The analytical values and norm component values are shown in Appendix 12.

According to Fig.30, the results obtained from the granite and granite porphyry are in the extremely narrow range of SiO_2=70 to 75% and no major difference is seen for any of the other elements.

The range is narrow, but a reduction of TiO_2, Fe_2O_3, FeO, MgO, CaO and K_2O accompanying differentiation is seen as well as a tendency for increased MnO and Na_2O.

In the QPA diagram in Fig.31, all the granite is classified into granite in a narrow sense. Furthermore, in the ACF diagram, although some of the samples are plotted as I-type, overall they are classified as S-type. In the MFA diagram, the differentiation trend of the granite conforms closely to that of island arc calc-alkali rock series.

3-5 Mineral Deposits and Occurrences

The location of mineral occurrences in the Ratchaburi area is shown in Fig.34.

Tin was long excavated in the Ratchaburi area and in addition to secondary placer deposits, there were primary tin deposits with pegmatite, greisen, etc. In the late 1980s deposits were found in about 40 places. Today all the mines have closed and pegmatite feldspar is mined in only one place.

As for the tin mining zone along the Thai-Myanmar border region which includes the Ratchaburi area, there is not only a clear concentration of high values for tin, but the region was also well known for gold.

Mineralization of tin and gold in the Ratchaburi area is limited to the boundary between granite and meta-sedimentary rock. Tin produces pegmatite and greisen which develop within the boundary of the granite bodies, and quartz veins in the granite and sedimentary rock, but the origin of gold is still not clear.

In this survey, no clear quartz veins were found in the granite, but quartz veins of between about several to less than 20cm are prolific in the sedimentary rock around the granite. No hydrothermal alteration is present around the quartz veins. The analytical values of the quartz veins in various parts of the survey area from which samples were taken is shown in Table 9.

3-6 Geochemical Prospecting

3-6-1 Sample collecting and pathfinder elements

Sampling was carried out in the Ratchaburi area in the same way as in the previous two areas.

However, as old secondary tin mines are distributed in many places along the main river in the area and there were fears of geochemical pollution, as far as possible samples were collected away from the remains of secondary deposits. 530 samples were taken. The locations where the samples were taken are shown in PL-19 together with the locations of samples collected by panning and the

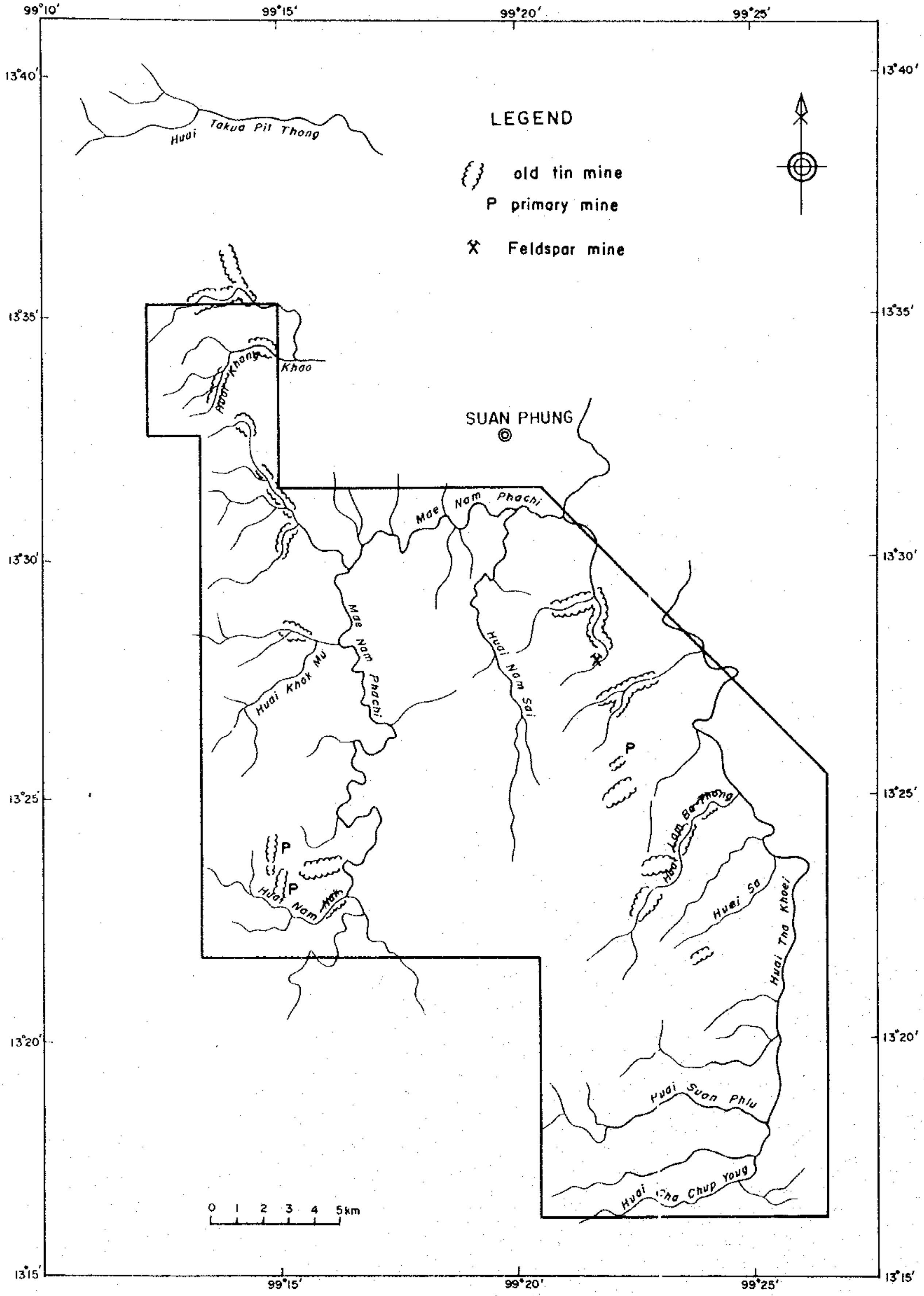


Fig.34 Location map of mineral occurrence in Ratchaburi area

locations of rock samples.

The Ratchaburi area has long been a tin deposit region and deposits of tin accompanied by unexplored niobium, tantalum and tungsten, can also be expected. 15 elements were taken as pathfinder elements: Au, Ag, Cu, Pb, Zn, Hg, As, Fe, S, W, Sn, Sb, F, Ta and Nb.

3-6-2 Analysis of data

1. Processing of statistics

As with the Chiang Khong and Doi Chong areas, statistical processing was carried out using logarithm values. For reasons of statistical processing, half of the analytical values below the minimum detection limit values were used.

Also, as the values of the Sn samples exceeded the upper limit analytical values, twice the upper limit values were taken as the component values. The maximum value, minimum value, mean value and standard deviation for each element are shown in Table 12.

The frequency distribution for each element and the cumulative frequency curve map are shown in Fig.35.

Table 12 Basic statistic quantities of stream sediments in Ratchaburi area

元素名	単位	検出限界値	最大値	最小値	平均値	対数標準偏差
Au	ppb	1	146	< 1	0.65	0.3294
Ag	ppm	0.2	0.4	<0.2	0.11	0.0888
Cu	ppm	1	38	< 1	3.08	0.3685
Pb	ppm	2	158	< 2	12.66	0.2753
Zn	ppm	2	162	< 2	20.67	0.2979
Hg	ppb	10	5000	< 10	11.11	0.2055
As	ppm	2	522	< 2	6.36	0.6251
Fe	%	0.01	2.83	0.07	0.53	0.3087
S	%	0.01	0.16	<0.01	0.007	0.1974
W	ppm	10	670	< 10	7.67	0.3411
Sn	ppm	2	>1000	< 2	86.9	0.8307
Sb	ppm	2	4	< 2	1.07	0.0933
F	ppm	20	>10000	70	349.56	0.2917
Ta	ppm	1	2080	< 1	15.83	0.7417
Nb	ppm	2	1645	< 2	49.77	0.4829

The correlation coefficients for each element are shown in Table 13.

A strong positive correlation is seen between the Sn, Ta, Nb, F and W group and the Cu, Pb, Zn, Fe, As group. On the other hand, no correlation is seen by Au, Ag, Hs and S to other elements.

2. Deciding the Thresholds

As in the Chiang Khong area, the mean values and standard deviation are taken as the main

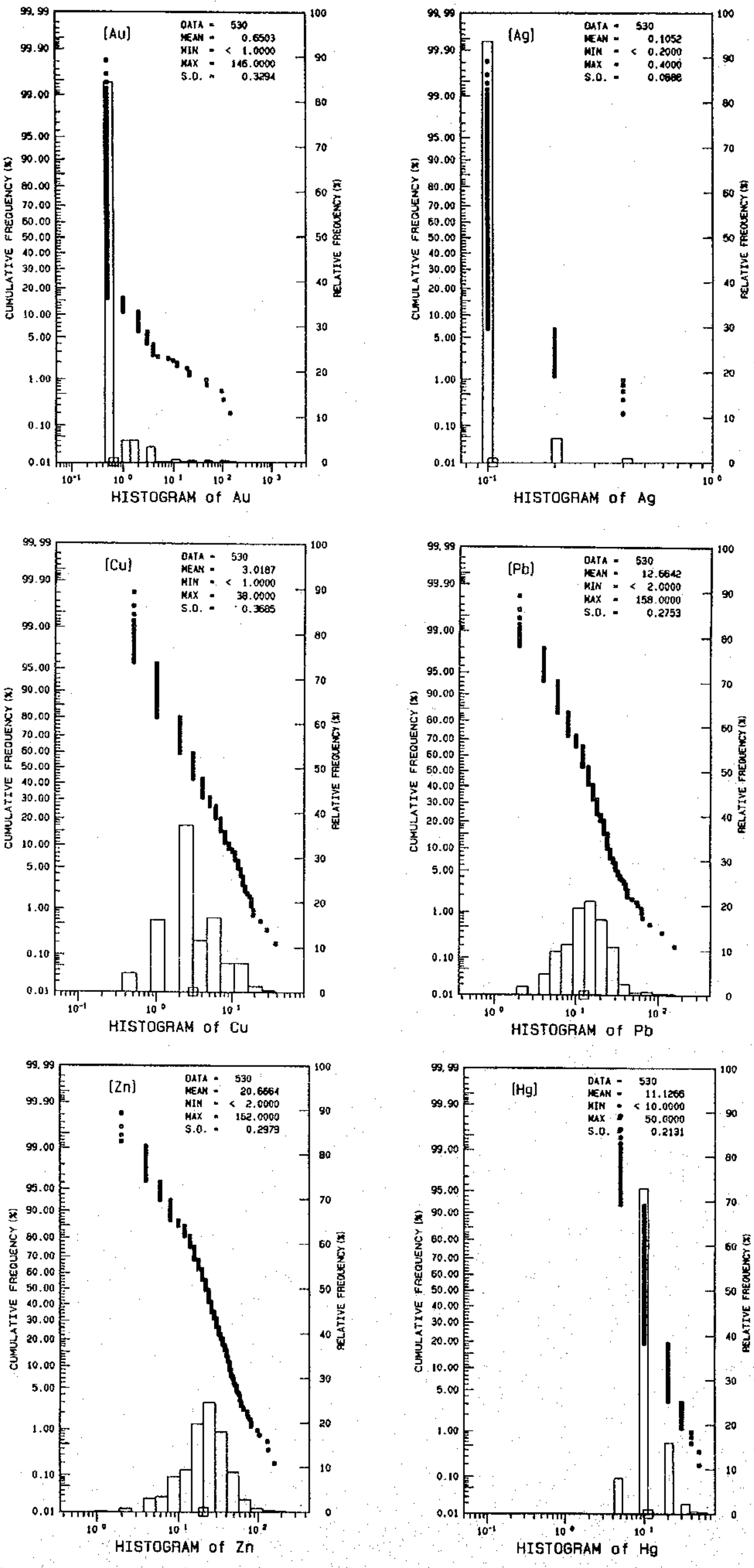


Fig.35 **Relative frequency and cumulative frequency histogram of stream sediments in Ratchaburi area (1)**

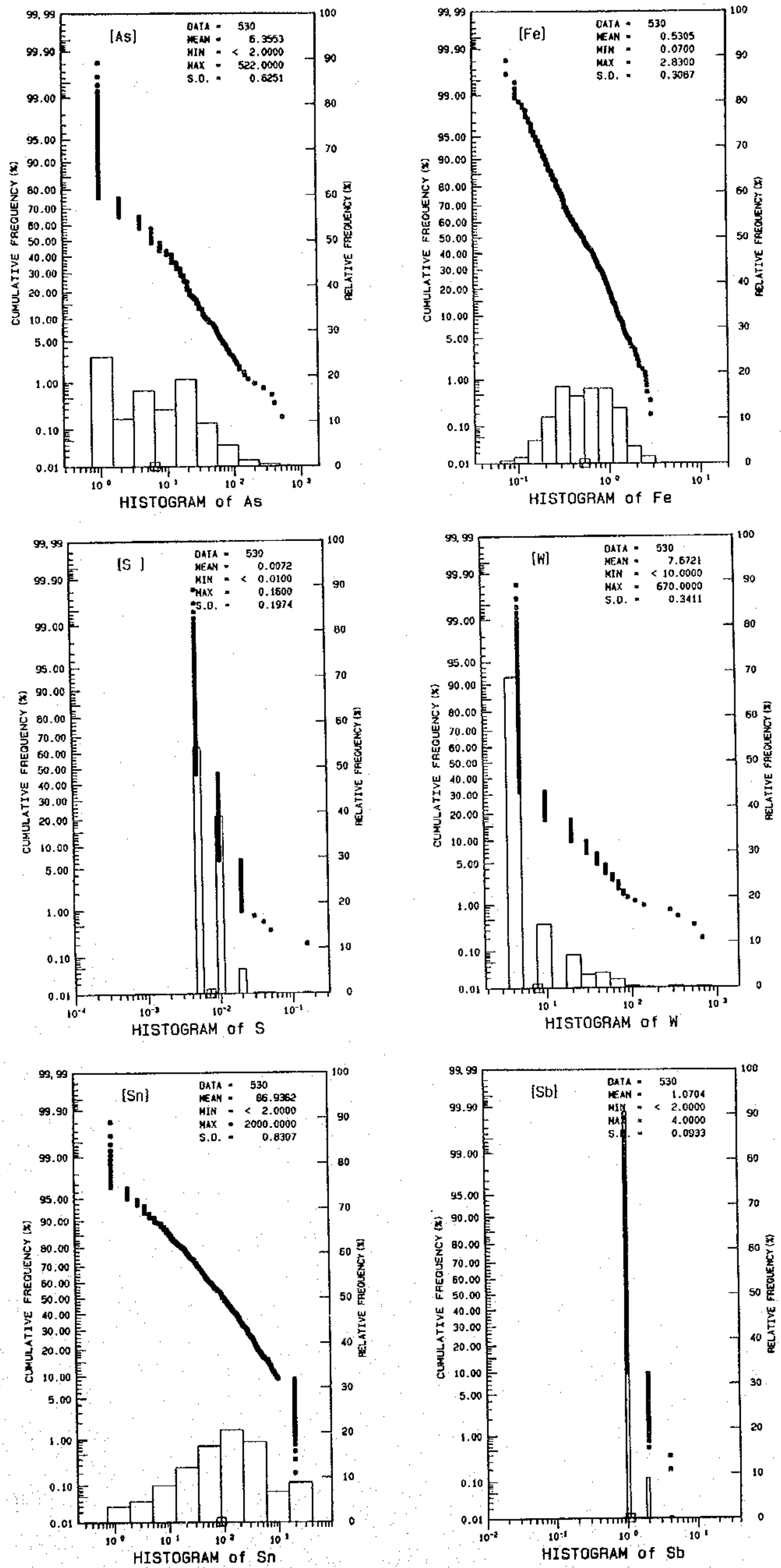


Fig.35 Relative frequency and cumulative frequency histogram of stream sediments in Ratchaburi area (2)

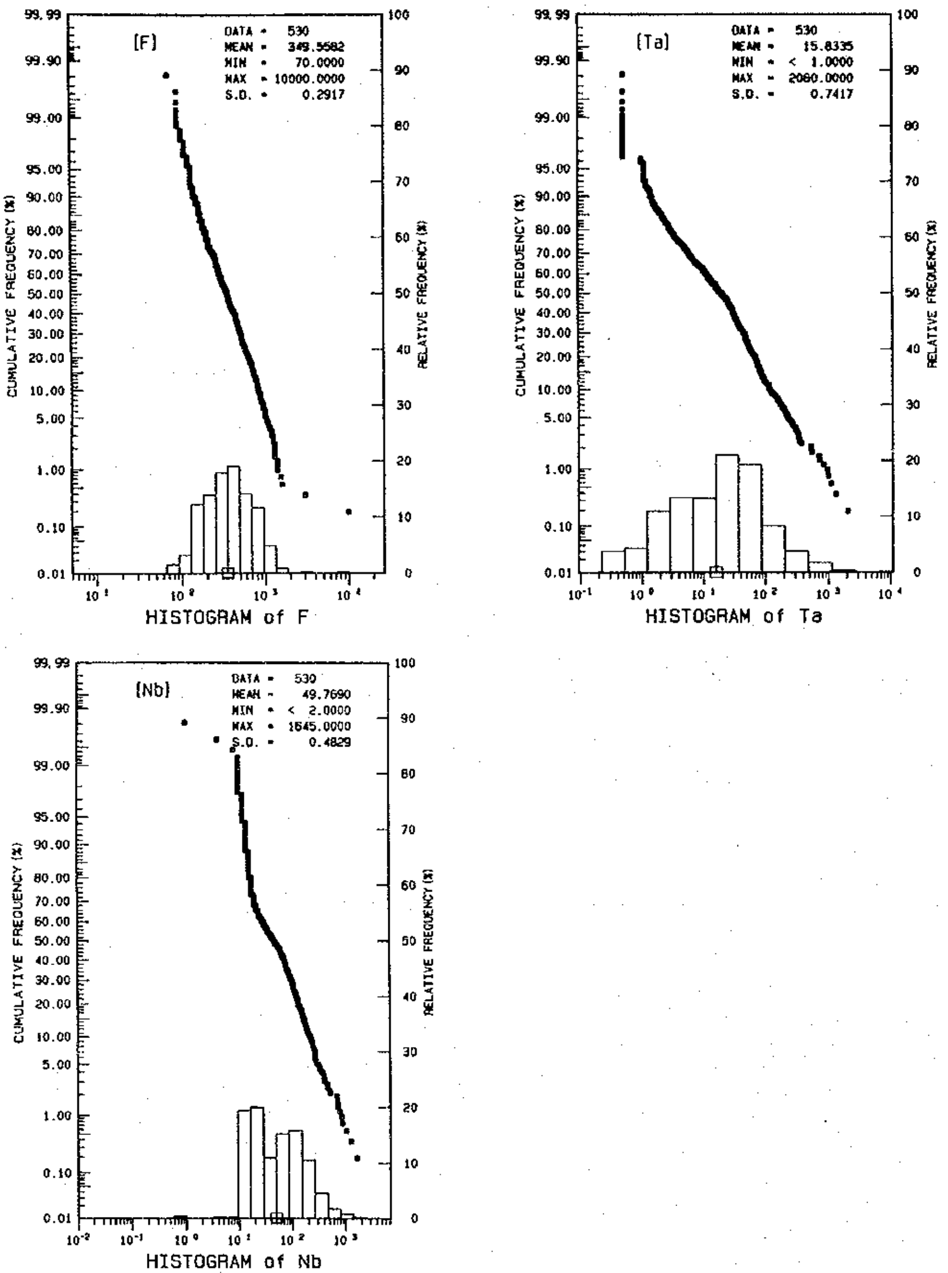


Fig.35 Relative frequency and cumulative frequency histogram of stream sediments in Ratchaburi area (3)

standard with the frequency distribution and cumulative frequency curve map added to determine the threshold values. The threshold values for each element are shown in Table 14.

Table 13 Geochemical correlation coefficients of stream sediments in Ratchaburi area

Au	1.0000														
Ag	-0.0211	1.0000													
Cu	0.1357	0.0398	1.0000												
Pb	0.1392	0.0499	0.5244	1.0000											
Zn	0.0573	0.1721	0.6860	0.6378	1.0000										
Hg	0.0187	-0.0220	0.2312	0.2392	0.2335	1.0000									
As	0.1235	-0.0605	0.4871	0.2566	0.1154	0.1576	1.0000								
Fe	0.0958	-0.0393	0.7420	0.4864	0.5118	0.2457	0.5528	1.0000							
S	0.0434	-0.0643	0.3345	0.1638	0.2418	0.2508	0.1787	0.2471	1.0000						
W	0.0445	0.1952	0.0920	0.1534	0.1015	-0.0705	0.1201	-0.0418	-0.0957	1.0000					
Sn	0.0051	0.1699	-0.0475	0.1365	0.1110	-0.0378	-0.1187	-0.1921	-0.2217	0.4973	1.0000				
Sb	0.0177	0.0449	0.1843	0.0645	0.0612	0.0915	0.2133	0.1431	-0.0292	0.2377	0.0621	1.0000			
F	-0.0490	0.2566	0.2360	0.3001	0.4676	0.0475	0.0207	-0.0940	-0.0190	0.4103	0.4363	0.1293	1.0000		
Ta	-0.1137	0.2723	-0.1897	0.0059	0.1524	-0.1086	-0.3722	-0.4032	-0.2735	0.5043	0.7438	0.0385	0.5899	1.0000	
Nb	-0.1012	0.3031	-0.1004	0.0442	0.2827	-0.1213	-0.4102	-0.3678	-0.2291	0.4896	0.6243	0.0384	0.6172	0.9005	1.0000
	Au	Ag	Cu	Pb	Zn	Hg	As	Fe	S	W	Sn	Sb	F	Ta	Nb

3. Distribution of Anomaly Zones

The anomaly zone distribution map was drawn up on the basis of the divisions in Table 14 (Fig.36). Distribution of the anomaly zones for each element is explained below.

[Au]

Au anomaly zones are found scattered particularly in the west and a large group of anomaly values is seen in the southeast of the area.

An anomaly value of 106 and148ppb was obtained in the boundary zone between sedimentary rock and granite in Huai Cha Chup Yong in the southernmost part of the area.

And 98ppb was obtained in the stream further north.

[Ag]

Around 95% of the anomaly values are detection limit values or below. There are many anomaly zones in the Mae Nam Phachi basin.

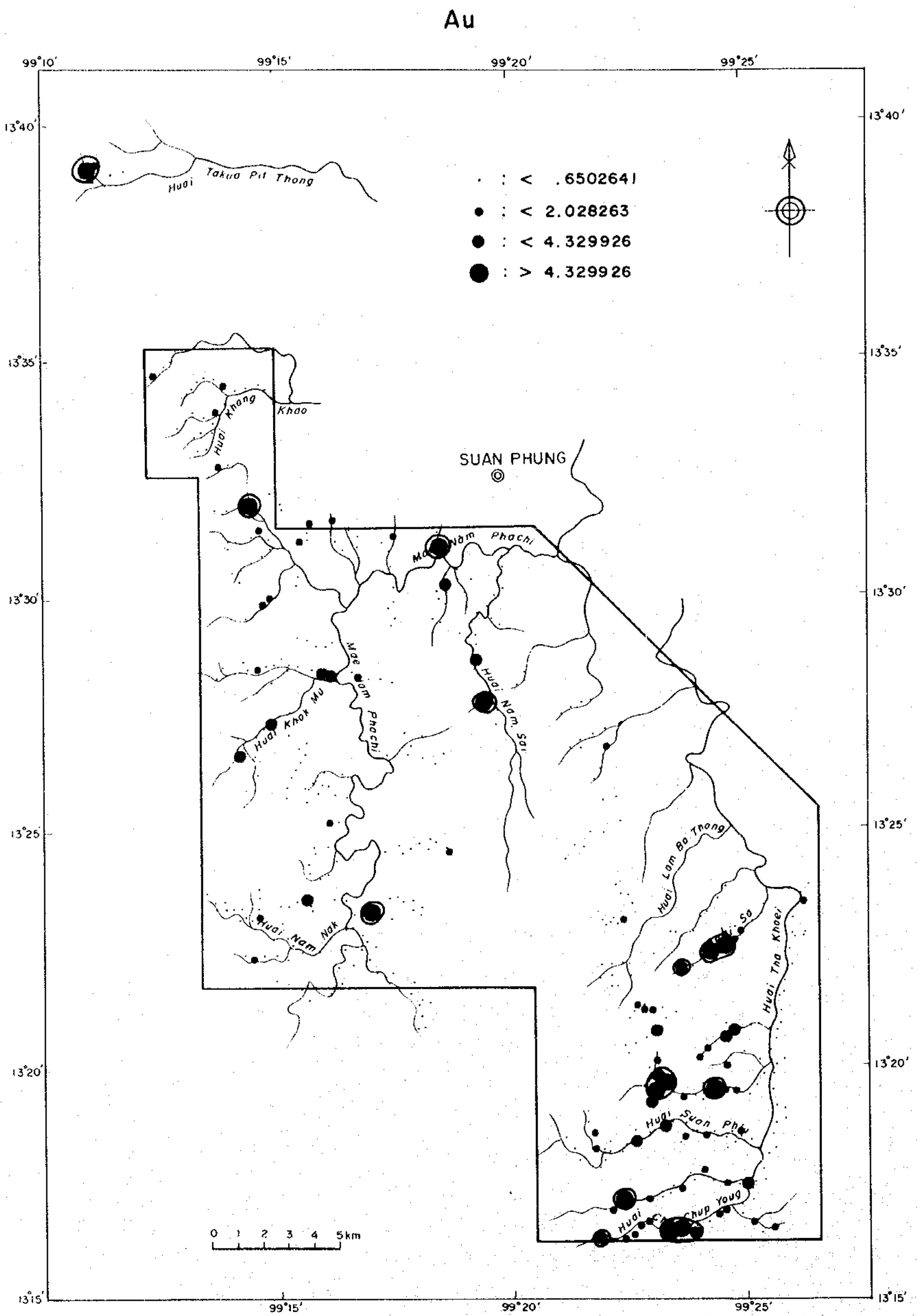
[Cu]

The highest value is 32ppm and this is lower than the Clark's numbers in the crust. In many parts distribution of anomaly zones overlaps sedimentary rock.

Nevertheless, anomaly zones are ranged along the fault at Huai Suan Phlu in the south of the area. High anomaly values for copper are seen in the roof pendant sedimentary rock at Huai Takua Pit Thong in the north.

[Pb]

The anomaly zones in the northwest tip of the area overlap the anomaly zones for Nb and Ta, suggesting the existence of U. As this area has no distribution of anomaly zones for F and overlaps the anomaly zones for Zn, it is possible that there has been some kind of mineralization.



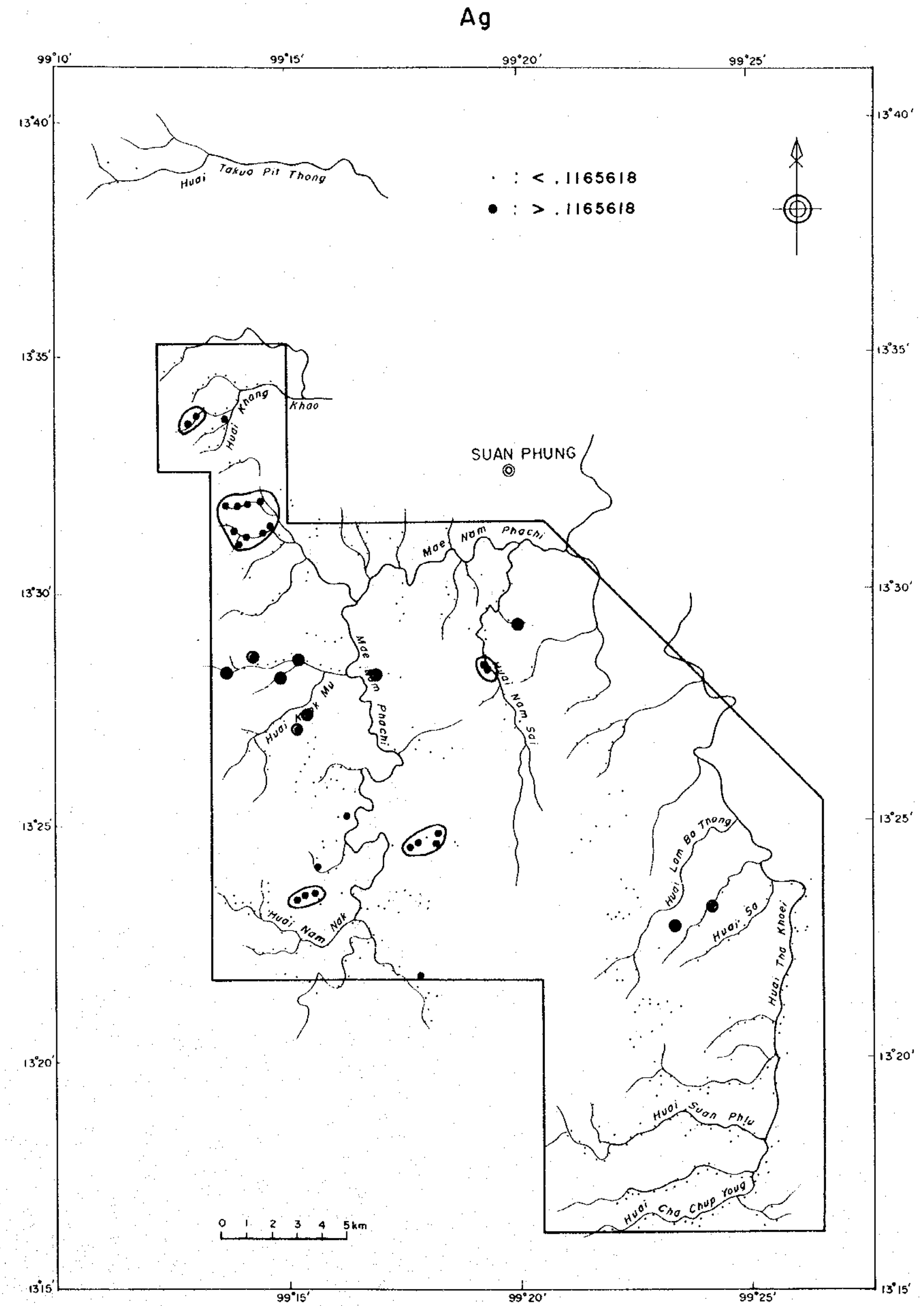
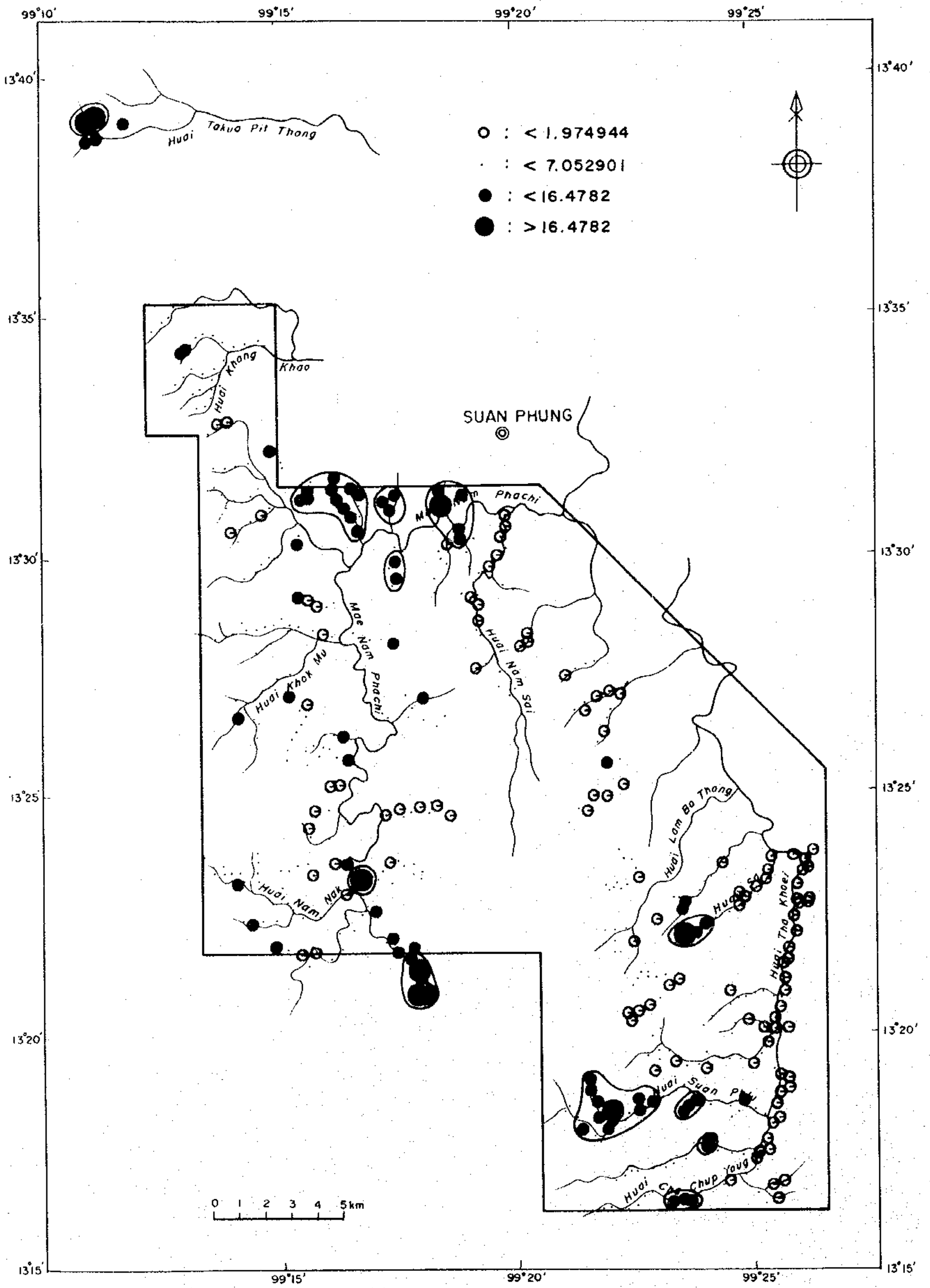


Fig.36 Geochemical anomaly map of stream sediments in Ratchaburi area (1)

Cu



Pb

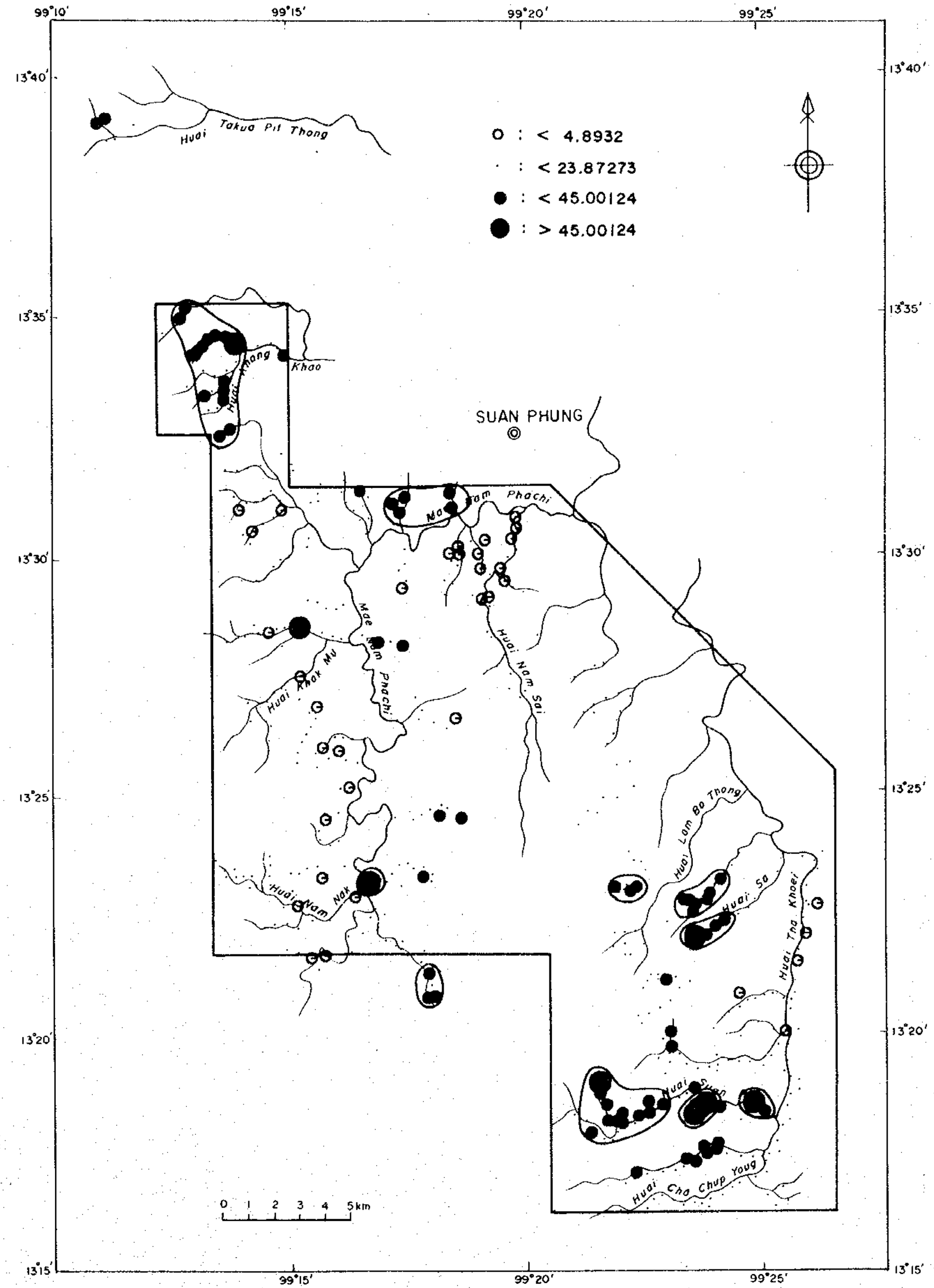
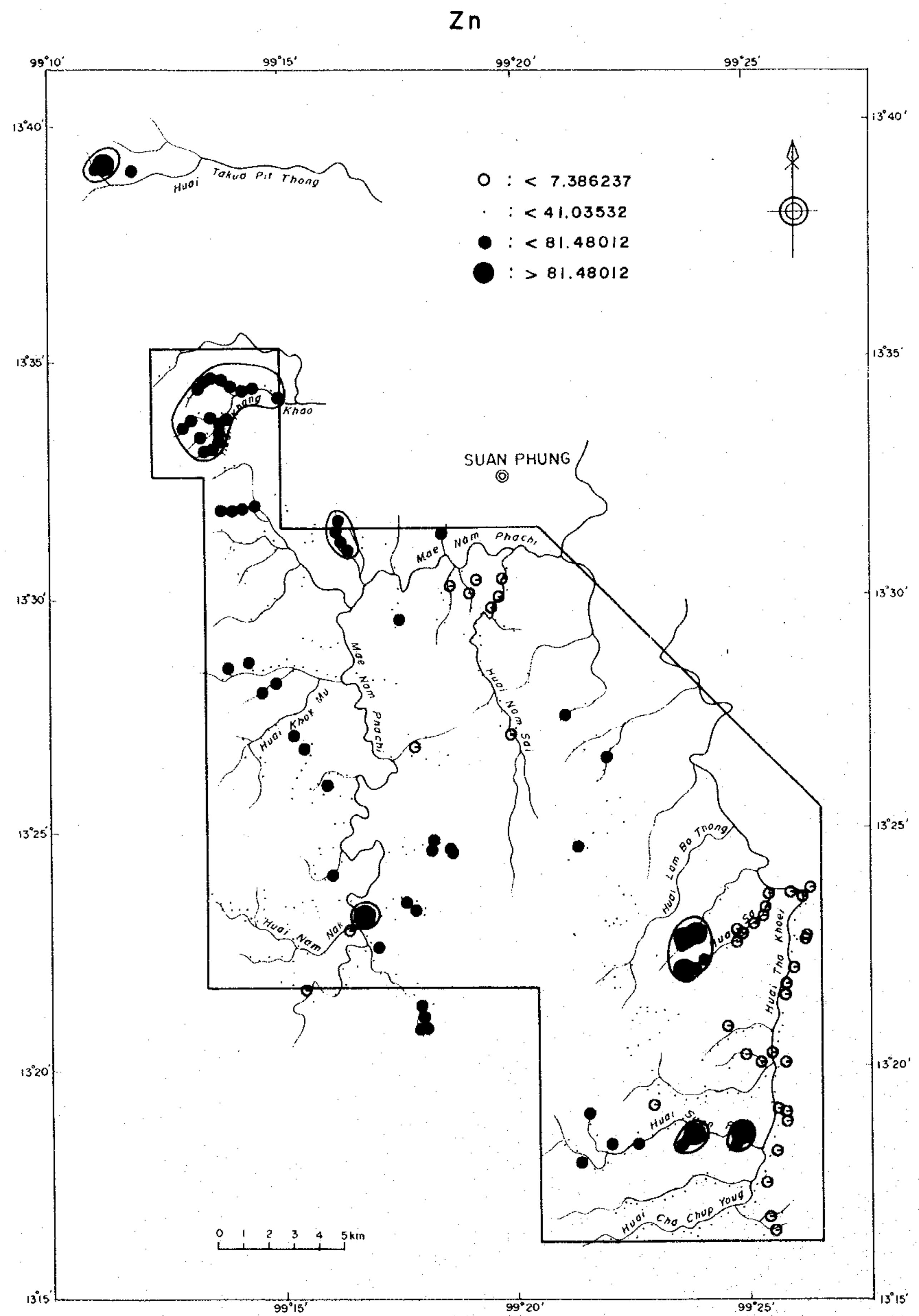


Fig.36 Geochemical anomaly map of stream sediments in Ratchaburi area (2)



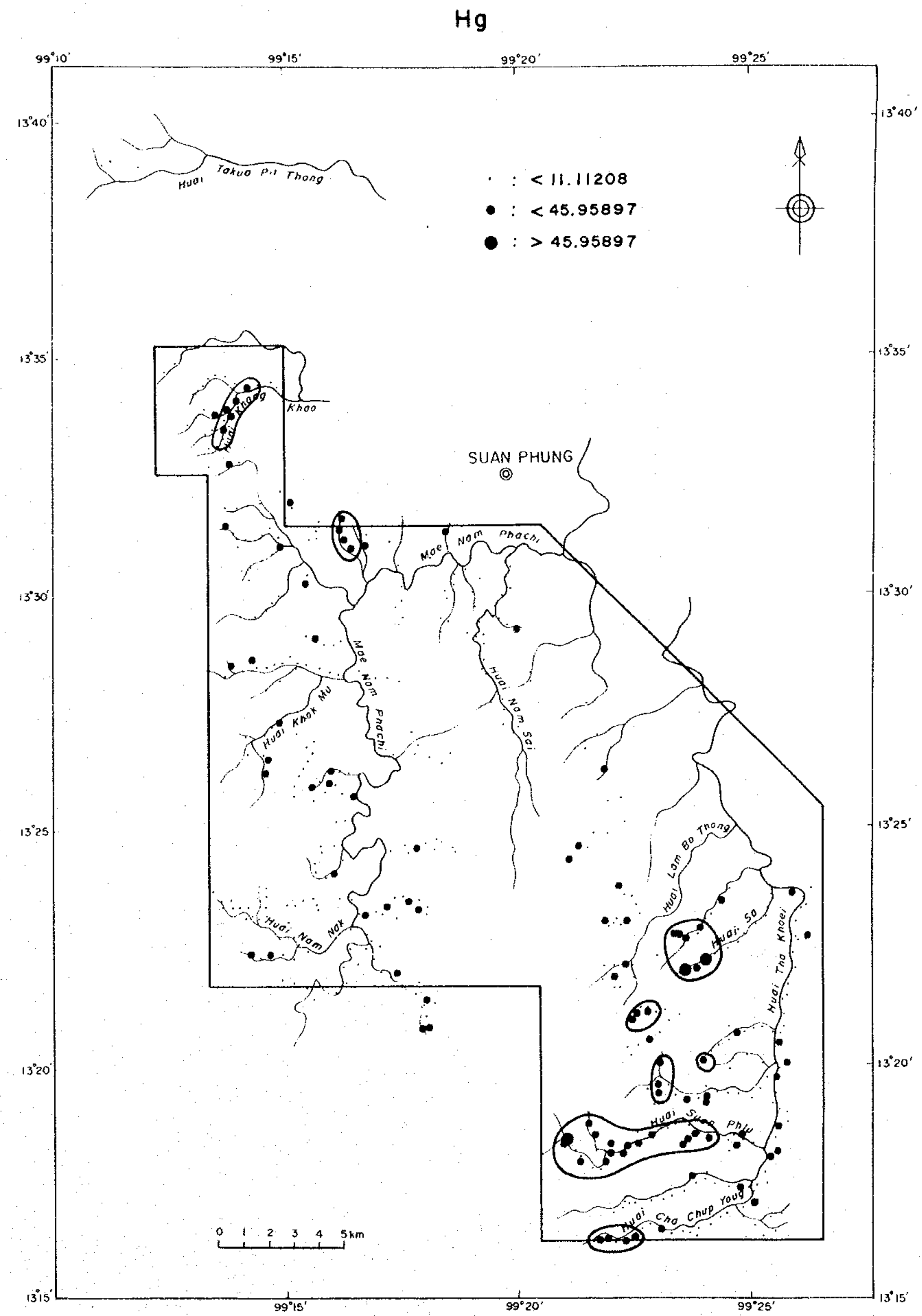
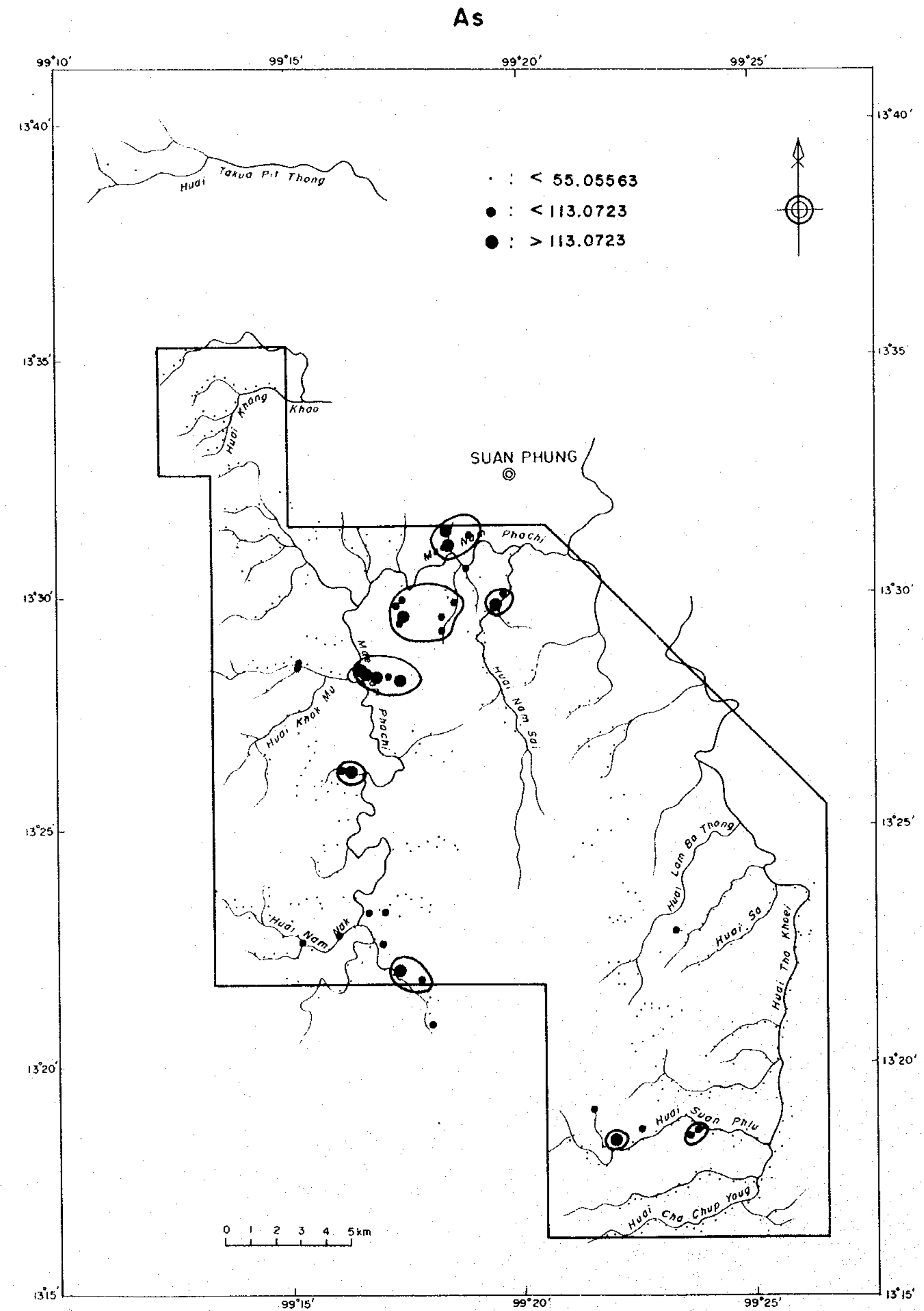


Fig.36 Geochemical anomaly map of stream sediments in Ratchaburi area (3)



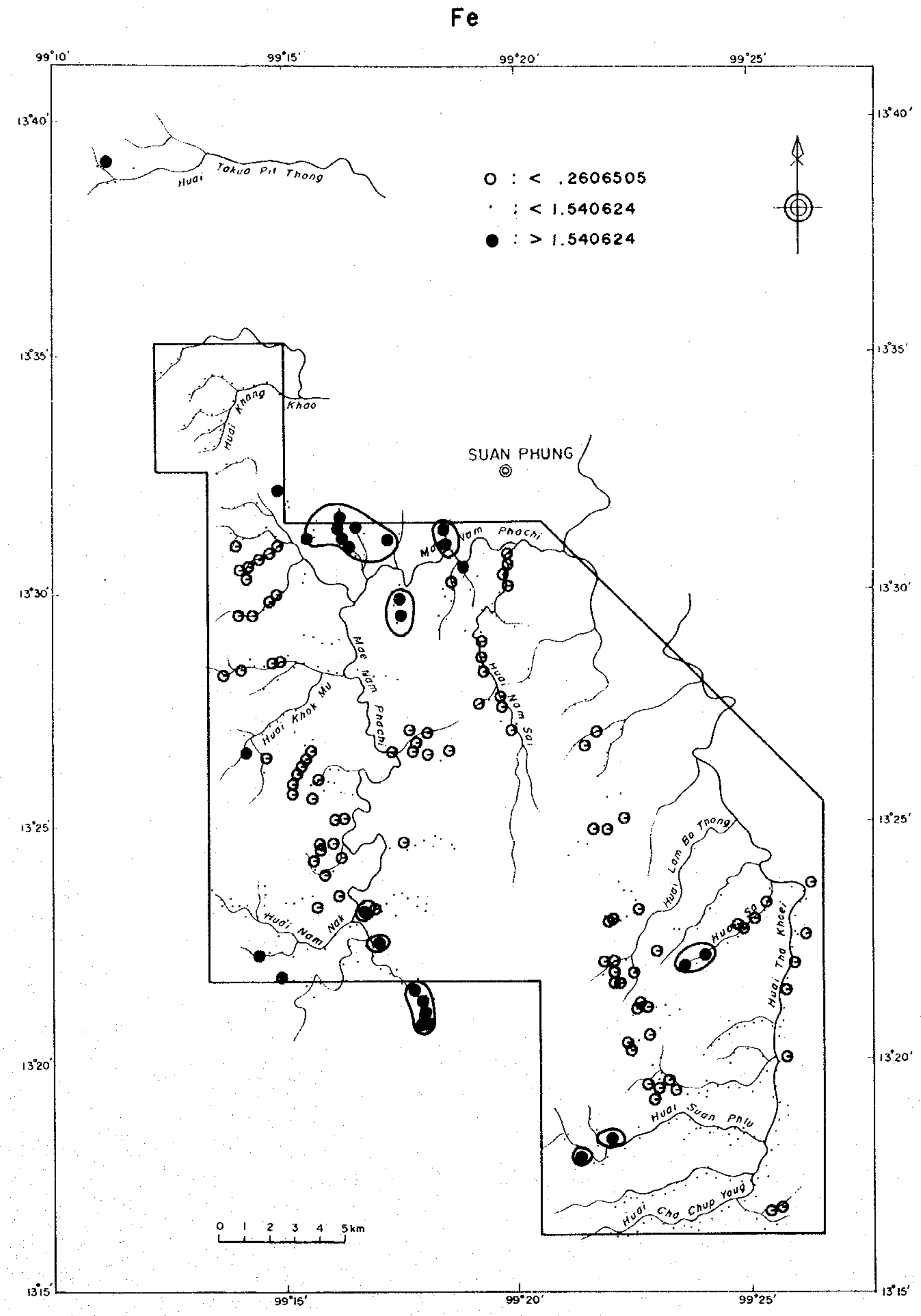
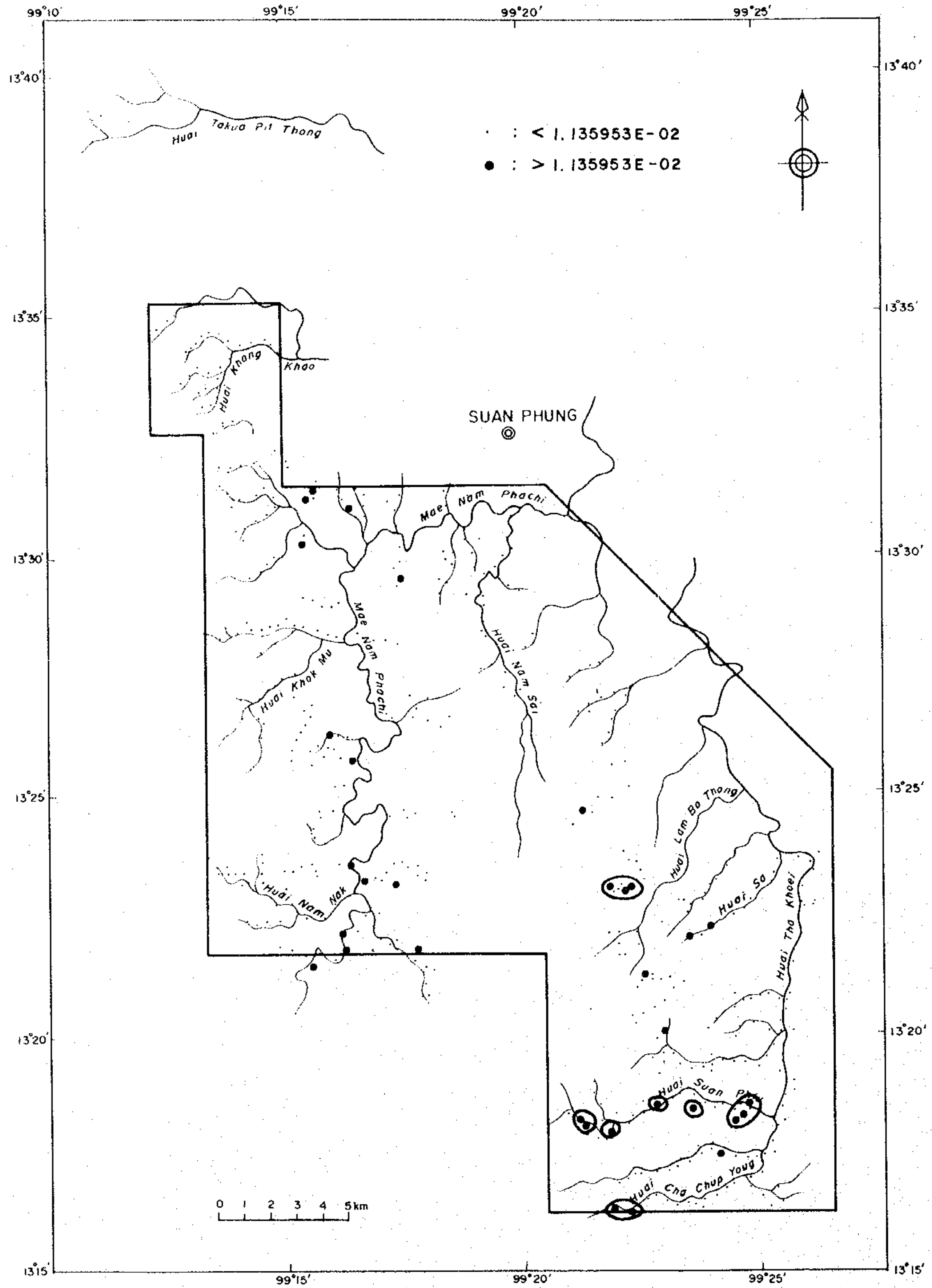


Fig.36 Geochemical anomaly map of stream sediments in Ratchaburi area (4)



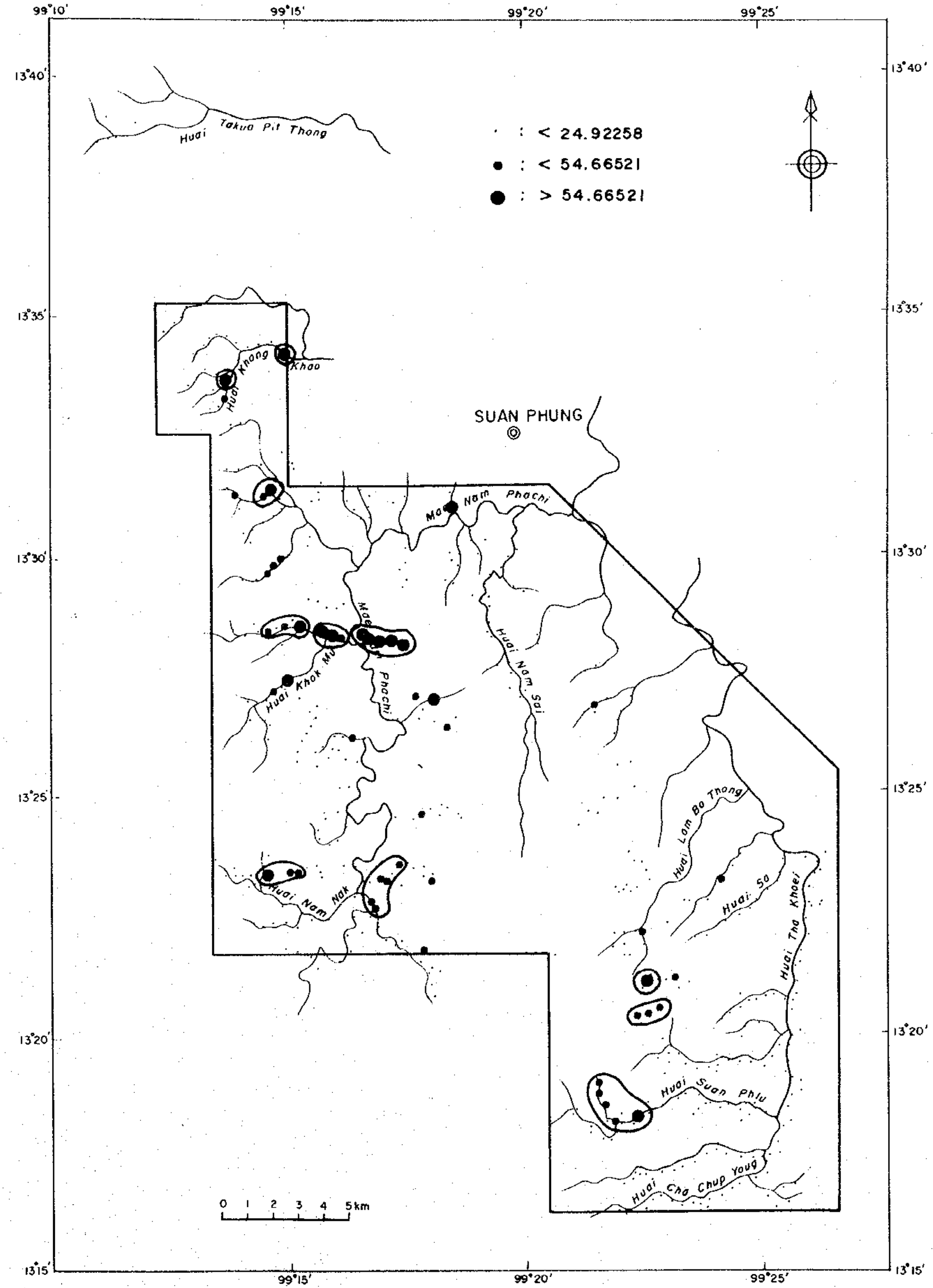
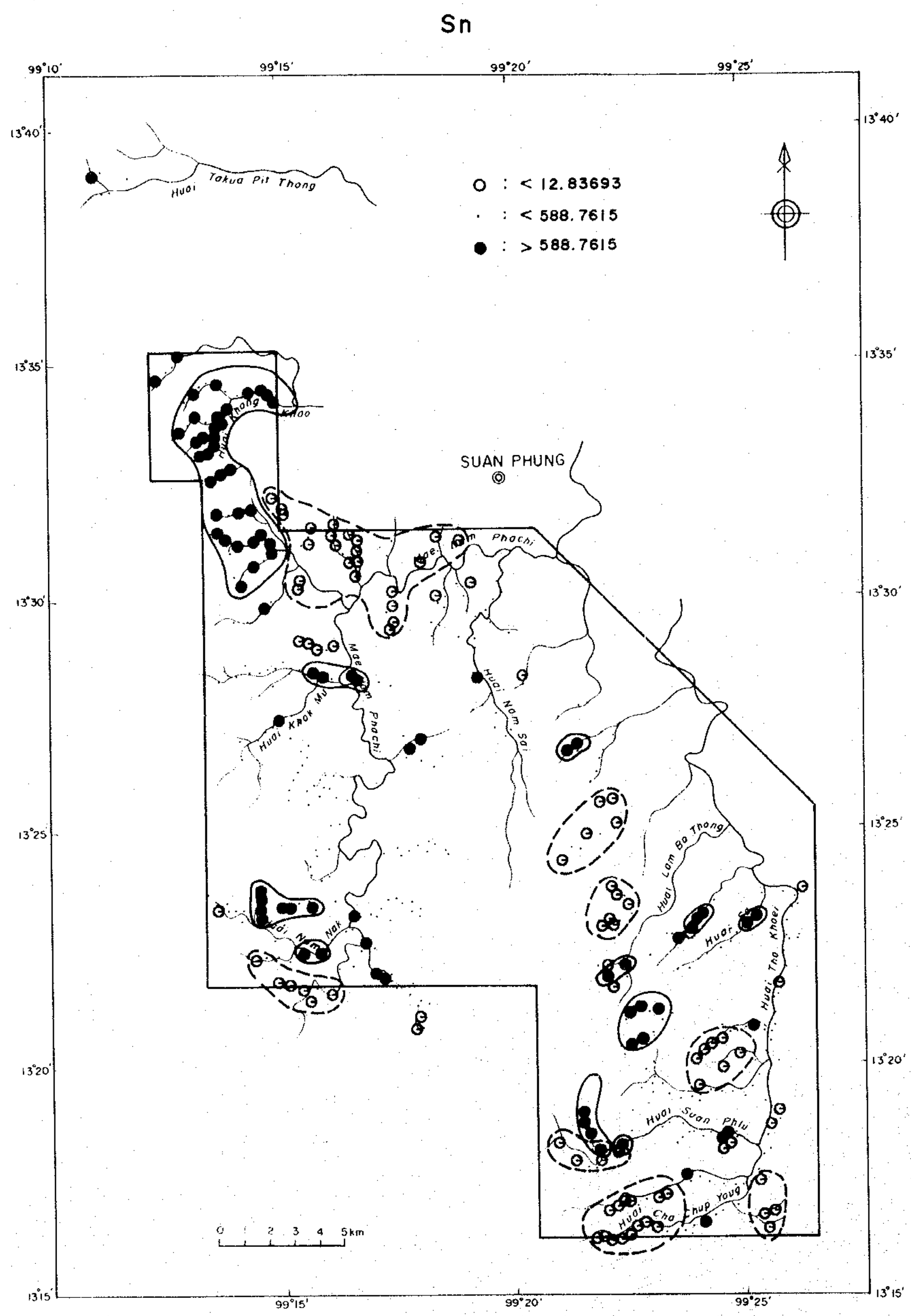


Fig.36 Geochemical anomaly map of stream sediments in Ratchaburi area (5)



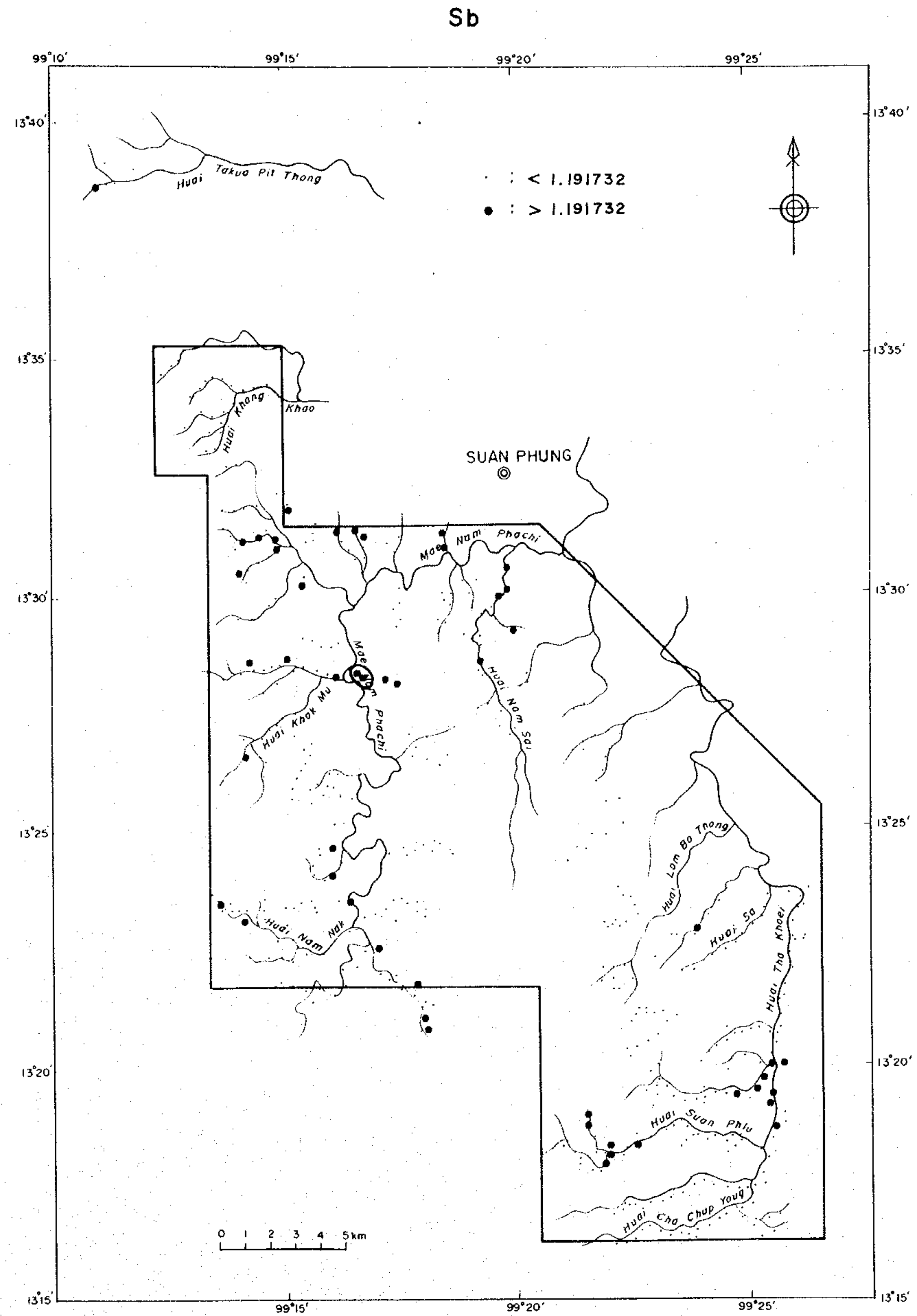
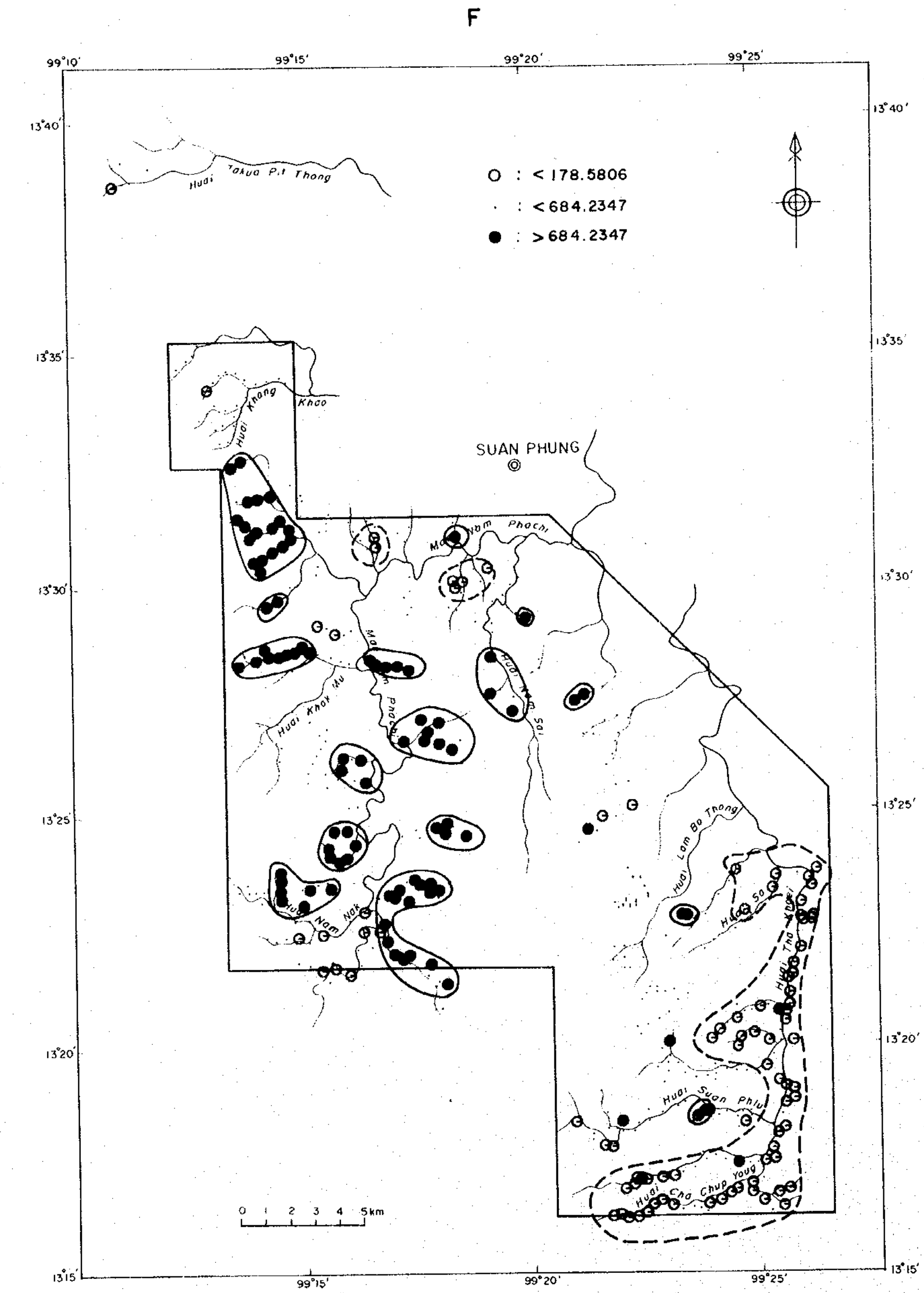


Fig.36 Geochemical anomaly map of stream sediments in Ratchaburi area (6)



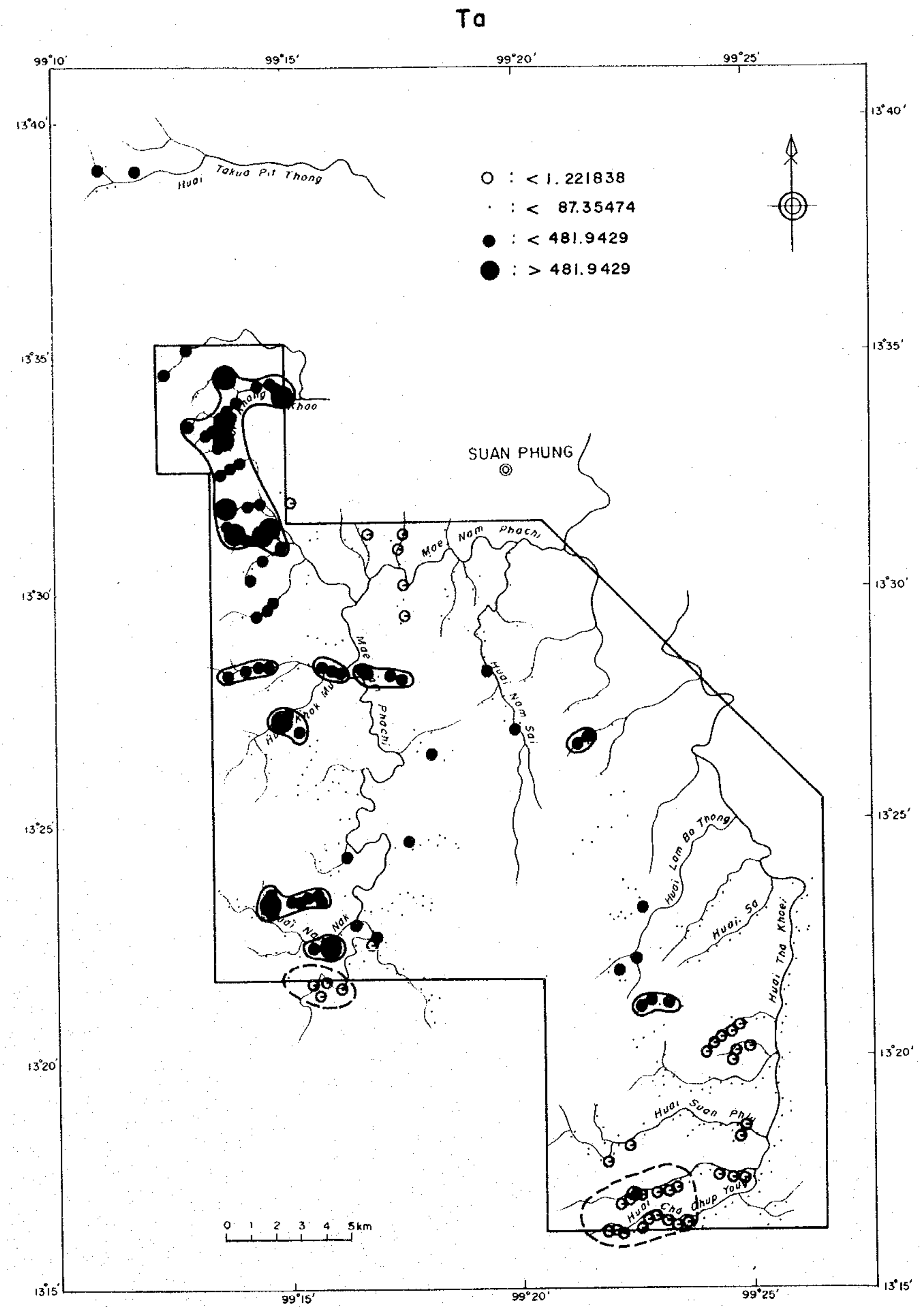


Fig.36 Geochemical anomaly map of stream sediments in Ratchaburi area (7)

Nb

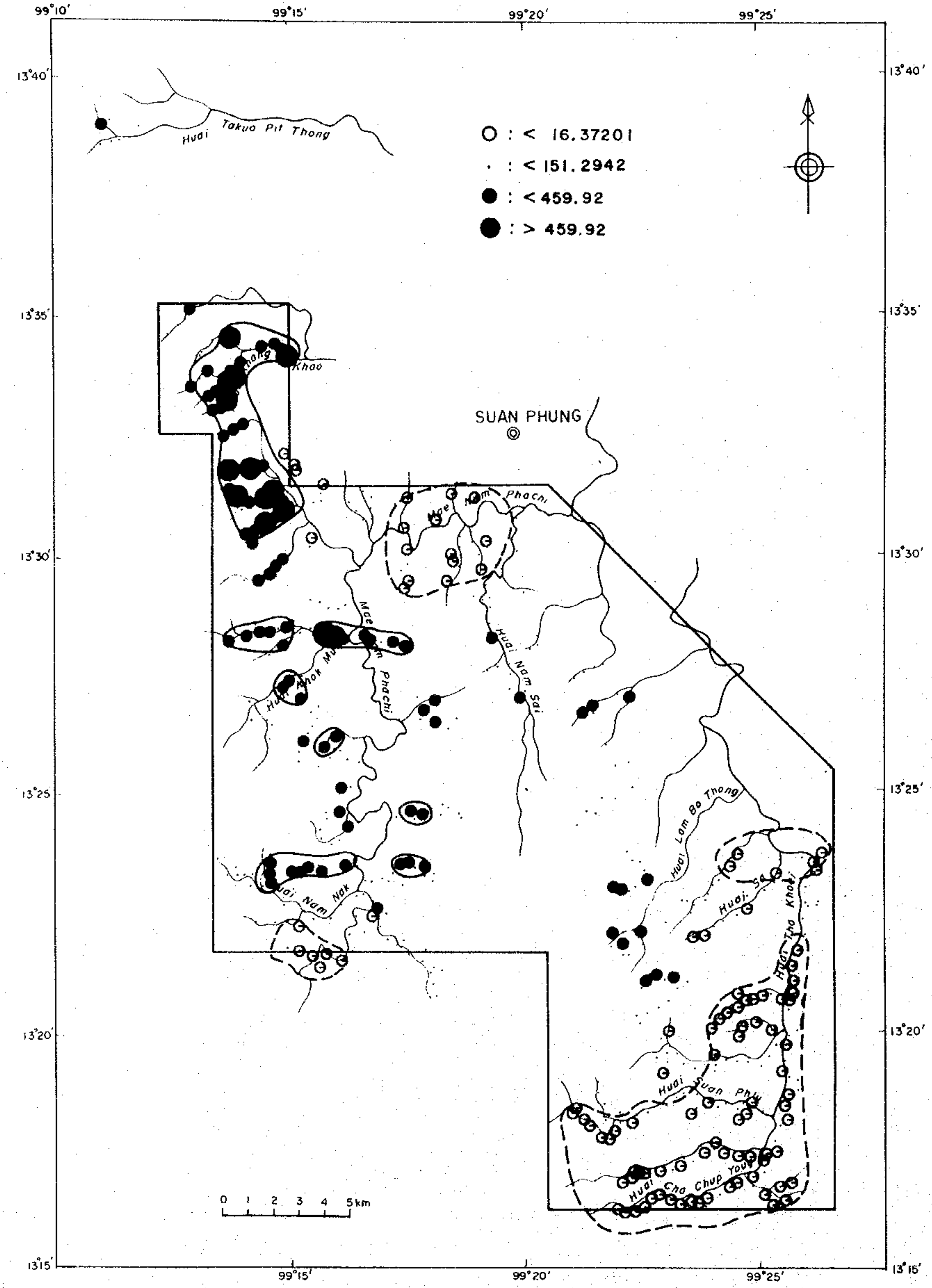


Fig.36 Geochemical anomaly map of stream sediments in Ratchaburi area (8)

Many of the anomaly zones in the southeast of the area are in the boundary region between sedimentary rock and granite, and anomaly zones are ranged along the fault at Huai Suan Phlu similar to Cu.

Table 14 Division into geochemical anomaly levels of stream sediments in Ratchaburi area

element	unit	low anomaly	background	high anomaly1	high anomaly2	high anomaly3
Au	ppb			M 0.65	M+1.5 σ 2.03	M+2.5 σ 4.33
Ag	ppm			M+0.5 σ 0.12		
Cu	ppm		M-1.5 σ 2.89	M+ σ 7.05	M+2 σ 16.47	
Pb	ppm		M-1.5 σ 4.89	M+ σ 23.87	M+2 σ 44.99	
Zn	ppm		M-1.5 σ 7.38	M+ σ 41.03	M+2 σ 81.47	
Hg	ppb			M 39.96	M+3 σ 89.19	
As	ppm			M+1.5 σ 55.00	M+2 σ 113.03	
Fe	%		M- σ 0.26	M+1.5 σ 1.54		
S	%			M+1 σ 0.011		
W	ppm			M+1.5 σ 24.92	M+2.5 σ 54.66	
Sn	ppm		M- σ 12.84	M 558.7		
Sb	ppm			M+0.5 σ 1.36		
F	ppm		M- σ 178.6	M+ σ 684.2		
Ta	ppm		M-1.5 σ 1.22	M+ σ 87.36	M+2 σ 481.9	
Nb	ppm		M- σ 16.47	M+ σ 151.3	M+2 σ 456.0	

[Zn]

In addition to the anomaly zones in Huai Takua Pit Thong in the north similar to those of Cu, there is an overlap with Pb anomaly zones in the northwest tip of the area. The anomaly zones are ranged along the fault at Huai Suan Phlu in the southeast in the same way as Cu and Pb. There are also anomaly zones at Huai Sa.

[Hg]

There are many high anomaly values for mercury in the southeast of the area and distribution of the anomaly zones is similar to that of Cu, Pb and Zn.

[As]

High anomaly zones are distributed in the sedimentary rock distribution zone south of Amphoe Suan Phung where the district office is situated, and in the stream on the east side of Ban Bo Wi. No other large anomaly zones are found.

[Fe]

Even the highest value of 2.8% is extremely low. High anomaly zones are seen in the sedimentary rock distribution area west of Amphoe Suan Phung, in the upper reaches of Mae Nam Phachi.

[S]

95% of the samples give detection limit values or below. The high density values are mainly in the southeast of the area.

[W]

The distribution pattern of anomaly zones is extremely similar to that of Sn.

[Sn]

High anomaly zones are distributed in the northwest of the area and the mineral deposit zone in the southwest and background. There are many secondary tin deposit remains in the Huai Tha Khoei basin in the east of the area, but there are few high anomaly zones even in the granite distribution zone.

Conversely, high anomaly zones are seen in the sedimentary rock distribution zone which has not been exploited for mineral deposits.

Most of the low anomaly zones overlap the sedimentary rock zones, but despite the fact that there are secondary tin deposits in the lower reaches of Huai Lam Bo Thong which is a tributary of Huai Tah Khoei, and Huai Phai, these are low anomaly zones.

[Sb]

Only two samples give values greater than the detection limit values. The 2 samples were taken east of Ban Bo Wi.

[F]

The high anomaly zones are distributed in the granite distribution zone in the Mae Nam Phachi basin. Like tin, they conform to the old deposit zones and background, but no anomaly zones are seen in the Huai Ban Bo basin at the northern tip of the area.

In addition to overlapping the sedimentary rock distribution zones, the low anomaly zones occupy a wide area in the upper reaches of Huai Tha Khoei.

[Ta, Nb]

Anomaly zones are distributed in the old mineral deposit zones in the Mae Nam Phachi basin and background. Hardly any high anomaly zones are distributed in the Huai Tha Khoei basin. The low anomaly zones show a similar distribution to that of F.

4. Analysis of Principal Components

Analysis was carried out of the correlation series obtained from the logarithm values of the geochemical analytical values for 13 principal components, excluding As and Sb for which over 90% of the samples showed detection limit values or below. The results are shown in Table 15.

Table 15 Results of principal components analysis in Ratchaburi area

Principal componet	Eigen-value	Contribu-tion rate%	Cumulaive%	Factor loading	Z-01	Z-02	Z-03	Z-04
Z-01	3.8024	29.2490	29.2490	Ta	**0.9067**	0.2878	-0.0511	0.0139
Z-02	3.3570	25.8231	55.0721	Nb	**0.8642**	0.3456	-0.1359	0.0445
Z-03	1.1639	8.9531	64.0252	Sn	**0.6981**	0.3635	0.2024	0.0157
Z-04	0.9437	7.2596	71.2848	W	**0.4892**	0.4248	0.4524	-0.1463
Z-05	0.8924	6.8644	78.1491	As	**-0.5318**	0.3597	**0.5033**	-0.3108
Z-06	0.7817	6.0131	84.1623	Fe	**-0.6589**	**0.5583**	0.1277	-0.1766
Z-07	0.5454	4.1953	88.3576	Zn	-0.0941	**0.8402**	-0.2973	0.0717
Z-08	0.4751	3.6549	92.0125	Cu	-0.4531	**0.7654**	0.0346	-0.0843
Z-09	0.4393	3.3789	95.3914	Pb	-0.1949	**0.7427**	-0.0294	0.1045
Z-10	0.2135	1.6427	97.0340	F	**0.5059**	**0.6242**	-0.1028	-0.0506
Z-11	0.1699	1.3070	98.3410	Au	-0.1557	0.1239	**0.4913**	**0.8354**
Z-12	0.1455	1.1196	99.4606	Hg	-0.2745	0.3058	-0.3866	0.1976
Z-13	0.0701	0.5394	100.0000	S	-0.4270	0.2436	-0.3684	0.1715

The eigenvalues are 1 or over, or detailed to 1, up to the fourth component, and the cumulative contribution rate up to the fourth component is 71%. The point distribution chart up to the fourth component is shown in Fig.37.

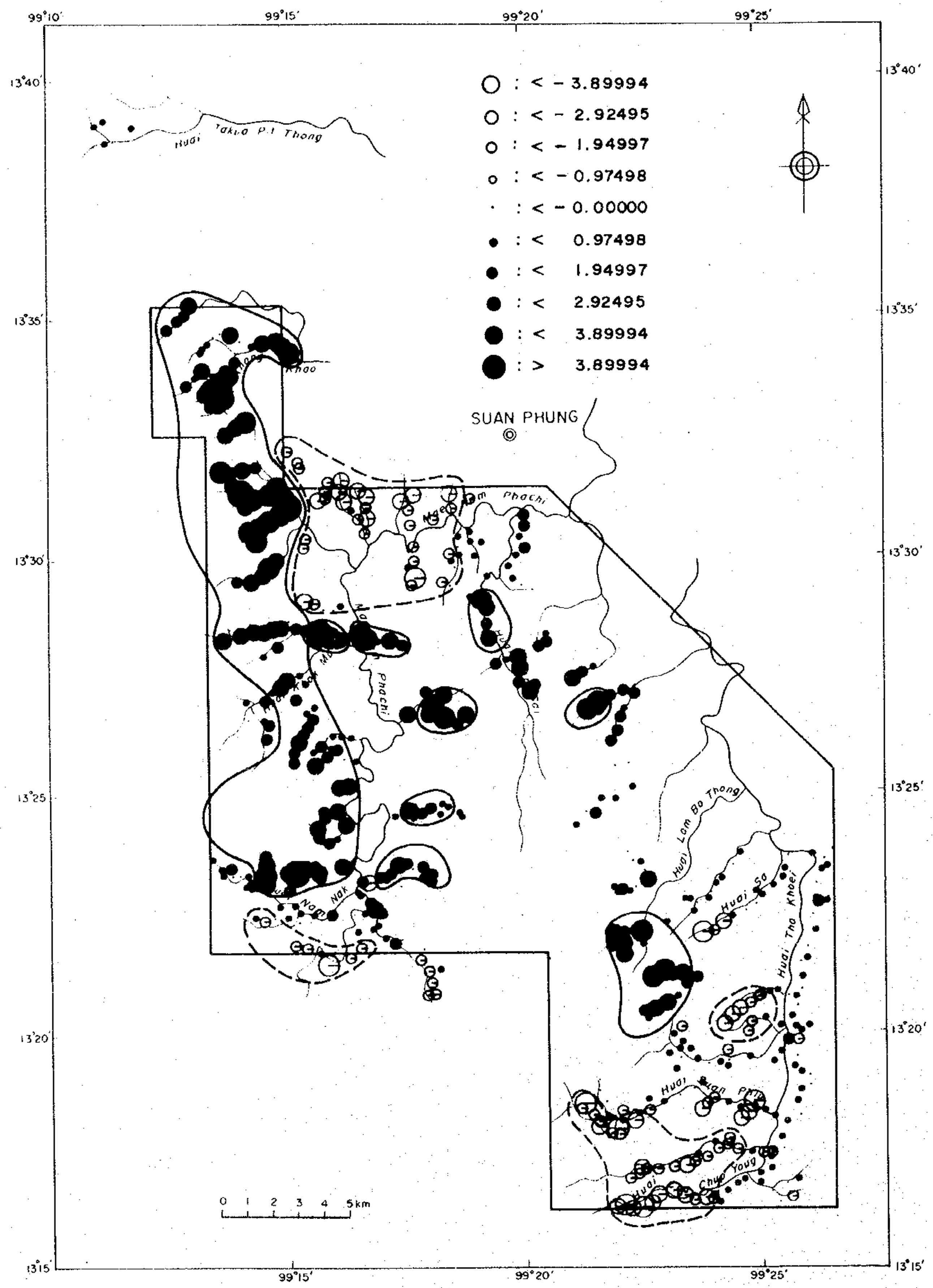
First component(Z--1):

The factor loadings for Sn, Ta, Nb, F and W are high, and the negative factor loadings for Fe, As, Cu, S, etc. are high. This component suggests distribution of Sn, Nb, Ta and F derived from granite in stream sediments and the existence of primary deposits. The high score zones are widely distributed in the old deposit zones in the west, with few deposit zones in the east.

Low score zones overlap sedimentary rock zones.

Second component(Z-2):

Whereas the factor loadings for Au, Ta, S, etc. are low, positive factor loadings are shown for all the elements, suggesting a high density distribution range of pathfinder elements with the exception of Au. High score zones are distributed particularly in the stream east of Ban Bo Wi, in the boundary zone between granite and sedimentary rock in the upper reaches of Mae Nam Phachi, in Huai Sa in the southeast of the area, Huai Suan Phlu and Huai Takua Pit Thong in the north.



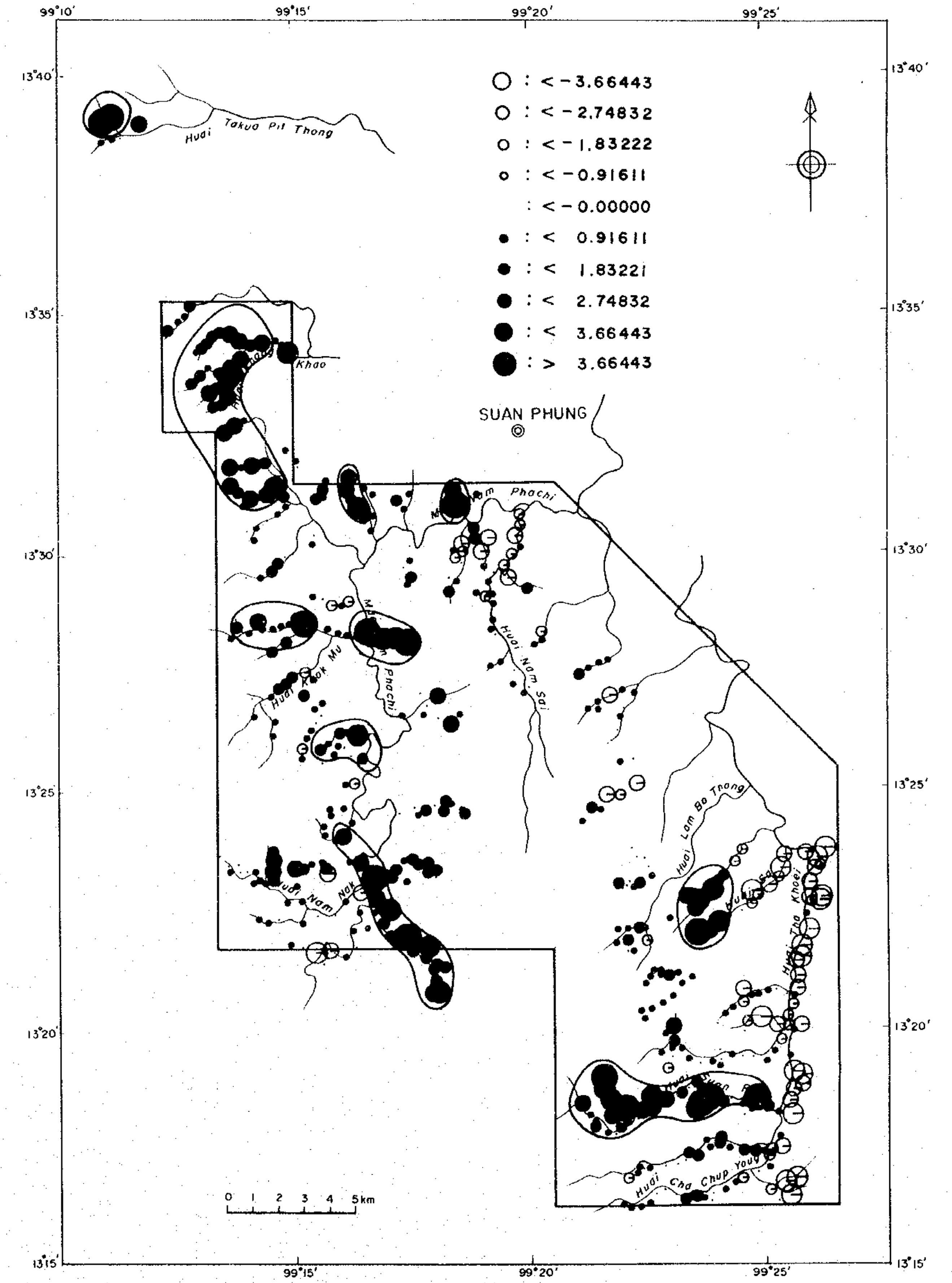
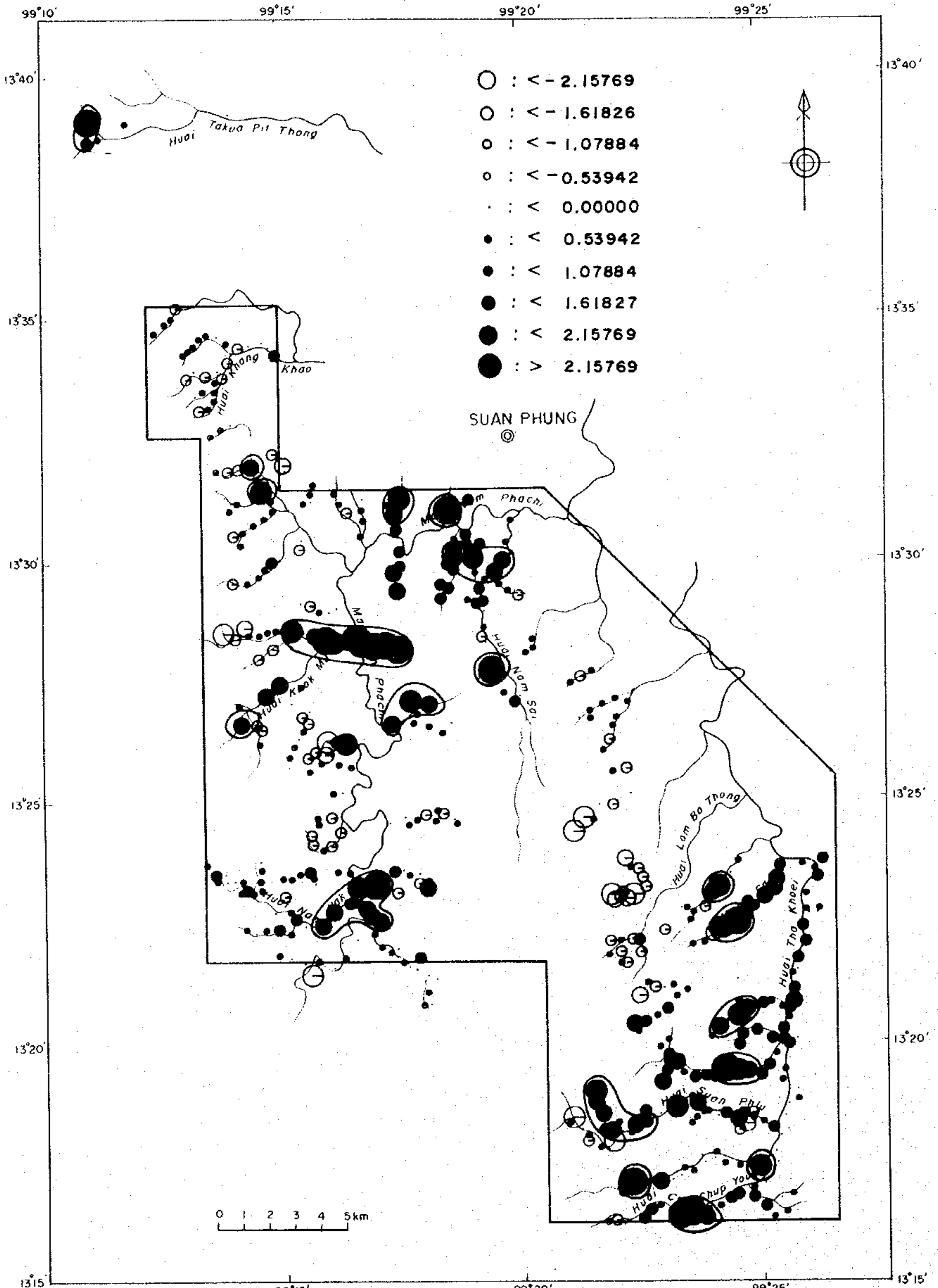


Fig.37 Scores of principal components analysis in Ratchaburi area (1)

Z-03



Z-04

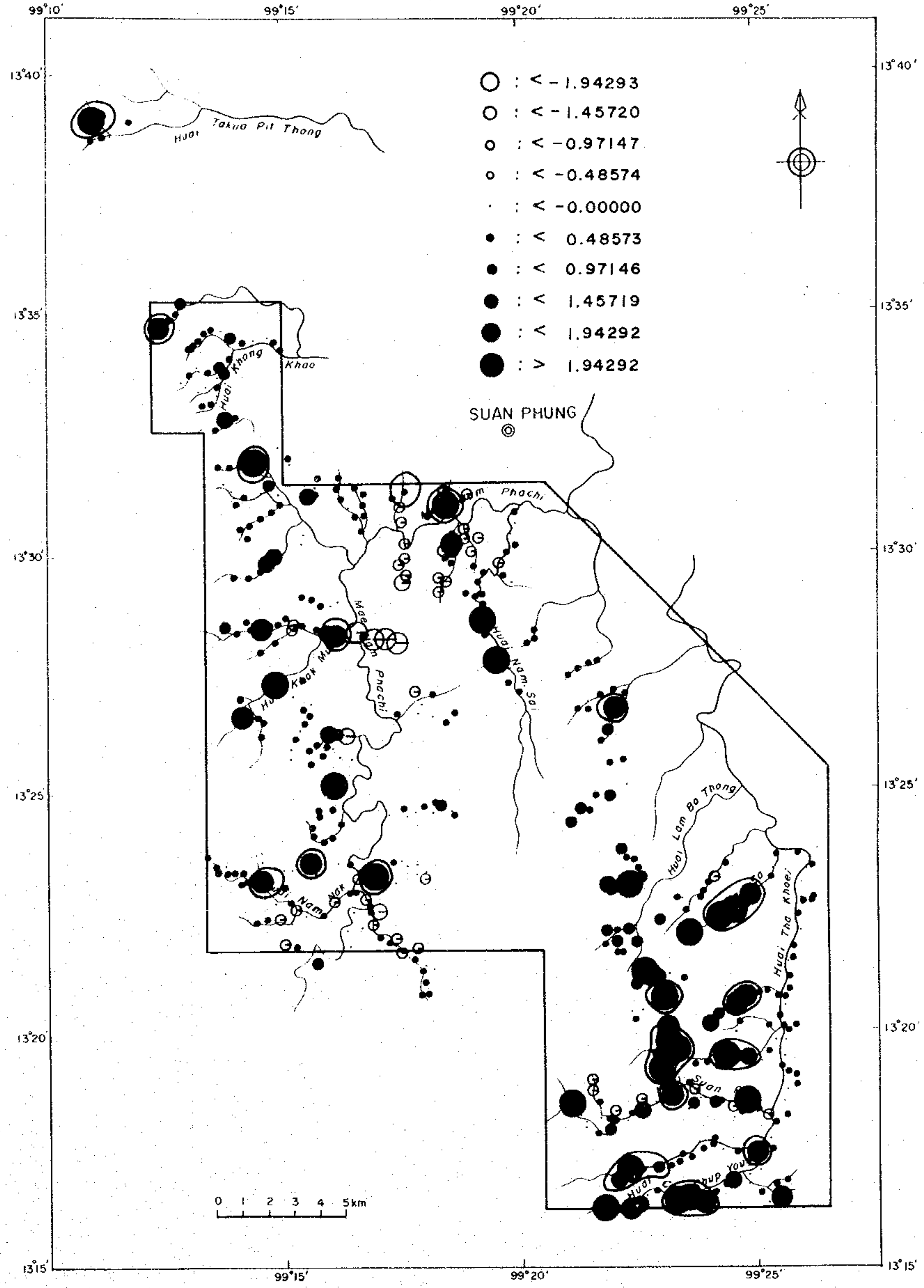


Fig.37　　Scores of principal components analysis in Ratchaburi area (2)

Third component(Z-3):

The factor loadings for As, Au and W are high. Taking the Cha Chai mine in the south of the area as an example and judging from the fact that arsenic is concentrated in quartz veins which cut across primary tin deposits (greisen-type), there is possible distribution of quartz veins from the latter period of mineralization related to granite in the deposits.

Fourth component(Z-4):

The factor loading for Au is extremely high and the factor loadings for the other elements are low. This suggests the existence of gold in stream sediments.

In addition to the 2 large high score zones at Huai Takua Pit Thong in the north of the area, high score zones are scattered here and there. High scores are concentrated in the boundary zone between sedimentary rock and granite in the southwest, or along faults.

3-7 Considerations

The Ratchaburi area is composed of Ordovician Thung Song Group, Silurian-Devonian Kanchananburi Group, Devonian-Carboniferous Kaeng Krachan Group Huai Phu Ron Formation, Kao Phra Formation and granite which has intruded into the Jurassic-Cretaceous. Thick stream sediments have accumulated along each stream and secondary tin deposits used to be mined at one time.

The structure of the sedimentary rock shows fragmented distribution on account of the intrusion of granite, but the schistosity and sedimentary structures display a NW-SE direction and there is a tendency for new strata to overlap on both sides of the Silurian-Devonian background structure.

The intrusive direction of the granite on the whole conforms to the structure of the sedimentary rock. Lineaments running NE-SW ` NNE-SSE are clearly seen in the granite zones.

Several old tin (-tungsten) placer and primary deposit exist, from the boundary zones between granite and sedimentary rock to the alluvial basins of the streams in the Ratchaburi area, but they are no longer worked today. Only one deposit presently being worked produces feldspar in pegmatite.

Sedimentary rock in contact with granite is turned to semi-schist or schist, and in many cases quartz veins develop along the schistosity. However, no argillization and / or other alteration is seen around the quartz veins.

The granite in this area is S-type and belongs to the ilmenite series. It shows the characteristics of tin granite clearly.

From the results of geochemical prospecting, it is noticeable that the density of individual elements is low overall, with the exception of Sn, Ta, Nb, F and W.

The anomaly zones of Sn, Ta, Nb, F and W are concentrated in the Mae Nam Phachi basin

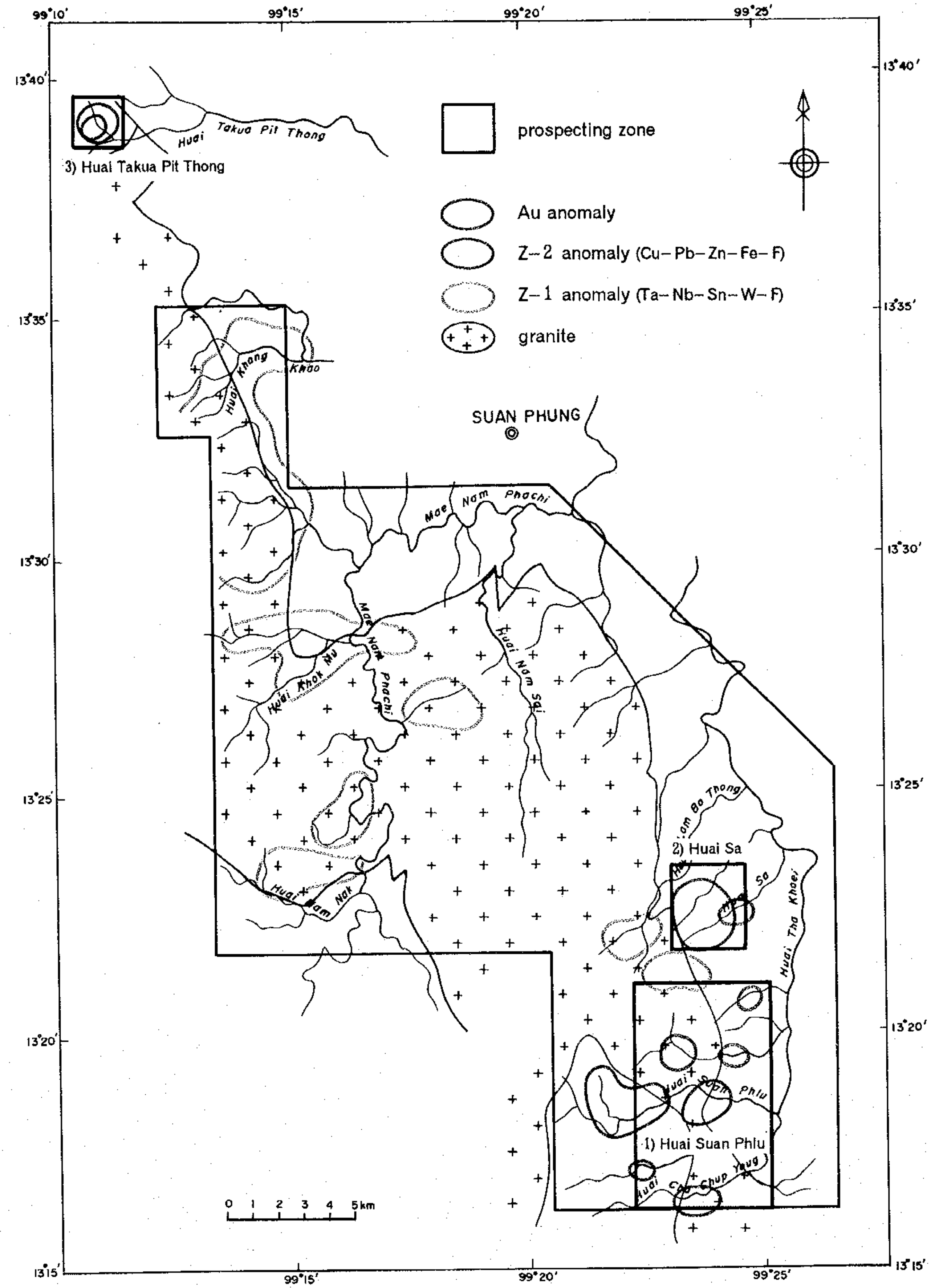


Fig.38 Interpretation map of Ratchaburi area

where there are many old deposits, and anomaly zones are distributed in the old deposits and background granite zones. On the other hand, in many cases no anomaly zones are seen in the granite zones and old mining site in the Huai Tha Khoei basin. It suggests that the erosion level of granite body is different at Mae Nam Phachi and at Huai Tha Khoei. It is likely that at Mae Nam Phachi shallow facies of granite that can still supply tin, niobium and tantalum in the stream has been exposed, and at Huai Tha Khoei regions deeper facies which contains tin-tungsten minerals not so much has been exposed. As for the north and south of the Huai Tha Khoei basin, it is assumed that there is less erosion the south where there are large distributions of sedimentary rock.

The anomaly zones conform to already known deposits and there is little possibility of the existence of new deposits.

The anomaly zones for gold and base metals are concentrated in the roof pendant Thung Song Group at Huai Takua Pit Thong in the north of the area, and in the contact zone between sedimentary rock and granite in the south of the area.

As mentioned earlier, the quartz veins are well developed in these areas, but there are few alteration zones and the existence of contact metasomatic-type deposits and / or stockwork-type quartz vein deposits lying near granite can be expected.

Mineralization in the Ratchaburi area includes deposits related to the Jurassic-Cretaceous granite, pneumatolytic to katathermal deposits of tin, tungsten, niobium and tantalum, contact replacement deposits observed at Huai Takua Pit Thong, and stockwork-type quartz vein deposits in the southeast of the area.

Promising regions are the Huai Takua Pit Thong region where gold and base metals can be expected, and the Huai Sa and Huai Suan Phlu regions where stockwork-type gold deposits can be expected (Fig.38).

PART Ⅲ CONCLUSION AND RECOMMENDATION

CHAPTER 1 CONCLUSION

In the first year of the survey, geologic surveys and geochemical prospecting were carried out with the aim of selecting promising regions from 3 areas extending over 1800 km^2 in the Kingdom of Thailand: Chiang Khong and Doi Chong areas in the north and Ratchaburi area in the west. The following conclusions were reached.

1-1 Chiang Khong Area

(1) The Chiang Khong area is composed of Permian sedimentary rock including sandstone, mudstone, conglomerate and limestone, Permo-Triassic andesitic and rhyolitic lava, tuff and tuff breccia, Triassic granite, Jurassic andesite, Jurassic red siltstone and sandstone, Pliocene siltstone, Plio-Pleistocene basalt.

(2) The overall survey area consists of a mountainous region extending NE-SW, and a tendency is seen for the distribution of the various strata to continue virtually in harmony with this direction. The lowest level Permian stratum shows a synclinal structure with its axis in the center of the mountainous region. Permo-Triassic volcanic rock accompanied by tuff covers the Permian system unconformably and is distributed in two parallel zones running NE-SW. It is likely that andesite was active along fractures running in this direction.

The faults or lineaments in the Chiang Khong area have developed in a NE-SW direction along the synclinal axis of Permian sedimentary rock, and there are noticeable faults crossing them obliquely in an ENE-WSW direction. The lineaments are more developed in the north than in the center of the Chiang Khong area. Distribution of Jurassic andesite and alteration zones in the north is controlled by these fault systems.

(3) These mineralizations occur with Permo-Triassic volcanic rocks and in parts, Permian sedimentary rocks. This alteration zone covers 3km wide by 12km long along the fault zone which runs in a NE-SW direction accompanied by Jurassic andesite. It is likely that in the north, mineralization occurred due to the activity of Jurassic andesite. In the south alteration pattern is similar to that in the north, but the Jurassic andesite is not observed. It thinks that the Triassic granite concerned mineralization in the south of area.

(4) From mutual examination of the results of the geologic surveys and geochemical prospecting, the following promising regions were selected.

1) Upper reaches of Nam Sala (20 km^2)

The fault systems running NE-SW and ENE-WSW and accompanied by activity of Jurassic andesite have developed conspicuously. White alteration zones accompanied by limonite-quartz veins extend along the fault systems. Au-Hg(-Ag-Pb) geochemical anomaly zones are distributed accompanying the alteration zones. Also the anomaly zone of As, Sb are observed. Gold anomaly in this zone is 30 to 770ppb, and gold flakes were ditected by panning. It is a high potential area for gold and epithermal vein deposits containing gold can be expected.

2) Nam Mae Bong region (20 km^2)

This region covers the southwest part of the upper reaches of Nam Sala and the southwest part of the fault and alteration zones extending from Nam Sala. Fe-Zn-Cu-Pb-Mn geochemical anomaly zones are distributed in the region. Also gold anomalies ranging from 10 to 60ppb are overlaping in the north of this region. Vein-type deposits of base metals and gold can be expected in this region. Gold anomaly zones are also distributed further to the southwest, but anomalies are less than 36ppb.

3) Upper reaches of Huai Mae Liap (10 km^2)

There are few outcrops and the geological condition is not clear in many places, but most of the region is composed of Permian slate and not many alterations are seen. In addition to Au-Hg-As-Sb, there are distributions of Cu and S geochemical anomaly zones.

4) Huai Mai Ya region (12 km^2)

This region is composed of Permian sedimentary rock and Permo-Triassic andesite and tuff. The tuff has altered intensely and Cu, Zn, Fe, Hg, S, As and Sb geochemical anomaly zones accompanied by quartz veins are seen, with Au anomaly zones in some parts. Vein deposits of base metals containing gold can be expected.

1-2 Doi Chong Area

(1) The geology of the Doi Chong area is composed, from below, of Carbono-Siluro-Devonian Mae Tha Group and Donchai Group, Kiu Lom Formation, Pha Huat Formation and Huai Thak Formation of the Permian Ratburi Group, Permo-Triassic volcanic Formation, Triassic Lampang Group Hong Hoi Formation and Triassic intrusive granite and diorite.

(2) There are assumed to be faults running NW-SE, N-S and NW-SE in the survey area. In particular, the faults running NNW-SSE 'N-S along Huai Mae Thot are assumed to be relatively large-scale reverse faults.

The Carbono-Siluro-Devonian and Permian geologic structure on the whole runs NNW-SSE and the upper strata overlie towards the NE. Also, Permo-Triassic volcanic rock and Triassic system are distributed, covering them unconformably.

However, judging by the fault along Huai Mae Thot, the east side of the fault is thought to have risen in relation to the west and the lower Permian stratums is exposed, with the fault as the boundary. The intrusive direction of the granite also conforms to the direction of the fault.

(3) Quartz veins have developed accompanied by small-scale silicified zones in the environs of granite bodies and small veins of aplite. Also, large-scale silicified zones are distributed around the diorite in the upper reaches of Huai Mae Toen. No ore-bringin igneous rock exists expecting

granite and diorite. Mineralization in the Doi Chong area is thought to be mainly connected with Triassic plutonic rocks.

(4) From mutual examination of the results of the geologic surveys and geochemical prospecting, the following promising regions have been selected.

1) Huai Mae Pu region (14 km^2)

Geochemical anomaly zones for base metals and Au, Sb and Hg accompanied with the volatile elements such as As, Hg are seen over an extremely wide area extending from Huai Mae Pu to Huai Mae Haet in the west.It seems that hydrothermal minaralization occuered in this region. Geologically, the Permian sandstone layer is prevalent, but according to local people, there was once an antimony mine. Polymetallic hydrothermal vein deposits can be expected.

2) Doi Khun Mae Thot region (24 km^2)

Many seams of granite and aplite have intruded into the Permian sandstone and mudstone along the schistose structure. There are also many quartz seams and silicified zones have developed in some parts.

Geochemical anomaly zones for Au and the parent elements of Hg and Sb are distributed running E-W along the sides of Doi Khun Mae Thot and As geochemical anomaly zones are distributed continuously to the south of these anomaly zones.

Also, geochemical anomaly zones for base metals are distributed at the foot of the mountain. Hydrothermal Au vein deposits and mineralization of base metals below them can be expected.

3) Region of upper reaches of Huai Mae Toen (18 km^2)

Geochemical anomaly zones for base metals (Cu, Zn and Fe) are distributed overlapping distribution of diorite in the upper reaches of Huai Mae Toen, silicified zones that have developed in the vicinity, and subsurface granite (diorite) to the south. An anomaly zone for the single element of gold (2,180ppm) is distributed overlapping these zones. Chalcopyrite is disseminated in the diorite, though in small quantities. Metasomatic and hydrothermal deposits of base metals can be expected.

4) Northern region of Ban Na Ban Rai (2 km^2)

Small granite bodies have intruded into the Permian semi-schist in the area where local people excavated gold. Au and Hg geochemical anomaly zones are distributed here. It is already known for mineral occurrences at the surface, but more detailed assessment is required in deeper part.

5) Mae Haet region (9 km^2)

As there are hardly any outcrops in the flat lands between Huai Mae Haet and Huai Mae Tam, the geological condition is not clear. Anomaly zones of base metals (Fe, Cu and Zn) and Hg and Sb are distributed here and hydrothermal base metal deposits can be expected.

6) Eastern region of Huai Mae Thot (20 km^2)

Geochemical anomaly zones for niobium and tantalum are extremely strong in the vicinity of granite zones to the east of Huai Mae Thot. In addition to niobium and tantalum, other rare earth element deposits can also be expected.

1-3 Ratchaburi Area

(1) The Ratchaburi area is composed of Ordovician Thung Song Group, Silurian-Devonian Kanchanaburi Group, Devonian-Carboniferous Kaeng Krachan Group Huai Phu Ron Formation, Kao Phra Formation and granite that has intruded into the Jurassic-Cretaceous.

(2) On account of the intrusion of granite, the sedimentary rock structure shows fragmental distribution, but the schistosity and sedimentary structures run in a NW-SE direction and there is a tendency for new strata to overlie on both sides of the Silurian-Devonian anticlinal structure.

The granite bodies are part of a giant batholith which has intruded along the Thai-Myanmar border, and the intrusive direction of the batholith on the whole conforms to the structure of the sedimentary rock. Lineaments running NE-SW to NE-SS W are conspicuous in the granite distribution zone.

(3) From mutual examination of the results of the geologic surveys and geochemical prospecting, the following promising regions have been selected.

1) Huai Suan Phlu region (34 km^2)

2) Huai Sa region (9 km^2)

Both region are located in the contact zone between granite and Devonian-Carboniferous sedimentary rock and narrow quartz veins have developed in the sedimentary rock. In addition to the anomaly zone just for gold, the region also shows an anomaly zone for base metals. The two anomaly zones overlap in few places and the gold anomaly zone tends to be distributed in the vicinity of the base metal anomaly zone. Judging from the fact that hardly any alteration zones are seen, mineralization of stockwork-type quartz veins that have developed near the granite bodies can be expected.

3) Huai Takua Pit Thong region (4 km^2)

Slate, calcareous mudstone and limestone are found in the granite and have undergone thermal metamorphism. Ploymetallic contact metasomatic deposits can be expected.

CHAPTER 2 RECOMMENDATION FOR THE SECOND PHASE SURVEY

The following surveys are recommended of the promising regions mentioned previously.

2-1 Chiang Khong Area

With regard to the upper reaches of Huai Sala in 1) and the Nam Mae Bong region in 2), in addition to conducting geochemical prospecting of the soil at random points using the ridges and streams (at intervals of about 50m) and detailed geologic investigation, electrical prospecting by specific resistance or the IP method should be carried out to narrow down the more promising zones.

With regard to the upper reaches of Huai Mae Liap in 3) and the Huai Mai Ya region in 4), considering that the type of mineral deposits is not clear, detailed geologic investigation and detailed geochemical prospecting of the stream sediments should be conducted to narrow down the promising zones and clarify the mineralization situation.

2-2 Doi Chong Area

With regard to the Huai Mae Pu region in 1) and the upper reaches of Huai Mae Toen in 3), as the whole range of mineral occurrence has not always been grasped, detailed geologic surveys and detailed geochemical investigation of stream sediments should be carried out to clarify the scale of mineral occurrence and narrow down the promising regions.

With regard to the Doi Khun Mae Thot region in 2), detailed geochemical investigation of the soil using the streams and ridges and detailed geologic surveys should be carried out to narrow down the more promising regions.

With regard to the northern part of Ban Na Ban Rai in 4), in addition to carrying out detailed geochemical prospecting of the soil by grid method to specify the location of promising quartz veins, the continuity of the quartz veins to deep parts should be grasped by electrical prospecting, etc. Where necessary, pits should be dug to confirm the grade and existence of quartz veins.

With regard to the Huai Mae Haet region in 5), exposure is poor and the mineralization pattern is not clear. Considering that the topography is flat, the promising regions should be narrowed down by geochemical prospecting of the soil and detailed geologic surveys and the mineralization pattern clarified.

With regard to the region east of Huai Mae Thot in 6), as the mineral occurrences are outside the mineral types under this survey, the pathfinder elements should be changed and detailed geochemical prospecting carried out. Reassessment is necessary.

2-3 Ratchaburi Area

It may be possible to clarify the origins of placer gold not previously specified. For this reason, detailed geologic surveys and detailed geochemical prospecting of stream sediments should be carried out to clarify the existence of quartz veins and mineral occurrence.

REFERENCES

Bunopus, S., 1982: Paleogeographic history of Western Thailand and adjacent parts of Southeat Asia - A plate tectonics interpretation. Geological Survey paper No.5, DMR, 810p.

Bunopus, S., 1992: Reginal Stratigraphic Correlation in Thailand. Proceeding of a National Conference on "Geologic Resources of Thailand: Potential for Future Development", DMR, 107-110.

DMR, 1971: Geological map of Thailand,1:250,000,Changwat Lampang. NE47-17, Geological survey division, Department of Mineral Resources.

DMR, 1974: Geological map of Thailand,1:250,000,Changwat Uttaradit. NE47-11, Geological survey division, Department of Mineral Resources.

DMR, 1985: Geological map of Thailand,1:250,000,Changwat Nakhorn Pathom. ND47-11, Geological survey division, Department of Mineral Resources.

German Geological Mission in Thailand, 1976: Geological Map of Northern Thailand 1:250000: Sheet 2 Chiang Rai. Federal Institute for Geosciences and Natural Resources, Hannover.

Govett,G.J.S., 1983. Handbook of exploration geochemistry,Volume 2. Statistic and Data Analysis in Geochemical Prospecting. ELSEVIER SCIENTIFIC PUBLISHING COMPANY, 437p.

Hahn, L., and Siebenhüner, M., 1982: Explanatory Notes (Paleontology) on the Geological Maps of Northern and Western Thailand 1:250,000, (Sheets Ann, Chiang Rai, Phayao, Chiang Dao, Chiang Mai, Li, Thong Pha Phum). Bundesanstalt für Geowissenschsften und Rohstoffe, Hannover, 76p.

Jungyusuk, N. and Sirinwin, T., 1983: Cenozoic Basalts of Thailand. Preprint Conference "Geology and Mineral Resources of Thailand", Bangkok, Thailand

Kenting Earth Sciences International Limited, 1989: Interpretation Report for Airborne Geophysical Survey of The Mineral Resources Development Project. Volume X, Mapsheet NE 47-11. 25p.

Kenting Earth Sciences International Limited, 1989: Interpretation Report for Airborne Geophysical Survey of The Mineral Resources Development Project. Volume XXXI, Mapsheet ND 47-11. 23p.

Kumachan, P., 1989: Gold Occurrence in the Upper Paleozoic-Mesozoic Volcanic Rocks of Thailand. Economic Geology Report No.7, DMR, 26p.

Lepeltier, C., 1969: A simplified statistical treatment of geochemical data by graphical representation. Econ. Geol.,64,538-550.

Mahawat, C., Atherton, M.P. and Brotherton, M.S., 1990: The Tak Batholith, Thailand: the evaluation of contrasting granite types and implications for tectonic setting. Journal of Southeast Asian Earth Scienès, Vol. 4, No.1, 11-27.

Potisat, S., 1992: Geological Setting, Characteristics and Regional Exploration for Gold along Lampang-Phrae Volcanic Belt. Proceeding of a National Conference on "Geologic Resources of Thailand: Potential for Future Development", DMR, 420-433.

Sinclair,A.J., 1976: Application of probability graphs in mineral exploration. Special volume No.4, The Association of Exploration Geochemists.

Suthakorn, P. and Udomporwirat, S., 1991: Geological Survey of Tin Deposits around Central Amphoe Suan Phung, Changwat Ratchaburi (in Thai). Economic Geology Report, No.4, DMR, 198p.