Petrel 2D Grid Algorithms and the Data Types they are Commonly Used With

Specific algorithms in Petrel's *Make/Edit Surfaces* process are more appropriate for specific types of data than are other algorithms. If you are new to Petrel or if you have only worked with one or two types of data and you must work with another data type, you may not know where to start. It is handy to know what algorithms others might use for the data type you are to build a grid for. The tables below list the Petrel algorithms useful for particular types of data or surface form and ranks the most commonly used ones. One table summarizes the algorithms used when data are available and the other when data are not available.

Table: Commonly used **algorithms when data are available**, grouped by data type and colored by first choice **(green),** second choice **(orange),** and third choice **(yellow).**

Structure	Faults and Contacts	Petrophysical	Thickness	Channels
Convergent	Convergent	Convergent	Convergent	Convergent
Min. Curvature	Min. Curvature	Min. Curvature	Min. Curvature	Min. Curvature
Kriging (either method)	Kriging (either Method)	Kriging (either method)	Kriging (either method)	Kriging (either method)
Cos. Expansion	Cos. Expansion	Cos. Expansion	Cos. Expansion	Cos. Expansion
	Functional	Functional		Functional
		Isochore	Isochore	Isochore
		Moving Average		
		Sequential Gaussian		

Table: Commonly used **algorithms when data are NOT available**, grouped by data type and colored by first choice (**green**), second choice (**orange**), and third choice (**yellow**).

Petrophysical	Contacts	Channels
Sequential Gaussian Simulation	Artificial (Plane, Areas, or Constant)	Artificial (draw polygons & use Channels)
Artificial (Fractal or Constant)		

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Petrel 2D Grid Algorithms Reviewed with a Comparison to Z-MAP Plus

The algorithms in Petrel's *Make/Edit Surfaces* process provide solutions for most mapping problems. Like Z-MAP Plus, there are many algorithms, some are useful only for specific surface geometries, some are general purpose and useful for a majority of surface forms, some are backup and fit that one special data set, and others are included for "historic" purposes but seldom, if ever, used. The table below lists the algorithms in Petrel and Z-MAP Plus, describes some of their features, and pairs them together based on functionality.

Table: Petrel / Z-MAP Plus algorithm parings with discussions.

Petrel	Z-MAP Plus	General Description
Convergent (no apparent maximum number of pts)	**LeastSquares with Biharmonic** filter (LS/BH)	General purpose algorithms used to build most structural surfaces. Typical surface forms they are applied to are roughly horizontal with or without large perturbations. Both tools use a series of refinements (Petrel done in the algorithm and Z-MAP Plus done in the filter) to locally tune the surface to the neighboring data and reduce wild extrapolations.
Isochore (no apparent maximum number of pts)	**Isopach**	Preprocessing algorithms that replaces zero data with negative values, resulting in a surface with zero contours somewhere between positive and zero data values. The standard gridding algorithm (Convergent in Petrel and LS/BH in Z-MAP Plus) is used with the modified data to build the thickness grid.
	Bounded Range	Preprocessing algorithm similar to Isopach that handles both upper and lower limit (e.g., N:G of 1.0 and 0.0) data, replacing the limits with values that exceed them. Uses the LS/BH algorithm as the basis for grid construction.
Minimum Curvature (No apparent maximum number of pts)		Calculates node values near data and then uses minimum curvature method for extrapolating the trends smoothly between and away from the data. The available parameters have little impact on the resulting surface except when Minimum curvature is switched to Full tension in which case extreme spikes occur at the data locations.

Minimum Curvature using dip and azimuth (no apparent maximum number of pts)	**Projected Slopes with Biharmonic filter using dip and azimuth**	Smooth surface fitting algorithms that use strike and dip at data locations to force the extrapolations away from the data to follow the dip trends. Petrel's algorithm is very local (extends dip trend a few grid nodes from data) while the Z-MAP Plus algorithm extends the dip nearly half way to the closest data or out to the grid edge. Using a larger grid increment in Petrel will increase dip projection distance.
Moving Average (max of 10,000 pts)	**Moving Average with Laplacian filter**	This algorithm was first used with computers in the 1950s and 60s due to its simplicity and speed. It creates poor geologic form, since it peaks up or down at data locations and goes to the local data average between points. Some of Petrel's point weighting parameter settings create more rounded form at data locations, similar to using a BH filter in Z-MAP Plus. Petrel's directional stretch capabilities for this algorithm may breath some new life into it.
Kriging (max of 2000 pts)	**Kriging**	Classic kriging algorithm written by in-house programmers. The algorithm uses a variogram (oriented ellipse of influence) to define the directional bias for linear interpolation of node values from neighboring points. Nodes more than the variogram distance from data are assigned the data average.
Kriging by Gslib (excessive time for large number of pts)		Kriging algorithm from the Geostatistical Library developed at Stanford. Basically the same as the previous Kriging algorithm but with subtle internal switches set and with the addition of collocated co-kriging (use of a secondary variable in the form of a grid and its correlation coefficient with the data being gridded to force the second variable's grid form into the output grid).
Kriging Interpolation		Uses the same method as Kriging by Gslib, but works internally. Differences are: 1) Works in XYZ rather than IJK. 2) only considers data within the variogram range. 3) much faster because external algorithms aren't used.
Cos expansion (max of 1000 pts)		A simple algorithm that attempts, through a series of equations, to reduce the dip and rate of change in dip of a surface to a minimum. In essence, it creates a very smooth roughly horizontal surface that passes through the input data. Algorithm speed slows with increased data and it is unstable when points are very close together. Its form, although similar to Minimum

		Curvature, tends to go to horizontal more quickly. The use of the directional bias tool in this algorithm has only limited impact on the resulting surface.
Functional (max of 10000 pts)	**Projected Slopes with Biharmonic filter**	Algorithms that fit a planar up to a paraboloidal form to data near each grid node, project and smoothly connect these forms away from the data areas, and tie the resulting surface to the data. The resulting surface projects trends away from data into non data areas. Petrel's algorithm will produce a general surface trend that is then tied to the data. The Z-MAP Plus algorithm will project the trend from the data locations outward which allows the trend on one side of the data to vary dramatically from that on the other side (depending upon the number of refinements used of course).
Sequential Gaussian Simulation (no apparent maximum number of pts)		A stochastic (having some randomness) algorithm based on kriging which randomly places highs and lows between data in a manner that honors the variogram (similar in size and orientation to the variogram). Superimposed on these highs and lows are smaller noise features. The size of the noise is dictated by the variogram type (exponential, spherical, and Gaussian). The Gaussian default appears incorrect but is fixed in part by using a normal distribution with estimated Mean and Std. The noisy results of this algorithm may be more similar to reality than the smooth surfaces from other algorithms but are not what most "managers" are used to seeing in the oil industry.
Gaussian random function simulation		Faster than SGS (Sequential Gaussian Simulation). It is not a sequential algorithm and this has allowed the algorithm to be parallelized. Uses the decomposition: Conditional Simulation = Kriging + Unconditional Simulation This allows the use of the new parallel Kriging algorithm as a base.
Assign to closest point (excessive time for large number of pts)	**Closest Point**	Assign to each grid node the value of the closest data point. An extremely simple algorithm that should take a fraction of a second to execute but requires seconds or minutes in Petrel when a large number of data points (several thousand) are input.
Artificial		Special algorithms for building:

algorithms		- Flat planes - Fractal surfaces - Tilted planes - Polygon defined constant value areas - Polygon defined stream channels
Surface resampling		Algorithm that will resample a grid to a new increment or origin or output the same increment and origin. Its primary goal is to allow the well adjustment (well tie) or post processing tools (smoothing or clipping) to be applied to the input grid and have a new grid created.
	Distance	Assigns to each grid node the distance from that node to the closest data point. This is an extremely useful algorithm in Z-MAP Plus and is not available in Petrel, nor is there any work-around to create the same type of grid.
	Point Density	Given a radius (search distance) the algorithm assigns to each grid node a value representing the number of points within that radius around the node divided by the area of a circle having that radius. This tool is useful for assigning a value similar to confidence to the information contained in a grid.
Neural net		You must have already made an appropriate estimation model using the *Train Estimation Model* process. The calculation of this estimation will automatically create a property fitting the supplied data.