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Title of article Vent sites and flow directions of the Otowi ash flows (lower Bandelier Tuff), New Mexico

Author(s) Donald B. Potter and Christa M. Oberthal

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Appendix 1

APPENDIX 1. Location and approximate stratigraphic positions of stations within the Otowi (Qbo) ash-flow tuffs where pumice fragment orientation and lithic inclusion compositions were determined in the Jemez Mountains, New Mexico. Abbreviations: AFT, ash-flow tuff; crops, outcrops; PFO, pumice fragment orientation.

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
Area A - northern part						
62	Seven Springs	3984.45	347.49	8680	x	
60	Seven Springs	3984.25	348.55	8780	x	
54	Seven Springs	3984.28	349.67	8920	x	
55	Seven Springs	3983.90	349.80	8860	x	
56	Seven Springs	3983.60	348.80	8600	x	
57, 233	Seven Springs	3983.60	348.90	8600	x	112
50	Seven Springs	3983.10	351.46	8770	x	
44, 209	Seven Springs	3982.10	350.85	8700	x	64
42	Seven Springs	3981.90	352.10	8840	x	
41	Valle San Antonio	3981.60	353.47	8860	x	
31	Seven Springs	3980.93	353.05	8560	x	
33	Seven Springs	3980.98	353.08	8620	x	
210	Seven Springs	3979.45	352.20	8350		64
49	Seven Springs	3980.80	352.47	8800	x	

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
64	Seven Springs	3980.57	349.50	8460	x	
76	Seven Springs	3980.23	348.10	8460	x	
77	Seven Springs	3980.94	347.40	8480	x	
48	Seven Springs	3979.10	350.85	8720	x	
47	Seven Springs	3978.00	350.93	8660	x	
46	Seven Springs	3976.72	350.10	8640	x	
45	Seven Springs	3976.72	350.10	8640	x	
73, 208	Seven Springs	3978.20	349.25	8480	x	74
84, 232	Seven Springs	3978.78	346.25	8250	x	65
75	Seven Springs	3979.20	345.40	8350	x	
85	Seven Springs	3979.39	345.18	8420	x	
74	Seven Springs	3977.47	346.52	8380	x	
70, 207	Seven Springs	3976.45	346.28	8160	x	70
67, 206	Seven Springs	3973.70	347.30	8140	x	45
66	Seven Springs	3973.10	345.26	7950	x	
69	Seven Springs	3974.13	345.36	7860	x	
82, 205	Seven Springs	3972.47	344.30	7820	x	55
81	Seven Springs	3971.87	342.91	8040	x	

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
80	Seven Springs	3971.85	342.78	8000	x	
79	Seven Springs	3971.92	347.68	8220	x	68
Area A - Southern part						
91	Jemez Springs	3970.30	350.20	8340	x	
204	Jemez Springs	3969.37	350.80	8350		69
8	Jemez Springs	3969.12	351.19	8500	x	
86	Jemez Springs	3967.10	344.78	8220	x	
234	Jemez Springs	3967.41	345.13	8220		108
98	Jemez Springs	3963.97	353.05	8400	x	
227	Redondo Peak	3963.95	353.50	8320		103
97	Redondo Peak	3962.90	354.10	8400	x	
180	Redondo Peak	3961.41	353.80	8300	x	48
181, 226	Redondo Peak	3961.03	354.75	8400	x	54
94	Jemez Springs	3964.59	347.33	7940	x	
228	Jemez Springs	3964.52	347.35	7860		158
96	Jemez Springs	3963.00	346.43	7480	x	

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
182	Jemez Springs	3958.43	352.81	7880	x	35
101	Bear Springs Peak	3956.89	353.43	7440	x	
100	Bear Springs Peak	3956.78	353.47	7560	x	
99	Bear Springs Peak	3956.78	353.45	7500	x	
183	Ponderosa	3955.63	352.78	7460	x	34
87	Jemez Springs	3961.90	343.51	7590	x	
190	Jemez Springs	3960.00	343.40	7200	x	64
148	Jemez Springs	3958.61	342.60	6980	x	
174	San Miguel Mtn	3959.15	339.05	7160	x	70
175	Ponderosa	3955.50	344.48	6680	x	
230	Ponderosa	3955.08	344.56	6580		95
179	Ponderosa	3955.03	348.47	6960	x	
177, 229	Ponderosa	3954.57	349.23	7060	x	177
178	Ponderosa	3953.70	349.20	6840	x	
103	Ponderosa	3951.09	350.40	6960	x	

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
104	Ponderosa	3450.95	350.33	6890	x	
102	Ponderosa	3951.02	350.45	6960	x	
176	Ponderosa	3951.80	347.25	6700	x	42

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
Area A - northern part			
62	100	-18	Upper Calaveras Canyon: northeast side of road; base of massive craggy crops
60	120	+85	Upper Calveras Canyon; 0.4 km north of road
54	120	-24	In woods near edge of field, north of 8848 mark
55	120	-42	North side of woods, above welded zone
56	120	+90	Upper Calaveras Canyon; base of craggy crops overlying welded zone
57, 233	120	+90	Upper Calaveras Canyon; base of craggy crops overlying welded zone
50	128	-13	230 m NW of road; good flow banding in massive unwelded crops
44, 209	137	+106	Base of crag, southwest side of road, at point marked 8695
42	120	-36	North side of road (Route 144)
41	120	-12	West edge quad; crag west of road (Route 144) at bend
31	120	+18	North of road, clast-rich, coarse-pumice AFT
33	120	+36	Some flattening of pumice in AFT
210	140	+20	Non-welded light colored crops west side of road
49	120	-30	Crag in woods, west side of rim road, Route 144
64	152	-42	Base of crag on steep east facing slope, 80 m above volley floor, Cebolla Canyon
76	110	-57	Tributory to Calaveras Canyon
77	110	-51	Massive, clast-rich, crude columns; Calaveras Canyon
48	60	+59	Head of Oat Canyon

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
47	152	+60	East of rim road (Route 144), upper part of Valles Caldera scarp
46	45	+12	Head of Bear Canyon, east side of road (Route 144), 0.4 km west of Valles Caldera scarp
45	45	+12	As above; 15 meters south of Sta. 46
73, 208	137	+126	Above bench on spur, north of jct. of Oat and Cabolla Canyons
84, 232	130	+50	Jct. Calaveras & Telephone Canyon Spur 0.2 km NE of BM 8151
75	90	-45	Telephone Canyon; north side of road; massive, lightly welded
85	76	-24	Southwest side of Rt. 126 Readings from area 7 x 22 m
74	152	-5	Above steep slope north of State Fish Hatchery
70, 207	97	+67	Spur at jct of Bear and Cabolla Canyons
67, 206	120	-33	Barley Canyon; crops at road level, north side of road
66	120	+83	Barley Canyon; north of road small crag forming bench; 10 m above welded zone
69	152	+91	Clast-rich massive crag 12 m above road at Seven Springs
82, 205	90	+54	Pumice-rich, clast-poor atypical Qbo in reentrant NW of Fenton Lake
81	90	+73	15 m above welded zone, in massive crudely jointed Qbo
80	90	+61	Same unit as above, 140 m west of Sta. 81
79	90	+70	At north side of Route 126. From upper flow unit 6 m above road level; PFO from 50 m - long zone

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
Area A - southern part			
91	180	+103	Tent Rocks. Clast-rich Qbo below tall tents
204	48	+30	Uppermost tents at head of Wildcat Canyon; pre-Qbo flows beneath
8	90	-60	Very coarse Qbo; thickness & stratigraphic position poorly estimated
86	90	+67	Canon Cebolita; north side of road, 0.72 km north of Cebollita Spring
234	90	+67	Canon Cebolita, north side of road, 1.2 km north of Cebolita Spring
98	90	-10 est.	Bouldery crops 0.3 km NW of sharp bend in Route 135; clast-rich moderately welded; some thin surge layers
227	90	+70	Massive crops, coarse Qbo Some lithic swarms 2 m thick
97	30	+25	Bouldery crops including at least one surge layer
180	40	+39	North side shallow tributory, 0.18 km east of elevation point 8384, moderately recrystallized
181, 226	30?	+20?	North side of Upper Paliza Canyon
94	77	+70	Qbo tents above outcrops of porphyritic basalt breccia, west side San Diego Canyon
228	77	+46	Qbo tents above outcrops of porphyritic basalt breccia west side San Diego Canyon
96	100	+18	South side San Diego Canyon; massive pumice-rich zone
182	68	-38	Upper San Juan Canyon; massive, clast-rich,somewhat welded

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
101	60	-40	Three stations in one small area of clast-rich, non-welded Qbo, San Juan Canyon
100	60	-3	As above
99	60	-20	As above
183	90	+80	West face of San Juan Canyon
87			Readings from Qbo tents beneath lahar & surge deposits
190	55	+10	Massive crops undercut at base; 45 m interval appears to be single flow unit
148	60	+10	Massive crops at stream level, Virgin Canyon
174	40	+10	South of access road on west spur, Holiday mesa; indurated gray-brown lithic-rich Qbo
175	120	+30	West slope, San Diego Canyon; Qbo pinches out to south
230	120	+1	From lower part of AFT which has pumice swarm at base; underlain by conglomerate which was sampled for comparison
177, 229	45	+10	East wall, Canon de la Canada; near base of massive high crops, indurated at top
178			East side of western finger, San Juan Mesa
103	60	-10	Coarse poorly welded, clast-rich Qbo. Stratigraphic position and thickness poorly known
104	60	-30	Coarse poorly welded, clast-rich Qbo. Stratigraphic position and thickness poorly known

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
102	60	-10	Coarse poorly welded, clast-rich Qbo. Stratigraphic position and thickness poorly known
176	44	+8	Mesa de los Palomares; massive clast-rich Qbo upon sandstone; basal 2 m has no coarse pumices nor clasts

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
Area B (northwest to southeast)						
109	Bland	3964.15	373.26	7740	x	
108	Bland	3964.24	373.28	7680	x	
231	Bland	3964.20	373.27	7700		73
112	Bland	3962.39	370.70	8040	x	
211	Bland	3962.28	370.80	8060		90
113	Bland	3960.81	370.06	7600	x	
114	Bland	3961.66	369.18	7960	x	
222	Redondo Peak	3959.00	363.68	8820	x	153
224	Bear Springs Peak	3956.00	362.34	8360		109
225	Bear Springs Peak	3955.91	362.34	8220	x	148
221	Bland	3959.07	367.38	8100		73
184	Bland	3958.52	368.04	7560	x	
220	Bland	3957.85	368.69	7580		93
105	Canada	3952.41	371.59	6620	x	
185	Canada	3950.89	372.18	6400	x	140

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
213	Canada	3950.89	372.18	6400		80
212	Cochiti	3951.40	376.20	5980		80
106	Cochiti	3950.19	377.52	5900	x	
107	Cochiti	3950.22	377.50	5900	x	
186	Canada	3949.38	375.48	5900	x	
235	Cochiti	3951.35	380.12	5640	x	180
189	Cochiti	3956.10	382.85	5680	x	
188, 243	Frijoles	3961.60	377.91	6920	x	84
110, 201, 236	Frijoles	3961.06	386.42	6300	xx	129

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
Area B (northwest to southeast)			
109	60	+48	Lower part of massive high tents; Canon de los Frijoles
108	60	+30	Lowest Qbo; potholes; Canon de los Frijoles
231	60	+36	Poor control on stratigraphic position; upper Canon de los Frijoles
112	100	+5?	West slope, east branch of Spruce Canon, base of large tents
211	100	+10	East slope, east fork of Spruce Canon, at base of 30-m high cliffs
113	213	-61	"Tent Rock" at junction of Spruce and Pine Canyons.
114	152	+109	Pines Canyon; northeast of Tent Rock Ranch
222	100?	+90?	Small cap of Qbo on spur west of Peralta Canon; punky lithic-rich Qbo underlain by welded zone
224	82	+58	Massive crystal-rich and lithic-rich Qbo
225	83	+6	Base of crude tents Lithics 3-5%
221	53	-10	Coarse, lithic-rich Qbo, east slope Bland Canyon
184			Road crop Medio dia canyon not shown on Smith, Bailey, Ross (1970) map
220			Road crop, Medio dia Canyon. Typical lithic-rich Qbo; not shown on geologic map.
105	60	-0.5	Lower Bland Canyon. In upper most AFT underlying 5 cm ash layer.

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
185	60	+3	Both 185 & 213 are in relatively lithic-poor AFT underlain by a Plinian pumice layer and overlain by laminated air-fall deposits.
213	60	+1	Below this AFT is 0.5 m coarse Plinian pumice layer overlying coarse lithic-rich AFT
212	23	+5	Low crops east of Eagle Canyon bottom
106	60	+30	Qbo tents and weathered massive crops
107	60	+30	50 meters northwest of Sta. 106 same general occurrence
186	80	+30	Road crop, west side of Rt. 268
235	60	+6	From basal part of 30 m AFT underlain by a sequence of Plinian pumice and AFT layers. Lower Medio Canyon.
189	60	+12	Lower Alamo Canyon
188, 243	60	+12	Upper Alamo Canyon
110, 201, 236	16	-4	Road crop, north side Loop 4; Pale brown Qbo (sampled) overlain by Tsankawi white pumice layer

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
Area C - north to south						
120	Guaje Mtn	3983.65	385.98	7080	x	
37	Guaje Mtn	3983.96	385.53	7110	x	
36	Guaje Mtn	3983.85	385.68	7090	x	
219	Puye	3981.84	387.40	7000		66
38, 149, 218	Puye	3980.29	389.50	6760	xx	75
38b	Puye	3980.29	389.50	6760	x	
146	Puye	3980.35	388.87	6840	x	
147	Puye	3979.47	388.10	6840	x	
124, 217	Puye	3978.80	390.48	6700	x	69
138	Puye	3976.87	389.49	6800	x	
139	Puye	3976.82	389.49	6770	x	
140	Puye	3976.45	391.33	6510	x	
202	Puye	3975.39	391.49	6500		33
144	Puye	3975.51	389.88	6660	x	
125	Puye	3975.50	389.73	6660	x	

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
142	Puye	3974.82	398.23	6400	x	
143	Puye	3974.62	393.06	6370	x	
40, 203	Puye	3974.63	391.55	6500	x	36
129,215	Puye	3974.20	389.00		x	71
127	Puye	3973.35	389.49	6600	x	
128	Puye	3972.86	389.12	6600	x	
116	Guaje Mtn	3972.84	386.28	6810	x	
151	Guaje Mtn	3971.68	386.00	6655	x	
152	Guaje Mtn	3971.68	386.10	6625	x	
214	Guaje Mtn	3971.73	386.10	6640		67
115	Puye	3971.47	387.25	6600	x	
133	Puye	3970.96	390.28	6430	x	
132	Puye	3970.72	389.93	6460	x	
135, 242	Puye	3970.78	390.48	6440	x	197
136	White Rock	3970.31	391.75	6320	x	
117	White Rock	3969.85	391.55	6340	x	

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
200, 216	White Rock	3969.93	391.45	6340	x	93
130	White Rock	3969.16	393.48	6260	x	

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
Area C - north to south			
120	15	+12	Road gutter, east side of paved road; punky AFT
37	21	+20.5	Bank of shallow stream valley
36	15	+14	Soft AFT 15 m west of paved road
219	15	+7	Grab samples from freshly bulldozed road banks
38, 149, 218	30	+1 to +3	General pumice mine; readings & specimens from AFT above coarse pumice swarm at base of Otowi
38b	30	in Guaje	Same localty as 38, 149, 218. From AFT within laminated lapilli tuff within upper Guaje and 0.5 m below base of Otowi AFT
146	30	+10	Lithic-rich Qbo
147	30±	-7	Garcia Canyon; overlain by spectacular Tsankawi crossbedded coarse surge deposits
124, 217	30	+6	Chupaderas Canyon. PFO from clast-poor AFT
138	23	-2	Brown AFT directly beneath 10 m sequence of Tsankawi, coarse lapilli tuff, fine grained white ash etc.
139	23	+12	Clast-rich massive non-welded Qbo
140	40	-24	Canada de los Naries; well developed tents in Qbo stratigraphic position poorly known
202	40	+4.5	Samples from base of well-formed tents
144	17	+0.5	Charred trees in coarse pumice swarm 0.5 meters above base of AFT. COPAR Pumice Mine
125	17	+0.5	Abandoned pit west of COPAR Pumice Mine

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
142	40	+7	Large breached tent
143	30	3	Large breached tents. Thickness not well known.
40, 203	26	+0.5 to +6	White Eagle Pumice Mine (abondoned) PFO at 0.5 m, lithics at 6 m above layered lapilli (Guaje)
129, 215	23	+3	Lithics from lag zone 3 m above Guaje; narrow mesa south of Rendija Canyon.
127	27	+15	Coarse clast-rich Qbo in gullies; midway between Rendija and Barrancas Canyons.
128	27	+5	5 m below tents; clast-rich but finer grained than Sta. 127
116	15	-1	Bayo Canyon, clast-poor AFT
151	26	-10	Upper Pueblo Canyon; overlain by well defined Tsankawi air-fall and ash-flow sequence.
152	26	-18	As above
214	26	-6	As above
115	20	+< 5	South slope Kwage Mesa, Pueblo Canyon; readings from base of tent
133	40	+5 to +10	South side Bayo Canyon; well-formed tents; Tsankawi above and Guaje below both well exposed
132	40	+12	Pueblo Canyon; tents below Tsankawi
135, 242	50	+0.5 (PFO) +5 (lithics)	Tributory between Bayo and Pueblo Canyons; Guaje and Puye lithics sampled here for comparison
136	40	+10	Bayo Canyon, above large slumps; poor quality readings

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
117	50	+10	Soft, non-welded Qbo above turn-out and popular road cut (Rt. 4) exposing Guaje and underlying basalt (Qtb)
200, 216	50	+10	Same as above; Stas. 200, 216 in gully 150 m NW of Sta. 117
130	48	-5	Cliff south of Los Alamos Canyon; beneath well-defined Tsankawi

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
Area D (north to south)						
163, 244	Canones	4003.00	370.55	7260	x	93
159, 238	Canones	4000.64	369.73	7400	x	82
162	Canones	3999.47	368.88	7520	x	
160	Canones	3999.64	366.18	8400	x	
161	Canones	3999.00	366.60	7800	x	
164	Polvadera Peak	3997.84	365.22	8020	x	
155	Polvadera Peak	3996.23	369.64	8190	x	
154	Polvadera Peak	3993.58	370.45	8320	x	
153, 237	Polvadera Peak	3993.97	370.31	8460	x	146

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
Area D - north to south			
163, 244	31	-15	Canones Creek; lithics from large natural alcove in gray upper half of Qbo; lower half is white. Clasts in underlying conglomerate identified for comparison
159, 238	120	+30	Canones Creek; thickness not known; AFT is gray in upper part and white below +30; Otowi underlain by 16 m of conglomerate
162	120	+6	Canones Creek; from top to bottom: AFT, thin air-fall deposit, conglomerate
160	120	+<30	Tributory to Canones Creek
161	120	+1	Canones Creek. Massive Qbo with many clasts of dacite near base
164	120?	+30	Tributory to Canones Creek; thickness and stratigraphic position not well known
155	60	-12	West Fork, Polvadera Creek; Brownish Qbo overlain by channel fill of bedded air-fall pumice
154	80	-30	Clasts include coarsely porphyritic Tt
153, 237	80	-12	Lithics from base of large tent at 8400

Station Number	Quadrangle	Coordinates on 1000 m UTM grid north	east	Elevation (feet)	PFO	Lithics (number counted)
Area E (north to south)						
168, 239	Arroyo del Agua	4001.90	353.39	7680	x	123
173	Jarosa	3998.58	352.60	7970	x	
167	Jarosa	3997.90	350.59	7960	x	36
165	Jarosa	3997.88	352.12	8070	x	74
166	Jarosa	3997.75	352.91	8070	x	
172	Jarosa	3993.82	352.75	8500	x	
241	Jarosa	3993.41	352.74	8460		130
170	Jarosa	3990.70	352.75	8570	x	
171	Jarosa	3990.68	352.83	8670	x	
240	Jarosa	3990.69	352.80	8620		99

Station Number	Minimum thickness of AFT in meters	Height above base (+), below top (-) in meters	Remarks
Area E - north to south			
168, 239	no information		Loma Coyote
173	30	+2	North flank Mesa Pinabetosa
167	30	+18	Northern flank, Mesa Pinabetosa; slightly welded fine-grained Qbo
165	30	+20	North flank, Mesa Pinabetosa clast-rich, light brown Qbo
166	30	+20	North flank, Mesa Pinabetosa; vapor phase alteration of clast-rich Qbo
172	60	+32	East slope Mesa Pinabetosa at its south end; vapor phase altered Qbo
241	60	+20	Vapor phase alteration; $<1\%$ lithics
170	75	+30	Upper Coyote Canyon; large crag with vapor phase alteration and lithification
171	75	+60	30 meters above Sta. 170, same locale
240	75	+45	Sampling over 12 meter vertical interval between Stas. 170 and 171