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Summary of the discussion on "Flow and transport processes in karst aquifers"

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The workshop started with a debate about the use of representative elementary volume (REV) based groundwater models in karst systems. Specific questions were: "Can we accept that REV based models may be used in karstified aquifers even when the parameters are not physically consistent?" and the related question "Is a good working REV model useful if some of the model parameters are without any physical meaning?"

The debate on the first question was very open. Most of the "modellers" know very well that modelling of karst aquifers is just a tool which can be used to improve the knowledge or the understanding that we have of the system. When calibrating the models using tracer studies (with natural and/or artificial tracers) we are obliged to introduce into the models parameter values which cannot be considered as being representative of reality. However, to some extent these models show how the karstic system is functioning.

The general discussion on the second question was rather broad and not specific to karst systems and it was agreed that a clear answer was not possible. However, it was felt important to distinguish between descriptive models and predictive models. The task of a predictive numerical model is to solve engineering problems and in this context the extent of the available data is crucial for the quality of the model. It is necessary to have a database which is as large as possible and which covers as long a time period as possible to facilitate calibration of the model. An important precondition is the consideration of possible scale effects. Often tracer methods provide not only physically based data but also physically based knowledge of the karst aquifer system.

Consideration was then given to another question: "What experience is available about the use of dual porosity models in karst systems?" The discussion showed that this question cannot be generalized. Reference was made to petroleum engineering where dual porosity models have been used for a long time. This knowledge can probably be very useful for the investigation of karst systems. The application of dual porosity models depends on the nature of the system being modelled. Various contributors described successful use of dual porosity models in aquifers such as the Chalk although it was agreed that this type of model is less suitable to karst areas with well developed conduit permeability. Possible matrix diffusion effects can also be explained by other processes (e.g. multi-flow paths, influence of flow through cave lakes, etc). A good database in space and time is again very helpful for the decision.

The impact of global changes on the parameters of numerical models was also considered. There is not very much experience about the application of models for this problem. A general conclusion about the influence of increasing or decreasing karst water levels on the parameters is not possible. However, it can be observed, that regional flow values are frequently different from local flow values.

Finally, it can be said that it is not possible to generalize the application of numerical models in karst systems. The application depends on the question and the nature of the system. The size of the database is most important for the quality of a model and for predictive models an extremely large database is necessary.

In general it seems that there are more or less two groups of researchers. One group is of the opinion that we need to understand very carefully the system before we model it with many details and contrasted parameters (probably including non Darcian laws which take into account turbulence, etc.). The other group prefers to build up a model first. This may even include very sophisticated models which take into account dissolution processes and turbulence in large conduits. The model is then calibrated, even if it is, at this stage, a "blind calibration". It is hoped that after performing sensitivity analyses and including different parameters or distinguished features in the model, a better understanding of the hydraulics of the system will be possible.