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| **Table S3.** Existed bedrock apatite fission-track data from the studied regions |
| Map ID | Locality |  Event Age (Ma) | Bedrock type | Data source | N | Age range (Ma) |
| >75 | 75-65 | 64-44 | 43-35 | 34-25 | 24-17 | <16 |
| **Altyn Tagh Shan** |
| 30 | Jinghong Shan | 47-44 | Pre-Mesozoic granodiorite and sediment | Sobel et al., 2001 | 13 | \* |  | \* | \* | \* | \* |  |
| 25-19 |
| 31 | Altyn Tagh north margin | 40±10  | Precambrian to Jurassic: granite, granodiorite, gneisse and syenite | Jolivet et al., 2001 | 16 | \* |  | \* |  | \* |  | \* |
| 31 | Central Altyn Tagh | 7 |
| 110 | Altun Shan | ~10 | Paleozoic granite and sediment | Jolivet et al., 1999 | 3 |  |  |  | \* |  |  | \* |
| B16 | Jianglisai fault | 40-35 | Proterozoic and Paleozoic granite, tonalite, amphibolite | Gao et al., 2022 | 8 | \* | \* | \* |  |  |  |  |
| 17-15 | 3 |  |  |  | \* |  |  |  |
| 43 | Yousha Shan | 31-15 | Paleozoic granodiorite | Wang E et al., 2006 | 8 |  | \* |  |  | \* | \* |  |
| 78 | Jianglisai | 17-14 | Jurassic sediment | Li M et al., 2015 | 6 |  |  |  |  |  |  | \* |
| 8-5 |  |  |  |  |  |  |
| **Hei Shan-kuantan Shan-Bei Shan** |
| 4 | Hei Shan | 53-40 | Paleozoic granite | An et al., 2020 | 14 | \* | \* | \* | \* | \* | \* |  |
|  | Kuangtan Shan | 8 | \* |  | \* | \* | \* |  |  |
| **Qaidam basin(basement)** |
| 6 | Yingchaogou  | 54-47 | early Jurassic-early Cretaceous sedement | Jian X et al., 2018 | 8 | \* | \* | \* |  |  |  |  |
| 111 | northwest edge | 7 | Precambrian to Jurassic: granodiorite, gneisse  | Jolivet et al., 2001 | 2 | \* |  |  |  |  | \* |  |
| **East Kunlun Shan** |
| 13 | Dongdatan-Xidatan-Golmud | 52.9 | Paleozoic granite | Chen et al., 2011 | 9 |  |  | \* |  |  |  | \* |
| 16.3-10 |
| 5.1 |
| 53 | Golmud | ~30 | Mesozoic granite | Wang F et al., 2004 | 1 |  |  |  |  |  | \* |  |
| B1 | Wenquanhu-Deshuiwai | 65-47 | Triassic/Permian sediment/granitoid | Staisch et al., 2020 | 7 | \* | \* | \* | \* |  |  |  |
| Xidatan | 23-20 | Triassic granite | 1 |  |  |  |  |  | \* |  |
| 70 | Dongdatan | 26±3 | paleozoic granite | Wu Z et al., 2009 | 1 |  |  |  |  | \* |  |  |
| 14 | Xiangride | 56-45 | Jurassic granodiorite | Wang G et al., 2007 | 9 | \* |  | \* |  |  |  |  |
| 15 | Buqingshan-Xiangride | 50 | Triassic granodiorite+sediment and paleozoic sediment | Tian et al, 2020 | 10 | \* | \* | \* | \* | \* |  |  |
| 72 | Buqingshan-Xiangride | 20-10 | Jurassic-Cretaceous granite; Triassic+Permian sediment | Yuan et al., 2006 | 41 | \* | \* | \* | \* | \* |  |  |
| 71 | Dulan-Ela Shan | 22-21 | Permo-Triassic granitoid | Jiang et al. 2008; Lu et al., 2012 | 12 | \* | \* | \* |  | \* | \* |  |
| 12-4.5 |  |
| 69 | Qimen Tagh | 20 | Ordovician-Silurian granitoid | Wu C et al., 2019 | 5 |  |  |  | \* |  | \* |  |
| Huashixia-Dulan  | Permo-Triassic granitoid | 6 | \* |  | \* | \* | \* |  |  |
| 91 | Naitou Shan | 14-10 | Paleozoic granite | Wang Y et al., 2018 | 6 | \* | \* | \* |  |  |  |  |
| 36 | Qimen Tagh | 40-30 | Mesozoic granite | Liu D et al., 2017 | 8 | \* |  | \* | \* | \* |  |  |
| 90 | Jingyu basin | 15 | paleozoic granite | Jolivet et al., 2003 | 2 |  |  |  |  |  | \* |  |
| 14-13 | Miocene+Quaternary basalt | 3 |  |  |  |  |  |  | \* |
| 10-9, 0.5 | 5 |  |  |  |  |  |  | \* |
| 50 | Kunlun fault Central | 20 | Triassic Flysch+diorite | Duvall et al., 2013 | 1 |  |  |  |  | \* |  |  |
| 15-12 | 1 |  |  |  |  |  |  | \* |
| Kunlun fault East | 8-5 | Mesozoic granite | 5 |  |  |  |  |  | \* | \* |
| **Qaidam Bei Shan and South Qilian Shan**  |
| 42 | Southwestern rim of Muli basin  | 40 | Paleozoic granite+sediment+tuff | Qi et al., 2016 | 13 | \* | \* |  |  |  |  |  |
| South-central Qilian fault  | 30 | Triassic sediment | 8 | \* | \* | \* |  |  |  |  |
| 9 | Qaidam Bei Shan | 20.6-12.5 | Ordovician granite | Zhuang et al., 2018 | 2 |  |  |  |  |  | \* | \* |
| 35 | east edge | 40 | Precambrian to Jurassic: granodiorite and syenite | Jolivet et al., 2001 | 3 | \* |  |  |  |  | \* |  |
| 52 | Qaidam Bei Shan | 40-30 | Ordovician-Silurian granite | Cheng X et al., 2016 | 16 | \* | \* |  | \* | \* |  | \* |
| 53 | Dachaidan | ~30 | Mesozoic granite | Wang F et al., 2004 | 1 |  |  |  |  |  | \* |  |
| 117 | Delingha | ~18-11  | Proterozoic sediment | Pang et al., 2019 | 7 | \* |  |  |  |  | \* |  |
| **Central Qilian Shan (Including Laji Shan-Jishi Shan)** |
| 16 | Shulenan Shan | ~55 | Ordovician granitoid | Li B et al., 2020 | 4 |  |  | \* | \* |  |  |  |
| 17 | Daban Shan | 50-30 | Silurian sandstone+Mesoproterozoic gneiss | Zhang J et al., 2015 | 7 |  |  | \* | \* | \* |  |  |
| West Laji Shan | 50-30 | Ordovician quartz diorite+Cambrian volcanic rock | 8 | \* | \* | \* |  | \* |  | \* |
| 17-8 |  |  |
| 75 | Laji Shan | ~22 | Paleozoic granite and sediment | Lease et al., 2011 | 5 | \* | \* | \* | \* |  |  |  |
| Jishi Shan | ~13 | 8 |  |  |  | \* |  | \* | \* |
| 98 | west Danghenan Shan  | 15 | Paleozoic granodiorite | Yu et al., 2019a | 19 |  |  | \* |  |  | \* | \* |
| B2 | Qilian City | 65-60 | Proterozoic to Mesozoic sediment and plutonic rock | Wu C et al., 2021 | 7 |  | \* | \* |  | \* |  | \* |
| Menyuan-Xining | 40-30 | Meso to Neo- Proterozoic sediment and Plutonic rock | 9 | \* | \* |  |  |  |  |  |
| 42 | Muli basin rim | 20 | Triassic sediment | Qi et al., 2016 | 13 | \* | \* | \* |  |  |  |  |
| North-central Qilian fault  | 10 | Paleozoic granite | 4 |  |  | \* |  | \* |  | \* |
| **North Qilian Shan**  |
| 54 | Tuolai Shan | 30-25 | Triassic sandstone and Ordovician granitoids  | Li B et al., 2020 | 10 | \* |  | \* |  | \* |  | \* |
| ~10 |  |  |  |
| 101 | Tuolai Shan (Qilian country) | 17-15 | Cretaceous to Cambrian sediments and Paleozoic granite | Yu et al., 2019b | 9 |  |  | \* |  | \* | \* | \* |
| 73 | North rim of Jiuxi basin  | 20-10 | Paleozoic-Mesozoic sediment | George et al., 2001 | 6 | \* | \* |  |  |  | \* |  |
| 114 | Qingtou Shan  | 10-8 | Palezoic sediment | Zheng et al., 2017 | 5 | \* | \* | \* |  |  |  |  |
| 100 | Tuolai Shan (west part) | 17-14 | Precambrian sediment | Zheng D et al., 2017 | 3 |  |  |  |  | \* | \* | \* |
| 74 | Baishuigou | 24 | Paleozoicgranitoid  | Pan et al., 2013 | 12 | \* | \* |  |  |  |  |  |
| 102 | Northeastern Menyuan  | 15-10 | Permian-Ordovician sediment+ Paleozoic granitoid  | Li B et al., 2019 | 8 | \* |  | \* | \* |  |  |  |
| **Longshou Shan** |
| B2 | Jinchang-Shandan |  | Archean to Neo- Proterozoic sediment and plutonic rock | Wu C et al., 2021 | 12 |  |  |  |  |  |  |  |
| **West Qinling Shan** |
| 21 | rim of Guide basin | 70-53 | Triassic+Ordovician granite | Wang X et al., 2016 | 10 | \* | 　 | \* | \* | 　 | 　 | 　 |
| *Notes.* Map ID and references are the same with Table S1. N = AFT age nmber, \* = age fall into the ranges. The >75 AFT ages generally represent the pre-Cenozoic fast exhumation events which not be included. |