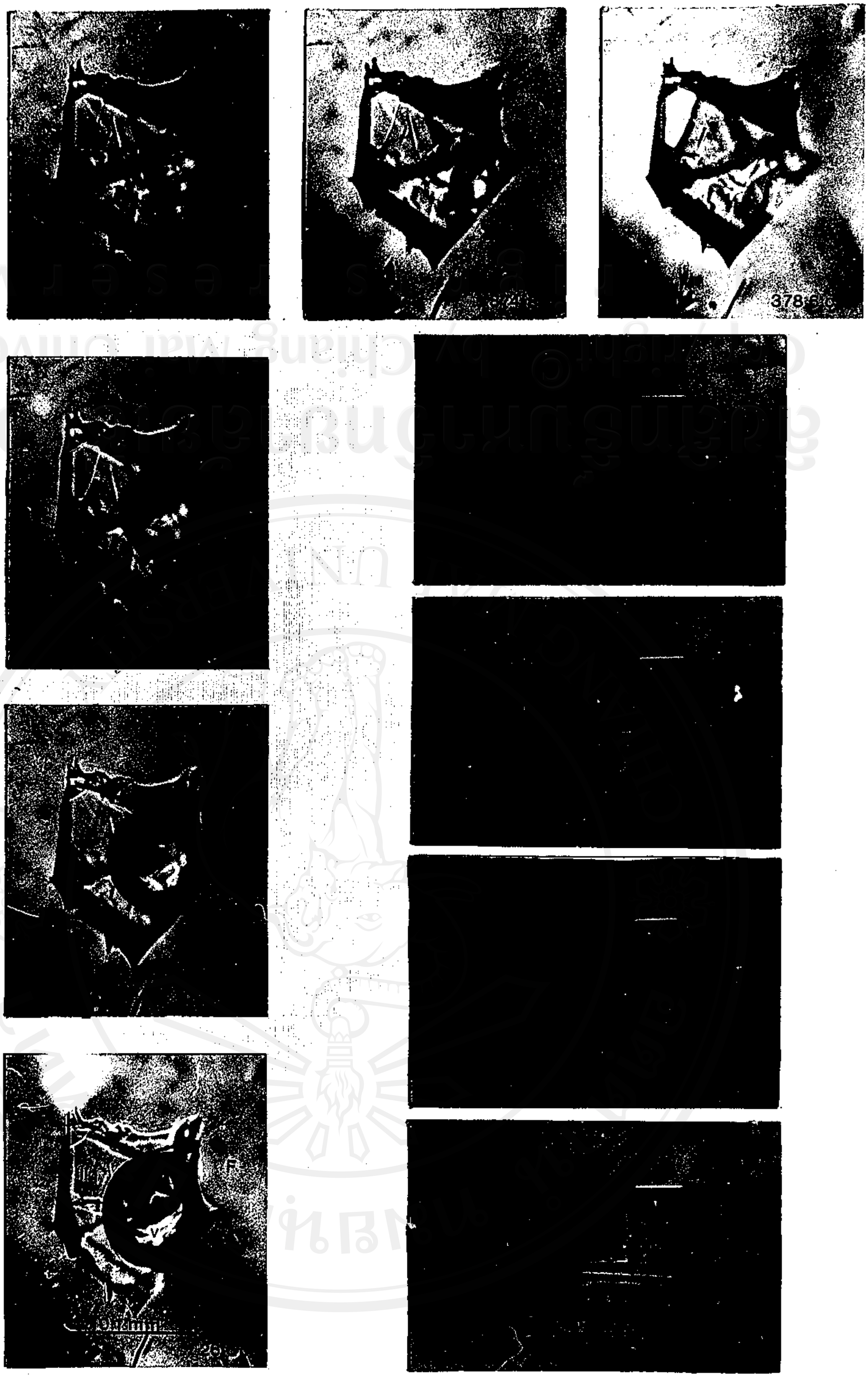
Left hand series.

Primary gaseous inclusion with about 60 % gas volume at room temperature. Vapour bubble decreased in size and inclusion finally homogenized in liquid phase at 378.6° c. Drill core 2105, sample at 73 m depth, Universal Mine, Mae Tha.

Right hand series.

Primary fluid inclusion (Type 3). Vapour bubble decreased in size, and inclusion finally homogenized in liquid phase at 139.8° c. Green fluorite sample TSY 4, South Pacific Mine, Tha Song Yang.

PLATE 13



PHASE CHANGES ON HEATING

PLATE 14

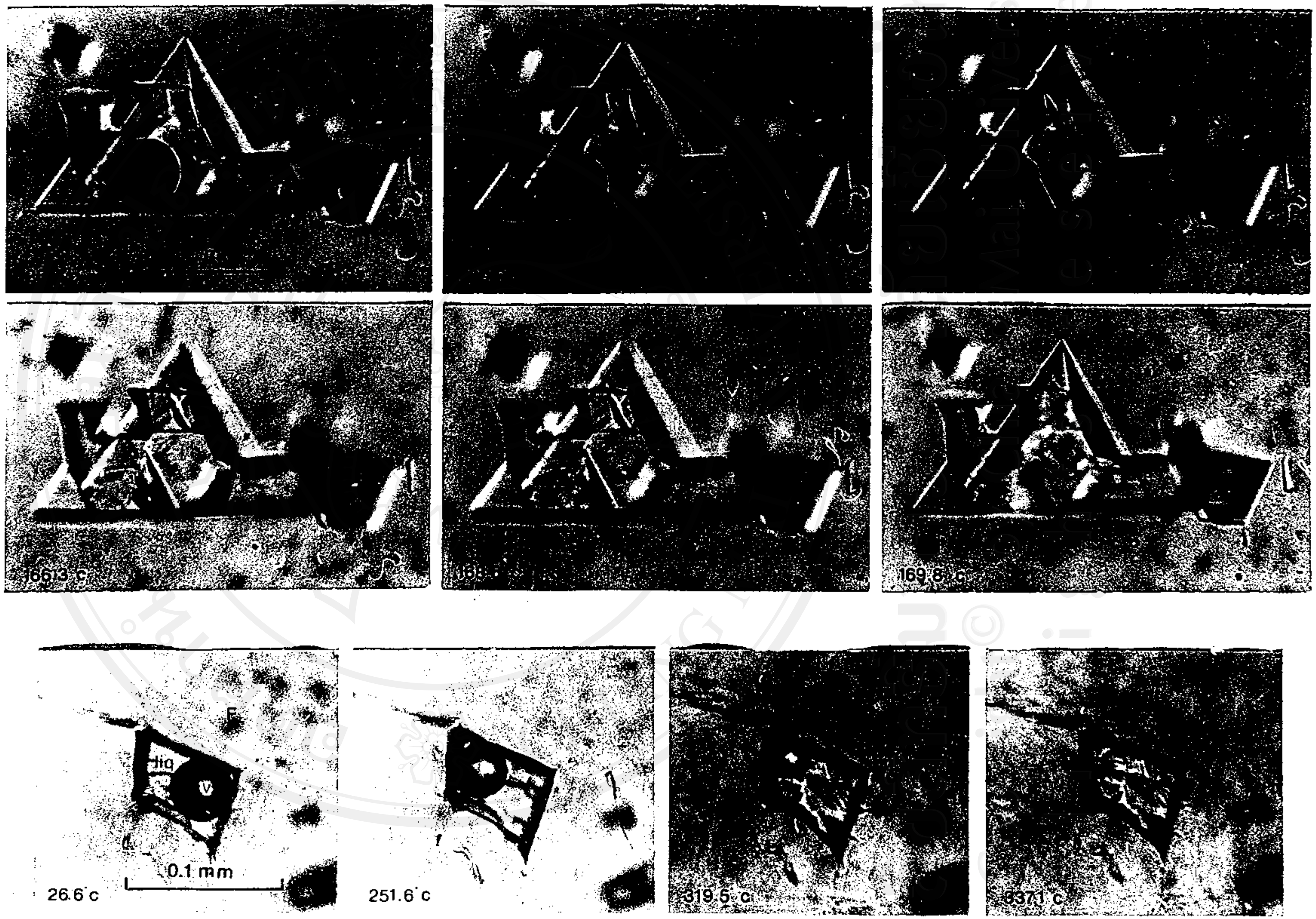
Serial photomicrographs of inclusions in fluorite to show homogenization with increasing temperature. Taken on heating stage. Symbols as for Plate 1.

Top series.

Type 3 inclusion, homogenized at 169.8 °c in liquid phase. Colorless fluorite, Sample AP 3/3, Vein no. 3, Mahalanna Mine, Amphoe Pai.

Bottom series.

Primary gaseous inclusion (Type 4) with more than 50 % gas by volume at room temperature (26.6 °c). Phase ratio decreased continuously on heating and inclusion homogenized at 337.1 °c in liquid phase. Mahalanna Mine, Amphoe Pai.



PHASE CHANGES ON HEATING

PLATE 14

PLATE 15

Serial photomicrographs of inclusions in fluorite to show homogenization with increasing temperature. Taken on heating stage. Symbols as in Plate 1.

Left hand series

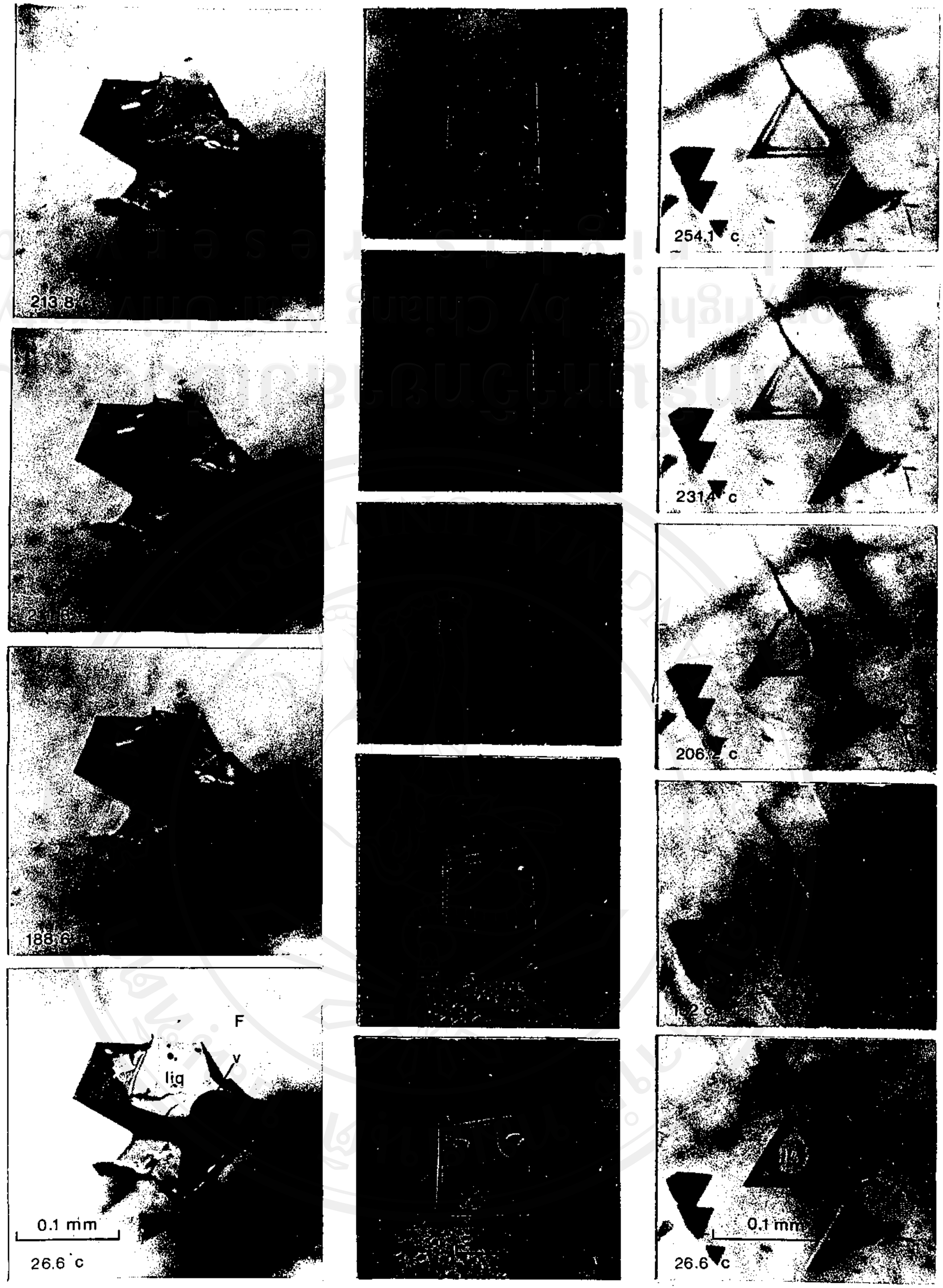
Type 3 primary fluid inclusion. Phase ratio decreased on heating, and inclusion finally homogenized in original liquid phase at 213.8° c. Universal Mine, Mae Tha.

Middle series

Type 3 primary fluid inclusion. Phase ratio decreased on continuous heating, and inclusion finally homogenized in original liquid phase at 164.8° c. South Pacific Mine, Tha Song Yang.

Right hand series.

Type 4 primary fluid inclusion with high phase ratio ($\approx$ 60 % gas) at room temperature. Phase ratio increased on heating and inclusion finally homogenized in gas phase at 254.1° c. Mahalanna Mine, Amphoe Pai.



PHASE CHANGES ON HEATING

PLATE 16

Serial photomicrographs of inclusions in fluorite to show homogenization with increasing temperature. Taken on heating stage. Symbols as in Plate 1.

Top series

Type 3 primary fluid inclusion. Phase ratio decreased at higher temperature and inclusion finally homogenized in liquid phase at 150.7°c. Pale green fluorite sample AP 3/2, Vein no. 3, Mahalanna Mine, Amphoe Pai.

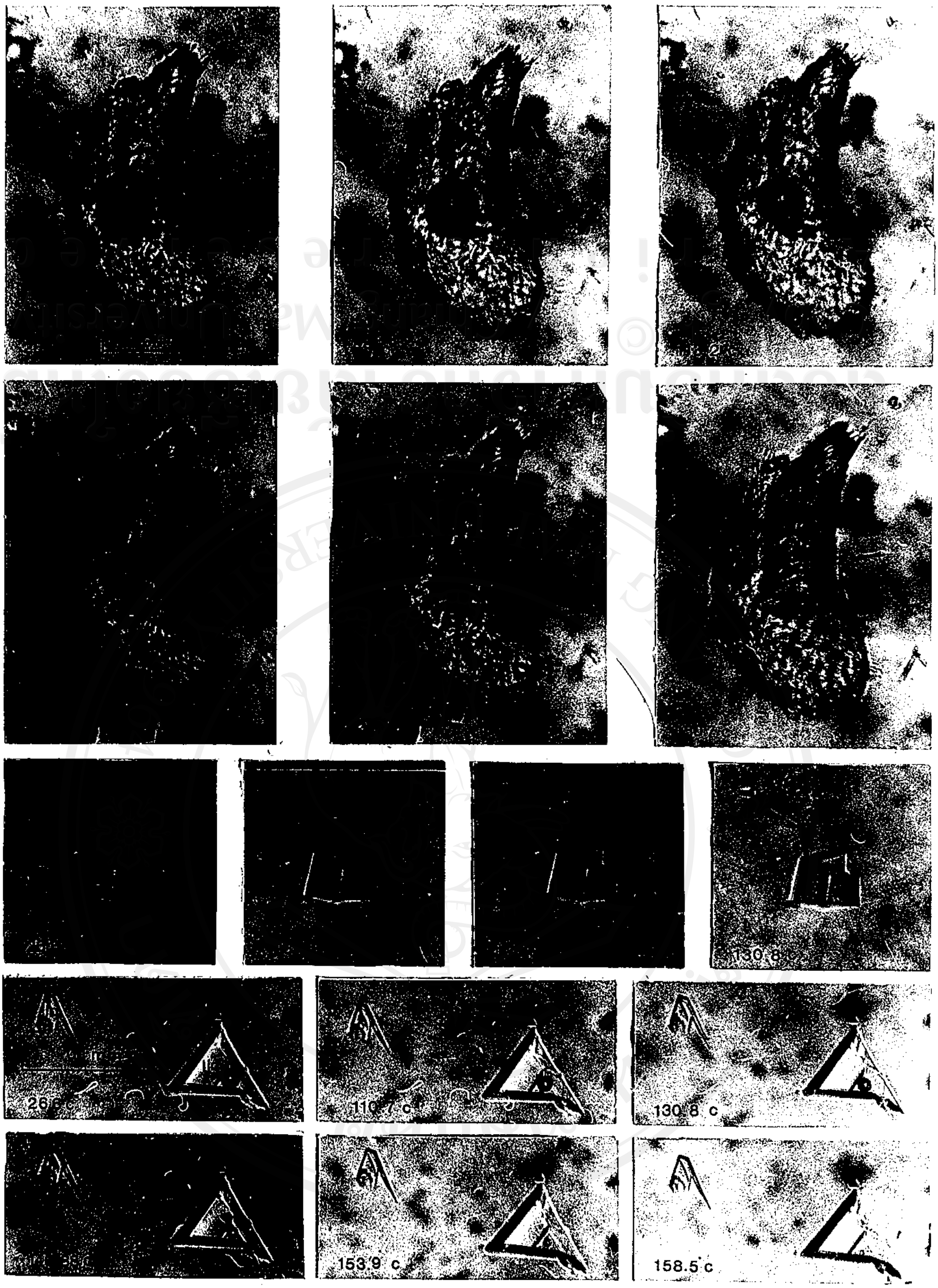
Middle series

Type 3 primary fluid inclusion. Phase ratio decreased on heating, and inclusion finally homogenized in liquid phase at 130.8°c. Clear-transparent purple fluorite from sample MT (U) $0/X_3$, Universal Mine, Mae Tha.

Bottom series

Type 3 primary fluid inclusions. Phase ratio decreased at higher temperature and inclusions finally homogenized in liquid phase at 153.9°c, and 158.5°c, respectively. Colorless fluorite from sample no. AP 3/4, Vein no. 3, Mahalanna Mine, Amphoe Pai.

PLATE 16



PHASE CHANGES ON HEATING

PLATE 17

Varieties of fluorite in hand specimen

1. Fluorite crystals, some as small cubes, coating prismatic stibnite crystals. Thepnithi Mine, Mae Tha, Lamphun.

2. Botryoidal fluorite. The botryoidal nodules are 2-5 cm diameter. Note the vuggy replacement fluorite inside the nodules (right and top left).

3. Coarse grained crystalline fluorite showing good cleavage. Mahalanna Mine, Amphoe Pai.

4. Globular radiated crystal aggregates of fluorite. The coloured layers of fluorite form rings around the rock nucleus. Mae Rid, Amphoe Mae Sariang, Mae Hong Son.

PLATE 17

1

3

PLATE 18

Varieties of fluorite in hand specimen.

1. Coloured-layered crystalline fluorite. The colours are colorless, pale green, and violet. Mahalanna Mine, Amphoe Pai.

2. Botryoidal fluorite. This honey-brown botryoidal fluorite with replaced rock nucleus inside is typical of the upper part of the fluorite vein at Thai Fluorspar Mine, Ban Hong.

3. Vuggy fluorite core. Universal Mine, Mae Tha.

4. Fluorite associated with stibnite. Fluorite replaced rock and formed the younger layered part near the vug, where it is associated with stibnite. Thepnithi Mine, Mae Tha.

5. Fluorite replaced limestone. The grain size, colour, and original texture of the limestone are still preserved, but the rock is now changed into fluorite by replacement, and more brittle. SP. mine, Mae La Noi.

PLATE 18

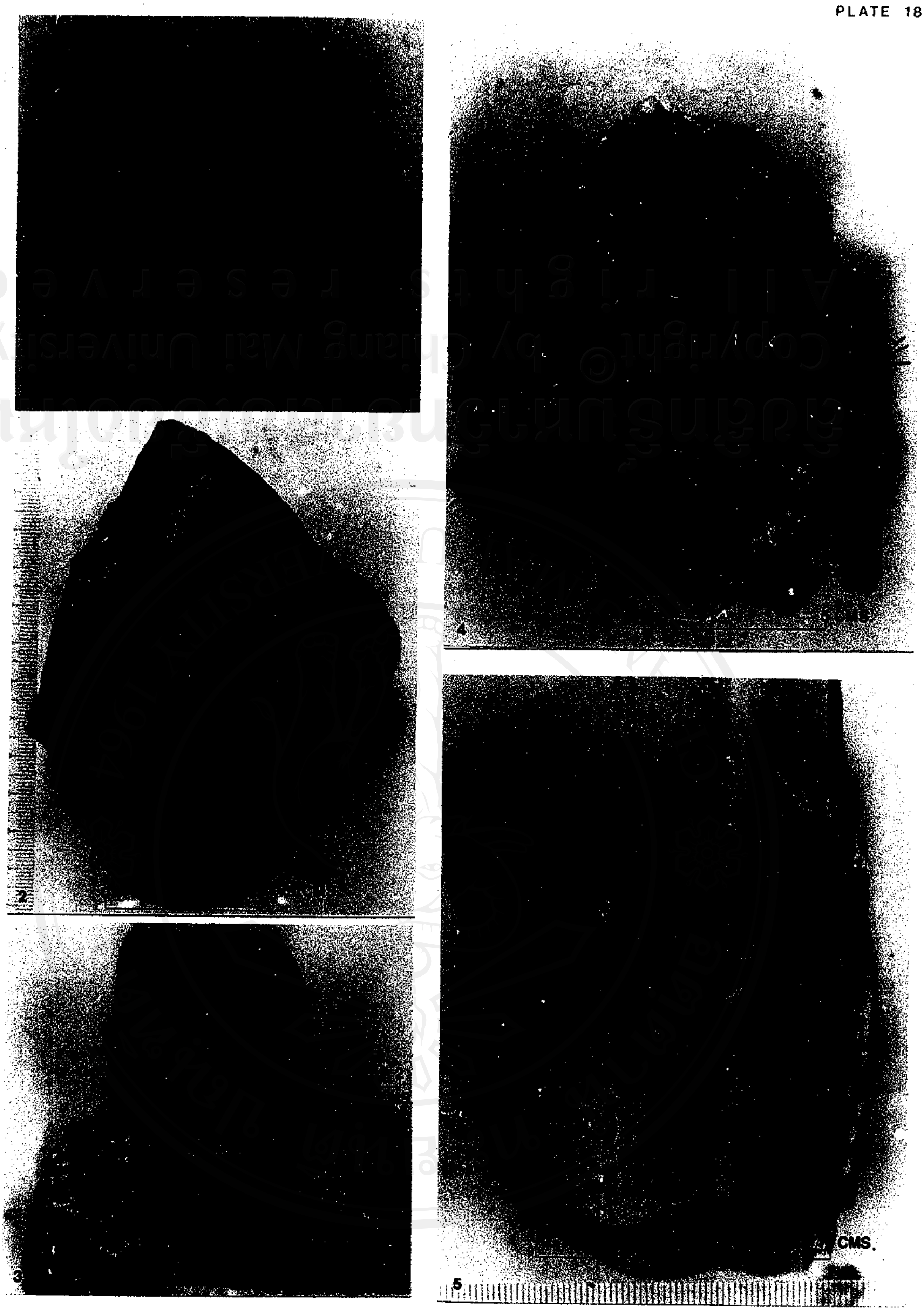


PLATE 19

Fluorite and gangues in fluorite deposits

1. Calcite crystals in vug of limestone. Diamond-drilled core, Universal Mine, Mae Tha.

2. Fluorite cubes associated with cryptocrystalline quartz. Stibnite-fluorite deposit, South Pacific Mine, Tha Song Yang.

3. Botryoidal fluorite showing different colours of concentric layering surrounding rock nucleus. Thin polished section, Thai Fluorspar Mine, Ban Hong.

4. Stibiconite pseudomorphs after stibnite, as oxidation product. Stibnite still remains in inner part of the prismatic crystals. Stibnite-fluorite deposit, South Pacific Mine, Tha Song Yang.

5. Layered fluorite. The pale brown fluorite layer is between layers of replaced rocks. SP Mine, Mae La Noi.

6. Fluorite breccia. Breccia of fluorite which replaced and surrounded rocks, interstices filled by yellow cryptocrystalline quartz. 'Low grade' ore from Universal Mine, Mae Tha.

7. Fluorite-replaced rock (dark portion). Fluorite later formed concentric layers around replaced rock (grey portion), with coarse crystalline layered fluorite adjacent (pale portion). Ban Muang Ngai deposit, Chiang Dao.

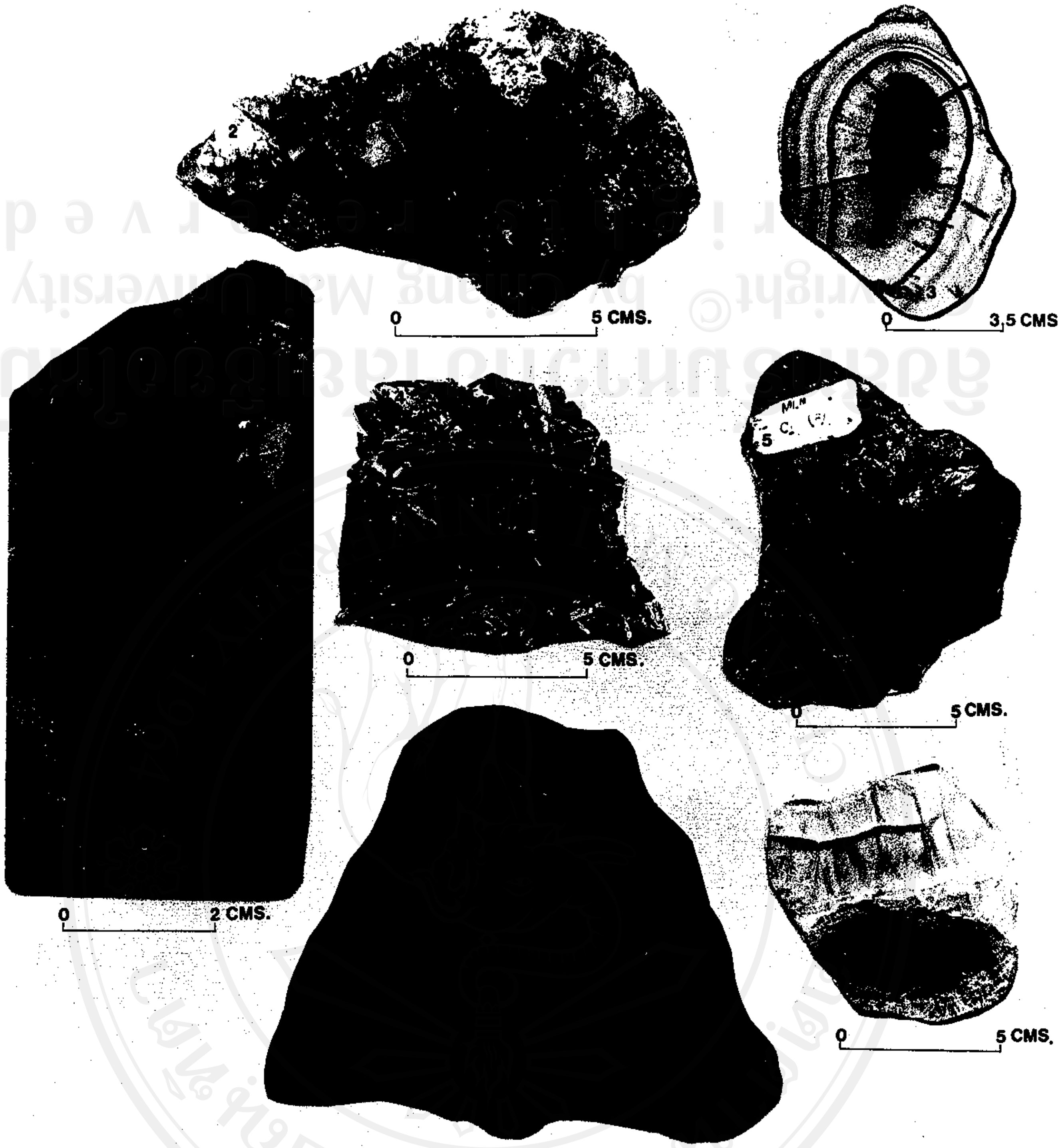


PLATE 19

FLUORITE AND GANGUES IN FLUORITE DEPOSITS

PLATE 20

Fossils in limestone from Universal Mine, Mae Tha, Lamphun.

1. unidentified fossil

2. Parafusulina sp.

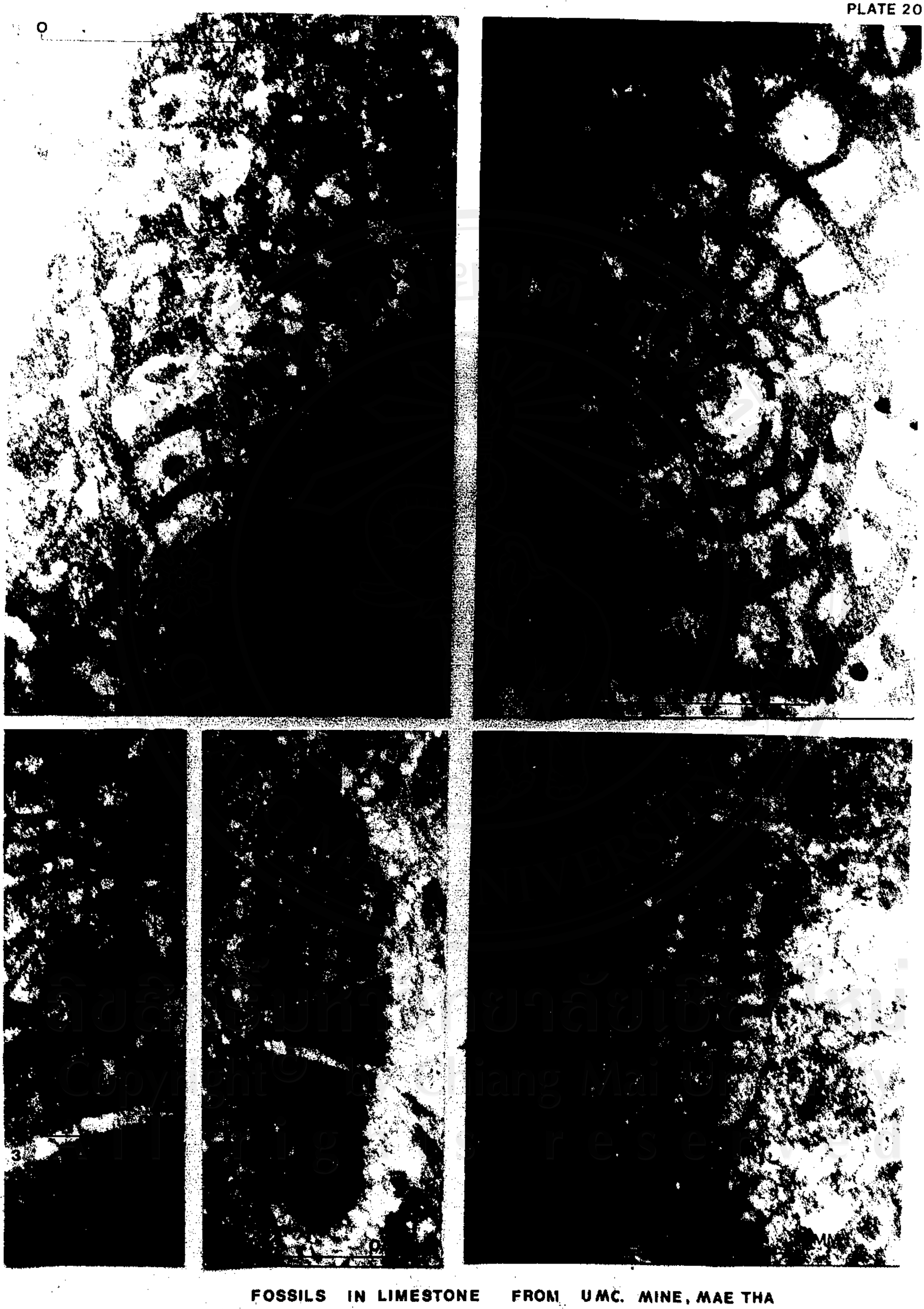
3. Neofusulina? sp.

4. Neoschwagerina sp.

5. Cribogenerina cf. sumatrana (Volz)

(Identified by R. Ingavat, 1978).

PLATE 20



FOSSILS IN LIMESTONE FROM UMC. MINE, MAE THA