Original Research Article

ANALYSIS OF QUATERNARY SEDIMENTS OF QUARTZ GRAINS APPLIED TO THE IDENTIFICATION OF THE ENVIRONMENT OF SOME IVORY BEACHES EAST OF ABIDJAN (CÔTE D'IVOIRE)

ABSTRACT

Morphoscopic and exoscopic analysis of quartz grains collected on the Ivorian beaches of the gulf of Guinea between Abidjan (Côte d'Ivoire) and Aforenou (Ghana) during topographic surveys between March 2007 and March 2009 on the examination of quartz at the binocular loupe, reveals blunting grains shining on all beaches (50% to 70%).

In Abidjan area, the majority of the grains are reddish, indicates a ferrous and inherited environment. The exoscopy for the fine and detailed study of the morphology and the surface of the quartz grains was made with the Scanning Electron Microscope (SEM). This approach makes it possible to interpret traces related to events (energy level) or environments (transport, transition and storage environments).

These observations indicate that the quartz after a long transport in a fluvial environment have been reworked in a marine environment. They were finally deposited in a low-energy aquatic continental medium marked by the polishing of the crystalline points and the siliceous corpuscles dotting the surface of the grains.

The energy of the transport environments crossed is high in a turbulent environment through traces of shock, as large and numerous as they are. SEM examination of the samples reveals that beach quartz has generally been transported by river and recovered in an intertidal and/or subtidal environment. They have a continental and marine origin.

Keywords: morphoscopy; exoscopy; quartz; transport; Côte d'Ivoire

1. INTRODUCTION

The succession of marks of different physico-chemical environments and paleogeographic evolution, sediments are to know for a better understanding of coastal dynamic. The work of [1, 2, 3, 4, 5, 6] have highlighted the importance of the study of sediments, in particular that of quartz grains in shoreline evolution, and the shingle studies of [7] and [8].

In Côte d'Ivoire, the work of [9, 10, 11, 12, 13, 14, 15, 16, 17, 18] provided a better understanding of the Quaternary and current deposits of the ivorian coast, as well as the fluvial and marine formation.

When a rock is subject to weathering, it releases a fraction of its constituent minerals in the form of grains. These grains are sometimes trapped and subject to pedogenic influences and in some cases may be released again and carried further [19, 20, 21].

Non-weatherable materials such as quartz undergo progressively during their evolutions more or less significant changes in size, shape and appearance compared to the original characters they had in the parent rock from which they come [22].

The grains found in the sedimentary formations bear on their surface the testimony of their history. It is a multitude of traces inherited from the various influences to which they were subjected during their transport.

These traces constitute a real archive which gives information on their conditions of transport, evolution and deposit [5, 6, 23] and that the examination. The sedimentology of the beach is one of the first essential steps in any impact study in the coastal environment [7, 8].

On this basis, a study of the quartz elements of several sedimentary formations of the Gulf of Guinea coast from Abidjan to Ghana by exoscopic analysis to characterize the hydrological environment of deposit of these formations has been realized.

The objective of this article is to highlight, through binocular magnifying glass and Scanning Electron Microscope (SEM) examination of the surface of quartz grains, the sediment environment that accounts for the mode of transport, of the crossed medium and deposit of the materials in order to advance in the knowledge of their origin.

This study is part of a research project on coastal erosion initiated by the Oceanological Research Center in collaboration with the laboratory of Marine Geology of the University Felix Houphouët Boigny will complement existing morphological databases on the coastline of the West African subregion.

2. PRESENTATION OF THE STUDY AREA

The study area concerns the segment of coast between Abidjan and Aforenou (border with Ghana) (Fig.1). Corresponding to the southern zone, situated between 0 and 200 m of altitude [24], the Ivorian sedimentary basin, formed of coarse sands, medium to very fine, extends along the atlantic coast. Covering an area of approximately 8000 km^2, this sedimentary basin covers approximately 2,5% of the Ivorian territory, doesn't exceed 35 km wide and extends from Fresco to Axim in Ghana. The coastline of the Abidjan coastline differs from that of the entire Côte d'Ivoire coast by its morphology.

Depending on its orientation and its lithological nature, the submarine beach at Abidjan is influenced by an underwater canyon called "bottomless hole " [25]. The coastline draws a bay before resuming the overall layout rather rectilinear. This configuration follows the outline of the head of the canyon of " bottomless hole ".

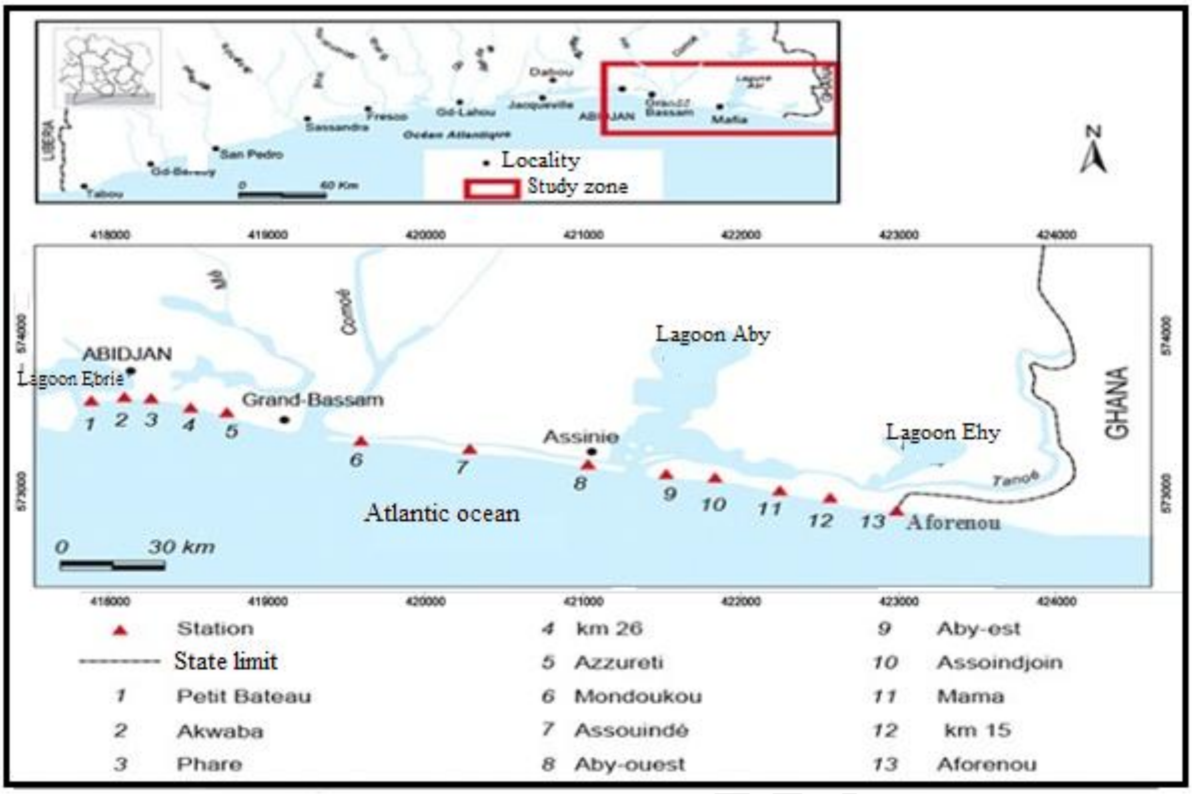


Fig. 1. Study area and presentation of sampling points [15]

3. MATERIALS AND METHODS

To carry out this study, several samples were taken (stations 1 to 13) including those of the light stations of Port-Bouët in Abidjan (3), Grand-Bassam (6), Assinie (8 and 9 located on the and others of the mouth of the Aby lagoon) and Aforenou (13, border with Ghana) were used. They were taken manually in the superficial layer of beach profiles on the upper foreshore (HE), the mid-foreshore (ME) and the lower foreshore (BE).

3.1 Morphoscopic study of quartz grains

The analysis of the quartz grains was based on the examination of the 500 µm to 630 µm fraction [26] on the shape and appearance (wear) of sand grains in order to identify their mode of transport.
For the morphoscopy of quartz grains, the selection of quartz minerals was carried out using a binocular magnifier connected to a screen. To do this the method of [1] was used.
The particle size fraction between 80 µm and 100 µm has been neglected because the shaping is generally poorly discernible and also requires high magnification [27].
The morphoscopic analysis is based on the classification of grains established by [1]. It takes into account the shape of the grains and the appearance of their surface. This classification thus leads to three main categories of grains:
The "No Worn" or "NW", the "Blunt shiny" or "BS" and the "Round-Mast" or "RM". To evaluate the percentage of the classes of the grain shape, the visual chart (Diagram of evaluation of the relative percentages of the grains) established by [28] was used starting from the surface of the thin blades made up.

3.2 Exoscopic study of quartz grains

The determination of the beach environment in this study is based on the observation of the surface of the quartz grains using the Scanning Electron Microscope (MEB FEG Supra 40 VP ZeissV). The sedimentological analysis was done beforehand according to the classical methodology described by [29] and according to the work of [30] on sediment samples taken. The techniques of [1, 2, 12, 23] allowed the exoscopic study of quartz grains. The study is based on the identification and interpretation of physical, chemical, mechanical and biological factors, which leave on the surface of quartz grains micro-characters of shape and size characteristic of the factors that generated them. These basic characters make it possible not only to accurately determine the deposit medium of a grain of sand, but also to trace its entire geological history, its environment traversed during transport and in some cases, its geographical origin [23].

4. RESULTS

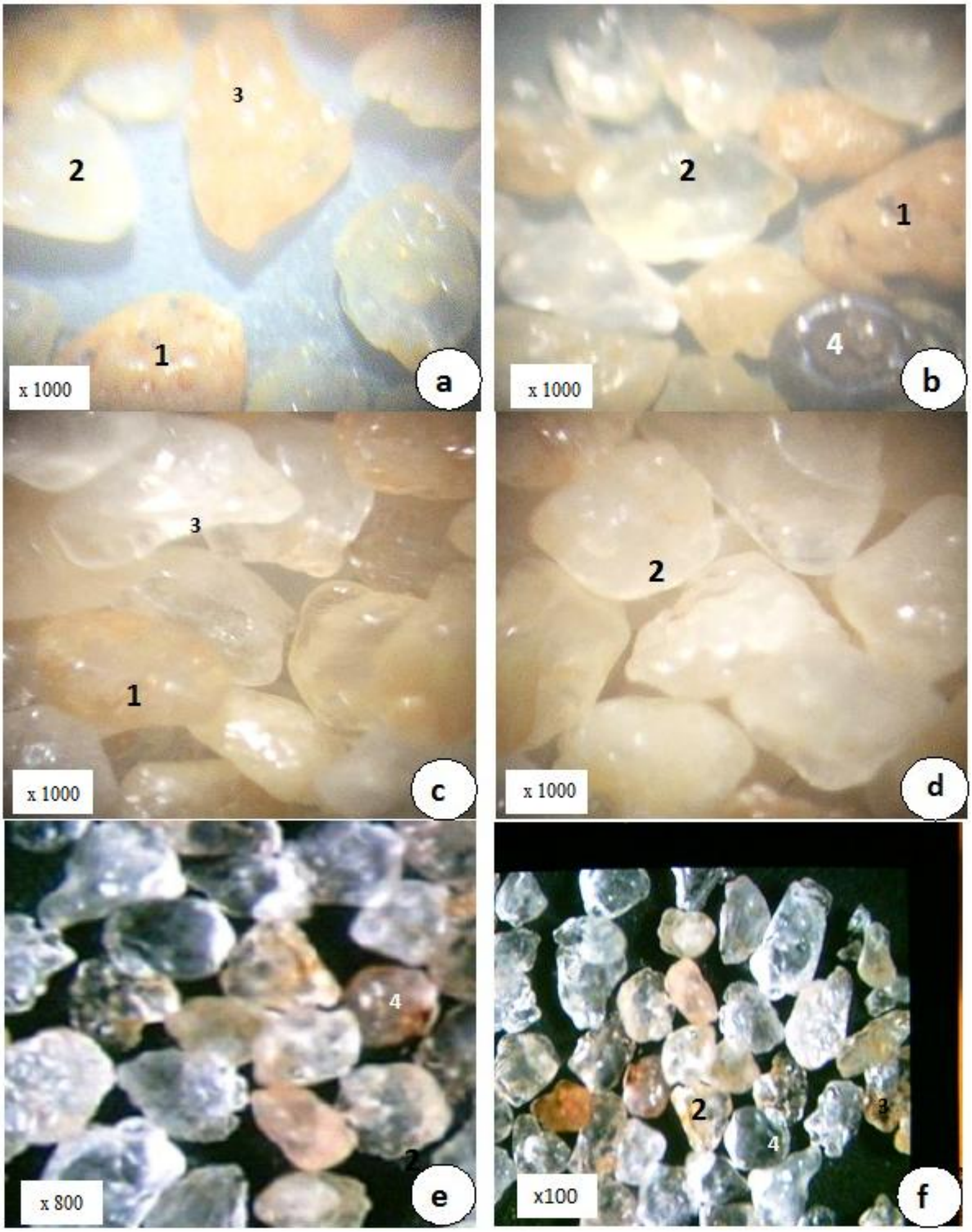
4.1 Shape and appearance of quartz grains

The morphoscopic analysis of the quartz shows the omnipresence of the blooming blunting grains (Fig.2), which highlights the influence of water transport and a dynamic fluvio-marine process. Matt, blunt, shiny round grains are found throughout the study area.
The percentage of shiny blutt grains blazing on the coastal zone is as follows: 50% on the beaches of Abidjan-Grand-Bassam, 60% in Assouindé and 70% in Assinie-Aforenou. These quartz grains show shock traces visible by scanning electron microscope (SEM) in the form of cups.
These quartz grains are, testifying to a wind recovery. The presence of a ferruginous coating on a few grains only in Abidjan bay indicates a ferrous environment. Unused grains are present in a small percentage (<2%) of up to 5% immediately east of the inlet channel in the port of Abidjan. The presence of these grains would reflect a nearby source of supply, with sediments little changed.
From Abidjan to Aforenou, there is a tendency for this percentage of unused grains to decrease, although it is not very clear in Port-Bouët bay (Abidjan), and at the same time there is an increase in blunted grains. The small proportions of the sub-angular, matte grains appear only in Port-Bouët bay, between the Vridi Canal and the Port-Bouët lighthouse, just at the entrance to the entrance channel in the port of Abidjan, in upstream of the bay.

Table 1. Evolution of the morphology of the grains from the morphoscopy of these on the various studied ranges

	Petit Bateau	Phare de Port-Bouët	Km 26	Mondoukou	Assinie France	Aforenou
NW	45%	40%	30%	30%	25%	15%
BS	50%	55%	60%	60%	50%	55%
RM	5%	5%	10%	10%	25%	30%

There is an increase in blunted shiny quartz (BS) grains as they are transported by coastal drift to the east.



1 = ferrous; 2 = blunted blunting and subarranged; 3 = subangular; 4 = Rounded
a-Petit Bateau; b-Phare de Port-Bouët ; c-Km 26; d-Mondoukou; e-Assinie France; f-Aforenou (data [15])

Fig. 2. Morphoscopy of quartz grains in some areas of study

4.2 Quartz grain environment of Abidjan beaches

4.2.1 Appearance of some quartz grains from the beaches of Abidjan

At low magnification of 50 and 200 times (Figs 3a and 3b), shock marks on quartz are numerous and visible. Some polished traces are exploited by dissolving figures on the parts most exposed to mixing (Fig. 3c). The edges are dull and the grains are sub-rounded to rounded. They appear very clearly in Fig. 3c with a white color, milky to the observation. They are distinguished by the presence of conchoidal breaks. Very small sizes smaller than 5 µm), these inclusions are difficult to detect.

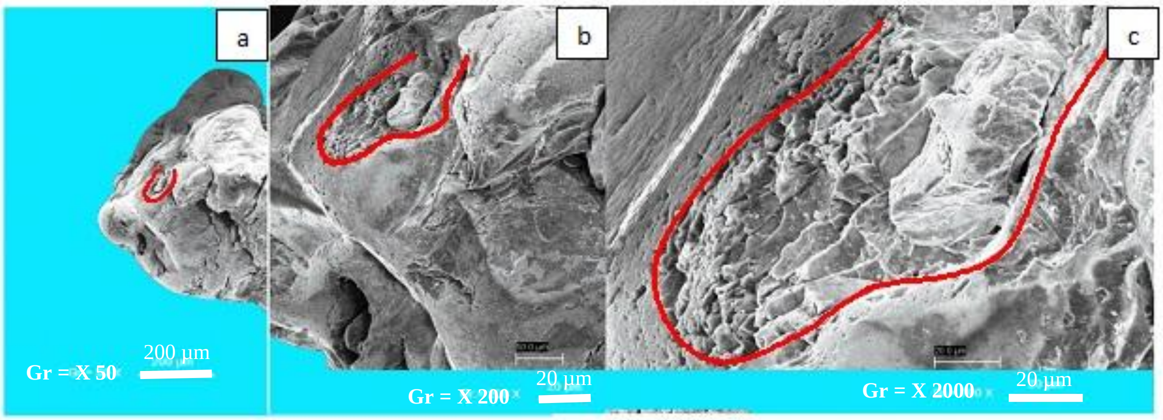


Fig. 3. Traces of shock exploited by figures of dissolution on quartz grains of the beaches of Abidjan (data [15])

Fig. 4a, 4b and 4c show on the surface of the quartz shock-related dips or dissolution in which live diatoms whose size does not exceed 20 microns. At a magnification of 2500 times, appears the complete form of a diatom, unicelleulaire alga which is one of the constituents of the plankton. It is housed at the bottom of a cavity (Fig.4b). On some quartz during corrosion, dissolving diatoms are visible (Fig.4c).

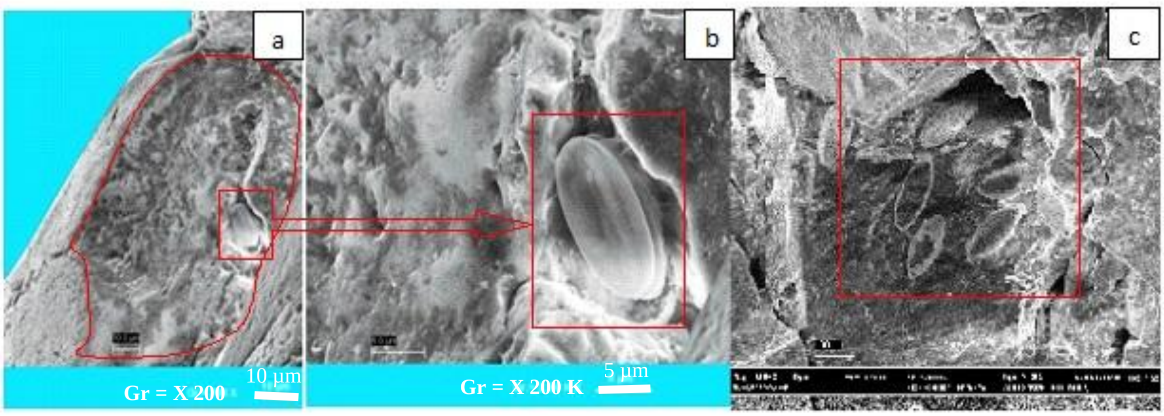


Fig. 4. Diatom housed in the shock traces of some quartz grains

(data [15])

4.2.2 Transport environment, evolution and deposition quartz of the beaches of Abidjan

The numerous shock marks observed on the quartz grains of this segment of coast reflect a turbulent environment or strong swell in which they have stayed. They also reflect a high energy level (Fig.3a and 3b). The rounded or sub-rounded shape of the ridges and the blunted appearance of the quartz grains (Fig.3c) are characteristic marks of sediments that have evolved in a coastal marine environment, where the comings and goings between the intertidal zone and the coastal dunes are very frequent.
The progressive rounding of their most prominent ridges indicates a mode of transport where these grains rubbed against each other. The phyto-plankton (diatoms) observed frequently in the shock marks on these beaches are proof of a low energy environment and calm deposition. Indeed, during the low seas, the quartz grains are exposed to the open air. However, their surface is generally not smooth. The quartz that hosts these phytoplankton, translate sediments that have passed through an environment, calm low energy. The different types of trace observed on the grains of this coastal area reflect the different types of energy (high and low) that shape it.

4.3 Quartz grain environment of Grand-Bassam beach

4.3.1 Appearance of some quartz grains of the beaches of Grand-Bassam

The quartz grains on this littoral space, generally very rounded, bear numerous traces of crescent shock, visible even at low magnification in Fig. 5a. These traces sometimes arranged in steps, appear at a high magnification in Fig. 5b. It is a remodeled quartz whose blunt edges consist of a group of pyramidal tops with blunt ends (Fig. 5a).

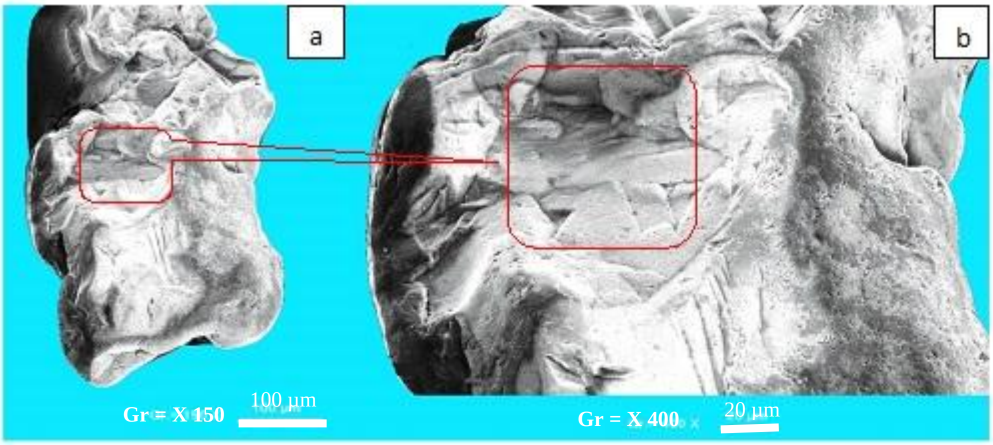


Fig. 5. Traces of shock and some internal figures on a grain of quartz of Grand-Bassam (data [15])

The study of the surface of some quartz grains on this beach shows corroded and flaky aspects. These imprints, visible in Fig. 6a and 6b, are the marks of an intense chemical surface dissolution.

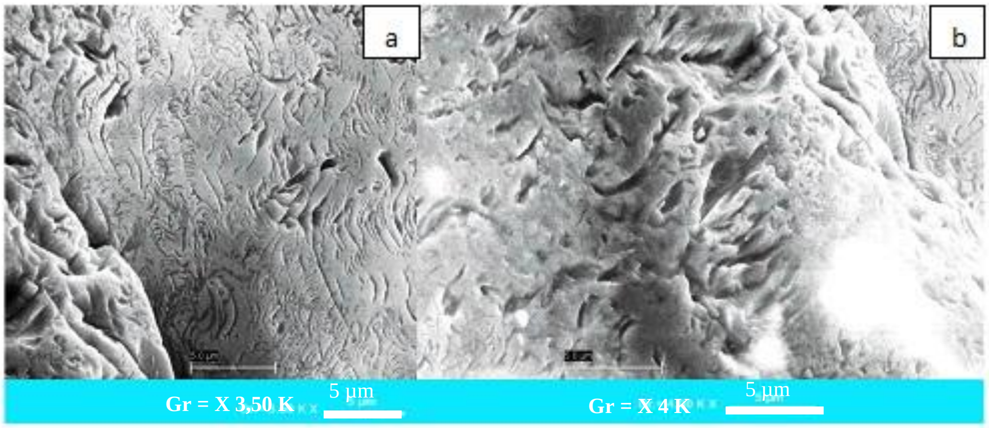
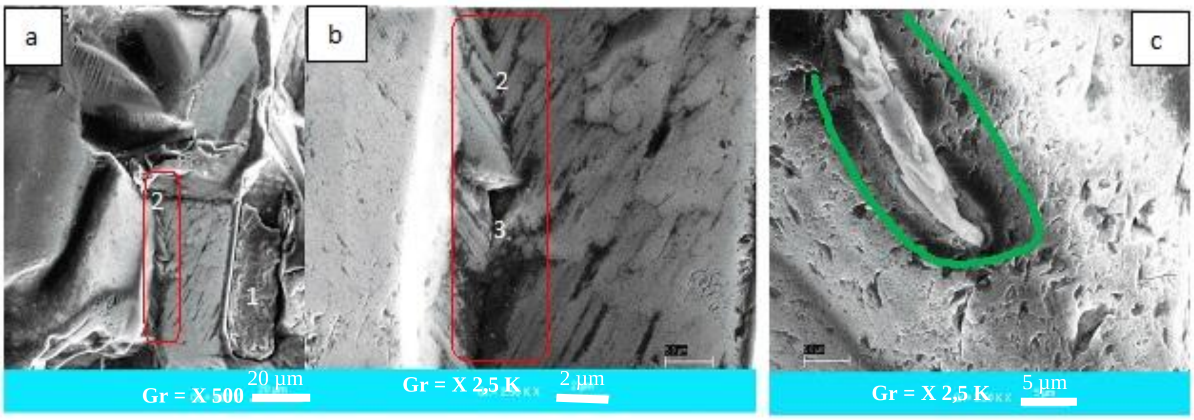


Fig. 6. Marks of superficial chemical dissolution on a Grand-Bassam quartz grain (data [15])

The flat surfaces are covered with amorphous silica film, and the general morphology of the cavities is similar to that of the inclusions (Fig. 7a and 7c). These magmatic vitreous inclusions totally crystallized in Fig. 7a (1), but not identifiable, coexist with structures in "V" clearly visible in Fig. 7b (2) (magnification x2500).



(a) magmatic, (b) glassy, (c) cavities

Fig. 7. Inclusions on the surface of certain quartz grains of the beaches of Grand-Bassam (data [15])

4.3.2 Transport environment, evolution and deposition of quartz of the beaches of Grand-Bassam

The very rounded shape in general of quartz grains on this littoral area, with a very blunted appearance, is the imprint of a quartz remodeled in the marine environment (Fig.5a).
Some quartz grains of corroded and desquamated appearance (Fig.6a and 6b) are traces of intense chemical surface dissolution. The numerous structures (in "V", inclusions, vitreous) that coexist on the surfaces of numerous grains show that this result reflects a low-energy fluvial or continental environment in which the mineral has been during its transport. The quartz grains in this littoral zone have, for the most part, had to cross several environments. They were taken up in an intertidal (aquatic) medium saturated with silica (river).

4.4 Quartz grain environment of the beach west of the embouchure of the Aby Lagoon (Assinie)

4.4.1 Aspect of quartz grains from beaches west of the embouchure of Aby Lagoon (Assinie)

In this beach, some quartz have smooth faces and faces finely corroded by dissolution figures visible in Fig. 8a. At a magnification of 1000 times (b) and 5000 times (c), these figures in triangular form with stair steps have frequent angles of 30 °, 60 ° in the arrangement of the crests. Parallel lines also confirm the stair arrangement. The preceding figures show shock traces exploited by the dissolution, on which appear the triangular truncated features of the latter (Fig. 8b and 8c).

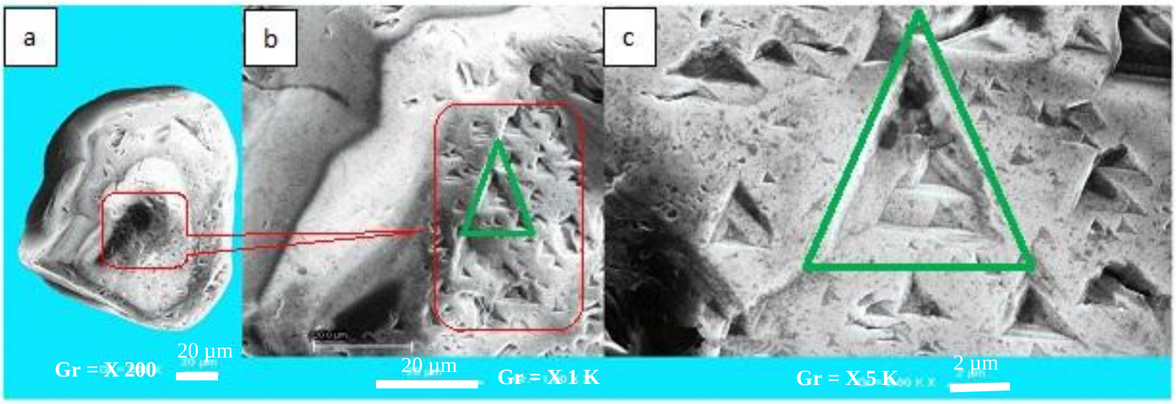


Fig. 8. Traces of dissolution and triangular figures on the beaches west of the mouth of the Aby lagoon in Assinie (data [15])

The loss of silica by dissolution of the surfaces of some quartz is not negligible although difficult to evaluate (Fig.9a x250). At medium magnification (x 1500), the microrelief is granular, marked with furrows where there is no sharp peaks (Fig.9b). It is a low-energy aquatic continental recovery: This recovery, which corresponds to the final sedimentation medium of the sample, results in the precipitation of numerous siliceous globules over the entire surface of the quartz, including on the top edges (Fig.9c).

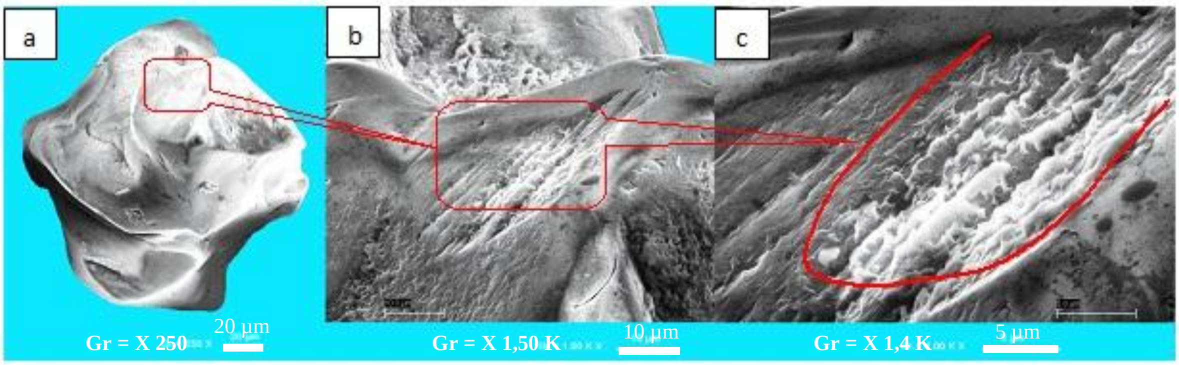


Fig. 9. Chemical dissolution of the surface of a quartz grain from the beaches west of the mouth of the Aby Lagoon in Assinie (data [15])

At a magnification of 150 times (Fig. 10a), the surface interspersed with microcracks appears to be particles in the course of disintegration, without definite orientation. But the crystalline points themselves were in turn dulled by the final fluvial upturn, which scattered all the surface of the grains with siliceous globules. This 1500-fold enlarged quartz grain exhibits discontinuous microcracks, 1 to 2 µm wide (Fig.10b). They have sinuous and sometimes branched outlines. Quartz irregular microrelief, are bumpy, sometimes cavernous, micro-fissured; but all the irregularities are blunted.

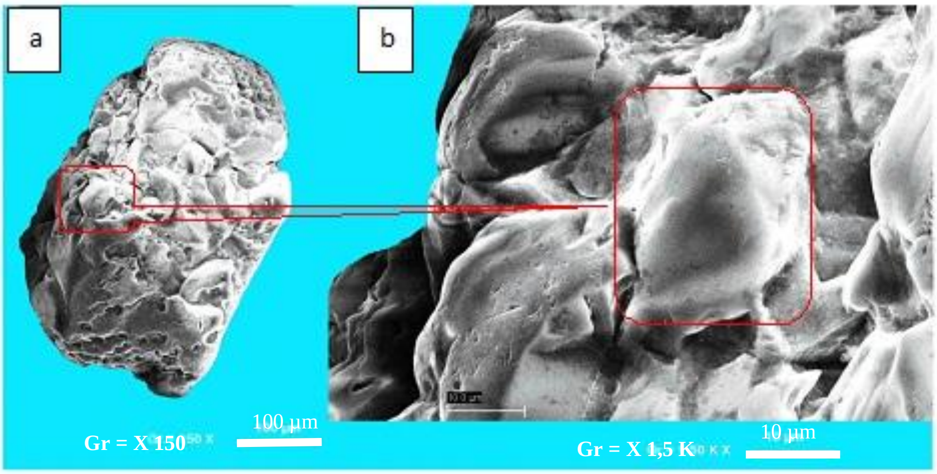


Fig. 10. Dissolution of the entire surface of the quartz grain generating rounded micro-reliefs to the west of the mouth of the Aby lagoon in Assinie (data [15])

4.4.2 Transport environment, evolution and deposition of quartz beaches to the west of the mouth of the lagoon Aby (Assinie)

The dissolution phenomena observed on the shock marks of quartz near the mouth are frequent and numerous. The hollow surfaces of the grains created by these dissolutions are often filled by precipitations of many crystalline siliceous globules (Fig. 9c), with very rounded edges and many globules all blunted (Fig.10). But the crystalline points themselves were blunted by the final fluvial recovery. These quartz grains were taken up in a calm aquatic continental medium of low energy. This recovery, which corresponds to the final sedimentation medium of the sample, results in the precipitation of numerous siliceous globules over the entire surface of the quartz, including on the vertex of the ridges (Fig.9c).

4.5 Environment of the quartz grains of the beaches east of the mouth of the Aby lagoon in Assinie

4.5.1 Appearance of quartz grains from the beaches east of the mouth of Aby lagoon in Assinie

Quartz have rounded and blunt edges, the faces remain smooth. These edges are affected, as in rivers, by polishing gradient shock traces, but another phenomenon appears. Seawater gnaws away at shock marks, which are exploited by dissolution figures, especially on the ridges. At low magnification (x 100), the microrelief of a healthy quartz flake appears irregular with sharp edges, with no apparent preferential orientation (Fig.11a). The face of this mineral at high magnification (x 1500) in Fig. 11b shows a pattern oriented along bundles of lines or ridges spaced a few microns, arranged in stairs. They are connected in relay on the main peaks, delimiting somehow the stack of micro-scales detached after the shock. At an enlargement of 4000 times in Fig. 11c, there appear fine parallel, tighter streaks spaced 1 to 2 µm in a direction perpendicular or oblique with respect to the preceding peaks.

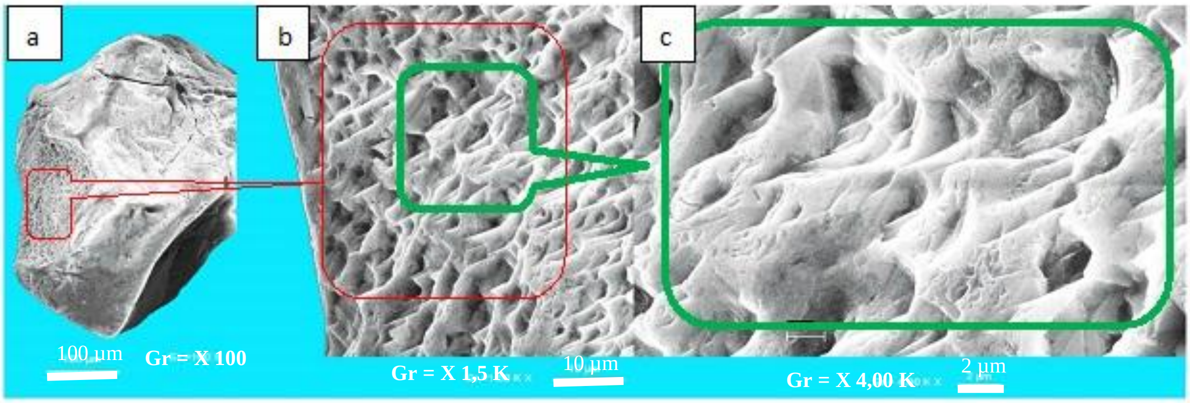


Fig. 11. Chemical dissolution appearing on the tops of a quartz grain from the beaches east of the mouth of the Aby lagoon in Assinie (data [15])

The traces in "V" in Figs. 12a and 12b are shapes which, in evolution, precede the figure in "pyramid", witnesses of an important evolution. The constant orientation of these figures makes it easy to distinguish them from similar-looking figures which, on reworked quartz, are caused by shocks or pressures. Occasionally, triangular dissolution figures can be seen at the bottom of some shock marks.

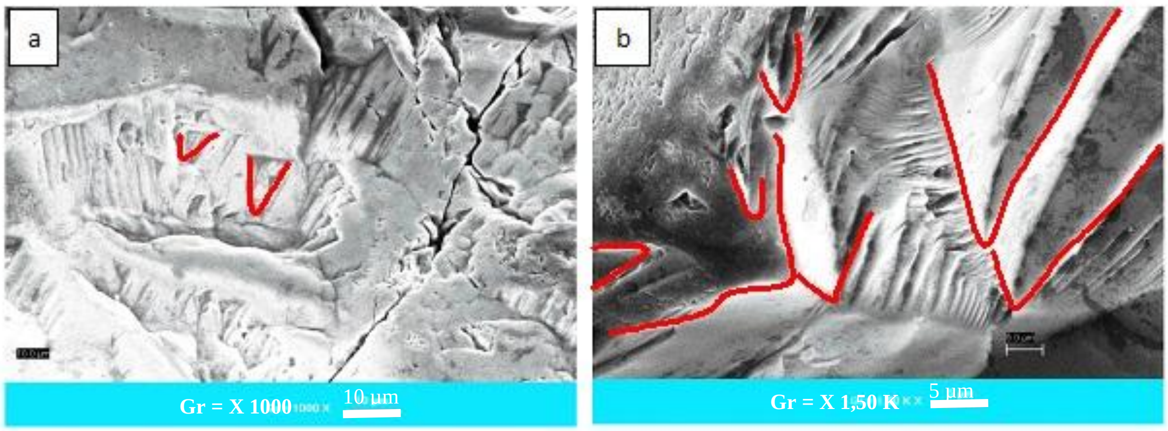


Fig. 12. Appearance of the "V" figures and pressure traces (b) on quartz from the beaches east of the mouth of the Aby lagoon in Assinie (data [15])

Figs. 13a and 13b show shallow shock cups acquired during transport and that transport is prior to the dissolution action. Solid inclusions are represented by minerals having crystallized before or at the same time as quartz in granitic magma. The most frequent are tabular or rounded crystals (Fig.13b). The quartz grains in this coastal zone come from various fluvial, continental, marine and reworked environments.

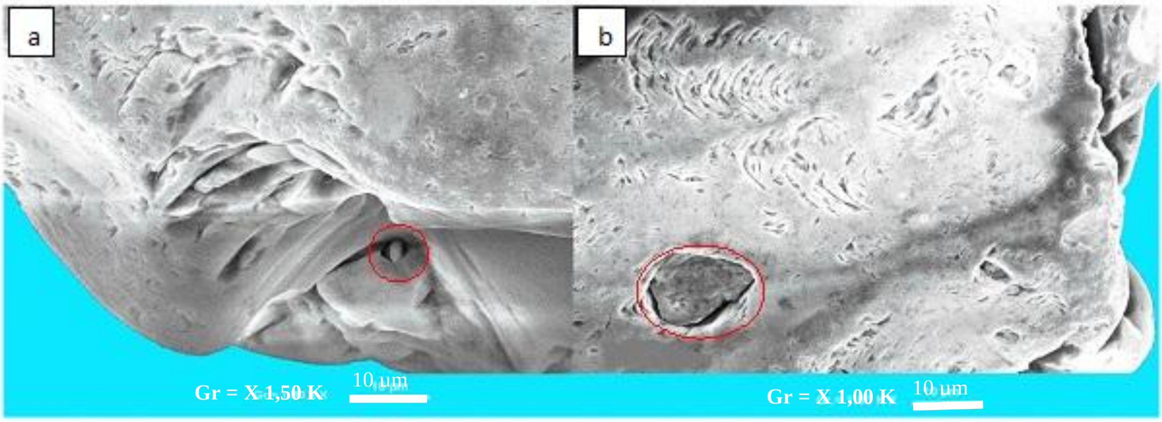


Fig. 13. Traces of shocks and inclusions on the surface of the quartz grains of the beaches east of the Aby lagoon in Assinie (data [15])

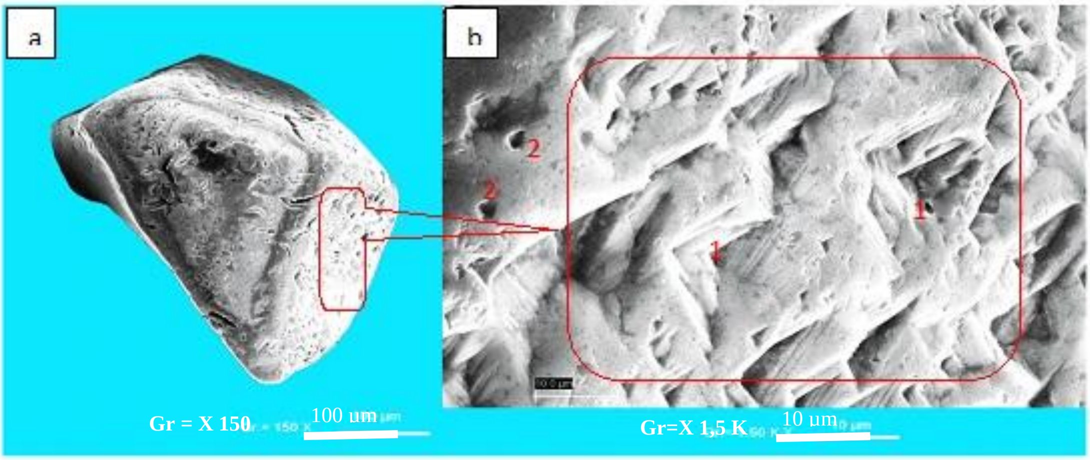
4.5.2 Transport environment, evolution and deposition of quartz beaches east of the mouth of the lagoon Aby (Assinie)

Fig. 13a and 13b show shallow shock cups acquired during transport. Solid inclusions are represented by minerals having crystallized before or at the same time as quartz in granitic magma. The most frequent are tabular or rounded crystals (Fig. 13b). The quartz grains in this coastal zone from various rivers, continental, marine and reworked environments.

However, the appearance of certain sharp edges (Fig.11a) and particular figures "V" and "pyramid" or "stairs" respectively translate turbulent media (Fig.13a), pressure environments (V) and several media different concentrations. These numerous imprints superimposed a few times on the quartz grains coming from the beaches of this zone of the Ivorian littoral of the Atlantic Ocean translate various continental, fluviatile, marine and reworked environments.

4.6 Quartz grain environment of Aforenou Beach (Ghana)

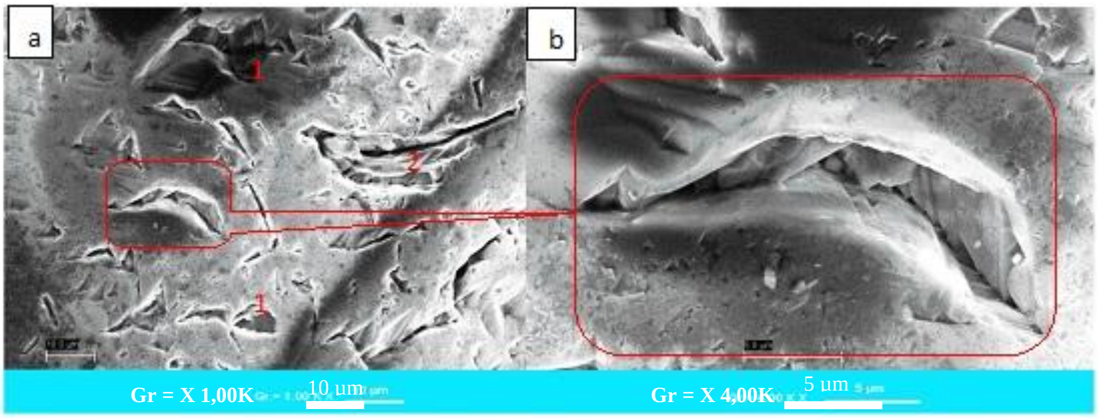
The observations show a very blunt grain with a cavernous and very irregular microrelief. At low magnification (x150), the quartz grain shows a corroded, cavernous surface (Fig. 14a). A magnification of 1500 times the corroded surface (Fig.14b) has cavities of depth and irregular size with parallel lines arranged in stairways, making between them sharp angles intersecting at 60 °, 90 ° and 120 ° approximately (1). The primary points of corrosion on flat surfaces are hollow and circular, rainbow and triangular (2).



(1-Cavities in stairs whose vertices form angles; 2-Primary points of corrosion)

Fig. 14. Important corrosion of the quartz grain in the form of cavities in which are visible parallel lines arranged in stairs at Aforenou (Ghana) (data [15])

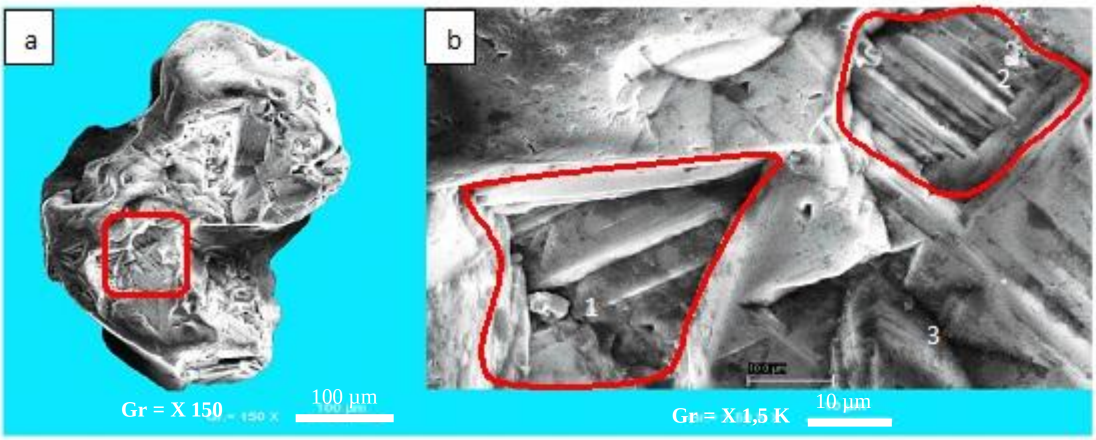
The surface of the quartz grain indicates marks of deep shocks in «nail stroke» of varied orientation (Fig.15a). These quartz grains could come from a wind transport. The edges of these marks are bright to angular visible at a magnification of 4000 times (Fig.15b). However, some of them are half-erased or have a blunt edge due to fluvial wear (Fig.15a (2)) during its course towards the oceanic domain. What [23] calls "polishing gradient". Some triangular markings, in "nail stroke" are still fresh and result from shocks.



(1 and 2 = traces of old shocks and blunted by fluvial wear,data [15])

Fig. 15. Numerous nail strokes appear in Aforenou (Ghana)

In Fig. 16a (x150), numerous traces of shock and chemical dissolution appear. At high magnification (x 1500, Fig.16b), there appears a series of parallel streaks. These figures are observable in the grooves along these streaks. Their width is of the order of 0,5 µm and more. Disaggregated particles in the process of desquamation still adhere to this surface (1), (2) and (3).



(1, 2 and 3 = Parallel lines containing disaggregated particles; data [15])

Fig. 16. Sand grain with many traces of shocks with dissolution figures in Aforenou (Ghana)

4.6.1 Environment of transport, evolution and deposit of the quartz of the beaches of Aforenou

We observe the presence of very blunted quartz grains on these beaches with corroded surfaces for some and deep cavities (nail claws) some of which in stairs, and quartz sharp edges and angular for others with blunt edges. The appearance of quartz grains on these beaches at the border with Ghana, whose particle size is very fine (less than 200 microns) indicate that they were transported mainly by the wind. They were blunted by fluvial wear by transport and transit through the Aby lagoon (Fig.15a (2)) as it traveled to the oceanic area. This definitive deposition medium has had the effect on certain quartz chemical dissolution.

5. DISCUSSION

5.1 General situation

Examination of the surface of the quartz grains in the MEB revealed a wide variety of impressions that testify to several environments traversed by them. They are comparable to those described by [2, 3, 31] who grouped them into two large groups. They are in the form of relief or hollow and are the traces of the environments crossed during the displacement or deposit of sands. They result from mechanical actions or characters of chemical origin.

Relief figures less frequent than those in hollow on the surfaces of quartz result from the crystallization of silica in an undersaturated marine environment or chemical dissolution. Some that can be offset from each other are running stairs when the offset becomes appreciable. Such figures have been observed and described by many authors [9, 10, 19, 32, 33] who testify that these quartz grains have undergone wind or water transport.

We also note the scattered presence on some of these surfaces of small scales of desquamation, particles in veneer as well as figures in nail clipping and thin elongated cavities. The hollow figures may be generally attributed to the dissolution of the quartz; while the relief figures can be interpreted as figures of crystalline decay [9, 10].

5.2 Quartz grain environment on the beaches between Abidjan and Grand-Bassam

The southeastern coast of the Gulf of Guinea between Abidjan and Aforenou in Ghana, consists mainly of loose sediments, mostly quartz grains. These sands of neogene age have various forms. The surface of these grains bears marks, traces or figures that trace the various environments or events during their transport. The work of [7, 8] reached similar conclusions by studying pebbles on the beaches of Sorso (Sardinia), Liguria and Corsica.
The very rounded quartz grains, some of whose dull edges are found on the coast of the Gulf of Guinea between Abidjan and Grand-Bassam, bear many crescent marks with triangular figures in steps or pyramids. These marks indicate a wind transport of the grains before being taken up in an aquatic environment (Fig.5a and 5b).
The SEM observation of 3 m deep sands in the Cechi region (Agboville, Côte d'Ivoire) by [19] also showed frequent pyramid-shaped triangular-based figures indicating a reworked quartz. In addition, the majority of the quartz grains in these samples have an ocher yellow to reddish hue. This characteristic suggests a certain pedogenetic influence, a probable index of a paleosol, a soil that evolved during the Quaternary and Tertiary periods according to [19].
The presence of solid inclusions, milky (Fig.3a, 3b and 3c) or vitreous, almost completely crystallized or mineral enclaves housed at the bottom of the depression of the shock mark with siliceous deposits located on some faces (Fig. 7 and Fig. 9) confirms that the quartz grain was taken up in an intertidal medium or marine domain under saturated silica described by [4].
However, for [34] the siliceous deposits indicate a low energy continental or fluvial medium. This low energy environment is indicated by the presence on the surfaces of the quartz grains of numerous siliceous deposits, confirmed by phytoplankton that are the diatoms found in the old dissolution figures or shock figures. The presence of these unicellular algae testifies to a calm environment.
Indeed, the closure of the mouth of the Comoé River located in Grand-Bassam (about 30 km) allows sediments, mainly quartz grains, to transit through the Ebrié lagoon (low-energy calm environment), connected to the sea by the Vridi canal (access to the port of Abidjan) before being evacuated to the Atlantic Ocean.

5.3 Quartz grain environment in the coastal zone Assinie-Aforenou (Ghana)

In the near-coastal environment of Ghana (from Assinie to Aforenou), the quartz grains, which are mostly rounded, are the expression of the mechanical action of the waves (Fig.8a, 9a and 11a) and (Fig.14a and 16a) or transport over a long distance. The surfaces of the grains are covered with cavities of variable depth and size, irregular with often parallel lines arranged in steps (Fig.8b, 8c, 14a, 14b, 16a and 16b). The arrangement of the ridges shows angles of 30 ° C, 60 ° C, 90 ° C and 120 ° C. These cavities, generally triangular, with pyramidal points have been reported by [19] on quartz of some ferralitic soils in the region of Cechi (Agboville, Ivory Coast).
Moreover, the works of [9, 35] have shown that they are characteristic of tropical zones. These samples have a continental origin and come from the catchment area upstream. [23] emphasizes that these figures constitute an evolution of the aeolian shock croissants exploited by the dissolution, on which appear the triangular figures in hollow characteristic of these (Fig.12b). The slightly curved deep striations on which is implanted a succession of "V" in characteristic form in fishbone (Fig.12b) are traces of strong pressures such as volcanic quartz.
Numerous marks of shocks and very tight nail (Fig.15a and 15b) without preferential orientation are observed on the surfaces of many quartz grains with sometimes edges blunted

by fluvial wear or marine; it is a "polishing gradient". Referring to the analytical work of [19, 36], we attribute these shock marks to wear during a wind transport or a violent torrent [37, 38].
The detailed analysis of the surface of certain quartz grains shows that it is rough and covered with ovoid particles. These are coatings in the form of oval beads on some very rounded and blunted grains that can be compared by morphological analogy to the amorphous silica film described by [2]. This form would indicate a fluviatile or continental medium of low energy. Indeed, [34] report that the precipitation of siliceous globules over the entire surface of the grains, including the vertex of the ridges (Fig.9) indicate a final deposit in a low energy aquatic continental medium.
The steady increase in the percentage of blunted from Abidjan to Ghana (Aforenou) (50% to 70%) shows that the sands undergo wear during their transport by coastal drift to the east. The swell reshapes the sediments because of its orbital movements that are transformed near the bottom into alternating currents that can reach a high speed and put in motion the materials that can be either reworked on site or driven by perpendicular or parallel currents. The increase in the percentage of blunting blunted grains indicates that there is equipment transport from Abidjan to Aforenou in Ghana in the direction of the littoral drift (west-east).

5.4 Origin of the soft sediments of Ivorian beaches

The continental origin of some of the beach sediments is confirmed by the studies of [39]. Indeed, if we refer to the summary work of [39], as part of the Sassandra-Cavally operation (SasCa) between 1962 and 1968 in the south-west of Côte d'Ivoire, these minerals of geological interest constitute the bulk of the sediments of the beaches studied. Thus, one more argument to confirm the continental origin of littoral sedimentary deposits, suggested in the detailed study of the quartz grain surface of the emerged beaches and the granulometry [14,15].
Studies by [16, 41] on the origin of sediments in the Fresco lagoon indicated mainly continental inputs (wind, runoff and Bolo and Niouniourou rivers) and oceanic. Some sediments come from areas close to beaches [14, 17, 18, 42]. This is the case in this study of the sediments of the beaches of Abidjan, close to the entrance channel in the port of Abidjan (Vridi Canal).

6. CONCLUSION

The grains of sand have many traces of shock and dissolution figures on their surface. Marine sand combines bleached and matte round blunted quartz grains, evidence of the plurality of coastal wear agents. The slight increase in the percentage of blunted blunted grains from Abidjan to Aforenou in Ghana indicates the drift (West-East) in this part of the Gulf of Guinea.
The grains released during the rock weathering process were transported and finally sedimented in a low-energy aquatic continental medium (Ebrié lagoon and Aby lagoon with their respective estuaries) marked by the polishing of the crystalline points and the siliceous globules. sometimes scattering all the surface of the grains. The main attacker of quartz crystals is thus transport (air, fluviatile or marine), during which they are rubbed against each other. The most exposed parts are the grain edges, which are affected by polishing gradient shock traces, recent for the angular and old for the blunt ones. These traces are even larger and more numerous than the transport energy is high.

The SEM examination indicates that some of the quartz have fluvial shaping marks, the unworn quartz carries abundant marks of chemical dissolution. The still varied, better sorted and largely dull-glistening grains of these samples reveal the impact of hydraulic transport on the original material over a long distance driven by the eastward drift of the original arena.
During this study, it was impossible to find two identical grains of sand. They all carry a multitude of specific information concerning their origin (continental, fluvial), and each episode of their existence. The SEM examination of quatrz mineral samples revealed that the sediment present on the beach of the study area are quartz that have generally undergone violent air transport, before fluvial transport and taken up in an intertidal environment and /or infratidal.
They result from a mixture of sands brought by the continent (Comoé and Tanoé rivers) and the sea (reworking).

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