

Archaeogeophysical investigations in Tiwanaku: preliminary results

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The study of the human past needs the effort of different disciplines including history, archaeology and non invasive imaging techniques such geophysics whose application for cultural heritage has been dramatically increasing in the last two decades. The capability of geophysical techniques in identifying subsurface features of cultural interest depends on: 1) the nature of the physical interaction between the archaeological residues and its surrounding; 2) the performance of geophysical sensors, including Ground Penetrating radar (GPR), magnetometry, electrical resistivity along with other earth observation imaging systems (SAR, LiDAR, multispectral remote sensing); 3) the knowledge of the expected features of cultural interest to be detected. A correct approach must necessarily take into account these three factors on which depends the success of any preventive archaeological investigation based on geophysical prospecting techniques and remote sensing [1].

Such approach characterized the scientific researches performed by ITACA Mission of CNR in Southern America, since 2008, aimed at discovering unknown prehispanic sites, mapping historical settlements and monitoring archaeological heritage affected by man-made and natural risks [2-5].

One of the sites recently investigated by ITACA Mission is Tiwanaku, which is located on a valley at 3880 m above sea level, near the southern shoreline of the Titicaca Lake, in Bolivia. Tiwanaku was center of a prehispanic civilization which influenced large territories of south-central Andes from 500 to 1150 AD [6-7]. The available archaeological records attest a long human frequentation divided in three phases. In the first one (100 BC–AD 500), Tiwanaku emerged as major regional center. In the second one (AD 500–1150), it became a densely inhabited center with a political and economic leading role in the southern-central Andean region which ended around 1000 AD due to a long-term drought. Finally, in the third phase (AD 1150–1450) Tiwanaku was characterized by the resurgence of regional identities and polities

In spite of the rich archaeological record numerous issues, related to the function and the extension of Tiwanaku, need to be investigated especially in the monumental core which includes the pyramid of Akapana, and other ceremonial places such Kalasasaya, Putuni and Kantatallita. To this aims some geophysical investigations were performed in 2009 and 2014 in the context of multidisciplinary research including the use of satellite remote sensing [8].

This paper deals with the discussion of preliminary results of geomagnetic and GPR investigations, some of which have been verified by trial archaeological excavations which have unearthed some buried structures, improving the knowledge of the ceremonial areas of Tiwanaku.

References

- [1] Lasaponara R., Leucci G., Masini N., Persico R., Scardozzi G., Towards an operative use of remote sensing for exploring the past using satellite data: The case study of Hierapolis (Turkey), *Remote sensing of Environment*, 174 (2016) : 148–164, doi:10.1016/j.rse.2015.12.016
- [2] Masini N., Lasaponara R., Rizzo E., Orefici G. 2012. Integrated Remote Sensing Approach in Cahuachi (Peru): Studies and Results of the ITACA Mission (2007–2010), In: Lasaponara R., Masini N. (Eds) 2012, *Satellite Remote Sensing: a new tool for Archaeology*, Springer, Verlag Berlin Heidelberg, ISBN 978-90-481-8800-0, doi: 10.1007/978-90-481-8801-7_14; pp. 307-344
- [3] Rizzo E., Masini N., Lasaponara R., Orefici G. 2010, *ArchaeoGeophysical methods in the Templo del Escalonado (Cahuachi, Nasca, Perú)*, *Near Surface Geophysics* 8 (5), 433-439, doi:10.3997/1873-0604.2010030
- [4] Masini N., Rizzo E., Lasaponara R., and Orefici G. 2008, *Integrated remote sensing techniques for the detection of buried archaeological adobe structures: preliminary results in Cahuachi (Peru)*, *Advances in Geosciences*, 19, 75-82
- [5] Lasaponara R., Leucci G., Masini N., Persico R. 2014. Investigating archaeological looting using satellite images and GEORADAR: the experience in Lambayeque in North Peru. *Journal of Archaeological Science*, 42,

216-230, <http://dx.doi.org/10.1016/j.jas.2013.10.032>

[6] Kolata, A.L., 1993. *Tiwanaku: Portrait of an Andean Civilization*. Blackwell, Cambridge.

[7] Janusek, J. W., 2004. *Identity and Power in the ancient Andes. Tiwanaku cities through time*. Routledge, New York-London

[8] Lasaponara R., Masini N. 2014. Beyond modern landscape features: New insights in the archaeological area of Tiwanaku in Bolivia from satellite data. *International Journal of Applied Earth Observation and Geoinformation*, 26, 464–471, <http://dx.doi.org/10.1016/j.jag.2013.09.00>