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Natural Emission of Carbon dioxide with Capture and Sequestration (NECCS), applied to the French carbonic province (Fonts-Bouillants, Nièvre, France)

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The Fonts-Bouillants sector is a natural CO_2 emission site located in the Nièvre department in the north of the Massif Central, part of the French carbonic province. CO_2 emissions are mainly accompanied by Nitrogen and minor gases such as Helium and Methane. Various monitoring techniques were deployed during four field campaigns (May, September, November 2022, and February 2023) from -10 meters to the atmosphere. Measurements performed on the mixture of dissolved gases at equilibrium with natural spring water in two flooded wells indicated differences in the behavior of CO_2, CH_4, and N_2. These results suggest different sources feeding the local aquifers over time. Gas concentrations at -1 meter ranged from 0 to 40% for CO_2, with CH_4 concentrations below detection limits. At ground level, CO_2 concentrations varied from 400 to over 10,000 ppm, decreasing to 370-1,600 ppm at +1 meter. These measurements highlighted an area of high emissions mainly governed by the "Saint Parize Le Chatel fault". Images obtained by infrared remote sensing did not reveal any CO_2 or methane plumes above the site, demonstrating the instantaneous dilution of the emitted gases in the atmosphere. The maximum annual geological CO_2 emission mass in this 400 m² area is estimated at 1,700 tons.

This study introduces NECCS (Natural Emission of Carbon dioxide with Capture and Sequestration) technology, comparing it to DACCS, which aims to capture diluted atmospheric CO_2. Large-scale deployment of NECCS requires an inventory of naturally emissive sites and the development of capture technologies suitable for gases richer in CO_2 than the atmosphere. The CO_2 capture unit consists of a separation module to purify the CO_2, compress it, and transport it in liquid form by truck or train in iso-containers to consumer industries (food processing, fire extinguishing, cryogenics, etc.). Long-term storage in geological reservoirs is another option. An important advantage of NECCS technology lies in the possibility of recovering co-emitted gases with CO_2, such as CH_4 or strategic gases like helium or hydrogen. The feasibility of CO_2 capture from natural emissions has been demonstrated through the implementation of a factory by 45-8 Energy at the Fonts-Bouillants site in September 2024.