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Appendix 10

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Appendix One:
Calibrated chronology for Mexico

Table 1: Tephrochronology for the Mexico Basin. For uncalibrated ages, radiocarbon ages have been calibrated using the INTACAL13 curve (Reimer et al. 2013) in CALIB (Stuiver et al. 2017). Ages are calibrated using the Intercal13 curve (Reimer et al. 2013) with Oxcal 4.2 (Bronk-Ramsey, 2009). 1: Niederberger, 1976. 2: García, 1986;.3: Ortega & Newton, 1998. 4: García-Palomo et al. 2002; Arce et al. 2003; Sosa-Ceballos et al. 2012; Torres-Rodríguez et al. 2015. 5: Lonzano et al. 1993; Ortega & Newton, 1998. 6: Macías, 2007. 7: Siebe et al.2017. 8: Roy et al. 2012. *NDT = Nevada de Toluca, Popo = Popocatépetl

Analysis Lab	Sample Name	Material dated	Sample Number	13C	^{14}C age yr bp	CALIB 95.4 % (2s) cal. BP age ranges	Relative area under distribution	Mean 14C age cal. BP
NFS USA	Huitzilzingo Creamy White Ash	5: Bulk sediment, Chalco Core E	AA17046	NA	2645 ± 55	cal. BP 2750 - 2763	1.0	2757
NA	Dark grey ash flow and sandy fall out, NDT Toluca Basin	6: ?	NA	NA	7100 ± 500	cal. BP 7879 - 7888	0.1	7946
						cal. BP 7931 - 7961	0.9	
NA	Dark grey ash flow and sandy fall out, NDT Toluca Basin	6: ?	NA	NA	9100 ± 500	cal. BP 10232 - 10248	1.0	10240
Geochron laboratories USA	Tephra I Basaltic Andesite - Andesite	5: Bulk sediment, Chalco Core D	GX16969	NA	9395 ± 255	cal. BP 10578 - 10664	1.0	10621
NA	Upper Toluca Pumice (UTP). NDT plinian eruption Mexico and Toluca Basins	*4 & 6: ?	NA	NA	10440 ± 95	cal. BP 12330 - 12310	1.0	12320
NA	Dark grey ash flow and sandy fall out, NDT Toluca Basin	6: ?	NA	NA	10700 ± 500	cal. BP 12640 - 12714	1.0	12677
NA	Middle Toluca Pumice (MTP) NDT plinian eruption Toluca Basin (Mexico basin?)	6: ?	NA	NA	12100 ± 500	cal. BP 13856 - 13898	0.1	13936
						cal. BP 13900 - 14088	0.9	
Geochron laboratories USA	Tephra II Rhyolite	3: Bulk sediment, Chalco Core D	GX16965	NA	12520 ± 135	cal. BP 14578 - 14582	0.0	14580
						cal. BP 14607 - 15071	1.0	14839
NFS USA	San Martin Black Ash (Dacitic - Rhyolitic)	5: Bulk sediment, Chalco Core E	AA13344	NA	13990 ± 100	cal. BP 16796 - 17147	1.0	16972
NA	Tephra V	3: Bulk sediment, Chalco Core D	NA	NA	14015 ± 130	cal. BP 16821 - 17164	1.0	16993
NFS USA	Chimalpa Black Ash (Basaltic - Andesitic)	5: Bulk sediment, Chalco Core E	AA13348	NA	14015 ± 130	cal. BP 16850 - 17180	1.0	17015
Texas USA*	Tlapacoya 2: Yellow Lapilli Ash. Pumice with Andesite (PWA)	2: Sediment, Chalco Core E	TX1784	NA	Average 14,116 ± 290	Average cal. BP 17007 - 17305	1.0	17156
NFS USA	Tlapacoya 2: Yellow Lapilli Ash (PWA)	5: Bulk sediment, Chalco Core E	AA13342	NA				
Texas USA*	Tlapacoya 2: Yellow Lapilli Ash (PWA)	2: Sediment, Chalco Core E	TX1914	NA				
Texas USA*	Tlapacoya 2: Yellow Lapilli Ash (PWA)	2: Sediment, Chalco Core E	TX1913	NA				
NA	Tutti Frutti Pumice (TFP), Popo	*4 & 6: Mexico Basin	NA	NA	14500 ± 100	cal. BP 17670	NA	NA
Geochron laboratories USA	Tlapacoya 1: Grey Ash	2: Sediment, Chalco Core E	GX0878	NA	Average 14,740 ± 307	Average cal. BP 17795 - 18064	1.0	17929
Teledyne Isotopes, Germany*	Tlapacoya 1: Grey Ash	1: Sediment, Chalco Core E	I5185	NA				
Teledyne Isotopes, Germany*	Tlapacoya 1: Grey Ash	2: Sediment, Chalco Core E	GX1361	NA				
NA	White pumice plinian eruption (Popo cone collapse)	7: Multiple samples	NA	NA	23500 ± ?	cal. BP 27800	1.0	27800
NA	Lower Toluca Pumice (LTP). NDT plinian eruption Toluca Basin (Mexico Basin?)	6: ?	NA	NA	24100 ± (1500?)	cal. BP 27899 - 28357	1.0	28128
NA	GBA (Great Basaltic-andesite Ash)	*4: Mexico Basin	NA	NA	/	cal. BP 28180 - 28140	NA	28160
Beta Analytic, USA	T2	8: Base of tephra, unit IV	NA	NA	31,000 ± 220	cal. BP 34670 - 35064	1.0	34867
Geochron laboratories USA	Tlahuac Tephra (GBA: Gran Ceniza Basaltica: XII, or Great Basaltic Ash) (Popo?)	3, 4 & 5: Green brown clay	GX16968	-19.9	<34,000 (± 1500?)	cal. BP 38331 - 38709	1.0	38520
BETA Analytic, USA	TrII: Base of tephra, unit IV	Beta-103569	103569	NA	31000 ± 220	cal. BP 34670 - 35064	NA	45239

Table 2: Lake Chalco radiocarbon ages converted to calendar years for this study using CALIB. 1: Niederberger, 1976. 2: García, 1986. 3: Caballero, 1997. 4: Caballero and Ortega, 1998. 5: Ortega & Newton, 1998. 6: Ortega, 1992; 7: Siebe et al.2017; 8: Cantarero, 2013.

Lab number	Sample Name	Material dated	Sample Number	13C	^{14}C age bp	CALIB 95.4 % (2s) cal. BP age ranges	Relative area under distribution	Mean 14C age cal. BP
NA	NA	NA	NA	NA	7000 ± 1500	cal. BP 7794 - 7814	0.2	7852
						cal. BP 7816 - 7863	0.7	
						cal. BP 7902 - 7921	0.2	
NFS USA	NA	4; Pollen in diatomite	AA13340	-25	10528 ± 74	cal. BP 12426 - 12495	0.6	12460
NA	NA	NA	NA	NA	12500 ± 1500	cal. BP 14473 - 15027	1.0	14750
University of Waterloo, Canada	NA	4: Organic silt, bulk sediment sample	WAT2487	-27.5	12800 ± 90	cal. BP 15129 - 15351	1	15240
Geochron laboratories USA	NA	3: Organic sediment, bulk sample	GX16971	-27.3	16820 ± 195	cal. BP 20118 - 20448	1.0	20283
University of Waterloo, Canada	NA	3 & 4: Organic sediment, bulk sample	WAT2488	-27.5	17450 ± 170	cal. BP 20893 - 21242	1.0	21068
Geochron laboratories USA	NA	3: Organic sediment, bulk sample	GX16558	-25.9	17560 ± 330	cal. BP 21021 - 21390	1.0	21206
NA	NA	4: NA	NA	NA	18500 ± (1500?)	cal. BP 22308 - 22488	1.0	22398
NA	NA	8: NA	NA	NA	19000 ± 1500	cal. BP 22695 - 23065	1.0	22880
Geochron laboratories USA	NA	3: Organic sediment, bulk sample	GX16559	-25.7	19040 ± 390	cal. BP 22762 - 23114	1.0	22983
NA	NA	3: NA	NA	NA	21000 ± (1500?)	cal. BP 25177 - 25522	1.0	25350
Geochron laboratories USA	NA	3 & 4: Silt, bulk sample	GX16967	-19.6	21600 ± 1050	cal. BP 25773 - 26001	1.0	25887
NFS USA	NA	4: Pollen in silt, bulk sample	AA17042	-23.2	22720 ± 250	cal. BP 26898 - 27332	1.0	27115
NA	NA	3 & 8: NA	NA	NA	25000 ± (1500?)	cal. BP 28802 - 29267	1.0	29035
NFS USA	NA	4: Silt, bulk sample	AA17043	-24.9	26910 ± 300	cal. BP 30849 - 31163	1.0	31029
NA	NA	8: NA	NA	NA	27500 ± 1500	cal. BP 31141 - 31446	1.0	31294
NA	NA	4: NA	NA	NA	30000± (1500?)	cal. BP 33856 - 34238	1.0	34047
NA	NA	3: NA	NA	NA	31500 ± (1500?)	cal. BP 35114 - 35625	1.0	35370
NA	NA	8: NA	NA	NA	37500 ± 1500?	cal. BP 41705 - 42131	1.0	41918
NA	NA	8: NA	NA	NA	45000 ± 1500?	cal. BP 47794 - 48979	1.0	48387

Table 3: Lake Texcoco radiocarbon ages converted to calendar years for this study using CALIB (Lamb et al. 2009)

Lab	Sample Name	Material dated	Sample Number	13C	^{14}C age yr bp	CALIB 95.4 % (2s) cal. BP age ranges	Relative area under distribution	Mean 14C age cal. BP
Oxford radiocarbon Accelerator Unit	NA	Mixed, marginal lake gastrop shells	OxA-15,842	-8.8	612 ± 22	cal. BP 452 - 500	1.0	476
NA	NA	NA	NA	NA	5000 ± 1500	cal. BP5664 - 5674	0.1	5693
						cal. BP 5677 - 5690	0.1	
						cal. BP 5709 - 5745	0.9	
Oxford radiocarbon Accelerator Unit	NA	Mixed, marginal lake gastrop shells	OxA-15,841	-2.9	6334 ± 30	cal. BP 6974 - 7143	1.0	7059
NA	NA	NA	NA	NA	10000 ± 1500	cal. BP 11341 - 11830	0.1	11446
						cal. BP11385 - 11415	0.2	
						cal. BP11418 - 11497	0.3	
						cal. BP 11527 - 11604	0.4	
NA	NA	NA	NA	NA	14000 ± 1500	cal. BP 16821 - 17164	1.0	16992
NA	NA	NA	NA	NA	16000 ± 1500	cal. BP 19183 - 19469	1.0	19326
Oxford radiocarbon Accelerator Unit	NA	Ostrocode shell	OxA-15,842	0.6	16730 ± 75	cal. BP 19784 - 20099	1.0	19942
NA	NA	NA	NA	NA	18000 ± 1500	cal. BP 21633 - 21953	1.0	21793
Oxford radiocarbon Accelerator Unit	NA	Ostrocode shell	OxA-15,877	2.8	19110 ± 90	cal. BP 22576 - 22953	1.0	22765
NA	NA	NA	NA	NA	23000 ± 1500	cal. BP 27169 - 27492	1.0	27331
NA	NA	NA	NA	NA	25000 ± 1500	cal. BP 28802 - 292671	1.0	29035

Table 4: Lake Tecocomulco radiocarbon ages converted to calendar years for this study using CALIB (Caballero et al. 1999; Roy et al. 2008; Roy et al. 2009).

Lab	Sample Name	Material dated	Sample Number	13C	^{14}C age yr bp	CALIB 95.4 % (2s) cal. BP age ranges	Relative area under distribution	Mean 14C age cal. BP
BETA Analytic, USA	NA	Base of unit I, organic brown sand and clay	BETA-103568	NA	3270 ± 50	cal. BP 3456 - 3485	0.6	3503
						cal. BP 3486 - 3464	0.0	
						cal. BP 3502 - 3509	0.4	
						cal. BP 3532 - 3555	0.4	
NA	NA	NA	NA	NA	15000 ± 1500	cal. BP 18080 - 18357	1.0	18219
BETA Analytic, USA	NA	Base of caliche layer. Cores TA and TB	BETA-74027	NA	16350 ± 60	cal. BP 19572 - 19912	1.0	19742
BETA Analytic, USA	NA	Top of unit III, brown sand and silt. Cores TA and TB	BETA-74029	NA	25730 ± 130	cal. BP 29595 - 30232	1.0	29914
NA	NA	NA	NA	NA	29000± 1500	cal. BP 32957 - 33501	1.0	33229
NA	NA	NA	NA	NA	30000 ± 1500	cal. BP 33856 - 34238	1.0	34070
BETA Analytic, USA	NA	Base of tephra, unit IV	Beta-103569	NA	31000 ± 220	cal. BP 34670 - 35064	1.0	34867
NA	NA	NA	NA	NA	36000 ± 1500	cal. BP 40327 - 40964	1.0	40646
NA	NA	NA	NA	NA	37000 ± 1500	cal. BP 41346 - 41818	1.0	41582
BETA Analytic, USA	NA	Base of unit V, dark brown silt and clay. Cores TA and TB	BETA-74031	NA	41850 ± 800	cal. BP 44910 - 45567	1.0	45239

Table 5: Central Mexico review ages converted to calendar years for this study using CALIB. 1: (Metcalfe, 2006. 2: Metcalfe et al. 2000).

Analysis Lab	Sample Name	Material dated	Sample Number	13C	^{14}C age yr bp	CALIB 95.4 % (2s) cal. BP age ranges	Relative area under distribution	Mean 14C age cal. BP
NA	NA	1: NA	NA	NA	3000	cal. BP 3164 - 3211	1.0	3188
NA	NA	1: NA	NA	NA	4000	cal. BP 4425 - 4446	0.3	4465
						cal. BP 4472 - 4515	0.7	
NA	NA	1: NA	NA	NA	5000	cal. BP 5664 - 5674	0.1	5693
						cal. BP 5677 - 5690	0.1	
						cal. BP 5709 - 5744	0.9	
NA	NA	2: NA	NA	NA	6000	cal. BP 6795 - 6863	0.9	6852
						cal. BP 6867 - 6881	0.3	
NA	NA	2: NA	NA	NA	7000	cal. BP 7794 - 7814	0.2	7888
						cal. BP 7816 - 7863	0.7	
						cal. BP 7902 - 7921	0.2	
NA	NA	2: NA	NA	NA	8000	cal. BP 8780 - 8833	0.4	8963
						cal. BP 8861 - 8922	0.3	
						cal. BP 8933 - 8941	0.0	
						cal. BP 8954 - 8961	0.0	
						cal. BP 8967 - 8995	0.2	
NA	NA	1: NA	NA	NA	9000	cal. BP 10183 - 10217	1.0	10178
NA	NA	1: NA	NA	NA	17650	cal. BP 21152 - 21537	1.0	21343
		1: NA			22000	cal. 26023 - 26374	1.0	26199
		1: NA			35000	cal. BP 39261 - 39849	1.0	39556

Table 6: Mexican Quaternary environmental records from the NAM regions, terrestrial records (from Metcalfe et al. 2015: see references therein). For ocean records see Metcalfe et al. (2015).

Record Name	Map Key	Record Name	Map Key
Harrisons Cave, Barbados	**1**	Lago de Patzcuaro, Mexico	**41**
Antoine, Grenada	**2**	Lago de Zirahuen	**42**
Cariaco Basin, off Venezuela	**3**	Laguna de Juanacatlan	**43**
Valencia, Venezuela	**4**	Lago de Santa Maria del Oro	**44**
Chilibrillo Cave, Panama	**5**	Las Cruces, Mexico	**45**
La Yeguada, Panama	**6**	Bolson de Mapimi	**46**
Lago de las Morrenas, Costa Rica	**7**	Sierra San Francisco	**47**
Venado Cave, Costa Rica	**8**	Lake Tulane, Florida	**48**
El Gancho, Nicaragua	**9**	Ci_enega de Camilo, Mexico	**49**
Manchon Swamp, Guatemala	**10**	Babicora, Mexico	**50**
Yok Balum, Belize	**11**	San Pedro Martir, Mexico	**51**
Peten Itza, Guatemala	**12**	Laguna Seca San Felipe, Mexico	**52**
Macal Chasm, Belize	**13**	Palomas Basin, Mexico	**53**
Salpeten, Guatemala	**14**	Cave of the Bells, Arizona	**54**
Puerto Arturo, Guatemala	**15**	Lake Cloverdale, New Mexico	**55**
New River Lagoon, Belize	**16**		
Nochixtlan Valley, Mexico	**17**		
Juxtlahuaca Cave, Mexico	**18**		
Cueva del Diablo, Mexico	**19**		
Tzib, Mexico	**20**		
Chichancanab, Mexico	**21**		
Los Petenes, Mexico	**22**		
Punta Laguna, Mexico	**23**		
Aguada X'Caamal, Mexico	**24**		
Chaac (Tzabnah Cave), Mexico	**25**		
San Jose Chulchaca, Mexico	**26**		
Rio Lagartos, Mexico	**27**		
Wallywash Great Pond, Jamaica	**28**		
Miragoane, Haiti	**29**		
Enriquillo Valley, Dominican Republic	**30**		
Castilla/Salvador/Felipe, Dominican Republic	**31**		
Dos Anas Cave, Cuba	**32**		
Lago Verde, Mexico	**33**		
Lake Aljojuca	**34**		
Agua El Marrano, Mexico	**35**		
Lakes Quila/Zempoala, Mexico	**36**		
Upper Lerma, Mexico	**37**		
Lago La Luna, Mexico	**38**		
Zacapu Basin, Mexico	**39**		
Hoya Rincon de Parangueo, Mexico	**40**		

Appendix Two:

Mansell Colour chart

Table 1: Munsell colour 2018

5R 8/2 Grayish Pink	5R 7/4 Moderate Pink	5R 6/2 Pale Red	5R 6/6 Light Red	5R 5/4 Moderate Red	5R 4/2 Grayish Red
5R 4/6 Moderate Red	5R 3/4 Dusky Red	5R 2/2 Blackish Red	5R 2/6 Very Dark Red	10R 8/2 Grayish Orange Pink	10R 7/4 Moderate OrangePink
10R 6/2 Pale Red	10R 6/6 Moderate Reddish Orange	10R 5/4 Pale Reddish Brown	10R 4/2 Grayish Red	10R 4/6 Modderate Reddish Brown	10R 3/4 Dark Reddish Brown
10R 2/2 Very Dusky Red	5Y 8/4 Moderate Orange Pink	5YR 7/2 Grayish Orange Pink	5YR 6/4 Light Brown	5YR 5/2 Pale Brown	5YR 5/6 Light Brown
5YR 4/4 Moderate Brown	5Y 3/2 Grayish Brown	5YR 3/4 Moderate Brown	5YR 2/2 Dusky Brown	10YR 8/2 Very Pale Orange	10YR 8/6 Pale Yellowish Orange
10YR 7/4 Grayish Orange	10YR 6/2 Pale Yellowish Brown	10YR 6/6 Dark Yellowish Orange	10YR 5/4 Moderate Yellowish Brown	10YR 4/2 Dark Yellowish Brown	10YR 2/2 Dusky Yellowish Brown
5Y 8/4 Grayish Yellow	5Y 7/2 Yellowish Gray	5Y 7/6 Moderate Yellow	5Y 6/4 Dusky Yellow	5Y 5/2 Light Olive Gray	5Y 5/6 Light Olive Brown

Table 1: Munsell colour 2018

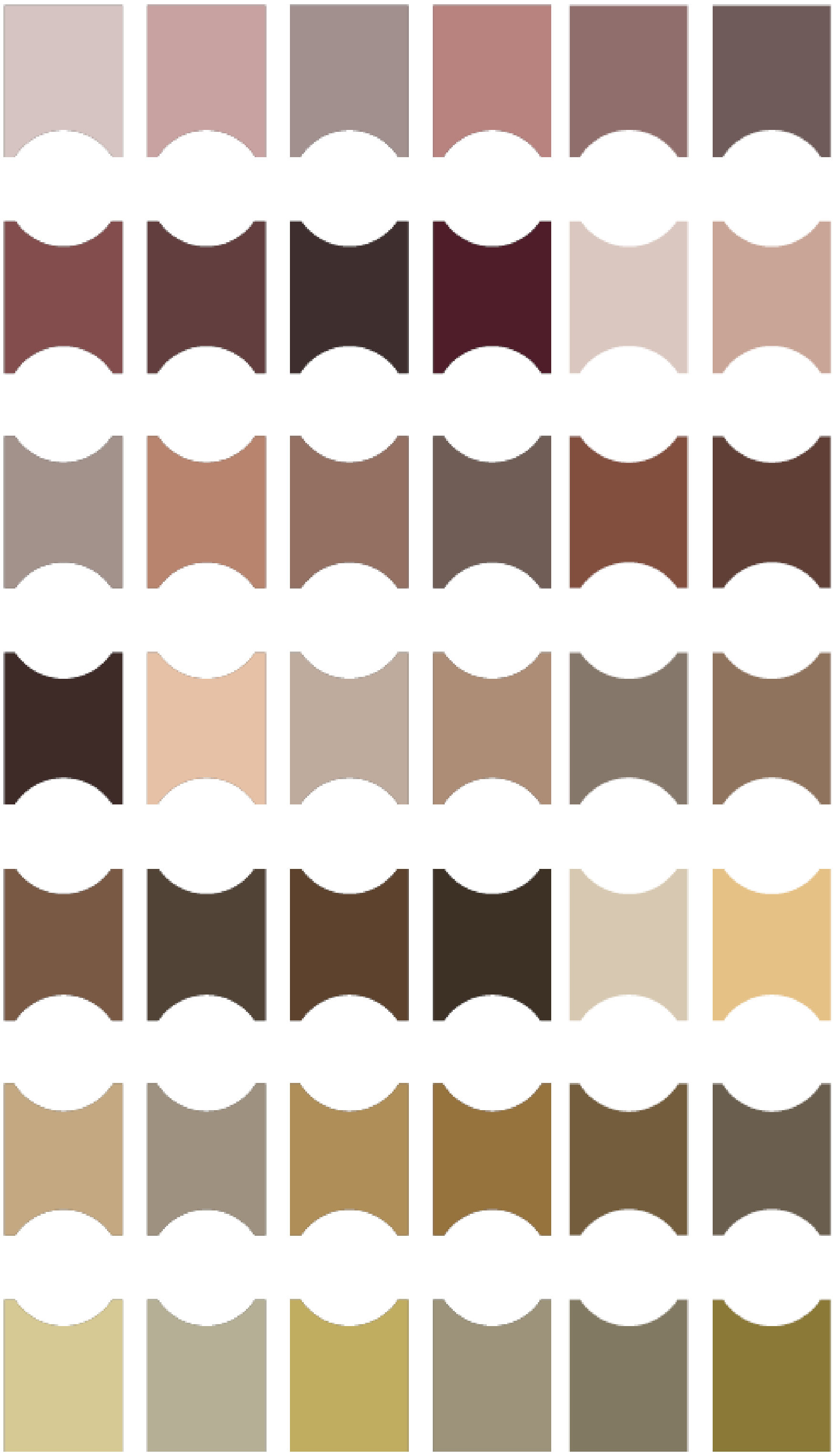


Table 1: Munsell colour 2018

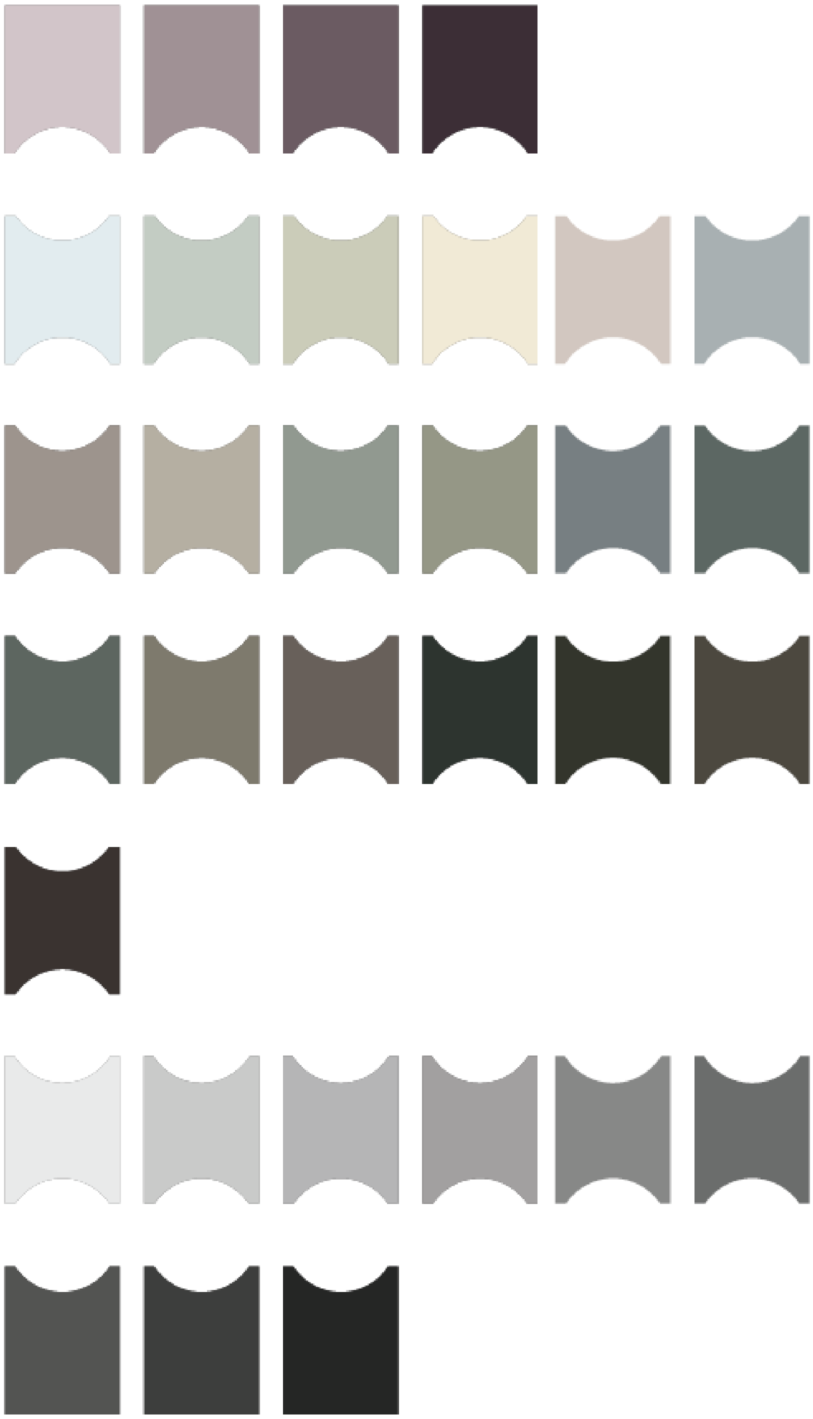
5Y 4/4 Moderate Olive Brown	5Y 3/2 Olive Gray	10Y 8/2 Pale Greenish Yellow	10Y 7/4 Moderate Greenish Yellow	10Y 6/2 Pale Olive	10Y 6/6 Dark Greenish Yellow
10Y 5/4 Light Olive	10Y 4/2 Grayish Olive	5GY 7/2 Grayish Yellow Green	5GY 7/4 Moderate Yellow Green	5GY 5/2 Dusky Yellow Green	5GY 3/2 Grayish Olive Green
10GY 7/2 Pale Yellowish Green	10GY 6/4 Moderate Yellowish Green	10GY 5/2 Grayish Green	10GY 4/4 Dark Yellowish Green	10GY 3/2 Dusky Yellowish Green	
5G 7/2 Pale Green	5G 7/4 Light Green	5G 6/6 Brilliant Green	5G 5/2 Moderate Yellow Green	5G 5/6 Moderate Green	5G 3/2 Dusky Green
10G 8/2 Very Pale Green	10G 6/2 Pale Green	10G 4/2 Grayish Green	5BG 7/2 Pale Blue Green	5BG 6/6 Light Blue Green	5BG 5/2 Grayish Blue Green
5BG 4/6 Moderate Blue Green	5BG 3/2 Dusky Blue Green	5B 8/2 Very Pale Blue	5B 7/6 Light Blue	5B 6/2 Pale Blue	5B 5/6 Moderate Blue
5PB 7/2 Pale Blue	5PB 5/2 Grayish Blue	5PB 3/2 Dusky Blue	5P 6/2 Pale Purple	5P 4/2 Grayish Purple	5P 2/2 Very Dusky Purple

Table 1: Munsell colour 2018

Table 1: Munsell colour 2018

5RP 8/2 Pale Pink	5RP 6/2 Pale Red Purple	5RP 4/2 Grayish Red Purple	5RP 2/2 Very Dusky Purple		
5B 9/1 Bluish White	5G 8/1 Light Greenish Gray	5GY 8/1 Light Greenish Gray	5Y 8/1 Yellowish Gray	5YR 8/1 Pinkish Gray	5B 7/1 Light Bluish Gray
5YR 6/1 Light Brownish Gray	5Y 6/1 Light Olive Gray	5G 6/1 Greenish Gray	5GY 6/1 Greenish Gray	5B 5/1 Medium Bluish Gray	5G 4/1 Dark Greenish Gray
5GY 4/1 Dark Greenish Gray	5Y 4/1 Olive Gray	5YR 4/1 Brownish Gray	5G 2/1 Greenish Black	5GY 2/1 Greenish Black	5Y 2/1 Olive Black
5YR 2/1 Brownish Black					
N9 White	N8 Very Light Gray	N7 Light Gray	N6 Medium Light Gray	N5 Medium Gray	N4 Medium Dark Gray
N3 Dark Gray	N2 Grayish Black	N1 Black			

Table 1: Munsell colour 2018



Appendix Three:

San Mateo Hill logs

Table 1: San Mateo Hill (SMH), Site TB17, Log 1 (ca. 4.69 m thick), San Mateo Hill quarry. See Section 6.3 and Figures 8.1 & 8.9							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 6, 0.60 m	Medium light grey (N6) medium fine sand with fine pebble gravel size pumice clasts	-The bed contains boundary and channel forms (max thickness 0.20 m)	-Non-observed	Re-worked medium to coarse volcanic ash with occasional trough cross-beds (Facies 18d)	Fsp. SB	Non	F3: 2
Bed, 5, 0.50 m	Medium light grey (N6) medium-coarse fine sand with very fine to fine pebble gravel pumice fragments with medium pebble gravel sized pumice clasts	-Poorly sorted -Boundary and channel forms (max 0.10 m thick) within the unit	-Non-observed	Re-worked medium to coarse volcanic ash with occasional trough cross-beds (Facies 18d). **Ar/Ar age of 550.7 ±4.1/4.7 ka BP from Table 1.**	Fsp, SB.	Non	F3: 2
Bed 4, 1.96 m	The is a composite unit made up of 8 cycles. Bed sets consist of pinkish grey (5RY 8/1) coarse to fine sand with fine pebble gravel that is capped by (white N9) indurate carbonate layers (0.10 – 0.03 m thick).	-This unit is made up of channels and sediment gravity flow beds that all sit within boundary and channel forms. The unit grades from larger bed and coarser sands to smaller beds and finer sand sin the upper bed. -Bed set thicknesses range from max 0.42 m (max) at the base to smaller beds (min 0.13 m) in the upper unit. c) Each cycle is capped by a massive, thin (<0.05 m) sandy carbonate deposit (c). b) The upper thinner beds have laminated, or cross-bedded interbeds. a) The first four cycles are massive coarse to medium sands with the occasional small-scale cross be sets and small pebble gravel intraclasts	-Carbonate cap formation	c) Massive groundwater calcrete (Facies 19d) b) Cross-bedded, fine laminated sands (Facies 14b) a) Intraformational, massive, normally graded course to fine sand monomictic fine pebble gravel (Facies 15).	b) CH, FSr: a) CH, FGmg, SG	c) CGWsh (?)	F3: 1

Table 1 continued							
Bed	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 3, 0.60 m +	Moderate red (10R 4/6), iron-rich fine sand with large to very coarse pebble gravel sized rip up clasts of indurated pinkish grey (5RY 8/1) fine silty sand. The bed is capped by 0.5m of (white) indurated sand.	-Iron staining in places -Massive -Poorly sorted -Sharp, parallel, wavy erosive lower contact -In places, the base of the bed is lined with pinkish grey (5RY 8/1) silty fine sand rip-up clast from bed 2. -This bed is laterally discontinuous and pinches out in places along the section cut by channels in other portions of the section - Occasionally interlaminated with discontinuous silt lamina	-Vertical jointing -Some brecciation	Massive fine sand with coarse pebble gravel (Facies 15/Facies14c matrix).	FGmm, SG	-Exposure, desiccation and drying	F3: 1
Bed 2, 0.50 m	Pinkish grey (5RY 8/1) fine silty sand with small pebble gravel clasts (<30%).	-Massive overall, but with occasional bed sets that infill small channels (<0.30 m in diameter and < 0.2 m in height) that go from trough cross-beds to horizontally laminated in the upper. - Disconformable lower contact, over-hangs lower bed by ca. 0.10 m -Channels occasionally cut this bed and bed 3 that are: • ca. 1m thick and 2 m wide. • Infilled with nonparallel, graded cross-bedded sets of small pebble gravel in fine sand to laminated to massive silty fine sand • Cut channels are infilled with bed 4	-Small nodules (small - very coarse pebble gravel in size) occur occasionally	Massive fine silty sand with fine pebble gravel lined channel scours (Facies 14b).	FFSm FSe, FSt	CPedN (?), CGwNod	F3: 1
Bed 1, 0.59 m +	Moderate reddish brown (10R 4/6) fine silty sand Thin cap of carbonate matrix with fine to medium sand which is uneven, < 0.01 m	-Massive -Sharp, parallel, uneven, wavy disconformable upper contact -Horizontal and laterally continuous large bed -The upper sandy (fine to coarse) indurated layer	-Vertical jointing -Brecciation -Calcite vain -Carb nodule	Upper bed, laminar calcrete (Facies 19a) Lowe bed, massive silty fine sand with vertical jointing (Facies 14a).	FP(?) Soil horizon	CPedPl	F3: 1

Table 2: San Mateo Hill (SMH), Site TB17, Log 2 (ca. 10.94 m thick), San Mateo Corn Field. See Section 6.3 and Figures 8.1 & 8.9							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 9, 1.10 m	Composite sequence. Beds made up of cycles of bed sets of pinkish grey (5RY 8/1) silty fine with fine pebble gravel. Pinkish grey (5RY 8/1) silty fine capped by (white N9) indurate carbonate layers	-This unit is very similar to bed 5 in structure although compositionally the sediment is finer, and the cycles are thinner and less pronounced. -The cycles again are massive then cross-bedded or laminated and each infill a channel form. -Topped by massive micritic silt < 10 mm thick	-Brecciation in the upper bed -Carbonate beds cap cycles	**c)** Massive sheet groundwater calcrete (Facies 19c). **b)** Cross-bedded, laminated fine silty sands (Facies 14b). **a)** Massive fine silty sand with fine pebble gravel (Facies 15).	**b)** CH, FSr **a)** CH, FGmg	**c)** CGwsh(?)	F3: 1
Bed, 8, 1.2 m	Medium light grey (N6) medium-coarse fine sand with medium to very coarse angular pebble gravel pumice fragments	- Grouped planar cross beds (max 0.45 m thick) within the beds -At least two interbeds that sit in boundary and channel forms -Poorly sorted -Very irregular base that loads and cuts the lower contact, disconformable. Upper contact is also very irregular. -The whole unit pinches and swells but is laterally continuous	-None observed	Re-worked medium to coarse volcanic ash with medium to very coarse pebble gravel (Facies 18d). **Inferred Ar/Ar age of 550.7 ±4.1/4.7 ka BP from Table 1, Bed 5**	Fsp, SB	-None	F3: 2
Bed 7, 0.50	Moderate reddish brown (10R 4/6) fine silty sand	-Massive -Relatively gradational lower contact	-Vertically jointed -Brecciated	Massive fine silty sand (Facies 14a).	Fp	-Exposure, drying and evaporation	F3: 1

Table 2, Continued							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 6, 4.9 m	This is a composite unit made up of 5 cycles of bed sets of pinkish grey (5RY 8/1) coarse to fine sand with fine to medium pebble gravel that is capped by (white N9) indurate carbonate layers (0.15 – 0.03 m thick).	-Boundary and channel forms. -Bed set thicknesses range from 1.22 m 0.30 m. -This bed overhangs the lower bed by at least 0.30 m **(c)** Each bed set is capped by a massive indurated carbonate layer **(b)** The upper cycles are fine silty sand with wavy to plane laminations and small-scale cross beds. These beds are poorly sorted and contain small pebble gravel intraclasts. **(a)** Massive, coarse to fine sand with poorly sorted, angular gravel clasts.	-Massive, sandy Carbonate cap	**c)** Massive sheet groundwater calcrete (Facies 19c). **b)** Cross-bedded, laminated coarse to fine sands (Facies 14c). **a)** Massive normally graded medium sand with course to fine pebble gravel (Facies 15).	**b)** CH, FSr, SB **a)** CH, FGmg	**c)** CGwsh(?)	F3: 1
Bed 5, 1.30 m +	Pinkish grey (5RY 8/1) fine silty sand with large - small cobble gravel sized rip up clasts of indurated moderate reddish brown (10R 4/6) silty fine sand.	-Iron staining in places -Massive -Poorly sorted -Sharp, parallel, uneven erosive lower contact -In places, the base of the bed is lined with pinkish grey (5RY 8/1) silty fine sand rip-up clast. -This bed thins laterally and almost pinches out in places along the section. In places, it is cut by fluvial channels -Disconformable lower contact -Loads onto the lower bed	-None	Massive, fine sand with very coarse pebble gravel (Facies 15).	FGmm, CH	-None	F3: 1
Bed 4, 0.05 m	Pinkish grey (5RY 8/1) silt with sandy inclusions.	-Massive -Uneven contacts that follow the erosional base of Bed 5	-None	Groundwater sheet carbonate layer (Facies 19d).	CGWsh		F3: 1

Table 2, Continued

Bed number and thickness	Field facies description	Sedimentary structures/features	Post-depositional facies	Bed Name and code (See Chapter 5)	Depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Post-depositional environments (Tables 16, Figs 4.2 – 4.4 and Chapter 5)	Facies Group (Chapter 8)
Bed 3, 1.20 m	Pinkish grey (5RY 8/1) fine silty sand (<30%).	-Massive overall, but with occasional beds sets that infill small channels (<0.30 m in diameter and < 0.2 m in height) that go from trough cross-beds to horizontally laminated in the upper. - Disconformable lower contact, over-hangs lower bed by ca. 0.10 m -Loads onto the lower bed	-Small carbonate nodules occur occasionally	Massive fine silty sand with occasional small pebble gravel lined channels (Facies 14a)	FFSm, SG, CH (FFs)	CPedN or CGNod	F3: 1
Bed 2, 0.30m +	Laminate silt-sized, indurated carbonate	-Plane laminations	-None	Upper bed, laminar calcrete horizon (Facies 19a)	CPedPl	CPedPl	F3: 1
Beds 1, 0.60 +	Moderate reddish brown (10R 4/6) fine silty sand.	-Massive -Sharp, parallel, uneven disconformable upper contact -Horizontal and laterally continuous bed	-Vertical jointing -Brecciation -Carbonate vain and nodule development	Massive silty fine sand with vertical jointing (Facies 14a).	- FP(?)	PBre/Nod Bre	F1

Table 3: San Mateo Hill (SMH), Site TB17, Log 3 (ca. 14.8 m thick), Barranca. See Section 6.3 and Figure 8.1 & 8.9							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 14, 1.88 m	Interbedded (<0.30 m) of pinkish grey (5YR 8/1) micritic silt with moderate reddish brown (10R 4/6) silt.	-laminations and cross-bedding,	-Vertically jointed	Interbeds of vertically jointed, laminate to cross-bedded muddy micrite (Facies 8b) and silt (Facies 13b).	LMa, F/LMs	LLer, PNod/Bre	F2: 1
Bed 13, 0.70 m	Moderate red (5R 4/6) silt	-Massive		Massive, vertically jointed silt (Facies 13b).			
Bed 12, 0.88 m	White (N9), hard, indurated micritic silt	-Massive	-None	Massive calc-mudstone (Facies 3a)?		None	
Bed 11, 0.40 m	Moderate red (5R 4/6) silt	-Massive	-Vertically jointed	Massive, vertically jointed silt (Facies 13b).		LLer, PNod/Bre	
Bed 10, 0.24 m	White, powdery micritic silt	-Vague horizontal laminations	-None	Laminated calc-mudstone (Facies 3a)?		None	
Bed 9, 0.30 m	Pale red (5R 6/2) silt	-Massive	-Vertically jointed	Massive, vertically jointed silt (Facies 13b).		LLer, PNod/Bre	
Bed 8, 0.40 m	White (N9), powdery micritic silt	-Vague horizontal laminations		Laminated calc-mudstone (Facies 3b)?			

Table 3, Continued							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chaper 8)
Bed 7, 0.20 m	Pale yellowish green (10GY 7/2) clay	-Massive -Gradational upper contact	-None	Massive clay (Facies 11b).	LMs	None	
Bed 6, 2.10 m	Pale red (5R 6/2) fine silty sand			Vertically jointed, massive silty fine sand (Facies 14a).			
Bed 5, 0.50 m	White (N9) powdery micritic silt	-Vague horizontal laminations -Disconformable upper and lower contacts	-Vertical jointing	Laminated calc-mudstone? (Facies 3a)			
Bed 4, 1.30 m	Pale red (5R 6/2) silt	-Massive -Horizontal and laterally continuous large beds		Massive silt (Facies 13a).			
Bed 3, 0.50 m	Pale yellowish green (10GY 7/2) clayey silt		-None	Massive mud (Facies 12b).			
Bed 2, 3.10 m	Pale red (5R 6/2) muddy silt			Massive mud (Facies 12a).			F2: 1
Bed 1, 3 m	Pale yellowish green (10GY 7/2) clayey silt			Massive mud (Facies 12a).			F1: 1

Appendix Four:
Barranca de Colores (Site TB9), Arroyo Salado de Hueypoxtla (Site TB12), Tlapanaloya (Site TB13), Barranca la Gloria (Site TB7) logs

Table 1: Barranca de Colores (BDC), Site TB9, Log 1 (ca. m thick), Lacustrine sediments on the vertical section. Samples collected every approximately 0.06 m. See Section 6.6 and Figures 8.1 & 8.9						
Bed number and thickness	**Field facies description**	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 24, 0.05 m: L1 0.04 m.	Very fine silt and clay with vertical and horizontal (ca. 0.30 m in diameter) prismatic structures. Contains flecks (< 1mm) of carbonate — straight disconformable boundaries.	Greyish yellow green (5GY 7/2), vertically jointed, mudstone**.**	Mudstone (Facies 12c)	Im:	PBre	F2: 1
Bed 23, 0.12m. L2. 0.04 m	Fine white (N9) silt. Undulates in section.	White (N9) muddy micrite	Muddy micrite (Facies 9b)	F/LMls, LMa, LMs	None	
L3 0.03 m	Fine white (N9) silt. Undulates in section.	White (N9) calc-mudstone	Massive calc-mudstone (Facies 3b)	F/LMls, LMa, LMs	None	
L4.0.05 m	Olive clay. Undulates in section, lensed in places.	Greyish yellow green (5GY 7/2), micritic mudstone.	Massie micritic mudstone (Facies 9b)	Im: Vegetated marsh or mudflat	PBre	
Bed 22, 0.10m: L5. 0.05 m	White, consolidated silt. Undulates, bed pinches and swells.	White, (N9) calc-mudstone.	Massive to faintly laminated calc-mudstone (Facies 3b)	F/LMls, LMa	None	
L6. 0.05	Olive clay layers that undulate laterally in areas creating thicker and thinner areas. Undulates in section, lensed in places.	Greyish yellow green (5GY 7/2), micritic mudstone.	Massive micritic mudstone (Facies 9b).	Im:	PBre	
Bed 21, 0.25m: L7 0.05 m	Hard white silt with olive clay balls (1-2 mm in diameter) re-worked into the bed. The bed undulates laterally and is.	White (N9) massive calc-mudstone. Contains greyish yellow green (5GY 7/2) mud clasts (<2mm diameter).	Massive, intraclastic calc-mudstone with clay rip-up clasts (Facies 6 in Facies 3b matrix).	FInls, F/LMls, LMa.	None	
L8 & L9 0.10 m	White powdery silt is containing root casts with manganese. Massive and lensed in places and pinches out, laterally discontinuous	White (N9) calc-mud. Poorly cemented, root casts and manganese.	Massive calc-mudstone (Facies 3b) with calcified roots	LMa, F/Lstmls 2, very poorly developed	None	
L10 0.05 m	Olive clay with carbonate inclusions (1-2 mm in diameter). Vertically jointed, massive, laterally discontinuous. Undulates in section, lensed in places.	Greyish yellow green (5GY 7/2), vertically jointed, micritic mudstone.	Massive, intraclastic micritic mudstone (Facies 9b)	Im, FGmm within that environment?	PBre	

Table 1: Continued						
Bed number and thickness	**Field facies description**	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 20, 0.30 m: L11 L12 L13 0.20 m	L11: Very fine white, massive silt with olive clay balls 1-2 mm across. The lower bed (L12) has 1mm balls of red/olive clay and includes coarser sandy sediment. Massive and lensed in places, laterally discontinuous	White (N9), massive calc-mudstone With clay rip-up clasts	Massive calc-mudstone with sand-sized clay rip-up clasts (Facies 6 in Facies 3b matrix)	FInls, F/LMls, LMa.	None	F2: 1
	L12: Coarse sand with 1mm balls of red/olive clay and includes coarser sandy sediment. Massive and lensed in places, laterally discontinuous	White (N9) massive packstone with clay rip-up clasts	Massive packstone with sand-sized clay rip-up clasts (Facies 6 in Facies 3b matrix)	FInls, F/LMls, LMa.	None	
	L13: Coarse sand with flecks of clay or manganese and larger (1-4 mm in diameter) balls of red and green clay. End of unit 1. Massive and lensed in places, laterally discontinuous	White (N9) muddy micrite. Contains greyish yellow green (5GY 7/2) and moderate red (5R 5/4) mud clasts (1-4 mm in diameter). Also, contain clay flecks <1mm and manganese.	Massive, intraclastic muddy micrite clay rip-up clasts (Facies 6)	FInls, F/LMls, LMa.	None	
L.14 L15 0.10 m	L14: Pink silt with flecks of white carbonate silt. Massive. Undulating upper and lower contacts.	Moderate pink (5R 7/4) massive muddy micrite. Occasional white (N9) intraclasts (<1 mm in diameter).	Massive intraclastic muddy micrite with (Facies 6 in Facies 8b matrix)	FInls, F/LMls, LMa.	None	
	L15: Pink silt with flecks of white carbonate silt. Massive. Undulating upper and lower contacts. Undulating upper and lower contacts.	Moderate pink (5R 7/4) micritic mudstone. Occasional white (N9) sandy micrite intraclasts (>1 mm in diameter).	Massive, intraclastic micritic mudstone (Facies 6 in Facies 9b matrix)	FInls, F/LMls, LMa.	None	
Bed 19, 0.25 m L16	White, hard carbonate band (0.07 m). Massive	White (N9), hard, massive, calc-mudstone.	Massive calc-mudstone (Facies 3a)	LMa, F/LMls: Shallow	None	
L17	Pink silt with small carbonate nodules 1-3 mm in diameter. Massive	Moderate pink (5R 7/4) massive muddy micrite. Occasional sandy white (N9) carbonate nodules (<2 mm in diameter).	Massive, intraclastic muddy micrite (Facies 8b).	FInls, LMa.	CGNod	
L18	As Above	Moderate pink (5R 7/4) massive, micritic mud.	Massive, intraclastic micritic mud (Facies 9b)	FInls, LMa.	CGNod	
L19	Light pink silt. Massive	Greyish pink (5R 8/2) massive muddy micrite.	Massive muddy micrite (Facies 8b)	F/LMls, LMa.	None	

Table 1: Continued						
Bed number and thickness	**Field facies description**	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Beds 18, 0.40 m L20, 0.02 m	Light cream silty fine sand with flecks of carbonate (<1 mm in diameter). Massive	Yellowish grey (5Y 8/1) massive calc-mudstone.	Massive calc-mudstone with sand-sized carbonate nodules (Facies 3b matrix/Facies 6).	F/LMls, LMa.	None	F2: 1
L21, 0.10 m	White silt layer with clay. Massive and lensed in places, laterally discontinuous, with occasional intraclast rich clusters and calcified roots	Yellowish grey (5Y 8/1) massive muddy micrite.	Massive muddy micrite (Facies 8b) with calcified roots (Facies 1)	LMa, F/Lstmls 2, very poorly developed	PRm?	
L22, 0.08 m	White silt layer with clay. Massive and lensed in places, laterally discontinuous with occasional intraclast rich clusters and calcified roots	As above	Massive muddy micrite (Facies 8b) with calcified roots (Facies 1)	LMa, F/Lstmls 2, very poorly developed	None	
L23, 0.10 m	White silt layer with clay. Massive and lensed in places, laterally continuous, also contains roots traces and carbonate flecks but generally as above.	As above. Also has calcified roots and intraclasts (< 2mm in diameter).	Massive muddy micrite (Facies 8b) with calcified roots (Facies 1)	LMa, F/Lstmls 2, very poorly developed	None	
L24, 0.10 m	None	Moderate pink (5R 7/4) massive, muddy micrite. Occasional white (N9) intraclasts (<4 mm in diameter).	Muddy micrite gravel with fine pebble clasts. (Facies 15, matrix Facies 8)	F/LMls, LMa.	None	
L25, 0.05 m	None	As above	As above	F/LMls, LMa.	None	
Bed 17, 0.42 m: L26, 0.02 m	Olive clay with tiny dots of carbonate. Massive, relatively well sorted	Greyish yellow green (5GY 7/2) micritic mud.	Micritic mud (Facies 9b)	Im. FGmm within that environment?	None	
L27, 0.06 m	Olive clay, vertical jointing. Massive, relatively well sorted	Greyish yellow green (5GY 7/2), desiccated, vertically jointed clay.	Massive clay (Facies 11b)	Im. FGmm within that environment	PBre	
L28, 0.12 m	Olive clay with a little silt, carbonate flecks (<0.5 mm) vertical jointing. Massive, relatively well sorted	Greyish yellow green (5GY 7/2), massive micritic mud.	Massive micritic mud with small carbonate flecks (<.5 mm) (Facies 9b)	Im. FGmm within that environment	FGwc, CGNod, PBre?	
L29, 0.18 m	As above, but with increasing silt and larger (<1 mm) carbonate flecks. Massive, relatively well sorted	Greyish yellow green (5GY 7/2), massive micritic mud.	Massive micritic mud with small carbonate flecks (< 1mm) (Facies 9b)	Im. FGmm within that environment	FGwc, CGNod, PBre?	
L30 - 32, 0.24 – 0.40 m	Olive clay. Massive, relatively well sorted	Greyish yellow green (5GY 7/2), massive micritic mud.	Massive micritic mud (Facies 9b)	Im. FGmm within that environment	None	

Table 1: Continued						
Bed number and thickness	**Field facies description**	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 16, 0.33 m: L. 33, 0.15 m	Light red clayey silt. Transitional bed from olive to red sediment. Massive poorly sorted	Moderate pink (5R 7/4), massive mud. Flecks (<1 mm) of greyish yellow green (5GY 7/2) mud.	Massive mud with small clay flecks (Facies 12a)	F/LMls, LMa.	None	F2: 1
L.34, 0.25 m	Transition from 0.9 m	Moderate pink (5R 7/4), massive mud.	Massive mud (Facies 12a)	F/LMls, LMa.	None	
L35	None	Moderate pink (5R 7/4), massive mud	Massive mud (Facies 12a)	F/LMls, LMa.	None	
Bed 15, 0.40 m: L36 (upper Log 1)	None	Moderate pink (5R 7/4), calc-mud	Massive calc-mud (Facies 3a)	F/LMls, LMa.	None	
Facies 18c tephra	Fine powdery greyish silt. Massive	Dacitic ash. White (N9) to very light grey (N8) fine sandy silt.	Massive, very fine andesitic ash (Facies 18c)	Re-worked tephra	None	F2: 2
Bed 14, 9.98 m: L37, 0.50 m	Red silty clay.	Pale red (5R 6/2), massive mud.	Massive mud (Facies 12a)	F/LMls, LMa.	None	F1: 2
L38, 0,50 m	Olive clayey silt.	Greyish yellow green (5GY 7/2), massive mud.	Massive mud (Facies 12a)	LMs	None	F1: 1
L39, 1 m	Olive silty clay.	Greyish yellow green (5GY 7/2), massive mud.	Massive mud (Facie 12a)	LMs	None	
L40, 1 m	Red silty fine sand.	Moderate pink (5R 7/4), massive fine sand	Massive fine sand (Facies 14c)	LMs	None	F1: 2
L41, 1 m	Red silty fine sand. .	Moderate pink (5R 7/4), massive fine sand.	Massive fine sand (Facies 14c)	LMs	None	
L42, 1 m					None	
L43, 1 m					None	
L44, 1.98 m					None	
Bed 13: No sample. 0.05 m L45	Carbonate band interbedded within the red silty fine sand. Wavy plane contacts. There are continuous and discontinuous lamina of silty fine sand, some lenses that are vertically jointed	White (N9) muddy micrite with manganese/moderate red (5R 5/4) silty fines sand	Muddy micrite interbedded with silty fine sand (Facies 9a/Facies 14a)	LMs	PBre	F1: 3
Bed 12, 0.90 m: L46.	Red silt	Pale red (5R 6/2), massive sandy micrite.	Massive sandy micrite (Facies 10a)	LMs	None	F1: 2

Table 1: Continued

Bed number and thickness	Field facies description	Petrographic facies description	Bed name (See Chapter 5)	Depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Post-depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Facies Group (Chapter 8)
Bed 11, 1.28 m: L47.	Transitional bed from olive clay to red silt (sample collected 0.75 m from upper contact). (on the slope now)	Pale red (5R 6/2), mud.	Missive micritic mud (Facies 9b)	LMs	None	F1: 2
Bed 10, 2.5 m: L48.	Olive clay (sample collected 0.75 m from upper contact).	Greyish yellow green (5GY 7/2) massive, muddy micrite.	Massive muddy micrite (Facies 9a)	LMs	None	F1: 2
Bed 9, 0.4 m: L49.	Transitional bed from red silt to olive clay (sample collected 0.60 m from upper contact).	Light greyish green (5G 8/1) massive muddy micrite.	Massive muddy micrite (Facies 8a)	LMs	None	F1: 2/F1:1
Bed 8, L.50: 0.10 m	Carbonate band interbedded within the red silty fine sand. Wavy plane contacts. There are continuous and discontinuous lamina of fine silty sand, some lenses that are vertically jointed	White (N9) Calc-mudstone with manganese/moderate red (5R 5/4) silty fines sand	Calc-mudstone interbedded with fine silty sand (Facies 14a/Facies 3)	LMs	None	F1: 3
Bed 7, 6.56 m: L. 51: 0.50 m	Red silt (collected at 0.25 m).	Pale red (5R 6/2), massive silt.	Massive silt (Facies 13a)	LMs	None	F1: 2
L.52, 1.2 m	Red silt	Pale red (5R 6/2), massive micritic mud.	Massive micritic mud (Facies 9b)	LMs	None	
L. 53, 2 m	Red silt (collected mid-section)	Pale red (5R 6/2), massive silt.	Massive silt (Facies 13a)		None	
L.54, 1 m	Red silt (collected from the base of the bed).	Pale red (5R 6/2), massive micritic mud.	Massive micritic mud (Facies 9b)		None	
L. 55, 2.4 m.	Red silt	Pale red (5R 6/2), massive mud.	Massive silt (Facies 13a)		None	
Bed, 6, 0.30 m: L56,	Carbonate band interbedded within red silty fine sand. Wavy plane contacts. There are continuous and discontinuous lamina of fine silty sand	White (N9) Calc-mudstone interbedded with fine silty sand	Calc-mudstone interbedded with fine silty sand (Facies 3/Facies 14a**). Older than 500 ka BP (U-Series age)**		None	F1: 3

Table 1: Continued						
Bed number and thickness	**Field facies description**	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 5, 1m: L. 57	The transition from olive clayey silt to red silt. Massive Plane bedding planes Laterally continuous	Moderate pink (5R 7/4) micritic mud.	Massive micritic mud (Facies 9b)	LMs.	None	F1: 2/F1:1
Bed 4: 1.7 m: L. 58	Olive clayey silt (sample collected mid-bed). Massive, plane bedding planes, laterally continuous	Greyish yellow green (5GY 7/2), massive mud.	Massive mud (Facies 12a)	LMs	None	F1: 1
Bed 3, 1.36 m: L. 59 taken mid-section	Red silt. Massive Plane bedding planes Laterally continuous	Pale red (5R 6/2), massive mud.	Massive mud (Facies 12a)	LMs	None	F1: 2
Bed 2, 1.4 m: L. 60 taken mid-section	Transitional contact from olive clayey silt to red silt. Massive Plane bedding planes Laterally continuous	Light greenish grey (5G 8/1) massive micritic mud.	Massive micritic mud (Facies 9b)	LMs.	None	F1: 2/F1:1
Bed 1, 6.28 m: L. 61, 1 m from upper contact	Olive clay. Massive Plane bedding planes Laterally continuous	Greyish yellow green (5GY 7/2), massive muddy micrite	Massive muddy micrite (Facies 8b)	LMs. TCC 50% suppressed TOC	None	F1: 1
L. 62, 3.5 m: down from the upper contact.	Olive clay. Massive Plane bedding planes Laterally continuous	Greyish yellow green (5GY 7/2), massive micritic mud	Massive micritic mud (Facies 9b)	LMs	None	
L63 & L64, 0.50 m + from the base.	Olive clay. Massive Plane bedding planes Laterally continuous	Greyish yellow green (5GY 7/2), massive micritic Mud	Massive micritic mud (Facies 9b)	LMs	None	

Table 2: Barranca de Colores (BDC), Site TB9, Log 2, limestone sequence at the head of the barranca. See Section 6.6 and Figures 8.1 & 8.8					
Sample number	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
None	Gravel	Monomictic, matrix supported gravel	Slope-wash	None	F4: 1
Bed 19, 0.20 m: T1 taken from the upper 0. 15	See below	Framestone limestone (Facies 1)	F/LpStLs, LMa	None	
T2 lower bed. See Fig 5.2, Table 5.6	Bed 5: Pelleted-peloidal (Packstone) Limestone (top). More Intraclastic at the base. Silt intraclast (<3 mm in diameter), gastropod shell. Macrophyte traces with very light grey (N8) sparry calcite fringe cement, and volcaniclastic input (2 - 5%). Macrophyte root replacement with drusy calcite cement. Sparry patches (<5%).	Pelleted-peloidal (Packstone) Limestone (top). More Intraclastic at the base) (Facies 5 & 6)		Diagenetic alteration and precipitation	
	Bed 4: Very light grey (N8) wavy, biofilm layers that have outer micritic cement fringes. Contains large (3 - 4 mm) micrite coated macrophyte stem (mcms) (Fig 5.2 a & c). Volcaniclastic input (2 – 5 %). Drusy calcite organic replacement and root voids coated or partially filled manganese	Micro-framestone limestone (immature) (Facies 1)			
	Bed 3: Yellowish grey (5Y 8/1) lithoclasts (lic) <3 mm in diameter within a greyish pink (5R 8/2) silty micritic matrix. The bed contains organic detritus (od) (Fig 5.2 a & c). Gastropod shell, oncoids, biofilm laminae and volcaniclastic input (2 - 5%). Organic detritus has been replaced by either manganese or drusy calcite. Sparry cement (<5%).	Intraclastic limestone (Rudstone) (Facies 6)			
	Bed 2: Very light grey (N8) biofilm build ups around macrophyte root casts (Fig 5.2 a & d). Volcaniclastic input (2 - 5%). Macrophyte roots have been lined or filled with manganese.	Framestone limestone (immature) (Facies 1)			
	Bed 1: Greyish pink (5R 8/2), micritic silty fine sand matrix. Pisoids are irregularly shaped (<1 mm in diameter). Within the bed, there are also fine biofilm laminae (<2 mm) (Fig 5.2 a, d & e). Volcaniclastic input (2 - 5%). Peloids and ooids. Some replacement of organic material with manganese. Sparry cement patches (<5%).	Pelleted-peloidal (Packstone) limestone (Facies 4)			

Table 2: Continued

Sample number	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 18, 0.45 m: T3 top 5cm. Fig 5.10, Table 5.12	Bed 3: Greyish pink (5R 8/2) silt matrix with occasional white micritic intraclasts. Infilled desiccation crack or remobilised silt and fine sand under deposited under vadose conditions	Silt (Facies 13b)	F/LMls, LMa, LMs: Primary: Water-lain carbonate. Relatively deep, saline conditions.	PBre/PRm: Calcite veins cut the sample. Moderate red (5R 5/4) silt infill has worked its way through the depots along weaknesses and joints. Secondary brecciation suggests strong drying and evaporation.	F4: 1
	Bed 2: Greyish pink (5R 8/2) grain supported peloidal (<1mm) packstone. Moldic porosity < 30%. Calcite vein development.	Peloidal packstone limestone (Facies 4)			
	Bed 1: Greyish pink (5R 8/2) pisoids (pi) (2-4 mm in diameter) have a maximum of two, relatively concentric coatings that mainly consist of darker and lighter white (N9) layers of micrite. Pisoids are set within a greyish pink (5R 8/2) to white (N9) matrix (Fig 5.10 a – e). Root penetration after water depth has decreased, leaving root traces (Fig 5.10 d). Calcite veins have replaced or been reprecipitated along joint weaknesses and cracks created by desiccation and root penetration. Root penetration, desiccation and potentially much later microkarst features have allowed groundwater to move light red (5R 6/6) clastic silt through the deposit that has replaced micrite along weaknesses or infilled void spaces. All the above have caused the brecciation of the original pisolitic limestone. Organic material has been replaced by drusy calcite, and in places coated with manganese (mg) (Fig 5.10).	Brecciated, Pisolitic limestone (Facies 5)	F/LMls, LMa, LMs: Primary: Water-lain carbonate. Relatively deep, saline conditions (Hunt pers comm, 2017). Pisoids flowing or turbulent water (Tucker and Wright, 1990). See T13.		
Bed 17, 0.55 m: T4, 0.30-0.35 m from the top of the bed.	Greyish pink (5R 8/2) stromatolitic limestone with sparry and micritic fringe cement	Stromatolitic limestone (Facies 2a)	Fstmls, LMi: Low energy fluvio-lacustrine?	None	
Bed 16; T5, 0.20 m. See Figures 5.6, 6.33 and Table 5.10	Greyish pink (5R 8/2) calc-mudstone. mud with shell fragments (upper bed). Possibly cross-bedded channels dissecting the whole bed with massive infills. Ephemeral deposition of calc-mud in cross beds ca. 7 mm thick. Secondary features include a salt hopper crystal, post depositional root traces and drusy calcite formation and karstification around the outer edges of the sample along weaknesses (most obvious in the lower bed). .	Massive calc-mudstone with shell (Facies 3b).	F/LMls, LMs: Fresh (indicated by shell), relatively deep-water environment.	salt growth with hopper forms (PMk). Sparry and drusy cement under vadose conditions (diagenetic).	

Table 2: Continued					
Sample number	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 15, 0.42 m: T6 top 10cm. T7, lower 0.10-0.20 m. T8 lower 0.30-0.35 m.	White N9 to greyish pink (5R 8/2) weakly laminated calc-mud.	Weakly laminated calc-mudstone Facies 3b/Facies 7)	F/LMls, LMa: Fresh (indicated by shell), relatively deep-water environment.	The deposit has undergone varying degrees of post-depositional cementation and weathering — some drusy calcite development.	F4: 1
Bed 14: 0.25 m: T9, lowest 0.05 m.	Moderate red (5R 5/4) micritic mudstone. Disconformable upper and lower contacts.	Massive micrite mud (Facies 8b).	LP, FFm: Variations to the hydrological regime, fluctuating water levels and subaerial exposure erodes and reworks existing sediments, and this can be followed by humus-rich soil horizon. This is corroborated by a corresponding peak in TOC (13%).	PBre	
Bed 13: 0.15 m: T10. Fig 5.19, Table 5.19.	Bed 3: Very light grey (N8) calcrete laminar feature, possibly with a lower nodular horizon directly below.	Immature laminar calcrete horizon (top). (Facies 19a	Flnls, LMa, LMs: Primary massive features indicate relatively deep, but fluctuating hydrology and energy levels.	PBre: The whole bed has been cut with post-depositional calcite veins along weaknesses. CPadPl, poorly developed	
	Moderate red (5R 5/4) fine-grained low energy mud that has areas of increased energy micritic sand in-wash. Volcaniclastic input (15%).	Micritic mudstone (Facies 10b)		The post-depositional movement of water through the deposit, probably under vadose conditions has removed the primary sediment and replaced this with calcite veins infilling the conduits.	
	Fine alternating parallel lamina of blocky moderate red (5R 5/4) micritic mud and indurated, greyish pink (5R 8/2) hard micritic lamina (< 2 mm). Volcaniclastic input (15%).	Stromatolitic micritic mudstone (bottom)(Facies 2a)			

Table 2: Continued					
Sample number	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 12, 0.30 m: T11	T11: Moderate red (5R 5/4) calc-mudstone. With biofilm lamina.	Faintly laminated to massive calc-mudstone with biofilm lamina (Facies 3b).	F/LMls, LMs: With fluctuating hydrology indicated by the biofilm lamina	PRm, PMk, Ich. Karst features as well as incision and re-working. Wetting and drying, possibly under vadose conditions, and desiccation has created karst features and replaced portions of the original matrix and secondary cement and moderate red (5R 5/4) silt. .	F4: 1
T12 (see Figure 1)	T12: Moderate red (5R 5/4) clayey mud interbedded with wavy continuous and discontinuous micritic lamina (<2 mm), (biofilm layers. Possibly some root voids but the sample is really too small to identify them correctly. There is a consistent component of volcanic mineral input into the clay.	Faintly laminated to massive calc-mudstone with biofilm lamina (Facies 3b).			
Beds 11, 0.40 m: T13, See Fig 5.9 and Table 5.11.	Bed 3: Desiccation cracks (dc) infilled with layers of reprecipitated white (N9) micrite and pinkish grey (5YR 8/1) clastic silty fine sand (Fig 5.9 b & c).	Bioturbated Peloidal limestone (packstone) interbedded with pisolitic limestone (Facies 4/Facies 5).	F/LMls, LMa, LMi: The pisoliths suggest fresh to brackish waters. In lake systems, they are associated with wave dominated zones. This could apply to smaller water bodies also. F/LMls, LMs: Bioturbated peloidal limestone suggests near shore to basinal shallow lake or pool environment.	None	
	Bed 2: Large, white (N9) freeform pisoids (pi) that are <5 mm in diameter within a pinkish grey (5YR 8/1) micritic (mi) cement (Fig 5.9 b).	Bioturbated Peloidal limestone (packstone) interbedded with pisolitic limestone (Facies 4/Facies 5).	Pisolitic limestone (Facies 5)	PRm	
	Bed 1: Rounded to irregular yellowish grey (5Y 8/1) peloids (pe) (<1 mm in diameter) that form a clotted fabric. Matrix is white (N9) - pinkish grey (5YR 8/1) bioturbated (bt) micritic silt (Fig 5.9 a, c & d).		Peloidal limestone (Facies 4)	None	

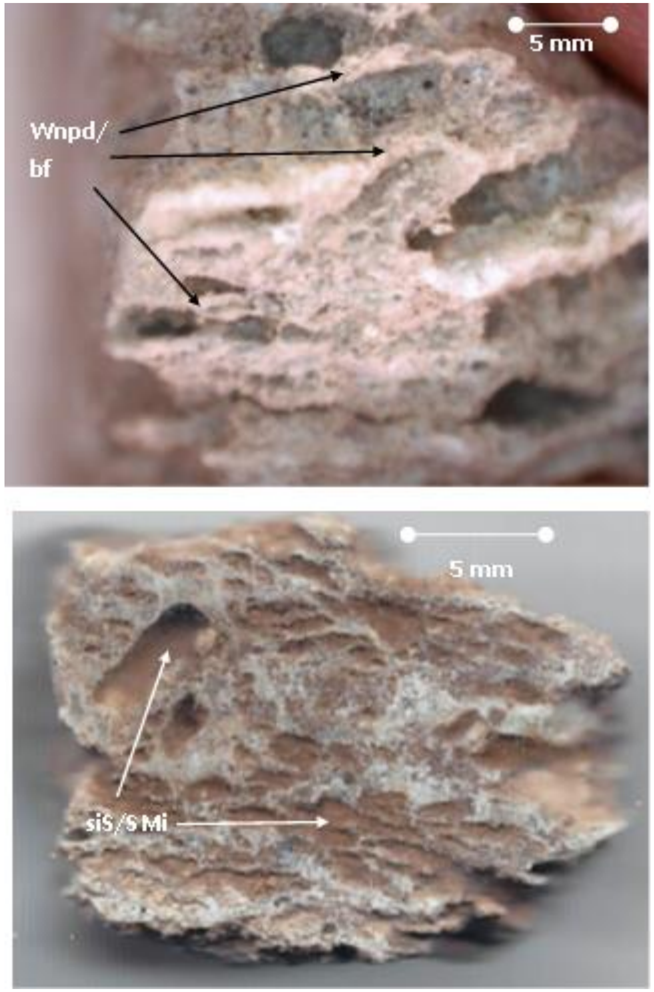


Figure 1: Sample T12. See Barranca de Colores, Table 2 for description

Table 2: Continued

Sample number	Petrographic facies description	Bed name (See Chapter 5)	Depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Post-depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Facies Group (Chapter 8)
Bed 10, 0.25 m: T14 (Figure 2)	Bed 2: White (N9) micritic silt with biofilm lamina, root traces, and organic detritus. Some organic material has been infilled with manganese or drusy calcite. Secondary brecciation of the micrite an calcite vain development and void infill with micritic silt and calcite. Volcaniclastic input throughout.	Brecciated, interbedded, biogenic calc-mud (Facies 3b).	F/LpStls, LMi: Pool or pond environment that had rooted and in-washed (detrital) vegetation that has been replaced with drusy calcite and manganese in some cases.	PBre: Manganese lines.	F4: 1
	Bed 1: Wavy biofilm lamina and in places bubbly texture with vegetation (ca. 4 mm) interbedded micritic and volcaniclastic silt trapped and infilling the bubbly texture. The above is interbedded with very fine micritic mud beds (<4mm). Sparsely interbedded with very fine, black – brown clastic (possibly volcanic) lamina (<1 mm). Calcite crystals within the fine micrite beds are thought to be secondary gypsum replacement.	Framestone carbonate (Facies 1) interbedded with very fine calc-mudstone (Facies 3b)	F/LpStls, LMi, Shallow, relatively saline pool or pond environment with strong evaporation is relate to the phytoherm framestone, further shallowing and stronger evaporitic processes are associated with the calcic-mudstone and gypsum formation.	Calcite crystals within the fine micrite beds that replaced the gypsum and calcite veins throughout the bed are secondary and thought to represent a second drying event were desiccation voids became infilled with sparry calcite.	
Bed 9, 0.40 m: T15 1 T16, bottom 0.5 m.	Greyish pink (5R 8/2) ripple cross-bedded calc-mud with coarser sandy in-wash lenses. Some micro trough crossbedding and channel forms with very occasional root traces infilled with drusy calcite and bio-film lamina High proportion of volcaniclastic input (30%). Speckled texture indicates aeolian fallout.	Interbedded massive, peloidal to intraclastic calc-mudstone with coarser sandy in-wash lenses and micro trough-cross bedding (Facies 3b, 4, 6, 10 & 14?)	Flnls, LMa, LMs: Primary features indicate low, but fluctuating, energy, ephemeral fluvial-lacustrine environments.	PRm: Calcrete calcite veins that cut all original features. Indicates alternations between standing/flowing water to drying, exposure and calcite vain development.	

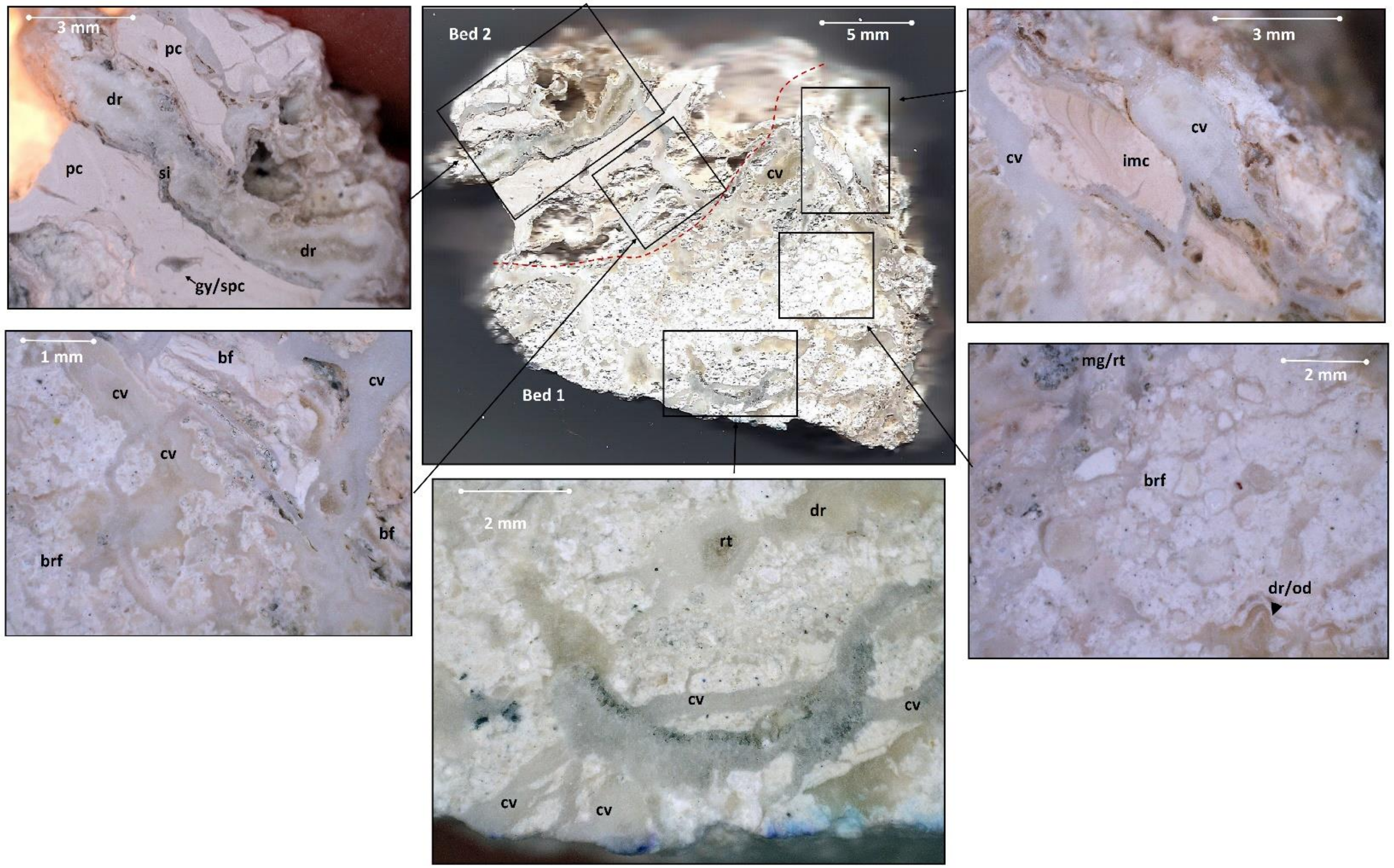


Figure 2: Sample T14, see Barranca de Colores, Table 2

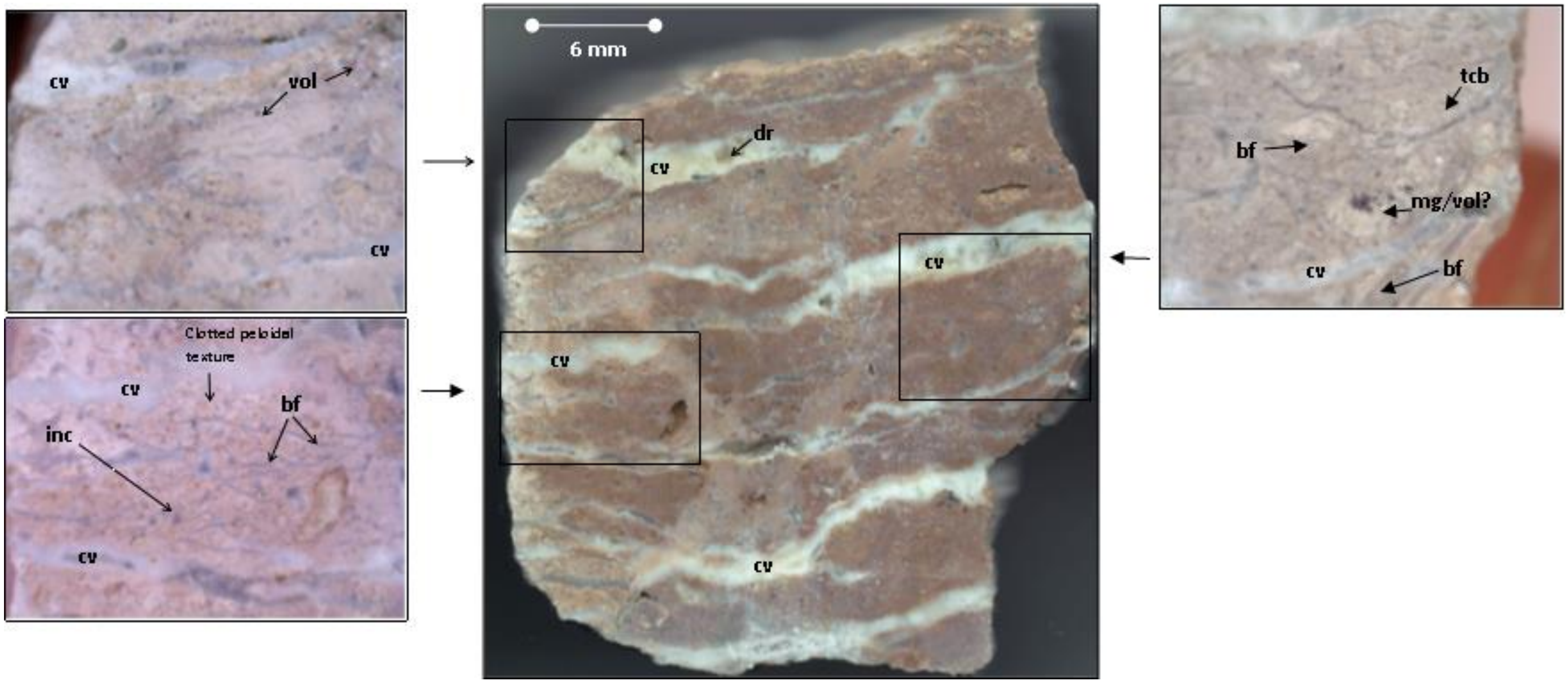


Figure 3: Sample T15, see Barranca de Colores, Table 2

Table 2: Continued

Sample number	Petrographic facies description	Bed name (See Chapter 5)	Depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Post-depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Facies Group (Chapter 8)
Bed 8, 0.35 m: T17 top 5cm.	Greyish pink (5R 8/2), muddy micrite.	Laminated muddy micrite (Facies 8b)	F/LMls, LMa: Low energy	None	F4: 1
T18, 0.10-0.15 m from top.	Greyish pink (5R 8/2), calc-mudstone. Contains occasional biofilm lamina (<1mm thick). Some micro cross-laminated that (<2 mm thick) are infilled with coarser micritic sand in-wash.	Very fine ripple cross-laminated calc-mudstone intraclastic lenses (Facies 3b).	FSr, Flnls, LMa: Shallow water and re-working. Relatively high energy environment. Fluctuating hydrology, biofilm represent calmer/warmer periods allowing microbial colonisation — lower flow regime.	None	
T1.19, Lowest 0.05 m.	As above, moderate red (5R 5/4), calc-mudstone.			None	
Bed 7, 0.15 m: T20, sample taken mid bed.	Moderate red (5R 5/4), mudstone.	Mudstone (Facies 12b).	LMa, FFsc, IOm: Organic deposit (High TOC 15%). Vegetated marsh? No evidence of drying = pool	None	
Bed 6, 1.2 m: T21: 0.05 m from the top of the bed. See Figure 4	b) The mid and upper, greyish pink (5R 8/2) calc-mudstone/packstone with cross-bedded ripples that are infilled in places with coarser sand. Incipient and isolated biofilms are present throughout the lower and mid bed. Upper bed contains void spaces, possibly bioturbation or void spaces. a) The lower bed greyish pink (5R 8/2) interbedded calc-mudstone/packstone and bio-film lamina. Volcaniclastic throughout (<10%). Secondary features include sparry (white (N9) and drusy (brilliant green 5G 6/6) cement (<5).	b) Bioturbated calc-mudstone (Facies 3b). a) Ripple cross laminated interbeds of calc-mudstone (Facies 3b), coarse sand and biofilm lamina dominating	b) F/LMls, LMs: Relatively deep, low energy pool environment with bioturbation. Bed has a stronger clastic influence a) Flnls, LMa: Fluctuating water levels indicated by the alternations between biofilms and calc-mudstone. Decreased water level (marginal pool) or shifting hydrology (fluvial). Higher energy environment suggested by cross-bedded ripples and coarser sediment in-wash. .	Along some of the cross-bedding contacts, secondary calcite veins have formed along weaknesses.	
T22 0.75-0.80 m					
T23 0.83-0.90 m	White (N9), powdery, weathered, poorly cemented calc-mud. Characteristically like T24.	Laminated to massive calc-mud (Facies 3b)	F/LMls, LMs, LMa: Relatively deep, low energy pool environment	None	
T24 base of the bed.	White (N9), calc-mudstone**.** The bed is littered with what look like decayed water weed filaments that have drawn in manganese during the decay processes (secondary). The bed is interspaced with biofilm layers, with a more established biofilm build-up in the upper bed, shallowing sequence? Sub-facies include shell fragments, volcaniclastic and some drusy cement (brilliant green 5G 6/6).	Laminated to massive intraclastic calc-mudstone with biofilm lamina and manganese (Facies 3b/6)	F/LMls, LMs, LMa: Calc-mudstone with shell suggests fresh, relatively deep water. Stromatolitic beds in the upper deposit suggest shallowing upwards. Clear waters with emergent plants, warm, evaporitic stage.	None	

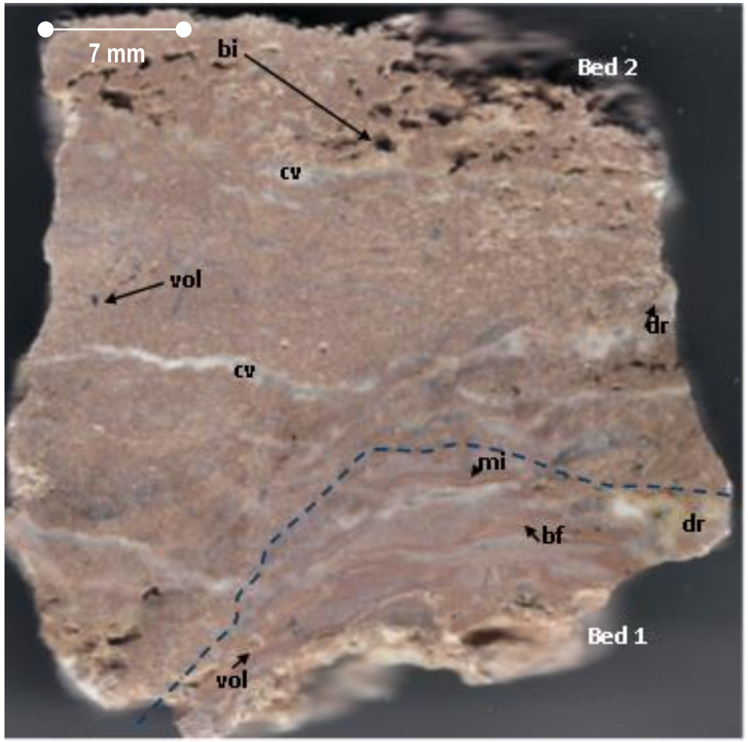


Figure 4: Sample T21, see Barranca de Colores, Table 2

Table 2: Continued					
Sample number	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 5	Basaltic-andesite tephra	Basaltic-andesite fine to medium ash (Facies 18a)	Re-worked	None	F4: 2
Bed 4, 0.20 m: T25, base	Moderate red (5R 5/4), massive, mudstone. Contains small channels and several units of re-worked sediment inter-bedded with carbonate nodules. At the base 0.01 m of red-brown silty clay (T25). Disconformable contacts.	Massive mudstone (facies 12c)	FFm, FP: drape deposit or paleosol deposit (High TOC 15%). Occurs in response to hydrological variations. Vegetated marsh?	Erosion, downcutting, re-working and dissolution in the upper bed. The lower sampled bed represents the onset of this cycle of erosion.	F4: 1
Bed 3, 1.40 **m:** T26 top 0.05 m.	White (N9) to greyish pink (5R 8/2) brecciated, pisolitic limestone. Bed contains volcaniclastics including a large schist particle (2mm in diameter).	Pisolitic limestone (Facies 5)	LMa, LMi: Fresh to brackish waters. In lake systems, they are associated with wave dominated zones or flowing waters in fluvial systems (e.g. FBls, Fig 4.8). This could apply to smaller water bodies also.	PBre, PRm: Secondary root penetration after shallowing that cut the pisoliths and fabric, organic material has been replaced with drusy cement. The salt hopper casts and gypsum suggest strong evaporation processes	
T27, 0.25-0.30 m down.					
T28 0.58-0.80m down.					
T29 1.10-1.15 m down.	Greyish pink (5R 8/2) biogenic calc-mudstone (Facies 3b). Manganese clusters and root traces or voids infilled with secondary silt.	Biogenic calc – mudstone (Facies 3b)	LMa, LMi	None	
T30 base of bed 1.4 m.					
Bed 2, 0.05 m: T31, mid bed	Vertically jointed greyish yellow green (5GY 7/2) mudstone.	Massive micritic mud (Facies 10)	Fp, Lp (Tables 4.8 & 4.10) Green to brown mixed carbonate organic deposits (although TOC values 8%)). Paleosol	PBre: Small carbonate veins and nodules that infill (Fp?). Root penetration.	

Table 2: Continued					
Sample number	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 1, 0.70 m. T32 top 0.10 m.	Greyish yellow green (5GY 7/2) agglutinated (?) stromatolitic limestone. Wavy, discontinuous sub-parallel white (N9) biofilm lamina (<5mm thick) interbedded with greyish yellow green (5GY 7/2) blocky, fine muddy micrite. The muddy micrite lamina (<10 mm) also contains balls (of the same sediment) that have, in some sections	Agglutinated stromatolitic limestone interbedded with sandy micrite and calc-mudstone (Facies 2b)	Agglutinated (?) stromatolitic. Trapping and binding of various and available clastic material. Represent fluctuating environments with cycles sandy micrite deposition and then relativity calm conditions allowing microbial growth.	PBre	F4: 1
T33, 0.20 m	Greyish yellow green (5GY 7/2) fine sandy micrite. Contains small carbonate nodules (1-2mm in diameter).	Massive sandy micrite with sand sized intraclasts (Facies 10b).	Im: Green to brown mixed carbonate organic deposits (high TOC values (15%)).	Carbonate nodule development.	
T34, 0.40 m	White (N9) calc-mudstone. Contains fragments and whole mollusc shell fragments. Void spaces (<4mm in diameter) suggesting rapid lithification. Some of the void spaces have been filled with clastic silt. In the upper bed (last 0.06m) stromatolitic lamina (ca.0.02 m).	Calc-mudstone with shell and biofilm lamina (Facies 3a).	F/LMls, LMs: Calc-mudstone with shell suggests fresh, relatively deep water. Void spaces suggest rapid lithification. Stromatolitic beds in the upper deposit suggest shallowing upwards.	Post-depositional silt infill of void spaces as groundwater moved through the deposit. Indicative of cold stage deposition, no evaporation (Hunt, pers comm). Although, the upper bed is probably the source and there is a little micrite in there.	

Table 3: Barranca de Colores (BDC), Site TB9, Log 3 (ca. m thick), Basaltic-andesite tephra interbedded within the limestone sequence at the head of the barranca. See Section 6.6.

Log 10 (Bed 5)	A2	Bed. 2: 0.07 m of laminated fine sand with greyish yellow green (5GY 7/2) hue.	Depositional environment	**Facies Group** (Chapter 8)
	A3	Bed. 3: 0.08 m. Upper 1.5cm consists of white (N9 to very light grey (N8) fine silty sand with coarser sand inclusions. Mid bed 1.5cm of parallel laminated fine sand, no colour change. Lowest bed fine silty sand with containing coarser sands, again no colour change. **(*Dated sample)**	Tephra fall out, possibly into water. Portions of the sequence have undergone post depositional reworking either in a marginal pool or ephemeral fluvial environment.	F4: 2
	A4	Bed. 4: 0.09 m white (N9 to very light grey (N8) silty fine sand		
	A5	Bed. 5: 0.10 m greyish yellow green (5GY 7/2) fine sand with black flecks		
	None	Bed. 6: 0.02 m white (N9) fine silty sand.		
	A6	Bed. 7: <0.05 m parallel, laminated fine silt		
	A7	Bed. 8: 0.30 m fine, white (N9) silt		
	A8	Bed. 9: 0.05 m of greyish yellow green (5GY 7/2) micritic mudstone with white (N9) carbonate nodules (<1 mm in diameter). Sharp uneven lower contact.		

Table 4: Barranca de Colores (BDC), Site TB9, Log 5 (ca. 8.8 m thick) channel cutting the tufa at the head of the barranca. See Section 6.6 and Figures 8.1 & 8.9						
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed, 16	Top soil					F5:1
Bed 15, 2 m	Pale reddish brown (10R 5/4) medium silty sand	-Horizontally laminated -relatively straight lower contact -Infills channel form	Plane laminated medium silty sand (Facies 14b/c)	FFI: Alluvial: Waning flood or drape deposits. (LEF).	-None	
Bed 14, 0.69 m	Thin cycles (max thickness 0.18 m) of pale reddish brown (10R 5/4) silty sand with medium to coarse pebble gravel angular limestone intraclasts and occasional floating very large cobble gravel clasts	-The lower bedding plane is an erosive channel base Each interbeds is, -Matrix supported -Massive -Weakly normally graded -Poorly sorted -Deposited in a cut channel, almost as pulse events	Normally graded coarse pebble gravel in medium silty sand medium (Facies 15).	FGmm, SG:	-None	
Bed 13, 0.60 m	Several interbeds that have a pale reddish brown (10R 5/4) medium silty sand matrix with limestone and moderate red (5R 8/2) sub-angular silt rip-up intraclasts. * in section this bed thickens to the south-east to over 4 m extending this cut channel diameter to over 3m. Within this portion, large cobble sized limestone, and silt intraclasts and this part of the bed has the same sedimentary structures.	-The lower bedding plane is an erosive channel base Each interbed is, -Matrix supported -Massive -Weakly normally graded -Poorly sorted -Lined along the base with large cobble sized silt clasts in channel form and deposited in a cut channel, almost in pulse events	Several cycles that follow: b) Very coarse pebble gravel in fine silty sand (Facies 15). a) Clast supported large cobble gravel in fine silty sand (Facies 16/17).	FGmm, SG, interbedded with, FGcm:	-None	
Bed 12, 0.12 m	Pale reddish brown (10R 5/4) fine silty sand with occasional fine pebble gravel limestone intraclasts	-Massive -Poorly sorted -Matrix Supported	Massive medium pebble gravel in fine silty sand fine (Facies 15).	FGmm, SG	-None	
Bed 11, 0.68 m	Pale reddish brown (10R 5/4) medium silty sand matrix with very coarse angular pebble gravel limestone clasts and moderate red (5R 6/2) silt rip-up clasts.	-Massive -Matrix supported -Poorly sorted -Erosive cut channel base	Massive medium coarse pebble gravel in silty sand very (Facies 15).	FGmm, SG	-None	

Table 4 Continued						
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 10, 0.12 m	Pale reddish brown (10R 5/4) fine silty sand with occasional fine, angular pebble gravel limestone intraclast	-Parallel laminated -Some clast alignment	-None	Massive fine pebble gravel in fine silty sand (Facies 15).	FGh: GB	F5: 1
Bed 9, 0.28 m	Pale reddish brown (10R 5/4) fine silty sand with limestone and moderate red (5R 8/2) silt angular coarse pebble intraclasts.	-Massive -Matrix supported -Poorly sorted	-None	Massive medium pebble gravel in silty sand fine too (Facies 15).	FGmm, SG	
Bed 8, 0.30 m	Made up of two simple bed set cycles (ca. 0.15 m thick) of; fine to medium pebble gravel moderate red silt (5R 6/2) intraclasts in a pale red (5R 6/2) fine silty sand matrix at the base. Each cycle fines to laminated fine sandy silt.	b) Upper bed sets are parallel laminated -The bed set cycles are weakly, but normally graded -The bet sets have erosive curved basal bedding planes a) Lower bed sets massive	-None	b) Plane laminated fine sandy silt (Facies 14a). a) Massive, fine to medium pebble gravel in fine silty sand (Facies 16).	b) FFl, LEF a) FGcm, SG	
Bed 7, 0.03 m	Pale reddish brown (10R 5/4) fine sand	-Parallel laminations	-None	Plane laminated fine sand (Facies 14c).	FFl, LEF	
Bed 6, 0.07 m	Pale red (5R 6/2) fine silty sand matrix with fine to medium pebble gravel moderate red silt (5R 6/2) intraclasts	-Massive -Poorly sorted	-None	Massive fine to medium pebble gravel in silty sand (Facies 15).	FGmm, SG	
Bed 5, 0.09 m	Pale red (5R 6/2) fine silty sand matrix with small pebble gravel angular to sub-angular clast of limestone and moderate red (5R 8/2) silt.	-Massive -Matrix supported -Poorly sorted	-None	Massive clast supported, fine to very course pebble gravel in fine silty sand, (Facies 16).	FGcm, SG	
Bed 4, 0.03 m	Pale red (5R 6/2) fine sandy silt	-Parallel laminations	-None	Plane laminated silty fined sand (Facies 14b).	FFl, LEF	
Bed 3, 0.07 m	Pale red (5R 6/2) fine silty sand matrix with fine to very coarse angular to sub-angular pebble gravel clasts	-Massive -Matrix supported -The matrix and intraclast are poorly sorted	-None	Massive, very course pebble gravel with fragmented megafaunal bones in silty sand (Facies 16).	FGmm, SG	

Table 4 Continued						
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 2, 1.3 m	Pale red (5R 6/2) medium silty sand matrix with angular to sub-angular pebble to very large angular boulders (intraclastic) of limestone and red silty clay. Mammoth tuck has also been recovered from the base of this sequence.	-Massive -Matrix supported -The matrix and intraclast are poorly sorted -There is weak but normal grading -Base of the bed is a cut channel ca. 10 m wide that cuts the tufa sequence (site TB9, Log 2) and the lacustrine sequence (TB9, Log 1).	-None	Massive, clast supported pebble to very large boulder gravel with fragmented megafaunal bones (Facies 16).	FGcm, SG	F5: 1
Bed 1, 1 m+	Moderate red (5R 8/2) silt	-Massive -Disconformable, erosive upper contact	-None	Massive silt (Facies 13a).	LMs	F1: 2

Table 5: Arroyo Salado de Hueypoxtla (ASH), Site TB12, Log 1. See Figure 6.13 for location. 19° 55.775 N - 99° 07.192 W, 2243 ± 9 m a.s.l. Chapter 8 for discussion. See Figures 5 and 8.1 & 8.9

Sample number	**Petrographic description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 13, 0.09 m, L1.	Pale pink (5RP 8/2) organic mudstone: Massive but with occasional schist clasts (<1mm in diameter).	Massive mudstone (Facies 12a/c)	F/LMls, LMa	PBre, FFmm	F2: 1
Bed 12, 0.10 m. L2, 0.02 m from top	Greyish pink (5R 8/2) muddy micrite matrix. There are lines of manganese that may have developed about re-worked organic material or could be post depositional. Throughout there are occasional micro-channel forms and associated cross-bedding, but for the most part, the fabric is massive. There are also occasional white (N9) micritic (?) and moderate red lithoclasts (<4 mm in diameter). The base of the sample has a relatively high proportion of shell fragments (5%).	Ripple-cross laminated wackestone – floatstone with microchannel forms (Facies 3b/Facies 6)	FInls, FSr	-None	
L3, Mid bed.	Undulating bed of rip-up clasts: Rip-up silt clasts that have been dropped into the micritic mud. They are sub-rounded and coated in manganese, see L16 for full description. This bed undulated, and nodules are between 0f m in diameter and 0.01-0.07 m thick.	Very coarse pebble gravel in micritic mud (Facies 15 in Facies 9).	FGmm, SG	None	
L4: 0.09 m.	Greyish pink (5R 8/2) poorly sorted, clayey micritic sand. Clasts of moderate red (5R 5/4) mud with very occasional white (N9) silt clasts (<4 mm in diameter).	Fine pebble gravel (Facies 15 in Facies 9) in clayey micritic sand.	FGmm, SG. Flood event causing erosion and re-sedimentation, alluvial sedimentation. Ich	-None	
Bed 11, 0.32 m. L5, 0.04 m from top.	Greyish pink (5R 8/2) micritic mud. Bed contains occasional sun-angular, carbonate lithoclasts < 5 mm in diameter.	Massive very fine pebble gravel (Facies 15 in Facies 9) in micritic mud with.		PBre	
L6, 0.09 m.	Greyish pink (5R 8/2) diamicton in a micritic mud. Contains occasional, relatively large (< 6mm in diameter) moderate red (5R 5/4), well rounded silt lithoclasts. Bed also contains coarse sand sized angular white (N9) micritic lithoclast.	Massive very fine to fine pebble gravel micritic mud with (Facies 15 in Facies 9)	F/LMls, LMs, FGmm, SG, Ich		
L7, 0.14 m.	Greyish pink (5R 8/2), blocky, massive micritic mud.	Massive micritic mud (Facies 9)			
L8, 0. 18 m.					
L9, 0.24 m.					
Bed 10, 0.14 m. L10	Greyish pink (5R 8/2), massive micritic mud matrix. Bed contains occasional small (<3 mm) mud clasts.	Massive very fine pebble gravel with rip-up clasts and bone fragments in micritic mud (Facies 15 in Facies 9)		Manganese coating in places on rip-up clasts.	

Table 5 Continued

Sample number	Petrographic description	Bed name (See Chapter 5)	Depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Post-depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	Facies Group (Chapter 8)
Bed 9, 0.24 m. L11, 0.01 m from the top.	Greyish pink (5R 8/2), massive, mud. Bed contains occasional sun-angular, carbonate lithoclasts < 4mm in diameter.	Massive very fine pebble gravel micritic mud with (Facies 15 in Facies 9).	F/LMls, LMs, FGmm, SG, Ich	None	F2: 1
L12, 0.06 m.					
L13, 0.12 m.					
L14, 0.16 m.	Moderate red (5R 5/4) sandstone. There are a few micro-cross beds (< 6 mm in diameter) and two spar lined void spaces (2 mm in diameter) in the upper sample. The whole sample contains angular, moderate red (5R 7/4) mud clasts and white (N9) silt clasts up to 10 mm in diameter.	Faintly cross-bedded to wave-rippled fine to medium pebble gravel in micritic mud with (Facies 15 in Facies 9).	FSp, Flnls: Down-stream attrition features, 2D dunes. More fluvial flow and re-working. Alternatively, LMa: subject to wave and current action.		
L15, 0.23 m.	Greyish pink (5R 8/2), massive, mud. Bed contains occasional sun-angular, carbonate lithoclasts < 4mm in diameter.	Massive micritic mud with very fine pebble gravel (Facies 15 in Facies 9).	F/LMls, LMs, FGmm, SG, Ich		
Bed 8, 0.14 m. L16, mid bed	Light grey (N8) rip-up clasts sat within a greyish pink (5R 8/2) normally graded, sand in the lower bed and a massive mud in the upper bed. Matrix contains occasional sun-angular, carbonate and mud lithoclasts < 3mm in diameter. The mud rip-up clasts are averagely 20-30 mm in diameter that have bed dumped into the matrix.	Very fine pebble gravel rip-up clasts in medium sand with (Facies 15).		PBre: Partial erosion has occurred pre-burial. Hiatuses have allowed lichen growth and biofilm development that have later oxidised and been replaced manganese and silt.	
Bed 7, 0.09 m. L17, 0.04 m L18, 0.08 m	Moderate red (5R 5/4), mudstone	Massive mudstone (Facies 12c)	F/LMls, LMs	PBre	

Table 5 Continued					
Sample number	**Petrographic description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 6, 0.9 m. L19, mid bed.	Rip-up clasts in a greyish pink (5R 8/2), massive, muddy micrite matrix with rip-up clasts. The rip-up clasts are compacted but have no pressure fissures or brecciation. There are clusters of manganese which may be related to the decay of organic material that was incorporated into the mudflow deposit.	Massive medium pebble gravel with rip-up clasts in muddy micrite with (Facies 15).	F/LMls, LMs, FGmm, SG, Ich	Along the outer edges of the nodule, there are lines of manganese that have probably collected along jointing fractures	F2: 1
Bed 5, 0.10 m. L20, top L21, mid L22, bottom	Greyish pink (5R 8/2), massive mud. Bed contains very occasional angular, mud lithoclasts < 3mm in diameter.	Very fine pebble gravel in mud (Facies 15).		PBre	
Bed 4, 0.13 m. L22, top	Greyish pink (5R 8/2), massive muddy micrite. Bed contains very occasional angular, mud lithoclasts < 3mm in diameter and rip-up clasts (< 0.10 m in diameter). This is the matrix within which the concretions sit.	Massive gravel with medium to small pebble gravel rip-up clasts in muddy micrite (Facies 15 in Facies 8).	FGmm, SG: Ephemeral fluvial channel dependent of seasonal rainfall events?		
L23, bottom	Moderate red (5R 5/4) rip-up clast. The nucleus contains a relatively high proportion of volcaniclastics (10%) and angular, greyish pink (5R 8/2) rip-up clasts (<5 mm in diameter).				
Bed 3, 0.33 m. L24: Top L25, 0.10 m.	Moderate red (5R 5/4) mud. Bed contains very occasional angular, mud lithoclasts < 10 mm in diameter.	Massive gravel with very fine to medium pebble clasts in mud (Facies 15 in Facies 12c).	F/LMls, LMs, FGmm, SG, Ich		
L26, 0.20 m.	Greyish pink (5R 8/2) micritic mud. Bed contains occasional angular, mud lithoclasts < 3 mm in diameter.	Very fine to medium pebble gravel in micritic mud (Facies 15 in Facies 9).		None	
L27, base	Yellowish grey (5Y 8/1), massive clayey mud. Bed contains sub-angular to sub-rounded mud and muddy micrite rip-up clasts < 5 mm – 0.40 m in diameter.	Very fine to medium pebble gravel in micritic mud (Facies 15 in Facies 9)		None	

Table 5 Continued					
Sample number	**Petrographic description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 2, 0.50 m+, L28, Mid bed	Moderate red (5R 5/4) muddy micrite. Very blocky in appearance and the bed, before desiccation, horizontal to wavy, very fine lamination. Along brecciated jointing fractures secondary white (N9) silt (micrite) in-fill has occurred.	Cross-bedded rippled muddy micrite (Facies 8).	FSr: Waning flood event ripples indicate lower flow regimes.	PBre	
Bed 1, 4 m	Moderate red (5R 5/4) massive silt.	Massive silt (Facies 13a)	F/LMls, LMs.	None	

Table 6: Arroyo Salado de Hueypoxtla (ASH), Site TB12, Log 2. See Figure 6.13 for location. 19°55.789 N - 99°07.152 W, 2248 ±9 m a.s.l. See Chapter 8 for discussion and Figures 5 (here), 8.1 & 8.9					
Sample number	**Petrographic description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed, 7, 3 m. T16, 1.2	Pale red (5R 6/2) muddy micrite: The upper bed is made up of intraclasts held within a muddy micrite matrix with occasional biofilm lamina.	Intraclastic, muddy micrite with occasional stromatolitic and biofilm lamina (Facies 8/Facies 6).	Fstmls 1, as part as FpBls: Relatively constant water movement, stromatolites represent short live lulls in fluvial energy or a shift in flow direction allowing microbial growth	None	F4: 1
T15, 0.80 m.	Bed 2: Greyish pink (5R 8/2) mudstone interbedded with thin lamina (<0.2 mm) of white (N9) micrite: 0.20 m, the base of bed two is a cut channel that cuts down into bed one. The channels form infilled with inclined cross-laminations of greyish pink (5R 8/2) mudstone < 5 mm that are interspaced by think < 0.5 mm lamina of white (N9) micrite. Bed 1: Greyish pink (5R 8/2) fine-medium sandstone: 0.60 m of micro cross-laminated, poorly sorted fine-medium sandstone with angular-sub angular carbonate lithoclast >5 mm in diameter.	Beds 2: Ripple cross-laminated mudstone (Facies 12a). Bed 1: Intraclastic cross-laminated sandstone (Facies 14b/Facies 6).	Bed 2: FFl Bed 1; FSp, FInls	None	
T14, 1 m	Greyish pink (5R 8/2) cross laminated fine-medium sandstone: Sub-laminated to micro cross-laminations. The bed contains sub-angular carbonate intraclasts 1-3 mm in diameter.	Cross- rippled to laminated fine to medium sandstone (Facies 14b/c).	Fluvial SB, FSr or LMa	None	
Bed 6, 1 m, T13	Very light grey (N8) wackestone -floatstone: Lithoclasts, micrite mainly, phytoclasts (cemented (drusy/sparry) plant fragments), black volcanic clasts and bioclasts (e.g. biofilm fragments). Very poorly sorted with a range of particle sizes from <1 mm - > 4 mm and generally sub-angular clasts.	Wackestone -floatstone (Facies 6 in Facies 3b).	FInls and/or LMa	PBre	
Bed 5, 2.3 m, T12, 1.6-2.3 m.	Yellowish grey (5Y 8/1), framestone limestone: Sample contains in-situ traces of root systems (<1-2 mm in diameter) infilled or lined with sparry and drusy (greyish olive 10Y 4/2) cements. Throughout the bed, there are biofilm lamina (<1 mm). Bed also contains a relatively high (>10%) 0f volcaniclastics.	Framestone phytoherm limestone (Facies 1)	FpChls, F/LpStls, LMa (?): Marginal fluvial palustrine setting, floodplain or lake shoreline. Warm, arid, relatively fresh conditions. Water lain deposits under-slow but constant flow conditions.	None	
T11, 1.0-1.6 m.	Yellowish grey (5Y 8/1), brecciated limestone: This is originally thought to have been a stromatolitic or phytoherm type limestone that has been brecciated post-depositionally. In the upper bed, an evaporitic gypsum layer that may have formed and then collapsed because of the dissolution and removal of the gypsum layer. The collapsed void was later replacement with calcite — Volcaniclastics <4%.	Stromatolitic (Facies 2a). Figure 5.5, 5.5, Table 5.8	FpChls, F/LpStls, LMa (?): Originally as above	PBre: Gypsum replacement.	

Table 6 Continued

Sample number	**Petrographic description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
T10, 0.60-1.0 m	Yellowish grey (5Y 8/1), framestone limestone: sample contains traces of root systems (<1-2 mm in diameter) infilled or lined with sparry and drusy (greyish olive 10Y 4/2) cements. Throughout the bed, there is biofilm lamina (<1 mm). Volcaniclastics <5%.	Framestone phytoherm limestone (Facies 1).	FpChls, F/LpStls, LMa (?) see T12	None	F4: 1
T9, 0.25-0.60 m	Bed 1: Yellowish grey (5Y 8/1), framestone limestone (top): Macrophytes (root voids and traces) predominantly at the base of the bed. Root voids and traces are infilled or lined with sparitic calcite, drusy calcite surrounded by micrite, or in some cases infilled with micritic. All sits within a biogenic calc-mudstone. Sub-facies include algal biofilms interbedded with algal micritic mud at the very base of the bed. Volcaniclastic input (<5%).			The upper bed has large voids lined with sparry calcite and partially filled with carbonate silt. Root voids or micro-karst features following bed weaknesses?	
T8, 0.20-0.25 m.	Bed 2: White (N9), shocked, brecciated limestone (top): Whole bed is littered with pockets of drusy and sparry calcite cement, that infills voids and replaces organic detritus. The left portion of the beds is dominated by biofilm layers while the rest of the bed is predominantly laminated biogenic calc-mud. However, all the laminations are folded, faulted and brecciated (e.g. broken laminae. The bed is ca. 25-30 mm thick. In the upper bed, there is a large (3mm wide, 7mm thick) desiccation fracture with a micritic silt infill. The whole bed has a maximum thickness of 7 mm but is uneven. Bed 1: Yellowish grey (5Y 8/1), framestone limestone (base): Algal biofilms interbedded with algal micritic mud and macrophytes. Root voids and traces are either infilled with sparitic calcite, drusy calcite, or a micritic mud. Throughout.	Bed 1: Shocked, brecciated stromatolitic/framestone limestone (Facies 1 – 2a?) Bed 2: Framestone phytoherm (Facies 1) See Figure 5.12 and Table 5.14.	Originally, FpChls, F/LpStls, LMa (?): Warm, arid, relatively fresh, conditions. Water lain deposits under-slow but constant flow conditions or in calm waters.	Bed 1: ShBLs Bed 2: Bre	
Bed 4, 0.50 m T7	Bed 2: Phytoherm Framestone: small plants (water weed) growing in them and into the surface of bed 1. There is the remints of micritic silt that infilled the spaces between the vegetation. Bed 1: Micritic calc-mud stone: throughout the bed, there are incipient laminations and shell fragments. Roots t penetrate from the upper bed.	Bed 2: Phytoherm Framestone Bed 1: Calc-mudstone. See Figures 5.3 & 5.7.	Bed 2: FpChls, F/LpStls, LMa: The angle of the encrusted vegetation suggests water flow. Bed 1: F/LMls: The incipient laminations suggest relatively slow flowing water. The absence of silt suggests warm/relatively dry stage deposition.	None	

Table 6 Continued					
Sample number	**Petrographic description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 3, 0.70 m: T6 T5	White (N9) – very light grey (N8) laminated muddy micrite: Micritic silt with sparry patches (<30%). Within the matrix, there are intraclasts (<5%) (sub-angular to sub-rounded carbonate mud/silt clasts <1mm in diameter, broken biofilms, organic detritus (<4 mm) and oncoids — moldic porosity (60%). The first 7 mm of the bad has a higher percentage (30%) of lithoclasts. Surfaces include in-situ (top and bottom) and incipient (2—0.2 mm) biofilms that have associated, localised bubble voids (<0.5mm). Volcaniclastic input 2-5%. Shell fragment in the base of the bed.	Plane laminated, normally graded intraclastic muddy micrite (Facies 3b). See Figure 5.17 and Table 5.17.	FIncls, F/LMls, LMa: Freshwater environment indicated by shell fragment.	Void spaces are very occasionally infilled with drusy calcite suggesting the presence of decayed organic matter (water weed?). Clastic and micritic silt infilling some of the void spaces may suggest groundwater moving through the deposit later, after lithification.	F4: 1
T4, lowest to 0.25 m.	Greyish pink (5R 8/2) - very light grey (N8) muddy micrite Framestone: Contains very occasional biofilm lamina. Porosity is moldic (<10%) with void spaces < than 2mm in diameter. In some sections there are large macrophyte with leaf traces that penetrates and are surrounded by, stromatolitic biofilm lamina (<1 mm) that alternate with micritic silt (<3 mm). Moldic porosity (50%). Volcaniclastic input (<3%). Void spaces remain void or have been partially infilled or lined with sparitic calcite, micritic silt, or manganese. In the upper bed, very light grey (N8) micritic silt that in places has a clotted texture and occasional sparitic cement. Within the silt matrix, there are sparse shell fragments, broken biofilm fragments, and small (<1 mm in diameter) micritic mud clasts. Moldic porosity (10%) and volcaniclastic input (<10%). Occasional patches of manganese within void spaces that suggest organic detritus was also incorporated into the matrix and later replaced.	Framestone phytoherm limestone (Facies 1) in a muddy micrite matrix. See Figure 5.16 and Table 5.16.	FpChls, F/LpStls, LMa (?): Marginal fluvial palustrine setting, floodplain or lake shoreline. Warm, arid, relatively fresh conditions. Water lain deposits under-slow but constant flow conditions. Shell fragments suggest freshwater conditions.	None	

Table 6 Continued					
Sample number	**Petrographic description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 2, 0.56 m: Upper bed T3 collected upper bed.	Greyish pink (5R 8/2), laminated muddy micrite. Graded contact between A1 and A2.	Laminated muddy micrite (Facies 8b). See Figure 5.14	F/LMls OF, LMs	None	F4: 1
T2 collected mid bed	White (N9) – very light grey (N8) fine dacitic ash. Bed has a very sharp, disconformable lower contact	Laminated to massive dacitic ash (Facies 18c)	F/LMls OF, LMs	None	F4: 2
Bed 1, 0.10 m: T1 collected mid bed. (end of log 1)	Greyish pink (5R 8/2) Calc-mudstone. Contains drusy (brilliant green) and sparry cement. There are lines of manganese and some cross-bedded.	Massive calc-mudstone (Facies 3b).	F/LMls OF, LMs	PBre:	F4: 1

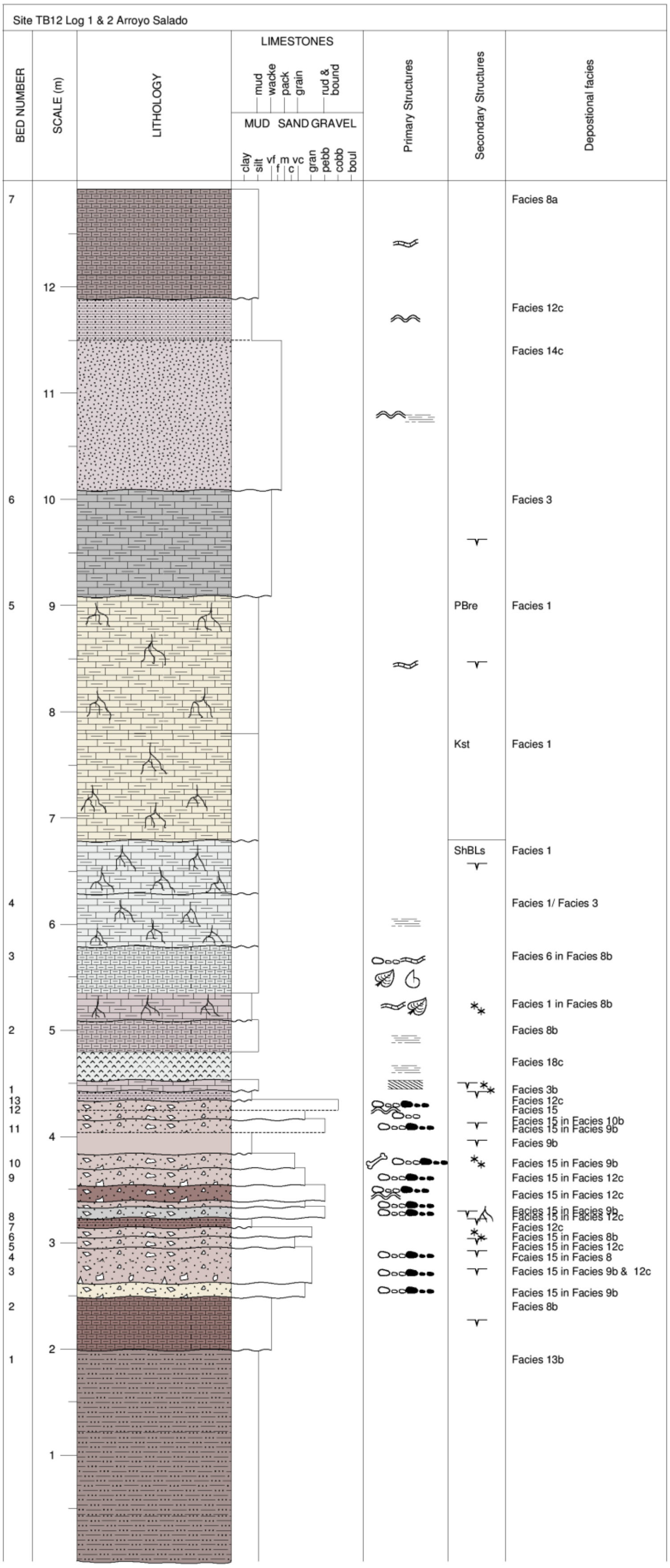


Figure 5: Logs 1 & 2 Tables 5 & 6, Arroyo Salado de Hueypoxtla

Table 7: Tlapanaloya (TLAP), Location 3, Site TB13. See Figure 6.13 for location. 19° 56.358 N - 99° 06.164 W, 2256 m a.s.l. See Chapter 8 for Discussion and Figure 6 (here), 8.1 & 8.9					
Sample	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 27 & 28, 0.33 m. T1, sample collected mid-section.	White (N9) clayey, brecciated, calc-mudstone. The bed contains occasional shell fragments, yellowish grey (5Y 8/1) micritic lithoclast, manganese clusters and a relatively high proportion of volcaniclastics (20%)	Brecciated, calc-mudstone (Facies 3b)	F/LMls OF, LMs. Fresh water	PBre	F4: 1
Beds 25 & 26 0.20 m. T2, sample collected mid-section	Pale reddish brown (10 5/4) organic mudstone.	Massive mudstone (Facies 12a)	F/LMls OF, LMs.		
Bed 24, 0.35 m. T3 top 5cm. T4: Mid bed	Bed 2: Medium grey (N5) laminated mud. The sample, upper 0.10 m, is made up of thinly laminated silt. Post-depositional features include the void and fracture fill with the grey upper silt, probably under vadose conditions. Bed 1: White (N9) calc-mudstone. Primary features include slightly moldic porosity. Secondary features include drusy and spary cement are thought to have replaced organic detritus falling into the pool rather than the decay of in-situ vegetation.	Massive to laminated calc-mudstone (Facies 3b)	Primary features and biogenic calc-mudstone are warm and dry deposits. The upper grey silt bed and the void fill and replacement passing through the calc-mudstone is secondary and related to groundwater moving through the calc-mudstone during a cool, dry stage or may be volcanic in origin.	Diagenetic alteration	
T5 lower 5 cm	Bed 2: Medium grey (N5) framestone limestone: Large (6 mm wide, 30 mm thick) macrophyte stem infilled with micritic silt and carbonate intraclasts, branching from the root casts have a moderate olive brown (5Y 4/4) stained, root and leaf system in sat within a yellowish grey (5Y 8/1) calc-mudstone (biogenic?) matrix. The matrix has a moldic porosity, but there has been no secondary cement development, void spaces are empty. There are traces of manganese that outline the macrophytes and clusters that suggest organic detritus incorporation into the matrix. Bed 1: White (N9) calc-mudstone. Primary features include slightly moldic porosity. Drusy and spary cement are thought to have replaced organic detritus falling into the pool rather than the decay of in-situ vegetation.	Framestone (Facies 1)	FpChls, LMa	Diagenetic alteration	
Bed 23, 0.03 m. T6	Pale reddish brown (10 5/4) organic mudstone.	Massive mudstone (Facies 12b)	F/LMls OF, LMs.	PBre	

Table 7 Continued					
Sample	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 22, 0.04 m. T7	White (N9) clayey, brecciated, calc-mudstone.	Brecciated, calc-mudstone (Facies 3b)	F/LMls OF, LMs.	PBre	F4: 1
Bed 22, 0.04 m. T7	White (N9) clayey, brecciated, calc-mudstone.	Massive mudstone (Facies 12b)			
Bed 20, 0.50 m. T9, Top of bed	Yellowish grey (5Y 8/1)/white (N9) framestone limestone. This sample has a moldic porosity (>50%) with void spaces <6 mm in diameter. Some are completely cemented with the post-depositional drusy calcite; others are lined with sparry cement or manganese, others are empty suggestions rapid lithification. There are large (<5 mm in diameter) branching (from a central core) patches of pale greenish yellow (10Y 8/2) micritic silt that is potentially macrophyte traces in- filled with silt. There are also white (N9) intraframe patches of micrite. Shell fragments (<1%) suggest freshwater conditions.	Framestone limestone (Facies 1)	FpChls, LMa. Freshwater probably flowing water indicated by shell	Diagenetic alteration	
T10, base.	Yellowish grey (5Y 8/1) calc-mudstone/framestone. As above although the moldic porosity is less (25%) and there is no drusy or sparry cement in void spaces. Manganese is still present. Looks almost pisolitic but, I think is whiter micritic fringe cement around darker root traces.	Framestone limestone (Facies 1)	FpChls, LMa. Freshwater indicated by shell		
Bed 19, 0.05 m. T11	Pale reddish brown (10 5/4) mudstone.	Massive mudstone (Facies 12b)	F/LMls OF, LMs	None	
Bed 18, 0.20 m. T12, 0.05 m.	Yellowish grey (5Y 8/1)/white (N9), brecciated framestone limestone. There are large (<4 mm in diameter) branching (from a central core) patches of pale greenish yellow (10Y 8/2) micritic silt that is potentially macrophyte traces in-filled with silt. There are also white (N9) intraframe patches of micrite. Shell fragments (<1%) suggest freshwater conditions. The bed also contains manganese clusters. The whole sample is brecciated, with jointing cutting all features.	Brecciated Framestone limestone (Facies 1)	FpChls, LMa. Freshwater indicated by shell	PBre. Diagenetic alteration	

Table 7 Continued					
Sample	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
T13, 0.12 m.	Bed 3: Yellowish grey (5Y 8/1) immature stromatolitic limestone (10 mm thick). Micrite (<2 mm) interlaminated with sparry lamina (<0.5 mm). These are separated with thin (<2mm) coarser intraclastic sediment in-washes. Bed 2: Micro-channel form (10 mm thick, 15 mm wide): Channel cuts upper bed on the left-hand side of the sample. The channel is filled with mixed intraclasts (rudstone that grades to wackestone). Bed 1 (30 mm thick): Yellowish grey (5Y 8/1) calc-mudstone. Relatively homogenous, densely packed micrite with very few sparry cement patches (<3%). Shell fragments scattered (<2%).	Bed 3: Stromatolitic limestone (Facies 2a) Bed 2: Intraclastic limestone (Facies 3b/Facies 6) Bed 1: Calc-mudstone (Facies 3b)	Bed 3: Fstmls 2, LMi Bed 2: Flnls, LMa Bed 1: F/LMls, LMa. Fresh water	-None	F4: 1
Bed 17, 0.10 m T14, last	Bed 3, 10-15 mm: White (N9) brecciated calc-mudstone. There are biofilm lamiae within the bed, but these have been dissected by the brecciation. Bed 2, 10 mm: Immature stromatolitic limestone. Bed 1, 20 mm: Framestone limestone. Large (5 mm wide) macrophyte stems infilled with brown stained silt, root and leaf system in sat within a yellowish grey (5Y 8/1) calc-mudstone (biogenic?) matrix. Virtually no secondary cement development. There are traces of manganese that outline the macrophytes.	Bed 3: Brecciated calc-mudstone (Facies 3b) Bed 2: Immature stromatolitic limestone (Facies 2a)	Bed 3: F/LMls OF, LMs. Freshwater Bed 2: Fstmls 2, LMi Bed 1: Framestone limestone (Facies 1)	Bed 3: PBre Bed 2: Drying, shallowing surface?	
Bed 16, 0.02 m. T15	Pale reddish brown (10 5/4) mudstone?	Massive mudstone (Facies 12b)	F/LMls OF, LMs.	None	
Bed 15, 0.07 m. T16	White (N9), intraclastic limestone. The base of the sample contains sub-angular, poorly sorted greyish pink (5R 8/2) to white (N9) litho, bio and phytoclasts that range from coarse sand to fine pebbles (0.5 -16 mm in diameter). There are occasional micro-channel forms that grade from medium sized pebbles at the base to coarse sand with an upper micrite infill topped by biofilm lamina (ca. 7mm thick). Post-depositional facies include white (N9) micritic, drusy and sparry cement. Karst or desiccation features that are infilled with white (N9) micritic silt. See Figure 5.11 and Table 5.13.	Intraclastic limestone (Facies 6)	Flnls, LMa	Diagenetic alteration PMk	

Table 7 Continued					
Bed 14, 0.45 m. T17 top 0.16 m.	Vertically jointed pale reddish brown (10 5/4) mud.	Brecciated massive mudstone (Facies 12b)	F/LMls OF, LMs	PBre	F4: 1
T18, 0.19-0.21 m.					
T19, 0.22-0.25 m					
Bed 13, 0.45 m T20, 0.05-0.10 m .	Pale greenish yellow (10Y 8/2) calc-mudstone. Massive with clusters of manganese. Vertically jointed with blocky textures. Also, some, but very little, moderate greenish yellow (10Y 7/4) drusy cement.	Massive calc-mudstone (Facies 3b)	F/LMls, LMa.	Diagenetic alteration	
T21, 0.21-0.35 m	Pale greenish yellow (10Y 8/2) muddy micritic. As above but less cemented, powdery.	Massive muddy micrite (Facies 8)	F/LMls OF, LMs.	None	
T22, 0.36-0.38	Pale greenish yellow (10Y 8/2) micritic mud. As above but almost unlithified.	Massive micritic mud (Facies 9)			
T23, base, 0.43 m	Pale greenish yellow (10Y 8/2) calc-mudstone. Massive with clusters of manganese. Vertically jointed with blocky textures. Also, some, but very little, moderate greenish yellow (10Y 7/4) drusy cement.	Massive calc-mudstone (Facies 3b)		Diagenetic alteration	
Bed 12, 0.35 m. T24, top 5 cm	Laminated white (N9) calc-mudstone. Lithified but powdery with manganese clusters,	Massive calc-mudstone (Facies 3b)	F/LMls, LMa.	None	
T25, 0.06-0.15 m	Bed 2 (15mm thick): White (N9) brecciated, stromatolitic limestone. Stromatolitic lamina sit above the contact with bed one and throughout there is a manganese content. Bed 1 (0.20 mm thick): White (N9) framestone limestone in a calc-mudstone matrix. The bed contains root traces that have been replaced with pale greenish yellow (10Y 8/2) micritic silt. The root traces form a central core from which root and leaf systems branch, these have also been replaced with pale greenish yellow (10Y 8/2) micritic silt. The bed has void spaces usually <1mm in diameter that is related to lithification.	Bed 2: Brecciated stromatolitic limestone (Facies 2a) Bed 1: Framestone limestone (Facies 1)	Beds 2: Fstmls 2, LMi Bed 1: FpChls, LMa.	Bed 1: PBre	

Table 7 Continued					
Sample	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 11, 0.35 m, T26 0.16-0.25 m from top	Bed 2 (35 mm thick): Pale greenish yellow (10Y 8/2) framestone limestone. Essentially the same as T25, bed one. Bed 1 (6 mm thick): Pale greenish yellow (10Y 8/2) intraclastic grainstone limestone. The is virtually no intraparticle cement if there is space between particles it remains void, although this may be a post-depositional process. Grains are intraclastic, varied and are < than 2 mm in diameter.	Bed 2: Framestone limestone (Facies 1) Bed 1: Intraclastic limestone (Facies 6)	Bed 2: FpChls, LMa Bed 1: Flnls, LMa	None	F4:1
T27 0.26-0.35 m from top					
Bed 10, 0.04 m, T28.	Pale reddish brown (10 5/4) mudstone with carbonate flecks	Massive mudstone (Facies 12b)	F/LMls OF, LMs.	None	
Bed 9, 1.0 m. T29, 0.15 m from the top.	Intraclastic limestone: Large (10mm in diameter) white (N9) silt (micritic?) sub-rounded lithoclasts in a pale greenish yellow (10Y 8/2) grainstone matrix that has virtually no intraparticle cement, if there is space between particles, it remains void, although this may be a post-depositional process.	Bed 1: Intraclastic limestone (Facies 6)	Flnls, LMa	None	
T30 at 0.40 m	Intraclastic wackestone limestone: Sub-rounded to sun-angular greyish pink (5R 8/2), white (N9) and very pale orange (10YR 8/2) lithoclasts (<3 mm in diameter), phytoclasts < 2 mm in diameter that has been replaced with sparry and drusy cement and biofilm fragment. This is a matrix supported deposit, within a calc-mudstone. The bed contains clusters of manganese. Secondary features, along with the cement, are mainly karst features or fractures that have been infilled with sparry cement.			PMk and diagenetic alteration	
Bed 8, 0.60 m T31 upper bed	White (N9) to very light grey (N8) homogenised calc-mudstone. Scattered bioturbation burrows (<1mm in diameter), and organic detritus that are represented as void spaces or infilled with sparry cement. The upper bed (5 mm) has desiccation features and medium grey (N5) manganese clusters and drusy calcite.	Massive, bioturbated calc-mudstone (Facies 3b)	F/LMls, LMa.	Diagenetic alteration of organic material	
T32, lower bed					

Table 7 Continued					
Sample	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 7: 0.25 m. T33	White (N9) framestone limestone. Bed contain large (5 mm in diameter) macrophyte root traces that are scattered with manganese. The intraframe matrix is a mixture of calc-mudstone, lithoclasts mixed > 2 mm in diameter (see T30 for description). There are patches of sparry cement infilling void spaces (<5%).	Framestone limestone (Facies 1)	FpChls, LMa	Diagenetic alteration of organic material	F4: 1
Bed 6: 0.40 m. L1 0.02-0.10 m. L2, 0.11-0.16 m.	Greyish pink (5R 8/2) intraclastic fine gravel in a fine sandy micritic matrix. The matrix and the lithoclast are poorly sorted. Within the matrix, lithoclast include yellowish grey (5Y 8/1) sub-angular micritic silt clasts < 3 mm in diameter and dark greenish yellow (10Y 6/6) angular mud clasts < 3 mm in diameter. Void spaces account for < 10% of the fabric and are mostly unfilled or lined, some have sparry fringes. In the upper sample, desiccation fractures are relatively deep (>20 mm). See Figure 5.18 and Table 5.18	Intraclastic sandy micrite (Facies 10b/Facies 6)	Flnls, LMa	PBre. Diagenetic alteration of organic material	
L3, 0.17-0.22 m. .	Bed 2 (30 mm thick): Greyish pink (5R 8/2) fine – medium sandy micritic**.** This bed has a very uneven, undulating contact with the lower bed. Mid bed there is a coarser section of lithoclast (see Bed 1) in-wash, possibly in a micro-channel (10 mm wide, 5 mm thick) that grades to medium sand at the top. Bed 1 (20 mm thick): Greyish pink (5R 8/2) intraclastic fine sand (<2%). Mostly clast supported made up of yellowish grey (5Y 8/1) sub-angular micritic silt clasts < 5 mm in diameter, dark greenish yellow (10Y 6/6) angular mud clasts < 5 mm in diameter, and sub-angular moderate red (5R 5/4) mud clasts < 3 mm in diameter. The bed also contains large (<6 mm in diameter) sparry-drusy clasts that are thought to be macrophyte stems that have been post-depositionally cemented and subsequently broken, hence the roundness. Void spaces in beds one and two accounts for < 4% of the fabric and are mostly unfilled or lined; some have sparry fringes.	Bed 2: Wave-rippled fine to medium sandy micrite (Facies 10b) Bed 1: Clast supported intraclastic sand matrix (Facies 6)	Flnls, LMa (SG)	Diagenetic alteration	

Table 7 Continued					
Sample	**Petrographic facies description**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
L4, 0.27-0.32 m.	Bed 1 (20 mm thick): Greyish pink (5R 8/2) intraclastic breccia in a fine sandy micritic matrix (<2%)**.** Angular to well-rounded dark greenish yellow (10Y 6/6) and moderate red (5R 5/4) mud clasts and white (N9) micritic silt clasts < 6 mm. This bed is well sorted and normally graded from the larger clasts to fine – medium sand in the upper bed**.** Bed 2 (25 mm): Greyish pink (5R 8/2) intraclastic breccia in a fine sandy micritic matrix (<2%). This bed is the second cycle of fluvial deposition. The characteristics of the bed mimic bed one, the only differences being that the clasts sizes at the base of the bed are slightly larger (<8mm) and, in the upper bed there are two root traces that have been infilled with micritic silt. On the sheltered side of the macrophytes fine to coarse sand has collated. Otherwise, the bed normally grades from medium sized pebbles to medium sand in the upper bed.	Normally graded Intraclastic sand matrix (Facies 6)	Flnls, LMa (SG-GB)	Diagenetic alteration	
L5, 0.33-0.38 m.	Greyish pink (5R 8/2) intraclasts in a fine sandy micritic matrix. The matrix and the lithoclast are poorly sorted. Within the matrix, lithoclast includes yellowish grey (5Y 8/1) sub-angular micritic silt clasts < 3 mm in diameter and dark greenish yellow (10Y 6/6) angular mud clasts < 3 mm in diameter. Collectively lithoclast accounts for < 30% of the sample. Void spaces account for < 5% of the fabric and are mostly unfilled with silt or lined by sparry fringes	Poorly sorted intraclastic sandy micrite (Facies 10b/Facies 6)	Flnls, LMa (SG-GB)	None	
Bed 5: 0.09 m. L6, mid bed.	Medium – coarse pebble gravel in a greyish pink (5R 8/2) micritic mud matrix. Massive with blocky, vertically jointed desiccation features. Bed contains white (N9) carbonate nodules, possibly angular lithoclast <4 mm in diameter.	Poorly sorted medium to coarse gravel in micritic mud (Facies 9b/Facies 15)	Flnls, LMa (SG-GB)	PBre	F4: 1
Bed 4, 0.22 m L7, 0.05 m down from contact L8, 0.10 m down.	Intraclastic, medium – coarse pebble gravel in a greyish pink (5R 8/2) micritic mud matrix. Intraclasts are mainly angular made of the same sediment as the matrix just lithified. There are also occasional white (N9) angular micritic silt clasts. Clasts <5mm in diameter. Poorly sorted. As above: However, the micritic matrix is generally darker, pale red (5R 6/2) and clasts sizes are larger, < 8mm in diameter. Overall there is grading from sample L8 to L7; clast sizes decrease up the bed. However, both beds are poorly sorted.	Poorly sorted medium to coarse gravel in micritic mud (Facies 9b/Facies 15)	Flnls, LMa (SG-GB)	None	

Table 7 Continued					
Bed 3, 0.15 m. L9, 0.05 m from top L10, 0.10 m from top	Pale red (5R 6/2) micritic mud. Massive with blocky fabric from desiccation. Moderate red (5R 5/4) sandy micrite. Massive, vertically jointed fabric. Micritic silt inclusions are probably post-depositional and related to evaporation. The bed has extensive desiccation features.	Massive micritic mud (Facies 9)	F/LMls OF, LMs.	PBre	
Bed 2, 0.14 m. L11, 0.04 m from top L12, 0.13 m from top	Intraclastic, medium – coarse pebble gravel in a pale red (5R 6/2) micritic mud matrix. Bed contains white (N9), angular micritic clast, possibly angular lithoclast <15 mm in diameter. L12: Intraclastic, medium – coarse pebble gravel in a greyish pink (5R 8/2) muddy micrite matrix. Bed contains white (N9), angular micritic clasts, and angular lithoclasts <15 mm in diameter.	Poorly sorted medium to coarse gravel in micritic mud (Facies 9b/Facies 15)	Flnls, LMa (SG-GB)	None	
Bed 1, 0.18 m. L13.	Pale red (5R 6/2) micritic mud. Massive with blocky fabric. Bed contains white (N9), angular micritic clast, possibly angular lithoclast <5 mm in diameter.	Massive micritic mud (Facies 9)	F/LMls OF, LMs.	None	

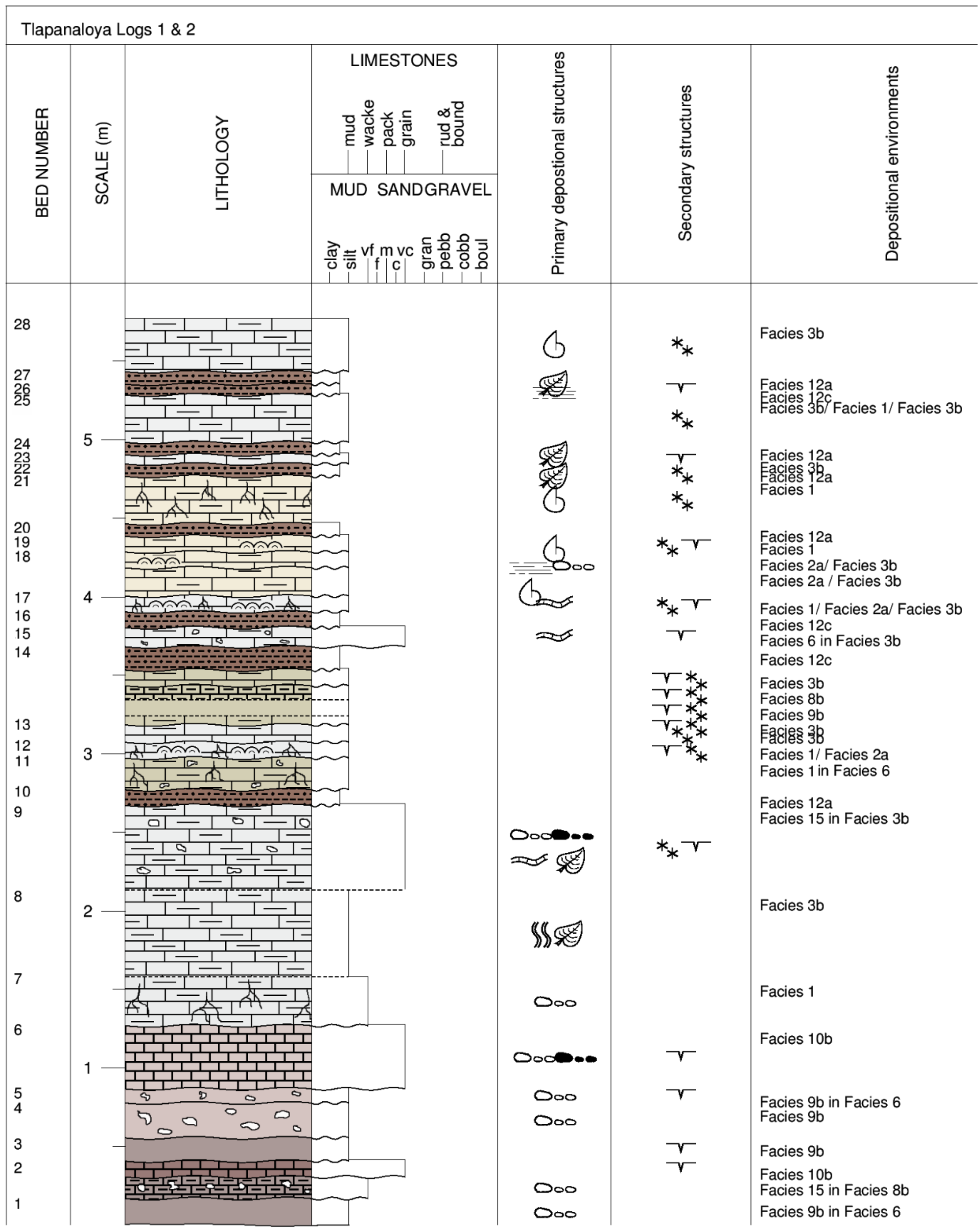


Figure 6: Log 1 Table 7, Tlapanaloya

Table 8: Barranca la Gloria (BLG), Site TB7, Log 2 (ca. 14 m thick) channel cutting the eastern side of the barranca, 19° 55.317 N – 99° 07.183, 2255 ± 4 m a.s.l. See Figures 6.13, 8.1 & 8.2						
Sample	**Facies Description**	**Structures/features**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 9, 2 m	Pale reddish brown (10R 5/4) medium sandy silt	-Horizontally and wavy continuous lamina	Plane to wavy laminated fine silty sand (Facies 14c)	FFI. OF	None	F5: 1
Bed 8, 1.5 m	Pale reddish brown (10R 5/4) medium sandy silt matrix with small pebble to large cobble gravel intraclasts (limestone and mud and silt clasts. Upper bed grades to fine sandy silt.	b) Upper 0.50 m: -Contains multiple lensed channel forms lined with small pebble gravel intraclast. Maximum thickness 0.07 m and width 0.30 m. a) Lowest 1 m: - Wavy, parallel bounding lower bounding surface, disconformity -Massive -poorly sorted	b) Small pebble gravel lived, low angle cross-beds (Facies 15/`16) a) Massive medium sandy silt with small pebble to large cobble gravel (Facies 15)	a) FSI, SB: b) FGmm, SG	None	
Bed 7, 0.03 m	Pale reddish brown (10R 5/4) fine mud with very occasional fine pebble gravel intraclasts	-Massive -Very fine pebble lined gravel channels -Bed shrinks backwards in section -Disconformable, uneven but horizontal upper bounding surface -Lower bedding plane, straight relatively blended unconformity -Vertical jointing	Massive fine mud with small pebble gravel lived, low angle cross-beds (Facies 16/17)	FSI, SB	PBre	
Bed 6, 0.60 m	Pale reddish brown (10R 5/4) fine sandy silt matrix with small pebble to large cobble gravel intra and extraclasts and fragmented megafaunal bones.	-Curved, None-parallel bounding surfaces -Laterally continuous within section -Bed infills a scoured, erosive channel base -Disconformable lower bounding surface -Massive with very weak grading -Poorly sorted -Intraclast: angular limestone and rip-up clasts of mud and silt -Extraclasts: Well-rounded vesicular basalt and oxidised vesicular basalt. -Megafaunal bones: mammoth shoulder blade	Massive fine sandy silt gravel with small pebble to large cobble clasts and re-worked megafaunal bone (Facies 16/17)	FGcm, SG	None	

Table 8 Continued						
Sample	**Facies Description**	**Structures/features**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 5, 0.73 m	Pale reddish brown (10R 5/4) fine silty sand matrix with small to medium pebble gravel angular to sub-angular clast of limestone and moderate red (5R 8/2) silt.	-Curved, None-parallel bounding surfaces -Massive -Matrix supported -Poorly sorted	Massive sandy silt medium pebble gravel (Facies 15)	FGmm, SG	None	F5: 1
Bed 4, 0.33m	Pale reddish brown (10R 5/4) silt with angular medium pebble gravel limestone intraclasts	-Curved, None-parallel bounding surfaces -Laterally continuous within section -Bed infills a scoured, erosive channel base -Disconformable lower bounding surface -Massive with weak grading -Poorly sorted	Massive silty gravel with medium pebble gravel clasts (Facies 15/16).	FGcm, SG.		
Bed 3, 1.7 m	Pale reddish brown (10R 5/4) fine silty sand matrix with fine angular to sub-angular pebble gravel rip-up clasts of moderate red (5R 8/2) silt.	-Massive -Matrix supported -Laterally continuous within section -The matrix and intraclast are poorly sorted -The basal bedding place is a curved scoured channel lined with 0.20 m of small up to medium pebble gravel intraclasts of limestone and moderate red (5R 8/2) and greyish yellow green (5GY 7/2) mud and clay rip-up clasts. -Disconformable lower contact	Massive fine silty sand gravel with pebble gravel rip-up clasts (Facies 15/16).	FGcm, SG		

Table 8 Continued						
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 2, 2.4 m	Pale red (5R 6/2) fine sand matrix with isolated fine pebble gravel intraclasts of limestone and moderate red (5R 8/2) and greyish yellow green (5GY 7/2) mud and clay rip-up clasts. Some sections have medium to coarse pebble intraclast (as above) that line scoured channel bases.	- Wavy, None-parallel bounding surfaces -Intrabeds are curved, None-parallel and discontinuous laminated to thinly bedded cross-bed sets up to 0.06 m thick. Each has a scoured erosive base and is, -Matrix supported -Poorly sorted -The matrix and intraclast are poorly sorted -There is normal but weak grading -Occasionally there are small to medium pebble gravel lined channels (maximum: 0.09 m thick, 0.18 m wide) -Disconformable, erosive, concave up lower contact, laterally continuous.	Normally graded, sand with fine pebble gravel, small pebble gravel and low angle cross-beds (Facies 16)	FGmg, SG FSI, SB	None	F5: 1
Bed 1, 3.2 m+	Moderate red (5R 8/2) silt to greyish yellow green (5GY 7/2) muds and clays.	-Massive -Laterally continuous -Horizontally bedded	Massive red silt.	F/LMIs, LMs	None	F1:2

Table 9: Barranca la Gloria, Site TB7, Log 1 (ca. 14 m thick) sequence at the head of the Barranca indurated limestone, Tephra and unconsolidated clastic material. 19° 55.317 N – 99° 07.183, 2255 ± 4 m a.s.l. See Figures 6.13, 8.1 & 8.2

Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 5, 5 m ±	White (N9) calc-mudstone with crystalline interlaminations in some sections	-Plane laminations -Uneven, curved algal laminations -Massive in some sections -Some beds appear intraclastic -Contacts are gradational and erosional depending on the bed	-None	Interbeds of massive to laminated (calc-mudstone (Facies 3b), Stromatolitic limestone (Facies 2a) and probably intraclastic limestone (Facies 6)	LMi, LLam, LMa	**-**None	F4: 1
Bed 5, 0.15 – 0.20 m	White (N9) fine silty sand to fine sand	-Massive to laminated	-None	Basaltic-andesite ash (Facies 18a?)	Water lain, re-worked tephra	-None	F4: 2
Bed 4, 1 – 4 m	White (N9) calc-mudstone with crystalline interlaminations in some sections	-Plane laminations -Uneven, curved algal laminations -Massive in some sections -Some beds appear intraclastic Contacts are gradational and erosional depending on bed	-None	Interbeds of massive to laminated (calc-mudstone (Facies 3b), Stromatolitic limestone (Facies 2a) and probably intraclastic limestone (Facies 6)	LMi, LLam, LMa	-None	F4: 1
Bed 3, 0.50 – 3 m	Moderate red (5R 8/2) silt to fine silty sandstone	Depending on the section -Cross-bedding -Laminations -Massive	-Karstification	Interbedded siltstone (Facies 13a) to fine silty sandstone (Facies 14b)	LMa	-PMk	
Bed 2, 0.2 – 0.8 m	White (N9), fine powdery greyish silt	-Massive -Uneven, straight but distinct upper and lower contacts	-None	Massive dacitic ash (Facies 18c?)	F/LMIs, LMs	-None	
Bed 1, 1 m +	Moderate red (5R 8/2) silt to greyish yellow green (5GY 7/2) muds and clays.	-Massive -Straight but uneven upper contact which is likely a none-depositional unconformity l Lower contact not exposed	-None	Massive fine silt (Facies 13c)	LMs	-None	

Table 10: Barranca del Muerto Site TB10, Log 1. Head of the Barranca. See Section 6.3 and Figures 6.13, 8.1 & 8.2							
Bed	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 14, 0.30 m	Moderate pink (5R 7/4) silt	-Massive -Angular limestone clasts up to 0.20 m in width -Uneven erosive base	-Vertical jointing	Massive, monomictic gravel (Facies 15)	FGmm, SG	PBre	F2: 1
Bed 13, 0.30 m	White (N9) silt	-Laminated -Some more indurated crystalline lamina -Sub-horizontal uneven boundary contacts	-None	Laminated calc-mudstone (Facies 3b)	LMa, F/LMls, LMi	None	
Bed 12, 0.30 m	Light brown (5YR 6/4) indurated fine silty sand	-Sub-horizontal bed -Uneven and erosive boundary contacts	-None	Massive fine silty sand (Facies 14b)	LMa, FFSm	None	
Bed 11, 0.30 m	Interbeds of white (N9) indurated silt and light brown (5YR 6/4) clay	-Massive. Sub-horizontal interbeds -Upper and lower erosive and uneven boundary contacts -Vertically jointed in the upper bed -Clay beds sticky and formable when rolled	-Vertical jointing in the upper bed	Interbedded calc-mudstone (Facies 3a) and clay (Facies 8a)	LMa, F/LMls	PBre	
Bed 10, 0.30 m	Light brown (5YR 6/4) indurated silty sand	-Plain bedded to lamented -Uneven and erosive boundary contacts	-None	Laminated muddy micrite (Facies 8a?)	LMa, F/LMls, LMi	None	
Bed 9, 1 m	Light greyish green (5GY 8/1) silt at the base that grades to laminated silty fine sand and then back to silt in the upper be	-Massive upper and lower silt beds -laminated central fine silty sand bed Upper and lower contacts are straight and possibly disconformable	-None	Interbedded massive silt (Facies 13 a) and laminated fine silty sand	LMa, F/LMls, LLam		
Bed 8, 0.30 m	White silt	-Massive	-None	Massive calc-mudstone (Facies 3a)	LMa, F/LMls, LMi	None	
Bed 7, 0.25 m	Light greyish green (5GY 8/1) silt	-Massive	-Vertically jointed	Massive silt (Facies 13a)	LMa, F/LMls	PBre	
Bed 6, 0.30 m	White (N9) indurated silt	-Massive -Straight possibly disconformable upper and lower contacts	-None	Massive calc-mudstone (Facies 3a)	LMa, F/LMls	None	
Bed 5, 0.50 m	Moderate pink (5R 7/4) silt	-Massive -Straight possibly disconformable upper and lower contacts	-None	Massive silt (Facies 13a)	LMs, F/LMls	None	
Bed 4, 0.25 m	White (N9) silt	-Massive	-None	Massive muddy micrite (Facies 8a?)	LMs, F/LMls	None	

Table 10 Continued							
Bed	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 3, 9.2 m	Moderate pink (5R 7/4) silt	-Massive	-None	Massive silt (Facies 13a)	LMs, F/LMls	None	F1: 2
Bed 2, >0.25 m	White (N9) mud	-Massive -Manganese clusters	-None	Massive calc-mudstone (Facies 3a)	LMs, F/LMls	None	F1: 3
Bed 1, 4m	Greyish yellow green (5GY 7/2) silt	-Massive	-None	Massive silt (Facies 13a)	LMs, F/LMls	-None	F1: 1

Table 11: Barranca del Muerto Site TB10, Log 2. Head of the Barranca. See Section 6.3 and Figures 6.13, 8.1 & 8.2						
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name**	**Depositional environment**	**Post-depositional environment**
Bed 5, 0.60 m	White (N9) silt	-Straight, wavy and cross laminations	-None	Laminated to wave-rippled calc-mudstone (Facies 3b)	LMa, F/LMls	-None
Bed 4, 0.75 m	White (N9) silt	-Massive -Bioturbation	-None	Andesitic ash (Facies 18b)	LMa, F/LMls	-None
Bed 3, 0.75 m	White (N9) silt with angular brown silt clasts and limestone clast >0.15 m in diameter	-Massive -Poorly sorted	-None	Massive, matrix supported monomictic gravel (Facies 15)	FGmm, SG	-None
Bed 2, >0.25 m	White (N9) mud	-Straight to wavy laminations -Lower contact uneven and disconformable?	-None	Massive calc-mudstone (Facies 3b)	LMa, F/LMls	-None
Bed 1, 0.60 m	White (N9) to very light grey (N8) silt	-Vertical to calcified root structures. 0.01 – 0.03 m wide. -Uneven upper and lower contacts		Framestone limestone (Facies 1)	F/LFm, LMa	-None

Table 12: Barranca del Muerto Site TB10, Log 3. Head of the Barranca. See Section 6.3 and Figures 6.13, 8.1 & 8.2						
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name**	**Depositional environment**	**Post-depositional environment**
Bed 4, 1 m	Yellowish grey (5Y 8/1) silty sand matrix with angular limestone gravel clasts (T3)	-Massive -Poorly sorted -Erosive disconformable channel base -Clast sizes up to 0.12 m (a-axis) -Clasts isolated and dispersed	-None	Massive monomictic, intraformational matrix supported gravel (Facies 15)	FGmm, SG	-None
Bed 3, 1.45 m	Yellowish grey (5Y 8/1) silt to coarse sand matrix with angular limestone gravel clasts and silt rip-up clast (T2)	-Massive -Poorly sorted -Erosive disconformable channel base -Clast sizes up to 0.06 m (a-axis) -Clasts isolated and dispersed	-None	Massive monomictic, intraformational matrix supported gravel (Facies 15)	FGmm, SG	-None
Bed 2, 2 m	Yellowish grey (5Y 8/1) silt to coarse sand matrix with angular limestone gravel clasts (T1)	-Massive -Poorly sorted -Erosive disconformable channel base -Clast sizes up to 0.50 m (a-axis)	-None	Massive monomictic, intraformational matrix supported gravel (Facies 15)	FGmm, SG	-None
Bed 1, 3 m +	Pale red (5R 6/2) silt	-Massive -Upper contact is an erosional unconformity	-None	Massive silt (Facies 13a)	LMa, F/LMls	-None

Table 13: Barranca del Muertro Site TB10, Log 4. See Section 6.3 and Figures 6.13, 8.1 & 8.2						
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name**	**Depositional environment**	**Post-depositional environment**
Bed 6, 0.50 m	Yellowish grey (5Y 8/1) silty fine sand matrix with angular limestone gravel clasts (T2)	-Massive -Poorly sorted -Erosive disconformable channel base -Clast sizes up to 0.03 m (a-axis) -Clasts isolated and dispersed	-None	Massive monomictic, intraformational matrix supported gravel (Facies 15)	FGmm, SG	-None
Bed 5, 0.12 m	Yellowish grey (5Y 8/1) silty fine sand (T2)	-Laminated -Gradational lower contact -Erosive upper contact	-None	Laminated fine silty sand (Facies 14b)	FFl, FFSm	-None
Bed 4, 1 m	Yellowish grey (5Y 8/1) silty fine sand matrix with angular limestone gravel clasts (T2)	-Massive -Poorly sorted -Erosive disconformable channel base -Clast sizes up to 0.05 m (a-axis) -Clasts isolated and dispersed	-None	Massive monomictic, intraformational matrix supported gravel (Facies 15)	FGmm, SG	-None
Bed 3, 0.50 m	Yellowish grey (5Y 8/1) silty fine sand matrix with angular limestone gravel clasts and white (N9) silt rip-up clast. (T2)	-Massive -Poorly sorted -Erosive disconformable channel base -Clast sizes up to 0.05 m (a-axis) -Clasts isolated and dispersed	-None	Massive monomictic, intraformational matrix supported gravel (Facies 15)	FGmm	-None
Bed 2, 0.70 m	Yellowish grey (5Y 8/1). c) Silty fine sand pelleted with pale red (5R 6/2) silt rip-up clasts **b)** Silty fine sand with occasional pale red (5R 6/2) silt rip-up clasts and fine pebble limestone clasts in the base of the bed. **a)** fine sand matrix with pale red (5R 6/2) silt rip-up clasts (at the base) and occasional angular limestone gravel clasts (T1)	**c)** -Bed sits within a boundary and channel form -Silt rip-up clasts < 0.02 m a-axis concentrated at base of bed, gravel lined scour **b)** -Poorly sorted -Weak wavy laminations in sections -Limestone and silt clast lined channel base at the base -Intact and fragmented molluscs **a)** -Massive -Poorly sorted -Erosive disconformable channel base -Limestone clast <0.05 m a-axis -Silt clasts -Intact and fragmented molluscs	-None	**c)** Laminated to wave rippled fine silty sand (Facies 14b) **b)** Weakly wave rippled fine silty sand (Facies 14b) **a)** Massive monomictic, intraformational matrix supported gravel (Facies 15)	**c)** FFl, FSe, FFSm, SG **b)** FFl **a)** FGmm, SG	-None
Bed 1 m +	Pale red (5R 6/2) silt	-Massive -Upper contact is an erosional unconformity	-Vertically jointed	Massive silt (Facies 13a)	LMa, F/LMls	-Drying, exposure and desiccation

Appendix Five:

Cattle Shed (Site TB15) Appendix Five:

Table 1: The Cattle Shed, Site TB15, Log 1 (composite) (ca. m thick), the exposed section on a farming field. See Figs 8.1 & 8.9. 19°55.379 N - 99°07.910 W, 2233 ± 4 m a.s.l.

Bed number and thickness	**Facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 29, 4.20 m	Light red (5R 6/6) fine silty sand with intraclasts	-Intraclasts are rip-up clasts sourced from the same bed	-Vertical jointing	Massive fine silty sand with fine pebble gravel (Facies 15)	FFSm, SG	PBre	F3: 1
Bed 28, 0.40 m	Light grey (N7) fine sand	-Massive	-Vertical jointing	Massive fine sand (Facies 14c)			
Bed 27, 0.10 m	Light red (5R 6/6) fine silty sand	-Massive	-Vertical jointing -Concentric carbonate nodules (0.09 x 0.06 m)	Massive fine silty sand (Facies 14b)			
Bed 26, 1.30 m	Greyish pink (5R 8/2) fine sand to fine silty sand with yellowish grey (5Y 8/1) gravel lined cross bed	-Erosive uneven lower contacts -Medium gravel lined cross-bed forms that thin up the bed (ca. 0.30 m to 0.03 m) -Beds fine upwards from medium gravel to fine silty sand in the upper interbeds -All interbeds contain occasional intraclasts that also fine upwards	- Occasional laminar calcreted beds at interbed contacts	Trough cross bedded diamicton gravel (Facies 16)	FSt or FSe:	CPlh: Facies 19a	
Bed 25, 5.00 m	Greyish pink (5R 8/2) fine sand that fines to silt in the upper bed	-From the base the bed grades from fine sand to silt in the upper bed. -Contains small (<0.03m in diameter) intraclasts	-None	Normally graded silty sand (Facies 14b)	FFSm, SG	-None	
Bed 24, 0.04 m	Yellowish grey (5Y 8/1) coarse sand interbedded with very light grey (N8) very coarse sand.	-Low small-scale cross bedding -Undulating upper and lower contacts	-None	Re-worked coarse volcanic ash (Facies 18d) (?)	FGmg, SG	-None	F3: 2
Bed 23, 0.44	Yellowish grey (5Y 8/1) fine sand to fine silty sand	-From the base the bed grades from fine sand into fine silty sand in the upper bed	-None	Forms part of Facies 18d, Tephra?	FGmg, SG	-None	
Bed 22, 0.12 m	Light grey (N7) very fine sand with small white flecks	-Massive -Undulating lower contact -Gradational upper contact	-None	Re-worked coarse volcanic ash (Facies 18d) (?)	FGmm, SG	-None	
Bed 21, 0.04 m	Yellowish grey (5Y 8/1) coarse sand	-Massive FSt, lower flow fluvial bed form, ephemeral?	-None	Forms part of Facies 18d, Tephra?	FSt	-None	

Table 1 Continued							
Bed number and thickness	**Facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 20, 0.12 m	Light grey (N7) fine sand with small white flecks	-Massive -Undulating upper and lower contacts	-None	Re-worked coarse volcanic ash (Facies 18d) (?)	FGmm, SG	-None	F3: 2
Bed 19, 0.02 m	Yellowish grey (5Y 8/1) coarse sand	-Continuous -Erosive, uneven but sharp lower contact	-None	Forms part of Facies 18d, Tephra?	FSt,	-None	
Bed 18, 0.30 m	Very light grey (N8) coarse sand	-Massive -Undulating upper and lower contacts	-None	Re-worked coarse volcanic ash (Facies 18d) (?)	FGmm, SG	-None	
Bed 17, 0.02 – 0.03 m	Yellowish grey 5Y 8/1 coarse sand interbedded with very light grey (N8) very coarse sand.	-Low small-scale cross bedding -Undulating upper and lower contacts	-None	Forms part of Facies 18d, Tephra (?)	-FSt	-None	
Bed 16, 0.06 m	Very light grey (N8) normally graded course – medium sand	-Poorly sorted -Straight but uneven lower contact - Fine to fine pebble gravel pumice fragments. At the base very light grey (N8) grads to light grey (N7) in the upper bed	-None	Re-worked coarse to medium volcanic ash (Facies 18d) (?)	FGmm	-None	
Bed 15, 0.01 m	Yellowish grey (5Y 8/1) coarse sand	-Discontinuous indurated layer that pinches and swells	-None	Forms part of Facies 18d, Tephra?	FSt	-None	
Bed 14, 0.14 m	Greyish pink (5R 8/2), indurated fine silty sand	-Small white (N9) intraclast (<1mm in diameter) -Uneven but sharp upper contact	-None	-Micrite (Facies 3) or muddy micritic (Facies 8)?	-FInls,	-None	F3: 1
Bed 13, 0.07 m	White (N9) micritic limestone	-Very uneven, wavy but straight upper and lower contact. -Bed undulates, almost looks like (up to 0.50 m in thickness) bioherms or concretions have co-joined in places and sit within a micritic matrix	-None	-Microdetrital limestone (Facies 3) containing oncoids or stromatolitic limestone (Facies 2a)	-F/LOnls, F/LMl or LMs. CGNo	CGNo	

Table 1 Continued							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 12, 0.26 m	Very dark red (5R 2/6) coarse sand	-Massive -Erosive uneven base	-None	Massive coarse sand (Facies 14d)	FFSm, SG	-None	F3: 1
Bed 11, 0.16 m	Light red (5R 6/6) silt	-Massive -Gradational lower contact	-None	Massive silt (Facies 13b)	-FFl	-None	
Bed 10, 0.55 m	Moderate red (5R 5/4) fine sand	-Massive -Normally graded -Gradational contacts	-None	-Massive, normally graded fine silty sand (Facies 14b)	-FFl	-None	
Bed 9, 0.25 m	Moderate red (5R 5/4) fine silty sand	-Massive -Small clay intraclasts <2mm -Gradational contacts	-None	-Massive fine silty sand (Facies 14b)	-FFl	-None	
Bed 8, 0.20 m	Moderate red (5R 5/4) fine silty sand	-Massive -very sharp lower contact -Sharp but uneven lower contact -Gradational upper contacts	-None	-Massive fine silty sand (Facies 14b)	-FFl	-None	
Bed 7, 1.35 m	Pale brown (5YR 5/2) fine sand	-Massive -Poorly sorted - Occasional, sub-angular fine to medium pebble gravel intraclasts	-None	-Massive fine sand (Facies 14c)	- FGmm, SG	-None	
Bed 6, 0.30 m	Dark grey (N3) micritic limestone	-Very uneven, wavy but straight upper and lower contact. -Bed undulates, almost looks like (up to 0.50 m in thickness) bioherms or concretions have co-joined in places and sit within a micritic matrix	-None	-Microdetrital limestone (Facies 3) containing oncoids or stromatolitic limestone (Facies 2a)	-F/LOnls, F/LMl or LMs. CGNo	CGNo	F2: 1

Table 1 Continued							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 5, 0.35 m	Pale brown (5YR 5/2) course sand with fine pebble gravel intraclasts	From the base: -Cut channel base that extends laterally in section for 5 m -10 mm of fining upwards from fine pebble, clasts supported gravel to massive coarse sand -In the upper bed the coarse sand grades to fine sand -The whole unit contains isolated intraclasts	**-**None	Massive normally graded coarse sand with fine pebble gravel (Facies 15)	-FGmg, SG	-None	F3: 1
Bed 4, 1.60 m	Pale brown (5YR 5/2) medium -coarse sand with fine pebble gravel intraclasts	-Gravel lined channel forms and occasional isolated intraclast in a coarse sand matrix (lowest 0.15 cm). -The rest of the bed grades to fine silty sand with occasional gavel clasts -Lower contact is curved, non-parallel and dips towards the centre of the cross-section	**-**None	-Trough cross bedded diamicton gravel (Facies 15)	-FSt or FSe or LMa, F/LMls	-None	
Bed 3, 0.20 – 2 m	Dark grey (N3) micritic limestone	-Massive -Occasional carbonate intraclasts	-None	-Microdetrital limestone (Facies 3) containing oncoids or stromatolitic limestone (Facies 2a)	-F/LOnls, F/LMl or LMs.	-None	F1: 3/F4: 1 type
Bed 2, 0.10 m	Pale reddish brown (10R 5/4) fine silty sand	-Some crude cross bedding -Erosional lower contact	-None	-Massive, silty fine sand (Facies 14b)	- FSe, LMa	-None	F2:1 type
Bed 1, 1.4 m	Moderate red (5R 5/4) fine sand	-Massive -Upper contact in this section is cut by channels (0.09 – 1 m thick, 0.40 – 2 m in diameters) infilled with bed 2 -Isolated fine to medium pebble gravel intraclast	-None	-Massive, silty fine sand (Facies 14b)	- LMa, F/LMls	-None	F1: 2 type

Appendix Six:

The mound and Presa Xocoyoltl (Sites TB6 & TB3)

Table 1: The mound, Site TB3, Log 1 domed deposit opposite Barranca La Gloria, see Figures 8.1 & 8.9. 19°55.755 N - 99°07.583 W, 2230 ± 6 m a.s.l.							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 3, 0.63 m	Simple bed sets of hard indurated white (N9) / light grey (N7) silt interbedded with powdery white/grey silt	-Erosive, uneven disconformable lower contact -Made up of wavy interbeds (>10 mm up to 0.15 m) -Bed contains multiple root tracts that have been replaced with micritic carbonate silt and stromatolitic lamina that make up some of the beds -Again, this bed also has basaltic lenses and lamina incorporated into the sequence	None	Framestone limestone (Facies 1)	F/LChls, LMa	None	F4: 1 type
Bed 2, 1.5 m	Composite bed sets of cream to light grey (N7) cemented silt, powdery white silt and fine sand and black (N8) fine sand with occasional fine to medium pebble gravel intra and extraclasts. Molluscs throughout	-The base of the bed is a medium pebble gravel lined channel with an erosive disconformable lower contact Made up of bed sets of cross-laminated sands and occasional gravel lined scours -This composite bed is made up of bet sets of powdery silt and sand at that base to indurate silt in the upper bed. Black layers occur as discontinuous lenses (max 0.50 m in diameter, 0.20 m thick) and interbedded lamina. -Sedimentary structures include; cross-ripple lamination, trough cross-lamina, climbing ripples and massive beds. -Bed thicknesses are >10 mm and up to 0.10 mm and set thicknesses have a maximum thickness of 0.35 m. -Bed sets are laterally continuous and discontinuous, and occasionally a set truncates and incises the lower set. -Occasionally the scours are lined with medium pebble gravel intra (limestone, sand and mud) and extraclasts (basalt, vesicular basalt, oxidised vesicular basalt). -Gravels are poorly sorted and sub-rounded to sub-angular	None	Rippled, trough cross-bedded, plane or massive interbedded sets of sandy micrite (Facies 10b), calc-mudstone (Facies 3b) and fine basaltic ash (Facies 18d0 with fine to medium pebble gravel lined scours (Facies 15/16)	FSt, FSp, FSr, FSh, FSe, FFSs & FFSm, SB	None	F5: 1 type
Bed 1, 0.70 m +	Moderate red (5R 5/4) silty fine sand	-Massive -Disconformable upper uneven but curved contact	-Vertically jointed	Massive fine silty sand (Facies 14a)	LMs	PBre	F1: 2 type

Table 2: The Mound, Site TB3, Log 2 (ca. m thick), domed deposit opposite Barranca La Gloria. See Figures 8.1 & 8.9. 19°55.753 N - 99°07.528 W, 2236 ± 6 m a.s.l.

Bed number and thicknes s	**Field facies description**	**Sedimentary structures/features**	**Post deposition al facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 6, 0.70 m	Pale brown (5YR 5/2) fine sand with angular cobble limestone intraclasts	-Massive	None	Massive, sand with medium to large cobble clasts (Facies 15/16)	FGcm, SG	None	F5: 1 type
Bed 5, 0.20 m	Composite bed sets of hard indurated white (N9)/ to light grey (N7) silt interbedded with powdery white (N9)/ to light grey (N7) silt	-Erosive, uneven disconformable lower contact -Made up of wavy interbeds (>10 mm up to 0.15 m) -Bed contains multiple root tracts that have been replaced with micritic carbonate silt and stromatolitic beds that make up to -Again, this bed also has basaltic lenses and lamina incorporated into the sequence		Framestone limestone (Facies 1)	F/LChls, LMa	None	F4: 1 type
Bed 4, 0.36 m	Cream silt	-Massive -Iron modelling on the surface		Calc-mud or muddy micrite (Facies 3b/8b)	F/LMls, LMs:	None	F4: 1 type
Bed 3, 0.20 m	A repeat of bed 2	-See bed 2 -Bed contains larger carbonate nodules (max 0.30 m in diameter), challenging to say if they are intraclast or post-depositional feature -Basaltic ash and extraclasts are absent from this bed	Vertically jointed	Rippled, trough cross-bedded, plane or massive interbedded sets of sandy micrite (Facies 10b), calc-mudstone (Facies 3b) and fine basaltic ash (Facies 18d0 with fine to medium pebble gravel lined scours (Facies 15/16)	FSt, FSp, FSr, FSh, FSe, FFSs & FFSm: SB.	PBre	
Bed 2, 0.75 m	Composite bed sets of cream to light grey (N7) cemented silt, powdery white silt and fine sand and black (N1) fine sand with occasional fine to medium pebble gravel Molluscs throughout	-Base: medium pebble gravel lined channel with erosive disconformable lower contact. Bed sets of powdery silt and sand. Occasional black discontinuous lenses (max 0.50 m in diameter, 0.20 m thick). -Sedimentary structures: cross-ripple lamination, wave rippled lamina, climbing ripples and massive beds. -Bed thicknesses >10 mm. Bed set thicknesses < 0.35 m. -Bed sets can be laterally continuous, discontinuous and occasionally truncated and incisional. -Occasionally bed sets are lined with medium pebble gravel intra (limestone, sand and mud) and extraclasts (basalt, vesicular basalt, oxidised vesicular basalt)					
Bed 1, 1.5 m +	Moderate red (5R 5/4) silty fine sand	-Massive, disconformable upper uneven but curved contact		Massive silty fine sand (Facies 14a)	LMs		F1: 2 type

Table 3: Presa Xocoyoltl (LB), Site TB16, Log 1 (ca. m thick) across the dam, exposed section. See Figures 8.1 & 8.9. 19°55.829 N – 99°09.028 W, 2225 ± 2 m. a.s.l.							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 3, 1.5 m	Pale yellowish brown (10YR 6/2) silty limestone	-Be overhangs the lower bed by ca, 0.10 m -Massive -Vertical burrow structures -Large (<0.30 m thick) tabular plane cross-beds	-None	Braided fluvial limestone (Facies 1)	FIBls?	None	F4: 1 type
Bed 2, 1.6 m	Moderate red (5R 5/4) silt matrix with sub-rounded carbonate (max 0.15 m in diameter) nodules and vertically elongated carbonated nodules (max 40 mm in diameter and 0.50 m thick)	-Massive -Horizontal bed -Poorly sorted -Uneven, but straight disconformable, upper contacts -Uneven, erosive channel scour lower contact	-Vertically jointed -Brecciated	Massive silt (Facies 13b)	FP, BS or LMa	CPedN, PNod.	F1: 2 or F2 type
Bed 1, 1m +	Composite bed sets of moderate red (5R 4/6) fine sandy silt and yellowish grey (5Y 8/1) micritic silt. Throughout there are occasional sub-rounded carbonate (max 0.20 m in diameter) nodules and vertically elongated carbonated nodules (max 0.25 m in diameter and 0.50 m thick)	-Alternating beds of discontinuous lensed and continuous sandy silt and micritic silt -Horizontal bed -Uneven, irregular upper contact, disconformable and erosive> -Uneven	-Vertically jointed -Brecciated -Nodule formation but not sure how	Massive silt (Facies 13b)	FP, BS or LMa	CPedN, PNod	F2: 1 or F5: 1 type
Bed 5, 0.65 m	Light brown (5YR 6/4) fine sand with fine to medium pebble gravel intraclasts	-Cross-bedded, ripple cross-laminated that is transverse, sinuous and out of phase -Uneven, erosive channel scour lower contact.	-Vertically jointed -Brecciated	Cross-bedded, ripple cross-laminated fine sand with fine to medium pebble gravel (Facies 16)	FSt, FSp, FSr, SB	None	F2: 1 or F5: 1 type
Bed 4, 0.85 m	Moderate red (5R 4/6) fine silty sand	-Massive	None	Massive fine silty sandstone (Facies 14c)	FFSm, SG	None	F2: 1 or F5: 1 type

Table 3, Continued							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 3, 0.55 m	Pale reddish brown (10R 5/4) fine sand with up to small boulder sized rip-up clasts of red-brown mud, sand and silt	-Massive -The upper bed (ca 0.10 m) grades into cross-laminated sets -Uneven, erosive channel scour	-Vertically jointed	Upper bed: Ripple cross-laminated fine sand (Facies 14c). Lower bed: Massive, fine sand with small boulder sized gravel (Facies 15)	Upper bed: FSr (LMa?): Lower bed: FGmm (LMs?)	PBre	F2: 1 type
Bed 2, 1.8 m	Light brown (5YR 5/6) medium to fine silt with sand. The unit contains occasional nodules and small pebble gravel intraclasts	-Made up of thick (max ca 0.50 m) curved plane lenticular beds -Internally beds are massive and very poorly sorted -The disconformable erosive lower boundary	-Vertical jointing -Carbonate nodules	Massive, medium to fine sand small pebble gravel (Facies 15)	FGmm, SG	PBre, FP	
Bed 1, 2.3 m	Moderate red (5R 4/6) silt sub-rounded carbonate (max 0.24 m in diameter) nodules and vertically elongated carbonated nodules (max 0.25 m in diameter and 0.50 m thick)	-Massive -Laterally continuous -A horizontal, plain bed	-Vertically jointed -Carbonate nodules	Massive silt (Facies 13b)	FP, LMa	CPedN, PNod	

Table 4: Presa Xocoyoltl (LB), Site TB16, Log 2 (ca. m thick) opposite Log 1. See Figures 8.1 & 8.9. 19°55.829 N – 99°09.028 W, 2225 ± 2 m. a.s.l.

Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed name** (See Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4 and Chapter 5)	**Facies Group** (Chapter 8)
Bed 4, 1 – 3 m	Brown medium sand matrix with large angular to sub-rounded pebble to very large boulders gravel clasts	-Massive -Poorly sorted -Lower contact, channel scour that extends the length of the sequence (ca 400m)	None	Gravel, Intraformational, medium to fine sand matrix with medium to large cobble clasts (Facies 16)	b) CG, GB, FGt, FGp:. a) CG, GB, FGmg:	- None	F5: 1
Bed 3, 1.5 m	Pale brown silty limestone	-Bed overhangs the lower bed by ca, 0.10 m -Massive -Vertical burrow structures -Large (<0.30 m thick) tabular plane cross-beds	None	Braided fluvial limestone (Facies 1)	FIBls	-None	
Bed 2, 1.6 m	Reddy light brown silt matrix with sub-rounded carbonate (max 0.15 m in diameter) nodules and vertically elongated carbonated nodules (max 40 mm in diameter and 0.50 m thick)	-Massive -Horizontal bed -Poorly sorted -Uneven, but straight disconformable, upper contacts -Uneven, erosive channel scour lower contact	-Vertically jointed -Brecciated	Massive silt (Facies 13b)	FP, BS or LMa	CPHh, PNod	
Bed 1, 1m +	Composite bed sets of moderate red (5R 4/6) fine sandy silt and yellowish grey 5Y 8/1 micritic silt. Throughout there are occasional sub-rounded carbonate (max 0.20 m in diameter) nodules and vertically elongated carbonated nodules (max 0.25 m in diameter and 0.50 m thick)	-Alternating beds of discontinuous lensed and continuous sandy silt and micritic silt -Horizontal bed -Uneven, irregular upper contact, disconformable and erosive> -Uneven	**-**Vertically jointed -Brecciated -Nodule formation but not sure how	Massive silt (Facies 13b)	FP, BS or LMa	CPHh, PNod	
Bed 5, 0.65 m	Light brown (5YR 6/4) fine sand with fine to medium pebble gravel intraclasts	-Cross-bedded, ripple cross-laminated that is transverse, sinuous and out of phase -Uneven, erosive channel scour lower contact.	-Vertically jointed -Brecciated	Cross-bedded and wave rippled fine sand with fine to medium pebble gravel (Facies 16/17)	FSt, FSp, FSr, SB	None	
Bed 4, 0.85 m	Moderate red (5R 4/6) fine silty sand	-Massive	None	Massive fine silty sand (Facies 14b)	FFSm	None	F1: 2

Appendix Seven:

Loma Bonita (Site TB11), Apaxco Football field (TB8) Site and Apaxco Quarry (Site TB18)

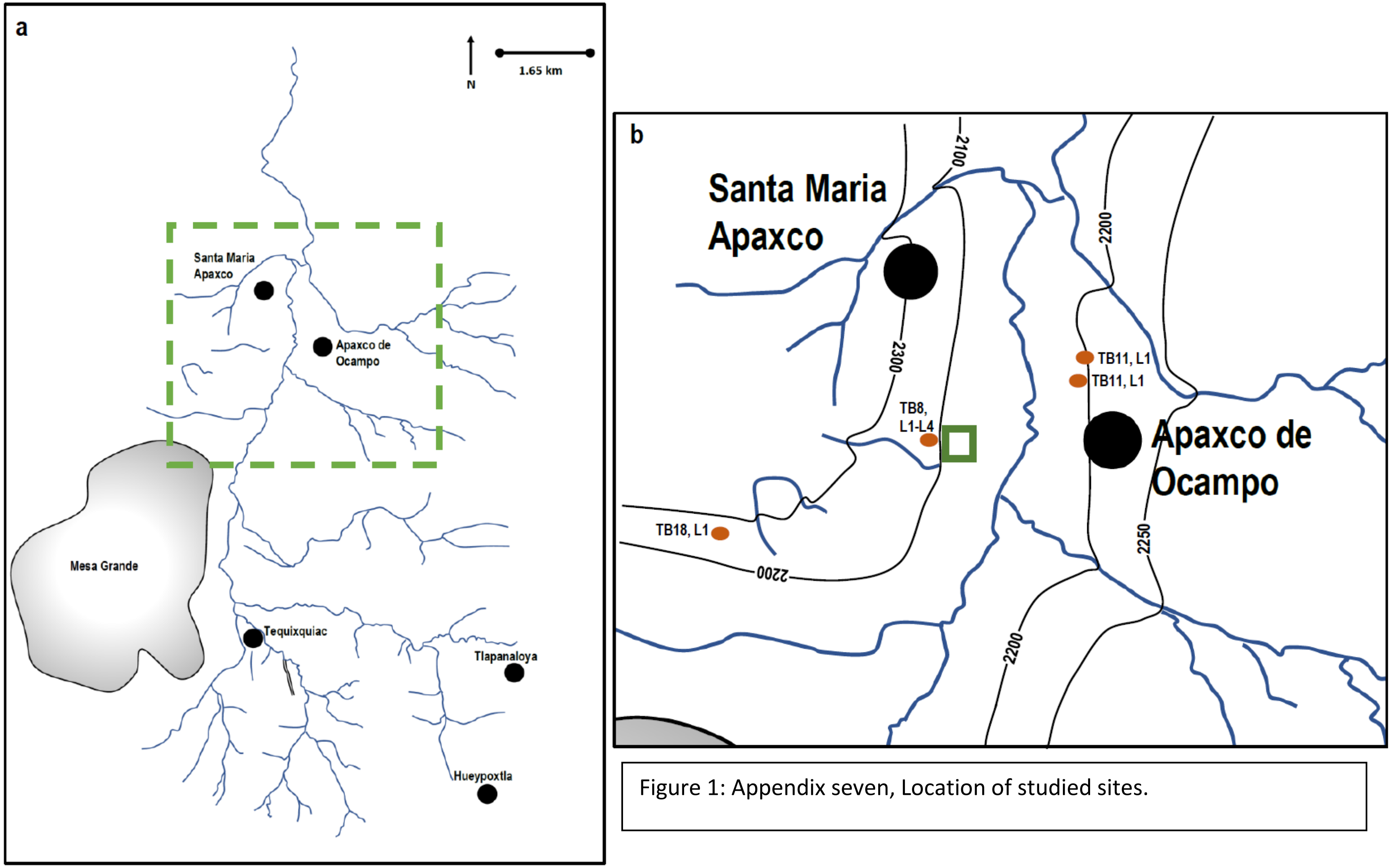


Figure 1: Appendix seven, Location of studied sites.

Table 1: Loma Bonita, Site TB11, Log 1 road-side quarry. See Table 4 and Figures 1, 8.1 & 8.9. 19° 57.362 - 99° 10.179, 2207±3 m a.s.l							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Tables 5.1 – 5.5, Fig 5.1)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 8, 1m	Yellowish grey coarse sand matrix with angular to rounded pebble – cobble limestone clasts and sandy silt rip-up clasts.	-Massive -poorly sorted	-None	Massive coarse sand gravel with pebble – cobble clasts (Facies 15)	FGcm, SG	None	F5: 1 type
Bed 7, 6 m	Composite sequence made up of at least two cycles that follow the same bed set pattern seen in beds 2 and 3.	-Max cycle thickness 3m	-Vertically jointed	See beds 2 & 3	See beds 2 & 3	PBre	F4: 1 and F5: 1 type
Bed 6, 1 m	Moderate reddish brown (10R 4/6) medium silty sand with fine to very coarse pebble sub-angular to sub-rounded gravel. At least two phases of limestone development (see bed 3). The first at 0.50 m (ca. 0.04 m thick) and the second in the upper bed (0.10 m thick) which top the massive sandy units.	-Upper contact very uneven, None-parallel, channel scours up to 0.50 m deep. These are infilled with the sediments from bed 7. a) Each unit is, -Massive -Poorly sorted -Uneven, curved parallel erosive lower contact b) -Limestone caps are discontinuous, wavy and None-parallel may have been continuous but have been broken up in sections and resedimented as intraclasts through fluvial incision	-Vertically jointed	a) Massive, medium sand coarse pebble gravel (Facies 15/16) b) Calc-mudstone interbedded with intraclastic limestone (Facies 3b/Facies 6)	a) FGcm, SG b) FBls, GB, SB, DA	PBre, ICh	
Bed 5, 0.28 m	Light grey (N7) micritic silt with varied limestone intraclast. Forms the upper portion of composite bed sets that repeat though the sequence	-Wavy, None-parallel upper and lower bedding planes, channel scour -Bed is either massive or contain low-angle climbing ripples in some sections but mostly wavy lamina that form low domes in portions.	-None	Calc-mudstone interbedded with intraclastic limestone (Facies 3b/Facies 6)	FBls, GB, SB, DA.	None	

Table 1, Continued							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Tables 5.1 – 5.5, Fig 5.1)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 4, 0.20 m	Light grey (N7) very fine silt with very occasional sub-rounded fine to medium pebble gavel intraclasts	-Massive -Poorly sorted -Wavy, None-parallel upper and lower bedding planes, channel scour -Sits in discontinuous curved parallel to None-parallel pockets (out of phase, transverse sinuous ripples) -In places the bed pinches out and beds 3 & 5 meet	-None	Massive silty sand with fine to medium pebble gavel (Facies 15)	FGmm: Plastic debris flow. GB: Gravel bars and bed forms.	None	F4: 1 and F5: 1 type
Bed 3, 0.40 m	Light grey (N7) micritic silt with varied limestone intraclast. Forms the upper portion of composite bed sets that repeat though the sequence	-Wavy, None-parallel upper and lower bedding planes, channel scour -Bed contain low-angle climbing ripples in some sections but mostly wavy lamina that form low domes	-None	Calc-mudstone interbedded with intraclastic limestone (Facies 3b/Facies 6)	FBls, GB, SB, DA.	None	
Bed 2, 0.50 m	Medium grey (N5) medium sand with angular to well-rounded fine pebble up to small cobble gravel intraclasts in the first 0.30 m. Upper 0.20 m fine sand. This bed forms the lower portion of composite bed sets that repeat up the sequence	-Massive -Poorly sorted c) The upper bed (ca 0.20 m) has clear, simple bed sets made up of laminations, cross-laminations and trough crossed-beds all of which can be continuous and discontinuous in section. b) Normally, but weakly graded form massive fine sands with small cobble clasts to fine pebble gravel clasts in the upper bed. Vaguely laminated, cross-laminated and trough cross-bedded, in places a) Lower contact, channel scour that extends the length of the sequence (ca 400 m), transverse sections. Disconformable	-Vertically jointed	c) Laminated, wave-rippled and cross-bedded fine silty sand (Facies 14b) b) Massive, normally graded, weakly laminated medium sand gravel (Facies 15/16)	c) Fst, FSr, FFl, CH, SB, OF b) FGt, FGp, GB, CH c) Channel base, concave upwards, disconformable and erosional	PBre	
Bed 1, 1m +	Moderate red (5R 4/6) fine silty sand	-Massive -Horizontal and laterally continuous large bed -Erosive, disconformable, curved, None-parallel upper contact that is cut by bed 2.	-Vertically jointed -Brecciated	Massive fine silty sand (Facies 14b)	FFSm, SG, or FP	Abandoned channel infill	

Table 2: Apaxco football field, Site TB18, Log 1, See Table 5, Figure 1. 19° 56.783 - 99° 11.334, 2198±1 m a.s.l.							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 4, 5 m+	Moderate red (5R 5/4) to Pale brown (5YR 5/2) fine silty sand with occasional small pebble up to large boulders	-Massive -Very occasional small (ca. 0.50 m in diameter, 0.10 m thick) small to medium pebble lined gravel channel scours	-None	Massive fine silty sand with an occasional small pebble to large boulder clasts (Facies 15)	FGmm, CH, SG	None	F5: 1 type
Bed 3, 5 m	Above the lensed and thinned northern end of bed 2 there are large (max thickness 0.60 m, 5 m wide) pale brown fine to medium sand tabular cross-beds	-Tabular cross-beds have planer bounding surfaces -The tabular beds pinch out in the north of the section thinning above bed 2 -Towards the upper section beds thin upwards	-None	Tabular cross-bedded fine to medium sand (Facies 14c)	CH, SB, FSp	None	
Bed 2, max thickness 3 m	Composite bed set made up of lower Pale brown (5YR 5/2) medium sand matrix with large angular to sub-rounded pebble to very large boulders gravel clasts in the first 0.30 m. The upper set is made up of moderate red (5R 5/4) medium sand with occasional fine to medium, up to large cobble intraclasts	b) Upper bed -ca 1.5m of massive, plane laminated to bedded, or cross-laminations and trough cross-bedded all of which can be continuous and discontinuous in section a) Lower bed (1.5 m) -Massive -Poorly sorted -Smaller clasts are oriented -Normally but weakly graded form massive fine sands with small pebble gravel clasts to vaguely plane bedded -Lower contact, channel scour that extends the length of the sequence (ca 500m), transverse section and this lenses to 0.50 m towards the edges	-Vertically jointed	b) Laminated to cross-bedded medium to fine sand with medium to large cobble clasts (Facies 16/17) a) Massive, normally graded medium to fine sand gravel with pebble to boulder clasts (Facies 15)	b) FGt, FGp, CG, GB a) FGmg, CG, GB	PBre	
Bed 1, 1m +	Moderate red (5R 5/4) silty sand	-Massive -Horizontal laterally continuous bed -Relatively -Erosive, disconformable, curved, parallel upper contact that is cut by bed 2. Cut channel	-Vertically jointed -Brecciated	Massive fine silty sand (Facies 14b)	OF, FFm		

Table 3: Apaxco Quarry, Site TB18, Log 1, opposite the northern face of the Mesa Grande. See Table 6 and Figures 1, 8.1 & 8.9. 19° 55.477 - 99° 12.276, 2290±4 m a.s.l							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 8, 0.40 m	Interbed of white (N9) to very light pink medium to fine silty sand and moderate red silt (5R 5/4). Contains very occasional pebble gravel intraclasts (white (N9) and moderate red (5R 5/4)).	-Bed set thicknesses are between 0.03 – 0.20 m thick. Bedding planes can be -Trough cross-beds -Hummocky cross-beds -Sequence thins upwards to the minimum bed size -Disconformable, even but horizontal lower contact	-Vertical jointing -Some brecciation	Cross-bedded medium – fine silty sand (Facies 14b)	SB, Fst, FSp, SB OF, FFl	PBre	F3: 1/F5: 1 type
Bed 7, 0.80 m	Light red mud (repeat of bed 5) interbedded with white to light pink muddy micrite to micrite laminations to small beds (<20 mm)	-Very uneven, parallel disconformable upper and lower contacts. -This bed is very similar to bed 5 except for the laterally continuous and discontinuous white mud bands running through the bed (<0.10 m thick)	-See bed 5	Massive mud (Facies 12c)	OF, FFm	PBre, OF, FP-FGwc	F3: 1/F5: 1 type
Bed 6, 1.5 m	See bed 4 for description	-This bed repeats the same depositional sequence described for bed 4. -Bed set cycles are smaller, larger massive beds towards the base < 0.40 m, and the upper smaller beds sets are < 0.20 m.	-See bed 4	b) Wave-rippled and trough cross-bedded medium fine silty sand (Facies 14b) a) Massive, silt (muddy micrite?) with fine pebble gravel (Facies 15)	b) OF, F/LMls-FFm a) CH, FGmg	PBre	F3: 1/F5: 1 type
Bed 5, 0.5 m	moderate red (5R 5/4) mud	-Very uneven, parallel disconformable upper and lower contacts -This is faint traces of laminations in the base of the bed, but it is too weathered and altered to say definitively -The upper bed is massive	-Vertical jointing -Brecciation -Carbonate nodules (very fine pebble gravel in size) -White silt infills the vertical fractures created by desiccation of the sequence	Massive mud (Facies 12c)	OF, FFm	PBre, OF, FP, FGwc	F3: 1/F5: 1 type

Table 3: Continued							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 4, 2 m	This unit is made up of composite bed set cycles of; at the base, white (N9) fine silty sand. The upper beds are made up of Pinkish grey (5R 5/4) medium fine silty sand and white (N9) fine silty sand. Bed sets can contain occasional fine pebble gravel intraclasts (white (N9) and moderate red (5R 5/4).	- The lower contact of the bed is curved, None-parallel, undulating and erosive. In places, the bed appears to be dissecting the lower bed with cut channels (ca <1.5 m wide, <3 m deep). b) upper bed, pinkish grey (5R 5/4) medium fine silty sand (<20 mm thick) interbedded with white (N9) fine silty sand (<0.30 m). The sequence has cross-bedded ripples and trough cross-bedding all of which infill laterally discontinues concave-up cut channels. a) Base ca. 1 m thick, massive white fine silty sand beds (<0.50 m) that have lower curved, none-parallel, erosive contacts and very occasional fine pebble gravel intraclasts.	-Vertical jointing -Some brecciation	b) Wave-rippled and trough cross-bedded medium fine silty sand (Facies 14b) a) Massive, silt (muddy micrite?) with fine pebble gravel (Facies 15)	b) OF, F/LMls-FFm a) CH, FGmg	PBre	F3: 1/F5: 1 type
Bed 3, 1.2 m	White (N9) silt with up to medium pebble gravel white (N9) silt balls	-Massive -The base of the log contains a large diaper infilled with moderate red (5R 5/4) silty fine sand (1.5 m thick, 1 m) which may be a very large mud lump? -Relatively gradational lower contact	-None	Massive, tabular silt (muddy micrite or calc-mud) (Facies 3b, 8b or 13a)	F/LMLs, LMs	Injection feature	F4: 1 type
Bed 2, 1.5 m	Composite lensed interbeds of moderate red (5R 5/4) fine silty sands and greyish pink (5R 8/2) to white (N9) muddy and sandy silt.	**-**Interbedded wavy-beds to cross-lamina of muddy and sandy silt (maximum thicknesses of 0.20 m) and discontinuous lenses of silty sand of (5 – 10 mm thick). Fine greyish pink (5R 8/2) muddy and sandy silt interbeds dominate the lower bed but become thinner (<0.10 m) and spaced in the upper bed. Instead, moderate red (5R 5/4) fine silty sands dominated, the thickness increase (<0.30 m) and the bedding becomes plane but wavy.	-Vertical jointing -Brecciated	Wave-rippled to horizontally laminated fine silty sand (Facies 14b) and medium sand (Facies 14c)	Of, F/LMls, FFm, LMa	PBre	F2: 1 type
Bed 1, 2 m+	Moderate red (5R 5/4) fine silt	-Massive	-Vertically jointed	Massive silt (Facies 13a)	OF,FFm		F1: 2 type

Appendix Eight:

Barranca Acatlan (Sites TB1), Tajo de Tequixquiac (Site TB2), Barranca El Salto (TB4), Barranca la Macura (Site TB5), Barranca la Botica (Site TB6)

Table 1: Site TB1, Barranca Acatlan and the Agua Negra. See Figure 1				
Log Num.	**Latitude**	**Longitude**	**Altitude m.a.s.l**	**Location description**
1	19 52.677	99 07.107	2314±6	The far Southern limit of Barranca Acatlan. Table 6
2	19 54.110	99 07.348	2229±8	Tunnel exit. Table 7
3	19 54.181	99 07.361	2228±8	Pump station. Table 8
4	19 54.192	99 07.435	2234±5	Opposite pumping station. Table 9
5	19 54.207	99 07.405	2229±6	El Sacro site. Table 10
6	19 54.222	99 07.324	2231±5	El Sacro site second log. Table 11
7	19 54.321	99 07.451	2230±3	Organics/silt, sand, gravel/lacustrine. Table 12.

Table 2: Site TB2, El Tajo de Tequixquiac. See Figure 1				
Log Num.	**Latitude**	**Longitude**	**Altitude m.a.s.l**	**Location description**
1	19 54.086	99 07.274	2241±8	El Tajo de Tequixquiac (silt/organics)
2	19 54.086	99 07.274	2243±8	El Tajo de Tequixquiac (bedded silt/organics)
3	19 54.086	99 07.274	2247±7	El Tajo de Tequixquiac (silt/sand)

Table 3: Site TB6, Barranca la Botica. See Figure 1				
Log Num.	**Latitude**	**Longitude**	**Altitude m.a.s.l**	**Location description**
1	19 53.516	99 06.190	2272±6	La Botica (bedded fine gravel/silt/sand/organics)

Table 4: Site TB4, Barranca el Salto**. See Figure 1**				
Log Num.	**Latitude**	**Longitude**	**Altitude m.a.s.l**	**Location description**
1	19 54.434	99 07.639	2231±6	Barranca El Salto, quarry gravels, sands and silt
2	19 54 25.14	99 07 42,83	2232±7	Barranca El Salto mid barranca, gravels, sands and silt
3	19 54.259	99 07.702	2249±8	Barranca El Salto, terrestrial carbonate/clay/silt

Table 5: Site TB5, Barranca la Macura. See Figure 1				
Log Num.	**Latitude**	**Longitude**	**Altitude m.a.s.l**	**Location description**
1	19 54.349	99 07.425	2235±3	Barranca La Mucura: Cross section logged from the north west by the pool under the bridge to the south east over 60m (interbedded gravels/silts/sand)
2				
3				
4				
5				
6				
7				

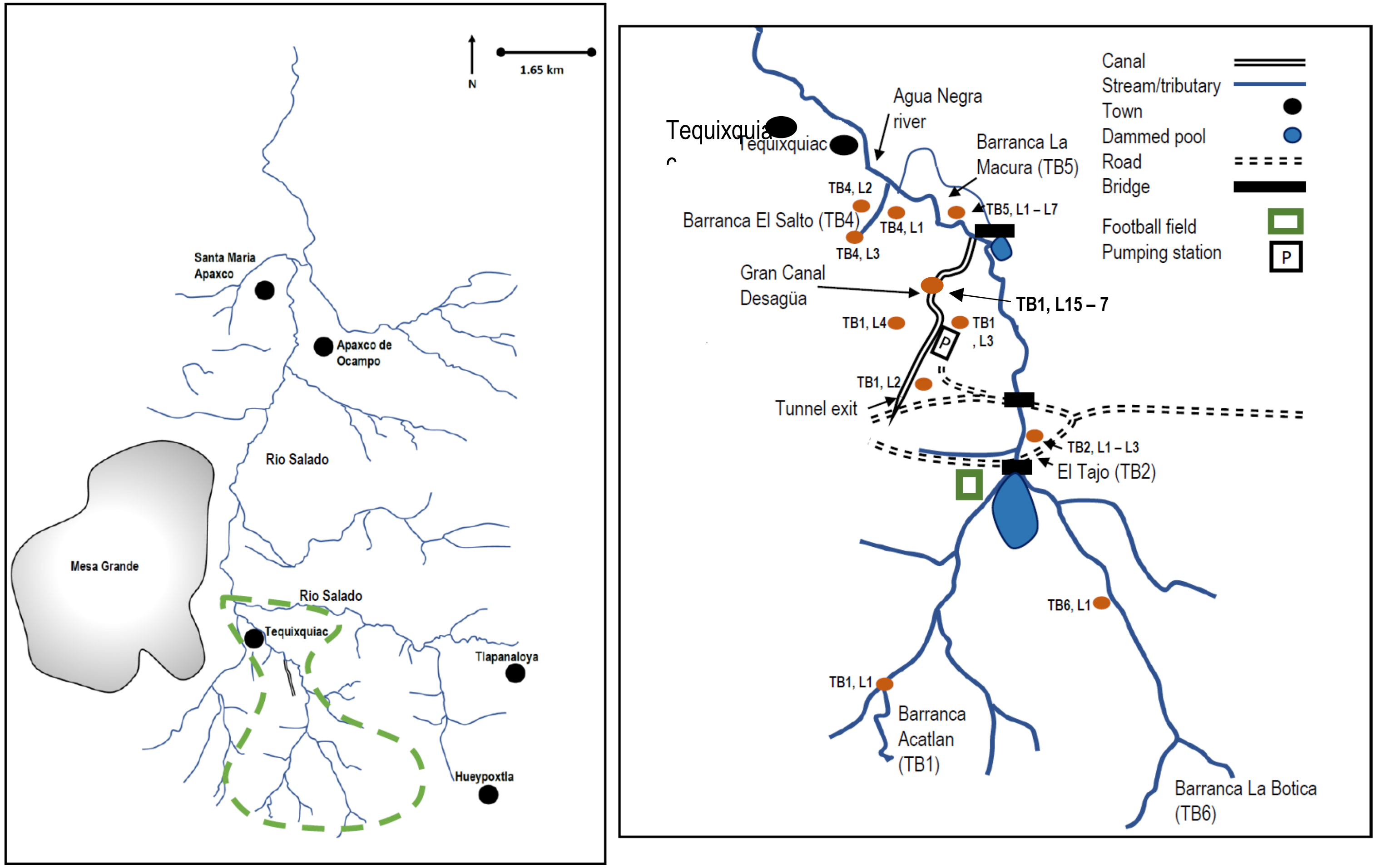


Figure 1: Location map of studies sites

Table 6: Barranca Acatlan (southern limit), Site TB1, Log 1 (ca. 18 m thick). See Table 1 and Figures 1, 8.1 & 8.9.							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 9, 1 m	Light brown (5YR 5/6) re-worked silt	-Massive -Disconformable lower contact	-None	Massive silt (Facies 13a)	FFm, FOF	None	F3: 1
Bed 8, 1 m	Light brown (5YR 5/6) fine silty sand with fine to medium sized fine pebble gravel silt clasts	-Parallel laminations	-None	Plane laminated silty fine sand with fine pebble gravel clasts (Facies 13a)	FFsc, FOF	None	
Bed 7, 2 m	Moderate red (5R 4/6) fine silty sand	-Very irregular lower contact	-Vertical jointing -Brecciation	Massive silty fine sand	FFm, FOF: Waning flood	PBre	
Bed 6, 0.40 m	Light brown (5YR 5/6) medium silty sand with silt pebble clasts and occasional granule gravel	-Cross bedded -Parallel laminated	-None	Plane cross-bedded to laminated medium silty sand (Facies 14c)	FSp, FSr, FSh, FSB, SB	None	
Bed 5, 2 m	Moderate red (5R 4/6) silt	-Massive	-Vertical jointing -Brecciation	Massive silt (Facies 13b)	FFm, FOF	FP	
Bed 4, 4 m	Light brown (5YR 5/6) fine silty sand	-Massive -Erosive irregular lower contact, disconformity	-Carbonate nodules	Massive fine silty sand (Facies 14a)	FFm, FOF	FP	
Bed 3, 0.5 – 1 m	Yellowish grey (5Y 8/1) medium silty sand	-Sets of trough cross beds -Base, erosive channels form -Beds pinch out in places -Undulating upper contact -Erosional, disconformable lower contact	None	Trough cross-bedded medium silty sand (Facies 14c)	Upper: FSt, SB, FCH.	None	

Table 6, Continued							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 2, 6m +	Medium grey (N5) coarse to medium sand	-2 sets of large tabular cross beds (ca 1 -2 m thick) at the base -The top of each set grades into trough cross-bedded and parallel laminated sands in the upper set (ca 0.5 – 1 m thick) -Above the two sets is made up of sets of trough-cross beds (0.30m) followed by -Uneven, undulating upper contact, disconformity?	-Vertical jointing in some sections	Upper: Trough cross-bedded medium sand (Facies 18d) Lower: Plane cross-bedded coarse sand (Facies 18d?)	Upper: FSt, SB, FCH. Lower: FSp, SB, FCH.	PBre	F3: 2
Bed 1, 2 m +	Yellowish grey (5Y 8/1) fine – medium sand with fine gravel clasts	-Massive -Poorly sorted	None	Intraformational, massive gravel with fine pebble gravel clasts (Facies 15)	FGmm	None	
Bed 1	Moderate red (5R 4/6) fine to coarse sand with silt	-Massive	None	Massive coarse to fine silty sand (Facies 14b)	LMa,	None	F1: 2 type?

Table 7: Agua Negra, Site TB1, Log 2 (ca. 3.5 m thick), Tunnel exit. See Table 1 and Figures 1, 8.1 & 8.9							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 3, 2 m	Yellowish grey (5Y 8/1) silty fine sand	-Massive Bed contains undetermined bone fragments -Disconformable lower contact	None	Massive fine silty sand (Facies 14b)	Massive silty fine sand with bone fragments	None	F5: 1
Bed 2, 0.20 – 0.50 m	Clast supported bed with very fine to very coarse pebble sized angular to sub-rounded clasts.	-Mixed intra and extra clasts dominated by rounded to angular oxidised vesicular basalt, basalt, vesicular basalt, quartz/silica, angular limestone up to 60 mm in diameter clasts. -Poorly sorted. -Infilling cut channel form -Disconformable lower contact	-None	Massive gravel with very course pebble clasts (Facies 16)	FGcm, FSG, FCH	None	
Bed 1, 0.10 – 0.40 m	Moderate red silt (5R 4/6)	-Erosive upper contact -Massive	-Vertically jointed -Brecciated	Massive silt (Facies 13b)	LMa	PBre	F1: 2?

Table 8: Agua Negra, Site TB1, Log 3 (ca. 2.73 m), Section behind the pumping station. See Table 1 and Figures 1, 8.1 & 8.9.							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 5, 0.41 m	Black (N1) organic mud	-Massive -Uneven disconformable (?) lower contact	-Vertical jointing -Brecciation	Organic mud (Facies 12b)	FP, OF	PBre	F5: 2
Bed 4, 0.22 m	Light brown (5YR 5/6) silty fine sand with fine to coarse pebble gravel lining the base of the bed and occasional sand clasts (<20 mm in diameter).	-Infilling cut channel (0.80 m wide) -Poorly sorted -Erosional (disconformable?) lower contact	-None	Silty fine sand with a fine to course pebble gravel lag deposit (Facies 16)	FFSs	None	F5: 1
Bed 3, 0.81 m	Bedded, light brown (5YR 5/6) fine sand with fine to coarse pebble gravel (40 – 60 mm thick) and brown silt beds (<20 mm thick).	-Horizontal planer cross-beds continuous and discontinuous -Erosional, uneven (disconformable?) lower contact	-None	Planer cross-bedded fine sand with fine to course pebble gavel (Facies 16/17)	FSp	None	
Bed 2, 0.90 m	Very fine to very coarse pebble sized angular to sub-rounded clasts within a moderate red (5R 4/6) sandy silt matrix. The upper 0.10 m of the bed fines to red silt	-Mixed intra and extra clasts dominated by rounded to angular oxidised vesicular basalt, basalt, vesicular basalt, quartz/silica, limestone up to 0.50 m in diameter clasts. - Infilling cut channel -Poorly sorted. -Upper 0.10 m massive	-None	Massive gravel with very course pebble clasts (Facies 15)	FGcm, FSG, FCH	None	
Bed 1, 1m +	Very fine pebble sized to cobble sized angular to sub-rounded clasts and a Yellowish grey (5Y 8/1) to grey medium sandy silt matrix.	-Mixed intra and extra clasts dominated by rounded to angular oxidised vesicular basalt, basalt, vesicular basalt, quartz/silica, limestone up to 0.50 m in diameter clasts. - Infilling cut channel -Poorly sorted.	-None	Massive gravel with very course pebble clasts (Facies 15)	FGcm, FSG, FCH	None	

Table 9: Agua Negra, Site TB1, Log 4 (ca. 8 m+), section opposite pumping station. See Table 1, Figure 1.							
Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 2, 4 m +	Several repeated cycles: -Upper cycle, fine sands to fine silt -Mid-cycle light grey to cream coarse to fine sand. -The base of the cycle, cream silty fine-coarse sand matrix with very fine to medium intraclast cream pebbles, brown silt clasts <60 mm in diameter and grey volcanic ash balls <80 mm in diameter.	-Each cycle grades normally upwards -Upper cycle, horizontally laminated -Mid-cycle, trough cross bedded -Base of cycle- moderately sorted, very coarse, intraclastic gravel in a silty fine sand matrix at the base -Within each stage of the cycle, each unit fines upwards -Maximum cycle thickness of 0.35 m -Each cycle infills a cut channel	-None	Normally graded, cross-laminated to plane fine laminated sand to fine sandy silt (Facies 14b, occasionally Facies 15)	FSr, FSh, SB, LS:	None	F5: 1
Bed 1, 4 + m	Moderate red silt (5R 4/6) silt	-Massive	-Vertically jointed -Brecciated	Massive silt (Facies 13b)	-LMs	PBre	F1: 2?

Table 10: Agua Negra, Site TB1, Log 5 (ca. 4 m), El Sacro sediments (first log). See Table 1 and Figures 1, 8.1 & 8.9

Bed number and thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 4, 0.20 m	Black organic silt	-Massive	-Vertical jointing	Paleosol	FC	PBre	F5: 2
Bed 3, 2.5 m	Yellowish grey (5Y 8/1) silty fine sand matrix with very occasional isolated very fine to very coarse pebble gravel intraclasts (<30%).	-Matrix is massive and poorly sorted -Intraclasts and bone fragments are sub-angular to sub-rounded and poorly sorted -Molluscs in the base of the bed account for >20% -The unit contains very occasional, fine pebble gravel lined channel forms that have been infilled with silt	-None	Massive gravel with very fine to coarse pebble gravel and molluscs (Facies 15)	F/LMls	None	F5: 1
Bed 2, 0.04 m	White (N9) silt	-Concentrated diatomite (petrographic analysis) taxa are both fragmented and intact	-Fragmented taxa may suggest subnarial exposure and drying	Diatomite	F/LMls	PBre	
Bed 1, 1m: 14C age 17, 695 cal. bp (see Table 2, Appendix 9 sample 6 (TX1)).	Yellowish grey (5Y 8/1) silty fine sand matrix with very occasional isolated very fine to very coarse pebble gravel intraclasts, fragmented, isolated, unidentified bone pieces (<0.40 m in diameter) and molluscs.	-Matrix is massive and poorly sorted -Intraclasts and bone fragments are sub-angular to sub-rounded and poorly sorted -Molluscs account for >20%	None	Massive gravel with very fine to coarse pebble gravel clasts, molluscs and megafauna bone fragments (Facies 15)	F/LMls	None	

Table 11: Agua Negra, Site TB1, Log 6, El Sacro sediments (second log). See Table 1 and Figures 1, 8.1 & 8.9. See Table 19 for diatom data

Bed number, thickness and sample number	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 9, 1.25 m, F14: 14C age 12, 354 cal. bp (see Table 2, Appendix 9, sample 5 (TX5)).	Black (N1) mud	-Occasional sets of laminated silt (bed thickness <0.10 m)	-Root penetration in the upper bed	Organic mud (Facies 12b)	FC: Diatoms indicate marginal river environment (See Appendix, Table)	PRm	F5: 2
Bed 8, 0. 45 m, F13 – F11	Light brown fine sand matrix with mud lumps (<30%) that are <5 mm in diameter	-Occasional sets of laminated silt (bed thickness <0.10 m)	-Carbonate nodules <4 mm in diameter	Plane, faintly laminated fine sand (Facies 14c)	FSh, FFl: Diatoms indicate marginal river, saline marsh environment.	FP	F5: 1
Bed 7, 0.10 m, F10	Light brown silty fine sand. Volcaniclastic present (petrographic analysis)	-Faint laminations	-None	Plane, faintly laminated fine silty sand (Facies 14b)	FSh: Diatoms indicate fresh to slightly saline stream environment.	None	
Bed 6, 0.10 m, F9	Dusky yellow green (5GY 5/2) fine silty sand	-Faint laminations	-Carbonate nodules <1 mm in diameter		FSh, OF: Diatoms indicate fresh to slightly saline stream environment.	FP	
Bed 5, 0.7 m, F 8	Dark reddish-brown (10R ¾) clay	-Massive	-Vertically jointed	Massive clay (Facies 11c/11a)	FFm: Standing shallow water (pond/marsh) environment. Strong evaporation and brackish conditions. Drying and further evaporation leading to vertical jointing,	FP	
Bed 4, 1.2 m, F7 – F5: 14C age 17, 695 cal. bp (see Table 2, Appendix 9, Sample 6 (TX1)).	Dusky yellow green (5GY 5/2) silty fine sand with very occasional fine to very coarse pebble intraclasts, bone pieces (<0.40 m in diameter) and molluscs. Clasts <30 %. Volcaniclastic present (petrographic analysis)	-Matrix is massive and poorly sorted -Intraclasts and bone fragments are sub-angular to sub-rounded and poorly sorted -Molluscs account for >20% -Made up of four beds (ca. 0.30 m thick) that have gradational contacts, and that grade generally from silt with medium sand in the lower bed to fine silty sand in the upper bed.	-None	Massive gravel with very fine to coarse pebble gravel, molluscs and megafauna bone fragments (Facies 15)	F/LMls, FFms: Diatoms indicate temporary aquatic habitat. Pool.	None	

Table 11: Agua Negra, Site TB1, Log 6, El Sacro sediments (second log). See Table 1 and Figures 1, 8.1 & 8.9							
Bed number, thickness and sample number	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 3, 0.30 m, F4	Very fine to medium pebble sized angular to sub-rounded clasts and mud lumps within a yellowish grey (5Y 8/1) sandy silt matrix and molluscs.	-Mixed intra and extra clasts dominated by rounded to angular oxidised vesicular basalt, basalt, vesicular basalt, quartz/silica, limestone clasts up to 30 mm in diameter. -Infilling cut channel -Poorly sorted	-None	Massive gravel with very course pebble clasts (Facies 16)	FGcm, SG: Diatoms indicate standing water habitats. Pool	None	F5: 1
Bed 2, 5 mm, F3	Moderate red (5R 4/6) clay	-Massive	-Vertically jointed	Massive clay (Facies 11a)	FFm: OF	PBre	
Bed 1, 0.50 m, F2 & F1	Yellowish grey (5Y 8/1) silty fine sand matrix with angular to sub-rounded fine pebble clasts and molluscs.	-Poorly sorted -Some lamination	-None	Massive fine pebble gravel with molluscs and megafauna bone fragments (Facies 15)	F/LMls, FFms: Diatom indicate brackish to saline marsh	None	

Table 12: Agua Negra, Site TB1, Log 7, Whole sequence. See Table 1 and Figures 1, 8.1 & 8.9							
Bed number, thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 9,1.5 m	Black (N1) organic silt	-Massive -Disconformable, erosional lower contact	-Vertical jointing -Brecciated	Massive organic silt	FP	PBre	F5: 2
Bed 8, 2 m	Yellowish grey (5Y 8/1) silt	- Very occasional channel forms (max ca 1m wide, 0.30 m deep) otherwise the unit is massive -Disconformable lower contact, erosive channel form	-None	Massive silt with occasional erosional sours (Facies 13a)	FFSs	None	F5: 1
Bed 7, 0.10 m	Moderate red (5R 4/6) silty clay	-Massive -Disconformable lower contact	-Vertically jointed -Brecciated	Massive mud (Facies 12b)	FFm	PBre	
Bed 6, 0.60 m	Yellowish grey (5Y 8/1) fine silty sand with rounded to sub-angular very fine to medium pebble intraclast gravel. Clast >30%.	-Massive -Poorly sorted -Some sections are reasonable well sorted -Relatively straight and sharp lower contact	-None	Massive fine silty sand with fine pebble-cobble gravel (Facies 15)	FGcm, SG	None	
Bed 5, 0.10 m	Moderate red (5R 4/6) sandy clay	-Massive -Disconformable, straight lower contact	-Vertical jointing	Massive fine sandy clay (Facies	FFm	PBre	F1: 2?

Table 12: Agua Negra, Site TB1, Log 7, Whole sequence. See Table 1 and Figures 1, 8.1 & 8.9							
Bed number, thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 4, 3 m+	At least four beds that repeat in sets of; yellowish grey (5Y 8/1) silty fine sand and tephra with fine to medium sub-angular to sub-rounded small cobble to pebble gravel clast at the base to cream fine silty sand in the upper bed. Occasional manganese clusters.	-The base of the bed is a large erosive channel (ca 8 m wide) -The first cycle is made up of small cobble gravel to pebble gravel (ca 1 m thick). -Subsequent cycles are: • -Approximately 0.50 m thick • -Poorly sorted • -Moreover, grade form poorly sorted pebble gravel to poorly sorted silt • -Each has as a disconformable lower contact -The entire sequence normally grades upwards	-Vertical jointing -Brecciation -Tree root penetration through the whole sequence	Normally graded fine silty sand with cobble to pebble gravel (Facies 16/17)	FGmg:	PBre, PRm.	F5: 1
Bed 3, 0.50 m	Moderate yellow green (5GY 7/4) silty clay	-Massive -Very straight but uneven disconformable upper contact	-Vertically jointed -Brecciated	Massive mud (Facies 12a)	LMs	PBre	F1: 1
Bed 2, 2 m	Moderate red (5R 4/6) silty sand	-Massive -Graded upper and lower contacts	-None	Massive fine silty sand (Facies 14a)	LMs	None	F1: 2
Bed 1, 3 m	Greyish yellow green (5GY 7/4) silty clay	-Massive -Graded upper and lower contacts	-None	Massive mud (Facies 12a)	LMs	None	F1: 1

Table 13: El Tajo de Tequixquiac, Site TB2, Log 1. See Table 2 and Figures 1, 8.1 & 8.9

Bed number, thickness	**Field facies description**	**Sedimentary structures**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 8, 0.25 m, None	Moderate brown (5YR 3/4) organic silt	-Massive - Small calcium carbonate nodules (<2 mm in diameter) -Calcified rootlets.	-Pedogenic: small calcium carbonate nodules (<2 mm in diameter) and some calcified rootlets.	Massive organic mud (Facies 12b)	FP	FP, PBre	F5: 2
Bed 7, 0.76 – 2m in section, None	Yellowish grey (5Y 8/1), poorly sorted fine silty sand the grades to organic silty clay in the upper 0.82 m.	-Massive with normal grading. -In channel form, erosive base	None	Upper, ripple cross-laminated fine sand. With fine pebble gravel lines channel (Facies 14b)	Upper: FFSm, SG Lower FFSs	None	
Bed 6, 0.12 m, None	Brownish black (5RY 2/1) organic clayey silt. Organic clay at the base of the bed that reverse grades into silty organic clay in the upper bed. At the base these a concentration of white clasts.	-Massive, possibly with some reverse grading.		Massive organic mud (Facies 12b)	FC, BS		
Bed 5, 0.60 m, None	Base of the bed 0.04 m of fine pebble gravel in a yellowish grey (5Y 8/1) fine sand matrix. Followed by 0.40 m of yellowish grey (5Y 8/1), cross-laminated sand and silty sand	-Normal gradin -Cross-bedding		Top: ripple cross-laminated fine sand (Facies 14b) Base: massive fine sand with fine pebble gravel (Facies 15)	Upper: FSr, SB Lower, FGmm, Sb, CH		
Bed 4, 0.25 m, None	Moderate brown (5YR 3/4) organic silt with merging upper and lower bedding planes	-Massive	Calcified roots -Carbonate nodules (5-8 mm in diameter)	Massive organic mud (Facies 12b)	FFr, BS	FP	
Bed 3, 0.10 m, None	Yellowish grey (5Y 8/1) silt	-Occasional small channel forms (<0.30 mm in diameter)	None	Massive silt with occasional cross-ripple lamination	FFl, OF	None	
Bed 2, 0.27 m, None	Brownish black (5RY 2/1) organic clay	-Massive - mollusc shell	None	Massive organic mud (Facies 12b) with molluscs	FC, FFms, BS		
Bed 1, 0.47 m, None	Brownish black (5RY 2/1) organic clay	-Massive -Mollusc shell		Massive organic mud (Facies 12b) with molluscs	FC, FFms, BS		

Table 14: El Tajo de Tequixquiac, Site TB2, Log 2. See Table 2 and Figures 1, 8.1 & 8.9

Bed number, thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Tables 5.1 – 5.5, Fig 5.1)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 9, 1.6 m, F1-F16, 1.6 m. 14C age 10,073 cal. BP (see Table 2, Appendix 9, sample 2 (TX7)).	Light grey (N7) fine sand	-Massive -Gradational lower contact - Isolated granule gravel sized clasts and small (<5 mm in diameter) carbonate. Bed contains mollusc fragments. -High frequency of volcanic glass and cinder.	-Small (<5 mm in diameter) carbonate	Massive fine sand with fine pebble gravel and molluscs (Facies 15)	FFsc, FFms, BS	FP, CPedN	F5: 2
Bed 8, 0.10 m, F17	Dark grey (N3) organic clay	-Massive -Gradational upper and lower contacts	-None	Massive organic clay (Facies 11c)	FC, BS	None	
Bed 7, 0.10 m, F18	Light grey (N7) fine sand	-Massive		Massive fine sand (Facies 14b)	FFSm		
Bed 6, 0.10 m, F19	Dark grey (N3) organic clay	-Massive		Massive organic clay (Facies 11c)	FC, BS		
Bed 5, 0.03 m, F20	Yellowish grey (5Y 8/1) sand	-Massive Very irregular, wavy lower contact -Small scale load structures (stringers and balls) that pass into the lower bed.		Massive sand (Facies 14b) with load structures	FFSc		
Bed 6, 0.30 m, F21-F26	Light brown (5YR 6/4) organic silt	-Massive	-Occasional iron staining	Massive organic silt (Facies 13a)	FFsc		
Bed 3, 0.68 m, F27-32	Black (N1) organic clay with flecks of cream fine sand	-Intact molluscs	-None	Massive organic clay (Facies 11c) with molluscs	FFsc, FFms		
Bed 2, 0.21 m, F32-F33	Light brown (5YR 6/4) organic silt with thin lamina of cream silty fine sand.	-Flecked texture -Black organic silt rip-up clasts (<40 mm in diameter) .	- Occasional carbonate nodules up to 10 mm in diameter	Plane laminate organic silt (Facies 13a)	FFsc	FP, CPedN	
Bed 1, 0.14 m, F34-F36: 14C age 11,028 cal. bp (see Table 2, Appendix 9, sample 3 (ET3TEQMEX)).	Dusky brown (5YR 2/2) organic silt	-Intact mollusc shells -Occasional carbonate nodules up to 10 mm in diameter.		Massive organic clay (Facies 11c) with molluscs	FFsc, FFms		

Table 15: El Tajo de Tequixquiac, Site TB2, Log 3. See Table 2 and Figures 1, 8.1 & 8.9						
Bed number, thickness	**Field facies description**	**Sedimentary structures/features**	**Petrographic facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 8, 0.60 m, F1-F12. 14C age 9,208 cal. bp (see Table 2, Appendix 9 sample 1 (TX6)).	Light grey (N7) fine sand	-Massive -Contacts are gradational	-Volcanic glass fragments	Massive fine sand with fine pebble gravel and molluscs (Facies 15)	FFsc, FFms, BS: Ephermal marsh/pond within a meadow flood plain environment. Alkaline to acidic. Regional pollen is dominated by tropical forest taxa and local taxa by shrubs and herbs **(TEQ 4 a & b, Fig 2)**	F5: 2
Bed 7, 0.13 m, F13-F14	Dark grey (N3) organically	-Massive -Gradational contacts	-High (<30%) volcanic glass content	Massive organic clay (Facies 11c)	FC, BS: Acidic saline marsh within a meadow flood plain environment. The regional pollen signal shows decrease temperate, and tropical foreset taxa and the local pollen taxa show increased wetland pollen taxa (<20%) and shrubs and herbs are dominant **(TEQ 4 a & b, Fig 2)**	
Bed 6, 0.39 m, F15-F22	Dusky brown (5YR 2/2) organic clay	-Massive	-Low percentage of volcanic glass and crystals (<5%)	Massive organic clay (Facies 11c)	FC, BS: Shallow ephemeral hydrological habitat under subareal conditions within a meadow flood plain. Conditions fluctuated between a saline and alkaline marsh environment that Local wetland taxa increase through the bed (<10% max). There is evidence of macrophytes **(TEQ 3, Fig 2)**	
Bed 5,0.10 m, F23 & F24	Dusky brown (5YR 2/2) organic mud	-Massive	-	Massive organic mud (Facies 12b)	FC, BS: Very similar to bed 4 **(TEQ 2, Fig 2).**	
Bed 4,0.04, F25	Interbedded dusky brown (5YR 2/2) organic mud with yellowish grey (5Y 8/1) fine silty sand	-Laminated -Soft sediment deformation	-	Plane laminated organic mud (Facies 12b)	FFsc: Flood plain meadow environment, environmentally very similar to bed 3 **(TEQ 2, Fig 2)**.	
Bed 3, 0.05, F26: 14C age 11,440 cal. bp (see Table 2, Appendix 9, Sample 4 (TX8)).	Black (N1) organic clay	-Massive	-	Massive organic clay (Facies 11c) with molluscs	FFsc, FFms: Conditions are drying, and shrubs and herbs dominate, wetland taxa start to occur again towards the upper bed but in very low numbers (<1%) **(TEQ 2, Fig 2)**.	

Table 15, Continued						
Bed number, thickness	**Field facies description**	**Sedimentary structures/features**	**Petrographic facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 2,0.51 m F27-F34	Interbedded yellowish grey (5Y 8/1) fine sand and Dusky brown (5YR 2/2) organic clay	-Laminated -Soft sediment deformation	-	Straight, lenticular lamiae	FFsc, OF, BS: Flood plain meadow environment, limit of a shallow fluctuating water body. Some samples indicate a marsh was present intermittently and that conditions were either saline or alkaline. Subareal conditions. Local wetland taxa are absent except immediately after short-lived spike (95%) in temperate forest taxa towards the base of the bed **(TEQ 2, Fig 2).**	F5: 2
Bed 1, 0.48 m, F35-F44	Yellowish grey (5Y 8/1) fine clayey sand	-Massive	- Low percentage of volcanic glass (<2%)	Massive clayey sand	F FFsc, OF, BS: Flood plain meadow environment, very low ephemeral water levels for the most part. Wetland taxa increase, suggesting two short live occasions of increased water, flooding events. At the same time, regional pollen signal is suppressed. Overall shrubs and herbs dominate **(TEQ 1, Fig 2).**	F5: 1

Table 16: Barranca La Botica, Site TB6, Log 1. Fluvial and alluvial sequence, channel fill sequence. See Table 3 and Figures 1, 8.1 & 8.9

Bed number, thickness	Field facies description	Sedimentary structures/features	Bed Name and code (Chapter 5)	Depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	Facies Group (Chapter 8)
Bed 7, 1 m	Multiple sets of light brown (5YR 6/4) fine silty sand containing fine pebble sized brown silt clasts	-Sets are poorly sorted -Each begins with a channel base	Fine silty sand with small pebble gravel lined scours (Facies 14b)	FFSs	F5: 1
Bed 6, 0.63 m	Upper 0.15 m light brown (5YR 6/4) silt. Lower bed brown silty fine sand with intra and extra clasts up to small cobble sized.	-Upper bed horizontally laminated relatively well sorted -Lower bed massive, poorly sorted -Gradational contact between the two - Mixed intra and extra clasts dominated by rounded to angular vesicular basalt, quartz/silica, angular limestone and silt clasts up to 60 mm in diameter clasts. -Poorly sorted. -Infilling cut channel	Upper bed, plane laminated silt (Facies 13a) Lower bed, Massive clast supported pebble to small cobble gravel (Facies 15/16)	Upper: FFl Lower: FGcm.	
Bed 5, 0.40 m	Light brown (5YR 6/4) fine sandy silt	-Massive, relatively well sorted -Relatively gradational lower contact	Massive fine sandy silt (Facies 14b)		
Bed 4, 0.07 m	Interlaminated light brown (5YR 6/4) fine sand with black (N1) basaltic ash	-Parallel laminations that alternate between re-worked basaltic (black) ash and fine sand -Relatively gradational lower contact	Plane laminated basaltic ash and fine sand (Facies 18d/Facies 14c)	FSr?	
Bed 3, 0.12 m	Light brown (5YR 6/4) coarse sand (lower bed) that has brown silt clasts fine pebble gravel sized brown silt clasts. The upper bed (top 0.03 m) grades to brown silt.	-Normally graded bed -Lower bed poorly sorted, massive matrix supported gravel -Upper bed massive -Relatively gradational lower contact	Upper bed massive sand (Facies 14c) Lower bed, massive, normally graded coarse sand with fine pebble gravel (Facies 15/16)	Upper bed, FFms, FFsc?	
Bed 2, 0.30 m	Light brown (5YR 6/4) fine to medium fine sand	-Erosive lower contact in channel form -Parallel laminated sands infill the channel (ca 0.50 m in diameter)	Laminated fine sand (Facies 14b)	FSH, SB, CH.	
Bed 1, 1m	Yellowish grey (5Y 8/1) beds (max thickness 0.40 m) of fine sand and silt	-Bedded, massive sets of normally graded fine sand at the base and silt at the top lower contact not visible	Plane laminated to ripple-cross lamented beds fine silty sand (Facies 14b)	FFsc, FFl, BS	

Table 17: Barranca El Salto (ES), Site TB4, Log 2. Fluvial - alluvial sequence. See Table 4 and Figures 1, 8.1 & 8.9							
Bed number, thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name and code** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 4, 1m	Black organic silty clay	-Massive	-Vertical jointing	Massive mud (Facies 12b)	FC, BS	None	F5: 2
Bed 3, 2.5 m	This bed is made up of sets of fine to medium pebble gravel lined beds that grade into coarse to medium sand	-At the base of the sets are gravel lined horizontal, and trough cross-bed channels forms and the upper sands can be massive or parallel laminated, occasionally cross bedded (max thick of sets ca. 0.20 m). Hence, each set sines upwards. -The unit appears to fine upwards, although the upper sections were too high to log in detail -Uneven, erosive lower contact that cuts lower bed		Coarse sand with multiple fine to medium gravel lined scours (Facies 14b)	FSl, FFSm		F5: 1
Bed 2, 1.5 m	This bed is very similar to bed one	-See below -Shap, Nonparallel erosional lower contact the cuts the lower bed	-None	Clast supported gravel with pebble to cobble sized clasts in fine sand (Facies 16/17)	FGcm, SG		
Bed 1, 2 m+	Pink -cream coarse sand matrix. At the base (ca. 1 m) of the bed pebble gravel up to small boulder sized intra and extra clasts. In the upper bed fine to medium pebble gravel clasts. The unit contains unidentified bone fragments of equal sixed to the clasts. * Recently an intact mammoth skull with tusks has been excavated from the base of this unit.	-Lower bed clast supported -Upper bed matrix supported -The entire bed is poorly sorted and massive but does vaguely grade from the base to the top. -Intra and extra clasts include Mixed intra and extra clasts dominated by rounded to angular oxidised vesicular basalt, basalt, vesicular basalt, quartz/silica, angular limestone up to 60 mm in diameter clasts. -Shap, Nonparallel erosional lower contact cuts the lower bed, disconformity	-None	Upper bed: fine to medium pebble gravel with fragmented megafaunal bones (Facies 15). Lower bed – Massive clast supported gravel with pebble to boulder sized clasts and fragmented megafaunal bones (Facies 15/17)	Upper bed: FGmm, SG Lower bed: FGcm, SG		
Bed 1, 1m	Red silty sand	-Massive	-Vertical jointing	Massive fine silty sand (Facies 14b)	LMa	PBre	F1: 2?

Table 18: Barranca El Salto (ES), Site TB4, Log 3. Terrestrial carbonate sequence. See Table 4 and Figures 1, 8.1 & 8.9							
Bed number, thickness	**Field facies description**	**Sedimentary structures/features**	**Post depositional facies**	**Bed Name** (Chapter 5)	**Depositional environment** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Post-depositional environments** (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	**Facies Group** (Chapter 8)
Bed 6, m	Black – grey organic silty clay	-Massive -Occasional laminations and bedding planes	-Vertically jointed	Massive organic mud	FC	Exposure, drying and desiccation	F5: 2
Bed 5, 3.30 m+	Base (max thickness 1m), very coarse pebble to large cobble sized angular to sub-rounded clasts. >30 % clasts in sand matrix. Mid (max thickness 0.70 m), small cobble to medium pebble sized angular to sub-rounded clasts. >30 % clasts in light pink cream silty sand matrix. Upper (max thickness 0.60 m), cream silty sand	Upper bed: Massive to faintly laminated Lower bed: -Mixed intra and extra clasts dominated by rounded to angular oxidised vesicular basalt, basalt, vesicular basalt, quartz/silica, limestone up to 60 mm in diameter clasts. -Poorly sorted. -Infilling cut channel form -Some grading, from the cobbles at the base to gravel, then sandy cross-beds in the upper unit that grades to massive silty sand -Nonparallel undulating, disconformable upper contact unit contacts.	-None	Upper bed: Faintly laminate fine silty sand (Facies 14b). Lower bed: Massive clast supported pebble to cobble gravel in medium sand with matrix (Facies 15/16)	Upper bed: FFsm Lower bed: FGcm, SG	None	F5: 1
Bed 4, ca. 2.5 m	Multiple sets of white, powdery silty fine to medium sand (max thickness 0.40 m) with or without fine pebble gravel intraclast topped by indurate white silt (micrite).	-Relatively straight but undulating lower contact and Nonparallel undulating upper contact bed contacts. -Interbed contacts between the sets are generally discontinuous, curved and Nonparallel to parallel, Within the unit there are: • Trough cross-beds with a set infill • Horizontal beds with a set infill • Undulating horizontal beds with a set infill • Small (<0.30 m wide, <0.25 m thick) medium gravel pebble line channel forms Overall the bed sets normally grade and the unit normally grades.		Braided fluvial tufa (Facies 3b, Facies 6, Facies 2a)	FBIS	None	F4: 1 type

Table 18, Continued

Bed number, thickness	Field facies description	Sedimentary structures/features	Post depositional facies	Bed Name (Chapter 5)	Depositional environment (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	Post-depositional environments (Tables 4.8 - 4.16, Figs 4.2 – 4.4)	Facies Group (Chapter 8)
Bed 3, 2.5 m	Light pink, wavy biofilm lamina that alternate with pink micritic (ca. 10 mm thick) mud, and clear sparry cement lamina (ca t20 mm thick) that contain peloids, oncoids, ooids, mollusc shell and probably microfossils.	-Occasional microchannel forms that have various fills, e.g. pisoliths and intraclasts, that cut the existing stromatolitic strata. -District overhang (over bed 2) of at least 0.50 m at the base -Disconformable, straight to wavy lower contact	None	Stromatolitic limestone (Facies 2a) interbreed with micritic mudstone (Facies 3b)	F/Lpstls, LMi.	None	F4: 1
Bed 2, 0.50 m	Red silty fine sand	-Massive	-Vertical jointing -Brecciation	Massive silty fine sand (Facies 14a)	LMa, F/LMls	PBre	F1: 2
Bed 1, 1m +	Olive organic clay manganese clusters	-Massive -Manganese clusters		Massive organic clay (Facies 11b)	LMa, F/LMls		F1: 1

Table 19, Diatoms recorded from Log 6, Table 11. Agua Negra				
Depth	**Diatoms**	**Other**	**Habitat, tolerances and environment**	**Interpretation**
Log 4: Bed 8: light grey organic silty sand				
15cm 55	1: *Hantzschia amphioxys*	2: Chrysophyte cysts	1: Soil and temporary aquatic habitats, under subaerial conditions at the limit of shallow fluctuating able to adapt to dry and wet habitats. (Grunow, 1877; Spaulding, 2013; Israde – Alcántara pers comm, 2014). 2: Most common in fluctuating shallow freshwater habitats (e.g. ephemeral ponds, meadows) of low to moderate pH (Adam & Mahood, 1995).	Within very shallow, seasonal/ephemeral water where levels fluctuate regularly. Meadow. The presence of Hantzschia amphioxys implies a very shallow water habitat at the moist ground margins (Bradbury, 1989).
20cm 54	1: *Epithemia turgida*	Volcaniclastics	1: Common in carbonate-rich (alkaline) water, can tolerate high conductivities (Spaulding, 2010; Israde – Alcántara, pers comm 2014). Epiphytic.	Alkaline, macrophyte habitat. (Israde – Alcántara, pers comm 2014). Small areas of open water. Marsh/pond environment? Can attach to macrophytes and other plants and surfaces and rocks in the littoral zone of lakes and streams.
25cm 53	1: *Pinnularia sp.*	Volcaniclastics	1: Can tolerate low conductivity in slightly acidic water (Bradbury, 1989; Spaulding & Edlund, 2009). Common in ponds and moist soil.	Acidic marsh/bog– wet meadow (Bradbury, 1989)? Very shallow standing water bodies within the grassland environment.
30cm 52	----	Volcaniclastics	----	Volcanic event
35cm 51	1: *Hantzschia amphioxys*	2: Phytolith	1: Soil/temporary aquatic habitat. 2: Common in very low water levels, often found in association with Hantzschia amphioxys and, in and around pastures, after flooding (Israde – Alcántara, 2014), or in shallow marsh environments (Bradbury, 1989)	Pasture/meadow subject to flooding from seasonal rain and storms, episodic flooding. The presence of Hantzschia amphioxys implies a very shallow water habitat at the moist ground margins (Bradbury, 1989).
40cm 50	1: *Cymbella cistula* 2: *Denticula sp.* remains	----	1: Common in alkaline water (Israde – Alcántara, 2014). 2: Some species are abundant in carbonate-rich (alkaline) waters with moderate conductivity, linked to warm springs (Le Claim & Stuckless, 2012; Spaulding & Edlund, 2009).	Alkaline, macrophyte habitat (marginal to shallow water) (Israde – Alcántara, 2014).
45cm 49	1: *Epithemia turgida*	Volcaniclastics	1: Carbonate-rich (alkaline) water with high conductivities. Epiphytic.	Alkaline, macrophyte habitat. (see 20cm)
50cm 48	1: *Rhopalodia sp.* remains 2: *Denticula sp.* remains	Volcaniclastics	1: Thrive in nitrogen poor water and are capable of N fixation (Prechtl et al., 2004; Spaulding & Metzeltin, 2011; Sutton et al., 2011). 2: Carbonate-rich (alkaline) waters, moderate conductivity.	Alkaline macrophyte habitat (Israde – Alcántara, pers comm 2014). Marsh or pond environment? The fragmented nature of both diatom genera suggests fluctuating water levels and exposure and drying (Bradbury, 1989).
55cm 47	1: *Epithemia turgida*	Volcaniclastics	1: Carbonate-rich (alkaline) water can tolerate high conductivities. Epiphytic.	Alkaline, macrophyte habitat (see 20cm).
Log 4: Bed 7: Darker grey silty organics				
65cm 46	1: *Pinnularia sp.*	Volcaniclastics	1: Low conductivity in slightly acidic water.	Acidic marsh/bog– wet meadow (see 25cm).

Table 19, Continued				
Depth	**Diatoms**	**Other**	**Habitat and tolerances**	**Environment**
Log 4: Bed 6: Dark brown organic clay				
77.2cm 44	1: *Rhopalodia gibberula* 2: *Surirella sp.*	----	1: Thrive in nitrogen-poor and saline habitats (Smol et al., 2002). 2: Common in the benthos, particularly epipelic (water-sediment interface) habitats where they grow and attach to fine clastic sediments (clays, silts, sand) (Spaulding & Edlund, 2010).	Saline marsh. Very shallow, ephemeral aquatic habitat.
82.2cm 43	1: *Denticula sp.* remains	2: Phytolith Volcaniclastics	1: Common in carbonate-rich (alkaline) waters tolerate moderate conductivity. 2: Linked to very low water levels, pastures and floodwaters.	Macrophyte habitat, small pond marsh area, within a meadow/pasture.
87.2cm 42	1: *Epithemia turgida* 2: *Denticula valida* 3: *Hantzschia amphioxys*	Diatoms immersed in lithics	1: Alkaline water with high conductivities. 2: Common in warm, alkaline to slightly saline habitats (Le Clam & Stuckless, 2012). 3: Soil and temporary aquatic habitats under subaerial conditions at the limit of shallow fluctuating water.	Alkaline, macrophyte habitat with ephemeral/fluctuating levels. Very shallow water habitat at the moist ground margins. Shallow alkaline marsh and/or ponded area.
92.2cm 41	1: *Hantzschia amphioxys*	Diatoms immersed in lithics	1: Soil and temporary aquatic habitats under subaerial conditions at the limit of shallow fluctuating water	Limit of a shallow, fluctuating water body, possibly a flood plain or marsh that has slightly acidic water. Very shallow water habitat at the moist ground margins.
97.2cm 40	1: *Hantzschia amphioxys*	----	1: As above.	As above.
102.2cm 39	1: *Hantzschia amphioxys* 2: *Anomoeoneis sphaerophora* 3: *Rhopalodia gibberula* 4: *Denticula valida*	5: Phytolith 6: Glass crystal.	1: As above. 2: Common in epipelic (water-sediment interface) habitats where they grow and attach to fine clastic sediments. Usually found in highly conductive brackish/saline waters (Spaulding et al., 2009). 3: Can indicate nitrogen-poor saline habitats. 4: Common in warm, alkaline to slightly saline habitats (Le Claim & Stuckless, 2012). Bradbury, (1979) links them to alluvial pond sediments in arid, ephemeral fluvial environments. 5: Common in very low water levels in and around pastures and floodwaters. 6: Volcanic.	Very shallow water habitat, at the moist ground margins of a fluctuating water body. Saline marsh.
107.2cm 38	*1: Denticula elegans* *2: Anomoeoneis sphaerophora fragment*	3: Phytolith	1: Adapts to damp or standing water habitats (Riding & Stanley, 2000). Found in pond sediments in alluvium stratigraphy (Bradbury, 1979). Common in high elevation desert habitats that have snow and seasonal rain (Smol & Stoermer, 2010). 2: Epipelic habitat in highly conductive brackish/saline waters. 3: Common in very low water levels in and around pastures and floodwaters.	Very shallow water habitat subject fluctuations. Saline marsh. Fragmented nature of Anomoeoneis sphaerophora may suggest drying, exposure and possible reworking.
111.7cm 37	----	1: Phytolith immersed in lithics	1: Common in very low water levels in and around pastures and floodwaters.	Limit of a shallow, fluctuating water body, possibly a flood plain or marsh.
Log 4: Bed 5: Brown organic clayey silt				
116.7	----	Only lithics	----	Dry

Table 19, Continued				
Depth	**Diatoms**	**Other**	**Habitat and tolerances**	**Environment**
Log 4: Bed 4: Interbedded brown organic clayey silt				
123.7		1: Phytolith remains Lithics and pollen	1: Common in very low water levels in and around pastures and floodwaters.	Meadow?
Log 4: Bed 3: Brown organic clay				
126.2cm	----	Only lithics	----	Dry
Log 4: Bed 2: Interbedded light brown sand with black/brown clay				
131.2cm	----	Volcaniclastics Clay	----	Dry and volcanic activity
136.2	1: Denticula sp. 2: Navicula sp. 3: Nitzschia sp. 4: Surirella sp.	5: Phytolith Volcaniclastics	1: Alkaline waters? Moderate conductivity. Marginal macrophyte habitats. 2 & 3: Very common across many habitats (Spaulding & Edlund, 2008). 4: Common in the benthos, particularly epipelic habitats in fine clastic sediments. 5: Common in very low water levels in and around pastures and floodwaters.	Saline marsh (see Bradbury, 1989)
141.2	---	Only lithics	----	Dry?
146.2		1: Phytolith	1: Low water levels in and around pastures and floodwaters.	Pasture/meadow.
151.2	1: Epithemia sp. fragment 2: Nitzschia sp.	Lithics	1: Carbonate-rich (alkaline) water with high conductivities. 2: Very common.	Alkaline marsh?
156.2				
161.2	1: Navicula sp.	Lithics	1: Very common	?
166.2		Lithics		
Log 4: Bed 1: Buff white fine sandy clay				
182.2	1: Nitzschia sp. fragment	Only lithics	1: Widely abundant.	
187.2		Seed Volcaniclastics		
192.2		1: Phytolith	1: Common in very low water levels in and around pastures and floodwaters.	Meadow.
197.2		1: Phytolith	1: Common in very low water levels in and around pastures and floodwaters.	Meadow.
222.2	1: Rhopalodia gibberula		1: Can indicate nitrogen poor saline habitats.	
225.2	1: Rhopalodia gibberula 2: Cocconeis placentula		1: Can indicate nitrogen-poor saline habitats. 2: Epiphytic, very common indicates well-oxygenated water (Israde – Alcántara pers comm, 2014).	Alkaline marsh?

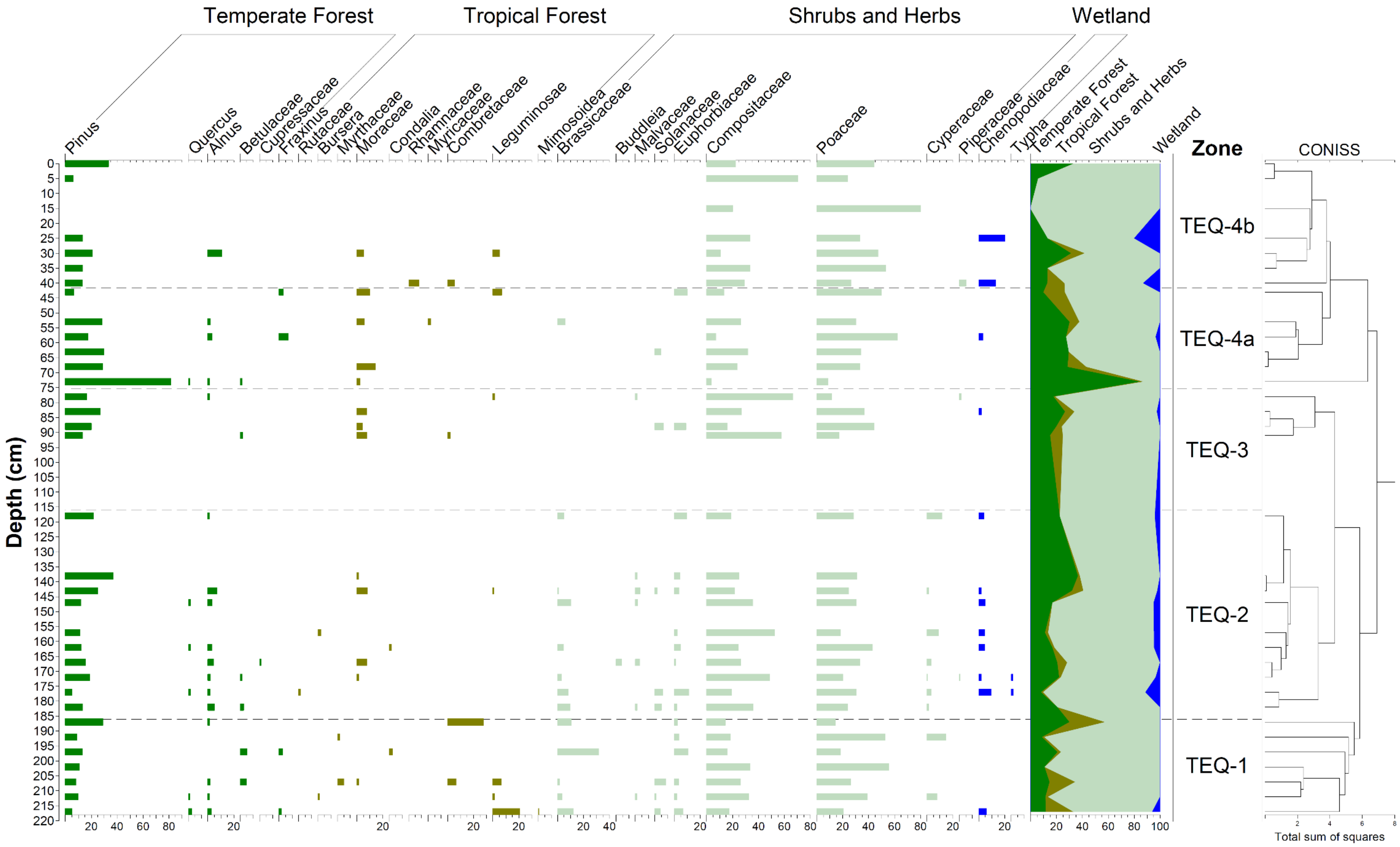


Figure 2, Pollen Diagram, Log 3, Agua Negra, Table 15

Appendix Nine:
Chronology for the study area

Run_ID	Material	40Ar	± 1s	39Ar	± 1s	38Ar	± 1s	37Ar	± 1s	36Ar	± 1s	39Ar (moles)	40Ar*/39Ar	± 1s	% 40Ar*	Age (ka)	± 1s
Pumice tephra sample SMH: Isotope measurements (volts)																	
90432-01	Sanidine	0.061727	0.000433	0.008082	0.000044	0.000132	2.75E-05	0.0000117	0.00002	5.71E-06	4.33E-06	9.13E-16	7.45	0.18	98	540.0	13.4
90432-02	Sanidine	0.057395	0.000433	0.006834	4.97E-05	0.000127	2.27E-05	-2.80E-06	2.08E-05	2.19E-05	4.56E-06	7.72E-16	7.42	0.23	89	537.7	16.6
90432-03	Sanidine	0.040555	0.000403	0.004865	4.22E-05	0.000152	2.19E-05	0.0000539	2.33E-05	1.43E-05	4.83E-06	5.50E-16	7.73	0.34	93	560.4	24.6
90432-04	Sanidine	0.049028	0.000367	0.006517	5.06E-05	8.66E-05	2.19E-05	0.0000536	2.64E-05	3.34E-06	4.75E-06	7.36E-16	7.57	0.26	101	548.6	18.5
90432-05	Sanidine	0.052474	0.000394	0.006326	4.49E-05	5.53E-05	2.11E-05	-5.14E-05	2.14E-05	1.15E-05	4.32E-06	7.15E-16	7.52	0.24	91	545.4	17.1
90432-06	Sanidine	0.074648	0.00044	0.008151	4.49E-05	0.000108	2.62E-05	0.000023	2.55E-05	3.34E-05	4.62E-06	9.21E-16	7.99	0.20	87	579.3	14.5
90432-07	Sanidine	0.040674	0.000376	0.004833	3.92E-05	3.98E-05	2.41E-05	-6.92E-05	2.48E-05	7.85E-06	4.24E-06	5.46E-16	7.54	0.31	90	546.6	22.4
90432-08	Sanidine	0.075662	0.000481	0.005231	4.05E-05	0.000114	2.68E-05	-1.77E-05	2.41E-05	0.000117	5.66E-06	5.91E-16	7.69	0.36	53	557.3	26.1
90432-09	Sanidine	0.065553	0.000409	0.007254	4.68E-05	9.17E-05	2.36E-05	-3.47E-05	2.34E-05	2.58E-05	4.55E-06	8.20E-16	7.83	0.22	87	567.7	15.8
90432-10	Sanidine	0.040633	0.000318	0.004654	0.000043	7.68E-05	2.36E-05	-1.16E-05	2.58E-05	2.82E-05	4.39E-06	5.26E-16	6.84	0.33	79	496.0	23.9
90432-11	Sanidine	0.070927	0.000437	0.008039	5.75E-05	0.000109	1.98E-05	-0.000042	2.58E-05	2.18E-05	4.47E-06	9.08E-16	7.86	0.20	89	569.7	14.6
90432-12	Sanidine	0.058812	0.000418	0.006493	5.07E-05	0.000121	2.58E-05	0.0000305	2.76E-05	3.74E-05	4.34E-06	7.34E-16	7.44	0.24	82	539.6	17.7
90432-13	Sanidine	0.073146	0.000437	0.007336	0.000044	0.00014	0.000025	-3.35E-05	2.48E-05	5.38E-05	4.58E-06	8.29E-16	7.65	0.22	77	554.3	15.9
90432-14	Sanidine	0.035875	0.000372	0.004743	4.08E-05	9.74E-05	0.000024	0.0000484	2.19E-05	2.27E-06	4.17E-06	5.36E-16	7.67	0.31	101	556.3	22.3
90432-15	Sanidine	0.057793	0.000443	0.006388	3.98E-05	0.000105	0.000024	4.80E-06	2.26E-05	0.000028	4.46E-06	7.22E-16	7.74	0.24	86	561.2	17.6
90432-16	Sanidine	0.053922	0.000461	0.005761	4.46E-05	3.96E-05	2.48E-05	0.0000247	2.26E-05	3.63E-05	4.61E-06	6.51E-16	7.57	0.28	81	549.0	20.2
90432-17	Sanidine	0.030929	0.000363	0.003519	0.000037	0.000083	2.37E-05	-1.60E-06	2.19E-05	1.24E-05	4.25E-06	3.98E-16	7.71	0.42	88	559.1	30.2
90432-18	Sanidine	0.051752	0.000381	0.006476	4.56E-05	7.93E-05	2.02E-05	-0.000039	2.19E-05	1.17E-05	4.18E-06	7.32E-16	7.28	0.23	91	527.6	16.3
90432-19	Sanidine	0.071546	0.000399	0.007032	4.71E-05	0.000116	2.39E-05	-6.93E-05	2.34E-05	5.63E-05	4.83E-06	7.95E-16	7.51	0.23	74	544.3	17.0
90432-20	Sanidine	0.048004	0.001309	0.005856	0.00005	7.49E-05	2.39E-05	-4.65E-05	2.27E-05	7.67E-06	4.75E-06	6.62E-16	7.58	0.35	93	549.6	25.3

Run_ID	Material	40Ar	± 1s	39Ar	± 1s	38Ar	± 1s	37Ar	± 1s	36Ar	± 1s	39Ar (moles)	40Ar*/39Ar	± 1s	% 40Ar*	Age (ka)	± 1s
Dacitic tephra sample BC: Isotope measurements (volts)																	
90431-01	Sanidine	0.034026	0.00044	0.005888	4.46E-05	4.94E-05	0.000027	0.0000855	0.000024	9.81E-06	4.88E-06	6.65E-16	5.63	0.28	97	408.3	20.4
90431-02	Sanidine	0.036719	0.000331	0.004361	3.58E-05	2.38E-05	2.22E-05	0.0000312	0.000024	0.0000422	4.82E-06	4.93E-16	5.69	0.37	68	412.9	26.7
90431-03	Sanidine	0.034203	0.000264	0.004937	4.22E-05	0.000111	2.28E-05	-4.60E-06	2.48E-05	0.0000222	4.82E-06	5.58E-16	5.55	0.32	80	402.4	23.5
90431-04	Sanidine	0.038371	0.000431	0.006507	5.25E-05	5.92E-05	2.34E-05	-7.20E-06	2.27E-05	1.76E-06	4.39E-06	7.35E-16	5.78	0.23	98	418.7	16.9
90431-05	Sanidine	0.036805	0.000381	0.006113	5.14E-05	6.87E-05	2.27E-05	-0.00005	2.69E-05	7.69E-06	4.53E-06	6.91E-16	5.43	0.26	91	393.5	18.7
90431-06	Sanidine	0.029433	0.000327	0.004607	4.37E-05	5.05E-05	0.000024	-6.42E-05	2.62E-05	4.10E-06	4.46E-06	5.21E-16	5.76	0.33	91	417.6	24.1
90431-07	Sanidine	0.062434	0.000484	0.009068	0.00006	0.000156	2.69E-05	-3.60E-06	2.05E-05	0.0000368	4.95E-06	1.02E-15	5.65	0.18	82	409.8	13.4
90431-08	Sanidine	0.040174	0.000409	0.005678	5.12E-05	0.000106	2.62E-05	-5.39E-05	2.42E-05	0.0000153	4.88E-06	6.42E-16	6.02	0.29	85	436.3	21.1
90431-09	Sanidine	0.036862	0.000484	0.006355	3.76E-05	9.35E-05	2.42E-05	-2.81E-05	2.27E-05	2.79E-06	4.68E-06	7.18E-16	5.55	0.25	96	402.1	18.2
90431-10	Sanidine	0.022803	0.000349	0.002015	2.68E-05	4.73E-05	2.62E-05	-1.82E-05	2.42E-05	0.0000356	4.75E-06	2.28E-16	5.80	0.79	51	420.1	57.0
90431-11	Sanidine	0.026599	0.000368	0.003825	4.18E-05	4.22E-05	2.55E-05	-5.45E-05	2.27E-05	0.0000152	4.53E-06	4.32E-16	5.40	0.40	78	391.2	28.8
90431-12	Sanidine	0.019137	0.000349	0.003601	3.53E-05	6.18E-05	2.41E-05	-1.43E-05	2.41E-05	-2.98E-06	4.46E-06	4.07E-16	5.45	0.42	103	395.1	30.4
90431-13	Sanidine	0.034904	0.000403	0.005818	4.74E-05	0.000069	2.48E-05	0.0000105	2.33E-05	0.0000126	4.46E-06	6.57E-16	5.39	0.26	90	390.4	19.0
90431-14	Sanidine	0.024901	0.000376	0.003907	3.99E-05	6.89E-05	2.41E-05	0.0000182	2.19E-05	0.0000152	4.31E-06	4.42E-16	5.32	0.37	84	385.5	27.2
90431-15	Sanidine	0.041339	0.000414	0.005865	5.04E-05	0.000101	0.000025	-8.49E-05	2.06E-05	0.0000206	4.76E-06	6.63E-16	5.62	0.27	80	407.8	19.6
90431-16	Sanidine	0.020092	0.000322	0.002956	3.32E-05	4.73E-05	2.58E-05	-3.68E-05	2.64E-05	0.0000102	4.53E-06	3.34E-16	5.44	0.52	80	394.4	37.9
90431-17	Sanidine	0.018687	0.000319	0.0033	3.64E-05	3.30E-06	2.34E-05	5.40E-06	2.55E-05	4.75E-06	4.60E-06	3.73E-16	5.26	0.47	93	381.4	34.2
90431-18	Sanidine	0.025611	0.000407	0.003898	3.55E-05	-3.3E-05	2.55E-05	-3.74E-05	2.48E-05	0.0000117	4.60E-06	4.40E-16	5.41	0.40	83	392.5	29.2
90431-19	Sanidine	0.016697	0.000351	0.002325	2.77E-05	2.79E-05	2.23E-05	7.60E-06	2.48E-05	0.0000133	4.67E-06	2.63E-16	5.54	0.68	77	401.8	49.1
90431-20	Sanidine	0.024632	0.000361	0.003835	3.23E-05	4.65E-05	1.71E-05	0.000035	2.27E-05	0.0000137	4.46E-06	4.33E-16	5.57	0.39	87	403.9	28.4
Backgrounds	-	0.005442	0.00014	0.000176	0.000013	3.52E-05	0.000015	0.0003487	0.000012	0.0000296	2.80E-06						

Table 1: $^{39}Ar/^{40}Ar$ Isotope data with calculated ages. Sample SMH, EK64 C V1, J: 0.0000401 ± 0.00000013, Age: 550.7 ± 4.1 ka (no data rejected). Sample BC, EK64 C V1, J: 0.0000401 ± 0.00000013, Age: 405.3 ± 5.1 ka (no data rejected). Atmospheric argon ratios and discrimination = ($^{40}Ar/^{36}Ar$) atm 298.56 ± 0.31; ($^{40}Ar/^{38}Ar$) atm 1583.7 ± 2. Minor irradiation parameters = ($^{38}Ar/^{37}Ar$) Ca 0.0000196 ± 8.160000e-7; ($^{38}Ar/^{39}Ar$) K 0.0122 ± 0.000027; P ($^{36}Cl/^{38}Cl$) 262.9 ± 1.1. Decay constants = Lambda ^{40}K epsilon 5.757000e-11 ± 0; Lambda ^{40}K Beta 4.955000e-10 ± 0; Lambda ^{37}Ar 0.01975 ± 0; Lambda ^{39}Ar 7.068000e-6 ± 0 Lambda ^{36}Cl 6.308000e-9 ± 0.

Table 2: AMS Radiocarbon ages for the study area from BETA Analytic. The calibrated (calendar) ages for samples 7, 8 & 9 have been calculated using the INTCAL13 curve (Reimer et al. 2013) in CALIB (Stuiver et al. 2017), see Section 4.8 for further discussion.

Sample No.	BETA Lab No.	Sample type	Site number and log number	Calibration Database used	$^{13}C/^{12}C$ ratio	Uncalibrated Radiocarbon Age bp	2 Sigma calibrated results (Cal BP).	Average 2 Sigma calibrated (Cal BP) age.
1: TX6	301356	Bulk sediment	TB2, Log 3, Table 15, Appendix 8	INTCAL04	17.7 o/oo	8,240 ± 40	9400 to 9360, 9320 to 9080 and 9050 to 9040	9208
2: TX7	301357	Bulk sediment	TB2, Log 2, Table 14, Appendix 8	INTCAL04	-15.7 o/oo	8,950 ± 40	10,220 to 10,102 and 10,070 to 9920	10,073
3: ET3TEQMEX	278268	Bulk sediment	TB2, Log 2, Table 14, Appendix 8	INTCAL04	-18.2 o/oo	9,690 ± 50	11,220 to 11,070 and 10,950 to 10,870	11,028
4: TX8	301358	Bulk sediment	TB2, Log 3, Table 15, Appendix 8	INTCAL04	-18.7 o/oo	9,980 ± 40	11,620 to 11,260	11,440
5: TX5	307721	Bulk sediment	TB1, Log 6, Table 11, Appendix 8	INTCAL09	-12.1 o/oo	10,460 ± 50	12,550 to 12,140	12,354
6: (TX1)	301535	Shell	TB1; Log 5, Appendix 8, Table 10	INTCAL04	-4.7 o/oo	14,610 ± 60	17,930 to 17,460	17,695
7: BDM2TEQ	278267	Shell	TB10, Log 4, Fig 6.21, Section 6.5.4	CALIB	-7.8 o/oo	40,100 ± 500	43,349 to 44,038	43,694
8: BC1TEQ	278266	Shell	TB9, Log 4, Fig 6.35	CALIB	-7.7 o/oo	40,670 ± 550	43,905 – 44,564	44,235
9: TX2	301354	Shell	TB3	CALIB	+1.2 o/oo	> 43,500	46,172 to 47,095	46,634

Table 3: U – Th isotope data, calculated ages (corrected and uncorrected) and activity ratios. Barranca de Colores, Site TB9 samples C2, C3 and C1. For the locations of the dated samples see Figures 6.29 & 6.33.

Sample Name	U (ppm)	±2s	^{232}Th (ppb)	±2s	(^{230}Th/^{232}Th)	±2s	(^{230}Th/^{238}U)	±2s	(^{234}U/^{238}U)	±2s	Uncorrected. ^{230}Th Age (ka)	±2s	Corrected. ^{230}Th Age (ka)	±2s	Corrected. Initial (^{234}U/^{238}U)	±2s
01 SG-C1	0.4187	0.0002	697.20	2.984	1.90	0.01	1.0657	0.0027	1.0566	0.0007	481	21	428	327	1.3522	0.23
02 SG-C2	0.7892	0.0006	239.20	2.437	10.07	0.11	1.0258	0.0031	1.0273	0.0011	484	28	475	33	1.1143	0.01
03 SG-C3	1.1990	0.0007	183.41	1.576	20.73	0.19	1.0658	0.0034	1.0368	0.0007	>500		>500			

Appendix 10:

Modern ground and surface water geochemistry

1: Tequixquiac Basin surface and groundwater

Modern $\delta^{18}O$ and δD (precipitation and groundwater) values along with major and minor geochemical solute data can be used to assist in interpreting geochemical data from terrestrial carbonate deposits. The application of this method is well understood in that, palaeo-terrestrial carbonate records are best utilised when there is a clear understanding of the contemporary geochemical relationship between individual environmental systems (e.g. hydrological & hydrogeological) and regional precipitation (see Section 19.2 and Leng et al. 1999; Vandenschrick et al. 2002; Leng & Marshall, 2004; Levin et al. 2004; Andrews, 2006; Leng, 2006; Leng & Lamb, 2006; Mattey et al. 2008; Leng et al.2010; Brett et al. 2014; Asta et al. 2017).

Nineteen meteoric water sample sites were collected and considered significant because of their geographic distribution and diversity. The sites include five wells, six springs and six deep boreholes along with one rainwater sample and one tap water sample (See location map Fig 1 & Table 1). The samples were collected during July of 2010 (rainy season) (see Section 15 for methods). Borehole water samples were obtained with the assistance of the local water department which granted access to the borehole sites that are pumped for drinking water in and around the towns of Tlapanaloya and Tequixquiac (Fig 1). The results are reported here for comparison with a geochemical data record that is reported in Chapter 6.

2: Tequixquiac Basin Precipitation $\delta^{18}O$ and δD values

Two comprehensive studies of the $\delta^{18}O$ and δD content of precipitation relating to the Tequixquiac Basin and Central Mexico have been published. Cortez & Favolden, (1989) carried out a two-year study during which 24 precipitation samples were collected from three different locations that sit at the same elevation (3250 m.a.s.l) along the Sierra de Las Cruces (Western margin of the Basin of Mexico (see Chapter 3). The analysis concluded that the values of $\delta^{18}O$ and δD found in precipitation samples were extremely variable, between -153 and -9 for δD and between -20.9 and -153 for $\delta^{18}O$. The range in isotopic concentrations was attributed to the different trajectories the air masses travelled before reaching the Basin of Mexico (Cortez & Favolden, 1989).

Cortez & Favolden, (1989) also established an LMWL for the Basin of Mexico which expresses the behaviour of the $\delta^{18}O$ and δD content of precipitation falling on the Sierra de Las Cruces (see Fig 7.1 for location) as that defined in Equation 1

Equation 1: δD = 7.95* $\delta^{18}O$ = + 11.77

A later study by Cortez et al. (1997) used a much larger $\delta^{18}O$ and δD precipitation data set from 16 studies scattered across Central Mexico to generate an RMWL (regional meteoric water line) defined in Equation 2,

Equation 2: δD = 7.97* $\delta^{18}O$ = + 11.03

Regression equation 2 (see Fig 3) expresses the regional behaviour of precipitation across the central part of Mexico, including the Basin of Mexico and the TMVB (see Cortez et al. 1997).

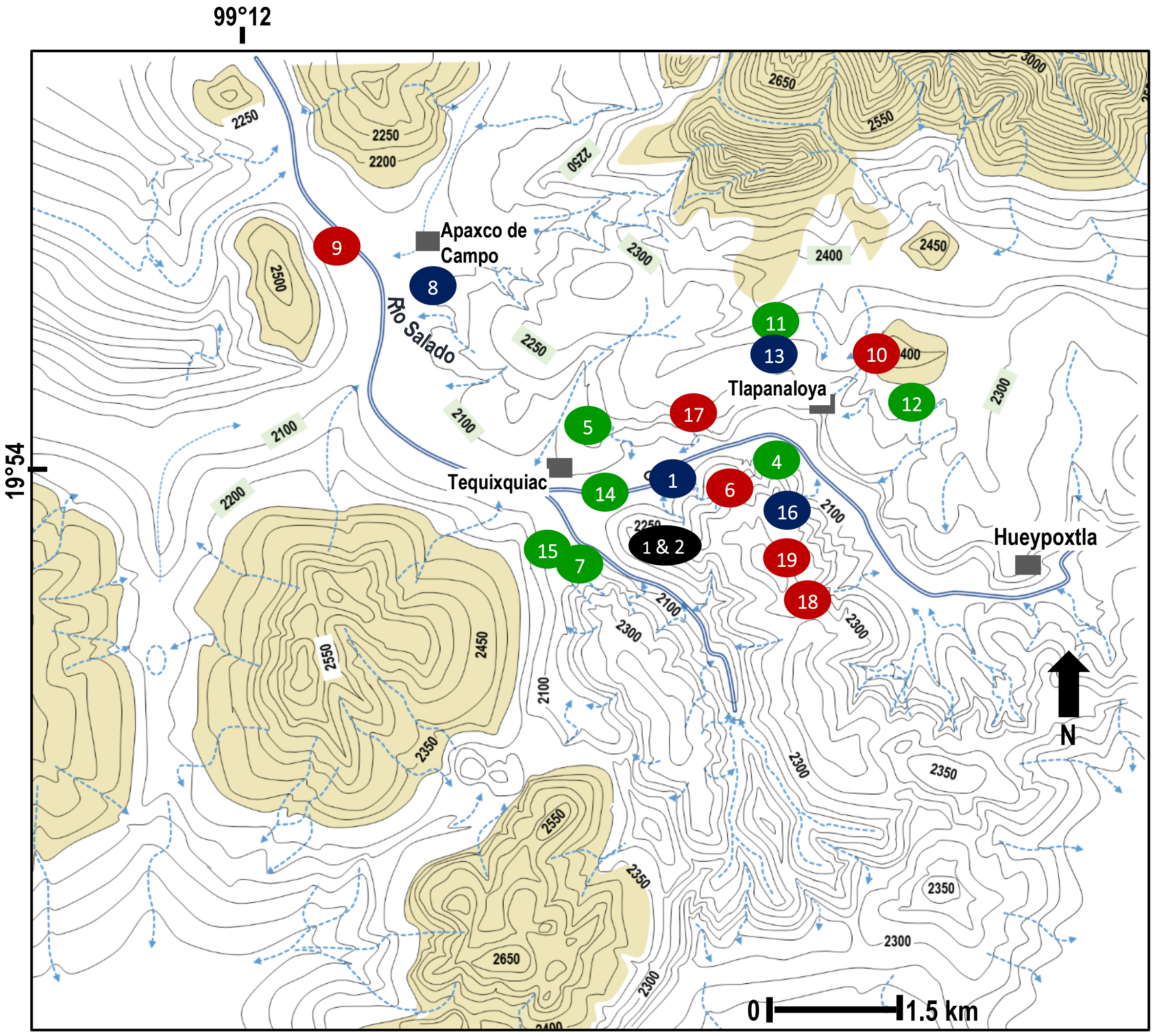


Figure 1: Water sample site locations. See Table 1 for sample names, GPS location and descriptions of water source. Green dots represent borehole sample sites, red dots are spring sample sites, blue dots are well sample sites and the black dot represents the one tap water sample and the rain water sample (samples 2 & 3) that were collected from the same site within the TB.

3: Tequixquiac precipitation Geochemistry

Sample 2 is slightly more positive ($\delta^{18}O$ 0.2‰ and δD 3.4‰) than the average for the Sierra de Las Cruces (Cortez & Favolden, 1989) (Fig 2) however, the $\delta^{18}O$ and δD content of Tequixquiac precipitation (Table 2) lies well within the $\delta^{18}O$ and δD range of values found in precipitation falling on the Western region of the Basin of Mexico

(Fig 2) (Cortez & Favolden, 1989). The concentration of ions (from the highest concentration to lowest) in sample 2 follows Na, Mg, Si, K, Ca and Ba (Table 3) with Si being a non-ionic uncharged dissolved species. Rainwater globally has an average pH of 5.7, which is slightly acidic due to the dissolution of CO^2; sample 2 is slightly more alkaline (see Table 2).

Table 1: Tequixquiac water sample sites, location descriptions and source (e.g. well, spring)

Sample Number	Water Sample Site Information	North coordinate	West coordinate
1	Barranca El Salto, Tequixquiac, well at the head of the barranca, pumped at approx. 11 litres per second. Thought to come from Quaternary alluvium. **Site TB4**	19° 54.363	99° 07.711
2	Rainwater, collected from San Mateo Hill, Tequixquiac.	19° 53.269	99° 07.711
3	Tap water, San Mateo Hill, Tequixquiac.	19° 53.269	99° 07.904
4	Pozo 275, Col Ejidal borehole, Tequixquiac. Has been in use since 1990 and is currently pumped at 40 litres per second. No sedimentological descriptions.	19° 54.666	99° 06.779
5	Pozo Cabecera Municipal borehole, Tequixquiac, in use since 1976, pumped at 6/7 litres per second. No sedimentological descriptions.	19° 54.539	99° 08.498
6	Palo Grande, Tequixquiac, natural spring running into a pool of fish and dragonflies, the channel cuts Quaternary alluvium and riverine carbonate deposits.	19° 53.872	99° 06.794
7	Pozo del Barrio de San Miguel borehole, Tequixquiac Town drinking water, Cl is added, pumped at 10 litres per second. No sedimentological details.	19° 51.814	99° 08.363
8	Apaxco, Pozada, Familiar Balnerario, well. Water level 3 - 4 m below the GPS altitude (see Table 5.5). No sedimentological descriptions.	19° 56.770	99° 09.153
9	La Tajera, Apaxco, spring-fed pool. The spring flows from the Cretaceous Basement Limestone, and the pool sits within the limestone.	19° 56.758	99° 10.084
10	Manantial Tlapanaloya, spring-fed pool. The spring flows from alluvial sediments and the pool situated within the alluvium. **Site TB12.**	19° 56.016	99° 06.348
11	Primary drinking water source, borehole, Tlapanaloya, spring. No sedimentological descriptions. **Site TB12.**	19° 56.296	99° 06.119
12	Pozo La Rinconada borehole, Tlapanaloya, water pumped at 38 litters per second. No sedimentological descriptions. **Site TB12.**	19° 55.483	99° 05.606
13	Pozo Superficial, La Rinconada, Manantial, Tlapanaloya, well. No sedimentological descriptions.	19° 55.581	99° 05.687
14	Pozo San Mateo, borehole, Central Tequixquiac, well. No sedimentological Descriptions.	19° 53.705	99° 08.389
15	Pozo La Presa borehole, San Mateo hill, Tequixquiac. No sedimentological descriptions.	19° 53.346	99° 08.938
16	Megafaunal museum well, family Barreda, San Jose hill, Tequixquiac. The well sits in upper alluvium which, at about a depth of 5m, changes to a hard-indurated carbonate layer. The water level of the well has been progressively lowering over the last five years.	19° 55.317	99°.07.183
17	Barranca la Gloria, Tequixquiac, spring flows at the intersection between the lower lake sediments and the upper spring carbonate deposit. **Site TB7.**	19° 54.362	99° 07.175
18	Barranca la Botica spring, Tequixquiac, a sample taken at the source where the spring emerges from the alluvium on the barranca floor. **Site TB6.**	19° 53.727	99° 06.482
19	Barranca la Botica, Tequixquiac, a sample taken 10m north of water sample 18. Spring flow has cut a channel that joins the main stream flowing down the barranca. **Site TB6.**	19° 53.831	99° 06.642

4: Interpretation

Sample 2 suggests that precipitation falling on the study area is within the range of $\delta^{18}O$ and δD recorded from Central Mexico. Compositionally the Tequixquiac Basin groundwater $\delta^{18}O$ and δD concentrations, without any alteration to their isotopic content, should fall on or close to either the GMWL, the RMWL or the LMWL (Fig 2)).

Figure 2: a: Photographs showing water sampling sites: Sample site 1, Barranca el Salto. **b:** Sample site 6, Palo Grande. **c:** Sample site 4, Pozo 275. **d:** Site 17 (TB7), Barranca la Gloria. **e:** Sample site 12, (TB12), Pozo La Rinconada, Tlapanaloya. **f:** Sample site 18 & 19 (TB6), Barranca la Botica. See Table 1 for site descriptions and Fig 1 for site locations.

Table 2: $\delta^{18}O$, δD, water temperature, depth from the surface at which the water sample was taken (i.e. the altitude is the height of the ground surface (m a.s.l), and the depth represents distance below the surface from which the sample was collected), pH, total dissolved solids (TDS) and the water type. Water type is based on freshwater having <1,000 ppm, slightly saline water having between 1,000 ppm to 3,000 ppm and moderately saline water having between 3,000 ppm to 10,000 ppm, highly saline waters 10,000 ppm to 35,000 ppm and >35,000 hypersaline water (USGS, 2013).								
Sample Number	**$\delta^{18}O$**	**δD**	**Water temp °C**	**Depth (m) from surface**	**Alt m.a.s.l**	**pH**	**TDS mg/l**	**Water type**
2	-10.1	-66.6	N/A	0	2272	6.7	690.9	Hyper saline

Table 3: ICP-MS concentrations in ppm for the measured elements in the TB precipitation sample 2.													
Na	**Mg**	**Si**	**K**	**Ca**	**Ba**	**Li**	**Cu**	**Zn**	**As**	**Cr**	**Al**	**Fe**	**Ni**
112.10	26.90	22.62	23.63	1.29	0.17	0.018	0.0010	0.0006	0.0068	0.0042	0.0021	0.0001	0.0002

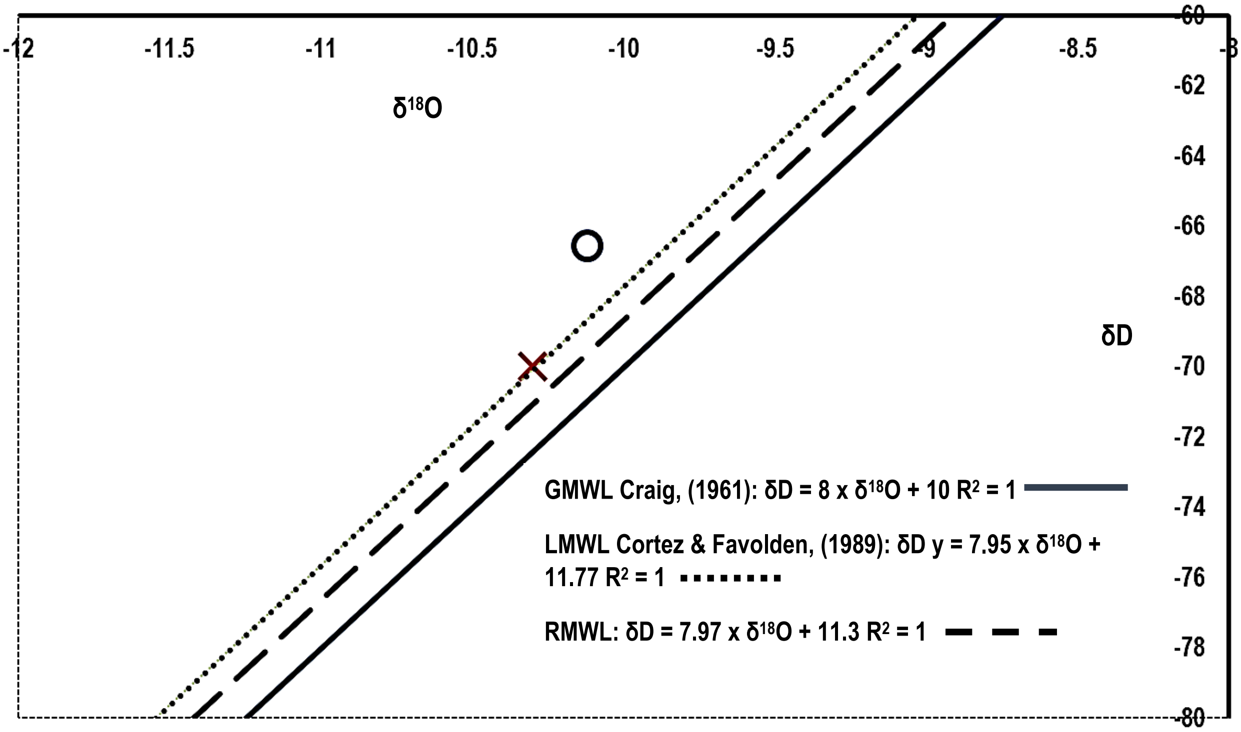


Figure 3: δD vs $\delta^{18}O$ for the TB precipitation sample plotted relative to the GMWL (Craig, 1961), LMWL based on precipitation data from the Sierra De Las Cruces region, Western Basin of Mexico (Cortez & Favolden, 1989), and the RMWL (Regional Meteoric Water Line, Cortez et al. 1997). The blue marker (**O**) represents the sample 2, collected from the study area precipitation. The red cross marker (**X**) represents the average $\delta^{18}O$ and δD content for precipitation from the Sierra De Las Cruces (Cortez & Favolden, 1989).

Therefore, any deviation from $\delta^{18}O$ precipitations concentrations above 0.05‰ can be considered as the modification to groundwater from its original meteoric state, assuming sample 2 is used as a broad baseline value (guided by the local values, (Fig 3).

The trace element geochemistry of sample 2 (Table 3) differs dramatically from the chemical composition of rainwater collected from sites close to University of Mexico during the 2001 and 2002 rainy seasons by Bàez et al. (2007). These samples have a volume weighted mean average of (in order of decreasing concentrations in ppm) Ca^{2+} (26.44), Na^{+} (7.00), Mg^{2+} (2.46), K^{+} (2.16). In sample 2, Na, Mg and K (Table 3) exceed the maximum values found in Bàez et al.'s (2007) rainwater samples. The measured Ca concentration measured in (sample 2) is 25.15ppm below the average Ca concentration found by Bàez et al. (2007). An explanation for this could be the addition of windblown dust particles containing Ca coming from the North-Eastern area of the Basin of Mexico (within the region of the study area). Si is typically found in precipitation, but only usually accounts for a minor proportion of the TDS. High Si values may be linked volcanic rock weathering and Si minerals being picked up by moving air masses. In Bàez et al.'s (2007) study, trace metal concentrations found in rainwater samples collected from the Basin of Mexico are related to anthropogenic activity and not air mass trajectory, and this may be the case with the study area.

Realistically a spatial and temporal $\delta^{18}O$ and δD precipitation data set would be required to gain seasonally averaged isotopic compositions for precipitation falling on the Tequixquiac Basin. These data could then be appropriately compared to Cortez & Favolden (1989), Cortez et al.'s (1997) studies and GNIP data and Tequixquiac Basin ground and surface water concentrations.

5: Geochemistry of the Tequixquiac Basin ground and surface water

In palaeo-carbonate studies, it is essential to determine, when possible if terrestrial carbonate deposits record equilibrium or disequilibrium isotope ratios (Leng & Marshall, 2004; Andrews, 2006). Sampling and studying active carbonate precipitating stream waters that deposited terrestrial carbonate sediments to determine differences between $\delta^{18}O$ and $\delta^{13}C$ water and carbonate ratios (Chafetz et al. 1991a&b; Arp et al. 2001 Garnett et al. 2004; Andrews, 2006) is a way to achieve this. Today in the study area, there are several actively flowing springs and multiple sites from which groundwater is pumped (Table 1). Although there is no active carbonate precipitation and deposition occurring in the Tequixuiac Basin today, springs that are currently active at sites Barranca de Colores (Site TB9 (intermittently) and Barranca la Gloria (sample 17, Site TB7), emerge mid slope either trough or at the base of inactive and karstified limestone sequences (see Chapter 6).

6: Tequixquiac ground and surface waters $\delta^{18}O$ and δD stable Isotope geochemistry

The ratios of $\delta^{18}O$ and δD measured within samples 1 and 4 – 19 (Table 4) fit within the average precipitation $\delta^{18}O$, and δD values found by Cortez & Favolden, (1987) and are close to sample 2 (Fig 2 and Table 2). Compared with Tequixquiac Basin precipitation (Table 2), there is a positive shift of 1.5‰ between the $\delta^{18}O$ content of sample 2 and the most positive groundwater sample (9). Overall there is a clear trend found in all the Tequixquiac Basin ground and surface waters with the majority of $\delta^{18}O$ and δD compositions falling to the right of the GMWL and the LMWL forming a separate evaporation regression line for the TB (see Fig 3 & Eq 3):

Equation 3: $\delta D = 6.4211 \times \delta^{18}O = - 8.0212$

Ratios of $\delta^{18}O$, δD and major ions Mg and Na all positively correlate with increasing TDS concentrations (R and R^2 values above 0.60) indicating that the positive isotopic shift relative to the LMWL (Tables 8, 9 & 10) is not independent, and that whatever process if affecting isotopic concentrations is also influencing the chemical concentrations of the study area ground and surface waters. Overall there is an average positive shift of 0.9‰ in $\delta^{18}O$ value (Table 4) relative to the Sierra De Las Cruces average $\delta^{18}O$ precipitation value (-10.3‰, Cortez & Favolden, 1989), and an average positive shift of 0.7‰ compared to Tequixquiac Basin precipitation sample 2 (-10.1‰, Table 2). Samples 10, 11,12 and 13 have the most negative values and show the least amount of modification compared to both sample 2 and Sierra De Las Cruces precipitation average $\delta^{18}O$ precipitation value (see Table 4). The majority of the water samples from the study area have $\delta^{18}O$ values that lie between -9.1 and -9.6 (Table 4).

7: Interpretation

Groundwaters from across Central Mexico that plot to the right of the LMWL and the RMWL form their LEL (Fig 3) because of evaporitic enrichment, mixing of older pore water with younger meteoric water, the surfacing of deep palaeo-waters, and hydrothermal activity (Payne, 1976; Quijano et al. 1980; Issar et al. 1984; Cortez & Favolden, 1989, Cortez et al. 1997; Flores-Márquez et al. 2006; Báez et al. 2007). As an additional consideration, the flow of the Tula River in the Mezquital Valley has increased from 1.6 to 12.7 m^3/s during the last 50 years (DFID, 1998; Siemens et al. 2008) because of wastewater drainage from the Basin of Mexico (Siemens et al. 2008). Because of unnatural groundwater recharge a new shallow aquifer system has developed in the Mezquital Valley (DFID, 1998; Siemens et al. 2008; Table 5.6) and the same is likely true for the study area. Ground and surface water $\delta^{18}O$ and δD ratios from the study area were plotted against wastewater $\delta^{18}O$, and δD concentrations collected from the Gran Canal (Agua Negra River, Oliver et al.1987) (Fig 4). Of the six Agua Negra water samples, two have δD values that are up to 12‰ more negative than δD values recorded from the study area (Fig 4). Four of the Agua Negra water samples plot along the SMWL and one sample plots on the GMWL. The remaining two plot to the left and right of all the regression lines because of their δD values (Fig 8).

8: Tequixquiac ground and surface waters trace element geochemistry

The main chemical components of the Tequixquiac Basin ground and surface water (including precipitation; sample 2) follow Na, Mg, Si, K, Ca, Ba (see Tables 3, 5 & 6) generally in that order of abundance. Concentrations of Mg, Si and K vary from sample to sample and group to group (discussed in later sections). Trace geochemical contributions are shown in Table 6 and Ba has the highest concentration in most of the samples with Li usually having the second highest concentration, depending on the water sample, followed by Al and Mn (again depending on the sample, see Table 5).

9: Interpretation

Similar concentrations of elements were found in groundwater from the Aquifer System below central Mexico City (Edmunds et al. 2002). The high concentration of Na found in the Mexico City Aquifer System (MCAS) is related to the glassy matrix of alkaline volcanic deposits and their sedimentary bi-products (Edmunds et al. 2002). Volcanic glass dissolution occurs ten times faster than crystalline basaltic minerals (Gislason & Eugster, 1987; Edmunds et al. 2002) with Na preferentially released over Ca (Edmunds et al. 2002). Groundwaters from the limestone aquifer in the Apaxco (Hidalgo: Fig 1) region has high salt concentrations and high Ca concentrations unlike the Tequixquiac Basin (Table 4). Low Ca and high Mg values found in ground and surface water concentrations may be a consequence of prolonged storage, low water levels, Ca saturation, and Mg dissolution because of this. Alternatively, groundwater from the regional limestone aquifer may have limited or seasonal input into the study area (except for group 3, see below).

Ba is present in low concentration. Although Ba is associated with carbonate minerals, it is also related to K-feldspars and clays (Edmunds et al. 2002), and this is thought to be the case for the Tequixquiac Basin, sourced from the Tarango Formation (F1: Chapter 8) and Quaternary Alluvial deposits (F5: Chapter 8. Al vs Fe, Li vs Cu, Li vs As, Fe vs Ni and Al vs Ni all positively correlate indicating that they increase together (R and R^2 values all above 0.67). The absence of Cl (returned undetectable levels) which is readily available in basaltic rock suggests limited to no interaction between groundwater in the study area and the basaltic geology found in north and southern

Central Mexican basins (Edmunds et al. 2002) (Table 7). In the Basin of Mexico, the MCAS also has undetectable levels of Cl suggesting rainfall recharge is a significant groundwater contributor, and that interactions between basaltic rock and groundwater are limited (Edmunds et al. 2002). The presence of Li (in relatively high concentrations 0.165ppm – 0.001ppm; Table 6) in the Tequixquiac Basin samples may be related to feldspars and clays (F1: Chapter 8) interacting with groundwater. High concentrations are indicative of the length of time groundwater has spent in contact with these sediments, as it is increasingly leached with time. High concentrations also support the absence of a basaltic substrate in the Tequixquiac Basin as Li has a low chemical abundance in basaltic rocks (Edmunds et al. 2002).

10: Tequixquiac ground and surface water temperatures, TDS and pH

The mean water temperature for all samples is 20°C with a range of between 10.7°C – 27.3°C (Table 4). In the study area, the high water temperatures are associated with borehole sample sites and temperature increases with sample depth (Table 4).

Table 4: $\delta^{18}O$, δD, water temperature (WT), depth from the surface at which the water sample was taken (i.e. the altitude is the height of the ground surface (m.a.s.l) and the depth represents distance below the surface from which the sample was collected), pH, TDS and the water type. Water type is based on freshwater having <1,000 ppm, slightly saline water having between 1,000 ppm to 3,000 ppm and moderately saline water having between 3,000 ppm to 10,000 ppm, highly saline waters 10,000 ppm to 35,000 ppm and >35,000 hypersaline water (USGS, 2013). SD = Standard deviation.

Sample	$\delta^{18}O$	δD	Water Temp °C	Depth	Altitude	pH	TDS (g/l)	PPM	Water type
1	-9.3	-68.8	21.6	1	2231	7.1	657.1	657,100	Hypersaline
3	-9.2	-67.3	N/A	0	2272	7	762.3	762,300	Hypersaline
4	-9.3	-67.4	24.4	90	2227	7.3	800.0	800,000	Hypersaline
5	-9.1	-66.4	25.9	99	2239	7.1	580.4	580,400	Hypersaline
6	-9.6	-70.9	19.6	0	2260	7.1	435.1	435,100	Hypersaline
7	-9.4	-67.6	27.3	305	2351	7.1	630.5	630,500	Hypersaline
8	-9.2	-70.0	20.3	2	2251	7	475.9	475,900	Hypersaline
9	-8.6	-62.9	22.4	0	2198	7.1	1533.3	1, 533,300	Hypersaline
10	-9.9	-71.4	19.1	0	2227	7.2	861.5	861,500	Hypersaline
11	-9.7	-72.6	20.3	0	2249	7.3	400.0	400,000	Hypersaline
12	-10.0	-71.5	27.3	400	2255	7.4	459.3	459,300	Hypersaline
13	-9.8	-69.6	23.5	0	2264	7.2	631.1	631,100	Hypersaline
14	-9.4	-66.5	24.6	80	2240	7.2	740.4	740,400	Hypersaline
15	-9.5	-65.6	21.6	180	2242	7	781.0	781.000	Hypersaline
16	-8.9	-63.7	20.3	20	2270	7	1021.4	1,021,400	Hypersaline
17	-9.2	-67.9	21	0	2255	7.3	710.3	701,300	Hypersaline
18	-9.4	-69.6	10.8	0	2267	7.2	571.4	571,400	Hypersaline
19	-9.8	-71.5	10.7	0	2263	7.2	510.3	510,300	Hypersaline
Mean	-9.4	-68.4	20.0	-	-	7.1	697.3	697.300	-
SD	0.3	2.7	6.6	-	-	0.11	-	-	-

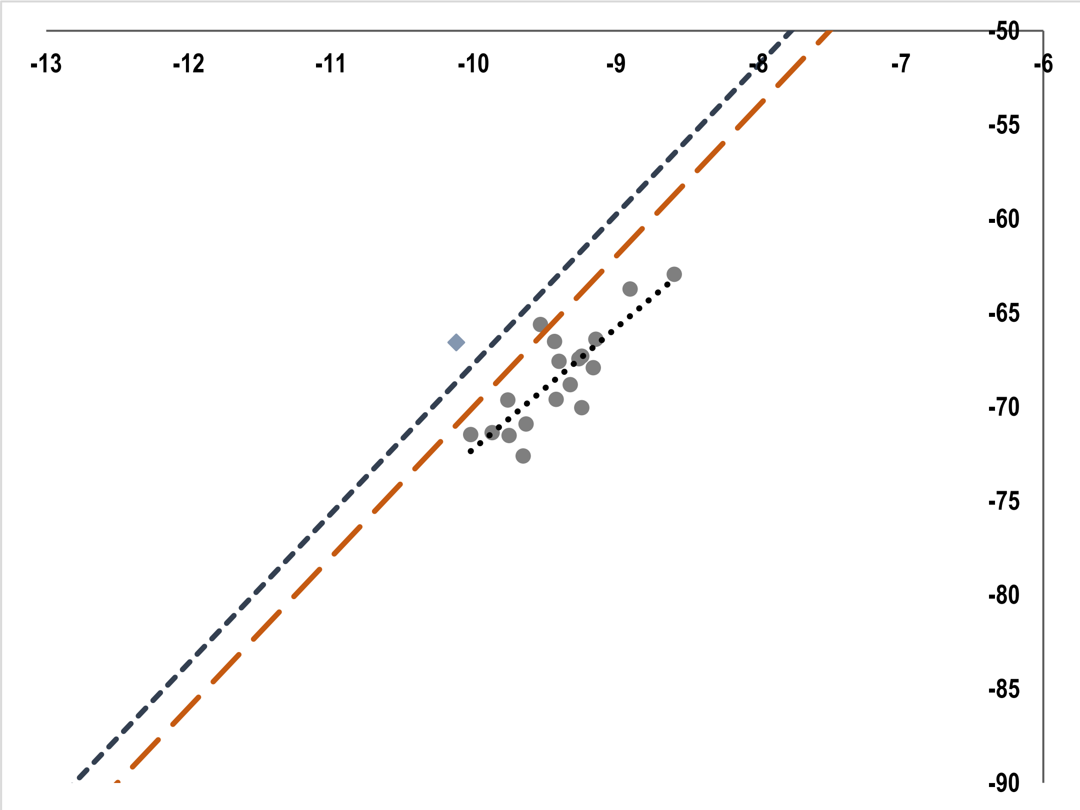


Figure 4: TB water samples: δ*D* vs $\delta^{18}O$ of the 18 meteoric water samples plotted relative to the GMWL (Craig, 1961; see section 3.4) and the LMWL that was constructed from precipitation data collected over a 2 year from the Sierra De Las Cruces region, Western Basin of Mexico (Cortez, 1989). The Tequixquiac Basin: LEL does not include sample 15 (blue triangle)

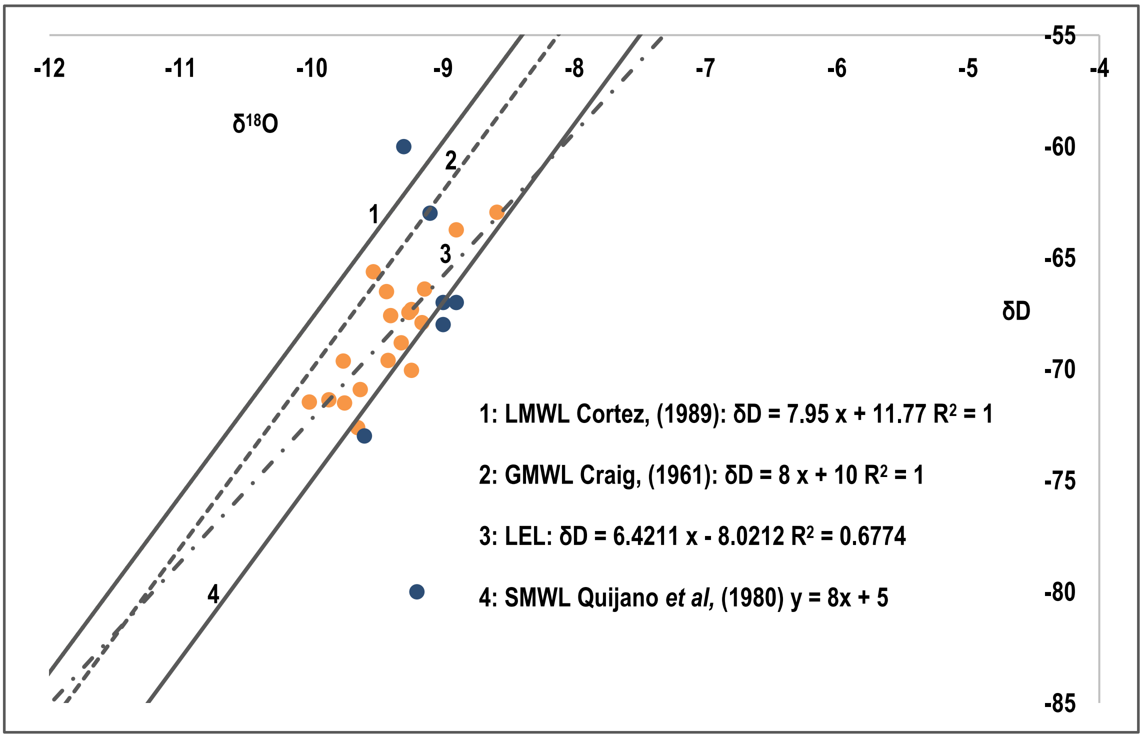


Figure 5: δD vs $\delta^{18}O$ for well, spring and borehole water samples collected from the TB and for water samples collected from the Agua Negra River/Gran Canal (Oliver et al, 1987; Ryan, 1989). The blue dots represent the Agua Negra water samples and the orange represent the TB water samples. SMWL: see table 5.6.

Table 5: ICP-MS concentrations in ppm for the measured elements in the TB ground and surface water samples. The analysis was carried out at Liverpool John Moores University.					
Sample	**Na**	**Mg**	**Si**	**K**	**Ca**
1	111.2	26.93	22.91	23.69	1.22
3	164.70	24.16	24.84	17.65	1.48
4	162.70	28.24	24.79	18.49	0.53
5	107.40	10.86	24.86	19.47	0.98
6	83.75	16.36	24.60	15.19	0.63
7	162.20	13.01	23.06	14.53	1.16
8	57.68	18.29	19.79	16.72	3.70
9	229.60	37.44	20.47	25.71	2.62
10	103.70	29.98	18.61	18.15	0.73
11	67.00	14.92	19.77	16.54	0.69
12	70.05	6.57	22.25	13.19	1.09
13	68.09	16.36	18.43	15.75	0.46
14	125.60	17.50	19.00	16.66	0.28
15	165.50	19.54	20.23	15.15	2.01
16	78.05	43.37	18.60	25.29	0.39
17	53.68	11.59	17.47	14.71	1.86
18	58.88	20.92	19.44	4.68	0.70
19	75.34	12.40	14.84	9.32	0.06
Mean	108.06	20.47	20.78	16.72	1.14
SD	50.14	9.65	2.91	5.11	0.92

Table 6: Trace element concentrations in ppm from and surface water samples collected from the study area.										
Sample	**Ba**	**Li**	**Al**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Cr**
1	0.165	0.018	0.002	0.000	0.000	0.000	0.001	0.012	0.006	0.004
3	0.111	0.051	0.003	0.000	0.000	0.000	0.003	0.000	0.007	0.007
4	0.145	0.059	0.003	0.000	0.000	0.001	0.004	0.006	0.007	0.009
5	0.096	0.081	0.003	0.000	0.000	0.000	0.000	0.000	0.011	0.005
6	0.164	0.025	0.003	0.000	0.000	0.000	0.001	0.001	0.005	0.001
7	0.074	0.027	0.002	0.000	0.000	0.000	0.001	0.001	0.006	0.003
8	0.095	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.004
9	0.396	0.090	0.006	0.001	0.001	0.002	0.001	0.003	0.010	0.010
10	0.334	0.021	0.007	0.002	0.001	0.001	0.000	0.002	0.004	0.006
11	0.010	0.013	0.003	0.000	0.000	0.000	0.000	0.001	0.003	0.003
12	0.099	0.165	0.001	0.001	0.000	0.000	0.010	0.001	0.013	0.003
13	0.189	0.013	0.001	0.000	0.000	0.001	0.005	0.022	0.003	0.002
14	0.071	0.038	0.328	0.000	0.009	0.009	0.001	0.013	0.005	0.004
15	0.976	0.033	0.003	0.000	0.000	0.000	0.001	0.001	0.005	0.006
16	0.475	0.018	0.003	0.000	0.000	0.001	0.001	0.007	0.002	0.007
17	0.095	0.006	0.004	0.000	0.000	0.000	0.000	0.000	0.004	0.002
18	0.526	0.001	0.115	1.204	0.008	0.002	0.001	0.012	0.001	0.001
19	0.232	0.006	0.207	0.004	0.001	0.001	0.000	0.000	0.001	0.001
Mean	0.236	0.037	0.036	0.067	0.001	0.001	0.002	0.004	0.005	0.004
SD	0.235	0.041	0.091	0.284	0.003	0.002	0.002	0.006	0.003	0.003

Table 7: Defined water types that have been identified for the Mezquital Valley and Hidalgo State (North), The Basin of Mexico (Central) and the Valsequillo, Oaxtepec, and Puebla regions (south).			
Water Type	**North**	**Basin of Mexico**	**South**
1	Local groundwater is coming from elevated springs that follow the GMWL in the Los Azufres geothermal field (Giggenbach, 1981). These waters are elevated and as such are isolated from the geothermal field.	Groundwater is emerging from alluvium and volcanic sediments from the foothills surrounding Lake Texcoco. It is characterized by low salinity and $\delta^{18}O$ & δD values that fall around the GMWL (Quijano, 1978; Issar et al. 1984).	Valsequillo Basin: thick alluvial deposits along the foothills have groundwater that falls on the GMWL (Issar et al. 1984).
2	Mezquital Valley: A shallow aquifer has developed due to increased groundwater recharge. Formed due to increased irrigation with untreated wastewater (DFID, 1989; Siemens et al. 2008). Water loosely follow the GMWL	No data	No data
3	Mezquital Valley: Natural groundwater from basalts have average stable isotopic values of δD – 77.5‰ and $\delta^{18}O$ - 10.5‰ that fall on the GMWL. In many cases, these waters have been contaminated by wastewater (Payne, 1974; Issar et al. 1984).	High altitude perched springs in volcanic deposits have a low salt load (Ca > Mg > Na and δD and $\delta^{18}O$ values fall on the GMWL (Issar et al. 1984). In most cases, these waters are isolated from wastewater and as such are not contaminated	Groundwater from the basaltic aquifer around Pico de Orizaba (Citlaltepetl) falls on the GMWL. Groundwater has a low salt load Na > Mg = Ca with a high SiO_2 content (Quijano et al. 1980). In the Del Besque, San Juan and Cantaritos areas small fresh springs emerge from fractured basalts and karstified limestone with low Ca concentrations and a δD excess that varies from +9.4‰ to +10.0‰
4	Mezquital Valley: Limestone springs have a δD excess range of between + 6‰ and +7‰ with water temperatures between 34°C - 55°C. δD vs $\delta^{18}O$ values suggest that recharge of the limestone aquifer is different from the basaltic aquifer (Payne, 1974). Warmer springs also come from the fractured basalt, and these have thick layers of travertine associated with them. They have similar isotopic concentrations to the above and high Ca and HCO3 levels (Payne, 1976).	No data	Limestone springs, springs emerging from terrestrial carbonate deposits and shallow wells in alluvium close to both of these deposits around Citlaltepetl form a cluster around δD - 8‰ and $\delta^{18}O$ + 5 to - +7‰ with a high salt load Na > Ca > Mg (Quijano et al. 1980). Springs coming from the transition between the limestone and the basalt around Oaxtepec are warm with a δD excess of + 7.8 to + 5.8‰
5	No data	Waters mainly found around the remnant Lake Texcoco created by the evaporation of surface water (Oliver et al. 1987). These waters have a high salt load Na > Ca > Mg (Issar et al. 1984; Cortez et al. 1997). Shallow wells that tap the lacustrine layers of the lake tend to form a cluster of around δD – 7.5 to + 2.6‰ and $\delta^{18}O$ + 1.7‰ to +3.5‰ which produces an LEL (Issar et al. 1984)	No data
6	Hot boiling springs in the Los Azufres Geothermal field at or above 240°C with δD concentrations around – 65‰ and $\delta^{18}O$ – 4.6 to - 3.5‰. The deuterium excess is strongly correlated with temperature (Issar et al. 1984). These groundwaters are enriched with salts.	No data	Puebla Basin: Hydrothermal fluids intrusions rise from depth, reaching shallower aquifers. Leads to groundwater with high TDS concentrations and the exchange of different water types between aquifers. The fractured nature of the basement rock aids this (Flores-Márquez et al. 2006). Additionally, the overexploitation of groundwater has increased the amount of hydrothermal fluid movement due to the lowering of groundwater levels (Flores-Márquez et al. 2006).

TDS values range from 400 mg/l to 1533.3 mg/l with a mean of 697.3 mg/l, and all samples are hypersaline (Table 4). Samples 9 and 16 have the highest TDS concentrations, and samples 6, 11 and 12 the lowest (Table 4). The mean sample pH is 7.1 with little variance around the mean (standard deviation, 0.11; Table 4.5), indicating neutral to alkaline waters (see Table 4).

11: Interpretation

High groundwater temperatures recorded from across the Trans Mexican Volcanic Belt have been associated with limestone and geothermal springs (see Tables 4 & 7). In the Basin of Mexico, the average TDS concentration for spring and well water samples lie between 13 – 460 mg/l (Cortez et al. 1989). Anomalies found across the Basin of Mexico are linked to hydrothermal activity including Peňon > 2500mg/l, El Pocito > 700 mg/l and Copilco > 540 mg/l (Cortez et al. 1989) which are like Tequixquiac Basin ground and surface water concentrations (Table 4.5). However, water temperatures at these sites are above 45°C which far exceeds any of the temperatures recorded in the Tequixquiac Basin, although it is possible that waters cooled as they begin to surface after deeper circulation.

In the Puebla Basin to the southeast hydrothermal fluid rises from depth, reaching shallower aquifers (Table 7). The result is groundwater with high TDS concentrations that develop terrestrial carbonate deposits as a by-product via the exchange of different water types between aquifers facilitated by fractured basement rock (Flores-Márquez et al. 2006). Groundwater overexploitation has increased hydrothermal fluid intrusion because of the lowering of groundwater levels (Flores-Márquez et al. 2006). Lowered groundwater levels may be the case with the Tequixquiac Basin indicating mixing at depth with older meteoric groundwater. The absence of active limestone development in the study area is likely to be strongly influenced by mean annual ambient temperatures at the present hydrological state of the basin (see Chapter 8).

12: Overall interpretation

Similarities and commonalities between all measured variables from the ground and surface waters collected from the study area. As a result, samples were grouped based on $\delta^{18}O$ and δD concentrations as these showed the most robust correlations (R and R^2 values above 0.90: Figures 8 & 9). The slope of the regression for groups 1 – 4 is around six as with the Tequixquiac Basin LEL (Figs 2, 3 & 4, 5) and this shows that the average condensation temperatures during rainout are similar across the basin.

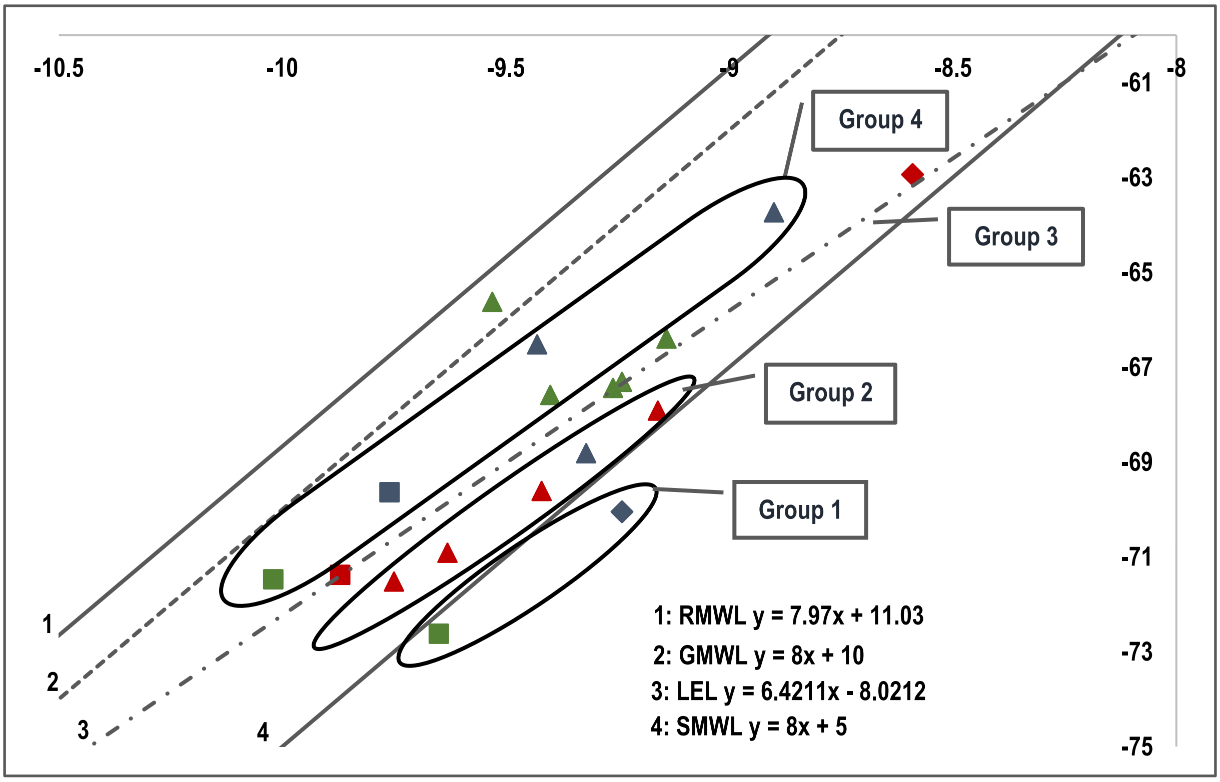


Figure 6: δD vs $\delta^{18}O$ for the well, spring and borehole water samples collected from the TB. Well **(blue),** borehole **(green)**, spring **(red)** water samples from Tequixquiac (triangle) Tlapanaloya (square), Apaxco (diamond) and rain and tap water (circle). Groups 1 – 5 show the water type groupings allocated for the TB ground and surface water samples allocated based on stable isotopic concentrations.

Meteoric waters affected by evaporation usually have a slope that is lower than 8 (GMWL, Figs 5, 6 & 7, 8) as is found with Tequixquiac Basin ground and surface waters. Kinetic fractionation occurring as precipitation falls through the dry air column can cause evaporation and the enrichment of $\delta^{18}O$ creating regression slopes of less than 7, particularly in arid regions (the amount effect, see Chapter 4) (Clark & Fritz, 1997).

12.1: Group 1 - well water samples 8 and 11

Water samples 8 and 11 were collected from wells situated on slopes along the eastern study area (Fig 1). The geology in this region of the basin consists of outcrops of basaltic and rhyolitic pyroclastic flows, lacustrine deposits, fluvial conglomerates (Pachuca Group & San Juan Group, see Chapter 3). Cretaceous basement limestone (El Doctor limestone) and the Tarango Formation (F1: Chapter 8) make up the lower slopes and infill the basin floor (see Chapters 3 & 8). Water temperature and altitude are the same for both sites (Fig 1). Wells 8 and 11 are elevated 150 – 200m above the basin floor within the recharge zone. The group has the lowest average TDS concentration across all groups, and the water is under-evolved (Tables 5 & 6). The $\delta^{18}O$ and δD values in group 1 lie to the right of the Spring Meteoric Water Line (SMWL) (see Fig 5 and Table 7, Type 4, south) and form a regression line expressed in Equation 4, although, the reliability of the regression is only based on two water samples.

Equation 4: $\delta D = 6.225 \times \delta^{18}O - 12.091$ (see Fig 6, Group 1)

The average $\delta^{18}O$ value for Group 1 is -9.5‰, which indicates a small degree of modification to samples 8 and 11 pre, during or post recharge. Despite this, the difference in $\delta^{18}O$ values is small, 0.65‰ (study area) and 0.85‰ (Basin of Mexico) and, given that the fractionation factor is approximately eight times greater for deuterium than it is for oxygen it is assumed that these waters are young, fresh and poorly evolved.

Because there is virtually no natural overland flow the more positive average $\delta^{18}O$ concentrations vs δD for this group are likely because of limited evaporation occurring either during rainout (dependent on condensation temperatures), because of the amount effect, or during transport through the unsaturated zone via diffusion (see Section and Barns & Allison, 1988; Kendall & McDonnell, 1998). The eastern side of the Tequixquiac Basin has the highest recharge elevation for the catchment (above 3000 m.a.s.l), and this is thought to be a contributing factor to negative deuterium concentrations.

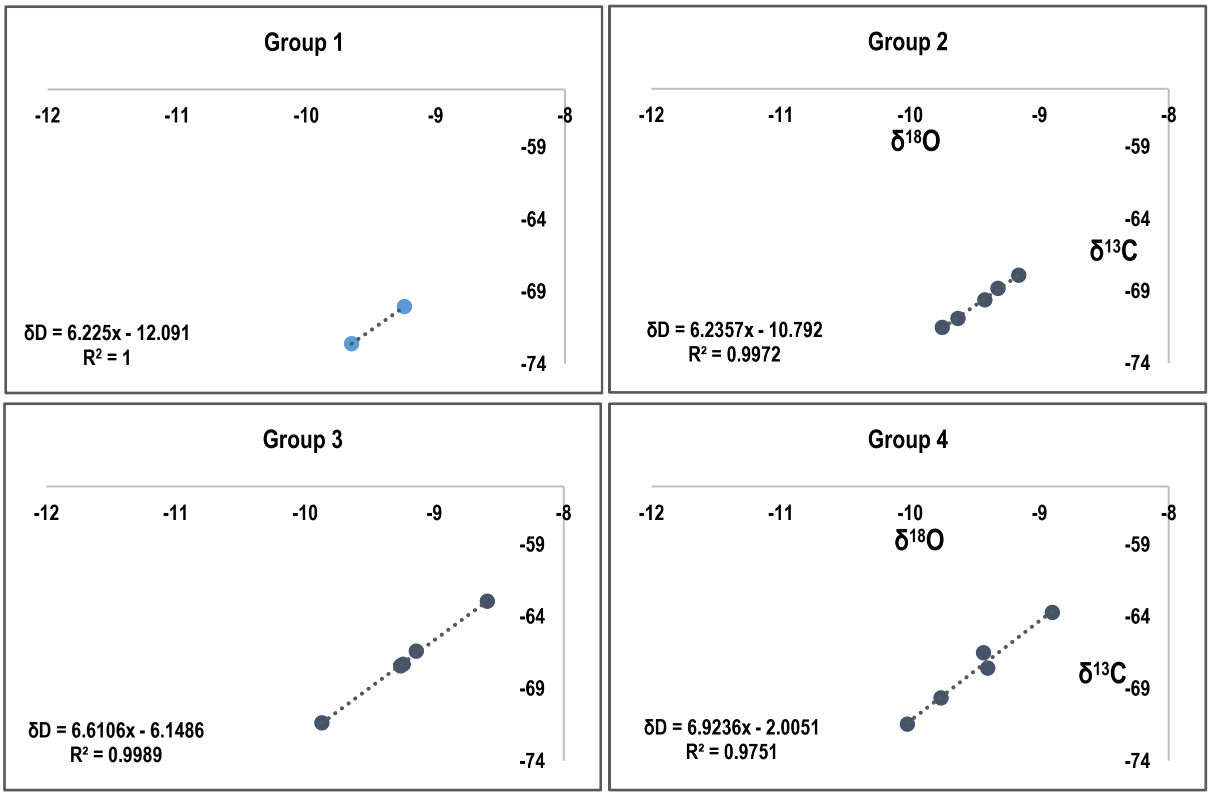


Figure 7: Grouped ground and surface water types based on their $\delta^{18}O$ and δD concentrations. Group 1 includes samples 8 & 11: Group 2 includes samples 1, 6, 17, 18 & 19: Group 3 includes samples 3, 4, 5, 9 & 10. Group 4 includes 7, 12, 13, 14 and 16.

The characteristics of Group 1 samples are similar to groundwater coming from the foothills around Lake Texcoco (Quijano, 1978) that have low salinity and $\delta^{18}O$ and δD concentrations close to local precipitation (Type 1 water; Table 7). Also, these waters group with the $\delta^{18}O$ and δD concentrations reported from the Agua Negra river (Fig 5) that are also like local precipitation values (Oliver et al. 1987; Ryan, 1989).

Ca concentrations in sample 8 (Table 5) are the highest across all groups, and Mg concentrations in sample 8 are significantly higher than in sample 11 (Table 5). High concentrations are thought to be related to the proximity of sample 8 to the El Doctor limestone basement outcrops (see Chapter 3) which occurs more frequently around the north-eastern TB towards Apaxco (Figs 1, 8.1 & 8.9). It may also be because of meteoric water mixing with palaeo-water coming from the limestone basement, but there is no evidence for this in the isotopic signature as they do not correspond to the chemical and isotopic values associated with this water type (see Tables 4 & 7, Type 4, North & South).

12.2: Group 2 - spring water samples 6, 17, 18 and 19 and well water sample 1

Group 2 are spring water samples, aside from sample 1, El Salto well, however, the well is within 200 m of a spring that flows from a lower elevation (ca. 1.5 m below the well). Geographically sample sites 6, 18 and 19 are situated along Barranca la Botica along the western flank of San Jose Hill, sample site 1 is situated on the eastern side of the Agua Negra River along the lower reaches of San Mateo Hill. Sample 17 was collected from Barranca la Gloria located along the north-eastern flank of San Jose Hill (Table 1, Fig 1). These samples sites draw a line of the transect from the recharge zone at the southern hydrological divide towards the discharge zone roughly NW – SE (Fig 1). Most, if not all the samples were collected from groundwater passing through Quaternary alluvium (F5: Chapter 8) and Tarango Formation (F1 – F4: Chapter 8). The average altitude of group 2 is the highest across all groups (2255.2 m a.s.l), and within the group, altitude decreases downslope from sample 18 to sample 1 along the line of the transect (Fig 1).

The group has the second lowest average TDS concentration across all groups (576.87 mg/l) and the least saline waters aside from group 1, although both groups are hypersaline (Table 4). Across all groups, the average Ba and Al concentrations are the highest reported (0.0236 ppm and 0.066 ppm respectively), and Fe has the second highest concentration (0.0019 ppm). Within the group Na, Mg, K, Cr and water temperature increase as the altitude of the sample site decreases (R values above - 0.65; Table 8) from sample 18 in the recharge zone towards sample 17 (see Fig 1) close to the discharge zone. As temperature increases, K, Ca, Li and As all increase again from sample 18 (recharge zone) to sample 1 (discharge zone) (R values above 0.65; Table 8). The increasing concentrations of Na, Mg, K and Cr with decreasing altitude and increasing K, Ca, Li and As with increasing temperature (which increase as altitude decrease) are thought to be related to the evolution of water along the line of flow from the recharge zone to the discharge zone (Fig 1). Similar trends have been found in the Independence Basin, Guanajuato, Mexico State where temperature increases with sample depth or decreases as altitude increases, and concentrations of Na, Ca and As increases from the recharge zone towards the discharge zone (Mahlknecht et al. 2004, 2006).

The opposite is true for Ba, Mn, Fe, and Ni concentrations that decrease as water temperature increases (R values above - 0.60, Table 8). High concentrations are associated with samples 18 and 19 and higher elevations in the recharge zone. Group 2 sits between the SMWL and the LEL (Fig 5). The regression line gives the group a δD excess of -10.7‰ (Fig 7), and this fits with water types 1 and 2 (Table 7). Both these water types are reported to sit close to the GMWL and be relatively un-evolved compared to water types 4, 5 and 6 (Table 7), and they are reported from elevated springs (Table 7).

Table 8: Correlation Matrix for TB water samples from group 2 (Pearson Correlation Coefficient).

	Mg	Si	K	Ca	Ba	Li	Al	Mn	Fe	Ni	Cu	Zn	As	Cr	δ18O	δD	WT	Depth	Alt	pH	TDS
Na	0.68	0.57	0.76	-0.14	-0.32	0.71	-0.27	-0.43	-0.45	-0.34	0.03	0.39	0.58	0.63	-0.17	-0.14	0.40	0.85	-0.78	-0.85	-0.11
Mg		0.61	0.43	0.07	0.29	0.30	-0.30	0.29	0.26	0.26	0.58	0.93	0.35	0.68	0.22	0.23	0.20	0.81	-0.64	-0.66	0.16
Si			0.54	0.15	-0.12	0.84	-0.73	-0.06	-0.09	-0.07	0.45	0.36	0.71	0.43	0.09	0.08	0.58	0.43	-0.42	-0.77	-0.23
K				0.48	-0.74	0.70	-0.70	-0.69	-0.72	-0.75	-0.38	0.13	0.92	0.85	0.35	0.38	0.87	0.80	-0.93	-0.45	0.34
Ca					-0.42	0.00	-0.76	-0.16	-0.19	-0.43	-0.33	0.08	0.61	0.64	0.96	0.95	0.74	0.27	-0.47	0.40	0.83
Ba						-0.53	0.51	0.96	0.97	0.99	0.83	0.56	-0.71	-0.38	-0.17	-0.19	-0.76	-0.24	0.50	0.01	-0.21
Li							-0.61	-0.55	-0.57	-0.48	0.01	-0.06	0.78	0.34	-0.19	-0.19	0.65	0.39	-0.46	-0.79	-0.38
Al								0.30	0.34	0.47	0.06	-0.11	-0.91	-0.65	-0.64	-0.63	-0.93	-0.39	0.56	0.21	-0.34
Mn									1.00	0.96	0.82	0.58	-0.59	-0.28	0.08	0.05	-0.60	-0.25	0.47	0.13	-0.03
Fe										0.97	0.81	0.55	-0.62	-0.31	0.05	0.02	-0.64	-0.28	0.50	0.15	-0.05
Ni											0.86	0.52	-0.69	-0.42	-0.19	-0.22	-0.74	-0.29	0.54	-0.01	-0.26
Cu												0.67	-0.25	-0.13	-0.14	-0.17	-0.37	0.00	0.24	-0.44	-0.36
Zn													0.06	0.55	0.32	0.32	-0.05	0.64	-0.43	-0.38	0.28
As														0.75	0.45	0.46	0.97	0.60	-0.76	-0.40	0.27
Cr															0.66	0.68	0.72	0.91	-0.96	-0.28	0.66
δ18O																1.00	0.57	0.32	-0.45	0.42	0.90
δD																	0.58	0.35	-0.48	0.42	0.92
WT °C																		0.49	-0.71	-0.19	0.41
Depth																			-0.95	-0.53	0.41
Alt																				0.40	-0.51
pH																					0.53

The average $\delta^{18}O$ value for group 2 is - 9.45‰ with a maximum of – 9.16‰ and a minimum of – 9.75‰ and δD has an average of - 69.76‰, a maximum of - 67.76‰ and a minimum of – 71.52‰. Hence, this group has undergone some modification to the $\delta^{18}O$ concentration of water samples from their assumed meteoric state, which exceeds the 0.05‰. $\delta^{18}O$ and δD ratios progressively increase along the transect from sample 19 to sample 17 (Fig 1) suggesting that, water passing through the alluvium from the recharge zone to the discharged zone becomes progressively move evolved (positive) along the line of flow. This is supported by increasing Na, Mg, K and Cr K, Ca, Li and As concentrations following the same trend. In semi-arid regions, moisture is often lost from the water table and the unsaturated zone, mainly from alluvial aquifers along drainage networks of barrancas (Clark & Fritz, 1999). It may be that as shallow groundwater travels from the recharge to the discharge zone moisture is lost via diffusion and evaporation causing an enrichment of $\delta^{18}O$, δD, Na, Mg, K, Cr, Ca Li and As to occur along the line of flow coupled with time and distance allowing increasing sediment and water interaction.

Fault systems associated with the Cuautitlan graben (Figs 8.14 & 8.15) which lies close to the study sites southern hydrological divide may allow deeper groundwater input, or the exchange of groundwater from the unsaturated zone to the saturated zone, like the Puebla Basin (see Table 7, Type 6, South). This may also explain the increased concentrations of Ba, Mn, Fe, and Ni in sample 18, with water being drawn up from greater depths. The elevation of most of these sample sites lies at least 400m above the lowest recorded altitude for borehole sample site 12 (Group 4 1855 m a.s.l) and at least 30m above the current fluvial base level.

Table 9: Correlation Matrix for Tequixquiac Basin water samples from group 3 (Pearson Correlation Coefficient).

	Mg	Si	K	Ca	Ba	Li	Al	Mn	Fe	Ni	Cu	Zn	As	Cr	δ18O	δD	WT °C	Depth	Alt	pH	TDS
Na	0.68	-0.04	0.75	0.81	0.40	0.56	0.09	-0.26	0.72	0.73	0.42	0.30	0.29	0.90	0.81	0.79	0.05	-0.33	0.09	0.09	0.83
Mg		-0.63	0.51	0.48	0.81	-0.11	0.63	0.45	0.80	0.91	0.25	0.54	-0.42	0.76	0.19	0.17	-0.64	-0.77	0.55	-0.07	0.84
Si			-0.37	0.86	0.53	-0.05	-0.26	0.90	0.38	0.97	-0.05	0.57	-0.23	0.12	0.63	1.00	0.51	0.88	-0.96	0.23	-0.28
K				0.86	0.67	0.70	0.46	0.04	0.91	0.80	-0.22	0.13	0.50	0.63	0.81	0.81	0.01	-0.47	0.10	-0.49	0.89
Ca					0.53	0.60	0.32	-0.03	0.78	0.71	-0.15	-0.22	0.41	0.52	0.79	0.79	-0.07	-0.54	0.35	-0.01	0.83
Ba						-0.05	0.94	0.74	0.90	0.92	-0.36	0.25	-0.28	0.42	0.13	0.12	-0.79	-0.98	0.66	-0.47	0.84
Li							-0.26	-0.63	0.35	0.18	0.00	-0.04	0.95	0.42	0.94	0.94	0.72	0.30	-0.53	-0.30	0.38
Al								0.90	0.38	0.97	-0.05	0.57	-0.23	0.12	0.63	1.00	0.51	0.88	-0.96	0.23	-0.28
Mn									0.38	0.44	-0.54	0.02	-0.70	-0.19	-0.55	-0.55	-0.97	-0.83	0.78	-0.30	0.27
Fe										0.97	-0.19	0.27	0.08	0.68	0.54	0.54	-0.42	-0.79	0.42	-0.43	0.98
Ni											-0.05	0.37	-0.12	0.73	0.42	0.41	-0.54	-0.83	0.51	-0.31	0.97
Cu												0.57	-0.12	0.57	0.14	0.11	0.28	0.36	-0.34	0.51	-0.04
Zn													-0.23	0.69	0.02	0.01	-0.06	0.05	-0.28	-0.34	0.28
As														0.12	0.79	0.81	0.84	0.49	-0.63	-0.27	0.09
Cr															0.63	0.61	0.02	-0.23	-0.06	-0.10	0.76
δ18O																1.00	0.50	0.04	-0.29	-0.13	0.61
δD																	0.51	0.05	-0.30	-0.15	0.60
WT °C																		0.88	-0.95	-0.11	-0.36
Depth																			-0.96	0.24	-0.73
Alt																				0.23	0.41
pH																					-0.28

12.3: Group 3 - water samples 3, 4, 5, 9 and 10

Water samples in Group 3 were collected from Quaternary alluvial deposits (F5: Chapter 8) and lacustrine, alluvial and fluvial sediments (F1 – F4: Chapter 8) except for sample 9, which was collected from a limestone pool fed by a spring (see Fig 1). Across all groups, the average Na (153.62 ppm) and Ba (0.22 ppm) concentrations are the second highest. Mg, K, Li, As, Cr and TDS concentration averages are highest across all groups (Tables 5 & 6). Within the group, as sample depth increases (see Table 4) Si and water temperature increase (R values of 0.88 and above; Table 9) and, as water temperature increases, Li and As (R values above 0.72; Table 9) increase. The opposite is found for Mg, Ba, Mn, Fe, Ni and TDS concentrations, which decrease as water depth and temperature increase (R values above - 0.64, Table 9). Also, as K concentrations increase within the group Ca, Fe, Ni, $\delta^{18}O$, δD and TDS concentrations increase, and as TDS decreases with the depth, the same trend is likely for these elements. Consequently, high Mg, Ba, Mn, Fe, Ni and TDS concentrations and more positive $\delta^{18}O$ and δD ratios are associated with shallow saline waters. High Si, Li and As values and more negative $\delta^{18}O$ and δD are associated with deep fresh water. Group 3 has $\delta^{18}O$, and δD values that lie along the LEL (Fig 5) and the group has the most positive average $\delta^{18}O$ and δD values across all groups with a maximum of – 9.2‰ and a minimum of -8.6‰.

The deuterium excess for group 3 is - 6.1486‰ (Fig 6). Palaeo-waters coming from the regional limestone aquifer (SMWL, Quijano et al, 1980 (Fig 5), Type 4, South Table 7) have a δD excess of between + 5 to +7‰ and $\delta^{18}O$ values of between - 9 to - 11‰ which does fit with the regression line for this group (Fig 6). Highly evaporated, isotopically enriched waters from Lake Texcoco (Table 7, Type 5) also have $\delta^{18}O$ and δD concentrations that are more positive than the GMWL and the LMWL. Palaeo-waters coming from the basement limestone (Type 4, South Table 7) and water collected from Lake Texcoco are also both reported to have a high salt content (see Table7). However, unless excessive evaporation occurred prior groundwater recharge at sites 3, 4, and 5 (boreholes), it seems likely that Group 3 has a chemistry that is governed by groundwater mixing with the limestone aquifer. Interaction with the limestone aquifer fits with the group having the highest Li concertation across all groups, which indicates a long residence time for groundwater and probably explains the high TDS measurements, possibly because to extended rock-water interaction times.

12.4: Group 4 - water samples 7, 12, 13, 14 and 16

Samples 12 and 13 are borehole water samples collected from the Tlapanaloya region to the southeast of the study area close to Cretaceous Limestone Basement and the andesitic and rhyolitic volcanic sierras. The boreholes pass through the Tarango Formation (F1 – F4: Chapter 8). Sample 16 is a well site and was collected from the eastern side of Barranca Acatlan from Quaternary alluvium that has a limestone upper cap. Sample 14, a borehole site located west of Barranca Acatlan on San Mateo Hill thought to be situated within Quaternary alluvial sediments and the Tarango Formation (F1 – F4: Chapter 8). Sample 7, a borehole site thought to be situated in the Tarango Formation close to Miocene volcanic andesites (Chapters 3 & 8: F1). Geographically these sample sites follow a line of transect roughly Northeast – Southwest across the southern end of the Tequixquiac Basin (Fig 1). The average depth of sample collection is the lowest across all groups, 2113 m.a.s.l (aside from group 5). Chemically these waters change from site to site, but Na consistently has the highest concentration (Table 5). Across all groups, Al, Fe, Ni, Cu and Zn concentrations are the highest, and group 4 has the lowest average concentration Ca (0.68 ppm) (Table 4). Na, Mg, Si, K and Ca has similar concentrations to Groups 2 & 3, relatively low (Table 5).

Water temperature is averagely the highest across all groups (24.6°C) with a maximum of 27.3°C and a minimum of 20.3°C. Within the group water temperature and Ca decrease from samples 12 (east) and 7 (west) towards the centre of the basin. Altitude, depth, TDS and $\delta^{18}O$, δD Ca, Ba concentrations all increase from the outer basin (samples 12 and 7) towards sample 16 (Fig 1). Na increases from sample 12 (east) to sample 7 (west) (Fig 1, Table 5). Sample 12 has the highest concentration of Li within the group and Al peaks in sample 14 (Table 5). Generally, within the group as depth increases so to do Si, Ca, As, Li, Mn and water temperature (R values above 0.60; Table 10) and, as depth and water temperature decreases Mg, K, Ba, Cr, $\delta^{18}O$ and δD generally increase (R values above – 0.64). The temperature increase with depth is thought to be related to the geothermal gradient, and group 4 seems to be closest to type 1 water (Table 7). Most of the sites are in the southeast, and southwestern portion of the study area positioned between 2240 – 2351 m.a.s.l (surface altitude), hence they are elevated above the basin floor, which sits around 2100 m a.s.l. This indicates that the boreholes likely tap aquifers within the Tarango Formation and Quaternary alluvial sediments based on the findings of Chapters 6 & 7. The $\delta^{18}O$ and δD values fall between the GMWL and the LEL, indicating that there is a degree of modification but to a lesser extent than is found in group 2. These waters are loosely associated with type 1 (Table 7) in the sense that they are related to Quaternary alluvial deposits and because they have $\delta^{18}O$ and δD values that fall close to the GMWL.

Table 10: Correlation Matrix for Tequixquiac Basin water samples from group 4 (Pearson Correlation Coefficient).

	Mg	Si	K	Ca	Ba	Li	Al	Mn	Fe	Ni	Cu	Zn	As	Cr	δ18O	δD	WT °C	Depth	Alt	pH	TDS
Na	-0.21	0.48	-0.24	0.30	-0.48	-0.31	0.33	-0.21	0.33	0.29	-0.66	-0.34	-0.05	-0.15	0.27	0.26	0.44	0.27	0.68	-0.31	-0.03
Mg		-0.61	1.00	-0.59	0.93	-0.54	-0.07	-0.75	-0.05	-0.01	-0.53	0.09	-0.68	0.95	0.89	0.88	-0.92	-0.66	-0.10	-0.81	0.97
Si			-0.61	0.97	-0.55	0.53	-0.32	0.35	-0.35	-0.39	0.23	-0.79	0.74	-0.48	-0.37	-0.45	0.85	0.95	0.64	0.34	-0.62
K				-0.59	0.93	-0.49	-0.05	-0.70	-0.03	0.02	-0.49	0.07	-0.64	0.97	0.87	0.87	-0.92	-0.64	-0.15	-0.76	0.97
Ca					-0.45	0.55	-0.54	0.32	-0.56	-0.60	0.36	-0.72	0.73	-0.52	-0.44	-0.54	0.80	0.92	0.64	0.37	-0.65
Ba						-0.35	-0.36	-0.64	-0.34	-0.29	-0.23	0.08	-0.53	0.86	0.69	0.65	-0.89	-0.56	-0.14	-0.64	0.82
Li							-0.13	0.87	-0.15	-0.17	0.84	-0.53	0.96	-0.35	-0.67	-0.67	0.57	0.77	-0.28	0.84	-0.65
Al								0.25	1.00	1.00	-0.33	0.24	-0.12	0.06	0.10	0.24	0.00	-0.25	-0.46	0.07	0.12
Mn									0.23	0.20	0.78	-0.18	0.84	-0.58	-0.83	-0.76	0.64	0.60	-0.46	0.97	-0.77
Fe										1.00	-0.34	0.26	-0.15	0.07	0.12	0.26	-0.03	-0.28	-0.47	0.05	0.14
Ni											-0.34	0.29	-0.18	0.11	0.14	0.29	-0.08	-0.32	-0.50	0.03	0.18
Cu												-0.08	0.73	-0.48	-0.83	-0.83	0.37	0.47	-0.42	0.87	-0.69
Zn													-0.64	-0.12	-0.08	-0.01	-0.45	-0.80	-0.44	-0.07	0.13
As														-0.48	-0.68	-0.70	0.77	0.92	-0.03	0.81	-0.75
Cr															0.87	0.88	-0.81	-0.49	-0.17	-0.70	0.94
δ18O																0.99	-0.69	-0.52	0.21	-0.94	0.95
δD																	-0.71	-0.57	0.09	-0.89	0.96
WT °C																		0.86	0.36	0.65	-0.88
Depth																			0.37	0.58	-0.70
Alt																				-0.41	-0.08
pH																					-0.86

They differ from group 2 because they are held at depth rather than being exposed at the surface and subject to evaporitic processes. Li is also comparatively high for this group, which indicates, as with group 3, that these waters are held in storage after recharge allowing time for leaching.

13: Summary.

13.1: Precipitation data

The single rainwater sample used by this work is not enough to state conclusively that precipitation falling on the study area is well within the $\delta^{18}O$ and δD range of average values that are now understood for Central Mexico. What is needed is a much larger seasonally averaged data set, preferably over at least two seasons. Instead, sample 2 is considered a guide indicating that precipitation falling on the Tequixquiac Basin is probably well within the $\delta^{18}O$ and δD range of concentrations found in Central Mexico, as was the case for sample 2. Consequently, any positive or negative change in the $\delta^{18}O$ and δD ratios of meteoric waters (surface and ground) relative to average precipitation ratios that are greater than 0.05‰ in the Tequixquiac Basin has been considered as a modification from its original meteoric state (Fig 3). The same principle is applied to the geochemical content of sample 2, which agrees well with ground and surface water geochemistry (Tables 3, 5 & 6).

13.2: Groundwater data

Tequixquiac Basin meteoric water samples plot an LEL (Fig 4, Eq 3) (not including sample 15) which sits between the GMWL and the SMWL. The ratios of $\delta^{18}O$ and δD fit well within the average precipitation $\delta^{18}O$ and δD values found by Cortez & Favolden, (1987) from the Basin of Mexico and are close to sample 2 (Figs 4 & 5). Ratios of $\delta^{18}O$ & δD and concentrations of Mg and Na all positively correlate with increasing TDS concentrations (R and R^2 values above 0.60) indicating that the positive isotopic shift relative to the LMWL (Figs 4 & 5) is not independent and, that whatever process if affecting $\delta^{18}O$ & δD is also influencing the chemical concentrations of Tequixquiac Basin ground and surface waters, probably evaporation. The absence of Cl and the presence of Li suggests limited interaction between groundwater in the study area and basaltic geology (Edmunds et al. 2002). High Na concentrations are related to the Quaternary basin fill and leaching of the Tarango Formation (see Chapters 3, 6 & 7). Ba is associated with carbonate minerals, but, it is also related to K-feldspars and clays, which seems a likely source in the Tequixquiac Basin.

13.3: Groups 1 - 4

The slope of the regression for Groups 1 – 4 is around six as with LEL (Fig 7) indicating the average condensation temperatures during rainout are similar across the study area. Group 1 water is like type 1 water (Table 7), relatively young and under-evolved. Short residence times are interpreted based on, low TDS concentrations and the almost undetectable levels of Li (Table 6).

Group 2 sits between the SMWL, and the LEL (Fig 6) and has a δD excess of -10.7‰ (Fig 7), which fits with water types 1 and 2 (Table 7). From the recharge to the discharge zone along Barranca Acatlan (Fig 1) moisture is thought to have been lost via diffusion and evaporation enriching f $\delta^{18}O$, δD, Na, Mg, K, Cr, Ca Li and As along the line of flow. In the Tequixquiac Basin, like the Mezquital Valley, elevated groundwater levels are thought to be linked with wastewater recharge although there is no genetic relationship between this group and $\delta^{18}O$ and δD concentrations recorded from the Agua Negra River (Fig 5). Group 2 is thought to be a mixture of natural recharge and wastewater recharge.

Group 3 has high Mg, Ba, Mn, Fe, Ni and TDS concentrations. Within the group, positive $\delta^{18}O$ and δD ratios are associated with shallower saline waters and negative $\delta^{18}O$ and δD with deeper fresher waters. The high salt content (Table 7) found with this group (see Table 5) may indicate palaeogoundwater mixing with the limestone aquifer like water type 4 (Table 7). This fits with the group having the highest Li concertation across all groups indicating long residence times, and explains the high TDS measurements, possibly due to extended rock-water interaction times.

Group 4: Waters coming from this group are thought to tap aquifers within Quaternary Alluvial sediments (F5: Chapter 8) that dominate the south-east and west basin. The $\delta^{18}O$ and δD values fall between the GMWL and the LEL (Figs 4 & 5) indicating that there is a degree of modification but to a lesser extent than is found in group 2. These waters are loosely associated with water type 1 (Table 7) in the sense that they are related to the Quaternary alluvium, and because they have $\delta^{18}O$ and δD values that fall close to the GMWL. They differ from group 2 because they are held at depth rather than being exposed at the surface and subject to evaporitic processes. Li is also comparatively high for this group (Table 6) which indicates, as with group 3 that these waters may be held in storage after recharge.

14: Discussion and conclusion

The water analysis alone is critical because, from this region of Central Mexico, this is the first available ground and surface water geochemical record. The problems this study has encountered have predominantly been because of an absence of similar records, which consequently prompted the need for this portion of the research to be carried out. Understanding the geochemical and stable isotope compositions of the modern meteoric water was essential in interpreting the $\delta^{18}O$ values of the carbonate precipitating waters that are reported in Chapters 6 & 8, and in generating a point of reference for the palaeo $\delta^{18}O$ values. Comparisons between stable isotopes of modern and palaeowater $\delta^{18}O$ values have been extensity used in numerous studies to constrain temporal changes in surface elevation and climate (Amundson et al. 1996; Garzione et al. 2000; Poage & Chamberlin, 2001; Rowley et al. 2001; Andrew, 2006; Bershaw et al. 2012). Knowing the element geochemistry and concentration values of the water samples, along with stable isotope, has allowed the water samples from the study area to be compared to other groundwater sources from across Central Eastern Mexico (Table 7) with more confidence. The use of geochemical data has allowed interpretations of palaeo $\delta^{18}O$ to be more informed. Tequixquiac Basin.

15: Methods

15.1: Water sampling

To satisfy objective 3 (Chapter 1), water samples were collected using pre-sterilized polyethene terephthalate (PET) bottles that were washed and rinsed three times with the sampled water before collection. Five well, six spring, six borehole, one rainwater, and one tap water samples were collected. Borehole water samples were obtained with the assistance of the local water department, which granted access to the borehole sites pumped for drinking water (Fig 1). Two 250 ml sample bottles were filled at each of the 19 sample sites. Spring and well samples were collected 20cm below the water surface as directed by NIGL (NERC Isotope Geoscience Lab). At borehole sites, water was left to run for 2 minutes before rinsing and sample collection. Samples were then capped, labelled and refrigerated. Insofar as possible, samples remained refrigerated until analysis. The sample collection method was set out by NIGL, who advised on water sample collection for stable isotope analysis (Leng pers comm. 2010).

15.2: $\delta^{18}O$ and δD in meteoric waters

Despite the complex nature of the hydrological system, $\delta^{18}O$ and δD are now understood to behave in a relatively simple and predictable manner within this system on a global scale (Craig, 1961; in Clark & Fritz, 1997; Sharp, 2007). Craig (1961), who produced the GMWL (global meteoric water line), was the first to define the relationship between $\delta^{18}O$ & δD in natural waters. The GMWL uses the average $\delta^{18}O$ and δD from many LMWL (local meteoric water lines) expressed as a regression of global meteoric water values, this defines the relationship between $\delta^{18}O$ and δD in fresh global surface water, as:

Equation 5: $\delta D = 8\ \delta^{18}O + 10‰$ SMOW

The GMWL shows, because of phase changes between vapour and condensing via equilibrium fractionation (Rayleigh fractionation), that $\delta^{18}O$ and δD (the heavier isotopes) are preferentially partitioned into falling precipitation with a vapour mass retaining the lighter isotopes ($\delta\ ^{16}O$ & ^{1}H) preferentially (Clark & Fritz, 1997; Sharp, 2007). The process distils heavy isotopes from a vapour mass into precipitation effectively raining them out with each precipitation event (see Fig 4.5 and Clark & Fritz, 1997; Sharp, 2007). Hence, with each precipitation event, a vapour mass and the precipitation it produces becomes progressively more negative along its trajectory towards latitudinally higher and colder regions (Clark & Fritz, 1997). Rayleigh distillation occurs during rainout causing $\delta^{18}O$ and δD to partition between warm and cold regions (Fig 4.5) leading to the association of isotopically negative waters with globally colder regions and isotopically positive waters with warmer regions along the GMWL (Craig, 1969).

15.2.1: Factors controlling the isotopic composition of precipitation

The position of a meteoric water sample along the GMWL is intrinsically linked to the temperature, latitude, longitude and altitude of a vapour mass at the time the precipitation (Clark & Fritz, 1997; Kendall & McDonnell, 1998; Tucker & Wright, 2004; Leng, 2005; Sharp, 2007). Intercontinental topographic and temperature changes can also force rainout to occur at an accelerated rate creating more negative δD and $\delta^{18}O$ values in the vapour mass than would be found in oceanic regions (Fig 4.5). Water vapour travelling inland can also be strongly affected by seasonal variations of temperature. During cooler seasons precipitation is generally more isotopically negative than precipitation falling warmer during seasons, relative to winter values, because temperatures are higher, and evaporation and evapotranspiration recycle precipitation feeding moisture back into the atmosphere (Fig 4.5) (Clark & Frits, 1997; Sharp, 2007). The “amount effect” can dominate tropical carbonate archives as heavy and sudden rainfall during the wet season is much higher than in the dry season (Sharp, 2007). The continentality of a vapour mass is affected by seasonality as the deuterium excess is higher during the winter than in summer. Seasonal changes in atmospheric circulation patterns between summer and winter will affect the isotopic composition of precipitation delivered to a region.

15.2.2: Methods used

Sample preparation and measurement of δD and $\delta^{18}O$ in the Tequixquiac Basin waters samples was carried out at the Scottish Universities Environmental Research Centre (SUERC) by Craig Barrie. The analysis was performed on an automated Thermo Finnigan DeltaV Plus system inclusive of a Gas Bench II attachment. In-house standards (see Table 11) consisted of distilled water (DW2/2), East Kilbride snow (EKS2) and distilled sea water (DSW2). In-house standard value ranges were calibrated against the international standards SMOW (Standard Mean Ocean Water), GISP (Greenland Ice Sheet Precipitation) and SLAP (Standard Light Antarctic Precipitation) resulting in a linear calibration line covering the most commonly encountered water sample values. The DW2/2 internal standard was positioned at the start, middle and end of each analysis as it corrects for drift measurements (Barrie pers comm. 2012). The following method of analysis was the standard method used at SUERC, where the Tequixquiac modern water samples were analysed.

15.2.3: $\delta^{18}O$ and δD sample preparation and run

From each water sample, 200 µl was pipetted into exetainers that were sealed and gas flushed to remove atmospheric gases. The remaining headspace gas in the exetainers is given one hour to equilibrate. The addition of a platinum rod catalyst into the exetainers speeds up the reaction. Otherwise, δD numbers are not enough for measurement. When atmospheric gases have been removed from the exetainer, and before connecting the measurement needle, the mass spectrometer is corrected for H^{3+} ions (H^{3+} correction). Without this step in the procedure, the IRMS system would produce small amounts of H^{3+} ions that affect the δD content of the sample and subsequently, the δD result. After this, each water sample is run firstly for δD by convection and then for $\delta^{18}O$ (see below. Four reference gas peaks (from a reservoir of reference Hydrogen) are produced along with ten sample peaks per sample. The result for each water sample is the average of the results of the ten peaks with a standard deviation of <2‰ for δD. For $\delta^{18}O$ measurement, exetainers are flushed with 0.5% CO_2 in a He mix before analysis to remove any remaining 2% H_2 after δD analysis. Samples are left to equilibrate (freshwaters 24 hours, saline water three days and seven days for hypersaline waters) to stop the gas fractionating. Once equilibration is completed the system does not need any additional tuning (except for standard source tuning as with any mass spectrometer) or corrections.

As with δD analysis, the IRMS generates four reference peaks (but from a reservoir of CO_2) and then 10 sample peaks. The result for each sample is calculated from the average of the ten peaks with a standard deviation of <0.3‰ for $\delta^{18}O$ (Barrie pers comm. 2012).

15.2.4: Calibration, Correction, and Reporting

All isotopic data is calibrated to standards of known values and waters are universally reported relative to SMOW. Other international standards reported relative to SMOW (IAEA δD_{VSMOW} = 0‰, $\delta^{18}O_{VSMOW}$ = 0‰), are GISP (IAEA δD_{VSMOW} = -189.5‰, $\delta^{18}O_{VSMOW}$ = -24.76‰) and SLAP (IAEA δD_{VSMOW} = -427.5‰, $\delta^{18}O_{VSMOW}$ = -55.50‰). The very light values of GISP and SLAP mean that while they are useful in calibrating very depleted water samples (and the in-house standards), they are not very useful in calibrating analytical runs for most commonly encountered water values.

Table 11: δD and $\delta^{18}O$ values of international and in-house standards as measured on the Delta V Plus and Gas Bench II system, East Kilbride, SUERC. STDs = Standards (Barrie pers comm, 2012).

International STDs	δD_{SMOW}	Std. Dev.		International STDs	$\delta^{18}O_{SMOW}$	Std. Dev.
SMOW	0.00	1.56		SMOW	-0.09	0.19
GISP	-190.56	1.66		GISP	-24.87	0.28
SLAP	-430.27	3.33		SLAP	-55.49	0.17
In-house STDs	**δD_{SMOW}**	**Std. Dev.**		**In-house STDs**	**$\delta^{18}O_{SMOW}$**	**Std. Dev.**
DW2/2	-45.54	2.45		DW2/2	-7.44	0.16
EKS2	-88.12	1.21		EKS2	-12.93	0.10
DSW2	-3.19	1.11		DSW2	-0.26	0.06

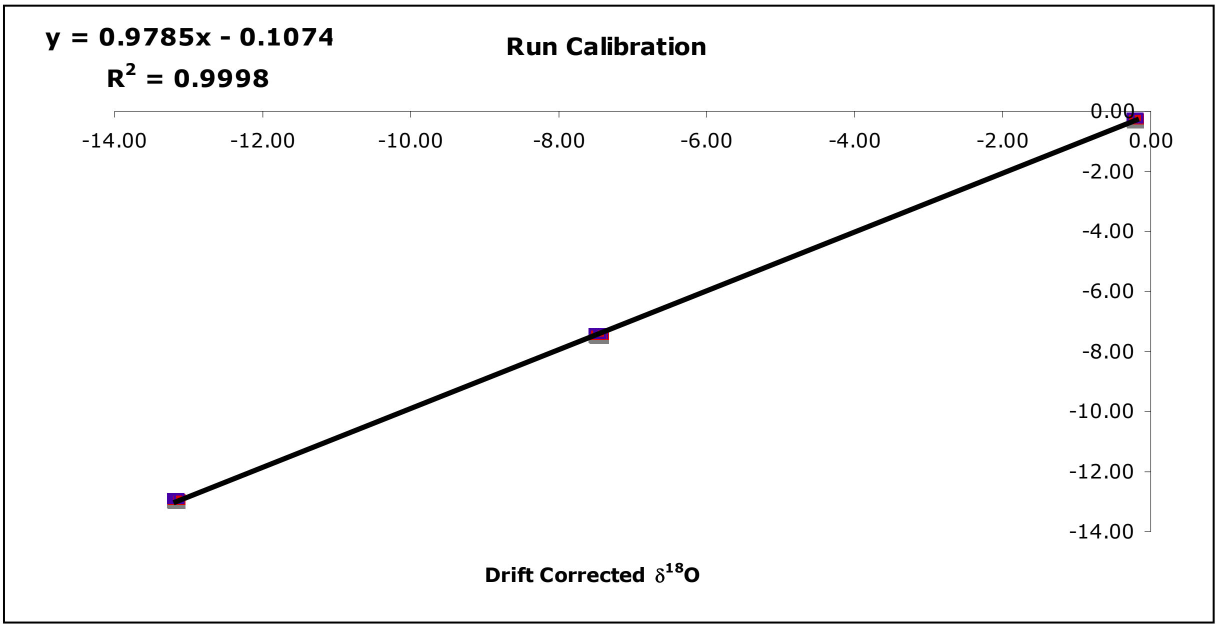


Figure 8*:* Graph plotting Drift Corrected $\delta^{18}O$ values against known $\delta^{18}O$ values (DSW2, DW2/2 and EKS2) for a single analytical run (Barrie pers comm, 2012)

For this reason, in-house standards which cover a more restricted but, more realistic set of isotope values (Table 11) were used at SUERC. The three in-house standards (DW2/2, EKS2, and DSW2) are included at the start and end of any analytical run to calibrate the measurements (Fig 8).

As well as the standards at the start and end for calibration, standard DW2/2 is included mid-way through the sample run to allow any systematic drift in the system to be corrected for, although this drift is negligible. After calibration and correction, the raw values are reported, as with the standards discussed above, relative to SMOW. Oxygen values which are heavier than SMOW can arise during measurement, but anything within ~2‰ for deuterium and ~0.3‰ for oxygen is considered an analytical error. Where values are increasingly heavier than this, waters must have generated this signature via evaporation, or via another process that preferentially retains the heavier isotopes of hydrogen and oxygen (Barrie pers comm, 2012).

15.3: ICP - MS water elemental geochemistry

ICP - MS water analysis was used to help generate a trace element signature for the collected Tequixquiac water samples (see Section 4.5). The ICPMS, and its setup, dictated the method of sample preparation and analysis, and guidance was given for sample and blank preparation by Dr Phil Riby (Liverpool John Moors). Sample and blank preparation were carried out by the author, and the sample runs were carried out by Dr Phil Riby at Liverpool John Moores University using the Thermo X-Series ICPMS.

15.3.1: Methods used

From each of the reference materials (Na, Mg, Si, K, Mn, Fe, Ni, Cu, Zn, As, Ca, Ba) 0.5 ml was decanted from a 1000 ppm concentration of the elemental standard and into a 500ml volumetric flask. To the 500 ml, volumetric flask 10 ml of concentrated nitric acid (trace element grade) was added, and the remainder of the volume of the 500 ml flask was made up with deionised water. From the stock five standards were prepared along with one blank in concentrations of 0 ppb (blank), 10 ppm, 20 ppb, 30 ppb, 40 ppb, 50 ppb in separate 100 ml volumetric flasks. To each of the flasks, 2 ml of concentrated nitric acid was added along with 1 ml of Rd taken from a pre-prepared 1 ppb stock. The remainder of the volume of the 100 ml volumetric flasks was made up with deionised water. For analysis 4.95 ml of each Tequixuiac water samples, 0.05 ml of the 1 ppb stock of Rd and one drop of nitric acid to acidify the sample was put into pre-labelled individual 50ml polyethylene test tubes. The standards, including the blank, were initially run independently of the Tequixquiac water samples to obtain the calibration curve. All samples were run overnight on the Thermo X-Series ICPMS with the concentration of each element within each water sample being taken as the average of three peaks reported in ppm.

15.3.2: Analytical precision

The RSD% (relative standard deviation) calculated for each element measured in every sample indicates analytical precision. The RSD% expresses how far from the mean value the values of the three measurements peaks lie. For example, If the majority of the data points lie close to the average (in this case the mean of the three recorded peaks) the standard deviation would be small and analytical precision would be high. If the data points lie far from the mean, the standard deviation is larger, and the analytical precision would be lower. An RSD% of 0% would indicate that the three peaks are identical, and analytical precision would be at 100%. RSD% values of 5 and below would indicate very high analytical accuracy, and RSD% values above 5% indicate progressively lower levels of analytical precision. All the TB water samples measured on the ICP-MS had an RSD of 7% or below.

15.4: Total dissolved solids (TDS) and pH

Due to problems with the field meter/probe, water sample TDS concentrations were measured in a laboratory at Liverpool John Moores University. Crucibles were dried in a 105ºC oven overnight and weighed using a four-point balance. Between 20 & 28 ml of the water sample for each sample site (including rain and tap water) was placed into a clearly labelled crucible and weighed on a four-point balance giving the weight of the dried crucible plus the wet sample weight. Crucibles were then placed in a sand tray, and water samples were left to dry in a 105ºC oven until all the moisture had evaporated. The crucibles were then removed from the oven, re-weighed using the four-point balance and converted to g/mg per litre of fluid.

15.5: Water sample pH

Water sample pH was tested at Liverpool John Moores University, by the author, due to calibration problems in the field with the pH meter. As an alternative, pH test strips were used after returning home.10ml of each sample was decanted into a clean test tube to prevent the alteration of the sample water chemistry, tested and then discarded.

Appendix eleven:
Sediment geochemistry (Sites TB9 & TB12)

Table 1: Barranca de Colores, Site TB9, Log 1 (upper and lower), Sediment geochemistry

Sample Name	d13C VPDB	d18O VPDB	d18O VSMOW	Water temp (a)	Water temp (b)	Ca (PPM)	Mg (PPM)	Sr (PPM)	Na (PPM)	K (PPM)	Fe (PPM)	Mn (PPM)	Al (PPM)	Organic carbon content	Calcium carbonate content	Mg/Ca	Sr/Ca
BDC L1						13171	18569	136	4700	13097	26960	127	75216	18.1	6.9	0.6222	0.0047
BDC L2	-3.5	-10.3	20.3	25.9	19.7	66389	2969	63	953	781	1331	54	3997	9.9	22.9	0.0250	0.0004
BDC L3	-2.8	-9.8	20.8	23.3	17.4	250376	4710	188	991	2664	4423	663	13992	6.9	63.6	0.0069	0.0003
BDC L4	-2.9	-9.1	21.6	20.1	14.3	57889	17363	164	3919	11688	20928	281	67105	18.0	30.4	0.1180	0.0013
BDC L5	-1.9	-9.7	20.9	22.9	17.0									3.9	82.5		
BDC L6														17.3	19.9		
BDC L7	-2.5	-9.3	21.3	21.1	15.3	235229	5113	239	2631	2953	5193	274	17654	6.6	78.1	0.0195	0.0005
BDC L8	-3.0	-9.6	21.0	22.6	16.7									16.5	74.4		
BDC L9	-2.8	-11.0	19.6	29.2	22.8									3.8	71.6		
BDC L10						27163	18586	199	7110	15774	25824	212	73724	16.2	15.6	0.4563	0.0033
BDC L11	-2.2	-9.3	21.4	20.9	15.1	195279	9190	300	3032	7296	11526	225	32093			0.0271	0.0007
BDC L12	-2.4	-9.1	21.5	20.3	14.5									8.0	61.4		
BDC L13	-2.3	-9.3	21.4	20.9	15.1									15.9	39.1		
BDC L14						43655	16998	282	5418	14574	22508	192	65175	10.0	31.9	0.2164	0.0030
BDC L15	-3.3	-9.1	21.6	20.0	14.2	47513	16150	309	8262	14287	21693	264	69635	13.3	14.0	0.3031	0.0030
BDC L16														15.7	69.5		
BDC L17														7.5	36.4		
BDC L18														12.4	20.6		
BDC L19														13.8	40.1		
BDC L20														11.9	73.3		
BDC L21														44.6	36.7		
BDC L22														20.7	36.8		
BDC L23	-3.6	-8.5	22.1	17.5	11.9									14.0	37.4		
BDC L24														2.2	29.0		
BDC L25														15.7	15.7		
BDC L26														-5.6	23.7		
BDC L27														15.3	6.5		
BDC L28														12.8	19.2		
BDC L29														10.9	20.4		
BDC L30														13.5	12.0		
BDC L31														13.6	9.4		
BDC L32														18.5	17.4		
BDC L33														18.0	6.0		
BDC L34														17.0	2.3		
BDC L35														14.6	6.4		
BDC L36														9.5	66.1		
BDC L37														14.3	6.5		
BDC L38														15.2	7.2		
BDC L39														39.1	6.4		
BDC L40														14.9	7.4		
BDC L41														12.5	8.6		
BDC L42														13.9	7.1		
BDC L43														12.4	9.1		
BDC L44														14.3	8.7		
BDC L45														13.5	34.1		
BDC L46														16.1	17.9		
BDC L47														16.0	21.5		
BDC L48	-4.7	-7.5	23.2	13.2	7.9									16.7	22.3		
BDC L49																	
BDC L50														8.6	64.4		
BDC L51														18.3	8.5		
BDC L52														14.7	18.7		
BDC L53														21.9	8.2		
BDC L54														18.4	15.0		
BDC L55	-5.3	-8.0	22.7	15.1	9.7									20.4	9.1		
BDC L56														16.6	60.5		
BDC L57														19.6	19.9		
BDC L58	-3.7	-5.1	25.7	3.6	-0.9									18.5	8.0		
BDC L59														20.4	8.4		
BDC L60														22.1	12.7		
BDC L61	-5.1	-7.6	23.1	13.3	7.6									15.8	47.9		
BDC L62	-3.7	-5.4	25.3	4.9	0.3									25.9	22.5		
BDC L63	-3.1	-6.5	24.2	9.1	4.1									19.0	24.2		
BDC L64	-3.3	-4.6	26.2	1.9	-0.7												
Average	-3.3	-8.3	22.3	17.2	11.7	115436.9	11384.9	217.9	4039.4	8752.2	14178.4	270.5	42921.7	15.0	27.9	0.1465	0.0016
Max	-1.9	-4.6	26.2	29.2	22.8	250376.3	18585.8	309.3	8262.0	15774.1	26959.5	662.7	75216.4	44.6	82.5	0.6222	0.0047
Min	-5.3	-11.0	19.6	1.9	-0.9	13170.7	2969.1	63.3	953.0	780.9	1331.5	54.1	3997.4	-5.6	2.3	0.00690	0.00034
Mean	-3.1	-9.1	21.6	20.1	14.3	57889.1	16149.7	198.7	3918.7	11687.9	20928.1	225.0	65174.8	15.2	19.9	0.1180	0.0013

Table 2: Barranca de Colores, Site TB9, Log 2, Sediment geochemistry

Sample Name	d13C VPDB	d18O VPDB	d18O VSMOW	Water temp (a)	Water temp (b)	Ca (PPM)	Mg (PPM)	Sr (PPM)	Na (PPM)	K (PPM)	Fe (PPM)	Mn (PPM)	Al (PPM)	Organic carbon content	Calcium carbonate content	Mg/Ca	Sr/Ca
BDC T1	-1.8	-8.5	22.1	17.6	12.0	218025.8	7308.4	756.0	2262.4	4871.9	7768.2	169.2	16713.7	7.2	70.3	0.001379	3.96E-05
BDC T2	-2.4	-9.2	21.5	20.5	14.7	253015.5	5287.4	859.9	1884.5	3782.5	6038.7	167.8	13431.2	5.3	79.3	0.00086	3.88E-05
BDC T3	-3.0	-9.0	21.6	19.8	14.1	265526.0	4212.4	661.1	965.7	1587.6	2679.1	78.0	7069.2	6.9	77.6	0.000653	2.84E-05
BDC T4	-2.7	-9.9	20.7	24.0	18.0	215817.8	7560.2	279.3	3936.5	6349.8	11197.2	250.8	25531.5			0.001441	1.48E-05
BDC T5	-1.9	-10.0	20.6	24.3	18.3	110539.6	7505.0	236.8	4360.6	6893.9	11280.6	192.7	24296.1	8.0	63.2	0.002793	2.44E-05
BDC T6	-2.1	-10.1	20.5	24.7	18.6									5.6	79.7		
BDC T7	-1.3	-10.0	20.6	24.4	18.4	213437.3	5010.2	181.6	2404.9	4256.7	8242.4	132.6	15602.9	7.9	58.5	0.000966	9.71E-06
BDC T8	-1.6	-9.8	20.8	23.5	17.5	256915.4	3741.3	276.8	4422.9	3164.2	6906.5	265.5	19840.8	11.4	58.5	0.000599	1.23E-05
BDC T9	-2.0	-10.0	20.6	24.3	18.3	205525.5	8160.4	282.7	5356.5	6234.8	12441.7	283.6	33152.9	13.6	27.9	0.001634	1.57E-05
BDC T10	-2.1	-9.8	20.9	23.3	17.3	210165.4	4369.6	261.1	5380.5	4330.1	8743.9	151.8	23900.8	5.1	45.0	0.000855	1.42E-05
BDC T11	-2.0	-8.9	21.8	19.1	13.4									5.9	66.4		
BDC T12	-1.7	-9.8	20.8	23.4	17.4	218314.6	4427.3	300.6	6205.3	4864.1	9375.7	152.7	27871.1	12.1	65.9	0.000834	1.57E-05
BDC T13	-1.3	-9.5	21.2	21.8	17.9									10.2	54.7		
BDC T14	-0.7	-9.7	20.9	23.0	17.1	240240.0	3193.6	292.9	4582.4	3037.6	5092.8	116.6	18664.0	12.1	59.4	0.000547	1.39E-05
BDC T15	-1.8	-9.4	21.3	21.4	15.6	291423.7	3162.8	582.3	307.8	696.5	1224.8	48.2	2642.7	6.2	89.9	0.000447	2.28E-05
BDC T16	-0.4	-9.5	21.1	22.0	16.1	190635.5	6606.4	255.2	8620.6	6371.6	12763.6	300.2	33281.0	18.2	53.0	0.001426	1.53E-05
BDC T17	-1.1	-9.3	21.4	21.0	15.1	153826.6	7188.2	354.4	9775.9	7442.7	16448.2	313.7	44050.7	13.0	30.9	0.001923	2.63E-05
BDC T18	-1.4	-9.7	20.9	23.2	17.2	178541.4	6840.0	271.9	7572.1	7080.0	15435.6	227.6	40246.5	9.8	53.1	0.001576	1.74E-05
BDC T19	-1.5	-9.8	20.8	23.5	17.5									10.6	46.2		
BDC T20						66406.3	8149.9	362.1	14635.1	11668.6	30942.8	240.9	71179.5	16.7	8.0	0.005049	6.22E-05
BDC T21	-0.9	-9.6	21.0	22.4	16.5	209133.1	3397.5	206.5	3539.6	2633.1	5491.1	200.5	7599.8	7.4	61.2	0.000668	1.13E-05
BDC T22	0.8	-10.0	20.6	24.3	18.2									3.9	90.4		
BDC T23	1.9	-9.7	20.9	23.2	17.2	248705.5	3275.2	291.1	785.1	733.0	1286.2	51.4	4543.1	13.3	51.1	0.000542	1.34E-05
BDC T24	-0.6	-9.6	21.1	22.3	16.4									6.3	56.0		
BDC T25						10653.6	8195.7	121.6	4764.1	5584.4	22769.3	88.8	55955.1	14.4	3.5	0.031651	0.00013
BDC T26														4.7	70.9		
BDC T27	-0.4	-9.6	21.0	22.5	16.6									7.6	68.9		
BDC T28	-1.1	-9.3	21.3	21.0	15.2	246847.7	2835.1	156.8	625.8	1035.9	2559.7	176.2	7736.2	8.4	62.8	0.000473	7.25E-06
BDC T29	0.0	-9.5	21.2	21.8	16.0									8.4	71.6		
BDC T30	-2.4	-9.6	21.1	22.3	16.4									9.5	66.1		
BDC T31														7.4	12.8		
BDC T32	-3.3	-9.8	20.8	23.4	17.4	192888.5	9581.8	326.2	3475.1	7195.0	12281.7	507.3	32029.8	11.8	59.5	0.002044	1.93E-05
BDC T33														16.5	39.3		
BDC T34														10.2	40.6		
BDC T35														12.8	36.2		
Avergae	-1.38	-9.58	21.03	22.43	16.57	199837.37	5714.68	348.43	4564.92	4753.05	10046.18	196.01	25016.12	9.66	55.25	0.00278	0.00003
Max	1.9	-8.5	22.1	24.7	18.6	291423.7	9581.8	859.9	14635.1	11668.6	30942.8	507.3	71179.5	18.2	90.4	0.03165	0.00013
Min	-3.3	-10.1	20.5	17.6	12.0	10653.6	2835.1	121.6	307.8	696.5	1224.8	48.2	2642.7	3.9	3.5	0.00045	0.00001
Mean	-1.6	-9.7	21.0	22.8	17.1	213437.3	5287.4	282.7	4360.6	4864.1	8743.9	176.2	23900.8	9.0	59.0	0.00097	0.00002