

Global Protactinium-231 Market Growth 2026-2032

<https://marketpublishers.com/r/G4E49F320653EN.html>

Date: October 2026

Pages: 90

Price: US\$ 3,660.00 (Single User License)

ID: G4E49F320653EN

Abstracts

The global Protactinium-231 market size is predicted to grow from US\$ 13.06 million in 2025 to US\$ 26.13 million in 2032; it is expected to grow at a CAGR of 9.9% from 2026 to 2032.

In 2025, global Protactinium-231 production was approximately 89 grams, with a global average market price of around \$150,000 per gram. That year, total global production capacity for Protactinium-231 reached 150 grams, and the industry's average gross profit margin stood at 39%. Protactinium-231 is a long-lived radioactive isotope of the actinide element protactinium (atomic number 91, mass number 231). It has a half-life of approximately 32,800 years and primarily decays via alpha emission into actinium-227. Naturally occurring within the uranium-235 decay chain, it is one of the few significant long-lived radionuclides found in nature. Due to its long half-life, unique geochemical behavior, and relationship with uranium and thorium systems, ^{231}Pa is highly valuable in fields such as marine geochronology, paleoenvironmental research, nuclear physics experiments, radionuclide tracing, and nuclear fuel cycle studies. ^{231}Pa and thorium-230 (^{230}Th) are frequently employed in uranium-series dating systems; the $^{231}\text{Pa}/^{230}\text{Th}$ ratio is used to analyze marine sediment accumulation rates, paleoclimatic changes, and the history of ocean circulation. Furthermore, as protactinium is an actinide with complex chemical properties, the techniques for its separation, purification, and measurement present significant technical challenges; consequently, production and research are primarily conducted by national nuclear research institutions, isotope laboratories, and specialized scientific organizations.

The upstream sector of the ^{231}Pa industry chain primarily encompasses uranium resource development, nuclear fuel cycle processes, actinide separation technologies, and radiochemical preparation systems. Naturally occurring ^{231}Pa originates mainly from the ^{235}U decay chain and exists in trace

amounts within uranium ores, nuclear fuel reprocessing waste streams, and related radiochemical systems. Given its extremely low natural abundance, commercial ^{231}Pa is generally not obtained through direct mining but rather through the processing of uranium ore samples, nuclear material separation workflows, or specialized radiochemical preparation methods. Production typically involves steps such as the processing of uranium-series materials, actinide separation, ion exchange, extraction chromatography, and high-purity refinement. Due to protactinium's unique chemical behavior—specifically its tendency to coexist in complex ways with elements like uranium and thorium during separation—advanced radiochemical expertise and precise analytical capabilities are required. The midstream sector of the industry chain primarily comprises nuclear research institutions, isotope laboratories, radiochemistry enterprises, and platforms supplying research materials; these entities are responsible for the further separation, purification, and quantitative analysis of Protactinium-231 (Pa-231), as well as the preparation of standardized products. As Pa-231 is a long-lived alpha-emitting radionuclide, midstream products typically take the form of research-grade solutions, standard reference sources, and samples representing specific chemical species. Production requires rigorous control over radionuclide purity, chemical purity, radioactivity, and long-term stability, with quality verification performed via techniques such as alpha spectrometry and mass spectrometry. Currently, Pa-231 is utilized mainly for scientific research rather than large-scale industrial commercial supply; its distribution relies primarily on research project collaborations, custom laboratory orders, and the provision of certified reference materials. Downstream applications of Pa-231 are concentrated in fields such as earth sciences, environmental research, nuclear physics, and radioactive tracing. The most established application is the $^{231}\text{Pa}/^{230}\text{Th}$ uranium-series dating technique, which is widely employed for dating marine sediments, reconstructing paleo-oceanic environments, studying glacial-period climates, and analyzing the global carbon cycle. Given that the migration behavior of Pa-231 in the ocean is closely linked to particle settling processes, it serves as a valuable tool for investigating marine particle transport, sedimentation rates, and paleo-environmental changes.

Protactinium-231 (Pa-231) and thorium-230 (Th-230) together form a crucial geochronological system within the uranium series; the $^{231}\text{Pa}/^{230}\text{Th}$ ratio is widely used to study marine sedimentation processes, paleoceanographic environmental changes, glacial-interglacial climate evolution, and the history of the global carbon cycle. Due to its long half-life (approximately 32,800 years) and unique adsorption behavior regarding marine particles, Pa-231 can record sediment transport and changes in ocean circulation over long timescales, making it indispensable in paleoclimate research, deep-sea exploration, and Earth system science. As research

into global climate change, polar scientific expeditions, and deep-sea resources advances, the growing demand for high-precision radioisotope dating techniques will provide stable support for the supply of research-grade Pa-231.

Pa-231 is a typical long-lived actinide radionuclide; its unique nuclear structure and chemical behavior make it a key subject for studying actinide migration patterns, nuclear reaction data, and the long-term evolution of radioactive waste. In fields such as advanced nuclear fuel cycles, nuclear waste safety assessment, and environmental radioactivity monitoring, researchers rely on long-lived radionuclides like Pa-231 to analyze the migration pathways and stability of radioactive elements in geological environments. Furthermore, the development of advanced nuclear energy technologies and stricter safety management requirements for nuclear materials are driving increased investment in the study of long-lived radionuclide behavior, thereby promoting the application of Pa-231 in nuclear chemistry, environmental nuclear science, and fundamental physics research.

Given its extremely low natural abundance and its coexistence with elements such as uranium and thorium in uranium-series materials, the preparation and purification of Pa-231 present significant technical challenges. Future industry development will focus on enhancing actinide separation efficiency, optimizing ion-exchange and extraction chromatography processes, minimizing sample processing losses, and improving product quality control through advanced detection techniques such as high-resolution mass spectrometry and alpha spectrometry. Simultaneously, the development of automated radiochemistry experimental platforms and standardized operating procedures promises to reduce the cost of preparing Pa-231 research samples, improve supply stability, and facilitate the transition from small-scale laboratory production to the supply of specialized research-grade materials.

Report Scope

LP Information, Inc. (LPI) ' newest research report, the "Protactinium-231 Industry Forecast" looks at past sales and reviews total world Protactinium-231 sales in 2025, providing a comprehensive analysis by region and market sector of projected Protactinium-231 sales for 2026 through 2032. With Protactinium-231 sales broken down by region, market sector and sub-sector, this report provides a detailed analysis in US\$ millions of the world Protactinium-231 industry.

This Insight Report provides a comprehensive analysis of the global Protactinium-231 landscape and highlights key trends related to product segmentation, company

formation, revenue, and market share, latest development, and M&A activity. This report also analyzes the strategies of leading global companies with a focus on Protactinium-231 portfolios and capabilities, market entry strategies, market positions, and geographic footprints, to better understand these firms' unique position in an accelerating global Protactinium-231 market.

This Insight Report evaluates the key market trends, drivers, and affecting factors shaping the global outlook for Protactinium-231 and breaks down the forecast by Type, by Application, geography, and market size to highlight emerging pockets of opportunity. With a transparent methodology based on hundreds of bottom-up qualitative and quantitative market inputs, this study forecast offers a highly nuanced view of the current state and future trajectory in the global Protactinium-231.

This report presents a comprehensive overview, market shares, and growth opportunities of Protactinium-231 market by product type, application, key manufacturers and key regions and countries.

Market Segmentation

Segmentation by Type:

Nuclear Reactor Production

Natural Uranium Extraction

Segmentation by Product Form:

Protactinium-231 Solution

Protactinium-231 Radioactive Source

Protactinium-231 Compound

Segmentation by Purity Grade:

Research-grade Protactinium-231

Industrial-grade Protactinium-231

Segmentation by Radioactivity:

Low-activity Protactinium-231

Medium-activity Protactinium-231

High-activity Protactinium-231

Segmentation by Application:

Nuclear Physics Research

Thorium Fuel Cycle Experiments

Medical Isotope Research

This report also splits the market by region:

Americas

United States

Canada

Mexico

Brazil

APAC

China

Japan

Korea

Southeast Asia

India

Australia

Europe

Germany

France

UK

Italy

Russia

Middle East & Africa

Egypt

South Africa

Israel

Turkey

GCC Countries

The below companies that are profiled have been selected based on inputs gathered from primary experts and analysing the company's coverage, product portfolio, its market penetration.

ORNL

Orano

Rosatom

CNNC

CERN

JAEA

Eckert & Ziegler

LANL

HZDR

Key Questions Addressed in this Report

What is the 10-year outlook for the global Protactinium-231 market?

What factors are driving Protactinium-231 market growth, globally and by region?

Which technologies are poised for the fastest growth by market and region?

How do Protactinium-231 market opportunities vary by end market size?

How does Protactinium-231 break out by Type, by Application?

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