GEOLOGICAL - ENGINEERING MAPPING PROBLEMS IN REGIONS OF INFLUENCE OF VEIN ORE MINING ON THE SURFACE CONFIGURATION

A mérnökgeológiai térképezés problémái teléres telepek fejtésekor fellépő felszini hatások között

JOANNA PININSKA*

An engineering-geological map should present in a conventional way the geotechnical conditions to enable the engineering decisions to be taken up in the every-day use. In the countries grouped in the Council for Mutual Economic Assistance the principles for preparation of geological-engineering maps are rather uniform and collected in the Instruction dealing with the scales from 1 : 300 000 to 1 : 5 000. In the Instruction the general principles discussing the purpose, content and way of preparation do not fulfil the requiries of the whole problem. As it is well known the maps for specific purposes can be prepared in another scales or else, in different phases of an investment realization the knowledge of the area and destination of the maps may change. Precision of the geological survey depends on the map scale but it is not quite clear what a precision, needed for the given scale of the map, means. In Poland a criterion of a number of documenting sites per a square kilometre of the studied area is quite generally used for standardization of the problem. According to the principles of J. Bazyński (1969) [3] taking simple and complex conditions into account, the following rules are used: ex. for scale 1 : 100 000 the number of documenting sites per 1 km^2 should be from 1 - 3 and for 1 : 2 000 from 160 - 930 1 : 1 000 range 400 - 2 500.
The term "the documenting sites" means generally the natural and artificial exposures, drills, pits, etc.

* Poland, Warsaw University

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But these are known to be only the general principles as in many cases an increase of a number of observations is purpose-less as they do not introduce already any new elements and at the same time a failure of the engineering decision may depend on a single extra factor that cannot be found even in the mostly densified system of observation posts. Among these new elements that have been only slightly expressed on the engineering-geological maps up to nowadays there are the problems connected with changes of a geological environment, influence of other engineering objects on processes in the surrounding areas, changes of a hydrogeological regime, stress state, etc. Usually the existing state is recorded. Such a static approach had been less important until a development of building did not introducted to considerations over the interreaction of the object with the soil bedrock as large engineering objects as over 300 m deep open mines, outer dumps up to 100 m high and did not cause a necessity of localization of more and more complex constructions in the areas previously found to be unfavourable for founding. It should be remembered that during the last years a need of construction of high - several dozen floor buildings in great urban agglomerations has started to be quite popular. Such buildings penetrate deeply the soils and they are usually constructed amidst highly urbanizes area, less deeply founded buildings, narrow streets, complex of underground installations, etc. (Fig. 1).

Therefore, it is quite obvious that the depth of survey of the geological--engineering maps is quite relative and in many cases it is useless if it is not prepared taking the prognosis of the extent of the zone of the object active reaction and in connection with the model of geological structure, hydrogeological conditions, evolution - activation or stabilization of geodynamic processes etc. At the same time it is known that the intensive development of building occurs in the areas that the areas that are subjected to industralization and these are the areas where the greatest changes are observed. In Poland, the open mines of brown coal at Bełchatów are a good example to analyze the changes of bedrock capacity: consolidation of some parts of the area by its drying and at the same time, with a several metres subsidence of the area due to deep draining [6]. All preparation of a geological-engineering map without any consideration of changes of rock properties would be purpose-less as the objects in this founding area are to be constructed in completely changed geotechnical conditions.

As an example of lack of prognosis the instability of the dump slopes and subgrade in the vicinity of the open mine at Machów can be presented (Fig.2). The subgrade deformation zone of that area comprised a wide belt of a dump forefield extending to 200 - 500 m and with a depth of 15-20 m, leading to "smearing out" of the dump. As a result, its height decreased more than twice, the area affected by degradation increased more than twice and the structures located in this area were destroyed. These results have been never expected at the designing time. Such situation seems to have been caused by the changes of properties of the dump subgrade due to an incommensurably high dumping speed in relation to consolidation of subgrade soils. As it is well known in such cases the pore pressure increases and the soil load bearing capacity is considerably lowered. With the dump growth the displacement front is successfully shifted (Z.Glazer, J. Pinińska 1979) [1].

The mentioned example suggests that in spite of a detailed survey of engineering--geological conditions, an emission of a consideration of a connection of a consolidation coefficient in a horizontally laminated soil and the growing up of the pore pressure occurs in the dump forefield, leading to an expansion of the wide deformation zone in its subgrade where the effective shear strength value of soils (τ) is strongly reduced and the shear stresses in the forefield of the dump face reach their critical value; so, the region becomes dangerous for urbanization.

More and more complex needs result in practice that it is really difficult to present the whole problem on a single map. So, a combination of several maps that analyze the successive problems is generally used. But it is really necessary to prepare these maps for concrete needs as it is difficult to meet the complex needs of modern building of any type. The maps should also enable to use in the best possible manner the capacity of the subgrade, suggest its reserves or insufficiencies that are hidden by a general symbol of changes of geological-engineering conditions due to man activity. The methods in that sphere are practically completely unknown. The right demands in the matter can be found in the paper of H. Łozińska-Stępień (1979) [2] who suggests a necessity of organizing the measuring net of observation post at every documentation phase - in the designing, realization and also, exploitation phases. If the observations are related to a concrete model of a geological structure so, in similar conditions they can protect from wrong decisions. But the engineering-geological mapping does not include only a separation of areas with different lithology, properties, etc, but also it is a modern synthesis resulting in exposition of these factors that play the most important part in the case in question and in masking of the ones that are not important. Frequently, although the latter seem to be more visible, they should be treated as the secondary ones.

In the described example from the area of the Machów mine e.g. the consolidation coefficient was the most decisive factor for finding the usefulness of the subgrade. For the urban areas occurring in the mine zones, the deformations of the surface over the mine should be considered and the other factors are of secondary importance. For the areas connected with black coal mining in Poland these problems are broadly known. The brown coal beds occuppy usually vast areas so the principles of changes of the surface are more easy to be found according to our present knowledge [5]. But for the irregular ore deposits of a vein type these rules are less known and dependencies on local conditions are more complex. Therefore, there are special problems of engineering-geological mapping that are to be described, taking the area of exploitation of vein barite deposits into account. It occurs in a tectonic and a metalogenic unit of the Western Sudetes - in the Kaczawa Mts.

In their geological structure may be distinquished the basement sedimentary and volcanic complexes of eocembrian to midlle devonian age. The platform cover consists mainly of carboniferous to cainosoic sedimentary rocks. The tectonic structures run in W - E to NW - SE directions. The rocks of lower structural stage are mineralized by Au, Ag, Cu, Pb, Fe - U ores. The barite constitutes an uniform formation with sulphides, quartz, haematite and siderite. The barite veins occur in various rocks of the lower structural stage, locally cutting the upper carboniferous subvolcanites ore are disrupted by permian and tertiary rocks. The analysed barite vein cuts the porphyzes possibly beyont to the permian or carboniferous eruptions. The strike of the barite vein is in agreament with the tectonical directions. At the contact with the porphyse massiff there are breccias of the enclosing rocks transformed by metamorphosis. According to the concept of A. Paulo (1973) [4] the barite was formed as a hydrotermal deposit in an open fissure of a gravitational and it is transformed by post - mineralization foults into a more complex one, so the shape of the vein is very complex and created by many secondary structures.

Engineering-geological evaluation of geotechnical conditions in these areas is then quite a complex problem. But surface mapping to a definite depth it needs to know a deep geological structure, listing of gallery fractures, orientation in old workings, measurements of fissures, properties and deformations of underground zones, geodetic measurements on the land surface. The basal material comes from surface complex engineering-geological sarvey of a given area in the scale of 1 : 2000. It allowes to find a changeability and properties of indirect building subgrade and is prepared on the ground of cartographic works based on observation posts, penetrative drills, research pits and analyse of natural as well as artificial exposures. During mapping all sings of surface deformations should be recorded. Considering the fact that the mining areas are usually the drained areas and surface depressed, for a principal criterion of subdivision of the soils for engineering-geological symbols, the lithological symbols based on physico--mechanical features should be used and especially, a oedometric coefficient of compressibility is important and also - cohesion, angle of internal friction, moisture.

In the discused area a principal significance should be described to finding the tills, westes, their thickness and bedrock that is covered by them as well as to barite outcrops, localization of dumps and embankments, anthropogenic soils, old workings and existing depressions. For a complex evaluation of engineering-geological conditions these surface data are encomplete and need to be supplemented by information of the underlying bedrock and technical data dealing with exploitation.

The vein barite ores under exploitation are included into the third group i.e. into a group of very changeable thickness and complex geological structure.

An inclination of the veins is 70 - 90^{o} to south-east. The veins are usually 1 - 2 m thick. The rocks sorrounding the deposit compose of porphyric breccia that gradually passes into porphyry (Fig. 4). The mining works allowed to describe the occurence of three veins A, B and C. Among them, A. and C have common roots whereas B is highly changeable and frequently, discontinous. The barite veins under exploitation are over 0,4 m thick. They are usually accesible by a shaft and galleries drilled along a vein at about 20 m of vertical distances. The exploitation is generally carried through from the top to the bottom. A system with a dry fulling up is used. The empty zones are filled up by bare rock coming from the upper horizon.

The porphyry is strongly cracked, especially close to the deposit what influenes the overlying sediments, particularly in the circumstances of changed (due to exploitation) stress.

The map Fig,5, is a synthesis of observations collected at the walls of transport and exploitation galleries of the mine, of physico-mechanical properties of waste that fills the cracks, of rocks that occur in gallery walls and also, of underground and surface geodetic measurements. Main cracking directions of porphyry are also presented.

As the faults running from NNW to SSE are recorded and found to be approximate to ones of the mach cracking directions, ways of water migration among the horizons are commpon. Thus, the waste zones within the open fissures are expanded and the existing waste transformed plastically. Such zones form the sliding surfaces along which, fragments of the massif may be displaced to mining pits. Due to that no depression is created close to the mine in result of subsidence and bending of the top but local depressions with faults at their bordes can be formed. This process is facilitated by contact cracks, agreeable with directions of galleries.

The analysis of these phenomena is presented on the map of land deformations (Fig. 6). As it can be noticed, the areas with unfavourable engineering-geological conditions occuppy a larger area than it can be expected from the surface analysis only. But some areas are dangerous from the point of view of unfavourable parametres of the subgrade as well as of influence of underground exploitation. Thus, they need an especially deep analysis at object localization and also, at evaluation of mining demage in the existing urban areas.

The engineering-geological map should be (from its assumption) the prognostic map and cannot be only a record of the existing state. A wery important task of it is to expose not only the elements of geological environment transformation that have a negative influence on geotechnical conditions but also, to expose the ones that result in their improvement. It decides about the economy of the investment.

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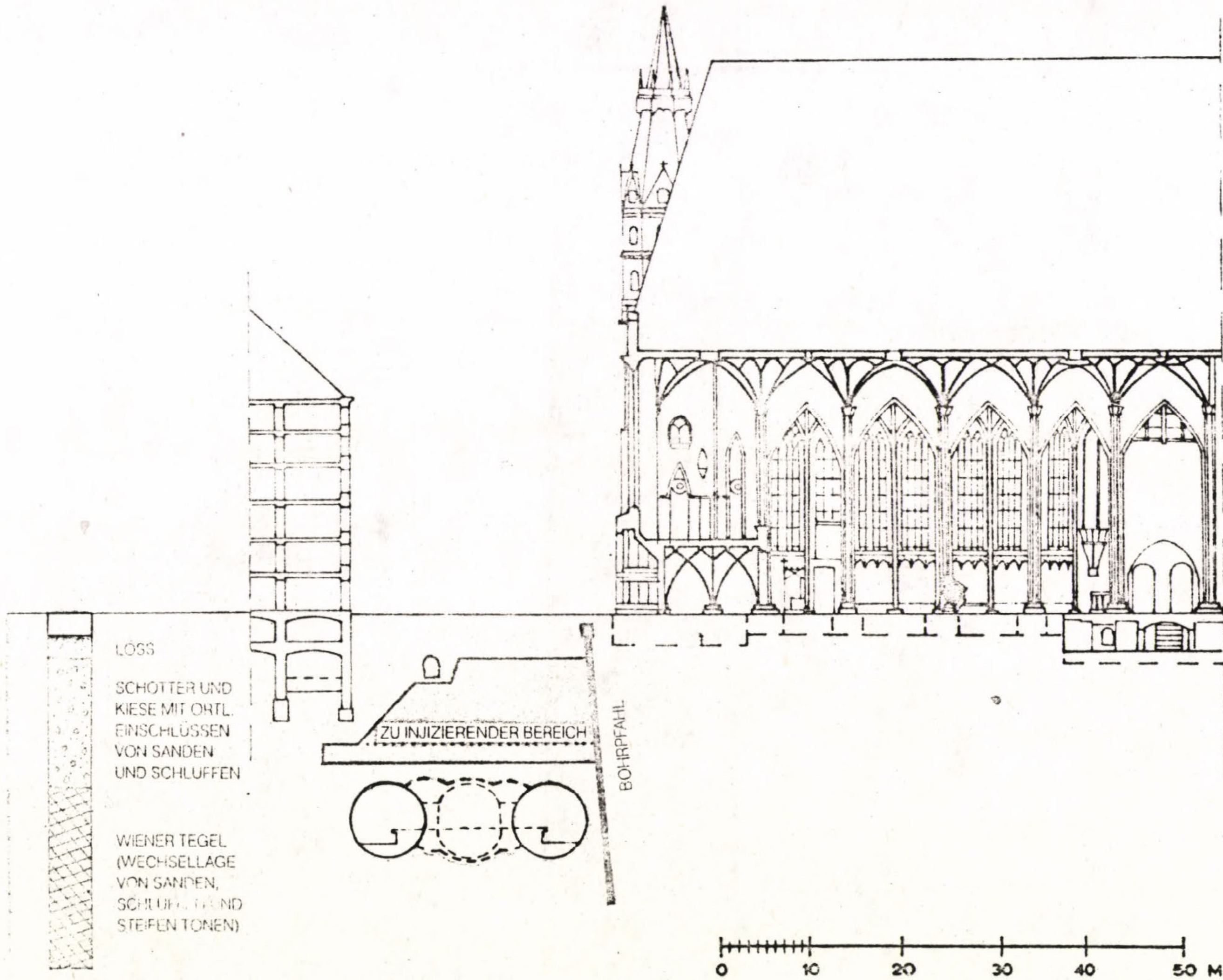

Fig. 1. Deep excavation (Vienna matro)

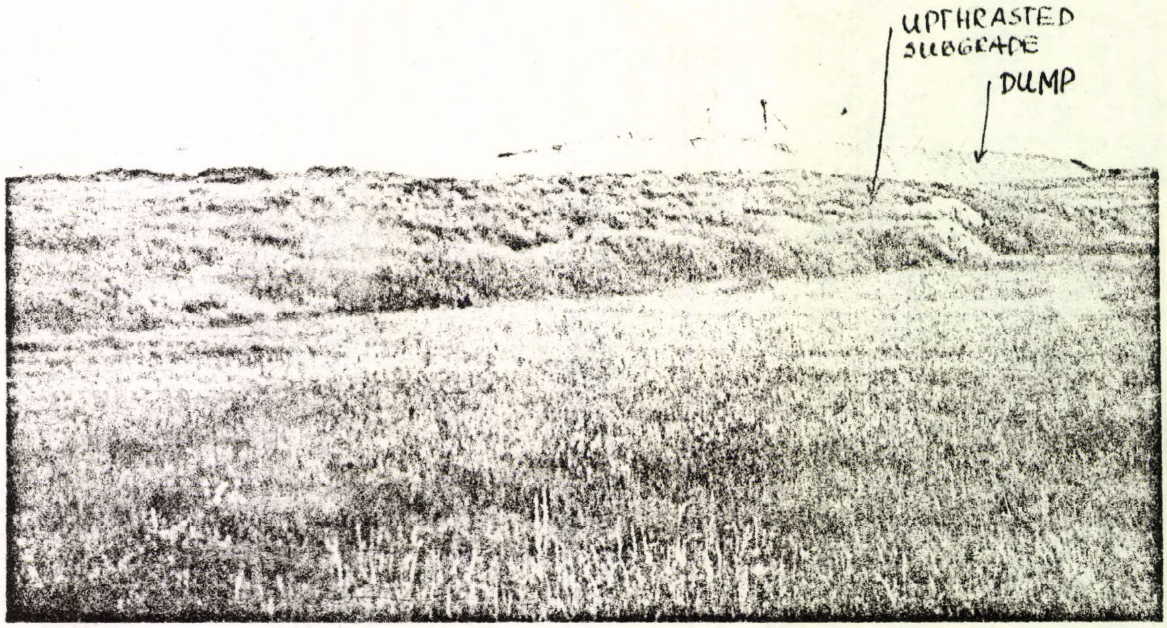

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Fig. 2. The subgrade instability of the open-cast dump.

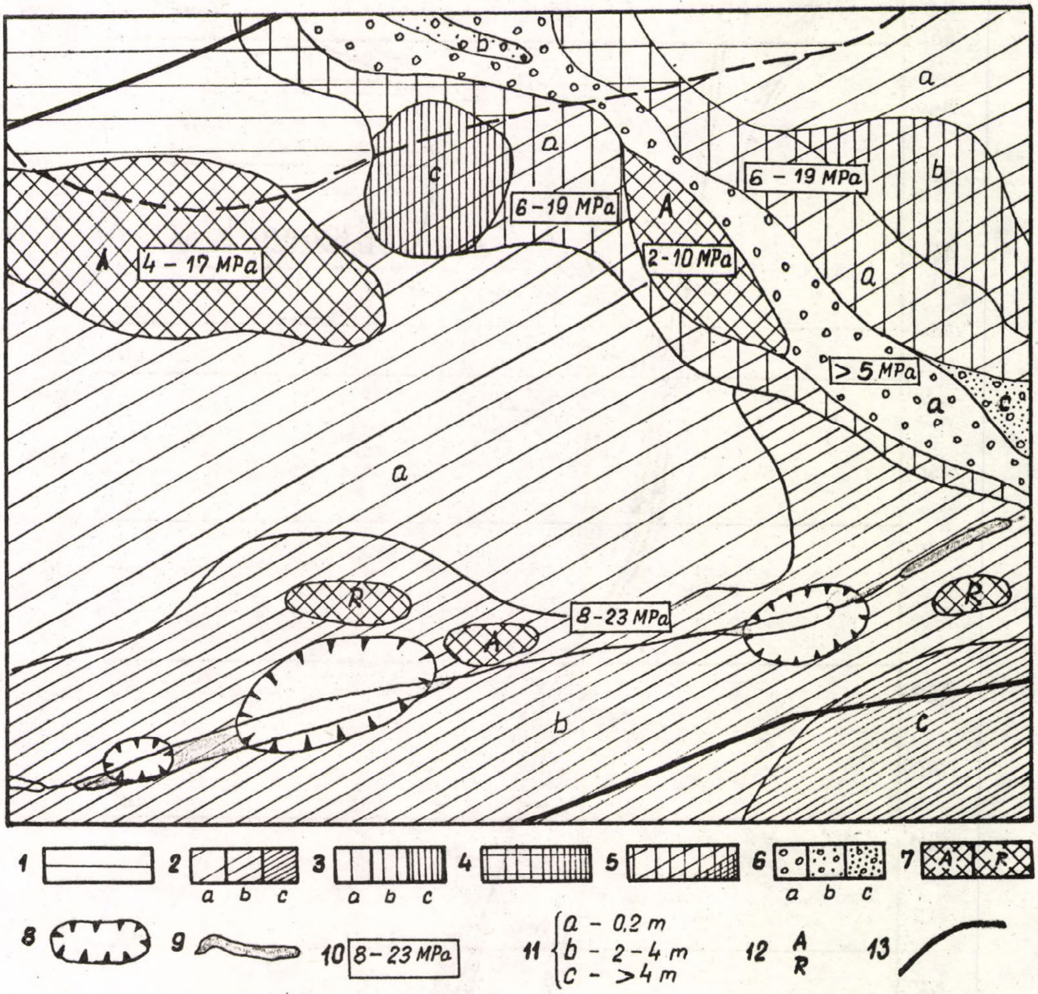

FIG. 3. A fragment of a surface geotechnical map- ideal sketch. 1- sandstone waste (carboniferous) 2- por phyry waste (permian), 3- deluvium (sandy loams, loams) 4- deluvium on the sandstone waste, 5- deluvium on the porphyry waste, 6- aluvium, 7- til 7- tills, 8- depressions, 9- barite aurcrops, 10- soils parameters, 11- thickness, 12- A-antropogenic soils, R-rock ruble, 13- zone of interest.

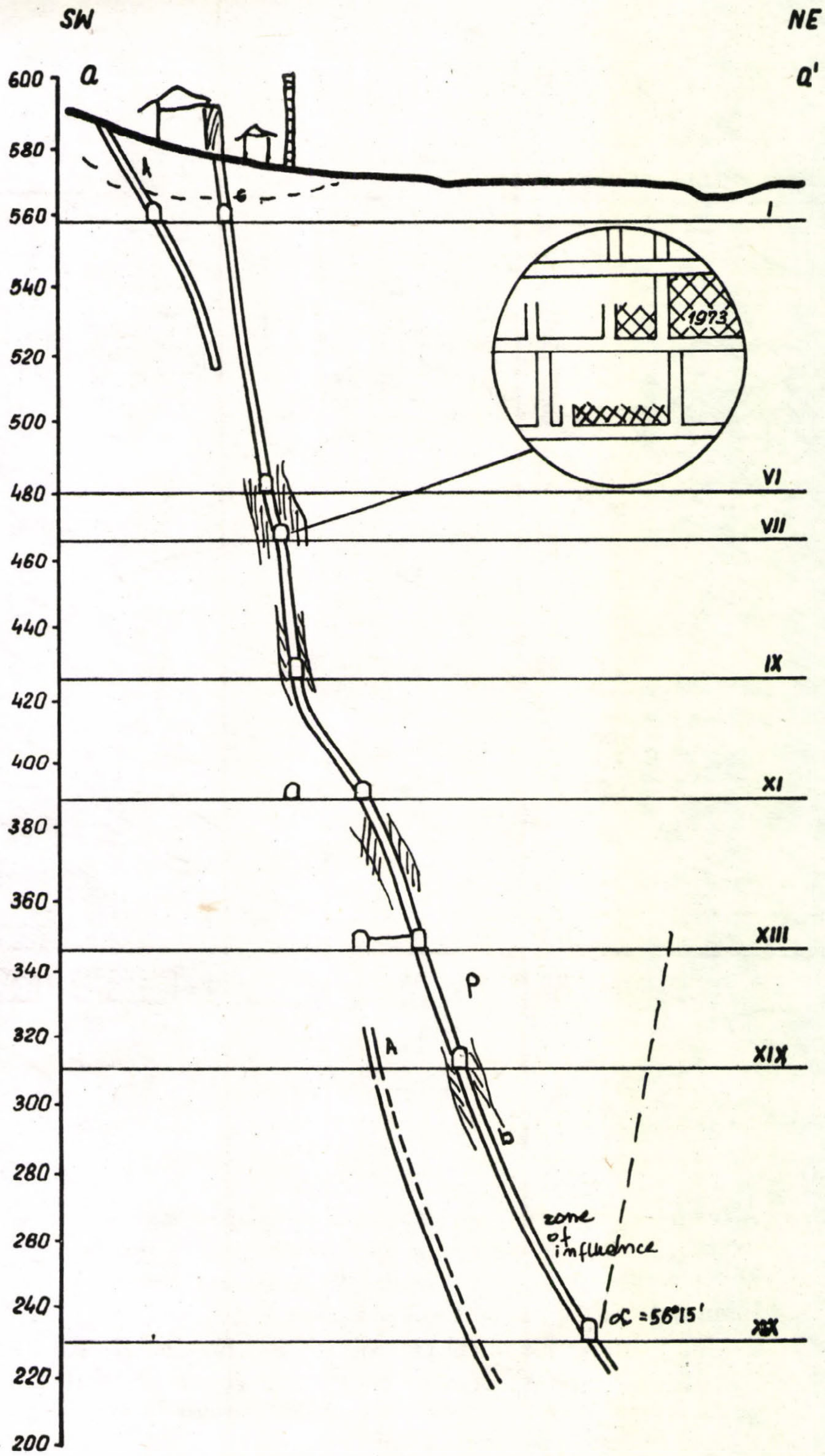

FIG. 4. Vein ore cross-section.
b- breciated contact zone, p- porphyr.

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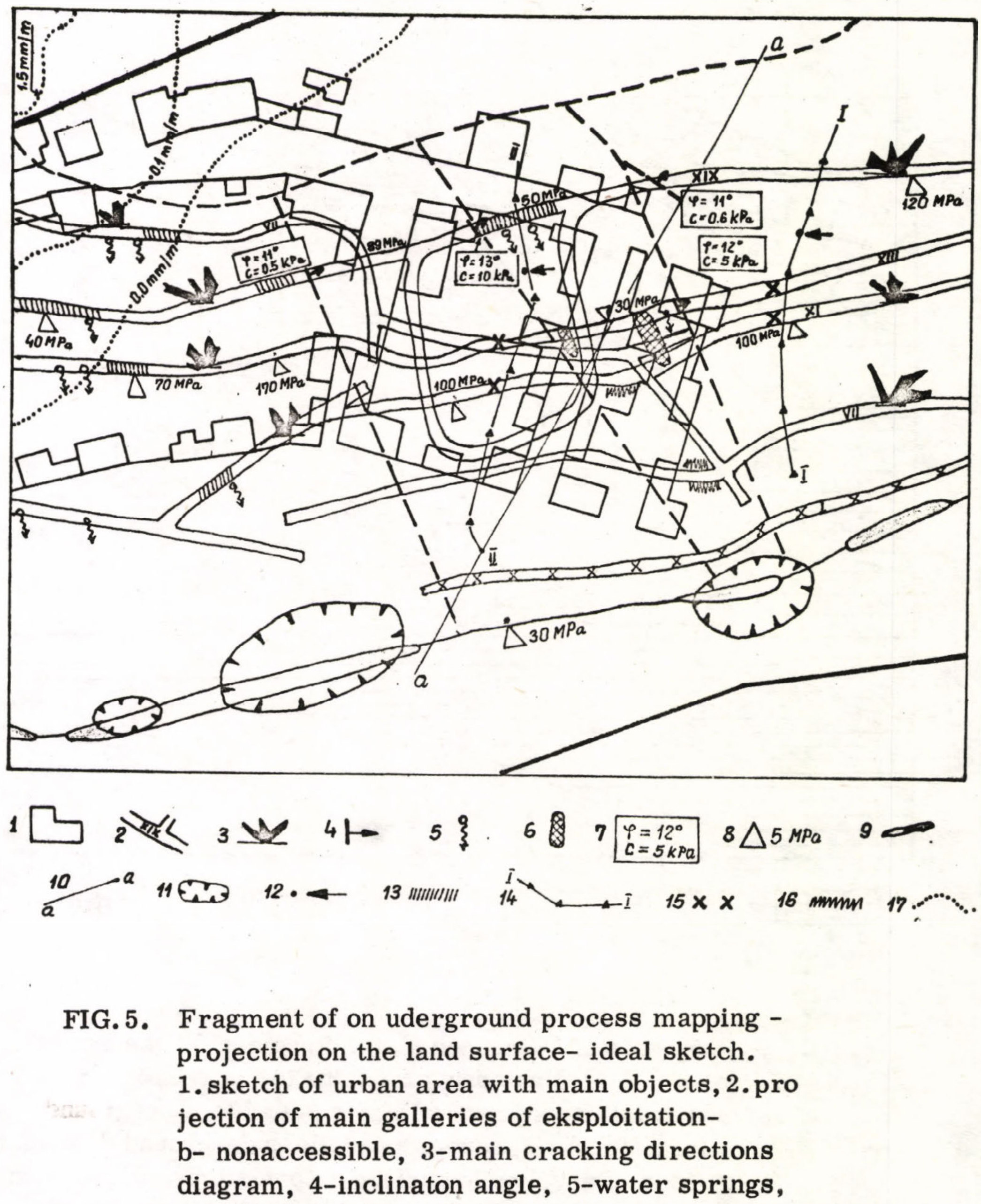

FIG. 5. Fragment of on underground process mapping - projection on the land surface- ideal sketch. 1. sketch of urban area with main objects, 2. pro jection of main galleries of eksploitation- b- nonaccessible, 3-main cracking directions diagram, 4-inclinaton angle, 5-water springs, 6-slide zones between horizons, 7-waste parame ters. 8. rocks parameters, 9-ore autcrops, 10-cross section, 11-depressions, 12-deformationed places, 13-strongly cracked zones, 14-line of surface geodeti observations, 15-underground geodetic observations, 16-zones of the barite-porphyry contact breccia, 17-zones of influence coals mining.

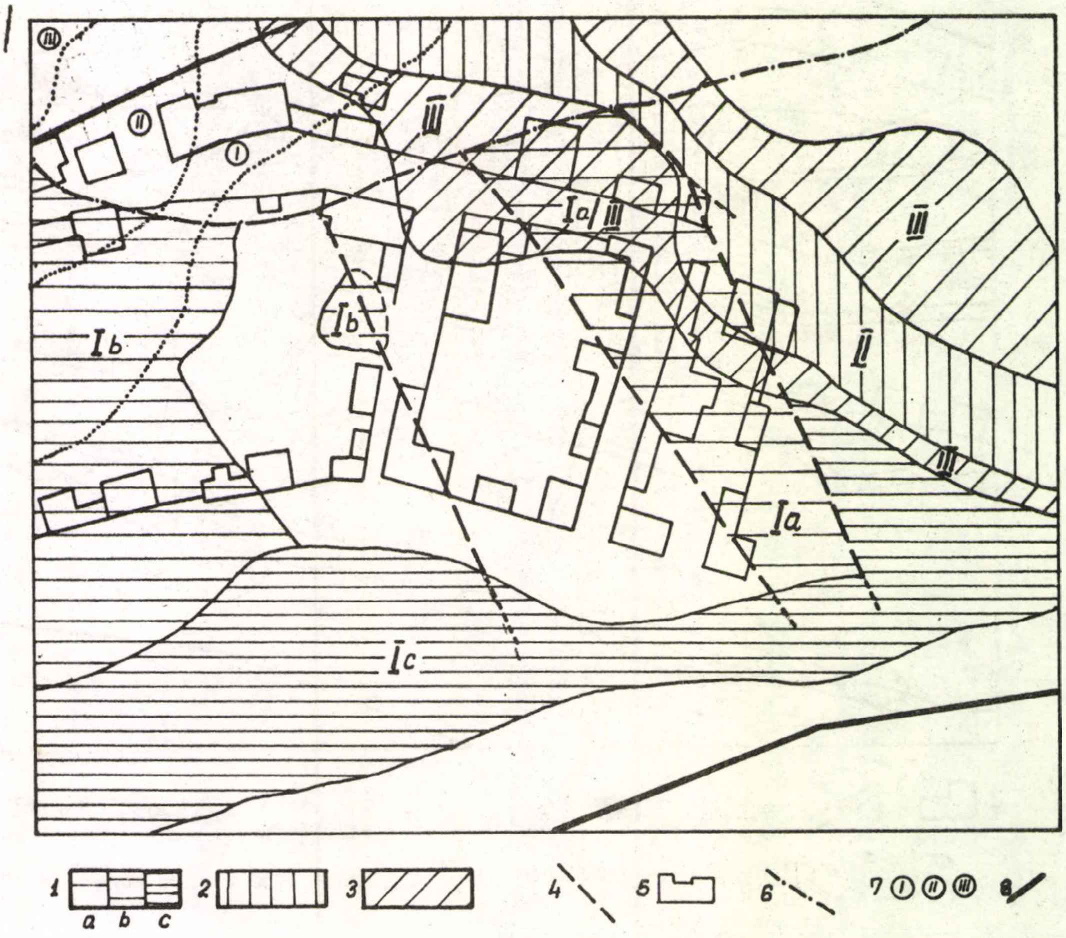

FIG. 6. Prognosis of influences state. Fragment of the syntetic map. 1. I- regions dangerous due to the vein ore eksploitation : a- zone of highly possible underground deformations, b- zone of possible underground deformation, c- zone of developing surface deformations, depressions. 2. II- regions of possible subsidence due to weak soils, 3. III- regions dangerous due to development of geodynamic processes, 4-faults lines, 5-main surface object areas, 6-carboniferous contact, 7-coals mining influence categories, 8-zone of interest.

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JOANNA PININSKA

Lengyelországban a mérnökgeológiai térképezéshez szükséges dokumentációs pontok száma és a feltárási mélység előirásokban rögzitett; habár bizonyos esetekben már eddig is bebizonyosodott, hogy az igy nyert információk nem kielégitőek (pl. külfejtések rézsüinél vagy toronyházak telepitése során). A Machów-i külfejtés példája bizonyitja, hogy a lejtőmozgásokban a felszin alatt 15-20 m mélyen fekvő képződményeknek is van szerepük; egy ilyen területen a mérnökgeológiai viszonyok ábrázolása is bonyolult, egy térképlapon általában már nem is lehetséges.

Még sokkal nehezebb problémát jelentenek a teléres telepek fejtése során előálló felszini változások, mint például a nyugati Szudétákhoz tartozó Kaczawa hegység barit-előfordulásainál. A feküt itt a kambriumtól a középső devonig terjedő időszak üledékes és vulkáni kőzetei alkotják, mig a fedő jobbára a karbontól az ujkorig terjedő időben keletkezett üledékes kőzetekből áll.
A barit szulfidokkal, kvarccal, hematittal és sziderittel alkotja a teléres formációt, helyenként harántolva a felső karbon szubvulkánitokat. A baritteléreк alakja igen bonyolult, ezért a terület mérnökgeológiai térképezése is igen sok nehézséget rejt magában. Ebben az esetben a felszini térképezéshez feltétlenül szükséges a mélyebb szintek földtani szerkezetének ismerete, mivel a felszinen észlelhető deformációk csak igy értelmezhetők.

Általában a térképezés igen fontos feladata minden olyan adat rögzitése, amely a régi bányászatra vonatkozik (pl. bányatérségek, omlások, kibuvások). A telérek vastagsága és szerkezete igen változó, ezért a dokumentációs pontok süritése szükséges.

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A dolgozat bemutatja a terület kőzeteit és térképen ábrázolja az észlelt adatokat (5. ábra), valamint a terület állapottérképét, különválasztva a különböző okokból veszélyesnek itélt területeket (I. veszélyesség a teléres bányamüvelés miatt, II. talajsüllyedésre veszélyes területek, III. dinamikai folyamatoktól veszélyeztetett területek, 6. ábra).

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