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Short communication

From empirical considerations to absolute ages: How geomagnetic field variation may date Teotihuacan mural paintings

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ABSTRACT

Teotihuacan, the most important city of the Americas during the Classic period, developed a deep and complex civilization without any written histories. This millennial culture mostly used pictorial forms of visual communication expressed in numerous mural paintings. Thus, the knowledge of the absolute chronology of some of the most important mural arts is of great importance. Here, we report a comprehensive magnetic survey on two major murals of Palace of Quetzalcoatl, which represent an initial stage of the Teotihuacan archaeology. The magnetic mineralogy of sampled murals is dominated by both magnetite and hematite grains. The contribution of hematite, however, seems to be minor in the Pictorial Remanent Magnetization. Characteristic remanence was successfully isolated for 11 out of 16 analyzed samples belonging to both paintings. Archaeomagnetic dating was achieved using magnetic inclination and declination, yielding an interval between 312 CE and 409 CE as the best estimate of the time of painting of the murals. This study reinforces the early hypothesis that, red color mural paintings may be considered a complementary source of information about the secular variation of the Earth's Magnetic Field.

1. Introduction

Dating of archaeological material is a key issue in the archaeological research as it may significantly contribute to better understand our past and rescue our cultural heritage. Magnetic methodology may be a valuable tool for dating of baked clay artefacts, particularly in cases where the archaeological findings do not include diagnostic objects or suitable material for other chronology techniques. Archaeomagnetic dating is based on the fact that burned artefacts (baked clay, furnace, tiles, burned floors or walls) contain small quantities of ferrimagnetic minerals (mostly titanomagnetite and/or titanohematite solid solutions) that under certain conditions can register the direction and intensity of the Earth's magnetic field during the last cooling. Magnetic dating consists in comparing the declination, inclination and intensity recorded by an archeological object against a known record of geomagnetic variation in order to associate a date to the artifact under study.

On the other hand, paleomagnetic analyses on well dated baked archaeological dtructures may contribute to the knowledge of the geomagnetic field variation prior to instrumental measurements. Usually, burnt archeological and volcanic materials can provide high quality records of both direction and absolute strength of the Earth's magnetic field through the acquisition of a thermoremanent magnetization (TRM) during their cooling in the presence of the Earth's Magnetic Field (EMF). However, since the pioneering work of Chiari and Lanza (1997), the so-called Pictorial Remanent Magnetization (PiRM) may be also used as an alternative source of information about the geomagnetic field secular variation. PiRM would be carried by red murals, assuming that the magnetization of mural paintings is mainly carried by hematite grains that are present in the red color pigments. When the red pigment is applied to the wall, these grains are free to move and they align their magnetic moment with that of the Earth's magnetic field (see the review paper by Goguitchaichvili et al., 2016). Once the painting is dried, the magnetic grains maintain their orientation providing a 'pictorial' remanent magnetization.

Teotihuacan, the most important city of the Americas during the Classic period (for the Teotihuacan Valley, from 200 to 700 CE, according to Rattray (2009)), developed a deep and complex civilization without any written histories. They mostly used pictorial forms of visual communication (Langley, 1986) and thus, the knowledge of the absolute chronology of some of the most important mural arts is of great

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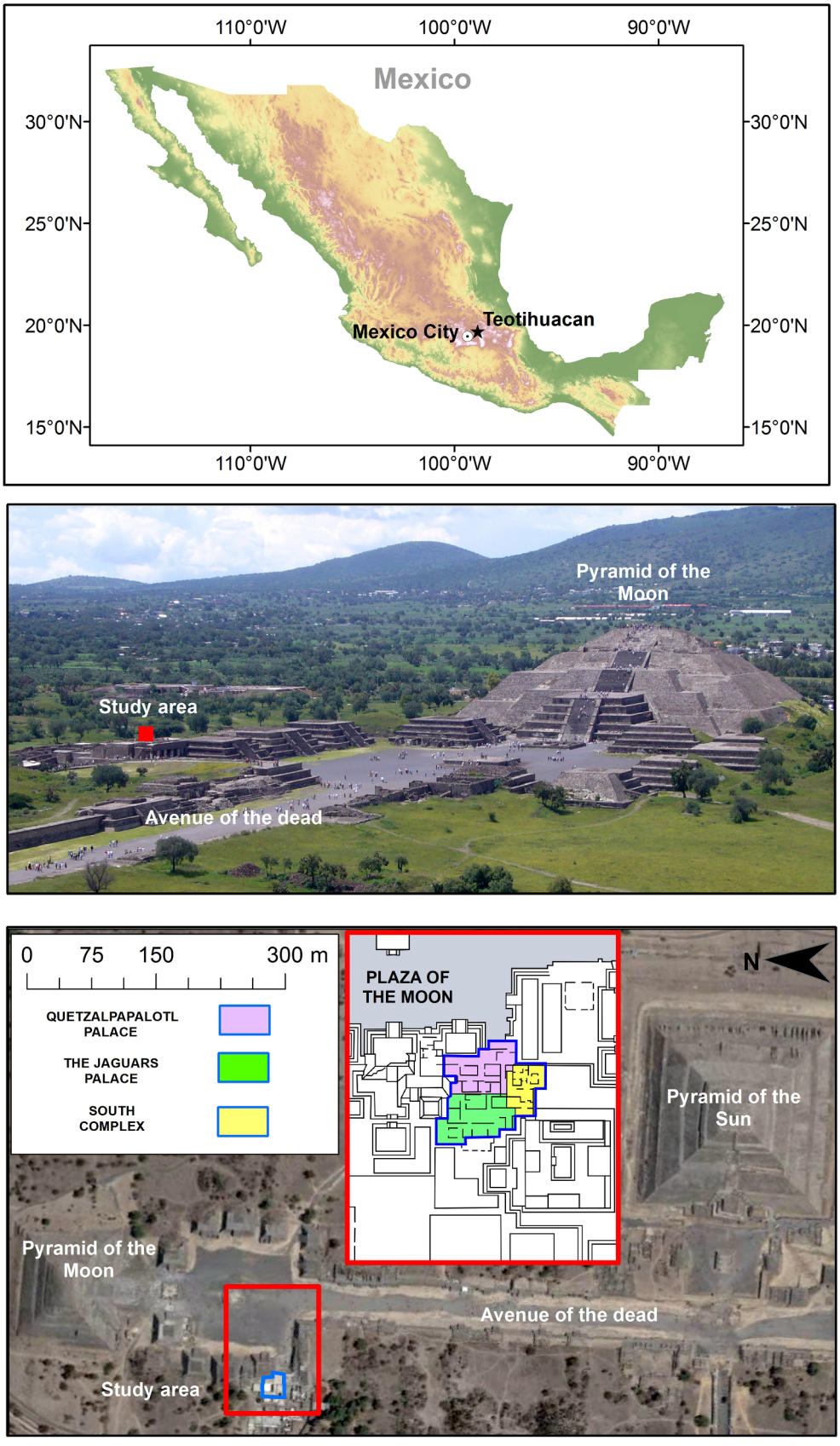

Fig. 1. General location (a) and view (b) of Teotihuacan archaeological complex near to Mexico City. Also shown is a schematic location of Palace of Quetzalcoatl (retrieved from Millon, 1973).