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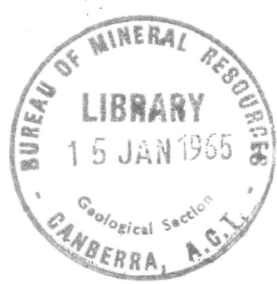
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THE PRODUCTION OF GEOLOGICAL MAPS IN THE BUREAU OF MINERAL RESOURCES,
AUSTRALIA

by

K.A. Townley

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THE PRODUCTION OF GEOLOGICAL MAPS IN THE BUREAU OF MINERAL RESOURCES,
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K.A. Townley*

* I have drawn very heavily in this account of the activities and methods of the Bureau's geological drawing office on the expert knowledge of Mr. E.H. Morgan, Chief Draftsman; Mr. H.F. Bolts, Assistant Chief Draftsman; and Messrs. H.F. Douth, P.A. Bockenstein, and R. Hennig, Section Leaders in the Drafting Office.

INTRODUCTION

The Geological Branch of the Bureau of Mineral Resources employs about 120 Geologists; and nearly all of them are busily producing maps, plans, sections, sketches, and so on practically continuously. The requirements cover a wide field of drafting expertise, from the meticulous finish of a published coloured map to the rapid sketch for an unpublished Record, and from fossil drawings to complex tabulated charts. Some take half an hour to draw, some two or three months; some are suited to one draftsman's temperament, some to another.

So perhaps one should start by listing the desirable skills of a geological cartographic draftsman: all draftsmen must have some of these skills, and some should have all of them.

1. Pennmanship: Pennmanship is becoming less and less important to the draftsman, as scribing and stick-up lettering come more and more into use; but there are still many jobs for which there is no substitute for good pennmanship: illustrations of fossils; three-dimensional topographic diagrams; pen and ink drawings from photographs; rapid sketch maps; and so on.
2. Ability to design: Designing can be subdivided into three main attributes. Colour design is a vital part of any geological draftsman's abilities: to a large degree a geological survey is judged by its peers on its coloured maps, and a design that is completely functional, unambiguous, easy to read, and if possible aesthetically pleasing, must be achieved;

and this can only be done by experts. LAYOUT DESIGN applies to all drafting jobs: again it must be functional, unambiguous, and easy to read; and it must also be economical - wasted space is wasted money in printing. The third sort of design I have no name for, but it is both common and important: it is needed when a geologist has a problem of presenting such-and-such an idea visually, or correlating a whole set of facts and interpretations, with no more than the vaguest notion of how it can be done. That is the draftsman's task: to grasp the idea and translate it into a diagram with the maximum impact.

3. Knowledge of geology: All geological draftsmen must know at least enough geology to interpret hints and signs correctly - just as a typist must know enough geological terminology to interpret bad handwriting. They should know a good deal more than that, for there is a big gap between the draftsman who does not hinder the geologist and the one who is a positive help. The draftsman needs also the ability to generalize information to the requirements of scale.

4. Ability to compute: The draftsman must be able to compute his own base.

5. Knowledge of printing processes: A knowledge of the tolerances and limitation of various printing methods is essential to all draftsmen. The designer of coloured maps must know such more: enough to be able to talk on equal terms with the lithographic printer.

6. Steadiness under fire: There are never enough draftsmen for the work in hand - that seems to be an immutable law. So the draftsman must be able to work without error under pressure.

I have omitted from this list the abilities in common to all draftsmen - techniques, instrumentation, media, and so on - because they are obvious.

ORGANIZATION AND STAFF

The B.M.R. geological drawing office is divided into three sections, each of which is concerned with one aspect of the work (though when the pace becomes more than usually hectic, work may overflow from one section to another). One deals with production of coloured maps of the 1:250,000 and similar series; one is concerned with drawings for publication; and one with 'general drafting'. The establishments for the sections are: 10 in the 1:250,000 Sections; 11 in the Publications Section; and 11 in the General Drafting Section; but I cannot remember when we were last up to strength. Out of the Publications and General Drafting Sections come the draftsmen attached to field parties, a requirement that varies from year to year.

Preparation of Coloured Maps (The '1:250,000' Section)

The Bureau is producing 20 to 25 multi-coloured maps a year. We therefore lack staff to undertake the full processing of a map, and fairdrawing is let out to contractors, under strict supervision.

The base map is generally provided by the Division of National Mapping or the Department of the Army as transparent diase contact prints from planimetric photo-scale compilations; and the geologist or field draftsman makes his compilation on this, in the field, from data plotted on air-photographs or on transparent overlays of air-photographs. Most air-photographs in use are at a scale of about 1:50,000; but new surveys are being flown at 1:60,000.

We prepare a 1:250,000 graticule on 'Australon', and the field sheets are photographically reduced to transparencies at the same scale and fixed in place on the graticule. Contact prints from this assembly serve as working sheets on which geological detail may be amended and generalized in preparation for the making of plates for the 'preliminary edition' maps, which are produced as soon as possible after the fieldwork is completed. Geological units are indicated by letter-symbols so that uncoloured copies of these maps are readily usable.

For the 'preliminary edition' we procure, if they are available, copies, on clear stable material, of the base-map plates that have been or will be used for the National Topographic Series. Sometimes they carry too much detail, which would obscure the geology, and have to be modified. The geological plate having been prepared separately, as described above, a composite print of the two is hand-coloured as a check for corrections, and the map is edited, though not in the meticulous detail needed for our final, coloured, series.

The 'preliminary' map is printed by photo-offset, in two line colours: the geological plate in black and the base plate usually in green; we have found that each is easily read with this contrast. One copy of the printed map is hand-coloured and photographed: the plate photographic colour transparency can be lent to any user of the 'preliminary' map who wishes to colour his own copy.

The preliminary map serves as draft copy for the final map; it is checked and where necessary amended by the author, and then edited in meticulous detail by a map-editor (who is a geologist, not a draftsman). Meanwhile, the Drawing Office prepares specifications for fair-drawing and designs the layout. A copy (on stable transparency) of the corrected map, a coloured print, the marginal data layout, and a copy of our standard layout sheet, which lays down standard for line weights, type styles and sizes, dimensions of symbols, and so on, are despatched to the contractor. (We should be happy to send a copy of this standard layout sheet to any Survey who might like one). For proofing purposes the contractor must give us contact prints of each plate, and a composite contact print. The final delivery is in the form of autopenitive or deep-etch copies of the fairdrawing on dimensionally stable plastic.

The contractor uses, as we do ourselves, scribing techniques, and photo-set lettering - including standard diagrams - on stripping film. The number of plates varies with the complexity of the map; we may require as

may as four - geology; cultural detail; hydrographic detail; and contours or dunes. Adopted geological symbols and repetitive words are available to the draftsman on a set of 16 standard negatives of which film or strip film positives can be made.

The colour design for the final map is made on a composite print from these plates. We have found it profitable to appoint a senior draftsman as colour designer, and he does nothing else. The importance of the design is multiplied many times by the need to produce a colour pattern that will apply not just to one map but to a whole group of contiguous sheets - our largest group so far, for instance, has been 17 sheets. His design is criticized and approved by a panel consisting of the author, a map editor, and the section leader of the '1:250,000 Maps' section of the drawing office. Colours have been allocated, with specified printers inks, to various geological ages by an Australia-wide committee, and a large range of screens enables the designer to distinguish formations by variations of tint or pattern. We recently published a booklet showing the range of colours and their variation through the screens that we possess. We do not use three or four colour printing, except for small scale, generalized geological maps - of Australia for example; it is too difficult to obtain the accurate delineation of tints in the 1:250,000 series by this method. Each colour is printed separately.

We now use little solid colour on our maps: our earlier maps used a good deal of solid colour, but gave a heavy, unbalanced appearance, and background detail was hard to read.

Colour Printing Several firms in Australia are undertaking the printing of our coloured maps. At present we specify deep-etch plates for printing, but other processes are developing to the point where we can accept them. The inks and paper specified are made in Australia - the inks by Collie's, and the paper by Australian Pulp & Paper Mills, a 90 lb quad Crown Offset which we have found as dimensionally stable as any; and it does not quickly lose its white colour.

Copy to the printer includes a fairdrawn plate for each line press plate and a colour guide, which is a composite print hand-coloured in printers ink. The inks and screens to be used are marked on the colour guide. The printer does all the preparatory artwork - that is, masking and application of screen patterns to a master plate for each colour used. From these he makes a dye-proof on white stable plastic foil, on which errors and omissions are spotted. Small errors we correct ourselves, but large ones are the responsibility of the printer. The object of the dye-proof check is to correct errors easily and cheaply before printing plates are made. Colours in the dye proof are not expected to match the final colours, but the closer they are the easier is the checking of the machine-proof later.

From the corrected masters the printer makes his press plates, and runs a machine proof. This provides a check on colour control, though not an infallible one, and on plate-making; and serves also to show whether the errors found in the dye-proof have been corrected. Furthermore, the machine proof has made it unnecessary to have a draftsman in attendance during the printing run to make any on-the-spot adjustments to colours.

Illustrations for Bureau Publications

The section leader concerned with illustrations for publication has provided the following notes. I may preface them with an outline of the state of copy provided. This ranges from reasonably accurate drawings through rather hasty scrawls to no drawing at all, but only a desire to have a point illustrated in some way to be devised by the draftsman and acceptable to the author. Many of the more complicated charts and graphs fall into the last category. Drawings of fossils have often to be made from the specimen, with the points of emphasis indicated by the author.

"Illustrations are drawn on linen, using waterproof ink or on plastic prepared with PKS cleaner and Palikan K ink or coated ink matte fixative and using T ink.

A suitable scale is chosen for the finished drawing, size being limited to $5\frac{1}{2}" \times 7\frac{1}{2}"$ for a text figure and the minimum size at which

legibility is retained for a plate. If the area covered by a figure is that of a 1:250,000 sheet, 1:1,000,000 scale is normal, the sheet boundaries being taken from an ICAO map.

Text figures and most plates are for reproduction in black and white, and consequently line weights are of the utmost importance. A structure map may have five or so line thicknesses, allowing immediate recognition of a particular feature. Geological or topographic figures do not usually have such a variety of line weights, but extensive use is made of hand or mechanical stipples, screens and symbols.

These figures may be drawn at a larger scale than that proposed for publication, greatly diminishing the need for fine line-work, but care must be exercised in the choice of line weights and screens which may disappear or "block in" when reduced.

On completion of the drawing a diase print is supplied to the author for checking purposes. After checking, a camera or contact negative is made of the drawing. This negative is carefully "duffed" and "needled" and forwarded to the printer for block making.

When text figures are being drawn, consideration is given to the balance of presentation to give a pleasing effect, as well as the best method of conveying the message to the reader. Positioning of reference, scale bar, and title for the best utilisation of the limited space available, and selection of screens, etc. over small or large areas and where it is necessary to accentuate some feature are considered.

A variation of the topographic map or figure is the physiographic block diagram. This is usually drawn on linen using waterproof ink, and can be either perspective or isometric, the former being suitable for large areas and the latter for small topographic or geological features.

Fossil sketches for palaeontological publications require a variety of approaches. They may be sections, outline sketches, or sketches shaded by continuous tones or fine lines. Sections and outline sketches are usually drawn on linen with waterproof ink. Sketches shaded by continuous tone are made on matte plastic or good quality white paper, using soft pencil.

On completion they are coated with a matte fixative to prevent smudging, are photographed, and prints made on fine-grained soft matte bromide paper. The originals are supplied to the printer together with a print indicating features to be high-lighted.

Sketches shaded with fine lines are usually ink on linen, fine pen lines showing relief. This gives a much coarser result than the pencil shaded sketches which show the subtle tones normally obtained by photographic means."

General Drafting

The third type of drafting undertaken is the production of drawings and charts for Records, memoranda, and so on, which are not published, but have a restricted circulation among interested people. A few of the drawings will later be used in publications, but for the most part the emphasis is on speed, accuracy, and legibility, rather than meticulous draftsmanship. Well logs, stratigraphic sections and correlations, tenement and lease maps, fossil distribution charts, mine plans and sections, and sketch maps of all kinds form the bulk of the work, though the overall variety is almost endless.

Quality of copy is very variable: some is so good that only a neat tracing is needed, but mostly the draftsman has to act as his own designer - and frequently as editor as well. The variety of type and quality of copy makes it necessary to adopt a fresh approach to each job. Speed and versatility are the essential qualities in the draftsman, and these are fostered by permitting individual styles, within limits.

Almost all work is for black-and-white reproduction, mostly by diazo, or blueprint. Stable plastic-base materials are of limited value, because they can be damaged by direct plan-printing methods, and the extra step of making a negative for blue-printing is not always justifiable. Therefore the section most commonly uses tracing linen, except when overlay register or strict scale-maintenance is required. Linen has the extra advantage of durability and long life in file. Lettering is mostly done with mechanical aids (Leroy & Letraest), hand-lettering being used only for the roughest or most intricate jobs. Stick-up lettering is used,

occasionally, and only when a photographic step cannot be avoided: stripping film for a contact negative, photo- or type-set lettering for a camera negative. Conventional signs, lithology, etc., are frequently depicted by stick-on screens and patterns such as Letraset or Zip-a-tone, but hand work is often necessary. With stick-on patterns there is always a risk of peeling during plan-printing, and as a precaution a negative is usually made before running off quantities of blue print or bromide copies.

PHOTOGRAPHY

A photographic laboratory is part of the drawing office. It is an all-purpose unit, photographing rocks and fossils, making photomicrographs, copying on microfilm, making slides, and printing and enlarging in both black-and-white and colour. The drawing office has a constant demand for scale enlargements and reductions of geological maps; for stripping film; for printer's copy (for many illustrations we prefer to send the printer a photographic copy rather than the original, to obviate the risk of loss or damage, particularly where stick-on lettering or screens have been used); and for half-plate colour transparencies of our hand-coloured copies of Preliminary Series maps. Some of the larger maps are beyond the capacity of the photographic laboratory, which has no process camera, and for such work we have to turn to other Government or commercial agencies.

TRAINING

Cartographic draftsmen are in short supply in Australia, and we have found it impossible to fill all vacancies for trained draftsmen. We have therefore had to institute our own training programme, taking in youngsters straight from school and holding them against higher positions until they grow into them. We encourage them to attend University or Technical College courses, but there are none in Canberra which cater for cartography as such, and training must therefore be 'on the job'. The General Drafting Section usually gives the newcomer his initial training, which rather militates against its efficiency as a production unit; but we expect the system to pay big dividends in the long run. When the trainees reach a certain degree of efficiency, they are

transferred to the other sections for further training in more specialized techniques.

INSTRUMENTATION

The instruments used in the Geological Drawing Office, and our impression of their efficiency, are:

Le Roy

Standard lettering templates in all sizes are indispensable in the General Drafting Section. They wear well and justify the outlay.

Letraset

Transfer lettering is preferred for titling and important lettering and for display work. It is usually sprayed with Faber's Nupastel Fixative before plan printing. A sample sheet made up of our standard signs and symbols is available to anyone interested, and can be bought in any quantity.

A Vari Typer Headliner 845

This provides stick-up lettering in a number of styles down to 12 pt. size, and USGS standard lithological symbols, in columnar section/log column form. The machine is a trifle temperamental in processing and spacing, but not unduly so.

Stick-on Patterns

Of the various stick-on screens and patterns Graftone is displacing Zip-a-Tone because of better quality printing. It is also surface printed, that is, patterns can be scratched out easily to clear map detail, and the surface takes ink amendment. Baxter, Contact, and Plastitone have troublesome adhesives.

Optical Pantographs

Two optical pantographs, the Grant and the Map-O-Graph, supplement photographic enlargement/reduction processes, for simple jobs, air photo rectifications, and in times of heavy work load. Neither has proved very robust mechanically, and we are considering replacing them with, or adding, an Omniograph, which our Geophysical Drawing Office (in Melbourne) is finding entirely satisfactory.

B.M.R. Cartographic screens for Reproduction

About 80 screens and patterns are available on film. Not all are of the highest quality. Klincksch screens are most satisfactory. None of our present screens is large enough to cover our series maps and sometimes has to be joined along grid lines. Therefore, new large percentage line screens are on order, 32" x 24" in size with 133 lines per inch. Line screens do not increase in weight as easily as dot screens in printing.

B.M.R. Standard Negatives

16 Standard negatives are available to contractors and State Geological Surveys, showing adopted geological and topographical symbols and repetitive type. Stripping film can be made for stick-up. As a result greater uniformity of our 250,000 sheets, drawn by various organizations, has been achieved.

Stabilene Scribing Material

All B.M.R. scribing is done on stabilene. This material is dimensionally stable and scratchproof, whereas Astracscribe is easily damaged and scratched. No other scribing materials are available in Australia at present.

Astracscribe Scribing Tools

These are low in cost and satisfactory in performance. More expensive instruments have little advantage and cost 6-8 times as much.

Register Punch

A register punch produced by A.C. Watts, Sydney, has proved useful in maintaining good register on a map drawn on several plates. Sheets are prepunched from compilation stage to final copies for printing. Register studs are inserted into the holes and hold sheets in correct position during work.