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## **Grave Reminders : Comparing Mycenaean tomb building with labour and memory**

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## Appendix 1. Labour rates

Table A1.1a. Extraction rates									
Context		Material		Tool			Rate		
ID	Stamina	kg/m <sup>3</sup>	Type	Cutting Surface	Handle Length	Description	ph/m <sup>3</sup>	m <sup>3</sup> /ph	kg/ph
9d	conditioned	2711	marble	metal	unsp	19th C. masonry kit	125.00	0.008	21.7
9f	conditioned	2711	marble	metal	unsp	16th C. masonry kit	90.00	0.011	30.1
14c	average	2500	limestone	stone, copper alloy	unsp	ancient Egyptian kit	50.00	0.020	50.0
14b	maximum	2500	limestone	stone, copper alloy	unsp	ancient Egyptian kit	30.30	0.033	82.5
6c	supervised	1786	chalk	bone	short	antler pick	13.57	0.074	131.6
13b	average	1500	tuff	unsp (stone?)	unsp (short?)	unspecified	12.20	0.082	123.0
14a	average	2500	limestone	iron	unsp	modern	11.24	0.089	222.5
6g	average	1600	turf	steel	long	modern	11.11	0.090	144.0
6d	unsupervised	1786	chalk	bone	short	antler pick	10.15	0.099	175.9
15h	average	2000	clay	unsp	unsp	unspecified	10.00	0.100	200.0
1a	average	1580	silt loam	stone	short	chert hoe	8.85	0.113	178.5
6i	average	1700	turf and soil	steel	long	modern	8.33	0.120	204.0
6h	average	1600	turf	steel	long	modern	7.69	0.130	221.0
6e	average	1786	chalk	bone	short	antler pick	7.14	0.140	250.0
2a	average	1795	chalk	bone	short	antler pick	7.04	0.142	254.9
1b	average	1580	silt loam	stone	short	chert hoe	6.67	0.150	237.0
1c	conditioned	1580	silt loam	stone	short	chert hoe	5.85	0.171	270.2
6j	average	1700	turf and soil	steel	long	modern	5.56	0.180	306.0
3a	conditioned	1400	unspecified	unsp (steel?)	unsp (long?)	unspecified	5.26	0.190	266.0
1d	average	1580	silt loam	stone	short	chert hoe	5.24	0.191	301.8
1e	conditioned	1580	silt loam	stone	short	chert hoe	4.90	0.204	322.3
4a	conditioned	1400	unspecified	unsp	unsp	unspecified	4.44	0.225	315.0
8c	conditioned	1500	tuff	wood	long	hardwood post	4.35	0.230	345.0
2b	maximum	1795	chalk	bone	short	antler pick	4.26	0.235	421.8
1f	conditioned	1580	silt loam	stone	short	chert hoe	4.00	0.250	395.0
2c	maximum	1795	chalk	bone	short	antler pick	3.92	0.255	457.7
5a	average	1580	silt loam	stone	short	chert hoe	3.45	0.290	458.2
3b	conditioned	1400	unspecified	unsp (wood?)	unsp (long?)	unspecified	3.03	0.330	462.0
6a	average	1795	chalk	bone	short	antler pick	3.03	0.330	592.4
1g	conditioned	1580	silt loam	stone	short	chert hoe	2.72	0.367	579.9
1h	conditioned	1580	silt loam	stone	short	chert hoe	2.71	0.369	583.0
6b	maximum	1795	chalk	bone	short	antler pick	2.67	0.375	673.1
6f	average	1786	chalk	steel	long	modern pick/shovel	2.38	0.420	750.0
7a	conditioned	1400	unspecified	steel	variable	pre-modern industrial	2.12	0.471	659.4
8a	conditioned	1300	sandy loam	wood	long	digging stick	1.92	0.520	676.0
9a	conditioned	1800	clay	steel	variable	pre-modern industrial	1.81	0.554	996.5
9b	conditioned	1800	clay	steel	variable	pre-modern industrial	1.72	0.583	1049.4
5b	conditioned	1800	clay	steel	variable	modern	1.67	0.600	1080.0
8d	conditioned	1500	tuff	iron	short	crowbar	1.49	0.670	1005.0
7b	conditioned	1400	unspecified	steel	variable	pre-modern industrial	1.42	0.706	988.4
5d	average	700	wood	stone	short	stone handaxe	0.70	1.429	1000.0
8b	conditioned	1300	sandy loam	steel	long	modern	0.69	1.440	1872.0
5c	conditioned	1280	loam	steel	variable	modern	0.50	2.000	2560.0
10a	conditioned	1600	turf	steel	long	modern	0.50	2.000	3200.0

Table A1.1b. Transportation rates											
Context		Material		Travel			Load	Portage	Rate		
ID	Stamina	kg/m <sup>3</sup>	Type	To source (km)	Round trips per hour	Speed (km/h)	kg	Method	ph/m <sup>3</sup>	m <sup>3</sup> /ph	kg/ph
12a	conditioned	2711	marble	35.40	0.02	1.2	500	drawn, single yoke (ox)	271.10	0.004	10.0
9i-a	conditioned	2000	unsp	10.00	0.25	5.0	55	pack, donkey	145.45	0.007	13.8
9i-b	conditioned	2000	unsp	5.00	0.50	5.0	55	pack, donkey	72.73	0.014	27.5
9j-a	conditioned	2000	unsp	10.00	0.25	5.0	120	pack, mule	66.67	0.015	30.0
9l-a	conditioned	2000	unsp	10.00	0.08	1.7	400	drawn, single yoke (ox)	59.88	0.017	33.4
9k	maximum	2000	unsp	10.00	0.25	5.0	135	pack, mule	59.26	0.017	33.8
9m	maximum	2000	unsp	10.00	0.08	1.7	640	drawn, single yoke (ox)	37.43	0.027	53.4
9j-b	conditioned	2000	unsp	5.00	0.50	5.0	120	pack, mule	33.33	0.030	60.0
11a	conditioned	2000	unsp	0.55	3.00	3.3	22	basketing (unsp)	30.30	0.033	66.0
8j	conditioned	1500	tuff	1.00	2.20	4.4	23	tumpline	30.00	0.033	50.0
9l-b	conditioned	2000	unsp	5.00	0.17	1.7	400	drawn, single yoke (ox)	29.94	0.033	66.8
9h	conditioned	2000	unsp	1.00	2.50	5.0	50	basketing (unsp)	16.00	0.063	125.0
8h	conditioned	1500	tuff	0.50	4.00	4.0	25	tumpline	15.00	0.067	100.0
8i	conditioned	1500	tuff	0.75	3.00	4.5	34	tumpline	14.51	0.069	103.4
8g	conditioned	1500	tuff	0.25	6.80	3.4	28	head balanced	7.89	0.127	190.0
9c	conditioned	1800	clay	0.25	5.00	2.5	50	basketing (unsp)	7.69	0.130	234.0
5e	average	600	wood	1.00	1.70	3.4	100	team (6) shoulder carry	3.50	0.286	171.4
8f	conditioned	1310	sandy loam	0.10	23.20	4.6	20	handheld container	2.86	0.350	458.5
8e	conditioned	1310	sandy loam	0.05	41.20	4.1	20	handheld container	1.59	0.630	825.3

Table A1.1c. Manufacturing and finishing rates								
Context		Material		Process	Tool	Rate		
ID	Stamina	kg/m <sup>3</sup>	Type	Description	Description	ph/m <sup>3</sup>	m <sup>3</sup> /ph	kg/ph
14d	average	2750	granite	percussion shaping granite (blocks)	stone and alloy	2777.78	0.00036	1.0
14f	average	2750	granite	channelling granite (obelisks)	ancient Egyptian kit	1923.08	0.00052	1.4
14e	average	2750	granite	percussion shaping granite (blocks)	stone and alloy	1785.71	0.00056	1.5
15a	average	2700	stone	sawing hard stones ( <i>pierres dures</i> )	metal alloy	1000.00	0.00100	2.7
9g	conditioned	2711	marble	shaping marble (blocks)	16th C. masonry kit	180.00	0.00556	15.1
15j	conditioned	2500	stone	channelling <i>poros</i> and sandstone	stone and alloy	101.00	0.00990	24.8
13a	conditioned	1500	tuff	dressing porous volcanic masonry	unspecified	90.91	0.01100	16.5
9e	conditioned	2711	marble	shaping marble (blocks)	19th C. masonry kit	75.00	0.01333	36.1
15c	average	2700	stone	percussion shaping stone (blocks)	stone and alloy	61.73	0.01620	43.7
15b	average	2960	gypsum	sawing gypsum slabs ( <i>dalles gypse</i> )	metal alloy	24.39	0.04100	121.4
15d	average	2000	brick	brick wall construction	stone and alloy	9.52	0.10500	210.0
15f	average	2000	brick	mixing bricks	stone and alloy	7.60	0.13150	263.0
4b	conditioned	1730	mudbrick	digging, mixing, and shaping bricks	ca. 2100-1600 BC kit	6.67	0.15000	259.5
15i	average	2700	rubble	rough manufacture (masonry)	stone and alloy	6.17	0.16200	437.4
15e	average	2100	mortar	mixing mortar	stone and alloy	4.35	0.23000	483.0
15g	average	2000	brick	moulding bricks	stone and alloy	3.03	0.33000	660.0
5f	average	700	wood	setting post upright (palisade)	stone hoe/handaxe	2.00	0.50000	350.0



Table A1.2. Supplement for context IDS

ID	Reference	Method	Material De- scription	Tool Description	Original Rate
1a	Milner et al. 2010:109	experimental	compact silt to clay loam, vari- able moisture and occasional rocks	Mill Creek chert hoe replica, hafted on short wooden handle with raw- hide, scooping assisted by white-tailed deer scapula and excavator's hands	0,202 m³ in 1,78 hr
1b					0,609 m3 in 4,05 hr
1c					0,171 m³ in 1,00 hr
1d					0,131 m³ in 0,68 hr
1e					0,085 m³ in 0,42 hr
1f					0,250 m³ in 1,00 hr
1g					0,367 m³ in 1,00 hr
1h					0,369 m³ in 1,00 hr
2a	Ashbee and Jewell 1998:491	experimental	chalk	antler pick, scapula shovel, woven basket	5 cwt/m-h, 1 cwt = 1 ft³
2b					8,3 cwt/m-h, 1 cwt = 1 ft³, assisted basketing not counted
2c	Ashbee and Jewell 1998:491, citing Pitt Rivers 1875	experimental	chalk	antler pick	9 cwt/m-h, 1 cwt = 1 ft³
3a	Squatriti 2002:41, citing Vulpe 1957	ethnographic	unspecified	unspecified	1,5 m³ in 8 hr
3b	Squatriti 2002:31, citing Hofmann 1965 and the Royal Frankish Annals	historical	unspecified	unspecified	750,000 m³, 6,000 workers, 55 days
4a	Ristvet 2007:199, citing tablet M.288 in Charpin 1993:196	historical	unspecified	unspecified	2.25 m³/m-d
4b	Ristvet 2007:200, citing Robson 1999	historical	Old Babylonian period mud- brick wall	unspecified	1.5 m³/m-d, 2.55 litres of barley/m-d
5a	Hammerstedt 2005:46	experimental	root-penetrat- ed, compact silty loam	Mill Creek chert hoe replica, metal bucket	0,29 m³ in 1 hr
5b	Hammerstedt 2005:50, citing ECAFE 1957	ethnographic	dry hard clay	modern hand tools	0,334 p-d per m³
5c			common soil		0,1 p-d per m³
5d	Hammerstedt 2005:59	experimental	tree cutting (30cm diam- eter)	stone tools	0.7 ph/tree, t=exp(-1.766058)d^1.622969 where t is time and d is diameter in cm
5e	Hammerstedt 2005:63– 64		post transport		25 min. to carry post 1 km (teams of 4 to 6)
5f			post setting		30 min. to set post (teams of 4 to 6)
6a	Coles 1973:74, citing Pitt Rivers 1875	experimental	chalk	antler pick	1 m³ in 1,5 hr for 2 men
6b					9 m³ in 12 hr for 2 men
6c	Coles 1973:73, citing Jewell 1963	experimental	chalk	red deer antler picks, ox and horse scapulae, wicker baskets	1543 ph, including 388 ph among 4 super- visors for 113.75 m³ (203,125 kg). Rate with supervision (0.0737 m³/ph or 131.61 kg/ph), without supervision (0.0985 m³/ph or 175.89 kg/ph)
6d				modern steel picks, shovels and buckets	750 kg/ph (50 kg = 0.028 m³)
6e					
6f					
6g	Coles 1973:81, citing Hobley 1967	experimental	turf	modern metal tools	4.5 - 6.5 turfs (32 - 34 kg/turf)/m-h, 144 - 221 kg/m-h, prison labour
6h			turf and soil		840 - 1200 ph for 7600 turfs (243,200 - 258,400 kg), turf cutting and total cost for Lunt fort (190,000 turfs, 6.46 million kg), plus 40 - 46 m³ earth fill
6i					
6j					

Table A1.2. Supplement for context IDS

ID	Reference	Method	Material Description	Tool Description	Original Rate
7a	Bachrach 2005:270, citing Bachrach 1993:65-72	ethnographic	unspecified	19th century hand tools	400,000 m <sup>3</sup> in 850,000 m-h
7b	Bachrach 2005:270, citing Bachrach 1993:65-72	ethnographic	unspecified	19th century hand tools	600,000 m <sup>3</sup> in 850,000 m-h
8a	Erasmus 1965:285–287	experimental	Las Bocas sandy soil	digging stick	2.6 m <sup>3</sup> /m-d, m-d = 5 hr
8b			Las Bocas sandy soil	modern shovel	7,2 m <sup>3</sup> /m-d, m-d = 5 hr
8c			tuff (porous rock from consolidated volcanic ash)	hardwood post	1700 kg per 5-hour man day, 1500 kg per m <sup>3</sup>
8d			tuff (porous rock from consolidated volcanic ash)	iron crowbar	5 tons of rock over an area of 30 sq. m in 5 hours
8e			Las Bocas sandy soil	5-gallon container	carrying soil 50 m, average load 0.02 m <sup>3</sup> (20 kg)
8f			Las Bocas sandy soil	5-gallon container	carrying soil 100 m, average load 0.02 m <sup>3</sup> (20 kg)
8g			Las Bocas sandy soil	head balanced	carrying rock 250 m, average load 28 kg, 6.8 trips per hour
8h			tuff (porous rock from consolidated volcanic ash)	tumpline	carrying rock 500 m, average load 25 kg, 4 trips per hour
8i			tuff (porous rock from consolidated volcanic ash)	tumpline	carrying rock 750 m, average load 34 kg, 3 trips per hour
8j			tuff (porous rock from consolidated volcanic ash)	tumpline	carrying rock 1 km, average load 23 kg, 2.2 trips per hour
9a	DeLaine 1997:116–118, citing Pegoretti 1865	historical	clay for brick-making	19th century hand tools	93 m <sup>3</sup> in 14 m-d
9b			clay for brick-making		49 m <sup>3</sup> in 7 m-d
9c			loading and carrying clay	metal tools	1.58 m <sup>3</sup> /m-d, 50 kg load averaged from Roman 2-modius basket (0.026 m <sup>3</sup> ) and 19th C. builder's basket (0.03 m <sup>3</sup> )
9d			marble quarrying		4 days for one mason and two assistants, or 12 md per m <sup>3</sup>
9e			squaring of marble block		7.5 days for one stonecutter
9f			Carrara quarrying		3 md per carrata (1/3 m <sup>3</sup> )
9g			Carrara squaring + quarrying		9 md per carrata (1/3 m <sup>3</sup> )
9h			human portage average	basketing, likely using tumplines	50 kg at 5 km/h
9i			pack transport (donkey)	small donkey (unsp)	55 kg at 5 km/h
9j			pack transport (mule)	large mule (low range)	120 kg at 5 km/h
9k	DeLaine 1997:98,107–108	historical	pack transport (mule)	large mule (high range)	135 kg at 5 km/h
9l			drawn transport (ox)	single yoke oxcart (low range)	400 kg at 1.67 km/h
9m			drawn transport (ox)	single yoke oxcart (high range)	640 kg at 1.67 km/h
10a	Geddes 2004, citing Souness 1985	ethnographic	cutting turf for roofing	metal tools	200 turfs per md, 1000 turfs needed for roof with average surface area of 100 sq. m, 20 m <sup>3</sup> /pd
11a	Aaberg and Bonsignore 1975:47,50–57	ethnographic	earthmoving with local soils	basketing, likely using tumplines	22 kg (0.011 m <sup>3</sup> ) loads, 10-minute walk of 600 yards
12a	Burford 1969:189	historical	Pentelic marble to Eleusis	ox-drawn cart/wagon, single yoke	500 kg load limit, 22-mile trip in 2.5 to 3 days

Table A1.2. Supplement for context IDS					
ID	Reference	Method	Material Description	Tool Description	Original Rate
13a	Abrams and McCurdy 2019:6–13, citing Abrams 1994	experimental	dressing volcanic tuff blocks	unspecified (stone tools?)	0.086 m <sup>3</sup> /p-d (8-hour workday)
13b			quarrying tuff (Honduras)		0.41 m <sup>3</sup> /p-d (5-hour workday)
14a	de Haan 2009:3, citing Lehner 1997:207	experimental	quarrying limestone blocks	iron tools (NOVA experiment)	0.089 m <sup>3</sup> /man-hour
14b				stone and copper alloy tools (estimated)	0.033 m <sup>3</sup> /man-hour
14c			quarrying granite blocks	stone tools	0.02 m <sup>3</sup> /man-hour, base case
14d					1800 cm <sup>3</sup> in five hours, or 0.00036 m <sup>3</sup> /man-hour
14e	de Haan 2009:3, citing Engelbach 1923:48	historical	channelling granite obelisk	stone tools	563 cm <sup>3</sup> in one hour, or 0.00056 m <sup>3</sup> /man-hour
14f	de Haan 2009:3, citing Arnold 1991:40 and Goyon et al. 2004:164–166				0.00052 m <sup>3</sup> /man-hour, estimated from Hatshepsut obelisk (7-month completion) and unfinished Aswan obelisk
15a	Devolder 2013:43	compilation	sawing hard stone	(hammer)stone and metal alloy tools	0.001 m <sup>2</sup> per p-h
15b			sawing gypsum slabs		0.041 m <sup>2</sup> per p-h
15c			shaping stone blocks by direct or indirect percussion		0.0162 m <sup>3</sup> per p-h
15d			brick wall construction		0.105 m <sup>3</sup> per p-h
15e			mixing of mortar		0.23 m <sup>3</sup> per p-h
15f			mixing bricks		0.1315 m <sup>3</sup> per p-h
15g			moulding bricks		0.33 m <sup>3</sup> per p-h
15h			clay for brick-making		0.1 m <sup>3</sup> per p-h
15i			rough rubble masonry manufacture		0.162 m <sup>3</sup> per p-h
15j			channelling cut stones		1 m <sup>3</sup> per 101 p-h

## Appendix 2. Other tombs

*Portes Chamber Tomb 1.* Along the eastern edge of the saddle bridging the hill and south-eastern ridge that hosts the majority of tombs at the cemetery, PT1 is mapped upslope and adjacent to the south of the roof of PT2. With no easy access from PT2 or our network of fixed points, PT1 was omitted from this study. According to one of the park's information placards (Kolonas et al. 2002: 1), PT1 is the smallest chamber tomb at the cemetery and was likely meant for a child. No remains were recovered here, but its proximity to the LHIIIA–C PT2, PT24, and PT27 suggests a close association with these.

*Portes Chamber Tomb 2.* The model for PT2 included 294 photos and 12 photopoint markers, many of which were linked with the failed model of PT24/27.

*Portes Chamber Tombs 4–6.* PT4, PT5, and PT6 are the easternmost of the mapped tombs at the cemetery. Lying outside the path and railing along the steep eastward slope leading into the valley more than 30 m below, the tombs were not safely accessible with equipment and are thus not included within this study.

*Portes Chamber Tomb 17.* PT17 forms the eastern edge of the 'bat cave cluster' (PT17/25/26/29) adjacent to the southwest of PT9. A small opening connects the collapsing tombs with the partially excavated *dromos* of PT9. A stone marker placed above the façade to mark the tomb's position is mentioned for three of the tombs in this cluster (PT17, 25, and 26), though it is not clear whether this refers to three separate markers or one with multiple associations due to the proximity of the tombs (Kolonas et al. 2002: 2). Due to the cluster's location on the steep slope southwest of Tumulus A and its apparent poor state of preservation, PT17 was not included within this study.

*Portes Chamber Tombs 19 and 20.* PT19 and PT20 lie on the south-eastern perimeter of the central cluster radiating from Tumulus A, separating it from the differently oriented PT3 directly to their southeast. Sheer-sided *dromoi* with no apparent ease of access automatically ruled out their inclusion within this study. The sign-posted map-scaling limits our knowledge of how these tombs actually appear relative to others that were included. PT21, for instance, opens into a secondary, higher vault with an original entrance into the side (rather than in-line) of a separate *dromos*. Unmapped and unlabelled, PT21's higher neighbouring vault may open into the PT19 *dromos*.

*Portes Chamber Tomb 24.* PT24 was part of the failed model with its immediate neighbours PT27 and PT2. Although the latter functioned in its own separate model, the small concave depressions left by PT24 and PT27 were discarded as meaningful candidates for photogrammetric modelling after initial attempts failed to align the tombs with one another and the adjacent trail.

*Portes Chamber Tombs 25–29.* These tombs were not included within this study for various reasons. PT25, PT26, and PT29 form part of the 'bat cave cluster' of unstable tombs along the western edge of the Tumulus A central group. Due to their placement on the slope and generally poor preservation state, the tombs were omitted from study. PT27 was included within the failed model of PT24 as the second in a pair of concave depressions in the hillside adjacent to the trail, and PT28 was not immediately identifiable, being unlabelled and unmapped.

*Tumuli B and C groups.* The remaining tombs on site, largely associated with the poorly preserved *tholos* PTh1, Tumulus B, and Tumulus C, were omitted from this study. This includes the built chamber and cist graves from the B (B1–4) and C groups (C1–3), Tumulus B (not mapped but likely in the vicinity of B group), and the destroyed PTh1. Notably, tomb C1 is the largest recorded built chamber tomb in mainland Greece and is mapped above the approximate position of the PT3 chamber (Kolonas et al. 2002: 5). The latter, otherwise

known as the Warrior Tomb and dated to the LH IIIC period, could have targeted this area as exceptional due to the presence of the LH IA/II period tomb C1, which preceded it by several centuries and was largely deconstructed for its useful stone.

*Voudeni Tomb 1.* The VT1 model included 485 photos and 15 photopoint markers and boasted one of the lowest error margins at under 3 mm.

*Voudeni Tomb 2.* With a maximum error of just under a centimetre, alignment of the VT2 model involved 405 photos and 15 photopoint markers.

*Voudeni Tomb 3.* VT3 was modelled with 306 photos and 8 photopoint markers with no more than a centimetre of error.

*Voudeni Tomb 4.* VT4 was modelled with 791 photos and 11 photopoint markers and, despite its size, maintained a maximum error margin under a centimetre.

*Voudeni Tomb 5.* VT5 was modelled with 657 photos and 9 photopoint markers with an average error of under 3 mm.

*Voudeni Tomb 6.* A total of 412 photos and 8 photopoint markers were needed to complete the model.

*Voudeni Tomb 7.* VT7 was modelled using 329 photos and 15 photopoint markers.

*Voudeni Tomb 8.* VT8 was modelled with 349 photos and 7 photopoint markers with an average error of under 5 mm.

*Voudeni Tomb 9.* A total of 447 photos and 15 photopoint markers captured the model with an average error of roughly a centimetre after revision of problematic photopoints.

*Voudeni Tomb 12.* VT12 is one of the few missing and unlabelled tombs not able to be paired with a likely candidate tomb surveyed here. As such, it is not included within this study.

*Voudeni Tomb 13.* Modelling of VT13 involved 432 photos and 9 photopoint markers with an average error of just over 5 mm.

*Voudeni Tomb 14.* The tomb was modelled with 478 photos and 7 photopoint markers maintaining an average error around 1 cm.

*Voudeni Tomb 15.* Modelling of the tomb comprised 465 photos and 9 photopoint markers with an average error of 1.1 cm.

*Voudeni Tombs 17–20.* VT17 and VT20 were unable to be located or convincingly linked to unlabelled tombs surveyed herein. Models for VT18 and VT19, both in the NE group, failed to render fully. VT18 has a steep *dromos* leading to a vault with circular base, vaulted roof, and ceiling cragged with partial fissure collapses. Modelling of the *dromos* succeeded and yielded 8.86 m<sup>3</sup>. The model of the vault inexplicably failed despite repeated attempts to realign. VT18 was recorded with 355 photos and 10 photopoint markers with an average error under 6 mm. Excavation of the *dromos* alone would require 80–107 ph or 3 days for 10 labourers.

Modelling of VT19 (312 photos, 10 photopoint markers, average error less than 2 mm), partially failed due to the overpass of the walkway that cuts across the top of the deep *dromos* directly above the facade of the



*stomion*, confusing Photoscan with an alternating open and closed *dromos* at the surface. A rough size can be estimated at 10.8 m<sup>3</sup> for the VT19 *dromos*. When added to the vault (6.5 m<sup>3</sup>), VT19's volume (17.3 m<sup>3</sup>) is comparable to that of VT24. The VT19 vault shows a circular base, vaulted roof, and partial ceiling collapse that would otherwise add 1.5 m<sup>3</sup> to its volume. Since the walkway overpass complicates the model of the *dromos*, the labour model for VT19 should be taken with an extra measure of caution. Accepting those limitations, excavation costs for VT19 are 156–208 ph or 5 days for 10 labourers.

*Voudeni Tomb 21.* Modelling of VT21 comprised 597 photos and 10 photopoint markers with an average error of under 8 mm.

*Voudeni Tomb 22.* A total of 619 photos and 10 photopoint markers produced an average error of under 7 mm.

*Voudeni Tomb 23.* Also in the central group near VT4 and VT22, VT23 failed to render fully in Photoscan. The tomb has a standard *dromos* and a circular chamber with an inclining vaulted (conical and *tholos*-like) roof. Reference points failed to reconstruct the *dromos*, leaving only a free-floating vault without secure dimensions. The stored dataset for reattempted models includes 480 photos and 9 photopoint markers.

*Voudeni Tomb 24.* The model comprised 404 photos and 8 photopoint markers with an average error of 4 mm.

*Voudeni Tomb 25.* The VT25 model comprised 532 photos and 8 photopoint markers with an average error of under 4 mm.

*Voudeni Tomb 26.* The model comprised 439 photos and 9 photopoint markers with an average error of 5 mm.

*Voudeni Tomb 27.* Its model comprised 600 photos and 9 photopoint markers with an average error of 1 cm.

*Voudeni Tomb 28.* The model comprised 633 photos and 10 photopoint markers with an average error of 5 mm.

*Voudeni Tomb 29.* The VT29 model comprised 488 photos and 10 photopoint markers with an average error of just over 3 mm.

*Voudeni Tomb 30.* VT30 represents a collapsed or unfinished tomb with only a *dromos* to model in its current form. The tomb lies at the far north-eastern corner of the lawn maintained for the cemetery. An overhanging branch from a nearby mature tree prompted additional steps in cropping the model, which relied upon 158 photos and 5 photopoint markers with an average error of 8 cm. Although not especially useful as a comparative in its current state, the VT30 *dromos* measures only 2.15 m<sup>3</sup>, the second smallest recorded on site after VT11 (2.05 m<sup>3</sup>). Expected excavation costs would range around 20–26 ph or no more than 2 days for 4 labourers.

*Voudeni Tomb 31.* Modelling of VT31 comprised 643 photos and 10 photopoint markers with an average error of 1 cm.

*Voudeni Tomb 32.* VT32 marks the entrance to what appears to be a collapsed *dromos*. The tomb lies to the northeast of VT31 in the central group below the modern path. Since the tomb is unfinished or unexcavated, it was omitted from this study.

*Voudeni Tomb 34.* Modelling of VT34 comprised 760 photos and 10 photopoint markers with an average error under 8 mm.

*Voudeni Tomb 36.* Modelling VT36 comprised 647 photos and 10 photopoint markers with an average error under 3 mm.

*Voudeni Tomb 39.* VT39 lies directly above the wood-frame awning covering VT4 in the central group downslope of the modern path. With a steep *dromos* and no secure tie-off, the tomb was omitted from this study.

*Voudeni Tomb 40 and 44.* Modelling of VT40 and VT44 comprised 705 photos and 9 photopoint markers with an average error under 3 mm.

*Voudeni Tomb 42.* Modelling of VT42 comprised 731 photos and 8 photopoint markers with an average error of 4 mm, though error was among the lowest seen pre-optimisation of the camera locations.

*Voudeni Tomb 43.* In the northeast group immediately west of VT42, VT43 has a multi-slope *dromos* and vault with a four-sided base. The *stomion* shows a low rectangular shape tapering at the top, trending toward a trapezoidal shape. Lighting differential between the sunny *dromos* and dark vault caused a failure of the vault point cloud. Separating the parts may prove successful in future ‘chunking’ and combining of the model. The dataset for VT43 comprised 624 photos and 9 photopoint markers with an average error under 10 mm. The *dromos* model succeeded and yielded a volume of 18.2 m<sup>3</sup>, approaching the total volume of VT42. Expected excavation costs for the *dromos* alone would range from 164–219 ph or 5 days for 10 labourers. Tombs with comparable *dromoi* include VT34 and VT36. Assuming the vault of VT43 lies between the range of their vaults (13.9–27.8 m<sup>3</sup>), estimated total investment for VT43 would rise another 3–6 days for 10 labourers.

*Voudeni Tombs 45–52.* VT45–52 cluster in the southernmost part of the cemetery. These were unable to be accessed and are not included within this study. As mapped, many appear to be buried beneath the slope around the modern paths near VT55.

*Voudeni Tomb 53.* Modelling for VT53 comprised 533 photos and 10 photopoint markers with an average error under 4 mm.

*Voudeni Tomb 54.* Modelling for VT54 comprised 715 photos and 10 photopoint markers with an average error under 10 mm.

*Voudeni Tomb 55.* The dataset for reattempted models for VT55 comprises 407 photos and 10 photopoint markers with an average error of 11 mm.

*Voudeni Tomb 56.* With a low pre-optimised error for camera locations, modelling for VT56 comprised 443 photos and 9 photopoint markers with an average, post-optimised error under 5 mm.

*Voudeni Tomb 57.* Modelling for VT57 comprised 131 photos and 7 photopoint markers with an average error under 8 mm.

*Voudeni Tomb 58.* VT58 is unlisted on site maps and could not be conclusively identified with one of the unnumbered tombs surveyed herein. It is likely in the southern portion of the cemetery and could be buried or misidentified.

*Voudeni Tomb 59.* Modelling for VT59 comprised 293 photos and 11 photopoint markers with an average error of 7 mm.

*Voudeni Tomb 60.* Modelling for VT60 comprised 354 photos and 9 photopoint markers with an average error under 15 mm.

*Voudeni Tomb 61 (U1).* Modelling for VT61 (U1) comprised 168 photos and 10 photopoint markers with an average error under 17 mm.

*Voudeni Tomb 62.* Modelling for VT62 comprised 492 photos and 9 photopoint markers with an average error under 6 mm.

*Voudeni Tomb 63.* Modelling for VT63 comprised 244 photos and 8 photopoint markers with an average error under 4 mm. Pre-optimisation of camera locations the average error remained under 6 mm, and the point cloud showed remarkable fidelity for the myriad of features surrounding the tomb, including the tile roof of the protective awning for VT62.

*Voudeni Tomb 64.* Modelling for VT64 comprised 408 photos and 8 photopoint markers with an average error of 5 mm.

*Voudeni Tomb 65.* Modelling for VT65 comprised 213 photos and 10 photopoint markers with an average error under 5 mm.

*Voudeni Tomb 66.* Modelling for VT66 comprised 386 photos and 10 photopoint markers with an average error under 10 mm.

*Voudeni Tombs 67 and 68.* Modelling for VT67 and VT68 comprised 848 photos and 10 photopoint markers with an average error under 8 mm.

*Voudeni Tomb 69.* Modelling for VT69 comprised 445 photos and 9 photopoint markers with an average error under 7 mm.

*Voudeni Tomb 70.* Modelling for VT70 comprised 483 photos and 10 photopoint markers with an average error under 7 mm.

*Voudeni Tomb 71.* Modelling for VT71 comprised 813 photos and 9 photopoint markers with an average error of 3 mm. Pre-optimisation error reflected a low 5 mm average.

*Voudeni Tomb 72.* Modelling for VT72 comprised 814 photos and 9 photopoint markers with an average error under 6 mm.

*Voudeni Tomb 73.* Modelling for VT73 comprised 338 photos and 10 photopoint markers with an average error under 8 mm.

*Voudeni Tomb 74.* Modelling for VT74 comprised 398 photos and 10 photopoint markers with an average error under 4 mm. Pre-optimisation, two photopoints were removed to correct an initial error of over a metre.

*Voudeni Tomb 75.* Modelling for VT75 comprised 1828 photos and 15 photopoint markers with an average error under 7 mm.

*Voudeni Tomb 76.* Modelling for VT76 comprised 130 photos and 8 photopoint markers with an average error under 4 mm.

*Voudeni Tomb 77.* Modelling for VT77 comprised 686 photos and 10 photopoint markers with an average error of 3 mm.

*Voudeni Tomb 78.* Modelling for VT78 comprised 647 photos and 11 photopoint markers with an average error of 5 mm.

*Voudeni Tomb (U2).* VT U2 is an unlabelled tomb that could not be conclusively identified with a missing mapped tomb in the west group. The proximity of VT66 and VT67 to the unlabelled VT U2 *dromos* may have contributed to some confusion between the diagrammatic map and the tomb plaques (Kolonas 2009b: 14, Figure 10). Only the *dromos* remains here, accompanying an unfinished or unexcavated vault and closed *stomion*. Some stone rubble signifies the latter, but much of the material marking the interior edge of the *dromos* matches the marl or earth fill of its walls. Construction or excavation of the vault may have been aborted due to the proximity of a collapsed adjacent tomb to the right below the modern path. In the description of VT68, Kolonas (2009b: 26) suggests that its damaged vault intersected with two neighbouring tombs to its northwest (VT67) and northeast. This could indicate the vault of VT U2. Modelling for VT U2 comprised 162 photos and 8 photopoint markers with an average error under 5 mm. Volume and labour estimates exclusively reflect the *dromos*, the only open feature remaining here. At 5.73 m<sup>3</sup>, expected excavation costs are 52–69 ph or 2 days for 10 labourers.

*Voudeni Tomb (U3).* VT U3 is the third and final unlabelled tomb that could not be linked to a missing mapped one in the northeast group. VT41 is listed here on the diagrammatic map (Kolonas 2009b: 14, Figure 10), but the tomb plaque for 41 at the cemetery lies in the pit cluster associated with VT33. Again, only the *dromos* remains for VT U3, leading to an unfinished or unexcavated collapsed vault. Where the *stomion* should lie, a sinkhole-like undulation could signify collapse. Construction or excavation may have been abandoned due to overlying *dromoi* directly upslope. In profile, the *dromos* does not maintain a consistent wedge shape as many others do, with the floor arcing downward gradually before becoming steep midway through and redirecting back to a gradual slope. Modelling for VT U3 comprised 274 photos and 8 photopoint markers with an average error of 3 mm. The *dromos* has a volume of 12.4 m<sup>3</sup> (RexD 0.92), near the expected standard for *dromoi* volume, with expected excavation costs of 112–149 ph or no more than 3 days for 10 labourers. With a completed vault of comparable size, it is easy to imagine VT U3 in a similar size class to VT8 and VT9.

### Appendix 3. Digital collection of excess tomb models

- A3.1.F4.2.6. PT2 entrance with PT1 visible as a small depression in the upper right corner near the protective awning, facing east.
- A3.2.F4.2.8. PT3 Warrior Tomb entrance, facing southwest.
- A3.3.F4.2.11. Remnant stone walling from Tomb C1 above the PT3 vault, facing northeast.
- A3.4.F4.2.12. C group of built chamber tombs and former Tumulus C near PT3, facing east.
- A3.5.F4.2.13. PT7 entrance, facing north. The entrance to PT18 is visible on the upper right edge of the frame.
- A3.6.F4.2.17. PT9 entrance, facing north.
- A3.7.F4.2.19. PT10 entrance, facing west.
- A3.8.F4.2.21. PT11 (right) and PT12 entrances, facing south.
- A3.9.F4.2.22. PT11 and PT12 ground plan and sparse cloud model (western cross-section).
- A3.10.F4.2.23. PT13 sparse cloud plan and dense cloud model (northern cross-section). See drawn ground plan for PT10 (Figure 4.2.13).
- A3.11.F4.2.24. PT16 entrance, facing south-southwest.
- A3.12.F4.2.25. PT16 ground plan and wireframe model (eastern cross-section).
- A3.13.F4.2.26. PT18 entrance, facing north-northeast.
- A3.14.F4.2.28. PT21 entrance, facing northeast.
- A3.15.F4.2.30. PT22 entrance, facing south.
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- A3.16.F4.3.4. VT1 entrance, facing southeast.
- A3.17.F4.3.6. VT2 entrance (right), facing south.
- A3.18.F4.3.8. VT3 entrance, facing southwest.
- A3.19.F4.3.10. VT4 entrance, facing southeast.
- A3.20.F4.3.12. VT5 entrance, facing southwest.
- A3.21.F4.3.13. VT5 ground plan and wireframe model (south-eastern cross-section).
- A3.22.F4.3.14. VT6 entrance, facing southwest.
- A3.23.F4.3.16. VT7 entrance, facing southwest.
- A3.24.F4.3.17. VT7 ground plan and sparse cloud model (eastern cross-section).
- A3.25.F4.3.18. VT8 entrance, facing south.
- A3.26.F4.3.20. VT9 entrance, facing south.
- A3.27.F4.3.22. VT10 entrance, facing south.
- A3.28.F4.3.23. VT10 ground plan.
- A3.29.F4.3.24. VT11 entrance, facing south.
- A3.30.F4.3.25. VT11 ground plan and wireframe model (eastern cross-section).
- A3.31.F4.3.26. VT13 entrance, facing south.
- A3.32.F4.3.27. VT13 ground plan and sparse cloud model (eastern cross-section).
- A3.33.F4.3.28. VT14 entrance, facing south.
- A3.34.F4.3.29. VT14 ground plan and sparse cloud model (eastern cross-section).
- A3.35.F4.3.30. VT15 entrance, facing south.
- A3.36.F4.3.31. VT15 ground plan and sparse cloud model (eastern cross-section).
- A3.37.F4.3.32. VT16 entrance, facing south.
- A3.38.F4.3.34. VT21 entrance, facing south.
- A3.39.F4.3.36. VT22 entrance, facing southeast.
- A3.40.F4.3.38. VT24 entrance, facing southeast.
- A3.41.F4.3.40. VT25 entrance, facing southeast.
- A3.42.F4.3.42. VT26 entrance, facing south-southeast.
- A3.43.F4.3.43. VT26 sparse cloud models (ground plan and eastern cross-section), showing failure of the model to render the chamber.



A3.44.F4.3.44. VT27 entrance, facing south-southeast.

A3.45.F4.3.45. VT27 sparse cloud models (ground plan and eastern cross-section), showing failure of the model to render the chamber.

A3.46.F4.3.48. VT29 entrance, facing southeast.

A3.47.F4.3.50. VT31 entrance, facing southeast.

A3.48.F4.3.52. VT33, 35, 37–38, 41 pit grave group, facing south.

A3.49.F4.3.53. VT34 entrance, facing south.

A3.50.F4.3.55. VT36 entrance, facing south.

A3.51.F4.3.56. VT36 ground plan and wireframe model (eastern cross-section).

A3.52.F4.3.60. VT42 entrance, facing south.

A3.53.F4.3.62. VT53 entrance, facing southeast.

A3.54.F4.3.64. VT54 entrance, facing southeast.

A3.55.F4.3.66. VT55 entrance, facing southeast.

A3.56.F4.3.67. VT55 sparse cloud models (ground plan and north-eastern cross-section), showing failure of the model to render the chamber.

A3.57.F4.3.68. VT56 entrance, facing southeast.

A3.58.F4.3.70. VT57 entrance, facing southeast.

A3.59.F4.3.71. VT57 ground plan and wireframe model (north-eastern cross-section).

A3.60.F4.3.72. VT59 entrance, facing southeast.

A3.61.F4.3.73. VT59 ground plan and sparse cloud model (north-eastern cross-section), partially rendered due to the blocked *stomion*.

A3.62.F4.3.74. VT60 entrance, facing southeast.

A3.63.F4.3.76. VT61 (U1) entrance, facing southeast.

A3.64.F4.3.77. VT61 (U1) ground plan and wireframe model (north-eastern cross-section).

A3.65.F4.3.78. VT62 entrance, facing southeast.

A3.66.F4.3.80. VT63 entrance, facing southeast.

A3.67.F4.3.81. VT63 ground plan and sparse cloud model (north-eastern cross-section), showing the shallow anomaly above (southeast of) the chamber.

A3.68.F4.3.84. VT65 entrance, facing southeast.

A3.69.F4.3.85. VT65 ground plan and wireframe model (north-eastern cross-section).

A3.70.F4.3.86. VT66 entrance, facing southeast.

A3.71.F4.3.89. VT68 entrance, facing southeast.

A3.72.F4.3.90. VT67/68 ground plans and sparse cloud model (eastern cross-section), showing the relative location of each chamber (VT68 partially rendered due to access difficulty).

A3.73.F4.3.91. VT69 entrance, facing east-southeast.

A3.74.F4.3.93. VT70 entrance, facing east-southeast.

A3.75.F4.3.95. VT71 entrance, facing east-southeast.

A3.76.F4.3.97. VT72 entrance, facing east-southeast.

A3.77.F4.3.99. VT73 entrance, facing east-southeast.

A3.78.F4.3.100. VT73 ground plan and wireframe model (northern cross-section).

A3.79.F4.3.101. VT74 entrance, facing south.

A3.80.F4.3.102. VT74 ground plan and wireframe model (eastern cross-section).

A3.81.F4.3.103. VT75 entrance, facing east-southeast.

A3.82.F4.3.105. VT76 entrance, facing southeast.

A3.83.F4.3.106. VT76 ground plan and wireframe model (north-eastern cross-section).

A3.84.F4.3.109. VT78 entrance, facing east-southeast.