

**Supplementary Table S1.** Backfill parameters of the open pit implemented previously.

Materials	Elastic Modulus (GPa)	Poisson's Ratio ( $\mu$ )	Density (kg/m <sup>3</sup> )	Compressive Strength (MPa)	Tensile Strength (MPa)	Cohesive Force (MPa)	Internal Friction Angle (°)
Foundation1	0.62	0.30	1870	2.0	0.29	0.31	39.56
Foundation2	0.62	0.30	1890	2.5	0.35	0.37	39.92
Foundation3	0.65	0.28	1920	3.0	0.41	0.44	40.15
Foundation4	0.68	0.27	1950	3.5	0.44	0.48	40.93
Foundation5	0.70	0.25	2010	4.0	0.51	0.56	40.80
Backfill 1	0.50	0.34	1710	0.5	0.08	0.08	38.52
Backfill 2	0.55	0.34	1780	1.0	0.16	0.17	38.52
Backfill 3	0.60	0.33	1830	1.5	0.23	0.24	38.98
Backfill 4	0.62	0.30	1870	2.0	0.29	0.31	39.56
Backfill 5	0.62	0.30	1890	2.5	0.35	0.37	39.92

**Supplementary Table S2.** Uniform design ratios.

Number	Barite powder (g)	Sand (g)	Barite Powder/Sand	Gypsum (g)	Cement (g)	Gypsum/Cement	Sand to Binder Ratio
1	8495	5663	1.50	106	35	3.03	100
2	9486	4672	2.03	106	35	3.03	100
3	10052	4106	2.45	106	35	3.03	100
4	8509	5673	1.50	89	30	2.97	120
5	9502	4680	2.03	89	30	2.97	120
6	10069	4113	2.45	89	30	2.97	120
7	8519	5679	1.50	76	25	3.04	140
8	9513	4686	2.03	76	25	3.04	140
9	10081	4118	2.45	76	25	3.04	140
10	8527	5684	1.50	67	22	3.05	160
11	9521	4690	2.03	67	22	3.05	160
12	10090	4121	2.45	67	22	3.05	160

**Supplementary Table S3.** Results of uniform parameter tests.

Number	Cohesive Force (MPa)	Internal Friction Angle (°)	Density (kg/m <sup>3</sup> )	Compressive Strength (MPa)
1	0.06	34.6	2179	0.35
2	0.067	31.8	2143	0.34
3	0.02	49.7	2103	0.32
4	0.043	38.0	2161	0.32
5	0.07	28.4	2172	0.23
6	0.06	33.4	2139	0.33
7	0.033	44.3	2125	0.26
8	0.033	37.7	2180	0.27
9	0.031	45.8	2194	0.25
10	0.021	41.2	2219	0.14
11	0.02	40.5	2534	0.13
12	0.02	37.6	2740	0.10

**Supplementary Table S4.** Simulation results of safety factors of roofs and underground backfill pillars.

Number	The First Principal Stress of the Roofs (MPa)	The Third Principal Stress of the Roofs (MPa)	The first Principal Stress of Underground Backfill Pillars (MPa)	The Third Principal Stress of Underground Backfill Pillars (MPa)	Safety Factors of Roofs	Safety Factors of Underground Backfill Pillars
1	8.74	0.89	3.94	0.12	4.36	2.91
2	8.93	1.09	3.90	0.13	3.52	2.64
3	10.34	1.20	4.32	0.17	2.95	2.45
4	11.25	0.84	4.96	0.14	3.99	3.71
5	11.98	0.98	5.00	0.14	3.27	3.62
6	9.74	1.34	4.27	0.14	2.74	2.95
7	11.71	0.84	4.71	0.12	3.87	4.04
8	10.78	1.59	5.22	0.20	2.17	2.76
9	9.15	0.82	3.53	0.08	4.60	3.64
10	8.12	1.64	4.18	0.12	2.44	3.22
11	11.68	1.84	4.80	0.18	1.77	2.70
12	7.50	0.59	4.33	0.11	6.98	3.90
13	8.57	1.34	4.01	0.13	2.92	2.76
14	9.95	1.09	4.42	0.15	3.32	2.83
15	11.03	1.09	4.63	0.20	3.11	2.28
16	10.84	1.34	4.08	0.16	2.56	2.32
17	10.94	1.34	4.39	0.17	2.55	2.46
18	10.17	1.09	4.72	0.18	3.28	2.62
19	10.51	2.09	6.60	0.43	1.68	1.82
20	7.83	0.59	4.93	0.13	6.90	3.80
21	10.38	1.09	6.15	0.19	3.24	3.60
22	10.09	1.59	6.52	0.25	2.26	3.00
23	8.74	1.59	3.65	0.10	2.44	3.02
24	9.73	1.34	4.24	0.11	2.74	3.77
25	10.25	1.50	6.12	0.20	2.37	3.56