

Dariusz Malczewski

AUTOREFERAT

/Curriculum Vitae/

(j. angielski)

Academic Development

1962 Born in Sosnowiec, Poland on 8 September 1962. Due to family moves, I attended elementary school in Bielsko Biala and I attended high school in Sosnowiec in 1972.

1982 Undergraduate study in physics at the Faculty of Mathematics, Physics and Chemistry, University of Silesia. In my third and fourth years at university, I received a scholarship.

1987 Master's thesis on "Conditions of forming positronium in solid state using 0-degree spectrometer" at the Department of Nuclear Physics and Its Applications, University of Silesia, under the supervision of Dr. Wojciech Osoba.

1994 Assistant lecturer at the Department of Nuclear Physics and Its Applications, the Institute of Physics, University of Silesia.

1995 Doctoral studies in the application of Mössbauer spectroscopy to the study of metamict gadolinites. I chose Mössbauer spectroscopy because this technique was rarely employed in studies of the metamict state. Measurements were performed at the Laboratory of the Mössbauer Effect, the Institute of Physics, which was managed by Dr. Eustachy Popiel. This study comprised my PhD thesis, entitled "⁵⁷Fe Mössbauer spectroscopy of the thermally recrystallized, fully metamict gadolinites", which was proposed for a scientific award with distinction. Dissertation supervisor, Prof. Wiktor Zipper.

During my doctoral studies, I cooperated closely with Prof. Janusz Janeczek from the Department of Mineralogy and Petrology, the Faculty of Earth Sciences, University of Silesia. Prof. Janeczek provided gadolinite specimens from Poland and Sweden for my study. At that time, I also learned to identify iron-bearing minerals in rocks using Mössbauer spectroscopy and to determine the levels of naturally occurring radionuclides in minerals using gamma-ray semiconductor detectors.

2000 PhD received in Physics from the Faculty of Mathematics, Physics, and Chemistry, University of Silesia.

2000 Research position at the Department of Applied Geophysics (Prof. Adam Idziak, Department Head), the Faculty of Earth Sciences, University of Silesia. I introduced new scientific issues concerning the application of nuclear methods in the Earth Sciences. I also performed studies that extended the significant findings of my doctoral study. The most important result was the determination of activation

energy for the thermal recrystallization process of fully metamict gadolinite from changes observed in Mössbauer spectra.

2000-2005 Developed and organized the Laboratory of Natural Radioactivity from the ground up.

2005 Head of the Laboratory of Natural Radioactivity at the Department of Applied Geophysics, Faculty of Earth Sciences. The Laboratory was well-equipped with a portable gamma-ray spectrometry system based on a coaxial HPGe Extended Range detector, portable electronic radon detector, scintillation beta and gamma detectors, lead shields, universal alpha, beta, and gamma dosimeter, extensive accessories, and computer software. Under my supervision, the research at the laboratory was mostly focused on nuclear geophysics; i.e., the study and practice of nuclear physics applied to geology.

Scientific Achievements

2005-2008 I supervised a large-scale study of the metamict state (over 30 metamict minerals) entitled: "The metamict state characterized with spectroscopic methods. Implications for stabilization of high-level nuclear waste". The study was supported by the State Committee for Scientific Research (Poland) through a scientific grant. Experimental procedures included Mössbauer spectroscopy; alpha, beta, and gamma-ray spectrometry; X-ray diffraction (XRD); transmission electron microscopy (TEM); scanning electron microscopy with an energy dispersive X-ray spectrometry (SEM-EDS); dielectric permittivity spectroscopy; and infrared spectroscopy. To realize this project, I collaborated with colleagues from the Institute of Electronic Materials Technology, Warsaw; the Institute of Physics, University of Silesia; the Institute of Materials Sciences, University of Silesia; and, in my parent Faculty, with the Department of Geochemistry, Mineralogy and Petrology. During the project, I also consulted with geologists from US Geological Survey (Ken Dixon, Rachel Dolbier, Nelia Dunbar, Michael Easton, Larry Garside, Dave Noe, Steve Shank and Scott Southworth); Michael Easton from the Geological Survey of Canada, Jenny Bevan from the University of Western Australia, Igor Pekov from Moscow University, Sten-Anders Smeds from Uppsala University and Nina Flagler Hall from the Mössbauer Effect Data Center, the University of North Carolina. The most important published achievements are:

(1) D. Malczewski

"Metamict state. Implication for stabilization and immobilization of nuclear high-level waste (HLW)"

**Publications of the Institute of Geophysics Polish Academy of Sciences (2002)
Monographic Volume M-24 (340); 397- 404.**

(2) D. Malczewski, J. Janeczek

"Activation energy of annealed metamict gadolinite from ^{57}Fe Mössbauer Spectroscopy"

Physics and Chemistry of Minerals (2002) 29; 226 – 232.

(3) D. Malczewski

"Structural analysis of radiation damage in Precambrian gadolinite from Ytterby by ^{57}Fe Mössbauer spectroscopy, transmission electron microscopy and X-ray diffraction"

Materials Science and Engineering A (2004) 375-377; 1259-1262.

(4) D. Malczewski, JE. Frąckowiak, EV. Galuskin

" ^{57}Fe Mössbauer spectroscopy and X-ray diffraction study of some complex metamict minerals"

Hyperfine Interactions (2005) 166; 529-536.

(5) D. Malczewski, JE. Frąckowiak, EV. Galuskin

" ^{57}Fe Mössbauer spectroscopy of annealed metamict davidite"

Nukleonika (2007) 52; 81-84.

(6) D. Malczewski, A. Grabias

" ^{57}Fe Mössbauer spectroscopy and X-ray diffraction study of complex metamict minerals. Part II"

Hyperfine Interactions (2008) 186; 75-81.

(7) D. Malczewski, A. Grabias

" ^{57}Fe Mössbauer spectroscopy of radiation damaged allanites"

Acta Physica Polonica A (2008) 114; 1683-1690.

(8) D. Malczewski,

"Recrystallization in fully metamict gadolinite from Ytterby (Sweden) annealed in air studied by ^{57}Fe Mössbauer spectroscopy"

American Mineralogist (2010) 95; 463-471.

(9) D. Malczewski, A. Molak

"Electrical properties of annealed, fully metamict $\text{REE}_2\text{Fe}^{2+}\text{Be}_2\text{Si}_2\text{O}_{10}$ "

Journal of Nuclear Materials (2011) 412; 239-249.

Description of the Scientific Achievements

Metamict minerals contain uranium and thorium, which cause their crystal structures to degrade over geologic time. The degradation occurs primarily through progressive, overlapping, recoil nuclei collision cascades from the α -decays of ^{238}U , ^{232}Th , ^{235}U and their daughter products. In many cases, the metamictization process may be reversible under high-temperature annealing in an inert atmosphere. Due to the natural occurrence of U and Th, they serve as natural analogues for the radiation effects of high-level nuclear waste over a geological time scale $\sim 10^9$ years **(1)**. The most important results were obtained from Mössbauer spectroscopy, gamma-ray spectrometry and X-ray diffraction **(2-8)**. To the best of my knowledge, this was the first time that Mössbauer spectra of metamict brannerite, cerite, davidite, perrierite, and samarskite were presented at international conferences and in publications **(2, 4, 5 and 6)**. The Mössbauer spectra of all of the investigated metamict minerals showed features that could only be explained by assuming octahedral coordinations for both Fe^{2+} and Fe^{3+} ions. In other words, the coordination number of the iron ions was the same in the crystalline and metamict states, despite the high absorbed alpha dose that ranged from 10^{15} - 10^{18} alpha-decays per milligram. That result was rather unexpected; it suggested that the main mechanism of the metamictization process involved the rotation and translation of tetrahedra, octahedra and other coordination polyhedra as a whole. In the extensive paper **(9)** the changes in the electrical properties of annealed, fully metamict gadolinite $\text{REEFe}^{2+}\text{Be}_2\text{Si}_2\text{O}_{10}$ as a function of annealing temperature, a previously unstudied phenomenon, were demonstrated. The electrical conductivity measured at $f = 100$ Hz between 110 and 750 K varies markedly, ranging from 10^{-10} to 10^{-6} Sm^{-1} for untreated samples and 10^{-9} to 10^{-3} Sm^{-1} for sample annealed in argon at 1373 K. Average measured activation energies for electrical conduction are 0.47 and 0.63 eV for ranges of 400 - 450 K and 500 - 600 K, respectively. The dielectric permittivity shows strong dispersion effects above 235 K. The combination of polaron hopping and hydroxyl anion migration is proposed for the electrical conduction mechanism. This work was noticed by an interested scientific community and a description of the paper was placed on the website (<http://reginnovations.com/>) of Renewable Energy - Global Innovations. The results obtained may be applicable to the nuclear industry, geophysics, and mineralogy.

A similar study of other metamict phases is currently in the planning stages. Other significant findings of the scientific achievement, including mass and surface radon emanations from the metamict, are presently being interpreted and prepared for publication.

Large-Scale, Collaborative Studies in Radioactivity

2002-2004 During that time, I arranged the first field trips with geology and geophysics students that employed a portable gamma-ray spectrometry system. We performed in situ measurements of the natural radioactivity of rocks and soils in the Karkonosze-Izera Block (SW Poland) and in exposed Upper Paleozoic rocks on the northern border of the Upper Silesian Coal Basin. Based on the results obtained there, the first MSc theses concerning the natural radioactivity of rocks were completed in my Faculty and the publication: D. Malczewski, L. Teper, J. Dorda (2004) "Assessment of natural and anthropogenic radioactivity levels in rocks and soils in the environs of Świeradów Zdrój in Sudetes, Poland, by in situ gamma-ray spectrometry" in the Journal of Environmental Radioactivity.

2004 I formed a collaboration with Prof. Jerzy Żaba to study the natural radioactivity of rocks from the Sudetes. We systematically studied these rocks under both in situ and laboratory conditions. To date, the measurements have included the Izerskie Mountains, the Sowie Mountains, the Kaczawskie Mountains, and the Opawskie Mountains. The purpose of this study was to provide an accurate description of the radioactivity of the Sudetes's rocks and to update earlier data in academic textbooks.

2005 Measured soil gas ^{222}Rn and ^{220}Rn concentrations in the Karkonosze-Izera Block. These surveys were the first direct detections of radon concentrations in the area in over 50 years. The results of the surveys were presented in an extensive article: D. Malczewski, J. Żaba (2006) " ^{222}Rn and ^{220}Rn concentrations in soil gas of Karkonosze-Izera Block (Sudetes, Poland)" published in the Journal of Environmental Radioactivity. The measurements of soil gas radon concentrations in the Karkonosze-Izera Block revealed several patterns. First, the concentrations versus depth profiles of radon differed considerably for soils developed on fault zones, soils developed on bedrock with uranium mineralization, and soil mixtures of

both types. The results may have geophysical applications in fault zone investigations, prospecting for uranium deposits and distinguishing between them.

2006-2009 Membership in the ILIAS/TARI (Integrated Large Infrastructures for Astroparticle Physics/Transnational Access to the EU Deep Underground Laboratories) project in the 6th EU Framework Programme. I was invited to participate in the project by Prof. Jan Kisiel, who, at that time, was the ILIAS/TARI coordinator at the University of Silesia. Within the project, I conducted in situ gamma-ray background measurements in the largest European underground laboratories, including Laboratori Nazionali del Gran Sasso (Italy), Laboratoire Souterrain, Modane (France), and the Institute of Underground Science, Boulby Mine (England). The portable gamma-ray system was also used in CERN to measure radioactive impurities in transformer cores destined for neutrino experiments. The results of the measurements were published in scientific reports and publications. My visits to the largest European underground laboratories gave me the opportunity to become acquainted with the latest experiments in particle physics, which were often related to the nascent branch of geophysics, neutrino geophysics.

Knowledge Dissemination

The results of my studies have been published in 28 publications in international and domestic journals. Among these, 19 are on the JCR list. I was the first author of 18 of those papers and I authored three final reports that were submitted to the coordinator of ILIAS/TARI project. I have participated in 17 international conferences and 9 Polish conferences. I have been a reviewer for: American Mineralogist, Applied Radiation and Isotopes, Hyperfine Interactions, Journal of Applied Physics, Journal of Environmental Radioactivity, Journal of Physics and Chemistry of Solids, Physics and Chemistry of Minerals, and Przegląd Geologiczny (Polish Geological Review). I am a member of the Mineralogical Society of America.

At the Faculty of Earth Sciences, my university duties included lectures and practices on Environmental Radioactivity, the Influence on the Environment of Nuclear Technology, Engineering and Environmental Geophysics, Computer Methods in Geology, and Computation Methods in Earth Sciences. I have also led field work,

laboratory classes and seminars. I have supervised 3 MSc and 10 BSc thesis students, and I tutored 14 MSc and one PhD candidates. I am involved in the popularization of science by giving lectures in an accessible way and by demonstrating detectors, software packages and other equipment used in nuclear geophysics.

Participation in international conferences

1. Conference: XXXIV Zakopane School of Physics

Venue and date: Zakopane, Poland, 9-15 May 1999

Organizers: Jagiellonian University, H. Niewodniczański Institute of Nuclear Physics, Cracow

Presentation: Mössbauer study of annealing of radiation damage in natural $\text{REE}_2\text{Fe}^{2+}\text{Be}_2\text{Si}_2\text{O}_{10}$ "

2. Conference: Polish-Czech-Slovakien Symposium on Mining Geophysics

Venue and date: Nidzica, Poland 11-13 June 2001

Organizers: University of Silesia and the Institute of Geophysics of the Polish Academy of Sciences

Presentation: "Metamict state. Implication for stabilization and immobilization of nuclear high-level waste (HLW)"

3. Conference: International Conference on the Application of the Mössbauer Effect ICAME 2001

Venue and date: Oxford, England, 2-7 September 2001.

Organizers: Oxford University

Presentation: " ^{57}Fe Mössbauer study of annealing of radiation damage in metamict gadolinites"

4. Conference: Eleventh International Conference on Rapidly Quenched and Metastable Materials RQ11

Venue and date: Oxford, England, 25-30 August 2002

Organizers: Oxford University

Presentation: "Precambrian glass - gadolinite from Ytterby"

5. Conference: XXXVIII Zakopane School of Physics

Venue and date: Zakopane, Poland 14-19 May 2003.

Organizers: Jagiellonian University

Presentation: "Some remarks on in situ gamma-ray spectroscopy in typical rocks of Świeradów Zdrój vicinity (Sudetes, Poland)"

6. Conference: Seventh International Symposium on Crystallisation in Glasses and Liquids

Venue and date: Sheffield, England, 6-9 July 2003

Organizers: University of Sheffield

Presentation: "Structural analysis of radiation damage in Precambrian gadolinite: implications for immobilization of nuclear waste"

7. Conference: International Conference on Fabrication and Properties of Metallic Nanomaterials

Venue and date: Warsaw, Poland, 17-19 June 2004

Organizers: Warsaw University of Technology

Presentation: "Characterization of amorphous state of $\text{Ree}_2\text{Fe}^{2+}\text{Be}_2\text{Si}_2\text{O}_{10}$ by Mössbauer spectroscopy, EPR, TEM, XRD, gamma - ray spectrometry and dielectric permittivity spectroscopy"

8. Conference: International Conference on the Applications of the Mossbauer Effect

Venue and date: Montpellier, France, 5-9 September 2005

Organizers: Universite Montpellier II

Presentation: " ^{57}Fe mössbauer spectroscopy and X-ray diffraction study of some complex metamict minerals"

9. Conference: The 1st Boulby Underground Science Workshop

Venue and date: York, England, 20-23 October 2006

Organizers: University of Sheffield

Presentation: "ILIAS/TARI inter - laboratory background comparisons"

10. Conference: XXXI. Czech-Polish-Slovak Symposium on Mining and Environmental Geophysics

Venue and date: Janov nad Nisou, Czech Republic, 24-27 September 2007

Organizers: Geological Institute Academy of Sciences of the Czech Republic

Presentation: "Radon concentrations in soil gas of Izero Block, (Sudetes, Poland)"

11. Conference: "International Conference on The Applications of the Mössbauer Effect

Venue and date: Kanpur, India, 14-19 October 2007

Organizers: Indian Institute of Technology Kanpur

Presentation: " ^{57}Fe Mössbauer spectroscopy and X-ray diffraction study of complex metamict minerals. Part II"

12. Conference: "EGU General Assembly 2008"

Venue and date: Vienna, Austria, 13-18 April 2008

Organizers: European Geosciences Union

Presentation: " ^{222}Rn and ^{220}Rn concentrations in soil gas of Izero Block, (Sudetes, Poland)"

13. Conference: "XI Latin American Conference on the Applications of the Mössbauer Effect"

Venue and date: La Plata, Argentina, 9-14 November 2008

Organizers: Universidad Nacional de La Plata

Presentation: " ^{57}Fe Mössbauer spectroscopy of radiation damaged samarskites and gadolinites"

14. Conference: ILIAS Sixth Annual Meeting

Venue and date: Dresden, Germany, 16-20 February 2009

Organizers: Technische Universität Dresden

Presentation: (co-author) TA Deep Underground Science Laboratories (TA-DUSL) report. Presentation given by L. Pandola (INFN Gran Sasso) the ILIAS/TARI coordinator; Dariusz Malczewski, coauthor.

15. Conference: XXXII Polish-Czech-Slovak Symposium on Mining and Environmental Geophysics

Venue and date: Piechowice, Poland 20-22 May 2009

Organizers: University of Silesia, the Institute of Geophysics of the Polish Academy of Sciences

Presentation: Inter-Laboratory Background Comparisons (Boulby-Modane-Gran Sasso)

16. Conference: International Conference on Failure Analysis
Venue and date: Cambridge, England, 04-08 July 2010
Organizers: Cambridge University
Presentation: "Mössbauer spectroscopy of the metamict state: implications for stabilization and immobilization of nuclear high-level waste"

17. Conference: VIII Meeting of the Mineralogical Society of Poland
Venue and date: Bukowina Tatrzańska, Poland, 21-23 October 2011
Organizers: Mineralogical Society of Poland
Presentation: "²²²Rn and ²²⁰Rn emanations from metamict minerals"

Participation in domestic conferences

1. Conference: All-Polish Seminar on Mössbauer spectroscopy OSSM'96
Venue and date: Lublin, Poland, 27-29 May 1996
Organizers: Maria Curie-Skłodowska University and Technical University of Lublin
Presentation: "Identification of ferruginous minerals in basalt from Kaczawa Mountains region by Mössbauer spectroscopy"
Dariusz Malczewski, coauthor.

2. Conference: V School of Mineral Physics
Venue and date: Wrocław-Sobótka, Poland, 26-28 September 1996
Organizers: University of Wrocław
Presentation: "Mössbauer study of stilpnomelane"

3. Conference: All-Polish Seminar on Mössbauer spectroscopy OSSM'98
Venue and date: Sobótka-Górka, Poland, 08-10 June 1998
Organizers: Polish Academy of Sciences, University of Wrocław
Presentation: " Mössbauer studies of fully metamict gadolinite annealed in air"

4. Conference: All-Polish Seminar on Mössbauer spectroscopy OSSM-2000
Venue and date: Radom-Zbożenna, Poland, 12-14 June 2000
Organizers: Technical University of Radom
Presentation: "Determination of the activation energy of annealed metamict gadolinite from Mössbauer spectroscopy"

5. Conference: All-Polish Seminar on Mössbauer spectroscopy OSSM-2002
Venue and date: Białystok-Goniądz, Poland, 09-12 June 2002
Organizers: University of Białystok
Presentation: "⁵⁷Fe Mössbauer spectroscopy and X-ray diffraction study of gadolinite REE₂Fe²⁺Be₂Si₂O₁₀ from Lower Silesia (Poland) and Ytterby (Sweden)"

6. Conference: All-Polish Seminar on Mössbauer spectroscopy OSSM-2004
Venue and date: Wisła, Poland, 6-9 June 2004
Organizers: University of Silesia
Presentation: "⁵⁷Fe Mössbauer study of stilpnomelane and associated chlorite from Polish granite pegmatites"

7. Conference: All-Polish Seminar on Mössbauer spectroscopy OSSM-2006
Venue and date: Koszęcin, Poland, 18-21 June 2006
Organizers: Częstochowa University of Technology
Presentation: "⁵⁷Fe Mössbauer spectroscopy of annealed metamict davidite"

8. Conference: All-Polish Seminar on Mössbauer spectroscopy OSSM-2008
Venue and date: Koninki, Poland, 8-11 June 2008
Organizers: Pedagogical University in Cracow, Jagiellonian University
Presentation: “⁵⁷Fe Mössbauer spectroscopy of radiation damaged allanites”

9. Conference: II All-Polish Geophysical Workshop Geo-Sphere 2009
Venue and date: Sosnowiec-Sławków, Poland, 22-26 April 2009
Organizers: Faculty of Earth Sciences, University of Silesia
Presentation: “Nuclear geophysics”

Future Directions

In the near future, I plan to initiate the next research projects on the metamict phases and radioactivity of rocks. I plan to compile a monograph on metamict minerals and a radiological atlas of Sudetes rocks.

A handwritten signature in blue ink, appearing to be 'J. Jurek', written in a cursive style with a large loop at the end.