

# Short Course – Open-source tools for pumping test interpretation: hytool for R

## Malaga, Spain, September 22, 2019

Rhytool is the hytool library for R users. Hytool is originally a matlab toolbox for the interpretation of hydraulic tests in wells. The toolbox contains analytical solutions used to describe groundwater flow around wells, and functions for importing, displaying, and fitting a model to the data. Rhytool is the R version of this toolbox (S4). Please see the following reference: Renard Philippe (2017), Hytool: an open source matlab toolbox for the interpretation of hydraulic tests using analytical solutions, *Journal of Open Source Software*, 2(19), 441.

### Short course agenda (Sunday 22<sup>nd</sup> September 2019):

13:30 – Start of the course: introduction to analytical models

Rapid review of the classical analytical solutions for pumping test interpretation: Theis (1935) for confined aquifer, confined aquifer with a boundary effect using the Theis (1941) solution, confined aquifer with an impermeable boundary with the Theis solution, confined aquifer with leakage with the Hantush and Jacob (1955) model, Boulton (1963) model for unconfined aquifer, Gringarten and Ramey (1974) model for infinite conductivity fracture in a confined aquifer, Warren and Root (1965) solution for double-porosity aquifers, Papadopulos and Cooper (1967) solution for well with well-bore storage effect, Barker (1988) for general radial flow model.

14:15 – 14:25 – break

14:25 – 15:50 – Back to course: presentation of rhytool and first examples

General presentation of Hytool and Rhytool. Install the R package from Github. Presentation of the structure of pumping test data and analytical models in Rhytool. Uploading pump test data and performing a simple interpretation: examples

15:50 – 16:00 – break

16:00 – 17:30 – Back to course: dealing with common issues and direct computing

Dealing with standard issues in pumping test interpretation: too many data, too short test, variable yield, data in the tested well, unclear analytical model... Examples. Use rhytool for direct computing: predict water level in single borehole, in a well field, at a single piezometer or an entire surface

### About Instructor:

Graduate from the Ecole Nationale Supérieure de Géologie (Nancy, France), **François Bertone** is specialised in groundwater resources management. After working for Hydroexpert, Egis and Schlumberger, he is now freelance consultant. During the last 27 years and in more than 40 countries, he has dealt with prospecting, protection, exploitation and management of the groundwater resources, sometimes for industrial projects, mostly for irrigation or drinking water supply. This experience has been acquired in varied geographical and geological contexts. He is a specialist in both quantitative hydrogeology and water wells design and construction. With Prof. Philippe Renard, he is the co-author of rhytool.

**Prepare your computer before entering the course:** be sure you have R installed and ideally Rstudio. Load the rhytool library on Github: `library(devtools); install_github("FrancoisBertone/rhytool")`

