The Radial Basis Function Algorithm

The Radial Basis Function interpolation constructs a weighting matrix based on the distances between control points and uses Gaussian elimination with partial pivoting to solve for interpolation weights. This RBF method produces very smooth surfaces without the "bull's eyes" that are a common problem with inverse-distance weighted models.

How It Works

1. **Influence of Points**:
    - Think of each known point as having a "bubble" of influence around it. The closer you are to the point, the stronger its influence on the value at that location. The further away you move, the weaker this influence becomes.
    - The shape of these "bubbles" is determined by a mathematical function called the Radial Basis Function (RBF). Different RBFs can create different shapes for these bubbles—some might spread influence widely, while others might keep it more localized.
2. **Combining Influences**:
    - For every location where you want to estimate a value, the algorithm looks at all the nearby points and combines their influences. Points that are closer to the location contribute more to the final value than those farther away.
    - This combination process ensures that the resulting surface is smooth and continuous, with no sudden jumps or gaps.
3. **Creating a Smooth Surface**:
    - As the algorithm moves across the map, it repeats this process at each location, gradually building up a complete surface. The surface passes through all the known points exactly, and smoothly transitions between them based on the combined influence of surrounding points.
4. **Balancing Smoothness and Accuracy**:
    - The algorithm also includes a "smoothness" factor, which controls how tightly or loosely the surface fits the known points. A tighter fit might capture all the details, but could also create sharp peaks or valleys, while a looser fit results in a smoother, more general surface.
5. **Final Adjustments**:
    - Once the surface is created, the algorithm adjusts the estimated values to ensure they stay within the range of the original data points, making the surface not only smooth but also realistic.

Algorithm Summary: The code implements a 2D **radial basis function (RBF)** interpolation using the **multiquadric method**, where the influence of control points is determined by a distance-based function. The multiquadric function is used to calculate the interpolation weights, and it is defined as f(r)=r2ln(r+ϵ)f(r) = r^2 \ln(r + \epsilon)f(r)=r2ln(r+ϵ), where r is the distance between points and ϵ\epsilonϵ is a small constant to prevent singularities. The algorithm creates a matrix of these multiquadric distances between all control points, and Gaussian elimination is used to solve for the weights that influence the surface. These weights are then applied to interpolate surface values at grid nodes by summing the contributions of nearby points, ensuring smooth surface transitions. The method is particularly effective for generating smooth surfaces from scattered data, as it balances between local and global interpolation influences.

The RBF algorithm produces smooth interpretations when compared to anisotropic inverse-distance weighting (AIDW). This can be considered to be both a blessing and a curse. For example, when modeling geochemical I-Data (Figure 1) for ore estimations or groundwater contamination, the smoothing provided by RBF is typically preferable to AIDW. Conversely, when plotting geophysical P-data (Figure 2), the lenticular “splaying” associated with AIDW may be preferable to the smoothing provided by RBF. This is particularly well-illustrated by the cross-sections depicted within Figure 3.

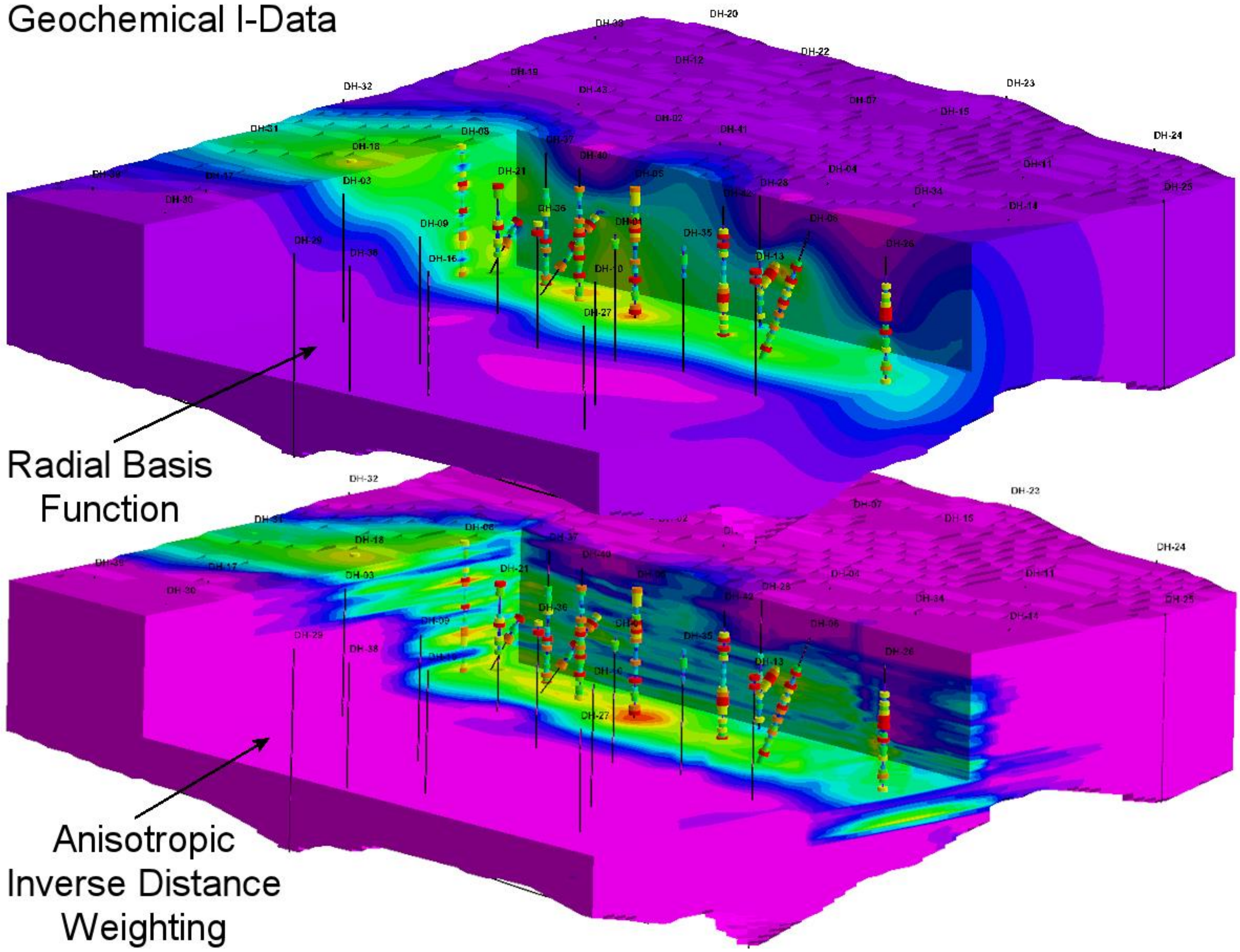

Figure 1

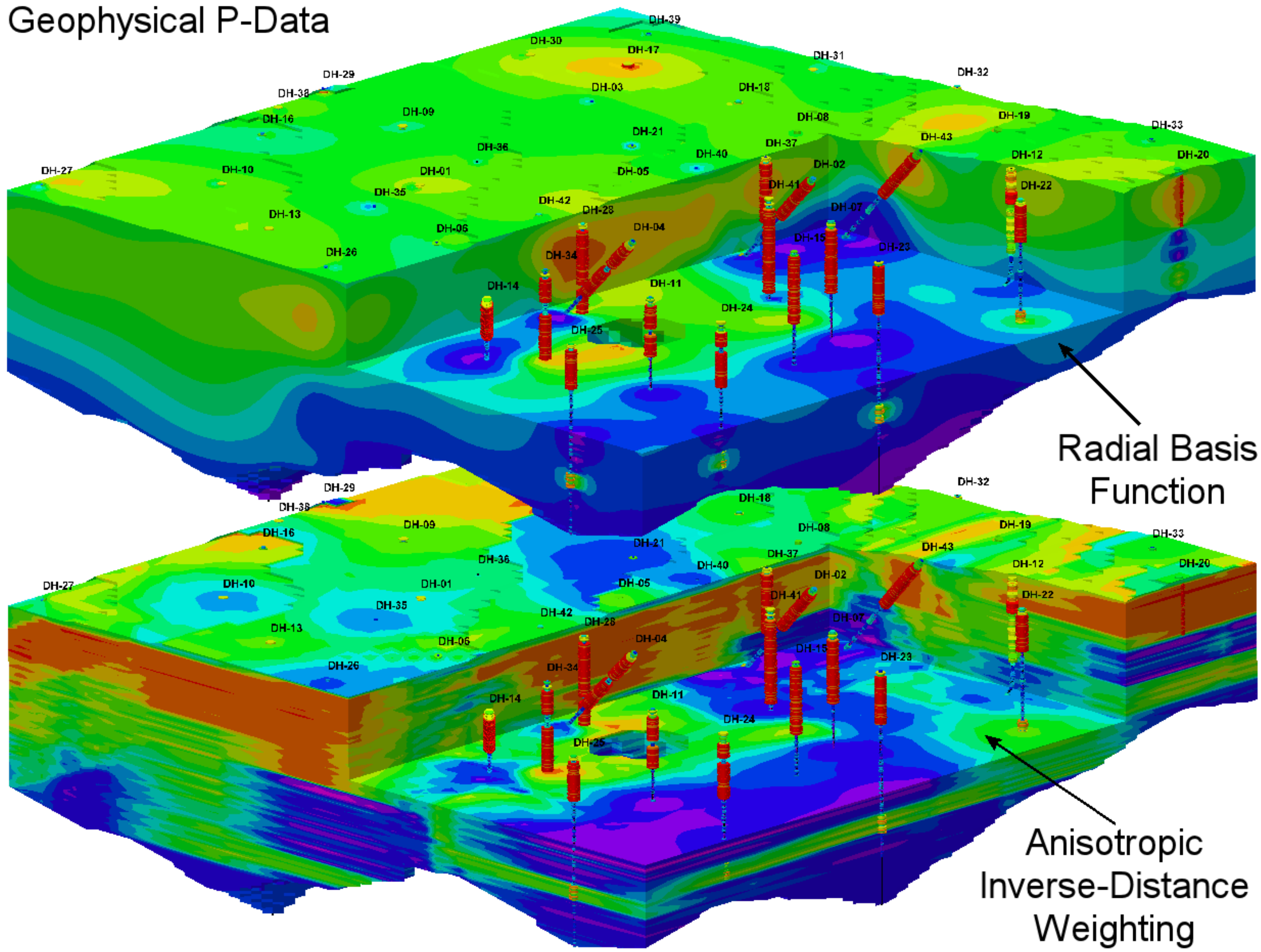

Figure 2

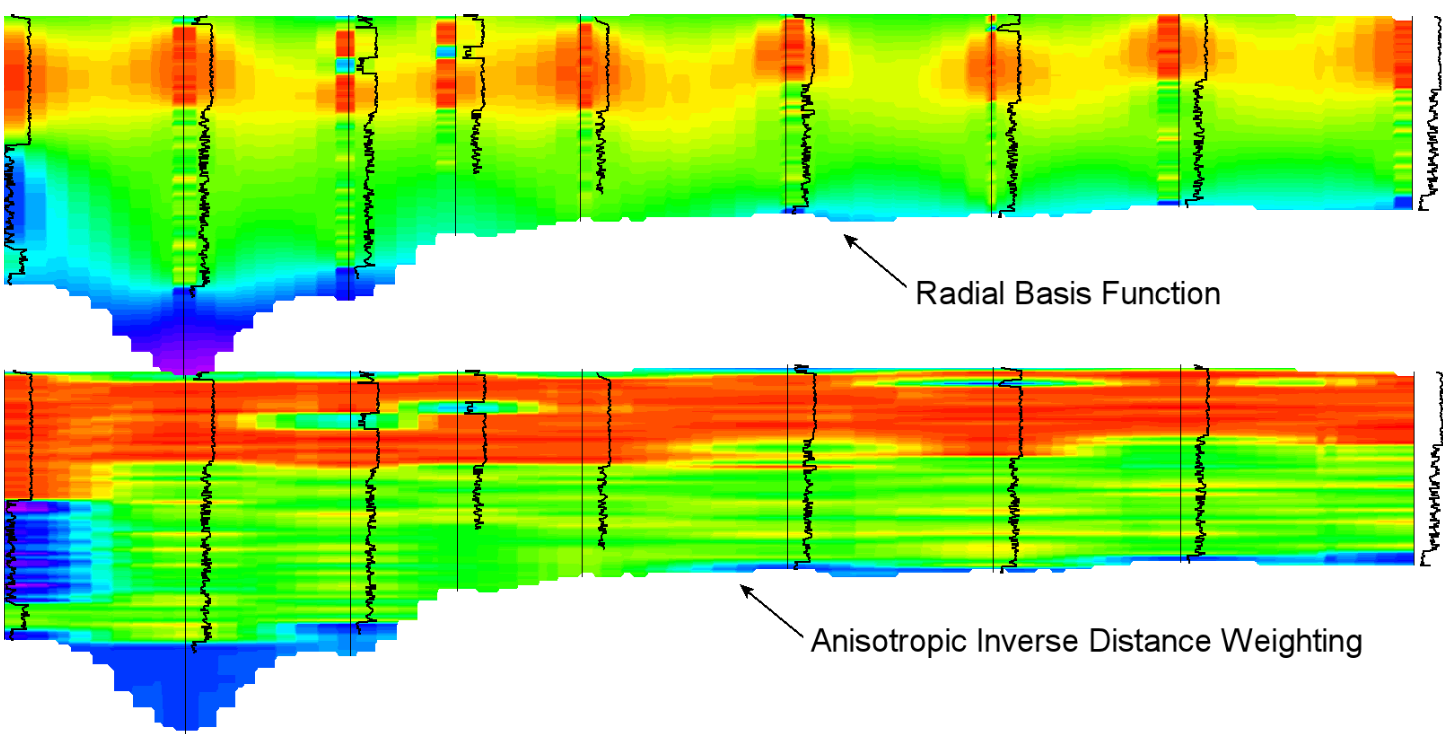

Figure 3