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Analysis of Dishman Hills Structure and Hydrogeology

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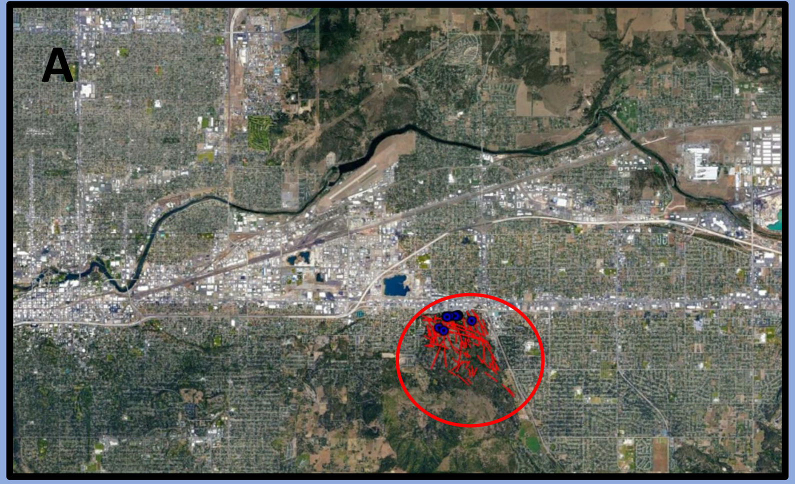
Abstract:

The structural and hydrogeology of Dishman Hills Conservation Area was interpreted to gain a better picture of its interaction with the Spokane Valley-Rathdrum Prairie aquifer. The rock in this area is Precambrian Ravalli Group with granitic migmatites. This is due to exhumation causing decompression melting in between the bed layers. Other rocks such as amphibolite, gneiss, schist, quartzite, and phyllite are seen along with granitic dikes (WSDNR). This rock type covers all of the Dishman area and is Precambrian in age. Due to tectonic forces in the Spokane area, fractures have also formed within the Precambrian rock. Water will concentrate in fracture zones, known to be areas of groundwater drainage. Many studies show that the water yield on a fracture trace is much greater compared to yields not on fracture traces, with the greatest yield found at intersecting fractures (Fetter 1994). Using lidar and field measurements, fracture orientations were measured and compared to the stress regime from Hammond 2013. Precipitation and evapotranspiration data were then used to estimate the amount of water that would enter the Spokane aquifer in non-ponded areas. Three-point problems were also created to see groundwater flow direction and to note if water exits these fractures. The calculations suggest that water tends to flow away from the Dishman Hills area. Also, it was found that the groundwater leaving the Dishman Hills area towards the Spokane Valley-Rathdrum Prairie Aquifer ranged between $2.37 * 10^7$ *and* $5.92 * 10^7$ gallons.



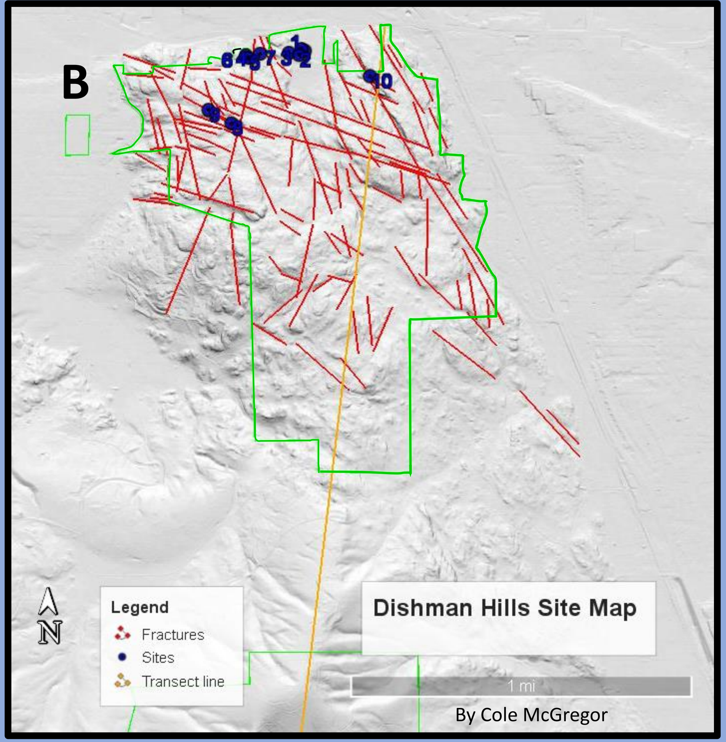


Figure 1:
A. Vicinity map of the Dishman Hills area relative to Spokane, shown as the circled area.

B. Site map of Dishman Hills area with lidar to better see the underlying geology. Fractures plotted from lidar are red lines, sites visited for field observation are blue points, and the transect line from which a cross-section was made is the orange line.

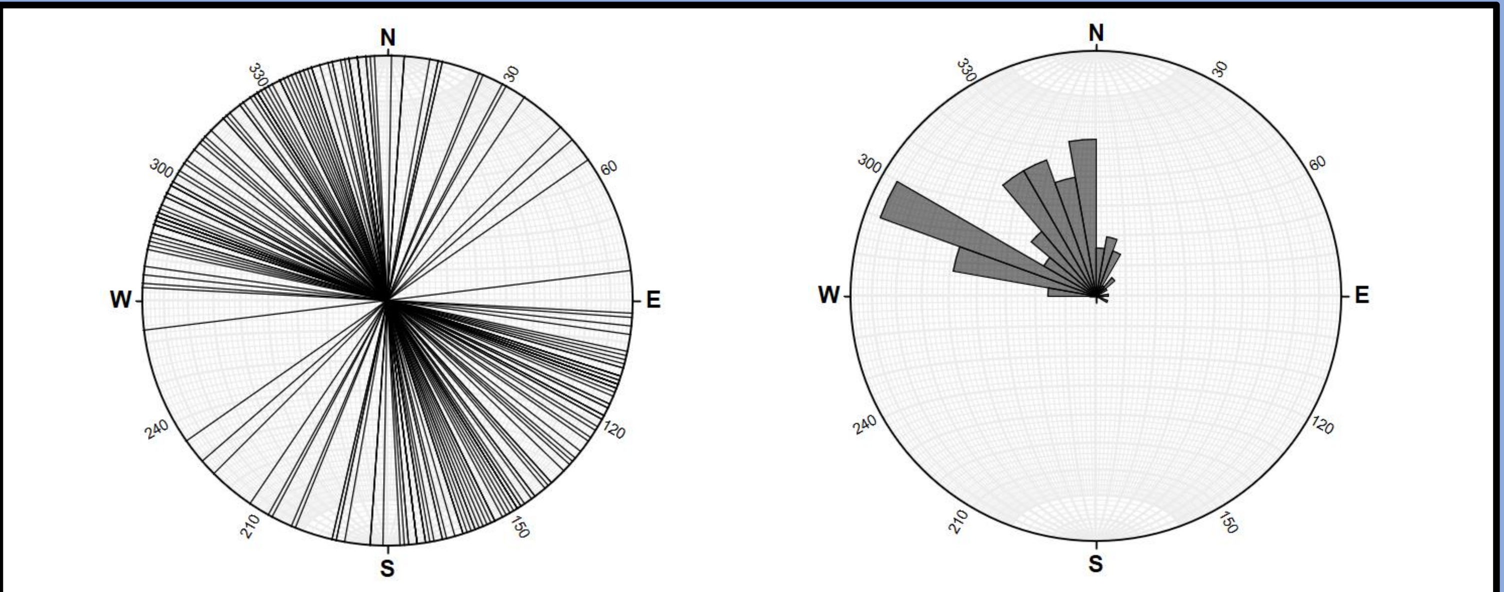


Figure 2: Stereonet and rose diagram generated from 114 strike measurements using lidar

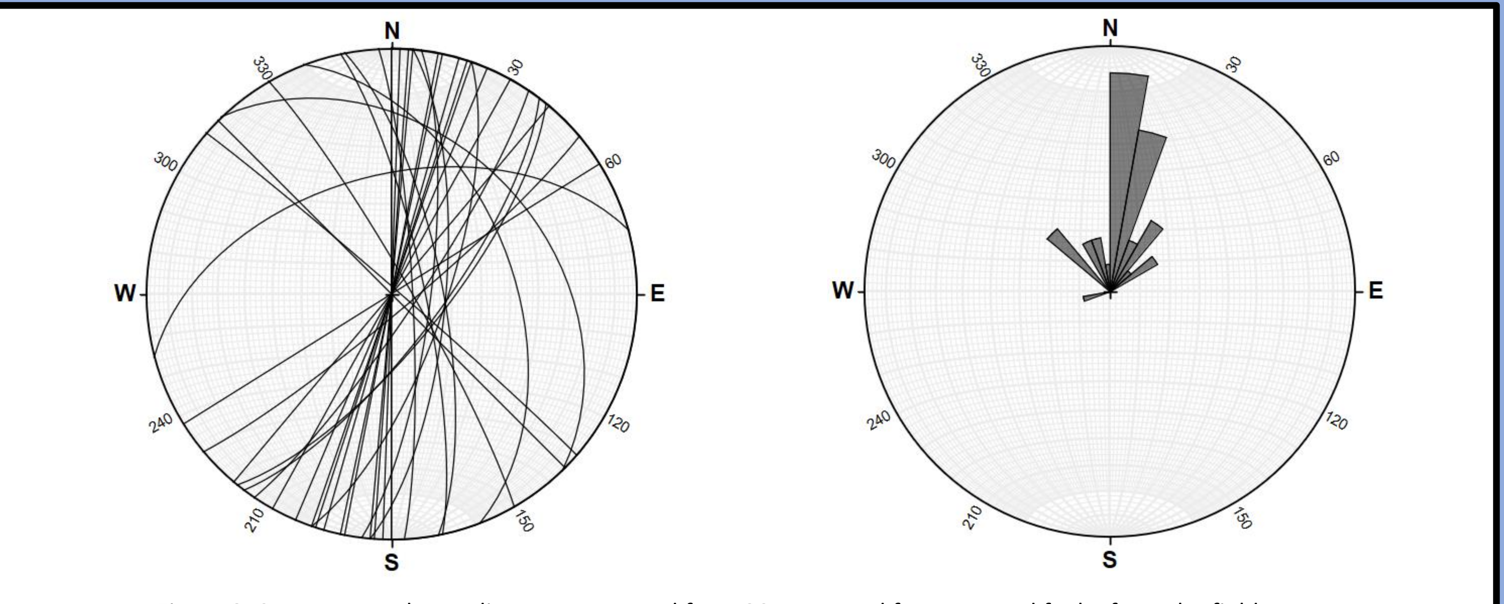


Figure 3: Stereonet and rose diagram generated from 30 measured fractures and faults from the field

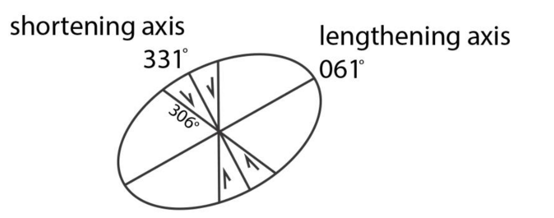


Figure 4:
Strain ellipsoid from Hammond 2013 showing the areas of shortening and lengthening. By comparing this with figures 2 and 3, most fractures are strike-slip, but some are faults dipping NE and NW.

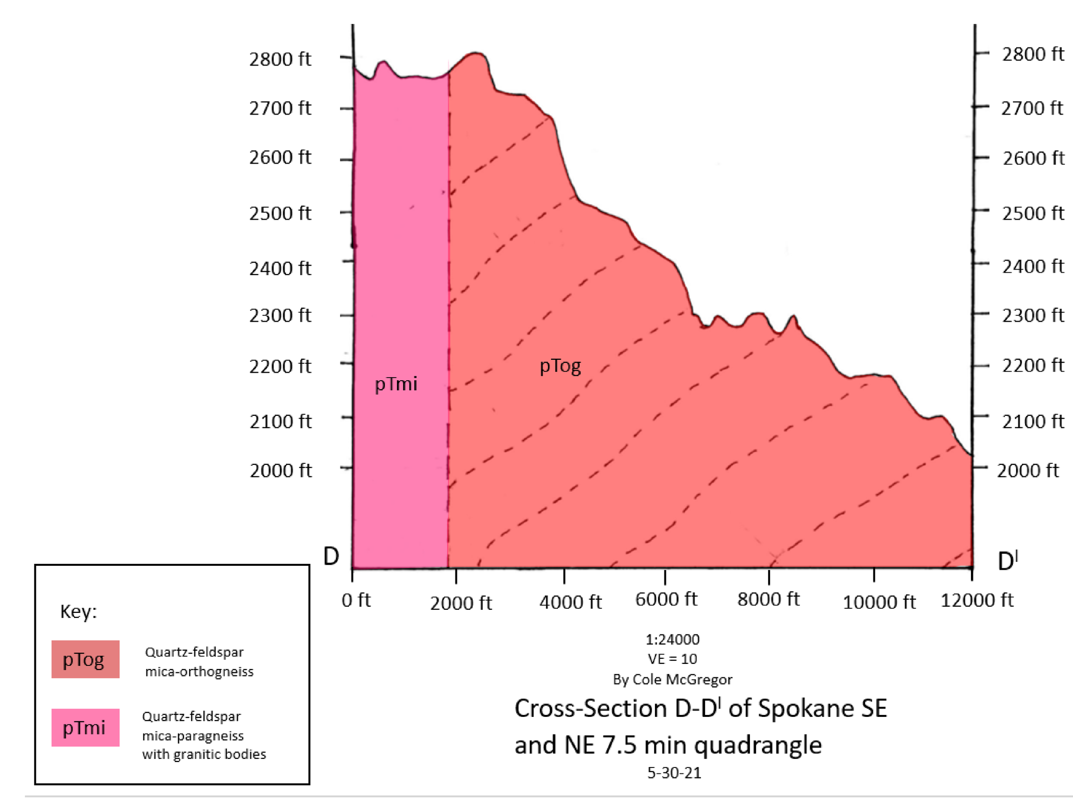


Figure 6:
A cross-section of the Dishman Hills area showing that the entirety of the underlying rock is Quartz-feldspar mica-orthogneiss and Precambrian in age (Derkey 1999). The other Precambrian unit is similar in composition and is seen just south of the park boundary.

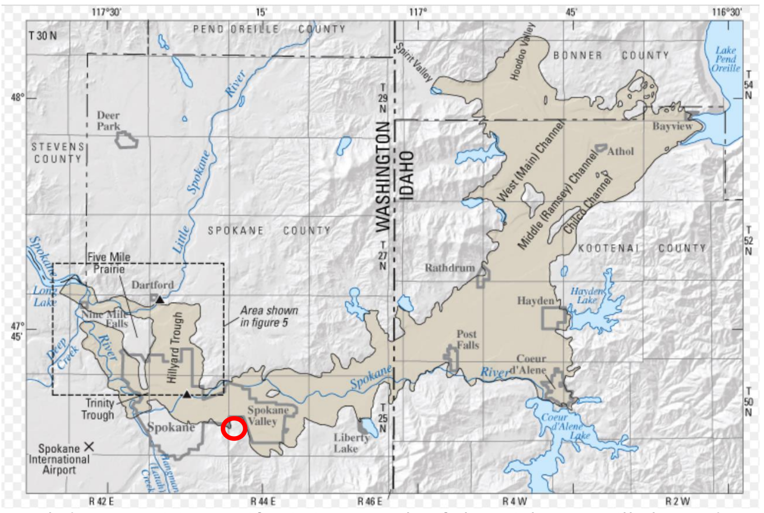


Figure 7: The Spokane Valley-Rathdrum Prairie Aquifer is just north of the Dishman Hills boundary, and it is possible that water flows through the fractures and into the aquifer.

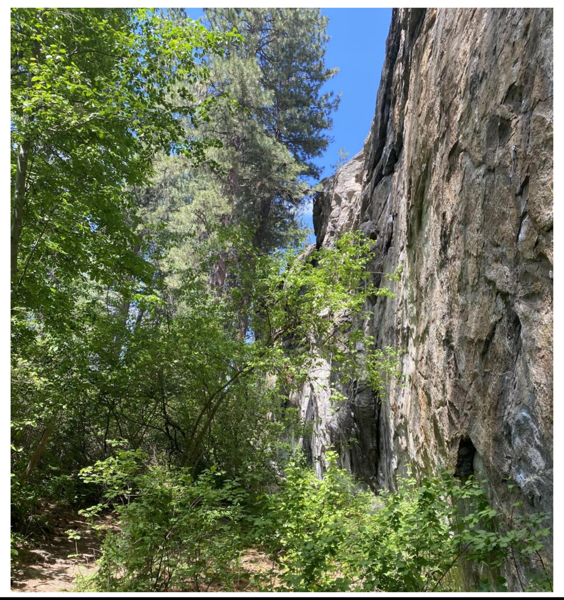
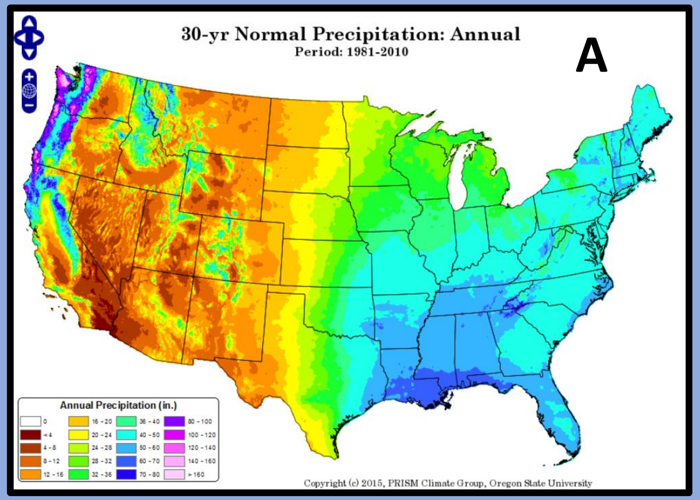


Figure 5:
A. This photo shows a view from within one of the widest fractures of the area. The fracture is striking 331 degrees which is same orientation as Hammond's strain ellipsoid. This indicates that the fractures align with other regional measurements and prefer to widen in this orientation. Fractures striking around 331 will have a higher hydraulic conductivity than fractures that don't.



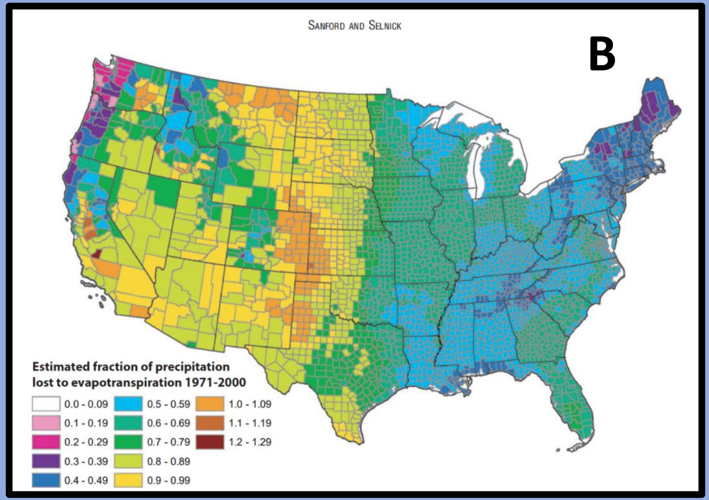


Figure 8:
A. The amount of precipitation in Dishman Hills can be estimated using PRISM climate data from Oregon State university. With this, the area receives about 16-20 inches of precipitation annually.

B. The amount of precipitation lost to evapotranspiration can be estimated using the map form Sanford 2012. This shows 80 to 90 percent of the water gained is put back into the atmosphere.

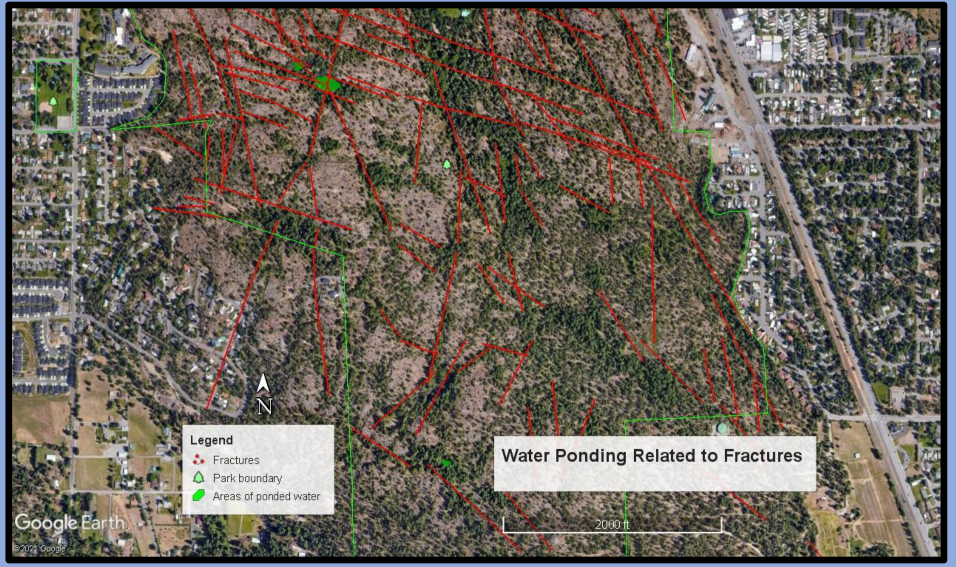


Figure 9:

The image shows areas of water ponding that don't enter the aquifer as green polygons. These seem to be in areas of high fracture density. Although, the interconnectivity of fractures leads to a higher hydraulic conductivity (Singhal 2010). A reason for this ponding is due to cocolalla soil in these areas. Using information from the USDA, this soil is an ashy silt loam, likely deposited in these depressions from higher elevations which prevent water infiltration.

Calculations:

The area ponded by water is $1.23 * 10^{-3}\ mi^2$ and the area of the Dishman Hills boundary is $0.85\ mi^2$, meaning 99.86% of the park allows for infiltration.

Using the area of potential infiltration along with the amount of precipitation from figure 8, roughly $2.37 * 10^8$ *and* $2.96 * 10^8$ gallons of water enter the aquifer. Using the amount of precipitation lost to evapotranspiration from figure 8, this becomes between $2.37 * 10^7$ *and* $5.92 * 10^7$ gallons of water that enter the aquifer.

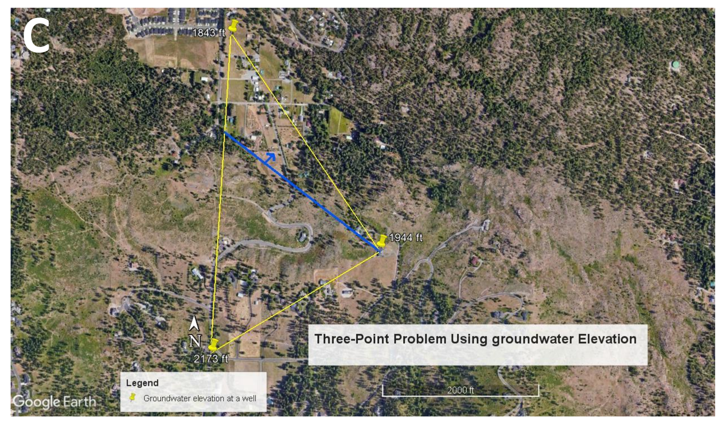


Figure 10:
A. Three-point problem using bedrock elevation to estimate groundwater flow direction. The yellow pins show the wells, the blue line represents equipotential, and the blue arrow is flow direction. This shows water would likely flow west away from the area.

B. Another three-point problem using bedrock elevation to estimate groundwater flow direction. These three wells are further south than in A, and flow in a NW direction.

C. Three-point problem using occurrence of groundwater in fractured bedrock. This shows a NE direction of flow.

Citations:

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