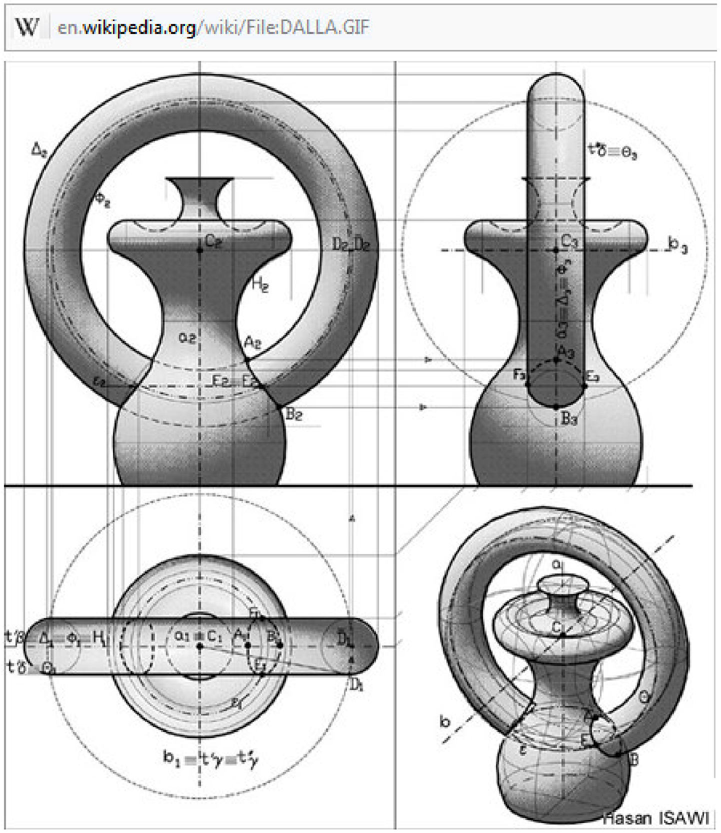
DESCRIPTIVE GEOMETRY, TRIGONOMETRY, and ANALYTICAL GEOMETRY.

Structural geology uses descriptive geometry, trigonometry, and analytical geometry to portray map and profile planar and linear geological features

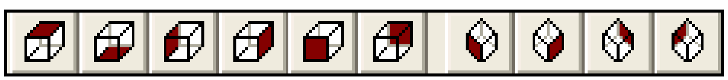


• *Wikipedia* - **Descriptive geometry** is the branch of geometry which allows the representation of three-dimensional objects in two dimensions, by using a specific set of procedures. The resulting techniques are important for engineering, architecture, design and in art…The theoretical basis for descriptive geometry is provided by planar geometric projections. Gaspard Monge is usually considered the "father of descriptive geometry". He first developed his techniques to solve geometric problems in 1765 while working as a draftsman for military fortifications, and later published his findings.

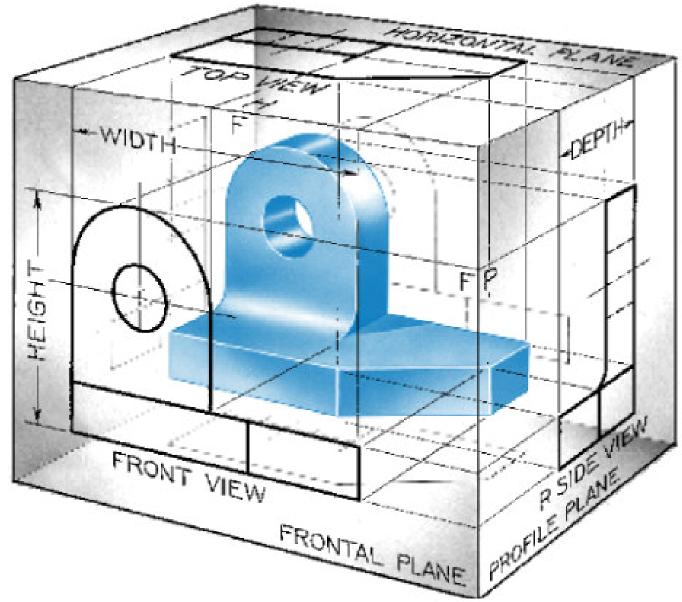
Among the many protocols:

•Each new view may be created by projecting into a direction perpendicular to the previous direction of projection. The result is one of stepping circuitously about an object in 90° turns and viewing the object from each step. Each new view is added as an additional view to an orthographic projection layout display and appears in an "unfolding of the glass box model".

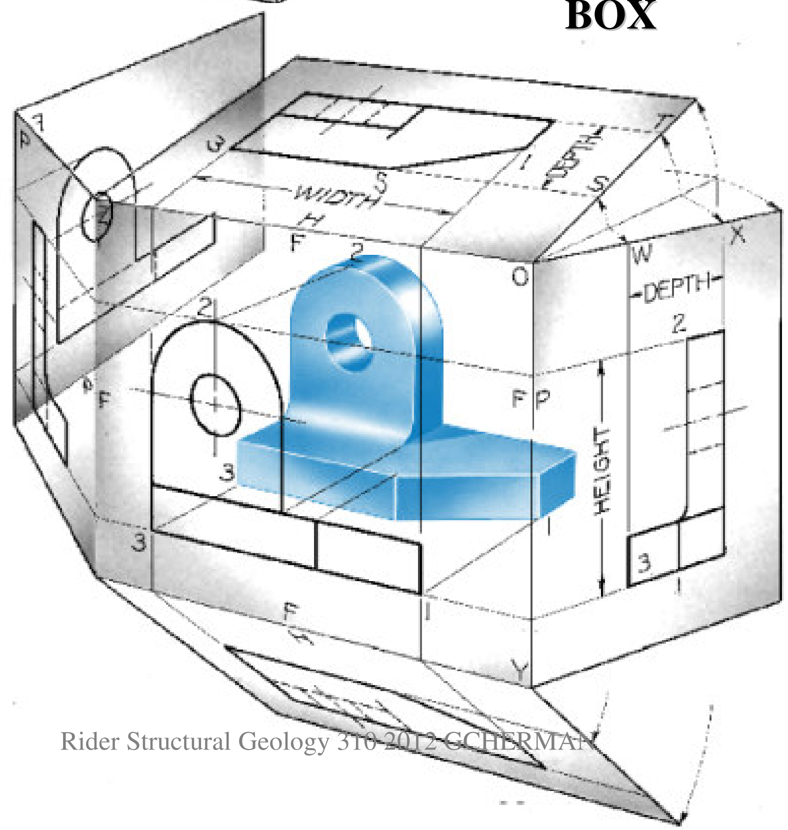
• Six standard principal views in CAD programs include Top; Bottom; Left Side; Right Side; Front, and Rear projections.



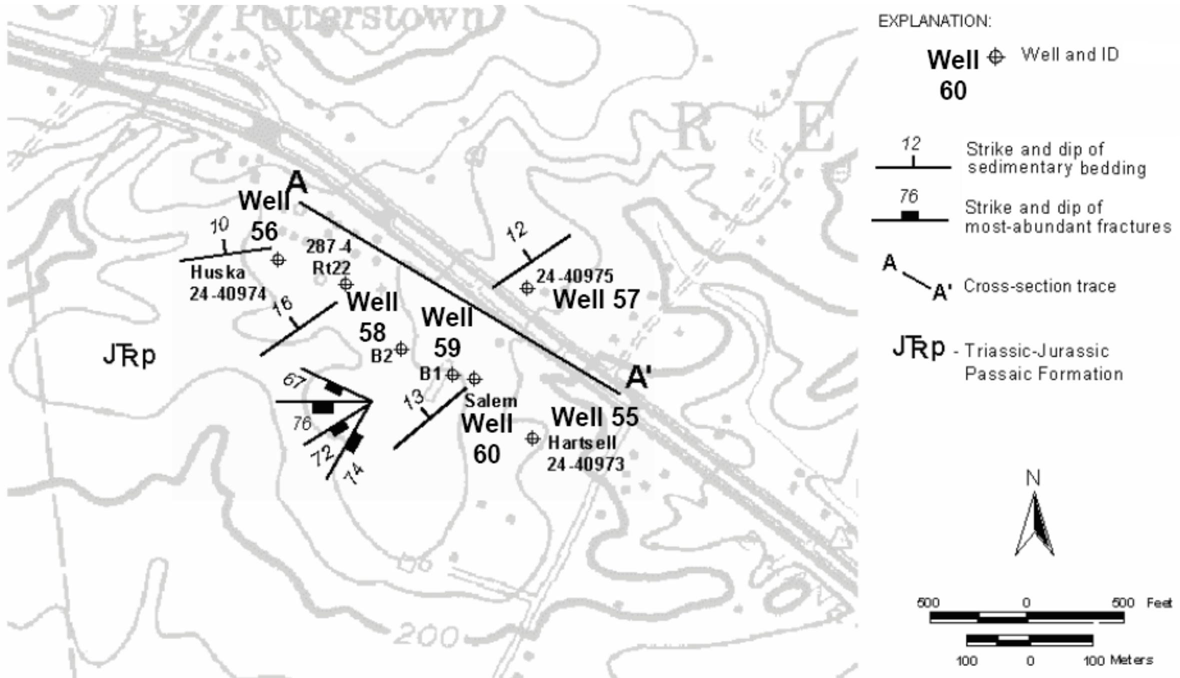
•Descriptive geometry strives to yield four basic solution views: the true length of a line (i.e., full size, not foreshortened), the point view (end view) of a line, the true shape of a plane (i.e., full size to scale, or not foreshortened), and the edge view of a plane (i.e., view of a plane with the line of sight perpendicular to the line of sight associated with the line of sight for producing the true shape of a plane).



UNFOLDING THE GLASS BOX

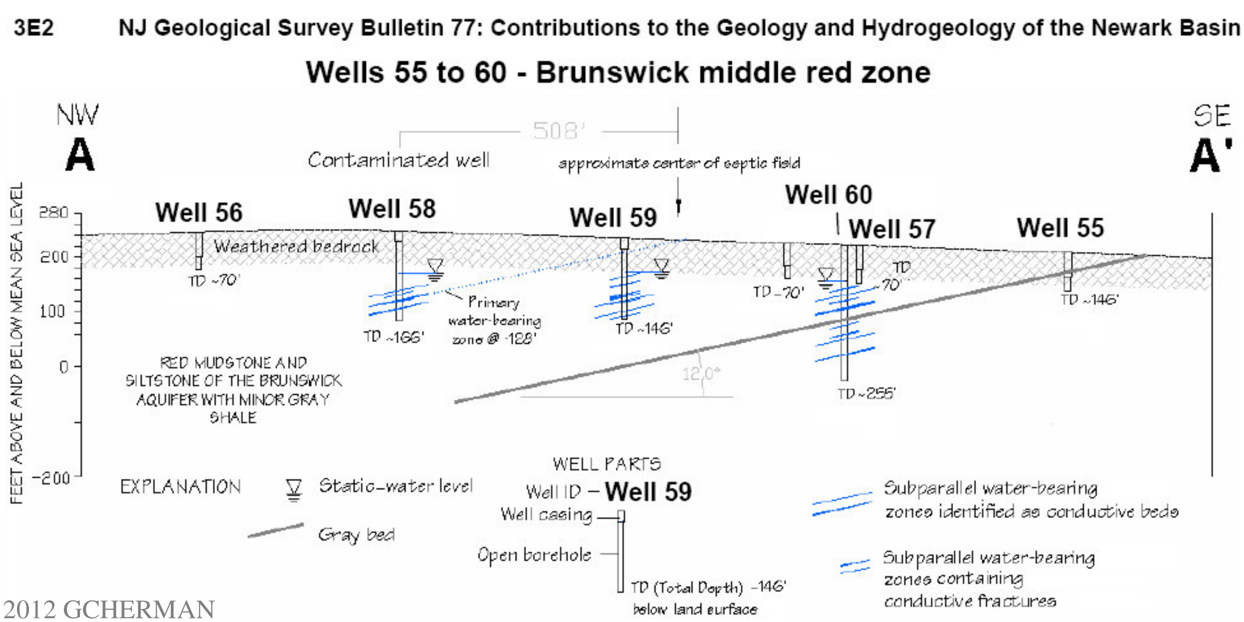


- In structural geology, map and cross-section views are basic. The map is the Top view, and the Cross-Section view is a Side view.
- The cross-section trace line is about perpendicular to primary geological features such as stratigraphic bedding or layering, or to a secondary structure such as a fold axis.



MAP VIEW

- The cross-section trace is the fold line.



CROSS-SECTION VIEW

•*Wikipedia* – **Trigonometry** (from Greek trigōnon "triangle" + metron "measure") is a branch of mathematics that studies triangles and the relationships between their sides and the angles between these sides. Trigonometry defines the trigonometric functions, which describe those relationships and have applicability to cyclical phenomena, such as waves. The field evolved during the third century BC as a branch of geometry used extensively for astronomical studies. It is also the foundation of the practical art of surveying.

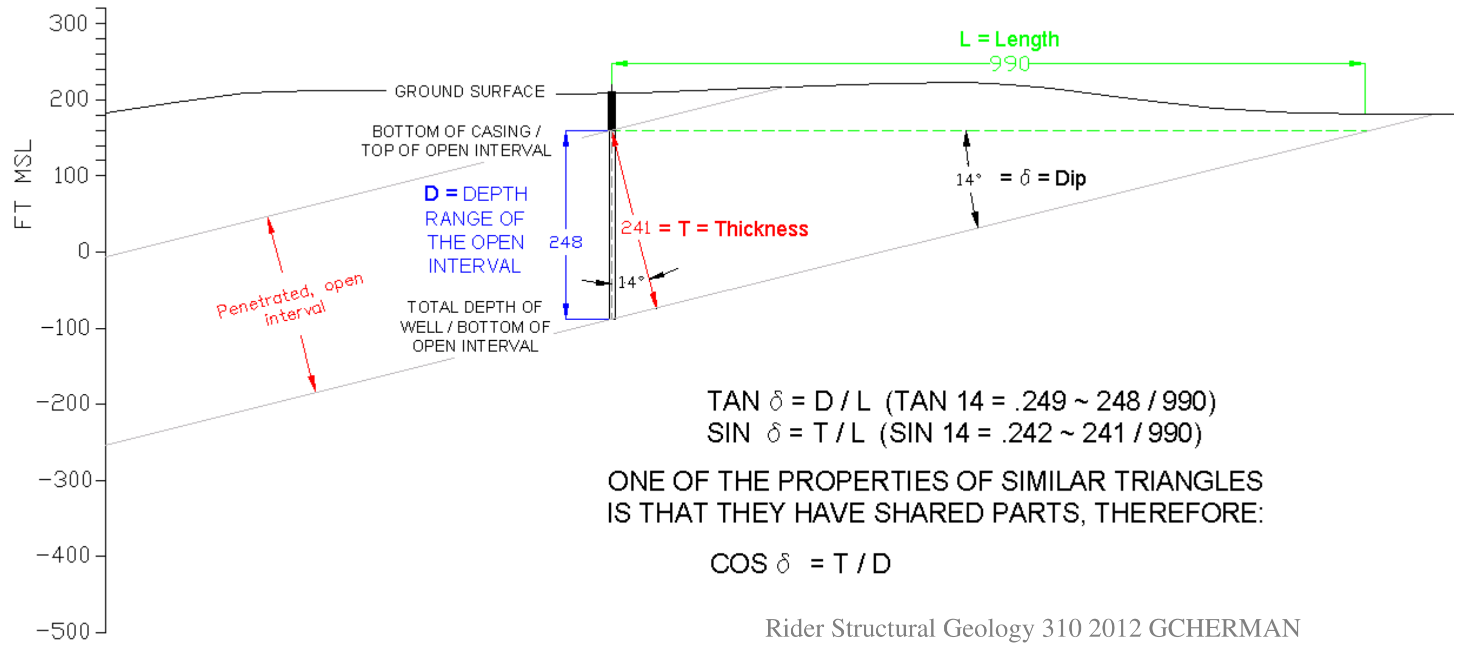
•In structural geology, the trigonometry of **Right Triangles** is used often to find **Analytical Geometric Solutions** to problems.

Example of using trigonometry and analytical geometry for solving length depth, and thickness solutions for bedrock hydrogeology problems using geology and water-well-construction data.

IF THE DEPTH RANGE AND DIP ANGLE OF THE OPEN INTERVAL ARE KNOWN, THEN:

1) THE LENGTH OF THE RECHARGE ZONE (L) = D / TAN δ

2) THE STRATIGRAPHIC THICKNESS OF THE PENETRATED, OPEN INTERVAL = COS δ * D

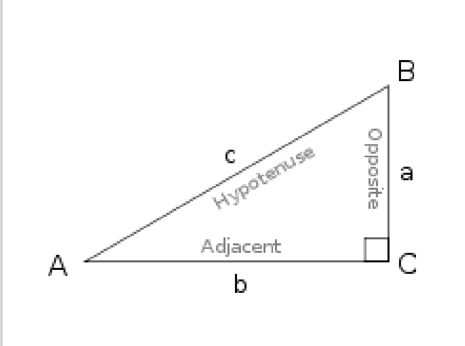


TAN δ = D / L (TAN 14 = .249 ~ 248 / 990)
SIN δ = T / L (SIN 14 = .242 ~ 241 / 990)

ONE OF THE PROPERTIES OF SIMILAR TRIANGLES IS THAT THEY HAVE SHARED PARTS, THEREFORE:

COS δ = T / D

If one angle of a triangle is 90 degrees and one of the other angles is known, the third is thereby fixed, because the three angles of any triangle add up to 180 degrees. The two acute angles therefore add up to 90 degrees: they are complementary angles. The shape of a triangle is completely determined, except for similarity, by the angles. Once the angles are known, the ratios of the sides are determined, regardless of the overall size of the triangle. If the length of one of the sides is known, the other two are determined. These ratios are given by the following trigonometric functions of the known angle *A*, where *a*, *b* and *c* refer to the lengths of the sides in the accompanying figure:



In this right triangle: sin *A* = *a*/*c*; cos *A* = *b*/*c*; tan *A* = *a*/*b*.

- **Sine** function (sin), defined as the ratio of the side opposite the angle to the hypotenuse.

$$\sin A = \frac{\textrm{opposite}}{\textrm{hypotenuse}} = \frac{a}{c}\,.$$

- **Cosine** function (cos), defined as the ratio of the adjacent leg to the hypotenuse.

$$\cos A = \frac{\textrm{adjacent}}{\textrm{hypotenuse}} = \frac{b}{c}\,.$$

- **Tangent** function (tan), defined as the ratio of the opposite leg to the adjacent leg.

$$\tan A = \frac{\textrm{opposite}}{\textrm{adjacent}} = \frac{a}{b} = \frac{\sin A}{\cos A}\,.$$

The **hypotenuse** is the side opposite to the 90 degree angle in a right triangle; it is the longest side of the triangle, and one of the two sides adjacent to angle *A*. The **adjacent leg** is the other side that is adjacent to angle *A*. The **opposite side** is the side that is opposite to angle *A*. The terms **perpendicular** and **base** are sometimes used for the opposite and adjacent sides respectively.

The reciprocals of these functions are named the **cosecant** (csc or cosec), **secant** (sec), and **cotangent** (cot), respectively:

$$\csc A = \frac{1}{\sin A} = \frac{c}{a},$$
$$\sec A = \frac{1}{\cos A} = \frac{c}{b},$$
$$\cot A = \frac{1}{\tan A} = \frac{\cos A}{\sin A} = \frac{b}{a}.$$

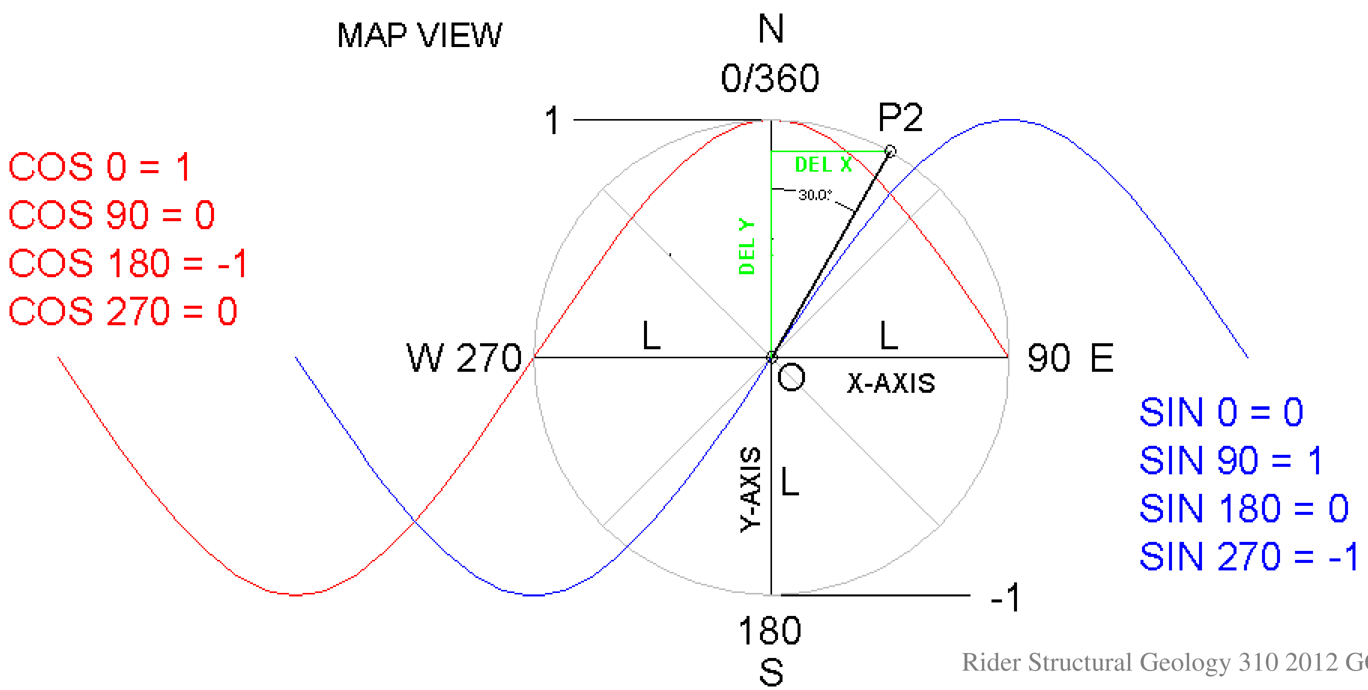
The inverse functions are called the **arcsine**, **arccosine**, and **arctangent**, respectively. There are arithmetic relations between these functions, which are known as trigonometric identities. The cosine, cotangent, and cosecant are so named because they are respectively the sine, tangent, and secant of the complementary angle abbreviated to "co-".

Using directional sines and cosines in map space to construct lines representing geological symbols

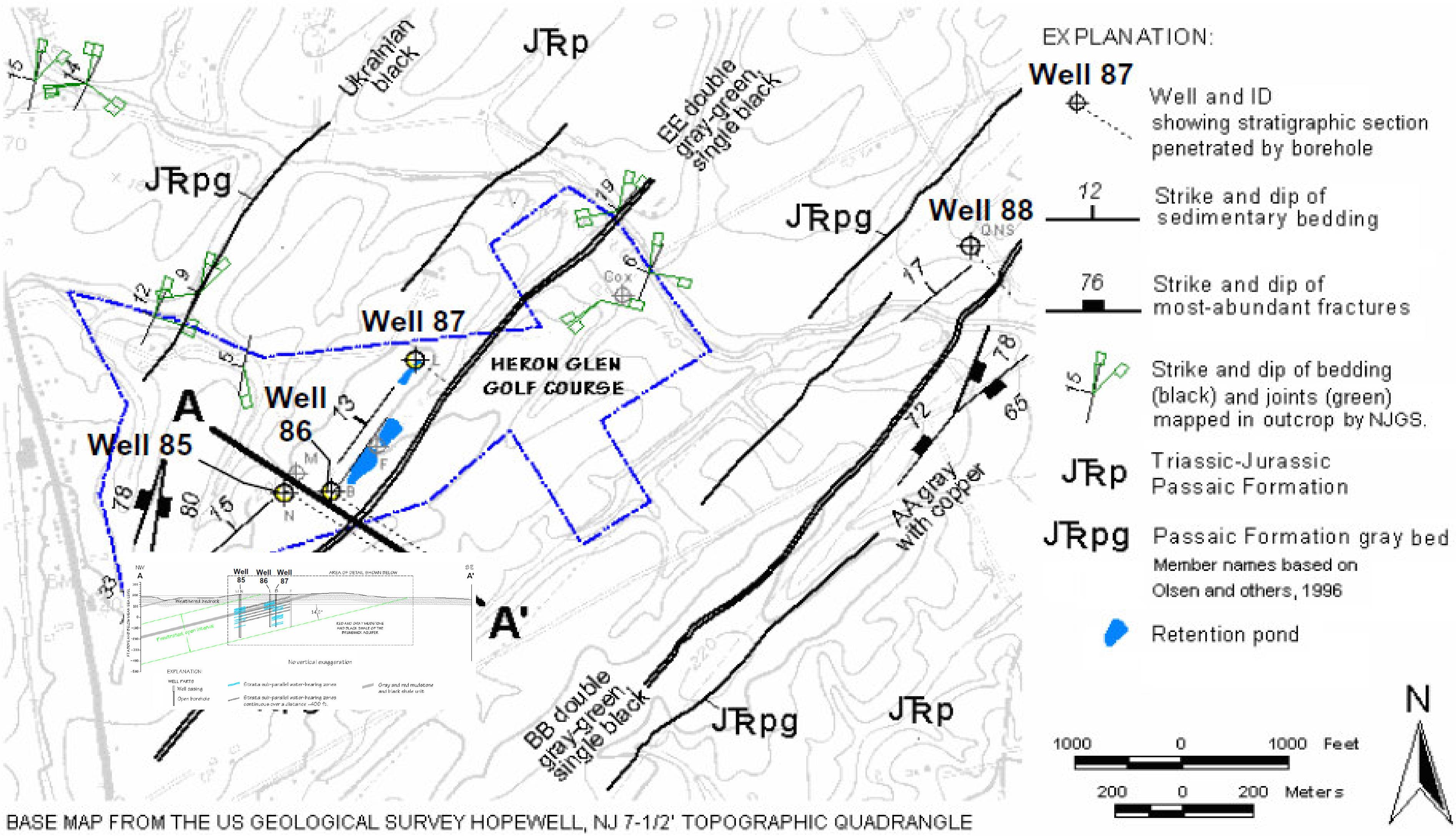
In cartesian (MAP) space, a field station has coordinates (X,Y), at the center of an imaginary circle with radius L. If you want to construct a line of radius L at a 30° clockwise rotation (α) from North, An analytical solution is to multiply L by COS (α) and SIN (α) to find DEL X and DEL Y,respectively, then add the results to the station coordinates to find P2.

DEL X = SIN 30 = 0.450, DEL Y = COS 30 = 0.866

O (Origin) = 0,0   P2 = (0 + .450, 0 + .866) = (0.450, 0.866)



Structural relationships of rock wells with casing in dipping planar beds.



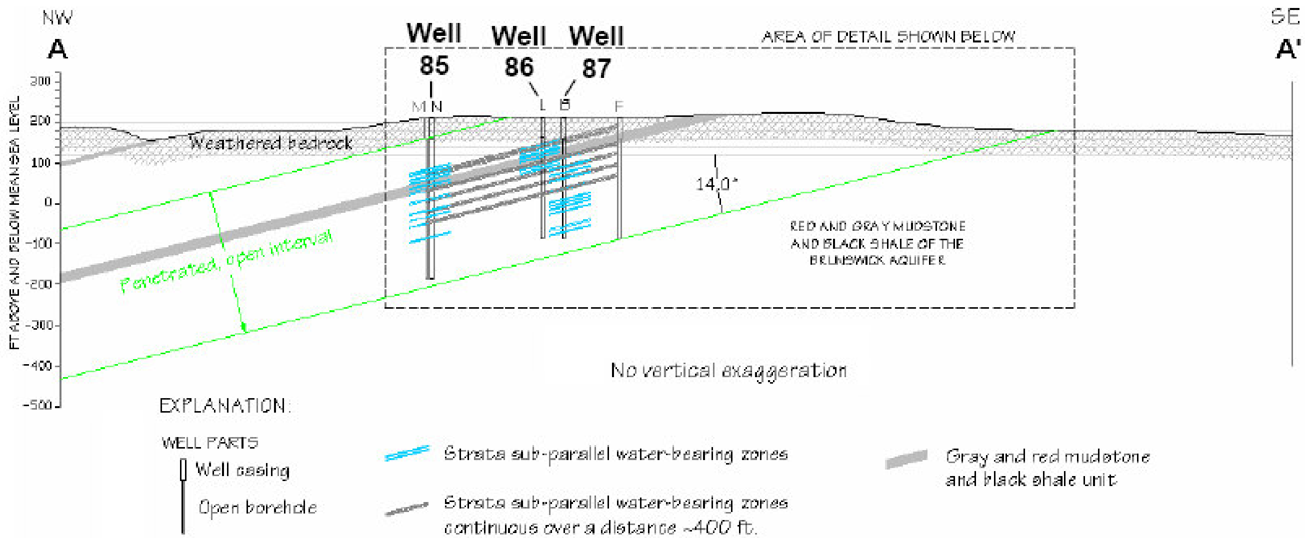
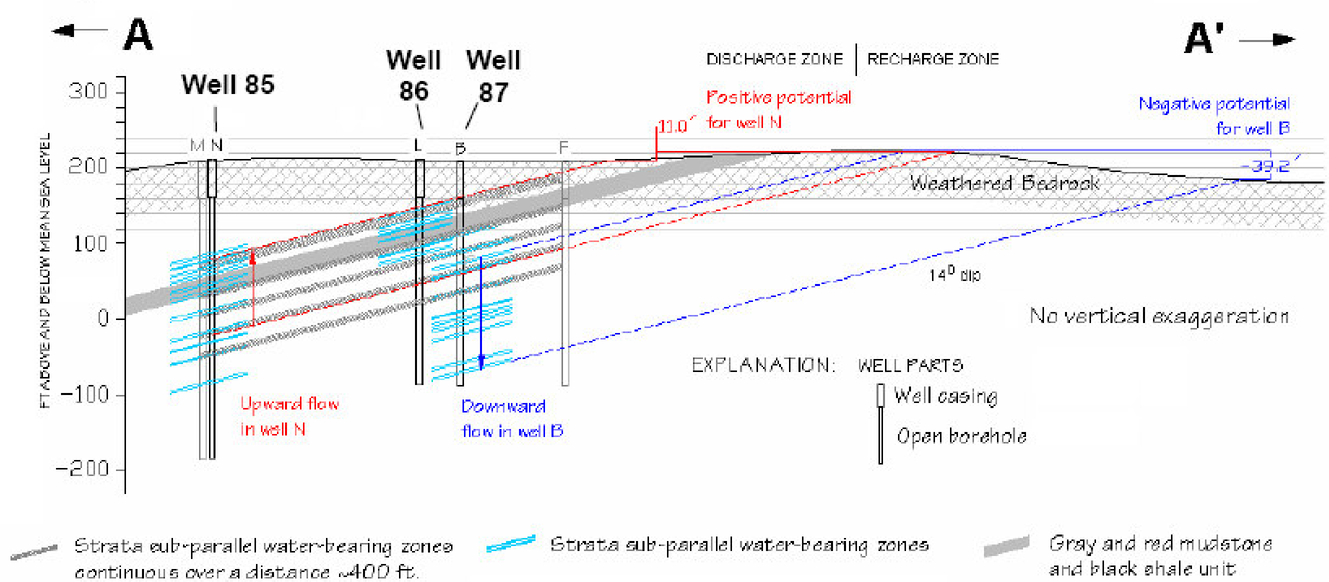


Figure 3K2. Hydrogeologic sections of the Heron Glen Golf Course well field, Rt. 202/31 N, Raritan Twp., Hunterdon County, NJ. Location of generalized section (above) shown on figure 3K1. Section details (below) show different cross-flow directions in wells 85 and 87 while pumping irrigation wells M and F at a combined rate of ~500 gpm. Flowing intervals are projected to land surface and shown in relation to topographic variations in the ground-water discharge and recharge zones.



Herman, G.C. and Curran, John, 2010, Borehole geophysics and hydrogeology studies in the Newark basin, New Jersey (38 MB PDF), *in* Herman, G.C., and Serfes, M.E., eds., Contributions to the geology and hydrogeology of the Newark basin: N.J. Geological Survey Bulletin 77, Appendexes 1-4, 245 p.