The intertidal sanding up of the Seine-Maritime coast (Normandy, France): Sedimentological and geochemical approaches.

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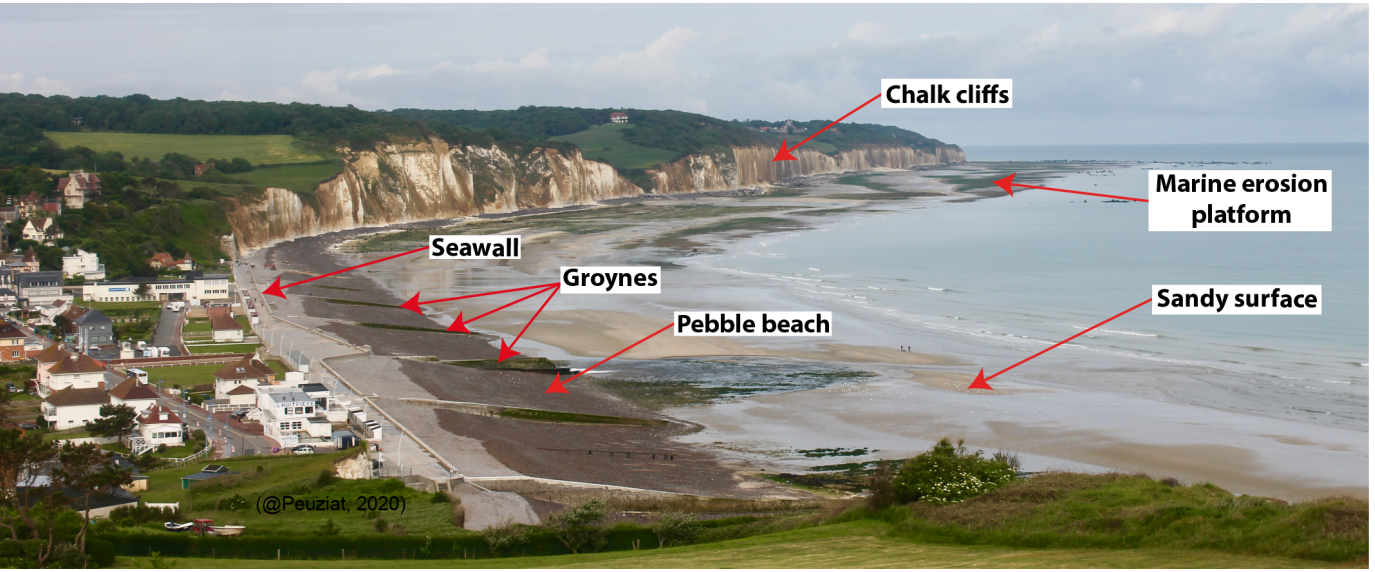
General context

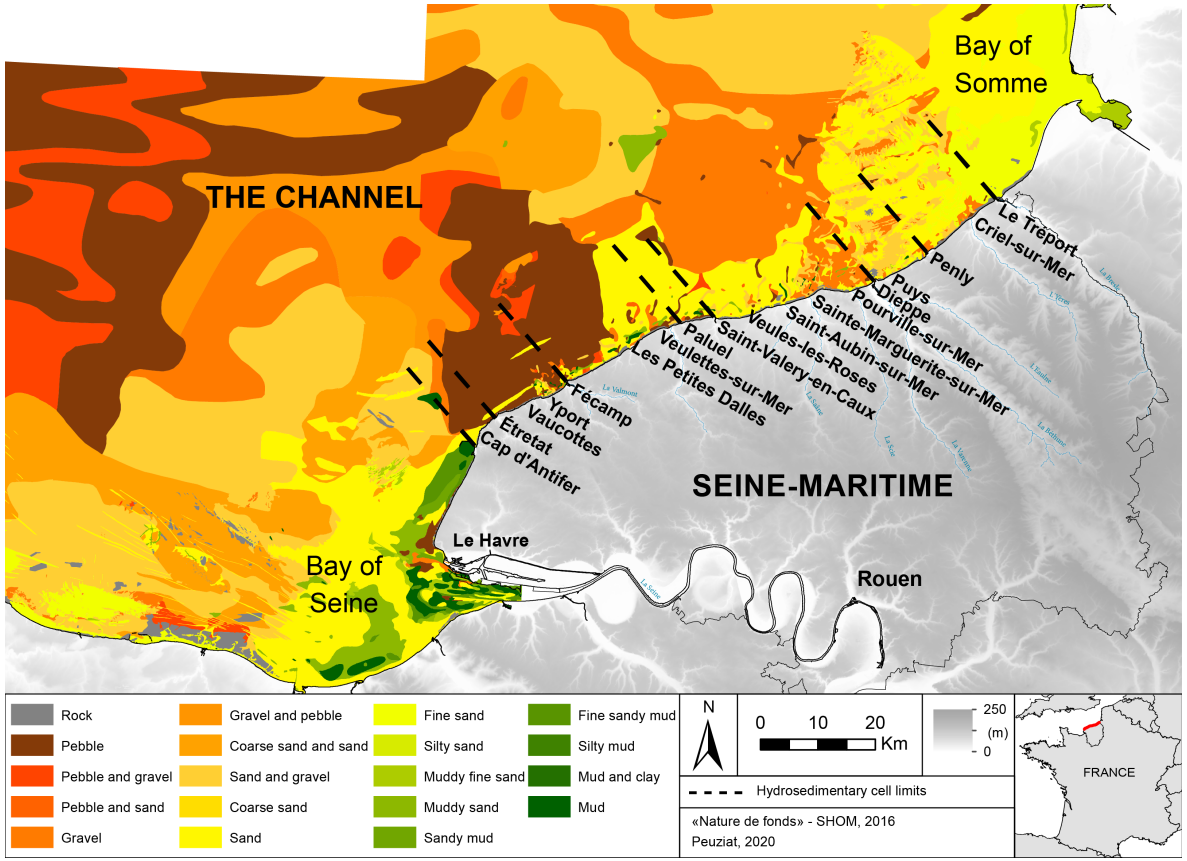
The **Channel sea** is an epicontinental basin, characterized by :

- a ***macro-tidal*** and ***semi-diurnal*** environment (8m tidal range);
- ***westerly atmospheric flows*** : winds and swells (Hs decadal: 4.65m);
- ***thick*** and ***unconsolidated*** superficial sedimentary deposits



Picture of Pourville-sur-Mer valley (📸Peuziat)

(Map of the superficial sedimentary deposits along Seine-Maritime coastline)



This study focus on the 130km of **Seine-Maritime coastline** (France), characterized by :

- ***high chalk cliffs***, locally interrupted by valleys ;
- ***wide marine erosion plateform*** (max 2% slope) *;*
- ***flint pebble beaches***, partially recovering the plateform and transiting from SW to NE.

Main issues

The rocky plateform is locally covered with **sandy surface formations** represented on multiple forms:

→ **perennial sandy surfaces**, metric to multi-metric thickness, located near valley outlets ;

→ **sandy deposits**, decimetric to metric thickness, transiting parallel to the shoreline to the NE under the action of wave and tidal currents.

➢ Observations since the 1990's showed a massive and recent **sanding up** along the rocky plateform but also in harbours :

WHERE DOES THE SAND COME FROM AND WHY SO RECENTLY ?

HOW DOES IT MOVE ALONG THE COAST ? WHAT IS THE SEDIMENT DYNAMIC ON THE INTERTIDAL AREA ?

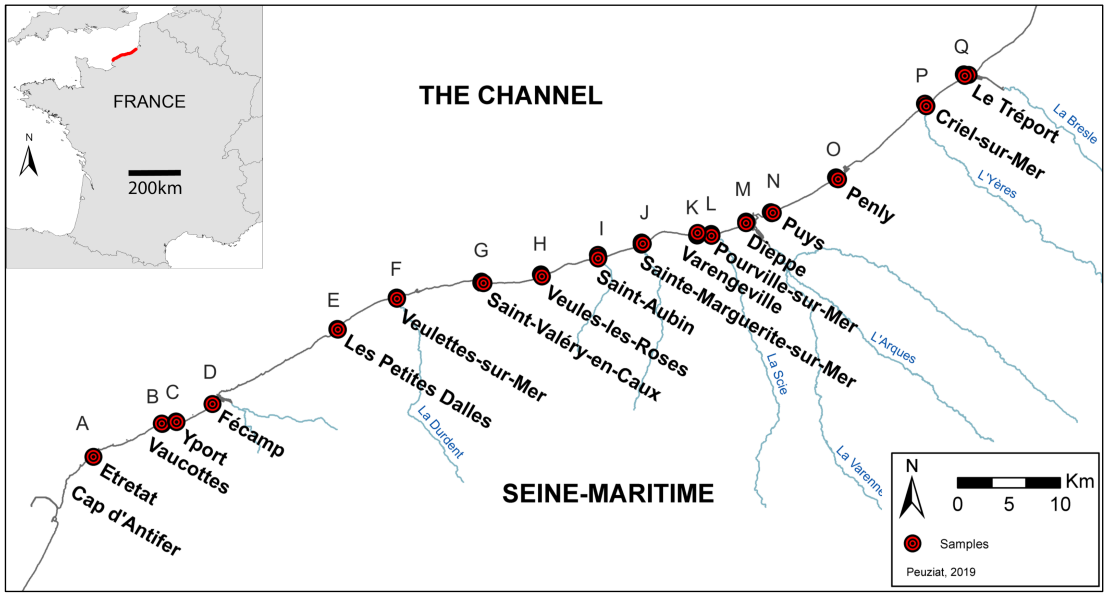
Sampling survey

17 sites were sampled along the study area.

For each site, **3 sand samples** were taken :

- on the pebble beach surface (= upper beach),
- at the middle of the beach (= middle beach),
- at the lowest part of the beach (= low beach).

→ **54 samples** were collected to analyse the geographical variations and the beach profile variations.



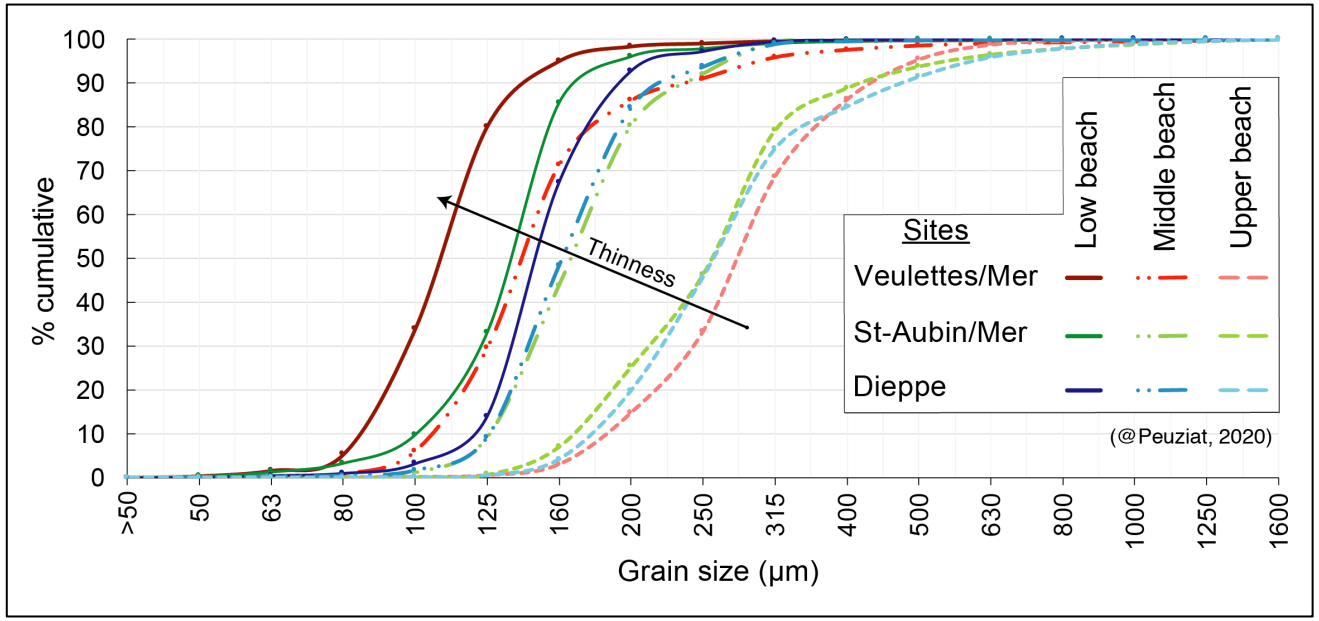
(Map of the sampled sites)

Grain-size analysis

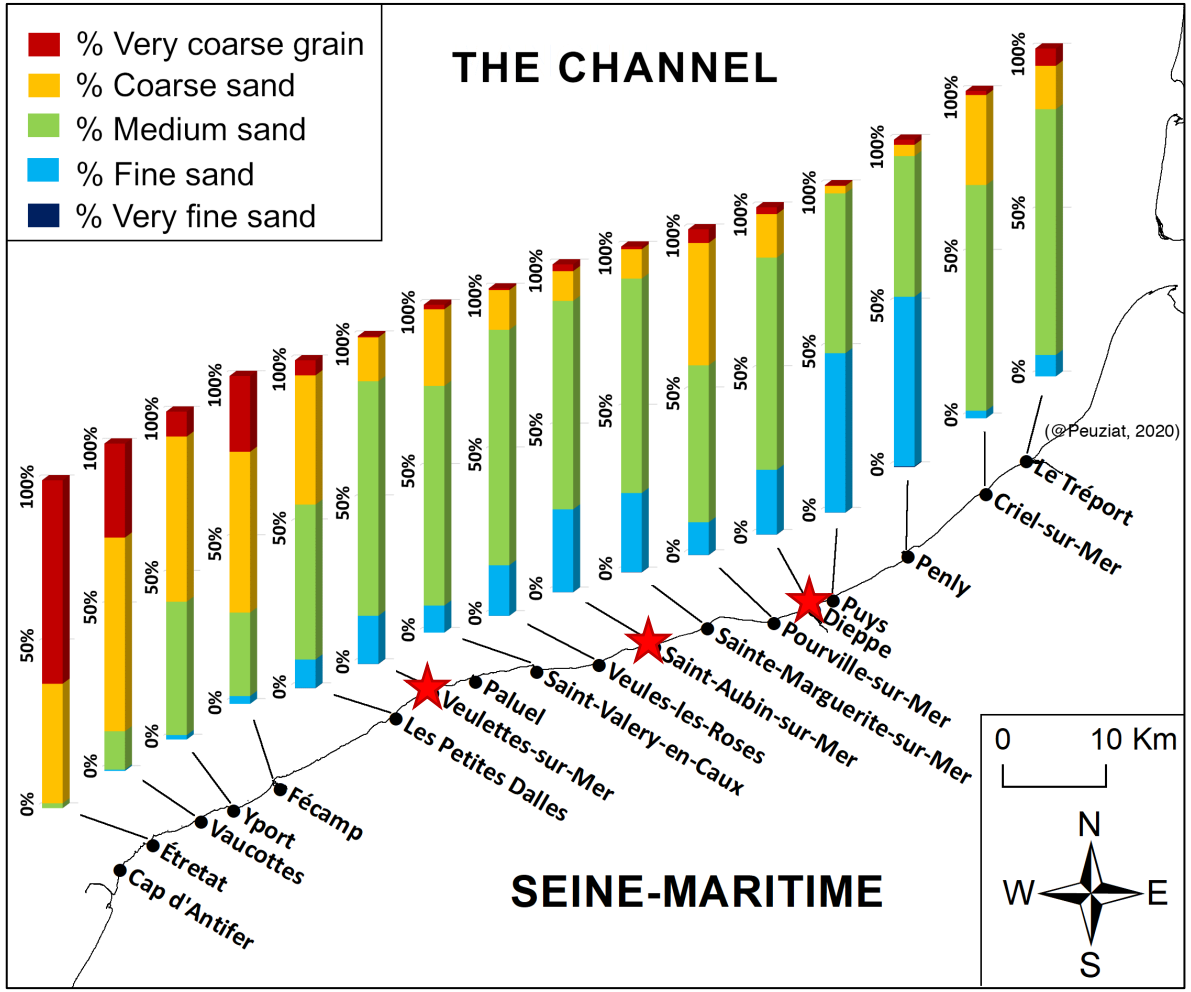
Grain-size results (obtained by sieve analysis) show that for all sites :

- **medium** to **coarse-grained** sands dominate in the **upper beach** (mode 315-400µm)
- **fine** sands dominate in the **middle** and **low foreshore** (mode 160-200µm).

A **decrease** in grain-size is thus evidenced from the upper beach to the low foreshore (Figure below).



(Cumulative percentage curve for the beach profile for 3 sites sampled)



(Geographical distribution of the grain-size results for the upper beach)

A **geographical variability** is also exposed, especially for the sand sampled at the surface of the pebble beach (upper beach) with thicker grains at the SW (Figure above).

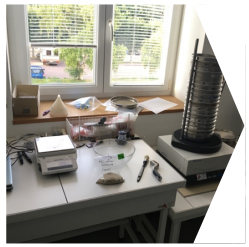
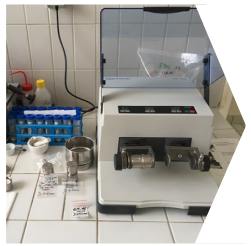
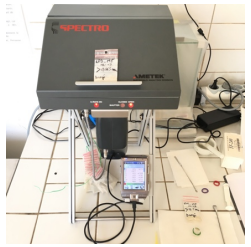
Geochemical analysis : XRF

The geographical variability of the **sand composition** and consequently their **sources** was determined on the basis of geochemical data.

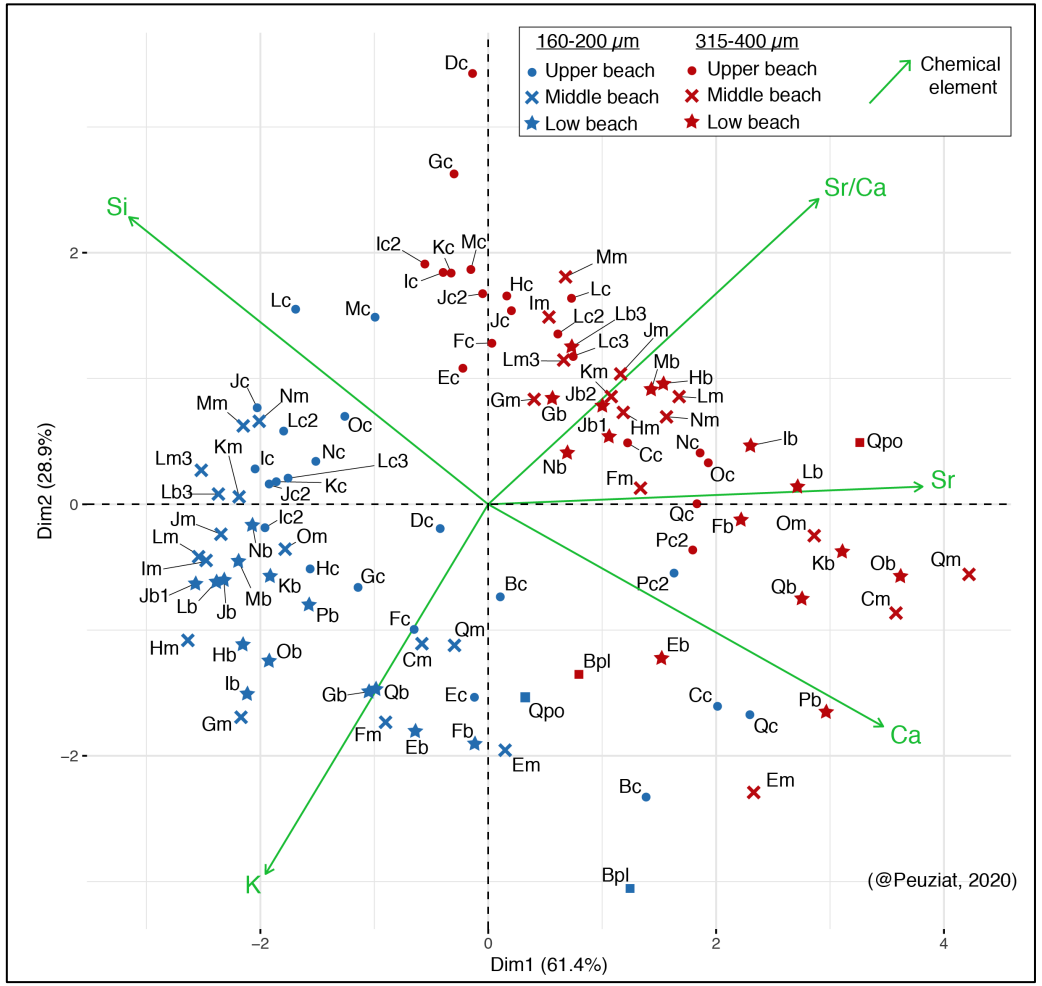
In order to avoid the granulometric effect on the data, **X-Ray fluorescence analysis** (xSORT, SPECTRO AMETEK) were performed on the two major grain-size modes of each sample (**160-200µm** ; **315-400µm**).

18 calibrated chemical elements were measured for each station → **Statistical processing** performed step by step allows to gradually reduce the number of significant geochemical parameters.



→ **4 major elements** (Si, Ca, Sr, K) as well as the ratio Sr/Ca have been considered as the best proxies of sample discrimination and potential sources.



(Principal Component Analysis (PCA) showing the correlation between the two major grain-size modes and the major chemical elements measured by XRF)

Main geochemical results

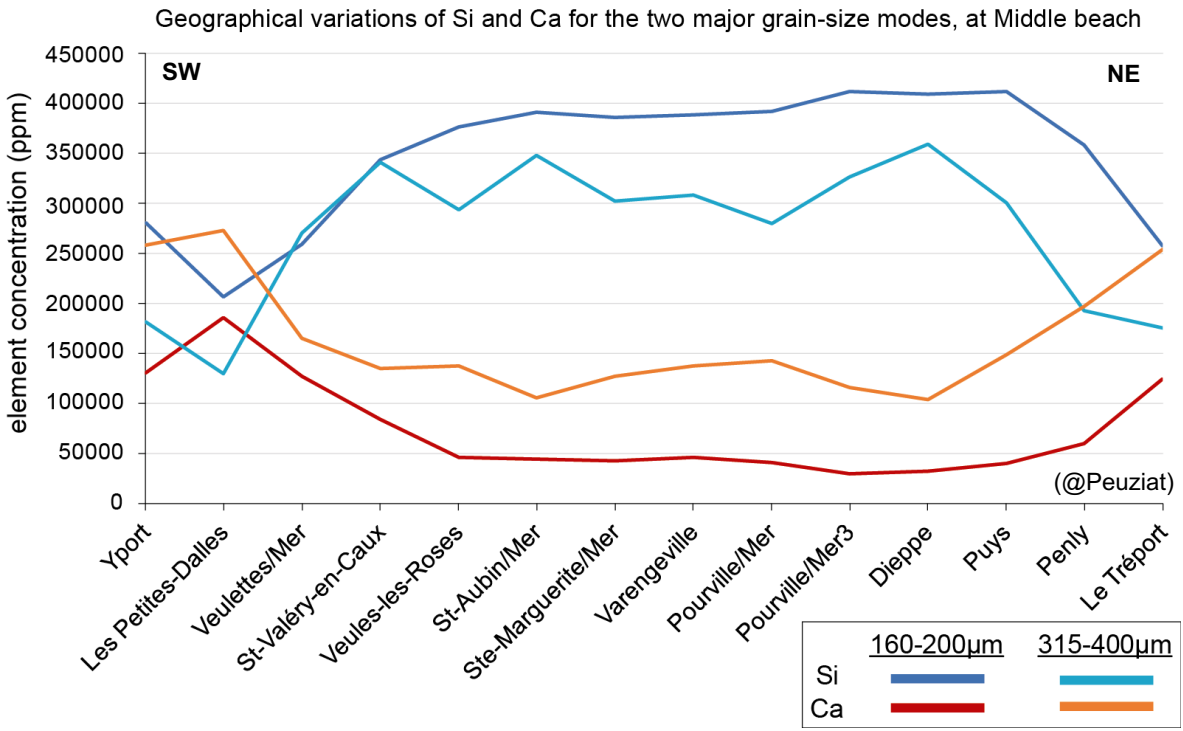
The main results show :

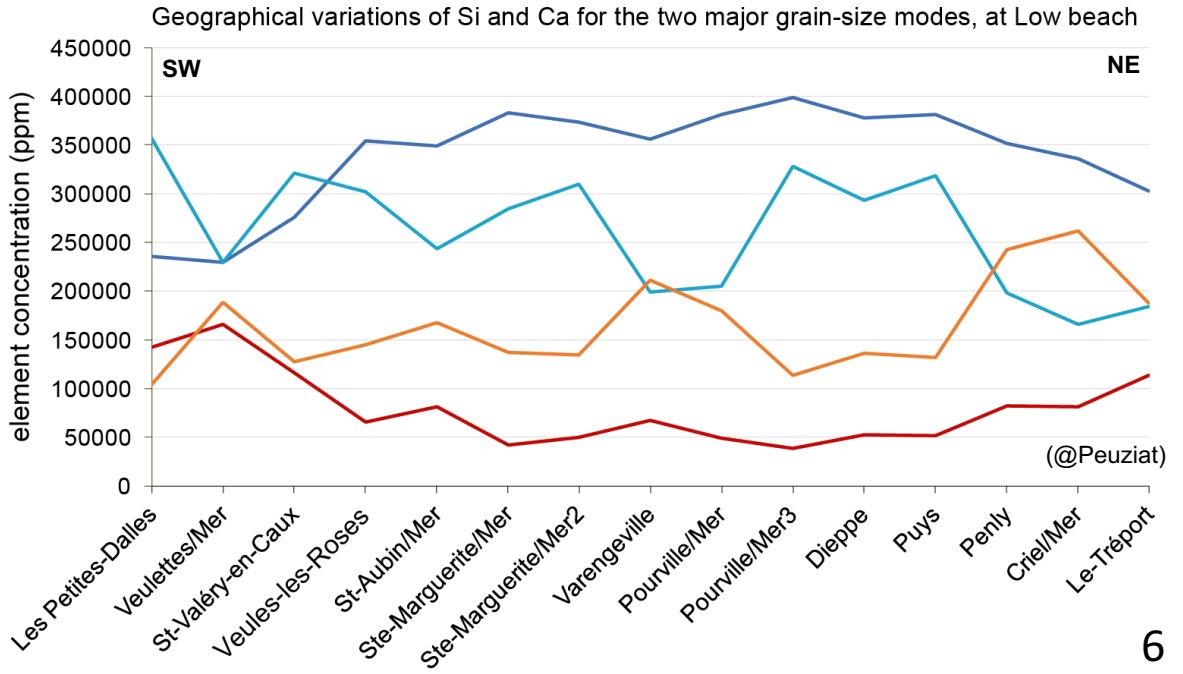
- A **longshore gradient** of Si and Ca, especially for the finest sands (160-200µm) :

an **enrichment** in **Si** (sands are more siliciclastic) and an **impoverishment** in **Ca.**

from SW to NE (=direction of the littoral drift) whatever the position across the beach profile

→ This gradient highlights **differentiated longshore sediment transport** and sorting, in relation probably with sediment sources (siliclastic sands vs bioclastics sands).





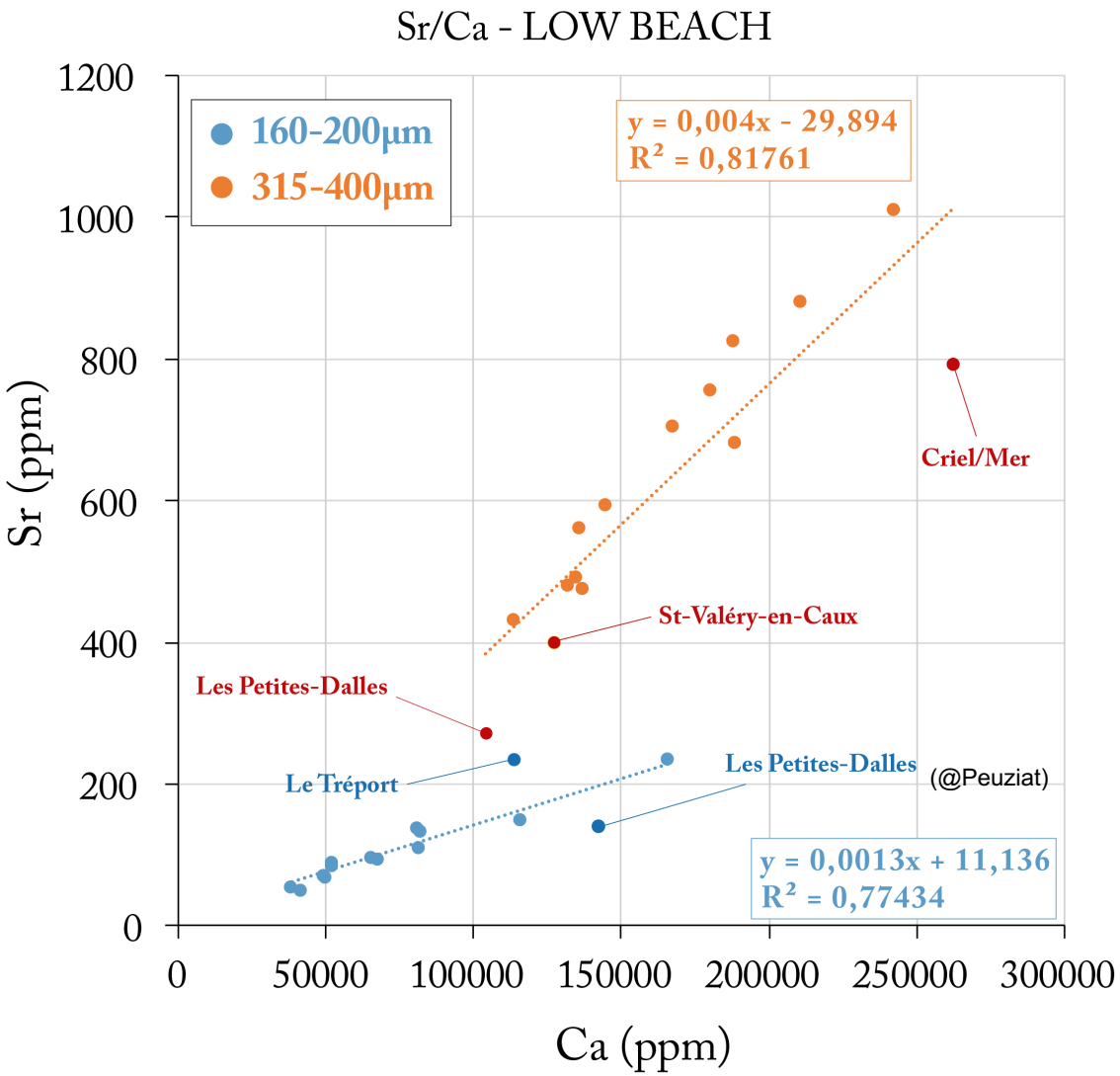
Main geochemical results

The study focus also on the sand supply along the intertidal area.
→ One of the purpose of geochemical analysis is to find a sources tracer

→ **Sr/Ca ratio** = potential sources tracer for carbonate in coastal sands

> The signal of **2 different carbonates** was find on the 2 grain-sizes classes analysed

- **Granulometric + geochemical analysis** allowed to observe the sand dynamic depending on the grain-size classes.
- Further analysis should be made on the subtidale area to try to find potential sources for this **sanding-up**



Sr/Ca ratio for the 2 grain-sizes modes. Darker points represent "anomaly" results, that is to say values that are distant from the linear regression line. Theses points could significate some local perturbations of the sand transport/dynamic.