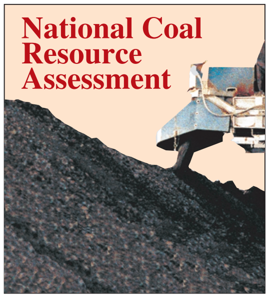

Click here to return to Disc 1 Volume Table of Contents

Chapter C

Methodology for Calculating Coal Resources for the Colorado Plateau, U.S. Geological Survey National Coal Assessment

By Laura N.R. Roberts,[1] Michael E. Brownfield,[1]
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Chapter C *of*
Geologic Assessment of Coal in the Colorado Plateau:
Arizona, Colorado, New Mexico, and Utah
Edited by M.A. Kirschbaum, L.N.R. Roberts, *and* L.R.H. Biewick

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Contents

Figures

Methodology for Calculating Coal Resources for the Colorado Plateau, U.S. Geological Survey National Coal Assessment

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Introduction

The coal assessment of the Colorado Plateau used four main criteria for prioritizing assessment units within the region: (1) areas containing significant mineral ownership that are administered by the Federal Government, (2) areas that have active coal mining, (3) areas where coal-bed methane is currently being produced or coal is the source rock for gas production, and (4) areas that have a high resource or development potential.

The result of this endeavor is a detailed assessment of more than 20 coal zones in five formations in the Colorado Plateau region (fig. 1). This report describes the steps we used in an automated process to calculate coal resources and to produce the numerous accompanying maps for each assessment unit.

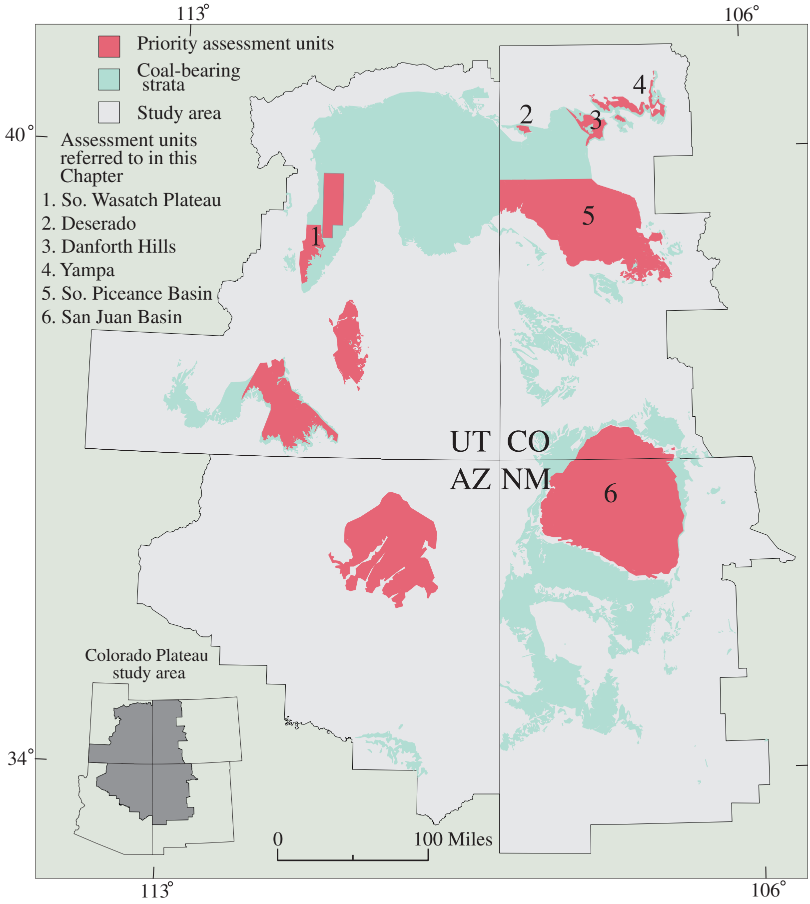


Figure 1. Priority coal assessment units in the Colorado Plateau.

We established an accurate, reliable, and time-efficient method of combining an ASCII-formatted file containing location (*x*, *y*) and coal-thickness data with multiple layers of digital geologic and geographic data to ultimately arrive at high-quality end-products that show the distribution of coal resources (fig. 2).

Methods were also developed to define areal limits of coal zones using a structural datum and a digital elevation model. As many as six commercially available software packages were used in conjunction with three custom programs to process the digital data. These programs range from simple conversion programs to highly sophisticated geographic information systems (GIS), two-dimensional geologic modeling programs, and spreadsheet software.

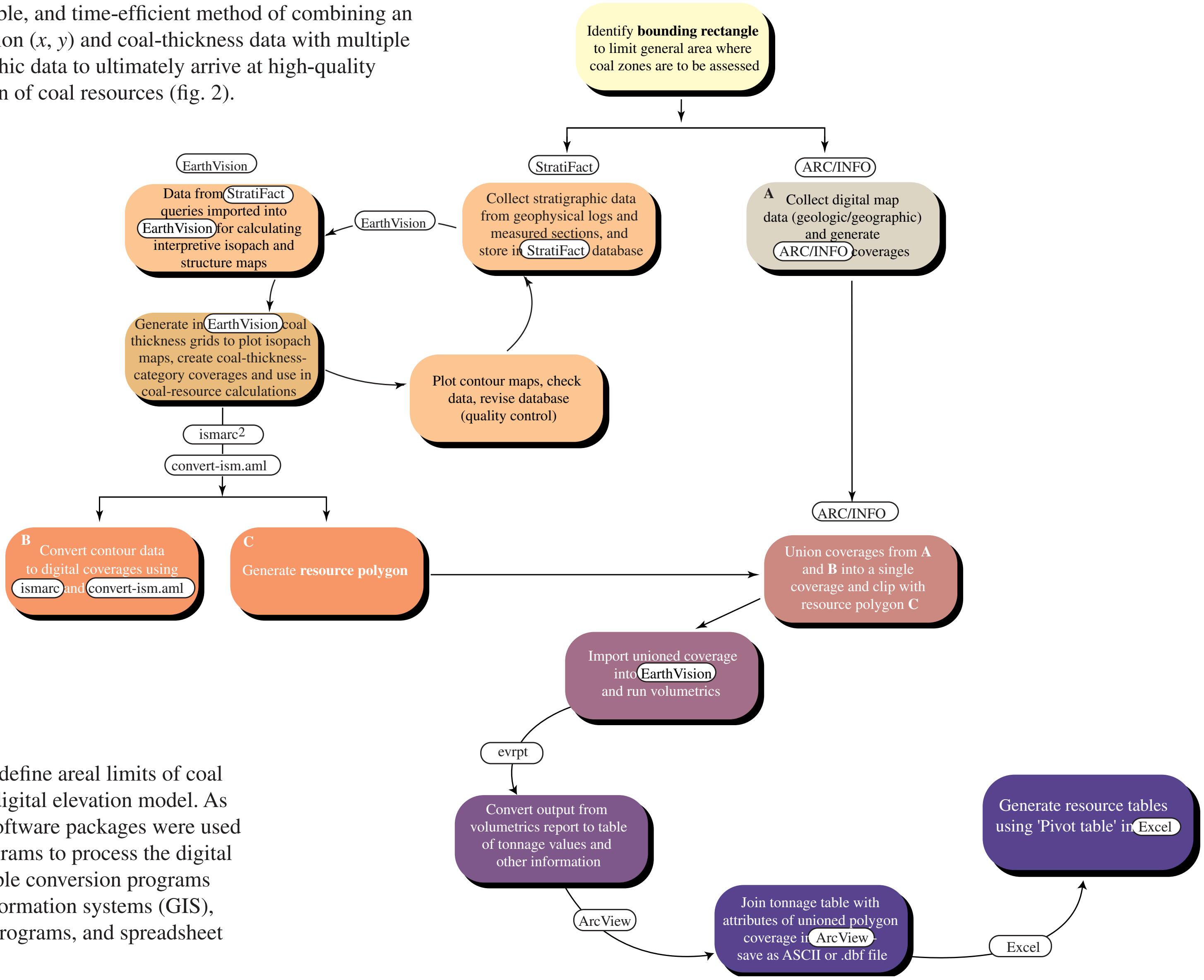


Figure 2. Flow chart for production of maps and coal resource tables.

Computer technology has it benefits and its shortcomings when it comes to representation of geologic data. In order to use a geographic information system, we create digital files that contain data that represent a mapped geologic unit or a well location (in projected map units) and record the *x*, *y* accuracy of that line or point to as many as 4 decimal places. We know that the *x*, *y* string representing that line is not accurate to that level. The data are only useful and reliable at the scale at which they were captured. Even then, care must be taken when using these digital data.

The benefits present themselves when we are asked to provide the best, most up-to-date estimate for coal tonnage for a particular coal zone in a particular area and, for example, for a particular overburden and coal-thickness category. We cannot provide a timely answer unless we have a database to query that contains all these parameters.

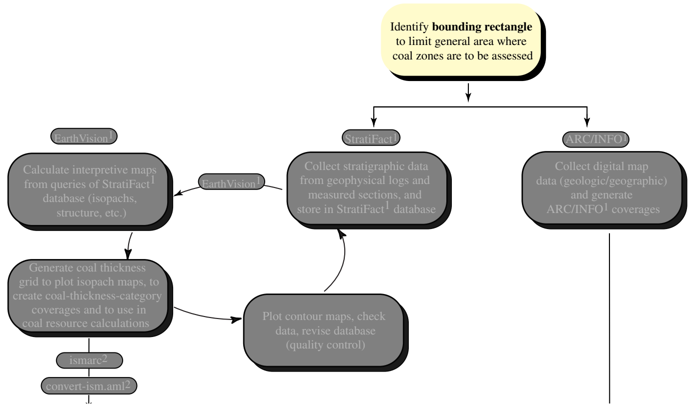
Tools and Input

A study of such scope as the coal assessment of the Colorado Plateau required a plan that could be followed step-by-step, data for input, and tools to manipulate and process the data.

Initial Step

After the study areas or assessment units of the Colorado Plateau were prioritized, based on the four main criteria, the next step was to identify a rectangular box slightly larger than each of the areas to be assessed (fig. 3). The size and location of the rectangle was based on our preliminary knowledge of the coal geology in each area.

The initial purpose for identifying the bounding rectangle was that it limited our search for stratigraphic data to include in the database.



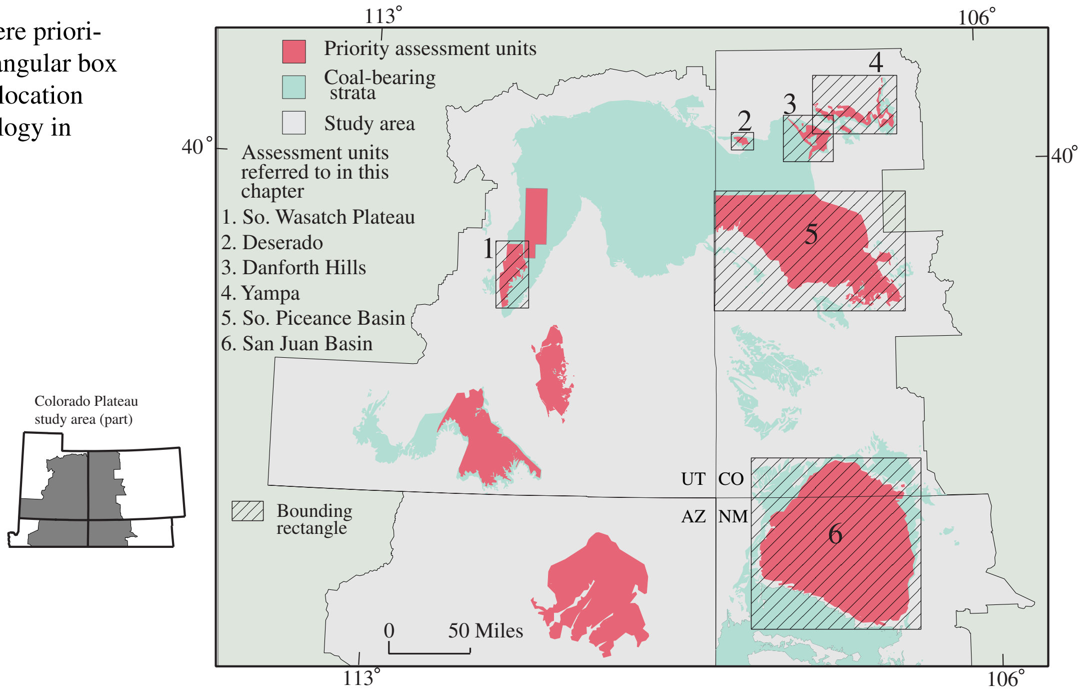


Figure 3. Priority coal assessment units of the Colorado Plateau and their associated bounding rectangles. The top part of the flow chart shown in figure 2 is also shown. In discussing this and following flow charts, the relevant part(s) of the flow chart will be shown clearly as on figure 2, but nearby boxes that are not relevant to the discussion will be grayed-out.

Geographic and Cultural Maps

The maximum and minimum *x* and *y* values of this "bounding rectangle" were used to clip data collected from sources at national, State, and regional scales. These data include such coverages as roads, counties, public land survey systems (township and range), hydrology, quadrangles, surface and mineral ownership (fig. 4), and geology. For the most part, these data were retrieved from internet sites.

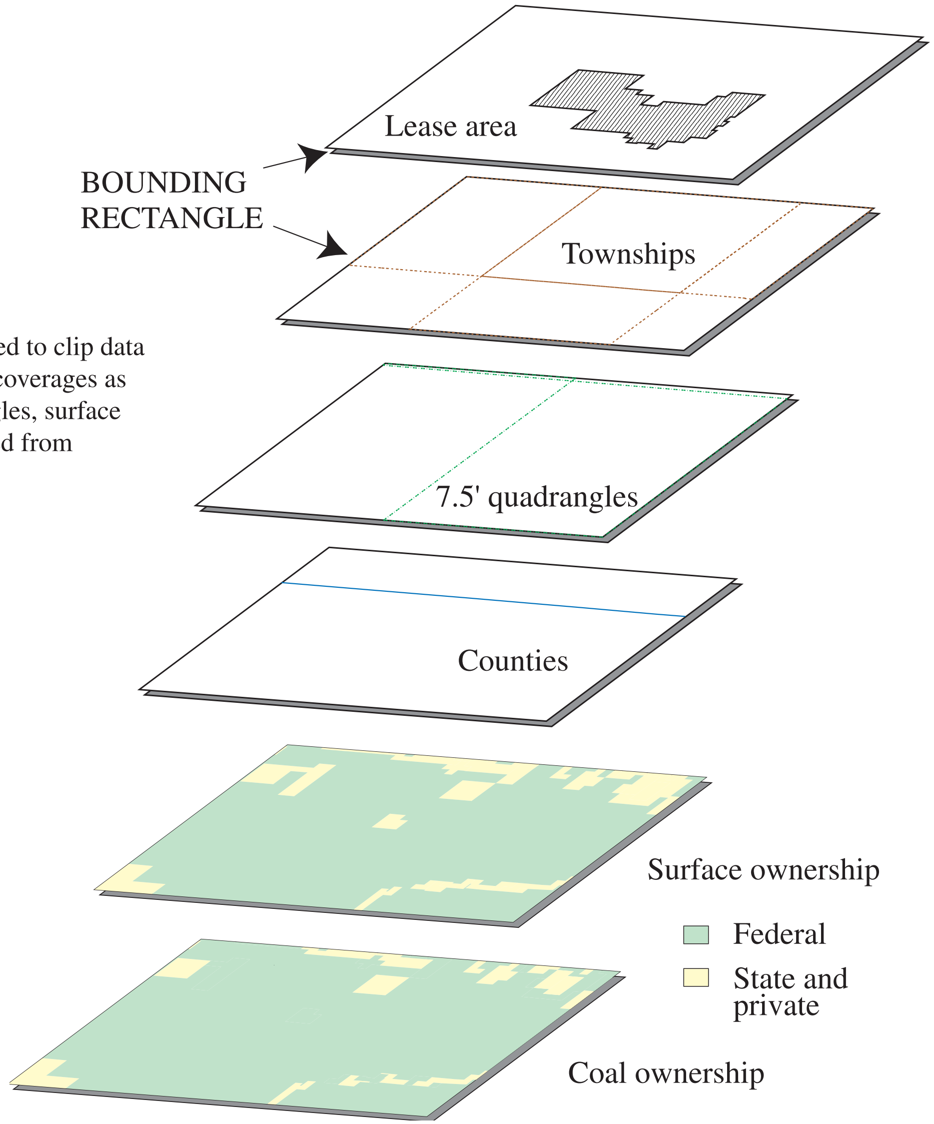


Figure 4. Geographic and cultural data within the bounding rectangle. Example from Deserado coal assessment unit, northwestern Colorado.

Ultimately, the bounding rectangle was used to limit gridding and contouring of data that resulted in interpretive maps. These data include net-coal thickness, coal-zone thickness, overburden thickness for isopach maps (fig. 5), and elevations on the top of a structural datum for structure contour maps.

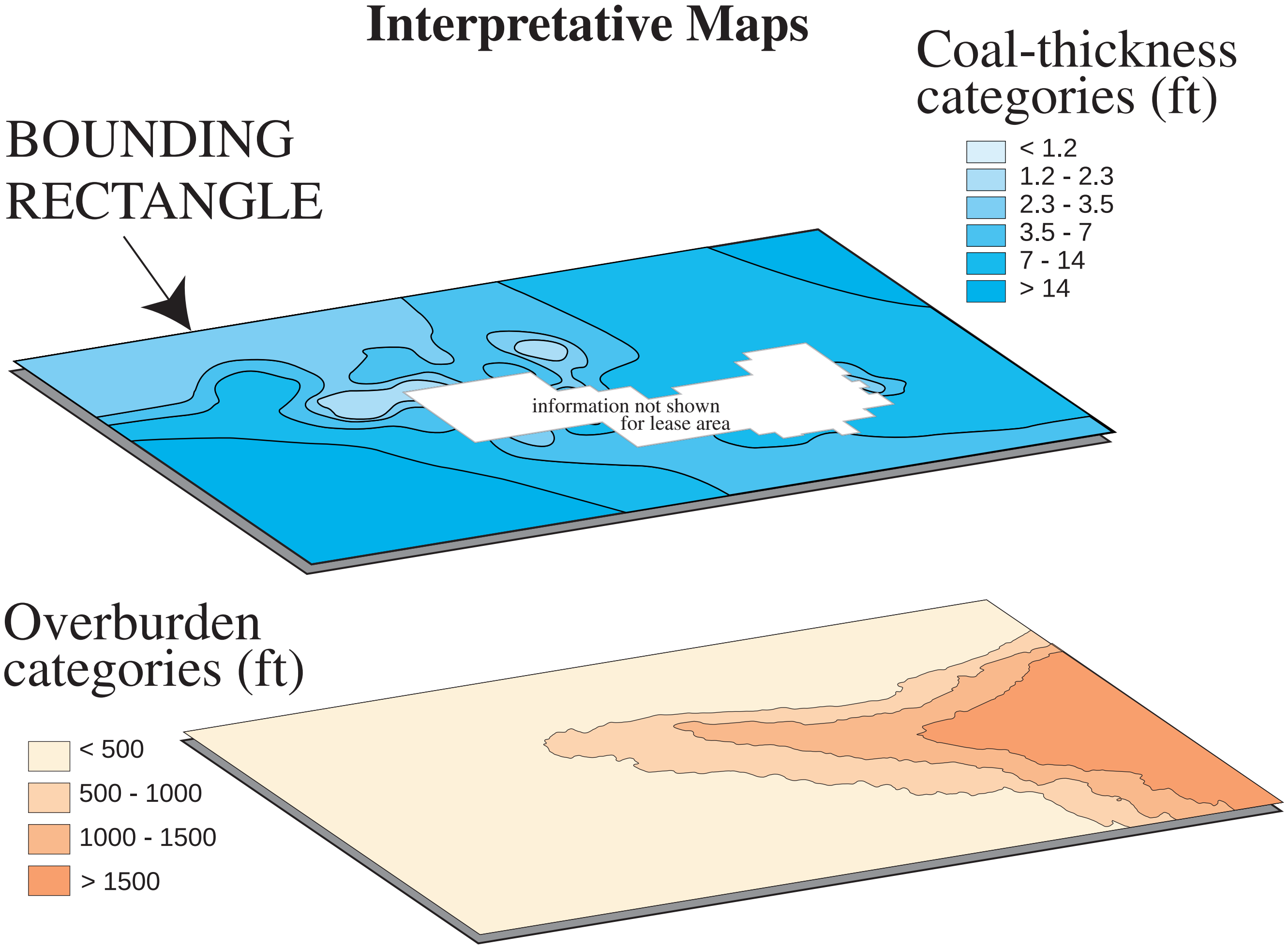


Figure 5. Gridded and contoured data within the bounding rectangle. Examples from Deserado coal assessment unit, Lower White River coal field, northwestern Colorado.

Data

The main sources of stratigraphic data are geophysical logs of holes drilled for coal (fig. 6), oil, and gas exploration and descriptions of stratigraphic sections measured in the field.

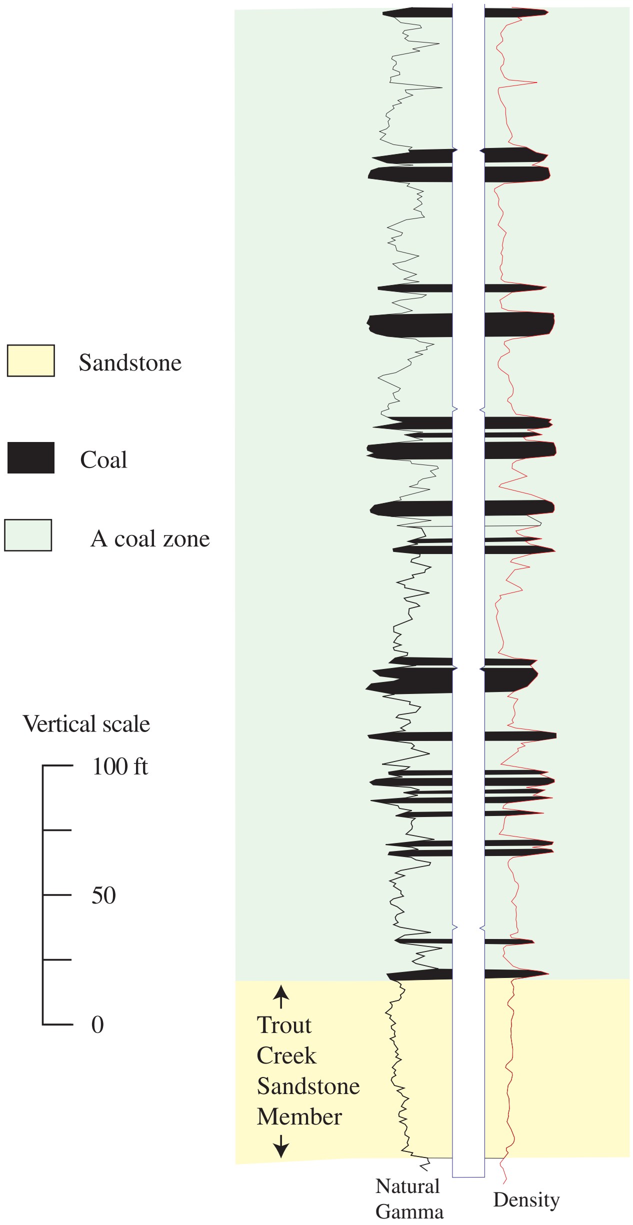


Figure 6. Example of interpreted geophysical log, Yampa coal field, northwestern Colorado. Modified from Johnson and others (chap. P, this CD-ROM).

Geologic information consisted mainly of published geologic maps that were either available digitally or were digitized in-house from published maps (fig. 7).

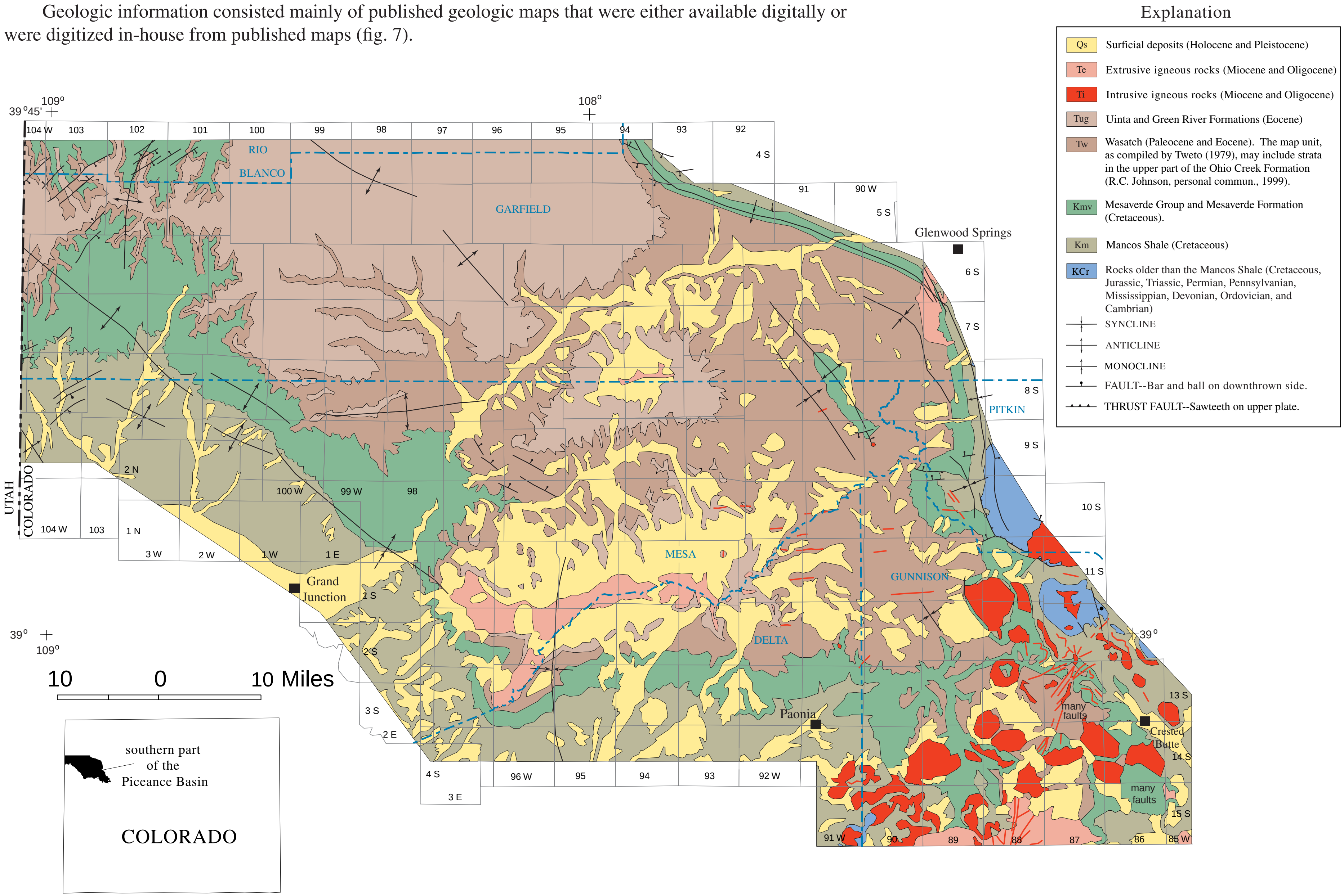


Figure 7. Geologic map of southern part of the Piceance Basin, northwestern Colorado. Modified from the digital geologic map of Colorado (Green, 1992). Illustration from Hettinger and others (chap. O, this CD-ROM).

Digital elevation models (DEM's) were used to represent topography of the Earth's surface (fig. 8). These models are available at different scales from the USGS Global Land Information System (see website at http://edc.usgs.gov/webglis). We used these data to generate polygons for the resource areas, overburden isopach maps, and polygons that define overburden categories for the assessed coal zones.

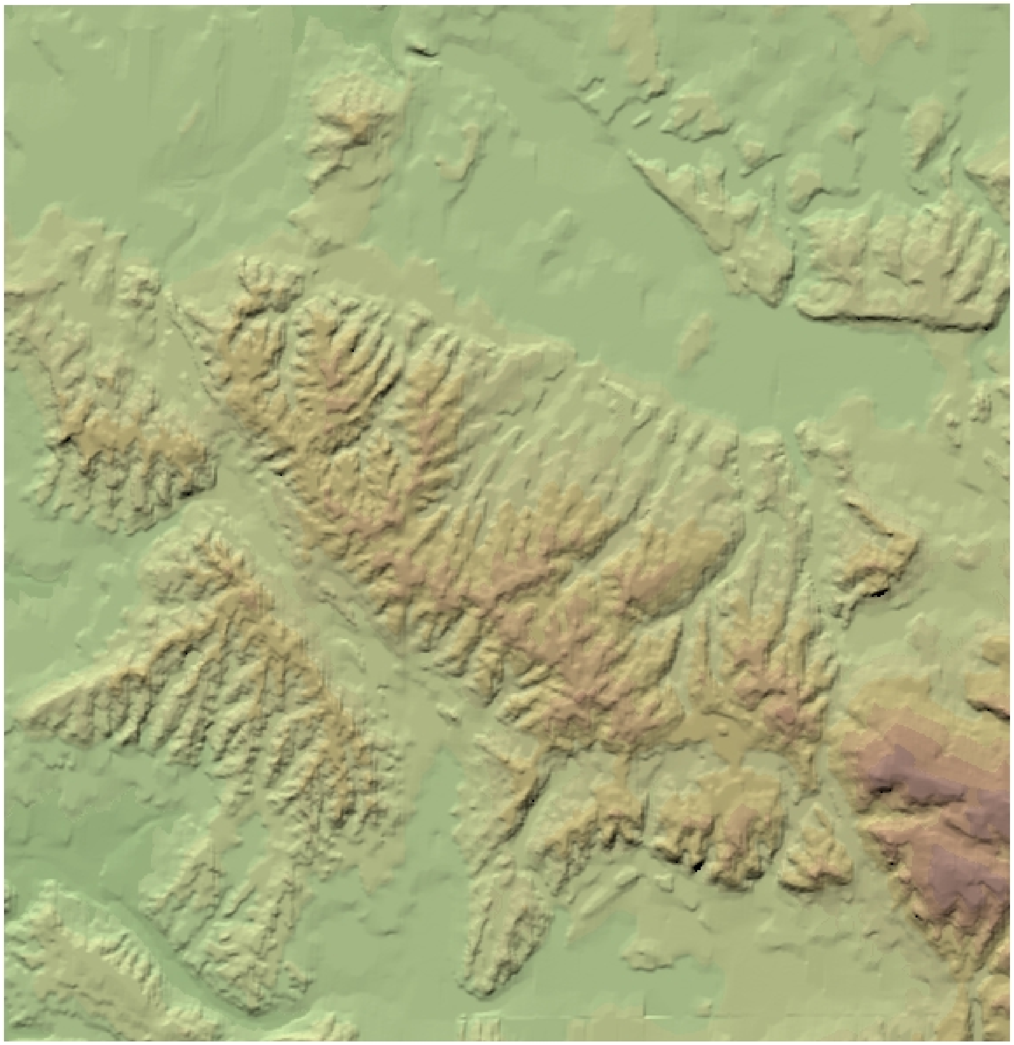


Figure 8. Example of shaded-relief topography generated from a digital elevation model (DEM), Danforth Hills coal field, northwestern Colorado.

Software

Stratigraphic data were entered into a relational database software package specifically designed for these kinds of data (StratiFact, Gallegos Research Group, Inc.). The querying and filtering capabilities of StratiFact allow for the output of ASCII-format files that contain information that can be imported into a two-dimensional modeling software package. These files contain data for location (*x* and *y* fields) and such data as net-coal thickness, elevation to top and (or) base of key horizons, and thickness of coal-bearing intervals.

We also used the vector-based GIS ARC/INFO (ESRI, 1998a) for storing polygon coverages.

EarthVision (Dynamic Graphics, Inc., 1997) was used to generate interpretive maps by gridding and contouring data extracted from StratiFact queries (fig. 2) and for calculating coal resource estimates. The capabilities within EarthVision to perform mathematical functions on grids and to plot and save virtually any contour line as an ASCII string of coordinates from a grid were used extensively.

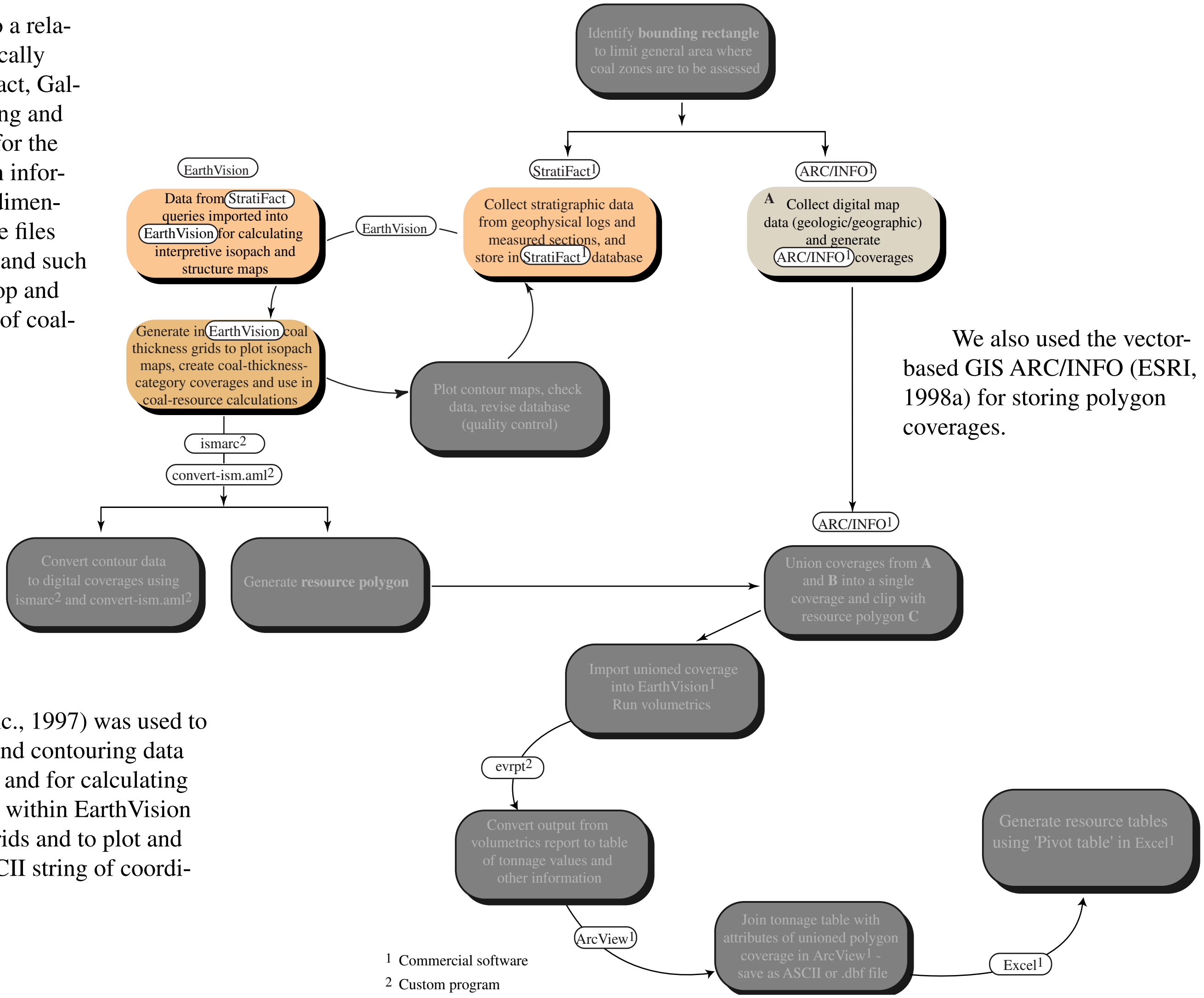


Figure 9. Software packages used in the Colorado Plateau coal assessment and their position within the flow chart shown in figure 2.

We used three custom programs to convert contour lines generated from grids in EarthVision to ARC/INFO polygon coverages. Details of the conversion process are documented in previous reports (Roberts and Biewick, 1999; Roberts and others, 1998). ArcView (ESRI, 1998b) was used for desktop mapping, data verification, and final data-table generation, and Microsoft Excel (Microsoft Corporation, 1997) was used to store coal tonnage figures and to create resource tables.

Coal-Thickness Data

Coal-tonnage estimates were calculated by multiplying coal thickness by area by the average weight of bituminous-rank coal (short tons per acre-foot; Wood and others, 1983). Data related to coal thickness and area must be as accurate as possible (fig. 10). A discussion of how the thickness data were derived, what they represent, and how they were used in the final reporting of coal resources follows.

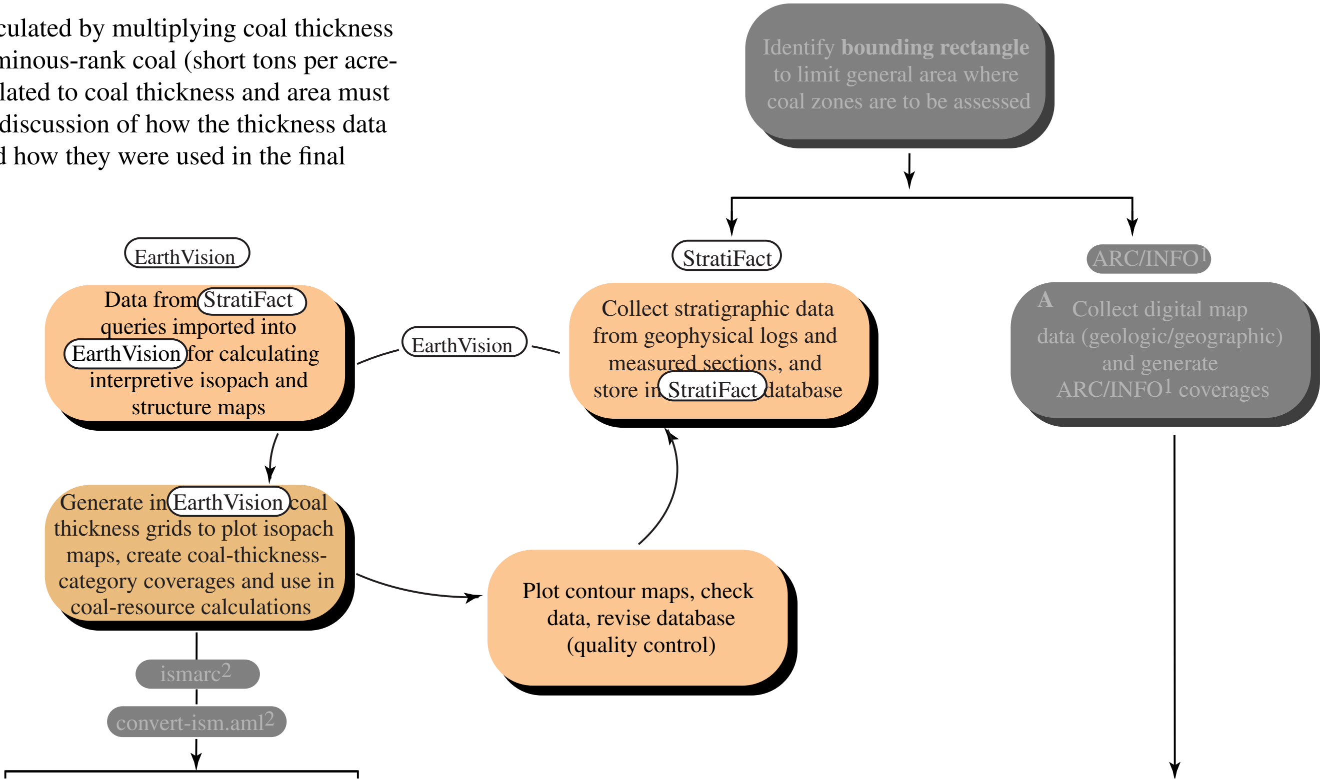


Figure 10. Part of flow chart (fig. 2) showing where coal-thickness data were processed and verified.

We used 1.0 or 1.2 ft as a minimum thickness for resource consideration based on a modification of the coal-bed-thickness criteria for bituminous coal (Wood and others, 1983). An ASCII-formatted file was created from a query of the StratiFact database containing the *x*, *y* values for location at each data point and a value for the net thickness of coal for the coal zone. The data were imported into EarthVision as a scattered data file. The data were gridded using the *x*, *y* limits of the bounding rectangle.

The coal isopach grid has several functions. First, the grid was contoured with a regular contour interval for displaying a coal isopach map (fig. 11). Plotting an isopach map often reveals problems with the data or errors in interpretation and is therefore valuable for quality control. Several iterations of the gridding and contouring process were sometimes required.

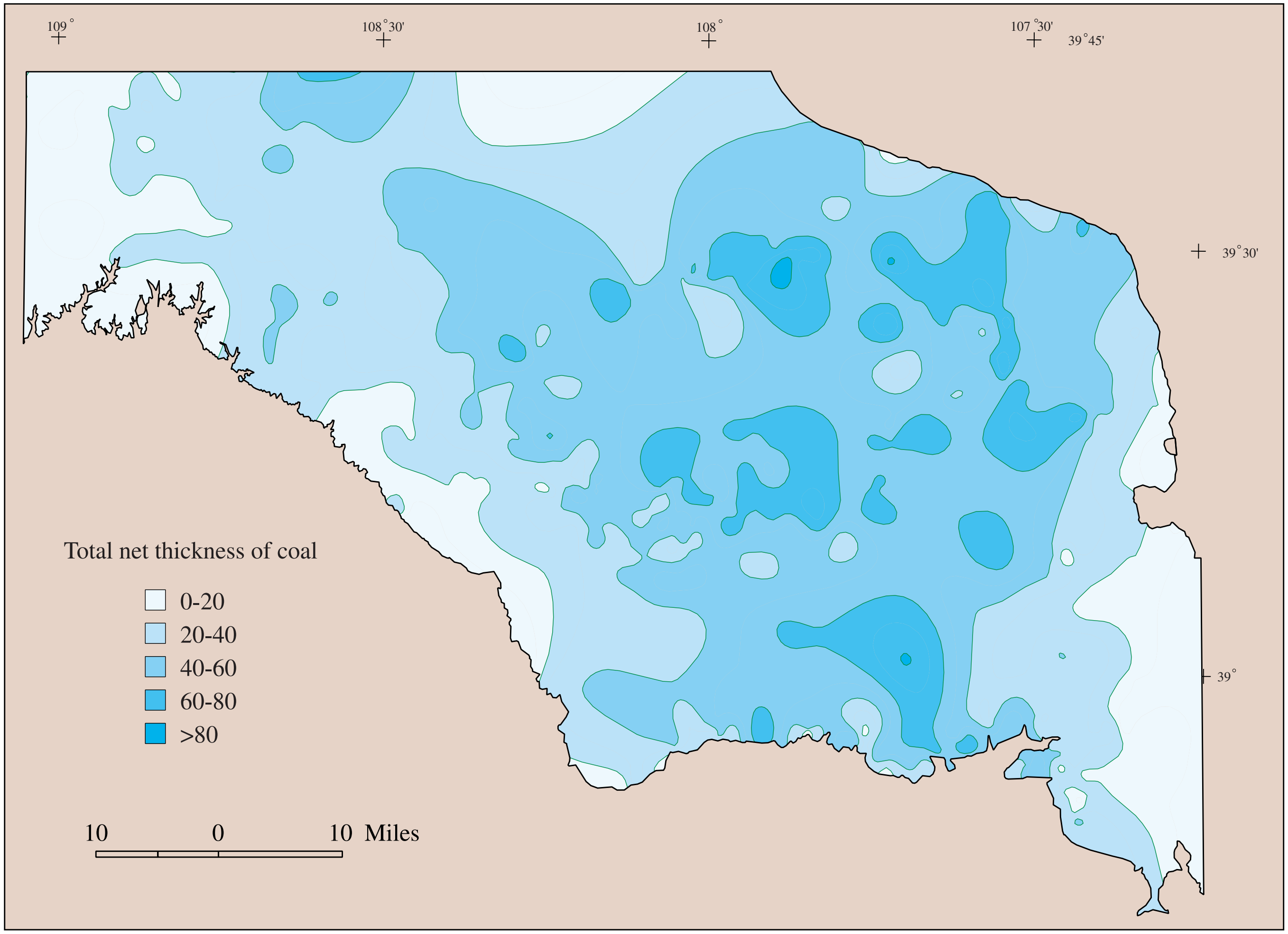


Figure 11. Example isopach map of net total coal using a regular contour interval, Cameo/Wheeler coal zone, southern Piceance Basin, Colorado.

Second, the final coal-thickness grid was contoured with an irregular contour interval (fig. 12)—that is, only those contours that represent the boundaries of net-coal-thickness categories for bituminous coal, which are the 1.2-ft, 2.3-ft, 3.5-ft, 7.0-ft and 14-ft contour lines (Wood and others, 1983). The lines eventually became polygon boundaries for the ARC/INFO coverage of coal-thickness categories, which is one of the parameters for reporting coal resource estimates.

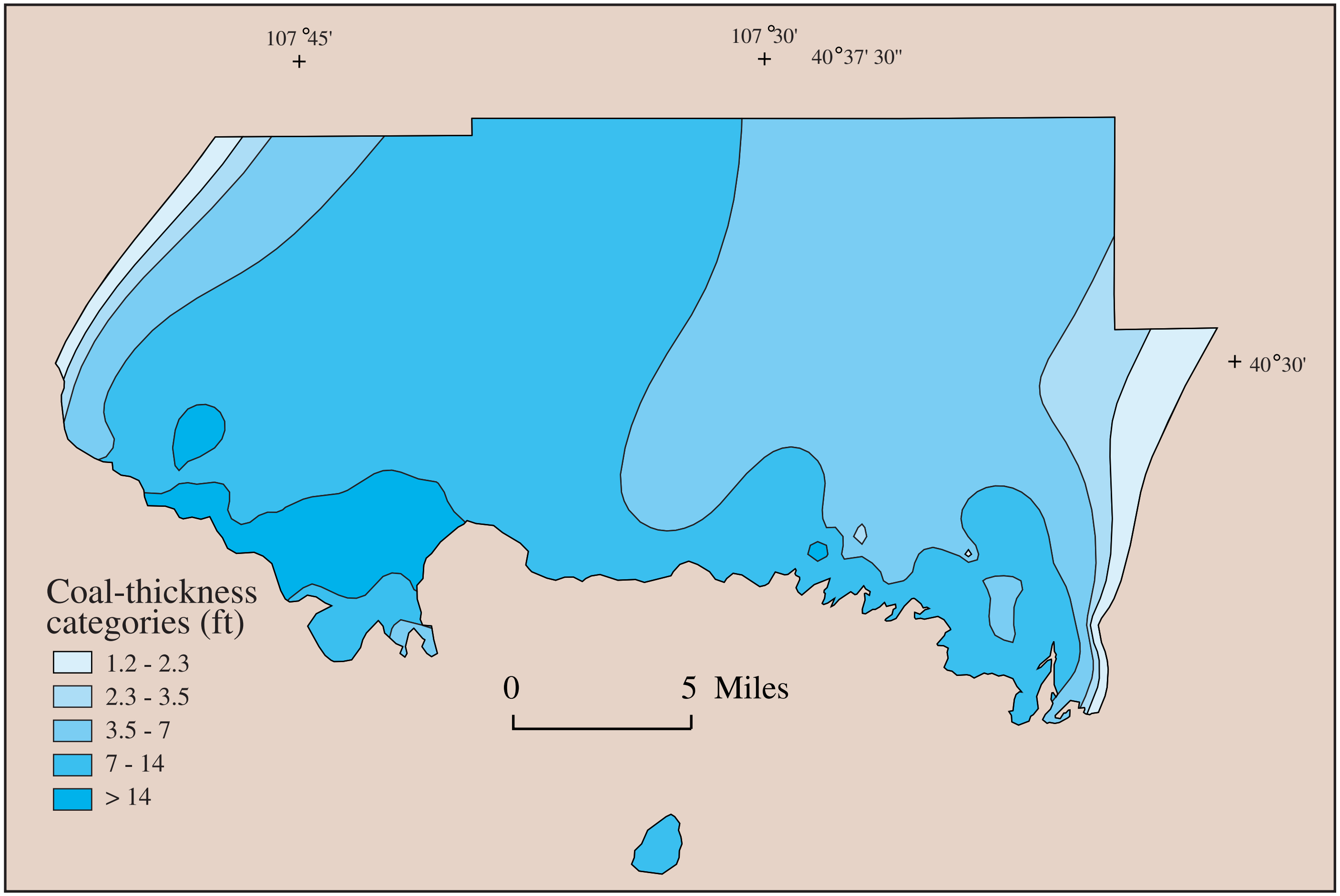
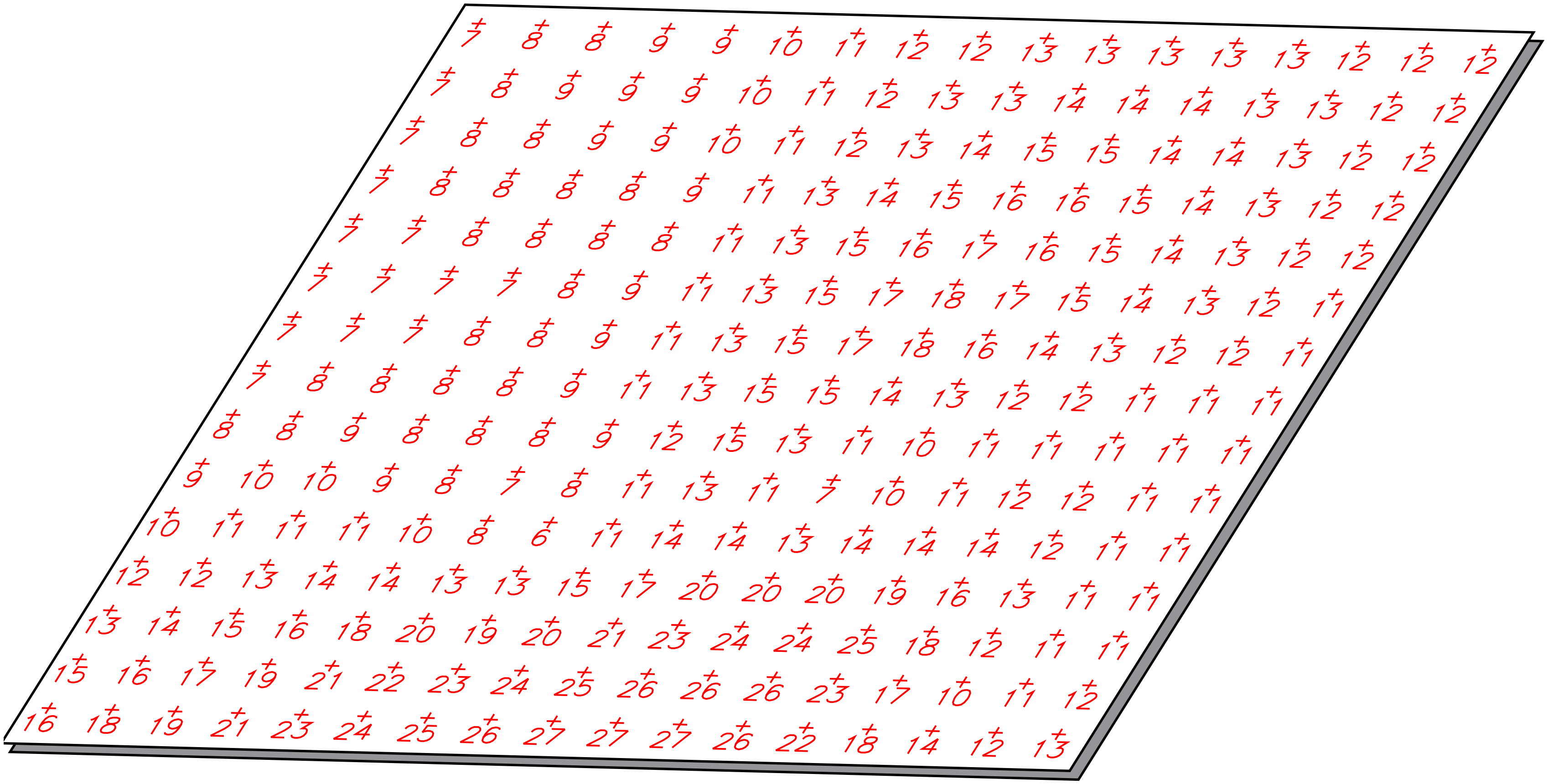


Figure 12. Example map of coal-thickness categories, C coal zone, Yampa coal field, Colorado.

Finally, the coal-thickness grid was used in the process of calculating coal volume and tonnage in EarthVision. The thickness values of the grid nodes, from the two-dimensional grid of coal thickness (fig. 13), supplied the thickness values used to calculate the coal tonnage within each polygon.



7	8	8	9	9	10	11	12	12	13	13	13	13	13	12	12	12
7	8	9	9	9	10	11	12	13	13	14	14	14	13	13	12	12
7	8	8	9	9	10	11	12	13	14	15	15	14	14	13	12	12
7	8	8	8	8	9	11	13	14	15	16	16	15	14	13	12	12
7	7	8	8	8	8	11	13	15	16	17	16	15	14	13	12	12
7	7	7	7	8	9	11	13	15	17	18	17	15	14	13	12	11
7	7	7	8	8	9	11	13	15	17	18	16	14	13	12	12	11
7	8	8	8	8	9	11	13	15	15	14	13	12	12	11	11	11
8	8	9	8	8	8	9	12	15	13	11	10	11	11	11	11	11
9	10	10	9	8	7	8	11	13	11	7	10	11	12	12	11	11
10	11	11	11	10	8	6	11	14	14	13	14	14	14	12	11	11
12	12	13	14	14	13	13	15	17	20	20	20	19	16	13	11	11
13	14	15	16	18	20	19	20	21	23	24	24	25	18	12	11	11
15	16	17	19	21	22	23	24	25	26	26	26	23	17	10	11	12
16	18	19	21	23	24	25	26	27	27	27	26	22	18	14	12	13

Figure 13. Hypothetical grid of net-coal thickness showing values at each grid node.

Resource Polygons

In addition to data related to coal thickness, data related to the area within which resources are to be calculated are very important. This area is referred to as a resource polygon. The resource polygon differs from the bounding rectangle, discussed earlier in this report, in that it more accurately depicts the areal distribution of the coal zone (fig. 14).

Many factors were used to define the boundaries for the resource-polygon areas. A few examples include: (1) areas where the coal zone is exposed at the surface, (2) areas where the coal is too thin or too deep to qualify as a resource using criteria of Wood and others (1983), and (3) areas where data are too sparse to adequately assess the coal zone. Resource polygons are the single most important polygons because they limit the resource. They may also be the most difficult to create, especially in the case where a large part of the boundary is defined by where the coal zone is exposed at the surface.

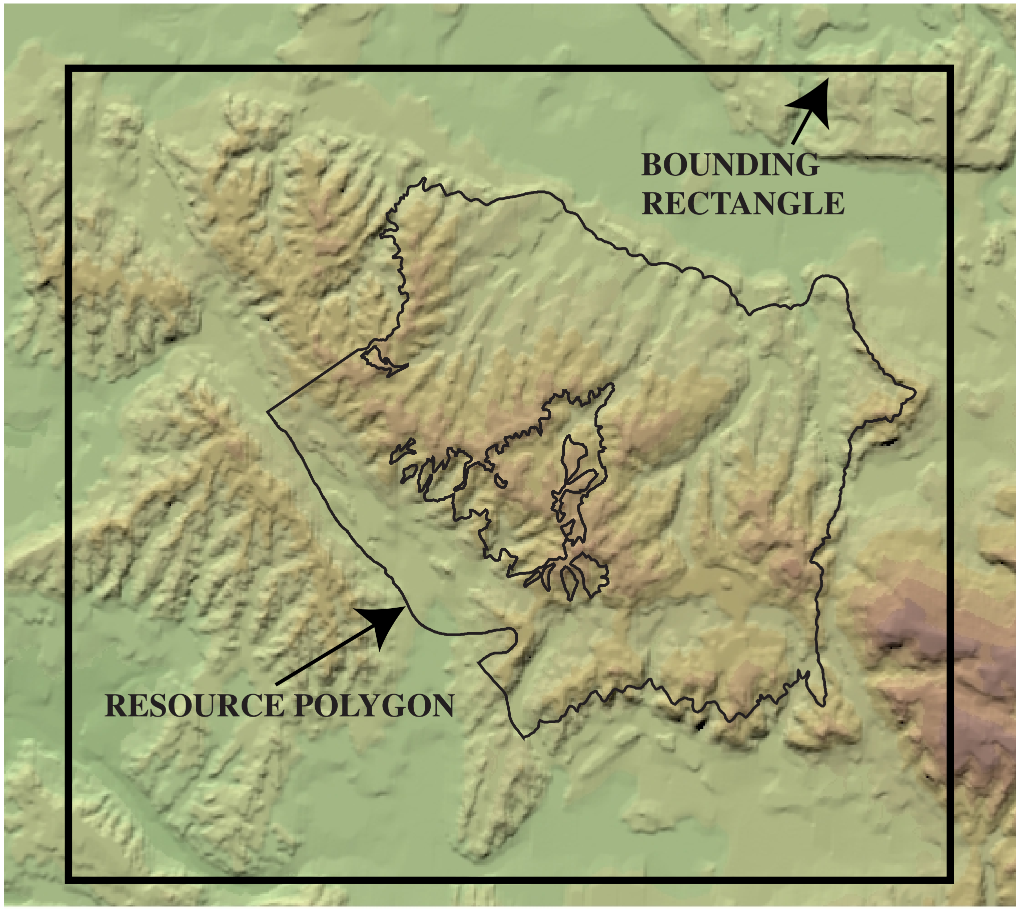


Figure 14. Example of the extent of the bounding rectangle compared to the more detailed resource polygon. Shaded-relief topography of Danforth Hills coal field in the background, northwestern Colorado.

Many of the coal zones that were assessed in the Colorado Plateau are directly above recognizable marker horizons (i.e., marine sandstone units) that can be mapped on the surface and, because of a fairly distinctive geophysical log signature, can also be mapped in the subsurface (fig. 15).

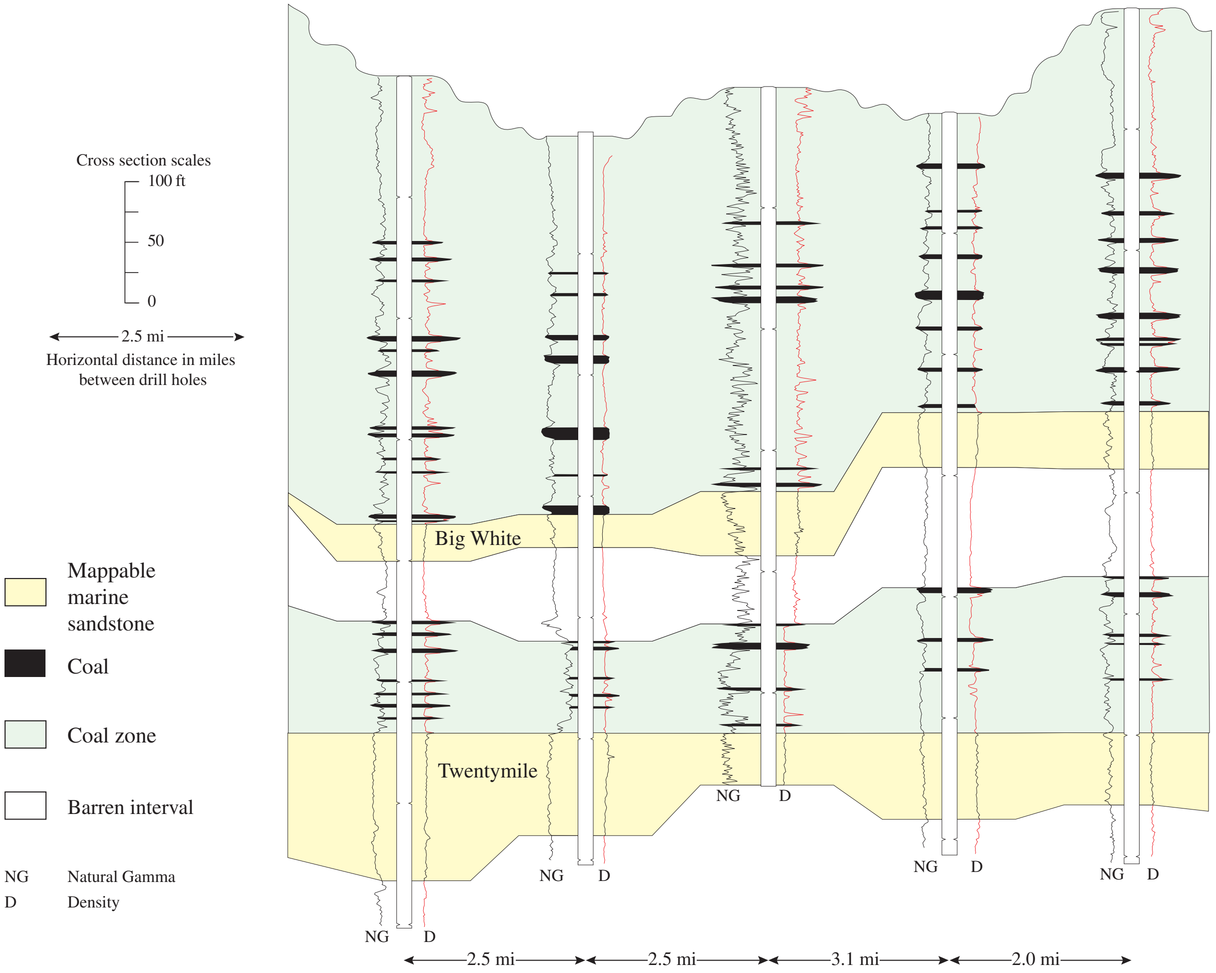


Figure 15. Example cross section showing position of coal zones stratigraphically above mappable marine sandstone units that are the marker horizons. Modified from Johnson and others (chap. P, this CD-ROM).

Figure 16. Cliffs are the Trout Creek Sandstone Member of the Iles Formation, which is overlain by the coal-bearing Williams Fork Formation, Yampa coal field, northwestern Colorado. Photograph by E.A. Johnson, 1978.

Digitized lines representing the exposures of the top of these marker horizons (i.e., the Pictured Cliffs Sandstone in the San Juan Basin, the Star Point Sandstone in the southern Wasatch Plateau, and the Trout Creek Sandstone Member of the Iles Formation in the Yampa coal field (fig. 16)) were used to partially define the resource polygon for the overlying coal zones (i.e., the Fruitland Formation, lower Blackhawk Formation, and Williams Fork Formation, respectively).

A problem arises in cases where a coal zone to be assessed has not been mapped on the surface and is not associated with a distinct marker horizon. In these cases, the location of the pseudo-outcrop must be estimated using innovative techniques. A description of some tools and techniques used to generate these pseudo-outcrops is provided in the following section along with two case studies.

Gridded Surfaces

Initially, two grids are generated in EarthVision, each of which represents a surface. One is a grid of a digital elevation model (DEM) that represents the surface topography in the study area. The other is a grid that represents a structural datum, such as the top of a mappable marine sandstone unit. From a query of the StratiFact database, a file is generated that contains fields for location (*x* and *y*) and elevation of the structural datum (for example, the Rollins Sandstone in the southern Piceance Basin; fig. 17).

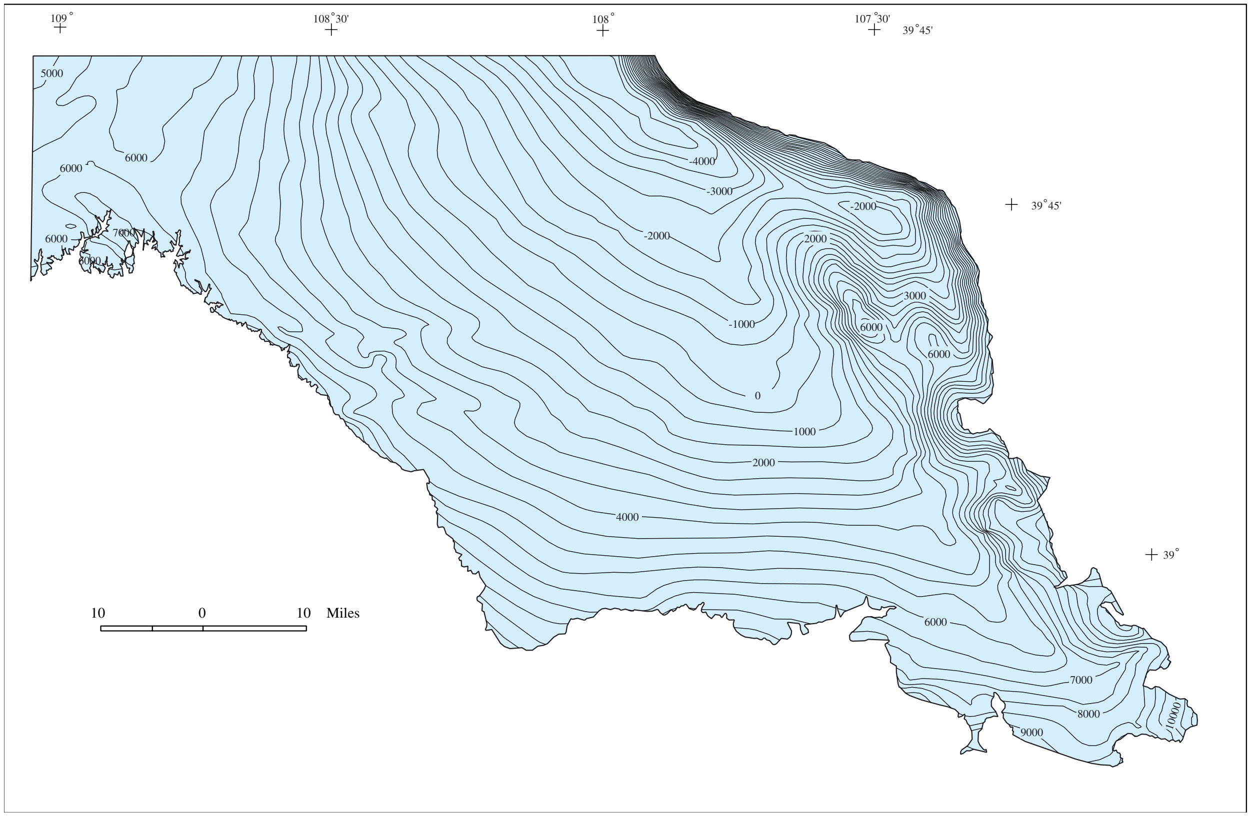


Figure 17. Structure contours on top of the Rollins Sandstone Member, southern Piceance Basin, Colorado.

Information on the elevation of this datum from other sources, such as outcrop measurements or published structure contour maps, is added to the drill-hole data in order to provide as much control as possible, especially where the structural datum is exposed at the surface. All of these data are gridded in EarthVision to create a two-dimensional grid file that represents the surface on the structural datum. Structure contours are then plotted from this grid file. The best possible representation of this surface on top of the structural datum is critical because additional surfaces are generated from it.

Case Study 1: Southern Piceance Basin

To create resource polygons for the coal zones assessed in the southern Piceance Basin (fig. 1), we combined a grid of thickness with a structure contour grid of the top of the Rollins Sandstone Member to generate pseudo-outcrops.

In this case study, a data set was extracted from StratiFact that contains *x*, *y*, *z* data, where *z* is the thickness between the top of the Rollins (a good marker horizon in this area) (fig. 18) and the base of the overlying South Canyon coal zone.

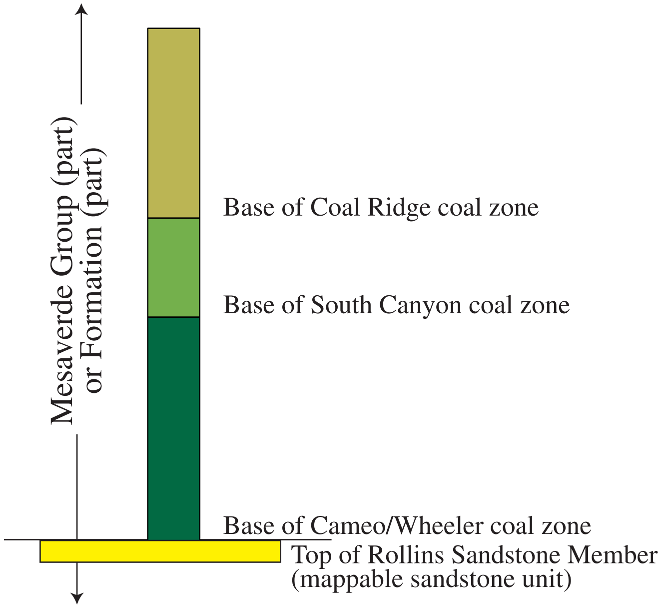


Figure 18. Diagrammatic stratigraphic column showing distribution of coal zones in the Mesaverde Group or Mesaverde Formation, southern Piceance Basin.

These thickness data were gridded and then, using the 'Formula Processor' utility in EarthVision, the resultant thickness grid was added to the grid of the structural surface on the top of the Rollins Sandstone Member. The resulting grid is a pseudo-structure grid on the base of the South Canyon coal zone (fig. 19).

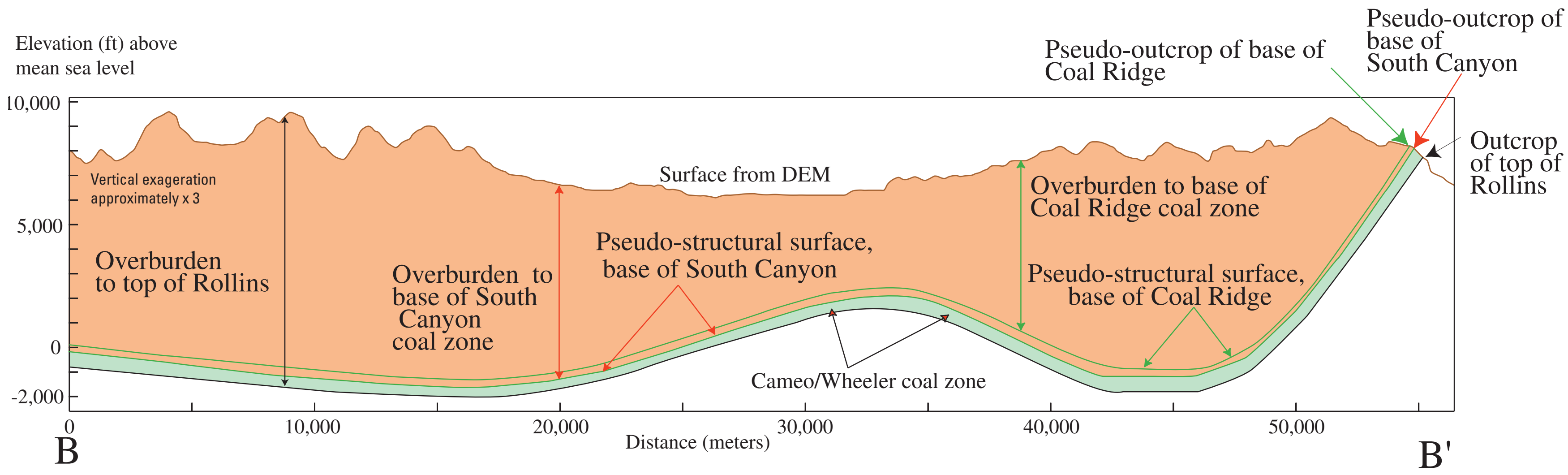


Figure 19. Cross-section view of surfaces of Rollins Sandstone Member and coal zones in the Southern Piceance Basin assessment unit. Location of cross section B-B′ is shown on fig. 20.

This pseudo-structure grid on the base of the South Canyon coal zone was then subtracted from the DEM grid of topography, resulting in a grid of overburden thickness to the base of the coal zone. The zero overburden line generated from this grid represents the pseudo-outcrop line for the base of the South Canyon coal zone and defines the areal limits of the coal zone, at least along the northeastern and southern parts of the area (fig. 20). The western limit of the area is represented by a line where the net-coal thickness becomes less than 1.2 ft.

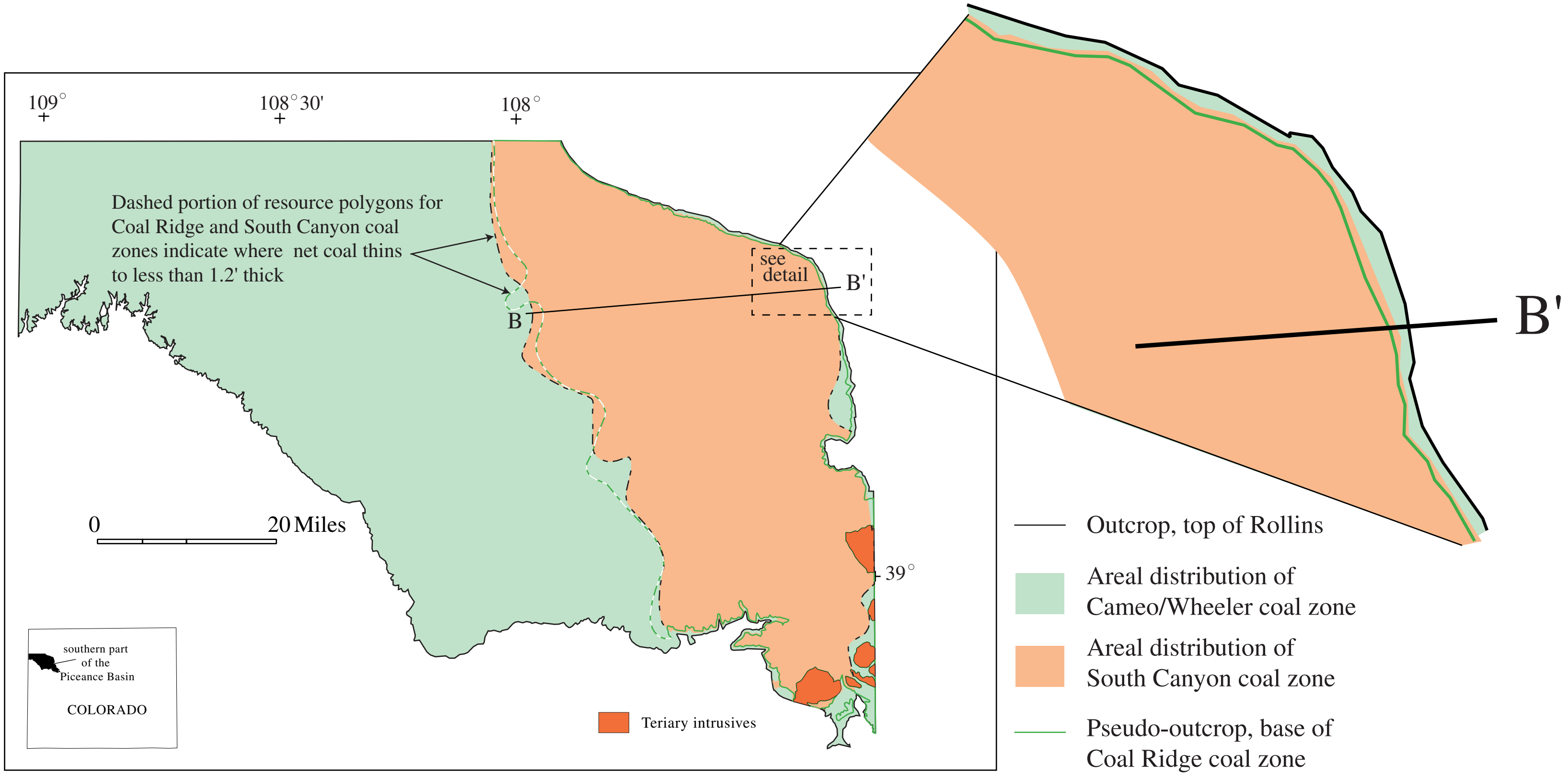


Figure 20. Map view of distribution of Rollins Sandstone Member and coal zones in the Southern Piceance Basin assessment unit.

The polygon defining the areal limits of the overlying Coal Ridge coal zone (fig. 21) was generated by adding the thickness grid of the South Canyon coal zone to the pseudo-structure on the base of the South Canyon coal zone and subtracting that resultant grid from the DEM topography. Again, the zero overburden line generated from this final grid represents the pseudo-outcrop line for the base of the Coal Ridge coal zone and partially defines the areal limits of this coal zone.

Case Study 2: Danforth Hills Coal Field

In this case, it was impossible to use grids of coal-zone thickness added to the top of the structural datum to create pseudo-structure grids and overburden grids because, in the Danforth Hills coal field, seven coal zones stratigraphically overlie the structural datum (the Trout Creek Sandstone Member of the Iles Formation) and the interval between the base of each successively higher coal zone is not very thick—in all cases less than 300 ft. The irregular distribution of coal-zone-thickness data precluded generating coal-zone isopach grids that, when added to the structural datum, would adequately represent a surface. When we tried the method used for the southern Piceance Basin, the result was computer-generated (pseudo) outcrop lines of the coal zones that, when plotted simultaneously, would cross each other in several places.

Using the 'Formula Processor' utility in EarthVision, we created a grid of overburden thickness by subtracting the gridded surface of the top of the Trout Creek Sandstone Member (structural datum) from the gridded surface of the topography. This resultant grid represents the thickness between the two surfaces—in other words, the thickness of overburden to the top of the Trout Creek. Once the grid of overburden thickness was calculated, an overburden isopach map was generated depicting the lines of equal overburden thickness above the Trout Creek (fig. 21).

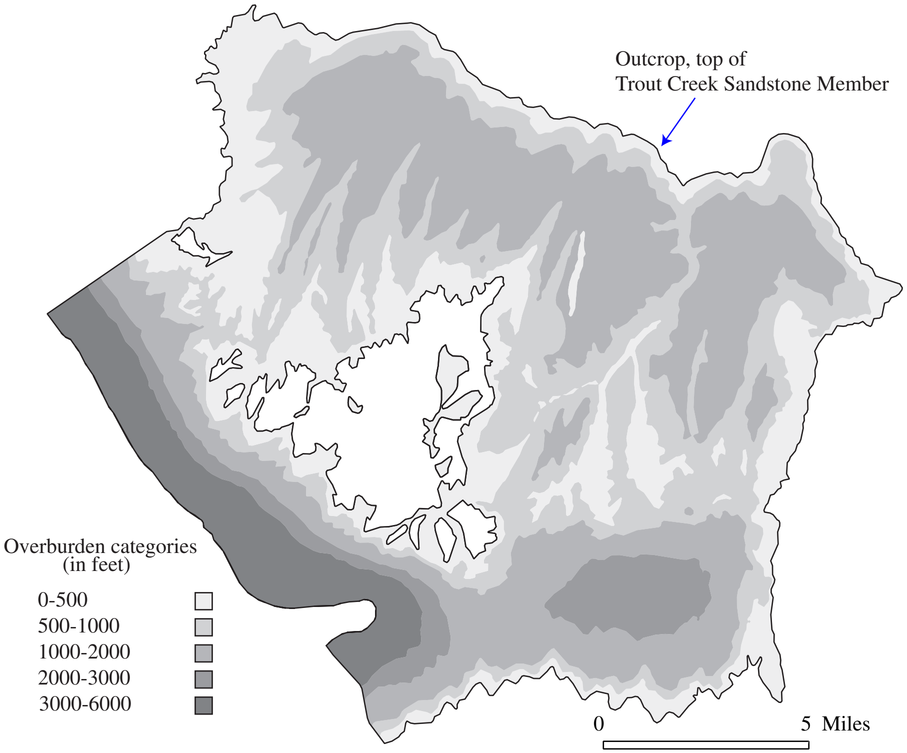


Figure 21. Overburden to top of the Trout Creek Sandstone Member, Danforth Hills coal field, northwestern, Colorado.

From a query of the StratiFact database, we then calculated the average distance (in feet) above the top of the Trout Creek Sandstone Member to the base of each of six coal zones (fig. 22).

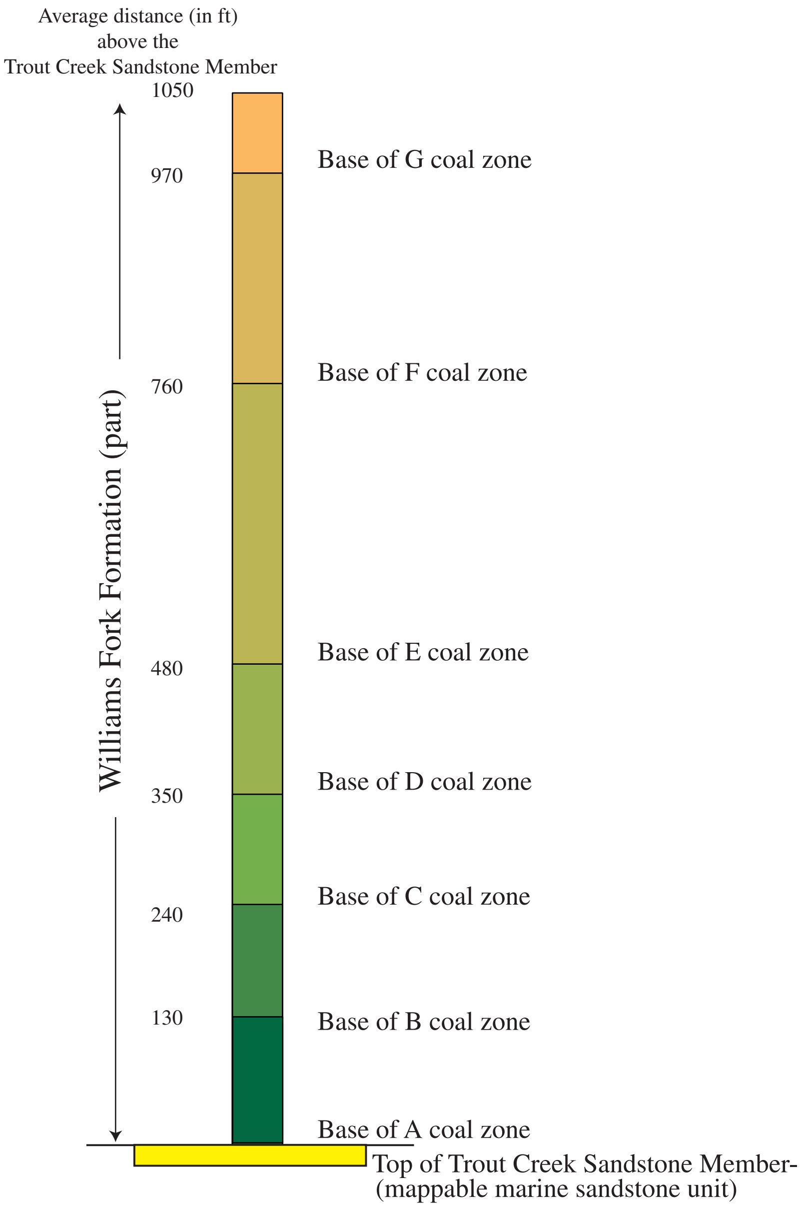
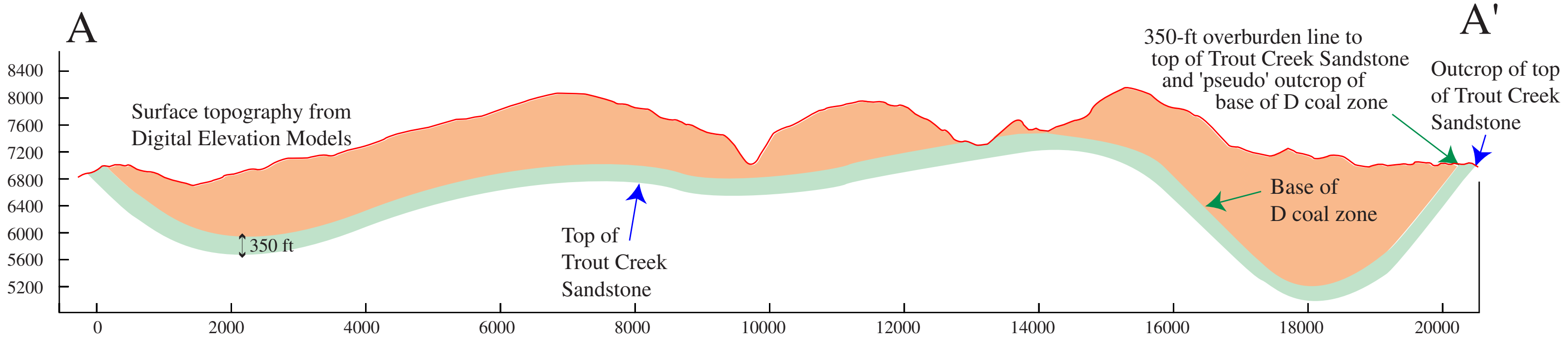


Figure 22. Generalized stratigraphic column of coal zones in the Danforth Hills coal field showing average distance (in ft) above the Trout Creek Sandstone Member.



For example, the stratigraphic distance above the top of the Trout Creek to the base of the D coal zone is, on average, 350 ft. Because this stratigraphic distance is equivalent to the average thickness of rock lying between the coal zone and the top of the Trout Creek, we can also interpret that, on average, 350 ft of overburden would separate the base of the D coal zone from the Trout Creek.

By this reasoning, we also interpreted that the D coal zone is only present in areas of the coal field where overburden to the top of the Trout Creek would be equal to or greater than 350 ft. Therefore, the 350-ft overburden line was used to define the maximum areal extent of the D coal zone and, thus, was considered as a pseudo-outcrop line (in map view) for the D coal zone (fig. 23).

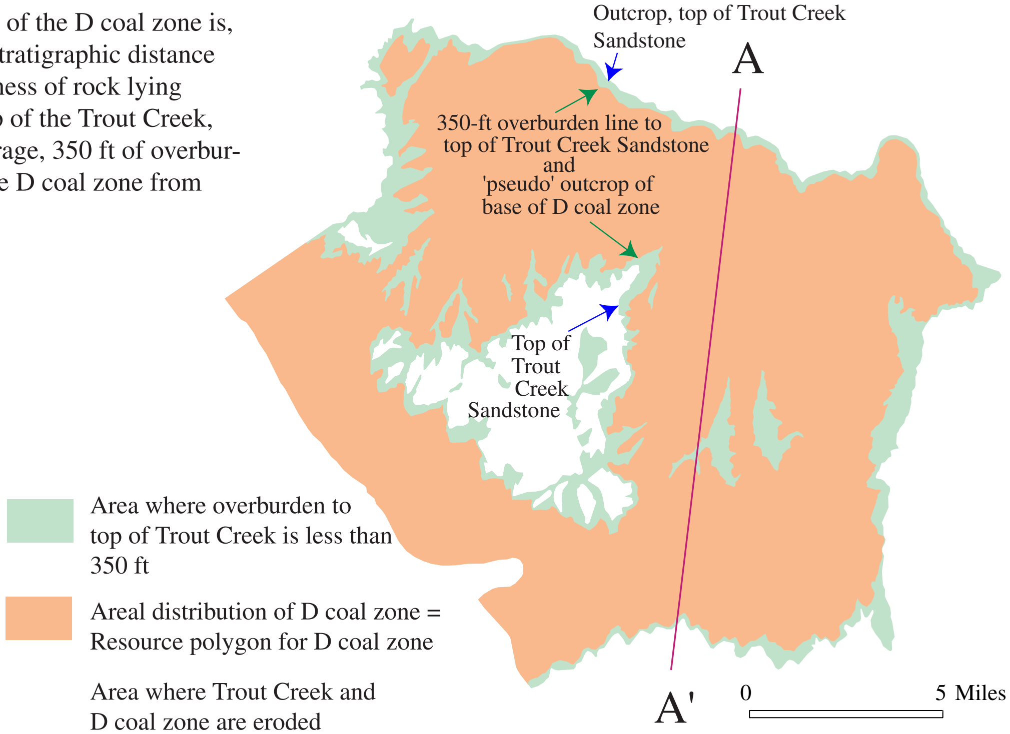


Figure 23. Cross section and map view of the distribution of the Trout Creek Sandstone Member and the D coal zone, Danforth Hills coal field, northwestern Colorado.

Through this process, pseudo-outcrop lines for each coal zone can be generated using the combination of the overburden map to the top of the Trout Creek and the average stratigraphic distance above the Trout Creek to the base of every overlying coal zone. Because the base of the B coal zone is only 130 ft, on average, above the top of the Trout Creek Sandstone, we used the line representing the Trout Creek Sandstone to also represent the boundary of the area underlain by the B coal zone. Note how, from map to map, the areal distribution of each successively higher coal zone is reduced (fig. 24).

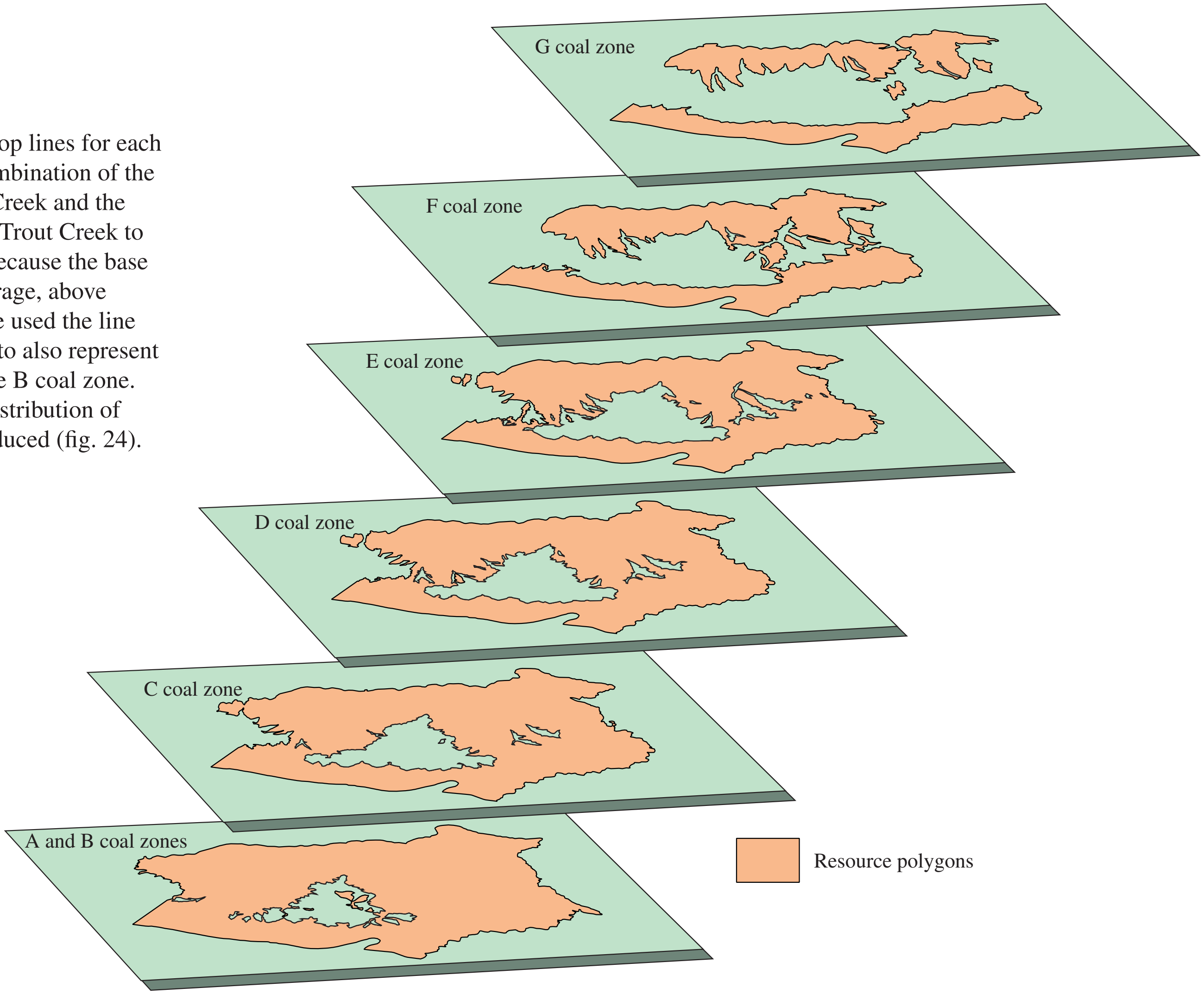


Figure 24. Resource polygons generated using structural surface of the Trout Creek Sandstone Member, the average thickness of each coal zone, and a digital elevation model, Danforth Hills coal field, Colorado.

Resource Calculations

The results of the procedures discussed so far are net-coal-thickness grids and resource polygons that were used in the final steps of coal-resource calculations. The Deserado assessment area, Lower White River coal field (fig. 1), is used as an example for the following discussion of calculating resources.

Once satisfied with the pseudo-outcrop line (zero overburden line), any other associated overburden lines and coal isopach lines, data were saved in ASCII format as a ‘contour output file,’ which is one of the EarthVision plotting options. The program ‘ismarc’ was then used to convert the contour output file from EarthVision to a file that is in ‘arc-generate’ format. The output file from ‘ismarc’ was then processed in ARC/INFO using an Arc Macro Language (AML) program (convert-ism.aml) that converted it into an ARC/INFO polygon coverage (fig. 25). Both ‘ismarc’ and ‘convert-ism’ were provided by the Illinois State Geological Survey.

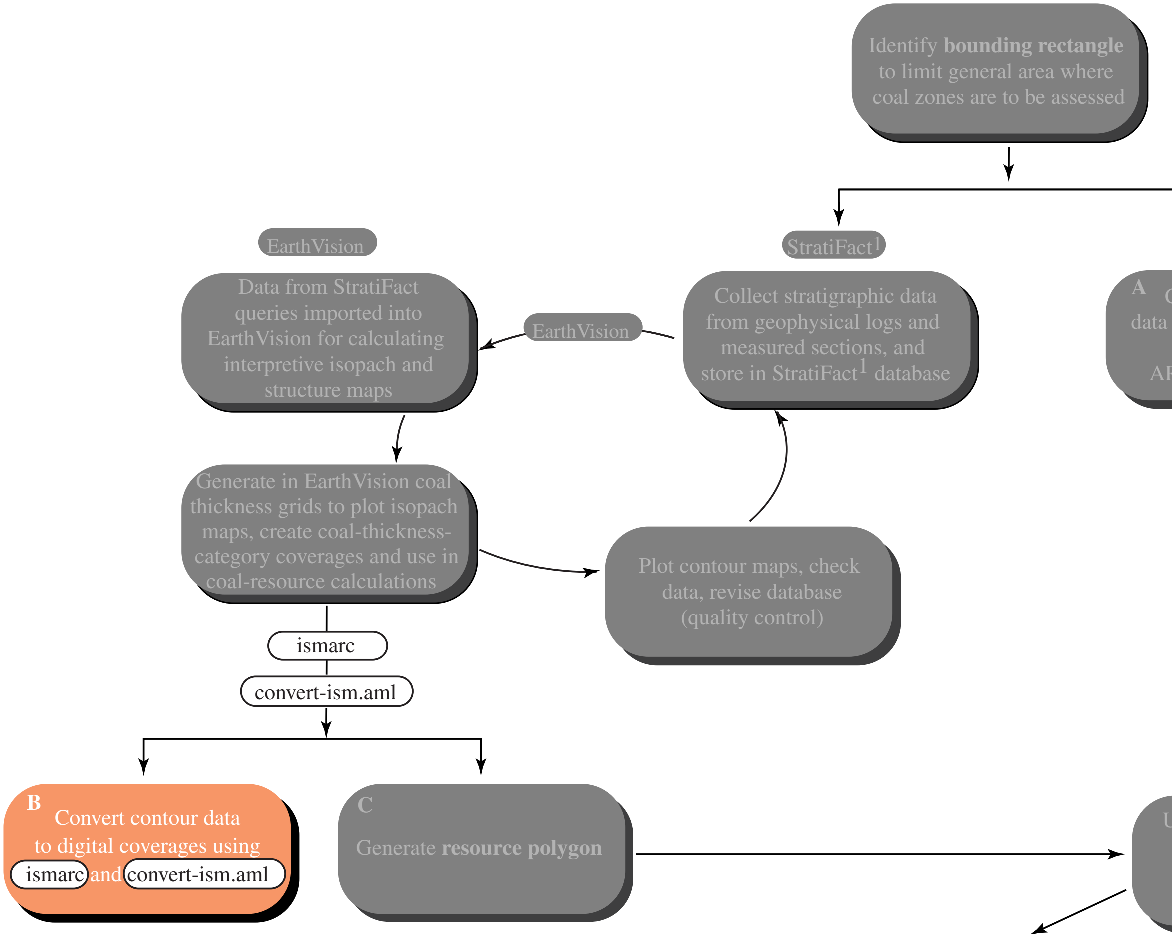


Figure 25. Part of flow chart (fig. 2) showing where contour data are converted to ARC/INFO coverages.

Using ARC/INFO, a single polygon coverage was created that is the union of all polygon coverages for which tonnages were reported (fig. 26), such as county, quadrangle, township, surface and coal ownership, and overburden- and coal-thickness categories.

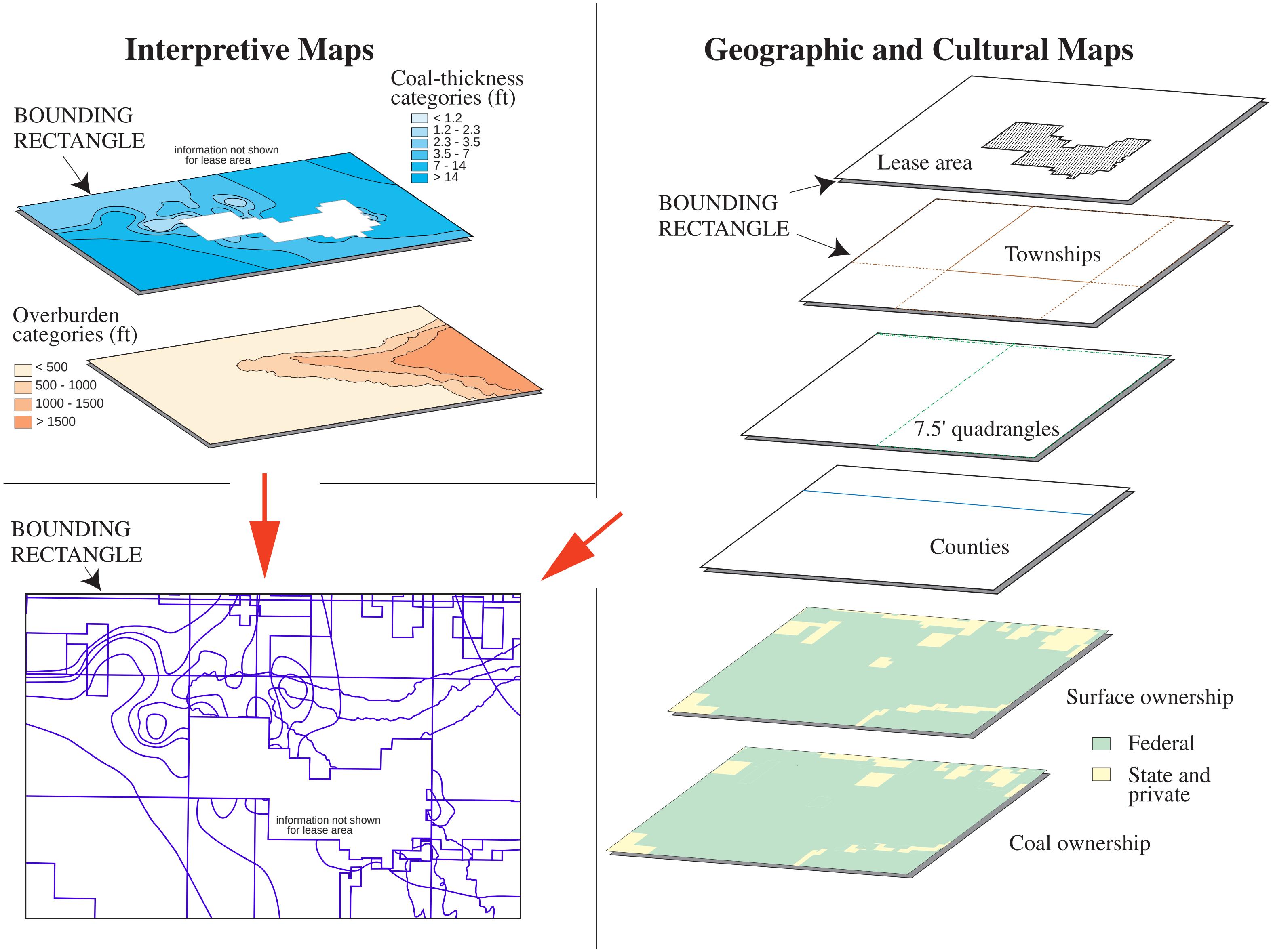


Figure 26. Individual polygon coverages were all unioned using ARC/INFO to create a coverage that was clipped with the resource polygon.

As a final step before resources were calculated, this polygon coverage was clipped by the resource polygon using the ‘identity’ command in ARC/INFO (fig. 27). This final polygon coverage was imported into EarthVision as a single polygon file. Although several attributes are associated with the individual polygons that make up the unioned polygon, the user is allowed to label only one attribute when importing the unioned polygon. The ‘coverage-id’ attribute must be used to label the individual polygons within the unioned polygon because it is a unique identifier for each polygon.

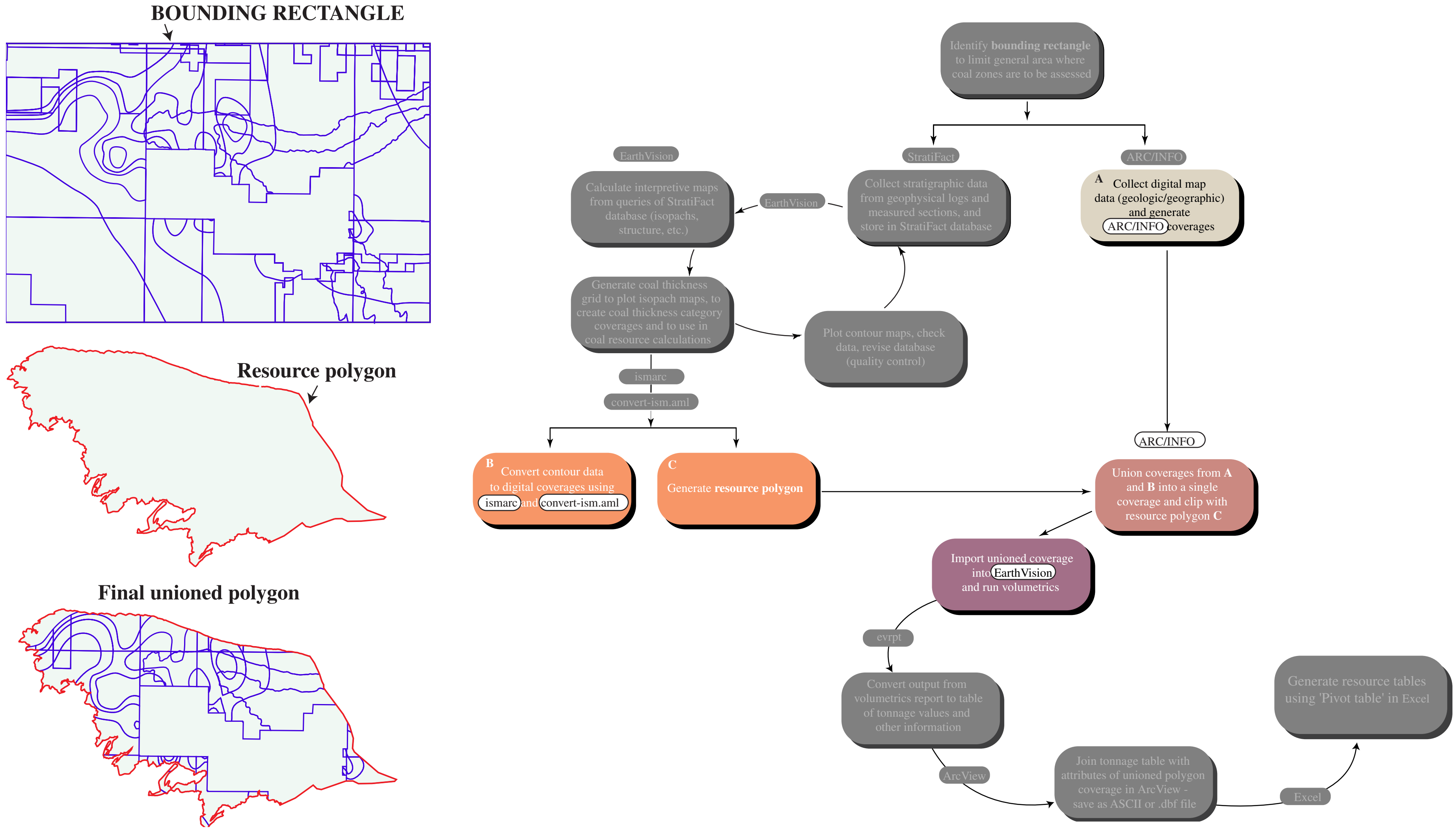


Figure 27. Final unioned polygon coverage created from the union of all other polygon coverages that contain data for reporting coal-resource tonnage. Also shown is part of the flow chart (fig. 2) where the final unioned polygon was generated and imported into EarthVision.

The volumetrics utility within EarthVision was used to calculate short tons of coal (fig. 28). The grid of net-coal thickness supplied the thickness values used to calculate coal tonnage within each polygon.

The result of running the volumetrics routine is an ASCII-formatted file (volumetrics report) that lists by polygon-id (same as coverage-id) a value for area and short tons for each polygon within the polygon file (fig. 29).

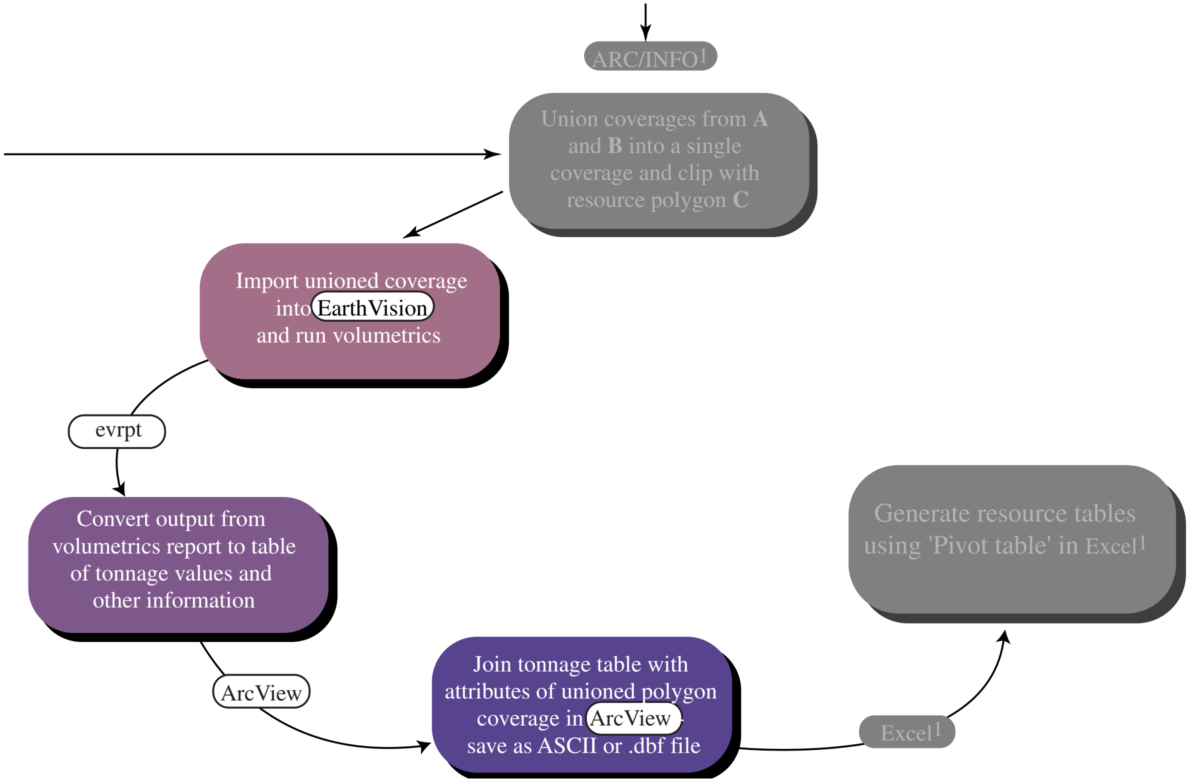
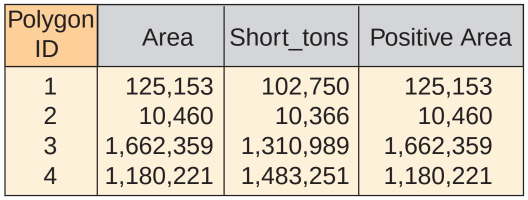


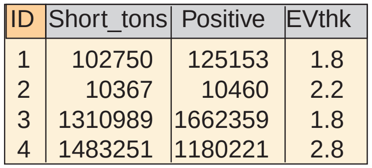
Figure 28. Part of flow chart (fig. 2) showing where coal resources are calculated.



Polygon ID	Area	Short_tons	Positive Area
1	125,153	102,750	125,153
2	10,460	10,366	10,460
3	1,662,359	1,310,989	1,662,359
4	1,180,221	1,483,251	1,180,221

Figure 29. Example output file from running volumetrics in EarthVision.

A program was written by the USGS called ‘evrpt’ that converts this volumetrics report to a tab-delimited ASCII-formatted file. The ‘evrpt’ program strips the header information from the volumetrics report and calculates the average coal thickness for each polygon that EarthVision used to calculate the short-ton value (fig. 30).



ID	Short_tons	Positive	EVthk
1	102750	125153	1.8
2	10367	10460	2.2
3	1310989	1662359	1.8
4	1483251	1180221	2.8

Figure 30. Example output file from running ‘evrpt’ program.

The resultant output file from the ‘evrpt’ program was imported into ArcView as a table.

Generating Resource Tables

0-500 ft of overburden					Total 0-500	500-1000 ft of overburden				Total 500-1000	>1000 ft of overburden				Total >1000	Grand Total
Coal thickness	1.2-2.3	2.3-3.5	3.5-7.0	7.0-14.0		1.2-2.3	2.3-3.5	3.5-7.	7.0-14.0		1.2-2.3	2.3-3.5	3.5-7.0	7.0-14.0		
Township																
T2N R100W	0	0	0	0	0	0	0	0	0	0	0	212	1247	3916	5375	5375
T2N R101W	101	234	9618	3200	13154	0	0	0	0	0	0	35	105	25	166	13321
T2N R102W	0	0	0	4111	4111	0	0	0	0	0	0	0	0	0	0	4111
T3N R100W	0	0	0	0	0	0	0	0	0	0	0	9	926	193	1129	1129
T3N R101W	577	3716	6453	8242	18990	630	2243	11427	17001	31302	151	976	1993	23414	26536	76829
T3N R102W	3519	4699	13725	26606	48551	0	0	0	0	0	0	0	0	0	0	48551
Grand total	4198	8649	29797	42160	84807	630	2243	11427	17001	31302	151	1234	4272	27550	33209	149319

Figure 33. Example of coal resource table generated using the Pivot Table function within Excel. Data are from table in figure 32.

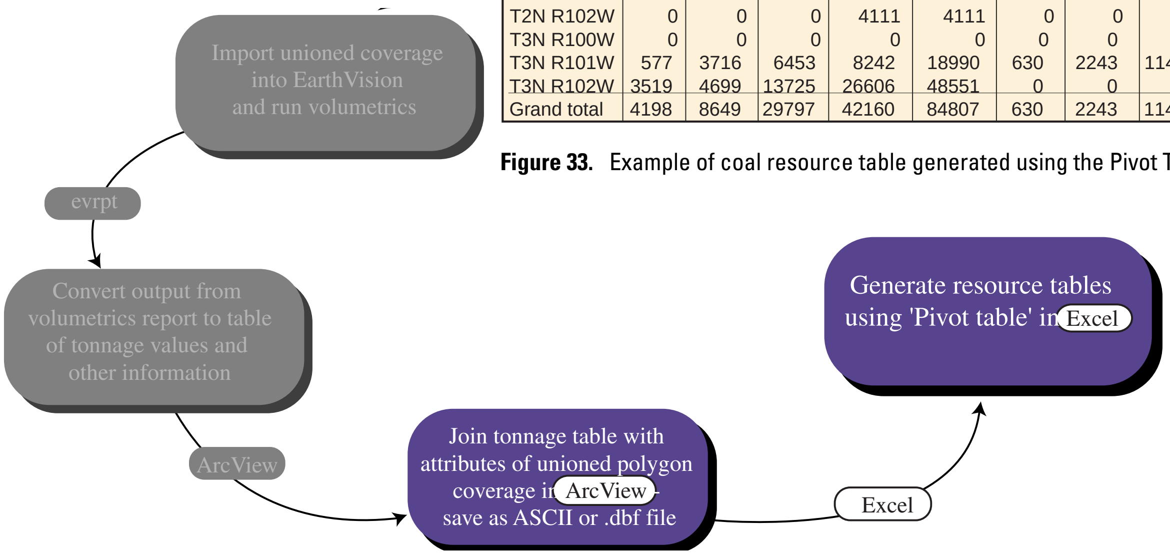


Figure 31. Part of flow chart (fig. 2) showing where coal resource tables are generated.

Once in Excel, the ‘Pivot Table’ utility was used to create tables that report resource estimates using any category in the spreadsheet (fig. 33).

In ArcView, the table was joined to the attribute table of the ARC/INFO unioned polygon coverage (fig. 31) using the ‘polygon-id’ (EarthVision) and ‘coverage-id’ (ARC/INFO). The result of joining the two tables is a new table with a record that contains a short-tons value for every polygon in the unioned polygon (fig. 32). The joined table was exported from ArcView as a delimited ASCII file or a standard database file (.dbf) and read directly into a spreadsheet program such as Microsoft Excel.

Area	ID	Thk_cat	Overb	Surf	Fedmins	7.5' Quadrangle	Cnty	TR	Short_tons	Positive	EVthk	Thous_tons
125153	1	1.2-2.3	0-500	BLM	All	Rangely NE	Moffat	T3N R102W	102750	125153	1.8	102
10461	2	1.2-2.3	0-500	BLM	All	Rangely NE	Moffat	T3N R102W	10367	10460	2.2	10
1662360	3	1.2-2.3	0-500	BLM	All	Rangely NE	Moffat	T3N R102W	1310989	1662359	1.8	1310
1180222	4	2.3-3.5	0-500	BLM	All	Rangely NE	Moffat	T3N R102W	1483251	1180221	2.8	1483

Figure 32. Example of table created in ArcView by joining output from ‘evrpt’ with attribute table of the unioned polygon coverage. Item used to join the tables is the ‘polygon-id.’

Conclusions

For the assessment of 20 coal zones in five formations of the Colorado Plateau region, we established a method of taking coal-thickness data, combined with multiple layers of digital geologic and geographic data pertaining to coal distribution and coal-resource reporting parameters, to ultimately produce the most current coal resource estimates. As many as six commercially available software packages, ranging from simple conversion programs to GIS and two-dimensional surface modeling programs, were used in conjunction with three custom programs to process the digital data. Because the end-products of the assessments are in digital format such as ARC/INFO coverages, stratigraphic databases, and spreadsheet files, it is possible to update resource estimates as new information becomes available.

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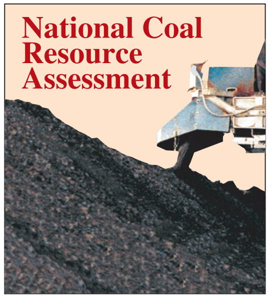

Click here to return to Disc 1 Volume Table of Contents