

MICROPETROGRAPHIC ANALYSIS AS A TOOL FOR PROVENANCE STUDIES OF LIMESTONE USED IN PREHISTORY AND ANTIQUITY OF ISTRIA, CROATIA

1. INTRODUCTION

The westernmost region of the Republic of Croatia – the Istrian peninsula – is characterized by predominantly carbonate surface deposits of Jurassic, Cretaceous and Paleogene age, as well as by terra rossa and alluvium deposits of Quaternary age (Miko *et al.* 2013). The carbonate deposits of Istria – limestones and dolomites – are of relatively high quality and have been exploited since prehistory. During prehistory stone was extracted from the very tops and slopes of the hills or in the immediate vicinity of the settlement for the construction of the ramparts of hillforts (Buršić Matijašić 2008). The local limestone sources were also used for funerary practices during the Bronze Age: the deceased was laid in a stone casket made from limestone slabs which was then covered with a stone pile (Codacci-Terlević 2004). On the other hand, during Antiquity limestone was extracted in a more systematic way in the shape of regular blocks which resulted in rectangular quarries (Parica 2014).

2. METHODOLOGY

We sampled several prehistoric sites and Roman monuments in Istria as well as several outcrops or quarries in an attempt to determine the limestone source. We undertook a micropetrographic analysis and classified all carbonate samples after Dunham (1962) and Folk (1959, 1962).

3. THE SAMPLES

Our samples from a prehistoric site come from a drywall rampart of a Bronze Age hillfort Glavica in Vrsar municipality, Istria, Croatia (**sample G-1**; Popović 2018). We took a sample from the north-eastern rampart of the hillfort. For comparison we sampled two limestone outcrops on the hillfort - one beneath the rampart itself (**sample U-2**) and one on the western side of the hillfort (**sample U-1**, fig. 1).

The **sample G-1** was determined as a mudstone/micrite which has undergone the processes of recrystallization, dolomitization and dedolomitization.

Sample U-1 from the western outcrop was determined as a late diagenetic dolomite with an idiomorphic texture. **Sample U-2** from the bedrock beneath the rampart was determined as a fenestral mudstone or dismicrite.

Our micropetrographic analysis shows the sampled stone block was not taken from the bedrock directly beneath it, nor on the western side of the hillfort. The hillfort itself lies on Upper Tithonian deposits of limestone differently affected by late diagenetic dolomitization, and Upper Tithonian-Neocomian deposits of late diagenetic dolomites (Miko *et al.* 2013, Matičec *et al.* 2015). This data, together with geological maps, could confirm this community exploited the outcrop from the hilltop itself.

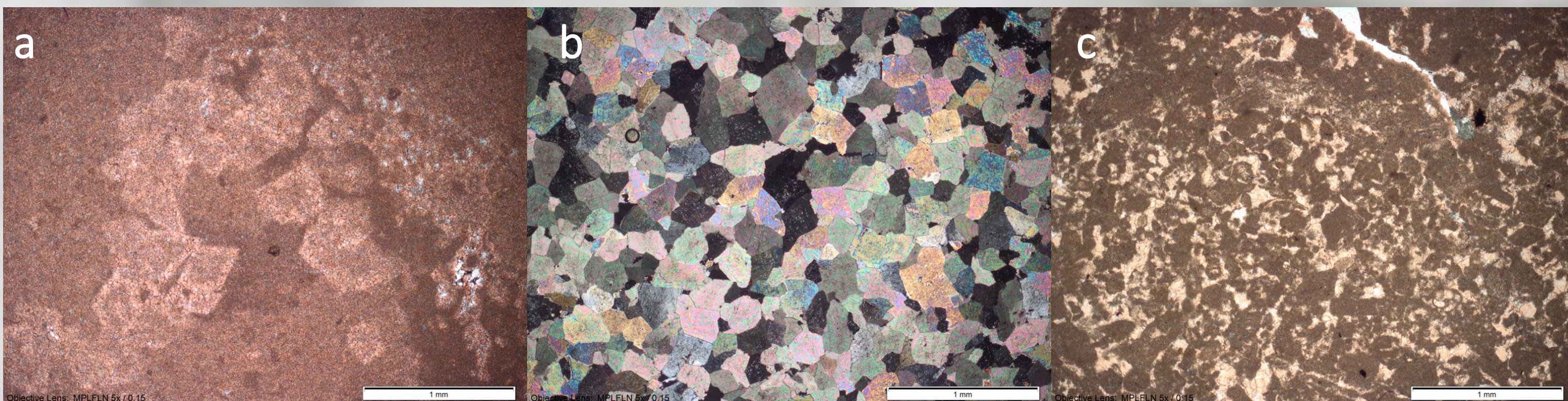


Figure 1. Photomicrographs of samples. a) **G-1**, PPL; b) **U-1**, XPL, and c) **U-2**, PPL. Magnification 50x, measure line 1 mm.

As we mentioned above, during Antiquity stone was extracted in a more systematic way, and used for several purposes, one of which was manufacturing funerary monuments. We sampled one lid of a sarcophagus from *Pola* dated from the second half of 1st century BC to the start of the 1st century AD (**FV-1**). For comparison, we took samples from two Roman quarries nearest to *Pola* (**Pješčana uvala** and **Vinkuran**), as well as one Roman quarry located further to the north (**Marčana**; fig. 2).

Micropetrographic analysis determined sample **FV-1** as a bioclastic grainstone/recrystallized biosparite.

The sample from **Marčana** quarry was determined as a grainstone/biosparite, while samples from **Pješčana uvala** and **Vinkuran** were determined as rudstone-floatstone/biomicroite-biomicrodite and packstone-floatstone/biomicroite-biomicrodite, respectively, with predominant rudist and orbitolinae fragments.

Our analysis determined **Marčana** quarry as the probable source of stone for the sarcophagus lid.

Other than funerary, we also sampled fragments of decoration of public buildings. For example, the trabeation of a temple with a decorated frieze from Roman *Parentium* dated to the 1st-2nd century AD (**sample ZMP-2**). Micropetrographic analysis already indicated that the source for this monument could have been the Oxfordian-Lower Kimmeridgian limestone deposits located throughout the larger part of the *Parentium* ager. Moreover, new Roman quarries were discovered recently several kilometres south of *Parentium*; for example the Monte del Vescovo site which was sampled for comparison (**sample U-13**; fig. 3).

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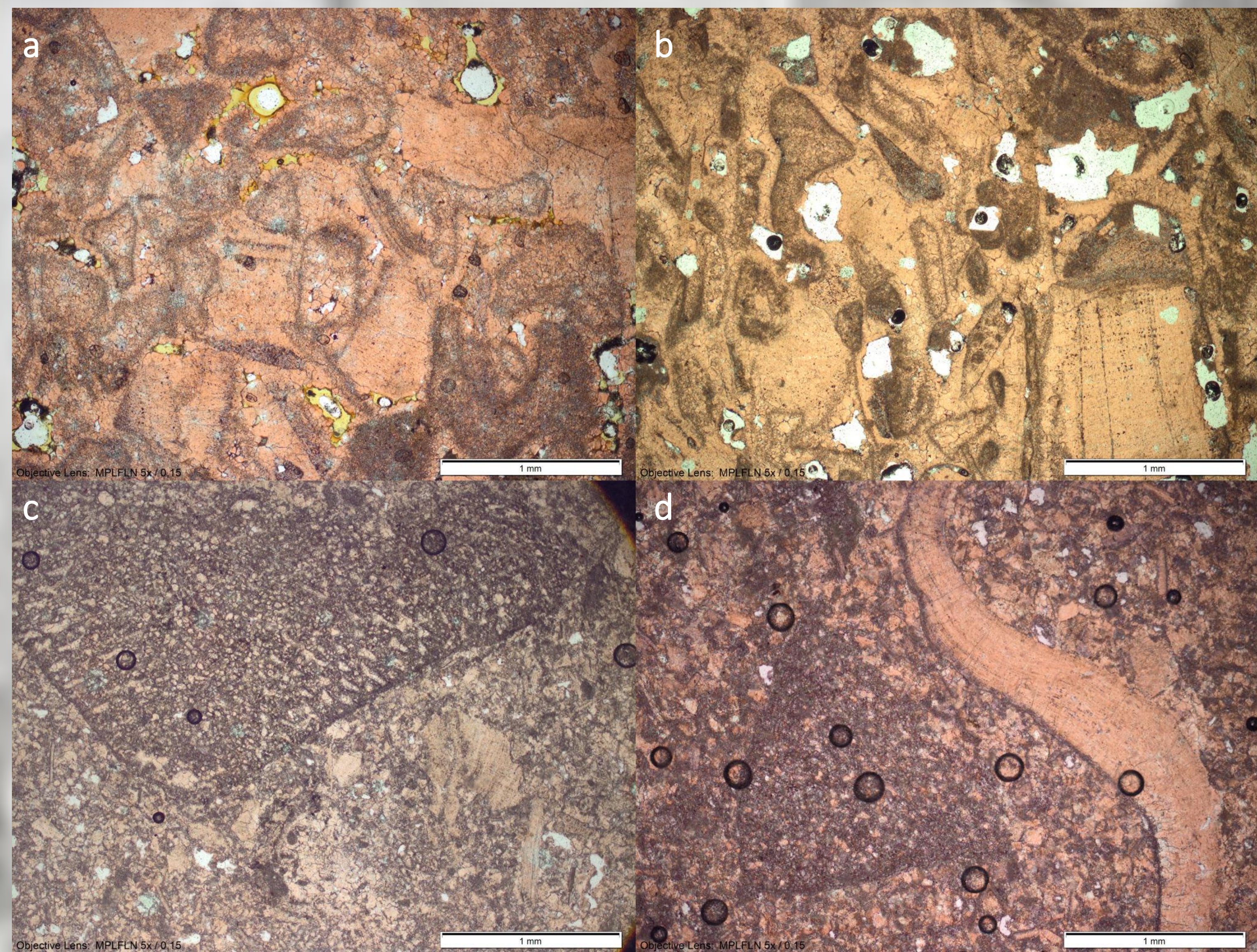


Figure 2. Photomicrographs of samples. a) **FV-1**, PPL; b) **Marčana**, PPL; c) **Vinkuran**, PPL; and d) **Pješčana uvala**, PPL. Magnification 50x, measure line 1 mm.

Sample ZMP-2 was determined as a bioclastic rudstone/oncosparite with the presence of the *Bacinella irregularis* microproblematica and *Trocholina* sp. foram. The sample is characterized by high porosity.

Sample U-13 from the Monte del Vescovo Roman quarry was determined as a ooid-bioclastic grainstone/oosparite-biosparit, also with the presence of the *Bacinella irregularis* microproblematica and *Trocholina* sp. foram. This sample is also characterized by high porosity. It corresponds to the sample **ZMP-2**.

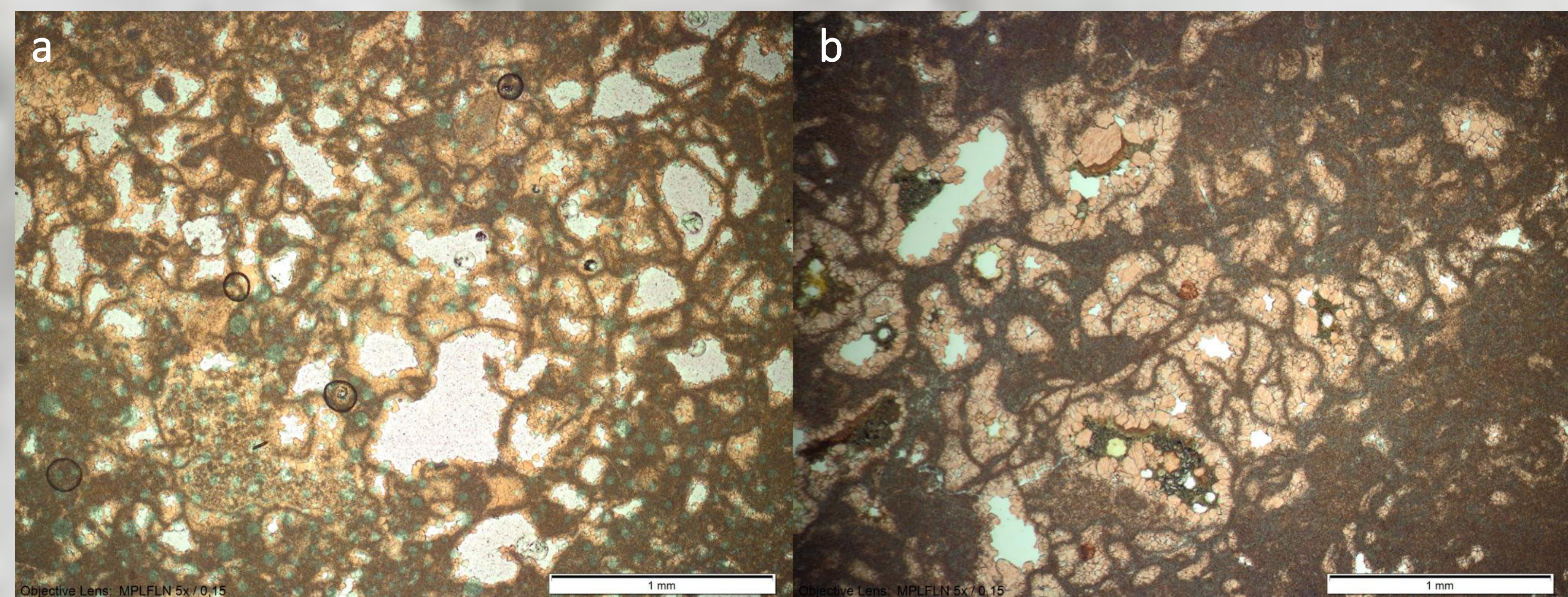


Figure 3. Photomicrographs of samples. a) **ZMP-2**, PPL and b) **U-13**, PPL. *Bacinella irregularis* microproblematica. Magnification 50x, measure line 1 mm.

4. CONCLUSION

Micropetrographic analysis can help us determine the provenance of used raw stone materials. During Bronze Age, communities frequently exploited limestone outcrops on the hilltops to build the drywall ramparts of their hillforts. On the other hand, during Antiquity stone was exploited systematically in quarries. Both prehistoric and Roman communities usually used the nearest limestone source for their purposes. This was the case with the drywall rampart of the Glavica Bronze Age hillfort (**sample G-1**) which was built from the limestone outcrops on the hill itself. However, the temple trabeation in *Parentium* (**sample ZMP-2**) was manufactured from stone extracted in quarries at least 3 km away, as the crow flies, even though there were quarries closer to the the city itself. We presume the sampled limestone was easier to work with due to its high porosity. The sarcophagus lid from *Pola* (**sample FV-1**) was manufactured from stone exploited in a quarry 13 km away as the crow flies, even though the city of *Pola* had in its vicinity two other quarries. However, we have no way of knowing when a certain quarry was opened.

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