

PHREALOG – overview of the development of measurement technology

The origins of PHREALOG can be traced back to the diploma thesis of its founder, Dr. Marc Schöttler. The project involved a risk assessment of the potential impact of landfill leachate on a drinking water supply in a narrow valley, where detailed information on the local groundwater flow conditions was required. As the necessary information could not be obtained using conventional hydrogeological methods, suitable in-situ groundwater flow measurement techniques were sought. Owing to the relatively high groundwater flow velocities encountered at the site, the application of in-situ tracer techniques was not feasible, prompting the search for new technical solutions. In September 1992, the concept of camera-based tracking of artificial and naturally occurring suspended particles was submitted as a patent application. During the following years, the method was investigated in laboratory and field studies at the University of Cologne and subsequently developed into a practical measurement technology.

With the founding of PHREALOG in 1999, the first measurement system, designated “GFV” (Groundwater Flow Visualization), became available for applications in monitoring wells with diameters ranging from 4 to 6 inches. The system was developed in cooperation with the swiss company Solexperts AG.

In the year 2000, PHREALOG received an innovation award for the development of the measurement system.

In the year 2002, a system for use in monitoring wells with diameters of 2 inches and larger was introduced, and the original name “GFV Measurement System” was changed to “PHREALOG Measurement System”.

In the year 2006, the first prototype for vertical groundwater flow measurements was presented.



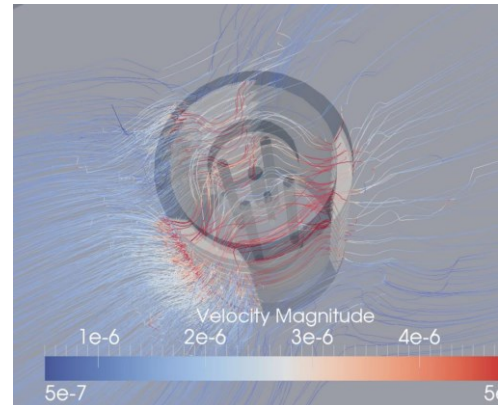
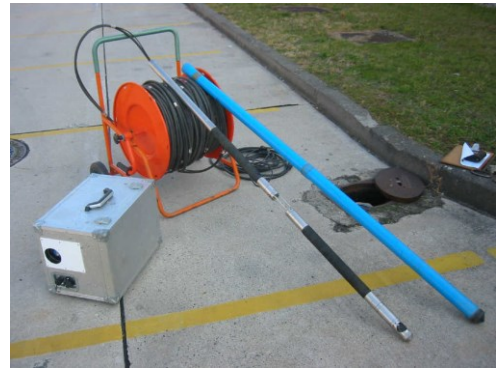
The wide range of field conditions encountered during the early years required continuous adaptations and improvements to both the measurement technology and the data-processing methods. As a result, the technical development activities were increasingly carried out in-house by PHREALOG, leading to the establishment of a laboratory workshop with specialized capabilities for the manufacture of measurement probes and optical components, as well as the development of dedicated testing procedures.

Beginning in 2011, the measurement technology was fundamentally revised within the framework of the BMBF-funded research project FLIMSYS. In collaboration with the research partners, the Institute of Geosciences at the University of Mainz and the Fraunhofer Institute for Industrial Mathematics ITWM, the flow behaviour in groundwater monitoring wells under different flow scenarios was investigated using laboratory models and numerical simulations. The results were published in the journal *Grundwasser* (Issue 3/2015). Additional intellectual property rights were filed to protect key technological developments arising from the project.

The findings of the FLIMSYS research project and the experience gained from numerous field applications provided the basis for further optimization of the measurement technology and its adaptation to a wide range of field conditions. Alongside ongoing field deployments, the technology was continuously refined, improved and expanded. As practical experience accumulated from addressing a broad spectrum of hydrogeological challenges, significant advances were achieved in survey planning, data evaluation and the interpretation of measurement results, leading to the development of a high level of specialist expertise.

From 2012 onwards, the collaboration with universities was intensified, and numerous research projects as well as undergraduate and graduate theses related to the measurement technology and system control were initiated and supervised by PHREALOG.

The laboratory workshop was further expanded to include specialized testing procedures, such as pressure testing of measurement probes and cable connections under operating conditions at external water pressures of up to 40 bar (4 MPa).



Since detailed knowledge of well construction and condition is essential for the quality assurance of groundwater flow measurements, the autonomous camera inspection system PHREACAM was developed in 2023. Since then, it has been routinely used for preliminary investigations in all measurement projects.



In 2025, PHREALOG introduced a fundamentally redesigned measurement system: a modular platform for horizontal multilevel groundwater flow measurements featuring newly developed flow-conditioning devices that establish stable and controlled flow conditions within the measurement section,



a compatible measurement probe for vertical groundwater flow measurements



as well as a redesigned control and field computer unit for data acquisition and processing.

