



Isotope investigations at an alpine karst aquifer by means of on-site measurements with high time resolution and near real-time data availability



A. LEIS¹, R. SCHMITT², A. VAN PELT³, M. PLIESCHNEGGER¹, T. HARUM¹, W. ZEROBIN⁴, H. STADLER¹

¹Joanneum Research Forschungsgesellschaft mbH, Institute of Water, Energy and Resources, Graz, Austria, ²Meteorologie consult GmbH, Frankfurter Str. 28, Koenigstein, Germany, ³Picarro Inc., Sunnyvale, USA, ⁴Vienna Waterworks, Vienna, Austria

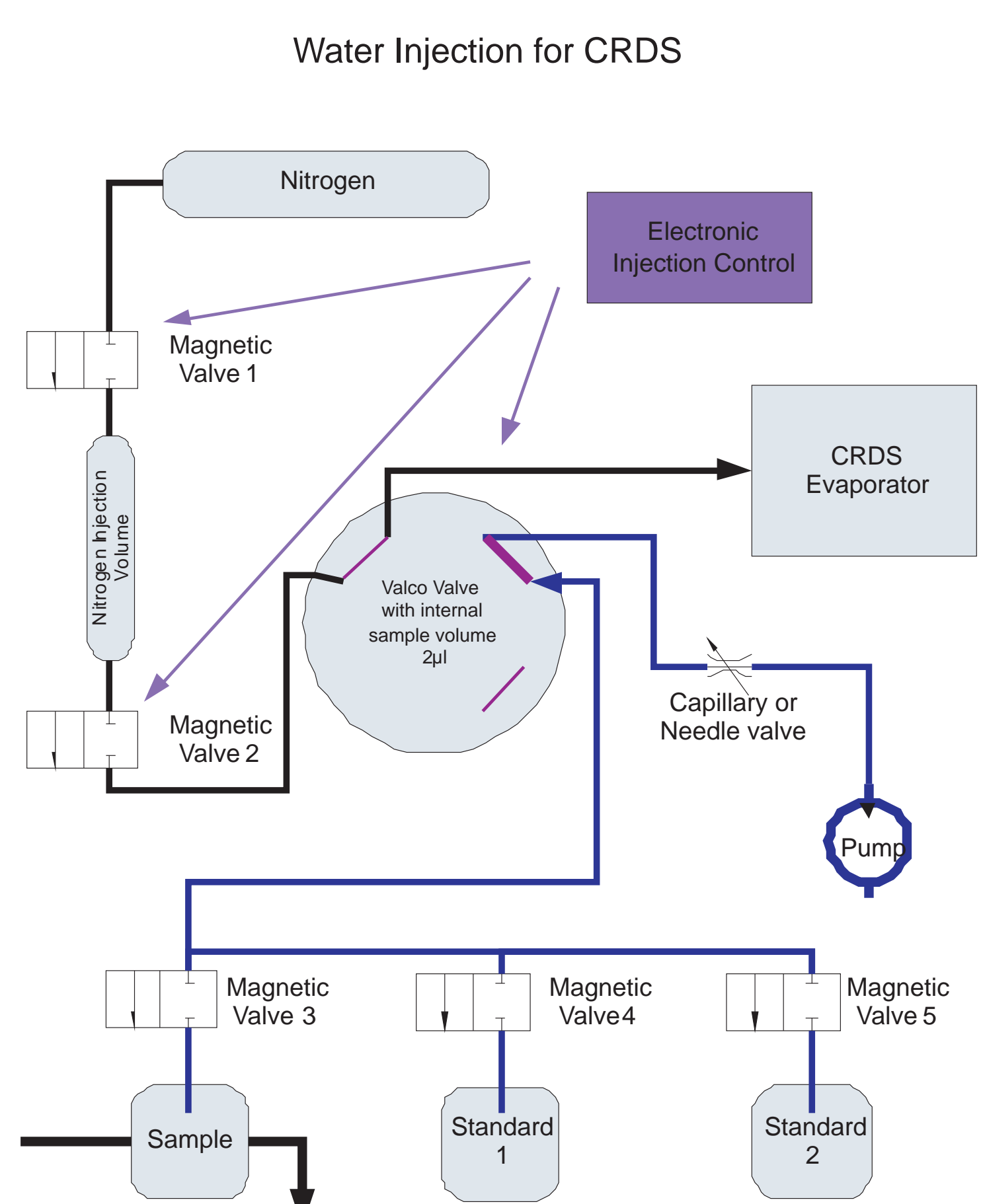
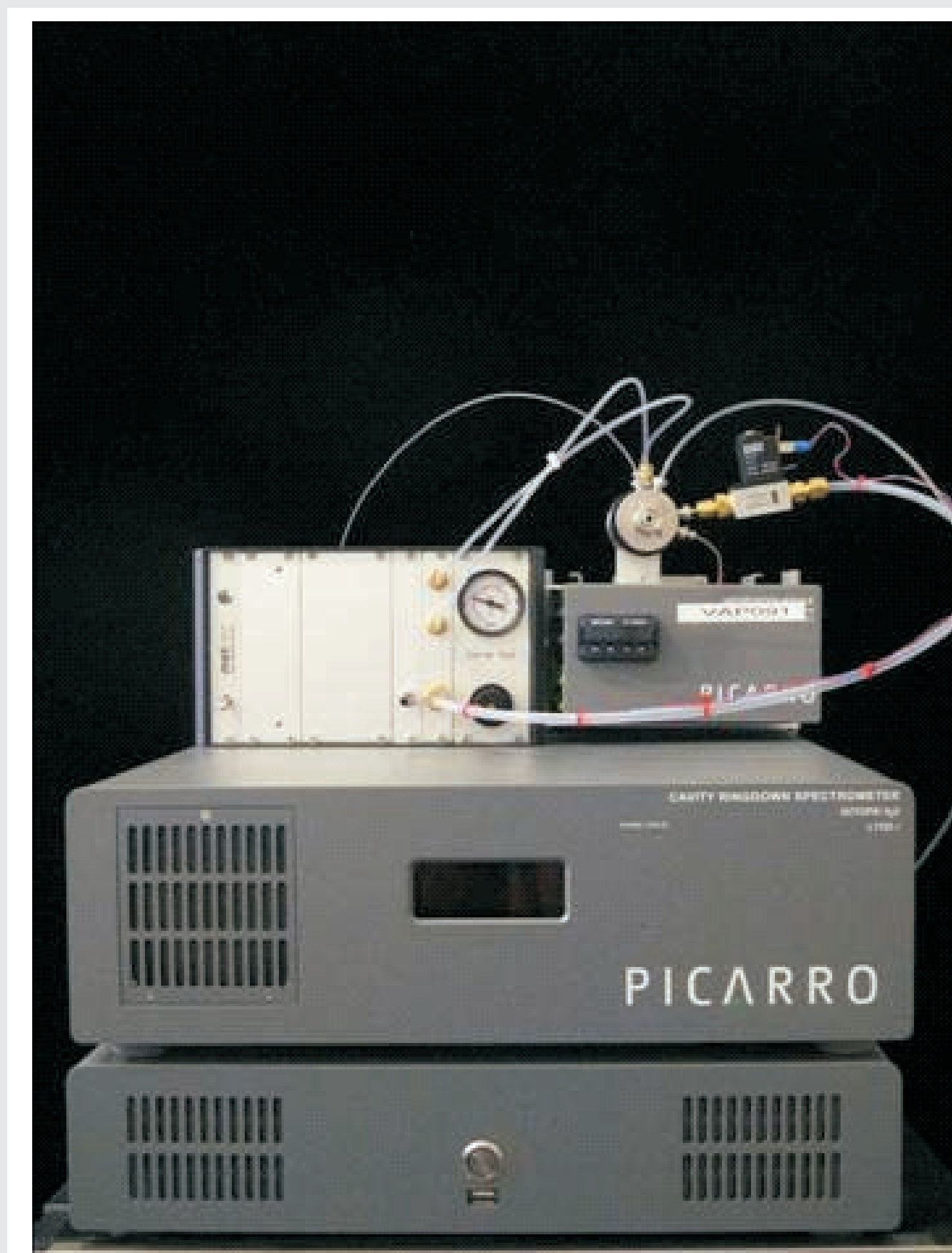
Introduction

For numerous hydrological investigations as the characterization of storage and discharge dynamics at karst springs on-site isotopic measurements with high time resolution could improve the significance of the investigations. Conventional isotope ratio mass spectrometers (IRMS) can only used in laboratories because of their technical complexity. Since a short time more compact laser based instruments, the so called cavity ring-down spectrometers (CRDS) are commercial available. For on-site use of such an instrument several adaptations are necessary. This concerns especially a direct sample injection from the outflow of the spring, because this is originally not intended.



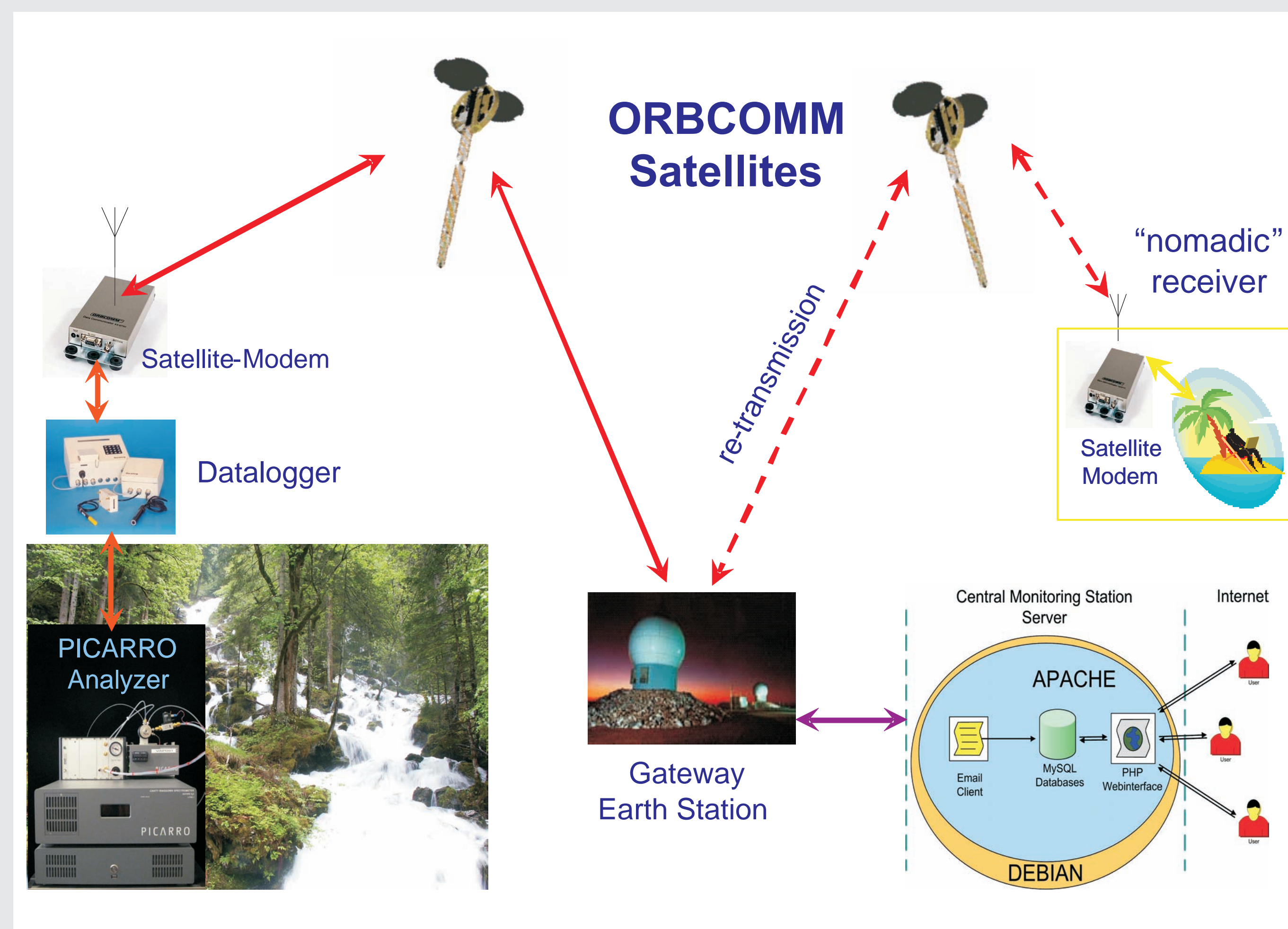
Investigation area

The studied alpine and mountainous karst system is located in the so called Northern Calcareous Alps in Austria reaching altitudes up to approx. 2300 masl. The spring is situated in the Salza-valley at an altitude of approximately 650 masl. The investigated karst spring is a typical limestone spring type according to having well developed karst conduits.



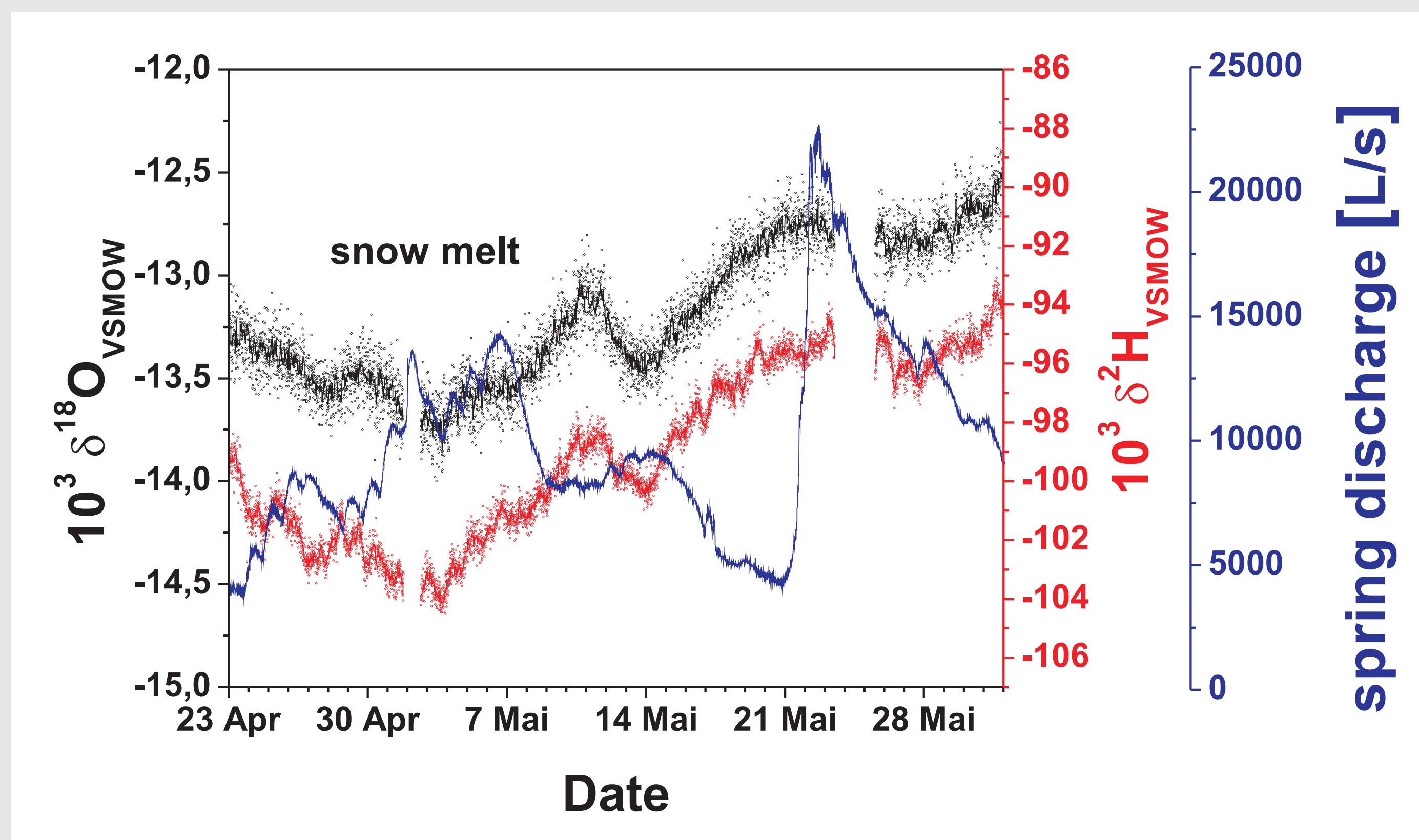
In-situ sampling device

The isotopic composition of the water samples were measured by using cavity ring-down spectroscopy with a WS-CRDS (Wavelength-Scanned Cavity Ring-Down Spectroscopy) instrument (Picarro, Inc.). In order to adapt the System for on-site isotope measurements at the spring the laser spectrometer was coupled to an automatic injection module for continuous measurements of liquid samples based on a VALCO valve. The device replaces the auto-sampler and allows quasi-continuous injections of a 2 µl-water samples into the Picarro L1102-iso-water analyzer via the Picarro vaporizer module.



Data transmission

The on-site measured isotope data are merged with other in-situ measured hydrological parameters and handed-over to a satellite-modem. This smart-modem is subscribed to the ORBCOMM-System, a Low Earth Orbiting (LEO) Satellite system. These systems have the advantage that the footprints of theirs satellites also reach narrow valley in alpine regions. So the data can be transmitted without terrestrial communication infrastructure at the measuring site. The ORBCOMM Satellites send the data back to a Gateway-Earth Station (GES). From there, data can be delivered via internet or retransmitted to a LEO-Satellite and received by a "nomadic" device. The connection is bidirectional and enables therefore also several remote configuration commands.



Results and Conclusion

Coupling the in-situ sampling device to the CRDS from Picarro Inc. it was possible to use the system on-site, to enable near real-time data availability with high time resolution. The system was installed during snowmelt at one of the most important Austrian karst springs. The measuring increment of the Picarro system was approximately 9.5 minutes. During this time datasets of the isotopic composition of the spring water and other hydrological parameters were transmitted with a 30 minutes time increment to a data base of the Central Monitoring Station. Via a web interface data were available in near real-time and ubiquitous. The first results were very promising and open up a new outlook to gather important information about water resources and the possibilities of protection.



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