APPLICATIONS OF PRODUCING PLOTS FROM DLG DATA

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ABSTRACT

The National Mapping Division of the U.S. Geological Survey is producing digital data representing boundary and Public Land Survey information derived from standard Geological Survey quadrangle maps. The digital data are formatted into digital line graphs (DLG's) and archived in a National Digital Cartographic Data Base. This paper describes the use of this data to produce publication-quality boundary and land net manuscripts.

BACKGROUND

The Geological Survey has developed the capability to produce publication-quality boundary and Public Land Survey (land net) overlay plots using digital line graph data. The plots will meet National Map Accuracy Standards and will use symbology that conforms to cartographic standards for provisional mapping.

Current procedures call for Public Land Survey information to be manually plotted on a manuscript and then digitized as a DLG. A film positive of the land net information, symbolized according to provisional map standards, is then plotted using software written for that purpose by the Western Mapping Center. This digitally produced land net manuscript is then used as the basis for a buildup of the boundary information. An incomplete DLG is produced by this procedure because the Public Land Survey information is not coincidence-referenced to the boundary information.

A significant amount of opaquing and rescribing of manuscripts is required to produce overlays which meet publication requirements. Additional editing of the DLG is required before it can be archived in the National Digital Cartographic Data Base (NDCDB).

NEXT GENERATION SOFTWARE

A programming effort is underway to address the problems and shortcomings of the first-generation land net plotting program and, at the same time, provide the ability to plot boundary information. The program will allow coincident features to be plotted--or not plotted--based on a predefined order of precedence. It is assumed that fully annotated land net and boundary source material is available for DLG digitizing so the information for both overlays is spatially correct and the attribute codes indicating coincidence can be included in the digital data. The software is being written in standard FORTRAN and many of the routines will be useful for future DLG plotting.

PROVISIONAL MAPPING

As part of the National Mapping Program, the U.S. Geological Survey produces a series of Provisional Edition maps containing essentially the same information as a standard quarangle map but with a provisional rather than a finished map appearance. This reduced amount of map finishing results in a significant cost savings in map production and a shorter map completion cycle. Provisional mapping symbology for Public Land Survey and boundary overlays can be more easily computer generated than corresponding symbology for traditional 1:24,000scale quadrangle mapping.

DLG STRUCTURE

A DLG is structured so that each graph is defined by nodes, lines, and areas. The nodes are the points that define the ends of each line. The line elements contain coordinate pairs that define the position of the line. Add itionally, each line element contains spatial information that topologically describes the areas to the left and right of the line. Theoretically, there is no limit to the number of coordinate pairs which can be used to represent a line. Two coordinate pairs are sufficient, for example, to define a straight line between two section corners, but a complex boundary requires many pairs to accurately represent it. In addition to coordinate information, each node, area, and line element contains attribute codes that further describe properties of the feature. An attribute code is composed of two numeric fields: a major code that identifies the major catagory to which the element belongs, and a minor code that specifically describes the element. In the case of the Public Land Survey and boundary overlays, most of the information that describes that type of feature is contained in the area attributes.

FEATURE DETERMINATION

For the Public Land Survey and boundary overlays, each area has attributes associated with it that identify the feature codes for that particular polygon. For a boundary overlay, most areas will have the attributes of a State and a county. The major code for a State is 091 and for a county is 092. In both cases, the minor code is the equivalent Federal Information Processing Standards (FIPS) code for that particular State or county. Other area attribute codes designate civil townships, national parks, military reservations, and so forth. Line types are determined by sorting through the attributes on both sides of any line to determine the symbology that should be used to represent the feature. The standards for 1:24,000-scale quadrangle maps establish the order of precedence for representation of land net and boundary features.

Figure 1 illustrates two examples using a city boundary and a park boundary. In part A the park is adjacent to the city but outside the city limits. The common line between the two has a city attribute (90.101) on one side and a park attribute (90.151) on

the other. The city boundary symbol will take precedence. Part B illustrates a variation of the same situation. In this case the park is contained entirely within the city limits. The lines representing the park have a city attribute on both sides and a park attribute on one side. Although the city attribute takes precedence, the program assumes that since 90.101 appears on both sides of the line, there is no city boundary, so the park boundary symbology will be plotted.

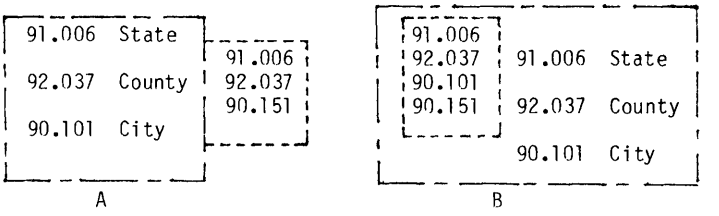


FIGURE 1--Example of symbology precedence.

LINE ATTRIBUTES

Additional information which may affect line symbology is provided by the line attributes. For boundaries, line attributes are used to define approximate, indefinite, disputed, or historical lines. For land net, the attributes define approximate or protracted lines, arbitrary closure lines, and base lines. For plotting purposes, lines with one or more of these attributes may require a reduction in line weight, line annotation, or perhaps a change in line symbology. An indefinite boundary will have normal symbolization but will be labeled as indefinite. An approximate section line will be plotted as a dashed line, rather than as a solid line.

NODE ATTRIBUTES

The node attributes supply specific information describing the feature positioned at the node location. For the boundary overlay, the nodes might be coded as boundary monuments or turning points. For the Public Land Survey data, the attributes would identify U.S. Public Land Survey section corners, closing corners, meander corners, witness marks, reference marks, and other appropriate marks. An additional attribute would designate corners which were identified in the field and corners with horizontal coordinates or elevation values. Again, for plotting purposes, these attributes would determine the symbology for the monumented features.

COINCIDENT FEATURES

Attribute codes are applied to lines or nodes to designate coincidence for features which occupy the same spatial position on more than one overlay. This code determines if a line should be plotted or not based on a hierarchical scheme. For example, a section line or boundary may be coincident with a road. For a double line road, major boundarys are plotted with a reduced line weight and placed between the two road casings. If a boundary is coincident with a section line, the boundary takes precedence and the section line is omitted from the land net plot.

SYMBOLOGY

In the program being developed, the symbology will conform to standards for publication symbols for 1:24,000-scale primary quadrangle mapping. A flatbed plotter capable of making photo plots will produce line weights and dashed line symbology which will meet these standards. Because pen plotters or electrostatic plotters do not have the same aperture selection capability as a film plotter, line weights of plots produced on paper will not meet standards in

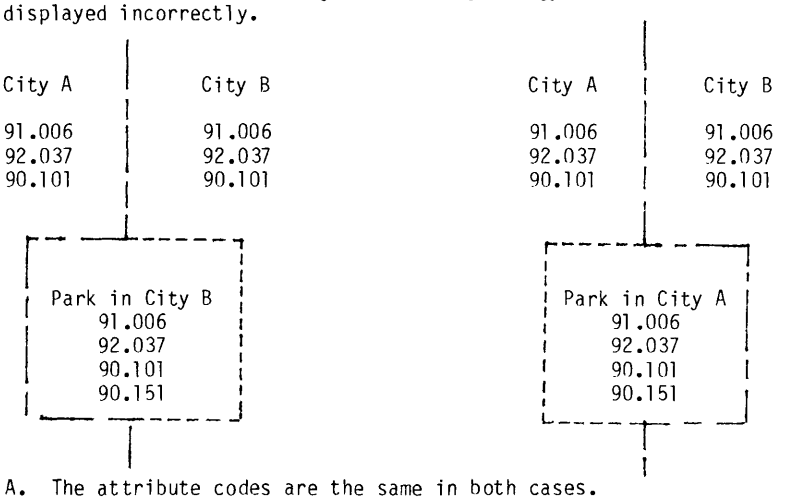
PROBLEMS

There are cases where deficiencies in attribute coding results in incorrect line type determination. This often happens in complex urban areas. Unique situations have surfaced in southern California because of the combination of land grants intermixed with public land surveys. Two identical feature types which join at a common line frequently cause problems. Figure 2 uses two examples to illustrate how attribute codes may not always uniquely identify line symbology.

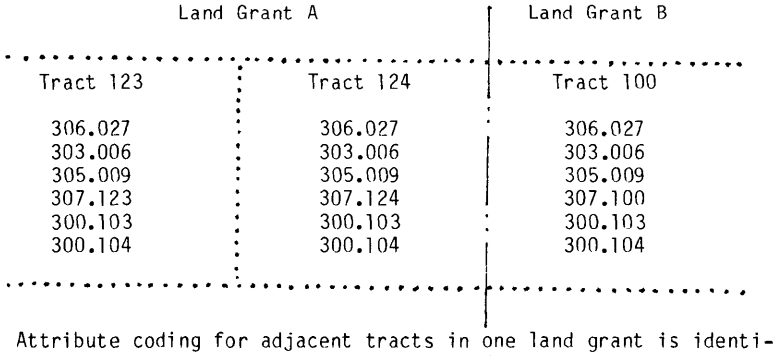
This problem can also cause misplaced labels for sections and tracts. A section or tract intersected by a line is treated as two polygons, and under the present programming scheme, each polygon is labeled separately. The placement of labels in irregularly shaped polygons may not be correct. Although plots produced by the present software are positionally correct, some capability needs to be developed which will allow editing of line symbology and label placement. Editing could be accomplished by an interactive interface or it could be in the form of correction overlays.

ADVANTAGES

There are many advantages to working with data in digital form. Plots can be made at any reasonable scale. Any combination of feature types can be plotted. Editing and replotting of overlays can be done easily and quickly. One very important feature that surfaced from symbolized plots is the ability to use the plots as a quality control check on the attribute coding. When an attribute code is incorrect or missing, the line symbology will often be displayed incorrectly.



A. The attribute codes are the same in both cases.



B. Attribute coding for adjacent tracts in one land grant is identical to coding for adjacent tracts in different land grants.

FIGURE 2

In these examples, the line symbology is not uniquely defined by the attribute codes.

CONCLUSION

DLG data can be used to produce symbolized land net and boundary manuscripts that meet publication requirements for provisional mapping with a minimum amount of editing. Techniques need to be developed which can be used to correct line symbology and label placement. A very important fallout of this programming effort will be the use of symbolized plots to quality control DLG attribute data.

SELECTED REFERENCES

Allder, W. R., and Elassal, A. A., 1983, Digital Line Graphs from 1:24,000-Scale Maps: U.S. Geological Survey Circular 895-C, 79p.

Allder, W. R., Sziede, A. J., McEwen, R. B., and Beck, F. J., 1983, Digital Line Graph Attribute Coding Standards: U.S. Geological Survey Circular 895-G, 31p.