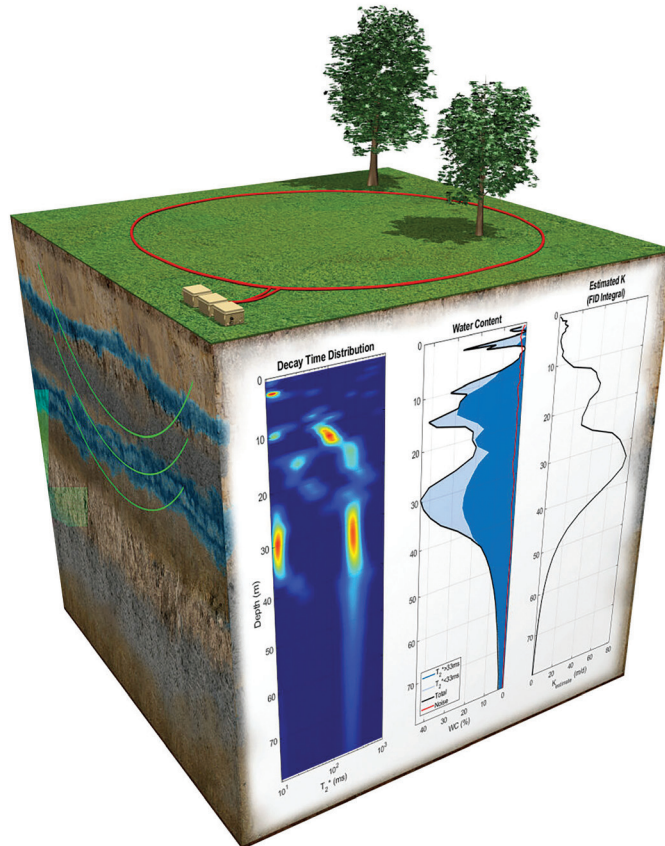




## SURFACE-BASED MAGNETIC RESONANCE INSTRUMENTS

SALES, RENTALS, AND GEOPHYSICAL SERVICES



# DETECT AND CHARACTERIZE AQUIFERS WITHOUT DRILLING

- DIRECT, NON-INVASIVE IMAGING OF GROUNDWATER TO DEPTHS OF 150 METERS
  - QUANTITATIVE DETERMINATION OF WATER CONTENT
  - ESTIMATES OF BOUND WATER VOLUME AND SPECIFIC YIELD
- RELATIVE OR CALIBRATED ESTIMATES OF HYDRAULIC CONDUCTIVITY



**VISTA CLARA** INC.  
NMR GEOPHYSICS

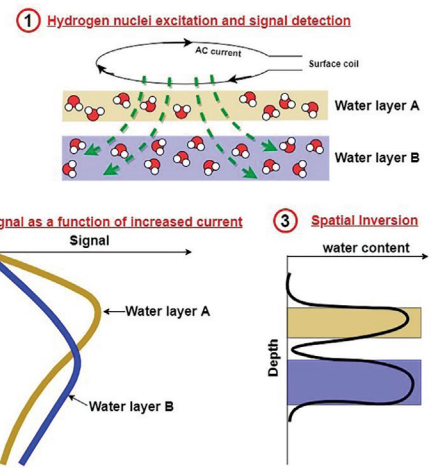
MEASURE GROUNDWATER DIRECTLY

# GMR™ See Groundwater Without Drilling

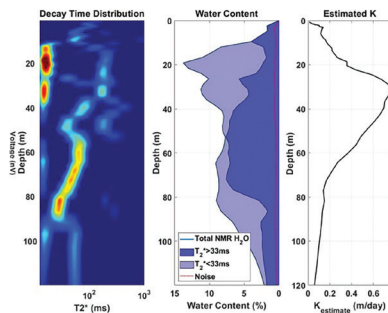
Non-invasively detect, measure, and image groundwater directly from the surface with Vista Clara's GMR product family. Using a measurement loop of 2-150 m (6-500 ft) in diameter, GMR uses the same NMR physics as medical MRI scanners. GMR's exclusive Multi-channel operation effectively cancels noise providing robust and accurate investigation outcomes.

## Direct Detection and Imaging of Groundwater

GMR provides non-invasive detection and imaging of groundwater. This non-radiative measurement uses the Earth's magnetic field to polarize the hydrogen nuclei of water. Alternating current pulses, routed through a wire loop on the surface, generate an alternating magnetic field in the subsurface, forcing the magnetic moments of the hydrogen nuclei to rotate in phase. This rotating magnetization from the groundwater is detected by the surface loop, as voltage signal, which is directly proportional to the volume of groundwater present in the formation. A forward mathematical model of the excitation profile is used to spatially invert and localize detected signals as a function of depth, yielding a 1D image of MR-detected water signals.



## GMR Characterization of Aquifer Properties

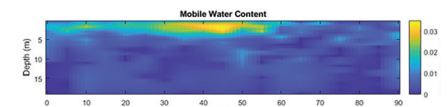
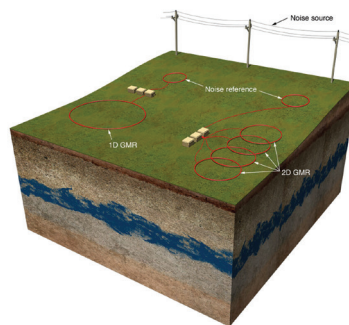


Time-domain analysis of the depth-localized NMR signals yields direct quantification of key aquifer properties, including:

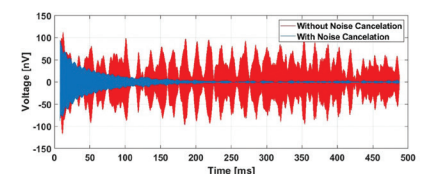
- Volumetric water content, or porosity if the ground formation is fully saturated
- Differentiation of mobile water in large pores (specific yield) from bound water in smaller pores, through calculation of the NMR relaxation times (T1, T2, and T2\*)
- Estimation of relative or calibrated hydraulic conductivity

## Patented GMR Multi-Channel Technology

The unique multi-channel architecture of GMR adaptively cancels high levels of noise, improves data quality, and enables use close to powerlines and other infrastructure. Multiple independent Tx/Rx channels enable efficient 2D profiling. Simultaneous wideband response and high-speed sampling on multiple channels ensures robust measurement in all applications.



2D measurement of mobile water content.



Cancellation of high level noise by GMR.

†Protected by US Patents # 7,466,128 B2; 8,451,004 B2; 8,581,587 B2; USRE43264 E1; 9,429,673 B2; 9,599,688 B2; 10,585,204 B2; 10,145,915 B2  
Additional patents: US EP 1651974 B2; US 9551807 B2; US 9588068 B2.  
GMR is a trademark of Vista Clara Inc.

# GMR™ Non-Invasive Surface NMR Investigations

All GMR products incorporate advanced features that are essential to performance, safety, and the user experience. All GMRs have short dead times to capture short NMR signals of water in magnetic geology, in fine grained sediments, or in the vadose zone. Safety features are extensively integrated in the GMR design, protecting the user from powerful electrical discharge.



## GMR

Our flagship product, GMR, is engineered for deepest possible groundwater imaging.

- Standard output of 600A and 4800V provides the highest power output of any surface NMR instrument, enabling resolution of aquifer properties to depths of up to 150 m (500 ft).
- Four full-capable Transmit/Receive channels with optional expansion up to 12 channels for efficient 2D profiling and noise cancellation.

## GMR Flex

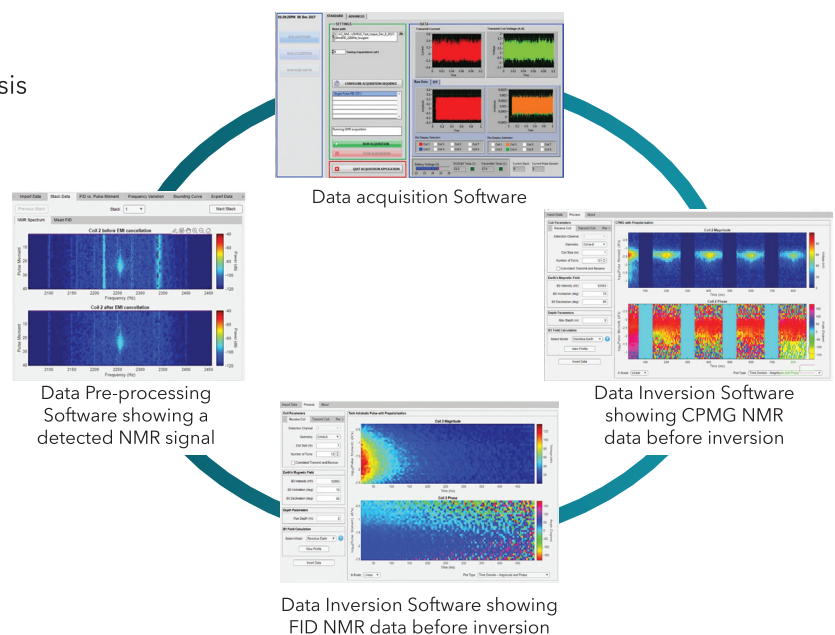
More portable and at a lower price point, the GMR-Flex packs high-power and maximum flexibility into a small and easy-to-use package:

- Output of 400A and 2000V, enables resolution of aquifer properties to depths of up to 85 m (280 ft).
- Additional Tuning and DC capacitance modules to increase output power and depth of investigation.
- Pre-polarization module enables detection of very near surface water with very small detection loops < 3 m.

## Advanced Embedded Methods and Software

With GMR's full featured data acquisition and analysis software you can plan surveys, perform forward models and then see everything you need for your groundwater investigation while collecting data in the field. Additionally provided are:

- Advanced, proprietary pulse sequences†: adiabatic pulse for 2x-3x larger signals; CPMG for unambiguous detection of large pore water; and phase-cycling to prevent data artifacts.
- Monitoring of data quality and data processing in real time.
- Inversions in 1D and 2D using both resistive and conductive earth models.
- Estimates of bound/mobile water content and relative hydraulic conductivity.



# GMR™ Applications

GMR Surface Magnetic Resonance instruments yield the direct and non-invasive measurement of aquifer properties. This results in superior project outcomes and lowered overall project costs across a number of important earth science applications.

## Groundwater Resources

GMR measurements can locate and characterize groundwater resources directly and non-invasively.

- Locate drill sites for groundwater production
- Delineate and characterize aquifer units for groundwater resource modeling and management
- Monitor changes in water table and saturation



## Environmental Monitoring and Water Resource Protection

GMR provides reliable and accurate monitoring of environmental processes completely non-invasively without any drilling.

- Vadose zone characterization
- Soil moisture monitoring
- Permafrost examination

## Mining

GMR provides direct non-invasive detection and mapping of water in permeable zones providing reduced risk, lower cost, and better project outcomes.

- Mine water management
- Dewatering site detections
- Mine tailings investigations



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