EXCAVATING THE SPANISH FLU

by Alan Heginbottom

Introduction

The unusual properties of the influenza virus that triggered the 1918-19 pandemic have intrigued scientists and historians for many years. This strain was characterized by being very infectious, extremely contagious and especially virulent. As a result, the pandemic led to widespread illness and high death rates all over the world. One particularly unusual feature of the 1918 flu was that it infected young adults in high numbers, with correspondingly high death rates.

Researchers remain interested in the causes of this form of the illness. The most promising line of investigation has been to seek to recover samples of the specific version of the responsible virus in the hope of replicating its genetic code and comparing these data to other versions of influenza virus. The long-term aim is, of course, to prepare for the possible reappearance of this virus with targeted vaccination and treatment protocols.

The restored Longyearbyen Cemetery as seen in July 2004.

Two different approaches for the recovery of the virus have been undertaken in recent decades. The first is the analysis of preserved samples of tissue from people who died of the 1918-19 influenza pandemic. This was largely unsuccessful. The second approach has been to attempt to get new samples from the bodies of influenza victims whose remains were buried in permafrost. In these cases, the expectation - or hope - is that the virus has been preserved adequately by remaining frozen for approximately a century.

This is the story of one of these efforts, a Canadian-led attempt to recover remnants of the virus from human remains preserved in permafrost. My involvement was a result of my work in permafrost research in the Canadian arctic, studying the effects of ground surface disturbance on permafrost, and in environmental impact assessment of human activity and construction in permafrost regions.

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What is Permafrost?

Permafrost is defined as the condition of ground that remains below zero degrees Celsius for at least two years. Permafrost is found in the polar and alpine regions of the earth but is most widespread in the arctic regions of North America and Asia, where it extends from sea level up to the tops of hills and mountains. Alpine permafrost is found in mountainous regions at both high and low latitudes. The thickness of permafrost varies from less than a metre at its outer and lower limits to thousands of metres in the polar regions. Permafrost commonly contains varying amounts of ice—ground ice—both within the soil or rock matrix and as distinct bodies of more or less pure ice. The surface layer of the ground thaws and refreezes on an annual cycle, with the depth of this "active layer" varying with latitude and altitude, from a few centimetres to a few metres.

The upper corner of the cemetery, with the mass grave of the Spanish Flu victims is in the corner. Note the earthen berm over the grave, edged with small boulders. The cemetery fence is made from miners drill rods and chain. The tape measure and flagging tape in the fore-ground are in preparation for the GPR survey. The town of Longyearbyen is visible in the background.

The ground surface in permafrost terrain is susceptible to damage by trampling, vehicle use, etc., particularly during the summer thaw season. Such damage can result in changes to the annual thermal regime of the ground, and commonly leads to the subsidence the ground surface as well as ponding of water on the surface. These reactions lead to further changes and the disturbance can spread and continue.

References

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Bodies in Permafrost

There are numerous examples of the discovery of bodies, both human and animal, being buried and preserved in permafrost. The condition of some of the remains so found is quite remarkable. With regard to recovering traces of the 1918-19 influenza virus from human remains, however, the viability of the samples turns on several strict conditions:

- the body or bodies have must be known to be victims of the disease,
- the location of the burial should be known to adequate precision, and
- the permafrost at this location has to have remained intact since the burial(s).

References

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Influenza Research

There have been three attempts to recover the influenza virus from bodies entombed in permafrost.

The Longyearbyen cemetery, seen from the road, in October 1998. The graves of the victims of the Spanish Flu are in the far back corner. The structures on the hillside are the remains of old coal mining operations.

The first was undertaken by Johan Hultén in Brevig Mission, Alaska, U.S., in 1951. This attempt was not successful in that no viral traces were obtained. Hulten made a second attempt in 1997, however, that proved to be successful.

The third was carried out in Longyearbyen, on the Norwegian arctic islands of Svalbard in 1997-98. This project was undertaken by an international team of researchers, led by Dr. Kirsty Duncan, then a University of Windsor professor specializing in climate change, meteorology and health. (She is presently the federal Minister for Science and Sport).
Other team members came from Canada, Norway, the United Kingdom and the United States.

The Longyearbyen Cemetery

In September 1918, a supply ship made its last voyage of the season to the arctic coal mining community of Longyearbyen (78°N, 15°E). On board were several Norwegians, farmers or fishers, all of whom were going to work in the coal mines for the winter. During the voyage, several people became sick with influenza and seven of them died once the ship reached Longyearbyen. Their remains were buried in a single, large grave in the local cemetery. The location of the grave was clearly marked, and their names recorded on grave markers. With the permission of the Norwegian authorities and of the families of the deceased, the team made plans to excavate the grave and take samples from the bodies.

A preliminary evaluation, based on a literature review and on discussion with knowledgeable people, of the likely permafrost situation at the cemetery site concluded that, at the expected depth of burial, the soils had been cold or frozen more or less continuously since the original burials occurred. The soils have also been moist to wet, on an annual basis for this time. These factors had to be taken into consideration in assessing the probability of the survival of biological material.

A critical question faced the research team: How likely was it that the bodies had been buried in permafrost, especially given the difficulties of excavating frozen ground?

In Norway, graves are typically dug to a depth of two metres. In the permafrost terrain at Longyearbyen, a coal mining town, the practise was to drill and blast a grave site to loosen the ground, with excavation and backfilling being completed with hand tools. As the deaths in question took place in an era when working men did what they had been told to do, it seemed very probable that this grave would have been properly prepared.

Preparatory Work

The team held several planning meetings, in Windsor, Ontario, in Atlanta, Georgia, and in London, England. The purpose of these was to examine ways of working in permafrost terrain, of how best to excavate the bodies, how to recover samples from them, how to handle the samples, and where and how to analyze them.

Given the information about the likely burial conditions and, having developed working plans for both the field work and the laboratory work, the team decided to proceed with the project.

Excavation of the Bodies at Longyearbyen

How does one recover a body from permafrost? The answer: Carefully!
Researchers and archeologists face numerous challenges when carrying out excavations in permafrost. One approach is to use fire or steam injection to thaw the ground. Yet the Longyearbyen team rejected these approaches as they would pose risks to the site, the caskets,

the bodies, and possibly even the researchers themselves, if virus-infected particles were to be liberated. The use of heat would also have made site restoration more difficult.

Instead, the Longyearbyen team opted to excavate the frozen ground using an electric jackhammer (paving breaker) to break up the frozen ground and then shovel out the debris by hand. In order to be able to restore the cemetery site to its original condition, the team planned to remove the turf over the grave in square sections and store them, in order, on plywood sheets, so they could be replaced in their original positions. All the excavated material was also to be stored in a similar way such that it could all be returned to the burial site at the end of the process. These storage areas were to be adjacent to the excavation site and designed so that the surrounding vegetation in these areas would not be damaged. The team would also take precautions to avoid damaging to the ground surface of the cemetery and its immediate vicinity.

The researchers conducted an initial site survey and geophysical survey in October 1997, when the ground surface was already frozen. For the main excavation work, in August 1998, they protected the ground surface with perforated polyethylene matting, scaffold boards for a trackway, and by avoiding the natural surface as much as possible.

Geophysical Survey

The grave site for these influenza victims is marked with a turfed mound, edged with small boulders, plus their grave markers (six wooded crosses and one stone pillar). In order to ensure that the surface features corresponded to the actual excavation location, however, and had been dug deeply enough, the team carried out a geophysical survey of the site in October 1997. They used ground penetrating radar (GPR), with equipment provided by the Canadian company of Sensors and Software Inc., of Mississauga, Ontario.

In preparation for the GPR survey, a one metre by one metre grid was laid out over the area of interest, extending some 10 to 15 metres outside the actual grave area. Over 70 GPR reflection survey line were run at 50 centimetres intervals, in both north-south and east-west directions. A GPR trace was collected every 20 milimetres along all the lines, to ensure that localized responses from any disturbed ground would appear in the data. The re-search team analyzed the data in both profile and plan form, to show areas of disturb-ance and the edges of excavations.

The results of this survey were encouraging: clearly there had been an excavation at the marked site and the ground had been disturbed to a depth of 2 to 2.5 metres, as expected. Thus, we concluded that the graves were indeed where they were indicated by the surface features and grave markers. At this stage, however, it was not possible to visualize the actual caskets.

References

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The Excavation and Results

The team carried out the excavation in August 1998, under a large, inflatable tent, for reasons of security, privacy and protection from the weather. The grave markers were removed and stored until they were to be replaced. The turf and boulders were removed in order, as planned, and the excavation began.

Unfortunately, the researchers encountered the top of the first of the casket at a depth of only 30 centimetres, instead of the 1 to 1.5 metres we had anticipated. The other caskets were also found at similar depths. In the end, the bodies had not been buried in permafrost but rather in the active layer closer to the surface. Consequently, they had not remained frozen since 1918 and so the likelihood of retrieving viable samples was very limited. Nevertheless, the team took samples and flew them to London, England, for evaluation. None of the caskets or the bodies were removed from the burial site; all the sampling was done in situ, using specialized medical tools.

Following the sampling, the team then backfilled the excavation pit, removed the tent, all the tools and the storage equipment, and finally replaced the turf, the boulder curb, and the grave markers. As of 2004, the site restoration remained quite stable.

Conclusion

What went wrong? Several questions arise: Did the caskets “float” towards the surface in response to the annual thawing and refreezing of the active layer? Or were they initially buried in a shallower grave then we had anticipated, based on our information about Norwegian burial customs?

My view is that the latter scenario is the more likely. If the caskets had floated in response to the annual thaw-freeze cycles, there would very likely have been some visi-ble disturbance at the ground surface. Also, the GPR profiles had shown that the ground had been disturbed to a depth of over two metres.

My hypothesis is that the men who were tasked with preparing the grave, probably mine labourers, did the drilling and blasting to the standard 2 to 2.5 metres depth. But they may not have carried out the actual hand excavation as per their instructions. Rather, they dug a shallow grave, placed the caskets in it, and covered them up.

Why? It is known that these burials were carried out rapidly, probably due to fear of infection. It is likely that the men who dug the grave were afraid of this risk and finished the job as quickly as they could. And, quite possibly, there was no one supervising the work. Lastly, in October, the temperatures would have been dropping with the onset of winter and so the labourers were likely in a hurry to finish the job and get out of the cold.