EVALUATION AND PROTECTION OF CAVES AND KARST SITES ON THE STATE AND INTERNATIONAL LEVEL – POLISH EXAMPLE

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Abstract: The scientific importance and state of legal protection of the caves and karst sites situated in the main regions in Poland are described in the paper. Problems of threats and practical protection of the caves are discussed on a basis of their scientific, cultural (aesthetic) and natural values. This discussion suggests that comprehensive system of legal and practical protection should be applied. Several changes in Polish law of nature protection are proposed, e.g. legal protection of all caves since their discovering, geological monitoring conducted in quarries and mines and re-introducing of "voluntary guards of nature". The practical actions should be focussed on cooperation of administration of nature protection with caving and changing of public awareness (also by economical motivations). Results of European project "Geosites" are also presented in the paper. Owing to realisation of this project, 26 cave and karst sites have been preliminary selected as geosites of super-regional importance in Poland. Verification of list of these objects on the interregional level needs activities of scientists in many European countries. It should result in the development of database, publication of "red list" of the sites and, finally, proposal of European List of Caves and Karst Sites as an element of European List of the Geological Heritage.

Key words: caves, karst, geosites, nature protection, nature evaluation, Poland, Europe

CRITERIA OF CAVES EVALUATION

At least three general criteria and motivations should be taken into account for caves' and karst sites' evaluation and protection (J. Urban, 2004):

a) scientific importance of caves and karst sites,

b) cultural significance of caves – their aesthetic values and sizes, relation to human existence (e.g. localities of prehistoric live, caves as art or religious centres)

c) role of caves as the specific spaces of occurrence of unique minerals (mineral forms) as well as animal and plant communities.

SCIENTIFIC IMPORTANCE OF CAVES AND KARST SITES IN THE MAIN REGIONS OF THEIR OCCURRENCE IN POLAND

Importance of the caves and karst sites of the main Polish regions of their occurrence (Fig. 1) for geological, geomorphological and paleontological investigations are briefly described hereafter.

The Tatra Mts (Inner Carpathians) is the only Polish region characterised by high-mountainous type of karst composed of subhorizontal and (sub)vertical karst conduits forming branchwork systems of vadose-phreatic origin (with remnants of thermal and artesian water flows), which is related mainly to the Pleistocene palaeomorphology and glacial events. Studies of the cave sediments, karst microforms and systems of conduits, stable isotopes in speleothems etc. enable a reconstruction of the paleoflows, paleovalleys and paleoclimatic conditions (Z. Wójcik, 1968; J. Głazek, 1996; J. Głazek – J. Grodzicki, 1996; H. Hercman, 2000; M. Gradziński – D. Kicińska, 2002; D. Kicińska, 2004).

The Beskidy Mts (Outer, Flysch Carpathians) are formed of non-karstified rocks, but they are abundant in caves developed due to gravitational movements of rock masses of mountain slopes. Two types of caves predominate in the region: a) crevice-type ones representing cracks widened in disitegrated slopes before landslides' formation or propagated due to spreading or sagging types of movements (Fig. 2), b) talus-type caves – spaces formed amongs large blocks in the landslide colluvia. Orientation of galleries indicate character of movements, whereas studies of the microstructures on the cave walls provide data on tectonic stresses in the massif (J. Urban – J. Otęska-Budzyn, 1998; W. Margielewski – J. Urban, 2003, 2004).

Sudetes represent region of both karst and non-karst caves' occurrence. Karst forms are connected with limestone-marble lenses in the Precambrian-Paleozoic rocks. Three sites have been matters of investigations: Przeworno – Neogene paleokarst with vertebrates and insects (beetles) fossils (J. Głazek, 1989), Jaskinia Niedźwiedzia cave (2230 m) composed of three levels related to stages of valley development and bearing the Late Pleistocene fossils (J. Jahn et al., 1987), Połom hill with system of the Cenozoic relic karst conduits (W. Rogala, 2003). The pseudokarst caves occur mainly in the Cretaceous sandstones of the Stołowe Mts and the igneous or metamorphic rocks of other mountain groups (e.g. Rudawy Janowickie).

Fig. 1. Legal protection of caves and karst sites in Poland. Explanations of symbols: 1 – the main regions of caves occurrence: Tatra Mts (TM), Beskidy Mts (BS), Sudetes (SD), Kraków-Wieluń Upland (WK), Nida Basin (NB), Kielce-Sandomierz Upland – Świętokrzyskie Mts (SW); 2a – approximated number of caves in the region, 2b – percentage of the number of caves protected in national parks and nature reserves, 2c – percentage of the length of caves protected in national parks and nature reserves; 3 – national parks mentioned in the text: 1 – Tatra, 2 – Gorce, 3 – Magura, 4 – Góry Stołowe, 5 – Ojców; 4 – nature reserves mentioned in the text: 6 – Kuźnie, 7 – Kornuty, 8 – Groty Kryształowe (Crystal Caves), 9 – Jaskinia Niedźwiedzia, 10 – Ruskie Góry, 11 – Góra Zborów, 12 – Parkowe, 13 – Sokole Góry, 14 – Szachownica, 15 – Węże, 16 – Skorocice, 17 – Góra Miedzianka (with Kozi Grzbiet), 18 – Góra Zelejowa, 19 – Jaskinia Raj, 20 – Chelosiowa Jama (Jaworznia), 21 – Kadzielnia, 22 – Wietrznia; 4 – other caves and karst sites legally protected (or partly protected) mentioned in the text: 23 – Jaskinia Malinowska (nature monument), 24 – Jaskinia w Trzech Kopcach (nature monument), 25 – Łopień (Grota Zbójnicka w Łopieniu – nature monument), 26 – Ojców Platteau (numerous nature monuments), 27 – Tarnowskie Góry (historical monument), 28 – Biśnik cave (documentary site), 29 – Jaskinia w Mechowie (nature monument); 5 – other caves and karst sites mentioned in the text: 30 – Wierch nad Kamieniem, 31 – Przeworno, 32 – Połom, 33 – Zabierzów, 34 – Czatkowice, 35 – Kowala-Nowiny; numbers of the sites preliminary proposed for the European List of Geological Heritage are underlined

Kraków-Wieluń (Kraków-Częstochowa) Upland is an area of numerous Cenozoic paleo and relic karst forms occurrence (J. Głazek – A. Szynkiewicz, 1987; J. Głazek, 1989; Felisiak, 1992; Gradziński, 1999; S. Alexandrowicz – Z. Alexandrowicz, 2003) with remnants of older paleokarst. There are situated almost all Polish localities of the Neogene (Middle Miocene, Pliocene) terrestial paleofauna as well as the great number of the Late Pleistocene paleontological and archeological sites (J. Głazek – A. Szynkiewicz, 1987; W. Chmielewski, 1988; T. Madeyska, 2000; T. Madeyska – K. Cyrek, 2002; K. Cyrek, 2004). Studies of these sites enables reconstruction of the paleoenvironment, paleogeography as well as evolution and systematics of vertebrates (T. Madeyska, 1981; K. Kowalski, 1989; H. Hercman et al., 2004). In two sites the Carboniferous, Permian-Triassic and Jurassic terrestial periods and fossils of vertebrates were documented (M. Paszkowski, 2000; M. Borsuk-Białynicka et al., 1999).

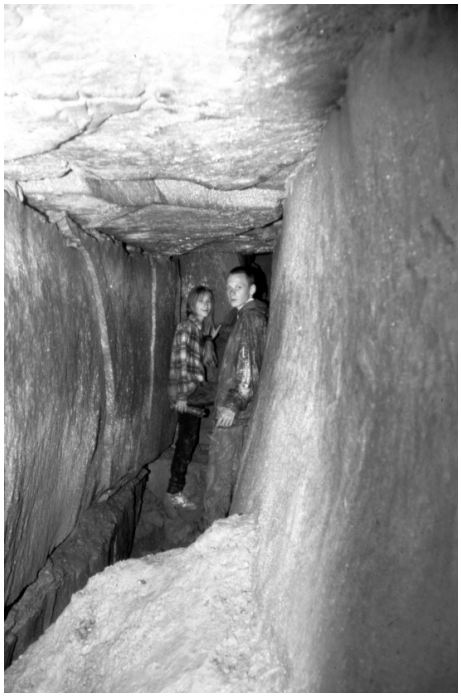

Fig. 2. Pseudokarst crevice-type caves developed in the sandstone (Magura Fm) due to gravitational movement of the rocks on the mountain slope. Genesis of the cave is confirmed by character of the walls (representing joint surfaces) and ceiling (bedding plane, along which the rock mass was shifted). Złotopieńska Cave, Mt Łopień, Beskidy Mts, Outer Carpathians

Fig. 3. Karst cave in the gupsum rocks developed in the water table and shallow phreatic zone, what is confirmed by (sub)horizontal conduits located on slighty different levels. Skorocicka Cave, Skorocice Valley, Nida Basin

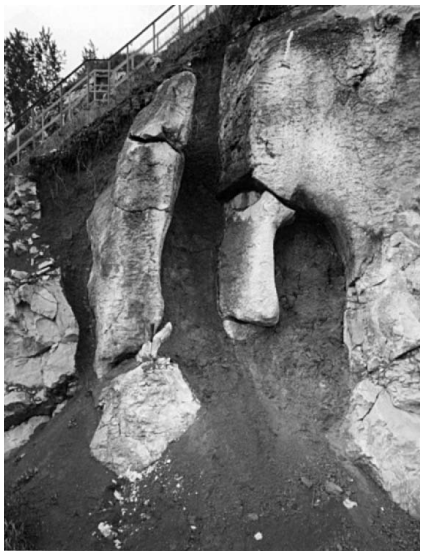

Fig. 4. Paleokarst form developed in the Devonian limestone and filled with the Neogene loam. Outcrop in the abandoned quarry Sitkówka, Świętokrzyskie Mts

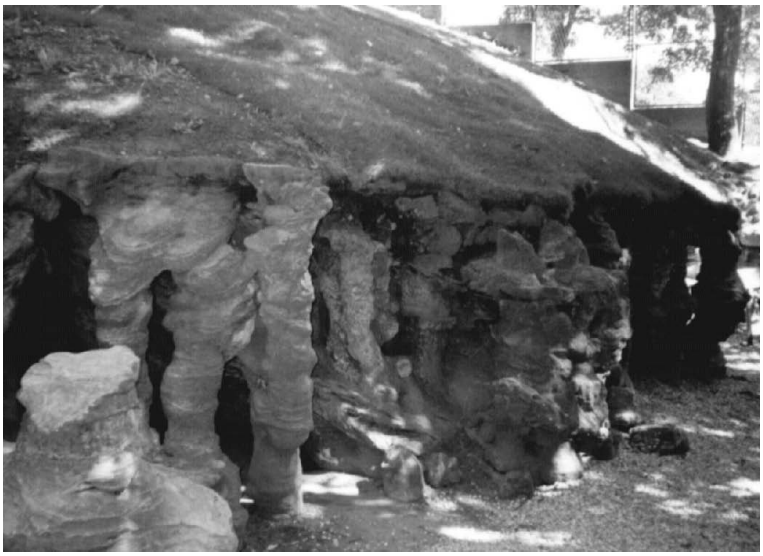

Fig. 5. Natural colonnade formed of the Late Pleistocene sandstone in the entrance of Jaskinia w Mechowie cave. The columns and horizontal blanket forming ceiling of the cave represent diagenetic bodies of sands harder (thus cemented with calcite better) than surrounding sediments.

The Nida Basin is the only Polish region of gypsum karst occurrence. Majority of the caves in gypsum rocks represent short, single conduits (Fig. 3). They were developed in a zone of the groundwater level (shallow phreatic – vadose) during the entrenched karst stage and represent relatively young, likely the Late Pleistocene-Holocene forms (J. Urban et al., 2003).

In the Kielce-Sandomierz Upland (Świętokrzyskie Mts) two main periods of karst development are distinguished: Permian-Triassic and Paleogene-Neogene. The Permian-Triassic paleokarst sites document post-Variscan terrestial period of evolution of the region (J. Urban, 2002). Cenozoic karst is represented with numerous fossil forms (outcropped in quarries – Fig. 4, and studied in bore holes' logs) as well as caves, among which cave system of Chelosiowa Jama-Jaskinia Jaworznicka in Jaworznia is the most interesting. Character and stages of denudation of the region during the Cenozoic can be reconstructed on the basis of studies of these forms (J. Urban et al., 1997; J. Urban, 2002). Pleistocene fauna have been found only in a few karst sites, but two ones (Kozi Grzbiet and Jaskinia Raj Cave) are of significant meaning for paleoclimatic reconstruction (Studies..., 1972; J. Głazek, 1989; K. Kowalski, 1989).

In the vast Polish lakelands and coastlands only 18 short caves have been found (J. Urban, 2000), but examination of these objects might be important for studies of recent lithification of the Late Pleistocene sands, in which the caves occur (Fig. 5).

THREATS

As the sites of complex character, different values and specific environment, the caves are very sensible to threats (Cave conservation..., 1995). Quarrying is the main external threat, causing total or partial damage of caves or other sites, although – paradoxically it also often means opening of karst conduits, what enables access to the caves. Intensive quarrying in the Świętokrzyskie Mts and Sudetes has contributed to opening and often destruction of numerous caves. Landfill (filling of karst depressions, often cave entrances with wastes) and sewage pollution represent external threats affecting caves or/and their environment especially in the populated and cultivated areas of uplands: the Nida Basin, some areas of the Kraków-Wieluń Upland and Świętokrzyskie Mts (J. Urban, in print).

People access to the caves and its consequences: collecting of minerals, exploration and excavation (digging) of sediments and scientific works, are internal threats (Cave conservation..., 1995; J. Nowak, 2003) commonly occurring not only in the regions of easily accessible caves, but in the mountainous areas legally protected, as well (e.g. Tatra Mts).

LEGAL AND PRACTICAL PROTECTION ON THE STATE LEVEL

System of legal protection of caves in Poland distinctly differs from law being in force in some other countries (e.g. Czech Republic and Slovakia), where all caves are protected *ex definitione*. In Poland legal protection of caves and karst sites, as individual landforms or within larger areas, requires creation of law by state or local authorities (establishing suitable category of protection). National parks and nature reserves are the most efficient legal categories of caves' protection. Within these areas access to the sites (also caves) is restricted and every land usage and management not connected with nature conservation is forbidden. Numerous caves are also protected as nature monuments, whereas karst sites have been often established as documentary sites recently. These protection categories should preserve them from damage by quarrying and other formal land management practices.

Due to law system in Poland number of legally protected caves significantly differs from their distribution in the particular regions (Fig. 1). Only in the Tatra Mts, covered by national park, all caves are legally protected. In other regions number of caves protected within national parks and nature reserves varies from 22 – 23 % in the Beskidy Mts and Sudetes to 48 % in the Świętokrzyskie Mts (where they represent 88 % of the total length of the caves – Fig. 1). Apart of the Tatra National Park, the highest numbers of caves are protected within the Ojców N.P. (ca 570 caves) covering the most picturesque part of the Prądnik creek valley in the Kraków-Wieluń Upland, as well as within Góry Stołowe N.P. (more than 20 – 900 m) in the Sudetes and within Gorce N.P. (32 – 276 m) and Magura N.P. (24 – 175 m) in the Beskidy Mts. Some nature reserves have been established for the caves, natural caverns and karst sites' preservation, e.g. Jaskinia Niedźwiedzia Nature Reserve (5 caves – 2498 m) in the Sudetes, Jaskinia Raj N.R. (1 – 240 m) and Chelosiowa Jama N.R. (11 – 4741 m) in the Świętokrzyskie Mts, Szachownica N.R. (5 caves – more than 800 m) in the Kraków-Wieluń Upland as well as Groty Kryształowe N.R. (Crystal Caves – caverns with halite crystals) in the Wieliczka Salt Mine near Kraków. In several other nature reserves caves are numerous and represent one of the main matter of protection, e. g.: Kuźnie N.R. (44 – 347 m) and Kornuty N. R. (13 – 254 m) in the Beskidy Mts, Góra Miedzianka N.R. (10 – 635 m) in the Świętokrzyskie Mts., Sokole Góry N.R. (ca 90 caves), Parkowe N.R. (40), Ruskie Góry N. R. (26), Góra Zborów N.R. (17) in the Kraków-Wieluń Upland and Skorocice N.R. (26 – 951 m) in the Nida Basin. Important paleokarst localities are protected in Chelosiowa Jama N.R., Wietrznia N.R., Kadzielnia N.R., Góra Zelejowa N.R., Góra Miedzianka N.R. in the Świętokrzyskie Mts and Węże N.R. and Sokole Góry N.R. in the Kraków-Wieluń Upland (Fig. 1)[1].

[1] Data on the caves' number and length in the Carpathians, Sudetes and Kraków-Wieluń Upland based on published inventories and materials of J. Ganszer, M. Szelerewicz and A. Wojtoń.

Significant number of caves is protected as nature monuments in the Świętokrzyskie Mts (ca 30 %), Beskidy Mts (ca 4 % of the number, but representing 25 % of the total caves' length in the region, among them is the longest Jaskinia w Trzech Kopcach – 1228 m) and in the Kraków Wieluń Upland (ca 5 % – protected directly as caves or occurring in the protected limestone crags). Several other surface karst landforms (dolines, swallow-holes) and paleokarst objects in the Świętokrzyskie Mts and Kraków-Wieluń Upland are protected as documentary sites and nature monuments.

Practical preservation of the caves should consist in activities executing and expanding legal protection, as: management of human access, monitoring of the caves' state (mineral forms, environment, fauna, etc.) as well as creation suitable public awareness of local populations (landowners, land users, local authorities) and other caves' visitors (tourists, cavers, scientists) (Cave conservation..., 1995).

One of the method of preventing the caves from repeated uncontrolled human access is continuous management. Nine caves in Poland are managed by touristic agencies as show caves (five ones in the vicinity of Kraków). Preparation of the caves for public access gave also convenient opportunities for scientific investigations (Studies..., 1972; J. Jahn et al., 1989).

The caves located within the national parks' areas are watched by guard services of these parks and access to them needs permission of the park managers. Entrances of several caves protected in the nature reserves or as nature monuments are declared to be locked, but the doors are often destroyed and left opened due to lack of watching. Only a few caves are monitored by speleological clubs and closed with doors. This kind of caves' management – popular in some other countries, where cavers supervise and watch out caves behalf of the administration of nature protection – has hardly developed in Poland, although there were proposals to introduce this system (e.g. J. Urban – M. Gradziński, 2004). Even the article constituting "voluntary guards of nature" has been removed from the last version of nature protection law (adopted in 2004). Also the public awareness of the relevance of caves and karst sites as natural heritage has not been practically propagated (even among cavers – E. Kotarba, 2004).

CAVES AND KARST SITES AS ELEMENTS OF NETWORK OF EUROPEAN GEOSITES

Several international programmes and initiatives have been designed to recognize and evaluate natural sites of outstanding values and a super-regional (universal) scientific importance (see appendices to "Recommendation on conservation of the geological heritage and areas of special geological interest" adopted by the Committee of Ministers of EU on the 5th May 2004). The first initiative, which should be mentioned is World Heritage Convention and its consequence – UNESCO World Heritage List (J. Weighell, 2004). Many karst regions and areas of caves occurrence have been registered on this List, e.g. caves of Hungarian and Slovak karst (P. Bella, 1996, 2001) in the vicinity of Poland. Among 12 Polish World Heritage Sites four ones offer specific abiotic features of unique values (Z. Alexandrowicz et al., 2005). In the two of them natural subsurface cavities are of significant importance: Groty Kryształowe (Crystal Caves) in the Wieliczka Salt Mine are characterised by occurrence of unique, large aggregates of halite crystals (Fig. 6), whereas Smocza Jama cave plays important role in cultural traditions of Kraków Historic Centre.

Fig. 6. Halite crystals covering the ceiling of Groty Kryształowe (Crystal Caves) in the Wieliczka Salt Mine near Kraków

The second programme identifying and selecting important geological sites is "Geosites" Project. Since 1996 it has been practically realized by European Association for the Conservation of the Geological Heritage "ProGEO". The project consists in recognition, documentation and evaluation of sites of super-regional geo(morpho)logical value and selection them for the European List of Geological Heritage. It is realised on several levels: from the lowest – sites' identification and evaluation in microregions within the every country to international level of selection and verification (Wimbledon

et al., 1998). Selection and evaluation of caves and karst sites as geological heritage is based on the general criteria mentioned above (J. Urban, 2004).

The "Geosite" project has been formally realised in Poland since 2002 and will result in completing of the database of ca 150 Polish geosites of superregional scientific importance (Alexandrowicz, 2003; Miśkiewicz, 2004). 26 sites – caves or karst forms or areas of their occurrence – represent outstanding values suggesting their superregional importance. The most frequent criteria justifying a selection were following scientific values (J. Urban, 2004):

a) importance for stratigraphical, palaeoecological and palaeogeographical documentation of the Neogene (Paleogene?) and/or Quaternary: Tatra Mts; Jaskinia Niedźwiedzia, Połom quarry and Przeworno in the Sudetes; Zabierzów, Ojców Platteau near Jerzmanowice, valley of Prądnik creek (Ojców N.P.), Góra Zborów, Sokole Góry, Biśnik cave and Węże in the Kraków-Wieluń Upland; Skorocice Valley (Fig. 3) in the Nida Basin; Jaworznia (Chelosiowa Jama-Jaskinia Jaworznicka cave system), Kadzielnia, Góra Zelejowa, Góra Miedzianka/Kozi Grzbiet and Jaskinia Raj in the Świętokrzyskie Mts;

b) importance for studies of the Permian-Triassic palaeogeography: Czatkowice in the Kraków-Wielun Upland; Jaworznia, Wietrznia and Kowala-Nowiny quarry in the Świętokrzyskie Mts;

c) importance for palaeontological investigations of vertebrates: Permian-Triassic – Czatkowice, Cenozoic – Węże, Biśnik, valley of Prądnik creek, Ojców Platteau, Góra Miedzianka/Kozi Grzbiet, Jaskinia Raj, Przeworno and Jaskinia Niedźwiedzia (some of them represent also significant archeological localities);

d) importance for mineralogy and petrography: Groty Kryształowe (Crystal Caves) in Wieliczka Salt Mine near Kraków (Fig. 6); historic mines in Tarnowskie Góry (hydrothermal paleokarst) in the Silesian Upland; Jaskinia w Mechowie (Fig. 5) in the Polish Lowlands (Baltic Coastland) and Jaworznia;

e) importance for studies of geomorphological processes in non-karstified rocks: Wierch nad Kamieniem, Malinowska cave and Łopień (Fig. 2) in the Beskidy Mts.

Only a few sites among proposed for the List represent caves of high aesthetic or/and cultural values, which can be compared to the famous show caves of Slovakia/Hungary and Slovenia. They are first of all: Jaskinia Niedźwiedzia, Jaskinia Raj and Groty Kryształowe (Crystal Caves). In several localities specific mineral forms occur: various calcite speleothems (Jaskinia Niedźwiedzia and Jaskinia Raj), other unique calcareous aggregates (Chelosiowa Jama-Jaskinia Jaworznicka in Jaworznia), Pb and Zn sulfides (Tarnowskie Góry) and large halite crystals (Groty Kryształowe – Crystal Caves, Fig. 6).

Apart of the sites mentioned above, karst of the Lublin area (eastern Poland) and the western section of the Silesian Lowland are considered as important for paleogeographical investigations, but representative localities have not been selected yet. On the other hand three of the sites mentioned above: Połom, Czatkowice and Kowala-Nowiny are endangered with complete damage as situated in active quarries and – due to commercial, economic reasons – must not be protected by law and, consequently, they must not be formally included to the List of European Geological Heritage now. Almost all other sites are under legal protection. Seven caves and historical mine in Tarnowskie Góry are accessible for public.

CONCLUSIONS

The caves and karst sites represent important elements of natural heritage, which are often characterized by important scientific, cultural (aesthetic) and natural values. They are very sensitive for human impact and can be easily damaged. Thus, comprehensive system of legal and practical protection should be applied. Polish law of nature protection ought to be changed so as to protect all caves since their discovering (except of the cases justified by tenable economic reasons) and the most interesting karst sites, which should be monitored along the progress of excavation.

Practical preservation requires changes of law articles (e.g. re-introducing of "voluntary guards of nature"), initiation of new methods and techniques as well as changes of public awareness. These fields of improvements may be based on the experiences of the other European countries. Evolution of public approach to the caves should be generated by activation of cavers clubs in the cave protection and management. Cavers co-operating with administration of nature protection are the most adequate people inspecting and watching caves. Functions of the clubs – specific for each protected area (site) – should be determined in the projects of management of the legally protected areas. Consciousness of local populations can be stimulated not only by traditional education, but also by economical motivations, e.g. financial profits for landowners observing rules of protections.

26 cave and karst localites (objects and areas) have been preliminary selected as geosites of super-regional importance in Poland, so far. Majority of them are practically (and most frequently legally) protected and – except of three sites threatened by quarrying – they are initially proposed for the European List of Geological Heritage. Now scientific and other values of these sites should be verified on the interregional level, what means practically – in the international scale. This verification ought to consist in common evaluation and

comparison of cave and karst sites in (Central) European countries. It needs common and interconnected activities of scientists studying caves and karst in these countries (as information exchange, workshops, conferences, etc.) resulting in the development of database of the sites of special values in (Central) Europe, publication of list and descriptions of these sites (some kind of "red book") and, finally, common proposal of (Central) European List of Caves and Karst Sites as an element of European List of the Geological Heritage.

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REFERENCES

Alexandrowicz, Z. 2003. Protection of the Polish geological heritage within the European framework of geosites (English sum.). Przegl. Geol. 51, 3: 224–230.

Alexandrowicz, W. – Alexandrowicz, Z. 2003. Pattern of karst landscape of the Cracow Upland (South Poland). Acta Carsologica 32, 1: 39–56.

Alexandrowicz, Z. – Urban, J. – Miśkiewicz, K. 2005. Geological values of selected Polish sites of the UNESCO World Heritage List. Proc. of 4th Intern. Symp. ProGEO on the Conservation of the Geological Heritage. 13. – 16. 9. 2005, Braga, Portugal: 15.

Bella, P. 1996. Jaskyne Slovenského a Aggtelekského krasu v zozname svetového dedičstva. Spravodaj SSS, 27, 1: 51–53.

Bella, P. 2001. Národná prírodná pamiatka Dobšinská ľadová jaskyňa – svetové prírodné dedičstvo. Ochrana prírody Slovenska, 1: 10–11.

Borsuk-Białynicka, M. – Cook, E. – Evans, S. E. – Maryańska, T. 1999. A microvertebrata assemblage from the Early Triassic of Poland. Acta Palaeont. Pol. 44: 167–188.

Cave Conservation Policy. National Caving Assoc., London 1995, pp. 32.

Chmielewski, W. Ed. 1988. Caves of the Sąspowska valley (English sum.). Prace Inst. Archeol. Uniw. Warsz., 1, pp. 173.

Cyrek, K. 2004. The beginnings of the Central Jura, Polska habitation against the background of environmental changes (since the Odra glaciation up the Eemian interglacial period) (English sum.). In J. Partyka, Ed. The diversification and tranformation of natural and cultural environment of the Kraków-Częstochowa Upland, v. 2. Ojców Nat. Park, Ojców: 11–18.

Felisiak, I. 1992. Oligocene-Early Miocene karst deposits and their importance for recognition of the development of tectonics and relief in the Carpathian Foreland, Kraków region, Southern Poland (English summary). Ann. Soc. Geol. Pol. 62: 173–207.

Głazek, J. 1989. Paleokarst of Poland. In P. Bosák – D. C. Ford – J. Głazek – I. Horáček, Eds. Paleokarst. Academia, Praha: 77–105.

Głazek, J. 1996. Karst and caves of the Polish Tatra Mts, state of knowledge and perspectives (English sum.). In A. Kotarba, Ed. Proc. 1st Polish Conf. "The Tatra Nat. Park – Nature and Man", v. 1, Kraków-Zakopane: 31–44.

Głazek, J. – Grodzicki, J. 1996. Karst and caves (English sum.). In Z. Mirek, ed.: Nature of the Tatra National Park. Tatra N.P., Kraków-Zakopane: 139–168.

Głazek, J. – Szynkiewicz, A. 1987. Stratigraphy of the Late Tertiary and Early Quaternary karst deposits in Poland and their paleogeographic implications (English sum.). In Problemy młodszego neogenu i eoplejstocenu w Polsce. Mater. Konf. Nauk. "Plioceńska i eoplejstoceńska sieć rzeczna i związane z nią kompleksy osadów gruboklastycznych w Polsce". Ossolineum, Wrocław: 113–130.

Gradziński, M. 1999. Position and age of conglomerates in caves near Kraków (Polish Jura). Ann. Soc. Geol. Pol. 69: 113–124.

Gradziński, M. – Kicińska, D. 2002. Morphology of Czarna Cave and its significance for the geomorphic evolution of the Kościeliska Valley (Western Tatra Mts.). Ann. Soc. Geol. Pol. 72: 255–262.

Hercman, H. 2000. Reconstruction of palaeoclimatic changes in Central Europe between 10 and 200 thousand years BP, based on analysis of growth frequency of speleothems. Studia Quatern. 17: 35–70.

Hecman, H. – Mirosław-Grabowska, J. – Madeyska, T. 2004. Record of the environment changes during the last 150 000 years in cave sediments of the Kraków-Częstochowa Upland (English sum.). In J. Partyka, Ed. The diversification and tranformation of natural and cultural environment of the Kraków-Częstochowa Upland, v. 1. Ojców Nat. Park, Ojców: 84–88.

Jahn, A. – Kozłowski, S. – Wiszniowska, T. Eds. 1989. The cave Jaskinia Niedźwiedzia in Kletno (English sum.). Ossolineum, Wrocław, pp. 369.

Kicińska, D. 2004. Kenozoiczna ewolucja podziemnej cyrkulacji wód krasowych w Tatrach Zachodnich (in Polish). Mat. 38. Symp. Spel., Zakopane 7. – 10. 10. 2004, Sekcja Spel. Pol. Tow. Przyr. im. Kopernika, Kraków: 51–52.

Kotarba, E. 2004. Jeszcze o ochronie jaskiń słów kilka (in Polish). Jaskinie 1 (34): 33.

Kowalski, K. Ed. 1989. History and evolution of the terrestial fauna of Poland (English sum.). Folia Quatern. 59–60, 278 pp.

Madeyska, T. 1981. Le milieu naturel de l'homme du Paleolitique Moyen et Superieur en Pologne a la lumiere des recherches geologiques (French sum.). Studia Geol. Pol. 69: 1–125.

Madeyska, T. 2000. Conference trip C. Palaeolithic cave sites of the Kraków Upland. In M. Gradziński, Ed. Climate changes – the karst record II, guidebook and abstracts. Inst. Geol. Sci. Polish Acad. Sci. and Inst. Geol. Sci. Jagiellonian Univ, Kraków: 25–33.

Madeyska, T. – Cyrek, K. 2002. Cave fillings – a chronicle of the past. An outline of the Younger Pleistocene cave sediments study in Poland. Acta Geol. Pol. 52, 1: 75–96.

Margielewski, W. – Urban, J. 2003. Crevice type caves as initial forms of rock landslides development in the Flysch Carpathians. Geomorphology, 54, 3-4: 325–338.

Margielewski, W. – Urban, J. 2004. Crevice-type cave Diabla Dziura in Bukowiec (Rożnów Foothill, Outer Carpathians) as an initial stage of deep-seated landslides development in the Flysch Carpathains (S Poland) (English sum.). Przegl. Geol. 52, 12: 1171–1178.

Miśkiewicz, K. 2004. Polish database of the representative geosites for the european framework. Pol. Geol Inst. Special Papers 13: 35–39.

Nowak, J. 2003. Czynna i bierna ochrona jaskiń (in Polish). Jaskinie 3 (32): 26–28, 4 (33): 31.

Paszkowski, M. 2000. Pre-Callovian multiple karstificatiom of Carboniferous limestone. In M. Gradziński, Ed. Climate changes – the karst record II, guidebook and abstracts. Inst. Geol. Sci. Polish Acad. Sci. and Inst. Geol. Sci. Jagiellonian Univ, Kraków: 16–21.

Rogala, W. 2003. A vertical distribution of karst cave system in the Połom hill (Kaczawskie Mts., Sudetes, SW Poland) (English sum.). Przegl. Geol. 51, 3: 238–240.

Studies on Raj cave near Kielce (Poland) and its deposits. Folia Quaternaria 41, 1972, pp. 148.

Urban, J. 2000. The sandstone tors and caves in the Polish Lowlands (English sum.). Przegl. Geolog. 48, 5: 409–411.

Urban, J. 2002. Kras kopalny trzonu paleozoicznego Gór Świętokrzyskich (in Polish). Streszcz. Ref. Wygł. w 2001 r., Pol. Tow. Geol., Uniw. im. A. Mickiewicza, 11: 53–69.

Urban, J. 2004. Caves and karst sites of Poland as a contribution to geological heritage of Central Europe. Pol. Geol Inst. Special Papers 13: 89–96.

Urban, J. (in print). Legal and practical protection of caves in Poland (English sum.). Chrońmy Przyr. Ojcz.

Urban, J. – Gradziński, M. 2004. Traditions and perspectives of protection of "Sokole Góry" nature reserve (English sum.). In J. Partyka, Ed. The diversification and tranformation of natural and cultural environment of the Kraków-Częstochowa Upland, v. 1. Ojców Nat. Park, Ojców: 89–95.

Urban, J. – Gubała, J. – Kasza, A. 1997. The caves in the Holy Cross Mts region (Central Poland and their protection (English sum.). Przegl. Geol. 45, 7: 700–706.

Urban, J. – Gubała, J. – Kasza, A. 2003. Caves in gypsum of the Nida basin, Southern Poland (English sum.). Przegl. Geol. 51, 1: 79–86.

Urban, J. – Otęska-Budzyn, J. 1998. Geodiversity of pseudokarst caves as the reason for their scientific importance and motive for protection. Geol. Balcan. 28, 3–4: 163–166.

Weighell, T. 2004. The role of the World Heritage Convention in landscape protection. In M. Parkes, Ed. "Natural and cultural landscapes – the geological foundation", Proc. conf. 9. – 11. 9. 2002, Dublin Castle, Ireland. Royal Irish Academy, Dublin: 159–160.

Wimbledon, W. et al. 1998. A first attempt at a Geosites framework for Europe – an IUGS initiative to support recognition of world heritage and European geodiversity. Geol. Balc. 28, 3–4: 5–39.

Wójcik, Z. 1968. Geomorphological development of the limestone areas of the Tatra Mts and other karst massifs in the Western Carpathians (English sum.). Pr. Muz. Ziemi 13: 3–172.