

# Sulphur isotopes: a tool to understand the variations of chemical composition of deep waters

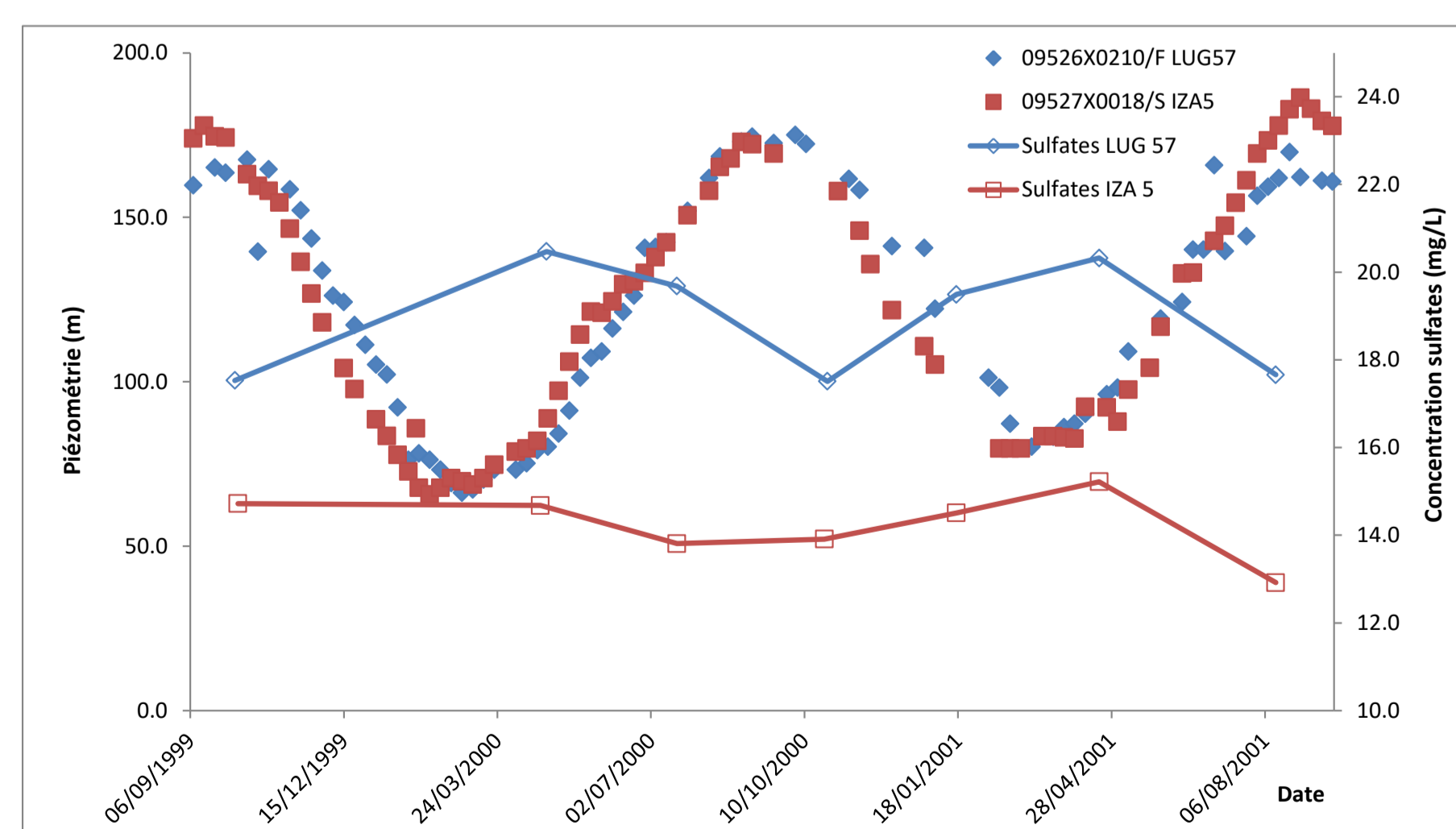
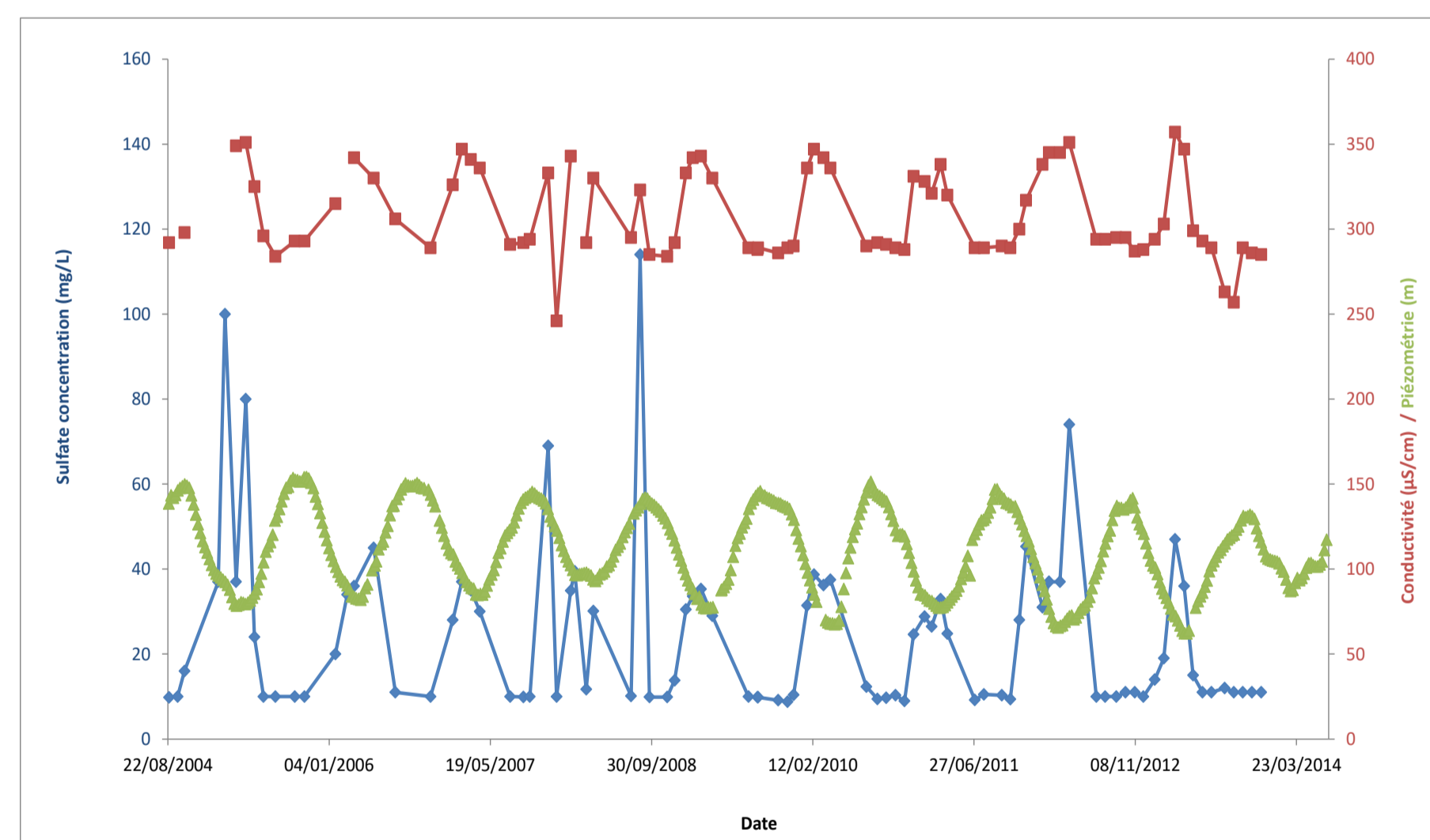
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Abstract n°1490

**1** Chemical composition of waters from deep aquifers are impacted by the interactions between waters and reservoir rocks. The determination of an accurate chemical composition of waters is thus necessary to identify the origin of this mineralisation. The water chemistry of the Infra-Molassic Eocene aquifer (Aquitaine Basin - France) has been investigated through different studies highlighting various origins for water mineralization. Isotopic analyses helped, in agreement with hydrogeology, to identify geochemical basins whose properties modify the chemical water composition (André, 2002; Douez, 2007).

## 2 Context

The chemical composition of waters from this deep aquifer (about 500 to 1000 m depth) does usually not change with time. However, seasonal variations of sulphate concentrations occur in a specific area. About 200 analyses of sulphate collected during more than 10 years show variations between 10 and 110 mg SO<sub>4</sub>/L. These local variations are correlated with the water conductivity and anti-correlated with piezometric variations (reaching about 80 m per year) induced by the seasonal storage of natural gas in a close sector of the aquifer.

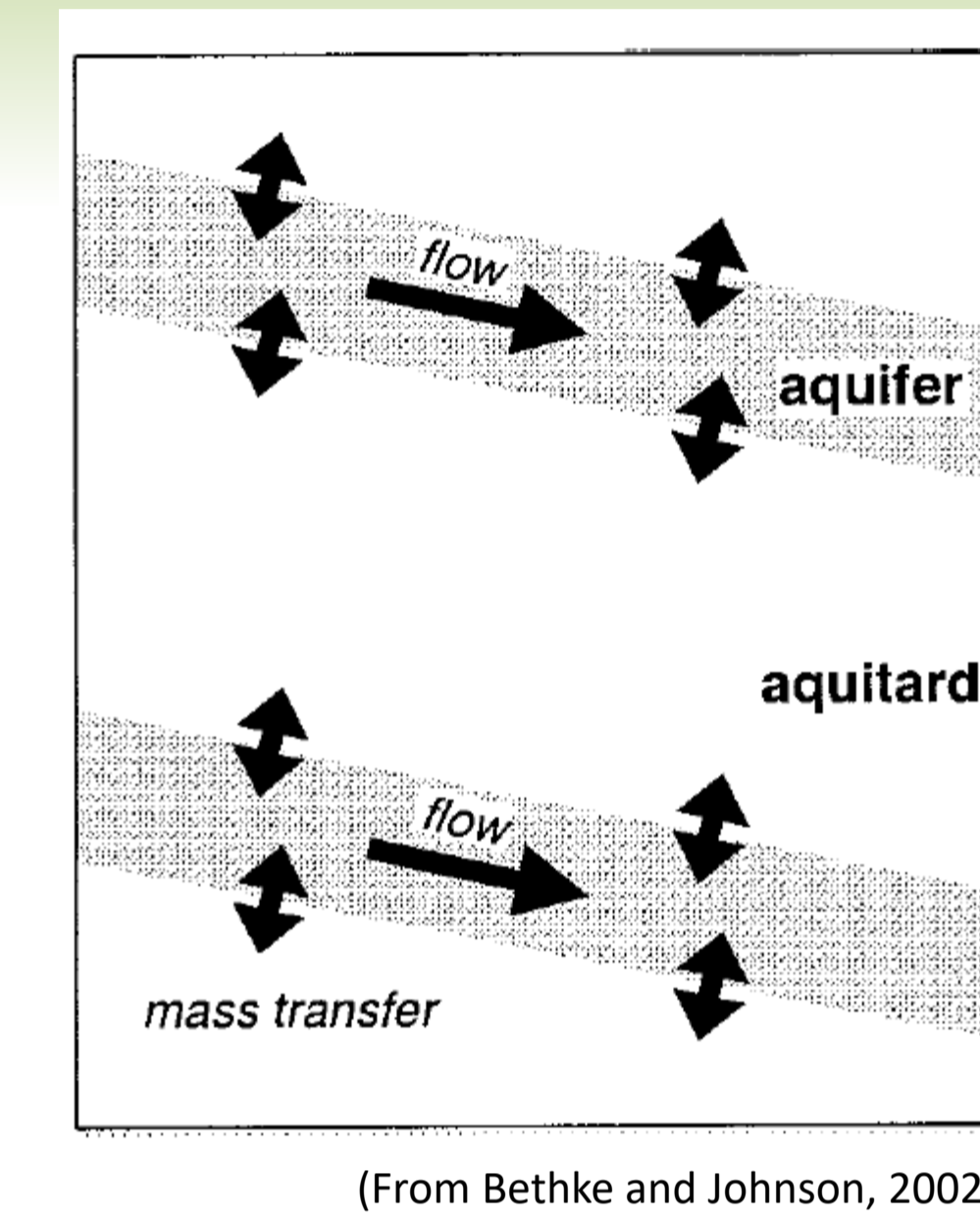


## 3 Objectives

Several hypotheses can be considered in order to explain these sulphate concentration variations:

- **mixing** of waters from different aquifers,
- **vertical transfers** by advection or dispersion from the upper molassic aquitard,
- local **biological processes**...

The objectives of this study are to determine which of these hydro-chemical processes plays the most important role.



## 4 Overall methodology of the approach

This study uses both **isotopic tracers** (<sup>18</sup>O and <sup>34</sup>S of sulphates, <sup>13</sup>C and <sup>14</sup>C) and **composition of trace elements** (F, B, Ba, Sr...) in order to determine the origin of these variations. It will be based on existing chemical data but also on the acquisition of new ones with **quarterly samplings of waters** (on the well of interest and 4 neighboring wells located within a 10 km range).

This chemical approach will be secondly coupled with an **hydrological model** of the specific area in order to understand the local behaviour of the aquifer (residence time, recharge processes, interaction with adjacent reservoirs/aquitards).

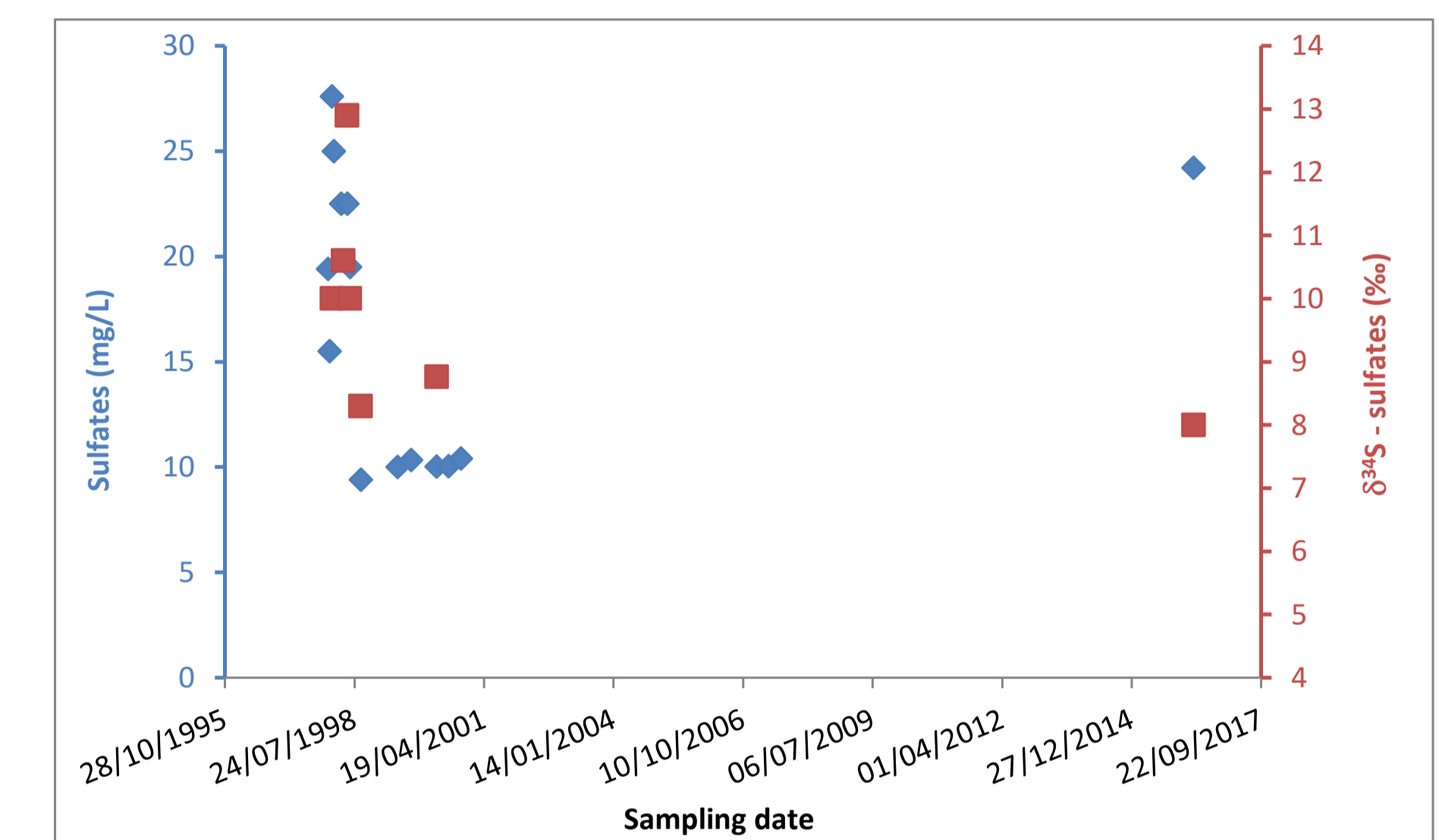
## 7 References

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## 5 First results

First results of chemical water composition were obtained after the first sampling campaign (2016).

**Waters are relatively old** with an average age higher than 30 000 years. It is expected that age variations with time, coupled with bore and strontium isotopes variations, may inform regarding groundwater's origin.



These isotope measurements will be coupled in the hydro-geochemical model with variations of sulphur isotopes in order to define the source of sulphur, knowing that no sulphur-bearing mineral is present in the aquifer (André et al., 2002).

	Sampling Date	δD	δ <sup>18</sup> O <sub>H2O</sub>	<sup>87</sup> Sr/ <sup>86</sup> Sr	δ <sup>13</sup> C	Act. <sup>14</sup> C	Age	δ <sup>11</sup> B	δ <sup>34</sup> S	δ <sup>18</sup> O <sub>SO4</sub>
		‰ vs SMOW	‰ vs SMOW		‰ vs PDB			pCM	years BP	‰
WELL 1	19/04/2016	-54.3	-8.5	0.708704	-14.60	1.8	32400	11.67	8	13.5
WELL 2	19/04/2016	-52.6	-8.3	0.708698	-14.60	1.5	33520	13.97	9.3	12.8
WELL 3	19/04/2016	-52.7	-8.3	0.708781	-15.30	3.2	27750	17.94	15.9	10.2
WELL 4	10/05/2016	-61.6	-9.4	0.708549	-11.90	1.6	33420	14.69		
WELL 5	10/05/2016	-59.0	-9.1	0.708688				15.44		

## 6 Preliminary conclusions

This study uses different geochemical tools in order to determine the origin of the mineralization of deep waters. Based on sulphur isotope measurements, first calculations determined potential exchange at the interface between aquifer and aquitard.

This study uses new geochemical markers to identify and confirm/infirm these exchanges.

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