Brief information about the project

Name of the project	BR18574219 «Development of environmentally safe technologies for obtaining innovative products from natural and man-made raw materials of Kazakhstan»
Relevance	Kazakhstan has significant reserves of rare metals but does not have enterprises of rare metal raw materials itself. In Soviet times, several rare metals were produced at enterprises of non-ferrous metallurgy of Kazakhstan. The revival of the rare metal industry should be the engine of the mining and processing industry. Involvement of deposits of rare metals together with industrial products and wastes of a few industries in industrial processing will be a breakthrough direction in the technological development of Kazakhstan. As is known, modern technologies, on which the innovative economy is based, are based on the high quality of products, energy and material saving, and environmental safety of processes. Supercritical fluid technologies (SCFT), which are based on simple reagents such as carbon dioxide, water, etc., are multi-tonnage productions that cover many industries. Every year several million tons of plant raw materials in the world are processed using CO_2. It is CO_2 that has found greater use as extractants in SCFE-processes due to its inertness, non-toxicity and cheapness. The target Program "Green technologies based on supercritical media" was successfully implemented at the CPCMRA from 2018 to 2020. The present project of the Program is its development and provides for the integrated processing of raw materials, semi-products and man-made waste containing valuable components by the SCFT method; development of environmentally safe technologies for obtaining metals and special purpose alloys.
Purpose	Integrated processing of raw materials, semi-products and man-made waste containing valuable components using supercritical technologies (SCFT). Development of environmentally safe technologies of production of metals and alloys for special purposes.
Objectives	- to develop and certify in the state bodies the new methods of analysis of rare and rare-earth metals and their impurities; - Develop scientific bases of technology for producing concentrates of rare-earth metals; - to develop technologies of by-product extraction of rare elements from stock solutions of technological cycle of mining enterprises of NAC KazAtomProm JSC; - to obtain individual metals from collective extracts of REM, extracted from man-made waste and natural raw materials by SCFE method; - to develop technologies for obtaining extra pure Hg, Zn, Cu, In; - to create the technology of obtaining precision titanium alloys with ultrafine grain structure using rare and rare-earth metals; - Develop a universal high-efficiency flow-through reactor with an original catalyst to produce biodiesel fuel.
Expected and achieved results	As a result of the Program implementation the following results will be achieved, specified in Terms of Reference No.26 to the tender: - new methods of analysis of rare and rare-earth metals and their impurities have been developed and certified in state bodies; - The SCF technology for the integrated processing of natural (the Kundybai deposit) and anthropogenic (phosphogypsum dumps of Kazphosphate LLP) raw materials with the extraction of a number of rare and rare-earth metals was developed;

	- the technology for associated extraction of rare elements from stock solutions of the technological cycle of mining enterprises of NAC KazAtomProm JSC was developed; - methods of obtaining especially pure Hg, Zn, Cu, In were created; - technologies for obtaining precision ultra-fine-grained titanium alloys with the use of some rare and rare-earth metals were developed; - A universal high-efficiency flow-through reactor with an original catalyst for producing biodiesel has been developed; - published at least five (5) articles and (or) reviews in peer-reviewed scientific publications in the scientific area of the program, included in 1 (first), 2 (second) or 3 (third) quartiles in the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 50 (fifty); and five (5) articles in editions recommended by the CQAES; - at least 3 applications for patents for utility models and (or) inventions were submitted For 2023, the following results were obtained: 1) Sample preparation and analysis of initial research objects was carried out. 2) Leaching of Kundybay deposit ore depending on the nature and composition of leaching mixture was studied. Supercritical CO2 conversion of PG containing REE was carried out. Optimal conditions of phosphogypsum conversion were determined. 3) Sorption of rhenium from model and process solutions by a number of ion-exchange resins was investigated. The best sorbents (Biolite 200U and SQD 201U) were selected for model solutions, the recovery was 99.96 and 99.76%, respectively. For sorption of rhenium from production solutions the best was Biolite 200U anionite, the recovery rate was 64.57%. Desorption of rhenium by sulfuric acid from Biolite 200U and SQD 201U sorbents allows to recover 84.73% and 80.17% of rhenium, respectively. 4) Methods for analyzing Hg and impurities in solutions were developed. Optimal electrolyte composition and electrolysis parameters for pure Hg extraction were determined. A simulation model of the electrolyzer for obtaining pure Zn and In in COMSOL Multiphysics was developed. 5) Regularities of the process of reduction of copper (II) ions by titanium (III) ions, which are intermediate products of electrode processes in the formation of Cu powders from electrolytes, have been established. It is shown that in the process of reduction of Cu (II) ions in sulfuric acid solutions by titanium (III) ions a copper powder with extraordinary activity is formed. 6) The technical task has been developed and design and engineering work on the manufacture of a universal high-efficiency flow reactor with the original catalyst has been carried out. 7) 3 patents for utility model and inventions were obtained. 3 articles have been published in a domestic or foreign scientific publication recommended by Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan
Research team members with their identifiers (Scopus Author ID, Researcher	1. Nauryzbayev Mikhail Kasymovich, Doctor of Technical Sciences, Professor, Academician of KazNANS. Hirsch Index - 9 (Scopus). Web of Science Researcher ID - D-3432-2012 https://www.webofscience.com/wos/author/record/180447,1093398,27160849 ORCID: 0000-0002-6781-6464 https://orcid.org/0000-0002-6781-6464 Scopus ID: 6506602038 https://www.scopus.com/authid/detail.uri?authorId=6506602038

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	https://orcid.org/0000-0003-2265-2125 ResearcherID Web of Science: DTW-0858-2022 https://www.webofscience.com/wos/author/record/14961260 33. Alimzhanova Aliya Margulanovna, PhD, RSE NC CPMC RK Hirsch Index - 2 (Scopus). Author ID in Scopus - 57190441009 https://www.scopus.com/authid/detail.uri?authorId=57190441009 ORCID 0000-0001-6098-7626 https://orcid.org/0000-0001-6098-7626 ResearcherID Web of Science: FYU-2530-2022 https://www.webofscience.com/wos/author/record/28712923 34. Mukhametzhanova Anar Amankeldykizy, RSE NC CPMC RK Hirsch Index - 1 (WoS). ResearcherID Web of Science: HJT-0790-2023 https://www.webofscience.com/wos/author/record/37561006 35. Sakhova Banu Tileubergenovna, Master's degree, RSE NC CPMC RK 36. Kali Aynur Azimkhankyzy, Master, RSE NC CPMC RK 37. Baeshov Abduali Baeshovich, Doctor of chemical sciences, Professor, JSC "Institute of fuel, catalysis and electrochemistry named after D.V.Sokolsky". D.V.Sokolsky Institute of Fuel, Catalysis and Electrochemistry Hirsch Index - 4 (Scopus). Author ID in Scopus - 55829870400 https://www.scopus.com/authid/detail.uri?authorId=55829870400 ORCID 0000-0003-0745-039X https://orcid.org/0000-0003-0745-039X ResearcherID Web of Science: AHE-8230-2022 https://www.webofscience.com/wos/author/record/3893742,4494879 38. Turlybekova Makpal, JSC "Institute of Fuel, Catalysis and Electrochemistry named after D.V.Sokolsky". D.V. Sokolsky Institute of Fuel, Catalysis and Electrochemistry 39. Fatima Mukhambetzhankyzy Zhumabay, JSC "Sokolsky Institute of Fuel, Catalysis and Electrochemistry". D.V.Sokolsky Institute of Fuel, Catalysis and Electrochemistry Hirsch Index - 1 (WoS). ResearcherID Web of Science: DYB-9119-2022 https://www.webofscience.com/wos/author/record/15969520 40. Toksanbayev Bolatbek Zhakypbekovich, PhD, "Institute of High Technologies" LLP 41. Iskakov Zaken Alisherovich Zaken Alisherovich, Institute of High Technologies LLP 42. Kumarbekova Almira Tursbekovna, Institute of High Technologies LLP 43. Artem Sergeevich Fomenko, Institute of High Technologies LLP 44. Akim Ruslanovich Ergeshev (NITU "MISIS", Moscow, RF) Hirsch Index - 1 (Scopus). Author ID in Scopus - 57219942105 https://www.scopus.com/authid/detail.uri?authorId=57219942105 ORCID 0000-0003-0581-4620 https://orcid.org/0000-0003-0581-4620 ResearcherID Web of Science: AGV-0967-2022 https://www.webofscience.com/wos/author/record/3817212 45. Mazanov Sergey Valerievich, Ph.D., KNITU (Kazan, Russia) Hirsch Index - 4 (Scopus).

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