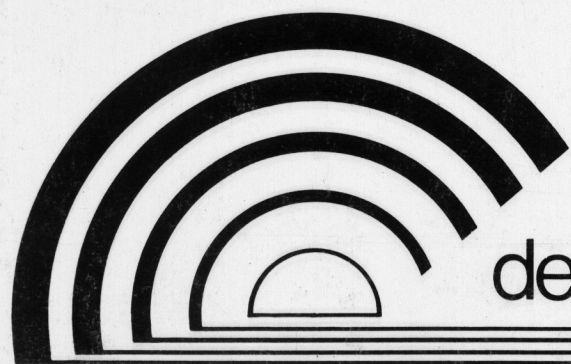


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Are Typical Tropical Karst Landforms Typical and Tropical?

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RESUM

Discutint experiències dutes a terme en àrees de carst tropical s'ha argumentat que els carsts de «kegel», «cons» i «torres» són formes típiques del carst tropical. Als tròpics, però, hi ha molts altres tipus de carst que, possiblement, es trobin amb més abundància, però que no se'n fa esment per ésser molt menys espectaculars.

Considero també un error qualificar els «kegel», etc. com uns tipus de carst, ja que aquests no són altra cosa que el resultat d'un procés de denudació; no es tracta, per tant, de cap carst típic.

D'altra banda, el carst de «kegel», etc. es pot localitzar en franges fora de la geografia tropical i, inclús, en casos especials, en climes àrids o desèrtics.

Quan es varen establir les diferents teories relatives al desenvolupament del carst tropical es van estudiar, fonamentalment, amb imatges de la superfície. Els estudis més recents en el camp de la investigació espeleològica demostren que el drenatge càrstic és un factor tan important com qualsevol altre. Sigui com sigui, les formes càrstiques no són altra cosa que el resultat d'un mateix procés hidrogeològic essencial.

RESUMEN

Discutiendo experiencias en áreas de karst tropical se ha argumentado que los karsts de «kegel», «conos» y «torres» son formas típicas del karst tropical. En los trópicos existen muchos otros tipos de karst, incluso puede que éstas sean mayoría pero mucho menos mencionadas por no ser espectaculares.

Se considera también un error clasificar los «kegel», etc. como «tipos» de karst puesto que éstos no son más que el resultado de un proceso de denudación en condiciones especiales, pero de ningún modo típicos.

Por otro lado, el karst de «kegel», etc. se puede encontrar en franjas fuera de la geografía tropical e incluso, en casos especiales, en climas áridos o desérticos.

Cuando se establecieron las teorías sobre el desarrollo del karst tropical, se estudiaron poco más que con imágenes de la superficie; lo último en el campo de la investigación espeleológica muestra que el drenaje kárstico en los trópicos es un factor tan importante como en cualquier otro lugar. Sea lo que fuere, las formas kársticas no son más que producto del mismo proceso hidrogeológico esencial.

SUMMARY

Discussing experiences in tropical karst areas it is argued that «kegel», «cone» and «tower» karsts were typical landforms of tropical karst. Many other types of karst exist in the tropics, these may even be the majority but much less publicized being not spectacular.

It is considered also a mistake to classify «kegel» and etc. as «types» of karst since these are but phases of a denudation process at special but by no means typical conditions.

On the other hand «kegel», etc. karsts can be found outside of the geographical tropical belt and also in arid or even desertic climates in special cases.

When theories on tropical karst development were conceived little else had been studied than views of the surface. Latter day speleological research proves that karstic drainage is as important a factor in the tropics as anywhere else, whatever karst landforms are but products of the essentially same hydrogeological process.

Leafing through the literature on karsts in the tropics /«tropical karst»/ one gets the idea that the typical result of karstic denudation is always and only a very spectacular multitude of steep, beehive-like hills and/or marching towers over green rice fields. Names were given by the lots, such as kegel-, cone-, tower-, pinnacle-, mogote-, polygonal-, cockpit-, rain forest-, etc. karsts. Many of these names mean the same thing some of them nothing, like rain forest karst /Jakucs, 1977/ Identical phenomena wearing the same names may confuse the reader e.g. kegel-cone or tower-pinnacle etc. while the Cuban mogote means both and more. Needless to say, that there exists a type of karst in the tropics that is usually described as «the typical tropical karst». On the other hand more than this one type of karsts exist in the tropics. Jimenez /1964/ classifies Cuban karsts into the listed types:

1. Mogote karst
2. Hill and mountain karst
3. Plain karst
4. Partially submerged swamp karst
5. Partially undersea karst
6. Coastal karst
7. Terrace karst

It is not very certain, that the specification were complete or flawless, but it certainly shows that out of seven types of karsts ONLY the mogote wears the «typical marks of tropical karst».

There are karst areas at many tropical locations of the World and most of them are known of their chaotic, cockpitty, conehillly, towery nature. There have not been much news about other types of karst in the tropics. Looking at the Cuban example other types must coexist elsewhere whith the «typical» karst but they are largely unknown. No wonder. The majority of tropical lands belong to developing countries, thus local interest and expertship is usually in shortage. Foreign experts visiting these countries have to endure climate, insecurity, retarded communication. What will the expedition discover and explore? Obviously the outstanding, unmistakable «cone/tower» karst. Other types of karst will wait recognition and exploration for next generations.

Typical or not there is a karst type widely considered that, and discussing other types, it offers a lot of difficulties in itself. Does it really have a name? In Cuba they call it the «MOGOTE» karst and whatever it is the Viñales/Sierra de los Órganos/ is a very typical example of it. Let's sit on the terrace of the Los Jasmines Hotel as many intrepid explorers did and look around. We see mountains, the Sierra de Viñales /413 m above sea level/ the Sierra de Guasasa /447 m/ the Mogote de Valle /413 m/ These mountains are separated by a plain on which meandering streams flow. From this flat valley floor conical hills of various height emerge none of them higher than 200 m of elevation. Let us try to classify what we see.

The karstic mountains are topped by a *polygonal plateau* that

is composed of cone-hills and polygonal shaped depressions or cockpits. The karstic mountains which are of practically uniform elevation are parts of a once continuous plateau. They are now separated by border plains from which karstic towers protrude, which are the last remnants of the once continuous limestone on this level. A karstic «tower» may appear in many shapes, it may not be «towery» at all, its emergence of something else than limestone makes it a tower. On the border plain streams or rivers flow that enter and cross the mountains through large caves. Summarised:

Cone hilly, polygonal plateau – stream caves
Karst towers – border plain with rivers

That is, vertical movement of the water – rainfall and infiltration develop the polygonal karst plateau, horizontal water flow develop caves mostly by erosion and finally this leads to the destruction of the thick limestone beds to the degree of oblivion except for the remaining limestone towers. This role of the underground drainage is usually not recognized in classical models of tropical karst still in circulation.

In the described respects «cone», «tower», etc. karsts can not be identified as types of karst, they are but phases of denudation of a single type. Cones, towers etc. occur in many different styles /Williams, 1972/ rather than types.

What would be a good and unmistakable name for the discussed type of tropical karst. «Cone» and «tower» fall out as they do not represent types, only phases of denudation. Also they are the sources of wild mistakes /Jakucs, 1977/ As cave development does not differ much or at all from temperate climate karsts but the surface of limestone that is exposed in plateaus is substantially different –the polygonal depressions must be emphasized as many authors realized. It may be cockpit/cone karst/Jennings, 1985/ As polygonal depressions are not always exactly cockpits conical-polygonal karst is suggested as these two features are considered widely as very typical karstic phenomena.

It has been pointed out, that conical-polygonal karst is not exactly «the» typical karst as many others exist in the tropics. If it is not typical, is it tropical? Only tropical? Or do they exist beyond the geographical Tropics? Yes, of course. Two thirds of the most spectacular «tropical» karst in South China is located North of the Tropic of Cancer thus this karst is SUBtropical, not tropical.

Putting the question in a more proper form, do conepolygonal karsts exist in substantially different climates than tropics? The answer is still yes. There is a karst area in North Africa, Libya, Tripolitania /Kósa, 1981/ complete with cone hills, cockpits, border plain, towers. /fig. 1/ Estimated annual rainfall doesn't exceed 130 mm. This amount is about only 10 % of a not very wet tropical area. The climate is desertic. The karstified rock is gypsum. Since the solubility of gypsum is a high multiple of that of limestone, no wonder that with so much less rain still tropical landforms develop.

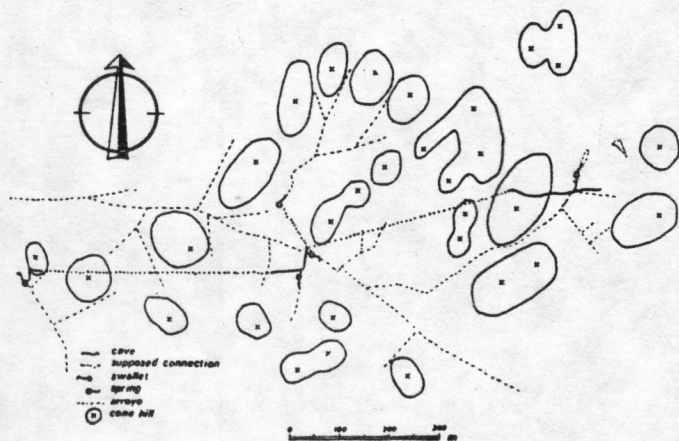


Figure 1. Part of the 300 kmsq desertic conical –polygonal Bir al Ghanam Gypsum Karst. Tripolitania

Are there then conical-polygonal limestone karsts in substantially non tropical climates? The answer is still yes. A conical-polygonal karst was recognized in Cyrenaica, Lybia /Kósa-Csernavölgyi, 1983/ in Myocenic limestone. Annual rainfall is an estd. 300 mm and it falls from October to March. Mean temperature of the rainy season is about 15°C, thus the climate is far from tropical. The relief of the karst is rather flat, the diameter/height ratio of the cone hills is 6 to 8 /fig. 2/

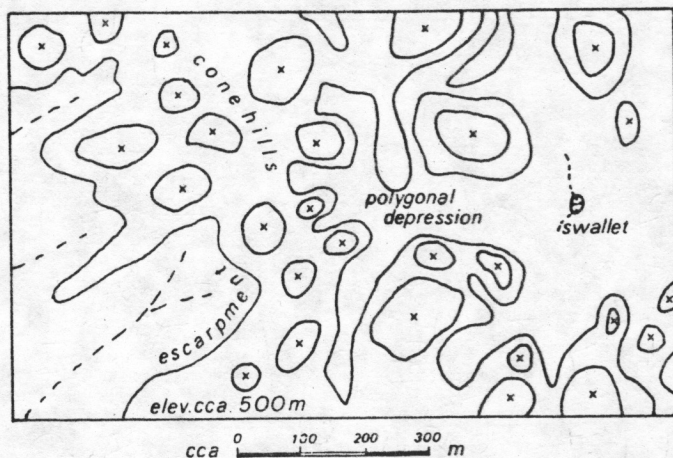


Figure 2. Part of the arid conical-polygonal limestone karst in Cyrenaica, near al Marj. /Sketch from aerial photograph

We have seen conical-polygonal karsts in limestone, marble /Kósa-Szentes, 1984/, gypsum. We have seen c-p karsts in different climates 24°C/2000 mm in Colombia, 23°C/1100 mm in Cuba, 16°C/1150 mm in Kweichow, China, 15°C/300 mm/rainy season/ in Cyrenaica, 15°C/130 mm in Tripolitania, Bir al Ghanam. The differences are substantial and still there must be something that results in the same or very similar type of karst in many different styles. It has been recognized /Sweeting 1973/ that possibly rainfall intensity is responsible for tropical karst landforms, rather than the rest of the factors. This applies to other than tropical climates like our Cyrenaican and Tripolitanian examples, where the intensity of precipitation is usually very high. /No precise data are available here, or almost anywhere else in the tropical karst areas./

Can the rhetorical question in the title of this paper be answered? The exploration of karst in tropical areas is not sufficiently advanced even in the case of the most scenic cone-polygonal karsts. It is hard to tell what percent of all known/unknown karst do they represent, but they are *not exclusively typical* in the tropics. On the other hand they are not *exclusively tropical* either as examples of conical karsts occur in other then tropical climates.

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