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Granite caves in the Fichtelgebirge Mountains, Germany

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Abstract

Granite caves occur in different areas of Germany, e.g., in the Black Forest Mountains, Harz (Hercynian) Mountains and in the Saxon and Bavarian part of the Bohemian Mass. Most of them are not well documented, but in the area of the Fichtel Mountains (Northeast of Bavaria, Hercynian-age granites of the Bohemian Mass) we documented a total number of 77 caves, most of them up to 50 m long. Most of them are situated in tors, autochthonous relics of deep Tertiary spheroidal weathering with subsequent re-movement of the granite detritus during Plio- and Pleistocene times. Consequently, they can be classified as woolsack caves. Smaller caves, often covered by only one or a few boulders, show a morphology similar to talus caves, but some longer caves (up to 90 m in length) are of a much more complex morphology, reaching the inner, more or less ordered parts of the tors, where the morphology is similar to that of fissure caves (structural caves) with narrow passages and parallel walls.
The longest cave of the Fichtel Mountains is ca. 100 m long and of different origin. It is developed also in autochthonous rocks, but as a fissure cave. The fissures might have opened due to gravitational mass movement (rock slide), but it is also discussed that they were enlarged in Pleistocene times by ice thrust.

Key words: granite caves, talus caves, boulder caves, structural caves, Fichtel Mountains, Germany.

1. GENERAL SITUATION

The Fichtel Mountains (germ. “Fichtelgebirge”) are situated in the northeast of Bavaria, which itself is situated in the southeast of Germany. They are part of the Bohemian Mass, a complex of mountainous regions reaching from the southwest of Poland via the Czech Republic to Austria and Germany. The geo-tectonic history started during the Hercynian (Variskian) Era, when folding of the sedimentary rocks occurred and granite intruded in greater depths. Later, parts of the Bohemian Mass were lifted up and heavily eroded; in consequence the granite intrusions have been exposed.

2. GRANITE WEATHERING AND WEATHERING FORMS

2.1 Large forms of weathering (primary forms)

In Tertiary times, possibly also in former times, intense chemical weathering during warm climatic epochs attacked the granite at first along the existing joints and disintegrated the rock material to a depth of several tenths of meters, leaving fine detritus material which first was not eroded mechanically but formed the typical deep-grounded tropical soils. Later, in Plio- and Pleistocene times, after a tectonic lifting and a climatic change, this detritus was mechanically eroded. Consequently, the partly disintegrated granite material, consisting of more or less voluminous and rounded boulders, remained and was exposed, now forming boulder fields. These fields may consist of allochthonous boulders dislocated by gravitational mass movements under periglacial conditions (rock slides) or of autochthonous boulders now situated in peak positions (tors).

This principle of woolsack weathering was first described by J. W. v. Goethe (1820), the famous poet and universal genius. He visited the Fichtel Mountains during three excursions (the most important ones in the years 1785 and 1820). He also described for the first time granite caves in the Fichtel Mountains.

2.2 Small forms of weathering (secondary forms)

Weathering pits (water pots or kamenica) are developed by stagnant water (dissolution, hydration, frost splitting etc.). They occur with drainage channels and on horizontal top sides of the woolsack blocks, indicating a subrecent age.

Karren (lapiés) of the Rillenkarren type can be found at inclined woolsack blocks, also an indication of a subrecent age. They develop by slowly running water (dissolution, hydration, frost splitting?).

Tafoni-like forms or forms of honeycomb weathering can be found seldom in the Fichtel Mountains. They possibly develop by physico-chemical weathering due to pore water or thin water films or even without water. Probably, thermal effects (daily or yearly temperature changes) may accelerate the development.

3. STATISTICAL DATA AND GENETIC CLASSIFICATION OF THE CAVES

Until today, in the Fichtel Mountains 77 granite caves are registered. Registration of a cave is done only if some base data is known (e.g., exact geographical position, approximated length). A number of 20 – 30 caves is known, but not registered due to the lack of exact base data.

Most of the registered caves are situated in some well-investigated areas which are of ca. 5 km^2 in total size. Regarding the total granite-covered area in the Fichtel Mountains (> 200 km^2), we must assume that the total number of granite caves must be a multiple of the number of registered caves today. Taking into consideration that our well-known 5 km^2 are "hot spots" of cave occurrence, and there are existing some other "hot spots", we estimate the total number of granite caves in the Fichtel Mountains with 500 – 1000 caves (minimum).

In Table 1 the length distribution of the caves is given. Like in the most other cave regions, most caves are small, but nearly 10% of the caves are longer than 50 m.

Length interval	5 ... < 20 m	20 ... < 50 m	50 ... 100 m
Number of caves	60	11	6

Table 1: Length distribution of the granite caves in the Fichtel Mountains.

Regarding the genetic conditions, Table 2 gives the classification of the caves. Some of the caves classified as woolsack caves may belong to an intermediate between woolsack and talus caves, because it is not sure that the cave-forming boulders are of pure autochthonous character.

The genetic types introduced in Table 2 are mentioned in the following chapters.

Genetic type of cave	**Number of caves**
Woolsack caves	68
Talus (boulder) caves (dry)	3
Erosion boulder caves (with small creek inside)	1
Others (here: possible influence of ice and/or snow)	1
Unknown	4

Table 2: Genetic classification of the granite caves in the Fichtel Mountains.

4. WOOLSACK AND MATTRESS CAVES

Woolsack caves are located in the tors (autochthonous boulder fields) and are cavities in-between the woolsack blocks. The blocks are often placed in an unordered manner. Therefore, the morphology is very similar to the classical talus (boulder) caves (cf. chapter 5 and Fig. 1). At some tors, the inner or deeper parts show partial order of the boulders.

Small caves are very common in tors and are often covered by only one boulder (Fig. 2 and 3). Some caves are of much more complex morphology, and may be covered by a number of boulders so as to be labyrinthic (Fig. 4a/b). A few caves reach the inner, more or less ordered parts of the tors, where the morphology is similar to that of fissure (structural) caves with narrow passages and parallel walls.

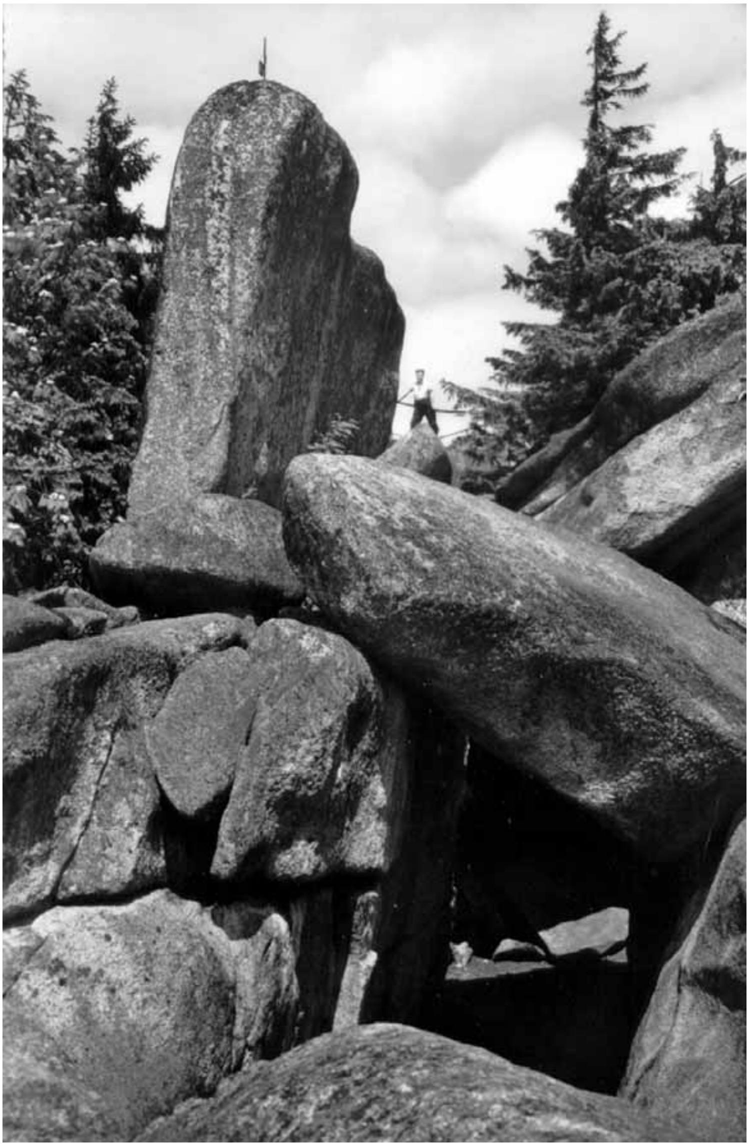

Fig. 1: Historical view (postcard) of the Nusshardt tor with the cave called Nusshardtstube 5937/03a (length 26 m).

Mattress caves are a special form of woolsack caves covered by flat boulders (big area extension, but only small thickness). These caves are often wide and low.

Fig. 2: Historical view (postcard) of the Klingergrotte, a cave not registered until today.

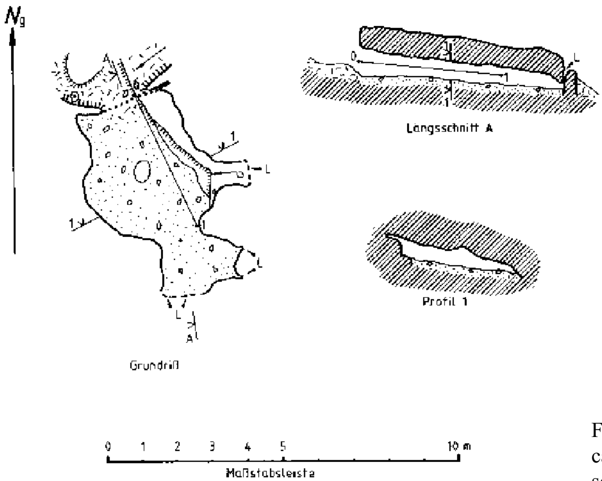

Fig. 3: Woolsack cave (here: mattress cave), simple morphology, plan and sections (Südliche Prinzenfelsenhöhle 6037/01, length 6 m).

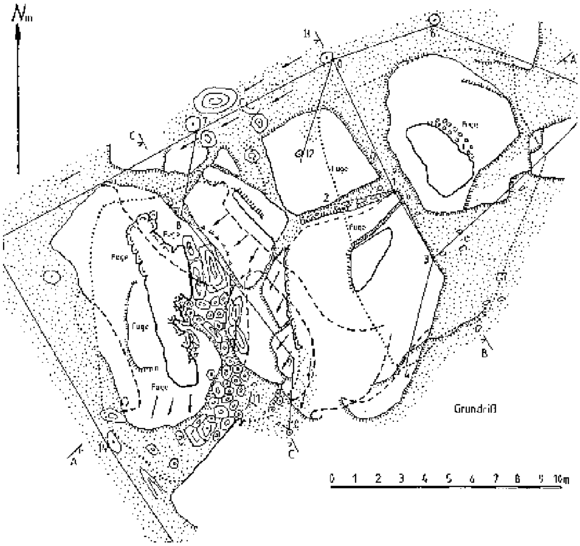

Fig. 4a: Woolsack cave, complex morphology, plan (Etagenhöhle 6037/13, length 50 m).

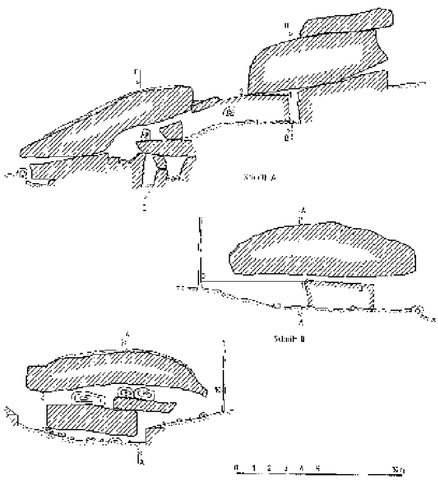

Fig. 4b: Woolsack cave, complex morphology, sections (Etagenhöhle 6037/13).

5. TALUS CAVES

Talus caves (boulder caves) are formed by gravitational mass movement. Such caves are typical of hard rock materials (limestone, dolomite, sandstone, granite...). It is important to emphasise that they develop in allochthonous landslide material - in contrast to woolsack caves. Talus caves are already well-documented in many different rock types (e. g., Eszterhás 1993, "Mass Displacement Caves"). Gaál & Furmánek (1995) pointed out the existence of an intermediate cave type between talus and fissure cave.

6. EROSION BOULDER CAVES

This is an important combined type of talus and erosion cave. First, landslides occur in incised creek gorges, forming the disposition for talus-like caves (but not necessarily true caves). Second, erosion by the creek forms the combined type of the erosion boulder cave (also called boulder fragment cave, Börner et al. 1988). This cave type is more common in sandstone areas. In the Fichtel Mountains, we have one such cave with a length of only a few meters. In the granite areas of Lower Austria caves with lengths of several hundred meters exist (Hartmann & Hartmann 1990).

7. ICE AND SNOW THRUST CAVES

Pressure of ice and snow in Pleistocene times enlarged existing fissures, possibly forming ice or snow thrust caves. The longest cave of the Fichtel Mountains appears to be of such an origin (Fig. 5). It developed in autochthonous rocks, located at a steep slope between two altiplanation terraces and consists in its main parts of widened fissures (Müller 1984, Hedler 1986). It is not known if other processes (mass movement) have been important for cave forming, so parts of the cave may belong to the type of fissure (structural) cave.

Fig. 5: Possible ice thrust cave, entrance (Ochsenkopf-Nivationshöhle 5936/01, length ca. 100 m) (photo by Horst Hedler).

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