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Enhancing Regional Quasi-Geoid Refinement Precision: An Analytical Approach Employing ADS80 Tri-linear Array Stereoscopic Imagery for Aerial Triangulation Densification and GNSS Gravity-Potential Leveling

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Table S1. Precision Enhancement of Aerial Triangulation for Control Point Layout Scheme I.

JCP								
NUM	**δXY(m)**	**δZ(m)**	**NUM**	**δXY(m)**	**δZ(m)**	**NUM**	**δXY(m)**	**δZ(m)**
1	0.1022	0	17	0.3662	0	33	0.146	0.1381
2	0.1759	0	18	0.0472	0.0224	34	0.108	0
3	0.0884	0.3914	19	0.0772	0	35	0.0848	0.0813
4	0.1993	0.3588	20	0.6252	0.244	36	0.0533	0
5	0.3534	0.3168	21	0.2557	0	37	0.0715	0
6	0.587	0.5708	22	0.1781	0.3254	38	0.085	0
7	0.2593	0.1218	23	0.0456	0	39	0.2569	0.0814
8	0.1218	0.1393	24	0.2962	0	40	0.0985	0
9	0.154	0.1341	25	0.0514	0	41	0.1022	0
10	0.0846	0	26	0.1462	0.1345	42	0.0846	0
11	0.0959	0	27	0.1284	0	43	0.0976	0
12	0.19	0.2435	28	0.0818	0.4068	44	0.0772	0
13	0.1082	0	29	0.2352	0.5695	45	0.0514	0
14	0.0976	0	30	0.0418	0	46	0.0418	0
15	0.315	0.3482	31	0.5281	0.4178	-	-	-
16	0.2495	0.4874	32	0.1414	0.1345	-	-	-

Table S2. Precision Enhancement of Aerial Triangulation for Control Point Layout Scheme II.

GCP			JCP				
NUM	**δXY(m)**	**δZ(m)**	**NUM**	**ΔXY(m)**	**δZ(m)**	**NUM**	**δXY(m)**	**δZ(m)**
1	0.3538	0.0978	1	0.0993	0	20	0.1057	0
2	0.2064	0.3914	2	0.4368	0	21	0.3283	0.078
3	0.3351	0	3	0.4806	0.0978	22	0.5484	0
4	0.2623	0.1624	4	0.1185	0.4193	23	0.1749	0
5	0.2128	0.2344	5	0.4202	0.4468	24	0.4392	0
6	0.4203	0.4881	6	0.3254	0.3742	25	0.1031	0
7	0.4179	0.1953	7	0.2216	0.0976	26	0.2495	0.1172
8	0.3534	0.3119	8	0.1998	0.3904	27	0.2256	0
-	-	-	9	0.1936	0	28	0.456	0.1754
-	-	-	10	0.1519	0.1952	29	0.1422	0.0696
-	-	-	11	0.2556	0.4062	30	0.1163	0
-	-	-	12	0.4969	0.2843	31	0.2379	0.0292
-	-	-	13	0.2285	0.4062	32	0.314	0.0668
-	-	-	14	0.2242	0	33	0.0993	0
-	-	-	15	0.2935	0.2339	34	0.1058	0.117
-	-	-	16	0.1058	0.117	35	0.0674	0
-	-	-	17	0.3492	0.2432	36	0.1057	0
-	-	-	18	0.0674	0	37	0.2256	0
-	-	-	19	0.1151	0	38	0.1163	0

Table S3. Precision Enhancement of Aerial Triangulation for Control Point Layout Scheme III.

GCP			JCP					
NUM	δXY(m)	δZ(m)	NUM	δXY(m)	δZ(m)	NUM	δXY(m)	δZ(m)
1	0.1444	0.1223	1	0.1217	0	17	0.2145	0
2	0.064	0	2	0.1977	0.2446	18	0.2531	0
3	0.3684	0.4892	3	0.4685	0.2437	19	0.3593	0.2258
4	0.0919	0.1337	4	0.1435	0.0976	20	0.0867	0
5	0.0609	0	5	0.1908	0.117	21	0.1528	0
6	0.0867	0	6	0.1611	0.3656	22	0.0882	0
7	0.1428	0	7	0.0121	0	23	0.4863	0.2339
8	0.1262	0.1952	8	0.3531	0.3656	24	0.2695	0
9	0.0865	0.2339	9	0.2663	0.1219	25	0.1572	0
10	0.2027	0	10	0.1463	0	26	0.1322	0.325
11	0.0121	0	11	0.0804	0	27	0.1314	0
12	0.1659	0.117	12	0.1094	0	28	0.1664	0.4881
13	0.0609	0	13	0.1945	0.2339	29	0.064	0
14	0.0933	0.2339	14	0.0367	0.1337	30	0.1463	0
15	0.11	0.1953	15	0.1937	0	-	-	-
16	0.0919	0.1337	16	0.139	0	-	-	-

Table S4. Precision Enhancement of Aerial Triangulation for Control Point Layout Scheme IV.

GCP						JCP		
NUM	**δXY(m)**	**δZ(m)**	**NUM**	**δXY(m)**	**δZ(m)**	**NUM**	**δXY(m)**	**δZ(m)**
1	0.2014	0	17	0.0514	0	1	0.0829	0
2	0.2561	0.125	18	0.1427	0.0351	2	0.1765	0.195
3	0.0695	0	19	0.3977	0.1945	3	0.2503	0.25
4	0.1865	0.4	20	0.0248	0.0679	4	0.0383	0.0234
5	0.1652	0.3899	21	0.2313	0.0814	5	0.1773	0.0976
6	0.0383	0.0234	22	0.1735	0.1218	6	0.3191	0.0976
7	0.1745	0	23	0.2408	0.1394	7	0.2452	0.0697
8	0.1514	0	24	0.349	0.1563	8	0.1745	0
9	0.014	0	25	0.1738	0.078	9	0.2104	0.293
10	0.0514	0	26	0.1786	0.1172	10	0.04	0.2423
11	0.1206	0.0697	27	0.2654	0.1358	11	0.2068	0.3899
12	0.0655	0.0697	28	0.2318	0	12	0.014	0
13	0.1352	0.2924	29	0.1514	0	13	0.1579	0.0977
14	0.4589	0.2843	30	0.0933	0.1218	14	0.0977	0.2486
15	0.2487	0.195	31	0.0752	0.0146	15	0.0695	0
16	0.1679	0	-	-	-	-	-	-

Table S5. Precision Enhancement of Aerial Triangulation for Control Point Layout Scheme V. 49

GCP						JCP		
NUM	**δXY(m)**	**δZ(m)**	**NUM**	**δXY(m)**	**δZ(m)**	**NUM**	**δXY(m)**	**δZ(m)**
1	0.1845	0	21	0.3075	0.067	1	0.2623	0.0489
2	0.1513	0.2437	22	0.0663	0.1626	2	0.0286	0
3	0.0298	0.0612	23	0.1162	0	3	0.0639	0
4	0.3581	0.1957	24	0.184	0.2441	4	0.0713	0.2339
5	0.2346	0.4543	25	0.0966	0	5	0.0459	0
6	0.1092	0	26	0.1115	0.0696	6	0.0259	0.0407
7	0.1983	0.1393	27	0.0566	0	-	-	-
8	0.0674	0.0936	28	0.169	0.0951	-	-	-
9	0.0911	0	29	0.0125	0	-	-	-
10	0.1519	0	30	0.1218	0	-	-	-
11	0.1393	0.1626	31	0.0772	0.0609	-	-	-
12	0.1002	0.0696	32	0.0576	0.078	-	-	-
13	0.1601	0.1393	33	0.1652	0.1559	-	-	-
14	0.1127	0	34	0.0213	0.2339	-	-	-
15	0.1186	0.1559	35	0.0298	0.0612	-	-	-
16	0.1516	0.1824	36	0.0674	0.0936	-	-	-
17	0.0468	0.1901	37	0.0639	0	-	-	-
18	0.1452	0.0814	38	0.0708	0	-	-	-
19	0.1212	0.134	39	0.0966	0	-	-	-
20	0.0708	0	40	0.0125	0	-	-	-

Table S6. Statistical information of levelling data and gravity data in China (unit:cm). 50

Model	**Degree**	**Gravity Model (576 Points)**				**Level Data (26 Points)**			
		Min	**Max**	**Mean**	**Rmse(±)**	**Min**	**Max**	**Mean**	**Rmse(±)**
EGM2008	2190	-7.23	21.98	6.88	8.61	7.37	19.38	14.36	14.83
SGG-UGM-2	2190	-17.46	9.51	8.14	9.09	1.98	22.10	17.14	17.79
SGG-UGM-1	2159	-17.14	10.82	-7.77	9.38	3.02	22.18	17.55	18.15
EIGEN-6C4	2190	-22.33	5.76	-10.17	11.74	2.75	23.14	18.19	18.75
GECO	2190	-39.84	3.83	-12.99	17.27	-4.68	30.34	16.84	18.97
XGM2019e_2159	2190	-26.79	4.76	-17.48	18.13	5.49	26.49	21.23	21.88
EGM96	360	-18.49	51.19	16.69	23.74	-37.48	-6.68	-17.69	22.89
GGM05C	360	-59.37	25.04	-22.29	25.59	-0.33	64.8	21.44	24.98
GO_CONS_GCF_2_TIM_R6e	300	-75.64	39.58	-14.14	29.98	4.29	74.26	31.52	36.11
Tongji-GMMG2021S	300	-64.12	52.62	-15.71	36.18	-13.76	62.33	33.77	37.05
EigenCG03C	360	-79.00	35.43	-38.19	39.92	-4.88	52.20	35.87	39.00
Tongji-Grace02s	180	28.91	58.02	42.99	43.31	-73.18	62.07	12.54	43.02