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Web-based Computer Application for Assessment of Hydrogeochemistry Data of Geothermal Sites of Turkey: Muğla (SW Turkey) Example

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ABSTRACT

Recent improvements in digital technology enable performing significant amounts of chemical analyses in a short time. For example, physical and chemical properties of the water can be measured by high frequency measurement devices, and remote sensing technologies provide valuable information about the earth surface. In order to deal with huge amount of information generated by means of electronic technology, computer technology should be used. In the recent years, computer technology allows researchers to report their findings in more expressive way. User-friendly computer programs such as ArcGIS, MapInfo, MatLab help dealing with the large amount of digital information. In addition to this, internet technology allows easy access to this information by the public.

With the aim of analyzing and presenting the data in a user-friendly way, a web page was designed. For the design of the web page, Adobe Dreamweaver computer program was used. For the primary application, the existing data from Muğla (SW Turkey) region was chosen. In the future, by using necessary softwares, it will also be possible to make statistical analyses on the raw data and to report the results in a more meaningful way. These kinds of applications will enable the scientific society to handle, analyze the data in a standard way and share the digital information.

1. INTRODUCTION

Turkey is located on the Mediterranean sector of the Alpine-Himalayan Tectonic Belt, which have an important geothermal potential (Bozkurt 2001; Şimsek et al 2005). The continental collision between the African and the Eurasian plates causes a complex rock deformation in this earthquake belt (Bozkurt 2001). Young volcanic and active faults along the border of these plates allow circulation of water, as well as heat flow and geothermal energy (Baba and Sözbilir 2012). Previous studies (Simsek et al 2005; Baba and Sozbilir 2012) already indicated that the distributions of hot springs are almost parallel to the elongation of the fault systems, young volcanism and hydrothermally altered areas. This natural setting serves as a suitable area for a total of about 1000 thermal and mineral water springs (MTA, 1996; Simsek et al 2005) (Figure 1.).

Increasing geothermal energy usage in Turkey resulted in the production of excess amount of data such as water chemistry analyses results. Success in the assessment of this tremendous amount of information is directly related to presenting them in a meaningful way. The aim of this study is to construct a website that can be used both for storing the data and presenting it visually.

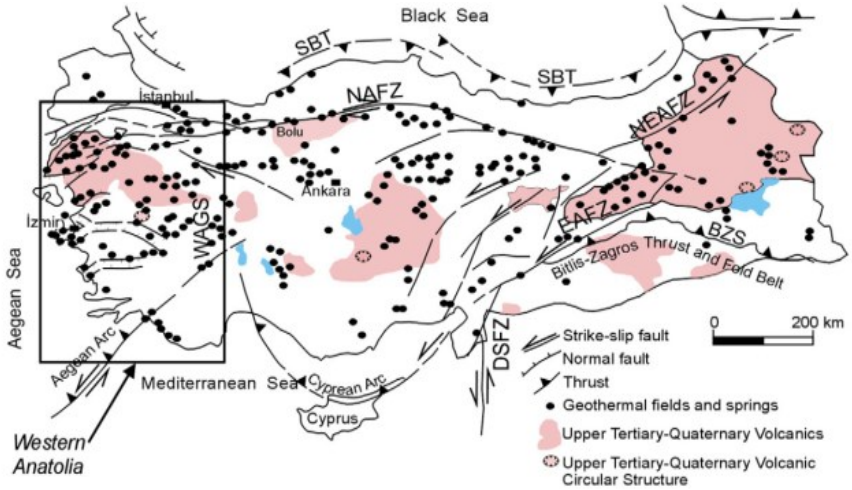

Figure 1: Tectonic map of Turkey illustrating the distribution of geothermal areas in the western Anatolia (from Baba and Sözbilir, 2012).

2. METHOD OF THE STUDY

There are many inventories about the geothermal sites of Turkey that were prepared by different researchers. The most famous one is prepared by the General Directorate of Mineral Research and Exploration of Turkey (MTA), which comprises all geothermal sites of Turkey (MTA, 2005). This inventory contains geological information about the wells and springs (e.g. temperatures, flow

rates) as well as the related water chemistry data. More detailed inventories were prepared for the local regions such as Muğla province (Avşar et al., 2012).

The main idea is to construct a web page that combines the geological information and physicochemical properties of the geothermal waters, which were already documented in these public inventories.

Since covering all information from the geothermal fields of Turkey would be a challenging mission, only the data gathered from Muğla region was used as the input for this prototype web site. The main structure of the web site was designed in order to combine data from all regions of Turkey as a preliminary approach but data of Muğla geothermal fields, which are based on Avşar et al.'s (2012) work, were input/entered to the web site.

3. GEOTHERMAL WEB PAGE DESIGN

As mentioned before, the web page was designed to allow the upload and presentation of data from all geothermal fields in Turkey. However, as a preliminary design only the results of Avşar et al. (2012), which is a study on Muğla geothermal and mineral waters, were input to the web site. The home page contains information about the team and the project (Figure 2). There is a page called GEOTHERMAL where the general information about geothermal energy together with the statistics from the world and Turkey can be found (Figure 3). There is another main page called GEOTHERMAL SITES. By a dropdown menu, Turkey is first divided into three main regions i.e., western, central and eastern Anatolia (Figure 4). Under the "Western Anatolia" tab, Muğla province and its sites are presented by providing general information, photographs, tables, and charts of the geothermal and mineral water sites of Muğla. Avsar et al. (2012) is currently the only reference on this page. At the top of this page, firstly the general information about the study and thermomineral waters is provided, and then links for every site are listed, from which detailed information can be found for each site (Figure 5). For example, clicking on "Mesken" opens the "Mesken mineral water spring" webpage containing information and data about this site for the inspection of the user (Figure 6). Along with the geographical information, the page presents the story of the spring (e.g., balneal usage of the site), photograph of the site, Schoeller diagram showing major ion concentrations of the water, physical properties of the water such as EC and temperature (Figures 6 and 7). Going back to the Muğla page (Figure 5) and exploring other sites is also possible, moreover opening more than one window for different sites may be a good way of comparing the sites.

Figure 2: The "Home" page of the web site.

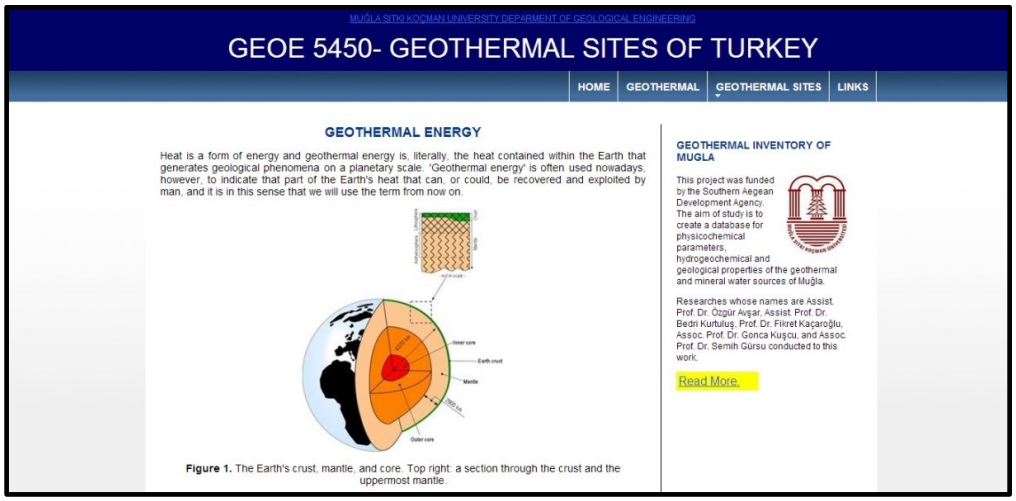

Figure 3: The "Geothermal" page of the web site.

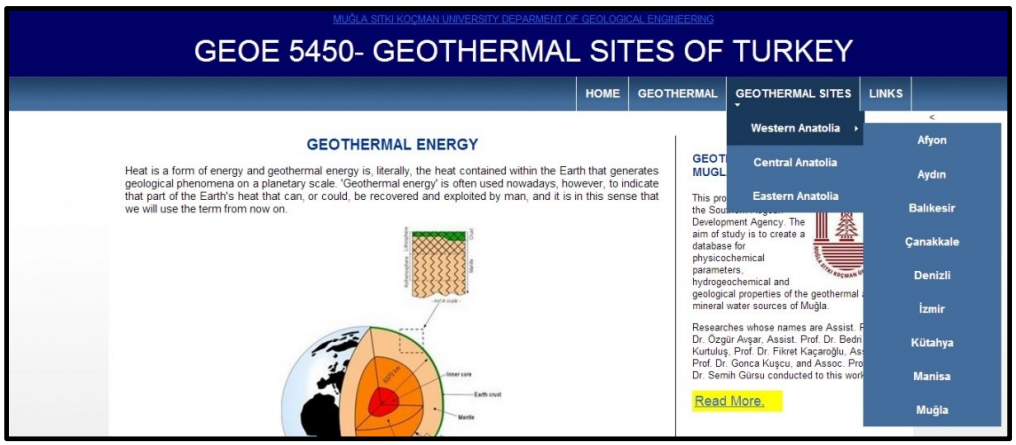

Figure 4: The screenshot of the "Geothermal Sites" page of the web site.

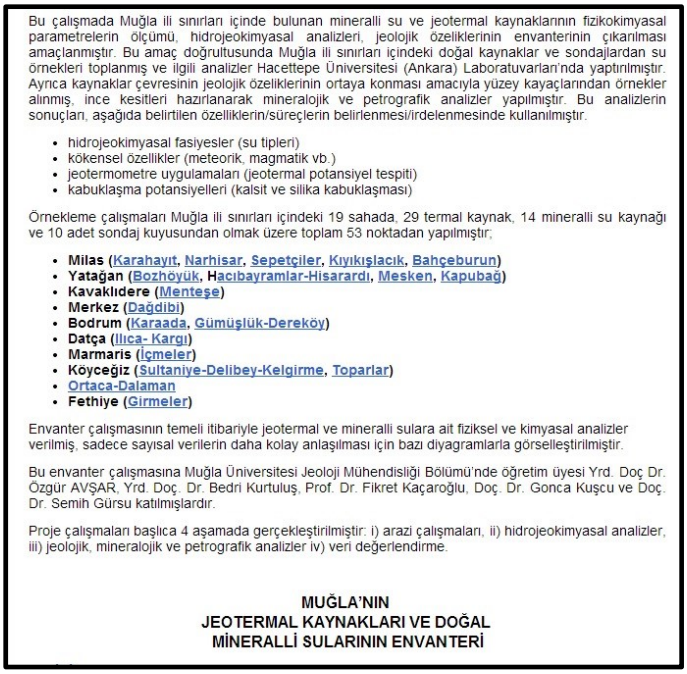

Figure 5: The screenshot of the "Muğla" page of the web site. Clicking on site names written in blue font user can open the page of that site.

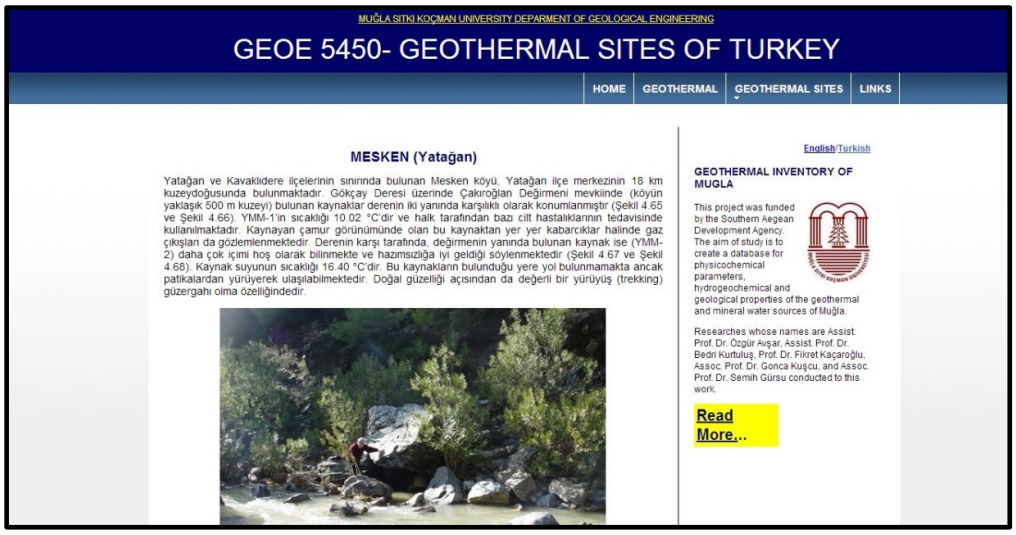

Figure 6: The screenshot of the "Mesken" page of the web site. Mesken is a mineral water spring.

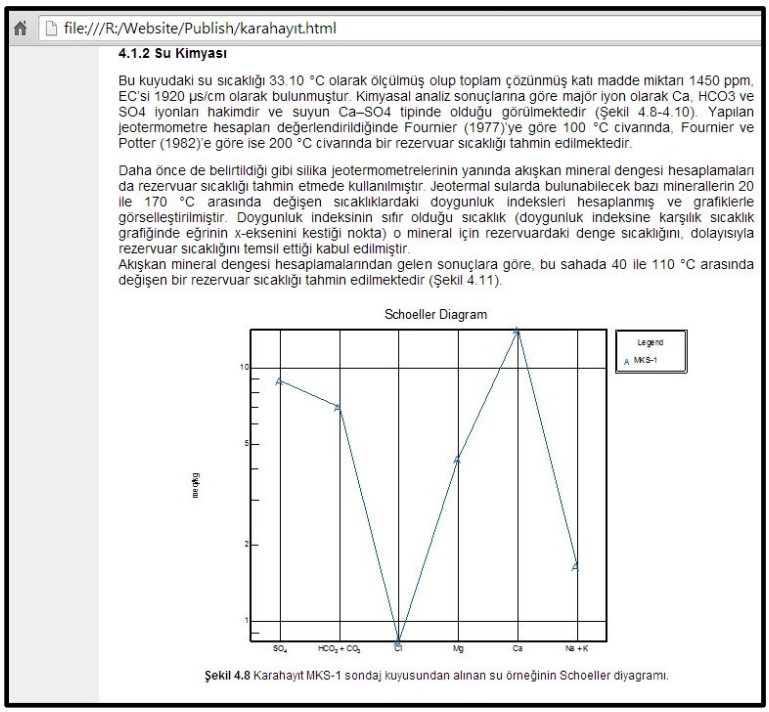

Figure 7: The screenshot from the "Karahayıt" page. Information about the water chemistry.

Along with the general information, there is an interactive Google Earth map of the region interested, where the well and spring locations are marked as dots. Clicking on dots opens a pop-up window, which contains a table presenting major and minor ion concentrations and stable isotope ratios (Figure 8). There is also a page where useful links about geothermal are given (Figure 9).

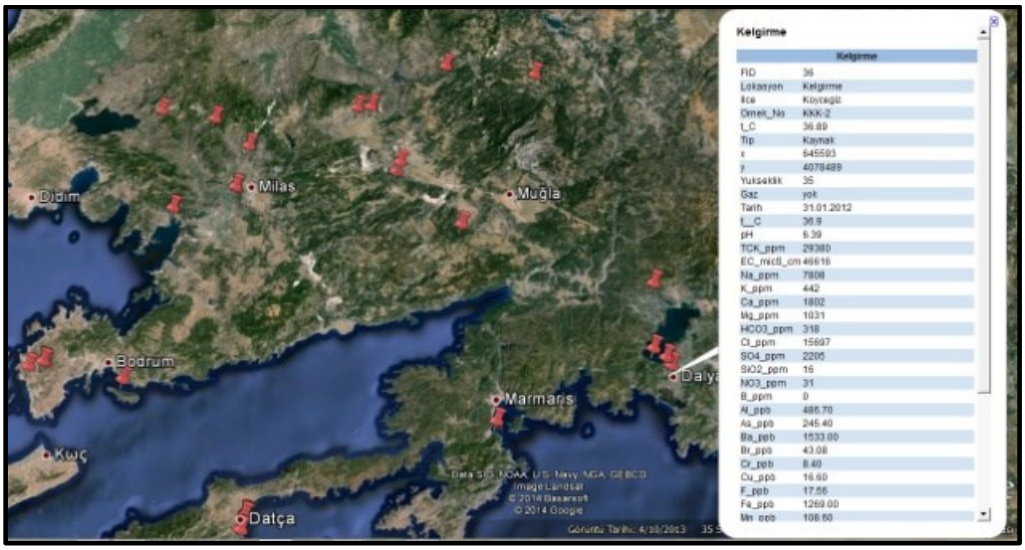

Figure 8: The interactive map.

3. CONCLUSIONS AND FUTURE STUDIES

This construction of preliminary model will be the key idea on presenting excess amount of digital data by online access. As mentioned before, presenting the information of the geothermal sites via a web site has several advantages, such as; easier access to the data via internet, storing huge amount of data in an order, easier visualization and comparison of the data by charts, diagrams, and interactive maps. Considering these advantages, this study was started with the aim of preparing the preliminary model of the web site. The web site is prepared as a term project of "Geothermal Sites of Turkey – GEOE 5450" course given at Muğla Sitki Kocman University, Turkey. The team members of this project are actually graduate students who were taking this course. Although it seems like an amateur attempt, the outcome of the study has shown that constructing a comprehensive web site comprising data from the whole world is not an unrealistic dream.

The future steps can be listed as:

- English version of the web page may be constructed. Then researchers from abroad can use the site.
- The web site will be improved in order to superimpose different kinds of maps.
- Recent technology allows making high frequency physicochemical measurements in natural waters. This way of measurement is widely used in the world. Any high frequency data produced in geothermal sites may be published by means of this web site.
- The web page may be arranged as to be editable by the users. By assigning separate accounts to the users, editing opportunity may be given them, which probably result in larger datasets.

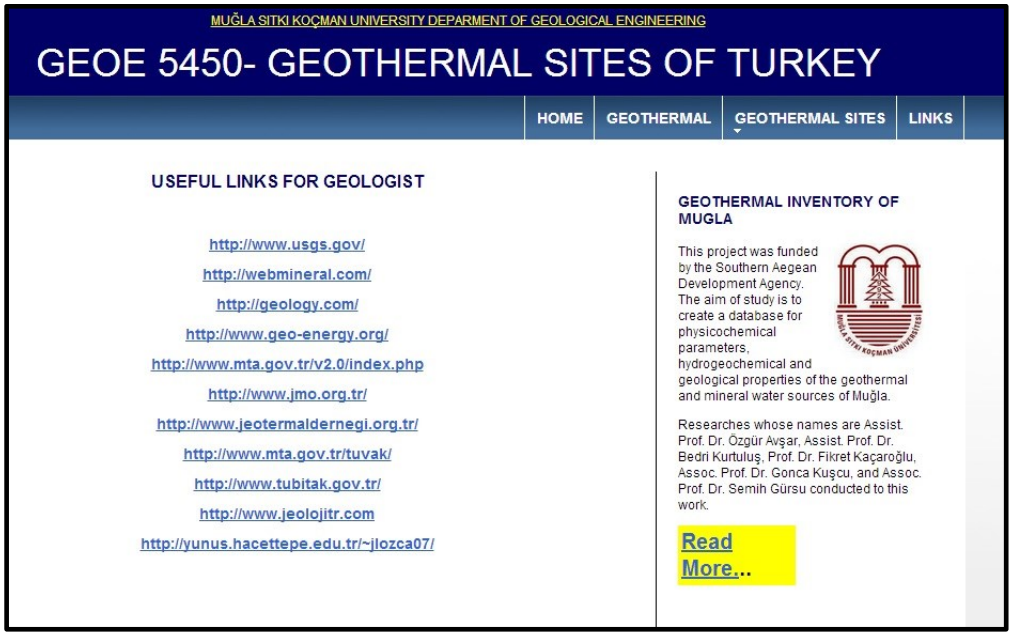

Figure 9: The screen-shot of the "Links" page.

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