

SCAR Code of Conduct for Activity within Terrestrial Geothermal Environments in Antarctica

Background

1. This SCAR Code of Conduct provides guidance when planning or undertaking field activities within terrestrial geothermal environments.¹
2. This Code of Conduct was prepared following discussions held at the August 2014 Auckland Workshop which focused on the need to develop guidelines for working in terrestrial geothermal areas in Antarctica (see ATCM XXXVIII (2015) IP024 and ATCM XXXVIII (2015) WP035) and has been finalised through broad consultation, including with the Council of Managers of National Antarctic Programs (COMNAP).
3. The *SCAR Environmental Code of Conduct for Terrestrial Scientific Research in Antarctica* (2009) continues to provide guidance on practical measures to minimize impacts by scientists undertaking fieldwork in terrestrial environments, generally applicable across all of Antarctica.
4. This Code of Conduct for activities within terrestrial geothermal environments was developed in recognition of a specific need for guidelines for operations and scientific activities beyond those generally applicable guidelines, since terrestrial geothermal environments in Antarctica represent a unique case where more specific and customized guidance is needed because safeguarding the values of these sites requires measures that extend beyond those required in most areas in which activities are undertaken.
5. This Code of Conduct will be updated and refined as new scientific results and environmental impact reports become available from future research in terrestrial geothermal environments.

Introduction

6. Terrestrial geothermal environments in Antarctica are of high scientific value to a wide range of disciplines, for example to geologists, glaciologists, biologists and atmospheric scientists.
7. Recent studies provide evidence that terrestrial geothermal sites in Antarctica support unique and diverse biological communities, and have played an important role as biological refugia in some regions of the continent, where indigenous species survived glacial cycles and from which regional recolonization took place.
8. These environments, particularly those that to date have not been subjected to a high number of visits, may be at risk from introduced species or other damage through human activity. Microbiological communities in these environments are highly vulnerable to disturbance, and require specialized and rigorous measures of protection.
9. Fragile soils, plant and microfaunal communities, and/or delicate geological or ice structures (e.g. steam vents, fumaroles), may exist on geothermally heated ground, and these may be particularly susceptible to damage by trampling.
10. It is recognised that some terrestrial geothermal sites in Antarctica have already been subjected to relatively high levels of various human activity, for example, at some sites on Deception Island or near the summit of Mount Erebus, and may already have permanent installations that are needed to monitor geothermal activity for reasons of safety, and these require regular visits and maintenance. For such sites, responsible stewardship during subsequent visits to those sites should proceed in a manner that is consistent with the Protocol to the Antarctic Treaty, that minimizes possible future impact and protect, as far as possible, their value.

¹ 'Geothermal' is defined as 'of or relating to the natural internal heat of the earth', and 'terrestrial geothermal environments' are defined as 'non-marine ice, land, water or atmospheric environments at or near the earth's surface that are detectably influenced by geothermal heat'.

11. The application of this Code of Conduct should be considered prior to visiting any terrestrial geothermal environment. At geothermal sites that have already been subjected to relatively high levels of various human activity, the general rules under the Protocol on Environmental Protection to the Antarctic Treaty and guidance as provided in the *SCAR Code of Conduct for Terrestrial Scientific Field Research in Antarctica* should be sufficient. At geothermal sites that are presently unvisited or relatively undisturbed by human activities, there are important scientific (e.g. microbiological, geochemical and geological) and environmental reasons why extra precautions should be taken before values are degraded or lost. In such cases, this Code of Conduct should be taken into consideration. This is especially the case for geothermal environments that are known to be previously unvisited and, for this reason, more stringent recommendations that apply to previously unvisited terrestrial geothermal sites are made at the end of this Code of Conduct.
12. At this time, geothermal sites in Antarctica have not been assessed or classified according to their level of disturbance or in terms of their scientific value. For practical reasons it is therefore recommended that National Programs consult with each other, and with appropriate experts, about the extent to which, and where, this Code of Conduct should be applied, and that these decisions and the site locations should be made publicly available.

Guiding Principles

13. Careful planning is required before undertaking research within a terrestrial geothermal environment, and appropriate measures need to be considered to help maintain the integrity of sites. These should include:
 - Careful selection of the site to be visited. Geothermal sites that are known to have been previously visited should be used, unless use of a previously unvisited site is essential to meet scientific needs;
 - Coordinating planned activities with other researchers interested in the area to the maximum extent practicable.
14. In accordance with the provisions of Annex I to the Protocol on Environmental Protection to the Antarctic Treaty, and as part of the planning process, decisions on the level of environmental impact assessment (EIA) to be applied should take full account of the extent of previous visits to the geothermal site, as well as the anticipated impacts arising from planned activities at the site.
15. Decisions on whether to implement aseptic measures² should be assessed as part of the EIA and should take into account the likelihood of any conservation or scientific benefit to maintaining a sterile regime at a particular geothermal site that has been previously visited. If such benefits are considered likely, then aseptic measures should be implemented.
16. The locations of sites visited and nature of activities undertaken should be documented and maintained in publicly available records, and include accurate locations recorded with GPS, so that visited and unvisited sites may be more easily distinguished by future researchers.

Code of Conduct

Access

17. Movement to a terrestrial geothermal environment should be by way of designated access routes and landing sites where these are known or have been used previously, and this should be discussed with all personnel in the group, including pilots or vehicle drivers, prior to departure.
18. All overland movement of visitors within terrestrial geothermal sites should be on foot.
19. To the fullest extent practicable, vehicles and crewed aircraft should not be operated close to, or within, terrestrial geothermal environments due to the risks of damaging sensitive vegetation and

² 'Aseptic measures' are measures that 'aim to exclude microorganisms not native to the local geothermal environment'.

introducing non-native species. As a guideline, it is recommended that crewed aircraft should avoid landing or overflying within **100 m** of geothermal sites.

20. Areas of visible vegetation or moist soil both on ice-free ground and among ice hummocks and, as far as practicable, areas of geothermally heated ground, should be avoided.
21. The number of visitors entering a geothermal site should be minimised without compromising safety and the ability to undertake planned research. Visitors should follow established trails/routes where available and be aware that geothermal environments are dynamic and may be subject to frequent change; sites that were safe for access or travel when visited on a previous occasion may not necessarily remain so.
22. Pedestrian movement within the terrestrial geothermal area should be kept to the minimum necessary consistent with the objectives of the visit and every reasonable effort should be made to minimise the effects of walking activity, including by educating members of the group visiting the site, because:
 - Fragile plant and/or microbial communities may be present, including beneath snow or ice surfaces. Be alert and avoid walking on, or close to, such features;
 - Walking can also compact soil, alter temperature gradients (which may change rates of steam release), and break thin ice crusts which may form over geothermally heated ground, resulting in changes to soil and biota below;
 - The presence of snow or ice surfaces is not a guaranteed indication of a suitable pathway.
23. Remotely operated vehicles, including Unmanned Aerial Systems (UAS) (also known as Unmanned Aerial Vehicles (UAVs), Remotely Piloted Aircraft (RPA), drones, etc.), may have useful scientific and other applications in terrestrial geothermal environments in Antarctica, and potentially may reduce environmental impacts. Such use of UAS should be carried out within relevant guidelines and given adequate consideration to national Antarctic programme operations procedures, including procedures to be implemented in the case of a malfunction of the UAS.

Camps

24. When a field camp is necessary to support activities, where practicable, this should be located at least **100 m** from the geothermal site.
25. To minimize contamination of geothermal sites from camping activities (e.g. from stove gases, food particles etc.), where practicable, locate camps downwind from geothermal sites, although not where there is a risk of noxious gases drifting downwind from geothermal sites.
26. Where possible, designated, former or existing camp sites should be used.

Clothing, footwear and equipment

Prior to access:

27. All clothing, footwear and personal equipment (including bags or backpacks, and safety equipment such as ropes and ice screws) brought to geothermal sites should, as a minimum, be thoroughly cleaned and maintained in this condition before use within the geothermal site. Consideration should be given to changing into clean³ clothing and footwear immediately prior to entry into a geothermal site.
28. Consideration should always be given to the use of sterile protective over-clothing and sterile footwear prior to working at geothermal sites. The over-clothing should be suitable for working at a wide range of temperatures and comprise, as a minimum, overalls to cover arms, legs, and body, a hat to cover the head and gloves (which may need to be suitable for placing over the top of cold-weather clothing). At sites where sterilization of footwear is deemed appropriate, this should be achieved by washing exposed surfaces in a 70% ethanol solution in water. Disposable sterile / protective foot coverings that can disintegrate under field conditions should not be used.

³ 'Clean' is defined as 'free from visible particles of biological material, soil, dirt, debris, food, mould or fungi'

29. To the maximum extent practicable, select clothing and equipment that are in good condition and are made of tightly woven or knitted fabrics that do not shed fibres.

Following access:

30. To the maximum extent practicable, visitors should remain covered by their clean or sterile protective clothing, including head covers, while conducting activities within geothermal sites where this Code of Conduct has been determined to apply.
31. Precautions should be taken to prevent human-mediated transfer of biota from one geothermal area to another. Footwear should be cleaned to remove all soil and biological material, preferably using a 70% ethanol solution in water. New, clean or just laundered outer clothing should be put on before entering the new geothermal location. Equipment used must be at least thoroughly cleaned, but ideally sterilized, before use at another geothermal site.

Food

32. Where practicable, depending on site size and duration of visit, avoid eating or drinking while within geothermal sites.
33. Where food and drink are necessary for health and safety, foods such as gels, compressed dried fruit bars, or bite-sized chocolates, etc. will help minimize dispersal of powders, crumbs and flakes. Foods containing yeasts, moulds (e.g. cheese) or other microbes must be avoided. Food and drink should be securely contained when not being consumed.
34. Where appropriate, establish food and drink staging points within larger geothermal sites and restrict consumption to these sites only. Ensure accurate location of these points is recorded. Where practicable, cover the floor of the staging point while in use and remove the cover (carefully containing any crumbs, etc.) at the conclusion of the work.

Waste

35. All waste, including liquid and solid human waste, must be removed from geothermal sites.

Fuel / energy

36. The use of fossil-fuel-powered tools at geothermal sites should be avoided where possible because exhaust emissions and / or spills can impact the microbial environment.
37. If power tools are necessary to support science within a geothermal site, electric machines powered by batteries, or by a generator or renewable source of energy located at least **100 m** away and preferably downwind from the site, are preferred.

Materials / chemicals

38. Activities that could result in spills or dispersal of materials should be avoided within geothermal sites (e.g. use of fuels, glycols, chemicals and isotopes, unpacking of boxes, sprays, etc.). Where such activities are necessary, they should be carried out at least **100 m** away from geothermal sites and preferably inside a tent or structure so that materials are not dispersed towards geothermal sites by wind.
39. Materials liable to shatter at low temperatures (e.g. polyethylene plastic products) should be avoided, as should those liable to melt at the high temperatures that can occur at geothermal sites.
40. Materials / chemicals should not be stored within geothermal sites, except as required for scientific or management purposes.
41. Explosives should not be used within geothermal sites.
42. Smoking may introduce contaminants and should therefore be prohibited within geothermal sites.

Installations / equipment

43. Except where essential for safety and / or long-term scientific or monitoring programmes, permanent installations (e.g. sensors, antennae, shelters, etc.) should be avoided within geothermal sites owing to risks associated with deterioration of materials that may compromise the microbial environment.
44. All installations and other scientific equipment brought to geothermal sites should, as a minimum, be thoroughly cleaned in advance and maintained in this condition before use on site. Consideration should always be given to sterilizing equipment prior to installation at geothermal sites.
45. Installations should be sited carefully and securely, and be easily retrievable when no longer required. Installations and equipment should be made of durable materials capable of withstanding the conditions at geothermal sites and, to the maximum extent practicable, pose minimal risk of harmful emissions to the environment (e.g. gel cells or other non-spill batteries).
46. Any long-term installations or markers should be clearly identified by country, name of principal investigator, year of installation, and intended duration of deployment. Installations and equipment should be removed by the installer or other appropriate authority at, or before, the conclusion of the activity for which they were intended.

Sampling

47. At sites where the implementation of aseptic measures is deemed appropriate, all sampling equipment, probes or markers must be cleaned appropriately and maintained in that condition before being used within geothermal sites.
48. If samples are collected from a terrestrial geothermal area, ensure sample sizes are the minimum necessary to meet scientific requirements and that any permit required for their collection has been given by an appropriate national authority.

Additional guidance for previously unvisited terrestrial geothermal sites

49. Terrestrial geothermal sites in Antarctica that are known, or suspected, to be previously unvisited are expected to be almost pristine (with the exception of low levels of contaminants transported via the atmosphere or perhaps by birds), and are considered to have exceptional value for science, especially for microbiological and geochemical studies. More stringent controls are therefore required to maintain their environmental and scientific values. Aseptic measures should always be implemented at previously unvisited geothermal sites.

Access

50. The interior and exterior of crewed aircraft, vehicles and boats should be inspected and cleaned thoroughly before being used for access to previously unvisited geothermal sites.
51. Where practicable, crewed aircraft, vehicles and boats should approach no closer than **200 m** from previously unvisited geothermal sites.

Clothing, food and waste

52. Sterile protective over-clothing and footwear should always be worn at previously unvisited geothermal sites.
53. Food should not be brought into or consumed within previously unvisited geothermal sites, unless it is essential for safety because of the visit length, or the size or nature of the site.
54. All wastes, including all human wastes, should be removed from the area.

Equipment, materials / chemicals, installations and sampling

55. When accessing a previously unvisited geothermal site, it is strongly recommended that only new equipment, materials and installations be used within that site.

56. If moving between specific locations within a single previously unvisited geothermal site, only new or sterile materials / chemicals should be used at the subsequent locations.