

## Datashare 46:

# *Outcrop-based reservoir characterization of a kilometer-scale sand-injectite complex*

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AAPG Bulletin, v. 97, no. 2 (February 2013), pp. 309–343

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## APPENDICES

The workflow of outcrop and petrographic data is shown in Appendix 1. The methods of outcrop, permeability, and petrographic data acquisition were similar for all studied outcrop localities and samples throughout the Panoche giant injection complex (PGIC). This ensured consistency throughout the study. The Appendices are divided into (1) outcrop data and sample location (Appendices 2–10); (2) N/G and the proportion of dikes, sills, and extrudites (Appendices 11–12); and (3) methodology of petrographic and permeability data acquisition (Appendices 13–16). The permeability data were then used to construct maps (Figures 12, 16). Some unconsolidated high-permeability samples were broken and fractured in transit from the Panoche Hills, California, to Aberdeen, Scotland. Thus, not all samples collected from outcrop were used in the construction of these maps, and this sometimes resulted with an irregular data distribution.

### Appendices 2–10: Outcrop Data and Sample Location

The PGIC consists of a northern area, a transitional area, and a southern area (Appendix 2). Logged sections (Appendix 3) were measured in Canyons (Appendices 4–10) from across the PGIC from the remobilized parent sandstone units to the sandstone intrusions and to the sandstone extrudites. This was to identify the stratigraphic intervals and the intrusive elements. From this, estimates of N/G and its distribution and the proportion of parent units, dikes, sills, and extrudites were made (Appendices 11–12).

Samples of remobilized sandstone and sandstone intrusion were collected along the logged sections (Appendix 3). They were collected from No Name Canyon (NoC, Appendix 4), Marca Canyon (Mc, Appendix 5), Capita Canyon (Ca, Appendix 6), Rossetta Canyon (Ro, Appendix 7), Dosados Canyon (Do, Appendix 6), Escapardo Canyon (Es, Appendix 9), Right Angle Canyon (RA), West Tumey (WT, Appendix 10), south of West Tumey (SofWT), and Tumey Gulch.

Type localities with excellent exposure of the intrusive elements were then selected for detailed outcrop and micro-textural studies. These include the multilayer sandstone sills in Mc (Figure 5E), the stepped sandstone sill in Es (Figure 5B), the stepped sandstone sill in NoC (Figure 5C), the low-angle

sandstone dike in Do (Figure 18B), and the high-angle sandstone dikes in Ca (Figures 4A, 16A) and NoC (Figure 5C).

### Appendices 11–12: Net to Gross and the Proportion of Dikes, Sills, and Extrudites

The calculated proportion of parent units, dikes, sills, and extrudites is shown in Appendix 11. Estimates of the net-to-gross (N/G) and abundance of high-angle dikes were made using image-analysis software (SigmaScan<sup>®</sup> Pro 5.0, trademark of Systat Software). The significance of high-angle dikes on N/G in mudstone was estimated by creating 150-m (492-ft)-thick by 150-m (492-ft)-wide blocks from outcrop in Moreno Gulch and Rossetta Canyon. Examples of scanned outcrop images from which N/G is calculated are shown in Appendix 12.

### Appendices 13–16: Petrographic and Permeability Data Acquisition

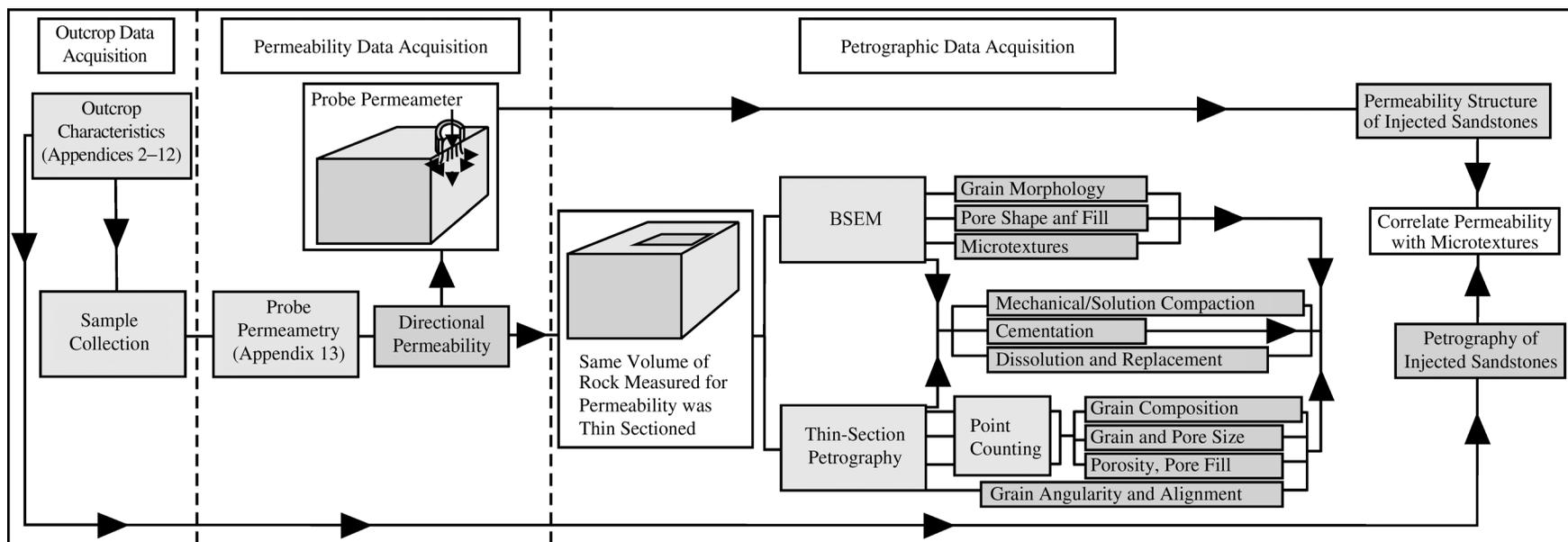
A probe permeameter consists of an annulus (the probe) through which gas (nitrogen) is injected into porous media (samples) (Appendix 13; Halvorsen and Hurst, 1990; Hurst et al., 1995). Leakage between the annulus and porous media was avoided by placing a ring of compressible impermeable rubber around the probe tip. Gas-flow rate is measured when steady-state conditions are reached and the gas-pressure drop between injection and background pressures is recorded. Gas-flow rate is transformed into permeability using the empirically derived relationship between probe-permeameter flow rate and Hassler-sleeve permeability on a set of standardized core plugs (Sutherland et al., 1993). Good to excellent correlations exist between the probe permeameter at different gas-flow rates (i.e.,  $r^2 = 0.91$ ,  $2 \text{ cc min}^{-1}$  [ $0.12 \text{ in.}^3 \text{ min}^{-1}$ ];  $0.94$ ,  $20 \text{ cc min}^{-1}$  [ $1.22 \text{ in.}^3 \text{ min}^{-1}$ ];  $0.72$ ,  $200 \text{ cc min}^{-1}$  [ $12.2 \text{ in.}^3 \text{ min}^{-1}$ ];  $0.98$ ,  $2000 \text{ cc min}^{-1}$  [ $122.0 \text{ in.}^3 \text{ min}^{-1}$ ]) and the Hassler-sleeve measurements.

All samples were cut with a rock saw to provide flat surfaces to avoid compromising the probe seal contact (Hurst and Goggin, 1995). This is because the probe-permeameter response is sensitive to sample fluid saturation and surface irregularities (Hurst and Rosvoll, 1991; Hurst et al., 1995). Care was taken not to introduce rock flour into the pores during

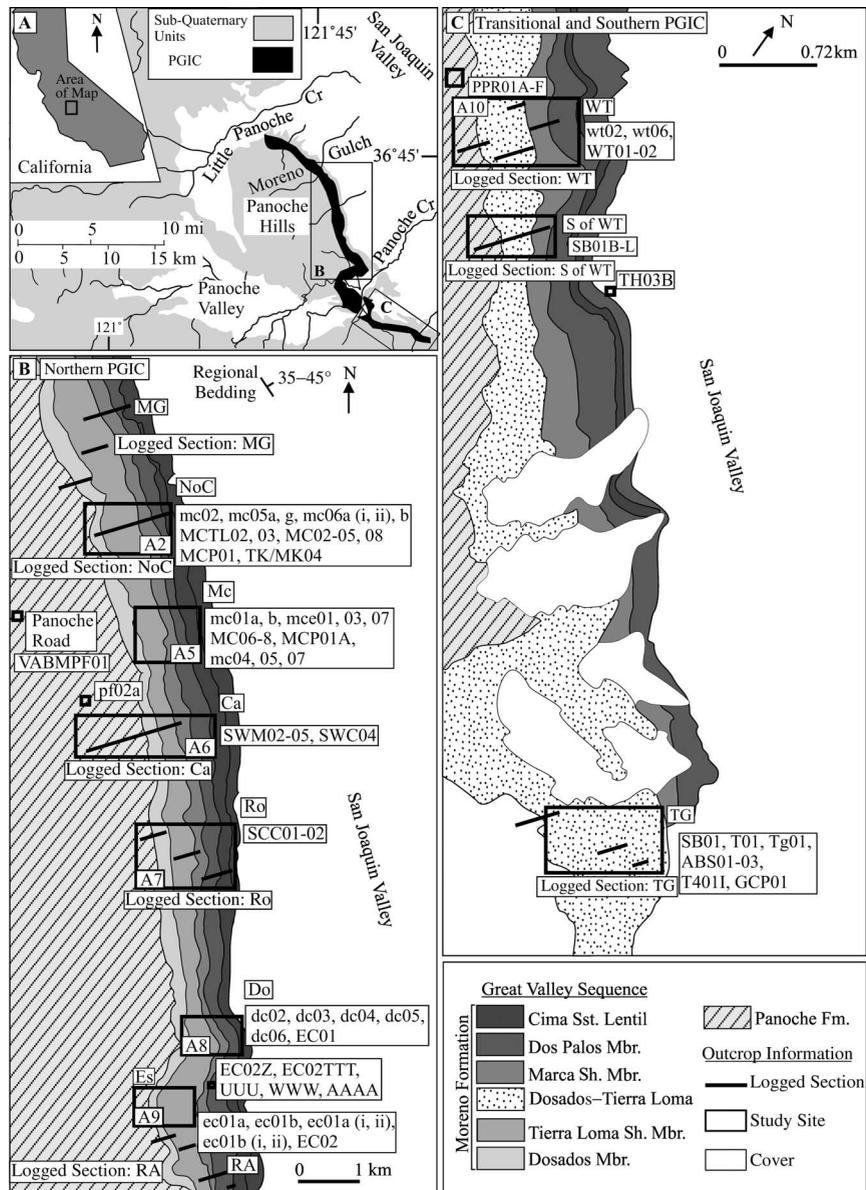
cutting because this can create artifacts in the flow characteristics. Two repeat measurements were made at each sample point to assess and ensure precision. The application force of the probe tip on the sample was kept constant and was sufficiently large to avoid gas-flow leakage. The probe position was recorded so that an appropriate sample was available for thin-section production (Antonellini and Aydin, 1994). Measurements were made both parallel and perpendicular to the sample surfaces so that permeability anisotropy was assessed. For each sample, the appropriate gas-flow rate was selected by

experimentation. Low-permeability samples (0–500 md) were measured using low gas-flow rates (2–20 cc min<sup>-1</sup> [0.12–1.22 in.<sup>3</sup> min<sup>-1</sup>]), whereas high-permeability samples (500–>1000 md) were measured at high gas-flow rates (200–2000 cc min<sup>-1</sup> [12.2–122.0 in.<sup>3</sup> min<sup>-1</sup>]). A steady-state gas-flow rate was ensured before each measurement was recorded.

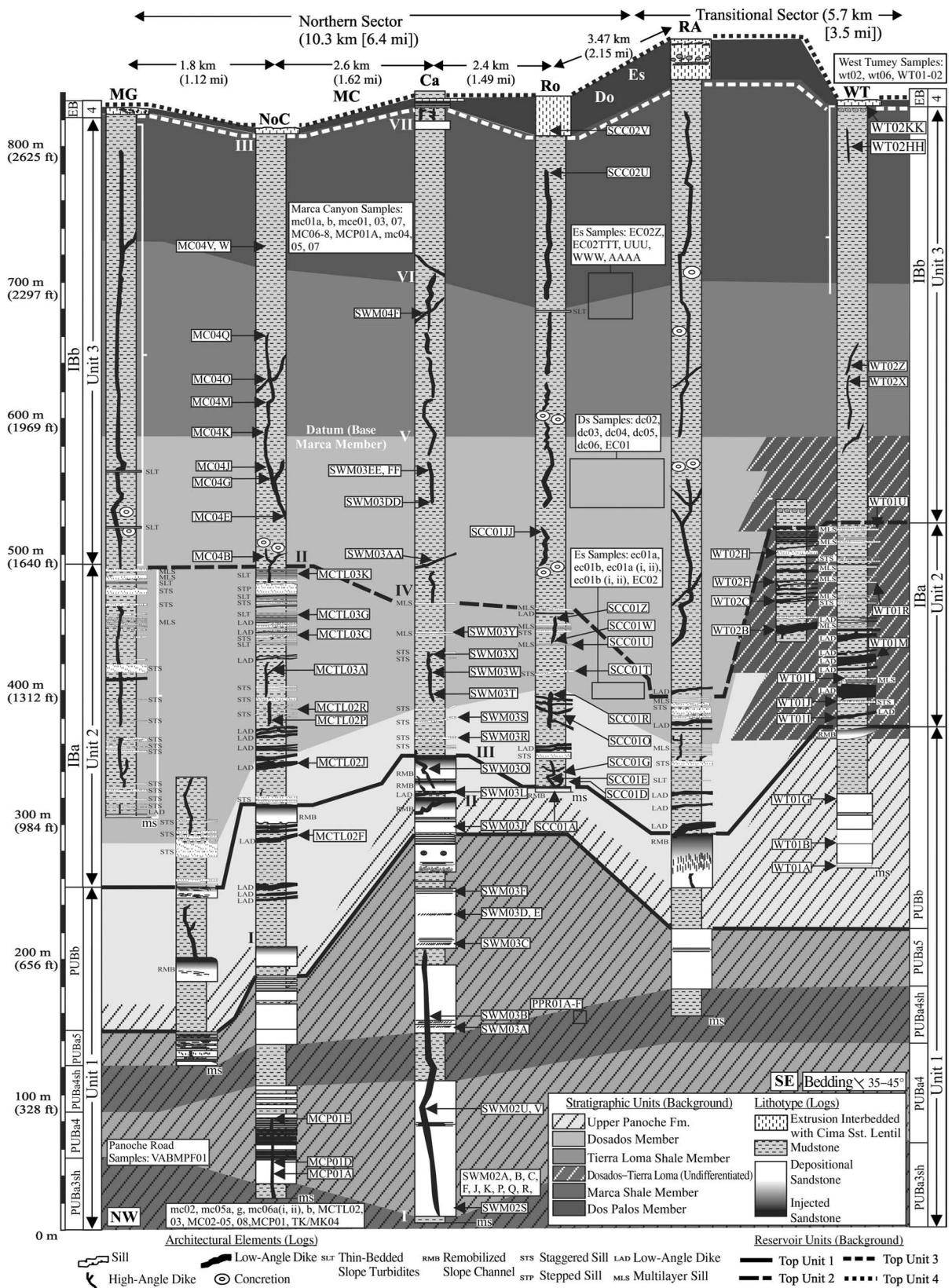
The petrographic and permeability data acquired from these analyses of samples collected from outcrop are synthesized in tables in Appendices 14, 15, and 16. The tables are subdivided into outcrop, petrographic, and permeability data.



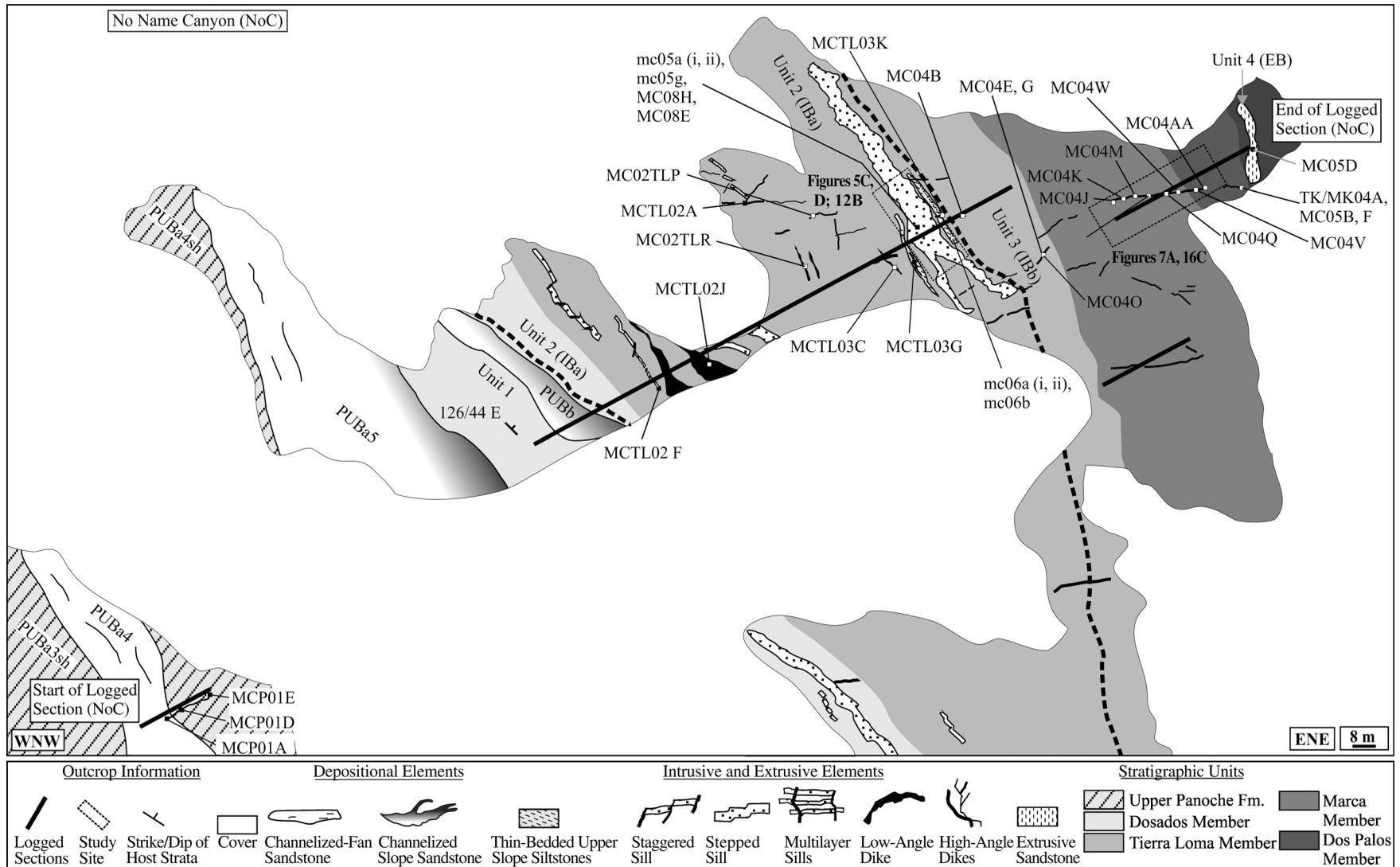
**Appendix 1.** Workflow from outcrop to permeability and petrographic data acquisition. BSEM = backscattered-electron microscopy.



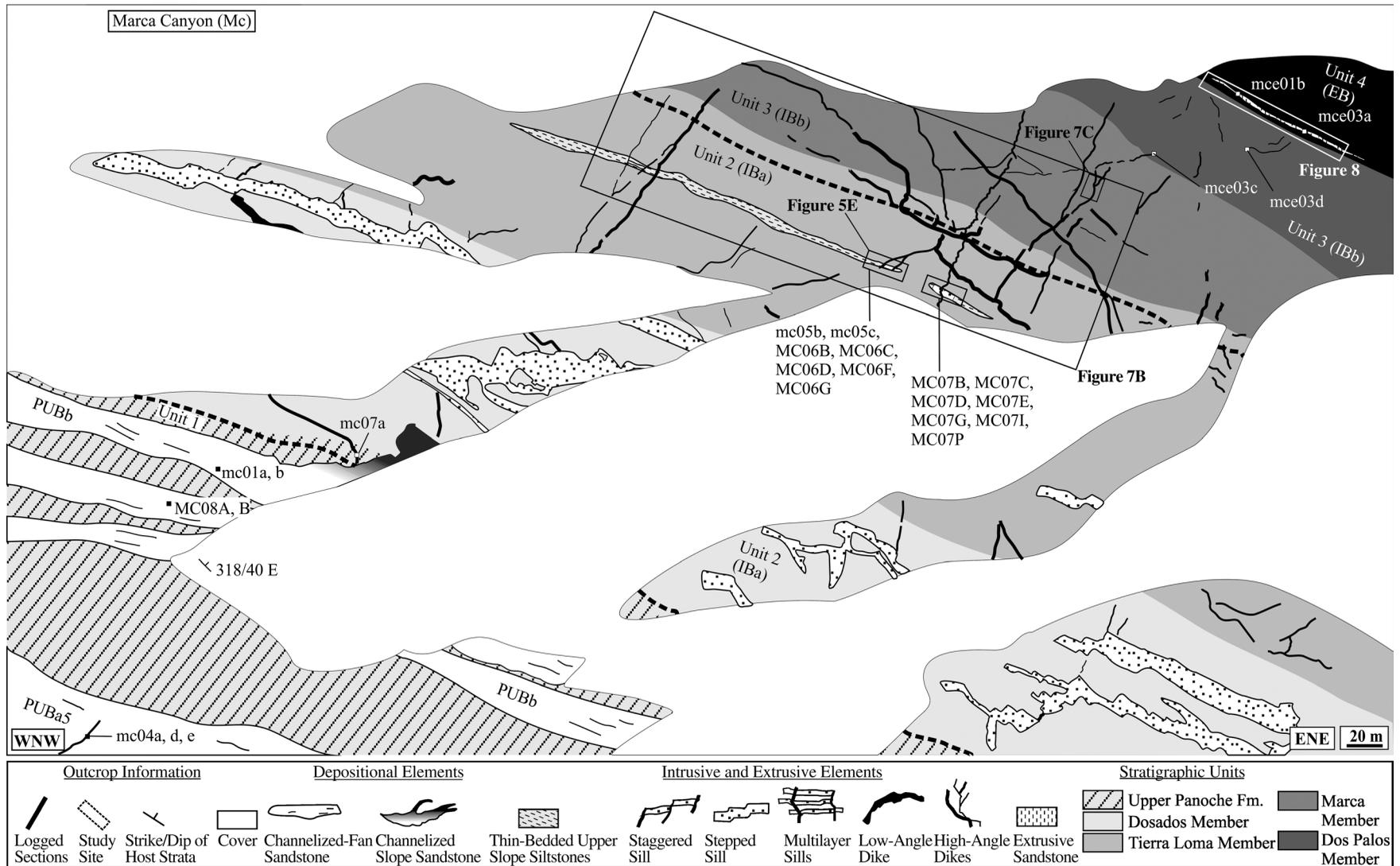
**Appendix 2.** Overview map of the Panoche giant injectite complex (PGIC) (A) composed of a northern area (B) and a transitional and southern area (C). Panel A was compiled and modified from Nilsen and Dibblee (1981). Geologic maps (B, C) are from Bartow (1996). Sample locations are superimposed on Google Earth images. Logged sections were measured from the parent sandstone bodies through the sand-injectite complex and to the sandstone extrudites. Samples of remobilized sandstone and sandstone intrusions were collected from across the PGIC. Type outcrop localities with excellent exposure of intrusive elements were then chosen for more detailed outcrop studies. Intensive sampling of the sandstone intrusions was conducted in these type outcrop localities. Samples of sandstone intrusion with and without (i.e., structureless) sedimentary structures were collected for permeability and petrographic analyses; geographic, spatial, and stratigraphic data were recorded. Study areas in the northern PGIC include Moreno Gulch (MG), No Name Canyon (NoC, A2.2), Marca Canyon (Mc, A2.3), Capita Canyon (Ca, A2.4), Rossetta Canyon (Ro, A2.5), Dosados Canyon (Do, A2.6), and Escapardo Canyon (Es, A2.7). The PGIC is composed of a transitional area that begins in Right Angle Canyon (RA). Study areas are in the transitional and southern study areas. In the transitional area, the main study areas were West Tumey (WT, A2.8) and south of WT (SofWT). The main study area in the southern PGIC was Tumey Gulch (TG, A2.9). Logged sections are through the northern, transitional, and southern PGIC. Logged sections display the sample location within the PGIC and the stratigraphic locations of the study areas. Locations of logged sections are marked in Appendix 2B and C. Mbr = Member; Fm = Formation; Sh = Shale; Cr = Creek; Sst = Sandstone.



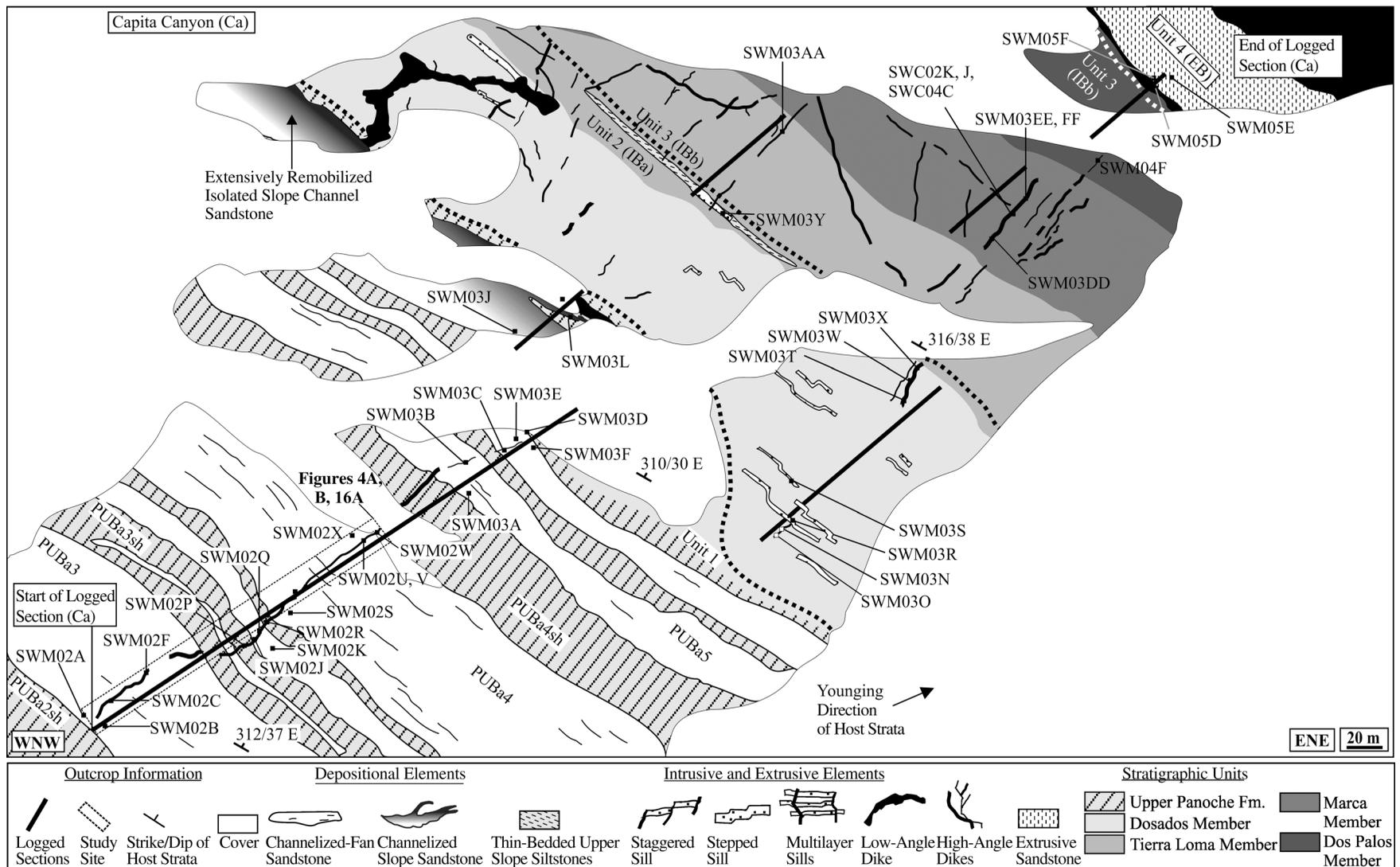
**Appendix 3.** Logged sections displaying the architecture, stratigraphy, and thickness of the Panoche giant injectite complex. The stratigraphic locations of the type outcrop localities and sandstone samples are located. MG = Moreno Gulch; NoC = No Name Canyon; Mc = Marca Canyon; Ca = Capita Canyon; Ro = Rossetta Canyon; Do = Dosados Canyon; Es = Escapardo Canyon; RA = Right Angle Canyon; WT = West Tumey; PUB = parent unit belt; IB = intrusive belt; EB = extrusive belt; Fm = Formation.



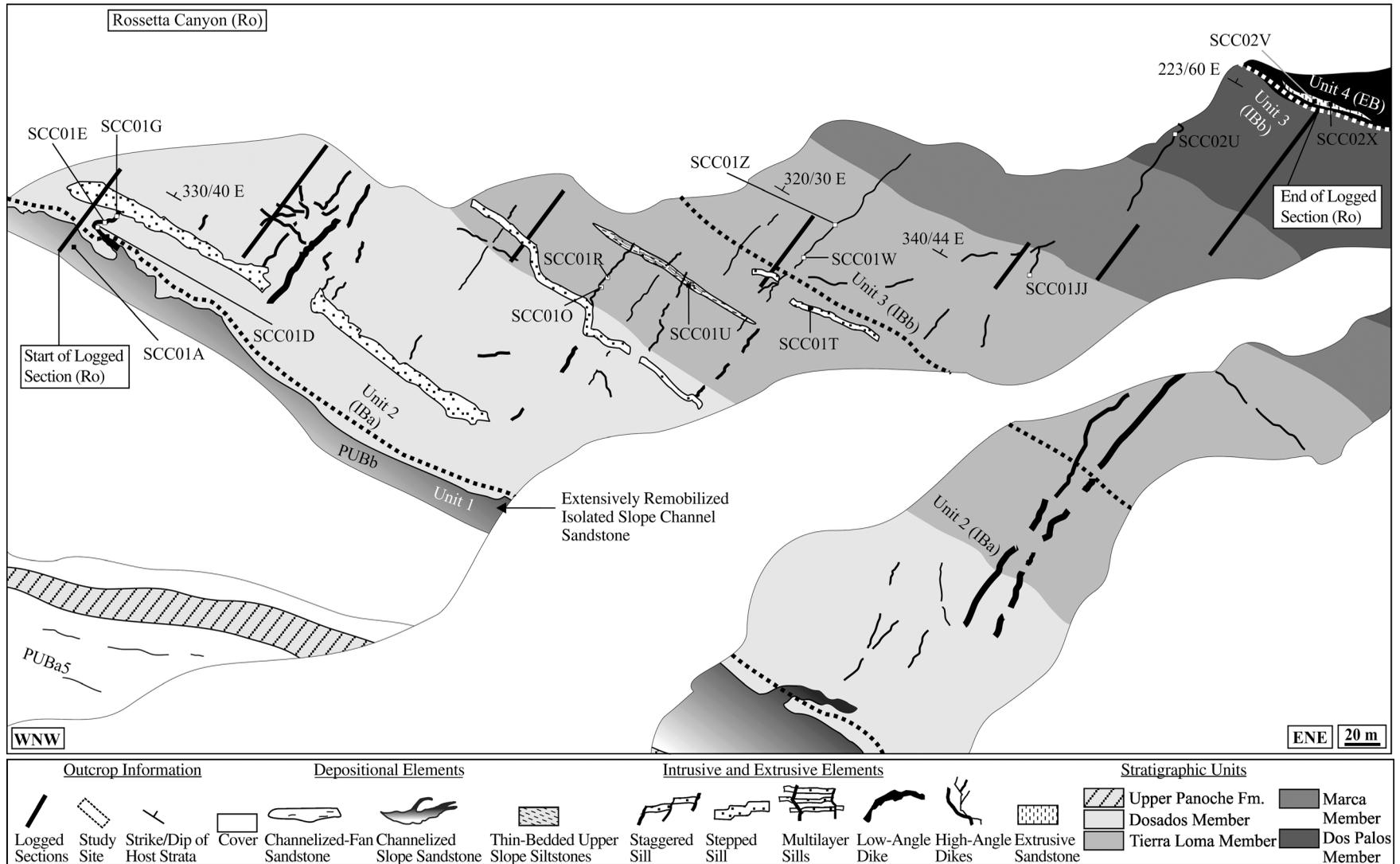
**Appendix 4.** Overview map of No Name Canyon (NoC) displaying the location of the outcrop study areas, sample locations, and transects of the logged sections. More detailed outcrop studies were conducted on the stepped sill (Figure 5C) and the high-angle dike (Figure 7A). Sampling along and across the intrusive elements allowed permeability maps of the sill (Figure 12A) and high-angle sandstone dike (Figure 16C) to be constructed. See Appendix 2 for the location of No Name Canyon within the northern Panoche giant injectite complex. The figure was traced from Google Earth. Unit 1, depositional sandstones act as parent beds that source the overlying intrusive complex (unit 2); unit 2, the intrusive network: a lower sandstone sill-dominated interval and an upper interval dominated by high-angle dikes; unit 3, the extrusive complex of sand extrudites and carbonate cold-seep communities. Contacts between units 1 and 2 and 2 and 3 are shown as red and green dashed lines, respectively. The contacts between the lower and upper intervals of unit 2 are shown as black dashed lines. PUB = parent unit belt; IB = intrusive belt; EB = extrusive belt; Fm = Formation.



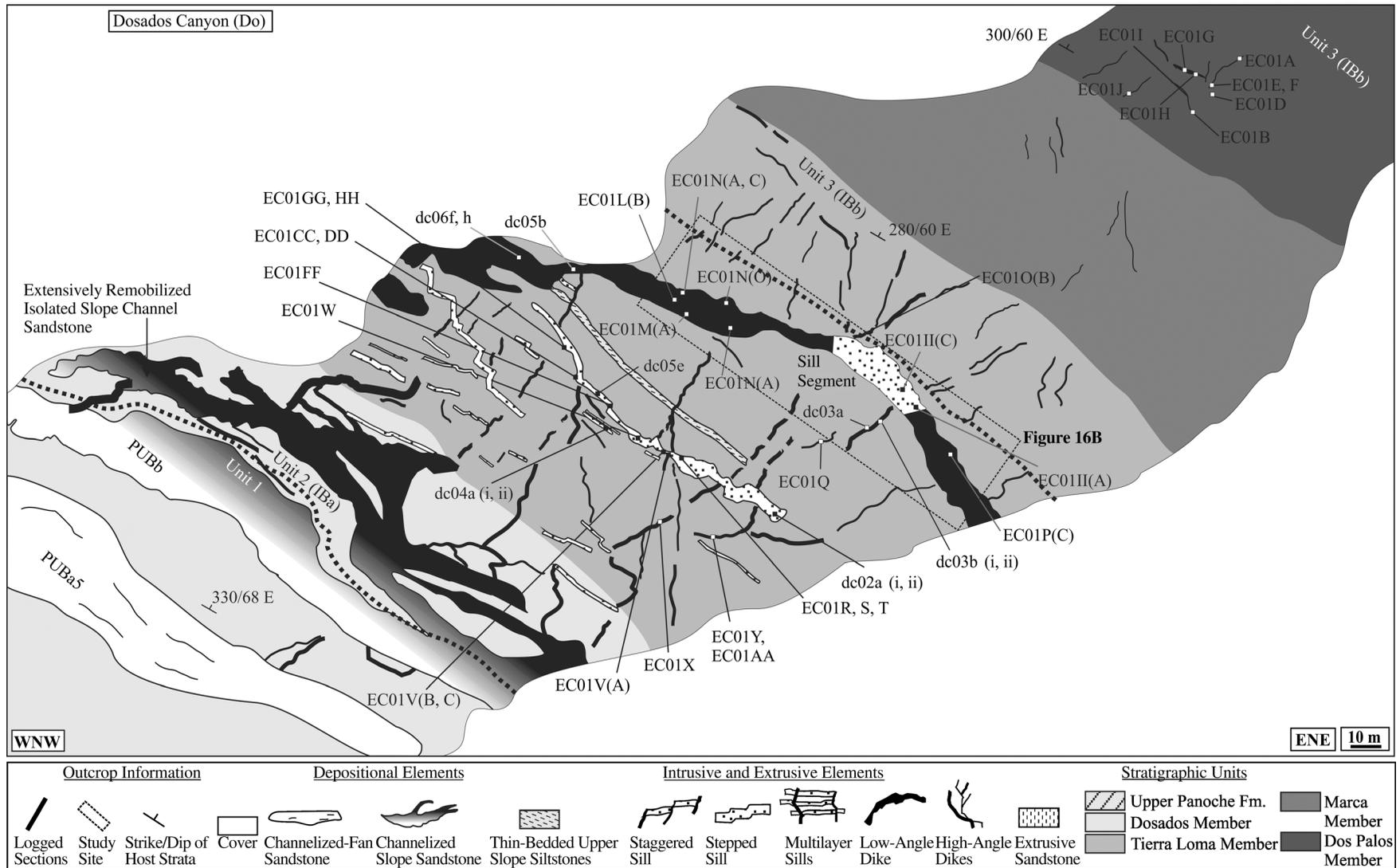
**Appendix 5.** Overview map of Marca Canyon (Mc) displaying the location of the outcrop study areas and sample locations. More detailed outcrop studies were conducted on the multilayer sandstone sills (Figure 5E). Sampling along and across the multilayer sandstone sills allowed permeability maps to be constructed (Figure 12C). See Appendix 2 for the location of Marca Canyon within the northern Panoche giant injectite complex. The figure was traced from Google Earth. PUB = parent unit belt; IB = intrusive belt; EB = extrusive belt; Fm = Formation.



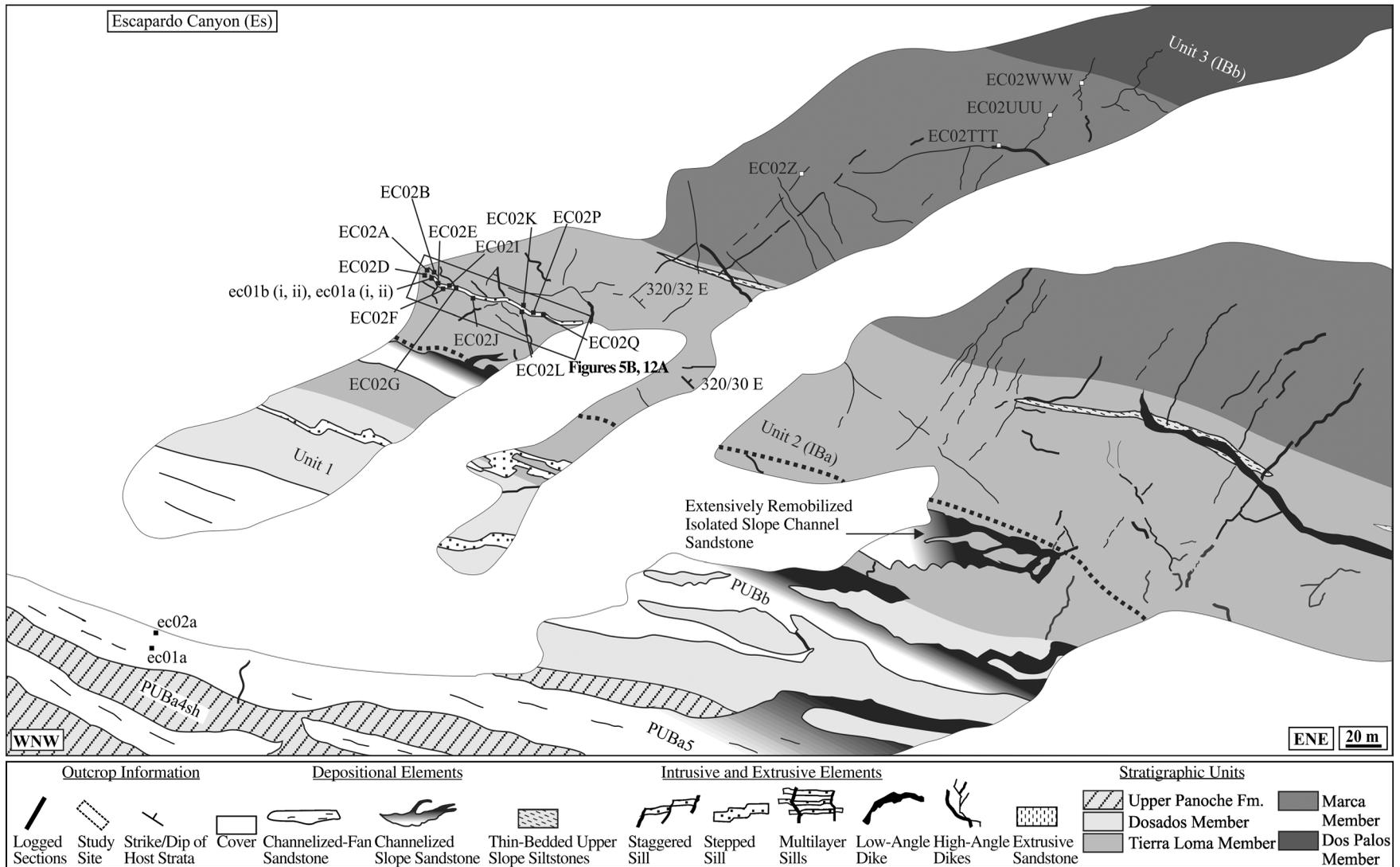
**Appendix 6.** Overview map of Capita Canyon (Ca) displaying the location of the outcrop study areas, sample locations, and transects of the logged sections. More detailed outcrop studies were conducted on the high-angle dike (Figure 4A). Sampling along the high-angle sandstone dike allowed a permeability map to be constructed (Figure 16A). See Appendix 2 for the location of Capita Canyon within the northern Panoche giant injectite complex. The figure was traced from Google Earth. PUB = parent unit belt; IB = intrusive belt; EB = extrusive belt; Fm = Formation.



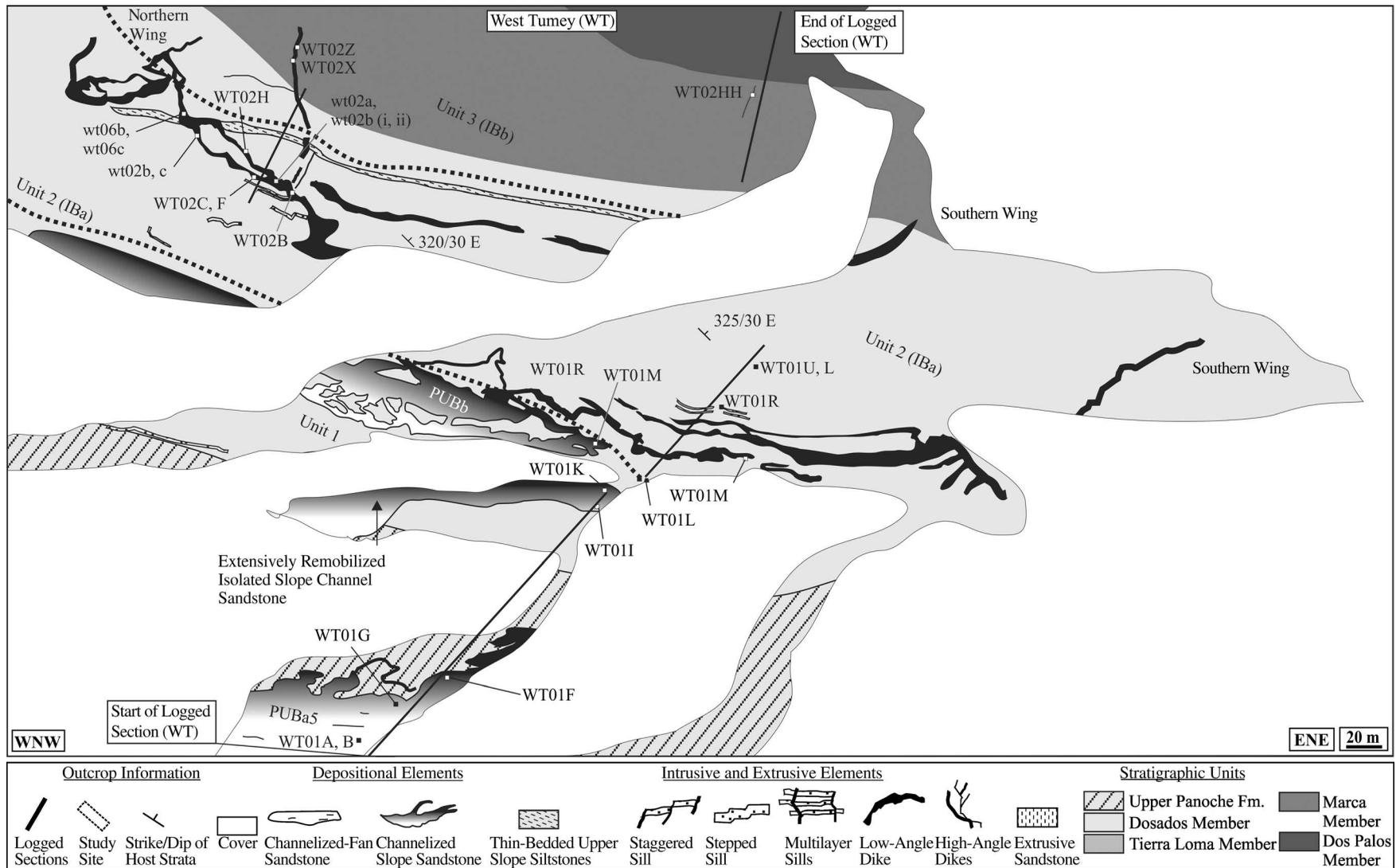
**Appendix 7.** Overview map of the informally named Rossetta Canyon (Ro) displaying the location of the outcrop study areas, sample locations, and transects of the logged sections. See Appendix 2 for the location of Rossetta Canyon within the northern Panoche giant injectite complex. The figure was traced from Google Earth. PUB = parent unit belt; IB = intrusive belt; EB = extrusive belt; Fm = Formation.



**Appendix 8.** Overview map of Dosados Canyon (Do) displaying the location of the outcrop study areas and sample locations. A detailed outcrop study was conducted on the low-angle sandstone dike (Figure 16B). Sampling along and across the low-angle sandstone dike allowed a permeability map to be constructed. See Appendix 2 for the location of Dosados Canyon within the northern Panoche giant injectite complex. The figure was traced from Google Earth. PUB = parent unit belt; IB = intrusive belt; Fm = Formation.



**Appendix 9.** Overview map of Escapardo Canyon (Es) displaying the location of the outcrop study areas and sample locations. A detailed outcrop study was conducted on the stepped sill (Figure 5B). Sampling along and across the stepped sandstone sill allowed a permeability map to be constructed (Figure 12A). See Appendix 2 for the location of Escapardo Canyon within the northern Panoche giant injectite complex. The figure was traced from Google Earth. PUB = parent unit belt; IB = intrusive belt; Fm = Formation.



**Appendix 10.** Overview map of West Tumey (WT) displaying the location of the outcrop study areas, sample locations, and transects of the logged sections. Sampling was conducted from the parent sandstone bodies through the sand-injectite complex to the sandstone extrudites. See Appendix 2 for the location of West Tumey within the transitional Panoche giant injectite complex. The figure was traced from Google Earth. PUB = parent unit belt; IB = intrusive belt; Fm = Formation.

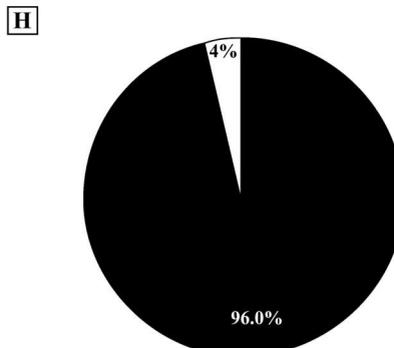
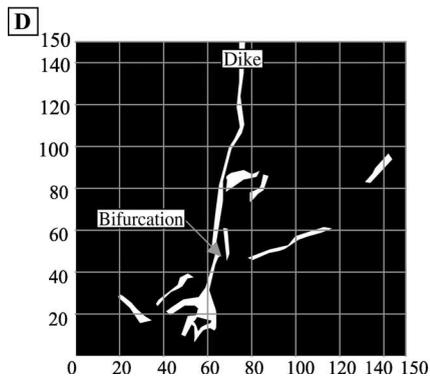
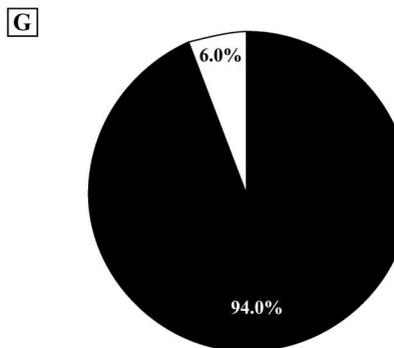
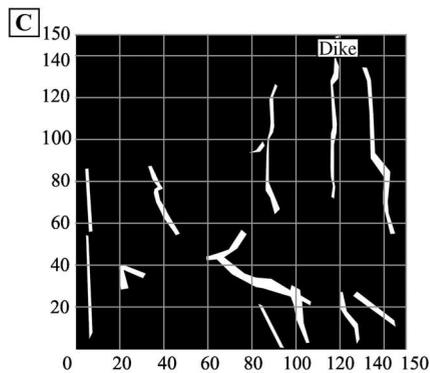
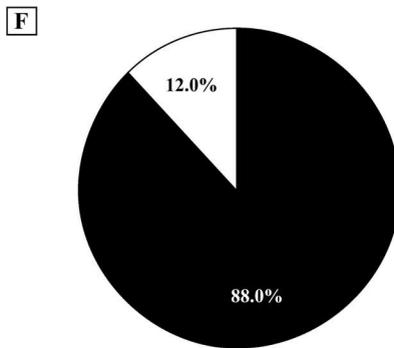
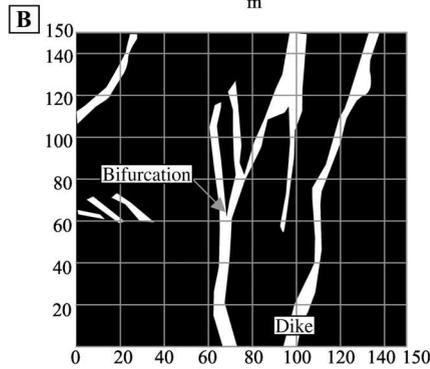
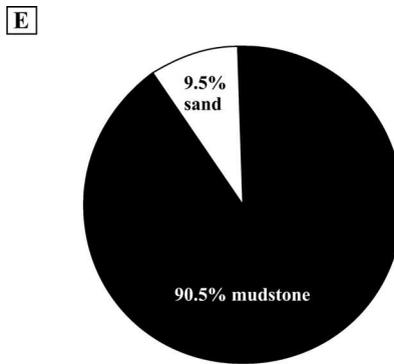
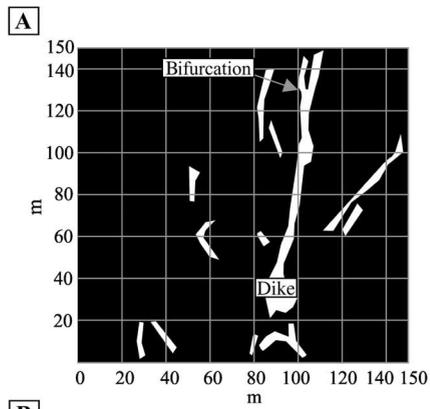
**Appendix 11.** Net-to-Gross Ratios and Proportion of Unremobilized Depositional Units, Remobilized Parent Sandstone Units, Sandstone Sills, Low-Angle Dikes, Sandstone Extrudites, and Host-Rock Mudstones in Units 1 to 4 in the Northern and Transitional Panoche Giant Injectite Complex\*

Reservoir Unit Characteristics**				Proportion of Depositional, Remobilized, and Injected Elements†					
Unit	Location	Thickness (m)	N/G ratios	Undep	RePU	Ss	LAD	Ex	Md
1	MG	>80	23,4	0,9	22,5	0,0	0,0	0,0	76,6
	NoC	>187	25,2	0,0	13,3	0,0	11,9	0,0	74,8
	Ca	>349	89,2	0,0	86,8	0,0	2,3	0,0	10,8
	Ro	>7	100	0,0	100	0,0	0,0	0,0	0
	RA	>137	57,6	0,3	43,6	0,0	13,7	0,0	42,4
	WT	>100	NA	NA	NA	NA	NA	NA	NA
2	MG	290	19,1	0,0	0,0	18,5	0,3	0,0	81,1
	NoC	283	25,5	4,7	0,0	9,7	11,0	0,0	74,5
	Ca	138	3,9	0,0	0,0	3,9	0	0,0	96,1
	Ro	121	13,2	0,7	0,0	8,6	4,5	0,0	86,2
	RA	109	29,6	0,0	0,0	30,2	0	0,0	69,8
	WT	131	23,4	0,1	0	6,7	16,5	0	76,6
3	MG	328	5,4	0,3	0,0	0,0	0,0	0,0	99,7
	NoC	311	0,03	0,03	0,0	0,0	0,0	0,0	99,9
	Ca	332	4,05	3,9	0,0	0,0	1,0	0,0	95,9
	Ro	353	0,27	0,3	0,0	0,0	1,1	0,0	99,7
	RA	441	0,2	0,0	0,0	0,0	0,6	0,0	98,9
	WT	312	0	0	0	0	0	0	100
4	MG	10	100,0	0,0	0,0	0,0	0,0	100,0	0
	NoC	10	100,0	0,0	0,0	0,0	0,0	100,0	0
	Ca	17	100,0	0,0	0,0	0,0	0,0	100,0	0
	Ro	31	100,0	0,0	0,0	0,0	0,0	100,0	0
	RA	35	100,0	0,0	0,0	0,0	0,0	100,0	0
	WT		100,0	0,0	0,0	0,0	0,0	100,0	0

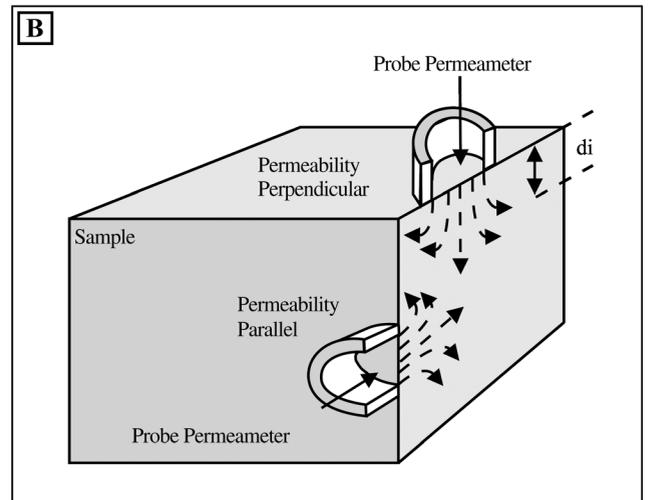
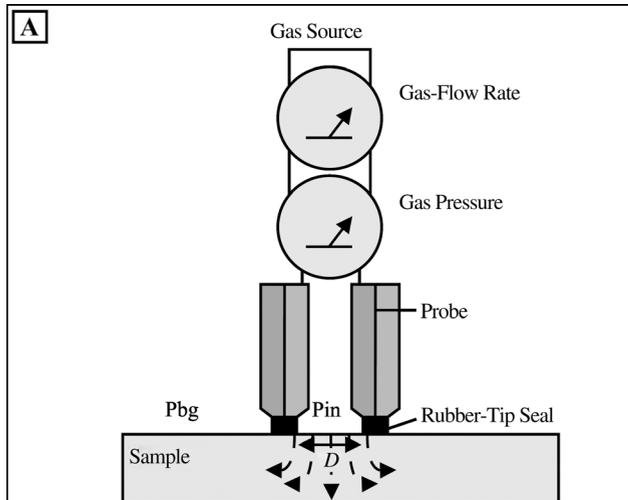
\*Note that logged sections captured unremobilized depositional and remobilized units, low-angle dikes, and sills. High-angle dikes are not included in these values because of difficulties in capturing them with conventional logging techniques. Unit 1 thicknesses are minimum values because logged sections did not transect the entire unit.

\*\*MG = Moreno Gulch; NoC = No Name Canyon; Ca = Capita Canyon; Ro = Rosseta Canyon; RA = Right Angle Canyon; WT = West Tumey; N/G = net to gross; NA = not applicable.

†Undep = unremobilized depositional units; RePU = remobilized parent sandstone units; Ss = sandstone sills; LAD = low-angle dikes; Ex = sandstone extrudites; Md = host-rock mudstones.



**Appendix 12.** Scanned images (A, B, C, D) of mudstone intervals dominated by high-angle sandstone dikes in units 2 and 3. Scanned images are composed of mudstone (black) and sandstone (white). From these images, net-to-gross (N/G) values (E, F, G, H) were calculated using the image analysis software SigmaScan<sup>®</sup> Pro 5.0 (trademark of Systat Software). Each scan image is 150 m (492 ft) thick by 150 m (492 ft) wide to ensure comparable N/G values. A scanned image of high-angle sandstone dikes in the Tierra Loma Shale Member (unit 2) in Moreno Gulch (A) has a calculated N/G ratio of 9.5% sand (E). High-angle dikes in the Marca Shale Member (unit 3) in Moreno Gulch (B) have a calculated N/G ratio of 12.0% (F). High-angle dikes in the Tierra Loma Shale Member (unit 2) in Rossetta Canyon (C) have an N/G ratio of 6.0% (G). High-angle dikes in the Marca Shale Member (unit 3) in Rossetta Canyon (D) have a calculated N/G ratio of 4.0% (H).



**Appendix 13.** Procedure for probe-permeametry analysis. (A) Schematic representation of the probe permeameter.  $D$  = internal diameter of probe tip. Permeability is estimated at steady-state conditions by measuring the gas-flow rate and the gas-pressure drop between the injection ( $P_{in}$ ) and background pressures ( $P_{bg}$ ). The figure was compiled and modified from Hurst and Goggin (1995). (B) Experimental setup for measuring the permeability perpendicular and parallel to the sample. Depth of gas injection from the tip of the probe permeameter into the rock ( $d_i$ ).

**Appendix 14.** Location, Element, Internal Sedimentary Structures, Mineralogy, Petrographic Description, and Permeability (md) of Samples from the Panoche Giant Injectite Complex

Outcrop Characteristics of Samples*						Petrographic Characteristics of Samples**												Permeability Characteristics of Samples†					
Sample	Location	Member	Unit	Element	Internal Structure	Q	L	F	Pl	Mi	G	CC	QC	Mm	Md	Ø	Grain Size (mm)	Petrographic Description	$k_{h1}$	$k_{h2}$	$k_{v1}$	$k_{v2}$	$k_a$
MC06G	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	26.5	9.5	30.5	5	0	2	7.5	0	0	5	13	0.186	s-s to m-s-s, Tgp to Mgp, Pgs to Mgs, G-S-M	-	-	-	-	-
mc05c	Marca Canyon	Tierra Loma Member	2	MLS	Clay laminae	30.5	4.5	18.5	4.5	0.5	1.5	0	0	7	26	8	0.263	s-s to v-f-s-s, Md and Mm, Tgp, and Pgs	-	-	-	-	-
mc05b	Marca Canyon	Tierra Loma Member	2	MLS	Laminae	18	7	13	7.5	8.5	7.5	1	3	0	16.5	3.5	0.137	s-s to v-f-s-s, Md, Tgp, and Pgs	5	5	9	7	7
MC07B	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	30	15	19.5	13	0	1	0	0	5	13	3.5	0.149	s-s to f-s-s, Md, Tgp, and Mgs	34	36	75	85	58
MC07C	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	22.5	20	21	11	0	0.5	0	0	6	9.5	9.5	0.170	s-s to f-s-s, Tgp, Mgs, and HGA	135	137	96	100	117
MC07E	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	24	15	21	8	8	1.5	0	0	9.5	15.5	5.5	0.153	s-s to m-s-s, Md and Mm, Tgp, and Pgs	12	11	10	9	11
MC07I	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	23.5	5.5	22	14.5	0.5	0	0	0	17.5	14.5	2	0.157	s-s to m-s-s, Md and Mm, Tgp, Pgs, and HGA	7	7	22	21	14
MC06B	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	27.5	9	23.5	7.5	0	1	0	0	16	7.5	7	0.157	s-s to v-f-s-s, Tgp, and Pgs	187	186	202	209	196
MC06D	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	31.5	12	26.5	7.5	0	2	0	0	7.5	10	2.5	0.163	s-s to v-f-s-s, Tgp, and Pgs	14	14	13	13	14
MC06F	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	43	6.5	25.5	11	5	1	4.5	0	0	3	0.5	0.165	f-s-s to m-s-s, Pgs, HGA	36	36	22	27	30
T01L	Tumey Gulch	Dosados Member	2	MLS	Structureless	31.5	12	30	4.5	0	0	0	0	17	4	1	0.202	s-s to v-f-s-s, Md, Mm, Tgp, and Pgs	14	14	-	-	14
SCC01U	South Capita	Tierra Loma Member	2	MLS	Structureless	22	5.5	29	10	Mi	2	0	0	8.5	14.5	7.5	0.152	s-s to f-s-s, Md, Tgp, and Pgs	145	144	-	-	145
WT01R	West Tumey	Dosados Member	2	MLS	Stratified	28	11	20	8	0	0.5	0	0	14.5	17.5	0.5	0.158	s-s to v-f-s-s, Md and Mm, Tgp, Pgs, G-S-M, and HGA	10	10	6	5	8
MC07P	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	95	95	111	106	102
MC07D	Marca Canyon	Tierra Loma Member	2	MLS	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44	54	48





EC02Q	Escapardo Canyon	Tierra Loma Member	2	SS	Structureless	21	7	24	5	2	0.5	0	0	2	13	25.5	0.151	s-s to m-s-s, Md, Mgp, and Mgs, and HGA	1669	1641	1021	996	1331
dc02a (ii)	Dosados Canyon	Tierra Loma Member	2	SS	Laminae	39.5	15	15	8	1	1	0	0	19	5.5	4	0.267	s-s to c-s-s, Mm, Tgp to Mgp, and Pgs	153	133	754	791	458
SCC01T	Rossetta Canyon	Tierra Loma Member	2	SS	Structureless	29	5.5	26.5	7.5	0	0	0	0	1	3	24.5	0.200	v-f-s-s to c-s-s, Mgp to Mgp, Mgs, and HGA	401	402	422	427	413
ec01a (i)	Escapardo Canyon	Tierra Loma Member	2	SS	Laminae	30	6.5	20.5	2	0.5	0.5	0	0	0	9	31	0.249	s-s to m-s-s, Md, Lgp to Ggs, G-S-M, and HGA	3315	3315	2780	2780	3048
ec01a (ii)	Escapardo Canyon	Tierra Loma Member	2	SS	Laminae	25.5	5	18	5.5	5.5	0.5	0	0	0	15	25	0.350	s-s to m-s-s, Md, Lgp, Ggs, G-S-M, and HGA	1409	1409	2313	2313	1861
ec01b (i)	Escapardo Canyon	Tierra Loma Member	2	SS	Laminae	24.5	7.5	14	6.5	7	0	0	0	0	10	30.5	0.296	s-s to m-s-s, Md, Lgp, Ggs, G-S-M, and HGA	3236	3236	2335	2335	2786
ec01b (ii)	Escapardo Canyon	Tierra Loma Member	2	SS	Laminae	33	9	16	5.5	0	1	1	0	0	15.5	19	0.331	s-s to m-s-s, Md, Lgp, Ggs, G-S-M, and HGA	283	283	237	237	260
EC02F	Escapardo Canyon	Tierra Loma Member	2	SS	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	432	432	-	-	432
TG01H	Tumey Gulch	Upper Panoche Formation	1	SS	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	13	15	155	162	86
TG01H (I)	Tumey Gulch	Upper Panoche Formation	1	SS	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	16	15	17	18	17
EC02J	Escapardo Canyon	Tierra Loma Member	2	SS	Structureless	31	5.5	20.5	7	3	0	0	0	0	10	28	0.205	f-s-s to c-s-s, Md, Lgp, and Pgs	2038	2064	2234	2195	2133
EC02K	Escapardo Canyon	Tierra Loma Member	2	SS	Mud clast breccias	27	4	32.5	9.5	0.5	0	0	0	0.5	8	18	0.213	s-s to m-s-s, Md, Mgp, Mgs, and HGA	253	252	316	326	287
SB01G	Southwest Tumey	Tierra Loma Member	2	SS	Structureless	24	5.5	22	7.5	2	0.5	0	0	1.5	27.5	9.5	0.193	s-s to c-s-s, Md, Mgp, and Mgs	-	-	-	-	-
MC08H	No Name Canyon	Tierra Loma Member	2	SS	Structureless	26	1.5	16	13.5	2.5	1	0	0	2	7.5	30	0.182	s-s to f-s-s, Md, Lgp, Ggs, and HGA	1475	1475	2079	2092	1780
mc05a (i)	No Name Canyon	Tierra Loma Member	2	SS	Parallel laminae	30	10.5	15.5	5	3	1	0	15.5	0	16.5	3	0.177	s-s to m-s-s, Md, Tgp, and Pgs	48	48	24	24	36



SB01L	Southwest Tume	Tierra Loma Member	2	LAD	Structureless	23	3	34.5	12.5	3.5	1	0	0	3.5	12.5	6.5	0.086	s-s, Md, Tgp, and Mgs	114	117	-	-	116
SB01B	Southwest Tume	Tierra Loma Member	2	LAD	Structureless	25.5	13	27	6	1	0.5	0	0	1	7	18.5	0.192	v-f-s-s to m-s-s, Md, Mgp, and Pgs	-	-	224	225	225
SCC01E	Rossetta Canyon	Dosados Member	2	LAD	Structureless	24	12	26	9	1	0	0	0	10.5	6.5	11	0.195	v-f-s-s to m-s-s, Md, Mgp, Mgs, and SHA to SVA	164	155	143	134	149
SWM03D	Capita Canyon	Upper Panoche Formation	1	LAD	Structureless	27.5	6.5	17.5	11.5	1	0.5	29.5	0	0	2	3	0.124	s-s to f-s-s, Mgp, and Pgs	72	75	56	60	66
SWM03L	Capita Canyon	Dosados Member	1	LAD	Structureless	21.5	4	19.5	5	0	0	0	8.5	9.5	9	22	0.162	s-s to m-s-s, Md, Mgp to Lgp, and Pgs	-	-	1179	1114	1147
WT01I	West Tume	Dosados Member	1	LAD	Mud clast breccias	25.5	4	27	9.5	0	0	0	0	2.5	12	17.5	0.173	s-s to f-s-s, Md, Mgp, Mgs, and SHA	304	314	301	292	303
WT01K	West Tume	Dosados Member	1	LAD	Margin laminae	34	8.5	21.5	4.5	0.5	1	0	0	22	5	3	0.162	s-s to m-s-s, Mm, Tgp, and Pgs	7	6	2	2	4
WT01M	West Tume	Dosados Member	2	LAD	Margin laminae	23.5	9.5	27.5	6	1	1	0	0	29	12	5	0.173	s-s to m-s-s, Mm, Md, Tgp, and Mgs	64	66	45	47	56
WT02C	West Tume	Tierra Loma Member	2	LAD	Structureless	27.5	4.5	30.5	16.5	1	0	0	0	0	2.5	17.5	0.159	s-s to m-s-s, Mm, Md, Mgp, Mgs, G-S-M, and SHA	311	324	274	275	296
WT02F	West Tume	Tierra Loma Member	2	LAD	Mud clast breccias	28.5	3	25.5	10	0	0.5	17.5	0	0	14.5	0.5	0.156	s-s to c-s-s, Md, Mgp, and Pgs	2	2	5	5	4
wt06b	West Tume	Marca Member	2	LAD	Pipes	35.5	7.5	22	8.5	0.5	0	0	0	4	15	7	0.246	v-f-s-s to f-s-s, Md, Tgp, Ggs, and SHA	11	11	15	15	13
wt06c	West Tume	Marca Member	2	LAD	Pipe	33.5	5.5	25.5	5	0	0	0	3	0	10.5	17	0.305	v-f-s-s to f-s-s, Md, Tgp, Ggs, and SHA	129	129	117	117	123
dc05b	Dosados Canyon	Tierra Loma Member	2	LAD	Pipes	29	9	18	5.5	3	1.5	0	0.5	0	12.5	18	0.137	f-s-s to m-s-s, Tgp, and Pgs	246	246	193	193	220
EC010(A)	Dosados Canyon	Tierra Loma Member	3	LAD	Margin laminae	36.5	3.5	26.5	9	0	0	0	0	13	9	2.5	0.157	s-s to m-s-s, Tgp, Mgs, and HGA	12	13	70	69	41
EC010(C)	Dosados Canyon	Tierra Loma Member	3	LAD	Margin laminae	34	4	25.5	14.5	1.5	0.5	7	0	0	7	6	0.151	s-s to m-s-s, Md, Tgp, Pgs, and HGA	22	22	24	24	23
EC010(B)	Dosados Canyon	Tierra Loma Member	3	LAD	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	s-s to m-s-s, Md, Mgp, and Pgs	6198	6429	6253	6340	6305



MCP01A	Marca Canyon	Upper Panoche Formation	3	HAD	Horizontal banding	29.5	3	28.5	4.5	0	0	30.5	0	2.5	1.5	0	0.242	s-s to c-s-s, Md, Tgp to Mgp, and Mgs	-	-	-	-	-
MCTL03A	No Name Canyon	Dosados Member	3	HAD	Margin laminae	19	11.5	26	14.5	0.5	0	0	0	13.5	9	4.5	0.162	s-s to m-s-s, Mm, Tgp to Tgp, and Pgs	-	-	-	31	31
MC04B	No Name Canyon	Tierra Loma Member	3	HAD	Horizontal banding	32	5.5	28.5	13	6	1	0	0	4	5	5	0.163	v-f-s-s, Tgp to Mgp, Pgs, and SVA	26	25	45	43	34
MC04E	No Name Canyon	Marca Member	3	HAD	Horizontal banding	25.5	4.5	23	15	2.5	1.5	0	0	9.5	11	7.5	0.198	f-s-s to c-s-s, Tgp, and Pgs	52	51	52	52	52
MC04G	No Name Canyon	Marca Member	3	HAD	Horizontal banding	29	3.5	20.5	15.5	3	1.5	0	0	12	9.5	5.5	0.199	s-s to m-s-s, Md and Mm, Tgp to Mgp, Pgs, and VGA	55	54	41	42	48
MC04J	No Name Canyon	Marca Member	3	HAD	Horizontal banding	39.5	8	26.5	6.5	4	0	0	0	0	13	2.5	0.189	s-s to m-s-s, Md and Mm, Tgp, Pgs, and VGA	23	23	8	8	16
MC04K	No Name Canyon	Marca Member	3	HAD	Horizontal banding	32	5	20.5	11	0	0.5	0	0	16	9	2.5	0.173	s-s to m-s-s, Md and Mm, Tgp, Pgs to Mgs, and SVGA	13	12	39	37	25
MC04M	No Name Canyon	Marca Member	3	HAD	Horizontal banding	38	5	19.5	9.5	1	0.5	0	0	7	6.5	13	0.154	s-s to m-s-s, Tgp, and Pgs to Mgs	146	147	113	114	130
MC04Q	No Name Canyon	Marca Member	3	HAD	Horizontal banding	33	6	19.5	10	0	0.5	0	0	0	11	19.5	0.174	s-s to m-s-s, Mgp, and Pgs to Mgs	-	-	-	-	-
MC04W	No Name Canyon	Marca Member	3	HAD	Horizontal banding	23.5	1	23	7	1	0.5	0	0	25	15	4	0.141	s-s to m-s-s, Tgp to Mgp, Pgs, and VGA	47	45	-	-	46
SCC01D	Rossetta Canyon	Dosados Member	2	HAD	Mud clast breccias	33	16	22	8.5	0	0.5	0	0	2	7.5	8.5	0.183	s-s to m-s-s, Md, Tgp, Pgs, and VGA	-	-	-	-	-
SCC01G	Rossetta Canyon	Dosados Member	2	HAD	Mud clast breccias	37.5	7.5	27	14	3.5	0	0	0	5	4	1.5	0.173	s-s to m-s-s, Md, Tgp, and Pgs	13	12	8	7	10
SCC01R	Rossetta Canyon	Tierra Loma Member	2	HAD	Deformed laminae	34	5	19	9.5	9.5	1	0	0	2	14.5	5.5	0.154	s-s to c-s-s, Tgp, Pgs, and VGA	56	54	86	80	69
SCC01W	Rossetta Canyon	Tierra Loma Member	3	HAD	Structureless	35.5	2.5	26	9.5	3.5	0	0	0	11	2.5	9.5	0.180	s-s to c-s-s, Md, Tgp, and Pgs	70	71	-	-	70
SCC01Z	Rossetta Canyon	Tierra Loma Member	3	HAD	Mud clast breccias	35	7	27.5	6.5	2.5	0	0	0	2.5	15.5	3.5	0.194	s-s to f-s-s, Md, Tgp, and Mgs	79	77	-	-	78
SCC02U	Rossetta Canyon	Dos Palos Member	3	HAD	Structureless	22.5	2.5	13.5	5.5	4	0.5	0	4	8.5	26	13	0.233	s-s to c-s-s, Md, Mgp, and Mgs	153	151	-	-	152

SWM03O	Capita Canyon	Dosados Member	2	HAD	Structureless	30	15	23.5	11.5	1.5	0	0	0	0	5	13.5	0.187	s-s to c-s-s, Md, Mgp, Pgs, and VGA	350	345	239	250	296
SWM02F	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	24.5	8.5	21.5	9.5	6.5	1.5	8	12	0	7	0.5	0.138	s-s to m-s-s, Md, Mgp, Mgs, and VGA	6	6	11	10	8
SWM02Q	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	27.5	13.5	21.5	10	2	0	16	0	0	6	3.5	0.174	s-s to m-s-s, Md, Tgp, and Pgs	138	141	107	105	122
SWM02R	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	31.5	11	23	7.5	3	0.5	9	0	2	12	0.5	0.153	s-s, Mm, Tgp, Pgs, and VGA	1	4	8	8	5
SWM02U	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	28	6	27	5	0	0	6.5	0	0	27	0.5	0.149	s-s to f-s-s, Md, Mgp, Pgs, and VGA	3	4	7	8	6
SWM02V	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	30	12.5	21	7.5	0	0	18	0	0	9	1	0.220	s-s to m-s-s, Md, Mgp, and Pgs	7	8	1	1	4
SWM02W	Capita Canyon	Upper Panoche Formation	1	HAD	Deformed laminae	27.5	8	26	7.5	1.5	0	13.5	0	0	12	4	0.152	s-s to m-s-s, Md, Mgp, and Pgs	23	25	7	7	16
mce03c	Marca Canyon	Dos Palos Member	3	HAD	Margin laminae	58	10	33	11	0	0	0	0	58	30	2	0.329	f-s-s to m-s-s, Md and Mm, Mgp, and Pgs	22	26	13	13	19
SWM03AA	Capita Canyon	Tierra Loma Member	3	HAD	Mud clast breccias	26.5	18	23	7	2	0.5	5.5	0	0	14.5	3	0.156	s-s to m-s-s, Md, Mgp, and Pgs	1	2	1	1	1
SWM03DD	Capita Canyon	Marca Member	3	HAD	Margin laminae	31.5	3.5	34	5.5	2	1	0	0	6	5	10	0.155	s-s to m-s-s, Md, Tgp, and Pgs	76	76	-	-	76
WT02X	West Tumey	Marca Member	3	HAD	Mud clast breccias	44	4	18	4.5	0	0	0	0	9.5	17	3	0.141	s-s to m-s-s, Md and Mm, Tgp, and Pg	30	33	1	1	16
dc03a	Dosados Canyon	Tierra Loma Member	3	HAD	Horizontal banding	25	10	15	4.5	2.5	0	0.5	4.5	19.5	12.5	6	0.246	s-s to m-s-s, Md and Mm, Tgp, and Mgs	91	91	88	88	90
dc03b (i)	Dosados Canyon	Tierra Loma Member	3	HAD	Margin laminae	34	7	22	6.5	1.5	0	0	0	13.5	7.5	8	0.319	s-s to m-s-s, Mm, Tgp, and Pgs	112	112	71	71	91
dc03b (ii)	Dosados Canyon	Tierra Loma Member	3	HAD	Vertical laminae	36.5	14.5	22	15.5	0.5	0	0	0	0	6.5	4.5	0.328	s-s to c-s-s, Md and Mm, Tgp, and Pgs	112	112	71	71	91
mc04a	Marca Canyon	Upper Panoche Formation	1	HAD	Vertical laminae	28	11	16.5	9	0.5	0.5	24	0	0	10	0.5	0.348	s-s to c-s-s, Md and Mm, Mgp, and Pgs to Mgs	1	1	6	6	3
mc04d	Marca Canyon	Upper Panoche Formation	1	HAD	Vertical laminae	31	6	24	6	5.5	0	26	0.5	0	0.5	0.5	0.296	f-s-s to m-s-s, Md and Mm, Tgp, and Pgs	3	3	2	3	2.75
mc07a	Marca Canyon	Upper Panoche Formation	2	HAD	Margin laminae	38	11.5	22.5	5.5	0.5	3	0	7	0	5.5	6.5	0.245	s-s to f-s-s, Tgp, Pgs to Mgs, and SVGA	10	11	-	-	10.5

mce03d	Marca Canyon	Dos Palos Member	3	HAD	Mud clast breccias	24.5	6	14.5	2	1.5	0	0	0	0	48.5	4	0.192	s-s to m-s-s, Md, Tgp, and Pgs	9	12	9	7	9
TH03B	Southwest Tumey	Dos Palos Member	3	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	-	-	77	80	-	-	78
ABS01B	Tumey Gulch	Tierra Loma Member	2	HAD	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	-	-	4
T401I	Tumey Gulch	Tierra Loma Member	2	HAD	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4	4	4	4
SB01H	Southwest Tumey	Tierra Loma Member	3	HAD	Banded	-	-	-	-	-	-	-	-	-	-	-	-	-	69	69	133	133	101
GCP01K	Tumey Gulch	Tierra Loma Member	2	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1
GCP01N	Tumey Gulch	Tierra Loma Member	2	HAD	Host mudstone rich breccias	-	-	-	-	-	-	-	-	-	-	-	-	s-s to m-s-s, Md, Tgp, and Pgs	35	32	-	-	34
GCP01P	Tumey Gulch	Tierra Loma Member	2	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	-	s-s to m-s-s, Md, Mgp, and Pgs	3	3	13	13	8
SWC02K	Capita Canyon	Marca Member	3	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	-	-	42	43	26	26	34
SWC02J	Capita Canyon	Marca Member	3	HAD	Pipes	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	-	-	3
SWC04C	Capita Canyon	Marca Member	3	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	-	-	14	14	-	-	14
SCC01O	Rossetta Canyon	Tierra Loma Member	2	HAD	Pipes	-	-	-	-	-	-	-	-	-	-	-	-	-	9	8	57	57	33
SCC01J	Rossetta Canyon	Tierra Loma Member	3	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9	14	13	11
EC02Z	Escapardo Canyon	Marca Member	3	HAD	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	46	45	109	109	77
EC02TTT	Escapardo Canyon	Marca Member	3	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	11	11	6
ECO2UUU	Escapardo Canyon	Marca Member	3	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6	2	3	4
EC02WWW	Escapardo Canyon	Marca Member	3	HAD	Structureless	-	-	-	-	-	-	-	-	-	-	-	-	-	18	17	2	2	10
TK/MK04A	No Name Canyon	Dos Palos Member	3	HAD	Banded	-	-	-	-	-	-	-	-	-	-	-	-	-	39	42	21	21	31
MC04O	No Name Canyon	Marca Member	3	HAD	Banded	-	-	-	-	-	-	-	-	-	-	-	-	s-s to c-s-s, Md, Tgp, and Pgs	54	52	57	57	55
MC04V	No Name Canyon	Dos Palos Member	3	HAD	Banded	-	-	-	-	-	-	-	-	-	-	-	-	f-s-s to c-s-s, Md, Tgp, and Pgs	126	115	50	48	85
MCP01E	Marca Canyon	Upper Panoche Formation	1	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	-	s-s to m-s-s, Md, Mgp, and Pgs	13	14	18	15	15
MCTL03K	No Name Canyon	Tierra Loma Member	3	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	-	-	20	20	19	19	20

MC04AA	No Name Canyon	Dos Palos Member	3	HAD	Banded	-	-	-	-	-	-	-	-	-	-	s-s to m-s-s, Md, Tgp, and Pgs	-	-	56	57	56
MC05B	No Name Canyon	Dos Palos Member	3	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	f-s-s, Md and Mm, Tgp, and Pgs	1	1	1	1	1
MC05F	No Name Canyon	Dos Palos Member	3	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	57	54	18	17	37
EC01B	Dosados Canyon	Dos Palos Member	3	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	s-s to f-s-s, Md and Mm, Tgp, and Pgs	91	89	60	60	75
EC01D	Dosados Canyon	Dos Palos Member	3	HAD	Structureless	-	-	-	-	-	-	-	-	-	-	s-s to f-s-s, Md, Tgp to Mgp, and Mgs	207	210	385	391	298
EC01VA	Dosados Canyon	Tierra Loma Member	2	HAD	Structureless	-	-	-	-	-	-	-	-	-	-	-	1802	1898	3370	3181	2563
EC01I	Dosados Canyon	Dos Palos Member	3	HAD	Structureless	-	-	-	-	-	-	-	-	-	-	-	41	40	-	-	40
EC01J	Dosados Canyon	Dos Palos Member	3	HAD	Structureless	-	-	-	-	-	-	-	-	-	-	-	26	25	36	32	30
WT02Z	West Tumey	Marca Member	3	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	24	25	-	-	25
WT02HH	West Tumey	Marca Member	3	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	5	5	15	16	10
SWM02C	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	-	-	-	-	-	-	-	-	-	-	-	8	8	1	1	5
SWM02J	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	-	-	-	-	-	-	-	-	-	-	s-s to m-s-s, Md, Mgp, and Pgs	1	1	-	-	1
SWM02P	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	-	-	-	-	-	-	-	-	-	-	-	61	9	6	23	25
SWM03B	Capita Canyon	Upper Panoche Formation	1	HAD	Banded	-	-	-	-	-	-	-	-	-	-	s-s to c-s-s, Md, Tgp, and Pgs	38	41	61	69	52
SWM03C	Capita Canyon	Upper Panoche Formation	1	HAD	Pipes	-	-	-	-	-	-	-	-	-	-	-	8	8	3	3	6
SWM03N	Capita Canyon	Dosados Member	2	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	7	7	11	11	9
SWM03T	Capita Canyon	Tierra Loma Member	2	HAD	Margin laminae	-	-	-	-	-	-	-	-	-	-	-	14	15	-	-	14
SWM03W	Capita Canyon	Tierra Loma Member	2	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	2	2	2	2	2
SWM03X	Capita Canyon	Tierra Loma Member	2	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	25	25	17	18	21
SWM03EE	Capita Canyon	Marca Member	3	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	-	-	73	72	72
SWM03FF	Capita Canyon	Marca Member	3	HAD	Mud clast breccias	-	-	-	-	-	-	-	-	-	-	-	32	32	53	54	43



SWM03E	Capita Canyon	Upper Panoche Formation	1	PB	Stratified	33.5	16	19	6	2	0	0	0	23	0	0.5	0.165	s-s to m-s-s, Mm, Mgp to Lgp, and Pgs	-	-	-	1	1
SWM03F	Capita Canyon	Upper Panoche Formation	1	PB	Stratified	23.5	8.5	28	8	0	2	27.5	0	0	2.5	0.5	0.177	f-s-s to m-s-s, Mm, Mgp to Lgp, Mgs, and HGA	4	4	-	-	4
mc06a(i)	No Name Canyon	Dos Palos Member	2	Thin-bedded slope siltstones	Laminae	33	8.5	25	3	1	2.5	0	0	7.5	15.5	4	0.160	f-s-s to m-s-s, Mm, Tgp, Mgs, and HGA	7	8	1	1	4
mc06b	No Name Canyon	Dos Palos Member	2	Thin-bedded slope siltstones	Laminae	30	7.5	15	3.5	0.5	3	0	0	27	9	4.5	0.262	f-s-s to m-s-s, Mm, Tgp, and Pgs	12	13	12	15	13
MC08A	Marca Canyon	Upper Panoche Formation	1	PB	Stratified	43	4	45	8	6	1	30	0	0	3	4	0.166	f-s-s to m-s-s, Mm, Lgp, and Pgs	173	167	46	66	113
MC08B	Marca Canyon	Upper Panoche Formation	1	PB	Stratified	29	8	22.5	11.5	1	0.5	23.5	0	0	0	1.5	0.184	f-s-s to m-s-s, Mm, Mgp, and Pgs	60	60	161	161	111
mc01a	Marca Canyon	Upper Panoche Formation	1	PB	Parallel laminae	34	13.5	25.5	5	1.5	1.5	14.5	0	0	4	1	0.269	f-s-s to m-s-s, Mm, Mgp to Lgp, Mgs to Ggs, and HGA	18	18	15	15	17
mc01b	Marca Canyon	Upper Panoche Formation	1	PB	Deformed laminae	35.5	19	23	7	1	0.5	13.5	0	0	0.5	0.5	0.302	f-s-s to m-s-s, Mm, Mgp to Lgp, and Mgs	1	1	5	5	3
WT01A	West Tumey	Upper Panoche Formation	1	PB	Stratified	21	11.5	17	6.5	0	0.5	35.5	0	0	1	0.5	0.170	s-s to c-s-s, Lgp, and Pgs	3	3	3	3	3
WT01B	West Tumey	Upper Panoche Formation	1	PB	Parallel laminae	18.5	4.5	10	3	0	0	0	0.5	62.5	0.5	0.5	0.095	s-s, Mm, Tgp, and Pgs	3	3	3	3	3
WT01G	West Tumey	Upper Panoche Formation	1	PB	Structureless	34.5	8	25.5	12.5	0	0	0	0	1	8.0	10.5	0.213	s-s, Tgp, and Pgs	-	-	157	154	156
VABMPF01A	Panoche Road	Middle Panoche Formation	1	PB	Structureless	23.5	26	20.5	10	7	0	0	0	0	2.5	10.5	0.159	s-s to m-s-s, Tgp, and Pgs	194	187	132	131	161
VABMPF01B	Panoche Road	Middle Panoche Formation	1	PB	Stratified	10.5	3	1	3.5	0	0	0	0	0	0	0.5	0.258	s-s, Tgp, and Pgs	5	5	-	-	5
VABMPF01C	Panoche Road	Middle Panoche Formation	1	PB	Structureless	22	19	26.5	13	0	2.5	0	0	0	3	6.5	0.173	s-s to m-s-s, Md, Tgp, and Pgs	143	144	129	144	140
VABMPF01D	Panoche Road	Middle Panoche Formation	1	PB	Structureless	31	20	25	6.5	1.5	1	0	0	5.5	5.5	4	0.190	s-s to m-s-s, Tgp, and Pgs	63	63	28	29	46
VABMPF01E	Panoche Road	Middle Panoche Formation	1	PB	Structureless	23.5	13.5	32.5	10.5	5.5	1	0	2.5	0	2	9	0.170	s-s to m-s-s, Tgp, and Mgs	139	144	73	70	107
VABMPF01G	Panoche Road	Middle Panoche Formation	1	PB	Structureless	29.5	14	26	11	5	0.5	0	0	9	2	3	0.121	s-s to m-s-s, Mm, Tgp, and Mgs	4	4	3	4	4



MC05D	No Name Canyon	Dos Palos Member	Extrudite	4	Horizontal laminae	38	4	22.5	6	0	0	18.5	0	3	8	0	0.188	f-s-s to m-s-s, Md, Mgp, and Mgs	2	2	4	4	3
SWM05F	Capita Canyon	Dos Palos Member	Extrudite	4	-	-	-	-	-	-	-	-	-	-	-	-	-	s-s to m-s-s, Md, Tgp, and Pgs	1	2	-	-	2
EC02AAAA	Escapardo Canyon	Marca Member	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	6	2	2	4
																			Mean (%)	2.1	Mean (md)	6.6	
																			Median (%)	0.5	Median (md)	3	
																			STDEV* (%)	3.1	STDEV* (md)	8	
																			CV*	1.48	CV*	1.21	

\*Tierra Loma Member = Tierra Loma Shale Member; Marca Member = Marca Shale Member; Dos Palos Member = Dos Palos Shale Member; MLS = multilayer sill; STS = staggered sill; SS = stepped sill; LAD = low-angle dike; HAD = high-angle dike.

\*\*Q = quartz; L = lithics; F = feldspar; Pl = plagioclase feldspar; Mi = mica; G = glaucony; CC = carbonate cement; QC = quartz cement; Mm = mud matrix; Md = mudstone clasts; Ø = porosity; s-s = silt-size grains; m-s-s = medium sand-size grains; v-f-s-s = very fine sand-size grains; f-s-s = fine sand-size grains; c-s-s = coarse sand-size grains; Tgp = tight grain packing; Mgp = moderate grain packing; Pgs = poor grain sorting; Mgs = moderate grain sorting; G-S-M = grain-size-microgradation; HGA = horizontal grain alignment; Lgp = loose grain packing; Ggs = good grain sorting; SHA = subhorizontal grain alignment; VGA = vertical grain alignment; SVGA = subvertical grain alignment.

† $k_{h1}$  = first horizontal-permeability measurement;  $k_{h2}$  = second horizontal-permeability measurement;  $k_{v1}$  = first vertical-permeability measurement;  $k_{v2}$  = second vertical-permeability measurement;  $k_a$  = average permeability.

**Appendix 15.** Sample, Location, Element, and Pore Size from Sandstone Sills and Dikes in the Panoche Giant Injection Complex

Sample	Location	Element*	Pore Size (mm)
<b>Thin (0.1–0.8 m) and Thick (~5 m) Sandstone Sills</b>			
MC07E	Marca Canyon	MLS	0.05
MC07E	Marca Canyon	MLS	0.03
MC07E	Marca Canyon	MLS	0.02
MC07E	Marca Canyon	MLS	0.03
MC07E	Marca Canyon	MLS	0.05
MC07E	Marca Canyon	MLS	0.16
MC07E	Marca Canyon	MLS	0.05
MC07E	Marca Canyon	MLS	0.02
MC07E	Marca Canyon	MLS	0.02
MC07E	Marca Canyon	MLS	0.02
MC07E	Marca Canyon	MLS	0.03
mc05g	No Name Canyon	SS	0.03
mc05g	No Name Canyon	SS	0.12
mc05g	No Name Canyon	SS	0.05
mc05g	No Name Canyon	SS	0.05
mc05g	No Name Canyon	SS	0.04
mc05g	No Name Canyon	SS	0.07
mc05g	No Name Canyon	SS	0.32
mc05g	No Name Canyon	SS	0.03
mc05g	No Name Canyon	SS	0.03
mc05g	No Name Canyon	SS	0.02
mc05g	No Name Canyon	SS	0.06
mc05g	No Name Canyon	SS	0.1
mc05g	No Name Canyon	SS	0.14
mc05g	No Name Canyon	SS	0.03
mc05g	No Name Canyon	SS	0.02
mc05g	No Name Canyon	SS	0.1
mc05g	No Name Canyon	SS	0.07
mc05g	No Name Canyon	SS	0.02
mc05g	No Name Canyon	SS	0.05
mc05g	No Name Canyon	SS	0.04
mc05g	No Name Canyon	SS	0.03
mc05g	No Name Canyon	SS	0.03
mc05g	No Name Canyon	SS	0.03
mc05g	No Name Canyon	SS	0.04
mc05g	No Name Canyon	SS	0.01
mc05g	No Name Canyon	SS	0.02
mc05g	No Name Canyon	SS	0.1
mc05g	No Name Canyon	SS	0.03
mc05g	No Name Canyon	SS	0.02
mc05g	No Name Canyon	SS	0.04
mc05g	No Name Canyon	SS	0.14
mc05g	No Name Canyon	SS	0.08
mc05g	No Name Canyon	SS	0.04
mc05g	No Name Canyon	SS	0.15
mc05g	No Name Canyon	SS	0.07
mc05g	No Name Canyon	SS	0.03
<b>High-angle Sandstone Dike</b>			
MC04W	No Name Canyon	HAD	0.02
MC04W	No Name Canyon	HAD	0.02
MC04W	No Name Canyon	HAD	0.02
MC04W	No Name Canyon	HAD	0.03
MC04W	No Name Canyon	HAD	0.02
MC04W	No Name Canyon	HAD	0.19

**Appendix 15.** Continued

Sample	Location	Element*	Pore Size (mm)
MC04W	No Name Canyon	HAD	0.07
MC04W	No Name Canyon	HAD	0.05
MC04W	No Name Canyon	HAD	0.06
EC01HH	Dosados Canyon	LAD	0.21
EC01HH	Dosados Canyon	LAD	0.4
EC01HH	Dosados Canyon	LAD	0.05
<b>Low-angle Sandstone Dike</b>			
EC01HH	Dosados Canyon	LAD	0.04
EC01HH	Dosados Canyon	LAD	0.05
EC01HH	Dosados Canyon	LAD	0.02
EC01HH	Dosados Canyon	LAD	0.05
EC01HH	Dosados Canyon	LAD	0.12
EC01HH	Dosados Canyon	LAD	0.07
EC01HH	Dosados Canyon	LAD	0.07
EC01HH	Dosados Canyon	LAD	0.04
EC01HH	Dosados Canyon	LAD	0.03
EC01HH	Dosados Canyon	LAD	0.03
EC01HH	Dosados Canyon	LAD	0.02
EC01HH	Dosados Canyon	LAD	0.05
EC01HH	Dosados Canyon	LAD	0.02
EC01HH	Dosados Canyon	LAD	0.07
EC01HH	Dosados Canyon	LAD	0.02
EC01HH	Dosados Canyon	LAD	0.05
EC01HH	Dosados Canyon	LAD	0.12
EC01HH	Dosados Canyon	LAD	0.12
EC01HH	Dosados Canyon	LAD	0.1
EC01HH	Dosados Canyon	LAD	0.02
EC01HH	Dosados Canyon	LAD	0.1
EC01HH	Dosados Canyon	LAD	0.01
EC01HH	Dosados Canyon	LAD	0.04
EC01HH	Dosados Canyon	LAD	0.15
EC01HH	Dosados Canyon	LAD	0.05
EC01HH	Dosados Canyon	LAD	0.32
EC01HH	Dosados Canyon	LAD	0.32
EC01HH	Dosados Canyon	LAD	0.04
EC01HH	Dosados Canyon	LAD	0.03
EC01HH	Dosados Canyon	LAD	0.04
EC01HH	Dosados Canyon	LAD	0.23
EC01HH	Dosados Canyon	LAD	0.03
EC01HH	Dosados Canyon	LAD	0.01
EC01HH	Dosados Canyon	LAD	0.01
EC01HH	Dosados Canyon	LAD	0.23
EC01HH	Dosados Canyon	LAD	0.16
EC01HH	Dosados Canyon	LAD	0.12
EC01HH	Dosados Canyon	LAD	0.21
EC01HH	Dosados Canyon	LAD	0.12
EC01HH	Dosados Canyon	LAD	0.02
EC01HH	Dosados Canyon	LAD	0.02
EC01HH	Dosados Canyon	LAD	0.02
EC01HH	Dosados Canyon	LAD	0.13
EC01HH	Dosados Canyon	LAD	0.03
EC01HH	Dosados Canyon	LAD	0.12
EC01HH	Dosados Canyon	LAD	0.07
EC01HH	Dosados Canyon	LAD	0.23
EC01HH	Dosados Canyon	LAD	0.14

## Appendix 15. Continued

Sample	Location	Element*	Pore Size (mm)
EC01HH	Dosados Canyon	LAD	0.01
EC01HH	Dosados Canyon	LAD	0.11
EC01HH	Dosados Canyon	LAD	0.04
EC01HH	Dosados Canyon	LAD	0.12
EC01HH	Dosados Canyon	LAD	0.12
EC01HH	Dosados Canyon	LAD	0.07
EC01HH	Dosados Canyon	LAD	0.17
EC01HH	Dosados Canyon	LAD	0.21
EC01HH	Dosados Canyon	LAD	0.2
EC01HH	Dosados Canyon	LAD	0.21
EC01HH	Dosados Canyon	LAD	0.02

\*MLS = multilayer sill; SS = stepped sill; HAD = high-angle dikes; LAD = low-angle dikes.

**Appendix 16.** Location, Element, Injectite Thickness and Average Sandstone Intrusion Permeability from Outcrop of the Panoche Giant Injection Complex

Outcrop Characteristics of Samples					Permeability Characteristics of Samples**				
Sample	Location	Element*	Internal Structure	Thickness (m)	$k_{h1}$	$k_{h2}$	$k_{v1}$	$k_{v2}$	$k_a$
MC06B	Marca Canyon	MLS	Structureless	0.22	187	186	202	209	196
MC06C	Marca Canyon	MLS	Structureless	0.06	76	72	139	139	107
MC06D	Marca Canyon	MLS	Structureless	0.14	14	14	13	13	14
MC07B	Marca Canyon	MLS	Structureless	0.13	34	36	75	85	58
MC07C	Marca Canyon	MLS	Structureless	0.23	135	137	96	100	117
MC07D	Marca Canyon	MLS	Structureless	0.07	-	-	44	54	48
MC07E	Marca Canyon	MLS	Structureless	0.1	12	11	10	9	11
MC07G	Marca Canyon	MLS	Structureless	0.08	7	6	23	22	14
EC01F	Dosados Canyon	STS	Structureless	0.25	48	49	23	33	38
EC01R	Dosados Canyon	STS	Structureless	0.22	32	32	32	31	32
EC01T	Dosados Canyon	STS	Structureless	0.13	114	118	93	93	105
EC01W	Dosados Canyon	STS	Structureless	0.09	8	8	-	-	8
EC01CC	Dosados Canyon	STS	Structureless	0.42	53	53	52	52	53
EC01DD	Dosados Canyon	STS	Structureless	0.85	58	61	53	56	57
EC01FF	Dosados Canyon	STS	Structureless	0.21	53	53	59	60	56
EC02D	Escapardo Canyon	SS	Structureless	0.12	255	251	201	203	228
EC02F	Escapardo Canyon	SS	Structureless	0.58	432	432	-	-	432
EC02G	Escapardo Canyon	SS	Structureless	1.7	-	-	1498	1535	1517
EC02J	Escapardo Canyon	SS	Structureless	1.3	2038	2064	2234	2195	2133
EC02P	Escapardo Canyon	SS	Structureless	0.06	257	275	-	-	266
EC02Q	Escapardo Canyon	SS	Structureless	0.25	1669	1641	1021	996	1331
WT01U	West Tumey	MLS	Structureless	0.2	110	105	87	86	97
WT01L	West Tumey	MLS	Laminae	0.2	-	-	89	86	88
MC08H	No Name Canyon	SS	Structureless	5	1475	1475	2079	2092	1780
mc05g	No Name Canyon	SS	Structureless	8	4556	4546	5236	5236	4894
ec01a (i)	Escapardo Canyon	SS	Laminae	1.7	3315	3315	2780	2780	3048
ec01a (ii)	Escapardo Canyon	SS	Laminae	1.7	1409	1409	2313	2313	1861
ec01b (i)	Escapardo Canyon	SS	Laminae	1.7	3236	3236	2335	2335	2786
ec01b (ii)	Escapardo Canyon	SS	Laminae	1.7	283	283	237	237	260
SCC01T	Rossetta Canyon	SS	Structureless	1	401	402	422	427	413
SCC01U	South Capita	MLS	Structureless	0.07	145	144	-	-	145
SWM03Y	Capita Canyon	MLS	Mud clast breccias	0.25	197	197	168	167	182
WT01R	West Tumey	MLS	Stratified	0.08	10	10	6	5	8
MCTL03G	No Name Canyon	MLS	Mud clast breccias	0.08	1	1	1	1	1
SWM05D	Capita Canyon	MLS	Structureless	0.05	150	151	-	-	151
dc05e	Dosados Canyon	STS	Laminae	0.12	252	252	336	336	294
mc05a(i)	No Name Canyon	SS	Parallel laminae	0.1	48	48	24	24	36
mc05a(ii)	No Name Canyon	SS	Parallel laminae	0.1	48	48	24	24	36
wt02b(i)	West Tumey	SS	Laminae	0.1	391	298	188	283	290
wt02b(ii)	West Tumey	SS	Laminae	0.1	391	298	188	283	290
wt02a	West Tumey	SS	Horizontal banding	0.1	102	105	116	114	109
EC02B	Escapardo Canyon	SS	Structureless	1.6	704	691	583	559	634
MC07P	Marca Canyon	MLS	Structureless	1	95	95	111	106	102
EC01G	Dosados Canyon	LAD	Structureless	0.21	157	155	202	203	179
EC01O(b)	Dosados Canyon	LAD	Structureless	11.7	6198	6429	6253	6340	6305
EC01MA	Dosados Canyon	LAD	Structureless	0.23	-	-	366	368	367
MCTL02R	No Name Canyon	LAD	Mud clast breccias	0.05	27	28	-	-	27
WT02B	West Tumey	LAD	Pipes	0.12	31	28	36	38	34
SWM03S	Capita Canyon	LAD	Margin laminae	0.1	17	17	-	-	17
EC02K	Escapardo Canyon	SS	Mud clast breccias	0.23	253	252	316	326	287
wt06b	West Tumey	LAD	Pipes	0.5	11	11	15	15	13
wt06c	West Tumey	LAD	Pipes	0.5	129	129	117	117	123
WT02C	West Tumey	LAD	Structureless	4	311	324	274	275	296
WT01I	West Tumey	LAD	Mud clast breccias	3	304	314	301	292	303

**Appendix 16.** Continued

Outcrop Characteristics of Samples					Permeability Characteristics of Samples**				
Sample	Location	Element*	Internal Structure	Thickness (m)	$k_{h1}$	$k_{h2}$	$k_{v1}$	$k_{v2}$	$k_a$
WT01K	West Tumey	LAD	Margin laminae	0.1	7	6	2	2	4
WT01M	West Tumey	LAD	Margin laminae	0.05	64	66	45	47	56
SWM03L	Capita Canyon	LAD	Structureless	1	–	–	1179	1114	1147
EC01H	Dosados Canyon	LAD	Mud clast breccias	1.1	239	234	297	302	268
EC01L(B)	Dosados Canyon	LAD	Structureless	0.35	327	326	284	271	302
EC01GG	Dosados Canyon	LAD	Structureless	0.08	188	191	–	–	190
EC01HH	Dosados Canyon	LAD	Structureless	2.1	1634	1623	1688	1676	1655
dc05b	Dosados Canyon	LAD	Pipes	1.5	246	246	193	193	220
EC01V(B)	Dosados Canyon	LAD	Structureless	0.3	506	508	413	437	466
EC01II(C)	Dosados Canyon	LAD	Structureless	7.8	4948	4947	–	–	4948
EC01S	Dosados Canyon	LAD	Structureless	0.33	32	26	37	37	33
EC01Y	Dosados Canyon	LAD	Structureless	0.34	69	65	23	23	45
EC01AA	Dosados Canyon	LAD	Structureless	0.16	184	183	281	279	231
MCTL02J	No Name Canyon	LAD	Structureless	0.4	400	395	370	369	384
SCC01E	Rossetta Canyon	LAD	Structureless	0.15	164	155	143	134	149

\*MLS = multilayer sill; STS = staggered sill; SS = stepped sill; LAD = low-angle dikes.

\*\* $k_{h1}$  = first horizontal-permeability measurement;  $k_{h2}$  = second horizontal-permeability measurement;  $k_{v1}$  = first vertical-permeability measurement;  $k_{v2}$  = second vertical-permeability measurement;  $k_a$  = average permeability.