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The Emergence of Glacial Archaeology

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Humans and glaciers

Frozen environments provide exceptional preservation of organic artifacts that are rare in other depositional environments. Although there is regional variation, annual average temperature has increased in the arctic at almost twice the rate as that of the rest of the world over the past few decades (ACIA 2004). Glacial melt in the northern hemisphere over the past few decades contributed about 0.15 to 0.30 mm/yr to the average rate of sea-level rise in the 1990s (ACIA 2005:997). This decline in glacier mass balance corresponds with the dramatic increase in artifact discovery at glaciers throughout the northern hemisphere beginning in the late 1900's (Figure 1).

Until recently glaciers have largely been overlooked as depositional environments likely to contain archaeological or paleontological remains. Most frozen archaeological finds have come from permafrost disturbed and exposed by erosion, construction, and placer mining. Archaeological discoveries from glaciers are markedly different than those from permafrost, because glaciers played a very different role in the lives of ancient people.

From an archaeological perspective, glaciers can be divided into three broad categories: 1) valley glaciers, 2) ice sheets, and 3) ice patches. Although there is overlap between them, these cryogenic environments were used for different purposes by ancient people. Particular alpine ice sheets and valley glaciers were used as ice-covered passes that served as corridors for travel, communication, and trade through mountainous terrain. In subarctic areas some comparatively small and relatively

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static perennial glaciers, known as ice patches, were used primarily for subsistence purposes. These cryogenic features are essentially "resource patches" suitable for a variety of subsistence activities. However, large mammal ecology, contemporary observations, and the recovery of faunal remains and artifacts from these sites indicate that caribou hunting was the most important economic activity at most ice patches.

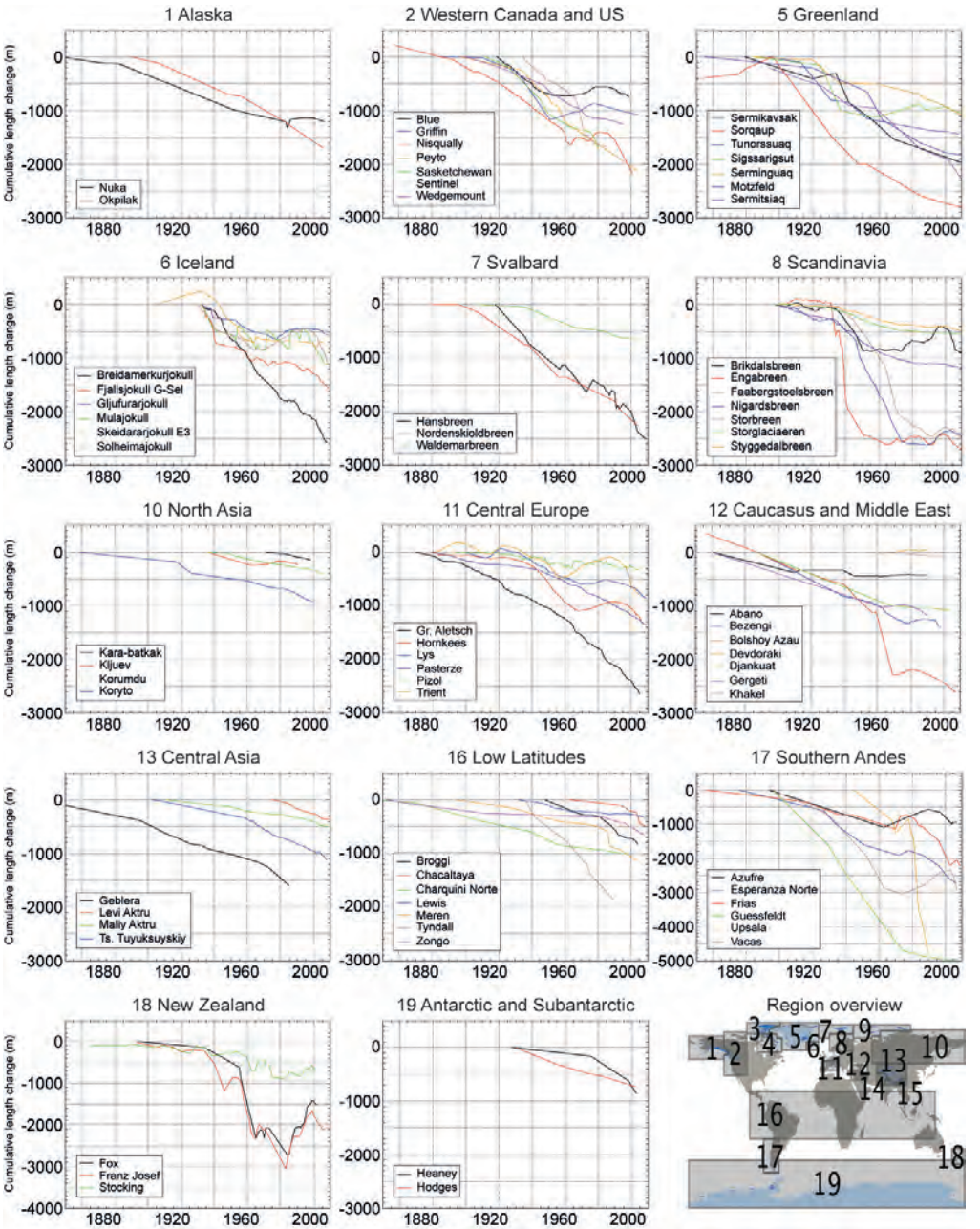

Figure 1 Selection of long-term cumulative glacier length changes as compiled from *in situ* measurements (adapted from IPCC WGI AR5 Figure 4.9, Vaughan *et al.* 2013).

Some mountain ranges define political and cultural boundaries. Glaciers and icefields that have been incorporated in defensive positions along territorial boundaries, and as theaters of war, preserve the remains of national defense, military conflict, and aircraft that have crashed on glaciers (Martinelli 1996-2002, Hafner 2012). In addition, glaciers and ice sheets played a spiritual role in the lives of some indigenous people. Cruikshank (2005) documents indigenous oral traditions from the Northwest Coast of North America that describe glaciers as being endowed with life capable of listening and action. In South America, the frozen cadavers of the "Inca Ice Maiden" and those of three children have been recovered from high altitude (6,000 – 7,000 m) sites in the Andes (Ceruti 2003, 2004; Reinhard 1996, 1999). Perfectly preserved, these remains provide valuable insights about Inca culture and cosmology.

Collectively the practice of archaeology in these types of cryogenic depositional environments is encompassed under the term "glacial archaeology." Glacial archaeology differs from traditional archaeology because exposed objects are generally found on the surface, collected without excavation, and commonly have been displaced from the original point of deposition. This presents new challenges in field collection, data recording, and analyses. Glacial archaeology is pioneering new methods by combining tools used for working on snow and ice with sophisticated instruments to determine the age and location of artifacts.

Archaeological remains melting from glaciers, ice sheets, and ice patches are vulnerable because once thawed and exposed to the atmosphere, the organic artifacts they contain soon decompose. There is immediacy to this research. Climate models suggest that in the next decades many sites will be lost to melting and decay. Consequently, it is imperative to extend the geographic scope of this research now. This will require collaboration of institutions on an international level to facilitate the discovery, research, and monitoring of these sites.

Because of the global distribution of glaciers (Figure 2), glacial archaeology is inherently interdisciplinary, international, and integral to the science of climate change. It provides independent paleontological and archaeological records from high altitude and high latitude environments applicable to a broad array of research and cultural values ranging from testing climate models to cultural heritage education.

In many regions throughout the world, indigenous people occupy high altitude and high latitude environments (Figure 3). Their knowledge and observations provide important sources of information about climate change, which are consistent with complementary information from scientific research (ACIA: 17). The exceptional preservation of organic material culture that characterizes glacial archaeology provides direct links between contemporary indigenous people and the ancient past.

Early research

Artifacts have probably been found on and adjacent to glaciers throughout human history; however, it wasn't until the early 1900's that the association between artifacts and perennially frozen ice became the focus of systematic scientific inquiry. This probably is due in part to the fact that the excellent state of preservation of these frozen specimens led to the assumption that they were not old.

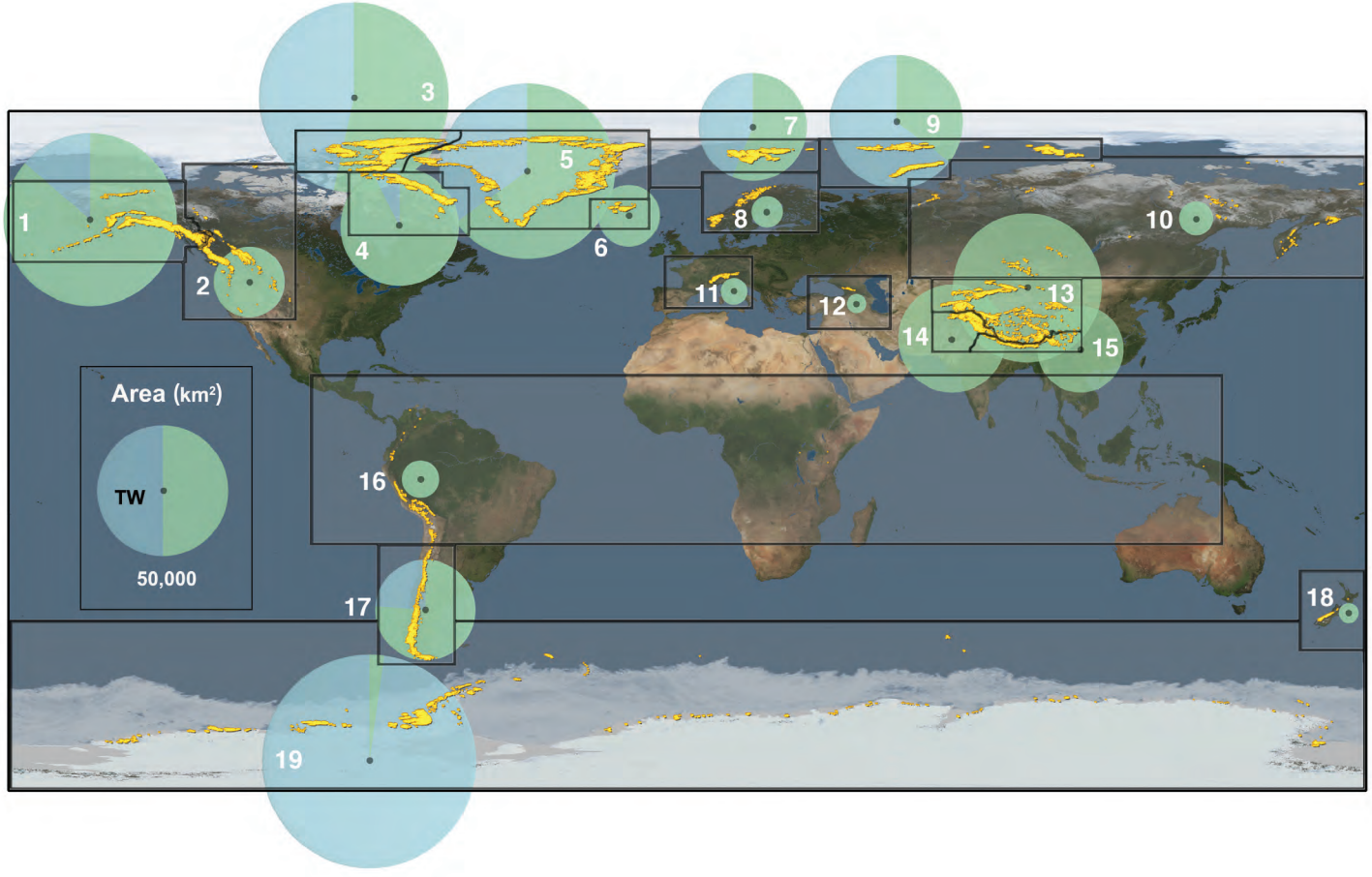

Figure 2 Global distribution of glaciers (yellow) and area covered (diameter of the circle), subdivided into nineteen regions (white numbers). The area percentage covered by tidewater glaciers is depicted in blue within the circles (IPCC 2014:337).

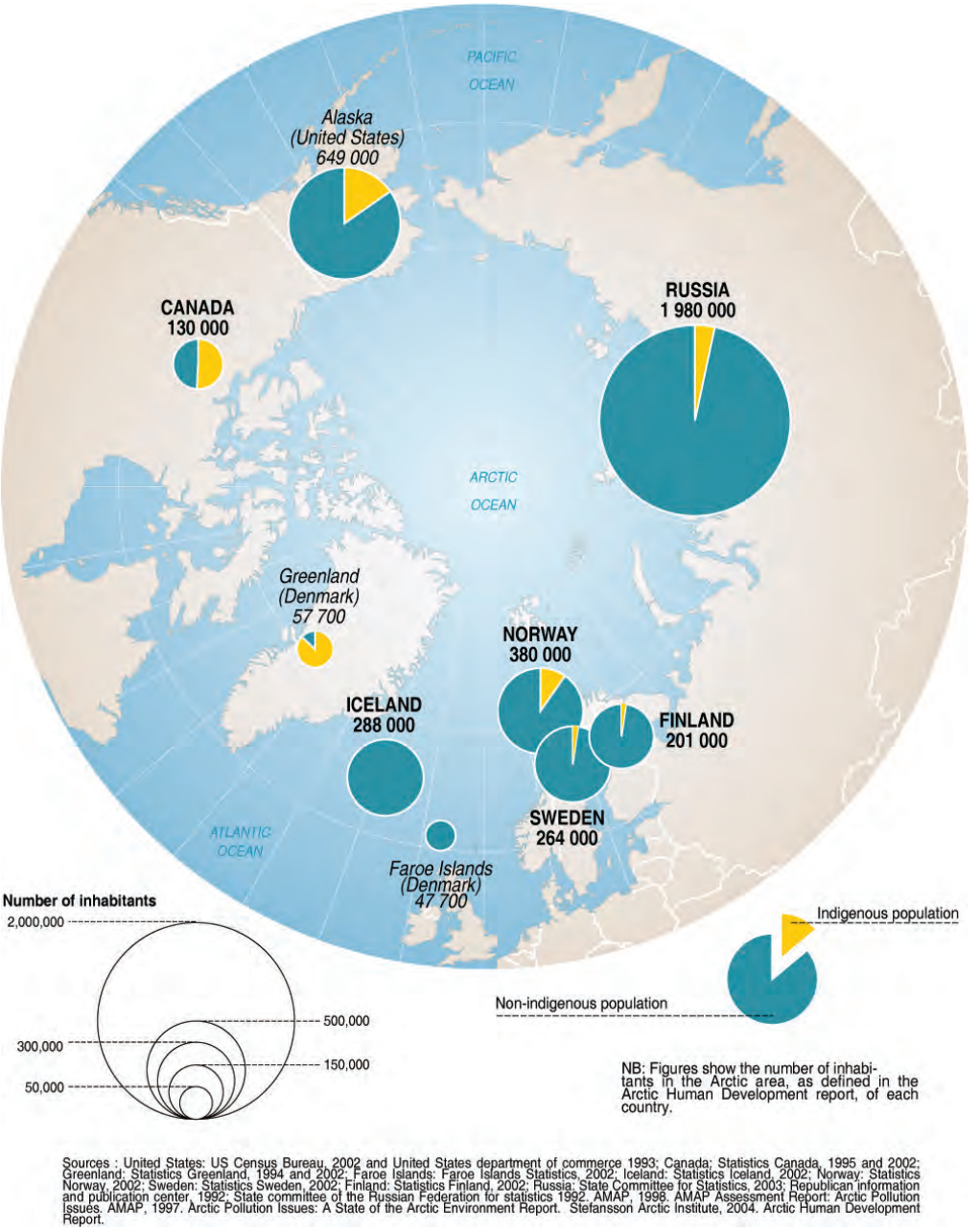

Figure 3 Population distribution in the circumpolar Arctic, by country (including indigenous populations) (Ahlenius 2005).

In the Subarctic the earliest well documented discovery was made in 1914 when a local reindeer hunter discovered an ancient arrow in the Oppdal region of Norway in 1914. The NTNU-University Museum enlisted the enlisted the cooperation of local reindeer hunters and began working with them to record the location of their discoveries and the Museum curated the artifacts melting from these small glaciers.

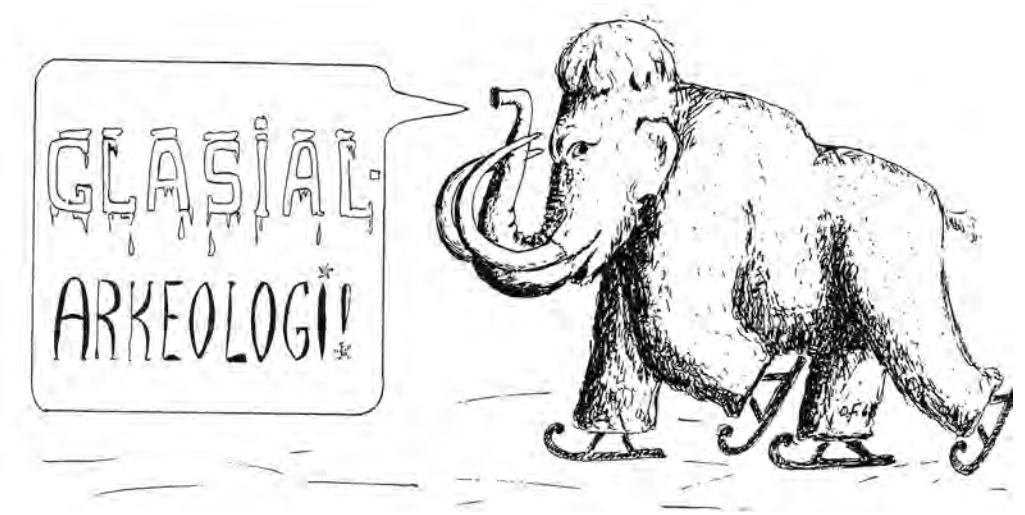

Figure 4 The term glacial archaeology was coined by Oddmunn Farbregd and first appeared in the student newspaper in 1968 (Farbregd 1968, 9).

Petersen (1937) was the first to recognize that the artifacts actually came from within the ice rather than merely being random discoveries of artifacts found near glaciers (Callanan 2010). This was an important observation because it directly linked discovery of archaeological remains to glacial ablation that was the result of changes in weather and climate. These and subsequent discoveries were reported in several Norwegian publications by Farbregd (1972, 1983, 1991) but remained largely unknown outside Norway until the early twenty-first Century.

In the Alps, a variety of archaeological finds from glaciers and ice patches were made in the 1930s and 1940s, but it wasn't until the discovery of Ötzi, the 5,300 - 5,200 BP Late Neolithic "Iceman" recovered from the Tyrolean Alps in 1991, that glacial archaeology captured international attention. Ötzi was carrying a sophisticated array of artifacts when he died including bark containers, clothing, hat, bow, quiver and arrows, fire starting equipment, food and even medicinal plants (Spindler 1994, Bortenschlager and Oeggl 2000).

In 1999 another frozen body was found at the edge of a melting glacier in northwest British Columbia, North America. This individual was named Kwäday Dän Ts'inchi (Long Ago Person Found) by the Champagne and Aishihik First Nations. The 200–250 year old individual was found about 2,000 m above sea level with well-preserved tools, weapons, cape, hat, and even trail food (Beattie *et al.* 2000). These and other spectacular finds have clearly demonstrated the importance of glacial archaeology and its contribution to a broader understanding of past material culture and paleoecology (Dickson *et al.* 2005).

Birth of a subdiscipline

The term glacial archaeology was coined by Oddmunn Farbregd in a short student publication in 1968 (Figure 4). However, the term was not widely known and was

independently reintroduced in the early twenty-first century (Dixon *et al.* 2005).

Although glacial archaeology got an early start in Europe, the significance of these frozen finds emerging from glaciers was not fully recognized in northern North America until the 1990's. The importance of the first ice patch artifacts was recognized by scientists working in Canada's Yukon in 1997 (Kuzyk *et al.* 1999), and a rigorous research program soon followed (Hare *et al.* 2004, 2012). The Yukon discoveries inspired similar research in Canada's Northwest Territories (Andrews *et al.* 2012), Alaska (Vanderhoek *et al.* 2012) and mid-latitude glaciers and ice patches of the western Cordillera of North America (Lee *et al.* 2006, Lee 2012). Natasha and Sergi Sloboden undertook the first glacial archaeological survey in the Russian Far East in 2011 (N. Slobodenia, personal communication, 2011). Although considerable progress has been made, there remain vast regions of Asia, Europe, and North and South America in which little research has been conducted.

Glacial archaeology has been the subject of individual presentations at a number of regional and international meetings. However, it wasn't until 2008, that Martin Grosjean and Albert Hafner organized the first international symposium, *"Ötzi, Schnidi and the Reindeer Hunters,"* that focused specifically on glacial archaeology. The symposium was hosted by the Oeschger Centre for Climate Change Research, University of Bern, Switzerland, featured 18 presenters, and was attended by 130 participants. The birth of glacial archaeology as a sub-discipline occurred at this conference and grew from subsequent dialogue during an associated field trip led to Schnidejoch.

As a result of these interactions several participants expressed interest in developing a follow-up symposium. Martin Callanan led the effort and organized the first "Frozen Pasts" meeeting which was sponsored by NTNU. The symposium was held in Trondheim, Norway and featured 37 presentations and 70 participants. Heidi Sorensen, the Norwegian Minister of Natural Resources, offered the opening remarks. The Trondheim conference was followed by a field trip to the Oppdal Mountains to visit key ice patch sites.

Concurrently Thomas Andrews and Glenn MacKay solicited manuscripts for a volume of the journal *Arctic* dedicated to ice patch archaeology. This significant 2012 publication featured twelve articles focusing primarily on the ice patch research in Canada's Northwest Territories and also incorporated research reports from other regions (Andrews *et al.* 2012).

The third international symposium was held in June 2012, in Whitehorse, Canada and organized by Greg Hare, Ruth Gotthardt, and Kwanlin Dün and Champagne and Aishihik First Nations. The Whitehorse conference carried forward the conference title "Frozen Pasts" from Trondheim and featured 34 presentations, 3 posters, and 90 participants. Unfortunately, poor weather and high altitude fog forced the organizers to cancel field trips to the important Yukon ice patches.

The search for a publisher for the Trondheim papers led to a proposal from Equinox Publishing, Ltd. to establish a journal specifically dedicated to glacial archaeology. The journal builds upon the three proceeding international conferences and further strengthens glacial archaeology as a sub-discipline within the larger framework of world archaeology.

Future prospects

Although survey for new sites continues to be important, increasing emphasis is being placed on more sophisticated research incorporating new technology and advanced theoretical concepts. Aerial photography and reconnaissance, satellite imagery, helicopter survey, and geographic systems modeling have become standard techniques for identifying survey locales in vast and often remote glaciated regions.

Researchers are using microsampling and accelerator mass spectrometry (AMS) ^{14}C dating of individual organic artifacts recovered through glacial archaeology. As a result, there is a growing body of high precision chronological records based on direct dates on artifacts. These high precision records are unique in archaeological science and are raising new questions that challenge traditional archaeological assumptions about artifact associations, site interpretation, and the role of high latitude environments in human adaptations and cultural development. While Scandinavian archaeologists have been documenting glacial finds for more than 100 years, the recent proliferation of new discoveries and research initiatives around the world represents a significant new horizon for archaeologists. Glacial archaeology improves our understanding of the range of human adaptations at the margins of our physical world.

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