Code of Conduct for Activities within Terrestrial Geothermal Environments in Antarctica

Introduction

1. Terrestrial geothermal environments[1] in Antarctica are of high scientific value to a wide range of disciplines, for example to geologists, glaciologists, botanists, microbiologists and atmospheric scientists.
2. 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, where indigenous species survived glacial cycles and from which continental recolonization took place.
3. 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.
4. In addition, 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.
5. The Code of Conduct for Activities within Terrestrial Geothermal Environments in Antarctica aims to provide practical guidance on field procedures and protocols to help maintain the unique environmental and scientific values of terrestrial geothermal sites.
6. It is recognised that some terrestrial geothermal sites in Antarctica have already been subjected to relatively high levels of human activity, for example at some sites at Deception Island or near the summit of Mount Erebus. In addition, in some places permanent installations are needed to monitor geothermal activity for reasons of safety, and these require regular visits and maintenance.
7. While the application of this Code of Conduct should be considered prior to visiting any terrestrial geothermal site, it is not intended to be applied at sites where little scientific or environmental benefit would result. In these areas, the rules generally applicable under the Protocol on Environmental Protection to the Antarctic Treaty are sufficient.
8. 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.
9. At those geothermal sites that remain relatively undisturbed by human activities there are important microbiological and other scientific and environmental reasons why extra precautions should be taken before their values are further degraded or lost. This is especially the case at geothermal sites that are known, or suspected, to be previously unvisited; for this reason more stringent recommendations are made at the end of this Code to apply at previously unvisited sites.

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 land, ice, water or atmospheric environments at or near the earth's surface that are detectably influenced by geothermal heat'.

Guiding Principles

10. Careful planning is required before undertaking research within a geothermally active environment, and appropriate measures need to be considered to help maintain the integrity of geothermal 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;
- Maintaining and making publicly available records of sites visited and the nature of activities undertaken (see Section on 'Reporting'), so that visited and unvisited sites may be more easily distinguished by future researchers;
- Coordinating planned activities with other researchers interested in the area to the maximum extent practicable.

11. 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.

12. Decisions on whether to implement sterile2 protective measures 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 sterile protective measures should be implemented.

13. Sterile[1] protective measures should always be implemented at previously unvisited sites.

14. SCAR's Code of Conduct for Terrestrial Scientific Field Research in Antarctica should also be consulted in the planning phase of activities.

Code of Conduct

Access - movement to, within and between sites

15. To the fullest extent practicable, vehicles and crewed aircraft should not be operated close to nor within terrestrial geothermal environments due to the risks of damaging sensitive vegetation and introducing non-native species. As a guideline, it is recommended that crewed aircraft should avoid landing or overflying within 100 m of geothermal sites.

16. Designated access routes and landing sites should be used where these are known or have been used previously, and should be discussed with pilots/drivers prior to departure.

17. All overland movement of visitors within terrestrial geothermal sites should be on foot.

18. 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.

19. 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 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. Care should be taken to re-assess safety of access on every visit to a geothermal site.

20. Pedestrian movement 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.

21. 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. However, in advance of remotely operating such vehicles over geothermal environments procedures for retrieval and impact mitigation need to be planned in anticipation of possible malfunctions.

2 'Sterile' is defined as 'free from living bacilli, bacteria or microorganisms'. Where sterile condition is not available by professional packaging, sterilisation should be by an acceptable

Camps

22. Where a field camp is necessary to support activities, where practicable this should be located at least 100 m from the geothermal site.

23. 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.

24. Where possible use designated, former or existing camp sites.

Clothing

Prior to access:

25. 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 clean[3] clothing and footwear immediately prior to entry into a geothermal site.

26. Consideration should always be given to 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 70% ethanol solution in water. Disposable sterile/protective foot coverings that disintegrate under field conditions should not be used.

27. 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:

28. To the maximum extent practicable, visitors should remain covered by their clean or sterile protective clothing, including headcovers, while conducting activities within geothermal sites where this Code of Conduct has been determined to apply.

29. Clothing, footwear and equipment used must be cleaned or sterilized before use at another geothermal site.

Food

30. Where practicable, depending on site size and duration of visit, avoid eating or drinking while within geothermal sites.

31. 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.

32. Where appropriate, establish food and drink staging points within larger geothermal sites and restrict consumption to these sites only. 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

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

Fuel/energy

34. The use of fossil-fuel-powered tools within geothermal sites should be avoided because exhaust emissions and/or spills can impact the microbial environment.

35. 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 from the site, are preferred.

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

Materials/chemicals

36. 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.

37. 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.

38. Materials/chemicals should not be stored within geothermal sites, except as required for scientific or management purposes.

39. Explosives should not be used within geothermal sites.

40. Smoking may introduce contaminants and should therefore be avoided within geothermal sites.

Installations/equipment

41. Except where essential for safety and/or long-term scientific or monitoring programs, 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.

42. 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.

43. 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. use gel cells or other non-spill batteries).

44. 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/experimental sites

45. At sites where the implementation of sterile protective measures are deemed appropriate, all sampling equipment, probes or markers must be sterile and maintained in a sterile condition before being used within geothermal sites.

46. Only samples (e.g. geological or biological materials, ice) for which authorization has been given by an appropriate national authority should be taken, and finite resources should be protected by ensuring sample sizes are the minimum necessary to meet scientific objectives.

Reporting

For the benefit of future researchers, site protection and management:

47. A report on activities at the geothermal site should be submitted to the appropriate national authority.

48. Map, record (including GPS coordinates), and report to the appropriate national authority the location of any spill, camp site, soil pit, drilling site, sampling site, or any other disturbance or useful observation (e.g. any disturbance to the site that existed prior to the visit, the safety of access, significant change to geothermal activity, etc.).

49. The Visit Report Form recommended for use following ASPA visits is suggested as a useful report template, which is provided in the Committee for Environmental Protection Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas (Resolution 2 (2011)), available from the website of the Antarctic Treaty Secretariat (http://www.ats.aq).

50. Reports from visits and relevant data (including GPS coordinates) should be archived in publicly accessible records documenting visits to geothermal sites. Such records would assist the scientific community in determining the amount of use sites have received, and in identifying those that remain unvisited.

Additional guidance for previously unvisited terrestrial geothermal sites

51. 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 studies. As such, more stringent controls are required to maintain their environmental and scientific values.

Access

52. 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.

53. Where practicable, crewed aircraft, vehicles and boats should approach no closer than 200 m from previously unvisited geothermal sites.

Clothing, food and waste

54. Sterile protective over-clothing and footwear should always be worn at previously unvisited geothermal sites.

55. Food should not be brought into or consumed within previously unvisited geothermal sites, unless it is essential for safety because of the size or nature of the site.

Equipment, materials/chemicals, installations and sampling

56. Field equipment, materials/chemicals and installations used at another geothermal site should not be used at previously unvisited geothermal sites: only new equipment, materials and installations should be used.

57. Field equipment, materials/chemicals, installations and sampling equipment must be sterile prior to use at previously unvisited geothermal sites.

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