

# Imaging in a Model the Flow Networks generated by Harmonic Pumping Tests in a Karstic Field (Lez Aquifer, France)

Pierre Fischer <sup>\*† 1</sup>, Abderrahim Jardani <sup>1</sup>, Hervé Jourde <sup>2</sup>, Xiaoguang Wang <sup>3</sup>, Stéphane Chedeville <sup>3</sup>, Michael Cardiff <sup>4</sup>, Nicolas Lecoq <sup>1</sup>

<sup>1</sup> UMR CNRS 6143 M2C – Université de Rouen – IRESE A, 1 Place Emile Blondel, France

<sup>2</sup> Hydrosiences Montpellier UMR5569 (HSM) – Université de Montpellier – Univ. Montpellier - Case MSE Place Eugène Bataillon 34095 MONTPELLIER CEDEX 5, France

<sup>3</sup> Hydrosiences Montpellier UMR5569 (HSM) – Université de Montpellier – Univ. Montpellier - Case MSE Place Eugène Bataillon 34095 MONTPELLIER CEDEX 5, France

<sup>4</sup> University of Wisconsin-Madison, Department of Geoscience (UW-Madison Dept. of Geoscience) – Weeks Hall 1215 West Dayton Street Madison, WI 53706, United States

Identifying flow paths within karstic fields remains a complex task because of the high dependency of the hydraulic responses to the relative locations between the observation boreholes and the karstic conduits and interconnected fractures that control the main flows of the hydrosystem. In this context, harmonic pumping is a new investigation tool that permits to inform on the flow paths connectivity between the boreholes. We have shown that the amplitude and phase offset values in the periodic responses of a hydrosystem to a harmonic pumping test characterize three different type of flow behavior between the measurement boreholes and the pumping borehole: a direct connectivity response (conduit flow), an indirect connectivity (conduit and short matrix flows), and an absence of connectivity (matrix).

When the hydraulic responses to study are numerous and complex, the interpretation of the flow paths requires an inverse modeling. Therefore, we have recently developed a Cellular Automata-based Deterministic Inversion (CADI) approach that permits to infer the spatial distribution of field hydraulic conductivities in a structurally constrained model. This method distributes hydraulic conductivities along linear structures (i.e. karst conduits) and iteratively modifies the structural geometry of this conduits network to progressively match the observed responses to the modeled ones. As a result, this method produces a conductivity model that is composed of a discrete conduit network embedded in the background matrix, capable of producing the same flow behavior as the investigated hydrologic system.

We applied the CADI approach in order to reproduce, in a model, the amplitude and phase offset values of a set of periodic responses generated from harmonic pumping tests conducted in different boreholes at the Terrieu karstic field site (Southern France). This association of oscillatory responses with the CADI method provides an interpretation of the flow paths within the field in a geologically realistic pattern of conduits. This method is therefore of considerable value towards an enhanced imagery of karstic fields in a distributed model for a better water management in this type of aquifer.

---

\*Speaker

†Corresponding author: pierre.fischer1@univ-rouen.fr