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Reykjavík 29. May 2018
UST201805-008/I.M.B.
09.05.01

Subject: Research permit in Geysir geothermal area

The Environment Agency of Iceland has received an application from Mr. Matteo Lupi, dated 2. May 2018, for a research of non-invasive 3D electrical resistivity tomography of the Strokkur geyser within the Geysir geothermal area on the 15.-25. June 2018.

Geysir is listed on the Nature Conservation Register and is under the Environment Agency supervision. Silica sinter deposit is protected by Act. no. 60/2013 on nature conserve and cannot be disrupted in any way.

Description of the project:

The research's aim is to constrain the distribution of fluids in the Geysir hydrothermal system. The goal of the experiment is to link surface observations (i.e. temperature) and subsurface (i.e. resistivity) data. The acquisition will be carried on in two steps: 1) 3D large scale deep electrical resistivity tomographic method (DERT) with expected penetration depth of 1km; 2) 4D high resolution ERT to try to capture resistivity changes at depth potentially associated to replenishment and expulsion of fluids at depth. DERT results will be combined with available data from the literature to develop a conceptual model of the recharge. Electrical Resistivity Tomography is particularly suited to investigate hydrothermal systems. High-resolution non-invasive geoelectrical methods will be used to acquire a 3D (and possibly 4D) resistivity tomography of Geysir area using the newly developed IRIS Fullwaver instruments. This will provide an image of the subsurface distribution of the fluids feeding the system including the morphology of the conduit and its extent as well as the possible occurrence of fluid-chambers.

There will be no sampling of fluids. Thermal measurements may be envisaged in the pool if possible to complement the resistivity data. The thermometers are cylinders with a basal radius of 2cm and a height of 3 cm that are lowered (and left inside the conduit) during the experiment. Thermocouples can be lowered into fumaroles, springs, mud volcanoes or lakes with the support of fishing rods. Since it can be logistically difficult to access the Stokkur geyser for those measurements the use of a drone to acquire thermal data is preferred. The measurements with a drone does not require to fly above 130 m. The drone will hover over the area for 15 mins, which is the time needed to record with high-resolution and thermal cameras the eruptive activity. 8 flights of 15 mins is estimated to be done at dusk or sunrise. The drone will fly above the geyser and surrounding regions (i.e. within 1 km radius) to collect thermal images of the thermal variations during charging and discharging dynamics.

The measurements consist of four 60 cm long injection electrodes and 75 30cm receiver electrodes that will be systematically distributed in the Geysir area. The diameter of the electrodes is about 1 cm. The electrodes will stand 10cm out of the ground. An electric cord will be attached to each electrode. The cords are then connected to 25 black boxes (fullwaver) distributed around the area. Each of the black box has three electrodes connected to them by a 0,5-100 m long cables. A generator to provide the electricity necessary to energize the subsurface measurements will be used and can be placed away from the touristic area.

Planned distribution of the instruments has been put forward on an aerial photograph accompanying the application.

The research will take place from 8:00 pm to 6:00 am from the 15. - 25. June 2018 and there will be 6 researchers executing the research on site. All the black boxes can be removed during the day. The cables of the remote stations, i.e. the ones far away from Strokkur will have to stay. The removal of the cables during the day will be decided in accordance with the ranger.

Research reviews:

The Environment Agency sent a request to the National Energy Authorities (NEA), the Institute of Earth Science and to the Icelandic Institute of Natural History for impact assessment on the research methods in regard of the possible negative effects that the research method could have on the research area and on the conservation value of the area. The NEA did not have any comments on the method.

The Icelandic Institute of Natural History does not regard the research to cause negative effects on the area if certain conditions are followed and that the installation of electrodes should be done in accordance with the Environment Agency. The Institute does not recommend that the electric cords will be covered with soil. The Institute also notes that the applicants take note of the security instructions next to the geyser and springs and avoid disruption of the silica sinter deposit since it is protected by Act. no. 60/2013 on nature conserve. The Institute would like to get the research results once they are ready. The Institute of Earth Science did not reply.

Impact assessment:

Based on the information from the applicant the Environment Agency of Iceland does consider the research likely to have temporary negative impact on the area due to the need to go off paths when installing and removing the equipment. The number of instruments used for the research and its dispersion in the area is considered likely to cause negative impact on visitor's experience. The research is however likely to give new and more detailed scientific knowledge about the underground processes and nature of the Geysir geothermal area.

Conclusions and conditions:

The Environment Agency of Iceland hereby grants a permission for the research on its behalf on following conditions:

- Keep this letter with you on site during the project.
- The Environment Agency requires that the ranger will be contacted before starting the project and inform him on your intentions.

- The Environment Agency should be informed if there will be any changes to the project description.
- If the dates of the project change the Environment Agency of Iceland shall be notified, with at least 5 days notice, if possible. Otherwise as soon as possible.
- Installation of the equipment shall be done with a ranger present.
- The equipment shall be installed where there is a minimum risk of disturbance to the area and for the visitors.
- The electrodes shall not be installed in the silica sinter deposit.
- The electric cords shall only be removed from the walking paths during the day and they shall not be covered with soil.
- The electric generator shall be located northeast of the Geysir area to minimise the risk of groundwater pollution in case of an oil/benzin spill and to minimise the disturbance for the visitors of the camping site and the service in the surrounding area.
- Thermal measurements using the thermocouples should be done with the utmost care and secure that nothing will fall into nor will be left behind in the conduit.
- All disturbance to the environment should be minimal.
- This permit is only valid for the research purposes listed above. It does not include a permit to take samples of water or silica sinter deposit.
- All participants in the project must wear high-visibility clothing during field work, labelled with the identity of the researcher or the research institute.
- The equipment shall be supervised at all times to prevent visitors to go off paths to look at the equipment.
- Crew members should always stay on authorized paths as much as possible and not walk on the silica sinter deposit. Since the soil is treacherous the crew must be extremely cautious when going off paths.
- Fauna, geological formations and landscape should not be disturbed in any way.
- All disturbance to animals and wildlife is strictly prohibited.
- The crew should be conscious of other guests on site and make sure that the project causes as little disturbance to visitors as possible.
- A sign should be put up at each entrance stating the aim of the research, the project duration and information that a permission for the project has been obtained from the Environment Agency of Iceland.
- All traces of the work must be removed carefully off the site by the end of the project.
- An unmanned aircraft should never be flown near people. Please take precaution not to disturb people's experience, their safety or personal privacy nor the general peace of the area filmed.
- Using a drone can only be done before 9:00 am and after 6:00 pm.
- According to Icelandic law it is forbidden to fly close to cliffs where birds nest. An unmanned aircraft should never be flown near animals or birds, neither in nesting areas nor during nesting season or any other seasonal time when animals or bird habitats are considered vulnerable.
- The conductor of the unmanned aircraft is responsible for the aircraft within the protected area. This includes responsibility so that people, fauna and nature is unharmed because of the aircraft's use and that no permanent mark be left on the site in question. Should the aircraft crash, all components from it must be collected and removed from the area.

- According to art. 88 in act no. 60/2013 on nature conservation the ranger has the authority to stop the project if the project is likely to cause damage to the area.
- If any complications occur during the project please contact the ranger or the Environment Agency of Iceland, tel. +354 591 2000

A permission from the landowners outside the Geysir geothermal area is needed for the project.

A permission for any researches within geothermal areas in Iceland are subject to a permission from the National Energy Authorisation (www.os.is).

A special permission from the Transport Authority is needed if the unmanned aircraft/drone weighs more than 5 kg. Permission is also required from ICETRA to fly the drone at a height of more than 130 metres (430 feet). Furthermore, a permission is required from an aerodrome operator to fly the aircraft/drone within 2 km from the boundary of aerodromes with scheduled air services, except where the drones are flown below the height of the highest structures in the immediate vicinity of the flight trajectory of the drone. Liability for the use of unmanned aircraft/drone goes by Act no. 60/1998.

Request:

The Environment Agency of Iceland wishes to be secured, free of charge, a copy of all reports and scientific articles that results from the research project.

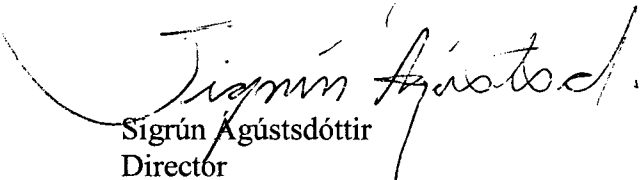
Permission fee:

The Environment Agency of Iceland notes that the agency charges a fee for processing applications for permits on the basis of Article 92 of Act no. 60/2013 on Nature Conservation. Due to the extent of the application and the research and due to the location of the equipment on and near the visitor's path the fee is 153.000 ISK according to art. 24. b. in the agency's tariff no. 535/2015.

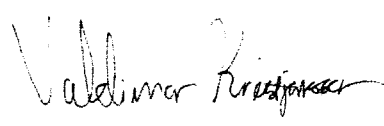
Supervision:

The Environment Agency will supervise the project. The supervisor will be a ranger from the Environment Agency.

Sincerely



Sigrún Agústsðóttir
Director



Valdimar Kristjánsson
Advisor