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GEOLOGICAL CHARACTERIZATION OF COASTAL DUNES IN GRAN CANARIA (SPAIN) BY SEDIMENTOLOGIC, MICROPALAEONTOLOGIC AND PETROGRAPHIC ANALYSES

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Resumen (Caracterización geológica de dunas costeras en Gran Canaria (España) mediante análisis sedimentológicos, micropaleontológicos y petrográficos): *Los materiales subyacentes del sistema de dunas móviles del campo de dunas de Maspalomas se han estudiado mediante diversas técnicas geológicas y micropaleontológicas sobre muestras obtenidas mediante sondeos. Los resultados indican que el depósito sedimentario está formado por dos unidades. La unidad inferior se formó a partir de aportes constantes y cada vez más significativos de los barrancos próximos, depositados bajo el agua en un ambiente de poca energía. En la unidad superior los aportes terrestres son mucho menos significativos. El escaso número de foraminíferos presente en esta segunda unidad podría interpretarse como resultado de cambios relativos del nivel del mar, aunque también como resultado de un evento de muy alta energía.*

Palabras clave: Análisis granulométrico, foraminíferos, aporte de sedimentos, evento de alta energía.
Key words: *Grain-size analysis, foraminifera, sediment provenance, high-energy event.*

INTRODUCTION

The Maspalomas dunefield is located at the southernmost point of Gran Canaria Island, partially over a fan delta associated to the mouth of the Fataga-Maspalomas ravine (Pérez-Chacón et al., 2007; Fontán et al., 2013). On top, the only transgressive dunefield in the island occurs.

The dunes migrate from the input area along El Inglés beach towards the southwest transported by the trade winds, which blow from the ENE. After crossing the system, the dunes reach Maspalomas beach, where they enter back into the ocean (Fig 1). The dune morphologies are mostly barchans and barchanoid dune ridges, as well as nebkhas associated with the vegetation in the eastern foredune.

The sedimentological characteristics of the dune sediments were addressed by Alonso et al., (2011), who states that on average 60% of the sediments are marine bioclasts and 40% terrigenous materials. Between the former group, fragments of calcareous algae are the most abundant, followed by molluscs, with bryozoans and foraminifera in very small proportion. Regarding the lithoclastic materials, the most abundant ones are ferromagnesium minerals and felsic rocks, which account for 60% of the terrigenous portion. The rest are fragments of basic rocks, other minerals and volcanic glasses.

The thickness of the aeolian deposit is not homogeneous along the dunefield. It is nearly nonexistent in many parts of the central area, were many outcrops of the underlying materials (alluvial and carbonated rocks, typical of alluvial-aeolian interference systems) can be observed (Pérez-Chacón et al., 2007). On the other hand, the aeolian deposit is 15-20m thick at the eastern part. To date in this last sector no outcroppings of those sedimentary materials have been detected, but only sands. According to Alcántara-Carrió and Fontán (2009), these differences reflect the eastward progradation of the coastline, although El Inglés beach has remained relatively constant over the last 50 years (Alonso et al., 2001; Smith et al, 2017).

With all these in mind, the aim of this study is to characterize the underlying materials of the eastern part of the dunefield, in order to get insights on its formation.

METHODS

Two drill cores named S1 and S3 were obtained at two different locations along El Inglés beach by means of a TP50-D drilling vehicle with rotational head. Location was selected considering that this is the area with the higher sediment thickness. Length of S1 and S3 drill cores were 19 and 16m respectively (Fig 2). In both sites drilling depth was down to a rocky basement. Since the drilled material is unconsolidated sediment, it was not possible to recover a continuous core, but discrete samples that were related to the corresponding drilling depth.

The detailed analysis of samples collected from both corers include grain size analysis through dry sieving at 0,5 Ø intervals for the sand-size fraction and pipette method for silts and clays. Determination of carbonate content was performed by Bernard method, organic matter following Walkey & Black method, grain roundness using a binocular microscope, petrographic studies by thin sections and foraminifera were classified following Loeblich and Tappan (1987). Approximately one sample every 50cm was used for the grain size and carbonate content determinations, while selected samples were used of the rest of analyses.

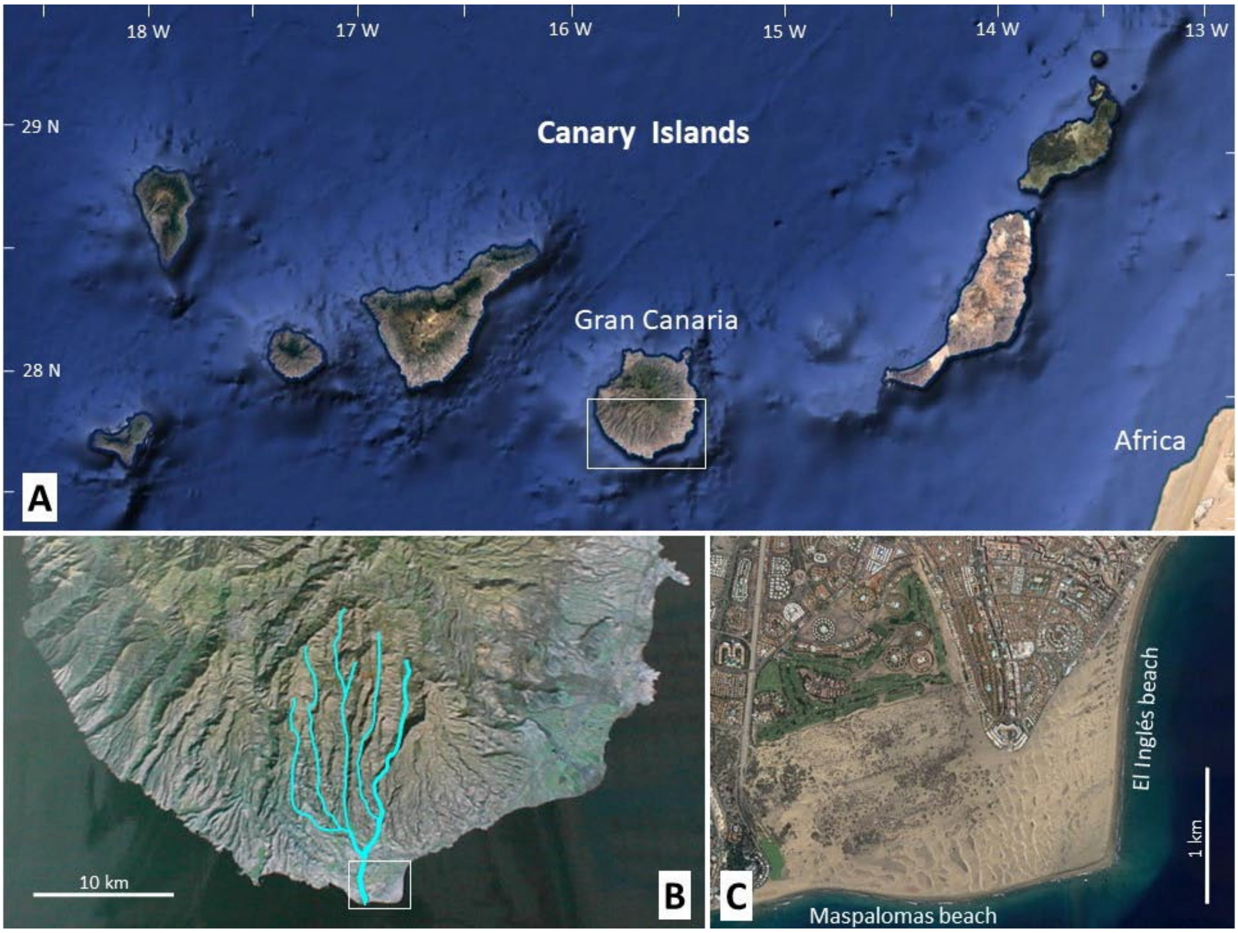

Fig. 1: Location map of the Canary Islands (A), closer view of the southern part of Gran Canaria showing the different branches of the Fataga-Maspalomas ravine (B) and aerial view of Maspalomas dune field, between El Inglés and Maspalomas beaches (C).

Fig. 2: Drilling vehicle on site ready to proceed with the drill process.

RESULTS AND DISCUSSION

Results show that for most of the different analysis carried out, there is a quite large variability between contiguous samples. Therefore, there is a continuous succession of peaks and lows along the log plot. Nevertheless, for most of the variables involved it is possible to identify two opposite trend lines separated at the depth of 8m. It means that when a certain variable increases upward between 0-8m, same variable decreases upward between 8-19m (8-16m for S3).

This pattern is clearly noticeable in both cores, with a break point located at 8m depth. This fact has allowed differentiating two sedimentary units within the deposit.

The lower unit extends from the lower limit of the corer up to 8m depth. In this unit the average content of silt and clay is 26,6% and 23,6% for S1 and S3 respectively, which is a significant portion of fine materials. However, apart from the data, there is a clear upward increasing trend for silts and clays in both drill cores (fig. 3). Basic and felsic fragments of rocks follow the same pattern as silts and clays. Considering the environmental setting, silts and clays can only be explained as alluvial inputs. The higher proportion of fragments of rocks is also indicative of runoff through the Fataga-Maspalomas ravine, as well as from other small ravines located around the dunefield.

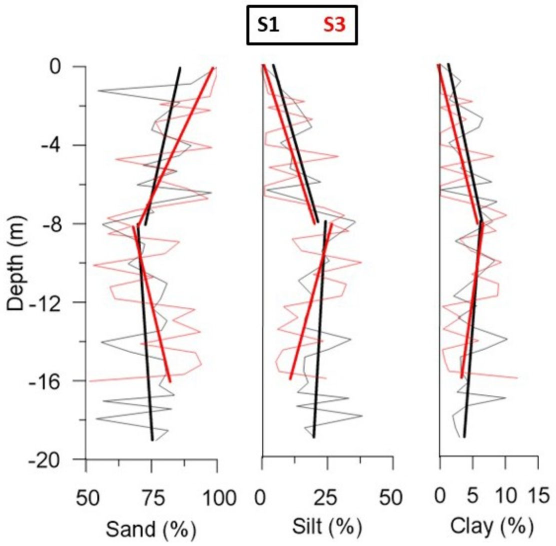

Fig. 3: Depth plots of sand, silt and clay for both drill sites. Thick lines correspond to linear regression fits, which show the different pattern associated with both units in the deposit.

Furthermore, the high amount of foraminifera, including some planktonic shells, indicates that these terrestrial materials were deposited under marine conditions.

On the other hand, the higher unit extends from the depth of 8m up to the surface. During this second unit, the average content of silt and clay is 15,4% and 11,7% for S1 and S3 respectively, much lower values than those found in the lower unit. In this case, these variables shows an upward decline (Fig. 3). Same pattern is found for the amount of rock fragments. As a result, sand-size fragments of calcareous seaweeds mostly form this unit. This fact reflects a weaker influence of inland contributions compared to the lower unit. In other words, this upper unit indicates a much stronger contribution of marine inputs.

Regarding the foraminifera content, the number of individuals present in this upper unit is much smaller in any of the cores compared to the lower unit. This difference could be explained either by the smaller contribution of marine inputs or by considering that this area was not any more below water.

The first possibility does not agree with the increasing amount of calcareous seaweeds, which is a consequence of marine inputs. The second option is not easy to explain. Considering that the beginning of this unit is located 8m bellow surface, and that the dunefield ground surface is approximately 1m above MSL, it indicates that the initial stages of this unit took place when the sea level was approximately 7m below present MSL.

How could it be that a huge amount of marine sediments accumulates 7m below water but incorporating only a very small number of foraminifera? There are two possible answers to this question. First relates to sea level changes, so that if sea level had presented a quick relative drop of 5-7m followed by a slower sea level rise, the area would have become much shallower. In these conditions the area would be in the surf zone, so that an accreting beach would steadily incorporate marine sediments, but the lack of a minimum water depth would explain the small amount of foraminifera.

Second possible answer relates to the sedimentation rates. Under very high-energy conditions, marine sedimentary deposits that were located below depth of closure could have been moved onshore. As far as these marine deposits become located in shallower areas, they would be available to enter into the littoral dynamics. Therefore, they could be moved by normal waves and be pulled up to the beach face, allowing the formation of El Inglés beach. From there, wind would be responsible of transporting these materials inland, and consequently the current mobile dunefield would have developed. This process would not be instantaneous, but the sedimentation rate would be much higher than it was in the previous unit. The only possible foraminifera would be those that were already settled in the original deposit.

CONCLUSIONS

The Maspalomas dunefield is partially (western) located on top of an alluvial fan, which is the result of runoff through the Fataga-Maspalomas ravine, and partially (eastern) on a sandy deposit. This last one consists of two different sedimentary units: the lower one extends from the bedrock (located between 16 and 19m below nowadays surface) up to a depth of 8m, and the upper unit which extends from 8m depth up to surface.

Around 25% of sediments in the lower unit is silts and clays, which follows an upwards increasing trend. There is also a high amount of foraminifera, including some planktonic individuals. From both facts, we can assume that inland inputs proceeding from ravines were steadily deposited below water mixed with marine sediments. This deposition took place until the deposit was approximately 7m below present MSL (8m below ground surface).

The upper unit shows much lower values of fine sediments, which additionally follow an opposite trend. This fact, coupled with the increasing amount of calcareous seaweeds, indicate that marine sediments mostly form the upper part of the deposit. The low amount of foraminifera found in this upper unit could be either an indication of relative sea-level changes or the consequence of a very high-energy event.

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