INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 25, No. 1, p. 40-47, 2024
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

# Vridi canal: A supply route for a new granulometric cortege in Ivorian coastal sediment transit

**Saimon Aby A. Mathurin[*1], Toure Mamadou[2], Gbamblé Bi Y. Aimé[3], Ambela Ze Marguerite Christelle[2]**

[1]*Oceanological Research Center (CRO), Environment Department, Laboratory of Marine Physics and Geology, 29 Fishermen's Street, Abidjan, Côte d'Ivoire*

[2]*Félix Houphouët Boigny University (UFHB), UFR of Earth Sciences and Mining Resources, Geology Laboratory, Mineral Resources and Energy, Abidjan, Côte d'Ivoire*

[3]*University of San Pedro, UFR of Marine Sciences (SDM), San Pedro, Ivory Coast*

Article published on July 05, 2024

**Key words:** Vridi canal, Granulometry, Morphoscopy, Coastal transit

**Abstract**

The Knowledge of the sandy material on either side of the Vridi channel on the Port-Bouët coast in Abidjan was obtained by granulometric and morphoscopic study of 9 cross shore beach sedimentological profiles**.** Three sedimentological campaigns with quarterly rhythmicity covering the period December 2020 to April 2021 were conducted by surface sampling, 50 cm deep and 1 m deep at the auger in the three upper, mid and low foreshore**.**Granulometric analysis reveals two different facies on either side of the channel. The western part of the channel has medium to coarse sand, while the eastern part has coarse and very coarse sand.The morphoscopic analysis shows a dominance of shiny sub-angular sand grains to the west of the channel against a dominance of shiny sub-rounded sand grains to the east of the channel. These results show a discontinuity in the supply of sandy material in the west-east direction of the Ivorian longshore drift on this part of the Port-Bouët coastline. The Vridi canal, at the heart of this granulometric discontinuity, is the route by which new material of continental origin feeds sediment to the coast.

***Corresponding Author:** Saimon Aby A. Mathurin ✉ saimon.aby@cro.edu.ci

## Introduction

The granulometric material of the Ivorian coast has been studied by several authors. These Monde (1997), Abé (2005), Konan (2012), Yao (2012), Dangui (2014), Egoran (2014), N'ganza (2015), Bamba (2016), Saimon *et al.* (2019) and Kouame *et al.* (2022) made it possible to determine the general distribution of the various particle size classes along the coast of Côte d'Ivoire. A link has been established between the direction of longshore drift and changes in the granulometric composition of the shoreline.Sediments are formed by the weathering of consolidated basement rocks in the south-west and are transported eastwards to serve as a sedimentary cover . As transport progresses, a decrease in transport energy related to marine topography can lead to the abandonment of coarse elements of the drift course and promote the pursuit of fine elements in the direction of the east. This mechanism could explain the presence of fine particles to the east of the Ivorian coastline. However, after covering more than 2/3 of the Ivorian coastline, the coarsest elements of the coastline according to Saimon *et al.* (2019) and Kouamé et *al.* (2022) are found to the immediate east of the Vridi canal in Abidjan. Is not the injunction in the littoral domain of the artificial canal of Vridi a way of supply of new granulometric processions in the coastal sedimentary budget. The aim of this study is to show the granulometric discontinuity at the level of the channel in the sedimentological facies of the Ivorian coast.

## Materials and methods

*Presentation of the study area*

The study area running from west to east of the Vridi canal with latitudes of 5°14' - 5°15' N and longitudes of 3°59' - 4°1'19' W is located in the eastern part of the Côte d'Ivoire sedimentary basin (Fig. 1). It is a straight low coast, bordering a wide coastal plain formed of quaternary sand. This coast is swallowed by an important infrastructure and, especially a very intense economic activity. The Port Autonome d'Abidjan handles international trade with the rest of the world via the Vridi Canal, which links the Ebrié Lagoon to the sea.

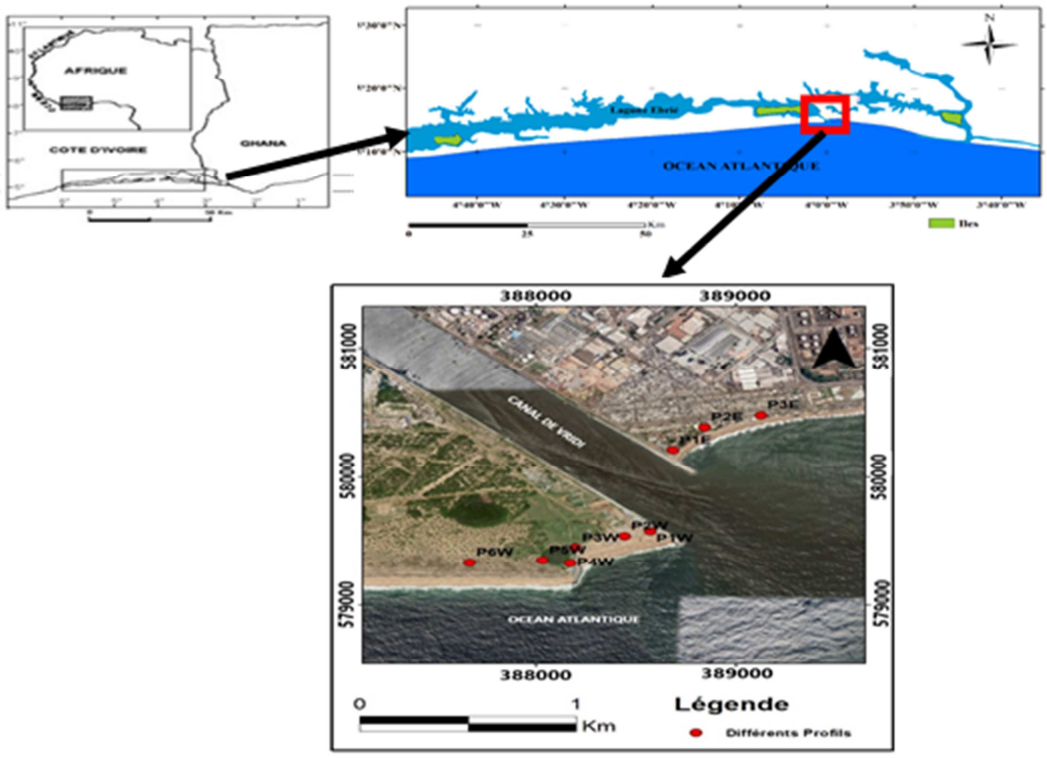


**Fig. 1.** Location of the Vridi canal on the Port-Bouëtcoastline

*Sedimentological survey*

The sedimentological survey consisted of sampling sand which is the material in place in the different parts of the foreshore: high, mid and low.Each part of the foreshore is sampled at three depths (at the surface, -50 cm and -100 cm). These sampling operations were carried out during three campaigns that took place successively on 08 December 2020, 16 February 2021 and 20 April 2021. A auger was used for these different samples.

*Sedimentological analysis*

It takes into account the preparation process, the treatment itself and the particle size analysis. This is a set of washing, drying and dry sieving operations on a column of 16 AFNOR series sieves. Sieving is carried out over a period of 15 minutes and the various rejects are weighed and processed using easysieve software.The granulometric parameters were deduced using the classification of Folk and Ward (1957).

*Morphoscopic analysis*

This analysis was done on the average sand slice between 250-500 µm. It is based on two methods: The method of Pettijohn (1949) which defines 6 grain forms. These are: Very angular, angular, subangular, subrounded, rounded and very rounded grains and the Cailleux method (1947) which defines 4 aspects of surface condition. These are: Unworn, blunt shiny, clean round-mats, dirty round-mats. The analysis was based on observations of 10 quartz grains taken from 9 profiles at a depth of 1 m, using a binocular magnifying glass coupled to a computer. The estimation of forms was based on the visual charter of Pettijohn (1949).

**Results**

*Sediment grain size distribution*

*Average grain size West of the Vridi canal*

*Surface sandy sediment*

The sandy sediments to the west of the Vridi canal have an average that varies between 443.47 µm and 1350 µm for all parts of the foreshore combined. It is therefore medium to very coarse sand found in this coastal area (Fig. 2).

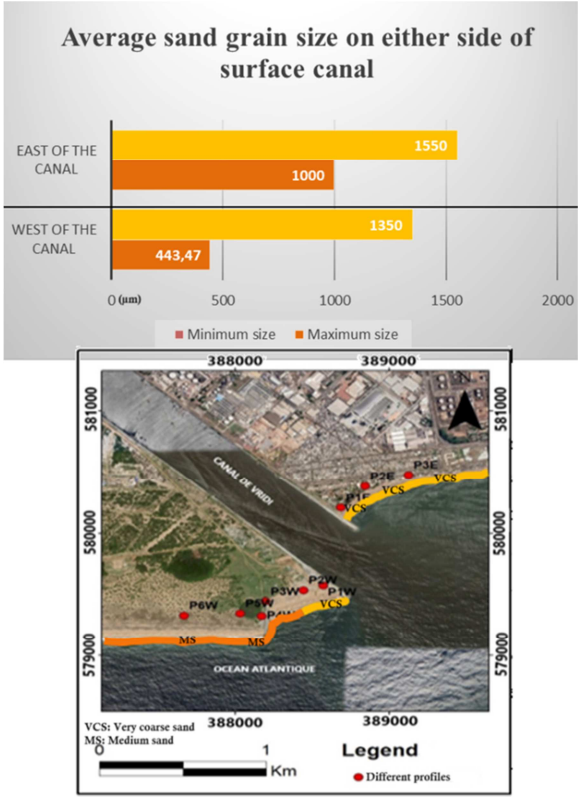


**Fig. 2.** Variation in the average size (µm) of sand grains on either side of the Vridi canal at the surface

The organisation of grain size in a cross-shore direction has no a priori defined meaning. However, it is marked by a dominance of decreasing grain size towards the lower foreshore. This organisation of sand grains reflects the variability of wave energy and its inability to move the sediment in place.

*Sandy sediment 50 cm deep*

The average grain size at a depth of 50 cm to the west of the Vridi canal in all parts of the upper, middle and lower foreshore ranged from 529.41 µm to 940.25 µm. This is coarse sediment (Fig. 3). The sediments present at a depth of 50 cm do not present similar depositional conditions to those at the surface, as they do not contain medium or very coarse grains, unlike at the surface.

The organisation of sand grains in the cross-shore direction does not follow any pattern, unlike at the surface where a dominant decrease in sand grain size in the direction of the low foreshore is observed. This other observation confirms the difference in the energy conditions prevailing in the deposit.

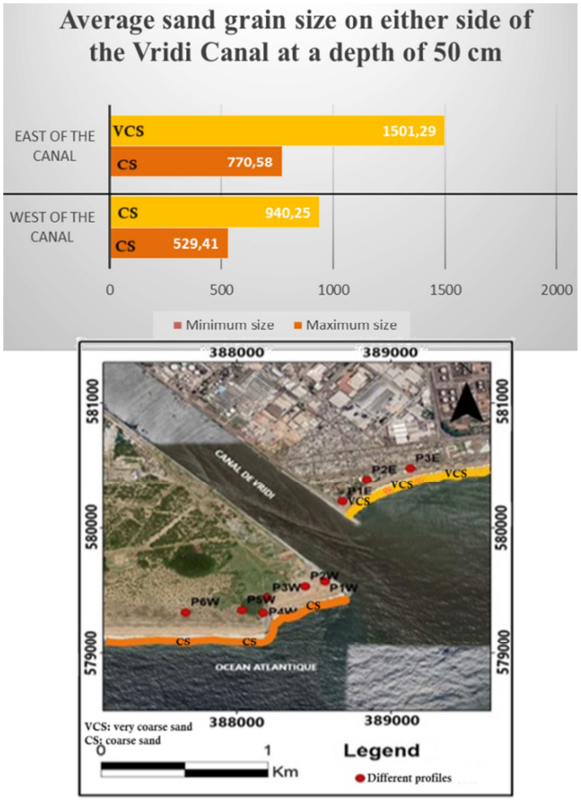


**Fig. 3.** Variation in the average size of sand grains on either side of the Vridi canal at a depth of 50 cm

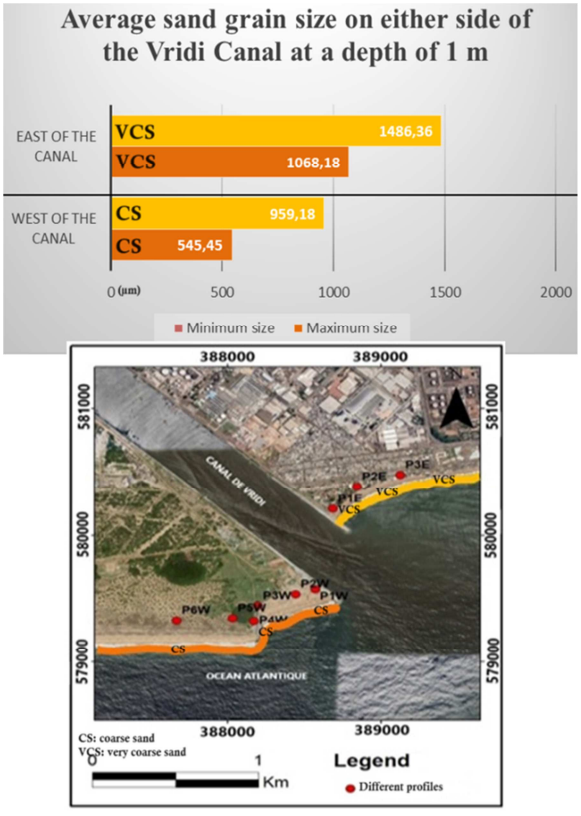


**Fig. 4.** Variation in the average size of sand grains on either side of the Vridi canal at a depth of 1 m

*Sandy sediment 1 m deep*

The average size of sediments sampled at a depth of 1m varies between 545.45 µm and 959.18 µm. It is coarse sand (Fig. 4). This same grain size is found at 50 cm depth. We can conclude that the deposition conditions are constant between 1 m and 50 cm depth. This hypothesis is also illustrated by the absence of a preferential arrangement in the cross-shore direction at a depth of 1m. This form of evolution had also marked the 50 cm depth.

*Average grain size East of the Vridi canal*

*Surface sandy sediment*

The sandy sediments in the east of the Vridi canal have an average that varies between 1000.00 µm and 1550 µm for all parts of the foreshore combined. It is therefore coarse to very coarse sand found in this coastal area (Fig. 2).

The eastern part of the Vridi canal is characterised by coarser sediments than the western part (Fig. 2). The mainly west-east coastal sedimentary transit on the Ivorian coast is artificially interrupted in its intertidal part by the outlet at sea of the Vridi canal. The part that passes through the off-shore continues its journey without the influence of the disturbance from the Vridi canal. The sediments encountered east of the Vridi Canal should be continuity in terms of size of those to the west. However, these are coarser and indicate a new source of sediment for this part of the coast.

The Vridi canal is immediately presented as the supply route for a new granulometric procession. As to the west of the Vridi canal, the evolution of the average grain size in the cross-shore direction is not static. Several organizations are met. However, the most common is where the grain size increases towards the lower foreshore. This shows a similar pattern between deposition energy and grain size in the western and eastern parts of the canal.

*Sandy sediment 50 cm deep*

The sandy sediments 50 cm deep to the east of the Vridi canal have an average size of between 770.58 µm and 1501.29 µm. These are coarse to very coarse sands (Fig. 3).

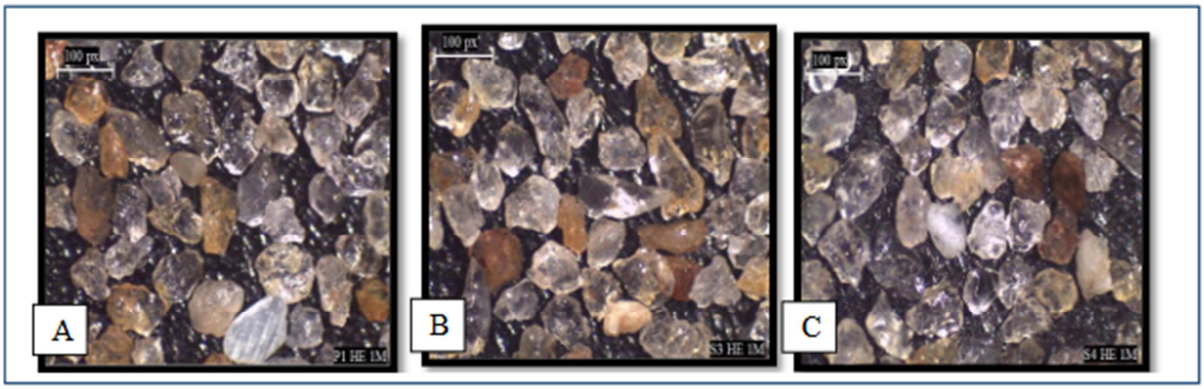


**Fig. 5.** Sub-angular (A, B) and sub-rounded (C) sand grains west of the Vridi canal

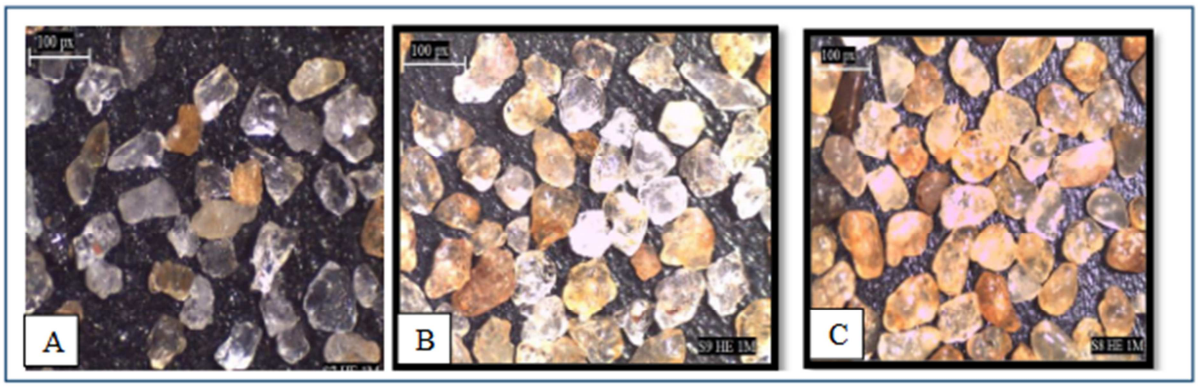


**Fig. 6.** Sub-angular (A) and sub-rounded (B, C) sand grains east of the Vridi canal

A comparison of sand grain sizes at a depth of 50 cm clearly shows that sand grains are larger to the east of the Vridi canal than to the west. This surface particle size sorting is also perceptible at a depth of 50 cm. The continuity of the sedimentary transit of the medium sands from the west of the Ivorian coast after the interruption by the artificial canal of Vridi is not done in the immediate east of the canal. Coarse sand is found both at the surface and at a depth of 50 cm. This means that the Vridi Canal contributes to feeding new sediments to the coastline. These sediments are preferably carried eastwards, which is the dominant direction of coastal drift in Côte d'Ivoire.

As in the west of the canal, the size distribution of the grains of sand in the cross-shore direction at 50 cm depth does not follow any arrangement. The depositional conditions that prevailed at a depth of 50 cm are identical to those in the west, since the west also has no cross-shore arrangement.

*Sandy sediment 1 m deep*

The sand encountered at this depth at an average size between 1068.18 µm and 1486.36 µm. It is very coarse sand (Fig. 4). As on the surface and at a depth of 50 cm, the eastern part of the canal is characterised by very coarse sand. In the cross-shore direction, sorting is achieved by a dominant decrease in grain size towards the upper foreshore. This sorting is not complete.

*Morphoscopy of sand grains 1 m deep*

*West of the Vridi Canal*

Analysis of the shape of sand grains from the high foreshore of the western littoral portion of the Vridi canal shows predominantly sub-angular to sub-rounded grains, all blunt and shiny (Fig. 5). These forms reflect short or more or less long transport in an aqueous medium.

*East of the Vridi canal*

The forms of the sand grains to the east of the Vridi canal show a predominance of rounded sub-grains

(Fig. 6). These forms mark the differentiation from the granulometric cortège to the west of the canal, where the dominance of forms is marked by sub-angular sand grains.

The east is characterized by a dominance of sub-rounded grains that are transported by the lagoon that communicates with the ocean through the canal and further upstream the lagoon meets the comoé river. These sands, transported by the lagoon and the river given the energies in place, are predominantly dominated by rolling, which gives them rounder edges. Unlike the west of the canal where the energy in place stronger keeps the grains more in suspension or saltation or temporary rolling so that even over a long distance the forms are dominated by angular character.

**Discussion**

The very clear difference in sand grain size on either side of the Vridi canal is already well described by Saimon *et al.* (2019). These authors indicated an average surface size of 454 µm to the west of the Vridi canal and 1415.14 µm to the east of the canal. These values place the west in the medium sand facies and the east in the very coarse sand facies. They also show that the coastal sector to the east of the Vridi canal has the coarsest sands on the Ivorian coast.These results confirm a break in the continuity of granulometric evolution in the western direction described by Varlet (1958) as that of the Ivorian littoral drift. However, these authors do not provide any indication of the possible reasons for this granulometric difference.

The work of N'ganza (2015) on grain size variation in Port-Bouët Bay, taking into account the eastern part of the Vridi canal, has shed light on grain size evolution. This author indicated very coarse sand to the immediate east of the canal and coarse sand further east. The coarse sand further east away from the canal is the same size as the sand to the west of the canal. This suggests that this sand further east away from the canal described by N'ganza (2015) could be the continuity of the grain-size procession from the west. In fact, this sand, having bypassed the existing canal protection infrastructure and the canyon of the bottomless pit, ends up further to the east of the canal. This hypothesis confirms that developed by Tastet *et al.* (1985) and updated by Koffi (2017) on the load of sediment drift respectively for each of these two authors of 800,000m$^3$/yearagainst 628,000m$^3$/year west of the canal and 400,000m$^3$/yearagainst 584,000m$^3$/year east of the canal.

The very coarse sand to the immediate east of the canal is of continental origin, given the narrowness of its extent strictly to the east of the canal. The work of Kouassi *et al.* (2022) on the forms of quartz grains of the Ivorian coast reveals 44% sub-rounded against 35% sub-angular. This work indicates that the rounding process has evolved in the direction of longshore drift, so that sub-rounded forms predominate, particularly to the east of the coastline. This work also shows that the east of the canal has more sub-rounded sand, unlike the west, which has sub-angular sand. The transition from a dominance of sub-angular forms to the west of the canal to a dominance of sub-rounded forms to the east in a shortened coastal space interrupted by the Vridi canal confirms the idea of a new source of sedimentary stock supply to the Ivorian coast at Abidjan.

**Conclusion**

Sedimentological analysis of the granulometric characteristics of the coastline on either side of the Vridi canal reveals a lithological environment made up of coarse to very coarse sand**.**

The average particle size of the surface, at 50 cm and 1 m depth on the different parts; high, mid and low foreshore varies from 443.47 µm to 1350 µm to the west of the Vridi canal and from 770.58 µm to 1501.29 µm to the east of the Vridi canal. The eastern part of the canal is supplied with much coarser sediment than the western part, and is therefore not fed by the sedimentological process coming from the west in the littoral drift. The sediments encountered to the east of the canal are an injunction of continental origin that

arrived via the Vridi canal path, which is connected upstream with the Ebrié lagoon and itself further upstream with the Comoé river.

Morphoscopic analysis confirms this hypothesis by its dominant sub-rounded character to the east of the canal compared with a dominant sub-angular character to the west of the Vridi canal. This difference in the forme of the sand grains in a coastal environment marked by the presence of a 350 m wide artificial canal offers less opportunity for a transformation from a sub-angular to a sub-rounded form. The very coarse sand present to the east of the canal is of continental fluvial and/or lagoon origin. It is diverted mainly to the east by the Ivorian longshore drift once it has left the canal, hence its presence to the east and its absence to the west. Their sub-rounded form would probably be the dominant haulage from the river to the lagoon.No granulometric sorting was immediately observed in the cross-shore direction of the foreshore either to the west or to the east of the canal, and this suggests similar qualitative conditions of deposition.

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