Brief information about the project

Title	AP25796583 «Development of Methods for Quantitative Analysis of Biogenic and Anthropogenic Pollutants in the Environment and Identification of Their Sources».
Relevance	In Kazakhstan, widely adopted methods for monitoring biogenic volatile organic compounds (BVOCs) and inorganic pollutants, such as heavy metals, in environmental matrices (water, soil, air) are lacking. This project proposes an innovative approach that combines dynamic headspace sampling (DHS) for the analysis of BVOCs with inductively coupled plasma optical emission spectrometry (ICP-OES) for the detection of inorganic contaminants. The developed method enables high-throughput screening of samples without the need for routine and labor-intensive sample preparation, thereby reducing both analysis time and operational costs. Unlike conventional laboratory-based techniques, the proposed solution offers rapid and accurate analysis under field conditions. This will open new opportunities for real-time environmental monitoring and the development of effective environmental strategies, which is particularly relevant for Kazakhstan.
Goal	The aim of the project is to develop analytical methods for the determination of biogenic volatile organic compounds (BVOCs) and inorganic elements in environmental samples based on dynamic headspace sampling onto sorbent tubes (DHS), gas chromatography coupled with mass spectrometric detection (GC-MS), and inductively coupled plasma optical emission spectrometry (ICP-OES).
Tasks	The aim of the project is to develop analytical methods for the determination of biogenic volatile organic compounds (BVOCs) and inorganic elements in environmental samples based on dynamic headspace sampling onto sorbent tubes (DHS), gas chromatography coupled with mass spectrometric detection (GC-MS), and inductively coupled plasma optical emission spectrometry (ICP-OES). **The project includes the following objectives:** 1. **Development of a method for analyzing biogenic volatile organic compounds (BVOCs) in water, soil, and air using dynamic headspace sampling and gas chromatography–mass spectrometry (DHS-GC/MS).** To establish accurate and reproducible methods, experiments will be conducted on sample preparation and analysis of volatile organic compounds (VOCs) using a DHS-GC/MS system. Key sampling parameters such as sample volume, gas flow rate, sorbent tube temperature, and desorption volume will be optimized. Method optimization for the detection of target compounds such as 2-pentanone, dibromomethane, α-pinene, Δ3-carene, and nonanal will ensure high sensitivity and analytical accuracy, thereby improving

	the effectiveness of BVOC detection under real-world conditions. The optimized method will then be applied to environmental samples in the next project stage. 2. **Development of a method for analyzing heavy metals in environmental samples using inductively coupled plasma optical emission spectrometry (ICP-OES).** The second objective of the project is to develop a method for the detection and quantitative analysis of inorganic pollutants, including heavy metals, using ICP-OES. Calibration parameters as well as sample collection and preparation conditions will be optimized to achieve high sensitivity in elemental analysis, enabling accurate quantification of metals in water, soil, and air samples. 3. **Validation of the developed methods using real environmental samples.** Field validation of the optimized DHS and ICP-OES methods will be performed on environmental water and soil samples from Kazakhstan. A broad spectrum of samples will be collected from various ecosystems, including freshwater and marine environments. The obtained data will be compared to control samples and evaluated based on adjusted accuracy and reproducibility metrics. Validation using real samples will assess the practical applicability of the developed methods in field conditions. The results will also be used to evaluate matrix effects and further refine the analytical protocols. 4. **Assessment of the influence of organic compounds and matrix effects on DHS method accuracy.** To investigate matrix effects, samples with varying concentrations of dissolved organic carbon (DOC) and sea salts will be analyzed to determine their impact on the accuracy and reproducibility of DHS-based measurements. This objective will help account for matrix-related interferences in the detection of BVOCs and minimize errors when working with diverse sample types. The results will be used to further adjust the method and improve DHS accuracy. These objectives ensure a comprehensive approach to developing analytical methods for both biogenic and anthropogenic pollutants in various environmental matrices, enabling the determination of their concentrations and potential sources of contamination.
Expected and Achieved Results	As part of the project, two articles will be published in peer-reviewed international scientific journals indexed in the Web of Science (Q1–Q3) or with a CiteScore percentile of at least 50 in the Scopus database. Target journals for submission include *Microchemical Journal*, *Analytica Chimica Acta*, among others. Each publication will acknowledge this grant as the source of funding. The project results will be disseminated among potential users, the scientific community, and the general public through journal publications, participation in international conferences, and outreach via social media, scientific platforms, and science communication resources.

	The primary end-users of the results include researchers in the fields of analytical chemistry, environmental science, and ecology, as well as international scientific communities. The outcomes will contribute to strengthening scientific collaboration between Kazakhstan and the global research community. In addition, the results will be valuable for governmental environmental protection agencies and the residents of Almaty.
Names and Surnames of Research Group Members with Their Identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and Links to Corresponding Profiles	**Marat Bektasov** Master of Engineering and Technology in the field of Inorganic Chemical Technology PhD Candidate H-index: 3 Scopus ID: 57188593383 ORCID: 0000-0003-2414-6912 Web of Science ResearcherID: AAC-4656-2022
Publications list with links to them	Orazbayeva D., Muratuly A., Bektassov M., Zhakupbekova A., Kenessov B., (2022). Chromatographic determination of pesticides in soil: Current trends in analysis and sample preparation. Trends in Environmental Analytical Chemistry, Volume 35, (Q1, индекс цитирования: 47)., https://doi.org/10.1016/j.teac.2022.e00174. Orazbayeva, D., Kenessov, B., Psillakis, E., Nassyrova, D., & Bektassov, M. (2018). Determination of transformation products of unsymmetrical dimethylhydrazine in water using vacuum-assisted headspace solid-phase microextraction. Journal of Chromatography A, 1555, 30–36. (Q1, индекс цитирования: 250) https://doi.org/10.1016/j.chroma.2018.04.048 Baimatova, N., Kenessov, B., Koziel, J. A., Carlsen, L., Bektassov, M., & Demyanenko, O. P. (2016). Simple and accurate quantification of BTEX in ambient air by SPME and GC–MS. *Talanta*, *154*, 46–52. (Q1, индекс цитирования: 185) https://doi.org/10.1016/j.talanta.2016.03.050
Patent information	-