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GEOLOGICAL AND GEOTHERMAL MAPPING IN DJUPAVATN VIGDIS-ARVELLIR AREA, SW-ICELAND

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INTRODUCTION

1.1 The study area

Djúpavatn-Vigdísarvellir area is located on the Reykjanes Peninsula, about 30 km south of Reykjavík, the capital of Iceland (Figure 1). The Reykjanes peninsula stretches out into the Atlantic Ocean. The ocean temperature is affected by the so-called Irminger current of the warm Gulf Stream which greatly moderates the climate of Iceland. The area has a relatively high annual rainfall, between 1200 and 2000 mm per year. Winters are temperate with a mean daily temperature in the range between -2°C and -4°C, during the coldest month, while the summers are moderate, with a mean monthly temperature of about 8-10°C (The Icelandic Meteorological Office, 2007). The present report is a part of the authors 6 month training at the United Nations University Geothermal Training Programme (UNU -GTP) in Iceland. An important part of the training in geological and geothermal exploration was to create a geological map and a geothermal map of the study area, the chief aim of the present study. In 2006, the energy company HS Orka hf, was awarded a ten year long geothermal research licence for the entire Krýsuvík area (Krísuvík area), and is accordingly conducting extensive geophysical and geological geothermal surveys and exploration drilling. The energy potential has been estimated as high as 200-300 MW of electricity.

THE GOALS

The main goals of this study were to Explored the geothermal energy resources and to make geological and geothermal maps of avolcanic field and to find out if a relationship could be established between the tectonic setting and the geothermal manifestations of the study area. The geological mapping exercise was carried out in 2009 in the first geothermal area (Djúpavatn-Vigdísarvellir area) .

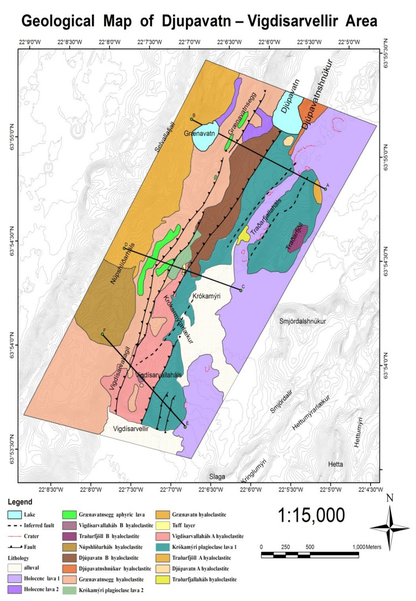


FIGURE 5: Geological map of the study

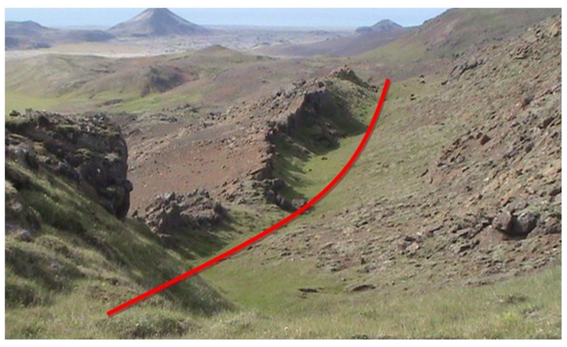


FIGURE 9: NE-SW trending fault in Djúpavatn B hyaloclastite unit

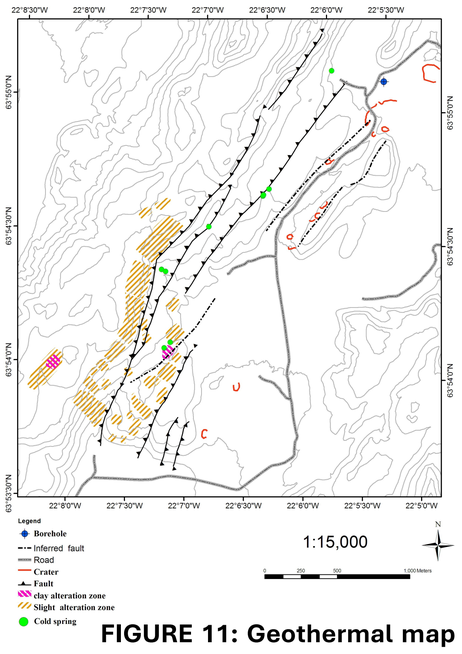


FIGURE 11: Geothermal map of the study area



FIGURE 12: Example of calcite veins.

Discussion

**** GEOLOGICAL MAPPING OF THE DJÚPAVATNVIGDÍSARVELLIR AREA***

The Djúpavatn-Vigdísarvellir area is a part of the Krýsuvík-Trölladyngja high-temperature geothermal area on the Reykjanes Peninsula. The low and flat lands are predominantly covered by Holocene lava flows covering the older hyaloclastite formation at low grounds, and in places alluvium erosional deposits below the mountain slopes. The topography is dominated by NESW trending ridges formed by different units of hyaloclastites, which are all products of subglacial eruptions. The elevation is between 200 and 300 m a.s.l. These mountains are considered to have formed during the last 2-3 glaciations (Jakobsson and Gudmundsson, 2008). The thickness of ice covering the area during the last glaciation was estimated to be around 300 m (Arnórsson et al., 1975; Abdelghafoor, 2007).

Figure 5 shows a Geological map of the study area. The bedrock of the area consists of NE-SW trending hyaloclastite ridges. The rock units in the Djúpavatn-Vigdísarvellir area are hyaloclastites, interglacial lava flows and Holocene lavas, all of which were mapped, and are presented on the geological map in Figure 5.

The units are made of fragmented glassy basalts (hyaloclastites) erupted within the confines of glacial ice where the material piled up but did not flow out like the subaerial basaltic lavas do during ice-free periods like today. Eleven eruptive hyaloclastite units and 3 interglacial lava flows were mapped.

The oldest rock units are found within the northeast part of the study area and are from the third last interglacial period and the third last glaciation.

The tectonics of the study area is controlled by the regional tectonics of the Reykjanes peninsula. The main structural feature is NE-SW trending hyaloclastite ridges. Numerous NE-SW trending normal faults were also mapped in the study area . They define graben structures along the axis of Djúpavatn hyaloclastite B, Graenavatnsegg hyaloclastite and Vigdísarvallaháls hyaloclastite A. Three large faults run along Djúpavatn hyaloclastite B, Graenavatnsegg hyaloclastite and Vigdísarvallaháls hyaloclastite A (Figuers 5 and Figuers 9). Two small faults run along the southern part of the Krókamýri plagioclase lava 1.

Geothermal mapping in the study area

Figure 11 shows a map of geothermal manifestations in the study area. No active fumaroles or hot springs were found in the study area, but the bedrocks show hydrothermal alteration from low intensity (slight alteration) to clayish alteration (intense alteration). The clayish alteration indicates formerly active fumaroles where the hyaloclastite rocks have been completely replaced by secondary minerals (mostly clays).

Geothermal manifestations

Geothermal manifestations are more common in the southern part of the mapped area. Two types of geothermal alteration were distinguished (see Figure 11). Slight alteration, mostly characterised by slight colour changes of the tuffs to lighter colours and also involving some calcite veins, and higher grade alteration where the host rock has been completely replaced by clay. Hydrothermal surface alteration, hot or cold, indicates the presence of a subsurface hydrothermal system at some time. Therefore, mapping the surface alterations is useful in delineating a hydrothermal system. The alteration intensity increases with increasing activity. Thin calcite veins were found in the southwest part of the study area. The hyaloclastite rock of Vigdísarvallaháls hyaloclastite A shows some narrow calcite veining (Figure 12). An XRD analysis of a sample confirmed the presence of calcite . Several samples were collected for clay analysis by XRD.

Slight alteration The slightly altered rocks are confined to the Vigdísarvallaháls and Graenavatnsegg hyaloclastite units in the southwestern part of the field area . Both these units are from the second last glacial period. Their alteration is most likely

CONCLUSION

The Djúpavatn-Vigdísarvellir area is located within the Krýsuvík-Trölladyngja volcanic system, which is one of four main volcanic systems within the Reykjanes Peninsula.

The age of the volcanic activity in the area spans from Holocene down to the third last interglacial period, or some 300,000 years.

The bedrock consists mainly of hyaloclastites with sparser interglacial lava flows and young Holocene lava at the lowest elevation.

The stratigraphy is divided into 11 hyaloclastite units.

The oldest bedrock units are Tradarfjallaháls hyaloclastite, Djúpavatn hyaloclastite A, and Tradarfjöll hyaloclastite A; these units are partly covered by plagioclase porphyritic basaltic lava. Holocene lava flows are mainly confined to low elevation on the east side of the mapped area.

The major structural trends that seem to control the geothermal manifestations orient NESW.

Two types of alteration zones are distinguished on the map, slight alteration, and extinct clay alteration.

References

1. Abdelghafoor, M., 2007: Geological and geothermal mapping in Sveifluháls area, SW-Iceland. Report 3 in: Geothermal Training in Iceland 2007. UNU-GTP, Iceland, 1-23.
2. Al-Dukhain, A.M.H., 2008: Geological and geothermal mapping in Trölladyngja-Sog area, SW-Iceland. Report 9 in: Geothermal Training in Iceland 2008. UNU-GTP, Iceland, 31-52.
3. Arnórsson, S., Björnsson, A., Björnsson, S., Einarsson, P., Gíslason, G., Gudmundsson, G., Gunnlaugsson, E., Jónsson, J., and Sigurmundsson, S.G, 1975: The Krísuvík area. A complete report on geothermal exploration. Orkustofnun, Reykjavík, report OS JHD-7554 (in Icelandic), 71 pp +
4. Clifton, A., 2006: Reykjanes field trip: tectonic magmatic interaction at an oblique rift zone. Web page: www.norvol.hi.is/~amy/ReykjanesFieldTrip.pdf, 9 pp.
5. EPICA Community Members, 2004: Eight glacial cycles from an Antarctic ice core. Nature, 429, 623-628.
6. Fridleifsson, G.Ó., 1983: Mineralogical evaluation of a hydrothermal system. Geothermal Resources Council, Trans., 7, 147-152.
7. Fridleifsson, G.Ó., Richter, B., Björnsson, G., and Thórhallsson, S., 2002: Trölladyngja, well TR-01. Orkustofnun, Reykjavík, report, OS-2002/053 (in Icelandic), 52 pp.
8. Gudmundsson, M.T., and Högnadóttir, T., 2007: Volcanic systems and calderas in the Vatnajökull region, central Iceland, constraints on crustal structure from gravity data. J. Geodynamics, 43, 163-169.
9. Hersir, G.P., Rosenkjaer, G.K., Vilhjálmsson, A.M., Eysteinsson, H., and Karlsdóttir, R., 2009: The Krýsuvík geothermal field. Resistivity soundings 2007 and 2008. ÍSOR Iceland GeoSurvey, Reykjavík, report (in Icelandic), in prep.
10. Jakobsson, S.P., and Gudmundsson, M.T., 2008: Subglacial and interglacial volcanic formations in Iceland. Jökull, 58, 179-196.
11. Jakobsson, S.P., and Gudmundsson, M.T., 2008: Subglacial and interglacial volcanic formations in Iceland. Jökull, 58, 179-196.
12. Jóhannesson, H., 1980: Structure and evolution of volcanic zones in W-Iceland. Náttúrufraedingurinn, 50, (in Icelandic), 13-31.
13. Jóhannesson H., and Saemundsson, K., 1999: Geological map of Iceland, scale 1,000,000. Icelandic Institute of Natural History.
14. Jónsson, J., 1978: A geological map of the Reykjanes Peninsula. Orkustofnun, Reykjavík, report OS/JHD 7831 (in Icelandic), 333 pp and maps.
15. Kifua, G.M., 1986: Geologic mapping for geothermal exploration, Trölladyngja area, Reykjanes Peninsula, Southwest Iceland. UNU-GTP, Iceland, report 4, 38 pp.
16. Kristjánsson, B.R., Sigurdsson, Ó., Mortensen, A.K., Richter, B., Jónsson, S.S., and Jónsson, J.A., 2006: Predrilling and 1st and 2nd phase: Drilling for 22½" surface casing in 85.5 m, 18⅝" security casing in 354 and 13⅜" production casing in 800 m depth. ÍSOR – Iceland GeoSurvey, Reykjavík, report ÍSOR-2006/051 (in Icelandic), 96 pp.
17. Kristmannsdóttir, H., 1979: Alteration of basaltic rocks by hydrothermal activity at 100-300°C. In: Mortland, M.M., and Farmer, V.C. (editors), International Clay Conference 1978. Elsevier Scientific Publishing Co., Amsterdam, 359 -367.
18. Mbogoni, G., 2008: Geological study of the sedimentary sequence lithology, depositional history, and hydrothermal alteration at Sog in Trölladyngja area, SW-Iceland. Geothermal Training in Iceland 2008. UNU-GTP, Iceland, 427-446.
19. Mortensen, A.K., Jónsson, S.S., Richter, B., Sigurdsson, Ó., Birgisson, K., Karim Mahmood, A.T., Gíslason, J., 2006: Trölladyngja, well TR-02, 3rd phase: Drilling of 12 ¼ production part from 800 to 2280 m depth. ÍSOR Iceland GeoSurvey, Reykjavík, report, ÍSOR-2006/060 (in Icelandic), 75 pp.
20. Muhagaze, L., 1984: Geological mapping and borehole geology in geothermal exploration. UNU-GTP, Iceland, report 5, 38 pp.
21. Ngaruye, J.C., 2009: Geological and geothermal mapping of Slaga-Arnarvatn area, Reykjanes Peninsula, SW-Iceland. Report 21 in: Geothermal Training in Iceland 2009. UNU-GTP, Iceland, Saemundsson, K., 1979: Outline of the geology of Iceland. Jökull 29, 7-28.
22. Saemundsson, K., and Einarsson, S., 1980: Geological map of Iceland, sheet 3, SW-Iceland (2nd edition). Museum of Natural History and the Iceland Geodetic Survey, Reykjavík. Saemundsson, K. and Gunnlaugsson, E., 2002: Icelandic rocks and minerals. Edda and Media Publishing, Reykjavík, Iceland, 233 pp.
23. The Icelandic Meteorological Office, 2007: Weather information.
24. The Icelandic Meteorological Office, webpage: http://andvari.vedur.is.

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