

## ***Interactive comment on “Optimization of CPMG sequences for NMR borehole measurements” by M. Ronczka and M. Müller-Petke***

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We appreciate the comments of reviewer 1 a lot. They will help to improve the manuscript and especially sharpen its focus. We will consider them all and include them. Unfortunately, we obviously still did not the best job to explain the intention of the new sequence. There are several comments pointing in the same direction:

Additionally, in their revision, the authors have not yet referred to other modified CPMG pulse sequence that have been used in borehole logging to collect NMR measurements.

Finally, it is not clear to me how collecting a measurement with a variable echo time gives the same information as collecting multiple CPMG pulse sequences at multiple

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echo times - some justification by the authors to clarify this point is warranted. By collecting CPMG measurements at multiple echo times one could determine the magnetic field gradient (last term in equation (4)) or alternatively, determine if there are magnetic susceptibility differences between the saturating fluid and the grains. By collecting a single CPMG measurement at multiple echo times it is not clear to me how this same information could be obtained. The authors should summarize how their pulse sequence is different than other modified CPMG pulse sequences. Some references they should look into are Song (2003, 2007), Hurlimann and Venkataramanan (2002).

Clarify what you mean by “it is common to conduct at least two different CPMG sequences”. Presumably the authors mean that to obtain information about magnetic effects of minerals it is necessary to collect measurements at two echo-times. I’m not sure that you could say that it is common to collect measurements at two echo times.

The intention of the sequence is not to provide the user with information on internal gradients or diffusion. The sequence is not about providing information usually obtained by multiple CPMG sequences. We agree with the reviewer this would hardly be possible. The sequence hopefully helps to build slimhole NMR tools that provide T<sub>2</sub> estimates (neither T<sub>1</sub>-T<sub>2</sub> nor D-T<sub>2</sub>). We were working on reducing the number of pulses needed to get a reliable T<sub>2</sub> estimates compared to usually conducted CPMGs. Since diffusion plays a key role for T<sub>2</sub> (that’s why it is used to measure diffusion as in a D-T<sub>2</sub> sequence) we had to focus on minimizing its influence (as it is done in the lab with thousands of pulses with very short tau) while keeping the number of pulses low. Probably that’s why this misunderstanding might be hard to completely avoided.

We will add some text to clarify this intention and to make clear that we are not about to measure neither internal gradient nor diffusion. At this place we will mention the references given. We hope to make clear that our intention was not to develop another modified CPMG (in the understanding of the given references, i.e. measuring diffusion (or internal gradients) that’s why we did not mention these publications and wrote that there is no other sequence (in our understanding of a modified CPMG).

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The energy use does not limit the tool size - Vista Clara has a tool that fits in boreholes with two inch diameters. A different reason for a more efficient pulse sequence would be that collecting measurements at multiple echo times currently takes a very long time. Particularly if the borehole is long or the water content is low.

We know about this instrument, in fact we own the second one that has been produced. However this tool did not solve the energy problem (according to how we define this problem). The focus of the Javelin (Vista-Clara NMR borehole Tool) is different to what we have in mind. The pulse power in the javelin comes from a surface station, i.e. needs to get down to the coil by the wire. This limits the maximum logging depth (to currently about 200m) and the compatibility to standard logging equipment. The javelin is a standalone tool, it is excellent for logging a 2-inch monitoring well. Furthermore, it is focused is on deep penetration inside the formation (about 5 inches), that why the frequency of this tool is so low (290kHz) which causes the need for many stacks.

A tool that we have in mind fits into the standard equipment, i.e. the pulses power cannot travel over the wire but has to be generated inside the tool using the standard power supply all tools use. If the tool should be small in diameter there is not much space to implement all the electronics to provide this power and the standard power supply is not much. That's why there is still a need to measure good T2 estimates using as few pulses as possible. This would also allow for deep logging.

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