**Supplementary file**

**Method: Assimilation Fractional Crystallization (AFC) modelling**

The AFC modelling follows the equations proposed by DePaolo (1981), the concentration of an element in the magma (C) can be calculated by:

in which is the original concentration in the magma, F implies the relative content of magma after AFC processes, r denotes the assimilation rate to fractionation, is the concentration of contaminant. z is calculated by:

where D is the bulk partition coefficient of element in the crystals, which can be calculated by:

in which X and K represent the proportion of phase i in the melt and partition coefficient of an element in the phase.

Given the lack of convincing primitive magma composition of Tarim basalts, we assume that the primary magma of Tarim basalts resembles that of Kilauea (Sobolev et al., 2005), which contains significant amount of pyroxenite in the mantle source and consistent with the scenarios of Tarim basalts (Cheng et al., 2018). The most fractionated magma comes from Keping basalts and commonly display relatively low MgO contents between 2.05 and 6.99 wt.% (Zhou et al., 2009). The contaminant composition is calculated by averaging the composition of Precambrian basement of Tarim block (Hu et al., 2000; Long et al., 2010; Zhang et al., 2012). The modal compositions of the fractional phases are set to olivine (20%), clinopyroxene (40%) and plagioclase (40%). Partition coefficients of each element in these minerals come from Bédard (1994). The assimilation rate versus fractionation is set as 0.2 following the assumption of Reichow et al. (2005). Details of modeling parameters are shown Supplementary Table 1.

Supplementary Table 1. AFC modelling parameters of Tarim basalts.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Ba | Th | Nb | K | La | Sr | Ce | Nd | Zr | Sm | Eu | Ti | Dy | Y | Er | Yb |
| Partition coefficients a |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| olivine | 0.0005 | 0.02 | 0.01 | 0.0068 | 0.0004 | 0.016 | 0.0003 | 0.0002 | 0.003 | 0.0002 | 0.0002 | 0.007 | 0.0007 | 0.0020 | 0.0017 | 0.0052 |
| clinopyroxene | 0.0007 | 0.0003 | 0.0077 | 0.0072 | 0.0536 | 0.1283 | 0.0858 | 0.1873 | 0.1234 | 0.291 | 0.3288 | 0.384 | 0.442 | 0.467 | 0.387 | 0.43 |
| plagioclase | 0.5477 | 0.05 | 0.001 | 0.017 | 0.042 | 1.797 | 0.036 | 0.029 | 0.09 | 0.022 | 0.22 | 0.045 | 0.013 | 0.01 | 0.012 | 0.012 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Primitive magma (C0) b | 84.1 | 0.7 | 11.2 | 2800.0 | 9.4 | 253.1 | 23.7 | 16.1 | 107.8 | 4.1 | 1.4 | 11440 | 3.8 | 18.5 | 1.8 | 1.4 |
| Contaminant (Ca) c | 1383.8 | 7.4 | 7.5 | 20940.0 | 35.7 | 432.5 | 70.9 | 32.0 | 145.4 | 5.4 | 1.3 | 3797 | 3.6 | 17.9 | 2.0 | 1.7 |

a Bédard (1994)

b Sobolev et al. (2005)

c Hu et al. (2000), Long et al. (2010) and Zhang et al. (2012)

Supplementary Figure 1. AFC modelling results of Tarim basalts

Chart, line chart

Description automatically generated

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