WNIOSEK
O WSZCZĘCIE POSTĘPOWANIA HABILITACYJNEGO

Załącznik 3

AUTOREFERAT W JĘZYKU ANGIELSKIM

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1. First name and last name

Marcin Stobiński

2. Education

2001	Professional title of a holder of MA degree in the field of the protection of the environment – special subject: environmental chemistry. The MA thesis was developed in the Department of Chemical Technology of the Jagiellonian University. The subject of the thesis: “The attempts at removing lead ions from a ‘copper concentrate’ with the application of xanthogenates” (in Polish). Supervisor: dr Andrzej Kochanowski
2009	A diploma of the completion of graduate studies in the field of Pedagogical Preparation, the Department of the Humanities of the AGH University.
2011	PhD degree in the field of technical sciences, in the field of environmental engineering – special subject: environmental monitoring. The PhD thesis was defended in the Department of Mining Surveying and Environmental Engineering of the AGH University. The title of the PhD thesis: “The evaluation of ecological threat of the contamination of the Tatra National Park with radioactive ^{137}Cs and selected heavy metals” (in Polish). Supervisor: dr hab. Barbara Kubica, prof AGH Reviewers: prof. dr hab. Zbigniew Hubicki, dr hab. inż. Antoni Barbacki, prof. AGH

3. Information about employment in scientific institutions

2001–2003	the Institute of Nuclear Physics – The Department of Nuclear Physicochemistry, the Workroom of Chemistry and Radiochemistry. Position: scientific and technical specialist.
2003–2011	the Institute of Nuclear Physics of the Polish Academy of Sciences – the Department of Nuclear Physicochemistry, the Workroom of Chemistry and Radiochemistry. Position: assistant.
2011–2012	AGH University of Technology in Kraków – the Faculty of Energy and Fuels. The Department of Coal Chemistry and Environmental Sciences. Position: assistant.
2012–present	AGH University of Science and Technology in Kraków – the Faculty of Energy and Fuels. The Department of Coal Chemistry and Environmental Sciences. Position: *adiunkt* (university lecturer).

4. Indication of an accomplishment pursuant to Art. 16 Par. 2 of the Law on Academic Degrees and Title and Degrees and Title in the Arts issued on 14 March (Dz. U. 2016 Item no. 882 as amended in Dz. U. of 2016 Item no. 1311)

4.1. Title of the scientific accomplishment

The distribution of anthropogenic ^{137}Cs and natural radioactive isotopes in the soils of protected areas as an instrument for the development of efficient methods of preventing the spread of contamination in the environment.

4.2. A list of publications which constitute the scientific achievement

1. **M. Stobiński**, F. Jędrzejek, B. Kubica: Preliminary studies on spatial distribution of artificial ^{137}Cs and natural gamma radionuclides in the region of the Ojców National Park (Poland). Nukleonika, 2018, vol. 63, no. 4.

2. **M. Stobiński**, B. Kubica: Chemometric analysis of ^{137}Cs activity and heavy metals distribution in the Tatras' soil. International Journal of Environmental Science and Technology, 2017, vol. 14, no. 6.

3. B. Kubica, **M. Stobiński**, G. Szaciłowski, F. Jędrzejek, K. Szarłowicz: Determination of the concentrations of artificial gamma radionuclide ^{137}Cs in soil samples taken from lake basins in Tatra Mountains (in Polish); Nauka i przemysł – metody spektroskopowe w praktyce, nowe wyzwania i możliwości, praca zbiorowa pod red. Z. Hubickiego. Uniwersytet Marii Curie-Skłodowskiej w Lublinie, Lublin, 2017.

4. B. Kubica, **M, Stobiński**, G. Szaciłowski, K. Szarłowicz: The activity of selected gamma radionuclides in the Tatra National Park. E3S Web of Conferences, 2017, vol. 14, no. 02036.

5. **M. Stobiński**: Interpretation of the environmental changes by means of advanced tools based on data processing (in Polish); Nauka i przemysł – metody spektroskopowe w praktyce, nowe wyzwania i możliwości, t. 2, praca zbiorowa pod red. Z. Hubickiego. Uniwersytet Marii Curie-Skłodowskiej w Lublinie, Lublin, 2014.

6. B. Kubica, K. Szarłowicz, **M. Stobiński**, S. Skiba, W. Reczyński, J. Gołaś: Concentrations of ^{137}Cs and ^{40}K radionuclides and some heavy metals in soil samples from the eastern part of the Main Ridge of the Flysch Carpathians. Journal of Radioanalytical and Nuclear Chemistry, 2014, vol. 299, no. 3.

7. **M. Stobiński**, K. Szarłowicz, W. Reczyński, B. Kubica: The evaluation of ^{137}Cs radioactivities in soils taken from the Babia Góra National Park. Journal of Radioanalytical and Nuclear Chemistry, 2014, t. 299, no. 1.

8. The method of producing a composite sorbent on the basis of NiFN (in Polish). Inventor: B. Kubica, Z. Hubicki, **M. Stobiński**, K. Szarłowicz, M. Bartyzel. Patent description PL 217761, the Patent Office of the Republic of Poland, 2014.

4.3. A description of the scientific purpose of research, the results which were obtained and the possibilities of utilising these results

4.3.1. The purpose of research

The purpose of the research which was conducted was to extend our knowledge about the mechanisms of the translocation of radioactive isotopes in the environment and the development of the method of the remediation of the ^{137}Cs isotope from the soil and aquatic environment.

The focus of the works was associated with soils, for it is in soils that toxic substances are subject to accumulation to a considerable extent. As a component of the natural environment, soils are in contact with the remaining components of the natural world, including above all with precipitation waters and the dust contained in the air. In order to minimise factors associated with human activities, one selected the areas of the National Parks as the area of research, where by the law, human activities are practically reduced to zero. In order to completely identify the paths of transport of caesium and its spread in the environment, it was also in twelve measurement points located in the Tatra National Park that one performed the monitoring of the content of ^{137}Cs in soils, and one also measured the activity of caesium in the atmospheric precipitation. In a parallel manner with research associated with the conditions of the accumulation and the release of radioactive isotopes from soils. I also conducted research in the technical possibilities of the removal of anthropogenic ^{137}Cs from a soil.

4.3.2. Justification of the engagement of research and the area of research

In the 20th century man started utilizing the energy of the atom. This was associated with the carrying out of test nuclear explosions (more than 2000 nuclear bomb tests were conducted), and also with the activity of nuclear power plants. As a result of nuclear weapons tests and the failures in nuclear power plants a number of artificial radioactive isotopes entered the environment, including ^{137}Cs. Human activity was responsible for the presence of artificial radioisotopes in practically all components of the environment. In Poland, the presence of ^{137}Cs is associated with atmospheric precipitation and dry deposition. Currently, in our geographical region, contamination with caesium is the exclusive result of nuclear explosions and the Chernobyl disaster. The disaster in the Japanese Fukishima Daiichi nuclear power plant did not provide substantial activities of the isotope under study to Poland [National Atomic Energy Agency]. Therefore, any current changes in the activity of ^{137}Cs in soils are associated with its accumulation, movement in the environment and the natural decay to inactive ^{137}Ba ($T_{1/2}$^{137}Cs = 30.05 years). In the world, apart from global sources of contamination with radioactive elements, there were many nuclear accidents which caused only local contamination (e.g. in Goiânia or in the Mayak plant).

One may not rule out that in the future, an uncontrolled release of radioactive substances to the environment may occur in Poland. This may be a result of an accident during the transport of nuclear materials (or waste materials), the theft of such materials, the fall of an aircraft or a satellite carrying nuclear materials, and also a potential failure in a nuclear power plant whose construction is planned in Poland. One should mention that even though these accidents seem unlikely to happen, they did happen elsewhere in the world. The development of the conventional energy industry and the general industry also causes the constant enrichment of the environment with natural radionuclides. Long-lived natural radioactive isotopes contained in soils, such as ^{40}K, ^{226}Ra, ^{228}Th in anthropogenic pressure-free areas, are predominantly associated with the mineral content of the matrix from which this soil originated. The variability of the concentration of these substances is associated exclusively with the fluctuations of organic matter. Only sudden events, such as forest fires or floods, and human activity, e.g. fertilisation or the combustion of solid fuels, may influence their concentrations. Therefore, one may assume that for a given type of soil in a given area, these activities should be invariable in time (the half-life of the natural radioactive isotopes which are studied may be completely disregarded, for the half-life of the shortest-lived isotope in this group – ^{226}Ra – is equal to 1599 years, whereas ^{228}Th continually arises from the native ^{232}Th isotope). The identification of such changes may attest the existence of anthropogenic pressure factors in a given area. The content of natural radionuclides in relation with the concentrations of heavy metals enable the establishment of the natural component of these metals in soils. In a land environment the isotopes which are released predominantly enter soils. These isotopes may accumulate in these soils but they may enter (by means of plants) the food chains or they may be washed away to surface waters, which may constitute a threat for humans.

The present research was conducted in soils which were extracted from the areas of six National Parks. National Parks are areas where the human influence upon the environment is minimised on the basis of a specific act of law. The soils in these areas may constitute a point of reference (a "zero point" in a sense) for the soils from other areas, where the extent of the anthropogenic factor may be difficult to establish. Due to the fact that there are extreme restrictions placed on research in protected areas one decided to acquire soil cores only up to the maximum depth of 10 cm, which ensured the minimisation of the influence upon the nature of the parks.

In a parallel manner with research associated with the translocation of ^{137}Cs in the environment I participated in the research associated with the magnetic ion exchange, which could be applied in a situation when the natural defence mechanisms of the environment will become insufficient in the face of the rising contamination with this isotope or when considerable amounts of caesium would be released to the environment. This composite may remove caesium from soils and from an aquatic environment in a selective manner.

4.3.3. The methodology of research

a) Field work

Soil samples were acquired only in places where no human influence was identified. On the basis of permits which were acquired it was possible to move beyond the generally available trails in the National Parks. Therefore, the samples were always acquired in the area which was at the distance of a few dozen or a few hundred meters from trails and paths. By means of a GPS device one established geographical coordinates and the altitude above the sea level of the sampling site and one took a few soil samples from an area which was shaped like a circle with a diameter of one metre. A different procedure was applied for the measurement site in the Ojców National Park, where in the Dolina Sąspowska one acquired samples at a distance of five and ten metres from the central point, moving in four different directions (a total of nine samples was acquired). All samples were acquired by means of a cylindrical (a sharpened tube) with a diameter of 10 cm and a length of 10 cm. The sampler was driven into the soil, and then it was extracted along with the soil core inside. The soil core which was acquired in this manner was then divided (*in situ* or in the laboratory) into three equal layers (the surface layer was indicated by the symbol "a", the middle part – "b", and the deepest part – "c"). In the course of the research which was conducted there were situations in which due to the shallowness of the soil crust there was no last layer.

b) Laboratory work

After the samples were transported to the laboratory, they were dried by me at a temperature up to 60ºC (in some cases 105ºC), then I crumbled and sieved them through an automatic sieve whose sieve eye diameter was 1 mm. A sample which was prepared in such a manner was moved to a polystyrene measurement vessel. The vessel was additionally sealed with a metallised adhesive tape in order to provide insulation – and thus in order to prevent the exhalation of radon (^{222}Rn). Then before the measurement proper one was supposed to wait at least three weeks in order to establish the balance between radium (^{226}Ra) and the products of its decay. In a parallel manner, I determined the content of organic matter in soil samples by performing combustion in porcelain crucibles at a temperature of 600ºC (I determined the loss of mass after combustion) and the bulk density of the soil.

I performed the measurement proper by means of gamma radiation spectrometers equipped with an HPGe-type coaxial detector (relative efficiency 20%), and, since 2015, also a broad energy-type germanium detector (relative efficiency 34%). The detectors were equipped with lead (cast) shields which I designed myself. As the material of the shield, apart from ordinary lead, I also used low-background lead (with a content of ^{210}Pb below 6 Bq/kg) and cadmium and copper metal sheets, which enabled the minimisation of the background for low energies (they shield against secondary Roentgen radiation).

It took at least three days to perform the measurement of a single sample. This enabled the measurement of an average of two samples per week by means of one spectrometer.

An analysis of the spectra which were obtained involved, apart from peaks derived from ^{137}Cs (661.6 keV) and ^{40}K (1460.8 keV) also peaks which enabled the establishment of the activities of such isotopes as ^{210}Pb, ^{241}Am, ^{235}U, ^{226}Ra, ^{238}U, ^{232}Th and ^{228}Th (energies ranging from 46.5 keV for ^{210}Pb to 2614.5 keV for ^{208}Tl).

During a quantitative analysis I made allowances for self-absorption in the sample, which I determined according to a modified description drawn from a publication which I co-authored [Appendix 4, Item J10]. The results of the measurements of the activity of the artificial ^{137}Cs isotope were presented in two units. The first one which is obtained directly from measurements is Bq/kg, the second one is the so-called precipitation and it is expressed in Bq/m^2. The recalculation into this unit required the familiarisation with the total mass of the soil core which was acquired (of the particular layers) and of the surface of the soil which was acquired – which was a result of the diameter of the sampler which was used.

4.3.4. A description of the results which were obtained

As a part of research which were presented in a series of publications one analysed anthropogenic pressure in the soils from the following protected areas [i.e. National Parks]: Babiogórski Park Narodowy, Tatrzański Park Narodowy, Tatranský Národný Park (Slovakia), Flysch Carpathians (the area of the Magurski and Bieszczadzki Park Narodowy) and the Ojcowski Park Narodowy.

In all soils which were studied one identified a diversity of concentrations of both artificial ^{137}Cs and of natural radionuclides. The most intensive activities of ^{137}Cs were identified in soil samples acquired from hollows located at higher elevations in the Polish and Slovak Tatra National Parks [Appendix. 4, Item O2, O3, O4]. In these soils one also determined other metals which may be of anthropogenic origin. The application of advanced methods of data processing facilitated the identification of the mechanism in which ^{137}Cs and some other heavy metals are retained in soils. An analysis of multidimensional data (ones which consist of many variables) is relatively difficult when one applies standard methods. The analysis of the results of research in environmental samples (both soils and bottom sediments) is considerably aided by the application of statistical data, such as the similarity analysis and the analysis of principal components [Appendix 4, item O5]. The application of these methods indicated the anthropogenic origin of not only the radioactive caesium but also of stable lead. These metals are strongly (ab)sorbed in the surface, organic matter-rich layers of soils. One should remark that their concentrations rise also with the rising average annual amount of atmospheric precipitation. At the same time, potassium, and zinc and chromium in the soils which were studied were associated with the mineral fraction of the soil. Their concentrations rose along with the depth and the density of the soil, which indicates that the source of these metals is rather natural (matrix). The monitoring which was conducted in the Tatra National Park indicates the gradual decline of the activity of ^{137}Cs in soils, which is caused by the natural decay of this isotope and the slow migratory processes toward the bottom of the soil profile, whereas one did not identify the provision of new, substantial amounts of caesium to soils.

In the soils which were acquired from the remaining mountain-region National Parks (Park Babiogórski, Magórski and Bieszczadzki) the dependence of the activity of the radionuclides which were studied on the altitude, the content of organic matter and the density of soil were similar. However, due to the fact that the aforementioned mountain regions are considerably lower than the Tatra mountains, the acquired maximum values of the activity of anthropogenic ^{137}Cs were smaller [Appendix 4, Item O6, O7].

The Ojców National Park is one of the parks which were studied and which is not located in a mountain region. In this park, in the Dolina Sąspowska, there is a peculiar microclimate characterised by a considerably greater amount of atmospheric precipitation than in the remaining areas of the park. One managed to confirm that anthropogenic caesium reached the soil along with the precipitation. At the same time the taking into consideration of the topography of the area enabled the author to establish that in the soils which contain organic matter caesium is not transported along with precipitation waters down the valley (to the Sąspówka stream), but it is retained in the soil, which may be applied in reference to the protection of drinking water intakes. The contents of natural isotopes ^{40}K as well as ^{226}Ra and ^{228}Th in the soil samples which were acquired from the Ojców National Park are balanced in all measurement points. This is testimony of the identical geological basis of the soils of this park [Appendix 4, Item O1].

4.3.5. The utilisation of the results of research

The exploration of the mechanisms of the translocation of the anthropogenic ^{137}Cs isotope, of other heavy metals, and also of natural radionuclides in soils which are not subject to direct human influence constitutes substantial knowledge in the case of the releasing of radioactive isotopes to the environment. Organic matter-rich soils strongly bind elements such as caesium and lead, and as such they constitute the protection of underground and surface waters against contamination with these metals. Potassium is competitive in reference to caesium in the process of the retention in the soil, hence the excessive amount of potassium in the soil (caused by e.g. fertilisation) may lead to the remediation of caesium from the soil and to its runoff along with precipitation to surface waters, as a consequence of which it may pose a threat to drinking water intakes.

Although soils have considerable possibilities to retain caesium, these possibilities are not unlimited and in the case of the occurrence of strong anthropogenic pressure natural defensive mechanism of the environment may prove insufficient. Therefore, in parallel with the research in the conditions of the activity of radioactive isotopes in the soils in National Parks, I participated in the research in the synthesis of a composite sorbent on the basis of NiFN with magnetic elements [Appendix 4, Item O8]. The ion-exchange resin which was produced in accordance with the description of the patent is a selective sorbent for caesium. The process of the sorption of caesium (including also of the ^{137}Cs isotope) occurs with very high efficiency in a wet environment. The application of a pure/clean sorbent (nickel hexaferrocyanide dispersed in phenylsulfonic resin), despite very good sorption properties and selectivity toward caesium, did not solve the problem of the removal of the resin itself from the purified surface of the soil. Therefore, at the level of the sorbent one adds to it crumbled magnetite (Fe_3O_4), which confers magnetic properties to the composite. Owing to this, after the crumbling of the composite on the surface of the soil (it has the form of spherical grains whose diameter is about 0.2 mm), after a few hours, when the resin permanently binds caesium cations, it may be scooped by means of an electromagnet or a permanent magnet, thus removing the radioactive caesium from the soil. The efficiency of such a method of the remediation of caesium was more than 95% for a sandy ground, whereas for a soil it was 85%. The purification of soils is not the only possible application of the patented selective magnetic sorbent. It may also be applied in reference to the contaminated bottom sediments in water reservoirs, and also to the purification of natural waters contaminated with caesium.

Another application of the patented sorbent has to do with the determination of the content of radioactive caesium in precipitation waters [Appendix 4, Item O4]. Such a measurement consists in the placement of a few grams of a composite ion exchange in a special vessel through which precipitation waters flow. After a specific period of time elapses (one year), one measures the caesium which was absorbed on it.

5. A description of other scientific and research-related accomplishments

5.1. Scientific and research-related accomplishments before obtaining the PhD degree

After the completion of MA studies in the Department of Chemistry of the Jagiellonian University I became an employee of the Institute of Nuclear Physics, in the Workroom of Chemistry and Radiochemistry. The team in which I worked engaged a subject which was completely new to me – it was associated with radioactive isotopes and their properties. Practically throughout the entire period of my employment in the IFJ (from 2003 – IFJ PAN), until the defence of my MA thesis, I conducted parallel research in two principal areas. The first one is associated with the research in the sorption of metals in various kinds of ion exchange (including also the ferrocyanides of transition metals) [Appendix 4, Item J1, J3, J6, M1, M2]. As a part of this subject matter, I participated in research projects realised in the Joint Institute for Nuclear Research in Dubna (Russia) in 2003–2008 entitled "The Research in the chemical properties of super-heavy elements". This was associated with two research expeditions to the Joint Institute for Nuclear Research (The Laboratory of Nuclear Reactions, in the period of 12-26.11.2004 and 18-28.01.2007). The experiments which were conducted there were devoted to the separation of short-lived Sr and Ba isotopes in the following systems: hardly soluble hexaferrocyanides of divalent transition metals in the environment of the hydrochloric acid or the sulphuric acid. In the same period I managed to acquire an EU scholarship (owing to my participation in a relevant competition) in order to participate in the workshop "Nuclides.net – an integrated environment for computation on Radionuclides and their radiations" in the Kernforschungszentrum, in Karlsruhe (Germany) in the period of 19-21.09.2003. During this workshop I found my way around the environment of the "Nuclides.net" application, which is an advanced piece of software for the calculation of the activity of radionuclides, their mixtures, radiation doses and the parameters of nuclear fuel. The software provides comprehensive information in the field of radiochemistry, physics, radiology and the protection of the environment.

The second subject which was explored in the Laboratory of Chemistry and Radiochemistry was associated with the research in the levels of contamination of various components of the environment with artificial radioactive isotopes and heavy metals. Within the framework of this subject matter one studied above all soils and bottom sediments. Research in bottom sediments is presented *inter alia* in the publications which are listed [Appendix 4, Item J5, M3, M5]. As a part of this research I was an Contractor in the research project of the Komitet Badań Naukowych (KBN) [The Committee of Scientific Research] no. 3T09D 09429 (in 2005–2008) entitled "Badania procesów akumulacji i przemian toksycznych składników w osadach zbiornika wody pitnej dla miasta Krakowa w Dobczycach" ["The research in the processes of the accumulation and transformations of toxic components in the sediments of the drinking water reservoir for the city of Kraków in Dobczyce"] and in the Aquaterra project (conducted as a part of the 6th framework project) entitled "Understanding river-sediment-soil-groundwater interactions for support of management of waterbodies (river basin & catchment areas)" in 2004–2009. Both projects were directed by prof. dr hab. Janusz Gołaś. This research focused on the accumulation of heavy metals (including mercury) and artificial radioactive isotopes in bottom sediments. One also researched the conditions in which toxic substances may be released from a sediment and reach water. This was particularly important in the case of the reservoir in Dobczyce due to the fact that it is the reservoir of drinking water for the city of Kraków.

As a part of research conducted in soils I was an contractor in the research project of the KBN no. 6P04G 06323 (in 2002–2005) entiled "Badanie poziomu i przestrzennego rozkładu zanieczyszczeń radionuklidami i pierwiastkami ciężkimi w ekosystemie Tatrzańskiego Parku Narodowego" ["The research in the level and the spatial distribution of contamination with radionuclides and heavy elements in the ecosystem of the Tatra National Park"] and in the project financed by the National Science Centre (NCN) no N305 01 131 (in 2006–2009), which is a continuation of previous research ("Badanie poziomu i przestrzennego rozkładu zanieczyszczeń radionuklidami i pierwiastkami ciężkimi w ekosystemie Tatrzańskiego Parku Narodowego" – kontynuacja). Moreover, I was the principal contractor in the project realised in 2005–2006 in the Wojewódzki Fundusz Ochrony Środowiska [The Voivodeship Environment Protection Fund] for the years 2005–2006 in Kraków "The development of maps with reference to the spatial distribution of radionuclides in the Tatrzański Park Narodowy".

As a part of activities based on the agreement about scientific collaboration between the Polish Academy of Sciences and the Slovak Academy of Sciences (Slovenská Akadémia Vied) I participated in the realisation of two projects: “Badanie poziomu i przestrzennego rozkładu zanieczyszczeń gamma radionuklidami ^{137}Cs (sztucznym) i ^{40}K (naturalnym) ekosystemu Tatr” [The study of the level and the spatial distribution of contamination of the ecosystem of the Tatra mountains with (artificial) gamma radionuclides ^{137}Cs and (natural) ^{40}K”] in 2007–2009 and “Badanie radioaktywności radioizotopów ^{238}U, ^{226}Ra, ^{210}Pb, ^{210}Po i sztucznego ^{137}Cs oraz stężeń Zn, As, Cd i Pb w próbkach gleb pobranych w nieckach stawów tatrzańskich, a także w osadach dennych pobranych z wybranych stawów tatrzańskich” [“The research in the radioactivity of ^{238}U, ^{226}Ra, ^{210}Pb, ^{210}Po radioisotopes and of artificial ^{137}Cs and the concentrations of Zn, As, Cd and Pb in soil samples collected in basins of Tatra lakes, and in bottom sediments acquired from selected Tatra lakes”] in 2010–2011. The partial result of work in these projects was associated with my PhD thesis, which I defended in 2011. Simultaneously, in 2008, due to close scientific collaboration with the Department of Coal Chemistry and Environmental Sciences of the AGH, I was presented with a team award of the President of the AGH University of Science and Technology of the 3rd degree as a token of recognition of my scientific achievements.

Right before I defended by PhD thesis a work was published [Appendix 4, Item J10], which describes the proposition of a new method of determining allowances for self-absorption in gamma radiation spectrometry. This method was an experimental one, consisting in the determination of coefficients of transmission for a broad range of the energy of gamma radiation. In order to acquire new skills and knowledge associated with spectrometry with the application of detectors with high-purity germanium (HPGe) I departed in order to participate in a one-month scientific internship (7.02–11.03.2011 r.) to the Department of Radiochemistry and the Chemistry of Colloids at the Maria Curie-Skłodowska University in Lublin, where I learnt the methods of the optimisation of gamma spectrometry measurements and various methods of determining efficiency-related calibration.

5.2. Scientific and research-related accomplishments after obtaining the PhD degree

After I acquired the degree of a doctor of technical sciences in the field of environmental engineering I completely changed my scientific and research-related environment. I became an employee of the AGH University of Science and Technology in the Department of Coal Chemistry and Environmental Sciences. The change of the environment resulted in the diminished access to modern measurement apparatuses, due to which the first years of work were associated above all with the organisation of a new laboratory and the purchase of modern spectrometers. These spectrometers enabled precise measurements also of isotopes other than ^{137}Cs and ^{40}K. However, this necessitated the introduction of certain modifications to the approach to the measurements. I developed a method of determining efficiency-related coefficients and allowances for self-absorption for completely new (heretofore unused) measurement geometries, which correspond to the volumes/capacities: 67 cm^3 and 27 cm^3. In order to be able to determine such natural isotopes as ^{226}Ra, ^{228}Th, ^{210}Pb, ^{225}U and additionally the artificial ^{241}Am in a precise manner, I had to design the shields of detectors which efficiently minimised the natural ambience/background and the secondary Roentgen radiation in reference to the energy lines of the isotopes which were determined. I designed these shields in such a way so that their internal layer was cast in the form of circles of low-background lead (lead which was much depleted in reference to ^{210}Pb, but which unfortunately is many times more expensive than ordinary lead), whereas the external layer was made of relatively cheap, ordinary lead. The problem which I faced was associated with the fact that I had to choose the particular heights and thicknesses of the shields in such a way as to maximise the shield effect, and at the same time to avoid over-elaboration of the shields (due to the durability of the ceiling). For the internal part of the shield I applied cadmium and copper metal sheets, which enabled the elimination of Roentgen radiation in terms of low energies.

In the years which followed, due to the necessity of determining radioactive isotopes in samples of sediments whose mass was much lesser than the weight of soil samples (and, which follows, which were of lesser volume), I developed efficiency-related calibration for measurements in new geometries of the volumes of 1.5 cm^3 and 2.8 cm^3, whereas for these geometries the duration of the measurement had to be considerably greater than the duration that I applied in a standard manner – 259 200 seconds (3 x 24 hours). The most important publications with the application of new measurement-related geometries and low-background shields are listed in Appendix 4 [Appendix 4, Item O1, O6, O7, J12].

At the same time I was the main contractor in a project financed by the Ministry of Science and Higher Education (NCN 1070/B/P01/2011/40) entitled "Badanie poziomu i przestrzennego rozkładu zanieczyszczeń niektórymi radionuklidami i pierwiastkami ciężkimi w ekosystemie Głównego Grzbietu Karpat Fliszowych na obszarze Polski" ["The research in the level and the spatial distribution of contamination with certain radionuclides and heavy elements in the ecosystem of the Main Ridge of Fliess Carpathians in Poland"], which was realised in the period 2011–2014. Due to the realisation of this project one managed to determine the content of both artificial and natural radionuclides and selected heavy metals in the Magurski and Bieszczadzki Park Narodowy. These instances of research confirmed the increased accumulation of ^{137}Cs and of lead in organic matter-rich soils, acquired at high elevations in mountain regions, and, what follows, in soils which feature greater average annual amount of atmospheric precipitation. For zinc and copper one did not establish such a dependence, which indicates rather a natural character of the elements which were studied, i.e. that these elements originate from a matrix [Appendix 4, Item O6, M19, M20].

I also conducted research in energy carbons and waste products from conventional (coal-fired) power plants. As a result of research, I established that almost the entire activity of such isotopes as ^{238}U, ^{228}Th, ^{226}Ra or ^{40}K after combustion remains in the solid products of combustion, i.e. in clinker and in dust from electrofilters and bag filters. Only ^{210}Pb (total lead contained in coals), probably due to its volatility, manifests relatively lesser concentration in solid waste materials than the expected value (resulting from its content in coal). Therefore, I could draw the conclusion that the lead contained in energy coals, and also its radioactive isotope ^{210}Pb (whose half-life is more than 20 years), enters the environment from coal power plants along with the gaseous products of combustion [Appendix 4, Item M24]. This is quite an important fact, particularly so because the toxicity of lead is commonly known. Although the ^{210}Pb isotope does not belong to the group of dangerous isotopes (it emits gamma radiation of low energy – 46.5 keV), but as a result of its beta decay (and the successive beta decay of the derivative ^{210}Bi) there arises a very dangerous and toxic alfa radioactive ^{210}Po isotope. Therefore, in an indirect way, the lack of efficient purification of exhaust gases/flue gases in coal-fired power plants influences the increase of the content of ^{210}Po in the environment. After I established that there are dangerous contaminants in coals combusted in Poland, I decided to examine the content of radioactive isotopes also in waste materials which are produced by hard coal mines. Waste material such as residues/silt and sediments derived from water tanks and sedimentation tanks. My research which was conducted in waste materials acquired from two hard coal mines located in the Upper Silesian Coal Field District demonstrated that the waste materials which were studied feature varied content of radioactive isotopes and that they are many times greater than the activity of these isotopes in the coals which are extracted. By making reference to coefficients f1 and f2 (which refer to the Polish Norm associated with building materials), some of the waste materials which were studied are not even appropriate for use in construction. One should remember that these waste materials contain a relatively great amount of coal and therefore they are sometimes used as the cheapest fuel in home hearths. The combustion is such heaths (which are deprived of any elements which depulverise or purify exhaust gases) may lead to a great emission of radionuclides to the atmosphere [Appendix 4, Item M27].

In 2011–2014 I was a contractor in two projects associated with the processing of hard coal. This was the Innovative Project – KIC (Knowledge and Innovation Community) CoalGas entitled “Development of Coal Gasification Technology for High Efficiency Fuel and Power Production” (total budget: 4 350 000 EUR) and a project financed by NCN – “Analiza możliwości ograniczenia emisji rtęci z procesów energetycznego przetwórstwa węgla [An analysis of the possibility of limiting the emission of mercury from the processes of energy processing of coal] (no. 4521/B/P01/2011/40)”. Both projects were directed by prof. dr hab. Janusz Gołaś. Currently I conduct research in a quick and precise method of determining the levels of the radioactivity of natural and artificial radionuclides in waters derived from rivers and lakes.

6. A summary of the accomplishments and the output

6.1. Scientific and research-related activities

Articles in periodicals indexed in JCR (without articles listed in Par. 4 which constitute the scientific accomplishment)	12
Other articles and chapters in monographs	28
Papers presented at conferences and conference abstracts	60
Total IF (without articles listed in Par. 4 which constitute the scientific accomplishment)	8,189
Total points according to MNiSW	346
Hirsch index	7
Citations (all) according WoS (as of 15 January 2019)	79
Citations (without instances of self-citation) according to WoS (as of 15 January 2019)	58
Citations according Scopus (as of 15 January 2019)	97
Contractor in domestic research projects	6
Contractor in international research projects	3
Contractor in projects conducted as a part of statutory activities	7

6.2. Teaching-, popularisation- and organisation-related activities

My teaching-related activity began in 2008, when I took up additional employment in the Zespół Szkół Ogólnokształcących Społecznego Towarzystwa Oświatowego (STO). Initially I taught in a *gimnazjum*, and then in a secondary school. Currently I prepare pupils for the secondary school-leaving exam (*matura*) in the field of chemistry (extended level). I am also responsible for the subject known as *przyroda* (nature). In 2015, after an almost two-year tenure, I passed an exam and was granted the qualifications of a certified teacher. I am the co-author of a four-volume work and a coach in the programme known as Interblok [Appendix 4, Par. III G 1]. The Interblok programme was co-financed by the European Union within the Framework of the European Social Fund (the years 2012–2013). The work which was developed in this project constitutes in fact a three-year curriculum of technical and laboratory-related activities, during which students independently perform various experiments and projects, combining knowledge drawn from such subjects as mathematics, physics, biology, geography and chemistry. I was commissioned by one of the publishers to develop a collection of 250 chemistry problems for *gimnazjum* pupils along with answer keys, hints, graphical elements and films which present chemical experiments [Appendix 4, Par. III G 2].

My work at school was of great relevance when I began employment at the AGH University of Science and Technology. As an active and greatly experienced teacher I transitioned smoothly to the procedures associated with teaching students. On the basis of student surveys I may infer that the student community holds my classes in high estimation. I received two team-based awards of the President of the AGH for pedagogical achievements: a second degree prize in 2014 and a first degree prize in 2017. I organised classes, workshops and visits to the laboratories of the AGH and the Center of Energy AGH for pupils and teachers from the schools of the Małopolska region. I also participated in the activities of the team which developed a new major in MA studies of the second degree – Industrial and environmental analytics. In reference to this major, I am responsible for the subject known as the Evaluation and the quality control of analytical results – I deliver lectures and hold practical classes in this field. I also co-authored syllabi for such subjects as: Radiochemistry, Nuclear chemistry with radiochemistry, Radioactivity in the environment, Elements of the chemistry of the environment and The protection of the environment in chemical technology. Due to the fact that in the majority of cases these were completely new subjects, I had to develop and prepare the following: laboratory classes (work stations and instructions), the curricula of practical classes and seminars. In the course of the last six years I was the supervisor of five MA theses and more than twenty engineer's theses.

Beginning from the 2011/12 academic year, at the request of the directors of The College of the In-Service Enhancement of Pedagogical Skills for the Employees and PhD Students of the AGH I inspect the classes of the participants of the course in in-service enhancement of pedagogical skills.

As a part of the organisation-related activities I co-organised the Fifth Domestic Conference of Radiochemistry and Nuclear Chemistry in 2009, and a member of the organisation committee of the 6th Domestic Conference of Radiochemistry and Nuclear Chemistry in 2013. In 2015–2016 I prepared the documentation for a part of tenders in reference to the purchase of scientific and research-related apparatuses for the Laboratory of the Protection of the Environment and Radiochemistry of the Center of Energy AGH and a gamma spectrometer (HPGe) for the Laboratory of Chemical Analyses and Radioactivity in the Environment. I was also a member of the tender committee in these tenders.

Stobiński Marcin