

FRACTURE TRACE METHOD
OF
HIGH YIELD WELL LOCATION

The science of geology and modern water well drilling technology has grown by leaps and bounds over the past 20 years. Miller Drilling Company, Inc. has grown from a rural domestic drilling business in 1947 to one of the largest industrial and municipal ground water contracting firms in the southeast with extensive fractured bedrock drilling experience. Historically most of the drilling is done in rock of low average yield in the range of 10 to 20 gallons per minute. It is our intent to change this.

In the past a 50 gallon per minute well was considered a high yield well. Then there were those rare occasions when a well was able to produce 300 to 400 gallons per minute. Not only were these significant yields rarely found, but also there was no way to predict in advance of drilling (even if on the same property) if the same well yield could be duplicated in a second drill hole. Development of ground water resources required randomly drilling of numerous test wells in order to single out the highest yielding ones for on-line production. This kind of drilling was time consuming and quite costly to achieve the desired high yields of one million gallons per day.

Prospecting for high yield wells is difficult because the water in bedrock occurs in crevices. Most of the bedrock in the southeast has variable water-bearing properties. The amount of water in the bedrock is related to the number, size, and interconnection of fracture openings. Fracture locations are hidden from view, and the position of the key fracture can only be found by drilling numerous test wells to single out the one well with

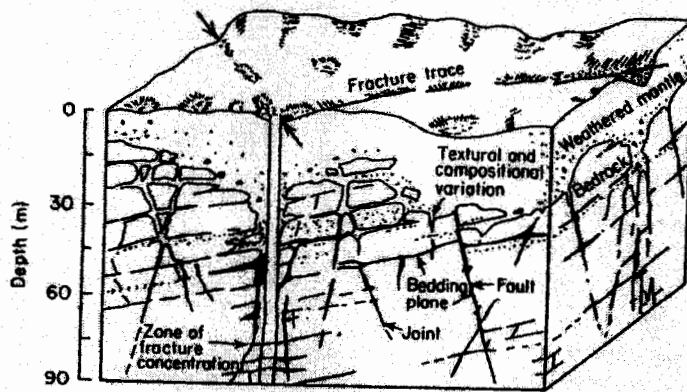


Figure 4.8 Occurrence of permeability zones in fractured carbonate rock. Highest well yields occur in fracture intersection zones (after Lattman and Parizak, 1984).

the most fracture occurrences producing the highest yields. How to find these fracture openings is the central problem related to the development of ground water resources.

A recent state geological report says a high yield well can only be developed where ground water occurs in unusual concentrations. I find nothing unusual about high yield ground water supplies. Miller Drilling Company, Inc. has the key to the ground water prospecting dilemma by using the most modern air rotary drilling equipment, trained drilling personnel, and, most of all, space-age geotechnical knowledge. High yield ground water supplies are now routinely developed in rocks traditionally thought to have low yields using a hydrogeologic technique called fracture trace analysis.

FRACTURE TRACE ANALYSIS

Fracture trace analysis is a photo-geologic exploration tool used to locate rock fractures buried below the surface of the earth. The chief effect of this new tool is that it minimizes the total number of test holes needed to identify and pinpoint groundwater resources. Successful wells often produce greater than average well yields, reduce energy operation cost, and lengthen scheduled preventative maintenance periods.

“What are fracture traces and why are there high yield wells bedrock?” Fracture traces are natural occurring vertical cracks or crevices formed in bedrock that extend

downward to a great depth below land surface. Their location can be detected by a trained hydrogeologist's evaluation of satellite and low altitude photographs. In order to verify the existence of fracture traces plotted on the photographs, an on-site inspection is conducted to better define the ground position of the fracture trace. Higher yielding wells are possible where two or more fracture traces intersect one another. The zone of fracturing increases at the intersection point. A survey conducted in downtown Chattanooga, Tennessee reveals that of the 23 or so known high yield well all are associated with identifiable photo-fractures. These high yield wells, depending upon the hydrogeologic setting, have been test pumped from 150 to 5,560 gallons per minute; and two of these will have an estimated discharge of 6,000 gallons per minute. One of the wells has an on-line production discharge of 3,000 gallons per minute, and the other one produces 5,000 gallons per minute! The main reason for the presence of high yield wells is their direct association with fracture traces and the fracture traces ability to transport ground water into the influence of a pumping well.

It's a whole new ball game to purposely go out into the field and consistently drill successful high yield wells. It's not magic, nor does fracture trace analysis rely upon psychic powers. Hundreds of successful high yield wells have been drilled using fracture trace analysis. There is nothing occult or mysterious about the occurrence of ground water. In reality, the presence of ground water beneath the surface of the earth follows well-established natural laws and hydrogeologic principles. Using modern scientific techniques, geologic conditions, which promote the occurrence of groundwater, can be predicted in advance of any drilling venture.

In Knox County, Tennessee, site of the 1982 Worlds Fair, a state geological survey report says the odds of a three-gallon per minute or greater yielding well is 93.7 percent. This is one of the main reasons why water witchers are so successful in locating underground water. There are few places in the United States where there is not any ground water. On the other hand, says the report, the drilling of industrial and municipal high yield wells for the same county is only 2 percent for well discharges greater than 100 gallons per minute. Does this 2 percent figure mean that drilling a high yield well discharging more than 100 gallons per minute are remote? Statistically the 2 percent figure does, in fact, suggest this. But is this small percentage really accurate? This figure is not only inaccurate, but blind acceptance of it encourages water users to find other water sources. Of the thousands of water wells drilled each year, only a few of that number rate as high yield wells, and these few wells are owned by industries and municipalities scattered across the state.

Regardless of water requirement and hydrogeologic conditions, the odds of successfully drilling a well using random method of site selection is very low. Examples of a random method are, selecting the site without geotechnical assistance, employing a water witch, or better still, just throw a rock over your shoulder and drill where the rock lands on the ground. All of these random methods will guarantee a 60 percent failure rate at locating high yield ground water supplies. As the water requirements of society and industry increase, these failure rate figures using random drilling methods dramatically sky rocket when high yields are needed in hard bedrock.

In order to maximize our ability in finding the future location of a high capacity well, a hydrogeological investigation by a trained geologist must be conducted along with

a fracture trace analysis of the target property, followed up with a test drilling program and a calibrated production well pump test. Only then will the odds swing the pessimistic statistical figures over into our favor. The ratio of accidentally hitting a fracture trace in any 100-acre parcel of land is 4:6. These are odds worthy of careful consideration before going out and just putting down a hole hoping to strike a high yield well.

By conducting a hydrogeological evaluation of a site prior to launching a test-drilling venture could mean all the difference between a low and high yield well in the range of 100 to 1,000 gallons per minute using the fracture trace technique. Fracture trace analysis has applications in bedrock other than limestone. Yields for wells drilled into thin sand and gravel deposits can be improved by setting the well over identifiable fracture traces. Wells drilled into sandstone formations realize greater yields. High yield wells can be developed in metamorphic rocks like granite. These are some of the lowest, least productive rock sequences where impressive ground water resources can be developed. The following table illustrates various kinds of rocks and their average yields. Also included is an estimated yield from wells drilled into fracture trace.

FRACTURE TRACE APPLICATION

ROCK TYPE	AVERAGE YIELD GPM	YIELD FROM FRACTURES GPM
Limestone, Dolomite, Marble	1 - 20	100 - 6,000
Sandstones, Silt, Siltstones	100 - 400	500
Sandstones - Tightly Cemented	2.0 - 30	100 - 200
Metamorphic	None	100 - 200

Using the fracture trace analysis system of well location, Miller Drilling Company, Inc. has in recent years achieved an 88 percent well drilling success in satisfying client water requirements. Prior to using the technique and in the absence of professional geological advice, only a 40 percent success was achieved. This kind of phenomenal drilling capability and geotechnical exploitation represents thousands of dollars saved in additional test drilling expenditure.

Miller Drilling Company, Inc. utilized these geologic techniques in diverse geographic terrains across Tennessee, Alabama, Georgia, Mississippi and Kentucky. The utility of fracture trace analysis is such that the technique can be used in every state in the union, as well as worldwide applications.

Miller Drilling Company, Inc. is one of the few drilling contractors in the nation that has derived direct benefits in customer satisfaction by developing high yield wells using the fracture trace analysis method. A number of benefits obtained using fracture trace analysis:

1. The technique reduces the total number of exploration test wells needed to find a high yield well.
2. Fewer fracture trace wells are needed to meet on-line production requirements.
3. A well located on an identifiable fracture trace, fracture trace intersection, lineament, mega-lineament, or any combination of the group of fractures will result in productivity well yields ranging from 10 to 1,000 times higher than one not drilled into a fracture sequence.
4. The occurrence of fracture traces usually provides well locations that are generally within easy reach of most municipalities and industries.

5. Utilizing the fracture trace method of well location saves tens of thousands of dollars and hundreds of man-hours in trying to develop ground water supplies.
6. Wells centered on fracture traces display a more consistent yield rather than variable yields associated with non-fracture trace location wells.
7. Fracture trace well sites result in improved ground water yields, higher specific capacities, high productive well yield values, and reduced operational energy cost.

Ancient civilizations utilized wells for supplying water to improve their citizen's quality of life. Today we have an economical and successful way to more accurately find underground water resources. By using modern scientific technology, we are able to realize higher yields in a county-by-county area than has ever been possible before. Fracture trace analysis is the gateway to successful high yield super wells.