

KARSYS, KarstALEA and KarstFlowSIM: applied and innovative methods for the management of karst environment

Date: July, 5-6 2018 (2 days)

Minimum and maximum number of participants: 10/20

Instructors: Dr. Pierre-Yves Jeannin, Dr. Arnaud Malard (ISSKA, CH).

This 2-days workshop is dedicated to the learning of the KARSYS approach through an application on the Swiss Jura Mountains. The first day, participants will be guided through a field trip in the Val-de-Travers (Switzerland, 1.5h from Besançon). The second day, participants will apply the approach by themselves, using data and experience they acquired on the test site.

KARSYS is developed for hydrogeologists working in karst regions, in order to address hydrogeological questions in a very pragmatic and concrete way. KARSYS makes it possible to build an explicit conceptual model (3D image) of the karst aquifers and of the associated flow systems. The approach is based on a 3D model of the carbonate aquifer synthesizing all standard geological and hydrological data, and coupled to a series of simple hydraulic principles. This provides, within a limited effort, a consistent hydrogeological conceptual model of karst flow systems within any investigation area. The course is designed for hydrogeologists with basic knowledge on karst, hydrogeology and 3D modelling. Any professional interested in groundwater management, engineering, renewable energies in karst environments will gain a good understanding of karst hydrogeology and a pragmatic way to assess karst hydrogeological systems. Participants will apply KARSYS by themselves on a case study. For that, they will be initiated to the functioning of the Visual KARSYS tool, which is still under development, but already support users to apply KARSYS.

The course will be extended further with an introduction to KarstALEA method, which has been developed for predicting the position and characteristics of karst occurrences within a massif. KarstALEA was initially designed for tunneling, but can be applied to any kind of underground construction in karst areas. At last, an outlook to flows simulation procedures based on KARSYS (KarstFlowSIM) will be presented.

KarstALEA and KarstFlowSIM are both extensions of KARSYS, providing *de facto* a consistent and continuous workflow in karst to address pragmatic issues.

Key-words: Karst hydrogeology, Conceptual model, 3D, Water management, KARSYS, KarstALEA, Visual KARSYS, KarstMOD



Workshop agenda:

Day 1 – Field trip Val-de-Travers (CH) – Departure from Besançon - morning 08:00

Stop 1 – Poljé Brévine (10:00)

- (1) Visit of the entrance of the cave “La Renouillère”*
- (2) Visit of the Brévine groundwater well*
- (3) Brévine Poljè*
- (4) sinking stream that develops at the fringes of the lake “Les Taillères”*

Stop 2 - Areuse spring (11:00 – 12:30)

- (5) Visit of the spring, introduction to KARSYS to understand the aquifers and the flow-system feeding the spring*

Lunch break (12:30 – 13:30)

Stop 3 - Môtiers (13:30 – 16:30)

- Trip on the synclinal of the Riau and of the small carries*
- (6) Visit of the Môtiers spring,*
 - (7) Visit of the Môtiers cave*

Stop 4 – Café Môtiers – Les 6 Communes (16:30 – 17:30)

**Introduction to KARSYS: a way to understand karst flow-systems
(A. Malard & P.-Y. Jeannin)**

- a. Basics and application principles
- b. Issues and applicability
- c. Visual KARSYS

Back to Besançon at 18:30-19:00

Day 2, morning – Workshop – Besançon (09:00 – 13:00)

Practical exercise (A. Malard & P.-Y. Jeannin)

- a. Drawing of geological cross-sections
- b. Data entry into Visual KARSYS (cross-sections, maps, springs, boreholes)

11h00 - 15 minutes break

- c. KARSYS-express
- d. Hydrostratigraphy
- e. Geological modelling
- f. KARSYS-Standard (2D sur carte Isohypeses, 3D et 2D)

Lunch break (13:00 – 14:00)

Day 2, afternoon – Workshop – Besançon (14:00 – 18:00)

14:00 – 14:45- Application examples (BRGM, ISSKA)

- a. Application of the KARSYS approach to the Plateau de Sault (France)
- b. Other examples and feedbacks



14:45 – 16:00- Extensions: KarstALEA and KarstFlowSim (ISSKA)

- a. KarstALEA (prediction of karst in tunneling)

16h00 - 15 minutes break

- b. Karst & sinkholes (sinkhole hazards map)
- c. Generation of karst conduit networks
- d. Flows simulation (flood hazards maps, effect of climate change on GW-resources)
- e. Conclusion

About Instructors:

Pierre-Yves Jeannin (SISKA), Ph.D., is hydrogeologist, Director of the Swiss Institute for Speleology and Karst-Studies and Invited lecturer and researcher at Centre d'hydrogéologie (Univ. Neuchâtel). He is a researcher on karst hydrogeology since 1988 and closely supervised several PhD-theses related to the understanding and modelling of flow and mass transport in solution in karst systems. He also took part to the development of methods for the evaluation of the vulnerability of karst groundwater (EPIK and VULK). Pierre-Yves supervised several research projects on the infiltration of water in karst regions, showing the very important role of the soils and the epikarst (weathered zone at the top of limestone) for absorption, temporary storage and the self-purification of water. In 2009, he successfully submitted the Swisskarst project to the Swiss National Science Foundation on the sustainable management of water (PNR61). The KARSYS approach developed in this project induces a high degree of interest among the water community because it provides an explicit 3D conceptual model of karst hydrogeological systems.

Arnauld Malard (SISKA), Ph.D., is scientific collaborator since 2011 and specialist for 3D modelling and flow simulation. He works as hydrogeologist for ten years in different public offices and private companies in France and overseas department. He is member of the French geological society and responsible for several publications in karst and volcanic aquifers. Arnauld Malard was the main actor for the development of KARSYS in the frame of the Swisskarst project (2011-2013). He is now developing extensions for KARSYS, mainly regarding hydrogeological mapping principles and flow-simulation modules.