Review

by Assoc. Prof. PhD Peter Tzvetanov Tzvetkov

regarding a competition for the academic position of Associate Professor in the professional field 4.4. Earth Sciences (Mineralogy and Crystallography) for the needs of the thematic area "Experimental Mineralogy and Crystallography", Institute of Mineralogy and Crystallography – Bulgarian Academy of Sciences.

This review was prepared in connection with a competition announced for the selection of an Associate Professor in the State Gazette, No. 56 of 19.06.2026. The only candidate to participate in the competition was Assistant Professor, PhD Liliya Vladimirova Tsvetanova, an employee at the Institute of Mineralogy and Crystallography – Bulgarian Academy of Sciences.

Assistant Professor, PhD Liliya Vladimirova Tsvetanova completed her higher education in 2002 at the University of Mining and Geology "St. Ivan Rilski" in Sofia, earning a Master's degree in the field of Geology of Mineral Resources. From 2011 to 2017, she was a PhD student at the Institute of Mineralogy and Crystallography (Bulgarian Academy of Sciences), where she successfully defended her dissertation in 2017 titled "Structural Characterization of Ion-Exchanged ETS-4," under the supervision of Prof. PhD Rositsa Nikolova. Throughout her scientific career, Liliya Tsvetanova has authored 23 scientific publications (according to Scopus), two of which appeared in journals lacking an Impact Factor (IF) or SJR ranking. Furthermore, as of the end of October 2026, Scopus data indicates 76 citations across 19 of her publications, excluding self-citations.

The scientific results with which Assistant Professor, PhD Liliya Tsvetanova is participating in the announced competition for the academic position of "Associate Professor" are presented in a total of 21 scientific publications; one of these is a conference paper lacking an Impact Factor (IF) or SJR ranking. Of the remaining articles, 11 are published in journals with Q1 and Q2 rankings, 6 have Q3 and Q4 rankings, and 3 possess only an SJR ranking. For indicator B.4, the candidate has submitted 4 publications, all of which fall within the Q1 quartile, yielding a total of 100 points for this criterion. These publications form the basis of the author's summary regarding the original scientific contributions of Assistant Professor, PhD Liliya Tsvetanova for the purposes of this competition. Under indicator G.7, 17 publications are presented: 2 in the Q1 quartile, 5 in Q2, 1 in Q3, and 5 in Q4. The remaining 3 publications under this indicator lack an IF and/or SJR ranking, including one

conference paper. The total score for indicator G.7 is 261. The 27 citations (excluding self-citations) sourced from the Scopus database, pertaining to criterion D.11 are based on 9 articles included in the competition, amounting to a total of 135 points. At the time of the application submission, the calculated Hirsch index (h-index) according to Scopus is 5. All scientific publications of Assistant Professor, PhD Liliya Tsvetanova are in English and have been published in 8 Bulgarian and 13 international scientific journals. The presented scientific results were developed within the framework of 7 national projects. The candidate has served as the principal investigator for 1 national project funded by the Bulgarian National Science Fund. She has participated in 27 scientific forums – 15 international and 12 national. Of these, 21 were poster presentations and 6 were oral presentations. The points accumulated in each category of indicators exceed the national minimum requirements (as per the Regulations for the Application of the Act for the Development of the Academic Staff in the Republic of Bulgaria), as well as the specific minimum requirements set by the Bulgarian Academy of Sciences and the Institute of Mineralogy and Crystallography - BAS for the academic position of "Associate Professor."

The scientific contributions presented by Assistant Professor, PhD Liliya Tsvetanova for this competition are described in detail in the submitted summary of the candidate's work. The articles included under criterion B.4, four in total, collectively meeting the point requirements for a habilitation thesis are grouped under the thematic area: "Synthesis, modification, characterization, and application of natural and synthetic mineral materials." All articles under criterion B.4 are published in Q1 quartile journals. In one of these, Liliya Tsvetanova is the first author. The candidate′s primary contributions relate to the hydrothermal synthesis of titanium silicates and their subsequent modification (via ion exchange, calcination, or isomorphous substitution within the crystal structure) to achieve specific adsorption and catalytic properties. A similar modification approach was also applied to the natural zeolite Clinoptilolite to impart new adsorption and antimicrobial properties. The modified compounds were characterized using powder X-ray diffraction performed at both room and elevated temperatures to determine their qualitative and quantitative phase composition, as well as any potential phase transitions. Additionally, semi-quantitative X-ray fluorescence analysis was employed to determine elemental composition, and the adsorption selectivity and kinetics of the modified natural and synthetic mineral materials were evaluated. The described practical applications of the investigated modified materials include the removal of heavy metals, such as Pb^{2+}, from water using titanosilicates or clinoptilolite (Article No. 1 in the list of publications), as well as the adsorption of Cd^{2+} using modified clinoptilolite (Article No. 4). The latter study is particularly noteworthy, as it examines the “in vivo” adsorption of Cd ions from contaminated water using natural clinoptilolite subjected to Na exchange and

mechanochemical (tribochemical) activation, administered as a dietary supplement to laboratory mice. The results demonstrate a significantly lower accumulation of Cd in the tissues of the mice that received the supplement. In addition to heavy metals, water is frequently contaminated by various industrial dyes. Due to their high stability and toxicity, these substances pose a serious environmental challenge. In this context, Article No. 2 in the habilitation portfolio demonstrates the potential for near-complete (96%–98%) photocatalytic degradation of methylene blue and crystal violet in water under UV light. To achieve this, ETS-10 titanosilicate was synthesized via a hydrothermal method and partially substituted with varying weight percentages of Zr. The study further characterizes its kinetic parameters and stability. Beyond water purification, modified mineral materials can also be utilized as antimicrobial coatings. Publication No. 3 explores this application by employing natural clinoptilolite modified with Ag^{+} and Cu^{2+} ions, which is incorporated into a geopolymer matrix of a specific viscosity. The resulting composite material exhibits proven antimicrobial activity and can be used as a coating for various surfaces, including concrete, ceramics, steel, and drywall. The research studies mentioned above establish Assistant Professor, PhD Liliya Tsvetanova as an accomplished specialist in the field of hydrothermal synthesis. She possesses a high level of proficiency in powder X-ray diffraction utilized for qualitative and quantitative phase analysis, as well as in X-ray fluorescence analysis, employed to determine the elemental composition of both starting and modified compounds. Furthermore, she demonstrates a thorough understanding of the mechanisms involved in ion exchange within modified natural and synthetic materials, along with the ability to provide detailed interpretations of the resulting data.

A very detailed overview regarding Criterion G is also presented, outlining the specific contributions of Assistant Professor, PhD Liliya Tsvetanova to the 17 publications listed (excluding her original contributions mentioned so far). The publications themselves demonstrate that the candidate′s contributions relate to the preparation, modification, and application of natural and synthetic zeolite materials, as well as their characterization specifically through powder X-ray diffraction and X-ray fluorescence analysis and the execution of ion-exchange processes and the subsequent data analysis. In the candidate′s own summary, these articles are categorized into three groups based on their primary focus. The first group, titled "Investigation of the Sorption, Catalytic, and Biological Properties of Natural and Synthetic Materials," comprises 6 publications. They largely represent a continuation of the research presented in her habilitation thesis. A methodology was developed for modifying Na-X zeolite via impregnation or ion exchange with Mn, Cu, and Ag. It was demonstrated that the type, chemical form, and distribution of the active component are critical

factors for catalytic activity in ozone decomposition reactions. As expected, the modified forms exhibit higher activity compared to the starting material. Furthermore, with a view toward biomedical applications, a geochemical characterization was conducted for zeolite deposits at four locations: Beli Plast, Golobradovo, Most, and Beliya Bair. Specific geochemical features have been identified, characterized by a depletion in transition and rare-earth elements, and an enrichment in Be, S, Ag, In, Sn, Sb, Tl, Bi, and Pb relative to the upper continental crust. The Beli Plast and Most deposits have been determined to be the most suitable for medical applications in accordance with current standards. A series of Zr-modified ETS photocatalysts has been synthesized for the photocatalytic degradation of organic dyes. The use of a composite consisting of modified ETS-4 and ETS-10 titanosilicates enhances photocatalytic activity in the degradation of crystal violet and methylene blue. Cu-modified forms of natural Clinoptilolite have been produced, featuring a controlled transformation of copper states, ranging from ion-exchange Cu^{2+} centers to $Cu(OH)_2$ and CuO. This modification ensures high photocatalytic efficiency in the degradation of the dye Congo Red.

Publications within the next Area "Characterization and Utilization of Natural and Technogenic Raw Materials for the Production of Geopolymer, Ceramic, and Cementitious Materials," comprise a total of six articles. A primary focus of this research is the utilization of natural and technogenic raw materials to produce functional materials. Natural raw materials employed include loess and apatite derived from phosphorite deposits, while technogenic raw materials include cement kiln dust, sunflower husks, and metallurgical slags. The method for modifying the starting materials is determined by their chemical and mineralogical composition, the processes in which they will be involved, and the desired characteristics of the final product. Following this approach, the articles demonstrate that powdered waste from electrical and electronic equipment can serve as an active precursor (containing Si, Al, and Ca) for the synthesis of geopolymer materials, rather than merely functioning as an inert filler. Through solid-state sintering of natural loess from the Danubian Plain (with the addition of MgO and Na_2O) at 1100–1200 °C, porous augite-based ceramics with a controlled phase composition were produced. The potential for CO_2 capture using cement kiln dust was also investigated. It was found that even non-hydrated cement dust can form a stable chemical bond with carbon dioxide through carbonation, resulting in the formation of Calcite and Vaterite. In addition, an elemental and phase analysis of cement dust from three Bulgarian plants was conducted, taking into account the influence of raw materials and technological constraints (high levels of K_2O and Cl). Sustainable binder materials based on ladle furnace slag were developed, utilizing ash from sunflower husks as a dry alkaline activator. Mechanochemical treatment (grinding) of natural phosphorites from

Estonia significantly enhances their chemical reactivity and solubility, enabling their use as effective mineral fertilizers.

Research under the last Area "Mineralogical, Crystal Chemistry, and Analytical Studies," is presented in a total of five articles. These papers focus on elucidating mineralogical phase and chemical composition, crystal structure, phase transformations, and the conditions under which mineral associations form. Attention is also given to the assessment of natural raw materials with technological significance. For instance, regarding formation conditions, the study characterizes the distribution of minor and trace elements within Pyrite and Marcasite from the Sarnak deposit, utilizing SEM-EDX and LA-ICP-MS spectroscopy. The research confirms that elements such as Au and Ag occur in various forms: as solid solutions, nanoparticles, or mineral inclusions. These findings contribute to a better understanding of the geochemical conditions and ore-forming mechanisms within the deposit. Furthermore, Epsomite, Pickeringite, and Alunogen have been identified at a new locality within the Lozen ore field. Reversible phase transformations between these minerals were observed in response to cyclic humidity fluctuations. The study clarifies the crystal-chemical relationships and proposes a mechanism for the formation of this secondary sulfate mineralization. Additionally, a detailed structural analysis was conducted on Serpierite samples from Zvezdel (Bulgaria) and the type locality of Lavrion (Greece), marking the first recorded occurrence of this mineral in Bulgaria. A new polytypic variant, Serpierite-1M, has been identified, expanding the understanding of the structural diversity of copper sulfate minerals. From a methodological perspective, a study was conducted on Bulgarian marls and Mg-rich raw materials as potential raw material for the production of "yellow paving brick" (yellow paver) type ceramics. Using XRF and PXRD, the composition and evaluation criteria for the raw materials were determined. Marls from Popovo and Tanyova Mogila showed the greatest similarity to the original Hungarian raw material. The potential of Mg-rich materials to serve as corrective additives was established, as was the application of XRF and PXRD as reliable methods for the selection and optimization of raw materials. Through comprehensive phase and chemical characterization, it was demonstrated that Au and Ag can be simultaneously recovered from dithiosulfate solutions using a microbial fuel cell operating in short circuit mode, achieving an efficiency of 96.7 ± 3.3% without the need for an external power supply. The deposition of the noble metals in their zero-oxidation state (Au and Ag) onto a graphitized carbon cathode was observed. The phase and chemical composition of the bimetallic deposits were confirmed. These deposits exhibit higher electrocatalytic activity for hydrogen evolution compared to single metal Au or Ag deposits.

An analysis of the documents submitted for the competition for the academic position of "Associate Professor" confirms that Assistant Professor, PhD Liliya Vladimirova

Tsvetanova meets all national minimum requirements as stipulated by the Law on the Development of the Academic Staff in the Republic of Bulgaria and its Regulations for Application. Furthermore, she fulfills the minimum requirements set forth in the Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and Occupying Academic Positions at the Bulgarian Academy of Sciences, as well as the specific requirements of the Regulations on the Conditions and Procedure for Acquiring Scientific Degrees and Occupying Academic Positions at the Institute of Mineralogy and Crystallography, Bulgarian Academy of Sciences. The candidate's summary of her original scientific contributions, along with the details regarding her specific role in the cited publications, have been prepared accurately and correspond to the research conducted and presented in those works. The scientific results achieved to date establish Assistant Professor, PhD Liliya Vladimirova Tsvetanova as an experienced specialist in the fields of experimental mineralogy, X-ray structural analysis, and X-ray fluorescence analysis. Consequently, I am fully convinced in recommending that the Scientific Jury submit a positive report to the Scientific Council of the Institute of Mineralogy and Crystallography, Bulgarian Academy of Sciences, proposing that Chief Assistant Professor, PhD Liliya Vladimirova Tsvetanova be appointed as an ASSOCIATE PROFESSOR in the professional field of "Earth Sciences" (Mineralogy and Crystallography), specifically to support the thematic area of "Experimental Mineralogy and Crystallography."

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Reviewer :
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