**附件1 东昆仑造山带地壳包体、古老S型花岗岩和石炭纪-三叠纪岩浆岩**

**Appendix 1 Crustal xenoliths, ancient S-type granites and Carboniferous-Triassic magmatic rocks, in the East Kunlun Orogen**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **地点** | **岩性** | **年龄/Ma** | **数据** | **参考文献** |
| 金水口 | 麻粒岩包体 |  | Sr-Nd | (龙晓平, 2004) |
| 波克开力 | S-型花岗片麻岩 | 2404~758 | Hf | (He, et al., 2016) |
| 金水口 | S型花岗岩(壳源) | 402 | Sr-Nd | (余能等, 2005) |
| 阿尼玛卿 | 洋中脊玄武岩 | 350 | Sr-Nd | (郭安林等, 2007) |
| 阿尼玛卿 | 洋岛玄武岩 | 350 | Sr-Nd | (郭安林等, 2007) |
| 石头坑得 | 镁铁质-超镁铁质岩 | 334 | Sr-Nd | (Zhang, et al., 2018) |
| 坑得弄舍 | 辉长岩 | 266 | Sr-Nd | (Zhao, et al., 2019) |
| 希望沟 | 橄榄辉长岩 | 265 | Hf | (孔会磊等, 2021) |
| 金水口 | 煌斑岩 | 253 | Hf | (Xiong, et al., 2013) |
| 白日其利 | 镁铁质岩 | 251 | Hf | (熊富浩等, 2011) |
| 白日其利 | 镁铁质岩 | 251~241 | Sr-Nd-Hf | (熊富浩, 2014) |
| 按纳格 | 角闪辉长岩 | 242 | Sr-Nd-Hf | (赵旭等, 2018) |
| 野牛沟 | 辉绿岩 | 218 | Sr-Nd-Hf | (Hu, et al., 2016) |
| 五龙沟 | 花岗闪长岩 | 260 | Sr-Nd-Hf | (罗明非等, 2015) |
| 约格鲁 | 闪长岩 | 256 | Sr-Nd | (刘成东等, 2003) |
| 坑得弄舍 | 花岗斑岩 | 256 | Hf | (Zhao, et al., 2020) |
| 香日德和青海湖南 | 花岗岩类和包体 | ~250 | Sr-Nd-Hf | (Huang, et al., 2014) |
| 巴隆 | 闪长岩、花岗闪长岩和包体 | 250~251 | Sr-Nd-Hf | (熊富浩, 2014) |
| 白日其利 | 镁铁质包体 | 250 | Sr-Nd-Hf | (熊富浩, 2014) |
| 白日其利 | 二长花岗岩 | 250 | Sr-Nd | (熊富浩, 2014) |
| 白日其利 | 英云闪长岩 | 249 | Sr-Nd | (熊富浩, 2014) |
| 白日其利 | 花岗闪长岩 | 248 | Sr-Nd-Hf | (熊富浩, 2014) |
| 巴隆 | 花岗闪长岩和包体 | 252~242 | Sr-Nd | (Zhang, et al., 2012) |
| 哈拉尕吐 | 包体 | 248 | Hf | (Li, et al., 2018) |
| 哈拉尕吐 | 花岗闪长岩 | 247 | Hf | (Li, et al., 2018) |
| 香日德 | 石英闪长岩 | 248 | Sr-Nd-Hf | (熊富浩, 2014) |
| 都兰北部 | 流纹岩和英安岩 | 245~244 | Sr-Nd-Hf | (Li, et al., 2015) |
| 夏日哈木 | 石英闪长岩 | 245~239 | Hf | (王冠等, 2014) |
| 五龙沟 | A型花岗岩 | 244 | Sr-Nd-Hf | (Ding, et al., 2014) |
| 约格鲁 | 花岗闪长岩和包体 | 243~239 | Sr-Nd | (刘成东等, 2003) |
| 南戈滩 | 花岗闪长岩和包体 | ~243 | Sr-Nd-Hf | (Xia, et al., 2015) |
| 香日德 | 花岗岩类 | 242 | Sr-Nd | (陈能松等, 2007) |
| 阿斯哈 | 石英闪长岩 | 242 | Sr-Nd-Hf | (Chen, et al., 2017) |
| 香日德 | 花岗闪长岩和包体 | 242 | Sr-Nd-Hf | (Chen, et al., 2017) |
| 坑得弄舍 | 凝灰岩 | 241 | Hf | (Zhao, et al., 2020) |
| 巴隆 | 石英闪长岩 | 241 | Sr-Nd | (Zhang, et al., 2012) |
| 都兰 | 花岗岩类和包体 | 240~235 | Sr-Nd-Hf | (Shao, et al., 2017) |
| 英德尔 | 花岗闪长岩和闪长岩 | 237 | Sr-Nd-Hf | (Shao, et al., 2017) |
| 香日德 | 钾长花岗岩 | 236 | Sr-Nd-Hf | (熊富浩, 2014) |
| 香日德 | 花岗斑岩 | 236 | Sr-Nd | (熊富浩, 2014) |
| 热水 | 花岗闪长岩、闪长岩和二长岩 | 235 | Sr-Nd-Hf | (Shao, et al., 2017) |
| 卡尔却卡 | 花岗闪长岩和包体 | 234 | Hf | (高永宝等, 2015) |
| 巴隆 | 正长花岗岩 | 231 | Sr-Nd | (Zhang, et al., 2012) |
| 香日德 | 包体 | 224 | Sr-Nd | (熊富浩, 2014) |
| 香日德 | 花岗闪长岩 | 224 | Sr-Nd-Hf | (熊富浩, 2014) |
| 都兰 | 花岗岩 | 220 | Sr-Nd-Hf | (Shao, et al., 2017) |
| 土房子 | 流纹质凝灰岩和斑岩 | 220 | Sr-Nd-Hf | (Hu, et al., 2016) |
| 屈库勒克东 | 闪长斑岩 | 221~204 | Hf | (Xing, et al., 2022) |
| 屈库勒克东 | 花岗闪长岩 | 217~210 | Hf | (Xing, et al., 2022) |
| 五龙沟 | 埃达克质高镁闪长岩 | 215 | Sr-Nd-Hf | (Ding, et al., 2014) |
| 香日德 | 闪长玢岩 | 215 | Sr-Nd-Hf | (熊富浩, 2014) |
| 香日德南西 | 流纹岩 | 213 | Sr-Nd | (丁烁等, 2011) |
| 香日德 | 包体 | 212 | Sr-Nd-Hf | (熊富浩, 2014) |
| 坑得弄舍 | 花岗斑岩 | 211 | Hf | (Zhao, et al., 2020) |

注：”数据”一列为正文图6和7所引用的数据类型.

**References**

Chen, J., Wei, J., Fu, L., et al., 2017. Multiple Sources of the Early Mesozoic Gouli Batholith, Eastern Kunlun Orogenic Belt, Northern Tibetan Plateau: Linking Continental Crustal Growth with Oceanic Subduction. *Lithos*, 292-293: 161-178. https://doi.org/10.1016/j.lithos.2017.09.006

Ding, Q., Jiang, S., Sun, F., 2014. Zircon U–Pb Geochronology, Geochemical and Sr–Nd–Hf Isotopic Compositions of the Triassic Granite and Diorite Dikes From the Wulonggou Mining Area in the Eastern Kunlun Orogen, NW China: Petrogenesis and Tectonic Implications. *Lithos*, 205: 266-283. https://doi.org/10.1016/j.lithos.2014.07.015

He, D.F., Dong, Y.P., Zhang, F.F., et al., 2016. The 1.0 Ga S–Type Granite in the East Kunlun Orogen, Northern Tibetan Plateau: Implications for the Meso–to Neoproterozoic Tectonic Evolution. *Journal of Asian Earth Sciences*, 130: 46-59. https://doi.org/10.1016/j.jseaes.2016.07.019

Hu, Y., Niu, Y., Li, J., et al., 2016. Petrogenesis and Tectonic Significance of the Late Triassic Mafic Dikes and Felsic Volcanic Rocks in the East Kunlun Orogenic Belt, Northern Tibet Plateau. *Lithos*, 245: 205-222. 10.1016/j.lithos.2015.05.004

Huang, H., Niu, Y., Nowell, G., et al., 2014. Geochemical Constraints On the Petrogenesis of Granitoids in the East Kunlun Orogenic Belt, Northern Tibetan Plateau; Implications for Continental Crust Growth through Syn-Collisional Felsic Magmatism. *Chemical Geology*, 370: 1-18. https://doi. org/10.1016/j.chemgeo.2014.01.010

Li, R., Pei, X., Pei, L., et al., 2018. The Early Triassic Andean-type Halagatu Granitoids Pluton in the East Kunlun Orogen, Northern Tibet Plateau: Response to the Northward Subduction of the Paleo-Tethys Ocean. *Gondwana research*, 62: 212-226. 10.1016/j.gr.2018.03.005

Li, X., Huang, X., Luo, M., et al., 2015. Petrogenesis and Geodynamic Implications of the Mid-Triassic Lavas From East Kunlun, Northern Tibetan Plateau. *Journal of Asian Earth Sciences*, 105: 32-47. 10.1016/j.jseaes.2015.03.009

Shao, F., Niu, Y., Liu, Y., et al., 2017. Petrogenesis of Triassic Granitoids in the East Kunlun Orogenic Belt, Northern Tibetan Plateau and their Tectonic Implications. *Lithos*, 282-283: 33-44. https://doi.org/10.1016/j.lithos.2017.03.002

Xia, R., Wang, C., Qing, M., et al., 2015. Zircon U–Pb Dating, Geochemistry and Sr–Nd–Pb–Hf–O Isotopes for the Nan'getan Granodiorites and Mafic Microgranular Enclaves in the East Kunlun Orogen: Record of Closure of the Paleo-Tethys. *Lithos*, 234-235: 47-60. https://doi. org/10.1016/j.lithos.2015.07.018

Xing, L., Li, W., Liu, J., et al., 2022. Mineralization Timing and Genesis of the Qukulekedong Au–Sb Deposit in the East Kunlun Orogenic Belt, Northern Tibetan Plateau: Constraints From Arsenopyrite Re–Os Ages, Zircon U–Pb Ages, and Lu–Hf Isotopes. *Ore Geology Reviews*, 143: 104731. 10.1016/j.oregeorev.2022.104731

Xiong, F., Ma, C., Jiang, H., et al., 2013. Petrogenetic and Tectonic Significance of Permian Calc-Alkaline Lamprophyres, East Kunlun Orogenic Belt, Northern Qinghai-Tibet Plateau. *International Geology Review*, 55: 1817-1834. 10.1080/00206814.2013.804683

Zhang, J.Y., Ma, C.Q., Xiong, F.H., et al., 2012. Petrogenesis and Tectonic Significance of the Late Permian–Middle Triassic Calc-Alkaline Granites in the Balong Region, Eastern Kunlun Orogen, China. *Geol. Mag.*, 149: 892-908. https://doi. org/10.1017/S0016756811001142

Zhang, Z., Wang, Y., Qian, B., et al., 2018. Metallogeny and Tectonomagmatic Setting of Ni-Cu Magmatic Sulfide Mineralization, Number I Shitoukengde Mafic-Ultramafic Complex, East Kunlun Orogenic Belt, NW China. *Ore Geology Reviews*, 96: 236-246. 10.1016/j.oregeorev.2018.04.027

Zhao, X., Fu, L., Wei, J., et al., 2019. Late Permian Back-Arc Extension of the Eastern Paleo-Tethys Ocean: Evidence From the East Kunlun Orogen, Northern Tibetan Plateau. *Lithos*, 340-341: 34-48. https://doi. org/10.1016/j.lithos.2019.05.006

Zhao, X., Wei, J., Fu, L., et al., 2020. Multi-Stage Crustal Melting From Late Permian Back-Arc Extension through Middle Triassic Continental Collision to Late Triassic Post-Collisional Extension in the East Kunlun Orogen. *Lithos*, 360-361: 105446. 10.1016/j.lithos.2020.105446

Chen, N.S., Wang, X.Y., Zhang, H.F., et al., 2007. Geochemistry and Nd-Sr-Pb Isotopic Compositions of Granitoids From Qaidam and Oulongbuluke Micro-Blocks, NW China: Constraints On Basement Nature and Tectonic Affinity. *Earth Science —Journal of China University of Geosciences*, 32: 7-21 (in Chinese with English abstract).

Ding, S., Huang, H., Niu, Y.N., et al., 2011. Geochemistry，Geochronology and Petrogenesis of East Kunlun High Nb-Ta Rhyolites. *Acta Petrologica Sinica*, 27: 3603-3614 (in Chinese with English abstract).

Gao, Y.B., Li, K., Qian, B., et al., 2015. The Genesis of Granodiorites and Dark Enclaves From the Kaerqueka Deposit in East Kunlun Belt: Evidence From Zircon U-Pb Dating, Geochemistry and Sr-Nd-Hf Isotopic Compositions. *Geology in China*, 42: 646-662 (in Chinese with English abstract).

Guo, A.L., Zhang, G.W., Sun, Y.G., et al., 2007. Sr-Nd-Pb Isotopic Geochemistry of late-Paleozoic Mafic Volcanic Rocks in the Surrounding Areas of Gonghe Basin, Qinghai Province and Geological Implications. *Acta Petrologica Sinica*, 23: 747-754 (in Chinese with English abstract).

Guo, A., Zhang, G., Sun, Y., et al., 2007. Sr-Nd-Pb isotopic geochemistry of late-Paleozoic mafic volcanic rocks in the surrounding areas of Gonghe basin, Qinghai Province and geological implications. *Acta Petrologica Sinica,23(04)*: 249-261 (in Chinese with English abstract).

Kong, H., Li, Y., Li, J., et al., 2021. Petrogenesis of Xiwanggou Olivine Gabbro in East Kunlun Mountains: Constraints From Geochemistry, Zircon U-Pb Dating and Hf Isotopes. *Geology in China*, 48: 173-188 (in Chinese with English abstract).

Liu, C., Mo, X., Luo, Z., et al., 2003. Pb-Sr-Nd-O Isotope Characteristics of Granitoids in East Kunlun Orogenic Belt. *Acta Geoscientica Sinica*, 24: 584-588 (in Chinese with English abstract).

Long, X.P., 2004. The Research of Zircon Chronology in Orogenic belts-A Case Study in Jinshuikou Zone. master, Jilin University:129 (in Chinese with English abstract).

Luo, M., Mo, X., Yu, X., et al., 2015. Zircon U-Pb Geochronology, Petrogenesis and Implication of the Later Permian Granodiorite From the Wulonggou Area in East Kunlun, Qinhai Province. *Earth Science Frontiers*, 22: 182-195 (in Chinese with English abstract).

Wang, G., Sun, F.Y., Li, B.Y., et al., 2014. Zircon U-Pb Geochronology and Geochemistry of Diorite in Xiarihamu Ore District From East Kunlun and its Geological Significance. *Journal of Jilin University (Earth Science Edition)*, 44: 876-891 (in Chinese with English abstract).

Xiong, F.H., 2014. Spatial-Temporal Pattern, Petrogenesis and Geological Implications of Paleo-Tethyan Granitoids in the East Kunlun Orogenic Belt (Eastern Segment). doctor, China University of Geosciences:1-191 (in Chinese with English abstract).

Xiong, F.H., Ma, C.Q., Zhang, J.Y., et al., 2011. LA-ICP-MS Zircon U-Pb Dating, Elements and Sr-Nd-Hf Isotope Geochemistry of the Early Mesozoic Mafic Dyke Swarms in East Kunlun Orogenic Belt. *Acta Petrologica Sinica*, 27: 3350-3364 (in Chinese with English abstract).

Yu, N., Jin, W., Ge, W.C., et al., 2005. Geochemical Study On Peraluminous Granite From Jinshuikou in East Kunlun. *Global Geology*, 24: 123-128 (in Chinese with English abstract).

Zhao, X., Fu, L., Wei, J., et al., 2018. Geochemical Characteristics of the An'nage Hornblende Gabbro From East Kunlun Orogenic Belt: Constraints On the Evolution of Paleo-Tethys Ocean. *Earth Science*, 43: 1-23 (in Chinese with English abstract).

**附中文参考文献**

陈能松, 王新宇, 张宏飞等, 2007. 柴-欧微地块花岗岩地球化学和Nd-Sr-Pb同位素组成:基底性质和构造属性启示. 地球科学(中国地质大学学报), 32: 7-21.

丁烁, 黄慧, 牛耀龄等, 2011. 东昆仑高Nb-Ta流纹岩的年代学、地球化学及成因. 岩石学报, 27: 3603-3614.

高永宝, 李侃, 钱兵等, 2015. 东昆仑卡而却卡铜矿区花岗闪长岩及其暗色微粒包体成因:锆石U-Pb年龄、岩石地球化学及Sr-Nd-Hf同位素证据. 中国地质, 42: 646-662.

郭安林, 张国伟, 孙延贵等, 2007. 青海省共和盆地周缘晚古生代镁铁质火山岩Sr-Nd-Pb同位素地球化学及其地质意义. 岩石学报，23(04): 249-261.

孔会磊, 栗亚芝, 李金超等, 2021. 东昆仑希望沟橄榄辉长岩的岩石成因：地球化学、锆石U-Pb年龄与Hf同位素制约. 中国地质, 48: 173-188.

刘成东, 莫宣学, 罗照华等, 2003. 东昆仑造山带花岗岩类Pb-Sr-Nd-O同位素特征. 地球学报, 24: 584-588.

龙晓平. 2004. 造山带锆石年代学研究——以金水口地区为例. 硕士. 长春: 吉林大学. 129.

罗明非, 莫宣学, 喻学惠等, 2015. 东昆仑五龙沟晚二叠世花岗闪长岩LA-ICP-MS锆石U-Pb定年、岩石成因及意义. 地学前缘, 22: 182-195.

王冠, 孙丰月, 李碧乐等, 2014. 东昆仑夏日哈木矿区闪长岩锆石U-Pb年代学、地球化学及其地质意义. 吉林大学学报(地球科学版), 44: 876-891.

熊富浩. 2014. 东昆仑造山带东段古特提斯域花岗岩类时空分布、岩石成因及其地质意义. 博士. 武汉: 中国地质大学. 1-191.

熊富浩, 马昌前, 张金阳等, 2011. 东昆仑造山带早中生代镁铁质岩墙群LA-ICP-MS锆石U-Pb定年、元素和Sr-Nd-Hf同位素地球化学. 岩石学报, 27: 3350-3364.

余能, 金巍, 葛文春等, 2005. 东昆仑金水口过铝花岗岩的地球化学研究. 世界地质, 24: 123-128.

赵旭, 付乐兵, 魏俊浩等, 2018. 东昆仑按纳格角闪辉长岩体地球化学特征及其对古特提斯洋演化的制约. 地球科学, 43: 1-23.