Australian Quaternary Newsletter

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This issue of the newsletter is devoted entirely to a report on a visit to the People's Republic of China last November by six Quaternary scientists from the ANU. The group was fortunate not only to be able to meet and talk at length to Chinese scientists, but also to visit several significant Quaternary sites and landforms. While somewhat outside the intended scope of the newsletter, we feel that an account of the trip and our impressions of Chinese Quaternary research will be of interest to other Australian researchers.

China, extending over much the same latitudinal range as Australia, is in some ways its northern hemisphere counterpart, connected by the tropical regions of South-East Asia and the important biogeographical region of the Indo-malaysian archipelago. It represents an extreme of continentality in contrast to Australia's insularity, and has the highest mountains and some of the major rivers of the world within its boundaries. Yet, like Australia, glaciation played a relatively minor role in the Quaternary of China, and deserts have been extensive throughout this period.

The emphasis placed on Quaternary research in China, and the amount carried out since 1949, is quite impressive, and we are pleased to be able to bring some of the published results to the notice of a wider audience.

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1. INTRODUCTION

The Chinese Academy of Science (Academia Sinica) invited six Quaternary scientists from the Australian National University to visit China as its guests late in 1975. They were :-

J.M. Bowler, Department of Biogeography and Geomorphology (Stratigraphy)

Jeannette H. Hope, Department of Prehistory (Vertebrate Palaeontology)

J.N. Jennings, Department of Biogeography and Geomorphology (Geomorphology)

I. McDougall, Research School of Earth Sciences (Geochemistry)

A.G. Thorne, Department of Prehistory (Human Palaeontology)

D. Walker, Department of Biogeography and Geomorphology (Vegetation History)

We entered China from Hong Kong at about 10.00am on 16 November. We were met at the frontier by a representative of the Kwangtung Bureau of Science and after the first of many excellent meals were taken by rail to Canton. After a short rest there the party was flown to Peking where it was received on the airport steps by an almost equally excited group from Academia Sinica. After a high-spirited exchange of greetings in the airport lounge we were driven to the Peking Hotel where we were accommodated in the spacious splendour of the newest wing. It was already late in the evening and, as our hosts left us, we were each given a copy of the programme which they proposed for the rest of our visit. We eventually went to bed elated as much by what seemed to be in store for us as by the excellent Peking beer.

The following morning saw us meeting at 8.00am with the man whom we subsequently grew to recognise as the Grand Organiser of the trip, Tsien Hao, and his colleagues from the Foreign Affairs Bureau of Academia Sinica. We were able to assure them that their programme surpassed our wildest hopes before roaring off to our first appointment at the Museum of Geology. In fact, we stuck very closely to the programme filled out by banquets, theatre visits, shopping outings and similar diversions. Naturally, discussions started in institutes and in the field spilled over into dinner and beyond and filled those hours in trains and aeroplanes when we were not snatching sleep or just gazing wide-eyed at the passing scene. The following is an outline of our programme :-

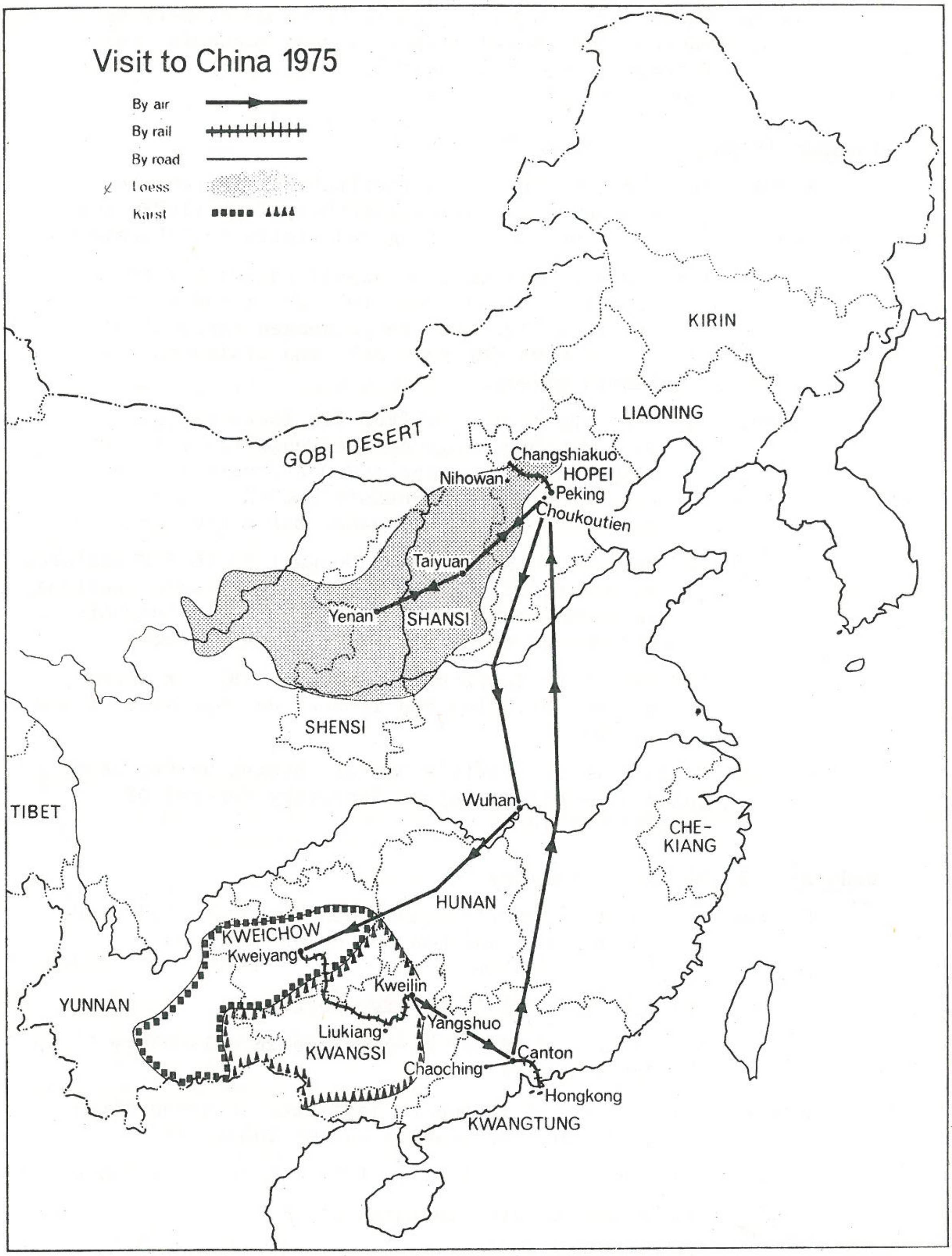
<u>Sunday 16 November</u>

7.25pm Arrived Peking.

<u>Monday 17 November</u> (Peking)

8.00am Discussion of programme.

8.40am Visit to Museum of Geology.


Visit to China 1975
By air
By rail
By road
Loess
Karst
GOBI DESERT
KIRIN
LIAONING
Changshiakuo
Nihowan
HOPEI
Peking
Choukoutien
Taiyuan
Yenan
SHANSI
SHENSI
TIBET
Wuhan
CHE-
KIANG
HUNAN
KWEICHOW
Kweiyang
Kweilin
YUNNAN
Yangshuo
Liukiang
KWANGSI
Canton
Chaoching
Hongkong
KWANGTUNG

Monday 17 November cont.,

1.45pm Reception by Chinese Committee on Quaternary Research in the Administration Building on Academia Sinica followed by lectures introducing aspects of Chinese Quaternary studies.

Tuesday 18 November (Peking)

8.00am (a) Hope and Thorne to Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) for introductory briefing and visits to laboratories.

(b) Bowler, Jennings, McDougall and Walker to Institute of Geology (IG) for introductory briefing, lectures on palaeogeography of Mt Jolmolungma (Mt Everest), and visits to laboratories.

1.45pm (a) Hope and Thorne to IVPP for lectures on palaeoanthropology and palaeolithic cultures, mammalian faunas and the Quaternary of the Lantian district (Shensi) and the Cenozoic stratigraphy of the Yuanmo Basin (Yunnan).

(b) Bowler, Jennings and McDougall to IG for lectures on uplift of the Himalaya, climatic fluctuations in Jolmolungma Region (S. Tibet) and isotopic chronology of Nanking-Wuhu volcanic rocks.

(c) Walker to Institute of Botany (IB) for introductory briefing and lecture on vegetation types of China.

6.30pm Banquet in the party's honour, hosted by Professor Chien San-chiang, Deputy Secretary General of Academia Sinica.

Wednesday 19 November (Peking)

8.00am (a) Bowler, Hope, Jennings and Thorne to IVPP for further discussions and demonstrations. Lecture by Bowler.

(b) McDougall to IG to give lectures.

(c) Walker to IB for discussions in palynology laboratories.

2.00pm (a) Bowler and Thorne to Institute of Archaeology, including radiocarbon dating laboratory.

(b) Hope and McDougall to IVPP. Lecture by Hope.

(c) Walker to give lectures at IB.

(d) Jennings to give lecture at Institute of Geography.

Thursday 20 November

8.00am - 9.45am
Peking to Choukoutien by road.

Thursday 20 November cont.,

9.45am - 3.00pm
Discussions of Peking Man materials and related stratigraphy; visits to sites and museum.

3.00pm - 5.00pm
Return to Peking by road.

7.25pm - 11.46pm
Peking to Changshiakuo by rail.

Friday 21 November

7.00am - 9.30am
Changshiakuo to Nihowan area by road.

9.30am - 3.15pm
Field sites near Nihowan and official luncheon.

3.15pm - 5.40pm
Return to Changshiakuo by road.

6.00pm Banquet followed by theatre visit.

Saturday 22 November

1.36am - 7.00am
Return to Peking by rail.

10.00am Visit to Natural History Museum, Peking.

1.30pm (a) Thorne to give lectures at IVPP.

(b) Rest of party to Palace Museum.

Sunday 23 November

7.30am Visit to Great Wall, Ming Tombs and Palaeomagnetic Station of the Institute of Geomechanics.

7.00pm Banquet in honour of the Chinese hosts given by H.E. the Australian Ambassador.

Monday 24 November

8.00am Visit to Evergreen Peoples' Commune.

2.00pm Visit to Peking University.

Tuesday 25 November

7.55am - 10.50am
Peking to Yenan by air.

2.00pm Visits to loess sections near Yenan.

6.30pm Banquet.

Wednesday 26 November

8.30am Visit to Museum of the Revolution and other sites of Yenan.

2.00pm Visits to land development schemes near Yenan.

7.00pm Film show.

Thursday 27 November

8.30am Visits to the revolutionary headquarters of Chairman Mao Tse-tung.

4.30pm - 7.20pm
Return to Peking by air.

Friday 28 November

8.05am - 3.30pm
Peking to Kweiyang by air.

6.00pm Banquet.

Saturday 29 November

8.00am Kweiyang Institute of Geochemistry (Academia Sinica) for briefing on the work of the Institute and lectures on aspects of the Quaternary of China.

2.00pm (a) Jennings and Walker to lecture at Institute of Geochemistry.

(b) Bowler and McDougall visit laboratories of Institute.

(c) Hope and Thorne visit zoo.

7.00pm Concert.

Sunday 30 November

8.00am (a) Hope, McDougall and Thorne to lecture in Institute of Geochemistry.

(b) Walker visiting laboratories in Institute.

(c) Jennings touring karst.

2.00pm Visit to the Big Cave (Ta Tung).

8.00pm Discussions of Quaternary topics.

Monday 1 December

4.40am - 8.00pm
Kweiyang to Liuchou by rail through karst country.

Tuesday 2 December

8.00am Visit to Liukiang cave site on San Tsien collective farm.

2.00pm Visit to public park and zoo at Liuchou.

5.30pm Banquet.

8.20pm - 12.00 mdt.
Liuchou to Kweilin by rail.

Wednesday 3 December

8.30am Visit to Seven Stars Cave, Kweilin.

2.00pm Visit to Yangshuo tower-karst.

6.30pm Banquet.

Thursday 4 December

8.00am (a) Bowler, Hope, Jennings, McDougall and Thorne to Reed Flute Cave.

(b) Walker to Institute of Botany, Kweilin for discussions and visit to botanic garden.

2.30pm - 3.45pm
Kweilin to Canton by air.

4.30pm (a) Jennings, Bowler and McDougall to Seven Stars Crags resort, Chaoching.

(b) Hope, Thorne and Walker to Kwantung Provincial Museum, Canton.

Friday 5 December

(a) Jennings, Bowler and McDougall visit caves at Seven Stars Crags, near Chaoching, returning to Canton in afternoon.

8.30am (b) Hope and Thorne to Canton zoo.

(c) Walker to Kwangtung Institute of Botany.

2.00pm Hope, Thorne and Walker to Kwangtung Botanic Garden.

6.30pm Banquet.

Saturday 6 December

8.00am - 10.30am
Canton to Shum Chun by rail and thence to Hong Kong.

In Peking we were always attended by an English speaking member of the Bureau of Foreign Affairs of Academia Sinica and interpreters drawn from the Bureau and from the Institutes visited. On our visits to the provinces we were accompanied by Tsien Hao and an interpreter whilst the local Bureau of Science (a liaison body) provided at least one organiser who usually spoke English. The leading civil authorities were all represented amongst the welcoming, farewelling and banquet parties. Enough of the middle-aged and elderly scientists spoke some English, some of them fluently, so that, with the aid of Tsien Hao and interpreters, language was never an insuperable barrier to discussion. Academia Sinica arranged for the specialists who had most recently worked at any site to visit it with us and on the long trip from Peking through to Canton we were privileged to have the company of Professor Liu Tung-shen throughout. And where but in China would the mayor of a city of 100,000 spend a cold day in the field and then turn out in the early hours to farewell half-a-dozen scientists?

Discussion with everyone we met, scientists and non-scientists alike, was completely free. We were encouraged to handle and photograph materials in museums and institutes and many unpublished data were exposed to us without hesitation. We were presented with a great deal of literature (50 kg of it!) and several important specimens. Only one possible request of this kind had not been anticipated. At Yenan, Bowler asked if he might take a specimen of loess away with him. Our local hosts were uncertain of the rules so Bowler naturally withdrew his request. But a few days and many hundreds of kilometres later, a small box of Yenan loess duly caught up with us!

Lecture sessions and visits to laboratories were conducted in an informal atmosphere and as leisurely as the crowded programme would permit. Our questions, comments and criticisms were constantly solicited and always well received.

Naturally we were only able to experience a small part of Chinese Quaternary research at first hand and our assessment of it may be correspondingly unbalanced, but our hosts did their best to avoid this by the review content of a number of their lectures.

Aspects of Quaternary studies are conducted in several institutes of Academia Sinica, in Peking and the provinces, and to a lesser extent in other national and provincial establishments (e.g. Museum of the Ministry of Geology, Peking) and the universities. The Committee on Quaternary Research of Academia Sinica was formed in 1957 under the leadership of the late Li Ssu-kuang. It is currently headed by Professor Hou Teh-feng, Director of the Institute of Geology, and draws its members from a number of disciplines; Professor Liu Tung-shen of the Institute of Geology, Peking, and the Institute of Geochemistry, Kweiyang, is its Secretary-General. The functions of the Committee are to provide a joint forum for the contributory disciplines, to define problems and priorities and to promote research projects; from time to time it organises national conferences on Quaternary topics.

The importance attributed to Quaternary research in China stems from the recognition of its significance for rational land use, water supplies and so on. Much of it therefore has a strong 'applied' flavour yet, as in some other areas of Chinese science, the practical value of some things which we would consider 'pure' is more clearly descried than in Australia and becomes 'applied' by definition. During recent years the main pre-occupations seem to have been in the establishment of type sections in the main geographical regions (e.g. the loess, the North China Plain) and their correlation both internally and with the European sequence. To this end most of the standard chronological methods are available, some of them only recently so, and are used. Perhaps because of this concentration on a major aim, some techniques (e.g. palynology) may not have been developed so imaginatively as their potential offers; others, however, (e.g. the application of palaeomagnetism to loess deposits) have been correspondingly stimulated. In yet other fields (e.g. vertebrate palaeontology) the synthesis of results is held back by the sheer quantity of material continually coming to light in spite of the rather large number of scientists in the field by Australian standards.

In the Chinese institutes there is not so clear a distinction made between scientist and technician as exists in most comparable Australian laboratories. Research is conceived very much as a team responsibility and it seems that an individual is accorded a place consistent with his capacity rather than the nature or source of his original training. Perhaps because of this, perhaps also as a result of the structure of university courses (about which we know practically nothing), workers in separate fields seemed to us to be more intellectually isolated from one another than we are. This was most evident amongst the younger workers and certainly did not apply to many of the middle-aged or even elderly leaders in Quaternary research.

We were frankly surprised that our Chinese colleagues should be so concerned to find close parallels of the European glaciation-based sequence in China. Yet, had we thought, we might have recognised how recently Australian workers have themselves shaken off that deadening hand. China has magnificent materials and better natural opportunities for achieving correlation between them than have most parts of the world.

Most publications of Quaternary interest with English abstracts appear in the following journals:

Geochimica
Scientia Geologica Sinica
Vertebrata PalAsiatica
Acta Botanica Sinica

All these are published by Academia Sinica.

Although our days in China were dominated by scientific matters we could not fail to respond to what we saw of everyday life going on around us. Nor was there any inhibition to the discussion of social matters with our hosts. We emerged with the impression of a people with a unity of purpose quite beyond the experience of any of us. In our contacts with individuals we invariably found humour barely concealed by the most dour exterior. And above all we sensed a humanity that was something more than charm. Certainly, nobody could fail to be immensely impressed by the great achievements in all aspects of Chinese endeavour since 1949.

We were privileged to be taken to a number of places which are not normally open to foreigners; at some indeed we were the first Western visitors since the Liberation. This must have put unusual strain on transport, accommodation and entertainment capacities but in such places, as everywhere else, we experienced the smoothest organisation and the warmest hospitality imaginable. Everywhere, every detail of organisation and preparation had been carried out to ensure that we made the most of our time scientifically. And one of us had but to cough a few times for a doctor to appear!

No account of a visit to China could be complete without tribute being paid to its cooks, whose delectable products punctuated each day. Rarely did we encounter a dish for a second time. We also record our appreciation of the quality of Chinese beer, a good light bitter, still tasting of hops. But the food and drink were only two aspects of the many-sided hospitality we were accorded everywhere we went in China and which made the trip a heart-warming experience.

In the accounts which follow we have tried to give a balanced picture of a number of aspects of Chinese Quaternary research as we saw them. We have not set out to use unpublished data which we were shown but some of the information about techniques and some facts about particular sections may not have appeared in the literature. If we have not reported on some aspect (e.g. sea level change) this does not mean that it is not being pursued in China, only that we have no first-hand experience of it.

We acknowledge a great debt to Academia Sinica and to all those provincial authorities who contributed to the success of our visit; to the committees, the organisers, the interpreters, the drivers and the guides. We hope that those who were not familiar with Westerners will not generalise from their experience of us; otherwise they may believe that 80% of male Australians are bearded and that 20% of them habitually collect beer bottle labels. When our Chinese colleagues read these reports we hope that they will forgive the omissions and the unintentional misrepresentations and accept that we have tried to do as they asked us, namely to "describe us as we are". On their behalf I happily convey the fraternal greetings of Chinese Quaternary scientists to all their Australian colleagues.

D. Walker

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2. QUATERNARY STRATIGRAPHY

General

The great extent, thickness and variety of Quaternary deposits in China make them of great practical importance as, for example, in mineral prospecting, irrigation and hydro-electric construction. Because of this a great deal of attention has been devoted to them since the Communist Revolution in 1949 and the numbers at work in Quaternary geology have increased rapidly. In 1957 a Committee on Quaternary Research was organised by the Academy of Sciences and in 1959 a National Conference on Quaternary Stratigraphy took place at which the major immediate problems were isolated, stratigraphic division and correlation being regarded as the most important. Since then a number of specialised symposia have been held, for example, a field conference on loess at Lantien in Shensi. After 1969 local type sections and chronologies have been established in each province of the

Republic. Lacustrine, aeolian, glacial, cave and fluvial deposits have all contributed to them. Marine sediments are important in the eastern part of the N. China Plain, the lower Yangtse (Kiangsu), in Chekiang where the rocky, tropical southeast coast begins, and in Taiwan. However, less attention appears to have been given to the marine sequence as yet and correspondingly mammalian fossils loom large in the Quaternary palaeontology.

Lacustrine sediments and the Early Pleistocene

Early Pleist
lake deposits

Lacustrine sediments, with associated fluvial deposits, are particularly important for the Early Pleistocene. They increase in abundance from the Pliocene to the Pleistocene; whether this is due solely to tectonic disturbances or whether climatic change is also involved is not clear. Then drier conditions end the Early Pleistocene and lakes diminish.

cf Afar

The type sequence for the Early Pleistocene is provided by the Nihowan Formation. It is described in Section of Nihowan Cenozoic (Anon., 1974), which is in Chinese and has no English abstract but has useful sections and a map. The following notes depend on the field exposition of Wei Qi of the Institute of Vertebrate Paleontology and Paleoanthropology.

Nihowan is located about 180 km WNW of Peking on the Sangkan River, a tributary of the Hai River. In a subhumid climate, with harsh seasonal contrasts, the rugged ranges of the Western Hills of western Hopei rise sharply from tectonic basins of Cenozoic sedimentation. In the Nihowan basin, alluvial fans form bahadas along the foot of the bounding ranges; its central parts about 900-1000 m a.s.l. are occupied by two terraces and the floodplain of the Sangkan. The upper terrace is depositional, comprising the Nihowan Formation and the lower terrace is erosion, the Sangkan having "invaded" (an expressive Chinese usage) the lacustrine beds at this level.

cf Gadeb

We were shown several good sections in terrace bluffs, exposing all told 100 m of the sequence, much more of which lies at depth. A section in the area of the original site from which Pere Licent dug fossils in 1924-7 consists mainly of silts with coarse gravels interbedded, indicative of marginal conditions in the former lake. In other sites greenish sandy clays and red, crossbedded gravelly sands also occur and there are erosional breaks and pedogenic horizons with carbonate concretions. The mammalian fauna from these sites is regarded as equivalent of the Villafranchian and of Early Pleistocene age. Farther west the sections are characterised much more heavy green clays and in them a stickle-back fish, *Pungitius nihowanensis*, has been found. These beds are described as lying lower in the formation but there is the possibility that they simply represent a deeper facies of the lake sediments. A paleolith has been recovered from the Nihowan Formation.

cf Gadeb

Late Pleistocene loess covers parts of the lacustrine beds and at the Shingo site (Tiger Head Plateau) the top of the latter has been stiffened by calcrete. Here also there is pronounced cryoturbation of the top of the terrace gravels and of infolded silts on the two sides of a large gully; the age of this periglaciation is not known.

Another important lacustrine sequence is that at Yuanmou in Yunnan Province in South China. It also was well known in the 1930's when it was all placed in the Middle Pleistocene. Now it is divided into four formations, ranging from Pliocene to Late Pleistocene; of these the Yuanmou *sensu stricto* or Watajing is Early Pleistocene.

In recent years fresh Pleistocene lacustrine sequences have been found in other parts of China.

Reliance on mammalian fossils for a Quaternary time scale presents well known difficulties. These are evident, for example, with regard to the Plio-Pleistocene boundary. Most workers now adopt the base of the marine Calabrian stage in Italy as the beginning of the Pleistocene. On this basis much of the Villafranchian belongs to the Pliocene.

The loess of N.W. China; the aeolian component

Under the direction of Liu Tung-sheng, the Laboratory of Quaternary Geology of the Academy has directed a major effort at the loess of N.W. China and a book has been published (Liu Tung-sheng and others 1966). This special effort has been well justified because of its practical importance for soil and water conservation and in the results which are of world-wide significance. In the field in Shensi, Lu Yen-chou gave us an excellent exposition, and at Kweiyang, Wen Chi-chong lectured to us on the subject.

The loess occupies about 300,000 km^2, chiefly in the arid and semi-arid reaches of the Hwang Ho basin in Kansu, Shensi and Hopei provinces. Forty per cent of its extent lies in the famous loess plateau of Shensi and Shansi where it chiefly blankets dissected Mesozoic sandstones and mudstones to a thickness of 80-120 m, reaching a maximum of 175 m. The relief is made up of 'yuan' (= elongated ridges) and 'mao' (= knolls); the first prevails in the north and the other two in the south as a result of more advanced dissection in that direction.

Although there is a high degree of uniformity in the loess over its extent, there are regional differences in the surface loess with a gradient of change from the NW to the SE. Though it is dominantly silty, a three fold textural zonation can be identified with an inner, northwestern sandy loess, a central belt of loess proper, and an outer, southeastern clayey loess belt. Clay content increases from 10 to 25% along this gradient. The loess gets thinner in the direction in which it gets finer.

The silt grade, comprising more than half of the loess, consists of 40-50% quartz and 30-40% feldspar. Scanning electron microscope studies show that the mainly angular to subangular quartz grains have irregular edges and laminated, stepped surfaces.

Some grains have concoidal facture and some are subrounded. The surface of the grains is the result of mechanical action of some kind. Silica is precipitated in pits and cracks, some as thin films and some as minute granules. Quartz silt in the desert to the NW has this character also. The feldspar silt is subrounded to rounded and slightly weathered to fresh in state.

Carbonate forms 10% of the loess on the average, chiefly rounded calcite grains, which are primary constituents deposited along with the quartz and feldspar. The content declines from NW to SE. Heavy minerals constitute a few per cent, decreasing from NW to SE. The SiO_2/Al_2O_3 ratio decreases in the same sense in accord with the reciprocal changes in the sand and clay size fractions.

Three kinds of micro-morphology are recognised:

(a) Grains in angular contact, adherent matter in thin films, interstices open and porosity high.

(b) Subangular grains, clay percentage higher, cement largely filling voids, porosity lower.

(c) Rounded or subangular grains, 20% clay or more, general groundmass cementation, low porosity.

(b) and (c) become more important to the SE.

The distribution of characteristics applies to the Malan loess at the surface, which overlies reddish clays disconformably. Formerly there was a simple stratigraphic division of the loess into these two components. Now two further erosion surfaces provide the additional bases for a fourfold division, which has been dated palaeomagnetically at a site in Shansi where the loess is 134 m thick. Radiocarbon dates have also been obtained from the Malan loess.

	Loess Formation	Depth (m)	Palaeomagnetism	Polarity	Age (m.y.)
		0			
Late Pleistocene	Malan		Brunhes	N	
		15			
Middle Pleistocene	Upper Lisheh				
		40			
	Lower Lisheh	65			0.69
		74			
Early Pleistocene	Wucheng		Matuyama	R	0.89
		100	Jaramillo	N	0.95
		110			
	Base of section	134	Matuyama	R	

As many as six soil horizons have been found in the Upper Lisheh and five in the Lower Lisheh. In the Wucheng there are two buried soils and four weathering horizons. In the soil horizons, there are rootholes and animal burrows, the $CaCO_3$ content and the SiO_2/Al_2O_3 ratio decrease from the bottom to the top, and there is more groundmass cementation with voids filled with clay and cement. The soils associated with the erosion surfaces are the more developed, whilst the weathering horizons are characterised by reddening only. The number of soil horizons varies from place to place. Near Yenan where we saw this sequence well exposed, there are also horizontal carbonate concretionary layers which are unrelated to soil development and are effects of groundwater table standstills.

The Malan loess sometimes overlies fluvial gravels of the Salawusu Formation, which because of erosion may rest on any of the earlier loess. The type site is on the Salawusu River in Inner Mongolia. From its mammalian fossils it is regarded as late Pleistocene in age. At Sujakuo in Kansu, the Malan loess is progressively thinner on sequentially younger river terraces.

The loess is well endowed with fossils itself. The fauna are terrestrial, including many burrowing animals of the steppe. Similar indications come from the dominance of non-arboreal pollen in the loess, especially of *Artemisia,* Chenopodiaceae and Gramineae.

There has been disagreement in the past about the manner of loess deposition but the new knowledge has (to perpetrate a vile pun) 'settled the dust' of this controversy. From NW to SE in the loessland today, the annual precipitation increases from less than 500 mm to more than 1000 mm, steppe soil is succeeded by forest soil and in vegetation there is a sequence from desert steppe through arid steppe to forest steppe. The various changes in loess character down this gradient suggest that the present environment also applied during some parts of the Quaternary and that the mode of transport was aeolian. The nature of the loess is the same whatever its catenary location - on a plateau top, in a valley bottom or on a valley side. It contains more than 30 mineral species unrelated to local bedrock. The lack of bedding and the prevalence of primary calcareous silt, argue strongly against the fluvial origin, but conform with an origin as aeolian dust from the Ordos, Alashan and Gobi Deserts to the northwest.

The ultimate provenance of the material is not so certain and it may be multiple. It may be the cold desert weathering product of the Mesozoic sandstones and siltstones forming much of the 'gobi' (in the systematic meaning of that word - pedimented rocky desert plains). There is also the possibility that the Hwang Ho has brought down glacier flour from high mountain ranges in Tsinghai and Kansu Provinces to its great braided outwash plains in Ninghsia and Inner Mongolia. The origins of the large proportion of unweathered feldspar and the primary calcite grains in the loess silt may help towards the resolution of this problem.

Of great interest are the climatic implications of the loess sequence. Clearly it accumulated in a weakly alkaline oxidising and dry environment. The various soils and weathering horizons relate to wetter times than the intervening periods of loess accumulation. Also the Salawusu fluvial gravels have a woodland and forest fauna indicative of a warmer and moister climate. Thus many arid/humid oscillations are involved, though of varying magnitude. The differences at the extremes between the yellow Malan loess and the red Wucheng may imply an overall tendency to increasing aridity on top of these oscillations.

Fluvial deposits and the N. China Plain

The N. China Plain presents a fascinating face to the Quaternary scientist flying over it, even though its dense population and long history has resulted in a much modified geomorphology and hydrology. Abandoned river courses are commonly used for artificial water storage and irrigation canal alignment, the last reminding us of a similar pattern in the Victorian Riverina in Australia. However it is still possible to trace 'prior streams' in the consolidated larger fields of Communist China where no engineering works disturb their meander pattern. In places also once can see that the arable land bared to the northwest winds from Siberia suffers wind erosion resulting in tongues of thin sand that resemble in pattern the grass and bush fire scars of the Australian plains. Near the Hwang Ho, thicker sands, probably due to crevassing in its floods, have been reworked into parabolic dunes open to the north.

Working out the Holocene geomorphology of this plain may be difficult because of all the human works but the tremendous thickness of sediments beneath is beginning to yield its history with the opportunities presented nowadays by boreholes for water and petroleum search as Cheng Chang-wei described to us at the Kweiyang Institute of Geochemistry.

There are over 1000 m of unconsolidated sediments of which 150-250 m are Quaternary. They are mainly fluvial-lacustrine clays, sandy clays, sands and gravels but there are also peats. Fresh and brackish forms of pelecypoda, gastropoda, ostracoda, fishes and algae are found. East of the Peking-Shanghai railway these give way to marine sediments.

The fabric and the fauna (chiefly the ostracods) permit a threefold division into Lower Pleistocene, Upper Pleistocene and Holocene. Attempts have been made to measure the palaeomagnetic polarity of two cores and it is believed that the Brunhes-Matuyama boundary occurs at a depth of about 106 m in the Changchow bore and about 140 m in the Hengshui bore. Interpretation of the measured polarity at greater depth is much less certain.

Palynology and C-14 dating are proving fruitful in the upper parts of the sequence. In the Late Pleistocene, arboreal pollen are few and herbaceous taxa predominate. Arid conditions and steppe vegetation with a few trees are indicated. In the Holocene, arboreal pollen are common between 10,000 and 5,000 B.P., with variations in the proportions of angiosperms and gymnosperm trees. Since 5,000 B.P. non-arboreal pollen recover dominance.

The suites of heavy minerals in the Quaternary sediment differ from those in the Tertiary and there is evidence of volcanic activity at five horizons in the Changchow bore, well distributed through the Quaternary. The presence of illite distinguishes the clay minerals of the Quaternary from those of the Tertiary and the alternations of illite-kaolinite and illite-montmorillonite horizons in the Quaternary point to changing environments.

The N. China Plain is important in the potential there is for the correlation of the biostratigraphy of the Quaternary. On the inner margin of the Plain, the loess of the Western Hills and Loess Plateau, with their mammalian fauna, inter-finger with the fluvial deposits. These in turn intercalate with marine sediments in the outer Plain, both with invertebrate zonation. Offshore drilling for oil may permit correlation also with long, uninterrupted oceanic sequence.

Glacial deposits and the Himalaya

Our itinerary did not include any glacial sites, probably because of our expressions of where our interests lay, though a lecture was given on Australian glacial and periglacial geomorphology in the Kweiyang Institute of Geochemistry. Moreover a review in English of the state of knowledge of glaciation in China has recently been published (Li Yung-chang and others, 1972). However glacial deposits are much more important in China than in Australia and Hsüan Tien'ch'in introduced this aspect of the Quaternary in China to us in general terms. Recent work in the Himalaya was the subject of three lectures by Zhou Kun-shu, Guo Xi-dong and Zhao Xi-tao at Peking. A brief account is appropriate here therefore.

The extent and chronology of glaciation have been much disputed in China as in Australia and remain uncertain in many regions as for example in relation to the important Peking Man (*Homo erectus*) site of Choukoutien. In 1922, J.S. Lee, China's most famous geologist, published evidence of Quaternary glaciation in the eastern end of the Tien Shan, in Shansi and in the northeastern provinces. In the 1930's he extended such findings to the middle and lower Yangtse valley, including the Lu Shan in Kiangsi province. His claims for glaciation in South China have not all found ready acceptance. Since Liberation, construction works have exposed many sections in glacial deposits, which have revealed, for instance, markedly different degrees of weathering of boulder clays. Boreholes have encountered buried glacial sediments. In turn the needs of hydro- and engineering geology have prompted fresh studies of a fundamental nature.

In the 1972 review, Pleistocene mountain glaciation is mapped from Sinkiang in the extreme west to the coast of Chekiang and from Heilungkiang in the north to Kwangtung. However even the great altitude of the plateaus of Tibet and Tsinghai could not bring about the formation of large ice sheets because of inadequate moisture supplies. Hsüan Tien'ch'in amplified the general chronology of the 1972 review to the following sequence, repeating its tentative correlation with the classic sequence of the European Alps. Flint has, of course, given good reasons why correlation with that sequence is inadvisable.

Stage	Type Area	Correlation with the Alps
Poyang Gl.	Boreholes at Poyang Lake (Kiangsi)	Gunz
Yuanmou Igl.	Lake beds at Yuanmou (Yunnan) *Homo erectus* present	
Taku Gl.		Mindel
Choukoutien Igl.	Peking Man Site, Choukoutien (Hopei) *Homo erectus* present	
Lu Shan Gl.	Lu Shan (Kiangsi)	Riss
Lantien Igl.	Lantien (Shensi)	
Tali Gl.	Tali Lake (Yunnan)	Wurm

Since Liberation, there have been a number of scientific as well as mountaineering expeditions to the Jolmolungma area. Indeed there have been three expeditions in three years since the Cultural Revolution! The Tibetan plateau is the highest arid area in the world at 4500-5000 m. To the south the average elevation of the Himalaya is 6000 m. In the middle, three peaks of the Jolmolungma area rise over 8000 m (Mt Everest itself 8848 m); the large glaciers which radiate from them with a snowline at 6000 m are smaller than those of earlier times. The following sequence has been established from the geomorphic, sedimentologic, mammalian fossil and palynological evidences (Guo Xu-dong 1974; Yang Li-hua and Liu Tung-sheng 1974; Zhao Xi-tao 1975).

Q1	Shisha Pangma (Gasianthan) Gl.	Small valley glaciers with snowline at 6200-7000 m. Uplifted 3000 m so snowline depressed 2000 m compared with now. Temperature 13°C lower than now.	Early Pleistocene
	Phari Igl.	Lake deposits at 4500 m on top of Q1 glaciofluvials and overlain by Q2 till Broad leaved forest (warm humid) followed by alpine brushwood meadow steppe (cold humid).	

Q2	Niehnien-Hsungla Gl.	Piedmont glaciers reaching onto Tibetan plateau; valley glaciers only on S side. Snowline about 6100-6700. Uplifted 2000 m so snowline depressed 1300-2000 m cf. with now. Temp. 10°C lower than now.	Middle Pleistocene
Q3	Jolmolungma Gl.	Valley glaciers but reaching lower down than Q2 piedmont glaciers. Terminal moraine at 4950 m. Uplifted 1400 m. Temp. on N side 5-6° lower than now; 3°C lower on side.	Late Pleistocene
	Yali Igl.	Climate similar to the present but Hypsithermal.	Holocene
Q4	Chunpote (Rongbud) Gl.	Last 5-7000 years colder and drier than before. Neoglacial.	

Neotectonic uplift as a result of underthrusting of the Indian Plate beneath the South Tibet Plate is a factor complicating understanding of the Quaternary climatic indicators in the Himalaya. The unwarping is greatest along the main Himalayan range and ends along the downfaulted belt of the Brahmaputra River. Estimates of this uplift have been derived from comparison of the altitudes at which plant fossils of the Pliocene and of the interglacials are found now and at which the kind of vegetation they represent is now found on the southern flank. Thus *Cedrus deodar* and *Quercus semicarpifolia*, found in Pliocene red sandy gravels at 5900 m on the north side of Jolmolungma where the mean annual temperature is -9°C, grow today in evergreen forest at 2500 m on the south side with a temperature of 10°C. Most of this difference is attributed to an uplift of 3000 m. Again the plant fossils of the Yali Stage (Holocene Hypsithermal) are found at 4300 m whereas the equivalent present vegetation grows at 3400-3700 m. It should be found 400-600 m higher than that because on evidence from other parts of the Northern Hemisphere Hypsithermal temperatures here should have been 2-3°C higher than now. Therefore an uplift of 200-300 m since the Yali Stage is inferred. Altitudes of glacial cirques belonging to different glaciations are used to arrive at independent figures for uplift.

Clearly a degree of circular argument is involved in this procedure when these results are used to determine the temperatures during the intervening glaciations as in the table above. A gross conclusion is that most of the substantial uplift since the Pliocene took place in the Late Pleistocene. This introduced a powerful new geographical factor in the pattern of climate. In the Early and Middle Pleistocene when the average elevation of the Himalayan range was only 4400 m, the evidence from the interglacial deposits shows that the north side was as warm as the south side at similar elevations. However the uplift to bring the range to its present 6000 m average elevation made the Himalaya a much more effective climatic barrier, preventing warm, moist air from entering the Tibetan Plateau. Exclusion of the Indian Monsoon made the north side colder and drier and this restricted the growth of glaciers.

Cave deposits

Cave deposits have loomed large in the study of the Quaternary in China so far, partly because of the very great extension of carbonate rocks in South China. The mining of cave deposits rich in phosphate and nitrogen for fertiliser has led to the discovery of many bones and the use of such bones for drug preparation have together led to the finding of important primate and other vertebrate fossils in drugstores and so to cave excavations of importance with the recovery of artefacts and hearthsites also. Rock shelters in other rocks, e.g. in sandstones in deeper valleys in the loess plateau, are still in use as habitations and storehouses so that similar discoveries are likely to be made in contexts other than karst caves, to which however all reports seem as yet to be confined.

We examined cave deposits at Choukoutien (Hopei), near Liuchou (Kwangsi) and near Chaoching (Kwangtung) as well as visiting several other caves without significant deposits in them. Huang Wan-po, a stratigraphic geologist at the Institute of Invertebrate Paleontology and Paleoanthropology informed us generally about Chinese cave deposits and expounded those at Choukoutien and Liuchou to us on the ground.

Before Liberation, very few cave deposits had been excavated but the situation has changed in part as a result of the requirement by the new Government that finds of bones have to be reported and meantime work has to cease temporarily. The wanderings of the Red Guards and the vigorous drive for agricultural improvement have led to new finds and the IVPP has been sending out parties all over the country. Although most sites are still located in the 600,000 km^2 of Palaeozoic and Mesozoic carbonate rocks in South China, there have now been excavations in provinces ranging from a cave 4000 m high in Tibet to the caves in the far northeastern provinces of Liaoning and Kirin.

In age the cave deposits range from early Pleistocene to Holocene on the basis mainly of mammalian fossils, though radiocarbon dating has helped with Late Pleistocene and Holocene materials.

Caves with deposits as old as Early Pleistocene in them are uncommon enough for the related circumstances to be interesting. Although more than one such is now known from China, we obtained details only of the cave in which the primate *Gigantopithecus* was first found. This is at Liucheng near Liuchou in Kwangsi. It is in a tower karst area and the sediments were found in an abandoned river cave opening 90 m up the cliffside of a tower (and 110 m above the surrounding plain). Such caves form at plain level and the plain has lowered considerably since. The tower may have been reduced in area also by lateral solution, leaving a small fragment of the original cave. We did not see this cave and do not have the details of the cave sediments. Nevertheless the geomorphic relationships are compatible with considerable age.

Also near Liuchou in San Tsien farm is the cave famous for Liukiang Man (Tien Dung Tung), which we did see. The sediments in which Liukiang Man was found are fine-grained waterlaid sediments with flowstone horizons, though there is also breccia from cave breakdown in the cave. This small cave is due to phreatic solution by slow-moving water in a thin limestone formation interbedded with much sandstone and mudstone making up most of the hill in which it is set. A cave in such a circumstance is not likely to be very longlived. From the fauna the fill is attributed to the Late Pleistocene. The human skull and other human bones, together with a rich mammalian fauna, are believed to have been washed in and there is a big difference in this respect from Choukoutien with its living sites.

Near Chaoching in Kwangtung, we saw Si Giang Cave, under the guidance of Wong Tsiang-ke of Tsung Shan University, Canton. It is a small cave also nearly filled with sediment until excavated like Tien Dung Cave. Like it also it seems to have been formed in a waterfilled state with slow moving water. Later it was nearly filled by bedded clay and silt capped by flowstone. The cave is in an isolated residual hill of limestone and although the picture is complicated by the making of an artificial lake at this holiday resort, the cave, though inactive, is only a few metres above the surrounding alluvial plain, like a number of other caves in the limestone towers nearby. These geomorphic relationships suggest no great age for the cave and its fill. This is in agreement with the Late Pleistocene age ascribed to the fauna from it. Ecologically the fauna suggests a tropical to subtropical forest environment, not different from the conditions which prevailed prior to land clearance within the last two thousand years here.

Isolated bodies of cave sediment are not easily brought into an overall stratigraphic sequence but there is need to do this in South China where so far such deposits have been the chief source for Quaternary history. Little recent work seems to have been done on the relationship of the caves and their fills to surface deposits. Teilhard de Chardin and others (1935) placed the planation of the limestone around the tower karst as older than the Tertiary Red Beds. Lower limestone surfaces between the towers are regarded as older than lateritised fans with vermicular red clays at their surface, which are equated with the Villafranchian (presently correlated by the Chinese workers with Early Pleistocene). This scheme may not be easy to reconcile with the evidence of such sites as the *Gigantopithecus* cave near Liuchou and the modern view appears to be that the vermicular red clays are much younger than they were considered before.

The Choukoutien caves are situated in a hill of Ordovician limestone where the Western Hills of Hopei meet the N. China Plain. Above the caves here, fluvial Upper Gravels are 70 m above the present day river at the edge of the plain. These are regarded as Pliocene. The Upper Cave, the highest, is a small cave which had a fill of loess and breccia. Such a fill could have got in much later than the formation of the cave and no discrepancy arises therefore from the indications of Late Pleistocene age for the fill from a young fauna, the presence of *Homo sapiens* and a radiocarbon date of 18,400 BP. The main body of excavated material at Choukoutien has come from an unroofed cave lower down the hill but still well above the level of the plain. A 'cap travertine' with bat bones in it is the evidence for the inference that it is the fill of a cave and not of an open cavity in the limestone. Much cave breakdown is included in the fill as is to be expected of the ruin of a cave but there was also much bedded gravel and sandy clay which were waterlaid. It is easier to understand the emplacement of these beds if they accumulated when the plain stood at a considerably higher level than now. The Middle Pleistocene age attributed on faunistic grounds to these beds from which *Homo erectus* came allows a good length of time for plenty of landscape modification. Pigeon House Cave is an artificial excavation within the body of this fill, much of which remains for future excavation. The New Cave is at much the same level as the main *Homo erectus* excavation. The front of this cave was almost blocked by angular rock debris from cave entrance collapse or from the slope above it. The sediments on the floor of the cave inside include much flowstone and some fine sediment, neither of which imply river flow in the cave. They could have formed with the plain outside at a much lower level than that of the New Cave. The age of these deposits has yet to be determined but there is organic carbon available for absolute dating.

Cave deposits may not retain the prime position they have had in the past in Quaternary studies in China but they are bound to remain important. Therefore we can expect to see the use of other physical dating methods such as the uranium/thorium decay series to help with the problems of correlating deposits from different caves and with other kinds of deposits at the surface.

J.N. Jennings

3. QUATERNARY VERTEBRATE PALAEONTOLOGY

In China vertebrate palaeontology is an integral part of Quaternary studies. The presence of extensive terrestrial deposits, with their rich mammal faunas, and the relative lack of good marine sequences, has led to a great dependence on mammalian biostratigraphy for geological dating.

The main centre for research into vertebrate palaeontology is the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) in Peking, one of the many institutes of Academia Sinica, the Chinese Academy of Science. Active research is also carried out at several museums elsewhere in the country, but we visited only IVPP. IVPP is divided into four laboratories, usually referred to by number. These are Laboratory 1, studying lower vertebrates, including birds, mainly from Palaeozoic and Mesozoic sites; Laboratory 2, Mammalian evolution; Laboratory 3, Cenozoic research, basically mammalian biostratigraphy; and Laboratory 4, dealing with both physical anthropology and studies of palaeolithic living sites. Altogether there are about 180 people working at the Institute, and about 80 of these are scientific staff.

Most of the scientists we met at IVPP were from Laboratories 3 and 4, and the introductory lectures were designed to give us a general survey of Quaternary biostratigraphy in China. Chou Min chen reviewed research on Quaternary stratigraphy in China since the Liberation; Mrs Hu reviewed the Quaternary mammal faunas; Mrs Chang Yu ping covered the Pleistocene of the Lantien district and Woo Ju kang reviewed the state of Palaeoanthropology in China.

Although many of the classic faunal sites in China were discovered earlier this century, there is no doubt that a tremendous amount of work has been done since the Revolution. This is essentially because of the applied nature of the work, its use in geological reconnaisance and stratigraphic dating.

Research in palaeontology and archaeology is also helped by the legal requirement for all fossils or stone tools found during agriculture or construction to be reported to the central authorities. Consequently the palaeontologists spend a lot of time following up the numerous reports that flow into IVPP. Partly because of this, and also because of the importance of VP in geological survey, there seems to be a great emphasis on field work. Several of the scientists we met had recently returned from extensive field seasons. Some time is also spent in assisting museums setting up palaeontological exhibits. In Peking alone we saw excellent, and fairly new fossil displays at the Institute of Geology Museum, the Natural History Museum and the Choukoutien museum.

We were fortunate to be able to visit several important Quaternary fossil sites: Nihowan, Choukoutien and Liukiang, and the following account describes these in the context of a brief summary of the Pleistocene mammal faunas. Throughout the Pleistocene the faunas of north and south China seem to have remained fairly distinct, the boundary between the two being at about the Tsinling Ranges. In the north, Pleistocene fossils occur mainly in open sites; in fluvial and lacustrine deposits, red clays and loess. Lacustrine deposits were most extensive in the early Pleistocene, and these beds contain species of warm and humid environments. Since then, the climate gradually became cooler and more arid; loess accumulated and steppe species appeared. There were at least four oscillations from humid to arid conditions throughout the Pleistocene; but overall conditions became drier.

Nihowan, about 200 km west of Peking, is regarded as the type locality of the Early Pleistocene in North China. To reach Nihowan we drove south from the city of Changshiakuo, in the foothills of the ranges rising up towards the border of Inner Mongolia. The road wound through the rocky foothills and finally broke into the wide basin of the Sangkan River, a tributary of the Hai River which runs south of Peking. To the north and south the basin is flanked by rugged mountains which in early winter were streaked with snow. The terraces and floodplains of the Sangkan River were a uniform yellow-brown colour, as were the low houses, whose golden-yellow shuttered windows all face south. At this time of the year there was no trace of green anywhere, and the deep erosion gullies in the terraces increased the desert-like appearance. Beneath a superficial cover of loess lie the gravels and clays of the Nihowan formation.

We visited an exposure in the area of the original sites where Licent first discovered fossils in 1924-27 (Barbour, Licent and Teilhard de Chardin, 1926), and a nearby locality where a stone artefact and a skull of the extinct elephant, *Palaeoloxodon namadicus*, have been recently found (Gai Pei and Wei Qi, 1974). Both these localities lie to the north of the Sangkanho, close to the village of Nihowan, and this area is illustrated in Plate I (1) in the paper Section of Nihowan Cenozoic (Anon., 1974). From here we moved west to the junction of the Sangkan and its tributary the Houliu River, to the north-west corner of the high terrace which Barbour *et al.* called the Changchiawan Platform. (This section is illustrated in Section of Nihowan Cenozoic Plate 1, 2.) Farther west, we visited the locality where fossils of a gasterosteid (stickleback) *Pungitius nihowanensis*, have been found in heavy green clays. (Liu Hsien-t'ing and Wang Nien-chung, 1974; Section of Nihowan Cenozoic, Plate II, 1.) Here the exposure is approached from the road on the plateau high above the Sangkan River, and the section is seen in the deeply eroded gully of a creek flowing south to join it.

The fauna of the Nihowan beds is listed in Section of Nihowan Cenozoic. Thirty-seven mammals have been found here, including rodents, various dogs and wolves, hyaenas, lynx, sabre-toothed cats, the elephant *Palaeoloxodon*, rhinoceros, pig, camel, deer, gazelle, sheep and bison. The fauna is characterised by the survival of Tertiary forms, notably the three-toed horse, *Hipparion*, but many modern animals make their first appearance here, including the horse, *Equus*. The lacustrine beds and their fauna have generally been considered as equivalent to the European Villafranchian. In China, as elsewhere, opinions differ as to the base of the Pleistocene; the lower part of Nihowan is one option.

The other important fossil locality we visited in North China was Choukoutien, where the deposit containing the remains of Peking Man is regarded as the type locality of the Middle Pleistocene. Choukoutien lies about 48 km south-west of Peking. In a low hill of Ordovician limestone there is a great variety of cave fills covering a wide range in time. The most famous of these is Locality 1, where the first skull of Peking Man was discovered in 1929. The hominid remains, hearths, and mammal fossils were found in deposits consisting of debris of cave breakdown, and waterlaid gravels and sandy clays.

This Middle Pleistocene fauna includes some survivals from the earlier Pleistocene faunas, such as sabre-toothed cats and primitive horses, which became extinct in the Middle Pleistocene, others typical of the Middle Pleistocene itself, such as thick-jawed deer, and the first appearances of some modern species. Both the fauna and pollen analysis of the deposits at Locality 1 suggest interglacial conditions.

As well as this Middle Pleistocene deposit, there are also younger faunal deposits at Choukoutien. Amongst these is the Upper Cave deposit. This small cave contained a burial of *Homo sapiens* and associated fauna in a midden deposit, in a fill of loess and breccia. The fauna is Late Pleistocene in age, and includes several extinct species, such as the ostrich, cave bear, hyaena and elephant. There is one radiocarbon date on charcoal from this deposit, of about 18,400 BP. The fauna from the Upper Cave and other Late Pleistocene sites in Northern China contains many modern species, generally indicative of colder climates. Mammoths and woolly rhinoceros occur in sites in the north-east Provinces; mammoths at least seem to have died out before 20,000 years ago. However, many of these sites seem to be dated by correlation with the fauna in the Upper Cave, rather than by direct radiometric age determinations. Other Late Pleistocene fossils are known from the extensive loess deposits, and these reflect the dry, steppe conditions of the Loessland.

At Choukoutien we also visited the New Cave, discovered during the Cultural Revolution by the Red Guard, and as yet only partly excavated. An exposed section consists of layered clays and gravels, with ashy lens, sealed with flowstone. The fauna from this site is not yet completely studied, but in age it is considered to be somewhere between that of the Middle Pleistocene Peking Man site and the Late Pleistocene Upper Cave.

In contrast to the gradual change in climates and mammal faunas in North China through the Pleistocene, the fauna of Southern China has remained remarkably constant. The typical southern Pleistocene fauna, generally known as the *Ailuropoda/ Stegodon* fauna (*Ailuropoda* is the giant panda, *Stegodon* an extinct elephant) has been known since the discovery of the drugstore teeth from the caves and fissures of the karst areas of southern China. In fact most of the fossil deposits in the south are from caves and fissures; since 1955 over 300 caves have been investigated for fossil deposits in Kwangsi and more than half of these contain fossils. More recent work on these cave deposits has led to the sub-division of the *Ailuropoda/ Stegodon* fauna into Early, Middle and Late Pleistocene (e.g. Pei, 1963).

The Early Pleistocene in the south is typified by the *Gigantopithecus* fauna. It shares many species with the later classic *Ailuropoda/Stegodon* fauna, but has more primitive survivals, including *Gigantopithecus* itself. However, in contrast to some of the changes in the northern faunas, these more primitive species tend to be forerunners of those typical of the Middle Pleistocene. So the Early Pleistocene *Stegodon praeorientalis* is replaced by the Middle and Late Pleistocene *S. orientalis*, and likewise *Ailuropoda microta* is replaced by *A. melanoleuca*. The *Ailuropoda/Stegodon* fauna is most widely represented in the Middle Pleistocene, and is more restricted in the Late Pleistocene. Throughout the Pleistocene the faunas of southern China are indicative of forest vegetation and warm climates, and their relationships lie to the south as far as the Indo-malaysian Peninsula.

We visited one major fossil site, the Liukiang man site in Kwangsi, but in fact vertebrate fossils had been recovered from most of the other caves we inspected in Kweiyang, Kwangsi and Kwangtung. Liukiang Cave lies in a citrus and peanut producing collective farm a few miles from the town of Liuchou. In this region the country is open and rolling with occasional isolated limestone towers, a contrast to the rugged karst ranges we had travelled through by train the previous day on the way from Kweiyang. The contrast with North China was dramatic; instead of austerity of the cold, dry, and brown plains with rocky mountains rising on the horizon, we had entered the subtropics; although cool at the beginning of winter, it was wet and misty, and the vegetation green and luxuriant. Much of it, especially away from the dramatic limestone towers, was surprisingly reminiscent of Australian scenery, because of the red clayey soils and the extensive groves of eucalypts, with some casuarinas and melaleucas. (At least 40 species of eucalypt are grown in the south, and a species of melaleuca is a common street tree.)

Liukiang Cave is a fissure cave, with a small entrance in a low rolling hill. The hill and the surrounding slopes are covered with grassland, with a few recently planted pines. The whole area has had a long history of clearance, but apparently pollen analysis of sites in the area suggests that the pre-Neolithic vegetation was forest or shrubland. The cave was originally full of sediments, and the fossils were discovered in July 1958 when these sediments were dug for fertiliser. Since then about half the deposit has been excavated, and work on the site continues with contributions from several disciplines. Mr Huang Wan-po, who had worked on the stratigraphy of the site, accompanied us to the cave and described the deposits.

The cave is entered by a small horizontal passage in limestone; steps, wooden bridges with handrails and electric light from a portable generator enabled us to inspect all of the 10 m depth of the excavated section. About half of this had been removed for fertiliser before the human skull was found. Two types of deposit can be seen in the cave, fine silty horizontal waterlaid sediments, and a blocky limestone breccia. The colour of the sediments is yellow-grey, intermediate between the typical older yellow sediments found in many caves in Southern China, and the younger, grey sediments usually associated with human occupation of the caves (e.g. Huang, 1963). This method of characterising cave sediments by colour in Southern China has had a long history, but detailed sediment analysis is now being used as well.

Preserved in the sediment was a human skull, and some postcranial fragments, and several species of mammals, including rhinoceros, tapir, deer, *Stegodon orientalis*, and a complete skeleton of the giant panda. Earlier in Peking we had been presented with casts of the human and panda skulls from Liukiang Cave. The bone remains were not evenly distributed throughout the cave but were in pockets, and none of the mammal fossils were associated with the human remains. No tools have been found in this site, or other signs of human occupation, though this is not surprising since the material is considered to be water deposited. The age of the fauna is considered to be Late Pleistocene; but isotopic dating has not yet been tried.

In a general way, the cave and its deposits reminded us of Wellington Caves, NSW, where the sediments are water washed clays, incorporating the bones of large animals. The Wellington sediments are however, a deep red in colour and there is a much greater concentration of bones than at Liukiang.

The only important open site in South China is the fluvial deposit at Yuanmou, in Yunnan. Discovered in 1940, it was originally thought to be Middle Pleistocene in age, but is now considered to include several units of different ages. The Early Pleistocene fauna at Yuanmou is correlated with the Nihowan fauna of North China and the Upper Irrawaddy fauna of East Burma. A recent paper describing two hominid teeth from Yuanmou, the first discovery of Early Pleistocene hominid remains from South China, also contains data on the stratigraphy, pollen analysis and mammal fossils. It may be of interest to Australian palynologists that pollen of *Nothofagus*, *Cyathea* and *Dicksonia* has been reported from Yuanmou (Hu, 1973).

Finally, mention should be made of the fossils found in the Lantien District, as the Pleistocene faunas of this region provide a link between those of North and South China. Lantien lies just on the northern slopes of the Tsinling Range in Shensi Province. There is about 400-500 m thickness of Pleistocene deposits here, ranging from Early Pleistocene to Holocene. The Early Pleistocene Laochiho/Youngko (or Yongguo) fauna is similar to that at Nihowan, though it may be slightly younger (Chi, 1975). Above the Youngko Formation is the Yehu Formation, containing the remains of Lantien Man; this is thought to be Lower Middle Pleistocene. Associated with the hominid remains is the Konwaling Fauna, which includes both southern species, notably *Ailuropoda* and *Stegodon*, and northern ones.

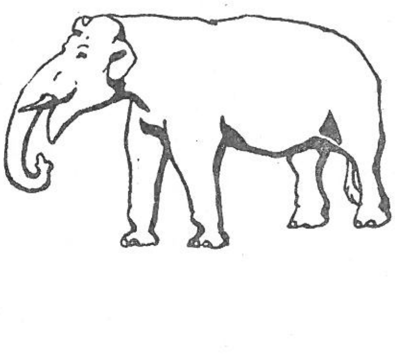
There are also Late Pleistocene faunas at Lantien. One recently studied in the Laochihegou Valley is similar to those found at Sjaraosso-gol and other Late Pleistocene localities of North China (Chi, 1973). This fauna contains animals of woodland and forests, and suggests a warmer and moister climate than today.

age?

This account of the Pleistocene mammal faunas of China and of the sites we visited is a very brief summary of the research done in Quaternary vertebrate palaeontology. I cannot comment on the research being done on the taxonomy and evolution of the mammal species, but it is on this that the validity of the correlation between, and the relative dating of sites, depends. Clearly, to verify the correlations now made purely on faunal grounds, more absolute radiometric dates and relative dates from other sources (such as palaeomagnetic reversals) would be desirable. This was recognised by the scientists we talked to. The lack of many radiocarbon dates for the Late Pleistocene faunas, and the use of just a few to correlate faunas over wide areas, was surprising, especially in comparison with Australia, where dozens are available, (mainly from archaeological sites), although vertebrate palaeontology is rather neglected here.

The dangers of correlating by faunal stratigraphy alone are particularly great in China because of the enormous size of the country and the great range of climates encompassed by it. As an example, one could take the deposits at Lantien, where the fauna associated with the hominid remains is considered to be more primitive than other Middle Pleistocene faunas of North China such as Choukoutien. It is therefore considered to be of Early Middle Pleistocene Age. However, this fauna also contains elements of the subtropical southern faunas; and it was not clear from the seminars we heard whether consideration had been given to the possibility that at any given time in China, the southern, more temperate regions may have acted as refugia for species which had been earlier replaced further to the north. This will no doubt be clarified as taxonomic studies continue and istopic dating is developed.

Jeannette H. Hope



4. PALAEOANTHROPOLOGICAL RESEARCH IN CHINA

The development of man and society is an essential element in modern Chinese social and political philosophy. Human palaeontology is therefore an important focus of multidisciplinary research and the major discoveries and results of work in this field are widely known and understood by the people. 'The abundant fossils discovered in China occupy an important place in the study of human history' (Woo, 1971) as many of the major trends within human evolution and adaptation during the Quaternary have been demonstrated by evidence from Chinese sites. Historically, the discoveries and excavations at Choukoutien represent a landmark for palaeoanthropology and today, more than 50 years after scientific work began in the area, it can be argued that the Peking Man deposit is still its most important single site. It should be recognised also that the discoveries of early man in China have been and are being made by people who are the descendants of the earliest occupants of the same area.

Research and training in palaeoanthropology centres on the Institute of Vertebrate Palaeontology and Palaeoanthropology (IVPP) of the Chinese Academy of Sciences. Direct and indirect research bearing on early man is also prosecuted from provincial centres such as museums and universities. Many of the province-based workers were either trained at the IVPP or were seconded to it for training in various fields. Palaeoanthropology constitutes one of four departmental or laboratory divisions within IVPP but it is my impression that there is considerable professional exchange of ideas and information with other laboratories, particularly with the Cenozoic Laboratory, which is concerned primarily with mammalian biostratigraphy.

The defined role of the Palaeoanthropology Laboratory embraces physical anthropology (mainly osteology and dental anatomy) and the archaeology of prehistoric China. The Laboratory also deals with physical materials stemming from historic-period research at the Institute of Archaeology. It is clear that in recent years a high proportion of research time has been devoted to fieldwork. It is not hard to see why. Relics legislation regulations require that accidental discoveries of human and other prehistoric materials be reported. Given the explosive growth in manufacturing industry and the rapid expansion of agriculture, particularly in previously undeveloped areas, many new discoveries are being made and require immediate investigation. Because of its relevance to geological survey the IVPP is involved in cooperative research with other institutes of the Academy. Also, the excavations conducted by the Institute of Archaeology produce substantial osteological materials. And finally, the Laboratory is generating fieldwork as a result of its own research needs.

The IVPP is involved in public education also. Apart from popular articles and books written by staff members the displays in a number of museums, in Peking and elsewhere, reflect recent Chinese fossil evidence and the research conclusions of specialists. The site museum at Choukoutien is an excellent example. Though the exhibition areas are small the displays are well presented and the information includes casts and photographs of all the relevant material, cultural and osteological.

Without having participated in the excavation of the prehistoric sites visited by the Quaternary Group it would be presumptuous to criticise the work, particularly as many of the difficulties that had had to be faced were apparent during even short visits. I was struck however by the absence of preserved sections or baulks in several sites, though there may be good reasons why it was not possible to retain any original deposit for later study.

Perhaps the most stimulating moment of the visit, to a palaeoanthropologist, occured at Choukoutien. During our inspection of the site we were shown the 'New Cave', a new fossiliferous locality discovered by Red Guards in 1967. The deposit here is an extension of Locality 4, which was thought to have been fully worked out. Preliminary excavations in 1971-2 produced faunal remains, stone artifacts, hearths and a human tooth. While on stratigraphic and artifactual grounds IVPP specialists believe the deposit may be more recent than the Locality 1 deposit, they consider it is possible that the new locality may link with the upper part of the lower cave. The implications of this possibility are far reaching indeed, given the history of scientific work at Choukoutien and the loss of the skeletal remains during the anti-Japanese war. If the New Cave deposit proves to be extensive, and certainly if it does connect with at least part of the lower cave, it will be possible to repeat much of the earlier work at the site and 'replace' lost material. Further, it may be possible to expand the strictly archaeological aspects of the research with the excavation of living floors and an analysis of the evidence for intrasite specialisation. We were told, for example, that in the preliminary excavations there appeared to be a sorting of animal skulls and various post-cranial remains into distinct groups or piles. With new stratigraphic and chronological controls for the Quaternary of China being developed at this and other localities, research on the New Cave deposit and the remaining Locality 1 deposits must be accorded a special priority.

Although much work, direct and indirect, has gone into the production of a Quaternary stratigraphic and chronologic sequence for use over large areas of China results at present are of limited value, particularly on recently discovered sites. Biostratigraphic chronologies, often relative, are commonly the only window on the ages of particular fossils. There are a number of major difficulties. Perhaps the most obvious is the sheer size of the country and the widely spaced scattering of fossil and occupation sites. The transition from Palaearctic to Oriental biogeographical provinces in China today and the substantial fluctuations across the country in the past are formidable analytical problems. Many of the major sites under investigation at present do not preserve or contain materials suitable for, say, potassium-argon determinations. Finally, many human skeletal fossils were found by accident in sites that were disturbed or at least partly removed. In the very brief fossil resumé that follows, the ages suggested are indicative of the chronological problems.

Since 1949 a large number of human fossil materials have been recovered in China. In 1956 and 1957 some 10 teeth were found in Tertiary deposits in Yunnan. These are probably *Ramapithecus* (Chow 1958) and indicate that a possible ancestor for the hominids was present in China as well as India and Africa. Although not a hominid the large and puzzling primate *Gigantopithecus* has been demonstrated by more than 1000 teeth, and three mandibles, from sites in Kwantung and Kwangsi. The ages of the various deposits range from early to middle Pleistocene.

Osteological and dental remains of *Homo erectus* have been recovered from three sites. At Choukoutien new fragments of crania and long bones have been found in the Middle Pleistocene lower cave, including the frontal bone of one of the 'lost' specimens known previously from a parieto-occupital section only. As mentioned above new material stems from the New Cave deposits some distance away. The two sites near Lantien, in Shensi, are clearly earlier than those at Choukoutien although how much earlier is uncertain. This is important, given the anatomical differences between the two groups of fossils. The Lantien cranial remains are more primitive, anatomically, and in some ways resemble the Javan *erectus* forms more than those from Peking. The most recent finds were made in Yunnan in 1965 when a pair of upper central incisors of *erectus* type were recovered from deposits of late early Pleistocene age (Hu 1973). In addition there are sites in Shansi, Kweichow, Hupei and Liaoning containing animal fossils and tools that are generally similar to those found at Choukoutien. The geographical spread of these sites suggests that by the middle Pleistocene man had adapted to a wide range of environments in various parts of north and south China.

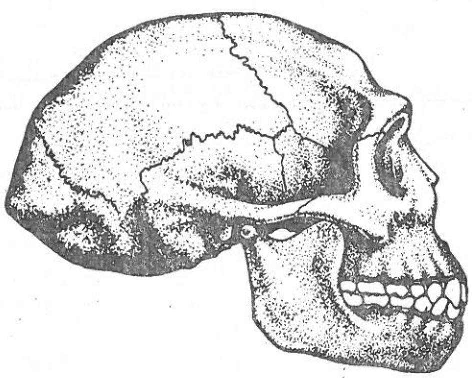
From what may be the early part of the late Pleistocene, characterised as middle Palaeolithic by some Chinese specialists, there are several osteological clues to man's presence in China. At Changyang in Hupei maxillary fragments and teeth were found in 1956 (Chia 1957). Three teeth of an adolescent were found in Shansi in 1954 (Pei *et al.* 1958). Two more teeth were recovered in Kweichow in 1972 but are as yet undescribed. The most complete specimen of this period is the partial cranium from Mapa in Kwantung (Woo and Peng 1959). This individual exhibits a mixture of features, having a much more modern parieto-occipital region than frontal. In this it appears to parallel some of the Australian fossils of more recent age. The Mapa frontal bone preserves the general form of the Choukoutien *erectus* supraorbital region and forehead. The Australian crania from Cohuna, Mossgiel and Kow Swamp demonstrate a somewhat more recent frontal form, but one that preserves many of the characteristics of the Javan *erectus* frontal bones. As the Mapa individual includes some Mongoloid features and the Australian fossils are clearly Australoid, I believe the Peking Man-Mapa-Mongoloid and Java Man-Kow Swamp-Australoid sequences, despite differences in timing, indicate that the origins of at least two of the major contemporary racial groups can be traced well back into the Pleistocene.

As might be expected, skeletal and cultural remains from the late Pleistocene, or late Palaeolithic in Chinese grouping, are more numerous than from previous periods. The best preserved specimens are the crania from Liukiang Cave in Kwangsi and from Tzeyang in Szechuan, described as early Mongoloids (Woo 1958, 1959).

I would like to make two general observations about the conduct of Palaeoanthropology in China and want to point out that they parallel my feelings about the subject in Australia. As mentioned above there has been a considerable emphasis on and necessity for field work in recent years. While it is likely that such pressures will continue for some time it is desirable that the results of fieldwork and resulting laboratory analysis be published in some detail. Much of the recent publication in the field has been preliminary and brief. Osteologically, there are a number of highly significant finds or groups of finds that more than justify anatomical description, both metrically and non-metrically. In many countries more and more fieldwork is used as an excuse to defer the laborious tasks of analysis and writing up. This applies particularly to researchers working on joint projects, where integrated statements can be made that have local and international importance. Contact with Chinese colleagues leads me to conclude that researchers with field and analytical data need to be given the opportunity to defer new fieldwork so that conclusions about current information can be drawn and new perspectives and priorities developed for work in the coming years.

A related point concerns the development of a regional picture for early man. For many years human evolution, particularly in the later Pleistocene, has been interpreted in terms of European evidence. Fossil and other data from outside Europe has been assessed in terms of a European (and/or African) model, in some cases when the best evidence for theoretical constructs was in fact Asian. It is becoming clear that the European evidence describes a regional European pattern of changes and that other areas saw relatively independent developments of man and society. It may be that the effort required for detailed description and publication would strengthen our understanding of the unique nature of human development in China.

A.G. Thorne



5. PALYNOLOGY IN CHINA

There are said to be about 400 palynologists in China, most of them, as elsewhere in the world, working on coal and oil stratigraphy. The first laboratory was established in 1953. I visited three laboratories in which basic Cenozoic pollen analysis is carried out. These were at the Institutes of Botany and of Geology in Peking and at the Institute of Geochemistry at Kweiyang. I also spent a few moments in a section of the Kwangtung Botanical Institute where pollen morphological studies have recently begun.

The Institute of Botany in Peking has a scientific staff of about 300 persons in seven departments, one of which, Palaeobotany, is headed by Professor Hsu Jen, the doyen of Chinese palynology. The Palynology Section has a staff of eight plus a few students and visitors. Equipment is basic but of high quality. I was shown photographs taken on a scanning electron microscope being built in the workshops of Academia Sinica. The reference collection contains the pollen of about 9000 species. In general, work is in progress on the pollen morphology of living plants and on the fossil record from the Cretaceous through the Quaternary. I was given a volume of pollen and spore descriptions and photographs covering 118 families, 900 genera and 1400 species published in 1960. Pollen morphological work continues with emphasis on tropical and subtropical groups to meet the needs of oil exploration; a further volume describing more than 1000 species is in preparation. Most Quaternary pollen analysis is associated with major geological or palaeontological sites (e.g. Lantien, Choukoutien). The Erdtman technique is used for most preparations.

In the Institute of Geology in Peking, the Quaternary laboratories (microscope and preparation rooms separate) are used by two or three persons headed by Zhou (Chou) Kun-shu. Again, the equipment is simple but very good; there is a substantial reference collection. Heavy liquid separation is the preferred preparation technique. The research described from this laboratory was mainly concerned with the Jolmolungma (Everest) region. Pollen analytical results from interglacials and the Holocene have been compared with the present distribution of analogous vegetation. They indicate that the mountains have risen more-or-less continuously by as much as 1600 m since the early Quaternary and have substantially modified access of damp air from the south.

At Kweiyang, in the Institute of Geochemistry, two rooms are devoted to palynology, research being carried out by Mr Chen Cheng-hui and an assistant. The basic equipment is of excellent quality and there is a substantial reference collection. Heavy liquid extraction, using cadmium iodide, is the usual preparation technique for fossil samples. Holocene pollen diagrams demonstrating three or four vegetation stages in northeast China were displayed, the chronology adequately controlled by radiocarbon dates.

At the Kwantung Botanical Institute on the outskirts of Canton, Professor Yu, the head of the large department of taxonomy and morphology, has recently begun work on pollen morphology of tropical plants.

Although we did not try to discover where each individual piece of Quaternary pollen analysis had been carried out, a number of laboratories have evidently contributed to the rather large amount of data relevant to the stratigraphical subdivision of the North China Plain, sites ranging geographically from Changchow on the middle Huang River to Tientsin and Peking. The main purpose of this work as of much of Chinese Quaternary palynology, is to identify the climatic conditions of intervals stratigraphically defined. Much depends on the balance between gymnosperms and broad-leaved trees and on the relative contributions of *Abies, Picea, Pinus, Podocarpus* and *Larix* or *Celtis, Ulmus, Quercus* and *Carpinus* to these two groups. The occurrence of suites of herbaceous steppe plants and the penetration of subtropical elements northward are also used as climatic indicators.

In addition to these geologically and palaeoclimatically directed studies I was told of some work on the environments of archaeological sites (e.g. Inner Mongolian tombs now in grassland were surrounded by pine forest at the time of their building in 4000 BP).

The preparations I saw in China were as good as the best I have seen from any other part of the world and the capacity of the analysts to identify their material is evidently very high indeed. Coming late into the field of Quaternary pollen analysis, although earlier than did Australia, they have aligned themselves with the stratigraphers. This has proved to be a valuable alliance in sorting out the major stratigraphic units of China's great fluvial-lacustrine spreads. But it seems not to have produced many long continuous records of vegetation change from sites chosen primarily for their suitability for pollen analysis. I believe these to be essential if the full significance of the more fragmentary sections is to be correctly determined. There are indications that this is beginning, particularly in the excellent Holocene diagrams I was shown in Kweiyang and the report that somebody in southern China is working on a long sequence from a crater lake. One could also criticise the use of the Blytt-Sernander subdivisions of the Holocene at a time when regional variety in vegetation and climatic history is becoming more evident throughout the world.

In spite of these criticisms I am bound to say that, on all counts, Chinese Quaternary palynology is as good as that being carried out in 80% of the rest of the world's laboratories and, in some respects, distinctly better. The calibre of the personnel is high and their laboratory equipment is good. I look forward to the development of the contacts we have made to the benefit of our subject in both countries and suggest that Australian palynologists with interests they would like to share with our Chinese colleagues should contact me in the first instance.

D. Walker

6. ISOTOPIC DATING OF ROCKS

Isotopic dating of rocks is an important tool for elucidating geological history over virtually the whole range of geological time from the Precambrian to the Quaternary. The various methods are particularly valuable in regions where palaeontological control is poor or absent. Apart from the radiocarbon dating method, discussed elsewhere in this report, the other main technique used for physical dating of rocks in the Quaternary is the K-Ar method.

It is obvious that China recognises the value of isotopic dating methods in geological studies as about 20 laboratories have been established. Visits were made to two of these isotope dating laboratories, one within the Institute of Geology, Peking, and the other in the Kweiyang Geochemical Institute. Both laboratories are carrying out K-Ar and Rb-Sr geochronology, and I was informed that other laboratories in China are similar to the two visited. An impressive array of results now exists on the physical ages of rocks in China; however, to the present time little or no dating work has been carried out on Quaternary rocks, except, of course, by the radiocarbon method. The reason why the K-Ar method has not been applied to Quaternary rocks is that there have been many other parts of the time scale for which data are required, and also because the equipment available is not very suitable for dating young rocks. Nevertheless there is considerable interest in developing the techniques and equipment to enable young rocks to be dated by the K-Ar method.

I. McDougall

7. PALAEOMAGNETIC LABORATORY, INSTITUTE OF GEOMECHANICS, PEKING

This laboratory is located in the Shishainling People's Commune close to the Ming Tombs, northwest of Peking. Li pu, an engineer in the Institute, kindly showed us the facilities. The laboratory was started in 1963 and began operating in 1965. We were told that there are now about five palaeomagnetic laboratories in China, but that not all of these are functioning as yet. The equipment seen at Shishainling consisted of an astatic magnetometer with a high sensitivity, and an alternating field demagnetising apparatus. While this equipment is far from modern and slow in operation it is certainly possible to obtain reliable results on suitable samples. The main aim of the palaeomagnetic investigations is to determine the direction of the magnetic pole through geological history, and thus to derive information on the tectonic evolution of China.

In Kweiyang we were shown palaeomagnetic data obtained on two sections through the Quaternary loess deposits in Shansi Province, and data on sediments sampled in bore cores drilled in the North China Plain. We understood that the palaeomagnetic measurements were made in the Institute of Geomechanics Laboratory. These data were invaluable because polarity changes are recorded in the sections and it is possible to correlate these polarity reversals with the geomagnetic polarity time scale, thus providing information on the age of the sections and facilitating correlation. For example it has been shown that the Malan and Upper Lisheh Loess have normal polarity and that the Brunhes-Matuyama boundary of age about 0.69 million years occurs in the lower part of the Lower Lisheh Loess. This work is of world significance and interest and hopefully will be continued and expanded.

I. McDougall

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8. KWEIYANG GEOCHEMICAL INSTITUTE

During our visit to this Institute several of us made an extended tour of the laboratories. We were greatly impressed by the wide range of facilities and instrumentation available in the Institute - indeed one of the best equipped geochemical laboratories I have ever seen. Laboratories visited included emission spectrography, electron microscopy, electron microprobe, electron spin resonance, X-ray diffraction, X-ray fluorescence, the laboratory for designing and manufacturing of a portable X-ray crystal analyser, differential thermal analysis, calorimetry, polarography, atomic absorption, fluid inclusion studies, palynology, and several chemical separation and analytical laboratories. In addition to the isotope geology laboratory facilities previously described, I was shown an Atlas CH4 mass spectrometer currently being used for the isotopic analysis of sulphur. Much of the equipment seen was rather old, but used carefully and intelligently very satisfactory results on geological samples can be obtained. Clearly a very wide range of geochemical studies are undertaken in the Institute as is shown by the many papers published in the journal Geochimica covering trace and major element geochemistry, mineralogy, petrology, isotopic dating, mineral separation techniques, hydrothermal studies and organic geochemistry.

I. McDougall

9. RADIOCARBON DATING IN CHINA

There are four active radiocarbon dating laboratories in China all of which were visited by members of our party. Three use proportional counting in acetylene gas but all have some equipment for scintillation counting awaiting assembly and one operates this technique exclusively. The first equipment was made by a group of potential users over a period of eight years.

Institute of Geology, Academia Sinica, Peking

(Peng kui.) A proportional counter of 1800 cc with mercury and Geiger shields is operated at 850 mm of mercury pressure. The dating error is about ± 100 years at 2000 BP. Standards used are pre-1950 wood of a poplar tree and local coal. Wood, coral and shells have been dated in a programme largely directed at coastal stratigraphy and archaeology. Output is about 35 dates per year.

Institute of Archaeology, Peking

Dating began in 1960. The proportional counter has a capacity of four litres. The maximum output is about 12 samples per month.

Peking University, Department of Archaeology

(Wang Liang-hsiun.) A new laboratory employing scintillation counting in benzene. The sample is converted to acetylene which is in turn catalysed to benzene giving 95% recovery at 140°C. Background 16.3 to 16.5 cpm.

Institute of Geochemistry, Academia Sinica, Kweiyang

(Shen Chen-teh and seven colleagues.) A proportional counter of 1800 cc capacity is shielded by Geiger counters, paraffin and boric acid and a steel turret. Background is about 16 cpm and a poplar wood sample dated at 1891 ± 10 years AD is used as a standard. Usual counting time is 1000 minutes. The programme has involved the dating of peat samples from northeast China, marine shells now 25 km inland, uplifted coral from south China, carbonate mud from the formation stages of salt lakes and some archaeological samples. Output is about 50 dates per year.

The leaders of the groups at the Institute of Geology and the Institute of Geochemistry both responded enthusiastically to my suggestion for exchange of standards, particularly the new sugar standard. I also suspect that discussions about the variety of preparation methods and problems of dating 'difficult' materials would be opportune.

D. Walker

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