

# Empowering the Future of Geothermal Energy with Subsurface Excellence



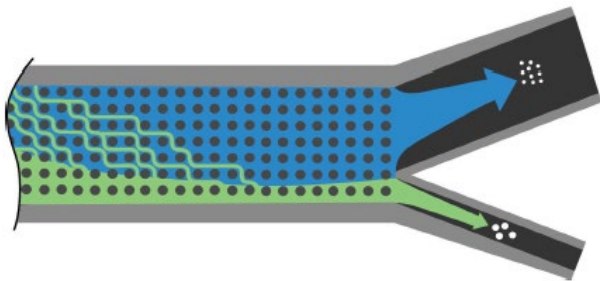
Advanced Resources International, Inc.

## Subsurface Innovation and Technology Integration

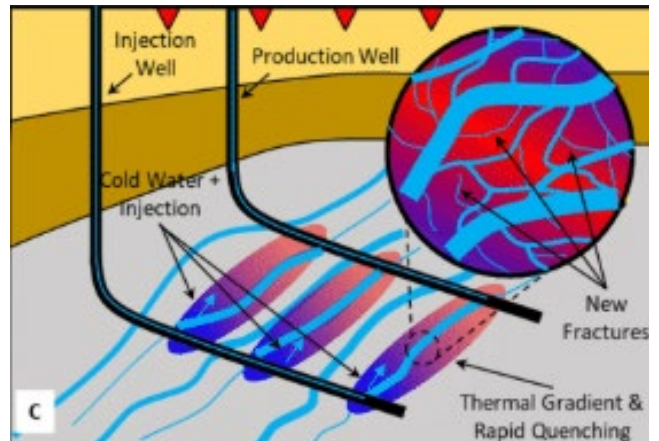
### Applying Novel Technologies in the Field

Advanced Resources International's (ARI) core strength lies in translating theoretical understanding into practical field solutions. ARI's staff have contributed to EGS field development, utilizing non-traditional technologies and fracking fluids to mitigate seismic and environmental risks. They have also supported the development of high-temperature geophones for subsurface imaging and EGS monitoring.

ARI personnel have helped integrate experimental technologies into commercial operations, such as advanced scale inhibition strategies to reduce downtime and mineral recovery from geothermal brines, thereby enhancing project revenue. While ARI partners with research institutions for R&D, the firm focuses on the application and integration of these innovations in the field.



Applying mesofluidic separation technology (Micropillar Enhanced Separators) at the Salton Sea, CA.



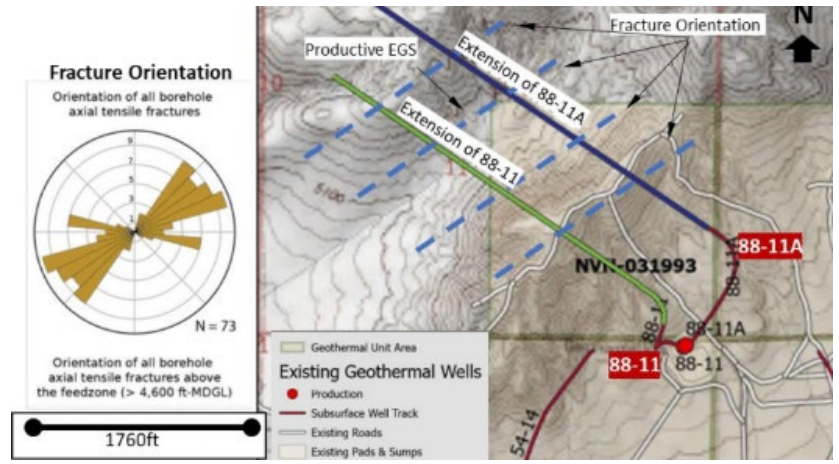
Using StimuFrac polymers and Electric Reservoir Stimulation in Fish Lake Valley, NV.

## Execution and Advice

### Consulting on Field Development Strategy

ARI staff have managed hybrid projects that combine research and development with commercial deployment, helping bridge the gap between lab-scale innovation and operational reality. Their project experience includes integrating experimental tools into field operations, improving efficiency and reducing operational costs while managing risk.

Team members have provided strategic consulting to the U.S. Department of Energy's Geothermal Technologies Office (DOE-GTO), offering input on innovation pathways, technology roadmaps, commercialization strategies and alignment of federal R&D with national geothermal goals.



EGS Field Development Plan (Fish Lake Valley, NV).

## Geothermal Well Planning and Execution

### Solving Complex Geothermal Well Challenges

ARI's staff specializes in solving complex challenges unique to the project setting. One example is our staff's collaboration with Sage Geosystems in the re-entry and reconfiguration of a deep legacy well in Starr County, Texas, to enable Sage's pilot testing of geopressured geothermal technology.

The project aimed to validate the well for both power generation and long-duration energy storage through controlled high-pressure injection and recovery cycles. The original wellbore was configured with a production liner set inside 11-3/4 inch intermediate casing. To meet the mechanical integrity and operational requirements for the planned gravity fracture, the well required relining with a 9-5/8 inch casing string. This original concept presented several technical challenges due to the minimal annular clearance between the casing strings and the need to isolate the existing production liner top.

To overcome these challenges, ARI's staff has developed and helped execute a tie-back cementation procedure, extending the new 9-5/8-inch casing string from the existing liner top to the surface. This approach ensured full mechanical and hydraulic integrity throughout the wellbore, allowing the casing system to withstand the thermal and pressure cycling associated with gravity-based injection and production processes.



Sage Geosystems well work in Starr County, TX

## Geothermal Well Completions

### Engineering Solutions to Meet Hot Downhole Environments



Utah FORGE 16B(78)-32 well in Beaver County, Utah

ARI's staff worked on the U.S. DOE's Frontier Observatory for Research in Geothermal Energy (FORGE) project in Utah to successfully install a permanent fiber optic monitoring system in the 16B(78)-32 well. The project sought to test deep crystalline EGS resources in Beaver County, Utah, near the western flank of the Mineral Mountains. Fiber deployment in this well was deemed a challenge due to high temperature conditions and their impact on the durability of commercially available fiber optic solutions.

ARI's staff worked with a fiber optic service provider to custom-engineer a design and deployment solution for this well. The fiber optic cable was deployed along the production casing and cemented in place to ensure full coupling with the formation, enabling high-fidelity data acquisition. The system

was designed for real-time monitoring of microseismic activity using Distributed Acoustic Sensing (DAS) and temperature profiling via Distributed Temperature Sensing (DTS) to detect thermal breakthroughs during long-term flow testing, as well as strain monitoring for assessing rock deformation and fracture propagation.

The installation posed significant technical challenges due to the elevated formation temperatures (~200°C) and the high-strength granitic rock. To mitigate risk and enhance system durability, several components of the fiber optic assembly were modified for thermal and mechanical robustness. The cable was successfully installed in July 2023 and has since met its performance and monitoring objectives.

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