PROGRAM AND ABSTRACT BAND

3rd Bolzano Mummy Congress

ÖTZI: 25 YEARS OF RESEARCH
ÖTZI: 25 JAHRE FORSCHUNG
ÖTZI: 25 ANNI DI RICERCA

September 19th - 21st 2016
EURAC Research
Viale Druso 1 - I-39100 Bolzano

ORGANIZED BY

Institute for mummies and the Iceman
Institut für Mumien und den Iceman
Istituto per le mummie e l'Iceman

South Tyrol Museum of Archaeology
Südtiroler Archäologiemuseum
Museo Archeologico dell'Alto Adige

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The Scientific Committee of the conference
is composed of the members of the advisory boards
of the EURAC Institute for mummies and the Iceman
and the South Tyrol Museum of Archaeology.
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Program Overview

Monday, September 19th 2016

8.30 - 9.30	check in and opening
9.30 - 10.30	lectures
10.30 - 11.00	coffee break
11.00 - 12.30	lectures
12.30 - 14.00	lunch
14.00 - 15.30	lectures
15.35 - 16.05	coffee break
16.00 - 17.00	lectures

Tuesday, September 20th 2016

9.00 - 10.30	lectures
10.30 - 11.00	coffee break
11.00 - 12.30	lectures
12.30 - 14.00	lunch
14.00 - 15.30	lectures
15.30 - 16.00	coffee break
16.00 - 17.00	lectures
18.00 - 20.30	public event

Wednesday, September 21st 2016

9.00 – 10.30	lectures
10.30 – 11.00	coffee break
11.00-12.00	round table: “Ötzi’s research perspectives”
12.00 – 12.30	closing words

Scientific Program

Monday, September 19th 2016

8.30 - 9.30	**Registration and Poster Setup**
9.30 - 10.00	**Opening and Welcome Address**
	Roland Psenner (President EURAC)
	Florian Mussner (Landesrat für Ladinische Bildung und Kultur, Denkmalpflege, Museen, Verkehrsnetz und Mobilität)
	Karin Dalla Torre MAS (Direktorin der Abteilung Museen und des Betriebs Landesmuseen)
10.00 - 10.30	**Conference Introduction**
	Albert Zink: Introduction Scientific Program
	Angelika Fleckinger: 25 Jahre Mann aus dem Eis
10.30 - 11.00	**Coffee Break**
11.00 - 12.45	**Lectures Session I: Molecular Studies**
	Chairs: N. Lynnerup, J. Zschocke
11.00 - 11.30	Introductory lecture Frank Maixner et al.: Ancient DNA studies of the Iceman: the human genome, pathogen detection and dietary reconstruction.
11.30 - 11.45	Valentina Coia et al.: Whole mtDNA sequencing in Alpine populations and the genetic history of the Neolithic Tyrolean Iceman
11.45 - 12.00	Amaury Cazenave-Gassiot et al.: Lipidomics analysis of the Ötzi's last meal
12.00 - 12.15	Marek Janko et al.: Ötzi meets Nanotechnology - Skin, wound tissue, and stomach content analysis
12.15 - 12.30	Thomas Rattei et al.: Microbial genomes inside the mummy of the Iceman
12.30 - 12.45	Andreas Keller: Analysis of miRNAs in tissue specimens of the 5,300 year-old Tyrolean Iceman
12.45 - 14.15	**Lunch Break**
14.15 - 16.50	**Lectures Session II: Archaeology**
	Chairs: C. Marzoli, P. Gleirscher
14.15 - 14.35	Introductory lecture Günther Kaufmann: Der Mann aus dem Eis aus archäologischer Sicht. Status quo der archäologischen Forschungsarbeit.
14.35 - 14.50	Walter Leitner: Neuer Hot spot am Tisenjoch?
14.50 - 15.05	Hubert Steiner: Gletscherarchäologie im Schnalstal

15.05 - 15.20	Andreas Putzer: Tracing human presence connected to Pastoralism at Schnals Valley
15.20 - 15.35	Umberto Tecchiati, Annaluisa Pedrotti: Copper Age in Trentino Alto Adige: New Data, Syntheses and Open Problems
15.35 - 16.05	**Coffee Break**
16.05 - 16.20	Gerhard Sperl: Neuere Aspekte zur Metallurgie der Beilklinge des Eismannes
16.20 - 16.35	Gilberto Artioli, Ivana Angelini: Lead isotope investigation of Iceman copper axe: provenance of the metal
16.35 - 16.50	Benno Baumgarten, Günther Kaufmann: Die Beilklinge des Mannes aus dem Eis – Hinweise auf Produktion, Bearbeitung und Nutzung
16.50 - 17.20	**Lectures Session III: Museology**
	Chair: F Marzatico
16.50 - 17.05	Alex Barker, Edward Liebow: „World on the Move: the Copper Age" – A Research Symposium
17.05 - 17.20	Emlyn Koster: Insights into the Human Journey: A New Touring Exhibition

Conference speakers are kindly invited to:

Reception Iceman 25th Anniversary
h. 18.00 at the South Tyrolean Museum of Archaeology

Tuesday, September 20th 2016

9.00 - 10.30	**Lectures Session IV: Archeobotany, Isotopes, Dating and Climate**
	Chairs: C. Lass-Flörl, W. Leitner
9.00 - 9.30	Introductory lecture Klaus Oeggl et al.: Archaeobotany and the possible involvement of Ötzi, the Iceman, in pastoral activities
9.30 - 9.45	James Dickson, Klaus Oeggl: Bryophytes and the Tyrolean Iceman
9.45 - 10.00	Wolfgang Müller et al.: On the heavy metal(loid) exposure of the Alpine Iceman recorded in his nail, hair and soft tissue
10.00 - 10.15	Walter Kutschera et al.: Radiocarbon measurements around the Iceman

10.15 - 10.30	Paolo Gabrielli: Climate and environmental changes in South Tyrol from the Ortles ice core since the time of the Iceman
10.30 - 11.00	**Coffee Break**
11.00 - 12.45	**Lectures Session V: Radiology and Cause of Death** Chairs: F. Rühli, E. Egarter-Vigl
11.00 - 11.30	Introductory lecture Patrizia Pernter et al.: The Iceman: a radiological summary 25 years after his discovery and Iatrogenic modifications on the Iceman
11.30 - 11.45	Paul Gostner, Patrizia Pernter: New radiological insights into the Iceman´s state of health
11.45 - 12.00	Stephanie Panzer et al.: Checklist and Scoring System for the Assessment of Soft Tissue Preservation in CT Examinations of Human Mummies: Application to Ötzi
12.00 - 12.15	Chiara Villa, Niels Lynnerup: Ötzi segmented
12.15 - 12.30	Oliver Peschel et al.: Re-evaluation of the cause of death of the Neolithic Iceman, c. 5300 BP
12.30 - 12.45	Alexander Horn: Behavioural analysis of the iceman murder case
12.45 - 14.15	**Lunch Break**
14.15 - 17.00	**Lectures Session VI: Clothing and Tools & Miscellaneous** Chairs: P. Gleirscher, F. Marzatico
14.15 - 14.45	Ursula Wierer et al.: The Iceman lithic toolkit: raw material, technology, typology and use
14.45 - 15.00	Paola Salzani, Umberto Tecchiati: For a Cultual Geography of “The Ice Man”: Raw Materials, Places of Worship and Ideology of the Warrior Ancestor between Alto Adige and the Lessini Mountains
15.00 - 15.15	Niall O’Sullivan et al.: A whole mitochondria analysis of the Tyrolean Iceman’s leather provides insights into the animal sources of copper age clothing
15.15 - 15.30	Carney Matheson: The archaeochemistry of the artefacts and associated remains of Ötzi the Iceman
15.30 - 16.00	**Coffee Break**
16.00 - 16.15	Manuel Lizarralde: Were Ötzi’s bow stave and arrow shafts planned to be effective for hunting and warfare?
16.15 - 16.30	Martin Callanan: Ötzi, Primus inter pares- The Iceman seen from the field of glacial archaeology
16.30 - 16.45	Sandra Lösch, Amelie Alterauge: Death in the Ice: Re-investigations of the Remains from the Theodul Glacier (Switzerland)
16.45 - 17.00	Oliver Gauert: Two Remarkable Peruvian Skulls from the Collection of the Roemer- und Pelizaeus-Museum Hildesheim

17.00 - 17.15 **Session VII: Short Poster Presentations** (5 min each)

Chair: F. Maixner

Valeria Mattiangeli et al.: Pick the right pocket. Sub-sampling of bone sections to investigate diagenesis and DNA preservation
Valeria: Pick the right pocket

Valentina Depellegrin et al.: Hunting and herding: Animal exploitation in Isera la Torretta (Rovereto, TN, Italy) during the late Neolithic period and early Copper Age. Preliminary results of the zooarchaeological analysis

Beat Schmutz et al.: Secular change of femoral morphology from a clinical perspective: How would a modern anatomically pre-contoured fracture fixation implant fit the Neolithic Iceman in comparison to medieval and modern femora?

18.00 - 19.00 **Round Table: Fallanalyse Ötzi - Neue Rückschlüsse zum Tötungsdelikt am Mann aus dem Eis**

Öffentliche Veranstaltung / Public lecture / Evento aperto al pubblico

In deutscher Sprache / In German language. Simultanous translation will be provided/ In lingua tedesca con traduzione simultanea

Moderation: **Martina Schönfeld, ZDF Hauptredaktion Geschichte und Wissenschaft**

Einführung Projekt Fallanalyse: Angelika Fleckinger

Teilnehmer Diskussion/Participants: Alexander Horn (Polizeipräsidium München), Albert Zink (EURAC), Oliver Peschel (University of Munich), Klaus Oeggl (Universtiy of Innsbruck), Paul Gleirscher (Landesmuseum Kärnten), Frank Rühli (Universtiy of Zurich)

19.00 - 20.30 **Aperitif (EURAC foyer auditorium)**

Wednesday, September 21st, 2016

9.00 - 10.15 **Lectures Session VIII: Conservation and Tattoos**

Chairs: O. Peschel

9.00 - 9.30 Introductory lecture
Marco Samadelli et al.: 25 Years of Conservation of the Iceman. Development of analytical methods and technological devices

9.30 - 9.45 Ludwig Moroder: Characterization of the cultivable microbial flora on the Mummy OETZI

9.45 - 10.00 Marcello Melis et al.: Complete mapping of the tattoos of the 5300 years old Tyrolean Iceman

10.00 - 10.15	Maximilian Moser et al.: Newly discovered tattoos support acupuncture treatment in Oetzi
10.15 - 10.45	**Lectures Session IX: The Iceman's voice**
	Chair: P. Pernter
10.15 - 10.25	Francesco Avanzini, Rolando Füstös: How do mummies and fossils speak
10.25 - 10.35	Rolando Füstös et al.: Anatomy and physiology of the voice organs: what do we think about the Iceman´s voice
10.35 - 10.45	Piero Cosi, Andrea Sandi: How do we reconstruct the Iceman´s voice
10.45 - 11.15	**Coffee break**
11.15 - 12.15	**Round Table: Future of Iceman Research, Conservation and Museology**
	Open Discussion
	Moderation: Albert Zink (EURAC)
	Participants: Angelika Fleckinger (South Tyrolean Museum of Archaeology) Emlyn Koster (North Carolina Museum of Natural Sciences) Catrin Marzoli (Amt für Bodendenkmäler, Provinz Bozen) Annaluisa Pedrotti (University of Trento) Patrizia Pernter (Central Hospital Bolzano) Oliver Peschel (University of Munich) Frank Rühli (University of Zurich)
12.15 - 12.30	**Closing Remarks**

Lectures Session I: Molecular Studies

A1 The 5,300-year-old Helicobacter pylori genome of the Iceman

Frank Maixner[1], Ben Krause-Kyora[2]*, Dmitrij Turaev[3]*, Alexander Herbig[4,5]*, Michael R. Hoopmann[6], Janice L. Hallows[6], Ulrike Kusebauch[6], Eduard Egarter Vigl[7], Peter Malfertheiner[8], Francis Megraud[9], Niall O´Sullivan[1], Giovanna Cipollini[1], Valentina Coia[1], Marco Samadelli[1], Lars Engstrand[10], Bodo Linz[11], Robert L. Moritz[6], Rudolf Grimm[12], Johannes Krause[4,5]#, Almut Nebel[2]#, Yoshan Moodley[13,14]#, Thomas Rattei[3]#, Albert Zink[1]#*

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The stomach bacterium *Helicobacter pylori* is one of the most prevalent human pathogens. It has dispersed globally with its human host, resulting in a distinct phylogeographic pattern that can be used to reconstruct both recent and ancient human migrations. The *H. pylori* strains found in most Europeans today (hpEurope) have pu-

tatively originated from recombination of the two ancestral populations Ancestral Europe 1 and 2 (AE1 and AE2). However, there exist different hypotheses about when and where the hybridization took place, reflecting the complex demographic history of Europeans.

In this study, we screened biopsy samples from the gastrointestinal tract of the Iceman, a 5300-year-old European Copper Age mummy, for the presence of *H. pylori*. By using metagenomic diagnostics and targeted genome capture, we determined the presence of *H. pylori* and reconstructed its complete genome. Comparison with contemporary *H. pylori* sequences and proteomics analysis classified the ancient *H. pylori* as a cytotoxic type strain that triggered already calprotectin release as a result of host inflammatory immune responses.

Comparative analysis of ancient housekeeping gene fragments with a global multilocus sequence typing (MLST) database and comparative whole-genome analyses assigned the 5,300-year-old bacterium to the population hpAsia2 today commonly found in Central and South Asia. The "Iceman" *H. pylori* is a nearly pure representative of the bacterial population of Asian origin (AE1) that existed in Europe before hybridization, suggesting that the African population (AE2) arrived in Europe within the past few thousand years, which is much more recent than previously hypothesized.

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A2 Multi-omics study of the Iceman's stomach content shows main components of a Copper Age meal: fat, wild meat and cereals

Frank Maixner[1], Dmitrij Turaev[2]*, Ben Krause-Kyora[3]*, Amaury Cazenave-Gassiot[4,5]*, Marek Janko[6,7]*, Michael R. Hoopmann[8], Mark Sartain[8], Gea Guerriero[9], Niall O´Sullivan[1], Matthew Teasdale[10], Giovanna Cipollini[1], Alice Paladin[1], Marco Samadelli[1], Umberto Tecchiati[11], Andreas Putzer[12], Mine Palazoglu[13], John Meissen[13], John Baines[14], Bum Jin Kim[15], Hyun-Joo An[15], Eduard Egarter-Vigl[16], Peter Malfertheiner[17], Andreas Keller[18], Robert W. Stark[6,7], Markus Wenk[4,5], David Bishop[19], Dan Bradley[10], Oliver Fiehn[13], Lars Engstrand, Robert L. Moritz[8], Philip Doble[19], Andre Franke[3], Almut Nebel[3], Klaus Oeggl[20], Thomas Rattei[2]#, Rudolf Grimm[21]#, Albert Zink[1]#*

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Human evolution is closely linked to dietary changes and food processing. This is clearly observed with the transition from hunter-gatherer lifestyle to agriculture, which gave rise to cultivation of crops, animal husbandry and permanent settlements. The more stable availability of food boosted ancient population growth. However, changes in diet had drawbacks for health such as increased rates of caries. Added to this, permanent large settlements with adoption of agriculture promoted the spread of density-dependent infectious diseases. This study aims to reconstruct the dietary choices of ancient populations and the consequences these may have had for their health.

The detection of the Iceman´s stomach content provided the unique opportunity to fully reconstruct the main components of a Copper Age meal. Initial macro- and microscopic analysis revealed that the material is extraordinarily well preserved and contains large amounts of fat residues. By using a combined multi-omics approach targeting biomolecules (ancient DNA, proteins, metabolites, and lipids), we obtained a molecular "fingerprint" of the Iceman's diet preceding his death.

This presentation will focus on the results obtained by analyzing the DNA, proteins and metabolites detected in the stomach content, while the results of the lipid analysis are presented by Cazenave-Gassiot and co-workers. The molecular data we present shows the presence of four components in the Iceman´s last meal: ibex and red deer meat supplemented with cereals and traces of bracken. Our multi-omics study provides important insights into the general life and nutritional habits of a Copper Age individual in the Alpine area.

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A3 Whole mtDNA sequencing in Alpine populations and the genetic history of the Neolithic Tyrolean Iceman

Valentina Coia[1], Giovanna Cipollini[1], Paolo Anagnostou[2], Frank Maixner[1], Alberto G Carballa[3], Giovanni Destro Bisol[2], Antonio Salas[3], Albert Zink[1]

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2 University of Rome la Sapienza, Department of Environmental Biology, Italy
3 Universidade de Santiago de Compostela, Unidade de Xenética, Departamento de Anatomía Patolóxica e Ciencias Forenses

The Tyrolean Iceman is an extraordinarily well-preserved natural mummy that lived south of the Alpine ridge ~5,200 years before present (ybp), during the Copper Age. Despite studies that have investigated his genetic profile, the relation of the Iceman´s maternal lineage with present-day mitochondrial variation remains elusive. Studies of the Iceman have shown that his mitochondrial DNA (mtDNA) belongs to a novel lineage of haplogroup K1 (K1f) not found in extant populations. We analyzed the complete mtDNA sequences of 42 haplogroup K bearing individuals from populations of the Eastern Italian Alps - putatively in genetic continuity with the Tyrolean Iceman- and compared his mitogenome with a large dataset of worldwide K1 sequences (> 1070). Our results allow a re-definition of the K1 phylogeny, and indicate that the K1f haplogroup is absent or very rare in present-day populations. We suggest that mtDNA Iceman´s lineage could have disappeared during demographic events starting in Europe from ~5,000 ybp. Finally, we compared our results with published data on mtDNA and Y-chromosome from modern and ancient DNA studies. We propose a scenario that could explain the apparent contrast between the phylogeographic features of maternal and paternal lineages of the Tyrolean Iceman within the context of the demographic dynamics happening in Europe from 8,000 ybp.

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A4 Lipidomics analysis of the Ötzi's last meal

Amaury Cazenave Gassiot[1], Mark Sartain[2], Robert Moritz[2], Rudolf Grimm[3], Markus Wenk[1], Frank Maixner[4], Albert Zink[4]

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Ötzi, the Tyrolean Iceman, was found in the Tyrolean Alps in 1991. One of the oldest natural mummies ever discovered, his body was perfectly preserved for more than 5,300 years in an Alpine glacier. The Iceman is a so-called "wet mummy": humidity was retained in his cells while he was naturally mummi?ed by freeze-drying. The body tissues are therefore still well preserved, making them suitable for modern scienti?c. Previous analyses of the Iceman's tissues have provided information regarding his health condition and the way he died.Recently, new radiological analyses led to the discovery of the Iceman's stomach, which was once thought to have decomposed. New samples were isolated with the aim to shed more light on Ötzi's lifestyle. To this end, a multi-omics approach was chosen to fully characterise these samples.As part of this multi-omics study, we have conducted lipidomics analysis using state-of-the-art mass spectrometry techniques. Lipids were isolated using well-established organic solvent-based extraction and analysed using liquid chromatography and un-biased high-resolution mass spectrometry on a Q-ToF instrument. The analyses revealed a large number of preserved lipid molecular species, mostly triglycerides. Separate analyses by another team identified very similar profiles. MS/MS analyses revealed that fatty acids esterified to these triglycerides are mostly un- or mono-unsaturated.The Iceman's stomach content lipid profiles were then compared to contemporary samples from the Tyrolean region, namely muscle and adipose tissues from *Capra ibex* and *Cervus elaphus*, and milk and cheese from *Capra hircus*. Although, species specific identification is not possible from lipid profiles alone, the distribution of triglycerides and their constituting fatty acids is consistent with the consumption of animal muscle and adipose tissue.

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A5 Ötzi meets Nanotechnology - Skin, wound tissue, and stomach content analysis

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The Iceman, Europe's oldest natural mummified human body, has been extremely well-preserved over the millennia.To retrieve additional insights in the preservation of the mummy tissue, into the circumstances of death as well as in dietary habits of the man, two quasi-non-invasive analysis techniques, atomic force microscopy (AFM) and Raman spectroscopy, were used. With these methods, the submicron structure, chemical composition, and nanomechanical properties of small mummified tissue samples were determined.Both techniques were used to analyse the collagen in the Iceman skin, to detect and analyze red blood cells in wound tissue samples and to examine meat remnants from the Iceman stomach content.While AFM revealed intact collagen fibrils, showing the characteristic banding patterns of about 69 nm, Raman measurements showed no significant modifications within the collagen molecular structure. Thus, the micro- and the ultrastructure of the collagen were found to be largely unaltered.Further studies revealed particles with the typical morphology of red blood cells in Iceman wound tissue. Raman spectra approved molecular similarities in comparison to recent red blood cells. Also bands characteristic for fibrin were identified, which suggest that some red blood cells are remnants of a blood clot.Finally, analysing meat from the Iceman stomach content by AFM and Raman spectroscopy allowed for determining the dietary habits of the man. Changes in muscle tissue structure due to heat can be observed microscopically. However, no morphologic and no molecular changes were found in the meat samples extracted from the Iceman stomach content. These results foster the assumption that the meat the Iceman consumed was either raw or dried.

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A6 Microbial genomes inside the mummy of the Iceman

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The DNA isolated from the mummy of the Tyrolean Iceman is of human, of microbial and (in the intestinal tract) of other origin. Unexpectedly high amount of microbial DNA were even observed in bone and muscle samples. The identity of this DNA, its age and its relation to the life of the Iceman raise many questions. Ancient microbial DNA is likely derived from Iceman's microbiome and from its bacterial infections. Younger and recent DNA is expected from microbes involved in degradation processes and from the environment.To better understand the microbial DNA from the Iceman mummy we have established and applied a computational workflow for the reconstruction and the analysis of microbial genomes from mummy samples. It is based on assembly and multiple-coverage based binning of whole-genome shotgun sequencing reads, estimation of genome completeness and contamination, analysis of DNA degradation patterns and phenotype prediction. This workflow allowed us to investigate the about 60 most abundant microbial genomes from the mummy. Many of these belong to the genera Clostridium and Pseudomonas and are likely to be involved in the microbial degradation.

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A7 Analysis of miRNAs in tissue specimens of the 5,300 year-old Tyrolean Iceman

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Molecular analyses of ancient specimens have gained increasing importance over the past decades. While most research is carried out in the area of DNA analysis we investigated abundance of small non-coding RNAs, so-called miRNAs, in several specimens of the Iceman. To compare the detected miRNAs to modern tissue patterns we first generated a human miRNA tissue atlas (freely available online at https://ccb-web.cs.uni-saarland.de/tissueatlas/). Then we applied RT-qPCR measurement for seven specimens from the Iceman. Our results suggest that different miRNAs are detected in the different specimens, which partially fit to modern miRNAs in the same tissues. The best example are miRNAs in the Iceman and modern muscle tissue, showing a highly significant overlap (9x10-11). Follow-up studies - also including sequence-based information - will potentially improve our knowledge on miRNAs in ancient specimens further.

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Lectures Session II: Archaeology

A8 Der Mann aus dem Eis aus archäologischer Sicht. Status quo der archäologischen Forschungsarbeit.

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Am 19.09.1991 hat das Ehepaar Simon durch Zufall die Mumie am Tisenjoch entdeckt. Nach mehreren Begehungen durch verschiedene Personen wurde vom 3.-5. Oktober 1991 eine erste Nachuntersuchung durch die Universität Innsbruck unter der Leitung von Andreas Lippert durchgeführt. Eine zweite archäologische Nachuntersuchung fand vom 20. Juli bis 25. August 1992 statt, sie oblag dem Amt für Bodendenkmäler in Bozen und wurde von Lorenzo Dal Ri und Hans Nothdurfter sowie Andreas Lippert und Bernardino Bagolini geleitet. Bereits im Juni 1992 hat die Universität Innsbruck ein internationales Symposium zum Thema „Der Mann aus dem Eis“ veranstaltet und im selben Jahr noch den Tagungsband herausgebracht. Darin veröffentlichte Markus Egg erstmals die archäologischen Funde. Nach der Bergung sind die Beifunde in den Restaurierungswerkstätten des Römisch-Germanischen Zentralmuseums in Mainz von Roswitha Goedecker Ciolek restauriert worden. Im Jahr 1995 erschien der Vorbericht von Markus Egg und Konrad Spindler zur Gletschermumie und den Ausrüstungsgegenständen. Letztendlich aus dem Jahr 2009 stammt die große Monographie von Markus Egg und Konrad Spindler zur Kleidung und Ausrüstung der Gletschermumie. Dies sind die Meilensteine der archäologischen Forschung über den Mann aus dem Eis. Dazwischen und danach sind weitere wissenschaftliche Arbeiten erschienen, die sich mit der archäologischen Fundstelle, den Beifunden organischer und nicht organischer Natur befasst haben. Der Vortrag bietet einen Überblick über die archäologische Forschungsgeschichte der letzten 25 Jahre und einen Ausblick auf noch offene Fragestellungen.

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A9 Neuer Hot spot am Tisenjoch? / New hot spot at the Tisenjoch?

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Immer wieder hat man sich die Frage gestellt ob die Fundstelle am Tisenjoch schon erschöpfend ausgegraben ist. Seit der letzten Ausgrabung im Sommer des Jahre 1992 ist die Felsrinne schon mehrmals zur Gänze ausgeapert, ohne dass weitere Funde zu Tage gekommen sind. Wie aber sieht es mit der unmittelbaren Umgebung aus? Auf Luftbildaufnahmen erkennt man mehrere Schneefelder, die unter Umständen potentielle Suchstellen darstellen könnten. Die sog. Snow-patch-Archäologie könnte hier vielleicht zu einem unerwarteten Ergebnis führen.

On and off the question arose whether the find spot on the Tisenjoch has already been completely excavated. Since the last excavation in summer of 1992, the gully has already been entirely free of snow several times, but no further finds have come to light. But what about the immediate vicinity? On aerial photographs several snowfields can be seen, which could be potential sites for new finds. There the so-called snow-patch archeology could perhaps lead to unexpected results.

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A10 Gletscherarchäologie im Schnalstal

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Gletscherarchäologie ist auch oder besonders 25 Jahre nach der Auffindung von Ötzi ein Gebot der Stunde. Aufgrund der Klimaerwärmung und der in Folge abschmelzenden Gletscher und Schneefelder eröffnet sich ein neues Aufgabenfeld für die Archäologie. Optimale Erhaltungsbedingungen für organische Funde erlauben neue und detaillierte Einblicke in die Vorgeschichte.Das Auffinden von Gletscherfunden bleibt aus vielerlei Gründen nach wie vor dem Zufall überlassen. So ist es der Umsicht von Christine und Alois Igelspacher aus Röhrmoos in Oberbayern zu verdanken, dass am Langgrubenjoch, einem Übergang zwischen dem Matschertal und dem Schnalstal etwas südlich des Alpenhauptkammes gelegen, auf über 3.000 m Meereshöhe kupfer-, bronze- und römerzeitliche Funde entdeckt, geborgen und untersucht werden konnten. Besonders hervorzuheben sind Leder- und Fellreste der Kupferzeit sowie Reste eines bronzezeitlichen Gebäudes, darunter mehrere Dachschindeln aus Lärche und ein hölzerner Gürtelhaken. Die starke Frequentierung des Alpenhauptkammes seit der Vorgeschichte dokumentieren des Weiteren Neufunde vom Gurgler Eisjoch (3.134 m) im Pfossental/Schnalstal.Das wissenschaftliche Potential der Gletscher zeigt sich im näheren Umfeld durch den Fund von bronzezeitlichen Überresten von Steinböcken (Knochen, Horn, Fell, Exkremente). Diese kamen auf 3.064 m Höhe zwischen dem Heufler- und dem Trinkerkogel (Pfelders/Obergurgl) zum Vorschein. Die Funde liefern aufschlussreiche Informationen über prähistorische Steinbockpopulationen.

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A11 Tracing human presence connected to Pastoralism at Schnals Valley

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The Schnals Valley is the largest tributary valley of the Vinschgau (South Tyrol/Italy) ranging from 560 m a.s.l at the valley entrance, terminating in an Alpine Ridge, the highest peak of which is Similaun at 3596 m a.s.l. The valley is oriented northwest and follows the typical U-shaped morphology of a valley formed by glacial modelling. 33 % of the valley persist in high alpine pasture and represent the abundant for the historical settlements founded in the 13th century. Animal husbandry, hay making and pastoral activity remained the main economic source of the valley since the 20th century. This particular high alpine landscape of the Schnals Valley attracted humans since more than 10,000 years and evidences the diversity of human activities. In the Mesolithic (c. 9000–6000 cal BC) the availability of faunal species above the tree line is seen as the main attractor for the investigation of high altitudes by humans. The high number of Mesolithic hunting camps suggests subsistence hunting of big game. At the beginning of the Neolithic (c. 6000–3500 cal BC), there seems to have been little interest in the high alpine environment of the Schnals Valley despite the existence of agro-pastoral communities in the main valley of Vinschgau. Following a hiatus, new evidence for human presence is observed at the end of the Neolithic (about 4000 cal BC) and during the Chalcolithic (c. 3500–2200 BC), represented by the Iceman and his equipment. A major impact on the natural landscape is emerges during the Early Bronze Age (c. 2200–1700 cal BC) based on the onset of transhumance system in the study area. Archaeological features show intensification during the entire Bronze Age connected to pastoralism.

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A12 Copper Age in Trentino Alto Adige: New Data, Syntheses and Open Problems

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25 years after the discovery of "The Iceman," the research on Copper Age in the Southern Alps has significantly progressed, especially as regards the reconstruction of the contemporary ideological and spiritual world. New cultic sites (La Vela, Campi Neri di Cles, Varna, Millan) and new statues menhir (Arco, Laion, Vezzano) provide documentary evidence, also at a regional level, for the early rising and the long continuity of the ideology of the warrior-ancestor.Many new radiocarbon datings offer a more comprehensive picture of the chronology of this Age. Its internal articulation into three periods (Copper 1, 2 and 3) can be considered a useful classification tool. If the full Copper Age, dominated by the statues menhir with Remedellian dagger, and Copper 3, characterized by the spread of the Bell-Beaker "phenomenon," are sufficiently charachterized in a cultural sense, Copper 1, which can be identified with the Tamins-Carasso-Isera horizon, still awaits a better definition, especialli in Alto Adige. The scarcity of inhabited sites, especially for the most ancient periods (Copper 1 and 2), leaves many questions open, which constitute the topic of this essay, as regards the typologies and patterns of settlement, the structures of the inhabited area, the subsistence economy and the use of the territory. With the exception of very few settlements, such as, for example, Isera La Torretta, Villandro-Plunacker and Laces-Gasdotto, most of the available documentary research refers to sporadic discoveries, which contribute nonetheless to stress the remarkable mobility, also in altitude, of the Copper Age peoples.

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A13 Neuere Aspekte zur Metallurgie der Beilklinge des Eismannes

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Die Beilklinge der „Gletschermumie aus der Kupferzeit", allgemein „Ötzi" genannt, wurde am 19.September 1991 nahe dem Hauslabjoch in den Ötztaler Alpen gefunden. Für den Metallurgen interessant ist das Kupferbeil mit 0,2% Arsen 0,1% Silber und etwa 0,5% Sauerstoff als Verunreinigungen. Arsen(As) und Silber (Ag) können grobe Hinweise auf die Herkunft geben, wodurch manche Lagerstätten, wie die Inntaler Kupfergebiete oder das Ahrntal in Südtirol, ausgeschlossen werden können. Andererseits gibt es deutliche Hinweise, daß die Bergbauzone zwischen Agordo und Trient als Herkunftsbereich anzunehmen ist.

Die Frage nach der Art der Kupferbasis, ob gediegen Kupfer, oxidische oder sulfidische Erze, wird von metallurgischer Seite diskutiert, wobei eigene praktische Versuche als Grundlage dienen.

Der durch Anschliffe gefundene Sauerstoffgehalt ist für die Beurteilung der Metallurgie beim Guss des Rohkupfers interessant, da dadurch vor allem der Arsengehalt modifiziert wird. Der Sauerstoffgehalt hat auch Einfluß auf die Hämmerbarkeit beim "Dengeln" der Schneide.

Aus der Lage des verhämmerten Gußlunkers kann bewiesen werden, dass der Guss in stehender Form erfolgte. Das Gewicht mit 174 Gramm ergibt auch Fragen zur Art der Erhitzung über die Schmelztemperatur (um 1080 C), wofür Schmelzversuche mit Blasrohren durchgeführt wurden. Durch metallographische Untersuchungen an der Schneide und im Bereich der Randleisten zeigte sich, dass die Klinge mindestens einmal nach dem „Dengeln" bei über 600 C geglüht wurde.

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A14 Lead isotope investigation of Iceman copper axe: provenance of the metal

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Extensive databases of lead isotope measurements have been developed concerning the copper mineral deposits present in the Alpine region (Artioli et al. 2013), in most continental Europe, around the Mediterranean area and part of the Middle East (Pernicka 2014, Ling et al. 2014). Based on the successful provenancing of several prehistoric copper and bronze objects found in Norther Italy through the use of the lead isotope data (Angelini et al. 2015), a small micro-sample of the copper metal has been extracted from the Iceman axe in the attempt to determine the source of the copper metal. The lead isotope data have been measured using stat-of-the-art MC-ICP-MS instrumentation. The analytical results obtained on the copper of the axe will be critically discussed in comparison with the available database of Alpine copper deposits.

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A15 Die Beilklinge des Mannes aus dem Eis – Hinweise auf Produktion, Bearbeitung und Nutzung

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Mit Hilfe eines Stereo-Binokulars wurden zerstörungsfreie oberflächenstrukturelle Untersuchungen der Beilklinge des Mannes aus dem Eis durchgeführt.Spuren der Herstellung und BearbeitungDie Kupfer-Beilklinge des Mannes aus dem Eis weist aufgrund der optimalen Konservierung im Eis kaum Korrosionsspuren auf. Weite Teile der Metalloberfläche befinden sich im ursprünglichen Zustand und lassen daher die von der Herstellungstechnik hinterlassenen Bearbeitungsspuren viel deutlicher erkennen als andere zeitgleiche Kupferobjekte. Vorausgegangene NAA-Gefügeuntersuchungen ergaben, dass es sich bei der Beilklinge um ein Gussstück mit mechanischer Nachbearbeitung des vorderen Klingenbereichs (zur Härtung? Zur Nachschärfung) handelt (Artioli et al. 2003)1.Eine früher von den Autoren durchgeführte überschlägige Oberflächenprüfung zeigte eine Reihe von Bearbeitungsmerkmalen, die einerseits Hinweise auf die Herstellungstechnik, andererseits auch auf die Verwendung der Klinge geben. Neben dem Gusslunker, der nochmals bewertet wird, fanden sich vor allem an den Randleisten spitzwinklige Scherbrüche, die eine durchgeführte Schmiedearbeit belegen und bisher nicht beschrieben wurden.Alte NutzungsspurenDie Nackenpartie und die Schneide weisen Veränderungen auf, die durch die Nutzung des Beiles hervorgerufen worden sind: Druckstellen im Nackenbereich, Scharten an der Klinge.Spuren der Oberflächenveränderungen seit der AuffindungAußerdem werden die seit dem Fundzeitpunkt erfolgten Veränderungen durch die verschiedenen Untersuchungen (Abschaben der Klinge und Verschmieren der Oberfläche mittels Skalpell in Innsbruck, Abraspeln für die RFA-Oberflächenanalyse im RGZM) (Egg / Spindler 2009, 36, 124)3 in ihrem Umfang detailliert nachgewiesen und dokumentiert.

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Lectures Session III: Museology

A16 "World on the Move: the Copper Age" – A One-Day Symposium in Washington DC, November 2017

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"World on the Move: 100,000 Years of Human Migration" is a public education initiative of the American Anthropological Association that emphasizes the essential and enduring role that mobility has played throughout the course of human history. The Association will host a day-long public symposium in Washington DC on 28th November 2017, in conjunction with its annual Research Conference, placing the spotlight on mobility in the Copper Age. Taking its cue from a seminal essay by Stephen Greenblatt identifying "resonance" and "wonder" as two key dimensions of high-impact museum visitor experiences, the symposium will explore mobility during this exciting period of rapid social change and human population movements. Combining bioarchaeological contributions resulting from the Ötzi discovery with the public's fascination with Ötzi as a window on the past, the symposium will compare developments in central Europe with settlement, expansion, and Copper Age intercultural contact in Mesopotamia, the Indus Valley and Pakistan, Jiangzhai and Hongshan cultures of China, North and West Africa, and the Americas. These widespread social processes will be made resonant for the public through expression at the human scale of a single individual, and by discussing these processes, including impacts on human settlement and mobility during fluctuating Ice Age and Holocene climates, through concerns familiar to latter-day visitors. The element of wonder will be emphasized through the breadth of social interactions in prehistory and the complexity of forensic and archaeological reconstructions possible through cutting-edge science. The symposium coincides with the arrival in North America of a traveling museum exhibition about Ötzi and current scholarship on his times, building on the South Tyrol Museum of Archaeology's current exhibition, Heavy Metal. Symposium

participants will also explore the impact of single individual like Ötzi on public perceptions of—and interest in--the past.

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A17 Fascinating Insights into the Human Journey: A New Touring Experience in North America

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Murdered in his 40s, Ötzi's remarkable story from 5,300 years ago is powerfully grasped in the context that most babies born at the dawn of the 20th century still did not live past 50. What began 25 years ago with classic anatomical studies and dating techniques has been transformed with sophisticated, multidisciplinary, research approaches into an exponentially more detailed picture of Ötzi's lived experience, his health, prevailing diseases, and with an abundance of wider insights. These include developments in the exploitation of metals and other natural resources; in rituals and spirituality; clothing and weapons; food and cooking; animal domestication and agriculture; social structure and migration; technology and trade; conflict and diplomacy. Dramatically underscored is the surging progress of the medical sciences to analyze and extend life.

Museums are unique resources for reflection and inspiration that help us to understand the world and our place in it. In the Anthropocene, nature and science museums face new accountabilities, including the engagement of all ages and stages of learning with the human journey. Its chapters have been before, during and since human life diverged from wildlife and with the most recent one comprising prehistoric, historic and modern stages: Ötzi offers an unparalleled time capsule into the prehistoric human journey.

Opened in 1879, today's North Carolina Museum of Natural Sciences is an innovative research, exhibition and education resource. Its mission is 'to illuminate the interdependence of nature and humanity' with a 'what do we know?', 'how do we know?', 'what is happening now?' and 'how can the public participate?' compass. Enhanced by regional and national partnerships, the North American premiere in October 2017 of the new Ötzi-focused exhibition from the South Tyrol Museum of Archaeology and Museums Partner will engage diverse audiences with scientific evidence for cultural developments and medical advances as well as stimulate dialogue across the humanities. This experience will follow linked ones about the human microbiome from the American Museum of Natural History and the science of race conceived

by the American Anthropological Association and from the Science Museum of Minnesota.

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Lectures Session IV: Archeobotany, Isotopes, Dating and Climate

A18 The Archaeobotany of Ötzi, the Iceman, and his possible involvement in pastoral activities

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Twenty-five years of studies on the find assemblage of the Tyrolean Iceman "Ötzi" reveal a great deal of information about the life and environment of this Neolithic man in the Alps. The archaeobotany of his artefacts discloses a skilled person, well adapted to the alpine environment. Sequential analysis of ingesta from different locations of his intestinal tract encompass at least three different meals. He consumed a well-balanced omnivore diet during his last two days. Much more, the background pollen of the ingesta samples enables the reconstruction of his travels just before his demise. These results lend new weight to the disaster theory of Ötzi´s death, which suggests that returning from the high alpine pastures to his native village he came into a severe conflict with his kin that he had to flee from the community back to the high ground familiar to him, where he died. Since the discovery of an arrow head in his left shoulder a strong evidence for a violent death is on hand, but several questions are still unsolved.

Besides the dispute about Ötzi's personal fate, his social status and societal role is an open issue. The suggested possibilities range from hunter, herder, ore prospector, outlaw to shaman and warrior. Anyway, the implication is that his sojourn into the high-altitudes of the Alps seems to be associated with alpine pasture. So here we show in an interdisciplinary study the beginning of pastoral activities in high altitudes in the central part of the Eastern Alps by combining data from pollen analyses, isotopic analyses and archaeological surveys. Both pollen analyses and archaeological surveys are conducted along the traditional alpine transhumance route from the Vinschgau to the backmost Ötz valley. Isotopic analysis (Sr, O) conducted at high-spatial resolution to retrieve (sub)seasonal mobility signals were directly conducted on Copper

aged sheep/goat molars from the Vinschgau site of Latsch. Taken together, these studies reveal that grazing pressure is reflected at the earliest since the Bronze Age, which is corroborated by archaeological findings near the palynologically investigated sites and isotopic analyses. This sheds new light on the fundamental aspects of interpreting Ötzi's social status, which is incompatible with his role as herder.

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A19 Bryophytes and the Tyrolean Iceman

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At present a mere 25 species of Bryophytes (mosses and liverworts) grow around the site of discovery of the Tyrolean Iceman at 3210m above sea-level in the nival zone where the environmental conditions are very severe. In very striking contrast stand a total of 80 species (67 mosses and 13 liverworts). Bryophytes sieved from the icy sediments in the rocky hollow, picked from the mummy's clothes and extracted from the alimentary tract have been identified and counted. In a series of papers published during the last 20 years JHD et al have discussed what might account for this more than three times disparity. Numerical analyses of the results from the 160 samples are being applied to test these hypotheses. They inform us about the most likely ways the high number of lowland species reached the site and have the potential to shed new light on the habitat of the Iceman's former domicile.

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A20 On the heavy metal(loid) exposure of the Alpine Iceman recorded in his nail, hair and soft tissue

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The Iceman's involvement in early copper metallurgy remains controversial (Brothwell and Grime, 2003; Gössler et al., 1994; Pabst and Hofer, 1998; van Loon, 1998). Given the mummy's organic tissue preservation, nail, hair and other soft tissue samples provide excellent opportunities to help resolve this question. What is more, time-series information of heavy metal(loid) concentrations can be retrieved from continuously forming samples such as hair and nail using high-spatial resolution laser-ablation mass spectrometry (LA-ICPMS (Müller et al., 2009)). LA-ICPMS furthermore allows evaluating post-mortem ('diagenetic') alteration of in-vivo signals via depth-profiling and has the added benefit of minimal sample consumption / destruction.

The results obtained so far indicate that the Iceman's hair and nail samples are characterized by elevated concentrations of alteration-indicator elements such as Al, Ce, U, Y, all of which are found in much lower concentrations in modern keratin samples. These elements correlate with elevated Cu, Zn, Pb concentrations, while those of Sn, Cd and other heavy metals overall are (very) low. There are clear depth-dependent concentration profiles present especially in the Iceman's nail, suggesting that inside and outside surfaces show highest levels of alteration, and true in-vivo levels may only be approximated but possibly not fully preserved anymore in all cases. This is in line with the alteration of the Iceman at the discovery site reported earlier (Bereuter et al., 1997; Oeggl, 2003).

Arsenic (As) in the Iceman's samples is noteworthy as it shows slightly elevated levels compared to modern samples. Moreover, As does not correlate well with above-mentioned alteration-indicator elements. In order to further evaluate the origin of As, we are currently conducting As speciation analysis (Raab and Feldmann 2005). Via a comparison with local water data in South Tyrol as well as sediments and ice at the discovery site we intend to evaluate whether this constitutes an in-vivo or post-mortem signal. If the former, then the issue of accidental or deliberate (Przygoda

et al., 2001) arsenic ingestion might help explain the initial findings. In any case, earlier claims for the Iceman's involvement in smelting activities have to be considered with caution. Corresponding results will be presented.

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A21 Radiocarbon measurements around the Iceman

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In 1991, 14C measurements of tissue and bone samples from the Iceman were performed in Oxford and Zuerich. They revealed that the Iceman had died between 3370 and 3100 BC (95.4 % probability range). The validity of the 14C calibration curve between 3500 and 3000 BC was later checked in Vienna with 14C measurements of absolutely dated tree-rings from a high-altitude stone-pine dendrochronology (Dellinger et al. 2004). Only small deviations from the global 14C calibration curve were found (17 ± 5 yr). During an extensive archaeological excavation in 1992, a large variety of materials were recovered at the discovery site of the Iceman, and a selected subset was 14C dated (Kutschera et al. 2014). While pieces of equipment associated with the Iceman confirmed the dates of the body, a number of botanical and animal specimens spread far outside the Iceman period. These results initiated a wider campaign of 14C dating of high-altitude sites throughout the Ötztal, where evidence for human presence was found (Kutschera et al. 2014). The Iceman lived some 5300 years ago, in the middle of the Holocene. Detailed studies of tree-line and glacier movements in the European Alps using dendrochronology, 14C dating and other cosmogenic radioisotopes (e.g. 10Be) revealed considerable variations during the last 10,000 years. Besides presenting the 14C results of the Iceman, the glacial variations and their implications on the climate in the Holocene will also be discussed.

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A22 Climate and environmental changes in South Tyrol from the Ortles ice core since the time of the Iceman

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In 2011 four ice cores were extracted from the summit of Alto dell'Ortles (3859 m), the highest glacier of South Tyrol in the Italian Alps. This drilling site is located only 37 km southwest from where the ~5.2 kyrs old Tyrolean Iceman was discovered emerging from the ablating ice field of Tisenjoch (3210 m, near the Italian-Austrian border) in 1991. The excellent preservation of this mummy suggested that the Tyrolean Iceman was continuously embedded in coeval prehistoric ice and that additional ancient ice was likely preserved elsewhere in South Tyrol. Dating of the ice cores from Alto dell'Ortles based on 210Pb, 3H, beta activity and 14C determinations, combined with an empirical model (COPRA), provides evidence of a chronologically ordered ice stratigraphy from the modern glacier surface down to the bottom ice layers with an age of ~7 kyrs which confirms the hypothesis. Our results indicate that the drilling site was continuously glaciated on frozen bedrock since ~7 kyrs BP. Absence of older ice on the highest glacier of South Tyrol is consistent with removal of basal ice from bedrock during the Northern Hemisphere Climatic Optimum (NHCO; 6-9 kyrs BP), the warmest interval in the European Alps during the Holocene. At the end of the NHCO temperatures started to decrease allowing the accumulation of cold ice on frozen bedrock. A short increase in precipitation at ~7 kyrs BP could also have contributed higher accumulation and ice thickening on Alto dell'Ortles. Although high precipitation did not persist during the mid-Holocene, progressively more favourable glacial conditions characterized the Eastern Alps at the end of the NHCO and glaciers extended in general to lower elevations, including the Tisenjoch (3210 m) where the Tyrolean Iceman was buried in snow and ice since 5.2 kyrs BP.

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Lectures Session V: Radiology and Cause of Death

A23 Der Mann aus dem Eis: ein radiologisches Resümee 25 Jahre nach Auffindung der Mumie / The Iceman: a radiological summary 25 years after his discovery

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The summary of radiological recognizable anomalies, degenerative alterations of the skeleton and signs of pathologies on CXR and CT examinations.

Zusammenfassung der radiologisch erkennbaren Anomalien, degenerativen Veränderungen am Skelettsystem, Hinweis auf Erkrankungen anhand der Röntgenbilder und CT-Untersuchungen

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A24 Latrogene Veränderungen am Mann aus dem Eis / Latrogenic modifications on the Iceman

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On the basis of CXR and CT images analysis acquiered over the last 25 years we tried to identify iatrogenic and non iatrogenic alterations of the mummy, to order them chronologically and to subdivide them into: 1) damages during the recovery of the corpse; 2) decompositive alterations during mummification; 3) damages secondary to bioptic samples for research reasons

Anhand der Analyse der Röntgenbilder und CT-Bilder der vergangenen 25 Jahre haben wir versucht, die iatrogenen und nicht iatrogenen Veränderungen an der Mumie, chronologisch einzuordnen und sie in Zusammenhang zu bringen mit:- Verletzungen bei der Bergung der Mumie- umweltbedingten Zerfallserscheinungen- wissenschaftlich motivierten Gewebsprobenentnahmen mit Zuordung eventuell erbrachter Forschungsergebnisse

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A25 Neue Erkenntnisse über den Gesundheitszustand des Mannes aus dem Eis / New radiological insights into the Iceman´s state of health

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Im Jahre 2013 wurde die letzte CT-Kontrolle der Mumie „Ötzi“ im Krankenhaus Bozen durchgeführt. Dazu stand ein Gerät einer neuen Generation (dual-energy computet tomography) zur Verfügung. Bei der Durchsicht des Bildmaterials ergaben sich neue Erkenntnisse über den Gesundheitszustand des Mannes aus dem Eis. In diesem Kurzreferat wird darüber berichtet.

The last CT-tests on the mummy of "Ötzi" took place at Bolzano hospital in 2013 using the latest dual-energy-computed tomography. The immages revealed new information about the Iceman´s state of health and this will be explained in this short lecture.

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A26 Checklist and Scoring System for the Assessment of Soft Tissue Preservation in CT Examinations of Human Mummies: Application to Ötzi

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Structured reporting is emerging in clinical radiology. To transfer structured reporting also into the field of paleoradiology we recently developed a checklist and scoring system for the assessment of soft tissue preservation in CT examinations of human mummies (Panzer S, Mc Coy MR, Hitzl W, Piombino-Mascali D, Jankauskas R, Zink AR, Augat P. Checklist and Scoring System for the Assessment of Soft Tissue Preservation in CT Examinations of Human Mummies. PLoS One. 2015; 10(8):e0133364).

The aim of this presentation is to introduce the checklist by applying it to Ötzi.

The checklist contains 97 checkpoints and was divided into two main categories, "A. Soft Tissues of Head and Musculoskeletal System" and "B. Organs and Organ Systems", each including various subcategories.

Basing on this checklist Ötzi revealed a very high soft tissue preservation status. Most of the checkpoints from subcategory A were present and more than half of the checkpoints from subcategory B. Compared to other mummies and mummy collections, Ötzi consistently revealed the highest total preservation scores.

In conclusion, the developed checklist allows for a standardized assessment and documentation of soft tissue preservation in whole-body CT examinations of human mummies. The scoring system facilitates a quantitative comparison of the soft tissue preservation status between single mummies or mummy collections. Basing on this method Ötzi revealed an extremely high soft tissue preservation status.

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A27 Ötzi segmented

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CT-scanning is one of the most used non-invasive procedures to study mummies. The benefits are obvious as the radiological technique allows for a millimeter by millimeter, in side-out visualization of internal structures. This results in a high degree of documentation, and it allows a thorough study of anatomical structures, macroscopic organ pathology and lesions.

Ötzi has been CT-scanned several times, not least resulting in the observation of an arrow-head lodged in his right shoulder region. However, a full tissue-based segmentation has not been performed.

Using state-of-the-art software, we have initiated a full segmentation of the tissues and organs of Ötzi. This will allow 3D views of the singe tissues and organs, including a closer study of the arrow trajectory and the lesions suffered by Ötzi. The segmentation will allow for a better visualization of organs such as the brain, lung and heart and major vessels.

The 3D models resulted from segmentation process will be also 3D printed such as to have a real view of internal structures that otherwise would not be accessible. We will create actual copy of the arrow-head, the skull, the brain and other relevant structures.

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A28 Re-evaluation of the cause of death of the Neolithic Iceman, c. 5300 BP

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The cause of death of the Neolithic Iceman, c. 5300 BP, has been controversially debated during the past 25 years. The most recent established theory has been proposed by Murphy et al. (2003) and more detailed by Pernter et al. (2007) showing the radiologic proof of a laceration of the left subclavian artery by an arrowshot, and subsequent internal bleeding to death. Additionally proposed - potentially lethal - lesions include a.o. of the neuro- and viscerocranium as well as brain contusion

The aim of this presentation is to review these proposed injuries of the Iceman with a particular forensic perspective.

All available imaging data (X-ray, CT) of the Iceman are analysed with a historic and modern forensic perspective. This includes re-evaluation of the type, localisation and pathophysiological impact of the major lesions; including a.o. the extent of bleeding, possible pain-related handicaps, possible infections, estimated time of survival and overall mortality outcome.

Additionally, based on these data, further diagnostic non-invasive and invasive evaluation procedures to be done on this unique mummy are proposed. This project is part of a larger case study co-lead by forensic profiling specialists.

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A29 Behavioural analysis of the iceman murder case

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Behavioural Investigative Advice (BIA) is a criminalistic tool, which enables the investigators in major crime cases (homicide, rape, arson) to gain a deeper understanding of the crime. It is based mostly on objective information and supports the leading investigator by offering investigative suggestions based on the behaviour the offender displayed in committing the crime. Especially the assessment of the motive of the crime and the profile of the unknown offender are often of importance.

A multidisciplinary team used methods of BIA to reconstruct the events at the crime scene, to further understand the circumstances of the murder and to assess the motive of the homicide, the iceman fell victim to.

This analysis is based on the information gathered from the crime scene where the body was found, the objects that were found in the vicinity and the data from the (forensic) medical examinations as well as the now existing information about the victimology known about the iceman.

The main findings of the behavioural analysis of the iceman murder case will be presented.

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Lectures Session VI: Clothing and Tools & Miscellaneous

A30 The Iceman lithic toolkit: raw material, technology, typology and use

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The Iceman's artefact assemblage is a rather unique case in the archaeological research. Considering that it represents the personal tool set used by a specific person for daily activities during the last period of his life, the single tools and the complex as a whole are a mean to investigate the story of the owner, Ötzi - his activities and habits, his technical know-how, the territorial and environmental context he was living in – in order to reconstruct aspects of his individual history and to gain knowledge about his cultural and social background.In this light new analyses are being conducted on the elements of Ötzi's equipment which are made from chert or are related to chert working: the retoucher, the dagger blade, the two arrowheads and the three lithic instruments contained in his belt-bag. The different steps of the tool-life, from production to the last phase of modification and use (chaîne opératoire), are investigated in the frame of an interdisciplinary research project headed by the South Tyrol Museum of Archaeology. Analysis of the lithic raw material based firstly on the identification of the geological formations are carried out to identify the chert provenance areas. The methods and techniques used to knap the chert, from the detachment of the blanks to the repeated resharpening of the tools, are investigated through a technological study which allows furthermore to evaluate the knapper's level of technical skill. A use-wear study, carried out with a 3D video-microscope and followed

by a dedicated experimental program, aims at understanding the different functions of the lithic implements. Finally, typological comparisons are going to verify the presence of comparable tool types in the contemporaneous contexts of the Alpine area.

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A31 For a Cultual Geography of "The Iceman": Raw Materials, Places of Worship and Ideology of the Warrior Ancestor between Alto Adige and the Lessini Mountains

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The reserach on Ötzi developed in the last 25 years aims at situating its individual event within a wider historical and cultural context, capable also of defining its identity; however, the fragmentary nature of the available archaeological documentation for the Copper Age in the Southern Alps makes its cultural classification problematic.The analysis of the raw materials (flint, copper) and of the artifact typologies found at the Giogo di Tisa underline the existence of a wide network of relations, first of all in the Souther Alps, which also influence the partaking of this area in the early elaboration of a common ideology of the statues menhir and the warrior ancestor.This essay analyzes, for a comparison, two control areas (the Eisack Valley and the Lessini Mountains) which were associated, between the second half of the Fourth Millenium and the End of the Third Millenium, through cultic evidence and relations in the trade of raw materials, firstly flint.In particular, the cultic site of Varna near Bressanone and Arano in the Illasi Valley (Verona) allow to graps the first rising and the development of site centered on the offer of weapons (arrow heads, daggers), human remains and burned animals (Varna), and characterized by structured areas (Varna, Arano) which, in the case of Arano, take a triangular form typical of contemporary copper dagger (Copper 2). In these and other similar cultic sites, the male component in the offerings and in the spirituality underpinning it appears as evident.Therefore, between the Alto Adige and the Lessini Mountains, the circulation of flint and the distribution of common handicrafts (scaly 'a squame' pottery, Remedello-style pottery forms, copper artifacts such as axes and halberd) take place in the context of a more complex and very long-term process of cultural sharing, which affects also the spheres of mindset, ideology and spirituality.

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A32 A whole mitochondria analysis of the Tyrolean Iceman's leather provides insights into the animal sources of copper age clothing

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The attire of the Tyrolean Iceman, a 5,300-year-old natural mummy from the Ötzal Italian Alps, provides a surviving example of ancient manufacturing technologies. Research into his garments has however, been limited by ambiguity surrounding their source species. This presentation will show a targeted enrichment and sequencing of full mitochondrial genomes sampled from his clothes and quiver, which elucidates the species of production for nine fragments. Results indicate that the majority of the samples originate from domestic ungulate species (cattle, sheep and goat), whose recovered haplogroups are now at high frequency in today's domestic populations. Intriguingly, the hat and quiver samples were produced from wild species, brown bear and roe deer respectively. Combined, these results suggest that Copper Age populations made considered choices of clothing material from both the wild and domestic populations available to them. Moreover, these results show the potential for the recovery of complete mitochondrial genomes from degraded prehistoric artefacts using next generation sequencing of DNA markers of interest that have been captured in-solution.

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A33 The archaeochemistry of the artefacts and associated remains of Ötzi the Iceman

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Over the past 25 years there has been a tremendous amounts of research on Ötzi and his associated remains. However there has been very little on the analysis of his artefacts from the perspective of usewear and residue. Although there are many descriptions of the various associated remains with the iceman there are only a small number of researchers that have analysed these remains focusing on residue analysis. These previous reports include the unpublished work of Loy and a few others focusing on the hafting material (Sauter et al. 2000), bow (Baugh et al. 2006), arrows (Brizzi and Brizzi 2012), axe (Loy 1998) and knife (Loy 1998). Here we have analysed the chemical traces in the residues of Ötzi's artefacts using chemical methods and combined this data using the traditional approaches of residue analysis. This has allowed us to expand our interpretations beyond that of Loy's to provide a better understanding of the tools and associated remains and how they have been used. This all supports the utilitarian use of these artefacts and the association between tools and artefacts within Ötzi's possession.

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A34 Were Ötzi's bow stave and arrow shafts planned to be effective for hunting and warfare?

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Since the discovery of Ötzi, there have been many questions and hypotheses about the quality and effectiveness of his unfinished bow stave and arrows, especially about their intended functions. Was he planning to make them for hunting or warfare and if so, how effective could they have been if completed? The goal of this presentation is to provide empirical data to test these hypotheses. The author has made seven bows and 24 arrow replicas (at lengths of 72, 84, and 86cm) to use in this experiment. These bows, 182.5cm long, have been replicated to be 25-28kg draw weight (at 72cm) and the arrow spines were crafted to match the bow draw weight. Results from 3,000 shooting rounds to measure the accuracy and kinetic force of each of the arrows with these seven bows will be presented to determine if these tools were efficient enough for hunting or warfare. As an ethnobotanist, hunter and bow maker specializing on the hunting technology of indigenous peoples in North and South America (Barí of Venezuela, Matsigenkas of Peru and Mashantucket Pequot of the United States), the author has a unique perspective to understand Ötzi's equipment from a multitude of perspectives. This is an experimental archaeological research project to empirically prove the efficiency of Ötzi's hunting equipment.

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A35 Ötzi, Primus inter pares- The Iceman seen from the field of glacial archaeology

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There will never be another Iceman. His was a unique discovery that stands alone in many ways; the circumstances of his recovery, his iconic role in the media and popular culture and not least, the ever-growing bank of knowledge of the past gleaned through years of careful study of his remains.However as global climates warm and alpine ice shrinks around the globe, the same miraculous tableaux, where precious remains of the past emerge from melting ice, is playing itself out time and again in several regions around the world. So frequent is this occurrence now, that a sub-discipline called glacial archaeology has recently emerged. This is an active and dynamic international field, with a range projects, conferences and publications currently ongoing.This presentation offers a retrospective from a glacial archaeological perspective that traces relevant threads and developments from the discovery of the Iceman up until the present. What can we learn by looking back at late 1992 and the time around the discovery of The Iceman, given what we now know about frozen cultural remains in alpine areas and the effect that modern climate change is currently having on glacial archaeological sites?

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A36 Death in the Ice: Re-investigations of the Remains from the Theodul Glacier (Switzerland)

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Scattered human and animal bones, weapons, knives, jewellery, coins, leather fragments and fabrics were found at the Upper Theodul glacier (Switzerland) between 1984 and the early 1990s. The finds are assumed to represent a single fatal event. Until recently, the remains were interpreted as those of a mercenary. All objects and fabrics were restored and investigated by experts using macroscopic, microscopic and typological methods. The animal bones were sorted, identified and attributed to species. The human remains were investigated using standard osteological methods, computed tomography, and stable isotope analysis. The bones belong to an adult male individual who was wearing woollen and silk clothes and leather shoes. He was equipped with a rapier, a dagger and a wheel-lock pistol that were probably manufactured in Germany. Due to their type, it is unlikely that the weapons were used as military arms. The coins were mainly minted in Northern Italy and date the fatal event on the Theodul glacier to around 1600 AD. The associated finds, in particular the weapons, contest the former interpretation as a mercenary and suggest an identification as a traveller or tradesman.

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A37 Two Remarkable Peruvian Skulls from the Collection of the Roemer- und Pelizaeus-Museum Hildesheim

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The Roemer- und Pelizaeus-Museum Hildesheim is home to a remarkable collection of mummified remains from different cultures. These human and animal remains are currently under intensive investigation in the framework of the newly established Hildesheim Mummy Research Project, a cooperation with the St. Bernward Hospital Hildesheim, the University of Göttingen and the Reiss-Engelhorn-Museums Mannheim. The collection also contains a number of Peruvian mummy heads. The soft tissue of two of them is remarkably well preserved. One of the skulls has been artificially elongated with the hair still fixed to the scalp. The other one has a trepanation,which had been carried out ante mortem and through the aperture preserved soft tissue inside the cranial cavity is still recognizable. The CT investigation scheduled for July 2016 will result in new and more detailed information regarding the degree of soft tissue preservation inside the cranial cavity. The contribution will present these new results and will also give a general overview of the Hildesheim Research Project, its origins and future prospects.

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Session VII: Short Poster Presentations

P1 Pick the right pocket. Sub-sampling of bone sections to investigate diagenesis and DNA preservation.

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Many archaeological bones display a heterogeneous degradation pattern. Highlydegraded bones could contain pockets of well-preserved bone, harbouring goodquality DNA. This dichotomy may explain why the relationships between global bonepreservation parameters such as histological integrity, bone mineral crystallinity orcollagen yield, and bulk DNA preservation / amplification success rate, have beenfound to be at best, weak to moderate. In this pilot study, we explore whether or nota more localized approach will highlight a stronger relationship between diageneticparameters and DNA preservation. This study includes a detailed histologicalcharacterization of bone diagenesis in sub-areas of three bone samples. Regions ofthe same bone, which displayed differential degrees of preservation or type ofdiagenesis were sampled for further analysis and both genetic (small scale IlluminaMiSeq sequencing) and chemical (FTIR) analyses were performed. The aim was toinvestigate how bone diagenetic processes relate to DNA preservation at a higherresolution than in previous studies. This is key in order to improve DNA analyticalsuccess rates. The expected relationship between bone and DNA preservation(retrieved endogenous DNA) was observed and the results corroborate previouswork that DNA preservation is linked to the integrity of bone collagen and mineral.The results further suggest that non-biological diagenetic alterations such as etchingand the presence of mineral infiltrations and inclusions have a negative effect onDNA preservation/extraction.

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P2 Hunting and herding: Animal exploitation in Isera la Torretta (Rovereto, TN, Italy) during the late Neolithic period and early Copper Age. Preliminary results of the zooarchaeological analysis

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This paper presents the preliminary results of the zooarchaeological analysis of the animal bones from Isera la Torretta (Rovereto, TN). During the excavations carried out between 1990 and 1991, an important stratigraphic sequence emerged: its study, together with the typological analysis of the material culture found, allowed the identification of five phases of human occupation, dated between the second half of the fifth and the first half of the third millennium BC. In particular, the last phase of Isera (Isera 5; 3.300-2.900 / 2.600 BC) coincides with the cultural horizon of Ötzi. The bone sample is currently the focus of the doctoral thesis of one of the author's (VD). On the basis of what has been achieved so far by the zooarchaeological study we try to set out an overview of animal exploitation models and their evolution over time, with particular attention given to the last phase of occupation of Isera. So far, over 29.000 animal bones have been analysed. The most represented animals are cattle and red deer. Furthermore, all domestic animals with economic value are recorded. The sex and age ratios of domestic animals show that they were mostly bred for their meat, although some evidence attests to the exploitation of secondary products. The red deer is the most documented species among the wild animals found. The red deer was hunted not only for its meat, but also for its antlers. The wild species documented at Isera reflect an environment characterized by deciduous forests and wetlands, favoured by the proximity of the River Adige. It is therefore possible to assume that the human community of Isera based its economy mainly on farming and hunting. Apparently, the agricultural structure was not yet fully developed and other economic activities such as hunting and gathering were still important economic factors.

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P3 Secular change of femoral morphology from a clinical perspective: How would a modern anatomically pre-contoured fracture fixation implant fit the Neolithic Iceman in comparison to medieval and modern femora?

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Current treatment for internal fixation of bone fractures requires metal implants (plates and intramedullary nails) which are optimally contoured to fit the specific shape of patient's bones. As bone morphology is influenced by factors such as nutrition and activity level, there is high clinical interest on acquiring data for the design of such implants from specific populations. However, little is known how secular changes impact on implant design.

Therefore, utilising the Iceman, and femora from the Dalheim Collection (NW Germany, dated ca. 1300AD) as example, this study aims to investigate and quantify to what extent femoral morphology might have changed over the last 5200 years in relation to implant design.

Virtual 3D models reconstructed from computed tomography data of the Iceman, from 20 femora of the Dalheim Collection and from 31 modern Caucasian (Switzerland, North America) are utilised. The 3D models of a recent proximal femoral nail design were virtually implanted into the intact bone models. Anatomical nail fit was determined from the total surface area of nail protrusion from the inner cortex surface and maximum distance of nail protrusion. The position of the distal nail tip within the medullary cavity was also quantified.

There was a considerably larger anatomical misfit (2978mm2, 3.5mm) of the nail for the Iceman compared to the medieval (n=20) bones (mean: 914mm2, 2.0mm), whereas a better fit was obtained for the modern (n=31) femora (mean: 583mm2, 1.3mm). Surprisingly, the distal nail tip was centred in the canal of the Iceman's femur, whereas the clear majority (75%) was located anterior for the medieval bones, versus a marginal majority (55%) in the modern sample, respectively.

This, together with anatomical measurements of the specimens, suggests that secular change over the last 5200 years might have had a considerable impact on femoral morphology in relation to implant design.

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Lectures Session VIII: Conservation and Tattoos

A38 25 years of conservation of the Iceman. Development of analytical methods and technological devices

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Starting from the definition and motivation of the standard physical parameters for the correct Iceman conservation, this work goes on to explain the history that has led to the actual Iceman conservation system configuration.This work aims to evidence the elevated degree of precision and reliability provided by this system and to highlight the technologically advanced content within the system.Past, present and future of technological and scientific research develop the continuous compromise between the necessity to preserve the historic value and to present it to the public. This new technology is the attempt to valorize the pioneering challenge to preserve a unique mummy while at the same time bringing greater importance from the scientific and media point of view.

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A39 Characterization of the cultivable microbial flora on the Mummy Oetzi

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The study aims to identify the presence of cultivable microorganisms, adapted to the cold environment on the tissues of the Iceman. The research is based on the evaluation of microbial growth in superficial and deep samples obtained by collecting defrost liquids and by the use of swabs and sponges to collect internal and external samples.The characterization of the microbial flora that colonized the frozen body over the years forms the basis for the right intervention measures to prevent microbial deterioration.The microbiological samples were taken during the thawing of the Mummy OETZI, the November 8, 2010 at the Archaeological Museum in Bolzano.The research methodology is based on the classical microbiological techniques. The primary samples collected where streaked on the surface of agar plates to facilitate the formation of visible colonies, and in parallel added to non-selective broth culture medium to improve the recovery of stressed microorganisms more difficult to grow. Culture media were chosen to allow the growth of most of the cultivable microorganisms (bacteria and fungi).Among the colonies grown on the plates, 40 colonies phenotypically different where chosen and picked for strain-identification, using sequencing of 16S region according to standard procedures and obtaining identification to genus level.Of the 43 samples analysed, 30 showed some microbial growth; 10 of them showed significant counts of colonies after direct plating, whereas the other 20 samples led to growth of single colonies (1-3) or just to positive broth culture.The predominant flora belongs to the genera Ralstonia and Arthrobacter end makes up more than 90% of the total colonies grown. These are strictly aerobic bacteria, typically oligotroph and usually found as a characteristic soil component.The attempt to isolate anaerobic strains, such as e.g. strains belonging to the genus Clostridium, did not give any results.

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A40 Complete mapping of the tattoos of the 5300 year old Tyrolean Iceman

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This study documents for the first time the complete mapping of one of the world's most ancient tattoos present on a mummified human body dating back to over 5300 years ago, belonging to the so-called Iceman mummy. For this purpose, we utilised innovative non-invasive multispectral photographic imaging techniques capable of “seeing” in a range from IR to UV. An especially developed innovative system (HMI), based on modified camera and advanced calibration algorithms, which allows to measure and process the spectral reflectance sampled on seven bands in the range of UV-VIS-NIR (near infrared) for each pixel of the acquired scene, has led us to identify and certify the presence of 61 tattoos divided into 19 groups in various parts of the body. The presence of the tattoos and their precise positioning on the mummy's body shall prove helpful in the future for the in-depth analysis of their relationship with recent scientifically acquired knowledge, to help determine the real function of tattooing in prehistoric times.

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A41 Newly discovered tattoos support acupuncture treatment in Oetzi.

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When the Tyrolean Iceman was discovered in Southern Tyrolia (Alto Adige) in 1991, medical science got first access to a human body preserved in ice for 5300 years. It soon became evident that several tattoos had been applied to the skin of the prehistoric hunter-gatherer. In 1998 and 1999 we could show, that these tattoos, which were obviously non-decorative due to their shape and location, had medical purpose: A close connection between points used in Chinese acupuncture and the location of the tattoos could be demonstrated. Later the use of different staining substances in decorative and therapeutic tattoos in a Peruvian mummy from the Atacama desert as well as modern anthropological research supported the idea of a medical purpose of these tattoos as well. Here we show, that newly discovered tattoos on the anterior chest of the Iceman fit well into the hypothesis of acupuncture treatment by tattooing. We found that the positions of these new tattoos correspond to Kidney 9 (T13), Liver 5 (T 14) and Liver 14 (T15) of the traditional Chinese acupuncture. Remarkably, all lines of the old as well as the new tattoos, except the two crosses described already in 1999, are parallel to the corresponding Chinese acupuncture channels and not crossing them. Our result demonstrate that acupuncture should be dated earlier than expected, at least to the times when the Iceman lived. It can be concluded further that there either had been an early contact between Asian culture and the culture of the Iceman, or the origins of acupuncture are multifocal. A last possible conclusion would be, that Acupuncture originally was invented in Europe, but after having dissipated to China, was conserved in the Chinese medical books, whereas it was forgotten in Europe.

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Lectures Session IX: The Iceman's Voice

A42 How do mummies and fossils speak

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Do the mummies have a speech? This is the intrigung question we payed when we saw for the first time the Ötzi´s CT& scans. Starting from the imaging of the vocal tract cavities and the abundant research in this field, it is possible to infer the acoustics of the voice from the so called area functions. We recall here the milestones of the research regarding the evolution of human voice and speech and try to shed light into the fascinating field of paleoanthropology. It will be particularly explained the main data of the scientific literature regarding the possible reconstruction of the voice, starting from the anatomical structures of hominins´ and ancestors´ vocal tract Our study represents the first attempt to reconstruct the voice of a mummified Homo sapiens sapiens with the aid of the modern technology applied on human anatomy and physiology. So we try to imagine a new field where vocology meets paleoanthropology in an attempt to found a new science: the paleo-phoniatrics

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A43 Anatomy and physiology of the voice organs: what do we think about the Iceman´s voice

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Starting from the anatomical features of the structures involved in voice production, from the vocal chords to the labial output, it is possible to go back to one´s vocal characteristics with the aid of several methods.

The vocal chords are the source of the vocal sound, but the main contribution to it is given by the selective filtering accomplished by the vocal tract configuration.

This is what we tried to do on the "Iceman" Ötzi. We reviewed the corpus of paleoanthropological literature regarding the cranial bases, the hyoid bone and the cervical spine of various fossils of hominins in order to comprehend the evolution of the vocal tract anatomy and gain important pieces of information for our study.

We based our research on the CT scans of the mummy in order to build a model of synthetic material that allows us to gain with sufficient approximation the vocal tract anatomy. We are going to try a second step with the reconstruction of the plausible characteristics of the soft tissue sorrounding the vocal tract structures. This will allow us to perform the acoustic analysis for the voice reconstruction.

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A44 How do we reconstruct the Iceman´s voice

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How is it possible to gain a voice from a tube? Recalling the anatomy and physiology of the vocal tract structures, the modern technology applied on vocology allows us to try to give an answer to the question.

In the field of voice synthesis it is well known that one can reconstruct the sound of a voice from the study of the so called area functions. By means of area functions calculation applied on the structure of the vocal tract, we can have a representation of a certain vocal sound. It is then possbile to resynthesize the sound on the base of the calculated vocal tract area functions acting as a filter. We have digitized the CT scans of the mummy in order to gain the profile of the vocal cavities. With the aid of the softwares....

We then calculated the area functions and so we tried to extract the formants of a synthetized sound "injected" in the reconstructed vocal tract. Our aim was to demonstrate how the research on voice acoustics can successfully interacting with the intriguing field of paleoanhropology

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