7. The Dachstein Caves

7.1. The Dachstein Region - its karst and its caves

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Introduction

Among the karst massifs of the Northern Calcareous Alps, built mainly from Triassic and partially well-karstifiable carbonate rocks, the almost 3,000 m high glaciated Dachstein mountain range is for sure the most significant. It is known for the great number of caves, with the Hirlatzhöhle being the longest (currently 86 km) and the Dachstein-Mammuthöhle being the third longest (55 km) among Austria's explored caves, as well as for three major show caves being accessible to the public and well-suited for studies on cave development and formation, each of it representing another cave-type. Especially the ice cave, the Dachstein-Rieseneishöhle, is an outstanding example of its kind in Austria. The Dachstein-Mammuthöhle is a typical giant high alpine cave with enormous galeries and labyrinths, whereas the Koppenbrüllerhöhle down in the Traun-valley represents an active water cave at the level of the local karst water table. The Dachstein region has gained natural scientific significance through the excellent documentation work that has been going on for more than a century now. It started with the work done by Friedrich SIMONY in the 19th century and has continued almost uninterrupted up to the most recent research works. The outcome of these studies is reflected in an enormous bulk of literature. Also, the Dachstein mountains have been used for scientific comparisons and for clarifying karst-specific, cave-related and hydrogeological issues. At the same time this region has been a trailblazer in the field of cave documentation. For instance, the Dachstein-Mammuthöhle served as a model for the first presentation of an „underground atlas“ and the Hirlatzhöhle is documented by state of the art CAD-techniques.
The possibility to compare the pictures made by F. SIMONY in 1895 and those from 1950 by F. BAUER and other more recent ones is an excellent opportunity to study the changes in a karst landscape. The Dachstein region can also be considered as a model of subterranean karst drainage. It is precisely this area where a number of recent trials have resulted in a reassessment of underground drainage patterns whereby the currently well-recorded enormous horizontal and vertical insights into the underground (especially via *Hirlatzhöhle* and *Mammuthöhle*) have heightened the understanding of these drainage systems through visual and scientific information obtained from the interior of the karst massif.
The fact that the Dachstein massif is one of the few still glaciated karst regions in the Alps will enable further research approaches.
The early development of this area at the surface and underground for mountain climbing and touristic purposes, as well as its forestry and dairy farming use, enable to study the influence of man on a major Alpine karst area.

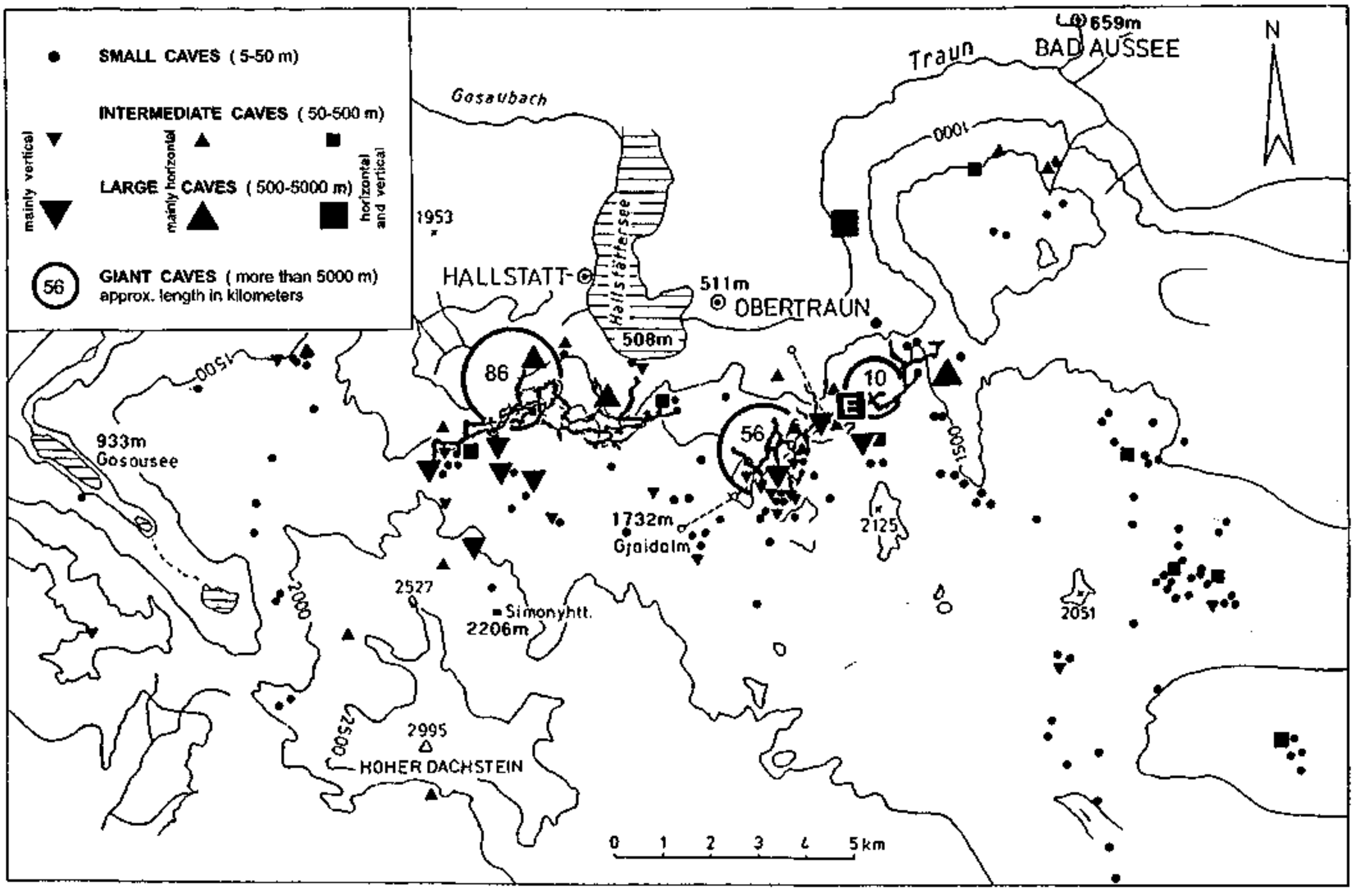

Fig. 7.1.1.: Caves and cave passages at the northern margin of the Dachstein range: Hirlatzhöhle 86 km, Dachstein-Mammuthöhle 56 km, Dachstein-Riesen-eishöhle (Ice Cave) E = 2 km, Schönberghöhle 10 km.

Geological, morphological and speleological overview

In geological terms, the Dachstein massif is comparatively simple and clear in its setup. Its central part is dominated by Upper Triassic Dachstein limestone gently dipping towards the north. The Dachstein is the „type location" of the well-banked Upper Triassic limestone of an extensive lagoon area, this limestone having been widely spread throughout the whole area of the the ancient Thetys-ocean.

Some 45 km long and 20 km wide, the Dachstein massif is quoted in literature to have a surface of 574 square kilometres. The area with subsurface drainage amounts to approximately 240 square kilometres. As compared to the 300 square kilometres of the large subterraneously drained plateau of the Totes Gebirge, the Dachstein mountain range represents the second largest karst massiv in Austria. Its glaciated peaks (Hoher Dachstein, 2995 m) rise above extensive plateaus (such as Am Stein at about 1800 to 1900 m above sea level). Especially in the south (Ennstal, 750 m above sea level) and partly in the north (Traun valley with the Hallstättersee, 508 m above sea level) the mountains drop sharply eventually yielding tremendous walls attracting mountain climbers.

Rock stratification, which is important for cave formation, is dipping slightly north / north-west towards the Traun and Echern valleys. Joints and faults - essential for for karstification - mainly strike NW-SE and NE-SW, fewer ones also W-E and N-S.
Especially along the northern edge of the mountains huge glacial valleys cut into the mountain body. An allocation of the different remnants of former surfaces to a specific age seems to be particularly difficult. There is evidence that tectonic activities have transported identical pediments to different heights. The large plateau areas are mainly characterized by a *Schichttreppen* landscape - partially sculptured by glaciers - evolved along bedding faces. Here one can often find smaller caves along the bedding planes. A more detailed study of the location of cave entrances in the Dachstein cave park has shown that most of the cave entrances are either in steep walls (mostly glacially reopened) or in the highest zones of mountain ridges. In the synclinal and deep zones we see a clear decline in the number of passable entrances, most of them probably sealed by moraine material.
The Austrian cave register refers to the Dachstein massif under figure 1540. This figure is subdivided into groups 1541 to 1549. The highest topographic point of the subgroup is the *Hoher Dachstein* (2995 m), the lowest is the Hallstättersee (508 m). The lowest cave is the *Kessel* (1546/2), 512 m above sea level in today's valley level, the highest cave is the *Nördliche Durchgangshöhle* (1543/46), 2770 m above sea level; 550 caves are currently recorded in the Dachstein mountain range.

Historic survey

Historic documents dating from the past century are mainly due to research work, drawings and publications by F. SIMONY (1895). A more systematic cave research, however, began in 1910 only in the so-called „Dachstein Cave Park" (these are caves situated in the area of the *Schönbergalpe*) when the two most important caves, the *Dachstein-Rieseneishöhle* and the *Dachstein-Mammuthöhle,* were discovered. A few years later numerous kilometres had already been surveyed and recorded. More recent research started with a theodolitic investigation into the most important parts of the *Dachstein-Mammuthöhle* in 1952.
Current speleological studies are still focused on the area of the Dachstein Cave Park and the *Hirlatz* area, with work going on both above and below the surface. In recent times tremendous discoveries have been made in the *Hirlatzhöhle*. For years the Dachstein Cave Park has also been an area for accompanying geo-scientific investigations with special emphasis on cave-sediments, -waters and -ice and cave-climate to study human influence and interference as well as natural variations of the cave ice. These studies are conducted by the Department of Karst and Caves of the Museum of Natural History in Vienna. Both the *Hirlatz* cave area and the Dachstein Cave Park are subject to active exploration and documentation of hitherto unknown cave passages by speleological societies. Our knowledge of the Dachstein caves is still far from being complete.

Karst water, springs and dye-tracing

Cave formation and the karstification of a landscape require the presence of "karstifiable rock" (such as limestone) plus corrosively acting water. In such a way karst areas become important "water reservoirs", and the knowledge of subterranean drainage patterns will help understand karstification and cave formation; it turned out to be an important factor in water management.

This aspect has been the focal point of the pioneering spore drift and dye-tracing tests in the Dachstein area since 1953. The first trials revealed mainly radially directed drainage patterns. The first series of colour tracing tests (1984-1986) however yielded maps with a general subsurface runoff from south to north following mainly the dip of the Dachstein limestone.

In 1990 more detailed studies were made in the central Dachstein area revealing minor differences to the 1984-1986 test results due to the different meteorological conditions, but basically the original findings were confirmed. The studies reasserted the necessity of introducing a comprehensive karst water conservation plan for the Dachstein so as to maintain the water quality of the major water supply systems (Gosau, Hallstatt).

The more recent results now show drainage patterns in north/north-west direction towards the *Echern* valley, the *Gosau* lakes and the *Traun* valley. All these investigations have provided evidence for a direct correlation between the waters disappearing in the karst plateau and the major springs and spring caves (with different flow times of course) along the northern margin of the Dachstein. The subsurface water streams - meanwhile discovered both in the *Mammuthöhle* and especially in the *Hirlatzhöhle* - complete the results of the dye tracing tests.

Karst and caves

Although Friedrich SIMONY has already described and documented the karst and some of the caves in his publications and notes (1895), and although Franz KRAUS lists a great number of caves in the Dachstein region in his *Höhlenkunde* (1894), a major progress in speleological terms was made in 1910 only when the *Dachstein-Rieseneishöhle* and the *Dachstein-Mammuthöhle* were discovered. A few years later some 9 km of cave passages had been explored. At the same time this region served and still serves as a forum for different cave formation theories and karsthydrogeological investigations which have resulted in a great number of publications on the Dachstein caves, karst and underground drainage systems. Owing to continuous studies some 25 km of cave passages were recorded in 1950 (at the onset of renewed and intensified research after World War II). The venture into the upper levels of the *Hirlatzhöhle* in 1983 (the cave passage length has grown since 1983 from about 8 km to more than 86 km !), the current studies of the *Dachstein-Mammuthöhle* (in 1959 some 10 km of passage were known, in 1999 about 56 km) and research in the *Schönberghöhle* have unearthed in the past decade completely new findings on the pattern of the giant cave systems at the north edge of the Dachstein. Scientists now have full information on 160 km of cave passage (of 5 major caves) including their underground horizontal and vertical extension.

A current cave register where all the well documented caves have been entered (these are approximately 70 % of all caves, the missing ones being small caves) clearly shows a

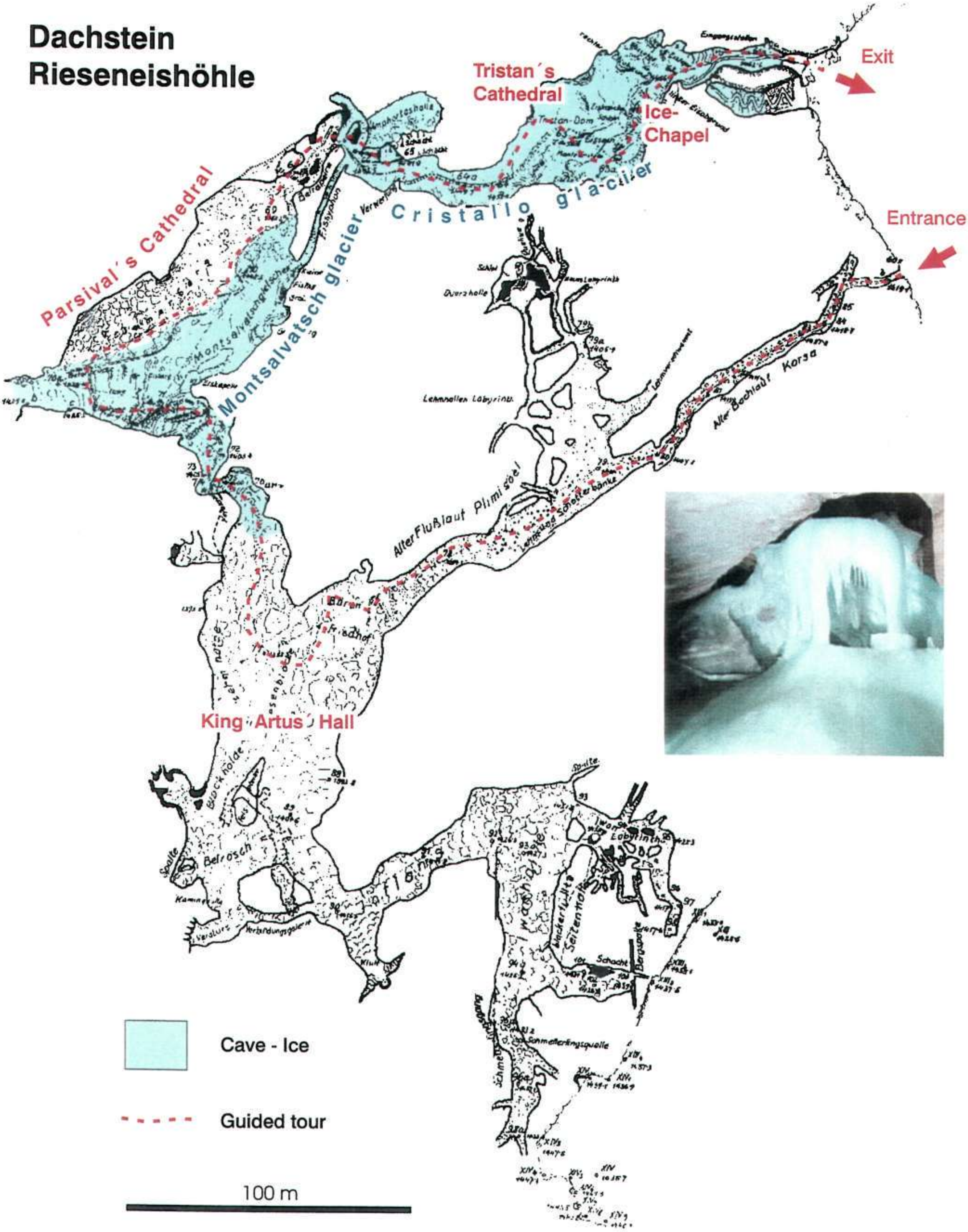

Fig. 7.1.2.: Schematic map of the Dachstein Rieseneishöhle, after F. Saar 1953, modified.

cluster of caves in the northern part of the Dachstein range which mainly houses the largest and deepest caves (Fig. 7.1.1.) stretching some 10 km W-E and some 3 km N-S. More recent cartographic and statistic evaluations have shown that the subterranean course of a major portion of this giant cave system is bound to the fault directions mentioned earlier and to the dipping of the Dachstein limestone. Whereas most of the inactive cave parts of various sizes run NW-SE and NE-SW, and also partially W-E, there are enormous (mostly active) canyons that fall steeply down north and frequently reach the phreatic zone. Here the overlying strata are only some 200-500 m, in some cases up to a maximum of 800 m. Apart from the more than 86 km long Hirlatzhöhle (i.e. the longest cave in Austria) the Dachstein Cave Park consists of the 56 km long Mammuthöhle (also one of the deepest caves in Austria featuring a level-difference of 1180 m in total and reaching from the edge of the plateau almost down to the valley floor), the 2 km long Dachstein-Rieseneishöhle (Fig. 7.1.2.) and the 10 km long Schönberghöhle (the quite exposed entrance to this cave can be seen from the cable car during the ascent to the Schönbergalpe looking to the east). This area is particularly well explored and recorded which is certainly also due to the cable railway system that enhances the accessibility of the region.

The Austrian cave register currently lists 560 caves (as of spring 1999) as compared to KRAUS's list of 16 caves (1894), BOCK's list of 30 caves (1913), ARNBERGER's list of 229 caves (1964) and the 1988 cave register that mentions 450 caves in the Dachstein region. A statistic evaluation of the data on the state of research, type and size of caves shows the comparatively fine store of knowledge (3/4 of the caves are either fully or partially explored) and the dominating feature of approximately the same number of horizontal caves (mostly in steep slopes) and shaft caves (mostly on plateaus). About 15 per cent of the caves are ice and/or water caves. If we categorise the caves by their size (length of passage) we see the great portion (about 70%) of small caves having a total passage length of 5-49 m. However, among the great number of caves there are only 3 which are „giant caves" (more than 5 km of passages) and only 17 which are „large caves" (500-5000 m). There are hardly any caves of 5-52 km currently known. If we add the known passage lengths of the giant caves to the mean passage length of the small and medium-size caves, there are more than 220 km of known and surveyed cave passages in the Dachstein area currently.

Allocation of the cave entrances by their altitudes reveals the maximum to lie between 1,500 m and 2,000 m above sea level. However, the altitudes recorded for most of the cave sections of the *Hirlatzhöhle* and *Dachstein-Mammuthöhle* show that the level of the entranceways is of little relevance in relation to the actual altitude of the passages inside the karst massif. For instance, the more than 86 km long *Hirlatzhöhle* currently has only one entrance at about 890 m above sea level, whereas the overall level difference of the cave amounts to some 1,000 m.