

Proposals for the national ProGEO list of Geological Heritage

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Abstract: The rich geological heritage of Slovakia, due to its position on the contact of Alps and Carpathians, has made this area one of the most important core regions for geological teaching and research. The creation of data bank of the geosites network conservation is the essential step towards the protection of natural areas and sites of both scientific and educational geological importance.

Key words: geological heritage of Slovakia, ProGEO, geosites, protection.

Introduction

The Geological Heritage, a non-renewable natural resource, allows us to recognise, study and interpret the geological history of the Earth and of the processes involved. At the start of the new millennium, the protection and conservation of the Geological Heritage – an important element of both our Natural and our Cultural Heritage – still raise important issues of all sorts: scientific, legal and administrative, management and representation. All these issues should be dealt globally, because the geological setting do not respect national borders or any other administrative limits.

At present, the only one potentially world designation for geological site protection is a World Heritage Site Status. World Heritage work has to date lacked any framework for the consideration of geological proposals. The conclusions of the Belogradchik workshop June 1998 and of the methodology in general, to WH may be summarised, as follows.

Geosites

1. Formation of network of informants in countries
2. Definition of key regional geo(morpho)logical elements
3. Selection of Geosites in such frameworks
4. Selection of a Geosites list for each country
5. Country selection of European WH
6. Comparative documentation of Geosites
7. Proposal of WH sites by countries

In 1995, at its Sigtuna conference, ProGEO decided to compile an European list of significant geosites. The purpose of such a list was seen as promoting geoconservation, providing a focus for cross-border collaboration, and an actual mechanism to push the process of site identification (and protection) in those countries as yet with no inventory.

In 1995 the International Union of geological Sciences decided, subsequently with the support of UNESCO, to promote a new project to compile a global inventory and related database. The president of IUGS wrote to all national committees and affiliated bodies to enlist their support for the project in 1996. IUGS has set up a new Global Geosites Working Group to undertake the work, an ProGEO has agreed to act as its agent in Europe.

Further workshops (1996 Roma, 1997 Tallin, 1998 Krakow, Prague, 2000) have set the methods for both identification of geosites and creating of single databases.

A lot of work has been done in Slovakia within the the study of its geological settings through the 20th century. Numerous papers and scientific works aid to the geological knowledge of our country. This paper is not aiming to list all of them.

Now we have reached the first stage of Geosite identification. Our national group has started to both identify their frameworks and to make choices of site areas (Wimbledon et al., 1998). Such identification will operate through two mechanisms: one by national groups and regional groupings of country participants, and secondly through specialist contributors providing a wider international perspective, on, for instance, fossils and minerals, or the history of science.

In selecting of national geosites we have to find a way how to overcome and to see through the complexity of the geological record and the numerous of localities. We have to justify what is special and representative for each country taking into account its regional geological setting.

To fulfil these demands, we have to set a national group to take the work forward. This paper ought to be perceived as an invitation for a wide national discussion on our national geosites, with enough specialists from relevant disciplines. We hope, that the best advice will be obtained through exchange and discussion amongst researchers.

Draft List on Slovak Geological Heritage

PALEOZOIC

Stráňanský Potok valley, Malá Fatra Mts., Stráňanský Potok Fm.

Tatricum - autochthonous unit, continental-alluvium sediments of braided rivers. Cyclically arranged sediments – coarse-grained diagonal-bedded sandstones-sandy conglomerates with a partial fine-grained uppermost member. *Upper Permian*

Zelená Dolina valley, Nízke Tatry Mts., Starohorské vrchy Hills

Northern Veporicum Špania Dolina Fm. autochthonous unit. Braided stream deposits composed of graded bedded coarse-grained sandstones and sandy conglomerates with dominant arcose material, sporadically volcanoclastic horizons, *Upper Permian*

Bystrô valley, Veporské Vrchy, Čierťaž Mts., Brusno and Predajná Fms. (Lubietová Group)

The type profile of the Brusno Fm. – Dominant arcose sediments of psephitic to psammitic grade and the presence of a volcanic horizon in its middle part (Harnobis horizon), Predajná Fm. – complex of clastic sediments (conglomerates, sandstones, sandy shales) – megacyclic sequence with vertical and lateral changes in lithofacies, varied colours of sediments, *Lower - Upper Permian*

Road Krokava – Burda – Slatviná, Veporské vrchy Mts., Revúcka vrchovina Upland and Rimava Fms. (Revúca Group), Southern Veporicum. It represents the upward-coarsening sequence with mutual transition from delta-shallow water to continental, fluvial association. Alpine ages of the contact metamorphism are dated acc. Rb/Sr, U/Pb, K/Ar. The climax of the contact – thermal metamorphism determined by mineral thermobarometer LP/HT. Microflora *Stephanian C-D to Permian*

Nižná Boca, Nízke Tatry Mts., Nižná Boca and Malužiná Fms. (Ipolitica Group of the Hronicum allochthonous unit)- regressive clastic sequence — medium to fine grained sandstones to siltstones and claystones. Syngenetic dacite, andesite volcanism. Macroflora and microflora – *Stephanian B-C*

Ipolitica valley, Nízke Tatry Mts., Malužiná Fm. - typical red beds with alternation of conglomerates, sandstones and shales, locally there occur layers of dolomites, gypsum and caliche. Important phenomenon is a polyphase synsedimentary andesite-basalt volcanism of continental tholeiitic magmatic type. Microflora – *Lower to Upper Permian*

Ochtiná magnesite quarry, Spišsko - gemerské rudohorie Mts., type loc. of Ochtiná Fm, Northern Gemericum, allochthonous unit. Flysh-like clastic sediments – metaconglomerates, metasandstones, metapelites, interlayered with metabasalts and basaltic metavolcanoclastics, in the upper part of Fm. are neritic and littoral dolomitic shales, dolomites, magnesites. *Visean – Serpukhovian*.

Dobšiná, Biengarten quarry, Spišsko-gemerské rudohorie Mts., Zlatník Fm.

Shallow water foreshore carbonate horizon of the basal part of the Zlatník Fm. very rich on fragments of fauna, fine-grained clastic metasediments associated with fine basaltic metavolcanoclastics and scarce effusions of high-K tholeiitic basalts. *Westphalian B-C*

Závadka quarry, Spišsko-gemerské rudohorie Mts., Rudňany Fm.

Polymict boulder conglomerates, conglomerates, sandstones interpreted as delta-fan deposits. From conglomerates 34 petrographic rock types have been described. *Westphalian*

Závadka, Spišsko-gemerské rudohorie Mts., Knola Fm. of the basal part of the Krompachy Gr.

Variiegated thick-bedded conglomerates of an alluvial fan environment are structurally and mineralogically immature. More than 15 petrographic types of rocks have been described from the pebble material. *Lower Permian*

Petrova Hora Hill quarry, Spišsko-gemerské rudohorie Mts., Petrova Hora Fm.

Andesites and rhyolitic ignimbrites. Synsedimentary volcanites correspond to calc-alkaline magmatic trend. Prevalent volcanoclastic/mixed sediments are indicative of highly explosive volcanism. *Permian*

Kolínoce, Spišsko-gemerské rudohorie Mts.

The uppermost part of Petrova Hora Fm. With claystones, siltstones and local layers of redeposited volcanoclastics. Parallel-layered thin patches of sandstones of low-energy streamflows, which existed immediately in front of the alluvial fan. Assymetric wave ripples are exposed. *Permian*

Ostrá skalka, Rákoš, Spišsko - gemerské rudohorie Mts. Basal part of Gočaltovo Group, Rožňava Fm., Southern Gemericum. Thick bedded oligomict conglomerates with low textural maturity indicating alluvial water deposits, mostly stream-channel and sheet-flood deposits of typical verrucano facies. *Permian*

Road Gočaltovo-Štítnik, Spišsko-gemerské rudohorie Mts.

Štítnik Fm. - upper part of Gočaltovo Fm. - Lagoonal sediments - a complex of well stratified sandy-dolomitic limestones with intercalations of light green-grey shales. *Upper Permian to Lower Triassic*

Večný dážď („Eternal rain,,), Velická valley, Vysoké Tatry Mts.

Megaxenolite of the metamorphites in the neighbouring granites

Velická dolina, Vysoké Tatry, an outcrop in the path to the Dlhé pleso tarn

Magmatic contact of two types of granitoids and diorite enclaves in granitoids.

Žiarska dolina, Západné Tatry Mts.,

Natural outcrop of banded amphibolites on a contact of the Hercynian nappe structure.

Vyšné Matejkovo, Podsuchá, Veľká Fatra Mts., quarry Etalon of the Smrekovica tonalite (complete geochemical - isotopic characteristics).

Kolbašský jarok (Kolbachy creek), Branisko Mts.

"Pseudopillow" structures in gabbro in the anatexy and migmatites zone

Rösslerov lom quarry, Bratislava, Malé Karpaty Mts. Granite pegmatite body with more than 60 mineral forms
Klenovský Vepor, Veporské vrchy Mts., natural outcrops Cliffs of porphyric granodiorites with subhorizontal foliations. Granitoid body creates a substratum for Tertiary volcanic rocks. *Permian*

Hriňová, Veporské vrchy Mts., natural outcrops Basal diorite enclaves in the Sihla type granodiorite with indications for mixing of two magmas, 300 Ma.

Muráň, Spišsko-gemerský kras Mts., natural outcrop-Contact of crystalline and Mesozoic rocks of the Muráň nappe unit, exposed along an important Muráň fault

MESOZOIC

Belianska dolina valley, Veľká Fatra Mts., Lithostratigraphic profile through the Tatricum envelope sequence, *Triassic - Cretaceous*

Orava castle rock massif, Oravský Podzámok Lithostratigraphic profile through the Klippen belt, *Jurassic*
Ždiar, Vysoké Tatry Mts., road-cut

Lithostratigraphic profile of the Carpathian Keuper of the Krížna nappe, *Norian*

Podtureň, Nízke Tatry Mts., quarry lithostratigraphic profile of the Lunz beds of the Choč nappe, *Carnian*

Skladaná skala, Chočské vrchy Mts., quarry Type locality of the Allgäu beds (Fleckenmergel), lithological profile, Križná nappe, *Lotharingian*

Doggerské skaly (Doggerian rocks), Trlenská dolina valley, Veľká Fatra Mts., protected area – Natural Monument, type locality of the Ždiar Fm., radiolarian limestones, radiolarites, Križná nappe, *Upper Bathonian - Oxfordian*

Veľký and Malý Rozsutec Hills, Jánošíkove diery, Vrátna dolina valley, Malá Fatra Mts., Demonstration of nappe structures of the Western Carpathians - contact between the Križna and the Choč nappes

Meliata, Slovenský kras Mts., creek-bluff Type locality of the Meliata Unit and Meliata Fm., *Jurassic* with *Triassic* olistholits

Hačava and Šugov valleys, Slovenský kras Mts., creek-bluff Subduction-accretionary complex of the *Triassic-Jurassic* Meliatic ocean with exhumed blue-schists Complexes. Rarity: carbonate platform with volcanites (glaucophanites), Bôrka nappe.

Haligovce, Pieniny Mts., natural outcrop Stratigraphy profile through the Haligovce unit of the Klippen belt (carbonates/flysch/marls), *Triassic-Paleocene*
Dlhá n. Oravou – Dlhánsky Cickov, Oravská Magura Mts., abandoned quarry Sandstones, tectonic slice of the Magura unit in the Klippen belt, *Eocene*

PALEOGENE

Sološnica, Malé Karpaty Mts., Transgression of the Paleogene sediments on the karstified Triassic limestone, large foraminifers, *Middle Eocene*

Ráztočno, Handlová basin, quarry Elipsoidal fragmentation of the weakly cemented conglomerates and sandstones of the Biely potok Fm., *Oligocene-Miocene (Egerian)*

Lisková, Liptovská kotlina basin Large foraminifers and macrofauna in the Borovská Fm., *Upper Lutetian*

Radôstka, Kysucká vrchovina upland, road cut P-stratotype of the flysch Bystrica beds (alternation of sandstones and claystones), Magura unit, *Eocene*

Radôstka, Kysucká vrchovina upland, creek bed P-stratotype of the flysch Beloveža beds (alternation of sandstones and claystones), Magura unit, *Eocene*

Ružomberok, quarry Transgression of the Borovská Fm. – conglomerates on *Triassic* dolomites, *Priabonian*

Ružomberok, brickfield, pit in operation Claystones - Hutianska Fm., *Priabonian*

Kňažia, Orava, roadcut Transgression of the Borovská Fm. on the Klippen belt, *Upper Lutetian*

Pucov, Orava, roadcut, protected area – Natural Monument Stratotype of the Pucov conglomerates, submarine slump body, *Lower Priabonian*

Oravský Biely Potok, Orava, abandoned quarry Stratotype of the Biely Potok Fm. (sandstones), *Lower Oligocene*

Kežmarok, Popradská kotlina basin, abandoned quarry Stratotype locality of the Kežmarok beds, *Oligocene*

Korňa, Turzovská vrchovina upland Oil-field water spring, Zlín Fm., flysch Magura unit, *Eocene*

Krásno n. Kysucou, Kysucká vrchovina upland, road cut Stratotype locality of the Kýčera beds (alternation of sandstones and claystones) flysch Magura unit, *Eocene*

Stará Lesná, Poprad basin, creek bluff Flysch of the Zuberec Fm, *Eocene*

Terchová – Berešici, Kysucká vrchovina upland, natural outcrop Olistostrome body in flysch sequence of the Klippen belt *Paleogene, Eocene*

Ždiar, Poprad basin, roadcut Chaotic conglomerates with intraclasts of the Pucov beds, *Priabonian*

Svetlice, Laborecká vrchovina upland, natural outcrops along creek Stratigraphy profile through flysch sequences of the Dukla unit, *Paleocene - Oligocene*

Spišské Tomášovce, Hornád basin, quarry in operation Stratotype of the Tomášovce beds, sandstones, siltstones, macrofauna Pectens, *Priabonian*

Záblatie, Javorníky Mts., creek bluff P-stratotype of the flysch of the Magura unit (alternation of sandstones and claystones), *Senonian*

NEOGENE - VOLCANICS

Burda - Kamenica nad Hronom, Burda Mts., abandoned quarry, protected area

Submarine andesite volcanics - hornblende-hypersthene andesite extrusive dome and related hyaloclastite breccias, breccia flow deposits, reworked phreatomagmatic pyroclastic rocks and conglomerates, *Early Badenian*

Stará Huta - Blýskavica,

Type section of the Blýskavica Fm., basaltic andesite lava flows and related hyaloclastite breccias, *Early/Middle Badenian*

Hrochot' - Jánošíkova skala, Žiarec, Poľana Mts., natural cliffs, Natural Monument

Type section in the proximal zone of the Abčina and Veľká Detva Fms, alternating pyroxene and hornblende-pyroxene andesite epiclastic volcanic breccias, reworked pyroclastic breccias, rare pyroclastic flow deposits and lava flows, capped by pyroxene andesite lava flows of the Veľká Detva Fm., *Sarmatian*

Medovarce, natural cliffs

Typical section in the distal zone of the Sebechleby Fm., alternating pyroxene and hornblende-pyroxene andesite mudflow deposits with conglomerates and sandstones of coastal zone, *Badenian*

Plášťovce, natural cliffs and outcrops

Type section in the distal zone of the Sebechleby Fm./Plášťovce Member, fauna bearing tuffaceous siltstones with conglomerate/sandstone slump and density current bodies filling erosion channels, *Badenian*

Hronská Breznica, Banská Štiavnica Mts., natural cliffs and outcrops, Natural Monument

Type section of the Breznica Complex, - crosscut of a large fan at the northern side of the Štiavnica stratovolcano made up by alternating andesite mudflow, debris flow and hyperconcentrated flow deposits (epiclastic breccias), pyroclastic flow deposits and lava flows, *Early/Middle Sarmatian*

Banská Štiavnica - Glanzenberg, Banská Štiavnica Mts., Natural Monument

Outcrops of the Spitaler base metal epithermal vein with remnants of Middle age mining works. Cliffs above the medieval mining city Banská Štiavnica (on the UNESCO List of Cultural Heritage).

Hliník nad Hronom - Szabova skala, Banská Štiavnica Mts., Natural Monument

Type locality of the Jastrabá Fm., rhyolite extrusive dome with well preserved glassy margin and related hyaloclastite breccias, *Late Sarmatian*

Remata - Bralová skala, Kremnické vrchy Mts., natural cliffs, Natural Monument

Type locality in the proximal zone of the Remata Fm., alternating pyroxene andesite lava flows, epiclastic breccias, capping pyroclastic flow deposits, *Early/Middle Sarmatian*

Žiar nad Hronom - Šibeničný vrch Mt., Kremnické vrchy Mts., abandoned quarry

Type locality of the Šibeničný vrch Complex, *Pannonian age* - high alumina basalt dyke cutting *Late Sarmatian* conglomerates and remnants of a related tuff cone - phreatomagmatic surge and fall palagonite tuffs with numerous bombs.

Nevol'né, Kremnické vrchy Mts., large road cuts

Type locality of the Kremnický štít Fm., thick hornblende-pyroxene andesite lava flows with characteristic platy jointing at the base and coarse blocky breccias at the top, *Late Badenian*

Ihráč, Kremnické vrchy Mts., natural outcrops

Typical locality of the Krahule Fm., biotite-hornblende andesite dome flow with related hyaloclastite breccias at the base, oxidised block-lava breccias at the top, *Late Badenian*

Kamenec pod Vtáčnikom, Vtáčnik Mts., natural outcrops

Type section of the Kamenec Fm. - conglomerates and sandstones overlain by remnants of the coal-bearing Nováky Fm., *Early Badenian*

Pokoradza, Cerová upland, abandoned quarries and natural cliffs

Type section of the Pokoradz Fm., - basal shallow marine sandstones are overlain by mudflow (lahar) deposit, fine to coarse conglomerates and capping pyroclastic flow deposits. Features of large scale sliding on underlying *Early Miocene* sediments, *Badenian*

Šurica - Soví hrad, Cerová upland, natural cliff - Natural Monument

Type locality of the Cerová Basalt Fm. - alkali-olivine basalt diatreme with palagonite tuff/scoria filling. Processes of diatreme formation documented by textures, *Pliocene*

Rankovce - Rankovské skaly (Ranková rocks), natural cliffs

Type section in the central zone of the Rankovce Fm. (volcano) - remnants of volcanic cone made up by alternating thin and highly brecciated pyroxene andesite lava flows, pyroclastic breccias, agglomerates and tuffs, *Sarmatian*

Dubník - opal mines, Slánske vrchy Mts., Natural Monument

Abandoned medieval precious opal mines.

NEOGENE - SEDIMENTARY

Bretka, South-Slovakian basin, abandoned quarry

Correlation hypostratotype for Central Paratethys and facies-stratotype of transgressive conglomerate and limestone Fm., *Egerian*

Podbranč, Vienna basin, quarries partly in operation

Slovak facies-stratotype of the littoral conglomerate-sandstone development, transgressive position over Klippen belt, *Eggenburgian*

Cerová-Lieskové, Vienna basin, loam pit

Type profile of the off-shore aleuropelites with rich index fauna, *Karpatian*

Sandberg, Devínska Nová Ves, Vienna basin, abandoned sand pit, Natural Monument

Littoral facies-stratotype of the *Upper Badenian* sediments

Pezinok, Danube basin, loam pit, partly in operation

Correlation locality of the *Pannonian* clayey sediments of the Ivánka Fm.

Košice, East-Slovakian Neogene Basin, pit
Stretava Fm., deltaic and shallow marine clastics, *Sarmatian*

Košická Polianka, East Slovakian Neogene basin, pit
Stretava Fm., beach and shoreface deposits, *Sarmatian*

Varhaňovce, East Slovakian Neogene Basin, pit
Klčovo Fm., Gilbert type deltaic deposits. *Late Badenian*

QUATERNARY

Močarany, East Slovakian Neogene Basin, pit
Loess-like loams and fossil soils, *Holsteinian, Saalian*

Gánovce, Poprad basin, abandoned quarry, Natural Monument

Travertines, in which the cast of a brain of the *Homo neanderthalensis* was found (120.000 years old).

Dreveník, Spišské Podhradie, Spiš castle, Žehra, Hornádska kotlina basin, National Natural Monument

Unique gravitational disintegration of Dreveník travertine mound by creep movements. The part of Dreveník – Spiš castle – is a constituent of the World Cultural Heritage.

Chabenec Mt., Nízke Tatry Mts., Nízke Tatry Mts. National Park

Rock slide – an impressive feature of a deep-seated gravitational deformation.

Tatranská Polianka - (Veľká žltá stena), Vysoké Tatry Mts., natural outcrop

Profile of periglacial polygenetic accumulations, *Middle/Late Pleistocene*

Nová Lesná, Studený Potok valley, Vysoké Tatry Mts., natural outcrop

Stratotype locality of Nová Lesná beds - glaci-fluvial sands, (? *Biber*)

Vavrišovo, Belá valley, Vysoké Tatry Mts., gravel pit
Stratotype locality of Vavrišovo beds - glaci-fluvial gravels and sands (*Mindel*)

Nová Baňa - Brehy, Hron valley, Štiavnické vrchy Mts., quarry

The youngest volcano in Slovakia (180.000 years) with basalt lava flow on *Middle Pleistocene* fluvial gravels of the Hron terrace, covered by fossil soil of the latest Inter-glacial

Veľký Kýr (Milanovce), Nitra valley, Nitrianska pahorkatina hilly land, road cut

Fossil soil complex (red clays – red soils), *Lower Pleistocene*

Lukáčovce, Nitrianska pahorkatina hilly land, sand pit
Stratotype locality of the Lukáčová beds - fluvio-limnic sandy gravels, *Lower Pleistocene*

Komjatice, Nitrianska pahorkatina hilly land, brickfield pit

Loess and fossil soils complex with occurrence of volcanic ash, *Middle Pleistocene*

Mnešice, Váh valley, Trnavská pahorkatina hilly land, brickfield pit

Loess and fossil soils complex, *Middle/Late Pleistocene*

Senec, Trnavská pahorkatina hilly land,

Loess and fossil soils complex, *Pleistocene*

Hajnáčka, Cerová vrchovina upland, erosion gully

Maar sediments with *Vertebrata* fauna, *Late Pliocene*

Ratka, Cerová vrchovina upland, quarry

Fluvial sediments with superincumbent basalt lava flow and fossil soils, *Lower Pleistocene*

Husina, Lučenská kotlina basin, quarry

Fluvial sediments (*Lower Pleistocene*) with superincumbent basalt lava flow, loess and fossil soils complex (*Middle/Late Pleistocene*)

Hranovnica, Nízke Tatry Mts., natural outcrop

Travertines, *Late Pliocene/Lower-Middle Pleistocene*

Sivá Brada, Spišské Podhradie, Hornádska kotlina basin

A travertine mould, present travertine deposition, *Late Pleistocene/Holocene*

Caves of the Slovenský kras Mts., 3 caves of the Slovenský Kras and Aggtelek kras karst - on the UNESCO list of the World Cultural and Natural Heritage

Demänová cave, Demänová valley, Nízke Tatry Mts., National Natural Monument

The largest Slovak cave with the total length of more than 36 km

Literature

Wimbledon, W., Ischenko, A., Gerasimenko, N., Alexandrowicz, Z., Vinokurov, V., Liščák, P., Vozár, J., Vozárová, A., Bezák, V., Kohút, M., Polák, M., Mello, J., Potfaj, M., Gross, P., Elečko, M., Nagy, A., Baráth, I., Lapo, A., Vdovets, M., Klincharov, S., Marjanac, L., Mijovic, D., Dimitrijevic, M., Gavrilovic, D., Theodosiou-Drandaki, I., Serjani, A., Todorov, T., Nakov, R., Zagorchev, I., Perez-Gonzalez, A., Benvenuti, M., Boni, M., Brancucci, G., Bortolami, G., Burlando, M., Constantini, E., D'Andrea, M., Gisotti, G., Guado, G., Marchetti, M., Massoli-Novelli, R., Panizza, M., Pavia, G., Poli, G., Zarlenga, Satkunus, J., Mikulenas, V., Suominen, V., Kananoja, T., Lehtinen, M., Gonggrijp, G., Look, E., Grube, A., Johansson, C., Karis, L., Parkes, M., Raudsep, R., Andersen, S., Cleal, C., Bevins, R., 1998:

A first attempt at a geosites framework for Europe – an IUGS initiative to support recognition of world heritage and European geodiversity. *Geologica Balcanica*, 28.3-4, Sofia, p.5-32.

Important note: Due a mistake in press two contributors of the above paper were omitted: Janočko, J., Lexa, J.