Supplementary Figure 1. Simplified geological map of the Chifeng flood basalt province showing the sample locations and $^{40}$Ar/$^{39}$Ar dating results (in red) for this study.
Supplementary Figure 2. Age spectra, with integrated and plateau ages.
Supplementary Figure 3. (a) CIPW normative compositions of the Chifeng CFBs. Norms were calculated assuming Fe$^{2+}$/Fe$_{\text{total}}$ = 0.9. The 1 atm and 9 (±1.5) kbar cotectics are from Thompson$^{1, 2}$. Arrows point to the direction of decreasing temperature. (b) Total alkalis vs. SiO$_2$ diagram$^3$ for classification of the Chifeng CFBs.
Supplementary Figure 4. (a) K$_2$O/(Na$_2$O-2) versus SiO$_2$; (b) K$_2$O versus Na$_2$O; (c) K$_2$O versus SiO$_2$ (Peccerillo and Taylor, 1976), and (d) K$_2$O+Na$_2$O versus SiO$_2$ diagrams for the Chifeng CFBs. Alkali (Na$_2$O + K$_2$O) contents of the studied samples range from ~3 to 9% and the compositions plot in the medium- to high-K fields in (c). The samples show high sodium relative to potassium with K$_2$O/(Na$_2$O-2)<1.
Supplementary Figure 5. (a) Chondrite-normalized rare earth element patterns and (b) Primitive mantle-normalized incompatible trace element patterns for the Chifeng CFBs. Normalization values are from Sun and McDonough.\textsuperscript{4}
Supplementary Figure 6. Correlation of (a) K/Ce, (b) Tb/Yb, and (c) Sr/Ce ratios with eruptive longitude for the Chifeng CFBs. Error bars indicate 1 standard deviation (1 s.d.).
Supplementary Figure 7. Olivine $\delta^{18}$O values for 11 of the Chifeng continental flood basalts. For locations see Supplementary Fig. 1.
Supplementary Figure 8. Olivine $\delta^{18}$O values plotted against chemical compositions. This diagram shows that the melts with $\delta^{18}$O values lower than that of pristine mantle olivine are characterized by relative depletion in incompatible trace elements and low Nb/La and La/Sm ratios, but high Fe/Mn ratios. This suggests that the source of low-$\delta^{18}$O end-member melts was dominated by subducted oceanic crust.
Supplementary Figure 9. Plots of (a) TiO$_2$, (b) Al$_2$O$_3$, (c) CaO, and (d) CaO/Al$_2$O$_3$ versus Mg#. Mg# = 100×Mg/(Mg+Fe), Fe$^{2+}$/Fe$_{\text{total}}$ = 0.85 cation ratio. This shows that differentiation of the Chifeng CFBs is dominated by olivine and clinopyroxene fractionation.
Supplementary Figure 10. Variation of incompatible trace element ratios as a function of melting fraction. The partition coefficients and melting function for a peridotitic source from Salters and Stracke\textsuperscript{5} and for garnet-bearing pyroxenites are from Kelemen et al.\textsuperscript{6}. The partial melting was conducted using the same source. The
fractionation of these ratios from their source values at intermediate (≥0.1) to high
(0.2–0.3) melting fraction is insignificant. Compared to the large range of these ratios
in the Chifeng CFBS, the effect of partial melting on fractionation of these ratios can
be ignored.
Supplementary Figure 11. Covariations of selected major-trace element and incompatible trace element compositions and ratios as a function of Ce/Pb for the Chifeng CFBs and potential source components. Geochemical compositions of subducted slabs and sediments, average value of alkali OIB and N-MORB, Gaussberg lamproite, and partial melts of K-hollandite at 23 GPa are also shown. The samples with MgO≥9.0 wt% were also adjusted to equilibrium with primitive olivine (Fo90) (see details in Wang et al.). Inset in (e) shows the effect of partial
melting on the trace element ratios of Ce/Pb and Ba/Nb (see details in Supplementary Fig. 10).
Supplementary Figure 12. Plots of incompatible trace elements with Ce/Pb for the Chifeng CFBs. Geochemical compositions of subducted slabs and sediments\textsuperscript{7}, OIB and N-MORB\textsuperscript{4}, Gaussberg lamproite\textsuperscript{8} are also shown. The 30% clinopyroxene fractionation is from the Rayleigh fractionation model. The partition coefficient data are from Salters and Stracke\textsuperscript{5}.
Figure 13. Chemical variation of olivine phenocrysts. The red line that separates magmatic and xenocrystic olivines on the basis of CaO in (a) is after Thompson and Gibson\textsuperscript{11}. The mantle olivine array and fractional crystallization trend in (c) are from Sato\textsuperscript{12}. The ‘common’ olivine field in (c) outlines the compositional range for olivines.
from peridotites, mantle xenoliths, orogenic massifs and ophiolites, oceanic abyssal and mid-ocean-ridge basalts\textsuperscript{13}, whereas the Hawaiian olivine field denotes the range for olivine from the Hawaiian basalts, which are interpreted to have been derived from a hybridized pyroxenitic source formed by reaction of mantle peridotite with melts derived from recycled eclogitic oceanic crust\textsuperscript{13}. 
Supplementary References