

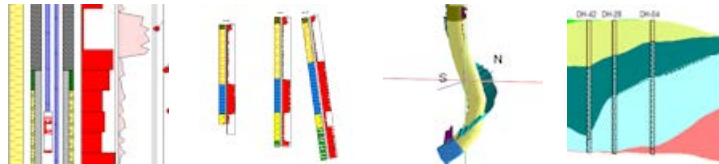
RockWorks17 Advanced Level Feature List

Data Input: Two main data windows:

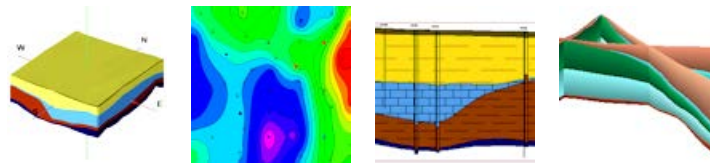
The **Borehole Manager** stores multiple blocks of data for each borehole in a SQLite database (SDB) file. (SQL Server also supported.) Different blocks of data include locations, downhole survey for non-vertical wells, lithology, stratigraphy, downhole point (P-Data) / interval (I-Data) / time (T-Data) based quantitative measurements (geochemical, geophysical), downhole raster images, text data (comments), water levels, fractures, vectors, color intervals (e.g. Munsell), well construction, special log symbols & patterns. Define "types" for lithology, stratigraphy, aquifer, and well construction materials. Define map coordinate system and units, and depth/elevation units. Reproject coordinates. Create custom borehole fields and organize on specific tabs. Reference depths to surface or collar. Transfer locations, stratigraphy to the RockWorks Utilities datasheet. Edit data tables as a spreadsheet. Simple & complex queries, database backup & integrity checking. Embedded look-up tables (colors, faults, polygons, etc.) Memo (long) descriptions. "QuickMap" for easy viewing of borehole locations. See also *Import* and *Export*, below.

The **RockWorks Utilities** datasheet reads and saves row and column data as tab-delimited text files. Easy cut and paste from other applications. Display graphic symbols, patterns, colors, and line styles right in the data sheet. Define coordinate system and units for spatial data. Store metadata with file. Tablet-friendly display windows. Insert/delete rows, column arithmetic operations, statistics computations, data filters, sorting. Transfer borehole locations or stratigraphy tops to the Borehole Manager. Data sheet capacity: 1,048,000 rows x 199 columns. See also *Import* and *Export*.

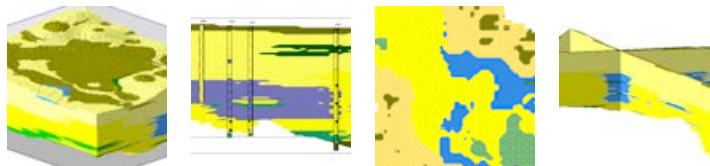
Logs and Log Diagrams: Display observed data for individual wells as a **2D** or **3D** log, or for multiple wells in 2D hole to hole **cross sections**, projected "**profile**" sections, multi-panel **projected cross sections**, **3D log diagrams**, **log maps**, and **plan projections** of log orientations. Include **simple correlations** of stratigraphy, I-Data and P-Data in section panels. Compute **downhole XYZ** points for non-vertical wells & display diagrams. **Inclined & deviated wells** displayed with true geometry. Interactive **log designers** allow you to specify column order, size, and to activate any of the columns: title, depth labels, lithology patterns or colors & text, stratigraphy patterns/colors & text, 1-4 interval-data bargraphs & text, 1-4 point-data curves, 1-4 time-interval-data bargraphs, downhole i-text & p-text, raster images, well construction & text, water levels & text, vector tadpoles (2D) or arrows (3D), fracture tadpoles or 3D discs, log symbols, generic pattern blocks, color intervals. Append logs to any of the interpolated diagrams described below.



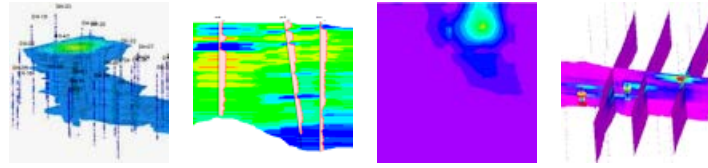
Stratigraphic Models and Diagrams: Create a customized **stratigraphy library** for each project to link formation names to patterns and colors and define sequence. **Pick stratigraphic tops** interactively from curve, lithology, raster logs. Enter **dip direction and inclination** for any contacts for "dip gridding." Illustrate borehole formations in single 2D and 3D **logs**. Use a variety of **gridding tools** to interpolate surfaces for all/specified formations, choose from stratigraphy rules to define behavior for **missing units**. Stratigraphic surfaces can be displayed as **structure maps**, **isopach maps**, **3D stratigraphy diagrams**, **3D fence diagrams**, **2D projected cross-sections**, **hole to hole sections**, and multi-panel **projected cross sections**. Create **geology maps** where stratigraphy intersects a surface or lies at a particular elevation. Compute formation **volumes**. **Manually** build stratigraphic models and fences from individual grid models. See also *Gridding Tools*, below.



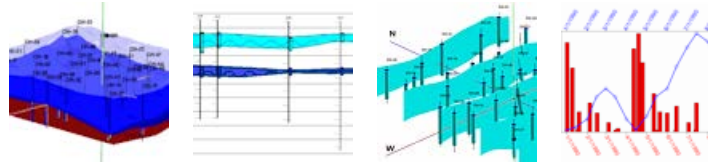
Lithology Models and Diagrams: Create customized **lithology library** for each project to link rock types to patterns and colors. **Pick lithology intervals** interactively from curves, raster logs. Illustrate borehole lithology in single 2D and 3D **logs**, **2D projected cross sections** and **hole to hole sections**, with user-declared lithology patterns and colors. Interpolate a 3D **solid model** of lithology materials for display as 3D **block diagrams**, **3D fence diagrams**, **2D profile slices**, **2D cross sections**, and multi-panel **projected cross sections**. Create **geology maps** where lithology intersects a surface or lies at a particular elevation. Create grids and maps for upper and lower **elevations** of materials, and total **thicknesses**. Compute lithology **volumes**. See also *Solid Modeling*, below.



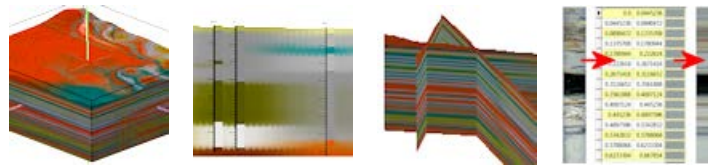
Models and Diagrams for Interval-Sampled, Time-Interval-Sampled, Point-Sampled Quantitative Data: Illustrate as bargraphs or curves on **2D logs**, or as bars, tubes, spheres or oblates in **3D logs**. Create **solid models** and display as 2D **profile slices**, **cross sections**, **projected cross sections**, **plan slices**; and as 3D **fence panels**, **isosurfaces**, and **voxel displays**. Compute **volumes** with a variety of filtering options. Create data **statistics** computations, **frequency histograms**, and **maps**. Create **time-graphs** and **time-graph maps** for T-Data. See also *Solid Modeling*, below.



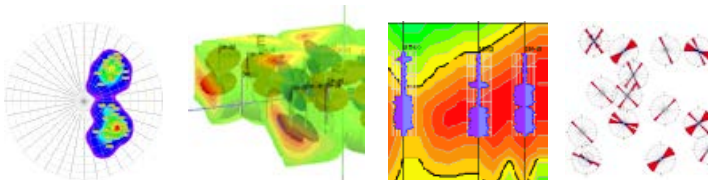
Aquifer Models and Diagrams: Interpolate **water level surfaces** for specified aquifers and dates; create 2D and 3D plan-view **surfaces**; 2D **profiles**, **cross sections**, projected cross sections, **plan slices**; 3D **fences** and **surface displays**. Display water level on 2D and 3D **logs**. Create **hydrograph diagrams** and **hydrograph maps**.



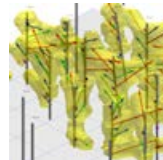
Color Models and Diagrams: Display color blocks in **2D** and **3D logs**. Interpolate a **solid model** for colors, display as 2D **profile slices**, **cross sections**, **projected cross sections**, **plan slices**, and as 3D **fence panels** and **voxel displays**. Determine colors from raster logs, **descriptions** or **Munsell** codes.



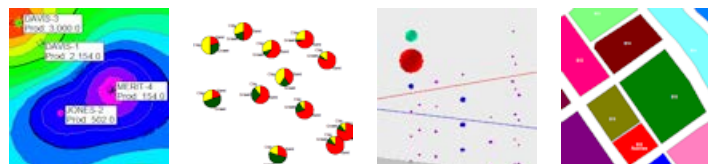
Fracture Models and Diagrams: Display as discs on **3D logs**. Create **solid models** representing fracture proximities and display as 2D **profile slices**, **cross sections**, **projected cross sections**, **plan slices**; and as 3D **fence panels**, **isosurfaces**, and **voxel displays**. Create **rose diagrams** and **rose maps**, **stereonet diagrams** and **stereonet maps**.



Vector Diagrams: Interpolate **cavern models** from downhole laser surveys.



Mapping Tools: Map types: 2D and 3D point maps, triangulation-based contour maps, and grid-based line contour, color-filled contour, labeled cell, strike and dip, uphill and downhill gradient, 2D and 3D flow maps, 3D surfaces. Point maps with **customized symbols**, **multiple labels**, and optional **proportional scaling**. **Polyline** and **polygon** maps. Import commercial **land grid (PLSS)** data or use the RockWare LandBase to create **section maps** and **lease maps**. Read **survey data** and translate to XY and create map. **Multi-variate maps** display pie-charts, starbursts, barcharts, spiders at X,Y locations. **Annotation** with border tick marks and coordinate and axis labels. Automated profile, cross-section, fence diagram maps showing **section traces**. See also *Google Earth Maps*, below.



Gridding Tools: Grid stratigraphic or water level data in the Borehole Manager. Grid any X,Y,Z data in the RockWorks Utilities. **Gridding algorithms:** inverse distance, with optional radial searching/sector searching/directional weighting, triangulation, closest point, kriging (with variogram displays), trend surface analysis, trend surface residuals, distance to point, cumulative & sample density (count occurrences), dip gridding for contacts with dip direction and angle. **2D & 3D Faulting** available. Grid utilities: grid **statistics, residuals,** and multi-variate **anomalies,** display as **histogram or scatterplot;** grid-grid or grid-constant **arithmetic** operations; grid **filtering** (real number or grid limits, minimum area, normalize, standardize, polygon, rounding, and smoothing); grid **logic** operations; interactive **grid editor, grid export** (see *Export*, below), **grid import** (see *Import*, below). Compute **slope** and **aspect** and display as upgradient, downgradient, strike and dip, 2D & 3D flowlines; compute drainage areas. Build **profiles & fences** from grid models. Manually build **stacked surfaces,** stratigraphic **fences** and **block models** from a grid list. **Morph** grids into a slide-show/animation.

Solid Modeling: Reads **XYZG data** from RockWorks downhole database, data sheet or external XYZG files. **Modeling methods:** Inverse-distance with directional weighting, isotropic or anisotropic; distance to point; closest point; lateral extrusion. **Modeling tools:** Warp or tilt model based on a surface or inclined plane, filter based on stratigraphic surfaces, smooth by category or gradationally. **3D Faulting** available. Display solid models as **voxels** or **isosurfaces,** with rotation, exaggeration, lighting, zoom. **Morph** multiple solid models for animated display. **Filter** display on G value, display volume computation; insert slices. Other solid model options: **statistical** computations, **arithmetic** operations, model **editing,** extraction and insertion of 2-D horizontal or vertical **slices** as grid files. Other tools: **rounding, filtering** based on data range, grid surfaces, polygon overlays, distance from control points. **Boolean** models created and filtered based on thickness of ore zones and stripping ratios; density conversions convert volumes to mass. **Import** XYZG ASCII solid model files. **Export** solid model files (see *Export*, below).

Volumetrics: Compute volumes of X, Y and Thickness values using simple **triangulation technique.** Or use **grid-based volumetrics** with thickness, stripping ratio, distance-to-point, polygon clipping, and up to 5 other data column filters; the grid-based volume or mass results can be output in a report and visualized in a 2 or 3D map. **Advanced 3D volumetrics** create solid models of "ore" versus "not-ore" and offer the 2D filters in 3-dimensions, with report and block diagram output of volumes or mass. Create a simple pit **extraction model** based on solid model characteristics. Create **grade thickness** maps from 3D grade models.

Statistics: 1 variable: **Basic statistical** computations, relative frequency **histograms** (with optional color-coding & annotation based on standard deviations), **normalize** or **standardize** a column of values. 2 variables: XY (**scattergram**) plots with optional point-to-point, smoothing, and linear regression annotations. 3 variables: **Ternary plots** with optional point density contours as lines and solid colors. **Random number** generators. Create **sieve grain size distribution** diagrams.

2D Feature Analysis: **Rose diagrams** (full or half) created from azimuth bearing or line endpoint data from the Utilities data sheet. Data interpreted as uni- or bi-directional; may be rotated and filtered (by length and/or direction). Variable petal width, optional statistical legend and mean ray and error, and easy modification of title, reference rays and circles. **Lineation gridding** tools offer 2D and 3D maps of lineation frequencies, lengths, intersections, or a combination, reported as real number, normalized, or standardized values. **Lineation maps** and **arrow maps** illustrate lineations on a 2D map. Compute **azimuth, line length,** and **lineation midpoint** for line endpoint data. Movement analysis computes direction, distance, inclination, and velocity data from X, Y, Z, and time data. **Import DXF** Line and Polyline entities into the data sheet.

3D Feature Analysis: **Stereonet diagrams** created from strike and dip (or dip-direction, dip-angle) data; plot linear, planar, or rake features. Planar data plotted as great circles or pole (normal). Unique symbols for each sample or groups of samples. Mean directional vectors, statistics, symbol index, and legend. Optional line and/or color-filled **contours** to illustrate point density; density grid computed using step function or spherical Gaussian technique. Other options: **Rotation** of planar data, computation of **planar intersection lineations,** conversion of **rake** information to lineations. Equal area (**Schmidt**) or equal angle (**Wulff**) projections.

Hydrology, Hydrochemistry: Compute simple **drawdown** for a single well using Theis equation, display as report and/or diagram. Compute drawdown for multiple pumping or injection wells listed in data sheet (also using Theis equation), display as 2D or 3D surface map. Display imported **flowpath** data as 3D flowlines. **Piper, Stiff,** and **Durov** diagrams and **Stiff diagram maps** for common cation/anion distribution, **ion balance & TDS** computations.

Fault tools: Display dip data (XYZ points, dip direction, dip angle) as 3D "ribbons", create **fault files** for solid and surface modeling, create Boolean **fault model.**

Survey tools: Convert **bearing/distance** measurements to XYZ points, 2D & 3D map. **Triangulation** survey data translated to XYZ. Display **downhole well survey** (depth, bearing, inclination) in plan-view, 3D or cross section. Compute **optimal well paths** given XYZ control points. Generate 2D and 3D **geosteering diagrams.**

Image tools: **Import raster images** into 2D maps or 3D space (draped or floating). **Rectify** images. **Digitize** points from imported images, and **convert** image types. Display images as **vertical panels** in 3D, interpolate **color models** from images. Display image sequences in a **slide show** and create **movies.** See *Logs and Log Diagrams*, above, for downhole imagery.

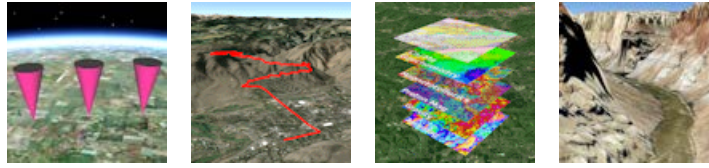
Misc. graphics tools: 3D: horizontal & vertical **tanks; oriented objects** (fossils, fractures, archaeological tools); **surface** objects, 3D **spheres** and **tubes, fault surfaces** from polylines, **perimeters.** 2D: Append, import, export 2D images.

Coordinate Conversions: Translate XY coordinates listed in datasheet and borehole database between **longitude/latitude, State Plane, UTM.** Geo-reference **local** coordinates with a source lon/lat. Translate **PLSS descriptions** to XY coordinates. Convert **azimuth bearings** to/from **quadrant. Rescale, rotate,** and **shift** XY coordinates.

Geological Tools: **Three-point** contouring, **periodic table** of the elements, **geologic time scale, structural and trigonometric** computations, **geometry** computations, measurement **unit conversions** (length, area, mass, etc.), **financial** utilities.



Google Earth Tools: Export **RockPlot2D** and **RockPlot3D** graphics to KMZ. Read geographic data from the datasheet and create Google Earth output: **Point Maps** – icons, circles, cones, cylinders, strike and dips; **Line Maps** – lines, polylines, tubes, pipelines, parabolas; **Polygon Maps** – polygons, claims, leases, PLSS land grids, states and countries; **Images** – drape, float, vertical, legends; **Flyovers** – circular and forward-looking, simple and detailed; **Cell Maps** with a variety of interpolation options; **Survey Maps** – points and polygons.



RockPlot2D: **Edit graphic entities** with click-and-drag including contour lines, colors, text, legends. **Append** other images. **Undock** embedded plot window. Draw **points, lines, polylines, polygons, text**. Snap and "smart snap" tools. Insert **legends, grid lines, scale bars**. Measure **area, distance, perimeter, bearing**. **Rescale** coordinates, **clip** images, group **layers**. **Zoom** on screen, **stretch** on screen, **print** to any scale on any paper. Define/reproject **coordinate** system and units. Define default **font** and customize individual text items. See also *Import* and *Export*.

RockPlot3D: **Append** other images, turn **layers** on/off, adjust vertical **stretch, lighting, transparency**. **Undock** embedded plot window. **Rotate, zoom**, view from any **angle**, capture rotation as **animations** –AVI or individual frames. **Filter** surface and solid/isosurface values on the fly, update **volume** computations. Insert **slices, cutouts**, adjust **color** schemes and drawing styles. Add **legends, viewpoints**. Define/reproject **coordinate** system and units. **Digitize** points, **measure** distance and bearing.

ReportWorks: **Page layout program** for placement of .Rw2D images, bitmaps (BMP, JPG, TIFF, PNG, GeoTIFF, etc.), scale bars, legends, text, lines, symbols, polygons.

Import: **Borehole Manager:** RockWorks15-16, LogPlot DAT, ODBC (database, such as aqQuire), AGS, Text, Excel, gINT, GDSII, IHS (297 well data), KGS, LAS, Newmont Assay, Tobin WCS, Penetrometer, Colog, Fugro CPT. **Utilities Datasheet:** ODBC (database), Text, CSV, DBF, DXF, Excel, Garmin text, Geonics, Delorme GPL, GPX, GEM Systems mag data, LAS, Laser Atlanta surveys, Modpath particle flowpaths, NEIC Earthquakes, SEG-P1 shotpoints, Shapefiles, Tobin WCS. Import commercial **land grid** data. **Grid import** from Surfer, ESRI ASCII grid, Geosoft GXF, RockWorks DOS v.7, ASCII, ZMAP formats, and from bitmaps. **Solid** model import from ASCII, MicroModel. **RockPlot2D:** Import DLG, DXF, E00, XML, Shapefiles, raster formats. **RockPlot3D:** Import DXF.

Export: **Borehole Manager:** Text, Excel, LogPlot DAT; ASCII XYZG, Shapefiles. **Utilities Datasheet:** Text, Dbase, Excel. **Grid files** exported to ASCII XYZ or matrix, DXF matrix, Ohio Automation ENZ, RockWare RTM, RockWorks DOS (v.7), Surfer, VistaPro. **Solid model files** to ASCII, NOeSYS, Slicer Dicer formats. **RockPlot2D:** Google Earth, Raster & metafiles (BMP, JPG, PNG, TIFF, WMF, EMF, etc.), DXF, Shapefiles, MapInfo MIF/MID, RockPlot3D. **RockPlot3D:** Export Google Earth, BMP, JPG, TIFF, PNG, AVI, ESRI 3D Shapefile

Other System Features: **RCL** (RockWare Command Language) for automated processing and display. **Symbol, pattern, and text editors, graphics** file rescaling and combining, **printer/plotter** output with full scaling. **Unicode** support for non-Latin alphabets. **64-bit** software with **multi-threading**. **Customize display** of menus and database tabs. Embedded/searchable **Help** messages, on-line **tutorials**, searchable **knowledge base** on RockWare's User Forum, online **discussion forum**. Server-based **network license manager** with check-out features. **User-specific** menu settings for shared projects.

Minimum System Requirements: Computer running Windows 7, Windows 8, Windows 10, 64-bit operating system, 4 GB of RAM, 75 MB of free disk space for program installation, display set to greater than 800 x 600 pixels, read/write privileges to a %Userprofile%My Documents directory. Supports most Windows-supported peripherals. Single and network licenses available. For the RockWare Network License Manager (network licenses only) we recommend Windows Server 2008 and newer.

