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Building a Globally Distributed Historical Sheet Map Set

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***Building a Globally Distributed
Historical Sheet Map Set***

2007

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Abstract: This paper describes the procedures used to create a distributed collection of topographic maps of the Austro-Hungarian Empire, the Spezialkarte der Öesterreichisch-ungarnischen Monarchie, Masse. 1:75,000 der natur. This set of maps was published in Vienna over a period of years from 1877 to 1914. The part of the set used in this project includes 776 sheets; all sheets from all editions number over 3,665. The paper contains detailed information on how the maps were converted to digital images, how metadata were prepared, and how Web-browser access was created using ArcIMS Metadata Server. The project, funded by a 2004 National Leadership Grant from the Institute for Museums and Library Science (IMLS), was a joint project of the Homer Babbidge Library Map and Geographic Information Center at the University of Connecticut, the New York Public Library, and the American Geographical Society's Map Library at the University of Wisconsin Milwaukee.

Keywords: topographic maps, digitization, distributed databases, metadata, Austria

University of Connecticut
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*Advancing the use of geographic data and spatial analytic techniques
at the University of Connecticut and in the region it serves*



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Introduction

Working with sets of topographic maps has always been difficult for scholars, geographers and libraries. Books are linear, with page 2 generally following page 1 after we get past the messy i, ii and iii. Maps, on the other hand, are multi-dimensional, set out like tiles on a floor in a Cartesian grid arrangement maintained over time. So, editions of a map of Warsaw on multiple sheets show change over a hundred years. The scholar has these sheets spread out over the floor. The scholar follows the road north to Gdansk, or is it Danzig, and wants to move to another sheet. Is it in the collection? Is it the same date? A big wind comes—the Winds of War?—and the wind blows the sheets away. They land in diverse collections and libraries around the world. Maps, topographical intelligence, the stuff of spy novels, have always been spoils of war.

In more peaceful times, scholars refer to these temporal and spatial representations of worlds long gone but preserved cartographically. These places might be shtetls long ago emptied, battlefields forgotten, or farms now developed into parking lots. Maps pick up annotations, troop movements, “X marks the spot,” plans for highways, canals, new settlements, boundaries and borders. All collections of historical topographic map sheet sets are incomplete. The librarian’s challenge is to bring the globally dispersed collection together for the international “K to Grey” scholarly community. This paper describes one approach to bring a globally dispersed historical map sheet collection together in a virtual sense in a Web environment.

IMLS National Leadership Grant for the Austro-Hungarian Project

In 2004, the Homer Babbidge Library, University of Connecticut, was awarded a National Leadership Grant for Libraries—Preservation or Digitization Grant titled *Building a Globally Distributed Historical Sheet Map Set*. The goal of the project was to build a scalable structure for the distributed sharing of significant sheet map collections in an international, metadata-driven, web-based environment. For the purposes of working with a testbed and proto-typing, the Homer Babbidge Library created an international metadata-driven, dynamic access tool that enables users to access and view scanned and georeferenced images from 1877-1914 Austro-Hungarian topographic maps with a scale of 1:75,000 by querying an easy-to-use digital gazetteer. This project became known as the AuHu75 project.

In partnership with the New York Public Library and the American Geographical Society's Map Library at the University of Wisconsin, Milwaukee, the University of Connecticut Libraries committed to achieving the goal of developing a model for an international metadata-driven, dynamic access tool to bring together globally dispersed sheet map collections. In this model, the key components of strong digital collections are people, technology and content.

Building Digital Collections: People

The digital model design for AuHu75 grew out of discussions at various national and international map librarian professional conferences. The geo-spatial community has been an early adapter of digital content. Maps are representations of the Earth's surface using a standard cartographic symbology that is embraced world-wide. In the United States, direction at the national level has come from the Federal Interagency Coordinating Committee on Digital Cartography in 1983 and the Federal Geographic Data Committee (FGDC) in 1990. The National Academy of Sciences' Mapping Science Committee serves as a focus for external advice to federal agencies on scientific and technical matters related to spatial data handling and analysis. The purpose of the committee is to provide advice on the development of a robust national spatial data infrastructure for making informed decisions at all levels of government and throughout society in general.

The concept of a National Spatial Data Infrastructure (NSDI) was first advanced by the Mapping Science Committee (MSC) in its 1993 report, *Toward a Coordinated Spatial Data Infrastructure for the Nation*. Executive Order 12906, *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure*, issued in 1994, directed the development of spatial metadata standards coordinated by the FGDC. Subsequent MSC reports have addressed specific components of the NSDI, including partnerships (*Promoting the National Spatial Data Infrastructure Through Partnerships*, 1994), basic data types (*A Data Foundation for the National Spatial Data Infrastructure*, 1995), and future trends (*The Future of Spatial Data and Society*, 1997). On June 15, 1998, the Academy's Mapping Science Committee convened a workshop, *Distributed GeoLibraries*, to explore:

- a vision for geo-spatial data dissemination and access in 2010
- comparisons of different efforts in digital library research clearinghouse development and other data distribution

- suggestions of short and long term research
needs identification of policy and institutional issues

That workshop recognized the strong, integral relationship between libraries and the geo-spatial community. Map librarians have been engaged in spatial metadata since its inception in 1992. Map libraries have used GIS software since 1990, sharing training, insights and tips.

Key to building digital collections is engaging champions who understand the changing nature, not only of mapping, GIS and cartography, but of the role of libraries as storehouses of scientific data, traditionally in analog format. By scanning and georeferencing the map images, map libraries are positioned as important partners in spatial information research, familiar with GIS technology.

Building Digital Collections: Technology

Libraries have been using GIS software technology for up to a decade at varying levels. Libraries in the U.S. began engaging in GIS around 1990 in response to publication of the Bureau of the Census TIGER Files, the geospatial data that spurred growth in the desktop GIS software industry. Businesses began using MapQuest and similar products for marketing. The availability of vast amounts of large digital data files, the development of the CD-ROM as a cheap and convenient alternative to 9-track tape and the partnership between ESRI and libraries fostered by the Association of Research Libraries was the “perfect storm” leading to the emergence of a core of knowledgeable librarians with access to GIS software. Library administrators soon understood the need for hardware with more processing power than the standard library workstation to handle digital spatial data and the user community began demanding access to data and services.

The technology has moved from CD to network, metadata tools have improved and the hardware dollar buys more now than it did in 1990. ESRI’s ArcGIS is hard-coded to create a metadata record for any database the user creates, and uses that metadata as a core component. Metadata has become the linchpin for data sharing in the GIS community.

The AuHu75 project model uses ESRI’s ArcIMS (Internet Map Server) Metadata Server and ESRI’s Geography Network geodatabase protocol with existing cataloging/metadata programs, such as FGDC’s Spatial Metadata Training programs (Figure 1).

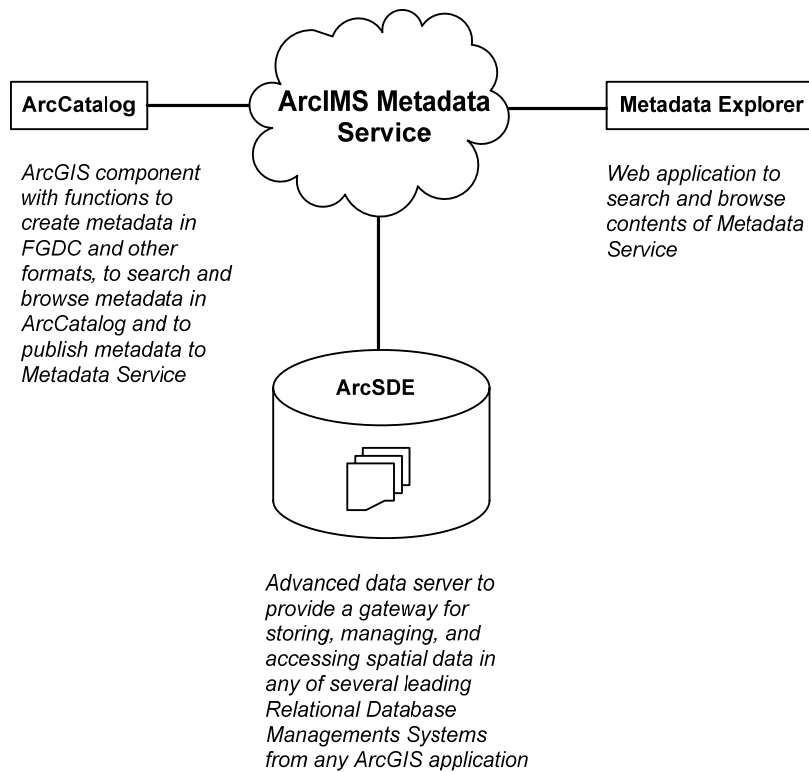


Figure 1. AuHu75 project model.

Building Digital Collections: Content

The digital content for the AuHu75 project was a set of historical map sheets, the *Spezialkarte der Österreichisch-ungarnischen Monarchie, Masse. 1:75,000 der natur*. This set of maps was published in Vienna over a period of years from 1877 to 1914. The set used in this project includes 776 sheets; all sheets from all editions number over 3,665. Each map represents a 15 degree minute x 30 degree minute tile (about 1,000 sq. kilometers) and can have several editions and print dates. Other map sets published before, during and after the Second World War used the *Spezialkarte der Österreichisch-ungarnischen Monarchie* as a base map, making the AuHu75 set a key map set for studying a large and significant area of Central Europe in the 19th and 20th centuries.

The user community for the set is made up of historians and genealogists, archaeologists, architects, not to mention lawyers researching Second World War reparations claims who represent a large and sophisticated community familiar with the Internet. More than one million people emigrated from the part of Europe that was the Austro-Hungarian Empire to the United States in

the period 1820 to 1880, followed by an additional four million during period from 1880 to 1930. This map set was selected because descendants of these emigrants are part of the World Wide Web genealogical research community and they are heavy map library users.

The maps detail the physical and cultural landscape, showing hills, valleys and rivers as well as houses, mills, manufactories and farms (Figure 2). The cartography represents deciduous and coniferous trees differently and shows natural forests and plantings, like the trees lining the stream in the figure below. The variant place names are also clearly evident.



Figure 2. Portion of a map sheet from the AuHu75 project.

Libraries hold copies of the AuHu75 for different reasons. Delegates to the League of Nations defined and delimited the boundaries of countries established after the First World War using sheets from the American Geographical Society's (AGS) collection. Map sheets held by Slovenia and Croatia are part of their national heritage and reflect their unique histories in the maps' annotations and marginalia. The New York Public Library's (NYPL) collection serves the community of citizens and scholars and works integrally with other collections at NYPL, such as the Slavic & Baltic, Jewish and U.S. History, Local History and Genealogy Divisions and the archival collection of YIVO Institute for Jewish Research. The University of Connecticut acquired its map sheets from the Library of Congress, which received them from the U.S. Department of Defense through the U. S. Army, whose troops captured them

from the German Army, who captured them from the Russian Army.

There are few comprehensive collections of the AuHu75 maps. The AGS holds 1,000 sheets, the NYPL has 776 sheets, and the University of Connecticut Map and Geographic Information Center in the Homer Babbidge Library has 542 sheets. Other libraries including the Library of Congress, the British Library and the National Libraries of Austria and Hungary have large and significant collections.

The distributed model adopted for the AuHu75 project is designed so that collections of digital map images can be added to it over time. Bringing various map sheets together virtually from a global network of libraries adds value to the individual library collections. Libraries recognize that no library holds a complete set of maps because the map sheets reflect all of the ways that they were used, especially as documents to codify political, military or diplomatic decisions.

The distributed model also supports multiple points of entry to multiple collections. A project website has been developed to provide access to the data, but researchers can also access the site through the site maintained by the Latter Day Saints Church Family History Library, one of the project partners. Using the Library's FamilySearch, a major resource of web-based genealogical data, genealogists, local historians and life-long learners can access the maps and geographic information describing historic Austria-Hungary. Current estimates of use show 176,000 potential views per month that might concern Austro-Hungary, about 5,866 views per day.

Building a Globally Distributed Historical Sheet Map Set

The process described in this workbook made use of several software packages that are readily available in most academic libraries or via the Internet. The first is ArcGIS, a geographic information system (GIS) package produced by Environmental Systems Research Institute (ESRI). ArcGIS is comprised of several modules, two of which, ArcMap and ArcCatalog, were used extensively throughout the development of the map set. Within ArcMap, the Georeferencing and Spatial Analyst Extensions were used. Both of these are included with the basic ArcGIS software package but they must be installed and enabled. Instructions for these procedures are provided below.

The extension, XTools Pro, provided by Data East, is also used. The extension was downloaded from:

<http://www.xtoolspro.com/>

XTools Pro is a shareware program which is also available in a licensed version. Originally developed by Mike DeLaune (ODF) as a set of useful vector spatial analysis, shape conversion and table management tools for ArcView GIS 3.x., the XTools extension was converted to the ESRI ArcGIS environment and later re-designed, enhanced and extended as XTools Pro to provide a higher level of functionality and performance. A number of powerful tools have been implemented and many adaptations and enhancements have been made since the XTools 3.1 version to meet user needs and ArcGIS ArcMap user interface standards. The free portion of XTools Pro was all that was required for the AuHu75 project. Microsoft Excel, or any equivalent spreadsheet software, was also used quite frequently throughout the project.

Building the globally distributed historical sheet map set was a multi-stage process:

Stage 1. Create a digital image of each map.

Stage 2. Determine coordinates of scanned map image corner points.

Stage 3. Define the bounding rectangle enclosing each scanned map image.

Stage 4. Georectify the scanned map.

Stage 5. Clip each map image based on its bounding rectangle to remove the map edges to create a seamless mosaic.

Stage 6. Compress each map image for efficient storage, transportation and retrieval.

Stage 7. Create metadata records for the scanned maps.

Once these steps have been completed, a metadata server application can be developed to provide Web access.

Stage 1: Create a Digital Image of Each Map

Step 1. Scan each paper map

The historical paper maps were scanned using a black and white roll scanner with a resolution of 300 dots per inch (DPI) (Figure 3).



Figure 3. The scanning process for the AuHu75 project.

Step 2. Save the scanned image

The scanned image was saved as a grayscale image in Tagged Image File Format (TIFF).

Stage 2: Determine Coordinates of Scanned Map Image Corner Points

To create a seamless set of digital maps from the scanned paper maps, it was necessary to determine the coordinates of the map image corner points. Four coordinate pairs are identified for each scanned map image in this stage of the process.

Step 1. Open ArcCatalog and connect to the folder of scanned map images

Open ArcCatalog and connect to the folder where the TIFF images of the scanned maps are stored.

Step 2. Open ArcMap and add a scanned map image to the Data View

Open ArcMap and choose to start **A new empty map** then click **OK** (Figure 4).

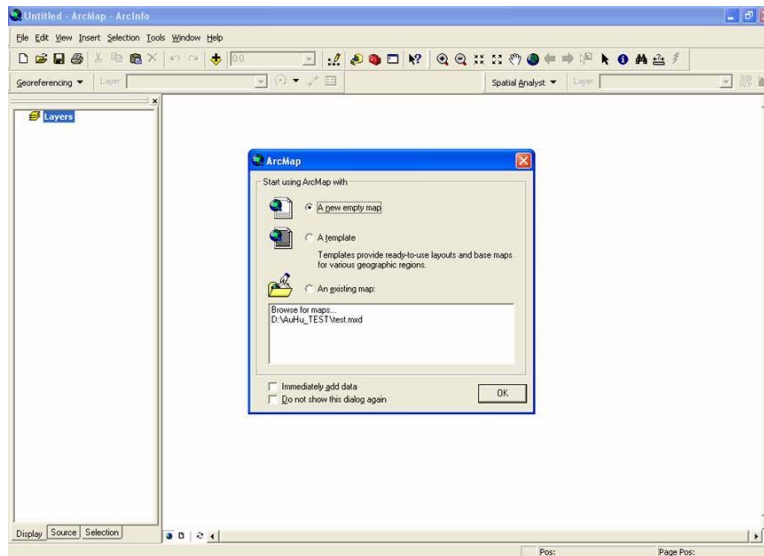


Figure 4. Start using ArcMap with a new empty map.

Step 3. Add a scanned map image to the Data View

Click either **File⇒Add Data...** or click the **Add Data** button to add the first scanned map image to the project (Figure 5).

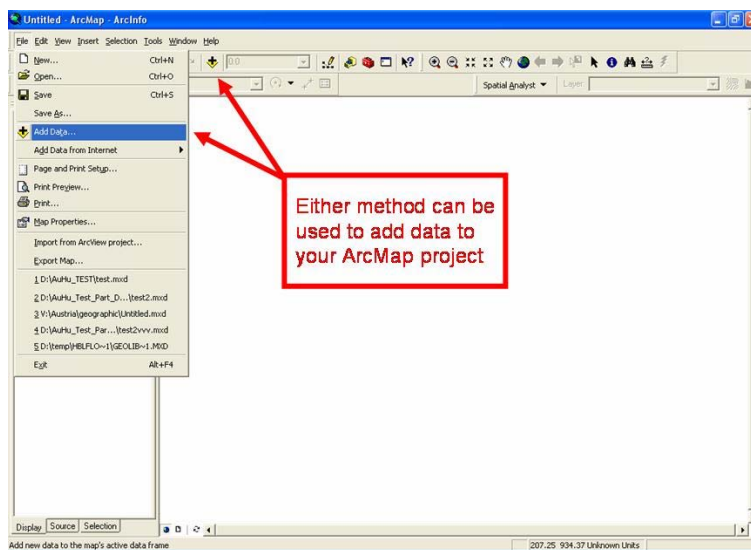


Figure 5. Add the first scanned map image to the Data View.

A message indicating that the scanned map image is missing spatial reference information should appear (Figure 6). This is to be expected because the scanned map image does not have any spatial reference information. Creating this information is an important step in the processing of the images.

Click **OK** to proceed.

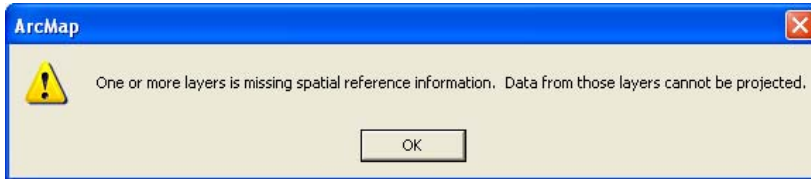


Figure 6. Acknowledge lack of spatial reference information for the scanned image.

A message indicating that the scanned map image does not have pyramids should appear (Figure 7). Pyramid building for raster images allows for more rapid display.

Click **Yes** to create pyramids and proceed.



Figure 7. Create pyramids for more rapid display of the scanned map image.

After completing these steps, the first scanned map image should appear in the Data View (Figure 8). At this point in the processing, the margins of the scanned paper map have not been clipped and are still visible. Any printing or handwritten information in the margins can also be seen.

Step 4. Save the Map Document

At this point, it is a good practice to save the ArcMap document. Users should save the document periodically to assure that work is not lost and does not have to be repeated.

Click on **File⇒Save As**, enter a name for the ArcMap document and navigate to the appropriate directory where the map documents will be saved (Figures 9 and 10).

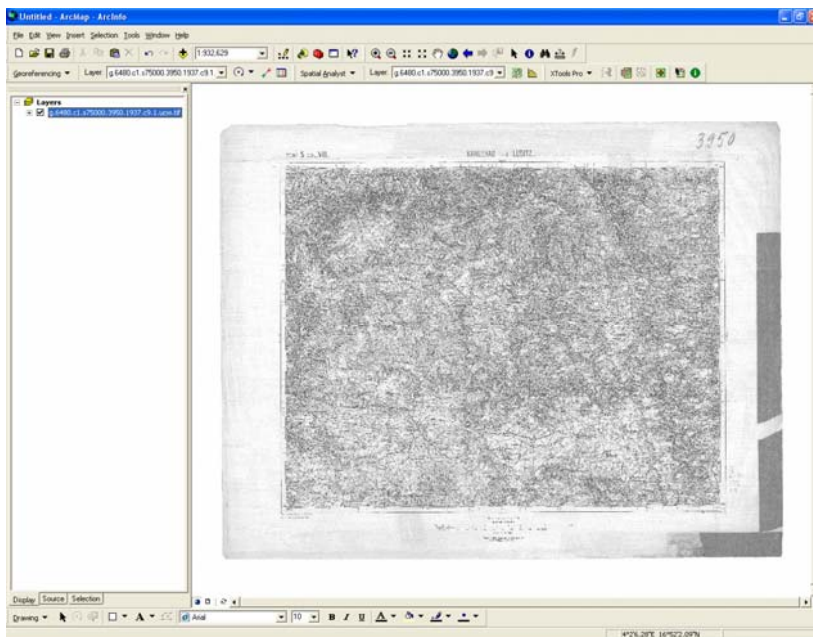


Figure 8. The scanned map image in the Data View.

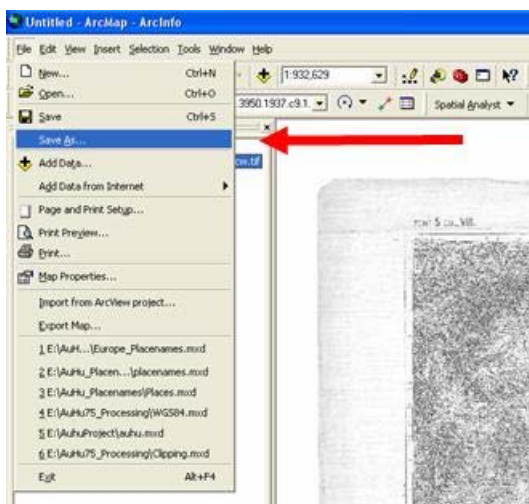


Figure 9. Using the Save As... menu.

Keeping image and map document files well organized throughout the process is important. Creating easy to understand folder names and file names is essential. Figure 10 illustrates one approach.

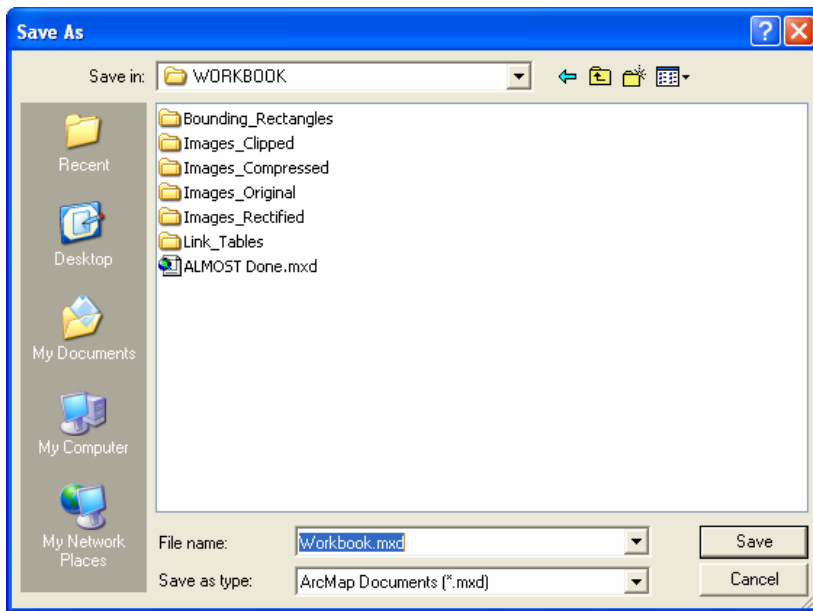


Figure 10. Navigating to a folder and saving the ArcMap document.

Step 5. Pan and zoom to identify coordinates of map corner points

Explore the pan and zoom buttons on the toolbar (Figure 11) to familiarize yourself with these functions.



Figure 11. Location of panning and zooming tools in the toolbar.

Pan and zoom to the upper left corner of the scanned map image and note the coordinate pair printed on the map (Figure 12). In this case, the first coordinate pair is:

Longitude 30°30'00"
Latitude 50°15'00"

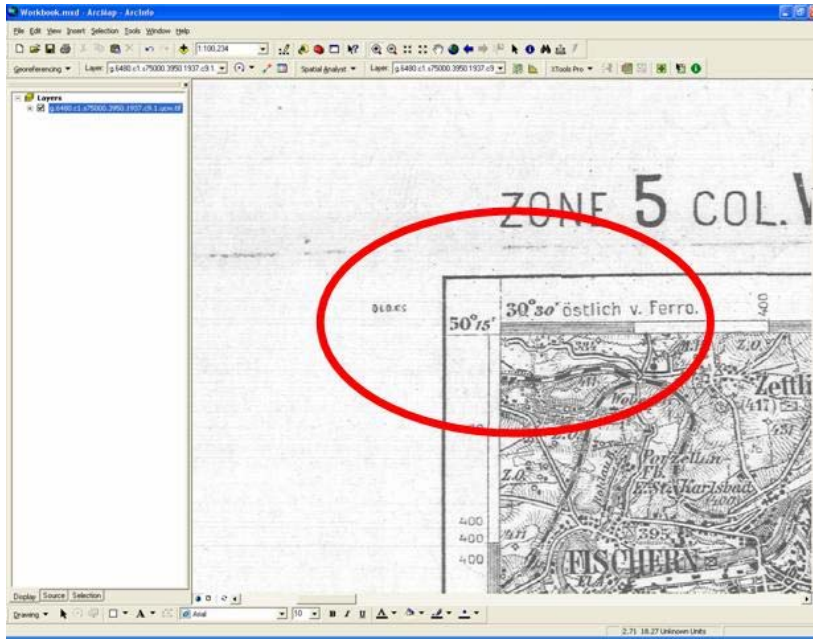


Figure 12. Viewing the first coordinate pair in the upper left hand corner of the scanned map image.

Note that the Austro-Hungarian maps used the Ferro Line as the origin for east-west coordinates and expressed coordinates using the Degrees-Minutes-Seconds convention (DMS).

Then pan and zoom to the other corner points of the scanned map image in a clockwise order to determine the coordinate pairs that correspond to the corner points of the map (Figure 13). **The four coordinate pairs should be recorded starting with the coordinate pair in the upper-left corner of the map, then proceeding in a clock-wise manner around the corners.** It is imperative that the coordinate pairs are chosen in this order to ensure that later operations can be carried out correctly.

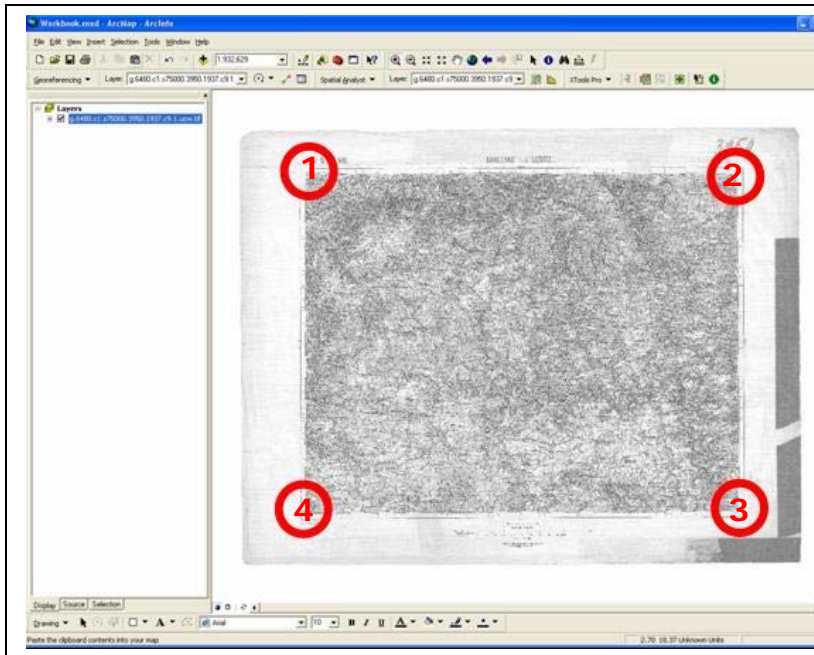


Figure 13. The four corner points of the scanned map image.

The coordinate pairs determined in this stage are used throughout the remaining stages. The final coordinate pairs serve as the four ground control points (GCPs) used in the rectification process as well as in the construction of the bounding rectangle used to clip the rectified images.

Step 6. Create a spreadsheet to record and convert coordinate pairs for each scanned map image

For the purposes of the AuHu75 project, the project team decided to use the current conventions of measuring east-west coordinates from the Prime Meridian and expressing coordinates using the Decimal Degrees (DD) convention. This required recording and converting the corner point coordinates for each scanned map image. In this workbook, a single map image is used to demonstrate the process. This project, however, is a prime example of a project where batch processing could be much more efficient. Converting coordinates and building the bounding rectangles for several maps at a time can be a real time saver.

A spreadsheet was created in Microsoft Excel to record coordinate pairs and to manage the conversion process (Figure 14). The DMS coordinates based on the Ferro Line were entered for each GCP based on the coordinates observed for each corner point of the scanned map. Longitudes were entered in one table; latitudes were entered in a second table. The converted values were stored in a third table.

Converting the corner point values to the desired coordinates was a two-step process for each coordinate pair. First, the DMS values for longitude and latitude were converted to decimal degrees (DD) with six decimal places. To convert DMS to DD:

- Divide the number of seconds by 60.
- Add the number of minutes.
- Divide this sum by 60.
- Add the number of degrees.

Second, the longitudinal origin was shifted to correspond to the Prime Meridian. This step affects only the Decimal Degrees longitude values for the map corner points in this project. To shift the longitudinal origin:

- Subtract 17.662778° from the Decimal Degrees longitude value.

These steps would not be necessary if the corner points of the maps in the collection being developed are already available in the geographic or projected coordinate system of choice.

Figure 14 shows a work sheet that is set up to deliver the coordinates for an image with 4 ground control points at the corner of the map. For this project, only 4 ground control points are being used to rectify the image. It would be possible to use the spreadsheet to record and convert lon/lat values for other control points on each map. The conversion process would be the same for each point.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Longitude Conversion											
2	GCP	ddmmss	degrees	minutes	seconds	Decimal Degrees	New Coordinate					
3	1	303000	30	30	00	30.500000	12.837222					
4	2	310000	30	60	00	31.000000	13.337222				Ferro Constant	
5	3	310000	30	60	00	31.000000	13.337222				17.662778	
6	4	303000	30	30	00	30.500000	12.837222					
7	Latitude Conversion											
8	GCP	ddmmss	degrees	minutes	seconds	Decimal Degrees						
9	1	501500	50	15	00	50.250000						
10	2	501500	50	15	00	50.250000						
11	3	500000	50	00	00	50.000000						
12	4	500000	50	00	00	50.000000						
13	Converted Coordinates											
14	GCP	Long	Lat									
15	1	12.837222	50.250000									
16	2	13.337222	50.250000									
17	3	13.337222	50.000000									
18	4	12.837222	50.000000									
19												
20												
21												
22												
23												
24												
25												

Figure 14. A sample Coordinate Conversion spreadsheet.

First, the Longitude Coordinate 30°30'00" for the first control point is entered in Cell B3 of the worksheet in Degrees-Minutes_Seconds format as 303000. The corresponding Longitude Coordinate degrees, minutes, and seconds are automatically updated in Cells C3, D3, and E3 using formulas embedded in the spreadsheet. The corresponding Decimal Degrees value is updated in Cell G3 based on the formula for converting Degrees-Minutes-Seconds to Decimal Degrees. Finally, the constant for shifting to the prime meridian stored in Cell K5 is subtracted from each Longitude Decimal Degree value by using a formula to update Cell I3.

Second, the Decimal Degrees conversion procedure is repeated for the Latitude Coordinate 50°15'00" for the first control point. Enter 501500 into Cell B10 and look at the results. The corresponding Latitude Coordinate degrees, minutes, and seconds are automatically updated in Cells C10, D10, and E10, and the corresponding Decimal Degrees value is updated in Cell G10 based on the formula for converting Degrees-Minutes-Seconds to Decimal Degrees. No further adjustment is required for the latitude values.

In the last step, the converted lon/lat values for each of the four ground control point are shown in Cells A17:C20.

Save this spreadsheet in appropriate directory.

Once the spreadsheet has been used to record the ground control points for the four corners of each map sheet, the data can be used to create dBase tables that can be imported into the GIS software and converted to point shapefiles. The point shapefiles are then used to create the bounding rectangles for each map sheet.

Stage 3: Define the Bounding Rectangle for the Scanned Map Image

In this stage, the bounding rectangle that serves as the perimeter marking the extent of the map graphic on each map sheet is created. This involves converting data in the spreadsheet to dBase tables, importing them into a GIS application, converting records in the tables to point shapefiles, and creating the bounding rectangles to be used in clipping the scanned images.

Step 1. Create .dbf files

In the spreadsheet, highlight the columns that correspond to the adjusted coordinates for one map sheet. Be sure to include the header names **Long** and **Lat** (Figure 15).

15	Converted Coordinates		
16	GCP	Long	Lat
17	1	12.837222	50.250000
18	2	13.337222	50.250000
19	3	13.337222	50.000000
20	4	12.837222	50.000000

Figure 15. Highlighted converted coordinates.

Use the **File⇒Save As...** menu to save the highlighted portion of the spreadsheet as a DBF 4 (dBASE IV) *.dbf file type (Figure 16). Navigate to a folder set up to store the DBFs and assign a file name that references the map sheet.

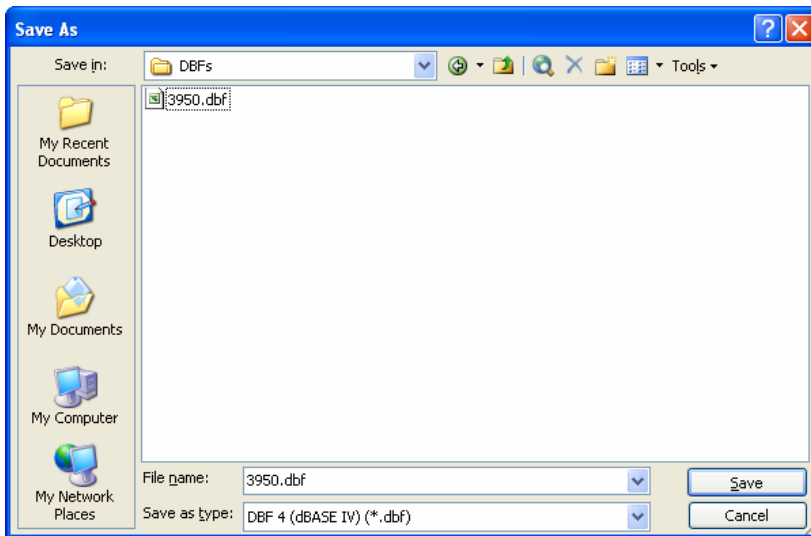


Figure 16. Saving converted coordinates as a .dbf file.

Open the .dbf file in Excel and check it to make sure that the table looks correct (Figure 17).

	A	B	C
1	LONG	LAT	
2	12.837222	50.250000	
3	13.337222	50.250000	
4	13.337222	50.000000	
5	12.837222	50.000000	
6			
7			

Figure 17. The .dbf file of converted coordinates for a single map sheet.

This file must now be converted to a point shapefile in order to create the bounding rectangle.

Step 2. Create a point shapefile from a .dbf file

The point shapefile is created in ArcCatalog. Open ArcCatalog from the Start menu or from a desktop icon (Figure 18).

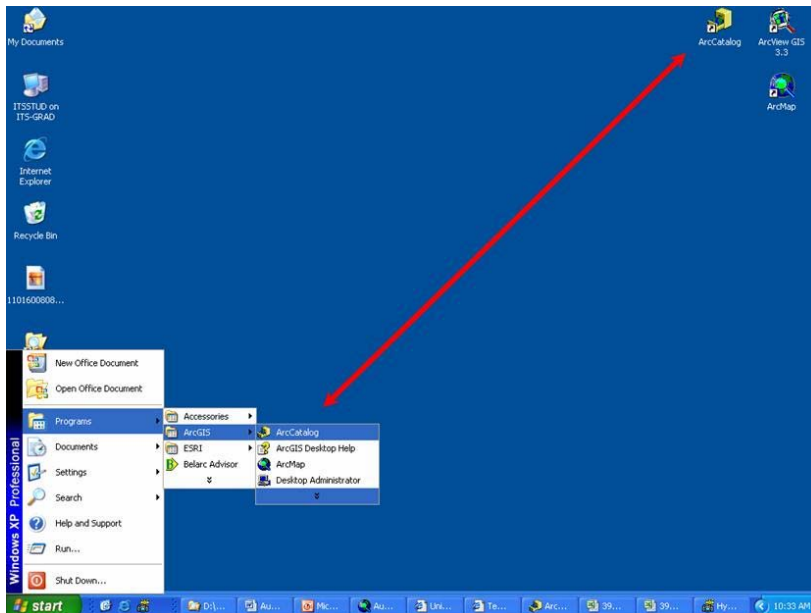


Figure 18. Open ArcCatalog from the Start menu or from a desktop icon.

Navigate to the directory where you saved the .dbf file from Step 1 (Figure 19).

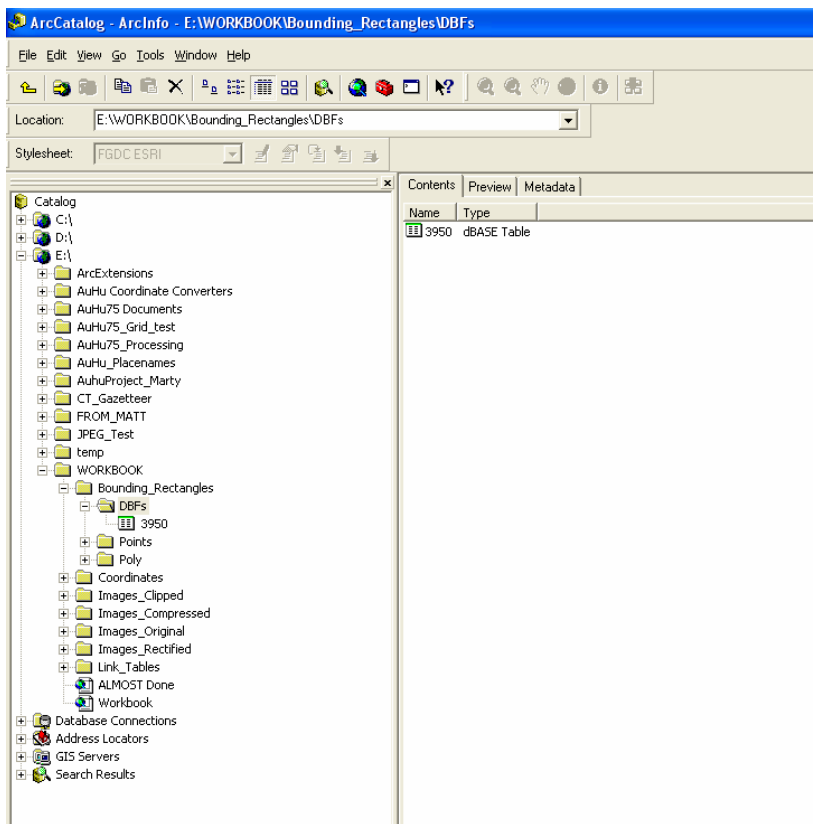


Figure 19. Navigating to the DBFs folder where the tables of converted coordinates are stored.

Right click on the .dbf file (3950.dbf in this case) and select **Create Feature Class⇒From XY Table...** from the menu (Figure 20).

Be sure that the .dbf file is not open in Excel or you will receive an error message.

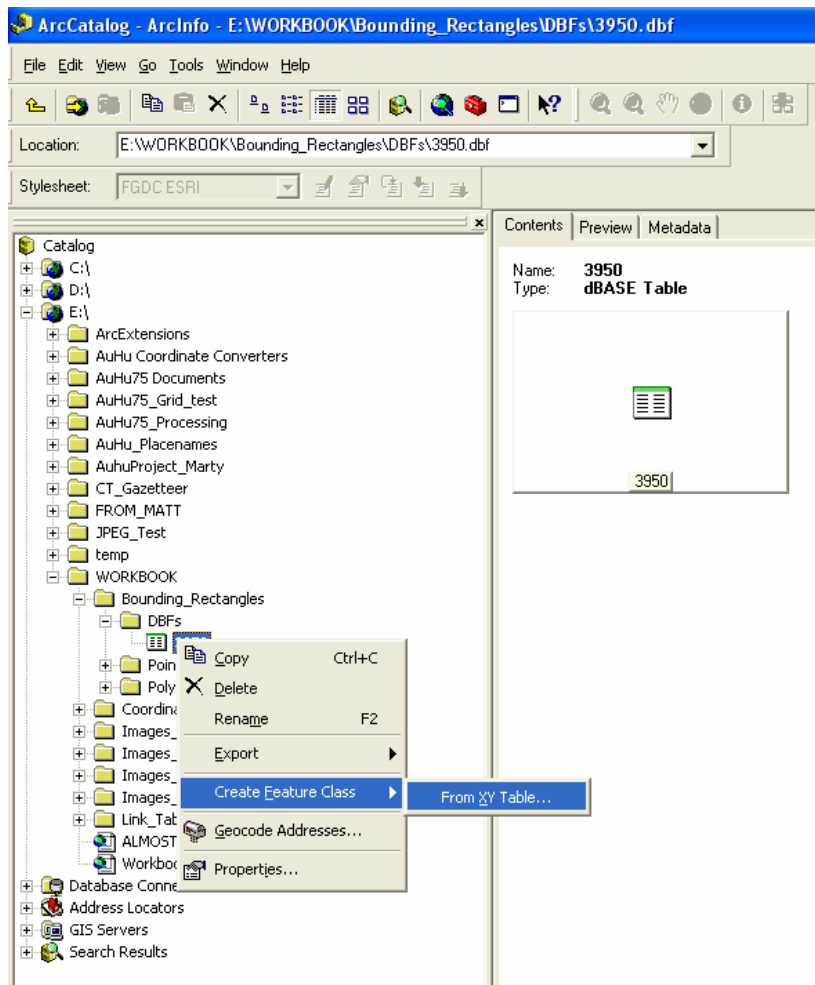


Figure 20. Creating a point shapefile from a .dbf table containing XY data fields.

This will open the **Create Feature Class** dialog box as shown in Figure 21.

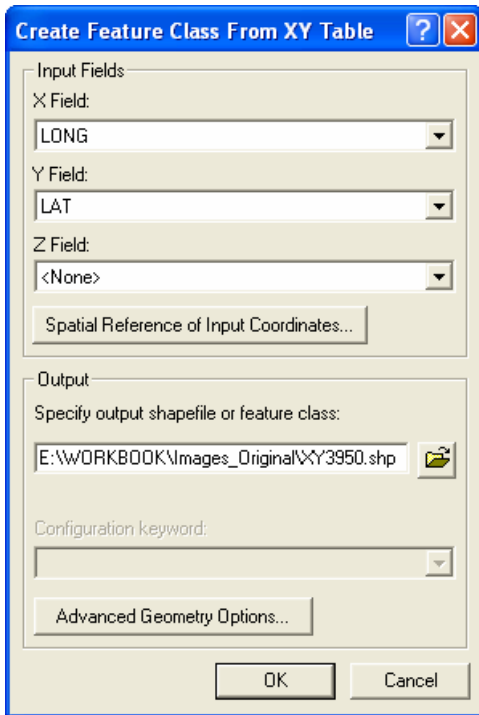


Figure 21. The Create Feature Class dialog box.

Notice that the X Field and the Y Field are automatically filled in based on the header names in the .dbf file. ArcCatalog will automatically recognize Long and Lat as X and Y field names.

Several additional parameters must be set at this point, however. These include:

- Spatial Reference
- Folder to save the shapefile in
- File name

The spatial reference information can be set by clicking on the **Spatial Reference of Input Coordinates** button to open the Spatial Reference Properties box (Figure 22.)

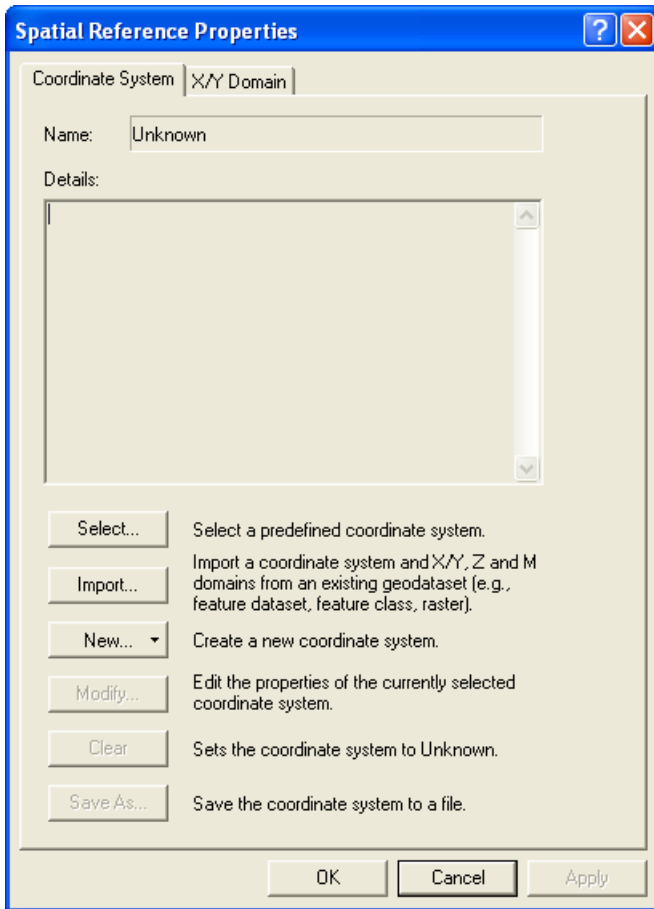


Figure 22. The Spatial Reference Properties box.

Click on the **Select** button and choose the appropriate coordinate system. Because the coordinates for this project are lon/lat and not projected, select Geographic Coordinate Systems as shown in Figure 23.

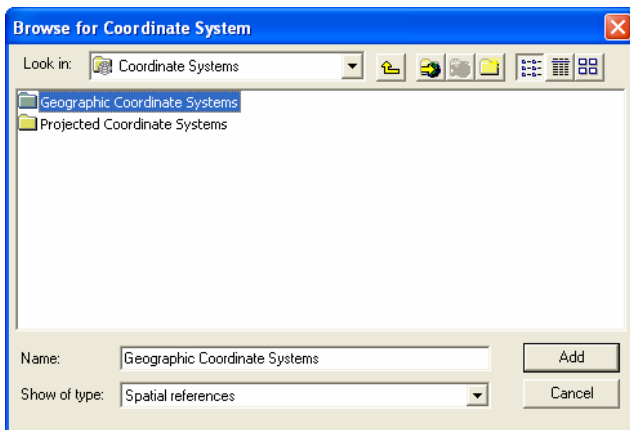


Figure 23. Select the Geographic Coordinate Systems folder for this project.

In the Browse for Coordinate System window, choose World (Figure 24).

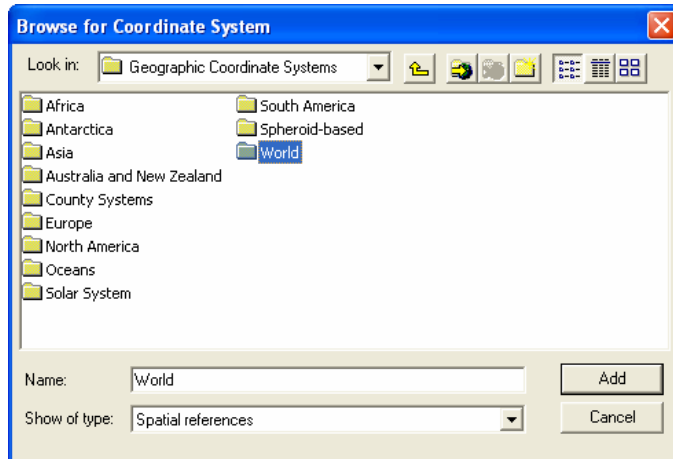


Figure 24. Select the World folder for this project.

Choose WGS 1984 from and then click the Add button (Figure 25).

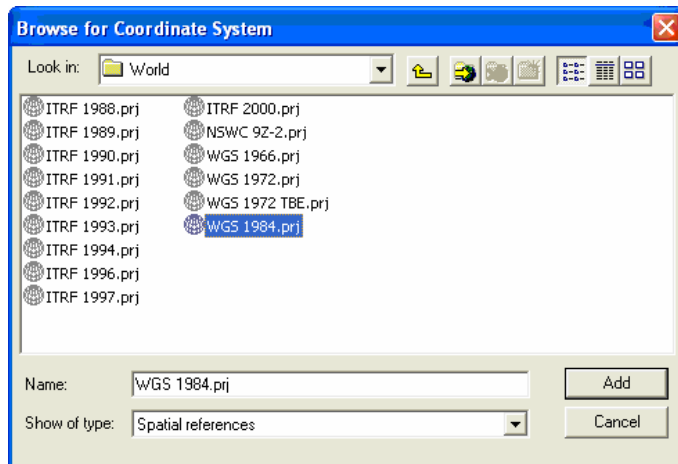


Figure 25. Select the WGS 1984.prj projection for this project.

Finally, specify an output location with an appropriate file name and click the **Save** button (Figure 26) then click the **OK** button in the Spatial Reference Properties box.

Next, click on the **Open Folder** button in the Output section of the Create Feature Class box shown in Figure 21. In the Saving Data window that opens, navigate to the folder where you wish to store the shape file and assign it a name as shown in Figure 26.

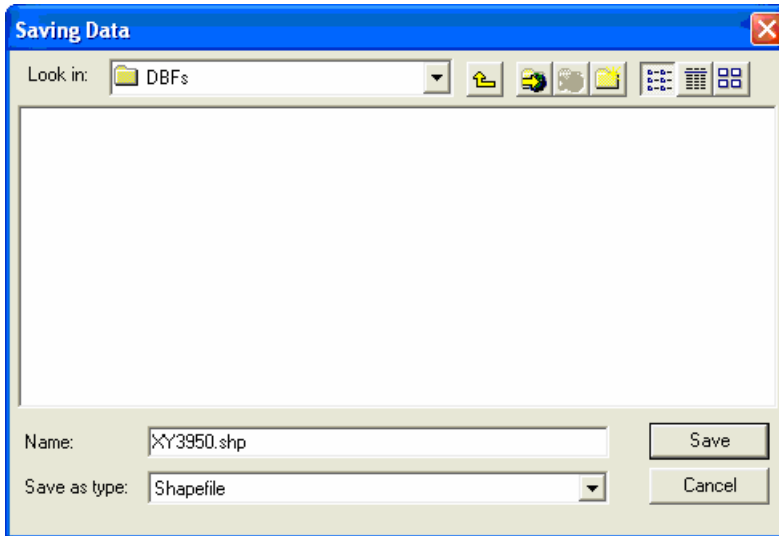


Figure 26. Save the shapefile created from the .dbf file.

You should now have a point shapefile in the directory (Figure 27) and a view of the four corner points can be displayed in the Preview tab of the display window to the right of the Catalog tree.

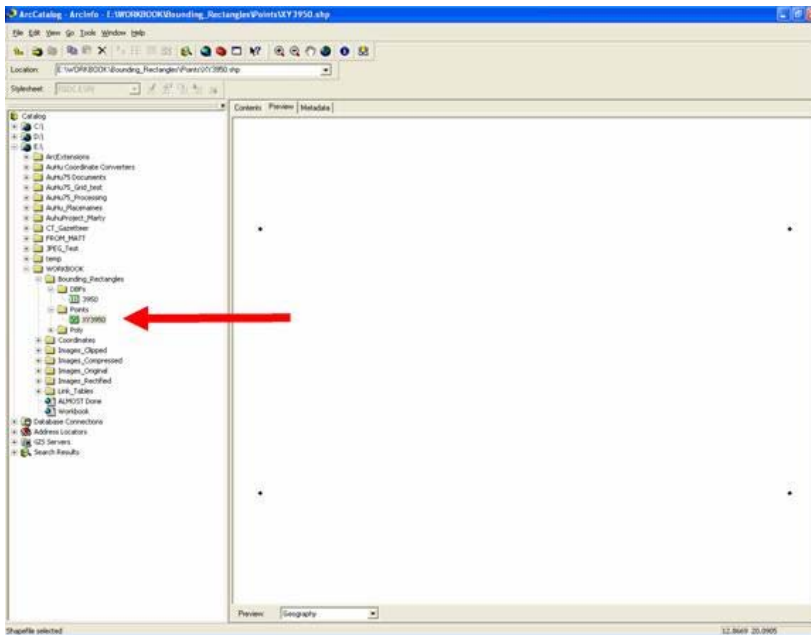


Figure 27. The shapefile created from the .dbf file stored in the Catalog and displayed in the Preview display in ArcCatalog.

Once this step has been completed, the four points in the polygon shapefile can be converted into a polygon shapefile representing the bounding rectangle of the map graphic.

Step 3. Create a polygon shapefile from a point shapefile

This step uses ArcMap and the XTools extension for ArcMap.

Open the ArcMap map document and add the point shapefile created in the last step (Figure 28).

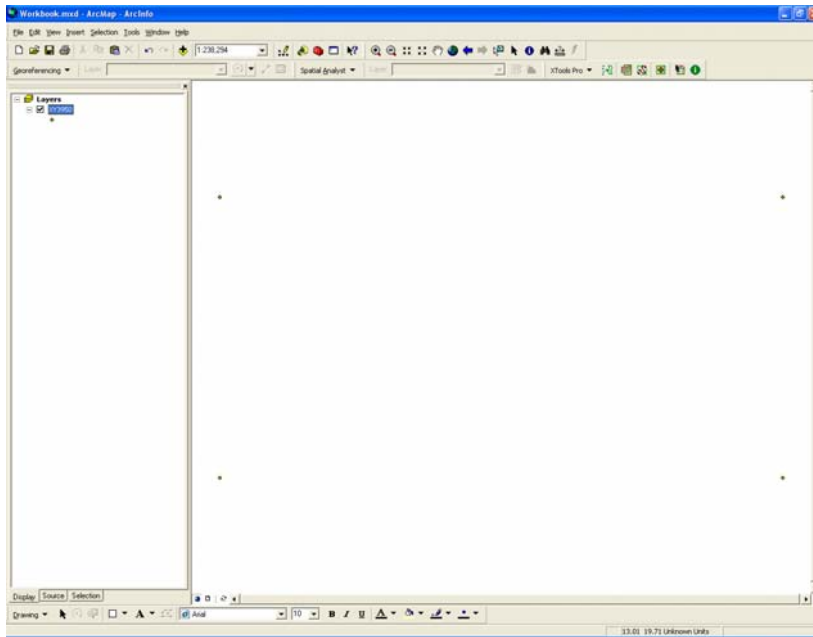


Figure 28. The point shapefile added as a data layer in the ArcMap map document.

If you have not already done so, add the XTools toolbar to the map document and enable the extension. To enable the XTools Pro extension click on the **Tools⇒Extensions...** menu (Figure 29) and then check **XTools Pro** (Figure 30).

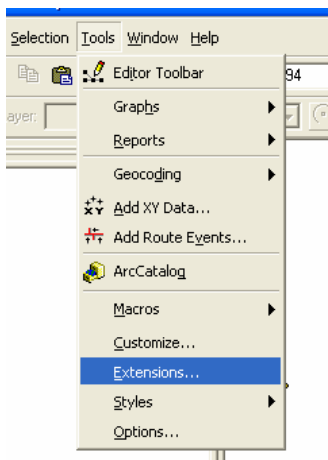


Figure 29. Using the Tools menu to connect to a list of Extensions.

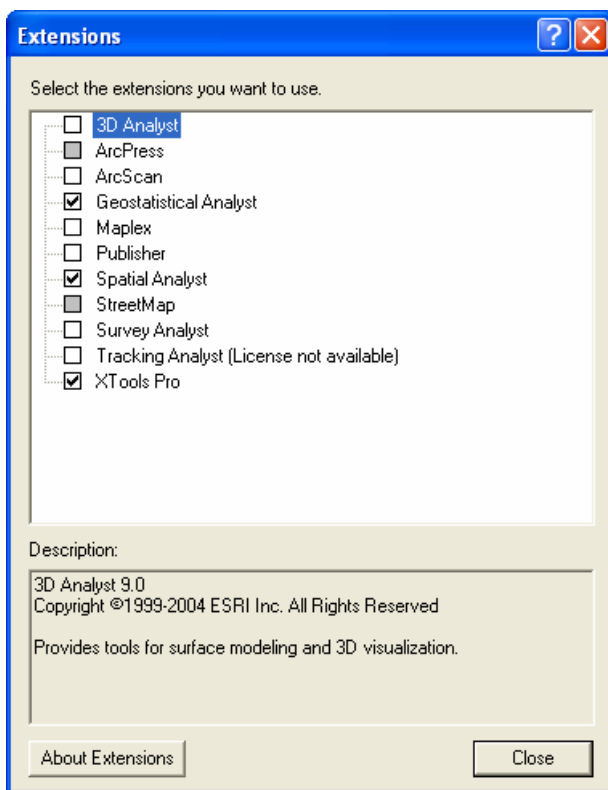


Figure 29. Enabling the XTools Pro extension.

Click the **Close** button to enable the extension.

The toolbar for the enabled extension will not be visible until the toolbar is turned on. Use the **View⇒Toolbars⇒XTools Pro** menu to display the toolbar for the extension (Figure 31).

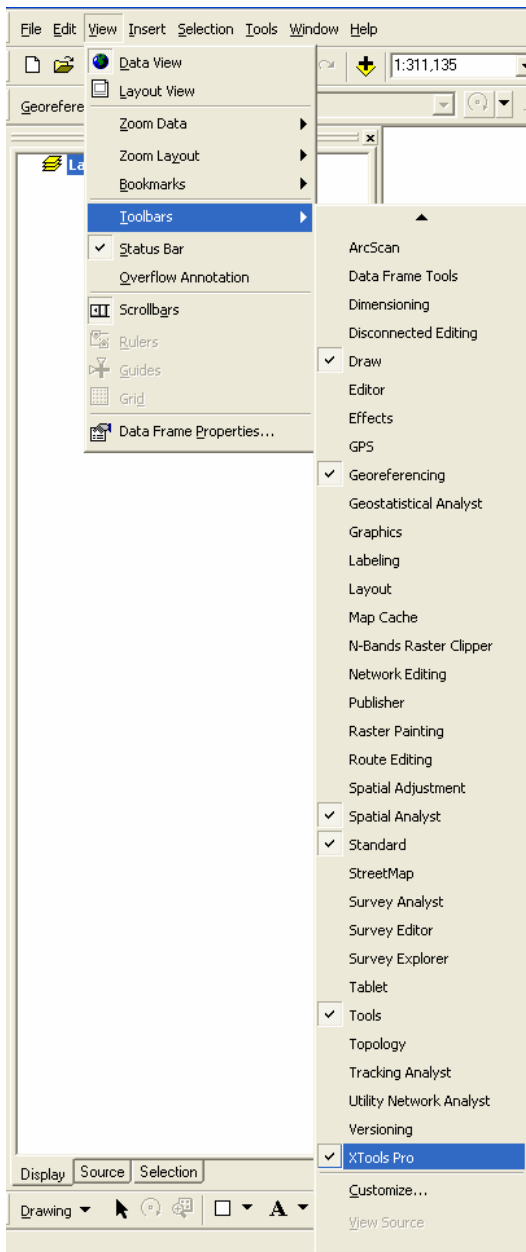


Figure 31. Using the View menu to display the XTools Pro toolbar.

If you display the toolbar for the extension but the buttons are grayed out (Figure 32), the extension has not yet been enabled.

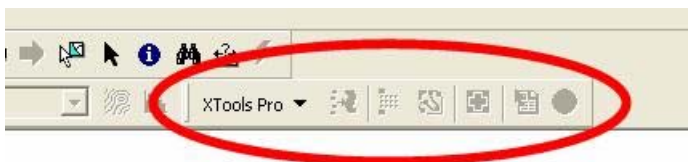


Figure 32. The XTools Pro toolbar is visible but the extension is not enabled.

Use the procedures shown in Figures 29 and 30 to enable the extension. The XTools Pro toolbar should now be active and available for use (Figure 33).

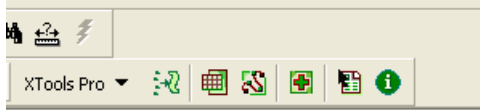


Figure 33. The XTools Pro Toolbar with the extension enabled and the toolbar visible.

Now use XTool to convert the point shapefile into a polygon shapefile. On the XTools Pro toolbar, click the **XTools Pro⇒Feature Conversions⇒Make One Polygon from Points** menu (Figure 34).

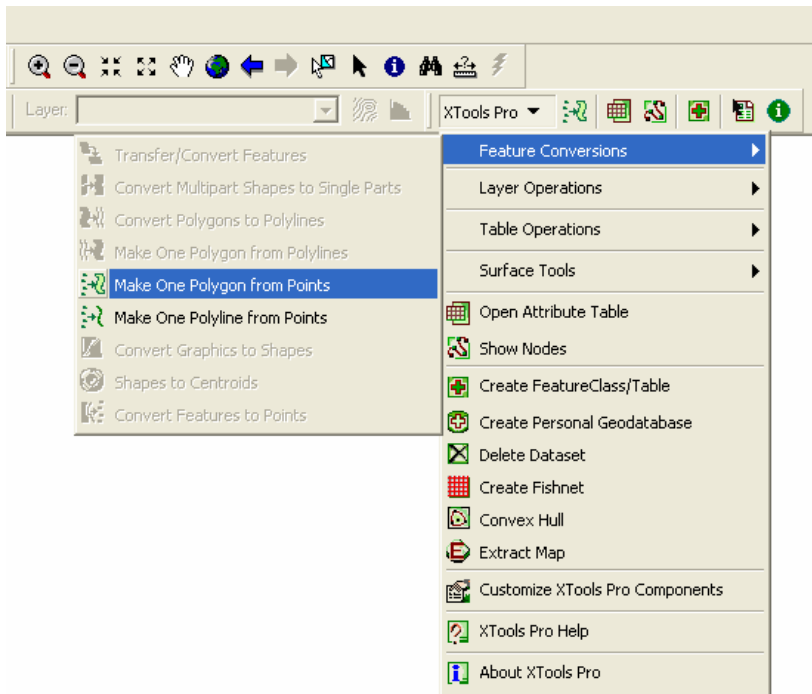


Figure 34. Feature Conversions menu in XTools Pro extension.

This will open up the Make One Polygon from Points dialog box (Figure 35). Select the point shapefile as the Input feature layer. Make sure that none of the points are selected. Navigate to an appropriate folder to save the polygon file and assign an appropriate file name. Check the **Add output feature class to current map** so that the polygon shapefile will be automatically added to the Data View and check **Create spatial index**. Then click **OK**.

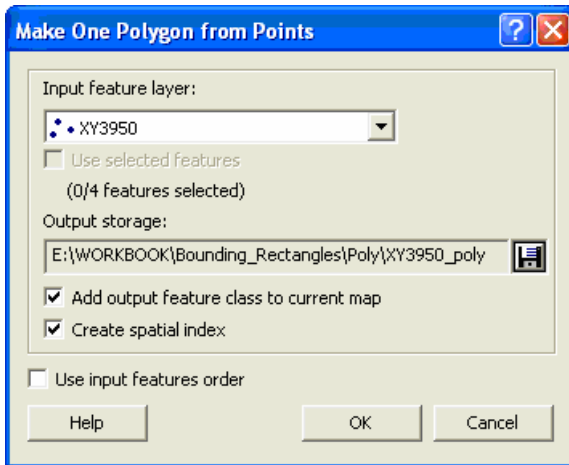


Figure 35. Creating a single polygon from the shapefile of control points.

The polygon shapefile that results from this operation will appear as a layer in the Data View as shown in Figure 36.

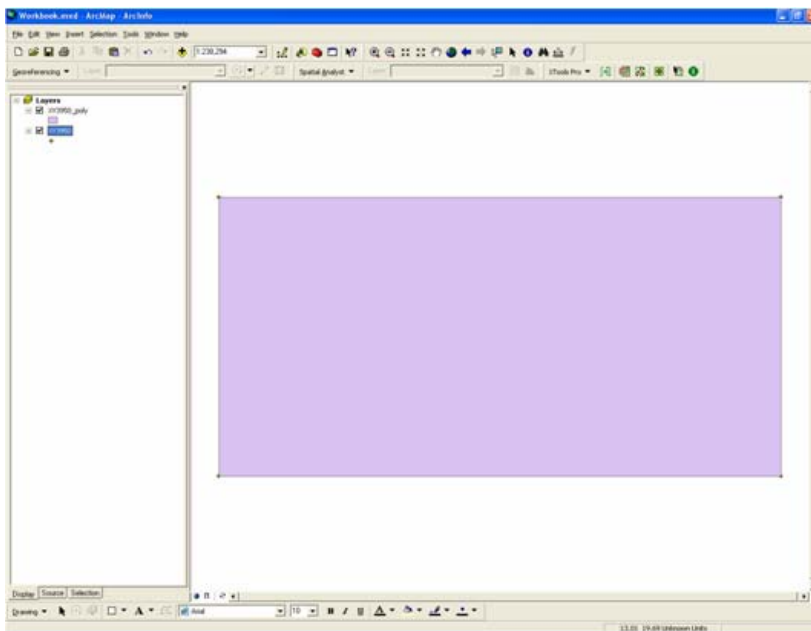


Figure 36. The single polygon shapefile resulting from the procedure added to the Data View.

Now right click on the name of the polygon file to open its Layer Properties and click on the Source tab (Figure 37).

Notice that the new polygon shapefile was assigned **NAD 1927** as the assumed coordinate system. For the examples used in this workbook, the desired coordinate system is **WGS 1984**. Thus, this polygon shapefile needs to be projected into the appropriate coordinate system.

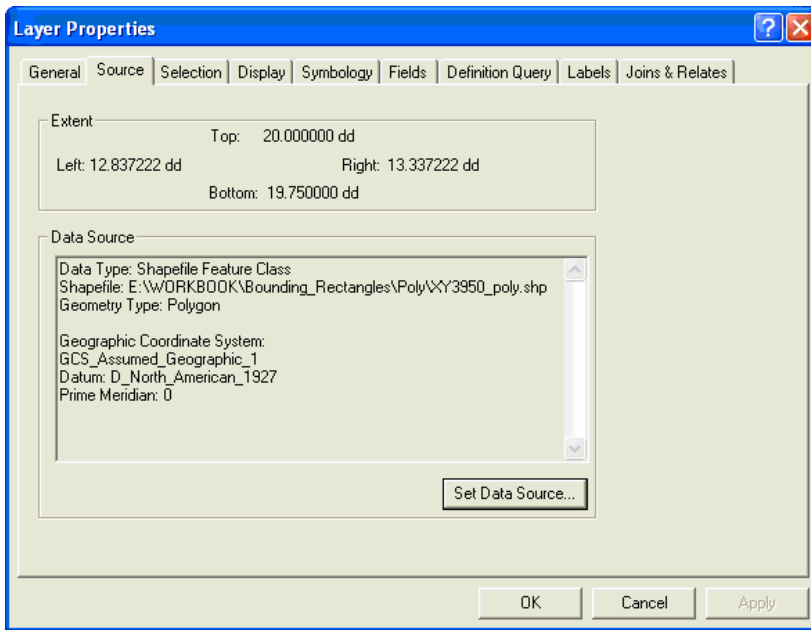


Figure 37. The Source tab in the Layer Properties window provides a description of the coordinate system for the data layer.

The choice of coordinate system may vary from project to project. Choose the coordinate system that meets the needs of the project.

Step 4. Project the polygon shapefile of the bounding rectangle

First, open ArcCatalog and open ArcToolbox by clicking on the icon (Figure 38).



Figure 38. The ArcToolbox button.

Next, click **Data Management Tools⇒Projections and Transformations⇒Project** in the ArcToolbox window to navigate to the Project wizard (Figure 39).

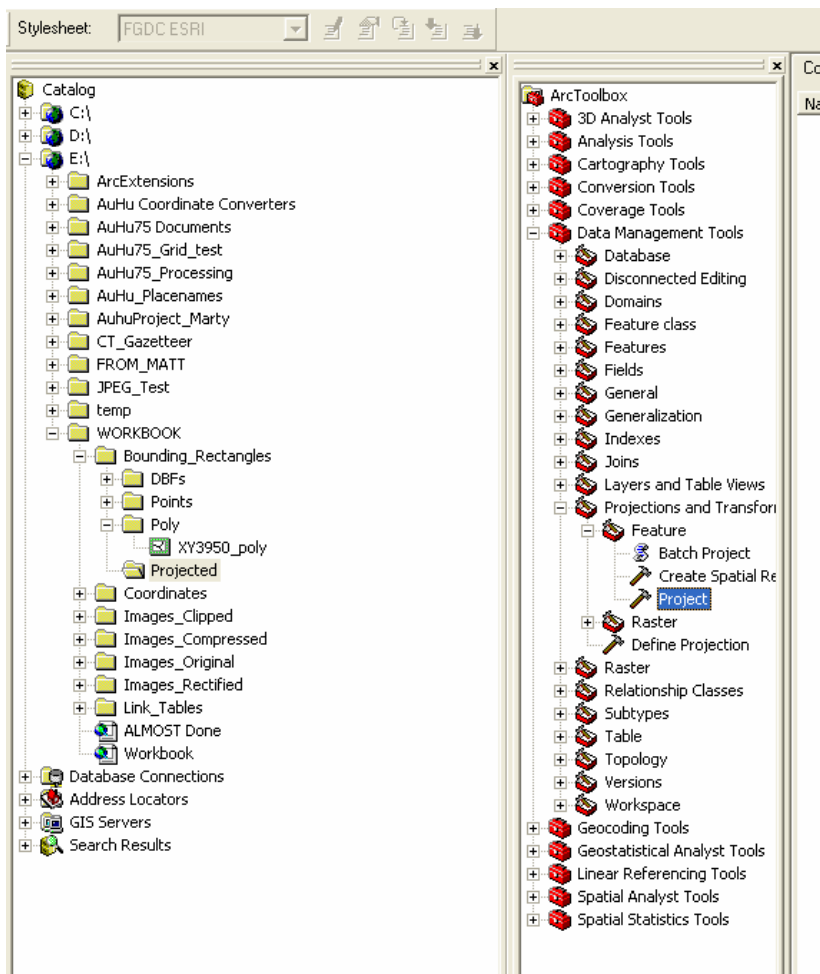


Figure 39. Navigating to the ArcToolbox Project wizard.

Click on **Project** to open the dialog box shown in Figure 40. Browse to the file to be projected as the Input Dataset, browse to the location for the Output Dataset, and select the Output Coordinate System (Figure 41).

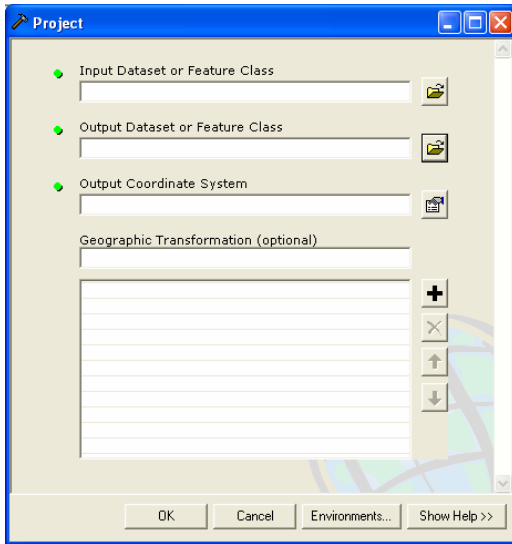


Figure 40. The Project wizard dialog box.

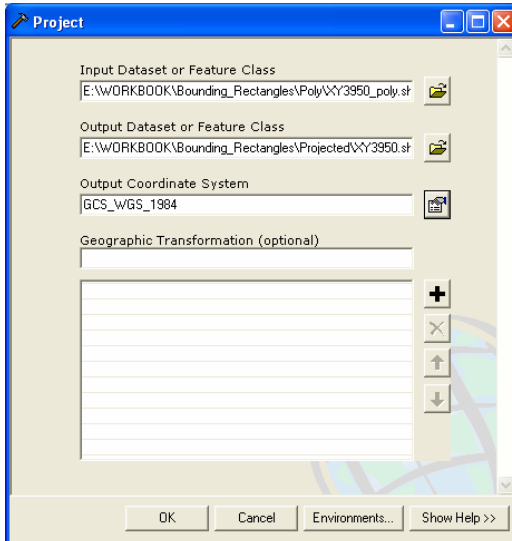


Figure 41. The completed Project wizard dialog box.

This completes the processing of the bounding rectangle for the first map image to be rectified and clipped.

Stage 4: Georectify the Map Image

In this stage, the scanned raster images of the Austro-Hungarian maps are rectified. The georeferencing tool in ArcMap is used to perform an affine transformation from the X-Y grid coordinates of the map image to the X-Y coordinates of the chosen projection. All Austro-Hungarian maps were projected to the World Geodetic System 1984 (WGS84) using latitude and

longitude. The four ground control points (GCPs) identified in the previous stage for each of the Austro-Hungarian maps are used in this process.

Step 1. Add the scanned map image and the georeferencing tool bar

Add the map image to be rectified to the Data View in an ArcMap map document (Figure 42).

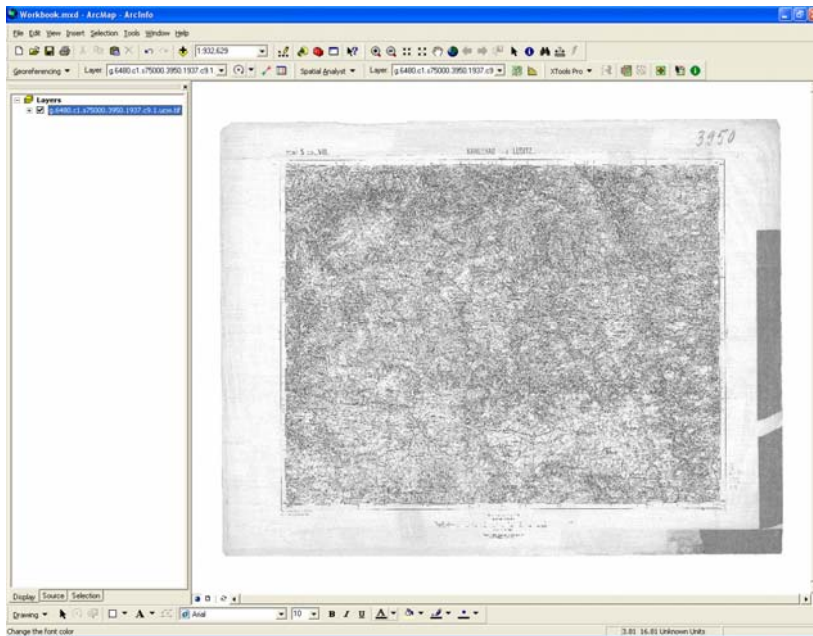


Figure 42. An unrectified map image.

Next, add the **Georeferencing Toolbar** by using the **View⇒Toolbars⇒Georeferencing** menu (Figure 43).

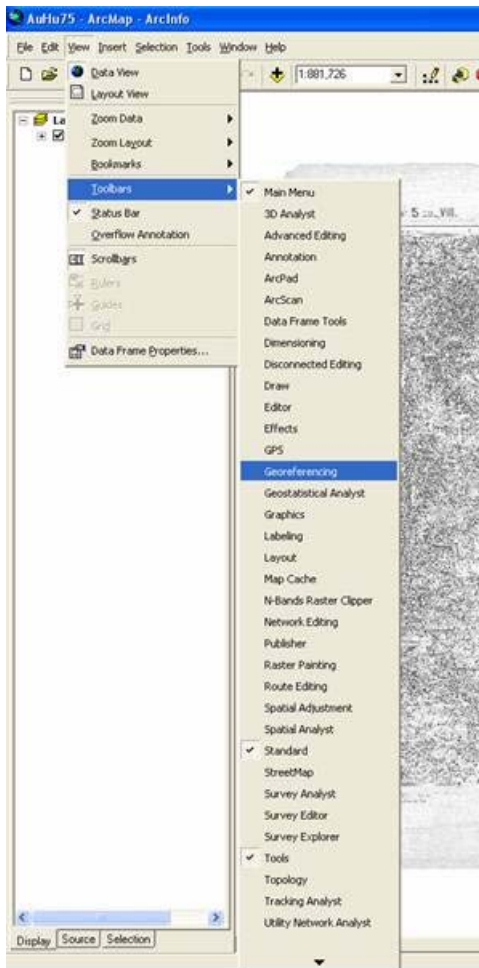


Figure 43. Adding the Georeferencing Toolbar.

In the Georeferencing Toolbar, the Layer pull-down selection box identified the scanned image that is being georeferenced. If more than one scanned image has been added as a data layer, be sure that the image you wish to rectify is the image shown in the Layer box of the Georeferencing Toolbar (Figure 44).

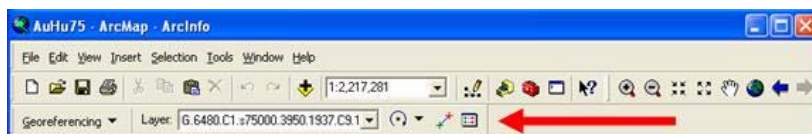


Figure 44. The Georeferencing Toolbar indicating the image to be rectified.

It cannot be emphasized enough that the image being rectified must be set as the target in the Georeferencing toolbar as shown in Figure 45.

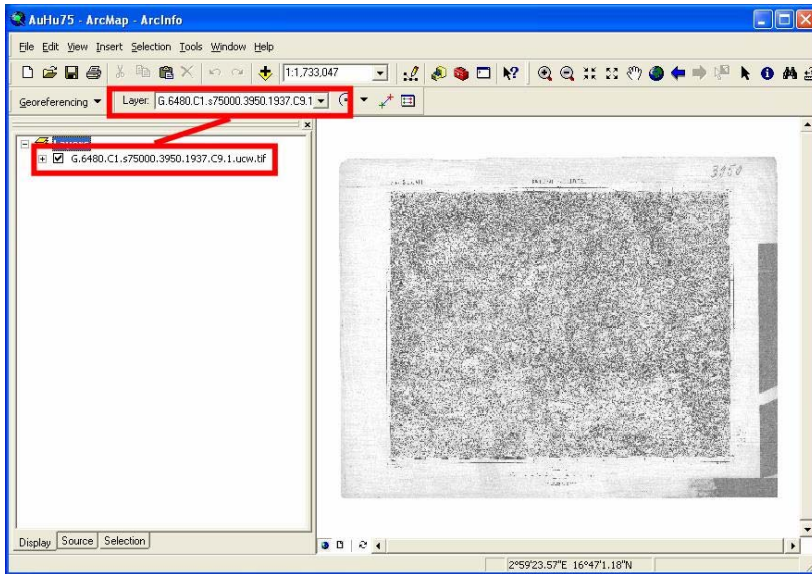


Figure 45. The image name in the Layer box matches the name of the image to be georeferenced as shown in the Table of Contents.

Step 2. Create the link table

The next step is to create the link table that links the four corners of the scanned map image to the four GCPs used to create the bounding rectangle in Stage 3. It is imperative that the same four GCPs used in the previous stage to create the bounding rectangle are also used in this stage and that the clockwise in which the points were chosen is preserved in creating the link table.

Zoom to the upper left corner to the corner point of the image (Figure 46).

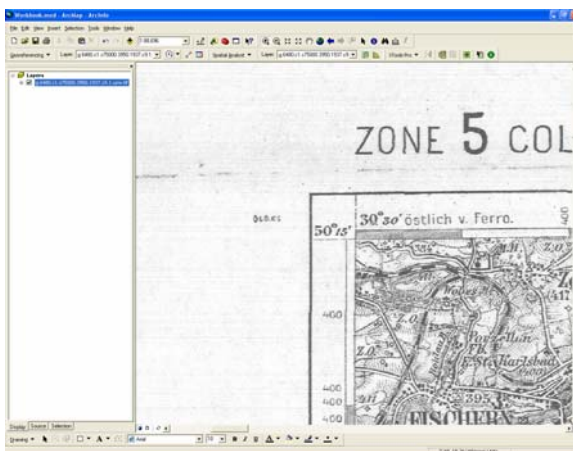


Figure 46. The upper left corner of the scanned map image.

Next, open the Link Table by clicking on the link table button in the Georeferencing Toolbar (Figure 47). Look at layout of the Link Table. For each link associated with a control point and identified by a numerical Link ID, the table records the link between the X,Y Source coordinates (from the scanned image) and the X,Y Map coordinates (to the georectified image). The Residual field reports the Root Mean Square Error (RMS) associated with a particular link and total RMS. If the RMS value is too high suggesting a high degree of error, the user can delete a link and try again to establish a more accurate link.

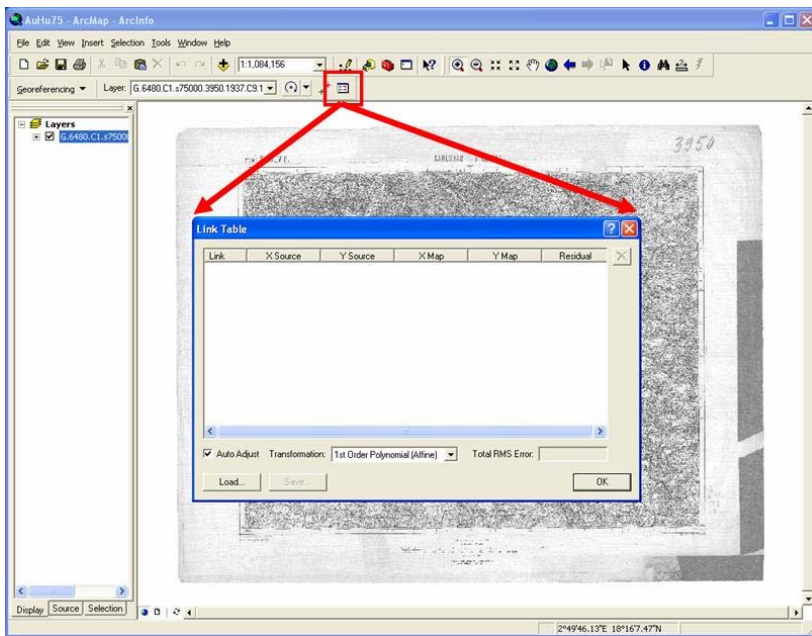


Figure 47. The upper left corner of the scanned map image.

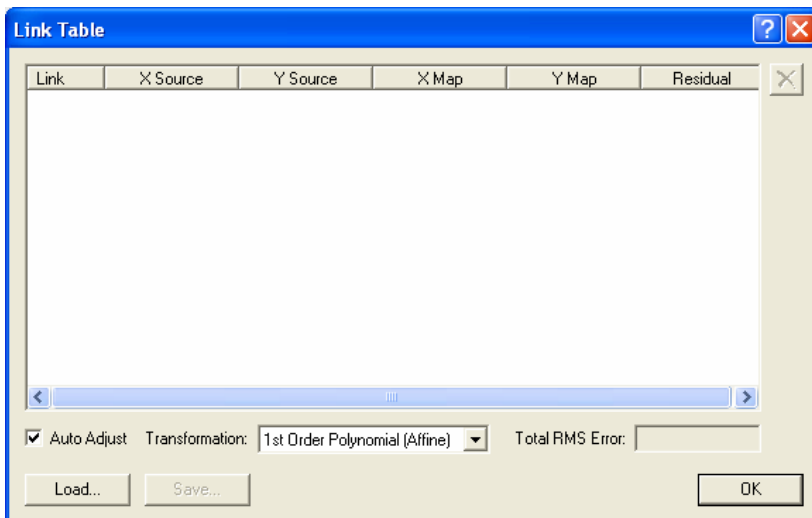


Figure 48. The open link table.

To complete the Link Table, you will click on points on the scanned map image and then upload the associated ground control points from the Excel spreadsheet. First, click on the **Add Control Points** button on the Georeferencing Toolbar (Figure 49). The cursor icon will turn into a crosshair.

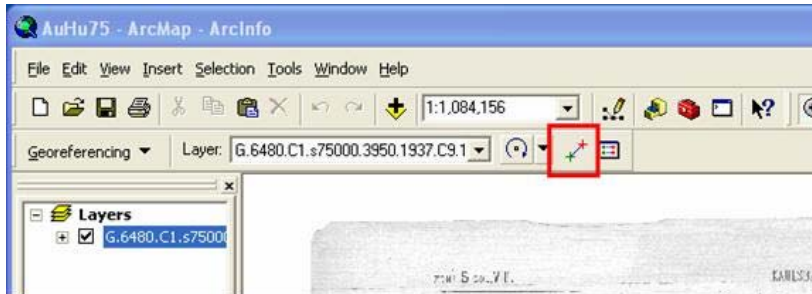


Figure 49. The Add Control Points button in the Georeferencing Toolbar.

Place the cursor in position for the first GCP to be entered from the upper left corner of the scanned map image as shown in Figure 50 and SLOWLY double click the left mouse button. If you clicked in the wrong place, highlight the GCP in the Link Table and press the Delete key or the X button to delete it.

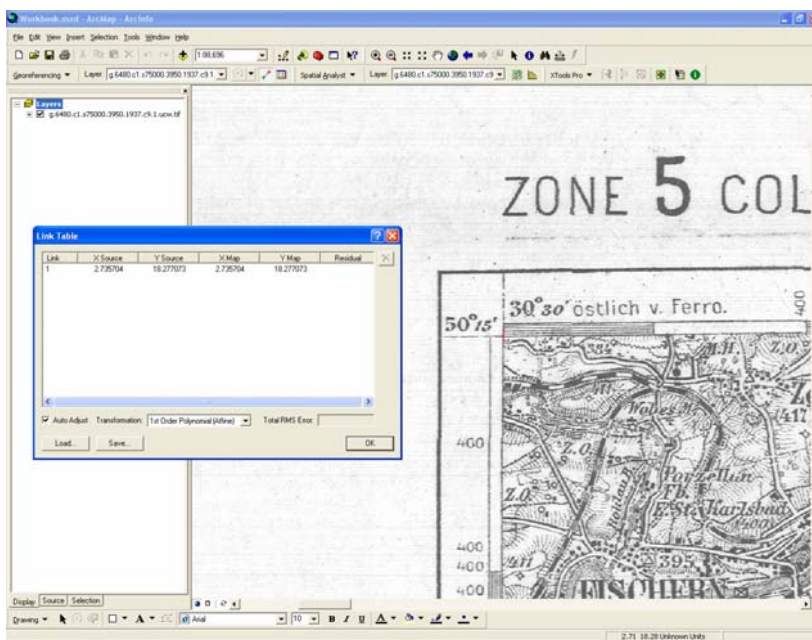


Figure 50. Selecting the first GCP.

The Link Table should show the coordinates for the first GCP as Link 1. Click to add the other GCPs by scrolling clockwise around the map until the 4 corner points have been recorded in the Link Table (Figure 51).

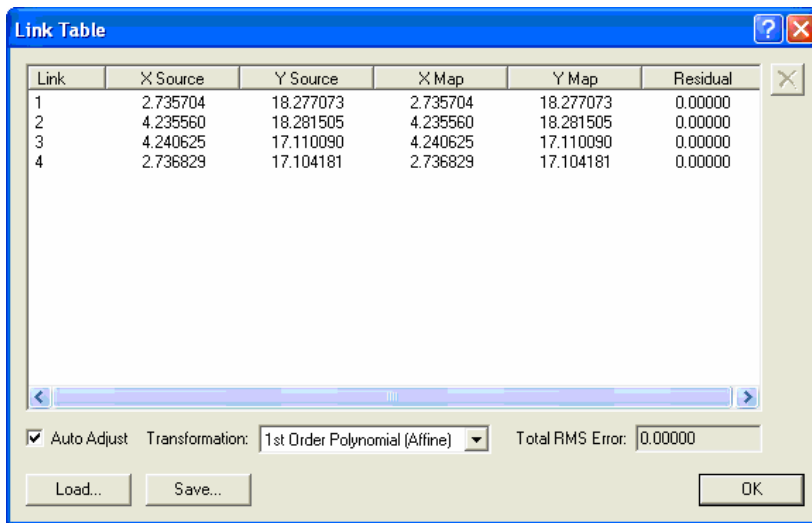


Figure 51. The link table with all four map corner points entered.

Step 3. Save the Link Table as a text file

Save the Link Table as a text file by clicking on the **Save** button. Save the link file to an appropriate directory and folder with a relevant name that relates to the map image for which the link table is being created (Figure 52).

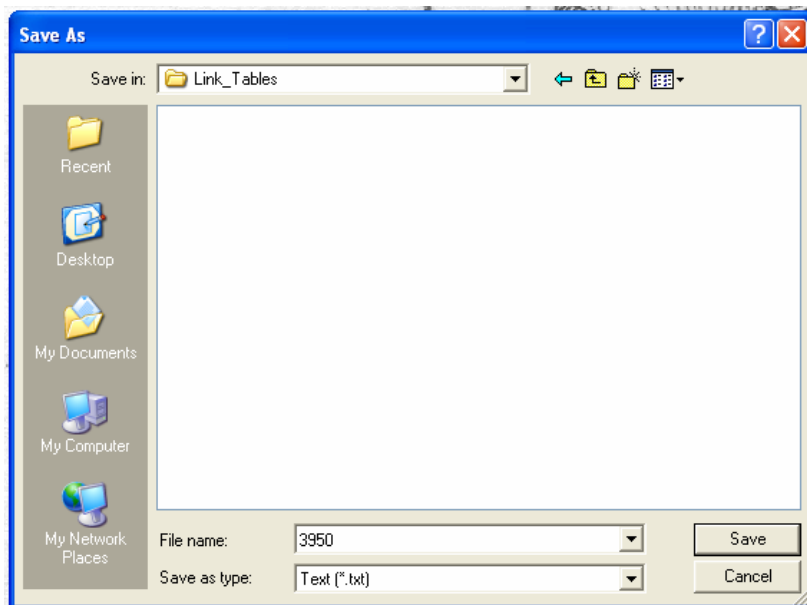


Figure 52. Saving the link table as a text file.

After saving the Link Table as a text file, open the text file using Excel. Be sure to change the file type that is being opened to “All Files” (Figure 53).

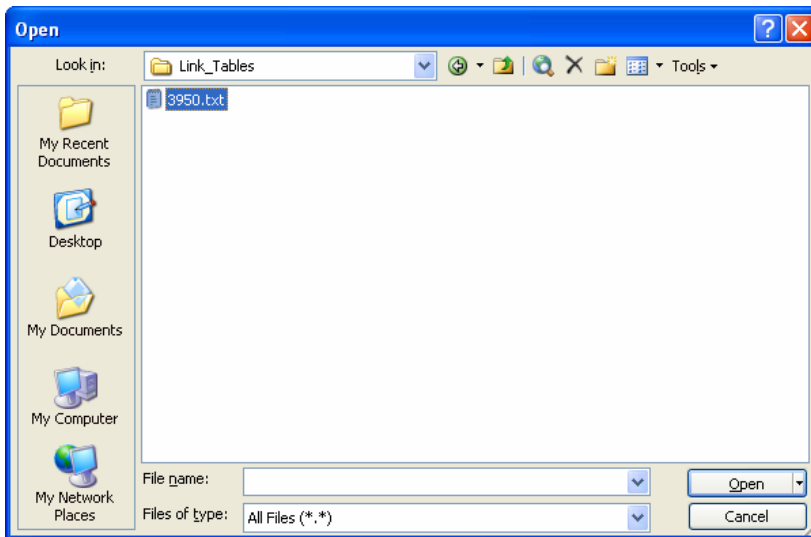


Figure 53. Opening the saved link table in Excel.

Because the saved table is in text file format, the Text Import Wizard will open in Excel (Figure 54). Simply hit the **Finish** button to import the text file (Figure 55).

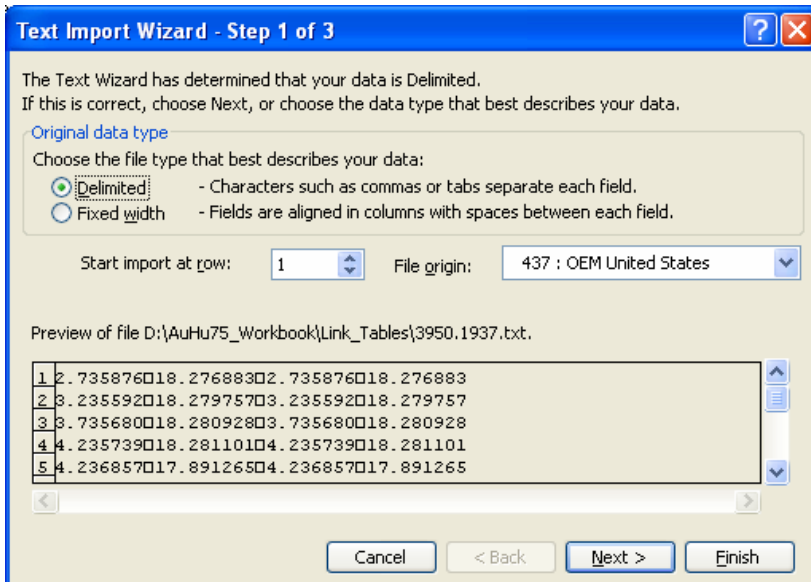


Figure 54. Using the Text Import Wizard in Excel to import the text file of coordinates.

	A	B	C	D	E
1	2.735704	18.27707	2.735704	18.27707	
2	4.23556	18.28151	4.23556	18.28151	
3	4.240625	17.11009	4.240625	17.11009	
4	2.736829	17.10418	2.736829	17.10418	
5					
6					

Figure 55. The imported link table in an Excel spreadsheet.

Step 4. Update the Link Table

The next task is to copy the adjusted coordinates from the Coordinate Conversion Worksheet prepared in Stage 2 and paste them into the Excel link table as the XMap and YMap coordinates. Figure 56 shows the adjusted coordinates from the source spreadsheet and the target area in the Excel link table where the adjusted coordinates will be pasted.

	A	B	C	D	E
1	2.735803	18.27729	2.735803	18.27729	
2	4.235621	18.28155	4.235621	18.28155	
3	4.240778	17.11033	4.240778	17.11033	
4	2.736851	17.10429	2.736851	17.10429	
5					
6					

Figure 56. Updating the map coordinates in the link table.

First, highlight the **Long** and **Lat** values in the cells of the coordinate conversion worksheet and use the Edit⇒Copy menu to copy the highlighted values (Figure 57). Be sure to include only the values; do **not** include the header names Long and Lat.

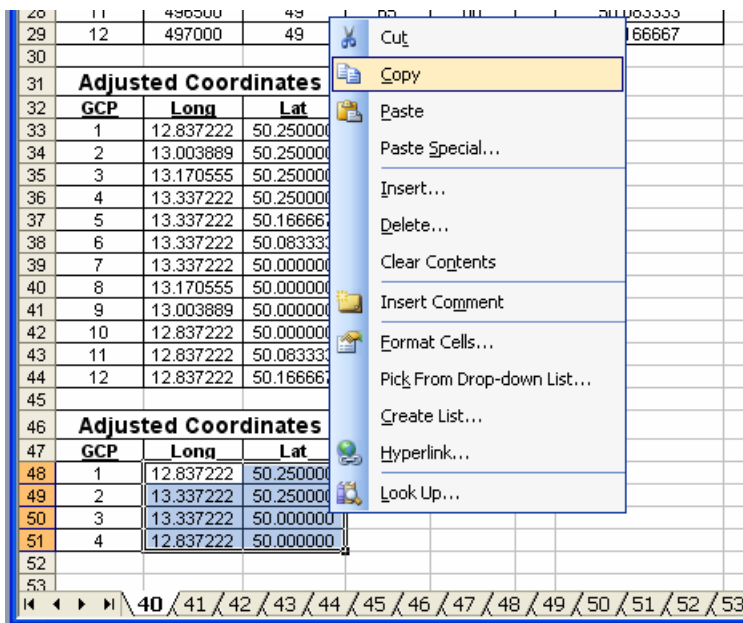


Figure 57. Copying the adjusted coordinate values.

Next, paste these numbers into the Link Table for the map image being rectified, copying over the values in the link table. Be sure to select **Paste Special⇒Values** and number formats (Figure 58).

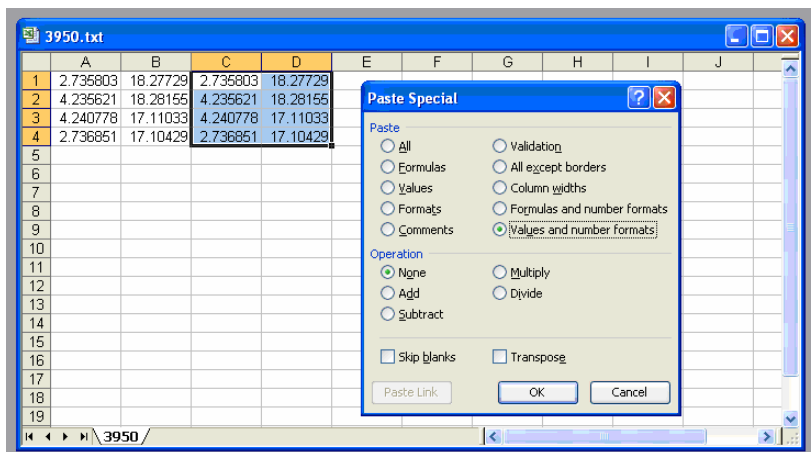
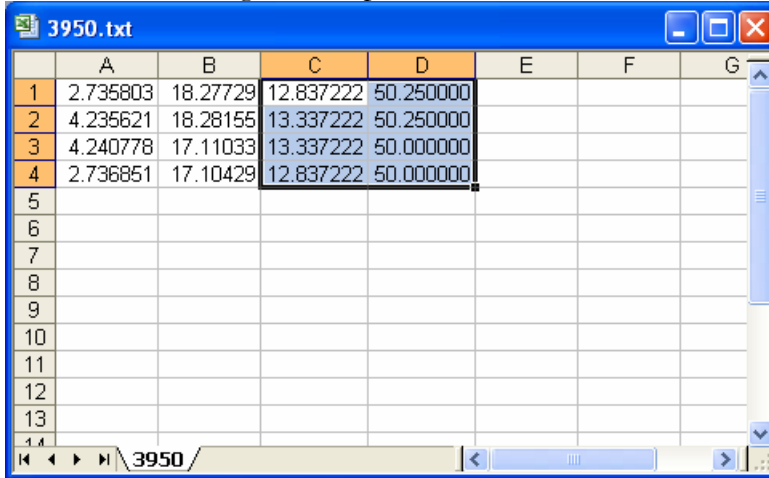


Figure 58. Pasting the adjusted coordinates into the link table.

The resulting table should look like the table in Figure 59. Compare this with the link table in Figure 51 to see the difference. The X Source, Y Source and X Map, Y Map coordinates are no longer the same as they are in Figure 51 because you have set the X Source, Y Source coordinates of the

image to X Map, Y Map coordinates corresponding to the location of the image corner point on the surface of the earth.



	A	B	C	D	E	F	G
1	2.735803	18.27729	12.837222	50.250000			
2	4.235621	18.28155	13.337222	50.250000			
3	4.240778	17.11033	13.337222	50.000000			
4	2.736851	17.10429	12.837222	50.000000			
5							
6							
7							
8							
9							
10							
11							
12							
13							

Figure 59. The link table with adjusted coordinates.

Save the updated link table Excel and then be sure to close the Excel file. Leaving the file open means that the table is still being used by Excel and other programs like ArcMap will not have access to the table, resulting in an error message.

Step 5. Load the updated Link Table into ArcMap

Now return to ArcMap and load the updated link table. First click the **Load** button on the Link Table window and navigate to the appropriate directory and file where you saved the updated Link Table (Figure 60).

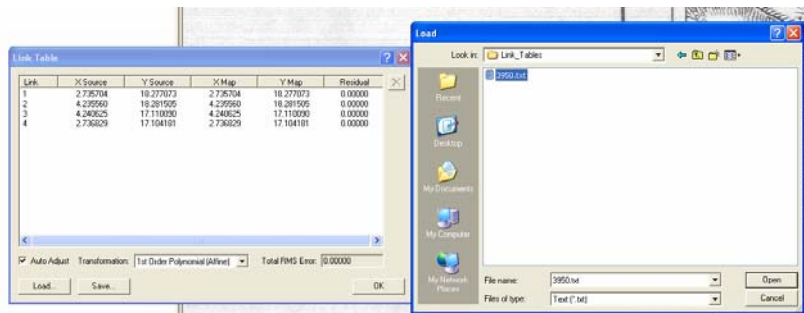


Figure 60. Loading the updated link table into ArcMap.

The link table should now have the adjusted coordinates for the rectified image (Figure 61).

Link	X Source	Y Source	X Map	Y Map	Residual
1	2.75603	18.277285	2.75603	18.277285	0.00000
2	4.22621	18.281952	4.22621	18.281952	0.00000
3	4.240778	17.110330	4.240778	17.110330	0.00000
4	2.736851	17.104295	2.736851	17.104295	0.00000

Link	X Source	Y Source	X Map	Y Map	Residual
1	2.75603	18.277285	12.837222	50.250000	0.00036
2	4.22621	18.281952	13.337222	50.250000	0.00036
3	4.240778	17.110330	13.337222	50.000000	0.00036
4	2.736851	17.104295	12.837222	50.000000	0.00036

Figure 61. A comparison between the initial and the updated link table.

Step 6. Rectify the map image

The map image is now registered to the proper coordinates (Figure 62). At this point, the rectification is not permanent. To save the registration and create a world file to make the rectification permanent, click on **Georeferencing**⇒**Rectify** (Figure 63).

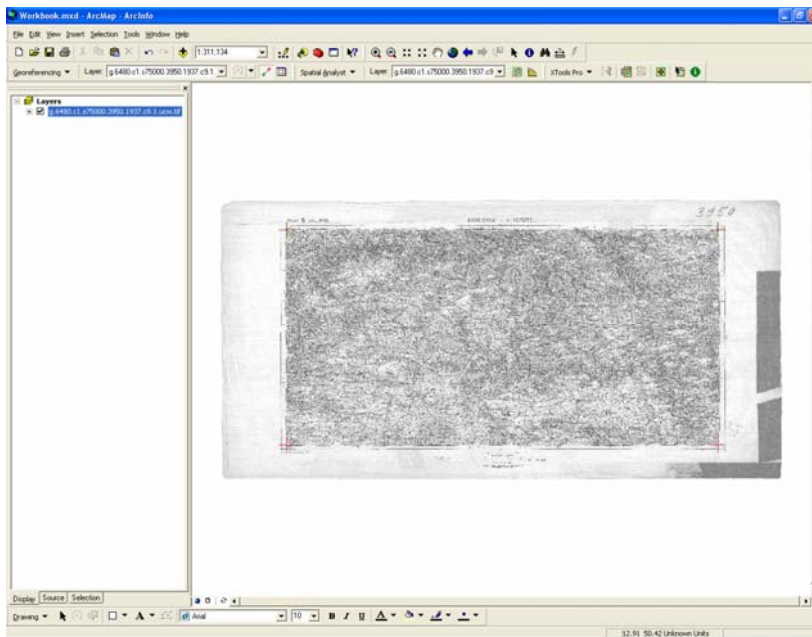


Figure 62. The correctly registered scanned map image.

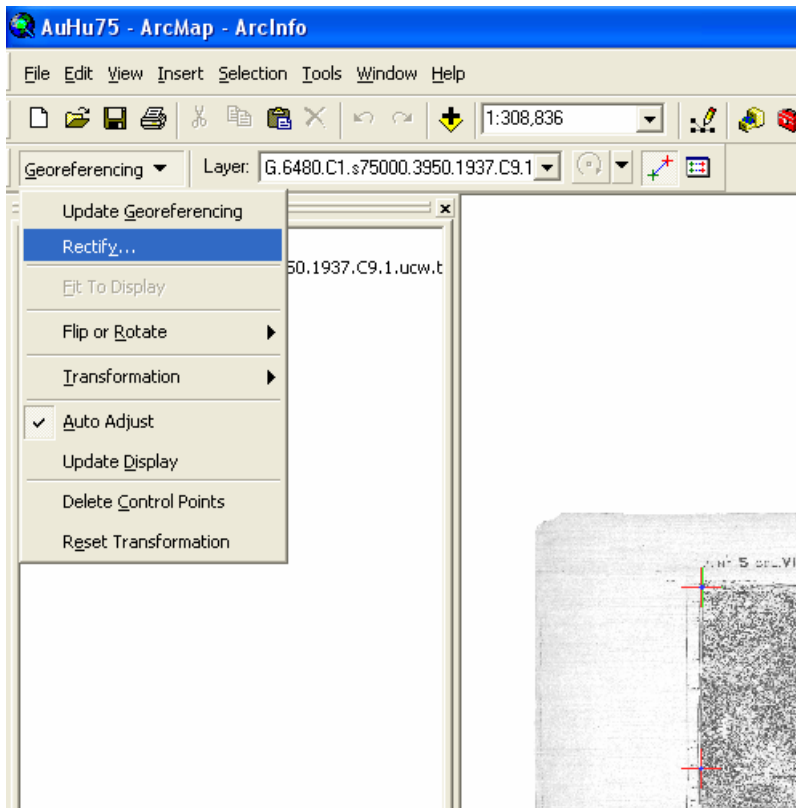


Figure 63. Rectifying the registered scanned map image.

Save the Rectified Image as a .tiff file to an appropriate directory (Figure 64). Notice that ArcMap has added **Rectify** to the beginning of the file name.

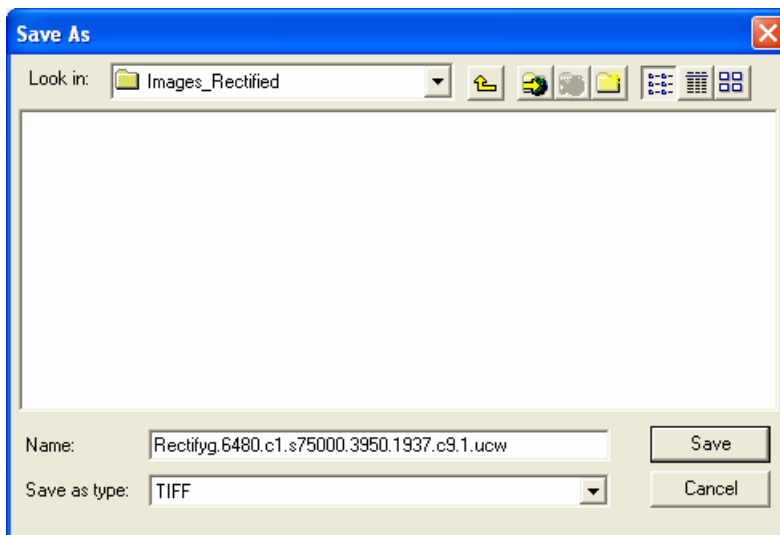


Figure 64. Saving the rectified scanned map image.

Below is a view of the original image, a display of the original and the rectified image, and a view of the rectified image (Figure 65).

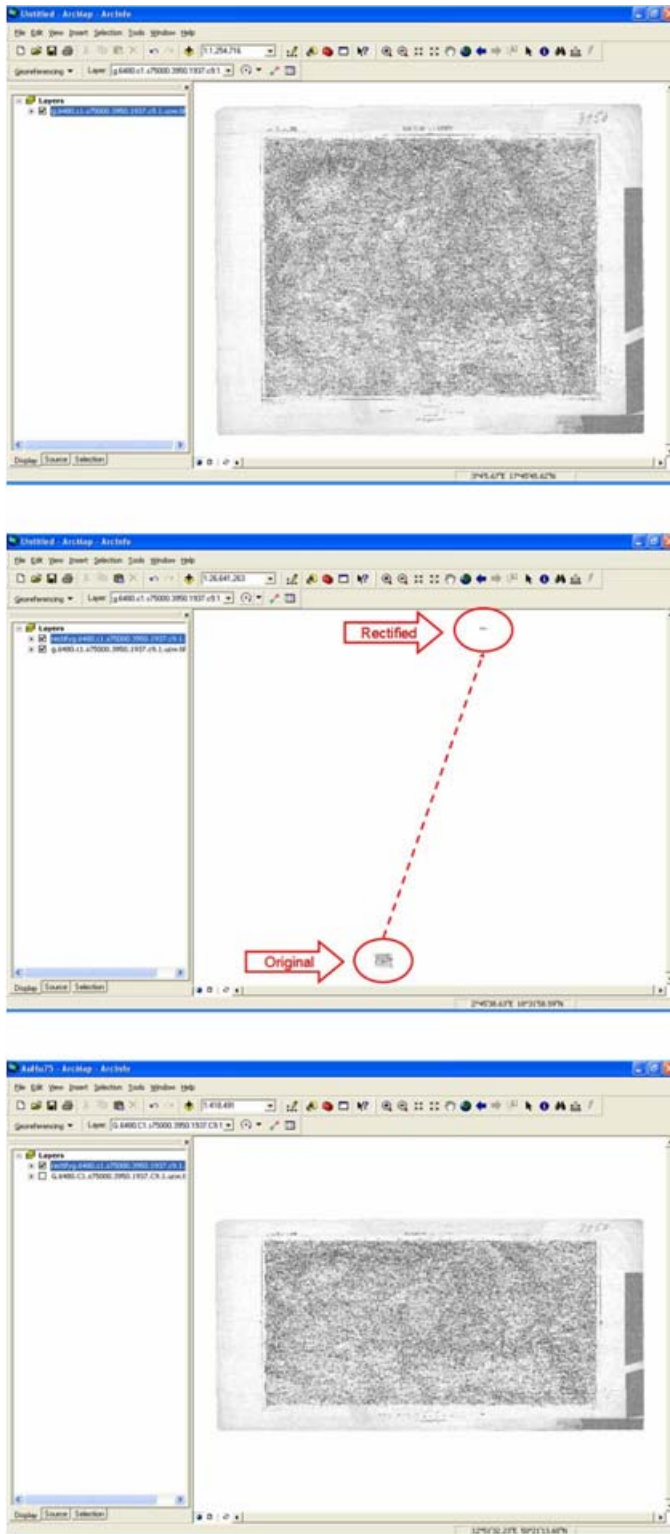


Figure 65. Comparison of the original and rectified images.

As a check on the georeferencing process, add the bounding rectangle shapefile that you created for this image in Stage 3 to the Data View in ArcMap. It should correspond to the graphic extent of the map image (Figure 66). The bounding rectangle will be used to clip the image in the next stage to remove the collar around the map.

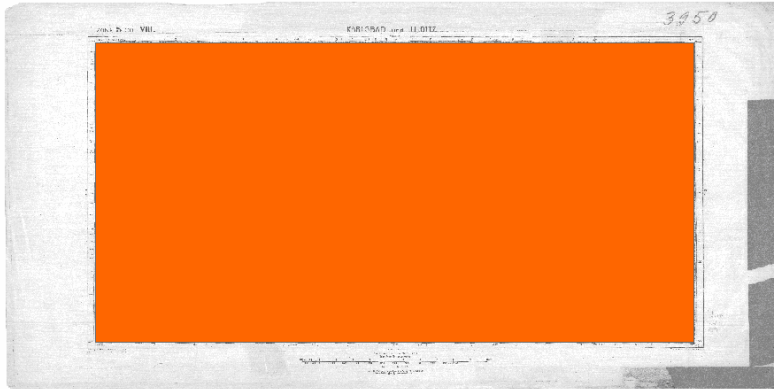


Figure 66. Rectified image with overlay of bounding rectangle shapefile.

Stage 5: Clip the Map Image

The clipping procedure can be used to remove the “collar” of the map, the margin between the edge of the map image and the edge of the paper map sheet. This will allow for creation of a seamless mosaic of the maps. The bounding rectangle polygon created in Stage 3 will be used to clip the map.

Step 1. Enable the Spatial Analyst Extension

First, you must enable the Spatial Analyst Extension in ArcMap. To do this, use the **Tools⇒Extensions** menu and check the Spatial Analyst Extension (Figure 67). Then, make the Spatial Analyst toolbar visible. Click on the **View⇒Toolbars** menu and **check Spatial Analyst** in order to add the toolbar (Figure 68). The toolbar will appear in the Data View (Figure 69).

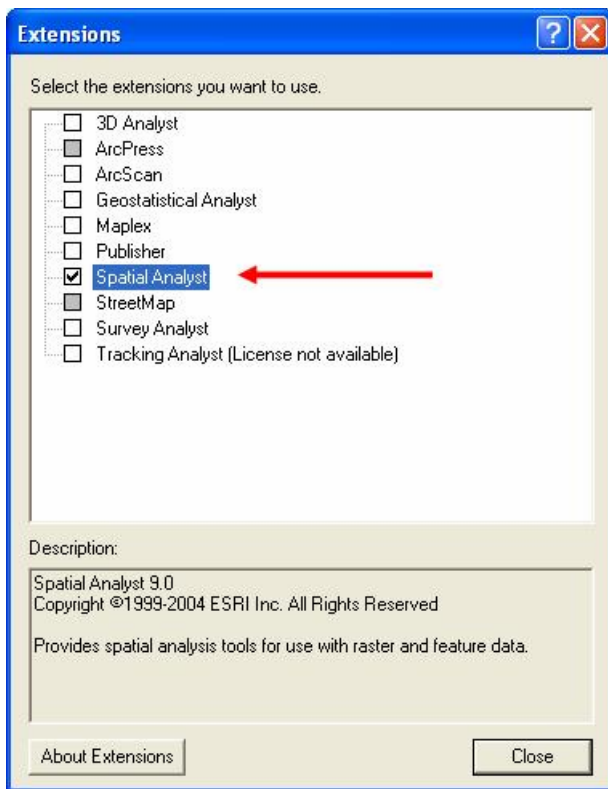


Figure 67. Enabling the Spatial Analyst extension.

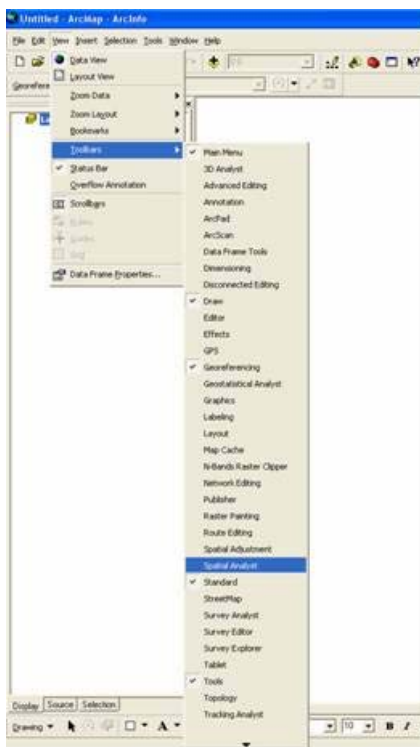


Figure 68. Making the Spatial Analyst toolbar visible.



Figure 69. The Spatial Analyst toolbar.

After ensuring the Spatial Analyst Extension is enabled and the toolbar has been added, be sure the map image to be clipped and the polygon that will act as the clip shape have been added to the Data View in ArcMap (Figure 70).

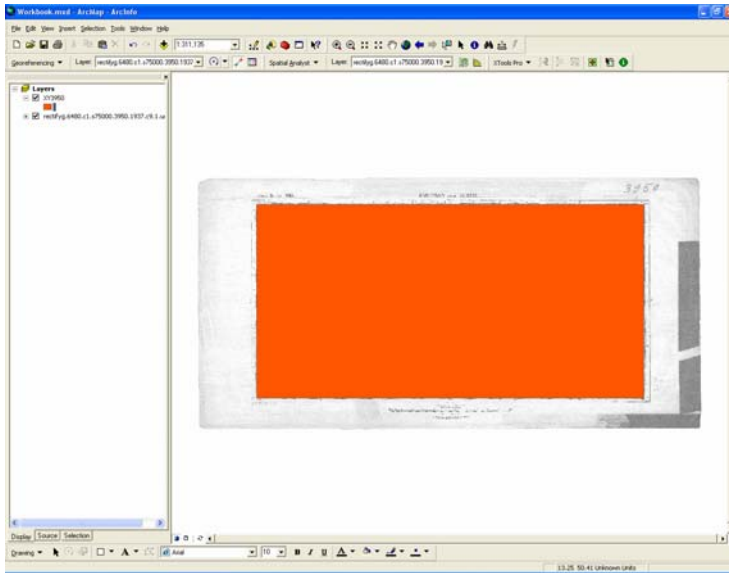


Figure 70. The clip polygon and the scanned and rectified map image.

Step 2. Use the Raster Calculator to clip the image

The Spatial Analyst Raster Calculator, with appropriate Analysis Options set, is used to clip the map image. First, click on the **Spatial Analyst⇒Options** menu (Figure 71).

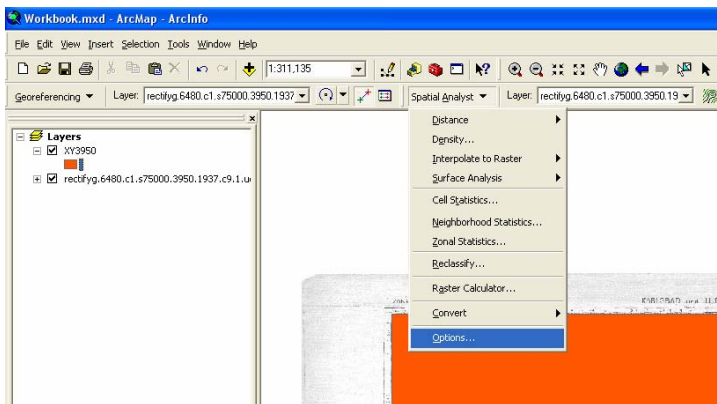


Figure 71. Setting the Options in Spatial Analyst.

Click on the **General** tab and set the **Analysis Mask** to the polygon layer you are using to clip the map image with (Figure 72). This establishes the clip layer as the mask and limits the processing of the map image to the area within the polygon layer.

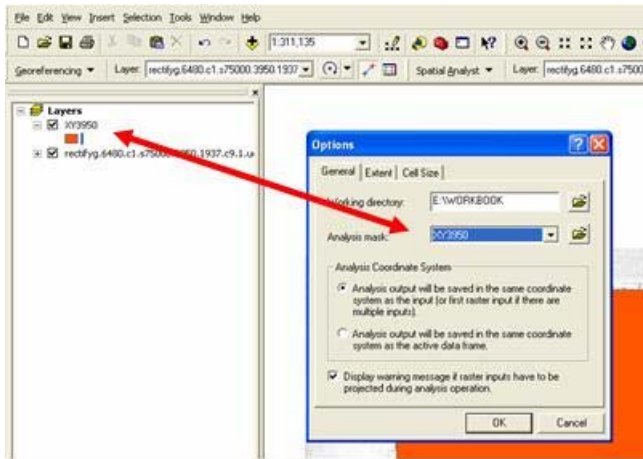


Figure 72. Setting the Analysis mask in Spatial Analyst.

Next, click on the **Extent** tab and set the **Analysis Extent** to correspond to the polygon layer being used to clip with (Figure 73). This ensures that the output from the map image will not be larger than the polygon being used as the clipper.

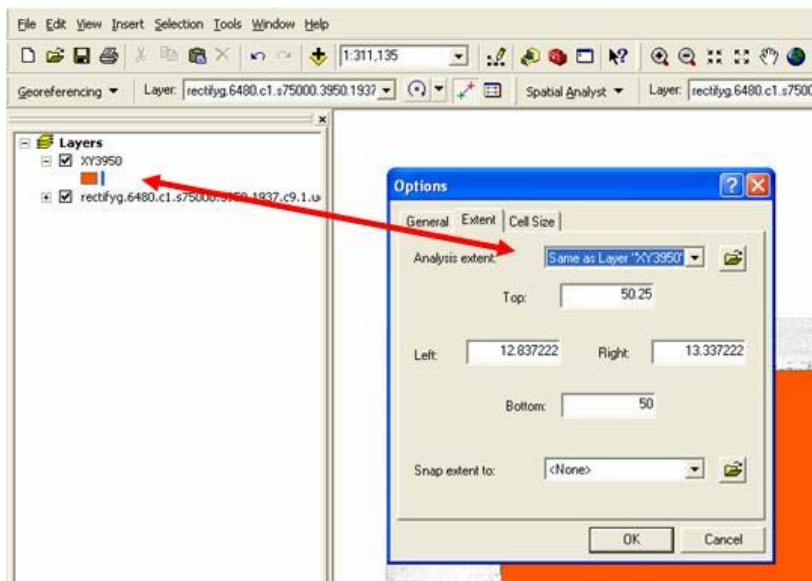


Figure 73. Setting the Analysis extent in Spatial Analyst.

Click the **Cell Size** tab and set the **Analysis Cell Size** to be the same as the cell size of the map image layer being clipped (Figure 74).

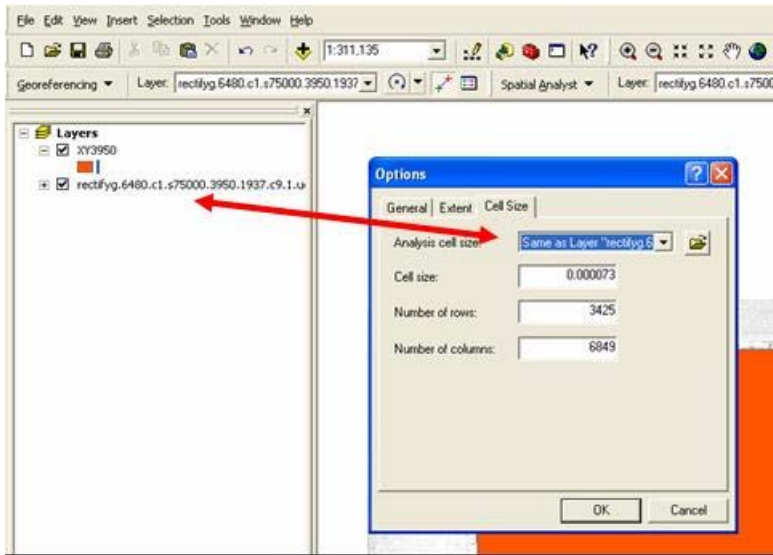


Figure 74. Setting the Analysis cell size in Spatial Analyst.

Close the Options dialog by clicking **OK**.

Once the Options have been set, open the Raster Calculator by clicking on the **Spatial Analyst⇒Raster Calculator** menu (Figure 75).

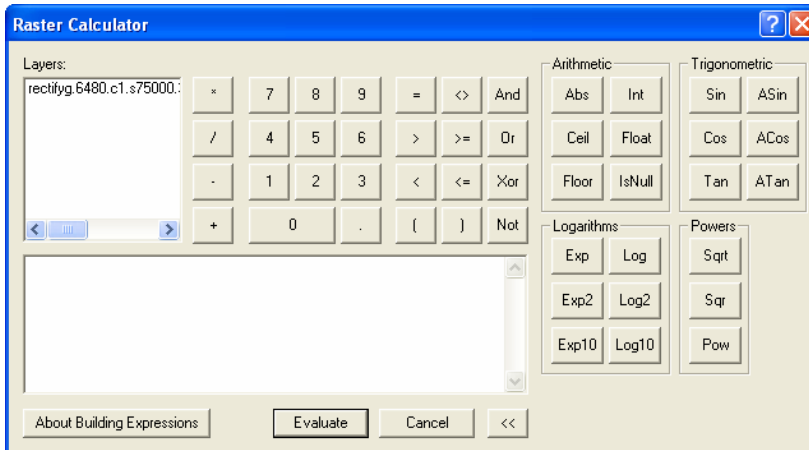


Figure 75. The Raster Calculator.

Double click on the raster map layer of interest listed in the Layers: window to add it to the expression box in the lower left (Figure 76). Because you are not performing an algebraic operation on the cell contents of the layer, the values in the new clipped layer will equal the values for the corresponding cells inside the mask from the original layer.

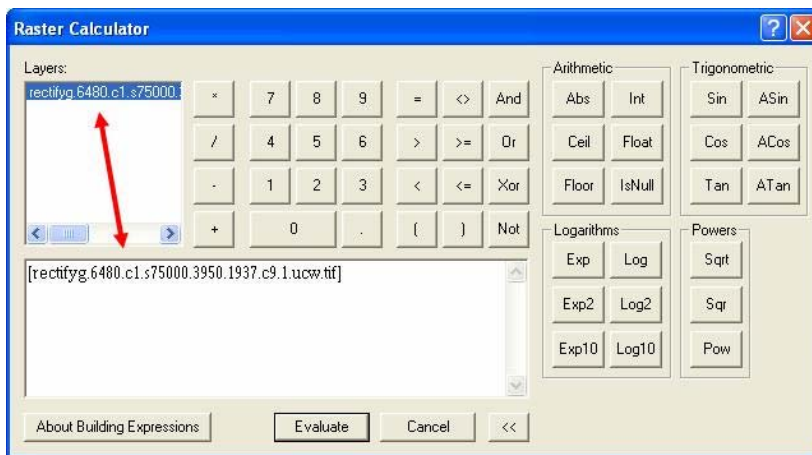


Figure 76. Adding a layer to build an expression in the Raster Calculator.

Click **Evaluate**. The result should look like the image in Figure 77.

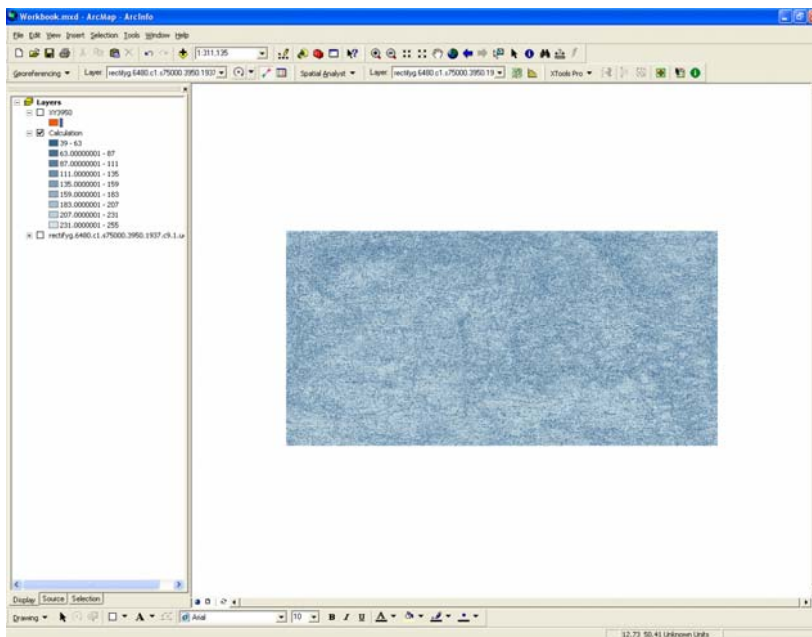


Figure 77. The temporary clipped map image.

To keep the file name of the original, unrectified and clipped image, **Copy** the filename after you have setup the Raster Calculator as shown in Figure 78.

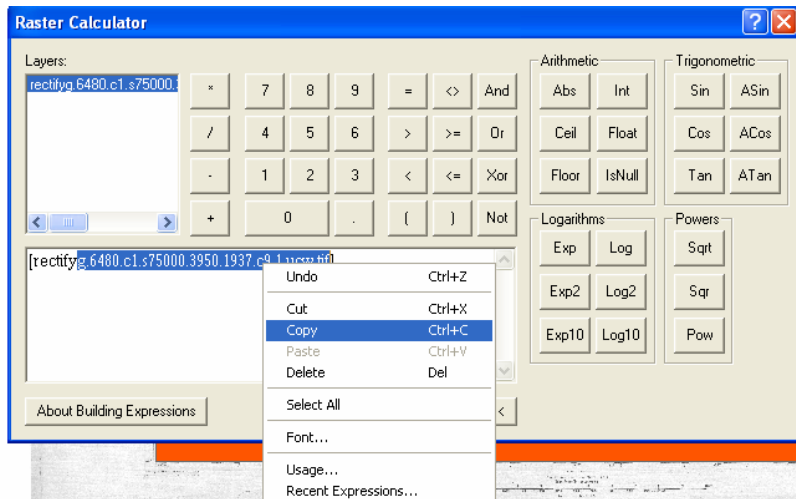


Figure 78. Copying the filename of the image for future use.

The results of the clipping procedure must now be made permanent. Right click on the filename and click **Make Permanent** (Figure 79).

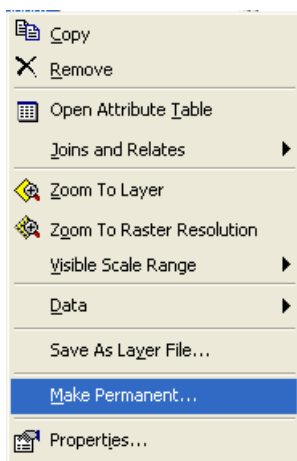


Figure 79. Making the masked calculated layer permanent.

Step 3. Save the clipped image

Save the clipped image in an appropriate directory with an appropriate name in **TIFF** format as shown in Figure 80. Use **Paste** to paste the filename you copied from the Raster Calculator as shown in Figure 78 above.

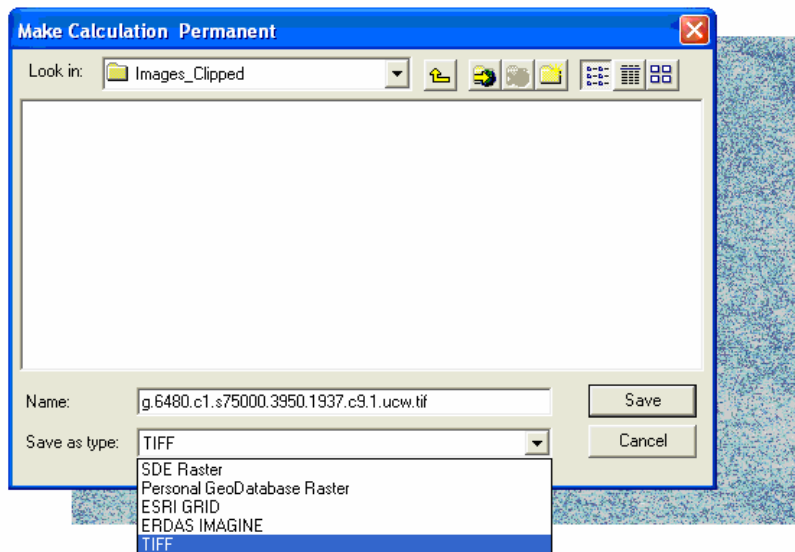


Figure 80. Saving the clipped image.

The final uncompressed image can then be added to the display. The view of the entire image should be similar to Figure 81. A zoomed view of the image should be similar to Figure 82.

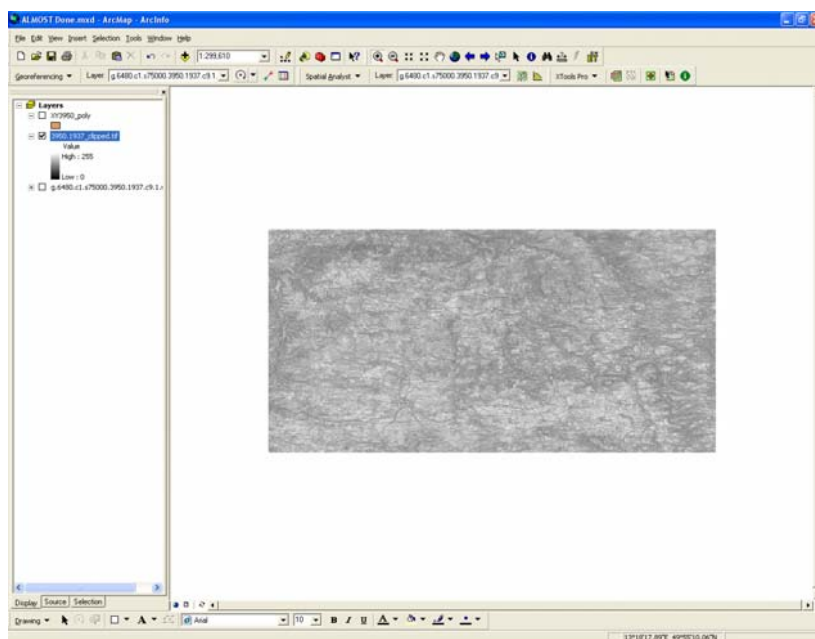


Figure 81. The rectified and clipped map image.

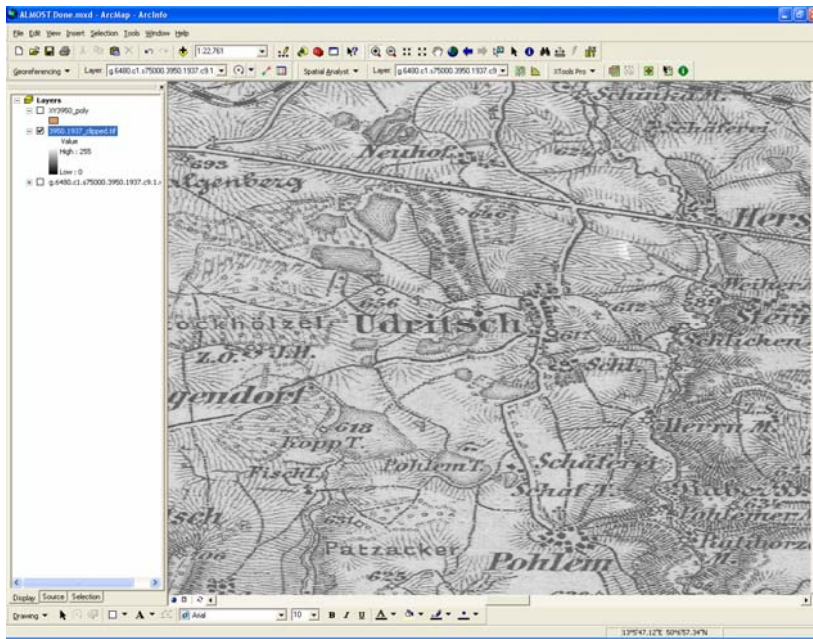


Figure 82. A zoomed view of the rectified and clipped map image.

Stage 6: Compress the Map Image

In this stage, the georeferenced and clipped images are compressed using MrSid format. Image compression makes storage and transfer of images more efficient without a significant loss of quality. ArcCatalog supports compression of images of up to 50 megabytes with no additional software or licenses required.

First, open ArcCatalog and navigate to the folder with the rectified and clipped images. Right click on the file to be compressed and select **Export⇒ Raster to MrSID** (Figure 83).

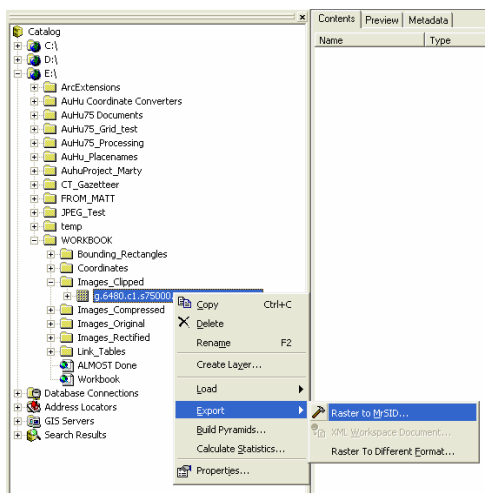


Figure 83. Exporting from Raster to MrSID.

Be sure to select the correct file as the input raster to be compressed and to save the exported file in an appropriate location. You can highlight and copy the input raster filename if you want to keep the input and output names the same in the different input and output folders (Figures 84 and 85).

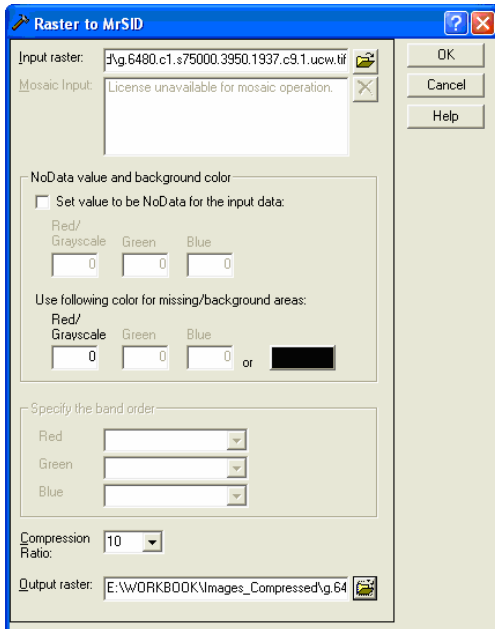


Figure 84. Raster to MrSID dialog box.

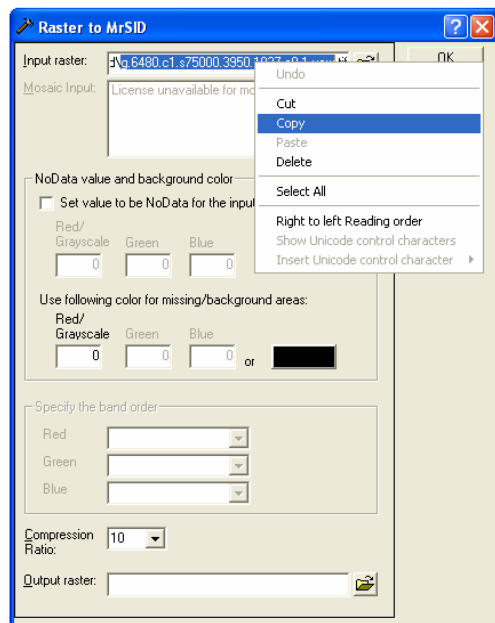


Figure 85. Copying the input raster file name to use as output MrSID file name.

Figure 86 shows a comparison between the clipped raster and MrSID images and with associated files for each. Note the much smaller sizes of the compressed files.

Name	Size	Type
g.6480.c1.s75000.3950.1937.c9.1.ucw.aux	16 KB	AUX File
g.6480.c1.s75000.3950.1937.c9.1.ucw.rrd	1,925 KB	RRD File
g.6480.c1.s75000.3950.1937.c9.1.ucw.tif	22,936 KB	Microsoft Office Do...
g.6480.c1.s75000.3950.1937.c9.1.ucw.tif.xml	9 KB	XML Document

Name	Size	Type	Date Modified
g.6480.c1.s75000.3950.1937.c9.1.ucw.aux	8 KB	AUX File	8/31/2005 9:17 AM
g.6480.c1.s75000.3950.1937.c9.1.ucw.sdw	1 KB	SDW File	8/31/2005 9:17 AM
g.6480.c1.s75000.3950.1937.c9.1.ucw.sid	2,329 KB	SID File	8/31/2005 9:17 AM

Figure 86. Comparison of clipped raster image and ancillary file sizes (top) with compressed image and ancillary file sizes in MrSID format (bottom).

Stage 7: Create Metadata for the Map Image

The next stage in building a distributed collection of historical sheet maps is to attach metadata to each of the map images that have been processed in the previous stages. Metadata describe bibliographic, technical and spatial information about the image file. They are the key component to sharing map images in a distributed networked environment.

Overview of Geospatial Metadata Content Standards

Metadata are the linchpin to serving distributed map images. A critical part of sharing has to do with adopting metadata standards. Preparing metadata according to standards ensures that the images can be shared in a distributed geography network. Two parallel standards for geospatial metadata have been developed: the ISO/DIS 19115, an international standard, and the FGDC Content Standard for Digital Geospatial Metadata, a U. S. standard. A moderately detailed explanation of the two is useful at this point. Development of the FGDC standard predated the ISO standard by almost a decade. To some extent, the ISO grew out of the FGDC. It is also worth noting that the FGDC standard has antecedents in MARC Maps format. The FGDC is now working to make its standard compatible with the ISO standard, and good technology exists to crosswalk information from one standard to the other.

ISO Content Standards for Spatial Metadata. ISO/DIS 19115 provides a schema for describing digital geo-spatial data using a comprehensive set of mandatory and optional metadata elements. These elements support four major uses:

- **Discovery of data.** Metadata elements have been selected which enable users to locate geo-spatial data and also allow producers to advertise the availability of their data.
- **Determining data fitness for use.** Users can determine if a dataset meets their needs by understanding the quality, accuracy, spatial and temporal extents , and the spatial reference system used. Metadata elements have been selected accordingly.
- **Data access.** After locating and determining if a dataset will meet their needs, users may require metadata elements that describe how to access a dataset and transfer it to their site. Metadata elements have been selected to provide the location of a dataset (e.g. through a URL) in addition to its size, format, price and restrictions on use.
- **Use of data.** Metadata elements have been selected so that users know how to process, apply, merge and overlay a particular dataset with others, as well as understanding the properties and limitations of the data.

The ISO standard uses the hierarchical structure utilized by most of the national standards. In the ISO standard, metadata is presented in the UML (Unified Modeling) packages listed below. Each package contains one or more entities (UML class attributes), and within each entity there are mandatory and optional metadata elements.

Metadata entity set information

Identification information (includes data and service identification);

Browse graphic information

Keyword information

Representative fraction information

Resolutions information

Usage information

Constraint information (includes legal and security);

Data quality information

Lineage information

Process step information;

Source information

Data quality element information

Result information

Scope information
 Maintenance information;
 Scope description information
 Spatial representation information (includes grid and vector representation);
 Dimension information
 Geometric information
 Reference system information (includes temporal, coordinate and geographic identifiers);
 Ellipsoidal parameter information
 Identifier information
 Oblique line azimuth information
 Oblique line point information
 Projections parameter information
 Content information (includes Feature catalogue and Coverage descriptions);
 Range dimension information (includes Band information)
 Portrayal Catalogue information;
 Distribution information;
 Digital transfer options information
 Distributor information
 Format information
 Medium information
 Standard order process information
 Metadata extension information;
 Extended element information
 Application Schema information;
 Feature type list information
 Spatial attribute supplement information
 Extent information;
 Geographic extent information
 Temporal extent information
 Vertical extent information
 Citation and responsible party information;
 Address information
 Contact information
 Date information
 OnLine resource information
 Series information
 Telephone information
 Metadata Application information

These elements and structure are different only in format from the original FGDC standard. Even after ISO 19115 becomes the accepted standard, the FGDC standard will serve as an important metadata standard for the user. In existence for a decade, the FGDC Content Standard for Digital Geospatial Metadata has

provided the building blocks for a dynamic and effective information sharing network.

FGDC Content Standard. The elements used in FGDC metadata are not radically different from those used in ISO 19115. Both standards are strictly hierarchical and both cover the basics (and maybe a bit more) of describing geospatial data. The FGDC standard has seven main sections—Identification, Data Quality, Spatial Data Organization, Spatial Reference, Entity and Attribute, Distribution and Metadata Reference Information—and three supplement sections—Citation, Time Period, and Contact Information. FGDC is a content standard. This means that it specifies the required content, not the format in which the content must be presented.

When the Content Standards were devised by the FGDC Working Group, they had the good fortune of having an excellent map cataloger working with them. Elizabeth Mangan, retired from the Geography and Map Division of the Library of Congress and one of the authors of the MARC Maps Format, provided strong guidance in the underlying concepts of the Standards. The documentation clearly states which elements are required, mandatory and optional. These statements make what could be a complex and difficult format reasonably articulate.

AuHu75 FGDC Metadata Example. The example of the AuHu75 metadata shown here is illustrative and not exhaustive of the FGDC standard. It is included to show the scope of the standard and its hierarchical nature.

Identification Information

Identification Information is the first section. Large numeric data files typically lack descriptive information, albeit when headers are included and then the information is highly structured and idiosyncratic. The section provides basic information on the data set title, the area covered, keywords, the purpose and an abstract, and access and use restrictions. This key section includes the Citation and Time Period supplemental sections. While these sections are repeated this is the first and primary use.

Citation Information

Citation Information is fairly straightforward for the librarian. A particular consideration for spatial information is the *Geospatial_Data_Presentation_Form* (element 8.6 in the CSDGM Manual). This ‘mandatory if applicable’ element provides the opportunity to cite, whether the data came from an atlas, audio, diagram, document, globe, map, tabular digital data, etc. The documentation states, “the listed domain is partially

from pp 88-91 in Anglo-American Committee on Cataloging Cartographic Materials, 1982, Cartographic materials: A manual of interpretation for AACR2...”

Citation:

Citation_Information:

Originator: Austro-Hungarian Monarchy. Militärgeographisches Institut.

Publication_Date: 19120101

Title: Schluckenau--Spezialkarte der österreichisch-ungarischen Monarchie im Maße 1:75,000 der Natur.

Geospatial_Data_Presentation_Form: map

Publication_Information:

Publication_Place: Vienna

Publisher: Austro-Hungarian Monarchy. Militärgeographisches Institut.

Other_Citation_Details: 3553

The Identification Information section's purpose is to provide a narrative describing the data set's "fitness for use". Spatial data are complex in many ways. The data represent a scale or granularity of information. Spatial data are often reused for a variety of purposes. For the data producer, as much as the data user, there is an anxiety that the data will be used irresponsibly. For example that TIGER street centerline data (represented at 1:100,000 scale or, 1 cm. equals 100,000 cm. or, 1 inch equals 100,000 inches) can be used to site a storm drain (typically requiring an engineering scale; 1 inch equals 1,000 feet or 1:12,000). The Abstract and Purpose provide a place to put down in plain language why the data set was created and what it is meant to do. The particular spatial component of the Identification Information section is the Spatial_Domain. This bounded box describes a "footprint" of the data, and in Clearinghouse can enable spatial location of information. If I am looking for information about Hartford, Connecticut whose center point is West 72° 20' 32"/N41° 15' 24" code can determine that the point is within the bounding box for Connecticut.

Description:

Abstract: The Spezialkarte der Österreichisch-ungarnischen Monarchie was published in Vienna over a period of years, 1877-1914. The set is 776 sheets with all sheets from all editions numbering over 3,665. Each map represents a 15 degree minute x 30 degree minute (about 1,000 sq. kilometers) 'tile' and can have several editions and print dates. Other map sets published before, during and after WWII used the Spezialkarte der Österreichisch-ungarnischen Monarchie as a base map, making the AuHu75 a key map for studying a large and significant area of Central Europe in the 19th and 20th Centuries. As a set of maps, it enjoys a user community made up of historians and genealogists, archaeologists, architects, not to mention lawyers researching WWII reparations claims, representing an enormous, sophisticated Internet community.

Purpose: These cartographic materials are made available for scholarly reference

Supplemental_Information: Topo map (hachures), Printed map - monochrome, Standard quadrangle, 15 minutes, 30 minutes, Revised 1912, Situation/Survey 1907, GZN, 641-b A-1:75,000

Time_Period_of_Content:

Time_Period_Information:

Range_of_Dates/Times:

Beginning_Date: 19070101

Ending_Date: 19120101

Currentness_Reference: publication date

Status:

Progress: Complete

Maintenance_and_Update_Frequency: Unknown

Spatial_Domain:

Bounding_Coordinates:

West_Bounding_Coordinate: 14.33333

East_Bounding_Coordinate: 14.83333

North_Bounding_Coordinate: 51.25

South_Bounding_Coordinate: 51

Keywords:

Theme:

Theme_Keyword_Thesaurus: LCSH

Theme_Keyword: Maps topographic

Place:

Place_Keyword_Thesaurus: LCSH

Place_Keyword: Saxony (Germany)

Place_Keyword: Böhmen (Czech Republic)

Place_Keyword: Prussia (Germany)

Access_Constraints: None.

Use_Constraints: None.

Data Quality Information

The Data Quality Information section documents horizontal and vertical accuracy assessment, data set completeness and lineage. Lineage is perhaps the most important element of the metadata record, and perhaps the least applied. Data are, by their nature, processed and re-processed. Each time a process step is performed, it should be noted in the lineage. The Process_Step element can, and should, be repeated when necessary.

Spatial Data Organization Information

This section relates how the data are organized; with raster, vector, or an indirect (e.g. address) link to location. Spatial data are organized in a variety of ways, some more appropriate for certain types of analysis than others. A raster data set provides continuous data, but can be difficult to interpret. Vector data can seem easier to interpret, though it may reflect aggregated data that by its nature is more imprecise. The user often must choose one over the other, and determine the spatial authenticity of the choice. The information in this section is essentially software supplied and is primarily mathematical data.

```
= <spdoinfo>
<direct>Point</direct>
```

```

=<rastinfo>
  <rasttype Sync="TRUE">Pixel</rasttype>
  <rowcount Sync="TRUE">3425</rowcount>
  <colcount Sync="TRUE">6849</colcount>
  <rastxsz Sync="TRUE">0.000073</rastxsz>
  <rastysz Sync="TRUE">0.000073</rastysz>
  <rastbpp Sync="TRUE">8</rastbpp>
  <vrtcount Sync="TRUE">1</vrtcount>
  <rastorig Sync="TRUE">Upper Left</rastorig>
  <rastcmap Sync="TRUE">FALSE</rastcmap>
  <rastcomp Sync="TRUE">Wavelet</rastcomp>
  <rastband Sync="TRUE">1</rastband>
  <rastdtyp Sync="TRUE">pixel codes</rastdtyp>
  <rastplyr Sync="TRUE">TRUE</rastplyr>
  <rastifor Sync="TRUE">MrSID</rastifor>
</rastinfo>
</spdominfo>

```

Spatial Reference Information

The Spatial Reference Information section contains latitude/longitude or other coordinate system information and/or the map projection. In a spatial data set, a very large numeric data set, the numbers require context. The Spatial Reference Information is critical to determining what the number means. Without this critical set of information the GIS displays the numbers where they lie. The map layers may not line up, unless or until the coordinate systems and projections are resolved. This information is often supplied by software systems as well.

```

=<spdom>
=<bounding>
  <westbc>14.33333</westbc>
  <eastbc>14.83333</eastbc>
  <northbc>51.25</northbc>
  <southbc>51</southbc>
</bounding>
=<lboundng>
  <leftbc Sync="TRUE">14.337222</leftbc>
  <rightbc Sync="TRUE">14.837199</rightbc>
  <bottombc Sync="TRUE">51.000000</bottombc>
  <topbc Sync="TRUE">51.250025</topbc>
</lboundng>
</spdom>

```

Entity and Attribute Information

The Entity and Attribute Information section is perhaps the least developed of the sections. FGDC metadata was devised to describe spatial data, specifically cartographic data. As it now stands, there are two levels of description in the Entity and Attribute Information section, the Detailed and Overview Descriptions. The Detailed Description deals with attributes or variable while the Overview provides the opportunity to give a

narrative description. This section is not required and is more applicable to vector data than it is to raster data like images of maps.

Distribution Information

The Distribution Information section provides the distributor, file format of data, off-line media types, on-line link to data, and fees, if any.

Distribution_Information:

Distributor:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Map Librarian

Contact_Organization: Map and Geographic Information Center

Contact_Address:

Address_Type: Mailing and Physical Address

Address:

Homer Babbidge Library

MAGIC U-2005

369 Fairfield Rd.

City: Storrs

State_or_Province: CT

Postal_Code: 06269-2005

Country: USA

Contact_Voice_Telephone: (860) 486-4589

Contact_Facsimile_Telephone: (860) 486-2184

Contact_Electronic_Mail_Address: map.librarian@uconn.edu

Distribution_Liability: None.

Metadata Reference Information

Finally the Metadata Reference Information section relates who created the metadata and when.

Metadata_Reference_Information:

Metadata_Date: 20051004

Metadata_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Map Librarian

Contact_Organization: Map and Geographic Information Center

Contact_Address:

Address_Type: Mailing and Physical Address

Address:

Homer Babbidge Library

MAGIC U-2005

369 Fairfield Rd.

City: Storrs

State_or_Province: CT

Postal_Code: 06269-2005

Country: USA

Contact_Voice_Telephone: (860) 486-4589

Contact_Facsimile_Telephone: (860) 486-2184

Contact_Electronic_Mail_Address: map.librarian@uconn.edu

Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998

The MetaLite for Map Librarians (ML4ML) Application

Metadata is an integral part of this project. A custom metadata application, **MetaLite for Map Librarians (ML4ML)**, was developed for the project (Figure 87). The ML4ML application focuses primarily on **required** fields in the FGDC metadata standard.

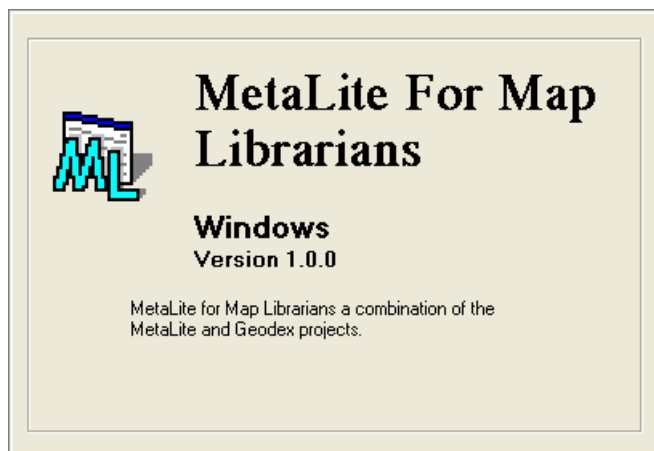


Figure 87. MetaLite for Map Librarians.

ML4ML builds on the work of the U. S. Geological Survey and the American Geographical Society. Peter N. Schweitzer of the USGS developed **MetaLite: PC Metadata Entry System** (<http://edcnts11.cr.usgs.gov/metalite>), a metadata creation tool in the public domain. MetaLite was written in VB 8.0. This program was adapted to create the custom **MetaLite for Map Librarians (ML4ML)** used in this project. MetaLit for Map Librarians supports importing and crosswalking of metadata in GEODEX format.

GEODEX (GEOgraphic InDEX System for Map Series) was developed by Christopher Baruth of the American Geographical Society Library in the mid 1980's to inventory and access the AGS Library's map sheets in series. It enables rapid input of data on maps sheets into the system, and fast geographic (latitude/longitude) searching, by point or area. As of 2005, there were a total of 347,729 GEODEX records for map sheets from 169 multi-sheet map sets.

With the exception of the sheet name and number and a brief optional note, all other data fields are coded (Figure 88). These fields fall into one of two types: fixed fields and open fields. In addition to holdings, the fixed fields indicate that: the map is a part of a series; it is a topographical map using hachures to show elevation; it is a monochrome printed map; the format is a standard quadrangle; the quadrangle's dimensions are 15 x 30 degree minutes; it is drawn using the Polyhedric projection; it uses Ferro, not Greenwich, as the prime meridian; and it is at a scale of 1:75,000. A GEODEX record can also contain up to five open fields that record contour intervals, editions and various date types. The level of map sheet control provided by CODES resulted in a significant savings in labor in creating metadata records for the AuHu75 Project.

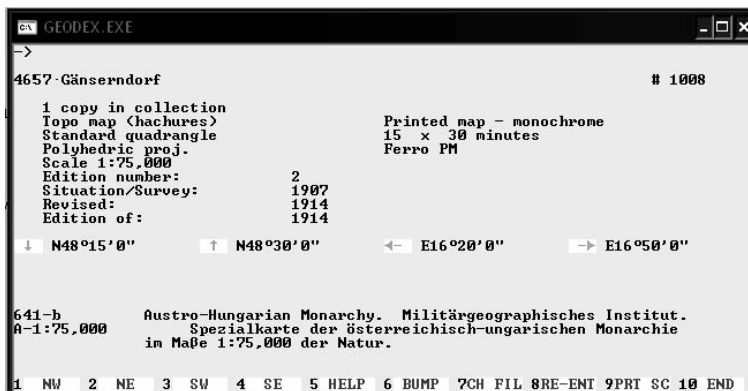


Figure 88. An example of a GEODEX record.

GEODEX was written in QBasic, a 1980's programming language which is not readily accessible. The ML4ML application was designed to convert a GEODEX record to the Federal Geographic Data Commission's Content Standard for Digital Geospatial Metadata and support editing of the record to describe the 'map in hand.' Crosswalking the GEODEX database to the FGDC Content Standard makes it easier for libraries to add their sheet holdings records to an international union collection. The descriptive information from GEODEX and the detailed spatial referencing information from the ArcGIS metadata records which can be viewed and edited in ArcCatalog can be integrated.

Working with ML4ML

Step 1. Download GEODEX records

Download and unzip GEODEX records. Enter the following URL to download the GEODEX files for the maps of interest:

ftp://ftp.csd.uwm.edu/pub/geodex/. GEODEX uses a suite of files: ACL, CAT, FIL, FIN, INA and INB. The American Geographical Society has compiled sheet level cataloging for 163 sets of maps. Most are not in the public domain, but F0005 Central & Eastern Europe 15 x 30 min. quads has records for AuHu75 (and maps at 1:100,000) (Appendix A).

In the future ML4ML will enable Import from a network source. Now it must have the suite of files downloaded as zip files and loaded locally.

Step 2. Create Sheet Metadata Records in ML4ML

Open the ML4ML program (Figure 89) to import the downloaded GEODEX records.

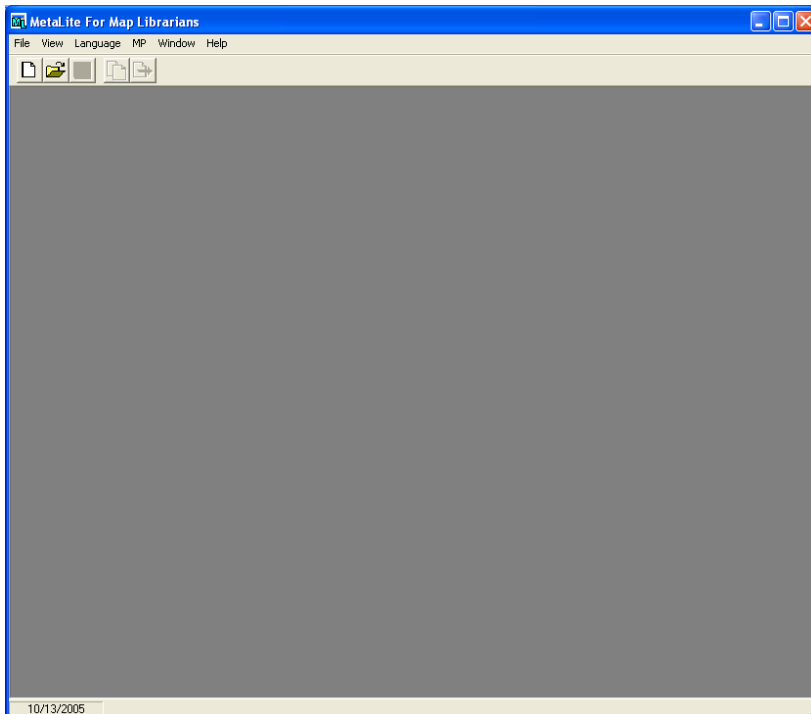


Figure 89. The MetaLite Program window.

Click on **File⇒Import** to open the dialog shown in Figure 90.

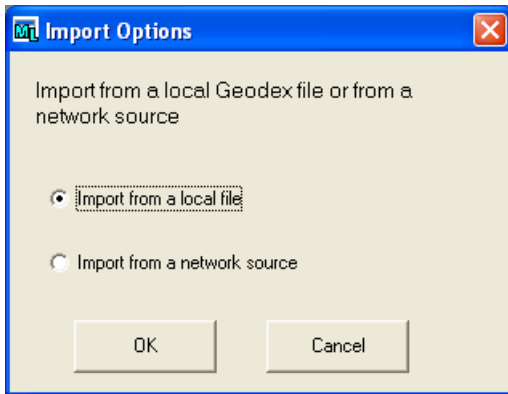


Figure 90. The Import Dialog Box.

Click on the appropriate radio button. In this workbook example, click the radio button to **Import from a local file** and then click **OK**. This will open the dialog box as shown in Figure 91.

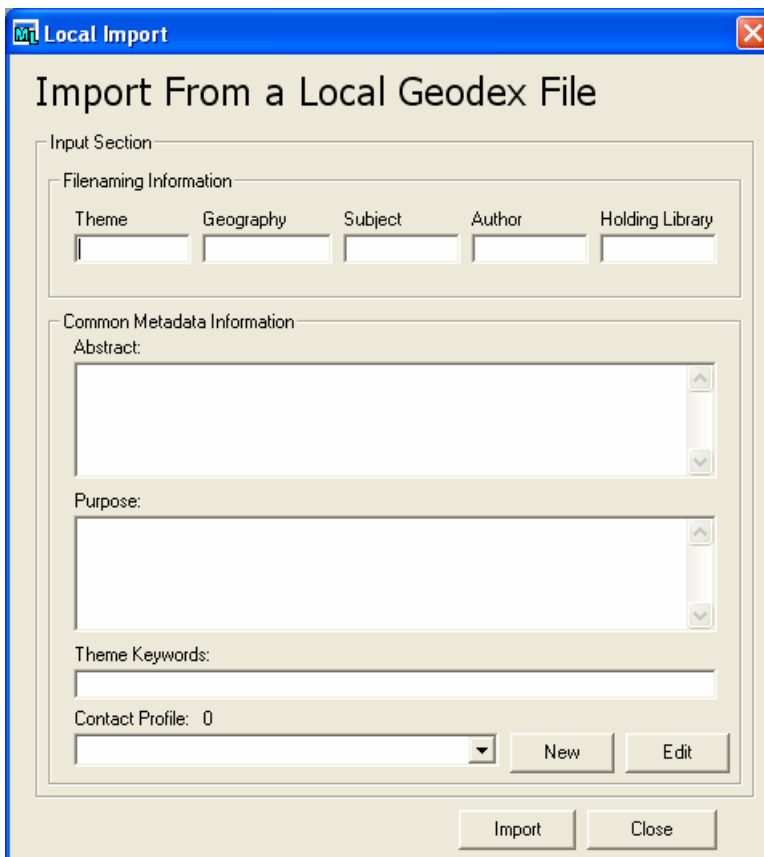


Figure 91. The Local Import dialog box.

The **Abstract**, **Purpose**, **Theme Keywords** and **Contact Profile** can then be entered for the metadata page for the first map. A completed initial page would look like this (Figure 92).

Figure 92. The completed input section of the Local Import form for importing data from a Geodex file.

The file name elements are determined and entered in this section. The AuHu75 Project uses a file naming convention similar to the Library of Congress (LC) Classification Scheme:

G_6480_C1_s75_4469_1937_A9_ucw_1.tif
1_2_3_4_5_6_7_8_9

- 1 = Theme
- 2 = Geography (from G Schedule)
- 3 = Subject Cutter (from G Schedule)
- 4 = Scale (derived from metadata)
- 5 = unique identifier (sheet number, title...
in this instance derived from metadata)
- 6 = date (derived from metadata)
- 7 = author cutter (determined from cutter list)
- 8 = holding library (from OCLC Institution List)
- 9 = copy

The **Abstract** describes the set of maps in general terms:

This set of maps was published in Vienna over a period of years, 1877-1914. The set is 776 sheets with all sheets from all editions numbering over 3,665. Each map represents a 15 degree minute x 30 degree minute (about 1,000 sq. kilometers) 'tile' and can have several editions and print dates. Other map sets published before, during and after World War II used the Spezialkarte der Österreichisch-ungarnischen Monarchie as a base map, making the Spezialkarte a key map for studying a large and significant area of Central Europe in the 19th and 20th Centuries. As a set of maps, it enjoys a user community made up of historians and genealogists, archaeologists, architects, not to mention lawyers researching World War II reparations claims, representing an enormous, sophisticated Internet community.

The **Purpose** states the reason the data set was created:

This topographic map set documents the cartographic history of the Austro-Hungarian Empire.

The Abstract, Purpose, Theme Keywords, and Contact Profile will be the same for every map sheet in the set. After they have been entered as input on the initial metadata page, they can be written to the metadata pages created for each additional map sheet in the set. Once the import form has been completed, click Close to close the import form.

To open an imported record, click the **File⇒Open** menu (Figure 93).

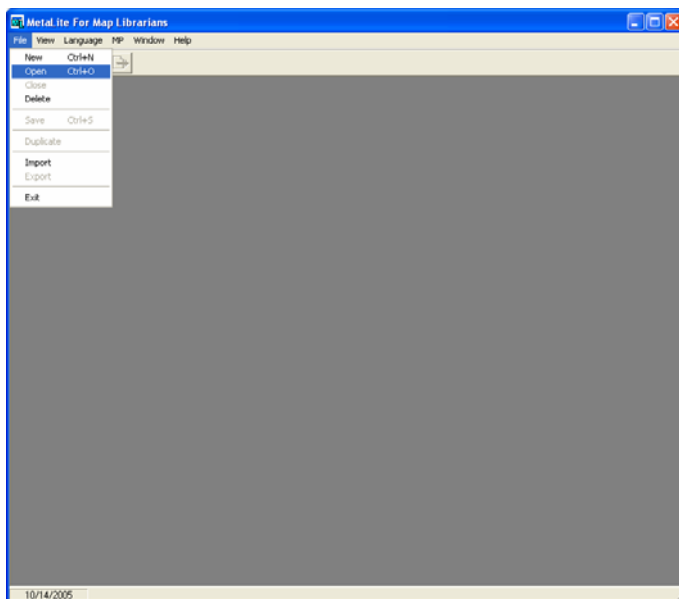


Figure 93. Opening the imported Geodex record in MetaLite for Map Librarians.

This will open a metadata form containing information for the previously imported metadata record for the Austro-Hungarian map set being processed (Figure 94). Notice that the abstract has been carried over from the import step shown in Figure 92.

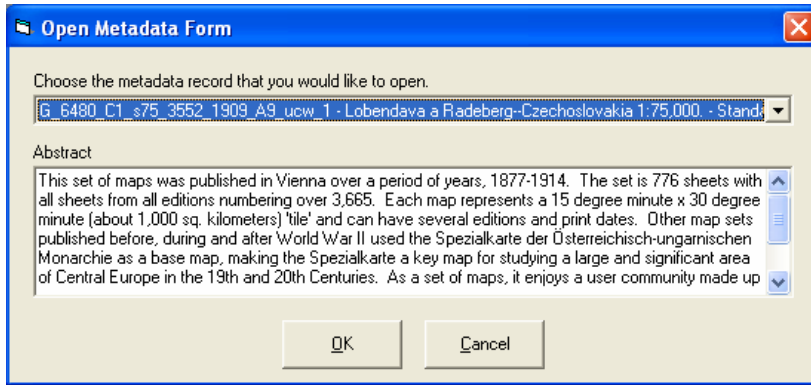


Figure 94. The open metadata form for the imported Geodex record in MetaLite for Map Librarians.

Click on the pull-down arrow to browse through the metadata records that have been imported for maps that are in the map sheet database (Figure 95). Then highlight the metadata record that you would like to open (Figure 96).

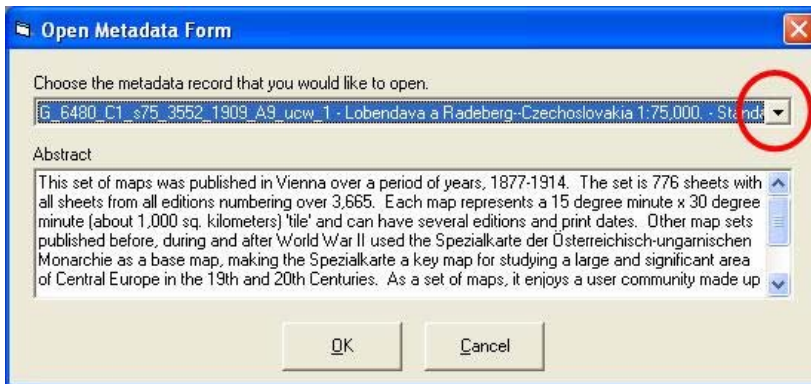


Figure 95. Pull-down arrow to select metadata records.

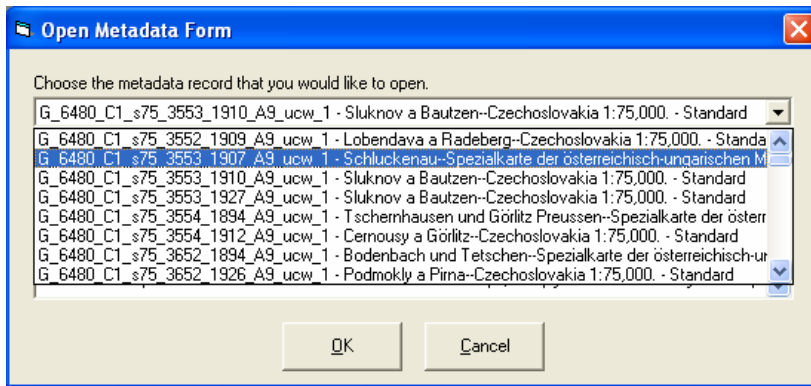


Figure 96. Selecting a metadata record from the pull-down list.

Once you have selected a metadata record, the Standard Metadata Entry Form will open as shown in Figure 97.

Figure 97. The metadata entry form.

Click on the tabs to explore the metadata content in each section of the form. Most of the information should already be entered into the form based on the information that was imported from the GEODEX File. There are still several pieces of information that need to be entered.

Click on the **Originator** tab (Figure 98). Check the **Title** to make sure it is correct. Check the **Sheet Identification** number to make sure it corresponds. Finally, check the **Publication Date**. In this case, the publication date has to be changed from 1907 to 1912 based on the date on the map for which this

metadata record is being updated. Notice that the **Filename** generated by MetaLite shows 1907 as the date. **This needs to be changed and will be addressed later.**

The screenshot shows the 'Originator' tab of the 'Standard Metadata Entry Form'. The form is titled 'G_6480_C1_s75_3553_1907_A9_ucw_1 : Standard Metadata Entry Form'. The 'Originator' tab is selected, showing fields for 'Originator', 'Publication Date', 'Title', 'Edition', 'Scale', 'Geospatial Presentation Form', 'Publication Information', and 'Online Linkage'. The 'Originator' field contains 'Austro-Hungarian Monarchy. Militärgeographisches Institut.'. The 'Publication Date' field contains '19120101'. The 'Title' field contains 'Schluckenau-Spezialkarte der österreichisch-ungarischen Monarchie im Maße 1:75,000 der Natur.'. The 'Edition' field is empty. The 'Scale' field contains '1:75000'. The 'Geospatial Presentation Form' dropdown is set to 'map'. The 'Publication Information' section includes 'Publication Place' (Unknown), 'Publisher' (Austro-Hungarian Monarchy. Militärgeographisches Institut.), and 'Sheet Identification' (3553). The 'Online Linkage' field is empty.

Figure 98. The Originator tab on the metadata entry form.

Now click on the **Description** tab (Figure 99). The **Abstract** and **Purpose** have been carried over from the import stage. Check the date in **Supplemental Information** and change it, if needed. In this case, change the **Revised** date to 1912.

The screenshot shows the 'Description' tab of the 'Standard Metadata Entry Form'. The form is titled 'G_6480_C1_s75_3553_1907_A9_ucw_1 : Standard Metadata Entry Form'. The 'Description' tab is selected, showing fields for 'Abstract', 'Purpose', and 'Supplemental Information'. The 'Abstract' field contains a detailed description of the map set. The 'Purpose' field contains 'This topographic map set documents the cartographic history of the Austro-Hungarian Empire.'. The 'Supplemental Information' field contains 'Topo map (hachures). Printed map - monochrome, Standard quadrangle, 15 minutes, 30 minutes, Revised 1912, Situation/Survey 1907, GZN, 641-b A:1:75,000'. The 'Supplemental Information' field is highlighted with a red box.

Figure 99. The Description tab on the metadata entry form.

Now click on the **Time Period & Status Information** tab (Figure 100). Under **Time Period of Content**, change the **Ending Date** to match the individual map for which the metadata record is being created. In this case, change the date to 19120101.

The screenshot shows the 'Standard Metadata Entry Form' with the 'Time Period & Status Information' tab selected. The 'Time Period of Content' section is highlighted with a red box. It contains the following fields:

- Time Period Information**
 - Beginning Date:** 19070101 (with a 'Calendar' button and format '(YYYYMMDD or bcYYYYMMDD)')
 - Ending Date:** 19120101 (with a 'Calendar' button)
- Currentness Reference:** publication date (dropdown menu)
- Status:**
 - Progress:** Complete (dropdown menu)
 - Maintenance and Update Frequency:** None planned (dropdown menu)

Figure 100. The Time Period & Status Information tab.

Now click on the **Spatial Domain** tab (Figure 101). Nothing needs to be changed in this tab.

The screenshot shows the 'Standard Metadata Entry Form' with the 'Spatial Domain' tab selected. It contains the following fields:

- Bounding Coordinates:**
 - West Bounding Coordinate:** 14.33333
 - East Bounding Coordinate:** 14.83333
 - North Bounding Coordinate:** 51.25
 - South Bounding Coordinate:** 51
- Direct Spatial Reference Method:** Point (dropdown menu)
- Prime Meridian:** Ferro Prime Meridian (dropdown menu)
- Map Projection:** Polyhedral (dropdown menu)
- DMS -> DD Converter:** (button)
- Spatial Reference Information:** (button)

Figure 101. The Spatial Domain tab.

Next, click on the **Keywords** tab (Figure 102). In the **Place** section, enter LCSH (Library of Congress Subject Heading) to identify the Place Keyword Thesaurus. The **Place Keyword** provides an opportunity to enter place names, like the MARC 651 field. Use the Library of Congress site (Figure 103), <http://authorities.loc.gov/>, and click on **Search Authorities** to search for the correct form of the place name.

The screenshot shows a web browser window titled "G_6480_C1_s75_3553_1907_A9_ucw_1 : Standard Metadata Entry Form". The "Keywords" tab is selected. The form has several sections: "Theme", "Place", and "Temporal". The "Place" section is highlighted with a red rectangle. It contains the following fields: "Place Keyword Thesaurus" (with "LCSH" entered), "Place Keyword" (with "Saxony (Germany),Bohemia (Czech Republic),Preussen (" entered), and a "Keywords" button. The "Theme" section has "Theme Keyword Thesaurus" (with "LCSH" entered) and "Map topographic". The "Temporal" section has "Temporal Keyword Thesaurus" and "Temporal Keyword".

Figure 102. The Keywords tab on the metadata form.

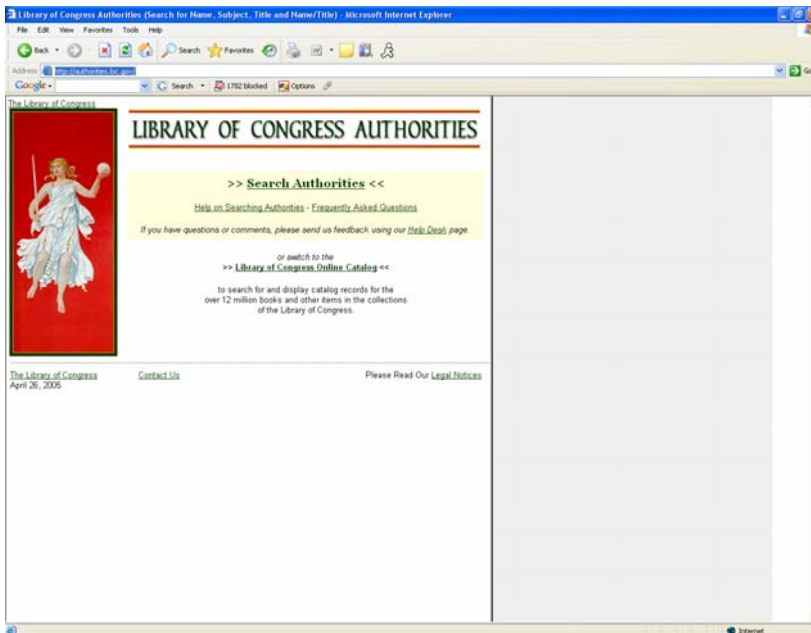


Figure 103. The Library of Congress Authorities website.

Move on to the **Constraints & Graphics** tab (Figure 104). “None” is the default for Access and Use Constraints. If there are constraints on access or use, enter them here. Otherwise, everything here should be left as is.

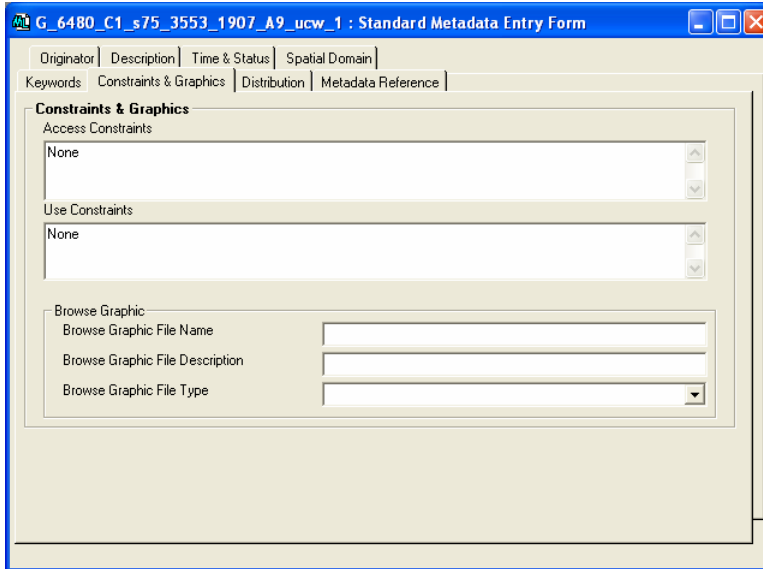
The screenshot shows a software window titled "G_6480_C1_s75_3553_1907_A9_ucw_1 : Standard Metadata Entry Form". It has several tabs: "Originator", "Description", "Time & Status", "Spatial Domain", "Keywords", "Constraints & Graphics", "Distribution", and "Metadata Reference". The "Constraints & Graphics" tab is active. It contains two sections: "Access Constraints" and "Use Constraints", both with a "None" dropdown menu. Below these is a "Browse Graphic" section with three input fields: "Browse Graphic File Name", "Browse Graphic File Description", and "Browse Graphic File Type".

Figure 104. The Constraints & Graphics tab on the metadata form.

Now click on the **Distribution** tab (Figure 105). Make sure the Current Control ID identifies the institution at which you are working. This information should not have to be re-entered. It was entered on the initial page. If multiple Current Control IDs are needed, you may add them. The #1 Control ID will be added as the default, unless another ID is selected.

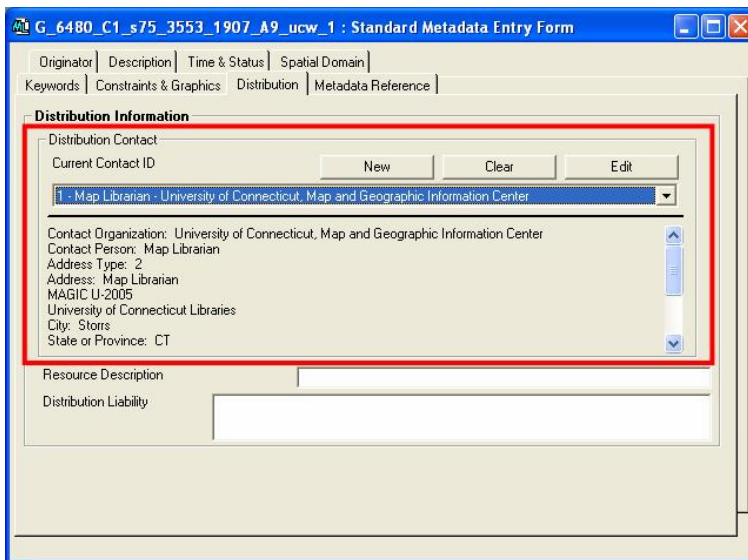
The screenshot shows the same software window, but now the "Distribution" tab is active. It is titled "Distribution Information". It features a "Distribution Contact" section with a "Current Contact ID" dropdown menu showing "1 : Map Librarian - University of Connecticut, Map and Geographic Information Center". Above this dropdown are "New", "Clear", and "Edit" buttons. Below the dropdown, the contact details are listed: "Contact Organization: University of Connecticut, Map and Geographic Information Center", "Contact Person: Map Librarian", "Address Type: 2", "Address: Map Librarian", "MAGIC U-2005", "University of Connecticut Libraries", "City: Storrs", and "State or Province: CT". Below this section are "Resource Description" and "Distribution Liability" text input fields. A red rectangle highlights the "Distribution Contact" section.

Figure 105. The Distribution Information tab.

Finally, click on the **Metadata Reference** tab (Figure 106). The same Current Control ID list is used. Again, multiple Current Control IDs may be added, if needed, but the #1 Control ID will be added as the default, unless another ID is selected.

Figure 106. The Metadata Reference tab.

Step 3. Export the metadata record

Now it is time to export the metadata record. Click on the **MP** menu (Figure 107). MP is a compiler to parse formal metadata. It checks the syntax against the FGDC Content Standard for Digital Geospatial Metadata and generates output in HTML suitable for viewing with a web browser or text editor and in XML suitable for using in ArcCatalog to support the underpinnings of a geography network. MP runs on Linux and UNIX systems and on PC's running all versions of Microsoft Windows (95 and up including XP). MP generates a text report identifying errors in the metadata, primarily in the structure but also in the values of some of the elements whose values are restricted by the standard). More information about MP is available at:

<http://geology.usgs.gov/tools/metadata/tools/doc/mp.html>

From the menu, select the appropriate forms to export. In this case, XML and SID are selected. You will always export the XML form. The file type to be associated with the metadata record will depend on the format of the images for which you are preparing

the metadata record. Based on the image processing section of this workbook, the appropriate format is SID format.

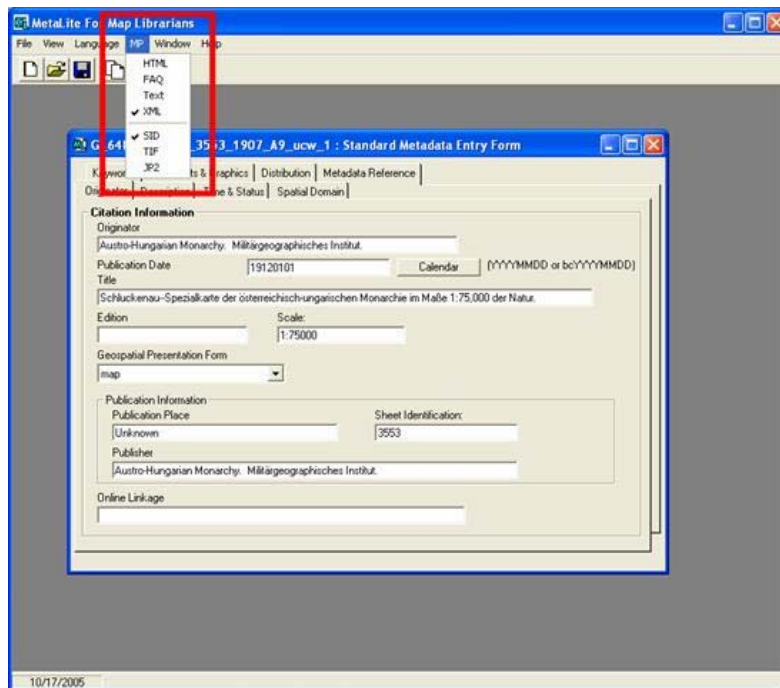


Figure 107. Exporting the updated metadata record using the MP menu.

Now click on the **Export** button in the interface (Figure 108).

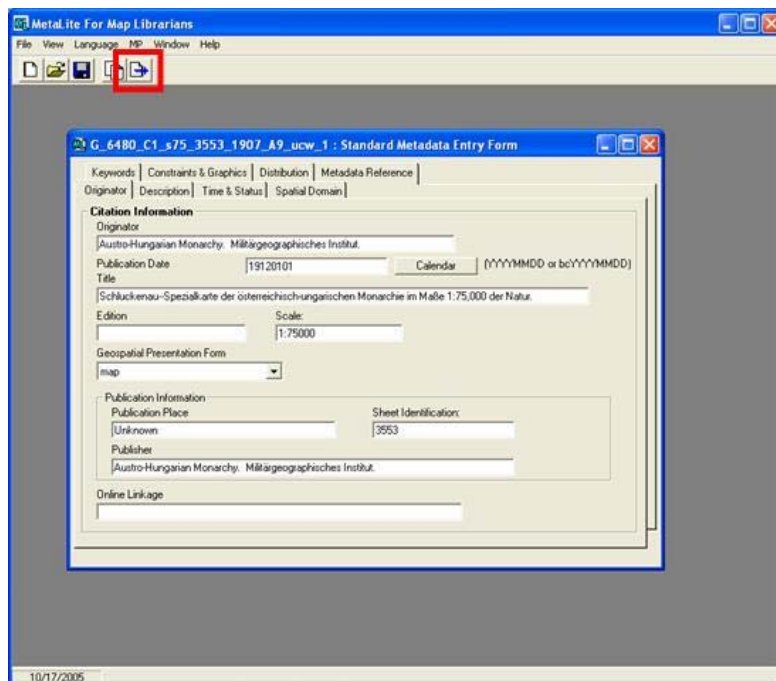


Figure 108. The Export button.

You will receive the following message prompt when you click the export button (Figure 109). Click **Yes**.

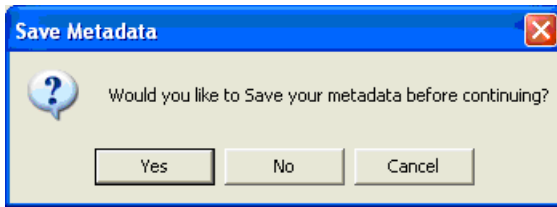


Figure 109. The Save metadata prompt.

After clicking yes, the following box will open (Figure 110). You will need to navigate to the folder where you have saved the image that corresponds to this metadata record and then click **Save**.

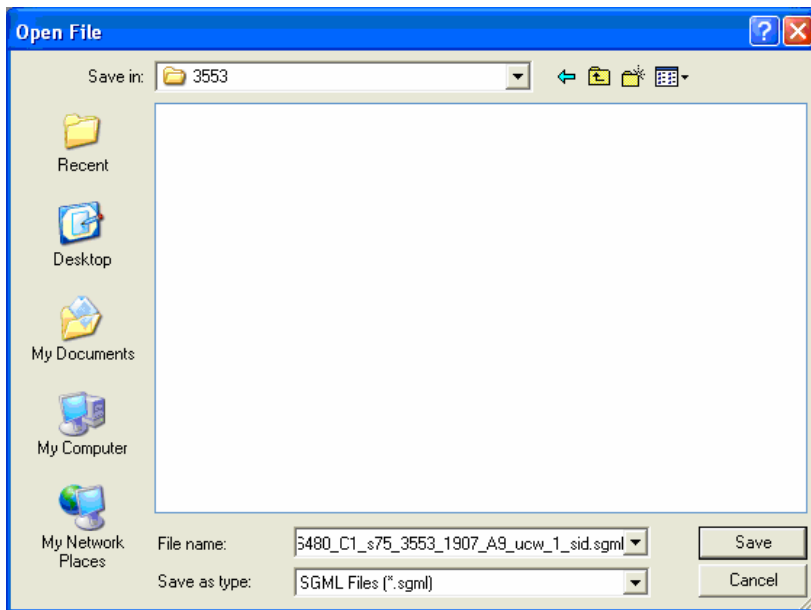


Figure 110. Saving the metadata record in the folder where the associated map image is stored.

If you have left a field blank, MetaLite will not let you export the record and you will receive a message like the one in Figure 111. This is a critical error checking step to confirm that the XML record is a well formed record. If there are errors you will need to go back and fill in the appropriate information. If there are no errors, the Export Results will look like the report in Figure 112.

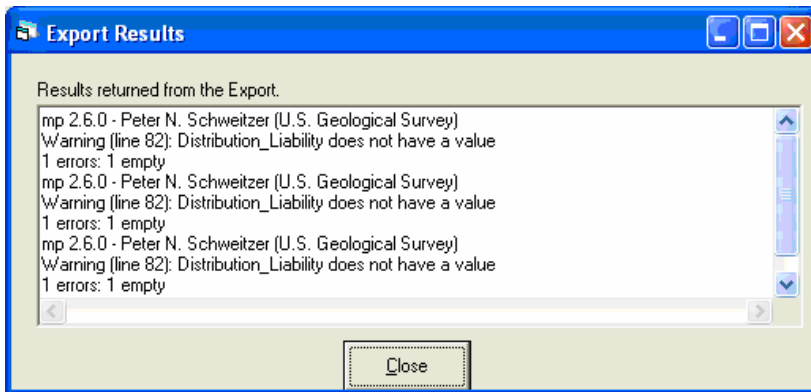


Figure 111. Metadata Export Results error message.

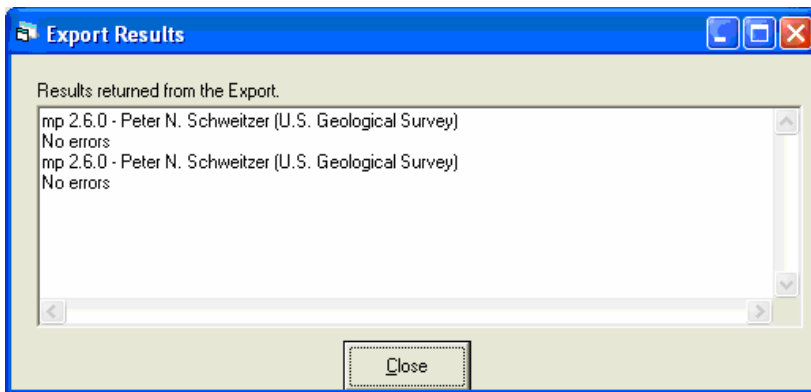


Figure 112. Successful metadata export.

Now navigate to the directory where the images and metadata record have been saved (Figure 113). The files listed at the top were generated by Metalite. The files listed at the bottom are the SID map image, world, and auxiliary files for displaying the scanned, rectified, and clipped map image.

Name	Size	Type	Date Modified
G_6480_C1_s75_3553_1907_A9_ucw_1_sid.err	1 KB	ERR File	10/17/2005 10:42 AM
G_6480_C1_s75_3553_1907_A9_ucw_1_sid.sgml	4 KB	SGML File	10/17/2005 10:42 AM
G_6480_C1_s75_3553_1907_A9_ucw_1_sid.xml	4 KB	XML Document	10/17/2005 10:42 AM
G_6480_C1_s75_3553_1912_A9_ucw_1.sid	2,309 KB	SID File	4/26/2005 10:09 AM
G_6480_C1_s75_3553_1912_A9_ucw_1.aux	8 KB	AUX File	4/26/2005 10:14 AM
G_6480_C1_s75_3553_1912_A9_ucw_1.sdw	1 KB	SDW File	4/26/2005 10:09 AM

Figure 113. Metadata and image files in the folder.

You can delete the .ERR and the .SGML files. They are work files and not ultimately necessary. This will leave only the .XML file (Figure 114).

Name	Size	Type	Date Modified
G_6480_C1_s75_3553_1907_A9_ucw_1_sid.xml	4 KB	XML Document	10/17/2005 10:42 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_sid	2,309 KB	SID File	4/26/2005 10:09 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_aux	8 KB	AUX File	4/26/2005 10:14 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_sdw	1 KB	SDW File	4/26/2005 10:09 AM

Figure 114. XML metadata and images files in the folder.

Notice that the filename exported by Metalite shows the 1907 date (Figure 115). This must be changed to match the map image file name. So edit the file name to change 1907 to 1912 (Figure 116). You will also have to change `_sid` to `.sid` in the filename of the XML document as shown in Figure 117.

Name	Size	Type	Date Modified
G_6480_C1_s75_3553_1907_A9_ucw_1_sid.xml	4 KB	XML Document	10/17/2005 10:42 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_sid	2,309 KB	SID File	4/26/2005 10:09 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_aux	8 KB	AUX File	4/26/2005 10:14 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_sdw	1 KB	SDW File	4/26/2005 10:09 AM

Figure 115. Mismatched XML and image file names.

Name	Size	Type	Date Modified
G_6480_C1_s75_3553_1912_A9_ucw_1_sid.xml	4 KB	XML Document	10/17/2005 11:01 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_sid	2,309 KB	SID File	4/26/2005 10:09 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_aux	8 KB	AUX File	4/26/2005 10:14 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_sdw	1 KB	SDW File	4/26/2005 10:09 AM

Figure 116. Corrected XML file name matching image file names.

Name	Size	Type	Date Modified
G_6480_C1_s75_3553_1912_A9_ucw_1_sid.xml	10 KB	XML Document	10/17/2005 11:01 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_sid	2,309 KB	SID File	4/26/2005 10:09 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_aux	8 KB	AUX File	4/26/2005 10:14 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_sdw	1 KB	SDW File	4/26/2005 10:09 AM

Name	Size	Type	Date Modified
G_6480_C1_s75_3553_1912_A9_ucw_1.sid.xml	10 KB	XML Document	10/17/2005 11:01 AM
G_6480_C1_s75_3553_1912_A9_ucw_1.sid	2,309 KB	SID File	4/26/2005 10:09 AM
G_6480_C1_s75_3553_1912_A9_ucw_1_aux	8 KB	AUX File	4/26/2005 10:14 AM
G_6480_C1_s75_3553_1912_A9_ucw_1.sdw	1 KB	SDW File	4/26/2005 10:09 AM

Figure 117. Correcting the file extension for the `.sid.xml` file by changing the underscore to a period.

Once the metadata has been created and exported, the metadata and image file names match, and the metadata file extension has been corrected, it is time to open ArcCatalog to check the metadata.

Step 4. Importing metadata into ArcCatalog

Open ArcCatalog. In the Catalog tree, navigate to the folder where the metadata record and map image are stored and click on the name of the map image to highlight it (Figure 118).

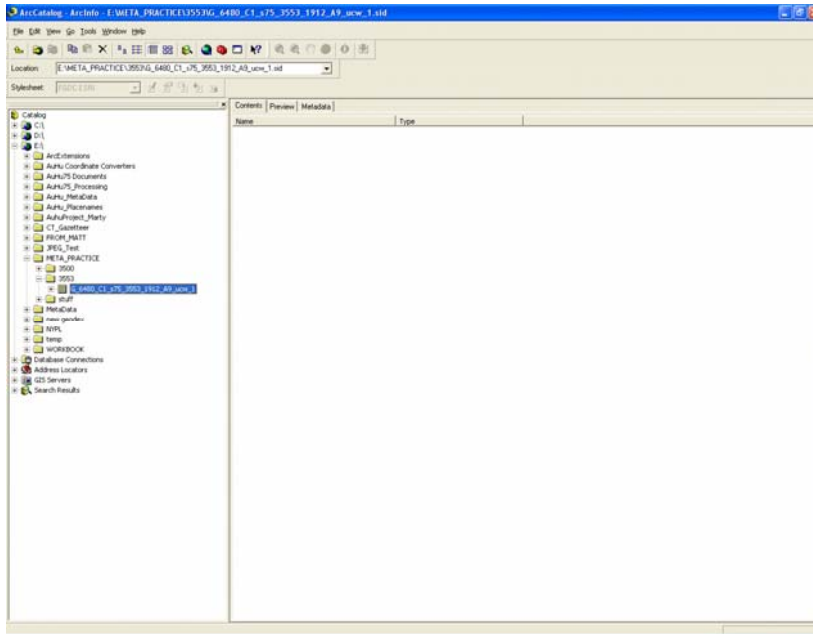


Figure 118. Navigating to the map image in ArcCatalog to view metadata.

Click on the **Metadata** tab in the ArcCatalog window (Figure 119). You should see the metadata for your map image as created using MetaLite (Figure 120).

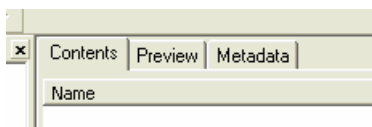


Figure 119. The Metadata tab in ArcCatalog.

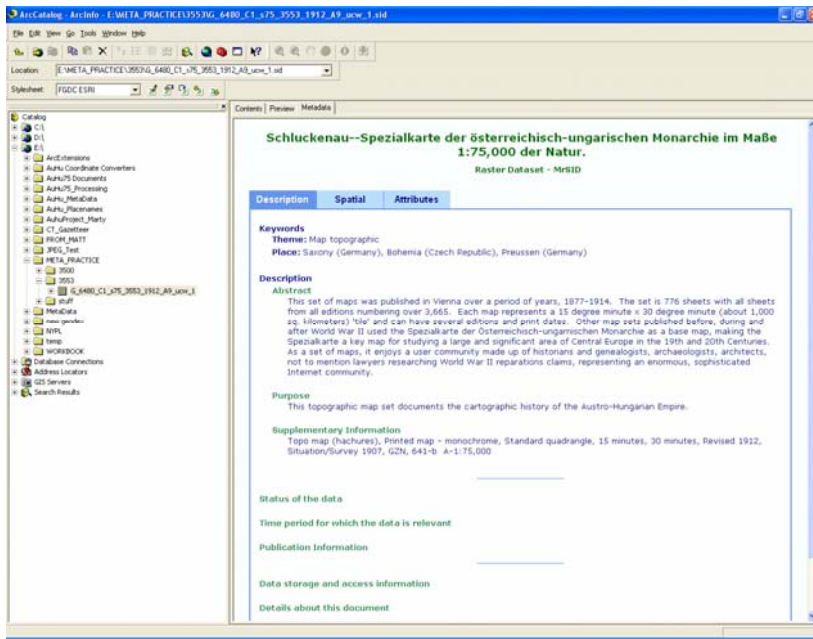


Figure 120. Displaying metadata for the image in ArcCatalog.

Click on the Stylesheet arrow and scroll to change the style to FGDC Classic (Figure 121).

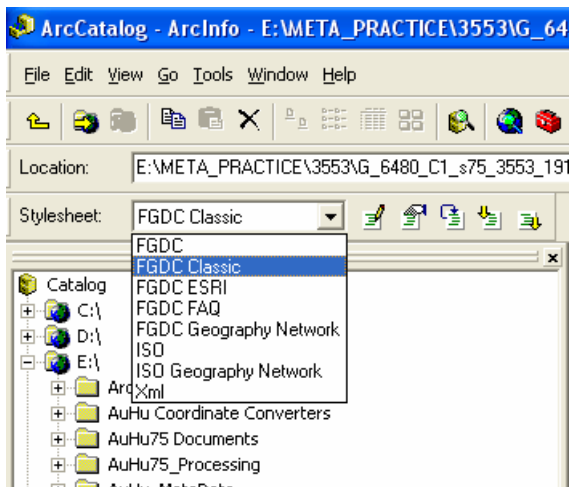


Figure 121. Changing the metadata stylesheet in ArcCatalog to change the appearance of the metadata to FGDC Classic.

Scroll through the metadata to check it (Figure 122).

Contents	Preview	Metadata
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Schluckenau--Spezialkarte der österreichisch-ungarischen Monarchie im Maße 1:75,000 der Natur.

Metadata:

- [Identification Information](#)
- [Spatial Data Organization Information](#)
- [Spatial Reference Information](#)
- [Entity and Attribute Information](#)
- [Distribution Information](#)
- [Metadata Reference Information](#)

Identification Information:

Citation:

Citation Information:

Originator: Austro-Hungarian Monarchy. Militärgeographisches Institut.

Publication Date: 19120101

Title:

Schluckenau--Spezialkarte der österreichisch-ungarischen Monarchie im Maße 1:75,000 der Natur.

Geospatial Data Presentation Form: map

Publication Information:

Publication Place: Unknown

Publisher: Austro-Hungarian Monarchy. Militärgeographisches Institut.

Other Citation Details:

3553

Online Linkage: [NCCOGIA12VE\\$META_PRACTICE3553G_6480_C1_s75_3553_1912_A9_ucw_1.sid](#)

Description:

Abstract:

This set of maps was published in Vienna over a period of years, 1877-1914. The set is 776 sheets with all sheets from all editions numbering over 3,665. Each map represents a 15 degree minute x 30 degree minute (about 1,000 sq. kilometers) 'tile' and can have several editions and print dates. Other map sets published before, during and after World War II used the Spezialkarte der Österreichisch-ungarischen Monarchie as a base map, making the Spezialkarte a key map for studying a large and significant area of Central Europe in the 19th and 20th Centuries. As a set of maps, it enjoys a user community made up of historians and genealogists, archaeologists, architects, not to mention lawyers researching World War II reparations claims, representing an enormous, sophisticated Internet community.

Purpose:

The topographic map set documents the cartographic history of the Austro-Hungarian Empire.

Figure 122. The metadata record for Map 3553 in FGDC Classic format.

Conclusion

This project began with a set of historical map sheets. At the conclusion of the project, there is now the original TIF image of each scanned map sheet, a compressed, clipped, projected and georeferenced image of each map sheet, and a metadata file describing the digital object and its fitness for use. These can be used in a GIS application or with ArcIMS. With minimal further processing, the collection can be distributed using Web 2.0 technologies.

During the work on this project, the launch of Google Earth and Google Maps provided new tools for distributing information about places on the Web. In order to make these map sheets available through Google Earth or Google Maps, the images would have to be converted to JPEG format and described with KML, the Google Keyhole Markup Language (<http://code.google.com/apis/kml/documentation>). Despite the evolution of information technology, the process described in this workbook addresses the fundamental elements of a digital geo-spatial object and creates the basic building blocks of a distributed map library of the future.

Appendix

American Geographical Society GEODEX File List

The following table lists the map set number and name and the number of GEODEX records for maps in each set. The Central & Eastern Europe set highlighted on p. A-2 was the source of records for map sheets in the AuHu75 project.

Set Number and Name	Number of Records
F0020 World 1:500,000 (Series 1404)	394
F0039 World 1:250,000 (WAC)	1915
F0048 World 1:2,500,000 (Karta Mira) [102]	263
F0059 World 1:1,000,000 (IMW, etc.)	3661
F0083 World 1:500,000 (GWM)	1185
F0157 Antarctica 1:250,000 (Geology)	158
F0162 Joint Operations Graphics 1:250,000	1012
F0168 World 1:1,000,000 (ONC'S)	746
F0171 World 1:500,000 (TPC Charts)	491
F0046 Great Lakes Charts - U.S.(LARGE SCALE)	494
F0072 Great Lakes Charts - U.S. (SMALL SCALE)	56
F0085 Canada 1:500,000 (NTS)	1032
F0167 Canada : land information series, 1:250,000	155
F0170 Canada 1:250,000 (NTS)	2610
F0173 Canada 1:50,000 (52ø-88ø) NTS 1-49, 120, 340	8148
F0174 Canada 1:50,000 (88ø-141ø) NTS 52-117, 560	13420
F0002 Mexico 1:50,000 (1974-) [z]	2279
F0042 Central America 1:50,000 (Various AMS)	822
F0044 Mexico 1:100,000	112
F0045 Uruguay 1:100,000 (Planimetric)	87
F0053 Brazil 1:100,000 [z]	2212
F0056 Venezuela 1:100,000	637
F0067 Cuba 1:62,500	97
F0075 Peru 1:100,000	407
F0076 Argentina 1:100,000	455
F0093 Ecuador 1:100,000	16
F0095 Argentina 1:50,000	880
F0154 Latin America 1:250,000 (PAIGH)	444
F0310 Argentina 1:500,000	216
F0017 South Africa (Geology)	87
F0051 Liberia, constituencies 1:250,000	10
F0055 Africa (var 1ø quads) 1:200,000 & 1:250,000	2234
F0066 Egypt 1:50,000 (German War Maps)	324
F0071 Sudan 1:100,000	10

Set Number and Name	Number of Records
F0077 Nigeria 1:50,000	1500
F0079 Kenya, Tanzania, Uganda 1:50,000	1499
F0081 Zambia 1:50,000	1372
F0097 French West Africa 1:500,000	120
F0301 Africa 1:1,000,000 & 1:2,000,000	281
F0313 South Africa 1:50,000	262
F0315 Gambia 1:50,000	67
F314 Ghana, Ivory Coast (Various)	651
F0037 Asia 1:250,000 (Various AMS)	2002
F0038 India 1:126,720 (Survey of India)	1441
F0047 Israel 1:100,000	50
F0052 [Asia] 1:253,440 (GSGS, Surv. of India	1798
F0078 Iran 1:100,000 & 1:253,440	187
F0091 India 1:1,000,000 (Geol and Mineral Atlas)	24
F0099 Malaya-Thailand 1:63,360	248
F0169 Japan 1:50,000 (Geology)	6283
F0308 Philippines 1:50,000 (AMS S712)	786
F0311 Taiwan 1:50,000 (Geologic)	379
F0312 Korea 1:50,000 (AMS)	369
F0082 New Zealand 1:63,360	762
F0155 Australia 1:100,000 [z]	3171
F0166 Australia 1:250,000 (Various)	1303
F0004 France 1:50,000 (Orange Series) [z]	1099
F0005 Central & Eastern Europe 15 x 30 min. quads	3745
F0006 Poland 1:25,000 (1928-1938)	1260
F0019 Greece (various topographic)	295
F0021 German Empire 1:25,000 [z]	5115
F0023 Great Britain 1:63,360 (7th series)	292
F0024 France 1:250,000 (Geology)	17
F0027 Europe 1:250,000 (Various AMS)	1101
F0028 Spain 1:800,000	9
F0029 Ireland 1:63,360 (Ordnance Survey)	179
F0030 Belgium 1:50,000	147
F0031 Switzerland 1:50,000	108
F0032 Luxembourg 1:20,000	30
F0033 Balkans 1:50,000 (GWM)	600
F0035 Italy (Various topographic)	2682
F0049 Spain 1:50,000	1295
F0050 Russia 1:100,000 (German War Maps)	1099
F0054 Ireland - Town Plans, 1:500	647

Set Number and Name	Number of Records
F0057 Lithuania 1:100,000 & Latvia 1:75,000	228
F0058 Central Europe 1:200,000	793
F0060 Central Europe 1:300,000	389
F0063 Germany 1:50,000	869
F0064 Russia 1:50,000 (German War Maps)	583
F0065 Denmark 1:40,000	589
F0068 Romania 1:100,000	171
F0069 British Geological Survey 1:250,000	71
F0086 France 1:100,000	162
F0096 Hungary 1:100,000	84
F0098 Great Britain 1:50,000 (Second series)	204
F0163 West Germany 1:200,000 (1964-)	232
F0164 Norway 1:50,000 (Series 711)	922
F0172 Carta Corografica de Portugal 1:50,000	248
F0175 Sweden 1:50,000	2169
F0303 Slovakia 1:100,000	91
F0304 Poland 1:100,000 (new series)	286
F0305 Europe 1:100,000 (war maps)	285
F0306 Soviet Union 1:200,000	4197
F0177 Nautical charts (DMA/NOS) -1:399,999	7510
F0178 Nautical charts (DMA/NOS) 1:400K-1:3.99M	1045
F0179 Nautical charts (DMA/NOS) 1:4M-	146
F0302 Nautical Charts - Coast & Geodetic Survey	77
F0307 Canada-Hydrographic Charts (Various)	1416
F0309 New Zealand Oceanic Series 1:1,000,000	173
F0009 Tennessee 1:24,000 (Geology)	378
F0010 Maryland 1:24,000 (Geology)	19
F0011 Desert Access Guides, California 1:100,000	25
F0041 United States Land Cover 1:250,000 (L Series)	193
F0080 United States 1:100,000 (AMS)	301
F0094 United States (AMS) 1:25,000	5630
F0152 United States 1:50,000 (DMA)	4257
F0156 United States 1:100,000 (1980-)	3544
F0158 United States--Counties, Eastern	249
F0159 United States--National Forests 1:24,000 [w]	2834
F0160 United States 1:250,000 (USGS & DMA)	2908
F0161 United States--Counties, Western	375
F0165 United States--Geology (GQ Series)	1772
F0101 Arkansas USGS (Various)	2997
F0102 Alabama USGS (Various)	2777

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F0103 Alaska - USGS (Various)	6313
F0104 Arizona USGS (Various)	6156
F0105 California - USGS 1:31,680 AND LARGER	11111
F0106 California - USGS (Various)	3829
F0107 Colorado USGS (Various)	6034
F0108 Connecticut - USGS (Various)	1050
F0109 Delaware USGS (Various)	252
F0110 Florida - USGS (Various)	3874
F0111 Georgia - USGS (Various)	3114
F0112 Hawaii - USGS (Various)	583
F0113 Idaho - USGS (Various)	4527
F0114 Illinois - USGS (Various)	3309
F0115 Indiana - USGS (Various)	2421
F0116 Iowa - USGS (Various)	2774
F0118 Kentucky - USGS (Various)	3115
F0119 Louisiana - USGS (Various)	4137
F0120 Maine - USGS (Various)	2995
F0121 Maryland and D.C. - USGS (Various)	1912
F0122 Massachusetts - USGS (Various)	2523
F0123 Michigan - USGS (Various)	3458
F0124 Minnesota - USGS (Various)	3733
F0125 Mississippi - USGS (Various)	2017
F0126 Missouri - USGS (Various)	4436
F0127 Montana - USGS (Various)	7059
F0128 Nebraska - USGS (Various)	2464
F0129 Nevada - USGS (Various)	5042
F0130 New Hampshire - USGS (Various)	925
F0131 New Jersey - USGS (Various)	1241
F0132 New Mexico - USGS (Various)	5082
F0133 North Carolina - USGS (Various)	3778
F0134 North Dakota - USGS (Various)	2519
F0135 New York - USGS (Various)	6454
F0136 Ohio - USGS (Various)	3579
F0137 Oklahoma - USGS (Various)	2478
F0138 Oregon - USGS (Various)	6102
F0139 Pennsylvania - USGS (Various)	5436
F0140 Rhode Island - USGS (Various)	252
F0141 South Carolina - USGS (Various)	1495
F0142 South Dakota - USGS (Various)	2691
F0143 F0143 Tennessee - USGS (Various)	3552

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F0144 Texas - USGS (Various)	11062
F0145 Utah - USGS (Various)	4971
F0146 Vermont - USGS (Various)	848
F0147 Virginia - USGS (Various)	4577
F0148 Washington - USGS (Various)	5033
F0149 West Virginia - USGS (Various)	2375
F0150 Wisconsin - USGS (Various)	3234
F0151 Wyoming - USGS (Various)	5490
F0153 Puerto Rico (USGS Various)	349