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Topographic Map Margins Information for Educators

An abbreviated, two page version of this document is an excellent quick reference.

The neatline is the line separating the body of a topographic map from the map margin, or collar. The space outside the neatline on published USGS maps identifies and explains the map. This marginal information corresponds somewhat to the table of contents and introduction of a book – it tells briefly how the map was made, where the quadrangle is located, what organizations are responsible for the contents, and gives other information to make the map more useful.

Each map is identified in the upper right margin by its quadrangle name, the state or states in which it is located, and the map series and type (7.5–Minute Series, Topographic). The quadrangle name and state are repeated in the lower right margin.

The Department of the Interior – Geological Survey heading in the upper left margin is accompanied by the USGS identifier (logo) in maps published after 1995.

Refer to the attached map for the location of all the numbered elements below. The example map is a 1:24,000-scale topographic map, also called a 7.5-minute map because it covers 7.5 minutes of longitude and 7.5 minutes of latitude:

1. State plane coordinate system grid tick and value. In this example, 660,000 feet north of origin within the state plane grid system. This coordinate system was established by the U.S. Coast and Geodetic Survey (renamed the National Geodetic Survey) for use in defining positions of points in terms of plane rectangular (x, y) coordinates. There is usually at least one system for each state with a specific origin point. Each state determines whether the units will be measured in feet or meters.

2. Latitude. In this example, 39 degrees, 37 minutes, 30 seconds (north latitude; north of the equator, which is 0 degrees latitude). Geographic coordinates (latitude and longitude) are shown at all four corners of the map; the minutes and seconds are additionally shown at 2.5-minute intervals along the neatlines. This latitude is in the degrees-minutes-seconds format. Have students convert these to decimal-minutes format. For example, 30 seconds / 60 seconds = .5 minutes. Therefore, the decimal-minute format for this latitude is 39 degrees 37.5 minutes. Next, have students convert degrees-minutes-seconds to decimal-degree format: 30 seconds / 3600 = .008333 degrees. 37 minutes / 60 = .61666 degrees. Add them together (.008333 + .61666 + 39) for a decimal-degree reading of 39.625 degrees. Use a GPS unit and try all three formats there as well.

3. Longitude. In this example, 105 degrees, 15 minutes, 00 seconds (west longitude; west of the Prime Meridian of Greenwich, England, which is at 0 degrees longitude). Convert these degrees-minutes-seconds longitude values to decimal-minutes and decimal-degrees values as you did for latitude.

4. North American Datum of 1927 (NAD27). This is the horizontal datum; the reference for all x-y coordinates. It is the datum used for most USGS topographic maps printed before 2009. Note that the North American Datum of 1983 (NAD83), which is used on maps printed after 2009, is also indicated on this map by dashed crosses that are slightly offset from each corner of the map. On some maps, the dashed crosses are absent but the amount of offset is given in the text. If you are using GPS along with a topographic map, you must make sure that the GPS datum matches the datum used on the map. The default datum for most GPS units is the World Geodetic System of 1984 (WGS84), which is virtually identical to NAD83.

   This section also identifies the State plane coordinate system used on the map; in this example, Colorado Coordinate System, Central Zone. You could create a grid across the map by connecting all of the 10,000-foot margin ticks. How much land is covered by the resulting rectangles that are 10,000 feet x 10,000 feet? The Universal Transverse Mercator (UTM) zone is identified as Zone 13, which spans 102 to 108 degrees west longitude.

   This entire block of text is called the credit legend. It also lists the name of the mapping agency, the name of the agency that furnished the geodetic control, methods by which the mapping was performed, credit note for any hydrological information, and informative and explanatory notes.

5. GN, or Grid North. This is UTM grid north; measured at the center of the map. The numbers directly below indicate the angle between grid north and true north. That angle is given in minutes (top) and MILS (bottom). MILS is an angular measurement used by the military.

6. State plane coordinate system coordinate. This tick mark is 2,080,000 feet east of the origin of the Colorado Central Zone.

7. ★ This star indicates true or geographic north. The star and line point to the north geographic pole.

8. MN, or Magnetic North. This is the approximate direction (at the center of the map) to the north magnetic pole at the date given, in this case 1994. Remember that the magnetic pole, and thus the magnetic declination, change over time. This is the direction to which a magnetic compass needle points. Take a topographic map outside and use it with a standard compass or with a GPS unit with a compass.

9. 11^{o} east. This is the magnetic declination or variation of the compass – the number of degrees a compass needle at a particular location bears away from true north and points to the north magnetic pole. 196 MILS indicates the military angular measurement of the angle, which is used for artillery settings. This entire diagram of lines and arrows is called the magnetic declination diagram.

10. Longitude. This is a 2.5 minute geographic grid tick given in minutes and seconds (12 minutes, 30 seconds west). The degrees (in this case 105 degrees) are understood. Have students connect the

2.5-minute grid ticks in the margin with lines across the map. This will divide the map into 9 rectangles of 2.5 minutes x 2.5 minutes. These lines will go through the 2.5-minute grid crosses in the middle of the map. Doing this provides a handy 9-section map that you can use for directing student attention toward features you want them to identify. Ask the students why the rectangles are not perfect squares. It is because of the convergence of longitude lines toward the poles. Get out a topographic map of a place north or south of the current map. Will the 2.5-minute rectangles be more like squares closer to the pole or closer to the equator. Why?

11. Adjoining USGS quadrangle name “Indian Hills.” The notation “4963 II SW” is the NGA (National Geospatial-Intelligence Agency, formerly NIMA, National Image and Mapping Agency) sheet designator for the same map.

    Under this text is the scale. Use it to measure distances and create topographic profiles. Compare this 1:24,000-scale map to a USGS map of the same area at 1:100,000 scale, 1:250,000 scale, and 1:500,000 scale. How much area does each map cover? What detail is visible on each map?

    Under the scale bar is the contour interval, which is the vertical distance between each contour line. Compare this contour interval to one in a flatter or steeper area on a different map. How are contour intervals chosen? This block also indicates the vertical datum used to reference the vertical distances. On maps published prior to 1975, the vertical datum is mean sea level. After that date, the National Geodetic Vertical Datum of 1929 is used.

12. Range 69 West. This is part of the Public Land Survey System (Township and Range System). This is the 69th range west of 6th Principal Meridian (which is at Meades Ranch, Kansas). Each range is 6 miles wide; therefore, the origin is 69 x 6 = 414 miles to the east.

    In 1785, Congress adopted a plan for surveying public lands. According to this plan, land was divided into townships approximately 6 miles square, which were further subdivided into 36 sections approximately 1 mile square. Each section was divided into smaller plots, for example, of 640 acres. Principal meridians and base lines were established as a reference system for the township surveys.

    Pull up some online legal descriptions or lots for sale, and note how the Public Land Survey System pervades modern law. It is yet another way to “reference,” or “address” locations on the Earth’s surface.

13. UTM (Universal Transverse Mercator) easting value. Here, the point is 486,000 meters false easting (last 3 zeroes are omitted for brevity) (Zone13). The Central Meridian in Zone 13 is at 500,000 meters easting, which is 14,000 meters, or 14 kilometers, to the east of this line (in downtown Denver). Change the units of your GPS to UTM and have students walk directly east. The eastings should increase by 1 meter with each large step they take. Then, walk north and watch the distance to the equator increase. Meters are an easier unit to work with than the fractions of a degree with latitude-longitude, and therefore, UTM is quite useful and logical to use in the classroom. In addition, a meter is the same everywhere across the Earth’s surface, unlike a degree, which changes depending on where a person is on the planet.

14. UTM (Universal Transverse Mercator) easting value. This line is 488,000 meters false easting (Zone 13). Have the students draw the 1000-meter grid lines across the map using the UTM coordinates in the margins. Each resulting grid section will be 1000 meters x 1000 meters or 1 square kilometer.

15. Map Name. Maps are usually named after the most prominent cultural (airport, town) or physical (mountain, valley, lake) feature on the map. What is considered most prominent might have changed since the map was created. For example, Eastlake, Colorado was named after a railroad siding, but the map is now nearly covered by the suburb of Thornton. Discuss with your students the types of changes that can occur to make the original map name obsolete. If you were to name this section of the Earth, what would you name it?

    This block might also contain the map reference code, which begins with the geographic position of the corner of the map nearest the Greenwich meridian and the Equator:
    39 = Degrees North Latitude
    105 = Degrees west longitude
    F2 = index number (area reference code)
    TF = Topographic map with contour values in Feet
    024 = 1:24,000 scale

    The date of the map and any revision dates are given below the name. What has changed since the map was made? What was added when the map was revised? What has stayed the same? Some maps contain purple revisions to help identify the changes.

16. ISBN number – International Standard Book Number.

17. UTM northing value. In this example, the tick mark is 4,387,000 meters north from the Equator. “Northings” in the southern hemisphere begin with the Equator value = 10,000,000 meters and decrease in value as one moves toward the South Pole.

18. Section number 5. A part of the Public Land Survey System subdivisions; each section is 1 square mile. Have students note how corrections were made on maps in the original survey, where the section lines deviate from being east-west and north-south (western side of the map). Which section on the map would you say has the greatest population density? Why?

19. Township 4 South in the Public Land Survey System. This township is 4 townships (or 4 x 6 = 24 miles) south of the base line. In this part of the country, the Base Line of 1855 is used; the base line is on the 40 degrees north latitude line.

20. Latitude reading. This is another 2.5 minute grid tick. In this example, 39 degrees is understood; 40 minutes, 00 seconds are indicated.

Resources:

Map Margins (2 page version of this document)
http://education.usgs.gov/lessons/map_margins_2p.pdf

Teaching About and Using Coordinate Systems
http://education.usgs.gov/lessons/coordinatesystems.pdf

Latitude and Longitude
http://earthquake.usgs.gov/learn/animations/animation.php?flash_title=Great+Circles&flash_file=greatcircles&flash_width=450&flash_height=305

UTM Coordinates
http://pubs.usgs.gov/fs/2001/0077/report.pdf

State Plane Coordinate System
http://www.usgs.gov/faq/?q=categories/9794/3025

Datum Shifts and Map Coordinate Displays
http://thor-f5.er.usgs.gov/drg/datum_shifts_v2.pdf

Public Land Survey System
http://nationalmap.gov/small_scale/a_plss.html

Principal Meridians and Base Lines
http://www.blm.gov/wo/st/en/prog/more/cadastralsurvey/meridians.html

Magnetic Declination
http://www.usgs.gov/faq/?q=categories/9782/2736

How to obtain USGS Topographic Maps

- Download free digital topographic maps in a GeoPDF format by going to the USGS Store (http://store.usgs.gov) and clicking on "Map Locator & Downloader". Choose from two different kinds of topographic maps. Both are available as free digital downloads or they can both be purchased as paper products:
    - US Topo maps: Computer-generated topographic maps that are updated every three years. They come in layers that can be turned on and off and include an orthoimage (air photo) layer. Free analytical tools can be downloaded http://nationalmap.gov/ustopo
    - Historical USGS topographic maps at multiple scales: Maps that were produced until about 2003. These maps were made by hand and were designed for maximum readability. The standard 1:125,000-scale maps are indicated as "7.5x7.5 grid" maps. Students who are just learning about topographic maps might find these easier to work with than the computer-generated US Topo maps. http://nationalmap.gov/historical
- Digital historical topographic maps can also be downloaded in several formats from our topoView site. http://ngmdb.usgs.gov/maps/TopoView/

Questions? Need help? Call 1-888-ASK-USGS (1-888-275-8747) or go to http://www.usgs.gov/ask