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Calculation of Coal Resources Using ARC/INFO* and EarthVision*: Methodology for the National Coal Resource Assessment

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Introduction

This report documents a comparison of two methods of resource calculation that are being used in the National Coal Resource Assessment project of the U.S. Geological Survey (USGS). Tewalt (1998) discusses the history of using computer software packages such as GARNET (Graphic Analysis of Resources using Numerical Evaluation Techniques), GRASS (Geographic Resource Analysis Support System), and the vector-based geographic information system (GIS) ARC/INFO (ESRI, 1998) to calculate coal resources within the USGS. The study discussed here, compares resource calculations using ARC/INFO* (ESRI, 1998) and EarthVision (EV)* (Dynamic Graphics, Inc. 1997) for the coal-bearing John Henry Member of the Straight Cliffs Formation of Late Cretaceous age in the Kaiparowits Plateau of southern Utah. Coal resource estimates in the Kaiparowits Plateau using ARC/INFO are reported in Hettinger, and others, 1996.

The initial steps for the ARC/INFO and the EarthVision methods are the same. The input data used for the resource calculations is an ASCII-formatted file consisting of 203 points with x and y fields for location and a z field for the total net coal thickness in beds >1 ft thick in John Henry Member. Location data (x, y) units in meters are in Universal Transverse Mercator projection (zone 12). Coal thickness data units are in feet. This data file is introduced into EV and gridded. Once satisfied with the position of the coal isopach lines generated from the gridding process, the isopach lines are saved in ASCII format as a 'contour output file', which is one of the EV plotting options. The program 'ismarc', which we received from the Illinois Geological Survey (personal communication 1995, Colin Treworgy), is then used to convert the EV contour output file to a file that is in 'arc-generate' format.

The output file from 'ismarc' is processed in ARC/INFO using an Arc Macro Language (AML) program (convert-ism.aml), also provided by the Illinois Geological Survey (personal communication 1995, Colin Treworgy). This program converts the 'ismarc' output file into an ARC/INFO polygon coverage. Each polygon created using this AML is attributed with a value for net coal thickness, which is an average of the thickness values of the two contour lines on either side of the polygon. For example, if the contour interval is 10 feet, then the entire area between the 20- and 30-ft. contours is attributed with the thickness value of 25 ft. The ARC/INFO coverage for thickness is unioned with the other polygon coverages representing geologic and other spatial information for which tonnages are to be reported, (i.e., county, 7.5' quadrangle, township, surface and coal ownership, reliability, overburden thickness, etc.). Figure 1 shows polygons within the unioned polygon coverage for a part of the study area with labels for the thickness value that was generated using the AML program.

ARC/INFO

Thickness values generated using the 'convert-ism' AML (fig. 1) are used to calculate coal volume. To calculate coal tonnage using ARC/INFO, two items were added to the final unioned coverage: 'Acreft' - a numeric field calculated by multiplying the area in square meters by .0002471 (the number of square meters per acre) times the net coal thickness (in feet) and 'Shtons_bit' - a numeric field calculated by multiplying the field for 'Acreft' by 1800 (the number of short tons per acre-foot for bituminous-rank coal; Wood and others, 1983).

EarthVision

To calculate coal tonnages using EV, the same unioned polygon coverage that is used in the ARC/INFO calculations is imported into EV as a single polygon file. Although multiple attributes are associated with the individual polygons, the user is allowed only one attribute to label when importing the unioned polygon. We use the 'coverage-id' attribute to label the individual polygons within the polygon file because it is a unique identifier.

The volumetrics utility within EV is used to calculate short-tons of coal. The thickness values of the grid nodes from the 2-dimensional grid of coal thickness, supply the thickness values used to calculate the coal tonnage within each polygon. This grid is the same one used in the preceding process to generate the polygon coverage of coal thickness. The volumetrics routine produces an ASCII-formatted volumetrics report that lists by polygon-id (coverage-id) the area and short tons for each polygon within the polygon file. A program was written at the USGS called 'evrpt' that converts this volumetrics report to a tab-delimited ASCII-formatted file (personal communication 1997, Dorsey Blake). 'Evrpt' also calculates the coal thickness value that EV uses to calculate short-tons for each polygon and writes the value to a column. The thickness values in this file will often be different than those that are used to calculate coal tonnage using the ARC/INFO method. Consequently, the total coal tonnage values may also differ. Figure 2 shows the same part of the unioned polygon as that in figure 1. The labels in this figure, however, represent the thickness that the volumetrics routine in EV used to calculate the short tons values. The shaded areas in figures 1 and 2 highlight those polygons where the thickness values are significantly different.

Discussion

Tables 1 and 2 are a comparison of the John Henry Member coal resources rounded to millions of short tons as calculated by the two techniques. Results are reported by County and by overburden thickness (table 1). As can be seen in the table, the tonnage values for the total area and for large areas such as an entire County are very similar (differing by < 1 percent). Table 2 shows tonnage reported by Townships. The larger differences in tonnage values are for small areas and for areas adjacent to lines of a polygon that represent coal isopachs.

References Cited

Dynamic Graphics, Inc., 1997, EarthVision,. v. 4.

ESRI - Environmental Systems Research Institute, Inc., 1998, ARC/INFO, v.7.1.1.

Hettinger, R.D., Roberts, L.N.R., Biewick, L.R.H., and, Kirschbaum, M.A., 1996, Preliminary investigations of the distribution and resources of coal in the Kaiparowits Plateau, southern Utah, U.S. Geological Survey Open-File Report 96-539, 72 p.

Tewalt, S.J., 1998, National coal resource assessment methodology: Comparison of resource calculation methods by two geographic information systems (GIS): U.S. Geological Survey Open-File Report 98-365, 5 p.

Wood, G. H., Jr., Kehn, T.M., Carter, M.D., and Culbertson, W.C., 1983, Coal resource classification system of the U.S. Geological Survey: U.S. Geological Survey Circular 891, 65 p.

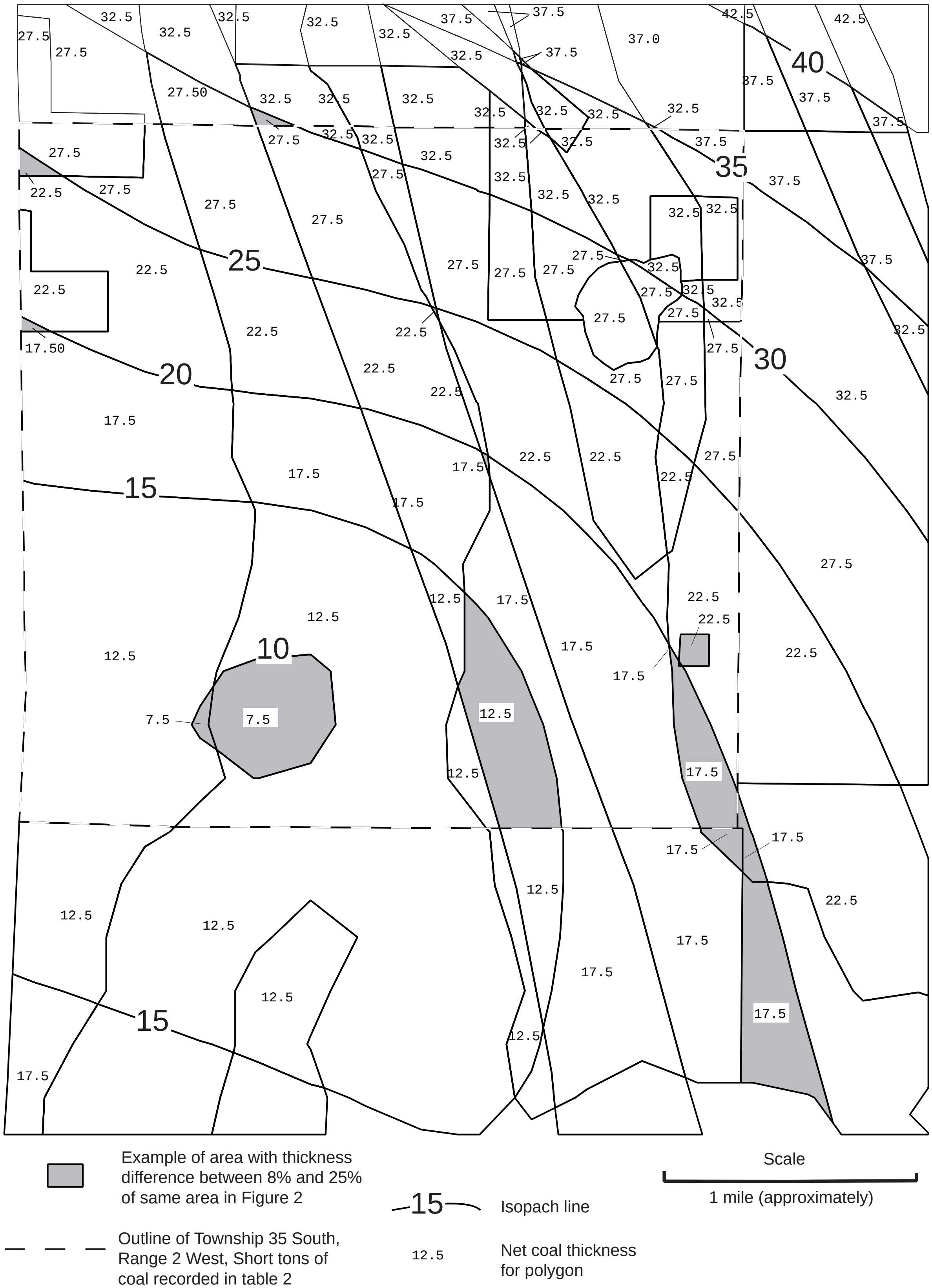

Figure 1. Net coal thickness values generated in ARC/INFO using 'convert-ism.aml' for an area in the Kaiparowits Plateau, Utah

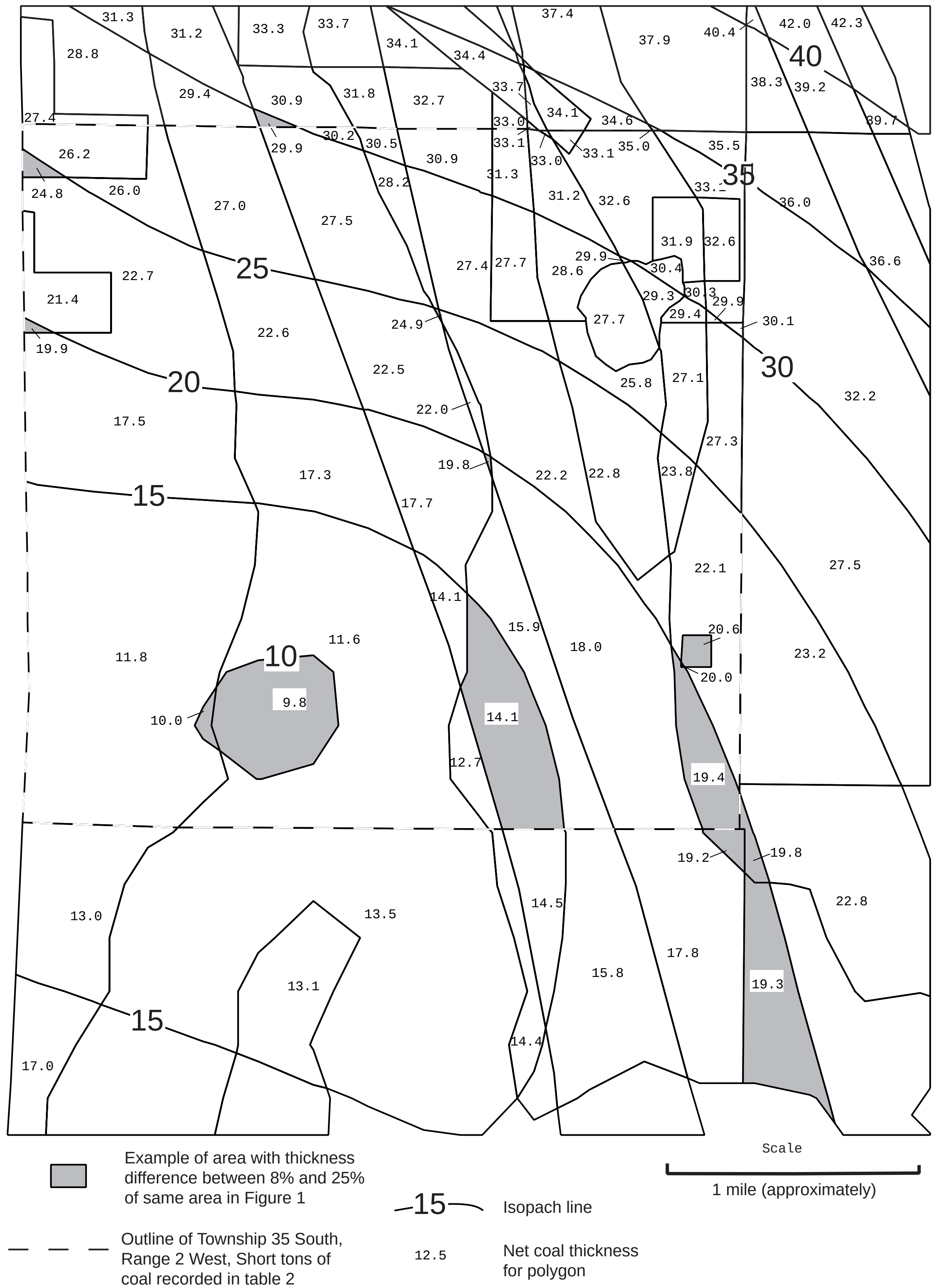

Figure 2. Net coal thickness values generated by the ’evrpt’ program from data in the EarthVision volumetrics report for an area in the Kaiparowits Plateau, Utah

Table 1. Comparison of coal resources (in millions of short tons) by County for the John Henry Member of the Straight Cliffs Formation, Kaiparowits Plateau, Utah using the two different resource calculation methods.

	EarthVision (grid method)					
	Overburden (ft)					
County	0-1000	1000-2000	2000-3000	3000-6000	>6000	Grand Total
Garfield	2814	7004	4465	11696	1748	27727
Kane	13469	9354	10981	696	0	34501
Grand Total	16283	16358	15446	12392	1748	62228
	ARC/INFO (average contour value method)					
	Overburden (ft)					
County	0-1000	1000-2000	2000-3000	3000-6000	>6000	Grand Total
Garfield	2841	6994	4464	11678	1735	27713
Kane	13532	9370	10999	696	0	34597
Grand Total	16373	16364	15464	12374	1735	62310
	% Difference					
County	0-1000	1000-2000	2000-3000	3000-6000	>6000	Grand Total
Garfield	1.0	0.1	0.0	0.2	0.7	0.1
Kane	0.5	0.2	0.2	0.0	0.0	0.3
Grand Total	0.5	0.0	0.1	0.1	0.7	0.1

Table 2. Comparison of coal resources (in millions of short tons) by Township for the John Henry Member of the Straight Cliffs Formation, Kaiparowits Plateau, Utah using the two different resource calculation methods. Township with asterisk is outlined in figures 1 and 2.

EarthVision Township	EarthVision Grand Total	ARC/INFO Township	ARC/INFO Grand Total	% Difference
33S1E	2016	33S1E	2016	0.0
33S1W	616	33S1W	615	0.2
33S2E	277	33S2E	277	0.0
33S2W	124	33S2W	124	0.0
34S1E	1712	34S1E	1711	0.1
34S1W	3523	34S1W	3527	0.1
34S2E	46	34S2E	46	0.0
34S2W	1723	34S2W	1724	0.1
35S1E	945	35S1E	939	0.6
35S1W	2163	35S1W	2150	0.6
35S2E	2	35S2E	2	0.0
* 35S2W	671	* 35S2W	676	0.7
36S1E	1865	36S1E	1841	1.3
36S1W	1431	36S1W	1433	0.1
36S2E	1414	36S2E	1415	0.1
36S2W	229	36S2W	232	1.3
36S3E	270	36S3E	271	0.4
37S1E	2920	37S1E	2922	0.1
37S1W	476	37S1W	487	2.3
37S2E	4195	37S2E	4186	0.2
37S3E	1084	37S3E	1091	0.6
37S4E	18	37S4E	21	14.3
38S1E	1314	38S1E	1314	0.0
38S1W	31	38S1W	32	3.1
38S2E	3850	38S2E	3849	0.0
38S3E	3561	38S3E	3562	0.0
38S4E	994	38S4E	993	0.1
38S5E	52	38S5E	57	8.8

Table 2. Comparison of coal resources (in millions of short tons) by Township for the John Henry Member of the Straight Cliffs Formation, Kaiparowits Plateau, Utah using the two different resource calculation methods. Township with asterisk is outlined in figures 1 and 2—Continued.

39S1E	870	39S1E	868	0.2
39S1W	5	39S1W	7	28.6
39S2E	3302	39S2E	3302	0.0
39S3E	4579	39S3E	4579	0.0
39S4E	2391	39S4E	2390	0.0
39S5E	2670	39S5E	2669	0.0
39S6E	18	39S6E	28	35.7
40S1E	136	40S1E	155	12.3
40S1W	2	40S1W	6	66.7
40S2E	1804	40S2E	1806	0.1
40S3E	3075	40S3E	3076	0.0
40S4E	245	40S4E	245	0.0
40S5E	885	40S5E	885	0.0
40S6E	105	40S6E	116	9.5
40S7E	1	40S7E	4	75.0
41S2E	541	41S2E	551	1.8
41S3E	1375	41S3E	1379	0.3
41S4E	1620	41S4E	1595	1.6
41S5E	571	41S5E	567	0.7
41S6E	2	41S6E	2	0.0
41S7E	16	41S7E	28	42.9
41S8E	1	41S8E	3	66.7
42S2E	82	42S2E	88	6.8
42S3E	318	42S3E	335	5.1
42S4E	71	42S4E	70	1.4
42S8E	4	42S8E	19	78.9
43S3E	19	43S3E	21	9.5
Grand Total	62228	Grand Total	62310	0.1