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Isotopic, geochemical, and temporal characterization of Proterozoic basement rocks in the Quitovac region, northwestern Sonora, Mexico: Implications for the reconstruction of the SW margin of Laurentia

DATA REPOSITORY MATERIAL

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ANALYTICAL TECHNIQUES AND DATA TABLES

Aliquots of the same sample produced zircon separates for U-Pb geochronology, powders for geochemistry of major and trace elements, and powders for whole-rock U-Th-Pb, Rb-Sr, and Sm-Nd isotopic analysis. The Pb-Sr-Nd isotopic data are directly correlative because they are all obtained from the same dissolution, and corresponding initial values are calculated from same sample U-Pb zircon ages, with the exception of the two amphibolite samples in which we assume a 1.7 Ga age for our calculations. The following procedure was completed for each of the samples, and special care was taken to avoid possible sample contamination.

Rock Sample Preparation

Each sample was first crushed and then pulverized using a Bico pulverizer. After pulverizing, the sample was passed through a splitter that mixes the sample in the event layering has occurred. Aliquots of this material were further ground with an agate mortar and pestle providing the appropriate whole rock samples for geochemical and isotopic studies.

The remainder of the sample was placed on a Wilfley table to extract heavy minerals. The heavy fraction with the zircons was then sieved at –60 mesh (250 µm) and separated into different fractions on a Frantz isodynamic magnetic separator. The Frantz separator was set with a +15°side tilt and a 9° forward tilt. The sample was run through at 0.5, 1.0 and full-scale amp settings. The final non-magnetic fraction was ready for separation using heavy liquids.

The heavy liquid separation was carried out using Methylene Iodide with a density of 3.32 g/cm^3. This procedure was used primarily to separate zircons from other heavy minerals in the non-magnetic fraction (e.g., apatite). In a final attempt to increase purity, the heavy fraction was put through the Frantz separator again at maximum amps and with a side tilt of +5°. The final zircon fractions were saved in glass vials for further processing and classification procedures in the laboratory.

U-Pb Zircon Geochronology - Methods

Total zircon populations separated for this study were washed, sieved, and magnetically split. Final zircon populations for analysis were handpicked. Prior to dissolution, individual fractions were cleaned in distilled 7N HNO_3, and weighed into PFA Teflon vials. Dissolution was achieved in distilled concentrated HF + HNO_3 in a large (6.5-cm-diameter) Parr-type TFE Teflon dissolution vessel at 210 °C for approximately 4-7 days using the HF-vapor technique of Krogh (1978). The fractions were then spiked with a ^{205}Pb-^{233}U-^{236}U-^{230}Th dilute tracer solution and equilibrated at high temperature. Once dissolved, U-Th-Pb from individual fractions were extracted from the zircon solutions using ion exchange resins, Pb in a HBr medium, and U and Th in a HNO_3 medium. The U-Th-Pb isotopic ratios were measured using either a NBS-style, tandem (two-stage) mass spectrometer equipped with an ion-pulse counter at the end of the second stage, or a VG Isomass 54R fully-automated multi-sample, single-collector, thermal ionization mass spectrometer.

For the zircon analyses, the Pb isotopic ratios were corrected for a mass fractionation of 0.13 ± 0.05 % per a.m.u.; a laboratory Pb blank of varying amounts between 10 and 75 pg total Pb averaging 37 ± 7 pg with a composition of $^{206}Pb/^{204}Pb$ = 19.05 ± 0.24, $^{207}Pb/^{204}Pb$ = 15.496 ± 0.065, and $^{208}Pb/^{204}Pb$ = 37.87 ± 0.19; and initial common Pb using values of Stacey and Kramers (1975) at $^{238}U/^{204}Pb$ = 9.74 for the appropriate age of the rock. U and Th ratios were corrected for a mass fractionation of 0.13 ± 0.03 % per a.m.u. and both have laboratory blanks between 1 to 20 pg.

U-Pb Zircon Geochronology - Results

Seventeen of the nineteen basement samples from the Quitovac region are granites that yielded zircons. A total of 58 zircon multi-grain fractions were analyzed by conventional thermal ionization mass spectrometry (TIMS) U-Pb zircon geochronology to determine the crystallization ages of these granites. These fractions were hand-picked from sieved, non-magnetic populations, to select the clearest, cleanest, euhedral whole grains with a minimum of inclusions, fractures, and discolorations in an attempt to produce the least discordant and least disturbed isotopic data. In addition, an air-abrasion technique (Krogh, 1982) was employed on several fractions in an attempt to further reduce the degree of discordance. However, in some instances, this technique did not produce favorable results.

Ages were calculated using decay constants from Steiger and Jäger (1977). Concordia intercept ages were determined using data reduction and algorithms of Ludwig (1980, 1989, 1991), that typically produce ages with expanded errors compared with other regression techniques (York, 1969; Davis, 1982). Uncertainties are reported at the 95% confidence level. The U-Pb zircon geochronology results are given in Tables DR1 and DR2 and shown in concordia diagrams in Figures DR1, DR2, and DR3. In addition, a summary with the interpreted crystallization ages for all samples is shown in Table DR3.

TABLE DR1. U, Th, AND Pb CONCENTRATIONS AND Pb ISOTOPIC COMPOSITIONS OF ZIRCON SEPARATES FROM PROTEROZOIC BASEMENT ROCKS IN THE QUITOVAC REGION, NW SONORA, MEXICO

Sample	Fraction	Lab number	Weight (mg)	U (ppm)	Th (ppm)	Pb (ppm)	$^{206}Pb/^{204}Pb^{*}$	% error	$^{207}Pb/^{206}Pb^{\dagger}$	% error	$^{208}Pb/^{206}Pb^{\dagger}$	% error
Caborca block samples												
CA-1	A	1-2(73)	0.135	315	114	88	6300	14	0.10507	0.262	0.11278	0.641
	B	1-6(57)	0.051	361	129	102	1611	2.5	0.11132	0.417	0.12887	0.947
	C	1-1(73)	0.085	322	115	86	3110	21	0.10571	0.423	0.11576	1.01
	D	1-6(55)	0.177	380	138	95	6632	0.79	0.10464	0.149	0.11653	0.348
CA-4	A	4-1(63)	0.059	465	140	124	13293	2.56	0.09892	0.197	0.09423	0.538
	B	4-2(74)	0.166	357	129	100	629.5	0.62	0.115576	0.362	0.153752	0.714
	C	4-1(58)	0.095	349	122	87	6548	1.1	0.09642	0.089	0.1102	0.176
	D	4-2(58)	0.091	290	115	68	5262	0.7	0.09238	0.108	0.12463	0.204
CA-11	A	11-5(59)	0.037	378	58	80	3881.7	0.568	0.1041	0.339	0.06574	1.44
	B	11-5(66)	0.029	673	100	163	284.21	0.166	0.14803	0.192	0.19154	0.393
	C	11-3(63)	0.072	659	96	123	5987.1	0.482	0.10189	0.243	0.06476	1.02
	D	11-6(66)	0.08	382	49	70	433.28	0.154	0.10085	4.8	0.05773	22.7
	E	11-4(74)	0.156	180	17.5	31	759.4	0.22	0.115	0.237	0.08179	0.895
CA-12	A	12-4(70)	0.032	584	103	131	3244	1.50	0.08991	0.646	0.06099	2.530
	B	12-3(70)	0.036	569	118	128	2863	2.60	0.09376	0.572	0.07757	1.830
CA-14	A	14-3(73)	0.083	516	144	146	6530	13	0.1036	0.254	0.09044	0.772
	B	14-4(73)	0.158	571	139	155	13600	16	0.10269	0.13	0.07957	0.437
	C	14-2(71)	0.05	548	137	149	2737	0.44	0.10591	0.273	0.0854	0.9
	D	14-1(71)	0.099	165	71	43	115.69	0.28	0.10489	20.1	0.08601	65.8
CA-15	A	15-3(71)	0.082	502	743	143	2838	0.88	0.10644	0.176	0.09049	0.545
	B	15-4(71)	0.105	535	135	148	7914	1	0.10345	0.14	0.08228	0.454
CA-16	A	16-3(72)	0.056	289	99	82	2347	0.69	0.10677	0.537	0.11369	1.33
	B	16-4(69)	0.055	239	79	65	3328	1.4	0.10601	0.327	0.10977	0.834
	C	16-4(72)	0.088	363	120	114	336.1	0.67	0.14327	0.198	0.2209	0.337
	D	16-3(69)	0.097	316	102	84	4150	13	0.10566	0.293	0.10972	0.74
CA-17	A	17-1(72)	0.072	634	110	144	5250	2.5	0.10362	0.236	0.06537	1
	B	17-1(69)	0.057	589	93	130	2222	3.9	0.10713	0.109	0.07345	0.412
	C	17-2(69)	0.086	620	98	135	3880	5.2	0.10459	0.077	0.06583	0.293
	D	17-2(72)	0.141	657	29	140	3080	11	0.10476	0.13	0.0627	0.558
CA-18	A	18-5(69)	0.056	445	122	113	2400	6.5	0.10421	0.742	0.09217	2.24
	B	18-6(69)	0.084	380	105	97	4180	4.1	0.10495	0.289	0.09716	0.829
	C	18-5(72)	0.061	520	138	129	2718	3.1	0.1061	0.311	0.09849	0.892
	D	18-6(72)	0.075	666	186	157	3559	2.3	0.10528	0.212	0.10275	0.575
CA-19	A	19-5(73)	0.038	315	1172	88	1810	7.3	0.10503	0.918	0.10732	2.38
	B	19-5(70)	0.055	365	122	99	2268	0.94	0.10639	0.44	0.11301	1.08
	C	19-6(73)	340	104	92	3760	16	0.1044	0.378	0.10725	0.964	
	D	19-6(70)	0.08	341	113	91	3860	2.8	0.10499	0.334	0.10895	0.841
CA-20	A	20-6(71)	0.083	309	101	90	4979	1.5	0.10503	0.279	0.10262	0.754
	B	20-5(71)	0.076	440	137	126	6160	16	0.10487	0.224	0.09775	0.621
	C	20-6(74)	0.159	309	108	93	688.7	0.83	0.12315	0.085	0.15561	0.172

TABLE DR1. (continued).

Sample	Fraction	Lab number	Weight (mg)	U (ppm)	Th (ppm)	Pb (ppm)	$^{206}Pb/^{204}Pb^{*}$	% error	$^{207}Pb/^{206}Pb^{\dagger}$	% error	$^{208}Pb/^{206}Pb^{\dagger}$	% error
“Grenvillian” Caborca block samples												
CAG-2	A	2-2(57)	0.222	249	98	49	575	0.41	0.09927	0.235	0.18256	0.324
	B	2-3(57)	0.242	287	101	51	2416	2.4	0.0802	0.247	0.12587	0.399
	C	2-1(57)	0.324	519	212	86	1031.1	0.3	0.08803	0.114	0.16407	0.159
CAG-13	A	13-1(70)	0.071	806	274	147	5850	7.6	0.07679	0.322	0.10744	0.585
	B	13-2(70)	0.125	901	284	163	2250	5.7	0.08123	0.226	0.11405	0.289
“North America” block samples												
NA-3	A	3-1(74)	0.213	145	113	45	773.1	0.53	0.11743	0.604	0.141762	1.33
	B	3-4(57)	0.073	223	76	66	3830	9.9	0.10583	0.468	0.11012	1.18
	C	3-1(66)	0.037	246	90	80	188.25	0.22	0.1317	5.44	0.19482	9.66
	D	3-5(57)	0.172	225	90	67	1245	3.6	0.11438	0.189	0.15131	0.371
NA-5	A	5-3(58)	0.028	1162	289	210	2640	0.63	0.10322	0.101	0.08946	0.29
	B	5-4(58)	0.026	1796	390	278	1873.5	0.17	0.10408	0.086	0.08509	0.248
	C	5-2(66)	0.038	2426	455	358	755	2.3	0.09741	2.8	0.06002	12.2
NA-7	A	7-3(66)	0.07	374	111	119	507.3	0.39	0.1297	0.146	0.157	0.293
	B	7-3(74)	0.173	301	107	93	690.9	0.42	0.12298	0.09	0.15745	0.16
	C	7-6(62)	0.039	386	120	107	4238.9	0.236	0.10473	0.515	0.10036	1.42
NA-8	A	8-2(59)	0.058	360	120	101	5119.9	0.773	0.10548	0.198	0.10884	0.466
	B	8-2(63)	0.042	365	111	96	5538.2	0.756	0.10438	0.179	0.10129	0.482
	C	8-4(66)	0.03	388	117	129	219.67	0.15	0.15889	0.596	0.25001	1.01

(*) Measured isotopic ratio, uncorrected for laboratory blank Pb and mass fractionation.

(†) Isotopic ratio corrected for laboratory blank Pb (total Pb blanks between 10 and 75 pg total averaging 37 ± 7 pg with isotopic composition of $^{206}Pb/^{204}Pb = 19.05 \pm 0.24$, $^{207}Pb/^{204}Pb = 15.496 \pm 0.065$, and $^{208}Pb/^{204}Pb = 37.87 \pm 0.19$) and mass fractionation (0.13 ± 0.03 % per a.m.u.) using the PBDAT Pb isotope reduction program of Ludwig (1989).

TABLE DR2. U-Pb RADIOGENIC ISOTOPIC DATA FOR ZIRCON SEPARATES OF PROTEROZOIC BASEMENT ROCKS IN THE QUITOVAC REGION, NW SONORA, MEXICO

Sample	Fraction	Lab number	^{207}Pb/^{235}U*	% error	^{206}Pb/^{238}U*	% error	U-Pb correlation error	^{207}Pb/^{206}Pb*	% error	^{207}Pb/^{235}U† age (Ma)	^{206}Pb/^{238}U† age (Ma)	^{207}Pb/^{206}Pb† age (Ma)
Caborca block samples												
CA-1	A	1-2(73)	3.8478	0.400	0.26643	0.235	0.693	0.10474	0.291	1603	1523	1710 ± 5.4
	B	1-6(57)	3.7841	0.261	0.26194	0.120	0.618	0.10478	0.210	1589	1500	1710 ± 3.9
	C	1-1(73)	3.6689	1.130	0.25514	0.548	0.636	0.10430	0.887	1565	1465	1702 ± 16
	D	1-6(55)	3.3792	0.134	0.23746	0.126	0.942	0.10321	0.045	1500	1374	1683 ± 0.83
CA-4	A	4-1(63)	3.5256	0.280	0.25913	0.275	0.984	0.09868	0.050	1533	1485	1599 ± 0.94
	B	4-2(74)	3.3308	0.237	0.25028	0.169	0.773	0.09652	0.151	1488	1440	1558 ± 2.8
	C	4-1(58)	3.1236	0.253	0.23947	0.246	0.972	0.09461	0.059	1439	1384	1520 ± 1.1
	D	4-2(58)	2.7587	0.508	0.22193	0.506	0.996	0.09015	0.045	1344	1292	1429 ± 0.87
CA-11	A	11-5(59)	2.9395	0.277	0.20892	0.272	0.982	0.10205	0.052	1392	1223	1662 ± 0.96
	B	11-5(66)	2.7771	0.396	0.19795	0.374	0.950	0.10175	0.123	1349	1164	1656 ± 2.3
	C	11-3(63)	2.5811	0.224	0.18607	0.221	0.985	0.10061	0.039	1295	1100	1635 ± 0.72
	D	11-6(66)	2.5604	0.727	0.18504	0.717	0.977	0.10035	0.154	1289	1095	1631 ± 2.9
	E	11-4(74)	2.2513	0.127	0.16539	0.102	0.820	0.09873	0.073	1197	987	1600 ± 1.4
CA-12	A	12-4(70)	2.8002	0.197	0.22681	0.170	0.881	0.08954	0.093	1356	1318	1416 ± 1.8
	B	12-3(70)	2.8387	0.216	0.22240	0.149	0.750	0.09257	0.144	1366	1295	1479 ± 2.7
CA-14	A	14-3(73)	3.9336	0.315	0.27624	0.113	0.586	0.10328	0.265	1621	1572	1684 ± 4.9
	B	14-4(73)	3.7732	0.199	0.26684	0.092	0.616	0.10256	0.160	1587	1525	1671 ± 3
	C	14-2(71)	3.7596	0.200	0.26510	0.193	0.968	0.10286	0.050	1584	1516	1676 ± 0.93
	D	14-1(71)	3.6372	3.120	0.25468	3.100	0.974	0.10358	0.712	1558	1463	1689 ± 13
CA-15	A	15-3(71)	3.9132	0.091	0.27592	0.067	0.768	0.10286	0.058	1616	1571	1676 ± 1.1
	B	15-4(71)	3.8368	0.101	0.27108	0.088	0.877	0.10265	0.049	1601	1546	1673 ± 0.9
CA-16	A	16-3(72)	3.9006	0.202	0.26994	0.186	0.926	0.10480	0.076	1614	1541	1711 ± 1.4
	B	16-4(69)	3.7521	0.159	0.26100	0.141	0.900	0.10426	0.069	1583	1495	1701 ± 1.3
	C	16-4(72)	3.6621	0.358	0.25400	0.179	0.641	0.10457	0.280	1563	1459	1707 ± 5.2
	D	16-3(69)	3.6383	0.472	0.25266	0.119	0.606	0.10444	0.411	1558	1452	1705 ± 7.6
CA-17	A	17-1(72)	3.2024	0.248	0.22625	0.236	0.957	0.10266	0.072	1458	1315	1673 ± 1.3
	B	17-1(69)	3.0201	0.280	0.21531	0.085	0.581	0.10173	0.240	1413	1257	1656 ± 4.4
	C	17-2(69)	3.0194	0.280	0.21567	0.192	0.755	0.10154	0.185	1413	1259	1652 ± 3.4
	D	17-2(72)	2.9445	0.563	0.21105	0.160	0.587	0.10118	0.487	1393	1234	1646 ± 9
CA-18	A	18-5(69)	3.5225	0.427	0.24635	0.147	0.585	0.10371	0.361	1532	1420	1692 ± 6.7
	B	18-6(69)	3.5227	0.173	0.24631	0.088	0.639	0.10373	0.135	1532	1419	1692 ± 2.5
	C	18-5(72)	3.4002	0.210	0.23873	0.120	0.678	0.10330	0.156	1504	1380	1684 ± 2.9
	D	18-6(72)	3.2020	0.221	0.22560	0.196	0.909	0.10294	0.092	1458	1311	1678 ± 1.7
CA-19	A	19-5(73)	3.8198	0.708	0.26645	0.389	0.669	0.10397	0.533	1597	1523	1696 ± 9.8
	B	19-5(70)	3.6841	0.162	0.25817	0.127	0.801	0.10350	0.097	1568	1481	1688 ± 1.8
	C	19-6(73)	3.6842	0.655	0.25843	0.189	0.589	0.10340	0.564	1568	1482	1686 ± 10
	D	19-6(70)	3.6661	0.215	0.25619	0.173	0.834	0.10379	0.119	1564	1470	1693 ± 2.2
CA-20	A	20-6(71)	4.0361	0.128	0.28076	0.110	0.872	0.10426	0.063	1642	1595	1701 ± 1.2
	B	20-5(71)	3.9636	0.498	0.27589	0.320	0.729	0.10420	0.343	1627	1571	1700 ± 6.3
	C	20-6(74)	3.8152	0.242	0.26615	0.154	0.720	0.10397	0.169	1596	1521	1696 ± 3.1

TABLE DR2. (continued).

Sample	Fraction	Lab number	$^{207}Pb/^{235}U^{*}$	% error	$^{206}Pb/^{238}U^{*}$	% error	U-Pb correlation error	$^{207}Pb/^{206}Pb^{*}$	% error	$^{207}Pb/^{235}U^{\dagger}$ age (Ma)	$^{206}Pb/^{238}U^{\dagger}$ age (Ma)	$^{207}Pb/^{206}Pb^{\dagger}$ age (Ma)
"Grenvillian" Caborca block samples												
CAG-2	A	2-2(57)	1.8179	0.177	0.17446	0.076	0.558	0.07557	0.149	1052	1037	1084 ± 3
	B	2-3(57)	1.7707	0.213	0.17083	0.053	0.511	0.07517	0.192	1035	1017	1073 ± 3.9
	C	2-1(57)	1.5588	0.112	0.15130	0.085	0.783	0.07472	0.070	954	908	1061 ± 1.4
CAG-13	A	13-1(70)	1.8695	0.344	0.17836	0.217	0.702	0.07602	0.247	1070	1058	1096 ± 4.9
	B	13-2(70)	1.8277	0.722	0.17492	0.470	0.712	0.07578	0.509	1055	1039	1089 ± 10
"North America" block samples												
NA-3	A	3-1(74)	4.0899	0.167	0.28376	0.125	0.794	0.10453	0.101	1652	1610	1706 ± 1.9
	B	3-4(57)	4.0474	0.401	0.28136	0.140	0.588	0.10433	0.338	1644	1598	1703 ± 6.2
	C	3-1(66)	3.9531	1.110	0.27510	1.090	0.967	0.10422	0.284	1625	1567	1701 ± 5.2
	D	3-5(57)	3.8836	0.454	0.27005	0.150	0.590	0.10430	0.385	1610	1541	1702 ± 7.1
NA-5	A	5-3(58)	2.3738	0.204	0.17488	0.196	0.962	0.09844	0.056	1235	1039	1595 ± 1
	B	5-4(58)	2.0086	0.181	0.15006	0.174	0.961	0.09708	0.050	1118	901	1569 ± 0.93
	C	5-2(66)	1.9824	0.677	0.14817	0.460	0.745	0.09704	0.454	1110	891	1568 ± 8.5
NA-7	A	7-3(66)	3.9743	0.223	0.27735	0.166	0.780	0.10393	0.140	1629	1578	1696 ± 2.6
	B	7-3(74)	3.9122	0.172	0.27332	0.128	0.780	0.10381	0.108	1616	1558	1693 ± 2
	C	7-6(62)	3.8268	0.199	0.26761	0.184	0.929	0.10371	0.074	1598	1529	1692 ± 1.4
NA-8	A	8-2(59)	3.8313	0.213	0.26825	0.187	0.881	0.10359	0.101	1599	1532	1689 ± 1.9
	B	8-2(63)	3.6157	0.293	0.25416	0.289	0.985	0.10318	0.050	1553	1460	1682 ± 0.93
	C	8-4(66)	3.5773	0.342	0.25178	0.312	0.923	0.10305	0.132	1545	1448	1680 ± 2.4

(*) Radiogenic ratios, corrected for laboratory Pb blank, mass fractionation (see Table DR1 footnotes), and initial Pb, equal to Stacey and Kramers (1975) values for the appropriate age (U-Pb zircon) of the sample using the PBDAT Pb isotope reduction program of Ludwig (1989).
(†) U-Pb and Pb-Pb ages calculated using PBDAT program (Ludwig, 1989) and U decay constants from Steiger and Jäger (1977); errors are given at the 2σ level.

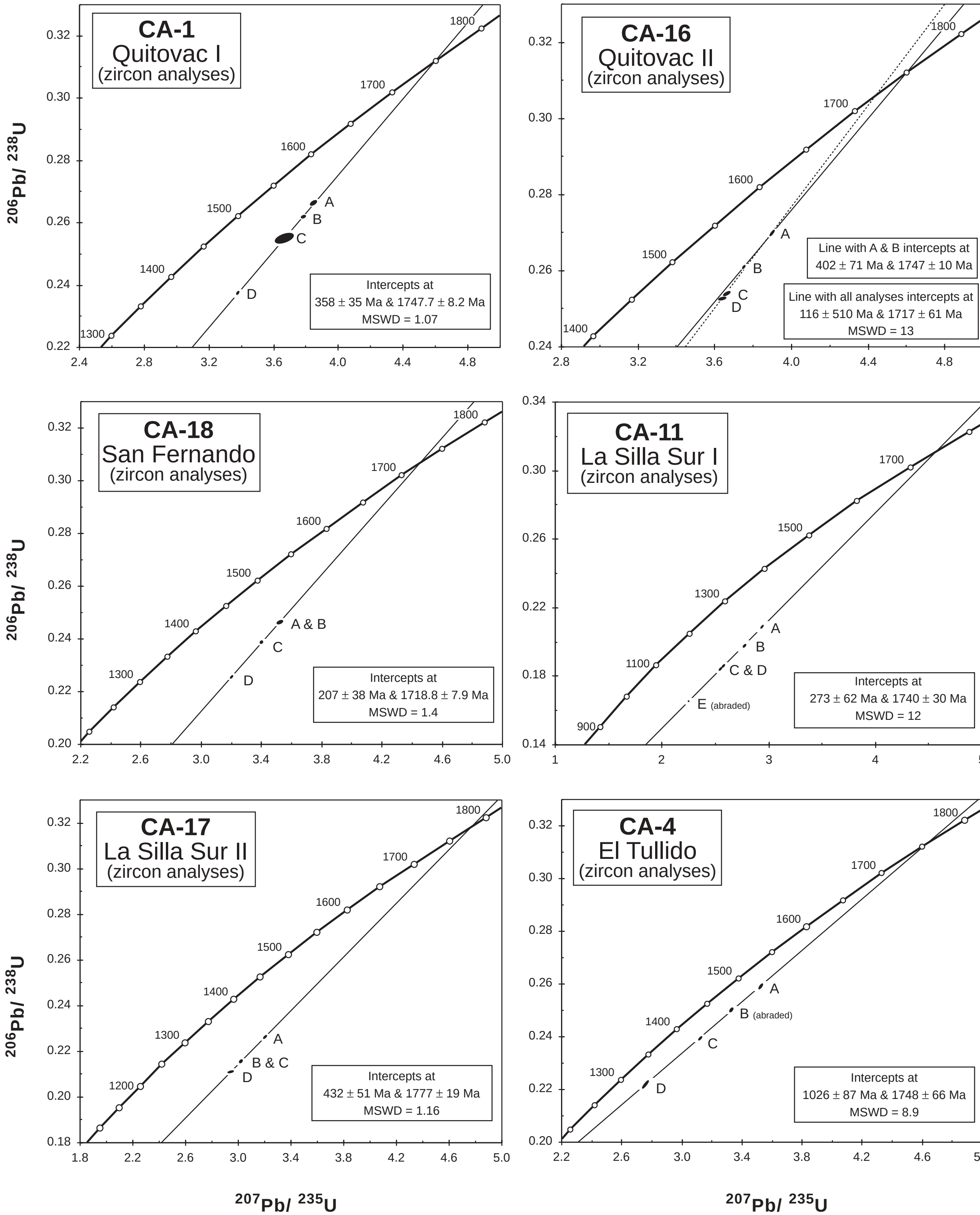

Figure DR1. Concordia diagrams with U-Pb analyses for zircons from the Paleoproterozoic Caborca block basement granitoids in the Quitovac region, NW Sonora, Mexico. Individual analyses are depicted in these diagrams as 2 sigma error ellipses as determined using PBDAT (Ludwig, 1989). Shaded area in CA-12 is the area of possible ages assuming the youngest possible Pb-loss from analysis A at 0 Ma, and the oldest reasonable lower-intercept age of ~ 1126 Ma for analysis B. All age regressions determined using Isoplot/Ex (Ludwig, 1998). MSWD = Mean Square of Weighted Deviates.

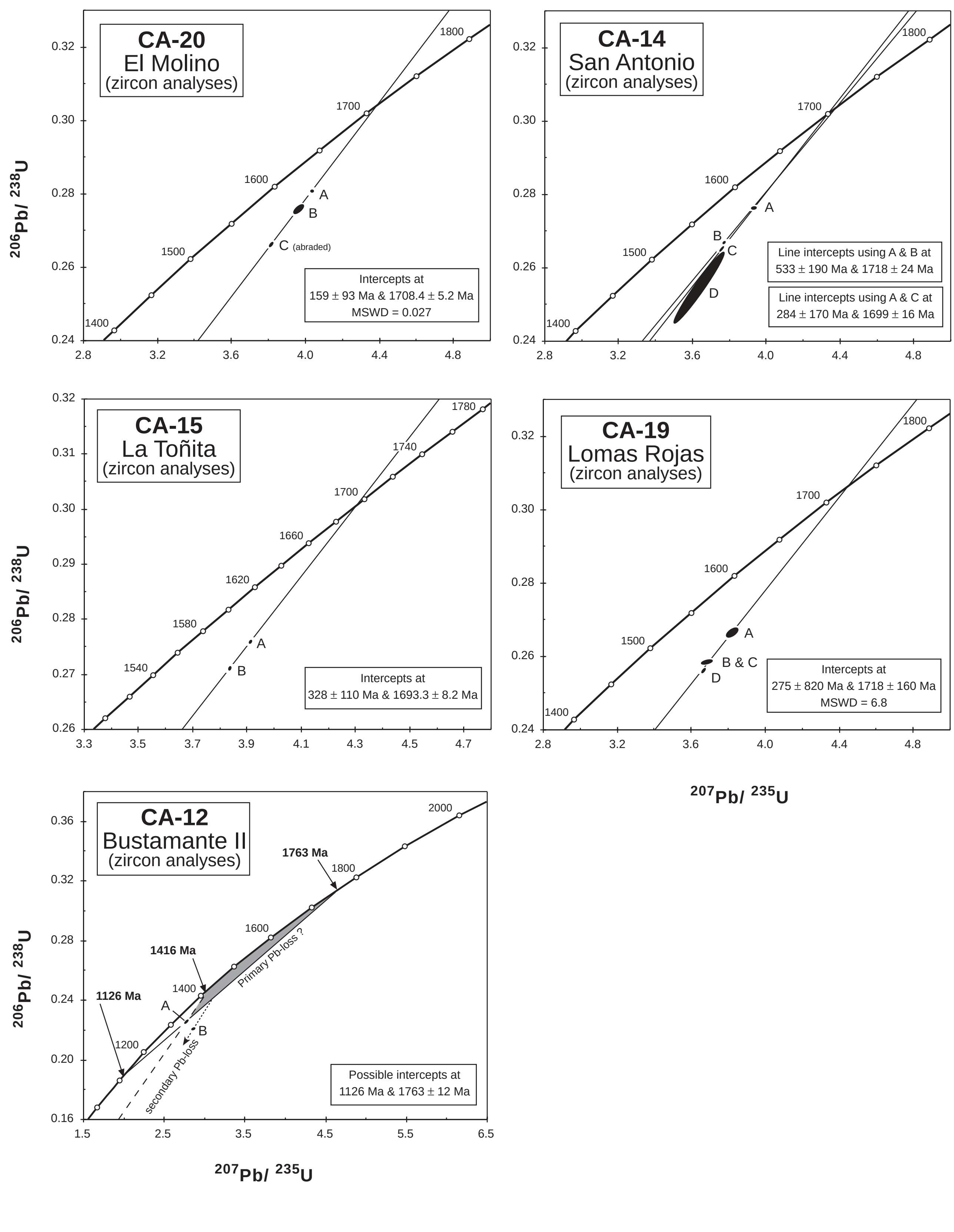

Figure DR1. Cont.

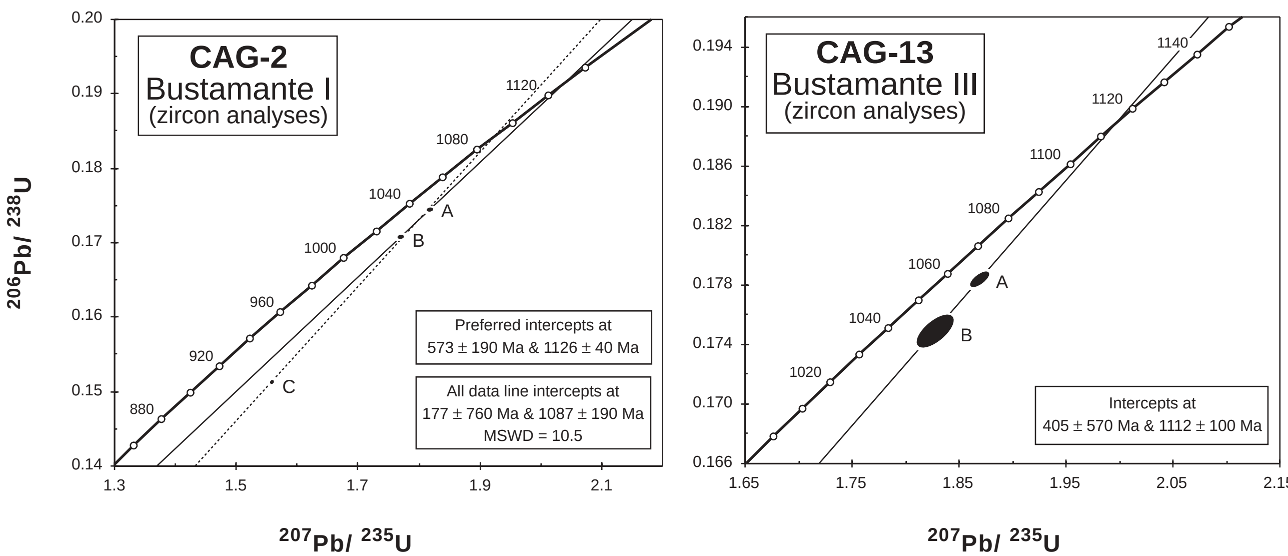

Figure DR2. Concordia diagrams with U-Pb analyses for zircons from the "Grenvillian" Caborca basement granitoids in the Quitovac region, NW Sonora, Mexico. Although these ages have very large errors, based on only 2 or 3 analyses, the results indicate a Grenvillian age of ~ 1120 Ma for these two samples. Individual analyses are depicted in these diagrams as 2 sigma error ellipses (Ludwig, 1989). Ages from regression treatment of Ludwig (1998). MSWD = Mean Square of Weighted Deviates.

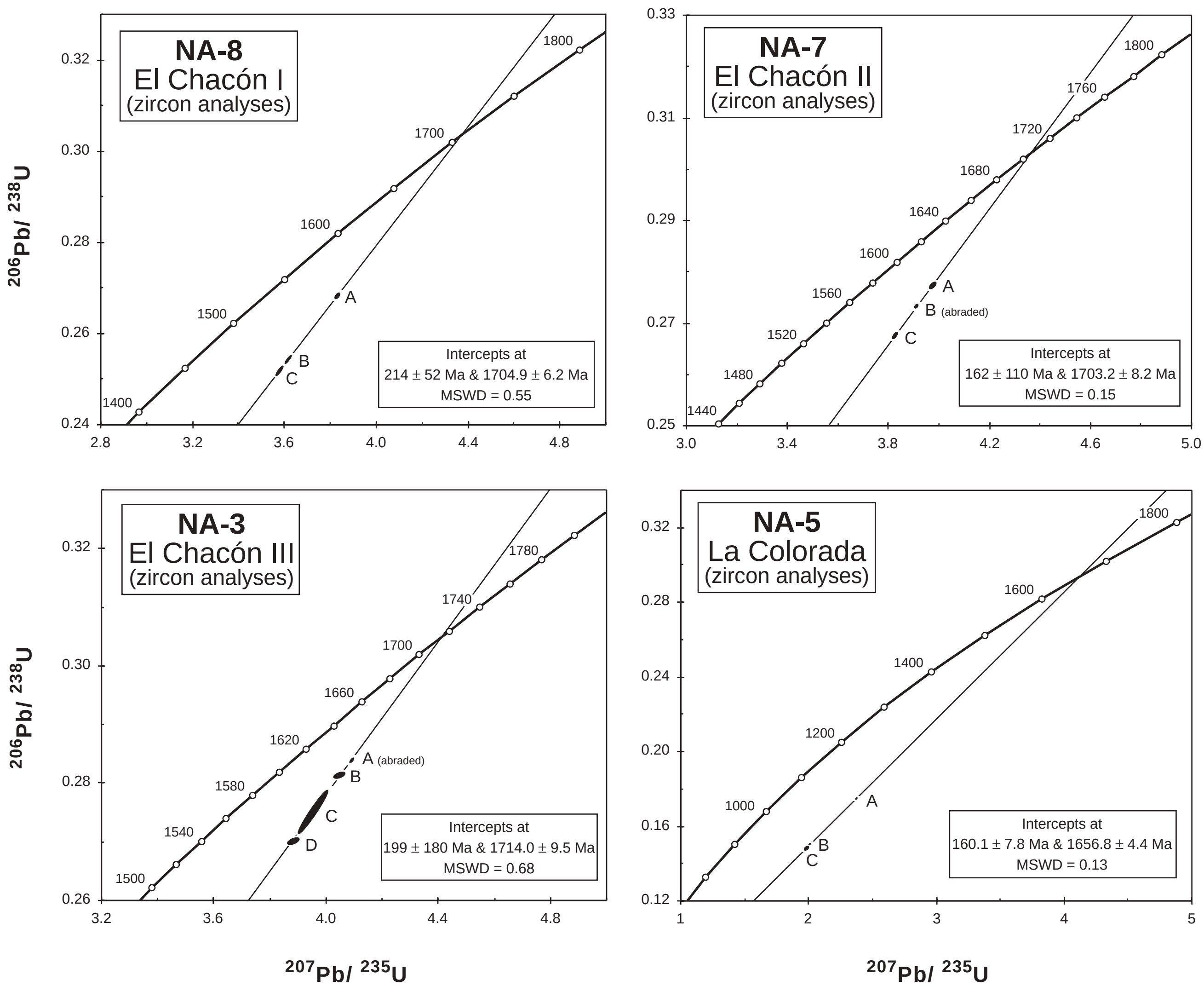

Figure DR3. Concordia diagrams with U-Pb analyses for zircons from the Paleoproterozoic "North America" block basement granitoids in the Quitovac region, NW Sonora, Mexico. Individual analyses are depicted in these diagrams as 2 sigma error ellipses (Ludwig, 1989). Ages from regression treatment of Ludwig (1998). MSWD = Mean Square of Weighted Deviates.

TABLE DR3. SUMMARY OF U-Pb ZIRCON GEOCHRONOLOGY FOR PROTEROZOIC BASEMENT ROCKS IN THE QUITOVAC REGION, NW SONORA, MEXICO

Sample	Location	Number of fractions*	MSWD†	Concordia Lower-intercept Age (Ma)			Concordia Upper-intercept Age (Ma)§		
Caborca block samples									
CA-17	La Silla Sur II	4	1.16	432	±	51	1777	±	19
CA-12	Bustamante II	1	N.A.#	1126	(Forced)		1763	±	12
CA-4	El Tullido	4	8.9	1026	±	87	1748	±	66
CA-1	Quitovac I	4	1.07	358	±	35	1747.7	±	8.2
CA-16	Quitovac II	2	N.A.#	402	±	71	1747	±	10
CA-11	La Silla Sur I	5	12	273	±	62	1740	±	30
CA-18	San Fernando	4	1.4	207	±	38	1718.8	±	7.9
CA-19	Lomas Rojas	4	6.8	275	±	820	1718	±	160
CA-20	El Molino	3	0.027	159	±	93	1708.4	±	5.2
CA-14	San Antonio	2	N.A.#	284	±	170	1699	±	16
CA-15	La Toñita	2	N.A.	328	±	110	1693.3	±	8.2
"Grenvillian" Caborca block samples									
CAG-2	Bustamante I	2	N.A.#	573	±	190	1126	±	40
CAG-13	Bustamante III	2	N.A.#	405	±	570	1112	±	100
"North America" block samples									
NA-3	El Chacón III	4	0.68	199	±	180	1714.0	±	9.5
NA-8	El Chacón I	3	0.55	214	±	52	1704.9	±	6.2
NA-7	El Chacón II	3	0.15	162	±	110	1703.2	±	8.2
NA-5	La Colorada	3	0.13	160.1	±	7.8	1656.8	±	4.4

(*) Number of fractions used in calculation of age.
(†) MSWD = Mean Square of Weighted Deviates: A measure of the ratio of the observed scatter of the points (from the best-fit line) to the expected scatter (from the assigned errors and error correlation).
(§) Upper-intercept age calculated using Isoplot/Ex regression treatment of Ludwig (1998) and interpreted here as possible crystallization age of the rock. Errors are given at the 95% confidence level.
(#) N.A. = not applicable.

Caborca Block Granitoids

Quitovac I (CA-1). A granite sample (Quitovac I, CA-1) that shows deformational fabrics was collected in the eastern part of the Sierra Quitovac (Fig. 3). Four zircon fractions (A, B, C, and D), including small to medium size euhedral zircon crystals of purplish to pinkish color, yielded discordant U-Pb ages (Fig. DR1). Linear regression analysis indicated an upper-intercept age of 1747 ± 8.2 Ma (lower intercept = 358 ± 35; MSWD = 1.07) that we interpret as approximating the crystallization age of the Quitovac I tectonized granite.

Quitovac II (CA-16). A second sample (Quitovac II, CA-16) was collected in Sierra Quitovac (Fig. 3) in an attempt to see whether the deformational fabrics preserved in sample CA-1 (Quitovac I) could have an impact in the U-Pb geochronology. We analyzed four different zircon fractions (A, B, C, and D) of small-to medium-size euhedral crystals of purplish to pinkish color with discordant behavior (Fig. DR1). The regressed line with the four analyses yielded an upper-intercept age of 1717 ± 61 Ma (lower intercept = 116 ± 510 Ma; MSWD = 13). However, removing the most discordant and less precise analyses (fractions C and D), that either followed a different Pb loss path than fractions A and B or contain inheritance, we obtained a line with fractions A and B defining an upper-intercept age of 1747 ± 10 Ma and lower-intercept age of 402 ± 71 Ma. The upper-intercept age is in agreement with the overall age of the Caborca basement and we accept this age as representative of the age for crystallization of the granitoid.

San Fernando (CA-18). Sample San Fernando (CA-18) was collected in the northern part of the San Fernando Hills south of Sierra La Silla (Fig. 3). Four zircon fractions were selected and analyzed. The zircons analyzed were very small, subhedral to euhedral, with purplish-yellow tints. Using all four zircon fractions, a linear regression yielded an upper-intercept age of 1718.8 ± 7.9 Ma (lower intercept = 207 ± 38 Ma; MSDW =1.4) that we interpret as the approximate crystallization age of the San Fernando granite (Fig. DR1).

La Silla Sur I (CA-11). Outcrops of Precambrian granite in the southern part of Sierra La Silla are in a very similar geologic position as the ones in Sierra Quitovac and San Fernando Hills. La Silla Sur I (CA-11) granite was collected in the southern part of Sierra La Silla (Fig. 3) and yielded small to medium size, mostly cloudy and beige-tinged zircon crystals. Five fractions were selected and analyzed (A, B, C, D, and E). Zircons in fraction E were abraded in an attempt to remove the discordant outer domains of the zircon grains in order to get a less discordant age. The procedure did not work and fraction E was the most discordant fraction of the rock (Fig. DR1). Using the five zircon fractions, a linear regression yielded an upper-intercept age of 1740 ± 30 Ma (lower intercept = 273 ± 62 Ma; MSDW =12) that we interpret as approximating the crystallization age of the La Silla Sur I granite.

La Silla Sur II (CA-17). We collected sample La Silla Sur II (CA-17) in an attempt to improve the age constraints for the newly discovered Proterozoic rocks from Sierra La Silla and San Fernando Hills south of Sierra La Silla (Fig. 3). This granite yielded small to medium-sized, euhedral, and slightly tinted zircons. A linear regression of four zircon fractions (A, B, C, and D) yielded an upper-intercept age of 1777 ± 19 Ma (lower intercept = 432 ± 51; MSWD = 1.16) that we interpret as representing the crystallization age of the granite (Fig. DR1). The 1777 ± 19 Ma La Silla Sur II granite is the oldest plutonic rock described from the Quitovac region.

El Tullido (CA-4). A two-mica granite sample (El Tullido, CA-4) was collected in the western part of Cerro El Tullido (Fig. 3). Four zircon fractions (A, B, C, and D) of small size, mostly euhedral crystals with purplish color defined a chord that yielded an upper-intercept age of 1748 ± 66 Ma and a lower-intercept age of 1026 ± 87 Ma with MSWD = 8.9 (Fig. DR1). We interpret the upper-intercept age as approximating the crystallization age of the granite and its lower intercept as the age of Pb loss possibly produced by metamorphism and crustal uplift related to Grenvillian plutonism-tectonism as proposed by the age of some of the samples in the Campo Bustamante Hills in the Quitovac region (CAG-2 and CAG-13).

El Molino (CA-20). El Molino granite (CA-20) was collected in the southeastern part of Cerro El Tullido (Fig. 3). Three zircon fractions (A, B, and C) of medium size, mostly subhedral crystals with reddish tints, defined a chord that yielded an upper-intercept age of 1708.4 ± 5.2 Ma (lower-intercept = 159 ± 93 Ma; MSWD = 0.027) (Fig. DR1). We interpret the upper-intercept age as the crystallization age of the granite. In contrast, the lower intercept age of El Molino granite is not similar to the Grenvillian lower intercept age of the nearby El Tullido granite (CA-4).

San Antonio (CA-14). The San Antonio granite (CA-14) was collected in the northeastern part of Sierra San Antonio (Fig. 3). We analyzed four zircon fractions (A, B, C, and D) but only three are regressed because of the large errors obtained for fraction D

(Fig. DR1). This fraction lies off a chord containing fractions A to C. Using fractions A and C the line yields an upper-intercept age of 1699 ± 16 Ma (lower intercept = 284 ± 170 Ma). If we use the least discordant fractions (A and B), the line defines an upper-intercept age of 1718 ± 24 Ma (lower intercept = 533 ± 190 Ma) that we interpret as representing the crystallization age of the rock.

La Toñita (CA-15). La Toñita granite sample (CA-15) was collected in the southernmost part of Sierra La Toñita (Fig. 3). Only two fractions (A and B) of medium- to large-size euhedral zircon crystals of tinted color were analyzed yielding discordant U-Pb ages (Fig. DR1). The upper-intercept age of 1693.3 ± 8.2 Ma (lower intercept = 328 ± 110 Ma) is interpreted here as the possible crystallization age for this granite.

Lomas Rojas (CA-19). Lomas Rojas Hills are located north of Sierra La Toñita and northwest of Campo Bustamante Hills (Fig. 3). A two-mica granite here (Lomas Rojas, CA-19) yielded small to medium-sized, subhedral, purplish-tinted zircons. Four zircon fractions (A, B, C, and D) are discordant and yield an upper-intercept age of 1718 ± 160 Ma (lower intercept = 275 ± 820 Ma; MSWD = 6.8) (Fig. DR1). Even though the upper-intercept age has a large error, we interpret this age as close to the age for crystallization of the Las Lomas Rojas granite.

Bustamante II (CA-12). A quartz-rich granitic sample (Bustamante II, CA-12) was collected in the western part of Campo Bustamante Hills approximately 7 km northwest of Quitovac (Fig. 3). Petrographic textures indicate that the rock has undergone some degree of strain. The sample yielded two zircon fractions of small, clear zircons that produced discordant and non-positively correlated results, indicating complex behavior involving multiple events of Pb-loss and/or zircon inheritance (Fig. DR1). A unique interpretation for the crystallization age of this sample is not possible with this data; however, it is evident that these zircons are at least 1400 Ma, given that their $^{207}Pb/^{206}Pb$ ages are 1416 and 1479 Ma (upper-intercept ages extrapolated from the origin at 0 Ma through each of the analyses) for fractions A and B, respectively (Fig. DR1).

It is possible that the older fraction contained some inherited zircon component; however, there were no visible signs of core material in any of the analyzed grains in either fraction. Assuming a maximum, reasonable, lower-intercept age of ~1126 Ma (sample CA-12 is from the Bustamante area that is dominated by Grenvillian magmatism at ~1126 Ma; samples CAG-2 and CAG-13), upper-intercept ages of 1763 ± 12 Ma and 2138 ± 14 Ma are calculated for fractions A and B, respectively.

Although the data for this sample is not good, we interpret the age of this rock is probably between 1400 and 1770 Ma (Fig. DR1).

Bustamante I (CAG-2). The Bustamante I granite (CAG-2) was sampled in the Campo Bustamante Hills (Fig. 3), and yielded medium-to large-sized, cloudy (opaque) zircons with deep maroon to pinkish colors. The best-fit line using three zircon fractions (A, B, and C) yielded an upper-intercept age of 1087 ± 190 Ma (lower intercept = 177 ± 760 Ma; MSWD = 10.5) (Fig. DR2). However, removing fraction C, the most discordant zircon fraction, changes the upper-intercept age to 1126 ± 40 Ma (lower intercept = 573 ± 190 Ma) that we interpret as the crystallization age for this rock. This is the first Grenvillian-age granite defined in the Quitovac region.

Bustamante III (CAG-13). Another of the Campo Bustamante granites, Bustamante III (CAG-13) was collected in an attempt to improve the age constraints and to determine the spatial extent of the newly discovered Grenvillian-age granites from the Campo Bustamante Hills (Fig. 3). Two fractions (A and B) of purplish-colored zircons were analyzed, yielding an upper-intercept age of 1112 ± 100 Ma (lower intercept = 405 ± 570 Ma) that we interpret as the best approximation for the crystallization age of this granite (Fig. DR2).

"North America" Block Granitoids

El Chacón I (NA-8). El Chacón I granite (NA-8) was collected in the southernmost part of Cerro El Chacón area, 12 km south from the village of Quitovac (Fig. 3). These are outcrops of newly proposed Paleoproterozoic granites in the Quitovac region. Three fractions (A, B, and C) with small to medium, euhedral zircons with a faint purple tint were analyzed and defined a chord that yielded an upper-intercept age of 1704.9 ± 6.2 Ma (lower intercept = 214 ± 52 Ma; MSWD = 0.55) (Fig. DR3). We interpret this age as the age of crystallization for the granite.

El Chacón II (NA-7). This granite was also collected in the southern part of Cerro El Chacón area (Fig. 3). The zircons analyzed from this granite were small to large euhedral crystals with purple and pink tints. Three zircon fractions (A, B, and C), including an abraded fraction, were analyzed to define a chord that yielded an upper-intercept age of

1703.2 ± 8.2 Ma (lower intercept = 162 ± 110 Ma; MSWD = 0.15) that we interpret as the crystallization age of the El Chacón II granite (Fig. DR3). Zircons from this granite have a very similar behavior to those from the nearby El Chacón I granite of essentially the same age.

El Chacón III (NA-3). El Chacón III (NA-3), is a quartz monzonite sample that was also collected in Cerro El Chacón area (Fig. 3). The zircons analyzed in this granite were small to medium in size with euhedral crystals. Using the four zircon fractions (A, B, C, and D), including an abraded fraction, the linear regression analysis yielded an upper-intercept age of 1714 ± 9.5 Ma (lower intercept = 199 ± 180 Ma; MSDW =0.68) (Fig. DR3) that we interpret as a close approximation of the crystallization age for the El Chacón III granite.

La Colorada (NA-5). La Colorada granite (NA-5) was sampled in the southeastern part of the Early Miocene La Colorada volcanic field (Fig. 3). The granite yielded small, euhedral, acicular zircons with very high discordance (~50%). The regressed chord using three zircon fractions (A, B & C) defines an upper-intercept age of 1656.8 ± 4.4Ma (lower intercept = 160.1 ± 7.8; MSWD = 0.13) that we interpret as the crystallization age of the La Colorada granite (Fig. DR3). This is the youngest described Paleoproterozoic granite in the Quitovac region.

None of the U-Pb zircon ages presented here were determined from concordant results. All of the ages were calculated using a regression treatment (Ludwig, 1998) of two to five analyses that were discordant to some degree. Abrasion techniques similar to Krogh (1978) were used on several of the zircon fractions in an attempt to produce less discordant analyses, however, for reasons unknown, most of these analyses did not reduce the amount of discordance.

Twelve of 17 samples produced least-discordant analyses that were only 6% to 17% discordant. The remainder ranged from 23% to 42% discordant. Using only conventional techniques, these results are considered typical for zircon populations from granitic samples of Proterozoic to Archean age (e.g., Premo and Van Schmus, 1989). Whereas, an increasing degree of discordance is thought to reflect decreasing confidence in the accuracy of the crystallization age, we do not feel that this is always the case. Despite high degrees of discordance (e.g., NA-5; 42%), an improved degree of confidence in the crystallization age is reflected in the linearity of some of the data, leading to relatively small age errors and corresponding MSWD values (e.g., NA-5; ± 4.4 Ma and 0.13, respectively).

In contrast, large age errors and MSWD values can be obtained on less discordant results (e.g., CA-19; 14% discordant, ± 160 Ma, and MSWD = 6.8), due to scatter in the linearity of the analyses. The cause of the scatter is often problematic, as it is possible that minute amounts of either inherited zircon or metamorphic overgrowths that were not detected by visual means on any one or more of the grains of a single zircon fraction could effect the results.

Nonetheless, we feel that the errors given on all the concordia upper-intercept ages listed are reasonably expanded to reflect realistic confidence limits and therefore most probably contain the actual crystallization age of the sample and the rock unit it represents.

Radiogenic Isotopes

The analytical techniques used for the U-Th-Pb on whole-rocks were similar to those reported by Tatsumoto and Unruh (1976) and Premo and Izett (1992). The whole-rock samples were dissolved with ultrapure concentrated HF + HNO_3 in 7 ml PFA Teflon vials. After drying, the samples were spiked with a dilute mixed tracer of ^{205}Pb-^{233}U-^{236}U-^{230}Th as well as dilute mixed tracers of ^{84}Sr-^{87}Rb and ^{150}Nd-^{149}Sm. The procedures for the extraction of Pb and U were the same as those listed above for the zircon chemistry; however, laboratory blanks ranged from 24 to 250 pg total Pb, averaging 66 ± 12 pg with a composition of $^{206}Pb/^{204}Pb$ = 18.458 ± 0.093, $^{207}Pb/^{204}Pb$ = 15.287 ± 0.03, and $^{208}Pb/^{204}Pb$ = 37.54 ± 0.11. The REE were separated from the rest of the sample using a large (30 ml resin-volume) column (Birck and Allègre, 1978), and Sm separated from Nd using the alpha-isobutyric method of Lugmair et al. (1975). Laboratory chemical contamination levels (blanks) were on the order of 500 pg total Sr or Nd and are essentially negligible compared to the sample aliquot amounts. Sm and Nd were loaded with very dilute H_3PO_4 acid onto tantalum filaments in the triple filament mode and run on a fully automated multi-sample VG Isomass 54R mass spectrometer. Instrumental bias was monitored using Sr (SRM 987) and Nd (La Jolla) standards with average values of 0.70126 ± 1 and

0.51186 ± 1 respectively. Uncertainties on isotopic ratios are given as footnotes in the accompanying data tables, and are reported at the 2-sigma level.

Sm-Nd Isotopes

Results of the Sm-Nd isotopic systematics for whole-rock powders of the Quitovac rock suite are given in Table DR5 and shown in Figs. 5, 6, and DR4. Although the entire suite does not yield a single array in a $^{143}Nd/^{144}Nd$ versus $^{147}Sm/^{144}Nd$ isochron plot (Fig. DR4), these results are in general better behaved than the previous Pb systematics. Two isochrons can be defined by some of the Paleoproterozoic samples from the Quitovac region. The "North America" block samples (NA-5, 6, and 7) define an isochron age of 1663 ± 36 Ma with an initial εNd value of ~ +2.5. The bulk of the Caborca block samples (CA-9, 11, 15, 16, 17, 19, and 20) define an isochron age of 1715 ± 94 Ma with an initial εNd value of ~ +1.2 (Fig. DR4). The Nd isochron ages for the Caborca and "North America" blocks are very similar to their actual crystallization ages determined by U-Pb zircon geochronology (Table DR3). This indicates that the original Nd isotopic compositions of these basement rocks in Quitovac are still preserved and may be used as an indicator of tectono-magmatic environments.

Rb-Sr Isotopes

The results of the Rb-Sr whole-rock isotopic systematics for the Quitovac rocks are given in Table DR6 and shown in a $^{87}Sr/^{86}Sr$ versus $^{87}Rb/^{86}Sr$ isochron plot in Figure DR5. It is immediately obvious that the Rb-Sr systematics are not well behaved and the isotopic data are very scattered, forming several pseudo-isochrons that probably represent partial to complete resetting of the isotopic system at the ages indicated. An isochron age of 1476 ± 210 Ma is obtained for the entire suite of Paleoproterozoic samples, somewhat younger than the 1613 Ma Pb-Pb age for the same suite. An apparent age of 1443 ± 73 Ma is obtained for the "North America" block samples (NA-3, 5, 6, 7, and 8), although three of these samples yield the best-behaved isochron age at 1571 ± 6.6 Ma with a Sr initial value = 0.70214, a very reasonable depleted initial value at 1.7 Ga. Calculated initial Sr values for samples NA-6 and 7 are more depleted at 0.7013, and slightly more depleted than the model depleted mantle value at 1.7 Ga (0.7017). However, these values are highly suspect due to the nature of their alteration during subsequent deformation,

TABLE DR4. U-Th-Pb ANALYTICAL DATA FOR WHOLE-ROCK SAMPLES FROM PROTEROZOIC BASEMENT ROCKS IN THE QUITOVAC REGION, NW SONORA, MEXICO

Sample	Location	Weight (mg)	U (ppm)	Th (ppm)	Pb (ppm)	$^{206}Pb^{*}/^{204}Pb$	$^{207}Pb^{*}/^{204}Pb$	$^{208}Pb^{*}/^{204}Pb$	$^{238}U^{*}/^{204}Pb$	$^{232}Th^{*}/^{204}Pb$	$^{206}Pb^{\dagger}/^{204}Pb$	$^{207}Pb^{\dagger}/^{204}Pb$	$^{208}Pb^{\dagger}/^{204}Pb$
Caborca block samples													
CA-1	Quitovac I	77.72	2.27	9.93	10.9	23.432	16.138	42.566	14.91	67.5	18.788	15.641	36.471
						15[§]	15	52	3	1			
CA-4	El Tullido	73.73	0.72	3.15	10.4	19.340	15.760	38.993	4.47	20.3	17.947	15.611	37.159
						13	15	48	1	1			
CA-9	La Toñita	56.72	0.29	0.78	2.81	20.158	15.795	38.677	6.70	18.7	18.067	15.572	36.986
	(Amphibolite)					12	14	47	2	1			
CA-11	La Silla Sur I	85.75	3.00	11.2	19.0	19.337	15.703	38.680	10.19	39.3	16.179	15.367	35.150
						13	15	48	4	2			
CA-12	Bustamante II	81.83	1.02	N.D.[#]	7.59	21.306	16.006	40.898	9.22	N.D.[#]	N.D.[#]	N.D.[#]	N.D.[#]
						14	15	51	2				
CA-14	San Antonio	84.24	1.49	7.45	9.90	21.604	15.932	41.262	10.35	53.6	18.483	15.607	36.557
						13	14	50	2	1			
CA-15	La Toñita	85.04	1.50	10.4	13.1	20.138	15.818	41.323	7.78	55.7	17.801	15.575	36.458
						12	15	50	3	2			
CA-16	Quitovac II	89.23	2.44	9.15	11.1	23.188	16.087	41.877	15.57	60.4	18.342	15.569	36.423
						14	15	51	4	3			
CA-17	La Silla Sur II	81.10	2.05	16.4	34.0	19.296	15.701	39.237	3.92	32.4	18.052	15.566	36.255
						12	14	48	1	1			
CA-18	San Fernando	82.46	3.43	16.8	26.3	21.269	15.885	39.961	8.83	44.6	18.571	15.601	35.999
						14	15	49	2	1			
CA-19	Lomas Rojas	85.86	3.06	13.1	11.8	22.830	16.070	42.256	18.50	81.5	17.194	15.477	35.025
						15	15	52	8	7			
CA-20	El Molino	77.69	1.95	10.6	9.86	22.960	16.072	44.080	14.37	80.6	18.600	15.616	36.969
						18	17	60	2	2			
“Grenvillian” Caborca block samples													
CAG-2	Bustamante I	52.30	3.68	13.2	25.0	19.597	15.706	38.936	9.58	35.5	17.769	15.565	36.902
						12	15	71	3	1			
CAG-13	Bustamante III	82.78	3.84	18.7	24.9	21.513	15.928	40.651	10.54	53.2	19.528	15.776	37.645
						13	15	50	4	10			
“North America” block samples													
NA-3	El Chacón III	55.79	1.38	4.12	8.83	18.842	15.634	38.022	9.99	30.7	15.799	15.315	35.499
						18	20	57	2	1			
NA-5	La Colorada	68.50	4.07	13.1	26.4	19.335	15.683	38.286	9.88	32.9	16.438	15.388	35.479
						14	16	49	3	1			
NA-6	El Chacón	61.01	0.24	0.65	3.13	18.393	15.621	38.724	4.79	13.6	16.946	15.470	37.528
	(Amphibolite)					11	14	47	1	1			
NA-7	El Chacón II	60.13	0.66	2.56	8.78	18.356	15.584	38.314	4.72	19.0	16.929	15.435	36.640
						12	15	48	1	1			
NA-8	El Chacón I	62.95	0.64	6.64	12.6	17.470	15.496	39.027	3.20	34.5	16.502	15.395	35.992
						12	15	49	1	1			

(*) Corrected ratios; corrected for mass fractionation (0.13 ± 0.05 % per a.m.u.) and blank Pb (variable amounts between 10 and 70 pg total Pb; blank composition: $^{206}Pb/^{204}Pb$ = 18.458 ± 0.093; $^{207}Pb/^{204}Pb$ = 15.287 ± 0.03; and $^{208}Pb/^{204}Pb$ = 37.54 ± 0.11) using the reduction program of Ludwig (1989).
(†) Initial ratios, calculated by subtracting the amount of ^{206}Pb, ^{207}Pb, and ^{208}Pb that has accumulated from the decay of U and Th in each sample since the formation of the rock, taken to be the zircon age.
(§) Uncertainty at 2 sigma, corresponding to the last two digits of the ratio.
(#) N.D. = not determined.

TABLE DR5. Sm-Nd ANALYTICAL DATA FOR WHOLE-ROCK SAMPLES FROM PROTEROZOIC BASEMENT ROCKS IN THE QUITOVAC REGION, NW SONORA, MEXICO

Sample	Location	Weight (mg)	Sm* (ppm)	Nd* (ppm)	$^{147}Sm/^{144}Nd$ †	$^{143}Nd/^{144}Nd$ †	$^{143}Nd/^{144}Nd_i$ §	εNd §	T_{DM} ** (Ma)
Caborca block samples									
CA-1	Quitovac I	77.72	6.43	32.1	0.1210	0.511894	0.510503	2.6	1880
					1	14	13	32	
CA-4	El Tullido	73.73	5.08	24.1	0.1269	0.511863	0.510404	0.6	2070
					1	14	18	33	
CA-9	La Toñita (Amphibolite)	56.72	1.45	5.12	0.1709	0.512402	0.510435	1.3	2280
					1	21	17	33	
CA-11	La Silla Sur I	85.75	5.07	23.4	0.1306	0.511950	0.510456	1.4	2000
					1	19	21	33	
CA-12	Bustamante II	81.83	2.78	15.8	0.1058	0.511752	0.510525	3.4	1820
					1	12	12	32	
CA-14	San Antonio	84.24	5.38	24.4	0.1333	0.512040	0.510551	2.2	1890
					1	10	21	33	
CA-15	La Toñita	85.04	6.23	30.6	0.1229	0.511875	0.510507	1.2	1950
					1	10	17	33	
CA-16	Quitovac II	89.23	5.53	26.9	0.1243	0.511871	0.510443	1.3	1990
					2	9	27	34	
CA-17	La Silla Sur II	81.10	5.63	30.2	0.1124	0.511745	0.510432	1.9	1950
					1	13	16	33	
CA-18	San Fernando	82.46	4.92	28.6	0.1038	0.511671	0.510498	1.7	1900
					1	10	11	32	
CA-19	Lomas Rojas	85.86	6.39	31.1	0.1240	0.511873	0.510472	1.2	1980
					1	10	17	33	
CA-20	El Molino	77.69	6.42	33.5	0.1158	0.511769	0.510468	0.8	1980
					1	18	14	32	
"Grenvillian" Caborca block samples									
CAG-2	Bustamante I	52.30	12.0	58.0	0.1247	0.512034	0.511113	-1.4	1720
					1	10	17	32	
CAG-13	Bustamante III	82.78	5.82	34.7	0.1012	0.511734	0.510996	-4.0	1770
					1	10	14	32	
"North America" block samples									
NA-3	El Chacón III	55.79	4.25	22.2	0.1155	0.511920	0.510618	3.9	1740
					1	16	18	33	
NA-5	La Colorada	68.50	4.19	23.8	0.1062	0.511769	0.510612	2.3	1800
					1	13	15	32	
NA-6	El Chacón (Amphibolite)	61.01	1.48	5.04	0.1772	0.512548	0.510567	2.6	2050
					1	11	12	32	
NA-7	El Chacón II	60.13	1.61	11.2	0.0869	0.511578	0.510605	3.4	1760
					2	19	24	32	
NA-8	El Chacón I	62.95	3.06	17.6	0.1048	0.511790	0.510615	3.6	1750
					1	14	12	32	

(*) Concentration uncertainties for Sm and Nd are ~0.5 % and ~0.1 %, respectively.

(†) Isotopic ratios corrected for blank and mass fractionation, $^{143}Nd/^{144}Nd$ data are normalized to $^{146}Nd/^{144}Nd = 0.7219$ and adjusted for instrumental bias to $^{143}Nd/^{144}Nd = 0.511860$ for the La Jolla Nd standard. The mean value of $^{143}Nd/^{144}Nd$ for 30 analyses of the La Jolla Nd standard was 0.511865 ± 10. Uncertainties correspond to the last significant figure(s) at the 95% confidence level.

(§) Initial $^{143}Nd/^{144}Nd$ ratios and εNd are calculated using U-Pb zircon ages from Table DR3; $\lambda = 6.54 \times 10^{-12}$/yr; present day $(^{143}Nd/^{144}Nd)_{CHUR} = 0.512638$, and $(^{147}Sm/^{144}Nd)_{CHUR} = 0.1967$, where CHUR = chondritic uniform reservoir.

(**) Nd model ages (T_{DM}) are calculated relative to depleted mantle (DM) evolution by solving for T (age in Ga) in the expression: $\varepsilon Nd(T) = 0.25T^2 - 3T + 8.5$ (DePaolo, 1981).

TABLE DR6. Rb-Sr ANALYTICAL DATA FOR WHOLE-ROCK SAMPLES FROM PROTEROZOIC BASEMENT ROCKS IN THE QUITOVAC REGION, NW SONORA, MEXICO

Sample	Location	Weight (mg)	Rb* (ppm)	Sr* (ppm)	$^{87}Rb/^{86}Sr$ †	$^{87}Sr/^{86}Sr$ †	$^{87}Sr/^{86}Sr_i$ §	ε_{Sr} §
Caborca block samples								
CA-1	Quitovac I	77.72	150.1	134.9	3.2376	0.769227	(0.687860)	N.A.#
					654	15		
CA-4	El Tullido	73.73	96.0	163.7	1.7037	0.747175	0.704358	27.5
					18	21	3142	
CA-9	La Toñita (Amphibolite)	56.72	4.2	140.3	0.0869	0.711399	0.709213	96.6
					1	15	22	8
CA-11	La Silla Sur I	85.75	179.9	248.3	2.1018	0.735389	(0.682812)	N.A.#
					30	21		
CA-12	Bustamante II	81.83	32.8	120.3	0.7911	0.727220	0.707166	67.7
					10	120	778	
CA-14	San Antonio	84.24	124.5	162.7	2.2237	0.754540	(0.700240)	(-32.0)
					120	420		
CA-15	La Toñita	85.04	118.3	167.8	2.0485	0.752080	(0.702237)	(-3.7)
					92	14		
CA-16	Quitovac II	89.23	129.6	130.5	2.8888	0.764834	(0.692275)	N.A.#
					39	28		
CA-17	La Silla Sur II	81.10	149.9	231.1	1.8839	0.746334	(0.698191)	N.A.#
					82	22		
CA-18	San Fernando	82.46	142.2	139.0	2.9806	0.780985	(0.707333)	(69.3)
					47	62		
CA-19	Lomas Rojas	85.86	104.4	157.9	1.9208	0.751210	(0.703774)	(18.6)
					56	260		
CA-20	El Molino	77.69	147.2	138.5	3.0924	0.769616	(0.693698)	N.A.#
					48	22		
"Grenvillian" Caborca block samples								
CAG-2	Bustamante I	52.30	142.6	182.2	2.2740	0.748642	(0.711990)	(125.4)
					38	25		
CAG-13	Bustamante III	82.78	211.4	194.9	3.1662	0.797744	(0.747352)	N.A.#
					48	33		
"North America" block samples								
NA-3	El Chacón III	55.79	76.9	515.1	0.4323	0.713203	0.702552	1.2
					6	21	244	20
NA-5	La Colorada	68.50	123.8	132.9	2.7070	0.759359	(0.694911)	N.A.#
					38	24		
NA-6	El Chacón (Amphibolite)	61.01	14.9	137.9	0.3133	0.709216	0.701560	-13.2
					4	36	135	12
NA-7	El Chacón II	60.13	58.7	344.9	0.4924	0.713244	0.701191	-18.4
					7	15	204	16
NA-8	El Chacón I	62.95	90.3	351.8	0.7433	0.718907	0.700692	-25.5
					7	21	523	37

(*) Concentration uncertainties for Rb and Sr are ~1.0 % and ~0.5 %, respectively.
(†) Isotopic ratios corrected for blank and mass fractionation, $^{87}Sr/^{86}Sr$ data are normalized to $^{86}Sr/^{88}Sr = 0.1194$ and adjusted for instrumental bias to $^{87}Sr/^{86}Sr = 0.710265$ for NBS SRM 987 standard. The mean value of $^{87}Sr/^{86}Sr$ for 30 analyses the Sr standard was 0.710265 ± 10. Uncertainties correspond to the last significant figure(s) at the 95% confidence level.
(§) Initial $^{87}Sr/^{86}Sr$ ratios and εSr are calculated using U-Pb zircon ages from Table DR3; $\lambda = 1.42 \times 10^{-11}$/yr; present day $(^{87}Sr/^{86}Sr)_{UR} = 0.7045$, and $(^{87}Rb/^{86}Sr)_{UR} = 0.0824$, where UR = Uniform Reservoir. Numbers in parentheses are highly unreliable to impossible, owing mostly to $^{87}Rb/^{86}Sr$ values of ~2.0 or greater and a large correction for radiogenic ^{87}Sr.
(#) N.A. = not applicable.

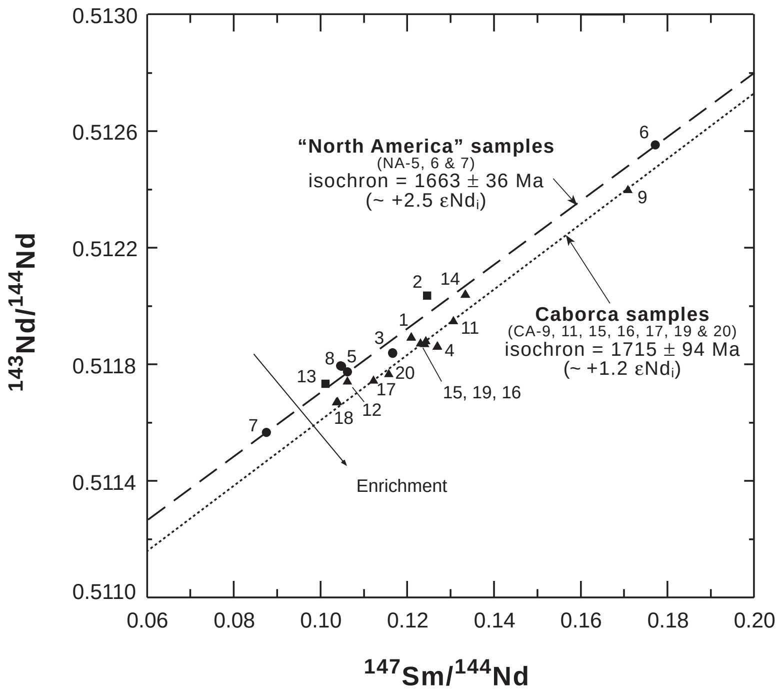

Figure DR4. 143Nd/144Nd versus 147Sm/144Nd isochron plot for Proterozoic samples from the Quitovac region in northwestern Sonora, Mexico. The Paleoproterozoic granites for the Caborca and "North America" blocks are represented by black triangles and circles, respectively. The Grenvillian-age samples from the Campo Bustamante area in Quitovac are symbolized by black squares. Dotted and dashed lines are isochrons for selected samples from the Caborca (~1715 Ma) and "North America" (~1663 Ma) blocks, respectively. Numbers next to the symbols represent the sample number without the letter prefix.

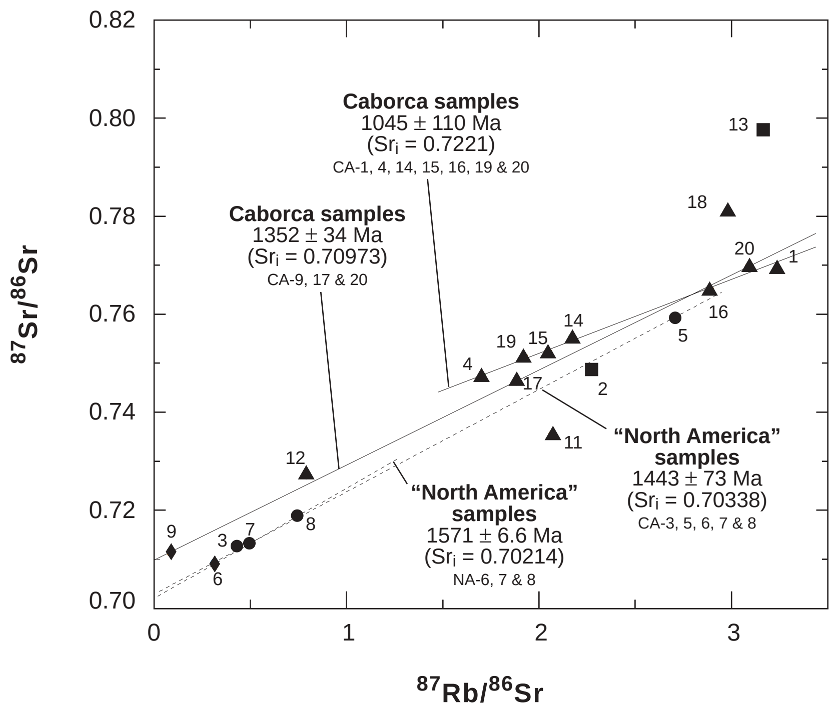

Figure DR5. 87Sr/86Sr versus 87Rb/86Sr isochron plot for Proterozoic samples from the Quitovac region in northwestern Sonora, Mexico. The Paleoproterozoic granites for the Caborca and "North America" blocks are represented by black triangles and circles, respectively. The Grenvillian-age samples from the Campo Bustamante area in Quitovac are symbolized by black squares. Numbers next to the symbols represent the sample number without the letter prefix.

metamorphism and uplift. From the Caborca block sample suite, the most depleted initial Sr value is 0.7022 from sample CA-15, and the most enriched (CA-4) at 0.7044; although once again, the isotopic systematics of most of the samples are not well preserved and are therefore suspect. The bulk of the Caborca block samples (CA-1, 4, 14, 15, 16, 19, and 20) lie along an ill-defined isochron at 1045 ± 110 Ma, very near the age for both the Grenvillian samples and the concordia lower-intercept age for CA-4, suggesting that a real geological event at that time affected these rocks. Despite the lack of primary ages by this isotopic technique, there is some indication of derivation from a depleted source for at least the "North America" block samples.

Major Element Geochemistry

Ten major element oxides were determined by wavelength dispersive X-ray fluorescence spectrometry (WDXRF) using a Phillips PW1606 spectrometer as described by Mee et al. (1996). A 0.8-g portion of minus 80-mesh of each sample was ignited in a tared 95% Pt/ 5% Au crucible at 925°C for 45 minutes. The weight loss was reported as percent loss on ignition (LOI). After fusion, a charge of 8 g of lithium tetraborate was added and thoroughly mixed with the sample. The combined weights of the sample and the flux were calculated to present an "infinitely thick" sample disk to the instrument. A 0.250 ml aliquot of the 1:1 LiBr solution was added as a non-wetting agent. Seven crucibles containing samples, and seven empty molds, were loaded onto the automatic fluxer. The loaded apparatus was placed in a muffle furnace at 1120°C. The samples were allowed to come to temperature for 10 minutes, and then they were homogenized in the furnace with an electric motor mechanism for 35 minutes. The fluxer was removed from the furnace, and the molten mixtures were poured from the seven crucibles into their respective molds, and cooled to near room temperature.

Using the wavelength dispersive X-ray spectrometer, the major element concentrations were determined by comparing the intensities obtained from standards with those obtained from the samples (Taggart et al., 1987). In addition to instrument standards, a standard sample (TB-1) disc was prepared and analyzed for every 20 rock samples analyzed. If the discs showed a deviation of 3 standard deviations or more, and the instrument standards showed no deviation, then another sample of TB-1 was prepared. If both, the sample preparation standard and the instrumental standard exceeded

TABLE DR7. MAJOR- AND TRACE-ELEMENT COMPOSITIONS OF PROTEROZOIC BASEMENT ROCKS IN THE QUITOVAC REGION, NW SONORA, MEXICO

	Caborca block samples														*"North America" block samples*				
Sample	CA-1	CA-4	CA-9[#]	CA-11	CA-12	CA-14	CA-15	CA-16	CA-17	CA-18	CA-19	CA-20	CAG-2[**]	CAG-13[**]	NA-3	NA-5	NA-6[#]	NA-7	NA-8
SiO_2	71.07	70.41	51.04	71.25	77	70.52	70.15	70.11	69.57	71.84	70.28	70.27	66.32	68.84	64.67	73.74	49.75	72.24	68.17
Al_2O_3	13.94	14.1	6.27	14	10.52	14.07	14.25	13.8	14.19	13.95	13.95	13.96	14.41	15.17	15.36	13.58	14.06	14	14.86
Fe_2O_3(t)	3.45	3.5	9.6	3.28	3.32	3.21	3.27	3.16	3.37	2.96	3.54	3.52	5.97	2.75	5.79	1.73	8.86	3.62	4.3
MgO	0.47	0.53	16.26	0.47	0.66	0.48	0.49	0.48	0.54	0.34	0.5	0.49	0.72	0.49	2.04	0.17	9.24	0.71	1.47
CaO	0.99	1.48	13.61	1.53	1.59	1.53	1.48	1.32	1.45	1.29	1.27	1.36	2.18	2.01	4.17	0.81	13.35	2.53	3.25
Na_2O	3.76	3.81	0.48	3.69	2.68	3.81	3.59	3.62	3.1	3.74	3.55	3.64	3.4	3.65	4.2	3.12	1.9	4.5	4.12
K_2O	4.7	4.61	0.26	4.31	2.37	4.64	4.89	4.78	5.91	4.1	4.58	4.78	4.75	4.7	1.74	5.69	0.57	1.28	2.15
TiO_2	0.32	0.33	0.32	0.23	0.17	0.31	0.32	0.31	0.21	0.23	0.31	0.32	0.68	0.25	0.74	0.14	0.57	0.34	0.51
P_2O_5	0.12	0.13	0.11	0.13	0.02	0.1	0.1	0.13	0.09	0.11	0.11	0.1	0.21	0.09	0.26	0.11	0.11	0.15	0.19
MnO	0.05	0.06	0.21	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.1	0.06	0.08	0.02	0.16	0.04	0.06
LOI	0.95	0.7	0.53	0.45	0.86	0.48	0.41	1.35	0.46	0.71	0.86	0.4	0.95	0.96	0.55	0.41	0.75	0.38	0.55
Total	99.82	99.66	98.69	99.39	99.24	99.21	99.01	99.12	98.95	99.33	99	98.9	99.69	98.97	99.6	99.52	99.32	99.79	99.63
A/CNK[*]	1.07	1.01	0.24	1.04	1.07	1	1.03	1.02	1	1.08	1.06	1.02	0.98	1.03	0.94	1.06	0.5	1.05	0.99
[Fe/Fe+Mg][†]	0.87	0.86	0.35	0.86	0.82	0.86	0.86	0.86	0.85	0.89	0.86	0.87	0.88	0.83	0.72	0.9	0.46	0.82	0.72
Fe	23700.00	23600.00	67000.00	24600.00	23681.00	22500.00	23900.00	22200.00	24300.00	20300.00	24900.00	25300.00	40800.00	20100.00	36900.00	11000.00	61200.00	24500.00	28400.00
Ca	8540.00	8810.00	107000.00	12300.00	10600.00	8181.00	7950.00	9830.00	10200.00	11000.00	6780.00	13400.00	16300.00	16800.00	32700.00	6990.00	104000.00	19400.00	27700.00
Na	26600.00	27000.00	3440.00	26700.00	20100.00	27900.00	27600.00	27400.00	23500.00	28400.00	27100.00	27900.00	23200.00	27500.00	31200.00	23200.00	13900.00	32800.00	29700.00
K	33000.00	34600.00	2210.00	31300.00	17500.00	37700.00	40900.00	41800.00	50100.00	36900.00	36700.00	36400.00	36200.00	35300.00	11600.00	44800.00	5390.00	13000.00	17200.00
Rb	143.00	95.70	7.86	180.00	35.40	126.00	125.00	138.00	156.00	144.00	110.00	153.00	136.00	215.00	72.40	122.00	14.50	57.80	92.60
Sr	131.00	163.00	90.90	258.00	146.00	179.00	187.00	156.00	252.00	157.00	175.00	155.00	179.00	212.00	552.00	146.00	174.00	355.00	377.00
Cs	3.40	1.69	0.13	7.56	1.26	1.27	1.92	1.90	4.41	1.72	1.23	3.95	4.25	6.29	3.89	1.23	2.48	2.81	5.08
Ba	825.00	1080.00	24.40	1030.00	1150.00	1070.00	1140.00	1000.00	1470.00	756.00	1070.00	983.00	1700.00	1500.00	710.00	690.00	112.00	482.00	577.00
Th	13.20	3.24	0.51	9.19	4.04	10.50	11.60	12.60	12.30	15.60	13.70	13.60	15.00	19.60	3.48	16.10	0.48	2.78	5.90
U	2.70	1.01	0.24	3.19	1.43	1.97	2.23	3.50	2.25	4.15	3.57	2.64	4.46	4.60	1.49	5.08	0.26	1.12	0.87
Zr	248.00	256.00	111.00	261.00	257.00	226.00	245.00	243.00	248.00	151.00	236.00	260.00	582.00	256.00	168.00	117.00	36.30	249.00	157.00
Hf	6.46	6.52	0.53	6.67	7.40	5.99	6.64	6.74	6.30	4.58	6.56	7.10	13.50	7.48	4.14	3.68	0.95	6.30	4.05
Ta	1.09	0.41	0.06	1.14	0.40	0.93	1.06	1.32	0.89	0.47	1.18	0.95	1.82	0.56	1.06	0.17	0.10	0.24	0.78
W	1.63	0.53	1.61	0.58	0.32	0.60	0.49	0.48	1.25	0.40	1.12	0.73	1.27	3.46	0.37	0.50	2.27	0.50	0.80
Sc	5.88	6.71	56.60	7.97	7.76	5.90	6.76	6.27	13.50	4.40	6.46	6.52	10.30	4.03	9.62	1.89	47.20	2.76	7.07
Cr	15.50	12.40	1870.00	12.10	19.10	10.60	10.10	12.90	14.60	8.47	13.70	18.60	11.40	11.90	43.20	11.90	1190.00	13.50	33.70
Co	3.00	3.36	53.50	3.92	0.99	3.16	3.31	3.14	2.47	2.30	3.36	3.33	5.77	2.75	14.70	1.16	40.10	5.26	10.60
Ni	9.40	7.56	244.00	10.20	11.40	11.30	4.70	6.09	7.66	7.50	4.50	8.38	11.90	10.70	30.10	9.65	159.00	8.19	21.80
Zn	31.70	33.40	80.70	32.80	48.20	31.60	40.10	29.00	33.00	41.20	31.60	33.20	93.30	49.40	56.20	22.30	67.40	25.40	45.60
As	0.90	0.59	2.28	0.43	0.45	0.32	0.25	2.86	1.15	0.47	0.62	1.86	0.99	0.70	0.24	0.56	0.53	0.56	0.75
Sb	0.44	0.12	0.11	0.12	0.17	0.11	0.09	0.76	0.25	0.14	0.36	0.36	0.29	0.13	0.10	0.09	0.09	0.18	0.15
Au (ppb)	1.35	0.57	1.27	0.27	1.70	0.90	2.43	0.82	0.17	1.09	2.19	0.91	0.13	0.83	0.26	0.34	1.45	0.10	0.49
Y[§]	46	31	11	29	21	41	39	34	26	21	42	39	62	21	17	6.9	15	4	13
Nb[§]	12	7.1	< 0.2	7.5	5.4	11	9.2	11	5.3	6.8	12	11	24	6.3	12	6.5	0.57	5.4	10
Pb[§]	12	11	2.7	20	10	12	14	14	30	26	13	11	25	29	9.2	26	3.5	9	13

Total Fe as Fe_2O_3. LOI = loss on ignition. Major elements in weight percent. Trace elements in ppm except Au in ppb.
(*) A/CNK = molecular ratio $Al_2O_3/(CaO+Na_2O+K_2O)$.
(†) [Fe/Fe+Mg] = $FeO_{(t)}/(FeO_{(t)}+MgO)$.
(§) ICP-MS determined.
(#) Amphibolite.
(**) "Grenvillian" samples from Caborca block.

control limits, then an instrument recalibration was performed. If an analysis yielded a total major element oxide determination of less than 97% or greater than 101%, then it was automatically repeated.

Trace Element and REE Geochemistry (INAA and ICP-MS)

The routine procedure for instrumental neutron activation analysis (INAA) at the U.S. Geological Survey (USGS) laboratory facility in Denver involves encapsulating approximately one gram of samples and standards in heat-sealed polyethylene vials. The vials with rock samples were simultaneously irradiated in the lazy Susan facility of the USGS TRIGA nuclear reactor for 8 hours with a neutron flux of $2.5x10^{12}$ $n/cm^2/sec$. Following a decay period of 6 to 8 days, each standard and sample was counted 90 to 120 minutes utilizing two high-resolution germanium detectors (one high-energy coaxial and one low-energy planar) coupled to a multi-channel analyzer system. The same distance between counting position and the detectors is maintained for all standards and samples, thereby eliminating errors associated with geometry differences. After an additional 7 to 9 day decay, the standards and samples were counted for 120 to 150 minutes, again maintaining an identical distance from each of the detectors for all standards and samples. Two additional counts were performed on each detector type for 240 to 300 minutes at 65 days following the irradiation. After the counting was completed, the spectral data were processed using an in-house modified version of a commercially-available computer program called SAMPO (Routti, J.T., 1969) that smoothes the spectral data and determines the net areas of the gamma-ray photopeaks and translates the area data into count rate data (e.g., counts per minute or cpm). The SAMPO program is capable of resolving overlapping and complex photopeak regions. Another data reduction program corrects the count rate data for decay time differences among the standards and samples, electronic dead time losses and unresolved interferences. The program compares the sample data (cpm/weight) to the standard data (cpm/ug) to calculate elemental abundances for each sample. In cases where multiple determinations are made, the elemental abundance data are combined and weighted according to the individual counting statistical errors. This sequential counting procedure allows for the determination of 33 elements.

TABLE DR8. RARE-EARTH ELEMENT (REE) COMPOSITIONS OF PROTEROZOIC BASEMENT ROCKS IN THE QUITOVAC REGION, NW SONORA, MEXICO

	Caborca block samples														*"North America" block samples*				
Sample	CA-1	CA-4	CA-9*	CA-11	CA-12	CA-14	CA-15	CA-16	CA-17	CA-18	CA-19	CA-20	CAG-2†	CAG-13†	NA-3	NA-5	NA-6*	NA-7	NA-8
La	42.10	27.50	2.83	29.00	26.30	33.60	37.50	27.20	33.80	35.10	37.90	44.80	54.70	53.40	21.30	38.10	3.36	20.00	25.10
Ce	82.50	52.60	6.71	56.90	44.00	67.00	75.10	56.80	67.60	64.40	75.80	85.40	114.00	93.00	43.60	70.80	7.03	30.30	44.50
Nd	34.00	24.80	4.04	25.10	17.30	28.70	33.90	27.30	29.90	25.60	34.00	34.80	55.70	35.60	20.50	27.40	4.99	9.92	16.50
Sm	6.61	5.37	1.32	5.81	3.06	5.84	6.91	6.23	6.06	4.48	6.96	7.00	11.90	6.24	4.23	4.94	1.55	1.70	3.12
Eu	0.82	1.00	0.36	0.91	1.61	0.90	0.97	0.84	0.97	0.83	0.95	0.95	3.22	2.11	1.16	0.68	0.55	0.90	0.81
Gd	5.91	4.96	1.68	5.35	2.64	5.76	6.67	5.66	5.55	4.27	6.89	6.61	11.10	5.56	3.41	3.61	2.06	1.37	2.67
Tb	1.01	0.83	0.28	0.93	0.42	0.96	1.06	0.96	0.87	0.61	1.09	1.06	1.77	0.66	0.48	0.41	0.35	0.14	0.36
Ho	1.42	1.20	0.41	1.15	0.66	1.45	1.55	1.49	1.09	0.77	1.66	1.51	2.33	0.87	0.59	0.36	0.52	0.17	0.46
Tm	0.69	0.51	0.00	0.42	0.42	0.63	0.72	0.65	0.42	0.32	0.74	0.69	0.91	0.36	0.21	0.00	0.00	0.07	0.20
Yb	4.39	2.98	1.06	2.52	3.09	4.05	4.50	4.39	2.70	1.98	4.71	4.52	5.75	2.36	1.34	0.52	1.45	0.39	1.17
Lu	0.66	0.44	0.16	0.34	0.52	0.61	0.67	0.66	0.42	0.30	0.69	0.66	0.85	0.36	0.19	0.08	0.22	0.07	0.16
ΣREE	180.11	122.19	18.85	128.43	100.01	149.51	169.54	132.17	149.38	138.65	171.38	188.00	262.23	200.51	97.02	146.90	22.08	65.01	95.06
$(La/Yb)_N$	6.475	6.231	1.803	7.771	5.747	5.602	5.627	4.184	8.453	11.970	5.433	6.693	6.424	15.279	10.733	49.101	1.565	35.084	14.487
Eu/Eu^*	0.399	0.589	0.727	0.498	1.728	0.471	0.434	0.434	0.510	0.578	0.416	0.424	0.855	1.093	0.932	0.492	0.939	1.793	0.859

REE in ppm. $Eu/Eu^* = Eu_N/(Sm_N \times Gd_N)^{1/2}$

(*) Amphibolite.

(†) "Grenvillian" samples from Caborca block.

The principal error in the analysis of geologic materials by INAA is the counting statistical error, which is based on the signal to background ratio at the gamma-ray energy region of interest. A one-sigma error for a photopeak area determination is approximately equal to the square root of the total counts (i.e., background plus net counts) divided by the net counts.

Y, Nb and Pb trace elements were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) using a Perkin Elmer Elan 6000 ICP-MS spectrometer following the methodology described by Lichte et al. (1987) and Meier and Lichte (1996). Briefly, each rock sample was ground in agate to pass through a 100-mesh sieve. A 0.100-g aliquot of sample is weighed and placed into a 5 ml zirconium crucible. Standard rocks and duplicates, as well as two samples of in-house glass standard for calibration PP93, are prepared using the same procedure. Approximately 0.6 g of dry sodium peroxide (Na_2O_2) is mixed thoroughly with the sample. This mixture is kept under a heat lamp until placed into a preheated muffle furnace (450°C). After heating for 30 minutes, the crucibles are removed from the furnace and allowed cool down to room temperature. Each crucible is placed into a Savillex Teflon screw-capped bottle, and about 10 ml of deionized water (DI) is added and mixed with the sample by inverting the bottle a few times. The solution is allowed to sit for a minimum of 4 hours. The sample is mixed again, and a precise amount (0.25 ml) of Lu Internal Standard Solution (400 µg/ml Lu) is added. The Lutetium solution serves as an internal standard to correct for instrument instability and oxide correction. About 10 ml of 25% nitric acid (HNO_3) is added, and the solution is let stand for about 15 minutes, at which time the reaction stops. The solution is mixed thoroughly and a 5-ml aliquot is diluted with 10 ml of 1% nitric acid (HNO_3) for ICP-MS analysis.

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