Fractured-rock Wells in the Pacific Northwest foothills: Not your average water source

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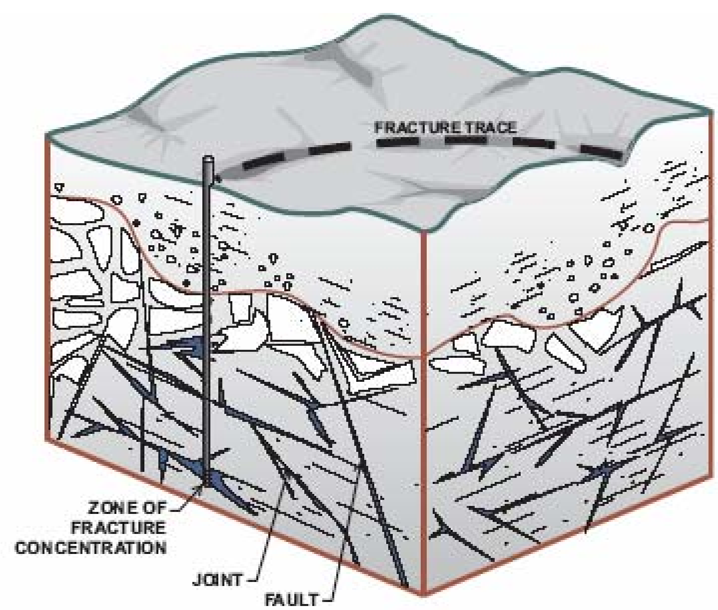
Very generally, there are three different geologic settings that support water wells in the Pacific Northwest. The most common setting is unconsolidated sediments laid down by glaciers and rivers (or other erosional processes). While the aquifers formed in these sediments can vary, this setting is clearly the most successful in providing ground water. The next major setting, mostly found east of the Cascade Mountains, is the regionally extensive basalts like those of the Columbia Plateau. Wells completed in the basalts (or more accurately between the basalt flows) can also be highly variable, but the current understanding of the geometry and hydrogeology of the basalt layers provides some certainty to water development projects. The final geologic setting is much more enigmatic: the fractured-rock groundwater environment of the mountain foothills (particularly the Coast Ranges or Cascades). While wells completed in fractured rock are invaluable in many areas as a source for domestic wells, and occasionally serve as a reliable source for higher production, they tend to be less predictable and less reliable than other wells. The reason lies in the fundamental difference in the way fractures-rock aquifers transmit water.

The ability to transmit water (permeability) in an unconsolidated aquifer is a result of the interstitial spaces (pore spaces) between each individual clast of sediment and the degree to which these spaces are connected to one another. As such, there is a significant amount of open area through which water can flow (typically 10% to 30%). What is more, these characteristics are usually found consistently over a significant lateral extent. Similar characteristics can be found in some rock settings, such as sandstone, where significant amounts of water can flow through the spaces inherent in those types of rock. In hydrogeology, this is called the “primary permeability” of the material.



In a fractured-rock environment, such as found in the foothills of the Cascades and the Coast Ranges (and below the sediment cover elsewhere in the Pacific Northwest), the primary permeability is extremely low. Almost no water at all can pass through the rock itself, so water can only be transmitted through cracks and fractures that result from the folding and faulting of the rock over time. Fractures create “secondary” permeability. Aquifers which rely on secondary permeability generally have much lower capacity to transmit water. This lower capacity results from both a smaller amount of open space (the size of the fracture) and a smaller lateral extent of the aquifer (fracture zones are not consistent throughout the rock), as compared to the primary permeability found in sediments. As a consequence, many rock wells are limited in the amount of water that they can reliably produce in the long term. Typically, these wells can have an apparent production during short-term testing that is higher than the actual amount that can be supported by the surrounding fracture-rock aquifer. As a result, the incidence of "well failure" is much higher in fractured rock wells than in other settings.

As if the poor ability to transmit water isn't enough, such settings also usually have difficulty collecting and storing water to transmit. In fractured-rock environments, an appreciably lower percentage of the precipitation over the area ends up getting into the groundwater system. This means that a smaller volume of water is available annually throughout the region served by an aquifer. This concept is known as the aquifer water budget. When more water is being removed through the wells in a region than is recharged from the precipitation (and other sources), the water levels in the wells of that region fall through time. If this is a chronic problem, eventually some or all of the wells become unable to produce water at the rate necessary to meet their demand.

Between the production constraints imposed by permeability issues in fractured-rock and the inherent water budget issues, caution must be used in the use of fractured-rock wells. Monitoring of the water levels and production of a rock well is essential, as is being aware of the regional-level changes (such as: is it a low water year? are neighboring wells experiencing similar patterns of change?). It is easy to be fooled into thinking a fractured-rock well will have a sustainable level of water production based on the initial (short-term) testing. Since these aquifer systems are unique, predicting a long-term production rate takes more care and often cannot be determined just from the testing done when the well is completed. Clearly, when dealing with this type of rock well, forewarned is forearmed – more than one vacation dream property has lost its value when the well gave out. Whether operating a water system or a single well for a home in the hills, keeping records of water levels and production will provide key information in defining a sustainable yield for fracture-rock wells.

The *Washington State Ground Water Association* is dedicated to technical and professional leadership in the advancement of the drilling and ground water industry. The Association produces these informational flyers to educate the public and its membership on the proper protection and use of ground water resources. The Association can be contacted at: (360) 757-1551 or online at www.wsgwa.org

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