BIBLIOGRAPHY OF RECENT ARCHEOLOGICAL DISCOVERIES

BEARING ON THE

HISTORY OF SCIENCE AND TECHNOLOGY

by

HSIA Nai 夏鼐

edited and translated by

Donald Blackmore WAGNER

Figure 1

The design on an inlaid bronze jar found in a Warring States tomb in Chengtu, Szechwan. From Item 66, Plate 2.
Abbreviations
CP China Pictorial
CR China Reconstructs
CSA Chinese Sociology and Anthropology
KK K'ao-ku 考古 (Archaeology)
KKHP K’ao-ku hsueh-pao 考古学报 (The Chinese Journal of Archaeology)
WW Wen-wu 文物 (Cultural Relics)

Editor's Introduction

No one sufficiently interested in Chinese science to read this journal will be
unaware that the major discoveries in this field made in China over the last dozen
years have sprung from archeological excavation rather than library research.
With the reconstitution of the Research Institute for the History of Natural
Sciences in 1977, the work of fully integrating these discoveries with the historical
record has begun to accelerate. It is perhaps symbolic of that transition that
early in 1977 Dr. Hsia Nai published in K’ao-ku, the bimonthly Chinese journal of
archeology, a general review of important publications over the last five years, as
well as materials not yet published, bearing on the history of science and technol-
y. His article in effect reviewed the important finds of the entire Cultural
Revolution era. No writer could have been more fully informed or more judicious
in his evaluations. Hsia’s interest in technical history was largely responsible for
the attention paid to it in China by archeologists, and for the willingness of arche-
ologists and historians to collaborate in the study of artifacts. I know of no
precedent anywhere for the extent to which these trends developed.

Shortly after the article appeared, Donald Wagner proposed that he translate it
into English for publication in Chinese Science. Before the details had been
worked out, I found myself quite unexpectedly at a meeting with Hsia Nai in
Peking. He gave me a copy of his essay with a great many emendations and
additions, and granted his permission for a translation—necessarily somewhat
condensed to fit within limits of space—to be published in Chinese Science.

In abridging the essay, Donald Wagner has endeavored to keep all of the tech-
ical detail that will help readers assess the meaning of the new discoveries. In order
to do so, he has had to sacrifice to some extent Hsia’s discussions meant to

Dr. Hsia is Director of the Institute of Archeology, Chinese Academy of Social Sciences. Mr.
Wagner is a Research Fellow at the Scandinavian Institute of Asian Studies, Copenhagen.
In the references, translations of titles enclosed in quotation marks are those given in the
publications themselves. Italics are used for volume numbers of periodicals; numbers not ital-
icized designate issues. References in which a dagger (†) precedes the item number were added
by the translator. Comments indented following references are by the translator unless other-
wise indicated. The abbreviation “Ed.” refers to the Editor of Chinese Science.

European readers may be interested to know that almost all of the material cited here may
be seen at the Danish Royal Library. Photocopies or microfilms are available at moderate
prices from the Oriental Department, The Royal Library, Christians Brygge 8, DK-1219 Copen-
hagen K, Denmark.
impress upon his readers the high level of science and technology in ancient China—a point already familiar to readers of this journal. Hsia’s bibliography has been reproduced completely, along with citations of more recent Chinese writing and germane publications in Western languages. Hsia Nai’s own revisions have been directly incorporated in the text.

This review essay is by no means exhaustive, and I doubt whether there would be any point in publishing an exhaustive bibliography on this subject. The selection is careful and thorough. Readers who want additional references on a particular topic can find them through Hsia’s citations. Wagner has provided in the next article a list of recent publications on topics not discussed in this one.

It is helpful to be aware that in general the titles given for ancient manuscripts are modern and provisional. Titles were very often not recorded on personal copies of early books; even when they were recorded, the outermost parts of manuscripts frequently have been damaged or lost over the centuries.


Translator’s Introduction

An important recent essay by Dr. Hsia Nai reviews significant archeological studies related to our subject from the Cultural Revolution to about mid-1976. “K’ao-ku-hsueh ho k’o-chi-shih 考古學和科技史” (Archeology and the history of science and technology; KK, 1977, 2: 81-91) is an essay review supported by 99 footnotes. I have cast the translation in the form of an annotated bibliography, interweaving the text and footnotes, in order to provide more immediate access to references. The citations incorporate a number of emendations provided by Dr. Hsia. I have added a number of references to publications after mid-1976. The next article provides references on related topics for the period from 1972 to the end of 1978.

Useful bibliographies of earlier publications on Chinese archeology are:

†1. Barnard, Noel; Satō Tamotsu 佐藤保
Metallurgical Remains of Ancient China 中國古代金屬遺物

†2. Ch’en Chin-po 陳錫波
Chung-kuo i-shu k’ao-ku lun-wen so-yin. I-chiu-ssu-chiu—i-chiu-liu-liu
中國藝術考古論文索引 一九四九——九六年

†3. Vanderstappen, Harrie A.
The T. L. Yuan Bibliography of Western Writings on Chinese Art and Archaeology

†4. Su Chen Ho

_Yearbook of Chinese Archaeology, 1956_

New York, 1968. Short summaries of articles in Chinese archeological journals published in 1956. No further volumes have been published.

1. Astronomy

In 1973, at the Yin waste near Anyang, Honan, over 4800 inscribed oracle bones and shells from the fourteenth to the eleventh century B.C. were found. Among the oracle inscriptions there is much material relevant to the calendar and to observational astronomy.

5. 1973年安阳小屯南地发掘简报


Among the silk manuscripts found at Ma-wang-tui, Changsha, Hunan, there is an astronomical text, “Planetary divination五星占,” along with an appendix, “Table of the motions of the planets五星度表.” The appendix records the observed and computed synodic and sidereal periods of Jupiter, Saturn, and Venus over the period 246-177 B.C. The manuscript was written about 170. The calculated periods of revolution of the planets are extremely close to the values established by modern methods.

6. Liu Yun-yu 刘云友

中国天文史上的一个重要发现——马王堆汉墓帛书中的《五星占》


7. 《五星占》附表释文


8. Hsu Chen-t’ao 徐振铎

从帛书《五星占》看“先秦浑仪”的创制

(“The invention of the pre-Ch’in armillary sphere viewed in the light of the silk manuscript of the Wu hsing chan (Treatise on planetary motions and their astrological significance)”). KK, 1976, 2: 89-94, 84.

Another manuscript found in the same tomb is “Chart of divination by the stars and the clouds天文气象杂占.” It consists of drawings of various kinds of comets and clouds, with explanations in divinational terms.

9. 马王堆二号汉墓发掘的主要收获

(“Significance of the excavation of Han tombs nos. 2 and 3 at Mawangtui in Changsha”). KK, 1975, 1: 47-57, 61, esp. p. 54.

†10. Ku T’ieh-fu 顾铁符

马王堆帛书《天文气象考占》内容简述

(“Notes on the silk manuscript of astrology found in the Han tomb no. 3 at Mawangtui, Changsha”). WW, 1978, 2: 1-4. Note the change in the title assigned to the MS, which bore no title when found.
Hsi Tse-tsung 席泽宗

马王堆汉墓帛书中的彗星图
(“The silk manuscript of comet map found in the Han tomb no. 3 at Ma-
wangtui, Changsha”). WW, 1978, 2: 5-9. This essay reproduces and
discusses the part of the above MS devoted to comets.

In A.D. 56 the Emperor Kuang-wu built an observation tower 灵台 in the
southern outskirts of Loyang (in the present city of Yen-shih 偃师 Honan). It
continued in use through the Wei and Western Chin periods. There have been
evacuations at this site in 1974-1975. It is built of pounded earth, and in its
present state is over 8 meters high. [No instruments remain at this site—Ed.]

12. 汉魏洛阳城初步勘查
(“Preliminary survey of the remains of the Han-Wei city of Loyang”).

13. 汉魏洛阳城东南的灵台遗址
(“The remains of the Ling T’ai of the Han and Wei dynasties on the

We have recently investigated a portable bronze gnomon 圭表 from the middle
of the Eastern Han period. It was discovered in 1965 in a Han tomb at I-cheng
仪征, Kiangsu. At that time it was thought to be a foot-rule. It consists of an
upright gnomon 19.2 cm. (8 Han ts’un) long and a shadow template 34.39 cm.
(15 ts’un) long. The template is graduated.

14. 东汉铜圭表

Two early single-vessel outflow clepsydras (or water clocks) have been found in
recent years. One of these was in the tomb of Liu Sheng 刘胜 (d. 113 B.C.) at
Man-ch’eng, Hopei, and the other in a Western Han tomb at Hsing-p’ing, Shensi.
They are cylindrical, and respectively 22.4 and 32.1 cm. high.

15. 满城汉墓发掘记要
(Report on the excavation of a Han tomb at Man-ch’eng). KK, 1972,

16. 陕西兴平汉墓出土的铜漏壶
(A bronze clepsydra found in a Han tomb at Hsing-p’ing, Shensi). KK,
1978, 1: 70.

In recent years a great many star maps have been found, painted or incised in
rock, in tombs ranging in time from the Northern Wei to the Sung and Liao peri-
ods. These are always on the ceiling of the tomb chamber. One of the most im-
portant charts is in the tomb of Yuan I 元乂 (d. A.D. 526) near Loyang. More
than three hundred stars are indicated; in a few cases stars are connected by
straight lines to indicate constellations.

17. Wang Ch’ê 王�; Ch’en Hsu 陈徳
洛阳北魏元乂墓的星象图
(“The star map found in the Northern Wei tomb in Loyang”). WW,
1974, 12: 56-60. Color photograph, Plate 1.

Recently we have also studied the stone-relief star maps in the tombs of Ch’ien
Yuan-kuan 钱元瓘 (d. 941) and his consort, near Hangchow. These two maps
are the oldest of their kind known in China, over three centuries older than the
world-famous Soochow Planisphere of 1247. About two hundred stars are indicated. Three concentric circles are drawn on the map: an “inner circle,” the celestial equator, and the “outer circle.” The “inner circle” is the bound for the circumpolar stars, always visible at the latitude of the site, and the “outer circle” is the bound beyond which stars are never visible. From the positions of these circles it has been calculated that the observations on which the maps were based had been taken at a latitude of ca. 37°N in about a.d. 850, possibly somewhat earlier. [The latitude of Hangchow is ca. 30°N, and no important observatory is known above ca. 35°N.—Ed.]

18. I Shih-t’ung 伊世同

最古的石刻星圖—杭州吳越墓石刻星圖評介

On the star map of 1116 in the Liao tomb at Hsuan-hua, Hopei, excavated in 1974, are portrayed not only the constellations of the twenty-eight lunar lodges (hsiu 宿), but also pictures of a Sinified version of the Western signs of the zodiac.

19. 河北宣化辽壁画墓发掘简报

20. 辽代壁画星圖是中國天文史上的重要發現
("The star map of the Liao dynasty, an important discovery in the history of Chinese astronomy"). WW, 1975, 8: 40-44.

21. Hsia Nai 夏鼐

从宣化辽代墓的星图论二十八宿和黄道十二宫

†22. Schafer, Edward H.

An Ancient Chinese Star Map


The star maps found in several large tombs of the seventh to the eighth centuries near Sian do not show much more than the twenty-eight lodges; the number of stars indicated is small, and their positions are not precise.

23. 唐章怀太子墓发掘简报

24. 唐懿德太子墓发掘简报

25. 和林格尔发现一座重要的东汉壁画墓
("An important Eastern Han tomb with wall paintings found at Ho-lin-ko-erh, Inner Mongolia"). WW, 1974, 1: 8-23, esp. p. 18.

26. 唐李寿墓发掘简报
("Excavations of the T’ang dynasty tomb of Li Shou at San-yuan County,
Shensi Province”). WW, 1974, 9: 71-88, 61, esp. p. 75. The star map is painted on the inside of the stone coffin.

In 1972 an ephemerides for the year 134 B.C. was found in a Western Han tomb near Lin-i, Shantung. This is the earliest comprehensive ephemerides so far found in China. The computation system is that of the Ch’in, and the civil year begins with the tenth month. This tallies with other evidence that the Ch’in system was still used in the early Han.

27. Ch’en Ch’iu-chin 陈久金; Ch’en Mei-tung 陈美东

临山出土汉初古历初探

2. Mathematics and Metrology

Calculating rods have been found recently in two tombs: in 1971 in a Western Han tomb in Ch’ien-yang, Shensi, and in 1975 in a Western Han tomb in Chiang-ling, Hupei. Thirty-one bone calculating rods were found in Ch’ien-yang. They are 13.5 cm. long and 0.3 cm. in diameter. The calculating rods from Chiang-ling were found in a bamboo box together with a steelyard shaft and weight.

28. 千阳县西汉墓中出土算筹

29. 湖北江陵凤凰山一六八号汉墓发掘简报

†30. Juliano, Annette L.

Three Large Ch’u Graves Recently Excavated in the Chiangling District of Hupei Province
Artibus Asiae, 1972, 34.1: 5-17.

†31. 关于凤凰山一六八号汉墓发掘简报

†32. Chung Chih-ch’eng 钟志成

江陵凤凰山一六八号汉墓出土一套文书工具

†33. 关于凤凰山一六八号汉墓天平衡杆文字的释读问题
(The interpretation of the inscription on the steelyard shaft found in the Han tomb no. 168 at Feng-huang-shan). WW, 1977, 1: 40-42.

†34. Huang Sheng-chang 黄盛璋

关于江陵凤凰山168号汉墓的几个问题

Balances and weights have been found in over one hundred tombs of the Ch’u state in Hunan, ranging in date from the end of the Spring and Autumn period to late Warring States. An extensive survey of these weights shows that in the Spring
and Autumn period one liang 两 was about 16.3 g.

35. Kao Chih-hsi 高至善
湖南楚墓中出土的天平与法码
(Balances and weights found in Ch’u tombs in Hunan Province). KK, 1972, 4: 42-45. Photograph, Plate 1.

In the past few years two standard weights of the Ch’in period have been found, an iron steelyard balance weight in Wen-teng, Shantung, and a ceramic standard weight in Kirin. Each is inscribed with Ch’in Shih-huang’s proclamation of standardized weights and measures, dated 221 B.C. This was one of the measures used to consolidate the political unification by the First Emperor.

36. Chiang Ying-chü 蒋英矩; Wu Wen-ch’i 吴文棋
山东文登发现秦代铁权
(An iron weight of the Ch’in period found in Wen-teng, Shantung). WW, 1974, 7: 94.

The Kirin find has not been published. It is mentioned briefly in the following article.

37. Wang Shih-min 王世民
秦始皇统一中国的史作用—从考古学上看文字、度量衡和货币的统一

A number of Han-period foot-rules of bronze and bone, and bronze measures of volume, have also been discovered.

38. 嵇壁汉画像砖墓
(The Han-period tomb containing stone-relief bricks at Chia-yü-kuan, Kiangsu). WW, 1972, 12: 24-41, esp. p. 29, Figure 6.

39. 迤草九龙山汉墓发掘简报
(Preliminary report on the excavation of the Han tombs at Chiu-liung-shan, in Ch’ü-fu, Shantung). WW, 1972, 5: 39-44, 54, esp. p. 43, Figure 6.

40. 咸阳市近年发现的一批秦汉遗物
("Recent finds of the Ch’in and Han dynasties at the city of Hsienyang"). KK, 1973, 3: 167-170, esp. p. 169 and Figure 5.

Several Han bronze measures of volume have been discovered, for example in Han tombs at Man-ch’eng, Hopei, and T’ung-shan 铜山, Kiangsu. Some of these have inscriptions recording their dimensions, volume, and weight. It is thus possible to determine the values of contemporary metrological units.

41. Ho Kuo-t’ao 何国涛
成都西郊罗家埂出土西汉量器—铜斗
(A Western Han bronze tou found at Lo-chia-nien, on the western outskirts of Chengtu). WW, 1974, 5: 92.

42. T’ien Shih 天石
西汉度量衡略说

3. Cartography
A discovery of great importance for the history of cartography in China is the
maps found among the silk manuscripts from Ma-wang-tui. Particularly interesting is the “Map of the southern part of the state of Changsha 长沙国南部地图.” Its length and breadth are each about 96 cm., and the scale is about 200,000: 1. South is at the top, north at the bottom. It shows important towns, rivers, and mountains, and uses conventional symbols for administrative centers and topographical features. Comparison with modern maps shows that this chart is rather accurate.

43. 长沙马王堆三号汉墓出土地图的整理
(“Report on the ancient maps found in the Han tomb no. 3 at Ma-wang-tui, Changsha”). WW, 1975, 2: 35-42. Illustrated.

44. T’an Ch’i-hsiang 谭其骧
二千一百多年前的一幅地图

45. T’an Ch’i-hsiang 谭其骧
马王堆汉墓出土地图所说明的几个历史地理问题
(Some problems in historical geography clarified by the maps discovered in the Han tombs at Ma-wang-tui). WW, 1975, 6: 20-28.

†46. A 2,100-year-old Map

Another map of the same area shows cities and the designations of their garrisons.

47. 马王堆三号汉墓出土地图整理简报
(“Report on the military map found in the Han tomb no. 3 at Mawang-tui”). WW, 1976, 1: 18-23.

48. Chan Li-po 廉立波
马王堆汉墓出土的守备图探讨
(Ts’an Li-po, “Notes on the military map found in the Han tomb no. 3 at Mawangtui”). WW, 1976, 1: 24-27. Photographs of the map and a reconstruction.

†49. Chou Shih-jung 周世荣
有关马王堆古地图的一些资料和几方汉印
(Material related to the ancient maps from Ma-wang-tui and some Han seals). WW, 1976, 1: 28-32. Explanations of geographical terms used on two of the maps. See also Item 51.

A third map is a plan of a hsien 县 seat, showing the city wall, buildings, etc. This map has not yet been published. It is discussed briefly in Item 9, p. 53, and in the next item.

50. Hsiao Han 晓菡
长沙马王堆汉墓帛书概述
(“Brief notes on the silk manuscripts of ancient books found in the Han tomb no. 3 at Ma-wang-tui, Changsha”). WW, 1974, 9: 40-44, esp. p. 43.

†51. Ku ti-t’u. Ma-wang-tui Han mu po shu 古地图·马王堆汉墓帛书
(Ancient silk manuscript maps from Ma-wang-tui). Peking, 1977. Photographic reproductions and partly conjectural reconstructions, each half the original size, of the two published maps. They are accompanied by a brochure in which are reprinted Items 43-45 and 47-49.

Ancient Chinese Maps. Two Maps Discovered in a Han Dynasty Tomb from the Second Century B.C.


Before these maps were discovered, the earliest known maps in China were two incised in stone, preserved at the Forest of Steleae (P'e-lin 碑林) in Sian. They are dated 1136, over thirteen hundred years later.

4. Hydraulic Engineering

At the Tu-chiang Irrigation Works 都江堰 in Kuan County 濯县, Szechuan, a stone figure of Li Ping 李冰 dated A.D. 168 was discovered in 1974, and another stone human figure in 1975. Under the state of Ch'in, Li Ping was Grand Administrator of the commandery of Shu in approximately 256-251 B.C. He started the construction of the Tu-chiang works, which is still in use today. He appears to have become a folk hero for the people of that region. According to _Hua-yang kuo-chih_ 华阳国志 (A.D. 347), among other written sources, the shoulders and feet of this statue marked the highest and lowest water levels.

53. 都江堰出土东汉李冰石像

54. Wang Wen-ts'ai 王文才
   东汉李冰石像与都江堰“水则”
   (The Eastern Han stone statue of Li Ping and the “Water Patterns” of Tu-chiang-yan). _WW_, 1974, 7: 29-32.

55. 都江堰又出土一躯汉代石像
   (Another Han-period stone statue found at Tu-chiang-yan). _WW_, 1975, 8: 89-90. Illustrated.

During the years 1967-1973, archeological investigations along the banks of the Yangtze below Chungking have revealed numerous stelae recording times of flood and drought. The most important of these is at Fu-ling 涪陵, Szechuan, where periods of drought are recorded for seventy-two years, starting in A.D. 764. Some of the stelae, besides recording the date, include a “stone fish” mark to indicate the actual water level.

56. 长江上游宜渝段历史水位调查——水文考古专题之一
   (“A historical study of the water level in dry period along the Upper Yangtze Kiang”). _WW_, 1974, 8: 76-90. Illustrated.

57. 从石刻题记看长江上游的历史洪水——水文考古专题之二

58. 略谈长江上游“水文考古”

5. Shipbuilding

Very few ancient Chinese ships have been discovered until recently. Our knowledge of early shipbuilding practice has come almost entirely from wooden and pottery models and from paintings.

In 1973 a T'ang wooden ship was excavated in Ju-kao County, Kiangsu. The surviving hull of the ship is 17.3 m. long, and at the widest point is 2.6 m. wide. The hull is divided by bulkheads into nine compartments, 1.6 m. deep. The holds and hull are reinforced with iron nails, and caulked with a mixture of lime and tung oil. There is a single mast, the extant remainder of which is 1 m. long. The hull has a flat bottom and no keel; thus it may be classified as a sha-ch'uan 沙船 [lit., "sand-boat"; Needham refers to this type of ship as a "Chiangsu freighter"]. It could probably carry about 20 tons of cargo. In the boat were found a few earthenware and crude porcelain vessels, which appear to be from the T'ang period. Three K'ai yuan 升元 (A.D. 713-741) coins were also found.

![Figure 2](image)

Rubbing of part of a "stone fish" inscription dated 1685. From Item 56, p. 86.

60. 如皋发现的唐代木船

("The T'ang dynasty junk unearthed at Ju-kao, Kiangsu Province"). WW, 1974, 5: 84-90. Illustrated.

In 1974 the skeleton of a thirteenth-century seagoing ship was found at Ch'üan-chou, Fukien, along with some fittings and shipbuilding tools. In the Sung and Yuan periods Ch'üan-chou was a world-famous port; Marco Polo refers to it as Zayton. The hull of the ship, almost complete, is about 24 m. long and 9 m. wide. Its capacity is estimated to be over 200 tons [but see Item 65-Trans.]. The hull is divided into thirteen watertight holds. There is a keel. There are copper-alloy slots in the deck for the mizzenmast and mainmast, and for the rudder [there may have been more than three masts—Ed.]. In the ship were found some structural members and gear, for example a windlass and oars. The structure

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of the ship is solid, and its stability is good; it would be suitable for long ocean voyages. The cargo includes 4700 kg. (wet weight) of various kinds of incense-wood, along with perfumes and medicinal material. There are also ninety-six wooden slips looped with light twine; these must have been used to label cargo. Five hundred and four coins were found, the latest of which was cast in 1171.

61. 袁州湾宋代海船发掘简报

62. 袁州港的地理变迁与宋元时期的海外交通

63. Wang Ts'eng-yü 王曾瑜
谈宋代的造船业

64. 袁州湾宋代海船复原初探

†65. Ch'en Kao-hua 陈高华; Wu T'ai 吴泰
关于袁州湾出土海船的几个问题
(Some problems concerning the seagoing vessel found at Ch'üan-chou Bay). WW, 1978, 4: 81-85. Here the capacity is corrected to 60-120 tons.

Recently a number of models and pictures of ships have also been found. A description of an inlaid bronze jar 壺 [of the Warring States period] found at Pai-hua-t' an 百花潭, in Chengtu, Szechuan, has recently been published. On it is a scene of a sea battle 宴乐工战图. It appears that both sides are using double-decked ships 楼船, with fighters above and oarsmen below. Some contend that what appears to be the upper deck is actually a land battle on the bank, but from the published picture it appears that the ships have upper decks.2

66. 成都百花潭中学十号墓发掘记

†67. Tu Heng 杜恒
试论百花潭散错图象铜壶

In 1973-1975 two wooden ship models were found in Western Han tombs in Chiang-ling, Hupeii. The two are very similar. In one of them, the hull is carved of a single piece of wood, with the bow and stern level. In the hold are fitted

2Considering the representation on this jar alone, either of these interpretations would seem to be admissible. Comparison with a remarkably similar jar in the Palace Museum, however, indicates that the ships are indeed double-decked. See Michael Sullivan, The Arts of China (London, 1973), p. 62. Unfortunately the original source is not indicated—Translator.
several beams, on which planking is laid. The model is 71 cm. long. The bottom is flat, and there is no keel. There is a cabin on the deck, and on each side of the cabin is a plank on which rowers and polers can walk back and forth. Oars were found, but no rudder.

68. 湖北江陵凤凰山西汉墓发据简报
("Excavations of the Han dynasty tombs at Feng-huang-shan, in Chiang-ling County, Hupei Province"). WW, 1974, 6: 41-61, esp. pp. 48-49. Illustrated. See also Item 29 above.

Boats appear in several murals in Han tombs. In an Eastern Han tomb excavated in 1972 at Horinger (Ho-lin-ko-erh), Inner Mongolia, there are two paintings in which boats appear: "The Wei River Bridge 涇水桥图" and "The Ch‘i-jung Pass 居庸关图". In each boat three persons sit, rowing. In a boat shown in a Han stone relief at Ts‘ang-shan, Shantung, there are four persons.

69. Lo Che-wen 罗哲文
和林格尔汉墓壁画中所见的一些古建筑

70. Huang Sheng-chang 黄盛璋
和林格尔汉墓壁画与历史地理问题

71. Han-T‘ang pi-hua 汉唐壁画

72. 山东苍山元嘉元年画像石墓
("The stone relief tomb of the first year of the reign of Yuan-Chia (A.D. 424) at Ts‘ang-shan, Shantung Province"). KK, 1975, 2: 124-134. Illustrated.3

A boat is also shown on an Eastern Han stone-relief coffin found in Pi-hsien, Szechuan. There are three persons: one sitting in the middle, one poling, and one working a stern-sweep梢桨.

73. Li Fu-hua 李复华; Kuo Tzu-yu 郭子游
邗县出土东汉画像石棺图象略说
(Explication of the illustrations on the stone-relief coffin found in Pi-hsien). WW, 1975, 8: 63-65, esp. p. 65, Figure 4. [Here the stern-sweep is mistakenly taken to be a rudder—Author.]

There has also been a study recently of the boat designs on bronze drums unearthed at Chin-ning, Yunnan. These drums have been shown to come from the ancient Tien people of that area. The boats may be of single-log construction. They are rowed with short oars and a stern-sweep; there is no rudder, and there do not appear to be sails or masts.

74. Feng Han-chi 冯汉骥

3 There were two Yuan-chia reign periods, one in the Han and one in the Liu Sung. Judging from the style of the characters in the inscription, this tomb must be from the Han, and the correct date would be A.D. 151—Author.
Of even greater importance is the discovery in Canton, in 1976, of the site of a large shipyard of the late Ch‘in and early Han periods. After excavation and preliminary on-site inspection, it has been determined that the central part of the shipyard includes three parallel shipbuilding berths. The slipway of each berth is at least 88 m. long. Each slipway is built of two huge slip-rails resting on sleepers. A series of wooden buttresses is mounted on the slipway to support the ship; the buttresses are mortised into the slip-rails to form the berth. Berth no. 1 is 1.8 m. wide. A carpentry shop containing various tools and a large quantity of wood chips was found. It has been calculated that at this shipyard ships could be built which were 6-8 m. wide and 30 m. long, weighing 50-60 tons.

75. 广州秦汉造船工场遗址试探
   (“Trial diggings at the site of a shipyard of Ch‘in and Han at Kwangchow”). WW, 1977, 4: 1-17.

76. 秦汉时期的船舶
   (Watercraft of the Ch‘in and Han periods. WW, 1977, 4: 18-22.

77. 广州秦汉造船工场遗址的木材鉴定
   (“Identification of timber unearthed from the shipyard site of the Ch‘in
and Han dynasties in Kwangchow"). KK, 1977, 4: 257-261. These three citations were provided for this translation by the author.

6. Land Transport

Many pit burials of horses and carriages from different periods have been found in recent years. One from the Yin period was found in 1972 south of Hsiao-min-t'ung in Anyang, Honan; three from the Western Chou, in 1972-1973 at Liu-li-ho, Peking; and one from the Warring States period in 1972 at Chung-chou-lu, Loyang. In each case there is one carriage with either two or four horses. The carriage has a single shaft and two wheels with eighteen to twenty-four spokes. At the rear of the body is a door. The wooden parts have rotted away, but traces are left in the loess soil. By carefully scraping away the earth surrounding these traces, it is possible to reveal the forms and dimensions of the wooden parts.

78. 安阳新发现的殷代车马坑

79. 北京附近发现的西周奴隶殉葬墓

80. 洛阳中州路战国车马坑
("The chariot pit found at Chung-chou-lu, Loyang"). KK, 1974, 3: 171-178, esp. pp. 171-173, and Figure 1.

These carriages are of the same type as several found before the Cultural Revolution; for example, from the Yin at Ta-su-k'ung-ts'un 太司空村, Anyang; from the Western Chou at Chang-chia-p'o 張家坡, Sian; and from the Warring States period at Liu-li-ho 璘璃阁, in Hui County, Honan. Bronze weapons were found in or near the carriages, so they may be war chariots.

†81. Dewall, Magdalene von
Pferd und Wagen im frühen China (Saarbrücker Beiträge zur Altertumskunde, 1)
Bonn, 1964.

†82. Feng-hsi fa-chueh pao-kao 滬西發掘報告

†83. Hui hsien fa-chueh pao-kao 輝縣發掘報告

In mountainside tombs of feudal lords of the Western Han period, separate chambers with horses and carriages are sometimes found; for example, in two tombs at Man-ch'eng, Hopei, and in four tombs at Chiu-lung-shan, Ch'ü-fu, Shantung. In tomb no. 1 at Man-ch'eng there were six carriages and sixteen horses; in tomb no. 2, four carriages and thirteen horses. The wooden parts of the carriages have rotted away without leaving traces, but the metal fittings have survived. In the four tombs at Chiu-lung-shan there were a total of twelve carriages and fifty horses. Traces of the wooden parts remain, and there are elaborate metal ornaments. After detailed studies, it appears that these carriages include “comfort carriages 安车” (low-bodied covered carriages for old people and women), hunt-
ing carriages (or war chariots), and small leisure carriages used in the palace grounds. See Item 15, pp. 9-10, and Item 39, pp. 41-42 and Figure 4.

Carriages shown on Han murals and stone reliefs are generally “comfort carriages” or light carriages. Among the stone reliefs in an early Eastern Han tomb at T'ang-ho, Honan, are three pictures which include six light carriages and one “drum-carriage 敲车.”

84. Chou Tao 周到; Li Ching-hua 李京华

唐河针织厂 汉画像石墓的发掘
(Excavation of a Han tomb containing stone reliefs at the knitting mill in

Figure 4

Bronze model of an “axe-wagon” found in the Han tomb at Lei-t'ai, in Wu-wei, Kansu.
The model is 36 cm. long. 1. Vertical cross-section. 2. Bottom view. 3. Front view of the wagon body. 4. Collar. 5. Cross-bar.

From Item 85, p. 92.

All the carriages shown on stone reliefs in a late Eastern Han tomb at Ts'ang-shan, Shantung, despite variations in design, have two shafts and one horse. See Item 72.

A curtained carriage 詝车 with a rolled-up slat screen is shown on a stone-relief coffin in a Han tomb in Pi-hsien, Szechuan. A woman is riding in it. See Item 73, p. 64, Figure 3.

In a mural in the Han tomb at Horinger, Inner Mongolia, there are several carriages. All appear to be light carriages. See Item 25, p. 14, Plates 2, 3, 5, and Item 71, Plates 18-21, pp. 28-29, 31-34.

A mural in a Wei or Chin tomb at Chia-yü-kuan, Kansu, has a carriage with two shafts, drawn by one ox. See Item 38, p. 26, Figure 17.

Models of carriages in various materials have been found. In an Eastern Han tomb at Lei-t'ai in Wu wei County, Kansu, were found fourteen bronze models: one "axe-wagon 斧车" (see Figure 4), six light carriages, and seven "large carriages 大车," six horse-drawn and one ox-drawn.

85. 武威磨台汉墓

†86. Ridley, Michael
China's Treasures Come to Canada
Canadian Geographical Journal, June 1974, 4-11, esp. p. 5. Photograph of one of the models.

†87. From a Han Tomb—Bronze Horses and Chariots

Three wooden models of carriages were found in two Western Han tombs at Feng-huang-shan in Chiang-ling, Hupei. Two appear to be light carriages, the third an ox-cart. See Item 68, p. 48, and Item 29, p. 5.

In a Western Han tomb at Mo-chü-tzu in Wu wei County were found one wooden model of a light carriage and three of ox-drawn carriages.

88. 武威磨咀子三座汉墓发掘简报
(Preliminary report on the excavations of three Han tombs at Mo-chü-tzu in Wu wei). WW, 1972, 12: 9-23, esp. p. 13, Figure 7, Plate 4 (1).

Carriages are seldom found among the grave goods in tombs of the Nan-pei, Sui, and T'ang periods. Recently a pottery model of an ox-drawn carriage was found in an early Eastern Chin tomb at Hsiang-shan, near Nanking.

89. 南京象山 5号、6号、7号墓清理简报
(Preliminary report on tomb nos. 5-7 at Hsiang-shan, Nanking). WW, 1972, 11: 23-41, esp. p. 30, Figure 37.

Two ox-drawn carriages are shown in murals in the tomb of Li Shou 李寿 (577-630) in San-yuan 三原 County, Shensi. Each has two shafts and no cover. See Item 71, Plate 62, and Item 26, p. 73, Figure 3.

Three light military carriages are shown in a mural in a royal tomb of A.D. 701. Each has two shafts. See Item 71, Plate 89, and Item 24, p. 28.

In an early Ming tomb were found two carved and painted wooden models of
carriages. Each has three shafts. The carriage fits the description of a hsiang-lu, used by imperial princes, in the “Treatise on Carriages” in the Standard History of the Ming.

90. 发掘明朱棟墓纪要
(Excavation of the Ming tomb of Chu T’an). WW, 1972, 5: 25-36, esp. p. 30, Figure 23.

Recently there has been a study of a highway built by Chi’en Shih-huang in the late third century B.C. It starts at Lin-kwang-kung 林光宫, north of Hsien-yang 咸阳, the capital, crosses the Kan-ch’üan mountains 甘泉山 at Tzu-wu-ling 子午岭, and proceeds through the steppe to Chiu-yuan 九原 Commandery (west of the present city of Pao-t’ou 包头, Inner Mongolia). Part of the original road is still preserved. The surface of the road is generally concave. At some places the width of the road is ca. 22 m., and its height above the surrounding land is 1-1.5 m.

91. Shih Nien-hai 史念海
秦始皇直道遗迹的探索
(“Reconnaissances of the remains of the straight road built by Chi’en Shih Huang”). WW, 1975, 10: 44-54, 67.

7. Textiles
Recently there have been several comprehensive studies of silk culture and weaving in the Yin period.

92. Hu Hou-hsuan 胡厚宣
殷代的蚕桑和丝织

93. Hsia Nai 夏鼐
我国古代蚕、桑、丝、繭的历史

Important discoveries of silk textiles and embroideries were found in 1975 in two Western Chou tombs at Pao-chi 宝鸡, Shensi. [These are impressions of textiles in the patina of bronze artifacts—Trans.] This material fills an important gap, as there has been virtually no material on textile techniques in the Western Chou. These textiles are very similar to those of the Yin, with simple twill or lozenge patterns. The embroideries use chain stitch. The red and yellow colors in the embroidered threads are said to have been achieved by direct application of cinnabar and orpiment paint, rather than with dyes.

94. Li Yeh-chen 李也珍; Chang Hung-yuan 张宏源; Lu Lien-ch’eng 卢连成; and Chao Ch’eng-tse 赵承泽
有关西周丝织和刺绣的重要发现
(Important discoveries concerning Western Chou silk weaving and embroidery). WW, 1976, 4: 60-63.

The earliest polychrome silks thus far found in China were found in a mid-Warring States tomb at Tso-chia-t’ang 左家塘, Changsha, Hunan. It is reported that the colors in these polychromes use mineral and vegetable dyes.
95. Hsiung Chuan-hsin 熊传新
长沙新发现的战国丝织物
(Chan-kuo-period silks recently found in Changsha). WW, 1975, 2: 49-56.
Illustrated.

A large quantity of textile material of the early Western Han was found in
tombs 1 and 3 at Ma-wang-tui, Changsha. Besides the silk tabby (chi’tan 锦),
monochrome patterned silk (ch’i 锦), and polychrome silk (chin 锦), there was
also found a kind of very advanced polychrome, called jung-ch’uan-chin 绒圈锦
or ch’i-jung-chin 起绒锦.4 [This textile should be described as a warp-faced
compound tabby with velvet pile. Cf. Item 113, p. 310, where it is mistakenly
referred to as a compound twill—Trans.] There is a silk tabby printed with
designs in several colors. The dyes and paints used were made of cinnabar, madder,
indigo, white lead, and sericite.

96. Ch’ang-sha Ma-wang-tui i-hao Han mu fa-chueh chien-pao
长沙马王堆一号汉墓发掘简报
(Preliminary report on the excavations at Han tomb no. 1, Ma-wang-tui,

97. Ch’ang-sha Ma-wang-tui i-hao Han mu 长沙马王堆一号汉墓
(“The Han tomb no. 1 at Mawangtui, Changsha”). Peking, 1973. 2 vols.,

98. 马王堆二,三号汉墓发掘的主要收获
(“Significance of the excavation of Han tombs nos. 2 and 3 at Mawangtui

99. 长沙马王堆一号汉墓出土的绒圈锦
(“The pile-loop brocade unearthed from the Han tomb no. 1 at Ma-wang-
tui in Changsha”). KKHP, 1974, 1: 175-186, confused English summary,
p. 187.

†100. Hall, Alice J.
A Lady from China’s Past
National Geographic Magazine, May 1974, 145: 660-681. Lavishly illus-
trated report on Ma-wang-tui tomb no. 1.

†101. A 2,100-year-old Tomb Excavated

†102. Rare Archaeological Find—2,100-year-old Han Dynasty Tomb Excavated
CP, 1972, 10: 18-25.

†103. Two-thousand-year-old Tomb Found in a Perfectly Preserved Condition
Eastern Horizon, 1972, 11.4: 16-25.

4 The words ch’i and chin are technical terms for which it is not possible to find precise
English equivalents. Ch’i refers to “monochrome patterned tabby silk.” In Han texts, chin
means “polychrome patterned compound tabby silk.” By the T’ang the latter term also
includes compound twills. “Polychrome” is a technical term referring to a weaving technique;
not all textiles with two or more colors are polychrome in this sense. Ch’i and chin are often
translated “damask” and “brocade”, respectively, but “damask” is a term for a specific tech-
nique that apparently did not appear in China before the Sung. “Brocade” is a vague word that
can be applied to any elaborate or expensive fabric; it is never used by modern textile historians.
On ancient Chinese textile terminology see Item 93. I am grateful to John Becker, a weaver
and textile historian of Sollerød, Denmark, for his help with this matter—Translator.
Figure 5

Diagram of the weave of a sample of jung-ch’ian polychrome fabric from Han tomb no. 1 at Ma-wang-tui, Changsha, Hunan. The warp runs up the page. Wefts 1' - 12' are temporaries, removed when weaving is completed. Warps 53, 56: basic pattern warps I and II. 54: jung-ch’ian warp. 55: basic warp. From Item 99, p. 183.

†104. Two-thousand-year-old Tomb Found in Perfectly Preserved Condition in Central China


A great deal of textile material was found in 1972 in Han tombs at Mo-chü-tzu in Wu-wei, Kansu. The finds include square-aperture open tabby; white tabby; lozenge-aperture material with an angle of 60° between warp and weft; patterned gauzes (true lenos); and “crushed-pattern crepe 轧纹缎.” There is also a knitted belt of fine silk. See Item 88, pp. 18-21.

Of important finds from after the Han period may be mentioned the Northern Wei embroideries and T’ang textiles found in the stone caves at Tunhuang, and the silk goods of the Northern Dynasties and T’ang periods found in Turfan and Pa-ch’u 巴楚, Sinkiang. Han polychrome silks are always warp-faced tabbies; among the T’ang polychromes, besides those which continue to use this technique, there are also weft-patterned twills. Toward the end of the T’ang the latter technique strongly predominates. This development appears to be a result of Persian influence; there are also clear signs of Persian influence in the motifs used:
boar’s head, confronted ducks, confronted riders, beaded roundels, etc.
105. 新发现的北魏刺绣  
(Recently discovered embroidery of the Northern Wei period). WW, 1972, 2: 54-60. Illustrated.
106. 莫高窟发现的唐代丝织物及其他  
(T’ang textiles and other artifacts found in Mo-kao Cave in Tunhuang). WW, 1972, 12: 55-67, 71. Illustrated.
107. 《丝绸之路》上新发现的汉唐织物  
(Textiles from the Han to the T’ang recently found on the Silk Road). WW, 1972, 3: 14-19, 13.
108. Chu Min 虞敏  
吐魯番新发现的古代織絹  
109. 吐魯番阿斯塔那—哈拉和卓古墓群发掘简报 (1963-1965)  
At Pa-ch’u was found a T’ang carpet in tapestry weave 通经断纬技法. Later this technique developed into the famous k’o-ssu 缝丝, 刺丝 tapestry weaving of the Sung period.
110. Ssu-ch’ou chih lu 丝绸之路  
(The Silk Road). Peking, 1972. See Item 107, p. 16, Plate 10. (Comrades from Sinkiang Museum inform me that the Pa-ch’u carpet is from late T’ang, not as stated from the Northern Dynasties—Author.)
Using illustrations on Han stone reliefs, we have studied and reconstructed a loom used at that time. It is extremely complex, with warp beam, heddles, and treadles; but the loom used in weaving the polychromes of the period must have been even more complex. See Item 93, pp. 20-23, Figure 13.
A cotton carpet found in a tomb in Lan-hsi, Chekiang, dated A.D. 1171, shows that the cotton weaving industry in the lower Yangtze region was already well advanced at the beginning of the Southern Sung period. It has generally been assumed that this development took place at the end of the Sung and the beginning of the Yuan.
111. Chung Hsia 钟遐  
从兰溪出土的棉毯谈到我国南方棉纺织的历史  
(The history of cotton weaving in South China in the light of the cotton carpet found at Lan-hsi). WW, 1976, 1: 89-93.
112. Wang Chi-ying 汪济英  
兰溪南宋墓出土的棉毯及其他  
(The cotton carpet and other artifacts found in the Southern Sung tomb at Lan-hsi). WW, 1975, 6: 54-56.
†113. Shih, Hsio-yen  
Studies in Textile History. In Memory of Harold Burnham  
8. Ceramics

In 1974, at the site of an early Eastern Han ironworks in Wen County, Honan, was found a kiln for firing clay molds. In construction it resembles the brick kilns of the Han. It has three parts: the tunnel, the fire chamber, and the baking chamber. The baking chamber is 2.9 m. long and 2.7 m. wide; it could hold over five hundred molds. The kiln includes a rather well-developed chimney. The design continues a kiln form which originated in the Warring States period.

114. 河南省温县汉代红范窑发掘简报

Seven tile kilns from the late Sui and early T'ang were found in the old imperial city at Loyang in 1966, but the finds were first published in 1974. In each kiln the baking chamber is horseshoe shaped; in the back wall are five flues leading to a "smoke chamber," from which a chimney leads upward.

115. 洛阳隋唐宫城内的烧瓦窑

Eleven porcelain kilns of the Sung period have been excavated at Chün-t'ai, Yü County, Honan. They are dug out of the earth, and have earthen walls. In each there are firing chambers and a somewhat elevated baking chamber, with chimneys in the back wall.

116. Chao Ch'ing-yun 赵青云
河南禹县钧台窑址的发掘

There has also been a study of the famous Lung-ch'üan kilns in Chekiang and Fukien. Here nine kiln sites have been discovered, dating from the Sung, Yuan, and Ming periods. They are all of the "dragon kiln" type [in which a series of interconnected chambers climbs up a hillside]. In one of these, of the Ming period, between the two chambers at the "tail" of the dragon there are two firewalls; thus this would be a step kiln.

117. Chou Jen 周仁; Chang Fu-k'ang 张福康; Cheng Yung-p'u 郑永圃
龙泉历代青瓷烧制工艺的科学总结

Other kilns which have been investigated recently are: from the Northern Sung at Tu-miao Village in Feng-k'ai County, Kwangtung; from the Southern Sung and Yuan in T'ung-an, Fukien (both celadon); at least ten kilns (mostly from the Yuan) in Hsin-an, Honan (chüin ware); from the Ming at Lo-p'ing, Kiangsi (blue-white ware); and from the Five Dynasties and Northern Sung in Yin-hsien, Chekiang (Yueh ware).

118. Ho Chi-sheng 何纪生; Chao Chin-shun 赵金顺
广东省封开县都苗宋代瓷窑遗址调查

119. Li Hui-ping 李辉炳
福建省同安窑调查纪略
(“Reconnaissance at the site of the porcelain kiln in T'ung-an County, Fukien Province”). WW, 1974, 11: 80-84.

120. Chao Ch'ing-yun; Wang Tien-chang 王典章
河南省新安县古瓷窑遗址调查

121. Ch'en Po-ch'üan 陈柏泉
江西乐平明代青花窑址调查

122. Li Hui-ping
调查浙江鄞县窑址的收获

At the various kiln sites, great quantities of sherds, saggars, and spacers were found. These will be of great value in the further study of ceramic techniques.

Of course a great deal of actual pottery has also been found and studied. There has been a study of proto-porcelain; it appears that certain Shang and Chou pieces which resemble celadon can, on the basis of the firing temperature of the body and glaze, be called proto-porcelain or proto-celadon. There seems to be a direct relationship between this material and the later southern stoneware.

123. Feng Hsien-ming 冯先铭
我国陶瓷发展中的几个问题—从中国出土文物展览陶瓷展品谈起

124. Li Chih-yen 李知宴
关于原始青瓷的初步探索

A large quantity of proto-porcelain artifacts, the earliest probably of the mid-Shang period, have been found at Wu-ch'eng, Kiangsi. There is not only a very large quantity of material, but also a great variety of different types. Some suggest that this proto-porcelain is related to the late Neolithic “white pottery” of the same region.

125. Li K'o-yu 李科友; Peng Shih-fan 彭适凡
略论江西吴城商代原始瓷器

There have been studies of the distribution of kiln sites, the gradual advance in firing techniques, and the periodization of porcelains, of the T'ang period.

126. Li Chih-yen
唐代瓷窑概况与唐瓷的分期
(The T'ang porcelain kilns and the periodization of T'ang porcelain). WW,

Studies of tools and sherds found at ancient porcelain kiln sites at Hu-t'ien, in Ching-te-chen, Hopei, have shed light on the development of bowl-stacking techniques in that area from the Five Dynasties period to the mid-Ming.

127. Liu Hsin-yuan 刘新圆

景徳镇宋、元芒口瓷器与覆烧工艺初步研究
(“The Sung and Yuan porcelains with unglazed rim from Chingtechen and their technological studies”). KK, 1974, 6: 386-393, 405.

128. 景徳镇湖田古窯各期碗类装烧工艺考

Of even more importance are some very detailed laboratory studies of Lung-ch'üan celadon. The composition of the body indicates that there was an admixture of Tzu-chin 裔金 clay. In the Five Dynasties and Northern Sung lime glazes were used, giving a rather strong gloss. From the Southern Sung to the Ming, lime-alkaline glazes with a rather high content of potassium and sodium were used, giving a softer gloss. Results of other analyses indicate that Lung-ch'üan firing methods reached a very high technical level. See Item 117, pp. 132-143.

†129. Medley, Margaret

The Chinese Potter. A Practical History of Chinese Ceramics
Oxford, 1976. A good survey of Chinese ceramic techniques from the earliest times, with much technical detail. It draws on some of the recent archeological studies.

9. Bronze Technology

It was formerly believed by some that bronze technology suddenly appeared in China in a very advanced form at the end of the Shang period. This has led some foreign archeologists to proclaim that bronze technology was imported to China at about that time. This assumption is called severely into question by recent finds which show the earlier development of bronze technology in China.

Shortly after Liberation, a mid-Yin bronze workshop and a number of bronze artifacts were found at Erh-li-kang, in Chengchow 郑州二里岗, Honan. [Detailed references on this site will be found in Item 1, p. 174.—Trans.]

In 1974 two large square ting 鼎 ritual vessels were found in the city of Chengchow. Though their form is rather simple, and the workmanship crude, the larger of the two is 1 m. high and weighs 86.4 kg.

130. 郑州出土的商代前期大鼎鼎
(“The early Shang great bronze ting unearthed at Chengchow, Honan Province”). WW, 1975, 6: 64-68.

Later we discovered an even earlier site, at Erh-li-t'ou, in Yen-shih, Honan, and found a few small bronze artifacts. Recently bronze socketed battle-axes 戟, dagger-axes 戈, and wine-vessels 酒 have been found there. These artifacts belong to the third period of Erh-li-t'ou, corresponding to the period of the early Shang palace site. Study of this material shows clearly that Chinese bronze technology evolved independently. The method of casting in multi-piece molds has its own unique characteristics. It is not, as has been suggested, only the aesthetic form of
the pieces which is uniquely Chinese, but also the fabrication process.

131. 儒师二里头遗址新发现的铜器和玉器
("The bronzes and jades recently discovered at Erh-li-t'ou in Yen-shih County, Honan"). KK, 1976, 4: 259-263.

Two copper-mine sites were excavated in 1974 at T'ung-lü-shan in Ta-yeh 大冶, Hupeh. At one of these sites bronze tools were found which belong to the late Spring and Autumn period. In the other, iron tools of the middle or late Warring States period were found. This is the first time such early mine sites have been excavated in China. The scaffolding is almost completely preserved, and a wide variety of tools was found, including tools for digging, ore transport, and water removal.

132. 湖北古矿冶遗址调查

133. 湖北铜绿山春秋战国古矿井遗址发掘简报

134. Shih Wen 石文
湖北铜绿山春秋战国古矿井遗址发掘简报
(The Spring and Autumn and Warring States mine sites at T'ung-lü-shan, Hupeh, are proof positive that the slaves were the makers of history). WW, 1975, 2: 13-18.

135. Yeh Chün 冶军
铜绿山古矿井遗址出土铁制及铜制工具的初步鉴定

†136. Hsia Nai
The Slaves Were the Makers of History

Three ancient smelting ovens have also been found near ancient slag heaps. A special study has recently been made of the Hou-ma finds of earthenware molds for casting bronze objects. Already at this early period (Warring States), the materials used for the molds were tailored to the demands of the particular casting procedure and to the temperatures involved. The method of securing the mold inset, and the pouring system, are surprisingly elegant. The mold-lining material was straw or rice-husk ash. The casting-on process 零件附铸法 was in use at this time.

137. Chang Tzu-kao 张子高; Yang Ken 杨根
从侯马陶范和兴隆铁范看战国时代的冶铸技术

There have also been some preliminary studies of gold inlay in bronze.
138. Shih Shu-ch'ing 边树青
我国古代的铜垫工艺

10. Iron and Steel Technology
A large halberd (yueh 钺) with bronze handle and iron blade was found in
1973 in the Shang excavations at T'ai-hsi-ts'un 台西村, in Kao-ch'eng, Hopei.

139. 河北薊城台西村的商代遗址
(“The Shang dynasty site at T'ai-hsi-ts'un, Kao-ch'eng County, Hopei
Province”). KK, 1973, 5: 266-271, esp. Plates 1-2, Figure 5.

Before this find, the earliest date which could be given for the discovery and
use of iron in China, considering both written sources and archeological material,
was the late Spring and Autumn period.

140. Huang Chan-yueh 黄展岳
关于中国开始冶铁和使用铁器的问题
(The problems of the origin of ferrous metallurgy and the use of iron

From the Western Chou period there have been only two weapons with bronze
handles and meteoritic iron blades, both discovered before Liberation. A recent
constituent analysis of the newly found halberd indicates that it also is of meteor-
ritic origin.

141. Li Chung 李众
关于薊城商代铜垫铁刃的分析
(“Studies of the iron blade of a Shang dynasty bronze yueh-axe unearthed

142. Yeh Shih 叶史
薊城商代铁刃铜垫及其意义
(The Shang bronze yueh-axe with iron blade found at Kao-ch'eng and its

By the end of the Spring and Autumn period at the latest, Chinese workers
were able to reduce iron ore at relatively low temperatures (800-1000°C) into
pieces of relatively pure bloom, which then could be forged to make weapons,
etc. Recently, in a late Spring and Autumn period tomb at Ch'eng-ch'iao, in Liu-
ho, Kiangsu, a small iron rod was found. Its remaining length is 5 cm. It was
made by forging this slab-refined iron.

143. 江苏六合程桥二号东周墓
(“Excavations of the Eastern Chou tomb no. 2 at Ch'eng Ch'iao in Liu-ho
County, Kiangsu Province”). KK, 1974, 2: 116-120, esp. p. 119, Plate 6
(8).

In an ash-pit of the fifth century B.C. near Loyang was recently found an iron
short-axe, the earliest cast-iron object yet discovered in China.

144. Li Chung
中国封建社会前期钢铁冶炼技术发展的探讨
(“The development of iron and steel technology in ancient China”).
KKHP, 1975, 2: 1-20, esp. p. 5, Plate 1 (1-3). English summary pp. 21-
22.

As mentioned above, a number of iron tools were found in the middle or late
Warring States mine excavated at T'ung-lü-shan. Besides ordinary wrought and cast-iron objects, malleable cast iron and surface-decarburized cast iron were found. See Items 132-136.

Among the iron swords of the late Warring States period found in 1973 at Yen-hsia-tu 燕下都 in I-hsien 易县, Hopei, were some of low-carbon steel which had been made by carburization of slab-refined iron. Apparently some of these, even at this early period, were tempered by quenching. The knives and swords found in the tomb of Liu Sheng (d. 113 B.C.) were made by surface carburization of slab-refined wrought iron. An early forerunner of "hundred-refinings steel 百炼钢" was found in a Han tomb at Ts'ang-shan in 1974. It had undergone repeated heating with charcoal, folding, and beating. Armor plates of the Han period have been found in the tomb of Liu Sheng and at Erh-shih-chia-tzu 二十九子, near Hu-hchot, Inner Mongolia. The raw material for these plates was slab-refined iron; after being beaten into plates, the iron was annealed and surface decarburized to increase ductility. See Item 144.

An iron knife dated A.D. 112 found at Ts'ang-shan shows progress in the technique of multiple refining. The method of annealing high-carbon steel was used to improve the quality of the knife. See Item 144.

Four thousand, one hundred and ninety-five objects and fragments were found buried in a pit of roughly the Northern Wei in Mien-ch'ih County, Honan, in 1974. A number of them may be somewhat older. The artifacts may be divided into the following categories: white, gray, and mottled cast iron; malleable cast-

Figure 6
Molds for mass-production casting of iron wagon parts. Han period, Honan Province.
1, 2. Stacked molds for casting 24 wheel bolts, top view and cross-sections.
3. Exploded view, with 4 of the finished wheel bolts. 4. Stacked molds for casting 4 wheel hubs, top view and cross-section.
5. Exploded view of the molds with one of the finished hubs. From Item 114, p. 71.
The scale is in cm.
iron treated by annealing; and some wrought iron. Most interesting are steel made by decarburization of cast iron, low-silicon gray cast iron, and nodular-graphite cast iron.

145. *墨池县发现的古代窖藏铁器*
   (“Excavation of the remains of a hoard of iron implements at Miench’ih County, Honan Province”). WW, 1976, 8: 45-51.

146. *河南墨池“窖藏铁器检验报告”*
   (Analysis of the hoard of iron implements found in Mien-ch’ih, Honan). WW, 1976, 8: 52-58.

147. Li Chung
   从墨池铁器看我国古代冶金技术的成就

As mentioned above, a kiln for firing clay molds was found in 1974 at Wen-hsien, Honan; a great many molds for iron objects, including the master models on which the molds were formed, were found. The firing temperature of the molds was about 600°C, so their body is rather hard. The same kiln was also used for preheating the molds prior to casting. This discovery gives a great deal of new information on the construction and firing of clay molds, and on provisions to control the flow of molten metal inside the mold, and rounds out the historical picture of the craft of iron casting. See Item 114.

We have also made a further study of the iron molds of Hsing-lung, Hopei. The close correspondence between the molds and the products, as well as the use of iron inner cores to form the sockets for hoe handles, prove that the technique of smelting iron for use in molds was relatively mature. See Item 137, pp. 64-65, Figure 4.

11. Other Metals
   The silver-refining methods of the T’ang period have been investigated through a study of clinkers excavated in 1970 at Ho-chia 何家 Village, near Sian. In that period the likely ore was a mixture of galena and argentite. After the dressing of the ore, the refining process was carried out in two steps: first the ore was roasted to yield a “lead camel” with a high concentration of silver; then pure silver was obtained by cupellation.

148. T-ping 丁冰
   唐代冶银术初探
   (Preliminary studies on the silver refining techniques of the T’ang period).

We have also made a new appraisal of the metal belt ornaments in the Western Chin tomb of Chou Ch’u. Using three different tests (density, X-ray diffraction, and spectrum analysis), we have proved that all sixteen of the relatively complete belt ornaments are of silver, not aluminum [as previously claimed for some]. The two or three small pieces of aluminum of unidentified form (possibly originally one piece) which were found in the mud sediment, although from the same place, are likely of much later date.

149. Hsia Nai
   晋周处墓出土的金属带饰的重新鉴定

Recently we have used an electron microanalyzer to confirm that the sixteen belt ornaments are indeed silver.

The chemical composition of the small pieces of aluminum is about 3% copper, 0.4% zinc, 1% iron, 0.6% silicon, and 0.2% magnesium. Using carbon to refine aluminum ore requires relatively high temperatures. Even if aluminum were obtained, the alloy could not contain such large amounts of copper, zinc, and magnesium, and at the same time so little iron and silicon. This is thus not ordinary pure aluminum. Its composition is quite close to that of Duralumin, which was invented in 1906. It appears furthermore to have been drawn. An important question in the history of Chinese metallurgy is now settled.

12. Medicine

In 1972, in an Eastern Han tomb in Wu-wei, Kansu, was found a medical treatise written on ninety-two wooden slips. This treatise records thirty-odd treatments for internal, external, gynecological, and other complaints, and also includes acupuncture therapy. About one hundred drug materials are mentioned, some of which are recorded in the later materia medica 本草. The drugs are administered in the form of infusions, pellets, thickened extracts, and powders.

150. Wu-wei Han-tai i-chien 武威汉代医简
(The Han period medical treatise on wooden slips from Wu-wei). Peking, 1975.

151. 武威旱滩坡汉墓发掘简报-出土大批医药简牍

152. 武威汉代医药简牍在医学史上的重要意义

153. Lo Fu-i 罗福颐
对武威汉医药简的一点认识

†154. Prescriptions of 2,000 Years Ago

Among the silk manuscripts found in the Western Han tomb no. 3 at Ma-wang-tui there are several medical treatises and a chart titled "Illustrations of physical exercises 导引图." The medical treatises comprise about two thousand characters, and can be divided into two categories. In the first category are lost medical treatises, including "Methods for abstention from cereals and ingestion of ch'i 驱谷食气方"; "Moxibustion canon of the eleven-tract system 十一脉条经"; and two manuals of diagnostics, "Pulse diagnosis 脉法" and "Yin and yang pulses and signs for prognosis of death 阴阳脉和死候."
155. 马王堆汉墓出土医书释文（一）
(“Transcription of the silk manuscript of medical treatises found in the
tomb no. 3 at Mawangtui in Changsha (1)”). WW, 1975, 6: 1-5.

156. T'ang Lan 唐兰
马王堆帛书《脉谷食气篇》考
(A study of the Ma-wang-tui manuscript, “Abstention from cereals and

157. 马王堆帛书四卷古医学佚书简介
(Introduction to four ancient medical treatises among the Ma-wang-tui

The second category is medical prescriptions. Two hundred and seventy-odd
prescriptions are recorded for fifty-two disorders, covering the same range of
complaints as those found at Wu-wei. For each disorder various prescriptions and
therapies are given. About two hundred and sixty medicinal substances are
named. They are animal, vegetable, and mineral in origin, or derived from manufac-
tured articles (e.g., coins). About one hundred of these drugs are also mentioned
in the Shen-nung Materia Medica 神农本草 (second century A.D.?).

158. 马王堆汉墓出土医书释文（二）
(“The transcription of the silk manuscripts of medical treatises found in
the Han tomb no. 3 at Mawangtui in Changsha (2)”). WW, 1975, 9: 35-48.

159. Chung I-yen 钟益研; Ling Hsiang 凌襄
我国现已发现的最古医方－帛书《五十二病方》
(The oldest pharmacopoeia found in China—the manuscript “Fifty-two

The manuscript on physical exercises includes over forty illustrations. Each
illustration includes a caption; for example, “bending the knees屈膝,” “embrac-
ing the legs抱腿,” “slow walk缓步徐行,” etc. Often the exercises are named
for the actions of animals; for example, “the gibbon's cry猿啼” and “the bear's
swaying熊经.” [Others are labelled with names of medical disorders, proving
their therapeutic purposes—Ed.] See the cover of this issue of Chinese Science.

160. 马王堆三号汉墓符画导引图的初步研究
(Preliminary studies on the silk manuscript calisthenics chart found in Han
tomb no. 3 at Ma-wang-tui). WW, 1975, 6: 6-13, 63, esp. Figures 1-3.

†161. Li Chin-yung 李今庸
谈帛画《导引图》中的“祛积”
(On the term “chü-chi” in the silk manuscript calisthenics chart). WW,

Silver and gold acupuncture needles and other medical instruments have been
discovered in the Western Han tomb of Liu Sheng at Man-ch'eng, Hopei.

5 The meaning of the second term remains uncertain, although it appears often in early writ-
ings, e.g., a late Chuang-tzu chapter (Sinological Index Series text), 15.5, and Huai-nan-tzu
(Err-shih-erh-tzu二十一子 ed. of 1876), 7: 88. The phrase is variously glossed as “the climbing
motions of a bear,” “hanging like a bear,” and “swaying like a bear.” The illustration rules
out the second possibility (which corresponds to Waley's and Watson's “bear-hanging”) and
fits the third somewhat better than the first—Editor.
162. Chung I-yen

西汉刘胜墓出土的医疗器具
(Medical equipment found in the Western Han tomb of Liu Sheng). KK, 1972, 3: 49-53. Illustrated. See also Item 15, p. 13.

All of these discoveries are evidence of the great achievements of ancient Chinese medicine.

Of greatest interest are two recent autopsies of ancient corpses, which have contributed materials for the study of anatomy, histology, and pathology; of these most important is the study of ancient pathology. Dissection of the female corpse buried in a Han tomb at Ma-wang-tui shows that in life she suffered from a number of medical disorders. She had arteriosclerosis; there were calcified tuberculosis foci in the lungs; in the stomach there were eggs of three parasites: schistosome blood flukes, pinworms, and whipworms. There was an abnormal bony growth on the spine, which probably led to pains in the back and legs. There were stones in the gall bladder. It may be inferred that the cause of death was acute pain in the gall bladder leading to coronary disease and then an occlusion.

163. 长沙马王堆汉墓女尸进行了解剖为科学研究提供了丰富资料
("Anatomical studies of the woman corpse unearthed from the Han tomb at Ma Wang-tui in Changsha made a contribution to scientific researches"). WW, 1973, 7: 73. Short report from Hsinhua News Agency.

164. 马王堆一号汉墓女尸研究的几个问题
("Some problems concerning the researches into the woman corpse unearthed from the Han tomb no. 1 at Ma Wang-tui, Changsha"). WW, 1973, 7: 74-80. Illustrated.

†165. Study of a Body 2,000 years Old

CR, 1973, 22.10: 32-34. See also Item 97, pp. 31-32, and Item 100.

Another well-preserved corpse was found in 1975 in Western Han tomb no. 168 at Feng-huang-shan, in Chiang-ling, Hupeii. This was a male corpse. There was no hair on the body, but the skin and internal organs were essentially intact. The gall bladder was enlarged, and contained over twenty stones. The autopsy showed the aftermath of pathological changes due to pleuritis, pericarditis, and cholecystitis. In the liver tissue were found a comparatively large number of blood-fluke and liver-fluke eggs, and in the intestines were whipworm and tapeworm eggs. See Item 29, pp. 3-4, Figure 5. Since schistosome eggs were found in both of these ancient corpses, it is apparent that schistosomiasis was common in the area of Hunan and Hupeii two thousand years ago.

In tomb no. 1 at Ma-wang-tui were found several silk bags containing medicinal herbs, including Chinese pepper berries 花椒 (Zanthoxylum armatum DC., Z. planispinum Sieb. et Zucc.), cinnamon bark 桂 (Cinnamomum chekiangense Nakai), cardamom 高良姜 (Alpinium officinarum Hance), and Hierochloe odorata (L.) Beauv. 茅香. 6

†166. Herbal Medicines Unearthed in Western Han Tomb

CP, 1973, 7: 42. See also Item 97, pp. 35-37.

6 Latin identifications here are taken from Item 97, pp. 35-36. English names are crude approximations—Translator.
13. Agriculture

A number of bone plowshares were found in a six- to seven-thousand year-old site at Ho-mu-tu, in Yü-yao 余姚, Chekiang; they were used in planting. This is the oldest find of its type.

167. 河姆渡发现原始社会重要遺址
("Reconnaissance of the Neolithic site at Ho-mu-tu in Yü-yao County, Chekiang Province"). WW, 1976, 8: 6-14, esp. pp. 9-10, Plate 2 (3), Figure 7.

†168. Hua Ch'üan 华泉
对河姆渡遗址骨制耕具的几点看法

†169. Yu Hsiu-ling 游修龄
对河姆渡遗址第四文化层出土稻谷和骨耜的几点看法
(Notes on the paddy rice and bone plowshares found in the fourth cultural stratum at the Ho-mu-tu site). WW, 1976, 8: 20-23.

†170. 河姆渡遗址第一期发掘报告

The use of oxen in plowing probably began in the Spring and Autumn period. During the Han, Wei, and Chin periods the practice spread over China. Recently a wooden model of an ox-plow was found in a late Western Han tomb at Mo-chü-tzu, in Wu-wei, Kansu. See Item 88, pp. 13-14, Figure 23.

Murals depicting ox-plowing and harrowing have been found in a tomb of the Wei or Chin period at Chia-yü-kuan, Kansu. See Item 38, p. 26, Plate 6 (1).

171. 嘉峪关魏晋墓壁画的题材和艺术价值
(The subject matter and the artistic value of the wall paintings in the Wei and Chin tomb chambers at Chia-yü-kuan). WW, 1974, 9: 66-70, esp. p. 67, Plates 1, 3. See also Item 71, Plates 42 and 49.

Ceramic models of plowing and harrowing were found in a tomb dated A.D. 312 in Lien-hsien, Kwangtung.

172. Hsu Heng-pin 徐恒彬
简谈广东连县出土的西晋犁田耙田模型
(Notes on the models depicting plowing and harrowing of the Western Chin found in Lien-hsien, Kwangtung). WW, 1976, 3: 75-76, esp. Figure 1.

Murals depicting plowing and sowing were found in the tomb of Li Shou from the beginning of the T'ang period. Two oxen are used in plowing, while in planting one ox pulls a seeding plow. See Item 26, p. 73, Figures 5, 23-24, and Item 71, Plates 59-60.

From written sources, archeological material, and modern ethnological material, it has been possible to obtain a rather clear understanding of the use of oxen in Western Han agriculture. This study shows that the agricultural machinery of the time had already undergone considerable development.

173. Sung Chao-lin 宋兆麟
西汉时期农业技术的发展-二牛三人耦犁的推广和改进
Seeding plow depicted in a mural in an early T'ang tomb in San-yuan, Shensi.
From Item 71, Plate 60: See also Item 171.

("The development of farming techniques in the Western Han"). KK, 1976, 1: 3-8.

A round stone rotary quern was found in a Han tomb at Man-ch'eng. This is a comparatively early example of this form of quern. See Item 15, p. 9.

There is a good deal of material on crops and domestic animals. At the Ho-mu-tu site mentioned above, cultivated paddy rice (Oryza sativa L. subsp. hsien Ting) was found. There was an accumulation of unhulled rice, chaff, stalks, and leaves. Not only is this the earliest paddy rice yet found in China, but it also shows that the farming culture of South China, in the lower Yangtze basin, is extremely ancient. It is not, as generally assumed, later than the Yang-shao culture of the Yellow River region. Besides rice, water-chestnut shells, gourds, Chinese dates, and chestnuts were also found. With regard to domestic animals, bones of pigs and dogs were found. Bones of water-buffalo, possibly domesticated, were also found. See Item 167, p. 10, Plate 3 (2), and Item 169.

174. Chung Hsia

从河姆渡遗址出土猪骨和陶猪试论我国养猪的起源
(Remarks on the origin of pig domestication in China in the light of the pig bones and pottery model pigs found at Ho-mu-tu site). WW, 1976, 8: 24-26.

Peach and plum kernels were found at the Shang site at Kao-ch'eng, Hopei. These kernels may have been used for medicinal purposes, but they also reflect the cultivation of fruit trees.

175. Keng Chien-t'ing 联鉴庭; Liu Liang 刘亮

黄城商代遗址中出土的桃仁和郁李仁
(The peach and plum kernels found at the Shang-period site in Kao-
In tomb no. 1 at Ma-wang-tui, Changsha, were found various grains—rice, wheat, barley, millet ( Panicum miliaceum L.), Japanese millet ( Setaria italica [L.] Beauv.), soybeans ( Glycine max [L.] Merr.), and red lentils ( Phaseolus angularis Wight.), and fruits—pears ( Pyrus pyrifolia Nakai), Chinese dates ( Zizyphus jujuba Mill. var. inermis [Bunge] Rehd.), Japanese apricots ( Prunus mume [Sieb.] Sieb. et Zucc.), and Myrica rubra Sieb. et Zucc. 杨梅. There were also found hemp seeds ( Cannabis sativa L.), curled mallow seeds ( Malva verticillata L.), mustard seeds ( Brassica cernua Hemsl.), ginger root ( Zingiber officinale Rosc.), and lotus root. Domestic animal remains include dogs, pigs, cows, sheep, and chickens. See Item 97, pp. 35-37.

In another Western Han tomb, excavated in 1973 in Hai-chou, Kiangsu, were found millet, Japanese millet, panicled millet, Chinese dates, apricots, and gourds.

176. 海州西汉霍贺墓清理简报

On the question of the precise zoological identification of the animals domesticated in ancient China, valuable material is provided by the earthenware figures of cattle and horses pulling plows and wagons mentioned above, and similarly by the many other figures of domestic animals found in tombs of various periods. These discoveries and studies are helpful in the history of agricultural science, and at the same time they are useful in the study of paleozoology and paleobotany.

177. Chang Chung-ko 张仲葛
出土文物所见我国家猪品种的形成和发展
(Zhang Zhung-ge, "The breeding from good domestic pigs in ancient China"). WW, 1979, 1: 82-91, 52.

* * *

The material presented in this article gives clear evidence of the intelligence and creativity of the working people of ancient China, who have made such outstanding contributions to the world's progress in science and technology. We archeological workers have, in our investigations and excavations, often discovered original material related to the history of science and technology. In the deeper study of this material, we have in the past obtained some important results. In the future there will surely be even more discoveries which advance the solution of problems in, and round out our general picture of, the history of science and technology.