

PROBLEMS IN MAP EDITING

by Edward B. ESPENSHADE, Jr.

Associate Professor of Geography at Northwestern University.

(From a paper read before the Washington Geographers' Club).

World War I was fought over a relatively limited area, and the more intense action was over an even more restricted area. Action was largely stationary, as indicated by the name "trench warfare", and took place for the most part in well-mapped areas. The demand for maps, therefore, was limited, both in areas to be covered and in quantity, since as a rule only officers needed maps. The French mapping agency, the Service Géographique de l'Armée, with some help from the British agency, the Geographic Section, General Staff, was able to supply these needs easily, largely from existing plates based on ground surveys. The United States Army had relatively little or nothing to do with map production.

The recent global war was in striking contrast. The airplane made complete coverage of the earth necessary on not one, but several scales. Ground operations on numerous fronts in widely separated areas required large-scale maps, not just for parts of countries, but for part or all of several continents. The mobile nature of warfare made maps a necessity for enlisted men as well as officers. In both cases maps had to be prepared covering large areas for which basic surveys were lacking and for which information was scanty. Whereas the same sheet may have sufficed for several months in World War I, in World II a soldier might have covered in a single day the area shown on several sheets at some scales. The result is that probably more maps were published in some months during World War II than during the whole of World War I. An operation like that in North Africa might require 15,000,000 maps, and annual production in this country alone might approximate 50,000,000 copies, involving from 5,000 to 10,000 different sheets. The enormous task of preparing military maps for field operations in World War II was assigned to the Geographic Section, General Staff, British War Office, including the Survey Directorates of the Commonwealth and Colonial Governments, and to the Army Map Service, Corps of Engineers, U. S. Army, in this country. By agreement between the two agencies, the world was divided into areas of responsibility for map production.

Scope and types of maps.

What were the types of maps required for military field operations? They fell into four broad groups: aeronautical charts, planning maps, maps for mechanized operations, and maps for infantry and artillery operations.

Aeronautical charts were the responsibility of the Army Air Forces, although the Army Map Service provided coverage for compilation and acted as printing contractor for them. These charts were for the most part on small and medium scales, but were planned for extensive coverage over the earth's surface. They included charts at scales of 1:5,000,000, 1:3,000,000, 1:1,000,000, and 1:250,000; for bombing-target charts, the scale might be as large as 1:75,000.

Most planning maps were on small scales, from 1:1,000,000 to 1:10,000,000. They included theater area and regional planning maps, strategic maps (usually over individual countries), communication maps for logistic planning, and such general series as maps belonging to the International Map of the World framework.

Maps for mechanized operations were usually on a medium scale, from 1:150,000 to 1:500,000. They were of a relatively general nature, with emphasis on roads.

Maps for infantry and artillery operations were on large scales, from 1:20,000 to 1:125,000. They were the common topographic map expressing surface configuration, cover, and cultural features in considerable detail. Large-scale city maps might also be considered in this group.

Methods of map production.

Maps can be produced to provide the various needs just mentioned in any of four ways or in various combinations of them.

1. They may be a reproduction of a ground survey ; for example, a U. S. G. S. Quadrangle.

2. They may be a reproduction of a survey from air photographs ; aerial mosaics might be included here along with maps drafted by trimetragon, multiplex, and other air-survey methods.

3. They may be the product of redrafting or mechanical facsimile reproduction in one or more colors of a previously published map.

4. They may be the result of compilation from several series of maps, possibly unrelated, and other source material.

Circumstances will decide which of the above methods or combination of them may best be used. The decision is determined generally by the information the map is to show, the source material available, the scale at which it is to be reproduced, and the time available for completion of the map. The last two methods were used for the greater number of the maps produced in World War II. Redrafting or mechanical facsimile reproduction is nothing more than copying an existing map, with possible revision and translation of border information and addition of the military grid. It is a method to be used when time is extremely short, and it is a procedure requiring a minimum amount of effort. The results are not always completely satisfactory : the date of the original map may be old, and the nature and appearance of the copy may give a reproduction not easily readable.

The last method, "compilation for an area", is the most difficult. It has been described as a "science" and as an "art", it requires some of each. It involves evaluation of the accuracy and usefulness of all available source material ; interpretation of the material and decisions concerning methods of using it ; and incorporation of this source material into a unified map at the desired scale.

The editing problems discussed here are concerned primarily with compiled maps. Many of the compilation problems were the result of three factors : mass-production methods, necessitating the use of relatively untrained personnel ; lack of knowledge of foreign maps ; and lack of familiarity with the areas covered. The 1:1,000,000 map of South America, compiled by the American Geographical Society, is the only extensive foreign compilation job undertaken by an American agency, with the exception of the nautical charts of the U. S. Hydrographic Office and the Coast and Geodetic Survey. Done over a comparatively long period of years, it was possible to use highly trained personnel for direct supervision and even to check material in the field or with local authorities. In contrast, under war conditions the quality and nature of the map could be controlled only indirectly by preparation of specifications and instructions as detailed in nature as possible, and by relatively rapid inspections of the work at critical stages by competent, experienced personnel.

Source material problems.

When a map is to be compiled, the first step is the collection of source material, including maps and pertinent reports over the area. The nature of the source material selected depends, of course, on the type and scale of the map to be prepared ; it may include all or only some of the following main types of materials :

1. Ground surveys, including completed or uncompleted field sheets of an area, town plans, and lists of geographical coordinates of various points, fixed by primary, secondary, or tertiary triangulation.

2. Air photographs, including systematically exposed strips of verticals, single photos or pairs of photos, and obliques.

3. General maps, including the following : (a) large-scale maps giving a representation of all physical features, both natural and cultural, which by their nature are usually based on ground or air surveys ; (b) medium-scale maps, which give a conventionalized picture of a country and show all features that can be legibly drawn at the scale used ; (c) small-scale maps used normally to give a broad picture of an area, on which features are generalized and information is often incomplete, but which

help to show the various relations between features — for example, the relative importance of towns and major relief structures.

4. Charts, of various scales, which are useful primarily because of their detailed treatment of coastal features.

5. Communication maps, consisting of medium-and small-scale road and railroad maps. They may show details of the surrounding country or they may be diagrammatic. Road guides, timetables, and similar items may be included here.

6. Explorers' route maps ; these may vary considerably from rough compass traverses, with brief notes, to detailed descriptions of routes, accompanied by aneroid readings and calculations of geographical positions by astronomical observations.

7. Descriptive material, including such diverse material as tourist guidebooks, textbooks, geographical articles from magazines, newspaper accounts, and military intelligence reports and summaries.

The collection of the source material in connection with a particular compilation job may require considerable effort and ingenuity ; the task of analyzing and evaluating it requires qualities of scientific integrity and judgment. It is the most fundamental problem in editing a map. The result is an estimate of the relative accuracy and utility of each piece of material. In a simple compilation it is a mental process ; in more compiled work it should be written. In either case it should systematically follow definite steps : the listing and appraisal of the material ; comparison of the material ; and a decision concerning its use. Let us examine each of these steps.

Listing and appraisal of the source material involved (*a*) drawing an index diagram in colors and showing in a generalized way the area covered by each source item ; (*b*) listing information concerning the title, scale, publisher, date, and detail shown ; and (*c*) preparing a statement of the reliability of each item. An accurate estimate of the reliability of any map or map series involves the analysis of many factors and sometimes can be ascertained only by careful and thorough research. If it is necessary to limit oneself to that information appearing on the face of the map, which is often the case, one is handicapped in an appraisal. Certain broad principles can be used, however, in an examination of the map on the basis of four factors : the authority, date, scale and appearance of the map.

The authority is an excellent index to the reliability of a map. Established government agencies that are known to be in the business of making maps may generally be accepted as competent and reliable. A government agency responsible for a basic field-mapping program in a country is apt to be more reliable than agencies whose mapping is incidental to other activities. On the other hand, if a particular type of areal information is desired, such as roads, maps published by an agency responsible for road material are apt to be more accurate for that particular feature. At the same time, such "special purpose" maps may be unreliable for other features. For example, a map published by a department of roads may not be reliable for railroad information. It is a mistake, however, to assume that because a map is published by a government agency it is reliable. This is particularly true in the case of countries relatively backward in cartographic development and especially when basic field surveys have not been made in the area in question. A German map for a section of China published by the Reichsamt für Landesaufnahme is apt to be more accurate than topographic maps made from reconnaissance surveys by the Chinese Government. Similarly, maps prepared in connection with flood and irrigation problems in North China by American engineering companies should be considered more reliable than official Chinese topographic maps.

It is somewhat more difficult to make generalizations concerning privately published maps. In the case of maps resulting from scientific expeditions, the reliability of the work can sometimes be ascertained from descriptive notes published with the maps. There are considerable differences in the accuracy, however, of many route traverses, and care is not always taken to report survey methods. For example, material published by Filchner in connection with his expedition into Central Asia, to make magnetic observations, appears to be much more reliable (probably because of the purpose of the surveys) than that of Roy Chapman Andrews, of the American Museum of Natural History. Privately published maps by commercial companies are subject to considerable variation. A few companies have world-wide reputations ; others, such as Bartholomew, Michelin, and Jih Sin, have national reputations, which can be used as an

index to selection of material. In some cases the reliability can be credited to a single man ; for instance, V. K. Ting, in China, and Fujita, in Japan. It is apparent, then, that there is no unqualified generalization that is infallible, but by experience one can gradually develop ability to estimate the reliability of a map from a knowledge of authorities.

Dates are a second index to the value of a map and one which at first glance would seem to be a relatively simple one. On the contrary, they offer many difficult problems. They are particularly important because of the emphasis in military maps of having material as recent as possible. Unfortunately, many maps do not carry dates. This is especially true of those made by private publishers. They feel it may prevent sales ; with the exception of such general items as road maps, I think this is a mistaken viewpoint. Many publishers, however, have codes from which dates may be ascertained. Some can be readily broken, others require information from the publisher. Lacking a date, one may be approximated from the time of purchase or acquisition ; by comparing with another map of known date to determine, for instance, if a railway or road under construction has been completed ; or by examination of the magnetic information. In some instances the style of the map may indicate its date.

Even though a map bears a date, one's difficulties may not be solved. The significance of the date may or may not be indicated. It may be the date of survey, compilation, publication, revision, reprint, or the latest edition ; there may be only one date or as many as four. Further difficulty is encountered in the terminology applied to dates on foreign maps. Some twenty-four different phrases applying to dates are found on the Chinese General Staff 1:100,000 topographic maps ; from one to three phrases may occur on a single map. Precise translations are difficult and often inconsistently applied. For example, the three terms "edition", "reprint" and "imprint" date, in English and in their various foreign counterparts, carry different implications, depending on the policy of the publishing agency. A new edition may involve major or minor changes ; a reprint may involve considerable change, minor plate changes, or no difference between copies ; and in imprint date may indicate minor changes that can be made on the press plate, or a new run with no differences. Of course, careful study can solve many of these problems or at least give an approximate answer. But time is often valuable, and days may be lost over a light table comparing editions of a large series of maps for emergency facsimile reproduction. A prime example is Central Europe, where several editions of a single map published by each of four countries may be available. Each map may carry from one to three dates with no indication of their significance. As a result of such problems, dated collation indexes for map series made up by different individuals located in London, Chicago, and Washington may result in the choice of the wrong sheet, since comparisons may not be possible and a common basis for dating cannot always be determined. The library of the Army Map Service has been working on a preliminary guide to dating methods for various countries, which should lead to more systematic results, if not the proper answer.

If one can solve the pure mechanics of dates, care must still be exercised in their use. If a date is that of an original survey, it is an important index to a map's accuracy. Land forms change very little within those time periods with which one deals in considering maps for military use, except along shore lines and meandering rivers. As a rule, therefore, general land forms as depicted by contours, hachures, and form lines may be accepted as being reasonably accurate regardless of the date of survey. It may be assumed, however, that prior to the extensive application of aerial photography to mapping, serious displacements of horizontal and vertical position may be encountered in extremely rugged and heavily wooded country, since such areas are difficult to delineate accurately in the normal use of ground survey methods. With respect to cultural features, the date of survey must be considered in relation to the normal expectancy of cultural change. Changes over a period of years may be minor or very extensive, depending on the rapidity of development of the region. In sparsely settled regions, maps from thirty to forty years old may be relatively accurate for cultural features. This does not hold, however, in some areas ; for example, in Central Asia, where surveys may show the locations and names of nomadic settlements. By cumulative compilation, made by cartographers over many years, a map may contain many non-existent settlements. Special symbols or the elimination of settlement locations in preference to tribal names should be used in such areas. In highly industrialized areas, extensive changes may render a map obsolete within a short time after publication. A knowledge of areas, however, often helps an individual to make further generalizations concerning the usability of features depicted on a map. In Central Europe the stabilized

nature of the forest cover, owing to methods of forest farming, makes it feasible to accept forest cover from maps of relatively old dates.

Dates other than that of an original survey date are subject to considerable misconception. One assumes that when a compiler makes a map he uses the latest source material he can find, but how thorough was his search and how extensive were his facilities? Most maps fail to list the source materials used and fail to give the date of publication. These are some of the problems that result from dates on maps. Since time is an important factor, it is often necessary to accept a map as it is and to assume, if the original basis is sound, that the physical detail will not be changed greatly and that, though the patterns and populations of cities may be altered significantly, their general positions and shapes will remain unchanged. The user of the map can be guided by a note giving the date of the original survey or publication of the map copied. Since communications are apt to be subject to considerable change and are of extreme importance in modern mechanized warfare, a fairly practical military map can be obtained by a revision only of communication features according to latest information, with a note giving the date and method by which they have been revised.

The scale at which a map is published may be helpful in indicating the accuracy of the original survey or compilation. It is normal cartographic practice to prepare original surveys and compilations at a scale somewhat larger than the final scale of reproduction. Therefore, the published scale reflects the accuracy of position and delineation of the original survey and likewise is indicative of the amount of detail which has been included or omitted. When several series of maps at different scales have been published over an area, care should be taken to note the order in which the original maps were prepared. If a first series published is at a large scale, a second series at a medium scale can usually be assumed to have been based on the first and larger series. In the case of the reverse situation, which amounts to the blow-up, or enlargement, of a series, care should be exercised. If the publisher redrafted the sheets in the process it is sometimes impossible to ascertain the facts. A position which may have a maximum error of 0.04 inch, or 200 feet on the ground at the scale of 1:62,500, may have a maximum error of 0.2 inch on the map at 1:12,000. The size of the conventional symbols used may increase this error further. There is little value to be gained from trying to compile a map on the scale of 1:100,000 from source material at 1:500,000. Compilers have not always been careful in this respect, and some medium-scale compiled maps should be used with caution. Map sources are full of cumulative errors from this faulty practice.

Finally, the general appearance and the detail of the map text may be a guide to its accuracy where there is no knowledge of the existence of ground surveys on a sound basis. Density of detail and types of features delineated are partially indicative. Improbable interpretations of geographical features revealed by examination may be a further clue. Are rivers shown in straight, sweeping lines in flat country? Are contours shown in smooth, parallel lines? Are villages shown without a road or track leading to them? Do streams run uphill? These and other improbable details should be watched for. It is advisable to read reports on the area involved before appraising its maps, so as to be able to observe any obvious contradictions that exist. In addition, examination of the map by an individual who has been over the ground the map covers may be valuable, although two difficulties present themselves: finding an individual who has been in the area, and ascertaining the trustworthiness of his knowledge.

Comparison of materials is the next step when the source material has been listed and appraised. Examination will have shown what pieces of information are available from each item of source material and what is common to several pieces. It is necessary to compare the common information to provide relative standards of accuracy for each feature. In some cases the base map or maps to be used can be established from the original appraisal. Features of other materials with the descriptive information gleaned from written sources can then be checked against this basic material for alignment, position, and classification. Sometimes no one map can be used as a suitable base for comparison of various features. Thus a different map may have to be selected as a basis for comparison of each feature. The relative standards of accuracy of features will be allotted automatically as a result of the comparisons made. It is important to avoid a prejudice in favor of one piece of material during this process. Systematic tabulation by check list is one way to prevent short cuts leading to such prejudices.

With completion of the listing and appraisal of each item and the comparison among items, decisions as to the use of source material can be reached. These decisions are

the basis for writing the instructions and specifications for the compiler. They should be clear enough so that there are no ambiguities and should visualize the problems that the compiler will meet and try to answer them. Each feature should be tabulated, and instructions given as to the source from which it is to be taken. Under mass-production methods, with relatively untrained personnel, the general accuracy of the map depends on the care with which these steps have been taken. A mistake in the selection of one piece of source material or in the treatment of one feature may destroy the ultimate value of the final map.

