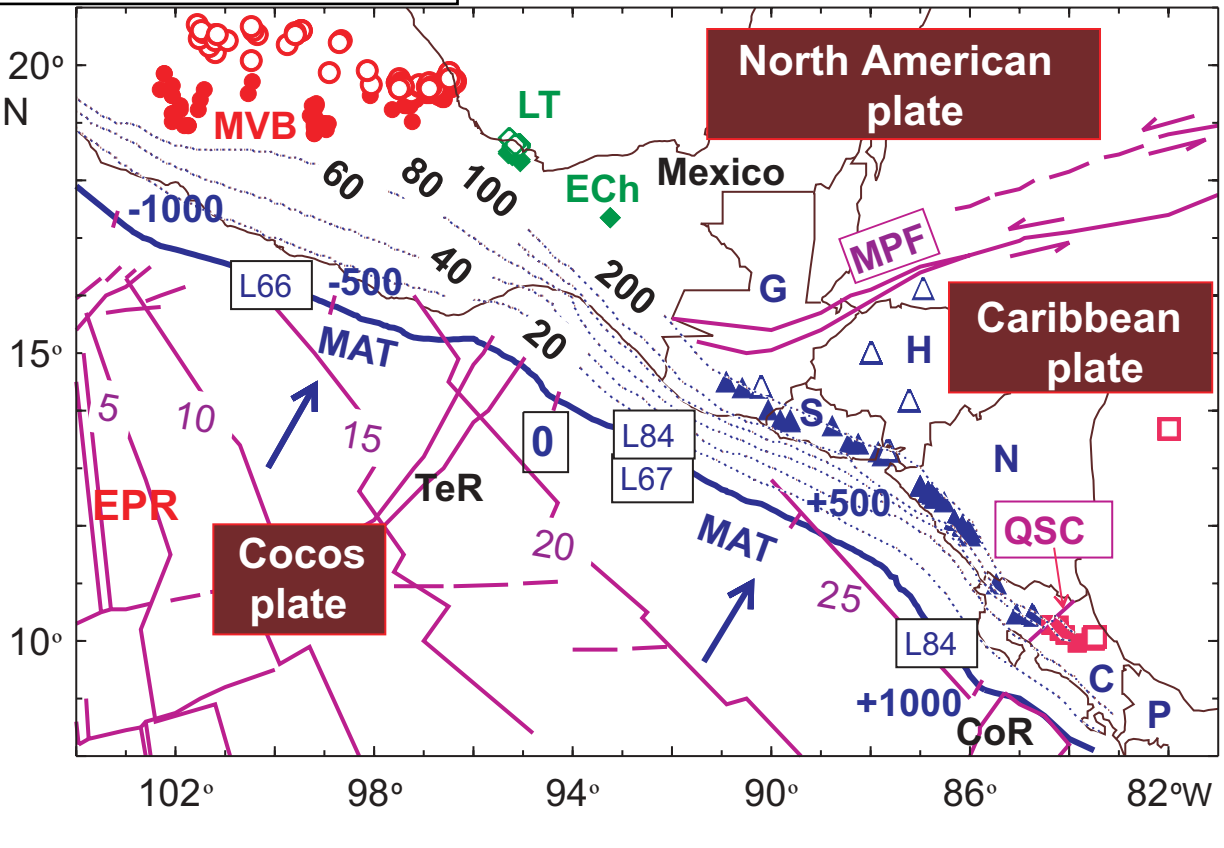
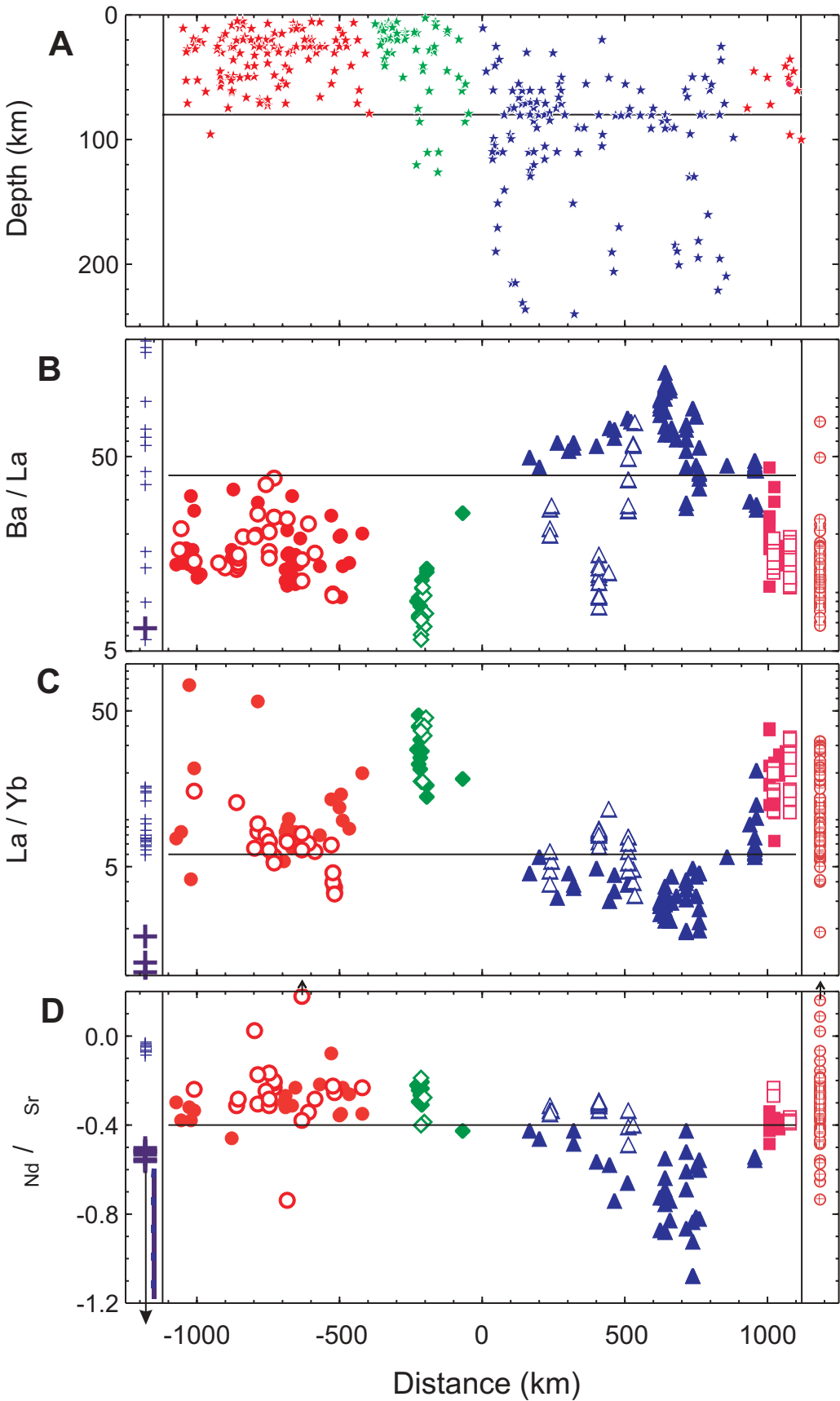
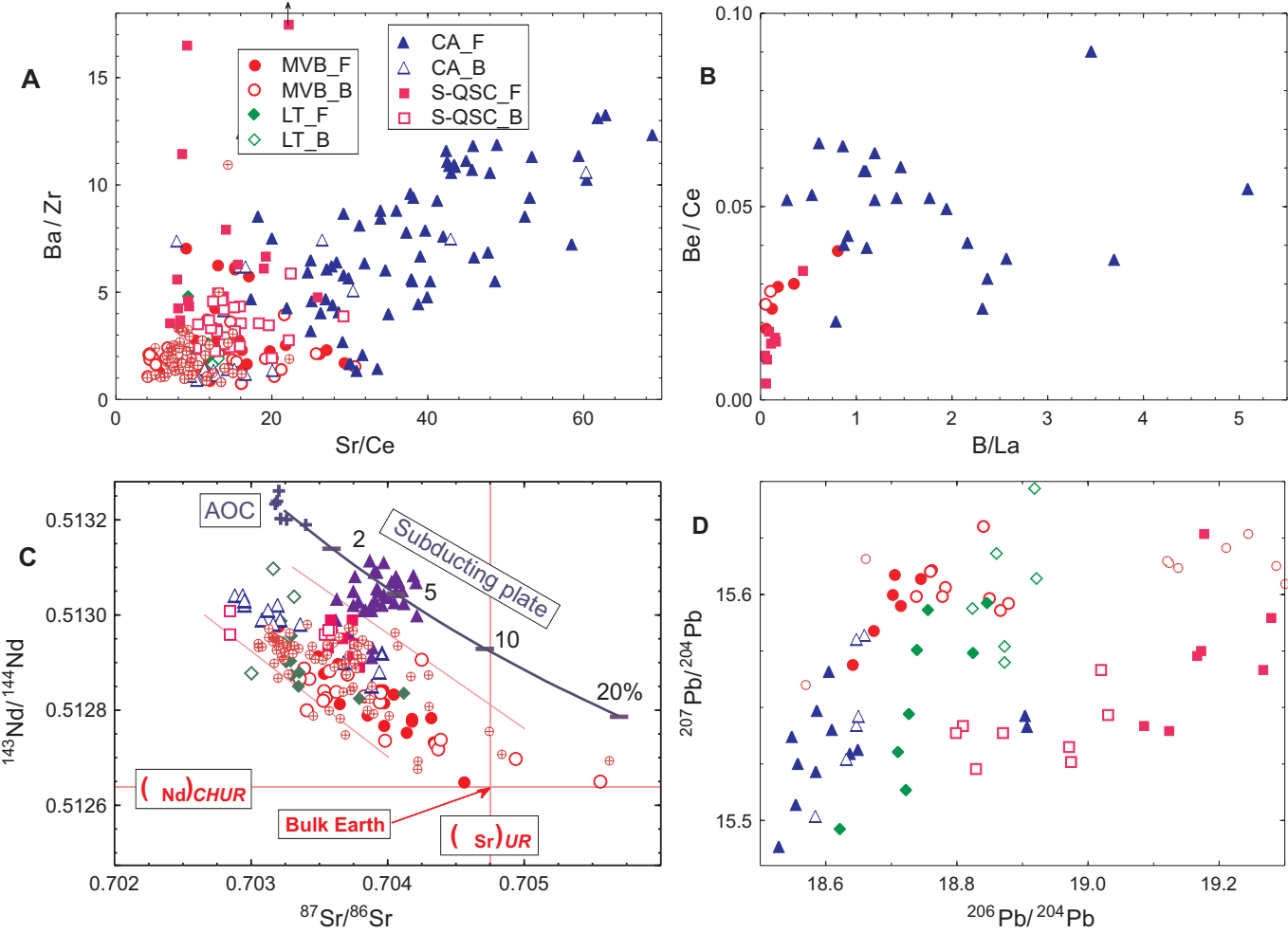
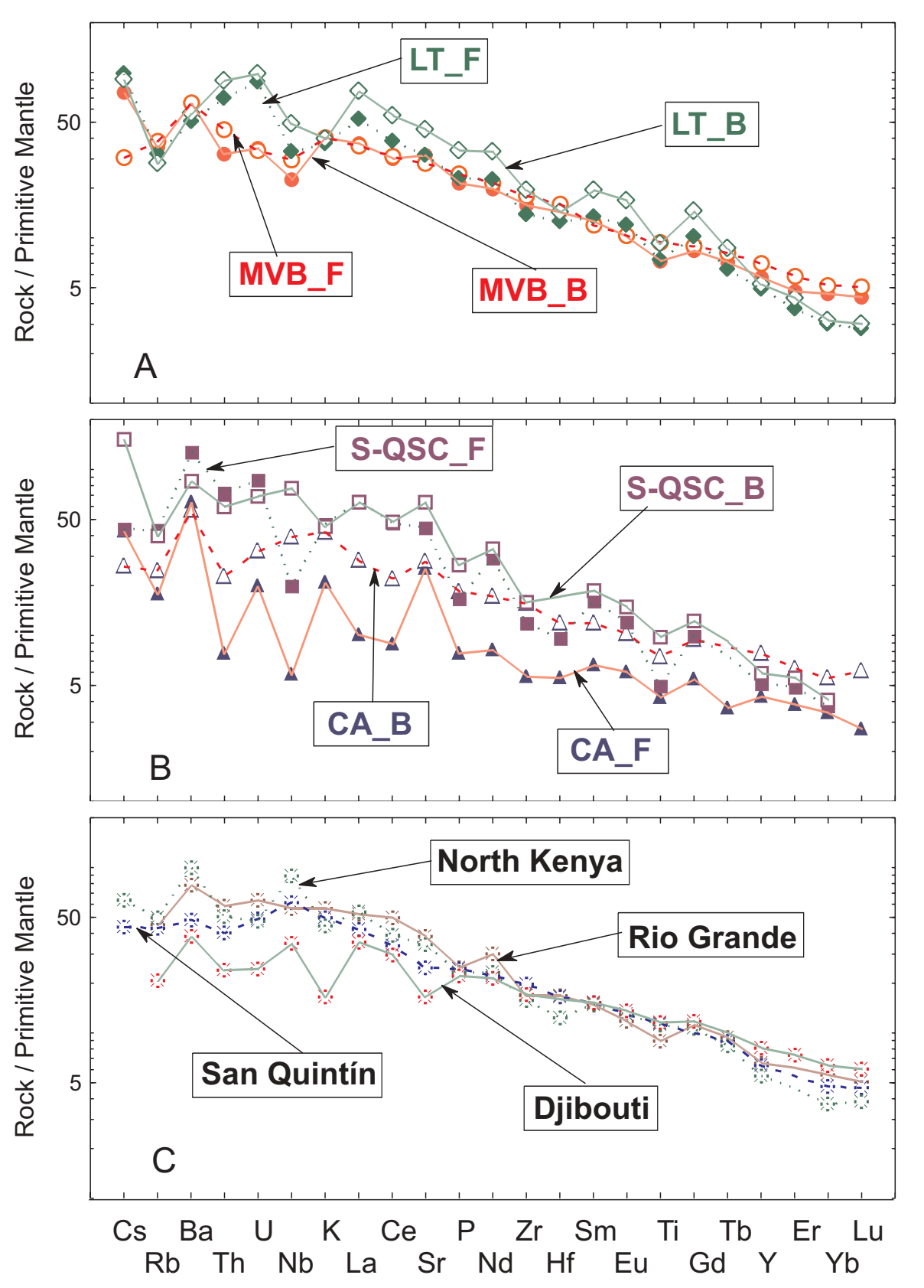
Data Repository item 2002129




A
Depth (km)
0
100
200
B
Ba / La
50
5
C
La / Yb
50
5
D
Nd / Sr
0.0
-0.4
-0.8
-1.2
-1000
-500
0
500
1000
Distance (km)


A
MVB_F
MVB_B
LT_F
LT_B
CA_F
CA_B
S-QSC_F
S-QSC_B
Ba / Zr
Sr/Ce
B
Be / Ce
B/La
C
AOC
Subducting plate
2
5
10
20%
(Nd)CHUR
Bulk Earth
(Sr)UR
143Nd/144Nd
87Sr/86Sr
D
207Pb/204Pb
206Pb/204Pb


Rock / Primitive Mantle
50
5
LT_F
LT_B
MVB_F
MVB_B
A
S-QSC_F
S-QSC_B
CA_B
CA_F
B
North Kenya
Rio Grande
San Quintín
Djibouti
C
Cs
Rb
Ba
Th
U
Nb
K
La
Ce
Sr
P
Nd
Zr
Hf
Sm
Eu
Ti
Gd
Tb
Y
Er
Yb
Lu

[1]GSA Data Repository item 2002####, Table DR1 (new data), Table DR2 (synthesis of all compiled data), Figures DR3–5 (Figs. 1–3 color version), Figure DR6 (Fig. 4–multi-element plot), and relevant references, is available from Documents Secretary, GSA, P.O. Box 9140, Boulder, CO 80301-9140, editing@geosociety.org, or at www.geosociety.org/pubs/ft2002.htm.

Absence of Cocos plate subduction-related basic volcanism in southern Mexico: A unique case on Earth?

Surendra P. Verma

GEOCHEMICAL DATABASE

New geochemical and isotopic data for 14 basic volcanic rock samples (Table DR1) from a wide area of southern Mexico were compiled in a database that constitutes now a total of 162 basic rock samples from southern Mexico and 145 from Central America. The latter were carefully selected from files downloaded from M. J. Carr´s web site (http://www-rci.rutgers.edu/carr/index.html). The Mexican data are from several references (included in the final list), and also include some unpublished data.

Only basic rock samples with SiO_2 < 52% (and apparently free from alteration and metamorphism) were used in order to minimize (although not completely eliminate) the effects of crustal assimilation, and therefore, highlight deeper processes of subducted slab input and mantle wedge melting. The conclusions drawn from this study will not change when only "primitive" basic magmas with high MgO and Mg# are used, although the number of compiled samples would then be very low. Complete data sets published for similar basic rocks from six well-known rifts (Rio Grande rift, USA; San Quintín volcanic field, Baja California, Mexico; Huri Hills, northern Kenya; Massif Central, France; Djibouti, Afar; and Ethiopia) were also compiled to facilitate comparison of southern Mexico with well-constrained rifts (references included in the final list). Likewise, altered MORB and overlying sediment data from the subducting Cocos plate were incorporated in this database to evaluate their possible relationship with the origin of basic rocks from southern Mexico and Central America.

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TABLE DR1. NEW GEOCHEMICAL DATA FOR BASIC ROCKS FROM SOUTHERN MEXICO

Sample	PUR01	JUR02	QRO01	ATH03	ATH02	ATH05	ATH04
Long. (°W)	100.48056	100.47500	100.38472	99.61944	99.61944	98.70556	98.68611
Lat. (°N)	20.09167	20.69167	20.55278	20.55556	20.55556	20.40833	20.44167
Rock *	B, subal	B, subal	B, subal	B, subal	B, subal	BTA, mug	B, subal
$(SiO_2)_{adj}$ †	51.98	51.33	51.97	51.51	51.05	51.27	51.47
$(TiO_2)_{adj}$	1.81	3.87	1.60	1.95	1.91	2.47	1.86
$(Al_2O_3)_{adj}$	16.90	14.38	17.31	16.88	16.69	14.90	16.98
$(Fe_2O_3)_{adj}$	2.19	2.23	2.14	1.63	1.68	3.34	1.59
$(FeO)_{adj}$	7.30	11.15	7.12	8.17	8.39	9.56	7.96
$(MnO)_{adj}$	0.16	0.21	0.16	0.16	0.17	0.23	0.16
$(MgO)_{adj}$	6.15	3.95	6.38	6.10	6.80	3.53	6.44
$(CaO)_{adj}$	8.46	7.76	8.69	8.43	8.40	6.72	8.39
$(Na_2O)_{adj}$	3.55	3.16	3.29	3.56	3.47	4.48	3.58
$(K_2O)_{adj}$	1.10	1.37	0.91	1.16	1.03	1.81	1.09
$(P_2O_5)_{adj}$	0.40	0.58	0.41	0.44	0.42	1.68	0.46
Q	-	4.02	0.60	-	-	-	-
Lc	-	-	-	-	-	-	-
Ne	-	-	-	-	-	-	-
Di	10.12	11.46	8.64	10.02	9.84	5.95	9.42
Hy	17.78	16.74	20.66	14.51	13.95	16.37	14.24
Ol	1.09	-	-	4.76	6.83	0.44	5.64
Mg# §	60.02	38.73	61.48	57.10	59.09	39.72	59.04
Ba	446	640	403	357	316	641	326
Nb	13.2	22.0	11.6	17.4	17.5	38.0	16.2
Zr	207	394	215	271	257	590	258
Y	31.6	56.7	28.8	36.4	32.8	85.6	33.2
Sr	435	390	598	500	491	535	509
Rb	22.0	18.2	12.8	19.0	17.8	34.7	20.0
Zn	88	142	90	100	98	170	93
Cu	21	28	19	25	22	12	22
Ni	52	15	36	70	74	12	52
Co	34	34	30	36	38	32	34
Cr	152	11	117	152	160	15	132
V	154	158	164	158	163	110	142
La	15.4	33	15.8	21.8	21.0	56	22.0
Ce	33	77	40	51	52	130	53
Pr	3.8	9.0	4.7	5.8	6.1	16.5	6.0
Nd	18.0	40.5	20.5	26.5	28.5	74	27.0
Sm	4.10	9.6	4.59	5.90	6.16	16.4	6.12
Eu	1.38	2.72	1.48	1.83	1.90	4.90	1.95
Gd	4.25	9.8	4.30	6.20	6.50	16.8	6.54
Tb	0.65	1.48	0.65	1.00	1.05	2.50	0.95
Ho	0.76	1.95	0.72	1.17	1.16	3.00	1.20
Er	2.10	5.60	2.00	3.32	3.40	8.2	3.44
Tm	0.26	0.70	0.25	0.44	0.46	1.00	0.47
Yb	1.85	5.0	1.69	3.04	3.30	6.8	3.42
Lu	0.26	0.70	0.25	0.50	0.52	0.90	0.55
$^{87}Sr/^{86}Sr$ #	0.703938± 7	0.705551± 9	0.703977±14	0.704350± 18	0.704367±13	0.704933± 18	0.704384± 19
$^{143}Nd/^{144}Nd$ #	0.512817± 8	0.512651±19	0.512737±29	0.512730± 10	0.512718±13	0.512699± 14	0.512738± 11
$^{206}Pb/^{204}Pb$**	N.D. ##	18.84 ± 6	N.D. ##	N.D. ##	N.D. ##	N.D. ##	N.D. ##
$^{207}Pb/^{204}Pb$**	N.D. ##	15.63 ± 6	N.D. ##	N.D. ##	N.D. ##	N.D. ##	N.D. ##
$^{208}Pb/^{204}Pb$**	N.D. ##	38.72 ± 6	N.D. ##	N.D. ##	N.D. ##	N.D. ##	N.D. ##

TABLE DR1 (Contd.). NEW GEOCHEMICAL DATA FOR BASIC ROCKS FROM SOUTHERN MEXICO

Sample	MAL01	E28	E25	E26	TUX15	TUX04	CH_I4
Long. (°W)	98.06493	97.64183	97.40867	97.33667	95.29306	95.07056	93.23333
Lat. (°N)	19.47297	19.23850	19.29417	19.28333	18.46500	18.57972	17.35000
Rock *	B, subal	B, subal	B, subal	B, subal	BSN, mnp	BSN, mnp	B, alk
$(SiO_2)_{adj}$ †	51.89	51.82	52.00	51.38	42.92	41.85	46.32
$(TiO_2)_{adj}$	2.12	1.29	1.54	1.24	2.30	2.64	1.54
$(Al_2O_3)_{adj}$	16.43	15.86	16.02	15.71	12.22	11.72	14.25
$(Fe_2O_3)_{adj}$	1.72	1.43	1.44	1.45	2.00	2.12	1.83
$(FeO)_{adj}$	8.62	7.15	7.21	7.26	9.98	10.61	9.16
$(MnO)_{adj}$	0.18	0.15	0.14	0.16	0.19	0.19	0.20
$(MgO)_{adj}$	5.39	8.67	8.10	8.79	13.66	13.30	12.30
$(CaO)_{adj}$	8.15	8.42	8.40	9.35	11.08	11.06	10.76
$(Na_2O)_{adj}$	3.66	3.39	3.41	3.06	3.47	3.92	1.90
$(K_2O)_{adj}$	1.21	1.46	1.36	1.20	1.43	1.74	1.27
$(P_2O_5)_{adj}$	0.62	0.36	0.37	0.41	0.76	0.84	0.48
Q	-	-	-	-	-	-	-
Lc	-	-	-	-	0.53	8.07	-
Ne	-	-	-	-	15.92	17.99	1.03
Di	9.47	12.65	12.07	14.67	29.35	31.49	19.05
Hy	18.54	8.78	12.04	11.36	-	-	-
Ol	1.07	12.15	8.74	10.00	23.88	22.86	24.97
Mg# §	52.71	68.36	66.70	68.36	70.92	69.07	70.53
Ba	260	509	436	468	414	536	610
Nb	19.2	12.2	21.0	13.3	43.7	71	36.0
Zr	206	179	185	168	222	282	128
Y	28.2	24.5	23.7	22.9	24.2	27.8	21.6
Sr	552	659	572	609	931	1008	529
Rb	14.0	28.2	24.6	26.2	24.8	33.1	23.6
Zn	84	84	78	86	106	133	97
Cu	34	32	30	46	83	80	80
Ni	42	182	162	132	333	330	232
Co	57	34	38	37	56	76	52
Cr	126	316	358	404	658	640	686
V	173	162	180	200	245	281	223
La	18.9	20.3	22.4	23.6	56	56	23.9
Ce	45	44	46.3	47.1	107	109	57
Pr	5.3	5.3	5.2	5.2	12.1	12.8	5.4
Nd	23.7	21.9	22.8	22.9	50.6	51.6	23.6
Sm	5.10	4.57	4.79	4.80	9.7	10.2	4.58
Eu	1.66	1.35	1.52	1.47	2.75	3.05	1.33
Gd	5.27	3.74	4.29	4.23	8.0	8.6	4.16
Tb	0.84	0.53	0.62	0.59	1.10	1.26	0.61
Ho	0.94	0.56	0.67	0.62	0.82	0.89	0.56
Er	2.74	1.55	1.90	1.75	1.92	2.05	1.68
Tm	0.35	0.20	0.25	0.22	0.18	0.22	0.20
Yb	2.40	1.50	1.88	1.64	1.21	1.40	1.32
Lu	0.38	0.21	0.30	0.23	0.16	0.20	0.20
$^{87}Sr/^{86}Sr$ #	0.703644±12	0.704561±13	0.703966±15	0.704178± 6	0.703297±13	0.703236±12	0.704118± 6
$^{143}Nd/^{144}Nd$ #	0.512814±14	0.512649±10	0.512842±21	0.512782±13	0.512956±14	0.512940±12	0.512836±10
$^{206}Pb/^{204}Pb$**	18.76 ± 6	N.D. ##	N.D. ##	18.714 ± 4	18.826 ± 5	18.922 ± 4	18.846 ± 2
$^{207}Pb/^{204}Pb$**	15.61 ± 6	N.D. ##	N.D. ##	15.595 ± 3	15.574 ± 4	15.607 ± 5	15.596 ± 6
$^{208}Pb/^{204}Pb$**	38.51 ± 7	N.D. ##	N.D. ##	38.412 ± 4	38.517 ± 7	38.644 ± 8	38.654 ± 8

Note: Trace elements (Ba to V) are by XRF and the REE by HPLC.

[*] Rock-types are presented according to total alkalis versus silica diagram and CIPW norms are on an anhydrous 100% adjusted basis. Abbreviations are: B, subal = Subalkali basalt; B, alk = Alkali basalt; BTA = Basaltic trachy andesite; mug = Mugearite; BSN = Basanite; mnp = melanephelinite.

[†] The subscript 'adj' refers to adjusted data (anhydrous 100% adjusted basis).

[§] Mg# = 100 Mg2+/(Mg2+ + Fe2+), atomic.

[#] The Sr and Nd isotopic ratios were measured in Max-Planck-Institut für Chemie, Mainz, Germany. The $^{87}Sr/^{86}Sr$ ratios were normalized to $^{86}Sr/^{88}Sr = 0.11940$ and adjusted to SRM987 $^{87}Sr/^{86}Sr$ ratio of 0.710230. The measured $^{87}Sr/^{86}Sr$ ratio for the SRM987 standard during the period of measurements of this study was 0.710216 ± 11 (1σ; n = 36). The $^{143}Nd/^{144}Nd$ ratios were normalized to $^{146}Nd/^{144}Nd = 0.72190$ and adjusted to La Jolla $^{143}Nd/^{144}Nd$ ratio of 0.511860. The measured $^{143}Nd/^{144}Nd$ ratio for the La Jolla standard was 0.511833 ± 12 (1σ; n = 82) during the period of measurement of about 1 year (September, 1986 - August, 1987). $\varepsilon_{Nd} = \{[(^{143}Nd/^{144}Nd)_m / (^{143}Nd/^{144}Nd)_{CHUR}] - 1\}10^4$, using $(^{143}Nd/^{144}Nd)_{CHUR} = 0.512638$. Further, the errors for individual Sr and Nd isotope ratios are 2 times the standard error of the mean ($2\sigma_E$) multiplied by 10^6. For average isotope ratios the errors are one standard deviation of the mean values, also multiplied by 10^6.

[**] The Pb isotopic ratios were measured in Max-Planck-Institut für Chemie, Mainz, Germany, except for two samples (JUR02 and MAL01) that were analyzed in the Laboratorio Universitario de Geoquímica Isotópica, Universidad Nacional Autónoma de México, D.F., Mexico. The Pb isotope ratios are corrected for fractionation estimated by running simultaneously the NBS982 standard and are relative to values of $^{206}Pb/^{204}Pb = 36.73845$, $^{207}Pb/^{204}Pb = 17.15946$, $^{208}Pb/^{204}Pb = 36.74432$, and $^{207}Pb/^{206}Pb = 0.46707$ for this standard. All Pb data are corrected for mass fractionation (a factor of 1.48 ± 0.04; 1σ; n = 9). The analytical uncertainties quoted for Pb isotopes are represented by one standard deviation values of duplicate measurements and are multiplied by 10^3.

[##] N.D. = not determined.

TABLE DR2. STATISTICS OF SELECTED GEOCHEMICAL DATA FOR BASIC ROCKS FROM SOUTHERN MEXICO, CENTRAL AMERICA, COCOS PLATE, AND WELL-CONSTRAINED RIFTS

Variable *	Mexican volcanic belt		Los Tuxtlas volcanic field & El Chichón volcano		Central America (Guatemala to north-western Costa Rica)		South of Quesada sharp cortortion (southeastern Costa Rica)		Cocos plate		Rifts †
	Front §	Back §	Front §	Back §	Front §	Back §	Front §	Back §	Altered Oceanic Crust	Sediments	
SiO_2	(67) 50.4±1.6	(73) 49.4±1.6	(14) 45.8±2.2	(8) 44.3±2.7	(74) 50.4±1.2	(24) 50.3±1.2	(17) 50.3±1.6	(30) 48.1±1.8	(17) 48.9±0.7	(30) 38±24	(86) 47.5±2.3
Ba/La	(47) 16.7±5.5	(30) 18.8±7.0	(13) 10.7±4.9	(8) 7.6±1.7	(67) 67 ± 28	(24) 26 ±18	(17) 21.2±8.7	(29) 14.3±2.8	(1) 6.6	(28) 130±120	(86) 13.7±8.6
La/Yb	(26) 14 ± 16	(23) 6.9 ± 2.8	(13) 25 ± 10	(8) 34 ± 11	(67) 4.3 ± 2.8	(24) 6.8±2.0	(17) 23.0±9.1	(29) 21.7±8.0	(5) 1.1±0.4	(26) 9.1±3.2	(82) 14.8±8.0
$\varepsilon_{Nd}/\varepsilon_{Sr}$	(18) -0.30±0.08	(22) -0.22±0.22	(9) -0.28 ± 0.07	(4) -0.31 ± 0.10	(36) -0.69 ± 0.17	(17) -0.34 ±0.05	(9) -0.39±0.04	(7) -0.34 ± 0.06	(6) -0.53 ± 0.02	(19) -0.06 ± 0.02	(74) -0.28 ± 0.22
Sr/Ce	(46) 13.5±5.0	(31) 12.4±6.9	(13) 10.4±1.4	(7) 9.6±2.2	(67) 38 ± 12	(24) 19 ± 12	(18) 13.3±6.0	(28) 15.2±4.2	34	(12) 820±520	(81) 9.0±2.9
Ba/Zr	(63) 2.8±2.4	(67) 2.5±2.2	(13) 2.30±0.77	(7) 1.83±0.29	(70) 7.2±3.2	(20) 3.5±3.0	(18) 8.1±7.1	(29) 3.5±1.2	0.2	(3) 100±70	(85) 2.1±1.4
B/La	(5) 0.30±0.30	(2) 0.08±0.04	---	---	(23) 1.7±1.2	---	(8) 0.14±0.13	---	---	---	---
Be/Ce	(15) 0.034±0.010	(2) 0.026±0.002	---	---	(32) 0.052±0.016	---	(20) 0.021±0.012	---	---	---	---
Zr/Y	(58) 6.7±1.5	(65) 6.3±1.6	(14) 7.5±1.7	(8) 9.0±2.2	(42) 3.0±0.7	(20) 4.8±1.9	(15) 5.9±1.3	(28) 6.6±1.0	1.6	(3) 1.1±0.4	(76) 7.5±2.3
Nb/Y	(48) 0.60±0.25	(65) 0.67±0.38	(14) 1.13±0.41	(8) 1.41±0.61	(33) 0.24±0.15	(17) 0.74±0.50	(12) 0.65±0.19	(10) 2.1±0.7	0.07	(12) 0.03±0.02	(77) 1.84±1.1
Ti/1000	(66) 9.5±2.5	(72) 12.3±3.9	(14) 9.5±2.5	(8) 12.0±3.6	(66) 5.9±1.2	(17) 10.7±3.8	(52) 8.2±4.2	(10) 12.7±1.4	(17) 5.16±0.18	(30) 2.9±2.5	(86) 15.0±3.5
V	(36) 178±27	(30) 195±47	(13) 258±43	(8) 293±61	(66) 301±47	(17) 226±36	(52) 248±33	---	245	(12) 60±40	(56) 222±57
$^{87}Sr/^{86}Sr$	(19) 0.70391±34	(25) 0.70383±55	(11) 0.70339±30	(5) 0.70320±13	(44) 0.70394±15	(19) 0.70336±41	(11) 0.70372±8	(8) 0.70330±38	(6) 0.70324±8	(19) 0.70859±55	(80) 0.70374±71
$^{143}Nd/^{144}Nd$	(18) 0.51282±8	(21) 0.51281±7	(10) 0.51288±5	(6) 0.51297±10	(36) 0.51304±5	(17) 0.51297±6	(9) 0.51294±4	(7) 0.51297±2	(6) 0.51322±3	(19) 0.51248±4	(72) 0.51289±8
$^{206}Pb/^{204}Pb$	(7) 18.70±0.04	(6) 18.82±0.06	(8) 18.74±0.07	(6) 18.88±0.04	(12) 18.64±0.13	(6) 18.70±0.04	(7) 19.18±0.07	(8) 18.91±0.10	(2) 18.22±0.24	(7) 18.52±0.32	(44) 18.95±0.35
$^{207}Pb/^{204}Pb$	(7) 15.60±0.02	(6) 15.60±0.003	(8) 15.55±0.04	(6) 15.60±0.03	(12) 15.53±0.02	(6) 15.55±0.03	(7) 15.57±0.03	(8) 15.54±0.01	(2) 15.50±0.07	(7) 15.53±0.13	(44) 15.61±0.16
$^{208}Pb/^{204}Pb$	(7) 38.46±0.08	(6) 38.54±0.08	(8) 38.37±0.15	(6) 38.56±0.06	(12) 38.28±0.15	(6) 38.22±0.10	(7) 38.93±0.13	---	(2) 37.75±0.42	(7) 38.16±0.39	(44) 38.88±0.21

[*] For each variable, the number in parentheses is the number of data points; the second row reports the mean and the standard deviation values. The errors (one standard deviation values) on Sr and Nd isotopic ratios are quoted as on the last digit reported; for all other parameters they are the actual one standard deviation values.

[†] Data sources for rifts are: Rio Grande rift, U.S.A.: Gibson et al. (1992); San Quintín volcanic field, Baja California, México: Luhr et al. (1995); Huri Hills, northern Kenya: Class et al. (1994); Massif Central, France: Chauvel and Jahn (1984); Djibouti, Afar: Deniel et al. (1994); Ethiopia: Hart et al. (1989).

[§] "Front" and "Back" refer to "front-arc" (volcanic front) and "back-arc" (behind the volcanic front) locations, respectively (Fig. 1).

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Figure DR3. (Figure 1 Color) Simplified map of sample locations in southern Mexico and Central America.

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Figure DR4. (Figure 2 Color) Selected parameters for basic rocks (SiO_2 < 52%) from southern Mexico and Central America plotted against distance along trench axis (Middle America Trench [MAT] in Fig. 1) as measured from close to Mexico-Guatemala border—marked 0 km distance.

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Figure DR5. (Figure 3 Color) Figure 3. Selected plots for basic rocks (SiO_2 < 52%) from southern Mexico and Central America.

[Please insert Verma_DataRepos_figure_DR6.eps]

Figure DR6. Primitive-mantle normalized diagrams for basic rocks (SiO_2 < 52%) from southern Mexico and Central America and their comparison with well-known rifts. See Table DR2 for more details. A: Southern Mexico (MVB–Mexican volcanic belt; LT–Los Tuxtlas volcanic field and El Chichón volcano; _F–volcanic front; _B–behind the volcanic front). B: Central America (CA–Central America; S-QSC–south of the Quesada sharp contortion). C: Well-known rifts.