**Supplementary Material**

**Diachronous Uplift in Intra-continental Orogeny: 2D Thermo-Mechanical Modeling of the India-Asia collision**

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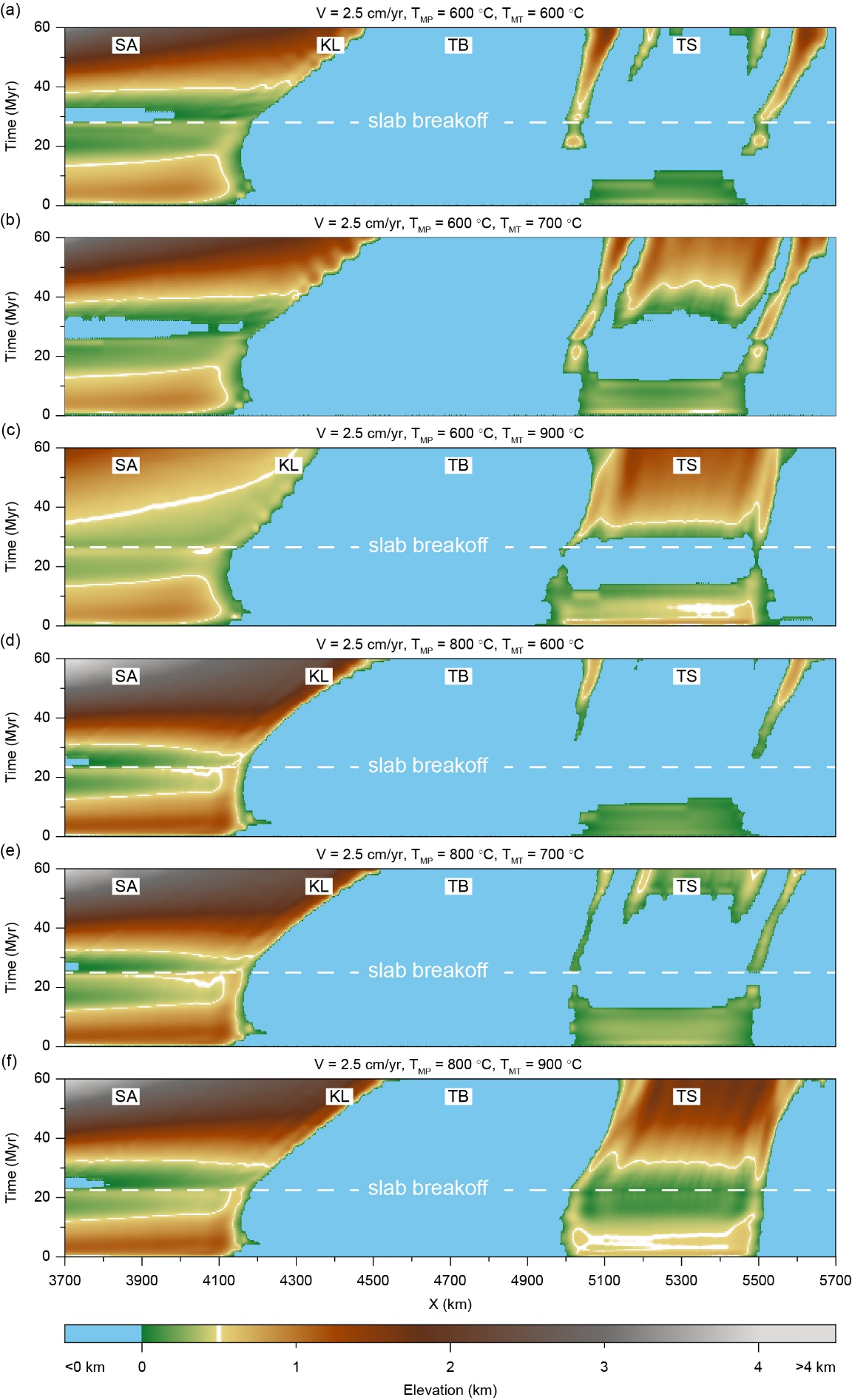
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Table A.1 Summary of the onset timing of ranges uplift

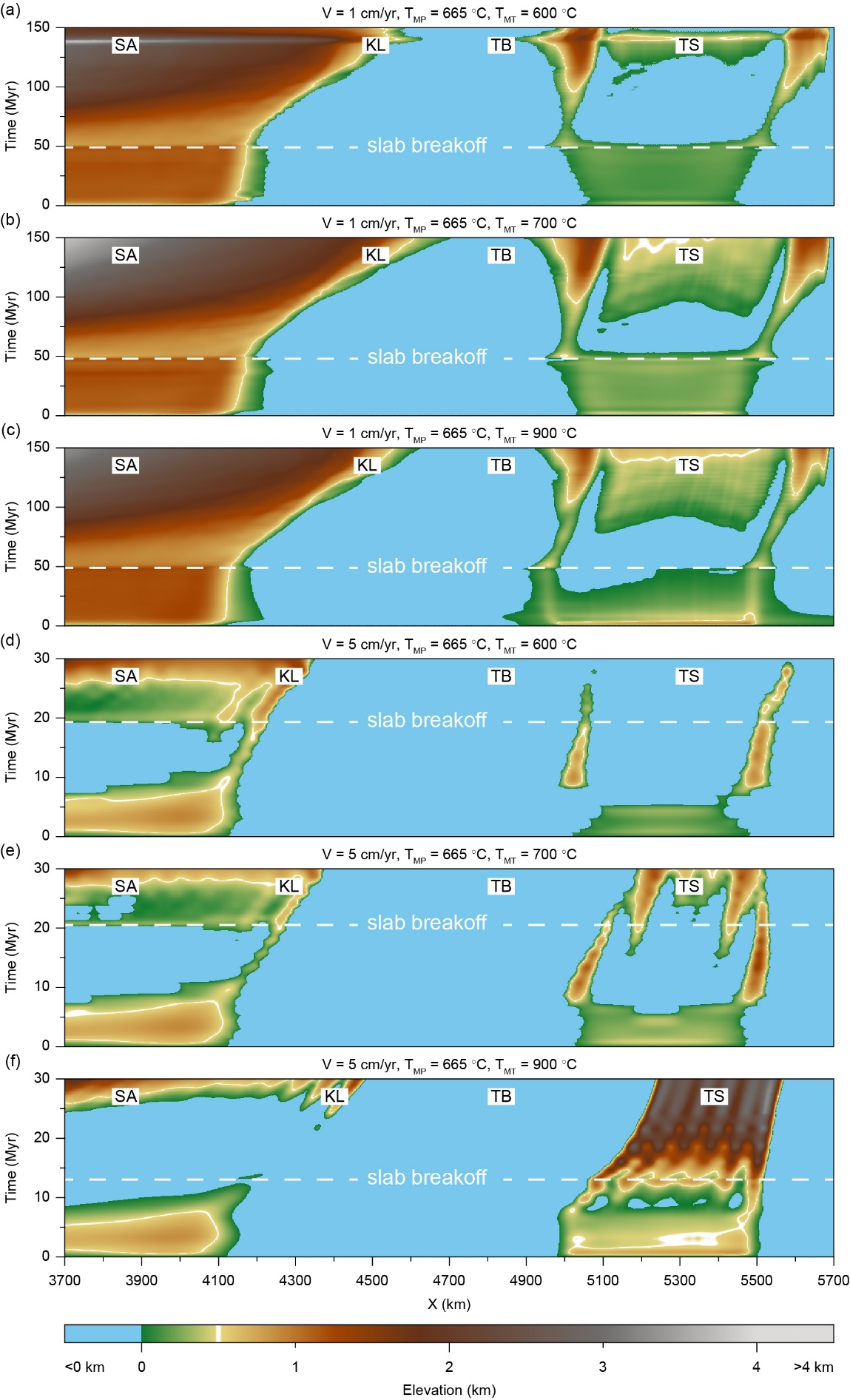
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| Name | Age(Ma) | Methods | References |
| South Tian Shan | ~36 | seismostratigraphy, paleomagnetism | Zhang et al., 2014 |
|  | ~30-25 | zircon (U-Th)/He, apatite fission track | Glorie et al., 2011 |
|  | ~26 | magnetostratigraphy | Li et al., 2019b |
|  | ~26-25 | growth strata | Wang et al., 2011 |
|  | ~25 | apatite fission track | Sobel and Dumitru, 1997 |
|  | ~25 | apatite (U-Th)/He, apatite fission track | Jepson et al., 2017 |
|  | ~24 | apatite fission track | Hendrix et al., 1994 |
|  | ~24 | apatite fission track | Sobel et al., 2006 |
|  | ~24-21 | growth strata | Yin et al., 1998 |
|  | ~17 | acceleration of sediment flux | Métivier and Gaudemer, 1997 |
|  | ~17-16 | magnetostratigraphy | Huang et al., 2006 |
|  | ~16.3 | growth strata | Heermance et al., 2007 |
|  | ~16 | crustal shortening | Avouac et al., 1993 |
|  | ~16-15 | magnetostratigraphy | Charreau et al., 2009 |
|  | ~13 | seismostratigraphy, paleomagnetism | Zhang et al., 2014 |
|  | ~11 | magnetostratigraphy | Charreau et al., 2006 |
|  | ~7 | magnetostratigraphy | Huang et al., 2006 |
|  | ~6.5 | seismostratigraphy, paleomagnetism | Zhang et al., 2014 |
|  | ~2.6 | seismostratigraphy, paleomagnetism | Zhang et al., 2014 |
| North Tian Shan | ~11 | apatite fission track, (U-Th)/He | Bullen et al., 2001 |
|  | ~11-10 | apatite fission track, (U-Th)/He | Bullen et al., 2003 |
|  | ~10.5 | magnetostratigraphy | Charreau et al., 2005 |
|  | ~10-8 | apatite fission track, (U-Th)/He | Glorie et al., 2010 |
| West Kunlun | ~23 | palaeo-environment | Jiang and Li, 2014 |
|  | ~22 | apatite fission track | Cowgill, 2001 |
|  | ~20 | apatite fission track | Sobel and Dumitru, 1997 |
|  | ~20 | apatite fission track | Wang et al., 2003b |
|  | ~16-15 | apatite fission track, (U-Th)/He | Ritts et al., 2008 |
|  | ~15 | Nd isotopic analysis | Li et al., 2011 |
|  | ~4.5 | palaeo-environment | Zheng et al., 2000; 2006 |
|  | ~4 | palaeo-environment | Tada et al., 2010 |
| Qilian Shan | ~66-50 | growth strata | Yin et al., 2008 |
|  | ~65-50 | K-feldspars 40Ar/39Ar | Zhuang et al., 2018 |
|  | ~60-45 | apatite and zircon (U-Th)/He and fission-track | Zuza et al., 2016; 2019 |
|  | ~55 | apatite fission track | Qi et al., 2016 |
|  | ~55-40 | sedimentary record | Zhuang et al., 2011 |
|  | ~50-30 | apatite fission track | Zhang et al., 2015 |
|  | ~50-30 | apatite fission track | Jolivet et al., 2001 |
|  | ~33 | apatite fission track | Yin et al., 2002 |

Continued Table A.1

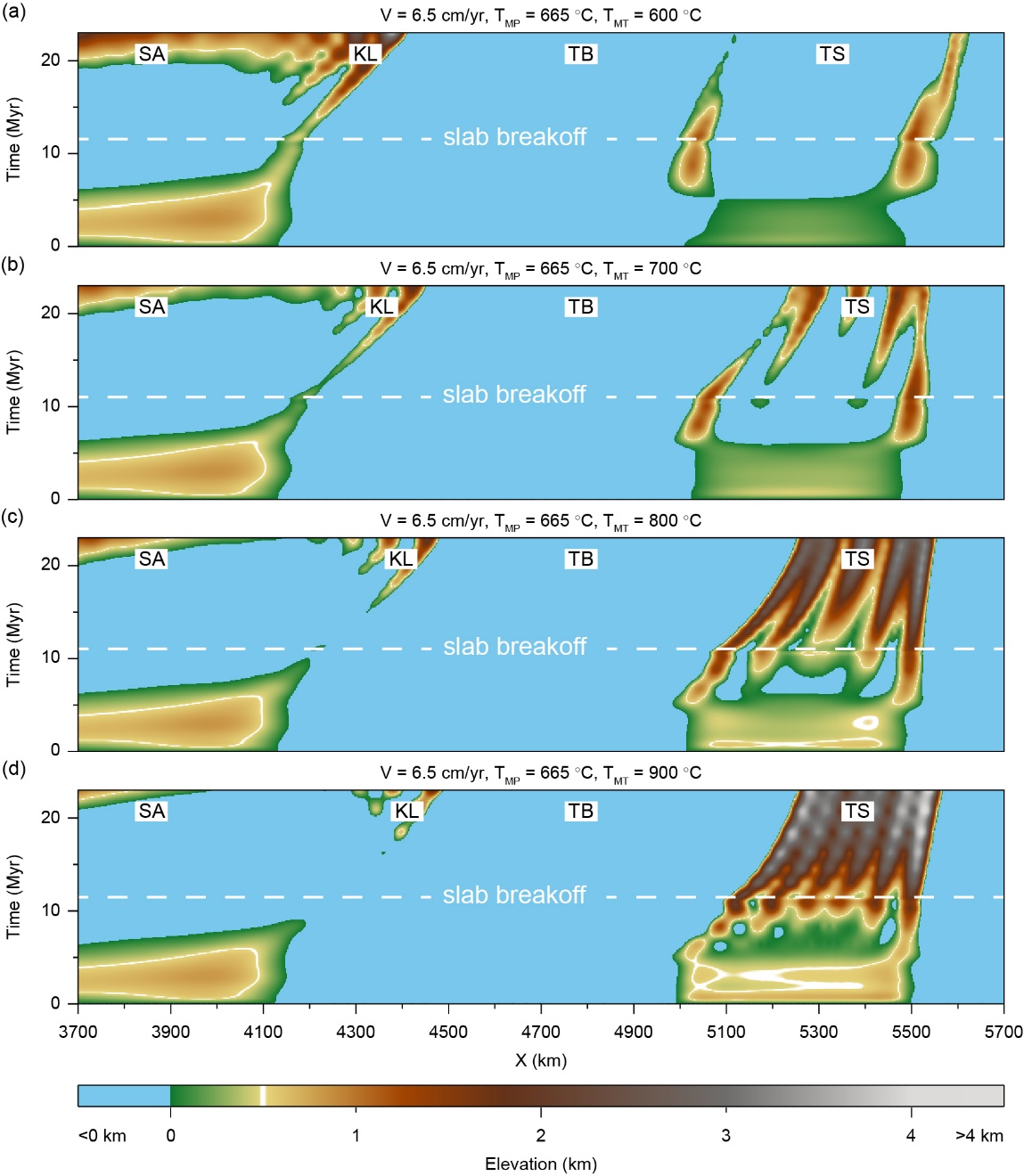
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| --- | --- | --- | --- |
| Qilian Shan | ~27 | apatite fission track, stratigraphy | Guo et al., 2009 |
|  | ~25 | apatite fission track | Lu et al., 2002 |
|  | ~20 | apatite and zircon (U-Th)/He | Shi et al., 2018 |
|  | ~15-10 | apatite fission track | Li et al., 2019a |
|  | ~14 | magnetostratigraphy | Sun et al., 2005 |
|  | ~13 | sedimentary record | Bovet et al., 2009 |
|  | ~12 | sedimentary record | Wang et al., 2003a |
|  | ~10 | apatite (U-Th)/He | Zheng et al., 2010 |
|  | ~10 | apatite fission track | Zheng et al., 2017 |
| East Kunlun | ~40 | 40Ar/39Ar and apatite (U-Th)/He | Wang et al., 2016 |
|  | ~35 | K-feldspars and Biotite 40Ar/39Ar, apatite fission track | Wang et al., 2004 |
|  | ~35 | apatite (U-Th)/He | Clark et al., 2010 |
|  | ~32 | 40Ar/39Ar | Liu et al., 2005 |
|  | ~30 | K-feldspars 40Ar/39A | Mock et al., 1999 |
|  | ~30-20 | apatite and zircon (U-Th)/He, apatite fission track | Duvall et al., 2013 |
|  | ~30-20 | apatite and zircon fission track | McRivette et al., 2019 |
|  | ~29-24 | growth strata | Yin et al., 2008 |
|  | ~28-24 | growth strata | Yin et al., 2007 |
|  | ~20 | apatite fission track | Wu et al., 2019 |
|  | ~20 | apatite fission track | Yuan et al., 2003 |
|  | ~20 | apatite fission track | Yuan et al., 2006 |
|  | ~20 | apatite fission track | Lewis, 1990 |
|  | ~19 | apatite fission track | Jolivet et al., 2001 |



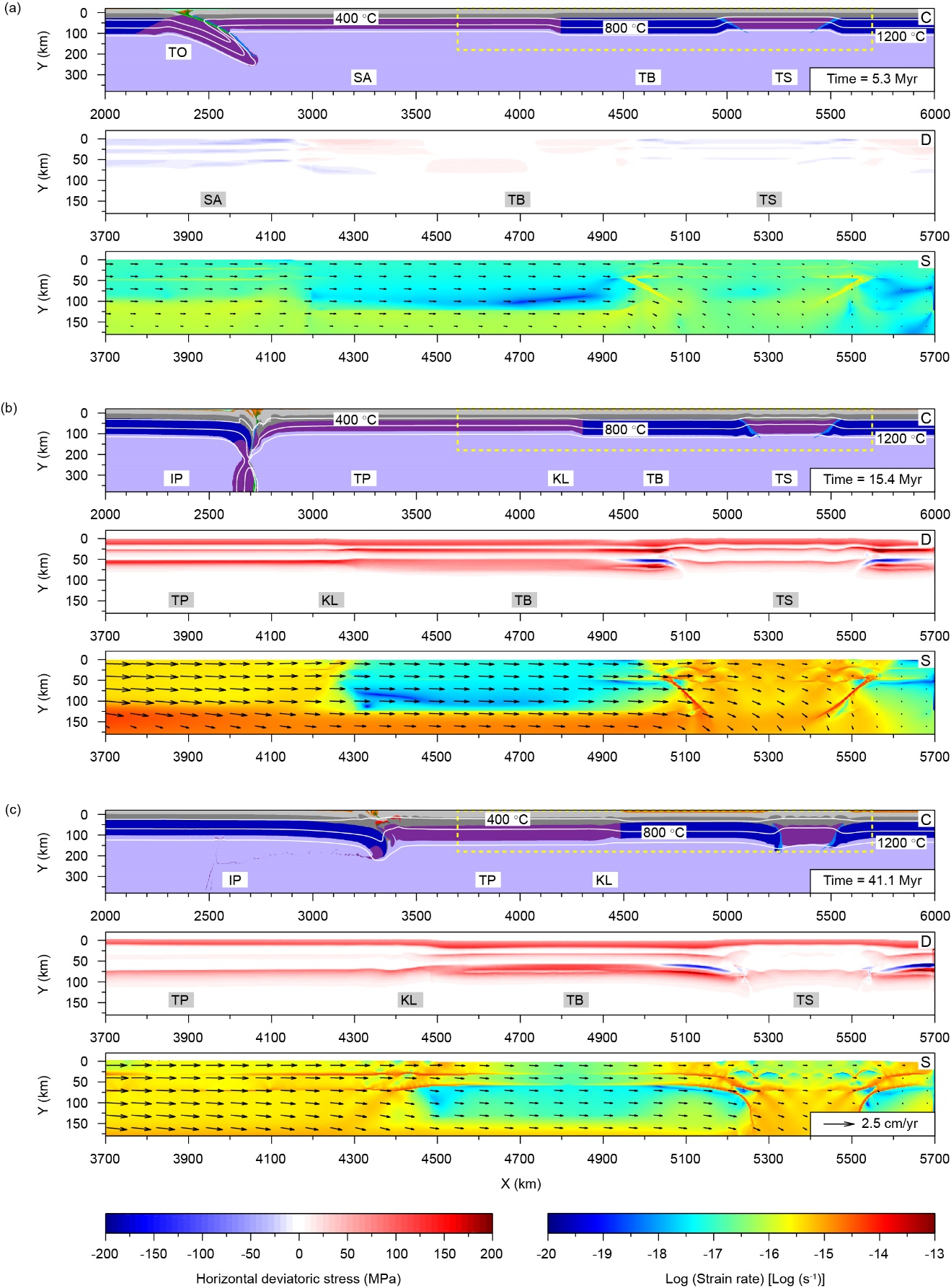
**Figure A.1.** Topographic evolution of the models outside the text in the Figure 11a.

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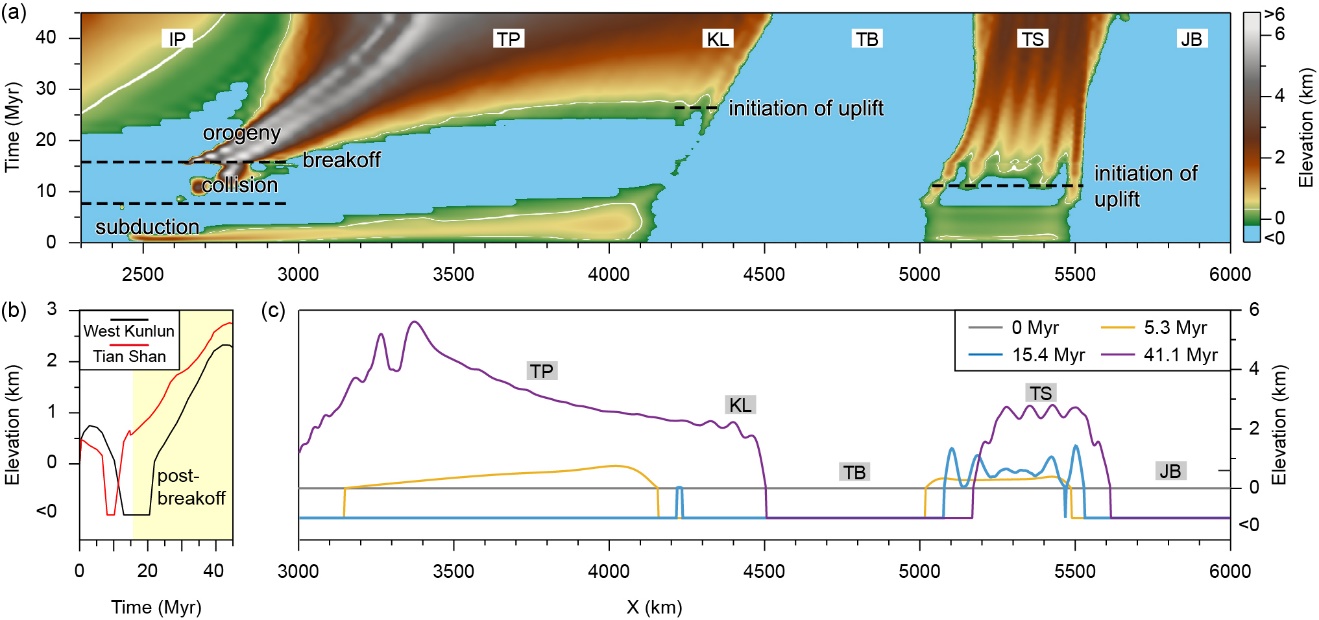
**Figure A.2.** Topographic evolution of the models outside the text in the Figure 11b.



**Figure A.3.** Topographic evolution of the models with higher convergence rate (V = 6.5 cm/yr). The higher convergence rate facilitates the build-up of topography, and yields more pronounced uplift difference between the West Kunlun and Tian Shan in the diachronous rise mode. The results reveal that an increased convergence rate is beneficial to the diachronous mode of intracontinental orogeny under the far-field effect of Indian-Asian collision.

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**Figure A.4.** Temporal evolution of the model with a changing convergence rate. The convergence rate is 5 cm/yr in the first 15 Myr, and then decreases to 2.5 cm/yr during the subsequent 5 Myr and keeps constant for the following processes. The snapshots are the composition fields, horizontal deviatoric stress and strain rate distribution of the whole process, which shows the same stages as in the reference model: (a) subduction of Tethys Ocean, (b) continental collision and (c) intraplate orogeny.

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**Figure A.5.** Results with respect to a changing convergence rate. (a) Topography evolution with time. The time when elevation reaches 500 m represents the initiation of uplift (white-colored contour line), and in this case Tian Shan uplifted earlier than that of West Kunlun range, demonstrating a diachronous rise pattern. (b) Topographic profiles of the Tian Shan and the West Kunlun. Light yellow-colored region represents post-breakoff stage. (c) Snapshots of topography distribution at 0, 5.3, 15.4 and 41.1 Myr, respectively. The result is a combination of the Model a (2.5 cm/yr) and the Model c (5 cm/yr). It yields diachronous rise mode, where the uplift difference of the Tian Shan and the West Kunlun is larger than that in the Model a, and the elevation of the West Kunlun is significantly higher than that in the Model c.

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