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GEOPHYSICAL PROSPECTION FOR ARCHAEOLOGICAL EXCAVATION OF DESERTED MEDIEVAL SETTLEMENTS OF 13.-15. CENTURIES IN THE CZECH REPUBLIC

Introduction

It was not until the beginning of the 1960's that the systematic study of settlements of the High Middle Ages in Bohemia and Moravia began to develop. More than thirty years of scientific work in this field (settlement, village, burial ground, church buildings, manor houses, fortresses etc.) have brought about a large amount of artifacts that give us evidence of different kinds of production and serve the purpose of deeper understanding of everyday life in rural areas and suburbs.

The character and development of medieval settlement were influenced by ecological conditions that were determining activities of the settlers in terms of satisfying their basic needs. Evidence of the development of society at that time is provided by open and walled agricultural settlements consisting of wooden and stone (rarely) buildings. During their historical development some considerable changes occur in terms of their structure.

Villages were emerging but some of them also perished. For instance in the Middle Ages in Bohemia there were 3000 deserted villages, in Moravia it was 1400. It has been proved by investigations that most of the Moravian ones (approx. 807) perished in the 15th century and at the beginning of 16th century.

According to V. Nekuda (1996) the causes of the process of desertion were the following:

structural changes in local economy, i.e. introduction of a new land administration system (end of the 12th – beginning of the 13th century),

emergence of towns – migration to towns (e.g. the medieval Hussite villages in the region of Tábor, i.e. those that were referred to as related to the Hussite movement)

serf migration from the villages – forced to pay feudal rent (since the 14th century),

wars (14th – 15th centuries),

climatic changes, natural disasters, epidemics etc.

In Moravia there were a large number of villages in mountain ranges that survived, whereas the villages in the valleys of Central and South-Eastern Moravia perished and gave rise to large cadasters (VÁLKA 1991). It is possible that one of the causes was migration to larger settlements which could be better defended; probably another cause was that it was easier to manage the arable land in large cadasters rather than in small pieces. The villages were located close to sources of water and roads.

The structure and character of medieval settlements can be traced from excavated settlemets such as in Bohemia: Svídno (region of Kladno), Sezimovo Ústí (district of Tábor), Tisová near Staré Mýto (district of Ústí nad Orlicí), Kravín, Potálov, Smolín (district of Tábor) and in Moravia: Záblacany near Polešovice (district of Uherské Hradiště), Pfaffenschlag near Slavonice (district of Jindřichův Hradec), Mstěnice near Hrotovice (district of Třebíč), Konůvky (region of Slavkov, district of Vyškov), Bystřec near Jedovnice (district of Blansko), Topolany near Vranovice (district of Břeclav), Kovalov near Žabčice (district of Brno) etc. The actual excavation works were focused on excavating individual buildings as well as whole settlements, determining types and their relation to the landscapes and the observation of settlement structures which helps to understand the economical development in the feudal period. Also methods of agricultural production and collected artifacts (such as pottery, tools made of metal, stone and bones) are gathered and studied.

Geophysical methods have become an integral part of complex investigation of medieval settlements after tentative magnetic measurement done by Lerici Foundation at the end of the 60's in the deserted village of Svídno (SMETÁNKA 1969) and a practical verification of resistance profiling in Staré Mýto (BÁRTA 1973) and Sezimovo Ústí (BÁRTA 1971). For the first time they were systematicaly applied at the excavation of a settlement in Záblacany near Polešovice (the second half of the 10th century – the 13th century) in 1971 (BÁRTA 1971) and 1974 (HAŠEK - LUDIKOVSKÝ 1977).

Geophysics was also applied but to a greater extent at the excavations in Tisová near Staré Mýto (MAREK - RICHTER 1987, 1989), Sezimovo Ústí (HAŠEK - KRAJÍC - TOMEŠEK 1995), Kravín (HAŠEK - KRAJÍC 1992), Bystřec near Jedovnice (HAŠEK - MĚŘÍNSKÝ 1991; HAŠEK - UNGER 1998), Mstěnice near Hrotovice (HAŠEK - NEKUDA 1998a), Kovalov near Žabčice (HAŠEK - MITRENGA 1992). This survey succeeded in tracing the overall size of the settlement and its separate buildings with their ground plans. The survey also enabled the archaeologists to locate cellars and different kinds of production buildings as well as to trace phases of the bulding process and/or the process of declining.

A sensible combination of aerial and geophysical prospection, and archaeological excavations for dealing with the issues relating to medieval settlements has brought about an abundance of new information and knowledge over the past thirty years. This knowledge provides scientific evidence towards completing the picture of the medieval village and the life of its inhabitants. In addition

it has considerably contributed to determining the settlement patterns in different regions of the Czech Republic.

Outline of the Deserted Medieval Villages

Until the 12th century the area of the Czech Republic was inhabited below the altitude of 300 – 350 m above sea level. Areas of this altitude featured a relatively higher average temperature as well as loess soils with the pH ranging from alkaline to neutral; e.g. the regions of Polabí, Povltaví, Pomoraví, Podyjí (i.e. valleys of the rivers of Labe, Vltava, Morava, Dyje) etc. The overall ground plans of settlements were influenced by the morphology of the terrain.

At the turn of the 12th century the process of settlement was going on up to an altitude of 500 m above sea level. There were areas of considerably lower average temperature compared to those of 300-350 m (Bohemian-Moravian Highland, areas at the edge of the Bohemian Valley). The soil in these areas was not as suitable for agriculture as the loess soil down in the valleys. In the 14th century, which was the third stage of the settlement process, areas higher than 500 m above the sea level also became inhabited, which brought about the necessity to face fairly unfavourable conditions such as low temperature, low soil fertility etc.

Based on the results obtained from archaeological excavations of deserted medieval settlements in Bohemia and Moravia it is possible to state that during the 12th and 13th centuries the scattered pattern of agricultural settlements began to change. Ground plans of the villages already had permanent outlines. At the end of the 13th century the irregular layout of several buildings grouped around the nobility's farmsteads was gradually replaced by well structured settlements.

The position of older types of villages (12th century) was determined by water source. Most of the settlements were located at river banks. Later settlements (13th cent.) were also built in the vicinity of rivers and brooks, but more frequently at confluences or the sources of the rivers. The settlements had to move up to higher areas.

The villages of the 13th –14th centuries tended to be larger in size than earlier settlements. Settlements with the average of 15-30 houses were found. Older settlements were gradually rebuilt to match the more closed types of village, i.e. street type and common types. Settlements in the so-called „location villages„ are lined up in regular rows relatively close to each other, either along both banks of a brook or along a road. The houses usually face each other with gables. In common-type villages the houses are lined along a triangle, square or circle-shaped common (PETRÁŇ et al. 1985). Roads enter through the corners of the common.

During the late settlement period, when settlement was reaching higher and higher areas, the long-village type with rows of houses was prevailing. Crofts were located behind the houses lined up along the banks of a brook.

Earlier Slavonic development was followed by single-room sunken buildings (cottages) and surface buildings. The sunken cottages uncovered in settlements from the Early Middle Ages (e.g. Mstěnice, Kravín) had square, rectangular or

oval-shaped ground plans. The depth of the underground part of the cottages was approx. 0.6 – 0.7m, the area was 12-14m^2 (NEKUDA 1997). From the 13th century onwards surface three-part houses (so-called chamber and granary type) with more than one room were emerging.

During the excavation of Mstěnice it was found out that most of the uncovered ground plans represented three-part houses of the chamber type, i.e. a house with a room and a chamber on the sides and a hall in the middle. The foundations were built of stone, width 60-80cm, height 50-70cm. The overall length 14.5 – 17 m, width 5 – 7m. The houses are oriented towards the common with gable walls. The chambers are predominantly square, approx. 12.5 – 16 m^2. Single-room houses and storied granaries of square ground plan (16 – 27.5 m^2) were either separate or they were built as a part of a three-part house. In Central Moravia the parts of houses were also perpendicularly arranged. The excavation of Konůvky and Bystřec showed that the hall and chamber were perpendicularly attached to the room.

The buildings differ in construction, the material they were built of and function. Since the beginning of the 13th century stone from local quarries was becoming more and more frequently used not only as foundation material for wooden houses but also as an ordinary building material. Auxiliary buildings such as barns and sheds were usually built of wood.

During the 15th century brick walls start to emerge in South Bohemian Hussite villages. Single-room sunken cottages were also uncovered with their sunken walls covered by stones or supported by a wooden structure. Also a further development of the three-part house took place here. Fields, meadowland and pastures were, alongside houses and auxiliary buildings, an inseparablepart of any settlement.

Between the 13th and 15th centuries there were three basic groups of village-house furnaces in the Czech Republic:

an open fireplace without a furnace,

an open fireplace attached to a furnace for heating,

a separate furnace without an open fireplace.

Agricultural (auxiliary) buildings such as stores, cellars, granaries etc. were either attached to the residential parts of the houses or they stood separate (barns, cowsheds).

Archaeogeophysical Prospection

Methodology of Terrain programme

The methodology of geophysical survey employed during an archaeological excavation of open and walled-in medieval settlements is based on:

knowledge of

surface inhomogeneities that occur due to human activities in the Middle Ages (e.g. sunken buildings of various size, relics of foundation walls etc.)

geological structure of the site, thickness of the anthropogenic layer, lithological properties of the soils in the subsoil that consist predominantly of a wea-

thered clay-sand layer that originates from the past effect of tropical climate on culmic Palaeozoic rocks, and crystallines,

probability of intensive interference in the vicinity of suburbs and various installations due to industrial currents and overhead/underground power-distribution networks,

knowledge obtained by geophysical and drilling works in historical city centres (13^{th}-16^{th} centuries), e.g. Hašek - Měřínský (1991), Hašek - Kovárník (1996), Hašek - Unger (1998), Fuchs - Hašek - Unger (1997), Hašek - Tymonová - Unger (1997), Hašek - Unger - Záhora (1997),

contemporary trends in the applicability of different geophysical methods in different kinds of environment.

Objectives of the archaeo-gophysical prospection:

tracing the overall size of the inhabited structure,

determining the ground plans of residential buildings, agricultural buldings, their arrangement and bearings in terms of morphological configuraton of the terrain,

determining the nature and properties of buildings - sunken cottages, semi-sunken cottages, houses with stone underpinning, storage pits etc.,

locating granaries, cellars, underground corridors,

detecting stone or earthen furnaces and fireplaces,

locating production buildings such as blacksmith's and potter's workshops, mills etc.,

The grids for geophysical surveys were determined in accordance with the particular terrain; they were calculated to be roughly perpendicular to the estimated position of the searched structures, i.e. predominantly N – S or W – E .

In the Czech Republic geophysical surveys are usually carried out employing a complex of methods: magnetometry – surface gradient measurement, dipole electromagnetic profiling and georadar.

The purpose of magnetometry is to trace the sources of shallow anomalies (max. depth 1.5 – 2.0 m) caused by:

terrain depressions filled with dark (fossil) soils with organic debris, sherds, pieces of charcoal, etc.; differencial magnetization of these depressions is positive in relation to the surrounding terrain: *cultural layers* (layers that include traces of human activity from a given period of time), settlement buildings, ditches, etc.,

burnt clay, furnaces with stones and/or bricks that became magnetized by high temperature combined with the geomagnetic field; thermoremanent magnetization takes place in soils with a content of magnetite exposed to high temperature with subsequent cooling down in the Earth's magnetic field: relics of brick foundations, etc.,

rocks of higher magnetic activity in walls (granodiorites, some metamorphites, basic and ultrabasic (volcanic)),

Fe-artifacts of different size, age and properties.

The surveys are currently carried out by PMG-1 gradiometers with adjustable sensor height. A grid interval measures 2 x 1 m or 2 x 2 m.

The purpose of the dipole electromagnetic profiling (DEMP) is to obtain a detailed set of data on:

bearings and size of stone and/or brick wall relics of surface buildings of various functions (residential, agricultural, production), and sunken buildings (sunken cottages, semi-sunken cottages, ditches),

lithological structure of the surface anthropogenic deposition and its subsoil, cumulation of rocks etc.,

power-distribution networks that differ from the surrounding environment in terms of their conductivity and resistance as the surroundings consist of clay-sand soils, gravel, sand, crystallines, etc.

The measurements are carried out by KD-2 (similar to Geonics DLM EM – 38) digital conductometer. The distance between transmitter and receiver is 1 m, frequency 13.2 kHz. The depth range which is determined by the distance between the transmitting and receiving magnetic dipoles is given to be about 1.5 m (vertically polarized dipoles), (HAŠEK - UNGER - ZÁHORA 1997). The depth range is about half of the above if the dipoles are horizontally polarized. The depth range also depends on the conductivity of the surrounding terrain, properties and size of any occuring inhomogenity, and the amplitude of an anomaly caused by such inhomogeneities.

The overall measurement of apparent conductivity is usually carried out employing ZZ-polarization in a grid interval of 2 x 1m or 1 x 1 m.

To determine the bearings of the targeted structures (remnants of stone wall, cellars, underground corridors, etc.) more accurately, a Swedish ground radar RAMAC/GPR is used (antenna 100 – 200 MHz, depth range 2 – 4 m) The antenna makes a continuous measurement on the surface at intervals of 10 cm.

Data Processing

Assessment and interpretation of the obtained (in some cases filtered) data from the magnetometric and DEMP measurements is usually carried out by a computer in T_z isanomale map format (formerly total vector of T magnetic field) and isolines of apparent conductivity ($\wp$ app = 1000/sapp).

The archaeological structures are depicted by both linear oriented and isometric (positive, negative) T_z anomalies (ΔT) as well as zones of increased or decreased conductivities.

GPR profile measurement output is a radarogram that lists the time of wave reception since transmittion of. an electromagnetic impulse. This method is based on the permissivity and resistance differences (ε_r) in different layers and inhomogeneities. Local inhomogeneities that occur in the surface layer (esp. relics of stone or brick walls, cumulations of stones from demolished walls, underground cavities, etc.) show multiple reflections of electromagnetic waves that look like a number of hyperbola-like curves piled up at different thicknesses and orientations. Sometimes they appear to be interrupted at individual reflection levels. A greater slope (such as ditches or contemporary structures) in

the subsoil that causes a considerable diffraction of electromagnetic waves show graphs similar to the above mentioned multiple reflections.

Discussion of Results

The following paragraphs present the main results that have been achieved over the past 10 years of the co-operation between geophysics, geology, aerial photography and archaeology at the most explored excavation sites in Bohemia and Moravia. Please see Figure 1. for an overall map of the sites dealt with in this article.

Deserted Medieval Towns – SEZIMOVO ÚSTÍ, district of Tábor

The site is situated on the left bank of Lužnice river at an altitude of 391-393 m above sea level. The area is slightly hilly and declines down to the banks of the river.

From the geological point of view the area lies in the vicinity of biotite – pyroxenic syenite and biotite paragneiss of a varied series of moldanubium with scattered spots of Miocene sediments from the Bohemian Massif. The Quaternary deposits include Pleistocene river sand and gravel-sand as well as loess soils (5–6 m layers).

A systematic archaeological excavation of the site was started in the 1960's by the former Institute of Archaeology, Czechoslovak Academy of Science (Institute of Archaeology, Academy of Science of the Czech Republic, since 1993). The archaeological excavations and prospection have been carried out in co-operation with the Hussite Museum, Tábor with occasional interruptions up to the present.

At the investigated area of the Nové Město (New Town) in the medieval Sezimovo Ústí, relics of dense inhabitation with buildings from the second half of the 13th century to the first half of the 15th century were found (Krajíc 1989) (Fig. 2). In the first half of the 15th century Nové Město burned down. The latest buildings were closed residential units about 23 x 9 m, that faced water sources coming from a slope on the western side of the site (Fig. 2). The houses are lined up in two rows on an elevated strip of land along the river. This feature is reflected in the inner division of the parcel.

Residential parts (with cellars) were located closer to the brook. The basic bulding unit was a house with a complicated ground plan and stone underpinning (biotite gneiss $\chi_{zd} = 0.125 \times 10^{-3}$SI units). Other separate buildings with the dimensions of 7 x 2.5 m, 5.6 x 4 m, 4.2 x 3.5 m, etc., including cellars, wells, garbage pits, etc were also part of the house complex . They are filled predominantly with a brown soil layer and rubble ($\chi_{zd} = 0.14 \times 10^{-3}$SI units) with clay ($\chi_{zd} = 0.33 \times 10^{-3}$SI units), a brown-gray and brown-red burnt layer, clay, pieces of charcoal, burnt pieces of wood ($\chi_{zd} = 0.50 - 0.80 \times 10^{-3}$SI units) and yellow-gray sand ($\chi_{zd} = 0.06 \times 10^{-3}$ SI units). Many settlements were built on the plots of older buildings. Archaeological artifacts, the remains of settlement buildings (foundation stonework, destroyed stonework, traces of fires, etc.) as well as re-

lics of medieval technological systems prove that the inhabitants were specialized in trades (KRAJÍC 1989, 1992).

In the south-eastern part of the site there is an area of 70 x 40 m that remained unexcavated (Fig. 2). In order to complete the topographical survey and identify the overall characteristics of this medieval suburb as accurately as possible , archaeogeophysical prospection and pedological sounding were carried out.

The main purpose of the geophysical work in 1996 was mapping the sites and ground-plan shapes of historical settlement complexes, production buildings and other structures located in the vicinity of Luznice river. The surveys were carried out employing magnetometry and dipole electromagnetic profiling (DEMP). An area of 2800 m^2 was measured in grids of 2 x 1 m and 5 x 5 m. The main anomalous zones were investigated by pedological probe to the depth of 1 m.

Magnetic survey showed a number of local isometric and linear positive and negative anomalies that could be caused by contemporary iron objects and detected underground cables, relics of historical surface buildings or demolition rubble. The results of DEMP measurement were similar, i.e. the increased specific resistance located stonework or concentration of building materials, etc., whereas decreased specific resistance indicated clay soils with a possibility of water saturation.

According to their mutual correlation and location of anomalous zones the results of both employed methods (Fig. 3) show four settlement groups that, perhaps, include cellars (as the *cultural layer* is thicker than 1m), and buildings with stonework in their foundations (largest dimensions are 9 x 7 m). Possibly there are also extensive demolition layers or rock beds that were indicated mostly by negatively polarized anomalies of the geomagnetic field as well as high values of specific resistance measured by DEMP. Based on the results of the geophysical works it is possible to conclude a similarity to the excavated northern part of the suburb that was excavated. The relics of medieval settlement in this unexcavated part are concentrated to the western part of the area, along the right bank of a nameless brook. Individual historical buildings measured from 2 x 2 m to 12 x 15 m, in some cases it was possible to locate spots with an acumulation of iron objects, slag and possibly remains of production devices. Pedological probes employed in points of geophysical anomaly vertices proved the hypothesis of occurence and cumulation of medieval structures. Almost all probes were positive in terms of archaeology, i.e. they indicated cultural layers (Krajíc 1998).

Based on the results of measurements, the obtained data and basic information (Fig. 3) can serve as an aid to future archaeological excavation of this part of the site.

Deserted Medieval Villages – KRAVÍN, district Tábor

Buildings uncovered during large-scale excavation works are of high importance for the study of the material culture of medieval settlements. Combined with historical data, surface examination and sciences it is possible to get the

most of the obtained materials. This was the way we carried out our measurements and excavations in the deserted Hussite villages of Kravín, Kavči and Potálov. The area excavated included a total of 15 buildings from the second half of the 13th century until the first half of the 15th century, when they were abandoned.

The deserted medieval village of Kravín is located between Sezimovo Ústí and Turovec (Fig. 1), about 6.5km south from Tábor. In terms of geomorphology this region is a part of Tábor Hills (CZUDEK 1973).

Prequarternary rocks are represented by biotite paragneiss of moldanubicum ($\chi_{zd} = 0.123 - 0.213 \times 10^{-3}$SI units), the overlayers include Quaternary weathered clays and sands.

The beginning of the study of this site dates back to 1965-67 when the former Institute of Archaeology, Czechoslovak Academy of Science uncovered a large sunken cottage (7 x 6 m) and a surface building of about the same dimensions, built on a semi-sunken underpinning wall with a clay furnace. The occurance of a single-room semi-sunken residential cottage (compared to the majority of the so far excavated buildings) shows a rather primitive environment in medieval rural areas at the beginning of the Hussite Period (KRAJÍC 1983). A systematic prospection of the site was started in 1973 by the Hussite Museum in Tábor (KRAJÍC 1980). Surface prospection of the 7-hectare area showed more than 30 semi-sunken single-room buildings. Two single-room semi-sunken cottages with buried walls were excavated. The walls of the building were destroyed, only corners remained in the original shape up to the surface level. A detailed investigation of building nr. 1 which was semi-sunken (average depth 130 cm) showed its roughly square-shaped ground plan (2.75 x 2.25 m). The northern part of the hollow is the actual room of the building, and is filled by brown-yellow clay with relics of destroyed walls and a brown-gray layer of clay and sand. The southern part makes some kind of entrance with stonework at some places (Pl. 1).

Apart from the above mentioned buildings and a paved area between them a well with stonework was excavated during this season.

The archaeological excavation carried out in 1965-86 showed that this village falls into the scattered type of village according to the arrangement of the excavated buildings. Residential rooms were not the only elements of this settlement unit. The semi-sunken single-room square or rectangle-shaped ground plan is a characteristic feature of all the six excavated buildings apart from the well and a furnace (KRAJÍC 1983). In the case of a deeply sunken building the edges of the pit were sloped and so the vertical sides of the pit were 100-120 cm deep but the total depth measured from the surface to the bottom was more than 200 cm. The surface part of the building probably had a log-cabin structure (Pl. 2). The traces of clay found suggest additional treatment of walls. All excavated buildings had the features of a sunken building, i.e. the entrances were protected by a slope or stair-shaped neck. Orientation of the entrances was not alike in most cases. The single-roomed, semi-sunken residential buildnings included basic items such as a fireplace, storage pits, etc.

There were also other sunken buildings that formed a part of a residential unit apart from the actual residential house, a well and a paved yard. These buildings served as storage space or as a small workshop for minor private trades' activities. They were usually built as surface buildings. The building materials of all buldings included bricks, tiles, paragneiss, wood and bonding agents such as soil mixed with clay and mortar. Based on the ground condition and uncovered objects it is possible to state that the buildings were abandoned deliberately and suddenly. No traces were found of fire in the vicinity of the uncovered buildings which is the reason why it seems that the settlements were abandoned quickly and for reasons other than fire. Evidence for a quick flight is provided by many artefacts that were just left in situ (KRAJÍC 1983).

In 1992 a magnetometric measurement of an area of 60 x 35 m (grid 1 x 1 m) in the north-westen part of the site was carried out in order to complete the knowledge of the archaeological situation of this village.

The area still features five morphological depressions that were several metres in diameter and whose depth ranges from 50 cm to almost 2 m. Based on the experience from archaeological excavations of similar features we expect these structures to be medieval sunken buildings (houses, auxiliary buildings, etc.). Since this site does not show any surface evidence of boundaries between the plots it was decided to carry out a detailed mapping of the site as well as geophysical prospection in order to check the properties of the visible depressions and to detect possible surface anomalies.

The most remarkable result of the magnetometric measurements (Fig. 4) is a detection of six spots (8 x 6 m) with strong negative anomalies of the geomagnetic field (marked as A-E, G) that are in places surrounded by positive point ΔT anomalies (fireplaces, furnaces, storage pits). In their vicinity we found both positive and negative linear ΔT anomalies (relics of brickwork and stonework). Hence it is possible to consider the deserted medieval residential and auxiliary buildings to be more accurately located by the measurements. In their vicinity the remains of other residential elements can be found, e.g. surface buildings, furnaces, pavement, roads etc. that are indicated by intensive flat ΔT anomalies (marked as B1 – E1, G1) measuring approx. 6 x 6m – 9 x 7m.

The processed data also suggests that a higher concentration of medieval settlements can be expected in the western and south-western part of the site.

The results of all the measurements thus make for a sound basis not only for completion of the ground plan of the village but also for the proposed archaeological excavation of this site.

BYSTŘEC NEAR JEDOVNICE, district of Blansko

The deserted medieval village of Bystřec is located in a valley of the Rakovec Brook, about 4 km south-east of the town of Jedovnice. The village originates at the beginning of the 13th century when the Drahanska Highland was being covered by a network of minor villages, market settlements and small towns. The decline probably occured between 1437 – 1464 since it is he ween these dates that the village was referred to as abandoned.

The region of interest is formed of culm rock bed (Early Carboniferous) (χ_{zd} = 0.10 x 10^{-3}SI units) with layers of conglomerate and Racice-type conglomerate. The upper layers include Quarternary weathered clay-sand, sand and flood plain deposits.

The village was discovered by E. Černý at the beginning of the 1960's (ČERNÝ 1970; ČERNÝ - ČERNÁ 1964) when he identified terrain elevations over the settlements and determined size of the village. A systematic archaeological study of the site was started by the Moravian Museum (V. Nekuda) in the mid 70's. The works carried out during 1975-98 have brought about a large amount of evidence that explains the settlement process in the region, new knowledge on development of residential houses, material culture and social structure (BELCREDI - NEKUDA 1983; NEKUDA 1976; BELCREDI 1986; 1986a; 1997; 1998).

The semi-sunken cottage with a fireplace represents the oldest type of building, whereas stake-built houses with big stone furnaces (χ_{zd} = 28.6 x 10^{-3}SI units) are representatives of later periods. The last type of bulding comes from the 14th century. Their rooms featured stone foundations for a log-cabin type of structure. The largest settlements were multiple-room buildings with hook-shaped ground-plan featuring a room, hall and an auxiliary building. The other buildings were probably a barn and a shed. A large number of agricultural and craftsmen's tools were found.

A thick burnt layer (a layer of ash, pieces of burnt wood, burnt clay etc.) found in all buildings provides evidence of a violent destruction of the village that took place in the framework of many wars that were going on in Moravia from the end of the 14th century until the 1570's.

Geophysical magnetic measurements became an integral part of excavation work in 1984, 1986, 1987, 1995, 1996 and 1998 . The measurements focused on the left and right slopes of the valley, i.e. an area of approx. 5.4 hectares (HAŠEK - UNGER 1998)

The purpose of these measurements was to determine the location and size of the individual settlements and to compare the results with those of E. Černý 1970. The data obtained in ΔT and T_z isoanomaly format shows that the subjects of measurements feature predominantly positive isometric anomalies, in places there were also linear negative anomalies of the geomagnetic field that suggest locations of square and rectangle-shaped plots (residential and auxiliary buildings) measuring approx. 3 x 5 m, 10 x 10 m, 15 x 10 m (HAŠEK - KOVÁRNÍK 1996). Regarding the intensity and extent of the anomalies we expect their sources to be combinations of burnt clay daub, furnaces, Fe-objects, sunken buildings, wells, wall relics etc.

The extent of the plots found so far is given in Figure 5. A comparison of location of individual plots according to Černý (1970) with geophysical interpretation of the data obtained and archaeological excavation highlights the fact that the geophysical measurements provided a convenient set of data on the number, size and location of the plots situated on morphological elevations. It is possible

that the village is larger than it appears from the excavated parts (BELCREDI - HAŠEK - UNGER 1990; HAŠEK - UNGER 1998).

The archaeological excavation carried out after the geophysical survey supported the main conclusions from the processed data. As an example we mention the results of excavation of settlements nr. V (BELCREDI 1997a) and nr. IX (BELCREDI 1998).

An artificially elevated strip along the left bank of the brook and western edge of the village ground plan included foundations of the settlement nr. V (Fig. 6). Area A (+ 100 nT) was the best preserved one, covered by burnt layer of clay daub from the ceiling and possibly from the walls, with a large number of iron objects. Due east of this building we investigated the first example of a separate granary whose cellar part featured stonework B (+ 50 nT). Due north of A we found a minor auxiliary building with a light stone foundation and burnt layer of clay daub C (+ 40 nT). Due north of the granary a residential building was excavated with a thick burnt layer of soil, sand and rocks D (+ 30 nT) (BELCREDI 1986, HAŠEK, MĚŘÍNSKÝ 1991). Due north/north-east from this group were several auxiliary buildings of different size, with relics of stonework E1 (+ 12 nT), E2 (+ 20 nT), E3 (+ 40 nT), E4 (+ 20 nT), E5 (+ 25 nT), due east of E2 there was a dung-hole F (+ 5 nT) (BELCREDI 1997).

Foundations of the building nr. IX (Fig. 7) were located on a morphological elevation situated on the right slope of the valley, i.e. the south-eastern edge of the village. An intensive ΔT anomaly (+ 50 nT) showed a big clay daub cake (8.5 x 7.5 m). The top of the elevation is created by a preserved foundation of a horisontal rectangle-shaped furnace (250 x 150 cm) (B). About 5 m due west from B we found a 12cm thick layer of slightly burnt clay daub (C) measuring 450 x 250 cm that was probably subsequently pressed down to the soil (+ 5 nT). A further 5 metres due west was the only auxiliary building found in this settlement D (+ 25 nT). Also a very well preserved storage pit of irregular plan (185 x 162 cm) was uncovered here. About 5 metres due south of C in an area of 400 x 275 cm we uncovered a 13cm thick layer of completely black soil with pieces of charcoal, tiny pieces of clay daub and a Fe-object E (+ 15 nT) (BELCREDI 1998). Due east of C a negative linear ΔT anomaly F (- 5 nT) was detected as it showed the position of destroyed stonework.

The investigation of the deserted medieval village of Bystřec with an excavated area of more than 3000 m^2 demonstrates its significance for the study of medieval settlement structure as well as the process of their decline.

MSTĚNICE NEAR HROTOVICE, district of Třebíč

The village of Mstěnice was located in the range of Jevišovická pahorkatina (Jevišovka Hills) at the confluence of two brooks (Mocla and Mlýnský potok) at an altitude of 350m above the sea level. Down from the confluence the brook is called Rouchovanka (Fig. 8). The geological bed of the area includes biotite orthogneiss of the Moravian type of moldanubicum (χ_{vd} = 0.8 x 10^{-3}SI units). The village lay in a valley which is about 40 metres below the area surface level. From the geophysical point of view the area is strongly influenced by ser-

pentinite (χ_{zd} = 11.4 x 10^{-3}SI units) that occasionally come to the surface as rocks. On one of them a stronghold was built during the second half of the 13th century.

A phosphate soil analysis was employed in order to precisely determine the properties of the inhabited area. Places that were inhabited in the past have been identified as containing a higher amount of P_2O_2. Its content depends upon the amount of waste compounds containing phosphate. Soil samples were gathered from an area of approx. 6000 m^2. Analysis showed that more than a third of the samples contained a high amount of phosphorus, i.e. 0.16 – 0.41 %. In 1960 the Moravian Museum in Brno started excavation on the places with a high phosphorus content.

The earliest inhabitation of Mstěnice dates back to the later Stone Age. This period is represented by one building with Moravian Painted Pottery. Further inhabitation is connected to the arrival of the Slavs at the turn of the 8th century AD. Since then the process of inhabitation continued till the mid 1500's when the village was burned down by troops of Mathias Corvinus, the King of Hungary. Buildings from the early Middle Ages were scattered all around the site and they were frequently built upon during later medieval periods. The oldest buildings were single-room sunken or surface cottages. Their area was 16 – 20 m^2, the cottages featured fireplaces or furnaces. Among the most important auxiliary buildings were grain pits whose volume ranged from 5 to almost 50 hl of grain. Apart from the grain pits there were also underground corridors that can be included auxiliary buildings. So far the excavation works have identified 7 underground corridors on the site.

The main work of the inhabitants was the cultivation of grain and the keeping of domestic animals. Apart from peasants there were also potters and smelters whose furnaces have been found. A new element that appeared in the late 1200's was a fortified residence – a stronghold that was build on a cliff and became a residence of a lower noble and his family.

The 13th century was a turning point in the life of the village as the village was rebuilt in a regular shape. The houses are lined up in two slightly bent rows that touch each other at both ends to make a central common. There are 10 dwellings in the northern row and 7 in the southern row. The parcels are rectangle-shaped with a three-part residential house and auxiliary buildings (barns, granaries, sheds etc.) along the sides. All the houses' gables faced the common except for house nr. XIV (the biggest house in the village) that faced the common with the longer sided of the building (Pl. 3). Mstěnice features all kinds of yard, i.e. one-part yard (e.g. nr. XV), parallel double-side yard (e.g. nr. IV), hooked double-side yard (e.g.nr. II), triple-sided yard (nr. III and XI) and four-sided yard (nr. VIII). Archaeological excavation in Mstěnice has for the first time brought about authentic evidence of each single type of agricultural buildings. The excavation results also explained the development of three-part houses (R. NEKUDA - V. NEKUDA 1997) and helped to date the buildings. Radar measurements proved continuation of low stone walls in the so far unexcavated parts of the site, i.e. dwellings nr. XIV, XVI and XVII. In front of the

dwelling nr. I the measurements showed relics of stonework near a dirt track (Fig. 9).

Due west of the excavated parts there is a relatively large piece of land (4000 m^2) that has not been analyzed for phosphorus. Therefore we carried out a magnetic measurement to find any possible remains of archaeological objects. Four extensive T_z anomalies were found (B3, B4, B5 and B7) that might correspond to the remains of buildings oriented in the NW-SE direction. Several isometric magnetic anomalies might indicate sunken buildings from the period of fortified settlement (Fig. 10). Across the measured area in the north-south direction there has been found a track that is recorded on a map from the early 19th century. These results prove the hypothesis that the northern row of buildings is longer than the excavation work has so far uncovered.

A very significant set of information on Mstěnice was provided by written sources, primarily the so-called Land Boards of Brno (Zemské desky brněnské) that register transfers of property. Hence we find out about the stronghold, yard and mill (1407). The mill that is mentioned in the Boards has not yet been found. Probably it was a water mill, which is confirmed by the name of the brook (Mill Brook – Mlýnský potok). In order to identify the location of the mill geophysical methods (magnetometry,DEMP) in 1997 were applied. Results of the measurements show several isometric and linear T_z anomalies and zones of increased or decreased conductivity that might identify archaeological structures. The space of two linear T_z anomalies with a NNW-SSE and NE-SW axis and an area of reduced conductivity might be caused by a combined effect of a layer of demolition rubble, relics of brickwork and a clay daub cake from a surface building or a group of buildings (16 x 7 m), that are situated in the vicinity of the original track of Mill Brook (Fig. 11, 12). The above mentioned featured can lead to the conclusion that the arrangement and orientation of the anomalies pinpoint the position of the medieval water mill.

The geophysical measurements were followed by archaeological excavation in September 1998. Despite the lack of time and bad weather we have succeeded in locating a part of a low stone wall and a clay daub cake. As we have also found fragments of millstones we expect the structure to be a part of the mill (Pl. 4 – 7).

The long-term purpose of the systematic archaeological excavation of the village of Mstěnice, which is the single example of its kind in the Czech Republic, is to obtain the overall ground plan of the whole village and its organizational structure. A further aim is to use this example to describe and clarify the development of settlement, the economical and social patterns of that time and social position of the villagers.

Conclusion

Excavations of deserted medieval settlements in the Czech Republic, combined with archaeogeophysical prospection prove that the 14th century was a period of quantitative changes in villages. The changes concerned ground plans and

arrangements of buildings, equipment of dwellings and arrangement of fields. This partial knowledge is then used as a base for decisions on further procedures of the excavations or measurements. The main purpose is a complex investigation of villages from the 10th century to the beginning of the 13th century. This aim might be very hard to accomplish, in terms of financial means and time; however, at the same time this aim is extremely important if archaeology is to contribute to dealing with the issues of economic and social history. The village of Mstěnice has a special place as its investigation has brought about a great deal of new knowledge.

Since the present state of our knowledge has many weak points we have to continue investigation and study of the high-medieval villages, based on the program of study of the early Middle Ages. The development patterns of settlement arrangement in south-western Moravia (Pfaffenschlag, Mstěnice) differs from those of Hussite settlements in southern Bohemia (Kravín, Potálov). The greater the number of sites investigated, the higher the information value of archaeological sources.

Agricultural production is one of the most fundamental issues of medieval history. Archaeology contributes to dealing with this issue by authentic sources of knowledge concerning the techniques of agricultural production, cultivation and animal husbandry. Dealing with these issues requires a close co-operation with other scientists, particularly with botanists and zoologists. In the study of High Middle Ages it is necessary to search in written sources as well.

A systematic archaeological investigation of the deserted settlements proved the importance of archaeological sources of knowledge for solving a variety of questions concerning the development of medieval villages, and their decline. The sources also create a sound basis for the study of economic and social history. Mstěnice is, after Pfaffenschlag, another example that clearly shows economic development with specific evidence of structures and artifacts. Unlike Pfaffenschlag, Mstěnice is much more significant in terms of economy since before the 13th century the village featured iron smelting and pottery, which proves that trades were not restricted to town and city centers and that trades remained a part of agricultural production. An arrival of a potter could be connected to the origin of the stronghold since the pottery found in the stronghold was the same as the pottery found in the potter's furnaces. Hence we know they were produced by the Mstěnice potter for the noble as well as for the villagers. Production of iron had the same function – to supply the noble with iron and iron products.

The most important archaeological sources obtained by systematic investigation of Kravín, Bystřec and Mstěnice are those that are connected to agricultural production and organization of agricultural settlements. Comparing the situation before and after the 13th century we see for instance a significant difference in quality of farm tools, technique of ploughing, grain storage, housing and ground plan of agricultural settlements.

An equally important role in the Czech medieval archaeology is played by investigation of medieval towns and their predecessors (so-called pre-located agglomerations) occuring in castle areas. For example the sites of Tisová near

Vysoké Mýto, Sezimovo Ústí and Tábor are very important for the study of the issues of town settlement in the 13th to the 15th centuries. During investigation of these sites many key-questions of medieval town topics were being solved, e.g. emergence and development of built-up areas in the 13th century, the oldest form of housing in the town, house development etc. The economical life of rural areas as well as other social groups of the medieval society were all connected to towns.

In this article we tried to briefly point out the current situation of archaeological investigation in the field of deserted medieval settlements in the Czech Republic. Its further development is unthinkable without extensive application of scientific and technical methods such as geophysics, aerial prospection, palaeobotany, metallurgy, pedology, petrography, anthropology etc. Their future results will bring about a complex approach to solving the questions that arise in the field of medieval archaeology.

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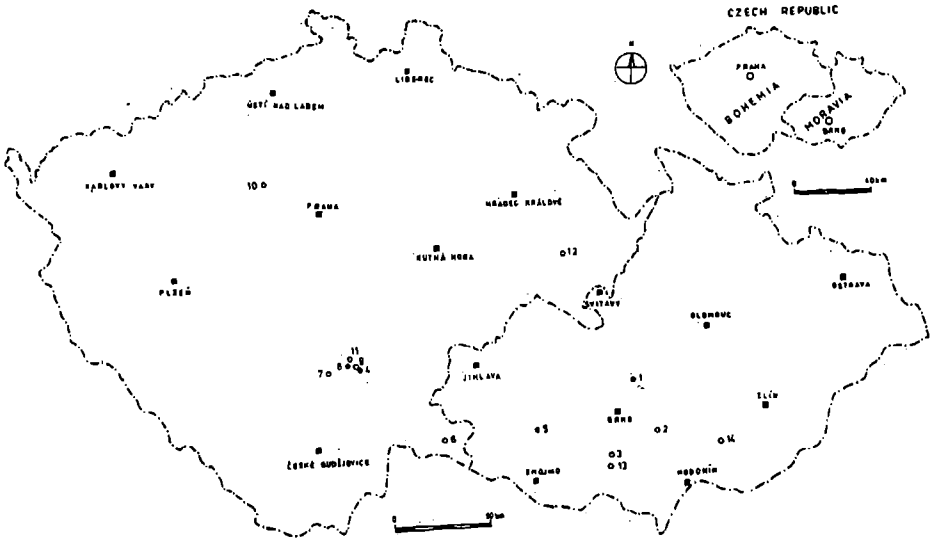

Fig. 1: Map of the investigated sites

1 – Bystřec near Jedovnice, district of Blansko, 2- Konůvky near Slavkov, district of Vyškov, 3- Kovalov near Žabčice, district of Brno, 4- Kravín, district of Tábor, 5- Mstěnice near Hrotovice, district of Třebíč, 6- Pfaffenschlag near Slavonice, district of Jindřichův Hradec, 7- Potálov, district of Tábor, 8-Sezimovo Ústí, district of Tábor, 9- Smolín, district of Tábor, 10- Svídno, district of Kladno, 11- Tábor, district of Tábor, 12- Tisová, district of Ústí nad Orlicí, 13- Topolany, district of Břeclav, 14- Záblacany, district of Uherské Hradiště.

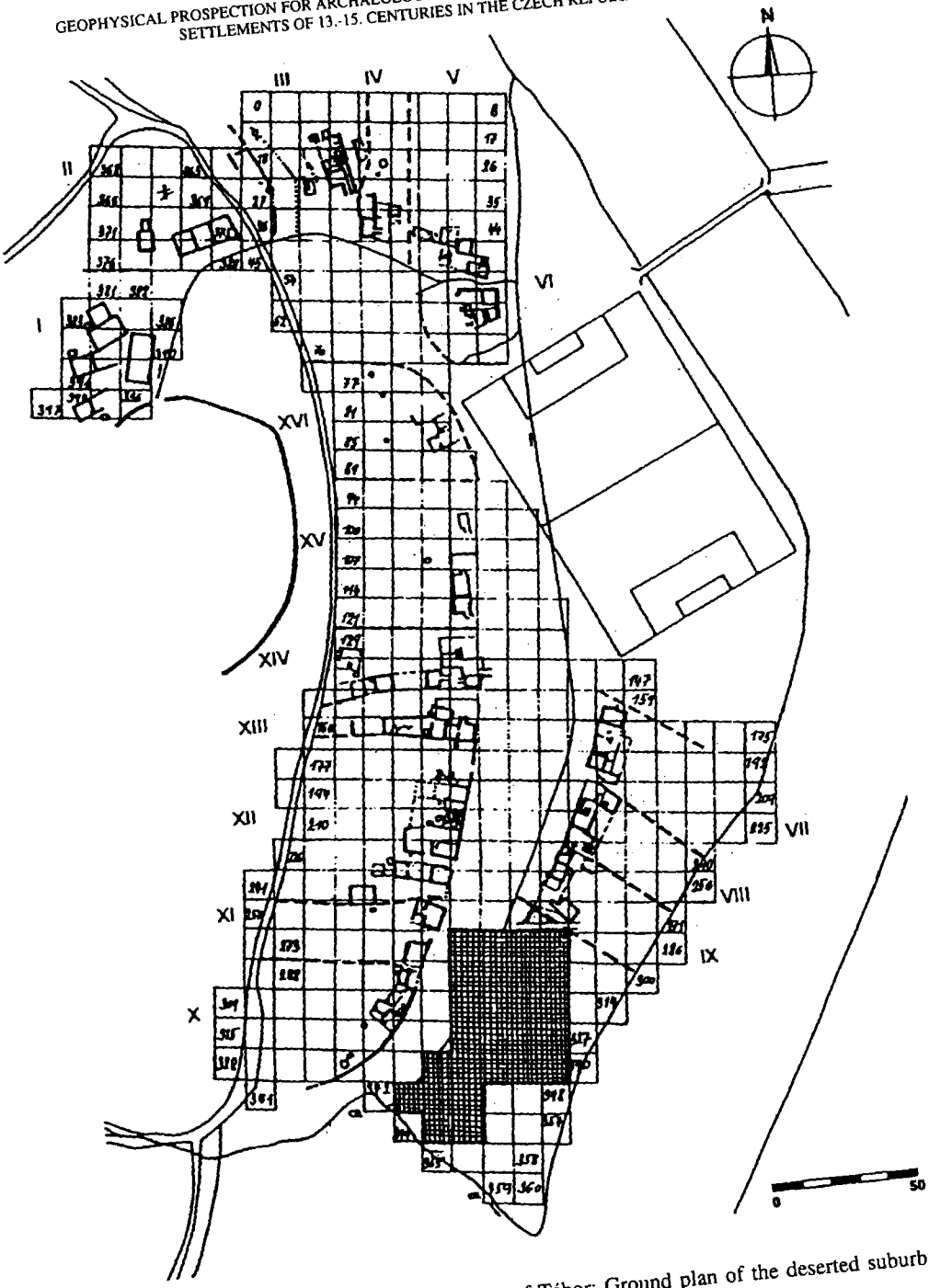

Fig. 2: Sezimovo Ústí – Nové Město, district of Tábor: Ground plan of the deserted suburb hatched: archaeogeophysical prospection in 1995.

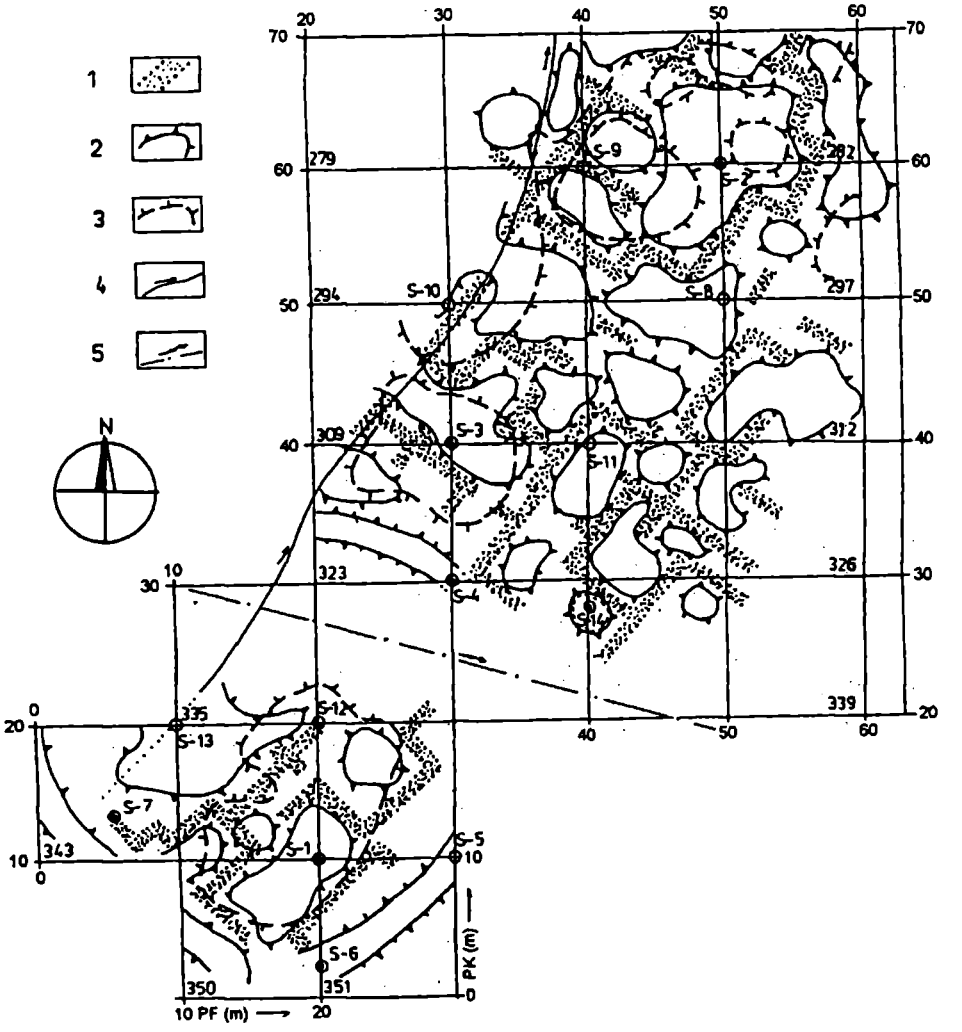

Fig. 3: Sezimovo Ústí – Nové Město, district of Tábor: Scheme of results of geophysical works in the SE part of the deserted suburb

1 – Axes of negative T_z anomalies (relics of foundations etc.), 2- axes of positive T_z anomalies, 3- areas of increased specific resistance (layers of destroyed stonework, deposits), 4- riverbed, 5- cable.

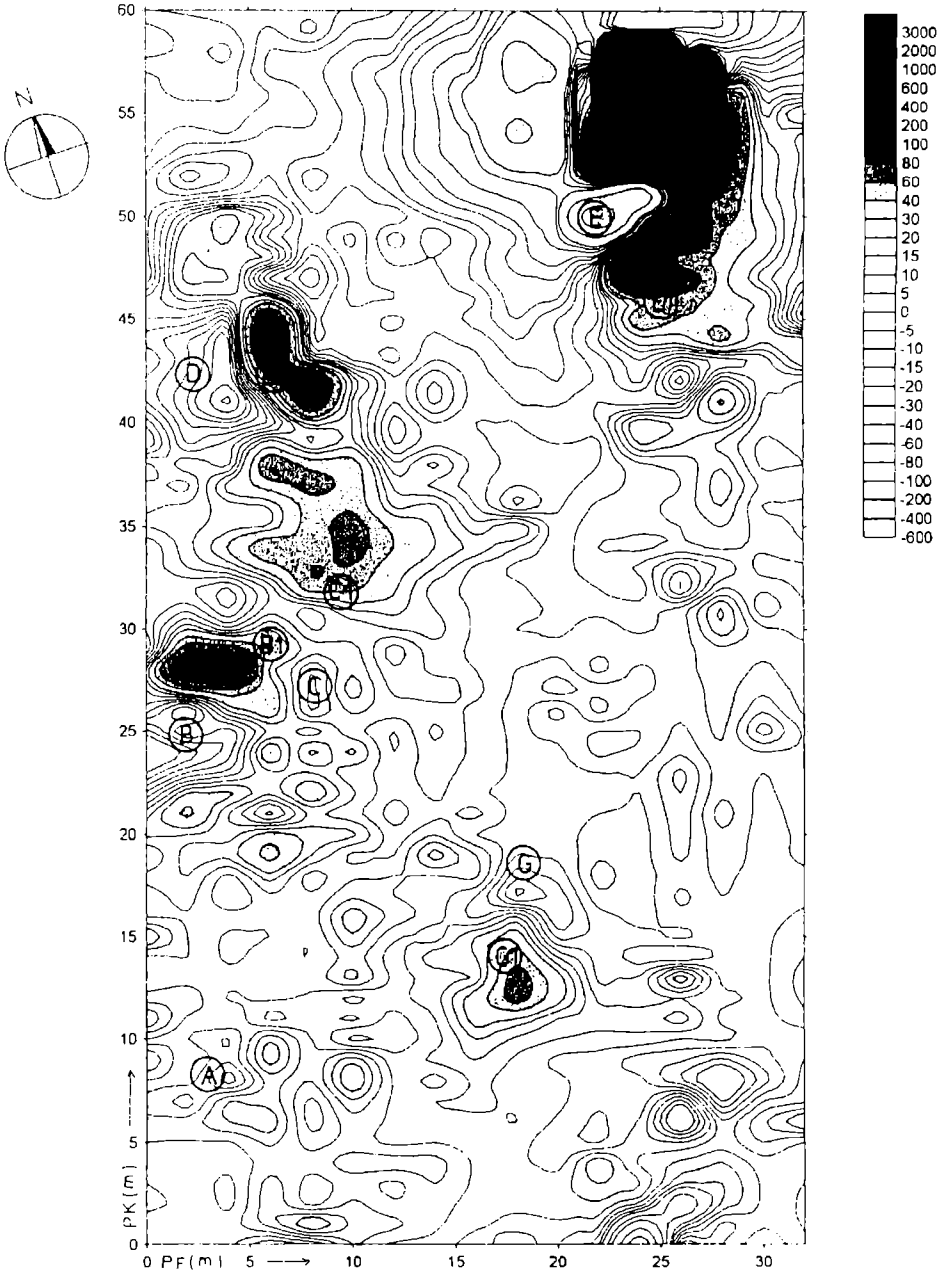

Fig. 4: DMV of Kravín, district of Tábor: Map of ΔT isoanomalies.

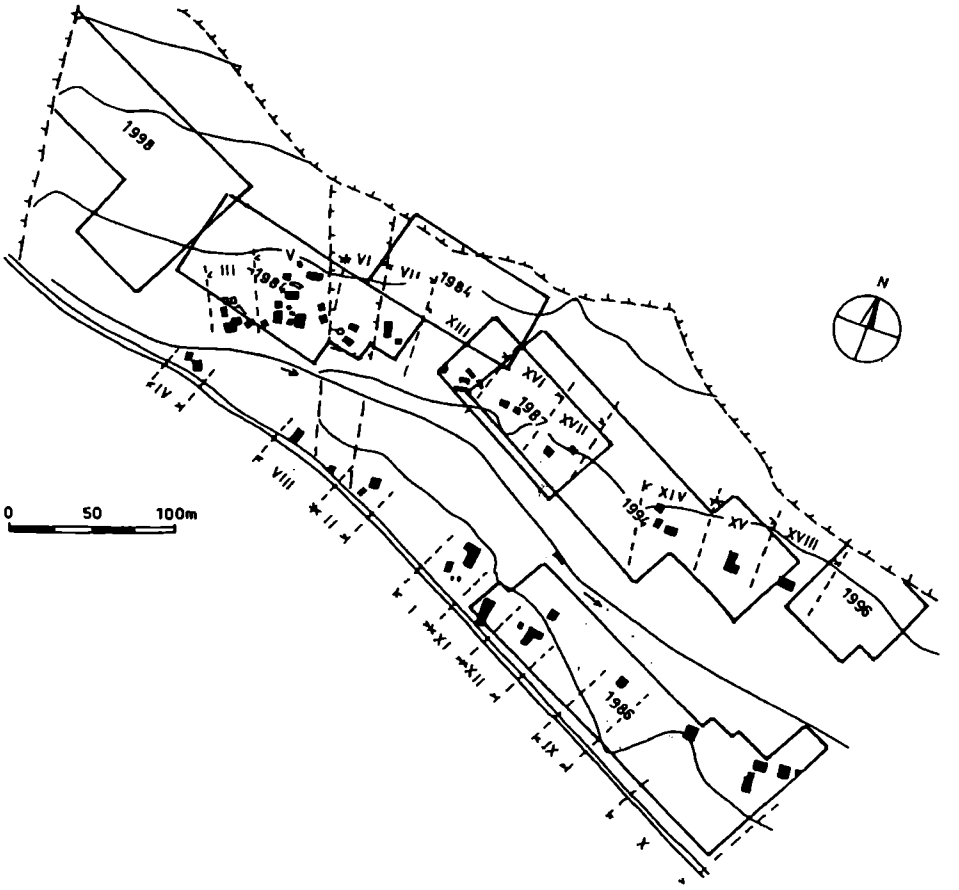

Fig. 5: DMV of Bystřec, district of Blansko: Map of measured areas.

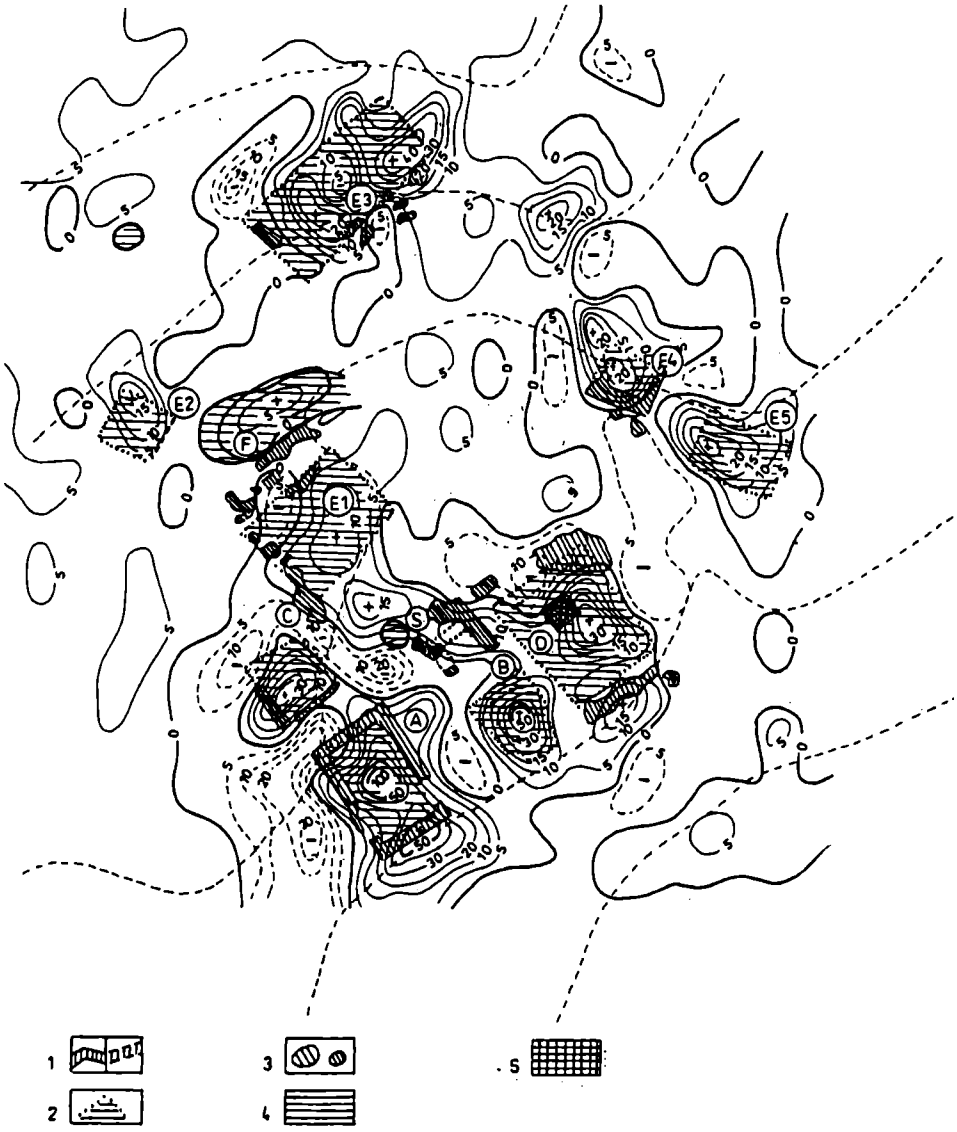

Fig. 6: DMV of Bystřec, district of Blansko: Settlement nr. V – map of ΔT isoanomalies and map of excavated area

1- estimated and determined stonework, 2- rough outline of ground plans, 3- relics of stonework, 4- building areas, 5- fireplace; A- storehouse, B- storage chamber, C- shed, D- residential building, E1-E5 – auxiliary buildings, F- dung-hole, S- well (BELCREDI 1997).

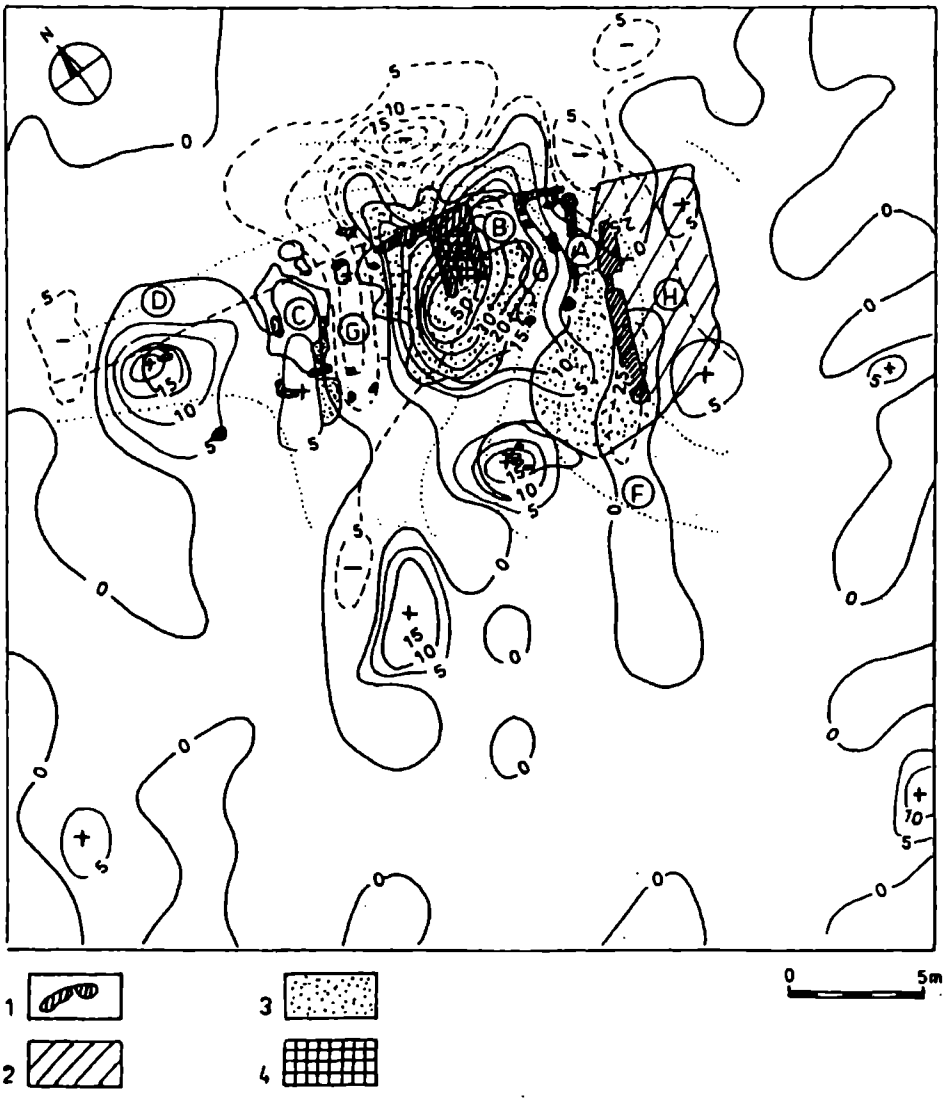

Fig. 7: DMV of Bystřec, district of Blansko: Settlement nr. IX – map of ΔT isoanomalies and map of excavated area

1- stonework, 2- gravel area, 3- continuous layer of clay daub with pieces of charcoal, 4- heating; A- residential room with heating, D- storage pit, G- estimated hall, H- gravel –covered surface (BELCREDI 1998).

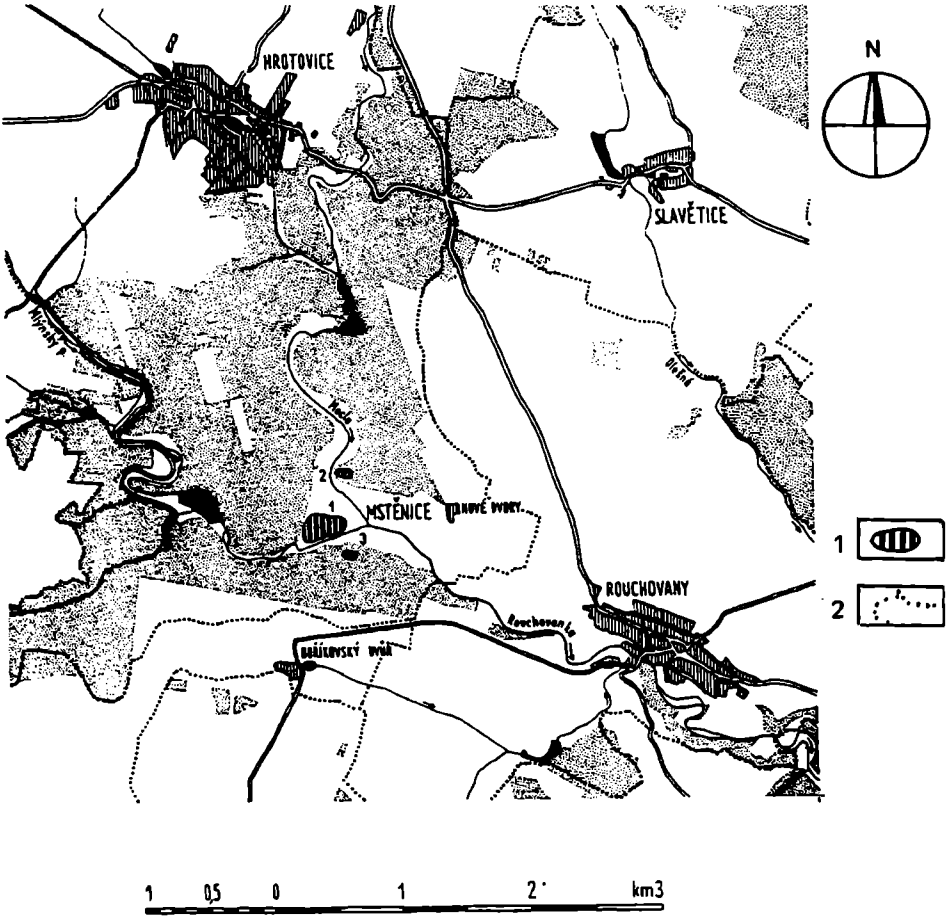

Fig. 8: DMV of Mstěnice, district of Třebíč: Map of the medieval village
1- archaeological site, 2- cadaster border.

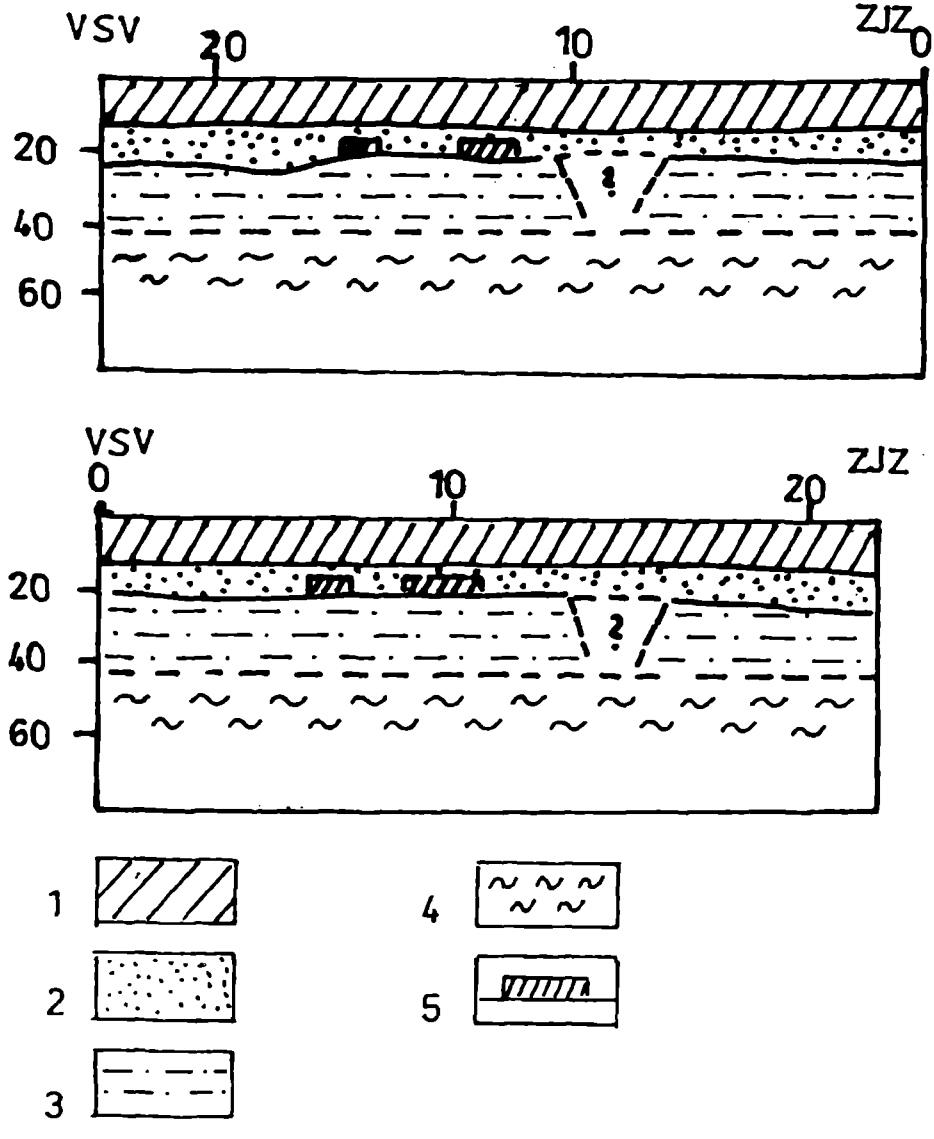

Fig. 9: DMV of Mstěnice, district of Třebíč: Results of measurement by ground radar
1- humus, dark clay soil, 2- cultural layer (surface of the medieval period), 3- relics of foundations, 4- sunken building, 5- loess soil, 6- gneiss eluvium

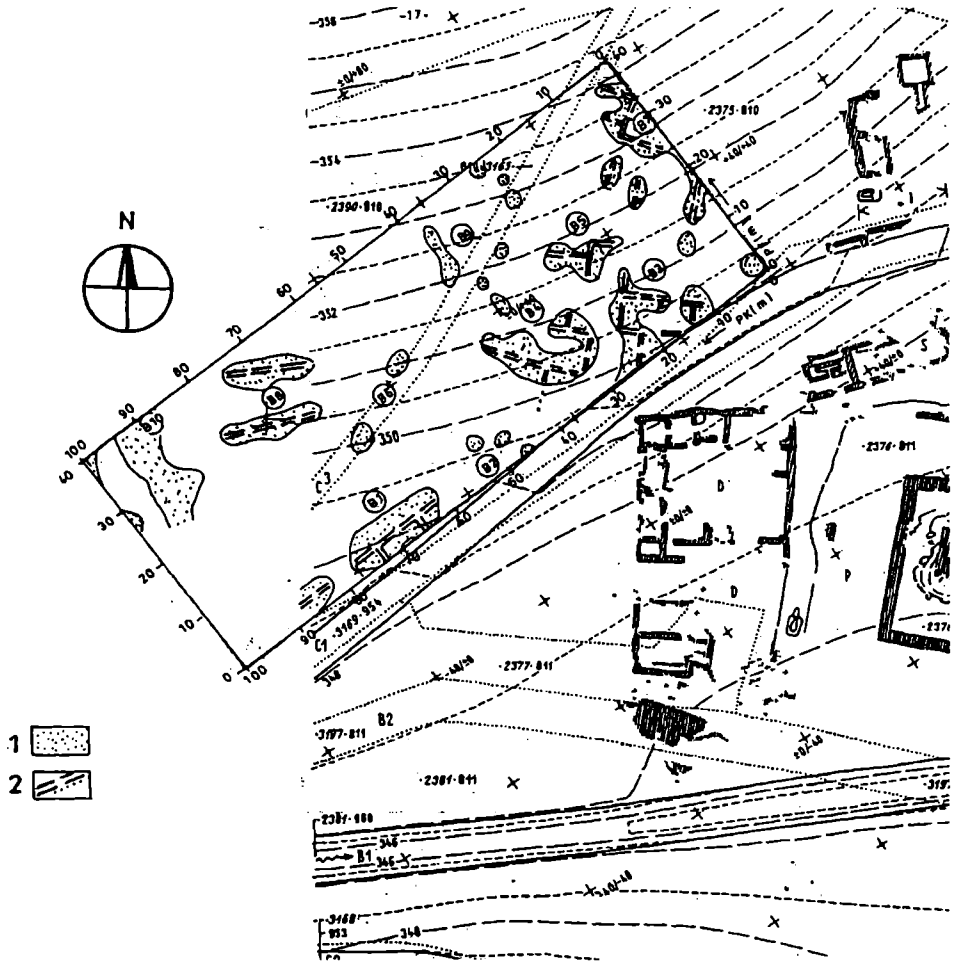

Fig. 10: DMV of Mstěnice, district of Třebíč: Ground plan of the village and map of T_z gradient in the SW part (so far unexamined)

1- positive T_z anomalies, 2- axes of the positive T_z anomalies.

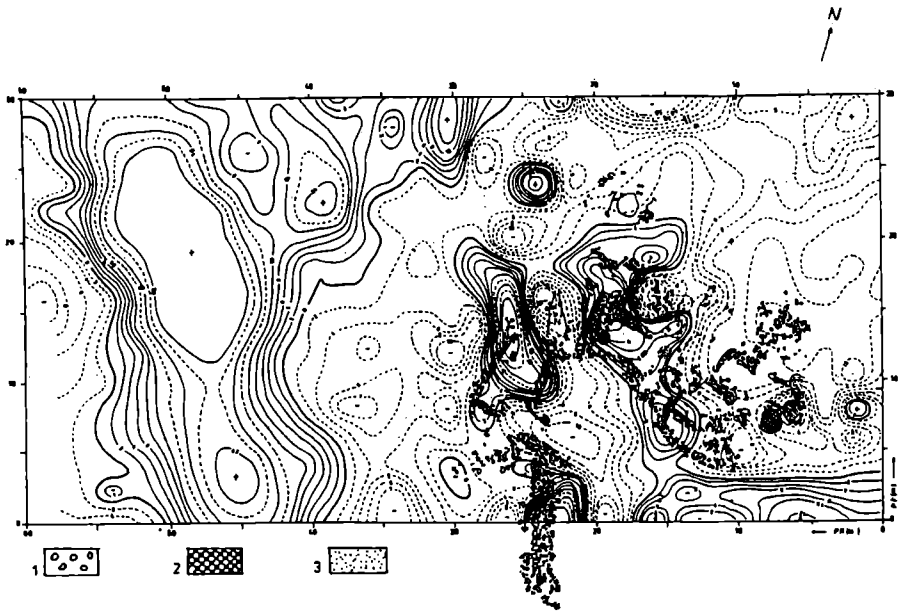

Fig. 11: DMV of Mstěnice, district of Třebíč: Map of T_z gradients and ground plan of the excavated structure at the expected position of mill
1- stonework, 2- burned clay daub, 3- pieces of charcoal.

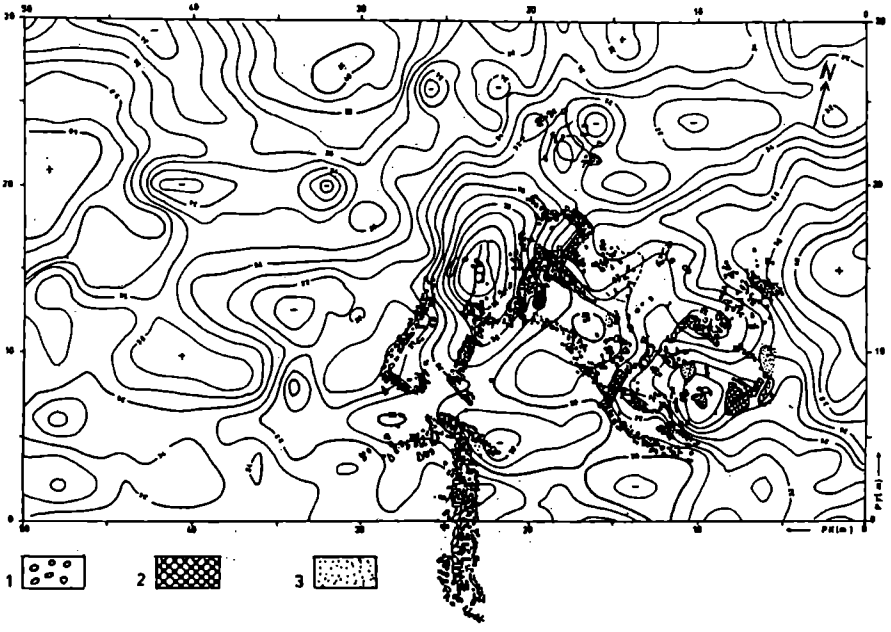

Fig. 12: DMV of Mstěnice, district of Třebíč: Map of σ_d isolines and ground plan of the excavated structure at the expected place of mill.