Supplement of Solid Earth, 8, 1211–1239, 2017
https://doi.org/10.5194/se-8-1211-2017-supplement

Supplement of

Constraints on the rheology of the lower crust in a strike-slip plate boundary: evidence from the San Quintín xenoliths, Baja California, Mexico

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Table S1. Estimated absorbance for principal vibrational directions based on Johnson and Rossman (2003)

Sample	Oriented band areas (cm^{-2})			Total band area (cm^{-2})
	x	y	z	
Andesine GRR1389	2455	1064	596	4115
Oligioclase GRR580	999	394	117	1511
Oligoclase GRR1280	2356	1310	215	3880
Sanidine GRR638	753	269	542	1564
Anorthite GRR1968	120	944	175	1239
Microcline GRR1281	10917	2485	5986	19389
Microcline GRR968	6892	1983	4704	13579

x, y, z: principal vibrational directions

Table S2. Representative mineral compositions

SAMPLE	**SQ-16**	**SQW-75**	**SQW-110**	**SQW-114**	**SQW-115**	**SQW-76**	**SQL-48**
OLIVINE							
wt. %							
SiO_2	40.14	38.02	33.19	38.51	36.98		36.56
FeO	14.89	19.61	47.78	17.82	28.38		29.82
Fe_2O_3	0.000	0.56	0.33	1.22	0.33		0.00
MnO	0.18	0.30	1.05	0.25	0.48		0.40
MgO	44.85	40.04	16.92	41.64	33.33		31.66
CaO	0.22	0.25	0.40	0.26	0.27		0.53
Sum	100.28	98.78	99.66	99.70	99.78		98.96
cations per 4 oxygen atoms							
Si	1.00	0.99	0.99	0.99	1.00		0.99
Fe^{2+}	0.31	0.42	1.20	0.38	0.64		0.68
Fe^{3+}	0.00	0.02	0.01	0.02	0.01		0.00
Mn	0.00	0.01	0.03	0.01	0.01		0.01
Mg	1.67	1.55	0.76	1.59	1.34		1.28
Ca	0.01	0.01	0.01	0.08	0.01		0.02
Sum	2.99	3.00	2.99	3.00	3.00		2.97
X_{Mg}	0.84	0.78	0.39	0.80	0.67		0.65
ORTHOPYROXENE							
wt. %							
SiO_2	52.57	52.53	50.31	55.75	51.71	50.33	51.41
TiO_2	0.03	0.08	0.10	0.03	0.15	0.12	0.08
Al_2O_3	3.39	4.01	2.27	1.31	3.49	2.22	2.93
FeO	14.59	15.01	26.42	10.95	17.64	26.15	20.27
Fe_2O_3	1.11	0.78	1.78	0.40	1.56	1.11	2.22
MnO	0.36	0.32	0.79	0.24	0.38	2.11	0.48
MgO	26.49	26.19	17.74	29.31	24.01	17.26	22.35
CaO	0.61	0.81	1.01	2.16	0.82	1.03	0.55
Na_2O	0.01	0.02	0.03	0.04	0.03	0.06	0.01
Sum	99.16	99.73	100.44	100.20	99.79	100.40	100.29
cations per 3 oxygen atoms							
Si	0.95	0.95	0.96	0.96	0.99	0.95	0.95
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	0.07	0.09	0.05	0.05	0.03	0.08	0.06
Fe^{2+}	0.22	0.23	0.42	0.42	0.16	0.27	0.31
Fe^{3+}	0.02	0.01	0.02	0.03	0.01	0.02	0.03
Mn	0.01	0.01	0.03	0.01	0.00	0.01	0.01
Mg	0.72	0.71	0.49	0.51	0.77	0.66	0.62
Ca	0.01	0.02	0.02	0.02	0.04	0.02	0.01
Na	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	2.00	2.00	2.00	2.00	2.00	2.00	2.00
X_{Mg}	0.75	0.75	0.53	0.53	0.82	0.69	0.64

Table S2. Continued

SAMPLE	SQ-16	SQW-75	SQW-110	SQW-114	SQW-115	SQW-76	SQL-48
CLINOPYROXENE							
wt. %							
SiO_2	48.92	51.23	50.50	52.83	49.74		49.93
TiO_2	0.83	0.29	0.36	0.06	0.62		0.65
Al_2O_3	7.17	4.66	3.61	3.27	5.09		4.92
FeO	4.63	4.16	11.80	5.71	6.41		6.44
Fe_2O_3	0.77	1.67	1.78	1.10	2.68		2.44
MnO	0.12	0.13	0.41	0.20	0.22		0.23
MgO	13.67	14.37	11.76	17.24	13.19		12.88
CaO	22.47	23.07	19.67	19.33	21.38		22.38
Na_2O	0.28	0.44	0.52	0.38	0.54		0.44
Sum	98.86	100.01	100.41	100.12	99.86		100.30
cations per 6 oxygen atoms							
Si	1.82	1.88	1.90	1.93	1.85		1.86
Ti	0.02	0.01	0.01	0.00	0.02		0.02
Al	0.31	0.20	0.16	0.14	0.22		0.22
Fe^{2+}	0.14	0.13	0.37	0.17	0.20		0.20
Fe^{3+}	0.02	0.05	0.05	0.03	0.08		0.07
Mn	0.00	0.00	0.01	0.01	0.01		0.01
Mg	0.76	0.79	0.66	0.94	0.73		0.71
Ca	0.89	0.91	0.79	0.76	0.85		0.89
Na	0.02	0.03	0.04	0.03	0.04		0.03
Sum	3.99	4.00	4.00	4.00	3.99		4.00
X_{Mg}	0.82	0.82	0.61	0.82	0.73		0.73
SPINEL							
wt. %							
TiO_2	0.18	0.04		0.02			
Al_2O_3	60.14	60.16		61.38			
Cr_2O_3	1.13	0.03		0.90			
FeO	18.98	17.64		14.72			
Fe_2O_3	4.44	6.11		4.45			
MnO	0.19	0.15		0.09			
MgO	14.96	15.41		17.45			
CaO	0.06	0.02		0.04			
Sum	100.08	99.56		99.02			
cations per 4 oxygen atoms							
Ti	0.00	0.00		0.00			
Al	1.87	1.88		1.89			
Cr	0.02	0.00		0.02			
Fe^{2+}	0.42	0.39		0.32			
Fe^{3+}	0.09	0.12		0.09			
Mn	0.00	0.00		0.00			
Mg	0.59	0.61		0.68			
Ca	0.00	0.00		0.00			
Sum	3.00	3.00		3.00			
X_{Mg}	0.54	0.55		0.62			

Table S2. Continued

SAMPLE	SQ-16	SQW-75	SQW-110	SQW-114	SQW-115	SQW-76	SQL-48
PLAGIOCLASE (Recrystallized grains)							
wt. %							
SiO_2	43.65	44.31		44.31	46.23	60.08	44.58
Al_2O_3	36.32	34.96		34.84	33.44	25.80	34.55
FeO	0.00	0.00		0.00	0.00	0.00	0.00
Fe_2O_3	0.00	0.00		0.00	0.00	0.00	0.00
MgO	0.00	0.01		0.04	0.04	0.02	0.01
CaO	19.92	19.01		19.28	17.73	7.68	19.09
Na_2O	0.30	0.77		0.74	1.53	7.02	0.79
K_2O	0.01	0.00		0.00	0.03	0.31	0.05
Sum	100.18	99.06		99.21	99.00	100.91	99.08
cations per 8 oxygen atoms							
Si	2.02	2.07		2.07	2.15	2.65	2.08
Al	1.98	1.92		1.91	1.83	1.34	1.90
Fe^{2+}	0.00	0.00		0.00	0.00	0.00	0.00
Fe^{3+}	0.00	0.00		0.00	0.00	0.00	0.00
Mg	0.00	0.00		0.00	0.00	0.00	0.00
Ca	0.99	0.95		0.96	0.88	0.36	0.95
Na	0.03	0.07		0.07	0.14	0.60	0.07
K_2O	0.00	0.00		0.00	0.00	0.02	0.00
Sum	5.01	5.01		5.01	5.00	4.98	5.01
PLAGIOCLASE (Symplectites/melt)							
wt. %							
SiO_2	46.95	47.51		59.98	52.72		
Al_2O_3	34.06	32.66		15.32	28.66		
FeO	0.00	0.31		2.15	0.00		
Fe_2O_3	0.00	0.00		3.64	0.00		
MgO	0.17	0.21		3.21	0.16		
CaO	17.37	16.73		6.39	12.43		
Na_2O	1.62	1.90		5.50	4.43		
K_2O	0.01	0.02		1.08	0.21		
Sum	100.18	99.33		97.26	98.61		
cations per 8 oxygen atoms							
Si	2.15	2.20		2.80	2.42		
Al	1.84	1.78		0.84	1.55		
Fe^{2+}	0.00	0.00		0.08	0.00		
Fe^{3+}	0.00	0.01		0.13	0.00		
Mg	0.01	0.01		0.23	0.01		
Ca	0.85	0.83		0.32	0.61		
Na	0.14	0.17		0.50	0.40		
K_2O	0.00	0.00		0.06	0.01		
Sum	5.00	5.00		4.97	5.01		

Table S3. The volume percentage, magnesium numbers, Al_2O_3 in orthopyroxene and clinopyroxene, CaO in plagioclase and clinopyroxene in samples SQ-16, SQW-75, and SQW-114.

Xenolith	SQ-16	SQW-75	SQW-114
Vol%			
Plg	43.8	50.1	15.9
Cpx	19.7	32.2	19.5
Sp	13.0	2.2	13.0
Ol	22.5	2.0	23.7
Opx	–	14.0	27.9
Total	99.0	100.5	100.0
X_{Mg}			
Cpx	0.97	0.82	0.83
Sp	0.59	0.55	0.62
Ol	0.82	0.75	0.80
Opx	–	0.75	0.82
Al_2O_3			
Cpx	0.16	0.10	0.07
Opx	–	0.04	0.01
CaO			
Plg	0.85	0.94	0.96
Cpx	0.89	0.91	0.75

Opx is on a 3 oxygen basis

Table S4. Results of two-pyroxene geothermometry

Sample	T (°C) calculated at a pressure of 600 MPa			
	2-Px BK[a]	2-Px T[b]	2-Px Avg	1 std dev
SQ-16	732	770	751	27
SQL-48	739	790	765	36
SQW-75	741	777	759	25
SQW-110	824	947	886	87
SQW-114	863	908	886	32
SQW-115	834	874	854	28

[a]*Brey and Köhler* (1990); [b]*Taylor* (1998)

Table S5. Experimental flow law parameters

Lithology	Deformation Mechanism	A (MPa^{-n} μm^{m} s^{-1})	n	m	Q (kJ/mol)	V (m^3/mol)	Reference
An100, Dry	Dis	5.01×10^{12}	3	0	648		Rybacki & Dresen (2000)
An100, Dry	Dif	1.26×10^{12}	1	3	467		Rybacki & Dresen (2000)
An100, Wet	Dis	3.98×10^{2}	3	0	356		Rybacki & Dresen (2000)
An100, Wet	Dif	5.01×10^{1}	1	3	170		Rybacki & Dresen (2000)
$An25Di_{45}$, Dry	Dis	6.15×10^{-4}	3.03	0	701		Dimanov & Dresen (2005)
$An25Di_{45}$, Dry	Dif	*1.26×10^{6}*	1	3	454		Dimanov & Dresen (2005)
$An25Di_{35}$, Wet	Dis	5.25×10^{-15}	3.01	0	391		Dimanov & Dresen (2005)
$An25Di_{35}$, Wet	Dif	*1.24×10^{0}*	1	3	291		Dimanov & Dresen (2005)
Olivine, Dry	Dis	1.1×10^{5}	3.5	0	530	1.8×10^{-5}	Hirth & Kohlstedt (2003)
Olivine, Dry	Dif	1.5×10^{9}	1	3	375	1×10^{-6}	Hirth & Kohlstedt (2003)
Olivine, Dry	disGBS	6.31×10^{4}	2.9	0.7	445		Hansen et al. (2011)

The preexponential parameters (A) in italics are recalculated based on this study (see text for explanation); Dis: Dislocation creep, Dif: Diffusion creep, disGBS: Dislocation accommodated grain boundary sliding

Table References

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