Correction to "Effects of hydration on the elastic properties of olivine"

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[1] In the paper "Effects of hydration on the elastic properties of olivine" by S. D. Jacobsen et al. (*Geophysical Research Letters*, *35*, L14303, doi:10.1029/2008GL034398, 2008), the sample of hydrous olivine labeled hy-Fo_{97} with (001) orientation in the bottom plot of original Figure 1b has been subsequently identified by Raman spectroscopy as OH-chondrodite, $(Mg,Fe)_5Si_2O_8(OH)_2$ [e.g., *Lin et al.*, 1999]. The OH-chondrodite co-existed with hydrous forsterite in the synthesis run, and all other samples in the study have been confirmed to be hydrous forsterite. Upon removing the OH-chondrodite platelet from the fit, we obtain a corrected set of elastic constants (C_{ij}) and crystallographic orientations for hy-Fo_{97} using a two-plane fit, displayed in corrected Figure 1 and presented in corrected Table 1. The original Table 2 of anisotropy factors has been updated and presented here in corrected Table 2. Brillouin spectra from the two remaining orientations of hy-Fo_{97} determine eight of the nine C_{ij}, leaving C_{12} unconstrained. As a result, C_{12} was fixed to the value obtained for hy-Fo_{100} and a large uncertainty of ±5 GPa in this parameter was assumed in calculating the aggregate bulk (K_{S0}) and shear (G) moduli.

[2] In addition, a minor correction to the elastic constants of hydrous forsterite (hy-Fo_{100}) is presented in revised Table 1 because the original calculation used an earlier estimated density of 3.19 g/cm^3, instead of the actual measured X-ray density of 3.180(3) g/cm^3. The measured X-ray density of 3.180(3) g/cm^3 was correctly reported in the original text, but not used in the calculation of C_{ij}. The revised C_{ij} of hydrous forsterite are affected by only 0.2–0.3% from the original calculation as a result of the error.

[3] The revised values of elastic properties for hy-Fo_{100} and hy-Fo_{97} presented in the corrected Table 1 apply to the following statements in the text:

[4] The last four sentences of paragraph [1] should read: The adiabatic bulk (K_{S0}) and shear (G_0) moduli of hy-Fo_{100} are 125.4(±0.2) GPa and 79.6(±0.1) GPa, respectively. For hy-Fo_{97}, we obtain K_{S0} = 125.2(±0.8) GPa and G_0 = 77.7(±0.3) GPa. Compared with anhydrous forsterite, the combined effects of 3 mol% Fe and 0.8 wt% H_2O reduce bulk and shear moduli by 2.9(±0.6)% and 4.5(±0.4)% respectively, with greater reductions expected for more iron-rich Fo_{90} mantle compositions. Although lattice preferred orientation (LPO) studies have not been carried out under relevant conditions of water or pressure, analysis of idealized single-crystal anisotropy for various known LPO types predicts no more than 2% effect of hydration on S-wave splitting anisotropy in olivine.

[5] The last sentence of paragraph [9] should read: We measured two platelets of hy-Fo_{97} with fitted orientations of (100) and (010), shown in the corrected Figure 1b.

[6] The last two sentences of paragraph [10] should read: The addition of 0.89 wt% H_2O to forsterite in our hy-Fo_{100} samples shows a reduction of all C_{ij} by 1.8–4.3%, except C_{33}, which is reduced by only 0.8%. For hy-Fo_{100}, we obtain K_{S0} = 125.4(±0.2) GPa and G_0 = 79.6(±0.1) GPa, which are about 2.7% and 2.2% lower than anhydrous forsterite, respectively.

[7] The first two sentences of paragraph [11] should read: Comparing the C_{ij} of hy-Fo_{97} with anhydrous Fo_{100} to ascertain the net effect of iron and hydration shows that there is a large reduction in C_{ij} by 2.4–6.4%, except for C_{23}, which increased by 2.1%. For hy-Fo_{97}, we obtain K_{S0} = 125.2(±0.8) GPa and G_0 = 77.7(±0.3) GPa, which are 2.9% and 4.5% lower than anhydrous forsterite.

[8] The last sentence of paragraph [11] should read: The aggregate hy-Fo_{97} velocities Vp and Vs (with only 3 mol% Fe) are 2.1% and 2.4% lower, respectively, than anhydrous forsterite, suggesting that hydrous Fo_{90} olivine, closer to mantle composition, would exhibit even further reduced velocities.

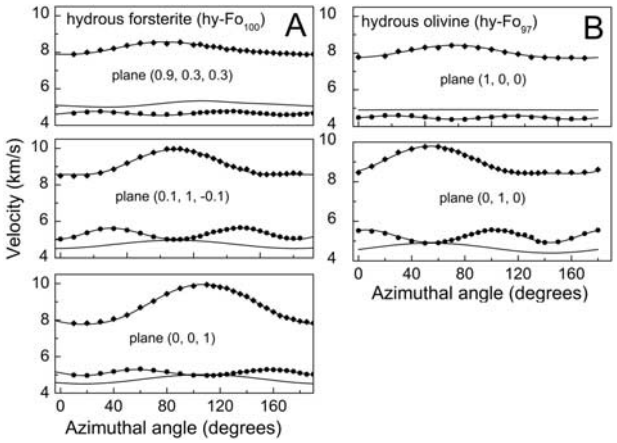

Figure 1. Measured acoustic velocities (solid symbols) as a function of azimuthal angle in different platelets for each composition, (a) hy-Fo_{100} and (b) hy-Fo_{97}. Fitted solutions to the Christoffel equations are shown by solid lines.

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Table 1. Elastic Properties of Olivine With Varying Iron and Water Content[a]

	Forsterite[b]	San Carlos Olivine[c]	Effect of Fe (%)[d]	Hy-Fo100[e]	Effect of H_2O (%)[d]	Hy-Fo97[e]	Effect of Fe and H_2O (%)[d]
Mg#	1.00	0.90		1.00		0.97	
H_2O (wt%)[f]	0	0		0.89		0.80	
C_{ij} (GPa)							
C_{11}	328.6 (5)	320.2 (4)	−2.6	314.4 (6)	−4.3	311.2 (11)	−5.3
C_{22}	200.1 (3)	195.9 (3)	−2.1	194.6 (5)	−2.7	193.5 (10)	−3.3
C_{33}	235.7 (5)	233.8 (3)	−0.8	233.7 (7)	−0.8	230.1 (6)	−2.4
C_{12}	66.8 (3)	67.9 (3)	+1.6	64.7 (6)	−3.1	64.7[g]	−3.1
C_{13}	68.4 (4)	70.5 (3)	+3.1	67.0 (6)	−2.0	64.7 (7)	−5.4
C_{23}	72.7 (3)	78.5 (4)	+8.0	70.0 (6)	−3.7	74.2 (6)	+2.1
C_{44}	67.0 (1)	63.5 (2)	−5.2	65.8 (3)	−1.8	62.7 (1)	−6.4
C_{55}	81.2 (2)	76.9 (2)	−5.3	79.9 (2)	−1.6	78.5 (3)	−3.3
C_{66}	80.9 (1)	78.1 (1)	−3.5	78.4 (4)	−3.1	77.8 (8)	−3.8
ρ (kg/m^3)	3225	3350	+3.9	3180 (3)	−1.4	3240 (3)	+0.5
K_{S0} (GPa)	128.9	129.5	+0.5	125.4 (2)	−2.7	125.2 (8)	−2.9
G_0 (GPa)	81.4	77.5	−4.8	79.6 (1)	−2.2	77.7 (3)	−4.5
V_P (km/s)	8.58	8.34	−2.8	8.53 (1)	−0.6	8.40 (1)	−2.1
V_S (km/s)	5.02	4.81	−4.2	5.00 (1)	−0.4	4.90 (1)	−2.4
V_P/V_S	1.709	1.734	+1.5	1.706 (5)	−0.2	1.714 (6)	+0.3
Poisson, ν	0.240	0.251	+4.6	0.238 (7)	−0.8	0.242 (7)	+0.8

[a]Values in parentheses are standard deviations in the last place.
[b]*Suzuki et al.* [1983].
[c]*Webb* [1989].
[d]Percent change compared with anhydrous forsterite.
[e]This study.
[f]Water contents estimated using the calibration of *Bell et al.* [2003].
[g]Value of C_{12} for hy-Fo_{97} was unconstrained by our data and fixed to the hy-Fo_{100} value of 64.7 GPa. We assume a large uncertainty of ±5 GPa in C_{12} for the purpose of calculating aggregate moduli, K_{S0} and G.

Table 2. Anisotropy of Single-Crystal Olivine With Varying Iron and Water Content

	Forsterite[a]	San Carlos Olivine[b]	Hy-Fo_{100} This study	Hy-Fo_{97} This study
		P-Wave Anisotropy		
Vp[100][c]	10.09	9.78	9.94	9.80
Vp[010]	7.88	7.65	7.82	7.73
Vp[001]	8.55	8.35	8.57	8.43
%Anisotropy[d]	25.0 (±0.4)	24.8 (±0.1)	24.1 (±0.5)	23.9 (±0.4)
		S-Wave Anisotropy		
Vs//*a*-axis				
Polarized [010]	5.01	4.83	4.97	4.90
Polarized [001]	5.02	4.79	5.01	4.92
% anisotropy[d]	0.2 (±0.3)	0.8 (±0.1)	0.8 (±0.5)	0.4 (±0.7)
Vs//*b*-axis				
Polarized [100]	5.01	4.83	4.97	4.90
Polarized [001]	4.56	4.35	4.55	4.40
% anisotropy[d]	9.4 (±0.2)	10.5 (±0.2)	8.8 (±0.6)	10.8 (±0.6)
Vs//*c*-axis				
Polarized [100]	5.02	4.79	5.01	4.92
Polarized [010]	4.56	4.35	4.55	4.40
% anisotropy[d]	9.6 (±0.3)	9.6 (±0.2)	9.6 (±0.6)	11.2 (±0.3)
		LPO Analysis		
A-type fabric[e]				
V_{SH}	5.02	4.79	5.01	4.92
V_{SV}	5.01	4.83	4.97	4.90
V_{SH}/V_{SV}	1.002	0.992	1.008	1.004
B-type fabric[e]				
V_{SH}	5.02	4.79	5.01	4.92
V_{SV}	4.56	4.35	4.55	4.40
V_{SH}/V_{SV}	1.101	1.101	1.101	1.118
C-type fabric[e]				
V_{SH}	4.56	4.35	4.55	4.40
V_{SV}	5.02	4.79	5.01	4.92
V_{SH}/V_{SV}	0.908	0.908	0.908	0.894
E-type fabric[e]				
V_{SH}	5.01	4.83	4.97	4.90
V_{SV}	5.02	4.79	5.01	4.92
V_{SH}/V_{SV}	0.998	1.008	0.992	0.996

[a] *Suzuki et al.* [1983].
[b] *Webb* [1989].
[c] Uncertainties in velocities are 0.01–0.02 km/s, propagated from uncertainties in C_{ij}.
[d] Anisotropy (%) is calculated as (Vmax − Vmin)/Vmean.
[e] Assumes horizontal flow, S-wave propagating in the shear plane, parallel to shear direction, with V_{SH} polarized in the shear plane, and V_{SV} polarized perpendicular to the shear plane. The crystal orientation for each fabric type is idealized using observed lattice preferred orientation (LPO) fabric types given by *Jung et al.* [2006].

[9] The last sentence of paragraph [13] should read: Hydration of forsterite only slightly reduces the maximum P-wave anisotropy, expressed as [(Vmax − Vmin)/Vmean] × 100, from 25.0(±0.4)% to 24.1(±0.5)% for hy-Fo_{100}, with moderate further reduction to 23.9(±0.4)% for hy-Fo_{97}.

[10] The third sentence of paragraph [15] should read: Under horizontal shear (used to reference V_{SH} and V_{SV}), the hy-Fo_{97} olivine shows no change in shear-wave splitting anisotropy for idealized LPO type-A and type-E compared with dry forsterite.

[11] The fifth sentence of paragraph [15] should read: In both cases (type-B and type-C) there is moderate 1–2% change in S-wave splitting anisotropy with hydration (corrected Table 2).

References

Lin, C. C., L. G. Liu, and T. Irifune (1999), High-pressure Raman spectroscopic study of chondrodite, *Phys. Chem. Miner.*, *26*, 226–233.