

Curriculum Support Maps for the Study of Indiana Coal



By Walt Gray

Targeted Age: High School/Middle School

Activity Structure: Individual Assignment or Group Project

Indiana Standards and Objectives: E.S. 3.9, 5.2, 5.3, 6.4; ICP 8.1, 8.2

Material Requirements: A computer with Internet access; printing or e-mail capability (optional).

Introduction

In this activity, teachers or students will use IndianaMap to create geographic information systems (GIS) maps to demonstrate the distribution of coal mines within the state of Indiana. Step-by-step directions and tutorial videos will provide students with the necessary resources to create the final product. A list of questions is provided in each section to judge student comprehension of the data presented to them. It is expected that students have studied the process of coal formation, especially the different types of coal, before attempting this activity.

What products does the instructor want the students to create and in what format?

IndianaMap provides students the ability to create a map, bookmarks to maps, hyperlinks, and to print the maps they have created. As the instructor, you will need to determine functions you would like students to use during the lesson, based on the technological issues in your classroom and the outcomes you desire.

General Class Discussion

Coal is a combustible sedimentary rock and a valuable economic resource. During the Pennsylvanian Period (318 to 299 million years ago), poorly decayed plant materials were deposited in swamps in the central to eastern regions of the United States. Over time, these deposits eventually formed peat. As the peat was buried by additional sediments, the overlying weight caused the dewatering of the peat while compressing the deposits into thinner beds. Continued increases in both heat and pressure over millions of years produced the coals currently found in southwestern Indiana.

Coals are classified in one of four general categories or “ranks”: lignite, subbituminous, bituminous, and anthracite. Indiana coals are bituminous and composed of 55 to 79 percent carbon with an average heat value of 12,000 Btus per pound.

Indiana currently ranks as the seventh-largest coal-producing state in the nation and has an estimated 57 billion tons of unmined coal, of which nearly 17 billion tons is recoverable. These reserves could last another 585 years at the current rate of production. This valuable, nonrenewable energy resource is used to provide electricity to citizens across the state of Indiana.

After mining operations have ceased, companies are required to reclaim the mined land under provisions of the Surface Mining Control and Reclamation Act (SMCRA) of 1977.

Essential Questions to Be Addressed

Describe the process of coal formation.

What geological time period is known for major coal deposits?

What rank of coal is mined in Indiana?

Coal mines, both abandoned and current operations, are located in which region of Indiana? Why are these mines limited to this region?

Explain why most underground coal mines are generally found west-southwest of surface mines.

Closure

Students, using the GIS map they created, should recognize that all operational and abandoned coal mines in Indiana are located within the southwestern region of the state. The region represents the area of Indiana containing Pennsylvanian-age rocks, which are known for major coal deposits. Using the layers displaying depths of the Danville and Springfield coal units, students should have recognized that the units dip to the south-southwest and thus occur at a greater depth along the Indiana-Illinois state border compared to more eastern locations. Hence, surface mines are established where coal deposits are shallow, and underground mines are dug where the coal deposits are deeper.

Extension or Enrichment Ideas

Have students research the economic benefits coal provides to the state and its citizens.

Compare and contrast potential environmental issues surrounding underground and surface coal mining.

Explain the importance of mapping the location of abandoned coal mines.

What is subsidence and how is it related to underground coal mines?

Explain the Surface Mining Control and Reclamation Act (SMCRA) of 1977 and demonstrate how reclaimed lands can benefit the community.

Other IGS products supporting the study of coal topics:

Coal of Indiana (2010), Item #: Poster 12

Coal Mining History of the United States with Emphasis on Indiana (2003), Item #: MI 37

Coal Supply and Demand in Indiana (2009), Item #: OFS 09-05

Coal in Indiana, <http://igs.indiana.edu/coal/index.cfm>

Curriculum Support Maps for the Study of Indiana Coal (Student Handout)



Introduction

In this lesson you will learn how to use a geographic information system (GIS) program (IndianaMap) to investigate coal deposits and mines in the Hoosier State.

Essential Questions

Describe the process of coal formation.

What geological time period is known for major coal deposits?

What rank of coal is mined in Indiana?

Coal mines, both abandoned and current operations, are located in which region of Indiana? Why are these mines limited to this region?

Explain why most underground coal mines are generally found west-southwest of surface coal mines.

The IndianaMap Tutorial

1. Log onto http://inmap.indiana.edu/tutorial_video/Quick_Tour_GISAtlas.html.
2. Watch this tutorial video to learn how to use a variety of features to create your map. You may watch the video again if needed.
3. To end the session, click on **File** in the upper left corner and select **exit**.

Creating a Map

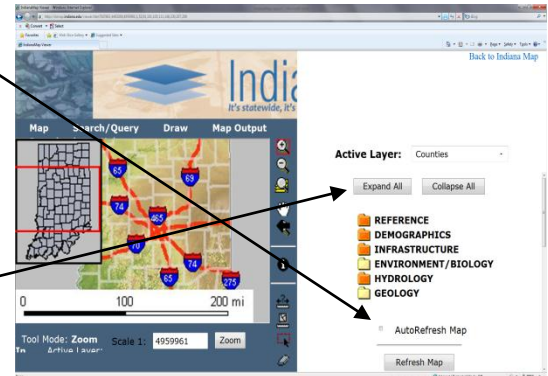
1. Begin by logging on to the following Web site: <http://www.indianamap.org>.
2. Now find the **indianamap** tab on the menu that runs across the top of the page.
3. Click on the **indianamap** tab.



We are now going to deselect a few layers that appear by default on the map you are currently viewing.

4. Start by deselecting the **AutoRefresh Map** box. Note: This will require you to refresh the map each time you want to view a new set of map components.

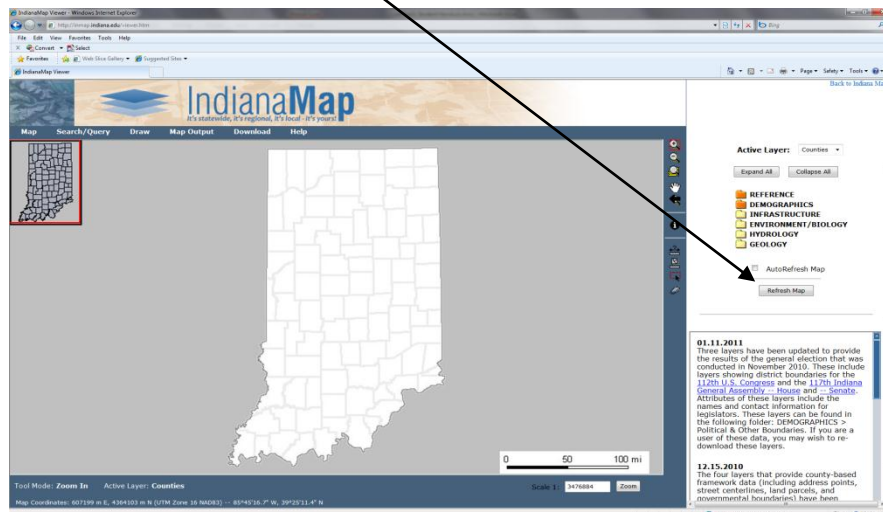
5. Now click on the **Expand All** button to open all folders and subfolders.



6. Begin deselecting following layers: *Elevation*, *Urban Areas*, *Interstates (TIGER)*, *Roads (INDOT -labeled)*, *Roadways (INDOT)*, *Rivers (NHD)*, and *Lakes (NHD)*.

7. Scroll to the top and click on the **Collapse All** button.

8. Now click on the **RefreshMap** button. Your map should look like the image below:

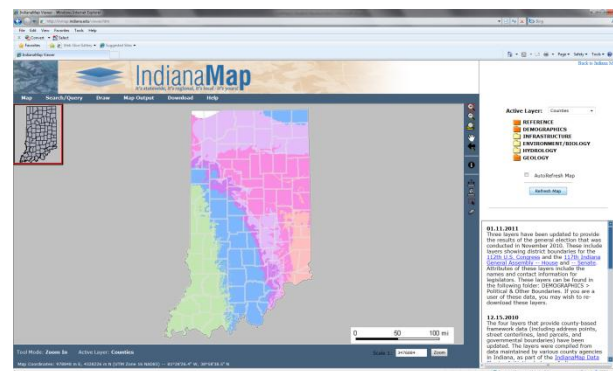
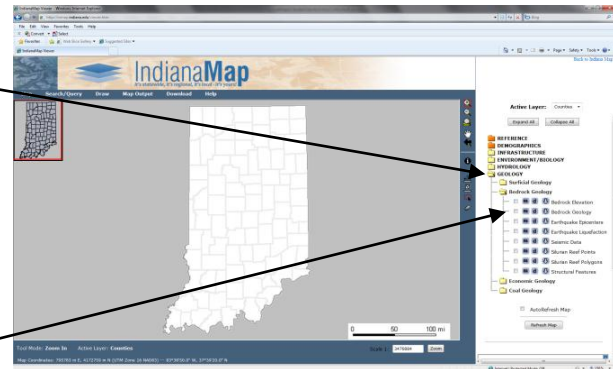


You'll notice that only the *Reference* and *Demographics* folders are orange while other folders are yellow. Orange folders represent those that contain layers that have been selected. Folders are displayed in yellow when none of layers inside that folder are selected.

Adding Additional Layers

Indiana coal is found in Pennsylvanian-age rocks. In order to locate these rock units we will need to select a new layer.

1. Click on the **Geology** folder and then click the subfolder titled **Bedrock Geology**.
2. Under the subfolder titled **Bedrock Geology**, select the **Bedrock Geology** layer.
3. Now click the **Refresh Map** button.
4. Scroll to the top and click the **Collapse All** button to close all the open folders.

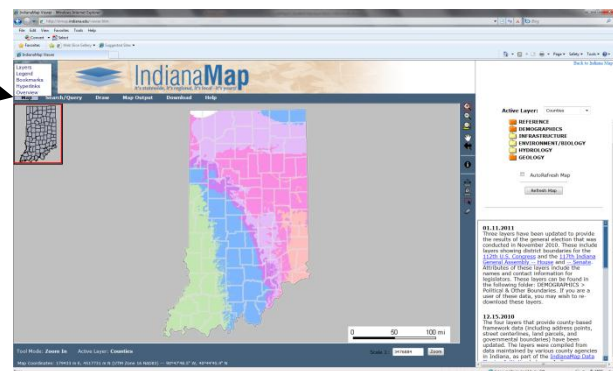


Your map should now look like the example provided on the right.

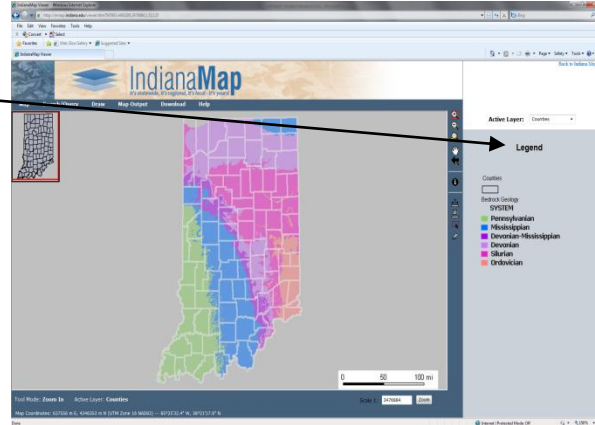
Adding a Legend to a Map

A map without a legend does not allow us to extract data or draw any conclusions, so you should learn how to add a legend at this point.

1. To view the legend click on the **Map** tab found on the top menu.
2. A list appears which includes layers, legend, bookmarks, hyperlinks, and overview. Select **legend**.



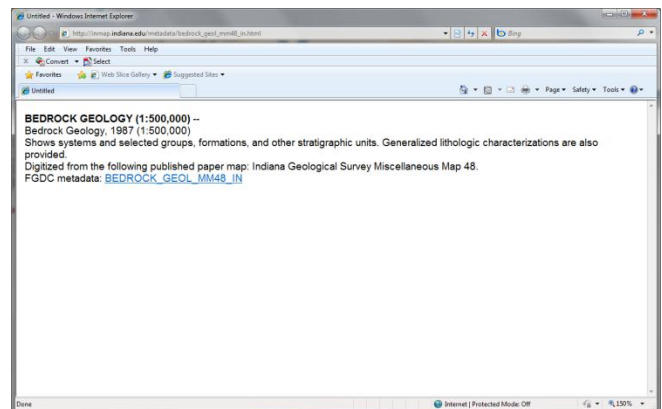
A legend should now appear to the right of the map.



Viewing Metadata

In order to learn more about the source of a data set used to create a layer, you will now learn how to view the metadata provided with each layer. Metadata describes how, when, and by whom a data set was collected and formatted. In short, metadata are data about data.

1. First, we must select the **layers** option under the **Map** tab we just accessed to create the legend.
2. Next, click on the **Geology** folder and the **Bedrock Geology** subfolder.



You should see three buttons next to the layer. Each is marked with a different letter or symbol: **m**, **d**, or a ↕

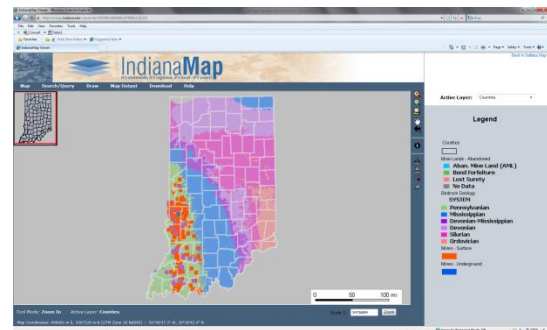
3. Click the button labeled with a lowercase **m** for the **Bedrock Geology layer**. This is the “view metadata” button. The popup window provides information related to the data shown on the map.
4. Exit metadata by clicking on the red **X** in the upper right corner.

Identifying Locations of Indiana Coal Mines, Past and Present

We will now add layers that will allow us to identify the locations of current and abandoned coal mines within the state.

1. In the *Geology* folder, click on subfolder titled *Coal Geology*.
2. Next, select the *Mines-Surface*, *Mines-Underground*, and *Mine Land-Abandoned* layers.
3. Now click the **Refresh Map** button.
4. Return to the **Map** tab and select **legend** once again.

Your map should now look like the example provided on the right. You should notice that all of the data points representing past and present coal mines are located within the green shaded area of the map.

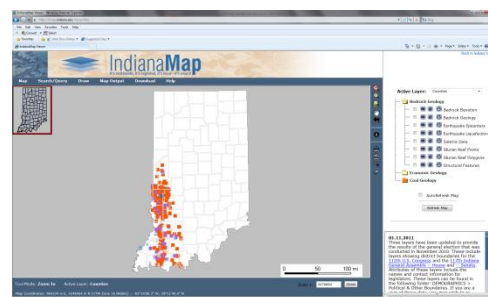


Using the background information provided by the instructor and the maps you have created, answer the questions in Section One of the Student Response Sheet.

Viewing Smaller Regions of the Map

We are now going to view the coal region of Indiana in more detail while making the map clearer.

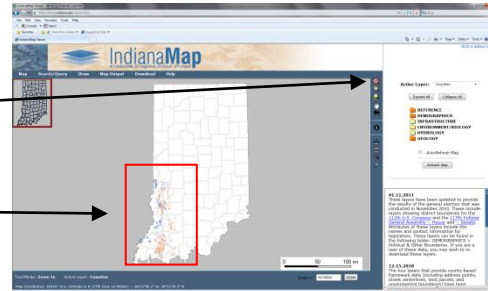
1. Return to the **Map** tab and select **layers** once again.
2. Under the *Geology* folder and the *Bedrock Geology* subfolder, deselect the layer titled *Bedrock Geology*.



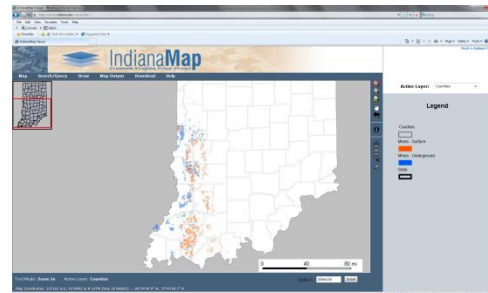
- Next, deselect the *Mine Lands-Abandoned* layer in the *Coal Geology* subfolder.
- Click on the **Collapse All** and **Refresh Map** buttons.

These steps will allow us to view the current coal mines operations within the state. Given that all the current mines are located in the southwestern region of Indiana, we want to zoom into that area of the state.

- Click on the **zoom in** icon found on the vertical menu.
- Select the area containing all the active coal mines in the state. Notice that the map will automatically refresh on its own.



- Next, create a legend following the same procedures used previously in this lesson. Your map should now appear like the map to the right.



Note that, in general, more of the underground mines (blue) are concentrated west of the surface mines (orange). Let's attempt to figure out the cause of this relationship.

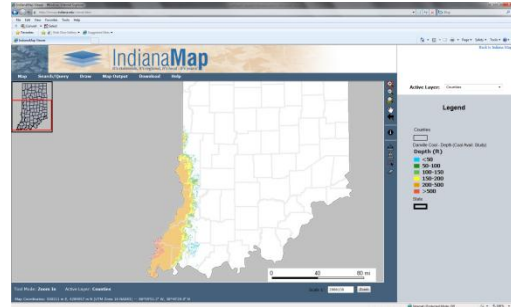
Depth of Coal Units

- Under **Map** tab, select **layers** in order to add and subtract layers.
- Click on the *Geology* folder and the *Coal Geology* subfolder.
- Deselect the *Mines-Surface* and *Mines-Underground* layers.

4. Next, select *Danville Coal Depth (Coal Avail. Study)* layer. You may need to use the horizontal scroll bar below the layers to see the full text.

5. Click the **Refresh Map** button.

6. Finally, add a legend to the map following the procedure you used previously in this lesson.



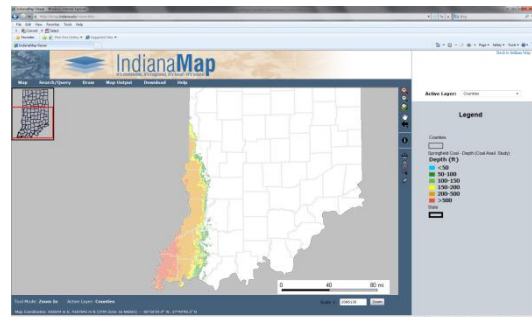
Your map should look like the one provided (above right). By examining the depth of the coal deposit from east to west, you should observe a trend.

7. Under the **Map** tab select **layers**.

8. Deselect the layer titled *Danville Coal Depth (Coal Avail. Study)*.

9. Next, select the layer titled *Springfield Coal Depth (Coal Avail. Study)*.

10. Click the **Refresh Map** button.



By examining the depth trend of the Springfield coal, you should notice it follows a similar pattern as that observed in the Danville coal unit.

You are now ready to answer the questions in Section Two of the Student Response Sheet.

Creating Hyperlinks

To create a hyperlink of your maps, watch the video tutorial at http://inmap.indiana.edu/tutorial_video/GIS Atlas Hyperlink & JPEG.html.

Printing Maps Created with IndianaMap

To print your maps, watch the video tutorial at http://inmap.indiana.edu/tutorial_video/GIS Atlas Custom Printing.html.

Student Response Sheet

Name: _____

Section One. Introduction

1. Describe the basic process of coal formation.
2. During which geological time period was peat deposited in swamps that would later become Indiana's major coal deposits?
3. Indiana coal is classified or "ranked" in which category?

Section 2. Coal Mine Locations

1. Pennsylvanian-age rocks are located in which general region of Indiana?
2. Please complete the following table:

Seismic Data	Region of Indiana having greater number of data points
Surface Mines	
Underground Mines	
Abandoned Mines	

3. Using the metadata provided for the *Bedrock Geology* layer, answer the following questions:
 - a. The information provided in this layer was digitized from which Indiana Geological Survey publication?

 - b. What is the scale of map used to create this layer?

4. If a company wanted to mine the Danville coal deposits along the western border of Indiana, would those mines be surface or underground mining operations? Explain your answer.

5. Should companies desiring to mine Springfield coal deposits along the western border of Indiana use surface or underground mines? Explain your reasoning.

6. Let's say that you are employed by a company to find a location suitable for a surface mining operation. In which region of the state would you direct your efforts? What coal member would you attempt to locate and why?