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# A volunteered geographic information system for collecting and rating petroglyph data

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## ABSTRACT

In this paper we exploit a volunteer-based paradigm for archeological aims. In particular, we present PetroAdvisor, a system supporting several fundamental activities to digitally preserve petroglyph sites. The system exploits a rewarding strategy to stimulate people participation to the project, so that those entering useful information gain free archeological data, tips on excursions and tours, opinions and rating from previous tourists, and so forth. User provided information typically consists of petroglyph pictures, descriptions, and several useful metadata, such as geo-referenced information, petroglyph contours, and so forth, which can potentially empower the work of the archeologists, enabling them to tackle technology shortfalls.

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## 1. Introduction

In the last years, the World Wide Web has been used as a means to stimulate knowledge sharing and collaborative work, also letting people launch new models for developing services. This paradigm is generally referred to as “crowd” followed by a term identifying the aim of the service, e.g., crowdsourcing or crowdfunding. Moreover, a crowd service permits to gain information, money, or other services by leveraging the strength of the participating web community.

The World Wide Web has become one of the most powerful media to start collaborations and to tackle problems that would otherwise be simply unmanageable. Nowadays,

there are already meaningful examples of services provided by means of people combining their resources on the Web. These include the world's largest knowledge base Wikipedia,<sup>1</sup> several complementary services for GPS-assisted navigation, such as Waze,<sup>2</sup> and the emergency coordination platform Ushahidi-Haiti, which has been used to coordinate disaster response after the 2010 Haiti earthquake [1]. This new way of providing services is commonly referred to as *crowdsourcing* [2,3], and it may be adapted to gather information while solving real problems in several application domains. One of the problems that may arise in crowdsourcing is due to possible conflicts in the data provided by the crowd. Moreover, there are contexts in which few people have the necessary knowledge to provide reliable data. As an example, this happens in the context of geographic information, where

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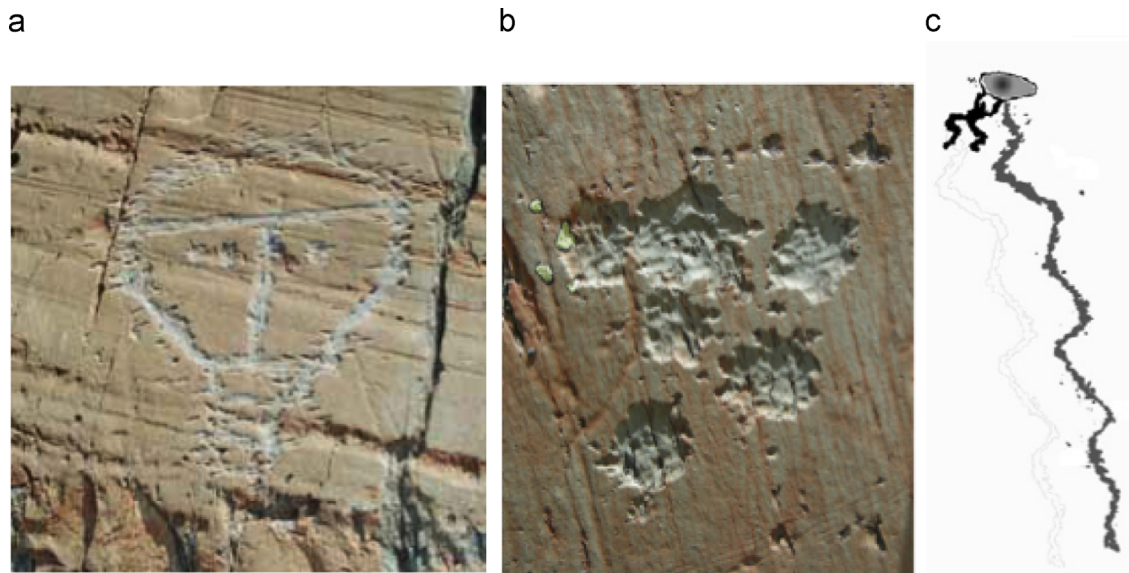
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<sup>1</sup> <https://www.wikipedia.org>

<sup>2</sup> <https://www.waze.com>



**Fig. 1.** The picture of a petroglyph supposed to represent a Christ (a) [7], a picture interpreted as the stellar cluster of the Pleiades (b) [6], and a relief depicting a priest making water spout from the rock (c) [5].

the process of gathering information from users is known as *volunteered geographic information (VGI)* [4].

The aim of this work is to exploit the volunteered geographic information paradigm for several archeological activities. In particular, we address issues related to the exploration of archeological sites, in order to derive a complete map of carvings, and digitally capture their images. Indeed, rock carvings represent an invaluable cultural and natural heritage, since they are often located in wonderful natural sites and represent an irreplaceable resource for understanding our history [5,6]. Unfortunately, they are constantly exposed to weathering and vandalism, and it is up to humanity to preserve them for future generations [7]. Moreover, site exploration and carving cataloguing is a complex and expensive activity, which cannot always be completely supported by domain experts, such as the archeologists. For this reason, VGI appears to be a promising solution to explore [8]. In fact, the growing will of people to participate in this kind of projects, together with the capillarity of smartphones, tablets, and wireless connections, can potentially increase the possibility of having fully mapped sites [9].

In this paper, we present PetroAdvisor, a system supporting archeologists in the digital preservation of petroglyph sites. In particular, the user provided information gathered by PetroAdvisor consists of petroglyph pictures, their contours, descriptions, comments, ratings, geo-referenced information, and so forth. This way of collecting data not only reduces the necessity of man power, but it also allows archeologists to tackle several technology shortfalls, such as the automatic segmentation and identification of petroglyphs within pictures [10].

However, in order for a VGI-based strategy to be successful, it is necessary to stimulate the participation of people in the data collection process. To this end, we use a rewarding strategy based on a “do ut des”: users entering useful information gain free tourist services, e.g.,

archeological data, tips on excursions and tours, opinions and ratings from previous tourists.

Finally, the main objectives of PetroAdvisor are (i) to map, collect, and analyze carving data for digitally preserving petroglyphs, also yielding new research opportunities, (ii) to collect user provided information in order to automate petroglyph recognition, and (iii) to reward tourists with information guiding them during their visits to petroglyph sites.

The remainder of the paper is organized as follows. **Section 2** introduces background information on rock art archeology and provides motivations of this research. **Section 3** shows some details about PetroAdvisor design and architecture, with particular emphasis on the actors and their functionalities. Some examples of usage scenarios from both the user and the archeologist points of view are described in **Section 4**. **Section 5** provides a discussion of works related to the proposed system. Finally, conclusion and future works end the paper in **Section 6**.

## 2. Context and motivations

Our work falls in the domain of rock art archeology. We have worked with prehistorical archeologists involved in the study of rock carving sites. In following subsections we provide background knowledge about rock art and the motivations of this work.

### 2.1. Rock art archeology

Rock art is a term coined in archeology for indicating any human made markings carved on natural stones [11]. Most of the symbols concerning rock art are represented through petroglyphs, which are created by removing parts of a rock surface by picking, carving, and abrading. They are among the oldest forms of art known to humans. Indeed, although early petroglyphs have traditionally been related to the appearance

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