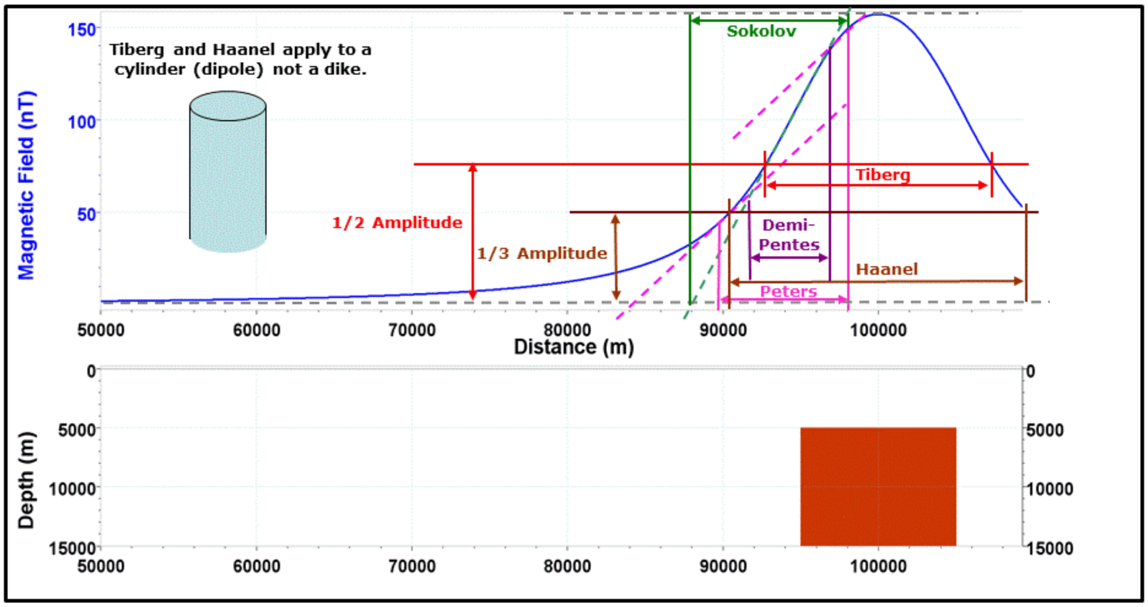
BainGeo: MagDepth™

MagDepth™ is BainGeo's depth to magnetic source interpretation toolkit. It combines cutting-edge research by Flanagan and Bain (2013) to improve magnetic depths over thinned magnetic crust, with pioneering work by experts including Bean, Åm, Nabighian, and numerous others.

Many of these depth methods use the approach of "curve characteristics" recommended by Åm and others. BainGeo's approach allows the user to interactively and quickly measure a series of characteristic points along the magnetic anomaly, as shown in the figure below. These horizontal distances are then related (mathematically) to the depth, which properly accounts for the thickness of the crust.



Depths are properly computed by incorporating thickness information for the magnetic crust using our method called "TCDepth™". Magnetic basement depths previously computed for thin-crust basins were typically much too shallow, which was recognized as deep seismic imaging began to offer calibrating information. TCDepth incorporates the improvements in mathematical physics required to compute proper depths, as the crust thins from infinity to (sometimes) near zero.

The figure below illustrates the TCDepth™ correction for the famous Peter's Half-Slope method (1949). We can see that for an infinite dike, the divisor to obtain depth is 1.6 (the famous published number). However, Åm and others understood that this factor must change as the thickness of the magnetic crust changes. Accordingly, the divisor for a thin crust, where the thickness "T" is approximately the same as the depth "D" (so T/D = 1) is only 1.2. This equates to a roughly 25% error in depth if the T/D = infinite case was used, without the TCDepth™ improvements proposed by Flanagan and Bain. For Peters' Half-Slope depth method, the error increases as the body width increase – the width can be approximated from the magnetic map, to allow the user to quickly apply the correct parameters for both the crustal thickness, and body width.

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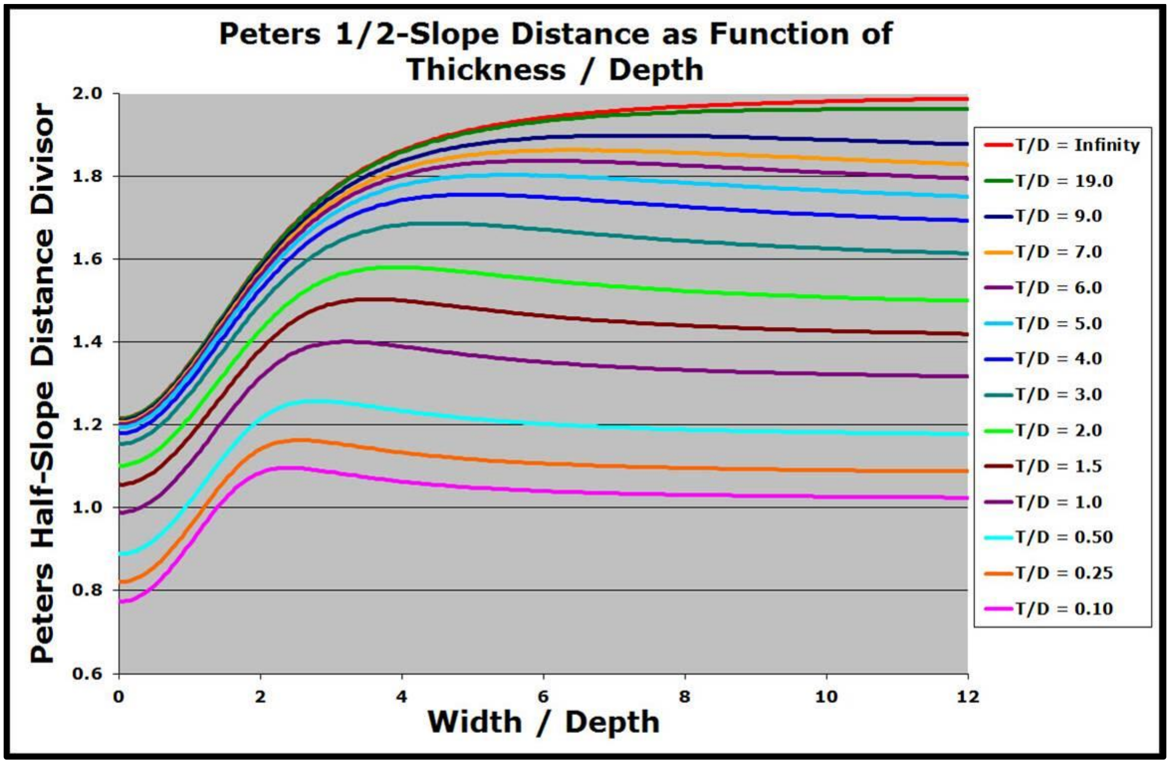
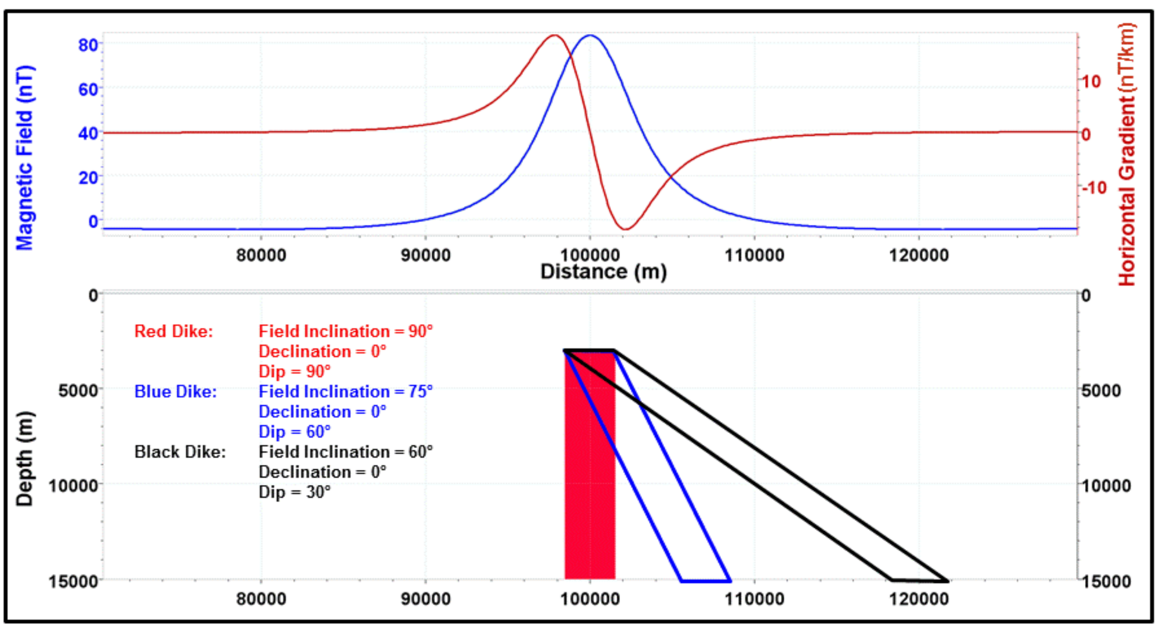


MagDepth also allows the use of either RTP fields, or non-RTP, inclined fields, by solving for nomograms across the inclination and declination spectrum. See Flanagan and Bain (2013) for more information on this important improvement.



Another method that we favor is Bean's "Ratio A" method. Bean was among the first to recognize the importance of this thickness correction; he graciously worked with Bain as a mentor on these methods. The following figure shows the vast amount of information available from a few ratios measured along the

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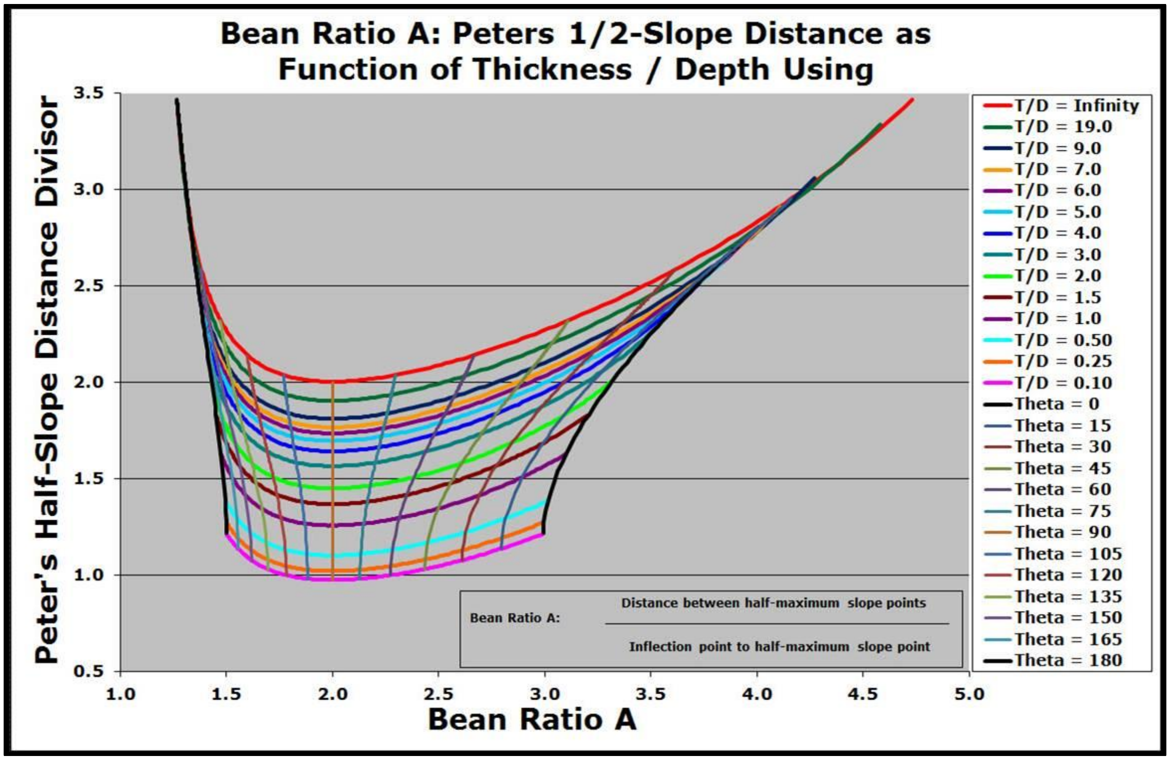
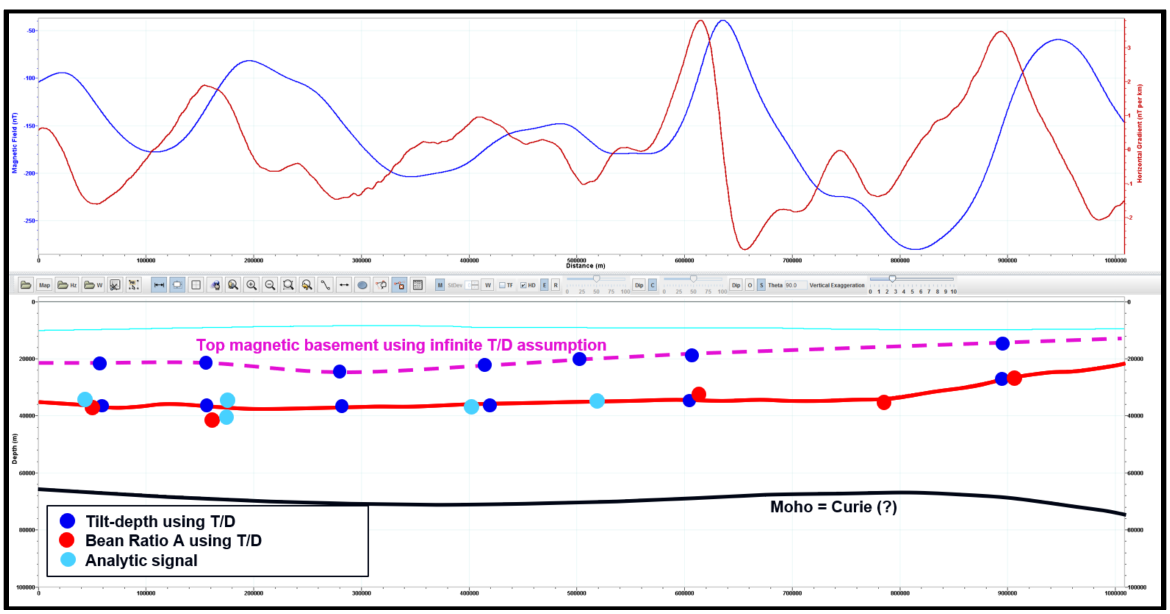
magnetic field profile. While these figures appear complicated, all the math takes place behind the screen, allowing the user to rapidly compute proper depths.



The depth section below shows the proper depth to basement points from multiple methods using TCDepth (along the red basement horizon). The pink dashed line illustrates the significantly too-shallow horizon that would be computed if an infinite bottom was assumed for our magnetic crust (commonly used in the literature over thin-crust environments). Errors here reach as much as 50%.



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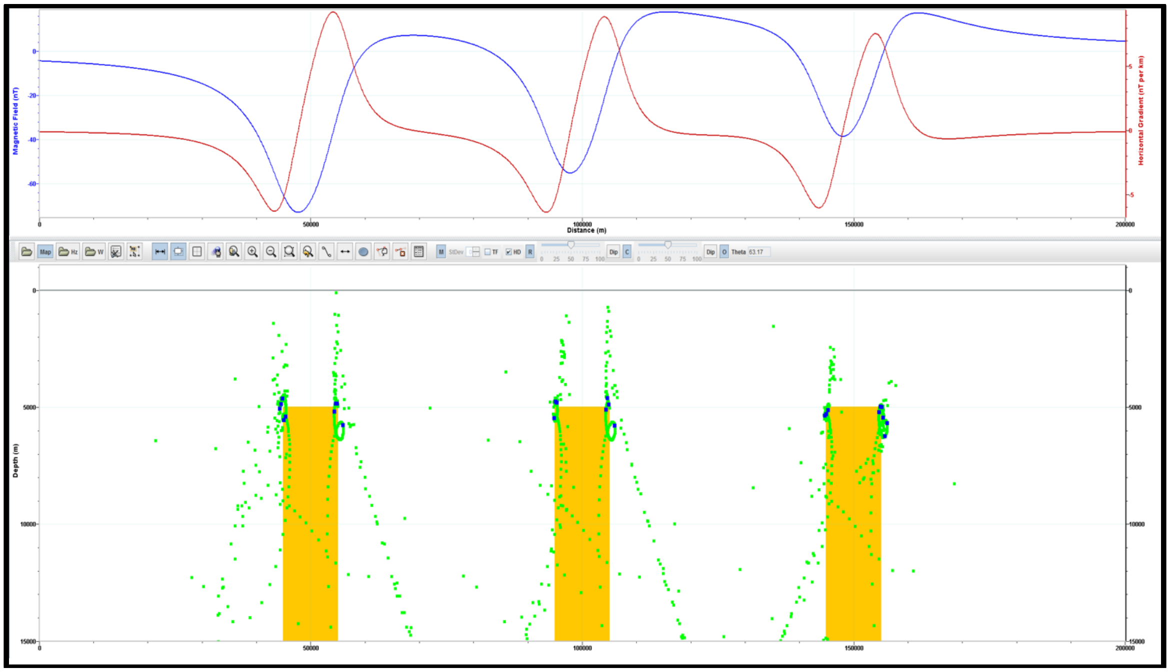
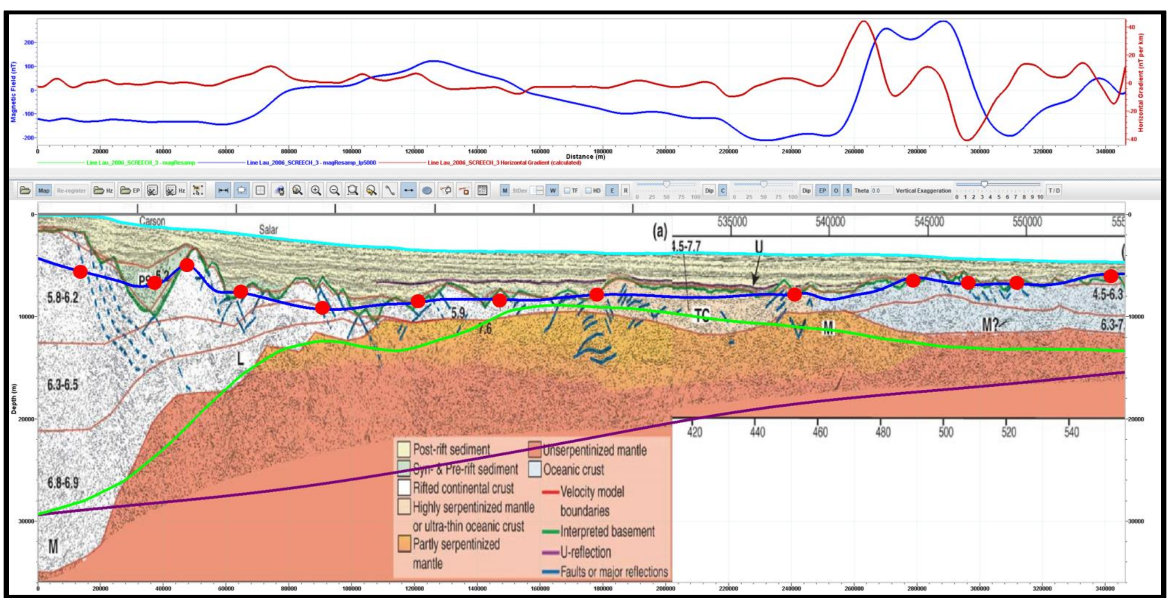
In addition to a multitude of so-called “manual depth methods” such as Åm, Bean, Demi-Pentes, tilt-depth, Nabighian, Piatnitsky and others, MagDepth™ also incorporates both Werner and Euler (2-D and 3-D) into the depth toolkit.



The depth panel allows import of both time and depth cross sections, allowing rapid overlay of seismic interpretations and published cross sections. Below we see an example from Eastern Canada (Lau, 2006), with Bain Geo’s depth to magnetic basement solutions shown as red circles, resulting in the blue magnetic basement depth horizon, along with depth to Moho from BainGeo’s 3-D gravity inversion software toolkit GravDepth™ (green line), indicating an extremely thin crust in this region. The combination of these tools with BainGeo’s CurieDepth™ completes the loop (deep, dark purple horizon), using gravity and magnetics data to interpret important information about the earth’s crust.



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REFERENCES

Åm, K., 1972. The arbitrarily magnetized dyke: Interpretation by characteristics: Geoexploration, 10, 63-90.

Bean, R.J., 1966. A rapid graphical solution for the aeromagnetic anomaly of the two-dimensional tabular body: Geophysics, 31, 963-970.

Flanagan, G., Bain, J., 2013, Improvements in magnetic depth estimation: application of depth and width extent nomographs to standard depth estimation techniques: First Break, 31

Nabighian, M.N., 1972. The analytic signal of two-dimensional magnetic bodies with polygonal cross-section, its properties and use for automated anomaly interpretation: Geophysics, 37, 507-512.

Peters, L.J., 1949. The direct approach to magnetic interpretation and its practical application: Geophysics, 14, 290-320.

Pyatnitsky, V.K., 1961. On the maximum slope method: Proceedings of the Institute of Geology and Geophysics, Siberian Branch, USSR Academy of Sciences, 11, 109-120.

Salem, A., Williams, S., Fairhead, J.D., Ravat,D., and Smith, R., 2007. Tilt-depth method: A simple depth estimation method using first-order magnetic derivatives: The Leading Edge, 26, 1502-1505.

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