Research

The iceman as a burial

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Since his discovery in 1991 the iceman has been widely seen as meeting a dramatic end – mortally wounded by an arrow shot while attempting to flee through an Alpine pass. A careful study of all the located grave goods, here planned comprehensively for the first time, points strongly towards the scene as one of a ceremonial burial, subsequently dispersed by thawing and gravity. The whole assemblage thus takes on another aspect – not a casual tragedy but a mortuary statement of its day.

Keywords: Alpine region, Copper Age, iceman, formation process, burial rite

Introduction

In September 1991, the iceman, a well-preserved 5000 year-old human corpse, was found on the partially glaciated Tisenjoch pass in the Tyrolean Alps (Figure 1). The common interpretation is that he died with his belongings on the pass of the partially melted Similaun glacier (Höpfel *et al.* 1992; Barfield 1994; Spindler 1994; Spindler *et al.* 1995, 1996; Bortenschlager & Oeggl 2000; Nerlich *et al.* 2003; Pernter *et al.* 2007; Lippert *et al.* 2007). In this so-called 'disaster' theory, the mortally wounded man froze at a high altitude with his tools and personal items, succumbing to an arrow point deeply embedded in his left shoulder while escaping from a tribal clash. Interestingly, such a demanding reconstruction has never been supported by the publication of a detailed spatial analysis of the discovery scene. Here, we present a point pattern analysis based on a detailed map of the items on record and show that a different interpretation is more probable. The original position of

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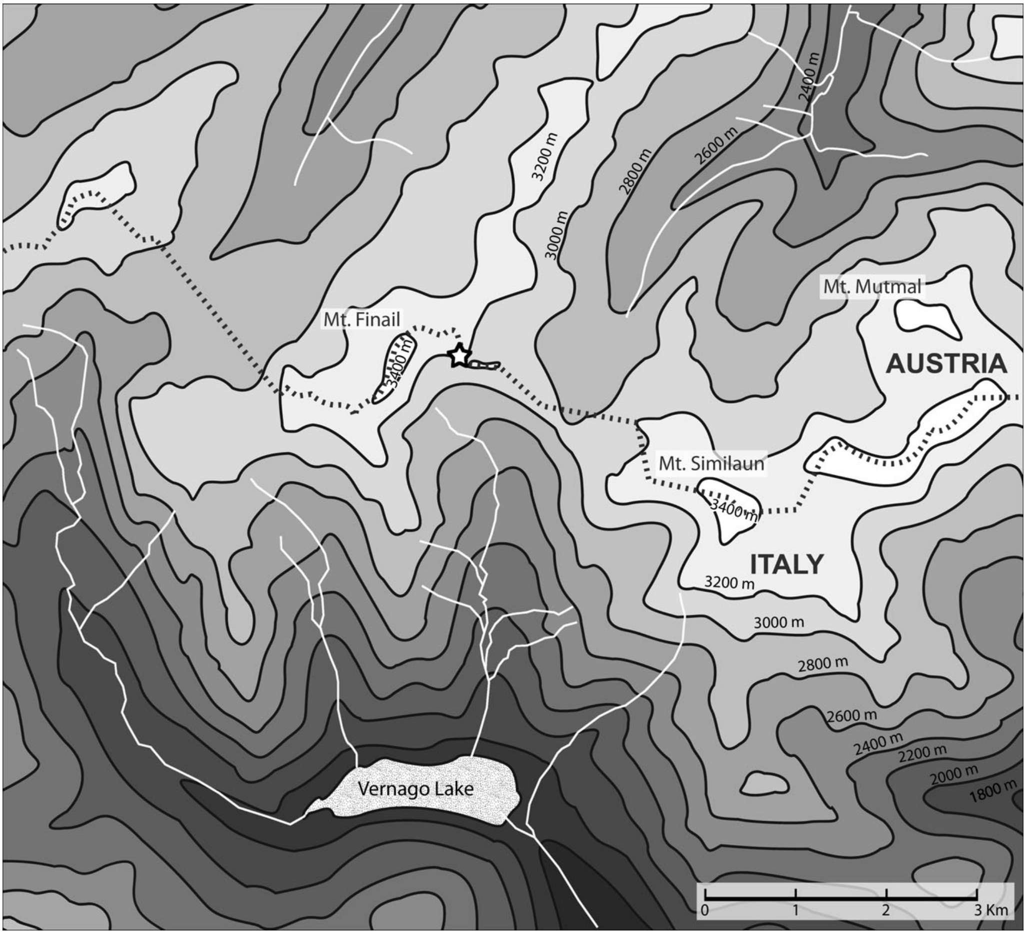

Figure 1. Location of the findspot (white star), on the Tisenjoch pass, at the Italian-Austrian border. Contour line interval: 200m. Redrawn from Google Maps and from Geo-browser (Provinz Bozen, Italy).

the body was possibly on a modified natural stone platform, 0.8m above and 5.0m away from the final discovery spot. We propose that this platform served as the burial place of the iceman and his grave goods. Our plots of the artefact scatter suggest the burial goods and body fell from here and were later repositioned downslope by gravity, suspended in semi-melted ice and water during warm episodes. This reconstruction is consistent with previous discoveries and the analytical results of the body's state of conservation. It also accounts for the contrast between botanical evidence in his gut, placing his death at a lower altitude in early/mid spring, and environmental and botanical evidence on the Tisenjoch suggesting a burial in late summer/early autumn.

Mapping the find area

The local geomorphology is crucial to evaluate post-depositional movements. The findspot lies in a shallow depression between two low ridges (at the time of the discovery filled with

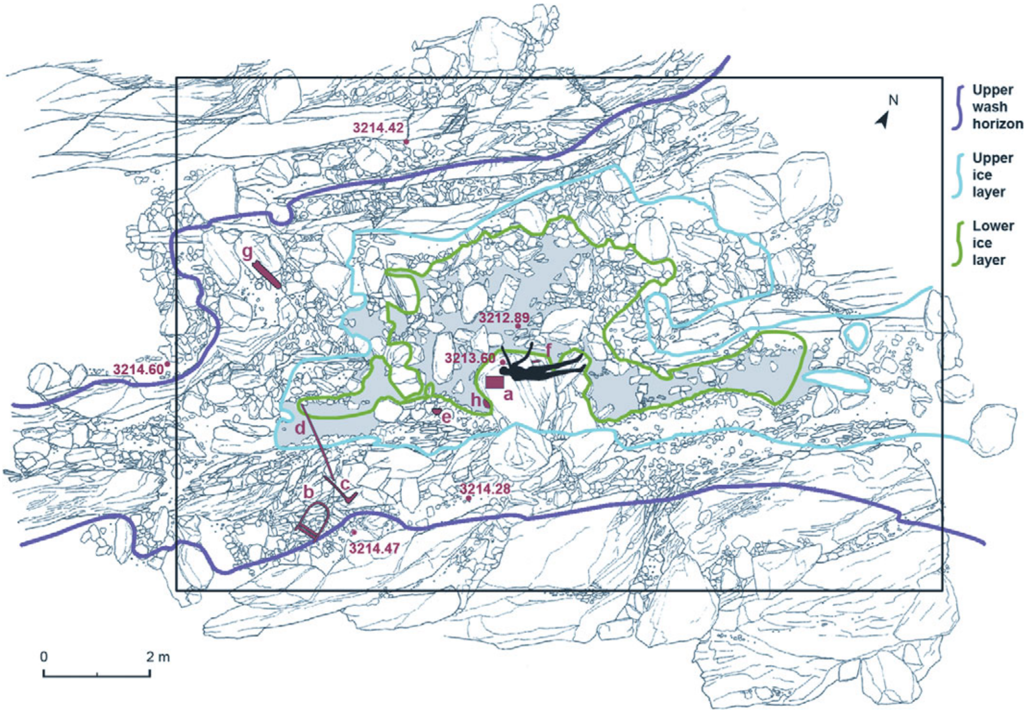

Figure 2. The shallow depression hosting the iceman's body and the principal objects recovered. The rectangle corresponds to the area displayed in Figure 3. Modified from Spindler et al. *1995. The main items found are displayed in red: a) grass mat; b) backpack frame; c) axe; d) bow; e) birch bark vessel; f) dagger; g) quiver; h) cap.*

ice) discharging towards the north-east (Figure 2). The depression is approximately 17.50m long and 5.0m wide with a maximum depth of 1.25–1.50m (bottom: 3212.89m asl; ridges at 3214.25–3214.50m asl). The elevation of the boulder on which the iceman rested is about 3213.6m asl. A small platform (outlined in white on Figure 3), about 2.2 × 1.0m, is located to the south-west over the southern ridge. It is bounded by two parallel protruding stones and has a slightly higher rock at its north-eastern end facing the basin. This platform is 0.8m above and 5.0m west from the location of the corpse and is connected to the nearby depression through a natural fissure, running between this rock and the main bedrock ridges to the east.

After their accidental discovery during 19–23 September 1991 (Egg *et al.* 1993), the body and some large objects scattered on the surface were haphazardly collected by visitors. At this time it was still believed that the corpse was a modern casualty and no precise spatial information was recorded. The position of the body and the items had to be reconstructed from photographs and personal recollections (Egg *et al.* 1993). From 3–5 October 1991 a field campaign was led by an archaeological team from Innsbruck University and directed by A. Lippert (1992). As the weather was bad, only part of the ice surrounding the body had melted and only a few items were recovered. Spatial information was limited but included a general plan.

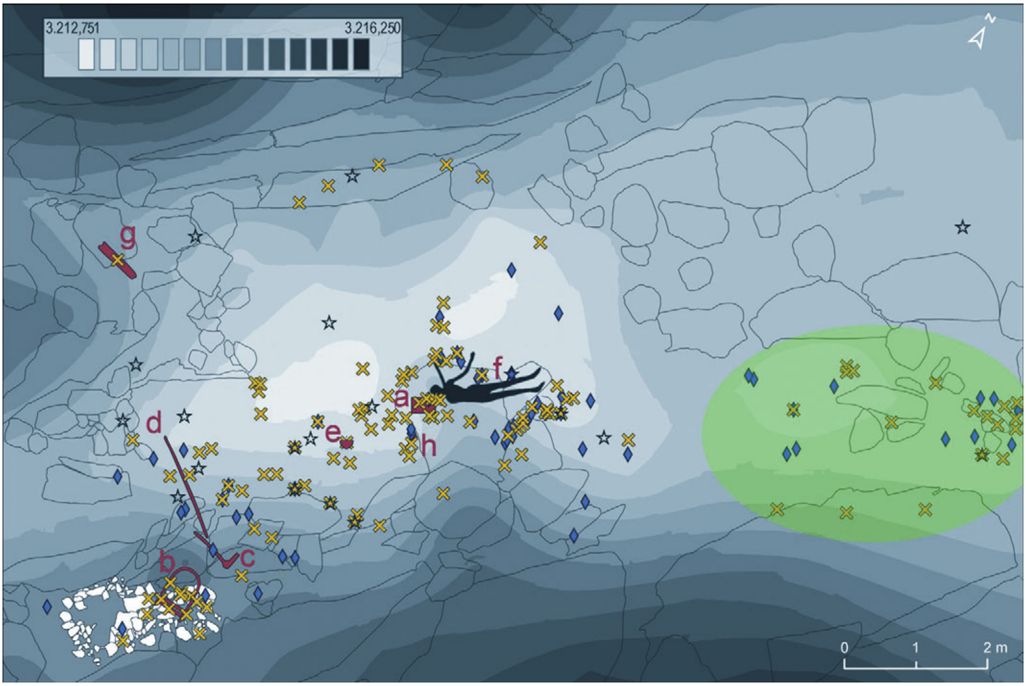

Figure 3. Simplified map with the distribution of items over the iceman site. White boulders and stones mark the platform, the proposed grave location. Heavier items (pelt and leather): blue diamonds. Lighter items (grass and hair-like items): yellow 'x's. Intrusive items: black empty stars. Light green area: items displaced during excavation. Contour line interval: 25cm. The main items found are displayed in red: a) grass mat; b) backpack frame; c) axe; d) bow; e) birch bark vessel; f) dagger; g) quiver; h) cap.

A second field campaign was carried out from 4–24 August 1992 by a joint team from Innsbruck University and archaeologists from Bozen (Bolzano), directed by A. Lippert and B. Bagolini (Bagolini *et al.* 1995). This expedition aimed to recover completely the remaining artefacts and take a comprehensive range of samples. At this time the ice sheet had thawed and a detailed plan was made. The locations of the finds are published in the final report with variable precision as coordinates, in grid systems, descriptions or by combined sources.

Figure 3 is the first comprehensive distribution map of the body and the finds. We superimposed the two available plans and made a location record that included all the recovered items. This database has 466 entries, including the eight main objects: the dagger, backpack frame, axe, quiver, one of the birch-bark containers (the other was collected from the depression), grass mat, bow and pelt cap. Setting aside 151 botanical, ice and sediment samples, we could relocate 250 out of the 315 recovered items (approximately 80 per cent of the total). The resulting distribution was plotted on a detailed digital elevation model of the basin with a simplified rendering of the local rock setting.

Visual analysis of the distribution

The plan suggests a flow of material originating from the alignment of rocks we have identified as the platform (designated in white). The hypothesis suggested is that the iceman's body, artefacts and associated items were first located on this platform, and were dispersed to the lower level of the depression and its outlet through disturbance by cyclical thawing and freezing, as well as by trampling during the 1991 and 1992 recovery activities (Bagolini *et al.* 1995). Only the backpack frame (Figure 2: b), among the larger objects, remained on the platform, trapped against the protruding rock at its north-eastern end. On the platform, near and below the backpack frame, there is a cluster of human and animal hair and vegetal fragments. Their upslope position is inconsistent with the disaster theory that the iceman died where he was found (Lippert *et al.* 2007), but in accordance with the hypothesis that the platform was the burial place. The axe (Figure 2: c) and the bow (Figure 2: d) shifted just below the platform through the fissure leading to the lower basin where the iceman was found. Data are consistent with the distribution of some splinters of the arrow shafts found on the platform and near the fissure. These can be refitted with those still contained in the quiver (Oeggl 2009: fig. 7), suggesting that the quiver too was originally on the platform and later shifted to its discovery location. The cap (Figure 2: h), leather and pelt fragments followed the body, while a few of the lighter items such as grass (Acs *et al.* 2005), net and string fragments and the hollow quiver (Figure 2: g) floated farther afield. The northern limit of their distribution corresponds to the edge of the depression. By contrast, items not primary to the burial (spanning *c*. 5000–2000 cal BC, see Kutschera & Müller 2003), such as coniferous needles, animal dung (Oeggl *et al.* 2009) and feathers, are scattered randomly in the depression, but not on the platform.

Recent analysis of plant macro-remains may also support this model. Heiss and Oeggl (2009: 23) recently presented the first spatial analysis of the distribution of selected plant remains. They arrived at a similar distribution plan to ours, but decided that '*. . . the Iceman had died in an area about 5m south-west of the position where he was discovered in 1991*' and that post-depositional displacement followed.

Spatial Point Pattern Analysis

The authors and Heiss and Oeggl (2009) thus agree that the death assemblage items are not in their original position and this view gains support from spatial analysis. In fact, more than 36 per cent of the plotted artefacts with recorded absolute elevation are located above the 3213.6m asl of the boulder where the corpse rested, a distribution inconsistent with the main assumptions of the disaster theory. To better understand the scatter of the items at the findspot we used Spatial Point Pattern Analysis (SPPA) (Ripley 1977; Diggle 1983) as the main analytical tool for the statistical properties of the observed distribution. We defined a Region of Interest (ROI) including the concentration of items in the basin and the upper slope but excluding the eastern area since it was heavily disturbed (Figure 3, in green). All objects deemed intrusive (Kutschera & Müller 2003; Oeggl *et al.* 2009) were excluded. As a final result, 158 items (50 per cent of the total) retain information suitable for SPPA.

If the iceman died with his belongings gathered around him and his body was found in or near his original death spot, as assumed by the disaster theory, the artefact scatter should be randomly distributed about his body, as the objects would have been simply repositioned by melting and freezing cycles (Model A). We tested this as the null hypothesis of Model A. Figure 4a shows the estimation of the items' density (i.e. the expected number of remains

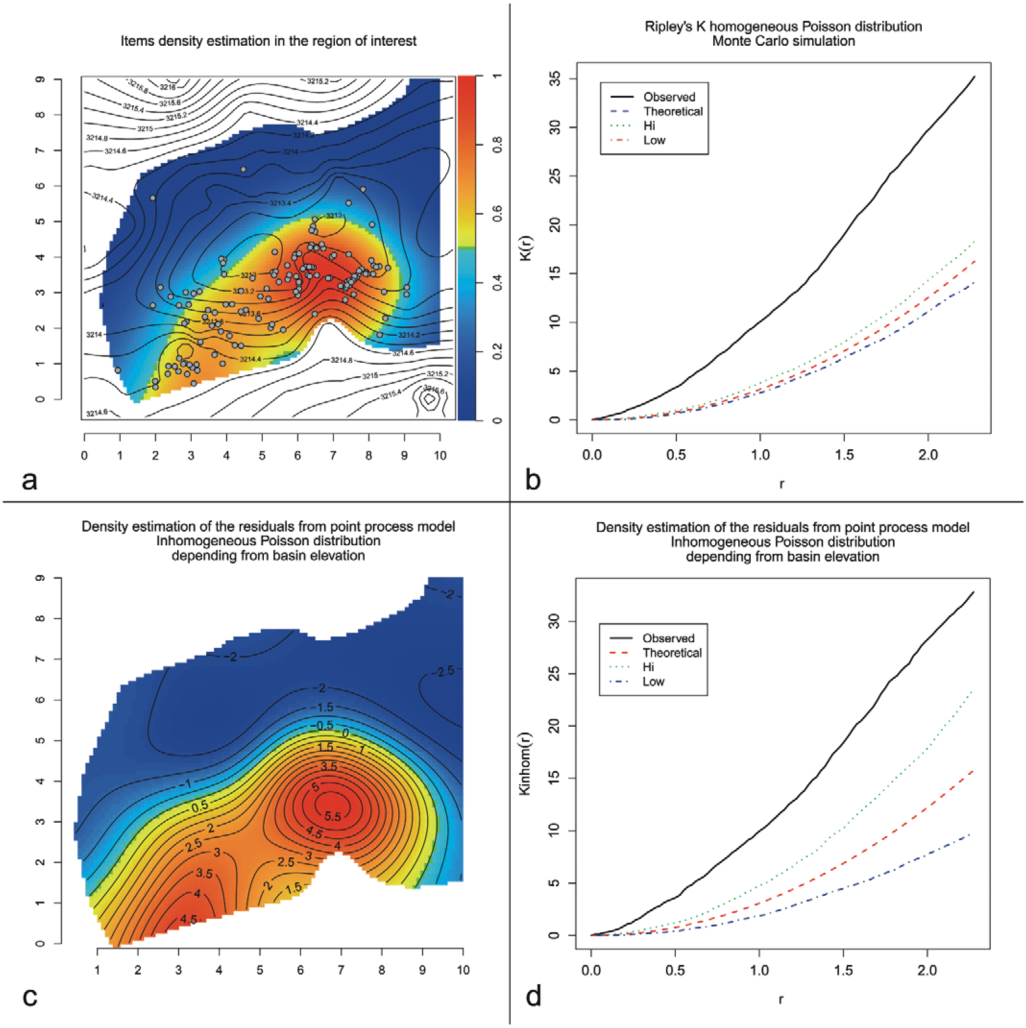

Figure 4. Spatial Point Pattern Analysis: a) plot of items density estimation (pseudo colour scale) on the ROI superimposed to the elevation contour lines (20cm) of the basin. Each dot represents the position of an item; b) Ripley's K function estimation for the observed pairwise distances among items compared with a Monte Carlo simulation (100 iterations) of the null hypothesis of a completely random spatial distribution; c) pseudo colour representation of the intensity of the residuals from the point process model that accounts for the point pattern dataset of items; the model considers the distribution of points as a function of the X, Y spatial coordinates with Z (elevation) as a covariate; d) comparison of the Ripley's K function estimation of the Monte Carlo simulation (100 iterations) of the point process model described in (c) against the original observed pairwise distances among items.

per unit area) in the ROI. The density is shown as a pseudo-colour map superimposed on the contour plot of the basin. Ripley's K function estimation (Baddeley & Turner 2000) for the observed pairwise distances among the items is shown in Figure 4b. It is compared with a Monte Carlo simulation (100 iterations), where the 158 points were scattered in the ROI using a Complete Spatial Randomness (CSR) process. The K function for the observed data is higher than for the simulated data and outside its range of variation for all inter-point distances ranging from 0–2m. The CSR null hypothesis for Model A is therefore rejected at a significance level of the point-wise Monte Carlo test of 2/101 (0.02). This indicates a strong non-random clustering of the items in the basin and on the platform.

SPPA was used again to investigate whether the observed average spatial density of items could be satisfactorily explained by the morphology of the local slopes (Model B). In the model tested, elevation is assumed as an explanatory variable of the density of items within the ROI. The model was tested by a non-homogeneous Poisson point process fitting function algorithm (Baddeley & Turner 2000). The spatial distribution of residuals from the model (Baddeley *et al.* 2005) shows the persistence of the pattern observed in the original data (Figure 4c). As a result, the elevation of the depression is a poor predictor for the observed distribution. If the original pattern was completely explained by the area's morphology, the residual density plot shown in Figure 4c should be flat and its height should be close to 0. As in the Model A test, a Monte Carlo simulation was run to test if the model, where the elevation is assumed as the explanatory variable, was significantly different from the observed spatial distribution. The generalisation for non-homogeneous point patterns of the Ripley's K function was measured on the observed point spatial distribution and on 100 simulations of Model B (Figure 4d). The simulation rejects the null hypothesis of Model B at the 0.02 significance level for all inter-point distances ranging from 0.0–2.0m.

In sum, the spatial pattern shows the items are not randomly distributed, but distributed in two main places, the platform and the depression. This is fully compatible with the hypothesis of a post-depositional movement under gravity assisted by water flow from a precise zone of origin on the platform into the depression. The final distribution is partially affected by the local morphology and partially due to the floating of a few lighter items.

An original grouping of all the objects and the iceman himself on the platform need not necessarily imply a burial: the iceman may have collapsed, or decided to lie down or camp exactly on the platform. In this case he and his belongings will have been confined in an area of little more than $2m^2$. We know he was not wearing the backpack since it did not fall down with the body. If he put down the backpack and lay or sat next to it, no more than $1m^2$ would have been left on the platform for all the rest of his varied and bulky equipment. If this is feasible, it must be admitted that the resulting archaeological pattern would be hardly distinguishable from that of a grave; however, there is some additional evidence to support the grave hypothesis.

Indications from objects

A ceremonial burial accounts better for the unfinished weapons (Oeggl & Schoch 2000; Fleckinger 2005), which were more probably funerary items, since they would have been of no use to a living fighter or hunter hiking or fleeing at high altitude. A burial also provides a more realistic context for the grass mat, considered and reconstructed in exhibitions as a form of overcoat (Groenman-Van Wateringe 1993; Oeggl & Schoch 2000). If the iceman was the subject of a formal burial, the mat was more likely part of a funeral shroud. Cloth and weapons, similar to those associated with the iceman, were reproduced on Copper Age menhir-like stone slabs found in symbolic locations along the Alpine arch, for celebrating ancestors as powerful warriors (Gleirscher 2003). Ultimately, the impressive array of other objects is better explained as grave furnishings than as mountain equipment. It is also odd that a man shot dead with an arrow was not relieved of most of his possessions by his pursuers.

Indications of the time of death

The iceman's hand wound, which shows some evidence of healing (Nerlich *et al.* 2003), and the fatal arrow injury (Gostner & Egarter Vigl 2002; Murphy *et al.* 2003; Gostner *et al.* 2004; Pernter *et al.* 2007; Nerlich *et al.* 2009) were sustained at separate times (Oeggl 2009). Computed Tomography (CT) analysis of the shoulder wound indicates the arrow perforated the subclavian artery, resulting in almost immediate death (Pernter *et al.* 2007). However, treatment may have been attempted as indicated by the six inedible, but medicinal, mosses associated with the body (Dickson *et al.* 2009).

Isotopic dietary indicators (Macko *et al.* 1999), cereal pollen and grains (Groenman-Van Wateringe 1993) and the iceman's well-preserved last meal, when he also ingested fragments of grinding stones and ceramic particles (Oeggl 1999; Rollo *et al.* 2002; Oeggl *et al.* 2007), all place him in an agricultural community. In his last days he was roaming at different altitudes in springtime, as suggested by the variety of the pollen still in his gut (Oeggl *et al.* 2007). This detailed pollen analysis suggests April as the most probable month for his last meal (Oeggl 2009: fig. 11). At this time (spring) the Tisenjoch pass was certainly covered in snow. However, the first pollen analyses from the ice surrounding the iceman pointed to its formation between late summer and early autumn (Bortenschlager *et al.* 1992: 308, Abb. 2). There is thus an apparent mismatch between his time of death (April) and his time of burial (August/September).

The corpse had a small amount of adipocere (Bereuter *et al.* 1997) and microbiological intestinal bacteria (Cano *et al.* 2000). These observations imply that mummification occurred in alternating humid-dry conditions, not in a frozen situation as expected if the corpse was rapidly covered in snow and ice in the Tisenjoch pass. The following scenario could account for these details. The iceman died at a low altitude, and his body was cleaned and stored by packing it in ice for later burial. The poor state of adipocere can be accounted for by ice melting and refreezing in the primary deposition site. Eventually, mummification occurred due to the slow drying of organic tissues in freezing, circulating air. This explains why the iceman is so similar to the mummies of Pazyryk (Siberia), initially preserved in permafrost lenses, but then exposed to continuous flows of freezing air after the burial mounds were pilfered (Rolle 1992).

Ethnohistoric sources from at least the sixteenth century to the beginning of the twentieth, in the Tyrolean region, report that when someone died in the cold season the interment was frequently delayed. The dead were stored in *masi* (farmsteads) for weeks or even a few months, waiting for the snow to melt and the ground to thaw (Anon. 2009). Gorfer (2003: 55) states that when inclement weather and snow buried the tracks, the dead '*. . . were kept in rooms cold as freezers*' until transport and digging were possible. Other informants write that corpses could be kept protected on the roof (Giono 2009) or freezing in the attic (Garobbio 1969), until burial.

An alternative model

Our reconstruction therefore implies an initial storage of the body at a lower altitude followed by a later burial of the mummified corpse with his grave goods up on the mountain. After the interment on the Tisenjoch pass, the burial was probably covered with snow resulting in its protection and preservation. It remained undisturbed until one or more warm episodes (Baroni & Orombelli 1996; Patzelt 2000), when the body and objects slumped into the lower depression through the north-eastern fissure, where the bow and axe were captured and the backpack frame stopped against the protruding rock. The corpse turned prone, with the feet towards the north and the arms hanging down, like a body floating in dense fluid (Duday 2006). Finally, it lodged against the boulder where it was found in 1991. Here the left arm, trapped against the boulder, was slowly twisted to a peculiar angle, following the downslope flow traction of the body. The remarkable preservation of the iceman indicates that the body moved in semi-melted ice. A few lighter and hollow items, like the quiver, floated away, to the northern edge of the basin.

Discussion and conclusion

Since its discovery in 1991, the iceman has represented '. . . *a kind of frame fixed in the flow of time, a sudden stop in a continuous course . . . a prehistoric man . . . suddenly stuck forever with part of his cultural and material context*' (Pellegrini & Piperno 1991: 47). The reconstruction of the events proposed by Spindler (1993, 1996), leader of the Innsbruck research group, met general acceptance (the disaster theory). In 1994, Barfield remarked how amazing it was to have the equipment and clothing of one man in use at one moment of his life. He defined the objects recovered near the body as a mountain survival kit. The flint arrowhead found in the left shoulder (Pernter *et al.* 2007) simply became the fatal shot on the mountain peak (Gostner & Egarter Vigl 2002; Murphy *et al.* 2003; Gostner *et al.* 2004; Lippert *et al.* 2007). Oeggl (2003) is the only one, so far, to propose that body and objects were moved by natural processes. Yet, he never questioned the scientific and popular version of the killing at the Tisenjoch site (Oeggl *et al.* 2007; Oeggl 2009). Only two authors have proposed a different interpretation of the context: as the scene of a burial involving the ritual positioning of the goods around the basin (Carancini 2006) or as the result of killing or self-immolation by exposure (Teržan 1994).

The first idea that the iceman was frozen in time and place profoundly influenced all subsequent findings and the resulting popular interpretation (Höpfel *et al.* 1992; Spindler 1994; Fowler 2000). Such a perspective can be traced back to the methodological and psychological effects of the so-called 'Pompeii premise'. Ascher (1961: 324), while discussing the analogy, denied that archaeological deposits reflect '. . . *the remains of a once living community stopped, as it were, at a point in time*'. Binford (1981: 196), quoting Ascher, wrote that the past, being ravaged by time's arrow, cannot be preserved like an illusory Pompeii: '*Pompeii is only an ideal for one interested in events, specific behaviors, and event-centered history*'. In this perspective, '. . . *the imperfect world of "dirt archaeology" will almost always be a frustrating one*' (Binford 1981: 205; Schiffer 1985).

Because the iceman and his objects were widely accepted as a catastrophe context, reconstructions adopted the style of forensic investigations and the find was presented as an isolated case, without connections with the archaeological context of the Alpine and peri-Alpine Copper Age sites. The interpretation of the iceman as a formal burial not only accounts more fully for the available analytical data and the post-depositional movements; it also presents us with the potent agency of a deliberate mortuary assemblage. This takes nothing from the iceman's enormous scientific value, but this new perspective on his post-mortem treatment may help us to understand better other recent finds on prehistoric Alpine passes (Grosjean *et al.* 2007).

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