GLOBAL AND REGIONAL GIS DATABASE DEVELOPMENT IN SUPPORT OF CTBT MONITORING

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ABSTRACT

One of our main goals is to facilitate and enhance the capability of the US NDC and the IMS to accurately locate, calibrate, and evaluate seismic events in the Middle East, North Africa, and the United States. We achieve this by developing interactive, diversified geophysical, geological, and geographical digital databases to assist in the compliance and verification of the CTBT treaty. We are developing and testing an information system with a menu-driven, easy to use access tools. Currently, the information system includes large volumes of geophysical, geological, and geographical data sets relevant for research in CTBT monitoring. Newly collected data sets in the Middle East, North Africa, and the United States include detailed Moho and basement structures, velocity information, fault maps, Lg Q values, and many other geological and geophysical data sets. All these data sets are geo-referenced, formatted to allow simultaneous utilization and accessible with custom tailored tools.

For easy access to the information system we have developed two different mechanisms. The first is a menu-driven internal system that is run on UNIX and NT platforms. The second access mechanism is based on World Wide Web and easily accessible by any web browsers. The menu-driven system provides effective and efficient access to large volumes of data sets as well as the tools to manipulate them. Users can select any region on Earth and determine what relevant data sets are available and utilize them based on their objectives. Further information about this system can be accessed at http://atlas.geo.cornell.edu/ctbt/geoid.html. The web-based access is universal and allows any person to access and utilize the information systems with a JAVA enabled web browser. The web server is interactive and allows access to the core information system via a dynamic mapping interface developed for this purpose. The web site is accessible at http://atlas.geo.cornell.edu/ima.html.

All of the compiled data sets are also accompanied by related metadata. The metadata provide the necessary information about the quality, resolution, accuracy, and techniques that were used in collecting the original data. Refer to http://atlas.geo.cornell.edu/ for further information.

Key Words: Databases, Middle East, North Africa, United States, GIS, CTBT

OBJECTIVE

Our main objective is to facilitate and enhance the capability of the US NDC and the IMS to accurately locate, calibrate, and evaluate seismic events in the Middle East, North Africa, and the United States, by developing an interactive, diversified geophysical, geological, and geographical digital databases to assist in the compliance and verification of the CTBT treaty. We are also developing and improving the design of menu driven, easy to use, custom made tools as well as metadata for all developed data sets. The metadata will provide the necessary information about the quality, resolution, accuracy, and techniques that were used in collecting the original data. Another objective is to deliver results of the original research on crustal and upper mantle structures of the Middle East and North Africa, and the character of regional seismic wave propagation for the purpose of obtaining a better understanding of high frequency wave propagation in this region.

RESEARCH ACCOMPLISHED

Our efforts in global and regional GIS database development in support of CTBT monitoring have been going on successfully. We have added significant new data sets to our digital library, and revised our data access tools in the past year. We have added the following data sets to our data library.

Geographical	**Geologic**	**Geophysical**	**Gridded/Image**
US State boundaries	*US Aquifers*	*US CNSS Seismicity*	*US Moho*
US County boundaries	*US Mines*		*US Pn Velocity*
US Cities	*Global Tectonic Provinces*		*US Pg Velocity*
US Lakes	*Geology of Former Soviet Union*		*US Bouguer Gravity*
US Rivers	*Geology of Asia Pacific*		*US Magnetic Anomaly*
US Roads	*Plate Boundaries*		*Updated Middle East and North Africa Moho*
US Rail Roads	*US Tectonic Boundaries*		*Updated Middle East and North Africa Basement*
US Urban Araes			*Landsat TM*

We have added the recently released USA National Atlas data to our system. The USA Atlas is published by the USGS and includes many different data layers for the United States including all geographic data sets listed in the above table (first column) and additional data sets. In addition, we have developed our own new data sets both at the regional and global scales.

Tectonic boundary map of the US is one data set that was developed by us to provide a reliable and high resolution tectonic boundaries of the US (Figure 1). This map was digitized from analog maps and the results were compared with known tectonic units and digital elevation models at 90m resolution. In this map each tectonic unit is represented by a polygon with unique attributes and each unit can be used individually and/or as a whole.

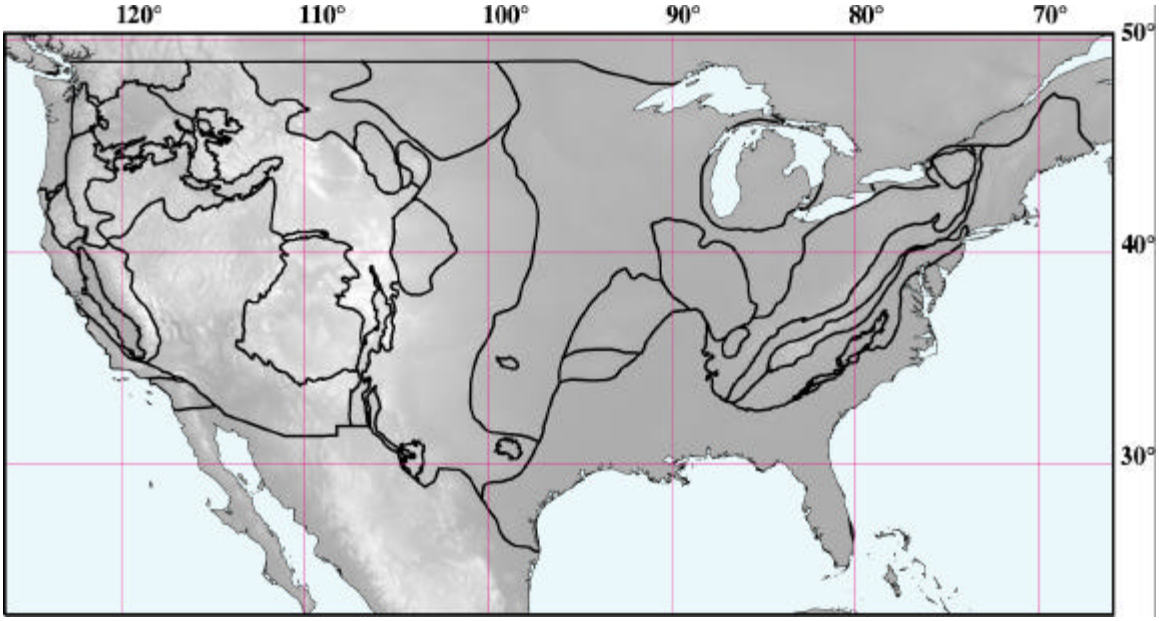

Figure 1. Tectonic boundary map of the United States.

Currently, we are developing detailed Moho and basement maps for the United States. The Moho map being developed is a collection of all published information about the depth of Moho anywhere in the US. This is a time consuming effort. However, the majority of available data have been entered into our system (Figure 2). Soon, this information will be used to make a detailed gridded Moho map for the US.

In our efforts to compile a comprehensive Moho depth data set, we not only record the point and the corresponding depth value, but also record all other relevant information such as the author names, publication source, the method used in obtaining the Moho point (Figure 3). This is extremely useful for researchers as they will always want to know about the details, resolution, and accuracy of the final gridded Moho map. These original point/contour information will be critical in judging the accuracy of the Moho map of the US. Results of this work will be essential to improve event locations and IMS calibration for the USA.

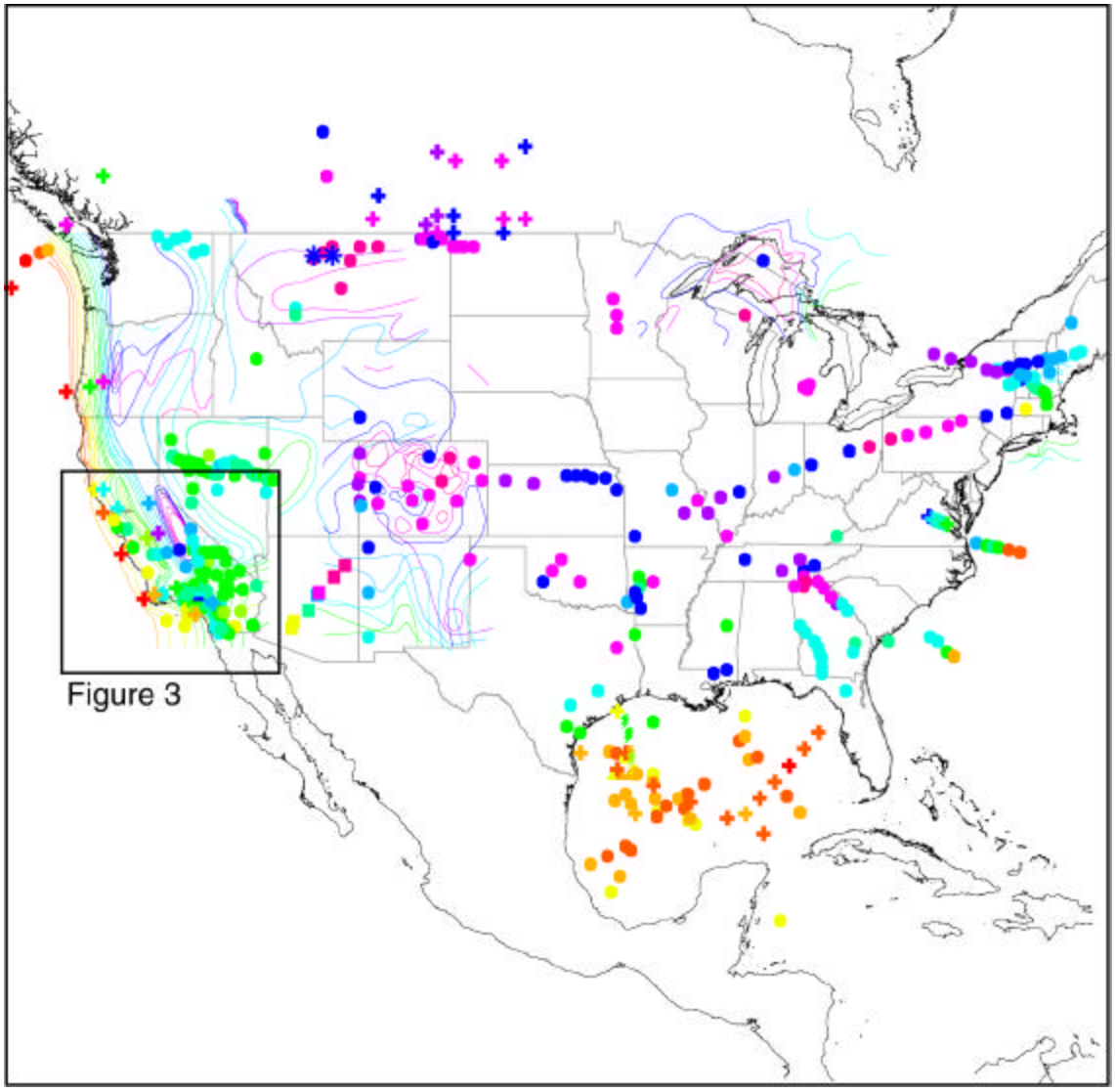

Figure 2. Map showing collected depth to Moho measurements in the US. Each point/contour represents locations where a Moho depth measurement exists. Each point/line shown also includes information about the source, author name, journal that the data were published in, and the method used in measuring the Moho depth. This work is in progress.

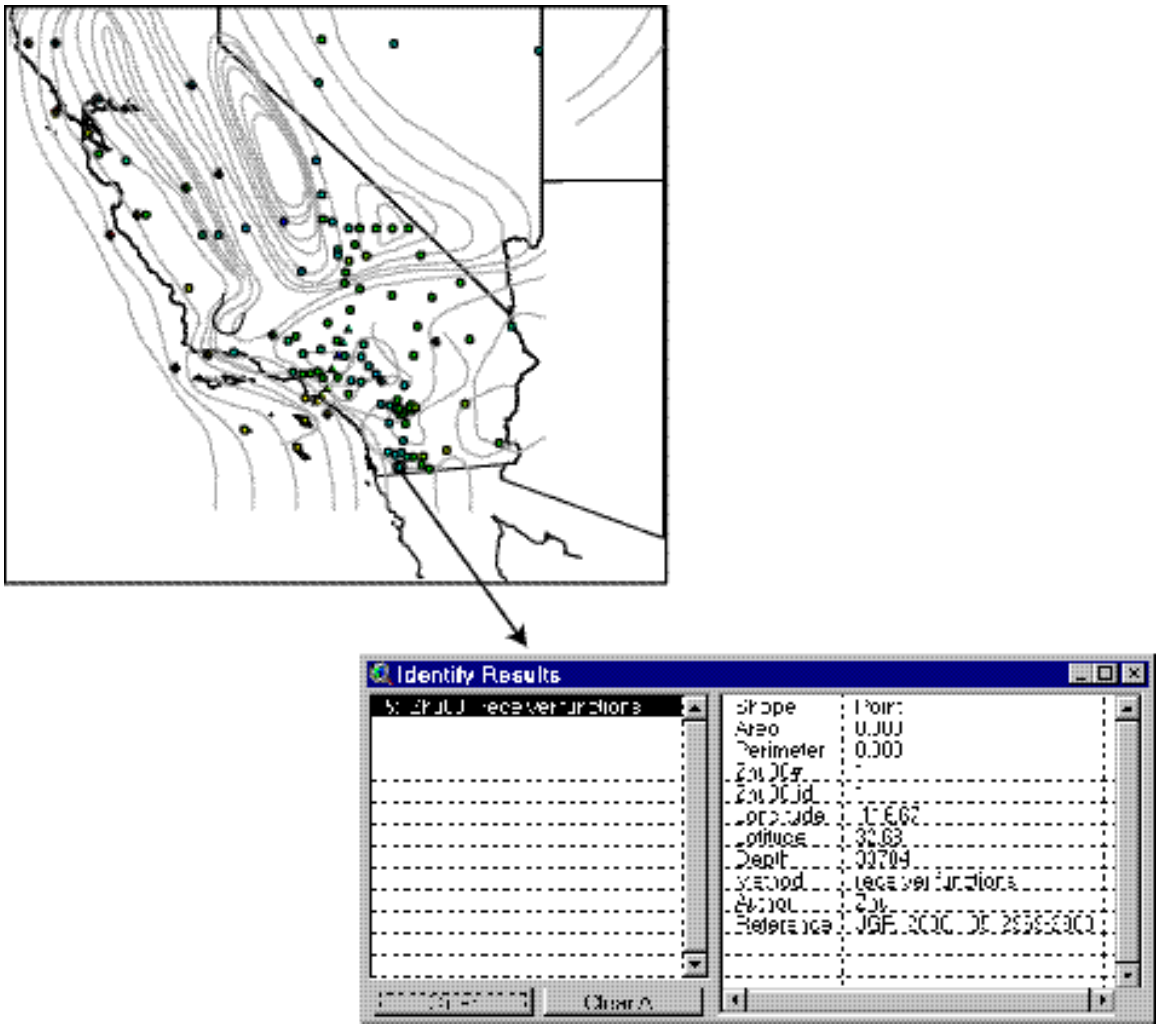

Figure 3. Detailed view of the inset map shown in Figure 2. Users of this data set can click on any of the points/contours in the map and display the information regarding that measurement.

We are also collecting all available sediment thickness maps at state levels. We have completed about ¾ of the US. The remaining ¼ coverage will be completed in the coming months.

In the Middle East and North Africa region we have improved our data coverage extent of the Moho and basement maps by collecting more data sets. We have now a complete crustal model for the entire Middle East and North Africa (Figure 4). This model is now being evaluated with independent data sources such as Bouguer gravity data and three-dimensional gravity modeling to determine which regions have reliable depth-to-Moho values, and which regions might need additional revisions.

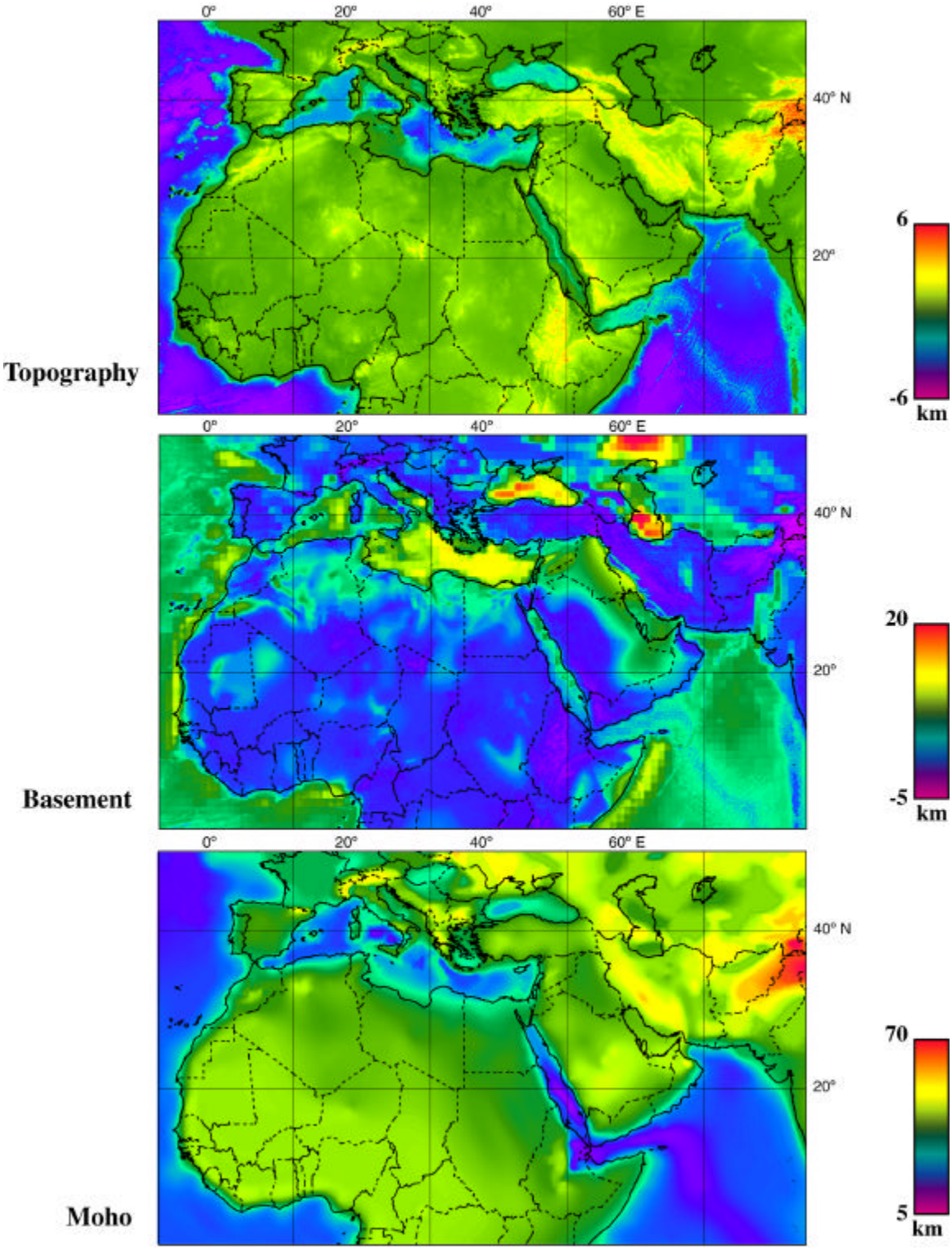

Figure 4. Maps showing the new crustal model for the Middle East and North Africa region. The model includes topography, sediment thickness, and Moho depth at the same scales.

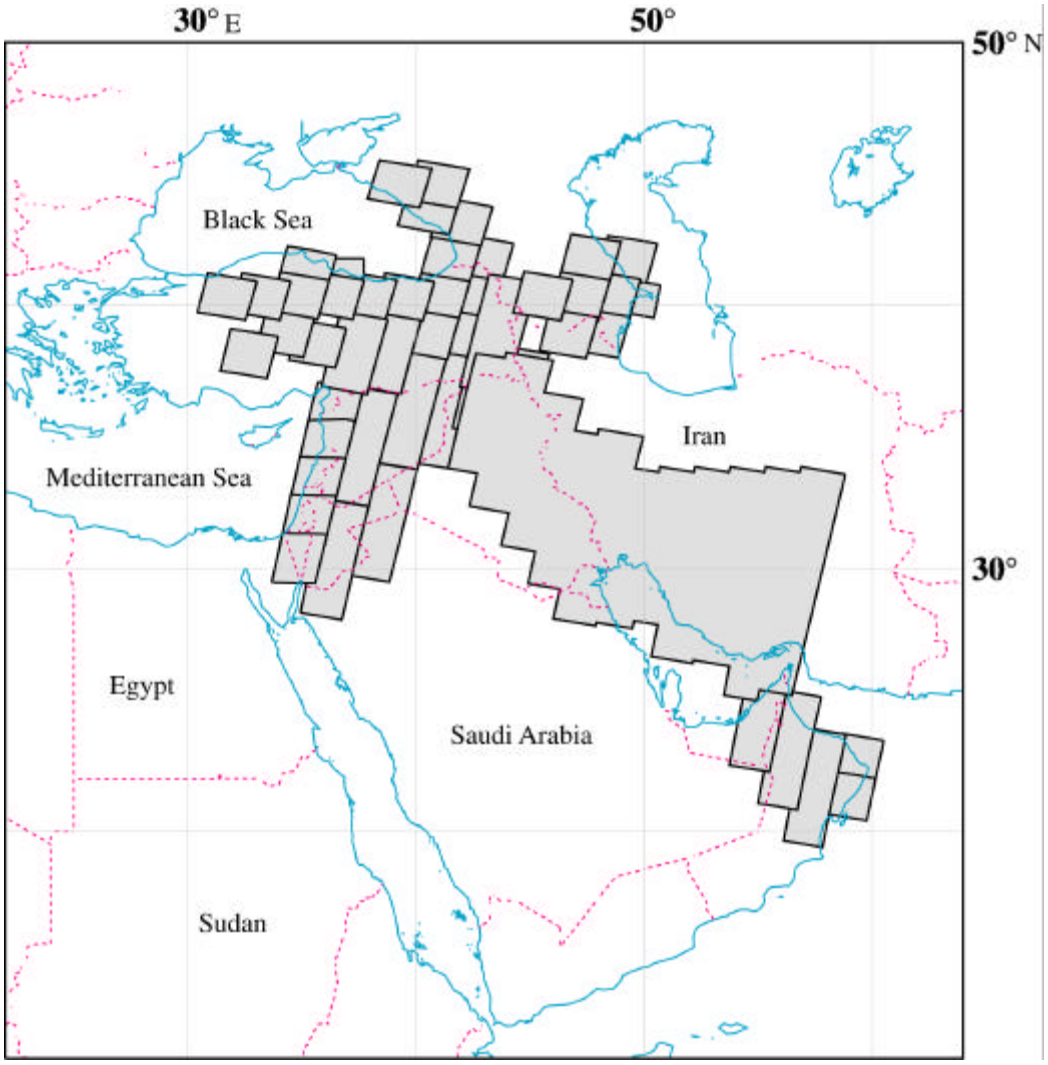

Figure 5. Landsat TM locations available in the Cornell database.

Also, for the Middle East and North Africa regions we continue to georeference our Landsat TM imagery (Figure 5). It is expected that this process will be completed within a couple of months and all these TM scenes will be made available online at full resolution via our main web server.

Data sets mentioned in this article and others covering the Middle East, North Africa, and the US along with their respective metadata can be accessed via our main web server at http://atlas.geo.cornell.edu (Figure 6).

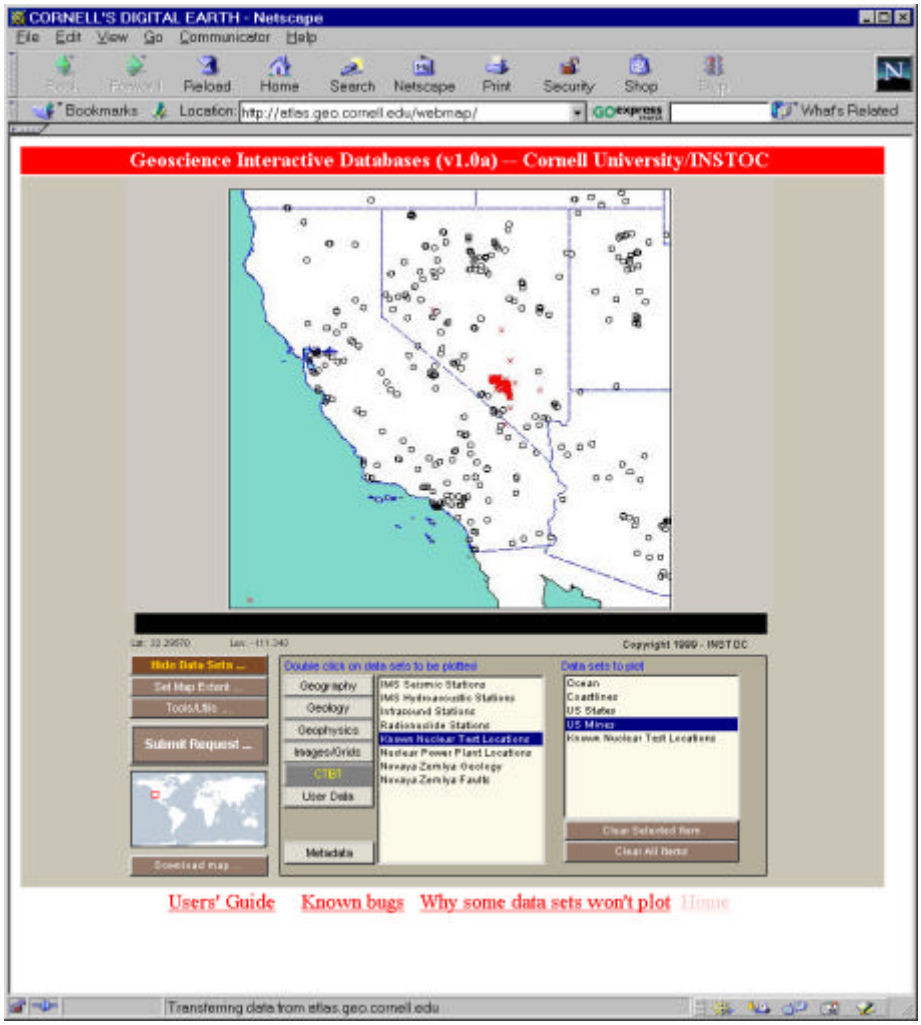

Figure 6. Web mapping applet available in our web site allows access to all data sets with an easy-to-use interactive application. Users can select any data sets and display it at any scales. Here, we selected US mines and known nuclear test locations. The application is available at http://atlas.geo.cornell.edu/.

CONCLUSIONS AND RECOMMENDATIONS

We have been collecting and organizing available seismological, geophysical, and geological data sets for the Middle East, North Africa and the United States into a comprehensive Geographic Information System (GIS). In addition to the GIS databases and tools, we have been developing a special World Wide Web (WWW) site to allow restricted access to our databases. All the data sets in our GIS system are documented with a standard metadata format in order to explain the source and nature of the data, their resolution, and their accuracy. The developed system and its efficiency in using and analyzing information will help CTBT researchers and decision makers to fuse and integrate the results of the four established monitoring technologies to reach a conclusion in a very short time. The system also significantly contributes to the better location and calibration of suspect events for any given region. This system will also help in On Site Inspection efforts.

We recommend that ongoing efforts to develop databases be expanded to include higher resolution data sets not only for the regions of the Middle East and North Africa but also to most regions on Earth. Such

developed information system and data sets will help to achieve better event locations with the required accuracy as stated in the CTBT.