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| **Table S4.** Summary of the paleoelevation results from the Himalayan-Tibetan orogen. | | | | | |
| Map ID | Locality | Age (Ma) | Paleoelevation (m) | Method | Data source |
| **Stage 1 (65-54 Ma and thereafter)** | | | | | |
| **Himalayas** | | | | | |
| 5 | Liuqu | ~56 | 919 | CLAMP | Ding et al., 2017 |
| **Lhasa** | | | | | |
| 8 | Linzhou | 60-50 | 4500±450 | δ18Oc of paleosols | Ding et al., 2014 |
| 10 | Tangrayum Co | 46 | 2590+730/-910 | δ18Oc of paleosols | Xu et al., 2015 |
| **Qiangtang** | | | | | |
| 13 | Heihuling | 50-28 | 5200±600 | δ18Oc of paleosols | Xu et al., 2013 |
| 15 | Gonjo | 54-50 | ~700 | carbonate clumped isotope | Xiong et al., 2020 |
| **Songpan-Ganzi** | | | | | |
| 18 | Tuotuohe | 52-30 | <2000 | δ18Oc of carbonates | Cyr et al., 2005 |
| 55-35 | ~4000 | δ18Oc of carbonates | Quade et al., 2011 |
| 55-35 | 2000-2600 | δD of n-alkane | Polissar et al., 2009 |
| **Northeastern Tibetan Plateau** | | | | | |
| 20 | Hero hill | 49-22 | 1462+148/-227 | δ18Oc of mammalian fossils, δ18Oc of carbonates | Li L et al., 2017 |
| **Stage 2 (43-39 Ma and thereafter)** | | | | | |
| **Lhasa** | | | | | |
| 12 | Lunpola | ~39.5 | <2300 | fossil palm leaves | Su et al., 2019; Xiong et al., 2022 |
| **Qiangtang** | | | | | |
| 14 | Nangqian | ~43-33 | <3000 | magmatism | Zhang et al., 2020 |
| 15 | Gonjo | 44-40 | ~3800 | carbonate clumped isotope | Xiong et al., 2020 |
| 16 | Markam | ~37 | 3837+1180/-1574 | δ18Oc of carbonates | Li S Y et al., 2015 |
| 17 | Liming | ~37 | 2700±300 | δ18Oc of carbonates | Hoke et al., 2014 |
| **Northeastern Tibetan Plateau** | | | | | |
| 23 | Longmori | 40.2-35.3 | 2180-3502 | δ18Oc and δ13Cc of lacustrine | Qi et al., 2015 |
| **Stage 3 (34-29 Ma and thereafter)** | | | | | |
| **Lhasa** | | | | | |
| 11 | Nima | ~26 | 4500-4700 | δ18Oc of paleosols | DeCelles et al., 2007a |
| 12 | Lunpola | 29-26 | 4260+475/-575 | δ18Oc of carbonates | Rowley and Currie, 2006; Fang et al., 2020; Xiong et al., 2022 |
| 4500-4900 | δD of n-alkane | Polissar et al., 2009 |
| 26-23 | 2770±530 | δD of n-alkane | Jia et al., 2015 |
| **Songpan-Ganzi** | | | | | |
| 18 | Tuotuohe | ~35 | 2000 | Fossil pollens | Miao et al., 2015 |
| ~36-30 | 4000 | leaf wax δ2H | Lin et al., 2020 |
| **Northeastern Tibetan Plateau** | | | | | |
| 21 | Dahonggou | 30.8 | 3300 ±1400 | CLAMP | Song et al., 2020 |
| 24 | Xining | ~36 | 2000-3000 | Fossil pollens | Dupont-Nivet et al., 2008 |
| 26 | Lanzhou | 30-28 | 2000-3000 | Fossil pollens | Miao et al., 2013 |
| **Stage 4 (24-21 Ma and thereafter)** | | | | | |
| **Lhasa** | | | | | |
| 6 | Qiabulin | 21-19 | 2315 | CLAMP | Ding et al., 2017 |
| 24-21 | ~2000 | δ18Oc of carbonates | Xu et al., 2018 |
| 21-19 | ~4100 |
| 9 | Kailash | ~24 | 4700-6700 | δ18Oc of paleosols | DeCelles et al., 2011 |
| ~20-19 | ~4900 | δ18Oc of carbonates | Xu et al., 2018 |
| 12 | Lunpola | 23 | 3000-3200 | Fossil pollens | Sun et al., 2014 |
| **Songpan-Ganzi** | | | | | |
| 19 | Wudaoliang | ~23 | 4000-4200 | δD of n-alkane | Polissar et al., 2009 |
| ~19 | 1300-2900 | Fossil leaves | Sun et al., 2015 |
| **Northeastern Tibetan Plateau** | | | | | |
| 20 | Hero hill | 22-8.1 | 1496+153/-234 | δ18Oc of mammalian fossils, δ18Oc of carbonates | Li L et al., 2017 |
| 23 | Sulixiang | 22.7-18.2 | ~2848 | δ18Oc and δ13Cc of lacustrine | Qi et al., 2015 |
| **Stage 5 (16-15 Ma and thereafter)** | | | | | |
| **Himalayas** | | | | | |
| 4 | Qomolangma | ~17 | 5100-5400 | δD of hydrous minerals | Gebélin et al., 2013 |
| **Lhasa** | | | | | |
| 7 | Namling | 15 | 5200+1370/-605 | δ18Oc of paleosols | Currie et al., 2005 |
| 4689±895 | CLAMP | Spicer et al., 2003 |
| 4638±847 | Khan et al., 2014 |
| 5400±728 |
| Mahasin et al., 2014 |
| 5100＋1300/-1900 | δD of n-alkane | Currie et al., 2016 |
| 12 | Lunpola | 18-16 | ~3000 | Mammalian fossils | Deng et al., 2012 |
| **Northeastern Tibetan Plateau** | | | | | |
| 22 | Huaitoutala | 10~15 | 3300-4000 | leaf wax δ2H | Zhuang et al., 2014 |
| ~12.4 | >700-1100 | soil tetraethers | Zhuang et al., 2019 |
| 23 | Sulixiang | 18.2-13.2 | ~3586 | δ18Oc andδ13Cc of lacustrine | Qi et al., 2015 |
| 26 | Zeku | 19-<16 | 1200-1400 | Fossil pollens | Hui et al., 2018 |
| **Stage 6 (11-3 Ma)** | | | | | |
| **Himalayas** | | | | | |
| 1 | Zhada | 9 | 5400±500 | T(△47) of carbonates | Hutingtion et al., 2015 |
| ~9 | 5600±300 | δ18Oc of fossil shells | Saylor et al., 2009 |
| ~4 | 4000±300 | δ18Oc of fossil shells | Murphy et al., 2009 |
| 2 | Thakkhola | ~7 | 4500-6300 | δ18Oc of paleosols | Garzione et al., 2000a |
| 5700+1410/-730 | δ18Oc of paleosols | Rowley et al., 2001 |
| ~11 | 3800-5900 | δ18Oc of paleosols | Garzione et al., 2000a, b |
| 6240+1410/-870 | δ18Oc of paleosols | Rowley et al., 2001 |
| 3 | Gyirong | >7 | <2900-3400 | δ13Cc of fossil teeth | Wang et al., 2006 |
| 6700±700 | δ18Oc of mammalian fossils | Xu et al., 2010 |
| 5850+1410/-730 | δ18Oc of mammalian fossils | Rowley et al., 2001 |
| 7-3.2 | <2300 | GDGTs | Chen et al., 2020 |
| **Northeastern Tibetan Plateau** | | | | | |
| 20 | Hero hill | 8.1-2.5 | 2084+247/-354 | δ18Oc of mammalian fossils, δ18Oc of carbonates | Li L et al., 2017 |
| <2.5 | 2476+321/-445 |
| 24 | Xining | ~10.5-8 | 1500-1800 | GDGTs | Chen et al., 2019 |
| *Note:* N= reference number and Map ID in Fig.1, represents the different locations referred in different literatures. | | | | | |

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