

Global Protactinium-231 Market 2026 by Manufacturers, Regions, Type and Application, Forecast to 2032

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Abstracts

According to our (Global Info Research) latest study, the global Protactinium-231 market size was valued at US\$ 13.74 million in 2025 and is forecast to a readjusted size of US\$ 26.63 million by 2032 with a CAGR of 9.3% during review period.

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

This report is a detailed and comprehensive analysis for global Protactinium-231 market. Both quantitative and qualitative analyses are presented by manufacturers, by region & country, by Type and by Application. As the market is constantly changing, this report explores the competition, supply and demand trends, as well as key factors that contribute to its changing demands across many markets. Company profiles and

product examples of selected competitors, along with market share estimates of some of the selected leaders for the year 2025, are provided.

Key Features:

Global Protactinium-231 market size and forecasts, in consumption value (\$ Million), sales quantity (Gram), and average selling prices (US\$/g), 2021-2032

Global Protactinium-231 market size and forecasts by region and country, in consumption value (\$ Million), sales quantity (Gram), and average selling prices (US\$/g), 2021-2032

Global Protactinium-231 market size and forecasts, by Type and by Application, in consumption value (\$ Million), sales quantity (Gram), and average selling prices (US\$/g), 2021-2032

Global Protactinium-231 market shares of main players, shipments in revenue (\$ Million), sales quantity (Gram), and ASP (US\$/g), 2021-2026

The Primary Objectives in This Report Are:

To determine the size of the total market opportunity of global and key countries

To assess the growth potential for Protactinium-231

To forecast future growth in each product and end-use market

To assess competitive factors affecting the marketplace

This report profiles key players in the global Protactinium-231 market based on the following parameters - company overview, sales quantity, revenue, price, gross margin, product portfolio, geographical presence, and key developments. Key companies covered as a part of this study include ORNL, Orano, Rosatom, CNNC, CERN, JAEA, Eckert & Ziegler, LANL, HZDR, etc.

This report also provides key insights about market drivers, restraints, opportunities,

new product launches or approvals.

Protactinium-231 market is split by Type and by Application. For the period 2021-2032, the growth among segments provides accurate calculations and forecasts for consumption value by Type, and by Application in terms of volume and value. This analysis can help you expand your business by targeting qualified niche markets.

Market Segmentation

Market segment by Type

Nuclear Reactor Production

Natural Uranium Extraction

Market segment by Product Form

Protactinium-231 Solution

Protactinium-231 Radioactive Source

Protactinium-231 Compound

Market segment by Purity Grade

Research-grade Protactinium-231

Industrial-grade Protactinium-231

Market segment by Radioactivity

Low-activity Protactinium-231

Medium-activity Protactinium-231

High-activity Protactinium-231

Market segment by Application

Nuclear Physics Research

Thorium Fuel Cycle Experiments

Medical Isotope Research

Major players covered

ORNL

Orano

Rosatom

CNNC

CERN

JAEA

Eckert & Ziegler

LANL

HZDR

Market segment by region, regional analysis covers

North America (United States, Canada, and Mexico)

Europe (Germany, France, United Kingdom, Russia, Italy, and Rest of Europe)

Asia-Pacific (China, Japan, Korea, India, Southeast Asia, and Australia)

South America (Brazil, Argentina, Colombia, and Rest of South America)

Middle East & Africa (Saudi Arabia, UAE, Egypt, South Africa, and Rest of Middle East & Africa)

Chapter Outline

Chapter 1, to describe Protactinium-231 product scope, market overview, market estimation caveats and base year.

Chapter 2, to profile the top manufacturers of Protactinium-231, with price, sales quantity, revenue, and global market share of Protactinium-231 from 2021 to 2026.

Chapter 3, the Protactinium-231 competitive situation, sales quantity, revenue, and global market share of top manufacturers are analyzed emphatically by landscape contrast.

Chapter 4, the Protactinium-231 breakdown data are shown at the regional level, to show the sales quantity, consumption value, and growth by regions, from 2021 to 2032.

Chapter 5 and 6, to segment the sales by Type and by Application, with sales market share and growth rate by Type, by Application, from 2021 to 2032.

Chapter 7, 8, 9, 10 and 11, to break the sales data at the country level, with sales quantity, consumption value, and market share for key countries in the world, from 2021 to 2026. and Protactinium-231 market forecast, by regions, by Type, and by Application, with sales and revenue, from 2027 to 2032.

Chapter 12, market dynamics, drivers, restraints, trends, and Porters Five Forces analysis.

Chapter 13, the key raw materials and key suppliers, and industry chain of Protactinium-231.

Chapter 14 and 15, to describe Protactinium-231 sales channel, distributors, customers, research findings and conclusion.

Contents

1 MARKET OVERVIEW

1.1 Product Overview and Scope

1.2 Market Estimation Caveats and Base Year

1.3 Market Analysis by Type

1.3.1 Overview: Global Protactinium-231 Consumption Value by Type: 2021 Versus 2025 Versus 2032

1.3.2 Nuclear Reactor Production

1.3.3 Natural Uranium Extraction

1.4 Market Analysis by Product Form

1.4.1 Overview: Global Protactinium-231 Consumption Value by Product Form: 2021 Versus 2025 Versus 2032

1.4.2 Protactinium-231 Solution

1.4.3 Protactinium-231 Radioactive Source

1.4.4 Protactinium-231 Compound

1.5 Market Analysis by Purity Grade

1.5.1 Overview: Global Protactinium-231 Consumption Value by Purity Grade: 2021 Versus 2025 Versus 2032

1.5.2 Research-grade Protactinium-231

1.5.3 Industrial-grade Protactinium-231

1.6 Market Analysis by Radioactivity

1.6.1 Overview: Global Protactinium-231 Consumption Value by Radioactivity: 2021 Versus 2025 Versus 2032

1.6.2 Low-activity Protactinium-231

1.6.3 Medium-activity Protactinium-231

1.6.4 High-activity Protactinium-231

1.7 Market Analysis by Application

1.7.1 Overview: Global Protactinium-231 Consumption Value by Application: 2021 Versus 2025 Versus 2032

1.7.2 Nuclear Physics Research

1.7.3 Thorium Fuel Cycle Experiments

1.7.4 Medical Isotope Research

1.8 Global Protactinium-231 Market Size & Forecast

1.8.1 Global Protactinium-231 Consumption Value (2021 & 2025 & 2032)

1.8.2 Global Protactinium-231 Sales Quantity (2021-2032)

1.8.3 Global Protactinium-231 Average Price (2021-2032)

2 MANUFACTURERS PROFILES

2.1 ORNL

2.1.1 ORNL Details

2.1.2 ORNL Major Business

2.1.3 ORNL Protactinium-231 Product and Services

2.1.4 ORNL Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)

2.1.5 ORNL Recent Developments/Updates

2.2 Orano

2.2.1 Orano Details

2.2.2 Orano Major Business

2.2.3 Orano Protactinium-231 Product and Services

2.2.4 Orano Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)

2.2.5 Orano Recent Developments/Updates

2.3 Rosatom

2.3.1 Rosatom Details

2.3.2 Rosatom Major Business

2.3.3 Rosatom Protactinium-231 Product and Services

2.3.4 Rosatom Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)

2.3.5 Rosatom Recent Developments/Updates

2.4 CNNC

2.4.1 CNNC Details

2.4.2 CNNC Major Business

2.4.3 CNNC Protactinium-231 Product and Services

2.4.4 CNNC Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)

2.4.5 CNNC Recent Developments/Updates

2.5 CERN

2.5.1 CERN Details

2.5.2 CERN Major Business

2.5.3 CERN Protactinium-231 Product and Services

2.5.4 CERN Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)

2.5.5 CERN Recent Developments/Updates

2.6 JAEA

2.6.1 JAEA Details

- 2.6.2 JAEA Major Business
- 2.6.3 JAEA Protactinium-231 Product and Services
- 2.6.4 JAEA Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)
- 2.6.5 JAEA Recent Developments/Updates
- 2.7 Eckert & Ziegler
 - 2.7.1 Eckert & Ziegler Details
 - 2.7.2 Eckert & Ziegler Major Business
 - 2.7.3 Eckert & Ziegler Protactinium-231 Product and Services
 - 2.7.4 Eckert & Ziegler Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)
 - 2.7.5 Eckert & Ziegler Recent Developments/Updates
- 2.8 LANL
 - 2.8.1 LANL Details
 - 2.8.2 LANL Major Business
 - 2.8.3 LANL Protactinium-231 Product and Services
 - 2.8.4 LANL Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)
 - 2.8.5 LANL Recent Developments/Updates
- 2.9 HZDR
 - 2.9.1 HZDR Details
 - 2.9.2 HZDR Major Business
 - 2.9.3 HZDR Protactinium-231 Product and Services
 - 2.9.4 HZDR Protactinium-231 Sales Quantity, Average Price, Revenue, Gross Margin and Market Share (2021-2026)
 - 2.9.5 HZDR Recent Developments/Updates

3 COMPETITIVE ENVIRONMENT: PROTACTINIUM-231 BY MANUFACTURER

- 3.1 Global Protactinium-231 Sales Quantity by Manufacturer (2021-2026)
- 3.2 Global Protactinium-231 Revenue by Manufacturer (2021-2026)
- 3.3 Global Protactinium-231 Average Price by Manufacturer (2021-2026)
- 3.4 Market Share Analysis (2025)
 - 3.4.1 Producer Shipments of Protactinium-231 by Manufacturer Revenue (\$MM) and Market Share (%): 2025
 - 3.4.2 Top 3 Protactinium-231 Manufacturer Market Share in 2025
 - 3.4.3 Top 6 Protactinium-231 Manufacturer Market Share in 2025
- 3.5 Protactinium-231 Market: Overall Company Footprint Analysis
 - 3.5.1 Protactinium-231 Market: Region Footprint

- 3.5.2 Protactinium-231 Market: Company Product Type Footprint
- 3.5.3 Protactinium-231 Market: Company Product Application Footprint
- 3.6 New Market Entrants and Barriers to Market Entry
- 3.7 Mergers, Acquisition, Agreements, and Collaborations

4 CONSUMPTION ANALYSIS BY REGION

- 4.1 Global Protactinium-231 Market Size by Region
 - 4.1.1 Global Protactinium-231 Sales Quantity by Region (2021-2032)
 - 4.1.2 Global Protactinium-231 Consumption Value by Region (2021-2032)
 - 4.1.3 Global Protactinium-231 Average Price by Region (2021-2032)
- 4.2 North America Protactinium-231 Consumption Value (2021-2032)
- 4.3 Europe Protactinium-231 Consumption Value (2021-2032)
- 4.4 Asia-Pacific Protactinium-231 Consumption Value (2021-2032)
- 4.5 South America Protactinium-231 Consumption Value (2021-2032)
- 4.6 Middle East & Africa Protactinium-231 Consumption Value (2021-2032)

5 MARKET SEGMENT BY TYPE

- 5.1 Global Protactinium-231 Sales Quantity by Type (2021-2032)
- 5.2 Global Protactinium-231 Consumption Value by Type (2021-2032)
- 5.3 Global Protactinium-231 Average Price by Type (2021-2032)

6 MARKET SEGMENT BY APPLICATION

- 6.1 Global Protactinium-231 Sales Quantity by Application (2021-2032)
- 6.2 Global Protactinium-231 Consumption Value by Application (2021-2032)
- 6.3 Global Protactinium-231 Average Price by Application (2021-2032)

7 NORTH AMERICA

- 7.1 North America Protactinium-231 Sales Quantity by Type (2021-2032)
- 7.2 North America Protactinium-231 Sales Quantity by Application (2021-2032)
- 7.3 North America Protactinium-231 Market Size by Country
 - 7.3.1 North America Protactinium-231 Sales Quantity by Country (2021-2032)
 - 7.3.2 North America Protactinium-231 Consumption Value by Country (2021-2032)
 - 7.3.3 United States Market Size and Forecast (2021-2032)
 - 7.3.4 Canada Market Size and Forecast (2021-2032)
 - 7.3.5 Mexico Market Size and Forecast (2021-2032)

8 EUROPE

- 8.1 Europe Protactinium-231 Sales Quantity by Type (2021-2032)
- 8.2 Europe Protactinium-231 Sales Quantity by Application (2021-2032)
- 8.3 Europe Protactinium-231 Market Size by Country
 - 8.3.1 Europe Protactinium-231 Sales Quantity by Country (2021-2032)
 - 8.3.2 Europe Protactinium-231 Consumption Value by Country (2021-2032)
 - 8.3.3 Germany Market Size and Forecast (2021-2032)
 - 8.3.4 France Market Size and Forecast (2021-2032)
 - 8.3.5 United Kingdom Market Size and Forecast (2021-2032)
 - 8.3.6 Russia Market Size and Forecast (2021-2032)
 - 8.3.7 Italy Market Size and Forecast (2021-2032)

9 ASIA-PACIFIC

- 9.1 Asia-Pacific Protactinium-231 Sales Quantity by Type (2021-2032)
- 9.2 Asia-Pacific Protactinium-231 Sales Quantity by Application (2021-2032)
- 9.3 Asia-Pacific Protactinium-231 Market Size by Region
 - 9.3.1 Asia-Pacific Protactinium-231 Sales Quantity by Region (2021-2032)
 - 9.3.2 Asia-Pacific Protactinium-231 Consumption Value by Region (2021-2032)
 - 9.3.3 China Market Size and Forecast (2021-2032)
 - 9.3.4 Japan Market Size and Forecast (2021-2032)
 - 9.3.5 South Korea Market Size and Forecast (2021-2032)
 - 9.3.6 India Market Size and Forecast (2021-2032)
 - 9.3.7 Southeast Asia Market Size and Forecast (2021-2032)
 - 9.3.8 Australia Market Size and Forecast (2021-2032)

10 SOUTH AMERICA

- 10.1 South America Protactinium-231 Sales Quantity by Type (2021-2032)
- 10.2 South America Protactinium-231 Sales Quantity by Application (2021-2032)
- 10.3 South America Protactinium-231 Market Size by Country
 - 10.3.1 South America Protactinium-231 Sales Quantity by Country (2021-2032)
 - 10.3.2 South America Protactinium-231 Consumption Value by Country (2021-2032)
 - 10.3.3 Brazil Market Size and Forecast (2021-2032)
 - 10.3.4 Argentina Market Size and Forecast (2021-2032)

11 MIDDLE EAST & AFRICA

- 11.1 Middle East & Africa Protactinium-231 Sales Quantity by Type (2021-2032)
- 11.2 Middle East & Africa Protactinium-231 Sales Quantity by Application (2021-2032)
- 11.3 Middle East & Africa Protactinium-231 Market Size by Country
 - 11.3.1 Middle East & Africa Protactinium-231 Sales Quantity by Country (2021-2032)
 - 11.3.2 Middle East & Africa Protactinium-231 Consumption Value by Country (2021-2032)
 - 11.3.3 Turkey Market Size and Forecast (2021-2032)
 - 11.3.4 Egypt Market Size and Forecast (2021-2032)
 - 11.3.5 Saudi Arabia Market Size and Forecast (2021-2032)
 - 11.3.6 South Africa Market Size and Forecast (2021-2032)

12 MARKET DYNAMICS

- 12.1 Protactinium-231 Market Drivers
- 12.2 Protactinium-231 Market Restraints
- 12.3 Protactinium-231 Trends Analysis
- 12.4 Porters Five Forces Analysis
 - 12.4.1 Threat of New Entrants
 - 12.4.2 Bargaining Power of Suppliers
 - 12.4.3 Bargaining Power of Buyers
 - 12.4.4 Threat of Substitutes
 - 12.4.5 Competitive Rivalry

13 RAW MATERIAL AND INDUSTRY CHAIN

- 13.1 Raw Material of Protactinium-231 and Key Manufacturers
- 13.2 Manufacturing Costs Percentage of Protactinium-231
- 13.3 Protactinium-231 Production Process
- 13.4 Industry Value Chain Analysis

14 SHIPMENTS BY DISTRIBUTION CHANNEL

- 14.1 Sales Channel
 - 14.1.1 Direct to End-User
 - 14.1.2 Distributors
- 14.2 Protactinium-231 Typical Distributors
- 14.3 Protactinium-231 Typical Customers

15 RESEARCH FINDINGS AND CONCLUSION

16 APPENDIX

16.1 Methodology

16.2 Research Process and Data Source

16.3 Disclaimer

List Of Tables

LIST OF TABLES

Table 1. Global Protactinium-231 Consumption Value by Type, (USD Million), 2021 & 2025 & 2032

Table 2. Global Protactinium-231 Consumption Value by Product Form, (USD Million), 2021 & 2025 & 2032

Table 3. Global Protactinium-231 Consumption Value by Purity Grade, (USD Million), 2021 & 2025 & 2032

Table 4. Global Protactinium-231 Consumption Value by Radioactivity, (USD Million), 2021 & 2025 & 2032

Table 5. Global Protactinium-231 Consumption Value by Application, (USD Million), 2021 & 2025 & 2032

Table 6. ORNL Basic Information, Manufacturing Base and Competitors

Table 7. ORNL Major Business

Table 8. ORNL Protactinium-231 Product and Services

Table 9. ORNL Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)

Table 10. ORNL Recent Developments/Updates

Table 11. Orano Basic Information, Manufacturing Base and Competitors

Table 12. Orano Major Business

Table 13. Orano Protactinium-231 Product and Services

Table 14. Orano Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)

Table 15. Orano Recent Developments/Updates

Table 16. Rosatom Basic Information, Manufacturing Base and Competitors

Table 17. Rosatom Major Business

Table 18. Rosatom Protactinium-231 Product and Services

Table 19. Rosatom Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)

Table 20. Rosatom Recent Developments/Updates

Table 21. CNNC Basic Information, Manufacturing Base and Competitors

Table 22. CNNC Major Business

Table 23. CNNC Protactinium-231 Product and Services

Table 24. CNNC Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)

Table 25. CNNC Recent Developments/Updates

Table 26. CERN Basic Information, Manufacturing Base and Competitors

Table 27. CERN Major Business
Table 28. CERN Protactinium-231 Product and Services
Table 29. CERN Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)
Table 30. CERN Recent Developments/Updates
Table 31. JAEA Basic Information, Manufacturing Base and Competitors
Table 32. JAEA Major Business
Table 33. JAEA Protactinium-231 Product and Services
Table 34. JAEA Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)
Table 35. JAEA Recent Developments/Updates
Table 36. Eckert & Ziegler Basic Information, Manufacturing Base and Competitors
Table 37. Eckert & Ziegler Major Business
Table 38. Eckert & Ziegler Protactinium-231 Product and Services
Table 39. Eckert & Ziegler Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)
Table 40. Eckert & Ziegler Recent Developments/Updates
Table 41. LANL Basic Information, Manufacturing Base and Competitors
Table 42. LANL Major Business
Table 43. LANL Protactinium-231 Product and Services
Table 44. LANL Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)
Table 45. LANL Recent Developments/Updates
Table 46. HZDR Basic Information, Manufacturing Base and Competitors
Table 47. HZDR Major Business
Table 48. HZDR Protactinium-231 Product and Services
Table 49. HZDR Protactinium-231 Sales Quantity (Gram), Average Price (US\$/g), Revenue (USD Million), Gross Margin and Market Share (2021-2026)
Table 50. HZDR Recent Developments/Updates
Table 51. Global Protactinium-231 Sales Quantity by Manufacturer (2021-2026) & (Gram)
Table 52. Global Protactinium-231 Revenue by Manufacturer (2021-2026) & (USD Million)
Table 53. Global Protactinium-231 Average Price by Manufacturer (2021-2026) & (US\$/g)
Table 54. Market Position of Manufacturers in Protactinium-231, (Tier 1, Tier 2, and Tier 3), Based on Revenue in 2025
Table 55. Head Office and Protactinium-231 Production Site of Key Manufacturer
Table 56. Protactinium-231 Market: Company Product Type Footprint

Table 57. Protactinium-231 Market: Company Product Application Footprint
Table 58. Protactinium-231 New Market Entrants and Barriers to Market Entry
Table 59. Protactinium-231 Mergers, Acquisition, Agreements, and Collaborations
Table 60. Global Protactinium-231 Consumption Value by Region (2021-2025-2032) & (USD Million) & CAGR
Table 61. Global Protactinium-231 Sales Quantity by Region (2021-2026) & (Gram)
Table 62. Global Protactinium-231 Sales Quantity by Region (2027-2032) & (Gram)
Table 63. Global Protactinium-231 Consumption Value by Region (2021-2026) & (USD Million)
Table 64. Global Protactinium-231 Consumption Value by Region (2027-2032) & (USD Million)
Table 65. Global Protactinium-231 Average Price by Region (2021-2026) & (US\$/g)
Table 66. Global Protactinium-231 Average Price by Region (2027-2032) & (US\$/g)
Table 67. Global Protactinium-231 Sales Quantity by Type (2021-2026) & (Gram)
Table 68. Global Protactinium-231 Sales Quantity by Type (2027-2032) & (Gram)
Table 69. Global Protactinium-231 Consumption Value by Type (2021-2026) & (USD Million)
Table 70. Global Protactinium-231 Consumption Value by Type (2027-2032) & (USD Million)
Table 71. Global Protactinium-231 Average Price by Type (2021-2026) & (US\$/g)
Table 72. Global Protactinium-231 Average Price by Type (2027-2032) & (US\$/g)
Table 73. Global Protactinium-231 Sales Quantity by Application (2021-2026) & (Gram)
Table 74. Global Protactinium-231 Sales Quantity by Application (2027-2032) & (Gram)
Table 75. Global Protactinium-231 Consumption Value by Application (2021-2026) & (USD Million)
Table 76. Global Protactinium-231 Consumption Value by Application (2027-2032) & (USD Million)
Table 77. Global Protactinium-231 Average Price by Application (2021-2026) & (US\$/g)
Table 78. Global Protactinium-231 Average Price by Application (2027-2032) & (US\$/g)
Table 79. North America Protactinium-231 Sales Quantity by Type (2021-2026) & (Gram)
Table 80. North America Protactinium-231 Sales Quantity by Type (2027-2032) & (Gram)
Table 81. North America Protactinium-231 Sales Quantity by Application (2021-2026) & (Gram)
Table 82. North America Protactinium-231 Sales Quantity by Application (2027-2032) & (Gram)
Table 83. North America Protactinium-231 Sales Quantity by Country (2021-2026) & (Gram)

Table 84. North America Protactinium-231 Sales Quantity by Country (2027-2032) & (Gram)

Table 85. North America Protactinium-231 Consumption Value by Country (2021-2026) & (USD Million)

Table 86. North America Protactinium-231 Consumption Value by Country (2027-2032) & (USD Million)

Table 87. Europe Protactinium-231 Sales Quantity by Type (2021-2026) & (Gram)

Table 88. Europe Protactinium-231 Sales Quantity by Type (2027-2032) & (Gram)

Table 89. Europe Protactinium-231 Sales Quantity by Application (2021-2026) & (Gram)

Table 90. Europe Protactinium-231 Sales Quantity by Application (2027-2032) & (Gram)

Table 91. Europe Protactinium-231 Sales Quantity by Country (2021-2026) & (Gram)

Table 92. Europe Protactinium-231 Sales Quantity by Country (2027-2032) & (Gram)

Table 93. Europe Protactinium-231 Consumption Value by Country (2021-2026) & (USD Million)

Table 94. Europe Protactinium-231 Consumption Value by Country (2027-2032) & (USD Million)

Table 95. Asia-Pacific Protactinium-231 Sales Quantity by Type (2021-2026) & (Gram)

Table 96. Asia-Pacific Protactinium-231 Sales Quantity by Type (2027-2032) & (Gram)

Table 97. Asia-Pacific Protactinium-231 Sales Quantity by Application (2021-2026) & (Gram)

Table 98. Asia-Pacific Protactinium-231 Sales Quantity by Application (2027-2032) & (Gram)

Table 99. Asia-Pacific Protactinium-231 Sales Quantity by Region (2021-2026) & (Gram)

Table 100. Asia-Pacific Protactinium-231 Sales Quantity by Region (2027-2032) & (Gram)

Table 101. Asia-Pacific Protactinium-231 Consumption Value by Region (2021-2026) & (USD Million)

Table 102. Asia-Pacific Protactinium-231 Consumption Value by Region (2027-2032) & (USD Million)

Table 103. South America Protactinium-231 Sales Quantity by Type (2021-2026) & (Gram)

Table 104. South America Protactinium-231 Sales Quantity by Type (2027-2032) & (Gram)

Table 105. South America Protactinium-231 Sales Quantity by Application (2021-2026) & (Gram)

Table 106. South America Protactinium-231 Sales Quantity by Application (2027-2032) & (Gram)

Table 107. South America Protactinium-231 Sales Quantity by Country (2021-2026) &

(Gram)

Table 108. South America Protactinium-231 Sales Quantity by Country (2027-2032) & (Gram)

Table 109. South America Protactinium-231 Consumption Value by Country (2021-2026) & (USD Million)

Table 110. South America Protactinium-231 Consumption Value by Country (2027-2032) & (USD Million)

Table 111. Middle East & Africa Protactinium-231 Sales Quantity by Type (2021-2026) & (Gram)

Table 112. Middle East & Africa Protactinium-231 Sales Quantity by Type (2027-2032) & (Gram)

Table 113. Middle East & Africa Protactinium-231 Sales Quantity by Application (2021-2026) & (Gram)

Table 114. Middle East & Africa Protactinium-231 Sales Quantity by Application (2027-2032) & (Gram)

Table 115. Middle East & Africa Protactinium-231 Sales Quantity by Country (2021-2026) & (Gram)

Table 116. Middle East & Africa Protactinium-231 Sales Quantity by Country (2027-2032) & (Gram)

Table 117. Middle East & Africa Protactinium-231 Consumption Value by Country (2021-2026) & (USD Million)

Table 118. Middle East & Africa Protactinium-231 Consumption Value by Country (2027-2032) & (USD Million)

Table 119. Protactinium-231 Raw Material

Table 120. Key Manufacturers of Protactinium-231 Raw Materials

Table 121. Protactinium-231 Typical Distributors

Table 122. Protactinium-231 Typical Customers

List Of Figures

LIST OF FIGURES

Figure 1. Protactinium-231 Picture

Figure 2. Global Protactinium-231 Revenue by Type, (USD Million), 2021 & 2025 & 2032

Figure 3. Global Protactinium-231 Revenue Market Share by Type in 2025

Figure 4. Nuclear Reactor Production Examples

Figure 5. Natural Uranium Extraction Examples

Figure 6. Global Protactinium-231 Revenue by Product Form, (USD Million), 2021 & 2025 & 2032

Figure 7. Global Protactinium-231 Revenue Market Share by Product Form in 2025

Figure 8. Protactinium-231 Solution Examples

Figure 9. Protactinium-231 Radioactive Source Examples

Figure 10. Protactinium-231 Compound Examples

Figure 11. Global Protactinium-231 Revenue by Purity Grade, (USD Million), 2021 & 2025 & 2032

Figure 12. Global Protactinium-231 Revenue Market Share by Purity Grade in 2025

Figure 13. Research-grade Protactinium-231 Examples

Figure 14. Industrial-grade Protactinium-231 Examples

Figure 15. Global Protactinium-231 Revenue by Radioactivity, (USD Million), 2021 & 2025 & 2032

Figure 16. Global Protactinium-231 Revenue Market Share by Radioactivity in 2025

Figure 17. Low-activity Protactinium-231 Examples

Figure 18. Medium-activity Protactinium-231 Examples

Figure 19. High-activity Protactinium-231 Examples

Figure 20. Global Protactinium-231 Consumption Value by Application, (USD Million), 2021 & 2025 & 2032

Figure 21. Global Protactinium-231 Revenue Market Share by Application in 2025

Figure 22. Nuclear Physics Research Examples

Figure 23. Thorium Fuel Cycle Experiments Examples

Figure 24. Medical Isotope Research Examples

Figure 25. Global Protactinium-231 Consumption Value, (USD Million): 2021 & 2025 & 2032

Figure 26. Global Protactinium-231 Consumption Value and Forecast (2021-2032) & (USD Million)

Figure 27. Global Protactinium-231 Sales Quantity (2021-2032) & (Gram)

Figure 28. Global Protactinium-231 Price (2021-2032) & (US\$/g)

Figure 29. Global Protactinium-231 Sales Quantity Market Share by Manufacturer in 2025

Figure 30. Global Protactinium-231 Revenue Market Share by Manufacturer in 2025

Figure 31. Producer Shipments of Protactinium-231 by Manufacturer Sales (\$MM) and Market Share (%): 2025

Figure 32. Top 3 Protactinium-231 Manufacturer (Revenue) Market Share in 2025

Figure 33. Top 6 Protactinium-231 Manufacturer (Revenue) Market Share in 2025

Figure 34. Global Protactinium-231 Sales Quantity Market Share by Region (2021-2032)

Figure 35. Global Protactinium-231 Consumption Value Market Share by Region (2021-2032)

Figure 36. North America Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 37. Europe Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 38. Asia-Pacific Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 39. South America Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 40. Middle East & Africa Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 41. Global Protactinium-231 Sales Quantity Market Share by Type (2021-2032)

Figure 42. Global Protactinium-231 Consumption Value Market Share by Type (2021-2032)

Figure 43. Global Protactinium-231 Average Price by Type (2021-2032) & (US\$/g)

Figure 44. Global Protactinium-231 Sales Quantity Market Share by Application (2021-2032)

Figure 45. Global Protactinium-231 Revenue Market Share by Application (2021-2032)

Figure 46. Global Protactinium-231 Average Price by Application (2021-2032) & (US\$/g)

Figure 47. North America Protactinium-231 Sales Quantity Market Share by Type (2021-2032)

Figure 48. North America Protactinium-231 Sales Quantity Market Share by Application (2021-2032)

Figure 49. North America Protactinium-231 Sales Quantity Market Share by Country (2021-2032)

Figure 50. North America Protactinium-231 Consumption Value Market Share by Country (2021-2032)

Figure 51. United States Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 52. Canada Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 53. Mexico Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 54. Europe Protactinium-231 Sales Quantity Market Share by Type (2021-2032)

Figure 55. Europe Protactinium-231 Sales Quantity Market Share by Application (2021-2032)

Figure 56. Europe Protactinium-231 Sales Quantity Market Share by Country (2021-2032)

Figure 57. Europe Protactinium-231 Consumption Value Market Share by Country (2021-2032)

Figure 58. Germany Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 59. France Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 60. United Kingdom Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 61. Russia Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 62. Italy Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 63. Asia-Pacific Protactinium-231 Sales Quantity Market Share by Type (2021-2032)

Figure 64. Asia-Pacific Protactinium-231 Sales Quantity Market Share by Application (2021-2032)

Figure 65. Asia-Pacific Protactinium-231 Sales Quantity Market Share by Region (2021-2032)

Figure 66. Asia-Pacific Protactinium-231 Consumption Value Market Share by Region (2021-2032)

Figure 67. China Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 68. Japan Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 69. South Korea Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 70. India Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 71. Southeast Asia Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 72. Australia Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 73. South America Protactinium-231 Sales Quantity Market Share by Type (2021-2032)

Figure 74. South America Protactinium-231 Sales Quantity Market Share by Application (2021-2032)

Figure 75. South America Protactinium-231 Sales Quantity Market Share by Country (2021-2032)

Figure 76. South America Protactinium-231 Consumption Value Market Share by Country (2021-2032)

Figure 77. Brazil Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 78. Argentina Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 79. Middle East & Africa Protactinium-231 Sales Quantity Market Share by Type (2021-2032)

Figure 80. Middle East & Africa Protactinium-231 Sales Quantity Market Share by Application (2021-2032)

Figure 81. Middle East & Africa Protactinium-231 Sales Quantity Market Share by Country (2021-2032)

Figure 82. Middle East & Africa Protactinium-231 Consumption Value Market Share by Country (2021-2032)

Figure 83. Turkey Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 84. Egypt Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 85. Saudi Arabia Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 86. South Africa Protactinium-231 Consumption Value (2021-2032) & (USD Million)

Figure 87. Protactinium-231 Market Drivers

Figure 88. Protactinium-231 Market Restraints

Figure 89. Protactinium-231 Market Trends

Figure 90. Porters Five Forces Analysis

Figure 91. Manufacturing Cost Structure Analysis of Protactinium-231 in 2025

Figure 92. Manufacturing Process Analysis of Protactinium-231

Figure 93. Protactinium-231 Industrial Chain

Figure 94. Sales Channel: Direct to End-User vs Distributors

Figure 95. Direct Channel Pros & Cons

Figure 96. Indirect Channel Pros & Cons

Figure 97. Methodology

Figure 98. Research Process and Data Source

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