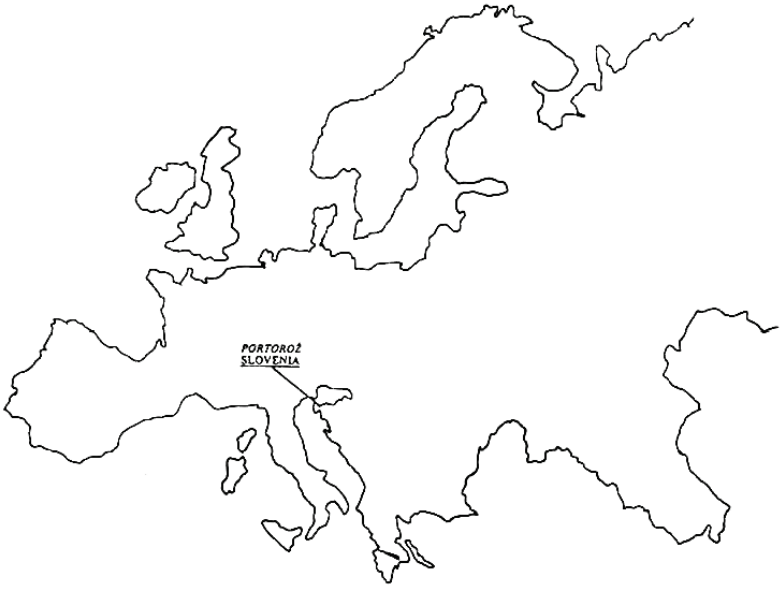
WORKSHOP

ENGINEERING IN KARST



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During the IMWA 1996 Workshop, fourteen national and international colleagues presented their experience about engineering and mining in karstic regions. The papers presented were not published in a proceedings volume, but handed out to the delegates as paper copies.

This PDF is one of those documents provided to the delegates.

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Dop. čl akad. Dr. A. Krajnc

KARST
as a complex system

1. Karst as a system,
2. Karst typology,
3. Karst morphology,
4. Karst in the World,
5. Man and karst,
6. Bibliography.

1. Karst as a system

1.1. The origin of the name and its meaning

See A. Kranjc, About the name and the history of the region Kras, Acta carsologica XXIII/6, Ljubljana 1994.

1.2. Definitions

Karst is terrain with distinctive hydrology and landforms arising from a combination of high rock solubility and well developed secondary porosity. Considerable rock solubility alone is insufficient to produce karst. Rock structure is also important. The key to karst is the development of its subsurface hydrology. The distinctive landforms above and below ground that are a hallmark of karst result from solution along pathways provided by the structure.

Hydrological and chemical processes associated with karst are best understood from a system perspective. Karst can be viewed as an open system composed of two clearly integrated hydrological and geochemical subsystems operating upon the karstic rocks. Karst landforms are the products of the interplay of processes in these linked subsystems (Ford & Williams 1989).

2. Karst typology

By the active or inactive role of the water playing in karst evolution, we can speak about **active** and **fossil** (or, maybe better, **buried**) **karst**. Natural erosion may uncover such an old karst; this produces **exhumed karst**.

Active karst systems can be called **recent karst** while karst which is hydrologically decoupled from the contemporary system is **paleokarst**. Usually it is isolated from recent karst and lies to it unconformably and is not adjusted to the present controlling

factors. Contrasting with paleokarst is **relict karst**, which exists within the contemporary system but is removed from the situation in which it is developed.

An important contrast is between **bare karst** and **covered karst**, where bedrock outcrop predominates in the former and occurs only to a limited extent or not at all in the latter. Solution may operate, and karst forms develop in karst rocks beneath other bedrock formations and this is called **subjacent** or **interstratal karst**.

A related distinction is between karst that drains directly to the sea, **free karst**, and karst completely surrounded by impervious rocks, **impounded karst**.

Cvijić distinguishes well developed **holokarst** with all karst forms and phenomena, while in **merokarst** only some karst phenomena are developed, so it is incomplete karst. Where the slopewash and river action retain a prime role in the latter, it is called **fluviokarst** to separate it from **karst proper** (Fig. 1, 2).

Where the rock mass is deep and deeply karstified, we are speaking about **deep karst**, while the oposite, where the rock mass is shallow or the base level is near under the surface, it is **shallow karst**.

Epikarst is despite the name not a type of karst but one of the hydrological zones, a part of vadose (above the water table, the uppermost layer of karstified rock) (Fig. 3).

Karst landforms result from proceses operating in coupled hydrological and geochemical systems. Essentially the same processes can operate over a very wide range of environments, but limiting conditions are provided by aridity and extreme cold. Karst is therefore characteristic of humid regions, where water normnally occurs in its liquid phase. So the typisation of karst according to climatic belts and characteristics is not valuable, but from the historic point of view it is good to mention. According to climates we can speak about the karst of polar, of temperate humid belt, mediterranean, and tropical karst. The karst under special conditions include glacial (subglacial), periglacial, alpine, and arid karst.

The role of biological agents is being recognized in influencing and indeed producing distinctive **biokarst** landforms.

3. Karst morphology

Most dissolution is expended near the surface, in the epikarst. Karst geomorphology considers the landforms and assemblages of landforms that are created there. These vary from small features (micro-) over medium size (meso-) to large scale landforms (macrofeatures) measured in kilomtres. Within the dynamic karst system they can also be classified as input, output or residual features (Fig. 4).

3.1. Small scale solution sculpture (Fig. 5):

- microkarren, microrills, rillenstein,
- solution pits, solution pans (kamenitza, tinajita), heel-prints (trittkarren), shafts or wells, cavernous weathering,

- fissure-controlled linear karren (splitkarren), grikes (kluftkarren), clints, cutters, subsoil pinnacles,

- hydraulically controlled linear forms - dissolution channels, rillenkarren (fluting), rinnenkarren, rundkarren, hohlkarren, decantation runnels and flutings (wandkarren), mäanderkarren, fluted scallops (Fig. 6),
- the composite nature of karren - assemblages of karren and giant karren - karrenfeld, limestone pavement, pinnacle karst (schlotten), ruiniform, corridors and streets, box valleys, platea, giant grikelands, corridor karst, labyrinth karst,
- littoral karren (Fig. 7, 8).

3.2. Dolines (sinkholes): any small to intermediate enclosed karst depresion.
- Genetic distinction: solution, collapse, suffosion, subsidence (Fig. 9 - 12).

3.3. Landforms, associated with allogenic inputs:
- through valleys (Fig. 13),
- dry valleys (Fig. 14),
- steep head valleys,
- blind valleys (Fig. 15, 16),
- karst poljes: flat floor in rock or in unconsolidated sediments, a closed basin with a steeply rising marginal slope, karstic drainage,
- types of poljes: border, structural, baselevel (Fig. 17, 18),
- corrosional plains and shifts in baselevel: baselevelled corrosion plains (Karstrandebene) (by corrosion planation: baselevel control, rejuvenation, submergence,
- residual hills on karst plains: hums, karst tower (Fig. 19),

3.3. Depositional and constructional karst features:
- calcrete,
- tufa deposits,
- tufa dams, terraces, waterfalls and mound springs (Fig. 20).

4. Karst in the World (climatic approach) (Fig. 21 - 25)
- cold extreme: (sub)glacial karst, nival karst, karst in permafrozen terrains, alpine karst (Fig. 26 - 27),
- karst in temperate humid regions (NW Europe karst),
- Mediterranean karst (Fig. 28 - 30),
- humid subtropical and tropical karst:
types according to "towers" - in groups: polygonal, cone, fengcong, cockpit karst,
- isolated: tower karst, fenglin, turmkarst, kegelkarst,
positive features: tower (feng, mogote, turm, kegel), cone, tsingy (megakarren),
negative featrues: cockpit, cenote, blue hole, (Fig. 31 - 37),
- hot arid extreme (north Africa, central America, Asia, the Middle East, Australia).

5. Man and karst:
- dwelling place,
- karst resources: soil, stone, minerals and ores, water, (38 - 45),

- recreational, scientific and other values of karst: nature parks, nature monuments, touristic attractions, scientific polygons and supports, military activity and purposes.

6. Bibliography

Balazs, D., 1977: The geographical distribution of karst areas.- Proceedings of the 7th International Speleological Congress, 13-15, Sheffield

Balazs, D., 1977: The optimal geo-climatic provinces of karstification.- Proceedings of the 7th International Speleological Congress, 15-17, Sheffield

Blanc, J.-J. & R. Monteau, 1988: Le karst du massif des Calanques (Marseille-Cassis).- Karstologia, 11-12, 17-24, Paris

Bosch Pulido, A. (ed.), 1993: Some Spanish Karstic Aquifers.- Project AMB 92-0211 DGICYT, pp. VI + 310, Granada

Collina-Girard, J., 1996: Préhistoire et karst littoral: la grotte Cosquer et les Calanques marseillaises (Bouches-du-Rhône, France).- Karstologia, 27, 27-40, Paris

Cvijić, J., 1960: La Géographie des terrains calcaires.- ASSA, Monographies, CCCXLI, pp. 212, Beograd

EUR 16526 - Hydrogeological aspects of groundwater protection in karstic areas - Guidelines.- European Commission, pp. 15, Brussels 1995

Fabre, G. & J. Radais, 1986: Karstologie urbaine et rurale appliquée, le problème de la Fontaine de Nîmes (Gard).- Karstologia, 8, 3-6, Paris

Ford, D. & P. Williams, 1994: Karst Geomorphology and hydrology.- Pp. 601, London & Glasgow etc.

Gams, I., 1992: Sistemi prilagoditve primorskega dinarskega krasa na kmetijski rabo tal.- Geografski zbornik, 31, 5-106, Ljubljana

Gams, I. & J. Nicod & M. Julian & E. Anthony & U. Sauro, 1993: Environmental Change and Human Impacts on the Mediterranean Karsts of France, Italy and the Dinaric Region.- Catena Suppl., 25, 59-98, Cremlingen

Gauchon, C., 1991: Mise en valeur et exploitation traditionelles des resources du karst souterrain dans le sud-est de la France.- Karstologia, 17, 11-18, Paris

Gerstenhauer, A., 1960: Der tropische Kegelkarst in Tabasco (Mexico).- Zeitschrift f. Geomorphologie, Intern. Beiträge zur Karstmorphologie, Suppl., 2, 23-48, Berlin

Guilcher, A., 1992: Relations entre la circulation karstique et la dolomitisation dans la structuration des atolls.- Karst et évolution climatiques, 105-114, Bordeaux

Heraud Pina, M.-A., 1995: La plate-forme du Yucatan (Mexique) un exemple de karst tropical péninsulaire.- Karstologia, 26, 1-12, Paris

Jennings, J. N., 1985: Karst Geomorphology.- Pp. 293, Oxford

Kranjc, A., 1994: About the name and the history of the region Kras.- Acta carsologica, XXIII, 81-90, Ljubljana

Lehmann, H., 1954: Der tropische Kegelkarst auf den Grossen Antillen.- Erdkunde, VIII, 1/4, 130-139, Bonn

Lowe, D. & T. Waltham, 1995: A Dictionary of Karst and Caves.- BCRA Cave Studies Series, 6, pp. 40, Bridgwater

Maire, R., 1990: La haute montagne calcaire.- Karstologia - Mémoires, 3, pp. 731, Paris

Mangin, A. & M. Bakalowicz, 1990: Le karst conique: sa genèse à partir de l'exemple du karst du sud de la Chine.- C. R. Acad. Sci., t. 310, Série II, 301-307, Paris

Mihevc, A., 1994: Brkini Contact Karst.- Acta carsologica, XXIII, 99-109, Ljubljana

Movčan, J. & D. Zdunić (Eds.), 1985: Plitvice Seen Nationalpark Naturerbe der Welt.- Pp. 36, Zagreb

Mudry, J. & J.-M. Puig, 1991: Le karst de la Fontaine de Vaucluse.- Karstologia, 18, 29-38, Paris

Radinja, D., 1987: Modern agricultural land improvement in slovene Dinaric karst. Removal of rock on the continental side and spreading of red clay.- Karst and Man, Proceedings of the Intern. Symposium on Human Influence in Karst, 123-135, Ljubljana

Vaumas, E. de, 1969: Formes de relief, consolidation et dissolution des grès littoraux du quaternaire.- Actes de la réunion internationale Karstologie, Méditerranée, 7, 151-187, Aix-en-Provence

Andrej Kranjc