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COLOUR PRINTING OF GEOLOGICAL MAPS

BY

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The lithographic process of colour printing briefly described here has been in constant use since 1899 for the reproduction in colours of the maps of the Geological Survey, Canada. It is an application of the same principle applied in three-colour halftone printing, whereby all colours, tints, hues, and shades are produced by the superposition of impressions in yellow, blue, and red from specially prepared copper plates, called halftone blocks.

The three above-mentioned colours have, from early times, been known as the *primary*, *fundamental*, or *elementary* colours in the textile arts and in painting. They yield practically all the colours of nature when their pigments are mixed together in various proportions; green is obtained from mixtures of yellow and blue, orange and buff from mixtures of yellow and red, violet and purple from mixtures of blue and red. Mixtures of the three pigments, which theoretically should produce black, give, on account of impurities, brown colours. This physical property of the colours forms the basis of trichromatic printing, in which case the colour effect of the mixture of pigments is produced automatically during the progress of printing.

It should be noted that mixtures of pigment colours, and not colours of the solar spectrum, are here dealt with. Spectrum colours are components of daylight or white light, whereas pigment colours (artists' colours, pastels, printing inks, etc.,) are the unabsorbed components of white light which render those pigments visible. The three fundamental spectrum colours, or colour sensations, are *red*, *green*, and *violet*, which, if combined in proper porportions, will form white light. Red and green combined yield yellow; green and violet combined yield blue; and violet and red yield purplish red or carmine. A yellow pigment emits yellow colour because it absorbs one of the components of white light, namely, the violet rays. Likewise, a blue pigment absorbs red rays and a carmine pigment absorbs green rays. In other words, the primary pigment colours, yellow, blue, and carmine, are residues of primary colour sensations of red, green, and violet, unabsorbed by the pigments, whereas pigment brown or black is the result of a more or less complete absorption of white light.

In geological map printing, the object in view, exclusive of the topographical base, is to produce the legibility, distinctness, and contrast requisite for clear illustration of the geological formations and features.

Different parts of a map require to be represented by deep and light colours so disposed that the above conditions are satisfied, and yet a pleasing general effect also produced. It follows that the colours should not, as in photographic halftone printing, blend in an infinite gradation of tones, but that a limited number of well-defined colours and tints of uniform range of depths should be selected.

The desired result is obtained in this process by the use of flat colours (pigments with admixture of white to a determined depth of colour), in combination with line-tints of same colours from finely ruled transfer plates. When flat colours and line-tints are laid on three printing stones, with plate rulings in appropriate positions, and are printed over one another in yellow, blue, and carmine inks, all the colours will be produced with the required contrast and distinctiveness.

By the use of ruled, patterned, or stippled plates of various weights, a great number of colour distinctions or effects may be produced; in practice, with few exceptions, a flat tint and one or two line-tints from parallel-ruled or cross-ruled plates in each colour are sufficient. For the maps of the Geological Survey, Canada, satisfactory results are uniformly obtained by using each primary colour in full tint and in one line tint from a ruled plate the lines on which are $\frac{1}{200}$ inch thick, and $\frac{1}{100}$ inch apart. Such a ruling when printed in colour has a colour intensity equal to about one-third of that of a solid printing of the same pigment.

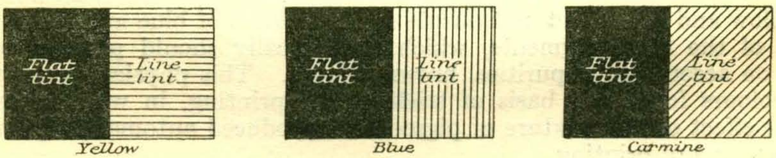

FIGURE 1. Direction of parallel rulings on printing stones.

The selection of ruled plates as well as the density of the colours should be carefully considered in view of the purpose of the intended maps. Coarse patterns or rulings are in some cases required for special features, and cross-ruling is often used.

Parallel rulings for yellow printing are always transferred to stone horizontally, for blue vertically, and for carmine diagonally (Figure 1). If more than two distinctions in each fundamental colour are required, a parallel-ruled plate with heavier and closer ruling is in some cases used in addition and in preference to one cross-ruled plate.

With cross-ruled plates, care must be taken in transferring to stone that the rulings for the different colours are laid on their respective stones in such positions that they will fall on each other at angles sufficiently large to avoid the production of motley colour surfaces. The rulings of cross-ruled plates, like the photographic halftone screens, are made at right angles; if two colours with such plates are to be printed in combination, one plate may be transferred to stone with lines laid horizontally and vertically, and the other, diagonally at an angle of 45 degrees (Figure 2 A). If the three colours are to be combined—which is seldom required—the second and third transfers must be made so that their rulings are at angles of respectively 30 and 60 degrees with those of the first transfer (Figure 2 B).

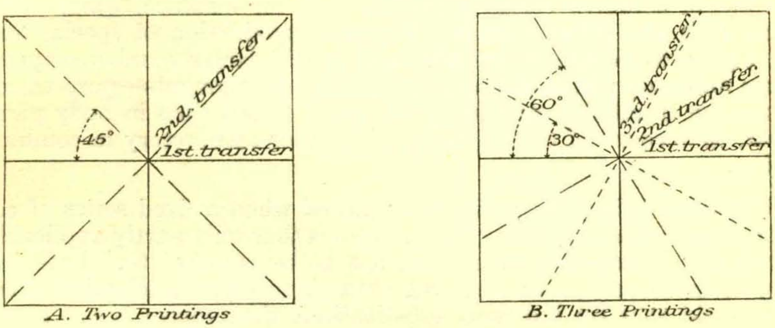

FIGURE 2. Relative positions of colour cross-rulings on printing stones.

Line-tint plates may be engraved especially for this process, but suitable plates of all descriptions are available in the lithographic trade. The process entails no difficult lithographic manipulation, and printing stones are prepared in the ordinary way by a skilled lithographic map artist who has only to follow definite specifications accompanied by copy showing the colour results, or if necessary, copy showing the required make-up of each colour stone (See Plates I, II, III, IV).

In planning colour schemes and specifications by this process for geological maps, the following conditions may be kept in mind:

(1) The selection of appropriate single or combined colours and tints for each map or set of map-sheets. Set schemes of map colouring for the whole range of geological formations, or reservation of certain colours or tints for particular geological formations on all maps, have been found to be objectionable to a degree incommensurate with the advantages of uniformity.

(2) Parallel line-tints of different colours, or combined line-tints of two or three colours, are preferable for large areas. Flat tints or combinations of flat tints are better for small areas.

(3) Flat tints of primary colours only, or extra printings in opaque colours, are best for very small features and those of special character such as dykes, symbols, etc., where the extreme precision of registration would preclude combination of flat tints.

(4) Harmony and contrast of colours should be sought, as well as selection of proper neighbouring colours and tints to avoid or counteract the distorting optical effect of one colour upon an adjacent one.

Transparent pigments as permanent as possible should be used. Such pigments should have no chemical reaction when mixed and should be as resistant as possible to the bleaching effect of strong light. They should also be well proportioned as regards their relative colouring power. The yellow, being less transparent than the other two colours, should be printed first. The map paper should be perfectly white, free of chemicals, and well calandered.

For average maps, perfect colour results may be obtained in one, two, or three printings, but for intricate maps it is in some cases advisable to make use of a fourth colour printing—grey for instance, which will harmonize with the other colours, For the reproduction of special features that require to be shown prominently, a still larger number of printings become necessary; in such cases, so-called body pigments—pure vermilion, ultramarine, gamboge, etc.—may be used. Ruled tints in body pigments are not, on account of their opacity, altogether satisfactory in combination printing.

Difficulty is in some cases encountered when a fixed series of colours must be rigorously followed. The process is then only partly applicable and flat printing in separate press runs has to be resorted to. It is seldom, however, that a scheme of colouring—that is to say, the selection of colours—is so rigid that by judicious substitutions the process is not adequate. Some advantage is gained, in certain cases, in modifying the hue of the primary pigments by admixture in small proportions, of other colours or black.

The advantages of this process over ordinary lithographic colour printing, particularly when large editions of maps are to be printed, are, mainly, uniformity of results, accurate registration or fitting of colours owing to the paucity of printings, and economy in the cost of production, the press work being reduced to a minimum in time and labour.

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The accompanying chart. Plate IV, shows the result of superpositional printing in the three fundamental colours, yellow, blue, and carmine, in all possible combinations, from three lithographic stones prepared, each with one full tint and one line-tint. The twenty-six colour distinctions thus produced have, in practice, been found to meet all ordinary requirements for geological maps.

YELLOW IMPRESSION

PLATE I

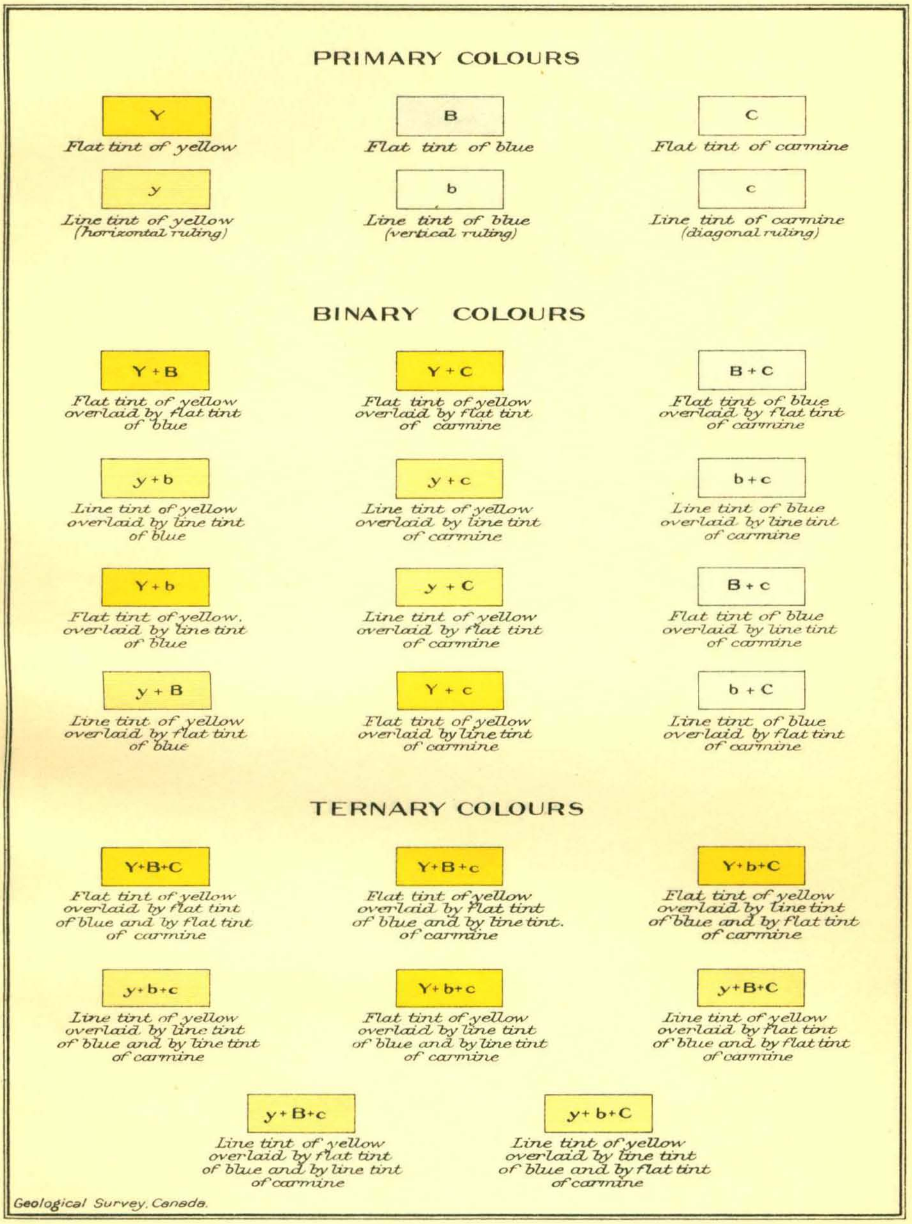
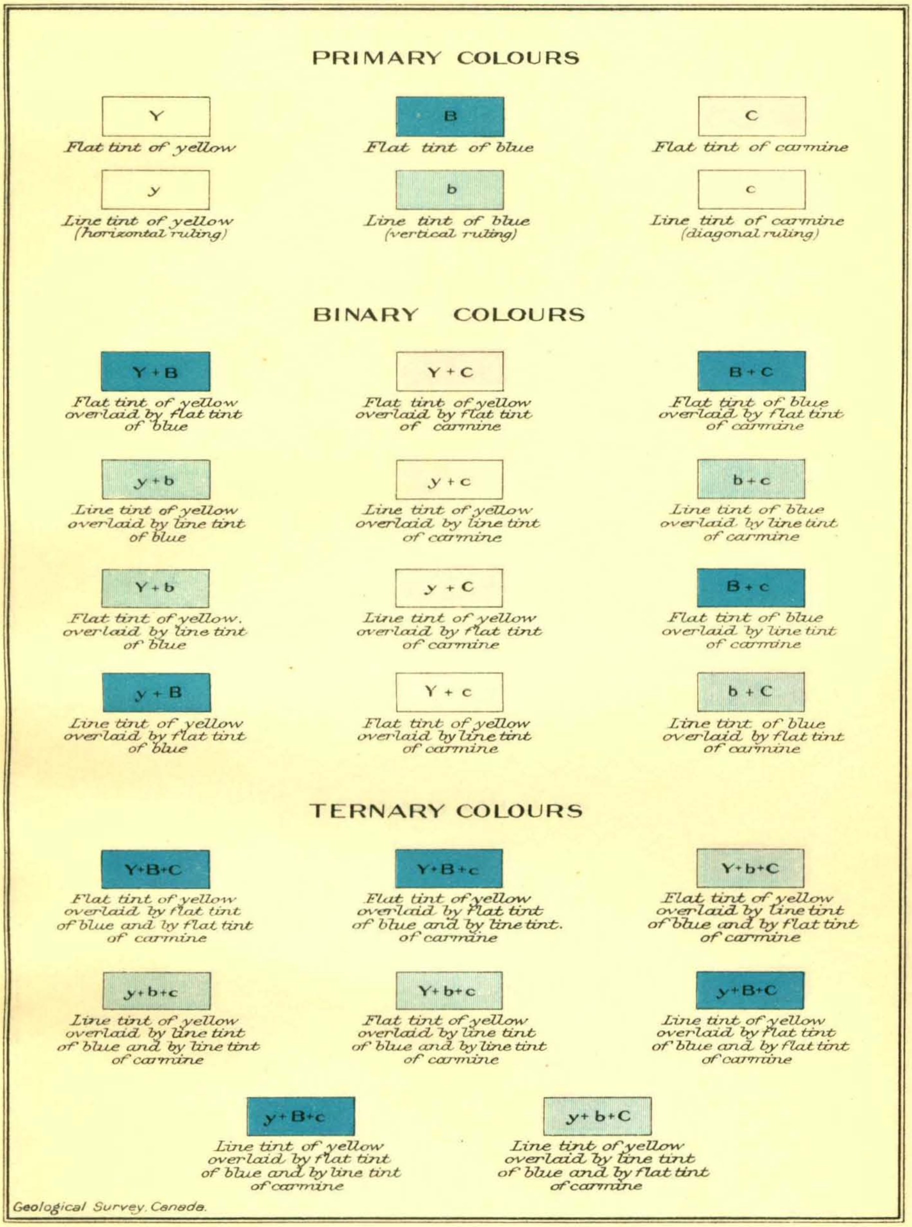


Chart illustrating a process of lithographic three-colour printing for the reproduction of geological maps.

To accompany Bulletin by C.O.Senécal

BLUE IMPRESSION

PLATE II



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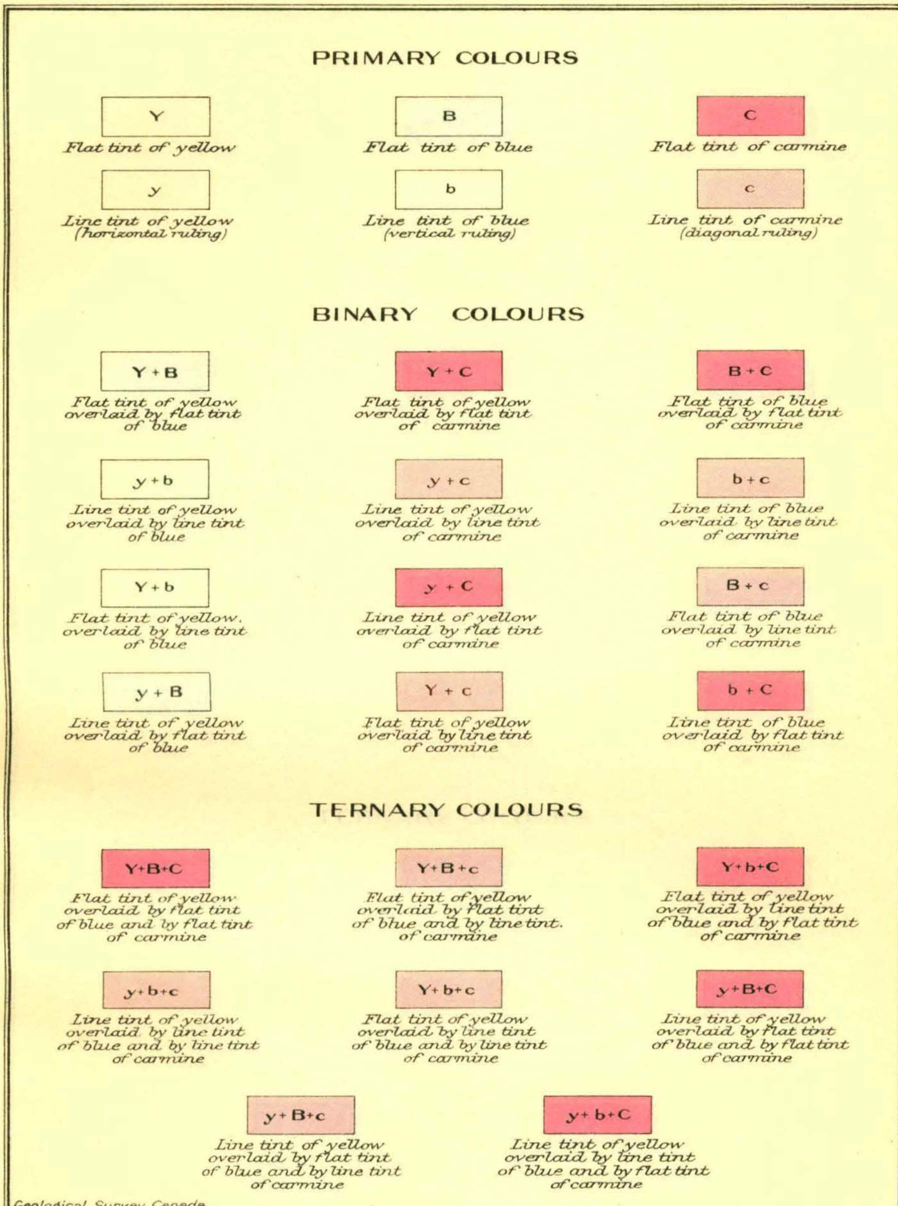
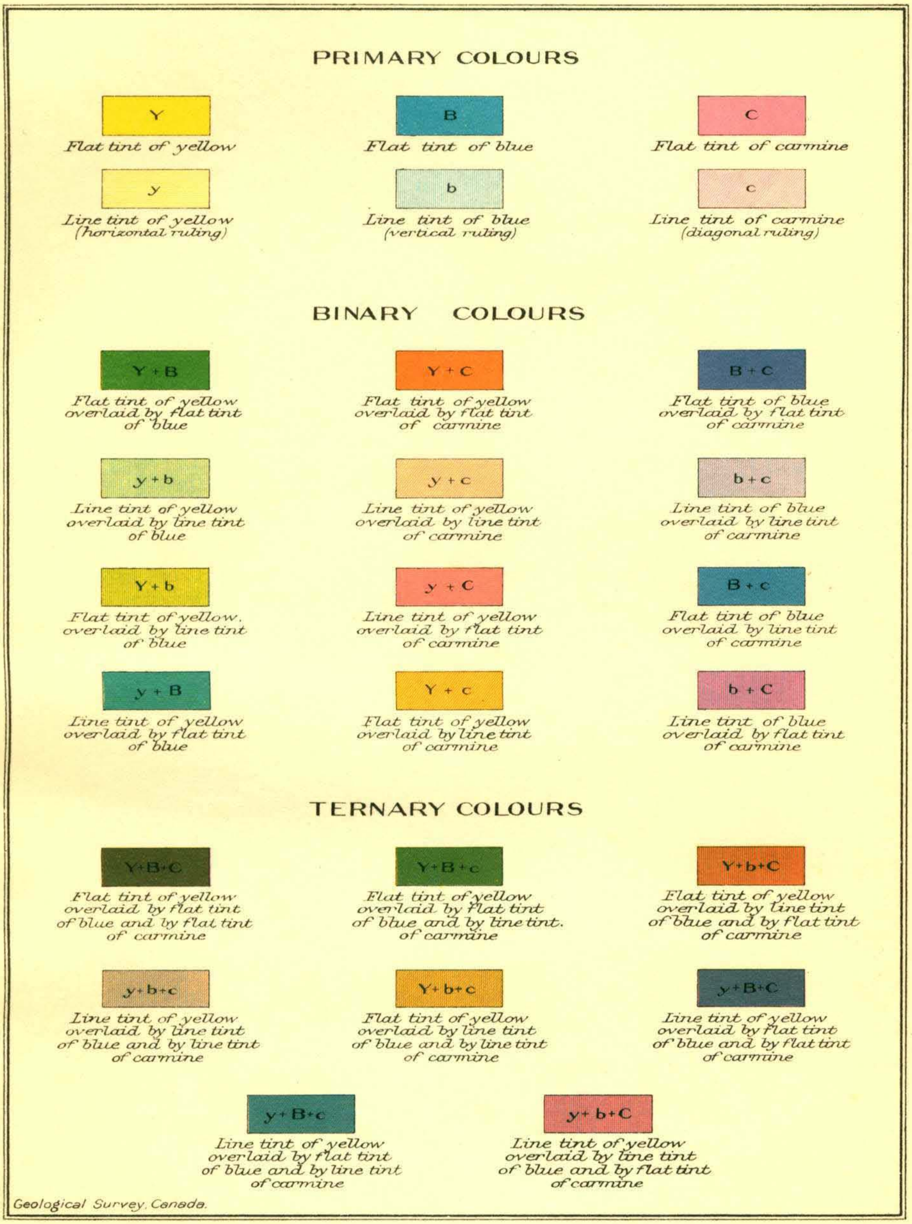


Chart illustrating a process of lithographic three-colour printing for the reproduction of geological maps.

YELLOW, BLUE, AND CARMINE IMPRESSIONS SUPERIMPOSED

PLATE IV



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