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GEODIVERSITY CONSERVATION — CONSERVING OUR GEOLOGICAL HERITAGE

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Abstract. This report presents the basic concepts of geodiversity and its relation to biodiversity and landscape. The authors provide the definition of geodiversity and geosite, enhancing the role of most of the geosites in monitoring physical and chemical changes in the environment. Moreover, geodiversity projects proposed or conducted by the Polish Geological Institute are discussed. The authors also present the critical view on the future of geoconservation in Poland regarding the nature as a whole lot composed of two interweaved abiotic and biotic parts.

Key words: geodiversity, biodiversity, geosites, geoparks, future development.

Abstrakt. „*Czas, czas geologiczny patrzy na nas ze skał jak z żadnych innych form krajobrazu. Młodość Ziemi i tryskająca z niej świeżość jest w glebach i drzewach, a jej sędziwy wiek tkwi w skałach*" — w słowach tych amerykański przyrodnik John Burroughs wyraził bardzo ważny aspekt ochrony georóżnorodności. Historia Ziemi wraz z jej różnorodnością i bogactwem procesów abiotycznych i biotycznych jest zapisana w formacjach geologicznych. Badanie tych procesów umożliwia nam nie tylko ich zrozumienie, lecz również przewidywanie przyszłych zmian w środowisku o zasięgu lokalnym, regionalnym, krajowym i globalnym. Integralna koncepcja ochrony georóżnorodności, bioróżnorodności i krajobrazu odgrywa kluczową rolę w ekorozwoju, stanowiąc wyzwanie do życia w harmonii z przyrodą. Georóżnorodność należy definiować jako naturalne zróżnicowanie powierzchni Ziemi, obejmujące formy i systemy geologiczne, geomorfologiczne, glebowe i wód powierzchniowych, powstałe w wyniku procesów naturalnych (endo- i egzogenicznych), miejscami o różnym wpływie antropogenicznym. Stanowiska geologiczne (geostanowiska) są więc zewnętrznym przejawem tych procesów. Większość tych stanowisk może być wykorzystana jako geoindykatory do monitorowania fizycznych i chemicznych zmian w środowisku. Ochrona georóżnorodności znalazła swój wyraz w licznych opracowaniach lub projektach badawczych Państwowego Instytutu Geologicznego, obejmujących: (1) *Mapę geologiczno-gospodarczą Polski,* 1:50 000, (2) mapy ochrony georóżnorodności (Karpat, Gór Świętokrzyskich i Dolnego Śląska), (3) geomonitoring osuwisk w Karpatach i przekształceń wybrzeża Bałtyku, (4) listę stanowisk stratygraficznych o randze międzynarodowej, narodowej i regionalnej oraz (5) propozycję utworzenia czterech geoparków (Łuku Mużakowa, jurajskiego, pienińskiego i chęcińsko-kieleckiego). Na uwagę zasługuje wstępna lista 149 najbardziej reprezentatywnych obiektów geologicznych i geomorfologicznych opracowana przez Instytut Ochrony Przyrody Polskiej Akademii Nauk w Krakowie. Zakres przyszłych działań powinien objąć: (1) opracowanie pełnej dokumentacji proponowanych geostanowisk i geoparków w Polsce, (2) uchwalenie konwencji o ochronie georóżnorodności, (3) włączenie ochrony georóżnorodności do Państwowego Monitoringu Ochrony Środowiska, (4) opublikowanie *Atlasu Georóżnorodności Polski*, (5) przygotowanie kolejnych edycji map ochrony georóżnorodności dla pozostałych regionów kraju, (6) rozwój geoedukacji i geoturystyki oraz (7) zsynchronizowane działania na rzecz idei ochrony georóżnorodności i dziedzictwa geologicznego na różnych szczeblach administracji państwowej oraz wśród samorządów i społeczności lokalnych.

Słowa kluczowe: georóżnorodność, bioróżnorodność, geostanowiska, geoparki, przyszły rozwój.

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INTRODUCTION

"*Time, geologic time, looks out at us from the rocks as from no other objects in the landscape. The youth of the earth is in the soil and in the trees and verdure that spring from it; its age is in the rocks...*" In these words John Burroughs, an American naturalist, expressed a very important aspect of geodiversity. The Earth history with all the variability and richness of different abiotic and biotic processes is recorded in geological formations. By studying these processes we are able not only to understand them, but also predict the future environmental changes according to the phrase: "the past is the key to the future". The evidence for the history of the Earth is one of the most important features of geodiversity (Eberhard ed., 1997).

During the last two decades, a considerable change has taken place in our attitude toward the nature conservation. The traditional nature conservation has been centred primarily on plants and animals. The so-called inanimate nature has played a "second fiddle" to the biotic elements. This approach turned out to be inefficient in solving more complex tasks in a fast changing world. New areas of concern have appeared. They include issues of global change, catastrophic events, land use, wetlands, coastal erosion, and pollution. These changes have been triggered at least partly by human activity which led to a rapid drop in a number of species. This phenomenon was determined by some scientists as the sixth phase of Great Extinction (Leakey, Lewin, 1996).

All these environmental concerns were a basis for passing a convention on the biodiversity conservation in Rio de Janeiro in 1992. Nine years later, as a convention signatory, Poland worked out its own strategy of biodiversity conservation and moderate use of its resources. The Rio de Janeiro convention encompassed three levels of nature organisation, i.e. the genetic, species and landscape. The last mentioned level implies an intrinsic relationship between abiotic and biotic elements of the environment. The landscape is constantly changing in response to forces both natural and artificial. The landscape diversity is understood as one of the conditions for life development; in addition, this is also closely linked to features and systems of abiotic world. The geodiversity, biodiversity and landscape conservation is a challenge for us to live in harmony with nature. This concept constitutes a pivotal part of the sustainable development.

Studying geodiversity enables us to understand the history of our planet and how life has evolved. This information helps us not only to manage the environment but also to better understand global changes and natural hazards, i.e. flash floods, landslides, earthquakes, volcano eruptions etc.

There are several organisations that are involved especially in geodiversity conservation, e.g. IUGS (International Union of Geologic Sciences), ProGeo and UNESCO. Both ProGeo and IUGS have developed a program which objective is to create a network of geosites. By contrast, the UNESCO initiative is focused on geoparks aiming at geological heritage promotion and economical development.

GEODIVERSITY AND BIODIVERSITY — DIFFERENCES AND SIMILARITIES

At the beginning of the XXI century, most people have become aware of the need for nature conservation, although still biotic elements of the environment were considered more fragile than the inanimate nature. This tendency is particularly visible when comparing a number of natural sites in the UNESCO World Heritage List. In 2000, of the total number of 630 sites, only 47, i.e. 7%, were selected for geological interest (UNESCO 160 Executive Board, 2000).

Even though there are certain differences between biodiversity and geodiversity in relation to the object, purpose and way of conservation, both of them aim at sustainable development (Table 1).

Table 1

Comparison between bio- and geodiversity

Criteria	Biodiversity	Geodiversity
Object of conservation	populations, living organisms, genes	rocks, landforms, soils, systems and processes
Purpose of conservation	preservation of organisms with their gene diversity from extinction	protection of geological and geomorphological objects from degradation
Way of conservation	ensuring the proper quality of the environment for living organisms propagation or breeding of threatened species	special management of geosites
Final effect	Action for sustainable development by preserving the environment for the next generations	

BASIC CONCEPTS OF GEODIVERSITY

There are two aspects of lithosphere[1] conservation:

1. The economical aspect encompasses mineral deposits, surface and ground waters, soils and atmosphere (mainly troposphere) (Kozłowski, 1998a, 2000; Migaszewski, Gałuszka, 2003) making up a source of abiotic natural resources. These elements constitute a basis for sustainable development.

2. The natural aspect includes geodiversity which is an integral part of ecosystems influencing both biodiversity and landscape. The relationship between geodiversity and landscape is visible especially in desert and semi desert areas covered with scarce vegetation.

Geodiversity (geological diversity)[2] may be defined as a natural diversification of Earth's surface including geological, geomorphological, soil, and surface water features, and systems formed by natural (endogenic and/or exogenic) processes, in places with a different anthropogenic imprint. Based on this definition, **geosite** may be determined as an outer manifestation of these processes. Most of the geosites can be used as **geoindicators** for monitoring physical and chemical changes in the environment. However, the term mentioned last includes also other abiotic elements that do not exhibit outer features, i.e. changes of water table, variations in chemistry of waters, sediments, soils, etc. (e.g. Zwoliński, 1998; Graniczny, 2001).

Mining and other man's activity plays an important role in exposing some geological features, for example folds, faults, stratigraphical or soil profiles, mineral- or fossil-bearing zones, etc. (Fortey, 1993; English Nature, 2000, 2002). Geodiversity encompasses a variety of rocks, minerals, fossils, soils and landforms that occur on our planet, along with the natural processes that shape the landscape. In this context, some of these combine scientifical, economical, social and environmental benefits. Geodiversity should also be regarded as a life marker in planets with adequate moisture, temperature and metastable geosphere[3] that encompasses geological setting, geomorphology, soils, surface waters and climate (Postgate, 1994).

Geodiversity conservation sometimes corresponds to geosozology — a discipline that deals with Earth's protection. The term sozology is derived from the two ancient Greek words: *sozo* — protect and *logos* — science (Goetel, 1966, 1971). Unfortunately, the term **geosozology** has not been widespread in the geological and environmental literature, and has been replaced by **geoecology**. By contrast, **landscape ecology** has a wider context and refers to geosphere, biosphere and noosphere (anthroposphere) (Richling, Solon, 1996).

The Goetel's ideas were developed in the project *Lithosphere protection concept* performed by the Polish Geological Institute during 1991–1997 (Kozłowski, 1998a). This project included many aspects of geodiversity and landscape conservation. Moreover, it outlined basic guidelines for future studies.

Poland has already got its own strategy of biodiversity, which is presented on the Ministry of the Environment website (www.mos.gov.pl). This is the main reason why the strategy of geodiversity should be worked out as soon as possible. Most of the crucial issues of this strategy were incorporated into the Polish Committee for Scientific Investigations (KBN) funded project *Geodiversity conservation system in Poland*, which was performed in 1997 through 1999 by the Polish Geological Institute in co-operation with Adam Mickiewicz University and Agricultural Academy in Poznań as well as the Institute of Nature Conservation of the Polish Academy of Sciences in Cracow. The principal objective of this project was to prepare valorisation of the abiotic environment in Poland that belongs to highly diversified countries in terms of geological setting, geomorphological features and climate conditions. Based on the obtained results, Kozłowski (1997, 2001) proposed a new division of geodiversity in Poland. Its updated version is presented in Table 2. It should be stressed that most of the distinguished elements are constantly affected by anthropogenic stresses that change their valorisation at a given place and time.

In Poland, there is a strong need for identifying areas of special geological significance. These identified areas should be properly managed to avoid degradation or total destruction. Geodiversity conservation in Poland is not implemented properly because it is not efficiently supported by law. The Nature Conservation Act that is being in force only mentions the preservation of geological heritage as one of the objectives of nature conservation. Of the existing nature conservation forms (national parks, nature reserves, landscape parks, protected landscape areas, nature landmarks, documentation sites, ecological use areas, nature-landscape assemblages), only documentation sites are linked directly to inanimate nature conservation, whereas nature reserves and landmarks may refer either to animate or inanimate nature. Moreover, the project proposal of the new Nature Conservation Act, which is being discussed by the Polish parliament, does not enhance the aspect of geodiversity conservation.

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[1] Lithosphere *sensu lato* is a collective term that encompasses lithosphere *sensu stricto* (rocks, minerals) and genetically related pedosphere (soils), hydrosphere (waters) and atmosphere (air) (Migaszewski, Gałuszka, 2003).

[2] The prefix "geo" does not always stands for "geological" because not all exogenic processes can be regarded as geological *sensu stricto*, especially those strongly influenced by biological activity, e.g. soil formation. In a measure, this corresponds to the difference between "geosciences" and "geological sciences".

[3] Geosphere usually refers to lithosphere *sensu lato*, but according to some authors (Manahan, 1994) only to lithosphere *sensu stricto* and pedosphere.

Table 2

Geodiversity division in Poland

Natural elements		Classes (5 in each)	Others
Geology	geological setting	very high, high, medium, small, very small	–
Geomorphology	relief energy (m a.s.l.)	>500, 200–500, 100–200, 40–100, <40	–
	relief dismembering	high mountains, medium + low mountains, high uplands, intermontane basins, valley floors + plains + coastal lowlands	–
	relief preservation state	forests + bogs + lakes, meadows + grasslands, arable lands, urbanized areas, industrial + mining + transport areas	
Soils	land production space (points acc. to IUNG in Puławy)	>90, 70–90, 50–70, 30–50, <30	
	surface water erosion	very high, high, medium, small, minimal	
Surface waters	springs (dm3/sec.)	>100, 50–100, 20–50, 5–20, <5	
	wetlands	national parks + reserves, unmanaged area, secluded + reclaimed, managed, dewatered + degraded + polluted	different anthropogenic impact
	lakes (purity)	A1, A2, A3, out of class (flow), out of class (lack of flow)	
	rivers (natural features)	river beds in legally protected areas, river beds in agricultural areas, stabilised river beds, regulated river beds, channeled river beds	
	rivers (purity)	A1, A2, A3, highly polluted by municipal wastes, highly polluted by industrial and municipal effluents	
Landscapes	landscape structure	very high, high, medium, small, very small	

GEODIVERSITY PROJECTS PROPOSED OR CONDUCTED BY THE POLISH GEOLOGICAL INSTITUTE

The Polish Geological Institute initiated and conducted many environmental projects that included studies of geodiversity, landscape and geological heritage conservation. The most important in this field is geological[1] and geo-environmental cartography. This describes many geosites, i.e. cliffs, springs, caves, glacial boulders, outcrops, stratigraphical profiles etc. Of the series of different maps, the following should be mentioned:

1. *Geological-Economical Map of Poland*, 1:50,000 (Kozłowski, 1998b) were preceded by *Geological-mineral deposit atlas of the Holy Cross Mts.* (Rubinowski *et al.*, 1986). It should be stressed that the geoenvironmental cartographical production of the Polish Geological Institute is unique in an international context. The geological-economical maps include the following aspects of the environmental protection:
   — potential occurrence of mineral deposits;
   — management and classification of mineral deposits;
   — actual and potential threats to the environment linked to occurrence, mining and processing of mineral materials;
   — selected hydrogeological elements for land use;
   — locations of protected objects and areas that constrain mineral deposit management;
   — subsoil conditions for optimal town-planning concepts;
   — nature conditioning for regional and local land use.

   Each map consists of an explanation book and a digital database. These maps are covering more than half of the area of Poland. The last sheet of this edition is supposed to be completed in 2007. A fragment of the sheet Tomaszów Mazowiecki is presented in figure 1. Even though these maps are designated primarily for resource managers and land use planners, they also contain many nature elements that show a close relationship with geodiversity, landscape and geological heritage conservation. In all, 289 regional sites (cliffs, outcrops, glacial boulders, caves, waterfalls) were recorded in the geological-economical maps of Poland, 1:50,000.

2. Geodiversity conservation maps, scales 1:200 000 through 1:400,000 of the following regions (Figs. 2–4):
   — Carpathians (Alexandrowicz, Poprawa, 2000);

[1] *Detail Geological Map of Poland*, 1:50,000

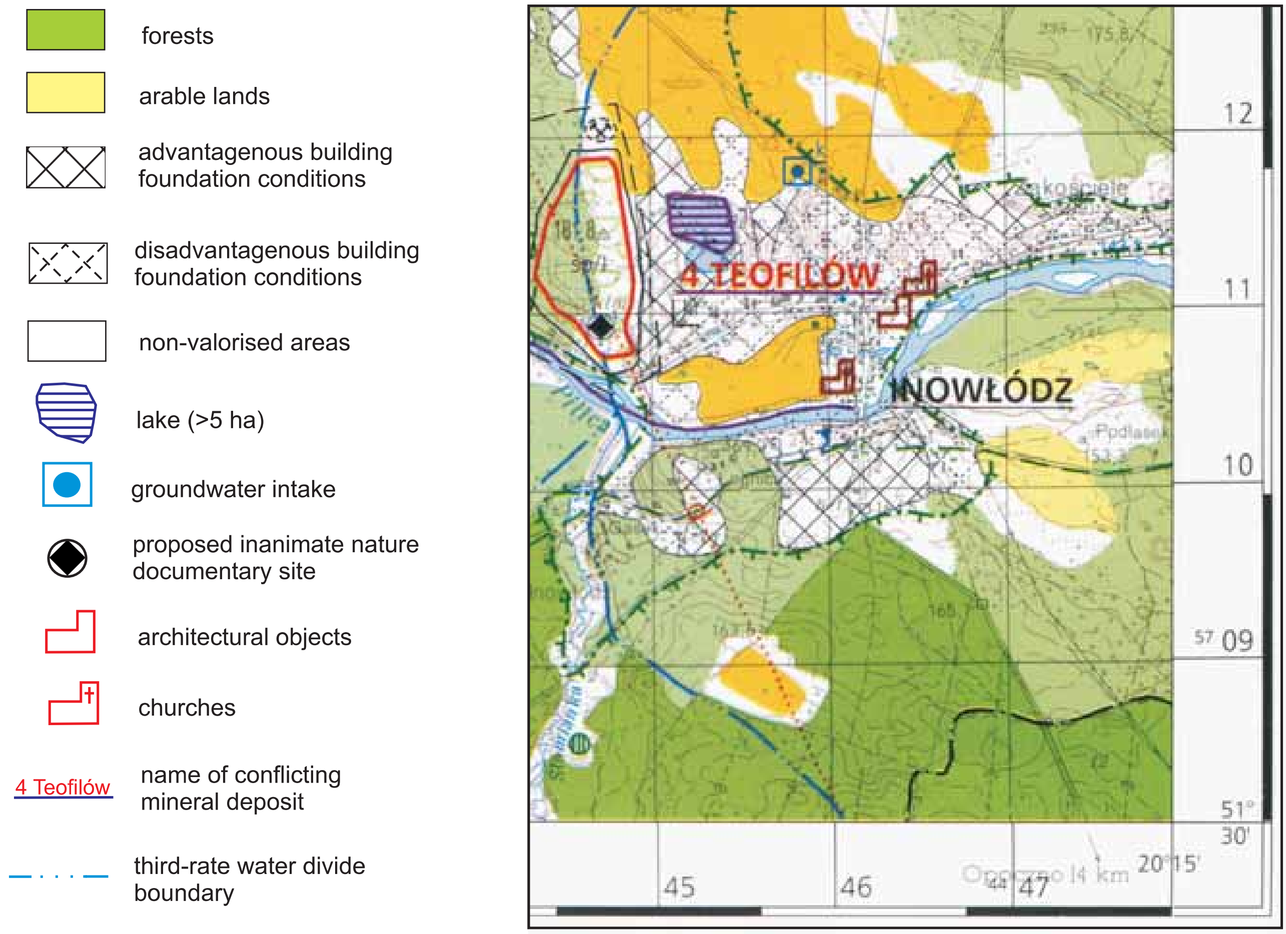

Fig. 1. Fragment of *Geological-Economical Map of Poland*, 1:50,000, sheet Tomaszów Mazowiecki (Pobratyn, Bednarz, 1998)

— Holy Cross Mts. (Wróblewski, 2000);
— Lower Silesia (Gawlikowska, 2000).

All these maps along with explanation books include geology and geomorphology of a given region and a detailed description of protected and proposed inanimate nature objects, e.g. nature reserves, nature landmarks, and documentary sites (artificial exposures resulting from man's activity).

3. Monitoring of environmental changes with some of the geological features (Graniczny, 2001):
— landslides,
— sea shoreline.

These encompass landslide movements in the Flysch Carpathians and the Baltic coast erosion. It should be mentioned that other geosites may also be used for monitoring of any changes in the environment, for example springs and caves.

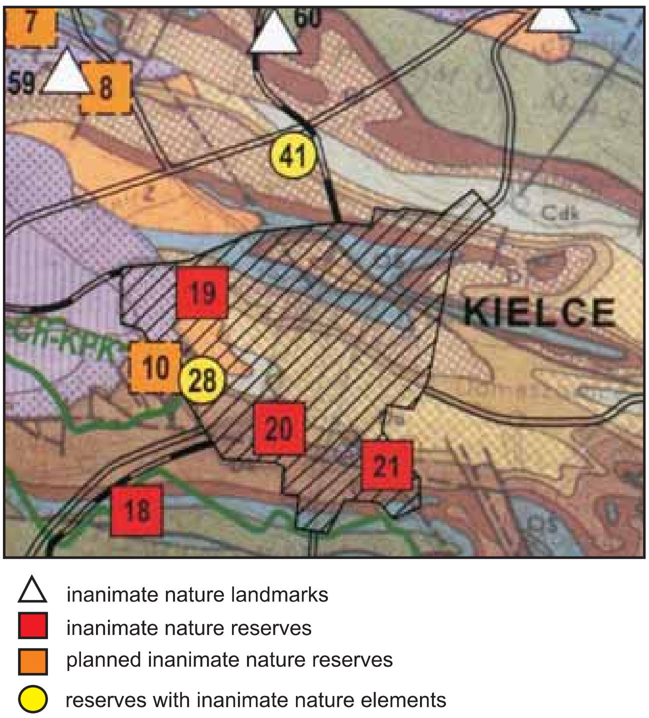

Fig. 2. Fragment of map showing protected areas and objects of inanimate nature

Attachment to the book *Geodiversity Conservation in the Holy Cross Mts. Region* (Wróblewski, 2000)

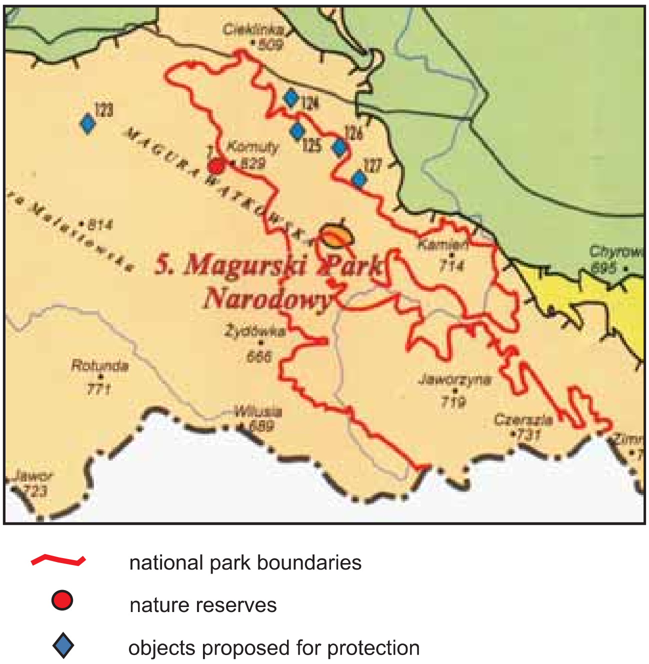

Fig. 3. Fragment of map showing protected areas and objects of inanimate nature on the geological background

Attachment to the book *Geodiversity Conservation of the Polish Carpathians* (Alexandrowicz, Poprawa, 2000)

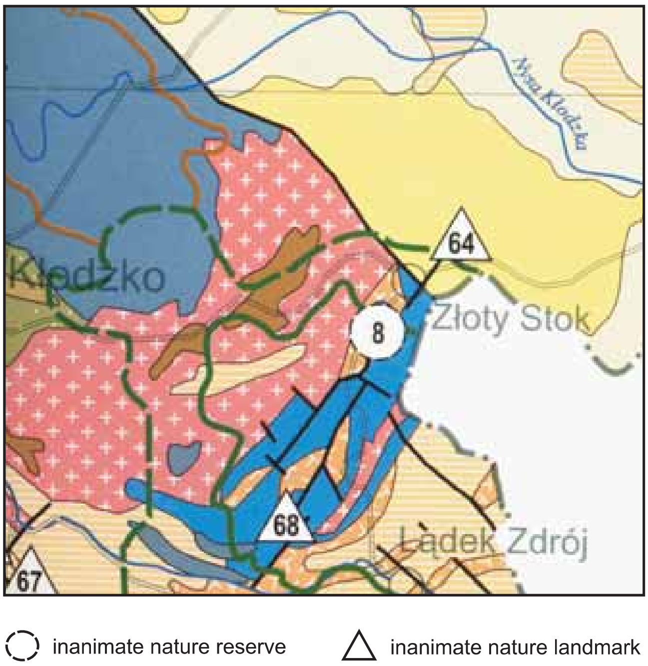

Fig. 4. Fragment of map showing protected areas and objects of inanimate nature on the geological background

Attachment to the book *Geodiversity Conservation of the Lower Silesia* (Gawlikowska, 2000)

4. Geological heritage conservation includes a number of geosites and landscapes that should be protected for the future generations. Except for the 289 regional sites recorded in *Geological-Economical Map of Poland*, 1:50,000, the additional geological objects or areas have been proposed for conservation:
   - — international geosites — a preliminary list of the most representative geological and geomorphological objects, encompassing 149 geosites of Poland, was prepared by Alexandrowicz (2003);
   - — stratigraphical sites of international, national and regional rank — the Polish Geological Institute proposed 290 stratigraphical sites in 1999;
   - — geoparks — establishment of at least 4 geoparks in Poland is considered, i.e. Łuk Mużakowa (Muskau Arch) – Polish–German International Geopark (Badura *et al.*, 2003), Jurassic Geopark located on the Cracovian–Wieluń Upland, Pieniny Geopark (southern Poland) and Chęciny–Kielce Landscape Park (south-western part of the Holy Cross Mts.). Of the parks mentioned above, the most advanced documentary works and scientific studies have been carried out for the Łuk Mużakowa Geopark.

THE FUTURE OF GEOCONSERVATION IN POLAND — WHAT SHOULD BE DONE?

Due to a critical role of geological, geomorphological, soil, and surface water features and systems in shaping both biodiversity and landscape, the implementation of the principal objectives is required. They are as follows:

1. Preparation of full documentation for proposed geosites and geoparks in Poland for drafting a law.
2. Passage of a convention on the geodiversity conservation which would include inventory and protection of geosites (and geoparks) for research, education and recreation. This would also encompass actions at different levels to counteract hazards that could jeopardise existing geosites. The act of law could outline the legal framework for geodiversity conservation and would enable to get funds for specific objectives. Without a legal basis, the geodiversity concept will remain “suspended in the air“.
3. Incorporation of geodiversity conservation into the Polish Environmental Monitoring. This should constitute a consistent whole with the biodiversity conservation.
4. Publication of the *Geodiversity Atlas of Poland* containing elements included in table 2.
5. Preparation of the subsequent geodiversity conservation reports and maps for the subsequent regions of Poland, especially for the Upper Silesia and the Baltic Coast.

6. Maximising the potential by identifying and exposing new features. These would also require a close co-operation with mineral industries to discover new geosites through quarrying operations.
7. Undertaking monitoring of geosites by professional geoscientists or academic research groups. These actions should be integrated with environmental management systems.
8. Involvement of Earth scientists and local authorities in providing information on the geodiversity and geological heritage conservation (festivities, mineral and fossil shows, informal and anniversary meetings, lectures etc). These would also stimulate local people to take an interest in the Earth science issues and to seek positive action. Moreover, this microcosm could provide a regional, national or global perspective as well as a better understanding in each area of concern.
9. Development of infrastructure for geotourism by preparing self-guided trails, maps, books and movies that would provide information on nature landmarks, lookouts, sites of ancient mining and related historical interest, places of different geoecological problems, etc.
10. Development of geoeducation at different levels (schools, museums, training courses, publications, co-operation with park and related services, etc). By gathering information and continuous education, people can develop a better understanding of the physical and chemical processes that have shaped and continue to shape the landscape and natural resources. Geoeducation also enables us to gain the knowledge on the fullest use and benefit of these national treasures.
11. Selection of best geoindicators among the existing geosites for conducting geomonitoring (in some places coupled with biomonitoring) to assess the environmental quality.

FINAL CONCLUSION — LINKS WITH BIODIVERSITY

There is a close relationship between geodiversity and biodiversity. Geoscientists should never forget about the other "lung" of nature — biosphere. The nature ought to be regarded as a whole lot composed of two interweaved abiotic and biotic parts. That is the main reason why representatives of geo- and biosciences should conduct studies together. Sometimes, however, a conflict or dispute may arise, for example, the removal of vegetation to improve access to a geosite. Moreover, an increased number of educational visits may jeopardise the very existence of some rare plant and animal species. The decision about how to proceed should be made on the basis of a relative importance of the geodiversity and biodiversity resources.

REFERENCES

ALEXANDROWICZ Z., 2003 — Protection of the Polish geologic heritage within the European framework of geosites [in Polish]. *Prz. Geol.*, **51**: 224–230.

ALEXANDROWICZ Z., POPRAWA D., 2000 — Geodiversity Conservation of the Polish Carpathians, with Map of protected and proposed for protection inanimated nature objects and areas, scale 1:400,000 [English Sum.]. Polish Geol. Inst., Warszawa.

BADURA J., GAWLIKOWSKA A., KASIŃSKI J.R., KOŹMA J., KUPETZ M., PIWOCKI M., RASCHER J., 2003 — "Muskau arch" Geopark – suggested trans-boundary area of geodiversity conservation [in Polish]. *Prz. Geol.*, **51**: 54–58.

EBERHARD R. (ed.), 1997 — Pattern and Process: Towards a regional approach to national estate assessment of Geodiversity. 1997. Technical Series No. 2, Australian Heritage Commission & Environment Forest Taskforce. Environment Australia, Canberra.

ENGLISH NATURE, 2000 — Position statement on fossil collecting. English Nature. Peterborough (www.english-nature.org.uk).

ENGLISH NATURE, 2002 — Position statement on aggregate extraction and nature conservation. English Nature. Peterborough (www.english-nature.org.uk).

FORTEY R., 1993 — The hidden landscape: A journey into the geologic past. Pimlico, London.

GAWLIKOWSKA E., 2000 — Geodiversity conservation of the Lower Silesia with Map of protected areas and objects of inanimate nature, scale 1:300,000 [English Sum.]. Polish Geol. Inst., Warszawa.

GOETEL W., 1966 — Sozology – science on the protection of nature and its resources [in Polish]. *Kosmos*, **5**.

GOETEL W., 1971 — Sozology – science discipline, its essence and tasks [in Polish]. *Sozol. Sozotech.*, **1**.

GRANICZNY M., 2001 — Geoindicators – workshops organized under the auspices of IUGS COGEO ENVIRONMENT Lusaka, Zambia, 25–26.07 [in Polish]. *Prz. Geol.*, **49**: 847–848.

KOZŁOWSKI S., 1997 — Geodiversity conservation program in Poland [in Polish]. *Prz. Geol.*, **45**: 489–496.

KOZŁOWSKI S. (ed.), 1998a — Lithosphere Protection. Open-file report [in Polish]. Polish Geol. Inst., Warsaw.

KOZŁOWSKI S., 1998b — Basic foundations for geologic-economic map of Poland [in Polish]. *Prz. Geol.*, **46**: 1032–1037.

KOZŁOWSKI S., 2000 — Ochrona geosfery. *Prz. Geol.*, **48**: 815–816.

KOZŁOWSKI S., 2001 — Progresses in studies on the geodiversity conservation in Poland [in Polish]. *Kosmos*, **80**, 1/2: 151–165.

KOZŁOWSKI S., 2002 — Selected problems of nature monitoring. *Bibl. Monit. Przyr.*, **1**, 3: 70–76.

LEAKEY R., LEWIN R., 1996 — The sixth extinction. Patterns of life and the future of humankind. Anchor Books, New York.

MANAHAN S.E., 1994 — Environmental Chemistry. CRC Press, Inc.

MIGASZEWSKI Z. M., GAŁUSZKA A., 2003 — Outline of Environmental Geochemistry [in Polish]. Wyd. Akad. Święt., Kielce.

POBRATYN A., BEDNARZ K., 1997 — Explanations for geologic-economic map of Poland, scale 1:50,000, Tomaszów Mazowiecki sheet . Polish Geol. Inst., Warsaw.

POSTGATE J., 1994 — The outer reaches of life. Cambridge Univ. Press., Cambridge.

RICHLING A, SOLON J., 1996 — Landscape ecology [in Polish]. PAN, Warsaw.

RUBINOWSKI Z., WRÓBLEWSKI T., GĄGOL J. (eds.), 1986 — Geologic-mineral deposit atlas of the Holy Cross Mts., 1:50,000 with sozological mineral materials classification. Open-file report [in Polish]. Polish Geol. Inst., Warsaw.

UNESCO 160 Executive Board, 2000 — Report by the Director-General on the feasibility study on developing a UNESCO Geosites/Geoparks Programme. Paris.

WRÓBLEWSKI T., 2000 — Geodiversity conservation in the Góry Świętokrzyskie region with Map of protected areas and objects of inanimated nature, scale 1:200,000 [English Sum.]. Polish Geol. Inst., Warszawa.

ZWOLIŃSKI Z., 1998 — Geoindicators in present geosystems dynamics research. *In*: Major trends in geomorphology research in Poland. Present state and perspectives (ed. K. Pękala) [in Polish]: 223–227. Lublin.