STRATIGRAPHY AND SEDIMENTARY FACIES OF THE LLOBREGAT DELTA FROM GEOTECHNICAL MEASUREMENTS

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Abstract

A 3D model of the Llobregat Delta has been constructed from CPT and CPTU measurements. This model shows the spatial distribution of sedimentary facies including beach sands, floodplain silts and clays, delta front sands and silts, and prodelta silts and clays. Each facies is described in terms of mechanical properties namely cone tip resistance (q_c) and friction ratio (FR%). Groundtruthing of lithologies is provided by continuous cores in control boreholes. Moreover, key surfaces for sequence stratigraphic interpretation, like transgressive and maximum flooding surfaces, have been identified.

Keywords: Geotechnical measurements, stratigraphy, sediment facies, Llobregat Delta

The present study is based on Cone Penetration Tests (CPT) and piezocone tests (CPTU) from a geotechnical study carried out prior to the construction of a new sewage treatment plant (EDAR) on the delta plain of the Llobregat River. 70 CPT/CPTU tests and 20 boreholes with continuous core recovery were performed within a 1.2 x 0.25 km^2 area. Despite of its small size, the study area is considered to be representative of the deltaic system because of its location near the current river mouth and orientation parallel to the river lowermost course. Both methods provide a high measurement rate of the soil resistance (q_c) and friction (f_s) recovered every 1 to 2 cm. CPT/CPTU data combined with continuous cores are widely used for the geotechnical and sedimentological characterization of soft soils [1].

The data set has been used to construct a 3-D model using the minimum tension gridding (MTG) method. This technique has the advantages of its simplicity. In addition, it does not require large calculation times. The modelling results unveil the internal structure of the delta by illustrating the spatial distribution of sedimentary units and q_c trends. The results obtained through the MTG method are supported by previous results from the same study area using kriging algorithms [2].

Within the general architectural frame, our study allows differentiating fluvial channel sands, beach ridge sands, crevasse sands, delta front sands, silts and clays, and prodelta silts and clays. Each facies is described in terms of its mechanical properties, namely q_c and FR%. Groundtruthing of sediment facies is obtained from continuous cores in control boreholes (Fig. 1). Plotting q_c *versus* FR% on Robertson's *et al.* chart [3] with inclusion of sediment facies allows establishing q_c-sediment facies correlation.

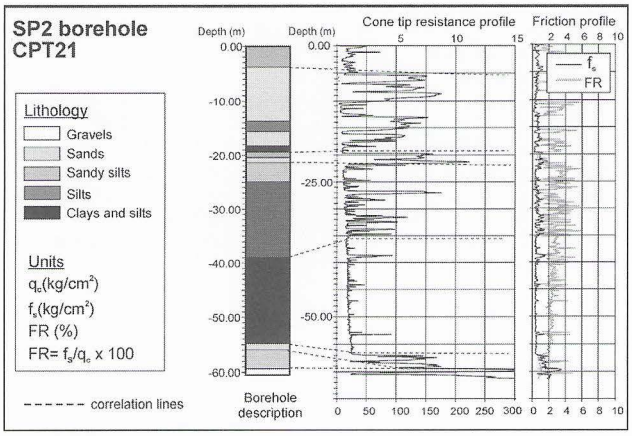

Fig. 1. CPT21 results plotted in parallel with the sediment log from a close borehole SP2. The correlation between soil resistance (q_c) values and the borehole lithological description becomes evident. The friction ration curve is also provided, since it is used jointly with q_c to develop the q_c-sediment facies correlation. The tree main sedimentary units are correlated: an upper sandy level between 5 and 20 m of depth, an intermediate level made of silts and clays with about 30 m of thikness, and a lower coarse level. This stratigraphic sequence represents the generally assumed deltaic coarsening-upwards sequence of prodelta and delta-front facies overlain by fine sediment attributed to the floodplain.

Relative sea-level stillstands have been identified from the location of landwards stepping beach ridge sands in the 3D model at 7, 13, 18 and 25 m of depth below the current sea-level. Their distribution can be attributed to retrogradational deltaic sequences formed during periods of relative stillstand within the transgressive systems tract related to the last post-glacial sea-level rise and subsequent shoreline migration. This fact allows to infer four relative sea-level stages associated to the upper part of the Versilian transgression, likely from about 11000 to 6000 yBP. Two additional, seaward shifted, uppermost beach ridge sands have been interpreted as representing two progradational phases associated to the highstand systems tract. This corresponds to a sustained delta growth and shoreline advance phase favored by a estabilization of the sea-level since 6000 yBP onwards.

References

[1] - Amorosi, A. and Marchi, N., 1999. High-reslution sequence stratigraphy from piezocone test: An example from the late Quaternary deposits of the southeastern Po plain. *Sedimentary Geology*, 128: 67-81.

[2] - Devincenci, J.M., Colàs, S., Falivene, O., Canals, M. and Busquets, P., 2003. Aplicación del piezocono para el estudio sedimentológico de detalle de los sedimentos cuaternarios del Delta del Llobregat, Barcelona. *Proceedings III Congreso Andaluz de Carreteras, Sevilla, España,* Octubre 2003.

[3] - Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986. Use of piezometer cone data. Proceedings of the ASCE Special Conference in situ '86: Use of *in situ* tests in geotechnical engineering, Blacksburg, 1263-80, American Society of Engineers (ASCE).