

Naturally CO₂-rich groundwater springs in Belgium evidencing complex subsurface interactions

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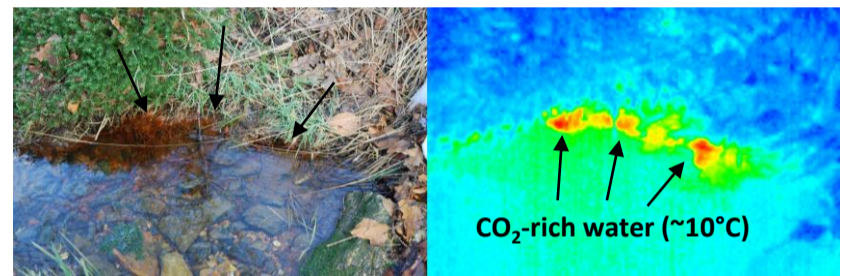
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A story of water and bubbles

Numerous naturally ferruginous and CO₂-rich (up to 4g/L) springs, locally known as **pouhons**, occur in the Belgian Ardennes



These waters have attracted economic and touristic interest for centuries, being exploited since the 14th century and bottled and exported since the 16th century



Where is the CO₂ coming from?

Two main hypotheses:

a) Generation by dissolution of carbonate rocks and/or carbonate nodules at depth



Crustal (heavy) C isotopic signature in CO₂

Unconfirmed presence of carbonate rocks at depth in the area

b) Volcanic degassing related to the neighbouring Eifel area in Germany

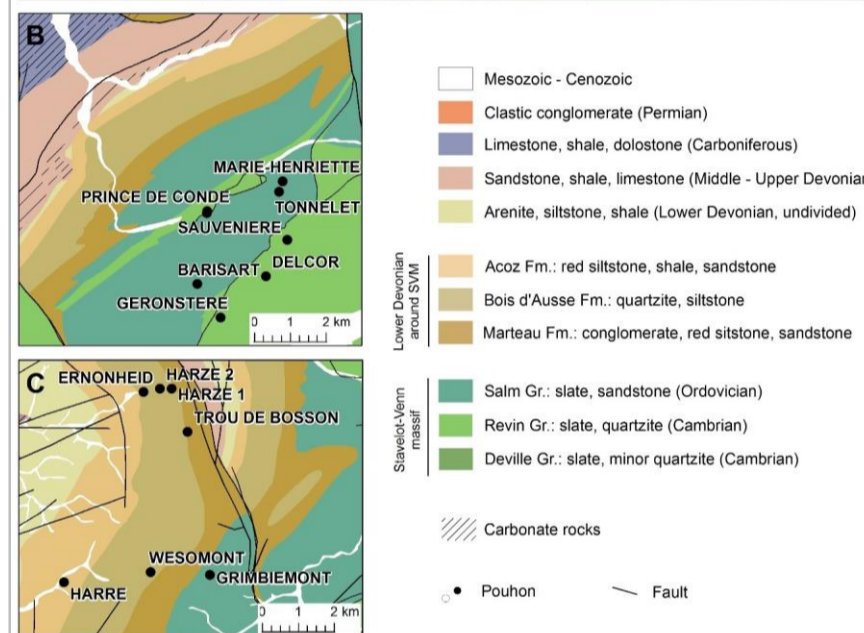
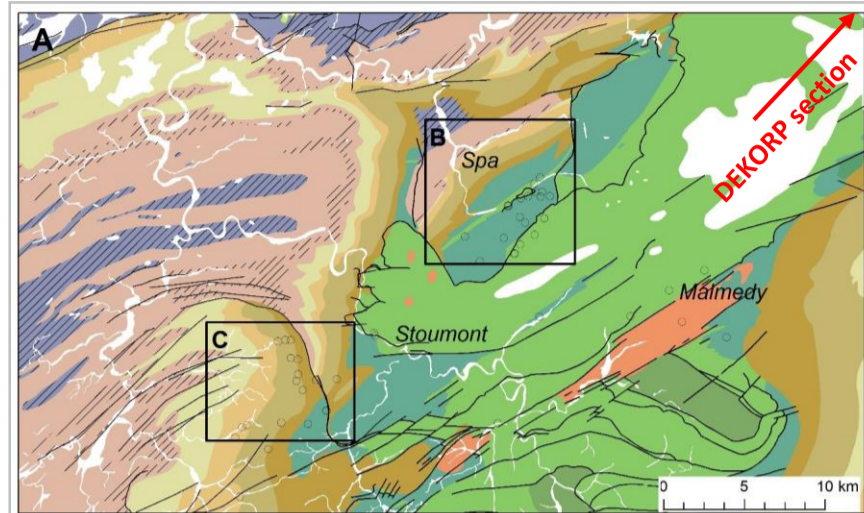


Mantle He isotopic signature in CO₂

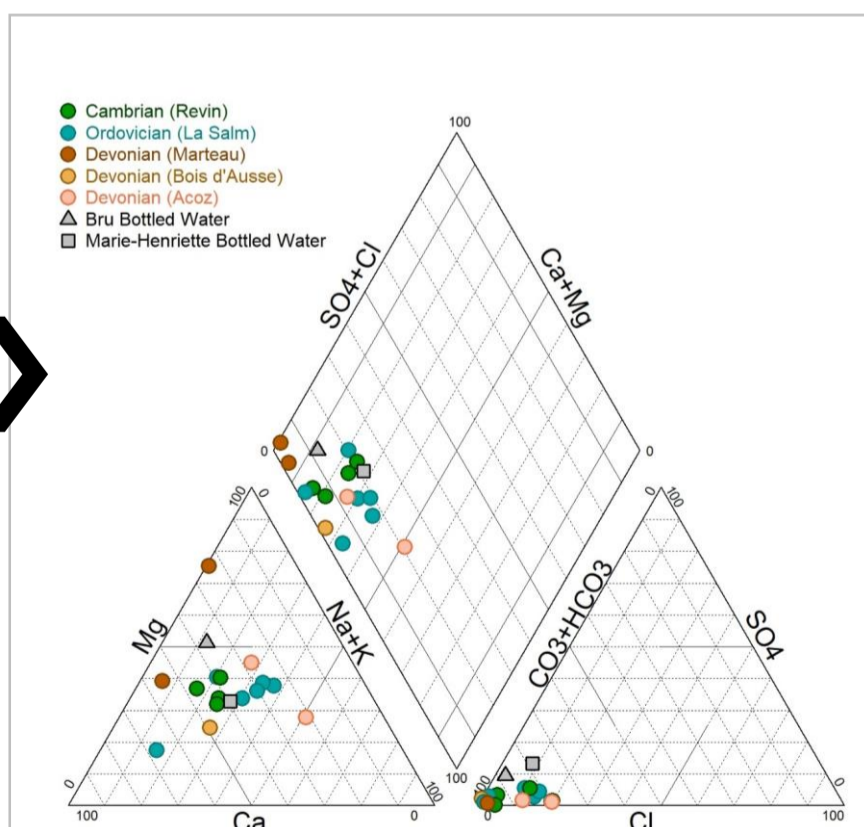
No magmatic reservoir known at depth in the BE side

Physico-chemical characterisation of spring waters and understanding of the geotectonic evolution of the region remain largely unrelated

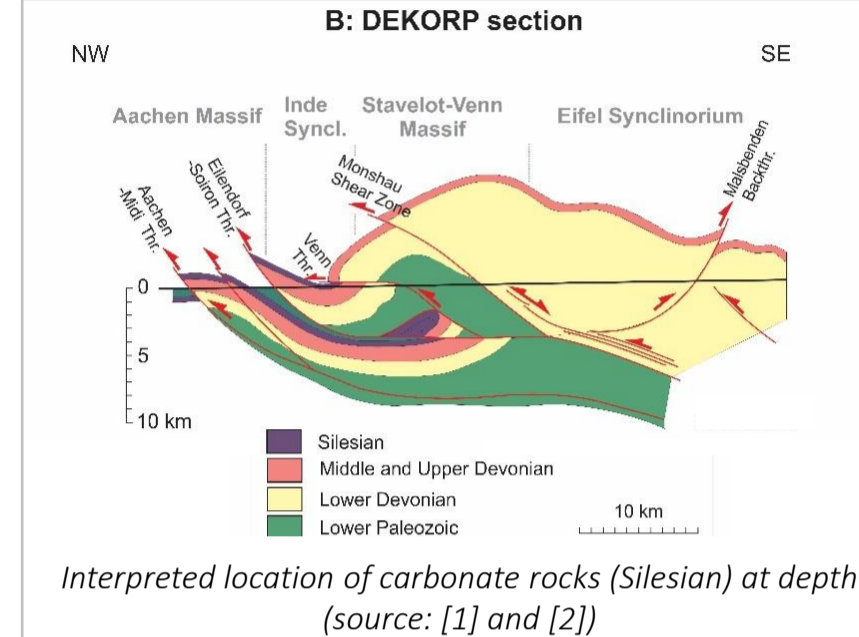
Geological setting & geochemical characterisation



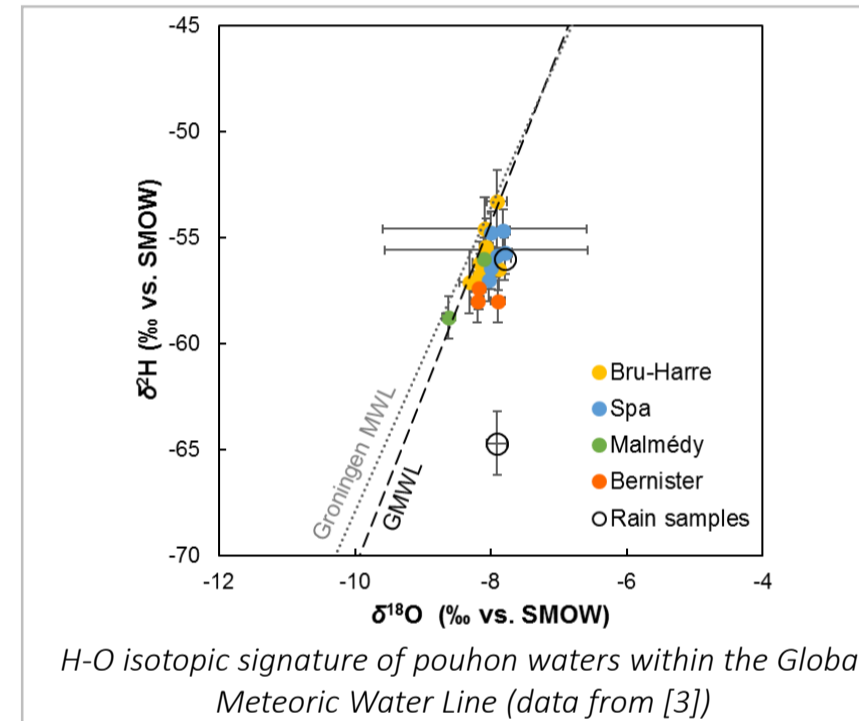
Geology of east Belgium and location of pouhons studied



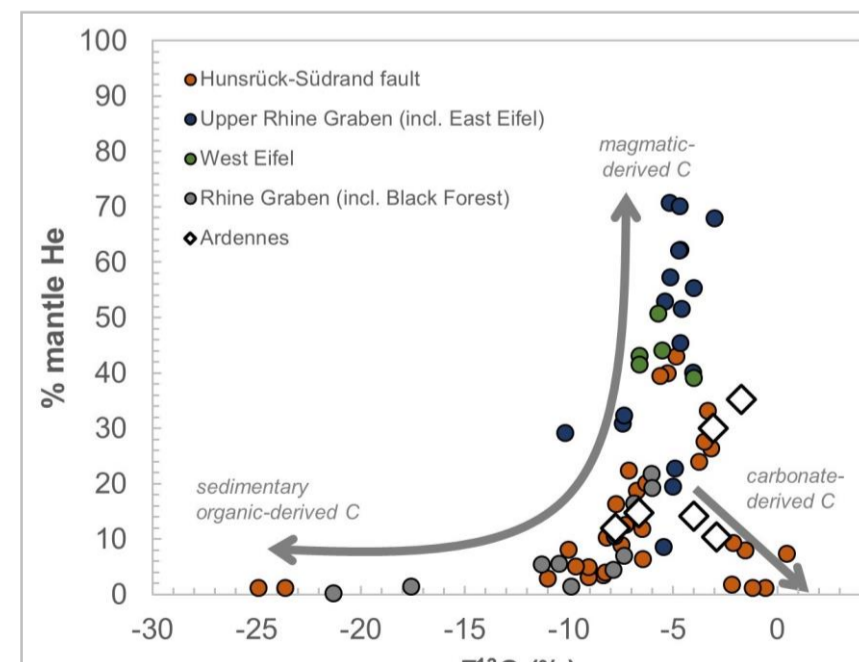
Differences in cation dominance in pouhon waters (data from [4])



Interpreted location of carbonate rocks (Silesian) at depth (source: [1] and [2])

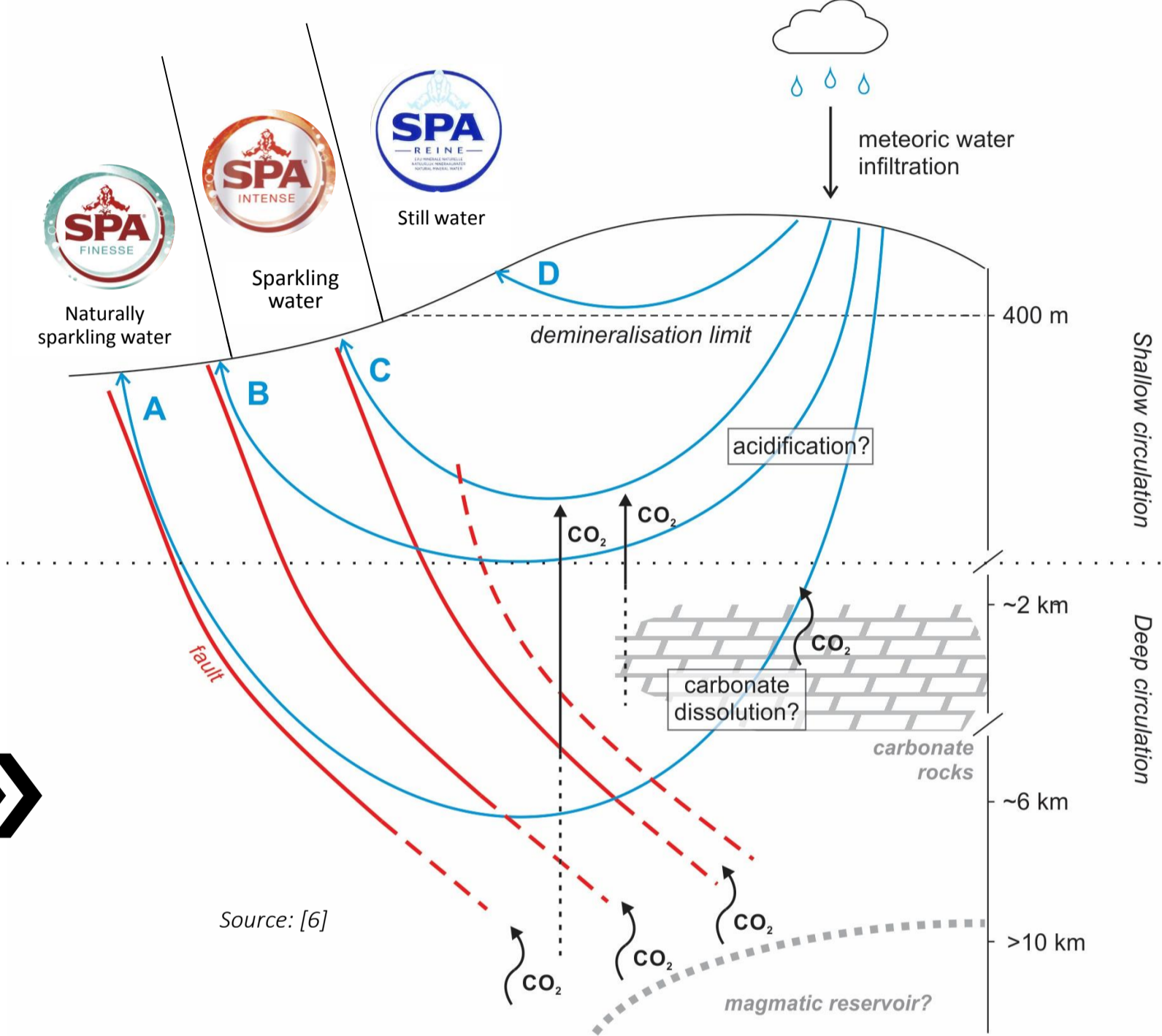


H-O isotopic signature of pouhon waters within the Global Meteoric Water Line (data from [3])



C and He isotopes of CO₂ gas phase in pouhons and neighbouring areas (data from [5])

What does it tell us about what happens in the subsurface?



Source: [6]

- H-O isotopic signature shows water is primarily meteoric in origin; He and C isotopes point to a mixed crustal and mantle origin for CO₂
- Previous studies favouring either CO₂ origin from carbonate dissolution or from volcanic degassing inferred deep circulation (>2km) is needed, followed by rapid ascent, which contrasts with low temperatures of springs
- We suggest CO₂ moves upwards to meet shallow aquifers; faults may act as pathways
- The occurrence of mofettes (dry CO₂ sources) in the region could be linked to such transport

Future work aims to provide new results on the isotope geochemistry of pouhon waters to determine the origin of CO₂ with greater detail

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References:

- [1] Fialit, W., 1992. Variscan transpressive inversion in the northwestern central Rhenohercynian belt of western Germany. *Journal of Structural Geology* 14, 547-563.
- [2] Vanbrabant, Y., 2001. Evolution géodynamique de la partie orientale de l'allochtone de l'Ardenne. Observations structurales et modélisations numériques. PhD thesis, Université de Liège, Faculté des Sciences, 350 p.
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- [4] Spadel internal data.
- [5] Griesshaber, E., O'Nions, R.K. & Oxburgh, E.R., 1992. Helium and carbon isotope systematics in crustal fluids from the Eifel, the Rhine Graben and Black Forest, F.R.G. *Chemical Geology* 99, 213-235.
- [6] Barros, R., Defourny, A., et al. (under review) A review of the geology and origin of CO₂ in mineral water springs in southeast Belgium. *Geologica Belgica*.

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