

Photogrammetric recording of an Early Iron Age hut tomb in central Oman

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State of archaeological research

The authors emphasise that the study of Early Iron Age south-eastern Arabia is underdeveloped. Advantageous would be systematic sources of images, a reason for the authors to build the pool “SKVO Oman” in the image bank heidICON. Relatively few archaeologists in this part of Arabia have cultivated high quality graphics, particularly of archaeological architecture generated by 3D scanning and/or photogrammetry [exceptions, e.g.: Yule *et al.*, 1998; Döpfer *et al.*, 2014; Schmidt *et al.*, 2017]. One project recorded artifacts with a 3D scanner made of copper alloy from the EIA site of ‘Uqdat al-Bakrah, a site which lies in Oman just inside the edge of the Empty Quarter [Yule, Gernez, 2018].

The terms Early Iron Age and Late Iron Age (EIA and LIA) usually are taken to refer to the time in south-eastern Arabia respectively from 1300-300 BCE and > 300 BCE-300 CE [Yule, 2016: 65 fig. 31]. In central Oman since this age is illiterate, it is considered to be prehistoric.

Criticisms published about the EIA and the LIA are notoriously inaccurate. One reads that in central Oman the graves of the Late Iron Age are similar to those of the Late Bronze and Iron Ages [Mouton *et al.*, 2014: 82], that the German team excavated 37 skeletons between 1980 and 1994 [Mouton *et al.*, 2014: no source given] instead of correctly, 191 [Yule, I, 2001: 477-480; 2017]. Colleagues who work in the United Arab Emirates generally attempt to force their own archaeological situation and nomenclature on that of central Oman. One such expert [Kennet, 2007] simply links his excavation at Kush (UAE) with sites on Bahrain and “Période préislamique récente” sites [definition of Mouton, 2008], to represent all of eastern Arabia from the 3rd century BCE to the 8th century CE, despite the lack of similarity to Central Oman’s LIA characteristics [Schreiber, 2007: 64]. However, increases in the number of sites and the documentation of the Samad LIA assemblage increasingly disable this agenda [most recently Yule, 2016]. One expert lapidarily opines that one cannot assign biological sex on the strength of burial goods [Magee, 2016: 254], which we never do, and that, Yule’s chronology, “is not widely accepted” although both of his points can be and have been easily countered [e.g. Yule, 2017]. It would certainly help the discussion, if the colleagues would simply read and cite the texts as they are published. The discussion regarding the EIA is a continuing one in search of a dialogue and less so brachial value judgements.

Clearly, the main burial structure in EIA central Oman is the hut tomb, which prior to 1970 in the pre-archaeological days, here and at other sites around the Gulf came to be known first as cairns, later as pillboxes, the latter term fashioned after machinegun emplacements of WW II. Their first mention in south-eastern Arabia come from the quill of Samuel B. Miles, who mentions them in Wādī Jizī [Miles, 1966: 534] and Bertram Thomas [Thomas, 1931: 167, 177], who refers to them as *buyūt al-jahalā* (houses of the illiterate). Until recently, in neighbouring places in the Gulf littoral any pile of stones was termed a pillbox or a cairn. Donald B. Doe corrected this in his systematic surveys of Oman in which he differentiates different kinds of cairns [Doe, 1976: 148-149]. Gerd Weisgerber first mentions EIA hut tombs in a concrete way [Weisgerber, 1980: 101-102 fig. 72 (“Musfa grave city”); Weisgerber *et al.*, 1981: 182-183 fig. 6.6].

Once the second Samad project of the German Mining project got on its feet in 1987, preliminary grave typology developed along the lines set out by Weisgerber [Yule *et al.*, 1988: 13 fig. 3.5 (a hut tomb)]. Subsequent studies of pre-Islamic funerary structures in the SE Arabia set out to establish a standard nomenclature which arrived at 28 different grave types up to and including the Islamic period [Yule *et al.*, 1993; Yule, 1994; I, 2001: 27-45]. The three studies cited are similar, with slight successive corrections over the years. Regarding a survey of large stretches for the Bāṭinah Expressway one author and evidently his editors reduce the number of grave types from 28 down to six [Saunders, 2016: 8-14]. In this Anglocentric text many previously known types are omitted in part because they did not occur in the areas surveyed. However, among the difficulties of this study is the unfamiliarity of the authors with the specialist literature which is insensitively cited.

For example, tomb type 2 hut tombs [Saunders, 2016: 10 figs. 9-10] reflect only indirectly the occurrences (tab. 1) and characteristic form of those in central Oman. Type 6 Wadi Suq cist graves omit any mention of the best known source for these, 64 “end-wall graves” excavated and published in Samad al-Shan [Yule, I, 2001: 31]. Moreover, the conclusion of one of the authors in this otherwise useful volume to omit all mention of previous literature regarding physical anthropology, “The limited information presently available for populations from the Bronze and

Tab. 1

Published mentions of EIA hut tombs in the central part of the Sultanate of Oman

Site	UTM E.	UTM N.	Publication	Comment
al-Feg	673242	2569218	Doe, 1976: 151	coordinates uncertain
al-Ḥawd, Ḥur al-Ḍaba'	622206	2608537	Gaudiello, Yule, 2018: 76	
al-Maysar gr M2716n	614985	2522250	Yule, I, 2001: 228-231, pl. 19	–
al-Maysar gr M8	615274	2522321	Yule, I, 2001: 225-228; II, 2001: pl. 11	partial LIA re-use
al-Nibā'	671064	2514475	Doe, 1977: site 49, 49, 51 fig. 13	coordinates uncertain
al-Šūwwa' 13.72	607259	2516001	Weisgerber, 1980: 101; Yule, I, 2001: 370; II, 2001: pls. 479, 582, 596	
Bāṭinah gr L3-32	510288	2631231	Saunders <i>et al.</i> , 2016: 89-90 figs. 187-191	–
Bāṭinah gr L3-17	513135	2628675	Saunders <i>et al.</i> , 2016: 32-34 figs. 55-59	–
Bāṭinah gr L3-18	513184	2628871	Saunders <i>et al.</i> , 2016: 34-36 figs. 59-62	–
Bāṭinah gr L3-20	513094	2628765	Saunders <i>et al.</i> , 2016: 37-38 figs. 66-68	–
Bāṭinah gr L3-32	510288	2631231	Saunders <i>et al.</i> , 2016: 89-90 figs. 187-191	–
Bāṭinah gr L3-34	514289	2626833	Saunders <i>et al.</i> , 2016: 27-29 figs. 42-47	–
Bāṭinah gr L3-35	513155	2628822	Saunders <i>et al.</i> , 2016: 39-40 figs. 69-72	–
Bāṭinah gr L3-55	513090	2628640	Saunders <i>et al.</i> , 2016: 40-42 figs. 73-76	–
Bilād al-Ma'ādin	628528	2542193	Weisgerber <i>et al.</i> , 1981: 209, 190 fig. 12; Yule, 1993: 396-398, pl. 8; 1994: 545-547 fig. 8, pl. 20b; I, 2001: 370; II, 2001: pls. 479, 582; 2014: 34-35 fig. 13.3	
Kuriyā Muriyā site 1	391274	1934016	Weisgerber <i>et al.</i> , 2014: 146 figs. 276, 158; Yule, I, 2001: 39 note 259	
'Musfa' (Ġebel al-Šalāyī site 1)	631901	2536305	Weisgerber, 1980: 102 figs. 71-72; Yule, I, 2001: 383; II, 2011: pl. 587 below	
Nigid Busfa	675238	2518093	Doe, 1977: site 48, 48-49, pl. xviii	coordinates uncertain
Rawdah/Muqata gr Mu1	626992	2531404	Yule, I, 2001: 396; II, 2001: pl. 531	LIA re-use
Samad gr S101200	617426	2521161	Yule, I, 2001: 286; II, 2001: pl. 229	–
Samad gr S10669	617513	2521188	Yule, I, 2001: 245; II, 2001: pl. 71	–
Šūr Mašīrah/Ġebel Ḥamr site 8	701822	2275800	Weisgerber <i>et al.</i> , 2014: 67; Yule, I, 2001: 39 note 259	–
Šūr Mašīrah/Ġisr Ġas site 22	677808	2259323	Weisgerber <i>et al.</i> , 2014: 74; Yule, I, 2001: 39 note 259	–
Šūr Mašīrah/Wādī al-Šwāb site 25.1	675889	2257287	Weisgerber <i>et al.</i> , 2014: 75; Yule, I, 2001: 39 note 259	–
Wādī Gheiran/Šiā'	673677	2569210	Doe, 1976: site 6, 152-153 fig. 28, pls. 13-14	attribution uncertain
Wādī Jizī	457102	2698463	Phillips, 1971: 55-56; Yule, I, 2001: 386; II, 2001: pl. 592	coordinates uncertain

Iron Age in this region emphasizes the importance of this study and analysis" [Caine, 2016: 134] is bad news for those who publish their results and hope for them to be cited. Based on a fragment of the data for central Oman, William Deadman concludes that "hut graves do form a discrete class" [Deadman, 2016: 192], although aspects such as the orientation for the definition are ignored (tab. 2) and prior to this hut tombs were already defined as a discrete artefactual group.

Table 1 summarises the state of research for EIA hut tombs, which shows most of published examples in our region. A few from the rescue excavations of packages 3 and 4 do not appear listed, not a result of any ill-will, but rather because we selected only the best-preserved ones for mention.

In any case, the majority of hut tombs in central Oman are flat at one end and at the other may be rounded, in plan like a horse-shoe. They range considerably in size from some 0.60 cm to 1.70 cm in height. A given group may have a single orientation, different groups may vary from each other. The EIA south-eastern tomb group at Bilād al-Ma'ādin shows different axis orientations.

	Inter. height	Exter. height	Orientation
1	1.0 m	1.9 m	N
2	0.6	0.9	N
3	0.8	1.7	N
4	0.8	1.3	ENE
5	0.8	1	NE
6	0.8	1.4	E
7	0.35	1	W
8	0.85	1.6	NE
9	0.8	1.3	NE
10	0.85	1.2	NE
11	0.85	1.5	SE
12	0.9	1	NE
13	0.9	1.4	NE
14	c. 0.8	1.5	E
15	0.8	1.1	E
16	0.7	1.5	E
17	1.1	1.6	W

Tab. 2

Height and orientation of the entrances of the hut tombs of the south-eastern group at Bilād al-Ma'ādin. From Yule, I, 2001: 40 pl. 4.9.

Method

We simply searched for EIA sites with hut tombs which were little documented and noted in a preliminary way the find situation, particularly the geographic position. In this way we chose the Ğebel al-Şalāyī site for photogrammetric recording.

Photogrammetric recording and rendering

With our short visit in January of 2018, we aimed to photograph one tomb photogrammetrically. Previously in 2015, we had used a 3D scanner for recording small metallic artifacts in the National Museum, but the importation, customs formalities and the high costs for the instrument consumed considerable time and effort and required outside financing. First we searched the best preserved example. We visited ad hoc the sites at Wariya and Musfa (tab. 1), but none of the tombs were in a good condition. Skipping over nearby Bilād Ma'ādin, we proceeded to a little known group at a place known first ambiguously as "Musfa" and later as "J. Salayli" [Yule *et al.*, 2018]. A more intensive questioning revealed the name of the adjacent mountain to the north actually to be Ğebel al-Şalāyī. To my knowledge site 1 contains the best-preserved EIA tombs (figs. 1, 2). We selected a better preserved tomb of the 46 examples. All were positioned in rows and oriented with the entrance to the west. The example which we recorded measures 2.0 x 1.60 x 1.30 meters and is made of dark grey fine granite which weathers to an ochre.

Recording parameters

Key problems involved how to deal with shadows in the photos, and use them advantageously with the Agisoft PhotoScan software (standard version, 1.4.0 build 5650 [64 bit] multi-view 3D reconstruction). A small problem is that the programme changes over time, which makes them out

of tune with online tutorials. Although we found no close tutorials for such tombs, still they were useful to explain methods of recording and rendering. We were indeed a low-budget project and had limited time in the field. Following diverse tutorials in the net, we used a Nikon d7100 with an AF-S Micro Nikkor 40 mm 1:2.8 G lens. In order to keep the data to a manageable volume, instead of using RAW/NEF camera option or subsequently converting to high-resolution jpg-images, we laid down the images directly in jpg format onto the flash card. This resulted in images on the average of 1400 KB size which corresponded to our intentions. We set the camera at 100 ISO and used the camera setting automatic in addition to autofocus. Since we had no remote release, we placed the camera on a 2 meters long monopod and used the time exposure feature to record the tomb roof. The location of surrounding tombs conditioned photography distances ranging from 0.5 to 1 meters. We used no pass crosses (which our version of the programme does not support). We photographed around the tomb in spiral fashion moving upwards and counter-clock-wise.

It was a cloudless day. We arrived at the site at 09:41 and began to photograph despite the presence of direct light and shadows with the surrounding tombs cast on that which we selected. Overview photos were possible only from the south and east. This resulted in F stops c. 9.5 and an exposure time of 1/350 of a second. We used a monopod where possible. We nearly finished with some 323 photos. We returned at 17:00 when the shadows covered the entire site and the light was diffuse, but still sufficed. We made a further 14 images, which in the evening we rendered in a hotel. The thin-cloud mode of PhotoScan suggested that there were small holes in the render, which required patching. Two days later we returned and reached the site at around noon and patched

Fig. 1. Google Earth image of the Ğebel al-Şalāyī cemetery, mining and smelting site.
Source Paul A. Yule.





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the holes with 154 more photos using the same camera settings. The best photos were made in the late afternoon in shadow. However, equally good would be morning shadow light. To optimise, we could have set for a longer exposure time and a high F-stop, in order to increase the depth of field. However, owing to adequate light, this proved not to be a problem (fig. 3).

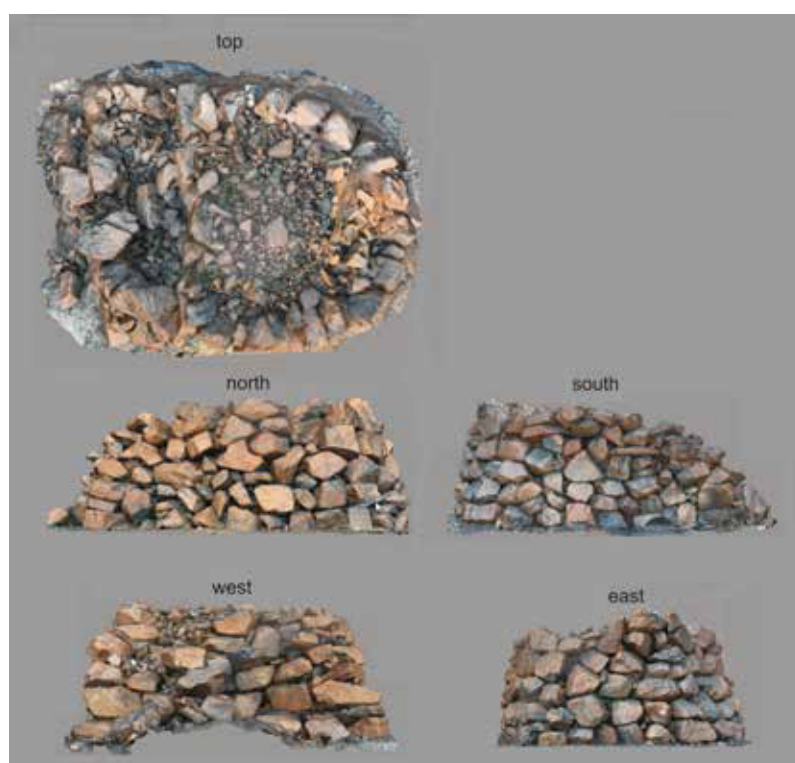
The computer used for the rendering is a Dell Optiplex desktop with the following configuration: Windows 7, Intel i7-2600 CPU @ 3.40 GHz, 16 MB RAM, 64 bit operating system, NVIDIA GeForce GT 720 graphic card. For rendering of less than 400 jpg files @ 1400 KB this configuration was adequate. The programme was factory-configured to use this hardware. But a notebook computer also sufficed for the rendering.

Conclusions

Advised in tutorials not to exceed 400 photos for the rendering, first we rendered 323 images (cameras) which yielded the following parameters: 217071 points, 891683 faces, 447614 vertices. The attempt to render all of the 491 photos of the tomb crashed the programme. Nearly all of these photos joined to each other, as we could determine from the photo feature below the modelling screen. Most showed the diagnostic orange check. Our first test was moderately successful. However, next time we would attempt to get more depth of field in the photographing. We were unable to get the ultra-high mode for rendering the dense cloud to function on our computer. Recording a second grave would be easier and go faster, having had this experience.

Fig. 2. Čebel al-Salāyīli cemetery 1 viewed to the north.
Source Paul A. Yule.

Fig. 3. Čebel al-Salāyīli cemetery 1, photogrammetrically recorded tomb no. 15.
Source Michela Gaudiello, Paul A. Yule.



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BIBLIOGRAPHY

- Caine A., *The human remains*, in Saunders B. (ed. by), *Archaeological Rescue Excavations on Packages 3 and 4 of the Batinah Expressway, Sultanate of Oman*, Oxford, 2016: 134-163.
- Deadman W., *Discussion*, in Saunders B. (ed. by), *Archaeological Rescue Excavations on Packages 3 and 4 of the Batinah Expressway, Sultanate of Oman*, Oxford, 2016: 189-206.
- Doe D.B., *Gazetteer of sites in Oman*, "The Journal of Oman Studies", 2, 1976: 148-187.
- Döpfer S., Schmidt C., *Bericht über die Ausgrabungen 2013 und 2014 in Bāt und al-Ayn, Sultanat Oman*, "Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin (MDOG)", 149, 2014: 55-85.
- heidICON: http://heidicon.uni-heidelberg.de/BildsucheFrames?easydb=49pvidrlaa4j-3v33aei0mh3sj5&pf_language=en (SKVO "Oman").
- Kennet D., *The decline of eastern Arabia in the Sasanian period*, "Arabian Archaeology and Epigraphy (AAE)", 18, 2007: 86-122.
- Magee P., *Review of Yule P., Cross-roads: Early and Late Iron Age South-eastern Arabia* (2014), "Antiquity", 2016: 253-254.
- Miles S.B., *The Countries and Tribes of the Persian Gulf* (1919), London, 1966.
- Mouton M., *La Péninsule d'Oman de la fin de l'Age du Fer au début de la période sassanide (250 av.-350 ap. JC)*, Oxford, 2008.
- Mouton M., Schiettecatte J., *In the Desert Margins: The Settlement Process in Ancient South and East Arabia*, Roma, 2014.
- Phillips W., *Unknown Oman*, Beirut, 1971.
- Saunders B. (ed. by), *Archaeological Rescue Excavations on Packages 3 and 4 of the Batinah Expressway, Sultanate of Oman*, Oxford, 2016.
- Schmidt C., Döpfer S., *Die Entstehung komplexer Siedlungen in nördlichen Inner-Oman im 3. Jahrtausend v. Chr.: Bericht über die Ausgrabungen 2015 und 2016 in al-Khashbah*, "Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin (MDOG)", 149, 2017: 121-58.
- Schreiber J., *Transformationsprozesse in Oasensiedlungen Omans. Die vorislamische Zeit am Beispiel von Izki, Nizwa und dem Jebel Akhdar*, Dissertation, München, 2007: http://edoc.uni-muenchen.de/7548/1/Schreiber_Juergen.pdf.
- Thomas B., *Alarms and Excursions*, London, 1931.
- Weisgerber G., *...und Kupfer in Oman*, "Der Anschnitt", 32, 1980: 62-110.
- Weisgerber G. et al., *Mehr als Kupfer in Oman*, "Der Anschnitt", 33, 1981: 174-263.
- Weisgerber G., Shānfarī A., *Archaeology in the Arabian Sea Masirah and Hallaniyyat Island*, Muscat, 2014.
- Yule P.A., Weisgerber G., *Samad ash-Shan vorläufiger Bericht 1988*, Bochum, 1988.
- Yule P.A., Weisgerber G., *ḥafriyāt fī samad al-šā'n (wilāyat al-muḍaybi), taqrīr 'ulā 1988 m, būl yūl wa ḡrd fāys ḡrbr, tar ḡamah, maktab al-darisāt al-āṭriyyah, dā'yrat al-āṭār, raḡmah bint qāsim bin ḡābir al-fārsī*, 1993.
- Yule P.A., Weisgerber G., Kunter M., Bemann M., *Wādī Sūq burial structures in the Sultanate of Oman*, "Nubica", 3, 1993: 379-415.
- Yule P.A., *Grabarchitektur der Eisenzeit im Sultanat Oman*, "Baghdader Mitteilungen", 25, 1994: 519-577.
- Yule P.A., Weisgerber G., *The tower tombs at Shir, eastern Hajar, Sultanate of Oman*, "Beiträge zur allgemeinen und vergleichenden Archäologie", 18, 1998: 183-241.
- Yule P.A., *Die Gräberfelder in Samad al Shān (Sultanat Oman). Materialien zu einer Kulturgeschichte*, II vols., Rahden, 2001.
- Yule P.A., *Cross-roads: Early and Late Iron Age South-eastern Arabia*, Wiesbaden, 2014.
- Yule P.A., *Valorising the Samad Late Iron Age*, "Arabian Archaeology Epigraphy", 27/1, 2016: 31-71.
- Yule P.A., *Identity and defence during the Samad period: beyond artefact classification*, in *Conference Report Archaeology of the Gulf*, 2017: in press.
- Yule P.A., al-Rasibī Kh., Gaudiello M., *Survey of Central Oman*, 1-6.01.2018, internal report 2018.
- Yule P.A., Gernez G. (eds. by), *Early Iron Age Metal-Working Workshop in the Empty Quarter, al-Zahirah Province, Sultanate of Oman*, Bonn, 2018.

ABSTRACT

PHOTOGRAMMETRIC RECORDING OF AN EARLY IRON AGE HUT TOMB IN CENTRAL OMAN

At an alarming rate, the archaeological monuments of central Oman are going the way of the extinct Arabian elephant and Arabian ostrich before they can be recorded. Aside from a simple drawing, until now there was no 3D orthographic recording of an Early Iron Age (EIA) tomb. Thus, it was unclear how the roof was fashioned into something durable enough to withstand the test of millennia. The EIA tombs located next to the ḡebel al-Ṣalāyī in the Sharqīyah province are the best-preserved ones in Oman, but are being encroached on, and are not in any way protected. At the lower end of a wādī, they lie 400 meters west of a long-abandoned copper mine to which they probably originally owed their existence. The mine was obviously in use during Muslim times, but probably also in the EIA. This is not a scientific experiment, but rather a recording of our experience during photogrammetric recording and rendering. Photogrammetric recording is preferable to 3D scanning owing to the logistical hurdles to get the instrument in and out of the country. Then one also needs a source of electricity, which in the field may be prohibitive. Should one manage this, scanning requires darkness which requires driving in the desert and finding a place to stay – or driving back to larger town with a hotel. By means of some 323 jpg images, we rendered one tomb using the Agisoft PhotoScan standard program.

DOCUMENTAZIONE FOTOGRAMMETRICA DI UNA "HUT TOMB" DELLA PRIMA ETÀ DEL FERRO IN OMAN CENTRALE

A una velocità allarmante, i monumenti archeologici dell'Oman centrale si stanno estinguendo come gli elefanti e gli struzzi dell'Arabia, prima che questi vengano registrati. A parte semplici disegni, finora non esiste una singola ricostruzione ortografica 3D di una tomba della prima età del ferro (EIA). Pertanto non è ancora chiaro come la copertura doveva apparire ed essere strutturata in modo da durare per millenni. Le tombe EIA individuate presso il ḡebel al-Ṣalāyī, nella provincia della Sharqīyah, risultano essere le meglio conservate in Oman, ma sono state violate e non sono in alcun modo protette. Nella parte bassa del wādī, queste sono state erette a 400 metri a ovest da una miniera di rame da lungo tempo abbandonata e a cui, molto probabilmente, devono la propria esistenza. La miniera sicuramente fu in uso durante l'epoca islamica, ma anche durante l'EIA. Questa nota non vuole essere un esperimento scientifico, quanto piuttosto un resoconto della nostra esperienza durante l'acquisizione dei dati e la ricostruzione fotogrammetrica.

La ricostruzione 3D attraverso fotogrammetria è preferibile all'utilizzo di laser scanner per le difficoltà logistiche nel fare entrare e uscire la strumentazione in un Paese. Altra problematica è la corrente elettrica, che sul campo è spesso proibitiva. Potendo risolvere ciò, il laser scanner richiede ombre che nel deserto implica il dover guidare a lungo per trovare un posto adatto o tornare indietro nell'albergo in città. Con 323 immagini jpg, siamo stati in grado di ricostruire una tomba utilizzando la versione trial di Agisoft PhotoScan.

KEYWORDS

central Oman, Early Iron Age, hut tombs, Agisoft PhotoScan, Salayli
Oman centrale, prima età del ferro, "hut tombs", Agisoft PhotoScan, Salayli

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