The Aitzgorrigain platform-margin paleokarst: general characteristics and origin (Lower Albian, N Spain)

El paleokarst de margen de plataforma de Aitzgorrigain: rasgos generales y origen (Albiense inferior, Bizkaia)

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RESUMEN

El paleokarst de Aitzgorrigain se encuentra en el margen de plataforma carbonatada de Itxina (Gorbea, Vizcaya). Es de tipo localizado, con una gran cavidad de disolución de 10 a 30 m. de anchura y 40 de profundidad, con morfologías ramificadas; fuera de esta cavidad apenas hay reflejo de disolución a gran escala. El relleno presenta calcarenitas laminadas con bioclastos recristalizados, alternando con micritas y ocasionales clastos de caliza encajante y dolomía. Tanto en el frente de la plataforma como detrás del margen el paleokarst se correlaciona con megabrechas calizas de resedimentación en masa. Se invoca una caída del nivel del mar de un máximo de 60 m. para explicar su origen; dicha caída provocó disolución localizada en grietas, resedimentación en masa y dolomitización superficial. El relleno de la cavidad principal se produjo durante la subida posterior del nivel del mar, mediante una sedimentación restringida de aguas tranquilas (micritas) y agitadas (calcarenitas).

Key words: *Paleokarst, rudist platform margin, laminated limestone infill, Lower Albian, N Spain.*

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Introduction

The Itxina limestones (Fernández-Mendiola, 1987) crop out in the western part of the Gorbea Massif, Bizkaia, northern Spain (fig. 1). They mainly consist of subtidal micrites with rudists, corals and orbitolinids, and show gently progradational relationships towards the west. Approximately in the area of Aldabide there is a platform margin with a steep foreslope facing the basin. This platform margin represents a turnover of the building style from mainly progradational to mainly aggradational. Clinoforms with original dips up to 30° intertongue with basinal marls downdip in this margin, and several megabreccia units onlap different erosional surfaces at the toe of the clinoforms (fig. 2).

In a recent work, Gómez-Pérez *et al.* (1991) related some of the slope megabreccias with paleokarst surfaces in the platform margin, and attributed them to phases of relative sea-level fall. Three different paleokarsts have been identified in the platform margin so far: 1) Aitzgorrigain, the oldest, with an irregular dissolution cavity and offshoots affecting nearly 60 m of section, filled with laminated micrites/calcarenites, 2) Petrondegui, with a neptunian dyke up to 3 m wide, which neatly cuts at leat 50 m of section and is made up of calcarenites, and 3) Itxingote, the youngest, consisting of irregular dissolution fissures down to a depth of 30 m, filled with quartz sandstones.

The purpose of this work is to characterize and describe the main features of the Aitzgorrigain paleokarst, ant to make some considerations about its laterally equivalent deposits and paleogeographic relevance.

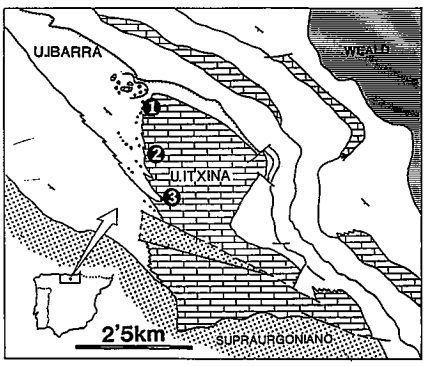

Fig. 1.—Location of the platform margin paleokarsts in the western rim of the Itxina platform, Lower Albian. 1: Aitzgorrigain paleokarst (object of the present study). 2: Petrondegi paleokarst. 3: Itxingote paleokarst.

Fig. 1.—Localización de paleokarsts en el margen de la plataforma Albiense de Itxina. 1: Paleokarst Aitzgorrigain. 2: Paleokarst Petrondegi. 3: Paleokarst Itxingote.

Aitzgorrigain paleokarst

Morphology

This is a «localized paleokarst» or paleokarst which had a localized drainage system (in the sense of Bonte, 1963). This means that only in some particular places, sometines widely separated from one another, the effects of dissolution and fill are clearly marked. The paleokarstic surface is normally represented by a rectilinear surface with minor dissolution features, under which skeletal rudstones with patches of dolomite or a completely dolomitized limestone bed 0,5 m thick, are found. Nevertheless, in the proximity of the Aitzgorrigain summit, the paleokarst appears as a major dissolution cavity, 10 to 30 m wide and 40 m deep (fig. 3), with offshoots affecting the host rock down to 60 m from the top. The host rock consists of mounded limestone beds several meters thick, with rudist micrites (fig. 4)

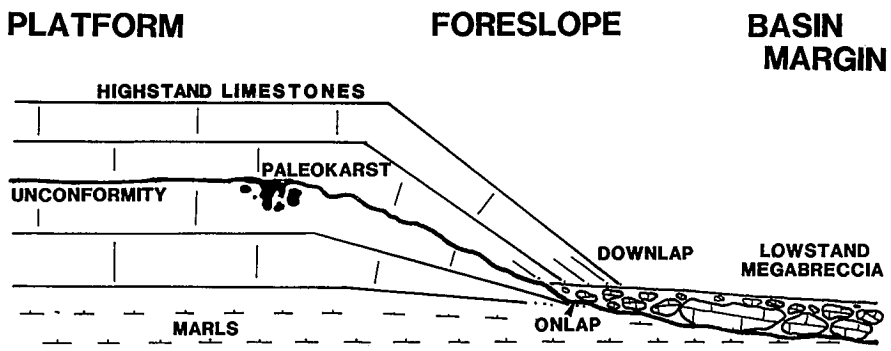

Fig. 2.—Simplified model of the platform margin paleokarst formed during a sea-level lowstand and correlated with a lowstand megabreccia wedge. From Gómez-Pérez *et al.* (1991).

Fig. 2.—Modelo esquemático interpretativo de la formación del paleokarst Aitzgorrigain y las megabrechas correlativas, durante un período de nivel marino bajo.

and skeletal packstones to rudstones. The lateral boundaries of the major cavity have fissures and replacement patches filled with white blocky calcite up to several cm in crystal length. Some other meter-sized cavities are wider downwards and have a concave-upwards lower profile, i.e. they have a «cul de sac» shape (fig. 5).

Infill

The bulk of the Aitzgorrigain cavity fill consists of laminated calcarenites. Additional deposists are micrite beds and blocks of the host rock detached from the walls.

The laminated calcarenites are normally medium to fine-grained and show normal graded pattern. They consist of packstone- grainstones of skeletal debris highly recrystalized, so that they have an appearance of detrital spar cristals (fig. 6). Some clearly distinguished skeletal fragments are of rudists and echinoderms. In many cases the calcarenites appear completely recristalized, and then only some bioclasts are seen «floating» within a massive sparry calcite mosaic (fig. 6). The spaces among the allochems in the packstones and the intervening laminae between the different detrital beds consist of micrite. The laminated calcarenites/micrites follow the irregular boundaries of the karstic cavity in places, but they are interrupted abruptly against the walls or onlap them in other places. The laminae show internal unconformities and locally convolute structures, and they may surround blocks of the host rock detached from the walls; sometimes these laminae show nearly vertical dips.

Micritic intervals alternating with calcarenite show very thin milimetric irregular and festoon-like or mounded laminations, which could be attributed to organic activity, perhaps of cyanobacteria. Apart from these laminae, micrites also make up thicker beds (up to a few decimeters), without any sign of organic remains or structures. Muddy/grainy couplets similar to the ones described are identified in the recent as laminites of algal mat origin (Park, 1976). The coarset grains are storm-induced skeletal grains recrystalized after the early burial diagenesis. Additionally, modern analogs of storm-influenced calcarenite infill of dissolution cavities (blue holes) have been documented from the Bahamas by Smart *et al.* (1988).

The blocks of the host rock within the cavity are mainly micritic limestones with rudists. They have rather smooth boundaries, show a random orientation, and reach from some centimeters to half a meter in length. They appear embedded in the laminated calcarenite/micrite facies. Some blocks from a few centimeters to 30 cm are made up of dolomitized limestones, and they probably were originated below the unconformity surface (emersion interface) which displays a rectilinear character and patchy dolomitization underlining it.

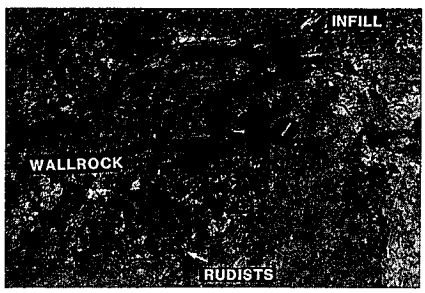

Fig. 4.—Field photograph of the laminated facies infilling a dissolution cavity in the wallrock rudist limestones.

Fig. 4.—Detalle del relleno por facies laminadas de un hueco de disolución en la caliza autóctona de rudistas. Cavidad kárstica principal.

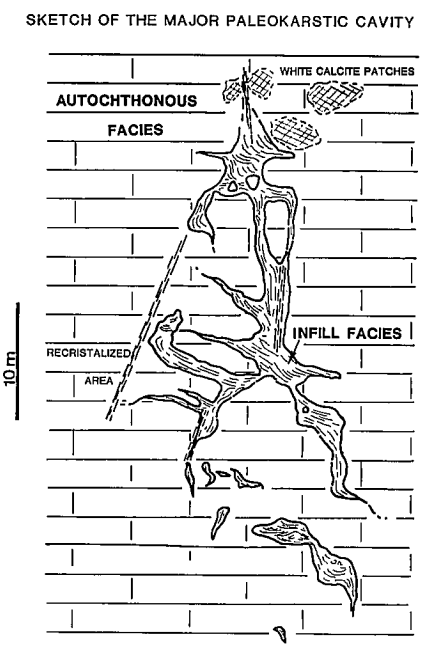

Fig. 3.—Field sketch of the major paleokarstic cavity (Aitzgorrigain). The autochthonous facies are rudist wackestones, the laminated infill is made up of laminated calcarenites and micrites.

Fig. 3.—Esquema de la cavidad paleokárstica principal. Las facies autóctonas están formadas por caliza micrítica de rudistas. El relleno consiste en calcarenitas laminadas y caliza micrítica pura.

Lateral correlation

The Aitzgorrigain paleokarst is correlated with an erosional surface truncating clinoforms in the upper foreslope of the platform margin. At the toe of the foreslope a multi-episodic megabreccia with olistoliths up to 100 m long and 6 m thick, consisting of micrite coral facies from the talus clinoforms, represents an erosional phase of the upper foreslope and platform margin. In a small intraplatform basin (Lexardi), the paleokarst is correlated with an interval of limestone

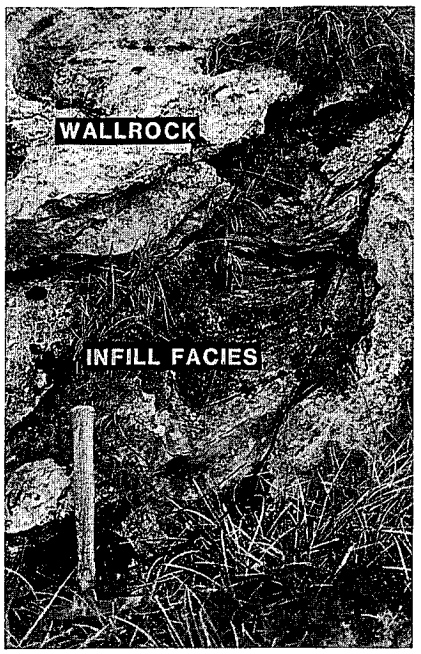

Fig. 5.—Field photograph of a metric paleokarstic cavity with «cul de sac» type infill made up of laminated calcarenite.

Fig. 5.—Cavidad kárstica métrica con relleno en «cul de sac» de calcarenita laminada.

breccias and megabreccias, which erode previous sediments and have an irregular distribution.

Interpretation

The presence and characteristics of the Aitzgorrigain paleokarst suggest a maximum sea-level fall of about 60 m in the Itxina platform margin. The localized drainage system which resulted from the margin exposure was most probably controlled by the development of a widely spaced pattern of major joints. These joints were strongly enlarged by dissolution of the pure limestones in the margin, and as no terrigenous input was simultaneously brought into the platform, no terrigenous sediment -residual or transported- represents this stage of dominant dissolution. Correlatively with this stage a severe erosion took place in the platform foreslope, probably because of the lowering of the wave-base level, the fracturing of the platform margin and, perhaps, the mobility of the substrate by tectonic action (fig. 7). The same erosion and resedimentation processes happened in the platform interior (Lexardi intraplatform basin), which means that the rim of the platform margin supplied detrital limestones to both sides, foreslope and back margin.

The fill of the major cavity in Aitzgorrigain was being completed as the sea level rose again, probably intermittently, to its former highstand position. Dissolution still was active, as the «cul de sac» structures and fallen blocks from the walls demonstrate, but deposition prevailed. This deposition was marine, with alternating phases of completely quiet waters and high-energy percolating waters. During episodes of calm waters, micrite settling or even in situ cyanobacterially-induced micrite production took place. During episodes of agitation, perhaps storm-induced waters, skeletal and inorganic particles were transported along fissures and deposited in the cavities. The fallen blocks from the walls of the cavity indicate that dissolution was still taking place during the phase of infill, or that early weakening by dissolution plus wave action, weight of sediment and water and bioerosion, triggered the collapse of the blocks. The dolomite clasts in the cavity suggest that the dolomitization associated with the unconformity pre-dated the cavity infill, so that such dolomitization was early and took place during the phase of sea-level fall, probably through mixing water diagenetic processes.

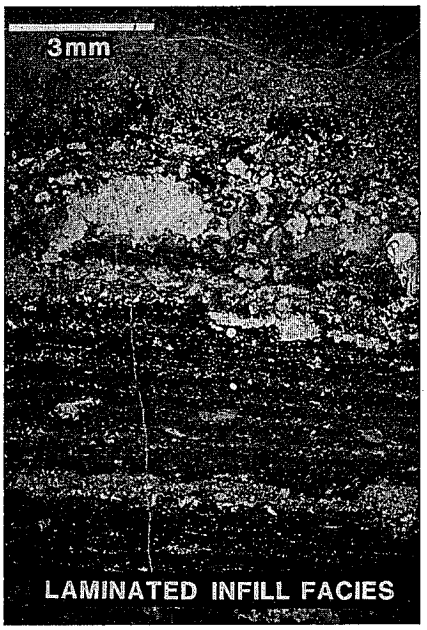

Fig. 6.—Photomicrograph of the laminated facies infilling the Aitzgorrigain paleokarst. Layers of detrital carbonate grains (rudist, echinoid fragments and recrystalized spar) alternate with micrite layers.

Fig. 6.—Microfacies de relleno del paleokarst. Láminas de caliza esparítica alternan con láminas de micrita.

Acknowledgements

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