Chapter 3
Phase I Drilling and Initial Attempts to Establish Hydraulic Communication

The world's first demonstration of the hot dry rock (HDR) geothermal energy concept took place at Fenton Hill, New Mexico, in the mid to late 1970s. The objective was to create a large, man-made HDR reservoir in rock at an appropriate temperature (~200°C) and accessed by two deep boreholes, completing the pressurized earth circulation loop.

As described in Chapter 1, the original concept of an HDR geothermal energy system was developed in 1970 by Bob Potter (Robinson et al., 1971). Figure 3-1 illustrates the concept as it was published two years later (Brown et al., 1972). The then-anticipated location for such a system was somewhere in the Basin and Range Province of the western U. S.—hence the 8000 ft of sedimentary and volcanic rocks estimated to overlie the basement rock and the assumed temperature of 300°C at 15,000 ft (technical specifications, such as hole diameters and pipe sizes, were included to enable thermal power production to be calculated).

Fig. 3-1. The originally proposed system for developing a dry geothermal reservoir in the western United States as a commercial energy source (1972).
Source: Brown et al., 1972
In those early days, Don Brown briefed Atomic Energy Commission (AEC) Headquarters staff and other interested parties on the simplicity of creating an HDR reservoir in hot crystalline rock—generally outlined as:

- drilling a vertical borehole to a depth at which the rock temperature is suitable for power generation;
- using proven oilfield techniques of hydraulic fracturing to create a large vertical fracture from the bottom of this hole; and
- using conventional directional drilling techniques to drill a second borehole to intersect the vertical fracture.

(Note: at the time, the directional drilling component was considered no more difficult than "hitting the broad side of a barn." Little did we know!)

The HDR concept published in 1972 was kept general for a very specific reason: The potential for HDR geothermal energy in the Basin and Range Province is huge, and not nearly enough was yet known for a particular site to be specified. As described in Chapter 1, that same year the nascent HDR group at the Laboratory undertook some initial studies in the Fenton Hill region of the Jemez Mountains, just west of the Valles Caldera. On the basis of regional geology and heat flow measurements in this region, they drilled the first exploratory borehole (GT-1), in Barley Canyon, to a depth of 2575 ft. The encouraging results obtained from GT-1 then led to selection of a nearby site for long-term HDR experiments.¹

The principal objective of the Phase I operations at the new Fenton Hill site was to assess the suitability of the deep Precambrian basement in this area for containing a pressurized HDR circulating system. Here, pressurized-fluid injection testing would be done in a second borehole (Granite Test Hole 2, or GT-2), at several depths. From the beginning, GT-2 was envisioned as an exploratory borehole—like GT-1, but considerably deeper (4500 to 6000 ft). It would be used, first, to confirm the suitability of Fenton Hill as the location for the world's first man-made heat-mining system; and second, as a deep seismic observation station during the hydraulic fracturing operations and experiments involved in reservoir development (and, later on, as a reservoir-interrogation and diagnostic borehole, separate from loop operations).

¹This site soon came to be known as the Fenton Hill HDR Test Site, referred to by the Laboratory as Technical Area 57 (TA-57), or simply as "Fenton Hill."