

Geo-Temas



Volumen 15

VIII Jornadas de
Geomorfología Litoral



Geo-Temas



VII JORNADAS DE GEOMORFOLOGÍA LITORAL

• Costa del Sol •
Marbella, 3-5 Junio 2015

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Vol. 15 (2015)

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Imagen de portada: Dunas de Cabopino, Ensenada de Marbella (Málaga). Coastal Environments Research Group (RNM 911) Universidad Pablo de Olavide, de Sevilla.

Beach erosion and hidden quaternary deposits in Northern Portugal: advantages of high resolution drone images for its study and mapping.

Erosión de las playas y los depósitos cuaternarios ocultos en el norte de Portugal: ventajas de las imágenes de aviones no tripulados de alta resolución para su estudio y mapeo.

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Abstract: Atlântico Beach is located between Valadares and Francelos, 6 km to the south of the Douro mouth, in the Vila Nova de Gaia municipality (Northern Portugal). It is a coastal sector where beach sands and dunes generally lay over precambrian rocks belonging to the Ossa-Morena Zone. The construction of a block protection for the submarine exhaust of the Wastewater Treatment Plant situated 3,7km to the North, triggered significant erosion and the partial destruction of a restaurant at Francelos. The sequence of storms that affected the Portuguese coast in the winter of 2014 caused generalized beach erosion along Portuguese western coast. On December 30th, 2014, an almost continuous and insightful deposit sequence was visible at Atlântico beach. On January 3, 2015 it was possible to perform a drone flight. The fine quality of the outcrop and the photographs, their geo-referencing and precise altimetry (GPS with differential correction) allowed detailed mapping of marine and solifluxive deposits and is a good contribution to the study of climate and related sea level changes in the last 125,000 years. All this reinforces the importance of using drone technology in coastal environments.

Key words: Northern Portugal, Vila Nova de Gaia, Pleistocene, Würmian solifluxive deposits, eemien beach.

Resumen: Playa Atlântico está situada entre Valadares y Francelos, a 6 km al sur de la desembocadura del Duero, en el municipio de Vila Nova de Gaia (Norte de Portugal). Se trata de un sector costero donde las arenas de playa y dunas asientan generalmente sobre rocas precámbricas pertenecientes a la Zona de Ossa -Morena. La construcción de una protección para el escape submarino de la Planta de Tratamiento de Aguas Residuales situado a 3,7km para Norte, desencadenó una dramática erosión y la destrucción parcial de un restaurante en Francelos. La secuencia de las tormentas que afectaron a la costa portuguesa en el invierno de 2014 causó la erosión generalizada de las playas en la costa occidental portuguesa. El 30 de diciembre de 2014, una secuencia de depósitos casi continua y bien expuesta era visible en la playa Atlântico. El 3 de enero 2015 fue posible realizar un vuelo de avión no tripulado. La alta calidad del afloramiento y las fotografías, su georreferenciación y altimetría precisa (GPS con corrección diferencial) permite un mapeo detallado de los depósitos marinos y solifluxivos y es una buena contribución al estudio de clima y del nivel del mar en los últimos 125000 años. Todo esto refuerza la importancia del uso de la tecnología de aviones no tripulados en entornos costeros.

Palabras clave: Norte de Portugal, Vila Nova de Gaia, Pleistoceno, depósitos solifluxivos do Würm, playa eemiense.

INTRODUCTION

Atlântico Beach is located between Valadares and Francelos, 6 km to the south of the mouth of Douro in the Vila Nova de Gaia municipality (Northern Portugal).

From the Spanish border to Espinho, the Northern Portuguese coast stays on the Iberian Massif. In this particular area the beach sands and dunes lay over bedrock that is included in Ossa-Morena zone. These rocks, mostly biotitic micaschists, sometimes rich in garnet, are considered as Proterozoic (Chaminé *et al.*, 2003).

The construction of a protection for the submarine exhaust of the Wastewater Treatment Plant situated 3,5km to the North (fig.1) triggered significant erosion and the partial destruction of a restaurant at Francelos (fig. 2). From this moment on, several times the eemien-würmian sequences underlying beach sand and dunes have been visible in the area south of the Bar Praia Atlântico (fig. 1).

The winter of 2014, with strong storm waves that attained the maximum height of 15m with maximum periods of 25 seconds (data of Instituto Hidrográfico), created a strong stress over the already weakened beach system of the whole of the western coast of

Portugal. In this particular sector there was an unexpected uncovering of beach and dune sands along a stretch *ca.* 120m. An almost continuous and insightful underlying deposit sequence was visible at the south of Atlântico beach, near Francelos beach for

the first time in several years (fig. 3). The situation was photographed at 30 December 2014 at a tide *ca* 33cm below mean sea level.



FIGURE 1. Google Earth Pro image showing the position of studied area in relation to Douro estuary.



FIGURE 2. 31 December 1998: the destruction of the so-called "Titanic" restaurant.

PLEISTOCENE DEPOSITS

Overlaying the neoproterozoic micaschists of the Lourosa unit (Chaminé *et al.*, 2003) a marine deposit could be seen (fig. 3). This formation corresponds to an iron-cuirassed conglomerate that is typical of the last interglacial marine deposits along this coastline (Araújo *et al.*, 2003). We have already a TL age (Araújo *et al.*, 2010) that points to an Eemien age.

On this eemien beach a mud-silty formation that has been considered a würmien solifluxive deposit (Araújo 1991) appears in two different aspects: the

lower one has a yellowish color and typically has mud cracks on its top (figs. 3 and 4). Upon it lies a more compact and hardened solifluxive formation. The contrast in resistance of the two layers creates a micro-cliff, which is quite visible in figures 3 and 5.



FIGURE 3. View of the Atlântico beach outcrop (30/12/2014). 1- Precambrian micaschist; 2- Eemien beach; 3- Solifluxive layer with mud cracks; 4- hardened top of the solifluxive layer

These kinds of sequences appear sometimes in these coastal areas. The construction of a detached breakwater in 2002, another 3,6km to the south of this spot, had shown an even more interesting sequence of Pleistocene-Holocene deposits (Araújo *et al.*, 2010).

METHODOLOGY: USE OF THE DRONE

The appearance of these outcrops is commonly ephemeral. So, we carried out a flight that took place the 3th January 2015. The drone photographed the area with a high-resolution camera. The photos were geo-referenced by the drone mechanism and the results were processed with the data obtained with a Leica SR20 GPS with differential correction.



FIGURE 4. *The fossil mud-cracks on the top of the lower layer of the solifluxive deposit*

The good outcrops that show last interglacial marine deposits and detailed solifluxive würmien sequences are a good contribution to the study of climate and related sea level changes in the last 125,000 years.

The fine quality of this outcrop and the photographs, with geo-referencing and precise altimetry allowed a detailed view of the deposits underlying beach and dune sands.

We think that some of these eemien beaches appear at different levels along this coastline (Araújo, 2008). So, this precise registration and mapping might be a key to understand eventual neotectonic movements.

Not surprisingly, less than four days after our first visit, there was already some accumulation of beach

sand upon the lower part of the sequence, and the fossil beach is barely seen on the drone pictures.

However, the excellent definition of the photos, the correct geo-referencing and the definition of its orthometric heights allowed a precise mapping of different layers. This is very relevant for building a database that may correlate these kinds of outcrops, as they appear quite randomly in time and space.

CONCLUSIONS

The use of a "drone" compared with other data acquisition techniques is very advantageous as it is a low cost procedure and the time required for data collection and processing is reduced. The collected data can be processed on site, allowing immediate visualization of results and error correction through the repetition of flights.

All this reinforces the importance of using drone technology in coastal environments due to the intense dynamism of these areas and the necessity of catching good photographs for the construction of reliable and detailed maps.

ACKNOWLEDGEMENTS

I am very grateful towards my "old" friend Lucinda Sá that discovered this outcrop and told me about it. Without her help this ephemeral view would never be registered.

I deeply thank my friend Pamela Matlack Klein whose support, competent and insightful revision improved the quality and legibility of this paper.

We also acknowledge gratefully the reviewer from the Scientific Commission of the Journeys for improving the quality of the paper.



FIGURE 5. *3D view obtained with the drone flight. The metamorphic bedrock appears on the left.*



FIGURE 6. The kind of details provided by the drone pictures. The hardened top of the solifluxion coverture corresponds to the one on figure 3. The lower area (left) is a layer marked by mud cracks also visible at fig. 4.

REFERENCES

- Araújo, M.A. (1991) - *Evolução geomorfológica da plataforma litoral da região do Porto* - Ph.D. Thesis, Porto, FLUP, 534 p.
- Araújo, M.A. (2008) - *Depósitos do Pleistocénico Superior e do Holocénico na Plataforma Litoral da Região do Porto: a Morfologia das Plataformas de Erosão Marinha e a Tectónica Recente*, APEQ - *Estudos do Quaternário*, nº 5, p. 17-32.
- Araújo, M.A., Vieira, M., Gomes, A. (2010) - "Depósitos eemianos e holocénicos do litoral da região do Porto - novos dados: apresentação preliminar". *Actas do V Congresso Nacional de Geomorfologia*, Apgeom, FLUP e ISEP. E-book (ISBN: 978-989-96462-2-3).
- Araújo, M. A.; Gomes, A.; Chaminé, H. I.; Fonseca, P. E.; Gama Pereira, L.C. & Pinto De Jesus, A. (2003) - "Geomorfologia e geologia regional do sector de Porto-Espinho (W de Portugal): implicações morfoestruturais na cobertura sedimentar cenozóica", *Cadernos do Laboratório Xeolóxico de Laxe*, nº 28, p. 79-105.
- Chaminé, H. I. (2000). *Estratigrafia e estrutura da faixa metamórfica de Espinho-Albergaria-a-Velha (Zona de Ossa-Morena): implicações geodinâmicas*. Universidade do Porto. 497 pp. (PhD Thesis).
- Chaminé, H. I.; Gama Pereira, L. C.; Fonseca, P. E.; Noronha, F. & Lemos de Sousa, M. J. (2003). Tectonoestratigrafia da faixa de cisalhamento de Porto-Albergaria-a-Velha-Coimbra-Tomar, entre as Zonas Centro-Ibérica e de Ossa-Morena (Maciço Ibérico, W de Portugal). *Cad. Lab. Xeol. Laxe*, A Coruña. Vol. 28, pp. 37-78
- WEBSITE Instituto hidrográfico:
<http://www.hidrografico.pt/boias-ondografo.php>