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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Assessment of open thermodynamic system concepts for fluviokarst temperature calculations – an example, the Cent-Fonts resurgence (Hérault, France)" *by* P. Machetel and D. A. Yuen

M. Bakalowicz

michel.bakalowicz@gmail.com

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Hydrogeologists and especially karst hydrogeologists know for long that groundwater (GW) temperature is an interesting indicator of GW flow conditions. For instance H. Schoeller (1962, see particularly p. 229 and following) showed that the equilibrium between aquifer rock and GW is reached only when the flow velocity is low. He showed that in karst aquifers, where conduit systems develop, the equilibrium is not reachedÂă; he then considered the thermal variability of a spring as a very interesting

information about the development and functioning of conduits in karst system (KS). H. Schoeller was then followed by several hydrogeologists who attempted to lay the foundation of an approach using GW temperatures as a natural tracer (see for instance de Marsily, 1986). As all tracers, it is not perfect and allows only an approach of flow conditions. In that sense the approach proposed by the authors is not really new. The use of ÂńÂăfluviokarstÂăÂż to define the Cent-Fonts KS is not correct. According to the Encyclopedia of caves (W.B. White & D.C. Culver 2012), as well as several other encyclopedias and lexicons, ÂńÂăFluviokarst is the name applied to many landscapes where exposed karstic rocks make up part but not all of the drainage basinsÂăÂż. This word was never used for characterizing the functioning of a KS, especially by the team who studied the Cent-Fonts KS (see all public reports by BRGM about it). In these reports the Cent-Fonts KS is defined as a binary KS, frequently also called allogenic KS, i.e. a KS recharged both by direct infiltration on its carbonate rock outcrops and by concentrated infiltration of water running on impermeable rocks and swallowed at the contact between impermeable and carbonate rocks. In White's papers cited by the authors, the conceptual models never refer to fluviokarst.So Figure 1(a) is partly inspired from White. In the same way Figure 5 caption contains some inaccuracies (ÂńÂăepikarstic basic flowÂăÂż, ÂńÂăintrusive underground rechargeÂăÂż). Figure 6 is not a map, but an unrolled cross section. The authors make several more or less implicit assumptions about the functioning of this well known KS. Some of them are necessary simplifications for modeling. But some others are not realistic and question the validity of their approach. The conduit system is very simple, connecting directly swallow holes, at the entrance of the CS, with the main spring. The infiltration from the carbonate outcrops recharge only the rock matrix. The exchanges between the conduit(s) and the matrix occur homogeneously all along the conduit(s). No boundary layer is considered between the flow and the conduit walls. In fact, the surface stream, the Buèges River, is never swallowed in open pits, because the river bed is covered by thick travertine deposits which delay the concentrated infiltration all along 2 km of the stream bedÂă: this is not at all a point recharge as the authors assume. This was especially studied (Ladouche et al., 2002) because the functioning of the recharge varies along the hydrological year. Generally in KS the infiltration through the carbonate outcrops is distributed in a very complex way (see for instance Bakalowicz, 2013). It recharges the aquifer either directly through the doline-shaft systemconnected to the CS, or through the epikarst delaying the input signal through matrix and fissure porosity. GW exchanges between the conduit and the matrix do not occur homogeneously as shown by Jeannin (1996), but are localized in parts of conduits and fractures. During the flood season (from autumn to spring in southern France), the water temperature in the conduit is certainly lower than the rock surrounding the conduit. During the low flow season, the water temperature in the conduit is very close to that in the matrix, all the more so as the swallowing part of the Buèges River does not work. This is not very well considered in the paper. As shown by tracing tests and some special morphological features such as scallops (Masséi et al., 2006), there is a boundary layer all along the conduit walls playing an important physical and chemical part in exchanges between rock and water. The importance of this layer is determined by the flow velocity in the conduit, mainly depending on the flow rate and the shape of the conduit. This is also true for heat transfer, but apparently not considered here. The annex A describing the Cent-Fonts KS compiles data from public reports by BRGM, the French Geological Survey, which was in charge of the hydrogeological studies for Conseil Général de l'HéraultÂă; the authors were never associated to these studies, being not at all specialized in karst hydrogeology. This annex is not really usefull to the readers insofar as these data are not well interpreted nor used in the paper. Moreover it contains a number of errors or inaccuracies (e.g. line 23 p.186Âă; lines 3-6 p.187Âă; lines 14-17 p.187). In such conditions I consider that the approach developed by Machetel and Yuen cannot be considered as an advance in the field of karst hydrogeology.

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