Petrographic and petrotextural characterisation of Holocene and Pleistocene carbonate eolianites

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Lithified eolian carbonate deposits (i.e. eolianites; e.g. Sayles, 1931, Abegg et al., 2001 and Brooke, 2001) made of particles of marine origin are widespread along arid to semiarid coastlines of Holocene and Pleistocene ages. These deposits have been seldom identified in the pre-Quaternary fossil record. This scarcity may be due to the great difficulty in differentiating between wind blown carbonate deposits and other carbonate sands associated with a coastline setting.

Observations made on recent sediments confirm that carbonate eolian sands have the same petrographic and granulometric signature as the associated subtidal sands (Le Guern and Davaud, submitted). When macroscopic sedimentary structure, such as very large-scale cross-beddings or millimetres-scale inverse-graded laminations (climbing translatent or pinestripe laminations, e.g. Hunter, 1977; Fryberger and Schenk, 1988) are absent, the eolian origin of bioclastic grainstones is impossible to confirm. As an example, the faunal diversity (measured with the Shannon-Weaver index) is even significantly higher in eolian deposits than in shoreface ones. Thus, eolianites could easily be misinterpreted as shallow marine deposits.

At a thin section scale, new criteria are needed in order to discriminate between shoreface and backshore carbonate deposits. Le Guern and Davaud (submitted) have shown that a petrotextural examination of thin sections by image analysis techniques enables to point out that grain orientation patterns differs from a depositional environment to an other. Shoreface deposits exhibit an unimodal distribution of the orientations, most particles lying horizontally, whereas backshore deposits show a tendency toward a bimodal distribution with a significant proportion of vertical grains (Figure 1).

Complementary studies, based on 304 thin sections, which represent more than 2'200'00 particles analysed according to 14 different parameters, confirm that the only unambiguous textural parameter that allows to distinguish eolian deposits from their subtidal counterparts is the grain orientation. The presence of an important population of vertical particles in carbonate wind-lain deposits has been detected in present day deposits (Chrissi Island, Crete; Shark Bay and Ningaloo Marine Park, Western Australia) and in Pleistocene formations of Eastern Tunisia and Western and South Australia.

Vertical particles are more prominent in lithified eolian grainstones than in present dunes. This could indicate that this petrotextural characteristic is not contemporaneous to the deposition processes, but may take place subsequently. Post-depositional processes related to percolation of meteoric waters explain in a satisfactory way the presence of the observed vertical grains. The apparition of vertical particles in sands sampled in active dunes from Western Australia after heavy rainfalls and laboratory experiments confirm this hypothesis (Le Guern and Davaud, submitted).

Verticalisation of a part of the grains’ population forming eolian deposits is then essentially due to the forces exerted on the particles by the percolating fluids. Where the packing of the sand is weak, spaces present between the grains are large enough to permit the grains to rotate in a

![Figure 1](image-url) Profile from the lower shoreface to the backshore environment of Chrissi Island (Crete). Rose diagrams symbolise the grain orientation (bin size of 20°). Measurements were performed by image analysis (modified from Le Guern and Davaud, submitted).
position where the minimum forces are exerted (i.e. particles’ longest axis parallel to the fluid’s flow).

The distribution of the grain orientation in carbonate deposits represents a new and effective feature allowing to recognise carbonate eolian sediments. Furthermore, the existence of an important population of vertical grains in eolian deposits may also be used as an indicator of climatic conditions prevailing during the deposition.

References