become oxidized grey from being exposed to air, which may cause noses and hairstyles to disappear, and falling arms. However, the officials dismissed the claims. In Daily Planet Goes to China, the Terracotta Warriors segment reported the Chinese scientists found soot on the surface of the statue, concluding that the pollution introduced from coal burning plants was responsible for the decaying of the terracotta statues.

The Mausoleum of the First Qin Emperor at Lintong has been designated as a World Heritage Site by the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Terracotta army made in two batches (Jennifer Viegas; 2-6-2007; News in Science: http://www.abc.net.au/science/news/stories/2007/1841166.htm)

The horses and warriors of China's terracotta army were made in different places, according to analysis of pollen found on the clay figures. The imposing faux army has mystified scholars since the 8099 clay warriors and horses were discovered in Emperor Qin Shihuang's mausoleum in 1974.The figures, meant to protect the emperor in the afterlife, were buried with him around 210-209 BC.

Now scientists, whose findings have been accepted for publication in the Journal of Archaeological Science, say at least one mystery about their origins has been solved.

"When the plants were flowering in the time of the Qin Dynasty 2000 years ago, the pollen flew in the air and fell in the clay, even if the pollen could not be seen with the naked eye," says lead author Ya-Qin Hu.

Hu, a scientist in the Institute of Botany at Beijing's Chinese Academy of Sciences, and colleagues crushed the collected terracotta fragments, washed them and spun the mix to separate

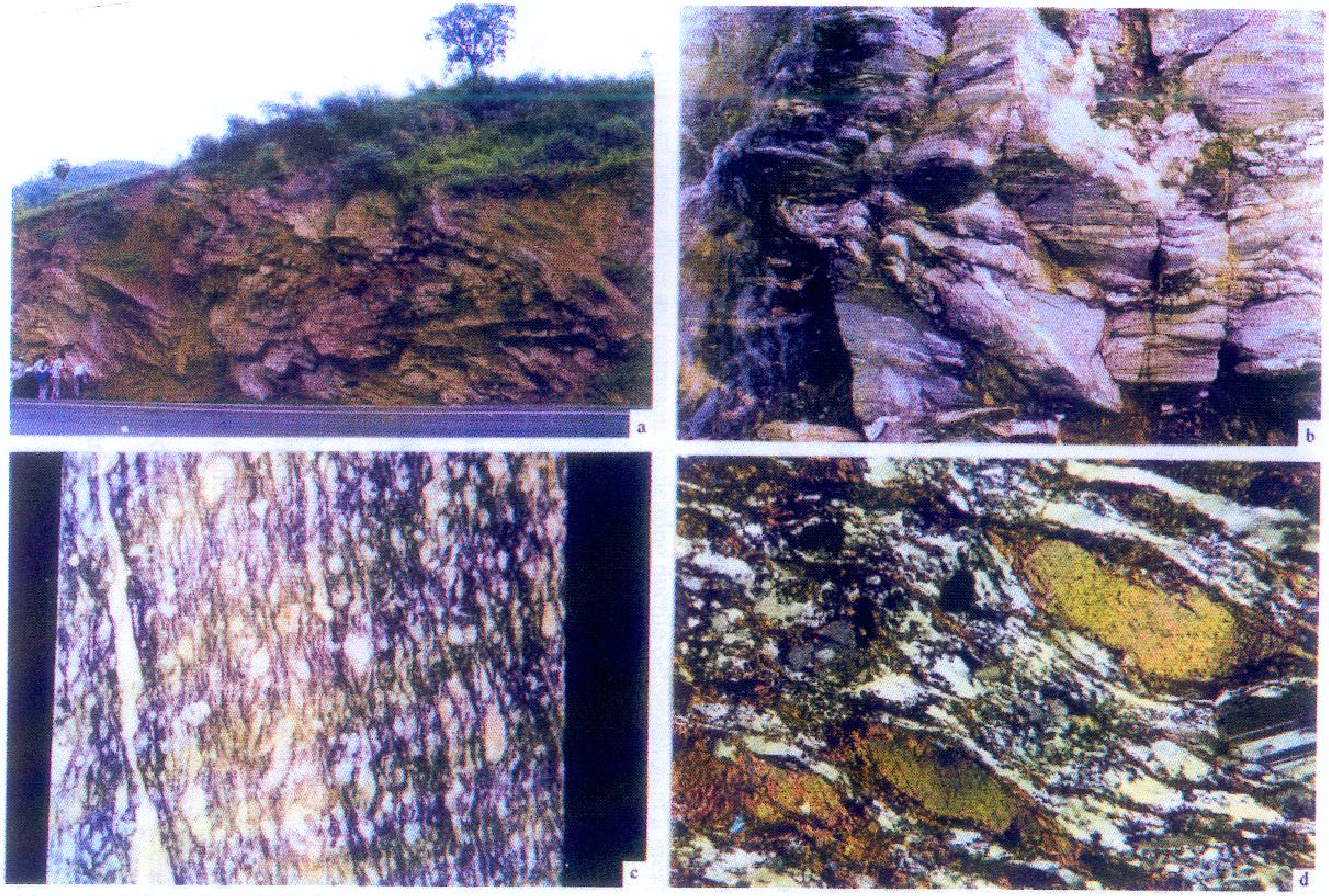

Figure 33. a. Bedding-plane folds in Cretaceous continental deposits, Shangzhou. b. Ductile shear zone and internal cleavages within the vertical plunging folds, Qinling Group, Weizhiling. c.-d. Melanges in the melange belt of Ningshan, and microscopic structures. From Zhou et al., 2002.

metamorphosed complexes. Metamorphism commonly reached amphibolite facies and locally gneissic facies. Migmatization and multi-stage deformation, metamorphism, and magmatism were intense. The age of Qinling Group ranges from 1.987 to 2.267 billion years. The parent rocks are sedimentary clastic and carbonate rocks intercalated with volcanic rocks, as a sedimentary-volcanic assemblage. Geochemical data of mafic volcanic rocks indicate a very high Pb value, suggesting a great difference from those in North China Block and a close resemblance with the Yangtze Block.

3. Ductile deformation of Paleo-Proterozoic Qinling Group

Five episodes of structural deformation were interpreted for Qinling Group (Fig. 34). The first is the formation of incumbent folds along bedding-parallel schistosity planes. Penetrative schistosity and gneissosity and associated joints were developed. Granitic invasion occurred. Boudinage structures of felsic dikes are common, indicating ductile deformation at a great burial depth.

The second episode is characterized by re-folding of the previous incumbent folds along the same axis to form close reversed incumbent folds, and penetrative axis-plane schistosity and joints. Ductile shearing associated with overthrusting also occurred, indicating plastic deformation in a solid state at a great burial depth. The first and second episodes also accompanied regional and dynamic metamorphism of the amphibolite facies. The ages of collisional granites and metamorphism events are concentrated around 1000-800 Ma and 1000-900 Ma, respectively, indicating the two episodes occurred before the Sinian. The P-T track analysis shows decreased pressure, indicating a burial depth of more than 35 km. Further

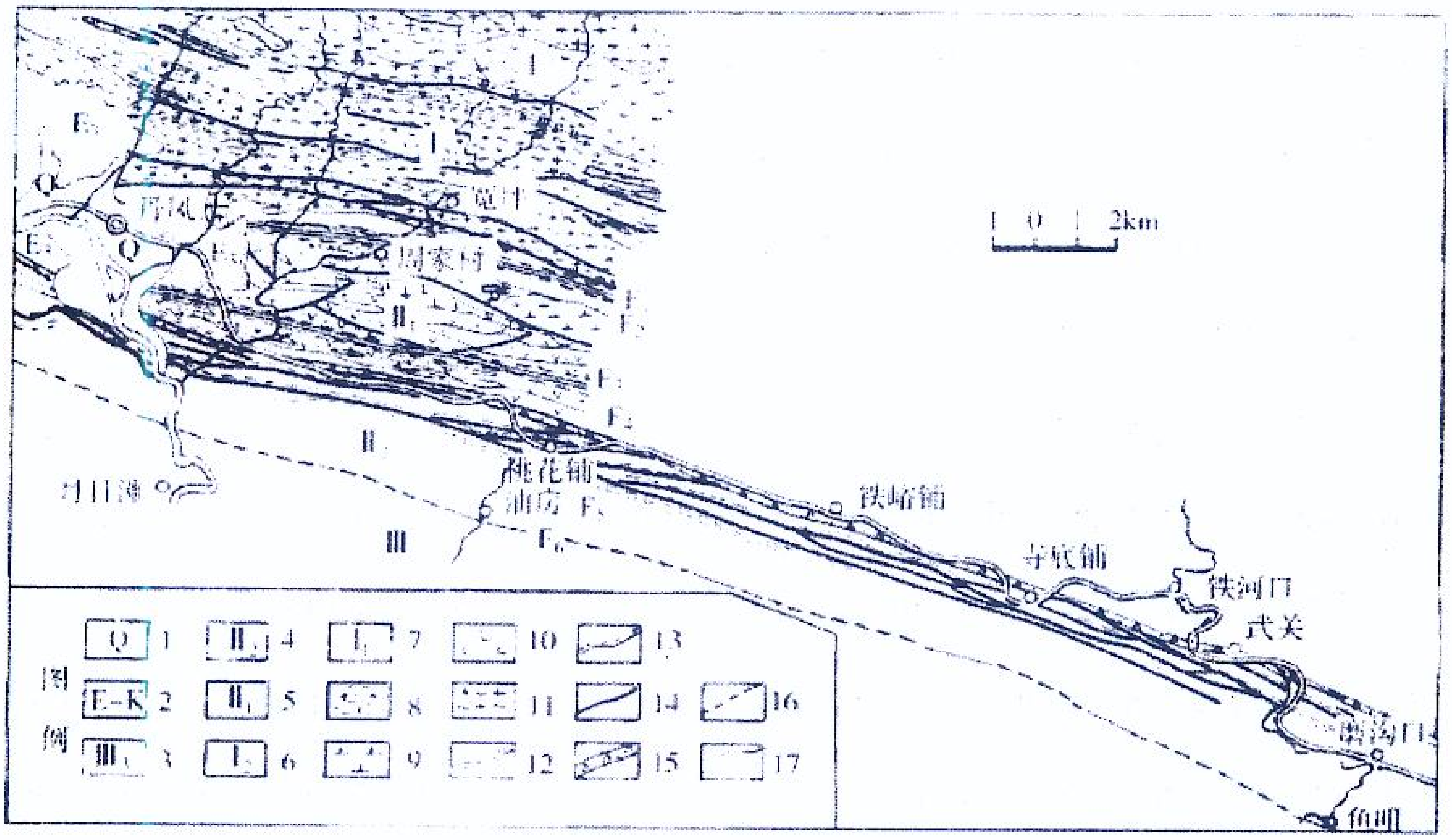

图 6-12　丹凤区段商丹带地质略图

（张国伟等，2001）

1. 第四系；2. 第三系－白垩系；3. 刘岭群；4. 变质沉积岩片组合带；5. 丹凤变沉积-火山岩带；6. 秦岭群上岩性段；7. 秦岭群下岩性段；8. 花岗片麻岩；9. 闪长岩；10. 辉长岩；11. 韧性剪切带；12. 脆－韧性断层；13. 平移断层；14. 断层；15. 脆性破碎带；16. 推测地质图线；17. 地质界线

Figure 34. Simplified geologic map of the Shang-Dan suture zone in Danfeng area. 1. Quaternary, 2. Tertiary-Cretaceous, 3. Liuling Group, 4. meta-sedimentary slate, 5. meta-sedimentary-volcanic rocks, 6. upper Qinling Group, 7. lower Qinling Group, 8. granitic gneiss, 9. amphibolite, 10. diabase, 11. ductile shear zone, 12. brittle-ductile shear zone, 13, strike-slip fault, 14, fault, 15, brittle fracture zone, 16. speculative geological contacts, 17. geological contacts. From Zhou et al., 2002.

analysis suggests that these episodes represent Paleo-Proterozoic oceanic plate subduction and ensuing continent-continent collision.

Several features characterize the third episode. First, subduction-collisional magmatism is indicated by calc-alkalic granites. Under this thermal regime, west-east-oriented broad to domal folds formed with the granites as the core. Correspondingly, penetrative new cleavages and joints formed. Afterwards, potassic granite formed, followed by widespread invasion of pegmatite dikes. In the late stage of this episode, south-verging overthrusting occurred. Under the unique thermal-dynamic conditions of this episode, regional and dynamic metamorphism occurred to form non-uniform amphibolite and ultra-amphibolite facies belts. Age of metamorphism centers around 450-400 Ma and that of subductional-collisional granites centers around 500-400 Ma. Thus, this episode of deformation and metamorphism belongs to the Caledonian Orogeny (Silurian-Devonian). It is postulated that the paleo-oceanic plate of Qinling ocean subducted northward, followed by continent-continent collision. These activities induced calc-alkalic magmatic activities, resulting in great thermal invasion and crustal thickening, and north-south overthrusting.

The fourth episode is represented by the ductile left-lateral strike-slip faulting along the Shangzhou-Danfeng suture zone 324-314 Ma. The antecedent structures of Qinling Group were altered. East-west-oriented vertical penetrative joint planes and superimposed vertically plunging folds accompanied by new joint planes with variable attitudes are the products of this episode in the south of Shangzhou. On the other hand, large-scale sinistral ductile shearing zone is the product in the north of the Shang-Dan suture zone (Fig. 33c, d).

The fifth episode is represented by the ductile reverse and overthrust shearing zone along the Shangzhou-Denfeng fault zone in 210 Ma. There are a series of secondary shearing zones and related folds.

In addition to the five episodes, the Qinling Group also experienced later brittle strike-slip faulting and block faulting and extension.

Stop 9 (June 28) – Zhashui:
Mélanges in Shaogoujie, Sedimentology and structural geology of Middle-Upper Devonian rocks in Huanghualing

1. Mélanges along the Shangzhou-Danfeng Fault Zone in Shaogoujie (Zhou et al., 2002, p. 197-200)

The Shang-Dan Fault Zone is a suture zone, as the southern boundary of the Northern Qinling Structural Belt, which is characterized by intense faulting of different types, in different stratigraphic levels, and in different ages.

In the vicinity of Stop 9, a 2-km exposure of the ductile shear zone of the Shang-Dan FZ will be observed (Fig. 35). Rocks (tectonites) include felsic mélanges, ultra-mélanges, and lenticular granitic mélanges, and discontinuous, irregular, elongate bands of pseudo-basaltic glasses. Four episodes of faulting of different types had occurred. First, the lenticular (eyeball-shaped) granitic mélange is 211 Ma in age, indicating the invasion time of original porphyritic granite. The rocks were subject to Indosinian (Triassic) overthrusting and associated strike-slip ductile shearing during the process of invasion. Other analysis indicates the formation of mélange occurred at a 10-15 km depth. Next, the age of granitic porphyritic mélange has an age of 126 Ma, when late Yanshanian (Cretaceous-Tertiary) thrusting ductile shearing occurred. Last, frictional heat generated by highly differential stress melted previous mélanges. The melts chilled quickly to form the pseudo-basaltic glass. It has an age of 45-100 Ma. This age corresponds to the timing of late brittle extension and translation in Late Cretaceous and Tertiary, as supported by extensional rifting of Late Cretaceous and Tertiary basins and brittle fault breccias.

The observations and interpretations of the movement of the Shang-Dan FZ (suture zone) suggest intense ductile to ductile-brittle overthrusting mainly along the fault zone during the

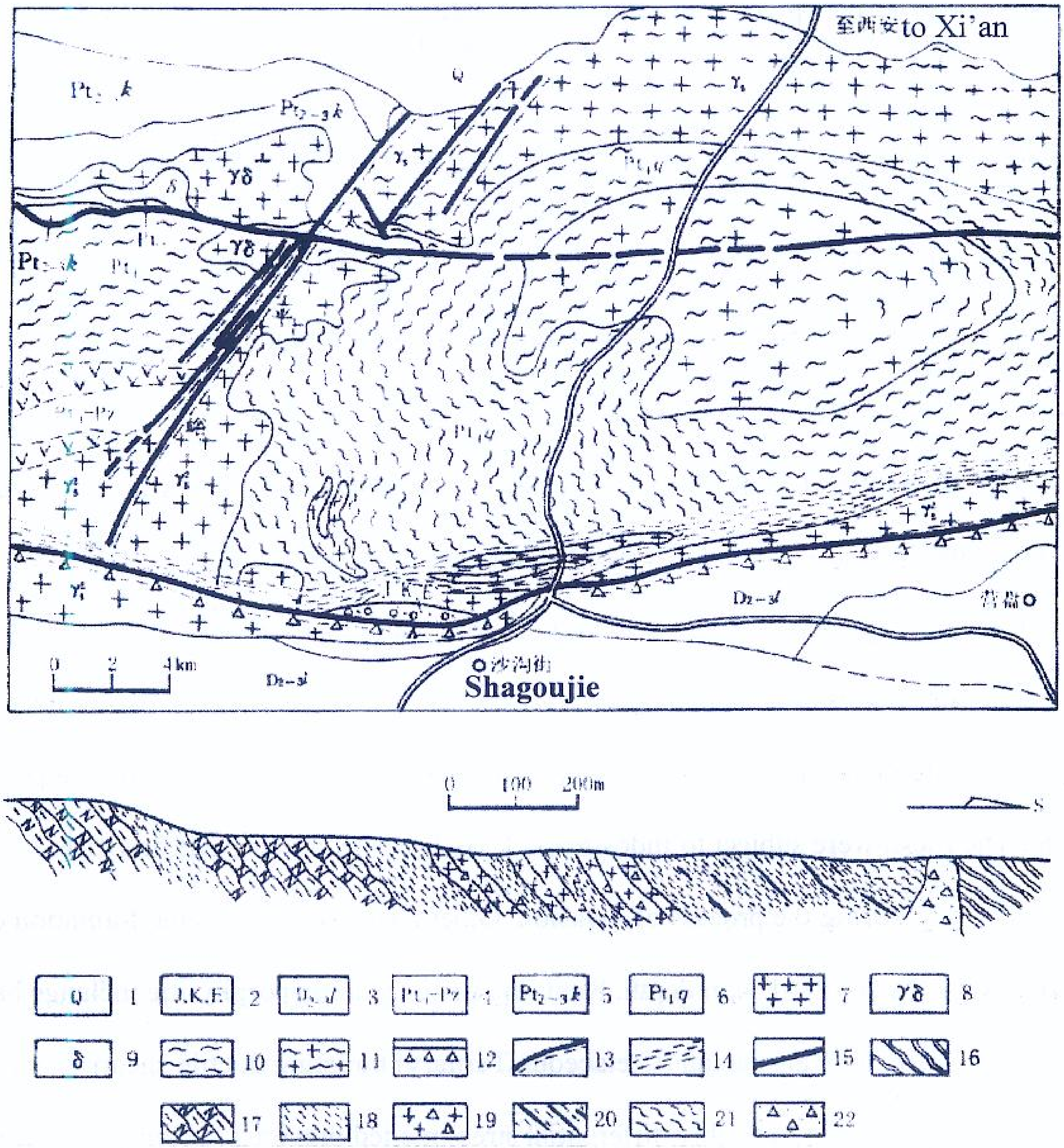

图 6-13 宁陕沙沟街商丹带区域地质图和糜棱岩带剖面图

（张国伟等，2001）

1.第四系；2.第三系-白垩系、侏罗系；3.泥盆系刘岭群；4.丹凤群变沉积-火山岩；5.宽坪群；6.秦岭群；7.花岗岩；8.花岗闪长岩；9.闪长岩；10.片麻岩；11.花岗片麻岩；12.脆性或脆韧性平移断层；13.脆韧性断层；14.韧性剪切带；15.假玄武玻璃岩；16.泥盆系板岩；17.斜长角闪岩；18.韧性剪切带；19.碎裂花岗岩；20.糜棱岩；21.构造片岩；22.碎裂岩

Figure 35. Geological map of Shang-Dan suture zone, Shagoujie, Ninshan area, and cross sections of melange zone. 1. Quaternary, 2. Tertiary-Cretaceous, Jurassic, 3. Devonian Liuling Group, 4. meta-sedimentary-volcanic Danfeng Group, 5. Kuanping Group, 6. Qinling Group, 7, granite, 8. granitic diabase, 10. gneiss, 11. granitic gneiss, 12. brittle or brittle-ductile strike-slip fault, 13, brittle-ductile fault, 14, ductile shear zone, 15, pseudo-basaltic glass, 16. Devonian slate, 17, plagioclase amphibolite, 18. ductile shear zone, 19, chilled granite, 20. melange, 21. tectonic slate, 22. fractured rocks. From Zhou et al., 2002.

Yanshanian Orogeny, forming a complex combination of faults in different tectonic sequences at different times (Fig. 36).

2. Sedimentology and structure of Middle-Upper Devonian Rocks in Huang Hua Ling (Zhou et al., p. 103-107)

Middle-Upper Devonian marine sedimentary rocks overlie unconformably the Lower Paleozoic metamorphosed sedimentary-volcanic rocks. They are mainly restricted to the Southern Qinling Structural Belt (Fig. 37). The rocks were deposited in highly partitioned small basins and have different characteristics, and are subdivided into three tectonic-sedimentary belts/zones, i.e. northern, middle, and southern belts, within the Southern Qinling Structural Belt.

Stop 9 is in the northern belt. Here the Middle-Upper Devonian Liuling Group is several thousand meters thick with a basal parallel unconformity over Cambrian-Ordovician rocks. The Liuling Group is composed mainly of siliciclastic rocks with limited carbonate rocks. Conglomerate is present in the basal part, whereas the majority is fine-medium feldspathic-quartzose sandstone, siltstone, muddy siltstone, mudrock, and thin limestone. Fossils are from carbonates, and siliciclastic rocks are devoid of fossils. Some sandy limestones containing skeletal fragments are intercalated with turbidites and, thus, were probably transported through sediment gravity flows.

The Liuling Group is composed of the following depositional systems:

1) Shoreface system: Fine to medium-grained feldspathic quartz sandstone and quartz sandstone are thin to thick bedded, cross or planar bedded. There is minor siltstone.
2) Storm-influenced shelf system: It includes massive sandstone, hummocky cross stratified sandstone, siltstone, muddy siltstone, and mudrock.

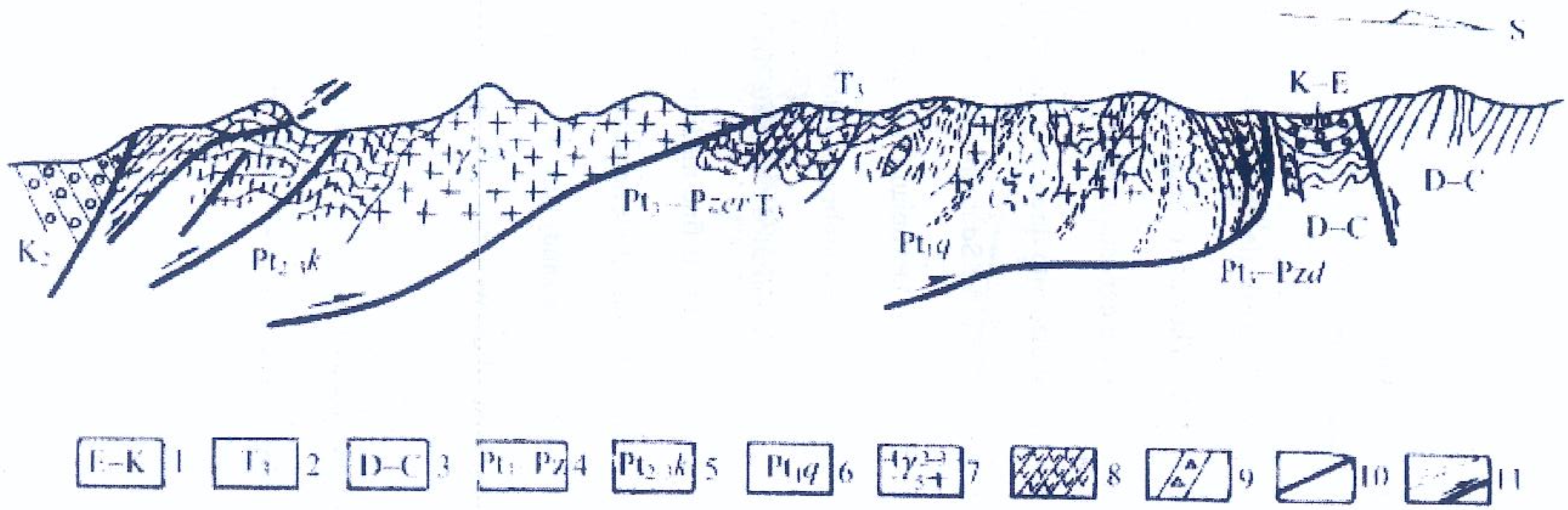

图 6-14 北秦岭叠瓦状逆冲推覆构造系统剖面图

（张国伟等，2001）

1. 老第三系—白垩系；2. 上三叠统；3. 泥盆系—石炭系；4. 丹凤群变沉积-火山杂岩(Pt_3—Pzd)、二郎坪群变沉积-火山岩(Pt_3—P_{zer})；5. 中新元古界宽坪群；6. 古元古界秦岭群；7. 花岗岩；8. 火山岩与花岗岩；9. 脆性断层角砾岩；10. 断层；11. 韧性剪切带和逆冲推覆断层

Figure 36 Cross section of imbricated overthrust systems in Northern Qinling Structural Belt. 1. Paleogene-Cretaceous, 2. Upper Triassic, 3. Devonian-Carboniferous, 4. meta-sedimentary-volcanic Danfeng Group (Pt3-Pzd) and Erlangping Group (Pt3-Pzer), 5. Meso-Neo-Proterozoic Kuanping Group, 6. Proterozoic Qinling Group, 7. granite, 8. volcanic and granitic rocks, 9. brittle fault breccia, 10. fault, 11. ductile shear zone and overthrust fault. From Zhou et al., 2002.

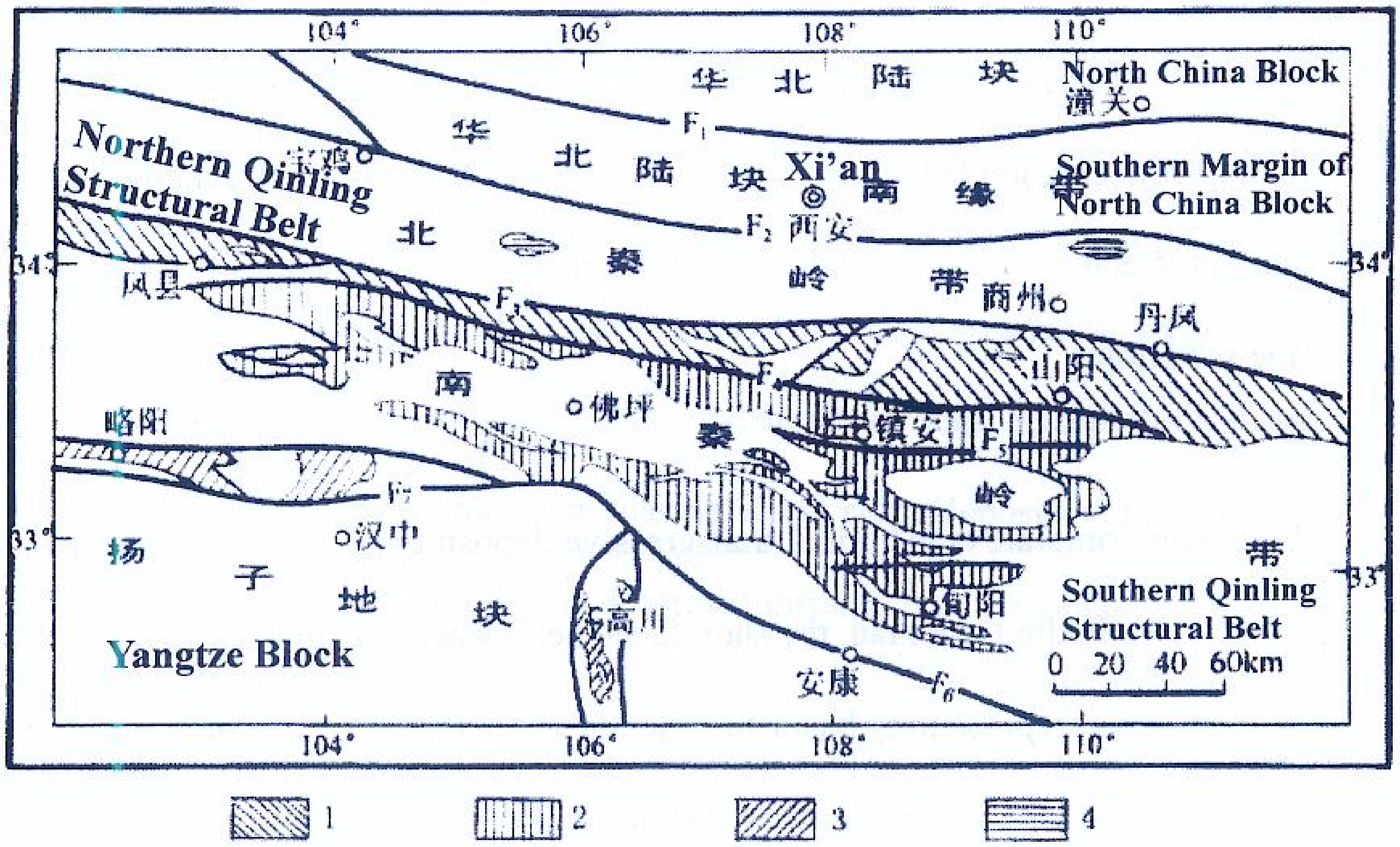

图 4-29 秦岭泥盆系的分布与构造简图

（据梅志超等改绘，1999）

1. 南秦岭北带泥盆系；2. 南秦岭中带泥盆系；3. 南秦岭南带泥盆系；4. 北秦岭泥盆系（?）；F_1. 秦岭北界断裂；F_2. 宝鸡-洛南-栾川断裂；F_3. 商丹缝合带；F_4. 山阳-凤镇断裂；F_5. 镇安-板岩镇断裂；F_6. 安康断裂；F_7. 勉略缝合带

Figure 37. Distribution and structures of Devonian rocks in Qinling Orogen. 1. Devonian in northern belts of Southern Qinling Structural Belt, 2. central belt, 3. southern belt, 4. Devonian (?) rocks in Northern Qinling Structural Belt, F1-northern bounding fault of Qinling, F2-Baoji-Luo'nan-Luanchuan fault zone, F3-Shang-Dan suture zone, F5-Shanyang-Fengzheng Fault Zone, F5-Zhengan-Banyan Fault Zone, F6-Ankang Fault Zone, F7-Mianlue suture zone.

3) Tide-influenced shelf system: It includes simple and complex cross-bedded sandstones, planar bedded sandstone, and thin-bedded mudrock and siltstone.
4) Shelf-slope system: It includes massive sandstone, cross-bedded sandstone, thin-bedded fine sandstone, planar-bedded sandstone, thin interbedded siltstone and mudrock and massive siltstone showing collapsing structures.
5) Slope-abyssal plain system: parallel and ripple laminated siltstone and fine sandstone, muddy siltstone, graded siltstone laminae, massive siltstone/mudrock, dark gray parallel-laminated and cross-bedded silty limestone, and a small amount of medium-thick-bedded fine sandstone.

The basal conglomerate is the initial transgressive deposit during the early phase of basin subsidence. In the Middle Devonian, the shoreface-shelf systems change upward into slope-abyssal plain systems, representing basin subsidence and deepening. Common soft-sediment deformation features in the shoreface-shelf systems and syndepositional faults and turbidites in shelf-slope systems suggest that basin subsidence was controlled by syndepositional faulting. Subsidence decreased in Late Devonian, causing an environmental change from deep to shallow water depths. Shallow-water deposits dominate and the depositional area also decreases upward, indicating basin contraction. Nevertheless, Upper Devonian deposits are up to 3000-4000 m thick, suggesting subsidence continued and sediment supply from both the north and south were copious.

Stop 10 (June 29) – Zhashui to Xian: Sedimentology and multi-stage structural deformation of Upper Devonian marine deposits, sedimentology of shallow-water Cambrian-Ordovician platform deposits in Zhashui Cavern, and Middle-Upper Devonian mass and gravity deposits.

1. Sedimentology and multi-stage structural deformation of Upper Devonian marine deposits in Longbozi (Dragon neck) (Zhou et al., 2002, p. 209-213)

This stop is in the Southern Qinling Structural Belt. The Southern Qinling Structural Belt is in contact with the Northern Qinling Structural Belt along the Shang-Dan FZ (or suture zone) to the north and with the Yangtze Block of Southern China Plate along the Mianlue-Chengkou-Fangxian-Xiangfan FZ (or suture zone). The Upper Paleozoic-Mesozoic tectonic sequence includes Devonian, Carboniferous, Permian, Triassic, and Jurassic rocks. Except the Jurassic deposits, the other ones are dominantly marginal marine, shelf, slope deposits with limited abyssal plain deposits. Thin-skinned tectonics is dominant through the Indosinian (Triassic) and Yanshanian (Cretaceous-Tertiary) orogenies.

Stop 10 is situated in the central part of the central Southern Qinling Structure Belt (Fig. 38). Middle and Upper Devonian, Carboniferous, and Lower and Middle Triassic are continuous marine deposits. Middle Devonian is in a parallel unconformable contact with underlying Cambrian-Ordovician open platform deposits, and is in an angular unconformable contact with underlying Precambrian volcanic and intrusive rocks. Middle Devonian depositional environments change from continental to marginal-marine and shallow-marine, and deep-water in Late Devonian to Early Carboniferous, and finally to shallow-marine environments from Middle to Late Carboniferous, Permian to Triassic.

Four tectonic episodes can be identified in this area:

- Episode 1: Multiple-stage continuous extension and subsidence caused by syndepositional normal faulting controlled Middle Devonian sediment gravity deposits

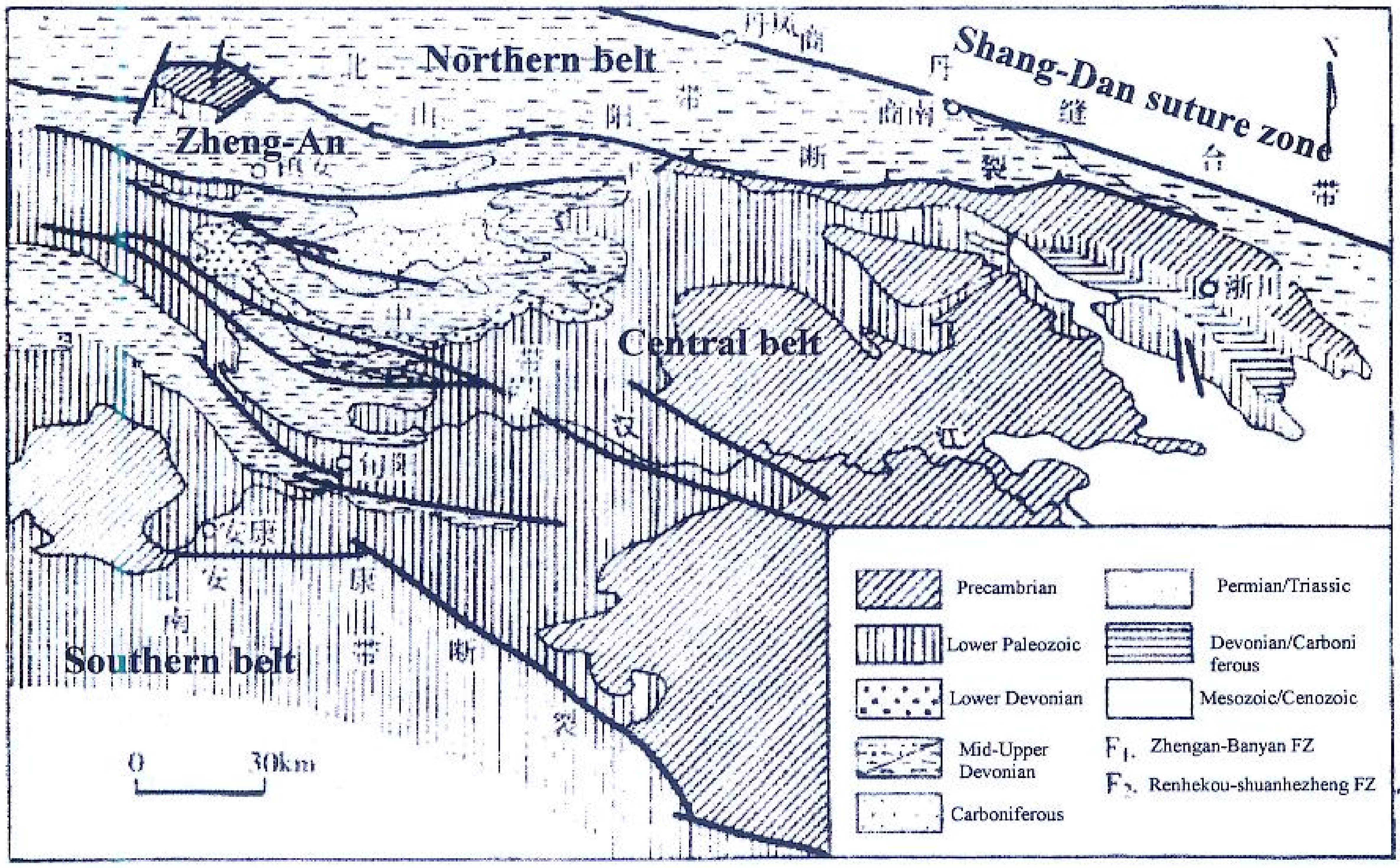

图 6-22 南秦岭中段地质略图
（据张国伟等，2001 改绘）

Figure 38. Simplified structural map of central belt of Southern Qinling Belt. From Zhou et al., 2002.

- (Fig. 18a, b, c, d), and evolution from nonmarine, marginal marine, shelf, and basinal environments.
- Episode 2: Inversion of preexisting normal faults formed south verging reverse faults. Overthrusting occurred along some fault zones to form large-scale ductile thrusting nappes. As a result, several orders of faults and different types of complex folds were generated in the Sinian-Middle Triassic sedimentary cover (Fig. 39). This episode of deformation was estimated to the Indosinian Orogeny on the basis of youngest rocks (Lower and Middle Triassic) deformed and radiometric ages of tectonites (203-197 Ma).
- Episode 3: This episode was interpreted from observations in this stop. Upper Devonian Jiuliping Formation is exposed in Longbozi area. Two left-lateral ductile-brittle shear zones are present over a distance of 7 km (Fig. 40), of which the Longbozi zone is about 700 m wide. Strike-slip shearing is indicated by penetrative cleavages developed on the broad open folds with a near-horizontal hinge line. The strike of the shear zone is 290-300°, dip is about 85° to NNW. Asymmetrical vertically plunging folds (Fig. 41a) are common with an axial orientation of 290° and a plunging angle of 75-90°; so are rootless vertically plunging folds within the cleavage zones. The geometry and dynamics of asymmetrical folds and the oblique array of deformed lenses indicate left-lateral strike-slip within the shear zone. Furthermore, the development of folded and slaty cleavages, and microscopic mica along cleavage planes suggest shearing occurred in a ductile-brittle state at a shallow burial depth.
- Episode 4: A series of large-scale overthrusting sheets formed by brittle reverse faulting and overthrusting. Accompanying block faulting modified preexisting structures. Basement rocks and Meso- and Neo-Proterozoic and Paleozoic rocks were incorporated

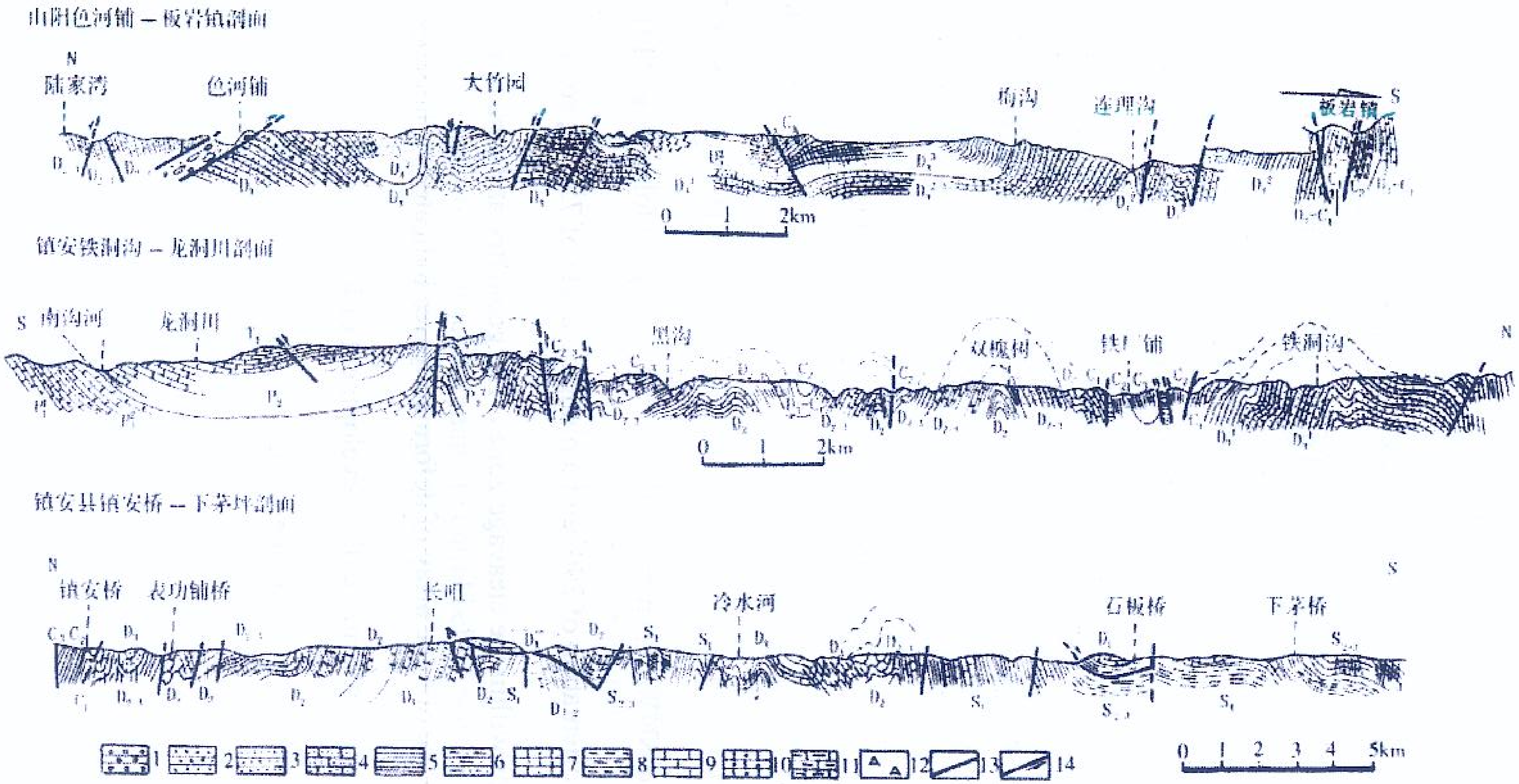

图 6-25 南秦岭中带(山阳-镇安)沉积盖层(S－T)构造变形剖面

(许志琴,1988)

1. 砾岩;2. 砂岩;3. 粉砂岩;4. 钙质粉砂岩;5. 板岩;6. 砂质板岩;7. 砂质灰岩;8. 碳质板岩;9. 灰岩;10. 砾状灰岩;

11. 泥质灰岩;12. 爆破角砾岩;13. 断层;14. 冲断层

Figure 39. Structural map of sedimentary cover (Silurian-Triassic) in the central belt of Southern Qinling Structural Belt. 1. Conglomerate, 2. sandstone, 3. siltstone, 4. calcareous siltstone, 5, slate, 6. sandstone slate, 7. sandy limestone, 8, carbonaceous slate, 9. limestone, 10. conglomeratic limestone, 11. argillaceous limestone, 12. explosive breccia, 13. fault, 14. reverse fault. From Zhou et al., 2002.

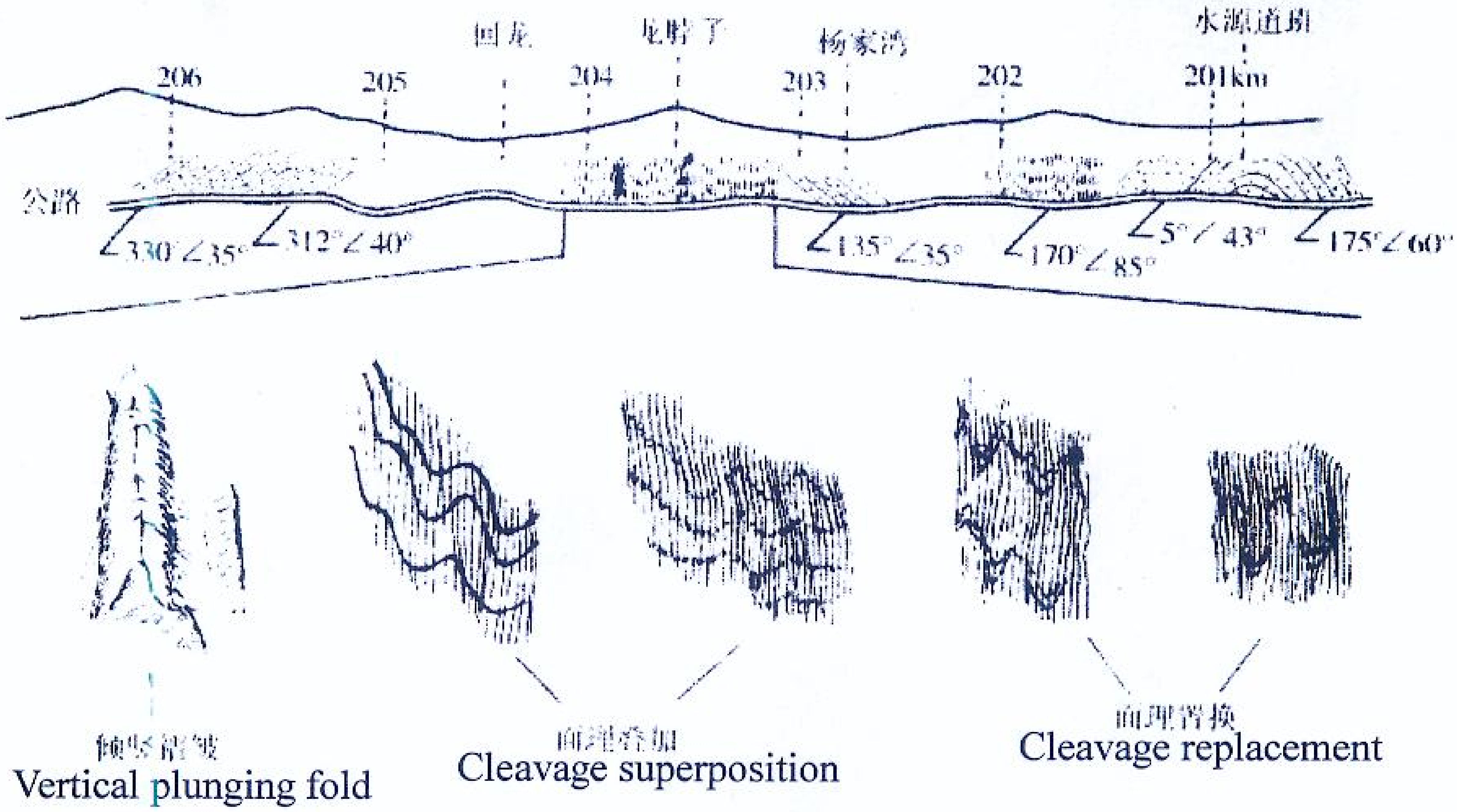

图 6-26　镇安回龙龙脖子地区的左行走滑剪切带

Figure 40. Sinistral (left-lateral) strike-slip shear zone in Longbozi and Huilong area, Zhengan. From Zhou et al., 2002.

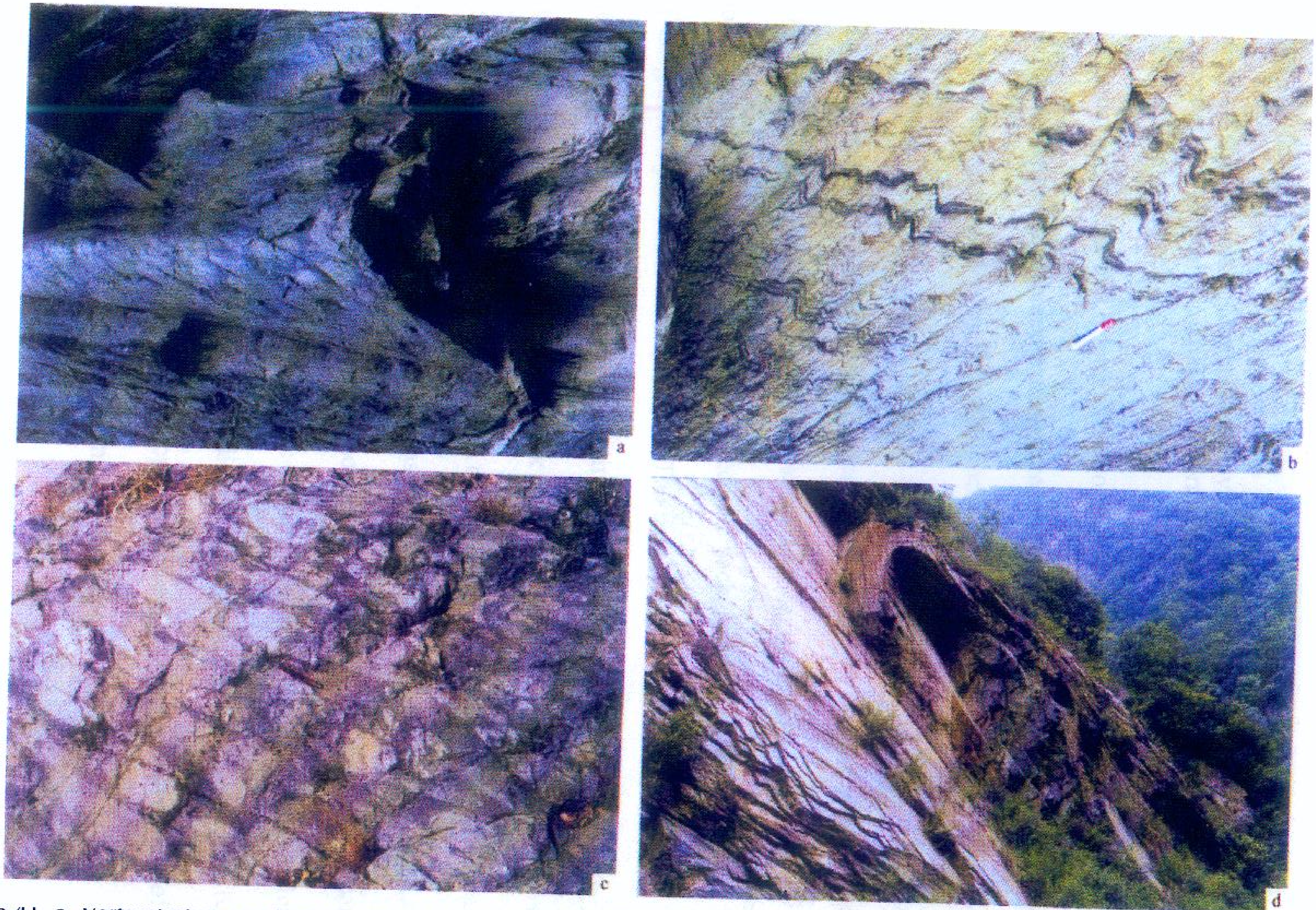

Figure 41. a. Vertical plunging fold in Huilong and Longbozi area, Zhengan. b. Cleavage replacement in the same area. c. Deformed conglomerate at basal Devonian, Shaliangzhi, Zhouzi. d. Isoclinal folds in Devonian sandstone, Dengwozhan, Zhouzi. From Zhou et al., 2002.

in the thrusts. In the vicinity of Zhashui (Fig. 42), Sinian and Cambro-Ordovician rocks were thrusted over on Upper Devonian strata, forming nappe outliers.

2. Sedimentology of shallow-water Cambrian-Ordovician platform deposits and Middle-Upper Devonian sediment gravity deposits in Zhashui Cavern (Zhou et al., 2002, p. 107-113).

The Devonian rocks in Stop 9 belong to the northern belt of the Southern Qinling Structural Belt. Devonian rocks in this stop are situated in the central belt. The Devonian rocks here were deposited in two small basins. Devonian rocks in the Zheng An Basin in the north will be the focus of this stop.

Middle and Upper Devonian rocks in Zhengan Basin overlie the Upper Paleozoic rocks unconformably. They were deposited in a rift basin, where sedimentation was controlled by syndepositional faults under a regional extensional tectonic background from late Middle to Late Devonian. Transgression proceeded from the south. The basal estuarine sandstone and conglomerate grade upward into siliciclastic and peritidal carbonate rocks, and further into carbonate platform deposits. The fan deltaic complex conglomerate deposits of the uppermost Devonian suggest uplifting of a northern source area or a sea level fall, when the basin was an extension of the basins to the south. However, the basin became partitioned in middle-late Late Devonian, when activities of both the northern and southern bounding faults intensified to cause great subsidence of the Zhengan Basin. Stratigraphic architecture and paleocurrent data indicate that sediments were transported down slope perpendicular to basin axis, and then along the basin axis, typical of sedimentation in grabens. The development of turbidites suggests steep dip of the bounding faults. Overall, Devonian deposits show an upward-deepening trend.

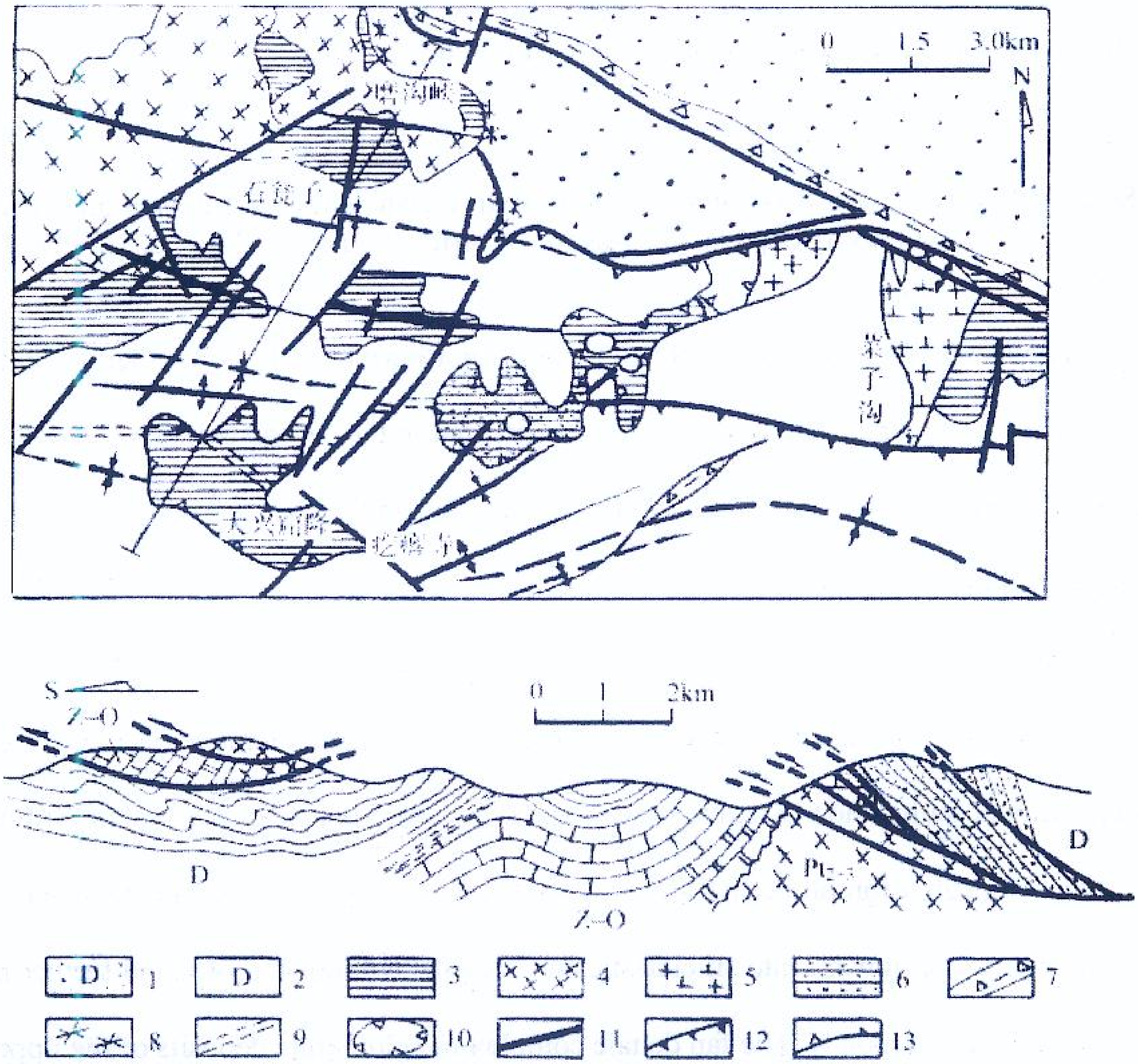

图 6-27 柞水磨沟峡－疙瘩寺地区构造图

（据陕西省区域地质调查队 1:5 万石嘴子幅地质图，1990，略有改动）

1. 北区泥盆系；2. 南区泥盆系；3. 震旦系－奥陶系；4. 小磨岭杂岩和加里东－海西期闪长岩体；5. 花岗岩、闪长岩；6. 推覆混杂构造岩；7. 碎裂岩；8. 糜棱岩；9. 韧性、脆韧性断层；10. 飞来峰；11. 脆性平移断层；12. 逆冲断层；13. 推覆构造主界面

Figure 42. Structural map in the Gouxia-Gedashi area of Zhashui. 1. Northern Devonian, 2. Southern Devonian, 3. Sinian-Ordovician, 4. Xiaomoling complex and Calidonian-Variscan diabase, 5. granite, diabase, 6. overthrusting tectonite, 7. fractured rocks, 8. melange, 9. ductile and brittle faults, 10. tectonic outlier, 11. brittle strike-slip fault, 12, reverse fault, 13. main surface of overthrusting structure. From Zhou et al., 2002.

Middle and Upper Devonian sediment gravity flow deposits are well exposed in the vicinity of the Zhashui Caverns. The Middle Devonian Longdonggou Formation consists of dolomitic sandy conglomerate and fine-grained conglomerate and intercalated calcareous siltstone at the base, sandy limestone intercalated with calcareous sandy conglomerate, dolomitic sandstone, and calcareous siltstone in the lower part, and grayish green and variegated conglomerate intercalated with purple silty slate in the upper part. The overlying Upper Devonian Er-Tai-Zi Formation contains sandy limestone, breccia-bearing limestone intercalated with silty slate, lime mudstone, and skeletal limestone in the lower part, and medium-thick-bedded crystalline limestone in the upper part. The two formations have a total thickness of nearly 500 m.

Equivalent to the Middle Devonian Longdonggou Formation to the south is the Gudaoling Formation. It is several to 100 m thick, consists of siliciclastic and carbonate rocks of a shelf system, whereas the Longdonggou is tidal flat and fan delta nearshore system. The tidal system of the Longdonggou consists of channel-shaped sandstone, sandy conglomerate, or cyclic deposits of lenticular oolitic limestone and nodular limestone and thin-medium-bedded siltstone, mudrock, and dolomite. The fan deltaic deposits include thick-bedded sandstone and conglomerate cycles. The Conglomerate is rich in matrix and is chaotic. Clasts are Proterozoic granulite, granite, amphibolite, and gneiss, and some Cambro-Ordovician limestone and dolomite. Sandstone is dominantly feldspar-quartz sandstone, with cross and graded beddings and basal scour surfaces. The deposits are wedge-shaped overall and pinch out basinward. They interfinger with nearshore or shelf deposits.

The Upper Devonian Hong-Pu Formation, laterally equivalent Er-Tai-Zi Formation, is 400-1000 m thick in the south. It consists of silty mudrocks intercalated with thin-medium-bedded limestones of a shelf system. On the other hand, Ertaizi in the north consists mainly of carbonate build-ups and slope carbonate rocks. The buildups are composed of thick to massive-bedded wackestone and reefal limestone, with a maximum thickness of 200-300 m, 20-30 km long, and several kilometers wide. Slope carbonates are limestone mudstone, thin-bedded silty limestone intercalated with chaotic limestone breccia and collapsing blocks. Collapsing/sliding breccias occur as sheets, commonly more than 4 m thick and are laterally persistent. The breccias are matrix supported; clasts are dark gray to grayish black limestone and lime mudstone, 2-20 cm in size, with maximum of 1 m in size. The clasts are platy, well-rounded semi-spheroidal, or angular where associated with sliding folds. Internal faulting, soft-sediment deformation, and toe upturning are associated with the folds. Clasts are frequently oriented parallel to bedding plane but are dominantly randomly oriented. Some bivalves and other shallow-water skeletal fragments are present in the matrix, suggesting sediments were derived from shallow-marine platforms. These deposits have sharp base and top. The basal surface is relatively flat or erosional, deformed with erosional marks. The top is wavy.

Regionally, the Devonian in Zhengan Basin has different systems from south to north and an east-west orientation. Sedimentary evolution was controlled mainly by tectonics, along with sea-level changes and sediment supply. Extensional subsidence provided accommodation space and controlled provenance, resulting in an overall upward fining and deepening succession (Figs. 43, 44, 45).

3. Sedimentology of shallow-water Cambrian-Ordovician platform deposits in Zhashui Cavern (Zhou et al., 2002, p. 88-92).

The Southern Qinling Structural Belt was a restricted basin in Early Cambrian, because it was a topographic low surrounded by islands and underwater highs (Fig. 46). At the beginning of

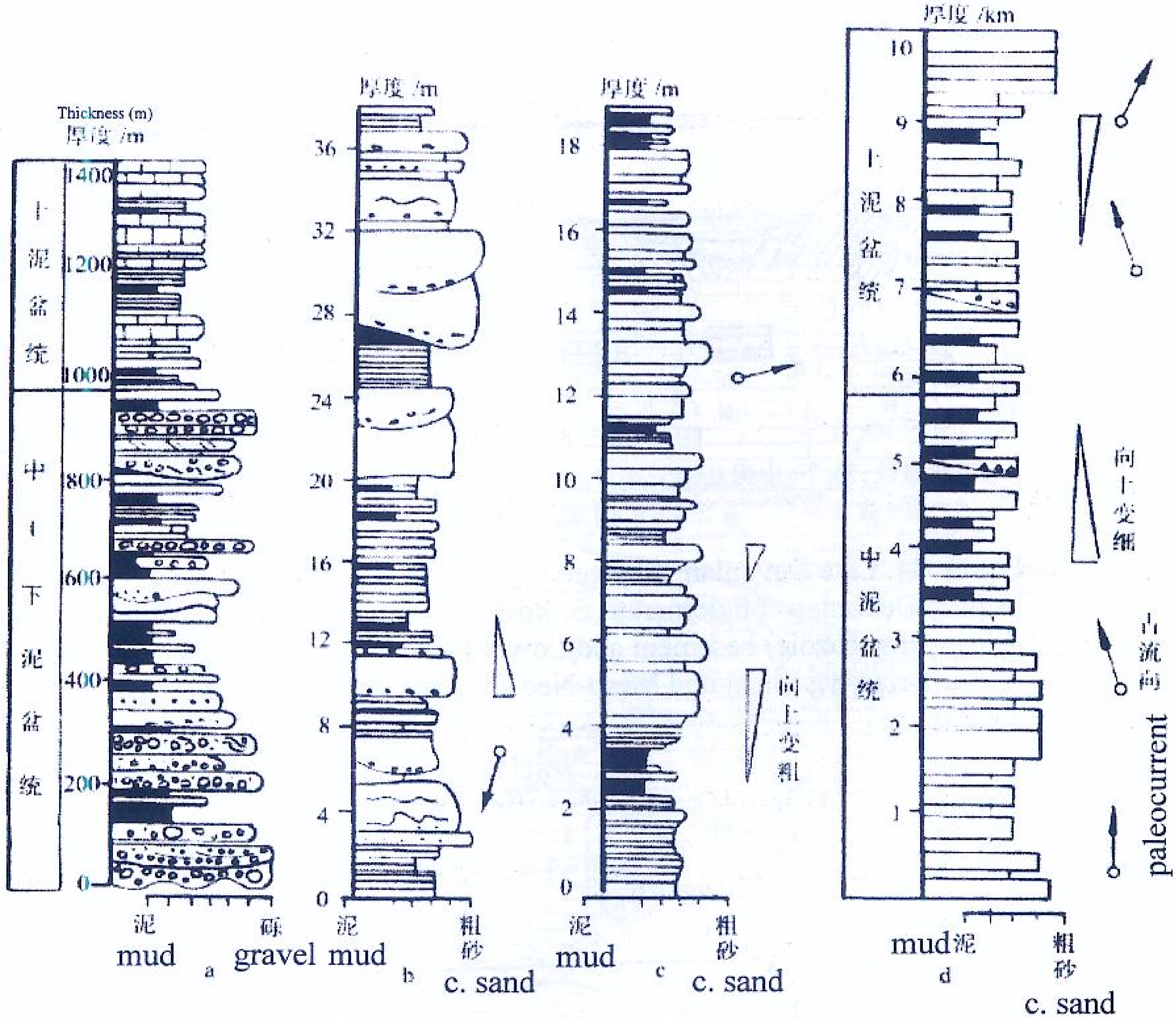

图 4-31　南秦岭泥盆系的沉积序列
（孟庆任，1994）
a. 南带略阳盆地南缘的沉积序列；b. 中带上泥盆统九里坪组浊积体系的水道-天然堤沉积序列；c. 叶状体序列；d. 北带柞水地区中-上泥盆统的沉积序列

Figure 43. Devonian sedimentary successions in Southern Qinling Structural Belt. a. Southern margin of Lueyang Basin, southern belt. b. Upper Devonian channel-levee succession of turbidite systems, Jiuliping, central belt. c. Succession of lobate systems. d. Middle-Upper Devonian successions, Zhashui, northern belt. From Zhou et al., 2002.

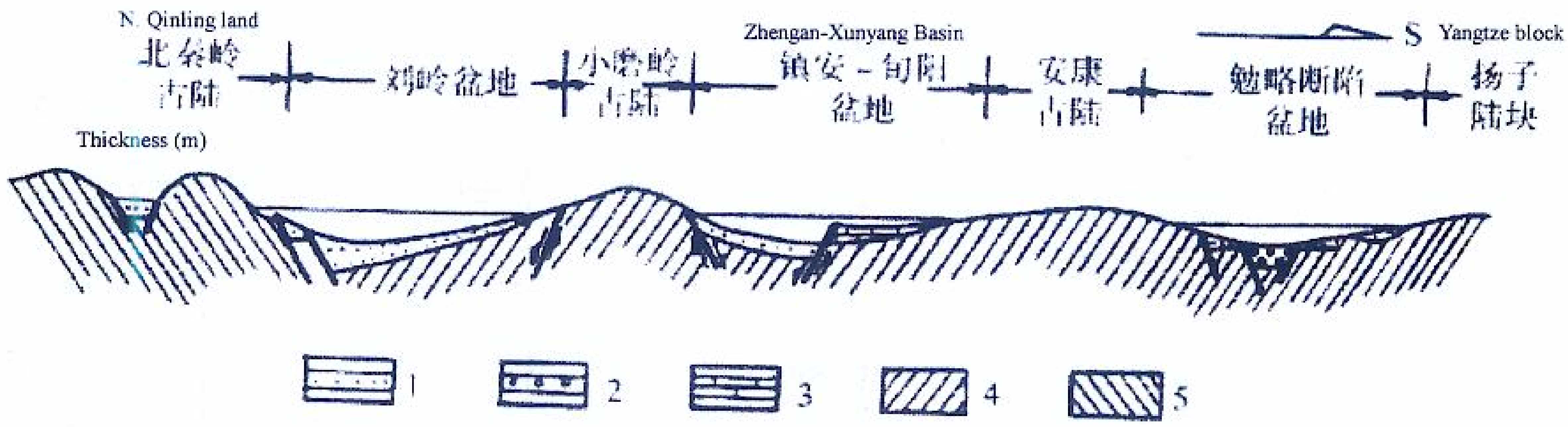

图 4-33 秦岭晚泥盆世古地理格局示意图

1. 中泥盆统;2. 下-中泥盆统杂砾岩;3. 下-中泥盆统碳酸盐岩;4. 晋宁期基底及早古生代盖层;5. 早前寒武纪基底及中晚元古宙盖层

Figure 44. Late Devonian paleogeography, Qinling. 1. Middle Devonian, 2. Lower-Middle Devonian conglomerate, 3. Lower-Middle Devonian carbonate rocks, 4. Jingnian (Meso-Proterozoic) basement and Lower Paleozoic sedimentary cover. 5. Early Precambrian basement and Meso-Neo-Proterozoic sedimentary cover. From Zhou et al., 2002.

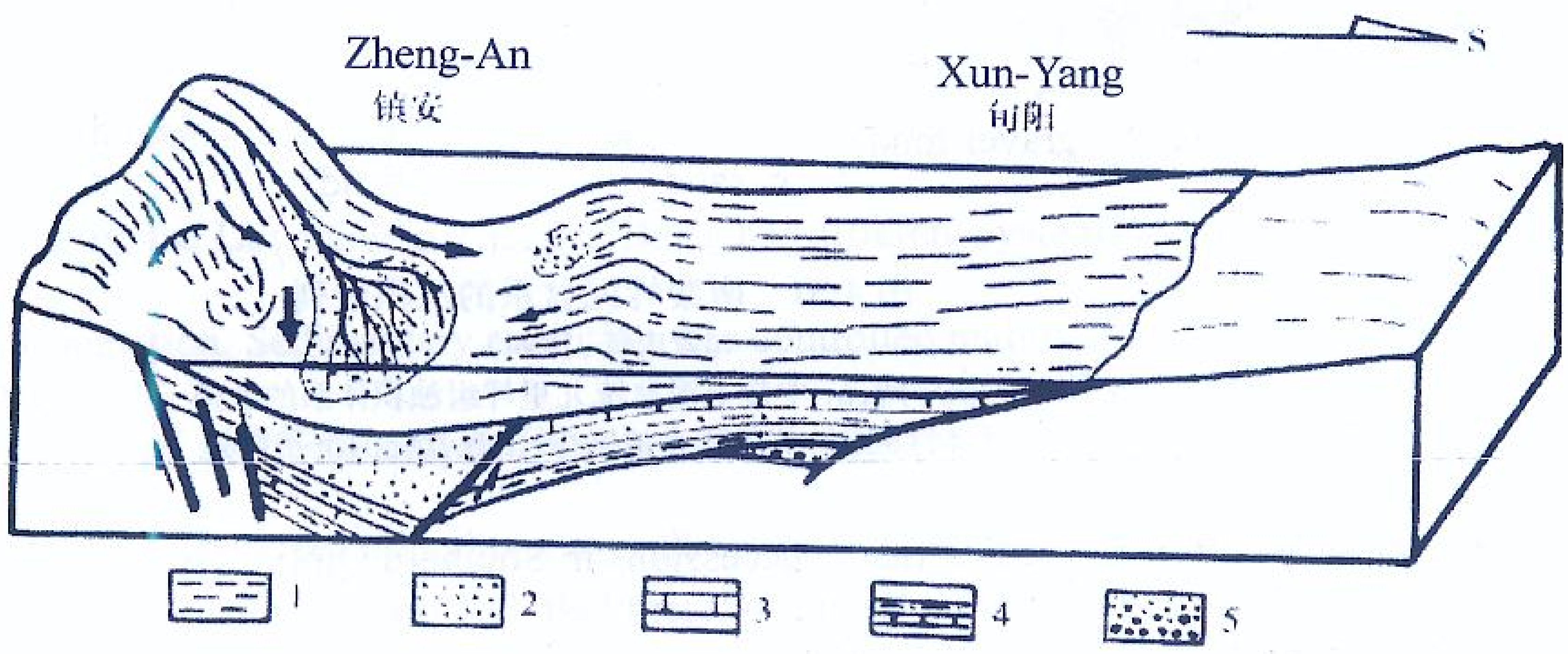

图 4-34 南秦岭中带泥盆纪的沉积作用与构造演化示意图

1.D_3^1 斜坡沉积;2.D_3^1 浊积岩;3.D_3^1 台地碳酸盐岩;4.D_2－D_3^1 混合大陆架沉积;5.D_1 潮缘沉积

Figure 45. Sedimentation and structural evolution during Devonian, central belt of Southern Qinling Structural Belt. 1. D^1_3-slope deposit, 2. D^1_3-turbidite, 3. D^1_3-platform carbonate rocks, 4. D2-D^1_3-mixed shelf deposits, 5. D_1-peritidal deposits. From Zhou et al., 2002.

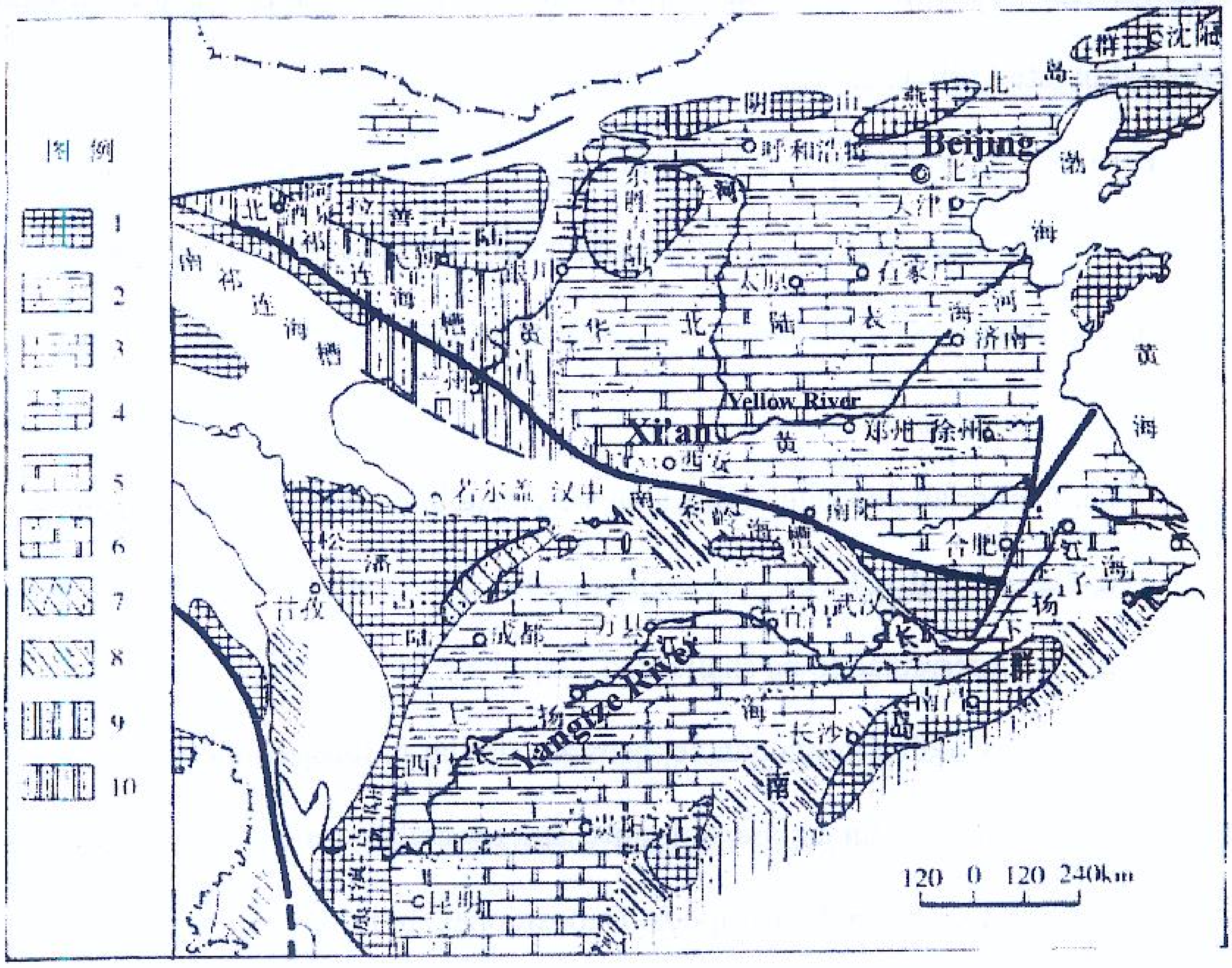

图 4-11　中国中东部中–晚寒武世古地理图

（王鸿祯等修改，1985）

1. 古陆；2. 滨浅海碳酸盐及粉砂质组合；3. 深浅海碳酸盐组合；4. 滨浅海含石膏泥质及含镁碳酸盐组合；5. 滨浅海含镁碳酸盐及粉砂泥质组合；6. 滨浅海含镁碳酸盐组合；7. 凝灰质碎屑组合；8. 半深海泥质及碳酸盐组合；9. 半深海泥砂质复理石及类复理石组合；10. 半深海含碳酸盐硅质泥砂质组合

Figure 46. Middle-Late Cambrian paleography, east-central China. 1. Land, 2. littoral-shallow marine carbonate rock and siltstone, 3. deep-shallow marine carbonate, 4. littoral-shallow marine gypsum and dolomitic deposits, 5. littoral-shallow marine dolomite and siltstone, 6. littoral to shallow marine dolomite, 7. tuffaceous siliciclastics, 8. slope muddy and carbonate deposits, 9. slope muddy-sandy flysh and para-flysh deposits, 10. slope carbonate-bearing siliciclastic mud and sand deposits. From Zhou et al., 2002.

Cambrian, this area experienced brief erosion and ensuing fast subsidence into relatively deep water, where siliceous rocks were deposited. Afterwards, regression started and water depth decreased. Thus, a shallow-water platform gradually appeared and peritidal environments dominated in late Early Cambrian.

Peritidal environments persisted into Middle Cambrian with a limited shelf environment. Dolomitic limestone and dolomitic algal laminites are the dominant deposits with local purplish red sandstone, shale, and chert nodules. Fenestrae and parallel laminations are common; fossils are rare.

Upper Cambrian deposits in this area are crystalline limestones, which were commonly dolomitized diagenetically. Fossils are mainly planktonic trilobites. The depositional environments are interpreted to be shallow to deep shelf.

Upper and Middle Ordovician deposits are similar to those of the Cambrian, and consist of thick-bedded dolomitic limestone, dolomite, and crystalline limestone with trilobites, cephalopods, brachiopods, and gastropods. Depositional environments are interpreted to be peritidal carbonate. Siliciclastic mud content increases and carbonate decreases to the south, gradually changing to the shallow platform and slope environments.

The Upper Ordovician is limited in its distribution. In the study area, the deposits are sandy mudrocks intercalated with argillaceous limestone, and limestone lentils, and in some cases, dolomitic lime mudstone. Corals are common. The depositional environment is interpreted to be shallow shelf. The area was completely exposed and eroded at the end of Silurian.

Summary

A scientific hypothesis originates from observations that cannot be satisfactorily explained by existing theories; and a scientific theory is being constantly tested by observations. Acute observational skills come from a curious, knowledgeable mind and are sharpened through practice. This is the central message from this field course.

Tectonic movement of the lithosphere is the key control on sedimentation, including deposition, nondeposition, and erosion, metamorphism, and igneous activities. In space, equant stable blocks are separated by linear active belts. In time, rock intervals are separated by unconformities to form tectonic sequences as observed throughout this course.

Interpreting the causes and processes and reconstructing the evolutionary pathways of tectonic, sedimentary, metamorphic, and igneous events and the earth as a whole on the basis of observations is the next more speculative step. This field course demonstrates the power of the plate tectonic theory. It provides a conceptual framework within which lithospheric movements and events can be better explained.

Many questions remain: For example, how complete is the geologic record, and is the Precambrian record less complete than the Phanerozoic record? What are the feedback mechanisms of sedimentation, metamorphism, and igneous activities on tectonics? How does one reconcile the apparent contradiction between the rock cycle and uni-directional and irreversible tectonic evolution (i.e. a fold can not be unfolded), and is the concept of "rock cycle" a fallacy? Will continental growth ever stop and what if it does not? Can the plate tectonic theory explain all observations, even Martian tectonics?

Keep expanding the list of questions and enjoy geology!

CULTURAL AND ARCHAEOLOGICAL STOPS WITHIN THE XIAN AREA (JUNE 16-17, 30; JULY 1)

Brief summaries from various internet sources. See also additional literature on these topics in travel guide books etc.

Lingtong – Terracotta warriors of the Qin Dynasty.

The Terracotta Army (http://en.wikipedia.org/wiki/Terracotta_Army). The Terracotta Warriors and Horses is a collection of 8,099 life-size Chinese terra cotta figures of warriors and horses located near the Mausoleum of the First Qin Emperor Qin Shi Huang. The figures were discovered in 1974 near Xi'an, Shaanxi province, China.

The Terracotta Army was buried with the first Emperor of Qin (Qin Shi Huangdi) in 210-209 BC (his reign over Qin was from 247 BC to 221 BC and over unified China from 221 BC to his death). Their purpose was to help rule another empire with Shi Huangdi in the afterlife. Consequently, they are also sometimes referred to as "Qin's Armies".

The Terracotta Army was discovered in March 1974 by local farmers drilling a water well to the east of Mount Lishan. (The precise coordinates are 34°23'5.71"N, 109°16'23.19"ECoordinates: 34°23'5.71"N, 109°16'23.19"E.) Mount Lishan is also where the material to make the terracotta warriors originated. In addition to the warriors, an entire man made necropolis for the emperor has been excavated

Construction of this mausoleum began in 246 BC and is believed to have taken 700,000 workers and craftsmen 38 years to complete. Qin Shi Huangdi was interred inside the tomb complex upon his death in 210 BC. According to the Grand Historian Sima Qian, the First Emperor was buried alongside great amounts of treasure and objects of craftsmanship, as well as a scale replica of the universe complete with gemmed ceilings representing the cosmos, and flowing mercury representing the great earthly bodies of water. Pearls were also placed on the ceilings in the tomb to represent the stars, planets, etc. Recent scientific work at the site has shown high levels of mercury in the soil of Mount Lishan, tentatively indicating an accurate description of the site's contents by Sima Qian.

The tomb of Qin Shi Huangdi is near an earthen pyramid 76 meters tall and nearly 350 square meters. The tomb presently remains unopened. There are plans to seal off the area around the tomb with a special tent-type structure to prevent corrosion from exposure to outside air. However, there is at present only one company in the world that makes these tents, and their largest model will not cover the site as needed.

Qin Shi Huangdi's necropolis complex was constructed to serve as an imperial compound or palace. It comprises several offices, halls and other structures and is surrounded by a wall with gateway entrances. The remains of the craftsmen working in the tomb may also be found within its confines, as it is believed they were sealed inside alive to keep them from divulging any secrets about its riches or entrance. It was only fitting, therefore, to have this compound protected by the massive terracotta army interred nearby.

The terracotta figures were manufactured both in workshops by government laborers and also by local craftsmen. It is believed they were made in much the same way that terracotta drainage pipes were manufactured at the time. This would make it a factory line style of production, with specific parts manufactured and assembled after being fired as opposed to crafting one solid piece of terracotta and subsequently firing it. After completion, the terracotta figures were placed in the pits outlined above in precise military formation according to rank and duty.

The terracotta figures are life-like and life-sized. They vary in height, uniform and hairstyle in accordance with rank. The colored lacquer finish, molded faces (each is individual), and real weapons and armor used in manufacturing these figures created a realistic appearance. Unfortunately, the weapons were stolen shortly after the creation of the army and the coloring has mostly faded. However, their existence served as a testament to the amount of labor and skill involved in their construction. It is also proof of the incredible amount of power the First Emperor possessed to order such a monumental undertaking as the manufacturing of the Terracotta Soldiers.

There is evidence of a large fire that burned the wooden structures once housing the Terracotta Army. The fire was described by Sima Qian, who described them as the consequences of General Xiang Yu, who raided the tomb less than five years after the death of the First Emperor, as that the effects of General Xiang's army included looting of the tomb and structures holding the Terracotta Army, as well as setting fire to the necropolis and starting a blaze that lasted for three months. Despite this fire, however, much of the remains of the Terracotta Army still survive in various stages of preservation, surrounded by remnants of the burnt wooden structures.

Today nearly two million people visit the site annually, and almost one-fifth is foreigners. The Terracotta Army now serves as both a phenomenal archaeological discovery as well as an icon of China's distant past recognizable the world over. The power and military achievement of the First Emperor Qin Shi Huang is evident in the massive and monumental achievements present throughout his tomb complex, most notably the 8,000+ terracotta figures eternally serving to protect their leader.

In 1999, it was reported that pottery warriors were suffering from "nine different kinds of mold", caused by raised temperatures and humidity in the building which houses the soldiers, and the breath of tourists. In addition, South China Morning Post reported the figures have

Yin, A., Nie, S., 1996. A Phanerozoic palinspastic reconstruction of China and its neighboring regions. In: Yin, A., Harrison, T.M. (Eds.), The Tectonic Evolution of Asia. Cambridge University Press, Cambridge, pp. 442-485.

Zhang H., Gao, S., Zhang, B., Luo, T., and Yin W., 1997, Pb isotopes of granitoids suggest Devonian accretion of the Yangtze (South China) craton to North China craton: Geology, v. 25, p. 1015-1018.

Zhang Shouxin & Zhen Yongyi 1991, "China" in The Palaeozoic, A, eds. M. Moullade & A.E.M. Nairn, Elsevier Sci. Publ., Amsterdam, Netherlands (NLD), Netherlands (NLD).

Zhao, M.-W., Behr, H.J., Ahrendt, H., Wemmer, K., Ren, Z.-L., Zhao, Z.-Y., 1996, Thermal and tectonic history of the Ordos Basin, China: Evidence from apatite fission track analysis, virtrinite reflectance, and K-Ar dating: American Association of Petroleum Geologists Bulletin, v. 80, p. 1110-1134.

Zhou, D.W. (senior editor), Li, W.H., Zhang, Y.X., Zhang, C.L., Zhang, F.X., Liu, Y.Q., Fu, J.H., Yue, L.P. (editors), 2002, Methodology and practice of comprehensive regional geologic analysis – A field guidebook for Ordos Basin-Qinling Orogenic Belt: Science Press, Beijing, China, 347 pp, IX plates.

the components. The resulting organic residue was mounted in glycerol and observed under a powerful microscope. Using these methods, the researchers identified and recovered 32 different types of pollen.

The pollen found in the terracotta warrior sample was mostly from herbaceous plants, such as members of the mustard and cabbage family, the genus of plants that includes sagebrush and wormwood, and the family of flowering plants that includes quinoa, spinach, beets and chard.

But the pollen detected in the terracotta horse sample mostly came from trees, such as pine, kamala and ginkgo.

Hu explains that pollen in clay is often destroyed after objects are fired. Some granules survived in the terracotta, however, because the figures appear to have been fired at inconsistent temperatures with parts of the objects, especially thicker portions, undergoing incomplete firing.

Two sites. Based on the pollen differences, the researchers conclude that the horses were produced near the mausoleum, while the warriors were made at an as-yet unknown site away from the region.

The horses are large (about 2 metres long) and heavy (nearly 200 kilograms) compared with the warriors, which weigh around 150 kilograms. The horses also are more delicate, given their relatively fragile legs.

The scientists therefore theorise that whoever planned the terracotta army's construction determined it would be easier to build the horses closer to the destination site to minimise transport.

Michael Nylan is a professor of history at the University of California at Berkeley who specialises in early Chinese history. Nylan says that because scientific access to the terracotta figures is difficult, it would be hard at present to verify the findings. Pollen analysis in recent years, however, has led to some remarkable discoveries, including solving murders and determining the origins of other artwork.

Hu says his team's work may open a new window for archaeologists.

"[They may] consider the possibility of finding pollen in ancient terracotta or pottery, as the pollen may tell us some stories that we want to know, but that are still unknown."

Banpo Neolithic Villiage and museum

Banpo Museum (http://en.wikipedia.org/wiki/Banpo)

Banpo is the site of a Neolithic village located near Xi'an, China. Banpo is the most famous archaeological site associated with the Yangshao culture. Archaeological sites with similarities to the first phase at Banpo are considered to be part of the Banpo phase (5000 BC to 4000 BC) of the Yangshao culture. Banpo was excavated from 1954 to 1957 and covers an area of around 50,000 square meters.

The settlement was surrounded by a moat, with the graves and pottery kilns located outside of the moat perimeter. Many of the houses were semisubterranean with the floor typically a meter below the ground surface. The houses were supported by timber poles and had steeply pitched thatched roofs.

According to the Marxist paradigm of archaeology that was prevalent in the People's Republic of China during the time of the excavation of the site, Banpo was considered to be a matriarchal society; however, new research contradicts this claim, and the Marxist paradigm is gradually being phased out in modern Chinese archaeological research.

The Yangshao culture was a Neolithic culture that existed extensively along the central Yellow River in China. The Yangshao culture is dated from around 5000 BC to 3000 BC. The culture is named after Yangshao, the first excavated representative village of this culture, which was discovered in 1921 in Henan Province. The culture flourished mainly in the provinces of Henan, Shaanxi and Shanxi.

The subsistence practices of Yangshao people were varied. They cultivated millet extensively; some villages also cultivated wheat or rice. The exact nature of Yangshao agriculture -- small-scale slash-and-burn cultivation versus intensive agriculture in permanent fields, is currently matter of debate. However, Middle Yangshao settlements such as Jiangzhi contain raised floor buildings that may have been used for the storage of surplus grains. They kept such animals as pigs and dogs, as well as sheep, goats, and cattle, but much of their meat came from hunting and fishing. Their stone tools were polished and highly specialized. The Yangshao people may also have practiced an early form of silkworm cultivation.

The Yangshao culture is well-known for its painted pottery. Yangshao artisans created fine white, red, and black painted pottery with human facial, animal, and geometric designs. Unlike the later Longshan culture, the Yangshao culture did not use pottery wheels in pottery-making. Excavations found that children were buried in painted pottery jars.

The archaeological site of Banpo village, near Xi'an, is one of the best-known ditch-enclosed settlements of the Yangshao culture. Another major settlement called Jiangzhai was excavated out to its limits, and archaeologists found that it was completely surrounded by a ring-ditch.

Xian Bell Tower

Bell Tower (Zhong Lou)

(http://www.travelchinaguide.com/attraction/shaanxi/xian/bell.htm)

The Bell Tower is a stately traditional building, that marks the geographical center of the ancient capital. From this important landmark extend East, South, West and North Streets, connecting the Tower to the East, South, West and North Gates of the City Wall of the Ming Dynasty.

The wooden tower, which is the largest and best-preserved of its kind in China, is 36 meters (118 feet) high. It stands on a brick base 35.5 meters (116.4 feet) long and 8.6 meters (28.2 feet) high on each side. During the Ming Dynasty, Xian was an important military town in Northwest China, a fact that is reflected in the size and historic significance of its tower.

The tower was built in 1384 by Emperor Zhu Yuanzhang as a way to dominate the surrounding countryside and provide early warning of attack by rival rulers.

The tower has three layers of eaves but only two stories. Inside, a staircase spirals up. The grey bricks of the square base, the dark green glazed tiles on the eaves, gold-plating on the roof and gilded color painting make the tower a colorful and dramatic masterpiece of Ming-style architecture. In addition to enhancing the beauty of the building, the three layers of eaves reduce the impact of rain on the building.

On the second floor, a plaque set in the west wall records the relocation of the tower in 1582. When it was first built in 1384, it stood near the Drum Tower on the central axis of the city, and continued to mark the center of the city since Tang Dynasty and the following the Five Dynasties and the Song and Yuan Dynasties. As the city grew, however, the geographical center changed. Therefore, in 1582, the Tower was moved 1,000 meters (3,280 feet) east of the original site. Except for the base, all parts are original, and history tells us that the relocation was accomplished quickly and inexpensively, making it a truly notable achievement in the architectural history in China.

Originally, the northwest corner of the tower housed the famous Jingyun Bell from the Tang Dynasty. Legend has it that although nothing had changed in the tower, the Jingyun Bell fell silent during the Ming Dynasty, so the current bell, a much smaller one weighing only 5 tons, was cast. The original Jingyun Bell can now be seen in Forest of Stone Steles Museum. The engravings on the doors of the Tower reflect the decorative fashion of Ming and Qing Dynasties, recounting popular stories of ancient China.

On each side of the base, there is an arched door 6 meters (19.6feet) high. In the past, vehicles were allowed to pass through the arches and under the tower, but as the city has grown the volume of traffic has become too great, so a bright, spacious pedestrian subway has been constructed under the tower. The entrance to the tower is from this subway.

A fenced-in area around the tower is planted with grass and flowers. In early spring, the tender plum blossoms and bright new grass surrounding the old tower provide a harmonious contrast. Not far from the Tower, modern shopping malls and a brightly decorated square reveal the prosperity of the city. When night falls, lanterns hung from the eaves illuminate the tower, making it even more enchanting.

Xian Big Goose and Little Goose Pagodas.

Big Wild Goose Pagoda

(http://www.travelchinaguide.com/attraction/shaanxi/xian/bigwildgoose.htm)

Originally built in 652 during the reign of Emperor Gaozong of the Tang Dynasty (618-907), it functioned to collect Buddhist materials that were taken from India by the hierarch Xuanzang.

Xuanzang started off from Chang'an (the ancient Xian), along the Silk Road and through deserts, finally arriving in India, the cradle of Buddhism. Enduring 17 years and traversing 100 countries, he obtained Buddha figures, 657 kinds of sutras, and several Buddha relics. Having gotten the permission of Emperor Gaozong (628-683), Xuanzang, as the first abbot of Da Ci'en Temple, supervised the building of a pagoda inside it. With the support of royalty, he asked 50 hierarchs into the temple to translate Sanskrit in sutras into Chinese, totaling 1,335 volumes, which heralded a new era in the history of translation. Based on the journey to India, he also wrote a book entitled 'Pilgrimage to the West' in the Tang Dynasty, to which scholars attached great importance.

First built to a height of 60 meters (197 feet) with five stories, it is now 64.5 meters (211.6 feet) high with an additional two stories. It was said that after that addition came the saying-'Saving a life exceeds building a seven-storied pagoda'. Externally it looks like a square cone, simple but grand and it is a masterpiece of Buddhist construction. Built of brick, its structure is very firm. Inside the pagoda, stairs twist up so that visitors can climb and overlook the panorama of Xian City from the arch-shaped doors on four sides of each storey. On the walls are engraved fine statues of Buddha by the renowned artist Yan Liben of the Tang Dynasty. Steles by noted calligraphers also grace the pagoda.

As for the reason why it is called Big Wild Goose Pagoda, there is a legend. According to ancient stories of Buddhists, there were two branches, for one of which eating meat was not a taboo. One day, they couldn't find meat to buy. Upon seeing a group of big wild geese flying by, a monk said to himself: 'Today we have no meat. I hope the merciful Bodhisattva will give us some.' At that very moment, the leading wild goose broke its wings and fell to the ground. All the monks were startled and believed that Bodhisattva showed his spirit to order them to be more pious. They established a pagoda where the wild goose fell and stopped eating meat. Hence it got the name 'Big Wild Goose Pagoda'.

Small Goose Pagoda: (http://en.wikipedia.org/wiki/Small_Wild_Goose_Pagoda)

The Small Wild Goose Pagoda, sometimes Little Goose Pagoda is one of two significant pagodas in the city of Xi'an, China. The other is the Big Wild Goose Pagoda.

Little Goose Pagoda was built between AD 707 – 709 during the Tang Dynasty by emperor Gaozong. The pagoda stood 45 meters until the Shaanxi Earthquake of 1556. The earthquake shook the pagoda so that it now stands at 43.4 meters high. Indian pilgrims have brought sacred Buddhist writings to the pagoda from India.

CULTURAL AND ARCHAEOLOGICAL STOPS WITHIN THE BEIJING AREA (JULY 3-4)

Brief summaries from various internet sources. See also additional literature on these topics in travel guide books, etc.

The Great Wall of China

The Great Wall of China (http://en.wikipedia.org/wiki/Great_Wall_of_China). The long wall of 10,000 Li (5000 km) is a series of stone and earthen fortifications in China, built, rebuilt, and maintained between the 5th century BC and the 16th century to protect the northern borders of the Chinese Empire during the rule of successive dynasties. Several walls, referred to as the Great Wall of China, were built since the 5th century BC, the most famous being the one built between 220 BC and 200 BC by the first Emperor of China, Qin Shi Huang. That wall was much further north than the current wall, built during the Ming Dynasty, and little of it remains.

The Great Wall is one of the existing megastructures and the world's longest human-made structure, stretching over approximately 6,400 km (4,000 miles) from Shanhai Pass in the east to Lop Nur in the west, along an arc that roughly delineates the southern edge of Inner Mongolia.

The Chinese were already familiar with the techniques of wall-building by the time of the Spring and Autumn Period, which began around the 8th century BC. During the Warring States Period from the 5th century BC to 221 BC, the states of Qi, Yan and Zhao all constructed extensive fortifications to defend their own borders. Built to withstand the attack of small arms such as swords and spears, these walls were made mostly by stamping earth and gravel between board frames.

Qin Shi Huang conquered all opposing states and unified China in 221 BC, establishing the Qin Dynasty. Intending to impose centralized rule and prevent the resurgence of feudal lords, he ordered the destruction of the wall sections that divided his empire along the former state borders. To protect the empire against intrusions by the Xiongnu people from the north, he ordered the building of a new wall to connect the remaining fortifications along the empire's new northern frontier. Transporting the large quantity of materials required for construction was difficult, so builders always tried to use local resources. Stones from the mountains were used over mountain ranges, while rammed earth was used for construction in the plains. There are no surviving historical records indicating the exact length and course of the Qin Dynasty walls. Most of the ancient walls have eroded away over the centuries, and very few sections remain today. Later, the Han, Sui, Northern and Jin dynasties all repaired, rebuilt, or expanded sections of the Great Wall at great cost to defend themselves against northern invaders.

The Great Wall concept was revived again during the Ming Dynasty following the Ming army's defeat by the Mongols in the Battle of Tumu in 1449. The Ming had failed to gain a clear upper-hand over the Mongols after successive battles, and the long-drawn conflict was taking a toll on the empire. The Ming adopted a new strategy to keep the Mongols out by constructing walls along the northern border of China. Acknowledging the Mongol control established in the Ordos Desert, the wall followed the desert's southern edge instead of incorporating the bend of the Huang He.

Unlike the earlier Qin fortifications, the Ming construction was stronger and more elaborate due to the use of bricks and stone instead of rammed earth. As Mongol raids continued periodically over the years, the Ming devoted considerable resources to repair and reinforce the walls. Sections near the Ming capital of Beijing were especially strengthened.

Towards the end of the Ming Dynasty, the Great Wall helped defend the empire against the Manchu invasions that began around 1600. Under the military command of Yuan

Chonghuan, the Ming army held off the Manchus at the heavily fortified Shanhai Pass, preventing the Manchus from entering the Liaodong Peninsula and the Chinese heartland. The Manchus were finally able to cross the Great Wall in 1644, when the gates of Shanhai Pass were opened by Wu Sangui, a rebel Ming border general. The Manchus quickly seized Beijing, and defeated the remaining Ming resistance, to establish the Qing Dynasty.

Under Qing rule, China's borders extended beyond the walls, and Mongolia was annexed into the empire, so construction and repairs on the Great Wall were discontinued.

The following three sections are in Beijing municipality, which were renovated and which are regularly visited by modern tourists:

• The "North Pass" of Juyongguan pass, known as the Badaling. When used by the Chinese to protect their land, this section of the wall has had many guards to defend China's capital, Beijing. Made of stone and bricks from the hills, this portion of the Great Wall is 7.8 meters high and 5 meters wide.

• One of the most striking sections of the Ming Great Wall is where it climbs extremely steep slopes. It runs 11 kilometers long, ranges from 5 to 8 meters in height, and 6 meters across the bottom, narrowing up to 5 meters across the top. Wangjinglou is one of Jinshanling's 67 watchtowers, 980 meters above sea level.

• South East of Jinshanling, is the Mutianyu Great Wall which winds along lofty, cragged mountains from the southeast to the northwest for approximately 2.25 kilometers (about 1.3 miles). It is connected with Juyongguan Pass to the west and Gubeikou to the east.

Another notable section lies near the eastern extremity of the wall, where the first pass of the Great Wall was built on the Shanhaiguan (known as the "Number One Pass Under Heaven"), the first mountain the Great Wall climbs. Jia Shan is also here, as is the Jiumenkou, which is the only portion of the wall that was built as a bridge. Shanhaiguan Great Wall is called the "Museum of the Construction of the Great Wall", because of the Meng Jiang-Nu Temple, built during the Song Dynasty.

Before the use of bricks, the Great Wall was mainly built from earth, stones, and wood. During the Ming Dynasty, however, bricks were heavily used in many areas of the wall, as were materials such as tiles, lime, and stone. The size and weight of the bricks made them easier to work with than earth and stone, so construction quickened. Additionally, bricks could bear more weight and endure better than rammed earth. Stone can hold under its own weight better than brick, but is more difficult to use. Consequently, stones cut in rectangular shapes were used for the foundation, inner and outer brims, and gateways of the wall. Battlements line the uppermost portion of the vast majority of the wall, with defensive gaps a little over 30 cm (a foot) tall, and about 23 cm (9 inches) wide.

The steps that form the Great Wall of China are very steep and tall in some areas. Tourists often become exhausted climbing the wall and walk no more than a kilometre or two (around a mile). While some portions north of Beijing and near tourist centers have been preserved and even reconstructed, in many locations the Wall is in disrepair. Those parts might serve as a village playground or a source of stones to rebuild houses and roads. Sections of the Wall are also prone to graffiti and vandalism. Parts have been destroyed because the Wall is in the way of construction. No comprehensive survey of the wall has been carried out, so it is not possible to say how much of it survives, especially in remote areas. Intact or repaired portions of the Wall near developed tourist areas are often frequented by sellers of tourist kitsch.

The wall also has watch towers at regular intervals, which were used to store weapons, house troops, and send smoke signals. Barracks and administrative centers are located at larger intervals.

Communication between the army units along the length of the Great Wall, including the ability to call reinforcements and warn garrisons of enemy movements, was of high importance. Signal towers were built upon hill tops or other high points along the wall for their visibility.

The Wall was made a UNESCO World Heritage Site in 1987. Mao Zedong had a saying, "You're not a real man if you haven't climbed the Great Wall". Originally this saying was used to bolster his revolution in trekking north. But over time the saying has been reduced to a promotional slogan for the Great Wall of China. In Badaling (north of Beijing) the 'real man stone' can be found with the saying engraved on it.

Ripley's Believe It or Not! cartoon from May 1932 makes the claim that the wall is "the mightiest work of man, the only one that would be visible to the human eye from the moon" and Richard Halliburton's 1938 book Second Book of Marvels makes a similar claim. This belief has persisted, assuming urban legend status, sometimes even entering school textbooks. Arthur Waldron, author of the most authoritative history of the Great Wall, has speculated that the belief might go back to the fascination with the "canals" once believed to exist on Mars. (The logic was simple: If people on Earth can see the Martians' canals, the Martians might be able to see the Great Wall.)

The Great Wall is a maximum 30 feet wide and is about the same color as the soil surrounding it. Based on the optics of resolving power (distance versus the width of the iris: a few millimetres for the human eye, metres for large telescopes) an object of reasonable contrast to its surroundings some four thousand miles in diameter (such as the Australian land mass) would be visible to the unaided eye from the moon (average distance from earth 238,857 miles). But the Great Wall is of course not a disc but more like a thread, and a thread a foot long would not be visible from a hundred yards away, even though a human head is. Not surprisingly, no lunar astronaut has ever claimed he could see the Great Wall from the moon.

A different question is whether it is visible form near-Earth orbit, i.e. at an altitude of less than 500 km (0.1% of the distance of the moon). The consensus here is that it is barely visible, and only under nearly perfect conditions; it is no more conspicuous than many other manmade objects.

Astronaut William Pogue thought he had seen it from Skylab but discovered he was actually looking at the Grand Canal of China near Beijing. He spotted the Great Wall with binoculars, but said that "it wasn't visible to the unaided eye." US Senator Jake Garn claimed to be able to see the Great Wall with the naked eye from a space shuttle orbit in the early 1980s, but his claim has been disputed by several US astronauts. Chinese astronaut Yang Liwei said he could not see it at all. Veteran US astronaut Gene Cernan has stated: "At Earth orbit of 160 km to 320 km high, the Great Wall of China is, indeed, visible to the naked eye." Ed Lu, Expedition 7 Science Officer aboard the International Space Station, adds that, "it's less visible than a lot of other objects. And you have to know where to look." Neil Armstrong stated about the view from Apollo 11: "I do not believe that, at least with my eyes, there would be any man-made object that I could see. I have not yet found somebody who has told me they've seen the Wall of China from Earth orbit. ... I've asked various people, particularly Shuttle guys, that have been many orbits around China in the daytime, and the ones I've talked to didn't see it." Leroy Chiao, a Chinese-American astronaut, took a photograph from the International Space Station that shows the wall. It was so indistinct that the photographer was not certain he had actually captured it. Based on the photograph, the state-run China Daily newspaper concluded that the Great Wall can be seen from space with the naked eye, under favorable viewing conditions, if one knows exactly where to look.

Thirteen tombs of the Ming dynasty

The Thirteen Ming tombs in Beijing

(http://en.wikipedia.org/wiki/Ming_Dynasty_Tombs) The Ming Dynasty Tombs are located some 50 kilometers due North of Beijing at an especially selected site. The site was chosen by the third Ming Dynasty emperor Yongle (1402 - 1424), who moved the capital of China from Nanjing to the present location of Beijing. He is credited with envisioning the layout of the ancient city of Beijing as well as a number of landmarks and monuments located therein. After the construction of the Imperial Palace (the Forbidden City) in 1420, the Yongle Emperor selected his burial site and creating his own mausoleum.

From the Yongle Emperor onwards, 13 Ming Dynasty Emperors were buried in this area. The tombs of the first two Ming Emperors are located near Nanjing (the capital city during their reigns). Emperor Jingtai was also not buried here as the Emperor Tianshun had denied Jingtai an imperial burial but was instead buried west of Beijing. The last Chongzhen Emperor who hung himself in April, 1644 was the last to be buried here, named Si Ling by the Qing emperor but on a much smaller scale than his predecessors.

During the Ming dynasty, the tombs were off limits to commoners but in 1644 Li Zicheng's army ransacked and set many of the tombs on fire before advancing and capturing Beijing in April of that year.

The site of the Ming Dynasty Imperial Tombs was carefully chosen according to Feng Shui (geomancy) principles. According to these, bad spirits and evil winds descending from the North must be deflected; therefore, an arc-shaped area at the foot of the Jundu Mountains north of Beijing was selected. This 40 square kilometer area - enclosed by the mountains in a pristine, quiet valley full of dark earth, tranquil water and other necessities as per Feng Shui - would become the necropolis of the Ming Dynasty.

The entire tomb site is surrounded by a wall, and a seven kilometer road named the "Spirit Way" leads into the complex which is one of the finest preserved pieces of 15th century Chinese art and architecture. The front gate of the complex is a large, three-arched gateway, painted red, and called the "Great Red Gate"

At present, three tombs have been excavated: Chang Ling, the largest (40°18'.16", 116°14'5.45"); Ding Ling, whose underground palace is open to the public (40°17'42.43", 116°12'8.53"); and Zhao Ling. There have been no excavations since 1989, but plans for new archeological research and further opening of tombs have circulated. The Ming Tombs were listed as a UNESCO World Heritage Site in August 2003. They were listed along with other tombs under the "Imperial Tombs of the Ming and Qing Dynasties" designation.

Tiananmen Square

Tiananmen Square (http://en.wikipedia.org/wiki/Tiananmen_Square) is the large plaza near the center of Beijing, China, named after the Tiananmen (literally, Gate of Heavenly Peace) which sits to its north, separating it from the Forbidden City. It has great cultural significance as a symbol because it was the site of several key events in Chinese history. Outside of China, the square is widely known for the Tiananmen Square protests of 1989.

The square is 880 metres south to north and 500 metres east to west, a total area of 440,000 square meters, which makes it the largest open-urban square in the world.

The Tiananmen was built in 1417 in the Ming Dynasty. In 1699 (early Qing Dynasty), the Tiananmen was renovated and renamed to its present form. During the Ming and Qing eras, there was no public square at Tiananmen, and instead the area was filled with offices for imperial ministries. These were badly damaged during the Boxer Rebellion and the area was cleared to produce the beginning of Tiananmen Square.

Near the centre of today's square, close to the site of the Mao Zedong Mausoleum, once stood one of the most important gates of Beijing. This gate was known as the "Great Ming Gate" during the Ming Dynasty, "Great Qing Gate" during the Qing Dynasty, and "Gate of China" during the Republic of China era. Unlike the other gates in Beijing, such as the Tiananmen and the Qianmen, this was a purely ceremonial gateway, with three arches but no ramparts, similar in style to the ceremonial gateways found in the Ming Dynasty Tombs. This gate had a special status as the "Gate of the Nation", as can be seen from its successive names. It normally remained closed, except when the Emperor passed through. Commoner traffic were diverted to two side gates at the northern and eastern ends of today's square, respectively. Because of this diversion in traffic, a busy marketplace, called Chessgrid Streets developed in the big, fenced square to the south of this gate.

In the early 1950s, the Gate of China (as it was then known) was demolished along with the Chessgrid Streets to the south, completing the expansion of Tiananmen Square to (approximately) its current size.

Enlarged in 1949 to the current size, its flatness is broken only by the 38 metre high Monument to the People's Heroes and the Mausoleum of Mao Zedong. The square lies between two ancient, massive gates: the Tian'anmen to the north and the Zhengyangmen, better known as Qianmen Hanyu Pinyin: Qiánmén; literally "Front Gate"to the south. Along the west side of the Square is the Great Hall of the People. Along the east side is the National Museum of China. Chang'an Avenue, which is used for parades, lies between the Tian'anmen and the Square. Trees line the east and west edges of the Square, but the square itself is open, with neither trees nor benches.

Forbidden City

The Forbidden City (Frommer's: http://www.frommers.com/destinations/beijing/0201022181.html)

The universally accepted symbol for the length and grandeur of Chinese civilization is undoubtedly the Great Wall, but the Forbidden City is more immediately impressive. A 720,000-sq.-m (7,750,008-sq.-ft.) complex of red-walled buildings and pavilions topped by a sea of glazed vermilion tile, it dwarfs nearby Tian'an Men Square and is by far the largest and most intricate imperial palace in China. The palace receives more visitors than any other attraction in the country (over seven million a year, the government says), and has been praised in Western travel literature ever since the first Europeans laid eyes on it in the late 1500s. Yet despite the flood of superlatives and exaggerated statistics that inevitably go into its description, it is impervious to an excess of hype, and it is large and compelling enough to draw repeat visits from even the most jaded travelers. Make more time for it than you think you'll need.

The palace, most commonly referred to in Chinese as Gu Gong (Former Palace), is on the north side of Tian'an Men Square across Chang'an Dajie (tel. **010/6513-2255;** www.dpm.org.cn). It is best approached on foot or via metro (Tian'an Men Dong, 117), as taxis are not allowed to stop in front. The palace is open daily from 8:30am to 5:30pm during summer and from 8:30am to 4:30pm in winter. Regular admission *(men piao)* in summer costs ¥60 ($8), dropping to ¥40 ($5) in winter; last tickets are sold an hour before the doors close. Various exhibition halls and gardens inside the palace charge additional fees. All-inclusive tickets *(lian piao)* had been discontinued at press time, perhaps in an effort to increase revenues, but it's always possible these will be reinstated. ***Tip:*** If you have a little more time, it is highly recommended that you approach the entrance at **Wu Men (Meridian Gate)** via **Tai Miao** to the east, and avoid the gauntlet of tiresome touts and tacky souvenir stalls.

Ticket counters are marked on either side as you approach. **Audio tours** in several languages (¥40/$5 plus ¥500/$63 deposit; the English version is narrated by Roger Moore) are available at the gate itself, through the door to the right. Those looking to spend more money can hire **"English"-speaking tour guides** on the other side of the gate (¥200-¥350/$25-$44 per person, depending on tour length). The tour guide booth also rents **wheelchairs** and **strollers** at reasonable rates. ***Note:*** Only the central route through the palace is wheelchair-accessible, and steeply so.

The Big Makeover--An immense **$75-million renovation of the Forbidden City**, the largest in 90 years, will be completed in two phases (the first by 2008, the second by 2020). Work started on halls and gardens in the closed western sections of the palace in 2002, with the most effort concentrated on opening the **Wuying Dian** (Hall of Valiance and Heroism) in the southwest corner of the palace, the **Jianfu Gong Huayuan** (Garden of the Palace of Building Happiness) in the northwest, followed by **Cining Huayuan** (Garden of Love and Tranquillity) next to the Taihe Dian. Wuying Dian, formerly the site of the Imperial printing press, should be open when you arrive, displaying a collection of Buddhist sutras, palace records, and calligraphy, as will Jianfu Gong Huayuan, an ambitious restoration as the entire section was devastated by fire in 1923. Cining Huayuan is said to be opening in 2008. Plans also call for the construction of new temperature-controlled buildings to house and exhibit what is claimed to be a collection of **930,000 Ming and Qing imperial relics**, most now stored underground.

On the other side of the palace, within the northern section of the Ningshou Gong Huayuan, a remarkable building is undergoing restoration with assistance from the World Cultural Heritage Foundation. Qianlong commissioned the European Jesuit painters in his employ to create large-scale *trompe l'oeil* paintings, which were used both in the Forbidden City as well as in the Yuan Ming Yuan. **Juanqin Zhai**, an elaborately constructed private opera house, houses the best remaining examples of these paintings, including a stunning image of a wisteria trellis, almost certainly painted by Italian master Castiglione. It is due to open in 2006.

Background & Layout

Sourcing of materials for the original palace buildings began in 1406, during the reign of the Yongle emperor, and construction was completed in 1420. Much of it was designed by a eunuch from Annam (now Vietnam), Nguyen An, but without improvements to the Grand Canal, construction would have been impossible -- timber came from as far away as Sichuan, and logs took up to 4 years to reach the capital. The Yuan palace was demolished to make way for the Forbidden City, but the lakes created during the Jin (1122-1215) were retained and expanded. Between 1420 and 1923, the palace was home to 24 emperors of the Ming and Qing dynasties. The last of these was Aisin-Gioro Puyi, who was forced to abdicate in 1912 but remained in the palace until 1924.

The Forbidden City is arranged along a north-south meridian, aligned on the Pole Star. The Qing court was unimpressed when the barbarians designated Greenwich Royal Observatory as the source of the prime meridian in 1885; they believed the Imperial Way marked the center of the temporal world. Major halls open to the south. Furthest south and in the center is the symmetrical **outer court**, dominated by immense ceremonial halls where the emperor conducted official business. Beyond the outer court and surrounding it on both sides is the **inner court**, a series of smaller buildings and gardens that served as living quarters. During the Ming, only eunuchs were allowed to pass between the two courts, enhancing their power.

The palace has been ransacked and parts destroyed by fire several times over the centuries, so most of the existing buildings date from the Qing rather than the Ming. The original complex was said to contain 9,999 rooms, testament to the Chinese love of the number nine, and also to an unusual counting method. The square space between columns is counted as a room *(jian)*, so the largest building, **Taihe Dian**, counts as 55 rooms. Using the Western method of counting, there are now 980 rooms. Only half of the complex is open to visitors (expected to increase to 70% after repairs are completed in 2020), but this still leaves plenty to see.

The Inner Court (Nei Ting)

During the Ming, only the emperor, his family, his concubines, and the palace eunuchs (who numbered 1,500 at the end of the Qing dynasty) were allowed in this section. It begins with the **Qianqing Men (Gate of Heavenly Purity)**, directly north of the Baohe Dian, fronted by a magnificent pair of **bronze lions** and flanked by a **Ba Zi Yingbi** (a screen wall in the shape of the character for "eight"), both warning non-royals not to stray inside. Beyond are three palaces designed to mirror the three halls of the Outer Court.

The first of these is the **Qianqing Gong (Palace of Heavenly Purity)**, where the emperors lived until Yongzheng decided to move to the western side of the palace in the 1720s. Beyond is **Jiaotai Dian (Hall of Union)**, containing the throne of the empress and 25 boxes that once contained the Qing imperial seals. A considerable expansion on eight seals used during the Qin dynasty, the number 25 was chosen because it is the sum of all single-digit odd numbers. Next is the more interesting **Kunning Gong (Palace of Earthly Tranquility)**, a Manchu-style bedchamber where a nervous Puyi was expected to spend his wedding night before he fled to more comfortable rooms elsewhere.

At the rear of the inner court is the elaborate **Yu Huayuan (Imperial Garden)**, a marvelous scattering of ancient conifers, rockeries, and pavilions, largely unchanged since it was built in the Ming dynasty. The crags allowed court ladies, who spent their lives inside the Inner Court, a glimpse of the world outside. Puyi's British tutor, Reginald Fleming Johnston, lived in the **Yangxin Zhai**, the first building on the west side of the garden (now a tea shop).

From behind the mountain, you can exit the palace through the **Shenwu Men (Gate of Martial Spirit)** and continue on to Jing Shan and/or Bei Hai Park. Those with time to spare, however, should take the opportunity to explore less-visited sections on either side of the central path.

Western Axis

Most of this area is in a state of heavy disrepair, but a few buildings have been restored and are open to visitors. Most notable among these is the **Yangxin Dian (Hall of Mental Cultivation)**, southwest of the Imperial Garden. The reviled Empress Dowager Cixi, who ruled China for much of the late Qing period, made decisions on behalf of her infant nephew, the Guangxu emperor, from behind a screen in the east room. This is also where emperors lived after Yongzheng moved out of the Qianqing Gong.

Eastern Axis

This side tends to be peaceful and quiet even when other sections are teeming. Entrance costs ¥10 ($1.25) and requires purchase of useless over-shoe slippers which quickly disintegrate (¥2/30¢). The most convenient ticket booth is 5 minutes' walk southwest of the Qianqing Men, opposite **Jiulong Bi (Nine Dragon Screen)**, a 3.5m-high (11 1/2-ft.) wall covered in striking glazed-tile dragons depicted frolicking above a frothing sea, built to protect the Qianlong emperor from prying eyes and malevolent spirits (that are only able to move in straight lines). The Qianlong emperor (reign 1736-1795) abdicated at the age of 85, and this section was built for his retirement, although he never really moved in, continuing to "mentor" his son while living in the Yangxin Dian, a practice later adopted by Empress Dowager Cixi, who also partially took up residence here in 1894.

Zhenbao Guan (Hall of Jewelry), just north of the ticket booth, has all 25 of the Qing imperial seals, ornate swords, and bejeweled minipagodas -- evidence that the Qing emperors were devoted to Tibetan Buddhism. One of the highlights is the secluded **Ningshou Gong Huayuan**, where the Qianlong emperor was meant to spend his retirement. Water was directed along a snakelike trough carved in the floor of the main pavilion. A cup of wine would be floated down the miniature stream, and the person nearest wherever it stopped would have to compose a poem, or drink the wine. The Qianlong emperor, whose personal compendium of verse ran to a modest 50,000 poems, was seldom short of words.

East of the garden is the **Changyin Ge**, sometimes called Cixi's Theater, an elaborate green-tiled three-tiered structure with trap doors and hidden passageways to allow movement between stages. Further north is sumptuous **Leshou Tang**, built entirely from sandalwood, where the Qianlong emperor would read, surrounded by poems and paintings composed by loyal ministers set into the walls and framed by blue cloisonne tablets. Cixi slept in the room to the west. The following hall, **Yihe Xuan**, is not a good place to bring friends from Mongolia or Xinjiang. The west wall has an essay justifying the Qianlong emperor's decision to colonize the latter, while the east wall has a poem celebrating the invasion of Mongolia. In the far northeastern corner is **Zhen Fei Jing (Well of the Pearl Concubine)**, a surprisingly narrow hole covered by a large circle of stone. The Pearl Concubine, one of the Guangxu emperor's favorites, was 25 when Cixi had her stuffed down the well by a eunuch as they were fleeing in the aftermath of the Boxer Rebellion. According to most accounts, Cixi was miffed at the girl's insistence that Guangxu stay and take responsibility for the imperial family's support of the Boxers.

Also worth seeing is the **Hall of Clocks (Zhongbiao Guan)**, a collection of timepieces, many of them gifts to the emperors from European envoys. Entrance to the exhibit costs ¥10 ($1.25).

Summer Palace

The Summer Palace or Yiheyuan (http://en.wikipedia.org/wiki/Summer_Palace), Yíhé Yuán; literally "Garden of Nurtured Harmony" is a palace in Beijing, China. The Summer Palace is mainly dominated by Longevity Hill (60 meters high) and the Kunming Lake. It covers an expanse of 2.9 square kilometers, three quarters of which is water. In its compact 70,000 square metres of building space, one finds a variety of palaces, gardens, and other classical-style architectural structures.

The Summer Palace started out life as the Garden of Clear Ripples in 1750 (Reign Year 15 of Emperor Qianlong). Artisans reproduced the garden architecture styles of various palaces in China. Kunming Lake was created by extending an existing body of water to imitate the West

Lake in Hangzhou. The palace complex suffered two major attacks--during the Anglo-French allied invasion of 1860 (with the Old Summer Palace also ransacked at the same time), and during the Boxer Rebellion, in an attack by the eight allied powers in 1900. The garden survived and was rebuilt in 1886 and 1902. In 1888, it was given the current name, Yihe Yuan. It served as a summer resort for Empress Dowager Cixi, who diverted 30 million taels of silver, said to be originally designated for the Chinese navy (Beiyang Fleet), into the reconstruction and enlargement of the Summer Palace.

In December 1998, UNESCO included the Summer Palace on its World Heritage List. It declared the Summer Palace an "outstanding expression of the creative art of Chinese landscape garden design, incorporating the works of humankind and nature in a harmonious whole."

Entering from the northern gate, the visitor first comes across Suzhou Street, designed to replicate the scenery of south-eastern China. At the top of Longevity Hill stands Duobao Glazed Pagoda. From the top of the hill one can see Kunming Lake to the south and southwest. The Marble Boat is at the southwest foot of the hill, and the Long Corridor runs east to west along its southern edge. Most of the other notable buildings (17-Arch Bridge, which has over 500 engraved lions run along the eastern edge of the lake, directly south of the eastern end of the Long Corridor. Other features of the Summer Palace include the Cloud-Dispelling Hall, the Tower of Buddhist Incense and Jade Belt Bridge, and the Garden of Harmonious Interests.

Temple of Heaven

The Temple of Heaven, literally the Altar of Heaven (http://en.wikipedia.org/wiki/Temple_of_Heaven): Tintán; Manchu: Abkai mukdehun) is a complex of Taoist buildings situated in southeastern urban Beijing, in Xuanwu District.

Construction of the complex began in 1420, and was thereafter visited by all subsequent Emperors of the Ming and Qing dynasties. It is regarded as the taoist temples , although the worship of Heaven, especially by the reigning monarch of the day, pre-dates Taoism.

The Temple grounds covers 2.73 km^2 of parkland, and comprises three main groups of constructions, all built according to strict philosophical requirements:

* The Earthly Mount) is the altar proper. It is an empty platform on three levels of marble stones, where the Emperor prayed for favourable weather;

* The House of Heavenly Lord, a single-gabled circular building, built on a single level of marble stone base, where the altars were housed when not in use;

* The Hall of Prayer for Good Harvests, a magnificent triple-gabled circular building, built on three levels of marble stone base, where the Emperor prayed for good harvests.

In ancient China, the Emperor of China was regarded as the "Son of Heaven", who administered earthly matters on behalf of, and representing, heavenly authority. To be seen to be showing respect to the source of his authority, in the form of sacrifices to heaven, was extremely important. The temple was built for these ceremonies, mostly comprising prayers for good harvests.

Each winter solstice the Emperor and all his retinue would move through the city to encamp within the complex, wearing special robes and abstaining from eating meat; there the Emperor would personally pray to Heaven for good harvests. The ceremony had to be perfectly completed; it was widely held that the smallest of mistakes would constitute a bad omen for the whole nation in the coming year.

The Temple of Heaven is the grandest of the four great temples located in Beijing. The other prominent temples include the Temple of Sun in the east, the Temple of Earth in the north and the Temple of Moon in the west.

According to Xinhua, in early 2005, the Temple of Heaven underwent a 47 million yuan (5.9 million USD) face-lift in preparation for the 2008 Beijing Summer Olympics and the restoration was completed on May 1st, 2006.

The Temple of Heaven was registered on the UNESCO World Heritage List in 1998.

* The Temple is surrounded by two cordons of walls; the outer wall has a taller, semi-circular northern end, representing Heaven, and a shorter, rectangular southern end, representing the Earth.

* All the buildings within the Temple have special dark blue roof tiles, again representing the Heaven.

* The Altar of Heaven was constructed with details representing the number nine, the representative number of the Emperor.

* It is said that if you stand at the centre of the platform and clap your hands, you can hear the echo because of the concavity of the surrounding wall.

* The House of Heavenly Lord is surrounded by a curved wall, 6 metres tall and 32.5 metres in radius. The wall has one opening. It is nicknamed the 'Echo Wall' because a person at one end of the wall (one side of the opening) can hear the voice of a person at the other end of the wall (the other side of the opening).

* The Hall of Prayer for Good Harvests is 32 metres in diameter and 38 metres tall. It has four inner, twelve middle and twelve outer pillars, representing the four seasons, twelve months and twelve traditional Chinese hours respectively.

* The Hall of Prayer for Good Harvests was built without a single nail.

* Hall of Annual Prayer has been said to be a more literal translation of Qi Nian Dian than Hall of Prayer for Good Harvests. In fact, the original meaning of nian (meaning 'year' in modern Chinese) was 'harvest', a meaning still found in phrases such as niancheng, 'harvest'. The earliest graph of the character is a representation of a man carrying a sheaf of grain.

References Selected

Blatt, H., Tracy, R. J., and Owens, B. E., 2006, Petrology, Igneous, Metamorphic, and Sedimentary: Freeman, New York, 530p.

Bureau of Geology and Mineral Resources of Shaanxi Province, Xi'an, China (CHN) 1989, "Regional geology of Shaanxi Province, China", Dizhi Zhuanbao, 1 = Geological Memoirs, Series 1 - Regional Geology, vol. 13, pp. 698.

Darby, B. J., and Ritts, B., D., 2002, Mesozoic contractional deformation in the middle of the Asian tectonic collage: in the intraplate Western Ordos fold-thrust belt, China: Earth and Planetary Science Letters, v. 205, p. 13-24.

Enkin, R.J., Zhenyu Yang, Yan Chen, and V.Courtillot, 1993, Paleomagnetic Constratints on the Geodynamic History of the Major Blocks of China From the Permian to the Present: Jour. Geophysical Res., v.97, no. B10, p. 13,953-13,989.

Enos, Paul, 1995, Permian of China, *in*, Scholle, P. A., Peryt, T. M., and Ulmer-Scholle, D. S. (eds.), The Permian of northern Pangea: Springer-Verlag, Berlin, v. 2, p. 225-256.

Geological Publishing House, 1992, Explanatory notes to Geological map of Qinling-Daba Mountains and adjacent regions, People's Republic of China (1:1,000,000): Beijing China.

Hacker, B.R., Wang, X., Eide, E.A., Ratschbacker, L., ???, Chapter 16, The Qinling-Babie ultra-high-pressure collisional orogen:???

Johnson, E.A., Liu, S., Zhang, Y.L., 1989, Depositional environments and tectonic controls on the coal-bearing Lower to Middle Jurassic Yan'an Formation, southern Ordos Basin, China: Geology, v. 17, p. 1123-1126.

Kaakinen, A., Sonninen, E., Lunkka, J.P., 2005, Stable isotope record in paleosol carbonates from the Chinese Loess Plateau: Implications for late Neogene paleoclimate and paleovegetation: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 237, p. 359-369.

Klimetz, M.P., 1983, An outline of the Mesozoic plate evolution of eastern China: Tectonics, v. 2, p. 139-166.

Li Sitian, Yang Shigong & Jerzykiewicz, T. 1995, Upper Triassic-Jurassic foreland sequences of the Ordos Basin in China; Stratigraphic evolution of foreland basins: *Special Publication - SEPM (Society for Sedimentary Geology),* vol. 52, pp. 233-241.

Liu, S., and S. Yang, 2000, Upper Triassic-Jurassic sequence stratigraphy and its structural controls in the western Ordos Basin, China: Basin Research, v. 12, p. 1-8.

Ma Lifang, Qiao Xiufu, Min Longrui, Fan Benxian, Ding Xiaozhong & Liu Nailong 2002, Geological atlas of China, Geological Publishing House, Beijing, China (CHN), China (CHN).

Mattauer M., Matte, P., Malavielle, J., Tapponier, P., Maluski, H., Xu, Z., Lu, Y., and Tang, Y., 1985, Tectonics of the Qinling belt: build up and evolution of eastern Asia: Nature, v. 317, p. 496-500.

Meng, Q., and Zhang G., 1999, Timing of collision of the North and South China blocks: controversy and reconciliation: Geology v. 27, p. 123-126.

Meng, Q.-R., Zhang, G.-W., 2000, Geological framework and tectonic evolution of the Qinling orogen, central China: Tectonophysics, v. 323, p. 183-196.

Ritts, B.D., Weislogel, A., Graham, S.A, and Darby, B.J., in press, Mesozoic Tectonics and Sedimentation of the Giant Polyphase Nonmarine Intraplate Ordos Basin, Western North

China Block, In: Phanerozoic Regional Geology of the World, A. Bally and D. Roberts, eds., Elsevier.

Sengör, A. M. C., 1987, Tectonics of the Tethysides- Orogenic collage development in a collisional setting: Annual Review of Earth and Planetary Sciences, v. 15, p. 213-244.

Sun W., and Li, S., 1998, Pb isotopes of granitoids suggest Devonian accretion of the Yangtze (South China) craton to North China craton: comment and reply: Geology, v. 29, p. 859-861.

Sun Zhaoeai, Xie Qiuyuan & Yang Junjie 1989, "Ordos Basin; a typical example of an unstable cratonic interior superimposed basin" in Chinese sedimentary basins, ed. Zhu Xia, Elsevier Sci. Publ., Amsterdam, Netherlands (NLD), Netherlands (NLD).

Tang, Y.J., Jia, J.Y., Xie, X.D., 2003, Records of magnetic properties in Quaternary loess and its paleoclimatic significance: a brief review: Quaternary International, v. 108, p. 33-50.

Wang, T., Pei, X.-Z., Wang, X.-X., Hu, N.G., Li, W.-P., Zhang, G.-W., 2005, Orogen-parallel westward oblique uplift of the Qinling basement complex in the core of the Qinling Orogen (China): An example of oblique extrusion of deep-seated metamorphic rocks in a collisional orogen: Journal of Geology, v. 113, p. 181-200.

Weislogel, A., 2004, Chapter 4: Stable isotopic record of Late Permian□Mesozoic climate and tectonics from pedogenic carbonate, central China: linkages between climate, tectonics and sedimentation: Ph.D. dissertation, Stanford University.

Xu, Y.C., Shen, P., 1995, A study of natural gas origins in China: American Association of Petroleum Geologists Bulletin, v. 80, p. 1604-1614.

Yang, Y., Li, W., Ma, L., 2005, Tectonic and stratigraphic controls of hydrocarbon systems in the Ordos Basin: A multicycle cratonic basin in central China: American Association of Petroleum Geologists Bulletin, v. 89, n. 2, p. 255-69.