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Aquifer sampling using ball check-valves system: what about sample representativeness?

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1

Deep aquifer sampling is frequently done using electric submersible pumps (ESP) as gas-lift methods are known to highly disturb physical and chemical properties of samples (Wolff-Boenisch and Evans, 2014). The use of ESP may be questioned when deep aquifer levels have to be sampled:

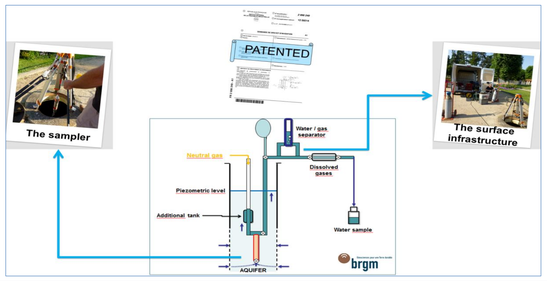
- What kind of **sample representativeness** can be reasonably awaited if the **pump is hundreds of meters above the screened section** of the borehole ?
- How to proceed when the **water table level is too deep for common pumping devices** (ESP operating with water table levels deeper than 100 – 150 m requires adapted surface infrastructures)?
- How to manage water sampling using ESP when the aquifer has low to **very low recharge rate** (risk of drying-out the well)?
- If large volumes of water are required to be pumped and cannot be flowed back into the environment, how to manage that?

In all these specific cases, **deep sampling** may be performed, but the representativeness of the waters collected using such devices has to be evaluated to ensure that 1) **reasonable estimates of water quality** can be achieved and that 2) the data obtained using deep sampling systems **can well compare with data obtained using pumping methods**.

2

Several deep sampling systems exist, often relying on the **use of sampling bottles** (wireline samplers), lowered to depth and retrieved at the surface each time the volume of the bottle has been filled (Wolff-Boenisch and Evans, 2014). Main limits are 1) a **restricted volume** of water that can be collected and 2) the need to have a **transfer system at surface**.

Here we present investigations with a system developed since the early 2000's (Gal *et al.*, 2014), relying on a functioning similar to that of the U-tube system (Freifeld *et al.*, 2005) but having more flexibility in the use (fixed character of the U-tube; Conaway *et al.*, 2016). This system allows the **collection of fluids at any depth** in the water column as it is mobile in the borehole (use of flexible tubing). It requires lower N_2 amounts to work (**ball check-valves** at max. 250 m depth) as only one leg is lowered down to the desired sampling depth (successfully tested down to 1030 m).



3

Investigations compare the characteristics of waters obtained by deep sampling and by pumping in 2 boreholes located near Castres (Tarn, France):

- **Physico-chemical well logging** is performed prior to and after any investigation in the borehole to evaluate the influence of pumping;
- **Pumping is performed at fixed depth**, above the screened section;
- **Deep sampling** is performed at the top of screen and at the productive horizon;
- **Major and trace elements** were analyzed at BRGM laboratories.

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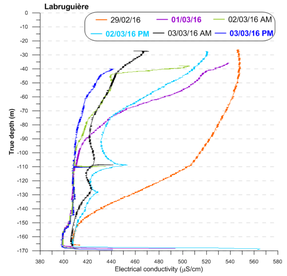
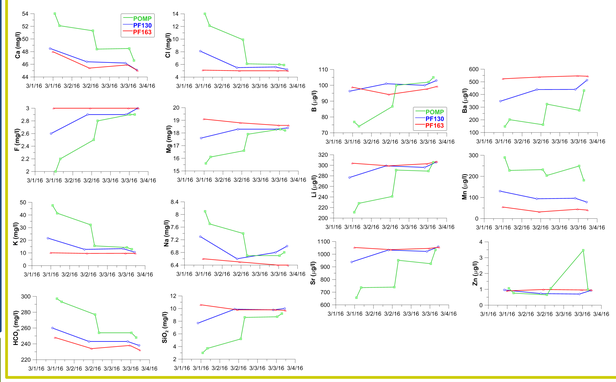
4 Borehole with low discharge capacity

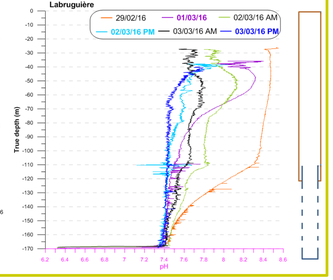
Labruguière borehole

Progressive "refresh" of the water column as result of several pumping sessions



Some major and trace elements **concentrations evolution during time**

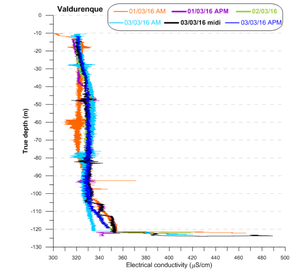




5 Borehole with higher discharge capacity

Valdurenque borehole

More rapid "refresh" of the water column as result of several pumping sessions



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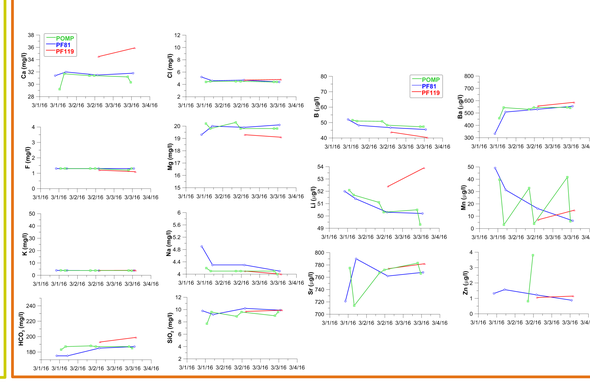

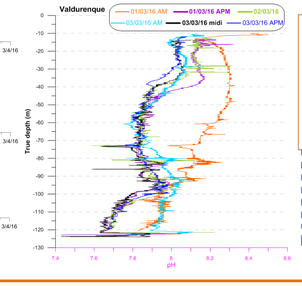

6 Conclusions

- **Deep sampling** is **adapted** for collecting fluid samples in **low discharge capacity boreholes**;
- The better the **water column is known**, the better the sampler can be located (and the collected fluid will be the most representative of the aquifer);
- **Chemical heterogeneities** that may exist in the tapped aquifer **can be characterized** using deep sampling without requiring pumping under packers;
- The **variability** between deep sampling **without purging** and deep sampling **after pumping** is **low at the producing levels**.

7 References

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Freifeld, B.M. et al., 2005. The U-tube: a novel system for acquiring borehole fluid samples from a deep geologic CO_2 sequestration experiment. J. Geophys. Res.:Solid Earth 110 (B10), B10203.

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