Hydrodynamics and hydrogeochemical changes in the mixing zone of a coastal aquifer during a heavy rain event

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Introduction

The coastal aquifers are the place where meet fresh water and seawater. This confluence between both of them is called mixing zone which is in equilibrium due to the different density of the two masses and where various biogeochemical reactions takes place. We know that this equilibrium can be canceled during an important recharge event. Within the aquifer, such events displace the mixing zone over a short time period.

This study is aims at the identification and description at high frequency of spatial and temporal response of the mixing zone and its impact on geochemical processes during one such fast water inflow event.

We choose the experimental site of Argentona as the place of this study. Located in the northeast of Spain this site is subjected to a Mediterranean climate characterized by heavy rainfall amount recorded during Fall and early Spring period, concentrated during a few hours. Furthermore, this site is located on an alluvial aquifer, equipped with 16 shallow boreholes over a 100 m scale (*Fig.1*). The geological cross section presented in *Fig.2* shows that the aquifer is multilayered and we suspect an effect of a clay/silt layer located at around 12 m.

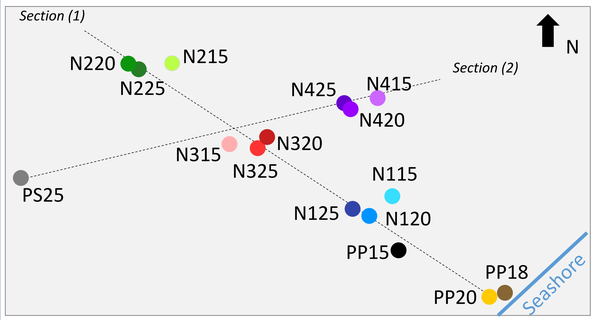

Figure 1. Distribution of wells on the site

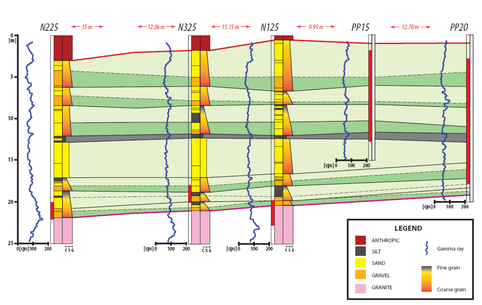

Figure 2. Cross-correlation of the geology section (1)

Materials & Methods

In a way to follow the event occurred from the 18/10 to the 19/10 devices as been installed (Figure 3).

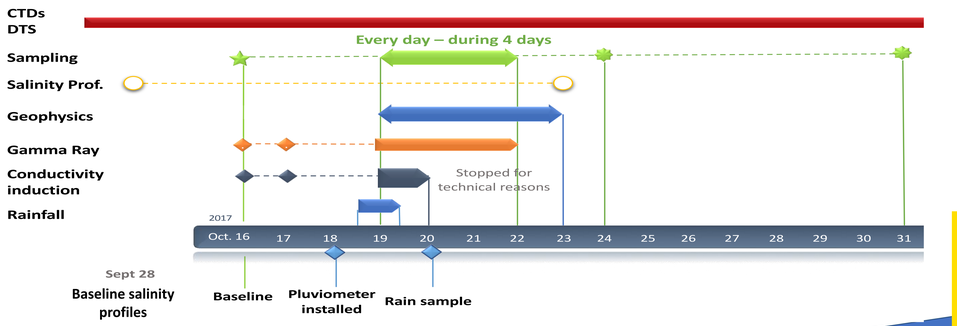

Figure 3. Organization and distribution of manipulations over the experiment

Results & Discussion

A Rainfall event characterization :

- **Amount** : 75 mm
- **Duration** : 18 h
- **Distribution** : 3 event of 1.5 h each

B Hydrodynamics response :

After noise filtering (low pass filter) head shows 3 main behaviors = silt/clay layer key-role (*Fig.5*):

- **High amplitude, short response time**
  - Shallow boreholes
  - Above the silt/clay layer.
- **Low amplitude, long response time**
  - Deepest boreholes
  - Under the silt/clay layer.
- **Intermediate reaction**

C Hydrogeochemical changes :

- Temperature : only for fully open boreholes
- Electrical conductivity (EC) decrease after the event and recover with higher values.
- Ra and Rn activities :

- Electrical tomography: (*Fig.6*) Resistivity changes are from the conductivity fluctuations
  - **Decrease on the upper part :**
    - Freshwater entrance diluting the upper part of the aquifer
  - **Increase on the lower part :**
    - Seawater entrance due to the stormy state of the sea = better connection with it.

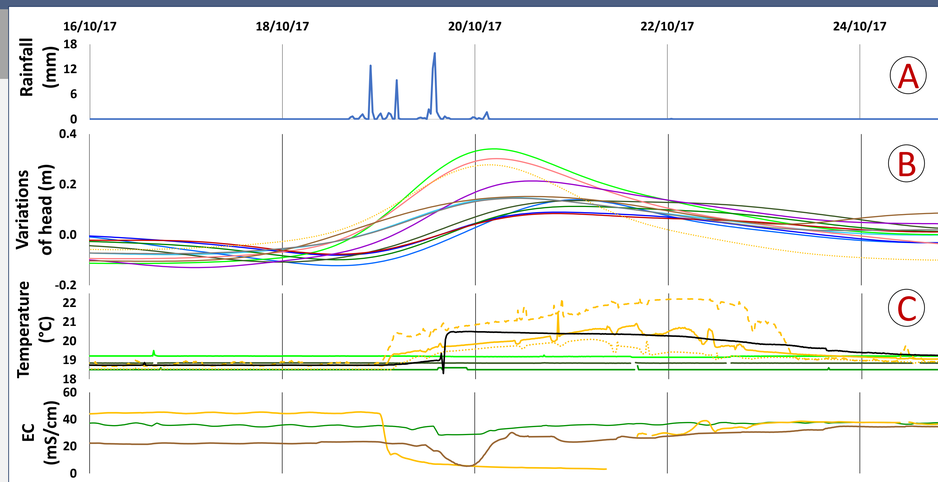

Figure 4. Hydrodynamic and hydrogeochemical changes

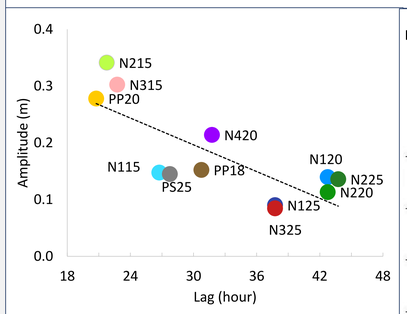

Figure 5. Comparison of the amplitude and lag from the event pick in wells

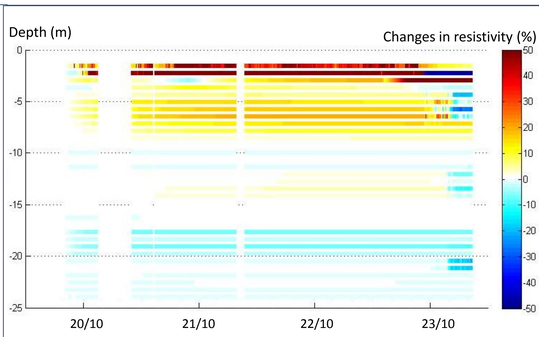

Figure 6. Resistivity changes time-lapse in N325

Conclusions

- Different behaviors in water table response are observed between wells slotted above and below the silt/clay layer ;
- Changes in EC suggest that dilution occurred rapidly after the event, but followed by a recovery towards higher salinity values, which suggest transient response ;
- Temperature fluctuation is observed only on the fully open boreholes ;
- Decrease in Ra and Rn activities during the rainfall event could be explained by changes in salinity and dilution processes.

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