

PEAT REVEALS 16 500 YEARS OF FALKLAND ISLANDS CLIMATE CHANGE, AND A LOT MORE BESIDES

by

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Peat is a ubiquitous feature of the Falklands landscape and historically has been vital as the only indigenous fuel source. More recently, in a bit of a role reversal, there has been a growing awareness that peat acts as a long-term carbon sink, supporting efforts to limit atmospheric CO₂ emissions arising from anthropogenic activity. Further, it provides a record of environmental variation that is a proxy for wider climate change as the region emerged from the last Ice Age. Accordingly, over the last decade or so a surge of scientific interest in Falklands peat has led to a range of publications. In one of the earliest accounts from this period, Payne *et al.* (2019) attempted a preliminary assessment of carbon storage in Falkland Islands peatlands but noted that “surprisingly little research has been conducted” and concluded that “Falkland Islands peatlands challenge many standard assumptions and deserve more detailed study.” This is now in progress and what follows here is an attempt to summarise some of the main conclusions drawn from recent work. Radiocarbon dating underpins much of the research and results are cited here as calibrated ages Before Present (BP); by convention BP references a baseline of 1950 CE. Key locations mentioned in the text are located on Figure 1.

Peat formation in the Falkland Islands

Despite the generally low rainfall experienced by the Falkland Islands there has been extensive peat accumulation. During short periods of wetter climate, *Sphagnum* mosses provided an important peat forming agent, but for most of its history Falklands peat was primarily derived from grasses. Currently there is no generally accepted explanation for this unusual circumstance but perhaps peat development was promoted by the durable vegetation litter produced by the native grass communities. Species such as White Grass (*Cortaderia pilosa*) and Blue Grass (*Poa alopecurus*) are adapted to poor quality soils and high wind speeds, and produce leaves that are highly resistant to decay, so allowing organic accumulation in what would otherwise be a marginal environment for peatland development (Scaife *et al.* 2019).

As the last Ice Age waned, peatlands started forming across the Falkland Islands from about 16 500 years BP (e.g. Payne *et al.* 2019; Scaife *et al.* 2019; Thomas *et al.* 2025). This was a time of accelerating climate amelioration during the transition

from the Pleistocene to the Holocene geological epochs. Sea level then was lower than at present, with vast quantities of water still frozen into ice sheets, but as they melted sea level rose. As a result, peat originally accumulated in areas that are now submerged, so in some sheltered parts of the Falklands coastline it can be seen to extend below current low water: a good example occurs at Salinas Beach, at the head of Brenton Loch. Elsewhere, on more exposed parts of the coast, the peat has been cut back by the sea and in places now forms an actively eroding cliff line. One such locality is close to Hookers Point, 3.5 km to the east of Stanley. There, about 5 m of peat rests on grey silt, with the contact lying about 3 m above current sea level.



Figure 1. The Falkland Islands showing the key localities discussed in this review. Underlying spatial data from General bathymetric chart of the oceans (2023).

The Hookers Point section is retreating in the face of vigorous marine erosion, so in February 2005 and in anticipation of its future scientific value, the opportunity was taken to sample and preserve peat from top to bottom of the cliff. The peat samples were collected in 50 cm long, open-sided tins which were driven into the cleaned peat surface in an overlapping array and then dug out (Figure 2). Since then, the peat samples have been carefully examined and the results have given rise to a series of scientific papers discussing the evidence from plant remains and pollen for vegetation and climate change, the introduction of volcanic dust from South America,

episodes of burning, and other aspects of the local ecology (Scaife *et al.* 2019; Monteath *et al.* 2019, 2022; Panaretos *et al.* 2025). Meanwhile, several other projects have assessed aspects of the Falklands peat using different sampling localities and are discussed below, whilst one involved resampling the remains of the peat cliff close to the originally sampled Hookers Point site (Groff *et al.* 2020).



Figure 2. Peat sampling in progress at Hookers Point, East Falkland, 10th February 2005: Phil Stone (left) and Alex Blake, then with the Department of Mineral Resources, Stanley. British Geological Survey image P587699 © UKRI 2005.

Data from any single site in the Falklands will have been influenced by climate changes affecting the archipelago as a whole but will also reflect circumstances particular to that locality. Nevertheless, in general the results to date are mutually supportive, with the data derived from a range of sites and by a variety of means. Investigations have noted the variable presence of recycled volcanic ash, charcoal dust and exotic pollens such as *Nothofagus* (Southern Beech) blown in from South America by the dominant westerly wind. The Falkland Islands lie in the core of the Southern Hemisphere Westerly Wind Belt (SHWW), variations in which are linked with sea-ice extent, ocean productivity and deep-water upwelling in the Southern Ocean, factors that in turn influence CO₂ sequestration and release. Therefore, the Falkland Islands data have global significance for climate change models and assessments, albeit the mixing of locally derived and exotic materials makes their analysis far from straightforward.

The climate transition

The most detailed analysis of the palynomorph (pollen and spores) assemblages, indicative of the vegetation at the time of peat deposition, is provided from Hookers Point by Scaife *et al.* (2019). Peat growth began at about 16 500 years BP, overlying a grey, fine-grained deposit of silt and sand thought to have accumulated slowly in a quiet, shallow, water body under the cold conditions pertaining during the last Ice Age. It is almost devoid of organic material apart from fresh-water diatoms

The lowermost peat, developed between about 16 500 and 15 940 years BP, has a dominance of grass pollen (Poaceae) accompanied by some derived from sedges (Cyperaceae), but notably contains preserved leaves and stems of Creeping Patria (*Patria repens*) and Diddle-dee (*Empetrum rubrum*). However, the absence of Diddle-dee pollen suggests that although introduced seeds were able to germinate, the climate was too severe to allow flowering: a cold, arid environment seems likely during this period. It's not easy to differentiate between grass pollens, but several species were probably present, including White Grass and Blue Grass.

From about 15 940 years BP there was an overall decline in the contribution of sedge pollen, suggesting increasing aridity, although Native Rush (*Juncus scheuzerioides*) and the sedge Sword Grass (*Carex trifida*) were now present. Grass pollen continued to dominate and grass rootlets are also preserved, but pollen from a range of other herbaceous plants shows a diversifying vegetation. Nevertheless, the woody remains of Diddle-dee are no longer present, and this suggests that the site was not sufficiently dry for heath communities to become established. It's likely climate remained cold, probably with locally damp areas surrounded by open grassland. These conditions prevailed until about 12 200 years BP, although at about 15 300 years BP there was a marked change in the grass population apparently unrelated to climate change, and this is still under investigation. Another feature of this interval was the first evidence for long-distance pollen transport, with the appearance at about 13 260 years BP of Southern Beech (*Nothofagus*) pollen blown in from South America (Figure 3). It becomes persistent in the younger part of the Hookers Point peat section (though rarely forms more than 2% of the total pollen) and has also been generally reported from peat elsewhere in the Falklands, with the earliest records from Port Howard, West Falkland (Barrow 1978) and Sea Lion Island, East Falkland (Gerrard & McAdam 1986).

At around 12 200 years BP there is the earliest evidence for fire, with burnt wood and charred plant fragments present in the peat with repeated layers containing charcoal thereafter (Scaife *et al.* 2019; Groff *et al.* 2020). Nevertheless, there was an overall change to wetter conditions and a dominance of *Sphagnum* moss, before dry conditions returned at about 11 330 years BP. At that time, a dwarf shrub and fern community began to establish itself, and woody plant remains are commonly preserved in the peat: Mountain Berry (*Pernettya pumila*) appeared first, closely followed by Diddle-dee, before ferns and Teaberry (*Myrteola nummularia*) became dominant, with a corresponding decrease in grasses.

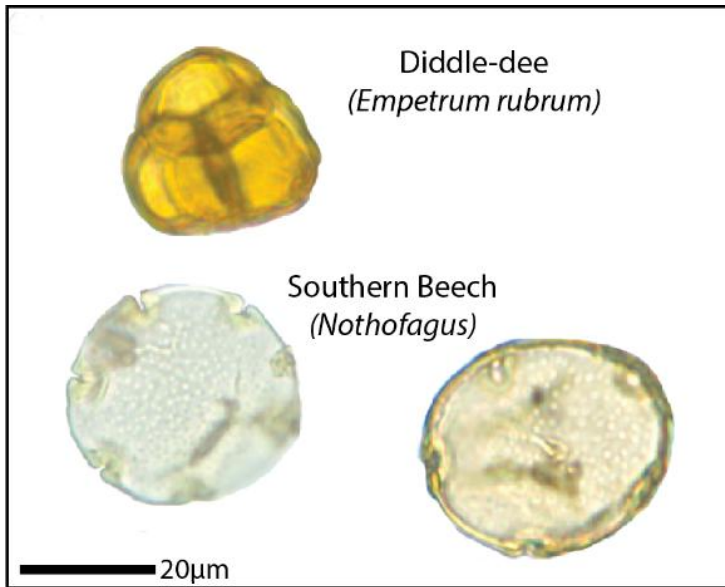


Figure 3. The contrasting pollen grains of locally-derived Diddle-dee (*Empetrum rubrum*) and exotic Southern Beech (*Nothofagus*) blown in from South America. Images courtesy of Dulcinea Groff.

Wetter conditions returned to Hookers Point at about 10 250 years BP and the dry, shrub and fern community was replaced by *Sphagnum* moss. Despite these local changes, pollen indicates that Diddle-dee remained abundant in the surrounding area and charred plant material provides evidence for repeated burning. Then, by about 8 210 years BP, there had been a transition back towards drier conditions with a decrease in moss, an increase in ferns and grasses, and the re-establishment of Teaberry. These trends continued beyond 6 450 years BP but from a nearby site on Canopus Hill (Figure 4) – about 1.5 km north of the Hookers Point peat cliff – a wetter and colder interval from about 5 000 until 2 500 years BP was deduced from a 1.5 m (5 000 year) peat core (Thomas *et al.* 2018). During that interval grasses, Diddle-dee and Fachine (*Chilietrichum diffusum*) were accompanied by sedges, but the latter disappeared after about 2 500 years BP; Fachine pollen then increased at the expense of grasses from about 1 100 years BP (Turney *et al.* 2016). The change at about 2 500 years BP coincided with a marked influx thereafter of exotic pollen from South America, principally *Nothofagus*, as stronger westerly winds were established and the climate shifted towards a warmer and drier state.



Figure 4. The six-inch Naval guns installed on Canopus Hill in the 1930s and 1940s. Reputedly, 22 feet (6.7 m) of peat had to be removed to establish the foundations (Penguin News, February 25, 2005, 10-11). This photograph was taken in 2001; the guns were repainted in 2005. British Geological Survey image P1074033 © UKRI 2001.

Another peat record, spanning 14 000 years was recovered from the Hookers Point peat cliff by Groff *et al.* (2020), although the locality was described as Surf Bay which lies adjacent to Hookers Point. There the peat record for the first 9000 years was dominated by low levels of grasses and a heathland of ferns (*Blechnum* spp.) and dwarf Ericaceous shrubs like Diddle-dee. This is a less variable pattern of vegetation than determined by Scaife *et al.* (2016). But Groff *et al.* (2019) focussed on a major ecological change at about 5 000 years BP when an abrupt increase in grass pollen, most probably tussac (*Poa flabellata*) coincided with increases in the chemical trace of guano-derived bionutrients: seabird colonies had become established in the vicinity. This was thought to have coincided with the onset of a period of regional cooling when the birds were using the Falklands as a cold-climate refuge. However, sea level rise might provide an alternative explanation by changing coastal geography and hence the distribution of nesting sites. Either way, from their data, Groff *et al.* (2019) identified a subtle shift in the bio-element distribution as suggesting a turnover of seabird species (or perhaps the arrival of seals) at about 2 000 years BP. This coincided with a regional shift from cool conditions to a warmer and drier climate. Further evidence for drier conditions from about 3 000 years BP was provided by charcoal in the peat, as evidence for burning.

Dust, charcoal and volcanic ash



Figure 5. Microscopic shards of volcanic ash (clear material) derived from Mt Burney in Chile and extracted from peat at Hookers Point. Image by Ali Monteath.

Nothofagus pollen wasn't the only thing to be blown in from South America. Terrestrial dust and volcanic ash (glass shards or tephra), the latter blown in from eruptions in Patagonia, are present throughout the peat sections at Hookers Point and elsewhere in the Falkland Islands (Figure 5). But not all the tephra was primary air-fall from contemporary eruptions; much proved to be mixed, detrital material, repeatedly reworked by wind action in Patagonia before final deposition. Monteath *et al.* (2019) described evidence for this conclusion from Hookers Point with the shapes of the individual glass shards and their mixed chemical compositions indicating multiple sources and continued weathering processes. Modern analytical techniques allow the chemical composition of individual microscopic shards to be characterised in detail and then compared with the typical chemical compositions of potential volcanic sources (Figure 6). There are several points in the Hookers Point peat sequence with a particular abundance of sharp, uneroded shards with a uniform chemical composition, both indicators of air-fall from a single eruption. To be clear, none of the tephra peaks in the Hookers Point peat is sufficiently concentrated to reveal itself as an obvious stratigraphical layer, and they are best described as cryptotephra that must be identified under a microscope. These discrete deposits contribute to an evolving tephrostratigraphy in the Falklands that includes tephra from multiple volcanic centres in southern South America.

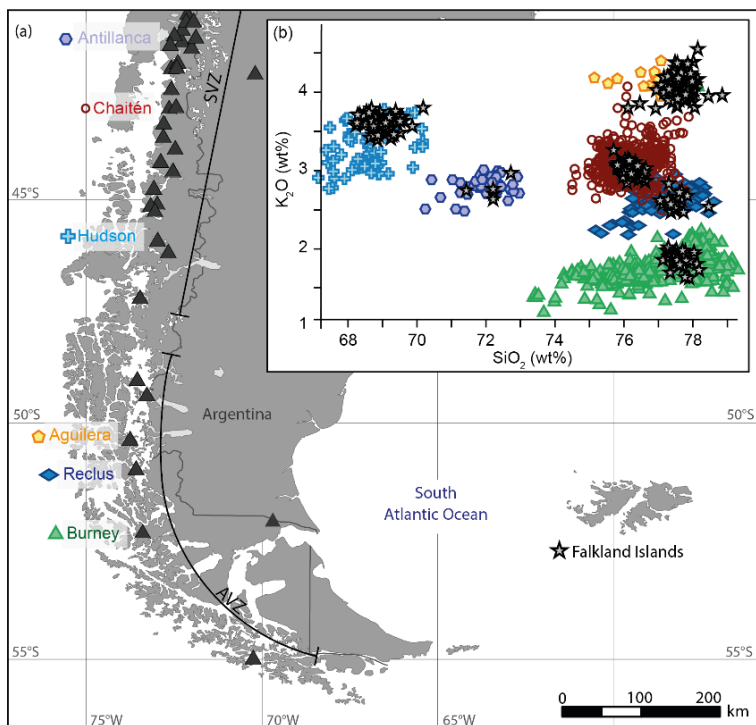


Figure 6. (a) Map of active volcanoes in southern South America. (b) Bi-plot of Falkland Islands tephra geochemical compositions superimposed on data from South American volcanoes. SVZ Southern Volcanic Zone, AVZ Austral Volcanic Zone. Data from Monteath *et al.* (2019), Panaretos *et al.* (2021, 2025) and the BOOM database (Fontaine *et al.* 2023). Icons are common to both panels.

Some of the largest events to have affected the Falklands have been detailed from the Hookers Point peat sequence (Monteath *et al.* 2019; Panaretos *et al.* 2025), principally the late Pleistocene eruption of Reclus volcano at about 14 280 years BP and an Early Holocene eruption of Mt Burney at about 9 510 years BP. These explosive eruptions were substantially larger than the 1991 eruption of Mt Hudson that led to several years of disruption in the Falklands as ash was repeatedly reworked across the landscape. Other, younger records from Hookers Point include tephras from eruptions of Aguilera volcano, Chaitén volcano and the Antillanca volcanic group, as well as a second eruption at Mt Hudson in about 3 950 BP (Panaretos *et al.* 2025). A cryptotephra from that same Mt Hudson eruption has also been described from peat cores acquired at Canopus Hill (Panaretos *et al.* 2021) and Weddell Island (Tamhane *et al.* 2023; Panaretos *et al.* 2025). Given the abundance of tephra preserved in peatlands in the Falkland Islands, it is likely that common

cryptotephra layers can be traced in peat deposits throughout the islands, and further into the Southern Ocean. These time-markers may aid climate scientists in the correlation of their palaeoenvironmental records.

Another important finding from the Canopus Hill core (Turney *et al.* 2016; Thomas *et al.* 2018) was a marked increase in charcoal dust from about 2 500 years BP onwards, not too dissimilar to the increase in charcoal from about 3 000 years BP subsequently reported from Hookers Point by Groff *et al.* (2019): there were especially high levels between 2 000 and 1 000 years BP and with peaks thereafter at about 550 and 250 years BP. The high levels of charcoal dust coincided with peaks in exotic pollens such as *Nothofagus* derived from Patagonia so some of the charcoal dust may have been produced by burning there, although local derivation from burning in the Falklands seems equally, or perhaps more, likely (Mauquoy *et al.* 2020; Von Scheffer *et al.* 2026). If strengthening and more persistent westerly winds are implicated the linkage between wind patterns and charcoal dust levels complicates any attempt to establish a burning history for the Falkland Islands *per se* from the peat record. More conclusive are reports of charcoal fragments too large to have been blown very far, such as the charred plant material found at Hookers Point and noted above.

Other examples of this ‘macrofossil’ charcoal have been described from the basal peat at Sapper Hill (2 km SW from Stanley) and throughout a peat-core retrieved from the Sussex Mountains on the west side of East Falkland. At Sapper Hill, macrofossil charcoal was found in the basal peat at a level earlier than about 5 500 years BP (Buckland & Edwards 1998); in the Sussex Mountains, in a 211 cm peat-core spanning the last 11 500 years, macrofossil charcoal occurred repeatedly suggesting fire was a persistent feature of the environment (Mauquoy *et al.* 2020). Peat in the Sussex Mountains core also showed enhanced degradation from about 7 200 years BP onwards, a feature taken to indicate strengthening westerly winds and enhanced aridity. Hamley *et al.* (2021) noted repeated episodes of burning from about 15 000 years BP onwards in peat sections from Mount Osborne, Bleaker Island and New Island; controversially they attributed an apparent increase in the frequency of burning at the New Island site from about 550 years BP to early human intervention (cf. Buckland & Edwards 1998). While these records preserve variable fire histories it is clear that burning is a natural part of the Falkland Islands environment. At least some of this variation may be caused by the nature of fires at any individual location (i.e., temperature and depth). A recent study by Von Scheffer *et al.* (2026) showed that lower intensity fires in Falklands peat produced more charcoal while higher intensity fires were associated with great carbon loss.

Whilst the volcanic ash, and possibly some of the fine charcoal dust, can be ascribed to sources in South America, the provenance of terrestrial dust found in peatlands – silt, clay etc. – is less certain. Nevertheless, the geological differences between the Falkland Islands and the South American mainland result in the dust derived from

each area having subtly different chemistry. Careful laboratory analysis can therefore indicate which source was dominant. Wind-blown sand from local sources can be expected as a general background, with more dust from South America blown in (along with far-travelled pollen such as *Nothofagus*) at particularly windy times. From this evidence, overall variation in wind speed can be identified and, when integrated with data from a wider network of sites, changes in the position of the SHWW can be inferred (Turney *et al.* 2016; Thomas *et al.* 2018; Monteath *et al.* 2022; Tamhane *et al.* 2023). At Hookers Point, the windiest period occurred between 13 000 and 12 100 years BP before the winds then weakened, reaching a minimum between 12 100 and 10 900 years BP. The least windy period overlaps with a phase of wetter climate; perhaps winds from the south were more common for a while. Despite such uncertainties, by comparing the Falkland Islands data with those from other parts of the region, they help track the migration, north or south, of the SHWW, an important component in climate modelling across the South Atlantic.

Looking ahead

Despite the body of work described here, scientific study of Falkland Islands peatlands is still in its infancy. The dry, grass dominated peatlands are quite unlike the blanket peat, fens and bogs found elsewhere in temperate or tropical latitudes, and fundamental questions about the development of peatlands in the Falklands remain unanswered. Moreover, climate change and extensive livestock grazing are putting this delicate environment at risk, reducing the capacity of the peatlands to sequester carbon dioxide (CO₂) from the atmosphere through peat formation, and possibly leading to greenhouse gas emissions in some areas. These issues are currently being addressed in projects led by Falklands Conservation and the Falklands-based South Atlantic Environmental Research Institute that involves the monitoring of greenhouse gas dynamics at more than twenty locations spread throughout the islands.

Although palaeoclimatic evidence from sites across the archipelago shows some agreement, the choice of different proxies and site-specific processes means that our understanding of the past is still limited, despite tantalising clues. Novel proxies may reveal more about the environmental history of the Falkland Islands, and experimental ancient sedimentary DNA analyses have been undertaken on samples from Hookers Point. The initial results contained faint traces of plant, bird and fish, but were dominated by microbial DNA making interpretation difficult. A more targeted approach that focusses on a limited number of taxa may uncover evidence for ancient ecosystems that have characterised the islands throughout the last 16 000 years (Murchie and Monteath, unpublished data).

What is certain is that peatlands in the Falklands preserved a wealth of information about the region's climate that is globally important. Once a simple fuel source but now seen as a natural laboratory and archive, these unique ecological systems will undoubtedly be of continuing scientific interest in the future.

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