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| **Table 1.** *The Oil Shale Oxide Analyses from the Chang7 Member oil shale, the Ordos Basin, Central NorthChina（wt%）* |
| No | Samples | Sampling Sites | SiO2 | Al2 O3 | TiO2 | Fe2O3 | MgO | CaO | Na2 O | K2O | Fe O | P2O5 |  |
| 1 | Y06-T-2 | Bawangzhuang Village, Tongchuan City | 56.14 | 12.22 |  | 8.62 | 1.28 | 0.67 | 1.79 | 3.19 |  |  |  |
| 2 | Y06-Y1 | Fudi Village, Yijun County | 47.89 | 14.61 |  | 5.44 | 0.95 | 0.88 | 1.53 | 2.72 |  |  |  |
| 3 | Y06-Y2 | Yaochi Town, Tongchuan City | 52.02 | 13.42 |  | 7.03 | 1.12 | 0.78 | 1.96 | 2.96 |  |  |  |
| 4 | Y06-Y3 | HejiaFang Village, Tongchuang City | 56.26 | 12.29 |  | 8.99 | 1.36 | 0.97 | 1.19 | 2.79 |  |  |  |
| 5 | Y06-Y4 | Wulizhen Town, Yinjun County | 46.88 | 16.69 |  | 4.46 | 1.21 | 0.68 | 1.72 | 2.53 |  |  |  |
| 6 | Y09-001 | Qianlieqiao Village, Tongchuang City | 49.11 | 14.59 |  | 11.55 | 2.23 | 2.10 | 0.66 | 3.17 |  |  |  |
| 7 | Y09-003 | Jinsuoguan Town, Tongchuang City | 54.97 | 15.93 |  | 5.83 | 0.98 | 0.66 | 0.67 | 3.11 |  |  |  |
| 8 | Y09-004 | Kouquan Town, Yinjun County | 58.62 | 16.63 |  | 5.92 | 1.07 | 1.14 | 0.80 | 3.45 |  |  |  |
| 9 | Y09-005 | Qipan Town, Yinjun County | 40.64 | 8.14 |  | 11.93 | 0.26 | 2.32 | 0.45 | 2.22 |  |  |  |
| 10 | Y09-007-A | Bawangzhuang Village, Tongchuan City | 59.66 | 17.81 |  | 4.97 | 2.08 | 0.71 | 0.95 | 3.47 |  |  |  |
| 11 | Y09-007-C | Yaochi Town, Tongchuan City | 46.04 | 11.84 |  | 9.49 | 0.72 | 1.48 | 0.87 | 2.68 |  |  |  |
| 12 | Y09-008 | Jinsuoguan town, Tongchuang City | 53.39 | 12.43 |  | 5.76 | 0.68 | 0.86 | 0.70 | 2.96 |  |  |  |
| 13 | Y09-009 | Yaozhou District, Tongchuan City | 46.85 | 12.14 |  | 8.39 | 0.64 | 1.19 | 0.51 | 2.93 |  |  |  |
| 14 | Y09-011 | Yaozhou District, Tongchuan City | 31.67 | 7.19 |  | 16.21 | 0.38 | 0.69 | 0.37 | 1.24 |  |  |  |
| 15 | Y09-012 | Yaozhou District, Tongchuan City | 34.52 | 9.78 |  | 13.37 | 0.85 | 1.17 | 0.52 | 1.55 |  |  |  |
| 16 | Y09-013 | Yaozhou District, Tongchuan City | 46.04 | 13.92 |  | 9.41 | 0.82 | 0.96 | 0.72 | 2.50 |  |  |  |
| 17 | Y09-014 | Zhanghong Town, Xunyi County | 48.23 | 13.36 |  | 9.01 | 0.88 | 0.80 | 1.08 | 1.57 |  |  |  |
| 18 | Y09-015 | Zhanghong Town, Xunyi County | 43.83 | 12.78 |  | 7.19 | 0.59 | 1.44 | 0.76 | 2.43 |  |  |  |
| 19 | Y09-016 | Zhanghong Town Xunyi County | 49.37 | 13.38 |  | 6.09 | 0.71 | 1.24 | 0.63 | 2.72 |  |  |  |
| 20 | Y09-017 | Shuibeicun Village Binxian County | 54.59 | 14.93 |  | 6.07 | 0.86 | 0.86 | 0.63 | 2.84 |  |  |  |
| 21 | Y09-018 | Shuibeicun Village Binxian County | 56.58 | 17.29 |  | 5.46 | 0.69 | 0.46 | 0.53 | 3.78 |  |  |  |
| 22 | Y09-019 | Shuibeicun Village Binxian County | 45.31 | 10.66 |  | 7.00 | 0.59 | 0.75 | 0.90 | 2.07 |  |  |  |
| 23 | Y09-020 | Shuibeicun Village Binxian County | 44.29 | 13.10 |  | 11.06 | 0.90 | 1.16 | 0.55 | 2.64 |  |  |  |
| 24 | Y09-021 | Tangnihe town, Tongchuan City | 54.51 | 14.60 |  | 5.89 | 0.77 | 0.52 | 0.94 | 3.45 |  |  |  |
| 25 | Y09-025 | Yaoqu town, Tongchuan City | 51.03 | 19.39 |  | 3.46 | 1.22 | 0.76 | 0.60 | 2.54 |  |  |  |
| 26 | Y09-030 | Mazhuang Village, Yijun County | 61.11 | 19.11 |  | 3.40 | 1.32 | 0.81 | 1.56 | 2.38 |  |  |  |
| 27 | 2010-793 | Hejiafang Village, Tongchuan City | 58.84 | 20.98 | 0.49 | 8.80 | 0.68 | 2.14 | 1.36 | 3.25 |  |  |  |
| 28 | 2010-795 | Hejiafang Village, Tongchuan City | 48.56 | 24.98 | 0.53 | 13.77 | 0.60 | 0.99 | 1.19 | 3.19 |  |  |  |
| 29 | 2010-797 | Hejiafang Village, Tongchuan City | 47.89 | 23.81 | 0.57 | 13.06 | 0.94 | 2.63 | 1.24 | 3.05 |  |  |  |
| 30 | 2010-799 | Qianlieqiao Village, Tongchuan City | 55.84 | 20.02 | 0.48 | 15.11 | 1.02 | 1.64 | 1.14 | 3.00 |  |  |  |
| 31 | 2010-801 | Qianlieqiao Village, Tongchuan City | 48.21 | 17.70 | 0.36 | 23.11 | 0.68 | 1.40 | 1.08 | 2.66 |  |  |  |
| 32 | 2010-803 | Qianlieqiao Village, Tongchuan City | 59.04 | 18.03 | 0.38 | 14.44 | 0.77 | 1.89 | 1.36 | 2.17 |  |  |  |
| 33 | 2010-805 | Banjiegou Village, Tongchuan City | 60.05 | 20.97 | 0.50 | 10.55 | 0.85 | 1.73 | 1.28 | 3.26 |  |  |  |
| 34 | 2010-807 | Banjiegou Village, Tongchuan City | 54.78 | 20.52 | 0.45 | 14.75 | 1.02 | 2.55 | 1.58 | 2.73 |  |  |  |
| 35 | 2010-812 | Qipanzhen Town, Yinjun County | 60.99 | 22.44 | 0.63 | 9.42 | 0.51 | 0.82 | 1.26 | 3.32 |  |  |  |
| 36 | 2010-1109 | Qipanzhen Town, Yinjun County | 53.79 | 22.58 | 0.92 | 7.47 | 0.72 | 1.05 | 1.85 | 3.13 |  |  |  |
| 37 | 2010-1088 | Qipanzhen Town, Yinjun County | 59.54 | 18.73 | 0.70 | 8.00 | 0.90 | 2.25 | 0.74 | 3.36 |  |  |  |
| 38 | Li-57-1 | Well Li-57 2335.05m depth | 49.29 | 13.31 |  | 6.66 | 1.21 | 1.60 | 1.29 | 2.89 |  | 0.55 |  |
| 39 | Li-57-2 | Well Li-57 2341.3m depth | 51.12 | 10.33 |  | 6.99 | 0.70 | 1.12 | 0.58 | 3.33 |  | 0.57 |  |
| 40 | Li-68-1 | Well Li-68 2079.8 m depth | 47.36 | 9.58 |  | 7.54 | 1.32 | 1.77 | 1.36 | 4.58 |  | 0.43 |  |
| 41 | Li-68-2 | Well Li-68 2081.8 m depth | 51.10 | 11.23 |  | 3.28 | 4.58 | 1.56 | 1.42 | 3.52 |  | 0.60 |  |
| 42 | LQ-1 | Qianlieqiao Village, Tongchuan City | 25.17 | 6.17 | 0.30 | 9.11 | 0.48 | 0.81 | 0.44 | 1.24 | 5.40 | 0.24 |  |
| 43 | LQ-2 | Qianlieqiao Village, Tongchuan City | 38.29 | 7.42 | 0.40 | 6.92 | 0.55 | 0.63 | 0.71 | 1.53 | 2.10 | 0.30 |  |
| 44 | LQ-3 | Qianlieqiao Village, Tongchuan City | 44.51 | 11.35 | 0.53 | 6.52 | 0.43 | 0.50 | 0.96 | 2.40 | 2.40 | 0.23 |  |
| 45 | LQ-4 | Qianlieqiao Village, Tongchuan City | 33.41 | 6.72 | 0.37 | 7.10 | 0.49 | 1.01 | 0.66 | 1.49 | 3.70 | 0.27 |  |
| 46 | JSG-HJF-1 | HejiaFang Village, Tongchuan City | 37.10 | 7.01 | 0.41 | 8.04 | 0.55 | 0.25 | 0.47 | 1.88 | 5.60 | 0.17 |  |
| 47 | JSG-HJF-2 | HejiaFang Village, Tongchuan City | 56.18 | 13.59 | 0.51 | 4.76 | 1.03 | 1.12 | 0.82 | 3.69 | 4.15 | 0.18 |  |
| 48 | JSG-HJF-3 | HejiaFang Village, Tongchuan City | 46.86 | 11.97 | 0.57 | 5.01 | 0.86 | 0.73 | 0.68 | 2.63 | 3.80 | 0.18 |  |
| 49 | TC-TNH-1 | Tangnihe Town, Tongchuan City | 61.27 | 12.88 | 0.68 | 9.34 | 0.86 | 0.21 | 0.93 | 2.07 | 3.85 | 0.38 |  |
| 50 | TC-TNH-2 | Tangnihe Town, Tongchuan City | 44.58 | 9.28 | 0.41 | 6.62 | 0.56 | 1.13 | 0.65 | 2.16 | 3.30 | 0.10 |  |
| 51 | TC-TNH-3 | Tangnihe town, Tongchuan City | 39.93 | 10.52 | 0.34 | 9.76 | 0.94 | 1.38 | 0.57 | 1.91 | 4.65 | 0.83 |  |
| 52 | TC-TNH-4 | Tangnihe town, Tongchuan City | 58.95 | 18.26 | 0.71 | 6.41 | 2.03 | 0.76 | 0.69 | 3.23 | 5.05 | 0.20 |  |
| 53 | Liwenhou | Well Zhentan-1 |  |  |  | 6.09 | 2.53 | 0.10 | 1.47 | 4.32 |  |  |  |
| 54 | Liwenhou | WeLL Quan-208 |  |  |  | 9.17 | 3.38 | 0.52 | 2.65 | 2.28 |  |  |  |
| 55 | Average | the Chang7 Member oil shale | 48.69 | 14.40 | 0.51 | 8.54 | 0.97 | 1.14 | 0.96 | 2.72 | 4.00 | 0.30 |
| 56 | NASC |  | 58.10 | 15.40 | 0.65 | 4.02 | 3.44 | 3.11 | 1.30 | 3.24 | 3.24 | 0.17 |  |
| Note：1-5 data compiled from Bai *et al* (2009); 6-26 data compiled from Zhang *et al* (2013); 27-37 data compiled from Wang *et al* (2016); 38-41 data compiled from the internal data of Changqing oilfield company, PetroChina (2008); 42-52 data compiled from Sun *et al* (2015); 53-54 data compiled from Miao *et al* (2005); 56 NASC according toGromet *et al* (1984*).* The analytical method for major elements is using X-ray fluorescence (XRF) in different laboratory following Chinese standards GB/T14506.14-2010 and GB/T14506.28-2010, and the analytical uncertainty is usually <1%. |
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| **Table. 2** *The Oil Shale Trace Elements Analyses from the Chang7 Member oil shale, the Ordos Basin, Central NorthChina（ppm）* |
| No | Samples | Mn | Sr | Ba | V | Zr | Rb | Cu | Pb | Zn | Cr | Ni | Co | Mo | U | Th |
| 1 | Y06-T-2 | 50 | 147 | 1010 | 183 | 91 | 130 | 71.4 | 29.0 | 13.1 | 65.0 | 6.9 | 1.4 |  | 36.2 | 1.4 |
| 2 | Y06-Y2 | 73 | 146 | 800 | 228 | 105 | 110 | 55.7 | 32.0 | 29.0 | 70.0 | 17.3 | 0.4 |  | 33.4 | 1.2 |
| 3 | Y06-Y3 | 1132 | 157 | 655 | 213 | 163 | 141 | 28.8 | 39.7 | 99.8 | 128.1 | 56.3 | 42.3 |  | 40.2 | 1.5 |
| 4 | Y06-Y4 | 62 | 525 | 985 | 167 | 192 | 181 | 118.1 | 47.5 | 47.5 | 85.9 | 8.9 | 14.0 |  | 26.7 | 1.0 |
| 5 | Y09-001 | 81 | 378 |  | 145 | 144 | 181 | 91.7 | 44.1 | 40.6 | 76.7 |  | 13.5 |  |  |  |
| 6 | Y09-003 | 1190 | 610 |  | 327 | 172 | 110 | 136.6 | 37.2 | 15.2 | 48.4 | 9.5 | 32.7 |  |  |  |
| 7 | Y09-004 | 217 | 129 |  | 83 | 225 | 172 | 71.5 | 44.1 | 136.8 | 77.0 | 24.6 | 17.7 |  |  |  |
| 8 | Y09-005 | 1532 | 232 |  | 177 | 94 | 123 | 101.5 | 26.7 | 83.9 | 44.1 | 25.7 | 31.2 |  |  |  |
| 9 | Y09-007-A | 72 | 359 |  | 191 | 162 | 142 | 104.6 | 43.9 | 26.4 | 83.3 | 4.1 | 13.3 |  |  |  |
| 10 | Y09-007-C | 52 | 264 |  | 219 | 139 | 137 | 64.0 | 46.8 | 19.7 | 82.1 |  | 37.4 |  |  |  |
| 11 | Y09-008 | 156 | 76 |  | 258 | 41 | 50 | 105.4 | 27.5 | 42.5 | 41.5 | 22.5 | 50.5 |  |  |  |
| 12 | Y09-009 | 320 | 121 |  | 263 | 69 | 69 | 189.9 | 38.9 | 73.5 | 54.1 | 36.9 | 44.0 |  |  |  |
| 13 | Y09-011 | 212 | 178 |  | 210 | 109 | 118 | 139.6 | 33.9 | 91.7 | 60.1 | 21.3 | 27.1 |  |  |  |
| 14 | Y09-012 | 349 | 125 |  | 185 | 133 | 69 | 123.8 | 46.5 | 78.8 | 39.8 | 32.7 | 26.5 |  |  |  |
| 15 | Y09-013 | 116 | 244 |  | 196 | 126 | 129 | 69.4 | 39.4 | 33.7 | 72.2 |  | 17.7 |  |  |  |
| 16 | Y09-014 | 87 | 132 |  | 189 | 117 | 143 | 86.5 | 46.8 | 41.0 | 69.6 |  | 16.7 |  |  |  |
| 16 | Y09-015 | 128 | 184 |  | 153 | 135 | 144 | 72.4 | 41.4 | 26.1 | 77.8 |  | 14.8 |  |  |  |
| 18 | Y09-016 | 20 | 207 |  | 132 | 135 | 165 | 118.2 | 20.3 | 20.8 | 62.0 |  | 11.8 |  |  |  |
| 19 | Y09-017 | 186 | 170 |  | 160 | 129 | 95.4 | 145.0 | 37.6 | 28.5 | 58.7 | 5.1 | 18.5 |  |  |  |
| 20 | Y09-018 | 198 | 118 |  | 161 | 81 | 112 | 121.8 | 29.0 | 78.7 | 62.4 | 15.0 | 34.9 |  |  |  |
| 21 | Y09-019 | 43 | 205 |  | 154 | 154 | 167 | 97.5 | 58.0 | 24,8 | 75.3 |  | 13.3 |  |  |  |
| 11 | Y09-020 | 158 | 147 |  | 121 | 195 | 182 | 64.5 | 35.3 | 243.5 | 105.1 | 19.7 | 14.2 |  |  |  |
| 23 | Y09-021 | 78 | 145 |  | 82 | 186 | 107 | 113.8 | 41.8 | 89.3 | 46.9 | 35.9 | 8.5 |  |  |  |
| 24 | Li-57-1 | 1000 | 133 | 700 | 224 |  |  | 226.4 | 31.6 | 90.6 |  |  |  |  | 41.6 | 16 |
| 25 | LQ-1 |  | 103 | 393 | 222 |  | 73 |  |  | 94.5 | 38.8 | 23.9 | 9 | 98.9 |  |  |
| 26 | LQ-2 |  | 168 | 395 | 216 |  | 73 |  |  | 77.7 | 39.9 | 11.9 | 4.7 | 112.0 |  |  |
| 27 | LQ-3 |  | 194 | 785 | 175 |  | 110 |  |  | 61.7 | 45.4 | 8.0 | 2.5 | 71.5 |  |  |
| 28 | LQ-4 |  | 117 | 238 | 189 |  | 68 |  |  | 60.8 | 32.4 | 16.9 | 6.8 | 90.6 |  |  |
| 29 | JSG-HJF-1 |  | 219 | 577 | 172 |  | 92 |  |  | 88.7 | 62.0 | 9.4 | 2.0 | 61.0 |  |  |
| 30 | JSG-HJF-2 |  | 120 | 662 | 132 |  | 158 |  |  | 105.0 | 70.0 | 15.6 | 5.0 | 32.3 |  |  |
| 31 | JSG-HJF-3 |  | 290 | 662 | 260 |  | 133 |  |  | 36.2 | 81.7 | 11.0 | 1.8 | 30.3 |  |  |
| 32 | TC-TNH-1 |  | 124 | 702 | 173 |  | 84 |  |  | 133.0 | 49.8 | 21.9 | 9.5 | 74.2 |  |  |
| 33 | TC-TNH-2 |  | 112 | 413 | 184 |  | 124 |  |  | 92.9 | 48.3 | 13.9 | 4.5 | 78.4 |  |  |
| 34 | TC-TNH-3 |  | 154 | 408 | 211 |  | 113 |  |  | 141.0 | 53.1 | 36.3 | 21.7 | 96.1 |  |  |
| 35 | TC-TNH-4 |  | 117 | 542 | 119 |  | 174 |  |  | 130.0 | 93.2 | 36.0 | 15.5 | 1.25 |  |  |
| 36 | Well-Zhentan1 |  | 154 | 423 | 125 |  |  |  |  |  | 90.2 | 50.7 | 16.3 |  |  |  |
| 37 | Well Quan-208 |  | 227 | 827 | 125 |  |  |  |  |  | 100.2 | 40.5 | 35.1 |  |  |  |
| 38 | 1005/wx2 |  | 144 | 475 | 60 | 159 | 99 | 27.8 | 22.4 | 100.0 | 31.5 | 11.3 | 4.18 | 27.1 | 9.88 | 11.1 |
| 39 | 2301/wx2 |  | 203 | 547 | 132 | 135 | 143 | 55.5 | 15.3 | 93.6 | 77.4 | 35.1 | 16.6 | 8.3 | 8.44 | 8.0 |
| 40 | 002/wx1 |  | 364 | 509 | 177 | 90 | 112 | 89.9 | 20.0 | 73.9 | 82.8 | 26.2 | 19.4 | 25.7 | 30.4 | 10.6 |
| 41 | 719/wx2 |  | 200 | 523 | 119 | 117 | 92 | 59.5 | 19.4 | 80.9 | 44.4 | 24.4 | 12.3 | 37.9 | 27.2 | 6.1 |
| 42 | 903/wx2 |  | 113 | 429 | 241 | 82 | 96 | 129.0 | 21.6 | 85.5 | 46.8 | 30.4 | 17.0 | 120.0 | 69.4 | 6.2 |
| 43 | 1704/wx2 |  | 234 | 573 | 106 | 176 | 102 | 60.9 | 18.7 | 73.9 | 65.4 | 20.2 | 12.4 | 39.7 | 27.6 | 9.9 |
| 44 | Averge | 313 | 197 | 593 | 176 | 132 | 121 | 98.0 | 34.5 | 74.5 | 65.2 | 22.5 | 17.1 | 59.1 | 31.9 | 6.6 |
| 45 | NASC | 922 | 142 | 636 | 130 | 200 | 125 | 32.4 | 20.0 | 70 | 125 | 58 | 26 | 3.1 | 3.0 | 12.3 |
| 46 | Enrichment coefficients | 0.33 | 1.39 | 0.93 | 1.35 | 0.66 | 0.96 | 3.02 | 1.7 | 1.06 | 0.52 | 0.39 | 0.66 | 19.1 | 10.63 | 0.54 |
| Note：1-4 data compiled from Bai *et al* (2009); 5-23 data compiled from Zhang *et al* (2013); 24 data compiled from Zhang *et al* (2008); 25-35 data compiled from Sun *et al* (2015); 36-37data compiled from Miao *et al* (2005); 38-43 data compiled from Ma *et al* (2016); 45 NASC according to Grome *et al* (1984). The analytical method for microelement is using X-ray fluorescence (XRF) and Inductively-coupled plasma mass spectrometer (ICP-MS) following Chinese standards GB/T14506.30-2010, and the analytical uncertainty is usually less than 5%. |

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| **Table. 3** *The Oil Shale Rare-Earth Elements Analyses from the Chang7 Member oil shale（ppm）* |
| No. | Samples | La | Ce | Pr | Nd | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | Y | ∑REE |
| 1 | 1005/Wx2 | 32.9 | 62.9 | 7.2 | 25.3 | 4.8 | 0.7 | 4.4 | 0.7 | 4.4 | 0.9 | 2.8 | 0.5 | 3.3 | 0.5 | 25.7 | 177.0 |
| 2 | 2301/Wx2 | 31.8 | 64.4 | 7.1 | 26.0 | 4.9 | 0.9 | 4.1 | 0.7 | 4.1 | 0.9 | 2.6 | 0.4 | 2.7 | 0.4 | 22.1 | 173.1 |
| 3 | 719/Wx2 | 30.4 | 56.7 | 6.2 | 21.5 | 3.9 | 0.9 | 3.6 | 0.6 | 3.4 | 0.8 | 2.2 | 0.3 | 2.4 | 0.4 | 20.8 | 154.1 |
| 4 | 903/Wx2 | 23.7 | 40.9 | 4.7 | 18.0 | 3.5 | 0.9 | 3.4 | 0.6 | 3.5 | 0.7 | 2.1 | 0.4 | 2.1 | 0.3 | 22.1 | 126.9 |
| 5 | 1704/Wx2 | 43.1 | 74.9 | 9.1 | 33.6 | 5.9 | 1.3 | 5.0 | 0.7 | 4.0 | 0.8 | 2.3 | 0.4 | 2.3 | 0.3 | 22.0 | 205.7 |
| 6 | 002/Wx1 | 29.9 | 55.9 | 7.0 | 27.3 | 5.3 | 1.3 | 5.1 | 0.9 | 5.2 | 1.1 | 3.4 | 0.6 | 3.8 | 0.5 | 35.3 | 182.6 |
| 7 | Tongchuan-Ⅱ-2 | 26.3 | 45.1 | 5.14 | 17.3 | 2.7 | 0.5 | 1.9 | 0.3 | 1.6 | 0.3 | 1.1 | 0.2 | 1.3 | 0.2 | 16.8 | 120.7 |
| 8 | Yingjun-Ⅳ-2 | 29.6 | 50.5 | 5.9 | 21.3 | 3.8 | 0.8 | 3.3 | 0.5 | 2.9 | 0.6 | 2.0 | 0.3 | 2.1 | 0.4 | 19.8 | 143.8 |
| 9 | averge | 31.0 | 56 | 6.5 | 24 | 4.4 | 0.9 | 3.9 | 0.6 | 3.6 | 0.8 | 2.3 | 0.4 | 2.5 | 0.4 | 23 | 160.5 |
| 10 | chondrite | 0.3 | 1.0 | 0.1 | 0.7 | 0.2 | 0.1 | 0.3 | 0.1 | 0.9 | 0.1 | 0.3 | 0.1 | 0.2 | 0.1 | 1.9 | 6.4 |
| 11 | NASC | 32 | 73 | 7.9 | 33 | 5.7 | 1.2 | 5.2 | 0.85 | 5.8 | 1.0 | 3.4 | 0.5 | 3.1 | 0.48 | 24 | 197 |
| Note：1-6 data compiled from Ma *et al* (2016); 7-8 data compiled from Bai *et a*l (2009); 10 chondrite according to Taylor & Melennan (1985), 11 NASC according to Grome *et al* (1984). The analytical method for rare earth element is using X-ray fluorescence (XRF) and Inductively-coupled plasma mass spectrometer (ICP-MS) in different laboratory following Chinese standards GB/T14506.30-2010 |

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| **Table. 4** *General Oil shale Quality of the Chang7 Member oil shale , the Ordos Basin, Central North China* |
| NO. | Samples | Sampling Sites(Coordinates) | Sample Description | Oil yield wt% | Qnet,v,ar MJ/Kg |  Ad wt% | St,d wt% | Mt wt% | Vdaf wt% |  Cad wt% | Had wt% | ARD g/cm3 |
| 1 | V-1 | Qianlieqiaocaozigou Village, Tongchuan City N36°30′49.5″ E110°11′21″ H778m | Black flaky oil shale（With plant debris） | 13.7 | 13.02 | 55.58 | 3.58 | 1.86 | 62.25 | 29.83 | 3.19 | 1.74 |
| 2 | t68 | Jiaquhe Village, Yaoqu Twon, Yaozhou District, Tongchuan City N35°13′51.4″ E108°55′16.9″ H=1218m | Black slip oil shale | 11.0 | 16.10 | 45.54 | 5.07 | 2.06 | 54.68 | 37.56 | 3.56 | 1.39 |
| 3 | VII-2 | Jiaoping Twon, Tongchuan CityN35°14′1.6″ E109°02′11.3″ H1238m | Gray-black flaky oil shale  | 10.6 | 6.23 | 68.73 | 0.37 | 8.31 | 60.42 | 17.86 | 1.78 | 1.82 |
| 4 | VI-1 | Hejiafang Village, Tongchuan City N35°24′21.6″ E109°14′36.8″ H1979m | Black flaky oil shale(gray and red after weathering) | 10.2 | 10.29 | 58.04 | 1,18 | 4.82 | 59.88 | 26.25 | 2.28 | 1.41 |
| 5 | IV-1 | Tiangnihe Village, Yijun County N35°16′59.2″E109°15′22.8″ H1334m | Black flaky oil shale | 9.6 | 9.48 | 64.05 | 4.19 | 2.62 | 60.44 | 22.09 | 2.41 | 1.85 |
| 6 | t74 | Wushimut Village , Qipan Twon, Wushimuta Village, Yijun County N35°15′48.8″ E109°08′37.9″ H1435m | Black flaky oil shale | 8.9 | 11.45 | 67.44 | 0.88 | 4.10 | 65.75 | 19.65 | 2.11 | 1.72 |
| 7 | t61 | Liushutai Village, Tongchuan City N35°14′52″ E108°58′22.2″ H1289m | Black flaky oil shale(gray after weathering)  | 8.6 | 10.80 | 55.29 | 0.84 | 6.78 | 62.64 | 28.30 | 2.54 | 1.48 |
| 8 | t21 | Fengjaqu Village, Tongchuan City N35°11′59.4″ E108°58′28″ H1172m | Black flaky oil shale | 7.0 | 9.56 | 63.63 | 0.82 | 3.79 | 63.10 | 24,02 | 2.30 | 1.73 |
| 9 | t94 | Maquan Village, Yijun County N35°16′59.2″ E109°15′22.8″ H=1334m | Black flaky oil shale | 6.4 | 7.71 | 67.44 | 0.88 | 4.1 | 65.75 | 19.65 | 2.11 | 1.72 |
| 10 | t69 | Niejahe Village, Yaoqu Twon, Tongchuan City N35°09′57.6″ E108°51′29.7″ H1060m | Black flaky oil shale(white after weathering)  | 5.2 | 8.55 | 58.21 | 4.17 | 3.4 | 67.51 | 22.02 | 2.52 | 1.42 |
| 11 | t86 | Fudishuikou Village, Wuli Twon, Yijun County N35°24′21.6″ E109°14′36.8″H=1979m | Grey black flaky oil shale | 5.2 | 3.96 | 80.76 | 0.53 | 2.23 | 70.54 | 9.70 | 1.43 | 2.06 |
| 12 | II-1 | Bawangzhuang Village, Tongchuan City N35°15′48.8″E109°08′37.9″ H1435m | Black flaky oil shale（grey -yellow after weathering） | 3.6 | 4.41 | 72.99 | 1.16 | 5.4 | 50.99 | 13.8 | 0,76 | 1.68 |
| 13 | t28 | Banjiegou Village, Jinsuoguan Twon, Tongchuan City N35°14′26″ E109°01′56.7″H=1185m  | Black flaky oil shale （white after weathering） | 2.5 | 1.66 | 85.18 | 0.70 | 3.98 | 81.43 | 5.38 | 0.94 | 1.79 |

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|  |  |  | **Table . 4** (Cont.) |  |  |  |  |  |  |  |  |  |
| NO. | Samples | Sampling Sites | Sample Description | Oil yield wt% | Qnet,v,ar MJ/Kg | Ad wt% | St,d wt% | Mt wt% | Vdaf wt% | Cad wt% |  Had wt% | AR D |
| 14 | TC-1-1 | Banjiegou Village, Jinsuoguan Twon, Tongchuan City N35°14′1.6″ E109°02′11.3″ H1238m | Minium oil shale after weathering | 1.8 | 1.62 | 83.96 | 1.18 | 3.60 | 80.36 | 5.21 | 0.57 | 1.60 |
| 15 | Quan3 | TC-3 Trench , Qianlieqiao Village, Tongchuan City | Grey black flaky oil shale | 6.25 | 7.75 | 61.56 | 5.80 | 9.70 | 59.65 |  |  |  |
| 16 | Quan 4 | TC-6 Trench , Qianlieqiao Village, Tongchuan City | Grey black flaky oil shale | 7.24 | 8.38 | 60.08 | 4.68 | 8.28 | 58.38 |  |  |  |
| 17 | Quan 21 | Well CK2, Liushutai Village, Tongchuan City | Black oil shale | 6.27 | 7.99 | 71.11 | 6.47 | 3.00 | 61.26 |  |  |  |
| 18 | Quan 22 | Well CK3, Hejiafang Village, Tongchuan City | Black oil shale | 6.12 | 7.28 | 74.68 | 5.95 | 2.97 | 67.52 |  |  |  |
| 19 | Quan 23 | Well CK5, Hejiafang Village, Tongchuan City | Black oil shale | 7.70 | 8.33 | 65.21 | 5.66 | 2.95 | 60.05 |  |  |  |
| 20 | Bai 240 | Well Bai-240, depth 2262.20m | Black oil shale | 4.75 | 11.00 | 76.60 | 6.60 | 4.21 | 75.00 |  |  |  |
| 21 | Li38 | Well Li-38, depth 2329.50 m | Black oil shale | 4.53 | 9.40 | 67.31 | 7.80 | 3.21 | 76.09 |  |  |  |
| 22 | Li51 | Well Li-51, depth 2266.55 m | Black oil shale | 2.67 | 6.60 | 63.61 | 10.9 | 4.89 | 65.89 |  |  |  |
| 23 | Li68 | Well Bai-240, depth 2079.80 m | Black oil shale | 4.02 | 15.21 | 67.71 | 5.54 | 6.96 | 69.20 |  |  |  |
| 24 | Wu25 | Well Wu-25, depth 2031.50 m | Black oil shale | 2.04 | 5.30 | 77.21 | 6.69 | 2.38 | 55.06 |  |  |  |
| 25 | Yuan132 | Well Yuan-132, depth 2472.00 m | Black oil shale | 1.68 | 3.80 | 61.36 | 7.61 | 5.66 | 63.05 |  |  |  |
| 26 | Zhentan1 | Well Zhen-37, depth 2237.30 m | Black oil shale | 6.75 | 10.55 | 60.39 | 6.63 | 3.28 | 71.00 |  |  |  |
| 27 | Zhuang 50 | Well Zhuang-50, depth 1943.20 m | Black oil shale | 3.13 | 11.27 | 67.91 | 4.66 | 4.46 | 65.76 |  |  |  |
| 28 | Jida-1 | Zhanghong Village, Bingxian County | Grey black oil shale | 6.92 |  | 78.00 | 2.43 | 1.10 | 70.33 | 13.46 |  |  |
| 29 | Jida-2 | Zhanghong Village, Bingxian County | Grey black oil shale | 5.85 |  | 79.63 | 2.55 | 0.80 | 69.91 |  |  |  |
| 30 | Jida-3 | Zhanghong Village, Bingxian County | Grey black oil shale | 5.6 |  | 77.16 | 1.73 | 1.34 | 76.62 |  |  |  |
| 31 | Average Value  | Average value of No.1-30 specimens  | Oil shale | 6.19 | 8.29 | 68.04 | 4.00 | 4.07 | 65.68 | 19.08 | 2.13 | 1.67 |
| 32 | ZWZ | Average value of 44 samples from the Chang7 Member oil shale of the southern Ordos areas | Oil shale | 13.00 |  |  | 7.37 |  |  |  |  |  |
| 33 | LYH-1 | Average value of 120 samples from the Chang7 Member oil shale of the Hejaifang village areas (at surface)  | Oil shale | 5.7 | 7.6 | 70.20 | 2.50 | 3.00 | 78.30 |  |  | 1.99 |
| 34 | LYH-2 | Average value of 60 samples from the Chang7 Member oil shale of the Hejaifang village areas (at well) | Oil shale | 5.9 | 7.7 | 70.20 | 6.70 | 2.10 | 69.30 |  |  | 1.68 |
| 35 | ZQC | Average value of 68 samples from the Chang7 Member oil shale of the Ordos areas(at surface) | Oil shale | 7.0 | 9.10 | 69.50 | 2.82 | 3.50 | 65.00 |  |  |  |
| 36 | Average Value | Average value of all specimens | Oil shale | 8 | 8.35 | 69.24 | 4.69 | 3.37 | 68.16 | 19.08 | 2.13 | 1.77 |
| Note: Qnet, v, ar =Net calorific value at constant volume; Ad =ash content (dry basis); St,d =sulfur content(dry basis); Mt=Total moisture; Vdaf =volatile (dry ash-free basis); Cad =carbon (air dry basis); Had=hygrogen (air dry basis); ARD=apparent density. 1-14 data compiled from Bai et al (2009); 15-27 data compiled from the internal data of Changqing oilfield company, PetroChina (2008); 28-30 data compiled from Ren (2007); 32 data compiled from Zhang *et al* (2006); 33-34 data compiled from Lu *et al* (2006); 35 data compiled from Zhang *et al* (2013). The analytical method for Oil yield is using Gray-King low-temperature distillation in different laboratory following Chinese standards GB-T1341-2007. The analytical method for ash yield is using fast ashing method in different laboratory following Chinese standards GB/T212-2008. The analytical method for calorific value is using the environmental isothermal automatic oxygen bomb calorimeter in different laboratory following Chinese standards GB/T213-2008. Other analysis methods are omitted. |

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| **Table.5** *The abundances of oil shale organic matter in the Ordos Basin* |
| NO | Samples | TOC(wt %) | Tmax( ℃) | S1（mg/g） | S2（mg/g） | S3（mg/g） | S1+S2（mg/g） | *I*H （mg/gTOC） | *I*O （mg/gTOC） | Remarks |
| 1 | TCIV-1 | 17.06 |  |  |  |  |  |  |  | Tongchuan city (at trench) |
| 2 | TCII-1 | 10.93 |  |  |  |  |  |  |  | Tongchuan city (at trench) |
| 3 | ZWZ-1 | 13.15  |  | 0.35  | 50.70  | 7.39  | 51.05  | 385.55  | 56.20  | Hejaifang village areas (at surface) |
| 4 | ZWZ-2 | 15.18  |  | 0.36  | 47.40  | 8.29  | 47.76  | 312.25  | 54.61  | Hejaifang village areas (at surface) |
| 5 | ZWZ-3 | 20.07  |  | 0.40  | 56.90  | 12.43  | 57.30  | 283.51  | 61.93  | Hejaifang village areas (at surface) |
| 6 | ZWZ-4 | 4.07  |  | 0.03  | 2.80  | 3.36  | 2.83  | 68.80  | 82.56  | Hejaifang village areas (at surface) |
| 7 | ZWZ-5 | 17.15  |  | 0.47  | 39.56  | 11.83  | 40.03  | 230.67  | 68.98  | Hejaifang village areas (at surface) |
| 8 | ZWZ-6 | 28.19  |  | 2.41  | 83.81  | 14.06  | 86.22  | 297.30  | 49.88  | Hejaifang village areas (at surface) |
| 9 | ZWZ-7 | 7.12  |  | 0.47  | 19.30  | 3.49  | 19.77  | 271.07  | 49.02  | Hejaifang village areas (at surface) |
| 10 | ZWZ-8 | 42.34  |  | 7.21  | 124.49  | 21.35  | 131.70  | 294.02  | 50.43  | Hejaifang village areas (at surface) |
| 11 | ZWZ-9 | 20.07  |  | 1.57  | 64.51  | 9.59  | 66.08  | 321.43  | 47.78  | Hejaifang village areas (at surface) |
| 12 | ZWZ-10 | 12.18  |  | 0.85  | 23.49  | 6.55  | 24.34  | 192.86  | 53.78  | Hejaifang village areas (at surface) |
| 13 | ZWZ-11 | 14.40  |  | 0.38  | 14.84  | 12.84  | 15.22  | 103.06  | 89.17  | Hejaifang village areas (at surface) |
| 14 | ZWZ-12 | 27.57  |  | 1.41  | 63.42  | 18.77  | 64.83  | 230.03  | 68.08  | Hejaifang village areas (at surface) |
| 15 | ZWZ-13 | 36.26  |  | 2.68  | 99.72  | 21.49  | 102.40  | 275.01  | 59.27  | Hejaifang village areas (at surface) |
| 16 | ZWZ-14 | 30.81  |  | 1.58  | 73.21  | 20.03  | 74.79  | 237.62  | 65.01  | Hejaifang village areas (at surface) |
| 17 | ZWZ-15 | 14.39  |  | 3.02  | 51.14  | 6.29  | 54.16  | 355.39  | 43.71  | Hejaifang village areas (at surface) |
| 18 | ZWZ-16 | 25.78  |  | 0.78  | 55.24  | 21.37  | 56.02  | 214.27  | 82.89  | Hejaifang village areas (at surface) |
| 19 | ZWZ-17 | 10.97  |  | 0.17  | 13.09  | 11.18  | 13.26  | 119.33  | 101.91  | Hejaifang village areas (at surface) |
| 20 | ZWZ-18 | 30.67  |  | 3.59  | 88.12  | 17.13  | 91.71  | 287.32  | 55.85  | Hejaifang village areas (at surface) |
| 21 | Bai well 240  | 23.26 |  |  |  |  | 76.38 |  |  | Well depth 2262.2m |
| 22 | Li well 38 | 19.16 |  |  |  |  | 72.53 |  |  | Well depth 2329.5 m |
| 23 | Li well 51 | 13.54 |  |  |  |  | 41.16 |  |  | Well depth 2266.55 m |
| 24 | Li well 51 | 15.20 |  |  |  |  | 49.78 |  |  | Well depth 2267.5 m |
| 25 | Li well 57 | 7.48 |  |  |  |  | 23.15 |  |  | Well depth 2324.15 m |
| 26 | Li well 57 | 9.82 |  |  |  |  | 28.86 |  |  | Well depth 2335.05 m |
| 27 | Li well 57 | 17.61 |  |  |  |  | 56.18 |  |  | Depth 3341.3 m |
| 28 | Li well 68 | 31.39 |  |  |  |  | 69.64 |  |  | Well depth 2079.8 m |
| 29 | Li well 68 | 29.99 |  |  |  |  | 82.36 |  |  | Well depth 2081.8 m |
| 30 | Wu well 25 | 11.57 |  |  |  |  | 24.64 |  |  | Depth 2031.5 m |
| 31 | Yuan well 132 | 6.83 |  |  |  |  | 20.72 |  |  | Well depth 2472 m |
| 32 | Zhen well 37 | 22.40 |  |  |  |  | 99.57 |  |  | Well depth 2237.3 m |
| 33 | Zhuang well 50 | 22.93 |  |  |  |  | 57.36 |  |  | Well depth 1943.2 m |
| 34 | Y09-001 | 18.05 | 438 | 1.16 | 6.12 | 2.66 | 7.28 |  |  | Southern Ordos Basin (at surface) |
| 35 | Y09-003 | 22.53 | 437 | 1.58 | 44.00 | 4.56 | 45.58 |  |  | Southern Ordos Basin (at surface) |
| 36 | Y09-004 | 8.50 | 437 | 0.76 | 24.84 | 4.60 | 25.60 |  |  | Southern Ordos Basin (at surface) |
| 37 | Y09-005 | 19.32 | 432 | 1.82 | 72.64 | 17.44 | 74.46 |  |  | Southern Ordos Basin (at surface) |
| 38 | Y09-007A | 6.35 | 440 | 1.20 | 14.32 | 1.74 | 15.52 |  |  | Southern Ordos Basin (at surface) |
| 39 | Y09-007C | 12.16 | 440 | 14.58 | 97.68 | 1.74 | 112.26 |  |  | Southern Ordos Basin (at surface) |
| 40 | Y09-008 | 1.57 | 433 | 5.32 | 80.80 | 9.36 | 86.12 |  |  | Southern Ordos Basin (at surface) |
| 41 | Y09-009 | 3.98 | 431 | 11.74 | 96.72 | 5.28 | 108.46 |  |  | Southern Ordos Basin (at surface) |
| 42 | Y09-011 | 32.46 | 439 | 12.54 | 106.64 | 1.26 | 119.18 |  |  | Southern Ordos Basin (at surface) |
| 43 | Y09-012 | 36.75 | 439 | 6.58 | 134.16 | 1.94 | 140.74 |  |  | Southern Ordos Basin (at surface) |
| 44 | Y09-013 | 22.39 | 440 | 3.84 | 96.56 | 1.36 | 100.4 |  |  | Southern Ordos Basin (at surface) |
| 45 | Y09-014 | 24.71 | 439 | 4.54 | 92.24 | 1.08 | 96.78 |  |  | Southern Ordos Basin (at surface) |
| 46 | Y09-015 | 26.31 | 436 | 4.06 | 94.96 | 2.84 | 99.02 |  |  | Southern Ordos Basin (at surface) |
| 47 | Y09-016 | 23.77 | 435 | 4.08 | 83.68 | 1.02 | 87.76 |  |  | Southern Ordos Basin (at surface) |
| 48 | Y09-017 | 17.37 | 435 | 1.90 | 62.04 | 0.82 | 63.94 |  |  | Southern Ordos Basin (at surface) |
| 49 | Y09-018 | 8.19 | 430 | 0.84 | 15.96 | 2.76 | 16.80 |  |  | Southern Ordos Basin (at surface) |
| 50 | Y09-019 | 18.53 | 430 | 3.42 | 45.80 | 7.44 | 49.22 |  |  | Southern Ordos Basin (at surface) |
| 51 | Y09-020 | 21.62 | 438 | 6.24 | 80.48 | 0.96 | 86.72 |  |  | Southern Ordos Basin (at surface) |
| 52 | Y09-021 | 17.25 | 430 | 2.94 | 65.48 | 5.04 | 68.42 |  |  | Southern Ordos Basin (at surface) |
| 53 | Y09-025 | 20.87 | 425 | 0.48 | 44.16 | 0.86 | 44.64 |  |  | Southern Ordos Basin (at surface) |
| 54 | Y09-030 | 5.89 | 436 | 0.85 | 29.06 | 1.34 | 29.91 |  |  | Southern Ordos Basin (at surface) |
| 55 | MZH-1 | 10.57 | 440 |  |  |  | 63.72 | 579 |  | Southern Ordos Basin (at surface) |
| 56 | MZH-2 | 21.22 | 442 |  |  |  | 148.25 | 680 |  | Southern Ordos Basin (at surface) |
| 57 | MZH-3 | 21.25 | 443 |  |  |  | 130.47 | 584 |  | Southern Ordos Basin (at surface) |
| 58 | MZH-4 | 15.52 | 440 |  |  |  | 101.46 | 641 |  | Southern Ordos Basin (at surface) |
| 59 | MZH-5 | 17.24 | 439 |  |  |  | 107.65 | 613 |  | Southern Ordos Basin (at surface) |
| 60 | MZH-6 | 18.25 | 438 |  |  |  | 128.71 | 692 |  | Southern Ordos Basin (at surface) |
| 61 | MZH-7 | 20.33 | 440 |  |  |  | 132.81 | 637 |  | Southern Ordos Basin (at surface) |
| 62 | MZH-8 | 19.37 | 442 |  |  |  | 105.95 | 530 |  | Southern Ordos Basin (at surface) |
| 63 | MZH-9 | 16.44 | 443 |  |  |  | 112.51 | 678 |  | Southern Ordos Basin (at surface) |
| 64 | MZH-10 | 15.49 | 438 |  |  |  | 99.82 | 614 |  | Southern Ordos Basin (at surface) |
| 65 | MZH-11 | 16.32 | 443 |  |  |  | 92.49 | 527 |  | Southern Ordos Basin (at surface) |
| 66 | MZH-12 | 5.80 | 437 |  |  |  | 37.77 | 633 |  | Southern Ordos Basin (at surface) |
| 67 | MZH-13 | 11.91 | 437 |  |  |  | 82.56 | 636 |  | Southern Ordos Basin (at surface) |
| 68 | MZH-14 | 14.43 | 435 |  |  |  | 95.24 | 634 |  | Southern Ordos Basin (at surface) |
| 69 | Jida-1 | 13.36 |  |  |  |  |  |  |  | Bingxian County (at surface) |
| 70 | Jida-2 | 11.99 |  |  |  |  |  |  |  | Bingxian County (at surface) |
| 71 | Jida-3 | 13.36 |  |  |  |  |  |  |  | Bingxian County (at surface) |
| 72 | YH | 13.81 | 450 | 4.02 |  |  |  | 300 | 〈 5 | 221specimen from the basin (at wells and surfaces) |
| 73 | Average Value | 17.76 |  |  |  |  | 70.00 |  |  |  |
| Notes：1-2 data compiled from Bai et al (2009); 3-33 data compiled from the internal data of the Changqing oilfield company, PetroChina (2008); 34-54 data compiled from Zhang et al( 2013);.55-68 data compiled from Ma *et al* (2016); 69-71 data compiled from Ren (2007); 72 data compiled from Yang *et al* (2005, 2016). |

The analytical method for Total Organic Carbon (TOC) is using the Carbon & Sulfur Determinator in different laboratory following Chinese standards GB/T19145-2003. The analytical method for Rock pyrolysis analysis is using the rock-eval pyrolysis apparatus in different laboratory following Chinese standards GB/T18602-2001.