

**EA2: SIMS Al-Mg isotope measurements of olivine, pyroxene and plagioclase standards, and calibration data for unknowns.**

Details of the instrumental bias correction for Mg-isotopes are given in EA1 from Ushikubo et al. (2017)

**Table EA2-1: SIMS olivine standard data correction factors for Mg isotopes of unknowns**

sample name	spot #	measured raw values							relative bias to SC-OI bracket			
		<sup>24</sup> Mg yield (cps/nA)	$\delta^{25}\text{Mg}_m$	(2SE/2SD)	$\Delta^{26}\text{Mg}_m^*$	(2SE/2SD)	$\delta^{25}\text{Mg}$ bias	2SD	$\delta^{25}\text{Mg}$	2SD	$\Delta^{26}\text{Mg}^*$	2SD
SC-OI	1	0.772	-2.73	0.05	0.20	0.07	-2.66					
Mg#=89.	2	0.782	-2.74	0.04	0.21	0.08	-2.67					
$\delta^{25}\text{Mg}=-0.072\text{‰}$ DSM.	3	0.781	-2.69	0.05	0.15	0.09	-2.62					
	4	0.781	-2.71	0.04	0.14	0.06	-2.64					
HN-OI.	1	0.786	-3.98	0.05	0.22	0.06	-3.62	-0.95		-0.02		
Mg#=100.	2	0.787	-4.00	0.06	0.19	0.05	-3.63	-0.96		-0.05		
synthetic forsterite.	3	0.777	-3.94	0.06	0.15	0.07	-3.58	-0.91		-0.09		
$\delta^{25}\text{Mg}=-0.366\text{‰}$ DSM.	4	0.778	-3.98	0.06	0.20	0.08	-3.62	-0.95		-0.04		
	average	0.782	-3.98	$\pm 0.05$	0.19	$\pm 0.06$	-3.61	$\pm 0.05$	-0.94	$\pm 0.05$	-0.05	$\pm 0.06$
OR-OI.	1	0.733	-0.53	0.04	0.06	0.06	-0.51	2.17		-0.17		
Mg#=60.	2	0.730	-0.49	0.03	0.11	0.06	-0.48	2.20		-0.13		
$\delta^{25}\text{Mg}=-0.013\text{‰}$ DSM.	3	0.743	-0.47	0.04	0.16	0.08	-0.46	2.22		-0.08		
	4	0.740	-0.51	0.04	0.17	0.07	-0.49	2.18		-0.06		
	average	0.737	-0.50	$\pm 0.05$	0.13	$\pm 0.10$	-0.49	$\pm 0.05$	2.19	$\pm 0.05$	-0.11	$\pm 0.10$
SC-OI	1	0.773	-2.80	0.03	0.38	0.07	-2.73					
Mg#=89.	2	0.776	-2.74	0.03	0.26	0.07	-2.67					
$\delta^{25}\text{Mg}=-0.072\text{‰}$ DSM.	3	0.781	-2.76	0.03	0.26	0.07	-2.69					
	4	0.780	-2.77	0.03	0.31	0.07	-2.70					
	bracket	0.778	-2.74	$\pm 0.07$	0.24	$\pm 0.16$	-2.67	$\pm 0.07$				

**Table EA2-2: SIMS low-Ca pyroxene standard data and correction factors for Mg isotopes of unknowns**

sample name	spot #	measured raw values							relative bias to the Sp79-11 bracket			
		<sup>24</sup> Mg yield (cps/nA)	$\delta^{25}\text{Mg}_m$	(2SE/2SD)	$\Delta^{26}\text{Mg}_m^*$	(2SE/2SD)	$\delta^{25}\text{Mg}$ bias	2SD	$\delta^{25}\text{Mg}$	2SD	$\Delta^{26}\text{Mg}^*$	2SD
SP79-11 Opx.	1	0.675	-0.11	0.06	0.33	0.07	-0.05					
En97, Wo0.5.	2	0.668	-0.10	0.05	0.44	0.07	-0.04					
$\delta^{25}\text{Mg}=-0.058\text{‰}$ DSM.	3	0.670	-0.13	0.04	0.35	0.08	-0.07					
	4	0.667	-0.11	0.04	0.28	0.08	-0.05					
IG-Opx.	1	0.629	0.48	0.05	0.36	0.05	0.52	0.58		0.02		
En89, Wo1.	2	0.635	0.43	0.05	0.31	0.08	0.47	0.52		-0.03		
$\delta^{25}\text{Mg}=-0.037\text{‰}$ DSM.	3	0.628	0.52	0.05	0.35	0.07	0.56	0.61		0.00		
	4	0.635	0.57	0.06	0.29	0.08	0.61	0.66		-0.06		
	average	0.632	0.50	$\pm 0.12$	0.33	$\pm 0.07$	0.54	$\pm 0.12$	0.59	$\pm 0.12$	-0.02	$\pm 0.07$
SP79-11.	1	0.668	-0.17	0.05	0.33	0.07	-0.11					
En97, Wo0.5.	2	0.668	-0.07	0.06	0.34	0.06	-0.01					
$\delta^{25}\text{Mg}=-0.058\text{‰}$ DSM.	3	0.670	-0.09	0.05	0.32	0.08	-0.04					
	4	0.669	-0.12	0.05	0.39	0.07	-0.06					
	bracket	0.669	-0.11	$\pm 0.06$	0.35	$\pm 0.10$	-0.05	$\pm 0.06$				

**Table EA2-3: SIMS anorthite glass standard data and correction factors for Mg isotopes of unknowns**

sample name	analysis #	measured raw values					
		$\delta^{25}\text{Mg}_m$	(2 SE)	$\Delta^{26}\text{Mg}_m^*$	(2 SE)	$^{27}\text{Al}/^{24}\text{Mg}$	(2 SE)
session 1.	1	-2.40	0.43	0.26	0.82	35.52	0.18
1 wt.% MgO An-glass.	2	-1.60	0.49	-0.01	0.96	35.70	0.15
$\delta^{25}\text{Mg}=-1.77\text{‰}$ DSM.	3	-1.66	0.49	0.38	0.92	35.67	0.17
$^{27}\text{Al}/^{24}\text{Mg}$ : 34.59.	4	-1.55	0.55	-0.07	1.07	35.79	0.20
300 cycles per analysis.	5	-0.78	0.94	-0.30	1.84	36.39	0.20
	6	-1.94	0.91	0.79	1.84	36.38	0.25
	7	-0.96	0.86	-0.13	1.64	36.29	0.20
	8	-1.71	0.78	1.04	1.50	36.23	0.22
	9	-1.77	0.43	-0.39	0.82	36.02	0.17
	average, 2SE <sup>(a)</sup>	-1.60	0.32	0.17	0.33	36.00	0.22
	$(\alpha-1)\times 1000$ <sup>(b)</sup>	0.17	0.32		RSF <sup>(c)</sup>	1.041	0.006
sample name	analysis #	measured raw values					
		$\delta^{25}\text{Mg}_m$	(2 SE)	$\Delta^{26}\text{Mg}_m^*$	(2 SE)	$^{27}\text{Al}/^{24}\text{Mg}$	(2 SE)
session 2.	1	-0.49	0.65	-0.38	1.09	36.01	0.21
1 wt.% MgO An-glass.	2	0.00	0.65	-1.28	1.14	35.85	0.21
$\delta^{25}\text{Mg}=-1.77\text{‰}$ DSM.	3	-0.56	0.67	0.28	1.20	35.91	0.22
$^{27}\text{Al}/^{24}\text{Mg}$ : 34.59.	4	-1.45	0.44	-0.31	0.87	35.56	0.17
300 cycles per analysis.	5	-1.38	0.51	-1.26	0.92	35.56	0.18
	6	-1.67	0.40	-0.33	0.77	36.04	0.22
	7	-0.98	0.61	-0.67	1.14	35.67	0.20
	8	-0.63	0.62	-0.99	1.17	35.66	0.22
	9	-1.10	0.69	0.04	1.36	35.82	0.22
	10	-1.60	0.69	0.20	1.33	35.75	0.24
	11	-1.37	0.69	-0.34	1.29	36.30	0.23
	12	-1.04	0.68	-0.25	1.31	36.30	0.25
	13	-1.19	0.56	0.03	1.02	35.90	0.21
	14	-1.23	0.41	-0.95	0.79	35.81	0.17
	15	-2.04	0.32	0.06	0.60	35.87	0.16
	16	-1.94	0.32	-0.47	0.59	36.00	0.15
	average, 2SE <sup>(a)</sup>	-1.17	0.27	-0.41	0.25	35.88	0.11
	$(\alpha-1)\times 1000$ <sup>(b)</sup>	0.60	0.27		RSF <sup>(c)</sup>	1.037	0.003
sample name	analysis #	measured raw values					
		$\delta^{25}\text{Mg}_m$	(2 SE)	$\Delta^{26}\text{Mg}_m^*$	(2 SE)	$^{27}\text{Al}/^{24}\text{Mg}$	(2 SE)
Session 3.	1	-0.95	0.53	0.28	1.02	35.45	0.18
1 wt.% MgO An-glass.	2	-1.24	0.53	0.09	1.03	35.46	0.18
$\delta^{25}\text{Mg}=-1.77\text{‰}$ DSM.	3	-1.73	0.54	-0.27	1.04	35.77	0.18
$^{27}\text{Al}/^{24}\text{Mg}$ : 34.59.	4	-1.78	0.59	0.40	1.21	35.90	0.19
400 cycles per analysis.	5	-1.41	0.59	-0.04	1.13	35.94	0.18
	6	-1.56	0.59	-0.35	1.18	35.93	0.19
	7	-1.63	0.60	-0.18	1.21	35.87	0.20
	8	-1.39	0.57	-0.46	1.05	36.35	0.17
	9	-2.04	0.55	-0.09	1.07	36.42	0.19
	10	-1.74	0.49	-0.38	0.94	36.00	0.16
	11	-2.20	0.45	-0.24	0.89	36.07	0.15
	12	-1.91	0.42	-0.43	0.84	35.99	0.14
	13	-2.22	0.43	-0.45	0.84	36.08	0.14
	14	-1.95	0.49	-0.36	0.99	35.97	0.20
	15	-1.78	0.61	-1.09	1.15	36.01	0.23
	16	-2.50	0.64	-0.10	1.16	35.97	0.24
	17	-1.94	0.84	-0.66	1.48	36.86	0.71
	average, 2SE <sup>(a)</sup>	-1.76	0.19	-0.26	0.17	36.00	0.16
	$(\alpha-1)\times 1000$ <sup>(b)</sup>	0.01	0.19		RSF <sup>(c)</sup>	1.041	0.005

<sup>(a)</sup> in the averages rows, reported 2SE values represent those compiled from

the  $\delta^{25}\text{Mg}_m$ ,  $\Delta^{26}\text{Mg}_m^*$ , and  $^{27}\text{Al}/^{24}\text{Mg}$  columns, respectively

<sup>(b)</sup>  $\alpha = (1 + \delta^{25}\text{Mg}_{\text{raw}}/1000)/(1 + \delta^{25}\text{Mg}_{\text{DSM}}/1000)$

<sup>(c)</sup>  $\text{RSF} = (^{27}\text{Al}/^{24}\text{Mg})_{\text{measured}}/(^{27}\text{Al}/^{24}\text{Mg})_{\text{known}}$

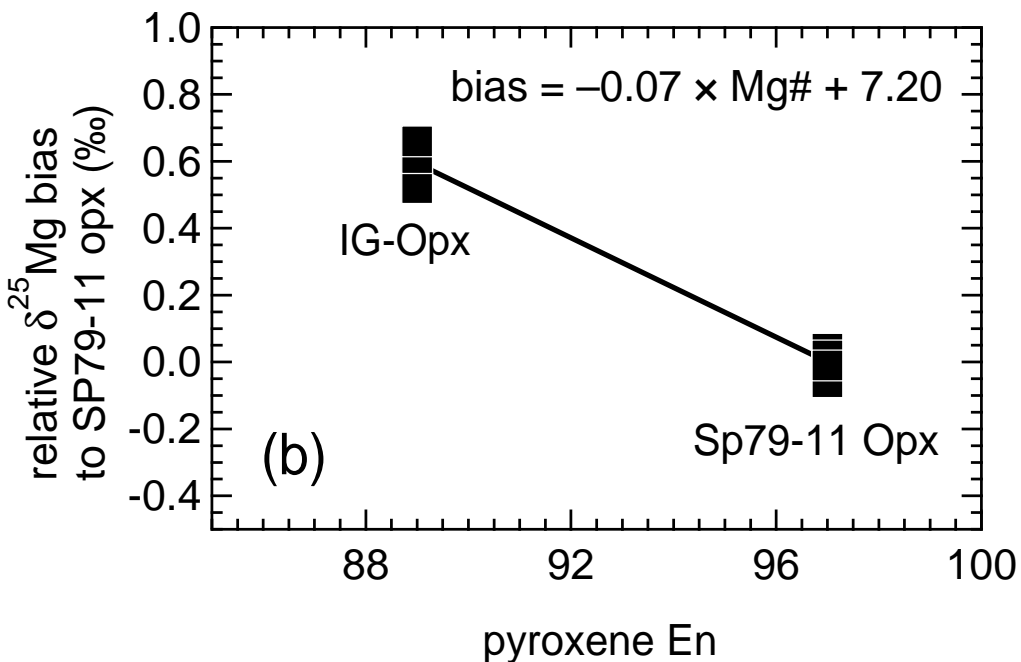
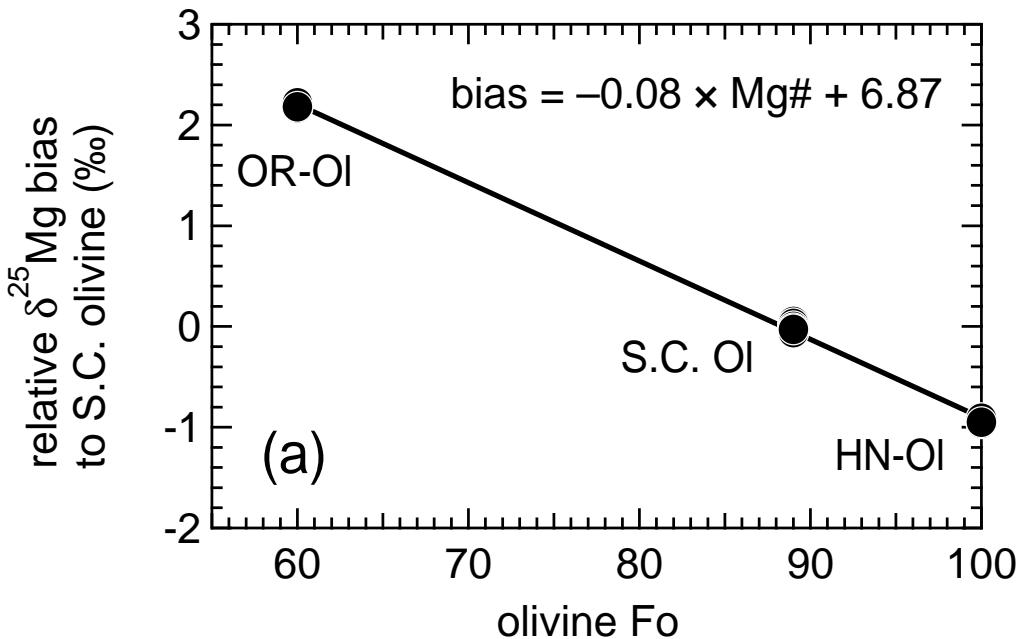


Fig. EA2-1. SIMS instrumental bias calibration curves for (a) olivine and (b) low-Ca pyroxene.