RASTER TECHNIQUES IN GEOLOGICAL MAP PRODUCTION

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ABSTRACT

The British Geological Survey has achieved significant reductions in the time and cost of producing selected maps in their 1:50 000 Series by raster scanning the initial compilation and raster plotting the final artwork for off-set litho plate making. Raster techniques involve little change to the earlier compilation stage other than preparing the linework on separate overlays. Line types are automatically coded on the basis of colour or thickness. Areas are coded by scanning overlays which have symbols positioned over each polygon. Alternatively the codes can be entered by digitizing or editing. For each colour plate required, a single plot on photographic film is produced containing all the percentage tones. This avoids the time consuming and error prone task of manually producing hold-out masks for the multi-exposure photographic method of producing a combined film positive for plate making. The raster plots can be accepted by any cartographic printer and the printed maps appear identical to those produced by conventional methods. Digital tapes are a useful byproduct.

INTRODUCTION

The British Geological Survey (BGS) has been producing and publishing geological maps for 150 years and during that period many new methods and materials have become available to the cartographer. Techniques such as colour printing, scribing and phototypesetting have been assessed and adopted as part of the standard method of map production because they offered improvements in quality or cost over existing techniques. This paper describes the introduction of high resolution raster scanning and plotting to replace the labour intensive scribing and hold-out mask preparation stage of 1:50 000 Series geological map production. Raster plotting is particularly suitable for these thematic maps which require areas of colour ornament or tone and appears to offer the greatest benefits for complex maps with many areas and classifications.

BGS first became aware of this method at the Eurocarto symposium at Oxford in 1981 where the Institut Geographique National (IGN) of Paris displayed some colour printed maps produced using raster devices.

EXPERIMENTS AND DEVELOPMENT OF METHOD

Initial Experiments

A fairly simple 1:50 000 Drift map of the Aberdeen area was chosen for the first experiment. This map had recently been produced and published by conventional means. The use of existing artwork saved draughting effort and offered a direct comparison of quality. One requirement of the new method which was not met by the conventionally prepared material was that every area requiring ornament or tone on the final map must have a continuous line around its boundary. There were many instances where lines of no geological significance had to be added to create closed polygons. For example, open water areas which are left uncoloured. To obtain these boundaries for the Aberdeen map, the open water area mask component for the topographic base map was raster scanned at 16 lines per mm and vectorized. It was then combined with the scanned geological lines to complete the areas. Only simple codes to meet the cartographic requirements were used with area coding performed interactively from guides supplied by BGS.

To demonstrate the system's ability to match existing maps, two colour proofs were produced. One from plots simulating the BGS colour scheme and the other simulating standard process colours. The plots were produced at a resolution of 16 lines per mm and combined with the topographical base map and text overlay at the colour proof stage. The overall impression was favourable, apart from the linework which although positionally accurate had an obvious staircase effect at this resolution. The results were encouraging enough to continue evaluating the method and a slightly more complex 1:50 000 Drift map of the Kintail area was prepared for raster scanning. The geological lines were drawn onto an overlay in register with the base map and scanned with the open water areas masked in a similar way to the previous map. The coding, plotting and colour proofing procedures were also the same as in the initial experiment with the process colour scheme chosen for final printing.

As a result of these experiments raster scanning and plotting gained acceptance as a fast, cost-effective alternative to scribing and tone preparation for 1:50 000 Drift maps. The geological data were also available as digital files in raster and vector form as a by-product. No attempt was made to structure the data as this would not have provided a true cost comparison with the normal method, but even so the digital data has been integrated with other digital data sets and displayed on in-house computer graphic systems.

Development of the method

The next stage of development was to use the method with more complex solid geology maps containing more line types and area classifications than the simpler Drift maps. Compilation of the 1:50 000 fair drawing from the 1:10 000 source material requires experience as well as close contact with the field geologist. A selection of the 1:10 000 geology is extracted onto an overlay along with relevant topographic features and then reduced, further generalised as required and adjusted to fit the topography of the 1:50 000 base map. As described earlier, for raster scanning the lines are drawn onto stable film overlays held in register with the base map by punch holes and studs. To avoid the cost of purchasing and scanning the open water mask, the water boundaries were drawn onto the geological line overlay. This will be unneccessary when the topographic data are available in digital form. Keeping the topography in registration is more difficult with the raster scanning method than previous methods where the geology was drawn directly onto the base map. However, the overlay allows the information to be presented to the scanner clearly and not cluttered with topography. It also allows line types to be coded automatically by scanning separate overlays.

Line coding can be achieved in a variety of ways. Using a colour scanner, lines can be drawn in coloured inks and the scanner set to identify them. This is an attractive solution, it allows up to 12 colours to be shown on one overlay which reduces scanning costs and improves registration. Unfortunately, it is not easy to maintain a uniform line colour due to ink flow and colour mixing where lines intersect. Similar problems arise with monochrome scanners when using line thickness to automatically code line types. The band widths required to uniquely identify each line type while allowing for variations due to ink flow, limit the number of lines possible on one overlay.

At present each map is assessed individually and the most suitable method chosen. In some cases where the vast majority of lines are one type, it is easier to leave the line classification to the interactive editing stage after vectorisation. If the lines require a lot of structuring, such as chaining many segments together to identify a fault line running across the map, it may be easier to vector digitize the lines. These can be incorporated using standard interchange format programs and raster plotted along with the area tones and ornaments. Raster scanning does have the advantage of accurately reproducing the lines drawn at the compilation stage. Scribing and manual vector digitizing methods tend not to follow the lines as accurately.

BGS experience is that bureaux offering raster scanning do not recommend the use of the colour scanner. The newer monochrome scanners operate over 7 times as fast rotating at 1000 rpm. Scanning costs are directly related to the area scanned and the resolution required. An average map 80 cm wide takes approximately 25 minutes to scan using a resolution of 30 lines per mm. The quality of these lines when plotted at the same resolution are indistinguishable from conventionally scribed lines under normal conditions.

For the 1:50 000 Series Solid map of Reay, six line types were drawn onto one overlay using coloured inks and successfully scanned and classified using a colour scanner. The lines were then vectorized to produce enclosed polygons and the areas coded. Again the colour scanner was used to automatically code the areas. Colour dots were positioned over each polygon on overlays. With a maximum of 12 colours per overlay, three overlays were required for this task. A similar technique can be used with monochrome scanners where dots or symbols of different sizes can be automatically identified. Alternatively each area can be identified by x-y coordinates and coded using a digitizing table. These methods avoid the effort of preparing explicit instructions for the operator and save time on an expensive editing system.

The raster data for the Reay map were plotted on photographic films at a resolution of 30 lines per mm. Four films were produced, one for each of the process colours - yellow, magenta and cyan - and one for the black lines. This, like scanning, is a fully automatic process and the cost of producing each plot is determined by its area and resolution, not by the number or complexity of the lines nor by the number of tints required. This is the stage where the major benefits of the raster method become evident. The labour intensive preparation of hold-out masks and photographic combination of screened areas is avoided.

The proofing method used so far has been chemical proofing rather than off-set litho proofing. As a consequence the proofs do not show the true colours that will be present on the final printed map, but these proofs are considerably cheaper and are adequate for checking line codes, area codes and the registration of topography, text and symbol overlays. One problem with the Reay map occurred after the proofing stage. When the printer photographically combined the black plate, topographic base map and text overlay a certain amount of distortion occurred which resulted in a slight loss of registration between the black and the other colours. To minimise the possibility of this recurring a different procedure was adopted. The topographic base and the text overlay are scanned, brought into registration with the geology within the raster system and plotted together. The topography is digitally screened to appear grey on the final map. The extra cost of scanning the topography and text are offset by the reduction in photographic costs and there is no additional plotting cost. The advantage of having everything combined and checked makes the plate-making and printing task much simpler, enabling BGS to approach a wide selection of printers to tender for the final printing work.

Low cost editing systems have recently become available. These will require new skills but will allow BGS to accept digital data from the scanning process, code and edit the data and then return it for raster plotting. Reducing these scanning, plotting and printing stages to routine tasks will reduce external costs.

Success with the 1:50 000 Series has led to the method being considered for other map series, such as the 1:250 000 Geochemical Atlas maps. Speed of scanning and plotting have been important factors in preparing a generalized geology of Britain for the BBC's Domesday Project. Another application was the production of a digital terrain model produced from contour information for the Southampton area. This will be combined with surface and subsurface geology in a spatial model (see Loudon, this volume). Experiments have also shown that the tape can be linked to digital satellite imagery and can be processed with other data sets using image analysis facilities.

CONCLUSIONS

Raster scanning and plotting has proved useful in reducing cost and time in map production. It has been readily accepted by cartographic staff within BGS. Their compilation work remains essentially the same as before.

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