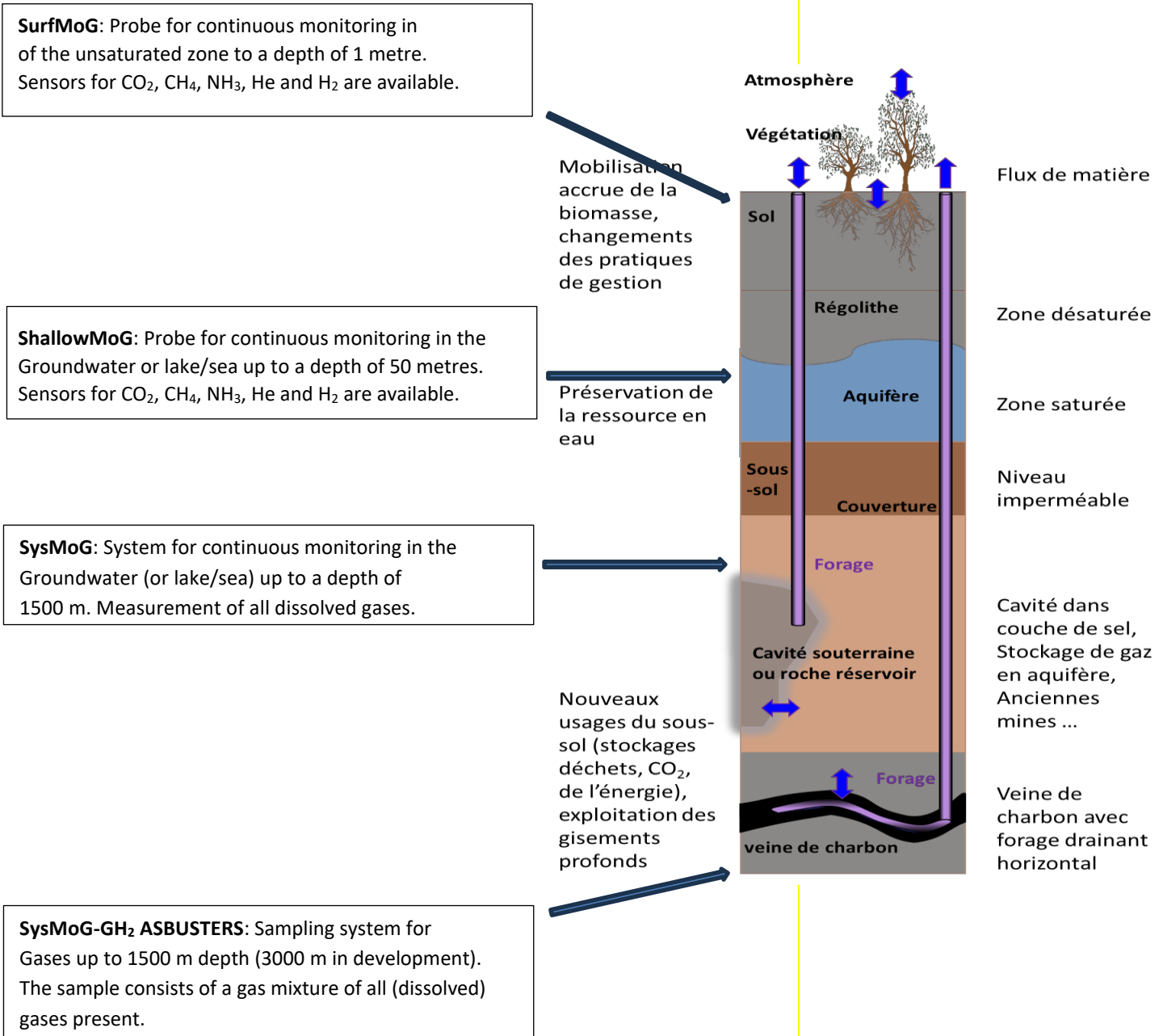


MoG probes: Measurement of gases underground

Knowledge of (dissolved) gases in the geosphere is of great benefit, for example, in volcanology, geothermal energy, the storage of CO₂, underground gas reservoirs or for the exploration and prospection of gases (H₂, He, CH₄). As part of many research projects with the GeoRessources laboratory of the Université de Lorraine-CNRS, we have developed innovative technologies for the in-situ measurement of gases.

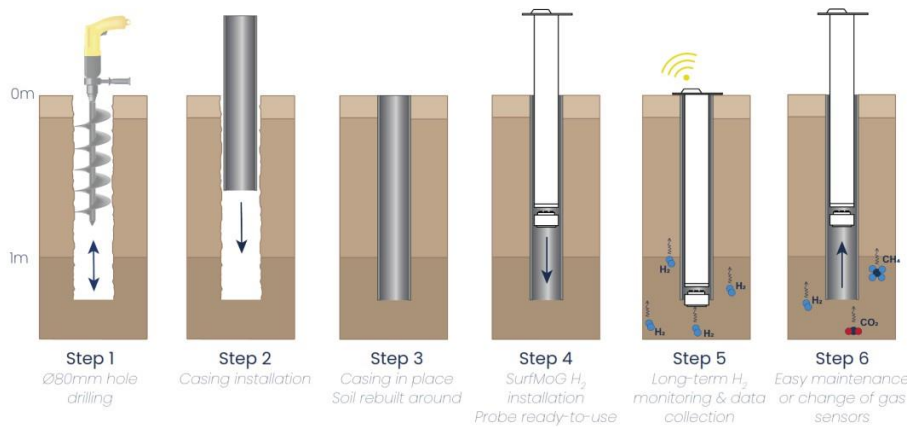
The MoG series consists of 4 probe types for gas measurements from the surface to deep boreholes. SurfMoG, ShallowMoG and SysMoG are designed for continuous in-situ gas measurements, while SysMoG-GH₂ ASBUSTERS is designed as a dissolved gas sampling system in boreholes up to 1500 m (3000 m is under development).



SurfMoG™, soil gas measurement down to 1 m depth

SurfMoG™ is a self-contained probe for the automatic measurement of gas concentrations at the transition from the geosphere to the atmosphere. The compact design allows easy installation in boreholes with a depth of 1 m and a diameter of 80 mm. Easy maintenance thanks to plug & play concept, quick change of gas sensor or battery.

The high autonomy and wireless data transmission to our IoT platform makes the SurfMoG probe an attractive solution for permanently tracking gas concentrations close to the surface, e.g. in the context of gas exploration projects, underground storage facilities or gas-emitting sites (volcanoes, landfills, industry, etc.)



The gases are measured with electrochemical or NDIR sensors. The following selection of gases can be monitored: CO₂, CH₄, NH₃, He and H₂ (others on request). The measuring ranges can be customised to the respective application. Measurements of pressure, temperature or relative humidity can also be combined.

SurfMoG™ has an IP69 waterproof cylindrical stainless-steel housing with a diameter of 69 mm and a length of 1 metre. The probe is protected and completely contained in the pipe, which is very advantageous in high-traffic areas.

SurfMoG™ has a reliable data acquisition system that sends the measurement data to our IoT platform, where it is visualised and available virtually in real time. The sampling rate is freely selectable. If no network is available, the data is read out manually (memory of 1,000,000 measurements with time stamp). The lithium battery has a minimum operating life of 48 months at a sampling rate of one hour and daily data transmission.

Specifications

Probe type	SurfMoG
Depth of application	1 m
Operating environment	Soil gas, unsaturated
Dimensions	Probe: length: 1 m, diameter: 69 mm Thermowell: Length: 1 m; Diameter: 76 mm
Installation	manually,
Type of measurement	permanent with adjustable sampling rate
Data management	Data transfer to IoT platform, without network, alternatively manual data readout of the memory (1 million measured values)
Gases	Gas-specific sensors for H ₂ , CO ₂ , He, CH ₄ , NH ₃

ShallowMoG™: Measurement of dissolved gases down to 50 m

The ShallowMoG™ is a self-contained probe for the automatic measurement of gases in both the saturated and unsaturated zones down to a depth of 50 metres. The compact shape allows easy installation in boreholes with a diameter of at least 80 mm. The probe measures the (dissolved) gases in-situ at installation depth. Sensors are available for the following gases: CO₂, CH₄, NH₃, H₂ and He. The measurement signal is transmitted with a cable to the data acquisition system at the borehole mouth, which sends the data to our IoT platform via GPRS.

The system can be used in a variety of ways, e.g. for monitoring CCS deposits or H₂ underground storage facilities, for applications in volcanology, observations of gas concentration changes in connection with seismic events or water pollution. The sensor type and its measuring range are adapted to the specific requirements of the application.



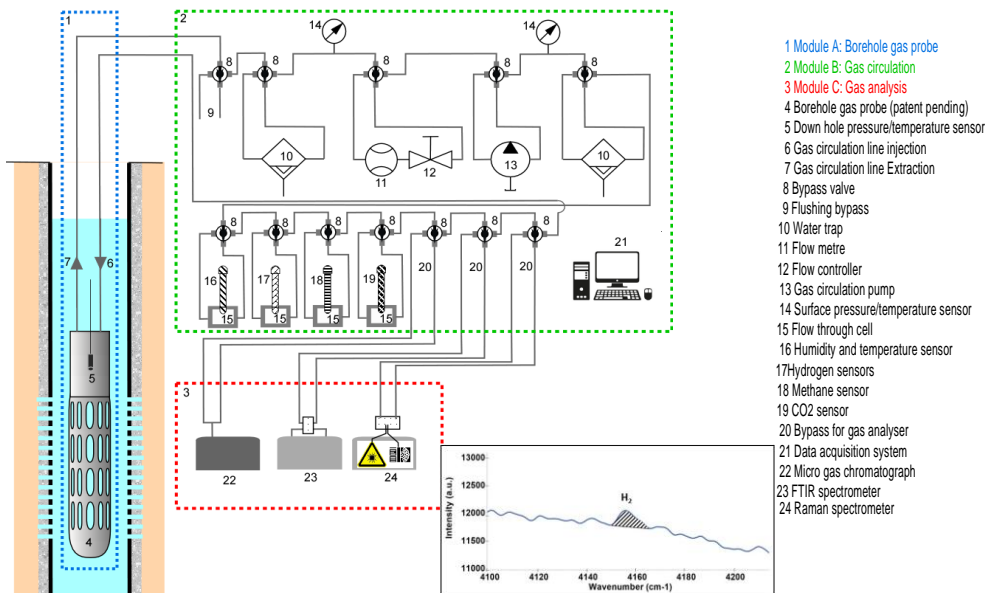
Specifications

Probe type	ShallowMoG
Depth of application	0 - 50 m
Operating environment	Soil gas (unsaturated) and groundwater (saturated)
Dimensions	Data logger: length: 40 cm, diameter: 54 mm Probe: length: 60 cm; diameter: 76 mm
Installation	Manual, data logger at borehole mouth, probe on cable in borehole
Type of measurement	permanent with adjustable sampling rate
Data management	Data transfer to IoT platform, without network, alternatively manual data readout of the memory (1 million measured values)
Gas analysis	Gas-specific sensors for H ₂ , CO ₂ , He, CH ₄ , NH ₃

SysMoG®: Measuring system for dissolved gases in aquifers

SysMoG® is a system for detecting dissolved gases in aquifers in boreholes up to a depth of 1500 metres. The probe is the result of a joint development with the GeoRessources laboratory at the University of Lorraine and the CNRS.

The measuring system consists of a borehole probe with a chamber into which the dissolved gases from the surrounding groundwater diffuse. The probe is connected to the measuring module on the surface via two pipes and a circulation module. Various analysers, such as Raman or FTIR spectrometers, are used to detect the gases. The measuring module integrated into the circuit continuously detects the components of the gas mixture and records the concentration development of the individual gases over time. The borehole probe can be installed in an open borehole, e.g. with a logging winch. Alternatively, it can also be integrated into a measuring interval of a multi-packer system.



- 1 Module A: Borehole gas probe
- 2 Module B: Gas circulation
- 3 Module C: Gas analysis
- 4 Borehole gas probe (patent pending)
- 5 Down hole pressure/temperature sensor
- 6 Gas circulation line injection
- 7 Gas circulation line Extraction
- 8 Bypass valve
- 9 Flushing bypass
- 10 Water trap
- 11 Flow metre
- 12 Flow controller
- 13 Gas circulation pump
- 14 Surface pressure/temperature sensor
- 15 Flow through cell
- 16 Humidity and temperature sensor
- 17 Hydrogen sensors
- 18 Methane sensor
- 19 CO2 sensor
- 20 Bypass for gas analyser
- 21 Data acquisition system
- 22 Micro gas chromatograph
- 23 FTIR spectrometer
- 24 Raman spectrometer



SysMoG® principle for continuous measurements -Raman spectrum: dissolved hydrogen 0.17 mg/L

Specifications

Probe type	SysMoG (permanently installed, continuous measurement)
Depth of application	up to 1500 m, up to 3000 m under development
Operating environment	Soil gas (unsaturated) and groundwater (saturated)
Dimensions of the probe	- Length: 3 m, - Diameter: 54 mm Integrated in packer system: customised to packer system
Installation	With winch, or if integrated in a packer system with extension rods, tripod or drilling machine
Type of measurement	Permanent with on-site gas analysers, possibility to take samples in the circulation module on the surface
Data management	Data transfer to IoT platform if mobile phone network available
Gas analysis	FTIR and Raman spectrometer, micro gas chromatograph, mass spectrometer Minirüedi, (EAWAG, ETH) Container on surface for circulation module and gas analysers

GH₂ ASBUSTERS: in-situ sampling system for dissolved gases

In open boreholes with a minimum diameter of 2½ ", SysMoG®-GH₂ ASBUSTERS can be used to take samples of dissolved gases down to a depth of 1500 m (3000 m is under development). The system consists of a SysMoG® probe with a chamber into which the gases (dissolved in the groundwater) diffuse. When the gas pressure in the probe has stabilised, the gas concentrations inside and outside the probe chamber are in equilibrium. A valve is then opened and two 75 ml sample containers are filled. After removing the probe, the gas samples are analysed either on-site or in a laboratory. Sampling takes less than 24 hours. Measuring the pressure and temperature of the gas mixture in the probe chamber allows the concentration of the dissolved gases to be accurately determined.

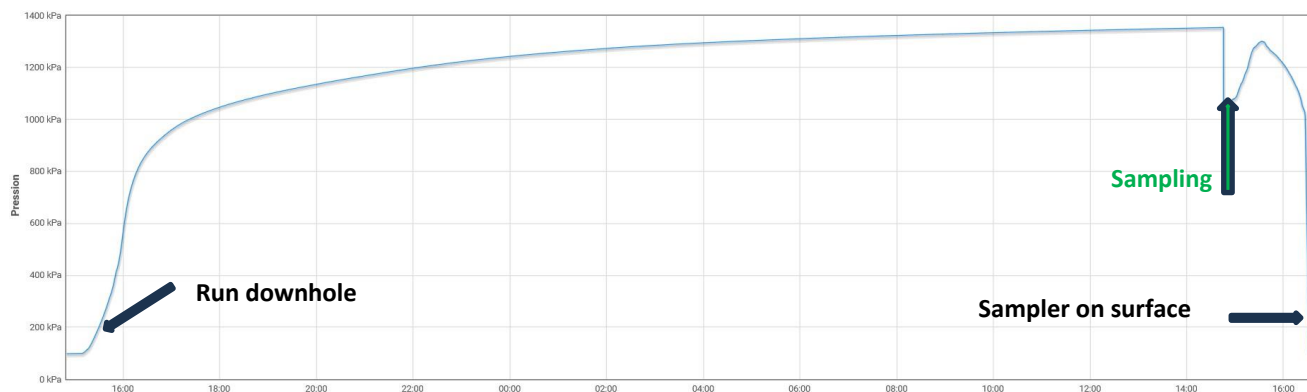
The entire SysMoG®GH₂ASBUSTERS sampling system can be transported in a delivery van. Short mobilisation times are therefore possible throughout Europe. For overseas deployments, the measuring equipment can be transported in a container.

Specifications:

Probe type	SysMoG GH ₂ ASBUSTERS, in-situ sampling of dissolved gases
Depth of application	up to 1500 m, 3000 m in development
Operating environment	Groundwater (saturated)
Dimensions	- Length: Total: 4.42 m, 2 components: Gas probe: 2.25 m, sampler and sensors: 2.17 m - Diameter: 54 mm
Installation	Logging winch
Type of measurement	In-situ sampling with on-line measurement of pressure and temperature in the gas chamber of the probe
Samples	2 pressurised containers with a volume of 75 ml,
Gas analysis	On-site analysis of samples (FTIR, Raman spectrometer, micro GC) or analysis in specialised laboratories



Mobile GH₂ ASBUSTERS sampling unit



Typical pressure curve in the borehole probe, sampling in less than 24 hours