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# Using the temporal distribution of noise for reference noise cancelation in sNMR surveys

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The surface Nuclear Magnetic Resonance method is gaining momentum as an efficient geophysical method for the detection and characterization of groundwater. However, the method still suffers from a low signal to noise ratio mostly due to electromagnetic noise of anthropic origin.

To solve this problem, signal processing in surface nuclear magnetic resonance surveys often relies on the reference-based noise cancellation technique. This method consists of capturing the main characteristics of the noise through a secondary loop ideally located and obtaining an estimate of the noise affecting the primary loop which can be subtracted from the noisy sNMR signal.

The main problem associated with the method occurs when the spatial distribution of the noise is heterogeneous, which can result in a low correlation between the reference loop and the primary loop, and hence in a poor noise reduction. Difficulties may also arise when the field survey location prevents the display of a reference loop for logistics or physical reasons.

To remediate these situations we have investigated the possibility of recording noise-only signals through the primary loop, prior to the sNMR measurement, and use those signals as references for subsequent calculation of the local transfer function. The correlation between a series of noise-only signal recorded on a primary loop was analyzed through the computation of the magnitude squared coherence function, and comparison was made with noise records from a secondary loop. The analysis demonstrates that temporal reference noise cancellation (TRNC) can provide more efficient noise reduction results than the classical spatial reference noise cancellation if the temporal noise-only database is large enough.

Such a technique would be particularly suited for the development of long-term sNMR monitoring systems, where noise records could be acquired for long periods without any difficulty. In addition to two field survey examples, we present a synthetic statistical analysis to estimate the minimal volume of the signal database required for optimal noise reduction.