

# Why Drill holes Deviate

We frequently see holes that have been started 2º or more off the planned direction and larger errors are not uncommon. Some of this "starting error" is caused by setup error, some by drill platform instability and some by drill rod instability at the start of the hole (see also Karlsson, 1997).The direction of the hole will not stabilize until at least a few meters of the rod is supported by the wall rock. All these factors can be minimized with care, but surveying at a 10 meter depth *will define the starting direction.* We may not be able to control the accuracy of all the steps, but we can determine *where the hole has gone.* For every 100 meters of drilling, a 2º error will cause 3.5 meters of offset (3.5 feet/100 feet), which may or may not be within acceptable error. But, if we add this error to less controllable deviation caused later by other factors, we may exceed the acceptable accuracy when only expensive remedies such as wedging or directional drilling techniques remain as remedies to save the hole.

The rocks through which the hole is drilled can influence the direction. Any rock which is layered (especially thin alternating soft and hard layers) or has a fissility (breaks preferentially along closely spaced parallel planes) will cause deviation if the hole is at an angle to the layering or fissility. The most common effect observed is that the hole has a tendency to deviate to become perpendicular to the layering (for example Broken Hill, Australia) or fissility (for example Bathurst N.B., Canada). If this layering or fissility has a constant attitude in the drill area, the direction of the hole deviation can be predictable and therefore useful in planning drill setups that will naturally deviate toward the desired target. If the layering is folded, the direction of deviation may change as the angle between the hole and the folded layering changes. We have observed a hole deviating to become normal to layering at a crest of an anticline only to happily deviate a small angle as the hole passed into the fold limb to become parallel to layering. And then staying in the layering for another 500 meters (1640 feet).

The physics of drilling can create forces which can amplify the rate of deviation. Worn and loose drill rod threads, non-rigid core barrels, and inappropriate bit design or cutting characteristics have long been known to contribute to crooked holes. Alternately, using rigid core barrels, well designed and properly placed stabilizers and suitable bits diminish the influence of rock imposed deviatory forces. The driller can influence the rate of deviation by using improper drilling forces. Large directional deviations can be caused by buckled drill rod trains brought about by excessive force on the bit. The desire for rapid hole advance often leads to poor drilling practices, but advance rates that are too slow may also produce more than necessary deviation. It is not unusual for each drilling shift to have their own specific deviation rate on a borehole- one crew consistently producing higher deviations.

Let us examine an actual example of drill hole deviation. **Figure # 1** is a vertical section of 4 boreholes drilled to intersect a **sulphide zone** . The top of drill hole 1 was not surveyed. The holes deviated to become normal to the fissility- the trace of which is shown as the double ended arrow. The deviation ranges from 1.8º per 100 m to 6.5º per 100 m (0.6 to 1.98º per 100 feet), correlating roughly with drill setup inclination at the surface. Pictorially, the effect of angle building when the 6.5º of the last 100 m is added on to that of the previous 100 m is impressive.

These holes were drilled with modern equipment in good physical condition and do not represent anomalous circumstances in the mining camp where these were drilled.

**Figure #1** shows the plotted (or apparent position) of **drillhole 4** if it had **not** been surveyed.

When a hole is not surveyed, the hole has to be plotted as a straight line using the drill setup angle at the surface. If we look at the apparent and the real sulphide intersections (**circled**) in hole 4, we are seeing a big difference in the *apparent position* of the sulphides.

The real intersection is 300m (1000 feet) shallower than the apparent one, and it is displaced 520 m (1700 feet) laterally from the apparent intersection. But the *apparent position error* is only one of the error attributes of un-surveyed boreholes. The others are *geometric distortion* and *volume distortion.*

The ***apparent* sulphide intersections** in all the holes are plotted as the **broken purple line** in the figure. Note that the angle of the real sulphide zone is significantly different from the apparent sulphide zone- this is *geometric distortion.*

The volume of the apparent sulphide zone is 56% larger than the volume of the real one- this is *volume distortion.*

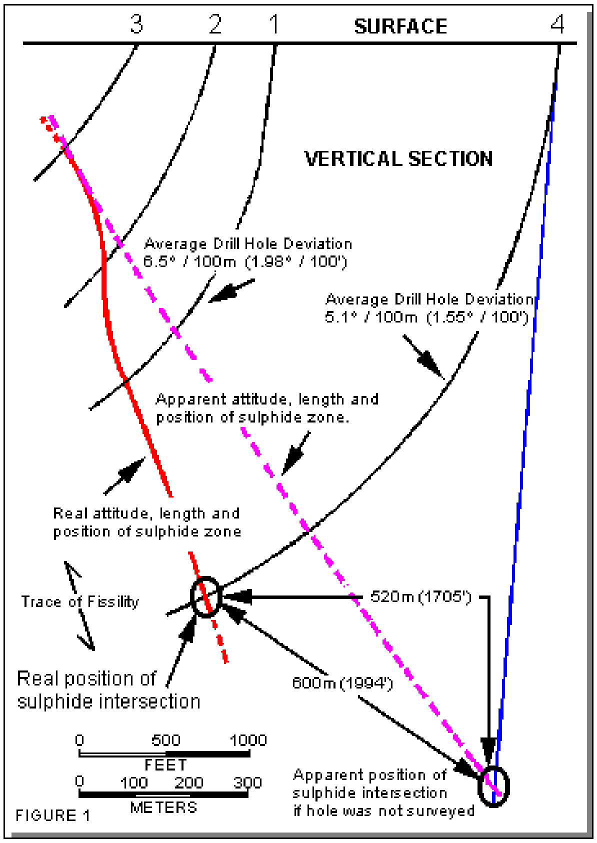


**Figure #1**

## There is nothing real about un-surveyed data.

Reference
Karlsson, F., 1997. What makes holes deviate?,
GeoDrilling, May, 1997, p.1.