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Relationship between the MRS water content and the specific yield measured by pumping tests in south-west Niger

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The Magnetic Resonance Sounding (MRS) method is a non invasive geophysical tool that has the advantage of having a signal whose amplitude is directly linked to the quantity of groundwater and whose relaxation time depends on the pore size. Because of an instrumental dead time, some part of water in the aquifer cannot be detected. This undetectable water is characterised by a short relaxation time and corresponds to the water located close to solid grain (typically bound water). Thus the water content measured by MRS is generally assumed being an estimation of the effective porosity. Nevertheless, the MRS water content is more often compared to the specific yield measured with pumping test than to the effective porosity measured using tracer methods. As the field estimate of specific yield needs an observation piezometer in addition to the pumping well, only few experimental examples are available for establishing a consistent relationship between the MRS water content and the specific yield.

During our field study in a sandy unconfined aquifer in south-west Niger, six sites equipped by a well and an observation piezometer were investigated with MRS and pumping tests. Results show that in this geological context the MRS water content is always higher than the specific yield and the relationship between MRS water content and the specific yield is not linear. A new approach has been developed for estimating the specific yield using the MRS water content. This approach is based on the available

in the literature relationships between the grain size distribution and the total porosity, the specific yield and the specific retention (total porosity minus specific yield). The specific retention non-linearly decreases with increasing grain size and the quantity of water undetectable by MRS is assumed non-linearly decreasing with increasing grain size too. We also assume that the decrease of water undetectable by MRS with increasing grain size has a similar shape as the decrease of specific retention. This assumption allows us to calculate the specific yield and the MRS water content for a given grain size and its corresponding total porosity. Thus the MRS water content can be expressed versus the specific yield for increasing grain size.

The relationship between the quantity of undetectable water by MRS and the grain size has been adjusted to obtain a relation between the MRS water content and the specific yield that fits the field measurements. It has been found that despite of some approximations (magnetic properties of the rocks and sorting of grains are assumed invariable in the investigated area) the specific yield can be estimated from MRS result with an acceptable error (RMS of 58%).