Tommaso Mattioli

Landscape Analysis of a Sample of Rock-Art Sites in Central Italy

Abstract: This paper presents research on viewshed analysis of a sample of 12 rock-art sites in central Italy. The simple Boolean approach of GIS software is supplemented by a visual distance decay index based on the resolution of the human eye. From data so far collected, this approach seems to provide interesting information about visual potential function of rock-art sites that can be subdivided into three types: narrow gorge view-dominance, river valley view-dominance, wide territory view-dominance.

Rock-Art Studies in Central Italy

Prehistoric rock-art, including paintings and engravings on rock surfaces as a whole, appears in Italy during the final Upper Paleolithic age and manifests itself sporadically and with varied geographical distributions in subsequent ages up to historical times. Most of the Italian examples are in northern Italy, in particular in the Alps, and in a few of the regions of southern Italy and islands. In central Italy rock-art has remained until now practically unknown to the larger public. In reality some samples were discovered in this area in the beginning of the first half of the 20th century, e.g. Riparo Roberto and Arnalo dei Bufali in Latium, while from the 1960s to 1990s numerous rock-art sites were also discovered in other regions such as Abruzzo and Marche (Mattioli 2006; idem 2007a; idem 2007b). All these examples have never been studied as a unique phenomenon until now. In recent years a research team from the University of Perugia has brought to light 12 new rock-art sites in Umbria, a region where rock-art figures were completely unknown. These new discoveries, together with previous studies, have exposed a new and consistent archaeological heritage that will be analyzed in my PhD project at the University of Rome "La Sapienza". From data collected so far in central Italy there are 69 rock-art sites, such as rock-shelters, caves, open-air rock-surfaces and about 700 figures, both paintings and engravings. Typological study of these figures, iconographic comparison with examples from other European regions, absolute dating such as 14C of carbonaceous accretions that seal paintings, have provided a chronology that ranges from the Neolithic to the Iron Age. The results of this study will be published in a monograph of the Quaderni di Protostoria of the University of Perugia (Mattioli in press).

Viewshed Calculation Method

Since rock-art study in central Italy is a new field of research, no typology of the sites has been undertaken yet. In this paper we would like to present a method and preliminary results of viewshed analysis that we applied to a sample of 12 rock-shelters[1]. Some years ago at the beginning of our surveys in central Italy we tried to apply a preliminary "visual domain" typology of rock-art sites based on a dominance index proposed by the French researcher P. Hameau (2002, 175–176): following the framework of his research we placed sites in an hypothetical section of an Apennine river valley and we distinguished four dominance locations[2] based on four different view-field values strictly dependent on the

[1] Umbria (see Mattioli in press): Pale (Foligno, PG), Formiche Rosse (S.Anatolia di Narco, PG), Lo Schioppo (Scheggino, PG), Le Mummie (Ferentillo, TR), Mesa Rosa (Ferentillo, TR). Latium: Riparo Roberto (Sezze, LT; Priuli / Sgabussi 1992), Arnalo dei Bufali (Sezze, LT; Blanc 1939), Morra di Colecchia (Rocca Canterano, RM; Mattioli 2007a), Riparo di Grotti (Cittaducale, RI; Mattioli 2006). Abruzzo: Santo Spirito I (Roccamorice, PE; De Pompeis / De Pompeis 1984), Sant'Onofrio I (Sulmona, AQ; De Pompeis 1993), San Bartolomeo II e III (Roccamorice, PE; De Pompeis 1993).

[2] Position A: complete territorial dominance over river valley; position B: river valley dominance; position C: very limited dominance to the bottom of the river valley; position D: no dominance at all, the site is located and hidden within a narrow gorge.

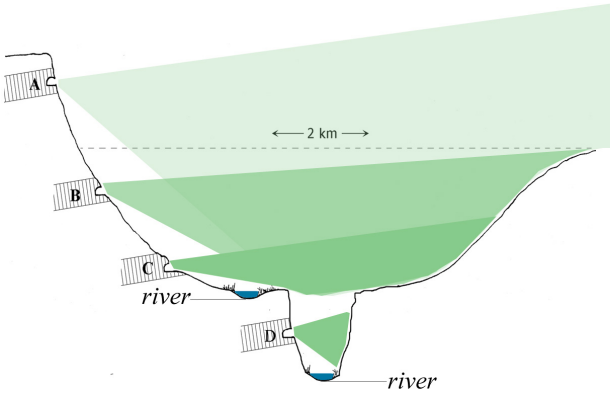

Fig. 1. First attempt to define dominance locations using the Hameau index.

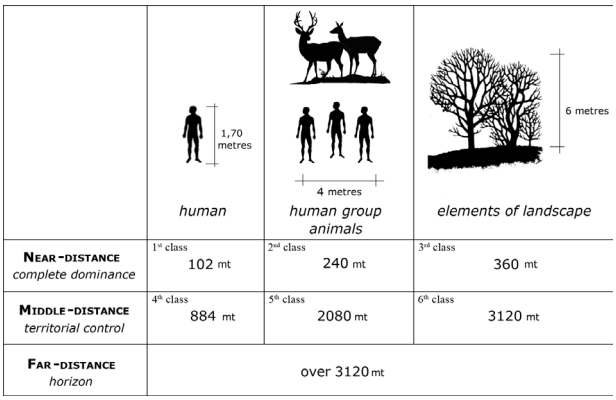

Fig. 2. Visual decay distance classes based on human eye perception of specific targets.

relative altitude of the sites *(Fig. 1)*. It is clearly noticeable that this approach is very simple because it is not based on quantitative data and it does not take into consideration other factors, such as the topographic variation of the terrain. Later on we started to work in more detail using ArcGis viewshed calculations: first we defined a standard area of 40 km^2 around each site, then we created a DTM model based on contour lines with a resolution of 10 m of elevation and finally, we performed the viewshed calculation. Viewshed is the result of a function that determines, given a terrain model, which areas can be seen from a given point. The traditional result is a simple binary data layer, coded '1' for areas in-view and '0' for those out-of-view. Even though various technical improvements to viewshed calculations have been proposed (e.g. Llobera 2003), these preliminary tests which we conducted produced satisfying results.

What was not satisfying, however, was the undifferentiated nature of the viewshed. In fact, moving from the Boolean approach of software to a real human perception of landscape, we know that numerous parameters of visibility decay play an important role (e.g. Wheatley / Gillings 2000). In seeking to establish an index of visual decay we decided to consider factors related to the human eye's degree of perception of different objects/targets. In fact as objects/targets of different size become more distant, they appear smaller to the human eye because the angular diameter decreases; moreover it is well known that in good conditions of humidity and

	Near distance			Middle distance		
site name	**1**	**2**	**3**	**4**	**5**	**6**
Arnalo dei Bufali	2.294	9.995	20.495	115.902	636.297	1416.033
Formiche Rosse	1.282	5.149	11.601	33.845	124.353	245.264
Grotti	1.552	3.354	10.086	85.158	271.254	321.787
Le Mummie	0.269	4.758	12.777	57.122	331.638	659.458
Lo Schioppo	2.149	12.38	23.833	74.818	252.794	457.417
Mesa Rosa	1.275	6.451	12.254	40.293	181.099	368.195
Morra di Collecchia	1.483	3.033	4.658	4.707	4.707	4.707
Pale	1.213	6.204	11.175	79.059	347.932	410.252
Roberto	1.185	5.923	8.929	13.953	87.211	222.390
San Bartolomeo	1.631	7.981	12.768	24.122	38.192	83.014
Santo Spirito 1	0.714	1.899	11.171	96.587	330.488	357.504
Sant'Onofrio I	0.437	1.688	6.101	62.857	426.052	1013.290
maximum area	3.268	18.095	40.715	245.501	1359.178	3058.151

Fig. 3. Area values of view-distance classes in hectares.

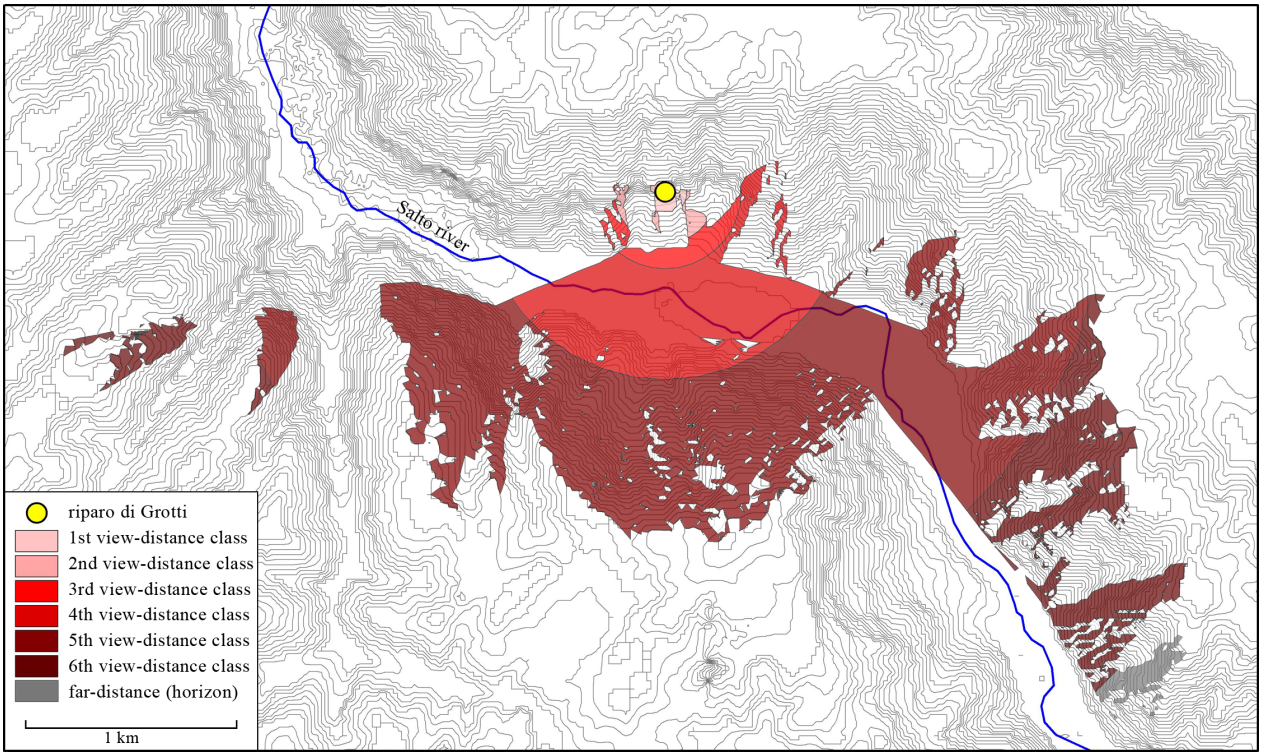

Fig. 4. Grotti rock-shelter viewshed layer re-classified (class nos. 1–4).

temperature the human eye can completely distinguish two objects/targets as individual entities under a minimum horizontal angle of 1 degree or at a maximum distance of 60 times the entity size (Catalano 2002).

Following this framework, in part already applied in other studies (Higuchi 1983; Wheatley / Gillings 2000), we distinguished three potential objects/targets that were of likely interest to prehistoric human groups (single human, human/animal group and elements of landscape like medium sized trees) and three visibility decay classes (near-distance, middle-distance and far-distance[3]) *(Figs. 2, 3)*. The next stage was then to re-classify the binary viewshed layer by an overlay operation with buffer distance layers based on visual decay distance classes (e.g. Wheatley / Gillings 2000, Fig. 2). Now we were able to quantify exactly the degree of perception of objects/targets and landscape features within the viewshed area or, more exactly, we were able to quantify the "visual dominance" potential of the site (e.g. Grotti rock-shelter, *Fig. 4*).

Preliminary Results

Once all the data was collected we tried to address some specific issues. First of all: are there patterns in landscape location depending on view-dominance or, conversely, did human groups choose specific rock-shelters, among others available in the same area, because they were looking for visual-control of specific targets present within the view-field? Although this process has been applied to a limited sample of 12 rock-art site, we are able to recognize three view-dominance models:

[3] Near-distance (60 times the size of the target entity): entities could be recognized as individual and perceived as being immediate and close to the viewer, in many cases engaging all senses; in this area, the dominance of the site is complete. Middle-distance (550 times the size of the target entity): the outline of entities is visible but not the detail. All sense impressions other than vision play no role. One merely views, and the variations in movements of entities or variations of the shape of terrain become important compositional elements. The visibility dominance shifts to a large landscape scale and probably defines the region of interest of the site. Far-distance (over 1100 times the size of the target entity): this is the horizon, there is no longer any sense of depth and dominance doesn't play any role.

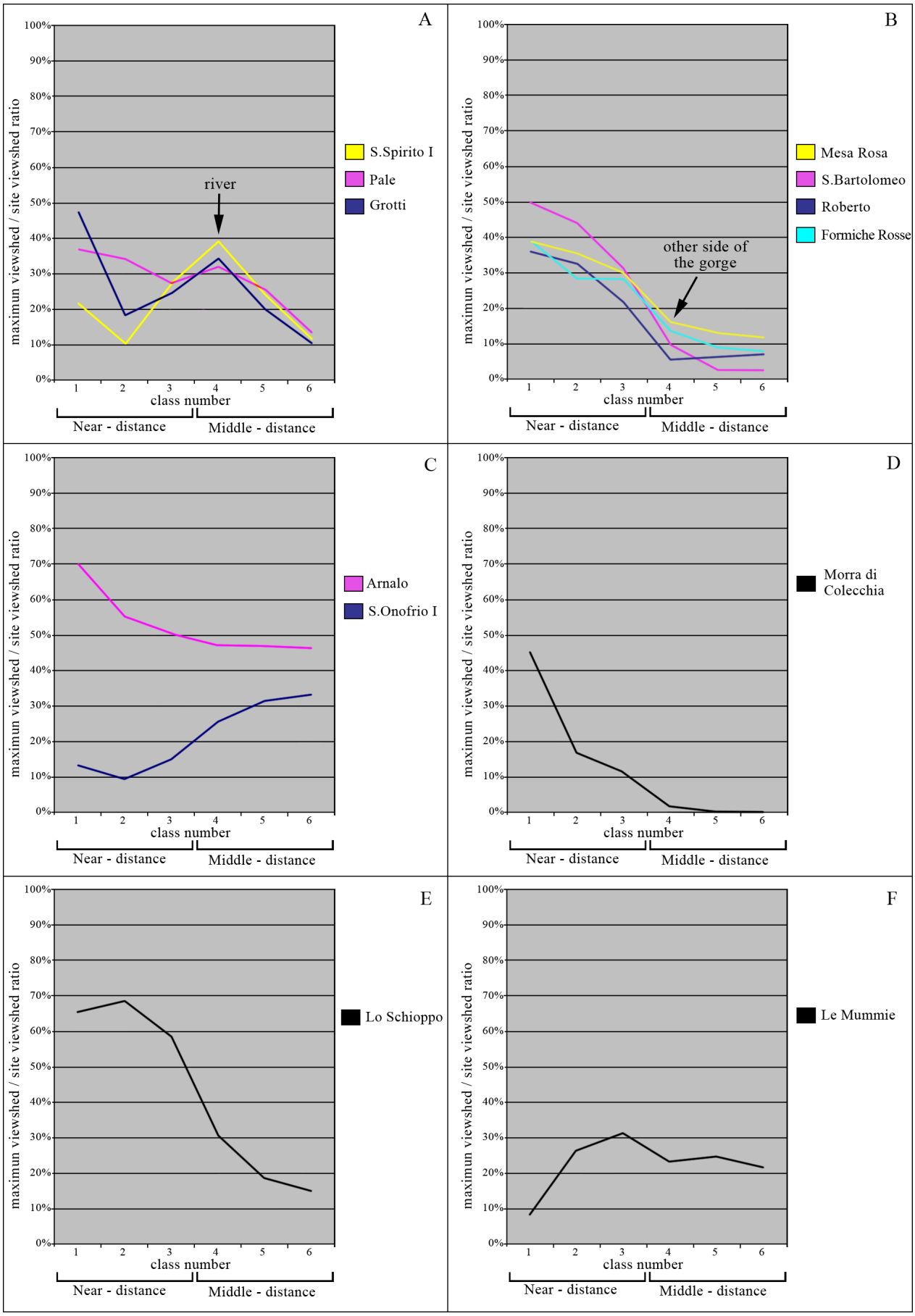

Fig. 5. Line graphs of view-distance classes area (see footnote 4).

1) River valley view-dominance (Grotti, Pale and Santo Spirito I): the line graph of view-distance classes area[4] *(Fig. 5A)* shows that the view-dominance function of these sites seems to be the visual control of medium size targets (human/animal group) who move inside the view-distance class area no. 4 (middle-distance) that corresponds, in all these examples, to the bottom of the valley where the river flows. On the contrary in the very close land (near-distance) these sites seem to prefer a complete dominance on the biggest elements of landscape located at the boundaries of this area (class no. 3) instead of complete dominance of closer medium size targets such as animal or human groups (class no. 2) who could approach the site. This could also mean that human groups that approached the site could not completely see the rock-shelter which has, as consequence, a good defensive position, which we could appreciate also by observing the median slope degree of the near-distance area (40° on average) as in fact the way to the rock-shelter is very steep and difficult. Probably man chose these rock-shelters from others available in the same land, because only from among these locations could they control, without being seen, human group movements along the river valley.
2) Narrow gorge view-dominance (Mesa Rosa, S. Bartolomeo II e III, riparo Roberto, Formiche Rosse)**:** in this case the sites are located on vertical rock surfaces of narrow and deep canyons, some metres above the river. The line graph *(Fig. 5B)* shows a quite high value in the near-distance area and is the same, in the very close land at the foot of the rock-shelter (classes nos. 1, 2), while view-dominance quickly decreases starting from view-class n.3 because the other side of the gorge closes off the view. The site is then well hidden within folds of the landscape and probably if someone wanted to approach it, they would have had to know the footpath to the site very well.
3) Wide territory view-dominance (Arnalo dei Bufali, riparo di Sant'Onofrio): even if these sites seem to have different values *(Fig. 5C)*, because they look at two different kind of lowlands (the wide Pontina lowland on Latium coastland and the narrow Sulmona lowland in the interior of Apennine), the view-dominance potential of these sites seem to be the middle-distance area (class nos. 4, 5, 6): these are exposed sites which could be seen from a great distance.

The last three sites of our sample *(Fig. 5D–F)* seem to belong, individually, to three different models. An interesting remark is that probably one of these sites, the rock-shelter of Morra di Colecchia *(Fig. 5D)*, which has the highest relative altitude value (about 550 m from the river valley), probably was not chosen for viewshed properties: the line graph of this site, a kind of natural dolmenic structure, shows a quite high value in very close land (class no. 1), while visual dominance quickly decreases starting from class no. 2. Why would man climb about 550 m from the river valley to the rock-shelter if it has no view-dominance over the landscape? Probably this site was chosen for some reason other than visibility (Mattioli 2007a): is it related to a footpath placed in a mid elevation along the mountain shoulder? Was its hidden location intentionally chosen by man?

Conclusion

It is clear that if visibility is to be adequately incorporated into rock-art studies, then a number of developments must take place. The aim of the present paper has been to demonstrate the augmentation of viewshed calculations with factors that could have been at work in the selection of rock-art locations. For us, the simple binary viewshed must be improved with a visual decay model based on the human eye's perception so as to better define view-dominance targets and view-dominance distance classes.

References

Catalano 2002

F. Catalano, Elementi di ottica generale (Bologna 2002).

Gillings / Wheatley 2001

M. Gillings / D. Wheatley, Seeing is not believing: unresolved issues in archaeological visibility analysis. In: B. Slapsak (ed.), On the good use of geographical in-

[4] In all line graphs area values are represented in hectares and in proportion (percentage) in relation to the maximum visible area that is, in each class, a circumference with a specific radius that depends on objects/targets distance of perception (see bottom values in *Fig. 3*).

formation systems in archaeological landscape studies (Luxembourg 2001) 25–36.

Hameau 2002
P. Hameau, Passage, transformation et art schematique: l'example des peintures neolithiques de sud de la France. BAR International Series 1044 (Oxford 2002).

Higuchi 1983
T. Higuchi, Visual and Spatial Structure of landscapes (Massachusetts 1983).

Llobera 2003
M. Llobera, Extended GIS-based visual analysis: the concept of visualscapes. International Journal of Geographical Information Science 17, 2003, 25–48.

Mattioli 2006
T. Mattioli, Le pitture rupestri del riparo di Grotti lungo la valle del fiume Salto (Comune di Cittaducale, provincia di Rieti, Italia Centrale). Quaderni di Protostoria 3, 2006, 1–17.

Mattioli 2007a
T. Mattioli, L'arte rupestre pre-protostorica del riparo sotto roccia di Morra di Colecchia (Rocca di Canterano, Roma). Atti del IV Incontro di Studi Lazio e Sabina (Roma 2006).

Mattioli 2007b
T. Mattioli, L'arte rupestre pre-protostorica del Lazio. Atti della XL Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria "Strategie di insediamento fra Lazio e Campania in età preistorica e protostorica" (Roma 2007), 363–367.

Mattioli in press
T. Mattioli, L'arte rupestre dell'Italia centrale: Umbria, Lazio, Abruzzo. Quaderni di Prostoria 4.

De Pompeis 1993
V. De Pompeis, Pitture rupestri in Abruzzo: nuove segnalazioni. Atti della Società Toscana di Scienze Naturali, Memorie, seria A 100, 1993, 65–83.

De Pompeis / De Pompeis 1984
C. De Pompeis / V. De Pompeis, Pitture rupestri nel vallone di Santo Spirito (Pescara). Bollettino del Centro Camuno di Studi Preistorici 21, 1984, 125–130.

Priuli / Sgabussi 1992
A. Priuli / G. Sgabusi, I disegni a carboncino del riparo Roberto (LT). In: Atti della XXVIII Riunione Scientifica dell'Istituto Italiano di Preistoria e Protostoria (Florence 1992) 525–536.

Wheatley / Gillings 2000
D. Wheatley / M. Gillings, Vision, perception and GIS: developing enriched approaches to the study of archaeological visibility. In: G. Lock (ed.), Beyond the Map (Amsterdam 2000) 1–28.

Tommaso Mattioli

Università di Roma
Dipartimento di Scienze Storiche
Via Palestro 63
00185 Rome
Italy
tommaso@cline.it