Surface-wave tomography of the Emeishan large igneous province: Magma storage system, hidden hotspot track, and its impact on the Capitanian mass extinction

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METHODS

Radial seismic anisotropy is calculated from the discrepancy of Rayleigh wave and Love wave dispersion curves. Rayleigh wave and Love wave waveforms (Fig. S1) are extracted with seismic data from a total of 101 tele-seismic earthquakes with sufficient azimuthal ray coverage (Fig. S2) recorded by an array consisting of 25 broadband seismometers operated by MIT and Chengdu Institute of Geology and Mineral Resources between September 2003 and October 2004 (Yao et al., 2008). We apply a two-plane-wave inversion tomography method to obtain 1-D and 2-D Rayleigh wave and Love wave phase velocities at 18 periods from 20 to 143 s and compare them with previous studies (Yao et al., 2008; Fu et al., 2010; Xie et al., 2013) (Fig. S3, Fig. S4, Fig. S5). Two-dimensional Rayleigh wave and Love wave phase velocities (Fig. S4 and Fig. S5) are calculated at the corresponding periods using the 1-D average phase velocities as starting values (Fig. S3). The lateral resolution of phase velocity maps varies with frequency and its average resolution is $1.5^\circ \times 1.5^\circ$ according to our tests on checkerboard models and standard error distribution of phase velocity perturbation (Fig. S6, Fig. S7). Previous ambient noise tomography obtained Rayleigh wave and Love wave dispersion curves at short period data from 8 to 45 s (Xie et al., 2013). The phase velocity maps from two independent methods and data show high consistency at overlapping periods (i.e. from 20 to 45 s) (Fig. S8, Fig. S9). The resulted Rayleigh wave and Love wave phase velocities (from 8 s to 143 s), which are sensitive to depth ranges of 5-240 km (Fig. S10), are inverted for 1-D and 3-D vertical and horizontal shear wave velocity models (i.e., V_{sv} and V_{sh}) separately beneath the ELIP (Fig. S11, Fig. S12, Fig. S13). In this inversion, the model parameters include shear wave velocities in 16 layers from the surface to 410 km depth. We use the method of Saito (1988) to calculate the partial derivatives of phase velocity against model parameters. The starting model is a modified AK135 model (Kennett et al., 1995) with crustal thickness constrained by receiver functions (Li et al., 2014). The crustal thickness has a trade-off effect on velocity and radial anisotropy in the layers of lower crust and uppermost mantle, but the effect is so small that it does not change the key observations in the upper crust and uppermost mantle as shown in the test in Fig. S11. Subsequently we calculate isotropic average shear wave velocity (V_s) from V_{sh} and V_{sv} via a Voigt average (Babuska & Cara, 1991), $V_s = \sqrt{(2V_{sv}^2 + V_{sh}^2)/3}$ (Fig. 2; Fig. S14). The radial seismic anisotropy is defined as the percentage difference between V_{sh} and V_{sv} in the medium: $\gamma = (V_{sh} - V_{sv})/V_s$ (Fig. 2; Fig. S15). The vertical resolution of the velocity model is good to ~240 km

depth based on the model resolution matrix (Fig. S16). The larger the diagonal element, the better the resolution of the velocity. Our description and discussion focus on the structures that are well resolved in the radial anisotropy and shear wave velocity models. Three additional profiles (B-B', C-C', and D-D') are shown in Fig. S17. Their locations are shown in Fig. 2. An additional test is presented (Fig. S18) to validate the observed negative radial anisotropy in the lower crust.

NOTES

In Figure 1(B), the map of the Emeishan Large Igneous Province is compiled from the following sources: eruption center (Xu et al., 2004), uplift center (He et al., 2003), flood basalts exposed on the surface (He et al., 2003, 2007; Xu et al., 2004; Zhou et al., 2005; Zhang et al., 2006; Anh et al., 2011; Liu et al., 2017; Xiang et al., 2018) and drilled in wells (Q. Jiang et al., 2018), basaltic lava and volcanic craters buried in the Sichuan Basin (Ma et al., 2019; Xia et al., 2020), basaltic dikes (Li et al., 2015; Shen et al., 2018), borders of inner (I), intermediate (II), and outer (III) zones (Chung and Jahn, 1995; Li et al., 2017), fault traces (Ren et al., 2013; Lu et al., 2019). Two photos of the dike-dominated magma storage system in the outer zone of ELIP are annotated and shown in Fig. S19.

Figure 1(C) shows a map of the remnant thickness of the Maokou Formation, which was deposited on the Yangtze carbonate platform just before the Emeishan LIP magmatism (He et al., 2003). It is compiled from studies based on stratigraphic section measurement on outcrops, and well logs and 3-D seismic interpretation in the Sichuan Basin (e.g., H.B. Li et al., 2011; Tang et al., 2016; Zhang et al., 2020). The original thickness data are listed in Table S1. Among these references, one study (Y. Zhang et al., 2020) compiled over 300 well logs and used 3-D seismic data to characterize the Maokou Formation; however, their data are proprietary of PetroChina and not available to the public. All isopach maps and wells of the studies are imported and georeferenced in QGIS. We largely followed their original contours from 0 m to 800 m at an interval of 100 m. To show more details in the Sichuan Basin, we traced the 160 m contour in the Sichuan Basin, after Tang et al. (2016) and Zhang et al. (2020). We also drew the 250 m contour in the basin, which was interpolated from the 240 m and 260 m contours in Zhang et al. (2020). Necessary changes were made in the overlapping areas among the maps to connect the contours.

In Figures 1(A) and 4(B), black curve with teeth denotes modern and ancient (Permian) trench systems, respectively (Yin and Nie, 1996; Lin et al., 2014). In Figure 4(C), the ca. 600-km displacement on the Cenozoic Ailao Shan-Red River shear zone (Chung et al., 1997) and the ca. 120-km displacement on the Cenozoic Xianshuihe-Xiaojiang fault (Wang et al., 2009) are not restored for simplicity.

In Figure 4(C), the lithospheric thickness of the Yangtze craton follows two seismic tomography models (Li et al., 2008; Tao et al., 2018).

SUPPLEMENTARY FIGURES

Fig. S1.

Examples of Rayleigh wave and Love wave waveforms at station MC25 from an earthquake that occurred in the Aleutian subduction zone. (A) Three components of raw waveform. (B) The waveform on the top is a broadband Love wave train, and other waveforms are filtered with a 10 mHz width filter centered at frequencies from 6 to 40 mHz. (C) Same as (B), but for Rayleigh wave. The amplitudes of Rayleigh waves and Love waves at the highest frequency are almost 30 times larger than those at the lowest frequency. Waveforms are scaled to fit the frame.

Fig. S2.

(A) Distribution of tele-seismic events used for Rayleigh wave (black and gray solid circles) and Love wave tomography (gray solid circles only). Black triangle denotes the center of the seismic network. Epicentral distance from the center of the seismic array is marked by large concentric circles with numbers. (B) Great circle ray paths for Rayleigh wave tomography at a period of 50 s. Red triangles represent seismic stations. (C) Same as (B), but for Love wave tomography.

Fig. S3.

Average Rayleigh wave (solid) and Love wave (dashed) phase velocities at 18 periods from 20 s to 143 s in the entire study region. The obtained Rayleigh wave and Love wave phase velocities show high consistency with previous surface wave tomography studies using earthquake data and ambient noise data in this region (Yao et al., 2008; Fu et al., 2010; Xie et al., 2013).

Fig. S4.

Maps of Rayleigh wave phase velocity perturbations relative to the observed average values which are shown in the upper right corner of each frame. Velocity in km/s. Grey lines denote major faults (ASRRSZ, XXF, LMST) shown in Fig. 1, and red triangles are seismic stations. Red star in (A) is the eruption center of the ELIP; black dashed curves in (A) denote the borders of the inner and intermediate zones of the ELIP.

Fig. S5.

Same as Fig. S4, but for Love wave phase velocity perturbations.

Fig. S6.

Distribution of 2 x standard error (σ) (%) of Rayleigh wave (left) and Love wave (right) phase velocity perturbation at 35 s. The Rayleigh wave and Love wave phase velocity maps in the following figures are clipped using the 2% contour (Love wave).

Fig. S7.

Input and recovered checkerboard models for resolution tests on Rayleigh wave and Love wave phase velocities. (A) Input model with anomaly size of $1.5^\circ \times 1.5^\circ$. (B–D) Recovered Rayleigh wave models at periods of 25, 50, and 100 s, respectively. The grey line denotes contour of two times standard error (2σ) on phase velocity perturbation at corresponding periods. (E–G) Recovered Love wave models at periods of 25, 50, and 100 s, respectively. The grey line denotes contour of two times standard error (2σ) on phase velocity perturbation at corresponding periods.

Fig. S8.

Comparisons of Rayleigh wave and Love wave phase velocity maps at the period of 20 s from ambient noise tomography of Xie et al. (2013) (A & D) and two-plane-wave surface wave tomography with earthquake data (B & E) and their differences (C & F). ANT is ambient noise tomography; ET is earthquake surface wave tomography.

Fig. S9.
Same as Fig. S8, but for 35 s.

Fig. S10.

Sensitivity kernels of Rayleigh wave and Love wave with respect to isotropic (A) V_{sv} and (B) V_{sh} based on the shear velocity model AK135 ([Kennett et al., 1995](#)).

Fig. S11.

(A) 1-D averaged Vsv and Vsh profiles in the study area. Error bars are two standard errors for the shear velocity models. Black solid line indicates the global model AK135 (Kennett et al., 1995). Crustal thickness used for inversion is 55 km. (B) Observed (symbols with error bars) and predicted (red and blue lines) average Rayleigh wave and Love wave phase velocities in the entire study region, respectively. Standard errors were computed from the posteriori model covariance matrix. (C)-(D) Same as (A)-(B), respectively, but the crustal thickness used for inversion is 52 km.

Fig. S12.

3-D vertical shear wave velocity models (i.e. V_{sv}) beneath the study area at depths of 0-240 km. Velocity in km/s. Red star in first panel (0-15 km) is the eruption center of the ELIP; black dashed curves mark the borders of the inner and intermediate zones of the ELIP.

Fig. S13.

Same as Fig. S12, but for 3-D horizontal shear wave velocity models (i.e. V_{sh}). Velocity in km/s.

Fig. S14.

3-D isotropic shear wave velocity models (i.e. V_s) beneath the study area at depths of 0-240 km. V_s is calculated via a Voigt average (Babuska & Cara, 1991), $V_s = \sqrt{(2V_{sv}^2 + V_{sh}^2)/3}$. Velocity in km/s.

Fig. S15.

Radial anisotropy at 0-240 km depth. Radial seismic anisotropy is defined as the percentage difference between V_{sh} and V_{sv} in the medium: $\gamma = (V_{sh} - V_{sv})/V_s$. The first five panels (0-100 km) are shown in Fig. 2 in main text.

Fig. S16.

Model resolution matrix for isotropic (A) V_{sv} and (B) V_{sh} inversion from the average Rayleigh wave and Love wave dispersion curves. The vertical resolution of the velocity model is good to ~240 km depth based on the model resolution matrix. The larger the diagonal element, the better the resolution of the velocity. The resolution matrix is calculated from the inversion using the reference model.

Fig. S17.

(A)-(C) Profiles B-B', C-C', and D-D', respectively. Their locations are shown in Fig. 2 in the main text. Each profile contains topography, absolute isotropic V_s , and radial seismic anisotropy. Topography is depicted in top panels as a black curve with a unit of kilometer. V_s is a Voigt average calculated from V_{sh} and V_{sv} (Fig. S14). Radial anisotropy is computed from V_{sh} and V_{sv} (Fig. S15).

Fig. S18.

A test to validate the observed negative anisotropy in the lower crust beneath the ELIP. (A) Input and recovered 1-D anisotropic model. The input 1-D model contains radial anisotropy with an amplitude of 4% in the lower crust (30-55 km). Black solid and dashed lines indicate the input V_{sh} and V_{sv} , respectively. Red solid and dashed lines indicate the recovered V_{sh} and V_{sv} , respectively. (B) Rayleigh wave and Love wave phase velocities calculated from the input anisotropic model (black lines in A) and shown as squares and triangles, respectively. The red solid and dashed curves are the predictions from the recovered model from the joint inversion. The result shows that the observed negative anisotropy in the lower crust can be well recovered and is reliable.

Fig. S19.

(A) Mafic dikes in the outer zone of the Emeishan LIP. Host rock is Neoproterozoic granitic gneiss in the Gezong metamorphic dome of the Danba Anticlinorium, eastern Tibetan Plateau, and the exhumation of the Gezong dome took place in the Cenozoic (Tan et al., 2017). The emplacement age of the dikes was inferred to be around 260 Ma associated with the ELIP, based on $^{40}\text{Ar}/^{39}\text{Ar}$ plateau ages (264-259 Ma) of the overlying Danba schist obtained by Zhou et al. (2008). Red arrows mark the location of dikes and sills and do not necessarily indicate the injection orientation. The overall structural pattern shows a dike-dominated magma storage system. The brightness of the photo is increased by 20% to improve visualization; no other change is made. Photo courtesy of Yiduo Liu.

Fig. S19 (continued).

(B) Same as (A), but at a different location ca. 2 km to the southeast of (A).

SUPPLEMENTARY TABLE

Table S1. Compilation of published remnant thickness data of the Maokou Formation.

No.	Lat. (°N)	Long. (°E)	Thickness (m)	Ref.	No.	Lat. (°N)	Long. (°E)	Thickness (m)	Ref.
1	30.055	102.152	81.5	[1]	41	28.478	102.663	340	[1]
2	27.308	99.954	901.8	[1]	42	28.521	102.949	250	[1]
3	29.591	103.384	346	[1]	43	28.043	101.847	115	[1]
4	29.6	103.485	202	[1]	44	28.449	99.366	707.7	[1]
5	29.622	103.193	211	[1]	45	27.419	101.033	500	[1]
6	29.608	103.205	230	[1]	46	27.588	101.86	146.8	[1]
7	29.55	103.427	346	[1]	47	28.512	103.309	90	[1]
8	29.416	103.553	202	[1]	48	28.257	103.571	250	[1]
9	30.191	102.479	145	[1]	49	28.137	103.213	210	[1]
10	30.386	102.813	103	[1]	50	27.76	103.26	255	[1]
11	30.378	103.008	374	[1]	51	27.58	103.35	330	[1]
12	30.612	103.186	376	[1]	52	28.326	104.266	328	[1]
13	30.384	102.281	303.4	[1]	53	28.162	104.51	294	[1]
14	28.883	101.548	450	[1]	54	28.044	105.702	427	[1]
15	30.067	102.759	242.3	[1]	55	27.847	105.922	283	[1]
16	30.134	103.09	50	[1]	56	27.993	104.567	379.7	[1]
17	29.141	102.83	334	[1]	57	27.12	102.74	155	[1]
18	28.955	102.938	346	[1]	58	26.327	102.749	194	[1]
19	29.41	102.711	270	[1]	59	24.955	99.868	25	[1]
20	28.826	102.841	346	[1]	60	23.004	102.381	52	[1]
21	29.036	102.555	55	[1]	61	22.878	102.831	58	[1]
22	27.326	105.278	266	[1]	62	27.903	99.391	418.8	[1]
23	27.141	105.613	195	[1]	63	23.394	103.791	291.4	[1]
24	29.872	102.66	305	[1]	64	23.263	103.463	563.2	[1]
25	29.394	102.868	243	[1]	65	25.24	104.201	304.8	[1]
26	29.53	102.603	144	[1]	66	25.012	104.024	322.4	[1]
27	26.769	102.027	73	[1]	67	25.308	104.312	543.9	[1]
28	26.721	102.21	91	[1]	68	24.926	104.687	200	[1]
29	27.295	102.685	256	[1]	69	24.027	99.269	743.8	[1]
30	26.862	102.928	128	[1]	70	22.934	103.188	439.3	[1]
31	28.227	100.725	401.1	[1]	71	23.026	101.98	550.5	[1]
32	26.788	101.495	29.6	[1]	72	26.069	103.775	532.1	[1]
33	26.79	101.664	16	[1]	73	26.618	103.683	332.7	[1]
34	26.737	101.712	290	[1]	74	25.904	103.299	418.1	[1]
35	27.457	102.597	97.8	[1]	75	26.855	101.343	135.9	[1]
36	27.428	102.638	109	[1]	76	24.403	102.401	294.1	[1]
37	27.375	102.866	217.8	[1]	77	26.326	100.383	172	[1]
38	27.12	102.87	200	[1]	78	26.749	100.981	191.4	[1]
39	27.53	102.695	76.8	[1]	79	27.077	100.991	183.8	[1]
40	28.703	102.686	364	[1]	80	27.224	100.531	246.2	[1]

Table S1 (continued)

No.	Lat. (°N)	Long. (°E)	Thickness (m)	Ref.	No.	Lat. (°N)	Long. (°E)	Thickness (m)	Ref.
81	27.325	100.725	383.5	[1]	121	27.956	102.169	550	[1]
82	27.255	100.234	361	[1]	122	26.473	103.24	482	[1]
83	26.74	101	142	[1]	123	25.35	102.87	245	[1]
84	27.339	100.182	500	[1]	124	25.273	103.133	316	[1]
85	27.521	99.007	326	[1]	125	24.9	103.858	490	[1]
86	26.739	99.128	357.8	[1]	126	24.586	103.84	437.5	[1]
87	25.894	100.217	355.4	[1]	127	23.643	102.773	367.5	[1]
88	25.833	100.338	110	[1]	128	23.73	102.94	307.5	[1]
89	25.332	100.542	160	[1]	129	23.58	103.89	220	[1]
90	25.288	100.543	82	[1]	130	23.225	103.525	500	[1]
91	25.809	100.227	21	[1]	131	23.684	104.994	158	[1]
92	24.901	102.652	315.2	[1]	132	27.809	104.52	305	[1]
93	25.341	102.777	392	[1]	133	24.037	104.198	238	[1]
94	25.678	102.708	239	[1]	134	23.994	104.937	500	[1]
95	26.012	102.921	143	[1]	135	25.422	104.514	612.5	[1]
96	26.629	100.669	172	[1]	136	25.279	104.318	560	[1]
97	25.723	103.889	260.1	[1]	137	23.728	104.39	425	[1]
98	26.638	103.431	204	[1]	138	26.412	103.374	583	[1]
99	25.583	103.308	425.5	[1]	139	26.486	104.453	552	[1]
100	24.094	100.489	210	[1]	140	26.463	105.058	467	[1]
101	27.341	100.735	1350.4	[1]	141	27.629	104.047	213.9	[1]
102	24.816	103.326	385	[1]	142	27.809	104.52	315.6	[1]
103	27.178	103.561	330	[1]	143	27.855	104.794	316.9	[1]
104	26.896	102.921	403	[1]	144	27.615	104.861	157	[1]
105	26.568	103.046	425	[1]	145	25.678	105.17	224	[1]
106	26.864	104.245	294.1	[1]	146	25.731	105.151	470	[1]
107	26.585	109.032	220	[1]	147	25.668	105.169	383	[1]
108	26.768	103.099	326.3	[1]	148	25.03	105.307	244	[1]
109	25.272	103.133	303	[1]	149	24.653	105.319	269	[1]
110	24.713	103.416	227	[1]	150	24.794	107.165	160	[1]
111	25.323	103.998	310.7	[1]	151	25.998	105.097	288	[1]
112	25.596	103.821	337	[1]	152	24.686	105.302	160	[1]
113	23.395	101.597	823.6	[1]	153	25.686	105.911	67	[1]
114	26.884	100.224	225	[1]	154	25.609	106.157	125	[1]
115	23.743	102.542	432.2	[1]	155	26.628	106.751	170	[1]
116	27.675	100.72	262.5	[1]	156	25.711	106.1	150	[1]
117	26.326	100.383	182	[1]	157	25.672	106.15	282	[1]
118	27.38	103.83	630	[1]	158	24.426	107.275	294	[1]
119	27.731	101.898	146.8	[1]	159	25.66	104.409	612.7	[1]
120	27.332	101.672	270.3	[1]	160	24.985	105.835	284	[1]

Table S1 (continued)

No.	Lat. (°N)	Long. (°E)	Thickness (m)	Ref.	No.	Lat. (°N)	Long. (°E)	Thickness (m)	Ref.
161	26.034	105.374	590	[1]	201	24.856	105.180	280	[1]
162	25.708	104.473	496	[1]	202	24.696	105.250	212.5	[1]
163	27.794	105.057	253	[1]	203	24.692	108.340	628	[1]
164	27.591	105.422	237.5	[1]	204	32.390	105.562	221	[2]
165	27.407	106.391	150	[1]	205	32.377	105.617	173	[2]
166	27.325	105.278	280	[1]	206	32.249	106.228	231	[2]
167	27.343	105.027	312.5	[1]	207	32.144	106.251	194	[2]
168	27.21	105.82	235	[1]	208	32.071	105.401	219	[2]
169	26.8	105.32	460	[1]	209	32.305	106.267	196	[2]
170	26.763	104.427	547.5	[1]	210	32.397	106.270	180	[2]
171	26.515	105.04	572.5	[1]	211	32.395	106.300	200	[2]
172	26.285	105.579	675	[1]	212	32.456	106.213	195	[2]
173	26.313	104.277	532.5	[1]	213	32.543	106.229	145	[2]
174	26.084	104.073	512.5	[1]	214	32.661	105.883	124	[2]
175	25.682	104.574	595	[1]	215	32.534	105.740	145	[2]
176	25.25	105.31	500	[1]	216	32.323	105.478	193	[2]
177	25.14	105.15	260	[1]	217	32.377	105.499	210	[2]
178	27.953	106.93	220	[1]	218	32.288	105.408	192	[2]
179	27.558	107.034	108	[1]	219	32.218	105.296	155	[2]
180	27.285	107.277	157.5	[1]	220	32.136	105.197	135	[2]
181	27.01	106.46	132.5	[1]	221	32.633	105.922	100	[2]
182	26.307	105.279	228	[1]	222	32.488	105.651	154	[2]
183	26.606	107.221	245	[1]	223	30.629	103.255	386.7	[3]
184	26.62	107.625	207	[1]	224	30.780	103.327	218.5	[3]
185	26.423	107.534	208	[1]	225	30.807	103.407	369.9	[3]
186	26.128	106.04	517.5	[1]	226	31.038	103.535	257.2	[3]
187	26.154	106.64	280	[1]	227	31.053	103.667	280.5	[3]
188	26.098	106.82	254	[1]	228	31.202	103.777	92.9	[3]
189	25.968	107.545	96	[1]	229	31.530	104.141	197	[3]
190	25.834	107.236	412	[1]	230	32.227	105.307	168.2	[3]
191	25.816	107.357	376	[1]	231	27.091	100.260	1351	[4]
192	25.482	107.908	500	[1]	232	26.745	100.445	320	[4]
193	25.281	108.117	617	[1]	233	26.506	100.674	190	[4]
194	25.495	106.857	320	[1]	234	26.621	101.008	94	[4]
195	25.503	106.255	423	[1]	235	26.537	101.382	13	[4]
196	24.841	107.046	243	[1]	236	26.627	101.741	27	[4]
197	24.741	106.546	510	[1]	237	26.426	102.383	131	[4]
198	24.483	106.363	480	[1]	238	26.136	103.005	330	[4]
199	28.669	108.341	252.5	[1]	239	25.430	106.098	590	[4]
200	28.521	108.885	207	[1]	240	23.054	102.862	439	[4]

Table S1 (continued)

No.	Lat. (°N)	Long. (°E)	Thickness (m)	Ref.	No.	Lat. (°N)	Long. (°E)	Thickness (m)	Ref.
241	25.441	100.575	82	[4]	281	30.039	104.128	306.5	[10]
242	25.891	100.622	53	[4]	282	29.857	103.264	317	[10]
243	26.614	102.169	0	[4]	283	29.947	103.472	315	[10]
244	27.020	102.272	64	[4]	284	29.807	103.136	369	[10]
245	27.306	102.329	286	[4]	285	27.566	102.707	97.8	[11]
246	29.103	103.585	270	[4]	286	27.518	102.903	76.8	[11]
247	29.056	103.851	419.2	[5]	287	27.623	103.486	197.2	[11]
248	29.390	105.095	194.3	[5]	288	26.893	102.362	62.1	[11]
249	30.198	106.484	194.6	[5]	289	26.682	102.910	23.7	[11]
250	30.621	107.557	278.8	[5]	290	26.802	103.131	326.3	[11]
251	30.934	108.324	248.2	[5]	291	26.611	103.638	332.7	[11]
252	30.640	106.626	209.6	[6]	292	26.397	102.692	95.8	[11]
253	32.349	105.543	224.9	[6]	293	25.989	102.925	92	[11]
254	30.277	106.749	208.3	[6]	294	26.274	103.416	218.7	[11]
255	30.494	106.263	188.6	[6]	295	26.166	103.759	531.7	[11]
256	30.804	106.223	218.2	[6]	296	25.704	102.662	239.2	[11]
257	30.630	106.668	217.4	[6]	297	25.711	103.287	425.4	[11]
258	30.563	106.713	212.9	[6]	298	25.759	103.836	257.8	[11]
259	30.074	103.436	315.6	[7]	299	30.069	104.474	248.8	[12]
260	30.062	104.088	307.3	[7]	300	29.621	104.647	226.2	[12]
261	29.578	104.544	230.8	[7]	301	29.283	104.952	209.8	[12]
262	29.403	104.822	224.5	[7]	302	29.116	105.270	189.8	[12]
263	28.844	105.637	227.4	[7]	303	28.876	105.582	233.5	[12]
264	28.590	106.063	401.6	[7]	304	28.804	105.713	230.9	[12]
265	32.043	105.388	340.6	[8]	305	28.688	105.854	217.7	[12]
266	30.804	106.223	220.5	[8]	306	29.300	105.146	209.9	[13]
267	30.494	106.263	187.4	[8]	307	29.294	105.281	177.9	[13]
268	30.630	106.668	216.9	[8]	308	28.816	104.198	339.6	[14]
269	30.446	106.935	239.8	[8]	309	29.102	104.443	304.2	[14]
270	30.076	107.983	175.8	[8]	310	29.395	104.828	225	[14]
271	23.653	109.303	231	[9]	311	29.557	105.397	202.6	[14]
272	31.460	104.189	161	[10]	312	30.383	106.164	203.2	[14]
273	32.387	105.793	177	[10]	313	30.401	106.189	203.7	[14]
274	31.662	104.387	197.7	[10]	314	30.625	106.634	212.1	[14]
275	30.369	106.181	191	[10]	315	30.775	107.186	240.2	[14]
276	32.285	105.591	190	[10]	316	31.357	107.988	165.1	[14]
277	31.809	104.653	232.7	[10]	317	32.136	106.226	199.5	[15]
278	31.453	105.950	201.5	[10]	318	30.144	105.455	198.9	[15]
279	29.952	104.564	265.1	[10]	319	32.125	105.119	247	[15]
280	30.661	103.187	330.4	[10]					

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