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Magnetic Susceptibility in Slovačka Cave and Crnopac Cave System: KM-7 vs. Bartington MS2B

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Abstract

This study focuses on two key locations: the deep Slovačka Cave and the extensive Crnopac Cave System (Kita Gaćešina entrance). Magnetic susceptibility in soft sediments was measured at all sites using the Kappameter KM-7 for in situ measurements and the Bartington MS2B System for laboratory analysis. Sampling locations were selected based on accessibility, and the results were subjected to statistical analysis. Significant discrepancies were observed between the measurements obtained from the two devices. The Bartington MS2B System exhibited greater precision, suggesting possible calibration or suitability issues with the Kappameter KM-7 for cave environments. For future magnetic susceptibility measurements, the Bartington MS2B is recommended, with portable devices used initially to assess relative variations in magnetism along the sedimentary profile.

Keywords: Croatian cave sediments; magnetic susceptibility; correlation coefficients, Normal distribution

1. Introduction

Cave sediments are excellent archives of geological, paleoenvironmental, and speleogenetic processes due to the stable climate conditions within caves (**Sasowsky, 2007; White, 2007**). These environments provide valuable insights into geological (**Stroj et al., 2024; Lacković et al., 2011**), physical (**Stroj and Paar, 2018**), and paleontological perspectives (**Kurečić et al., 2022**). The Dinaric Karst is notable for its well-developed profiles of allogenic cave sediments (**Zupan Hajna et al., 2020**), but the Croatian part remains underresearched, with most studies focusing on paleontological excavations (**Malez et al., 1980**). Recently, there has been a shift towards sedimentological and mineralogical research to establish a chronostratigraphic framework for depositional processes (**Kurečić et al., 2021**).

In the northwestern Dinaric Karst, magnetostratigraphy of cave deposits is well-developed (**Zupan Hajna et al., 2010**). However, research on magnetism and magnetic susceptibility in Croatian caves is significantly lacking. Magnetic susceptibility is a valuable metric for analyzing material magnetism, identifying magnetically rich minerals, and understanding rock formation or transport processes (**Dearing, 1994**). It is straightforward, non-destructive, and can be conducted on various rock types both in the laboratory and in the field. These measurements are quick, cost-effective, and support a wide range of studies, making them especially useful for remote areas lacking laboratory access (**da Silva et al., 2015**). Croatian allogenic cave sediments originate from diverse areas, resulting in varied mineral compositions and magnetic properties. Near the Kita Gaćešina entrance of the Crnopac Cave System in Velebit Mountain, occurrences of opaque minerals, pyroxene, chromite, and biotite have been documented (**Kurečić et al., 2021**). Additionally, the speleogenesis of this area is primarily linked to Mesozoic carbonate host rock (**Vlahović et al., 2005; Korbar, 2009**), suggesting the presence of calcium carbonate. The presence of both carbonate clasts and heavier minerals indicates that paramagnetic and diamagnetic materials are likely present in these caves. This study aimed to measure magnetic susceptibility in speleological sites on Velebit Mountain (**Figure 1 and Figure 2**).

Figure 1: Map of the research area, highlighted with black rectangle, with locations of investigated speleological sites – Slovačka Cave and Crnopac Cave System

Study focuses on determining the measurability of magnetic susceptibility subsurface and assessing changes in values across different depth profiles. It also aimed to establish whether significant correlation exhibits within measured values. A comparative analysis was conducted between in situ measurements and laboratory results to evaluate device compatibility. In situ measurements were performed using the Kappameter KM-7 from SatisGeo s.r.o., while laboratory measurements employed the Bartington MS2B System. Sampling targeted soft sediments, with locations selected based on accessibility.

Figure 2: Speleological maps of Kita Gaćešina-Draženova puhaljka, part of the Crnopac Cave System (left, adopted and modified from **Barišić, 2010**), highlighting the sampling area for profiles KG1 and KG2 within yellow rectangle, and Slovačka Cave (right, adopted and modified from **Bakšić 2016**), showing the enlarged area of the investigated SL1 profile within the blue rectangle

2. Methods

Magnetic susceptibility was initially measured with the Kappameter KM-7 on one profile in Slovačka Cave and two profiles in the Crnopac Cave System (**Figure 2**). Following this, the same samples underwent a second round of magnetic susceptibility measurements in the laboratory using the Bartington MS2B System. The results were analyzed using two types of correlation coefficients and tested for normal distribution. The research methods are outlined in the chronological order in which they were employed throughout this study.

2.1. Magnetic Susceptibility Measurement

The in situ magnetic susceptibility values were measured using the handheld Kappameter KM-7 device, manufactured by SatisGeo s.r.o. This device is widely utilized in mineral deposit research, borehole core analysis, and archaeology due to its high resolution, precision, and extensive measurement range. The Kappameter KM-7 features durable, non-erasable memory, individual and scanning measurement modes, a measuring needle, and Bluetooth-enabled GPS connectivity. Its specifications include a sensitivity of $1x10^{-6}$ SI units (or $1x10^{-5}$ SI units in scanning mode), a measurement range of +/- $999x10^{-3}$ SI units with automatic precision, and an operating frequency of 10 kHz. The device can store up to 999 readings without GPS data and has a power consumption of 8 mA (excluding Bluetooth and backlight). It is powered by two AAA batteries and operates in temperatures ranging from -20 °C to +60 °C, with dimensions of 165x68x28 mm and a weight of 250 g (including batteries), making it a versatile tool for field measurements. The Kappameter KM-7 offers three modes for measuring magnetic susceptibility: individual, scanning, and remote. For this field research, the individual measurement mode was used to capture readings. The measuring process involves three steps: first, positioning the device at least 30 cm away from the rock (AIR1); second, aligning the measuring needle parallel to the rock surface to obtain the SAMPLE value; and third, taking another measurement at least 30 cm away from the rock (AIR2). The SAMPLE value recorded between AIR1 and AIR2 is the measured magnetic susceptibility. One profile was measured in Slovačka Cave, and two profiles were assessed in the Crnopac Cave System. The locations and lengths of these profiles were selected based on the accessibility of the sampling sites within these speleological environments.

In the laboratory environment when measuring magnetic susceptibility, the Bartington sensor generates a subtle magnetic field through alternating electric current and detects the material's magnetization. The resulting magnetic susceptibility value is displayed on the digital screen. Bartington sensors measure magnetic susceptibility relative to air, which serves as a calibration standard for the device. In this study, the MS2B sensor was employed for laboratory research, providing magnetic susceptibility values in SI units. Samples were prepared following specific protocols: plastic utensils and bags were used to avoid metallic contamination, samples were dried for three days, crushed, and then placed into 10 cm^3 plastic vials. The MS2B sensor, a portable laboratory device, conducts measurements at two different frequencies, essential for detecting superparamagnetic minerals, crucial in soil and rock analysis.

The procedure with the MS2B sensor is more intricate than with the KM-7 device. It is configured to display magnetic susceptibility in dimensionless SI units (10^{-5}). Before measuring samples, a calibration plastic vial provided by the manufacturer is used to verify the device's calibration. Samples are first measured at a low frequency (LF) of 0.46 kHz with a 0.1 range multiplier, with air and sample measurements taken sequentially. Ideally, there is no difference between the first and third readings; otherwise, measurements are repeated. The device calculates volume susceptibility, denoted by κ, indicating the ratio of sample magnetization to the magnetic field (80 Am^{-1}) in the SI system. Values of κ on the MS2B device are typically in the order of 10^{-5}. After low-frequency measurements, samples are measured at a high frequency (HF) of 4.65 kHz. Plastic vials are consistently oriented to minimize measurement errors (**Dearing, 1994**).

After measurement, key parameters are calculated. Specific mass susceptibility χ is obtained by dividing the κ value by the total sample density ρ. Density is calculated by dividing mass by volume, and specific mass susceptibility (χ) has units in m^3/kg. Alternatively, the specific mass susceptibility of dual frequency, χ_fd, can be obtained from the **Equation 1** (**Dearing, 1994**):

$$\chi_{fd} = \frac{(\kappa_{lf} - \kappa_{hf})}{\rho} \quad (1)$$

Where are:
χ_{fd} – specific mass susceptibility of dual frequency (m^3/kg),
κ_{lf} – volume susceptibility at low frequency,
κ_{hf} - volume susceptibility at high frequency,
ρ - density (kg/m^3).

The difference in magnetic susceptibility of dual frequency is expressed as a percentage calculated using the **Equation 2** (**Dearing, 1994**):

$$\chi_{fd} = \kappa_{lf} - \frac{(\kappa_{hf})}{\kappa_{lf}} x100 \quad (2)$$

Where are:
χ_{fd} – specific mass susceptibility of dual frequency (m^3/kg),
κ_{lf} – volume susceptibility at low frequency,
κ_{hf} - volume susceptibility at high frequency.

These parameters are computed using Bartington Multisus software, providing comprehensive data analysis and storage capabilities. The MS2B sensor is widely used across various fields. In geology and soil analysis, it is crucial for individual sample assessments. In archaeology, it aids in locating former settlements, stratigraphic analysis, and identifying magnetic materials. It supports environmental pollution research by analyzing rock, soil, and vegetation samples. Additionally, it is used in construction material testing, facilitating geological origin determination and material permeability assessment (**Dearing, 1997**).

2.2. Statistical Analysis

The measured values of magnetic susceptibility were evaluated through cross-correlation of the values. Two correlation coefficients were calculated: Pearson's and Spearman's. The correlation coefficient, ranging from -1 to +1, indicates both the strength and direction of the linear relationship between two variables. A coefficient closer to +1 or -1 signifies a strong positive or negative correlation, respectively, where increasing values in one array correspond to increasing or decreasing values in the other. Conversely, a coefficient closer to 0 suggests a weak or no correlation between the arrays. Widely utilized in science and finance, this statistical measure assists in assessing associations between variables. The Pearson correlation coefficient, a commonly employed, precisely quantifies the strength and direction of a linear relationship. Spearman correlation, a nonparametric alternative to Pearson's, evaluates association based on ranked values rather than raw data. Unlike Pearson, which focuses on linear changes, Spearman assesses monotonic relationships where variables change together but not necessarily at a constant rate. It is preferred in scenarios involving non-linear relationships, non-normal distributions, ordinal variables, or significant outliers.

The correlation coefficient is a statistical metric that gauges the strength of the relationship between the relative movements of two variables. It quantifies how closely the predicted trend aligns with the actual trend. In this study, the variables under consideration are magnetic susceptibility values. Both correlation coefficients were calculated for all three frequencies used (10 kHz, 0.46 kHz, 4.64 kHz) and for all three analysed profiles (SL1, KG1, KG2).

To examine the measured values using the F and T tests, the values were first tested for normal distribution using the Shapiro-Wilk normality test. For cases where a normal distribution was established, F and T tests were conducted.

3. Results and discussion

In Slovačka Cave, magnetic susceptibility *in situ* was measured using the Kappameter KM-7 device along the profiles near the speleologist's rest stop ("bivak" in Croatian), located 360 meters from the cave entrance (**Figure 2**). The profile was recorded vertically, from top to bottom. Profile SL1 was selected due to its intriguing morphology, extensive vertical spread, and the feasibility of safely anchoring a researcher above it, making sampling both safe and practical.

Magnetic susceptibility values were obtained at 27 locations along the 2.85-meter length of the profile and are shown in **Figure 3** (green line). Samples from these points were later analyzed in the laboratory using the Bartington device. From 0 to 0.45 meters, 10 locations were measured and sampled at 0.05-meter intervals, with magnetic susceptibility ranging from 65.00 x 10^{-5} SI to 120.00 x 10^{-5} SI. Between 0.45 meters and 1.45 meters, another 10 measurement points were determined, showing a range of 7.00 to 88.00 x 10^{-5} SI. From 1.45 meters to the end of the profile, seven measurement points were placed at 20-centimeter intervals, with values ranging from -45.00 x 10^{-5} SI to 21.00 x 10^{-5} SI, resulting in a range of up to 66 x 10^{-5} SI. Notably, measurement points SL1-21, SL1-23, and SL1-26 recorded negative values (see **Figure 3**).

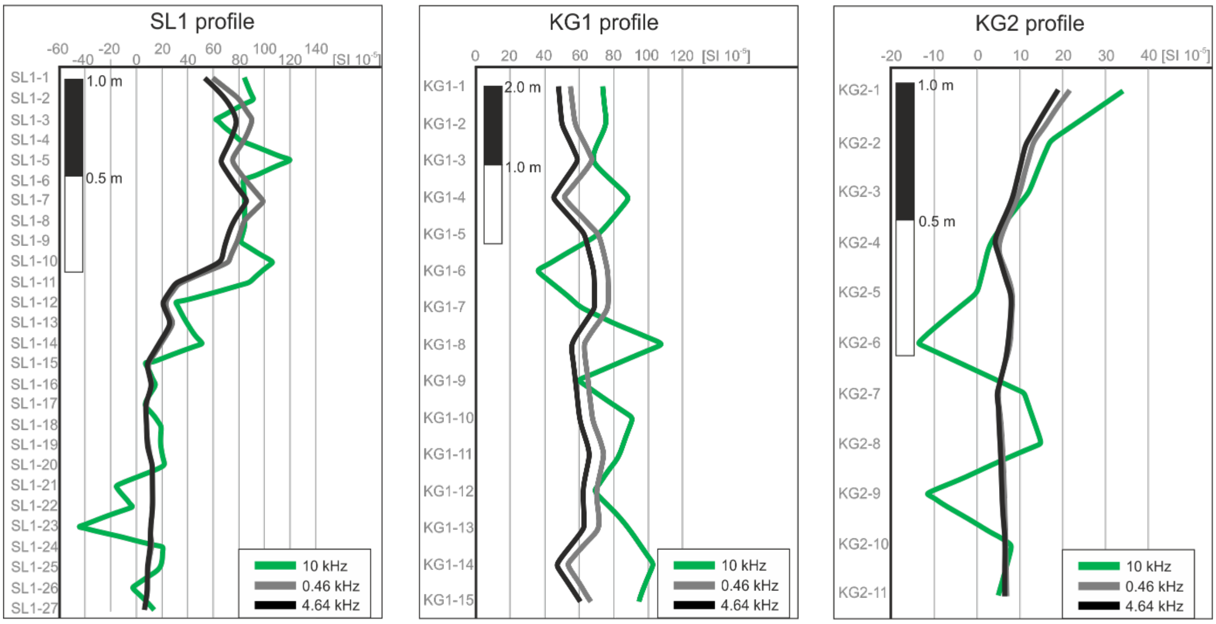

Figure 3: Magnetic Susceptibility values recorded on the investigated profiles. Green lines represent values obtained with the portable Kappameter KM-7 device (10 kHz frequency), and grey and black lines represent values acquired in the laboratory environment with the Bartington MS2B device at two frequencies respectively (0.46 and 4.64 kHz).

In the Crnopac Cave System (Kita Gaćešina entrance), *in situ* magnetic susceptibility measurements were conducted on two profiles, recorded from top to bottom. Both profiles are situated on the first level of the Crnopac Cave System, relative to the Kita Gaćešina entrance (**Figure 2**).

Profile KG1, which is seven meters long, is located at the end of the "Perzijska ljubav" channel (**Figure 2**). Measurement points on the KG1 profile are spaced half a meter apart. The magnetic susceptibility values range between 36.00 x 10^{-5} SI and 95.00 x 10^{-5} SI (**Figure 3**). The lowest value, 36.00 x 10^{-5} SI, is at measurement point KG1-6, located at 2.50 meters on the profile. The highest value, 95.00 x 10^{-5} SI, is at the last measurement point, KG1-15, which is also the lowest in the spatial profile. Profile KG2 is located directly adjacent to the "Ašov" resting point (**Figure 2**). This profile is two meters long, with measurement points spaced 20 centimeters apart. The highest magnetic susceptibility recorded is 34.00 x 10^{-5} SI, and the lowest is -14.00 x 10^{-5} SI (**Figure 3**). Measurement points KG2-6 and KG2-9 exhibit negative values.

In the laboratory, magnetic susceptibility measurements were performed using the Bartington MS2B System on the same samples previously measured in the cave systems with the KM-7 device at a frequency of 10 kHz. After recording magnetic susceptibility values at all measurement points on profiles SL1, KG1, and KG2 with the KM-7, soft sediment samples were collected. These samples were then analyzed for magnetic susceptibility at two frequencies: lower (0.465 kHz) and higher (4.65 kHz).

For profile SL1 from Slovačka Cave, no negative magnetic susceptibility values were observed (**Figure 3**, grey and black lines). At the lower frequency, values ranged from 6.60 to 99.40 x 10^{-5} SI. The lowest value was recorded in sample SL1-27, the lowest point on the profile, while the highest value corresponded to sample SL1-7. At the higher frequency, values ranged from 6.50 x 10^{-5} SI in sample SL1-27 to 86.40 x 10^{-5} SI in sample SL1-7.

In the Crnopac Cave System, magnetic susceptibility values for profile KG1 at a frequency of 0.465 kHz ranged from 51.00 to 77.20 x 10^{-5} SI. The lowest value was recorded in sample KG1-4, while the highest values were found in samples KG1-6 and KG1-7. At the higher frequency, values varied from 44.80 x 10^{-5} SI to 69.30 x 10^{-5} SI, with the lowest susceptibility in sample KG1-4 and the highest in sample KG1-7. For profile KG2, magnetic susceptibility values at the lower frequency ranged from 4.50 to 21.40 x 10^{-5} SI, and at the higher frequency from 4.00 to 19.00 x

10^{-5} SI. The lowest value at both frequencies was recorded in sample KG2-4, while the highest value was in sample KG2-1 (**Figure 3**).

Correlation coefficients were calculated for the obtained results, as detailed in **Table 1**. Subsequently, Shapiro-Wilk normality tests were conducted on the measured values depicted in **Figure 3**. The results indicated significant correlation coefficients (coefficients values in bold in **Table 1**), as well as enabled the application of t-tests and f-tests.

Table 1: Pearson and Spearman correlation coefficients for three analysed profiles

Profile	**Correlation type**	**10 kHz/0.46 kHz**	**10 kHz / 4.64 kHz**	**0.46 kHz/4.64 kHz**
SL1	Pearson	0.841517	0.846089	0.999713
	Spearman	**0.762668**	**0.765873**	**0.996947**
KG1	Pearson	**-0.495143**	**-0.482872**	**0.997293**
	Spearman	-0.503571	-0.456250	0.984821
KG2	Pearson	0.672635	0.652831	0.998824
	Spearman	**0.379545**	**0.381818**	**0.997727**

Values in bold represent significant correlations for the respective comparison. The results of magnetic susceptibility were also assessed for normal distribution. The corresponding P-values are displayed in **Table 2**.

Table 2: present the p-values from the normality tests. Values in italic indicate non-normal distributions

Profile	**Frequency**	**P-value**
SL1	10 kHz	0.1363
	0.46 kHz	*0.00006731*
	4.64 kHz	*0.000072*
KG1	10 kHz	0.8641
	0.46 kHz	0.3188
	4.64 kHz	0.2845
KG2	10 kHz	0.7872
	0.46 kHz	*0.006219*
	4.64 kHz	*0.0109*

Given that only the magnetic susceptibility values measured at the KG1 profile passed the normality test for all three frequencies, t-test and f-test were conducted specifically for this profile. Detailed results are presented in **Table 3**.

Table 3: displays the results of t-test and f-test on magnetic susceptibility values obtained from the KG2 profile

Profile	**Tests**	**10 kHz/0.46 kHz**	**10 kHz / 4.64 kHz**	**0.46 kHz/4.64 kHz**
KG1	t	0.017369	0.000683	0.008258
	f	0.005584	0.002586	0.780149

The investigation of magnetic properties in Croatian cave systems is significantly underrepresented in research, despite the excellent preservation of cave sediments. Given the presence of heavier mineral compositions in allogenic cave sediments within the Dinaric Karst (**Kurečić et al., 2021**), this study aimed to assess the feasibility of measuring magnetism in cave environments and to compare a portable measuring device with a commonly used laboratory instrument.

Magnetic susceptibility values measured in Slovačka Cave and the Crnopac Cave System using the Kappameter KM-7 (KM-7) device showed significant differences compared to laboratory measurements with the Bartington MS2B device (see **Figure 3**). This disparity is supported by statistical analyses (see **Tables 1-3**). Across all profiles investigated, KM-7 device readings were notably lower than laboratory measurements at both low and high frequencies. The correlation coefficient between values obtained at different frequencies in the laboratory was significantly higher (see **Figure 3**). KM-7 measurements consistently passed normality tests, suggesting suitability for such measurements, albeit with occasional anomalies attributable to the device's small sampling area on irregular outcrop surfaces compared to the lab's larger sample volume of 10 cm^3. Furthermore, negative readings recorded by the KM-7 device on the SL1 and KG 2 profiles (Figure 3 and Table 2) highlight the challenges posed by subsurface karst environments for studies such the one described in this paper. Readings that did not pass the normality test should be examined for non-normal distributions in further research.

Temperature fluctuations at the measurement needle's contact point and lateral mineral variations within the outcrop, spanning just a few millimeters, could influence measurement accuracy with the KM-7 device. Additionally, sparse measurement points may negatively impact precision. These factors collectively affect magnetic susceptibility recordings in speleological settings. Notably, the repeatability of results and measurement point density are crucial considerations influencing measurement accuracy and the interpretation of profile data.

4. Conclusions

Initial measurements of magnetic susceptibility were conducted using the Kappameter KM-7 on one profile within Slovačka Cave and two profiles in the Crnopac Cave System (Figure 2). Subsequently, these samples underwent additional magnetic susceptibility measurements in the laboratory using the Bartington MS2B System. The results were then subjected to analysis using two types of correlation coefficients and tested for normal distribution.

Magnetic susceptibility measurements in Croatian cave sediments have revealed significant variations along specific profiles. In Slovačka Cave on northern Velebit Mountain, and in the Crnopac Cave System (specifically at Kita Gaćešina entrance), magnetic susceptibility measurements identified changes presumably linked to variations in sediment mineral composition.

Considering higher correlation coefficient values, the Bartington MS2B device provided precise and reliable results suitable for detailed interpretation. In contrast, measurements using the Kappameter KM-7 device yielded preliminary field results that partially aligned with MS2B measurements. However, the accuracy of KM-7 results depended heavily on the measurement protocol and the design of measurement points along the profiles.

5. References

1. Bakšić, D., Petričević, J., Rakovac, M. (2016): Slovačka jama: Mali Kuk, Sjeverni Velebit. Speleološki nacrt. Zagreb: Speleološki odsjek Velebit.
2. Barišić, T., Branica, B. (2010): Jamski sustav Kita Gaćešina – Draženova puhaljka: Crnopac, južni Velebit. Speleološki nacrt. Zagreb: Speleološki odsjek Velebit.
3. Dearing, J. A. (1994): Environmental Magnetic Susceptibility: Using the Bartington MS2 System. Chi Pub.
4. Lacković, D., Glumac, B., Asmerom, Y. and Stroj, A. (2011): Evolution of the Veternica Cave (Medvednica Mountain, Croatia) drainage system: insights from the distribution and dating of cave deposits. Geologia Croatica. 64/3, 213-221. DOI: 104154/gc.2011.18
5. Korbar, T. (2009): Orogenic evolution of the External Dinarides in the NE Adriatic region: a model constrained by tectonostratig-raphy of Upper Cretaceous to Paleogene carbonates. Earth-Science Reviews. 96, 4:296-312. DOI: 10.1016/j.earscirev.2009.07.004

6. Kurečić, T., Hajek Tadesse, V., Wacha, L., Horvat, M., Trinajstić, N. and Mišur, I. (2022): Sub-recent microfauna within allogenic sediments at the bottom of a deep cave, Njemica (Biokovo Mt., Croatia). International Journal of Speleology. 51(3), 223-233. https://doi.org/10.5038/1827-806X.51.3.2428
7. Kurečić, T., Bočić, N., Wacha, L., Bakrač, K., Grizelj, A., Tresić Pavičić, D., Lüthgens, C., Sironić, A., Radović, S., Redovniković, L. and Fiebig, M. (2021): Changes in Cave Sedimentation Mechanisms During the Late Quaternary: An Example From the Lower Cerovačka Cave, Croatia. Frontiers in Earth Science. 9, 672229. DOI: 10.3389/feart.2021.672229
8. Malez, M., Smith F.H., Radovčić, J. and Rukavina, D. (1980): Upper Pleistocene Hominids from Vindija, Croatia, Yugoslavia. Current Anthropology. 21 (3). DOI: 10.1086/202463
9. Sasowsky, I.D. (2007): Clastic Sediments in Caves – Imperfect Recorders of Processes in Karst. Acta Carsologica. 36(1), 143-149. https://doi.org/10.3986/ac.v36i1.216
10. da Silva, A. C., Whalen, M. T., Hladil., J., Chadimova, L., Chen, D., Spassov., S., Boulvain, F. and Devleeschouwer, X. (2015): Magnetic Susceptibility Application: A window onto Ancient Environments and Climatic Variations. Geological Society London, Special Publications. 414, 1-13. https://doi.org/10.1144/SP414.12
11. Stroj, A., Lacković, D., Sasowsky, I. D., Bajo, P. and Glumac, B. (2024): The application of cave morphological and sedimentary deposit investigations to unravel tectonic history and landscape evolution: Insights from Veternica Cave, Medvednica Mountain, Croatia. Geomorphology. 446. https://doi.org/10.1016/j.geomorph.2023.109000
12. Stroj, A. and Paar, D. (2018): Water and air dynamics within a deep vadose zone of a karst massif: Observations from the Lukina jama – Trojama cave system (1.431 m) in Dinaric karst (Croatia). Hydrological Processes. 1-11. DOI: 10.1002/hyp.13342
13. Vlahović, I., Tišljar, J., Velić, I. and Matičec, D. (2005): Evolution of the Adriatic Carbonate Platform: Paleogeography, main events and depositional dynamics. Palaeogeography, Palaeoclimatology, Palaeoecology. 220, 3-4, 333–360.
14. White, W. B. (2007): Cave sediments and paleoclimate. Journal of Cave and Karst Studies. 69(1), 76-93.
15. Zupan Hajna, N., Bosák, P., Pruner, P., Mihevc, A., Hercman, H. and Horáček, I. (2020): Karst sediments in Slovenia: Plio-Quaternary multi-proxy records. Quaternary International. 546, 4-19. https://doi.org/10.1016/j.quaint.2019.11.010
16. Zupan Hajna, N., Mihevc, A., Pruner, P. and Bosák, P. (2010): Paleomagnetic research on karst sediments in Slovenia. International Jour-nal of Speleology. 39 (2), 47-60. DOI: 10.5038/1827-806X.39.2.1

SAŽETAK

Magnetski susceptibilitet u Slovačkoj jami i Jamskom sustavu Crnopac: KM-7 nasuprot Bartington MS2B

Istraživanje magnetizma u hrvatskim speleološkim sustavima znatno je nedovoljno istraženo, unatoč izvrsnoj očuvanosti sedimenata špilja. Ova studija fokusira se na dva lokaliteta: Slovačku Jamu i Jamski Sustav Crnopac (ulaz Kita Gaćešina). Magnetna susceptibilnost u mekim sedimentima mjerena je na svim lokacijama korištenjem uređaja Kappameter KM-7 za terenska mjerenja i Bartington MS2B sustava za potrebe laboratorijske analiza. Lokacije uzorkovanja odabrane su prema dostupnosti, a rezultati su podvrgnuti statističkoj analizi. Uočene su značajne razlike između mjerenja dobivenih s oba uređaja. Bartington MS2B sustav pokazao je veću preciznost, sugerirajući moguće probleme s kalibracijom ili prikladnošću KM-7 Kappametera za špiljski okoliš. Za buduća mjerenja magnetske susceptibilnosti preporučuje se Bartington MS2B, s početnom uporabom prijenosnih uređaja za procjenu relativnih varijacija magnetizma duž sedimentnog profila na terenu.

Ključne riječi: hrvatski špiljski sedimenti; magnetski susceptibilitet; korelacijski koeficijenti; normalna distribucija

Author's contribution

Ana Kamenski (1) performed the field work, laboratory and statistical analyses, interpretation and presentation of the results, wrote the first draft of manuscript. **Uroš Barudžija (2)** supervised analytics and reviewed the manuscript.