UNIVERSIDAD SAN FRANCISCO DE QUITO

Colegio de Posgrados

Methodology for capturing geological and geochemical information in the Mexican Geological Survey (MGS)

Vicente Díaz Reyes

Richarl Resl, Ph.Dc., Director de Tesis

Tesis de grado presentada como requisito
Para la obtención del título de Magister en Sistemas de Información Geográfica

Pachuca Hidalgo, Abril de 2013.

Universidad San Francisco de Quito

Colegio de Posgrados

HOJA DE APROBACIÓN DE TESIS

Methodology for capturing geological and geochemical information in the Mexican Geological Survey (MGS)

Vicente Díaz Reyes

Richard Resl, Ph.Dc. **Director de Tesis**	..…….……………………………
Anton Eitzinger, MSc **Miembro del comité de tesis**	……………………………………..
Richard Resl, Ph.Dc. **Director de la Maestría en Sistemas de Información Geográfica**	…………………………………..
Stella de la Torre, Ph.D. **Decana del Colegio de Ciencias Biológicas y Ambientales**	…………………………………..
Víctor Viteri Breedy, Ph.D. **Decano del Colegio de Posgrados**	…………………………………..

Pachuca Hidalgo, Abril de 2013

ACKNOWLEDGMENT

I thank the Mexican Geological Service for believing in me, and the great support during the course of this stage of improvement, for the successful completion of studies of expertise in Geographic Information Systems.

Thank Hector Alba engineer who was counselor by the Mexican Geological Survey for sharing your knowledge and be an essential part of my studies.

I thank Anton Eitzinger who was an adviser by UNIGIS and who guided me to the development of the thesis.

Finally, I dedicate this thesis to my parents, my wife Rosario and children Mariana and Carlos who have supported me to get ahead and be an example to follow.

RESUMEN

El servicio geológico mexicano (SGM), institución gubernamental de México, tiene la responsabilidad de explorar detalladamente las riquezas mineras nacionales, así como la de proveer a la industria minera de todos aquellos elementos indispensables para facilitar la exploración, identificación y cuantificación de los recursos minerales del territorio mexicano.

Uno de los objetivos del Servicio geológico Mexicano (SGM) es la generar y proveer información geológico-económica para facilitar el conocimiento del potencial de los yacimientos minerales.

Pensando en los objetivos del SGM se ha desarrollado la metodología de captura de información geológica que incluye un sitio Web, tiene como objetivo mejorar los procesos utilizados en la generación de información geológico minera.

La metodología consiste en estandarizar los atributos y simbología de cada uno de los niveles de información a capturar; y el desarrollo de un sitio Web que permite la publicación de la información geológico-minera que se encuentra en proceso de captura; así como la interacción que tendrá el personal de la institución con el geólogo que realiza la captura e interpretación de la información geológico-minera, a través de un sitio Web en donde el personal de la institución podrá observar y realizar los comentarios sobre la información que se encuentra en proceso de captura.

Al finalizar el proceso de captura del área, la información publicada en el sitio Web podrá ser enviada a la base de datos institucional en donde se almacena la información de los mapas terminados.

Como resultado de la metodología se observa que todos los niveles de información a capturar en campo tienen la misma estructura, permitiendo así, la integración de niveles de información de varias áreas de manera rápida; por otra parte, con el desarrollo del sitio Web solo existirá una versión de cada nivel de información, así como, la información que se encuentra en proceso de captura podrá ser consultada por el personal de la institución.

ABSTRACT

The Mexican Geological Survey (MGS), an institution of the Mexican government, has the responsibility to explore thoroughly the national mineral resources, as well as providing the mining industry with all the essential elements to facilitate the exploration, identification and quantification of the mineral resources in Mexico.

One of the objectives of the Mexican Geological Survey (MGS) is to generate and provide geological-economic information to facilitate the knowledge about the potential of mineral deposits.

With the goals of the MGS in mind, a methodology has been developed to capture geological and geochemical data which includes a Web site and has as its main objective to improve the processes used for the generation of geological mining information.

This methodology is based on standardizing the attributes and symbols that each of the information levels must capture; and the development of a Web site to publish the geological-mining information within the capture process, as well as the interaction that takes place between the institution and the geologist who captures and interprets that information. All of these through a Web site where personnel from the institution will be able to observe and make comments about the information, which is in capture process before such is finished.

When the research has been concluded, the information published in the Web site can be sent to the database of the institution where gathered data about the finished maps is stored.

As a result of the methodology used, it is shown that all layers of information to capture in the field have the same structure, thus allowing the integration of information from multiple layers of areas in a quick way. On the other hand, with the development of the website, it will only exist one version of each level of information, and the information in capturing process can be viewed by the institution staff.

CONTENTS

TABLES

Pag.

FIGURES

CHAPTER I
INTRODUCTION

1.1 OVERVIEW

Jean-Étienne Guettard (1715-1786) was a botanist, a geologist and the pioneer in the production of geological maps. In 1746, he presented a preliminary mineralogical map of France to the “Acedémie Royale des Sciences”. Within the maps, Guettard used symbols to represent mineral deposits, the different types of rocks and distinctive fossils (Jay, 2001).

Ever since Guettard produced the first geological map, there has been a great interest in representing geology in maps to facilitate the search for minerals. In the beginning, paper maps were enough to represent the classification of rocks; but in time, it was observed that there were different factor which helped determine the presence of minerals and rocks, such as the shape of the mountains, the type of vegetation, rivers, color of the soil, etc.,(Jay, 2001), which nowadays resulted in a great increase in the levels of information to locate new mineral deposits.

Today, people still use paper maps to make agreements, organize and make decisions on the field (Botella A., Muñoz A., Olivella R., Almedillas J.C., & Rodríguez J., 2011).

Since the introduction of Geographic Information Systems (GIS), storage, analysis and mapping has been simplified, and GIS systems provide quick answers about spatial data, searches, comparisons, analysis and measurement (Tomlinson, 2008).

Currently geographic information systems rely on Internet to share geographic information through the use of "web mapping" technology, which aims to bridge the distance between people from different continents and nationalities.

The term "web mapping" has been assigned to Internet map servers; these servers handle a variety of geographical applications and processes: from a simple web page that shows a satellite image to an application that interacts with several layers of information, and even data from other geographical servers. Most of the map servers have a web page with some kind of an interactive component which presents a list of layers that the user can turn on and off; and/or change the map according to his or her needs. The page can also have visualization tools that allow the users to zoom in the map or even consult the different attributes at each layer of the geographic information published (Mitchell, 2005).

The objective of “web mapping technology” is to create map servers and post maps that can be accessed through internet by the end-users (Mitchell, 2005).

Sharing information on-line via Internet or intranet has been part of the success of large corporations, government agencies, etc. because, at the same time, many people at different locations can access and analyze the same information, thus offering the possibility of excellent decision-making.

There are free map servers in the internet that are very useful, such as Google maps (http://maps.google.com.mx/) which allows people to visualize roads, cities, and similar data, so that they can navigate anywhere in the world; Google earth server at (http://www.google.com/earth/index.html) lets people find information about weather, photos of important places as well as an aerial view of any place on Earth, and even displays our information on the Google Earth server. The following table presents a list of websites that use map servers:

Table 1.1 List of some web sites which have interactivity with Web Map Services

Web Site	**Description**
http://www.dmsolutions.ca/solutions/tsunami.hmtl	Tsunami disaster mapping site
http://mesonet.tamu.edu	Real time U.S.A weather maps
http://maps.yahoo.com	Find an address; get driving directions, or check real-time traffic
http://mapsherpa.com/hawaii2	Comprehensive atlas of Hawaii, U.S.A.
http://gallery.openlayers.org/?tag=mapserver	Openlayers web client gallery that use MapServer web services
http://www.mapquest.com	Find address; plan a route
http://www.moximedia.com:8080/imf-ows.jsp?site=ms_users	Maps showing the location of some MapServer users
http://toporama.cits.mcan.gc.ca	Canadian topographic maps and aerial photos
http://geodiscover.cgdi.ca	Canadian portals to geographic information and services; include premade maps
http://mappoint.msn.com	Search for a place; find an address
http://www.gommap.org	Portal to Gulf of Maine (U.S.A) mapping applications and web services

1.2 BACKGROUND

For several decades now, the collecting of geological information has been important for mining; that is why every country has tried to improve their gathering techniques with base on technology.

According to Ernesto López Ramos, México was already a mining country even before the Spanish Conquest (1521) and it continued being so later on, when large silver and gold mines were discovered in Oaxaca, Hidalgo, Guanajuato and Zacatecas (López, 1988).

The following paragraphs describe the evolution that has taken place inside the Mexican Geological Survey, which is the institution in Mexico, responsible for generating the geological-mining information in the country and is the topic of this thesis work.

From 1944 to 1995, collecting geological-mining data consisted of a geologist relying in a compass, a topographical map of the area being studied, a notebook (field diary) and a camera. The geologist marked on the topographical map the geological information such as geological faults, veins, alteration zones, lithology and samples of rocks; on the notebook he described the geological feature marked on the map and took a picture to illustrate.

Figure 1.1: Beginning of geological mining data collecting (1979-1995).

Then at the office, the geologist continues marking the features in the map based on the notes written and the pictures taken. After that, he turned everything in to the drawer.

As we can see, when the geologist made the marks on the topographical map on the field, he was committing a precision mistake, because he marked them by approximation; and the drawer made the error larger when copying the geological features onto the new map.

The field diary also contributed to enlarge the mistake since sometimes the sequence in which the lines were drawn was lost. Even with photographic cameras, the process was not fail-proof because pictures were taken at the places visited on the field and they were later sent to be developed and, by memory, the places were associated with the notes thus giving a large margin of error.

In 1995, the Mexican Geological Survey began implementing technology to collect geological-mining data and to edit maps. Some of the devices that were first used were the computers, digitalizing tablets, plotters, GPS, as well as GIS software

(ArcInfo, Ermapper) and satellite imagery (Landsat). With the technology, important breakthroughs were made in each of the different areas of collecting geological-mining information.

Figure 1.2 Integration of technology in the Mexican Geological Survey.

At the beginning, the compass was used as a locating on the field tool. Later it was the hand-held GPS which showed locations and could even store some positions with a few attributes added, such as coordinates and an identifier. It was not necessary to digitize the points on the map.

With the addition of technology to Geographic Information Systems, the precision errors at the moment of capturing geological information have been reduced considerably. Nowadays, using mobile GIS, the errors in precision are down to 2 to 5 meters, and accuracy can be improved to 1 to 3 meters by using post-processing software (Trimble).

Technology for the collecting of geographic data has evolved substantially to the point that we have now the so-called mobile systems, by which devices can have a GPS, maps and at the same time connect several devices such as cameras or portable x-ray analyzers (http://www.niton.com/metal-and-alloy-analysis.aspx?sflang=en), thus connecting each element (line, point, polygon) with the data obtained from the mobile device. Afterwards, all the information from the mobile device can be downloaded quickly to a PC or a map server for later analysis at the office.

1.3 THE PROBLEM

The Mexican Geological Survey has 7 regional offices (Chihuahua, Sinaloa, Durango, Sonora, San Luis Potosi, Oaxaca and Jalisco) displayed all over the Mexican Republic and a central office in the State of Hidalgo. Each office has field geologists collecting geological-mining data. The info is processed with different software such as Ermapper, Surfer, AutoCad, and ArcGIS; when the collecting of information is done -approximately one year for each area of study- it is sent to the central office for reviewing, editing and publication.

The problem, though, is that the information received at the central office comes in different formats, such as shapefile, dxf, Ermapper, and there's often more than one version of each layer of information. Also, each layer of info comes with different attributes regarding other areas of study; sometimes, they feature less attributes than other occasions. Given the latter, the central office has to standardize each level of information in order to have one single format and the same file structure.

1.4 JUSTIFICATION

Hence, there's a need for standardization of the information captured to have quick access so the staff can review the capture advances and make suggestions about the information gathered until they can finish registration, and the boss knows the status of the captured areas.

With the design of a Web Map Server, the regional offices will send monthly progress reports to headquarters with the format and structure predefined for each layer of information. Later the central office will upload the information to a server where the responsible of each department will have quick access to data in process of being captured, and the staff of the institution will be able to make comments on the geological interpretation.

1.5 OBJECTIVES:

1.5.1 General Objectives:

To develop a Web Map Server for Capturing Process of the geological-mining information that will allow:

- Standardization of the formats and structure of the layers of information.
- Make fast queries of the process of the capturing process in all areas of study, and.
- Let the personnel at the organization provide ideas and comments to help on the geological interpretation.

1.5.2 Specific objectives

1. Research, review and document the different existing software technologies for the development of the Web Map Server that will allow visualization of the progress in capturing the geological-mining information at the Mexican Geological Survey (MGS).
2. Create a database with the information layer structure and format according to the guidelines established at the MGS.
3. Use Open Source tools for implementing the interactive map.
4. Standardize the symbology for all the information layers.

CHAPTER II
THEORETICAL FRAMEWORK

2.1 GEOGRAPHY

Rojas (2008) says that "Geography is the science that studies the physical, biological, and human facts and phenomena which happen on the surface of the Earth, as well as their causes and interrelationships".

Since ancient times men have been concerned about the environment in which they live, studying the origin and causes of natural phenomena such as earthquakes, eclipses and cyclones; as well as the physical processes which have occurred on Earth since its beginning, e.g. the forming of volcanoes, mountains, forests, and jungles. In the end, they have studied details in the ways of life of human beings such as customs and traditions (Rojas, 2008).

The importance of studying Earth has been such that it has become one of the branches of Science: the one we call Geography.

2.2 TOPOGRAPHY

After learning about our environment, we faced the need for representing, at a scale, the given environment around us, such as mountain ranges, rivers, position and form of areas of land; thus creating the science of Topography, this has been defined as the science that deals with the principles and methods used to determine the relative positions of places on the Earth's surface, through measuring and using the three elements of space (Garcia, 2003). These elements can be: two distances and an elevation, or a distance, a direction and an elevation.

Topography is used in different fields such as mining to control the location of underground works and connect them to surface works; it is also used in urban tracking to represent plots of land, construction sites, and sewer systems.

2.3 TOPOLOGY

Gomez and Garcia (2003) define Topology as the science that deals with studies of necessary methods to reach a representation of land with all its details, natural or man-made, along with the knowledge and handling of precise tools and techniques.

In order to represent the real world in a map, we need to reflect on the shape of Earth, with base on projection systems which allow considering our world from different views/forms such as conical, cylindrical, etc. (Gomez, 2003); each projection system is focused on the dimensions and location of the areas of study to be represented.

Topology facilitates and accelerates data collection by simplifying data analysis all together. In Topology, different entities are defined as (Franco, 2003):

Points: A point is a geographical entity defined by a pair of coordinates (XY) that may optionally have an elevation (Z). Associated to this point there may exist a number of attributes which describe the characteristics of such.

Lines: They are the entities represented by the union of several points.

Polygons: Polygons are entities that define geographic regions.

2.4 GEOLOGY

Geology (from the Greek geo, "Earth" and logos, "study") "is the science comprising the study of solid Earth, its constitution, structure and development, as well as the processes which take place inside of it; in its air, water and stony sheaths" (Gorshkov & Yakushova, 1970).

Geology allows the study of Earth, from the formation of its internal structure (layers inside), composition (rock and sediment), formation mechanisms, changes or alterations that have occurred from its beginning, events that take place in it (earthquakes, volcanoes, tsunamis, etc.) (Gorshkov & Yakushova, 1970)

By studying the composition of the soil, we can identify the different rocks and minerals that make it up. Geology is very important because through it, we can learn about the different types of rocks and geological faults to locate possible mineral deposits or the best suited areas for the construction of buildings, highways, etc.

2.5 MINERAL DEPOSITS

A mineral deposit is any abnormal concentration of minerals on the Earth’s crust (Canet & Camprubí, 2006).

According to Canet, the formation of mineral deposits requires, in the first place, a fluid circulation through the Earth's crust and permeable zones that are porous rocks or faults and fractures, through which fluids can circulate . Second, the fluids must be enriched by some elements which will let them evolve and interact with certain rock formations whose compositional and mineralogical characteristics will let the fluid extract the metals. Finally, an abrupt change in the physical-chemical conditions caused by variations in temperature, pH, lithology, pressure, etc. It is important that metals precipitate in a relatively small amount of rock, thus creating an area with the high concentrations that make up a mineral deposit (Canet & Camprubí, 2006).

Minerals and rocks are a fundamental part of human existence. We use rocks, for example, in construction, as ornamental rocks; to produce cement and other minerals that are obtained through industrial processes such as iron, lead, zinc, copper , gold, lead, which are used in the manufacturing of different objects such as bridges, cables, motors, tables, doors, windows, etc.

Quite great is the importance of minerals that, without them, human beings could not continue to exist because metals are used to deliver basic services needed to survive, such as pipelines to transport water, cables for obtaining electric light, machines for food manufacturing and preservation, etc.

2.6 GEOLOGICAL STRUCTURES

The term "geological structures" is used to describe fracturation of rock masses taking into account the three dimensions. The geological structures on the crust of the Earth may vary a lot in their size; they can be extremely big, for instance a continental plate or an ocean basin, or very small like a fragment of rock that can be held in one hand (Vega, 2002).

Fractures are generated by the pressure exerted between them. In some cases they break and they can even drift around.

The main structures are made out of a number of other small structures, which have been formed by processes of sedimentation, magmatic intrusion, continental drift, as well as the rise and fall of the levels of the Earth's surface at different locations (Vega, 2002).

2.7 GEOGRAPHIC INFORMATION SYSTEMS

A geographic information system (GIS) is a system conformed by hardware, software and procedures designed to capture, manage, analyze, model, and display spatially georeferenced data for management and territorial planning troubleshooting (Rodriguez & Olivella, 2011).

The main information contained inside a geographic information system must have a spatial reference, because the analysis made is based on the spatial interrelationship between the different layers of information, obtaining results with geographic locations, thus concluding that GIS provide solutions to common geographic problems that occur periodically in time, according to Rodriguez and Olivella (2011). GIS's for example:

- Give information to travelers and tourists when selecting routes, hotels and places of interest in the area.

- Provide information to forest companies to figure out what the best way to manage a forest is, or where a highway should be placed, or what zone needs to be reforested.
- Present information to transportation and delivery companies who are interested in knowing or discovering new shorter, economic or feasible routes simply because they suit the daily delivery programs better.
- Offer information to companies that will let them locate the best spot, geographically speaking, to build a business based on the type of product being marketed.
- Supply authorities with information about the road infrastructure in the country for a new route selection in order to build highways or roads in general.
- Locate new mineral deposits.

2.8 GEOGRAPHIC INFORMATION SYSTEMS IN GEOLOGY

Jean-Étienne Guettard (1715-1786) was a botanist and geologist and a pioneer in the production of geological maps, who, in 1746, presented a preliminary mineralogical map of France to the Acedémie Royale des Sciences, using symbols within maps to represent mineral deposits, types of rocks and distinctive fossils (Jay, 2001).

Ever since Guettard produced the first geological map, there has been great interest in representing geology in maps to ease the search for minerals, and people have also sought the creation of new support tools to facilitate the location, exploitation of mineral deposits and classification of rocks. At the beginning, paper maps were enough to represent rock classification. Later on, people noticed that there were different factors that could help determine the existence of minerals and rocks, such as the shape of the mountains, type of vegetation, rivers, color of the soil, etc., thus achieving up to now, a great amount of information that must be analyzed in order to locate new deposits.

Even today, paper maps are still being used to reach agreements, get organized, and make decisions on the field (Botella & Olivella, 2011).

Ever since Geographic Information Systems (GIS) came out, it has become easier and easier to store, analyze, and create maps, as well as handling information on a digital format, thus achieving quick response about spatial data, searches, comparisons, analysis and measurements (Tomlinson, 2008).

GIS have become an important tool in geology, because they allow managing information previously organized by layers and tabular data. They also allow and ease interaction among the different layers for their analysis and to carry out a series of possible combinations to have different scenarios on the information, thus making it easy to make decisions in regard of the location of possible mineral deposits.

2.9 WEB MAPPING

A Web Map Server is the engine behind the maps we can see in an Internet site. The map server or web mapping must be configured to allow communication with the web server and to place data layers on the correct image. (Mitchell, 2005).

The Web Map Service (WMS) offers an HTTP interface for inquiries about map images from one or more distributed geospatial databases. By request of the WMS, the geographic layers and the area to be processed are defined. The response to the request is one or more map images (which may come in JPEG, PNG or similar format); they can be visualized in any web browser (OGC, 2006).

Nowadays, there is a large number of servers that have been developed to work with Web Mapping Technology; these servers refer to mapping and mapping applications provided by a GIS, which can be manipulated through an interface via a Web browser (Mata, 2004).

With these applications we can access, manipulate, analyze and retrieve geospatial data in a specific format or content from a spatial database via Internet or Intranet.

The most common characteristic among GIS applications is operation on spatial data, using a client-server architecture accessing the information via Intranet or Internet protocols (OpenGIS Consortium, 2000).

2.10 MAP SERVERS

Today there is a wide variety of commercial map servers, open source and free services that support space applications. The map server is defined as the engine that allows the display of maps in a web page (Mitchell, 2005).

The maps are generated from spatial data which is stored locally or remotely. The map servers have the ability to integrate spatial data from different sources in a space application, which we will define as a graphic interface web that allows you to interact with spatial data.

A map server works by sending, at the user's request, from his browser or Internet browser, a series of HTML pages (usually DHTML1 dynamic content), with an associated cartography in an image format (such as a GIF or JPEG). A map server is, in fact, a GIS through Internet (Penroz, 2005).

Commercial map servers are an alternative for companies or organizations that are willing to pay the monetary cost of a map server. Besides, this type of map servers are less complicated to install and configure because they are based on a Windows platform, so we do not need advanced knowledge to perform these activities. Some examples of commercial map servers are: ArcIMS, ArcGIS Server, Autodesk MapGuide, MapXtreme, Web GeoMedia, Manifold 8.

There are, however, alternatives to use open source map servers which allow internal and external development and do not imply a monetary cost. Most of them are multiplatform, support OGC standards, multiple databases and multiple raster and vector formats. These types of map servers are suitable for difficult users who want to develop space applications to suit their requirements. The possible limitation of a user is the knowledge or skills he might have about the internal and external programming language of the map server. Examples of open source map servers are: GeoServer, UMN MapServer, MapGuide, Mapnik and Deegree

2.10.1 GEOSERVER

GeoServer started in 2001 because of The Open Planning Project (TOPP), a non-profit technology incubator based in New York. TOPP was the creation of a set of tools to enhance democracy and to help make government measures more transparent. The first was GeoServer, which came out of the recognition that a set of tools to facilitate citizen participation in government and urban planning would be greatly enhanced by the ability to share spatial data (Geoserver, 2012).

It is server-based software that allows users to view and edit geospatial data. It features great flexibility in creating data maps, showing their spatial information for the world.

GeoServer is an open source software server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards. GeoServer is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service (WMS). GeoServer forms a core component of the Geospatial Web (Open Geospatial Consortium, 2012).

The characteristics of Geoserver are the following:

• Variety of style to improve the publication of its maps

• It works according to the standard Web Feature Service (WFS)

• It allows the exchange and edition of the data used to generate the maps

• Incorporates its data and applications on the websites

• GeoServer is free software

• Significantly reduces financial barriers to entry compared to the products of GIS

• Not only it is free, it is also open source.

• Perform constant bug fixes and software enhancements for the community.

• Fully compatible with the specifications of WMS (web map service), WCS (Web Coverage Service) and WFS (web feature service), tested by the CITE conformance testing of OGC (Open Geospatial Consortium).

- Easy to use through the web administration tool - no need to wiggle in large and complicated configuration file.

• Support the mature PostGIS, Shapefile, ArcSDE and Oracle.

• VFP, MySQL, MapInfo, and Cascading WFS formats are also supported.

• Web Map Service output as JPEG, GIF, PNG, SVG and GML.

• Images with anti-aliasing.

• Full support for the SLD, as well as definitions of the user (POST and GET), widely used in the style settings.

• Full support for all filters in data formats in WFS.

• Support for transactions in an atomic database through WFS-T standard protocols, available for all data formats.

• Based on Java servlets (JEE), it can roll in any servlet container.

• Designed for extensions.

• Easy to write new data formats with the data storage interface GeoTools and helper classes

2.11 SPATIAL DATABASE

A spatial database is a collection of spatially referenced data that acts as a model of reality, in the sense that it represents a series or approach to phenomena. These selected features are considered important enough to be represented in digital form (Haithcoat, 2001).

The structuring of spatial information coming from the real world in layers carries some level of difficulty. First, the need of abstraction that computers require involves working with the very basics of drawing, so that all the complexity of reality is to be reduced to points, lines or polygons. Second, there are spatial relations among geographic objects which the system cannot prevent; topology, which is actually the logical- mathematical method used to define spatial relationships between geographic objects can become very complex, since there are many elements that interact with every aspect of reality(Wikipedia).

There is a variety of spatial database extension as Oracle Spatial; IBM has the extension Spatial Extender, MySQL with Spatial Extension, Postgres with PostGIS extension, etc.

PostgresSQL and PostGIS

PostGIS gives spatial support to the relation database PostgreSQL. Just as the PostGIS is stable, fast, compatible with the standards, it also has hundreds of spatial functions and is currently the most widely used open code spatial database.(Osgeo)

The characteristics of PostGis are the following:

- On-the-fly geometry transformations from a spatial reference to another.

- Addition of geometric features such as adding, modifying, and removing points
- The ability to read and write geometries in GeoJSON, GML, KML and SVG
- A wide range of comparisons among layers, such as including intersection, containment, crossing, equality, overlap, touching.
- Functions to calculate information like area, centroid, shorter routes, etc.

2.11.1 GEOGRAPHIC SPATIAL DATA

The spatial data in databases is important for the storage, structure and efficient consultation of data based on spatial locations; for example, be supposed that you want to store a set of polygons of an urban area in a database and query the database to find all polygons that are near a road.

The information cannot be checked if you have a conventional database that only store data with no spatial reference. So, for the processing of spatial queries to be efficient, it is necessary that spatial data is stored in a spatial database.
Spatial data is intended to represent different terrain features such as roads, water network, administrative boundaries, through points, lines and polygons, which are characterized for having as their main attribute, spatial location coordinates and the ability to carry out analysis between the data as: (Peña, 2008):

- Operation Attributes:
  - Operations on one or more attributes of an entity.
  - Operations in one or more attributes of multiple entities that overlap in space.

- Operations on one or more attributes that are directly connected (object orientation).
- Operations on one or more attributes that are contained by other entities (points to polygons).

- Distance/location operations:
  - Operations to locate entities with respect to a single Euclidean distance or single location criteria.
  - Operations to create proximity zones (buffer) around an entity.

CHAPTER III
METHODOLOGY

Developing good software depends on a large number of activities and stages, when the impact of choosing the best methodology for a team in a project is critical to the success of the product (inteco, 2009).

The role of methodology is essential in a project, especially in the initial step, which must fit well into the team to guide and organize activities that lead to the goals of the group.

A methodology or software model is a set of activities that lead to the creation of a software product (Sommerville, 2006).

There are several methodologies for software development, which are classified in traditional methodologies covering models RUP (Rational Unified Process) and MSF (Microsoft Solution Framework), and agile methodologies models comprising XP (Extreme Programming), AUP (Agile Unified Process), SCRUM and ICONIX.

Traditional methodologies are characterized by keeping complete documentation of the whole project and focusing on fulfilling a project plan, all of this defined at the initial phase of the project development (Kruchten, 2004).

Agile methodologies help decrease costs and provide flexibility for software projects in which uncertainty is present and the requirements are not exactly known (Beck, 2004).

For the development of the software, I chose traditional methodology because there is a great knowledge of the problem in it, and the objective of the project is well established; furthermore, traditional methodology recommends using this method at least in the first version of the software. For the following versions, it can be alternated with agile methodologies (Kruchten, 2004).

Once traditional methodology was chosen, we analyzed the characteristics of the RUP and MSF models. It was noted that RUP models are focused on big projects while MSF have flexible characteristics which can be adjusted for small or large ones.

According to the features found in each of the models, it was determined that the model for this project would be MSF (Microsoft Solution Framework).

The MSF model is divided into five main phases: vision and scope, planning, development, stabilization and implementation (Microsoft Solution Framework, 2005).

3.1 PROCESS MODEL

The Microsoft Solutions Framework (MSF) was first introduced in 1994 and it is a collection of software development processes, principles and proven practices. It is based on well-known best industry practices that allow developers to achieve success in the software development cycle (Shrimpton, 2006).

MSF focuses on three aspects of the people, process and technology involved in delivering solutions. Solutions include the coordinated delivery of technologies, documentation, training, and relevant support and service components, among others (Wilmot, 2006).

MSF acknowledges that no structure or methodology is appropriate for every project and for the environment, given the large variations in size, complexity, business requirements and organizational maturity process. It claims that an adaptive approach is an absolute necessity for success.

The MSF model has five main steps are (Figure 3.1):

- Vision and Scope.
- Planning.
- Development.
- Stabilization.
- Implementation.

Figure 3.1: The MSF Process Model showing phases and major milestones. Source: Microsoft TechNet (2005): Introduction to the Microsoft Solutions Framework. Available in http://technet.microsoft.com/en-us/library/bb497060.aspx

The **vision and scope phase** is one of the fundamental requirements for a successful project. This phase will define the goals and objectives to be achieved, which must be respected during the execution of the entire project. To define the objectives, one must take into account most of the people involved in the project in order to have a clear vision of what the customer requires and thus define the functions that the solution to be implemented should offer.

The **planning phase** is when most of the planning for the project is done. The team prepares the functional specifications, makes the design process for the solution, and prepares work plans, cost estimates and schedules for the various things to be delivered throughout the project. During this phase the functional and operational aspects of the new platform are described, the adoption of this phase will be the guideline for all the technical work to be performed, which from then on, must be consistent with this phase.

It is in **the development phase** that most of the construction of components is performed (both documentation and code). However, it is possible to do some of the development work during the stabilization stage in response to test results. The infrastructure is also developed during this phase.

It is during **the stabilization phase** when tests are conducted on the possible solution. Tests at this stage emphasize the use and operation under real conditions. The team focuses on priorizing and solving errors and preparing solutions before release. In this phase, a series of tests are carried out in response to the widest possible range of cases, so that they can bring out the maximum number of potential incidents in the shortest possible time.

Finally, in **the implementation phase** the team implants the core technology and the related components, stabilizes the system, transfers the project to the support and operations personnel, and obtains final customer approval. During this phase a record of improvements and functions not covered is kept and also new features to be incorporated in successive versions of the software are registered.

3.2 MODELING LANGUAJE

A model is a simplification of reality and, through abstraction and classification processes particular of the human mind, a scheme similar to the one observed is developed, this in order to get an idea of the complexity of the problem which faces the moment of building a final solution, thus allowing:(Fernández, 2005):

- Better understanding of the system that is being developed.
- Visualization of how the system is or how it should be.
- Specification of the structure or behavior of the system.
- Having a guide to building the system.
- Document decisions during the development.

To carry out a project we must first make a sketch of it. The Unified Modeling Language (UML) allows us to capture, in a detailed and intelligible form, the solution to the problem with the use of diagrams. For this project we used the UML as the modeling language.

UML (Unified Modeling Language) is a standard language for visualizing, specifying, constructing, and documenting the various components of an information system (Rumbaugh, 1998).

Gray Booch says 80 percent of most problems can be modeled using about 20 percent of UML.

In every software process where object-oriented methodology and notation UML are used, there must be diagrams present to represent the different views of the final product:

Static diagrams:

- Use Case diagram
- Class diagram
- Object diagram
- Component diagram
- Deployment diagram

Dynamic Diagrams:

- State Diagram
- Activity diagram

Interaction diagrams:

- Sequence diagram
- Collaboration diagram

As we can see, there are too many types of diagrams, each one used to represent different perspectives; however, it is not necessary to use all of them. It will be the practice, experience, and the type of system to be developed which will allow us to choose the diagram to be used.

3.3 USE CASES

For the development of this thesis, the author will employ the use-case model to describe, through diagrams, the methodology requirements in a more understandable manner. "The use cases describe in the form of actions and reactions the behavior of the system, analyzed from the point of view of the user”.(Debrauwer & der, 2005).

To complement the diagrams it is necessary to have the textual representation of the use cases, which explain the activities of every part of the process. The text representation contains: use case name, primary actor, system to which the use case belongs, participants (all actors) and preconditions that must be met before the use case can be executed.

The use case is used to express the functional requirements and verify that the system meets the requirements.

3.4 SOFTWARE TO BE USED IN THE DEVELOPMENT OF THE APPLICATION

3.4.1 OpenGeo Suite Community Edition

OpenGeo Suite is a geospatial applications complete platform which permits to display maps and data through web applications and mobile devices. It integrates a spatial database, an application server and an API client (Opengeo, 2012).

According to information obtained at the OpenGeo page (http://opengeo.org/products/suite/), the OpenGeo Suite is a complete mapping web platform consisting of several free software components that work together in a flexible architecture. The components are:

- PostGIS provides a quick and powerful database to respond spatial and alphanumeric queries.
- GeoServer is a map server that provides access to GIS data sources and cartographic quality maps using Web standards.
- GeoWebCache is interchangeable with TileCache, Google Maps, or the services of Microsoft Bing maps.
- OpenLayers is the standard factor for web clients that require custom maps; it can consult multiple sources and provide tools for editing and data capture.
- GeoExt is a framework based on ExtJS components including standard user interface for building web GIS applications with the look and functionality of desktop applications.

A key feature of the OpenGeo architecture is that any component is interchangeable with other products. This feature extends the sustainability of software systems.

3.4.2 PostGIS

PostGIS is an open source software program that adds support for geographic objects to the PostgreSQL database. PostGIS follows the Simple Features for SQL specification from the Open Geospatial Consortium (OGC). According to information obtained in the page http://postgis.refractions.net/, PostGIS has the following characteristics (Postgis, 2012):

- High performance, robust spatial database built on PostgreSQL
- Simple Features for SQL (SFSQL) compliance
- Proven reliability and transactional integrity (ACID compliance)
- Provides spatial representations of geometry types (points, lines, polygons)
- Support for common and advanced spatial operations such as geometry creation and conversion, projection, buffer, generalization, union, and more.
- Geodetic support for measurements across the globe/dateline
- Command-line and graphical tools for flexible management

3.4.3 Geoserver

GeoServer server is an open source software written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards, which has the following characteristics (Geoserver, 2012):

(Geoserver http://geoserver.org/display/GEOS/Welcome)

- Implements OGC services including Web Map Service (WMS 1.1.1 and 1.3.0), Web Feature Service (WFS 1.0.0 and 1.1.0), WFS-Transactional (WFS-T 1.0.0), and Web Coverage Service (WCS 1.0.0 and 1.1.1)
- Java J2EE application, works with Jetty, Tomcat, WebLogic, WebSphere, JBoss

- Support for many back-end data formats (ArcSDE, Oracle Spatial, DB2, SQL Server, shapefile, GeoTIFF, MrSID, JPEG2000)
- Multiple output formats (GML, shapefile, KML, GeoJSON, PNG, JPEG, TIFF, SVG, PDF, GeoRSS) plus Google Earth integration
- Fully-featured and intuitive web administration interface with REST API for programmatic control
- Full map styling support with Styled Layer Descriptor (SLD), including text-based and graphical editor
- User- and role-based security subsystem based on Spring Security

3.4.4 OpenLayers

OpenLayers is a JavaScript library for displaying map data in most web browsers, with no server-side dependencies. OpenLayers implements a JavaScript API for building web applications based on geographic, similar to Google Maps, with one important difference - OpenLayers is Free Software, developed for and by the open source software community. It has the following characteristics (Openlayers, 2012): (OpenLayers http://openlayers.org/)

- Overlay multiple standards-compliant map layers into a single application
- Displays tiles/images from WMS, WMTS, TMS, WMS-C, WMTS, Google Maps, Bing Maps, Yahoo Maps, OpenStreetMap, ArcGIS Server, ArcIMS
- Vector feature rendering and styling with support for KML, GeoJSON, WKT, GML, WFS, GeoRSS

- Web-based editing, including feature snapping and splitting, via WFS-Transactional (WFS-T) leveraging SVG or VML
- Pluggable with any JavaScript toolkit (JQuery, Ext, Dojo, MooTools)
- Client side map reprojection
- Feature clustering and paging

3.4.5 GeoExt

GeoExt is a JavaScript library that provides a basis for the creation of web mapping applications. Combines web mapping library Openlayers with ExtJS. GeoExt provides a set of customizable tools for manipulating data to make it easier to support the creation of applications for viewing, editing, and style of geospatial data. Its features are: (OpenGeo http://opengeo.org/technology/geoext /)

- Built with Ext JS, cross-browser rich Internet application framework
- Integrated OpenLayers mapping client
- Full dynamic user interactivity and animation without the need for Flash or Silverlight
- Well designed and extensible component model.
- Wide variety of generic widgets (grids, charts, trees, layouts, combo boxes, toolbars)
- Flexible, standards-based mapping widgets like legends, pop-ups, and scale choosers

- Printing controls from PDF serving platform, such as page layouts, resolution, and legends
- Customizable layer selection

3.5 DATA ACQUISITION

A comprehensive analysis of the requirements for the development of the methodology for geological and mining information capture has been carried out and a database of spatial extension in PostgresSQL has been built for data publication progress, based on the experience and knowledge we have in data collection, analysis, handling and editing of geological-mining and geochemical information. The requirements that have been identified are as follows: the analysis of quality system procedures of Mexican Geological Survey for geological information capture; maps index of 1:50,000 scale of the Mexican Republic and the projection parameters established by INEGI (National Institute of Statistics and geographical); exploration of GIS software used to process geological information.

The analysis of the procedures established in the Mexican Geological Survey Quality System for geological information capture is of upmost importance in the development of methodology, since we are relying on these procedures to collect geological information such as the amount of layers of information to be collected, attributes, symbology and classification of information.

For the creation of the layers of information, the projection parameters established by INEGI should be consulted. Given that it is the institution that provides the projection systems used for maps at different scales within the Mexican republic, it will be necessary also to rely on index of 1, 50,000 scale maps created by the INEGI as well.

The different GIS software used for generating geological-mining information will be analyzed to select the most suitable for the development of appropriate methodology.

CHAPTER IV

RESULTS

Concordant to the use case model selected for the development of this thesis, a table containing the documents for developed requirements for geological information capture methodology has been created (see table 4.1). In addition, use case diagrams have been made where it is possible to observe the processes that field geologists can perform, as well as database managers and any personnel who consult the developed website (see figure 4.1 to 4.3).

Table 4.1 Requirements document capture for the methodology of geological capture.

ID req.	**Description**	**Case of use**
RQ01	Selecting base folder grounded on geographical location, these can be: zona11,zona12, zona13, zona14, zona15, zona16	CU01
RQ02	Displaying symbology identifiers used.	CU02
RQ03	Capturing information at every layer of information.	CU03
RQ04	Sending Information to Database.	CU04
RQ05	Upload information to Database.	CU05
RQ06	Displaying maps in the process of capturing.	CU06
RQ07	Navigating within the map and be allowed to: Move around the map Zoom out Zoom in Check details of any item.	CU07

RQ08	Allowing the display or concealment of the different layers of information.	CU08
RQ09	Allowing the consultation of the different layers of information.	CU09
RQ10	Making map observations through the use of lines and polygons.	CU10
RQ11	Printing the map with all the layers currently visible.	CU11
RQ12	Commenting on the information published.	CU12

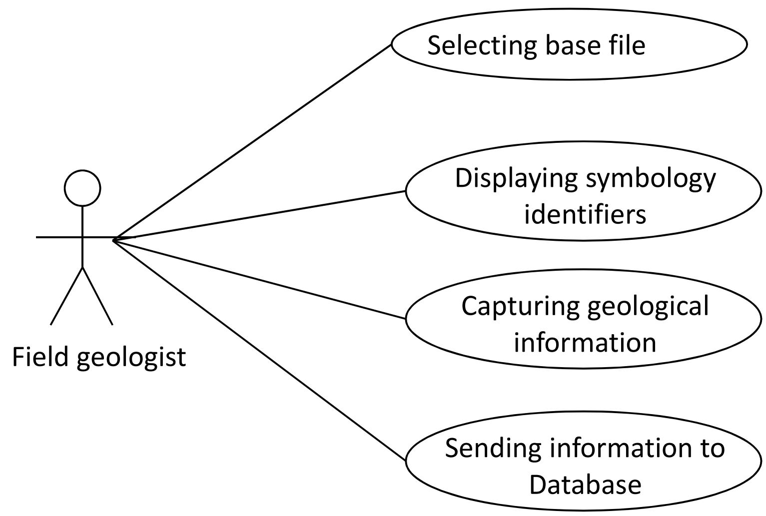


Figure 4.1 Use case Diagram for field geologists in the process of geological information capture.

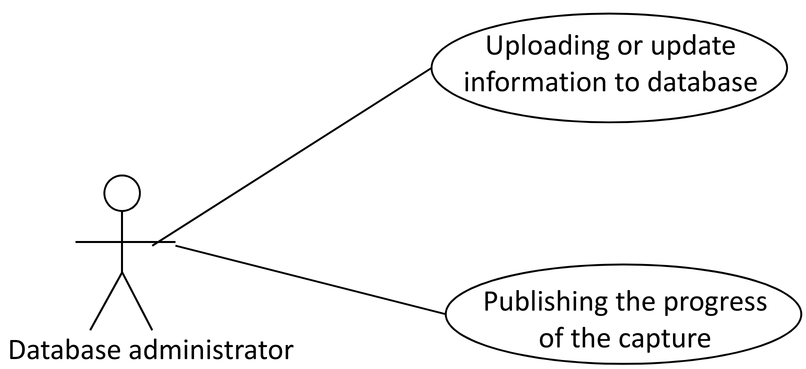


Figure 4.2 Use Case Diagram for Administrator of the database.

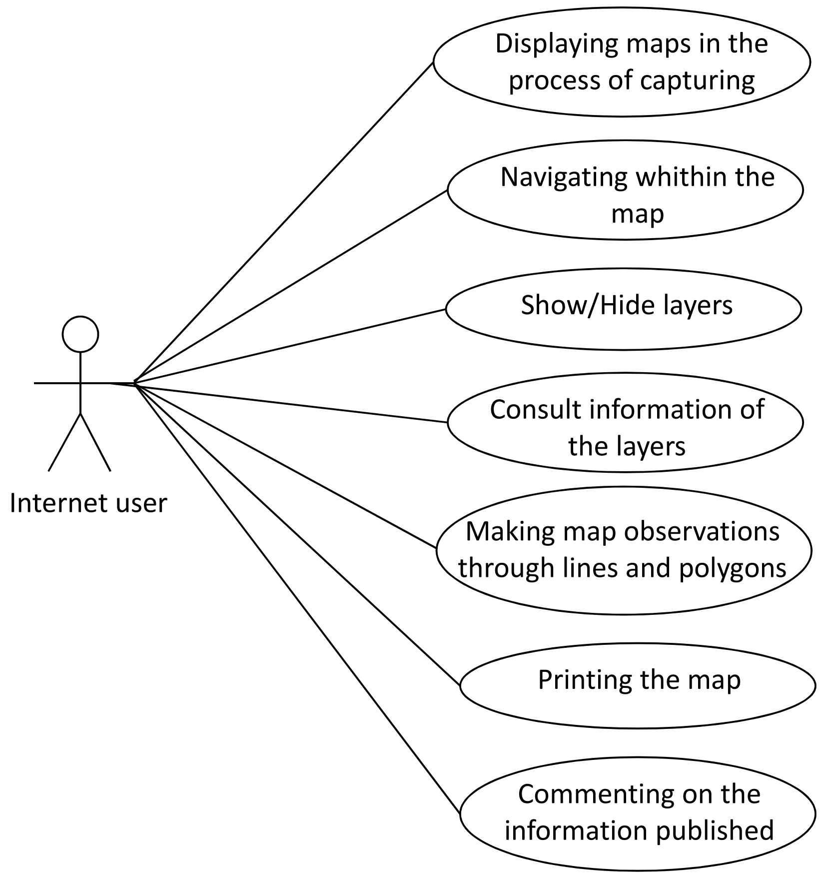


Figure 4.3 Use Case Diagram for internet users.

In the following paragraphs it is provided a brief description of the use case listed in table 4.1. In order to deepen into each use case, it is highly recommended to refer to appendix C use cases.

The use case CU01: The field geologist selects a base folder according to the location of the area to capture; shapefiles inside this folder will be used with Arcgis software for information collection process.

Use case CU02: The field Geologist identifies the chart with identifiers of every symbol corresponding to the element to be captured. The identifiers correspond to the symbols generated in ArcGIS.

Use case CU03: The field geologist captures the geological data according to the required attributes for each level of information; afterwards, he uses the compiled data at the beginning of the process and the captured information through GPS devices and mobile geographical information systems in order to incorporate them to the shapefiles base selected at the beginning of the process.

Use case CU04: The geologist sends the database administrator the shapefiles with the advances of the capture taken every month, so it can be published on the server, with the purpose of letting the institution staff know about the previews and location of the input areas, as the personnel can opine about the geological interpretation. The shapefiles data contents are susceptible to partial or total changes. Because of that, this information cannot be used for other projects, until it is marked as concluded in the input for the area information.

Use case CU05: The database administrator receives from the geologist the shapefiles with the advance of the mining geological input done per month in order to be published on the server. The administrator converts the shapefiles into SQL format files so he can capture them into the database where, in an automatic mode, the published information can be updated.

Use case CU06: The internet user enters the website and the input preview maps is shown with its basic information and its legend, tools of navigation, data reference and the list of the data levels to activate or deactivate them.

Use case CU07: The internet user selects one of the available navigation tools and they move over the map by clicking over the required area to generate a new view of the map.

Use case CU08: The internet users activate or deactivate the box that corresponds to each layer. The list of layers visible on the map is updated.

Use case CU09: The internet user will select the button to consult the information to obtain a window with the selected data on the map.

Use case CU010: The internet user selects the information button to see a window that shows the selected items on the map.

Use case CU011: The internet user selects the print tool. A window will appear with the current image of the map and the user saves the map as a pdf file.

Use case CU012: The internet user writes and sends the comments and observations on the map being captured using PowerPoint, to send the presentation or the PDF printing file to the field geologist.

For the database development, the Entity relationship diagram of the database was created (figure 4.4) and the attached CD contains the UML entity relationship diagram where the categories from the table are shown, as well as how they relate to each other.

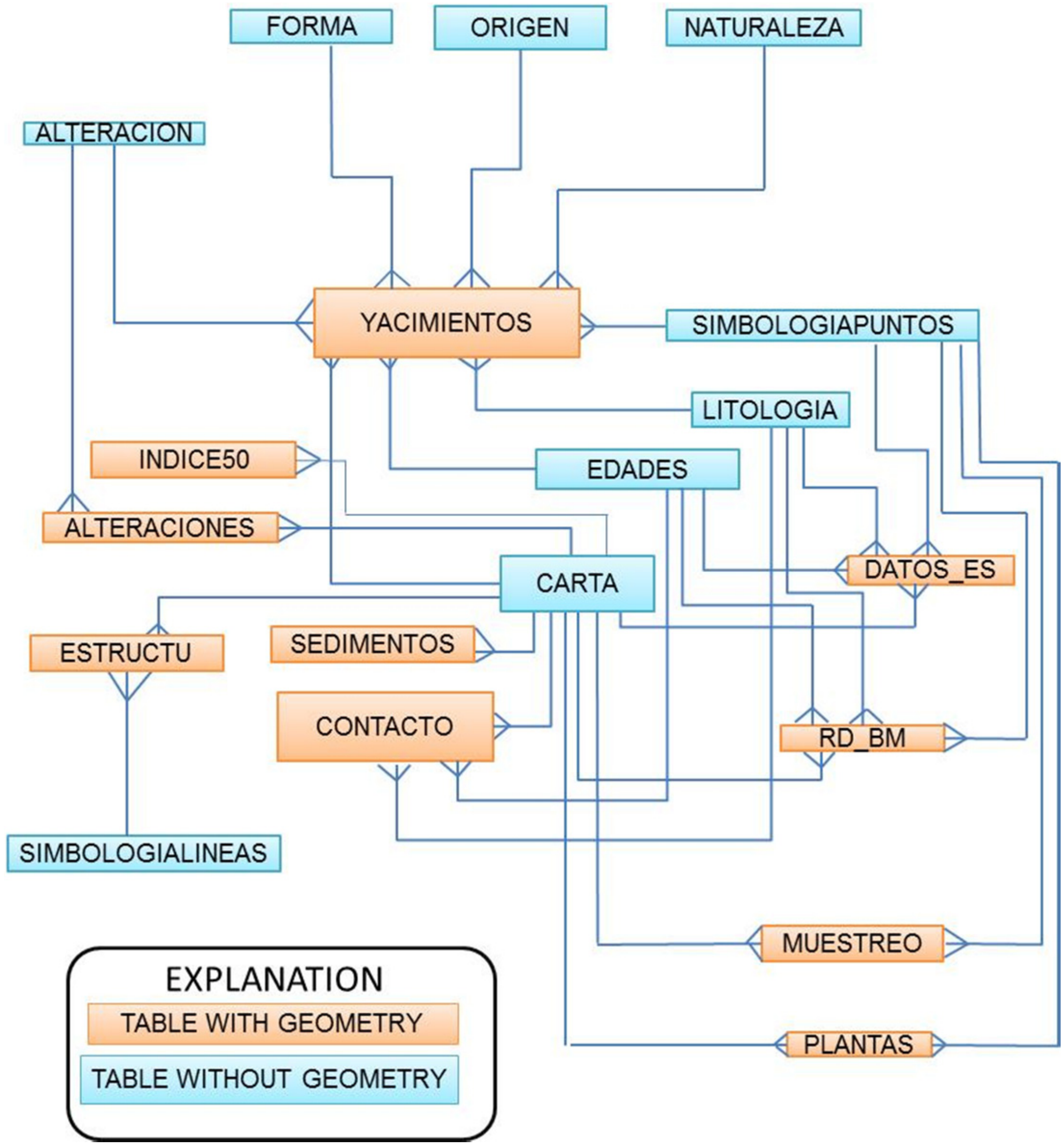


Figure 4.4 Entity relationship diagram for the design of the database.

Following development of a methodology to capture mining geological information, it has been possible to achieve standardization of the attributes of each information layer, as well as utilization of identifiers for the symbolic representation of each data type added to such information layers.

Information layers standardization allows a number of options ranking from quick integration of in-field collected data of different areas, to performance of a spatial analysis of each information layer.

Through development of the web server, it gets assured that the information layers captured for different areas hold the same attributes, as well as making it possible for the institution personnel to consult online the status of the capture areas and, in a given case, to post comments about the captured data with the object of allowing people responsible for the capturing to evaluate such insights. Thus performing the corresponding needed corrections, so as the final captured data includes no mistakes at the end of the process.

CHAPTER V
CONCLUSIONS

The Geographic Information System has been relying on increasingly advanced technology; in such a way that we can say that nowadays there are several methods, software and computer equipment to achieve the best results.

Using free software is a good option for generating Web map servers, because there are currently many internet users who share programming code, experiences, or even tutorials. Furthermore, free software has their own websites with several examples on how to use the tools.

Taking advantage of the benefits provided by free software has led to an interactive map for advance publication of geological data capture. For instance OpenGeo Suite Community Edition is a free software suite that comprises a database manager (PostgreSql), an extension for geographic data (PostGIS), and a map server (Geoserver).

The interactive map allows to visualize the location of the areas being captured, consulting attributes for each level of information and surfing the map so that the institution staff can make comments on the capture and geologic interpretation to send them to the field geologist later via e-mail, in which the geologist can evaluate the comments made, and if necessary be able to verify the field before the capture is completed.

Up to date every level of geologic information captured in the field, has more value when the layers have more attributes besides the coordinates (more attributes means higher value).

Using the available resources in the institution, we have used the software ArcGIS to design the layers in shapefile format with its corresponding symbols.

The layers designed for each level of information intend to provide the captured information that includes areas with the same attributes and same projection system.

It is of great importance that the geologist, who did field research, is the one who captures information, fills in the attributes for each layer and completes the description of the geographic elements in the “observation” field contained in each level of information.

Based on this methodology, and since layers won´t be digitalized nor attributes will be standardized; it is possible to save time in capturing and editing the geologic-mining information. When the capturing process is over, the layers will be sent directly to the map editing area and the institutional database for its publication.

The advantage of the standardization of levels of information is that when the capturing is done, the obtained information will be integrated to the one gathering in other areas in a faster way.

The development of the application GeoCap is very helpful, since given that the beginning of the process, geologists consider the attributes required for each level of information that must be fulfilled in order to integrate the database and the online publication.

The application has an institutional reach since the captured information will be susceptible to total or partial changes depending on the field visits and the comments made; therefore, it won’t be used for other projects until the end of the capture.

Institution staff will have a wide vision of the geologic-mining information capture activities, where they will be able to observe the progress on the areas being captured and being the case, the ones with a science of Earth profile will be able to make suggestions and comments on the captured and assessed information.

If more people has checked the interpreted information as soon as possible and before the capture is done, the geologist can have more chances to evaluate comments and go back to the field to verify again in case of possible questions.

According to the analysis of free software such as gvSIG, Quantum GIS and Grass, in the future, the use of the GIS software will be implemented for data capture, in a way that the same files in shapefile format will be used, and will only generate symbols equivalent to the ArcGis for each layer of information.

CHAPTER VI
RECOMENDATIONS

It is Important, to highlight the fact that the recommendations of this thesis are focused on the capture process of mining geological information from the Mexican Geological Service.

Please read the appendixes at the end of the thesis, which describe in detail each one of the levels of information, and the steps required for installation and configuration of the developed application.

In case of making changes to the structure of the layers or changing the coordinates system, it will also be necessary to make modifications within the database application, basing the on the UML diagram that is located on the UML folder in the CD

BIBLIOGRAPHY

- Beck, K. (2004): Extreme programming explained, Addison Wesley, U.S.A.

- Botella A., Muñoz A., Olivella R., Almedillas J.C., & Rodríguez J., (2011): Introducción a los sistemas de información geográfica y geotelemática. Barcelona: Editorial UOC, pp. 200.

- Canet, C. y Camprubí, A. (2006) Yacimientos minerales: Los tesoros de la Tierra, Fondo de Cultura Económica, México, pp. 16-17

- Debrauwer L. & der Heyde, F. (2005). HUML 2. Iniciación ejemplos y ejercicios corregidos. Ediciones ENI; España; Mayo 2005, Pp. 47

- Del Rio, J (2010), (Haithcoat et. al., 2001). Tratamiento de datos espaciales en la hidrología, Ed. Universidad Bubok España. pp. 6, 16

- Fernández, J.D.(2005):Sistemas organizacionales Teoría y práctica, editorial Universidad cooperativa de Colombia, pp. 38

- Franco, S & Valdez Ma. E.(2003) Principios básicos de Cartografía y Cartografía automatizada, Universidad Autónoma del Estado de México, primera edición, México. pp. 114,116

- García, F. (2003) Curso básico de topografía, Pax México, pp. 1-2

- Geoserver (2012): http://geoserver.org/display/GEOS/Welcome

- Geoserver (2012): http://docs.geoserver.org/stable/en/user/introduction/history.html

- Gómez, J; García, F. (2003) Matemáticas Volumen II, Mad, S.L., España, pp. 410-414
-

- Gorshkov, G.; Yakushova, A. (1970) Geología General, Ed. MIR, Moscú, pp. 7-10

- Inteco (2009): Ingeniería del software: Metodologías y ciclos de vida, pp. 41. [Online]. [Access date: July 23, 2012]. Available in: www.inteco.es/file/N85W1ZWFHifRgUc_oY8_Xg

- Jay, S. (2001): Las piedras falaces de Marrakech. Barcelona: Editorial crítica, S.L., pp. 105-106.

- Kruchten, P. (2004): The Rational Unified Process An Introduction, Pearson Education.

- López, E. (1988): Boletín de la Sociedad Geológica Mexicana, Tomo 49, No. 1-2, pp. 3-18. [Online]. [Access date: July 19, 2012]. Available in: http://dialnet.unirioja.es/servlet/articulo?codigo=280448

- Mata, 2004: Miguel Félix Mata Rivera. Recuperando y Analizando Datos Espaciales a través de Web Mapping, Tesis de Maestría. Centro de Investigación en Computación.

- Microsoft TechNet (2005): Introduction to the Microsoft Solutions Framework. Available in http://technet.microsoft.com/en-us/library/bb497060.aspx

- Mitchell, T. (2005): Web Mapping Illustrated. United States of America, O'reilly, pp. 3,5,11

- OGC (2006). Open Geospatial Consortium. [Online]. [Access date: July 25, 2012]. Available in: http://www.opengeospatial.org/standards/wms/

- OpenGeo (2012): http://opengeo.org/

- Open Geospatial Consortium (2012): http://www.opengeospatial.org/standards/wms/

- OpenGIS Consortium, 2000: OpenGIS Consortium, 2000. OpenGIS Web Map Server Interface Specification (versión 0.9). OGC 1999b, OpenGIS Project Document 99-0077r4

- OpenLayers(2012): http://openlayers.org/
- Osgeo (2012): http://live.osgeo.org/es/overview/postgis_overview.html
- Penroz, A. (2005) "Graphical User Interface (GUI) para el programa servidor de mapas MapSever 4.6.1
- Peña, J. (2008). Sistemas de Información geográfica aplicados a la gestión del territorio, Editorial Club Universitario, Tercera Edición, España, pp. 29
- PostGIS(2012): http://postgis.refractions.net/
- Rodríguez, J;Olivella, G (2011) Consideraciones conceptuales sobre los sistemas de información geográfica, pp. 22-23
- Rojas, L (2008): Geografía, segunda edición, Edamsa Impresiones, S.A. de C.V. México. pp. 3-5
- Rumbaugh, J, Jacobson, I and Booch, G.(1998): The Unified Modeling Languaje Reference Manual, Addison-.Wesley, pp. 1
- Shrimpton, S. (2006): Pro Visual Studio 2005 Team System Application Development, Apress, pp. 55
- Sommerville, I. (2006): Ingeniería del Software. Séptima Edición, Pearson Educación, Madrid, pp. 12,60
-
- Taboada, J. A. & Cotos, J. 2005: Sistemas de Información Medioambiental, netbiblo, España, pp. 39
- Tomlinson, R. (2008): Pensando en el SIG: Planificación del Sistema de Información Geográfica dirigida a gerentes. Esri Press, pp. 3.
- Trimble Nomad (2012): [Online]. [Access date: July 24, 2012]. Available in: http://www.trimble.com/mappingGIS/nomadg.aspx?dtID=key_benefits

- Vega (2002): Problemas de Ingeniería de puesta a tierra, Limusa, S.A de C.V., México, pp. 56-57

- Wikipedia (2012): Base de Datos Espaciales. [Online]. [Access date: August 08, 2012]. Available in: [http://es.wikipedia.org/wiki/Base_de_datos_espacial]

- Wilmot, P. (2006), Yu, L., Yuhas, J. & Zandbergen, W.: MSF, a pocket guide, delivering IT solutions. Microsoft Corporation. pp. 11, 12

APPENDIX A. STRUCTURE FOR CAPTURE SHAPEFILES

LAYER: CONTACTO	
FIELD	**DESCRIPTION**
ESCALA	Value 1 for scale 1:250,000, 1:50,000 scale value of 2
CARTA	Identifier map according to the index scale 1:50,000
EDADINI	Age range of the initial rock
EDADFIN	End of the age range of the rock
LITO1	First predominant lithology
LITO2	Second predominant lithology
CLAVE	Key rock type according to the geological age and rock type
SIMBOLO	Symbology identifier according to the type of rock
ORIGEN	Origin of the rock formation
FORMACIO	Formation belonging to lithology
OBSERV	Comments on the rock type
FOTO1	First filename photo
FOTO2	Second filename Photo
FOTO3	Third filename photography
AREA	Area of the polygon that defines the type of rock
GPS_DATE	Capture date
ESTRUCTU	
FIELD	**DESCRIPTION**
ESCALA	Value 1 for scale 1:250,000, 1:50,000 scale value of 2
CARTA	Identifier according to the index map scale 1:50,000
SIMBOLO	Symbology identifier according to the type of fault line
NOMBRE	Name of fault or geological structure
ENTIDAD	Group name of geological structure to which it belongs
LENGTH	Length of the fault
RUMBO	Degrees of direction of the fault
RUMBODIR	Direction of the fault
ECHADO	Degree of fault cast
ECHADODIR	Direction of dip of the fault
OBSERV	Comments field on the geological structure
FOTO1	First photographic filename
FOTO2	Second photographic filename
FOTO3	Third photographic filename
GPS_DATE	Capture date

MUESTREO	
FIELD	**DESCRIPTION**
ESCALA	Value 1 for scale 1:250,000, 1:50,000 scale value of 2
CARTA	Identifier according to the index map scale 1:50,000
MUESTRA	Sample key
X	X coordinate of sample
Y	Y coordinate of sample
Z	Sample height
SIMBOLO	Identifier according to the table of symbology
OBSERV	Comments on sampling
FOTO1	First photographic filename
FOTO2	Second photographic filename
FOTO3	Third photographic filename
EPE	GPS accuracy error
GPS_DATE	Capture date

DATOS_ES	
FIELD	**DESCRIPTION**
ESCALA	Value 1 for scale 1:250,000, 1:50,000 scale value of 2
CARTA	Identifier according to the index map scale 1:50,000
DEFINITIVO	Sample number
REGISTRO	Registration number of the structural data captured
ZONA	Geographical area of the map 11 to 16
X	Coordinate x
Y	Coordinate y
Z	Height
SIMBOLO	Identifier according to the symbology
RUMBO	Course grades of structural data
RUMBODIR	Direction of structural data
ECHADO	Thrown off course grades
ECHADODIR	Direction of dip
LITO1	First lithology where the data was taken
LITO2	Second lithology where the data was taken
EDAD1	Age range of the initial rock
EDAD2	End of the age range of the rock
OBSERV	Comment on the structural data
FOTO1	First photographic filename
FOTO2	Second photographic filename
FOTO3	Third photographic filename
EPE	Precision error of GPS equipment with which take the point
GPS_DATE	Capture date
ROTAR	Degrees of rotation according to the course and caught lying

PLANTAS	
FIELD	**DESCRIPTION**
ESCALA	Value 1 for scale 1:250,000, 1:50,000 scale value of 2
CARTA	Identifier of the card according to the index scale 1:50,000
NOMBRE	Name of the mineral processing plant
ZONA	Geographical area where the plant lies
X	X coordinate
Y	Y coordinate
Z	Altitude above sea level at which the plant is located
SIMBOLO	Symbology identifier for the type of plant
PROCESO	Name mineral extraction process using the plant
CAPACIDAD	Processing capacity of the processing plant
PRODUCTO	Plant producing mineral
OBSERV	Geological comments on the plant
FOTO1	First photographic filename
FOTO2	Second photographic filename
FOTO3	Third photographic filename
EPE	GPS accuracy error with which the information was captured
GPS_DATE	Capture date

ALTERACIONES	
FIELD	**DESCRIPTION**
ESCALA	1:250,000 scale value 1, value 2 for 1:50,000 scale
CARTA	Map identifier according to the index scale 1:50,000
ALTERACI1	First alteration predominant
ALTERACI2	Second alteration predominant
ALTERACI3	Third alteration predominant
SIMBOLO	Symbol identifier that corresponds
OBSERV	Comments geological observed in the area
FOTO1	First photographic filename
FOTO2	Second photographic filename
FOTO3	Third photographic filename
AREA	Area of the alteration zone
GPS_DATE	Capture date

SEDIMENTOS	
FIELD	**DESCRIPTION**
ESCALA	1:250,000 scale value 1, value 2 for 1:50,000 scale
CARTA	Map identifier according to letters index scale 1:50,000
REGISTRO	Sample key
X	X coordinate
Y	Y coordinate
Z	Height above sea level
SIMBOLO	Identifier according to the type of symbols
PH	Degree of acidity of the sample
ACTIVO	Stream status true or false
ANCHOACT	Width of the stream when active
ANCHOSEC	Width of the stream when dry
PROF	Depths
COLOR	Water color
VELOCIDAD	Speed of the river
MATERIAL1	First sample material
MATERIAL2	Second sample material
MATERIAL3	Third sample material
MATERIAL4	Fourth sample material
MATERIAL5	Fifth sample material
MATERIAL6	Sixth sample material
COLORSED	Color sample
MINERALES	Minerals in the sample
CONTAMINA1	1 source of water pollution
CONTAMINA2	2 source of water pollution
CONTAMINA3	3 source of water pollution
CONTAMINA4	4 source of water pollution
CONTAMINA5	5 source of water pollution
CONTAMINA6	6 source of water pollution
CONTAMINA7	7 source of water pollution
CONTAMINA8	8 source of water pollution
OBSERV	Geological observations of the sample
FOTO1	First photographic filename
FOTO2	Second photographic filename
FOTO3	Third photographic filename
EPE	Procession of GPS error
GPS_DATE	Capture date

RD_BM	
FIELD	**DESCRIPTION**
ESCALA	1:250,000 scale value 1, value 2 for 1:50,000 scale
CARTA	Map identifier according to letters index scale 1:50,000
NOMBRE	Bank material name
REGISTRO	Assigned to the bank key material
ZONA	Geographical area where the bank is located material
X	X coordinate
Y	Y coordinate
Z	Height above sea level
SIMBOLO	Symbol identifier according to the symbol table
STATUS	Material bank status
EDAD1	Initial age range of the rock explodes bank material
EDAD2	End of the age range of the rock which operates the bank material
LITO1	First Bank predominant lithology material
LITO2	Predominant lithology second bank of material
PRODUCTO	Material that exploits the bank material
CLASIFICA	Bank classification of material
OBSERV	Comments on the bank of geological material
FOTO1	First photographic filename
FOTO2	Second photographic filename
FOTO3	Third photographic filename
EPE	GPS accuracy error when the bank captured material
GPS_DATE	Capture date

YACIMIENTOS	
FIELD	**DESCRIPTION**
ESCALA	1:250,000 scale value 1, value 2 for 1:50,000 scale
CARTA	Map identifier according to letters index scale 1:50,000
NOMBRE	Name of the mineral deposit
REGISTRO	Key assigned to the mineral deposit
ZONA	Geographical area in which the site is located
X	X coordinate
Y	Y coordinate
Z	Height above sea level of the reserve
ENTIDAD	Group name of the mineral deposits to which belong this site belong.
SIMBOLO	Symbology identifier according to the data type
PRODUCTO	Mineral being mined
FORMA	Geological shape of the deposit

ORIGEN	Origin of the deposit
NATURALEZA	Nature of the deposit
RUMBO	Degrees of direction of the deposit
RUMBODIR	Deposit direction
ECHADO	Inclination degrees of the deposit
ECHADODIR	Direction of the inclination
LONG	Length of the deposit
ESPESOR	Mineral deposit thickness
PROF	Mineral deposit depth
OBRAS	Works made for mineral extraction
ROCAENC	Host rock of the mineral deposit
EDAD1	Age range of the initial rock
EDAD2	End of the age range of the rock
LITO1	First lithology of the rock
LITO2	Second lithology of the rock
MENAHIPO	Hypogene mena
MENASUPER	Supergene mena
GANGA	Bargain
TEXTURA	Rock texture
ALTERACI1	First alteration of the mineral deposit
ALTERACI2	Second alteration of the mineral deposit
ALTERACI3	Third alteration of the deposit
MUESTREO	Type of sampling conducted at the site
OBSERV	Geological of the mineral deposit comments
FOTO1	First photographic filename
FOTO2	Second photographic filename
FOTO3	Third photographic filename
EPE	Precision error to capture the mineral deposit
GPS_DATE	Capture date
ROTAR	Angle of rotation of the symbolism to represent the veins

APPENDIX B DESCRIPTION OF LAYERS

Table B.1 Base folder shapefiles.

Attribute	Shape	Description
Contacto	polygon	Stores information about the types of lithology present in the study area.
Estructu	Line	Store geological fault found in the study area.
muestreo	Point	Stores information about the location of the sample and the type of study that will be done in the laboratory.
sedimentos	Point	Stores information about the sampling taken from the stream´s sediments for analysis in the laboratory.
Plantas	Point	Stores information about the mineral processing plants located in the study area.
Rd_bm	Point	Stores information about material banks located in the study area.
yacimientos	Point	Stores information on mineral deposits in the study area.
Datos_es	Point	Stores information about structural data taken in structural geology.
Indice50	polygon	Stores 1:50,000 scale index cards to locate the study area.

APPENDIX C. USE CASES

C.1. USE CASE FOR SELECTED BASED FILE FOLDER

Use Case: Selected base file folder

Use Case ID: CU01

Actors: Field geologist (initiator).

Purpose: Select the folder that contains the base files to start the process information capture.

Summary: Field geologist selects base folder according to location of the area to capture; shapefiles inside this folder will be used with Arcgis software for information collection process.

Normal course of the events

ArcGIS software will be used in the processing of shapefiles where all data to be captured and interpreted by a geologist will be stored, and there will be six base folders (zona11, zona12, zona13, zona14, zona15 and zona16) with accordingly empty shapefiles. Appendix B Table B.1 shows names and descriptions of each of the shapefiles; the fields for every shapefile can also be found in the appendix A. The projection system of each base folder corresponds to each of the UTM (Universal Transversal Mercator) geographical areas in which the Mexican Republic is divided. The corresponding zone is implied within the folder's name.

1. Based on the location of the capture area (see figure C.1.1) the geologist selects the corresponding base folder to start the capture process.

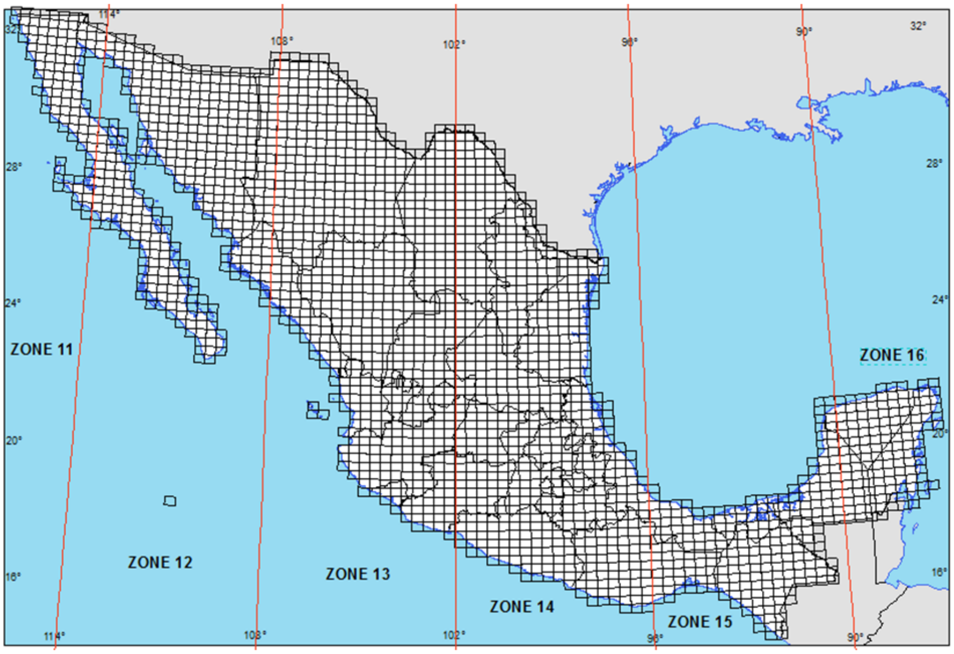


Figure C.1.1 Index of 1:50,000 scale maps and location utm zones of the Mexican republic.

2. The folder should be renamed with the corresponding name of the area in agreement with scale 1:50,000 index to have a good control with all capture areas.
3. All the information obtained through the Mexican Geological Survey and other source of information as universities, government bureaus should be copied within the selected base folder. The geographic information can be satellite images, topographic information, geological and mining information made in different date and/or different scale about the area to be captured.

   The added information to the folder will be taken as the base to making the geological interpretation and scheduling checkpoint in the field.

Sequence diagram

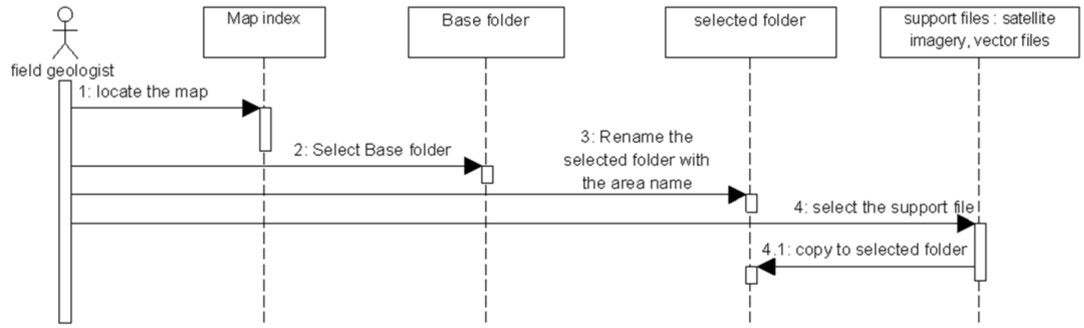


Figure C.1.2 Use Case Diagram for selected base file folder.

C.2. USE CASE VIEW SYMBOL IDENTIFIER

Use case: View symbol identifier

Use Case ID: CU02

Actors: Field geologist.

Purpose: To be able to know the charts of symbols identifiers for the possible geographic elements that can be captured at each level of information.

Summary: Field Geologist identifies the chart with identifiers of every symbol corresponding to the element to capture. The identifiers correspond to the symbols generated in ArcGIS.

Normal course of the events

To be able to know the charts of symbols identifiers that corresponds to possible elements to capture in each one of the layers (see Appendix B Tables B.2 to B.7). You can also display the symbols created to represent the mining geological information in the "Style Manager" ArcMap, window, as shown in Figure C.2.1. The symbology identifiers must be captured in the column named “simbolo" for each level of information according to the type of information captured.

1. View the layers with their attributes on Arcmap to know the attributes required when the field geologist is interpreting and capturing geological information.
2. View the symbology identifier to know where can be consult the identifiers of each element captured according to each layer.

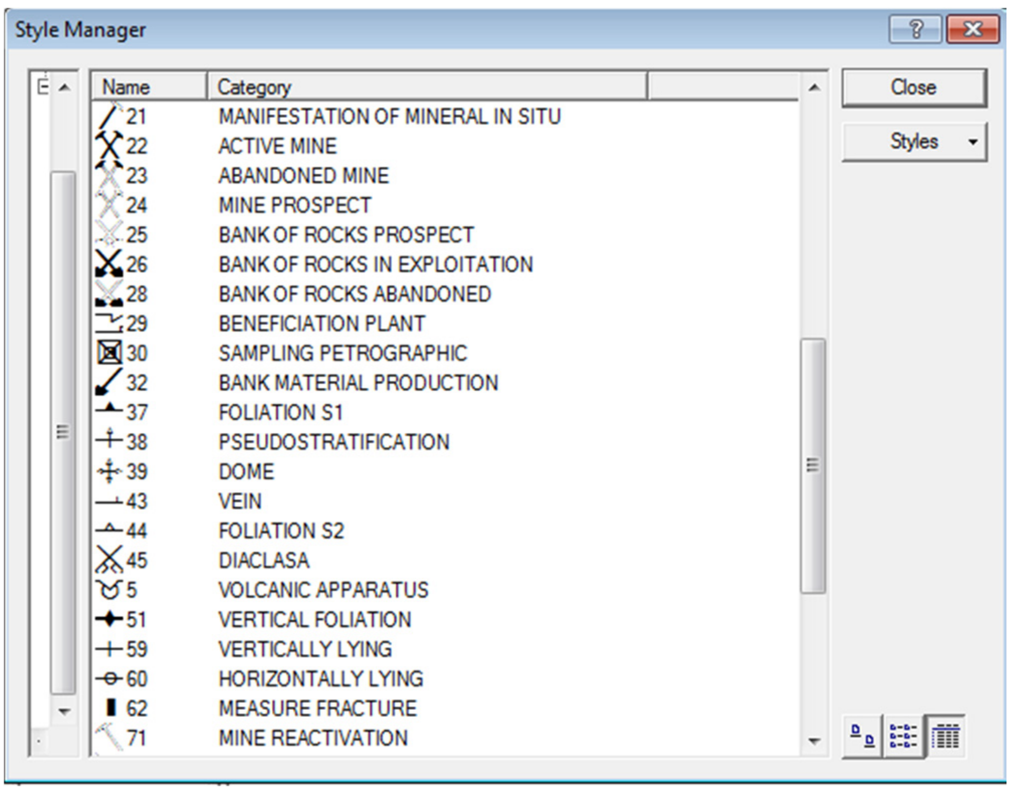


Figure C.2.1 Style manager with the symbology used to capture.

Sequence Diagram

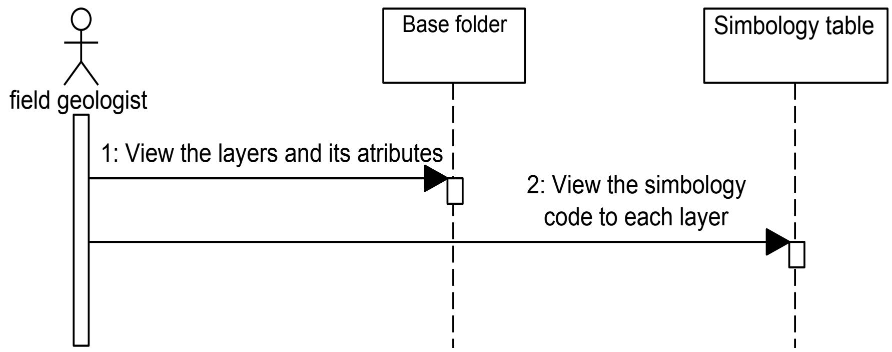


Figure C.2.2 Use Case Diagram view symbol identifier.

C.3 USE CASE CAPTURES GEOLOGICAL INFORMATION.

Use case: Capture geological information

Use case ID: CU03

Actors: Field geologist.

Purpose: Capturing geological information in the shapefiles obtained at the beginning of the process.

Summary: The field geologist captures the geological data according to the required attributes for each level of information; afterwards, he uses the compiled data at the beginning of the process and the captured information through GPS devices and mobile geographical information systems in order to incorporate it in the shapefiles base selected in the beginning of the process.

Normal course of the events

1. In Arcmap, load satellite imagery, geographic information obtained through other sources and the shapefiles located in the base folder.
2. Do the preinterpretation with information obtained through other sources and trace lines, points and polygons in the shapefiles loaded.
3. Schedule the order of capturing to verify the preinterpretation and complement with the capture of geological-mining information.
4. The geologist proceeds to capture information in the field according to schedule and attributes defined in each one of the levels of information.
5. The information collected will then proceed into ArcMap to update or add according to each layer; in case of line and polygon layers, information field and collected from other sources, it is taken as a basis for geological interpretation and thus captured on the geographical layers.
6. Add the symbology identifier to each element captured in each layer, and view the layers into Arcmap with their corresponding symbology.
7. Fill the attributes of each layer according to the information captured in the field.
8. Review the information captured with their symbology and attributes to make sure the information is correct.

In the figure C.3.1 we can observe an example of how the levels of information can be observed with their corresponding symbology.

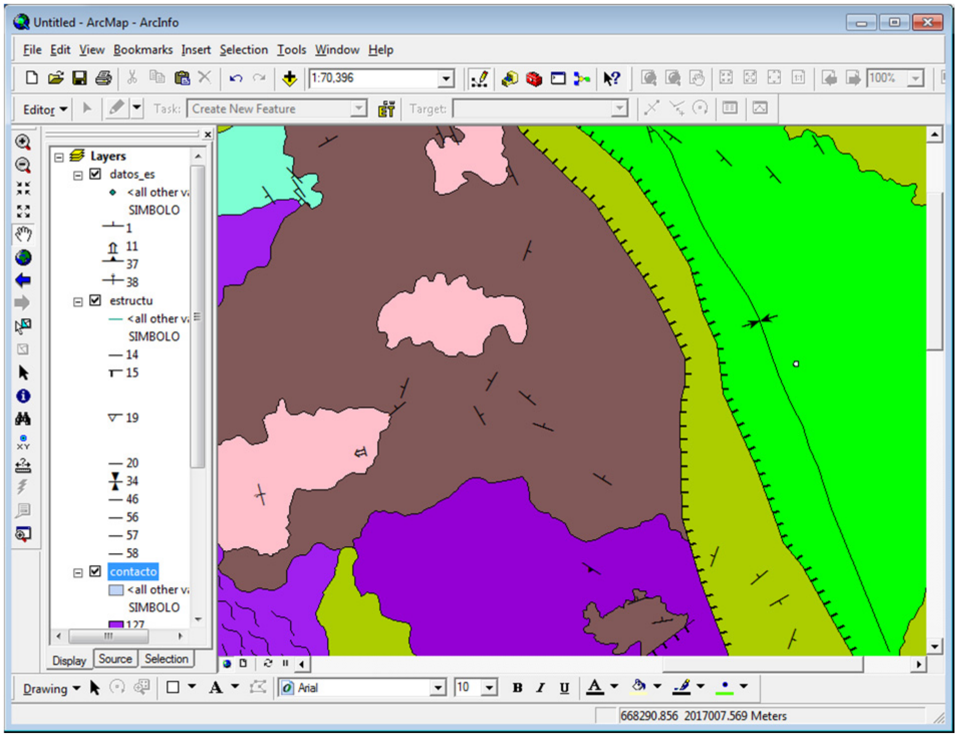


Figure C.3.1 Layers with mining geological symbology.

Sequence Diagram

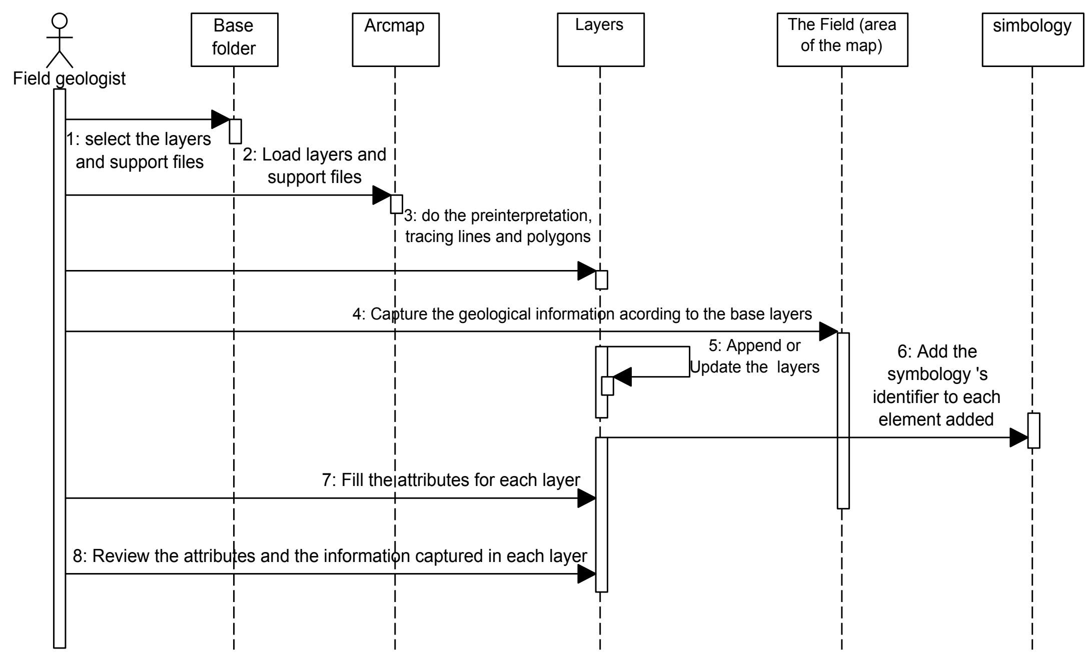


Figure C.3.2 Use case diagram of geological information capture.

C.4 USE CASE SENDS INFORMATION TO DATABASE

Use case: Send information to database

Use case ID: CU04

Actors: geologist.

Purpose: The geologist has to send the shapefiles with the capture advanced made per month to the administrator of the database, in order to be published in the database server.

Summary: The geologist sends the database administrator the shapefiles with the advanced of the capture that is taken per month, so it can be published in the server, with the purpose of letting the institution staff know about the previews and location of the input areas, as the personnel can opine about the geological interpretation. The shapefiles data contents are susceptible to partial or total changes. Because of that this information could not be used for other projects, until it is taken as concluded in the input for the area information.

Normal course of the events

1. The geologist checks the attributes of each layer to verify the whole elements that have complete and correct attributes.
2. Reviews the symbology used in each element captured to verify that the information captured is concordant with the features observed in the field.

3. After checking the layers; the geologist sends them by email to the database administrator so the information can be published and collect the comments from the institution staff about the preview of the input.

Sequence Diagram

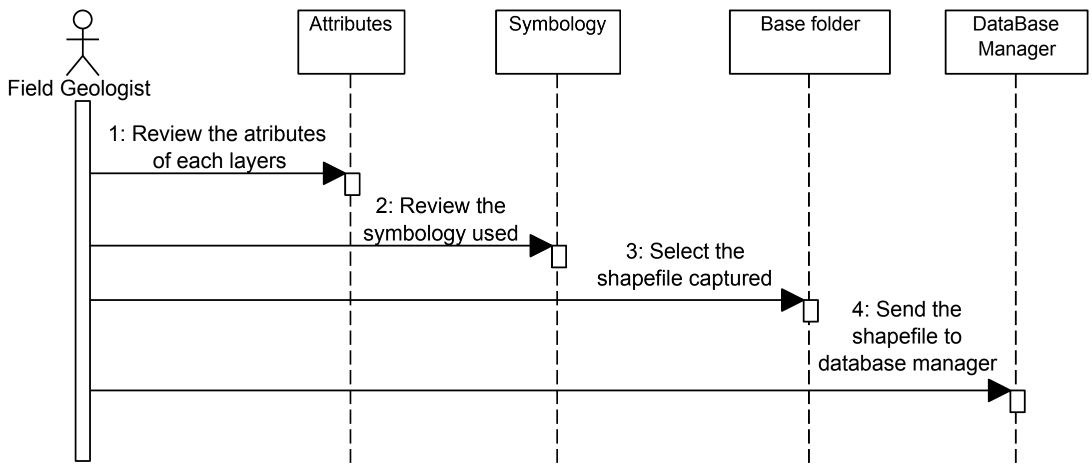


Figure C.4.1 Use Case Diagram sends the information to database.

C.5. USE CASE THE ADMINISTRATOR DATABASE LOADS OR UPDATES INFORMATION

Use case: Load or Update information to database

Use case ID: CU05

Actors: Database Administrator

Purpose: The database administrator receives from the field geologist all the shapefiles with the preview data input done per month, so it can be published in the server of the database.

Summary: The database administrator receives from the geologist the shapefiles with the advance of the mining geological input done per month in order to be published in the server. The administrator converts the shapefiles into SQL format so he can capture them into the database where in an automatic mode, the published information can be updated.

Normal course of the events

1. The database administrator receives from the field geologist the shapefile with the information captured per month and he proceeds to load the geographical information to the PostgreSQL database with PostGIS extension.
2. The administrator verifies that the layers go according to the attributes established on the base folder.
3. If the layers are wrong, the administrator reports the errors to the field geologist and requests the layers with the errors corrected.
4. The administrator opens the Database manager PgAdmin to start the process to upload the geological information and open the Query window.
5. The administrator checks in the database if there is existing information on the area, using the next sentence. He only has to change “contacto” by each layer and change the number 1896 by the id of the map(area):

   select *

   from contacto

   where carta = 1896;
6. if there is already existing information concerning the capture area received, it has to be deleted by using the following SQL statement:

Delete from <layer> where carta = <id map>

Where **layer** is each of the shapefiles set at the beginning of the process and **map id** is the identifier of the area to be captured according to index of 1:50,000 scale maps of the Mexican Republic.

7. Open the MSDOS window and change the path to “C:\Program Files (x86)\OpenGeo\OpenGeo Suite\pgsql\8.4\bin” to convert all layers received to sql format with the command shp2pgsql as follows:

   Shp2pgsql –s 94682 –W WINDOWS-1252 <layer shapefile> <table > <file.sql>

The **shapefile layer** is the name of the shapefile received; **table** is the name of the table in which the information is aggregated; and **file.sql** is the name of the output file that will contain a serie of sql commands to enter the information.

8. Return to PgAdmin’ Sql window and open the sql file for each layer and run it as shown in figure C.5.1.

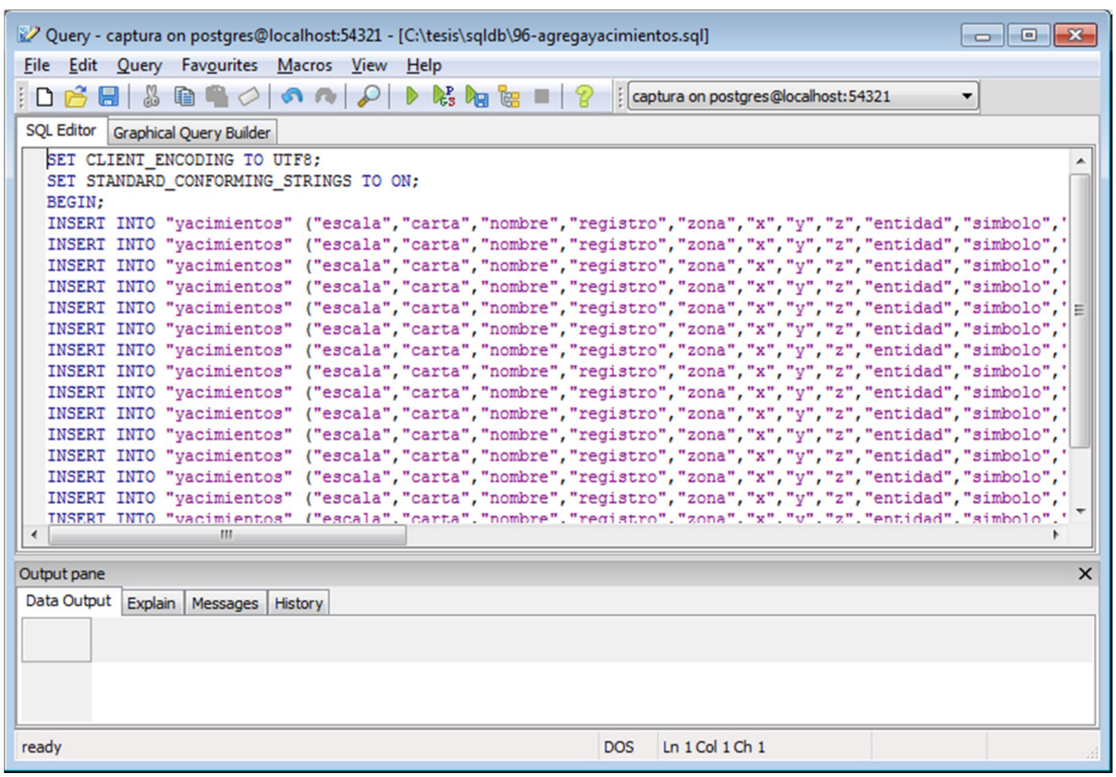


Figure C.5.1. Sql file the yacimientos layer.

Sequence Diagram

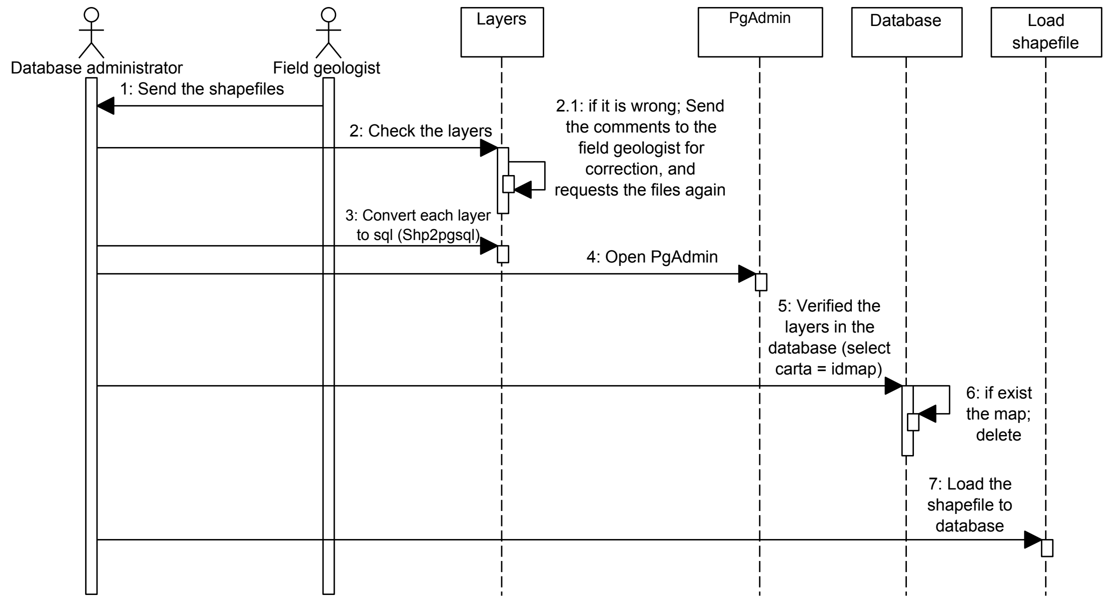


Figure C.5.2 Use case diagram Load or Update information to database.

C.6. USE CASE VISUALIZES THE MAPS WITH THE PROGRESS OF CAPTURE

Use case: Visualize the maps with the progress of capture

Use case ID: CU06

Actors: internet user (Mexican geological survey staff)

Purpose: Show the interactive map of the progress geological input with the tools of navigation and reference.

Summary: The internet user enters the website and the input preview maps is shown with its basic information and its legend, tools of navigation, data reference and the list of the data levels to activate or deactivate them.

Normal course of the events

Action actor	**System response**
1. This use case iniciates when the internet user writes the URL to enter to the server where the application is.	2. It shows the list with the available layers, symbology and navigation tool.
	3. It shows the capture advance map with the layers that will be visible firstly: • Google Satellite Image. • Preview input layer where it shows the areas that are in an input process.
4. The internet user starts to use the application.	

User Interface

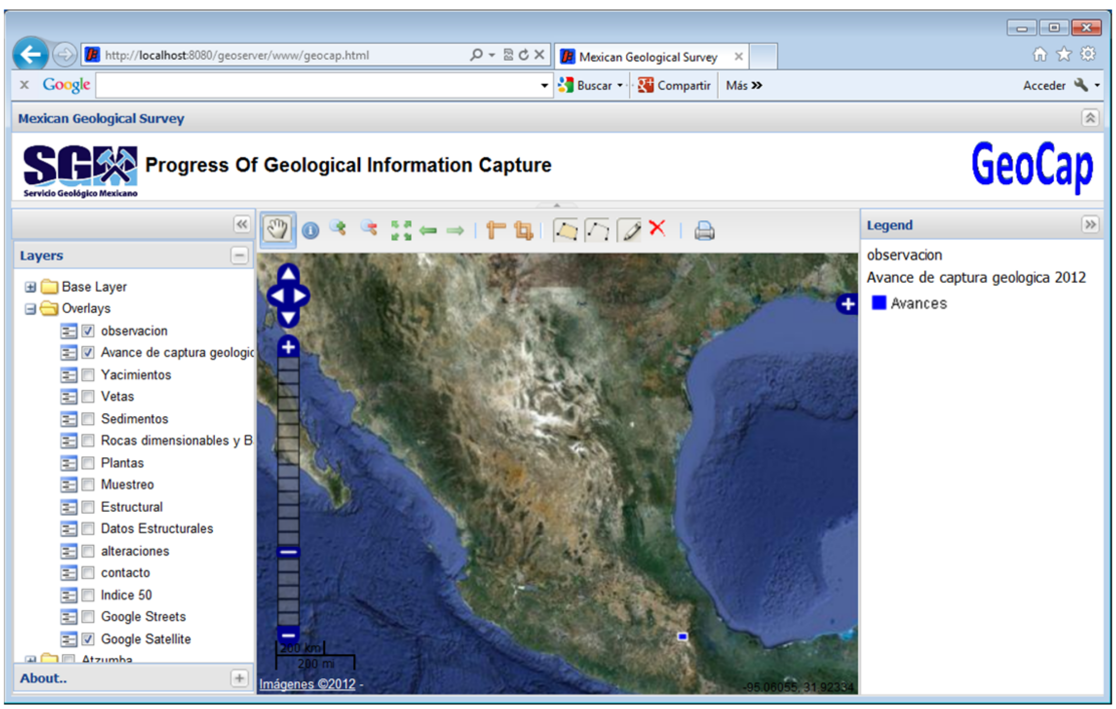


Figure C.6.1 Initial window of the GeoCap application.

Sequence Diagram

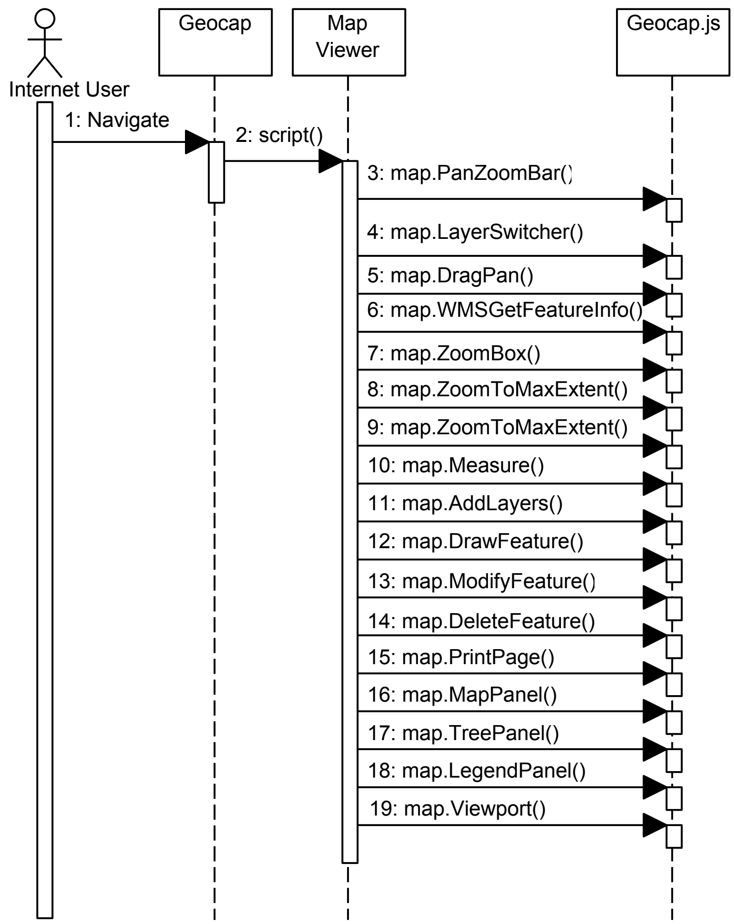


Figure C.6.2 Use case diagram visualizes the maps with the progress of capture

C.7 USE CASE NAVIGATES ON THE MAP

Use case: Navigate in the map.

Use case ID: CU07

Actors: Internet user (Mexican geological survey staff)

Purpose: Visualize the preview input map and allow navigation.

Summary: The internet user selects one of the available navigation tools and they move over the map

	by clicking over the required area to generate a new view of the map.

Normal course of the events

Action actor	System response
1. The use case starts when the internet user selects a navigation tool that it can be: • Move • Zoom in with rectangle • Zoom out with rectangle • Full View • Previous zoom • Next Zoom	
2. The internet user takes the mouse to move inside a map concordant to its functional requirement.	3. Updates the map. According to the navigation tool used.
4. The internet user observes the maps and keeps using the application.	

User Interface

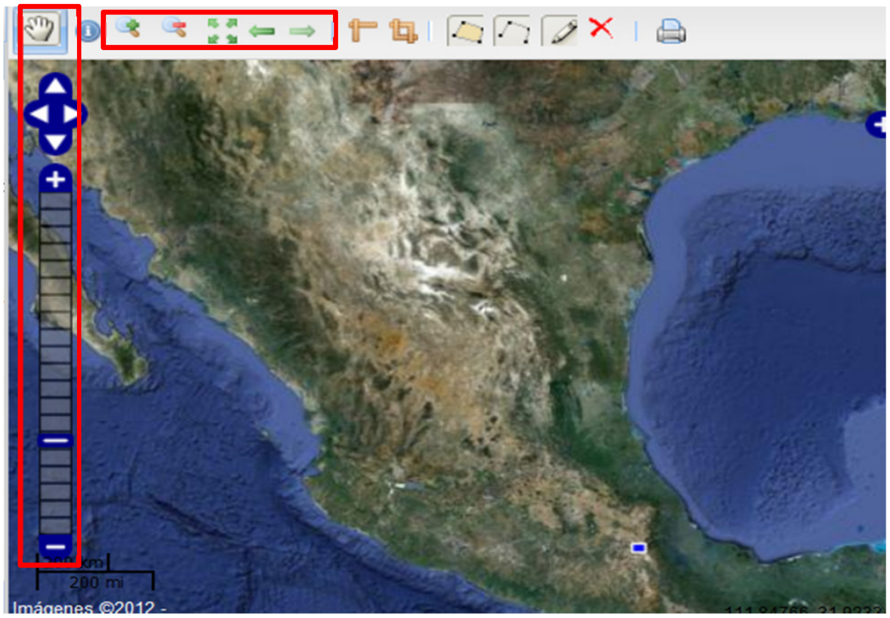


Figure C.7.1 Tools to navigate in the map.

Sequence Diagram

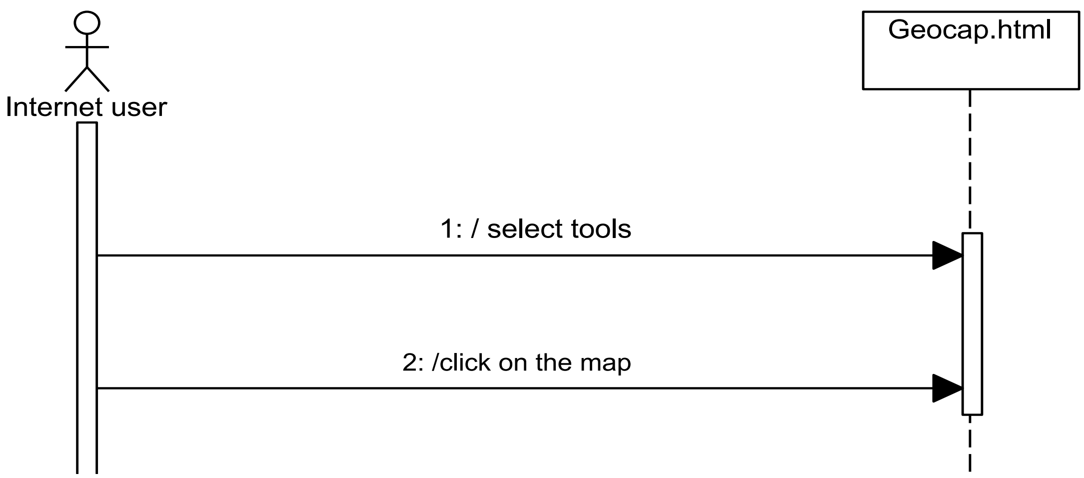


Figure C.7.2 Use Case diagram sequence navigating diagram in the map.

C.8. USE CASE SHOWS/HIDES LAYERS

Use case: Shows/hides layers

Use case ID: CU08

Actors: Internet user (Mexican geological survey staff)

Purpose: Update the map using or hiding the layers as appropriate.

Summary: The internet users activate or deactivate the box that corresponds to each layer. The list of layers visible in the map is updated.

Normal course of the events

Actor Action	**System response**
1. This use case starts when the Internet user clicks on the layer's box.	2. Check the status of each layer's boxes and generates a list of visible layers.
	3. Update the map showing the layers where the boxes are active.
4. The internet user observes the map keep using the application.	

User Interface

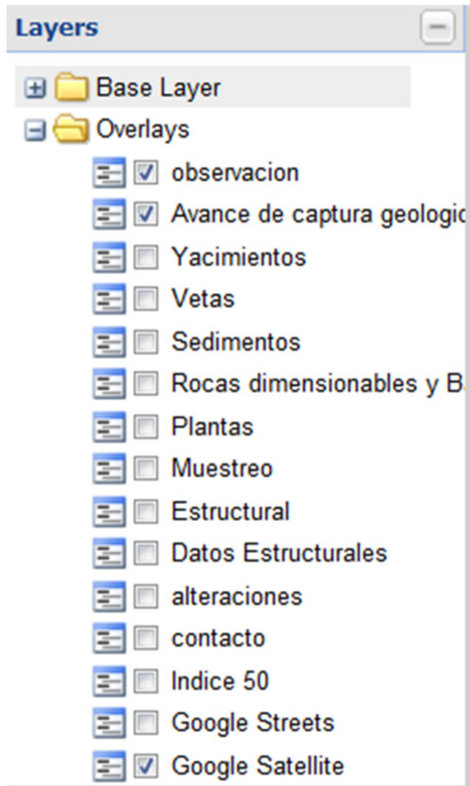


Figure C.8.1 List of available layers.

Sequence Diagram

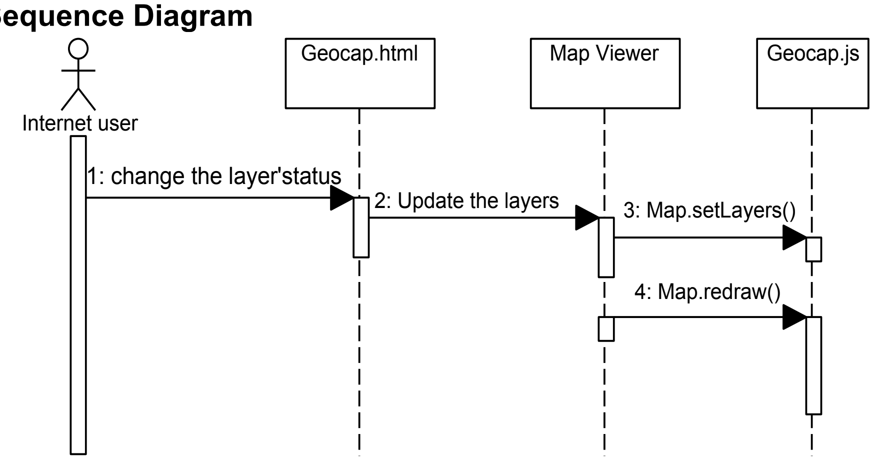


Figure C.8.2 Use Case Diagram Shows/hides layers

4.9. USE CASE SHOWS INFORMATION LAYER

Use case: Consult information of the layers

Use case ID: CU09

Actors: Internet user (Mexican geological survey staff)

Purpose: Consult information of the input and interpreted data.

Summary: The internet user will select the button to consult the information to obtain a window with the selected data in the map.

Normal course of the events

Actor Action	System response
1. This use case starts when the Internet user clicks on the button to view consult information.	
2. The internet user clicks to select the points, lines or polygons in the map according to his requirement.	3. It shows a window with the information of the selected points, lines and polygons.
4. The internet user looks at the window with the information and continues to use the application.	

User Interface

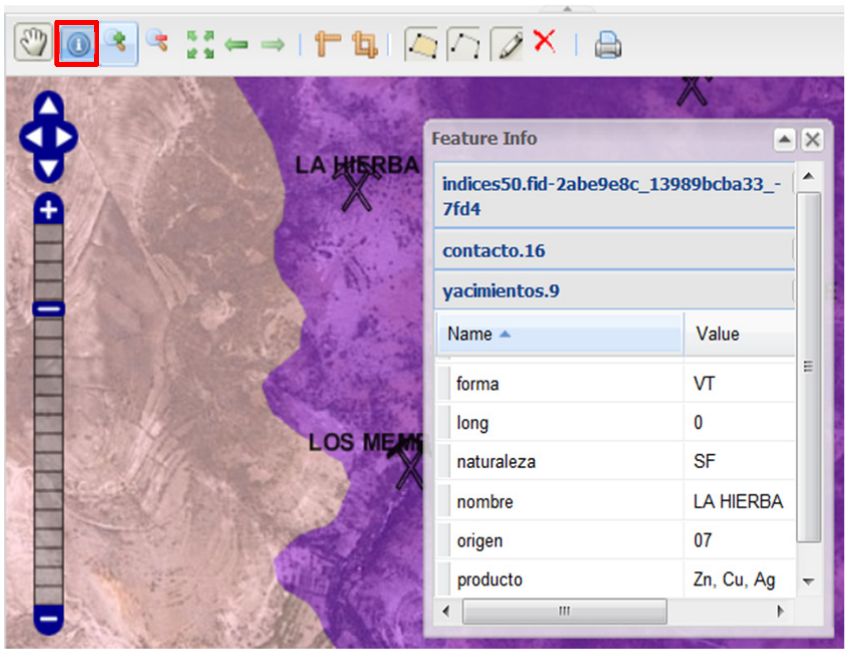


Figure C.9.1 Consult database about the map.

Sequence Diagram

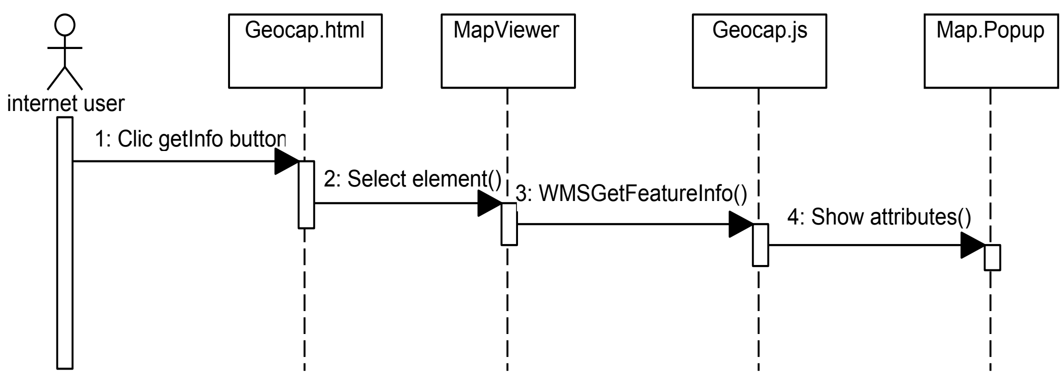


Figure C.9.2 Use Case Diagram Consults information of the layers

C.10 USE CASE DRAWS LINES AND POLYGONS TO MARK OBSERVATIONS

Use case: Draw lines and polygons to mark observations.

Use case ID: CU10

Actors: Internet user (Mexican geological survey staff)

Purpose: Draw lines and polygons on the map to mark the areas where comments are made.

Summary: The internet user selects the information button to see a window that shows the selected items on the map.

Normal course of events

Action actor	System response
1. This use case begins when the Internet user clicks on one of the drawing tools, for example: • Draw polygon • Draw line • Modify line or polygon • Delete line or polygon	
2. Draw lines and polygons on the map to mark areas or data where comments will be made.	3. It shows a window displaying information about the points, lines and selected polygons.
	4. Update the map view with polygons and lines drawn.
5. The internet user watches the	

map and continues using the application.

User Interface

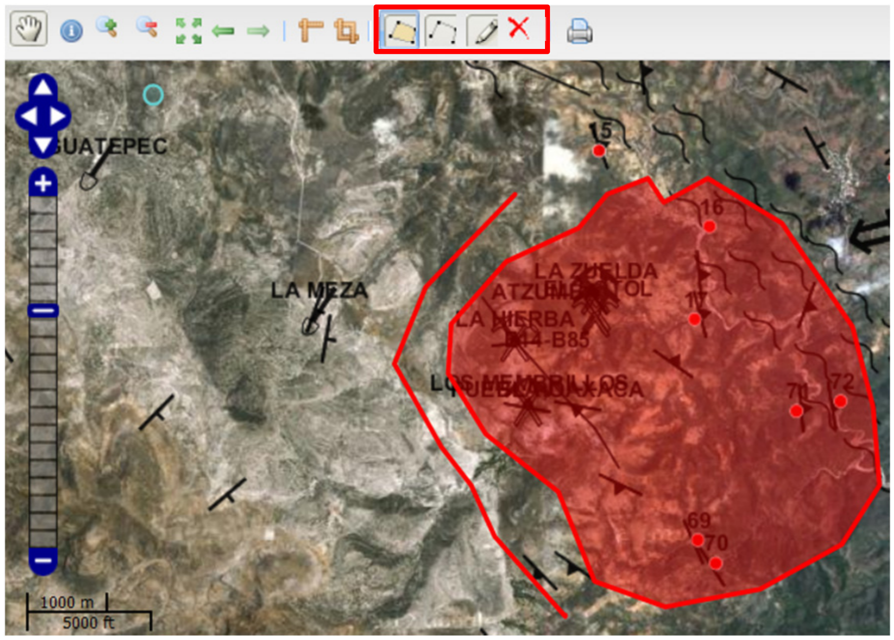


Figure C.10.1 Drawing system tools.

Sequence Diagram

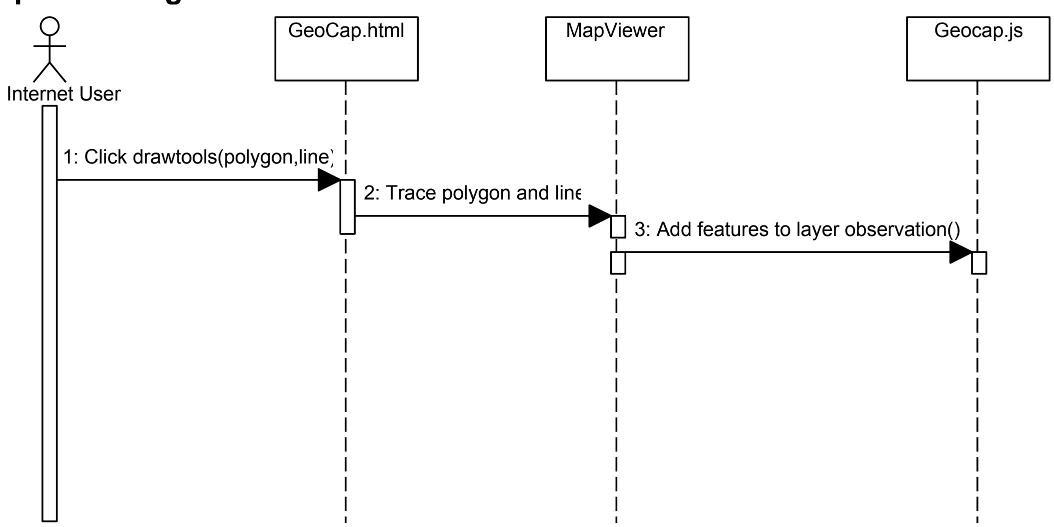


Figure C.10.2 Use Case Diagram Draw lines and polygons to mark observations.

C.11 USE CASE PRINTS THE MAP

USE CASE: Print the map.

Use case ID: CU11

Actors: Internet user (Mexican geological survey staff)

Purpose: To obtain a pdf file of the current map view of the map being captured.

Summary: The internet user selects the print tool. A window will appear with the current image of the map and internet user saves the map as a pdf file.

Normal course of events

Action actor	System response
1. This use case begins when the Internet user clicks on one of the print tools.	2. Displays a window with the current map view.
3. Save the view in a pdf format.	
4. The internet user watches the map and keeps on using the application.	

User Interface

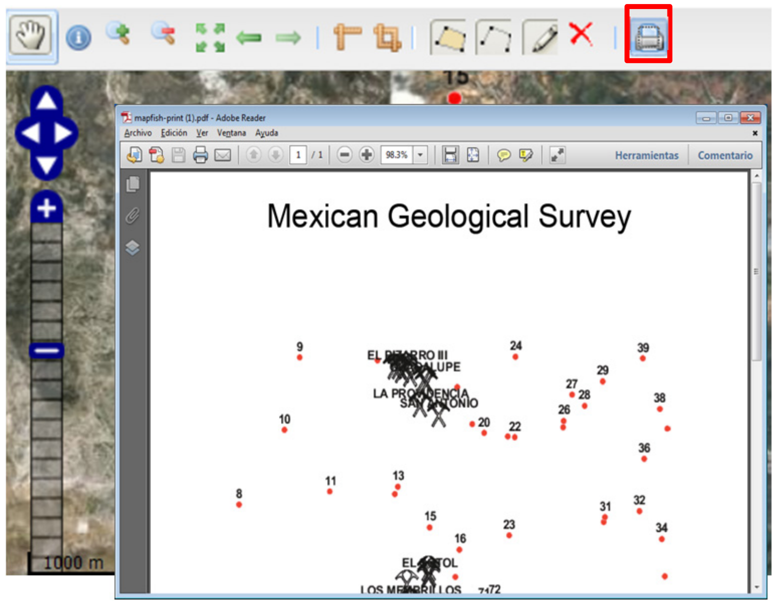


Figure C.11.1 Map printing tools.

Sequence Diagram

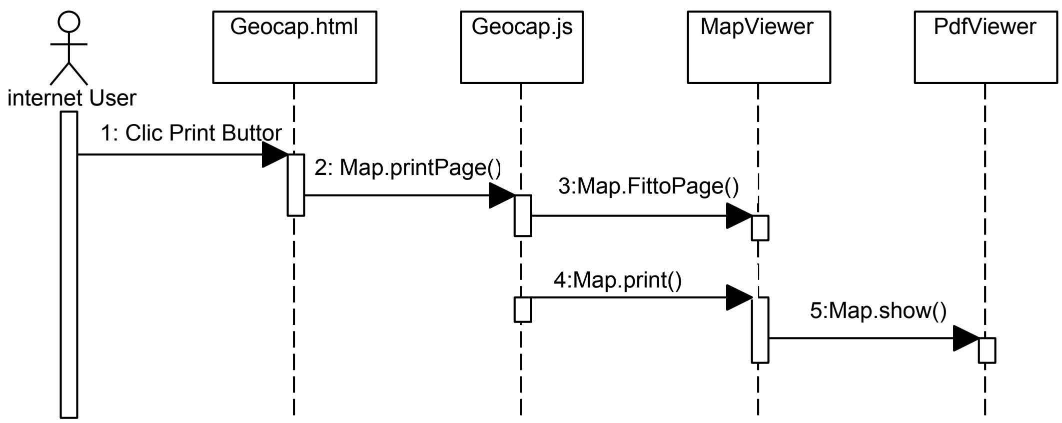


Figure C.11.2 Use Case Diagram Print the map.

C.12. USE CASE SENDS THE OBSERVATIONS

Use case: Send the observations.

Use case ID: CU12

Actors: Internet user (Mexican geological survey staff)

Purpose: Sends the file of the active map along with the comments made on the map being captured to the field geologist.

Summary: To make comments and observations on the map being captured using PowerPoint. To send the presentation or the PDF printing file to the field geologist.

Normal course of events

Internet users will make comments in PowerPoint marking with lines, polygons, texts, the locations on the map where the comments are located.

The user sends the field geologist the PowerPoint file and / or printed file in a pdf format where comments are marked on the status map. The purpose if this is that the geologist checks the comments on the status map and that he assess whether they proceed.

Sequence Diagram

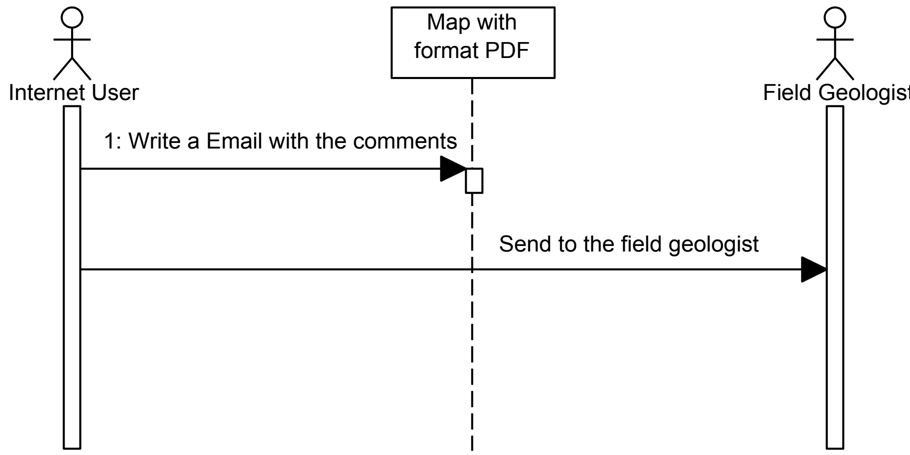


Figure C.12.1 Use Case Diagram Send the observations

APPENDIX D. INSTALLATION GUIDE

D.1 SYSTEM REQUIREMENTS

In regard to hardware, the interactive map GeoCap must be installed on a server or computer with the next characteristics or higher:

Processor: Dual Core Processor 2.2 GHz.

RAM memory: 4 GB

Hard disk: 320 GB

Internet connection

Network card with a static IP address

It also required the following software:

Operating system: Windows 7 Ultimate

Apache Web Server 2.4.3

OpenGeo Suite Dashboard 2.4.5

D.2. INSTALLATION

To install the application developed it is necessary to verify where OpenGeo Suite Dashboard 2.4.5 is installed to copy the required files from the CD to continue the installation. In the rest of the process, the path is used when installing the OpenGeo Suite Dashboard by default but if you have installed the suite in another path, then it will be necessary verify its equivalence..

Note: All files required are in the CD.

- Copy the files to activate the print function of the application.

With windows explorer, copy from the CD the file inside the folder “geoserver-2.1-SNAPSHOT-printing-plugin” to “C:\Program Files (x86)\OpenGeo\OpenGeo Suite\webapps\geoserver\WEB-INF\lib”

- Copy the application GeoCap.

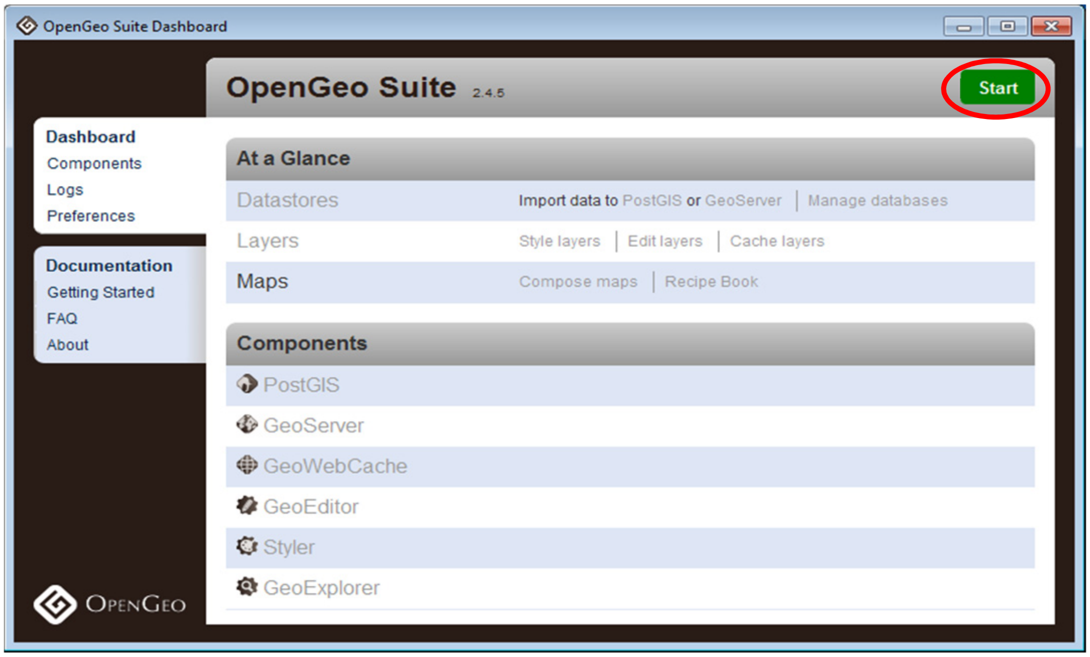
Using the windows explorer copy the content of the folder “www” to C:\Users\<username of your PC>\.opengeo\data_dir\www

- Copy the styles used to represent each element of each layer with their corresponding symbology.

Using the windows explorer copy the files inside the folder “styles” to “C:\Users\<username of your PC>\.opengeo\data_dir\styles”.

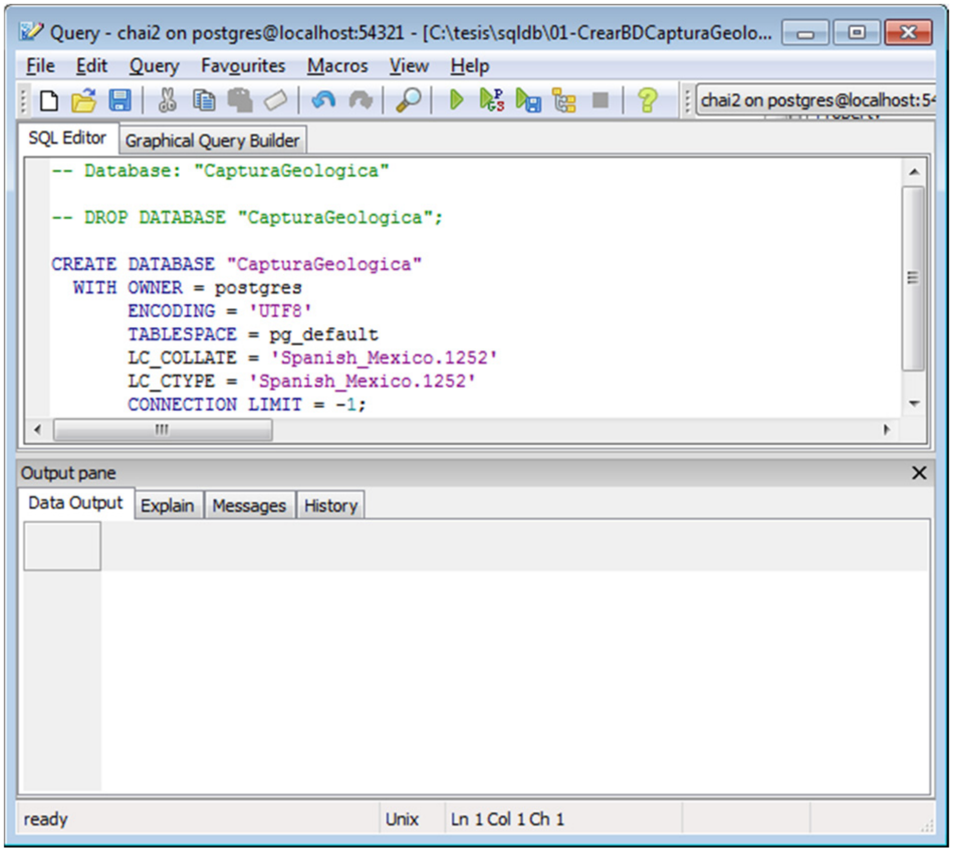
D.3. CREATE DATABASE

- To use the OpenGeo Suite Dashboard and create the database it is necessary to start the OpenGeo Suite as shown in the figure D.3.1.



D.3.1. OpenGeo's main window to start the Suite

- Start the database manager PostGis from OpenGeo's main window.
- From pgAdmin III open the query window to run the sql files to create the database.



D.3.2. pgAdmin III's Query window

- From the query window open the file "01-CreateDB.sql" from the CD's sql folder and run it to create the database.
- Open the file "02-proyeccion4682.sql" and run it to add the projection parameters in the database manager.
- Open the file "03-createtables.sql" and run it to create all the tables required for the application.
- Open the file "04-importcarta.sql" and run it to add the name and the identifiers for each map to the table "carta".
- Open the file "05-addage.sql" and run it to add all the geological ages used in the layers.
- Open the file "06-addlitology.sql" and run it to add the type of lithology in the table "litologia".

- Open the file “07-addform.sql” and run it to add the types of mineral deposits forms used in the layer “yacimientos”.
- Open the file “08-addorigen.sql” and run it to add the types of mineral deposits origin used in the layers “yacimientos”.
- Open the file “09-addnaturaleza.sql” and run it to add the types of nature of the mineral deposits into the table “naturaleza”.
- Open the file “10-addalteration.sql” and run it to add the types of alteration into the table “alteracion”.
- Open the file “11-addsymbologpoints.sql” and run it to add the name and the identifiers of each elements of each point layer.
- Open the file “12-addsymbologylines.sql” and run it to add the name and the identifiers of each elements of each lines layer.

In the folder uml from the CD you can view the entity relationship diagram of the database that we have created in this appendix.

APPENDIX E. CD CONTENTS

Folders Base	Folders base (with shapefiles) according the geographical area
Documents	Thesis with format Microsoft Word and PDF
Geoserver-2.1SNAPSHOT-printing-plugin	Files to active the application's function print.
Software	Software required to install the application
Sql	SQL files to create the database
styles	SLD files to give symbology to the layers in the application
Uml	Uml diagram
www	Source code of the application GeoCap