Supplementary materials

Variation in Platinum group metals analysis using ICP-OES induced by effect of complex matrices and correction method based on multivariate calibration

Ha Bich Trinh,[a] Seunghyun Kim,[a] Jaeryeong Lee,[a,*] Jae-chun Lee[b,c]

[a]Department of Integrated Energy and Infra System, Kangwon National University, Chuncheon, Gangwon-do 24341, Republic of Korea

[b]Resources Recycling, Korea University of Science and Technology, Daejeon, 34113, Republic of Korea

[c]Mineral Resources Research Division, Korea Institute of Geoscience and Mineral Resources (KIGAM), Daejeon, 34132, Republic of Korea

*Corresponding author: **Jaeryeong Lee** (jr-lee@kangwon.ac.kr)

List of additional Figures and Tables

Table S1: Calibration set using for correction method (single interferent)

Table S2: Calibration set using for correction method (mixture of interferents)

Table S3: Comparison of the standard relative error and the standard error of prediction calculated for simulated solution before and after employment of correction method (single interferent Ca, K, or Na).

Table S4: Comparison of the standard relative error and the standard error of prediction calculated for simulated solution before and after employment of correction method (mixture of interferents).

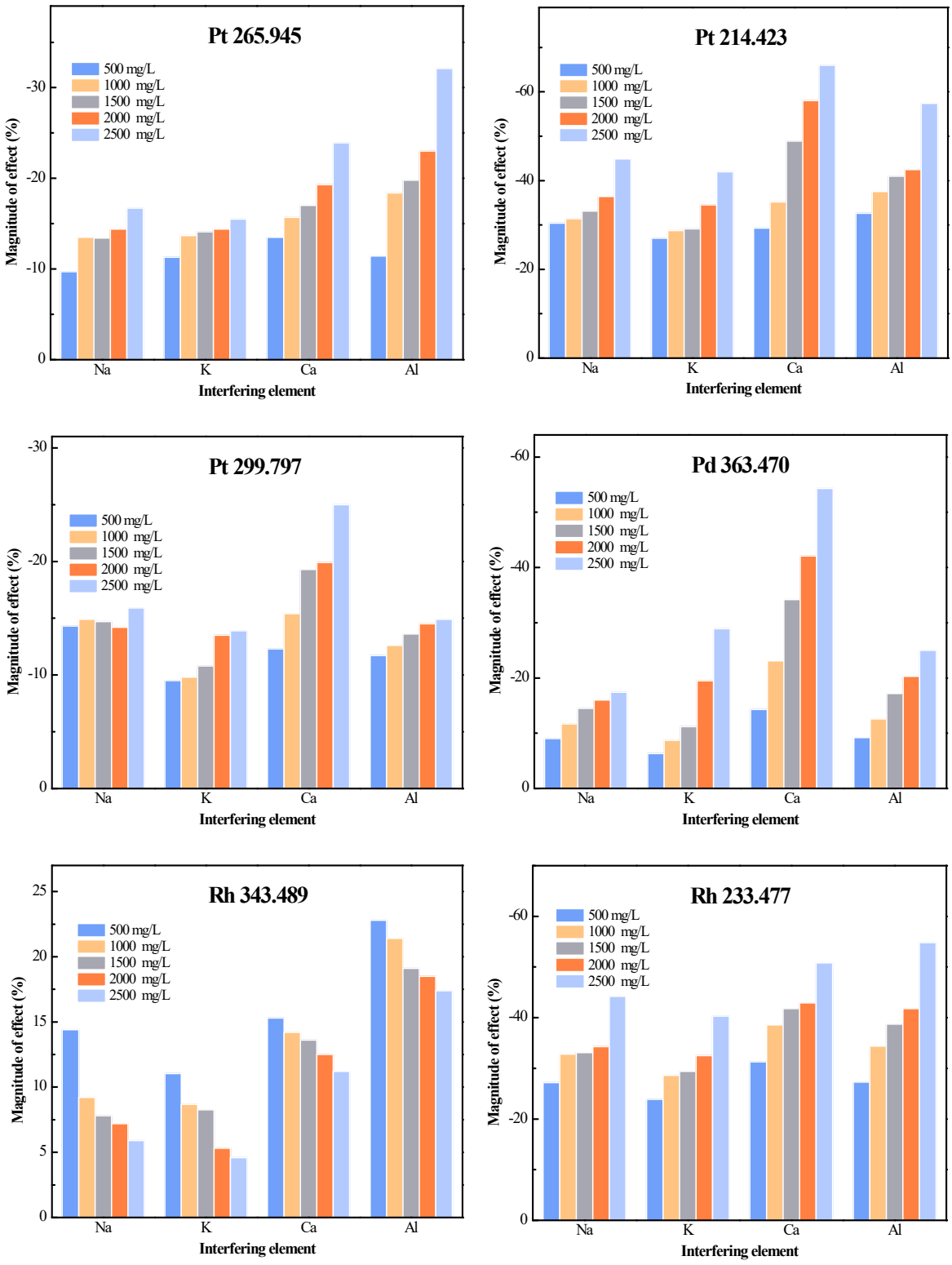

Figure S1: Effect of matrix complexity on PGM determination with variation of interelement concentration (concentration of interelement: 500–2500 mg/L; concentration of PGM: 1.0 mg/L)

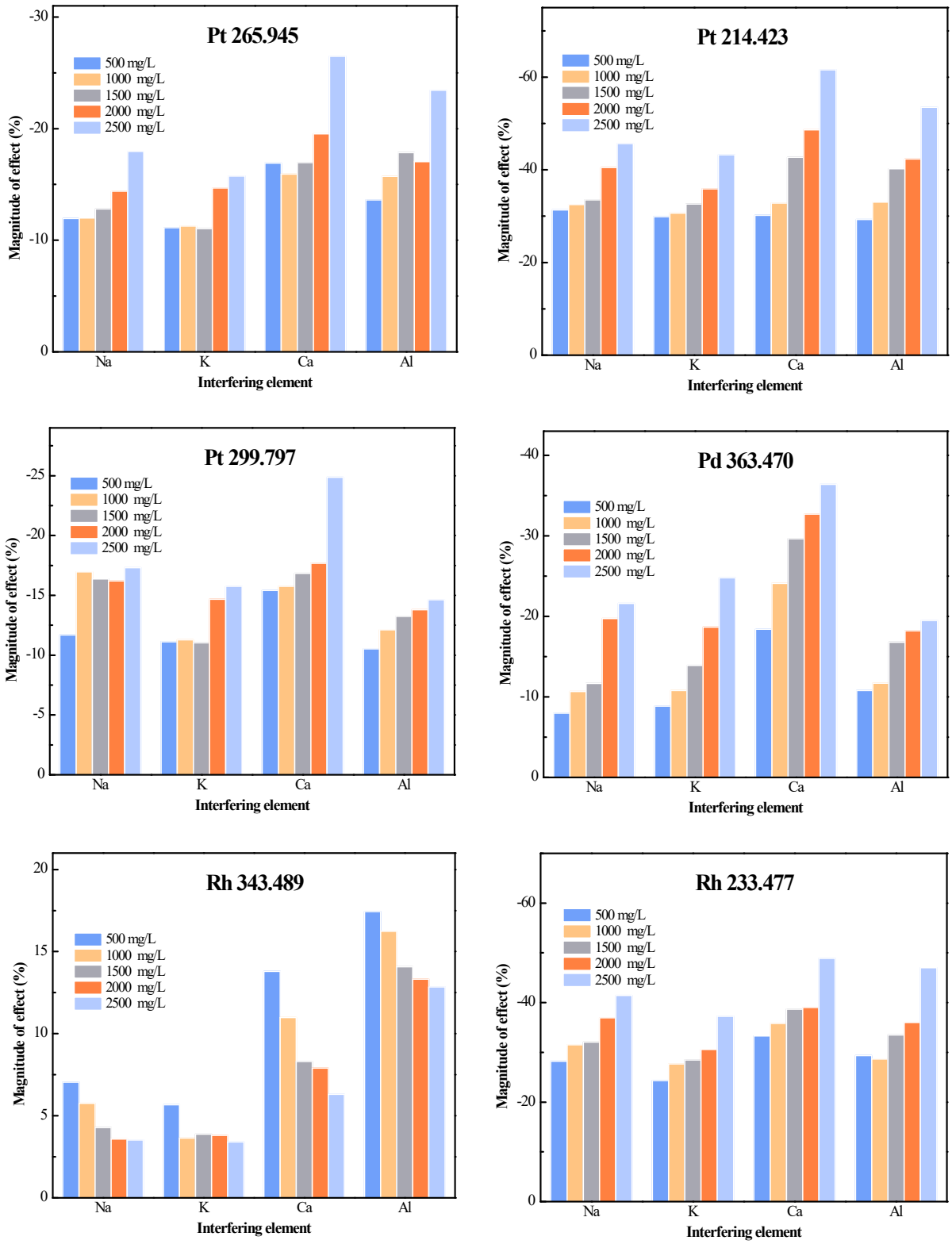

Figure S2: Effect of matrix complexity on PGM determination with variation of interelement concentration (concentration of interelement: 500–2500 mg/L; concentration of PGM: 2.5 mg/L)

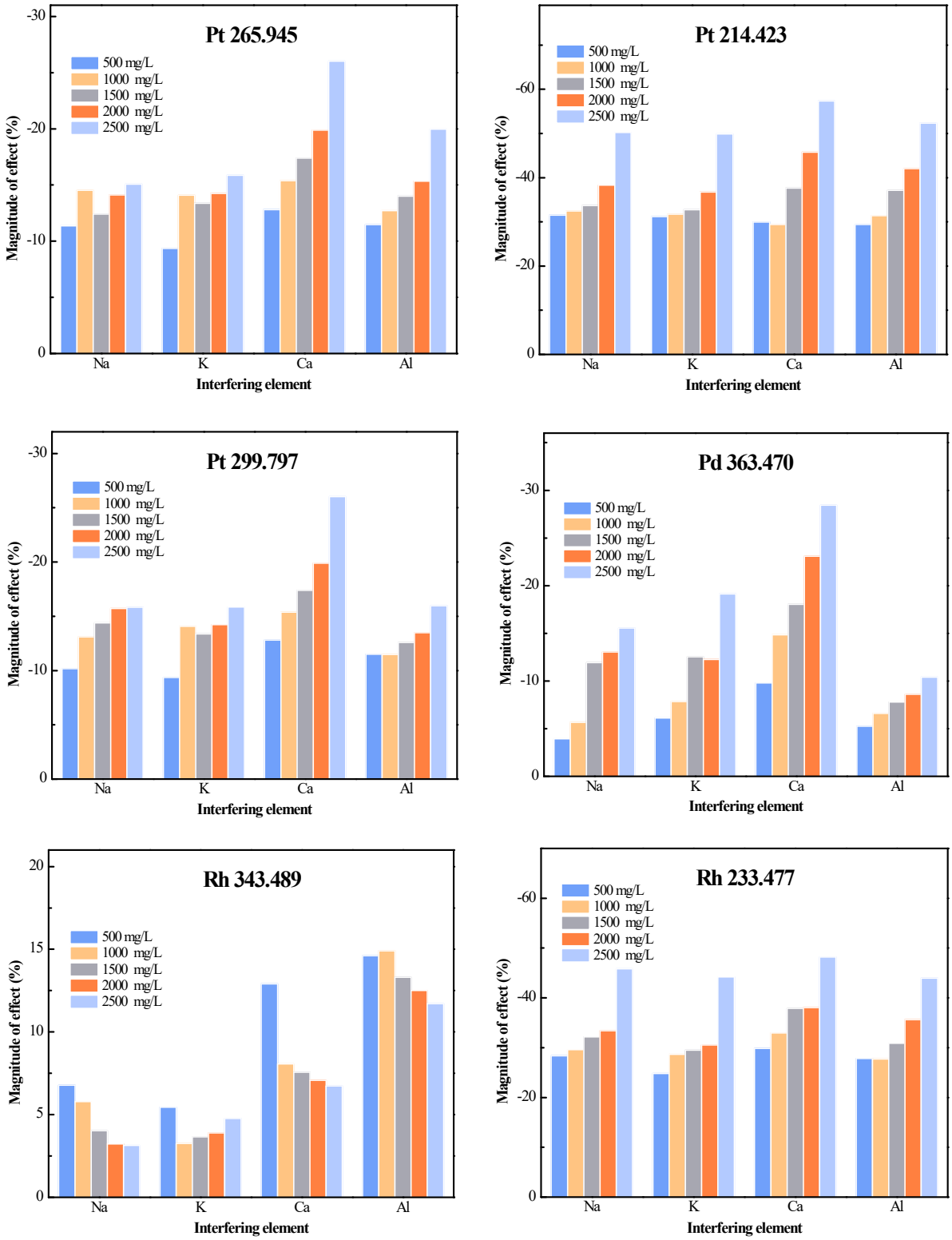

Figure S3: Effect of matrix complexity on PGM determination with variation of interelement concentration (concentration of interelement: 500–2500 mg/L; concentration of PGM: 5.0 mg/L)

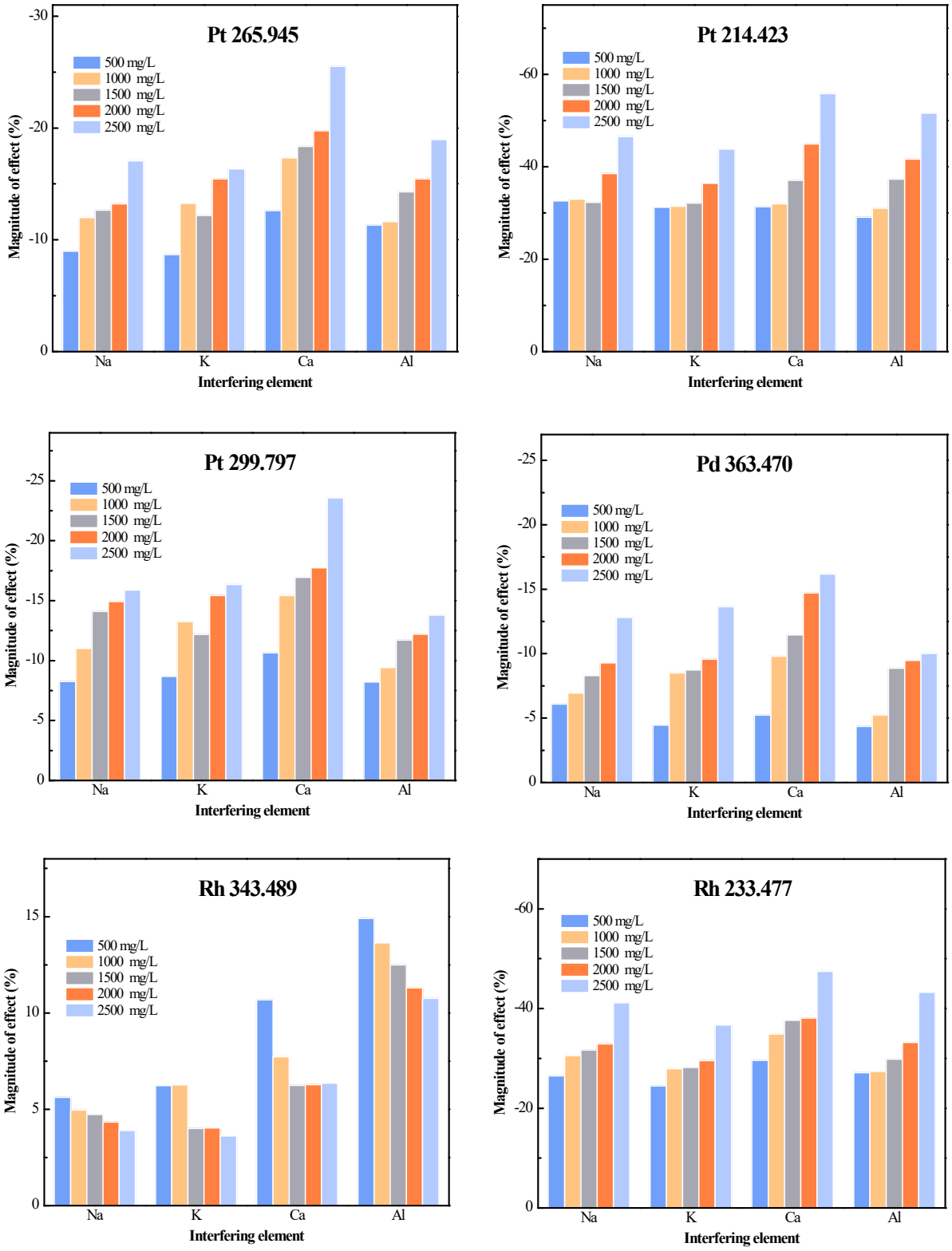

Figure S4: Effect of matrix complexity on PGM determination with variation of interelement concentration (concentration of interelement: 500–2500 mg/L; concentration of PGM: 7.5 mg/L)

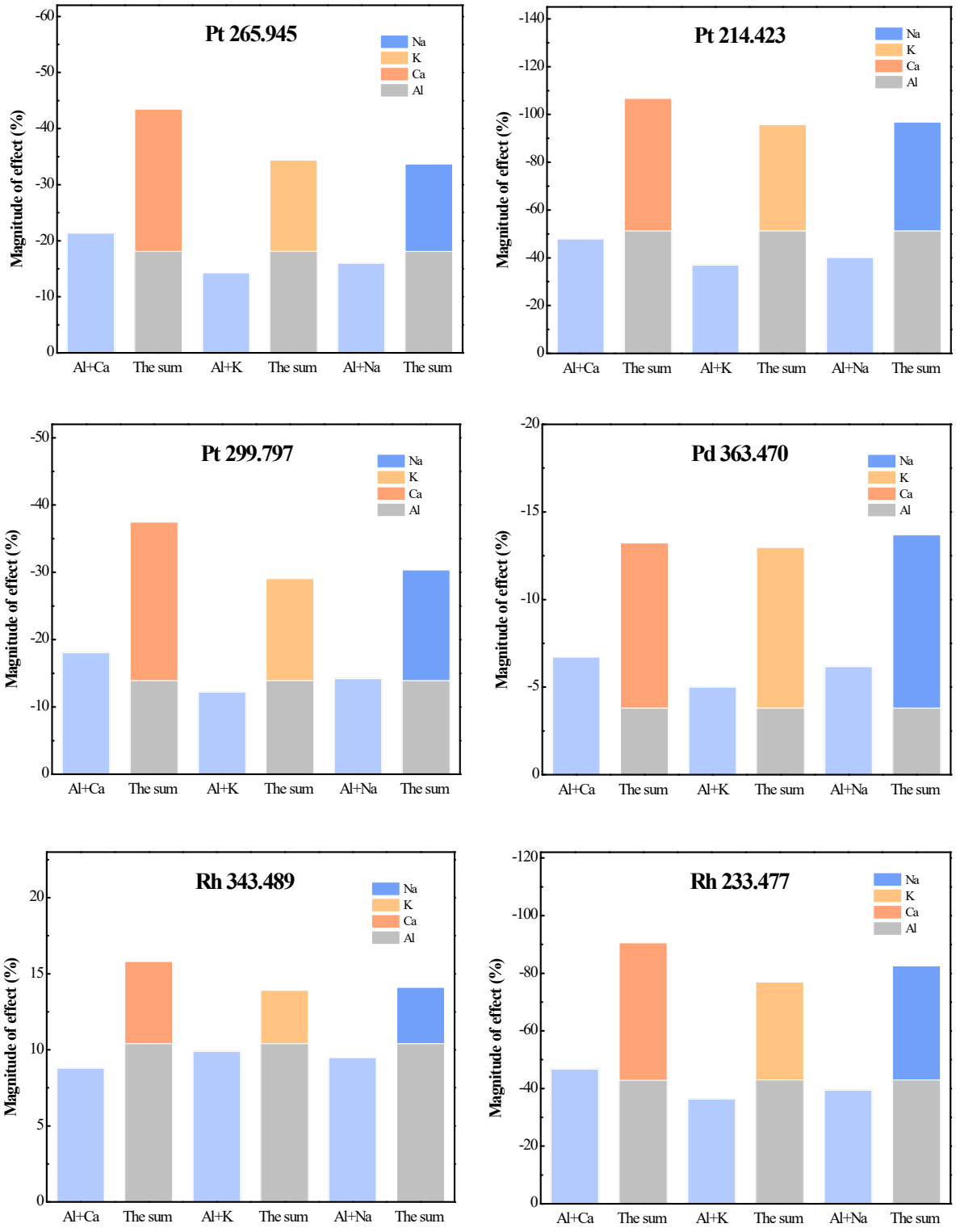

Figure S5: Comparison between the combined effect and the sum of individual effects for mixtures and single interelements (concentration of interfering element: 2500 mg/L; PGM concentration: 10 mg/L)

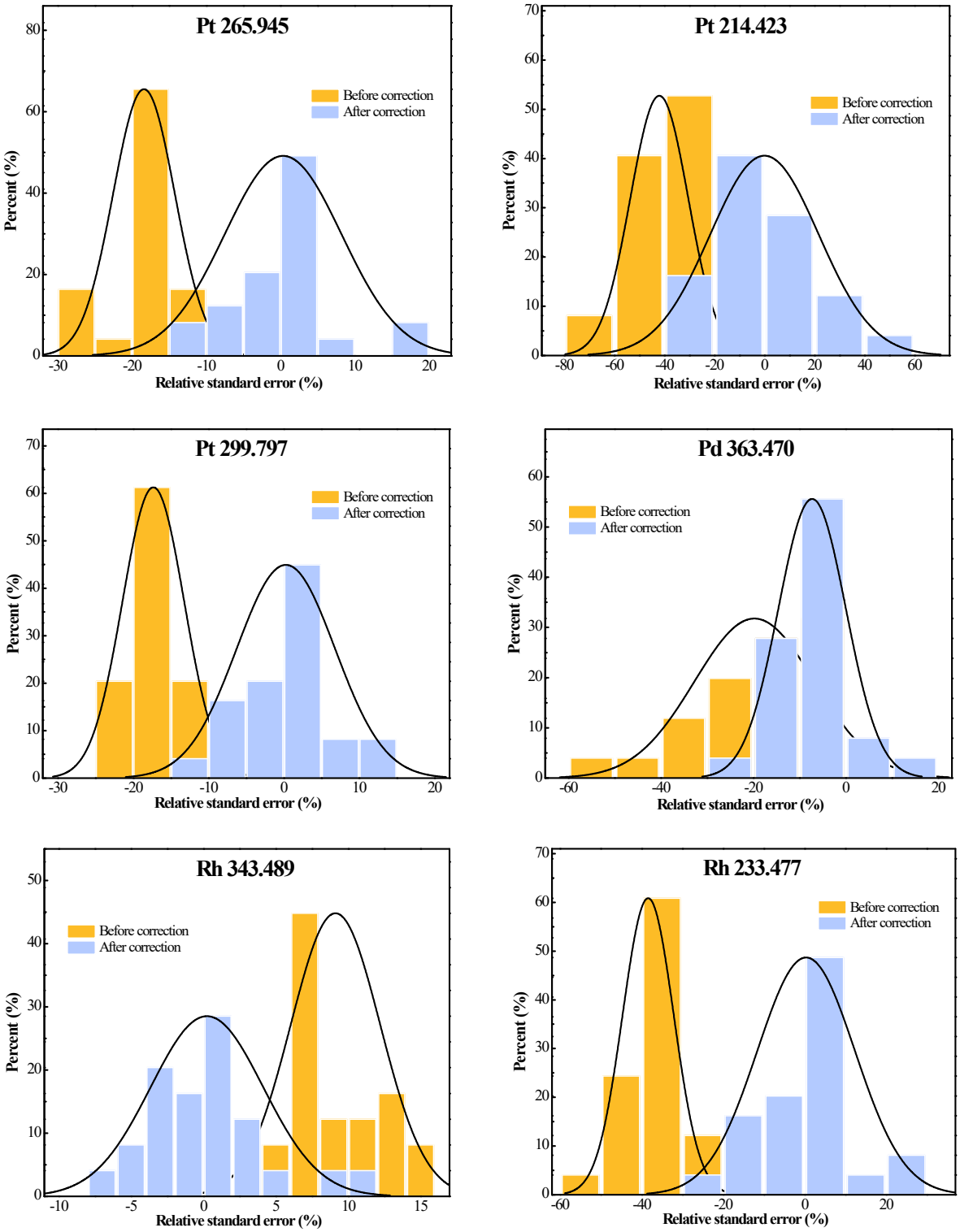

Figure S6: Comparison of the relative standard error distribution before and after employment of correction method for calibration sets (25 solutions; interfering element: Ca).

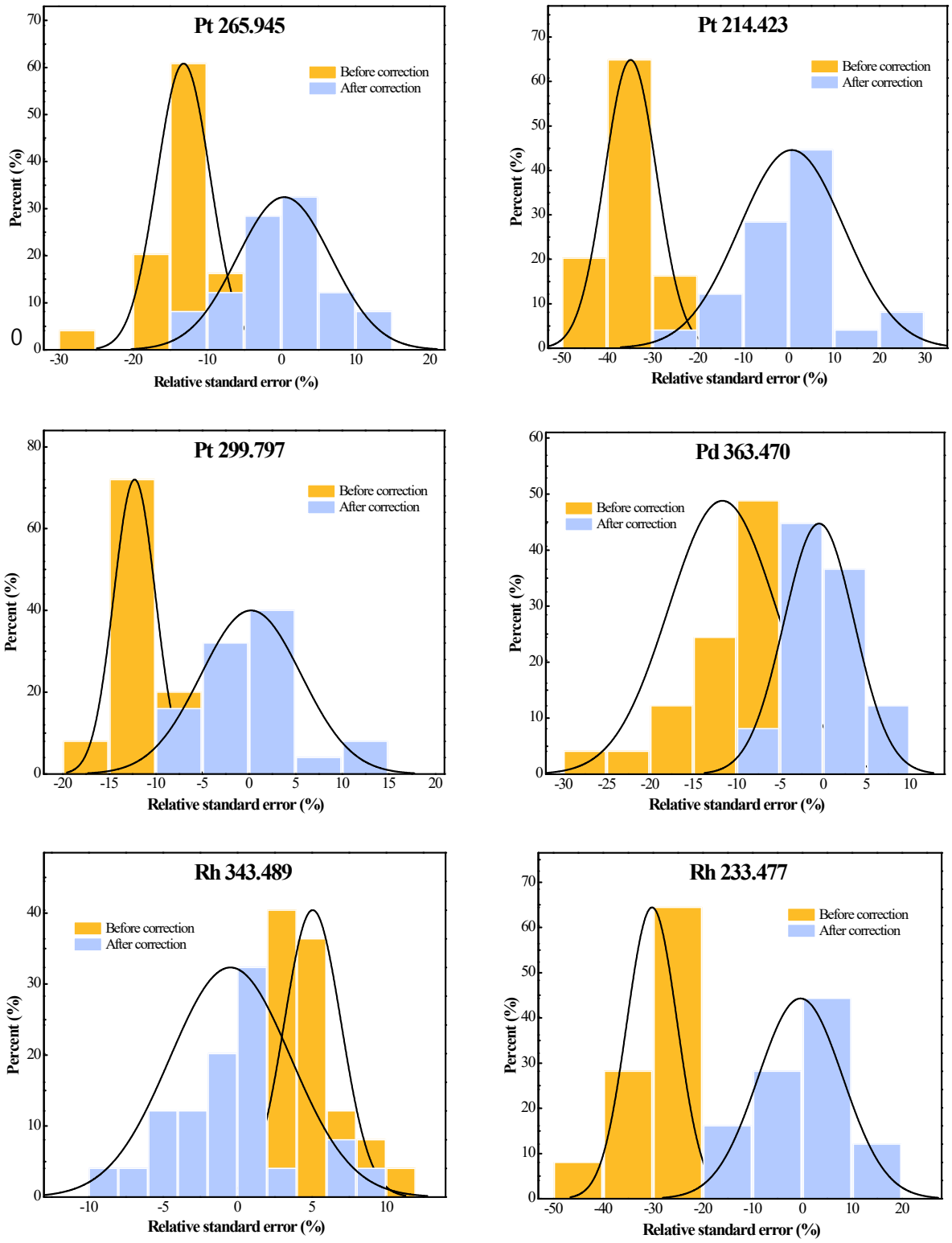

Figure S7: Comparison of the relative standard error distribution before and after employment of correction method for calibration sets (25 solutions; interfering element: K).

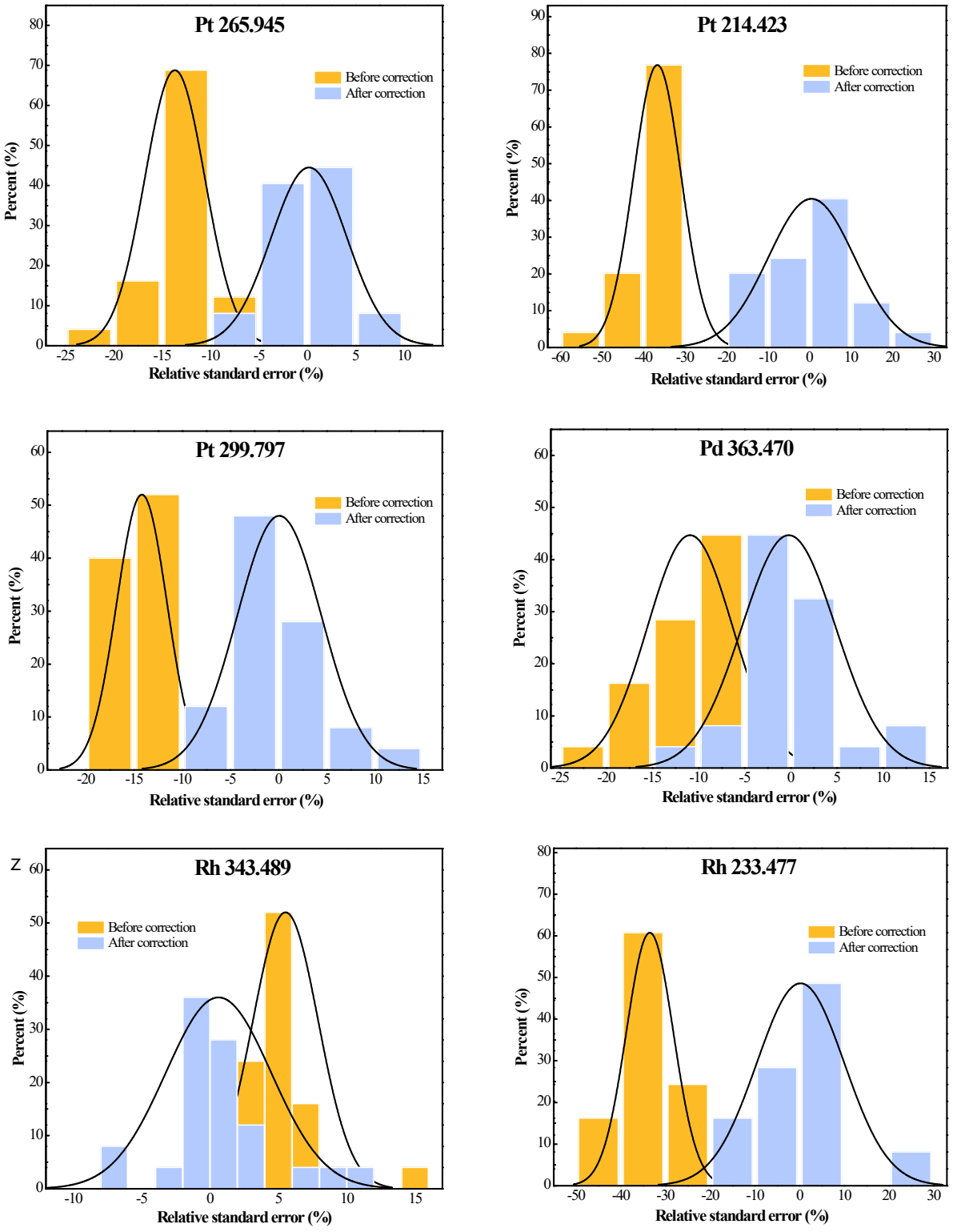

Figure S8: Comparison of the relative standard error distribution before and after employment of correction method for calibration sets (25 solutions; interfering element: Na).

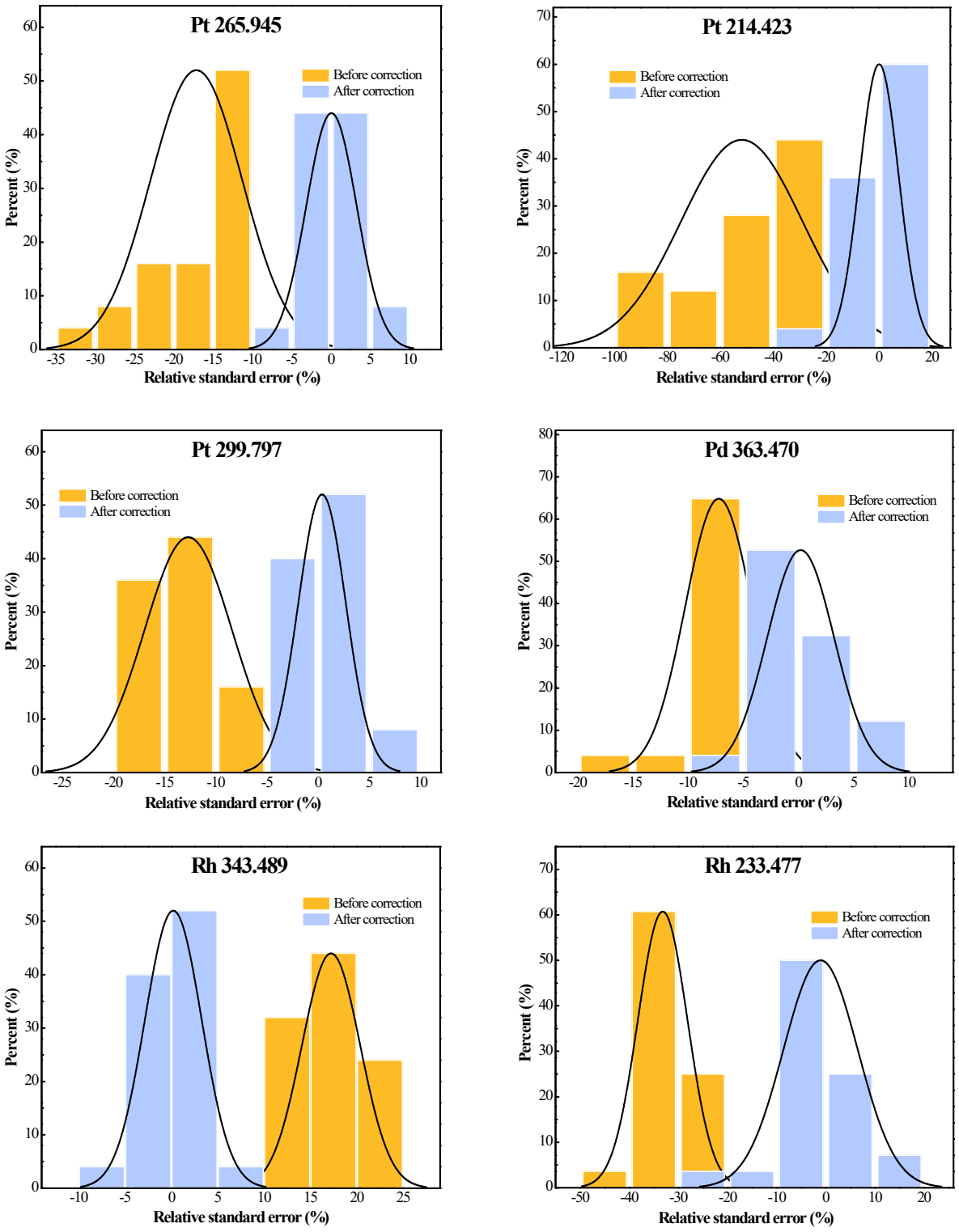

Figure S9: Comparison of the relative standard error distribution before and after employment of correction method for calibration sets (25 solutions; mixture of elements: Al+Ca).

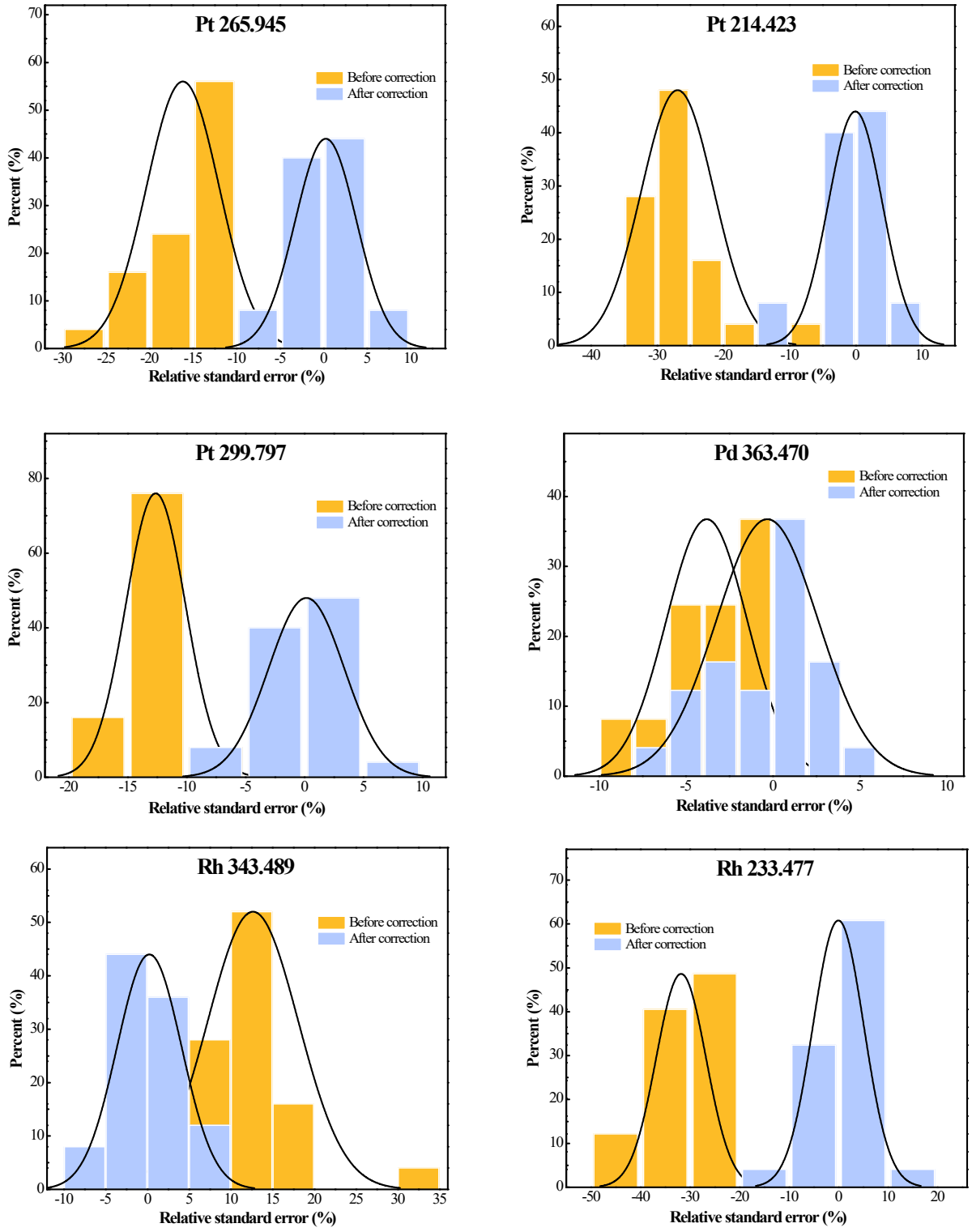

Figure S10: Comparison of the relative standard error distribution before and after employment of correction method for calibration sets (25 solutions; mixture of elements: Al+K).

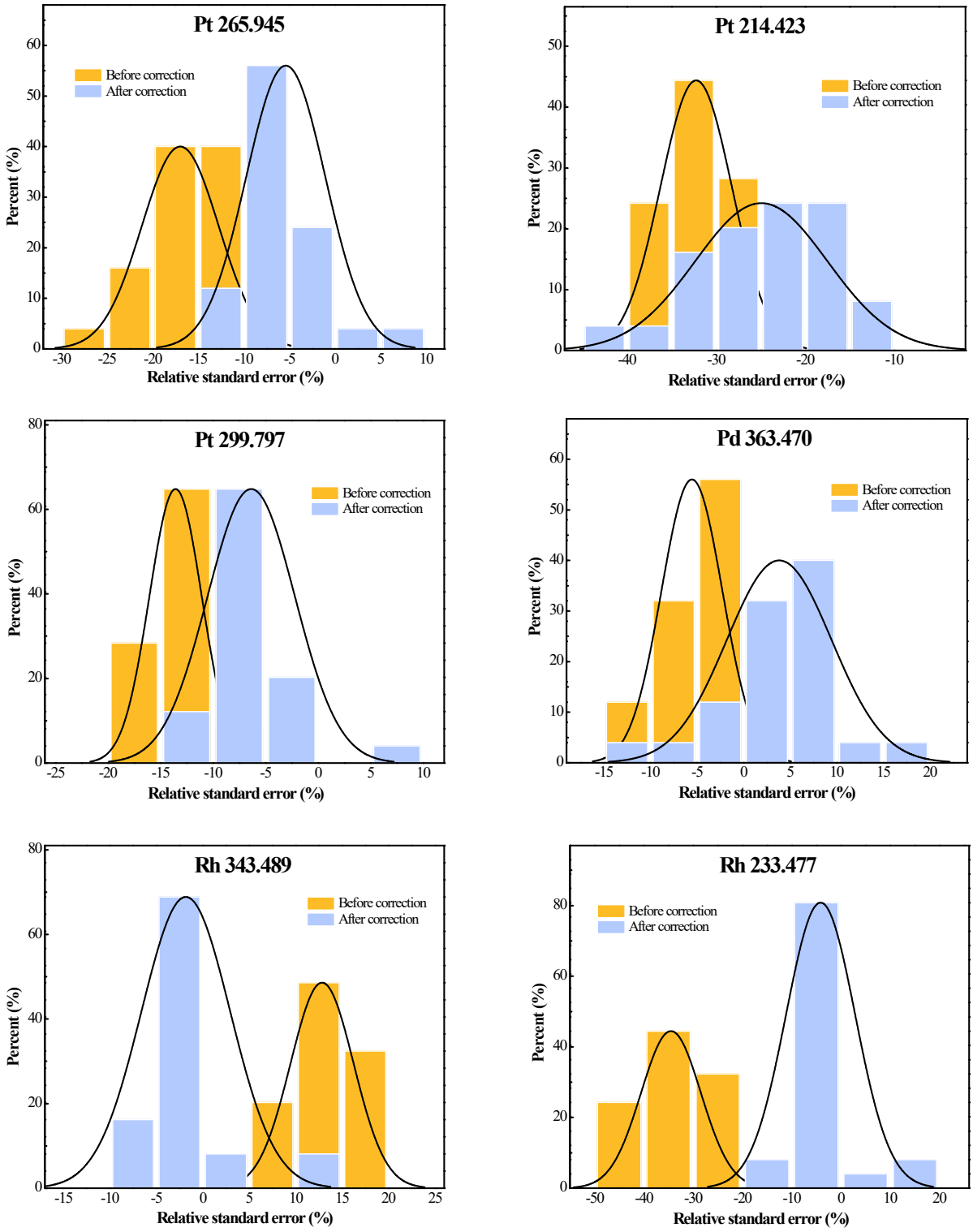

Figure S11: Comparison of the relative standard error distribution before and after employment of correction method for calibration sets (25 solutions; mixture of elements: Al+Na).

Table S1: Calibration set using for correction method (single interferent)

Calibration solution	Interelement concentration (mg/L)	PGM concentration (mg/L)
1	500	1.0
2	500	2.5
3	500	5.0
4	500	7.5
5	500	10.0
6	1000	1.0
7	1000	2.5
8	1000	5.0
9	1000	7.5
10	1000	10.0
11	1500	1.0
12	1500	2.5
13	1500	5.0
14	1500	7.5
15	1500	10.0
16	2000	1.0
17	2000	2.5
18	2000	5.0
19	2000	7.5
20	2000	10.0
21	2500	1.0
22	2500	2.5
23	2500	5.0
24	2500	7.5
25	2500	10.0

Table S2: Calibration set using for correction method (mixture of interferents)

Calibration solution	Al concentration (mg/L)	Ca/K/Na concentration (mg/L)	PGM concentration (mg/L)
1	500	500	1.0
2	500	1000	2.5
3	500	1500	5.0
4	500	2000	7.5
5	500	2500	10.0
6	1000	500	2.5
7	1000	1000	5.0
8	1000	1500	7.5
9	1000	2000	10.0
10	1000	2500	1.0
11	1500	500	5.0
12	1500	1000	7.5
13	1500	1500	10
14	1500	2000	1.0
15	1500	2500	2.5
16	2000	500	7.5
17	2000	1000	10.0
18	2000	1500	1.0
19	2000	2000	2.5
20	2000	2500	5.0
21	2500	500	10.0
22	2500	1000	1.0
23	2500	1500	2.5
24	2500	2000	5.0
25	2500	2500	7.5

Table S3: Comparison of the standard relative error and the standard error of prediction calculated for simulated solution before and after employment of correction method (single interferent Ca, K, or Na).

Simulated solution		Relative standard error (%)											
		Pt 265.954		Pt 214.423		Pt 299.797		Pd 363.470		Rh 343.489		Rh 233.477	
Ca[a]	PGM[b]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]
2400	1.5	-21.5	4.3	-56.6	-14.7	-24.2	6.5	-42.1	-9.3	11.6	6.0	-48.5	9.2
600	2.0	-14.7	-1.2	-38.2	-9.1	-16.7	-2.2	-18.7	-9.4	15.3	-6.7	-37.3	-7.7
1900	2.0	-20.3	4.1	-47.8	-12.7	-17.2	1.8	-24.6	-9.2	7.5	2.3	-37.8	14.1
1400	3.0	-18.5	-0.9	-49.8	-13.9	-14.1	-10.6	-25.4	-9.4	14.3	-2.0	-34.1	4.8
700	3.5	-18.6	-2.9	-38.3	-4.1	-11.3	-3.0	-12.7	-3.2	12.4	-2.3	-30.8	-2.0
800	4.0	-15.9	-1.9	-36.3	10.6	-12.9	-1.7	-16.9	-7.9	7.8	-3.9	-29.4	3.15
2300	6.0	-20.4	1.3	-51.5	-12.8	-17.5	-6.2	-27.2	-2.3	6.4	0.1	-38.9	-12.3
900	7.0	-16.0	0.2	-34.7	4.9	-10.9	-5.4	-7.6	-3.5	8.8	-2.2	-30	6.42
1700	8.0	-18.6	0.4	-42.0	-2.7	-18.9	-1.4	-10.2	-1.7	7.6	-0.6	-34.9	5.0
2200	9.0	-24.9	0.2	-55.8	-7.0	-23.1	-6.2	-9.4	-1.3	5.2	-0.4	-43.1	2.9
SEP (%)		**19.2**	**2.3**	**45.8**	**10.1**	**17.2**	**5.3**	**21.9**	**6.7**	**10.2**	**3.4**	**36.9**	**7.8**
K[a]	PGM[b]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]
2400	1.5	-14	4.6	-36.3	24.6	-13.6	7.9	-26.9	10.4	4.3	4.1	-38.7	24.5
600	2.0	-11.9	1.9	-29.5	-9.4	-9.3	-5.9	-10.6	-4.5	5.5	-4.1	-25.4	-9.7
1900	2.0	-10.5	2.1	-33.8	8.7	-13.9	7.1	-14.5	3.4	5.9	5.5	-30.9	8.0
1400	3.0	-12	3.0	-33.9	0.5	-12.7	0.7	-12.7	-1.6	3.5	0.2	-29.8	-0.2
700	3.5	-12.3	3.3	-32.8	-5.2	-11.7	-3.7	-6.9	-5.8	6.4	1.1	-28.8	14.7
800	4.0	-11.2	3.9	-30.7	-1.9	-13.3	-1.6	-8.7	-3.3	4.7	-2.8	-27.4	-2.8
2300	6.0	-15.2	6.2	-37.4	2.2	-12.3	2.5	-12.9	1.1	3.8	1.4	-37.9	1.2
900	7.0	-9.3	7.1	-32.2	1.9	-9.1	2.2	-6.3	0.8	6.0	0.9	-26.4	1.7
1700	8.0	-11.9	8.1	-36.0	0.3	-12.2	1.3	-9.6	0.9	4.8	1.1	-30.9	-0.5
2200	9.0	-13.5	9.0	-40.8	-0.7	-14.7	0.6	-8.9	0.5	3.3	0.4	-32.5	-0.7
SEP (%)		**12.3**	**5.5**	**34.5**	**8.9**	**12.4**	**4.2**	**13.1**	**4.4**	**4.9**	**2.8**	**31.2**	**9.9**
Na[a]	PGM[b]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]	Before[c]	After[d]
2400	1.5	-14.7	4.2	-42.6	-29.5	-16.5	4.9	-16.5	6.4	5.2	1.9	-43.8	7.5
600	2.0	-11.6	-4.4	-31.6	-17.2	-16.9	-5.2	-10.9	-5.7	12.7	1.6	-27.6	-9.2
1900	2.0	-15.5	3.8	-38.5	-30.2	-18.3	3.6	-18.3	-1.2	6.7	1.5	-37	4.7

1400	3.0	-15.0	-1.1	-36.3	-18.7	-15.1	-1.3	-15.9	-5.0	6.4	-2.4	-34.4	-2.5
700	3.5	-12.7	-2.7	-32.1	-8.4	-12.7	-2.9	-11.8	-6.2	4.9	1.2	-28.2	-2.1
800	4.0	-11.1	0.3	-32.4	-6.4	-11.3	-0.5	-9.4	-3.5	5.7	-2.1	-28.4	-0.2
2300	6.0	-23.8	2.0	-39.3	-13.1	-16.2	1.9	-19.8	0.3	4.6	0.5	-36.2	0.6
900	7.0	-12.3	-0.4	-33.5	-2.8	-9.2	-0.5	-6.3	-2.2	4.9	-1.9	-29.7	0.7
1700	8.0	-13.6	0.1	-37.8	-8.5	-14.2	-0.2	-8.2	-1.4	4.7	-0.9	-33.8	-0.8
2200	9.0	-14.8	0.3	-43.1	-11.5	-15.7	0.2	-9.2	0.3	3.8	0.2	-39.8	-2.7
SEP (%)		**14.9**	**2.5**	**36.9**	**17.1**	**14.8**	**2.8**	**13.4**	**3.9**	**6.4**	**1.6**	**34.2**	**4.3**

[a,b]: Metal concentration (mg/L). [c,d]: Before and after application of MLR method

Table S4: Comparison of the standard relative error and the standard error of prediction calculated for simulated solution before and after employment of correction method (mixture of interferents).

Simulated solution			Relative standard error (%)											
			Pt 265.954		**Pt 214.423**		**Pt 299.797**		**Pd 363.470**		**Rh 343.489**		**Rh 233.477**	
Al[a]	Ca[b]	PGM[c]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]
750	1800	2.0	-25.3	2.5	-67.7	2.9	-21.5	2.3	-11.7	5.1	16.0	3.9	-42..8	5.4
1300	850	3.0	-22.8	-3.3	-40.3	-8.8	-17.8	-4.6	-11.6	3.6	6.8	-2.8	-39.4	-4.1
1600	1700	4.0	-24.9	-1.6	-49.1	-8.1	-20.2	-2.7	-8.6	3.2	8.7	-1.1	-44.1	-1.0
2100	600	6.0	-22.1	-4.7	-34.2	-11.2	-17.3	-6.2	-6.5	3.0	9.3	-3.4	-40.1	-3.7
800	1600	8.0	-21.9	0.7	-35.3	3.8	-19.3	0.1	-7.1	0.2	9.5	-0.1	-40.6	1.8
1800	2100	9.0	-24.1	-2.1	-42.9	-7.9	-20.6	-2.9	-7.3	-2.1	8.8	-1.1	-45.9	-4.3
2200	1900	2.0	-30.6	3.8	-71.5	-18.6	-22.8	8.0	-7.9	-9.9	7.5	-5.5	-46.6	4.4
2500	2000	1.5	-34.6	-7.5	-83.8	21.2	-22.6	-13.2	-18.1	-12.3	14.5	-10.7	-49.5	11.7
2100	800	4.5	-21.5	6.7	-47.5	-11.6	-16.6	-6.03	-8.1	1.3	8.4	-5.2	-41.1	7.7
1500	500	9.0	-15.8	4.4	-30.3	10.4	-13.1	2.2	-6.8	-2.5	6.6	-2.5	-31.9	-4.2
	SEP (%)		**24.8**	**4.3**	**53.1**	**11.8**	**19.4**	**6.0**	**9.9**	**5.7**	**10.1**	**4.6**	**42.5**	**5.6**
Al[a]	K[b]	PGM[c]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]
600	1100	2.0	-19.2	-4.3	-38.2	-8.1	-13.6	-2.0	-12.6	2.4	8.6	-0.4	-34.2	-7.7
1300	850	3.0	-18.7	0.5	-36.6	-6.2	-12.1	2.0	-11.2	1.8	8.9	-1.7	-34.1	-2.6
1600	1400	4.0	-19.6	-2.0	-34.2	-7.6	-14.3	0.0	-8.4	-1.4	7.0	-4.0	-37.5	-3.8
2100	600	6.0	-17.6	-0.6	-34.4	-8.2	-11.7	1.7	-5.9	0.2	11.8	-2.9	-36.2	-2.2
700	1700	8.0	-14.5	2.3	-28.4	5.0	-11.8	2.9	-5.5	1.5	9.8	0.7	-31.6	3.5
1800	2100	9.0	-15.6	2.0	-33.6	-5.3	-12.9	3.6	-6.9	1.1	12.3	-0.4	-36.7	-1.3
2200	1800	2.0	-22.2	0.9	-37.6	3.7	-10.8	3.7	-10.1	6.3	10.8	-2.9	-40.2	0.4
2500	2000	1.5	-23.5	8.8	-39.3	13.9	-12.5	8.4	-14.6	10.1	7.8	-3.7	-41.8	11.4
2100	800	4.5	-13.6	5.2	-32.9	5.3	-14.7	7.3	-6.9	3.8	10.3	-0.6	-34.5	8.4
1500	500	9.0	-10.7	4.8	-21.2	6.9	-11.9	7.7	-5.1	1.1	8.6	0.4	-26.4	5.9
	SEP (%)		**17.9**	**4.0**	**34.0**	**7.5**	**12.7**	**4.8**	**9.3**	**4.1**	**9.7**	**2.3**	**35.6**	**5.8**

Al[a]	Na[b]	PGM[c]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]	Before[d]	After[e]
600	1100	2.0	-16.0	-0.2	-31.6	-5.1	-14.3	-1.1	-14.6	2.5	10.5	0.2	-39.5	-5.6
1300	850	3.0	-15.5	2.7	-31.9	2.8	-13.5	3.2	-12.9	4.7	14.7	2.2	-34.8	-0.9
1600	1400	4.0	-15.2	2.4	-37.3	3.6	-16.3	3.7	-13.3	5.4	12.2	3.3	-34.5	-2.4
2100	600	6.0	-14.6	2.5	-35.7	5.4	-13.3	4.5	-12.6	-1.5	11.3	4.2	-32.2	-2.5
700	1700	8.0	-15.9	0.9	-30.6	7.8	-13.0	1.3	-7.9	1.1	10.4	0.8	-35.8	1.3
1800	2100	9.0	-16.3	2.1	-32.5	8.3	-14.1	3.1	-8.5	2.7	11.5	2.7	-36.7	3.1
2200	1800	2.0	-18.7	5.9	-36.8	12.7	-15.9	3.7	-14.2	4.1	11.8	2.4	-39.1	7.1
2500	2000	1.5	-25.3	10.4	-40.6	17.7	-16.2	12.2	-22.6	10.2	9.9	10.1	-40.9	8.7
2100	800	4.5	-17.2	0.0	-35.0	6.8	-13.9	6.8	-7.6	2.8	9.3	-0.5	-38.6	-5.9
1500	500	9.0	-10.9	3.8	-23.4	4.2	-12.8	4.4	-6.9	-2.1	8.5	-2.2	-30.1	8.6
	SEP (%)		**16.9**	**4.3**	**33.8**	**8.6**	**14.4**	**5.3**	**12.9**	**4.5**	**11.1**	**3.9**	**36.4**	**5.4**

[a,b,c] Metal concentration (mg/L). [d,e]: Before and after application of MLR method