Terminological definition of the terms ĂPingeñ(Binge)

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The paper comprehensively analyses the montane concept of pinge (ping). It points to the origin of the word pinge and its primary meaning in historical - medieval mining. The main part of the paper is concerned with the evaluation of the conceptual terminological inaccuracy of the word pinge and analyses the individual historical montane shapes in detail. These shapes are often terminologically interchanged with pingen and also inaccurately considered pingen. These are surface concave montane shapes of relief in general, i.e., verhau, shurf, sinks, depressions, etc. These shapes have fundamentally different morphological and morphometrical properties and parameters, considering the different genesis of their origin. Nevertheless, these basic properties, which are not interchangeable were not considered in different scientific disciplines and were regarded as pingen. This part of the paper also evaluates the basic properties of pingen based on their relation to the relief and landscape, which must be studied from anthropogenic geomorphology and mining engineering. Final part of this paper offers the results of the research based on the analysis of medieval and modern archive sources, the oldest montane papers, the latest scientific studies and field research, which unequivocally establish the meaning of pinge in mining engineering (montane anthropogenic geomorphology), which is acceptable for all scientific disciplines concerned with this unique shape. A part of the final discussion is the exact definition of the term pinge and its meticulous delimitation.

Keywords: *pinge, concept genesis, conceptual terminological inaccuracy, morphological and morphometrical properties, new definition*

Introduction

Termination of mining activity in many mining areas during the 20th century brought a slow but important change in the outlook on the remains of mining activity. In many rich medieval mining sites significant terrain changes took place and after mining and processing of raw material the landscape was altered significantly, often degraded severely and recultivated only minimally. To this day there are many administration buildings, ore sorting machines, crusher houses, smelting houses, adit collars, drainage adits and shafts in the vicinity of mining and ore processing sites. However, it can be said that the cultural and historical value of these buildings was realised in the second half of the 20th century, followed by the creation of mining museums and exhibitions. With the development of tourism and its various forms during the 20th century a very specific type of tourism ï mining tourism - came into being, gradually hierarchically incorporated into geotourism. Abandoned ghost towns came back to life and depopulated mining areas gradually became centres of attention once again. Various ways of understanding of customary, initially mining expressions have appeared across scientific fields with the development of research methods and evaluations of various manifestations of mining activities, but also in their methodological classification and determination. An example can be the inconsistent view on the meaning of the Old German word ñpinge,ò or ñpinging,ò which is understood differently in mining disciplines and for example in post-war European geomorphology significantly complicates classification of montane anthropogenic forms of relief. The following study looks for the primary meaning of this term, using the original expert mining literature and archive map sources.

The origin of the word pinge comes from the old (early Medieval) German, where the word Bingen denoted pit or depression, probably tunnelled anthropogenically. Medieval German mining then gradually adopted this term. The first prospectors began to name randing and opening pits, which they tunnelled at the exit of ore veins or ore pillar on the surface. Primarily these forms at the beginning of early Medieval mining occurred at first during searching for deposits of industrial minerals (randing = pinging), which could gradually become surface or shallow subsurface mining. The significance of this type of ñsurveyò grew upon searching for the directional sequencing of the ore veins in the surface projection and upon determining their incline.

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The technique of exploring the deposits and subsequent surface and subsurface mining using mining pits – pingen was not discovered during the Middle Age. Logical principle of this method had already been used by prehistoric and ancient miners.

Theoretical framework and background

Beginning and history of using pingen (pinging) as a mining technique

The first anthropogenic mining depressions were produced with a gradual increase in demand for quality raw materials in the Stone Age (Paleolithic period, three million – 8 300 BC). The actual surface mining of inorganic minerals – stone began in the later Stone Age (Neolithic – about 6 000 BC), leading to the formation of mining pits, which can be identified as pingen. The demand for quality stone with specific properties (fissility with sharp edges, hardness, resistance, and later drillability) exhausted not only surface sites of its collection but also those sites, where the stone was extracted on the surface from the weathered or non-weathered surrounding rock. As a primaeval miner gradually penetrated deeper for quality stone, the first shallow mining pits were created on the plains and slopes. Upon removing overburden, that is the soil and overburden rocks, there was a waste, which was spilt near the shallow pits, forming ring-shaped mounds (waste dumps) around the „mining pit.“ Extremely corrugated relief emerged at the mining sites. During the mining process, the man could proceed steadily and dug pits after pits; in this case, the excavation material was often deposited in the previous pit. The active mining pits have gradually acquired a characteristic funnel shape, which is now called pingen. Primary surface mining in pingen resulted either in mining pits or open quarries (if mining spread to the sides, only then to depth), or mining shafts (if mining progressed primarily to the depth and only then to the sides) (Fig. 1).

The process of genesis of surface forms nowadays referred to as pingen, can also be described chronologically. By gradual monitoring the quality of extracted material and its selective extraction in the direction to the middle of the Earth, the pingen (mining pits) gradually deepened and shafts 15 to 20 meters waste dumps around deep occurred, depending on the height of groundwater and difficulties it caused. Their diameter was originally close to their depth. After sinking of a shaft, their bottom was gradually expanded, and the bell-chamber with a circular plan was formed around the perimeter. Simple ladders made from tree trunks and branches were used to enter the shaft. If the bell chamber was larger, the dump was heaped directly into its space (backfill). The next step towards the formation of broken mines was the star-shaped formation of the underground tunnels from the bell chamber or the bottom of the shaft (thill). Respective corridors followed the occurrence of extracted material, or the extracted mineral deposits and created vast underground spaces – the first mines. The height of corridors reached only the proportions necessary for human movement, up to 1.2 m, their length could be more than 20 m. Corridors ran from the entrance shaft in a star shape. With sufficient occurrence of quality stone, the tunnels were expanded to the sides, and first mine chambers were created underground (Borkowski, 1995).

This mining technique was used in the following millennia; it was the main mining technique of surface and subsurface mining even in the Middle Ages.

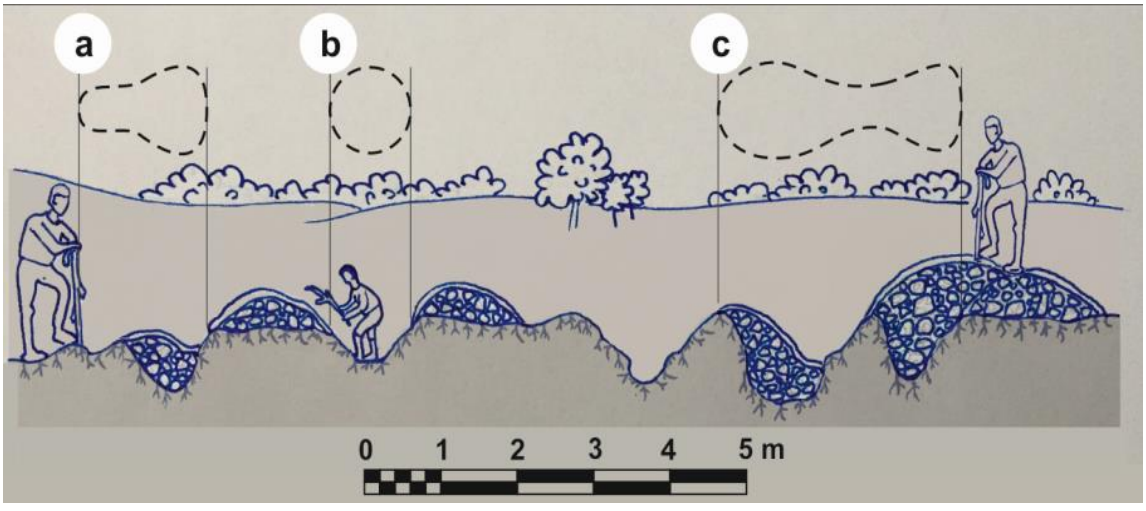

Fig. 1. Stone mining using surface mining pits – pingen. Legend: a) combined pinge, b) pinge with a regular circular plan, c) pinge with an irregular plan. Upon progressing mining, exhausted pingen were often covered with heaps of dump.

In the Middle Ages, mining rich ores on the surface in oxidation zones was gradually followed by subsurface and deep mining of minerals. The deep part during the Middle Ages is thought to begin from the 12th or 13th century. Pingen as a mining method became more and more obsolete, and in modern times they have exclusively been used as exploring and searching method. In Jan Möhling's textbook on mining geometry, the key shows both mining and exploring pingen (Fig. 2), including waste dumps around them (Möhling, 1793).

Fig. 2. The map key of Johann Möhling published in 1793 (Möhling, 1793).

General occurrence of pingen created while searching for deposits (geological survey) rises until the 16th and 17th century. The second type of surface active mining pingen, created by a drop of hanging wall into the mine basement began to appear later (18th and 19th century). While the first type did not reach large proportions (often only 1-2 m deep), the second type reached a depth of several meters, even tens of meters (depending on the size of undermined space, the thickness of hanging wall, wall stability, etc.). This form of relief and its sudden emergence is problematic especially in inhabited areas and sometimes is periodically filled with water. Unlike natural forms, pinge is an artificial object of anthropogenic origin with mining or searching (exploring) function. Regarding shape, and partially regarding their origin, they resemble natural karst forms of relief ï karst pits, sink-holes, which however lack heap or ring-shaped mound.

Inconsistency in the meaning of the term pinge

Currently, in mining or anthropogenic geomorphology, but also in other sciences, where it is the object of study (thus also among the general public), the understanding of the word pinge is broad, inconsistent in meaning, even fundamentally different. This problem can be observed not only in Central European science (Poland, Slovakia, Czech Republic, Hungary), including German-speaking countries but also in European or world science, written in English.

Nowadays, the term pinge (die Pinge ï in German) does not have an exactly defined object of naming in English, therefore does not name an actual anthropogenically created montane relief (as it is in other languages), but there is also no definite fixed nor word equivalent or phrase. Sporadically, in scientific papers written in English, there is a phonetic form ï ña pingeò (plural ï pingen), taken over from the German language, however, more often there are other terms without specific meaning. For example: ñopen mining pit,ò ñmining hole,ò ñmining sink-holeò or ñanthropogenic sink-hole.ò Descriptive expressions such as ñopencast mining,ò ñmine slumpò or ñglory holeò are also used.

It is clear that the term ñpingeò (in German ï Binge, Pinge, in Czech ï pinka, in Slovak and Polish ï pinga) has not been exactly defined by any scientific discipline yet, be it mining, anthropogenic geomorphology, economic geology, geography, geoecology or history, which are concerned with research and analysis of these relief relicts. This term, although actively used in mining terminology, remains without the exact definition of form (shape), process (activity) by which it came into being, or conditions, which it must meet. Terminological consolidation of this term is largely outside the fundamental interest of the disciplines in question. It can be said that they are in a terminological ñshadow,ò despite being very common, widespread and visually interesting and specific relics of old mining.

The term pinge or its close equivalent refers to many genetically and morphologically different surface concave forms of montane relief. This ambiguity is caused by taking over the term by geographers in the 20th century aits using without realising its exact meaning in mining and its application to a wide range of visually similar shapes. This inconsistency then leads to numerous misunderstandings and misinterpretations of the term. This way, all surface mines in the shape of the pit with various plans up to outstanding line shapes (excavations, abatis, mining excavations), often of great proportions are called pingen, regardless of the process, in which they originated, the function they performed and properties they have. Even greater disunity arose after the term ñpingenò was used to name brakes or debris-filled mines of concave shape, without a heap or ring-shaped mound. This problem was pointed out by geologists (Kuģvart & Böhmer, 1972), montane archaeologists in the Czech Republic (Nováļek, 1993; Hrubý et al., 2016), but also anthropogenic geomorphologists in Slovakia

(Hronļek, Rybár & Weis, 2011; Hronļek& Weis, 2010a, 2010b). This problem also prevails today in German mining, montane archaeology, and related sciences. As K. Nováļek writes, the partial thematic solution was the work of a German geographer D. Düsterloh (Düsterloh, 1967), who, however, did not find any followers, who would solve this problem in a complex way.

To this day, this problem has not been solved, and there are no general classification systems, which would explicitly define and divide concave montane relief shapes acceptable to all scientific disciplines which study these shapes.

Until now, the Czechoslovak geomorphological school or specialists in anthropogenic geomorphology have confirmed with German view on the issue of pingen. Contemporary German mining literature considers pingen shapes created directly by surface mining activity, by digging, deepening or disintegration (Grabung), regardless of the purpose of this activity (mining, exploration, etc.), but also shapes created by indirect mining activity, in breaking or collapsing (Einsturz) of hanging wall. This approach was also adopted by the Czech geomorphologist L. Zapletal (1968, 1969), whose work was also based on German school. He introduced the term ñpinkaò into Czech science as an equivalent of the German ñpinge.ò German literature, however, uses the term ñpingeò to denote shapes, created by inbreaking or collapsing of hanging wall (overburden), almost exclusively in cases where this secondary form continues to be an active mining space. This fact, however, is not defined as conditional for using the term ñpingeò.

As it was already mentioned, the process of formation of these forms of relief, their function in mining and their features were not taken into account geographically. This approach (ambiguity and inconsistency) was taken over by other experts in the Czech Republic, for example, Kirchner, Smolová (2010). In Slovakia, this view was taken over by the doyen of Slovak montane archaeology J. Mazúrek (1965, 1987, 1989) as well as by younger experts, for example, V. Ļech with J. Krokusová (2013), and Krokusová with Ļech (2014). The situation in Poland was similar, as was the case with older authors (Klimaszewski, 1961, 1978; Hornig, 1968), which continues with current generation (Pogrórski, 1999, 2001; Wójcik 1996).

The problem of inconsistency of the concept of ñpingeò on all levels was pointed out by numerous current experts in the Czech Republic, for example, K. Nováļek (1993) and K. Hrubý with a team of co-authors (Hrubý et al., 2016). These authors have tried partially unify this problem. In Slovakia, the attention to this problem was paid by P. Hronļek and K. Weis (Hronļek & Weis 2010a; Hronļek, Rybár& Weis, 2011), who attempted to define the geometry and necessary properties of this form of relief.

In general, the term ñpingeò can be defined by monolingual dictionaries and diverse scientific literature as a funnel or sphenic depression, created or related to mining activity. Its origin is directly related to the surface mining of minerals or with collapsing of shallow mines.

It can be said that this definition is general, vague and ambiguous. It is also confusing since the term ñpingeò is also used to refer to sink-holes and decline, which again suggests the absence of emphasis on Genesis, function and typical properties of this form.

Division of ñpingen,ò more precisely the concave surface shapes of montane relief from their relevant properties ï genesis, shape and original function

Nowadays almost all concave montane depressions without more specific identification of genesis, shape, proportions or original functions are called ñpingenò in anthropogenic geomorphology. This approach, however, does not pass the basic sorting of montane shapes, which can be divided into:

- those, which were created by a direct activity of anthropogenic geomorphological processes during mining activities, i.e., as a result of mining activity and using of mining techniques ï the so-called primary mining relics
- secondary mining relics, which are a reaction to a mining activity or they are created for mining. They were not created by anthropogenic geomorphological processes (mining activity), but the activity of natural geomorphological factors (Zapletal, 1968, 1969, 1978; Hronļek, Rybár & Weis 2011; Ļech & Krokusová 2013).

These processes or their combination are then reflected also to their morphological and morphometric parameters, which at first glance create similar or identical shapes from individual concave anthropogenic montane shapes of relief. This fact leads to their mistaken association and identification as ñpingen.ò This error is pointed out by historical context, which stems from medieval mining and geognosy.

Despite the fact that there is no unified relevant scientific classification of surface concave montane shapes of relief and exact terminological determination of the word ñpingeò, a basic division can be established, based on the genesis of their origin in accordance with the current understanding of a wide spectrum of scientific disciplines worldwide to: dug-out (excavated), crushed and debris-filled.

Dug-out (deepened, sunken) pingen are created by a direct exploring or mining activity, based on which they can be divided into two subtypes: exploring pingen and mining pingen. They are created by digging or

disintegration of hard rocks of the mantel. This process is called pinging. Once the pits are abandoned, they change their basic shape by the influence of natural geomorphological factors. The duration and intensity of these factors determine the stage of development of shape from almost ideal inverted hollow cone to a reversed shallow elliptical paraboloid.

This shape then can also be defined as a funnel-like terrain depression, which was primarily created while surface mining of minerals (pinging), or while exploring. Pingen were excavated on assigned small-scale mines with a mandated randing right.

The method was widely applied in the initial survey of a deposit, when it was necessary to map out exits, width and the course of veins on the surface, as well as while looking for the continuation of the vein structures just below the surface, or when determining their incline. This is why the line arrangement of pingen rows or disorganised texture of pinge fields can be often encountered (Mazúrek, 1987). Such an understanding of the term ñpingeò is more akin to the original old mining term, which referred to shallow randing surface pits, which were used to either monitor the course of ore veins on the terrain surface or to carry out selective mining. The funnel-like shape of ñpingenò is strikingly similar to naturally created karst sink-holes. However, they cannot be confused.

According to Polák (1952), Slotta (1991), Hronļek, Weis (2010a) pingen are exploratory or mining pits. A similar view is shared by K. Novál̦ek, who names them ring-shaped mounds. However, this terminology is not accurate, since ring-shaped mound, as a specific type of heap is only convex, above the ground part of pinge (Novál̦ek, 1993). The inconsistency in defining mining or exploratory pingen is also reflected in the fact that some authors consider ingenuine mining pits, or trenches, which they denote as line ranging or mining ditches (Weiss, 2005).

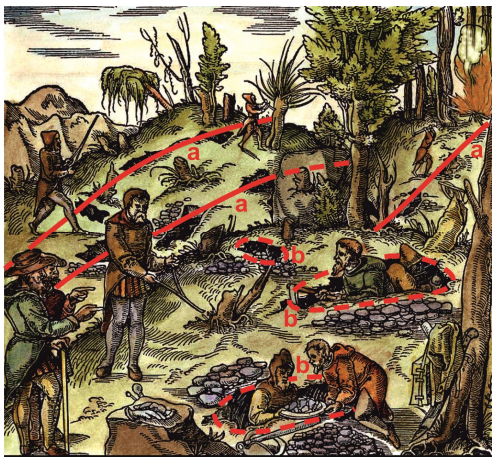

Fig. 3. Digging of exploration pits in the first half of the 16th century by G. Agricola (Agricola, 1556). Line grouping of pingen to pingen rows (a) and sheet layout of pingen into the pinge field (b).

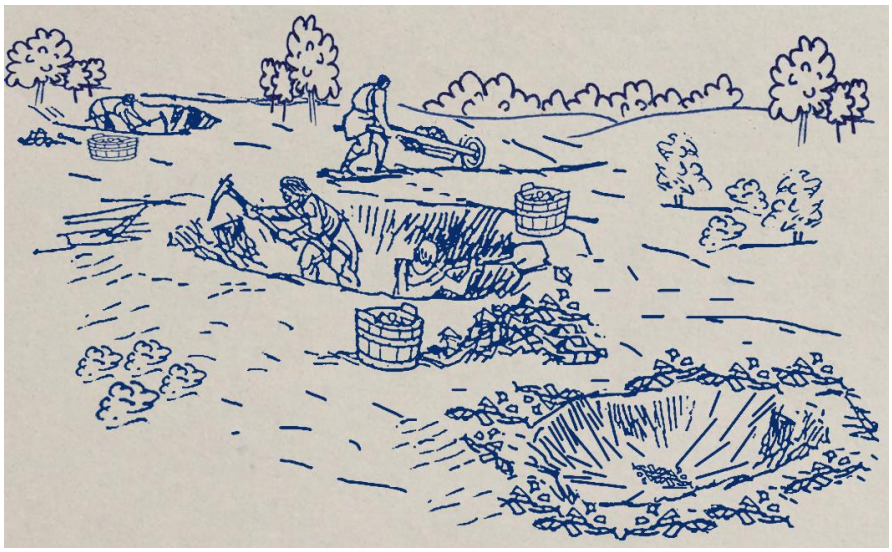

Fig. 4. Reconstruction of the digging of exploration and mining pingen inline form after the exit of ore vein to the surface ***ï*** *pingenrow.*

The correctness of the definition of pingen of this origin is pointed out by one of the oldest expert montane works of G. Agricola (Agricola, 1556), where the author mentions concave shapes of similar character (Fig. 3). When defining and identifying explorative or mining pinge (Fig. 4, 5), its second integral part in the shape of the convex part, made of the heap cannot be forgotten. Regarding pingen, the basic shape of the heap can be distinguished, which was created especially by upthrowing of disintegrated material evenly around its perimeter. These heaps are created on flat relief and are called ring-shaped mounds. On the slopes with moderate incline, the heaps have a plan in the shape of the moon (reminiscent of letter C), which are similar to desert sand barchan dunes. Typology of montane heaps is a concern of Zapletal (1968, 1969), Hronļek a Weis (Hronļek & Weis, 2010b, 2014). The slope heaps were created in the steepest slopes since throwing disintegrated rock only at the lowest point of the edge of the pinge required the least amount of energy.

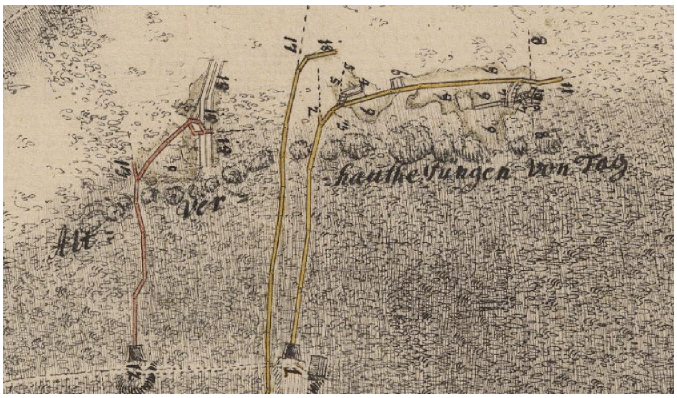

Fig. 5. Old mining pingen in the transitional stage to overhaul (HKG VI. Inv. Nr. 00095).

Mining pings are known for example near the town Suhl in Thuringian Forest (Thüringer Wald) in Germany or the historic ore ward Siegerländer in western Germany, on the hills MĐdník, Díģe in the Ore Mountains in the Czech Republic, pingenon the vein Schweizer in Jáchymov in the Czech Republic, Lomnické pingen to the north from Sokolov in the Czech Republic, the pingen from the vein Terézia in Banská Ġtiavnica (Fig. 6) and extensive pinge fields of vein Rabenstein from early Middle Ages, as well as veins Východná, Ġtefan, Leopold, Brenner, Moltra etc. in Hodruģa-Hámre in Slovakia (KaŔa et al., 2016) and others (Fig. 7, 8, 9).

Fig. 6. Abandoned mining pinge on the Terézia ore vein exit in Banská Ġtiavnica.

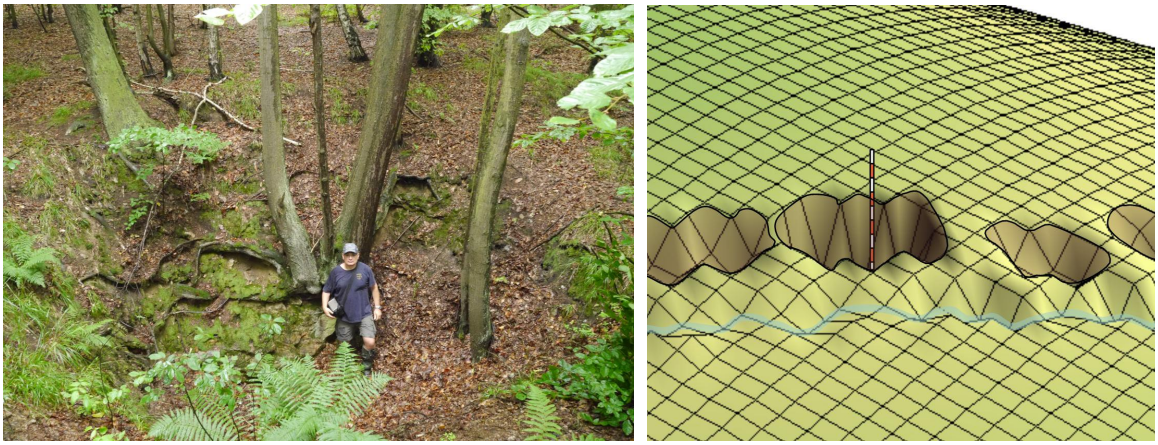

Fig. 7, 8. An example of the exploration pinge (on the left) and its 3D model created by detailed field research (on the right). Pinge is in the pingen row on the ore vein exit (east direction from Margecany) in the Ľ.ierna hora Mts. (eastern Slovakia).

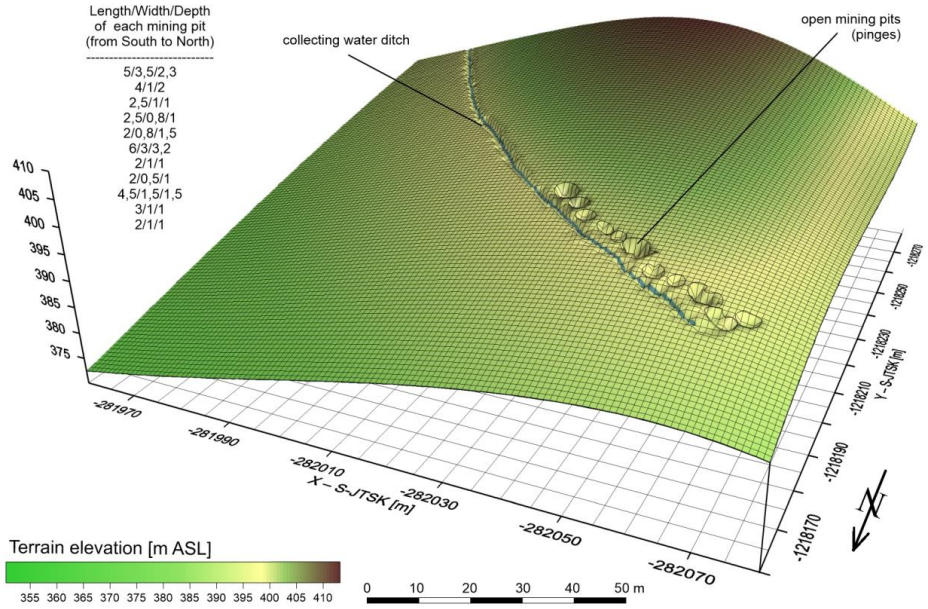

Fig. 9. 3D model of exploratory pingen row dug on the ore vein exit (east direction from Margecany) in the Ľ.ierna hora Mts. (eastern Slovakia).

Collapse pingen (Fig. 10, 11) did not occur directly through the extraction of mineral raw materials, but only as a secondary consequence of natural geomorphological processes. However, we propose to consider as pingen only those who were still part of an active mining area even after the collapse of their overburden, where the mining continued partly using surface mining (in the sense of the German approach).

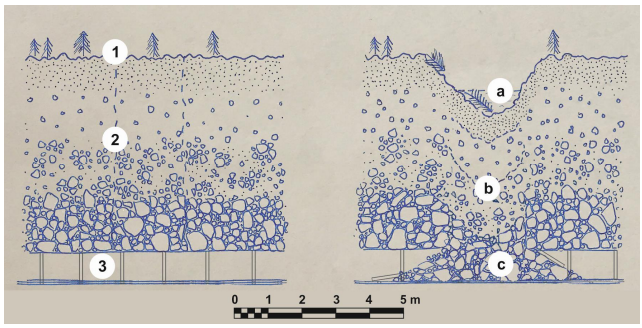

Fig. 10. Pingen created by a sudden (catastrophic) collapse of the overburden. Legend: 1. natural relief, 2. overburden layers, 3. mining underground, a. Collapse pingen, b. Collapsed overburden,c. mining collapse.

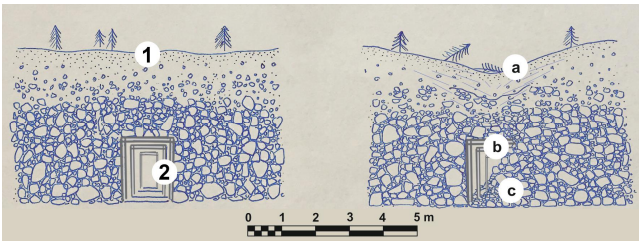

Fig. 11. Pingen created by a sudden (catastrophic) collapse of the overburden. Legend: 1. natural relief, 2. mining corridor, a. Collapse pingen, b.mining corridor, c. mining collapse.

However, if the overburden collapsed into abandoned and inactive galleries or chambers, we recommend using only the term sink-hole. The forms of relief called pingen until now can be divided according to their genesis into two subtypes ï sink-holes and depressions.

These shapes are formed when the degree of the undermining of the surface reaches the stage when the forces supporting the overburden reach their critical values, and the destruction of the ceiling (overburden) into the extracted spaces takes place. Collapses can occur over big chambers, above the intersections of the mining corridors (these places usually coincide with ore veins crossings), and in shallow depths also over exploratory galleries. These situations may occur suddenly forming a catastrophic situation of a rapid collapse of the overburden in the mining underground. An example of a typical collapse can be seen at the locality Ġurec near Kremnica (Slovakia) with a length of 700 m, a width of 250 m and a depth of 170 m (Fig. 12, 13).

Fig. 12, 13. The sink-hole Ġurec, an aerial view, and photography (SMM Archive, Banská Ġiavnica)

The sink-hole walls are usually very steep, often perpendicular. Different rock formations reminiscent of rocky towns can be found in their space. From the 17th century, vast sink-holes - called pingen occurred when the whole mine collapsed. Well-known examples include Altenberger Binge, Geyerischen Binge, Seiffen Pinge in Germany, a few pingen in the surroundings of HŚebeļné (Schneppôs pinge, Wildbahn pinge) in the Krugné Hory Mts. in the Czech Republic, Ġurec in Kremnica in Slovakia and many others.

If the sinking process of the terrain above mining works is very slow and long-term, or if it occurs in several stages, then we are clearly talking about sinks caused by collapses at the mining works level when the sinking of the overburden is limited by the volume of underground space. Walls, or slopes of sinks, are not steep but slightly inclined, corresponding formally to the shapes of trough depressions. This is absolutely typical for coal basins where the method of mining in a relatively plastic and unstable overburden causes sinks in relief, sometimes with huge horizontal dimensions and variable height amplitudes (Fig. 14, 15).

Fig. 14, 15. A depression "pinge"(or sink-hole) in Lehota pod Vtáļnikom. Legend: 1. sink-hole, 2. collapsed overburden, 3. mining underground.

Depressions are caused by relatively slow downward movements of overburden over excavated spaces, which occur gradually rather than momentarily. The main factors influencing the intensity of depressions and sinking of the overburden are the depth of the excavated spaces, thickness of excavated layers, area of excavated spaces, shape and length of the mining surface, layers slope angle and the mining technology (blasting or excavators, etc. cave-in with a partial back-fill, with a full back-fill, blasting, excavators, etc.). Time is an independent factor.

A large number of sinkholes - collapse pingen originated in the Middle Ages together with the beginnings of the subsurface (underground) mining ï in German der Deckelbaum, shallow, subsurface mining. It was an excavation of a dense network of shallow blind shafts connected by side by side leading corridors or narrow profile gallery passages. Several chambers were gradually connected to this network. All of these underground mines were following ore bands. Using this method led to such a disruption of the rock stability that the overburden usually collapsed into underground spaces (Nováļek, 1993).

A typical feature of all collapse pingen is that they consist only of the concave part. There is no heap near them because the heap of dirt from the originally excavated underground is located at a variable distance from the collapse pinge, at the site of the original exit of the mining works on the surface.

Screed pingen (Fig. 16), or more precisely scree-collapse depressions, are created by a screening of the mouth of vertical or nearly perpendicular mines on the Earth's surface, commonly including shafts, staple (small-profile shafts) or chimneys. The transport, extraction or ventilation function of an abandoned, secured shaft or an old ventilation chimney is terminated, i.e., degraded, usually by screening or flooding. After the mining process termination, a gradual rotting of the timbering and the subsequent weathering of mouths of these shapes takes places, which leads to the destruction of the immediate surroundings of the mouths, chimneys and blind shafts created by geomorphologically less resistant rocks. Applying gravitational forces over a longer period causes the rock material to collapse into the interior of the mining bodies, which are gradually filled up or clogged. This process creates a typical funnel shape of the pinge, but we do not consider these shapes pingen. It is necessary to preserve their original definitions together with their attributes - screed, collapsed, flooded, extinct, etc. (Fig. 17, 18, 19)

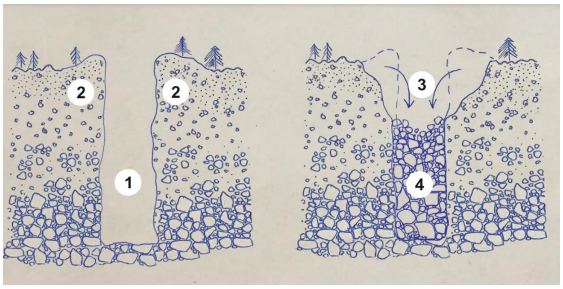

Fig. 16. Procedure for the formation of screed pingen in the openings of vertical mining works. Legend: 1. Vertical work in operation (shaft or small shaft) 2. vertical walls before destruction 3. crater depression similar to pinge (screed pinge), 4. collapsed vertical mining area.

Fig. 17. Screed pinge on Bärenleuten ore vein, chimney discharge to the surface in Hodruġa-Hámre.

Fig. 18. Screed pinge on the old nameless shaft on Vģechsvätých ore vein in Hodruģa-Hámre.

Fig. 19. An example of a flooded screed opening of an abandoned shaft Ján-Jozef near Banská Ġiavnica.

Heaps in their surroundings are not determinant for this category of shapes, because these can be accompanied by bring-shaped mounds especially in the mouths of shafts resp. On the slope - slope heaps, as is the case with the dug (exploratory and mining) pingen.

On the contrary, heaps are not present in the vicinity of shafts which have been traditionally long-term and intensively used for transportation or ventilation, but smaller terraces for manual capstans are preserved in the nearby surroundings of the shaft opening (Agricola, 1556), as well as larger terraces as the relics of horse-whims.

These forms have also been and are often understood as pingen, but this interpretation is incorrect and leads to inaccurate and often false scientific conclusions.

Basic properties of pingen based on their relationship to relief and landscape

Basic characteristics necessary for scientific analysis can be derived from many concave surface montane relief shapes - currently inaccurately referred to as pingen - according to their basic shape, position or specific properties in the terrain and the landscape (Hronļek, Rybár& Weis, 2011).

According to the **genesis of origin**, as detailed above, pings have been defined as dug, collapsed and screed, by the current inconsistent scientific literature. As we point out in Results and discussion, we do not approve such classification.

According to the **original function**, we distinguish pingen for exploration and extraction. As many exploratory pingen have continuously taken over the mining function a definite determination of their function is complicated. Similarly to subsurface mining, the function may change several times. This is determined by external conditions such as the yield of the used raw material processing technology, fluctuations in raw material prices, and so on. The function (exploratory or mining) is the distinguishing criterion of the new definition of the term pinge. Only using this criterion is it possible to avoid erroneous classification of sink-holes, depressions and collapses of shafts and chimneys (screening) as pingen!

From a **morphological point of view**, the pingen are defined as concave - hollow (clamped) shapes about the natural relief, with their entire volume under the natural relief. Exploratory and mining pingen have convex shapes in the form of heaps that protrude above the natural relief.

According to **the technology of origin**, pingen can be divided into hand-raked or partially digged (the historically oldest form, only primitive tools and their fragments like antlers are present, with preserved

fragments of wooden sticks in exceptional cases), digged using typical mining tools (hammer, chisels, various types of hoes, shovels ï worn out parts can be found in the adjacent heap or the mould volume) and combined digged and blasted where the penetration into cohesive rocks was achieved by means of black rifle dust (from 1627 to the end of the 19th century) or by other explosives (the 20th century).

Depending on the **occurrence and field arrangement** ï classification in the sense of pingen lines and pingen fields. Linear arrangement same as or parallel to the vein exit or the tracked structure is typical for pingen lines. Pingen fields are characterised by a seemingly chaotic arrangement without an apparent implicit condition. Like the pingen lines, both arrangements can have either exploratory or mining (digging) functions.

Based on **location in the terrain (on a slope), i.e. according to the local morphological situation**, we recognize alluvial pingen (on the floodplains), foothill pingen (created at the foot of slopes), slope pingen (on slopes), plain pingen (on plain reliefs) and peak pingen (lying on peak platforms and ridges).

Depending on **the angle of slope** - the basic shape properties of mining and exploratory pingen also change with the slope angle. (this is a diagram)

Depending on the size, we can recognise macro-shapes, meso-shapes, micro-shapes, and nano-shapes. Pingen can reach the size of macros-shapes only exceptionally. Macro-shapes are the largest; they must measure more than one hundred meters or up to several hundred meters in several directions (for example, width and length). This includes the largest sink-holes caused by undermining, but only under the condition of continuing mining (in the underground, or on the surface of the sinkhole and in its volume).

Meso-shapes are shapes reaching average sizes, i.e., several tens of meters, and in one direction they can exceptionally exceed hundreds of meters. Mainly sink-holes ï collapse pingen, for example, long linear excavations can be included, for example, the Rabenstein site in Hodruġa-Hámre, or Terézia, Bieber and Spitaler veins in Banská Ġtiavnica (Slovakia), Wolfspinge near the village of PotĘ¸ky in Krugné Hory Mts in West Bohemia.

Exploratory and mining pingen are typical micro-shapes with nano-shape elements. For micro-shapes, the individual basic dimensions (width, length, depth) are within ten meters (in units of meters), with one of the dimensions exceeding that limit. Nano-shapes have the smallest size, reaching a size of one meter, and it is difficult to identify them in the terrain because of their age and progressive re-naturalisation.

Depending on **the ground plan** - circular, elliptical, irregular, linear, etc. The shape is usually dependent on function, and the total depth reached in a certain type of rock.

According to the presence of water - dry, watered and flooded pingen can be distinguished. When it comes to watering, it can be permanent, or it may be formed by periodical rainfall or precipitation water. Pingen can be permanently flooded with free water if there is a high content of clay in the screen, or if impervious rocks at the bottom of the pinge are present.

About **the natural relief**, the surface forms of the montane anthropogenic relief can be divided into concave (i.e., hollow) and convex (i.e., heaped) shapes (Zapletal 1968, 1969). The concave shapes of the montane relief are completely, or only by a substantial part, located below the level of the original natural relief (when it is not part of a mullock tip). The convex shapes of the montane relief are overlapped above the original relief (heaps and moulds). Exploratory and mining pingen usually have preserved heaps, so we classify them as a combined ï concave-convex shapes.

According to **re-naturalisation or age** ï in scientific literature pingen characteristics referring to the periodisation of history, resp. Mining is used. We can talk about prehistoric pingen, ancient, medieval, modern time pingen, or pingen created lately. It is also common to use the time scale according to centuries. An accurate determination of the age is problematic because it can only be determined by historical sources. Only the most significant pingen have the exact year of origin written in archive documents.

The relative expression of individual concave shapes age is used in research, for example:

a) alive - shapes that are in the stage of development, i.e., they are at the stage of youth,
b) mature - shapes that are already developed, i.e., they are at the stage of maturity, with mostly sharp edges,
c) vanishing ï shapes that gradually begin to be subjected to the natural geomorphological process, signs of "re-naturalisation" are visible, and we can talk about the senescence of these forms. Their edges are mostly rounded, and the concave part is partially screed,
d) the extinct shapes may disappear by a natural way, which is incomparably longer than anthropogenically-determined extinction through plantation or degradation; these shapes can be documented only by montane archaeology.

Related to the **vegetation,** we can talk about "bare" pingen, which are not covered by vegetation either because of their age or inappropriate ecological properties of the site. Pingen can be only exceptionally found without a vegetation cover due to the degree of landscape devastation, pingen age, and progressive succession. The presence of resistant pioneer tree species and herbs is common. The degree of plant coverage, resp. the coverage of pingen and its surroundings by individual categories of secondary landscape structure is used to be expressed in the percentage scale.

Results and discussion

The primary objective of the presented work is to clarify the term „pinge“ from a semantic point of view and to determine it according to its characteristic features. The aim is to clarify terms related to particular concave montane relief forms which are inconsistently and inexactly explained by the contemporary scientific literature and are often considered as pingen. The term pinge is often used as a synonym for different relief forms or misplaced as equivalent.

From history, Montanism and anthropogenic geomorphology only shape directly created by exploration or extraction of mineral resources can be considered as pingen. Then we can only talk about two types of pingen – exploratory and mining. Their inseparable parts are heaps, whether different types of slope heaps or moulds.

Pinge can be defined as a depressed relief form, mostly of a funnel-like shape created directly by surface exploration (digging) or surface mining – so-called „pingingo“ (selective surface mining). It is exclusively an anthropogenically formed landscape form. The typical feature of a pinge is the presence of a mould (on a plain) or a sloping heap (on a slope). Two types of spatial layout, linear (pinging) and irregular (randomly spaced) planar (pingen field) layout are characteristic of pingen. However, the occurrence of pingen is always in groups. Pingen does not occur as a random depressed form of relief in montane (mining) landscape.

Based on our analysis, it is clear that other shapes of the concave montane relief did not necessarily need to have a typical funnel shape. They have a different genesis, an absent heap, large dimensions and have their specific systematic apparatus. Despite these facts, they have been called pingen. The most common confusions occur with the following montane forms:

Schurf (schürfe – testing and mining ditches and trenches) is a very old name for exploratory and mining linear shapes (von Charpentier, 1778; Karsten & Dechen, 1835). The shape is a shallow pitch, usually no more than 2 m deep, which is tens of meters long. A schurf has linear heaps in the form of mounds on both sides along its length if the angle of the slope is favourable. These shapes are often referred to as pingen or Surfping (Steen, 2013) in the literature. The historical name schurf can be identified with the term (exploratory, mining) excavation pit (trench), which is a linear exploratory surface mining work, more than 1.5 m wide, and its length must be bigger compared to its depth, while the inclination of the walls depends on rock coherence.

Mining forms referred to as **verhau** (ditch) represent an interstage between surface and subsurface mining. These are narrow linear excavations with very steep or perpendicular and usually rocky walls. They reach considerable depths, sometimes even a few tens of meters (Kratochvíl, 1952). Essentially they represent embossed "negatives" of extracted ore vein structures. These terms are sometimes used as a synonym for old mining (Lueger, 1910). These shapes are inaccurately referred to as pingen, or literally Verhaupingen (Steen, 2013).

Interesting verhaus are for example: verhau at Badenweiler and Münstertal in Schwarzwald in Germany, Himmelsehre near Salzburg in Austria, Vlčí jámy, Červená jáma near Horní Blatná in the Krušné Hory Mts. in the Czech Republic, Bludná at Snžná hůrka in the Krušné Hory Mts., Malá Čertova Zeď in North Bohemia, Rabenstein in Hodruša Hámre in Slovakia (Fig. 20, 21).

Fig. 20, 21. Verhau on Rabenstein ore vein in Hodruša-Hámre (photo L. Luptáková).

Mining (exploratory) ditches are long line shapes excavated - dug off the hillside approximately following the contour. Their bottom is horizontal and does not fall below the lower edge of the ditch. A linear slope heap shaped like an earth mould is at its lower edge along the entire length. **Mining cuts** have a similar genesis (Hrubý et al., 2016). These are small dugout spaces, usually with an elliptical ground plan and an adjacent slope

heap. These shapes are morphologically almost identical to the collapsed shaft openings with the character of bowl-like depressions.

Mining pits - soil ditches and surface quarries of different sizes are created exclusively by mechanisms or by combined blasting and breaking (stone) and are related neither to exploratory nor selective surface mining. These shapes are often unique. Therefore their group occurrence on a relatively small area is improbable.

Creep is a natural or a controlled burial of underground spaces due to the destruction of the ceiling or walls into the excavated underground mining area. The direction of movement is predominantly vertical, and its result is the filling of the originally empty mining spaces with overburden rocks. This process does not create pingen, but sink-holes or depressions. Sink-hole is a more frequent shape, which arises from a sudden catastrophic collapse of the overburden into the excavated spaces. The dimensions of sink-holes can reach several hundreds of meters in all directions. Depression is a part of the earth's surface of a bowl-like or funnel-like shape, in larger dimensions of a pan-like shape, caused by the slow downward (dropping) of the overlying layers into the excavated spaces. By large depressions, we can talk about ñdrop valleys.ò The basic parameters of depressions are derived from their edge, slope, bottom, depth, and area.

Screed openings and the exits of vertical mining works to the surface cannot be regarded as pingen, even though in many cases they retain a heap that originated during the excavation of the original vertical mining work. These concave shapes can be defined either as collapses, backfills (natural but also anthropogenic) of the mouths of vertical mines on the earth's surface. They acquire the characteristic conical shape gradually through natural erosion of the side walls. They arise primarily by screening or filling of the blind shafts or shafts. A blind shaft is an exploratory or mining work mined vertically into the Earth's crust, with a circular or square floor plan with an area of up to 3.75 m^2 and a depth of approx. 20 m, max. To 40 m. The shaft is a vertical or almost vertical underground mining work with a circular, square or rectangular ground plan, which mouths to the surface. With a floor plan of more than 3.75 m^2 and a depth of several tens of meters, it served for various mining purposes (for example, transport, mining, ventilation, drainage, etc.).

Creating new Slovak or national equivalents for individual shapes of concave montane relief is not a very good solution in the current globalising world. These forms are more like a shape-like relief form for which faulty synonyms are used, but the actual term concepts are different. It is, therefore, preferable to use original (often German) mining terms with their original meaning, being precisely defined and denoting the same montane shapes in each language. A partial solution has so far been a sporadic use of a phonetically almost identical term a pinge in English, or pinka in Czech and Polish, or pinga in Slovak. The adherence to their meaningful content as suggested by this study is, however, more important. The unambiguous definition of the term pinge is given together with the determination of the most important determinant, i.e., the original function because the criterion (the genesis of form) used so far has not been unambiguous. Definitions of individual concave montane shapes are derived from the historical early medieval mining, which was formed mainly in the Northern Alps, in the mountains north of the Alps and in the Carpathian region. It has a well-established logic and a steady meaning, which can also be applied in the current scientific research. A similar situation occurs with the one-word terms schurf or verhau. It is best to use the international term "quarry" for excavation pitches that can be identified with historical quarries.

Conclusion

The unambiguity and punctuality of the term pinge are indispensable for research in all disciplines dealing with surface concave relief forms such as Montanism, anthropogenic geomorphology, bearing geology, geography, landscape ecology and planning, and history.

The above-presented unambiguous classification is also necessary for practice and secondary use in montane tourism. It is tourism oriented towards those areas of the Earth that are of exceptional value from a geological point of view. These usually represent key witnesses of the evolution of a certain part of the Earth's surface and made a significant contribution to the development of human society.

From the montane tourism point of view, two possibilities of pingen visits can be offered. Pingen documented near mining towns such as Banská Ġtiavnica can be observed from existing educational trails. Similarly in the Pukanec Forest, where they are a part of the Pukanec educational trail. Some pingen can hide a buried shaft underneath. The material clogging the mouth of the shaft can occasionally collapse to a depth of several tens of meters, says the official web site of Pukanec.

Area of Staré Hory offers the possibility of observing the anthropogenic form of relief of montane origin - pingen. Staré Hory is well-known for the mining of copper ore in the past.

All of the mentioned areas have one thing in common. It is easy to combine montane tourism with traditional tourism, because of existing touristic infrastructure - accommodation, meals, urban and natural attractions. This could greatly facilitate the promotion of montane tourism. Reciprocally, the montane aspect of tourism could enhance local tourism. The holiday area Harmonia in the surroundings of Modra may serve as a good example.

The second option is to create a separate product which includes an attribute of adventure. The idea is to show pingen in nature, discovered by montane tourists themselves without touristic and educational trails. A beautiful example of exploration as well as the specific route is given by Adrián Harniár, Daniela Mlynarčíková and Peter Roth in their article The Extinct Mining Works on the Upper Hornád River, in which they identify and document individual pingen located in the Vernár village surroundings. These can be found and explored, and it was interesting to include them in the montane tourism concept within the area above. There are many possibilities.

Pingen and then their involvement in montane tourism abroad can be seen, for example, in Altenberg and Geyer in Germany, Czechia – Krušné Hory Mts., England - prehistoric mining.

Acknowledgement: *The present study was prepared as part of the project VEGA: Environmental aspects of mining localities settings in Slovakia in the Middle Ages and the beginning of Modern history. No.: 1/0236/18.*

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