

# MINERALOGICAL COMPOSITION AND PROPERTIES OF PELOID FROM DUČEVAC, SERBIA, TRADITIONALLY APPLIED TO HAIR TREATMENT

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## ABSTRACT

This study analyzes mineralogical composition and properties of two samples sourced from Dučevac, Serbia, which are traditionally used in hair treatment. This investigation provides the first systematic, multidisciplinary characterization of the specified material, comparing the samples with respect to their mineralogical phases, chemistry, and physicochemical properties. Notably, sample 1.1 is primarily calcite, with a smaller amount of clay minerals (illite, kaolinite, and smectite). In contrast, sample 1.2 showcases a blend of illite and quartz, with small amounts of other clay minerals (smectite, kaolinite, chlorite) and plagioclase. Sample 1.1 has higher amounts of CaO (9.83 wt.%) and Na<sub>2</sub>O (2.97 wt.%) than sample 1.2; in return, sample 1.2 has higher amounts of Fe<sub>2</sub>O<sub>3</sub> (4.25 wt.%) and MgO (4.61 wt.%). In terms of pH, both samples are moderately acidic, with CEC values ranging from 8 to 9 meq/100g, and SSA measurements between 66 and 75 m<sup>2</sup>/100g. The color also reflects distinct variations, with sample 1.1 registering at 583 nm and sample 1.2 at 573 nm. All analytical values align with reference peloids found in literature, enhancing our understanding of the samples' characteristics and origins. This highlights the material's geological significance and the importance of preserving traditional practices as part of the region's geoh heritage.

**Keywords:** Peloid, Dučevac, Hair treatment, Mineralogical properties.

## INTRODUCTION

Peloids have a rich history in the treatment of various skin conditions, such as psoriasis, atopic dermatitis, and acne (Maraver et al., 1965; Maraver, 2006). Today, peloid therapy is a popular component of health resort medicine, often practised through general pelotherapy, thermotherapy, balneotherapy and thalassotherapy (Almeida et al., 2025; Carretero, 2020; Cozzi et al., 2018; Maraver et al., 2015; Pastor Vega, 1998; Ferrand & Yvon, 1991). In recent years, peloids have also gained recognition as effective cosmeceuticals, contributing significantly to improvements in skin health and overall condition (Mourelle et al., 2024). The therapeutic benefits of peloids have been extensively researched, with compelling evidence highlighting their effectiveness, especially in the fields of rheumatology and dermatology (Pozo et al. 2013; Beer et al., 2003; Bellometti et al., 2005; Codish et al., 2005; Evcik et al., 2007; Fioravanti et al., 2007; Forestier et al., 2010; Fraioli et al., 2011; Nappi et al., 1996; Sukenik et al., 1990). Lewis first articulated the concept of peloids in 1933 (Lewis, 1935; Mourelle et al., 2024), who described them as “a peloid is, regardless of the medium, a natural product composed of a uniform mixture of solid matter, finely divided

organic matter, and water, which is applied in medical practice as a poultice for external treatment”. This definition highlights the natural origins and therapeutic application of peloids. In 2013, a Working Group led by Gomes (Gomes et al., 2013; Mourelle et al., 2024) provided a more nuanced understanding of peloids, defining them as “a matured mud or muddy dispersion with healing and/or cosmetic properties”. This definition emphasizes the complex nature of peloids, which are composed of a rich amalgamation of fine-grained natural materials derived from both geological and biological sources. This multifaceted composition makes peloids a valuable resource in both medical and cosmetic contexts, offering a natural means of promoting skin vitality and well-being (Tian et al., 2022). Peloids are complex natural substances formed by the interplay of three essential components. The liquid phase may consist of mineral moor water, seawater, or water sourced from salt lakes, each contributing unique mineral content and properties beneficial for therapeutic applications (Mourelle et al., 2024). The solid phase is predominantly composed of inorganic materials, such as clay, silt, or sediments, which provide structural integrity and therapeutic benefits through their mineral composition (Mourelle et al., 2024). Additionally, organic materials, such as peat, may be present, enhancing the healing properties of the peloids due to their richness in nutrients and organic compounds (Mourelle et

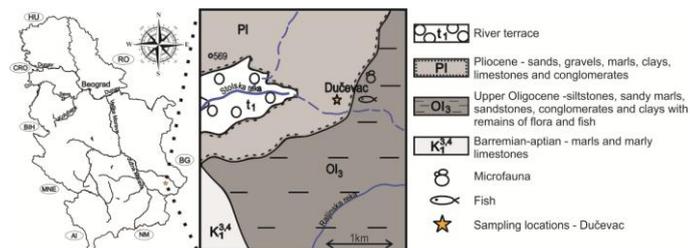
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al., 2024). The precise composition of these peloids plays a critical role in determining their effectiveness in treatment protocols. These materials primarily consist of silicates, including quartz, clay minerals, and feldspars. Additionally, peloids may contain significant amounts of carbonates, sulfates, and sulfides, along with varying proportions of organic matter (Bacaicoa, 1994; Gomes et al., 2013). This complex mixture often results from geological processes, including weathering, sedimentation, and organic accumulation, making peloids an important subject of study in both geology and environmental science. Their distinctive properties can provide valuable insights into past environmental conditions and the region's natural history. Interestingly, the names and classifications of these materials differ from one country to another, reflecting the rich cultural and geographic tapestry that informs their use in traditional and modern wellness practices (Gomes et al., 2013). The settlement of Dučevac, located in the Pirot district, approximately 300 km southeast of Belgrade, the capital of Serbia, is rich in silt sourced from the nearby alluvial valley of the Stolska Reka. This natural material has been traditionally utilized by local inhabitants for the treatment of hair follicles. For three centuries, empirical knowledge concerning the beneficial properties of this locally sourced raw material has been transmitted through intergenerational practice; however, rigorous compositional and provenance data remain conspicuously limited. This investigation provides the first systematic, multidisciplinary characterization of the specified material, integrating mineralogical, petrographic, and geochemical analyses to define its diagnostic features. Consequently, this investigation is pioneering in its analysis of the specified raw material. The information acquired from this study will enhance the understanding of its primary characteristics, thereby providing a valuable framework for the future identification of the provenance of such material within this region. The objective of this paper is to identify the key characteristics of this material and highlight its geological significance. We aim to ensure the preservation of our traditional practices as an essential part of the region's geoheritage while providing a solid foundation for future assessments of the area's resource potential.

### Geological and geographical setting

Dučevac is a settlement situated approximately 300 kilometres southeast of Belgrade, the capital of Serbia. It is part of the Pirot district and lies within the Babušnica basin. This region is characterized by its lower elevation and gently varied topography, in contrast to the surrounding mountainous terrain, particularly that of Suva Planina. The elevations in the basins generally range from 400 to 500 meters, with the highest point reaching 569 meters. The lowest areas are associated with the alluvial valley of the Stolska Reka. The

map (Figure 1) highlights the location marked with a star, indicating the site from which the two samples were collected for investigation.



**Figure 1.** Geographical position and geological map of the investigated samples.

The alluvium is widely found in this region, particularly in the valleys of larger rivers such as the Nišava, Južna Morava, and Lužnica. It is less common in the valleys of the Rutinska, Jelašnica, Toponička, and Stolska rivers (Vujisić et al., 1971). The alluvium comprises layers of pebbles, sand, and clay, generally of small thickness. In the lower southeastern parts of the Babušnički and Koritnički basins, Upper Oligocene sediments have been discovered (Vujisić et al., 1971). These sediments transgressively overlie Lower Cretaceous layers and are in tectonic contact with the older sediments along the basin's edges. The age of the Upper Oligocene layers, especially in the Dučevo region, is established based on abundant fossil flora and fish remains (Anđelković, 1970). In the Babušnica basin, the Pliocene sediments lie transgressively over the Upper Oligocene or Lower Cretaceous formations. The Pliocene is represented by coarse-grained yellow sands interspersed with sandy-marly lenses and limestone in the lower strata. The upper layers include grey-blue clays, friable mica sandstones, sandy clays, and gravel (Vujisić et al., 1971).

### Materials and methods

The selection of sample locations was conducted with the guidance of local inhabitants, resulting in the identification of two distinct sites within the same region. These locations were situated within 50 meters of one another. Approximately 1 kg of each sample collected from the Dučevac location was air-dried at room temperature, then crushed and homogenized without additional treatment.

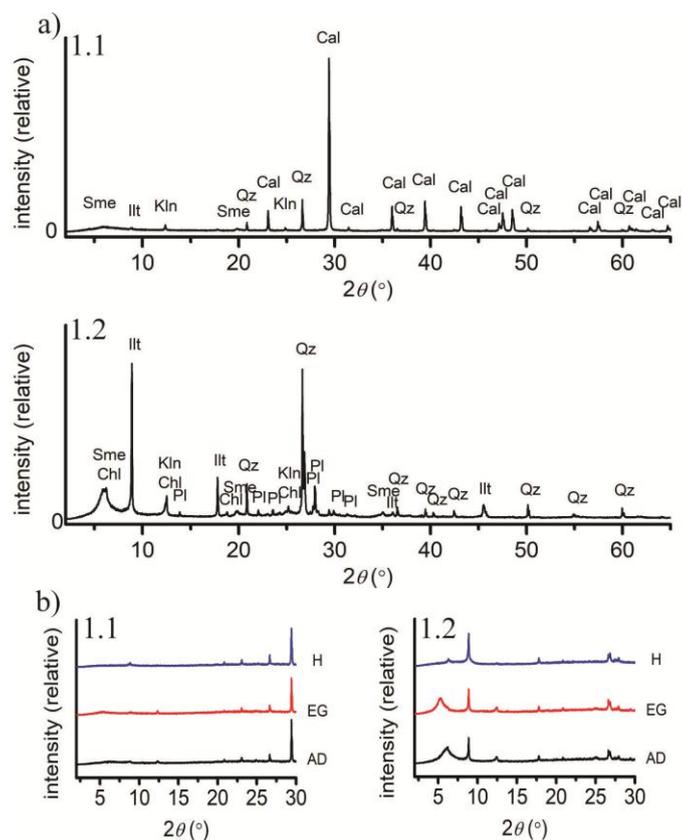
Semiquantitative chemical analysis was determined using Scanning Electron Microscopy (SEM) with a JEOL JSM-6610LV SEM coupled with an energy-dispersive spectrometer (EDS). The grain-size distribution was determined using the pipette method in accordance with DIN ISO 11277 (2002), followed by wet sieving with a standard set of stainless-steel sieves. The classification of sediments was performed according to Folk (Folk, 1954). The X-ray powder diffraction (XRPD) data were analyzed using powder samples and glass slide oriented mounts: air-dried, saturated with ethylene

glycol, and heated to 550 °C (Moore & Reynolds, 1997). The data were collected at room temperature on a Rigaku SmartLab X-ray diffractometer equipped with a D/teX Ultra 250 strip detector. Bragg–Brentano geometry and CuK $\alpha$  radiation were used, and the diffractometer was operated at 40 kV and 30 mA. The scan range was from 2 to 65° 2 $\theta$  with a scanning speed of 5°/min (for powder samples) and from 2 to 30° 2 $\theta$ , with a scanning speed of 10°/min (for the oriented mounts), while the step size was 0.01, in both cases. The cation exchange capacity (CEC) and specific surface area (SSA) of the samples were measured after saturating them with a methylene blue (MB) solution, following the relevant ASTM standards (1984). The analysis was conducted using a uniSPEC2 spectrophotometer. The color of the dry-pressed raw powder sample, as well as that of the samples subjected to heating at 1100 °C, was assessed utilizing a Thorlabs spectrometer configured for diffuse reflectance geometry. Measurements were conducted over a wavelength range of 400 to 700 nanometers, in accordance with the standards established by the Commission Internationale de l’Eclairage (1932) method. Barium sulfate (BaSO<sub>4</sub>) was used as the white standard with illuminant C as the employed light source. A 1% (w/v) aqueous solution of peloid sample was prepared in deionized water to determine its pH value. Aqueous solution was stirred for 20 minutes at 25°C and allowed to settle before measurement, which was conducted at 25°C with a pH meter - Cyber-Scan pH 11/110 Eutech Instruments.

## RESULTS AND DISCUSSION

X-ray powder diagrams of samples 1.1 and 1.2 are given in Figure 2. Sample 1.1 comprises dominantly calcite (ICDD No. 01-083-4601), while other present minerals in small amounts are quartz (01-085-1054), kaolinite (01-089-6538), smectite (01-073-6746; montmorillonite) and illite (01-078-5139). A database search revealed that the sample 1.2 contains quartz, illite, plagioclase (ICDD No. 01-089-6424; albite), smectite, kaolinite and chlorite (01-074-1137; clinochlore). A small amount of calcite is also possible, but cannot be unambiguously confirmed. The ratio of phyllosilicate minerals to non-plastic minerals, such as quartz, calcite and feldspars, can vary significantly in the classification of this type of material, with the non-plastic portion potentially reaching up to 70% (Dondi et al., 2014). Dondi (2014) also introduced a classification called "Red loams," which represents a unique case of red or marly clays that contain a high concentration of coarse-grained fraction (over 25% larger than 63  $\mu$ m). The sand component in these samples, investigated by Dondi and coauthors (2014), usually consists of quartz, feldspars, and rock fragments, while the clay component primarily includes a mixture of illite, kaolinite, and chlorite, with expandable clay minerals (smectite) possibly present in smaller quantities (Dondi et al., 2014).

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**Figure 2.** X-ray diffractograms of the bulk samples 1.1 and 1.2 (a) and their oriented mounts (b). Legend: Cal – calcite, Qz – quartz, Kln – kaolinite, Sme – smectite, Ill – illite, Pl – plagioclase; AD – air-dried, EG – saturated with ethylene glycol, H – heated.

Carretero (2020a) presented a comprehensive study on the mineral composition of peloids, which was based on various types of natural peloids discussed in more than 96 research papers. In this paper it was concluded that the solid component of most peloids consists of clay or clay-rich sediments, while in some instances, it is categorized as sandy silt, detrital material, clayey silt, or silty clays. Based on the solid components of the examined peloids, the predominant mineral phases found in most samples are phyllosilicates, quartz, calcite, feldspars, and dolomite; the primary phyllosilicates identified in the peloids studied include smectites, kaolinite, illite, illite-smectite mixed layers, and chlorite, in varying ratios (Carretero, 2020b).

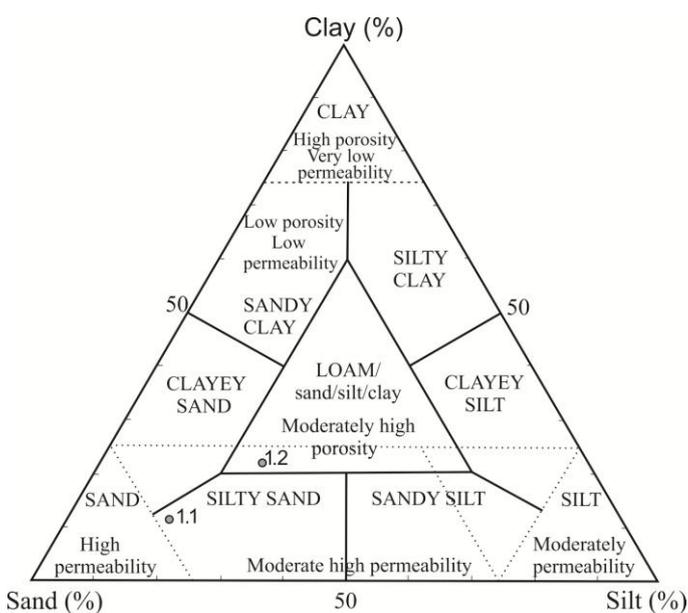
**Table 1.** Results of the grain size analysis of the investigated samples.

sample	sand %	silt %	clay %
1.1	72,71	16,35	10,94
1.2	52,30	25,78	21,92

The results of the grain size analysis of the investigated samples are shown in Table 1. When analyzing the percentage composition of each fraction, we can see that in samples 1.1

and 1.2, the sand phase was the dominant fraction. Sample 1.1 contains a high sand content of over 70%, while the silt and clay fractions are below 17%. In contrast, sample 1.2 has a slightly lower sand content and a higher percentage of clay and silt, compared to the previous sample.

According to Folk's (1954) sediment classification, sample 1.1 falls under the silty sand category while 1.2 could be categorized as loam, representing a mixture of clay, silt and sand (Figure 3). Sample permeability, which indicates the capacity of a porous material to transmit fluids, can also be inferred from the sediment classification. According to the results, both of the samples have moderate-high permeability.



**Figure 3.** Classification diagram of the investigated samples (adapted after Folk, 1954)

High concentration of particles under 2  $\mu\text{m}$  in dispersion reduces the abrasiveness of the peloid material, although the presence of sharp-edged quartz or feldspar grains in clays affects abrasion (Rapp & Laufmann, 1995; Klinkenberg et al., 2009; Pozo et al., 2013). This statement indicates that the investigative samples have a higher value of abrasiveness. Abrasivity increases with increasing content of hard minerals such as quartz, although it should be reduced if the sample is very fine-grained (e.g. below 2  $\mu\text{m}$ ) (Klinkenberg et al., 2009).

The measurement of the pH values revealed a consistent result of around 6.5 for both samples (6.51 for sample 1.1 and 6.53 for sample 1.2), indicating a slightly acidic environment. Peloids could be classified, according to pH value, as weak acid if their pH value is 5.1 – 7.0 (Stojković & Sremčević, 2011). Bigovic et al. (2019) have reported a pH value of 6.23  $\pm$  0.01 for weak acidic peloid from Igalo (Montenegro), while Karakaya & Karakaya (2018) have reported a range that was between 6.33 and 8.35 and classified the peloids from Turkey as neutral to slightly alkaline.

The cation exchange capacity (CEC) quantifies the exchange of cations and is essential for assessing the quality of clay minerals. Specific surface area (SSA), on the other hand, refers to the ratio of the total surface area to the total mass of the particles. Clay minerals are classified as those with granulometric sizes below 2 micrometers. These minerals include smectite, kaolinite, illite, and chlorite, the latter three have CEC values ranging from 3 to approximately 25 meq/100g and SSA values between 10 and 100  $\text{m}^2/100\text{g}$  (Chiappone et al., 2004; Milošević et al., 2024). In the samples investigated, the CEC values ranged between 8.5 and 9.6 meq/100g, while the SSA values varied from 66.25 to 75.16  $\text{m}^2/100\text{g}$  (Table 2).

**Table 2.** The cation exchange capacity (CEC) and specific surface area (SSA) of the investigated samples.

sample	CEC (meq/100g)	SSA ( $\text{m}^2/100\text{g}$ )
1.1	8.5	66.25
1.2	9.6	75.16

Pozzo and coauthors (2013) have observed a larger variety of CEC values, between 11 and 112 meq/100g, observed in the samples of peloids from Spanish spas. The lowest of CEC values (11 and 24 meq/100g) were noted in the samples that had illite–mica predominantly or due to the fact that they had muddy–silty composition (Pozzo et al., (2013). The results obtained from the analysis of the investigated samples indicate that they could primarily be composed of illite (sample 1.2) or have a significant presence of inert materials such as quartz and carbonates (Chiappone et al., 2004; Milošević et al., 2024). According to literature, ball clays exhibit a wide range of Methylene Blue Index (MBI) values, ranging from 8 to 40 meq/100g (Dondi et al., 2003, 2008, 2014; Wilson, 1998). Dondi et al. (2014) have categorized ball clay samples based on MBI values into the following classifications: low plasticity clays ( $\text{MBI} < 7.5$ ), medium plasticity clays ( $7.5 < \text{MBI} < 12$ ), high plasticity clays ( $12 < \text{MBI} < 16$ ), and very high plasticity clays ( $16 < \text{MBI} < 30$ ). Based on theoretical technological performance, samples 1.1 and 1.2 can be classified as medium plasticity clays.

Semiquantitative chemical analysis (SEM-EDS) of the sample is represented as a result of measurements on ten particles, and it is presented in the form of a mean value after fifty points (Table 3). Water content was not measured in this investigation. The analysis indicates that sample 1.2 has higher  $\text{Fe}_2\text{O}_3$  and  $\text{MgO}$  values (4.25 wt.% and 4.61 wt.%, respectively) compared to sample 1.1, alongside a closely similar content of  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$ . In contrast, sample 1.1 shows a higher  $\text{CaO}$  content, measured at 9.83 wt.%, as well as  $\text{Na}_2\text{O}$  of 2.97 wt.%. The calculated mass ratio for  $\text{SiO}_2/\text{Al}_2\text{O}_3$  is 1.52 (sample 1.1) and 1.62 (sample 1.2), which is higher than the values generally found in pure clay minerals (Boussen

et al., 2016). This difference from the theoretically pure clay minerals can be attributed to a higher content of quartz as a separate phase in the samples. This was confirmed by the XRD analysis where we can observe a higher content of quartz in sample 1.2 in regard to sample 1.1.

**Table 3.** Mean values of semiquantitative chemical analysis of the investigated samples.

Oxides (wt%)	Sample 1.1	Sample 1.2
Na <sub>2</sub> O	2.97	0.64
MgO	0.61	4.61
Al <sub>2</sub> O <sub>3</sub>	30.86	30.96
SiO <sub>2</sub>	46.88	50.15
K <sub>2</sub> O	2.98	3.94
CaO	9.83	0.82
TiO <sub>2</sub>	0.15	1.29
Fe <sub>2</sub> O <sub>3</sub>	0.79	4.25
NiO	0.10	0.17
Total (wt%)	95.17	96.83

The literature suggests that the investigated sample 1.2, besides being applied as natural raw peloid, could potentially be classified as "Red clays" provided they contain more than 3% Fe<sub>2</sub>O<sub>3</sub> and less than 10% carbonates (Dondi et al., 2014; Wilson, 1998). Sample 1.2 could be classified as Red clays since their Fe<sub>2</sub>O<sub>3</sub> content (4.25%) exceeds the threshold, while their CaO content (0.82%) is below 10%, as estimated by SEM-EDS analysis (Table 3). On the other hand, sample 1.1 does not meet these classification criteria because its Fe<sub>2</sub>O<sub>3</sub> content is only 0.79%, although it does have higher carbonate content (9.83% of CaO). Sodium ions play a critical role in enhancing skin permeability, facilitating the absorption of moisture and beneficial compounds. By forming hydrophilic interactions, sodium helps to bond water molecules within the skin, leading to a more hydrated and supple texture (Potpara et al., 2017; Potpara, 2011). Potassium concentration, according to recent findings, is considered a regulator of moisture in the skin (Potpara et al., 2017; Marinković-Siler, 2004). The iron content in the analyzed peloid sample predominantly exists in a form that is not bioaccessible. This iron is primarily bound within the mineral matrix as highly hydrated oxides, which contribute to its stability and limit its availability for biological uptake. The intricate interactions between these oxides and the surrounding minerals play a crucial role in determining the overall bioavailability of iron in the sample, highlighting the importance of the mineral composition in influencing nutrient accessibility (Potpara et al., 2017; Denda et al., 2000). The examined samples contain magnesium which is vital for the movement and growth of endothelial cells and acts as a strong anti-allergic agent and is essential for cell metabolism (Potpara et al., 2017; Pygmalion et al., 2010), although only sample 1.2

displays a significant amount. The content of total calcium in the examined peloid sample 1.1 is relatively high and, according to the XRD analysis, is mostly found in the carbonate phase; therefore, it can be easily mobilised. Calcium content is vital for strengthening cell membranes and cleansing pores (Potpara et al., 2017; Banai et al., 1990).

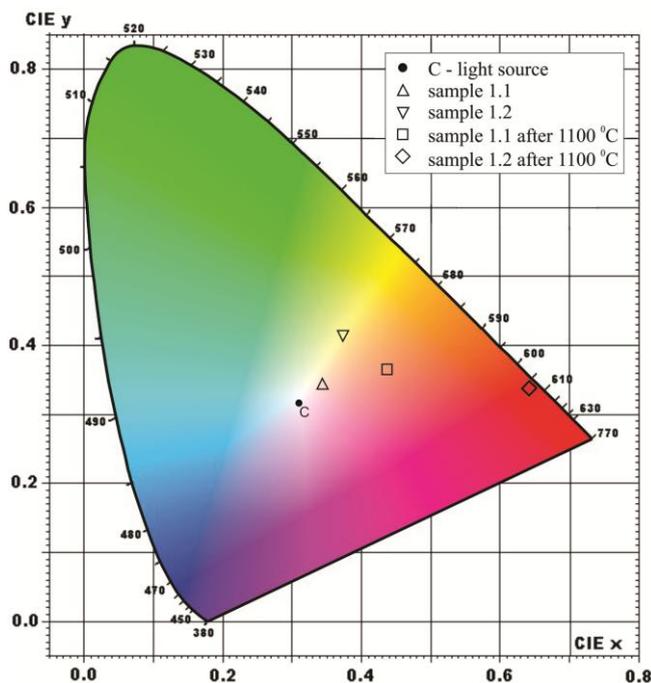
The color of a peloid is largely determined by its geological origin, mineral composition, and the presence of organic matter (Fedorov et al., 2019). After conducting spectrophotometric measurements of color, we observed the dominant wavelengths (Dc) for samples 1.1 and 1.2 to be 583 and 573 nm, respectively. Sample 1.1, before heating, demonstrated the least saturation with a color purity (Pc) of 7.1 (Table 3). Before heating, sample 1.1 fell within the yellow color spectrum while sample 1.2 fell in the orange/red category of the color spectrum (Figure 4). The dominant wavelength (Dc) and color purity (Pc) of the investigated samples, both before and after heating at 1100 °C, are displayed in Table 4.

**Table 4.** Dominant wavelengths and purity of color of the investigated samples.

Samples	Dc (nm)	Pc (%)
1.1	583	7.1
1.1 after 1100 °C	579	20.1
1.2	573	37.1
1.2 after 1100 °C	591	33.7

After subjecting the samples to heating treatment, a complete change in the color and its purity was noted in both of the samples, leading to darker color tones (Figure 4). It is essential to understand that the final color of a product is significantly influenced by the content of iron oxides, specifically Fe<sub>2</sub>O<sub>3</sub>, as well as other constituents like manganese oxide and titanium dioxide (Milošević et al., 2024). In the chemical analysis (Table 3), sample 1.1 exhibited a significantly higher calcium (Ca) content compared to sample 1.2. The presence of calcium plays a crucial role in the color development, as it often leads to the formation of yellow hues (Molera et al., 1997; Pogrebenkov & Sedel'nikova, 2020). This is primarily due to the production of calcium silicates during firing, both of which impart distinct yellow tones to the final product. Furthermore, titanium is known to produce a striking blue coloration, adding another layer of aesthetic appeal to the finished item (Pogrebenkov & Sedel'nikova, 2020). Although the sample 1.2 shows a titanium content above 1%, the blue color was not observed even after firing. This suggests that titanium does not significantly influence the color mixture. When considering the concentration of iron, specific thresholds yield distinctive colors: a concentration of less than 1 wt.% Fe<sub>2</sub>O<sub>3</sub> typically results in a pure white color, while a concentration between 1-2 wt.% imparts a yellow tint

(Molera et al., 1997). As the iron content increases to 2-3 wt.%, the color transitions to a buff hue; at 4-5 wt.% and above, the resulting shades shift toward red (Molera et al., 1997). Magnesium (MgO) content of 4.61% observed for sample 1.2 contributes to the development of intense red color, enhancing the visual complexity of the inspected color due to its concentration and combination with the iron content (Pogrebenkov & Sedel'nikova, 2020). Additionally, the classification of ceramic bodies can be based on their Fe<sub>2</sub>O<sub>3</sub> content; those with more than 5% Fe<sub>2</sub>O<sub>3</sub> are categorized as "dark-firing" ceramic bodies, characterized by deeper, richer colors due to the higher presence of iron oxides (Molera et al, 1997; Milošević & Logar, 2017; Wang et al., 2023; Abadir et al., 2002). Conversely, those with less than 4-5% Fe<sub>2</sub>O<sub>3</sub> fall into the "light-firing" category, typically exhibiting brighter and lighter tones (Molera et al, 1997; Milošević & Logar, 2017; Wang et al., 2023; Abadir et al., 2002). According to this classification, the samples could be separated into two groups after firing: the light-firing bodies (sample 1.1, with a yellow tint) and the dark-firing bodies (sample 1.2, with red hues).



**Figure 4.** Color of the investigated samples before and after heating to 1100 °C.

## CONCLUSION

The analyzed samples represent geologic materials characterized by diverse mineralogical compositions and elemental characteristics. The samples represent raw natural materials of predominantly inorganic composition, yet their structural, mineralogical, and granulometric characteristics indicate a potential classification as peloids. According to the author's knowledge, these samples have been used in hair

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treatments and therapeutic practices among local populations for generations, despite the presence of potentially harmful minerals, such as a higher concentration of quartz. The findings reveal marked differences between the two samples, especially regarding their mineral composition. Sample 1.1 is predominantly calcitic, with a smaller content of quartz and clay minerals, while sample 1.2 exhibits a mix of illite and quartz along with various other mineral phases. Notably, sample 1.1 possesses higher concentrations of CaO (9.83 wt.%) and Na<sub>2</sub>O (2.97 wt.%) compared to sample 1.2, which shows similar SiO<sub>2</sub> (46.88 wt.%) and Al<sub>2</sub>O<sub>3</sub> (30.86 wt.%) but higher Fe<sub>2</sub>O<sub>3</sub> (4.25 wt.%) and MgO (4.61 wt.%), when compared to sample 1.1. In addition to the mentioned elements, further examination of trace elements with known toxicological relevance, such as heavy metals or organic contaminants, is necessary. This will help to provide insights associated with the therapeutic use of the samples in the future. Based on their granulometric results, sample 1.2 can be categorized as loam, which represents a mixture of clay, silt, and sand. In contrast, sample 1.1 falls under the silty sand category. Both samples exhibit a higher level of abrasiveness. Both samples display weakly acidic pH levels (6.51 for sample 1.1 and 6.53 for sample 1.2), with a cation exchange capacity (CEC) ranging from 8 to 9 meq/100g (8.5 and 9.6 meq/100g, for samples 1.1 and 1.2 respectively), while the SSA values were measured at 66.25 for sample 1.1 and 75.16 m<sup>2</sup>/100g for sample 1.2. The optical properties differ as well, with sample 1.1 measuring at 583 nm in color, while sample 1.2 is at 573 nm. Upon heating, their colors shift to 579 nm and 591 nm, respectively, highlighting the pronounced changes in color purity, which are significantly impacted by iron oxide content. Both samples exhibit deeper color hues and increased saturation. The analytical values of the samples, despite their varying compositions, closely align with those reported in current literature, underscoring their significance. Our findings indicate that the clay from the Dučevo deposit is particularly well-suited for application as peloids. From a technological point of view, the clay sample 1.2 was characterized as illite loam, which is generally suitable for a wide range of ceramic industries, in addition to its current application. Future research and field investigations should focus on other regions within the Dučevo deposit to identify additional clay-rich areas and explore the potential for commercial applications of the raw clays studied. Furthermore, subsequent studies must evaluate the safety and toxicological effects of these geomaterials to ensure their preservation as part of the cultural heritage of the Dučevo region in Serbia.

## ACKNOWLEDGMENTS

This research was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, based on Contract on realization and financing of

scientific research of SRI in 2025, No. 451-03-34/2026-03/200126 and No. 451-03-33/2026-03/200126 (Faculty of Mining and Geology, University of Belgrade); 451-03-33/2026-03/200017 through the realization of research theme 1702614 (“Vinča” Institute of Nuclear Sciences—National Institute of the Republic of Serbia, University of Belgrade); 451-03-33/2026-03/200053 (Institute for Multidisciplinary Research, University of Belgrade).

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