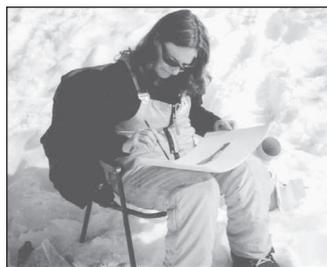


# scientific evaluation of deterioration of historic huts of Ross Island, Antarctica

*There are many challenges facing conservation of the historic huts in Antarctica including non-biological, biological and environmental impacts explains Professor Roberta L. Farrell, Department of Biological Sciences, the University of Waikato.*



**Professor Roberta Farrell – Birdi Artist Antarctica**  
Photograph courtesy of Roberta Farrell

The Antarctic Heroic Era was an exciting time of discovery and bravery – it was the furthest explorative reaching of man at the time, and can

be likened today to venturing into space. The British National Antarctic Expedition (1901-04) led by Robert F. Scott, built a large wooden building at Hut Point on Ross Island, Antarctica, commonly referred to as Discovery Hut, to shelter and store supplies for 48 men for 3 years. The British Antarctic Expedition led by Ernest Shackleton followed in 1907 with a hut built at Cape Royds to house a shore party of 15 men.

Scott returned in 1910 on the ill-fated Terra Nova British Antarctic Expedition. This 25-person expedition erected a large prefabricated hut at Cape Evans to provide accommodation, and also built a smaller structure that was framed in wood and lined with asbestos sheeting for taking magnetic observations. Discovery Hut was used extensively by the latter expeditions in the Heroic Era as a key stepping stone to the southern latitudes and a shelter for those who returned from the south.

Although all three expeditions had primary goals to discover new land and be first at the South Pole, they also had important scientific objectives. Each of the expeditions had one or more biologist, geologist, meteorologist and physicist to carry out the scientific programmes. When the expeditions ended and relief ships arrived, a rapid exodus allowed only essential items to be returned to England. The huts and thousands of items were left behind, including food stores and fuel depots with unused containers of petroleum products, asbestos materials, and diverse chemicals.

For the past ten years, a joint scientific collaboration between the University of Waikato and the University of Minnesota in the USA has evaluated the deterioration of the Historic Huts and artifacts of the Ross Island Historic Huts and their environs; Above right, is a photograph of some of the participants of the science collaboration, taken at Cape Evans in 2004.

The key to the collaboration has been to use state-of-the-art multi-disciplinary scientific methodology. Specifically, for the first time in the Antarctic, microbiology, wood chemistry, biochemistry, and molecular biology have been applied to the study of the deterioration, while also working with the Antarctic Heritage Trust and conservation architects who are developing conservation plans for the Ross Dependency Historic areas. The three major goals of the collaboration are as follows:

1. Identify the cause of non-biological and biological deterioration present in Historic Huts and artifacts.



**At Shackleton's hut in Cape Royds, January 2004. From left, Prof Robert Blanchette, Brett Arenz, Joel Jurgens, Joanne Thwaites, Roberta Farrell, and Shona Duncan.**

Photograph courtesy of Roberta Farrell.

2. Characterise environmental pollutants in the historic areas left behind from the 'Heroic Era' of exploration.
3. Investigate fungal biodiversity and ecosystem functioning in the historic hut areas, and generally in Antarctica.

The Ross Island Historic Huts and surrounding areas attract many tourists as well as scientists and visitors from nearby McMurdo and Scott Bases, and are therefore the most affected by decades of human activities of any Antarctic historic areas.

Standards that guide research and conservation work conducted at the historic sites include those derived from the Antarctic Treaty (1959), and the Protocol on Environmental Protection to the Antarctic Treaty, which provides for the preservation and protection of historic sites. The Antarctica (Environmental Protection) Act of 1994 (the Antarctica Act) is the New Zealand legislation implementing The Protocol and under which all activities concerning the Ross Island Historic Huts pertain. The Antarctic Heritage Trust (AHT) is a charitable trust formed in New Zealand in 1987 to conserve the historic sites of the Ross Sea region of Antarctica. The joint scientific collaborative research results are contributing to the fulfillment of the work of AHT by demonstrating scientifically the state of the huts and environs.

## Non-biological Deterioration

Non-biological degradation processes can severely affect the physical and chemical structure of wood (1). Morphological examination of minute wood samples, including light microscopy, scanning electron microscopy, and transmission electron microscopy are used by the Universities of Minnesota and Waikato collaboration to characterize decay patterns present.

Ultraviolet (UV) light, iron corrosion products, salts and other caustic compounds cause a deterioration that progresses from wood surfaces to inner regions of the wood. UV light may cause a selective attack of lignin and hemicellulose resulting in a defibrillation of the wood. Over time a gradual loss of the outer wood cells takes place and the surface gradually erodes away. Salt accumulations in wood cause chemical erosion of the lignified middle lamella and alterations to cellulose within the secondary walls. This chemical attack has only recently been described

and the conditions for its occurrence elucidated (2). Damage may occur quickly where large concentrations of salt are in contact with moist wood, or very slowly as low concentrations of salt accumulate in wood after evaporation. The diffuse nature of the damage throughout the wood, lack of fungal mycelia and selective attack on the lignified middle lamellae suggest deterioration of the surface layers of the wood are affected by this attack. Although the exact process of salt deterioration in wood is not fully understood, it is apparent that the high salt concentrations causes a chemical reaction to take place in which the hemicellulose and lignin in the middle lamella is degraded (2). This is exhibited in affected woods by a defibration of surface fibres, giving the wood surface a fuzzy appearance (see photo on right). There are many locations at all three huts that are affected by salt deterioration. All of these locations involve moisture absorption from melt water in pools on the ground, or by the melting of snow from the roofs directly onto the huts or artifacts (2).



**Non-biological deterioration from Cape Evans hut. Chemical deterioration causing a defibration of wood. As snow melts, large amounts of the wood fibres are removed and the historic wood is gradually destroyed.**

*Photograph courtesy of Professor Robert A. Blanchette.*

Wind erosion can be identified in many locations of the huts and associated artifacts (3). High velocity winds originating from the South Pole carry airborne particles that cause a sand blasting effect on the exposed wood. Therefore most of the significantly eroded areas are those that face south. By using digital videography over the past six years the collaboration has documented that the exterior wood is not eroded uniformly by wind. Windborne particles erode the highly lignified, thick-walled latewood cells at a slower rate than the thin-walled earlywood cells, leaving affected wood with an uneven, furrowed appearance.

#### **Biological Deterioration and Biodiversity in the Historic Huts**

Biological degradation of wood and other organic matter is common in the huts. Actively growing fungi have been observed and isolated from walls, floors, ceilings and beams, clothing, leather, wood, foodstuffs (see photo over page) and other artifacts within the huts, and from sampling the air. The Universities of Waikato and Minnesota joint collaboration have isolated and identified wood decaying microorganisms present in the Historic Huts and environs, and addressed the general biodiversity of microorganisms present (4, 5, 6, 7). Permits have been granted by the Ministry of Agriculture and Forestry, New Zealand to bring samples out of Antarctica. These samples are cultured in the Universities' laboratories on a wide variety of growth media, at various temperatures, typically in the range of 0 to 25 degrees Centigrade, for isolation of fungi and/or bacteria, or studied by molecular techniques. Pure cultures of fungi have been obtained and identified using various taxonomic keys from the mycological literature and/or molecular DNA probes, just as is done in forensic analysis.

Cellulases, enzymes that catalyse the degradation of cellulose in fibres, such as wood and/or cotton textiles, have been isolated from several of these organisms and have been characterised as to their role in the decay of wood at temperatures experienced within the huts (8).

An unusual wood destroying fungus is causing decay in the historic woods that are in contact with the ground (7). Micromorphological examinations indicate just one type of decay, a soft-rot, is present in all of the deteriorated woods. Pure cultures obtained from the historic woods were identified by morphological characteristics and phylogenetic analysis. The fungus grows into the wood cells, forming elongated cavities within the secondary wall layers. Soft-rot fungi were isolated from all three of the Historic Huts in the Ross Sea region, but were found most prevalent in wood from Shackleton's Cape Royds hut. New knowledge of these polar fungi is needed if we are going to find effective controls that can be used to preserve the huts long into the future. Successful conservation of the huts requires an understanding of these mechanisms, and the biology and ecology of these decay organisms so degradation processes can be controlled.

#### **General Environment of the Historic Huts and Environs**

The environment of the Historic Huts is also being scientifically studied. There are many chemicals in various unlabelled bottles, containers and in glass tubes or other scientific apparatus left within the huts that should be evaluated to ascertain their identity. Chemical spills may also still occur by freeze-thawing of liquids and subsequent glass breakage or by inadvertent accidents from curious tourists that visit the hut, or even conservation and research activities within the hut. An historic chemical spill, within the Cape Evans hut, apparently from caustic substances from one of the scientific experiments, has caused an unusual deterioration and defibration on affected woods.

Decaying stores around the hut are degrading the environment, and under current environmental protocols for Antarctica intervention, to prevent further pollution is imperative. Fuel depots with unused containers of petroleum products, asbestos materials, and diverse chemicals were also left at the huts (9, 10). The joint collaboration found high concentrations of polyaromatic hydrocarbons in soils under and around the historic fuel depots. Asbestos materials within the huts have been identified, and extensive amounts of fragmented asbestos were found littering the ground around the Cape Evans hut and these materials are continually abraded and fragmented as tourists walk over them and the coarse scoria breaks and grinds down the materials. Although these areas are important historic sites protected by international treaties, the hazardous waste materials left by the early explorers should be removed and remedial action has been proposed to restore the site to as pristine a condition as possible.

The micro-organisms found in Antarctica may provide unique compounds, enzymes and microbes for the biotechnology industry through bioprospecting (11). Bioprospecting projects require many years lead time prior to commercialisation in order to establish the expression libraries, culture collections, chemical testing etc required for the stages of bioprospecting, but the possibility exists that some unique opportunities will be realised.

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**Surface moulds appear on the food crate boxes and labels in the kitchen area at Discovery Hut.**

Photograph courtesy of Roberta L Farrell (2003).

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# Antarctica New Zealand

In this issue of the NZST we have focused on Antarctica and it is timely to introduce you to the organisation that manages New Zealand's interests in the region – Antarctica New Zealand.

In 1959 the Antarctic Treaty System was established to protect Antarctica and since that date Scott Base has been New Zealand's permanent base there. A 1994 review recognised Antarctica as strategically important to New Zealand as a Southern Hemisphere nation. This resulted in the establishment of the New Zealand Antarctic Institute, now known as Antarctica New Zealand, which is a Crown Entity with a six member board, 28 permanent staff in Christchurch and a team of temporary staff, including secondments from the New Zealand Defence Force, at Scott Base.

**Purpose**

- 1) Advance knowledge, appreciation and conservation, of Antarctica and the Southern Ocean for the benefit of New Zealand and the world community, through leadership, partnership, and involvement in high quality Antarctic related activities.
- 2) Established under the New Zealand Antarctic Institute Act 1996, it is responsible for: developing, managing, and administering New Zealand's activities in Antarctica and the Southern Ocean, particularly the Ross Sea region.
- 3) Responsible for enhancing New Zealand scientific research, and providing sound environmental stewardship. In addition to supporting scientific research through logistics planning and scholarships, it also runs arts, media and education programmes thereby increasing public awareness and appreciation of Antarctica and its conservation values.
- 4) Responsible for the year-round management of Scott Base.

**Major Projects**

1. ANDRILL
2. BIOROSS, funded by the Ministry of Fisheries, is a multi-disciplinary scientific investigation into the biodiversity of the Ross Sea Region.

3. The Latitudinal Gradient Project (LGP) gathers baseline ecological data over a Latitudinal Gradient.
4. Cape Hallett Remediation - A collaborative project between New Zealand and the United States Antarctic Programmes assisted by the Italian Antarctic Programme, to help clean up the Cape Hallett Station site.

**Science Role**

Antarctica New Zealand's role in science is to establish themes and priorities for New Zealand Antarctic science; encourage and facilitate the implementation of science projects that deliver on them; and present the outcomes and benefits of and advocate for Antarctic science.

A strategy for New Zealand Science in Antarctica and the Southern Ocean, published in 2004, establishes themes and priorities for New Zealand Antarctic science. These are addressed by the science events and projects that Antarctica New Zealand supports.

A science support bidding round is held annually for those wishing to undertake research in Antarctica.

**Scott Base Management**

Scott Base was constructed for New Zealand's participation in the Trans-Antarctic Expedition and International Geophysical Year and was officially opened on 20 January 1957. Although designed for a life of only a few years, the value of Antarctic research was soon recognised and a base re-building programme began in 1976.

Today only three buildings of the original Scott Base remain, the TAE/IGY Hut, which contains material recording New Zealand's involvement in Antarctica since 1957, and two science huts built for the IGY and still in use today.

Scott Base accommodates up to 85 people over summer, dropping to a skeleton staff of 10-14 over the winter. Most of its buildings are linked by all-weather corridors.

Antarctica New Zealand also manages several other research facilities in the McMurdo Sound region. These include the Arrival Heights laboratory, where atmospheric research is carried out, and scientific huts at Cape Bird, Bratina Island and several sites in the McMurdo Dry Valleys.

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