Supplementary Material

The following 28 tables and 7 figures complement those included in the article.

# 1 Supplementary Tables

**Supplementary Table 1.** Ages of the piedmont fault terraces in Sertengshan.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sample location** | **Terrace** | **Method** | **Age (ka)** | **Data source** |
| Northern Wujiahe | T1 | OSL | 9.29±1.11 | This paper |
| Northern Shuiquan | T2 | OSL | 22.42±2.56 | This paper |
| Eastern Fanrong | T2 | OSL | 33.01±1.99 | This paper |
| Western Langshankou | T2 | OSL | 23.97±3.45 | This paper |
| Western Liushuquanzi | T3 | OSL | 72.05±9.76 | This paper |
| Northern Shuiquan | T3 | OSL | 60.34±7.94 | This paper |
| Eastern Dashetai | T3 | OSL | 71.38±9.76 | This paper |
| Wulan | T3 | OSL | 79.50±9.67 | This paper |

**Supplementary Table 2.** Terrace height distribution for Sertengshan Mountain piedmont faults.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Segment | Sample location | Terrace height(m) | | | | Data source  (This paper) |
| T1 | T2 | T3 | T4 |
|  | Fanrong | 7.5 | 14 | 27.5 | 42 |  |
|  | Langshankou |  | 12 | 26 | 41 |  |
| Wujiahe segment | Eastern Langshankou | 7 | 14 | 24 | 38 |  |
|  | Wujiahe | 5.5 | 11.3 | 24.2 | 34 |  |
|  | Dahoudian |  | 12 | 26 |  |  |
|  | Hongqicun | 4 | 15 | 21 |  |  |
| Hongqicun segment | Liguigedan | 3.3 | 11.7 | 23 |  |  |
|  | Wubulangkou |  | 14 |  |  |  |
| Kuluebulong segment | Kuluebulong | 7.8 |  |  |  |  |
|  | Wayaotan | 7 | 16 | 25 |  |  |
|  | Northern Mabuzi | 7 |  | 21 |  |  |
| Dashetai segment | Eastern Xishuidao | 9 | 15 |  |  |  |
|  | Dashetai | 8 | 13 | 23 |  |  |
|  | Wulan | 7.8 |  |  |  |  |

**Supplementary Table 3.** Dating data for the piedmont terraces in Wulashan.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No. | Sample location | Terrace | Method | Age (a) | Data source |
| 1 | Western Tehanqi | T1 | TL | 7770±610 | This paper |
| 2 | Northern Gongmiaozi | T1 | TL | 9520±810 | This paper |
| 3 | Northern Baiyanhua | T1 | TL | 10150±860 | This paper |
| 4 | Western Hademengou | T1 | OSL | 13830±1430 | This paper |
| 5 | Aguigou | T1 | OSL | 5880±540 | This paper |
| 6 | Xishanzui | T2 | TL | 39920±3110 | Previous study\* |
| 7 | Hayehutong | T2 | TL | 27410±2280 | Previous study\* |
| 8 | Northern Gongmiaozi | T2 | TL | 42760±3630 | Previous study\* |
| 9 | Northern Hayehutong | T2 | TL | 53800±4580 | Previous study\* |

\*Institute of Crustal and Dynamics and China Earthquake Administration (2013).

**Supplementary Table 4.** Terrace heights in Wulashan.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Segment | Location | Terrace height (m) | | | Data source  (This paper) |
| T1 | T2 | T3 |
|  | Wulashandianchang |  | 75 |  |  |
| Wulateqianqi segment | Wulashan |  | 60 |  |  |
|  | Wulanbulage |  | 40 |  |  |
|  | Northern Gongmiaozi |  | 23 |  |  |
|  | Huhebulage |  | 24 | 53 |  |
| Gongmiaozi segment | Dabagou |  | 27 | 39 |  |
|  | Daligai |  | 27 |  |  |
|  | Northern Heshunzhuang | 9 | 35 |  |  |
|  | Northern Heshunzhuang |  | 47 | 72 |  |
|  | Wubulagou |  | 58 | 73 |  |
| Baotou segment | Nailingou | 10 | 42 | 72 |  |
|  | Meiligenggou | 6 | 21 | 41 |  |
|  | Northern Hayehutong | 6 | 19 |  |  |
|  | Sandaobagou | 10 |  | 40 |  |
|  | Hademen | 3 | 15 |  |  |

**Supplementary Table 5.** Elevations of Daqingshan piedmont terraces.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Segment | Location | T1 elevation (m) | T2 elevation (m) | T3 elevation (m) | Data source |
| Tuyouxi segment | Maoqilai  Adulai  Shamujia  Maliu  Shabingya | 1040  1030  1049.4  1039  1038 | 1070  1060  1066  1100 | 1100  1120  1136  1128  1140 | Liang et al. (1997)  Liang et al. (1997)  Liang et al. (1997)  Liang et al. (1997)  Liang et al. (1997) |
| Tuzuoxi segment | Guyangou  Shangdalai | 1054  1056 | 1107  1079 | 1145  1120 | Liang et al. (1997)  Liang et al. (1997) |
| Bikeqi segment | Zhuergou  Daqi  Shuimogou  Shibaoqi | 1083  1052  1110  1058 | 1111  1116  1126 | 1154  1143  1145  1150 | Liang et al. (1997)  Previous study\*  Liang et al. (1997)  Liang et al. (1997) |
| Huhehaote segment | Goumen  Yaojiawan |  |  | 1157  1170 | Previous study\*  Previous study\* |

\*Institute of Crustal and Dynamics and China Earthquake Administration (1994).

**Supplementary Table 6.** Relationship between the fault tensile stress axis and fault strike on the northern margin of the Hetao Basin.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Faults | Langshan fault | Sertengshan fault | Wulashan fault | Daqingshan fault |
| Fault strike | Approximately 50° | Approximately 90–120° | Approximately 90° | Approximately 75° |
| Angle between the extensional stress axis and the fault strike | 83° | 18–48° | 48° | 63° |
| Maximum vertical slip rate of late Pleistocene (mm/a) | 3.2 | 1.81 | 3.11 | 3.88 |

**Supplementary Table 7.** Lithologies in borehole VI-3.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of the stratum bottom (m) | Thickness (m) | Lithologic description |
| 1 | 15 | 15 | Topsoil, brownish-yellow clay, containing plant roots and no water |
| 2 | 88.13 | 73.13 | Yellowish-green silty sand, relatively loose, good permeability, top 15–20 m containing a small amount of clay |
| 3 | 97.51 | 9.38 | Brownish-yellow clay layer with a small amount of fine sand at the bottom, approximately 5%, no water |
| 4 | 116.26 | 18.75 | Fine sand, greenish-yellow, grey-green, very loose, containing a small amount of water |
| 5 | 122.51 | 6.25 | Brown-yellow clay layer, no water, no sand |
| 6 | 138.76 | 16.25 | Coarse sand, medium sand, grey-yellow, loose, good water |
| 7 | 148.76 | 10 | Brown-yellow clay layer, no bedding, no sand |
| 8 | 152.51 | 3.75 | Coarse sand, medium sand, no bedding, no water |
| 9 | 170.64 | 18.13 | Brownish-yellow clay layer with a small amount of fine sand at the bottom, approximately 5%, no water |
| 10 | 174.39 | 3.75 | Greenish-grey fine sand, unbedded, containing little water and no clay |
| 11 | 176.89 | 2.5 | Brown-yellow clay layer, no bedding, no water, no sand |
| 12 | 180.2 | 3.13 | Grey-brown sandy silt layer, saturated, unstratified |
| 13 | 189.4 | 9.38 | Greenish-yellow fine sand, unbedded, containing little water and no clay |
| 14 | 194.4 | 5 | Brown-yellow clay layer, gravel-free, unstratified |
| 15 | 203.78 | 9.38 | Light yellow silty sand, unbedded, free of clay and containing little water |
| 16 | 209.41 | 5.63 | Clay sandy soil, containing little water, unstratified, silt content approximately 40% |
| 17 | 233.16 | 23.75 | Yellowish-green silty sand layer, no bedding, large water content, no clay |

**Supplementary Table 8.** Lithologies in borehole Ⅵ-1.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 94.45 | 94.45 | Dark brown sandy gravel, with plant roots at the top, gravel normally 20-40 mm in diameter, greyish white in section and fine sand at the bottom |
| 2 | 217.24 | 122.79 | Blackish-green silt layer, large water content at the bottom, fine sand content of approximately 15%, no gravel, no bedding |
| 3 | 220.28 | 3.04 | A brownish-yellow clay layer with fine sand at the top, no gravel, horizontal bedding |
| 4 | 238.91 | 18.63 | Brown sandy gravel, gravel content of approximately 30%, coarse sand content of approximately 15%, no water |

**Supplementary Table 9.** Lithologies in borehole Ⅶ-1.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 7.14 | 7.14 | Brownish-yellow clay sandy soil with plant roots and fine gravel at the top, no bedding |
| 2 | 19.23 | 12.09 | Yellowish-green fine sand layer, with fine gravel in the middle, no water |
| 3 | 23.36 | 4.13 | Brownish-yellow clay sandy soil, no sand, no gravel, no bedding |
| 4 | 43.27 | 19.91 | Light yellow fine sand with a small amount of clay at the top and no gravel |
| 5 | 53.03 | 9.76 | Brownish-yellow clay sandy soil, no obvious bedding, no water, a small amount of fine gravel at the bottom |
| 6 | 70.2 | 17.17 | Yellowish-green fine sand, with a small amount of fine gravel at the bottom, 10-20 mm in diameter, approximately 10% content |
| 7 | 74.62 | 4.42 | A dark brown layer of sand and gravel, approximately 30% gravel, 20-35 mm in diameter, with greyish-white sections and no water |
| 8 | 77.85 | 3.23 | Brownish-yellow clay layer, containing medium fine sand, approximately 20% |
| 9 | 87.27 | 9.42 | Light yellow fine sand, containing a small amount of clay, approximately 10% |
| 10 | 97.37 | 10.1 | Brownish-yellow sandy clay layer, medium coarse sand content of approximately 15%, no gravel |
| 11 | 102.73 | 5.36 | Light grey fine sand, no gravel, no water, no bedding |
| 12 | 107.76 | 5.03 | Brownish-yellow sandy clay layer, approximately 20% fine sand, no gravel |
| 13 | 117.57 | 9.81 | Light yellow medium fine sand, containing a small amount of fine gravel, no water, relatively loose |
| 14 | 144.06 | 26.49 | Brownish-yellow clay sandy soil, relatively loose, no gravel, no water |
| 15 | 149.57 | 5.51 | Yellowish-green fine sand with a small amount of clay at the bottom, relatively loose |
| 16 | 155.38 | 5.81 | Light yellow sandy clay layer, medium coarse sand content of approximately 15%, no water |
| 17 | 199.12 | 43.74 | Yellowish-green fine sand layer, relatively loose, no water |

**Supplementary Table 10.** Lithologies in borehole VIII-1.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 33.56 | 33.56 | Brownish-yellow fine sand layer, loose, no gravel, no bedding |
| 2 | 56.22 | 22.66 | Dark brown sandy gravel, 15-35 mm in diameter, containing no water |
| 3 | 64.3 | 8.08 | Brownish-yellow clay layer, well - stratified, containing fine gravel, no water |
| 4 | 76.08 | 11.78 | Light grey fine sand layer, no bedding, no water |
| 5 | 79.55 | 3.47 | Brown gravel layer, gravel diameter is small, no water, no bedding |
| 6 | 88.59 | 9.04 | Light yellow coarse sand, containing fine gravel, no bedding |
| 7 | 105.52 | 16.93 | Blackish-green silt layer, containing little water, local carbon chips, no bedding |
| 8 | 110.98 | 5.46 | Light yellow fine sand, no gravel, no water, no bedding |
| 9 | 129.2 | 18.22 | Brownish-black silt with fine sand at the top, no gravel, no bedding and little water |
| 10 | 132.81 | 3.61 | Brown sandy gravel, small amount of water, gravel 10-20 mm in diameter, greyish-white in section |
| 11 | 146.7 | 13.89 | Blackish-green silt, containing water, no gravel, no bedding |
| 12 | 169.07 | 22.37 | Light yellow fine sand, containing a little water, no bedding |
| 13 | 174.41 | 5.34 | Brown gravel layer, gravel diameter 10-30 mm, the section is grey, containing a little water, no bedding |
| 14 | 180.94 | 6.53 | Brownish-yellow fine sand, containing a little water, with fine gravel at the top, no bedding |
| 15 | 188.98 | 8.04 | Dark brown sandy gravel, approximately 35% gravel, 15-30 mm in diameter, no bedding |
| 16 | 208.46 | 19.52 | Dark green silt, containing little water, no gravel, no bedding |

**Supplementary Table 11.** Lithologies in borehole H125.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 111.66 | 111.66 | Brown sandy gravel, loose at the top, 20-40 mm in diameter, with a small amount of clay at the bottom, no water, no bedding |
| 2 | 126.72 | 15.06 | Brownish-yellow clay sandy soil with a small amount of fine gravel at the top, no water, no bedding |
| 3 | 131.79 | 5.07 | Light yellow fine sand, with a small amount of fine gravel at the bottom, no water |
| 4 | 153.04 | 21.25 | Dark brown sandy gravel, relatively loose, no water, no bedding |
| 5 | 162.66 | 9.62 | Light yellow fine sand, containing little water, no gravel, no bedding |
| 6 | 184.25 | 21.59 | Yellowish-brown clay with a small amount of black clay at the bottom, approximately 5 cm in diameter |

**Supplementary Table 12.** Lithologies in borehole H141.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 88.26 | 88.26 | Brown sandy gravel, loose, approximately 30% gravel, 10-35 mm in diameter, with coarse sand at the bottom, no bedding |
| 2 | 112.38 | 24.12 | Brownish-yellow clay sandy soil, loose, no bedding, no gravel |
| 3 | 131.49 | 19.11 | Dark brown gravel, approximately 30% gravel, no clay and bedding |
| 4 | 142.8 | 11.31 | Light yellow clay sandy soil with a small amount of gravel at the top and no water |
| 5 | 151.66 | 8.86 | Dark brown silt, containing little water, no gravel, no bedding |
| 6 | 190.23 | 38.57 | Brown sandy gravel, with a little water at the top, gravel diameter in 10-30 mm, well rounded and sorted |
| 7 | 192.63 | 2.4 | Brownish-yellow clay sandy soil with little water and no bedding |
| 8 | 199.65 | 7.02 | Dark brown sandy gravel, containing little water, well rounded and sorted, no bedding |
| 9 | 218.32 | 18.67 | Blackish-green silt layer, large water content, no gravel, no bedding |
| 10 | 235.73 | 17.41 | Brownish-yellow clay sandy soil with little water at the top, no gravel, no bedding |

**Supplementary Table 13.** Lithologies in borehole ZH18.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 9.03 | 9.03 | Light yellow clay sand, dense, poor permeability, no gravel |
| 2 | 34.45 | 25.42 | Greyish-brown sandy gravel, with a small amount of clay at the top, poorly rounded and sorted, with a content of approximately 35% |
| 3 | 42.66 | 8.21 | Brownish-yellow sandy clay with a small amount of fine gravel at the bottom, no water and bedding |
| 4 | 56.67 | 14.01 | Dark brown sandy gravel with a small amount of fine sand at the bottom, no water, no bedding, gravel approximately 50 mm in diameter |
| 5 | 63.73 | 7.06 | Yellowish-green fine sand layer, no bedding, no water, relatively loose |
| 6 | 66.84 | 3.11 | Light yellow clay layer, no gravel and bedding |
| 7 | 87.87 | 21.03 | Yellowish-green fine sand, no gravel, no water, loose, no bedding |
| 8 | 150.28 | 62.41 | Blackish-green silt layer, large water content, no bedding, no gravel |

**Supplementary Table 14.** Lithologies in borehole ZK3.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 3.7 | 3.7 | Silt, yellow and brown, loose, poor water permeability |
| 2 | 18.9 | 15.2 | Sandy gravel, red to green–grey, loose. Gravel diameter 5-15 mm, maximum gravel diameter 20-50 mm |
| 3 | 19.6 | 0.7 | Brownish-yellow sandy clay, 25% fine sand and medium-coarse sand |
| 4 | 48.05 | 28.35 | Red to yellow sandy gravel, maximum gravel diameter 30-70 mm, 40% gravel, 25% medium-coarse sand, sandy clay in the middle |
| 5 | 54.8 | 6.75 | Greyish-green silty clay, partial cementation, 35% silt, occasional calcium nodules |
| 6 | 67.5 | 9.7 | Grey silty fine sand, loose, good water permeability |
| 7 | 69.4 | 1.9 | Greenish-grey silty sand, poor water permeability, chemical odour |
| 8 | 77.4 | 8 | Greyish-green intermediate fine sand, loose, good water permeability |
| 9 | 82.9 | 5.5 | Greyish-green silt, partial cementation |
| 10 | 105.3 | 22.4 | Greyish-green silty clay, weak stratification, strong chemical odour |
| 11 | 108 | 2.7 | Greyish-green silty fine sand, loose |
| 12 | 109.3 | 1.3 | Greyish-green compact silty sand |
| 13 | 141.8 | 32.5 | Greenish-grey fine sand, very loose, containing gravels with diameters of 5-10 mm, good water permeability |
| 14 | 153.7 | 11.9 | Greenish-grey silt, good stratification, chemical odour |
| 15 | 167.6 | 12.9 | Greyish-green sandy gravel, very loose, with gravel 5-10 mm in diameter, maximum gravel diameter 150 mm |
| 16 | 172 | 4.4 | Greyish-green silt |
| 17 | 188.4 | 16.4 | Greyish-green sandy gravel normally 5-10 mm in diameter, maximum gravel diameter 70 mm, good water permeability |

**Supplementary Table 15.** Lithologies in borehole ZK6.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 10.4 | 10.4 | Yellowish-green fine sand, relatively loose, containing little water, no gravel, no bedding |
| 2 | 16.69 | 6.29 | Brown sandy gravel, approximately 20% gravel, no bedding, no water |
| 3 | 19.75 | 3.06 | Light yellow sandy clay, no gravel, no bedding |
| 4 | 28.78 | 9.03 | Dark brown sandy gravel, well rounded and sorted, no bedding, gravel approximately 10 mm in diameter |
| 5 | 35.07 | 6.29 | Brownish-yellow silty clay, no water, no gravel and bedding |
| 6 | 47.68 | 12.61 | Brown sandy gravel, gravel content of approximately 35%, gravel well rounded, poor sorting, no bedding |
| 7 | 50.88 | 3.2 | Yellowish-green clay silt, loose, no water, no bedding |
| 8 | 74.48 | 23.6 | Brown sandy gravel, gravel poorly rounded and sorted, no bedding, no water |
| 9 | 77.61 | 3.13 | Sandy clay, well cemented, no gravel, no bedding |
| 10 | 93.17 | 15.56 | Greyish-brown sandy gravel, gravel content of approximately 30%, gravel approximately 20 mm in diameter, sorting and grinding is good |
| 11 | 98.77 | 5.6 | Dark green silt layer, no bedding, with a small amount of fine sand at the top, no gravel |
| 12 | 107.88 | 9.11 | Light yellow fine sand, containing little water, no bedding, no gravel |
| 13 | 112.71 | 4.83 | Dark brown silt, containing a small amount of fine sand, good permeability, no bedding, no gravel |
| 14 | 120.89 | 8.18 | Brownish-yellow fine sand with fine gravel at the top, no bedding and a little water |
| 15 | 128.41 | 7.52 | Dark brown sandy gravel, approximately 20% gravel, with little water, no bedding |
| 16 | 137.32 | 8.91 | Light yellow fine sand, containing little water, no gravel |
| 17 | 139.73 | 2.41 | Black-green silt layer, good permeability, no bedding, top 1 m containing fine sand, no gravel |
| 18 | 143.81 | 4.08 | Yellowish-green sandy clay layer, no bedding, poor permeability, no gravel |
| 19 | 165.57 | 21.76 | A dark green silt layer with a small amount of clay at the top, no gravel and a small amount of water |

**Supplementary Table 16.** Lithologies in borehole ZK7.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 5.95 | 5.95 | Greyish-yellow sandy gravel, 40-50% gravel, gravel normally 2-8 mm in diameter, clayey sandy soil in the upper 0.7 m |
| 2 | 18.5 | 12.55 | Greyish-black and yellow sandy clay containing mica and shells, silty sand and fine sand in the bottom layer |
| 3 | 22.59 | 4.09 | Yellowish-green sandy gravel with gravel normally 2-5 mm in diameter |
| 4 | 25 | 2.41 | Brown and greyish-black sandy clay occasionally containing gravely and medium-fine sand |
| 5 | 31.03 | 6.03 | Greenish-grey sandy gravel, loose, containing a silt layer, good water permeability |
| 6 | 59.68 | 28.65 | Greenish-grey fine sand, occasionally containing medium sand and gravel |
| 7 | 64.71 | 5.03 | Greyish-black silty sand, loose, well sorted |
| 8 | 75 | 10.29 | Greyish-white sand gravel, loose, with gravel normally 2-8 mm in diameter, subrounded, containing calcareous sands and sandy clay |
| 9 | 86 | 11 | Greyish-black and greyish-green clayey silty sand and some silty fine sand |
| 10 | 90 | 4 | Grey silt, poor stratification, containing gravel and silty sand at the bottom |
| 11 | 93.52 | 3.52 | Greenish-grey fine sand, loose, primarily quartz grains, containing a thin calcareous medium-coarse sand layer at the bottom |
| 12 | 115.19 | 21.67 | Greyish-black compact silt with horizontal bedding, some silty sand |
| 13 | 129 | 13.81 | Sandy gravel, grey at the top and yellowish-green at the bottom, loose, with gravel normally 2-6 mm in diameter |
| 14 | 159.66 | 30.66 | Yellowish-green and brown fine sand, loose, partial stratification, occasionally containing medium sand and gravel |
| 15 | 183.05 | 23.39 | Brownish-yellow silty sand, occasionally containing medium sand gravel |
| 16 | 200.11 | 16.06 | Yellowish-green silty sands, loose, containing fine sand and some clay as well as medium sand and gravel at the bottom |
| 17 | 241.4 | 41.73 | Brownish-yellow sandy gravel, loose, with gravel normally 3-5 mm in diameter containing 20-30% medium sand |

**Supplementary Table 17.** Lithologies in borehole C11.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of the stratum bottom (m) | Thickness (m) | Lithologic description |
| 1 | 16.25 | 16.25 | Grey-yellow coarse sand layer, no bedding, no water |
| 2 | 22.5 | 6.25 | Brownish-yellow clay layer, no bedding, no gravel, no water |
| 3 | 30 | 7.5 | Greyish-brown sand and gravel layer, gravel section is greyish white, gravel diameter 2–4 mm, good water permeability |
| 4 | 43.13 | 23.13 | Greyish-yellow clay sand layer, top 35–36 m with little gravel, 2–3 mm in diameter, bottom 40–42 m with a little water |
| 5 | 53.13 | 10 | Greyish-brown gravel layer, top 45–46 m containing a small amount of fine sand, gravel 3–5 mm in diameter |
| 6 | 61.26 | 8.13 | Brown clay silt, approximately 70% silt, 30% clay, unstratified, with little water |
| 7 | 68.51 | 7.25 | Brown-yellow silty clay, approximately 20% silty clay, unbedded, no water |
| 8 | 84.76 | 16.25 | Brown sandy silt layer, low silt and fine sand content, approximately 15%, developed horizontal bedding |
| 9 | 112.26 | 27.5 | Grey-yellow clay sandy soil, low clay content, mainly silt, no bedding, containing a small amount of water |

**Supplementary Table 18.** Lithologies in borehole C02.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 9 | 9 | Brown sandy gravel, gravel content approximately 35%, coarse sand content approximately 20%, gravel diameter in 20-40 mm, relatively loose |
| 2 | 17.35 | 8.35 | Brownish-yellow clay layer with fine gravel at the top, horizontal bedding, no water |
| 3 | 22.91 | 5.56 | Dark brown sandy gravel, 15-30 mm in diameter, with greyish-white sections, no bedding |
| 4 | 31 | 8.09 | Light yellow clay sandy soil, no gravel and bedding |
| 5 | 36.56 | 5.56 | Brown sandy gravel, gravel content of approximately 30%, the section is grey, no water |
| 6 | 48.38 | 11.82 | Pale yellow clay sandy soil with a small amount of fine gravel at the top, no water, no bedding |
| 7 | 62.66 | 14.28 | Dark brown sandy gravel layer, no water, no bedding |
| 8 | 71.09 | 8.43 | Orange clay layer, no gravel, horizontal bedding, dense |
| 9 | 84.2 | 13.11 | Dark brown sandy gravel layer, gravel content approximately 30%, well rounded and sorted, no bedding |
| 10 | 89.2 | 5 | Light yellow coarse sand, containing a small amount of fine gravel, no water |
| 11 | 120.74 | 31.54 | Greyish-brown silt, containing little water, no gravel, horizontal bedding |

**Supplementary Table 19.** Lithologies in borehole CKB33.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 16.86 | 16.86 | Brownish-yellow clay sandy soil with plant roots at the top, no gravel, no bedding |
| 2 | 23.3 | 6.44 | Orange coarse sand, containing a small amount of fine gravel, no water |
| 3 | 28.69 | 5.39 | Brown clay sandy soil, no gravel, loose, and no bedding |
| 4 | 39.83 | 11.14 | Pale yellow clay layer, no gravel, horizontal bedding |
| 5 | 46.24 | 6.41 | Yellowish-green fine sand, containing little clay, no gravel |
| 6 | 54.64 | 8.4 | Brownish-yellow clay sandy soil with a small amount of water at the base and no gravel |
| 7 | 87.93 | 33.29 | Dark green silt layer, containing little water, no gravel, horizontal bedding |

**Supplementary Table 20.** Lithologies in borehole Bao6.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 10.97 | 10.97 | Dark brown sandy gravel, gravel 15-40 mm in diameter, 35%, no water, no bedding |
| 2 | 16.37 | 6.12 | Brownish-yellow clay sandy soil, no gravel, no water, and no bedding |
| 3 | 22.49 | 6.12 | Brown sandy gravel layer, gravel diameter 10-20 mm, the section is grey, no water |
| 4 | 27.93 | 5.44 | Brownish-green silt layer, containing fine sand, horizontal bedding |
| 5 | 33.27 | 5.34 | Light yellow medium sand, containing a small amount of fine gravel, no water |
| 6 | 4636 | 13.09 | Dark green sandy silt layer, containing little water, no gravel, horizontal bedding |
| 7 | 54.74 | 8.38 | Brownish-yellow fine sand, with little water, no gravel, no bedding |
| 8 | 102.65 | 47.91 | Dark green silt layer, no gravel, containing little water, horizontal bedding |
| 9 | 138.01 | 35.36 | Pale yellow sandy clay layer with a small amount of gravel at the top, no water, no bedding |

**Supplementary Table 21.** Lithologies in borehole VIII-3.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of the stratum bottom (m) | Thickness (m) | Lithologic description |
| 1 | 21.88 | 21.88 | Brown-yellow silty clay with a silt content of approximately 20%, no bedding, no water |
| 2 | 39.38 | 17.5 | Greyish-brown gravel layer, 2–3 mm diameter gravel, 37–38 m bottom with a small amount of clay, good water permeability |
| 3 | 45.63 | 6.25 | Light yellow silty clay with a small amount of gravel at the bottom (43–44 m), gravel 2–3 mm in diameter, unstratified and free of water |
| 4 | 69.38 | 23.75 | Greyish-brown gravel layer, 3–4 mm diameter gravel, 68–69 m bottom with a small amount of silt, no water, no bedding |
| 5 | 76.26 | 6.88 | Dark brown sandy silt, free of gravel, developed in horizontal bedding |
| 6 | 98.76 | 22.5 | Light yellow fine sand, no gravel, no bedding, containing a small of amount of water |
| 7 | 136.26 | 37.5 | Dark brown sandy silt, free of gravel, with black bands and horizontal bedding at bottom |
| 8 | 145.01 | 8.75 | Brown silt layer, dense, lower part yellow green, with fine sand |
| 9 | 201.26 | 56.25 | Dark brown sandy silt, yellowish-green at the top, horizontal bedding, with a small number of pebbles at the bottom, pebbles 2–3 mm in diameter |

**Supplementary Table 22.** Lithologies in borehole Sa4.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 3.77 | 3.77 | Clay sandy soil with plant roots at the top, no gravel, no bedding |
| 2 | 8.43 | 4.66 | Brown sandy gravel layer, gravel diameter 5-25 mm, coarse sand at the bottom, no water |
| 3 | 16.98 | 8.55 | Brownish-yellow medium sand, containing a small amount of fine gravel, no water, no bedding |
| 4 | 29.36 | 12.38 | Dark brown gravel bed, 30% gravel content, loose, no water |
| 5 | 40.72 | 11.36 | Light yellow silty sand layer, relatively loose, no water |
| 6 | 51.69 | 10.97 | Brown sandy gravel layer, relatively loose, gravel content of approximately 30%, the section is grey |
| 7 | 73.23 | 21.54 | Brownish-yellow silty sand layer, loose, no bedding, no water |
| 8 | 87.39 | 14.16 | Light yellow fine sand, containing a small amount of medium sand, no gravel |
| 9 | 98.92 | 11.53 | Dark green silt layer, containing little water, no gravel, horizontal bedding |
| 10 | 103.7 | 4.78 | Light yellow silt, containing little water, no clay |
| 11 | 109.17 | 5.47 | Dark green silt layer, containing little water, no gravel, horizontal bedding |
| 12 | 121.94 | 12.77 | Pale yellow fine sand with a small amount of fine gravel and a small amount of water |
| 13 | 140.32 | 18.38 | Dark green silt layer, containing little water, no gravel |
| 14 | 146.05 | 5.73 | Brownish-yellow silt, with little water, gravel 20 mm in diameter |
| 15 | 153.02 | 6.97 | Dark green silt layer, no gravel, horizontal bedding, containing a small amount of water |

**Supplementary Table 23.** Lithologies in borehole TK7.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 8.65 | 8.65 | Dark brown sandy gravel, 15-30 mm in diameter, approximately 25% gravel, with approximately 15% coarse sand at the bottom |
| 2 | 15.01 | 6.36 | Light yellow medium coarse sand, coarse sand content of approximately 20%, no water |
| 3 | 29.17 | 14.16 | Dark green sandy silt layer, no water, dense |
| 4 | 35.41 | 6.24 | Brownish-yellow sandy clay layer, no gravel, with horizontal bedding at the top |
| 5 | 67.97 | 32.56 | Light yellow medium and fine sand layer, mainly fine sand, medium sand content of approximately 20% |
| 6 | 78.37 | 10.4 | Brown sandy gravel, gravel section is grey, content of approximately 30%, no water |
| 7 | 83.37 | 5 | Light yellow medium fine sand, no gravel, no bedding |
| 8 | 130.49 | 47.12 | Dark green sandy silt layer, containing little water, no gravel, horizontal bedding |
| 9 | 144.77 | 14.28 | Brownish-yellow medium coarse sand, coarse sand content of approximately 20%, containing a little water, relatively loose |
| 10 | 159.39 | 14.62 | Yellowish-green silty sand layer, relatively loose, no bedding |

**Supplementary Table 24.** Lithologies in borehole TS19.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 20.08 | 20.08 | Brown sandy gravel layer, gravel content of approximately 25%, coarse sand content of approximately 15%, the rest is medium fine sand |
| 2 | 27.66 | 7.58 | Pale yellow clay sandy soil, no gravel and bedding |
| 3 | 42.62 | 14.96 | Brown sandy gravel layer, gravel 10-30 mm in diameter, the section is grey, no water |
| 4 | 65.33 | 22.71 | Brownish-yellow sandy clay layer with a small amount of fine gravel at the top, no water, no bedding |
| 5 | 80.46 | 15.13 | Yellow medium and fine sand layer, medium sand content of approximately 30%, no water |
| 6 | 85.24 | 4.78 | Dark brown sandy gravel layer, no water, well rounded and sorted |
| 7 | 90.7 | 5.46 | Pale yellow clay sandy soil, no gravel and bedding |
| 8 | 97.5 | 6.8 | Brown sandy gravel layer, gravel grinding round sorting is good, diameter in 20-30 mm |
| 9 | 103.55 | 6.05 | Light yellow clay sandy soil, no gravel and bedding |
| 10 | 123.39 | 19.84 | Brown sandy gravel, no water, gravel content of approximately 30%, the section is grey, no bedding |
| 11 | 168.47 | 45.08 | Dark green sandy silt layer, approximately 10% fine sand content, little water, no bedding |
| 12 | 182.02 | 13.55 | Brownish-yellow sandy clay layer, no gravel, and no bedding |
| 13 | 216.48 | 34.46 | Dark green sandy silt layer, containing little water, no gravel, horizontal bedding |

**Supplementary Table 25.** Lithologies in borehole Ⅶ-1.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 33.71 | 37.11 | Brown sandy gravel, gravel content of approximately 40%, 15-35 mm in diameter, the section is grey, no water, no bedding |
| 2 | 45.07 | 11.36 | Grey–green silt layer, no gravel, and no bedding |
| 3 | 53.79 | 8.72 | Dark green sandy silt layer, fine sand content of approximately 15%, no gravel, horizontal bedding |
| 4 | 68.79 | 15 | Greyish-brown gravel layer, gravel diameter in 10-30 mm, the section is greyish-white |
| 5 | 77.39 | 8.86 | Dark green sandy silt layer, approximately 15% fine sand, no gravel, little water |
| 6 | 91.14 | 13.75 | Brown sandy gravel layer, approximately 25% gravel, 10-20 mm in diameter, no water |
| 7 | 125.04 | 33.9 | Dark green sandy silt layer, containing little water, no gravel, horizontal bedding |
| 8 | 177.14 | 52.1 | Greyish-brown sandy gravel, containing water at the top, coarse sand content of approximately 20%, no bedding |

**Supplementary Table 26.** Lithologies in borehole TK27.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 50.93 | 50.93 | Dark brown sandy gravel, approximately 35% gravel content, 10-30 mm in diameter, greyish-white section, poor gravel sorting |
| 2 | 57.17 | 6.24 | Brownish-yellow medium coarse sand, coarse sand content of approximately 30%, no water |
| 3 | 64.02 | 6.85 | Greyish-green sandy silt, approximately 20% fine sand content, horizontal bedding |
| 4 | 72.79 | 8.77 | Brown sandy gravel, gravel content of approximately 30%, no water, no bedding |
| 5 | 87.53 | 14.74 | Light yellow silty sand, no gravel and bedding |
| 6 | 102.37 | 14.84 | Yellowish-brown medium fine sand, with a small amount of fine gravel at the bottom, no water |
| 7 | 132.12 | 29.75 | Dark green sandy silt layer, containing little water, no gravel |
| 8 | 138.61 | 6.49 | Yellowish-green fine sand, no clay, and no bedding |
| 9 | 142.66 | 4.05 | Dark green sandy silt layer, containing little water, no gravel, horizontal bedding |
| 10 | 157.5 | 14.84 | Yellowish-brown medium fine sand, no gravel, with clay clumps in the middle |
| 11 | 194.22 | 36.72 | Light yellow sandy clay layer, no gravel, approximately 15% sand content, horizontal bedding |

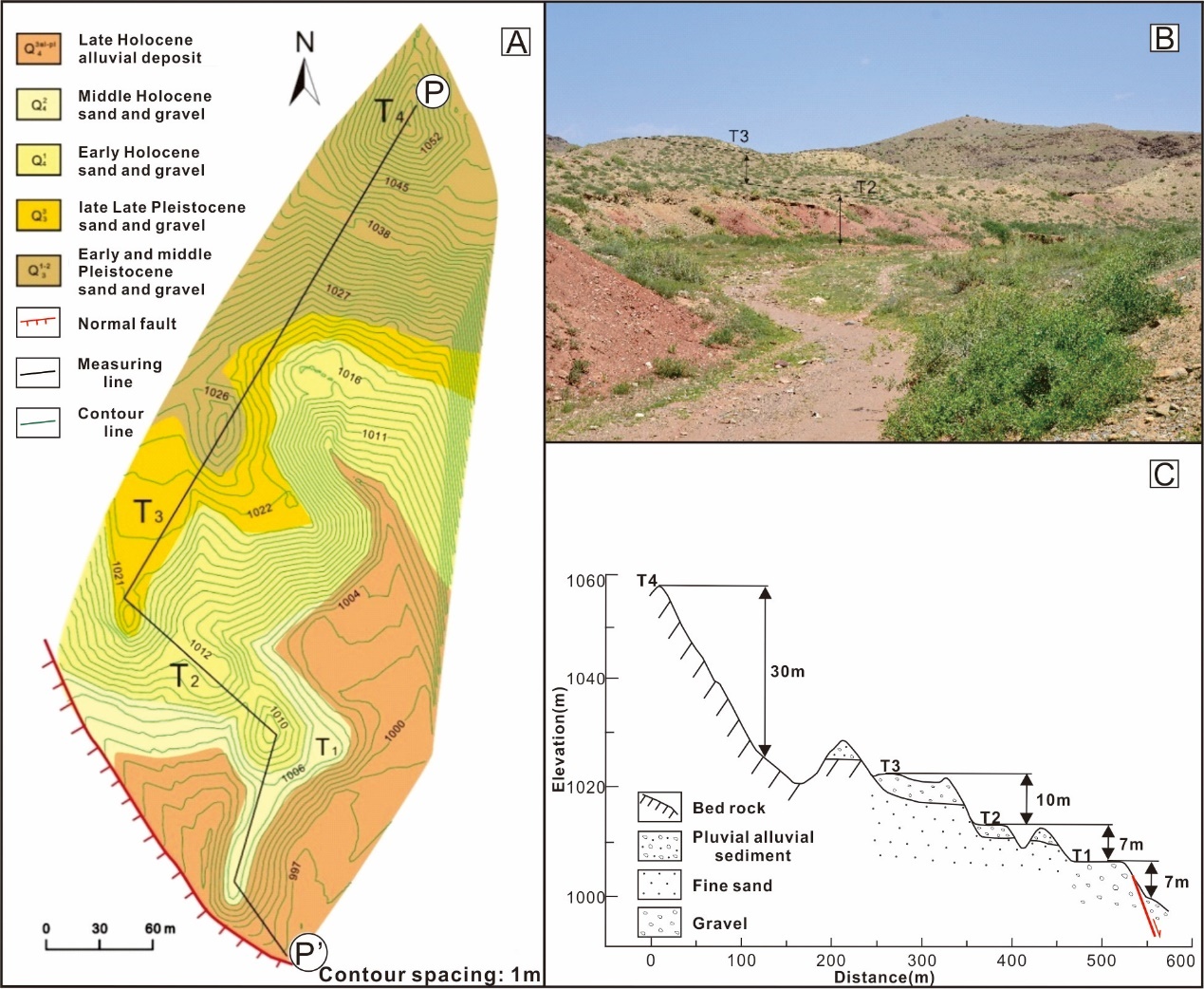
**Supplementary Table 27.** Lithologies in borehole TS67.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 21.98 | 21.98 | Brown sandy gravel layer, gravel 10-30 mm in diameter, approximately 35%, top containing plant roots, no water |
| 2 | 28.25 | 6.27 | Brownish-yellow clay sandy soil, loose, no gravel |
| 3 | 47.31 | 19.06 | Dark brown sandy gravel, gravel sorting is poorly rounded, no water, no bedding |
| 4 | 56.2 | 8.89 | Greyish-green sandy silt layer with a small amount of clay at the top, no gravel, no bedding |
| 5 | 91.08 | 34.88 | Brown sandy gravel layer, gravel content of approximately 30%, 10-40 mm in diameter, the section is grey |
| 6 | 106.94 | 15.86 | Light yellow sandy clay layer, approximately 15% fine sand, no gravel |
| 7 | 125.9 | 18.96 | Brown sandy gravel, coarse sand content of approximately 20%, gravel diameter in 10-30 mm, no bedding, no water |
| 8 | 138.28 | 12.38 | Brownish-yellow clay sandy soil, relatively loose, no water, no bedding |
| 9 | 172.98 | 34.7 | Greyish-brown gravel layer, gravel diameter in 10-30 mm, good sorting and grinding, no water |
| 10 | 179.95 | 6.97 | Light yellow clay sandy soil, relatively loose, no water, no bedding |
| 11 | 199.01 | 19.06 | Greyish-brown sandy gravel, gravel content of approximately 30%, poor sorting and grinding, no water |
| 12 | 211.15 | 12.14 | Light yellow sandy clay layer, fine sand content of approximately 15%, no water |
| 13 | 248.92 | 37.77 | Dark brown sandy gravel, gravel diameter in 10-30 mm, good sorting and grinding, no bedding |

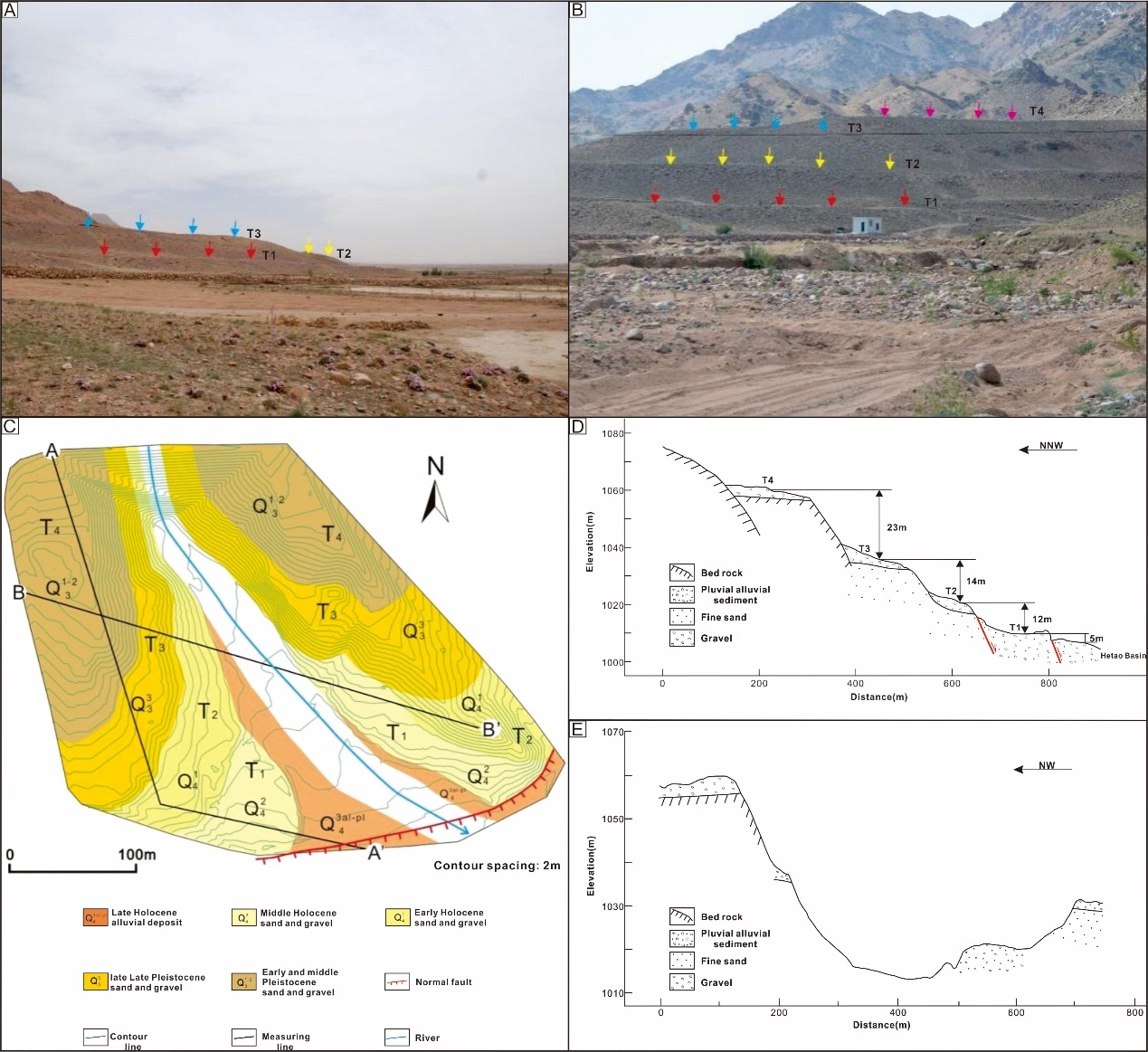
**Supplementary Table 28.** Lithologies in borehole Ⅱ-1.

|  |  |  |  |
| --- | --- | --- | --- |
| Stratum number | Depth of stratum bottom(m) | Thickness  (m) | Lithologic description |
| 1 | 10 | 10 | Brownish-yellow fine sand layer, top containing plant roots, no water |
| 2 | 13.26 | 3.26 | Brown sandy gravel, gravel diameter in 10-20 mm, poor sorting and grinding |
| 3 | 18.55 | 5.29 | Light yellow clay sandy soil, loose, no gravel, no bedding |
| 4 | 43.68 | 25.13 | Dark brown sandy gravel, approximately 30% gravel, no water and bedding |
| 5 | 69.18 | 25.5 | Light yellow sandy clay layer, approximately 15% fine sand content, no gravel, relatively loose |
| 6 | 85.48 | 16.3 | Greyish-brown sandy gravel layer, coarse sand content is approximately 20%, gravel sorting is better rounded |
| 7 | 94.08 | 8.6 | Brownish-yellow sandy soil, no gravel, relatively loose |
| 8 | 110.38 | 16.3 | Brown sandy gravel, approximately 35% gravel content, 10-30 mm in diameter |
| 9 | 114.88 | 4.5 | Light yellow clay sandy soil, containing little water, no gravel, relatively loose |
| 10 | 134.23 | 19.35 | Dark brown sandy gravel, gravel diameter in 10-30 mm, poor sorting and grinding |
| 11 | 141.03 | 6.8 | Orange-yellow sandy clay layer, approximately 15% fine sand content, with greyish-black clay clumps at the bottom |
| 12 | 147.41 | 6.38 | Greyish-brown sandy gravel, approximately 25% gravel, 15-35 mm in diameter, no water and bedding |
| 13 | 154.21 | 6.8 | Yellowish-green clay sandy soil, relatively loose, no water |
| 14 | 157.98 | 3.77 | Pale yellow sandy clay, dense, no bedding |
| 15 | 166.14 | 8.16 | Greyish-brown sandy gravel, gravel sorting is poorly rounded, diameter in 20-30 mm |
| 16 | 170.64 | 4.5 | Light yellow sandy clay layer, no water, relatively loose |
| 17 | 29534 | 124.7 | Orange yellow clay sandy soil, relatively loose, no water, no bedding |

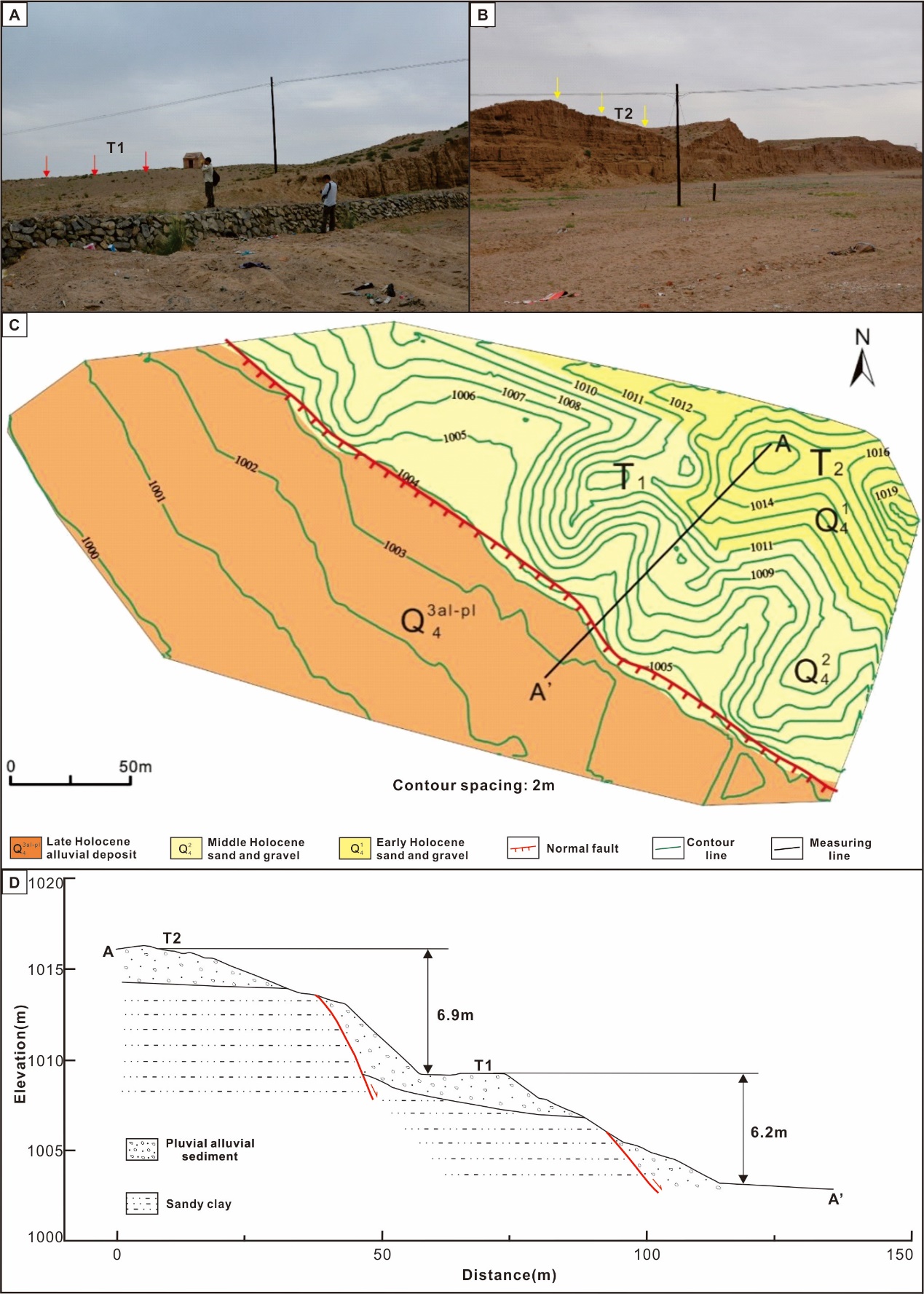
## 2 Supplementary Figures



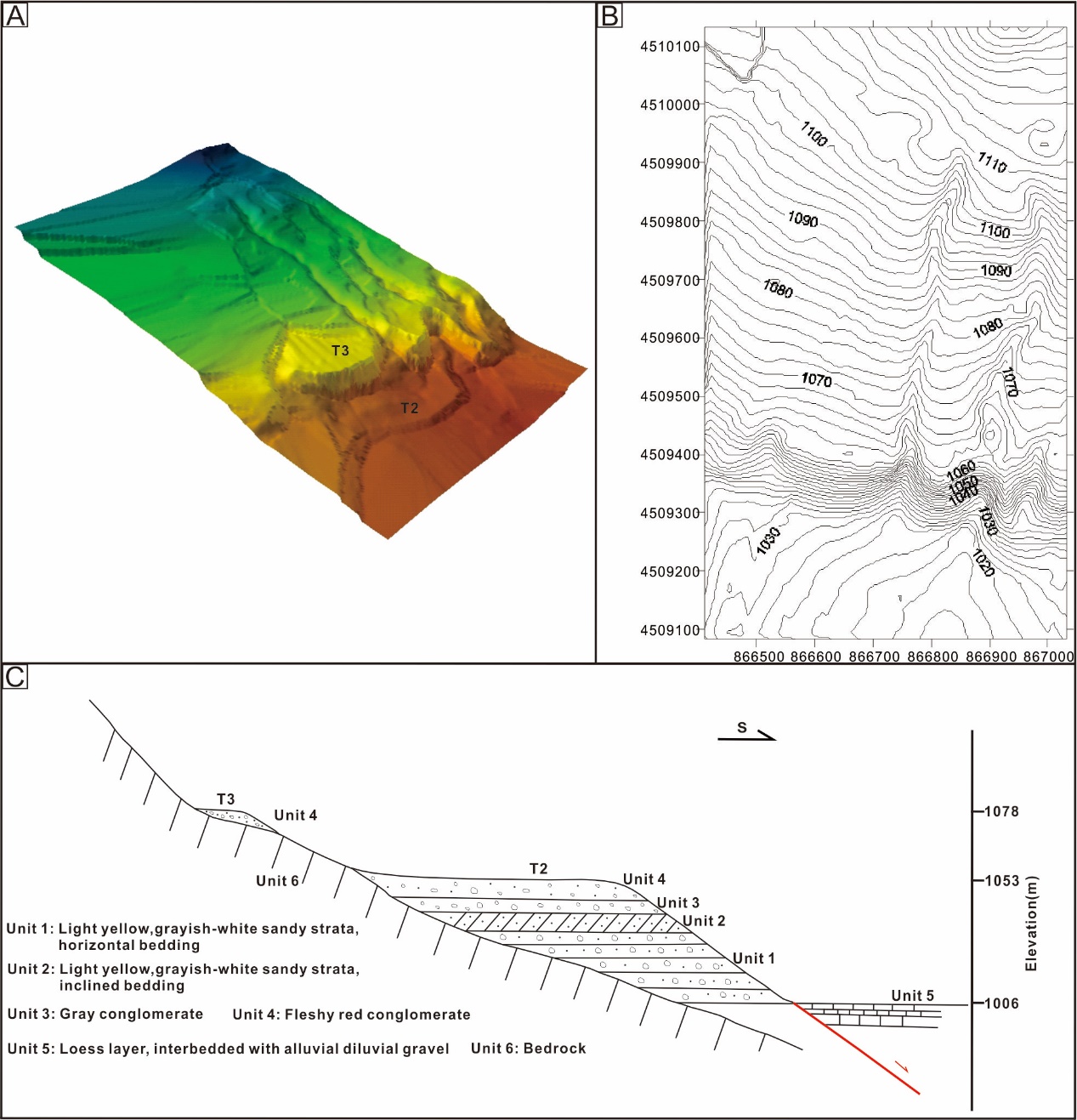
**Supplementary Fig. 1.** (A) Geological and geomorphological map of eastern Langshankou; (B) geomorphological photograph; (C) A-A’ section



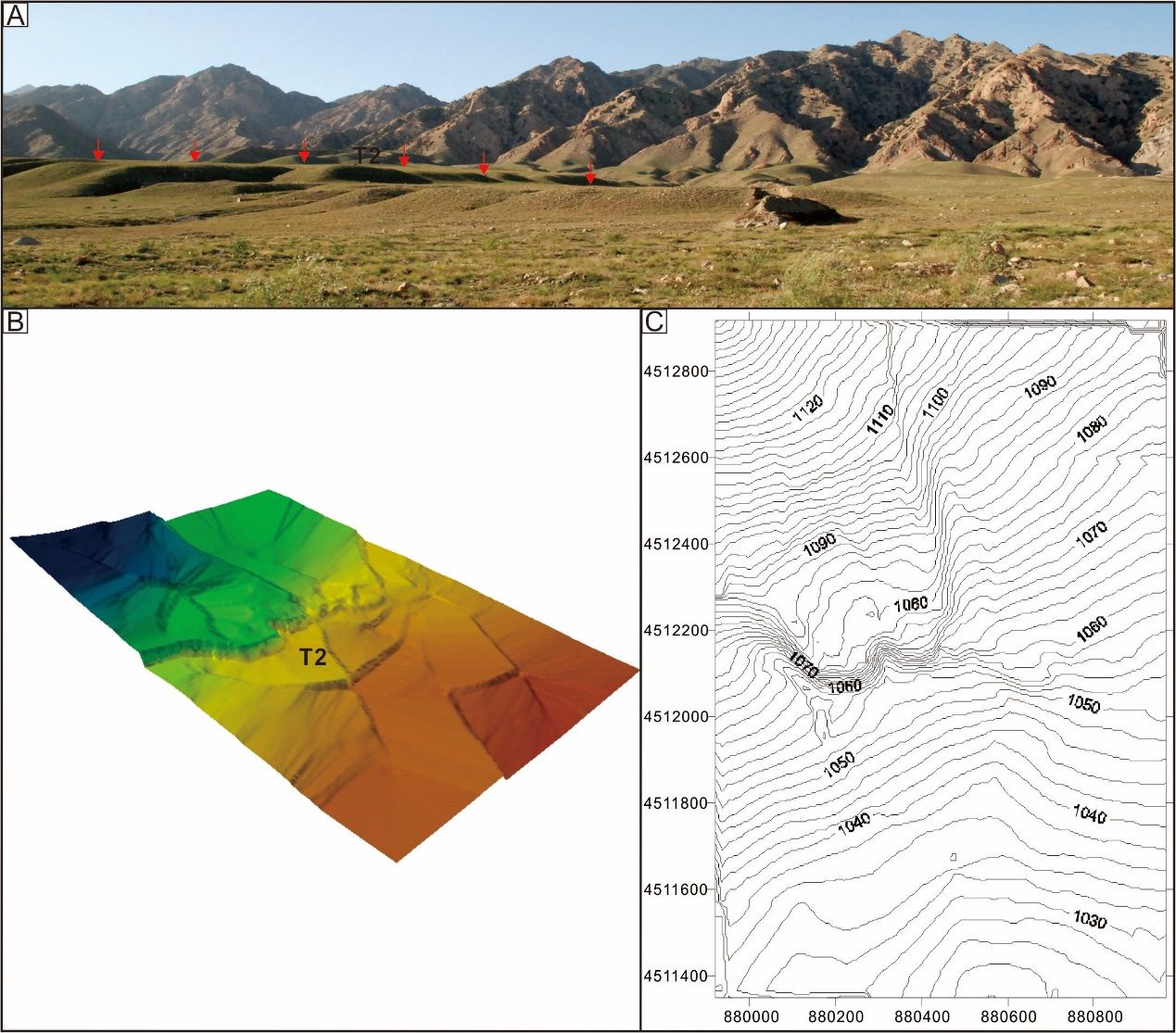
**Supplementary Fig. 2.** (A) Geomorphological photograph of eastern Yaoliangwan; (B) Geomorphological photograph of western Yaoliangwan; (C) Geological and geomorphological map of the Yaoliangwan; (D) A-A’ section; (E) B-B’ section.



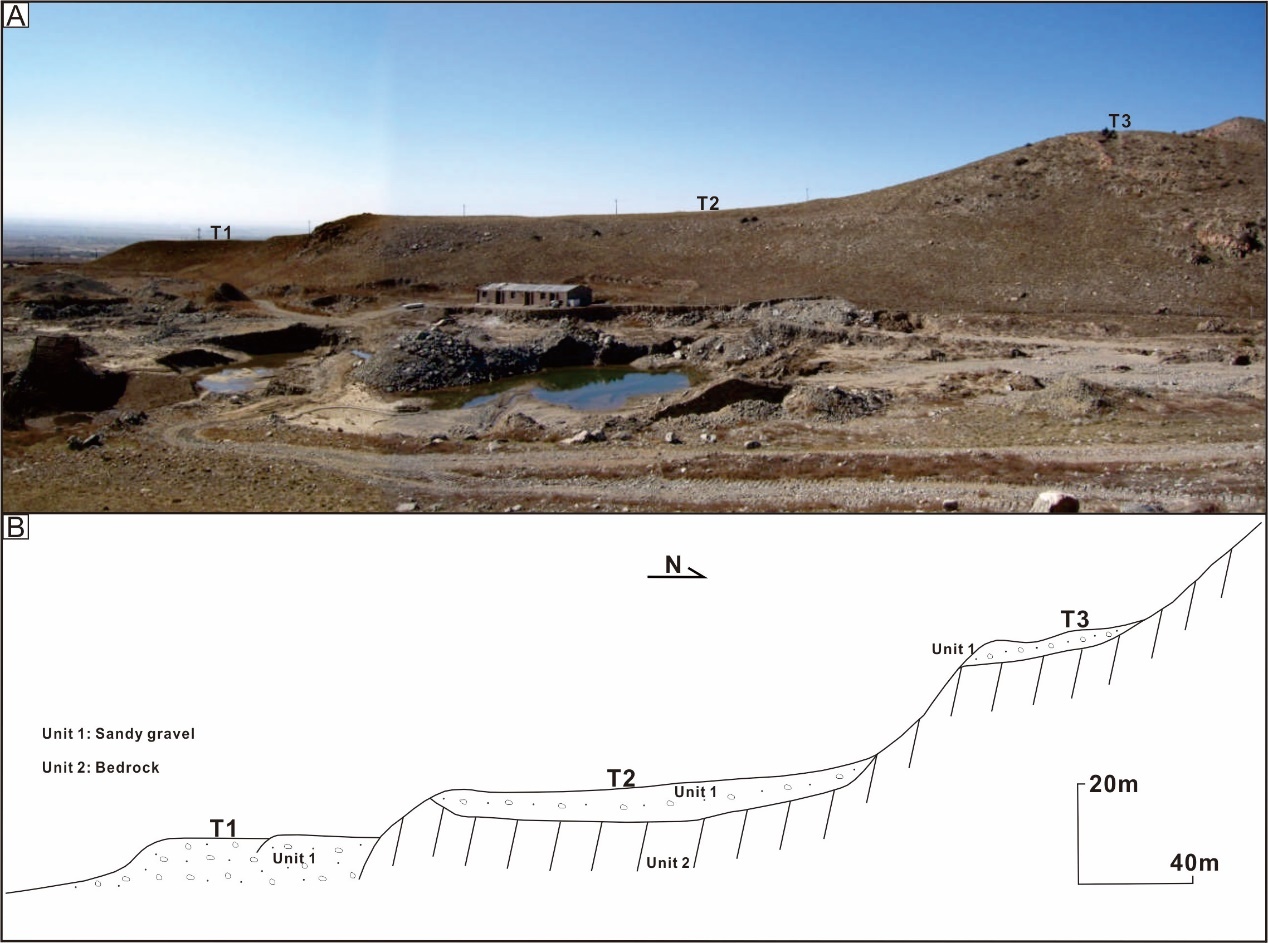
**Supplementary Fig. 3.** (A) T1 terrace landform; (B) T2 terrace landform; (C) Geological and geomorphological map of northeast Wulanganggangou; (D) A-A’ section



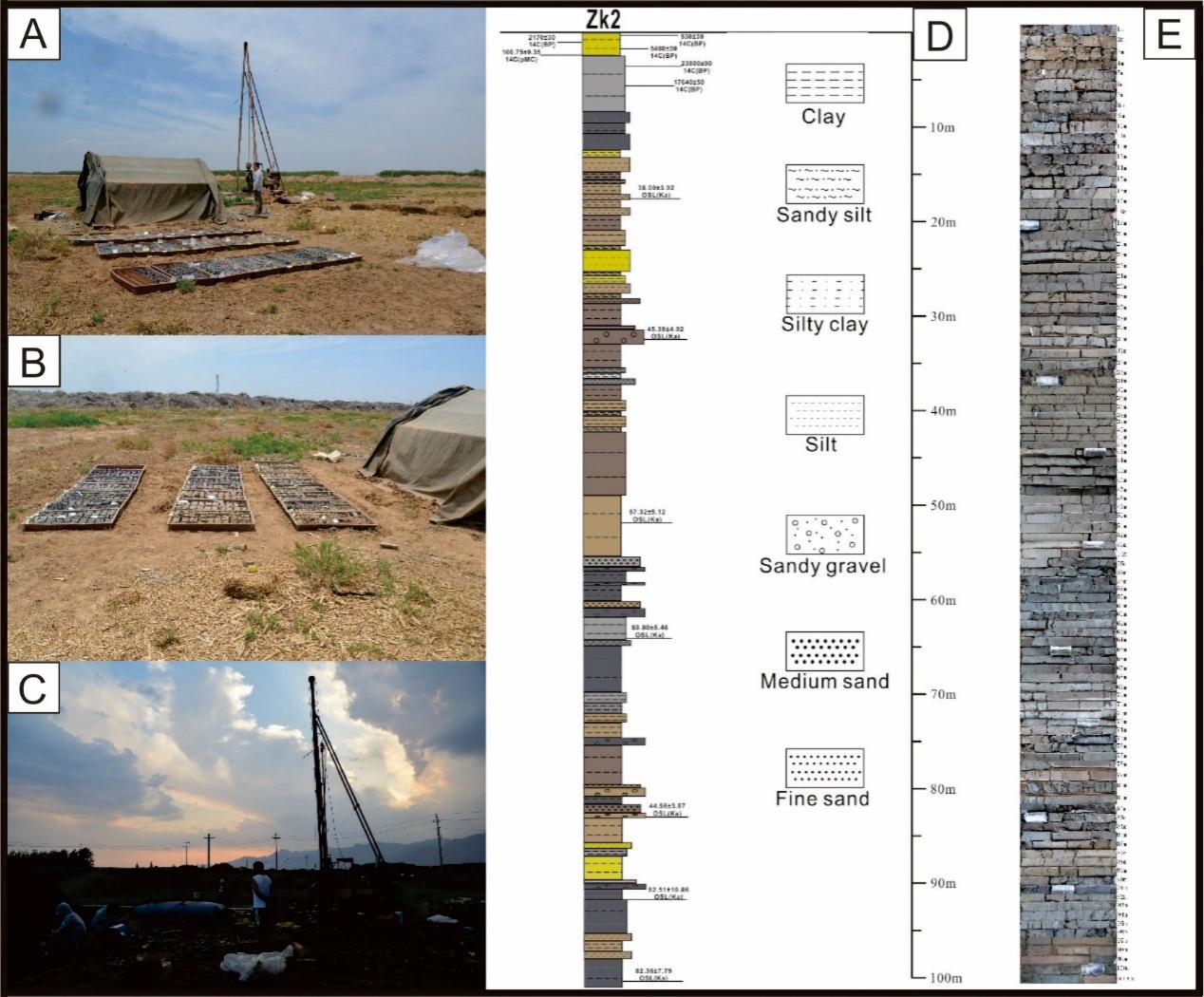
**Supplementary Fig. 4.** (A) DEM of the terrace; (B) Topographic map of the terrace; (C) Schematic diagram of the terrace near Heshunzhuang



**Supplementary Fig. 5.** (A) T2 terrace landform; (B) DEM of the terrace; (C) Schematic diagram of the terrace near Hayehutong



**Supplementary Fig. 6.** (A) Geomorphological photograph of Dabagou; (B) Schematic diagram of the terrace near Dabagou

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**Supplementary Fig. 7.** (A) (B) (C) Field photographs; (D) Zk2 bar chart of the borehole; (E) Photo of the Zk2 core from the borehole.