

Supplementary Materials

Table S1. Debris flow gully number and geographical location

Number	Gully Name	Location
1	Yapi gully	N27°39'1.23" E101°5'24.87"
2	Catuo gully	N30°02'51.72" E100°57'7.15"
3	Dakang gully	N30°02'27.73" E100°58'27.23"
V1	K88+230 gully	29°13'44.67"N 102°54'52.48"E
V2	Luoduo gully	29°14'27.65"N 102°50'11.92"E
V3	Banyang gully	29°17'23.84"N 102°49'16.57"E
V4	Tangshang gully	32°31'21.28"N 104°32'35.00"E
V5	Guanba gully	32°33'12.23"N 104°33'20.27"E
V6	Majingzi gully	29°10'52.55"N 102°23'26.14"E
V7	Chenghuangmiao gully	31°1'52.73"N 102°10'32.61"E
V8	Lebucun gully	28°19'6.88"N 103°5'37.72"E
V9	Shitouwa gully	28°39'19.01"N 103°30'14.92"E
V10	Wuyiwan gully	28°37'56.89"N 103°29'49.09"E

Table S2. Parameters of CDH in other seven watersheds along the Emei-Hanyuan Expressway, Jiuzhai-Mianyang Expressway, Lexi-Xichang Expressway

Gully Name	Hollow number	CDH					Ratio a	Safety factor (F_s)
		Area (m ²)	Average thickness (m)	Volume (m ³)	Average slope (°)	Back-end catchment area (m ²)		
K88+230 gully	AC1	932	1.7	1957	34.5	19305	21	1.11
Luoduo gully	AC1	838	2.1	1761	30.5	58099	69	1.12
	AC2	1034	1.9	1965	33.7	20824	20	1.06
	AC3	1273	1.8	2546	35.4	27009	21	1.04
Banyang gully	AC1	946	1.6	1514	28.9	23297	25	1.43
	AC2	508	1.4	711	27.6	5061	10	1.61
Tangshang gully	AC1	1182	2.4	2383	27.4	21105	18	1.14
	AC2	512	2.2	1127	29.3	8866	17	1.13
Guanba gully	AC1	200	2.0	400	31.0	4919	25	1.14
Majingzi gully	AC1	867	1.6	1387	40.1	22536	26	0.94
	AC2	726	1.4	1016	39.2	22821	31	1.05
	AC3	711	1.9	1351	37.8	22821	32	0.91
Chenghuangmiao gully	AC1	210	1.5	357	39.1	6831	32	1.02

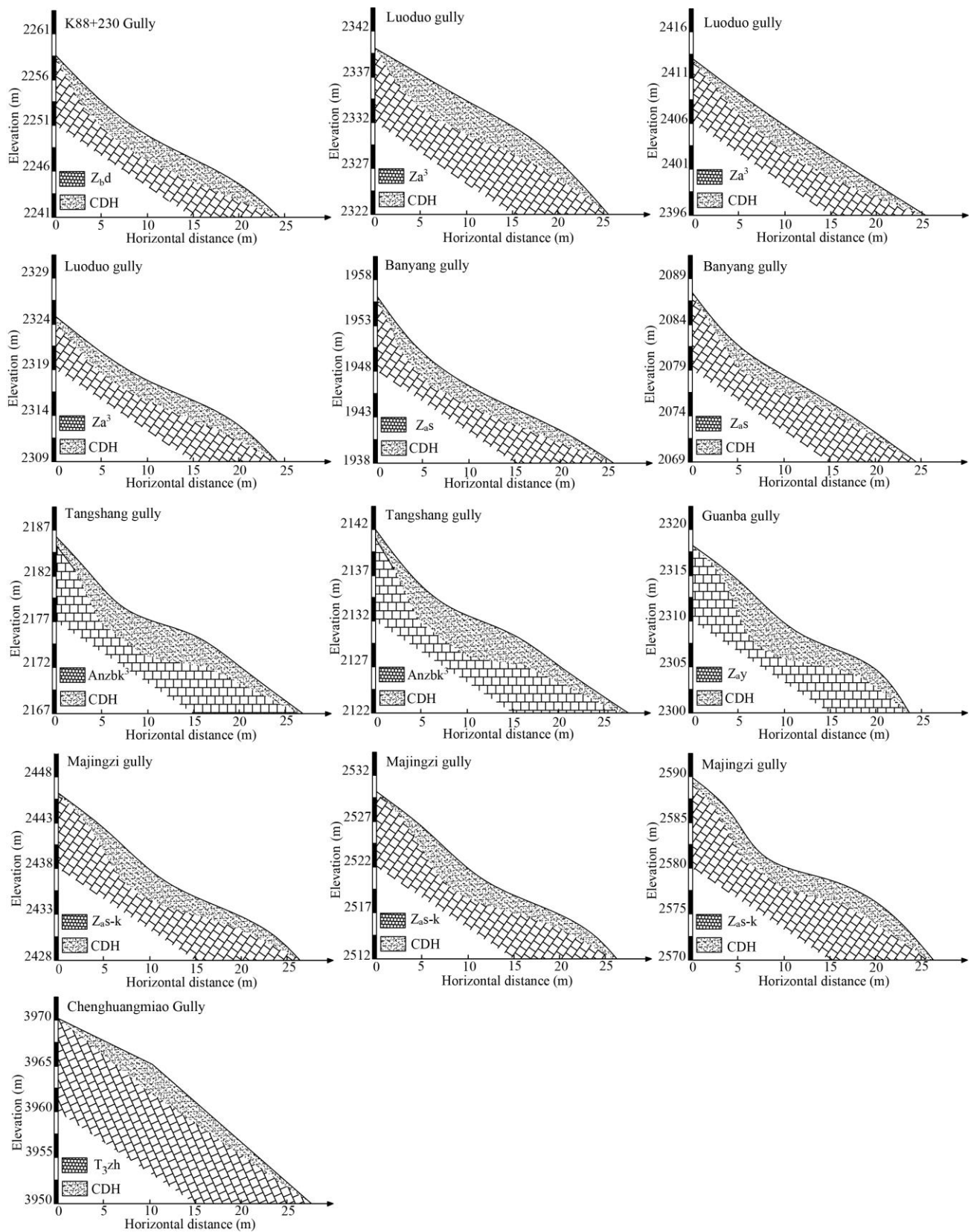


Figure S1. CDH profiles of seven watersheds along the Emei-Hanyuan Expressway, Jiuzhai-Mianyang Expressway, Lexi-Xichang Expressway.

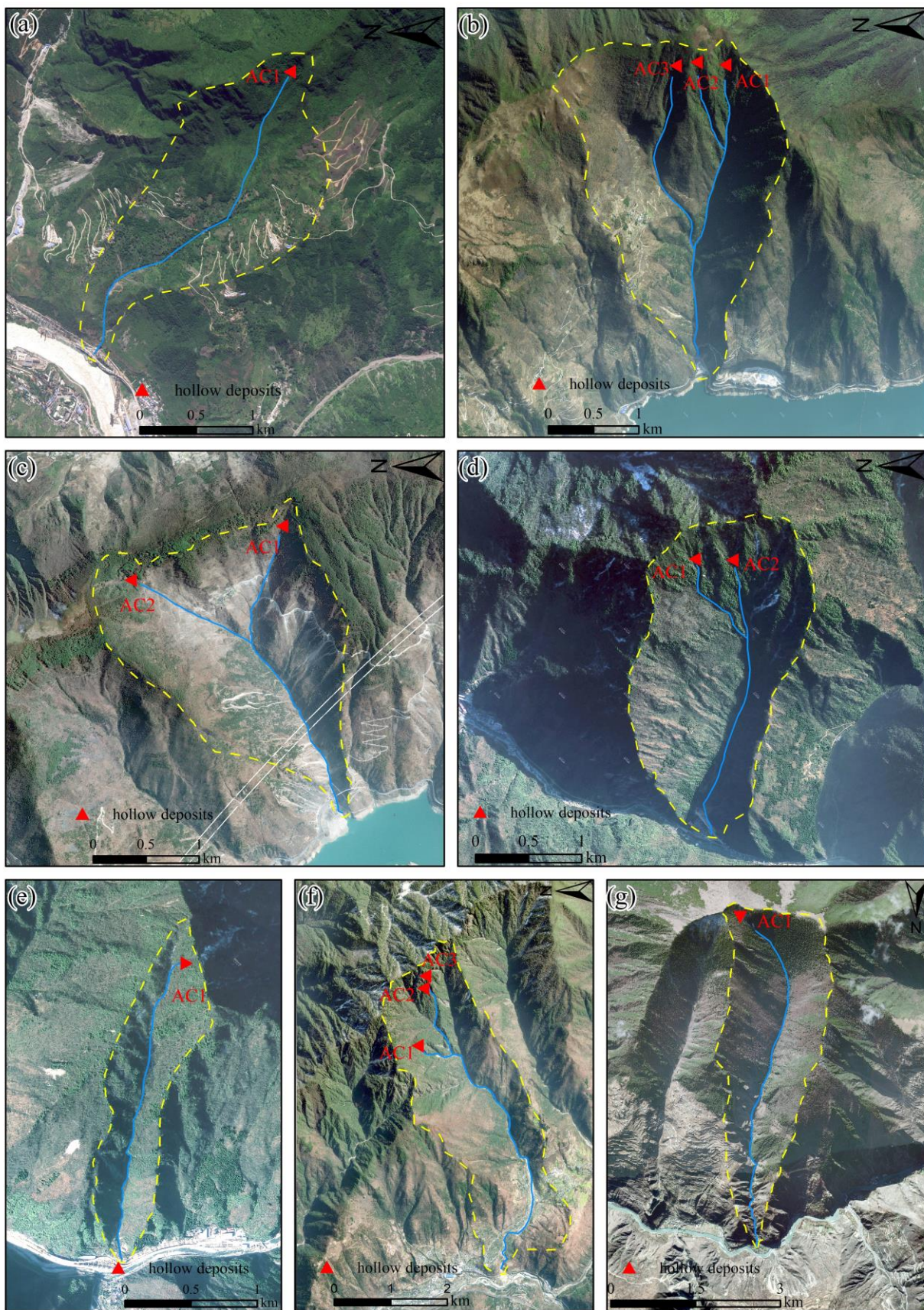


Figure S2 Distribution of CDH in other watersheds **a.** K88+230 gully, **b.** Luoduo gully, **c.** Banyang gully, **d.** Tangshang gully, **e.** Guanba gully, **f.** Majingzi gully, **g.** Chenghuangmiao gully.

Table S3 Investigation of particles in the deposit fan of Lebucun gully (First group).

Number	Grain size (cm)	Lithology	Roundness	Number	Grain size (cm)	Lithology	Roundness
1	10×13×9	Sandstone	Sub-angular	26	<2	/	/
2	6×6×10	Sandstone	Sub-angular	27	<2	/	/
3	19×20×12	Sandstone	angular	28	<2	/	/
4	20×17×10	Sandstone	Sub-angular	29	<2	/	/
5	<2	/	/	30	<2	/	/
6	8×5×4	Sandstone	Sub-rounding	31	<2	/	/
7	<2	/	/	32	<2	/	/
8	50×50×30	Sandstone	Sub-angular	33	13×20×15	Sandstone	Sub-angular
9	<2	/	/	34	<2	/	/
10	125×50×110	Sandstone	Sub-angular	35	9×15×8	Sandstone	Extremely-angular
11	<2	/	/	36	<2	/	/
12	<2	/	/	37	<2	/	/
13	<2	/	/	38	<2	/	/
14	17×15×12	Sandstone	Sub-angular	39	<2	/	/
15	10×13×14	Sandstone	Sub-rounding	40	27×13×20	Sandstone	Sub-angular
16	<2	/	/	41	<2	/	/
17	9×7×8	Sandstone	Extremely-angular	42	<2	/	/
18	3×3×2	Sandstone	Sub-rounding	43	<2	/	/
19	8×7×2	Sandstone	angular	44	28×11×8	Sandstone	angular
20	13×16×9	Sandstone	Sub-rounding	45	<2	/	/
21	3×2×1	Sandstone	Sub-angular	46	20×14×8	siltstone	Sub-angular
22	6×9×6	Limestone	Sub-angular	47	<2	/	/
23	<2	/	/	48	17×12×10	Sandstone	Sub-angular
24	9×22×10	Sandstone	Extremely-angular	49	23×22×10	Sandstone	Sub-angular
25	<2	/	/	50	12×14×5	Sandstone	Sub-angular

Table S4 Investigation of particles in the deposit fan of Lebucun gully (Second group).

Number	Grain size (cm)	Lithology	Roundness	Number	Grain size (cm)	Lithology	Roundness
1	27×30×15	Sandstone	Sub-angular	26	44×25×15	Sandstone	Sub-angular
2	5×10×3	Sandstone	Extremely-angular	27	<2	/	/
3	10×13×6	Sandstone	Sub-angular	28	9×15×23	Sandstone	Extremely-angular
4	<2	/	/	29	<2	/	/
5	15×36×15	Sandstone	Sub-angular	30	13×25×19	Limestone	Sub-angular
6	10×13×5	Sandstone	angular	31	<2	/	/
7	<2	/	/	32	<2	/	/
8	<2	/	/	33	30×15×10	Sandstone	Sub-angular
9	<2	/	/	34	<2	/	/
10	<2	/	/	35	47×35×23	Sandstone	Sub-angular
11	<2	/	/	36	19×15×40	Sandstone	Sub-angular
12	<2	/	/	37	<2	/	/
13	10×15×7	Sandstone	angular	38	<2	/	/
14	<2	/	/	39	50×30×40	Sandstone	Sub-rounding
15	<2	/	/	40	16×20×23	Sandstone	Sub-rounding
16	27×45×30	Sandstone	Sub-angular	41	<2	/	/
17	<2	/	/	42	<2	/	/
18	<2	/	/	43	40×10×20	Sandstone	Extremely-angular
19	<2	/	/	44	<2	/	/
20	<2	/	/	45	<2	/	/
21	8×5×10	Sandstone	Sub-angular	46	30×30×25	Sandstone	Sub-rounding
22	33×28×30	Sandstone	Sub-angular	47	<2	/	/
23	<2	/	/	48	<2	/	/
24	<2	/	/	49	<2	/	/
25	70×60×45	Sandstone	Sub-angular	50	<2	/	/

Table S5 Investigation of particles in the deposit fan of Shitouwa gully (First group).

Number	Grain size (cm)	Lithology	Roundness	Number	Grain size (cm)	Lithology	Roundness
1	30×24×16	Sandstone	Sub-rounding	26	16×8×4	Sandstone	Sub-angular
2	7×5×2	Sandstone	Sub-angular	27	<2	\	\
3	13×8×6	Sandstone	Sub-angular	28	<2	\	\
4	8×4×3	Limestone	Sub-angular	29	43×27×10	Sandstone	Sub-rounding
5	<2	\	\	30	13×8×7	Limestone	Sub-rounding
6	<2	\	\	31	16×14×7	Limestone	Sub-rounding
7	18×15×8	Sandstone	Sub-rounding	32	<2	\	\
8	24×10×6	Sandstone	Sub-rounding	33	15×10×7	Sandstone	angular
9	41×20×14	Sandstone	Sub-rounding	34	53×42×16	Sandstone	Sub-angular
10	<2	\	\	35	24×16×8	Limestone	Rounding
11	12×9×5	Sandstone	Sub-angular	36	32×18×10	Limestone	Sub-angular
12	43×29×18	Sandstone	Sub-angular	37	<2	\	\
13	16×15×8	Limestone	Sub-rounding	38	10×8×6	Sandstone	Sub-angular
14	9×6×5	Limestone	Sub-angular	39	40×30×23	Sandstone	Sub-rounding
15	<2	\	\	40	<2	\	\
16	30×23×18	Sandstone	Sub-angular	41	10×7×5	Limestone	Sub-rounding
17	32×23×14	Sandstone	Sub-angular	42	<2	\	\
18	18×11×7	Sandstone	angular	43	36×30×12	Sandstone	Sub-angular
19	55×40×18	Limestone	Sub-rounding	44	70×39×26	Sandstone	Sub-angular
20	<2	\	\	45	<2	\	\
21	13×7×5	Sandstone	Sub-angular	46	26×13×9	Limestone	angular
22	17×13×5	Sandstone	Sub-angular	47	20×12×6	Sandstone	Sub-rounding
23	17×10×6	Sandstone	angular	48	8×5×3	Sandstone	Sub-rounding
24	35×22×19	Sandstone	Sub-rounding	49	20×18×7	Sandstone	Sub-angular
25	50×33×28	Sandstone	Sub-rounding	50	50×32×18	Sandstone	angular

Table S6 Investigation of particles in the deposit fan of Shitouwa gully (Second group).

Number	Grain size (cm)	Lithology	Roundness	Number	Grain size (cm)	Lithology	Roundness
1	10×5×4	Sandstone	Sub-rounding	26	12×7×6	Sandstone	Sub-angular
2	28×15×10	Sandstone	Sub-angular	27	30×16×6	Sandstone	Sub-angular
3	<2	\	\	28	46×35×24	Sandstone	Sub-angular
4	55×30×6	Sandstone	angular	29	35×20×23	Sandstone	Sub-angular
5	47×24×16	Sandstone	Sub-angular	30	<2	\	\
6	9×8×4	Limestone	angular	31	70×56×27	Limestone	Sub-rounding
7	15×19×5	Sandstone	Sub-angular	32	<2	\	\
8	<2	\	\	33	34×25×15	Sandstone	Sub-angular
9	<2	\	\	34	23×12×11	Sandstone	Sub-rounding
10	16×7×5	Sandstone	Sub-angular	35	44×35×20	Sandstone	Sub-angular
11	15×13×7	Sandstone	Sub-angular	36	<2	\	\
12	43×34×25	Limestone	Sub-angular	37	<2	\	\
13	<2	\	\	38	18×13×9	Sandstone	Sub-rounding
14	60×40×27	Sandstone	Sub-angular	39	37×16×12	Limestone	Sub-angular
15	17×12×7	Sandstone	angular	40	40×27×25	Sandstone	Sub-angular
16	11×6×4	Sandstone	angular	41	124×90×52	Sandstone	Sub-angular
17	7×4×3	Sandstone	Sub-angular	42	<2	\	\
18	18×14×10	Limestone	Sub-angular	43	14×12×6	Sandstone	angular
19	21×17×6	Sandstone	Sub-angular	44	<2	\	\
20	35×19×16	Sandstone	Sub-angular	45	<2	\	\
21	16×13×7	Sandstone	Sub-rounding	46	<2	\	\
22	70×36×26	Sandstone	Sub-angular	47	55×28×24	Sandstone	Sub-angular
23	40×28×14	Limestone	angular	48	12×8×7	Limestone	Rounding
24	25×12×9	Sandstone	Rounding	49	<2	\	\
25	<2	\	\	50	12×8×7	Limestone	Rounding

Table S7 Investigation of particles in the deposit fan of Wuyiwan gully (First group).

Number	Grain size (cm)	Lithology	Roundness	Number	Grain size (cm)	Lithology	Roundness
1	30×24×16	Sandstone	Sub-rounding	26	16×8×4	Sandstone	Sub-angular
2	50×30×10	Sandstone	Sub-rounding	27	11×7×3	Limestone	Sub-rounding
3	20×18×10	Limestone	Sub-rounding	28	<2	\	\
4	85×40×23	Sandstone	Sub-rounding	29	43×27×10	Sandstone	Sub-rounding
5	100×80×30	Sandstone	Rounding	30	13×8×7	Sandstone	Sub-rounding
6	40×30×14	Sandstone	Sub-angular	31	56×54×13	Sandstone	Sub-rounding
7	87×50×48	Sandstone	Sub-rounding	32	8×4×2	Limestone	Sub-angular
8	14×10×6	Limestone	Sub-rounding	33	15×10×7	Sandstone	Sub-rounding
9	110×105×48	Sandstone	Rounding	34	53×42×16	Sandstone	Sub-rounding
10	<2	\	\	35	44×26×18	Sandstone	Rounding
11	12×9×5	Sandstone	Sub-angular	36	55×38×26	Sandstone	Sub-rounding
12	100×90×48	Sandstone	Rounding	37	<2	\	\
13	16×15×8	Limestone	Sub-rounding	38	10×8×6	Sandstone	Sub-rounding
14	90×66×35	Sandstone	Rounding	39	40×30×23	Limestone	Sub-rounding
15	<2	\	\	40	7×5×4	Sandstone	Sub-angular
16	30×23×18	Sandstone	Sub-angular	41	10×7×5	Limestone	Sub-rounding
17	32×23×14	Sandstone	Sub-angular	42	<2	\	\
18	78×49×32	Sandstone	Sub-rounding	43	36×30×12	Limestone	Sub-angular
19	55×40×18	Sandstone	Sub-rounding	44	110×90×26	Sandstone	Sub-rounding
20	<2	\	\	45	72×46×22	Sandstone	Rounding
21	43×18×12	Sandstone	Sub-rounding	46	63×26×22	Sandstone	Sub-rounding
22	37×33×17	Sandstone	Sub-angular	47	20×12×9	Limestone	Sub-rounding
23	17×10×6	Sandstone	Sub-rounding	48	13×9×3	Sandstone	Sub-angular
24	35×22×19	Sandstone	Sub-rounding	49	20×18×7	Limestone	Sub-angular
25	50×33×28	Sandstone	Sub-rounding	50	50×32×18	Limestone	Sub-rounding

Table S8 Investigation of particles in the deposit fan of Wuyiwan gully (Second group).

Number	Grain size (cm)	Lithology	Roundness	Number	Grain size (cm)	Lithology	Roundness
1	55×32×24	Sandstone	Sub-rounding	31	44×40×25	Limestone	Sub-rounding
2	<2	\	\	32	135×54×50	Limestone	Rounding
3	23×20×12	Sandstone	Sub-angular	33	12×6×5	Limestone	Sub-angular
4	68×40×32	Sandstone	angular	34	17×13×4	Sandstone	Sub-rounding
5	54×40×30	Sandstone	angular	35	<2	<2	\
6	75×48×21	Sandstone	Sub-rounding	36	80×35×27	Sandstone	Sub-rounding
7	7×5×3	Sandstone	Sub-angular	37	<2	<2	\
8	119×74×40	Sandstone	Sub-rounding	38	26×18×10	Limestone	Sub-rounding
9	15×9×2	Limestone	Sub-rounding	39	48×35×20	Sandstone	Sub-rounding
10	75×34×26	Sandstone	Sub-angular	40	20×17×6	Limestone	Sub-angular
11	30×16×8	Sandstone	Sub-rounding	41	14×11×9	Sandstone	Sub-angular
12	14×9×7	Limestone	Sub-rounding	42	32×19×16	Sandstone	Sub-rounding
13	12×4×3	Limestone	Sub-rounding	43	12×9×7	Sandstone	angular
14	40×18×9	Sandstone	Sub-angular	44	20×11×7	Limestone	Sub-rounding
15	7×5×3	Sandstone	angular	45	25×24×16	Sandstone	Sub-rounding
16	80×57×35	Sandstone	angular	46	27×10×10	Sandstone	Sub-angular
17	43×10×4	Limestone	Sub-angular	47	<2	\	\
18	120×52×40	Sandstone	Rounding	48	98×47×30	Sandstone	Rounding
19	19×12×3	Limestone	Sub-angular	49	23×20×16	Sandstone	Sub-angular
20	46×24×10	Sandstone	Sub-angular	50	42×27×16	Sandstone	Sub-rounding
21	<2	\	\	51	226×220×140	Sandstone	Rounding
22	40×32×18	Sandstone	Sub-angular	52	226×220×140	Sandstone	Rounding
23	30×16×13	Sandstone	angular	53	10×8×5	Limestone	Sub-rounding
24	70×46×25	Sandstone	Rounding	54	19×16×12	Sandstone	Sub-rounding
25	16×9×4	Limestone	Sub-rounding	55	21×14×7	Limestone	Sub-rounding