# REVIEWING MAPS AND CROSS SECTIONS

REVIEWING GEOLOGIC MAPS AND CROSS SECTIONS is much like making them: The reviewer and the author are concerned about the same things. A first concern is that maps and sections have all their needed parts—the simple matter of completeness that can be verified with a checklist. A second, more important concern deals with accuracy and logic—why lines are where they are, what they show and if they show it correctly, and what interpretations these lines suggest. Maps and sections must be geometrically consistent and logical.

## RESPONSIBILITIES

Reviewing maps from time to time is expected of all Survey geologists, just as each of us expects others to review maps that we have prepared ourselves. The principal responsibility of the technical reviewer is to help the author and, so, ultimately to help the Survey and the users of Survey products. With different eyes and different insights, you as reviewer can ferret out failures of logic or consistency in mapping or interpretation and other problems the author might fail to see. If an interpretation is flawed, tactfully suggest reasonable alternatives.

The author is obliged to consider each review comment and to make any necessary changes. If suggested changes are unacceptable, the author must explain why in a marginal note or memorandum. The responsibility of the author to respond to every comment should be kept in mind by the reviewer in deciding whether or not to comment on minor points of contention.

## STARTING THE REVIEW

As a first step, you as reviewer should scan the map, sections, and explanation to get familiar with the map units and their sequence, general lithologies, and thicknesses. Find out why the map was made; learn its intended purpose.

Get a general overview of the structure, both from the map and from the sections as interpreted by the author.

Look for obvious problems, such as dangling contact lines, questionably placed lines, erratic or unexplained changes in formation thickness, and doubtful fits of contacts and faults to topography and bedding attitudes.

Make some notes to yourself in soft pencil on the review copy—reminders to look more closely. (Do not mark on the colored copy.)

The first step serves two importants purposes:

1 It gives you a general feeling for the map area—a feeling to be expanded as you review the map and sections more closely.
2. It helps you gain some level of confidence in the map and sections. For example, you gain an impression that

> The map has few problems, or
> It is a good map but needs some attention, or
> It is a fair map but has many problems, or
> It is seriously flawed.

Maps and sections submitted for review should be able to stand by themselves without reference to others, published or unpublished. They must be legible, neatly drafted on a clearly legible base, and printed on a clearly legible review copy.

## WHAT TO CHECK NEXT

### Marginal data

Most but not all of the following apply to all maps:

Spelling and punctuation are correct.

Latitude and longitude, townships and ranges are correctly placed and numbered.

Scale is appropriately given:
- Ratio scale.
- Rake or bar scale.
- Vertical scale on sections; if exaggerated, must say so.
- Contour interval.

Magnetic declination and year, if needed, are correct.

Source of base map is credited, and projection of base map is provided with the credit.

Mapping credit is given:
Authors, assistants, time(s) of mapping, acknowledgment of work by others are included.
Location or index map is included.
A sketch map showing published maps of conterminous areas is included if appropriate.
A sketch map showing the reliability of data if appropriate. Such a map would show the area for which data were assembled from photogeologic interpretation, areas of reconnaissance mapping, areas originally mapped at different scales, and areas mapped by different contributing authors.
Title is appropriate and definitive. Includes quadrangle or area name, county (if needed), and State or country.
Authorship line and year of publication are correct and positioned below title.

### Correlation of map units

Unit boxes are complete and accurate in relation to adjacent units and time boundaries.
Age brackets are clearly and carefully drawn.

### Description of map units

All units shown in boxes are actually on the map.
All units shown on the map and sections are listed and described.
Map, sections, and explanation all use the same unit symbols.

### Map symbols

All conventional and special structural symbols shown on the map and sections are included in the explanation and are adequately explained.
Any dashed or dotted lines on the map are explained.
Faults shown on the map are adequately explained as to kind and attitude.
Symbols for fault displacements are explained.
Traces of axial surfaces of folds (or symbols for crests and troughs) are accurately plotted and explained.

### References

References are complete and in Survey style.

### Other

All enclosed areas on the map and sections are labeled by symbol or are distinctively colored.
Line weights on the map and sections are distinctive enough to be clearly identified by the illustrator for final drafting.

## Reviewing the Map Units

As you go over the map you will be working back and forth constantly from the map and sections to the explanation. You should carefully consider the "Description of Map Units" and "Correlation of Map Units," therefore, early in the review. In this way, you will quickly learn the sequence of units, their ages, thicknesses and variations, lithologies, sequence of events, and other characteristics that you must know to adequately evaluate the map and sections.

## What to Look For in the Explanation

Units and symbols for rock units on the map and cross sections are in the explanation and are clearly and consistently labeled on map and cross sections, in the correlation of map units, and in descriptions of map units. Symbols are kept to four letters or less.
Descriptions of map units are clear and concise and follow a consistent format, including distinguishing characteristics such as rock type(s), color, grain size, bedding, and thickness. Also given are any other distinctive characteristics that the map user should know about, such as mineralogy and fossils.
Descriptions are complete enough to enable a map user to identify the rock unit in the field and to permit a reader to compare each unit with the same unit elsewhere.
If a map unit is present only in a small part of the map area, its description might usefully say where.
If a description includes several units or members within a formation, they are described in sequence from youngest to oldest, from the top down.

## Reviewing the Map and Cross Sections

### General Guidelines

Maps and cross sections must be completely and clearly drafted. Poorly prepared copy reflects on the author, and the reviewer should not be asked to do what the author has not done in terms of compilation, thoughtful interpretation, and cross-checking.

Maps and cross sections must be internally consistent. Interpretations shown on maps or on cross sections must be logical, reasonable, and compatible with mapped data. Maps and cross sections should fit with adjacent, recently prepared maps and cross sections; structural interpretations, new concepts, or serious misfits should be explained.

### What to Look For on the Map and Sections

After reviewing the guidelines that follow, look at every line on the map and sections. Ask yourself the following questions:

Are all lines properly located? Are they topographically compatible?
Are they compatible with other stratigraphic and structural data?
Are they logical?

Every line on the map is related to other lines and to other data; taken together, all must make sense.

You cannot review a map well or consistently by random spot checking. You must work your way systematically over the map area bit by bit, checking back and forth from map to sections to explanation to make sure that everything fits. Only then, will you have answered the critical questions: Is this a disciplined, thoughtful, consistent geologic map; are the sections properly constructed and are the interpretations they show logically supported by the map; is this map a credit to the author and to the Geological Survey; and is it an appropriate addition to a long line of quality geologic maps made by Survey field geologists?

## CHECKLISTS FOR REVIEWING MAPS AND SECTIONS

### MAP LOGIC

| Feature | Check against |
|---|---|
| 1. Sequence of stratigraphic units and tongues. | Correlation of map units.<br>Description of map unit.<br>Text. |
| Thicknesses of stratigraphic units. | Thickness as measured from the map.<br>Thickness given in text and explanation. |
| Contacts. | Strike and dip on topography for consistency with bedding attitudes.<br>Offsets on faults (map units move up dip on downthrown side). |
| Normal, reverse, and strike-slip faults. | Justification by offset, structural deflections, or sheared rock symbol.<br>Offset shown by symbols.<br>Amount of throw along trace for consistency or merge into fold. |
| 4. Normal, reverse, and strike-slip faults—Continued | Direction and amount of dip (three-point method).<br>Direction of throw versus drag.<br>Agreement of throw symbols and unit offsets.<br>Offset of intersecting faults. |
| 5. Thrust faults. | Same as 4, plus:<br>Variation of foot-wall and hanging-wall units versus attitude of beds.<br>Vertical sequence of plates versus joints.<br>Ramps versus ramp folds or faults.<br>Direction of apparent transport versus erosional trace of thrust. |
| 6. Folds. | Justification of trace of axial surface, crest, or trough as deduced from bedding attitudes.<br>Plunge of fold from bedding attitudes and map patterns.<br>Dip of axial surface.<br>Offset on faults. |
| 7. Does the geology of the map area make regional sense? | External consistency or explanation for variation. |

### CROSS SECTIONS

___ Is topographic profile plotted correctly?
___ Are the lines of section selected to best show the structure?
. Do map lines correctly intersect the profile?
___ Are apparent dips correctly plotted?
___ Are all structural features in the line of section shown on cross sections?
. Are data near the line of section correctly projected into the cross section?
. Are unit thicknesses compatible with surface geology?
. Are folds correctly shown?
. Do kinds of structural features in section match kinds of structural features on map?
. Do structural features that intersect on the map near a section also properly intersect on section and at correct along-strike or along-plunge depths?

If two or more sections accompany the map, are thicknesses of units, dips and throws on faults, and depths to geologic intersections compatible from section to section? (At this point, a complex section might be cut apart and taped back together to restore the section as it was before faulting.)

Do hanging wall and foot wall match across faults and is direction of throw the same as indicated by map symbol? By pattern of units offset on map?

In restored (cut apart) sections, can holes or overlaps be explained reasonably? (Area or volume balance.)

Do bed lengths in highly folded areas or between major thrust faults match from top to bottom in the sequence? Do they match properly between restored structural features?

If two sections intersect, are all lines correctly plotted on both sections at the vertical line of intersection?

Does the map support the interpretation shown on the sections? Are the sections consistent with what is known regionally?

If the vertical scale is exaggerated, is the exaggeration warranted?

## Other Considerations

Maps occasionally are submitted for publication at scales larger than needed to adequately portray the geologic detail. Unless a particular scale is required to match some local map series, such as the uniform 1:24,000-scale series for Kentucky, the reviewer should recommend whatever scale best fills the need.

Appropriate map scales and data density are generally determined by the kind of geologic map needed to solve anticipated problems and by the available topographic base. Some mappers will doggedly plot every bit of available data, will carefully preserve every attitude, and will clutter the map in the belief that the more profuse the data the more accurate the map, no matter how repetitious. A sufficiently detailed geologic map is one that adequately (1) portrays the geology of a region at the selected map scale, (2) provides the factual basis for interpretations shown in accompanying sections, and (3) reflects disciplined, thoughtful fieldwork. If more detail is required in an especially complex area, an inset map may be prepared at an appropriate larger scale.

The accuracy and logic of a map reflect the care, thought, and discipline of the mapper. Carefully restored but erroneous cross sections can be drawn from a map that is wrong.

Even the simplest geologic map shows rock relations that have resulted from complex sequences of events. Such sequences must agree on the map and on all accompanying cross sections. A fault that moved only in Proterozoic time cannot be shown cutting Paleozoic rocks. A fault that is buried beneath alluvium should be shown by a dotted line if the alluvium appears on the map.

Some suggestions for reviewing large-scale maps of small areas do not apply to small-scale maps of large areas because both rocks and structures can and do change significantly across large areas, but the foregoing suggestions for map mechanics apply equally. Beyond that, the map and any accompanying cross sections must be logical, and interpretations in cross sections must be supported by mapped data. A second map may be appropriate for showing structural data.