Anniversaries

"Karst Phenomenon" 130 years ago

THE SERBIAN GEOSCIENTIST JOVAN CVIJIĆ (1865–1927) AND THE EMERGENCE OF KARST GEOMORPHOLOGY

Johannes Mattes (AUSTRIA)

Karst terrains cover about 20 % of the Earth's dry surface and contribute up to 25 % of the total drinking water supply of the world. Karst is a type of landscape with distinctive hydrology where the dissolution of soluble bedrocks such as limestone, dolomite, marble, or gypsum has created sinkholes, underground streams, caves, springs, and other features. The name originates from a barren plateau in the hinterland of the Bay of Trieste (Adriatic Sea), which in Slovenian is called "Kras", in Italian "Carso", and in German "Karst". Since the eighteenth century, naturalists and travelers who had to cross this area along ancient trade routes between Trieste and Vienna compared its characteristics with similar landscapes in South-Eastern Europe and thus extended the geographical range of the toponym "Karst". Until 1918, this plateau formed part of the multinational Habsburg Monarchy, and the study of karst landforms and hydrology at the end of the nineteenth century was supported by the state due to large-scale public undertakings for water supply and reforestation.

The Serbian geoscientist Jovan Cvijić (1865–1927) was the first to classify karst features and to propose a unified typology that is still widely in use to this day. His notable Ph.D. thesis "Das Karstphänomen" (The Karst Phenomenon, 1892), which he completed as a student of the world-renowned geographer Albrecht Penck (1858–1945) and geologist Eduard Suess (1831–1914) at the University of Vienna, is considered the starting point of karst geomorphology. It synthesized the international literature, discussed the variety of large- or small-scale features in sequence, and provided an overview of the worldwide distribution of karst terrains. Soon recognized as a standard reference, over time his study made the Dinaric Karst the world reference site for dissolutional landforms and aquifers and introduced Slavic terms such as polje, doline, or ponor to the international scientific community. On the occasion of the 130th anniversary of the completion of Cvijić's influential thesis a critical review of its genesis, sources, and aftermath is timely.

Figure 1. Jovan Cvijić. Photo: Milan Jovanović. 1911. Source: wikicommons.

Although history of geology scholarship widely considers the "Karst Phenomenon" thesis as a forceful scientific breakthrough that led to the establishment of a new field of research, Cvijić did not start his studies from scratch. His success is hardly imaginable

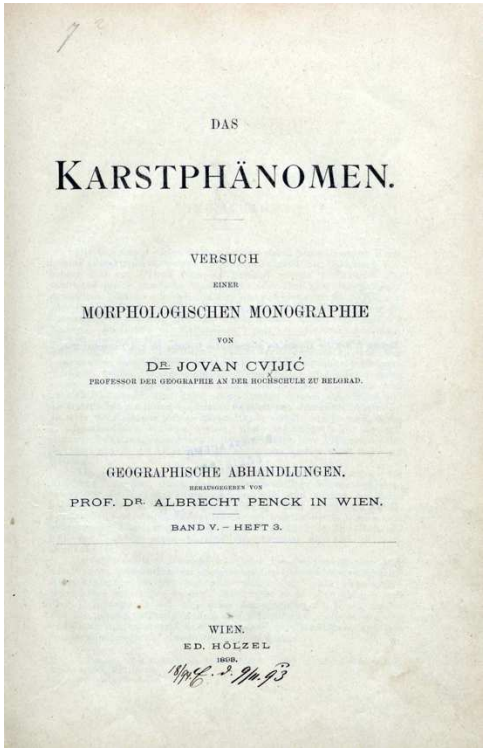
without the knowledge of his academic mentors, the fieldwork experience gained as a student, and the sources by naturalists and amateurs, nowadays widely forgotten, whose basic research on karst and caves served as the springboard for Cvijić's career. Having previously worked as a teacher in Belgrade, Cvijić moved to Vienna in 1889 thanks to a scholarship from the Serbian ministry. There, he attended lectures at the University for six semesters. At that time, the capital of the Habsburg Monarchy was one of the main geoscientific centers in Europe and attracted promising Ph.D. candidates from Central and South-Eastern Europe and beyond. Albrecht Penck, just a couple of years older than Cvijić, who was appointed professor at the University of Vienna in 1885, introduced excursions and practical fieldwork to the regular curriculum, and, at that time, was working on geomorphology and karst landforms. Cvijić's second mentor, Eduard Suess, was already world-famous for his multi-volume book "Das Antlitz der Erde" (The Face of the Earth), where he had created a worldwide synthesis and "globalized" his tectonic concepts, originally based on fieldwork in the Alps.

Cvijić likewise aimed at a worldwide synthesis of all previous research on karst landforms. His participation in Penck's excursions to the Moravian Karst and the Dachstein mountains may have been decisive for the choice of the topic of his thesis. During the summer months he also undertook field trips on his own to karst sites in Carniola, Istria, Croatia, Bosnia, and Eastern Serbia. Observations conducted there resulted in his first publications: among them two papers on the Prekonoška Cave and Kučaj Karst. In addition, Cvijić intensely studied the German, French, and English literature available in the library of the Natural History Museum in Vienna. However, only a minor part of the publications cited in the "Karst Phenomenon" stemmed from "professional" earth scientists working at universities or geological surveys. Instead, Cvijić's argumentation was based to a large extent on publications by local experts, naturalists and alpinists that had received little scientific attention.

Due to the touristic development of the Eastern Alps and the construction of the Vienna Spring Water Pipeline, a lively public interest in karst landscapes on the surface and underground features had emerged within the 1870s Habsburg Monarchy, particularly in the crown lands such as the Austrian Littoral, Carniola, Moravia, the Carpathians, and in the capital Vienna. Volunteer researchers working at the interface between state-owned research institutes and private associations traced and surveyed underground watercourses, provided a register (*cadastre*) of caves, and sought to understand the diversity of karst features recorded. The knowledge from these explorations provided in the form of field observations, papers and (popular) descriptions of entire karst sites that circulated within the Viennese scientific societies were eagerly considered by Cvijić. The pooling of this broadly topographical and practical knowledge within a new, scientifically accredited format and the global comparison of dissolutional landforms, distinct from phenomena of fluvial geomorphology, can be regarded as the essential merit of the "Karst Phenomenon". Even if, from the point of view of today's geomorphologists, the Dinaric Karst, due to its complex geological structure, is hardly suitable for a more general investigation of the development of dissolutional landforms.

Decisive for the attention that Cvijić's thesis received were certainly the scientific networks of his supervisors, the contemporary significance of German as a language of science, and the international recognition of the geosciences then being taught at the University of Vienna. Just seven months after Cvijić had defended his thesis, the "Karst Phenomenon" was published within Penck's book series "Geographische Abhandlungen" (Geographical Treatises) in 1893. By this time, Cvijić had already left Vienna for Belgrade, where he had been appointed full professor at Vlika Škola (from 1905 known as the University of Belgrade). There, Cvijić was surprised by the enthusiastic reviews and congratulatory letters he received from foreign colleagues. However, the fact that the term "karst" finally prevailed over alternatives such as "Le Causse", proposed by the French speleologist Édouard-Alfred Martel (1859–1938), may have been related to the fact that

Cvijić was supported by internationally leading geographers such as the American William Morris Davis (1850–1934). Inspired by Cvijić's karst research, Davis even undertook a round trip through Bosnia and Herzegovina together with Penck in 1899 and adopted Cvijić's findings in his own scientific concepts. At this time Davis further developed his notable cycle of erosion theory, which influenced the thinking of many fluvial geomorphologists and, in turn, inspired Cvijić to develop a similar theory for the evolution of karst landscapes. Moreover, the "Karst Phenomenon" provided the impetus for follow-up research by Penck's later Ph.D. students and other Habsburg geoscientists. Their works, which included Alfred Grund's "Karsthydrographie" (Karst Hydrography, 1903) and Friedrich Katzer's "Karst und Karsthydrographie" (Karst and Karst Hydrography, 1909), rendered Vienna the international center of karst research up until WWI.



DAS

KARSTPHÄNOMEN.

VERSUCH

EINER

MORPHOLOGISCHEN MONOGRAPHIE

VON

DR. JOVAN CVIJIĆ

PROFESSOR DER GEOGRAPHIE AN DER HOCHSCHULE ZU BELGRAD.

GEOGRAPHISCHE ABHANDLUNGEN.

HERAUSGEGEBEN VON

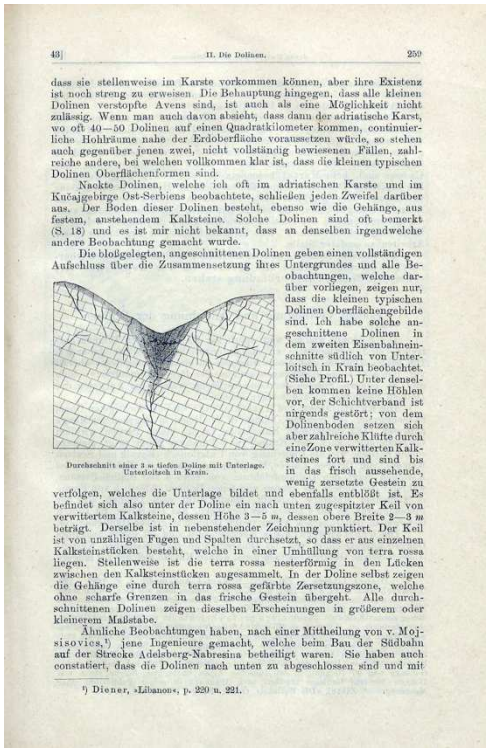
PROF. DR. ALBRECHT PENCK IN WIEN.

BAND V. – HEFT 3.

WIEN.

ED. HÖLZEL

1900.



43] II. Die Dolinen. 259

dass sie stellenweise im Karste vorkommen können, aber ihre Existenz ist noch streng zu erweisen. Die Behauptung hingegen, dass alle kleinen Dolinen verstopfte Avens sind, ist auch als eine Möglichkeit nicht zulässig. Wenn man auch davon absieht, dass dann der adriatische Karst, wo oft 40—50 Dolinen auf einen Quadratkilometer kommen, continuierliche Hohlräume nahe der Erdoberfläche voraussetzen würde, so stehen auch gegenüber jenen zwei, nicht vollständig bewiesenen Fällen, zahlreiche andere, bei welchen vollkommen klar ist, dass die kleinen typischen Dolinen Oberflächenformen sind.

Nackte Dolinen, welche ich oft im adriatischen Karste und im Kučajgebirge Ost-Serbiens beobachtete, schließen jeden Zweifel darüber aus. Der Boden dieser Dolinen besteht, ebenso wie die Gehänge, aus festem, anstehendem Kalksteine. Solche Dolinen sind oft bemerkt (S. 18) und es ist mir nicht bekannt, dass an denselben irgendwelche andere Beobachtung gemacht wurde.

Die bloßgelegten, angeschnittenen Dolinen geben einen vollständigen Aufschluss über die Zusammensetzung ihres Untergrundes und alle Beobachtungen, welche darüber vorliegen, zeigen nur, dass die kleinen typischen Dolinen Oberflächengebilde sind. Ich habe solche angeschnittene Dolinen in dem zweiten Eisenbaheinschnitte südlich von Unterloitsch in Krain beobachtet. (Siehe Profil.) Unter denselben kommen keine Höhlen vor, der Schichtverband ist nirgends gestört; von dem Dolinenboden setzen sich aber zahlreiche Klüfte durch eine Zone verwitterten Kalksteines fort und sind bis in das frisch aussehende, wenig zersetzte Gestein zu verfolgen, welches die Unterlage bildet und ebenfalls entblößt ist. Es befindet sich also unter der Doline ein nach unten zugespitzter Keil von verwittertem Kalksteine, dessen Höhe 3—5 *m*, dessen obere Breite 2—3 *m* beträgt. Derselbe ist in nebenstehender Zeichnung punktiert. Der Keil ist von unzähligen Fugen und Spalten durchsetzt, so dass er aus einzelnen Kalksteinstücken besteht, welche in einer Umhüllung von terra rossa liegen. Stellenweise ist die terra rossa nesterförmig in den Lücken zwischen den Kalksteinstücken angesammelt. In der Doline selbst zeigen die Gehänge eine durch terra rossa gefärbte Zersetzungszone, welche ohne scharfe Grenzen in das frische Gestein übergeht. Alle durchschnittenen Dolinen zeigen dieselben Erscheinungen in größerem oder kleinerem Maßstabe.

Durchschnitt einer 3 *m* tiefen Doline mit Unterlage. Unterloitsch in Krain.

Ähnliche Beobachtungen haben, nach einer Mittheilung von v. Mojsisovics,[1]) jene Ingenieure gemacht, welche beim Bau der Südbahn auf der Strecke Adelsberg-Nabresina betheiligt waren. Sie haben auch constatiert, dass die Dolinen nach unten zu abgeschlossen sind und mit

[1]) Diener, »Libanon«, p. 220 u. 221.

Figure 2 and 3. Title page of "Das Karstphänomen" (1903) and page with the cross section of a sinkhole in Carniola.

Even after his return to Serbia, Cvijić remained connected with the scientific communities in Vienna. Like other scholars from South-Eastern Europe, he benefited from their communicative resources and used the publication series and networks of Habsburg scientific societies for knowledge exchange, as door-openers for bilateral cooperation and career opportunities. In turn, the involvement of scientists from the Balkan Peninsula created a loyal educational class in the peripheries of the monarchy and became a means of scholarly acculturation of how science was practiced in Vienna. These included the use of German as a language of science and consensus on the integrity of the monarchy as a whole, the legitimacy of its government and its political-cultural claim to supremacy, on a par with other European empires.

Scholarly acculturation, however, can also be observed at the level of theories, terminology, methods, and literature. An integration of foreign scholars fostered the emergence of "thought collectives" (*Fleck*), based on a common reference to the same bodies of knowledge and culture. In the case of Cvijić, his academic education, common terms, and concepts about karst geomorphology initially bridged rising political tensions between Serbia and Austria-Hungary. It is ironic that Cvijić, whose career had been initiated in Vienna and

who was appointed rector of the University of Belgrade and, in later years, president of the Serbian Academy of Sciences and Arts, went on to become one of the most prominent critics of Austria-Hungary after the annexation of Bosnia by Habsburg forces in 1908. The Serbian Geographical Society, founded by Cvijić two years later, did not primarily investigate geoscientific features, but ethnographical and national relations on the Balkan Peninsula and aimed to cooperate with French and Anglo-American scholars. Research on karst geomorphology, which had served as a common reference linking scholars from the Habsburg Monarchy and South-Eastern Europe, had lost its integrative power. Cvijić's advocacy for a South-Slavic state under Serbian leadership was finally to come true in 1918. As one of the key scientific advisors to the Paris Peace Conference (1919–20), he shared responsibility for border demarcations in South-Eastern Europe following the political upheavals of WWI.

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Author: Dr. Johannes Mattes
INHIGEO Member (AUSTRIA)
Webmaster: IUGS International Commission on the History of Geological Sciences (INHIGEO)

Junior Group Leader, History of Knowledge Cluster
IKT, Austrian Academy of Sciences
Bäckerstraße 13, 1010 Vienna, Austria
Email: johannes.mattes@oeaw.ac.at

General Secretary, International Union of Speleology (UIS)
Titov trg 2, 6230 Postojna, Slovenia
Email: secretary@uis-speleo.org

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