A Project Report

on

"Geo-Exploration Web Development"

Submitted in Fulfilment of the Requirement for

"CS 637 Database-Backed Websites"

Submitted By:

KUNAL PRABHAKAR SANGURMATH (02126259)

Under the Guidance of:

Prof. Beatrice M Perez

Fall 2023

UNIVERSITY OF MASSACHUSETTS BOSTON

Massachusetts, United States

ABSTRACT

As the name specifies “GEO-EXPLORATION WEB DEVELOPMENT” is web developed for managing various activities with Minerals and its mining sites data. The project addresses the challenges faced by the mining industry by leveraging modern web technologies to streamline data management, enhance communication, and improve overall operational efficiency.

The web application facilitates the seamless organization and retrieval of critical information related to mineral deposits, mining activities, and sites. Through intuitive user interfaces and robust backend architecture, the system offers a user-friendly experience for stakeholders involved in mineral resource management, including geologists, engineers, environmentalists, and decision-makers.

Key features of the system include all mineral details, mineral composition search, and mining site details. The implementation of data visualization tools enhances decision-making processes by providing insightful analytics and trends related to mineral extraction, environmental impact, and production metrics.

Overall, the web-based Mineral and Mining Site Management System presented in this report represents a significant step forward in addressing the complexities of mineral resource management. It offers a robust platform for collaboration, data-driven decision-making, and sustainable practices within the mining sector, contributing to the overall advancement and responsible stewardship of mineral resources.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1. Introduction to Database

Database is a collection of related data. DBMS came into existence in 1960 by Charles. Again in 1960, IBM brought IMS-Information management system. In 1970 Edgor Codd at IBM came up with a new database called RDBMS. In 1980 then came SQL Architecture- Structure Query Language. From 1980 to 1990 there were advances in DBMS e.g. DB2, ORACLE. A database has the following implicit properties:

- A database represents some aspect of the real world, sometimes called the miniworld or the Universe of Discourse (UoD). Changes to the miniworld are reflected in the database.
- A database is a logically coherent collection of data with some inherent meaning. A random assortment of data cannot correctly be referred to as a database.
- A database is designed, built, and populated with data for a specific purpose. It has an intended group of users and some preconceived applications in which these users are interested.

In other words, a database has some source from which data is derived, some degree of interaction with events in the real world, and an audience that is actively interested in its contents.

A database management system (DBMS) is a collection of programs that enables users to create and maintain the database. The DBMS is a general-purpose software system that facilitates the process of defining, constructing, manipulating, and sharing databases among various users and applications.

Defining a database specifying database involves specifying the data types, constraints, and structures of the data to be stored in the database. The descriptive information is also stored in the database in the form database catalog or dictionary; it is called meta-data. Manipulating the data includes querying the database to retrieve the specific data. An application program accesses the database by sending the queries or requests for data to DBMS. The important function provided by the DBMS includes protecting the database and maintaining the database.

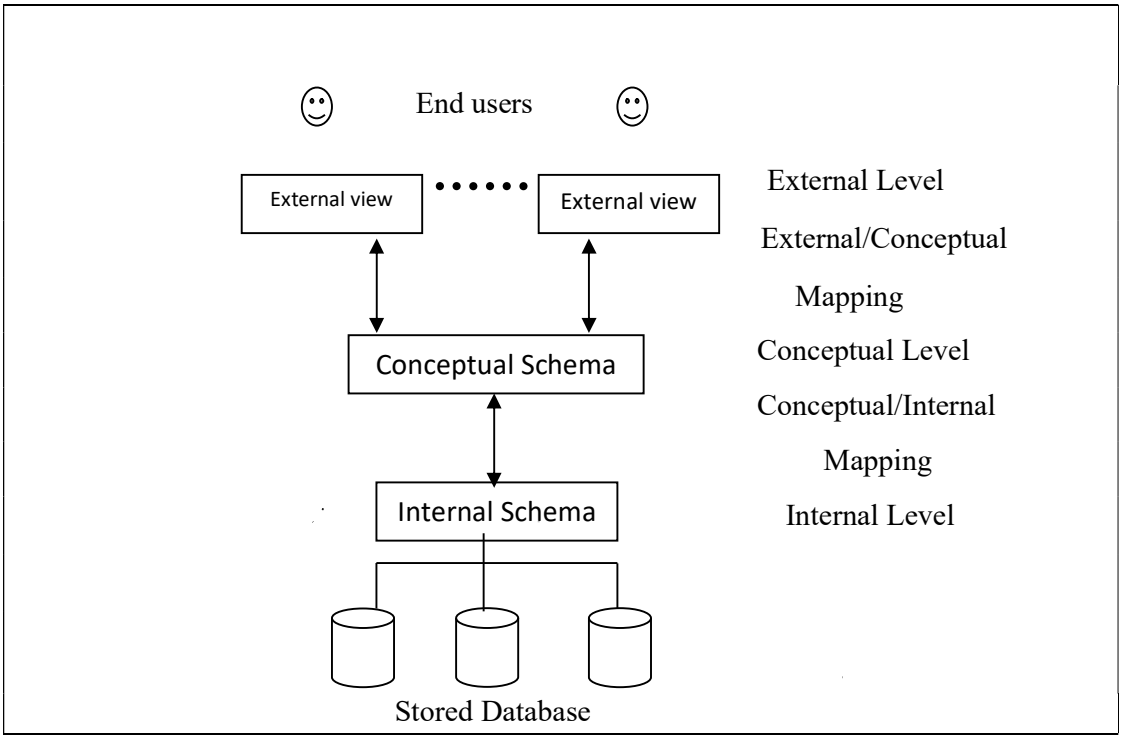


Figure 1.1: Three schema architecture

Figure 1.1 shows the Three schema architecture of Database Management System, The Three schema architecture consists of three levels of the architecture**:**

- **External Level:**
  The external level is the view that the individual user of the database has. This view is often a restricted view of the database and the same database may provide a number of different views for different classes of users. In general, the end users and even the application programmers are only interested in a subset of the database.
- **Conceptual Level:**
  The conceptual view is the information model of the enterprise and contains the view of the whole enterprise without any concern for the physical implementation. The conceptual view is the overall community view of the database and it includes all the information that is going to be represented in the database.
- **Internal Level:**
  The internal view is the view of the actual physical storage of data. It describes what data is stored in the database and how.

- The three schema architecture is a convenient tool with which the user can visualize the schema levels in a database system. DBMS must transform a request specified on an external schema into a request against conceptual schema and then into a request on an internal schema for processing over a stored database and the reverse should be done for retrieving the data. The process of transforming requests and results between levels are called **mapping**.

1.2. Overview of the project

The project is related to Geo-Exploration Web Development.

- The front end is designed using HTML, CSS, and MySQL, PHP, Python is used for the Back end.
- The main features available in this project are: -
  - To View all the minerals and their mining site details.
  - Mineral search based on its composition.
  - All the mining site's details.
  - Users can Login/Register and change their password(Implemented this to demonstrate the update and Insert transactions in the Database).

1.2.1. Problem statement:

To maintain and manipulate the data to be stored in the Geo-Exploration Web Development.

1.2.2. Objectives of the project:

- The main objective behind this project is to promote paperless data storage and its visualization and a move towards the digital advancement of data.
- Less retrieval time of project details from vast data.
- More secure as data is stored in a database and can be accessed only by authorized persons.

CHAPTER 2

SYSTEM DESIGN AND METHODOLOGY

2.1 System Architecture

The main software used are

1. HTML
2. MYSQL
3. CSS
4. PHP
5. Python

2.1.1 Hypertext Markup Language(HTML)

- HTML stands for Hypertext Markup Language, it is the standard markup language for creating web pages and web applications. With Cascading Style Sheets (CSS), it forms a triad of cornerstone technologies for the World Wide Web.
- Web browsers receive HTML documents from a web server or local storage and render them into multimedia web pages. HTML describes the structure of a web page semantically and originally included cues for the appearance of the document.
- HTML elements are the building blocks of HTML pages, with HTML constructs, images, and other objects, such as interactive forms, may be embedded into the rendered page.
- It provides a means to create structured documents by denoting structural semantics for text such as headings, paragraphs, lists, links, quotes, and other items. HTML elements are delineated by tags, written using angle brackets. Browsers do not display the HTML tags but use them to interpret the content of the page.

2.1.2 MYSQL

- It is an open-source relational database management system (RDBMS). Its name is a combination of "My", the name of co-founder Michael Widenius 's daughter, and " SQL ", the abbreviation for Structured Query Language.
- The MySQL development project has made its source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements.
- MySQL was owned and sponsored by a single for-profit firm, the Swedish company MySQL AB, now owned by Oracle Corporation. For proprietary use, several paid editions are available and offer additional functionality.
- The MySQL server package will install the MySQL database server which can interact with using a MySQL client. Users can use the MySQL client to send commands to any MySQL server; on a remote computer The MySQL server is used to persist the data and provide a query interface for it (SQL). The MySQL client's purpose is to allow you to use that query interface. The client package also comes with utilities that allow you to easily backup/restore data and administer the server.
- MySQL is a central component of the LAMP open-source web application software stack (and other " AMP " stacks). LAMP is an acronym for " Linux, Apache, MySQL, Perl / PHP / Python ".
  Applications that use the MySQL database include: TYPO3, MODx, Joomla, WordPress, phub, Mob, and Drupal. MySQL is also used in many high-profile, large-scale websites, including Google (though not for searches), Facebook, Twitter, Flickr, and YouTube.

2.1.3 CASCADING STYLE SHEETS (CSS)

- It is a style sheet language used for describing the presentation of a document written in a markup language. Although most often used to set the visual style of web pages and user interfaces written in HTML, the language can be applied to any document, including plain XML, SVG, and XUL, and applies to rendering in speech, or on other media.
- Along with HTML and JavaScript, CSS is a cornerstone technology used by most websites to create visually engaging webpages, user interfaces for web applications, and user interfaces for many mobile applications.

- CSS is designed primarily to enable the separation of presentation and content, including aspects such as the layout, colors, and fonts. This separation can improve content accessibility, provide more flexibility and control in the specification of presentation characteristics, enable multiple HTML pages to share formatting by specifying the relevant CSS in a separate .CSS file, and reduce complexity and repetition in the structural content. Separation of formatting and content makes it possible to present the same markup page in different styles.

2.1.4 PHP

- It is a server-side scripting language designed primarily for web development but also used as a general-purpose programming language.
- PHP was created by Rasmus Lerdorf in 1994, the PHP reference implementation is now produced by The PHP Development Team.
- PHP stands for the acronym: Hypertext Preprocessor.
- PHP code may be embedded into HTML or HTML5 markup, or it can be used in combination with various web template systems, web content management systems, and web frameworks. PHP code is usually processed by a PHP interpreter implemented as a module in the web server or as a Common Gateway Interface (CGI) executable. The web server software combines the results of the interpreted and executed PHP code, which may be any type of data, including images, with the generated web page.
- PHP code may also be executed with a command-line interface (CLI) and can be used to implement standalone graphical applications.

2.1.4 PYTHON

- Backend Development: Python is widely used for backend development due to its versatility and readability. Utilize frameworks such as Django or Flask to build the backend infrastructure of the web application. These frameworks provide a robust structure for handling HTTP requests, managing databases, and implementing the application's logic.
- Data Processing: Leverage Python libraries like NumPy and Pandas for efficient data manipulation and processing. These libraries are particularly useful for handling large datasets, which can be crucial when working with machine learning models.

- API Development: Use Python to develop APIs (Application Programming Interfaces) that enable seamless communication between the frontend and backend components of the web application. Tools like FastAPI or Flask-RESTful can simplify API development.
- Scripting and Automation: Python can be employed for scripting and automation tasks, streamlining various processes within the web application, such as data retrieval, preprocessing, and model deployment.
- Model Training: Python offers a rich ecosystem of machine learning libraries, including scikit-learn, TensorFlow, and PyTorch. These libraries can be employed to train machine learning models for tasks such as prediction, classification, or clustering.
- Feature Engineering: Python's extensive set of data manipulation libraries facilitates feature engineering, a crucial step in preparing data for machine learning. This involves selecting relevant features, handling missing values, and transforming data to improve model performance.
- Real-time Inference: Implement mechanisms for real-time model inference within the web application, enabling users to obtain predictions instantly. Tools like FastAPI can be useful for creating APIs that support rapid and efficient inference.

Datasets used in this Project are:

1. Minerals(1) around the world
2. Mining sites(2) around the world

2.2 ER DIAGRAM

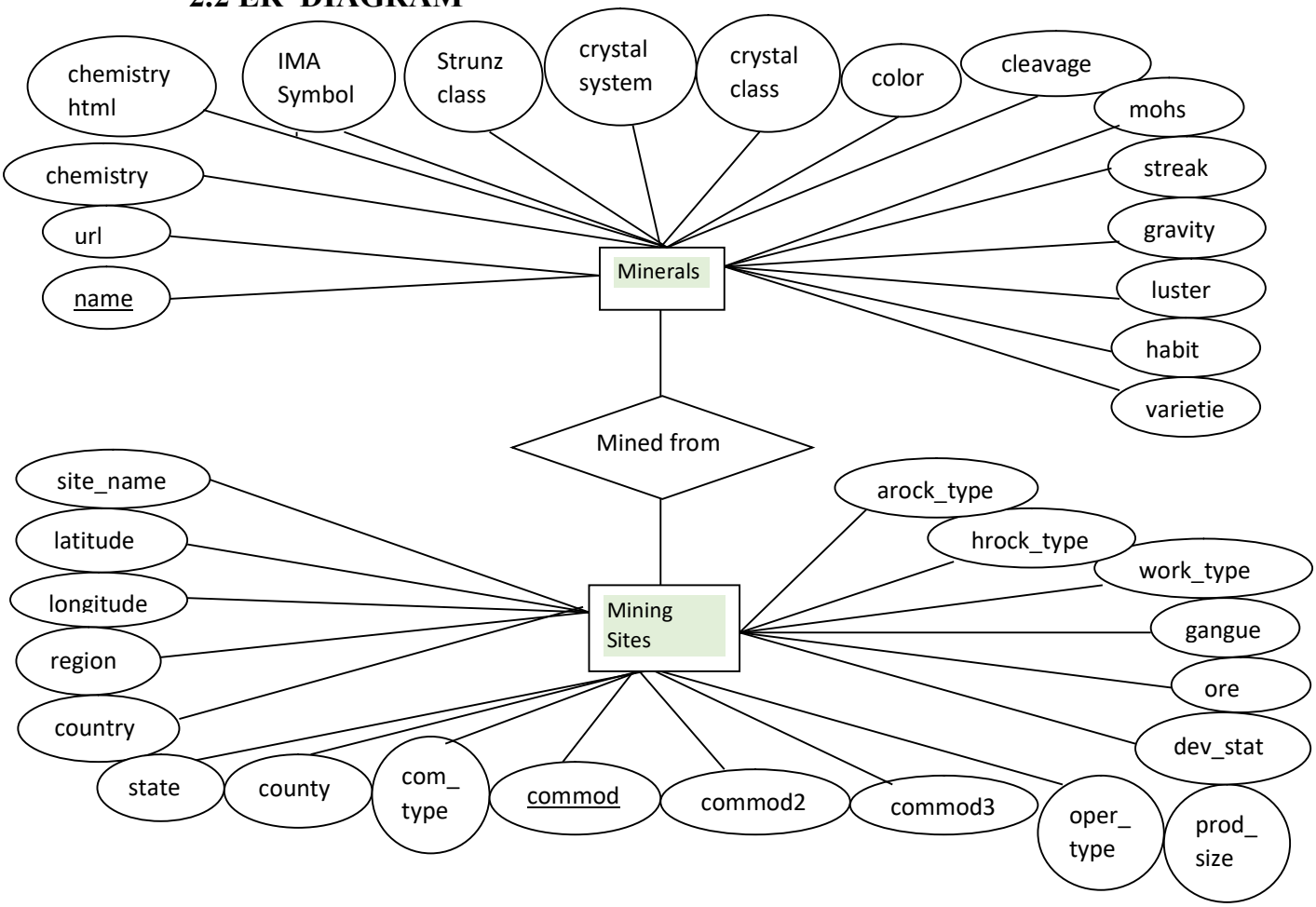


Fig 2.2 **ER Diagram**

The **Minerals(1)** dataset consists of the following attributes:

- Name which is the Primary key
- URL
- chemistry
- chemistry HTML
- IMA Symbol
- Strunz class
- crystal system
- crystal class

- color
- cleavage
- Mohs
- streak
- gravity
- luster
- habit
- varieties

The **Mining Sites(2)** dataset consists of the following attributes:

- site_name which is the Primary key
- latitude
- longitude
- region
- country
- state
- county
- com_type
- commod1
- commod2
- commod3
- oper_type
- prod_size
- dev_stat
- ore
- gangue
- work_type
- hrock_type
- arock_type

2.3 System Design

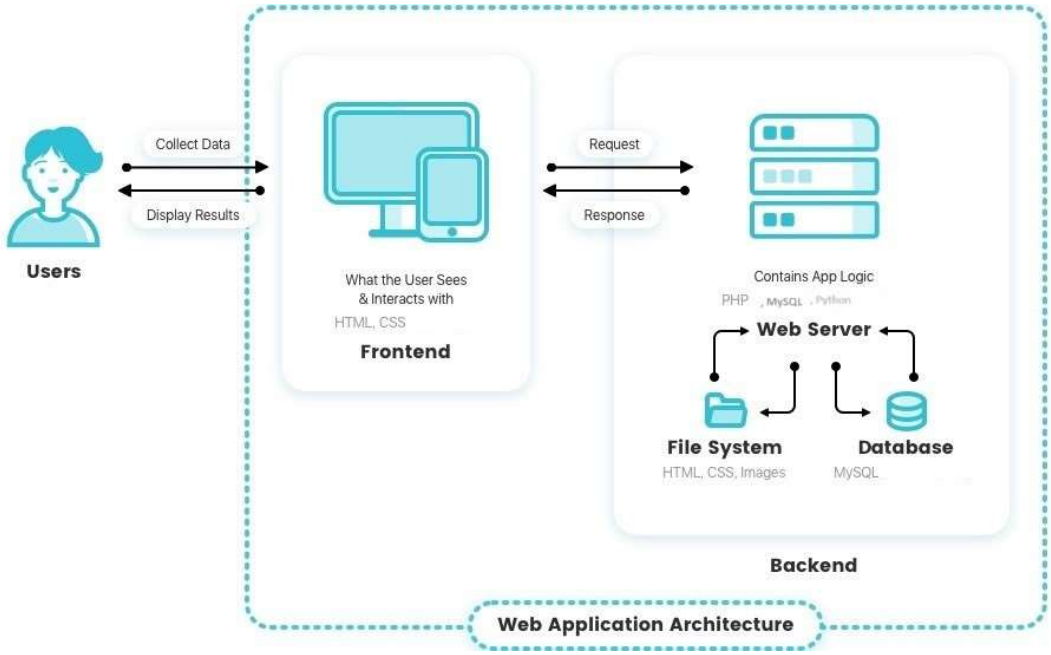


Fig 2.3 **System Design**

CHAPTER 3

SYSTEM IMPLEMENTATION

3.1. Module Description

The modules included in this project are:

3.1.1 Minerals

The Minerals Page serves as a comprehensive repository of minerals, complete with their elemental compositions, which users can access by clicking on individual entries. Additionally, a search option is provided to facilitate the exploration of various minerals. Users will also have the capability to view mining sites associated with each respective mineral.

3.1.2 Mineral Composition Search

This page is dedicated to the search functionality for various minerals based on their chemical attributes. It also has a feature, when a user inputs a chemical attribute common to subsets of minerals, the system will display all minerals within that particular subset.

3.1.3 Mining Site Details

Users can utilize this page to obtain detailed information about various mining sites. The interface allows users to select a country from a list and view the corresponding mining sites within that country.

3.1.4 Evaluating the potential for explored Secondary and Tertiary minerals in a region where the first (primary) mineral is explored

This page enables users to assess the potential for secondary and tertiary minerals in a region where primary minerals have been explored. Users are required to input the primary element explored, and the system will provide details regarding potential secondary minerals.

3.1.5 User Login/registration

I was interested in performing an insert and update transaction in the Database. This section facilitates user registration and login processes, providing the opportunity for users to perform insert and update transactions in the database. Following successful registration, users can log in and subsequently update their passwords as needed.

CHAPTER 4

RESULTS AND SCREENSHOTS

4.1. Admin Login Page

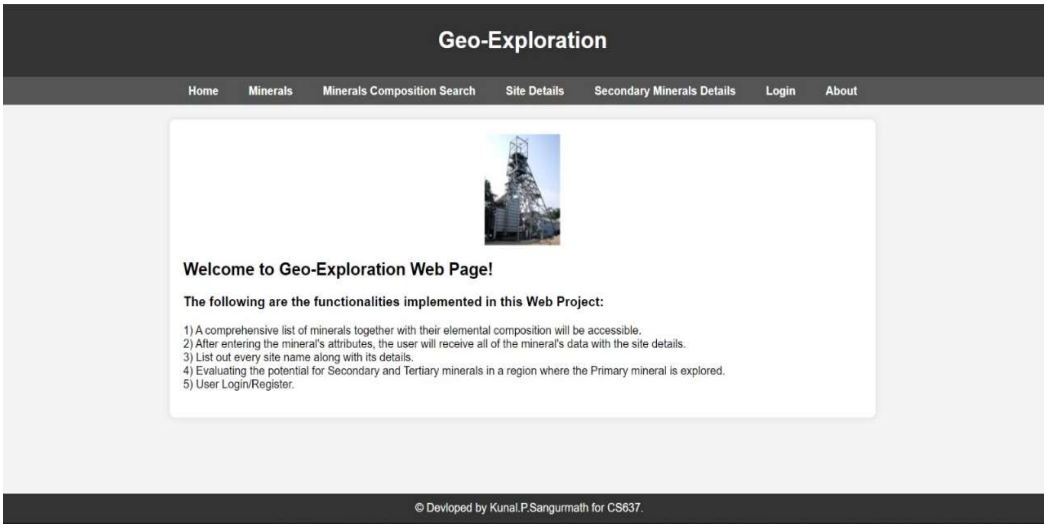


***fig* 4.1: Home Page**

DESCRIPTION: This is the Home Page.

4.2. Minerals List Page:

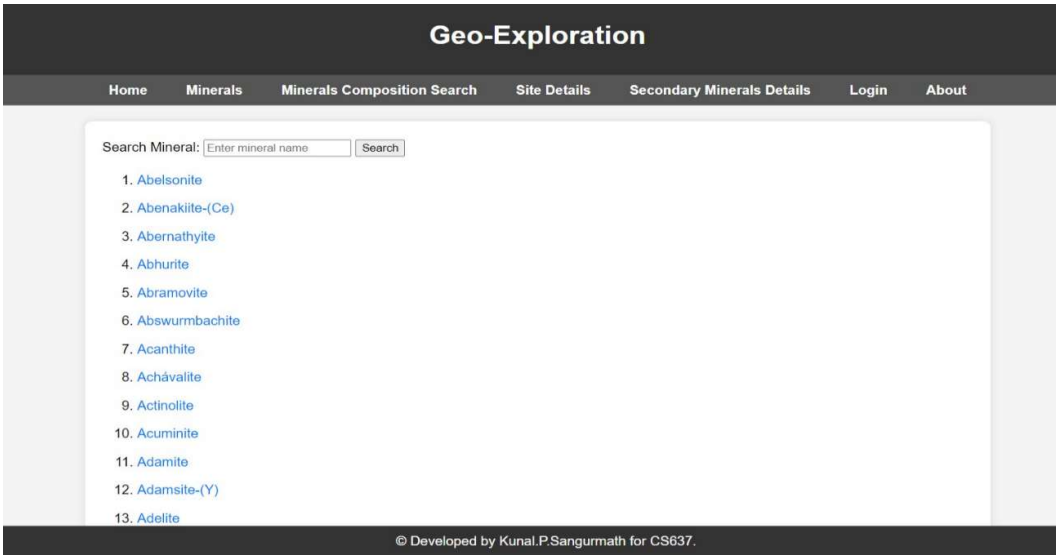


***fig*: 4.2: Minerals List page**

DESCRIPTION: This is the page showing the comprehensive list of minerals.

4.3. Mineral Details

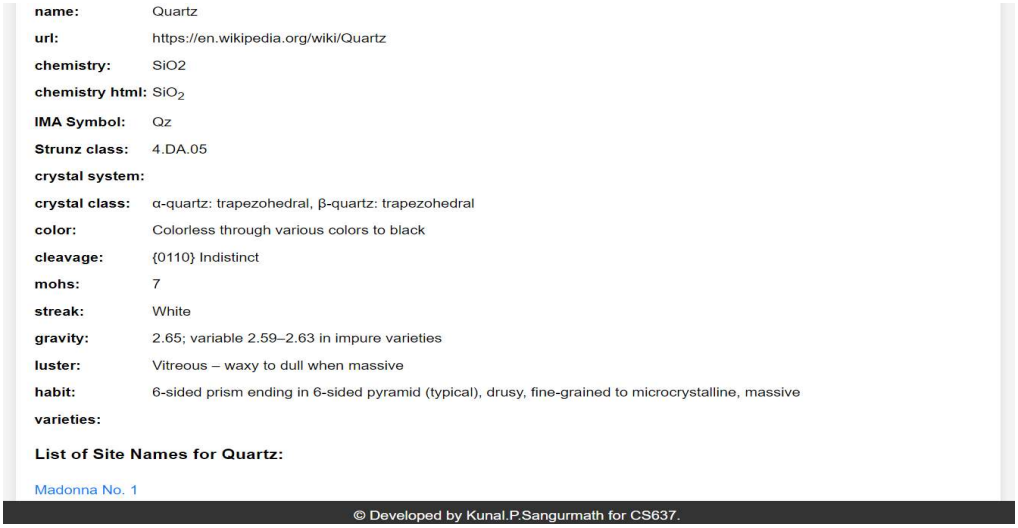


***fig*: 4.3: Mineral Details**

DESCRIPTION: This screenshot illustrates the interface through which users access detailed information about minerals, including the associated mining sites for respective minerals.

4.4. Mineral Compostion Search(1).

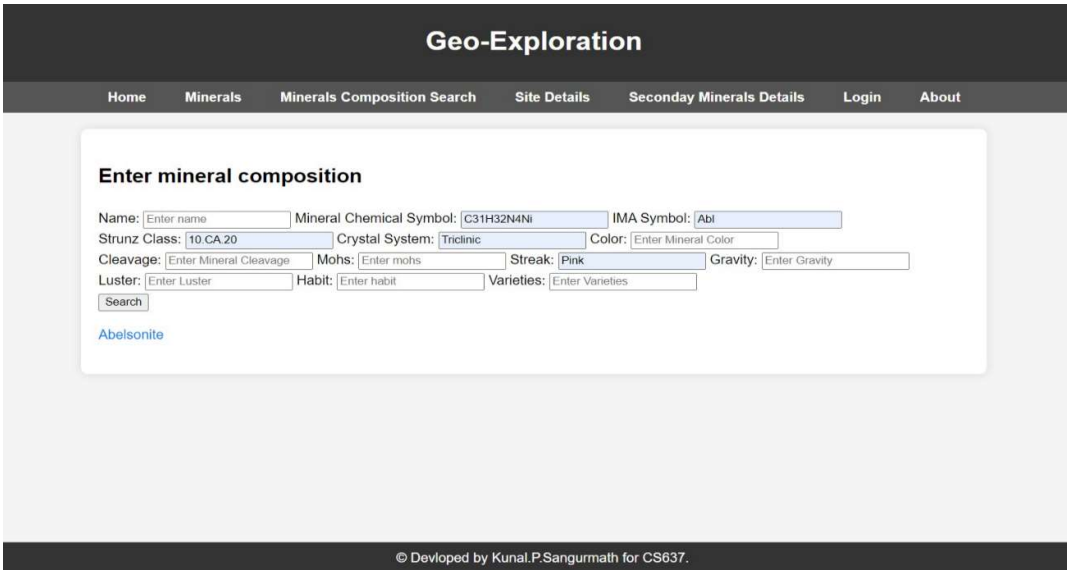


***fig*: 4.4: Mineral Composition Search**

DESCRIPTION: This screenshot illustrates the section where users input mineral attributes to retrieve details pertaining to matching minerals.

4.5. Mineral Composition Search(2)

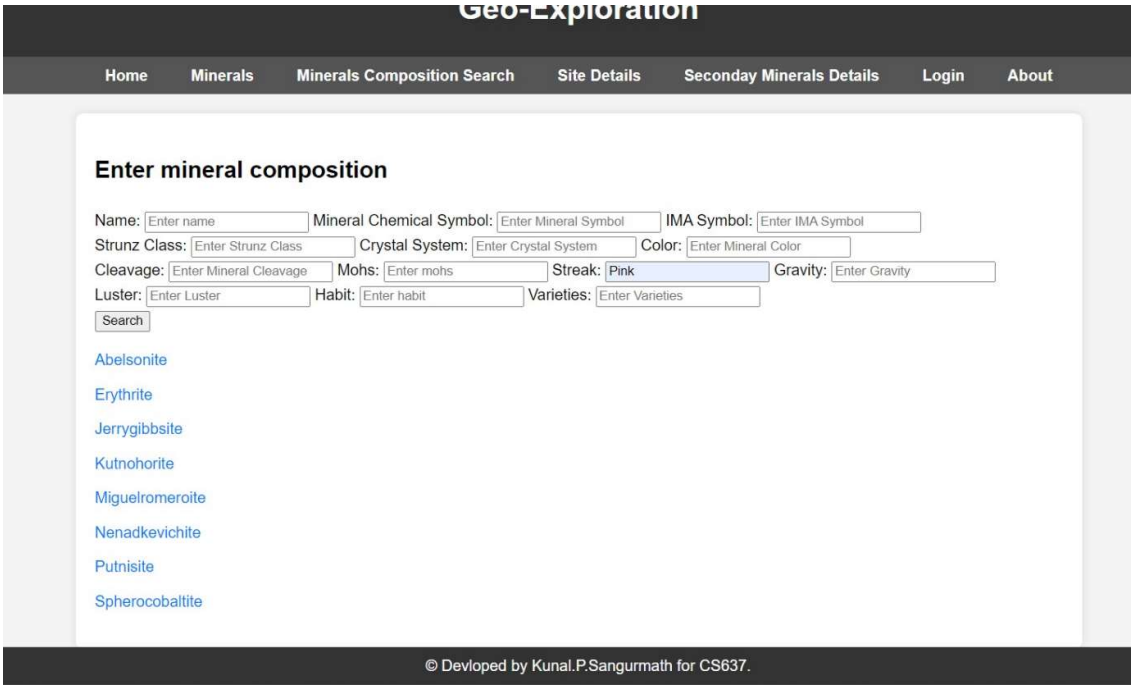
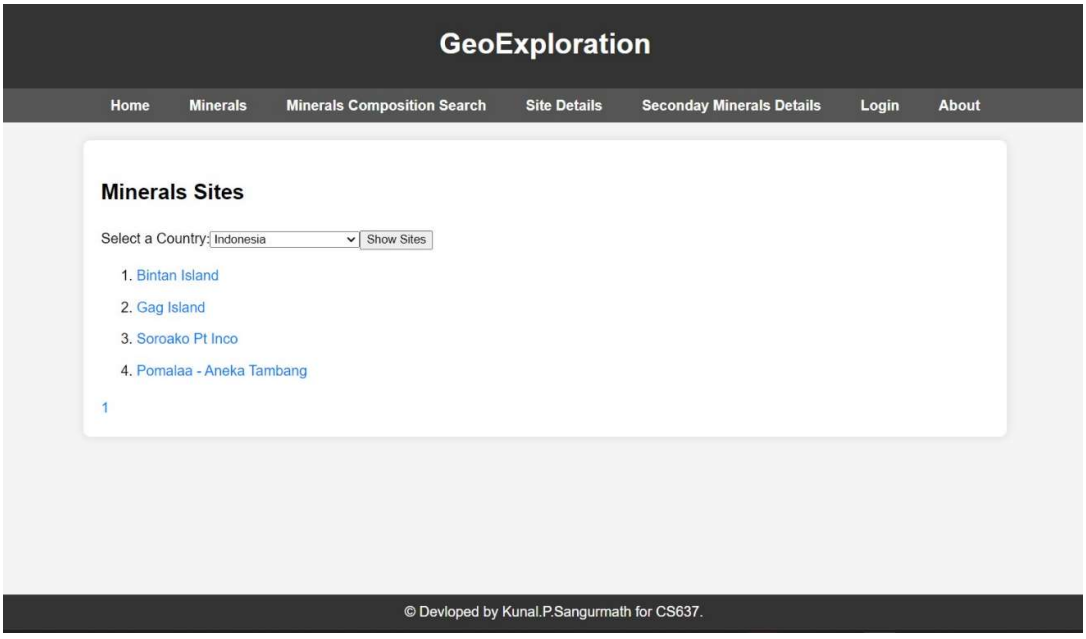


***fig*: 4.5: Mineral Composition Search(2)**

DESCRIPTION: This screenshot depicts the interface where users input mineral attributes to retrieve information related to corresponding minerals.

4.6. Mining Sites



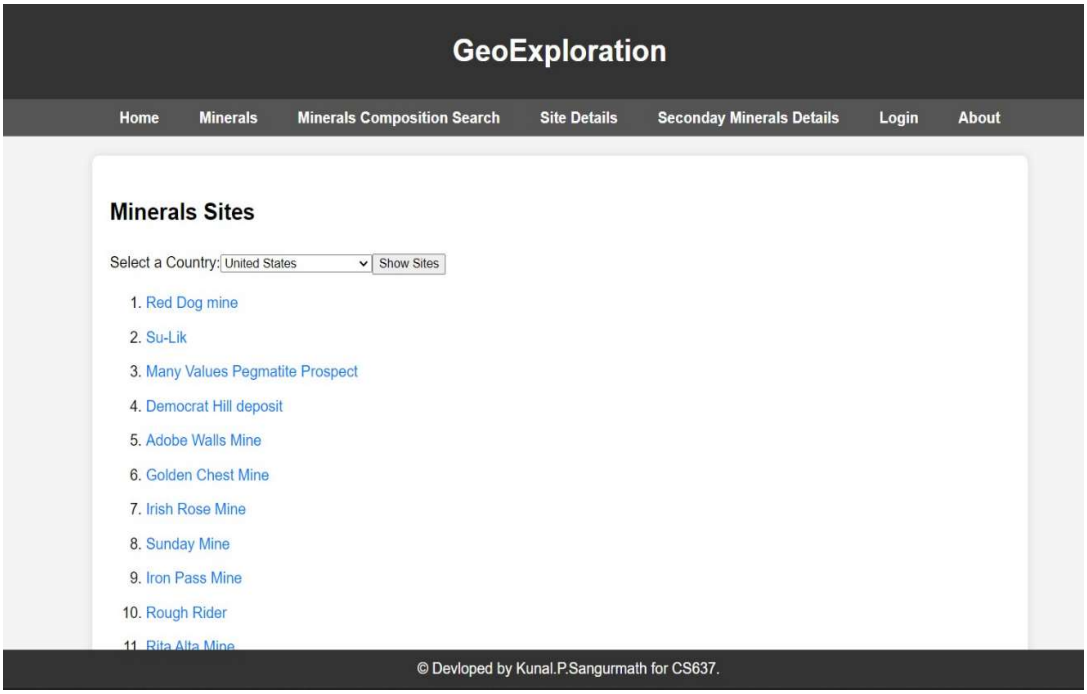


***fig*: 4.6: Mining Sites and its Details**

DESCRIPTION: This page displays information pertaining to mining sites categorized by their respective countries along with associated details.

4.7. Potential Secondary and Tertiary mineral explored in a region where a primary mineral is explored.

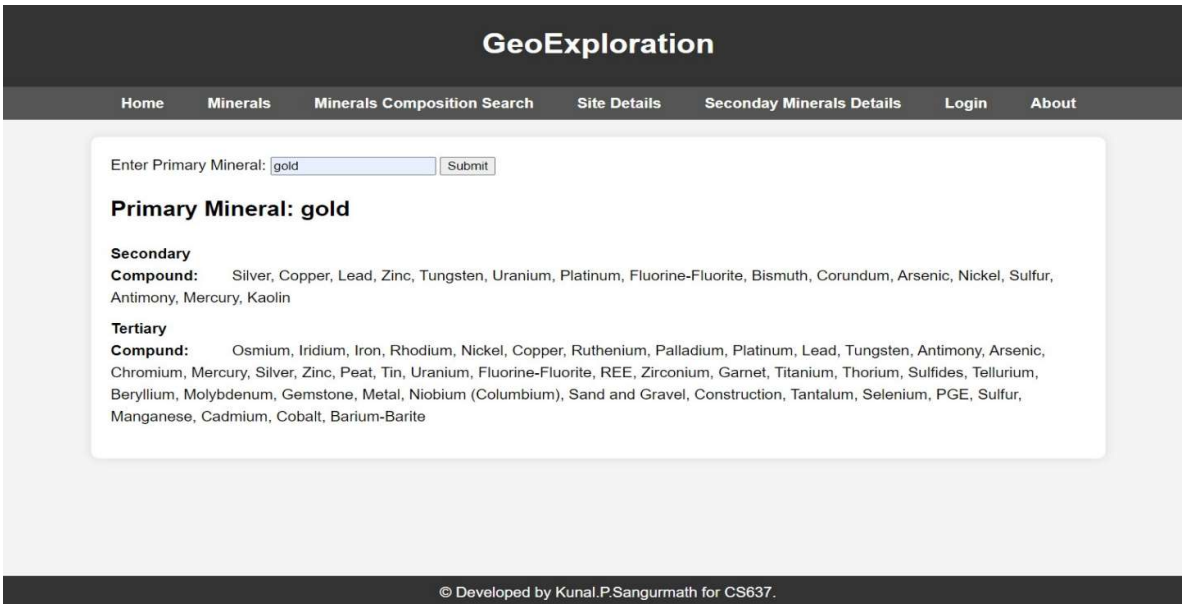
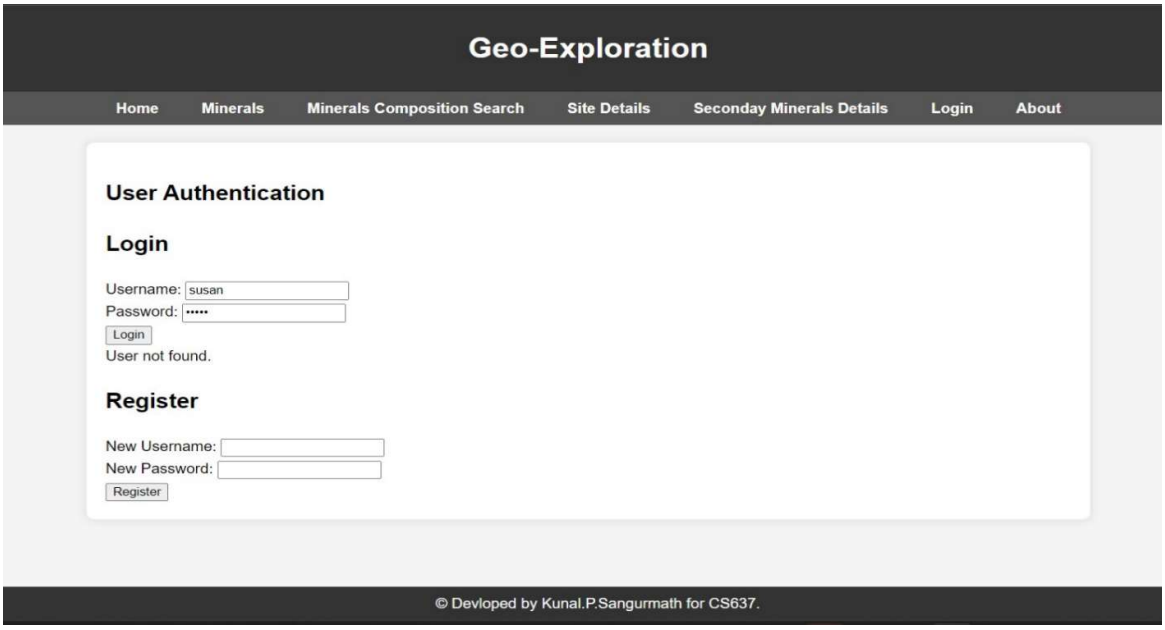
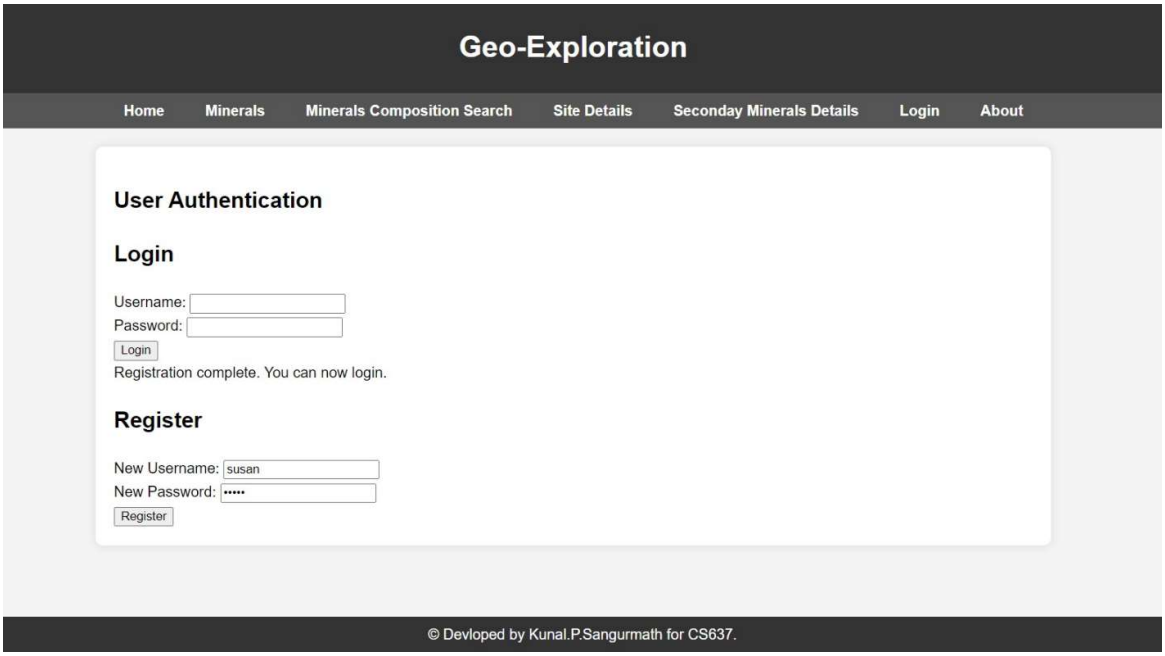


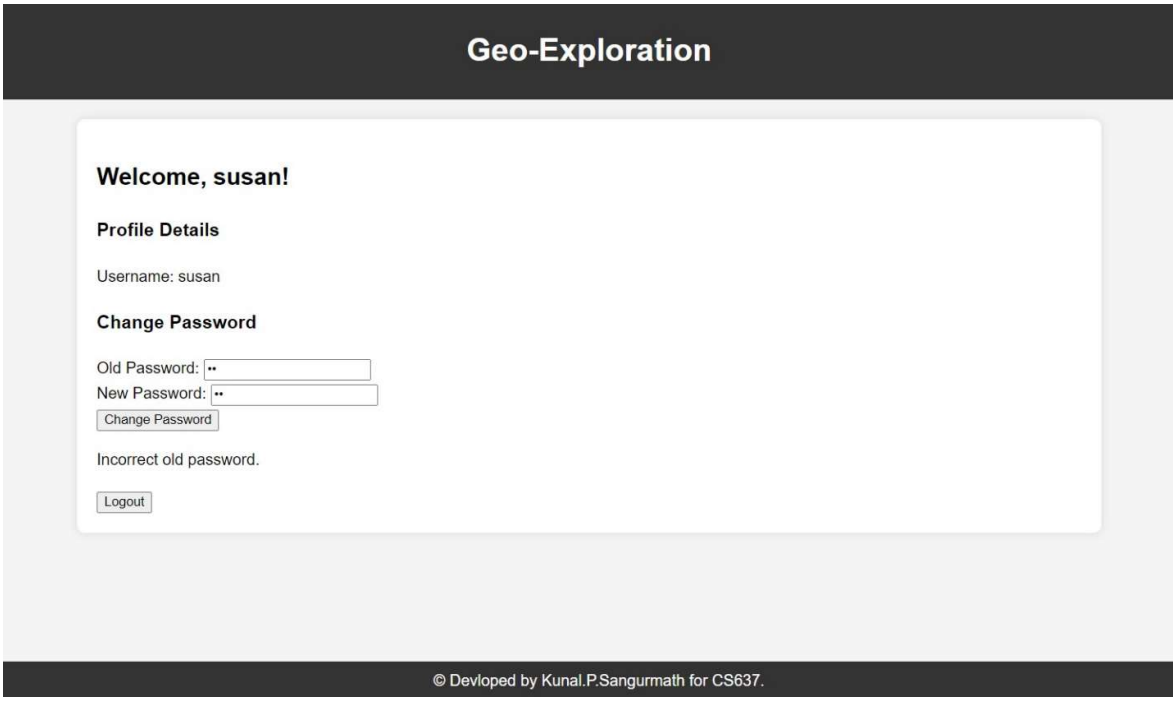
***fig* 4.7: Secondary Minerals**

DESCRIPTION: Users have the capability to designate the primary mineral discovered within a specified region and subsequently discern the potential presence of both primary and secondary minerals within that designated geographical area.

4.8. User Login/Register with Password Update




Geo-Exploration
Home
Minerals
Minerals Composition Search
Site Details
Seconday Minerals Details
Login
About
User Authentication
Login
Username:
Password:
Login
Registration complete. You can now login.
Register
New Username: susan
New Password:
Register
© Devloped by Kunal.P.Sangurmath for CS637.


Geo-Exploration
Welcome, susan!
Profile Details
Username: susan
Change Password
Old Password:
New Password:
Change Password
Incorrect old password.
Logout
© Devloped by Kunal.P.Sangurmath for CS637.

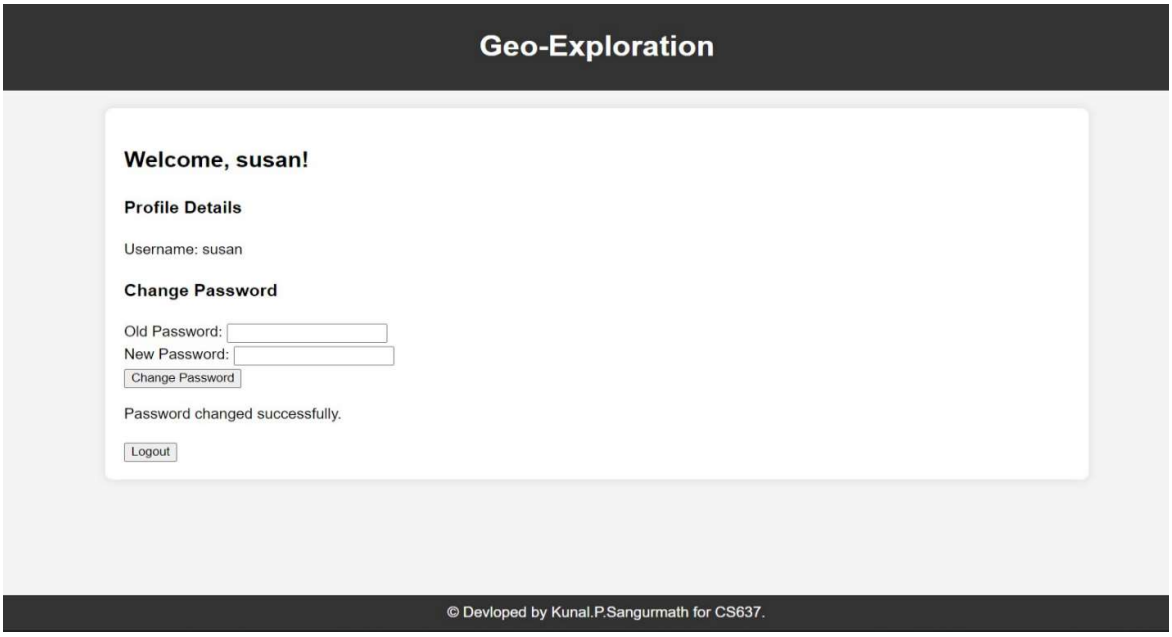


***fig* 4.8: User Login/Regsister with Password Update**

DESCRIPTION: On this page, users can register and log in. Subsequently, users are afforded the option to update their passwords, a process that necessitates verification of the old password for security purposes.

4.9. About Page

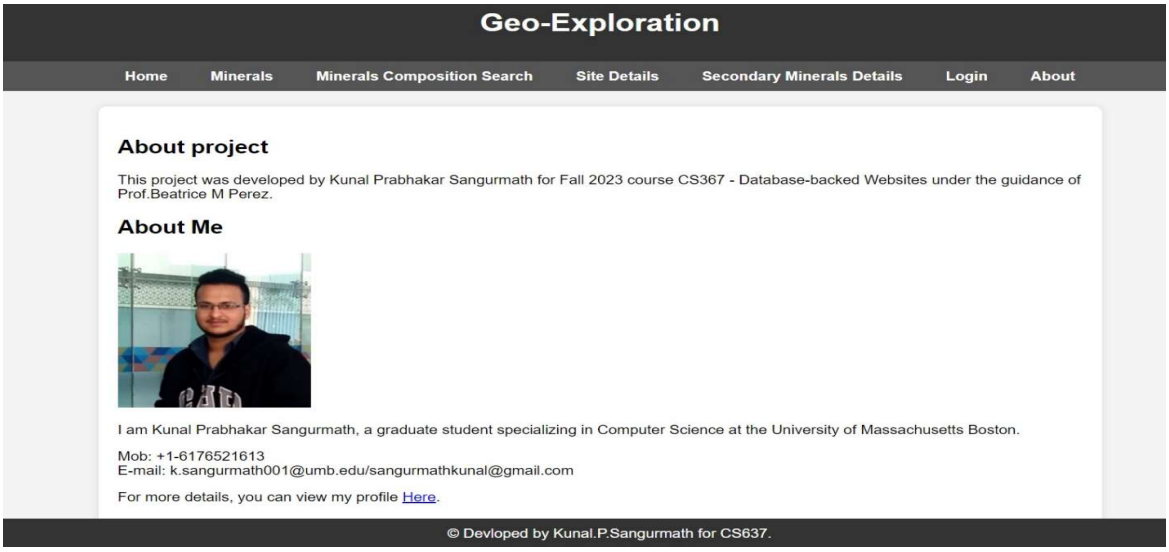


***fig* 4.9: About Page**

DESCRIPTION: On this page, comprehensive information regarding the project is accessible.

CHAPTER 5

CONCLUSION AND FUTURE WORKS

5.1 CONCLUSION

In conclusion, the successful implementation of our web application dedicated to mineral and mining site exploration marks a significant milestone in our project and matches the output as discussed with the professor. This comprehensive platform not only provides users with a wealth of information about various minerals, including their elemental compositions and associated mining sites, but it also incorporates advanced search functionalities for a seamless user experience.

5.2 FUTURE WORK

The successful implementation of the web application for mineral and mining site exploration lays the foundation for future enhancements and expansions. Here are some potential avenues for future work on the project:

1. Enhanced Data Integration:

- Explore opportunities to integrate real-time data feeds to ensure that the information on minerals and mining sites remains up-to-date.

- Consider partnerships with geological surveys, mining companies, or academic institutions to access and incorporate additional datasets for a more comprehensive database.

2. Collaborative Platform:

- Develop features that facilitate collaboration among researchers, geologists, and industry professionals. This may include discussion forums, collaborative research spaces, and the ability to share findings and insights.

3. Mobile Application Development:

- Extend the accessibility of the platform by developing a mobile application, enabling users to access information on minerals and mining sites while on the go.

4. User Feedback and Improvement:

- Establish a system for users to provide feedback on data accuracy, usability, and feature preferences, and use this feedback to continually improve and refine the web application.

By pursuing these future works, the web application can evolve into a more sophisticated, user-friendly, and globally relevant tool for the mineral exploration community.

CHAPTER 6

BIBLIOGRAPHY

[1] Head First HTML with CSS & XHTML Book by Elisabeth Robson and Eric Freeman Pearson

[2] www.stackoverflow.com

[3] www.youtube.com

[4] www.tutorialpoint.com

[5] www.w3schools.com

[6] www.geeksforgeeks.org

[7] Database management systems, Ramakrishnan, and Gehrke, 3rd Edition 2014, McGraw Hill.