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Supplemental Material

TABLE S1. HIGH-TEMPERATURE COMPONENT DIRECTIONS (HTC) OF THE LOCKHART FORMATION AT DODIYAL AND CHANGLA GALI SECTIONS

TABLE S2. HIGH-TEMPERATURE COMPONENT DIRECTIONS (HTC) OF THE KAWAGARH FORMATION AT DODIYAL AND JABRI SECTIONS

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TABLE S6. THE SELECTED CRETACEOUS AND PALEOGENE PALEOMAGNETIC POLES FROM THE TETHYAN HIMALAYA TERRANE

Figure S1. Equal-area projections of LTC directions for Lockhart (A,B) and Kawagarh Formation (C,D) in all sections. Red circles around the red stars denote the 95% confidence limit and mean directions. Solid (open) symbols denote the lower (upper) hemisphere. The black stars in the (A, C) denote the present geomagnetic direction (PGF) of the study area. LTC, low-temperature component; N: number of specimens; Dg, Ig, Ds, Is: declination and inclination values before and after tilt adjustment; k: the best estimate of the precision; α_{95} , the mean direction's radius lies within 95 percent confidence.

Figure S2. Equal-area projections of LTC (A,B) and HTC (C,D) directions for Lockhart in the Jabri section. Red circles around the red stars denote the 95% confidence limit and mean directions. The black star in (A) denotes the present geomagnetic direction (PGF) of the study area. The rest of the abbreviations are the same as for Figure S1.

TABLE S1. HIGH-TEMPERATURE COMPONENT DIRECTIONS (HTC) OF THE LOCKHART FORMATION AT DODIYAL AND CHANGLA GALI SECTIONS

Sample ID	Method	STEP-RANGE	N	n	D.T	D_g (°)	I_g (°)	D_s (°)	I_s (°)	k	MAD (°)	Polarity
Dodiya Section												
LD-39	GC	NRM-250C	7	7	T	198.7	41.4	134.2	65.5	228.6	4.0	R
LD-56	GC	2.0 mT –50.0 mT	21	16	A.F	209.8	40.6	142.8	73.3	309.2	2.1	R
LD-58	GC	10.0 mT –45.0 mT	23	17	A.F	191.9	41.6	130.7	60.6	63.8	4.5	R
LD-67	GC	2.0 mT –36.0 mT	20	18	A.F	197.1	40.5	135.5	64.1	14.5	9.4	R
LD-75	GC	140C-20.0 mT	15	11	H	154.1	62.7	89.5	42.6	12.2	13.6	N
LD-88	GC	140C-32.0 mT	20	16	H	229.3	20.2	225.5	67.1	10.3	12.1	R
LD-106	GC	RCD-40.0 mT	16	15	A.F	162.9	39.5	111.8	49.6	73.1	4.5	R
LD-117	GC	6.0 mT –24.0 mT	14	10	A.F	228.3	14.6	239.9	61.0	106.6	4.7	N
LD-120	GC	6.0 mT –45.0 mT	17	13	A.F	185.1	45.0	101.3	70.0	9.7	14.0	N
LD-150	GC	200C-350C	12	6	T	129.3	47.8	81.1	35.9	114.0	6.3	R
LD-151	GC	110C-325C	9	6	T	195.9	28.8	164.3	75.6	24.2	13.9	R
LD-188	GC	9 mT –33mT	16	9	AF	133.0	35.3	81.0	47.2	8.9	14.1	N
LD-189	GC	30 mT –90 mT	24	7	AF	141.6	37.5	83.1	49.8	9.9	17.2	N
LD-190	GC	5 mT –60mT	22	10	H	109.5	34.0	76.3	24.1	21.2	13.4	N
LD-191	GC	NRM-250C	9	7	T	179.4	26.4	137.2	76.2	15.7	12.6	N
Changla Gali Section												
LC-1	PCA	260C-470C	16	8	T	335.8	-32.7	332.8	40.5	83.4	6.1	N
LC-2	GC	6.0 mT –120 mT.	22	18	A.F	252.2	9.9	78.2	17.4	1193.5	1.0	N
LC-3	GC	6.0 mT –100 mT	20	15	A.F	271.2	12.2	259.9	1.4	1802.0	0.9	N
LC-4	PCA	290C-380C	16	4	T	347.0	-48.6	350.6	29.9	55.9	12.4	N
LC-5	GC	6.0 mT –100 mT.	20	16	A.F	275.3	41.8	230.9	9.1	74.5	4.3	N
LC-6	GC	4.0 mT –100 mT.	20	16	A.F	239.6	15.2	68.8	27.6	1123.4	1.1	N
LC-7	PCA	260C-380C	16	5	T	337.0	-36.6	336.6	37.8	88.0	8.2	N
LC-8	GC	10.0 mT –120 mT	33	27	A.F	240.5	6.8	78.3	29.4	302.2	1.6	N
LC-9	GC	6.0 mT –100 mT	20	15	A.F	264.4	21.2	69.7	3.3	2279.8	0.8	N
LC-10	PCA	230C-410C	17	7	T	345.9	-26.9	339.4	49.9	583.6	2.5	N
LC-11	GC	6.0 mT –110 mT	22	18	A.F	256.2	7.5	81.6	14.1	104.3	3.4	N
LC-13	GC	6.0 mT –90.0 mT	23	16	A.F	247.7	9.0	78.0	21.9	377.5	1.9	N
LC-14	GC	4.0 mT –90.0 mT	20	17	A.F	241.1	6.4	78.9	28.8	25.5	7.2	R
LC-15	PCA	260C-410C	17	5	T	314.0	-46.2	329.0	19.3	235.1	5.0	N
LC-16	GC	4.0 mT –55.0 mT	22	13	A.F	281.8	39.7	233.4	13.9	19.6	9.6	N
LC-17	GC	350C-100 mT.	23	12	H	272.8	47.0	225.5	7.8	146.3	3.6	R
LC-19	PCA	375C-50.0	23	8	H	324.0	-28.0	319.0	37.1	152.4	4.5	N
LC-21	GC	3.0 mT –100 mT.	24	22	A.F	243.1	13.4	72.0	25.0	123.5	2.8	N
LC-24	GC	RCD-12mT	7	5	A.F	248.9	1.8	85.8	22.4	42.3	11.9	N
LC-25	PCA	300C-120 mT.	23	11	H	342.5	-30.5	337.9	45.4	57.0	6.1	N
LC-30	PCA	300C-120 mT	23	10	H	305.5	-48.7	327.6	13.2	40.3	7.7	N
LC-31	PCA	10.0 mT –80.0 mT	20	8	A.F	292.0	-24.9	300.8	13.5	696.1	2.1	N
LC-32	GC	80C-120 mT.	23	16	H	242.2	28.7	56.3	20.3	13.5	10.4	N
LC-33	GC	3.0 mT –100 mT.	23	22	A.F	259.4	46.5	44.2	1.3	490.6	1.4	N
LC-34	PCA	375C-120 mT.	24	14	H	317.6	-35.3	321.6	28.3	438.2	1.9	N
LC-35	GC	21.0 mT –100 mT.	22	15	A.F	29.1	12.6	100.1	63.3	143.7	3.2	N
LC-36	GC	3.0 mT –80.0 mT	21	19	A.F	245.8	23.1	63.0	19.4	167.5	2.6	N
LC-38	PCA	10.0 mT –100 mT.	22	7	A.F	321.9	-41.6	329.4	26.6	2527.4	1.2	N

LC-39	GC	6.0 mT –120 mT.	23	21	A.F	244.1	20.3	65.3	21.8	150.3	2.6	N
LC-40	PCA	20.0 mT –100 mT.	22	7	A.F	304.1	-48.2	326.7	12.6	253.2	3.8	N
LC-41	PCA	250C-440C	16	6	T	306.7	-29.2	310.3	23.9	60.2	8.7	N
LC-42	GC	12.0 mT –100 mT.	22	21	A.F	243.9	21.9	63.6	21.5	70.9	3.8	N
LC-43	PCA	350C-100 mT.	24	10	H	309.0	-46.4	327.0	16.4	43.6	7.4	N
LC-45	PCA	375C-100 mT.	24	12	H	325.1	-40.2	330.3	29.3	1555.1	1.1	N
LC-46	GC	RCD-12.0 mT	7	5	A.F	238.2	21.1	62.2	26.7	131.3	6.7	N

Note: Abbreviations are: PCA/GC: direction obtained by using the principal component analysis/ great circle methods; *N*: number of steps used to demagnetize the specimen; *n*: number of data points used to calculate the direction; D.T: Demagnetization technique (T: Thermal; AF: Alternating field and H: hybrid thermal/AF; Dg and Ig (Ds and Is) are declination and inclination in geographic (stratigraphic) coordinates, respectively; MAD: Maximum angular deviation; N (R): normal (reversed) polarities.

TABLE S2. HIGH-TEMPERATURE COMPONENT DIRECTIONS (HTC) OF THE KAWAGARH FORMATION AT DODIYAL AND JABRI SECTIONS

Sample ID	Method	STEP-RANGE	N	n	D.T	D _g (°)	I _g (°)	D _s (°)	I _s (°)	k	MAD (°)	Polarity
Dodiya Section												
KD-2	GC	110C-430C	21	13	T	27.8	73.5	44.4	27.6	41.7	6.8	R
KD-4	GC	110C-400C	20	12	T	285.8	71.9	28.2	51.5	42.4	8.6	R
KD-5	GC	140C-470C	23	8	T	255.3	67.8	32.5	43.4	46.3	9.4	R
KD-7	GC	110C-440C	22	14	T	262.1	73.4	35.2	36.2	47.7	5.6	R
Jabri Section												
KJ-2	PCA	150C-540C	20	16	T	173.4	-47.4	154.8	12.6	162.7	2.9	R
KJ-6	PCA	300C-500C	18	9	T	162.6	-47.1	149.8	18.0	48.1	7.5	R
KJ-7	PCA	200C-500C	18	13	T	156.0	-42.0	149.3	25.0	48.7	6.0	R
KJ-18	GC	150C-430C	17	10	T	156.8	37.1	254.2	52.1	121.5	4.4	R
KJ-19	GC	150C-330C	15	5	T	144.3	38.7	266.6	59.2	74.9	8.9	R
KJ-21	GC	110C-410C	16	10	T	131.2	42.4	287.6	61.5	72.8	5.7	R
KJ-22	GC	110C-420C	17	9	T	156.9	36.2	252.9	52.4	45.7	7.7	R
KJ-26	GC	110C-420C	17	8	T	188.4	44.4	254.6	27.2	134.1	4.8	R
KJ-28	GC	80C-250C	7	5	T	190.9	52.5	263.3	24.6	43.0	11.8	R
KJ-31	GC	80C-360C	16	7	T	183.0	40.6	250.7	31.6	24.3	12.5	R
KJ-33	PCA	80C-300C	14	5	T	174.2	33.5	243.4	39.5	45.2	11.5	R
KJ-34	GC	80C-300C	14	6	T	205.6	40.1	250.3	14.5	144.1	5.6	R
KJ-35	GC	80C-330C	14	7	T	190.5	42.8	252.7	25.8	141.0	5.1	R
KJ-36	PCA	80C-430C	17	13	T	189.7	39.3	248.8	26.6	113.9	3.9	R
KJ-38	GC	80C-380C	15	7	T	141.1	25.5	245.5	69.3	34.6	10.4	R
KJ-41	GC	110C-360C	14	6	T	162.8	48.3	265.6	42.9	67.7	8.2	R
KJ-43	PCA	150C-330C	13	5	T	102.9	5.0	58.1	68.7	209.3	5.3	R
KJ-45	GC	110C-325C	13	5	T	104.5	32.8	340.7	66.2	42.3	11.9	R
KJ-46	GC	80C-330C	13	5	T	178.4	50.6	263.1	32.6	139.5	6.5	R
KJ-47	PCA	110C-250C	9	4	T	129.9	39.6	287.7	64.5	115.1	8.6	R

Note: For abbreviation, see **Tables S1**.

TABLE S3. LOW-TEMPERATURE COMPONENT MEAN VALUES AND STATISTICAL PARAMETERS FROM THE STUDY SECTIONS

Sections	Strike/Dip	N	D_g	I_g	k_g	$\alpha_{95\ g}$	D_s	I_s	k_s	$\alpha_{95\ s}$
<u>Lockhart Formation</u>										
Dodiyal	$\bar{X} \dagger = 300/50$	92	0.1	53.8	45.6	2.2	14.7	9.2	27.7	2.9
Changla Gali	90/80	37	5.6	55.3	32.1	4.2	179.1	44.6	32.1	4.2
Jabri	42/70	23	7.9	53.9	19.9	7.0	95.9	34.4	19.9	7.0
<u>Kawagarh Formation</u>										
Dodiyal	320/47	9	356.4	54.8	84.5	5.6	21.9	18.6	84.5	5.6
Jabri	42/70	31	357.8	48.8	46.0	3.8	338.9	-11.8	46.0	3.8

Note: N: number of specimens included in statistics; $D_g, I_g/D_s, I_s$: declination and inclination before and after tilt correction; $k_g, \alpha_{95\ g}/k_s, \alpha_{95\ s}$: precision parameter/radius of the cone of 95% confidence for mean direction before and after tilt correction; All angles are in degrees. Strike/Dip follows the right-hand rule.

$\bar{X} \dagger$ = Mean value

TABLE S4 THE PALEOMAGNETIC DATA FROM THE KLA

ID	Site	Time	N/n	Observed		Paleopole			Paleolat	Rock type	R	Reference	
	(°N/°E)	(Ma)		Dec	Inc	α_{95}	Plat	Plon	A_{95}	(°)			
				(°)	(°)	(°)	(°)	(°)	(dp/dm)				
Kohistan Island Arc At Reference Position (34.0°N, 73.0°E)													
1	35.5/71.8	Cretecous	7/42	311.2	-4.4	17.8	31.1	132.5	8.9/17.8	-2.2	Rb	P	Zaman and Torii (1999)
2	35.6/71.8	Cretecous	5/33	263.0	2.2	10.6	5.0	167.0	10.6/5.3	1.1	Rb	P	Zaman and Torii (1999)
3	36.1/74.2	75	60/-	11.5	39.8	3.5	N.D	N.D	N.D	22.6	D	S	Jadoon et al. (2021)
4	35.5/72.5	Late Palaeocene (Utror Volcanic)	17/-	N.D	17.1	8.3	N.D	N.D	N.D	9 ± 4	V	S	Ahmad et al. (2000)
5	35.5/72.5	Late Palaeocene (Utror Volcanic)	17/-	N.D	-24.6	7.4	N.D	N.D	N.D	13 ± 4	V	S	Ahmad et al. (2000)
6	36.3/73.2	Late Palaeocene (Teru Volcanic)	12/-	341.0	43.2	8.9	70.4	314.6	6.9/11.1	27.5 ± 6	V+P	S	Ahmad et al. (2001)
Ladakh Island Arc At Reference Position (34.0°N, 73.0°E)													
1	34.4/77.7	61.64–66.10	18/-	354.1	16.8	7.5	64.0	266.4	5.6	8.6	V	P	Martin et al. (2020)
Note: ID: Serial number; N/n: number of samples or sites used to calculate Fisher mean; Dec and Inc are declination and inclination, respectively; Plat and Plong are latitude and longitude of paleopoles; α_{95} and A_{95} is the radius of cone at 95% confidence level about the mean direction, $A_{95} = (\text{dp} \cdot \text{dm})^{0.5}$; Paleolat is the paleolatitude calculated for the reference point at 34.0°N, 73.0°E; Rock type: Rb, Red-beds; V, volcanic rock; D, dyke; R: remanence, P: primary, S: secondary													
[#] N.D. = not determined.													

TABLE S5 THE SELECTED CRETACEOUS AND PALEOGENE PALEOMAGNETIC POLES FROM THE LHASA TERRANE

ID	Site	Time	N/n	Observed		Paleopole			Paleolat	Rock type	Q	Reference
	(°N/°E)	(Ma)		Dec (°)	Inc (°)	α_{95} (°)	Plat (°)	Plon (°)	A_{95} (dp/dm)	(°)		
Lhasa terrane At Reference Position (34.0°N, 73.0°E)												
1	30.0/91.1	E(53)	9/-	15.4	27.2	9.7	68.9	225.4	7.8	14.9	Dy	Liebke et al. (2010)
2	30.0/91.1	E(54–47)	24/195	12.5	39.4	5.3	76.4	212.6	5	23.3	V	Dupont-Nivet et al. (2010)
3	30.0/91.0	E	8/46	350.9	25.5	11	71.4	299.8	11	20.4	V	Achache et al. (1984)
4	30.1/90.9	P-E(55)	14/99	359	26.1	9.2	73.6	274.3	7.3	18.6	V	Sun et al. (2010)
5	29.9/84.3	P-E(57–54)	-/62	348.1	42	7.1	78	329	5.9	30.3	S	Meng et al. (2012)
6	30.0/91.1	E(50–44)	18/-	12.3	23.2	7.2	69.1	234.2	5.6	14.0	V	Chen et al. (2014)
7	31.3/95.9	K2	15/-	0.9	24.3	5.6	71.4	273.1	5.2	16.4	Rb	Tong et al. (2017)
8	31.2/84.7	K2	33/291	316.8	30.2	5.4	49	344.3	5.3	25.7	Rb	Yang et al. (2015b)
9	29.9/90.7	K2	20/126	350.8	32.1	8.1	75	306.7	6.8	24.4	Rb+V	Sun et al. (2012)
10	29.9/91.2	K2	43/377	350.2	23.5	2.5	70.2	300.5	2.2	19.7	Rb	Tan et al. (2010)
11	31.6/82.2	K2(~80)	15/-	346.6	25.6	3.5	68.4	298.8	2.7	17.9	V	Yi et al. (2015)
12	32.4/80.1	K2(~92)	10/-	21.1	26.8	10	64.1	209	9.6	14.0	V	Yi et al. (2015)
13	29.9/91.1	K2(~70)	21/-	0.5	20.2	6.4	70.5	269.6	4.9	15.2	Rb+V	Cao et al. (2017)
14	32.3/80.1	K2(67–72)	17/-	43.3	30.3	6.9	47.8	181.4	6.4	13.8	V	Ma et al. (2017)
15	31.1/84.4	K1(121–117)	12/116	350.5	25.5	7.7	70.5	292.9	7.4	18.3	V	Yang et al. (2015b)
16	32.3/82.6	K1(132–120)	51/444	28.2	34.5	2.3	61.4	192.9	2.1	17.7	V	Ma et al. (2014)
17	31.3/85.1	K1(130–110)	18/162	327	35.7	4.5	58.2	341.9	4.6	27.8	V	Chen et al. (2012)
18	31.3/91.9	K1(~120.2)	19/163	356.4	16.4	6.3	66.9	281.2	6.1	13.2	S+V	Li et al. (2017)
19	32.2/80.4	K1(116–113)	19/164	340.9	36	4.6	69.1	319.8	4.8	23.9	V+Li	Bian et al. (2017)

Note: ID: Serial number; Time (Ma): K2, Late Cretaceous. K1, Early Cretaceous. P, Paleocene. E, Eocene; N/n: number of samples or sites used to calculate Fisher mean; Dec and Inc are declination and inclination, respectively; Plat and Plong are latitude and longitude of paleopoles; α_{95} and A_{95} is the radius of cone at 95% confidence level about the mean direction, $A_{95} = (\text{dp} \cdot \text{dm})^{0.5}$; Paleolat is the paleolatitudes calculated for the reference point at 34.0°N, 73.0°E; Rock type: Rb, Red-beds; S, sandstone; Li, limestone; V, volcanic rock; D, dyke; Ch, chert; Q: Paleomagnetic pole quality factor (Van der Voo et al., 1990).

TABLE S6 THE SELECTED CRETACEOUS AND PALEOGENE PALEOMAGNETIC POLES FROM THE TETHYAN HIMALAYA TERRANE

ID	Site	Time	N/n	Observed			Paleopole			Paleolat	Rock type	Q	Reference
	(°N/°E)	(Ma)		Dec	Inc	α_{95}	Plat	Plon	A ₉₅	(°)			
				(°)	(°)	(°)	(°)	(°)	(dp/dm)				
Tethyan Himalaya terrane At Reference Position (34.0°N, 73.0°E)													
1	28.3/88.5	P(59–56)	14/142	357	19.6	3.5	71.6	277.8	2.5	17.0	Li	7	Yi et al. (2011)
2	34.0/73.0	P(59–56)	50/-	329.9	24.8	3.7	55.6	312.8	2.2/4.1	13.0	Li	7	This study
3	28.3/88.5	P(62–59)	18/171	0.8	11.1	4.2	67.3	266.3	3.5	11.8	Li	7	Yi et al. (2011)
4	28.3/88.5	P(63–55)	14/113	356.2	7.9	7.5	65.4	277.6	3.8/7.6	11.2	Li	7	Patzelt et al. (1996)
5	28.7/87.2	P	4/28	335.5	–5.9	10.6	50.6	307.9	5.3/10.6	7.4	Li	5	Besse et al. (1984)
6	28.7/86.8	P	3/15	162.4	29.1	6.6	42.6	280.1	4.0/7.3	–9.5	Li	5	Tong et al. (2008)
7	29.3/85.3	P(62.5–59.2)	–/86	176.3	–26	2.6	74	278.5	2.5	19.3	Rb	7	Yuan et al. (2020)
8	28.3/88.5	K2(71–65)	14/156	4	–11.2	8.5	55.8	261.4	4.4/8.6	0.1	Li	7	Patzelt et al. (1996)
9	28.9/89.2	K2(76.2–74.0)	–/127	10.3	–35	2.1	40.8	256.3	1.8	–15.1	Rb	7	Yuan et al. (2020)
10	34.0/73.0	K2 (84.0–80.0)	24/-	331.9	–16.7	3.8	39.8	290.3	2.2/4.1	–8.5	Li	7	This study
11	29.7/84.0	K1(120.8–93.9)	12/53	341.7	–51.7	4.7	25	285.7	4.8/7.1	–23.3	Rb	7	Qin et al. (2019)
12	28.1/92.4	K1(134–131)	31/225	261.6	–68.5	3.6	26.8	135.2	5.7	–36.2	V	7	Yang et al. (2015a)
13	28.8/91.3	K1(135–124)	26/216	296.1	–65.7	4	5.9	128	6.1	–32	V	7	Ma et al. (2016)
14	28.9/91.3	K1(138–135)	31/-	321.2	–68.7	4.4	0.9	293.4	7	–38.5	V	7	Bian et al. (2019)
15	28.8/83.8	K1	–/95	326	–61.5	5	12	288.7	6.0/7.5	32.8	S	5	Klootwijk and Bingham (1980)
16	28.5/87.0	K1	–/201	19.7	–71	3	4.4	256	3	–51.5	S	5	Huang et al. (2015)
17	28.1/92.4	K1(–131.1)	8/-	7.3	–56.8	16.1	22	266.7	7.6	–32.5	V	7	Meng et al. (2019)
18	28.1/92.4	K1	20/-	6.4	–57.8	6					Li	7	Meng et al. (2019)
19	29.7/83.6	K1	–/53	3.1	–47.8	4.4	29.7	260.1	4.9	25.9	S+Ch	7	Meng et al. (2019)
India APWP At Reference Position (34.0°N, 73.0°E)													
1		40					74.7	286.8	2.9	21.0			Torsvik et al. (2012)
2		50					65.1	278.4	2.8	11.1			Torsvik et al. (2012)
3		60					48.5	280.9	2.1	–3.8			Torsvik et al. (2012)
4		70					36.4	280.7	2.5	–15.0			Torsvik et al. (2012)
5		80					29.1	283.5	2.9	–20.6			Torsvik et al. (2012)
6		90					20.9	291.4	2.5	–24.0			Torsvik et al. (2012)

Note: Abbreviations are the same as TABLE S6

In-situ

Tilt-corrected

Figure S1. Equal-area projections of LTC directions for Lockhart (A,B) and Kawagarh Formation (C,D) in all sections. Red circles around the red stars denote the 95% confidence limit and mean directions. Solid (open) symbols denote the lower (upper) hemisphere. The black stars in the (A, C) denote the present geomagnetic direction (PGF) of the study area. LTC, low-temperature component; N: number of specimens; D_g , I_g , D_s , I_s : declination and inclination values before and after tilt adjustment; k : the best estimate of the precision; α_{95} , the mean direction's radius lies within 95 percent confidence.

Figure S2. Equal-area projections of LTC (A,B) and HTC (C,D) directions for Lockhart in the Jabri section. Red circles around the red stars denote the 95% confidence limit and mean directions. The black star in (A) denotes the present geomagnetic direction (PGF) of the study area. The rest of the abbreviations are the same as for Figure S1.

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