

COMPARISON OF QUATERNARY DEPOSIT ENVIRONMENT AMONG LUSHAN, HUANGSHAN AND TIANMU MOUNTAINS

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ABSTRACT: The data of $\text{Fe}^{3+}/\text{Fe}^{2+}$ show that the lowest annual air temperature of the Lushan, Huangshan and Tianmu mountains was not below 0°C , therefore, glacier couldn't develop in these regions. According to palaeomagnetic test combined with the phenomenon of reticulate pattern ground and lithologic identification, the authors elaborate that the "Poyang moraine" is mainly the fluvial sediments of the early period of the Middle Pleistocene. It was formed by transportation of the ancient Ganjiang River under the humid hot climate. For CM image, the Dajiaochang profile of the Lushan Mountain is very similar to periglacial and the debris flow deposits, but the profile of Jiangpochang and Yaoshaling have many kinds of geneses, i. e., debris flow, water debris flow and alluvial etc. In the south piedmont of the Huangshan Mountain, slope gravity and slope seasonal running water transportation are mainly deposit factors. In the "glacial varve" of the Denglongqiao profile of the Tianmu Mountain, its CaO and Na_2O content is lower than the nonglacial varve, the fact shows that it has the features of the violent leaching, weathering and nonglacial action.

KEY WORDS: Lushan Mountain, Huangshan Mountain, Tianmu Mountain, Quaternary deposit environment

The Quaternary paleo-environment of the Lushan, Huangshan and Tianmu mountains is a significant academic problem to which much attention has been paid by many researchers in geoscience circle. Many scholars have studied the problem and got a lot of achievements over the past years (Lee, 1933; Lee, 1936; Lee, 1947; Ren, 1953; Huang, 1963; Li, 1974; Shi, 1989). However, identical views and conclusions have not been reached yet up till now, especially lacking of comprehensive study for sediments in these regions. In recent years, applying sedimental comprehensive index got from various experiments and analyses to resolve some important geoscientific problems has greatly succeeded (Shi, 1989; Liu, 1985). Based on extensive field investigations and sediment analysis such as $\text{Fe}^{3+}/\text{Fe}^{2+}$, paleomagnetism, pollen, clay mineral, oxide, lithological and material sources identification well as neotectonic movement and reticulate pattern ground analyses, the authors got the following new results of the

I. PALEOTEMPERATURAL CHARACTERISTICS INFERRED
FROM $\text{Fe}^{3+}/\text{Fe}^{2+}$ VALUES

Ferrite in strata is one of the most sensitive elements to climatic changes. In recent years, some scholars(Zhou, 1984; He, 1989; Zhu, 1994; Zhu, 1995) have applied $\text{Fe}^{3+}/\text{Fe}^{2+}$ values from the Quaternary sediment to infer palaeoclimatic changes.

The authors selected 4 representative profiles with large thickness, i. e. Dajiaochang in the Lushan Mountain, Jiangpochang at the eastern piedmont of the Lushan Mountain, Xiaoyaoxi in the Huangshan Mountain and Yaoshaling in the Tianmu Mountain to conduct $\text{Fe}^{3+}/\text{Fe}^{2+}$ analysis. The thicknesses of the profiles are 6.4 m, 18.5 m, 5.8 m and 12.5 m respectively, and the number of specimens from each profile in turn are 10,9,8 and 8 (Fig. 1).

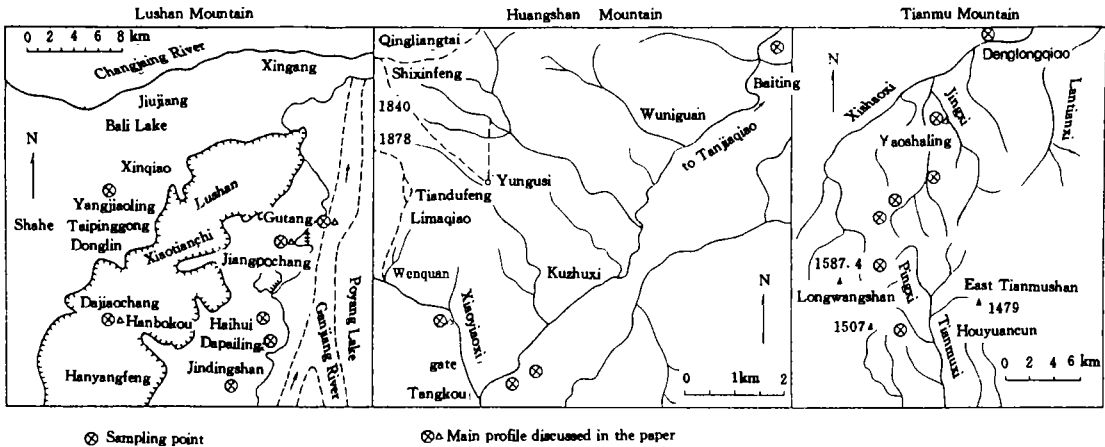


Fig.1 Sampling point position of Lushan (A), Huangshan (B) and Tianmu(C) mountains

Specimens are analysed by Modern Analysis Centre of Nanjing University using redox titrimetry method(Zhu, 1994). It is believed that the present mean annual temperature is between the coldest and the warmest in the Quaternary period(Zhou, 1984), and there exists linear correlation between the intensity of mineralization of hemitite and cold-warm changes of the Quaternary climate, it can be explained in detail that the higher the intensity of mineralization of hemitite was, the wetter and warmer the paleoclimate was. On the contrary, it should be colder and drier. Based on the above relation, if the $\text{Fe}^{3+}/\text{Fe}^{2+}$ values of each specimen of different profiles are added up, then their mean values should approach the present annual mean temperature. Thus, it can be described more specifically that: first, calculating the $\text{Fe}^{3+}/\text{Fe}^{2+}$ values, then taking their average in each stratum, finally, comparing the former with the latter, if the former is below the latter, it shows that the annual mean paleotemperature is below that of present, or it should be higher.

It is generally considered that temperature falls 0.6°C when elevation increases 100 m, so we can work out the following temperatures; the present annual mean temperature in Da-jiaochang (1060 m a. s. l.) is 12°C or so, regarding 11.4°C in Guling (1164 m a. s. l.) of the Lushan Mountain as a referred value (Shi, 1989), the present annual mean temperature of Jiangpochang (32 m a. s. l.) is about 17°C , referring that of Jiujiang City, and Xiaoyaoxi about 13.6°C , regarding that of the same altitude observed by Taiping observatory, Yaoshaling of the Tianmu Mountain 14.9°C , based on the data of the piedmont observatory at about 300 m a. s. l. On the bases of the above temperatures, we can obtain the inferred temperature of Quaternary in the three regions (Table 1).

From Table 1, it is easy to find that the lower temperatures in turn in the four profiles are 2.82°C , 7.62°C , 11.42°C and 3.41°C , the higher temperatures are 19.60°C , 21.19°C , 14.24°C and 20.39°C accordingly.

Although much work such as densely sampling analysis should be done, the above results are enough to prove that the three regions didn't develop glaciers during the Quaternary because of the mean temperature above 0°C .

II. RESULTS OF PALEOMAGNETIC MEASUREMENT

In the three regions 288 specimens were collected, and analysed by paleogeomagnetic laboratory of Chengdu Institute of Geology and Mineral Resources, Ministry of Geology and Mineral Resources. It can be found that polarity between 23.87 and 47.75 A/mm is the stablest during alternating field demagnetization, so the residual magnetization of the range were taken as an eigen value, then a polarity column of magnetic strata can be figured out. The authors have discussed the results of paleomagnetic measurement and lithological and material source identification about the Quaternary strata in Lushan area (Zhu, 1994), so there is no need to talk the problem again in this paper. Fig. 2 is a comparison map of paleomagnetic time scale among the three regions.

It must be pointed out that we have referred to the results of pollen, sediment features, magnetic susceptibility, elements and oxides analyzes as well as the data of paleomagnetism concerned in these regions (Xing, 1989) and ^{14}C dating in the Holocene (Shi *et al.*, 1989) and the strata table of East China when we confirm the time of each profile.

Based on the features of the magnetic strata of each profile, some new knowledge can be concluded as follows:

1) The Quaternary profiles in the three regions are dominated by normal polarity. Except for Jiangpochang in the Lushan Mountain and Denglongqiao in the Tianmu Mountain with obvious Matayama polarity in the lower Pleistocene strata, the other profiles lack of Q_1 strata. It can recognize the B/M boundary of polarity column at the depth of 22 m of the Jiangpochang profile of Lushan area, with the thickest Q_1 strata and successive deposit. This polarity column is identical with those of Lake Biwa in Japan and A. Cox's polarity roughly.

2) Over many years, scholars have considered that reticulate red ground developed under the wet and hot climate during the Middle Pleistocene epoch, but they neglected the important

Table 1 The Quaternary paleotemperature inferred by $\text{Fe}^{3+}/\text{Fe}^{2+}$ values

Profiles	Sample number	Depth (m)	Present annual air temperature (°C)	Fe^{3+} (%)	Fe^{2+} (%)	$\text{Fe}^{3+}/\text{Fe}^{2+}$ (X_n)	Mean value of $\text{Fe}^{3+}/\text{Fe}^{2+}$ of samples from one profile (\bar{X})	Difference between $\text{Fe}^{3+}/\text{Fe}^{2+}$ of individual sample and \bar{X} (M)	Inferred mean annual palaeo air-temperature (°C)
Dajiao-chang	L ₁₀	1.0	12	4.75	0.54	8.80	37.49	-28.69	2.82
	L ₉	2.3		4.19	0.09	46.56		9.07	14.90
	L ₈	2.8		6.08	0.12	50.67		13.18	16.22
	L ₇	3.5		2.45	0.09	27.22		-10.27	8.71
	L ₆	3.8		5.51	0.09	61.22		23.73	19.60
	L ₅	4.1		3.89	0.07	55.57		18.08	17.79
	L ₄	5.2		3.03	0.13	23.31		-14.18	7.46
	L ₃	5.6		2.60	0.15	17.33		-20.16	5.55
	L ₂	6.0		2.22	0.05	44.40		6.91	14.21
	L ₂	6.2		2.39	0.06	39.83		2.34	12.75
Jiang-pochang	J ₉	5.5	17	8.80	0.11	80.00	64.18	15.82	21.19
	J ₈	8.1		8.79	0.12	73.25		9.07	19.40
	J ₇	9.5		4.97	0.09	55.22		-8.96	14.63
	J ₆	11.0		5.28	0.10	52.80		-11.38	13.99
	J ₅	12.0		4.23	0.09	47.00		-17.18	12.45
	J ₄	14.3		3.69	0.05	73.8		9.62	19.55
	J ₃	16.4		2.59	0.09	28.78		-35.40	7.62
	J ₂	17.5		2.99	0.09	33.22		-30.96	8.80
	J ₁	18.5		3.84	0.06	64.00		-0.18	16.95
Xiao-yaoxi	H ₈	3.3	13.6	8.50	0.37	22.97	25.34	-2.37	12.33
	H ₇	4.0		9.23	0.41	22.51		-2.83	12.08
	H ₆	4.5		9.46	0.40	23.65		-1.69	12.69
	H ₅	5.0		9.42	0.43	21.91		-3.43	11.76
	H ₄	5.45		9.55	0.36	26.53		1.19	14.24
	H ₃	5.95		9.36	0.44	21.27		-4.07	11.42
	H ₂ *	6.5		7.56	0.20	37.80		12.45	20.29
	H ₁ *	7.0		8.93	0.40	22.33		-3.01	11.98
Yao-shalin	T ₈	2.9	14.9	4.18	0.08	52.25	18.60	-66.35	6.56
	T ₇	3.7		4.34	0.16	27.13		-91.47	3.41
	T ₆	7.9		7.83	0.05	156.60		38.00	19.67
	T ₅	9.1		4.71	0.07	67.29		-51.30	8.45
	T ₄	9.8		4.11	0.06	65.50		-50.10	8.61
	T ₃	10.7		9.74	0.06	162.33		43.73	20.39
	T ₂	11.5		3.38	0.11	34.36		-84.24	4.32
	T ₁	12.2		5.14	0.05	102.80		-15.80	12.92

* Sample H₁ and H₂ are metamorphic sandstone of the lower Proterozoic group, listed here only for comparison

phenomenon of the sediments in Poyang Lake shore near Gutang, indicating normal polarity and reticulation when they divided the strata. By means of paleomagnetism measurement, it

proves that the “moraine” from Gutang indicates normal polarity, moreover, the profile consists of pink mud and gravel composite among which the gravels are well rounded and most of

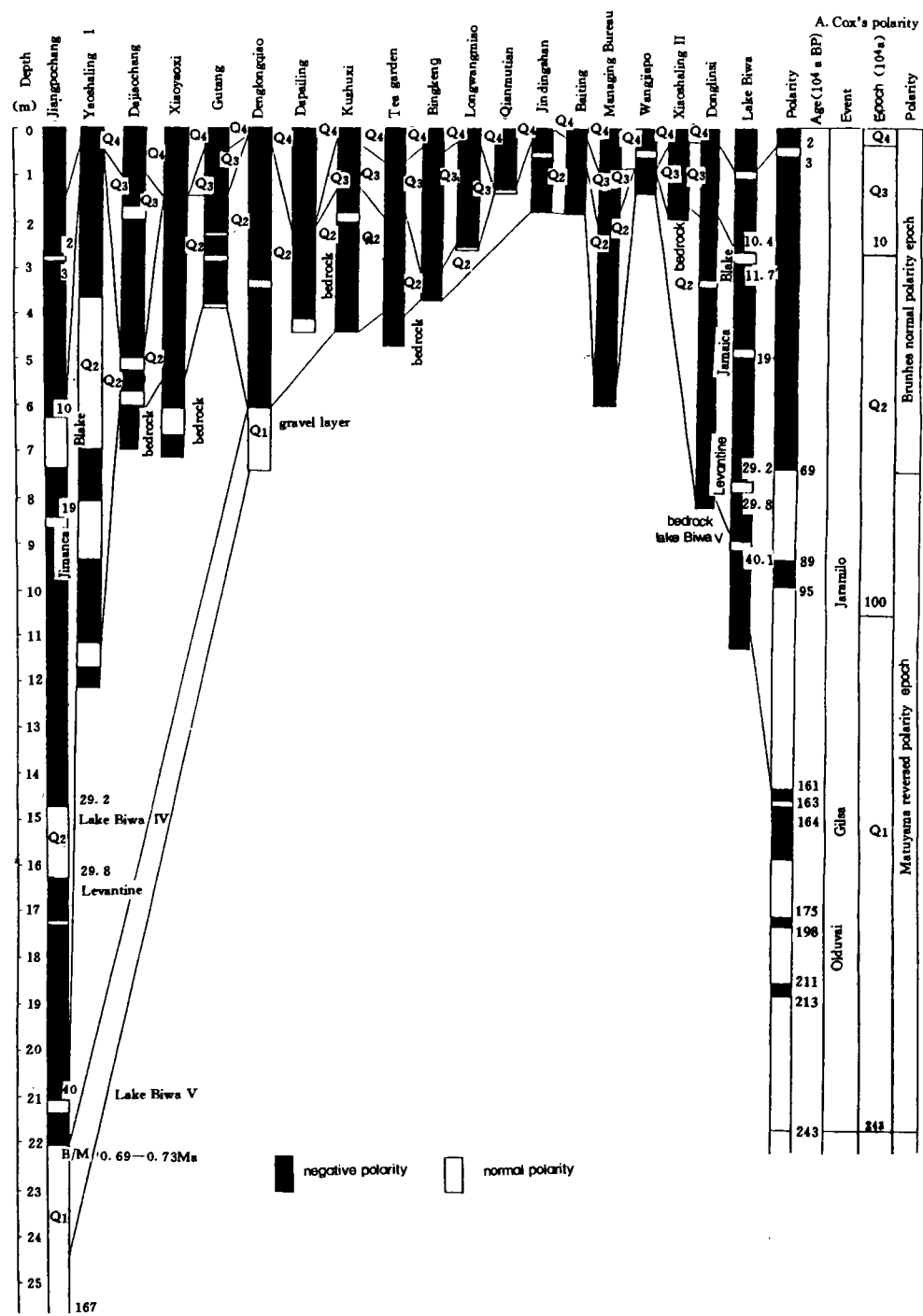


Fig. 2 Comparison of paleomagnetic time scale among Lushan, Huangshan and Tianmu mountains

them have a diameter of 10 – 20 cm, under polarizing microscope, we can find that they consist of pink quartzite, yellow metamorphic quartzite, grayish yellow feldspathic quartzose sandstone or black felsite, which are not in accord with greyish white feldspathic sandstone, pink phyllite, grey quartzose diorite, greyish black quartz porphyry along the Xiaotianchi at head of “Wangjiapo glacial valley” proposed by Mr. Li Siguang, but it is similar to the lithologic assemblage of Baishajing group (Q_2) in the upper reaches of the Ganjiang River and Poyang Lake. So it can be considered that so-called ‘Poyang moraine’ is actually the sediment, which is synchronous to reticulate red ground (Q_2) of the Middle Pleistocene, in genesis, it should belong to fluvial deposit mostly and lake facies as well as pluvial facies.

3) Combining the profile features, the polarity of Dajiaochang profile of the Lushan Mountain is mainly normal polarity, it can be divided into the following three parts: A. the Middle Pleistocene series at the depth of 5.0 – 6.3 m; B. the Upper Pleistocene series at 1.2 – 5.0 m or so and C. the Holocene series at 0 – 1.2 m. Its paleomagnetic features have been discussed in another paper(Zhu, 1995) so it is no longer described in this paper.

4) Xiaoyaoxi profile in Huangshan Mountain dominated by Brunhes normal polarity. Compared other profile, it can be found that the profile lacks of Q_1 and Q_2 strata, and it has no obvious reticulated phenomena in Q_2 strata. It can infer that material from high position accumulated at the piedmont after Huangshan uplifted greatly in the Late Middle Pleistocene. So its altitude was higher at that time, and the wet-hot climate was not so obvious as that of the beginning of the Middle Pleistocene, the Q_2 strata of this profile only shows deep red but no reticulation. The authors also considered that the reason of lacking of Q_1 and Q_3 strata may be attributed to a small-scale uplift and erosion environment(Zhu *et al.*, 1995) in this region.

III. POLLEN FEATURES

The pollen of the Quaternary, especially the Pleistocene, in these region are very few. Total 48 pollen specimens were collected, among them, 35 specimens contain 51 species pollen including 30 xylophyta, 21 herb, 5 Pterodophyte and 1 algae. Now the main profiles are described as follows:

1) Dajiaochang of the Lushan Mountain In the Middle Pleistocene series strata, at the depth of 5.95 m there are a lot of pollen, including Xylophyta such as *Fagus*, *Juglans*, *Liquidamber*, *Betula*, *Quercus*, *Eurga*, Cupressaceae, *Ulmus* and Euphorbiaceae, and herbs, for example, Leguminosae, Rosaceae, Chenopodiaceae, *Typha*, Verbenaceae, Rununculaceae, Cyperaceae and Sparganiaceae. But the 5.7 m and 6.15 m depths contain little pollen, the former contains several *Pinus*, *Tsuga*, Gramineae, Cyperaceae and *Pteridium*, the latter only contains *Pinus*. The specimens at 4.3 m depth contain a little pollen, including *Pinus*, *Betula*, Rosaceae, Gramineae, *Artemisia*, Adiantaceae and *Myriophyllum*, but only *Pinus* was found in the other two specimens at 2.8 m and 1 m depth. Based on the above facts, the authors think that the quantity of pollen relates to hydrodynamic intensity, that is, at the parts

containing much pollen the sediments' grain size is generally fine (Fig. 3), e.g. at 5.9 m and 2.3 m there are fine sand and gravellens, indicating weaker hydrodynamic environment, whereas at the parts with little pollen the grain size is rather coarse (mainly grit), indicating stronger hydrodynamic condition or under extreme dry-cool periglacial environment. Therefore, it must experience low-temperature environment at the beginning of the Holocene at 1 m depth. In view of pollen assemblage, the Middle Pleistocene strata at 5.95 m depth contain many warmphilous broadleaf trees , such as *Fagus* , *Juglans Liquidamber* , reflecting

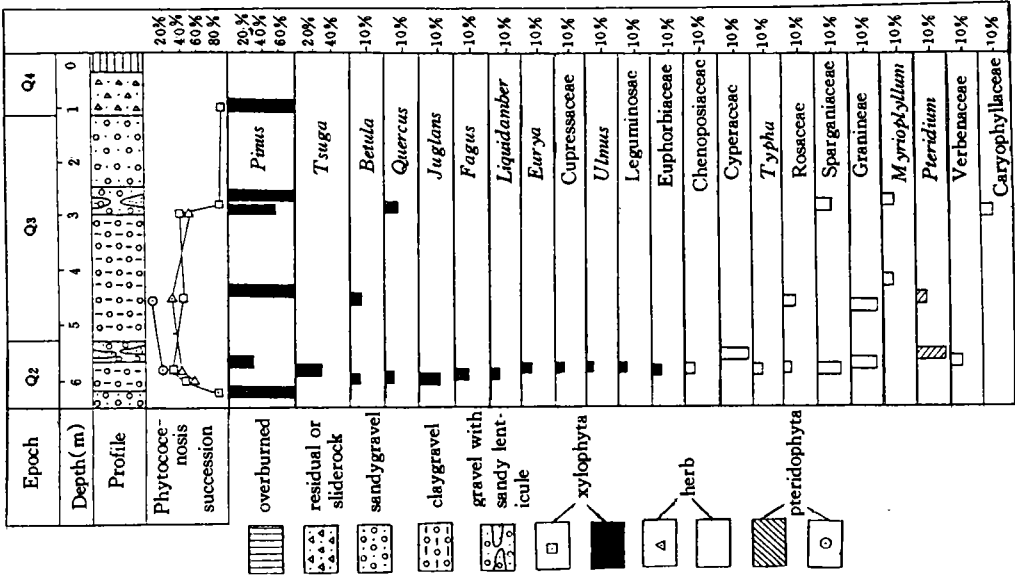


Fig.3 Pollen diagram of Dajiaochang profile in the Lushan Mountain

warm and humid deposit environment. Compared with paleotemperature inferred from Fe^{3+} / Fe^{2+} (Table 1), it can be found that the higher temperatures (14.21℃ at 6.0 m, 17.79℃ at 4.1 m, 16.22℃ at 4.1 m) are identical with much pollen and warphilous broadleaf trees at 5.9 m, 4.3 m and 2.9 m respectively. Meanwhile, the lower temperatures (2.82℃ and 5.55℃) are identical with little pollen or pollen dominated by herbs, at 1 m and 5.7 m respectively. The above facts show indirectly that the higher parts (above 1000 m a.s.l.) of Lushan experienced obvious cold-hot changes during the Quaternary. According to pollen assemblage, during the period of the Middle and Late Pleistocene, Lushan haas ever experienced more wet-hot environment with many warmphilous broadleaf trees, because of little pollen or much herbs pollen and coarse sediments, it can be considered that clod environment should belong to dry-cold or dry-cool periglacial environment.

2) Jiangpochang profile Nine speciments were analysed, but only 2 speciments (at 10.75 m and 3.00 m)contain pollen. Both of them consist of reticulated clayey gravel, belonging to the Middle and Late Pleistocene series respectively, the former contains very little pollen of *Pinus*, *Artemisia* and Polypodiaceae, and the latter contains a little pollen such as *Pinus*,

Tsuga, *Selaginella*, *Artemisia*, *Adiantaceae* and *Polypodiaceae*. In addition, large scale cross-bedding and river facies deposit rhythmite can be seen in this profile. So we can determine that the lack of pollen was mainly caused by very strong hydrodynamic condition. As for paleoclimate, at that time the mean annual temperature did not reach below 0°C (referring to Table 1).

3) Xiaoyaoxi profile of the Huangshan Mountain Pollen was discovered in two specimens of the Middle Pleistocene series in this profile, the specimen at 5.95 m contains little pollen, only *Pinus*, *Quercus* and *Typha* but the other at 3.3 m contains much pollen such as *Pinus*, *Quercus*, *Liquidamber*, *Myricaceae*, *Aquifoliaceae*, *Carpinus*, *Oleaceae*, *Rosaceae*, *Myriophyllum* and *Kerbenaceae*. They reflect the difference between dry-cool (the former) and warm-wet (the latter) climate, which is identical with the results listed in Table 1.

4) Yaoshaling profile of Tianmushan Only specimens at 12.2 m and 9.1 m of the Middle Pleistocene series (12 m thickness totally) contain some pollen, such as *Pinus*, *Quercus*, *Juglans*, *Taxodiaceae*, *Carpinus*, *Lonicera confusa*, *Artemisia*, *Typha*, *Polypodiaceae*, *Gramineae*, *Pteridium* for the former and *Pinus*, *Juglans*, *Corylus*, *Gramineae*, *Artemisia*, *Polypodiaceae*, *Pteridium* for the latter respectively.

Table 1 shows that the paleotemperatures of the two depths were 12.92°C and 8.45°C accordingly. The former developed under warm and humid climate, and the latter under cool-wet climate. Little pollen was discovered in the strata at 3.4 m, 9.8 m, 11.2 m. Table 1 also shows that they developed during low temperature period (3.41–8.61°C). The lack of pollen is related to the paleoclimate turning to cold, whether it is related to hydrodynamic intensity of the mouth of Jingxi River should be further studied and verified.

5) There exists a pollen assemblage in the Longwangmiao profile of the Tianmu Mountain, which consists of a great deal of monoraphe spores of *Polypodiaceae*, *Abies* and a few *Tsuga*, *Alnus*, *Pinus*, *Tilia*, *Artemisia*, *Gramineae*, *Nymphaeaceae* and *Botrychium*, indicating cold-wet climate. And its age is about 17560 ± 367 a B. P. (Shi, 1989) by means of ^{14}C dating. Besides affected by global climate, the cold-wet environment is related to the leeward slopes of the deep and narrow valley. According to sedimental and pollen features and the paleotemperature inferred from $\text{Fe}^{3+}/\text{Fe}^{2+}$, it must be cold-wet environment, not glacial sediment environment.

IV. RESULTS OF OTHER ANALYSES

Besides the above analyses, the grain size, clay mineral, elements and oxide analyses of sediments in these regions, have also conducted, now here are the results in brief.

1) According to grain size parameters, frequency curves, CM image, it can be concluded that most C values of main profiles exceed 1000 μ , while the M values do not fluctuate obviously. Most of the CM points distribute in this area which represents rolling and transporting mainly. Compared with the CM images of worldwide various moraines and debris flow with di-

amicton deposit, the CM images sediment of the Dajiaochang profile are very similar to periglacial deposit or debris flow, and the profiles of Jiangpochang and Yaoshaling are the combination of debris flow and alluvial, which reflects polygenesis deposit. But the CM points of Xiaoyaoxi is roughly perpendicular to the M axis and its C values may exceed 1000 times of its M value(Zhu *et al.*, 1995). Combining the investigation of topography position, it can be thought that it is caused by slop gravity and seasonal running water alternatively, and affected by neotectonic movement.

2) The Ns (open form index) and Hw (length-width index) values of 40 specimens from the above profiles are calculated by the X ray diffraction crests (d001) of illinite. The Ns values of Dajiaochang, Jiangpochang, Xiaoyaoxi and Yaoshaling profiles are 1.6–4.3, 1–3.6, 1–2 and 1–1.4 respectively, and the Hw values of the four profiles in turn are 2.5–30.8, 1.03–7.1, 1.95–5 and 3.92–10. These values indicate that the strongest weathering in Lushan was affected by wet-hot cold-dry climate alternatively, next to the Huangshan Mountain, finally the Tianmu Mountain. The authors think that the above phenomena were caused by the much less area of higher elevation (>1000 m) and higher susceptibility to climatic change for the Lushan and Huangshan mountains.

3) The geochemical analysis of the sediments so-called glacial varve(Li *et al.*, 1974) in the Denglongqiao profile of the Tianmu Mountain shows that the CaO and Na₂O Contents are 0.17 mg/kg and 0.31 mg/kg respectively, which are quite lower than those of the upper” nonglacial varve” (CaO 0.82 mg/kg and Na₂O 0.83 mg/kg respectively), it reflects that the leaching and weathering of the “glacial varve” is stronger than that of the “nonglacial varve”. Combining its position and obvious reticulated phenomenon, the authors think that it is not “glacial varve”, it is only reticulate pattern ground developed under wet-hot environment at the early time of the Middle Pleistocene period.

V. DISCUSSION

Based on the above results, the Quaternary deposit environment in the three regions can be concluded as the follows:

Affected by Himalayan orogeny, the three regions experienced a neotectonic movement. These regions uplifted at the end of the Tertiary period, which made denudation and descension at the early period of the Early Pleistocene which made local deposition, and also caused the absence of Tertiary strata in most parts of these regions. Only some coarse fluvial sediments accumulated on the piedmont or along the Changjiang River near the Lushan Mountain. The hilly landscape in the Early Pleistocene was contributed to the small scale elevation in the most period, which made the absence of the Early Pleistocene strata in most parts of these area. And only some local parts of piedmont such as Jiangpochang of the Lushan Mountain, and Denglongqiao of the Tianmu Mountain are the Quaternary sediments similar to Yuhuatai and Jiujiang gravel layer. In view of sedimental features, that time should be a warm-wet climate.

Since the beginning of the Middle Pleistocene, the distribution of the sediments had become wider due to neotectonic subsidence though it was not strong. According to pollen assemblage, at that time the predominant vegetation was Xylophyta, which consisted of about half deciduous broadleaf trees and half evergreen broadleaf trees. In terms of the well-developed reticulate pattern ground and gravel layers, the annual mean air temperature ranged from 18°C – 22°C, and the annual precipitation was between 1000 mm and 2000 mm, reflecting wet-hot climate and many evergreen and deciduous broadleaf trees grew. Under the strong redox environment, Fe_2O_3 , Al_2O_3 , K_2O , MgO and SiO_2 were accumulated largely, meanwhile, CaO , N_2O and Sr were greatly beached out. Influenced by undulated topography and local climate, sediments of each region experienced different wet-hot changes, but the reticulate phenomena and binary structure were the main features of these sediments. The thickness of the Middle Pleistocene strata in the Huangshan Mountain is thinner than those in the other two regions and the reticulate phenomena in Huangshan Mountain is not so obvious as that in the other two regions because of higher altitude for the Huangshan Mountain.

After the middle of the Middle Pleistocene, the neotectonic uplift reached to its maximum scope gradually. Affected by this movement, the Lushan Mountain became an abrupt horst fault-block mountain, the Huangshan and Tianmu mountains were also uplifted its maximum height gradually, and the piedmonts of these mountains developed to hilly landscape. The reticulate pattern ground in the Lushan and Tianmu mountains were uplifted to the altitude between 1000 – 2000 m (such as Dajiaochang, Xigu valley and Zhonggu valley of the Lushan Mountain, Yangshan valley of the Tianmu Mountain), and became to shift reticulate pattern ground. At the same time, the climate became cold and dry gradually. The vegetation were mainly composed of *Pinus*, *Adiantaceae*, *Betula*, *Tiliaceae*, *Gramineae*, *Polypodiaceae*, *Ulmaceae*, *Compositae* and *Artemisia*. Under the periglacial environment of the mountain areas, the bedrocks were disintegrated by frost weathering and accumulated at the tops and slopes then transported to low land by gravity, running water, gelifluction and nivation. At the that time, sediments on the mountains were mainly slide rock, residue and periglacial sediments such as block field, block slope periglacial talus and stone pavement. The material was transported by the mountain streams and seasonal running water to develop into alluvium, proluvium, detritus flow or thin debris flow at the piedmont.

These regions experienced a relative weak neotectonic uplift and subsidence and climate prevailed dry-cold and wet-hot alternatively during the early and middle of the Late Pleistocene. A medium-scale tectonic uplift at the end of the Late Pleistocene and the early Holocene, caused the climate gradually to turn to be cold and dry, obviously, the periglacial climate would be predominated in the mountains. The greyish yellow sediments, which is synchronous with Malan Loess deposited because of the strong wind under the periglacial climate. But the thickness of the Late Pleistocene strata was thin, even lack in some local areas because these regions were just denuding. Since the Middle Holocene, the neotectonic movement in these regions gradually calmed down and now turns to slow subsidence. But the Holocene peri-

od is very short, so the Holocene strata in these regions are thin, too.

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