USGS
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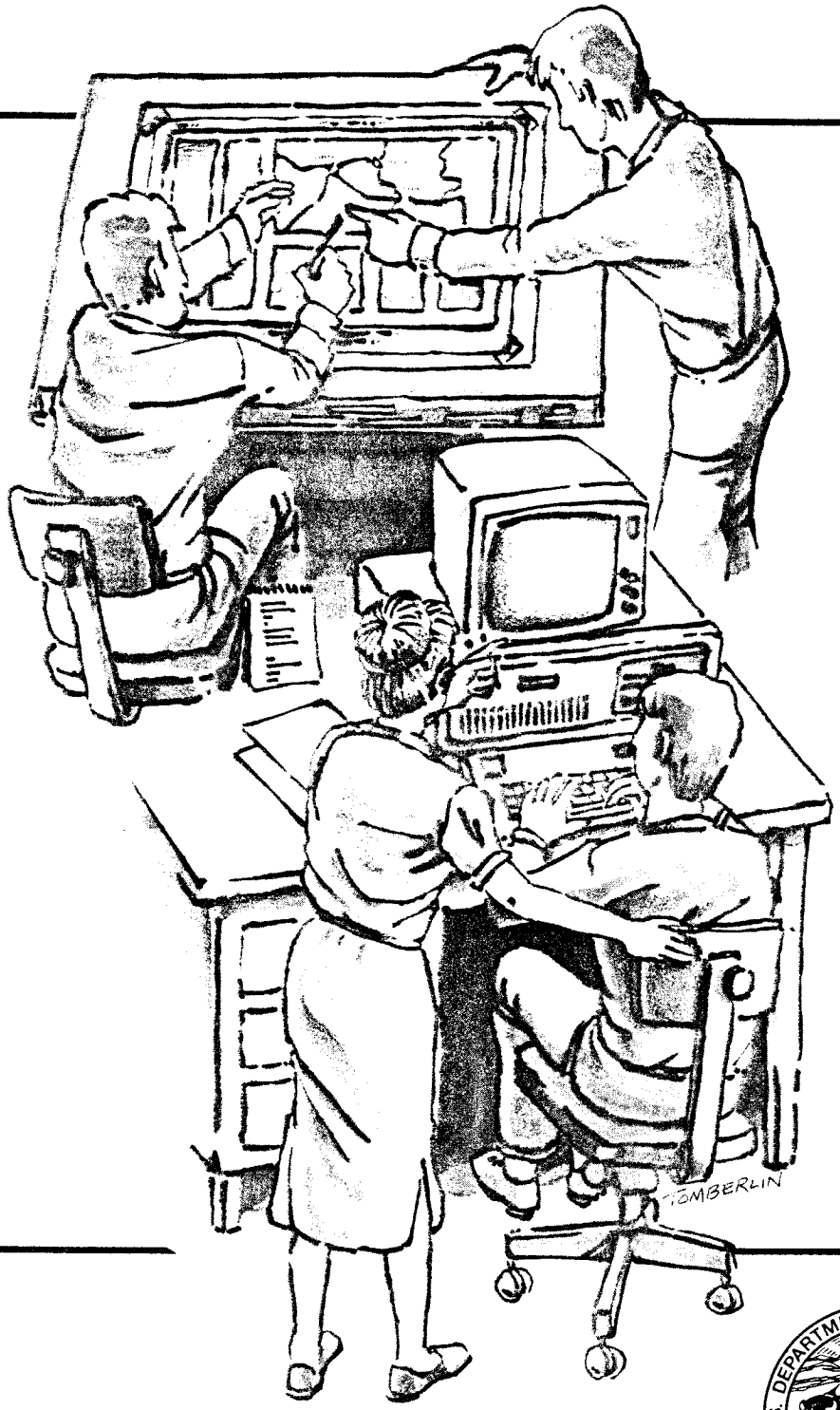
Standards for Illustrations in Reports of the U.S. Geological Survey, Water Resources Division



U.S. Geological Survey

Open-File Report 95-415

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.:	Effective Date: 10/5/73	Article No.: 3.09.4

Subject: ILLUSTRATIONS -- Maps - Base credit

A. Base credit is required for maps in all reports that use base maps made directly from:

1. U.S. Geological Survey maps -- 1:20,000, 1:24,000, 1:62,500, 1:63,360, and 1:250,000 quadrangle maps; State base maps; and United States base maps. (Note: The U.S. Geological Survey is now the sole source of the 1:250,000 quadrangle maps. The U.S. Army Topographic Command, formerly the U.S. Army Map Service, no longer is connected with the "AMS" quadrangles. Therefore, the U.S. Geological Survey must be cited as the source of these maps.)

2. Maps from other Federal agencies.

3. State or county highway maps.

4. Maps from private or copyrighted sources. Written permission to use base maps from these sources must be obtained by the author and included with the report when it is sent for Director's approval.

B. Base credit is required for maps having bases that have been redrafted or rescribed from the source materials listed above or that are composed of aerial photographs and that are used for:

1. Plates in Survey or non-Survey book reports.

2. Foldouts ("tip-ins") in non-Survey book reports.

3. Principal maps in Survey or non-Survey map reports.

C. Base credit is not generally required for maps having bases that have been redrafted or rescribed from the source materials listed above, with the exception of item A4, that are used for:

1. Page-size text figures, including index maps, in Survey or non-Survey book reports.

2. Secondary maps, including index maps, in Survey or non-Survey map reports.

D. Base credit is not required for maps having bases that consist of only a land net, such as latitude-longitude, township and range, or State-developed grids. However, if culture names, topographic contours, drainage or roads are shown, base credit must be given according to the foregoing instructions.

E. Base-credit notes

1. Form

The words "Base from" will be used for all base-credit notes (except photo base maps) regardless of whether the original base map has been altered in some way, such as change in scale, area, or information.

a. Maps listed under item A

1) Base map consists of one full quadrangle and quadrangle name appears in map title:

"Base from U.S. Geological Survey, 1960"

2) Base map consists of one full quadrangle and quadrangle name does not appear in map title:

"Base from U.S. Geological Survey
Rock Bluff, 1956"

3) Base map consists of one full quadrangle, quadrangle name appears in map title, and map contains purple interim revisions:

"Base from U.S. Geological Survey, 1960
Interim revisions as of 1970"

4) Scale of base map different from original and quadrangle name appears in map title:

"Base from U.S. Geological Survey
1:62,500, 1958"

5) Area of base map more than one full quadrangle and quadrangle names do not appear in map title:

"Base from U.S. Geological Survey
Clay Hills 1:24,000, 1954 and
Clay Hills 1 NW 1:24,000, 1952"

6) Area of base map is part of State base map and scale is unchanged:

"Base from U.S. Geological Survey
State base map, 1965"

7) Information added to base map, area less than one full quadrangle, scale changed, and quadrangle name does not appear in map title:

"Base from U.S. Geological Survey
La Crosse 1:250,000, 1958
Reservoirs as of 1970"

b. Maps listed under item B

1) Source of base map was 1:24,000 and 1:62,500 quadrangles:

"Base from U.S. Geological Survey
1:24,000 and 1:62,500 quadrangles"

2) Source of base map was 1:250,000 quadrangles:

"Base from U.S. Geological Survey
1:250,000 quadrangles"

3) Source of base map was State base map:

"Base from U.S. Geological Survey
State base map, 1:500,000"

4) Source of base map was county highway maps:

"Base from North Dakota Highway Department
county highway maps 1:63,360"

c. Aerial photographs

For bases that are composed of aerial photographs the credit note consists of two parts: the source of the photomap and the source and date (month and year) of the photography.

1) Aerial photography and photomap from same source:

"Aerial photomap by U.S. Geological Survey from
aerial photographs taken March 1969"

2) Aerial photography and photomap from different sources:

"Aerial photomap by U.S. Geological Survey.
Aerial photography by Chicago Aerial Survey, March 1969"

2. Placement -- On a rectangular-shaped map the base-credit note should appear under the south border and begin flush with the west border. On an irregular-shaped map the base-credit note should appear as close to the southwest margin of the map as possible. When a sheet contains two or more of the same base maps, the base-credit note should appear only once, below the south neatline of the sheet and flush with the west neatline of the sheet.*

*See pages 59 and 61.

F. Index to topographic mapping

1. Form -- The index consists of a complete outline of the source maps used to compile the base map. The index has no geographic detail or a scale but does have latitude and longitude numbers. The title, "INDEX TO TOPOGRAPHIC MAPPING," is placed below the index. The outline of the report area can be shown on the index and the area may be shaded. Labeling of the quadrangles should follow the "Index to Topographic Maps of (State)," published for each State.

2. Placement -- Placement below the southwest corner of the map is preferred. However, the index can be placed in any convenient location near the map.

References: Technical Standards Papers 3.04.1, 3.04.3, and 3.08.2 of Publications Division.

INFORMATION FOR BOTTOM MARGIN

(To Scale)

Base from U.S. Geological Survey
St. Cloud North, 1:24,000, photorevised 1970,
St. Cloud South, 1:24,000, photorevised 1980,
Narcoossee, 1:24,000, photorevised 1970,
Ashton, 1:24,000, photorevised 1970

BOTTOM LEFT

HYDROGEOLOGY OF THE LAKE MIONA AREA, NORTHEAST SUMTER COUNTY, FLORIDA

By
L. A. Bradner
1986

MIDDLE

Copies of this map can be
purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center
Box 25425
Denver, Colorado 80225

BOTTOM RIGHT

CARTOGRAPHIC TECHNICAL STANDARDS

Replaces T. S. P.		Subject: MARGINAL INFORMATION Base Credit Notes	T. S. Paper	3.00.3
Dated			Effective	12/6/76

Base credit notes should be as concise and informative as possible. Situations not covered by these guidelines must be discussed and resolved by the designer and the area map editor.

Type - Set base credit notes flush left in 6/8 pt.type; make the first line of type longer than succeeding lines where possible.

Examples

When the base map consists of one full quadrangle and the quadrangle name appears in the title of the map (including maps printed from DMATC material):

Base from U.S. Geological Survey, 1967

When the base is prepared and published by the U.S. Geological Survey for the Tennessee Valley Authority:

Base from Tennessee Valley Authority
and U.S. Geological Survey, 1953

When the scale of the base map is different from the original scale of the printed map and the quadrangle name appears in the title:

Base from U.S. Geological Survey
1:62,500, 1958

When less than a full quadrangle is used and the quadrangle name does not appear in the title:

Base from U.S. Geological Survey
Clay Hills, 1954

When the purple revision overprint is included as part of the culture and the quadrangle name appears in the title, show the date when the photographs were taken:

Base from U.S. Geological Survey, 1960
Photorevision as of 1968

When changes or additions are made to the base map and the quadrangle name does not appear in the title:

Base from U.S. Geological Survey
Clay Hills, 1954
Roads as of 1962

When the base consists of two or more quadrangles and either or both quadrangle names do not appear in the title:

Base from U.S. Geological Survey
Clay Hills, 1954, and Clay Hills 1 NW, 1952

When the base map is prepared by mosaicking maps of different scales:

Base from U.S. Geological Survey
Baltimore, 1:250,000, 1957–63,
and St. Michaels, 1:62,500, 1902

When part of the base is an unedited advance print:

Base from U.S. Geological Survey
St. Michaels, 1902, and unedited
advance print, 1960

When the base is prepared from maps other than topographic quadrangles, indicate the type of map in the credit note:

Base from U.S. Geological Survey
State base map, 1950

When the state coordinate system and the UTM grid are shown, use the wording given on the topo quadrangle:

Base from U.S. Geological Survey, 1960
Photorevision as of 1968
10,000-foot grid based on Wyoming coordinate system, west zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

Examples for photo base maps

When the base covers a standard quadrangle area:

Orthophotomap base by U.S. Geological Survey;
aerial photographs taken 1954

When the base covers an irregular area:

Orthophoto mosaic base by U.S. Geological Survey;
aerial photographs taken 1954

When a planimetric base has been prepared by tracing from an orthophoto mosaic or an orthophotomap:

Planimetric base by U.S. Geological Survey
from orthophoto mosaic; aerial photographs
taken 1954

When an uncontrolled photomosaic base is used:

Uncontrolled photomosaic base by
U.S. Geological Survey. Aerial
photographs from Lockwood, Kessler,
and Bartlett, Inc., Syosset, New York, 1968

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.: | Effective Date: 10/5/73 | Article No.: 3.09.5

Subject: ILLUSTRATIONS -- Maps - Mapping credit

Mapping credit is required for all maps that show geologic or hydrologic information. Geologic credit can be shown by a geologic-credit note or an index to geologic mapping. Hydrologic credit should be shown by a hydrologic-credit note.

A. Geologic-credit and hydrologic-credit notes*

1. Form -- Initials are used for the author's first and middle names. When an author has no middle name or initial, his first name will be spelled out. Initials or first name precedes the last name. When both geologic-credit and hydrologic-credit notes are required for a map, the hydrologic-credit note should be placed beneath the geologic-credit note; both credit notes can be combined into a credit note for "Geohydrology" if the name(s) and date(s) for geology and hydrology are the same. The following descriptions can be applied to hydrologic-credit notes by substituting "hydrology" for "geology."

   a. When the author's name appears below the title of the geologic map and he is solely responsible for mapping the geology, the credit note should read:

      "Geology mapped in 19__"

   b. When the author's name does not appear below the title of the geologic map and he is solely responsible for mapping the geology, the credit note should read:

      "Geology by name of author, 19__"

   c. If the geologic map appears in a report that has several authors, the name of the author solely responsible for the geologic mapping will appear in the credit note:

      "Geology by name of author, 19__"

      If more than one author is responsible for the geologic mapping, the names of the authors responsible for the geologic mapping will appear in the credit note:

      "Geology by name of author, name of author, and name of author, 19__"

*See page 67.

d. If the author of the geologic map was assisted by another person, the credit note should read:

"Geology by name of author, 19__; assisted by name of assistant, 19__"

e. If the person responsible for the geologic map is not an author of the report in which the map appears and the map is being reproduced without change from a published report, the credit note should read:

"Geology from name of person responsible for map (year of publication)"

If the author(s) of the report has slightly modified the geology shown on the map, the credit note should read:

"Geology modified from name of person responsible for map (year of publication)"

If the author(s) of the report has greatly modified the geology shown on the map, the credit note should read:

"Geology from name of person responsible for map (year of publication); modified by name of author, year of modification"

The complete bibliographic citation for the geologic map used must be shown in the list of references.

Thus, the name of the person responsible for mapping is separated from the date of mapping by a comma; however, the year of publication of a map follows in parentheses the name of the person responsible for mapping without an intervening comma.

2. Placement -- On a rectangular-shaped map the geologic-credit and hydrologic-credit notes should appear under the south border and end flush with the east border. On an irregular-shaped map the notes should appear as close to the southeast margin of the map as possible.

B. Index to geologic mapping (used only when two or more people are responsible for the geologic mapping of adjacent areas or when the geology was mapped by the same person(s) but published in different reports).

1. Form -- The index consists of an outline of the geologic map subdivided into the parts mapped by the different people. The index does not have a scale or latitude and longitude numbers. The title, "INDEX TO GEOLOGIC MAPPING," is placed below the index. The index can be presented in either of two formats.

a. The last names of the people responsible for the mapping, followed by the year the map was published (in parentheses), can be placed in the subdivided parts of the index.

b. The subdivided parts of the index can be numbered consecutively (1, 2, 3, 4, and so forth) and a listing of the people responsible for the mapping, keyed to the numbers, can be placed below the index title. The format for the listing is last name followed by the year of publication (in parentheses).

The complete bibliographic citations for the reports must be shown in the list of references.

2. Placement -- Placement below the southeast corner of the geologic map is preferred. However, the index can be placed in any convenient location near the geologic map.

References: Technical Standards Papers 3.04.2 and 3.08.3 of Publications Division.

CARTOGRAPHIC TECHNICAL STANDARDS

Replaces T. S. P.		Subject: MARGINAL INFORMATION - Geologic and Hydrologic Credit Notes	T. S. Paper	3.00.4
Dated			Effective	11/29/76

Type - Set geologic and hydrologic credit notes flush left in 6/8 pt. type; make the first line longer than the succeeding lines where possible. Show initials for authors first and second names; if an author has no middle name or initial, spell out his first name. Set the names so that each complete name appears on the same line of type, if possible.

Examples

When the name of the author (or authors) appears below the title of the map and he is solely responsible for the mapping, do not show the author's name in the credit note:

Geology mapped in 1970–71

When the name of the author (or authors) does not appear below the title of the map:

Hydrology by P. R. Williams, 1970

Geology by C. L. Sainsbury, 1960–69; assisted by Donald Grybeck, 1961, T. E. Smith, 1962, 1967, W. E. Todd, 1967; Reuben Edwards, 1967–68, and Travis Hudson, 1968–69

When credit is to be given to contributors or assistants whose names do not appear under the title:

Geology by Louis Palvides, 1959–63; assisted by W. P. Williams, 1959; W. H. Hanson III, 1960–61; and J. S. Derr, 1962

When information in addition to mapping credit is shown:

Geology by G. W. Withington, 1962, 1963, and 1968, assisted by J. S. Atherton, 1962; L. B. Smith and John Leftwich, Jr., 1968

Data on bedrock outcrops, boulder trains, glacial striae, and karst features provided by N. M. Fox and H. R. Burger

When a map has already been published in a different series:

Geology by K. J. Englund
Previously published as GQ-173

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.: | Effective Date: 3/15/74 | Article No.: 3.10.2

Subject: ILLUSTRATIONS -- Explanations - Maps

The purpose of a map explanation is to explain to the map user all the symbols, numbers, letters, patterns, and colors used to portray scientific data on a map. Because most map users are familiar with the symbols used to portray base features, either from using highway maps or Survey topographic maps, features such as roads, streams, canals, buildings, topographic contours, and levees are not shown in map explanations. If a base feature is used that the map user may not be familiar with, then the base feature should be labeled on the map.

The title of the map explanation is to be EXPLANATION and not LEGEND or KEY. The Survey considers Johnny Appleseed to be a legend and a key is that instrument used to open locks.

The map explanation must contain a sample of all the scientific data added to the map and not labeled on the map. For example, if a map contains only one fault shown by a solid line and the fault is labeled SAN ANDREAS FAULT on the map, the fault symbol need not be shown in the map explanation. If, however, other information is shown on the labeled fault such as arrows, U, and D, or if part of the fault is dashed, then the fault symbol with the additional information must be shown in the map explanation and the additional information explained. Also, if more than one fault is shown in addition to the labeled fault, then the fault symbol must appear in the explanation.

The sample shown in the explanation must be an exact duplicate of the data shown on the map. For example, if wells are shown by solid circles and a number is shown adjacent to the circle, then the solid circle and the number (a duplicate of one used on the map) must be shown and explained in the explanation.

The order of presentation of data in the explanation is: all geologic data precede all hydrologic data if both types of data are shown. Areal data usually shown in boxes (color or pattern) always precede line or point data. For example, if a map shows two geologic formations, geologic contacts, water-table contours, and water wells, the order of presentation in the explanation would be:

Geologic formations
Contact
Water-table contour
Well

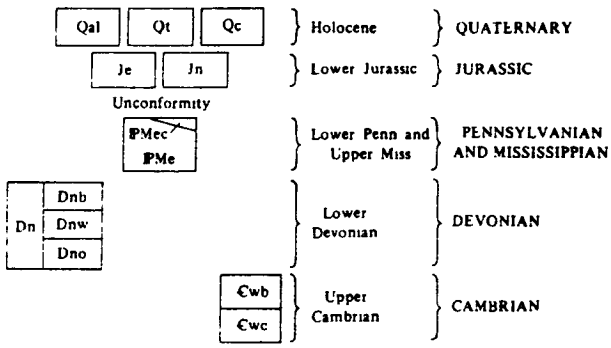
The preferred placement for the explanation is outside the right margin of the map when the map is square or rectangular in shape. When the map has an irregular shape, any convenient placement of the explanation is acceptable in the following order of preference: upper right, upper left, lower right, or lower left.

Recently the format for map explanations has been changed from placing the description of the data below the data sample to placing the description to the right of the data sample. The explanation for geologic units in the new format consists of two parts: correlation of map units and description of map units. One principal advantage of the new format, in addition to a considerable saving in time and cost of cartographic preparation, is the flexibility of presentation in showing correlation of map units.

Examples of the new formats for both geologic and hydrologic explanations follow. The examples of hydrologic explanations include only English units; therefore, the examples should be used for format only.

Example 1

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qal — ALLUVIUM – Mainly flood-plain deposits: numerous gravels

Qt — TERRACE DEPOSITS

Qc — COLLUVIUM – Mainly slope wash and solifluction mantle derived from higher outwash river terrace gravels

MEGABRECCIAS

Je — Composed mainly of blocks of Ely Limestone

Jn — Blocks of Nevada Formation

Unconformity

PMe — ELY LIMESTONE – Massively bedded bluish-gray limestone Abundant nodules or bands of dark tan-weathering chert Near the base, beds of brown sandstone, local chert pebble conglomerate

PMec — Coarse limestone conglomerate at top of formation north of Peterson Canyon, 500 feet exposed

Dn — NEVADA FORMATION – Dominantly composed of massive dolomite

Dnb — Bay State Dolomite Member – Massively bedded dark-gray to black dolomite Some beds contain abundant *Claopora* and *Stromatopa* colonies

Dnw — Woodpecker Limestone Member – Thin-bedded dark-gray limestone

Dno — Oxyoke Canyon Sandstone Member – Thick-bedded light-olive-gray dolomitic sandstone or quartzite weathering to shades of brown

WINDFALL FORMATION – Several outcrops occur in southwest corner of quadrangle

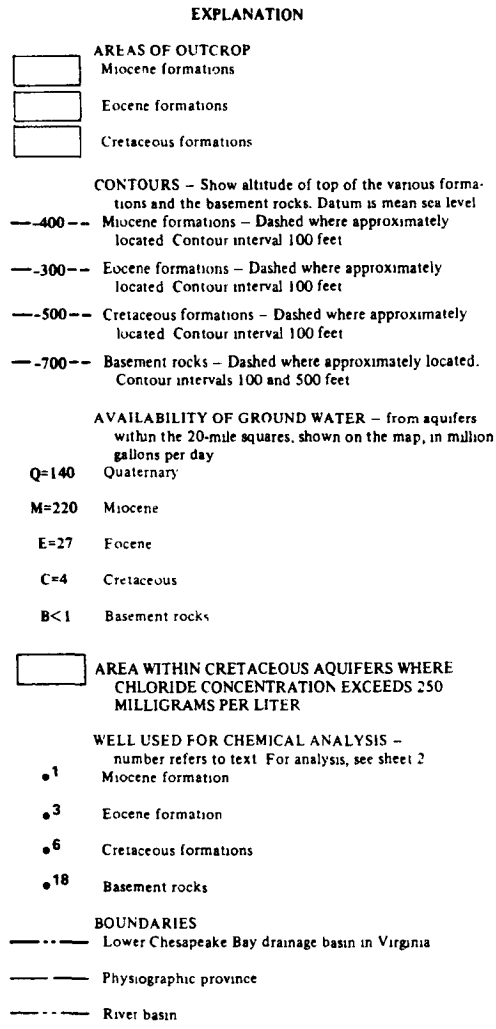
€wb — Bullwacker Member – Uniformly thin-bedded tan or light-brown sandy silty limestone

€wc — Catlin Member – Alternating massive limestone and thin-bedded sandy or silty limestone

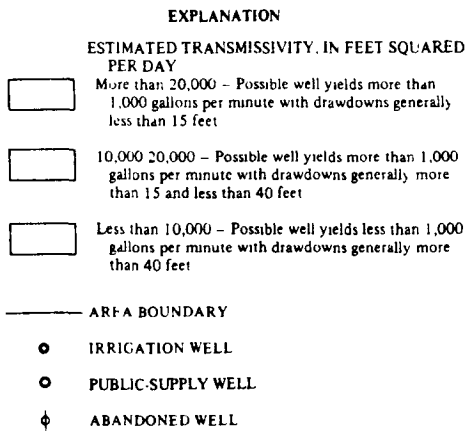
——— Contact – Dashed where approximately located, dotted where concealed

Strike and dip of beds
Inclined

Example 2



Example 3



References: Technical Standards Papers 8.01.1 and 8.04.1 of Publications Division.

The gradational use of a single color or two colors is a technique often used to present data where a range of values is used. Gradational tones can be readily seen by the human eye and are more easily understood by the map user than alternating bands of different colors. Some examples are:

A. One color

1. Well yields - tones of blue with the largest well yields the darkest blue and the smallest well yields the lightest blue or white.

2. Depth to water - tones of blue with the greatest depth the darkest blue and the shallowest depth the lightest blue or white.

B. Two colors

Dissolved solids - tones of blue and red with the smallest dissolved-solids content the darkest blue and the largest dissolved-solids content the darkest red.

DISSOLVED-SOLIDS CONTENT, IN MILLIGRAMS PER LITER

0- 500	- Dark blue	or	Dark blue
500- 1,000	- Medium blue		Light blue
1,000- 3,000	- Light blue		Light blue and light red
3,000-10,000	- Light red		Light red
10,000-35,000	- Medium red		Medium red
More than 35,000	- Dark red		Dark red

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.: | Effective Date: 8/27/73 | Article No.: 3.06.4

Subject: ILLUSTRATIONS -- Symbols - Standard lineweights for scribing

Standard widths of scribed lines for topographic, hydrologic, and geologic features in publications of the U.S. Geological Survey follow. Contours and lines of equal value for hydrologic features will be either solid or dashed -- solid for known locations and dashed for approximate locations. If all contours or all lines of the same feature on a map are approximately located, lines can be scribed solid and labeled as "approximately located" in the explanation. If known and approximate locations of the same feature occur together on a map, the approximate locations must be dashed.

A. TOPOGRAPHIC FEATURES	Line width (inch)
1. National boundary lines	0.016
2. State boundary lines	.012
3. County boundary lines	.010
4. City or town boundary lines	.007 (.008)
5. Railroads	.005
6. Township and range lines	.010
7. Section lines	.005
8. Grid coordinate lines	.005
9. Drainage	.005
10. Trails	.003
11. Road casings	
a. Four or more lanes	.003
b. Less than four lanes	.003
12. Contours	
a. Index	.007
b. Intermediate	.002

B. HYDROLOGIC FEATURES	Line width (inch)
1. Drainage-basin boundary lines	0.020
2. Drainage-subbasin boundary lines	.012
3. Flood-limit boundary lines	.012
4. Contours and lines of equal value	
a. Index	.015
b. Intermediate	.008

NOTE: Dashing of contours or lines of equal value:

Approximately located -- dashes 0.20 inch long with a 0.02-inch space between dashes.

C. GEOLOGIC FEATURES	Line width (inch)
1. Contacts	
a. Normal spacing	0.005
b. Where congested	.004
2. Anticlines and synclines	
a. Normal spacing	.010
b. Where congested	.008
3. Faults	
a. Normal spacing	.015
b. Where congested	.012
4. Contours	
a. Index	.015
b. Intermediate	.008

NOTE: Dashing of contacts, anticlines and synclines, and faults:

1. Approximately located -- dashes 0.14 inch long with a 0.02-inch space between dashes.

2. Inferred, indefinite, or gradational -- dashes 0.06 inch long with a 0.02-inch space between dashes.

3. Concealed -- dashes 0.02 inch long with a 0.02-inch space between dashes.

Dashing of contours:

Approximately located -- dashes 0.20 inch long with a 0.02-inch space between dashes.

LINEWEIGHTS

Technical pen point size/ metric size	Inked	Scribed	Jewel scribing point size
4/1.00			.030
3/0.80			.025
2.5/0.70			.020
2/0.50			.015
1/0.40			.012
0/0.35			.010
00/0.25			.008

BRANCH OF TECHNICAL ILLUSTRATIONS
TECHNICAL STANDARDS SECTION

T.S. Paper No.	2.4	Effective Date	7-18-63	Supercedes T.S.P. No.	

Subject | BORDER INFORMATION - Presentation for Index maps showing area of report, published maps in area, and quadrangle with certain exceptions for HA's

An index map showing 1. area of the report 2. the published maps in the series and 3. the topographic quadrangles will be designed as follows:

1. The area of the report will be stippled or cross-hatched. Where an extra color is used, that color should be printed in a stipple to show the area of the report. On a group of related reports the same stipple, cross-hatch, or stippled color will be made consistant for the series.

2-3. The published maps shown on an index map will be labelled with the actual identifying number of the sheet; ie:, for an HA series (or any Series) listing all the quadrangles, the names of the quadrangles will be named and only those sheets that are published will have the HA number or Series number added to the name of the sheet. (See sample)

Item 1 will normally be used for indexes showing only the area of the report. The type of stippling or cross-hatching will be determined by the designer of the job. There are too many factors involved in picking a specific stipple or cross-hatch to be used for all jobs.

Explanations are normally unnecessary on index maps; they should be self-explanatory.

The HA series are the exception where an explanation is required to define the "Area of this report".

EXPLANATION

Area of this report

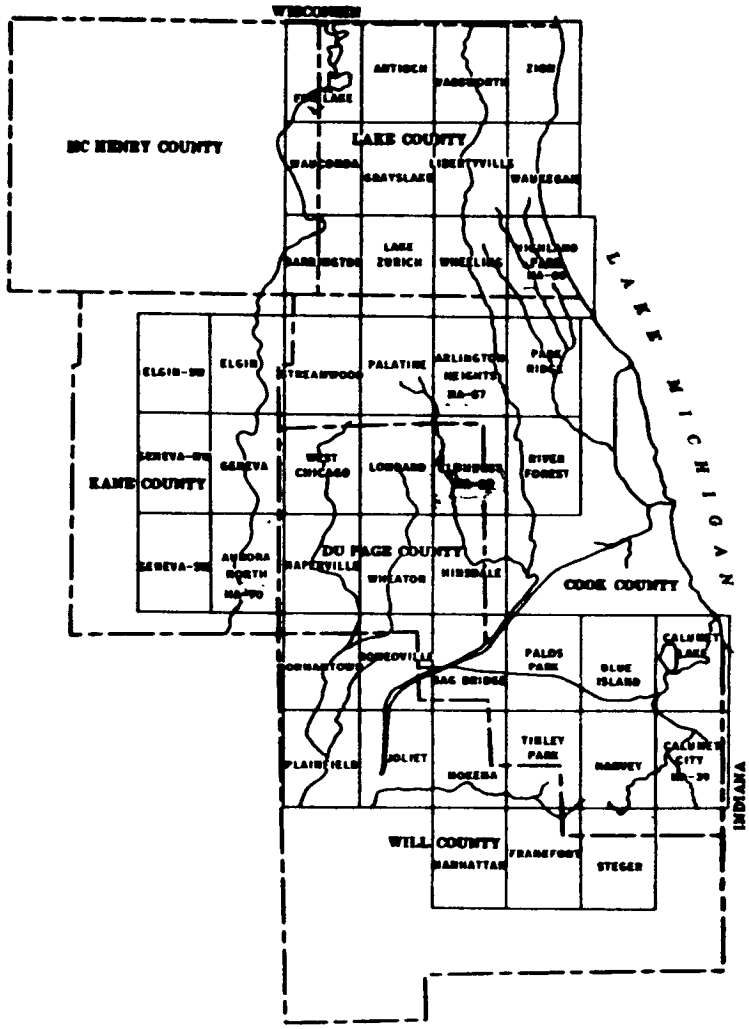
A recommended title for index maps with the three items mentioned in this paper is as follows:

"Outline map of (northeastern Illinois) showing location of (Elmhurst) quadrangle".

The title for HA index maps with the three items mentioned in this paper will read as follows:

"Fig 1 - Index map of (northeastern Illinois) showing location of quadrangles included in flood hazard mapping program."

July 23, 1963


WISCONSIN
MC HENRY COUNTY
LAKE COUNTY
KANE COUNTY
DU PAGE COUNTY
COOK COUNTY
WILL COUNTY
LAKE MICHIGAN
INDIANA
ANTIOCH
ZION
WAUKEGAN
LAKE ZORICH
WHEELING
PALATINE
ELGIN
GENEVA
LOMBARD
RIVER FOREST
NAPERVILLE
WHEATON
HINSDALE
PALOS PARK
BLUE ISLAND
JOLIET
ROMEOVILLE
TINLEY PARK
FRANKFORT
STEGER

CARTOGRAPHIC TECHNICAL STANDARDS

Replaces T. S. P.	2.02.2 3/31/78	Subject: Base Maps -- Biangle screens to be used with bases for thematic maps	T. S. Paper	2.02.2
			Effective	6/23/78

With the adoption of the 59-line (150 lines/in) composite biangle screens, the Branches of Cartography within the Publications Division will instruct whoever does the screening as to which biangle screen to apply to base negatives.

Use T.S.P. 7.10.1, along with the guidelines here when writing instructions about applying biangle screens to base negatives.

Most geologic maps will use topographic bases screened with the 50% biangle screen for the culture and the 50% biangle screen for the relief (both features usually print black). The drainage will print solid (100%) (usually cyan). Using this system, the topographic border data will be screened the same as the culture because they appear on the same negative. Though these instructions specifically apply to Geologic Quadrangle maps, they may readily be applied to many other map-series publications.

If the density of the culture is so great as to warrant use of biangle screens reading less than 50%, prepare two masks, to be itemized and included with reproduction items sent to the printer. Cut one mask to cover the border data outside the neatline, and save the inner, cut-out part for use as a second mask to cover the culture. The purpose of the inner mask is to allow all topographic border data outside the neatline to print a readable solid (100%), and the purpose of the outer mask is to allow all cultural data including the neatline to print less than 50%. The neatline scribed on the black scribecoat must coincide precisely with the screened base neatline to avoid a double neatline in printing. If this registration of neatlines is not precise, the base neatline should be deleted with the exception of the corner ticks. The mask will be cut between the neatline and the type that rims the neatline.

Cartography will instruct the printer to expose the culture negative twice--once with the collar of the mask in register with the culture negative, which will allow the culture and neatline to print less than 100%, and once with the collar and the biangle screen removed but with the inside of the mask over the map data and neatline on the culture negative. This treatment will allow the topographic border data to print solid (100%).

In the event that no separates are available and Cartography has a composite base to use as printer's copy, the screen percentage determination should be made on the density of the combined culture and relief and the detail of the geology shown on the map.

A guideline for selecting biangle screen percentages for bases to be used with thematic maps is as follows:

Screen a very dense culture or relief to print 30%
Screen a dense culture or relief to print 40%
Screen a culture or relief of medium density to print 50%
Screen a culture or relief of light density to print 60%
A very light culture or relief will print solid (100%)

Biangle screen percentages may change from map to map, and discretion must be used in selecting the appropriate screens for each culture and relief on each map.

(Example - roadfills which might be interpreted as faults should be screened 40% or even 30%.)

Specifications for 59-line (150 lines/in) biangle screens

(Optical density readings are minus the film's base fog density value.)

Screen Identification	Percent Range	Integrated Density	
		Aimpoint	Range
30%	30-34	.50	.52-.47
40%	37-41	.40	.43-.39
50%	47-51	.31	.33-.29
60%	59-63	.21	.23-.20

CARTOGRAPHIC TECHNICAL STANDARDS

Replaces T. S. P.		Subject: EXPLANATIONS Basic format for HYDROLOGIC explanations	T. S. Paper	8.04.1
Dated			Effective	6/29/79

Basic format.--On hydrologic map explanations, place the map symbols in a column to the left of the symbol names and descriptions. Place the title "EXPLANATION" in the visual center over the symbols and type; it should be 6.5 mm (0.25 in) above the first line of type.

Type.--Use SM-10 for "EXPLANATION" and SL-9 with 2-point leading for the symbol names and descriptions. Capitalize symbol names; set the description in lowercase. Use a long dash with a 3-unit space on both sides of the dash to separate the symbol name and its description. Indent the descriptive type overruns. Contour values will normally be set in UI-8; however, larger or smaller values may be more appropriate depending upon the number, line weight, and position of the contours and other map detail.

Indent 1 pica when the description requires two or more lines of type and indent subunit names one-half a pica. Do not justify the right margin, but keep it as straight as possible using a minimum of hyphenation.

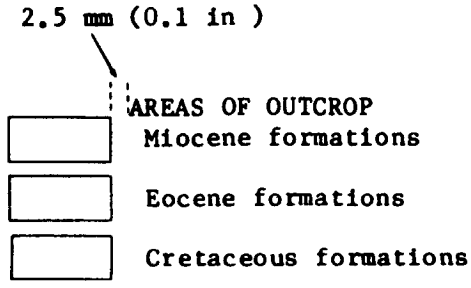
1-pica indention

CONTOURS - Show altitude of top of the various formations and the basement rocks. National Geodetic Vertical Datum of 1929

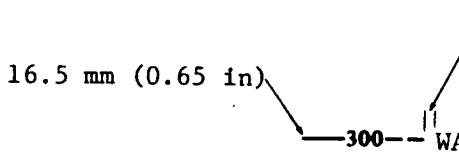
½ pica

BOUNDARIES
Lower Chesapeake Bay drainage basin in Virginia
Physiographic province
River basin

Boxes.--Where areal units are shown, use 14x6.5-mm (0.55x0.25-in) boxes. Place the boxes 2.5 mm (0.1 in.) from the names.



Symbols.--Make line symbols 16.5 mm (0.65 in) long, starting 1.2 mm (0.05 in) off the names.



WATER-LEVEL CONTOURS - Showing altitude of water level; dashed where approximate. Contour interval 10 feet; National Geodetic Vertical Datum of 1929

IRRIGATION WELLS

- ● Flowing
- ⌀ Not flowing
- o Not used

O INDUSTRIAL OR PUBLIC-SUPPLY WELLS

Example 1 (Based on HA-389)

EXPLANATION

ESTIMATED TRANSMISSIVITY, IN GALLONS PER DAY PER FOOT

- ▭ More than 150,000 - Possible well yields more than 1,000 gallons per minute with drawdowns generally less than 15 feet
- ▭ 50,000-150,000 - Possible well yields more than 1,000 gallons per minute with drawdowns generally more than 15 and less than 40 feet
- ▭ Less than 50,000 - Possible well yields less than 1,000 gallons per minute with drawdowns generally more than 40 feet

——— AREA BOUNDARY

- o IRRIGATION WELL
- O PUBLIC WELL
- ϕ ABANDONED WELL

Replaces

T. S. Paper No. 8.04.1(3)

Example 2 - (Based on HA-284)

EXPLANATION

AREAS OF OUTCROP

Miocene formations

Eocene formations

Cretaceous formations

CONTOURS- Showing altitude of top of the various formations and the basement rocks. National Geodetic Vertical Datum of 1929.

—400— Miocene formations - Dashed where approximately located; contour interval 100 feet

—300— Eocene formations - Dashed where approximately located; contour interval 100 feet

—500— Cretaceous formations - Dashed where approximately located; contour interval 100 feet

—700— Basement rocks - Dashed where approximately located; contour intervals 100 and 500 feet

AVAILABILITY OF GROUND WATER - from aquifers within the 20-mile squares shown on the map, in millions of gallons per day

Q=140 Quaternary

M=220 Miocene

E=27 Eocene

C=4 Cretaceous

B<1 Basement rocks

AREA WITHIN CRETACEOUS AQUIFERS WHERE CHLORIDE CONCENTRATION EXCEEDS 250 PARTS PER MILLION

WELL USED FOR CHEMICAL ANALYSIS-
number refers to text. For analysis, see sheet 2

•[1] Miocene formation

•[3] Eocene formation

•[6] Cretaceous formations

•[18] Basement rocks

BOUNDARIES

——·—— Lower Chesapeake Bay drainage basin in Virginia

—— —— Physiographic province

——·—— River basin

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.: | Effective Date: 2/15/74 | Article No.: 3.06.3

Subject: ILLUSTRATIONS -- Symbols - Geohydrologic map symbols

The geohydrologic map symbols that follow are for use on maps and in map explanations of Federal publications of the Geological Survey. Geohydrologic symbols follow geologic symbols in a map explanation; they should be grouped in the order of appearance in this article. The symbols are subdivided into four general groups: contours, lines, hydrologic data-site symbols, and miscellaneous symbols.

The symbols and descriptions of contours and lines include all levels of accuracy to be used; that is, solid lines for known locations and dashed lines for approximate locations. All contours and line symbols should be scribed in the specified lineweights and lengths.

Each map symbol is of distinctive geometric shape for a particular type of hydrologic data site: a circle for water wells, a circle with a "tail" for springs, a triangle for gaging stations, an inverted triangle for quality-of-water sites, and a diamond for weather stations.

Each group of hydrologic data-site symbols is divided into two subgroups: restricted and recommended. The restricted symbols must be used for the stated purpose. The recommended symbols may be used on maps to present data other than those described under the symbol headings. For example, a solid circle may be used to represent wells completed in bedrock and an open circle to represent wells completed in unconsolidated materials. However, if on the same map stock wells are shown, the symbol for stock wells (open circle) is recommended. In that instance a symbol other than an open circle would be used to represent wells in unconsolidated materials.

The use of symbols must be consistent on all maps within a report or within a related series of reports. The symbol restrictions apply only to maps. Any geometric shape may be used for symbols on illustrations other than maps. On maps where the plotted symbols are congested and difficult to interpret, insets at enlarged scales permit detailed plotting of the symbols.

All miscellaneous symbols are restricted and, therefore, must be used for the stated purpose.

CONTOURS

Used only in reference to altitude. Line widths (scribed): for index contours use 0.015 inch; for intermediate contours use 0.008 inch. Use 0.2-inch dashes with 0.02-inch space between dashes for approximate contours. Listed below are descriptions of commonly used contours in the format to be used for map explanations.

SYMBOL	DESCRIPTION
——100——	STRUCTURE CONTOUR -- Shows altitude of (top or base of, or horizon within) (stratigraphic unit, aquifer, or confining bed). Dashed where approximately located. Contour interval (number) (units). Datum is sea level
——50——	BEDROCK CONTOUR -- Shows altitude of bedrock surface. Dashed where approximately located. Contour interval (number) (units). Datum is sea level
——200——	WATER-TABLE CONTOUR -- Shows altitude of water table, (date). Dashed where approximately located. Contour interval (number) (units). Datum is sea level NOTES: 1. To be used only in reference to unconfined (water-table) conditions. 2. Date can be omitted from description if date given in map title.
——500——	POTENTIOMETRIC CONTOUR -- Shows altitude at which water level would have stood in tightly cased wells, (date). Dashed where approximately located. Contour interval (number) (units). Datum is sea level NOTES: 1. To be used in reference to either confined (artesian) or unconfined conditions. 2. To be used when both confined and unconfined conditions are not differentiated on the same map. 3. POTENTIOMETRIC CONTOUR is preferred. WATER-LEVEL CONTOUR is permitted. 4. Date can be omitted from description if date given in map title.
——1000——	WATER-QUALITY-ZONE CONTOUR -- Shows altitude of (top or base of, or horizon within) (type of water-quality zone or types of water in an aquifer), (date). Dashed where approximately located. Contour interval (number) (units). Datum is sea level NOTE: Date can be omitted from description if date given in map title.

LINES

Used when no reference is made to altitude. Terms prefixed by "ISO" are not recommended. Line widths (scribed) and dashes have same specifications as for contours. Listed below are descriptions of commonly used lines in the format to be used for map explanations.

SYMBOL	DESCRIPTION
———24———	LINE OF EQUAL (AVERAGE, MEAN, MEDIAN, ETC.) (ANNUAL, MONTHLY, DAILY, ETC.) PRECIPITATION, (DATE)* -- Dashed where approximately located. Interval (number) (units) NOTE: Date can be omitted from description if date given in map title.
———100———	LINE OF EQUAL DEPTH TO (GEOLOGIC FORMATION, BEDROCK, AQUIFER, WATER, ETC.), (DATE)* -- Dashed where approximately located. Interval (number) (units). Datum is land surface NOTES: 1. Date needed only for parameters that vary with time. 2. Date can be omitted from description if date given in map title.
———50———	LINE OF EQUAL THICKNESS OF (GEOLOGIC FORMATION, AQUIFER, CONFINING BED, SATURATED MATERIAL, ETC.), (DATE)* -- Dashed where approximately located. Interval (number) (units) NOTES: 1. Date needed only for parameters that vary with time. 2. Date can be omitted from description if date given in map title.
———10———	LINE OF EQUAL WATER TEMPERATURE, (DATE)* -- Dashed where approximately located. Interval (number) degrees Celsius NOTE: Date can be omitted from description if date given in map title.
———2000———	LINE OF EQUAL SPECIFIC CONDUCTANCE, (DATE)* -- Dashed where approximately located. Interval (number) micromhos per centimeter at 25 degrees Celsius NOTE: Date can be omitted from description if date given in map title.

*Show date in figure title.

SYMBOL	DESCRIPTION
———500———	LINE OF EQUAL (DISSOLVED-SOLIDS CONCENTRATION, HARDNESS, OR CHEMICAL-CONSTITUENT CONCENTRATION), (DATE)*-- Dashed where approximately located. Interval (number) (milligrams per liter or milliequivalents per liter) NOTE: Date can be omitted from description if date given in map title.
———20———	LINE OF EQUAL WATER-LEVEL (CHANGE, RISE, OR DECLINE), (DATE)*-- Dashed where approximately located. Interval (number) (units) NOTE: Date can be omitted from description if date given in map title.
———6———	LINE OF EQUAL RUNOFF, (DATE)*-- Dashed where approximately located. Interval (number) (units) or Interval (number) (flow unit) per (area unit) NOTE: Date can be omitted from description if date given in map title.
———10,000———	LINE OF EQUAL (TRANSMISSIVITY, HYDRAULIC CONDUCTIVITY, POROSITY, ETC.) -- Dashed where approximately located. Interval (number) (units)

*Show date in figure title.

WATER WELLS

Basic shape is a circle— ○

RESTRICTED SYMBOLS

DESCRIPTION	SYMBOL	SYMBOL WITH BASIC SHAPE	NOTES
Flowing artesian well			1. Supplemental information can be shown inside or on the periphery of these symbols. 2. Symbol should be centered over the data site.
Nonflowing artesian well			
Recharge or waste-injection well			
Observation well			
Observation well equipped with a recorder	R	R	
Dry well			
Destroyed well			
Test hole			

RECOMMENDED SYMBOLS

DESCRIPTION	SYMBOL	NOTES
Well used for domestic-water supply	●	1. Can be used in combination with the above. 2. Supplemental information can be shown on the periphery of these symbols
Well used for stock-water supply	○	
Well used for irrigation-water supply	◎	
Well used for industrial-water supply	◉	
Well used for public-water supply	○	
Unused well	⊕	

SPRINGS

Basic shape is a circle with a "tail"— 
The "tail" to point in direction of flow.

RESTRICTED SYMBOLS

DESCRIPTION	SYMBOL	SYMBOL WITH BASIC SHAPE	NOTES
Thermal spring	T		1. Supplemental information can be shown inside or on the periphery of these symbols 2 Symbol should be centered over the data site.
Mineral spring	M		
Extinct spring	/		

RECOMMENDED SYMBOLS

DESCRIPTION	SYMBOL	NOTES
Spring used for domestic-water supply		1. Can be used in combination with the above 2. Supplemental information can be shown on the periphery of these symbols.
Spring used for stock-water supply		
Spring used for irrigation-water supply		
Spring used for industrial-water supply		
Spring used for public-water supply		
Unused spring		

GAGING STATIONS

Basic shape is a triangle—△

RESTRICTED SYMBOLS

DESCRIPTION	SYMBOL	SYMBOL WITH BASIC SHAPE	NOTES
Gaging station equipped with a telephone or radio			1 Supplemental information can be shown inside or on the perimeter of these symbols 2. Symbol should be centered over the data site when used alone. Combined triangles should be centered over the data site when quality-of-water data are obtained at a gaging station. 3 Gaging-station symbol should be placed above and adjoin, the quality-of-water triangle when quality-of-water data are obtained at a gaging station
Peak-flow measurement station			
Low-flow measurement station			
Stage-measurement station			

RECOMMENDED SYMBOLS

DESCRIPTION	SYMBOL	NOTES
Continuous-record gaging station		1. Can be used in combination with the above 2 Supplemental information can be shown on the perimeter of these symbols
Partial-record gaging station (floods)		
Measurement site without a gage		
Discontinued gaging station		

QUALITY-OF-WATER SITES

Basic shape is an inverted triangle — ▽

RESTRICTED SYMBOLS

DESCRIPTION	SYMBOL	SYMBOL WITH BASIC SHAPE	NOTES
Chemical-measurement site	⁄	▽	1. Supplemental information can be shown inside or on the perimeter of these symbols. 2. Symbol should be centered over the data site when used alone. Combined triangles should be centered over the data site when quality-of-water data are obtained at a gaging station. The circle should be centered over the data site when quality-of-water data are obtained at a well or spring. 3. Quality-of-water symbol should be placed beneath, and adjoin, the gaging-station triangle or the circle when quality-of-water data are obtained at a gaging station, well, or spring.
Temperature-measurement site	\	▽	
Biological-measurement site	— (extension of top line to left)	▽	
Sediment-measurement site	— (extension of top line to right)	▽	

RECOMMENDED SYMBOLS

DESCRIPTION	SYMBOL	NOTES
Active site	▼	1. Can be used in combination with the above 2. Supplemental information can be shown on the perimeter of these symbols.
Active site equipped with a monitor	▽	
Inactive site	▽	

WEATHER STATIONS

Basic shape is a diamond divided into four parts— 

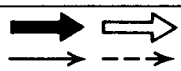
RESTRICTED SYMBOLS

DESCRIPTION	SYMBOL	SYMBOL WITH BASIC SHAPE	NOTES
Weather station equipped with a recorder	R		1. Supplemental information can be shown inside or on the periphery of these symbols 2. Symbol should be centered over the data site
Weather station equipped with a telephone or radio			

RECOMMENDED SYMBOLS

DESCRIPTION	SYMBOL	NOTES
Complete weather station		1. Can be used in combination with the above. 2. Supplemental information can be shown on the perimeter of these symbols.
Snow-survey course		
Weather stations where the following types of measurements are obtained:		
Precipitation		
Evaporation		
Temperature		
Humidity		
Solar radiation		
Wind velocity		
Discontinued weather station		

MISCELLANEOUS RESTRICTED SYMBOLS

DESCRIPTION	SYMBOL	NOTES
Basin boundary (surface water)		
Subbasin boundary (surface water)		
Ground-water divide		Open symbol where approximately located
Ground-water barrier (geologic)		
Infiltration gallery		
Direction of ground-water flow		Open or dashed symbol where approximately located.

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

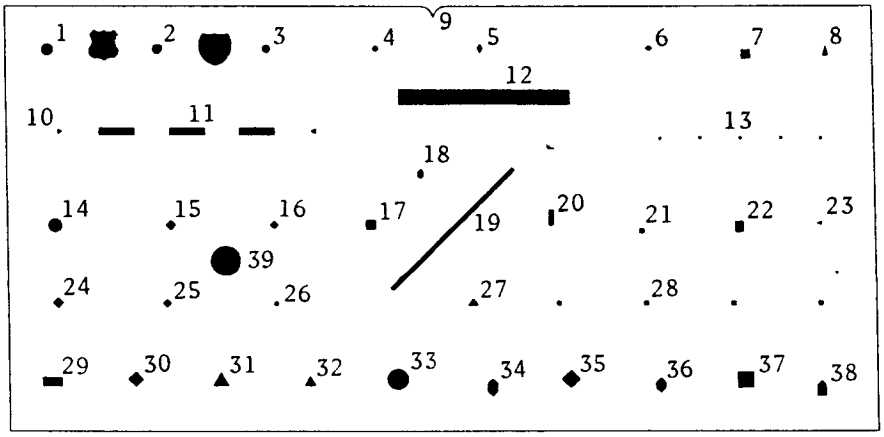
Replaces Article No.: | **Effective Date:** 11/1/73 | **Article No.:** 3.06.1

Subject: ILLUSTRATIONS -- Symbols - Geologic map symbols

Geologic map symbols recommended for publications of the Geological Survey are given in the following list. The symbols are arranged in order of usual appearance in an explanation, but the order may be altered for emphasis.

Line symbols are scribed on scribecoat or inked on positive material. Locational symbols may be scribed, inked, or attached by wax-backed film positives depending on the information to be shown and the material to be used.

The sequence for scribing symbols is keyed to the template numbers indicated below. For rectangular slots, L signifies use of the length or long side of the slot; W signifies use of the width or short side. For circles, a number followed by ($\frac{1}{2}$) signifies use of half the circle. For brackets, item 9 must be added to the template. A limited number of templates are available, at no charge, from the Office of Research and Technical Standards, Topographic Division, National Center, Reston, Va. 22092.



Standard geologic symbols used to create the symbols in the list are available on wax-backed film positives (stick-up). One sheet contains line symbols (lines, arrows, U/D); the other contains locational symbols (circles, triangles, crosses in various sizes). Cost per sheet is about $2.00 from regional offices of the Publications Division, Branch of Cartography: Eastern Region, National Center, Reston, Va. 22092; Central Region, Bldg. 20, Denver Federal Center, Denver, Colo. 80225; Western Region, 345 Middlefield Road, Menlo Park, Calif. 94025. An allotment number must be furnished with each order.

OUTCROPS

Line widths: All outcrop line widths .006 inch.

DESCRIPTION	SYMBOL	NOTES	
Bedrock outcrop		Solid or pattern 226 (horizontally)	Solid where mapped; patterned where too abundant to map separately. Generally shown in red on surficial geologic maps and screened black or gray on bedrock maps
Limit of outcrop	 HT15 HT30	Pattern HT15 or HT30 (use finer pattern for maps with large areas)	Used on detailed bedrock maps where soil and surficial deposits conceal much of surface. Outcrop area generally shown without contact except on detailed large-scale maps

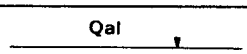
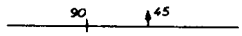
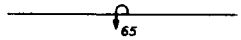
COAL AND OTHER ECONOMICALLY IMPORTANT BEDS

Line widths: Coal line widths generally .012 in.; .010 in. width in congested areas

DESCRIPTION	SYMBOL	NOTES	
Coal bed *Dashed where approximately located; short dashed where indefinite; dotted where concealed. Thickness of coal, in feet, measured at triangle*		Triangle height .1 in. width .05 in. Dashes .14 in. Short dashes .06 in. Dots .02 in. Space .02 in.	Letters designate coal bed. May be shown in color. Same width of line may be used for other economically important beds such as bentonite, phosphate, and limestone
Clinkered coal bed		Pattern 411 or 412	Shown in same color as coal bed and without contact

CONTACTS

Boundaries between geologic formations or other rock units. Symbols should be combined to fit available space where practical. Preferred phrasing when several types of contacts are mapped and combined in the explanation: *Dashed where approximately located; short dashed where inferred; dotted where concealed.* Contact line symbols signify accuracy of location or character of exposure; only solid line contacts used for maps at scales smaller than 1:125,000 (1:250,000; 1:500,000; 1:1,000,000). Generally solid line implies accuracy of placement within distance represented by 1/25 in. at scale of map. If symbols give engineering accuracy of location of contact, standard used in mapping should be given in italics. Coal and other economically important beds may also be used as contacts. Line widths: All contact line widths generally .005 in.; .004 in. in congested areas.

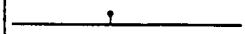
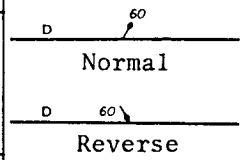
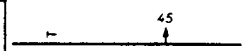
Contact		Template 8	Triangles indicate selected localities where contact was well exposed at time of mapping
Contact, showing dip		Template 37, 8 Template 35	If known, show top side of vertical contact by single arrow and 90
Overturned contact, showing dip		Template 1(1/2), 31, 8	
Contact, approximately located		Dashes .14 in. Space .02 in.	Not surely located within distance represented by 1/25 in. at scale of map
Indefinite contact		Dashes .06 in. Space .02 in.	Insufficient data to establish contact with certainity
Inferred contact			No data to establish contact but contact must be present
Gradational contact			Continuous change from one lithology or rock type to another. Contact arbitrary
Concealed contact		Dashes .02 in. Space .02 in.	Must be beneath mapped geologic units, water or ice. Symbols in parentheses indicate the concealed bedrock
Contact, located by ground magnetic survey		Dashes .22 and .06 in. Space .02 in.	Contacts determined by instrumentation or by other than conventional surface geologic methods may require special symbols for differentiation
Contact, located by airborne magnetic survey		Dashes .22 and .06 in. Space .02 in.	

FAULTS

Same line conventions used for faults as for contacts. Preferred phrasing when several line conventions are used for faults and combined in the explanation: *Dashed where approximately located; short dashed where inferred; dotted where concealed; queried where doubtful.* U, *upthrown side*; D, *downthrown side*. Dips shown where observed or known. Line widths: Fault line widths generally .015 in.; .012 in. on complex maps. Relative importance of faults may be shown by different widths of lines and suitable explanations.

DESCRIPTION	SYMBOL	NOTES	
Fault	OWL CREEK FAULT		
Fault, showing dip	90 65	Template 37, 8 Template 35	
Fault, approximately located		Dashes .14 in. Space .02 in.	Not surely located within distance represented by 1/25 in. at scale of map
Inferred fault		Dashes .06 in. Space .02 in.	Evidence for fault only indirect
Probable fault		Dashes .06 in. Space .02 in. Space for ? .1 in.	Queries, spaced three or more dashes apart, indicate uncertainty of existence, not location. Probable is more definite than doubtful
Doubtful fault	----?----?----?-		
Concealed fault		Dots .02 in. Space .02 in.	Must be concealed by overlying mapped geologic unit, water or ice
Hypothetical fault	.....?.....?.....?....	Dots .02 in. Space .02 in.	Existence from indirect geologic evidence; could be explained by causes other than faulting
Fault, located by ground magnetic survey		Dashes .22 and .06 in. Space .02 in.	
Fault, located by airborne magnetic survey		Dashes .22 and .06 in. Space .02 in.	
Fault, or lineament from aerial photographs *Not checked or identified on ground*		Dashes .22 and .06 in. Space .02 in.	
Lineament		Line width .012 in.	Used on small scale tectonic maps. Add lineament name where possible
Fault *Showing bearing and plunge of grooves, striations, or slickensides*	60	Template 29L, 5	Plunge measured in vertical plane. Identify type of evidence observed in italic statement
Fault *Showing dip and amount of displacement in feet.* U, *upthrown side;* D, *downthrown side*	80 D U	Template 37, 8	High angle, used in combination with dip arrow to indicate apparent normal or reverse movement. Where displacement is given, use vertical numbers

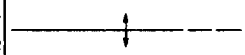
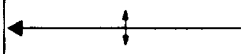
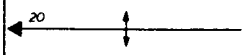
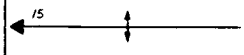
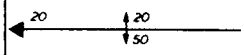
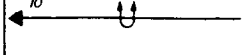
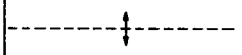
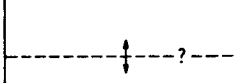
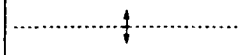
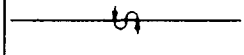
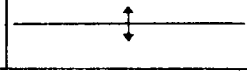
FAULTS (CON'T)

DESCRIPTION	SYMBOL	NOTES	
Fault *Bar and ball on downthrown side*		Template 22W, 4	Generally used where space does not allow U and D symbols without confusion; do not use bar and ball and U/D on same map
Fault *Showing relative horizontal movement*		Template 11, 39, 11, 39	
Fault *Showing bearing and plunge of slickensides on fault plane.* D, *downthrown side*		Template 29L, 5	
Normal fault *Hachures on apparently downthrown side*		Template 11	Used on tectonic maps or where space does not permit use of U and D
Reverse fault R, *upthrown side*			Angle of dip originally greater than 45° but precise value indeterminate. Hanging wall believed to have moved upward in respect to footwall
Thrust fault T, *upper plate*		Template 37, 8	Angle of dip originally less than 45°. Dip of fault, where known, shown by barbed arrow
Thrust fault *Sawteeth on upper plate*		Template 32	Symbol emphasizes fault; spacing of teeth may separate thrust faulting of different ages. May be limited to major thrust faults. Sawteeth may be spaced up to 0.5 in. apart on long thrust faults
Overturned thrust fault *Sawteeth in direction of dip; bar on side of tectonically higher plate*		Template 31, extend ends of triangle to fault	
Fault (shear or mylonite) zone, showing dip		Line width .005 inch Template 37, 8	Show relative movement by U and D or arrows
Fault breccia		Line width .005 inch Template 10 or Pattern 401	Extent may be outlined by faults or shown only where observed. Used as overprint for broad areas of fault breccia
Fault, intruded by dike		Template 7, 7	Use on small-scale black and white map or for narrow dike. On colored maps show dike in color and fault movement by U and D
Fault, intruded by dike		Template 7, 7 Pattern HT30	Use on large-scale black and white map for dike of sufficient width to be mapped. Former location of fault shown. Dikes usually shown in color
Subsurface fault		Dashing same as regular faults	Show in same color as structure contours where contours are offset along a dipping fault

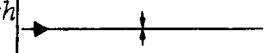
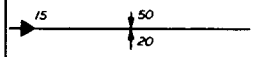
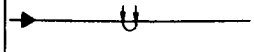
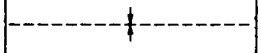
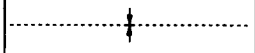
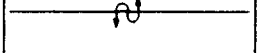
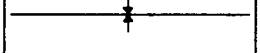
FOLDS

Same line conventions used for folds as for contacts and faults. Preferred phrasing when more than one line convention used for folds: *Dashed where approximately located; short dashed where inferred; dotted where concealed; queried where doubtful.* Line widths: Fold line widths .010 in.; .008 in. may be used if folds are congested.

ANTICLINES

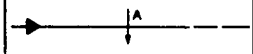
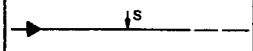
DESCRIPTION	SYMBOL	NOTES	
Anticline *Showing trace of crestal plane. Dashed where approximately located*		Template 11, 8, 8	On detailed geologic maps of asymmetric folding and high relief, trace of axial surface may be shown
Anticline *Showing trace of crestal plane and direction of plunge*		Template 31	
Anticline *Showing trace of crestal plane and plunge*			
Asymmetric anticline *Showing trace of crestal plane and plunge. Short arrow indicates steeper limb*		Template 11, 8 8	
Asymmetric anticline *Showing dip of limbs and plunge*			
Overturned anticline *Showing direction of dip of limbs and plunge*		Template 14(1/2), 37, 37, 8, 8	
Inferred anticline or Probable anticline		Dashes .06 in. Space .02 in.	Use inferred or probable, not both. Based on indirect geologic evidence; location probably not within distance represented by 1/25 in. at scale of map
Doubtful anticline		Dashes .06 in. Space .02 in.	Queries indicate doubt of existence of anticline from available data; location may also be in doubt
Concealed anticline		Dot .02 in. Space .02 in.	Must be beneath a mapped geologic unit or covered by water or ice. Not shown where extension of known anticline is obvious
Dome		Template 35, 35, 23 (4 times) Line width .005 inch	Generally used on small scale tectonic maps only
Inverted anticline		Template 1(1/2), 1(1/2), 37, 37, 8, 8	Beds inverted near trough
Antiform *Drawn on foliation, cleavage or bedding*		Template 29, 27, 27	Convex upward; structure in metamorphic rocks or in bedded rocks where tops are not known

SYNCLINES

DESCRIPTION	SYMBOL	NOTES	
Syncline *Showing trace of trough plane. Dashed where approximately located*		Template 11, 8 8 Dashes .14 in. Space .02 in.	On detailed geologic maps in areas of asymmetric folding and high relief, trace of axial surface may be shown
Syncline *Showing trace of trough plane and direction of plunge*		Template 31	
Syncline *Showing trace of trough plane and plunge*			
Asymmetric syncline *Showing trace of trough plane and plunge. Short arrow indicates steeper limb*		Template 11, 8, 8	
Asymmetric syncline *Showing dip of limbs and plunge*			
Overturned syncline *Showing direction of dip of limbs and direction of plunge*		Template 14(1/2), 37, 37, 8, 8	
Inferred syncline or Probable syncline		Dashes .06 in. Space .02 in.	Based on indirect geologic evidence. Location probably not within distance represented by 1/25 in. at scale of map
Doubtful syncline		Dashes .06 in. Space .02 in. Space for ? .10 in.	Queries indicate doubt of existence
Concealed syncline		Dot .02 in. Space .02 in.	Must be beneath mapped geologic unit or covered with water or ice. Not shown where extension of known syncline is obvious
Basin		Line width .005 in. Template 35, 35, 23 (4 times)	Generally used on small scale geologic maps only
Inverted syncline *Arrows show direction of dip of limbs*		Template 1(1/2), 1(1/2), 37, 37, 8, 8	Beds inverted near crest
Synform *Drawn on foliation, cleavage, or bedding*		Template 11, 27, 27	Convex downward: structure in metamorphic rocks or in bedded rocks where tops are known

MONOCLINES

May be classified as inferred, probable, doubtful, or concealed by same line conventions used for anticlines and synclines. Line widths: Make all line widths .010 in.

DESCRIPTION	SYMBOL	NOTES	
Monocline *Showing trace and direction of plunge. Dashed where approximately located*		Template 11, 8, 8	
Anticlinal bend *Showing trace and direction of plunge. Dashed where approximately located*		Template 11, 8 8	Use on large-scale detailed maps where anticlinal and synclinal bends diverge sufficiently to be mapped
Synclinal bend *Showing trace and direction of plunge. Dashed where approximately located*		Template 29, 8	

MINOR FOLD AXES

Line widths: Make all line widths .005 inch.

Minor anticline *Showing plunge*		Template 11, 1(1/2), 32	
Minor syncline *Showing plunge*		Template 11, 1(1/2), 32	Plunge measured in vertical plane
Minor fold axis *Showing plunge*		Template 11, 32	
Minor fold axis, horizontal		Template 11, 32, 32	
Minor folds *Showing plunge of axes*		Template 35, 8	Used where beds are too tightly folded to show axes of individual folds separately. Used to indicate sense of observed folds

PLANAR FEATURES

Planar symbols (strike and dip of beds, foliation or schistosity, and cleavage) can be combined with linear symbols to record data observed at same locality by superimposing symbols. Coexisting planar symbols are shown intersecting at point of observation. All combinations of planar and linear symbols used on map need not be shown in explanation. A statement "Planar and linear symbols may be combined" beneath PLANAR FEATURES AND LINEAR FEATURES in explanation is adequate. Examples of combined planar and linear features and coexisting planar features may be shown in explanation. Line width: Use .005 in. line width for all symbols.

ATTITUDE OF BEDS

DESCRIPTION	SYMBOL	NOTES	
Strike and dip of beds	45	Template 11, 11W	
Strike and direction of dip of beds			
Approximate strike and direction of dip of beds		Template 11, 11W, opaque center	
Strike and dip of beds *Top of beds known from sedimentary features*	30	Template 11, 11W, 4	Used only on maps where the top of beds is not always known
Strike and dip of overturned beds	65	Template 11, 1(1/2), 31, 31	
Strike and dip of overturned beds *Top of beds known*	65	Template 11, 1(1/2), 31, 31, 4	
Strike of vertical beds		Template 11, 11W	
Strike of vertical beds *Dot indicates top of beds*		Template 11, 11W, 4	
Component of dip *Dot marks point of observation*		Template 11, 4, 27	Do not use if symbols for lineation in metamorphic rocks are used on map
Horizontal beds		Template 30, 30, 14, opaque ends	
Strike and dip of beds and plunge of slickensides	60 40	Template 11, 11W, 29, 5	
Crumpled, plicated, crenulated, or undulatory beds and average dip	55	Template 15, 15 15, 15(side)	

FOLIATION OR SCHISTOSITY

Strike and dip of foliation	20	Template 11, 5(1/2)	
Strike and direction of dip of foliation			
Strike of vertical foliation *Relationship of foliation (or schistosity) to bedding not shown in outcrop*		Template 11, 5	
Horizontal foliation		Template 35, 35, 15	
Strike and dip of foliation and parallel bedding	10	Template 11, 22W, 25	

FOLIATION OR SCHISTOSITY (CON'T)

DESCRIPTION	SYMBOL	NOTES	
Strike of vertical foliation and parallel bedding		Template 11, 22L, 29L, 15	
Strike and dip of foliation and parallel overturned bedding	40	Template 11, 1(1/2), 35, 22L, 8	
Horizontal foliation and bedding		Template 30, 30, 33, 25	
CLEAVAGE			
Strike and dip of cleavage	15	Template 11, 11W, 11W	
Strike of vertical cleavage		Template 11, 11W, 11W	
Horizontal cleavage		Template 30, 30, 22(4 times)	
Inclined Vertical Horizontal		Template: as shown above for similar symbols	Contrasting symbols can be used to distinguish between different kinds of planar structures (slip cleavage, compositional layering, flow structure). Type of planar structure should be specified in explanation

LINEAR FEATURES

May be combined with the above planar symbols as shown. Symbols are joined at point of observation.

Bearing of plunge of lineation	15	Template 11, 8	
Vertical lineation		Template 32, 32	Use open symbol in combination with line symbols
Horizontal lineation		Template 11, 8, 8	
Strike and dip of foliation and plunge of lineation	25 30	Template 11, 10, 29, 23	
Vertical foliation showing horizontal lineation		Template 11, 8, 8, 5	
Strike and dip of foliation showing horizontal lineation	40	Template 11, 8, 8, 5(1/2)	
Strike and dip of beds and plunge of lineation	25 60	Template 11, 11W, 29, 23	
Vertical foliation and vertical lineation		Template 5, 11	
Strike of vertical foliation showing plunge of lineation	70	Template 11, 8, 5	
Vertical beds showing horizontal lineation		Template 11, 22L, 8, 8	
Horizontal beds, showing trend of horizontal lineation		Template 11, 22L, 14, 8, 8	

LINEAR FEATURES (CON'T)

DESCRIPTION	SYMBOL	NOTES	
Vertical beds showing plunge of lineation		Template 11, 22L, 23	
Approximate strike of folded beds showing plunge of fold axes		Template 15, 15, 15, 22W	
Attitude of foliation and overturned beds, strikes parallel but dips differ		Template 11, 1(1/2), 29L, 22W, 8	
Double lineation		Template 11, 10, 29, 29, 23, 23	
Strike and dip of beds intersecting slip cleavage		Template 11, 11W, 11W, 11, 11W	
Strike and dip of beds intersecting slip cleavage		Template 11, 11W (3 times)	

JOINTS

Open symbols may be contrasted with closed symbols to separate unmineralized and mineralized joints.

Strike and dip of joints		Template 11, 15(1/2)	
Strike and direction of dip of joints			
Strike of vertical joints		Template 11, 15	
Horizontal joints		Template 15	
Strikes and dips of multiple joints		Template 11 (3 times), 11(1/2) (3 times)	

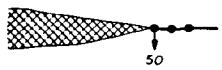
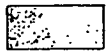
CONTOURS AND ISOPLETHS

Generally printed in red or other contrasting color but may be shown in black where the basic geology and base map are simple. Label and make every 5th contour heavier. May be used for many kinds of geologic data. In geophysical maps give nature of contoured data in map title. Line widths: Use .015 in. line width for heavy (index) contours and .008 in. for light (intermediate) contours.

DESCRIPTION	SYMBOL	NOTES	
Structure contours *Drawn on top (or base) of geologic horizon. Dashed where control is poor. Contour interval 20 feet. Arrow indicates direction of dip*	2000	Dashes .20 inch Space .02 inch Template 37, 8	Structure contours not shown as concealed; may be omitted in areas of no information. Arrows used only where index contours fail to show dip
Outcrop point *Used for structural control*	x		
Magnetic contours *Showing total intensity magnetic field of the earth in gammas relative to arbitrary datum. Hachured to indicate closed areas of lower magnetic intensity, dashed where data are incomplete. Contour interval 20 gammas*	2000	Dashes .20 inch Space .02 inch Hachures: line width same as light contours Length of tick: .05 inch	Show at least two hachures on small closed contours; otherwise use .7 inch space between hachures
Maximum or minimum intensity *Location measured within closed high or closed low*	x 2864		
Flight Path *Showing location and spacing of data*		Line width .005 inch Length .25 inch	Space as shown by author
Isoradioactivity contours (or isorads) *Interval 50 counts per second* (airborne survey). *Interval 50 microroentgens per hour* (ground surveys)			
Gravity contours (or Isogals) *Dashed where control is poor. Contour interval 1 milligal*			
Gravity station and number	.635	Template 4	
Isopachs *Dashed where control is poor. Interval 10 feet*			
Mineral isograds *Metamorphic zones indicated by mineral names*	SILLIMANITE / STAUROLITE		

VEINS, ORE, WALLROCK ALTERATION, AND DIKES

Shown in color, generally red, only where necessary to differentiate types and grade.

DESCRIPTION	SYMBOL	NOTES	
Vein, showing dip		Line width .015" Template 3(dots) Pattern 406 Template 37, 8	Give mineralogy and grade of mineralization in percent metal or oxide, or oz. per ton by notes. Can also be shown in solid
Ore body		Line width .005" Pattern 406	
Mineralized stringers or veinlets		Line width .010" Template 3	
Altered wallrock *Showing intensity of alteration by concentration of dots*		Pattern by hand	
Dike		Line width .015"	May be shown in color without x's when essential to distinguish different rock types

ORE IN SEDIMENTARY ROCKS AND SEDIMENTARY FEATURES CONTROLLING ORE DEPOSITION

Strike of roll *Showing geometric configuration in cross section*		Template 11, 14(1/2), 30, 30, 23, 23	Explain configuration by note
Direction of plunge of cross-stratification in sandstone *Showing direction of flow of depositing stream*			
Fossil Log		Template 11	
Lineation trend			
Festoon trend			

SURFACE OPENINGS AND EXPLORATION - LARGE-SCALE MAPS

Symbols drawn to scale on large-scale maps. Line width .005 inch.

Vertical shaft			
Inclined shaft			
Portal or adit			
Portal and open cut			
Trench			
Prospect pit or open cut			
Mine dump			

SURFACE OPENINGS AND EXPLORATION - LARGE-SCALE MAPS (CON'T)

DESCRIPTION	SYMBOL	NOTES	
Drill hole *Showing name and number*	PAHUTE 2		
Drill hole *No geologic data available*	ND		
Diamond drill hole	DDH		
Drill hole, low-grade ore			Give definition of low and high grade in explanation
Drill hole, high-grade ore			
Drill hole, inclined *Showing bearing and inclination; surface position and altitude; vertical projection of bedrock surface, bottom of hole, and thickness of overburden; and length of hole, in feet*	45° 3620 45		Combine drill-hole collar symbols as required with vertical projection to map

SURFACE OPENINGS AND EXPLORATION - SMALL-SCALE MAPS

Symbols not drawn to scale on map. Vary size of symbols with density of data.

Shaft			
Abandoned shaft	A		
Inclined shaft			
Tunnel, adit, or slope			
Inaccessible tunnel, adit, or slope			
Strip mine		Pattern 226 @ 45°	Pattern shows stripped area
Trench			
Prospect pit or outcrop			
Sand, gravel, clay, or placer pit			
Abandoned sand, gravel, clay, or placer pit			
Mine, quarry, glory hole, or open pit			
Abandoned mine, quarry, glory hole, or open pit			

UNDERGROUND WORKINGS AND EXPLORATION

Symbols drawn to scale on large-scale maps.

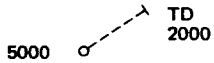
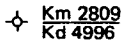
DESCRIPTION	SYMBOL	NOTES	
Shaft at surface			
Shaft, above and below surface			
Bottom of shaft			Show bottom of sump by note on map of lower level
Inclined workings, above and below level *Chevrons point down*			Spacing of chevrons may indicate steepness; place at regular intervals -5, 10, 20, etc., ft.
Winze or head of raise			
Raise or winze extending through level			
Raise or foot of winze			
Ore chute			
Stope			Can be explained by note, "Stoped above" or "Stoped below"
Elevation of roof or back			
Elevation of floor or sill			
Lagging or cribbing along drift			
Saved or otherwise inaccessible workings			
Drill hole			Give inclination of hole + or - in degrees in note and show vertical projection of bottom of hole to map

OIL AND GAS WELLS

Symbols for wells drilled for oil and gas are made up of seven compatible basic symbols which may be superimposed as necessary to show reported conditions

Drilling well or Well location			
Dry hole or Abandoned well			
Gas well			
Oil well			
Show of gas			
Show of oil			

OIL AND GAS WELLS (CON'T)

DESCRIPTION	SYMBOL	NOTES	
Shut in well			
Well *Showing vertical projection of bottom of hole, total depth, and surface altitude*			
Dry hole *Showing formation and altitude at surface, formation at bottom of hole, and total depth*			

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.: | Effective Date: 10/5/73 | Article No.: 3.06.2

Subject: ILLUSTRATIONS -- Symbols - Geologic letter symbols

Letter symbols are used by the U.S. Geological Survey on geologic maps and sections and in the explanations for each to identify geologic units. The symbols consist of a standard letter symbol, representing the system or era, followed by one or more lowercase letters, representing the formation or member.

Standard letter symbols are:

Quaternary	Q	Devonian	D
Tertiary	T	Silurian	S
Cretaceous	K	Ordovician	O
Jurassic	J	Cambrian	Є
Triassic	Ŧ	Precambrian	pЄ
Permian	P	Cenozoic	Cz
Pennsylvanian	IP	Mesozoic	Mz
Mississippian	M	Paleozoic	Pz

The letter symbol C can be used to designate the Carboniferous Systems if the Pennsylvanian and Mississippian Systems are not differentiated on the map or section.

The lowercase letter following the standard letter symbol generally is the first letter of the formation name, such as Tc for Calvert Formation of Tertiary age. For formation names consisting of two words, such as Fort Union Formation, the symbol can be Tf or Tfu. The shorter lowercase-letter usage (Tf), if not duplicated elsewhere on the map or section, is preferred to keep the symbol from being unnecessarily long. Where members are mapped, the letter symbol generally consists of the standard letter symbol, followed by the first letter of the first part of the formation name, followed by the first letter of the member name, such as Tfl for Lebo Shale Member of the Fort Union Formation. Series and group names are not generally indicated in the symbol. The symbol for a mapped unit that is identified by rock type instead of a formal name as a rule contains the first letter or first two letters of the rock type, as for example, pЄg or pЄgn for gneiss of Precambrian age.

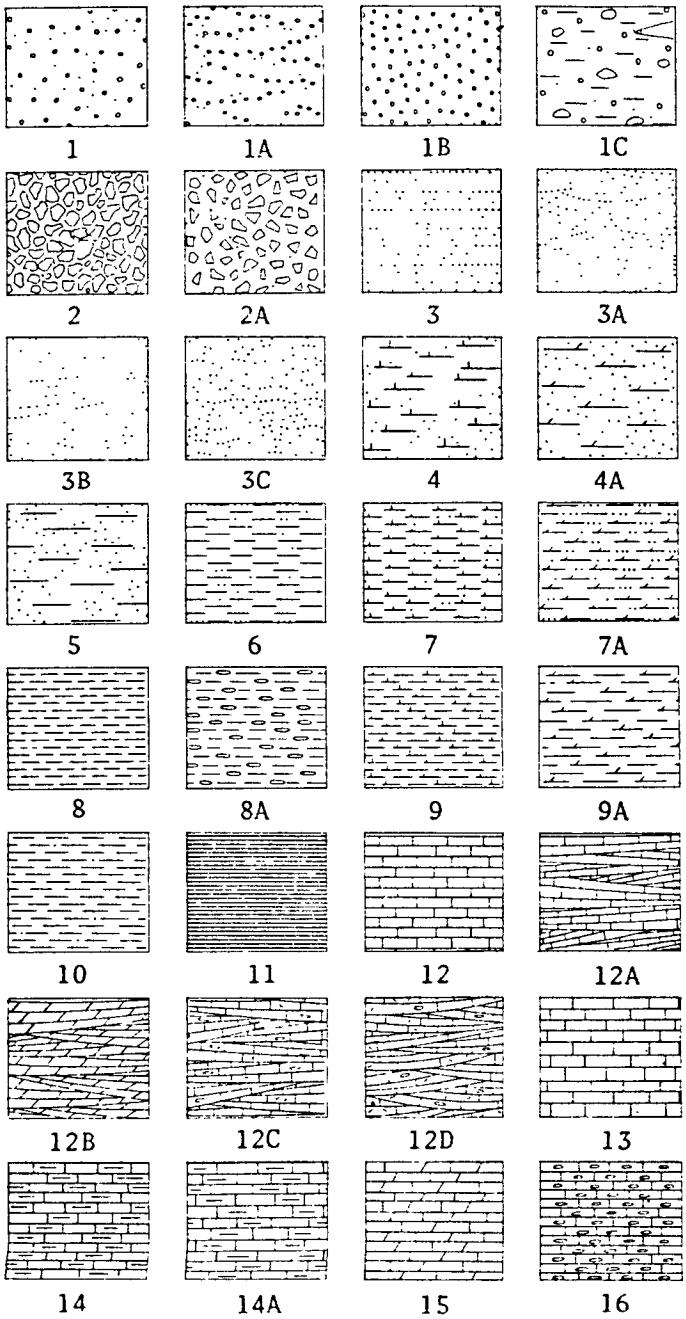
More than three letters for the complete symbol, including the age designation, should be used only where necessary for distinction of units on the map or section. Symbols are not recommended for use in the text part of a report.

Reference: Cohee, G. V., 1970, Stratigraphic nomenclature in reports of the U.S. Geological Survey: U.S. Geol. Survey adm. rept.

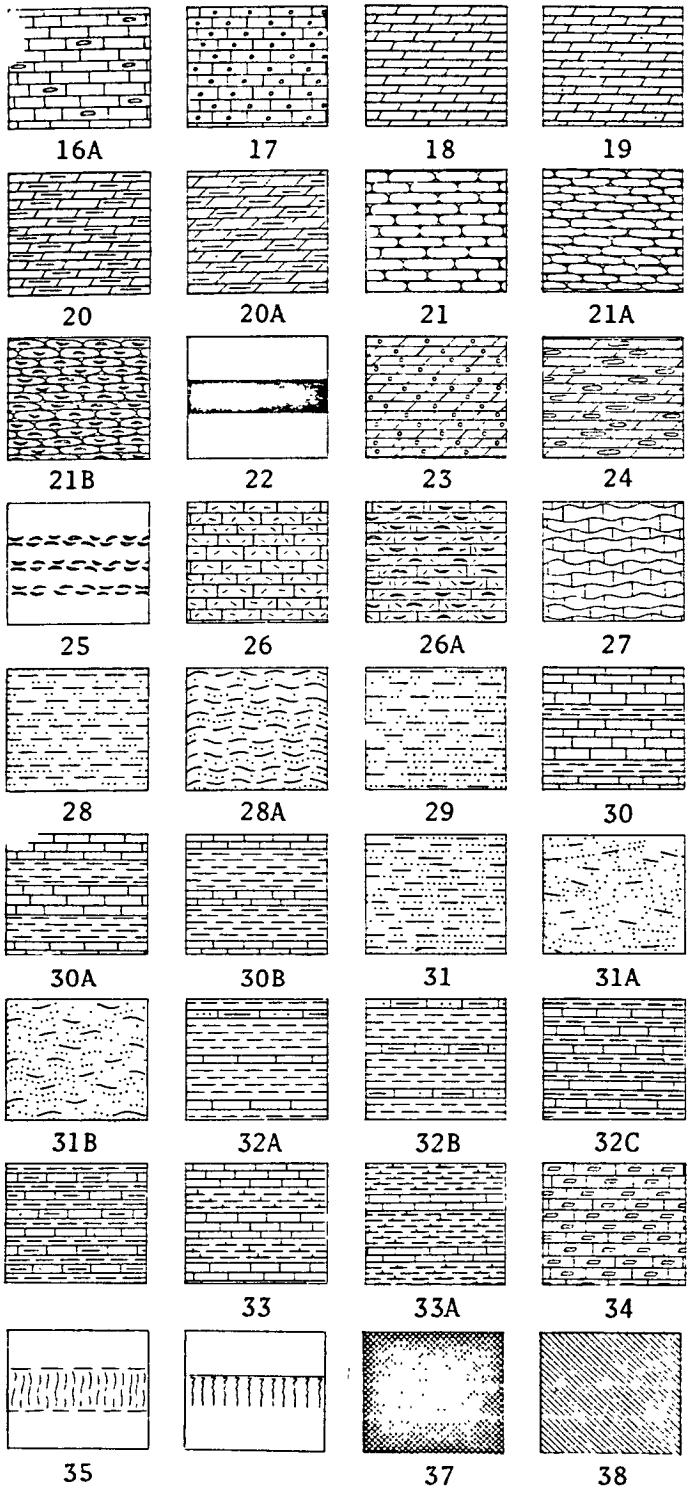
BRANCH OF TECHNICAL ILLUSTRATIONS
TECHNICAL STANDARDS SECTION

Replaces T.S. Paper		Effective Date	11/1/71	T.S. Paper No.	12.02.3
Subject	SECTIONS - Sedimentary lithologic patterns for columnar sections				

These patterns are generally accepted for columnar sections. Use the definitions as guidelines for selecting patterns for lithologic cross sections and other illustrations.



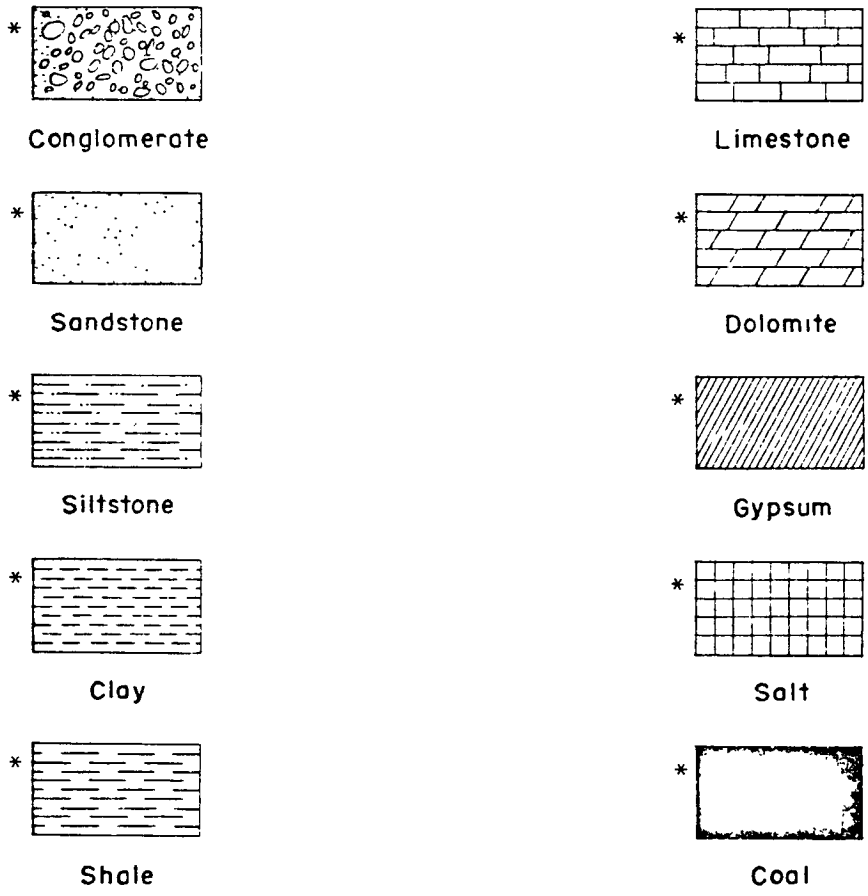
1 Gravel or conglomerate
1A Crossbedded gravel or conglomerate
1B Gravel or conglomerate
1C Drift
2 Breccia
2A Breccia
3 Sand or sandstone
3A Crossbedded sand or sandstone
3B Crossbedded sand or sandstone
3C Ripple-bedded sand or sandstone
4 Calcareous sandstone
4A Dolomitic sandstone
5 Argillaceous or shaly sandstone
6 Silt, siltstone, or silt shale
7 Calcareous siltstone
7A Dolomitic siltstone
8 Clay or clay shale
8A Cherty shale
9 Calcareous shale or marl
9A Dolomitic shale
10 Sandy or silty shale
11 Carbonaceous shale
12 Limestone
12A Crossbedded limestone
12B Crossbedded dolomite
12C Cherty crossbedded limestone
12D Cherty and sandy crossbedded clastic limestone
13 Sandy limestone
14 Argillaceous or shaly limestone
14A Silty limestone
15 Dolomitic limestone or limy dolomite
16 Cherty limestone



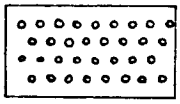
16A Cherty limestone
17 Oolitic limestone
18 Dolomite
19 Sandy dolomite
20 Argillaceous or shaly dolomite
20A Silty dolomite
21 Bedded chert
21A Bedded chert
21B Fossiliferous bedded chert
22 Coal
23 Oolitic dolomite
24 Cherty dolomite
25 Fossils
26 Clastic limestone
26A Fossiliferous clastic limestone
27 Nodular or irregularly bedded limestone
28 Interbedded sandstone and shale
28A Interbedded ripple-bedded sandstone and shale
29 Interbedded sandstone and siltstone
30 Interbedded limestone and shale (limestone dominant)
30A Interbedded limestone and shale
30B Interbedded shale and limestone (shale dominant)
31 Subgraywacke
31A Crossbedded subgraywacke
31B Ripple-bedded subgraywacke
32A Interbedded shale and limestone (shale dominant)
32B Interbedded shale and silty limestone (shale dominant)
32C Interbedded limestone and shale
32D Interbedded silty limestone and shale
33 Interbedded limestone and calcareous shale
33A Interbedded calcareous shale and limestone (shale dominant)
34 Limestone, irregular burrow(?) fillings of saccharoidal dolomite
35 Loess
36 Underclay
37 Flint clay
38 Gypsum

Asphalt
⊕ Siderite
⊙ Limonite
Phosphate
Glauconite
Bentonite

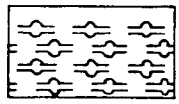
Symbols used for the general rock types



Symbols used to show variations of the general rock types

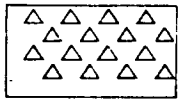


Oolitic

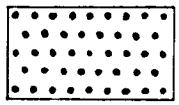


Diatomaceous

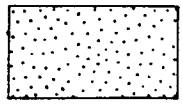
Carbonaceous

* 

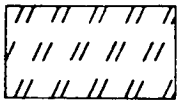
Cherty



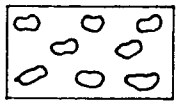
Phosphatic

* 

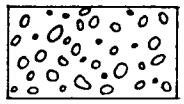
Sandy

* 

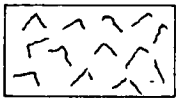
Gypsiferous



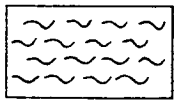
Concretionary

* 

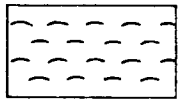
Conglomeratic

* 

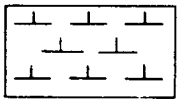
Quartzitic or silliceous



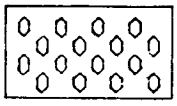
Glauconitic



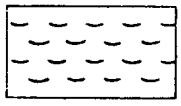
Fossiliferous (marine)

* 

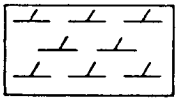
Calcareous



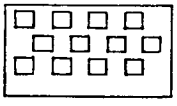
Micaceous



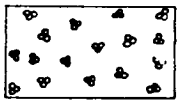
Fossiliferous (non-marine)

* 

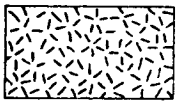
Dolomitic



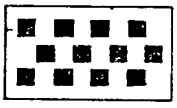
Pyritic



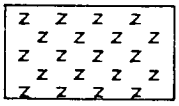
Microfossiliferous

* 

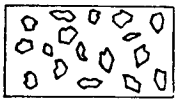
Feldspar



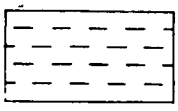
Ferruginous



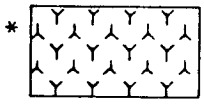
Plant fossiliferous

* 

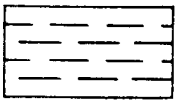
Brecciated

* 

Argillaceous

* 

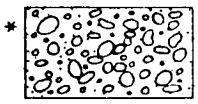
Tuffaceous

* 

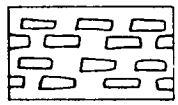
Shaley

Composite list of symbols used for the general rock types and their variations

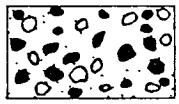
Conglomerate



Conglomerate



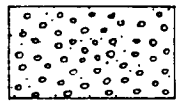
Intraformational



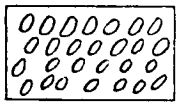
Glacial drift

Fanglomerate

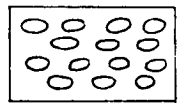
Agglomerate



Gravel



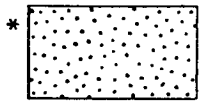
Edgewise conglomerate



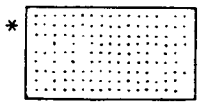
Bedded

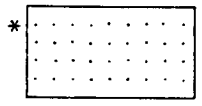
Sandstone

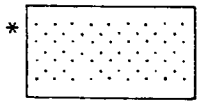

Sandstone

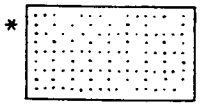

Massive

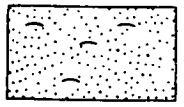

Cross-bedded

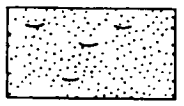

Thin-bedded

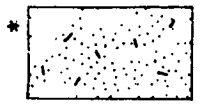

Thick-bedded

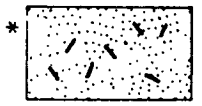

Regular bedded

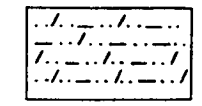

Irregular bedded

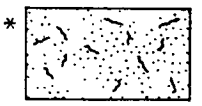

Fossiliferous (marine)

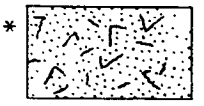

Fossiliferous (non-marine)


Feldspathic

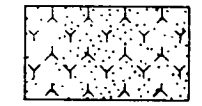

Arkose

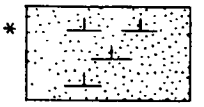

Graywacke

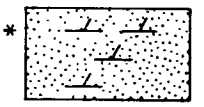

Quartzitic


Quartzite

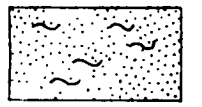

Tuffaceous

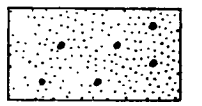

Tuff

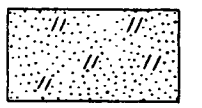

Calcareous

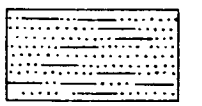

Dolomitic


Diatomaceous

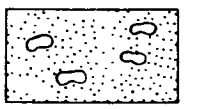

Glauconitic


Phosphatic

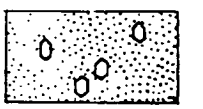

Gypsiferous

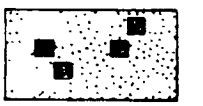

Silty


Shaley

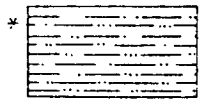

Concretionary

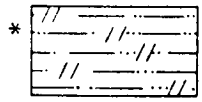

Conglomeratic

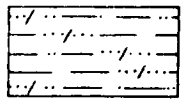

Micaceous

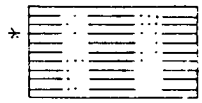


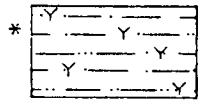
Siltstone

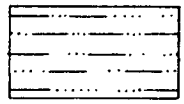

Siltstone

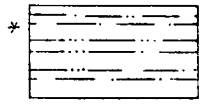

Gypsiferous

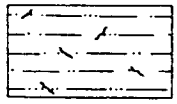

Graywacke


Regular bedded

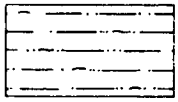

Tuffaceous

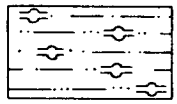

Sandy

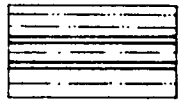

Irregular bedded

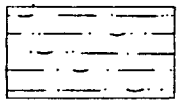

Quartzitic

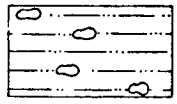

Phosphatic

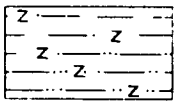

Fossiliferous (marine)


Diatomaceous

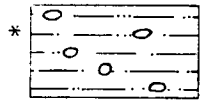

Carbonaceous

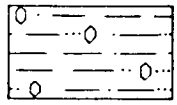

Fossiliferous (non-marine)

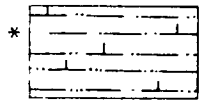

Concretionary

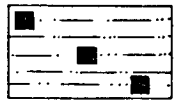

Fossil plants

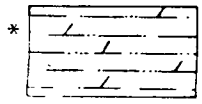

Loess

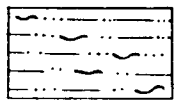

Conglomeratic


Micaceous


Calcareous

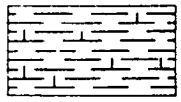

Ferruginous


Dolomitic

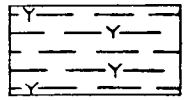

Glauconitic

Clay

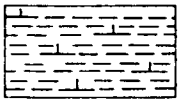
Clay



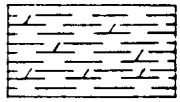
Calcareous shale



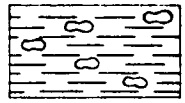
Tuffaceous shale



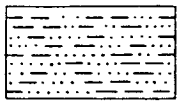
Marl



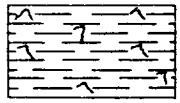
Dolomitic shale



Concretionary shale

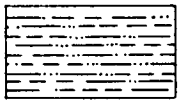


Sandy Clay

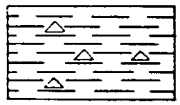


Siliceous shale

Ferruginous shale

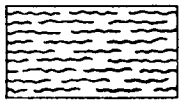


Silty Clay

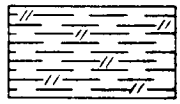


Cherty shale

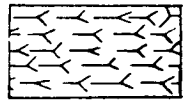
Pyritic shale



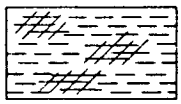
Mudstone



Gypsiferous

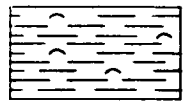


Bentonite

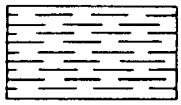


Flint or fire clay

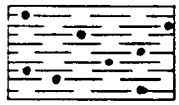
Carbonaceous shale



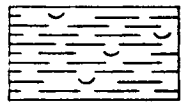
Fossiliferous shale (marine)



Shale



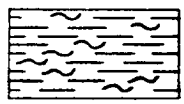
Phosphatic shale



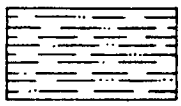
Fossiliferous shale (non-marine)

Sandy Shale

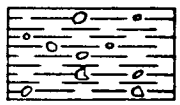
Diatomaceous shale



Glauconitic shale

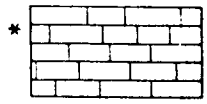


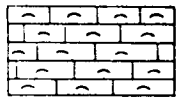
Silty Shale

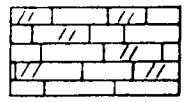


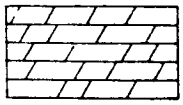
Conglomeratic shale

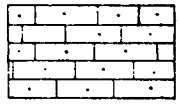
Limestone and dolomite

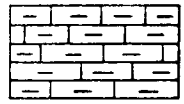

Limestone

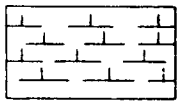

Coquina


Gypsiferous

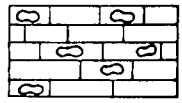

Dolomite

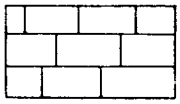

Sandy

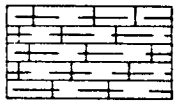

Argillaceous


Chalk

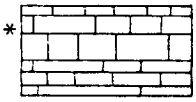

Silty

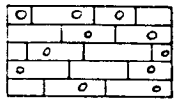

Concretionary


Massive

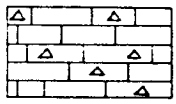

Shaley

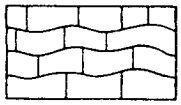

Carbonaceous

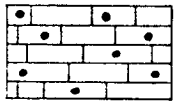

Irregular bedded

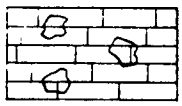

Oolitic

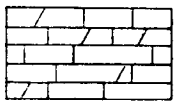

Thin-bedded

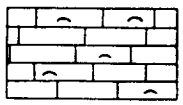

Cherty

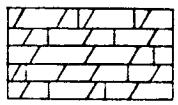

Wavy-bedded


Phosphatic


Brecciated

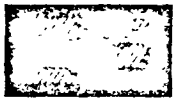

Dolomite limestone


52419 Fossiliferous

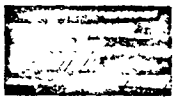

Calcareous dolomite

Coal, evaporites, and chert

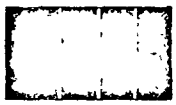
Coal



Bony Coal



Bone

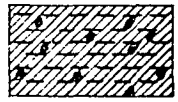


Cannel Coal

Cannel Shale

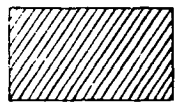
Oil Shale

Carbonaceous shale

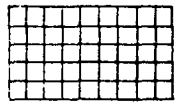


Peat

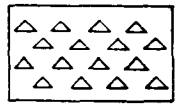
Lignite



Gypsum



Salt



Chert